

imc CRONOS

Manual

Edition 12 - 2023-10-24



imc CRONOScompact (CRC)



imc CRONOSflex (CRFX)



imc CRONOS-XT (CRXT)

Disclaimer of liability

The contents of this documentation have been carefully checked for consistency with the hardware and software systems described. Nevertheless, it is impossible to completely rule out inconsistencies, so that we decline to offer any guarantee of total conformity.

We reserve the right to make technical modifications of the systems.

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The software described in this document may only be used in accordance with the provisions of the "imc Software License Agreement".

Open Source Software Licenses

Some components of imc products use software which is licensed under the GNU General Public License (GPL). Details are available in the About dialog.

A list of the open source software licenses for the imc measurement devices is located on the imc STUDIO/imc WAVE/imc STUDIO Monitor installation medium in the folder "Products\imc DEVICES\OSS" or "Products\imc STUDIO\OSS". If you wish to receive a copy of the GPL sources used, please contact our Hotline.

Notes regarding this document

This document provides important notes on using the device / the module. Safe working is conditional on compliance with all safety measures and instructions provided. The manual is to be used as a kind of reference book. You can skip the description of the modules you do not have.

Additionally, all accident prevention and general safety regulations pertinent to the location at which the device is used must be adhered to.

These instructions exclusively describe the device, **not how to operate** it by means of **the software**!

If you have any questions as to whether you can set up the device / module in the intended environment, please contact the imc hotline. The measurement system has been designed, manufactured and unit-tested with all due care and in accordance with the safety regulations before delivery and has left the factory in perfect condition. In order to maintain this condition and to ensure safe operation, the user must observe the notes and warnings contained in this chapter and in the specific sections applicable to the concrete device. Never use the device outside the specification.

This will protect you and prevent damage to the device.

Special notes



Warning

Warnings contain information that must be observed to protect the user from harm or to prevent damage to property.



Note

Notes denote useful additional information on a particular topic.



Reference

A reference in this document is a reference in the text to another text passage.

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1 General introduction

1.1 imc Customer Support / Hotline

If you have problems or questions, please contact our Customer Support/Hotline:

imc Test & Measurement GmbH

Hotline (Germany): +49 30 467090-26

E-Mail: hotline@imc-tm.de

Internet: https://www.imc-tm.com

International partners

For our international partners see https://www.imc-tm.com/imc-worldwide/.

Tip for ensuring quick processing of your questions:

If you contact us **you would help us**, if you know the **serial number of your devices** and the **version info of the software**. This documentation should also be on hand.

- The device's serial number appears on the nameplate.
- The program version designation is available in the About-Dialog.

1.2 Legal notices

Quality Management



imc Test & Measurement GmbH holds DIN-EN-ISO-9001 certification since May 1995. You can download the CE Certification, current certificates and information about the imc quality system on our website: https://www.imc-tm.com/quality-assurance/.

imc Warranty

Subject to the general terms and conditions of imc Test & Measurement GmbH.

Liability restrictions

All specifications and notes in this document are subject to applicable standards and regulations, and reflect the state of the art well as accumulated years of knowledge and experience. The contents of this document have been carefully checked for consistency with the hardware and the software systems described. Nevertheless, it is impossible to completely rule out inconsistencies, so that we decline to offer any guarantee of total conformity. We reserve the right to make technical modifications of the systems.

The manufacturer declines any liability for damage arising from:

- failure to comply with the provided documentation,
- inappropriate use of the equipment.

Please note that all properties described refer to a closed measurement system and not to its individual slices. A liability claim requires particularly careful handling of the unprotected individual slices (e.g. CRXT slices).

Legal notices Chapter 1

Guarantee

Each device is subjected to a 24-hour "burn-in" before leaving imc. This procedure is capable of detecting almost all cases of early failure. This does not, however, guarantee that a component will not fail after longer operation. Therefore, all imc devices are granted liability for a period of two years. The condition for this guarantee is that no alterations or modifications have been made to the device by the customer.

Unauthorized intervention in the device renders the guarantee null and void.

Notes on radio interference suppression

Devices of the imc CRONOS system family satisfy the EMC requirements for an use in industrial settings.

Any additional products connected to the product must satisfy the EMC requirements as specified by the responsible authority (within Europe¹) in Germany the BNetzA - "Bundesnetzagentur" (formerly BMPT-Vfg. No. 1046/84 or No. 243/91) or EC Guidelines 2014/30/EU. All products which satisfy these requirements must be appropriately marked by the manufacturer or display the CE certification marking.

Products not satisfying these requirements may only be used with special approval of the regulating body in the country where operated.

All lines connected to the devices of the imc CRONOS system family should not be longer than 30 m and they should be shielded and the shielding must be grounded.



Note

The EMC tests were carried out using shielded and grounded input and output cables with the exception of the power cord. Observe this condition when designing your setup to ensure high interference immunity and low jamming.

Cables and leads

In order to comply with the value limits applicable to Class B devices according to part 15 of the FCC regulations, all signal leads connected to devices of the imc CRONOS system family must be shielded.

Unless otherwise indicated, no connection leads may be long leads (< 30 m) as defined by the standard IEC 61326-1. LAN-cables (RJ 45) and CAN-Bus cables (DSUB-9) are excepted from this rule.

Only cables with suitable properties for the task (e.g. isolation for protection against electric shock) may be used.

ElektroG, RoHS, WEEE, CE

The imc Test & Measurement GmbH is registered with the authority as follows: **WEEE Reg. No. DE 43368136**

valid from 24.11.2005



Reference

https://www.imc-tm.com/elekrog-rohs-weee/ and https://www.imc-tm.com/ce-conformity/

¹ If you are located outside Europe, please refer the appropriate EMC standards used in the country of operation.

Legal notices Chapter 1

FCC-Notice

This product has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment on and off, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult our imc Hotline or an experienced technician for help.

Modifications

The FCC requires the user to be notified that any changes or modifications made to this product that are not expressly approved by imc may void the user's authority to operate this equipment.

Explanation of symbols Chapter 1

1.3 Explanation of symbols



CE Conformity

see CE chapter 1.2 6



No household waste

Please do not dispose of the electrical/electronic device with household waste, but at the appropriate collection points for electrical waste, see also chapter 1.2 6.



Potential compensation

Connection for potential compensation



Grounding

Connection for grounding (general, without protective function)



Protective connection

Connection for the protective conductor or grounding with protective function



Attention! General danger zone!

This symbol indicates a dangerous situation;

Since there is insufficient space for indicating the rated quantity at the measuring inputs, refer to this manual for the rated quantities of the measuring inputs before operation.



Attention! Injuries from hot surfaces!

Surfaces whose temperatures can exceed the limits under certain circumstances are denoted by the symbol shown at left.



ESD-sensitive components (device/connector)

When handling unprotected circuit boards, take suitable measures to protect against ESD (e.g. insert/remove ACC/CANFT-RESET).



Possibility of electric shock

The warning generally refers to high measurement voltages or signals at high potentials and is located on devices suitable for such measurements. The device itself does not generate dangerous voltages.



DC, Direct Current

Supply of the device via a DC voltage source (in the specified voltage range)

Explanation of symbols Chapter 1



RoHS of the PR China

The limits for hazardous substances in electrical/electronic equipment applicable in the PRC are identical to those in the EU. The restrictions are complied with (see chapter 1.2 (a)). A corresponding "China-RoHS" label is omitted for formal/economic reasons. Instead, the number in the symbol indicates the number of years in which no hazardous substances are released. (This is guaranteed by the absence of named substances).



Labeling integrated energy sources

UxxRxx are integrated in the symbolism. "U" stands for the installed UPS energy sources, if 0 = not installed. "R" stands for the installed RTC energy sources, if 0 = not installed. You can download the corresponding data sheets from the imc website: https://www.imc-tm.com/about-imc/quality-assurance/transport-instructions/



Observe the documentation

Read the documentation before starting work and/or operating.

1.4 Last changes in content

Please help us to improve our documentation:

- Which terms or descriptions are incomprehensible?
- What additions and enhancements you suggest?
- Where have material mistakes slipped in?
- Which spelling, translation or typing errors have you found?

Responses and other feedback should be directed to the Hotline.

Amendments and bug-fix in manual edition 11

Chapter	Amendment		
Device overview	new imc measurement devices added: imc ARGUSfit		
EtherCAT	FAQ concerning transmission of Power over EtherCAT added		
UNI2-8 208	In the drawing, the screw terminal number for ±IN was wrong.		

Amendments and bug-fix in manual edition 10

Chapter	Amendment
Symbols	Missing symbols added in chapter "Explanation of symbols".
Connecting via LAN	The dialog for configuring the IP address of the device also provides the IP address of the PC. Thus, the first step was removed from the documentation, which presented different possibilities in Windows to determine the IP address.
Technical specs	We added a general introduction to this chapter.

2 Safety

This section provides an overview of all important aspects of protection of the users for reliable and trouble-free operation. Failure to comply with the instructions and protection notes provided here can result in serious danger.

imc CRONOS-XT may only be operated as a completely closed system.

Responsibility of the operator

Devices of the imc CRONOS system family are for use in commercial applications. The user is therefore obligated to comply with legal regulations for work safety.

Along with the work safety procedures described in this document, the user must also conform to regulations for safety, accident prevention and environmental protection which apply to the work site. If the product is not used in a manner specified by the manufacturer, the protection supported by the product may be impaired.

The user must also ensure that any personnel assisting in the use of the devices of the imc CRONOS system family have also read and understood the content of this document.

Operating personnel

This document identifies the following qualifications for various fields of activity:

- Users of measurement engineering: Fundamentals of measurement engineering. Basic knowledge of electrical engineering is recommended. Familiarity with computers and the Microsoft Windows operating system. Users must not open or structurally modify the measurement device.
- Qualified personnel are able, due to training in the field and to possession of skills, experience and familiarity with the relevant regulations, to perform work assigned while independently recognizing any hazards.

Warning

- Danger of injury due to inadequate qualifications!
- Improper handling may lead to serious damage to personnel and property. When in doubt, consult qualified personnel.
- Work which may only be performed by trained imc personnel may not be performed by the user. Any
 exceptions are subject to prior consultation with the manufacturer and are conditional on having
 obtained corresponding training.

Special hazards

This segment states what residual dangers have been identified by the hazard analysis. Observe the safety notes listed here and the warnings appearing in subsequent chapters of this manual in order to reduce health risks and to avoid dangerous situations. Existing ventilation slits on the sides of the device must be kept free to prevent heat accumulation inside the device. Please operate the device only in the intended position of use if so specified.



Danger



Lethal danger from electric current!

- Contact with conducting parts is associated with immediate lethal danger.
- Damage to the insulation or to individual components can be lethally dangerous.

Therefore:

- In case of damage to the insulation, immediately cut off the power supply and have repair performed.
- Work on the electrical equipment must be performed exclusively by expert electricians.
- During all work performed on the electrical equipment, it must be deactivated and tested for static potential.

Injuries from hot surfaces!



• Devices from imc are designed so that their surface temperatures do not exceed limits stipulated in EN 61010-1 under normal conditions.

Therefore:

• Surfaces whose temperature can exceed the limits under circumstances are denoted by the symbol shown at left.

The click mechanism allows CRFX- or CRXT slices to be quickly connected and disconnected. The click connections should always be secured to prevent unintentional unlocking.

In a wet environment, even low voltages can lead to dangerous flow through the body. For this reason, assemble the CRXT modules with special care, ensuring that the seals are clean and greased (e.g. with Vaseline) and use the supplied connecting elements. In a wet environment, no special modules with a protection degree lower than IP67 may be used.

Industrial safety

We certify that imc CRONOS systems in all product configuration options corresponding to this documentation conforms to the directives in the accident prevention regulations in "Electric Installations and Industrial Equipment" (DGUV Regulation 3)*. This confirmation applies exclusively to devices of the imc CRONOS system family, but not to all other components included in the scope of delivery.

This certification has the sole purpose of releasing imc from the obligation to have the electrical equipment tested prior to first use (§ 5 Sec. 1, 4 of DGUV Regulation 3). This does not affect guarantee and liability regulations of the civil code.

For repeat tests, a test voltage that is 1.5 times the specified working voltage should be used to test the isolation for the highly isolated inputs (e.g. measurement inputs for high-voltage applications).

* previously BGV A3.

Observe notes and warnings

Devices from imc have been carefully designed, assembled and routinely tested in accordance with the safety regulations specified in the included certificate of conformity and has left imc in perfect operating condition. To maintain this condition and to ensure continued danger-free operation, the user should pay particular attention to the remarks and warnings made in this chapter. In this way, you protect yourself and prevent the device from being damaged.

Read this document before turning on the device for the first time carefully.



Warning

Before touching the device sockets and the lines connected to them, make sure static electricity is diverted to ground. Damage arising from electrostatic discharge is not covered by the warranty.

After unpacking... Chapter 3

3 Assembly and connection

3.1 After unpacking...

Check the delivered system immediately upon receiving it for completeness and for possible transport damage. In case of damage visible from outside, proceed as follows:

- Do not accept the delivery or only accept it with reservations
- Note the extent of the damage on the packing documents or on the delivery service's packing list.
- Begin the claims process.

Please check the device for mechanical damage and/ or loose parts after unpacking it. The supplier must be notified immediately of any transportation damage! Do not operate a damaged device!

Check that the list of accessories is complete:

- AC/DC-power adaptor (not for racks) with cable and pre-assembled plug
- Getting started with your imc measurement device (printed)



Note

File a claim about every fault as soon as it is detected. Claims for damages can only be honored within the stated claims period.

3.2 Before commissioning

If components are brought into the operating room from a cold environment, condensation may occur. Wait until the CRXT slices are adapted to the ambient temperature and absolutely dry before clicking them together to form a system.

The click mechanism allows CRFX- or CRXT slices to be quickly connected and disconnected. The click connections should always be secured to prevent unintentional unlocking.

Good radiation and convection conditions must be ensured to prevent heat build-up inside the device. The devices must not be operated if there is a danger of explosion or if they are exposed to aggressive chemicals.

Existing ventilation slits (e.g. CRFX modules) must be kept unimpeded to avoid heat buildup in the device interior.

Ambient temperature

The limits of the ambient temperature cannot be strictly specified because they depend on many factors of the specific application and environment, such as air flow/convection, heat radiation balance in the environment, contamination of the housing / contact with media, mounting structure, system configuration, connected cables, operating mode, etc. This is taken into account by specifying the operating temperature instead. Furthermore, it is not possible to predict any sharp limits for electronic components. Basically, reliability decreases when operating under extreme conditions (forced ageing). The operating temperature data represent the extreme limits at which the function of all components can still be guaranteed.

3.3 Notes on connecting

3.3.1 Precautions for operation

Certain ground rules for operating the system, aside from reasonable safety measures, must be observed to prevent danger to the user, third parties, the device itself and the measurement object. These are the use of the system in conformity to its design, and the refraining from altering the system, since possible later users may not be properly informed and may ill-advisedly rely on the precision and safety promised by the manufacturer.



Note

If you determine that the device cannot be operated in a non-dangerous manner, then the device is to be immediately taken out of operation and protected from unintentional use. Taking this action is justified under any of the following conditions:

- the device is visibly damaged,
- loosed parts can be heard within the device,
- the device does not work,
- the device has been stored for a long period of time under unfavorable conditions (e.g. outdoors or in high-humidity environments).
- 1. Observe the specs in the chapter "Technical Specs 295" and the application hints about the individual system in order to prevent damage to the unit through inappropriate signal connection.
- 2. Note when designing your experiments that all input and output leads must be provided with shielding which is connected to the ground ("CHASSIS") at one end in order to ensure high resistance to interference and noisy transmission.
- 3. Unused, open channels (having no defined signal) should not be configured with sensitive input ranges since otherwise the measurement data could be affected. Configure unused channels with a broad input range or short them out. The same applies to channels not configured as active.
- 4. To measure voltages >60 V use adequate plug.
- 5. In case you are using a removable storage medium, please be aware that before you remove it (if the device is switched on), the button (1) must be pressed to ensure that storage medium can be safely removed. Please read the instructions in the chapter "removable storage".
- 6. Be aware that during a running measurement, modules should not be disconnected from the system (hot plug functionality is not supported during a running measurement).
- 7. Avoid prolonged exposure of the device to sunlight.
- 8. Make sure that there is sufficient space at the ventilation slits.
- 9. Note that parts that are not explicitly intended to be carried may be warmer than the handles.

For CRFX, the following also applies:

The use of handles is mandatory for safe use. In the event of deviations, other suitable methods must be used to ensure acceptable protection against burns. Under normal conditions, the surface temperature of the enclosure/housing does not exceed the limits for accidental contact according to IEC 61010-1. The handles also prevent the lateral plug contacts from being touched during a measurement, thus preventing accidental discharge (ESD) into the lateral plug contacts. ESD in the lateral plug contacts can lead to a crash of a running measurement (destruction does not take place).



With CRXT the following applies:

With CRXT, operation without handles is not permitted.

The CRXT device may only be disassembled into its slices in a controlled environment and must also be clicked together to form a closed CRXT device in a controlled environment. Only complete (closed) CRXT devices may be used in a non-controlled environment.

For the correct use of the imc click mechanism please observe to the instructions in the chapter "CRXT Attachment mechanism". The rubber seals must be clean before connecting CRXT modules together.

3.3.2 Potential difference with synchronized devices

When using multiple devices connected via the **SYNC socket** for synchronization purposes, ensure that all devices are at the same voltage level.



Note

The yellow ring on the SYNC socket indicates that the socket is shielded from voltage differences.

3.3.3 Fuses (polarity-inversion protection)

The supply input of all devices listed in this manual is provided with a maintenance-free reverse polarity protection.



Reference

In the chapter "Technical Specs" you will find information on the fuse or the overcurrent limitation of the individual devices, if applicable.

The supply voltage for external sensors wired out from the voltage channels is equipped with maintenance-free electronic fuses (current-limiters).

The incremental counter channels provide a supply voltage for external sensors, which is not protected and should be provided with an external fuse in order to be used!

3.3.4 Start of operation CRFX

3.3.4.1 Networking and power supply

All of the system's individual building blocks, both the imc CRONOSflex base unit and also each individual imc CRONOSflex measurement module, have their own LEMO sockets for an ultra-wide 10 to 50 V range of DC power input; additionally, each have two RJ45 network jacks (IN/OUT) for connecting the EtherCAT system bus. Both lines have robust connection terminals which provide both mechanical attachment to modules (locking snap) and electrical connection without any additional cables. By this means, multiple directly attached modules can be jointly powered by a single DC source which is always connected at the "far left" or "first"

module 2. If multiple power sources are accidentally connected to the same block of modules, then a latch circuit ensures that only the first module on the left receives the power.

With the **introduction of the 48 VDC power adaptor** for the imc CRONOS*flex* system (CRFX base unit and the CRFX input modules), the power supply socket on the device has been changed so that the 48 VDC power adaptor can only be used with imc CRONOS*flex* systems and not with other imc measurement devices with an input supply voltage of 10..32 VDC. You can identify the 48 VDC power adaptor at the **blue protective sleeve** at the LEMO.1B plug (LEMO.PHG.1B.302), see the following Fig. 18 The 15 VDC or the 24 VDC power adaptors are equipped with a **black protective sleeve** at the LEMO.1B plug and can also be used with imc CRONOS*flex* systems. The use of those power adaptors with imc CRONOS*flex* is not recommended. The imc CRONOS*flex* system have an input supply voltage range of 10 .. 50 VDC. The DC-supply inputs of our imc measurement devices are not designed for a connection to a DC-grid.



Note

The +pin is marked with a red dot!



input power supply socket LEMO.1B (female) for a connection with 24 VDC power adaptor (1 guide notch, LEMO.EGG.1B.302)



input power supply socket LEMO.1B (female) for a connection with 48 VDC power adaptor (2 guide notches, LEMO.EGE.1B.302)

			plug-type (female):		
			LEMO.EGG.1B	LEMO.EGE.1B	
			1 coding notch	2 coding notches	
			up to 8/2011	as of 9/2011	
plug-type (male):		power adaptor:			
LEMO.FGG.1B	1 coding key	15 V, 24 V	fit	fit	
LEMO.FGE.1B	2 coding keys	48 V	fits only with ACC/FGG-ADAP-PHE	fit	

If the imc CRONOSflex base unit runs with 48 VDC power supply rather than the 24 VDC power supply, it is possible to operate a larger number of modules or a module with more power consumption directly with one power adaptor. The power consumption of the modules can be as high as 149 W with a 48 VDC power supply. If you want to benefit of the Power over EtherCAT (PoEC) function a minimum voltage of 42 VDC is necessary.

For all previously delivered imc CRONOS flex systems with the LEMO.EGG.1B power supply socket (with one guide keyway), to be powered in future with 48 VDC, use the adaptor cable "CRFX adaptor cable for the supply LEMO.1B (article number: 13500151, order code: ACC/FGG-ADAP-PHE)" and the 48 VDC power adaptor.





Note

This adaptor cable may only be used with imc CRONOS flex. For devices with the 10..32 VDC input voltage range (imc C-SERIES, imc SPARTAN, ...), use of this adaptor cable and the 48 VDC power unit can damage or destroy the devices.



All imc CRONOSflex base units and Input Modules having the changed power supply plug can be continued to be powered with the 24 VDC power adaptor (without adaptor cable).

power adaptor 48 V up to 150 W (with blue protective sleeve at the plug) article no. 13500148



Reference

imc CRONOS-XT

The imc CRONOS-XT description can be found in the following chapter: imc CRONOS-XT of

3.3.4.2 Main switch

The imc CRONOSflex base unit has a central main switch by which the complete block of directly clicked (stacked) modules is activated/deactivated. Independently powered, spatially distributed modules and subsystems (blocks) are activated/deactivated directly via their power supply connections.

3.3.4.2.1 Remote control of the main switch

As an alternative to the manual main switch on the device's front panel, a remote-controllable electric contact can be used to switch the device on and off. The socket designated "REMOTE" provides this contact: connecting the signals "SWITCH" and "ON" switches the device on, connecting "SWITCH" to "OFF" switches the device off. Any switch or relay contact used for this purpose must be able to bear a current of approx. 50 mA at $10~\Omega$ max. The reference voltage for these signals is the primary voltage supply.

The signal "SWITCH1" serves to run the device with the switch permanently bridged: when "ON" and "SWITCH1" are connected, the device starts as soon as an external supply voltage is provided.

If this supply is interrupted, an internal buffer keeps the **base unit** activated for the appropriate buffer duration in order to close the measurement and files, and then the device deactivates itself. This type of operation is specially designed for use in a vehicle, permanently couples to the ignition and not requiring manual control. Pinout: LEMO.1B.306 socket

Short description of the signal:

Signal	Function	Connection	Remarks
SWITCH	switch signal / reference	connect to ON / OFF	Power up from internal battery is supported!
SWITCH1	activation only from external power supply	connect to ON / OFF	static, permanently jumpered: for automatic activation upon application of an external supply

Chapter 3 Notes on connecting

3.3.4.3 Power over EtherCAT (PoEC)

imc CRONOSflex Modules are compatible with Power over EtherCAT (PoEC), meaning they can receive power completely from the EtherCAT connection cable and consequently no longer need their own power supply line. This is especially attractive for decentralized satellite modules positioned somewhere remote and inaccessible, and having no other outside line than the CAT5 cable. Thus, centrally remote-controlled activation/deactivation of these satellites is achievable by means of PoEC.

3.3.4.4 Saving data in case of power outage

In case of an outage or interruption of the system's DC power supply, an internal buffer battery in the base unit ensures that any running measurement is ended in a controlled manner, that all measured data are safely transferred to the internal data storage and that the associated files are correctly closed. This procedure can take up to several seconds. Subsequently, the system shuts down automatically.

The standard-equipped system's internal supply buffering extends to the base unit, not the imc CRONOSflex Modules which are either directly stacked or connected by cable, and is provided for the purpose of preserving the data integrity under any conceivable operating circumstances.

Additional buffering for the entire system, including the imc CRONOSflex Modules, so as to ensure uninterrupted measurement operation even during phases of power failure, is also possible in conjunction with the optional UPS supply module which comes with the carrying handle. This makes mobile battery operation possible, or even bridge over power during vehicle starting processes. With UPS operation of this type, it is possible to set a so-called "buffer time": this time period specifies after how long a continuing power outage is no longer to be backed up, and thus when closure of the measurement and automatic deactivation are to be initiated.

3.3.4.5 Stabilized device supply and UPS (Power Handle)

Comprehensive systems with correspondingly high performance requirements can, in conjunction with low supply voltage and thus a high resulting current (e.g. 12 V in a vehicle), exceed the amperage capacity of the module terminal connections (max. 3.1 A). For this reason the possibility is provided to equip the left carrying handle with an optional supply unit, which generates a constant high system supply voltage of 50 V at max. 100 W from the 10 V to 50 V wide range supply voltage.



Power Handle

This not only makes it possible to reliably supply very large systems, but also to use the measurement modules' PoEC capabilities across the entire wide voltage supply range: according to PoEC specs, for PoEC functionality a minimum supply voltage of 42 V on the network line is required. This is provided by the supply unit in the handle for the entire 10 V to 50 V range. The optional handle 25 can additionally be equipped with a UPS function to ensure the device's operation even during a power outage. UPS units are available with a choice of either lead or Li-ion batteries.

3.3.4.6 Isolation and grounding concept

3.3.4.6.1 Isolation

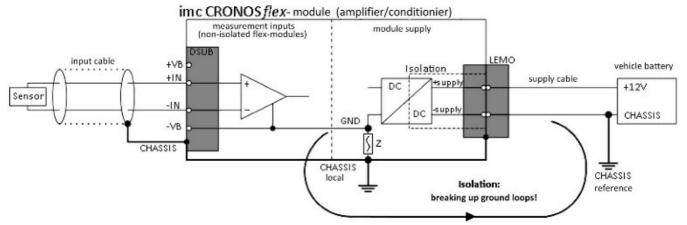
The imc CRONOSflex Modules' supply inputs are each isolated from the frame (CHASSIS) and measurement electronics. This ensures in particular that in spatially distributed systems, where no common CHASSIS or ground voltage for all subsystems can be assumed, neither uncontrolled ground loops nor compensation currents occur. Neither the base unit's supply input, nor the voltage it supplies to the measurement modules, is isolated. In a distributed system, therefore, the base-system's housing (CHASSIS), and the directly connected amplifiers, as well as their supply voltage level are to be seen as the central reference voltage (neutral point), to which the distributed satellites and their respective frames and supply voltages may each have a voltage differential. For the purpose of controlled grounding, each of the imc CRONOSflex Modules has a dedicated grounding contact on the lower part of its front panel.

Since the various housing frames and their reference grounds have a connection to the network cables via the shielding, it may be necessary to use network cables whose shielding has contact on only one side. In especially demanding applications, such as installation on board rail vehicles, where high static as well as dynamic ground differentials can exist across the various wagons, it is also possible to use fiber optic network converters for a pure optic EtherCAT system bus connection. Appropriate mechanically integrated converter modules for CRONOS flex are in preparation.

Concerning the isolation of imc CRONOS flex Measurement Modules' electronics from their respective frames, there are different options: modules both with isolated measurement inputs (e.g. ISO2-8) and without isolated measurement inputs (e.g. UNI2-8) are available.

3.3.4.6.2 Grounding concept

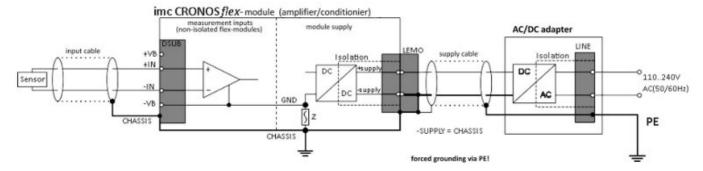
Isolated power inputs avoids ground loops in distributed topologies



Z describes a high-impedance connection that capacitively short-circuits RF interference.

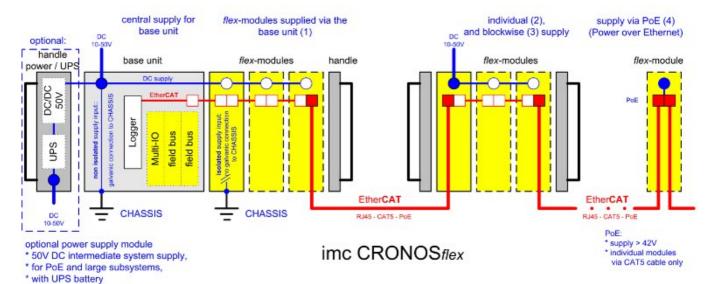
With stationary installations and the use of (already isolated) AC/DC adaptors, any system ground differentials between the device and the central or local power supplies may not be relevant. The big issue in such a case, in contrast to mobile, in-vehicle applications, is from where to obtain a reliable ground voltage. Since it is convenient to use the AC power supply's protection ground line as the ground voltage, the LEMO-terminated AC/DC adaptors for imc CRONOS measurement devices are designed so that the protection ground line is connected all the way through to the LEMO plug's housing, thus securing the device's voltage level to protection ground. Additionally, in the AC/DC-adaptor's LEMO-terminal (not the device's LEMO-socket!), the reference ground of the power adaptor is connected with the housing's (CHASSIS) protection ground: Since the AC/DC power adaptor is already isolating, as is the power input, this supply voltage's reference would not initially be defined and can be set arbitrarily. In particular for reasons of suppressing HF (high-frequency) interference signals stemming from the AC/DC switching power adaptor, direct grounding is normally advisable.

Forced grounding via the AC/DC adaptor's safety ground



3.3.4.7 Power supply options (CRFX)

3.3.4.7.1 Overview of power supply options



(1) via the imc CRONOSflex base unit

- for modules directly attached to the base unit
- multiple measurement modules operable at one base unit
- activation/deactivation via central main switch on the base unit
- in particular with low supply voltage and (12 V) and high resulting current, the plugs' maximum current carrying capacity (3.1 A) must be taken into account, which can limit the maximum size of a module block powered in common: max. 37.2 W (12 V)
- an optional supply module in the leftmost carrying handle ensures a common power supply for any size of blocks by providing a constant voltage of 50 V at max. 100 W for any input voltage between 10 to 50 V

(2) individual power supply

- for modules which are connected by CAT5 network cables across a wide area
- 10 V to 50 V DC via LEMO.1B socket
- activation/deactivation by connection of the power supply

(3) joint supply of a module substack

- a block can consist of: a base unit with signal conditioners, a block of purely signal conditioners and/or a block with a power supply module (the Power Handle)
- The power supply for stacked modules must always come via the LEMO-socket through the outer left module (looking at the conditioner terminals, the display and model plaque are on the left), the LEMO terminals of the other modules are then disconnected. A module's LEMO-socket is always deactivated whenever its neighbor to the left is directly connected via a module's plug-in connector. For the supply of the leftmost module within a block, the actual voltage is the higher of either the voltage applied to the LEMO or the voltage passing through the previous block's patch cable.
- activation/deactivation by connection of the power supply
- The maximum block-size depends on how high the supply voltage is (see above).

(4) via the Ethernet network cable

according Power over EtherCAT (PoEC)

- PoEC supply is also supported for multiple modules each connected via CAT5 network cables, however not for module substacks
 - Maximum: 350 mA, corresponding to PoEC power: 16.8 W (48 V) or 17.5 W (50 V)
- activation/deactivation via power supplying module, e.g. central main switch on Base Unit
- minimum supply voltage of the module fed via network cable (base unit or measurement module): 42 V DC (e.g. optional AC/DC power adaptor with 48 V)
- An optional supply module in the left handle provides a constant voltage of 50 V adequate for PoEC, for any input voltages of 10 V to 50 V.
- Standard 230 V AC adaptor for PoEC can be used

3.3.4.7.2 Rules governing supply configurations

For the supply of imc CRONOS flex Modules (CRFX) via the LEMO socket, the modules' plug-in (clicking) connectors, or via PoEC, the following rules apply:

- current limit of module plug-in connectors: 3.1 A
- current limit for PoEC via network cable: 350 mA
- The PoEC supply lines are conducted via RJ45, but not via the module connector.
- The local supply for a stacked block of directly connected imc CRONOSflex Modules always comes from the leftmost module's LEMO socket: pin-encoding on the module connector distinguishes which neighboring module is connected "on the left" and blocks the module's own LEMO supply connection.
- A block's leftmost module obtains its power either from its LEMO terminal (which is connected in all cases) or from the voltage at the network cable's (RJ45 network cable's) PoEC line, whichever voltage is greater.

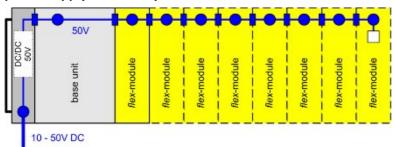
As a result, there are a number of different typical application topologies, presented below. The diagrams used employ the following symbols:

_	PoEC Power-connection	_	LEMO Power-connection	Power supplied via module connector (click)
	module supplied via PoEC (RJ45)		module supplied via LEMO	, ,
	module not supplied via PoEC	0	module not supplied via LEMO	LEMO feeding the PoEC connection (RJ45)

3.3.4.7.3 Directly stacked modules

imc CRONOSflex Modules can be stacked directly using a click-mechanism, thus not requiring extra power supply or cabling. Any signal conditioning modules directly connected to a base unit are jointly activated/deactivated by the base units main switch.

Directly connected imc CRONOS*flex* Modules with extra device power supply: stacked by "click"-mechanism



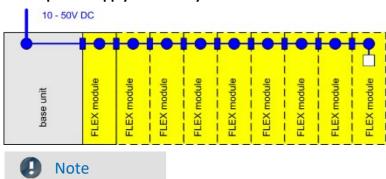
The current-carrying limit on the Module connector also limits the amount of signal conditioning modules which can be stacked directly. The higher the supply voltage is set, the less this limit matters, since the modules' (constant) power consumption leads to correspondingly low currents. The optional supplemental supply unit will convert the 10 V to 50 V input voltage to a fixed intermediate circuit voltage of 50 V at max. 100 W.

Thus, using the supplemental supply unit is the recommended configuration, especially in applications where only low voltage power supply is available (12 V vehicle) and extensive, primarily centrally-concentrated systems are set up.

If the supplemental supply is not used, then the wide-range (10 V to 50 V) rated supply voltage is used to power the modules, which means that at low voltages and correspondingly high currents there may be a maximum size for directly stacked module blocks to observe. However, this constraint by no means applies to the overall system, only to stacked blocks!

A distributed system of multiple, separately powered module blocks connected to each other by network cable is an easy way to circumvent any block-size limitation.

Directly connected imc CRONOSflex Modules without extra device power supply: stacked by "click"-mechanism



Make sure that the overall power consumption does not pass the available power consumption.



Example

For 24 V, the maximum size of a block is 6 to 11 modules, depending on the module type. For a supply voltage of 12 V (vehicle battery), the limit is about 3 to 5. For each satellite block consisting only of signal conditioners without a base unit, one additional module is allowed, since the first connection carried by the plug-in connector is to the second module.

3.3.4.7.4 Overall system consisting of multiple blocks

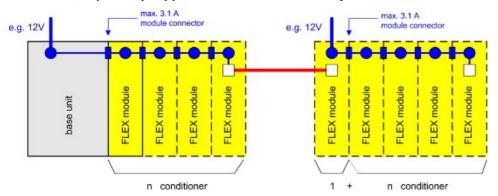
For various reasons, it may be desirable or necessary to divide up a large block into multiple smaller blocks or even individual modules:



Example

- widely spaced placement in remote locations
- splitting up an unwieldy block into multiple (for instance, stacked) blocks at one central location
- the module connector's current limit (3.1 A) for a contiguous block has been reached, especially in the case of low DC supply voltage (e.g. 12 V in a car)
- the power limit of a DC supply source, for instance, a 60 W AC/DC adaptor has been reached

Distributed, separately supplied blocks of imc CRONOSflex Modules



Separately powered individual signal conditioners or conditioner blocks are activated/deactivated by connecting their respective supply voltage. They are not coupled to the base unit's global main switch.

The exact power data for the various conditioner types, and their resulting maximum count of directly stacked modules, appear in the detailed technical specs or in <u>overview table last</u>. Otherwise, a convenient, interactive "Configurator" based on MS Excel is available, with which it is easily possible to check the supply needs and limits of any system topology.

The current at the module connector is prevented from exceeding the current limit by fuses (PTC). The trigger threshold for these fuses is temperature-dependent, and designed that even at maximum temperature, the rated current can be delivered reliably. For this reason, the trigger thresholds at lower temperatures or before the system is fully warmed up are typically higher. In case of overload, any directly connected conditioners are electrically disconnected, but not the base unit providing power, since its supply current is not carried by the module connectors.

3.3.4.7.5 Supplemental device power supply (Power Handle)

In order to provide adequate reserve power for any new modules attached, as well as sufficiently high voltage for PoEC operation, the optional power supply module Power Handle is available. As a DC/DC converter, it generates from an input voltage of 10 to 50V a constant, stabilized 50V supply able to power a large block of modules or a complete system.

The central main switch of the connected base unit also indirectly controls the activation/deactivation of the supplemental supply power. The Power Handle does not have a separate pushbutton for activation/deactivation, but instead it has a (LEMO) Remote terminal.

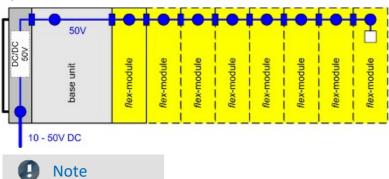
Remotely controlling the main switch of the system's supplemental power supply

As an alternative to manual activation and deactivation by means of the directly attached base unit's main switch, there is another controllable contact available for use at the socket designated "REMOTE". The Remote-Switch contacts respond similarly to the green push button on the base unit: Briefly connecting the signals "SWITCH" and "ON" activates the device, while connecting "SWITCH" with "OFF" deactivates it. Any button or relay contact used for this purpose must be able to conduct approx. 50 mA of current at max. 10 modules. The reference voltage for these signals is the primary power supply.

The signal "SWITCH1" serves to run the device with the switch continuously bridged: When "ON" and "SWITCH1" are connected, the device starts as soon as the external supply voltage is applied. If there is an outage of the supply voltage, the overall device's internal buffering is active for the duration of the buffer time constant set, and then switches off automatically. This operation mode is particularly designed for in-vehicle use, with fixed coupling with the ignition, and without manual control.

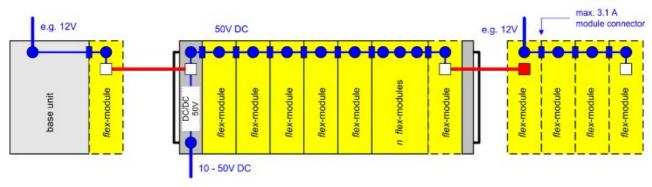
The additional contact "MUTE" (6) serves the purpose of muting the internal buzzer if necessary, by bridging the voltage to the reference voltage (5). The buzzer beeps to indicate that the external main power supply has failed and that the system is currently running on the internal buffer battery. This is very helpful for monitoring purposes, but can cause annoyance if acoustics measurements are involved. The beeping only begins 10 sec before elapse of the buffer time constant, meaning "soon" before the impending forced deactivation and (as of Revision 2 of the modules) can be completely suppressed by means of the MUTE signal. Before that, or in cases when longer time constants are set, reflecting typical applications of independent battery power, the beeping is suppressed as a rule, since it is usually not desired (similarly to a battery-powered Notebook).

Supplemental device power supply (CRFX-HANDLE-POWER) for system power supply by means of 50 V intermediate circuit



Make sure that the overall power consumption does not pass the available power consumption.

Supplemental device power supply for remotely installed conditioner block



In conjunction with the supplemental power supply, a block only of conditioners can be activated not only by connecting the local power supply, but remote activation can be achieved by means of the connecting network cable. This means that this isolated island of modules can also be switched on/off by the base unit's main switch. However, this only applies to contiguous blocks powered by the supplemental supply.

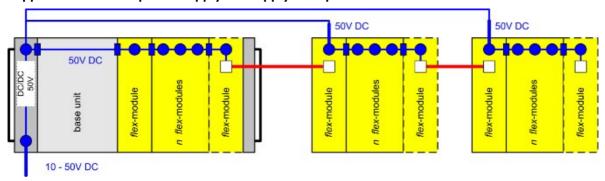
When the supplemental supply is used and a large block is subdivided into multiple smaller blocks which are each to be supplied separately, then it depends on the size of these blocks whether they can be directly run on lower supply voltage (smaller blocks), or whether (in the case of larger blocks) they require higher voltage. In such cases, multiple parallel 50V output socket on the supply unit makes it possible to use them to supply additional satellite blocks with five 4-pin LEMO sockets on the rear side of the handle to supply additional satellite blocks.



Reference

Please see the pinout here 483 of the: Additional output supply sockets: LEMO 1B.304

Supplemental device power supply can supply multiple blocks



3.3.4.7.6 Overview of available operation and remote control modes

The power supply module (Power Handle) does not have its own main switch, but can be switched on/off in three ways:

- Manual main switch of a connected base unit
- REMOTE-terminal on the Power-Handle
- A controlling PoEC voltage delivered from outside to the Power-Handle's RJ45 jack "IN" (particularly for operating a blocks of dedicated conditioner modules, without a base unit!)

In conjunction with a connected base-unit, deactivation is not accomplished directly but instead always by means of a "Shutdown"-signal communicating with it. This provides both the ability to stop the measurement in a controlled way and reliable conclusion of data saving to the device, and thus total data integrity.

In consequence, the following possible scenarios lead to activation of the Power-Handle and the module block connected to it:

- The base unit whose push button is pressed is connected (regardless of the base-unit's Remote terminal!),
- a push button connected to the Power-Handle's Remote terminal ("SWITCH") is pressed,
- an external power supply (LEMO) is applied and a switch connected to the Remote terminal is closed ("SWITCH1"),
- an external power supply (LEMO) is applied, and additionally, a PoEC voltage higher than 3V is applied at the Power-Handle's EtherCAT terminal ("IN").

The power supply module switches itself off under the following conditions:

- The base unit is connected and after having been active it has been powered down and has deactivated itself. This in turn may be initiated in particular when, after an outage of the external power supply, the UPS buffer duration has elapsed and the base-unit has received a "Shutdown"-command from the Power-Handle
- No base-unit is connected but only conditioning modules, and the voltage level of a PoEC voltage applied at the Power Handle's EtherCAT terminal ("IN") falls to below 2V.
- No base-unit is connected; sudden deactivation upon elapse of the UPS buffer duration in case of UPS operation, or in response to pressing the push button or throwing the Remote-terminal's switch.
- The Reset button on the front panel is pressed.



Note

During operation, a base-unit connected to the power supply unit receives a Shutdown-command if:

- a push button connected with the module's own Remote terminal is pressed,
- a switch connected with the module's own Remote terminal is opened, or
- in case of UPS operation, the UPS-buffer duration has elapsed.

3.3.4.7.7 Charging the internal battery of a Power-Handle having UPS-functionality

System power supply units (Power-Handles) having additional UPS functionality, i.e. an internal buffer battery, only charge up the battery if they are switched on. This is by intentional design, in particular for purposes of invehicle applications, in order to prevent accidental draining of a vehicle battery due to the considerable current draw for charging.

Therefore, if a Power-Handle having a UPS battery is to be charged separately from its measurement system, for instance in preparation for the buffer or in order to refresh it, by means of an AC/DC adaptor, while the rest of the system remains in the vehicle, then this Power-Handle module must be activated in "Stand Alone" mode. Since it doesn't have its own manual main switch, this can be accomplished by means of its REMOTE-terminal's remote control signals, for instance by bridging Pins 1 and 2.

Terminal connection Power-Handle: (CRFX/HANDLE-POWER, CRFX/HANDLE-UPS-L, CRFX/HANDLE-LI-IO-L)

Power supply
 LEMO.EGE.1B.302 (female) multicoded

• Auxiliary output 5x LEMO.1B.304 (female)

(rear side of the handle)

System bus (EtherCAT): RJ45 Buchse (EtherCAT IN)
 Remote control: LEMO.1B.306 (female)

Module socket: 20 pin (System bus and power supply)

The Power Handle provides the functioning of the overall system including all additional modules even during a power outage, thanks to battery buffering. UPS buffering is available with either lead batteries (CRFX-HANDLE-UPS-L) or Li-ion batteries as well as with extended battery capacity (CRFX-HANDLE-LI-IO-L). The supply module is protected by a non-resetable 20 A fuse at its input.



Both handles (CRFX-HANDLE-LI-IO-L and the CRFX-HANDLE-UPS-L) are equipped with a switch to set the buffer duration (table).

Position	Buffer duration
0	none
1	1 sec
2	2 sec
3	5 sec
4	10 sec
5	30 sec
6	1 min
7	2 min
8	5 min
9	10 min
Α	30 min
В	1 h
С	2 h
D	5 h
E	10 h
F	maximum

Short-circuit proof

Since theoretically any amount of imc EOS and imc CRONOS*flex* Modules could be connected to the supply module, the supply module comes with a power limiting circuit with long-term short-circuit protection. This circuit limits the power consumed to approx. 100 W.

When this limit is surpassed, the output voltage is cut, and then is enabled again after about 4 seconds. If the overload or short-circuit has still not subsided by that time, the system wait another 4 seconds etc. During the "waiting period", the supply module's Power-LED flashes at one-second intervals. The LED, designated "LIMIT" at the front of the Power Handle, is yellow if the output power consumption is more than 80 W and the LED will be red if the power consumption is more than 95 W.



Note

- The LED, designated "POWER" at the front of the Power Handle, is yellow in case of an operation in battery mode
- If the Power Handle is connected to a imc EOS or a CRFX base unit please make sure that the LEMO supply socket is connected with the Power Handle! The supply of a block of modules always comes from the leftmost module (first module).



Reference

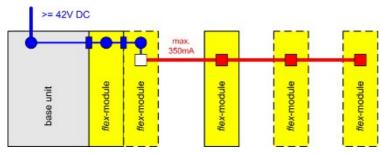
The meaning of the LEDs are described in the manual chapter: "Rechargeable accumulators and batteries".

¹ no use with imc EOS

3.3.4.7.8 Power over EtherCAT operation

imc CRONOS*flex* Modules can also be powered just from the network cable (EtherCAT-system bus), without any separate supply source. For this purpose a minimum voltage of 42 V is required, with a maximum current of 350 mA to be delivered.

PoEC - Supplying imc CRONOSflex Modules only via the network cable, without separate power source



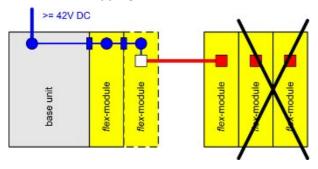
Depending on the power consumption of the module type used, up to three imc CRONOSflex Modules can be powered jointly. The <u>overview</u> table below 125 states the respective power consumption specs.

Since the PoEC supply lines are only available with at the RJ45 sockets, but not at the module plug-in connectors, multiple PoEC-powered

modules must be mutually connected with network cables and not directly clicked together.

PoEC - Supplying of imc CRONOSflex modules:

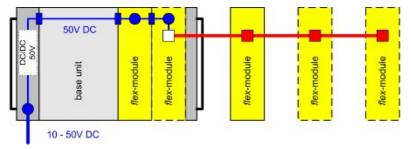
Instead of "snapping on", connection via network cable



PoEC-supply of one or more modules ensures indirect activation/deactivation through the supplying unit and thus, for example, remote switching by the base unit's main switch.

Since a minimum voltage of 42 V is required for the use of PoEC, the supplemental power supply can make this possible, if (for example on board a vehicle) the available voltage is insufficient, or if no 48 V AC/DC adaptor can be used.

Supplemental device supply for use of PoEC with low supply voltage





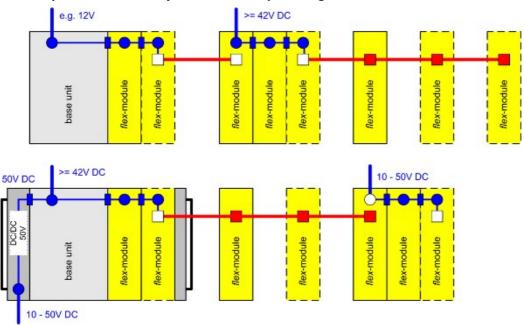
Note

The imc CRONOSflex CRFX/WFT-2 module does not support the PoEC operation.

3.3.4.7.9 Operation with multiple (varying) supply voltages

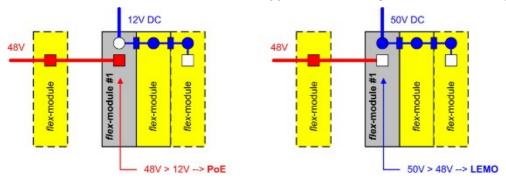
The minimum voltage requirement of 42 V for PoEC pertains to the respective module or block which supplies the PoEC module. This does not necessarily need to be the first block with the base unit, but it can be adequate for a purely signal-conditioning block as the PoEC-module's "predecessor" to deliver the voltage, or to be equipped with a 50 V supplemental supply.

PoEC requires at least 42 V just at the PoEC providing block



In operation with multiple supply voltages of various magnitude, a module's "leftmost" module can be a special case: Here, the rule is that the first module supplies itself from the higher of the two voltage sources (LEMO or PoEC on RJ45 patch cable). All of the block's other modules are supplied from the LEMO terminal in any case, which must be connected to the first module since PoEC supply cannot, as a matter of principle, be transmitted via direct click-together of modules. For the user, the significance is only that the block's first module, along with all others to its left, counts toward the maximum amount of PoEC modules supported.

PoEC - "far left" module in each block is supplied with the highest available voltage



3.3.4.7.10 PoEC-operation in stationary environment

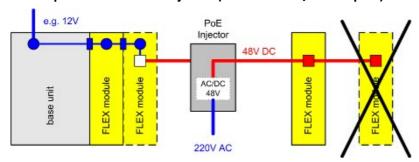
If PoEC-operation is intended for a stationary application where 220 V AC power supply is available, then a simple AC/DC adaptor with a 48 V DC output is available and is sufficient to power the entire system.

Note that other devices belonging to the imc CRONOS family or the imc C-SERIES are also equipped with LEMO plug, but are usually not compatible with the high supply voltage of 48 V: For these devices, the upper limit is generally 32 V!

The AC/DC-adaptor's plugs having 48 V DC output are denoted. Keyway coding prevents plugging into imc C-SERIES devices, for example, in which 32 V is the upper limit. imc CRONOSflex modules have a keyway-coded socket which is designed to be compatible both with the coded plugs of the AC/DC-adaptor having the 48 V DC output, as well as with the adaptors for the 32 V.

Other applications can be imagined where there is already a DC system supply for other reasons, and a single PoEC module is to be integrated into the system: For this purpose, a standard "PoEC Injector" can be used, which is also available as an optional accessory. This special AC/DC adaptor is connected into a network, here the EtherCAT-system bus, via two RJ45 terminals. It separates the PoEC supply lines (not the network communication lines!) and supplies a 48 V. In accordance with IEEE 802.3, these injectors can only be used for "point-to-point" connection with a single device, even if the supply power would be sufficient for multiple modules. The reason is that according to PoEC specs, communication is set up with the device supplied for the purpose of adjusting the power parameters. Since, in contrast to standard injectors, the CRONOSflex system makes no use of such functions, this limitation to a single directly connected PoEC-module only applies in conjunction with an AC-injector, but not for CRONOSflex in general.

PoEC-operation with PoE injector (48 V PoEC AC/DC-adaptor)



As a rule, imc CRONOS flex also allows connection for a chain of PoEC-supplied modules (via individual network cables), as long as the total power is adequate. The maximum this can be is $50 \text{ V} \cdot 350 \text{ mA} = 17.5 \text{ W}$. Depending on the module type, this is adequate for one to three imc CRONOS flex Modules.

Other applications can be imagined where a large number of modules is to be supplied via PoEC, e.g. because they are installed at a far distance (up to 100 m), and are badly accessible and without an available AC outlet. If this can not be solved by means of an additional supply module which would need to be located at a central position where AC/DC 48 V is available, then such a topology can also be achieved with a larger number of individual PoEC injectors.

3.3.5 Start of operation CRXT



Reference

Start of operation

Please find in the following chapter a detailed description: imc CRONOS-XT (CRXT) of.

3.3.6 Start of operation CRC, CRSL

3.3.6.1 Modularity

CRC systems

The devices belonging to the imc CRONOScompact (CRC) are modular systems. A variety of signal conditioners and digital I/O modules can be combined to a system.



Warning

Changing modules

Changing modules is only permitted for users trained by imc or imc service and in agreement with imc! Devices having HV modules (HV-2U2I etc.) do not support exchanging of modules (device safety!).

The following constraints, however, apply:

- Within the device, the necessary supply voltage is made available by a central power supply unit. A maximum supply current is specified for each supply voltage. The allowable current load on the voltage supply line is different for each module type. In addition, the power for the supply of an external sensor (e.g. supply of a strain gauge measurement bridge) must be taken into consideration. The supply power required by the power supply unit is tested at the factory. In the process, the power consumption of the modules ordered is taken into account. Power reserves can be requested from imc, if desired. If modules are subsequently added to a system which has already been shipped, it is absolutely necessary to check whether enough reserve power is available! As a matter of principle, only trained service personnel should install new system modules!
- Individual modules are distinguished by "module addresses". These module addresses must be configured prior to installing the module (e.g. DIP-switch, rotary switch, soldered jumpers). Previously existing addresses of other modules must be taken into account. If the same module address appears multiple times, conflicts will arise and the modules affected will either not be recognized by the device software at all or only incorrectly. This generally leads to errors which are hard to identify!
- The addresses of the module DI16-DO8-ENC4 can't be changed and are set to: DI4-16 (Addr. 1), DO8 (Addr. 0). That has to be considered, when addressing other digital modules (DI-16, DO-8, ENC-4). The variant of this multiboard with an additional DAC-4 will need an additional address. A further multiboard DI16(8)-DO8-ENC4(-DAC4) can be added without gap.
- For safety reasons high voltage modules (HV4U, HV2U2I etc.) are not to be changed by a customer!

CRSL systems

The devices of the imc CRONOS-SL (CRSL) series are factory configured devices. You can freely combine signal conditioning and digital I/O modules into one system. However, you **cannot** add new modules after delivery of an imc CRONOS-SL system, as for example with imc CRONOScompact.

3.3.6.2 Power supply

Measurement devices of the imc CRONOS system family are powered by a DC supply voltage which is supplied via a 2-pin LEMO-plug.

Device	LEMO plug type designation	Size
imc CRONOS-SL2/-SL4	FGG. 1B .302.CLAD.62ZN	(middle)
imc CRONOScompact	FGG. 2B .302.CLAD.82ZN	(big)
imc CRONOSflex	FGE. 1B .302.CLAD.52ZN (with 2 coding keys 16) *	(middle)

The permissible supply voltage range with is 10 V to 32 V DC. The standard product package includes a desktop supply unit with 15 V DC (<60 W) or 24 V DC (<150 W). On the input side the AC-voltage of the desktop supply is 100 V to 240 V 50/60 Hz. Measurement devices of imc CRONOS*flex* family are powered by LEMO terminal for an ultra-wide 10 to 50 V range of DC power input. The DC-supply inputs of our imc measurement devices are not designed for a connection to a DC-grid with reference to EN 61326-1.



Note

Desktop supply unit

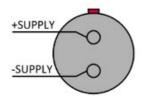
Please note, that the operation temperature of the desktop supply is prepared for 0°C to 40°C, even if your measurement devices is designed for extended temperature range!

The package also includes a cable with a ready-made LEMO-plug which can be connected to a DC-voltage source such as a car battery. When using this, note the following:

- Grounding of the device must be ensured. If the power supply unit comes with a grounding line, it would be possible to ground the system "by force", by making a connection from this line to the plug enclosure (and thus to the device ground). The table-top power supply unit is made to allow this.

 This manner of proceeding may not be desirable because it may be desirable to avoid transient currents along this line (e.g. in vehicles). In this case the ground-connection must be made to the device directly. For this purpose a (black) banana jack ("CHASSIS") is provided.
- The feed line must have low resistance, the cable must have an adequate cross-section. Any interference-suppressing filters which may be inserted into the line must not have any series inductor greater than 1 mH. Otherwise an additional parallel-capacitor is needed.

Pin configuration:



The +pin is marked with a red dot.

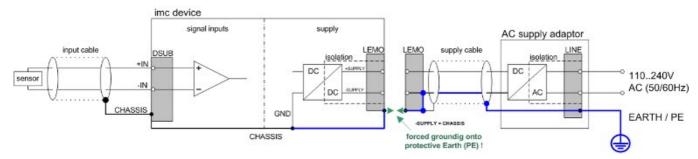
3.3.6.3 Grounding, shielding of the devices

In order to comply with Part 15 of the FCC-regulations applicable to devices of Class B, the system must be grounded. Grounding is also the condition for the validity of the technical specifications stated.

^{*} starting from September 2011 16, imc CRONOSflex Modules and Base Units (see type label)

3.3.6.3.1 Grounding with the use of the included power adaptor

The DC-supply input on the device itself (LEMO socket, female) is galvanically isolated from the housing (CHASSIS): -SUPPLY input is not connected to CHASSIS internally. That means the decive's internal power supply circuitry comprises isolating DC/DC converter.

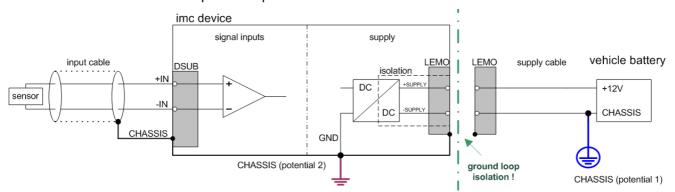


imc CRONOS-SL and imc CRONOScompact with desktop power supply unit

Use of the desktop power supply unit, included in the package, ensures proper grounding via the plug's protective earth terminal: the supply voltage's (-) pole as well as the shield and plug enclosure are connected to the cable's ground.

3.3.6.3.2 Grounding with power supplied by a car battery

If the power supply (e.g. car battery) and the measurement device are at different voltage levels, then if they were connected by the supply line, it would cause a ground loop. For such cases, the isolated internal device power supply ensures separation of the two voltage levels. The ground reference for the measurement device must then be established in a separate step.



imc CRONOS-SL and imc CRONOScompact powered by an isolated DC-voltage source (e.g. battery)

For running on an isolated DC power supply source (e.g. battery), either the grounding socket terminal, a grounding contact on the device ("CHASSIS"), or the CHASSIS contact on the imc signal plugs must be used.

Isolated power inputs avoids ground loops in distributed topologies

With stationary installations and the use of (already isolated) AC/DC adapters, any system ground differentials between the device and the central or local power supplies may not be relevant. The big issue in such a case, in contrast to mobile, in-vehicle applications, is from where to obtain a reliable ground voltage. Since it is convenient to use the AC power supply's protection ground line as the ground voltage, the LEMO-terminated AC/DC adapters for imc measurement devices are designed so that the protection ground line is connected all the way through to the LEMO plug's housing, thus securing the device's voltage level to protection ground. Additionally, in the AC/DC-adapter's LEMO-terminal (not the device's LEMO-socket!), the reference ground of the power adapter is connected with the housing's (CHASSIS) protection ground: Since the AC/DC power adapter is already isolating, as is the power input, this supply voltage's reference would not initially be defined and can be set arbitrarily. In particular for reasons of suppressing HF (high-frequency) interference signals stemming from the AC/DC switching power adapter, direct grounding is normally advisable.

3.3.6.3.3 Shielding

Also, all signal leads to the device must be shielded and the shielding grounded (electric contact between the shielding and the plug housing "CHASSIS").

To avoid compensation currents, always connect the shielding to one side (potential) only. If the imc DSUB block screw terminal plug is used, the shielding should be connected to the pull-relief clamp on the cable bushing. This part of the conductor-coated plastic plug housing has electrical contact to the device's housing, just as Terminals 15 and 16 (labeled: "CHASSIS", to the left and right of the imc-plug cable bushing) do; but is preferable to the "CHASSIS" terminals for optimum shielding.

3.3.6.4 Main switch

Switch on

The **device's main switch** is a **power-on button** with a built-in "POWER"-LED which must be pressed down for approx. 1 sec. to achieve activation, indicated by the "POWER"-LED flashing. If the device boots correctly, three short beep-tones are emitted.

Switch off

To switch the device off, press the power-on button again down for approx. 1 sec, what will cause a constant blinking of the "POWER"-LED. This causes the device to not be deactivated abruptly during a running measurement. Instead, any files on the internal hard drive involved are closed before the device switches off by itself. This process takes up to 10 sec. Holding the power-on button down is not necessary! If no measurement is currently running, it takes only approx. 1second for the device to be deactivated.

Some older imc measurement instruments may be equipped with a rocker-switch as main switch. It must be pressed down to the "ON"-side (upper portion) for approx. 1 sec to achieve activation, indicated by the "POWER"-LED flashing (e.g. CRONOS-PL devices). To switch the device off, press the rocker switch down on the OFF-side (lower portion) for approx. 1 sec.

3.3.6.5 Remote control

As an alternative to the manual main switch, imc devices can be switched on or off remotely with a wiring of the corresponding signals of the remote plug. There are several functions and operating modes available. The most common operating mode, available for all types, is the basic ON/OFF push button action performed with one single temporarily closing contact: connecting the signals "ON/OFF" and "SWITCH" for at least a short time, activates the device. The following table lists imc devices and the corresponding socket type.

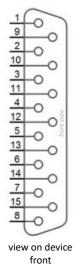
imc device			Remote socket
CRONOScompact (CRC	, CRONOS-SL	(CRSL), SPARTAN (SPAR)	DSUB-15
CRONOSflex Base and the	Power Handle	(CRFX)	LEMO.EGG.1B.306 (6-pin, middle big)
C-SERIES (CL)		· · · · · · · · · · · · · · · · · · ·	LEMO.EGG.0B.306 (6-pin, small)

Pin configuration



view on device front

	LEMO Pin	Signal name	Remarks
-	1	ON/OFF	LEMO Pin 1 and Pin 3 are internally bridged, two operating modes are supported: SWITCH and SWITCH1
_	2	SWITCH1	automatic activation when external power supply is connected, → permanently jumpered to ON/OFF, e.g. in vehicle
	3	ON/OFF	
	4	SWITCH	activation, deactivation like a push button, → briefly jumpered to ON/OFF, like the main switch
	5	MUTE_GND	
	6	MUTE	muting the UPS buzzer, only with the CRFX Power Handle



DSUB-15 Pin	Signal name	Remarks
1	RESET	immediate deactivation without saving, will cause lost of data
9	OFF	
2	SWITCH	activation, deactivation like a push button, → briefly jumpered to ON/OFF, like the main switch
10	ON	
3	SWITCH1	automatic activation when external power supply is connected, → permanently jumpered to ON/OFF, e.g. in vehicle
11, 4 und 12	n.c.	
5	MUTE	muting the UPS buzzer, e.g. for acoustic applications
13	ON/OFF	
6, 14, 7, 15, 8	n.c.	



Note

When the SWITCH and ON/OFF signals are bridged with a switch, the device remains permanently on. In this case, the main switch has no effect.

3.3.6.6 UPS

Devices with DC supply input are equipped with an uninterruptible power supply (UPS). This allows for a continuous operation unaffected by temporary short-term outage of the main power supply. This type of operation is particularly useful for operation in a vehicle, permanently attached to starter lock and main power switch and thus not requiring manual control. Activation of UPS buffering is indicated by the power control LED (PWR) changing from green to yellow. With many imc measurement devices, active UPS buffering is additionally indicated by an acoustic buzzer signal.

The UPS provides backup in case of power outage and monitors its duration. If the power outage is continuous and if it exceeds the specific device's "buffer time constant", the device initiates an automatic shutdown sequence, which equals manual shutdown procedure: Any current active measurement is automatically stopped, data storage on flash card or internal harddisk is completed by securely closing all data files, and finally the device is actually switched off. This entire process may take a couple of seconds.

Thus, a typical application of this configuration is in vehicles, where the power supply is coupled to the ignition. A buffer is thus provided against short-term interruptions. And on the other hand, deep discharge of the buffer battery is avoided in cases where the measurement system is not deactivated when the vehicle is turned off.

If the power failure is not continuous but only temporary, the timer that monitors blackout duration is reset every time the main supply has returned to valid levels. The buffer time constant is a variable device parameter that can be configured according to system size and battery capacity. It can usually be written into the device under software control and is preconfigured to reasonable default values upon delivery (see description in the software manual).



Reference

For the UPS module of the imc CRONOS flex series (optional handle with UPS 26), buffer time constant is set with a manual switch accessible on the front panel.

3.3.6.6.1 Buffering time constant and maximum buffer duration

The buffer time constant is a permanently configurable device parameter which can be selected as a order option. It sets the maximum duration of a continuous power outage after which the device turns itself off.

The maximum buffer duration is the maximum (total) time, determined by the battery capacity, which the device can run on backup. This refers to cases where the self-deactivation is not triggered; e.g., in case of repeated short-term power-interruptions. The maximum buffer duration depends on the battery's current charge, on the ambient temperature and on the battery's age. The device automatically deactivates itself just in time to avoid deep discharge of the battery.



Note

The buffer time constant can be changed using the imc operating software.



Reference

- See description in the manual of the imc operating software:
 - > Operation > User Interface > Device menu > Properties...: Entry UPS

3.3.6.6.2 Charging power

The charging power depends on the device type, its hardware configuration, and the amount and type of rechargeable batteries installed. For this reason, there are a variety of combinations with charging power between 2.4 W and 16 W.

3.3.6.6.3 Take-over threshold

The voltage threshold at which the storage battery takes over the power supply from the external source is approx. 9.75 V. The take-over procedure is subjected to an hysteresis to prevent oscillating take-over. This would be caused by the external supply's impedance. This inevitable impedance lets the external supply rise again, right after take-over to internal buffering. Hysteresis in the take-over threshold will prevent oscillations due to this effect. If, during supply from of the buffering battery, the external supply voltage rises as high as 10.9 V, the external voltage takes over again from the buffering battery.

If you check these thresholds, note that when the supply voltage is overlaid with a high frequency interference or ripple-voltage, the minima are of key importance. In fact, the overlying interference could be caused by feedback from the device itself.



Note

- The voltage specification refers to the device terminals. Please consider the voltage drop of the supply line, when determining the voltage supply.
- During activation the supply voltage must be above the upper take-over threshold (≥11 V).

3.3.6.6.4 Rechargeable accumulators and batteries

3.3.6.6.4.1 NiMH batteries

The lead-gel batteries are replaced by a solution with NiMH batteries. For you as a user, this change does not represent a significant change in his previous operation of the device. The battery type is marked on the device type plate: "Contains NiMH Battery" so that the devices can be distinguished externally.



Reference

- Please find here the technical specs UPS with NiMH batteries 3081.
- Devices from the imc CRONOS system family delivered by imc after November 2022 will have a "battery label" 10 on the nameplate for integrated energy sources.

Lead-gel batteries

Devices build before 2017 come with the optional UPS-Function containing maintenance-free **lead-gel batteries**. Charging these internal backup batteries is accomplished automatically when the activated device receives a supply voltage. Due to the inevitable leakage of charge we recommend that the device be activated for 6 to 9 hours at least every 3 months to prevent the batteries from dying.

In case the UPS is used a lot (many discharge and recharge cycles), the life time depends on how much (deep) it has been discharged (is the UPS buffering only for a short time or is the UPS discharged completely every time?). The manufacturer specifies 200 cycles @100% discharging and 1200 cycles @ 30% and 25°C ambient temperature. (that should be true in general for all Pb batteries.)



Do **not** throw the lead-gel accumulators in the household garbage.

3.3.6.6.4.2 Li-ion batteries

Devices can be equipped with an UPS supply unit, based on large capacity Li-ion batteries that allow for very long backup buffer duration. Devices with Li-ion batteries are equipped with power supply input circuitry that is galvanically isolated from the device housing (CHASSIS). Note that all instructions regarding grounding and shielding for devices with isolated power supply input apply. Li-ion UPS modules feature intelligent charging control. Charging of the batteries is performed automatically when the device is switched on and receives an external supply voltage.

The Li-ion batteries (Smart Batteries) are accessible for exchange, with a keyed insertion mechanism, secured against reversed polarity. They are installed at the bottom of an imc CRONOScompact (CRC) device. With imc CRONOSflex (CRFX) the Li-ion batteries are accessible on the rear side of a handle: CRFX/HANDLE-LI-IO-L.



imc CRONOScompact with two Li-ion battery packs
The batteries are equipped on the bottom.



imc CRONOScompact with two Li-ion battery packsThe batteries can be inserted easily, the connections are protected against polarity reversal.



Note

- Due to the inevitable leakage and self-discharge of the Smart Batteries we recommend a regular recharging cycle at least every 3 months that a device has not been in use (device must be switched on for charging).
- imc recommend maintenance every 2 to 3 years and for extended temperature range every 1 to 2 years



Do not deposit Li-ion batteries in domestic recycling containers!



Reference

Li-ion battery

Please find here technical specs! 313

Notes on Li-ion Smart Batteries:

• Failing to adhere to the recommended temperature ranges for storing, charging and discharging will not render the battery pack unsafe but will reduce its life expectancy and capacity.

- If Smart Batteries are stored in low charge state (<10%) they will age faster.
- When storing discharged Smart Batteries, internal deep discharge protection circuitry may get activated. This will cause the following charge cycle to run through a reactivation procedure, starting with a very low charging current. This may prolong the required charging time.
- Prolonged storage of discharged batteries is not recommended and may cause irreversible damage to the battery!
- The battery may temporarily deactivate itself in response to:
 - -excessive temperature
 - -excessive discharge current (e.g. due to short circuit)
 - -insufficient cell voltage (to prevent discharge)
 - Otherwise the UPS is operable as long as the battery does not prevent discharge.
- Once the passive temperature fuse has been triggered, it cannot be reset and thus renders the battery pack unusable. The rated temperature may not be exceeded!
- For safety reasons, the Li-ion batteries may not be exposed to temperatures exceeding 100°C!



Note

In order to preserve maximum life expectancy of the Smart Batteries they should be recharged at least every 3 months. The device must be switched on for charging!

State of charge indicator of the Li-ion batteries

The state of charge of the Li-ion batteries is indicated by different signal patterns of the LEDs. The position of the LEDs on your measurement device can differ from the pictures below. The following signal patterns can be interpreted as follows:

UPS Status	UPS Status	UPS Status	UPS Status	UPS Status
0 100	O 100	O 100	O 100	O 100
75	75	O 75	O 75	O 75
O 50	O 50	O 50	O 50	.O 50
O 25	O 25	O 25	O 25	-0-25
state of charge:				Flashing at 2 Hz
75% to 100%	50% to 74%	25% to 49%	10% to 24%	<10%

During active charging the last active one of the four green status LEDs flashes at a rate of approx one second. In contrast to this, the warning signal at very low state of charge (<10%) consists in the lowermost ("25") flashing at an even faster rate.

The UPS Status LED is bicolor. In case of an error it flashes red.

Error Conditions

If the UPS Status LED flashes alternating red and green, a long term continuous battery operation is inhibited due to high battery temperature of $60^{\circ}\text{C} \le \vartheta < 75 \pm 5^{\circ}\text{C}$ (1). In this case, the buffer time constant of the UPS is reduced to 15 seconds, regardless of the configured setting. Thus, in case of an outage of the external power supply automatic shutdown procedure will already be initiated after 15 seconds, stopping the current measurement, storing all data and turning off the device.

The following error conditions are indicated by LED signal patterns:

Battery is not present or cannot be detected	Internal Error (UPS may not be operable)	Battery operation is inhibited and the UPS is not operable $\vartheta \ge 75 \pm 5^{\circ}C$ (2)
UPS Status	UPS Status	UPS Status
O 100	0 100	O 100
O 75	O 75	75
O 50	O 50	O 50
O 25	O 25	O 25

- (1) ±5°C due to tolerances of internal temperature measurement of the battery
- (2) Internal protection circuitry prevents discharge at temperatures above $\vartheta \ge 75 \pm 5$ °C. The UPS may only be operable again once the batteries have cooled down to 65°C.

The following picture display the front of devices with integrated Li-ion batteries. The exact position of status LED can differ between each system.







CRC Rack

CRC portable housing

CRFX Power Handle (Li Ion)

3.3.7 Signal connection

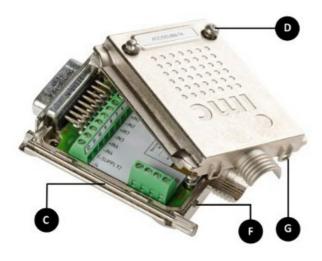
For devices with DSUB-15 connection technology, the convenient imc terminal plugs for solderless screw terminal connection are available as optional accessories.

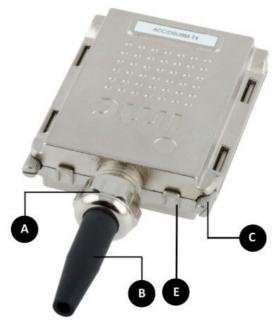


ACC/DSUBM-xxx: snap the nose into the slot

Open the Metal plug:

- 1. Unscrew the cable fitting (cable gland) [A]
- 2. Remove the bend protection [B]
- 3. Unscrew the lid screws [D]
- 4. Lift the lid in the DSUB connection area and unfasten the nose of the slot





- A: Cable fitting (cable gland)
- **B:** Bend protection
- C: Fastening screw for the devices' front panel
- D: Lid screws
- E: Locking key (Nose / Slot)
- G: Slot
- F: Nose

Close the Metal plug:

- 1. Assemble the lid by snapping the nose into the slot (see the picture above)
- 2. Audible click when the lid snaps in the front of the DSUB pod
- 3. Insert the bend protection
- 4. The pressure nut must be screwed back on
- 5. The lid screws can be tightened



Reference

Pin configuration

Please find the pin configuration of each available plug in the chapter: Pin configuration 472.

4 Maintenance and servicing

4.1 Maintenance and servicing

imc recommends performing a service check every 12 months. An imc service check includes system maintenance in accordance with the service interval plan as specified by the manufacturer and a complete function test (maintenance, inspection and revision). Maintenance (*repair*) work may only be carried out by qualified personnel from imc Test & Measurement GmbH.

For service and maintenance work, please use the <u>service form</u> that you download from our website and fill out: https://www.imc-tm.com/service-training/customer-service/system-service



Reference

Device certificates and calibration protocols

Detailed information on certificates, the specific contents, underlying standards (e.g. ISO 9001 / ISO 17025) and available media (pdf etc.) can be found on our website, or you can contact us directly.

4.2 Cleaning

- Always unplug the power supply before cleaning the device. Only <u>qualified personnel</u> and are permitted to clean the housing interior.
- Do not use abrasive materials or solutions which are harmful to plastics. Use a dry cloth to clean the housing. If the housing is particularly dirty, use a cloth which has been slightly moistened in a cleaning solution and then carefully wrung out. To clean the slits use a small soft dry brush.
- Do not allow liquids to enter the housing interior.
- If you clean the rubber seals with commercially available household cleaning products, please follow the respective cleaning instructions of the manufacturer. The seal is thus protected against premature aging because no air can reach the seal. Before connecting CRXT slices together (Attachment mechanism), the rubber seals must be clean and greased (e.g. with Vaseline).

4.3 Storage

As a rule, the measurement device can be stored at temperatures ranging from -40°C to +85°C. Special care is required when storing individual CRXT slices. The rubber seals on the sides must be handled and maintained with care. Before storage we recommend that the rubber seals are cleaned (see Cleaning) and greased. The seal is thus protected against premature aging because no air can reach the seal. CRXT slices should preferably be stored as a closed CRXT unit.

4.4 Transport

When transporting, always use the original packaging or a appropriate packaging which protects the device against knocks and impacts. Transport CRONOS components / slices preferably as a closed device. If transport damages occur, please be sure to contact the imc Customer Support. Damage arising from transporting is not covered in the manufacturer's guarantee. Possible damage due to condensation can be limited by wrapping the device in plastic sheeting.

The represented handling label for lithium ion batteries can be attached also independently printed on the package (e.g. by gluing on the package or in a transparent unlabeled document bag). Note however that the form and the format are accurately given by IATA and the expression has to take place in color. Format: 120 x 110 mm.



Installation - Software Chapter 5

5 Start of operation Software / Firmware

5.1 Installation - Software

The associated measurement engineering software imc STUDIO, the configuration and operating interface for all imc instruments, provides the devices with exceedingly versatile functionality. It achieves comprehensive total solutions for everything from laboratory tests through mobile data logger application all the way to complete industrial test stations.

Use of the software requires a license, subject to the purchase order and configuration (see e.g. imc STUDIO manual product configuration / license).

In order to be able to install or uninstall imc STUDIO products, you must be registered with a user account possessing administrator rights to the PC. This applies to the overwhelming majority of all installations of Windows. However, if you are only logged on to your PC without administrator rights, log off and log back on with an administrator user account. If you do not possess an administrator user account, you will need the support or your system administrator or IT department.

You will find a detailed description to the installation of the software in the adequate manual or getting started.

5.1.1 System requirements

The minimum requirements of the PC, the recommended configuration for the PC, the supported operating system are mentioned in the data sheets and the imc STUDIO manual.

5.2 Connect the device

There are multiple ways to **connect the imc measurement devices with the PC**. In most cases, the **connection via LAN** (local area network, Ethernet) is implemented. See section "<u>Connecting via LAN in three steps</u> 46" for the **quickest way to connect** PC and measurement device.

But there are also other connection types:

- WLAN
- LTE, 4G, etc. (via appropriate routers)

These are described in a separate chapter in the software manual: "Special options for connecting to the device".

The devices use the **TCP/IP protocol** exclusively. With this protocol, some settings and adaptations for your local network may be necessary. For this purpose, the support of your network administrator may be necessary.

Recommended network configuration

The latest and high-performance network technologies should be used to achieve the maximum transfer bandwidth. This means especially 1000BASE-T (GBit Ethernet). GBit Ethernet network devices (switches) are downward compatible, so that imc devices that only support 100 MBit Fast Ethernet can also be operated on them.

The cable length between the switch and a PC or a device should be less 100 m. Use a shielded cable. If the length of 100 m is exceeded, then you have to insert another switch.

If the system is being integrated into an existing network, you must ensure that the minimum data rate can be guaranteed. Under some circumstances, this may require using switches to subdivide the network into separate segments in order to govern the data traffic in a targeted way and thus optimize the data rate.

Connect the device Chapter 5

In very demanding applications, you might consider grouping multiple GBit Ethernet devices via even higher-performance sections lines of the network (e.g. via 5 GBit Ethernet) and to connect these groups to NAS-components, for instance, via these lines.

When such imc devices are included which use network-based PTP-synchronization (e.g. CRXT or CRFX-2000GP), then it is necessary to use network switches which fully support this protocol on the hardware side. Appropriate network components are also available as imc accessories (e.g. CRFX/NET-SWITCH-5) and are then electrically and mechanically fully compatible with the imc systems.

5.3 Connecting via LAN in three steps

The most common case is described below: the PC and the device are connected via cable or network switch. The device's IP address must be set in the PC's address range. Subsequently, the device can be connected with the PC. If a connection has ever been established previously, the software recognizes the device's hardware configuration. In that case, experiment configurations can be prepared without any connection to the device.

Step 1: Connecting the measurement device

To connect via LAN there are two options:

- 1. The measurement device is connected to an **existing network**, e.g. via network switch. Only with a switch is it possible to run multiple devices.
- 2. The measurement device is connected directly to a network adapter on the PC (point-to-point).

In a LAN, the first case is typically implemented. Modern PCs and network switches are usually equipped with Auto-MDI(X) automatic crossover recognition, so that it is not necessary to distinguish between crossed and uncrossed connection cables. Thus both cable types can be used.

Step 2: IP-configuration

Start imc STUDIO. Click the "Device interfaces" button (to open the dialog for configuring the IP address of the device.

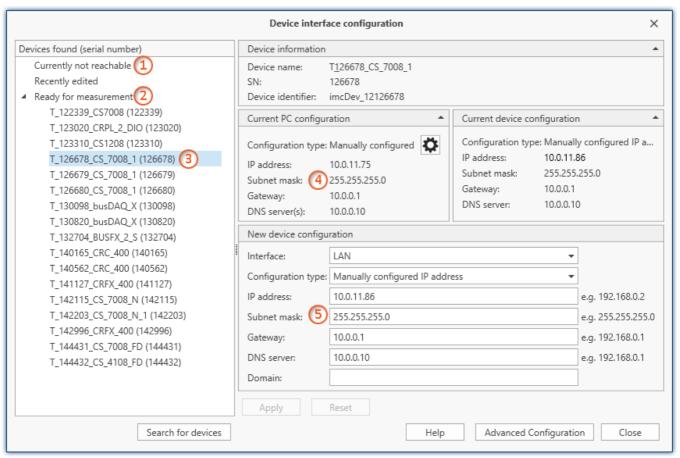
Ribbon	View
Setup-Configuration > Device interfaces (Complete

If this **button** is **not present** in the view, it is also possible to open the dialog after a device search if it failed to find any new devices. Subsequently, a prompt appears asking whether to search for devices with an inappropriately configured network interface. Close this message box by clicking "*Yes*".

Once the dialog starts, the system automatically searches for all devices in the network. In the tree diagram, all available devices are indicated. If the device appears among the group "Currently not reachable" (1), it is necessary to modify the device's LAN-settings. If the device appears among the group "Ready for measurement" (2), you can leave the settings as they are or review them.

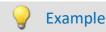
If there is any IP-conflict, devices affected will not be listed.

Select the device for making modifications 3.



Display of measurement devices found and of the IP address

Set the **IP address manually** if you are not using DHCP. The device's IP address 5 must match with the PC's address 4. To conform to the network mask, only the device portion may be different (see example).



In the example shown, the fixed IP 10.0.11.75 with subnet mask 255.255.255.0 is selected for the PC. For measurement devices, any numbers would be suitable which begin with 10.0.11. and then do not contain 0, 75, or 255. The 0 and the 255 should not be used, if possible, due to their special significance. The 75 is the computer's number.

Example for IP settings	PC	Device
IP address	10 . 0 . 11 . 75	10 . 0 . 11 . 86
Network mask	255 . 255 . 255 . 0	255 . 255 . 255 . 0

If the configuration type: "DHCP" is used, the IP address is obtained automatically from the DHCP-server. If it is impossible to obtain any setting values via DHCP, the alternative values are used. These could lead to errors in the connection (different networks, same IP addresses, etc.).

If there is a direct connection between the device and the PC by a cable, then DHCP should not be used.

In order to apply the changes, click on the button "Apply". Wait for the device to restart and then close the dialog.



Note

Connection via modem or WLAN

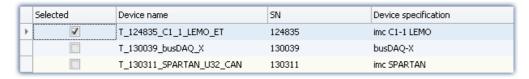
If the connection to the device is established via a modem or WLAN, start the program "imc DEVICES Interface Configuration" by clicking on the button: "Advanced Configuration" (see previous figure). An exact description is found in the software manual chapter: "Setting Up - Connect the device" > "Special options for connecting to the device".

Step 3: Integrating a device into an experiment

Now you are ready to add the device to the imc STUDIO experiment. If your device is unknown to the system, first perform the "device search".

Ribbon	View
Home > Search for devices (()	all
Setup-Control > Search for devices (()	Complete

Select the desired device: Once you click in the checkbox "Selected" for the desired device, it is ready to use in the experiment.



You can also select multiple devices for your experiment.

Now the device is "*known*". After the next program start it is available for selection. For further information, see the documentation on the component "*Setup*".



Reference

Time zone

Now check whether the correct time zone is set for the device. For more info, see the description of the software manual under the keyword "*Device properties*".

Firmware update Chapter 5

5.4 Firmware update

Every software version comes with matching firmware for the hardware. The software only works with devices having the right firmware.

Once the program connects up with the unit, the device's firmware is checked. If the software version doesn't match the device's firmware version, you are asked if you want to perform a firmware-update.



Note

The firmware update is only required if the software was obtained as an update. If you obtained your hardware equipment together with the software, no firmware update is necessary.



Warning

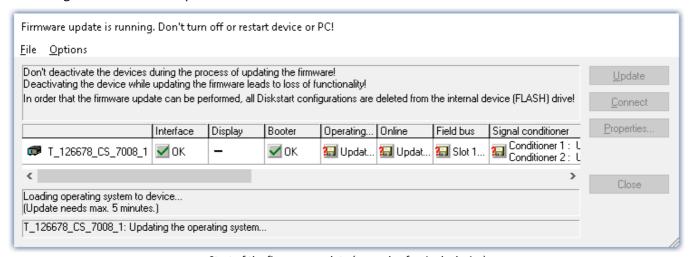
Do not interrupt the firmware update!

Be absolutely certain to observe the following:

- 1. Under no circumstances should the device or its power supply be deactivated during the firmware update!
- 2. The network connection may not be interrupted. Use a cable connection, not WLAN!

Depending on the device type, the following components are loaded automatically: Interface-firmware (Ethernet, modem, ...), booting program, amplifier firmware, firmware for the signal processors.

The dialog for the firmware-update looks like this:

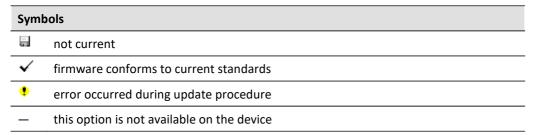


Start of the firmware update (example of a single device)
The state of the components of the firmware is diaplayed in the list.

Component	Description
Interface	Interface-Firmware (Ethernet)
Booter	Start-up program for the device upon switching-on
Operating system	Device operating system
Online	Online-functions and hard drive controller
Display	Operating system of the connected displays
Fieldbus	Fieldbus interfaces (e.g. CAN etc.)
Signal conditioners	Amplifiers

Firmware update Chapter 5

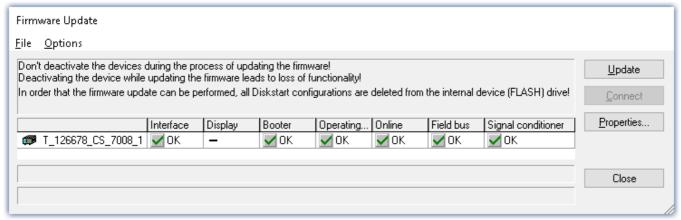
The following symbols for the individual firmware components appear in the list:



If no status indicators are displayed, no connection could be made to the corresponding device.

The duration of the update depends on the number of amplifiers (can last up to several minutes). You will be informed on the progress.

You are notified when the firmware setup concludes successfully, as shown below:



Conclusion of the firmware update (example of a single device)

Choose "Close". The device can now be used with the product software.

Firmware update Chapter 5



Warning

Be sure to observe in case of error

• For a variety of reasons, the firmware update sometimes does not conclude properly, for example due to interruption of the power supply. For instance, the "handshake signal" at the end of the procedure may be missing. In this case, no measurement channels would be displayed initially. However, restarting the device and its software and performing the firmware update again usually restores everything to normal. It may be necessary to call the menu function "Update all components" in the Firmware update dialog's Options menu. This scenario only results in permanent damage in the most rare cases, and it is very worthwhile to repeat the procedure before sending a device in for repair.

- Behaviour under error condition, Windows cuts off the network connection without the user's knowledge; but this can be prevented using the PC's Control Panel.
 Background: During the firmware updates there is no data transfer for a few minutes and thus no network activity; Windows detects inactivity of the connection and the following mechanisms are set in motion:
 - a) Windows' energy saving mode switches the LAN adapter off, consequently interrupting the network connection!
 - b) Windows switches to the next LAN adapter if there is one (some PCs have multiple adapters in order to, for instance, to access services in parallel that are accessible via separate networks.)
 - c) Other scenarios are feasible, e.g. if switches are activated, which can also respond to missing data traffic.

If an error message is posted during the firmware update, leave the device on and contact the imc Hotline. The firmware update may be continued with guidance from the Hotline.



Note

Firmware logbook

The "File" menu offers a function for working with the firmware log file. Every action taken during a firmware update plus any errors which may occur are recorded in a log file. This log file can be displayed with menu "File" > "Show log file".

Update all components

The "Options" menu offers the option to "Update all components". This makes it possible to earmark all the components of the selected device for an update. The function is only to be used in compliance with instructions from the imc-Hotline.

6 Properties

6.1 What does imc CRONOS-series have to offer?

The following is a short introduction into the philosophy of the device's design and operation, intended to get you off to a good start in working with devices of the imc CRONOS-series.



imc CRONOSflex Base Unit with imc CRONOSflex modules

Concept

The imc CRONOS-SL and the imc CRONOScompact systems are compact measurement devices for physical quantities. Those systems offer direct connection of many sensor types, as well as multi-channel data acquisition and vast capabilities of real-time data processing, all within one handy device structure. The measurement devices accomplishes the measurement independently. That means: the PC only configures with the operating software imc STUDIO the experiment. With this concept it is possible to start the measurement automatically after turning on the device.

The imc CRONOSflex and imc CRONOS-XT are modular systems providing an unprecedented degree of flexibility in configuring an integrated measurement and control solution. The system does not require any mounting rack or mainframe: both the base unit and the measurement modules (amplifiers or signal conditioners) are self contained, but are easily stacked together by means of a robust "click-mechanism". To complete the portable system or even to expand the input supply options of the system handles can be stacked to the modules by means of the mechanism. The CRFX-modules can be connected through standard network cables, allowing a spatially distributed system topology with up to 100 m between individual modules.

With signal bandwidths of up to 48 kHz per channel, and an aggregate sampling rate of up to 2 MSample/s, imc CRONOSflex covers the frequency range of virtually all physical, mechanical, and electromechanical signals. Amplifiers with integrated signal conditioning are available for all common sensor types.

Conditioning

The devices of the imc CRONOS-series can be outfitted in adaptation to their intended application. For analog signal conditioning, there are channels for voltage/current, temperature, bridge measurement, displacement or rotation speed etc., as well as inputs for current-fed sensors

(IEPE-inputs). The isolated digital inputs complete the range of plug types offered.





















For the output of alarm signals or for controlling external devices in response to measurements, there are also digital outputs with up to 1 A driver strength.

The connections for the inputs and outputs take the form of DSUB plugs located on the device's back panel and ordered by sensor types and channels. To simplify the handling of the signal lines, the system comes with special screw terminals to which the lines can be directly connected.

TEDS sensor recognition

The imc concept for TEDS (Transducer Electronic Datasheet) extends the IEEE P1451.4. Upon request, clip-on TEDS (Reconstruction) memory chips can be connected onto any sensor connection cable. imc CRONOS-system's parameters are then set automatically either directly form the TEDS or using the sensor database imc Sensors. You can find a detailed description for a adoption of TEDS in the imc STUDIO manual.

Real-time calculations with imc Online FAMOS

imc Online FAMOS enables calculation of various measurement quantities by the device. The extensive functions library additionally enables the creation of test procedures with open and closed-loop control functions. https://www.imc-tm.com

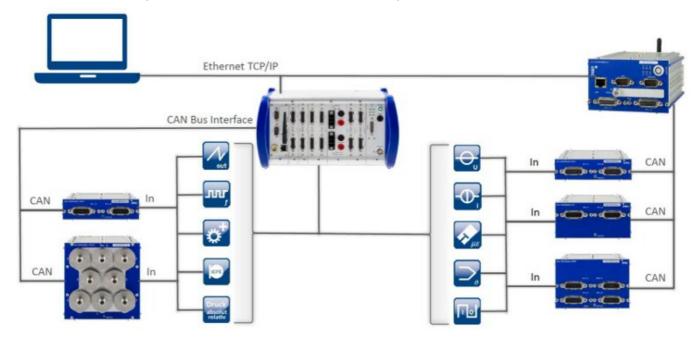
Trigger

Devices of the imc CRONOS-series can use threshold values, etc., to detect a digital event on any measurement channel, making measurement data monitoring easily possible.

The digital events defined can be directly assigned to a digital output and/or combined with each other to form trigger events. Up to 48 independent triggers are available, so that complex measurement tasks can be solved without needing very many steps. Triggers can be defined and assigned to any channel.

Fieldbusses

There are different fieldbusses (CAN FD, FlexRay, Profibus, ...) possible to connect with devices of the imc CRONOS-series. To expand via the CAN Bus even more it is also possible to connect imc CANSAS modules.



Example system with two measurement devices and a couple of CANSAS modules integrated via CAN-Bus.

Different imc measurement devices in an experiment

Devices of the imc CRONOS-series, C-SERIES, imc BUSDAQ and imc SPARTAN can be used with the same software. A mixed mode with different devices is possible.

Display

A PC is not absolutely necessary for operating devices of the imc CRONOS-series. If you program an autostart in devices of the imc CRONOS-series, it will begin a measurement independently. If you have a Display unit, you can use the built-in touch pad to start a measurement and save the data. Here you find the description of the Display and find here the DSUB-9 pin configuration.



PC-operating software imc STUDIO

If you use the PC-operating software imc STUDIO, then you have practically unlimited curve display, triggering and data storing capabilities at your disposal. Together with imc Online FAMOS, you can obtain from raw data any type of result data desired and display them.

6.1.1 imc CRONOSflex Description of the system

6.1.1.1 Building Block Principle Maximizes Flexibility

The inherently modular construction of imc CRONOSflex eliminates the constraints of a predefined system size or configuration 25, found in usual data acquisition systems. Integrated modules free the user to design – and redesign – their system as required: small and compact one day; a large number of channels, of different sensor types with tailored signal conditioning the next. Today a centralized bench top system; tomorrow a decentralized system with satellite modules each assigned to a remote measurement site. The flexibility of imc CRONOSflex allows the reuse of system components to build the optimal solution in a matter of seconds; the system's scalable and expandable architecture eliminates the need for exact planning when purchasing equipment for a specific application. Based on EtherCAT, the system bus 55 to connect the central base unit with measurement modules, it is possible to both connect the measurement modules directly to a central unit, and/or to set up a spatially distributed system by means of standard Ethernet network cables (RJ45, CAT5) 56 The resulting measurement system can be managed from a PC (also connected via an Ethernet LAN or WLAN) which serves as the configuration tool and repository for measured data.

However, the system can also work autonomously without a control PC: either starting immediately upon being powered, or automatically at a specified time according to a pre-set autostart configuration. In either case, the recorded data may be saved to the device's storage (hard drive, flash card or USB media), or to a network drive. Data can be retrieved from a remote device directly (removable storage media), or via the network if there is a (temporary) outside connection.

Technical specs of the base unit 298

6.1.1.2 System bus

The selection of EtherCAT as the system bus provides the user with the advantage of being able to set up a distributed measurement system with standard CAT 5 network cables, including those in an existing Ethernet infrastructure. EtherCAT's software protocol is an established industry standard which supports deterministic transfers and synchronization mechanisms, guaranteeing precisely synchronized measurements throughout the network.

6.1.1.3 Modular components "click" together

The individual modules are constructed to form a tight mechanical connection "with a click", while being electrically connected to the imc CRONOSflex data bus and, if desired, power. When added or removed, hardware modules are also automatically included/excluded by the imc STUDIO software. An optional powered handle unit can be attached to the stack in the same manner as imc CRONOSflex Modules, optionally containing a stabilized 50 V system power supply unit with buffered uninterruptible power supply (UPS). When "clicking together (connecting the components)" so modules in this way, you create a portable, centralized measurement system which can subsequently be customized both in terms of the module types and quantity.

6.1.1.4 Assignment of the module address

The imc CRONOSflex modules are configured by the device software just as signal conditioner modules within the imc CRONOScompact frame; each module requires a unique identifier, which allows identification of each physical input channel with its respective channel name and settings. However, unlike CRONOScompact, CRONOSflex measurement modules are automatically recognized and numbered in the user activated identification procedure. This module number is displayed on the modules front panel, and is retained until the next system-identification process. This ensures that modules, along with their names and configurations, remain uniquely assigned, even if other imc CRONOSflex Modules are added or removed from the system, or if the physical order changed.

The flexible modularity of the system and the robust connection mechanism make it possible to easily assemble customized measuring systems from a pool of basic units and measuring modules in seconds. This method of operation is supported in address management by the fact that an imc CRONOS flex module stores the number (address) assigned to it together with an identifier of this controlling base unit when the number is assigned. Several such "address configurations" can be stored. A measuring module can thus assume the appropriate number depending on the currently connected base unit or the current system configuration without the need to reassign the module address each time.



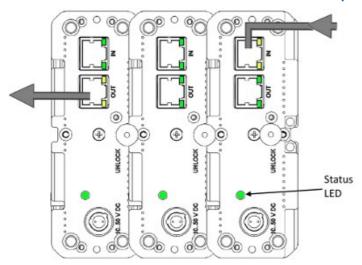
Reference

For a description of the necessary settings in the operating software please refer to the imc software manual.

6.1.1.5 Internal system-bus: network cables

For connecting the imc CRONOSflex base unit and multiple imc CRONOSflex Modules together to form a single imc CRONOSflex system, besides the power supply an internal system bus is necessary. It is based on standard network hardware and the real-time -Ethernet protocol "EtherCAT". The bus has a line-shaped topology where each module has both an input and output terminal to the bus. For modules directly stacked by the click mechanism, the bus as well as the supply lines is connected by means of the modules' plug-in connectors. Accordingly, for the EtherCAT bus the system features priority and blocking circuitry, which only enables the RJ45 network terminals provided for external cabling if no directly docked module is detected. Indicator LEDs on the network sockets support the wiring process and status diagnostics.

Network terminals and status LED on the rear module panel



Constant yellow lights on the terminals indicate the system expects connection of an external network or patch cables, where the bus line originating at the base unit is connected at "IN" terminals and the line leading outward to any further bus subscribers is connected to the "OUT" terminal.

The last imc CRONOSflex Module in the system's "OUT" terminal then stays unoccupied; the bus is not circuited as a ring.

Green flashing terminal lights indicate bus activity, not necessarily in the sense of actually proceeding measurement but also in the sense of previously started modules which have recognized the neighboring modules to which they are connected either via external cables or by direct module stacking. In this case, the respective green-blinking RJ45 sockets are empty, and no longer occupied by cables.

Status LED

- Normal operation: the Status LED shines green
- Error: LED shines red! (possible causes: problems communicating with the ECAT master, or ESD problems.
- Power ON/reboot: LED first shines yellow, then red, then the status LED flashes green for approx. 5 s, then the initialization phase starts
- Initialization phase: LED flashes for approx. 10 s to 15 s yellow;

subsequently normal operation should be indicated by constant green shining

6.1.1.6 Distributed measurement system

For even more flexibility, the EtherCAT based imc CRONOSflex system can be physically distributed using standard cables (RJ45, CAT5). Additional measurement modules can be connected, individually and as local blocks of modules which are locally clicked together, but remote from the base unit. The combination of these two connection techniques, centralized "clicked" stacks and distributed cable connected modules and substacks, allows any imaginable topology of measurement locations to be joined together into a logically integrated, centrally controlled, data acquisition and control system.

The spatial distribution of such a measurement system can extend to distances of 100 m between any two components. This makes it possible to place measurement modules in close proximity to local measurement sites and sensors, in many cases drastically reducing the amount of wiring required.

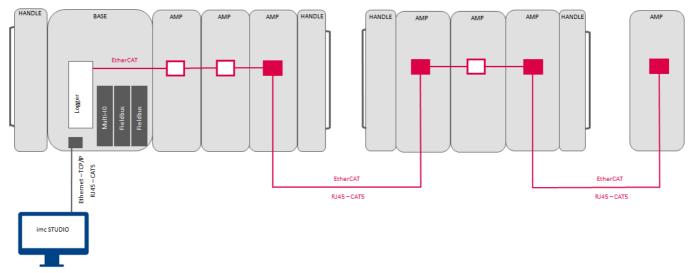
Consider as well that long signal cables, especially carrying weak analog measurement signals, are generally much more sensitive to electrical interference problems than the error-tolerant network connections used by

imc CRONOS*flex*. Consequently, a distributed system topology can benefit from a more flexible and cost effective setup, with improved signal quality.

6.1.1.6.1 System structure and components

A complete system always consists of a central imc CRONOS*flex* base unit and a flexible amount of imc CRONOS*flex* modules (AMP). The imc CRONOS*flex* base unit is available as a <u>variety of models</u> 2981. With either one or two fieldbus interfaces (each with two nodes), as well as an optional Multi-IO extension, which provides digital inputs and outputs plus incremental counter measurement channels and analog outputs.

imc CRONOSflex as a decentralized, distributed measurement system



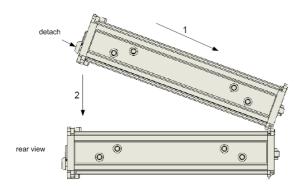
6.1.1.6.2 Use with imc CRONOScompact

One additional use for the flex-series' signal conditioning modules is in conjunction with an imc CRONOScompact system: in contrast to CRONOSflex system, CRONOScompact is a "rack"-based series of devices, which can accommodate several conditioners as plug-in modules in a device frame. These "CRC-plug-in modules" do not have either their own housing nor their own power supply, and are not spatially distributed.

6.1.1.7 Attachment mechanism

Stacking of the imc CRONOSflex Modules

1. Hook tongue into the groove



2. Press modules together



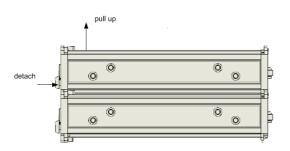
You will here a "clicking" sound after successfully connecting the modules.

After successfully clicking the modules together, you should hear a "click sound".

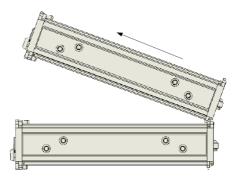
The modules are now mechanically locked and electrically connected!

Detaching modules from the stack

1. Detaching



2. Pull tongue out of groove





Note

Handling

- Be aware that **during a running measurement**, modules should not be disconnected from the system (hot plug functionality is not supported during a running measurement).
- To avoid damage: Before clicking together or removing modules and power handles, disconnect the supply lines and switch the system off, in order to ensure that the system is disconnected from the supply voltage.
- The <u>CRFX handles</u> are mandatory for the safe transport and handling of a module block: e.g. CRFX/HANDLE-L (left, 11900008) and CRFX/HANDLE-R (right, 11900007).
- A maximum total length of 85 cm of attached (clicked) modules should not be passed! Mounting elements *can* be used for more stability.
- The sizes (drawings) of all available modules are listed in a separate document (data sheet). The dimensions, the distances of the bore holes for available mounting elements are also stated in this separate document.



Description of the mounting systems

6.1.2 imc CRONOS-XT

An imc CRONOS-XT (CRXT) system is composed of a base unit plus a power supply module and one or more CRXT modules as well as the system sealing handles (left and right). The individual modules are constructed to form a tight mechanical connection. At the same time, the "click" establishes an electrical connection to the system bus and the power supply. Clicking (or releasing) the CRXT slices together is only allowed in a controlled environment. The resulting measurement system can be manged from a PC which serves as the configuration tool and repository for measured data. Additional fastening elements are recommended for particularly harsh conditions. Please refer to the CRXT base unit data sheet for vibration specifications and IP protection level.

The CRXT slice with the weakest specification is decisive for the entire CRXT system.

The power supply of a CRXT system is provided exclusively via the power socket (Fig. 1 item A) by the POWER Module. If the supply voltage fails, an internal buffer keeps the base unit of the device active for a few seconds to complete the measurement save data files and then automatically shuts itself off. Short-time buffering to ensure data integrity is always a standard part of the system.

Main switch

The CRXT base unit has a central main switch (Fig. 1 item B) by which the complete block of directly clicked (stacked) modules is activated/deactivated. As an alternative to the manual main switch on the device's front panel, a remote-controllable electric contact can be used to switch the system on and off. Both the extended POWER module (CRXT/POWER-X) and the base unit are equipped with a REMOTE socket.



Fig. 1: CRXT/POWER and CRXT/2000

Legend:

_	
Α	power socket
В	main switch
С	REMOTE socket
D	cap of the data storage slot
F	grounding



Reference

Please find here technical details 303.

Pin configuration XT-Con: Power supply, Remote, SYNC, Display and GPS 492

6.1.2.1 CRXT/POWER-X functions

Within an imc CRONOS-XT device the POWER-X module fulfills the function of an extended system supply. It can be used as an alternative to the simple POWER module, which only provides the simple supply voltage feed via XT-Con socket. The POWER-X module offers the following extended functions:

- Voltage converter for internal 34 V DC link
- Available interface for connection of distributed EtherCAT-based amplifiers of the imc CRONOS series (CRXT and CRFX)
- Support of Power-over-EtherCAT (PoEC) for distributed CRXT systems
- centrally remote controlled switching on of distributed amplifier blocks

6.1.2.2 Voltage converter

In the sense of a "Step-Up" converter the connected supply voltage is raised to a constant device-internal intermediate circuit of 31 V to 35 V. This allows in particular the operation of larger devices with low supply voltages, such as the 12 V on-board power supply in vehicles, since the currents via the module click connectors (subject to limits) are reduced accordingly.

6.1.2.3 EtherCAT system bus wit XT

The internal EtherCAT system bus of the device is provided to the outside via M8 sockets, thus enabling the operation of distributed systems. These can be composed of a master device (base unit with or without further amplifier modules) and spatially separated blocks of amplifiers (slaves). CRXT amplifier blocks must in turn be equipped with a POWER-X module. Such distributed systems can also be combined from slices of imc CRONOS-XT (CRXT) and imc CRONOSflex (CRFX). This means that distributed flex amplifier modules can be operated on an XT device and a flex base unit can also be combined with an XT amplifier block (with POWER-X). Suitable connection cables with mixed connection technology (M8 to RJ45) are available.

Networking via EtherCAT can also extend over several stages: A further slave can be connected to a slave block via cable (EtherCAT IN/OUT).

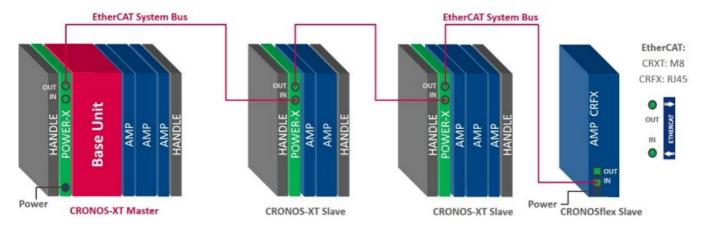


Fig. 2: distributed system configuration with CRONOS-XT and CRFX components

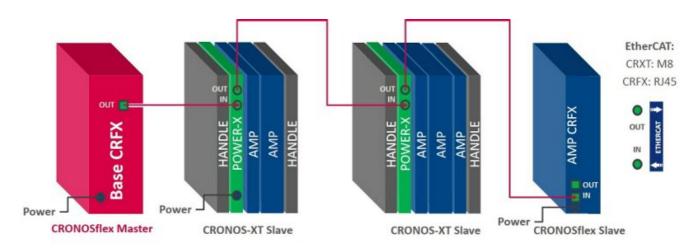


Fig. 3: distributed system configuration with a CRFX Base Unit, CRONOS-XT and CRFX components



Notes concerning the EtherCAT System bus

- The internal EtherCAT system bus directly provided at the POWER-X serves exclusively for networking with the EtherCAT-based components of imc CRONOS. General EtherCAT components of third party suppliers are not supported!
- The CRONOS-XT base unit can be equipped with an EtherCAT slave fieldbus interface. However, this interface is not related to the EtherCAT system bus (master) described here, which is accessible at the POWER-X module and allows networking of imc modules.
 - The ECAT slave interface does NOT **directly** provide the internal system bus, but rather forms a **decoupled** interface to the overall system: This slave interface (with its own interface processor) then allows selected channels of the overall CRONOS device, in the sense of a complex slave subsystem, to be exchanged with a **foreign external** EtherCAT master (automation systems, e.g. TwinCAT)!

Power over EtherCAT (PoEC)

Via the EtherCAT system bus interface, the imc components involved can also be supplied via Power-over-EtherCAT (PoEC) using the same cable. This makes a separate supply connection for remote amplifiers generally unnecessary. The available operating supply power exchanged between the imc CRONOS-XT slices can be sufficiently large (max. 1.5 A).

Remote controlled switch-on (REMOTE)

The distributed amplifier units can be switched on remotely via the central main switch of the base unit. Although this function uses PoEC signals, it is independent of whether remote modules are actually supplied via PoEC.

Furthermore, the POWER-X module has its own REMOTE socket (XT-Con) with control signals for switching on and off. In connection with an XT base unit, its main switch is decisive for manual switch-on, but the REMOTE connection of the base is not effective.

6.1.2.4 Switching on and off

The POWER module does not have a separate push button for switching on and off, rather the main switch (push button) of the base unit installed in the same device is decisive. The device (or an amplifier block) combined with the POWER-X module switches on when

- the button of the base unit (if available) is pressed.

 The REMOTE connection of the base is not considered!
- a button connected to the REMOTE socket of the POWER-X is pressed.
- a switch connected to the REMOTE socket of the POWER-X is closed and at the same time an external supply via the XT-Con socket is present.
- a PoEC voltage is present at the module's own EtherCAT input socket (≥30 VDC). This mode is especially relevant for the operation of distributed amplifier blocks.
 If an external supply (10 to 35 VDC) is available via the XT-Con socket at the same time, the block connected to the POWER-X is only supplied via the XT-Con socket, while the PoEC signal may only control the power-on.

Accordingly, power off is controlled by the main switch of the adjacent base unit, as well as the control options, which are also supported for amplifier blocks:

- pressed button via REMOTE socket on the POWER-X
- open switch via REMOTE socket on POWER-X
- a PoEC voltage at the EtherCAT input socket drops to <25 VDC.

Switching on of a distributed system

When operating a master device (with one POWER-X) together with a unit of amplifiers (with another own POWER-X), the master device always provides a "valid" PoEC voltage at the EtherCAT interface (M8) at power-on thanks to the 31 V voltage converter. The amplifier expansion block connected via this cable is therefore switched on and off remotely via the PoEC signal. The actual supply of the slave system can be done either via the XT-Con socket or via PoEC, which then has to be considered as part of the output power of the master system.

Remote socket

The assignment of the REMOTE socket of the CRXT/POWER-X is identical to the CRXT base unit $(Fig. 1 item C \mid 60)$ except for pin 5 and pin 6. A static switch (between pin 1 and pin 2) or a push button (between pin 3 and pin 4) can be connected for switching on and off (In the following section you will find the pin assignment (492)).

6.1.2.5 LED status indicators

The CRXT/POWER-X module is equipped with two multi-color LEDs that provide information about various operating states:

"POWER"-LED	State
green	operation without special limitation of the output power, device is supplied by external supply voltage 10 V to 35 VDC
yellow	operation with particularly limited output power, device is supplied via external supply voltage <10 VDC
alternately flashing green and yellow	Operation without special limitation of output power, device is powered by PoEC due to an external supply voltage <10 VDC
red	An error has occurred. The following causes are possible:
("LIMIT"-LED is off)	 Device is shut down, but cannot switch off, e.g. because the remote switch is closed or PoEC voltage is present. Output voltage is less than 26 VDC and therefore too low (hardware defect) internal error

"LIMIT"-LED	State
green	current output power at less than 80 % of the permissible output power
yellow	current output power between 80 % to 95 % of the permissible output power
red	current output power over 95 % of the permissible output power; there is a risk of forced shutdown due to overload
red flashing	the short-circuit protection of the device has deactivated the output voltage for 4 seconds; the output voltage is then switched on again

6.1.2.6 Technical performance (CRXT/POWER-X)

6.1.2.6.1 Output voltage and connection of additional measuring modules

The CRXT/POWER-X module boosts any external supply voltages (via XT-Con sockets) in the range of 7 to 31 VDC high to a constant output voltage of 34 VDC. If the external supply voltage is higher than 31 VDC, it is passed on to the output unregulated.

A PoEC voltage, fed into the EtherCAT input socket is passed to the output if its level is higher than 31 VDC and the external supply voltage at the XT-Con socket is lower than 10 VDC. At a PoEC level lower than 31 VDC the output voltage is increased to constant 31 VDC. The output voltage is available at the lateral "click" mechanism that connects to the adjacent device block as well as at the EtherCAT output socket. The available output power is divided between both sockets.



Reference

Technical Specs 307

6.1.2.6.2 Output-side overcurrent protection

To protect against overloads caused by a configuration of unacceptably large systems, the POWER-X module has two independent current limiting circuits:

- 1. Short circuit protection (response time 10 to 30 ms)
- 2. static overload protection (reaction time approx. 1 second)

The **short-circuit protection** limits the output current to approx. 2.5 A (=85 W @ 34 VDC). If this limit is exceeded, the output voltage is cut off after approx. 10 to 30 ms and is only enabled again after approx. 4 seconds. If the short-circuit has not yet been eliminated, the system waits another 4 seconds and so on. During this "wait" the "LIMIT" LED of the Power Module flashes red every second.

The overload protection continuously evaluates the current output power and initiates a shutdown process after 10 seconds if the permissible static output power of 70 W is exceeded. The "LIMIT"-LED lights up yellow at an output power >80 % and red at an output power >95 % of the maximum permissible static output power.

6.1.2.6.3 Fuse

The CRXT/POWER-X module is protected by a non-resettable 16 A fuse at the input.

6.1.2.7 Attachment mechanism (CRXT)

Stacking the modules

- 1. Check the greased rubber seal for cleanliness
- 2. Make sure that the blue slider (protective function) is in position "open" (the blue handles of the slider are not aligned with the cooling fins of the housing)
- 3. Hook the front side of the modules into each other
- 4. Compress the rear side of the modules
- 5. For checking press the locking rocker and
- 6. Check the protective function: the blue handles of the slider are in alignment with the cooling fins of the housing, see Fig. 4 67

Detaching modules

- 1. Release the protective function and press the locking rocker
- 2. Detach modules from each other

Protective function

Until May 2020 the locking rocker was equipped with a locking screw so that the rocker cannot be operated. As of May 2020 the rocker will be equipped with a **locking slide in blue color**. With this slider the rocker can be fixed without tools.



Warning

All sliders respectively locking screws should be tightened before switching on the system.



Note

- During operation respectively powered device: modules should not be disconnected from the system To avoid damage:
 - Before clicking together or removing modules, switch off the system and disconnect the supply lines. (hot plug functionality is not supported during a running measurement).
- A maximum total length of 0.5 m of attached (clicked) modules should be observed!
- The rubber seals must be greased and clean so that the system is well sealed.
- The **CRXT handles** are mandatory for the safe transport, handling and sealing of a module block.

Sealing, IP rating and environmental specs

A single base unit or single CRXT slices cannot achieve an IP protection level at first because it is left open at the side. The given specifications are always only valid for a complete in a controlled environment clicked (closed) CRXT system. Only after it has been combined with a CRXT base unit (plus power module), CRXT slices if applicable, and the final sealing handles to form a complete CRXT system, sealing and environmental properties can be determined. The specification for shock, vibration and IP degree of protection applicable to the entire device is then derived from the weakest specification of the CRXT slices used in this combination (given in the technical data sheets of the respective CRXT slices). They assume that the individual CRXT slices are each mounted in conjunction with the additional stabilizing interconnect brackets (included in the standard accessories supplied).

According to IEC 60529 the Ingress Protection (IP) rating refer to protection classes provided by a housing, the protection of the electrical parts within the housing shell. If all functionally accessible contacts of the sockets are also to be protected, the corresponding plugs must be connected to all sockets. In many cases, a protective cover can also be used alternatively on unused sockets.



Reference

The sizes (drawings) of all available modules are listed in the data sheets of the modules and the base unit. The dimensions, the spacing of threadings for available mounting elements are stated in this separate document: "Description of the mounting systems".





Note

For the protective function: The blue handles of the slider have to be in alignment with the cooling fins.

Fig. 4 shown: open, unlocked state

6.1.3 imc CRONOScompact (CRC)

imc CRONOScompact (CRC) is a modular and compact measurement system which is available in a variety of housing sizes and designs. It consists of a base system in the form of a portable or 19" rack housing which can be equipped by the user with plug-in amplifier and/or conditioning modules to achieve quick and easy modifications.



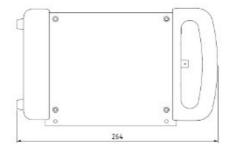
front imc CRONOScompact



rear view



lateral view

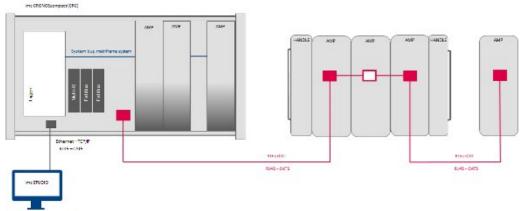


dimension

Device types

Devices belonging to the "GP" series can additionally be equipped with a "CRFX-Interface" (extension module "CRC/CRFX"). It operates as an EtherCAT master, interfacing to external CRONOSflex modules (amplifiers). These modules can be distributed in a decentralized setup, and with their channels they increase the system's total aggregate sampling rate to up to 2000 kHz.

Devices equipped with a "CRFX-Interface" are also referred to as "CRC-2000G(P)" such as in the manual and technical documentation. However, such systems are not listed as a particular sales item but rather they can be assembled from CRC-400GP devices of any model or size plus the additional "CRFX-Interface" (only available for order as a factory option), as desired.



"internal" CRC plug-in modules and "external", distributed imc CRONOSflex Modules.

As with the CRONOSflex system, in this environment, too, the "external" signal conditioners are fully supported by and integrated into operating software (imc STUDIO). There are no appreciable differences between operation and administration of



Note

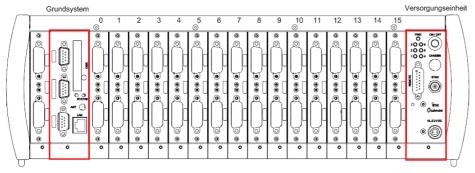
The power supply of a connected CRFX module out of a CRC system is not possible (no PoE of)

Which address is useful for a new module in an equipped CRC device?

The individual modules of an imc CRONOS device are distinguished from the measuring system by module addresses (hardware and software). These module addresses must be set before the module is installed (HEX switch). The module addresses of the other modules in the device must be taken into account. If module addresses are assigned twice or several times, this leads to conflicts and the affected modules are not or not correctly recognized by the device software. This leads to errors that are difficult to identify!

The possible slots, combinations of "CRC plug-in modules" and restrictions are described in this chapter. First an example with a device that is equipped with modules that are 4 TE (=20.32 mm) wide, i.e. occupy a slot in your imc CRONOScompact device. The following instructions for setting the module address of a module in an already equipped device must be observed:

1. the supply unit is configured in the device ex factory. The supply unit must not be subsequently replugged!



2. The numbers 0 to 15 on the cover plate (see Figure above) of your imc CRONOScompact device correspond to the module addresses ex works. The module address 0 to F of a module is set via a HEX switch on the "CRC plug-in module".



Note

The module address (0 to F) set on the module with the HEX switch must match the slot position (see cover plate 0 to 15)!



Attention! Do not break the security seal!



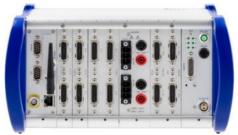
The modules (e.g. HV2-4U) with security seal (under the cover strip) were checked in the measuring system for compliance with the safety regulations according to DIN EN 61010-1 before delivery and subjected to a high-voltage test. After the success of these final tests, the module is sealed. If the security seal is broken, safe operation can no longer be guaranteed. Any intervention, such as a temporary removal of the module, requires a renewed security test.

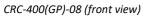


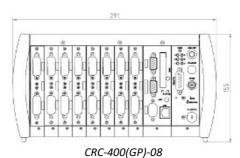
Reference

You can <u>find here further features</u> and technical details.

6.1.3.1 CRC-400(GP)-08







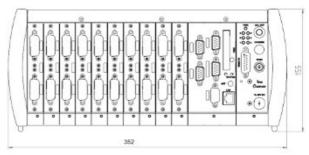
0.10 100(0.700

CRC-400(GP)-08 has the dimensions of half of a 19" rack and weighs approx. 7 kg (max. 9 kg).

6.1.3.2 CRC-400(GP)-11



CRC-400(GP)-11 (front view)

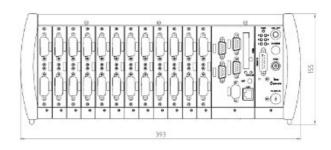


CRC-400(GP)-11

6.1.3.3 CRC-400(GP)-13



CRC-400(GP)-13 (front view)

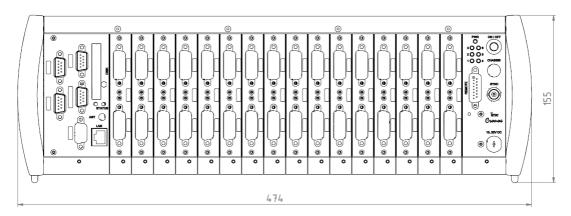


CRC-400(GP)-13

6.1.3.4 CRC-400(GP)-17



CRC-400(GP)-16



CRC-400(GP)-17



Note

This housing variant can be equipped with analog, digital and fieldbus modules (see list of the modules and combined freely. The number of used analog respectively digital modules may not exceed 16.

The battery is situated on the bottom side of the measurement device. It is possible to order two battery sets for this housing and for the $\underbrace{\text{imc CRONOScompact-400(GP)-17}}_{70}$ housing model. In contrary to the CRC-400(GP)-08 or the CRC-400(GP)-11. In those housing models only one batty pack will fit. The charging level can be indicated on the front of the device by four LEDs. The charging level is $\underbrace{\text{described}}_{\text{here}}$



imc CRONOScompact with two Li Ion battery

6.1.3.5 CRC-400(GP)-RACK

All terminal connections (and the handholds) are situated on the front of a imc CRONOScompact RACK, only on one side of the RACK (as per standard). An alternative configuration e.g. the supply connection, the SYNC- and remote connection can be situated at the opposite side of the module's inputs.



There are 16 free slots in a CRONOScompact AC- and DC-RACK. Your system can be freely configured with analog, digital and fieldbus modules. Exception #1: totally 16 analog or 16 digital modules, e.g. 16 analog and two digital modules. Exception #2: the SYNTH-8 294 module, this module will be detected as a fieldbus module.



Note

AC-RACK

- The stated amount of free slots (16 free slots) can only be achieved if the AC supply unit is situated on the rear panel of the RACK. The DC supply unit will stay at the front.
- The power adaptor that is integrated in a CRC-AC-RACK should not be used in extended temperature ranges!

6.1.4 imc CRONOS-SL

imc CRONOS-SL are highly compact, super- robust mobile measurement systems, for applications in rough environments. They conform to MIL STD810F, one of the highest standards for temperature, pollution protection, and shock resistance. The imc CRONOS-SL systems fulfill the IP65 degree of protection. Please find here a short IP65 description 91 and the use with the imc plugs.

The signal conditioning, AD-conversion, online processing and data storage are integral components of the measurement system. This makes imc CRONOS-SL ideal for measurement tasks in experiments or long-duration test, or monitoring tasks e.g. on board vehicles, machines or in outdoor measurement sites, where regular measurement equipment fails.

Technically, the SL systems have the same possibilities as imc CRONOScompact. However, the designations CRONOS-SL-2 and -4 indicate that two or respectively four measurement amplifiers with up to 16-, or 32 channels can be configured. The device properties are stated here 314.

6.1.4.1 imc CRONOS-SL-2



imc CRONOS-SL2 (front view)

Dimension (W x H x D): 286 x 80 x 350 mm

Weight: approx. 6,5 kg

Max. number of amplifiers: 2 (16 max. analog channels)



imc CRONOS-SL2 (back view)

Signal plugs (backplane): DSUB-15 for analog and 4x DSUB-15 for DI-DO-ENC or 16x LEMO 7-pin

6.1.4.2 imc CRONOS-SL-4



imc CRONOS-SL-4

Dimension (W x H x D): 286 x 116 x 352 mm

Weight: approx. 8 kg

The sockets on the device side require suitable plugs to be terminated for tightness, or alternatively suitable sealing protective caps.

Device overview Chapter 6

6.2 Device overview

Some of the capabilities discussed in this document only pertain to certain device models. The associated device groups are indicated at the respective locations. The groups are shown in the following table.

					— CRXT	not ava	ilable DNOS-XT	C	• sta CRFX im	indard c CRONC	Sflex	C	o opti RC imc	onal CRONOS <i>co</i>	mpact
imc device	SPARTAN BUSDAQ	BUSDAQflex	SPARTAN-R SPARTAN-N	CRSL-N	CRC-400 CRFX-400	C1-N C-SERIE-N	C1-FD C-SERIE-FD	CRFX-2000	CRC-2000G	CRC-400GP	CRFX-2000G	CRFX-2000GP	CRXT	EOS	ARGUSfit
Driver package						ir	nc DEVIC	ES						imc DE\	/ICE <i>core</i>
Firmware group							Α							В	
Device group	А	4			A5			A6			A7			B10	B11
SN ¹	1	3			14			16			19			4120	416
TCP/IP Interface [MBit/s]	10	00	100			100			1000			1000	1000		
Sampl.Rate ² [kHz]	40	00		400		2000 / 400 ³	2000 / 400 ³	2000 / 400 ³	2000	2000	2000	4000	5000		
imc STUDIO Monitor supported		•	•			•	•				_	_			
Connections ⁴	4	l .		4			4	4			_	_			
							Data Sto	rage							
CF		•			•			_			_			_	_
Express Card	_	-			_			•	-				_	_	
CFast	-	<u> </u>			_			_			•			_	_
USB	-	-			_			•	•	•	•	•	_	_	_
microSD	-	-			_			_	-				_	•	
Storage on network drive	•	•			•			•	•				_	_	
Internal hard disk	(o) ⁵	_	0	0	0	_	_	0	0			•	_		
						Sy	ynchroni	zation							
DCF	•	•			•			•			•			_	_
IRIG-B	_	•			•			•			•			•	•
GPS	•	(●) ⁶	•			•	•				_	_			
NTP	_	•		•		•			•			•	•		
РТР	_	_	_		_	-	•	_	•	•	_	_			
Phase offset correction	_	•		•			•			•			•	•	

¹ Extend serial number range by four digits (three for imc EOS)

² Max. aggregate sampling rate (see data sheet)

^{3 2000} via EtherCAT else 400

⁴ Number of imc STUDIO Monitor-connections or imc REMOTE (as of 14xxxx) connections

⁵ not available for imc BUSDAQ-2

⁶ not available for imc BUSDAQflex-2-S

6.3 Miscellaneous

This chapter describe imc specific solutions and expansion possibilities of your measurement device.

6.3.1 Sampling rate

Among the measurement device's physical measurement channels, up to two different sampling times can be in use. The smallest possible sampling time is 10 μ s, corresponding to a channel sampling rate of 100 kHz (sampling frequency). The aggregate sampling rate of the system is the sum of the sampling rates of all active channels.

The aggregate sampling rate can take a maximum value of 400 kHz with devices of group A4 to A5 74.

The aggregate sampling rate can take a maximum value of 2 MHz via EtherCAT else 400 kHz with devices of group A7 74. This maximum aggregate sampling rate (2 MHz via EtherCAT) can only be achieved when not using the process vector variables, without any trigger, and only in 16-bit mode! A CRFX / DAC-8 module contributes 5 kHz and 16 bits per channel, regardless whether it is used in the experiment.

The sampling rates of the **virtual channels** computed by **imc FAMOS** do not contribute to the sum sampling rate. Along with the (maximum of) two "primary" sampling rates, the system can contain additional "sampling rates" resulting from the effects of certain data-reducing imc Online FAMOS functions (ReductionFactor RF).



Note

There is one constraint when selecting **two different sampling rates**: **Two sampling rates** having the ratio **2:5** and lower than 1 ms are not permitted (e.g. 200 μ s and 500 μ s). Any attempt to set sampling rates which do not comply with this rule will cause an error message to be posted:

"The two active sampling intervals may not be in a ratio of 2:5. Error number: 365"



Note

Note for imc CRONOSflex/CRONOS-XT

For CRFX/CRXT modules, the following limitations apply due to the CRFX systembus's 5 kHz bus rate:

- A CRFX/CRXT-channel sampling at a slower rate than 5 kHz produces the same data load on the systembus as a 5 kHz channel. Thus for instance, 20 channels sampled at 100 Hz produce a load of 100 kHz on the systembus instead of 2 kHz.
- With 2 kHz channels, the resulting data load per channel is 10 kHz due to the 2:5 ratio.
- <u>DIO- and DAC modules [253]</u> support a maximum sampling rate of 5 kHz, even though 100 kHz can be set in the software.



Note

Note for GPS channels

Due to system limitations, **GPS channels** for determining the fastest sampling rate in the system are not taken into account. For an working configuration, at least one other channel (fieldbus, digital or analog) must be sampled at the same or faster sampling rate.



Reference

Please consider the specifications in chapter " $\frac{\text{Technical Specs}}{\text{configuration}}$ " and the description of the channels configuration in the software operating manual.

6.3.2 Filter settings

Theoretical background

The filter setting is especially important in a signal-sampling measurement system: the theory of digital signal processing and especially the **sampling theorem** (Shannon, Nyquist) state that for such a system, the signal must be restricted to a limited frequency band to ensure that the signal has only negligible frequency components beyond one-half of the sampling frequency ("Nyquist-frequency"). Otherwise, "aliasing" can result – distortions which cannot be removed even by subsequent filtering.

The imc device is a sampling system in which the sampling time (or sampling rate) to be set is subject to this condition. The low pass filter frequency selected thus hinges on how band-limited the signal to be sampled at that rate is.

The control AAF for the filter setting stands for "Automatic Anti-aliasing Filter", and automatically selects the filter frequency in adaptation to the sampling rate selected. The rule this is based on is given by:

```
AAF-Filter frequency (-80 dB) = sampling frequency \cdot 0.6 = Nyquist frequency \cdot 1.2
AAF-Filter frequency (-0.1 dB) = sampling frequency \cdot 0.4 = Nyquist frequency \cdot 0.8
```

General filter concept

The imc system architecture is actually a two-step system in which the analog signals are sampled at a fixed "primary" sampling rate (analog-digital conversion with Sigma-Delta ADCs). Therefore a fixed-frequency analog low pass filter prevents aliasing errors to this primary rate. The value of this primary rate is not visible from the outside, depends on the channel type and is generally greater than or equal to the sampling rate which is selected in the settings interface.

The filter to be set is realized as a digital filter, which offers the advantage of precise characteristic and matching with respect to magnitude and phase. This is especially important for the sake of matching of channels which are jointly subjected to math operations.

For any data rate to be set in the system configuration (f_sample), then digital anti-aliasing filters (low pass filters) ensure compliance with the conditions for the Sampling Theorem. Three cases can be distinguished.

Implemented filters

Filter-setting "Filter-Type: without":

Only the (analog) anti-aliasing filter, matched to the primary data rate is in effect.

This setting can be useful if maximum bandwidth reserves are to be used and there are known limitations on the measured signal's spectral distribution, which justify not performing consistent filtering.

Filter-setting "Filter-Type: AAF":

The (digital) anti-aliasing filters are elliptical Cauer filters. Their "tight" characteristic curve in the frequency range makes it possible to have the cutoff frequencies approach the sampling and Nyquist frequencies much closer without having to make a compromise between the bandwidth and freedom from aliasing.

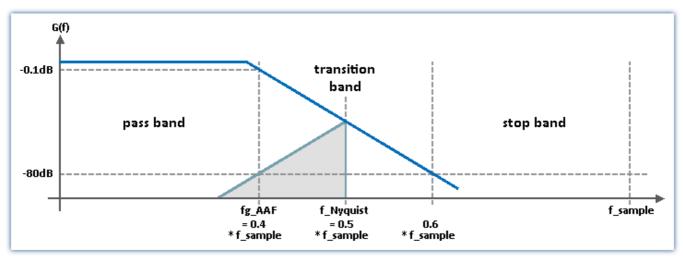
The automatic selection of the cutoff frequency in the setting "AAF" is based on the following criteria:

• In the pass band, a maximum (AC-) gain uncertainty of 0.06% = -0.005 dB is permitted. The pass band is defined by the cutoff frequency at which this value is exceeded.

- The stop band is characterized by attenuation of at least -80 dB.
 This damping is considered sufficient since discrete disturbance frequencies can never reach 100% amplitude: the input range is mostly filled by the useful signal.
- The transition band is typically situated symmetrically around the Nyquist-frequency. This ensures that the aliasing components reflected from the stop band back into the pass band are adequately suppressed, by at least -80 dB. Remnant components from the frequency range between Nyquist-frequency and stop band limit only reflect back into the range beyond the pass band (pass band to Nyquist), whose signal content is defined as not relevant.

The criteria stated are fulfilled with the Cauer-filters by the following configuration rule:

- fg_AAF (-0.1 dB) = 0.4 · f_sample
- Characteristics: Cauer; Filter-order: 8th order



Filter-setting "Filter-type: Low pass" (band pass and high pass):

A low pass frequency can be set manually, which satisfies the application's requirements. In particular, a cutoff frequency significantly below the Nyquist frequency can be set which guarantees eliminating aliasing in any case, though consequently "sacrificing" the corresponding bandwidth reserves.

```
with fg_AAF (3 dB) = f_sample / 4 attenuation at Nyquist-freq.: 1/64 = -36 dB with fg_AAF (3 dB) = f_sample / 5 attenuation at Nyquist-freq.: 1/244 = -48 dB with fg_AAF (3 dB) = f_sample / 10 attenuation at Nyquist-freq.: 1/15630 = -84 dB
```

• Characteristics: Butterworth, 8th order (48 dB/octave)

Other possible filter settings are "band pass" and "high pass" - both 4th order.

6.3.3 Synchronicity

If certain channels are to be correlated to each other, for instance, for the purpose of computing the power, it's vitally important that there not be a phase-offset between them, in other words, that they be captured synchronously.

One of the main features of devices of the imc CRONOS system family is that it can provide this synchronicity, even for channels of different types and different sampling rates. The condition for this is, that the channels be configured with the same filter setting. The low-pass filters always cause a defined additional phase-offset. For a 1 kHz low pass Butterworth filter, this phase-offset corresponds to a frequency-independent, constant "group delay" which is 663 µs (for frequencies well below the cutoff frequency).



Note

Note that two channels having different sampling rates and both configured with the filter setting Anti-Aliasing-Filter do not have the same filter frequency!

6.3.3.1 Delay

In order to ensure the **synchronization** of all of a system's active channels, all amplifiers' channels are artificially prolonged to the duration of the slowest amplifier's processing time.



Example

Channels having the following amplifiers are involved in a measurement (experiment): BR-4 and UNI-8, UNI2-8.

The specific delays up to the "Process vector" are:

UNI-8, UNI2-8: 1 msBR-4: 3 ms

This means that the total delay up until the display is set at 3 ms. All channels with less delay (process vector) are "artificially" prolonged to the total delay in order to ensure signal synchronization.



Note

Exception

OSC-16 is not compensated since its sampling rate and the associated digital delays is too large.

6.3.3.2 CRC and CRSL

The total digital delays for the various signal conditioners for CRC and CRSL base systems:

Module	Delay
SC2-32	10*Ta (max 5 ms)
ICPU-16	1 ms
LV-16	2 ms
ISO2-8	2 ms
HISO-8	2 ms
UNI-4	2 ms
UNI2-8	1 ms
DCB2-8	1 ms
LV3-8	1 ms
ICPU2-8	1 ms
AUDIO-4 (CRC)	2 ms
ISOF-8	1 ms
FRQ	3 ms

Module	Delay
HRENC	60 μs@50 ksps; 200 μs@20 ksps; 400 μs@10 ksps; 400 μs@5ksps; 1ms@2ksps; 2ms@1ksps;
DIOINC ENC-4	3 ms 3 ms
OSC-16	>10 ms (without compensation)

The displayed delay is the largest single delay of an amplifier involved in the measurement.

6.3.3.3 CRFX and CRXT

The total digital delays for the various signal *conditioners* for base systems CRFX and CRXT:

Module	Delay
BR4	420 μs
ISOF-8	460 μs
ACI-8	460 μs
WFT-2	100 μs
ISO2-8	810 μs
HISO-8	770 μs
UNI-4	440 μs;
	1 ms@1 ksps
DCB2-8	610 μs
UNI2-8	460 μs
LV3-8	460 μs
AUDIO2-4	440 μs
Qi-4	440 μs
FRQ	800 μs
HRENC	600 μs

The displayed delay is the largest single delay of an amplifier involved in the measurement.

6.3.4 SYNC

In order to synchronize the device to an absolute time reference and/or synchronize multiple imc devices (even of different types) use the SYNC terminal. That connector has to be connected with other imc devices or a DCF77/IRIG B signal generator. Technical details: synchronization 317



Note

- To use the SYNC input, IRIG B must be supported. SYNC use with BUSDAQ flex (serial number circle 13...) is therefore also possible.
- The yellow ring on the SYNC socket indicates that the socket is shielded from voltage differences.
- See also chapter *Synchronization* in the imc software manual.

6.3.4.1 Optical SYNC Adapter: ACC/SYNC-FIBRE

One fundamental feature of all imc measurement devices, is their ability to synchronize multiple devices, even of differing models, and to operate them all in concert. The synchronization is typically accomplished by means of a Master/Slave process via the electrical SYNC-signal, which terminates on the devices at a BNC socket.

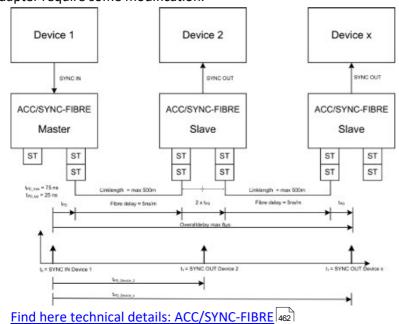
In areas of high electrical interference, or where long-distance signal transmission is needed, the signal can be conducted via fiber optic cabling with total isolation and no interference. For this purpose, the externally connectable optical SYNC adapter ACC/SYNC-FIBRE is available.

When this adapter is used, the BNC socket is not, but rather one of the DSUB-9 sockets for the GPS, DISPLAY or MODEM, which then conducts both the isolated electrical SYNC signal and additionally a supply voltage which is required by the adapter, as well as supplying directional indication (Master to Slave).

For this reason, any imc measurement devices used must be remodeled in accommodation to one of the DSUB-9 sockets. Once either the MODEM or the GPS socket has been remodeled, it is no longer usable for its original purpose. For the GPS socket, this does not apply. Even parallel operation is possible (via Y-cable), if the GPS-data are only used for the position data and the adapter is used for the SYNC signal.

For whichever signal (adapter or BNC) is currently connected, both the electrical and the optical mode can be used, however not both at the same time.

The plug is designed for the extended environmental range. The imc measurement devices used with this adapter require some modification.



6.3.5 Operation without PC

To operate your imc measurement device, you don't necessarily need a PC. Your device will start the measurement independently, if an autostart has been prepared. Using the display, you can use its keyboard to control the measurement. The display serves as a comfortable status indicator device and can replace or complement the imc operating software when it comes to controlling the measurement. It can even be used where no PC can go.

The Display can be connected or disconnected at any time without affecting a running measurement. This makes it possible, to check the status of multiple devices running simultaneously one at a time.



integrated display, only with CL and PL devices

imc CL-xx devices are equipped with an integrated display.

The Display's interaction with the measurement device is handled by means of virtual Display variables or bits, which can either be evaluated for the purpose of status indication or set in order to affect the measurement process.

Detailed descriptions of the functions are presented in the chapter *Display* of the imc software manual.

6.3.5.1 Graphical display



The imc graphical display allows the user to interact with a running measurement process by displaying system status and allowing parameter adjustments via the membrane touch panel.

If the measurement device is prepared for opening a particular configuration upon being activated, it's possible to carry out the measurement without any PC. The Display serves as a convenient status indicator.

The description of the control elements and their function can be found in the imc STUDIO manual chapter "imc Display Editor".

Properties:

- 320 x 240 pixels in 65536 colors
- Housing dimensions approx. 306 x 170 x 25 mm; Readout screen size: approx. 11.5 cm x 8.6 cm
- Bore diameter for Display fixing: diameter core hole 5.11 mm, diameter exterior 6.35 mm (1/4" - 20 UNC),
- Weight: approx. 1 kg, more properties see chapter "Technical Specs 451".
- The Display is controlled by a serial RS232 connection. The update frequency can't be changed. It depends on the load of the device, which is at best 15 Hz.
- The Display must be powered via the 3-pole Binder socket.

6.3.6 LEDs and BEEPER

6 Status LEDs and a beeper are provided as additional visual and acoustic "output channels". They can be used just as standard output channels in imc Online FAMOS by assigning them the binary values "0" / "1" or functions taking the Boolean value range. Interactive setting and Bit-window display for these output channels is neither especially useful nor supported. It is not possible to deactivate the beeper by software. The beeper indicates the starting buffering period of the UPS.

6.3.7 imc Plug & Measure

6.3.7.1 TEDS

imc Plug & Measure is based on the TEDS technology conforming to IEEE 1451.4. It fulfills the vision of quick and error-free measurement even by inexperienced use. TEDS stands for Transducer Electronic Data Sheet and amounts to a spec sheet containing information about a sensor, a measurement location and the measurement technology used. It is stored in a memory chip which is permanently attached to the sensor, and can be read and processed by the measurement equipment. Besides this, the memory also include a number (unique ID) by which the sensor can be uniquely identified.

A TEDS sensor or a conventional sensor equipped with a sensor recognition memory unit is connected to the device. The sensor recognition contains a record of the sensor's data and the measurement device settings. The device reads this info and sets itself accordingly. Any inapplicable sensor information is rejected, and a notification is posted accordingly. For more information, refer to the software user's manual under "Read sensor information".



Note

Used TEDS chip (storage)

Full sensor TEDS support, including the DS2431 type used in most current IEPE sensors, is only available for modules of the imc CRONOSflex (CRFX) and imc CRONOS-XT (CRXT) device platforms.

6.3.7.2 MMI-TEDS

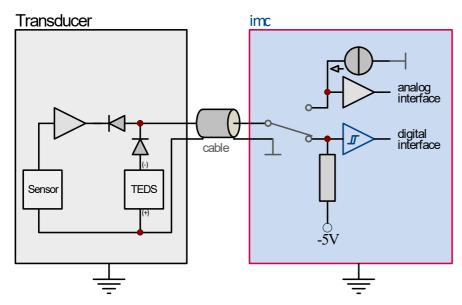
Mixed **M**ode Interface-TEDS, abbreviated **MMI-TEDS** in accordance with IEEE 1451.4. is available in multiple varieties. imc STUDIO supports the following models:

- Class I interfaces are designed for constant current-fed piezo-electrical sensors and use these sensors' quasi standard (integrated electronic piezoelectric IEPE / ICP transducer)
- Class II interfaces are designed for bridge sensors and other sensors.

Class I MMI

A MMI-TEDS in accordance with IEEE 1451.4. Class I Mixed Mode Interface is a memory chip containing an electronic spec sheet directly connected with the sensor's signal lines. This means that the sensor is supplied with power, its signals are carried, and the information in the memory chip is accessed all via the same lines. The sensors are commonly fed with a constant current of approx. 4 mA and are connected via a coaxial cable having a BNC terminal.

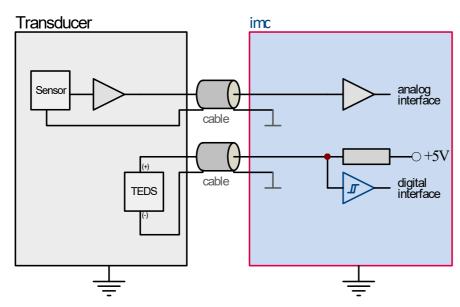
For access to the memory chip, the sensor's reference is connected to a digital interface and supplied with a positive voltage of approx. 5 V, which requires the sensor to be installed having isolation. A technical solution to avoid this limitation is in preparation.



A Class I Mixed Mode Interface receives/ sends TEDS data and analog signals on the same line

Class II MMI

With this model, the TEDS information is transferred over an additional line. The reference ground is connected via the sensor's supply line.



A Class II Mixed Mode Interface receives/ sends TEDS data and analog signals on different lines. The sensor is not influenced.

6.3.7.3 Particular advantages and applications

- Quick and error-free measurement device setting
- Reduction of routine work
- Recordable measurement channel parameter recommendations (sampling rate, filter settings, etc.)
- Standardization of channel designations for particular sensors used
- Verification of calibration data and their validity
- Quick and unambiguous traceability of calibration data per ISO9000
- Monitoring of calibration intervals
- Measurement device-independent sensor administration
- Sensor identification CHIP ACC/TEDS-CHIP; TEDS-Chip on conductor; dimension: 8 mm x 5 mm
- Sensor identification CHIP-D ACC/TEDS-CHIP-D; TEDS-Chip on conductor with 10 cm pigtail plug

6.3.7.4 Sensor administration by database

In the administration of sensor information, the user is supported by imc SENSORS (sensor database for the *imc Plug & Measure technology*).

Along with import of information from TEDS, parameters values can also be transferred from the sensor database by means of drag&drop.

Sensor information can be transferred via the measurement device software from the sensor database to the sensor recognition and vice versa.

For more advanced sensor administration, the sensor database supports barcode reading devices. imc SENSORS makes the use and administration of many different sensors quick, easy and economical by the use of TEDS and imc Plug & Measure.

imc SENSORS is a software expansion for our imc operating software. But *imc Plug & Measure* also functions as a stand-alone application. imc SENSORS is designed to make a sensor's data quickly and comprehensively available.

This makes it possible to:

- · administer sensors in a central database
- parameterize a measurement channel
- trace the calibration history
- inspect the spec sheet

In conjunction with TEDS-capable measurement amplifiers for imc CRONOS System family, imc SENSORS supports modern TEDS sensors in accordance with IEEE 1451.

Especially recommendable for this purpose is the amplifier UNI2-8, to which a wide variety of sensors can be connected directly.



Note

Incremental counter channels neither support TEDS nor information exchange with imc SENSORS.

6.3.8 GPS

At the GPS socket it is possible to connect a GPS-receiver. This makes it possible to achieve absolute **synchronization to GPS time**. If the GPS-mouse has reception, the measurement system synchronizes itself automatically. **Synchronization with a NMEA source** is possible. The precondition for this is that the clock must return the GPRMC-string along with the one-second-interval clock signal.

All **GPS information** can be **evaluated** and subjected to **subsequent processing** by imc Online FAMOS.

GPS signals are available as: process vector variables and fieldbus channels.

GPS information	Description
pv.GPS.course	Course in °
pv.GPS.course_variation	Magnetic declination in °
pv.GPS.hdop	Dilution of precision for horizontal
pv.GPS.height	Height over sea level (over geoid) in meter
pv.GPS.height_geoidal	Height geoid minus height ellipsoid (WGS84) in meter
pv.GPS.latitude pv.GPS.longitude	Latitude and longitude in degree (Scaled with 1E-7)
pv.GPS.pdop	Dilution of precision for position
pv.GPS.quality	GPS quality indicator 0 Invalid position or position not available 1 GPS standard mode, fix valid 2 differential GPS, fix valid
pv.GPS.satellites	Number of used satellites.
pv.GPS.speed	Speed in km/h
pv.GPS.time.sec	The number of seconds since 01.01.1970 00:00 hours UTC.
	For this reason, it is no longer possible to assign the value to a Float-format channel without loss of data. This count of seconds can be transformed to absolute time under Windows and Linux.To do this, use the function below. MySeconds = CreateVChannelInt(Channel_001, pv.GPS.time.sec)
pv.GPS.vdop	Dilution of precision for vertical
	see e.g. www.iota-es.de/federspiel/gps_artikel.html (German)



Note

Scaling of the latitude and longitude

pv.GPS.latitude and pv.GPS.longitude are **INT32 values**, scaled with **1E-7**. They must be **treated as Integer channels**, otherwise the **precision is diminished**.

By means of imc Online FAMOS, you are able to generate virtual channels from them. However, due to the reversal of the scaling, precision is lost:

```
latitude = Channel_001*0+pv.GPS.latitude *1E-7
```

Recommendation: Use the corresponding fieldbus channel: "GPS.latitude" or "GPS.longitude". Here, no scaling is required, so that the precision is preserved.

Sampling rate

Due to system limitations, GPS channels for determining the fastest sampling rate in the system are not taken into account. For an working configuration, at least **one other channel** (fieldbus, digital or analog) must be sampled at either the **same** sampling rate as the GPS-channel, or a **faster** one.

Internal variables; do not use

- pv.GPS.counter
- pv.GPS.test
- pv.GPS.time.rel
- pv.GPS.time.usec

RS232 port settings

For imc devices to be able to use a GPS receiver, the following conditions must be met:

- Baud rate: Possible values are 4800, 9600, 19200, 38400, 57600 or 115200
- 8 bit, 1 stop bit, no flow control
- The following **NMEA strings** must be sent: *GPRMC, GPGGA, GPGSA*. The order of the strings must be adhered to.

Additional strings should be deactivated. If this is not possible, all other strings must be **before** the GPGSA string!

- The receiver must deliver a 1 Hz clock.
- The rising edge of the clock must mark the second specified in the next GPRMC string.
- All three strings should be sent as soon as possible after the 1 Hz clock, so that there is sufficient time for processing between the last string and the next 1 Hz clock.

NMEA-Talker IDs

Supported NMEA-Talker IDs:

- GA: Galileo Positioning System
- GB: BeiDou (BDS) (China)
- GI: NavIC (IRNSS) (India)
- GL: GLONASS, according to IEIC 61162-1
- GN: Combination of multiple satellite systems (GNSS) (NMEA 1083)
- GP: Global Positioning System (GPS)
- GQ: QZSS regional GPS augmentation system (Japan)

DSUB-9 pin configuration 484

6.3.9 NET-SWITCH

The NET-SWITCH is a Network-Switch with PTP-Synchronization and compatible with imc BUSDAQ*flex* (BUSFX) housing (Click-mechanism and power supply).

Highlights:

- 5 Ethernet-Ports up to 1 GBit (1000BaseT)
- Supports PTP (Precision Time Protocol, IEEE 1588v2, end-to-end transparent clock)
- Synchronization of imc CRONOSflex (CRFX-2000GP) and imc CRONOScompact (CRC-400GP)
- Housing compatible with imc BUSDAQflex: Click-mechanism / supply. Can be operated as:
 - o Stand-Alone Switch
 - o Directly connected with imc BUSDAQflex devices (Note: imc BUSDAQflex does not support PTP)
- 2-way redundant options for the power supply (10 to 50 V DC):
 - o Module connector/locking slider
 - o LEMO.0B
- Extended operating temperature range for industrial applications: -40 to +85°C

Click-mechanism (imc CANSASflex / imc BUSDAQflex):

- Modules joinable to module-blocks: mechanically and electrically connected (power supply)
- No tools or additional cabling required
- With guide grooves, magnetic catches and locking slider
- Both short and long housing versions joinable:
 with electrical connection: align on rear side; mechanically only: align on front side
- Direct connection of compatible CAN-logger: imc BUSDAQflex



Reference

Technical specs 466

6.3.10 IRIG-B module

This external IRIG-B module can convert a time signal in IRIG format to the GPS format NMEA 0183 and thus be used for synchronization of different devices.

The expansion module exclusively supports amplitude modulated IRIG signals according to the standards IRIG-B1xx! This is why it can be used both to upgrade older imc device generations which provided no IRIG-B support at all, and to enhance current imc device generations with additional capabilities regarding modulated signals: While many up-to-date imc device series (CRFX, CRC, C-SERIES) offer IRIG-B synchronization via their standard BNC synchronization plug as a standard feature (including DCF-77 / IRIG-B auto-detection), this path only supports direct unmodulated TTL-signals (IRIG-B0xx).

The definition of the various IRIG time codes is specified in the IRIG standard 200-98. This adaptor module supports sub-standards IRIG-B120 through B127. These are characterized by 100 pulses per second, AM (amplitude-modulated) sinusoidal signal, 1 kHz carrier frequency, BCD Time-of-Year.

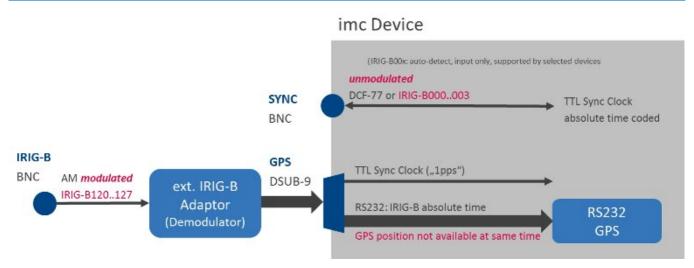
The module's rear panel holds the DSUB-9 plug, which is connected to the measurement system's GPS plug via the included RS232 expansion cable. The pinout of the DSUB-9 plug directly conforms to the "GPS" connectors pin configuration, which is uniform to imc measurement systems.

When using the IRIG-B adaptor in conjunction with this GPS port, absolute time information is captured via this RS232 interface, and additionally, synchronization of the device's system clock is performed by means of an additional clock signal ("1 pps") provided on a dedicated pin of the DSUB-9 terminal. While this occupies the port, simultaneous capture of GPS geo positioning information is not supported at the same time.



Note

The operating software (imc STUDIO) will denote the used synchronization type as "GPS", simply because the respective port is used to interface the IRIG-B module.



The module's front panel has one BNC plug and two LEDs. The LOCK LED shines when the input signal is synchronized with the IRIG-B module. If the input signal is not valid or not synchronized with the IRIG-B module, the FAIL LED shines.



"0" is returned.

The IRIG-B module comprises a realtime clock (RTC) with a backup battery, which is set to time and date according to the IRIG B-signal received. If the IRIG B year codes received equal "00" (depending on used sub-standard) these are ignored and only RTC time and day values are set, while the year continues to reflect the value resulting from counting since the last update with a valid year number. This means that the year number is incremented at the turn of the new year.

To monitor an imc measurement system's synchronization status, it is possible to use the imc Online FAMOS function "IsSynchronized()". Its return value is "1" if the device is synchronized to an external time reference; otherwise, a

Loss of the external time signal is detected within 1-2 seconds. However, the process of restoring synchronization can last approx. 20-25 seconds.

Technical Specs of IRIG-B 463.

Optionally, the module can be factory installed in a measurement system.

6.3.11 WiFi connection

Measurement devices can optionally be equipped with a built-in WiFi (WLAN) adaptor. An alternative wireless network connection may especially useful in applications such as mobile test drives. Measurement devices can be equipped with WiFi adaptors conforming to the standard IEEE 802.11g, which achieve maximum gross transfer rates of 54 Mbit/s, more specifications see chapter <u>Technical details</u>: WiFi [464].

WiFi (WLAN) antenna for a CRx - 400 system (see device overview 74)

Each antenna of the corresponding system is labeled ex-factory at imc Berlin:

- imc CRx 400; antenna with SMA Male only fits with devices with RP-SMA (SMA Female)
- imc CRx 2000; antenna with RP-SMA plug (SMA Female) only fits with devices with SMA Male



WiFi (WLAN) antenna for a CRx - 2000G system

The "2000G" devices allow installation of optional WiFi (WLAN) adaptors conforming to the standard IEEE 802.11n, which by using multiple antennas provides higher data rates. Two externally connectable antennas are supported (standard SMA connection), which together achieve a data rate of 300 Mbit/s.

The WLAN antenna with an SMA male terminal is no longer offered by the manufacturer. imc has a modified substitute antenna from the same manufacturer (this affects systems shipped as of August, 2014). For this reason, imc has changed the connection terminals on the devices (SMA Male). Devices previously having RP-SMA (SMA Female) terminals will instead have SMA Male terminals in future.

There is a new label for the new antenna to differentiate:



WiFi (WLAN) antenna for CRx - 400 system

▶ imc CRx - 400 Typ 2; antenna with RP-SMA plug (SMA Female) — only fits with devices with SMA Male

The antenna labeled: "imc CRx - 2000" can be used for all imc CRONOS with built-in WiFi (WLAN) adaptor (SMA Female).

In order to make the label of the antenna for all devices uniform, we changed the label as follows:



Please pay attention to the terminal connection on your device!

WiFi antenna with RPSMA (female) is only compatible to RPSMA (male) on your device.



WiFi - antenna with RPSMA (female) connection at your device RPSMA (male)



WiFi - antenna with SMA (male) connection at your device SMA (female)

6.3.12 ACC/DSUB-XX-IP65 - protection class IP65

Protection classes serve the purposes of making classifications and identifications with reference to existing safety measures.

The first digit of the (IP 6X) protection type specifies:

• complete protection against ingress of dust



and the second digit (IP X5) specifies:

• protection against jets of water (from any direction)





Note

What must be done

to maintain a IP65-rated connector's protection degree after having been opened?

In order for an imc to retain its protective capability after having been opened and connected, be sure to keep the contact surfaces clean and dry while opening. This is because contaminations can cause damage to the sealing. Such damage can lead to failure of the sealing.

The screws closing the lid should be tightened in diagonal sequence, for instance, starting at the upper right, then bottom left, then top left and then bottom right. In the process, not all screws should be tightened all the way at first. Instead, tighten the screws so that the lid is pressed only lightly over the opening. This is necessary for ensuring that the lid is seated equally on all sides. Once all the screws have been tightened loosely, tighten them all completely, so that the lid is seated firmly and the connector is tightly sealed. This is to prevent spraying water or dust from penetrating.



The two PFLITSCH M12 x 1.5 cable connections seal cables with a diameter from 6.5 mm up to 9.5 mm.

For deviating cable diameters appropriate cable gland sets should be selected.

The seal is included in the imc IP65 specified connector shipment.

This ring is for the groove on your imc CRONOS-SL device's socket. To obtain a clean seal between the connector and the device, the sealing must be placed and glued into the groove.



Warning

- Ensure that the connector is not screwed on croockedly and that the sealing surface is clean and dry.
- Your imc CRONOS-SL device may already have such a sealing ring. In this case you can ignore the ring which comes with the connector.

6.3.13 ACC/DSUBM-ESD



When deploying measurement equipment in electromagnetically "polluted" industrial environments, careful installation and cabling is essential (proper grounding, shielding etc.). As an additional provision, this ESD filter plug can be applied between measurement amplifiers and the sensor installation. It is intended to suppress transient disturbance and discharge and thus make the system more robust and reliable. The plug is equipped with identical filter elements for each of the 15 DSUB pins, providing a "neutral" 1:1 connection from input to output. The uniform filter design makes it suitable for all types of measurement modules such as analog inputs, outputs, pulse counter, digital IO. While providing effective filtering and protection, it is not associated with any functional restrictions and in particular does not involve limitations of signal bandwidth within the relevant scope of the measurement.

Properties

- Retrofit adapter plug for suppression of conducted interference on measurement inputs
- Preventing possible malfunction of measurement amplifiers due to discharge and transient voltage spikes
- Passive HF filtering elements
- Easy retrofit for flexible solutions providing robust test and measurement under demanding industrial conditions
- Suitable for any type of imc modules equipped with DSUB-15 connectors
- No limitations to functionality and bandwidth within the relevant baseband of the measurement



ACC/DSUBM-ESD and the ACC/DSUB-ESD

Please finde here the technical details of the <u>ACC/DSUB(M)-ESD page</u>: 460. The technical details are valid for both variants: the plastic housing and the metal housing.

6.3.14 Storage Media

Alongside transfer to the PC, it is also possible to save measured data on removable data storage media. The operating software allows free selection of data storage options (see the description of data storage in the operating software's user manual). imc measurement devices of a particular device group are compatible with particular data storage media, such as CF-Card, CFast-Card or USB data volumes.

imc device	serial no.	device group	CF	CFast	USB
CRONOS <i>flex</i> CRFX-2000GP, CRONOS <i>compact</i> CRC-400GP	19XXXX	A7	-	~	~
CRONOSflex CRFX-2000GP, CRONOScompact CRC-400GP, C-SERIE, SPARTAN-R, CRONOS-SL, BUSDAQflex (BUSFX)	14XXXX	A5	~	-	-
SPARTAN, BUSDAQ <i>flex</i> (BUSFX), CRONOS-SL	13XXXX	A4	~	-	-

Certain devices can be equipped with a hard drive (see chap. "device overview" in each manual). A distinction is drawn between **removable and internal storage media**.

Removable and internal storage media

Internal storage media can not be interchanged, but rather are permanently installed inside the device. They are usually magnetic or SSD harddrives. Use of such media is the best approach whenever the required storage capacity exceeds data volumes which removable media can provide. The internal storage media exclusively serve the purpose of data acquisition. Hard drives are ordered along with the device, and can only be retrofit by imc for existing equipment.

If both large storage capacity and interchangeability are required at the same time, a drive bay for 2.5" SATA hard drives can be used, see photo:CRC/HDD-FRAME. For some device types, hotplug capability is available. This means that the system displays this drive as a removable drive. Otherwise, this drive is displayed as internal storage. Irrespective of the hotplug capability, the drive can always be exchanged while the device is deactivated, so that the accumulated data can be conveniently analyzed or archived.

Guidelines for proper handling of the removable storage media

- Always insert only one removable storage medium (either CFast or USB).
 In the case of multiple installed storage options (CFast & USB) the device does only support one storage volume at a time. Which one is determined upon activation, and there is no fixed sequential order. For this reason, remove any data storage volumes which you do not wish to use for the measurement before activating the device. When one removable data storage volume is currently inserted and an additional one is then inserted, the status-LED flashes red one time to indicate that the removable volume can not be used.
- Ensure that sufficient time is available for the exchange. The time needed for registering and deregistering with the system depends on the data carrier and on the channel count. As a guideline value, we recommend at least 30 s, even for simple configurations.
- Formatting of the 1 TB SSD hard drive can only take place when it is inserted in the device. It is important that this hard drive is only formatted in FAT32.

Exchanging the data carrier

In case you are using a removable storage medium, please be aware that before you remove it (if the device is switched on), the Hotplug button must be pressed to ensure that storage medium can be safely removed.

When you click on the Hotplug button, you request the system to remove the removable data carrier. In response, the device stops access to the data carrier (LED lights up). If you remove the drive without prior notification, defective clusters can occur in consequence. If you unplug the data carrier during a running measurement, data sets will not be closed but rather end up corrupted. For this reason, when exchanging the data carrier, proceed as follows:

- 1. Press the Hotplug button
- 2. Once the status LED is flashing, remove the data carrier.
- 3. Insert the new data carrier. The LED flash briefly to acknowledge that the new drive has been recognized successfully.



Note

File system & writing performance

The following **file systems** are supported: FAT16 up to 2 GB, **FAT32** up to 8 TB (max. possible size, that is supported with this file system). Please find further details in the software manual.

The **writing performance** is not actually indicated by "Speed-Grades" or similar parameters. The writing performance can not be estimated as a calculated data rate expressed in Byte/s. Instead, it depends strongly on the properties of the medias' controller chips and the operating conditions, in particular on the number of channels or files to be processed in parallel.



Reference

Please find a detailed description of internal removable storage media in the software manual, chapter "Device hard disk, removable drive".

Removable CF Storage Media Cards

Overview of the available storage media

Order code	article number
ACC/CF-2.0-GB-ET	13500020
ACC/CF-8.0-GB-ET	13500079
ACC/CF-16.0-GB-ET	13500081
ACC/CF-32.0-GB-ET	13500137



Operating conditions - removable CF storage media

Storage temperature: -65°C to 150°C

Operating temperature: -40°C to 85°C condensation allowed (extended temperature range)

Shock protection in operation 1000 g

Removable CFast Storage Media Cards

conforming to CFast 2.0 specification

One major advantage of the new CFast-format is its high transfer/write-speed. **CFast is not compatible with CF** (CompactFlash). The shape of the connectors is the same, but electrically the format is not compatible.



CFast is based electrically on the serial SATA Standard, while CF is based on the parallel IDE-ATA, so that the former offers significantly higher transfer speeds.

The CFast storage media are compatible with devices with a serial number (SN) > 190000 (device group A7)

Overview of the available CFast storage media

Order code	article number
ACC/CFast-8 GB ET	13500163
ACC/CFast-16 GB-ET	13500164
ACC/CFast-32 GB-ET	13500165
ACC/CFast-64 GB ET	13500260

Operating conditions - removable CFast storage media

Operating temperature: -40°C to 85°C

Shock and Vibration conforming to MIL-STD-810F

CFast Card Reader with USB 3.0

Order code article number FH/CARDREADER-CFAST-USB3 13300018

- Hot Swap, Plug & Play
- 1x micro USB 3.0
- 1x CFast Card Slot
- Supports CFast type I/II memory cards
- Data transfer rate up to 5 Gb/s
- Aluminium case

(LxWxH: 82 x 60 x 12 mm)



Removable USB 2.0 Storage Media Cards

Overview of the available USB storage media for devices of the group A7

Order code article number ACC/USB-32,0 GB-ET 13500200

Operating conditions - removable USB storage media

Operating temperature: -40°C to 85°C

Shock and Vibration conforming to MIL-STD-810F



Note

When using USB hard disks with external power supply, this may not be applied to the USB port. This may destroy the current limitation of the imc USB port when the measuring instrument is switched off.

SSD hard drive

Overview of the available hard drives

Order Code	article number	remarks
CRC/400-SSD-256GB	11700193	SSD hard drive for CRC-400
CRC/400-SSD-1TB	11700261	SSD hard drive for CRC-400
CRC/400GP-SSD-256GB	11700xxx	SSD hard drive for CRC-400GP
CRC/400GP-SSD-1TB	11700260	SSD hard drive for CRC-400GP
CRFX/400-SSD-256GB	11900177	SSD hard drive for CRFX-400 Base Unit
CRFX/400-SSD-1TB	11900xxx	SSD hard drive for CRFX-400 Base Unit
CRFX/2000GP-SSD-256GB	11900116	SSD hard drive for CRFX-2000GP Base Unit
CRFX/2000GP-SSD-1TB	11900xxx	SSD hard drive for CRFX-2000GP Base Unit
CRSL/SSD-128GB	11800107	SSD hard drive for CRSL

Operating conditions of the SSD hard drive

Storage temperature: -20°C to 70°C

Operating temperature: 0°C to 70°C

Shock resistance during operation: 175 g

Operation permitted only at up to 3000 m above sea level

approx. 14% of the total volume are intended for possible defragment and thus not available

Removable frame - HDD-FRAME

Order Code	article number	remarks
CRC/HDD-FRAME	11700230	frame component for removable SSDs, max. one
		component per CRC device, requires 2 slots
CRC/HDD-FRAME-R	11700231	variant for the imc CRONOScompact-RACK

no condensation

Housing/frame component for SDD 2.5" SATA Format, max. one per device, not Hot-Swap capable.



- In order to fit into the frame, the max. height of a hard drive should not be more than 9.5 mm.
- If you buy the storage media from a supplier other than imc, we can not guarantee the quality.

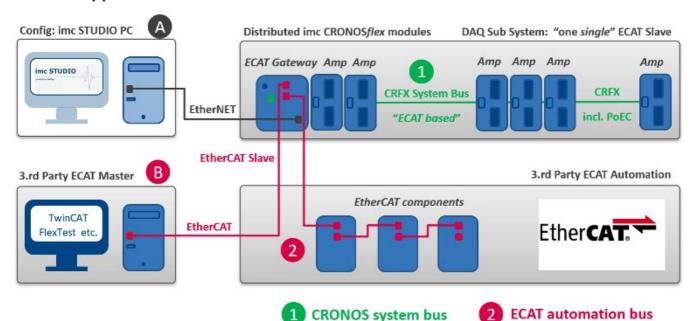


CRC/HDD-FRAME how to insert the SSD

6.3.15 CRFX/ECAT-GATEWAY

The imc CRONOSflex EtherCAT Gateway is a bus coupler that allows a number of imc CRONOSflex amplifier modules to be used within an EtherCAT-based automation or control system. imc amplifier components can thus be used in EtherCAT environments such as Beckhoff TwinCAT or MTS FlexTest, for example, without the need for a complete CRONOS data logger system (with base unit).

6.3.15.1 Application



Configuration

Configuration of the imc sub system via imc STUDIO Software (PC via EtherNET)

CRONOS system bus

- → Output ESI and A2L: Information for the EtherCAT Master
- → subsequently: connection no longer required (PC, imc STUDIO): Auto-Start Mode
- Data acquisition operation via "external" EtherCAT test automation system DAQ operation (e.g. TwinCAT Master) → no redundant parallel data acquisition via imc STUDIO

In connection with the gateway, the CRFX modules act as a data acquisition subsystem in the sense of an EtherCAT slave, without operating in the network of a complete CRONOS data logger. The individual modules are interconnected via the CRFX system bus. This CRONOS system bus is based on the "EtherCAT standard", uses network hardware and is spatially distributable via network cables (Power-over-EtherCAT). The protocol of the CRONOS system bus differs from the "EtherCAT Standard". It is not compatible with EtherCAT 3rd party systems, i.e. the CRFX modules cannot be operated in such an environment. The ECAT gateway establishes this connection, forming a single EtherCAT slave station.

The ECAT slave subsystem is configured once using imc STUDIO via EtherNET. Afterwards and during active operation this access is no longer necessary.

Typical applications are:

- Test benches
- Integration of CRFX modules in EtherCAT system environment, such as:
 - TwinCAT automation
 - MTS FlexTest
 - o Horiba STARS Engine
 - o FEV MORPHEE
 - o Instron
- Use of WFT measurement wheels via CRFX/WFT-2 interface module in 3rd party environment

If the target systems implement real-time control, the resulting latencies (signal propagation times) of the system must be taken into account in addition to the sampling rates of the amplifiers (max. 5 kHz) and cycle times of the EtherCAT bus (e.g. 5 kHz or 1 kHz). These are in the order of <2 ms.

6.3.15.2 Configuration via imc STUDIO

The gateway and the connected modules are configured via imc STUDIO. For this purpose, an Ethernet connection between the gateway and the STUDIO PC must be established.

This configuration and also the Ethernet connection is typically required only once. After that the autostart functionality of gateway and amplifiers can be used. The last valid configuration stored in the device is then automatically loaded when the device is switched on and operation is started.

During configuration, the measuring channels must be set to the desired measuring mode, measuring range, etc.

For the filter setting AAF (automatic anti-aliasing) is to be selected and thereby the sampling rate of the channels is to be set exactly to the rate which is used on the EtherCAT bus as bus cycle, typically either 5 kHz or 1 kHz. Exactly then the AAF filter frequency is matched to the internal cycle rate of the data or pv variable corresponding to the bus cycle.

The actual update rate and thus the effectively utilized EtherCAT bus rate is limited to 5 kHz. If the EtherCAT bus cycle should be selected faster, then the internal rate of max. 5 kHz must still be configured at this EtherCAT gateway during channel configuration. With this rate actually new data are delivered at the bus and also the AAF filter must be adjusted to this rate.

Following the configuration, an A2L file must typically be exported. This file is used to configure the EtherCAT master system. After finishing the configuration, an Autostart configuration must be uploaded to the device (Diskstart), see imc STUDIO manual.

Key data

- Max. ECAT bus cycle: 5 kHz (200 μs), supported bus cycle: 5 kHz, 1 kHz, 500 Hz, 200 Hz, 100 Hz
- Max. number of channels respectively sampling rates:

34 channels @ 5 kHz

(170 kHz sampling rate)

128 channels @ 1 kHz

and lower



Reference

Find technical specs in the chapter "Technical Specs 468".

6.4 Fieldbus interfaces

Along with the capture of data with the modular amplifiers, imc measurement devices can also collect data from digital bus systems. The data acquired using the bus systems are treated in the same way as other data, and can be synchronously stored and displayed along with these, and jointly subjected along with them to calculations. Depending on the software- and hardware configurations, targeted output of data on specific bus systems may also be possible. Depending on the software and the hardware equipment a purposeful expenditure of data to the adequate bus system is possible.



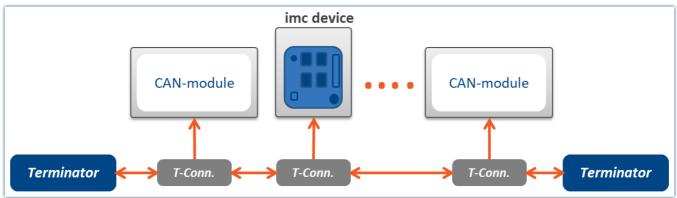
Note

fieldbus connection options

The fieldbus connection options are configuration options, imc measurement systems can only be equipped ex-factory with those modules. An exchange or plug-in by the user is not allowed.

6.4.1 CAN, CAN FD

If your imc device is equipped with at least 2 nodes (DSUB-9), each of them is supposed to be connected with a Y-adaptor.



imc CRONOS System family with connected Y-adaptor

Note that for a transfer rate of 1 Mbit/s to the CAN-Bus the stub line of a tee-junction may only be up to 30 cm long. In general, the wiring within imc CRONOS System family is already 30 cm long. Therefore if an external tee-junction is connected, the junction must be connected straight into the terminal.

In this context it doesn't matter whether the other sensors are connected via tee-junction or not. The illustration simply shows the options available.

Find here the <u>technical details</u> 437 and the <u>pin configuration</u> 485 of the CAN-Bus interface.

Find here the <u>technical details</u> 438 and the <u>pin configuration</u> 485 of the CAN FD interface.

Connecting the terminators

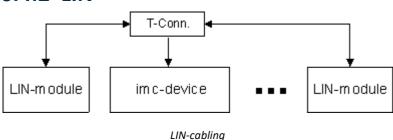
- Terminator-resistance is 120 Ω as per CAN in Automation (CiA).
- If terminators are connected, then between Pins 2 and 7.
- Terminators are only applied at the ends of the bus; nowhere else in the line. The bus must always end at a terminator.



Note

With High-Speed CAN a termination on each node can be activated by software.

6.4.2 LIN



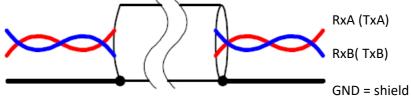
To the <u>technical data</u> and the <u>pin configuration</u> and the <u>pin configuration</u> the LIN-BUS interface.

6.4.3 ARINC

imc standard: DSUB-15

This pin configuration corresponds the suggested imc standard. Transmitting channels and any differing pin configuration can be considered as special order.

We recommend for the connection twisted and shielded wiring:



To the <u>technical data 444</u> and the <u>pin configuration 488</u> of the ARINC-Bus interface.

6.4.4 FlexRay

Standard 1x DSUB-9



Reference

To the <u>technical data</u> 40 and the <u>pin configuration</u> (optional 2x DSUB-9) 486 of the FlexRay interface.

6.4.5 XCPoE

Standard 1x RI45



Reference

To the <u>technical data</u> 442 and the <u>pin configuration</u> 486 of the XCPoE interface.

6.4.6 PROFINET



Reference

To the technical data 441 and the pin configuration 489 of the PROFINET interface.

6.4.6.1 LED

PROFINET						
Parameter	Va	lue	Remarks			
Explanation NET LED	C	off	no supply			
			no connection to the IO-Controller			
	gr	een	connection with IO-Controller established IO-Controller in RUN state			
	green, 1	x blinking	connection with IO-Controller established IO-Controller in STOP state or erroneous IO data RT synchronization not completed			
	green,	blinking	network identification			
	r	ed	internal error in combination with red module status LED			
	red, blin	king once	station name not set			
	red, blin	king twice	IP address not set			
	red, blinkin	g three times	expected IO-Device identification deviates from real identification			
Explanation MOD LED	C	off	no supply			
			device not in initialization phase			
	gr	een	normal operation			
	green, bli	nking once	diagnosis-event(s) available			
	r	ed	internal error in combination with red NET-LED			
	alternatinį	g green, red	Firmware-Update. The device must not be switched off during the update. Otherwise it can lead to total failure of the device.			
Explanation LEDs of the	green (left)	yellow (right)				
network socket	off	off	no connection			
	on	off	100 Mbit/s connection			
	blinking	off	100 Mbit/s connection, active			
	off	on	10 Mbit/s connection			
	off	blinking	10 Mbit/s connection, active			

6.4.7 PROFIBUS



Reference

To the <u>technical data [440]</u> and the <u>pin configuration [489]</u> of the PROFIBUS interface.

6.4.8 MVB

EMD (Electrical Medium Distance) with duplicate interconnection providing redundant transmission for the bus via two differential lead pairs. Up to 32 devices can be connected across a distance of max. 200 m. The cables used are standard 120 Ω lines. The signals are connected by means of two DSUB-9 plugs. The shielding is connected directly to the device housing. The housing should be grounded if possible. Internally, the bus is electrically insulated from the device connected.



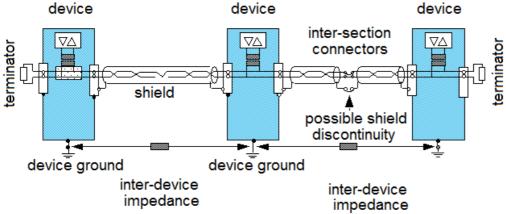
Reference

To the <u>technical data [443]</u> and the <u>pin configuration [490]</u> of the MVB-Bus interface.

6.4.8.1 EMD

EMD (Electrical Medium Distance) with duplicate interconnection providing redundant transmission for the bus via two differential lead pairs.

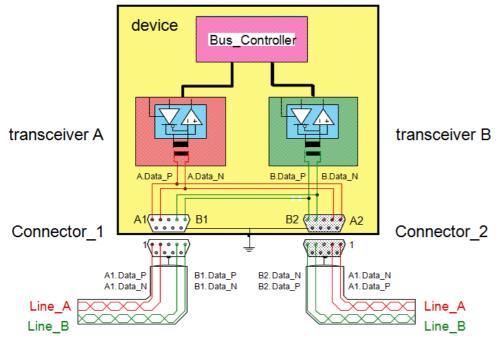
- Up to 32 devices can be connected across a distance of max. 200 m.
- The cables used are standard 120 Ω lines.
- The signals are connected by means of two DSUB-9 terminals.



MVB-bus cabling for EMD

The shielding is connected directly to the device housing. The housing should be grounded if possible.

Internally, the bus is electrically insulated from the device connected.

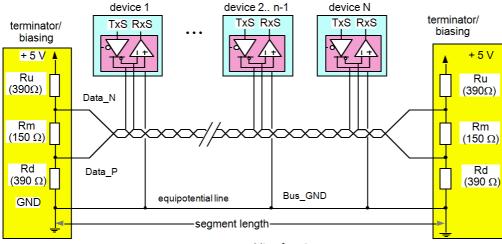


Internal wiring for EMD connection

6.4.8.2 ESD

ESD (Electrical Short Distance) RS485 sets up the connection without galvanic isolation. The variant ESD+ comes with galvanic isolation and is available from imc.

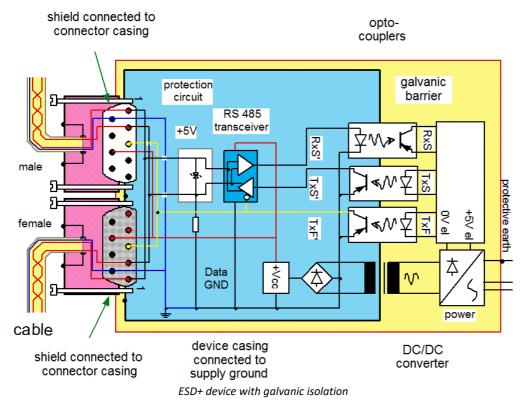
- Up to 32 devices can be connected across a max. distance of 20 m.
- Standard 120 Ω cable leads are used.
- Lines are connected via DSUB9 terminals.



MVB-Bus cabling for ESD

The shielding is connected directly to the device chassis, which should be grounded if possible.

Internally, the bus is galvanically isolated from the connected device.

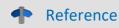


6.4.9 EtherCAT

The fieldbus module EtherCAT Slave Interface (imc ECAT-Slave-IF) provides the integration of imc CRONOS*flex* and imc CRONOS*compact* devices into an automation system based on EtherCAT fieldbus.

The complete imc CRONOS device is integrated as a slave into an EtherCAT fieldbus, which is operated by an external master.

Data from the imc measurement device are thus available throughout an EtherCAT system and integration of the device into other system environments is achieved. This interface is not limited to readout of data and variables from the imc system. Moreover, variables and system parameters of the imc system (Slave) can also be set and manipulated by the external EtherCAT Master, which allows for close interaction and further control schemes.



To the <u>technical data</u> 439 and the <u>pin configuration</u> 487 of the imc EtherCAT module.

7 Measurement types

7.1 Temperature measurement

Two methods are available for measuring temperature. Measurement using a **PT100** requires a constant current, e.g. of 250 μ A to flow through the sensor. The temperature-dependent resistance causes a voltage drop which is correlated to a temperature according to a characteristic curve.

When measuring with **thermocouples**, the temperature is determined via the series of voltages of different alloys. The sensor generates a temperature-dependent voltage which is relative to the terminal point on the plug. To find the absolute temperature, the temperature of the terminal point must be known. This is determined with a **PT1000** directly in the terminal plug and requires a special plug type.

The measured voltage is converted into the displayed temperature value according to the characteristics of the temperature scale ITS-90.



Note

Making settings with imc software

A temperature measurement is a voltage measurement whose measured values are converted to physical temperature values by reference to a characteristic curve. The characteristic curve is selected using the "Correction" parameter on the "Measurement mode" tab. Amplifiers which enable bridge measurement, must first be set to the "Voltage" measurement mode in order for the temperature characteristics curves to be available for selection.

7.1.1 Thermocouples as per DIN and IEC

The following standards apply for thermocouples, in terms of their thermoelectric voltage and tolerances:

Thermocouple	Symbol	max. temp.	defined up to	(+)	(-)		
DIN IEC 584-1 (2014-07)							
Iron-constantan (Fe-CuNi)	J	750°C	1200°C	black	white		
Copper-constantan (Cu-CuNi)	Т	350°C	400°C	brown	white		
Nickel-chromium-Nickel (NiCr-Ni)	K	1200°C	1370°C	green	white		
Nickel-chromium-constantan (NiCr-CuNi)	E	900°C	1000°C	violet	white		
Nicrosil-Nisil (NiCrSi-NiSi)	N	1200°C	1300°C	red	orange		
Platinum-Rhodium-platinum (Pt10Rh-Pt)	S	1600°C	1760°C	orange	white		
Platinum-Rhodium-platinum (Pt13Rh-Pt)	R	1600°C	1760°C	orange	white		
Platinum-Rhodium-platinum (Pt30Rh-Pt6Rh)	В	1700°C	1820°C	n.a.	n.a.		
	DIN 43	3710					
Iron-constantan (Fe-CuNi)	L	600°C	900°C	red	blue		
Copper-constantan (Cu-CuNi)	U	900°C	600°C	red	brown		

If the thermo-wires have no identifying markings, the following *distinguishing characteristics* can help:

• Fe-CuNi: Plus-pole is magnetic

• Cu-CuNi: Plus-pole is copper-colored

• NiCr-Ni: Minus-pole is magnetic

• PtRh-Pt: Minus-pole is softer

The color-coding of compensating leads is stipulated by DIN 43713. For components conforming to IEC 60584: The plus-pole is the same color as the shell; the minus-pole is white.

7.1.2 PT100 (RTD) - measurement

RTD (PT100) sensors can be directly connected in 4-wire-configuration. An additional reference current source feeds a chain of up to 4 sensors in series.

With the imc Thermo plug, the connection terminals are already wired in such a way that this reference current loop is closed.



Note

If fewer than 4 PT100 units are connected, the current-loop must be completed by a wire jumper from the "last" RTD to -I4.

If you dispense with the "support terminals" (\pm 11 to \pm 14) provided in the imc Thermo plug for 4-wire connection, a standard terminal plug or any DSUB-15 plug can be used. The "current loop" must then be formed between +11 (DSUB Pin 9) and -14 (DSUB Pin 6).

7.1.3 imc Thermo plug (T4)

The imc Thermo plug contains a screw terminal block in a DSUB-15 plug housing with a built-in temperature sensor (PT1000) for **cold junction compensation**. This provides for direct connection of thermocouples of any type, directly to the differential inputs (+IN and -IN) without external compensation leads. That plug can also be used for **voltage** measurement.

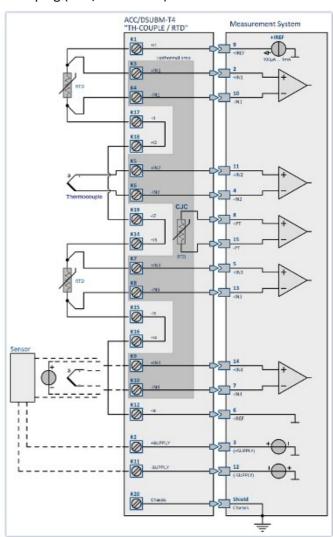
The difficulty with thermocouple measurements are the "parasitic" thermocouples which inevitably form where parts of the contacts made of different materials meet. The temperature sensor measures the temperature at the connection terminal and compensates the corresponding "error"-voltage. Normally, the connection to this compensation point (inside the device) is made by special compensation leads or plugs made of material identical to the respective thermocouple type, in order not to create additional (uncontrolled) parasitic thermocouples.

imc's system avoids the problem through the use of individual compensation sensors directly inside the plug, thus offering an especially simple, flexible and cost-effective connection solution.

7.1.3.1 Schematic: T4 plug

Plastic plug (ACC/DSUB-T4, discontinued)

Metal plug (ACC/DSUBM-T4)



7.2 Bridge measurement

Bridge channels are for taking readings from **measurement bridges** such as resistor bridges or strain gauges. The channels are equipped as **non-isolated differential** amplifiers and can alternatively be used for direct **measurement of voltages**.

There is a distinction among the following operating modes:

≻ Sensor

- Full bridge
- Half bridge
- Quarter bridge (120 Ω)

➤ Strain gauge

- Full bridge with 4 active strain gauges in uniaxial direction
- Full bridge with Poisson strain gauge in adjacent bridge arms
- Full bridge with Poisson strain gauge in opposing bridge arms
- Half bridge with one active and one passive strain gauge
- Half bridge with 2 active strain gauges in uniaxial direction
- Poisson half bridge
- Quarter bridge with 120 Ω strain gauge

7.3 Bridge measurements with wire strain gauges

Strain in this sense refers to the ratio of a body's original length to the change in length due to a force exerted upon it.

$$\varepsilon = \frac{dL}{L}$$

By selecting "Strain gauge" as the measurement mode, common bridge circuits and configurations for wire strain gauges are offered for selection. The scaling can be adjusted in terms of typical parameters for strain measurements such as the gauge factor or Poisson's ratio, the transversal expansion coefficient.

If a strain gauge adheres to a test object, the strain on the object is transmitted to the bridge circuit. The changes in the lengths of the bridge arms cause their impedances to change. There is a correlation between the changes in length and the changes in resistance:

$$\varepsilon = \frac{dL}{L} = \frac{dR/R}{k}$$

Legend:	
ε	strain
dL	change in length
L	original length
dR	change in resistance
R	resistance of strain gauge
k	Gauge factor, describing the ratio of relative length change to change in resistance

The changes in resistance caused by the strain are very small. For this reason, a bridge circuit is used to translate these changes into voltage changes. Depending on the circuit, from one to four strain gauges can be employed as bridge resistors.

Assuming that all bridge resistors have the same value, we have:

$$V_a = V_e \cdot \frac{dR}{4 \cdot R} = \frac{V_e}{4 \cdot R} \cdot k \cdot \varepsilon$$

Legend:	
Va	measurement voltage
Ve	excitation voltage

$$\varepsilon = \frac{V_a \cdot 4}{V_a \cdot k}$$

For concrete measurement tasks, the arrangement of the strain gauges on the test object is important, as well as the circuitry of the bridge. On the "Bridge circuit", you can select from among typical arrangements. A graphic below shows the position on the test object and the bridge circuitry. Notes on the selected arrangement are displayed in the text box.

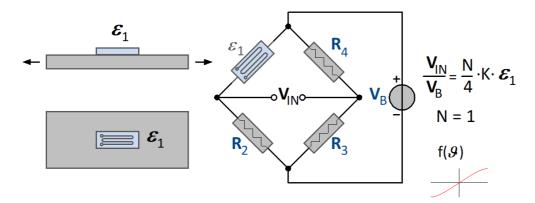


Note

For an easier operation, ranges that are unsuitable are hidden in the operating software.

Chapter 7

7.3.1 Quarter bridge for 120 Ohm strain gauge



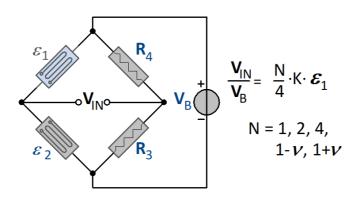
This strain gauge arrangement uses an **active** strain gauge which is positioned on the test object in a uniaxial stress field. This strain gauge is joined by three passive resistors within the module to form a full bridge. The strain gauge can have a resistance value of 120Ω .

This arrangement does not come with temperature compensation. The strain is computed as:

$$\varepsilon \left[\frac{\mu m}{m} \right] = \frac{4 \cdot 1000}{k} \cdot \frac{V_a}{V_e} \left[\frac{mV}{V} \right]$$

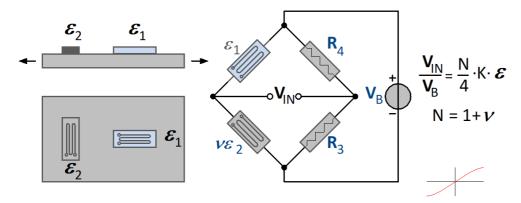
Legend:
k gauge factor

7.3.2 General half bridge



General half bridge with bridge completion in measurement device. N has to be set from a list.

7.3.3 Poisson half bridge

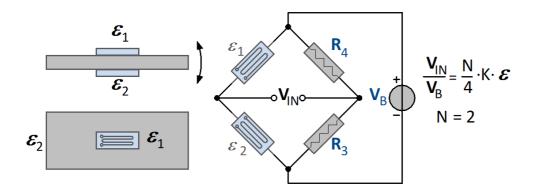


In this circuit, two active strain gauges are used. The strain gauge is positioned transverse to the main direction of strain. The transversal contraction is exploited. For this reason, the Poisson's ratio for the material, which is its transversal expansion coefficient, must be supplied along with the gauge factor. This circuit offers good temperature compensation. The strain is computed as:

$$\varepsilon \left[\frac{\mu \mathbf{m}}{\mathbf{m}}\right] = \frac{4 \cdot 1000}{k \cdot (1 + \nu)} \cdot \frac{V_a}{V_e} \left[\frac{\mathbf{m} \mathbf{V}}{\mathbf{V}}\right]$$

Legend:		
k	gauge factor	
ν	Poisson's ratio of test object material	

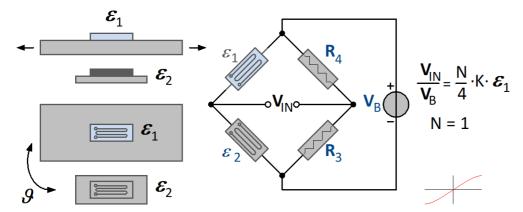
7.3.4 Half bridge with two active strain gauges in uniaxial direction



Two active strain gauges are placed under stress in opposite directions but equal magnitude, i.e. one strain gauge is under compression and another under equal tension. (bending beam circuit). This arrangement doubles the measurement's sensitivity to a bending moment. On the other hand, longitudinal force, torque and temperature are all compensated for. The strain is computed as:

$$\varepsilon \left[\frac{\mu m}{m} \right] = \frac{4 \cdot 1000}{2 \cdot k} \cdot \frac{V_a}{V_e} \left[\frac{mV}{V} \right]$$

7.3.5 Half bridges with one active and one passive strain gauge



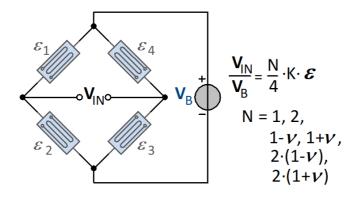
This circuit involves strain gauges. The first one is positioned on the test object, the second on a sample of the same material under the same ambient temperature and serves the purpose of temperature compensation. The strain is computed as:

$$\varepsilon \left[\frac{\mu m}{m} \right] = \frac{4 \cdot 1000}{k} \cdot \frac{V_a}{V_e} \left[\frac{mV}{V} \right]$$

Legend:

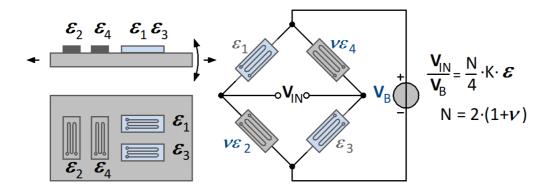
k gauge factor

7.3.6 General Full bridge



General full bridge. N has to be set from a list.

7.3.7 Full bridge with Poisson strain gauges in opposed branches

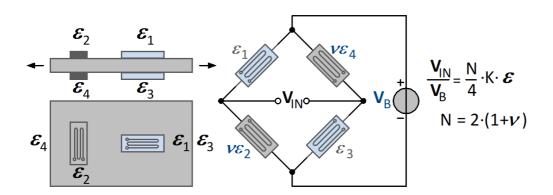


Two active strain gauges are positioned along the longitudinal strain and are joined by two transversally positioned strain gauges to complete the bridge (torsion bar arrangement). In the bridge, the longitudinal strain gauges are located in opposite branches. This circuit provides better exploitation of transversal contraction and longitudinal force as well as good temperature compensation. In this arrangement, the transversal expansion coefficient must be specified. The strain is computed as:

$$\varepsilon \left[\frac{\mu m}{m} \right] = \frac{4 \cdot 1000}{2 \cdot k \cdot (1 + \nu)} \cdot \frac{V_a}{V_e} \left[\frac{mV}{V} \right]$$

Lege	Legend:		
k	gauge factor		
ν	Poisson's ratio of test object material		

7.3.8 Full bridge with Poisson strain gauges in adjacent branches

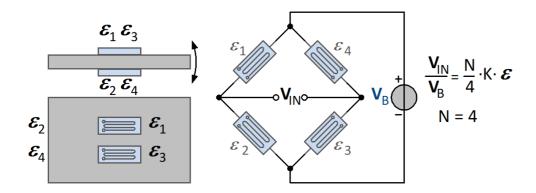


Full bridge with 4 active strain gauges. 2 active strain gauges complemented by 2 transverse Poisson strain gauges. They are located in opposed bridge arms. Higher exploitation of transverse contraction longitudinal expansion while providing good temperature compensation.

$$\varepsilon \left[\frac{\mu m}{m}\right] = \frac{4 \cdot 1000}{2 \cdot k \cdot (1 + \nu)} \cdot \frac{V_a}{V_e} \left[\frac{mV}{V}\right]$$

Legend:		
k	gauge factor	
ν	Poisson's ratio of test object material	

7.3.9 Full bridge with 4 active strain gauges in uniaxial direction



The circuit consists of 4 active strain gauges. Two are under compression and the others under equal tension. The strain gauges under tension are positioned in opposite bridge arms. The sensitivity to the moment of bending is increased. At the same time, longitudinal force, torque and temperature are compensated. The strain is computed as:

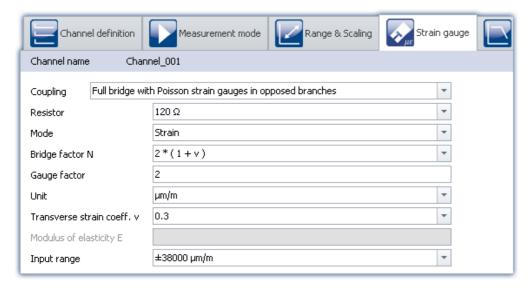
$$\varepsilon \left[\frac{\mu \mathbf{m}}{\mathbf{m}}\right] = \frac{4 \cdot 1000}{4 \cdot k} \cdot \frac{V_a}{V_e} \left[\frac{\mathbf{m} \mathbf{V}}{\mathbf{V}}\right]$$

Legend:
k gauge factor

7.3.10 Scaling for the strain analysis

It is possible to choose whether to determine the strain or the mechanical stress suffered by the part. In the range of elastic deformation, the axial stress (force / cross section) is proportional to the strain. The proportionality factor is the modulus of elasticity.

Mechanical stress = modulus of elasticity * strain (Hooke's law)



Gauge factor (K-factor)

The K-factor is the ratio by which the mechanical quantity (elongation) is transformed to the electrical quantity (change in resistance). The typical range is between 1.9 and 4.7. The exact value can be found in the spec sheet for the strain gauge used. If the value entered for this parameter is outside of this range, a warning message will appear but the module can still be configured.

Transverse strain coeff.

(poisson's ratio): If a body suffers compression or tension and is able to be freely deformed, then not only its length but also its thickness changes. This phenomenon is known as transversal contraction. It can be shown that for each kind of material, the relative change in length is proportional to the relative change in thickness D. The transversal elongation coefficient (Poisson's ratio) is the material-dependent proportionality factor. The material constant is in the range 0.2 to 0.5.

In bridge circuits where the strain gauges are positioned transversally to the main direction of strain, this constant must be supplied by the user. The ratios for various materials are available in the list box. These values are only for orientation and may need to be adjusted.

Elastic modulus

The elastic modulus E, is a material parameter characterizing how a body is deformed under the action of pressure or tension in the direction of the force. The unit for E is N/mm². This value must be entered for the mechanical stress to be determined The e-moduli for various materials are available in the list box. These values are only for orientation and may need to be adjusted.

Unit

When the strain is determined, the readings appear with the unit $\mu m/m$. For the mechanical stress one can toggle between GPa and N/ mm² .

 $1 \text{ GPa} = 10^3 \text{ N/ mm}^2$

Note that the elastic modulus is always in GPa.

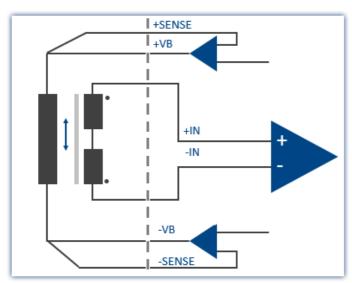
7.4 LVDT

LVDT and inductive displacement transducers are operated with carrier frequency mode bridge amplifiers such as module BR(2)-4 [146].

LDVT (Linear Variable Differential Transformer) and RVDT (Rotary Variable Differential Transformer) are based on the transformer principle with an actively driven primary coil. They are configured as full bridge circuit where the two inversely phased secondary windings are compensating each other in the neutral position. Depending on type and winding ratios, the typical output signals are in the range of 200 mV/V but can also exceed 1000 mV/V.

In contrast, inductive displacement sensors do not possess any galvanically isolated primary but consist of two differential coils, wound in phase, that form an inductive half bridge circuit. Their signal range is typical 80 mV/V.

Full-Bridge

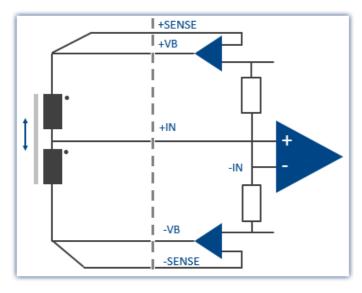


Typically 200 mV/V signal or even < 1000 mV/V.

Opposite winding directions of the two secondaries

Galvanically isolated primary / secondary

Half-Bridge



Typically 80 mV/V signal.

Uniform winding directions of the two coils.

7.5 Incremental Counters Channels

The incremental counter channels are for measuring **time** or **frequency**-based signals. In contrast to the analog channels as well as to the digital inputs, the channels are not sampled at a selected, fixed rate, but instead time intervals between slopes (transitions) or number of pulses of the digital signal are measured.

The **counters** used (set individually for each of the 4 channels) achieve time resolutions of up to 31 ns (32 MHz); which is far beyond the abilities of **sampling procedures** (under comparable conditions). The *sampling rate* which the user must set is actually the rate at which the system evaluates the results of the digital counter or the values of the quantities derived from the counters.



Note

Sampling rate for incremental counter channels

Only one sampling rate can be set per module.

The description of the ENC-4. 278

The description to the DI16-DO8-ENC4. 260

The description of the HRENC-4. 285

7.5.1 Signals and conditioning

7.5.1.1 Mode

The various modes comprise the following measurement types:

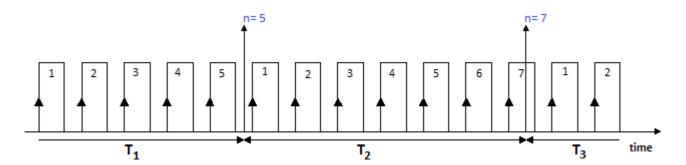
Event-counting	Time	Combined measurements
• events	• time	• frequency
distance(differential)	 pulse time 	• speed
 angle (differential) 		• RPM
angle (sum)		
 angle (abs 0-360°) 		
distance (sum)		

Event-Counting

The following variables are derived from **Event counting**:

- events 121
- distance(differential) 121
- angle (differential) 122
- distance (abs.) 122
- angle (abs.) 122

The amount of events occurring within one sampling interval is counted. The event counter counts the sensor pulses within the sampling interval. An event is a positive edge in the measurement signal which exceeds a user-determined threshold value.

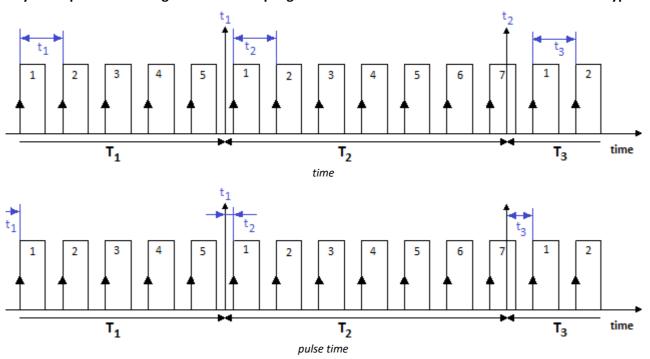


Time Measurements

Exclusive measurement of time is performed as:

- <u>time</u> 122 (of two successive signal edges)
- <u>pulse time</u> 123 (time from the beginning of one sampling interval until the next signal edge)

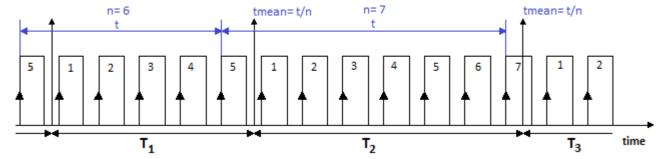
Any other pulses occurring within the sampling interval are not evaluated for these measurement types.



Combination Mode

Determining a frequency and the derivative quantities RPM and velocity is based on the **combination of event counting and time measurement**. In other words, during a sampling interval, the number of events occurring as well as the time interval between the first and last event are measured:

- frequency 124
- speed 124
- RPM 124



The frequency is determined as the number of events counted divided by the time between the first and the last "complete" event in the interval. An event is complete when a positive edge is succeeded by a subsequent positive edge.

The frequencies must lie within the bandwidth of the module used. If the maximum frequency is exceeded during a measurement, the system returns the input range end value instead of the true measured values.

The derivative quantities displacement and angle measurement have the following settings:

- Choice of single-track and dual-track encoder 1201
- Start of measurement with or without "Zero impulse" 121
- Number of pulses (per unit)

The input ranges and resolutions for the RPM or velocity also depend on the number of encoder pulses set. If the number of pulses is known, the RPM and velocity values can easily be computed using the above table according to:

Parameter	Description	
RPM	Input range = ([Frequency input range in Hz] $*$ 60 / [Encoder pulses per revolution]) in RPM	
	Resolution = ([Frequency resolution in Hz] * 60 / [Encoder pulses per revolution]) in RPM	

Behavior in response to missing signal pulses

If a sequence of signal pulses is slowing down and then one sampling interval elapses without any pulse, no calculation can be performed for that sampling interval. In that case, the system assumes that the rotation speed is simply decreasing and an attenuating signal course is extrapolated. This "estimated" measurement value is then closer to the true value than the value determined from the preceding sampling interval. This technique has demonstrated its validity in practice.



Note

In extreme cases, the sensor does not return any more pulses, e.g. in case of a sudden outage. Then the algorithm generates an attenuation curve, meaning values > 0, even if the measurement object is actually no longer moving.

7.5.1.2 Measurement procedures

Measurement procedures	Description		
Differential measurement procedures	The quantities derived from <i>event-counting</i> , Events , Distance and Angle denoted by the annotation (diff.) are "differential" measurements. The quantity measured is the respective change of displacement or angle within the last sampling interval. (positive or, for dual-track encoders, negative also) or the newly occurred events (always positive).		
	If, for instance, the total displacement is desired, it must be calculated by integration of the differential measurements using imc Online FAMOS functions.		
Cumulative measurements	The quantities derived from <i>event-counting</i> , Distance and Angle appearing with the annotation (abs.) are "cumulative" measurements. In cumulative measurements, the return value is the sum of all displacement or angle changes, or of all event which occurred.		

7.5.1.3 Scaling

A maximum value must be entered under *Input range* (max. frequency etc, depend on mode). This **Maximum** determines the scaling factor of the computational processing and amounts to the range which is represented by the available numerical format of 16bits. Depending on the measurement mode (quantity to be measured), it is to be declared as an input range's unit or in terms of a corresponding max. pulse rate.

In the interest of maximizing the **measurement resolution** it is recommended to set this value accordingly.

The *Scaling* is a sensor specification which states the relation between the pulse rate of the sensor and it's corresponding physical units (sensitivity). This is also the place to enter a conversion factor for the sensor along with any physical quantity desired, for instance, to translate the revolutions of a flow gauge to a corresponding volume.

The table below summarizes the various *measurement types' units*; the **bold**/*cursive* letters denote the (fixed) primary quantity, followed by its (editable) default physical unit:

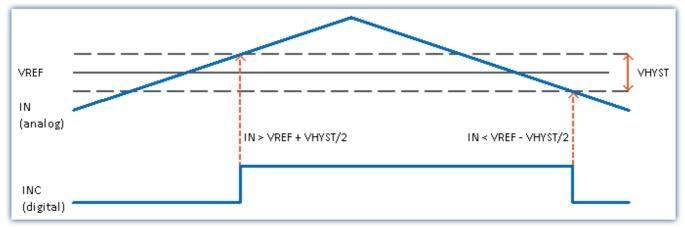
Measurement quantity	(Sensor-) scaling	Range	Maximum
Linear motion	pulse/m	m	m/s
Angle	pulse/ <i>U</i>	U	U/min
Velocity	pulse/m	m/s	m/s
RPM	pulse/ <i>U</i>	U/min	U/min
Event	pulse/pulse	1 pulse	Hz
Frequency	Hz /Hz	Hz	Hz
Time	s /s	S	S
Pulse time	Hz/code	Hz	Hz

7.5.1.4 Comparator conditioning

The incremental counters' special properties make **special demands for signal quality**: the very high resolution offered by the detector or counter means that even very short impulses can be captured and evaluated, which sampling-based measurement methods (such as for the digital inputs of the DI16 module) would not (or almost never) be able to detect. Therefore, the digital signals must have clear edges in order not to produce disturbed readings. Spurious impulses or contact bouncing can lead to artifacts such as enormous peaks in RPM-signals etc..

Simple sensors working on the principles of induction or photoelectric relays often emit unconditioned analog signals which must be evaluated according to a threshold condition. Aside from that, problems can occur even with conditioned encoder signals (e.g. TTL-levels) due to long cables, bad reference voltages, ground loops or interference. imc incremental counter channels are able to counteract these problems thanks to a special 3-stage conditioning unit.

First comes a high-impedance **differential amplifier** (\pm 10 V range, 100 k Ω) which enables reliable acquisition from a sensor even over a long cable as well as effective suppression of common mode interference and ground loops. Next, a (configurable) **smoothing filter** offers additional interference suppression adapted to the measurement situation. Lastly, a **comparator** with adjustable threshold and hysteresis serves as a digital detector. The (adjustable) **hysteresis** also serves to suppress interference.



The digital signal changes from 0 to 1 when the analog signal exceeds the VREF + VHYST/2 threshold.

The digital signal changes from 1 to 0 when the analog signal falls below the VREF - VHYST/2 threshold.

The size of the hysteresis represents the width of a range-band inside of which the signal can fluctuate (due to signal noise and interference) without an impulse being recorded.

Ranges:

- VREF (Threshold) = -10 V .. +10V
- VHYST (Hysteresis) = +100 mV...+4V
- Low pass filter: None, 20 kHz, 2 kHz, 200 Hz

7.5.1.5 Single-track / Dual-track encoder

The **single-track encoder** returns a simple pulse sequence. This means that the pulse count and the time between pulses can be determined, but not the rotation direction of the incremental counter.

A **dual-track encoder** returns two pulse sequences with a 90° offset. Along with the pulse frequency, the rotation direction can also be indicated as positive or negative. To configure a measurement with a dual-track encoder, set the parameter "**Counter signal**" which is on the Setup page "*Digital channels*" under the tab "*Encoder*", along with the desired "*Mode*".



Note

Problems with two-point scaling of analog inputs

Affects both the devices belonging to the imc C-SERIES, and also any devices belonging to the imc SPARTAN and imc CRONOS families which are equipped with the digital multiboard: DI16-DO8-ENC4 or the DI8-DO8-ENC4-DAC4.

When an input is set to **dual-track encoder**, it is not possible to **calibrate** the scale with **two-point scaling** for any **analog inputs**. When you click "Record" to take a measurement, the following message appears: "The device is not prepared to allow necessary initialization! Please execute menu action "Prepare" (device control)! imcDevices V2.x Adapter"

However, the "*Prepare*" procedure does not solve the problem. Instead, temporarily set the incremental counter inputs of the modules affected to "*Single-track encoder*" in order to be able to measure the two data points used for two-point scaling.

7.5.1.6 Zero pulse (index)

The **zero pulse** starts the incremental counter channels' counter mechanism. This means the measured values are only recorded, if an event occurs at the **index-channel**. If measurement without a zero pulse is selected, the measurement starts directly upon starting the measurement.

The **index signal** is differential and set by the comparator settings of the **first** incremental counter channel of the module, even for modules that have several index tracks. The bandwidth is limited to 20kHz.



Note

• By default, the option "*Encoder w/o zero impulse*" is activated in imc STUDIO. If this option is deactivated and the zero pulse fails to appear, the encoder module does not start the measurement at all! In that case, the channels only return zero.

7.5.2 Mode (events-counting)

•	.
Mode - Events	Description
Events	The event counter counts the sensor pulses which occur during a single time interval (differential event counting). The interval corresponds to the sampling time set by the user. The maximum event frequency is about 500 kHz.
	An event is a positive edge in the measurement signal which exceeds the user-set threshold value.
	The derivative quantities displacement and angle measurement have the following settings:
	Choice of single-track and dual-track encoder 120
	• Start of measurement with or without "Zero impulse" 121
	Number of pulses (per unit)
Mode - Distance	Description
Distance (differential)	Path traveled within one sampling interval. For this purpose, the number of pulses per meter must be entered.
Distance (absolute)	Absolute distance. The differential distance measurement is converted to the absolute distance. By taking the zero impulse (the counter with no zero impulse should not be selected) into account, the absolute distance position is determined and indicated.

Otherwise, the distance value is assumed to be 0° when the measurement begins.

Mode - Angle	Description
Angle (differential)	Angle traveled within one sampling interval. For this purpose, the number of pulses per revolution must be entered. The absolute angle can be calculated in imc Online FAMOS or determined by the mode Angle(abs).
Angle (absolute)	The differential angle measurement is converted to the absolute angle. By taking the zero impulse (the counter with no zero impulse should not be selected) into account, the absolute angle position is determined and indicated. Otherwise, the angle value is assumed to be 0° when the measurement begins.
Angle (sum)	The differential angle measurement is converted to the cumulative angle. In the process, any zero pulse is evaluated only one time. For this reason, angles which are > 360° are possible.

When using incremental counter modules that work internally with a 16-bit counter, encoders with high pulse rates can lead to overflows. The count is always carried out with sign: 2^{16} = 65536, i. e. ± 32767 . With dual-track encoders the pulse number is quadrupled internally and leads to a maximum number of pulses per revolution of 8192. For encoders with more pulses per revolution, the hardware must have a 32 bit counter, e. g. imc CANSAS *fit*-ENC6, otherwise an event count must be carried out instead and converted with imc Online FAMOS.

7.5.3 Mode (time measurement)

Time measurement

The time measurement mode allows the definition of **edge conditions** between which the time interval is to be measured.

The following combinations are possible:

positive edge	>	negative edge:	(↑>↓)
negative edge	>	positive edge:	(↓ > ↑)
positive edge	>	positive edge:	(↑ > ↑)
The combination negative edge	>	negative edge:	$(\downarrow > \downarrow)$ is not allowed

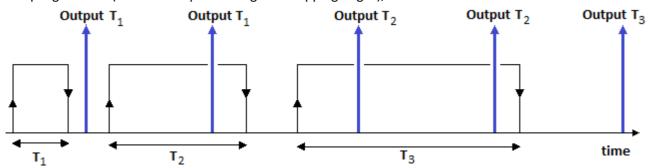
To ensure a high time resolution for the measurement results, suitable scaling must be set for the measurement. An **input range (INC4)** or **Max. time (s) (ENC-6)** specifies the maximum time interval which can be measured between the selected starting and stopping edge. **The time between the signal edges may not be greater than the selected input range.** If the maximum time interval is exceeded during measurement, the system returns the input value range end instead of the true measured value.

Input range	Time resolution	Input range	Time resolution
1 ms	31,25 ns	250 ms	8 μs
2 ms	62,50 ns	500 ms	16 μs
4 ms	125 ns	1 s	32 μs
8 ms	250 ns	2 s	64 μs
16 ms	500 ns	4 s	128 μs
30 ms	1 μs	8 s	256 μs
60 ms	2 μs	16 s	512 μs
120 ms	4 μs	30 s	1024 ms

Time resolution of INC4

The time resolution corresponds to the value of an LSB (Least Significant Bit).

During sampling intervals when no time measurement was possible (because either a starting or stopping edge was missing), the last valid return value continues to be returned until a time measurement is completed. If there is no valid return value, zero is returned. If more than one time measurement is completed during a single sampling interval (due to multiple starting and stopping edges), the last time measured is returned.



Above is illustrated a measured signal from which time readings are taken. Each reading starts at a positive edge in the signal and is stopped at a negative edge. The "up" arrows indicate the times at which the system returns a result. The returned values in this case are T1 –twice; T2 –twice; and T3.

Pulse Time

The point in time at which the edge is located within the sampling interval is determined. This information is needed by some functions in imc Online FAMOS, e.g. for determining the course of the RPMs from a pulse signal: OtrEncoderPulsesToRpm.

The measurement variable *Pulse Time* refers to phase-based data which is only relevant to special applications (particularly order-tracking analysis). It is required for subsequent online calculations. It represents the time between the last detected (asynchronous) pulse and the (synchronous) sampling time at which the counter readings were sampled and evaluated. The unit associated with this variable is called *Code*.



Note

The mode *Pulse Time* depends on the sampling rate. For all ENC-4 types, the entry is visible only if the sampling rate is equal or smaller 1ms. For HRENC-4 the sampling rate must be equal or less 100µs.

PWM

Pulse width modulation (PWM) is a type of modulation in which a technical variable (e.g. electrical current) switches between two values. In the process, the **duty cycle ratio** is **modulated at constant frequency**. PWM is also known as pulse duration modulation (PDM).

A good illustration of this modulation type would be a switch used to continually switch a heater on and off. The higher the ratio of the on-time to the off-time, the higher the average heating power is.

Measurement of PWM can not be performed directly with the device software. However, if the frequency is known, it is possible to perform it indirectly by time measurement with the following settings:

The **ratio** is the *Duration of HIGH (signal) level* over the *Period duration*.

The *Duration of HIGH (signal) level* is obtained by means of a **time measurement** from *positive to negative (signal) edge*.

The *Period duration* is the **inverse of the frequency**, which must be known.

PWM=
$$t_{pulse}/t_{Period\ duration} * 100\%$$
 or $t_{pulse} * f * 100\%$

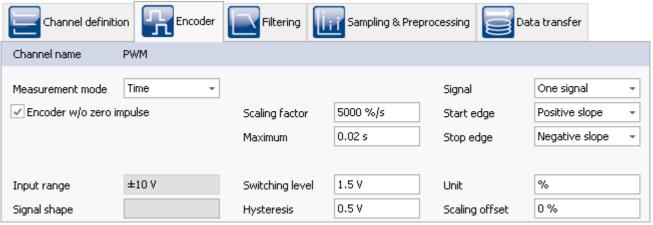
Example:

f= 50Hz, Pulse duration = 10ms

Scaling: $t_{pulse} * f * 100\%/ s = 5000\%/s$

at 10ms: 0.01s*5000%/s= 50%

This can be entered directly via the scaling:



Settings for PWM measurement in time mode

7.5.4 Mode (combined measurement)

Mode	Beschreibung		
Frequency	Frequency is determined by means of a <u>combination measurement [118]</u> . If the frequency was previously multiplied or divided, this can be reflected in the scaling value. The frequency is always unsigned, for which reason there is no dual-track encoder for it.		
Speed	The sequence of pulses is converted to m/s by means of a <u>combination measurement</u> 118. Toward this end, the number of pulses per meter must be entered.		
RPM	The sequence of pulses is converted to revolutions per minute by means of a <u>combination</u> <u>measurement</u> 118. Toward this end, the number of pulses per revolution must be entered.		

8 Measurement Modules

8.1 Audio, Vibration and charge measurement

Analog, 4-channel amplifier available:					
Order Code	CRFX, width:	CRC, CRSL and CRXT function			
AUDIO2-4 125	61.62 mm	-	IEPE/ICP, voltage measurement		
AUDIO2-4-MIC 127	61.62 mm	-	IEPE/ICP, microphone, voltage		
QI-4 128	61.62 mm	-	charge measurement, IEPE/ICP, voltage		

8.1.1 AUDIO2-4

The AUDIO2-4 has four individual, galvanically-isolated channels for the acquisition of:

- IEPE/ICP sensors (current-fed 4 mA)
- Voltage (AC and DC coupling)

Direct connection of IEPE/ICP sensors takes place via BNC plugs.



Reference

Technical details of the AUDIO2-4(-MIC) 319.

Highlights

- Per-channel galvanic isolation
- Robust and feedback-free signal acquisition
- Signal bandwidth 48 kHz
- Large signal-to-noise ratio (-110dB SNR)
- Low signal distortion (-115dB THD)
- High-precision measurements over broad voltage ranges
- Supports imc Plug & Measure conforming to IEEE 1451.4 (Class I mixed mode interface)
- Optional supply unit for a condenser microphone available (AUDIO2-4-MIC 127)

8.1.1.1 Voltage measurement

The input configuration is differential. It is possible to choose between AC and DC coupling. In the measuring ranges greater than ± 2.5 V, an internal voltage divider is effective. The input impedance in these ranges is 1 M Ω , in all other ranges 10 M Ω . When the unit is switched off, the input impedance is always 1 M Ω .

8.1.1.2 Current fed sensors

The use of ICP™ e.g. DeltaTron-sensors® is supported by a 4 mA current source. The sensor information can be read directly from the sensor in accordance to the standard "TEDS - Transducer Electronic Data Sheets (IEEE 1451.4)".



Note

Once the TEDS information (CLASS1, content ="AC with current feed") has been imported, the only available setting for the coupling type is "AC with current feed". In order for DC or AC coupling to be displayed as options, the channel must be disassociated from the sensor information:

imc STUDIO: Setup page: "TEDS" -> "Reset channel's sensor information"

Next to each measurement input on the CRFX/AUDIO2-4 module's **front** panel, there is an **LED** for the purpose of **probe breakage recognition** in the measurement mode/coupling "AC with current fed" as of imc STUDIO 5.2 R15 "IEPE".

8.1.1.3 Bandwidth

The channels' max. sampling rate is 100 kHz (10 μ s sampling interval). The analog bandwidth (without digital low-pass filtering) is 49 kHz (-3 dB).

8.1.1.4 Connection

The signals are connected via BNC, in case of using a AUDIO2-4.

8.1.2 AUDIO2-4-MIC

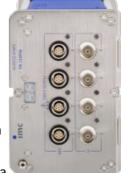
The AUDIO2-4-MIC complies the AUDIO2-4 amplifier by providing an additional supply voltage for microphones.

AUDIO**2**-4-**MIC** is equipped with four **LEMO**.1B.307 sockets. Switching between the AUDIO**2**-4 amplifier's BNC sockets and the LEMO sockets is performed using the software, by **selecting microphone** as the input coupling.

Direct connection of ICP-compatible sensors (ICP®, Deltatron®, Piezotron® sensors) takes place via BNC sockets.

LED's BNC: In case of an error, such as cable breakage and short circuit a LED beside each BNC socket will shine and signalize the error case. In case of a missing connection to the sensor the LED will shine permanently.

LED's LEMO: (as of Revision 2) Beside each LEMO socket (microphone supply) there is a LED in order to monitor the polarization voltage. During normal operation the LED will not shine.



Front: CRFX/AUDIO2-4-MIC

The supply voltages can be set channel-by-channel and are bipolar. ± 14 V bipolar corresponds to 28 V unipolar (± 60 V $_{=}$ 120 V unipolar). The supply voltages need to be adapted to the input range. For peak signal levels from 5 V onward, a supply of ± 60 V is recommended, if your microphone supports this. The polarization voltage is 200 V.



Warning

When the polarization voltage resp. ±60 V supply voltages is active, there is danger of electric shock! It is also activated, if an Autostart experiment is used - configured with that supply voltage.



Reference

LEMO Pin configuration 482

Technical details of the CRFX/AUDIO2-4-MIC 3191.

8.1.3 QI-4 for imc CRONOSflex (CRFX/QI-4)

The imc CRONOSflex measurement module **CRFX/QI-4** is specially suited for quasi-static as well as dynamic charge measurements. By means of piezoelectric sensors, it is possible to measure forces, pressure, acceleration, as well as to perform analysis of solid-borne noise such as that occurring in engine indication on vehicle test stands.

As an alternative to standard BNC plugs, triaxial terminals are available which allow the use of charge sensors with built-in TEDS (Transducer Electronic Data Sheet).

The module is additionally designed for acoustics measurements and vibration analysis. For this purpose, current-fed IEPE sensors such as ICP™-, DeltaTron®-, and PiezoTron® sensors are supported. Further, the module can be used for high-precision measurement across a wide voltage range.

The module features a very high signal-to-noise ratio and high fidelity. In combination with its large bandwidth of around 50 kHz and its 24-bit resolution, a wide scope of applications in the field of measurement engineering can be accomplished. The separate galvanic isolation for each channel provides for robust, interference-free signal capture.

Highlights

- Charge measurement with low drift over time, for quasi-static measurements
- Per-channel galvanic isolation
- High Signal-to-Noise ratio (-110 dB SNR)
- Low signal distortion (-115 dB THD)



Note

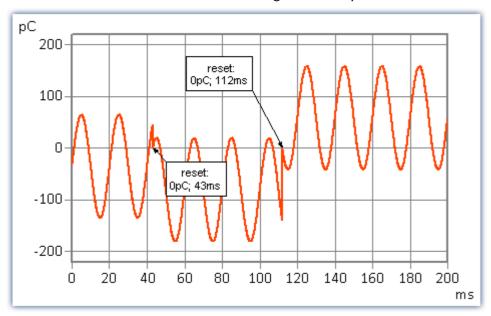
Next to each measurement input on the CRFX/QI-4 module's **front** panel, there is an **LED** for the purpose of **probe breakage recognition** in the measurement mode/coupling "**AC with current fed**", as of imc STUDIO Version 5.2 R15 the coupling is called "**IEPE**".

Find here the technical details of the CRFX/QI-4 323

8.1.3.1 Reset the charge of the integrator

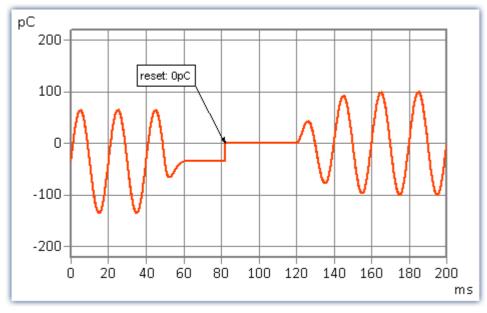
The QI-4 measurement module integrates the charge from the sensors. It is the time integral of the signal. Therefore the current displayed value of reading depends on the previous waveform. In order to delete this memory the reset of the integrator has to be used (via Software imc STUDIO, similar to bridge adjustment). The accumulated charge up to the reset time will be cleared - 0 C will be displayed. From this point on the charge can be measured corresponding to chosen measurement range independent from the charge that was captured before.

If you want to measure oscillation via a acceleration sensor you have to make sure that the sensor is steady at least for 10 s at the reset time otherwise a signal drift may occur.



Due to a changing signal at the measurement input during the two reset procedures at the two following particular moments 43 ms and 112 ms, the time value at those particular moments will be the new arithmetic mean (integration constant).

The reset procedure typically takes a few milliseconds if the red LED beside the BNC socket turns off. The LED will shine typically 0.4 s.



If the charge crosses the limits of the measurement ranges before the reset process a overdriving of the measurement input will be existent. Therefore a reset process has to be done two times in a priod of 30 s one after another.

8.1.3.2 Voltage measurement

The input configuration is differential. It is possible to choose between AC and DC coupling. In measurement ranges > ± 2.5 V a internal pre-divider is in effect. The differential input impedance is 1 M Ω , in all other ranges 10 M Ω . If your measurement device is de-activated, the impedance is always 1 M Ω .

8.1.3.3 Current fed sensors

The use of ICP™ e.g. DeltaTron-sensors® is supported by a 4 mA current source. The sensor information can be read directly from the sensor in accordance to the standard "TEDS - Transducer Electronic Data Sheets (IEEE 1451.4)".



Notes

Once the TEDS information (CLASS1, content ="AC with current feed") has been imported, the only available setting for the coupling type is "AC with current feed". In order for DC or AC coupling to be displayed as options, the channel must be disassociated from the sensor information:

imc STUDIO: Setup page: "TEDS" -> "Reset channel's sensor information"

Next to each measurement input on the CRFX/QI-4 module's **front** panel, there is an **LED** for the purpose of **probe breakage recognition** in the measurement mode/coupling "AC with current fed", as of imc STUDIO Version 5.2 R15 the coupling is called "IEPE".

8.1.3.4 Bandwidth

The channels' max. sampling rate is 100 kHz (10 μ s sampling interval). The analog bandwidth (without digital low-pass filtering) is 49 kHz (-3 dB).

8.1.3.5 Connection



The connection is made via eight BNC sockets, four of which are for voltage measurement or optionally for ICP (\mathbf{U}) and four for charge measurement (\mathbf{Q}). The connections are labeled accordingly: U or Q

8.2 Bridge measurement amplifier

Analog, 4- and 8-channel amplifier available in:					
	CRFX, width:	CRXT, width:	CRC,CRSL	function	
ACI-8 131	61.62 mm			dynamic strain measurement	
BR2-4 146	43.3 mm	34 mm	1 slot needed	strain gauges, LVDT, voltage, IEPE/ICP	
B-8 145 BC-8 145	61.62 mm 43.3 mm	64.5 mm 34 mm	2 slots needed 1 slot needed	strain gauges, voltage, IEPE/ICP	
DCB2-8 133 DCB(C)2- 8 133	61.62 mm 43.3 mm	64.5 mm 34 mm	2 slots needed 1 slot needed	strain gauges, voltage, IEPE/ICP	

8.2.1 CRFX/ACI-8: 8 channel module for dynamic strain measurement

The ACI-8 is a module with 8 individually isolated channels, specifically designed for dynamic strain measurements with single strain gauge sensors. Unlike conventional bridge amplifiers it feeds the gauges with a constant current in 2 wire configuration. The measured signal is AC coupled and thus captures dynamic strain while suppressing any static signals originating from either the sensor or the cabling.

- Voltage mode with current fed sensors, AC coupled
- Assessment of dynamic strain with strain gauges

Highlights

- Channel wise galvanic isolation
- Signal bandwidth 0.5 Hz to 48 kHz
- Connection of strain gauges in 2-wire configuration
- Configurable internal connection of cable shield via rotary switch (case, input, not connected)
- Current source disable for diagnosis

Typical applications

- Dynamic strain measurement, in particular on rotating turbines
- Applications that involve high temperature resistant thermo cables with very high impedance
- Aerospace industry and power generation (aircraft, gas and steam turbines)



Reference

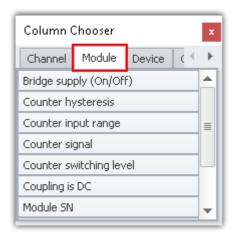
Technical details of the ACI-8 328.

8.2.1.1 Current source (bridge supply)

The current source (**bridge supply**) of the CRFX/ACI-8 module can be switched on and off. But first you have to add the switch in your user interface.

Please read the following chapter in the imc STUDIO manual: description of adding a column in the channel list: Section: Setup - Device (general) > "Information and tips" > "Setup-layout" > "Showing and moving columns"

Add on the setup page "Analog Channels" the following column: "Bridge supply (On/Off)". This column is a "Module" column:



In order to save this configuration and see the new column next time you use imc STUDIO it is necessary to save this view after adding the column. Additionally imc STUDIO will save in this configuration the last window you have opened before saving.

8.2.1.2 Bandwidth

The channels' max. sampling rate is 100 kSamples/s (10 μ s sampling interval).

The **analog bandwidth** (without digital low-pass filtering) is 48 kHz (-3 dB). In AC mode the lower cut off frequency is 0.5 Hz.

8.2.1.3 Connection

Please find here the module's <u>pin configuration: 3-pin LEMO [482]</u> ERN.1S.303.GLN. The recommended LEMO plug is: FFA.1S.303.CLA.

8.2.2 DCB(C)2-8: Strain gauges, Voltage, IEPE/ICP

This bridge amplifier provides eight differential, analog inputs with integrated sensor supply for the measurement of resistive bridges or strain gauges, as well as voltage, current and IEPE/ICP-sensors.

A software selectable sensor supply is included, for powering of external sensors or resistive bridge / strain gauge networks. The DCB2-8 amplifier is also available in a compact version (DCB"C"2-8) with high-density DSUB-26 connections.

Technical details 341

8.2.2.1 Bridge measurement

The measurement channels have an adjustable DC voltage source which supplies the measurement of bridges such as strain gauges. The supply voltage for a group of eight inputs is set in common. The bridge supply is asymmetric, e.g., for a bridge voltage setting of VB=5 V, Pin +VB is at +VB=5 V and Pin -VB at -VB=0 V. The terminal –VB is simultaneously the device's ground reference.

Per default 5 V and 10 V can be selected as bridge supply. As an option ex-factory this amplifier can be build with 2.5 V bridge supply and/or 1 V bridge supply. Depending on the supply set, the following input ranges are available:

Bridge voltage [V]	Measurement range [mV/V]	
10	±1000 to ±0.5	
5	±1000 to ±1	
2.5 (optional)	±1000 to ±2	
1 (optional)	±1000 to ±5	

Fundamentally, the following holds: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals the sensor emits and thus the measurement's **signal-to-noise ratio** and drift quality. The limits for this are set by the maximum available current from the source and by the dissipation in the sensor (temperature drift!) and in the device (power consumption!)

- For typical measurements with **strain gauges**, the ranges 5 mV/V to 0.5 mV/V are particularly relevant.
- There is a maximum voltage which the **potentiometer sensors** are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

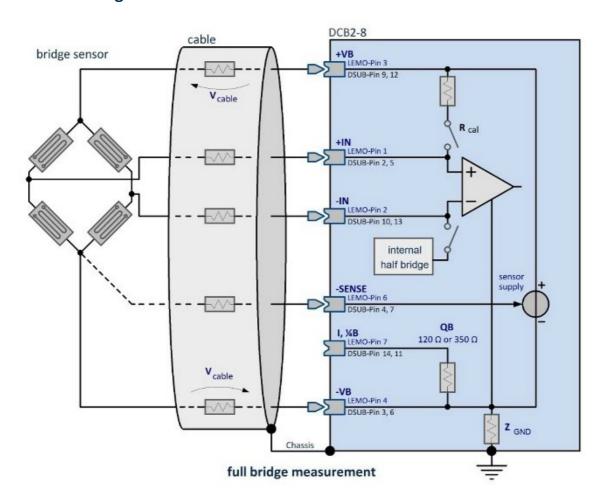
Bridge measurement is set by selecting as measurement mode either *Bridge: sensor* or *Bridge: strain gauge* in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where *quarter bridge*, *half bridge* and *full bridge* are the available choices.



Note

We recommend to angle a maximum range on the not used voltage measurement. An open entry in half- or quarter bridge mode can annoy the neighbor channels if this is also in half- or quarter bridge mode.

8.2.2.1.1 Full bridge

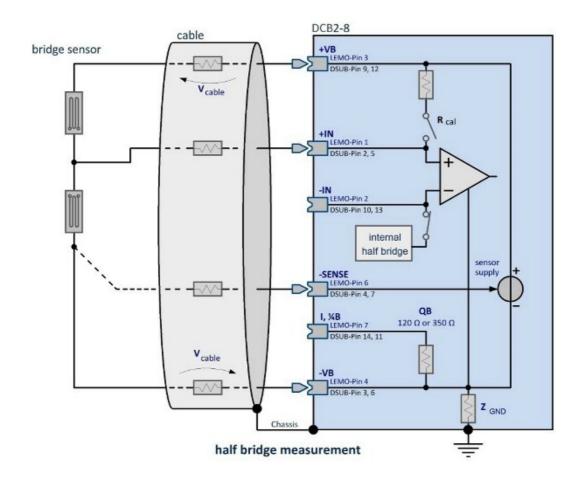


LEMO is the 7-pin LEMO (standard pinning) 48^{\uparrow}
DSUB 15-pin DSUB standard pinning 47^{\uparrow}
is ca. 500 kΩ for CRFX, else 0 Ω

Please note that the maximum allowed voltage drop along a cable may not exceed approx. 0.5 V. This determines the maximum possible cable length.

If the cable is so short and its cross section so large that the voltage drop along the supply lead is negligible. In this case the bridge can be connected at four terminals by omitting the Sense line.

8.2.2.1.2 Half bridge



LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

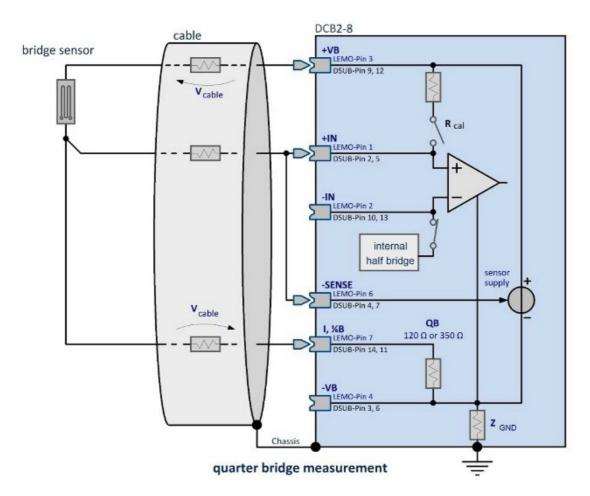
A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has four terminals to connect. For information on the effect and use of the Sense lead SENSE, see the description of the full bridge.

The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a genuine <u>full bridge</u> 134.



It is important that the measurement signal of the half bridge is connected to +IN. The -IN access leads to implausible measured values and influences the neighbor channels.

8.2.2.1.3 Quarter bridge



LEMO is the 7-pin LEMO (standard pinning) 481DSUB 15-pin DSUB standard pinning 474is ca. 500 k Ω for CRFX, else 0 Ω

A quarter bridge can consist of a single strain gauge resistor, whose nominal value can be 120 Ω or 350 Ω .

The amplifier internally completes an additional 120 Ω or 350 Ω quarter bridge switchable by software.

The quarter bridge has 3 terminals to connect. Refer to the description of the full bridge for comments on the Sense lead. However, with the quarter bridge, the Sense lead is connected to +IN and SENSE jointly.

If the sensor supply is equipped with the option " ± 15 V", a quarter bridge measurement is not possible. The pin $I_1/4B$ for the quarter bridge completion is used for -15 V instead.

8.2.2.1.4 Sense and initial unbalance

The SENSE lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then SENSE (F) must be connected in the terminal plug according to the sketches above.

A bridge measurement is a relative measurement (**ratiometric procedure**) that calculates what fraction of the supplied bridge excitation voltage is given off from the bridge (typically in the 0.1% range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the **bridge supply's actual magnitude is not relevant** and need not necessarily lie within the measurement's specified overall accuracy.

Any **initial unbalance** of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set.

Possible initial unbalance

input range [mV/V]	bridge balancing	bridge balancing	bridge balancing
	(VB = 2.5 V) [mV/V]	(VB = 5 V) [mV/V	(VB = 10 V) [mV/V
±1000	200	500	240
±500	2000	100	700
±200	40	400	60
±100	140	20	200
±50	200	70	10
±20	20	100	35
±10	30	14	50
±5	7	18	7
±2	9	3.5	10
±1	-	4.5	2
±0.5	-	-	5

8.2.2.1.5 Balancing and shunt calibration

The module offers a variety of possibilities to trigger bridge balancing:

- Balancing / shunt calibration upon activation (cold start) of the unit. If this option is selected, all the bridge channels are balanced as soon as the device is turned on.
- Balancing / shunt calibration via graphical user interface of device software (channel balance respectively amplifier balance)
- In shunt calibration, the bridge is unbalanced by means of a 59.8 k Ω or 174.66 k Ω shunt. The results are:

Bridge resistance	120 Ω	350 Ω
59.8 kΩ	0.5008 mV/V	1.458 mV/V
174.7 kΩ	0.171 mV/V	0.5005 mV/V

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.



Note

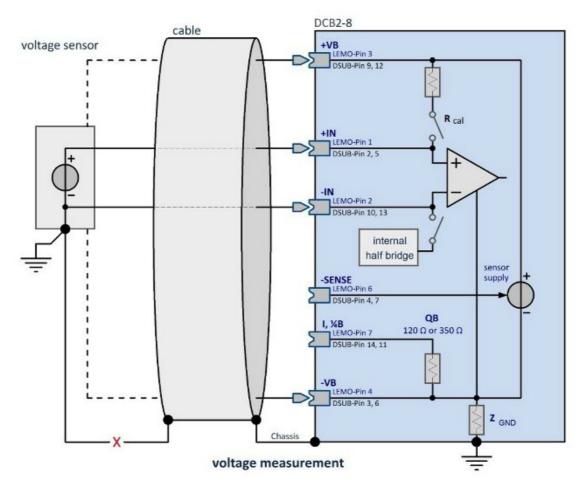
• We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

8.2.2.2 Voltage measurement

Voltage: ±10 V to ±5 mV in 9 different ranges

The input impedance is $20M\Omega$. ($1M\Omega$ when switched off)

8.2.2.2.1 Voltage source with ground reference



LEMO is the 7-pin LEMO (standard pinning) $\boxed{48}$ DSUB 15-pin DSUB standard pinning $\boxed{474}$ Z GND is ca. 500 k Ω for CRFX, else 0 Ω

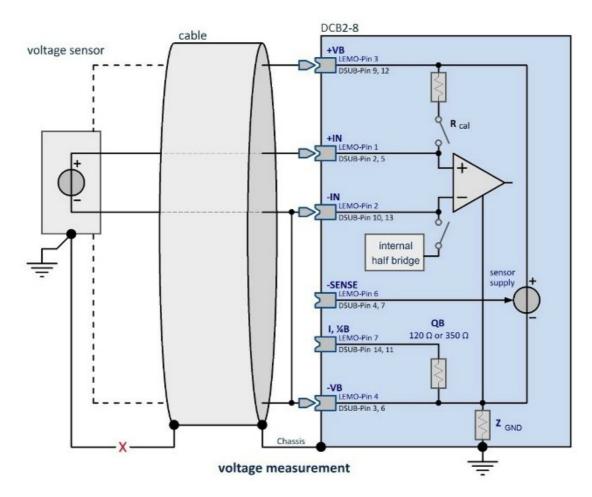
The voltage source itself already has a connection to the device's ground. The potential difference between the voltage source and the device ground must be fixed.

Example: The device is grounded. Thus, the input -VB is also at ground potential. If the voltage source itself is also grounded, it's referenced to the device ground. It doesn't matter if the ground potential at the voltage source is slightly different from that of the device itself. But the maximum allowed common mode voltage must not be exceeded.

Important: In this case, the negative signal input -IN may not be connected with the device ground -VB. Connecting them would cause a ground loop through which interference could be coupled in.

In this case, a genuine differential (but not isolated!) measurement is carried out.

8.2.2.2.2 Voltage source without ground reference



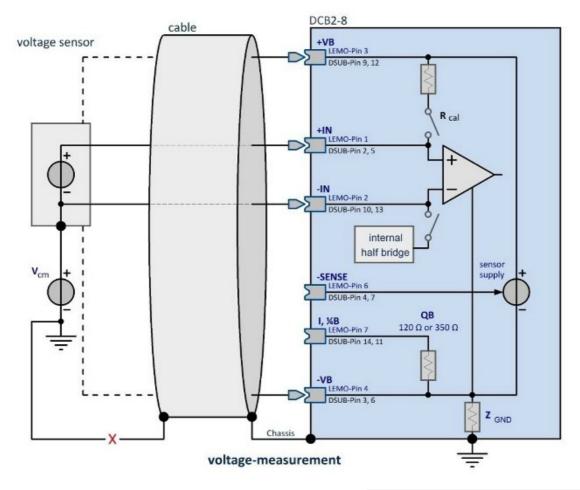
LEMO is the 7-pin LEMO (standard pinning) $\boxed{48}$ DSUB 15-pin DSUB standard pinning $\boxed{474}$ is ca. 500 k Ω for CRFX, else 0 Ω

The voltage source itself is not referenced to the device ground but is instead isolated from it. In this case, a ground reference must be established. One way to do this is to ground the voltage source itself. Then it is possible to proceed as for "Voltage source with ground reference". Here, too, the measurement is differential. It is also possible to make a connection between the negative signal input and the device ground, in other words to connect -IN and -VB.

Example: An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The module is grounded.

Important: If -IN and -VB are connected, care must be taken that the potential difference between the signal source and the device doesn't cause a significant compensation current. If the source's potential can't be adjusted (because it has a fixed, overlooked reference), there is a danger of damaging or destroying the amplifier. If -IN and -VB are connected, then in practice a single-ended measurement is performed. This is no problem if there was no ground reference beforehand.

8.2.2.3 Voltage source at a different fixed potential



LEMO is the 7-pin LEMO (standard pinning) 481DSUB 15-pin DSUB standard pinning 474is ca. 500 k Ω for CRFX, else 0 Ω

The common mode voltage (U_{cm}) has to be less than ± 10 V. It is reduced by ½ input voltage.

Example: Suppose a voltage source is to be measured which is at a potential of 120 V to ground. The device itself is grounded. Since the common mode voltage is greater than permitted, measurement is not possible. Also, the input voltage difference to the device ground would be above the upper limit allowed.

8.2.2.3 Current measurement

The current measurement is realized with shunt plug or with ground reference via the internal quarter bridge completion.

8.2.2.3.1 Differential current measurement

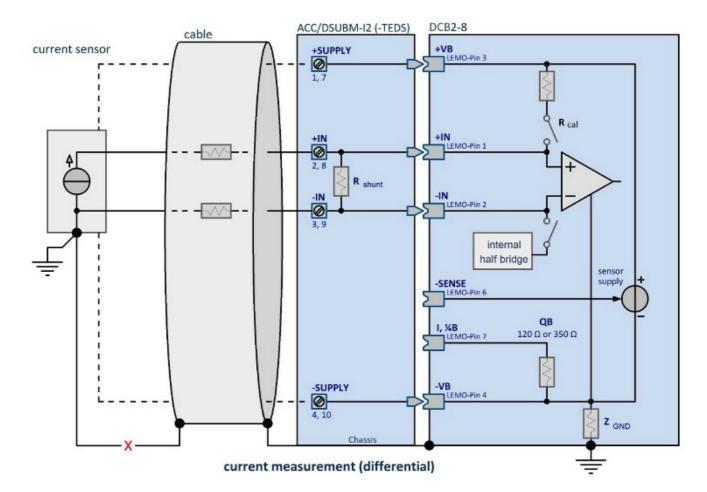


Note

Requirement

The following statements only apply for modules with DSUB sockets.

• Current ±50 mA to ±1 mA



LEMO is the 7-pin LEMO (standard pinning) 481DSUB 15-pin DSUB standard pinning 474is ca. 500 k Ω for CRFX, else 0 Ω

For current measurement could be used the DSUB plug ACC/DSUBM-I2. That plug comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. Appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor needs an adequate level of precision. Pay attention to the shunt's power consumption.

The **maximum common mode voltage** must be in the range ±10 V for this circuit, too. This can generally only be ensured if the current source itself already is referenced to ground. If the current source is ungrounded a danger exists of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

The sensor can also be supplied with a software-specified voltage via Pins +VB and -VB.

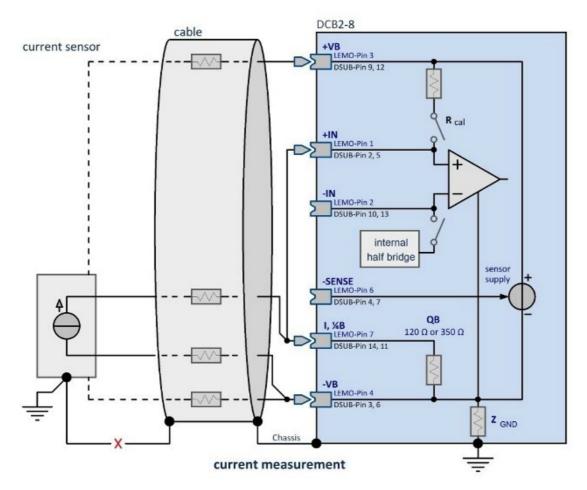


Note

Since in this procedure a voltage measurement at the shunt resistor is involved, it is necessary to configure the imc software for voltage measurement. The scaling factor is entered as 1/R and the unit set is A $(0.02 \text{ A/V} = 1/50 \Omega)$.

8.2.2.3.2 Ground-referenced current measurement

• Current: ±50 mA to ±2 mA



LEMO is the 7-pin LEMO (standard pinning) 48 Ω DSUB 15-pin DSUB standard pinning 474 is ca. 500 kΩ for CRFX, else 0 Ω

In this circuit, the current to be measured flows through the 120 Ω shunt in the amplifier. Note that here, the terminal -VB is simultaneously the device's ground. Thus, the measurement carried out is single-ended or ground referenced. The potential of the current source itself may be brought into line with that of the units ground. In that case, be sure that the device unit itself is grounded.

In the settings interface, set the measurement mode to Current.

Note that the jumper between +IN and +I; ¼Bridge should be connected right inside the plug.

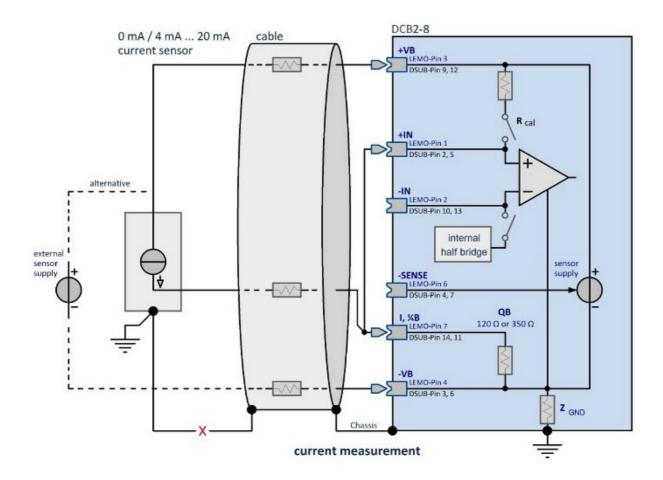


Note

For an (optional) sensor supply with ±15 V ground referenced current measurement is not possible. The pin *I;%Bridge* is used as -15 V pin.

8.2.2.3.3 2-wire for sensors with a current signal and variable supply

• E.g. for pressure transducers 4 mA to 20 mA



LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning $\overline{474}$ is ca. 500 k Ω for CRFX, else 0 Ω

Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal.

In the settings dialog on the index card *Universal amplifiers/ General*, a supply voltage is set for the sensors, usually 24 V. The channels must be configured for *Current measurement*.

The sensor is supplied with power via Terminals +VB and +I; $\frac{1}{4}_{Bridge}$.

The signal is measured by the amplifier between +IN and I; \mathcal{L}_{Bridge} . For this reason, a wire jumper must be positioned between Pins +IN and I; \mathcal{L}_{Bridge} inside the plug.



Note

There is a voltage drop across the resistances of the leadwires and the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω · 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a leadwire with a large enough cross-section.

8.2.2.4 Current fed sensors

For the measurement of current-fed sensors we recommend the expansion plug <u>ACC/DSUBM-ICP2I-BNC(-F,-S)</u> [237].



Note

DCB2-8 or B-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

The use of plastic plugs (ACC/DSUB-ICP2, ACC/DSUB-ICP4) in connection with triaxial sensors is not possible.

8.2.2.5 Sensor supply

The channels are enhanced with an integrated sensor supply unit, which provides an adjustable supply voltage for active sensors. The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for all measurement inputs in common.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.



Note

The voltage selected is also the supply for the measurement bridges. If a value other than 5 V or 10 V is set, bridge measurement is no longer possible!

8.2.2.6 Bandwidth

The channels' **maximum sampling rate** is 100 kHz (10 μ s). The analog bandwidth (without digital low-pass filtering) is 5 kHz (-3 dB).

8.2.2.7 Connection

The following terminal connections are available:

- DSUB-15 connector (find here the pin configuration 474)
- LEMO (find here the pin configuration 481)
- DSUB-26-HD (find here the pin configuration 478)

The BC-8 uses 26-pin HD (High Density) DSUB connections. Those provide four channels for each DSUB connection.

8.2.3 B(C)-8: Strain gauges, Voltage, IEPE/ICP

The B(C)-8 is a compact bridge amplifier and is similar to the $\frac{DCB(C)2-8}{48}$ amplifier with an higher bandwidth of 48 kHz (-3 dB).

The description of the $\frac{DCB(C)2-8}{133}$ applies to the B(C)-8 with the exception of the bandwidth and filter.



Reference

Technical details of the B(C)-8 341

8.2.3.1 Connection

The following terminal connections are available:

- DSUB-15 plug (find here the pin configuration [474])
- LEMO (find here the pin configuration 481)
- DSUB-26-HD (find here the pin configuration 478)

The BC-8 uses 26-pin HD (High Density) DSUB connections. Those provide four channels for each DSUB connection.

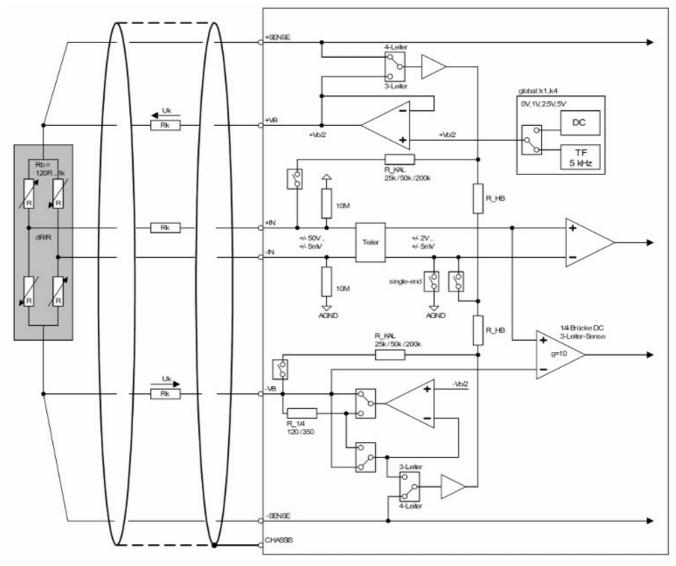
8.2.4 BR2-4: Strain gauges, LVDT, Voltage, IEPE/ICP

BR2-4 is an all-purpose bridge amplifier for four channels (also employable as a DC differential amplifier). It enables measurement of four bridges, load cells or strain gauges and inductive LVDTs, supplied with a software selectable choice of either DC or CF (AC carrier frequency) excitation, technical details

Highlights

- DC and Carrier frequency mode (5 kHz)
- Lead wire compensation with single and dual sense line configurations are supported (e.g. 5/6-wire-circuit with full bridge)
- Symmetric bridge supply of 1 V, 2.5 V, 5 V and with DC and CF (AC) mode
- Software selectable quarter bridge completion 120 Ω and 350 Ω switchable
- Cable breakage recognition

8.2.4.1 Bridge measurement



Block schematic

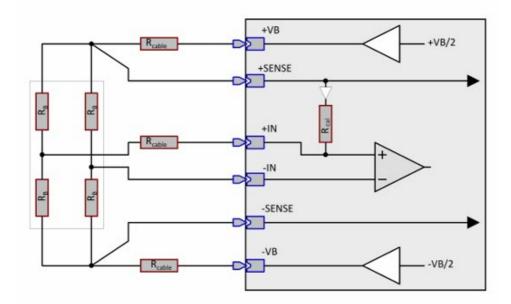
Sense line

The amplifier supports configurations with single-line sense, for compensation of symmetric cables: Just leave the unused sense line unconnected (+ or –SENSE): Internal pulldown-resistors provide defined zero levels to

detect the SENSE configuration automatically. It will be shown at the balance dialog of imc software and allows probe-breakage recognition.

8.2.4.1.1 Full bridge

Connection scheme: Full bridge, double sense



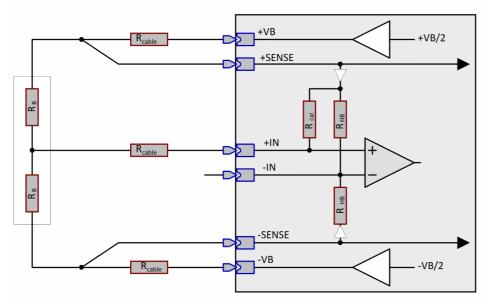
- 6-wire connection
- Both SENSE-lines, ±SENSE, used ("double sense").
 Compensation of the influence even of asymmetric cable resistances.
- Calibration resistor for shunt calibration; for long cables in CF mode, reduced precision due to phase errors

Connection scheme: Full bridge with single line-Sense, only DC mode

• Analogous to the corresponding half-bridge configuration

8.2.4.1.2 Half bridge

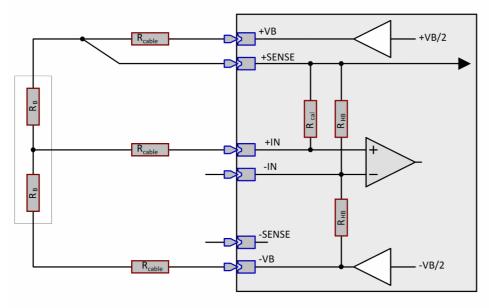
Connection scheme: Half-bridge, double Sense



Half-bridge, double Sense

- 5-wire connection
- Both SENSE-lines, ±SENSE, used (double Sense):
 Compensation of the influence even of asymmetric cable resistances.
- Calibration resistor for shunt calibration: shunt calibration of external half-bridge arm; for long cables in CF mode, reduced precision due to phase errors
- Internal half-bridge completion excitation is controlled by an internal, buffered SENSE line; therefore asymmetric cable is permitted without the resulting offset-drift!

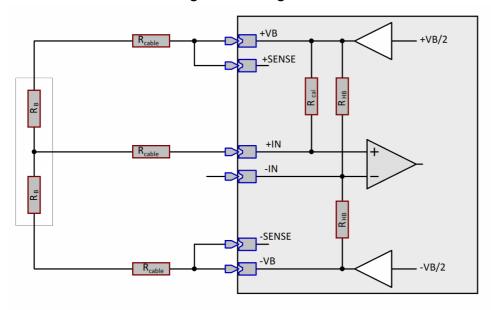
Connection scheme: Half-bridge, single line-Sense, only DC mode



Half-bridge, single line-Sense

- 4-wire connection
- Only one SENSE-line is used (single line-Sense):
 Compensation of the influence of symmetric cable resistances.
 +SENSE or -SENSE can be used, recognized automatically, unused SENSE left open.
- Calibration resistor for shunt calibration of external half-bridge arm; for long cables in CF mode, reduced precision due to phase errors.
- Internal half-bridge completion fed by ±VB, therefore symmetric cable required, otherwise not only incorrect gain correction but also corresponding offset drift!

Connection scheme: Half-bridge without single line-Sense



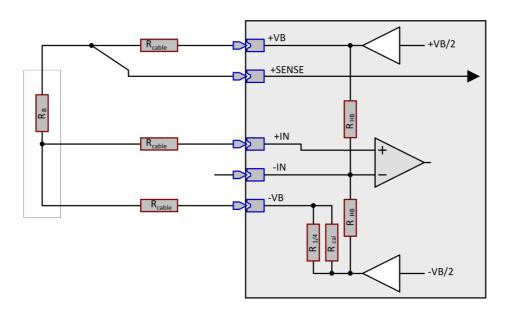
Half-bridge without single line-Sense

- 3-wire connection
- No SENSE-line used, SENSE terminals to be left open of jumpered to ±VB at the plug, in order to compensate the plug's contact resistance.
- Calibration resistor for shunt calibration on external half-bridge arm; for long cables in CF mode, reduced precision due to phase errors.
- Optional cable resistance calibration ("offline"):
 Cable resistance determined by means of shunt calibration and automatic calculation.

 Symmetric cabling required (also to +IN!).
 No acquisition of cable resistance drift, since it can only be performed offline before measurement.
- Internal half-bridge completion fed by ±VB, therefore symmetric cabling required, otherwise not only incorrect gain correction but also corresponding offset drift!

8.2.4.1.3 Quarter bridge

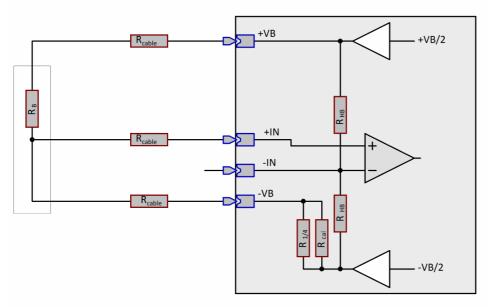
Connection scheme, quarter bridge, with Sense



Quarter bridge, with Sense

- 4-wire connection
- SENSE is used: compensation of voltage drop at symmetric cables
- Calibration resistor for shunt calibration: Shunt calibration at internal quarter-bridge completion. Shunt calibration can also be used with long cables in the CF mode!
- Symmetric cables required, otherwise corresponding offset drift!

Connection scheme: Quarter-bridge, without Sense



Quarter-bridge, without Sense

- 3-wire connection
- No SENSE-line is used, leave SENSE terminals open.
 +SENSE may also NOT be connected. Compensation of the plug contact resistance at VB is thus not possible (in contrast to the case of half-bridge 2-wire configuration).
- Symmetric cabling required, otherwise corresponding offset drift!
- Calibration resistance for shunt calibration: Shunt calibration at internal quarter-bridge completion. Shunt calibration can also be used with long cables in the CF mode!
- For DC: Compensation of gain error due to cable resistance at VB by means of measurement and automatic compensation of the voltage drop along the cable between –VB and +IN
 Online-compensation, capture also of cable drift (which must be symmetric!)

8.2.4.1.4 Background info on quarter-bridge configuration

In quarter-bridge configuration the external ¼-bridge branch is connected via three cables, where the two current-bearing leads "+VB" and "-VB" must be symmetric (same resistance, thus identical length and cross-section). Under these circumstances, their influence (in terms of the offset, not the gain) is compensated, so that no offset versus the (constant) internal half-bridge's potential arises.

If this symmetry condition is not met (e.g. if only two cables are used and the terminals "–VB" and "+IN" are directly jumpered at the terminal) the following offset drift would result due to the temperature-dependent cable resistance in series with the bridge impedance:

Assuming a (one-way) cable length of 1 m, we get:

Cu-cable: 0.14 mm^2 , $130 \text{ m}\Omega/\text{m}$, cable length l=1 m Cable Rk = $130 \text{ m}\Omega$

Temperature coefficient Cu: 4000 ppm / KDrift Rk: $0.52 \text{ m}\Omega \text{ / K}$

Equivalent bridge drift (120 Ω bridge) $\frac{1}{2}$ 0,52 m Ω / (K *120 Ω) = 1.1 μ V/V / K

Example: Temperature change dT = 20 K $22 \mu V/V (dT = 20 K)$

Cable resistance values which aren't ideally symmetric would have a proportionally equal effect: e.g., 500 m of cable with 0.2% resistance difference would cause the same offset drift of 1.1 μ V/V / K.

Along with the offset, a gain uncertainty given by the ratio between the cable resistance and the bridge impedance must also be taken into account. For 120 Ω bridges, it remains under 0.1% for cable lengths of approx. 1 m:

Cu-cable, 0.14 mm², 130 m Ω /m --> cable Rk/Rb = 1/1000 for I = 0.9 m

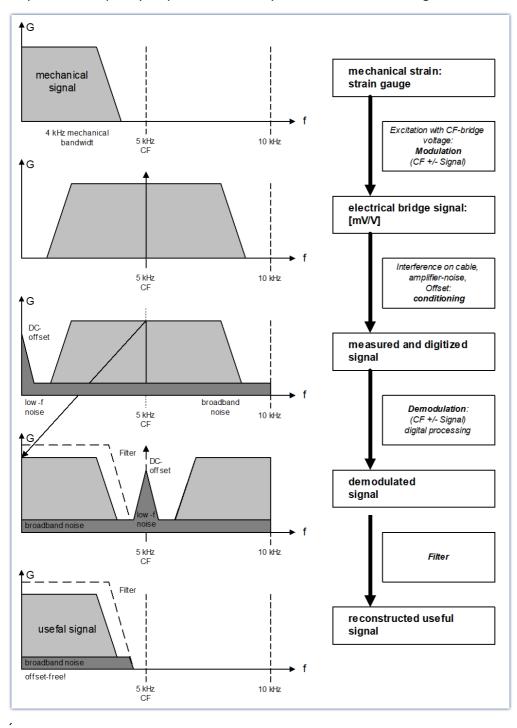
There are three different procedures for cable compensation:

- Connection of an additional 4th line: "+SENSE":
 - automatic calculated compensation on the condition of cable symmetry
 - online compensation procedure which also takes temperature drift into account
 - can be used with CF and DC-mode
- Evaluation of the voltage drop along the cable to "-VB" by means of measuring the voltage difference between the terminals "-VB" and "+IN":
 - automatic computed compensation on the condition of cable symmetry
 - online-compensation procedure which also accounts for temperature drift
 - only can be used for DC

8.2.4.2 Carrier frequency amplifier: Modulation principle

Operational principle for the effective suppression of low-frequency disturbances, e.g. 16 Hz, 50 Hz. These can work from the wiring or the measuring process and/or from low-frequency noise and offset drift and also from the process and the amplifier.

The following schematically description shows that carrier frequency amplifier is based on a modulation / demodulation process. This process support low-frequency and/or DC disturbances which are linked on electrical way. Carrier frequency amplifier is necessary for inductive sensors, e.g. LVDT.



8.2.4.3 Overload recognition

Overload is indicated as double the value of the input range limit value. If the negative input range is exceeded, then in DC-mode, the doubled negative input range is indicated. In CF-mode, the doubled positive input range is always shown. The chapter: Overdriving a measurement range about describes the implemented behaviour to facilitate easy identification of overrange status.

8.2.4.4 Bandwidth

imc CRONOScompact and imc CRONOS-SL:

The channels' max. sampling rate is 20 kHz (50 μ s). The analog bandwidth (without digital low-pass filtering) is 8.6 kHz (-3 dB) in DC mode and 3.9 kHz in CF mode (-3 dB).

imc CRONOSflex

The channels' max. sampling rate of a CRFX/BR2-4 is 100 kHz (10 μ s). The analog bandwidth of the CRFX/BR2-4 (without digital low-pass filtering) is 14 kHz (-3 dB) in DC mode and 3.9 kHz in CF mode (-3 dB).

8.2.4.5 Connection

DSUB-15 plugs can be used for the modules with DSUB connections, find here the <u>pin configuration of the DSUB-plugs</u> [474]. LEMO plugs can only be used for modules with LEMO connections, please find here the <u>pin configuration</u> [487].



Note

±SENSE will be detected automatically by the BR-4, BR2-4 amplifier (as of imc firmware Version 2.7 R3 SP7).

8.2.5 LVDT-8: LVDT Bridge measurement

The CRC/LVDT-8 module is specially designed for LVDT measurements (Schaevitz coils according to the transformer principle and inductive half bridges).



Reference

- measurement description 115
- technical specs 338
- pin configuration: ACC/DSUBM-B2 474

8.3 Voltage, Current and Temperature

	CRFX width	CRXT width	Slots needed CRC, CRSL	Bandwidth	function
<u>C-8</u> 156			1	20 Hz	voltage, temperature, current (20 mA)
HISO-8-L 159, HISO-8-T-XL 159	81.9 mm			11 kHz	high isolated: voltage, current (20 mA), temperature
HV2-2U2I / 164 HV2-4U 164	81.9 mm		2	48 kHz	high isolated: high voltage, current probe
ICPU2-8 173	61.62 mm	64.5 mm	2	48 kHz	voltage, IEPE/ICP
ICPU-16 176			4	6.6 kHz	voltage, IEPE/ICP
<u>ISO2-8</u> 177	43.3 mm	34 mm	1	11 kHz	isolated: voltage, current (20 mA), temperature, IEPE/ICP
ISO2-16-2T 177	61.62 mm				isolated: temperature
ISOF-8 182	43.3 mm	34 mm	1	48 kHz	voltage, current (20 mA), temperature, IEPE/ICP voltage
<u>LV-16</u> 186			2	6.6 kHz	voltage, current (20 mA), IEPE/ICP
LV3-8 187	43.3 mm	34 mm	1	48 kHz	voltage, current (20 mA), IEPE/ICP
OSC-16 190			2	1 Hz	isolated: voltage, current (20 mA), temperature
SC2-32 193			4	20 kHz	voltage, current (20 mA), IEPE/ICP

8.3.1 C-8: Voltage, temperature, current (20 mA)

This C-8 is a measurement amplifier for 8 channels measuring:

- voltages, current (20 mA) and
- temperature (thermocouple, PT100)

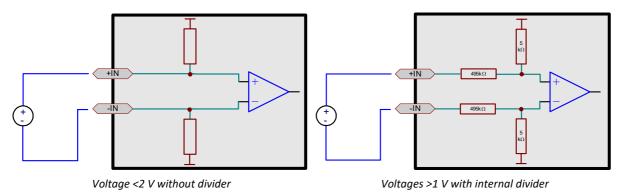
Technical details of the C-8 347 and the pin configuration of the DSUB-15: ACC/DSUBM-U4

8.3.1.1 Voltage measurement

- ±50 V to ±2,5 V with divider
- ±1 V to ±5 mV without divider

A voltage divider is in effect in the voltage ranges ±50 V and ±2,5 V;

the resulting input impedance is 1 $M\Omega$ - even when the device is deactivated. The input configuration is differential and DC-coupled.



8.3.1.2 Temperature measurement

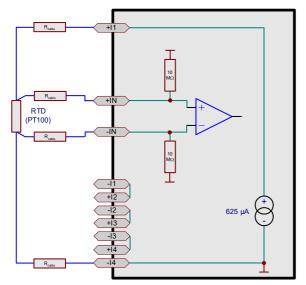
The C-8-module's channels are designed for measurement with thermocouples and PT100-sensors (RTD). Any combination of sensor types can be connected. Many common thermocouple types use linearization based on characteristic curves.

The cold-junction compensation for the thermocouple measurements is either built-in or is handled by the imc Thermoplug (DSUB-15) [106], depending on the device variety.

8.3.1.2.1 Measurement with PT100 (RTD)

Besides thermocouples, it's also possible to connect PT100 sensors directly in 4-wire-configuration. A (supplementary) reference current source feeds up to four sensors connected in series jointly.

When the imc Thermoplug is used, the connection terminals are already wired in such a way that this reference circuit is closed.



Example for one PT100(RTD) in 4-wire configuration

Example for two PT100(RTD) in 4-wire configuration

8.3.1.2.2 Thermocouple measurement

The thermocouples are connected with type-K Thermo-plugs into sockets of the same type of the amplifier (C-8-T, 3-pin thermo slot, type K, green). The reference point is at the terminal on the front panel, whose temperature signal is captured and evaluated by the device.

8.3.1.3 Optional sensor supply module

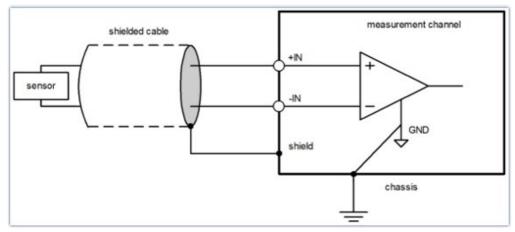
The C-8 can be enhanced with the sensor supply unit: SUPPLY, which provides an adjustable supply voltage for active sensors.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

Technical details of the sensor supply module 46.

8.3.1.4 Connection

The measurement inputs should be connected using a shielded cable in which both the positive and negative measurement inputs (+IN and -IN) are located inside the shielding. The shielding must be connected to the housing of the plug.



Pin configuration: standard (ACC/DSUB-STD) 474 or LEMO connection 481.

8.3.2 HISO-8-L, HISO-8-T-8L and HISO-8-T-2L: High isolated: Voltage, Temperature

The HISO-8 is an isolated, differential measurement amplifier with 8 analog inputs for measuring small voltage signals with high common mode isolation up to 800 V. The following signals and sensors are supported, depending on the chosen variant:

HISO-8 variant	supported measurement modes	LEMO REDEL
CRFX/HISO-8-T-8L	thermocouple measurement type K	LEMO.2P (2-pin)
CRFX/HISO-8-T-2L	thermocouple measurement type K	LEMO.2P (8-pin)
CRFX/HISO-8-L	voltage measurement (±50 mV to ±60 V) current measurement (20 mA) PT100, PT1000 measurement	LEMO.1P (5-pin)







Highlights

- Channel-wise isolated, galvanically-separated inputs
- High common mode isolation up to 800 V
- Overvoltage protection ±600 V (differential)
- High signal bandwidth of up to 11 kHz
- Each channel with its own adjustable filter (e.g., anti-aliasing filter) and simultaneous A/D converter

Typical applications

- Testing in e-mobility environments (e.g., electric and hybrid vehicles)
- Tests where full personal safety must be guaranteed even in case of hazards
- Measurements on high-voltage components, such as batteries, power electronics components and Power supply circuits; low-voltages, including signals on external current measurement shunts



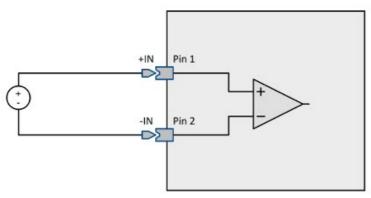
Reference

Please find here the <u>LEMO.1P</u> [483] and the <u>LEMO.2P</u> [483] pinning.

Technical details of the HISO-8 350.

Please consider the following chapter: General remarks on isolated channels 1771.

8.3.2.1 Voltage measurement



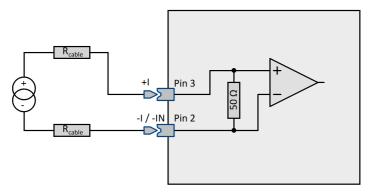
configuration for voltage measurement

Measurement ranges: ±50 mV to ±60 V

The differential input impedance is 6.7 M Ω in ranges up to ±2 V. For all other ranges and if the device is de-activated, the impedance is always 1 M Ω .

The inputs are DC-coupled. The differential response is achieved by means of the isolated circuiting.

8.3.2.2 Current measurement



configuration for current measurement

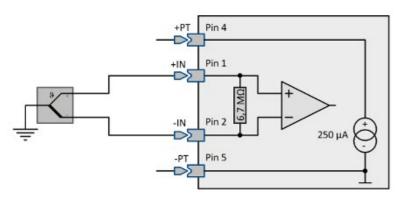
Measurement ranges: ±40 mA, ±20 mA, ±10 mA

The current is measured via an internal 50 Ω shunt. The current signal has to be connected to +I and -IN / -I.

8.3.2.3 Temperature measurement

The input channels are designed for direct connection of thermocouples and PT100 / PT1000 sensors.

8.3.2.3.1 Thermocouple measurement



Temperature ranges:

- -270°C to +1370°C
- -270°C bis +1100°C

Thermocouple type K

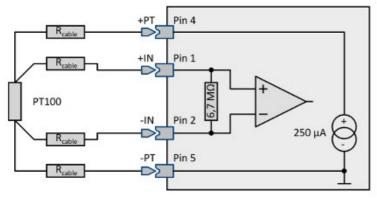
configuration for thermocouples



Note

Note that the physical location is important. The precision stated in the technical specs applies for installation location in a thermally stabilized environment.

8.3.2.3.2 PT100 (RTD) - Measurement



configuration for PT100 (RTD) sensors

Measurement range:

- -200°C to +850°C
- -200°C to +250°C

A PT100 sensor is connected in a 4-wire configuration.

Each connected sensor is feed individually from a separate reference voltage supply.

8.3.2.4 Bandwidth

The channels' max. sampling rate is 100 kHz (10 μs). The analog bandwidth is 11 kHz (-3 dB).

8.3.2.5 Connection box for high voltage (HV) modules

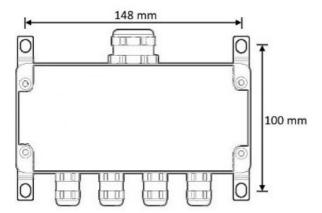


External HV connection box

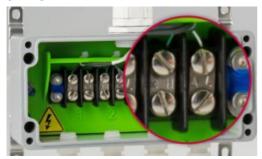
- with 10 m special HV cable via LEMO.2P (Redel)
- isolated screw terminals in polymer box
- sensor cable entry via cable gland (PG)
- serves as flexible and safe cabling interface to any arbitrary user cable
- clear division between fully specified, HV-rated CRFX/HISO-8-T-2L measurement module and suited HV-rated connectors on one side and custom and application specific cables and sensors on the other side that might comply with differing rules or regulations, under exclusive responsibility of the user

TC type K PT100/1000 Cell voltages HV-Batterie Inverter Cable, adapters, assembly HVBOX-8 with cable and plug LEMO.2P (Redel)

Mechanical drawings with dimensions - HVBOX-8:



Interior view



for the thermocouple variant: HVBOX-8-T-10M as an example, two wires are enlarged left + and right - for the fourth thermocouple

Terminal		Lead Wire (Color Code)		
Signal / Material	Label	IEC 585-3	ANSI	
(+) Ni-Cr	СН	green	yellow	
(-) Ni-Al	AL	white	red	

Symbols



Attention! Risk of electric shock. Dangerous voltages from the measuring sources may be applied to the terminals (HV onboard). Please observe the rated values!



Reference

Please find in the following chapter the <u>technical specs of the connection box</u> 3551.

8.3.2.6 Connection



Reference

HISO-8-xx

Please find here the LEMO pin configuration 483 of all available HISO-8 variants.

8.3.3 HV2-2U2I, HV2-4U High isolated: Voltage, Current probe

With this four-channel amplifier: HV2-2U2I, two channels are available for measuring voltages and two channels to measure with current clamps.

With the HV2-4U module variant four channels are available for measuring voltages.

Typical applications:

• Power measurements, measurements on electric motors, batteries, fuel cells, etc.



Reference

Technical details: HV2-2U2I 356, technical details: HV2-4U 360

8.3.3.1 High-voltage channels

The high-voltage channels are each equipped with an galvanically isolated amplifier. They enable direct measurement of voltages of up to 1000 V_{rms} , in accordance with the protection class CAT II, see <u>technical Specs</u> 336.

The measurement signal is connected directly to the device via a safety banana jack.



Warning

Each high-voltage module (HV2-2U-2I, HV2-4U) was inspected for compliance with the safety guidelines per DIN EN 61010-1 prior to delivery, and subjected to a high-voltage test. The module is sealed after having passed these final tests.

If the safety seal is damaged, safe work cannot be ensured.

Any intervention, for instance temporary removal of the module, makes re-inspection for safety.

8.3.3.1.1 Voltage measurement

• Voltage: ±1000 V to ±2.5 V in 9 different ranges

The inputs are DC-coupled and have a permanent input impedance of 2 M Ω . The differential response is achieved by means of the isolated configuration.

For the voltage measurement at common low voltage systems there is a reserve of the displayed value, therefore imc recommends the choice of the following measurement ranges:

- range = 250 V for 230 V-system +25 %
- range = 500 V for 400 V-system +40 %

8.3.3.2 Current measurement channels

Those current measurement channels are specially for the use of current transducers with voltage output (only the HV2-2U2I variant). Current Probes and Rogowski Coils can be transducer, which perform a power voltage conversion. Besides this kind of current measurement there is also the measurement of low voltage signals possible within the respective measurement ranges. The following ranges are available ±5 V to ±250 mV. The differential inputs are DC-coupled and galvanically isolated.

Suitable current probe and Rogowski Coils can be delivered.



Note

- Use only current probes provided by imc, or have your own current probes modified by our customer service. Only then can error-free functioning be assured. imc will not accept responsibility for disturbances or damage sustained by the device if unauthorized probes are used.
- Whenever you connect a new current probe, read its TEDS information. The TEDS data are recorded along with the experiment and therefore need not be imported each time the same equipment is activated, see also the notes for <u>making settings in the imc software</u> 1691.
- Amplitude and angle error of the external measurement transducer influence the measurement result and this mostly effect the power quality measurement.

8.3.3.2.1 Current measurement using Current Probes

Current Probes are compactly structured, electrically isolated sensors shaped like clamps, by which currents can be measured simply by encircling the conducting wire, without interrupting the circuit. The current under investigation is converted to a proportional voltage signal. Active sensors such as compensation transducers require their own power supply. In most cases, this is already provided by a battery in the Current Probe. Like Current Probes, Rogowski Coils enable contact-free measurement of current in a conductor by simply encircling it. In contrast to active Current Probes, Rogowski Coils don't require a power supply, but they can only measure AC-currents. To be exact, they measure the change in current, which makes integration of the signal necessary.

In both application cases, configuration of the measurement channel according to the type used is necessary. The Current Probes offered by imc come this way and will be detected by the imc operating software, see also the notes on making settings in the imc operating software 169.



Warning

- The measurement inputs are high-impedance and are not intended for direct connection of current transducers.
- The measurement signal can be accompanied by dangerous contact voltages. Please use only safety plugs.

8.3.3.2.2 Current measurement using Rogowski Coil

A Rogowski coil encircles a current conductor thus encompassing its magnetic flux field. By means of appropriate measurement engineering technology which is able to take the time integral of the encircled output voltage, it is possible to measure the current conducted. The measurement inputs of the HV2-2U2I are able to perform this integration when the Rogowski coil is connected with a TEDS or if the corresponding sensor information from the imc SENSORS database is used.

The Rogowski coil consists of a single wire which winds along the entire length of the loop. Due to design issues, not the whole magnetic field of the Rogowski coil is measured, since the winding stops at the coil's "node" (or the "buckle" of the loop/"belt"). This gap and the associated incomplete measurement of the magnetic field cause a certain measurement error whose magnitude depends on the conductor's position relative to the node; the closer the node, the greater the error.

As you can see in the following figure, the measurement error depends on where the conductor is located within the loop, in terms of the distance from the node at which the conductor passes perpendicularly through the plane of the loop. It can be shown that the optimum location for the conductor is across from the node.

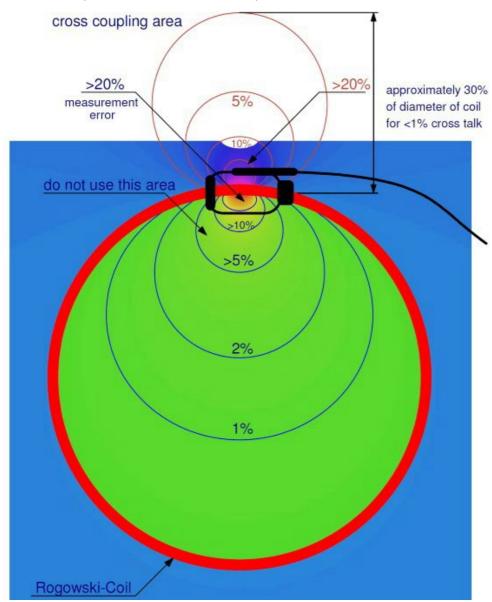


figure 1: measurement error in a Rogowski coil

Since the coil does not completely surround the conductor, only a part of the current is measured. In the one-third of area opposite from the node, the amount measured is ca. 98%. The sensor's sensitivity is calibrated at factory in the optimum position and is saved in the TEDS which is installed in the coil. This value is automatically used by the measurement system as the correction value. Thus, the measurement error at the optimum conductor position is less than 0.5%. The measurement uncertainty for HV2-2U2I is significantly less. (Bending the coil into an ellipse is not recommended.)

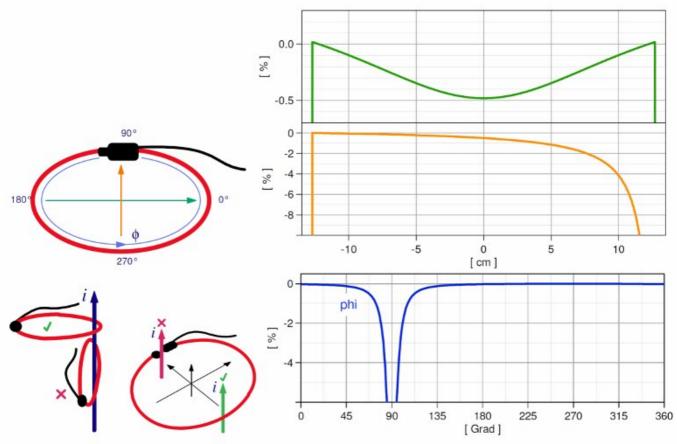


figure 2: location-dependent measurement error in a Rogowski coil for selected distances

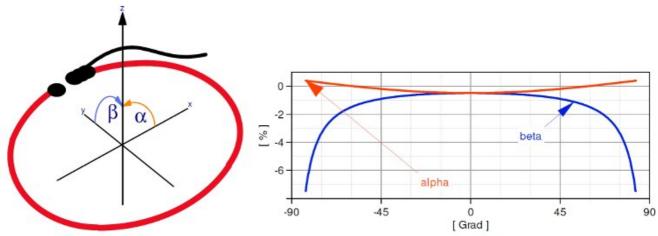


figure 3: Location-dependent measurement error in a Rogowski coil for different angles of inclination to the loop plane

An angle between the axis of the conductor and the plane of the loop also causes measurement error — especially if it causes the node to get near the conductor. This relationship is graphed in Fig. 3 for rotation in the angle b. (Figures 1 through 3 apply to a coil length of 80 cm / 32 inch. For loops having a length of 40 cm / 16 inch, the position dependency is greater and is approximated by Fig. 1 for equally-sized nodes.)

If there is an additional conductor in proximity to the node, its magnetic field also affects the sensor and thus distorts the measurement. For this reason, the node should be positioned in such a way as to maximize its distance from the conductor, see Fig. 1_{166} .



Note

For small measurement errors, observe the following rules:

- Place the conductor across from the loop node.
- Secure the loop in a plane perpendicular to the axis of the conductor.
- Keep the greatest possible distance between the loop node and other conductors.

Only alternating currents can be measured. The measurement bandwidth thus has only a lower cutoff frequency. For signal frequencies below or near this cutoff frequency, it is to be anticipated that there will be an amplitude-and phase error in reference to signals at the voltage measurement inputs. This phase error in particular will affect the measurement of power. HV2-2U2I has a very low lower cutoff frequency and low phase error, so that very good results are obtained at up to 1 Hz.

On the other hand, this high-pass response causes signal transient behavior which may last up to 30 s in the worst cases. This duration applies for signals which modulate to the measurement range maximum (e.g. 2 kA) and is is much less for lower instantaneous values of the current being measured.

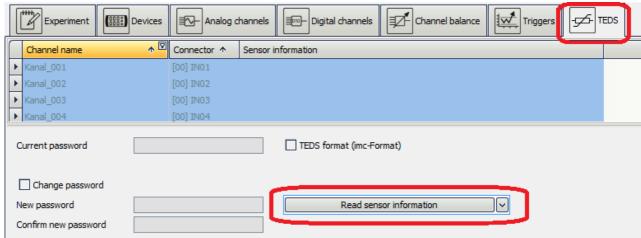
8.3.3.2.3 Notes on making settings in the imc software

Electrically, a current transducer (Current Probe or Rogowski Coil) always measures a voltage. The measurement device converts the captured voltage value to the corresponding current value by means of the Y-factor and unit supplied.

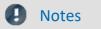
The current transducers provided by imc have been tested and supplied with TEDS which record the associated correction values. These correction values must absolutely be imported in order for the appropriate correction value and unit to be entered along with the experiment.

- 1. Connect the current transducer.
- 2. Start the imc operating software and connect the device with the PC.
- 3. Open the configuration dialog under Settings / Configuration
- 4. On the Base page of the dialog, select the current transducer connected
- 5. Import the transducer's sensor information from the transducer:

With **imc STUDIO** click to *Read sensor information* at the TEDS page. The TEDS page can be loaded from menu *View* \ *Tool windows* \ *Layout repository*.



Reading the TEDS information in imc STUDIO



- The correction values of the individual sensors result in uneven input ranges.
- The available current input ranges result via the scaling factor of the transducer and the amplifiers' voltage measurement ranges (250 mV to 5 V). Only select the ranges, that are appropriate for your Current Transducer. There is no danger for the device with other ranges.
- The displayed input ranges take RMS values into account of up to a crest factor of 1.45. For instance, for a clamp probe of 2000 A RMS-value, an input range of at least 2000 A to 2500 A must be set for the purpose of full utilization.

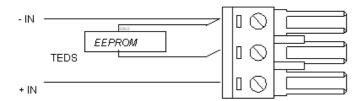
8.3.3.2.4 Voltage measurement

• Voltage: ±5 V to ±50 mV in 4 different ranges

The isolated differential inputs are DC-coupled and have a permanent input impedance of 20 M Ω . Besides measurement with Current Probes, any other voltage signals can also be connected.

8.3.3.3 Pin configuration and cable wiring

Cable connection plug – Current measurement channels



Cable connection plug

Plug (female) in device		Definition
+ IN TEDS - IN	+IN	Signal input
	-IN	Signal input
		Transducer Electronic Data Sheet provides recognition of the current probe connected



In order to protect against touch-dangerous voltage the connector housing is always to be used!

8.3.3.1 Notes on the measurement setup

Measurement lines must be kept away from unshielded conductors, sharp edges, electromagnetic fields and other adverse environmental factors.

- Measurement line for the voltage: The measurement line's connection to the measurement object must be designed for the maximum occurring voltage. Before conducting the measurement, check the line leading to it in order to prevent the occurrence of dangerous touch voltages and short circuits. The use of flexible terminals makes special care necessary. It must be checked whether the mechanical connection is secure and what would happen if it is accidentally disconnected. For increased reliability, the lines should be secured at the measurement location. The fuse's breaking capacity must correspond to the expected error current at the measurement location.
- Measurement line for the current: The current probes must be connected in a mechanically secure manner. The aim should be to orient it orthogonally to the current rail or lead. This applies especially to current measurement coils operating according to the Rogowski principle.
- Measurement device: The device must be placed in such a way that no terminals can be accidentally disconnected.

8.3.3.4 Connection

8.3.3.4.1 Voltage

For voltage measurements of up to 1000 $V_{rms'}$, safety banana jacks are provided:







The maximum permitted voltage to ground depends on the measurement site, please consider the data sheet see safe.

Only use connectors which are protected on all sides against touch.

All the inputs are individually isolated. The voltage channels are built up with channel-wise galvanically isolated (potential-free) amplifiers. They allow the direct measurement of voltages up to $1000 \, V_{rms}$. The permissible range of application (measurement in supply networks, nominal rated voltage etc.) depends on the relevant measurement category.

The analog bandwidth (without low-pass filtering) enables correct measurement of up to the 50 harmonic. The inputs are DC-coupled and have a permanent input impedance in the $M\Omega$ range. The differential response is achieved by means of the isolated configuration.



Note

For measurements on multi-phase systems, implement a connection scheme that is as symmetrical as possible: The (-) connections of the measurement inputs must also be routed with separate cables for each phase. If these measurement references belong to a common reference potential (e.g. N or PE), they must be connected at the test object and not bridged or looped through at the amplifier inputs.

8.3.3.4.2 Current



Current measurement is achieved contact-free by means of current probes. To connect these transducers, three-pin screw terminal block are provided.





Current transducer AmpFLEX A100

The current probes recommended by imc cover the range for low currents (<10 A) and for medium to high currents (5 kA to 10 kA). With probes having multiple input ranges, the input range set on the probe must also be correctly set by hand in the user's interface.

8.3.4 ICPU2-8: Voltage, IEPE/ICP

The measuring inputs (non-isolated, differential inputs) are used for voltage measurement and allow direct connection of any IEPE type sensors via BNC, such as ICP™, DeltaTron®, accelerometers or microphones, see technical details 362.

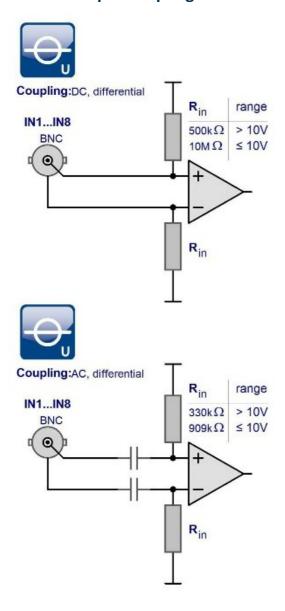
8.3.4.1 Voltage measurement

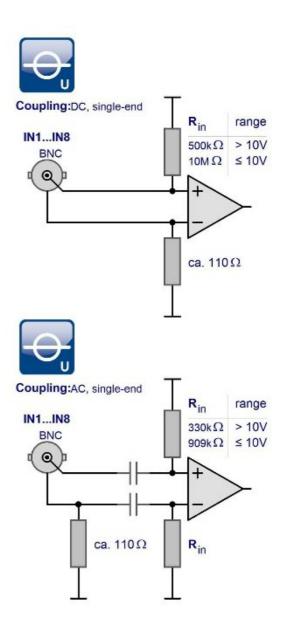
• Voltage: ±50 V to ±5 mV

In the voltage ranges ± 50 V and ± 20 V, a voltage divider is in operation; the resulting input impedance is 1 M Ω in DC mode and 0.67 M Ω in AC mode. In the voltage ranges $\leq \pm 10$ V, by contrast, the input impedance is 20 M Ω in DC and 1.82 M Ω in AC mode. When the device is deactivated, it drops to about 1 M Ω .

With the AC coupled ICP-measurement the DC voltage is suppressed by a high pass filter of 0.37 Hz for all ranges $\leq \pm 10$ V. For the ranges $\geq \pm 20$ V the low pass cut-off frequency is 1 Hz.

8.3.4.1.1 Input coupling



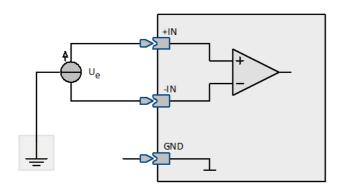




Note

- In the coupling mode "AC with current supply" respectively "IEPE", an open-circuit current-fed voltage of about 30 V is present at the BNC sockets, which can cause damage to other (non-current-fed) sensor types. For that reason, this mode should only be set for appropriate sensors. It is assured that no current feed is active when the device is started. This state remains in effect until the measurement is first prepared, no matter what is set in the user's interface.
- When a channel is not active, there will be no current-fed voltage in the settings mode AC with current feed as of firmware version 2.7 R3.
- As of imc STUDIO version 5.2 R15 the coupling mode "AC with current supply" is renamed to "IEPE".

8.3.4.1.2 Case 1: Voltage source with ground reference



The voltage source itself already is referenced to the device's ground. The voltage source is at the same potential as the device ground.



Example

The measurement system is grounded. Thus, the input GND is at ground potential. If the voltage source itself is also grounded, it is referenced to the device ground. It isn't any problem if, as it may be, the ground potential at the voltage source deviates from the ground potential of the device itself by a few degrees. The maximum permitted common mode voltage must not be exceeded.

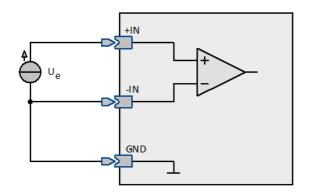


Note

In this case, the negative signal input -IN may not be connected to the ground contact GND in the device. Otherwise, a ground loop would result, through which interference could be coupled in.

In this case, a true differential (but not isolated!) measurement is performed.

8.3.4.1.3 Case 2: Voltage source without ground reference



The voltage source itself has no reference to the device's ground, but instead, its potential floats freely compared to the device ground. If a ground reference cannot be established, it's also possible to connect the negative signal input –IN to the ground contact GND.



Example

A voltage source which isn't grounded (e.g. a battery) and whose contacts have no connection to ground potential is measured. The measurement system is grounded.



Note

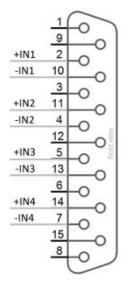
When –IN and GND are connected, be sure that the signal source's potential can actually be drawn to the device ground's potential without an appreciable current flowing. If the source can't be brought to that potential level (because it turns out to be at fixed potential after all), there is a risk of permanent damage to the amplifier. If IN and GND are connected, a Single ended measurement is performed. This isn't a problem unless a ground reference already existed.

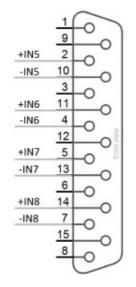
8.3.4.2 Bandwidth

The channels' max. sampling rate is 100 kSamples/s (10 μ s sampling interval). The analog bandwidth (without digital low-pass filtering) is 14 kHz and with ICPU2-8: 48 kHz (-3 dB). In AC mode the lower cut off frequency is 0.37 Hz for all ranges $\leq \pm 10$ V, else 1 Hz.

8.3.4.3 Connection

The terminal connections of the ICPU2-8 and of the ICPU2-8-70mHz (special version with <u>0.07 Hz cut-off</u> <u>frequency</u> are of the type BNC, see <u>schematics</u> 173. The ICPU2-8-**D**-70mHz is equipped with two DSUB-15 sockets:







8.3.5 ICPU-16 Voltage, current-fed sensor

This model includes an internal ICP expansion, so that no external ICP-plug is necessary. The interconnections are of the type BNC. This means there is no possibility to measure current via the special DSUB terminal.

The ICPU-16 supports TEDS (Transducer Electronic Data Sheet) as per IEEE 1451.4 Class I Mixed Mode Interface. According to this protocol, both TEDS data and analog signals are sent and received along the same line. Technical details of the ICPU-16 (366).

8.3.5.1 Circuit diagrams

see ICPU2-8 173.

8.3.5.2 Voltage measurement

Voltage: ±10 V to ±250 mV

The input impedance is 20 M Ω in DC and 1.82 M Ω in AC mode. When the device is deactivated, it drops to about 1 M Ω . With the AC coupled IEPE (ICP)-measurement the DC voltage is suppressed by a high pass filter of 0.37 Hz.

The input configuration is differential.

8.3.5.2.1 Case 1: Voltage source with ground reference

see ICPU2-8 173.

8.3.5.2.2 Case 2: Voltage source without ground reference

see ICPU2-8 173.

8.3.5.3 Bandwidth

The channels' max. sampling rate is 20 kSamples/s (50 μ s sampling interval). The analog bandwidth (without digital low-pass filtering) is 6.6 kHz (-3 dB). In AC mode the lower cut off frequency is 0.37 Hz.

8.3.5.4 Connection

The interconnections are of the type BNC.

8.3.6 ISO2-8(-16)/-2T Isolated: voltage, current (20 mA), temperature, IEPE/ICP

The isolated voltage channels of the module ISO2-8(-16) have their **own isolated amplifier**, operated in the voltage mode.

Along with voltage measurement, current measurement via a shunt plug and temperature measurement via temperature plug ACC/DSUBM-T4 can be performed. The use of the ICP-expansion plug is also possible, however it cancels the isolation.

Parameter	Value	Remarks
Measurement modes	voltage measurement	voltage plug ACC/DSUBM-U4
DSUB	current measurement	current plug ACC/DSUBM-I4
	thermocouples, RTD (PT100)	thermo plug ACC/DSUBM-T4
	IEPE/ICP (current fed sensors)	IEPE/ICP expansion plug ACC/DSUB-ICP4
Measurement modes	voltage measurement	
LEMO	current measurement	single end (internal shunt)
	RTD (PT100)	
Measurement mode	temperature measurement	
CRFX/ISO2-8(-16) -2T	thermocouple measurement type K	



Reference

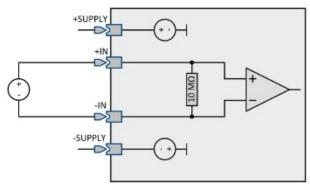
- Technical details of the ISO2-8 368
- Technical details of the ISO2-8(-16)-2T 375

8.3.6.1 Voltage measurement

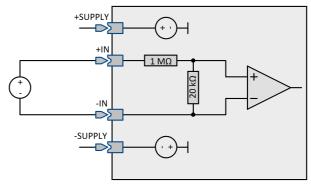
Voltage: ±60 V to ±5 V with divider
Voltage: ±2 V to ±50 mV without divider

An **internal pre-divider** is in effect in the voltage ranges ± 60 V to ± 5 V. In this case, the differential input impedance is 1 M Ω , in all other ranges 10 M Ω . If the device is de-activated, the impedance is 1 M Ω .

The inputs are DC-coupled. The differential response is achieved by means of the isolated circuiting.



configuration for voltages <5 V



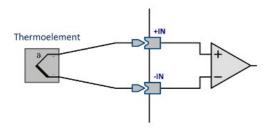
configuration for voltages >2 V with internal divider

8.3.6.2 Temperature measurement

The input channels are designed for measurement with **thermocouples and PT100**-sensors (RTD, platinum resistance thermometers). Any combinations of the two sensor types can be connected. <u>A detailed description of temperature measurement is presented here 105</u>.

Temperature measurement is performed with the imc plug <u>ACC/DSUBM-T4 107</u>. Thermocouples can alternatively be captured using two-pin thermo-plugs.

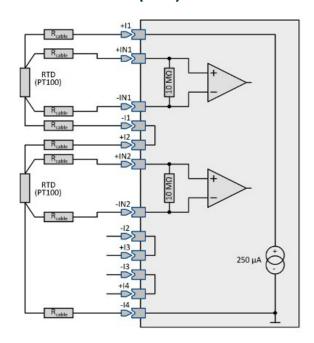
8.3.6.2.1 Thermocouple measurement



The common thermocouple types make use of linearization by characteristic curve.

The cold-junction compensation necessary for thermocouple measurements is built into the imc thermo-plug (ACC/DSUBM-T4 107).

8.3.6.2.2 PT100 (RTD) - Measurement



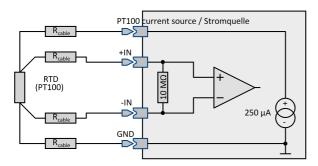
Along with thermocouples, **PT100** sensors can also be connected, in **4-wire configuration**. An extra reference current source feeds an entire chain of up to four serially connected sensors.

The imc-thermo plugs (ACC/DSUBM-T4) 476 has 4 contacts which are available for the purpose of 4-wire measurements. These current-supply contacts are internally wired so that the reference current loop is automatically closed when all four PT100 units are connected. This means that the –I contact of one channel is connected to the +I contact of the next channel (see the sketch imc thermo plug 107). Therefore, for channels not connected to a PT100 sensor, a wire jumper must be used to connect the respective "+Ix" and "-Ix" contacts.

Normal DSUB-15 plugs don't come with these extra "auxiliary contacts" for 4-wire connections. This means that you must take steps to ensure that the reference current flows through all PT100 units. Only "+I1" (DSUB(9), Terminal K1, "(RES.)") and "-I4" (DSUB(6), Terminal K10, "(GND)") are available as a contact or DSUB-15 pin, respectively. The connections "-I1 = +I2", "-I2 = +I3", and "-I3 = +I4" must be wired externally.

PT100 sensors are fed from the module and don't have or even require an arbitrarily adjustable reference voltage in the sense of an externally imposed common mode voltage. It is also not permissible to set one up, for instance by grounding one of the four connection cables: the PT100 reference current source is referenced to the device's frame (CHASSIS), and is thus not isolated.

Using the ISO2-8 with LEMO connections (ISO2-8-L) the following schematic could be helpful:



Each connected sensor is feed individually form a separate reference voltage supply.

8.3.6.3 Current fed sensors

At the DSUB-15 sockets, a permanent $\underline{5 \text{ V supply voltage for external sensors}}|_{251}$ is available. This voltage source is grounded to the measurement device's frame. The description of measurement with ICP sensors is presented here. $\boxed{237}$ For the measurement of current-fed sensors we recommend the expansion plug $\boxed{\text{ACC/DSUBM-ICP2I-BNC(-F,-S)}}\boxed{237}$.



Note

ISO2-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

The use of plastic plugs (ACC/DSUB-ICP2, ACC/DSUB-ICP4) in connection with triaxial sensors is not possible.

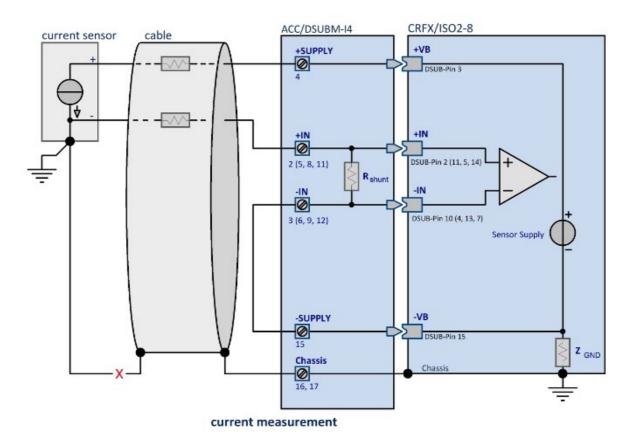
When using the two channel IEPE plug: ACC/DSUBM-ICP2I-BNC(-S/-F) in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

8.3.6.4 Current measurement

• Current: ±40 mA, ±20 mA, ±10 mA ... ±1 mA in 6 ranges

ISO2-8 amplifier with DSUB-15:

A special plug (ACC/DSUBM-I4) with a built-in **shunt** (50 Ω) is needed for current measurement. For current measurement with the special shunt-plugs ACC/DSUBM-I4, inputs ranging only up to max. ± 50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.



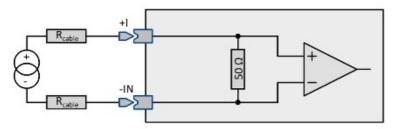
Note

Since this procedure is a voltage measurement at the shunt resistor, **voltage measurement** must also be set in the imc Software.

The **scaling factor** is entered as 1/R and the unit as A (e.g. $0.02 \text{ A/V} = 1/50 \Omega$).

8.3.6.5 Current measurement with internal shunt

ISO2-8-L: ISO2-8 variant with LEMO sockets



8.3.6.6 Bandwidth

The channels' max. sampling rate is 100 kHz (10 μ s). The analog bandwidth (without digital low-pass filtering) is 11 kHz (-3 dB).

8.3.6.7 Connection



Reference

Please find here DSUB-15 plugs, on page 474 or LEMO plugs, on page 481.

8.3.7 ISOF-8: voltage, current (20 mA), temperature, IEPE/ICP

The isolated voltage channels of the module ISOF-8 have their **own isolated amplifier**, operated in the voltage mode. Along with voltage measurement, current measurement via a shunt plug and temperature measurement via temperature plug ACC/DSUBM-T4 can be performed. The use of the <u>ICP-expansion plug 237</u> is also possible, however it **cancels the isolation**.



Reference

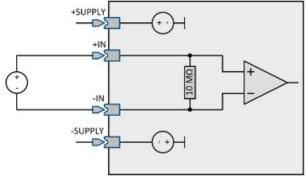
- Technical details of the ISOF-8 377
- Please find here <u>DSUB-15 plugs</u>, on page 474 or <u>LEMO plugs</u>, on page 481

8.3.7.1 Voltage measurement

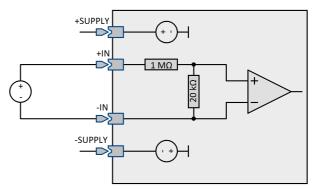
Voltage: ±60 V to ±5 V with divider
Voltage: ±2 V to ±25 mV without divider

An internal pre-divider is in effect in the voltage ranges ± 60 V to ± 5 V. In this case, the differential input impedance is 1 M Ω , in all other ranges 10 M Ω . If the device is de-activated, the impedance is always 1 M Ω .

The inputs are DC-coupled. The differential response is achieved by means of the isolated circuiting.



configuration for voltages <5 V



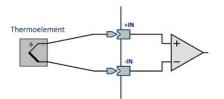
configuration for voltages >5 V with internal divider

8.3.7.2 Temperature measurement

The input channels are designed for measurement with **thermocouples and PT100**-sensors (RTD, platinum resistance thermometers). Any combinations of the two sensor types can be connected. A detailed description of temperature measurement is presented here 105.

Temperature measurement is performed with the imc plug <u>ACC/DSUBM-T4 107</u>. Thermocouples can alternatively be captured using two-pin thermo-connectors.

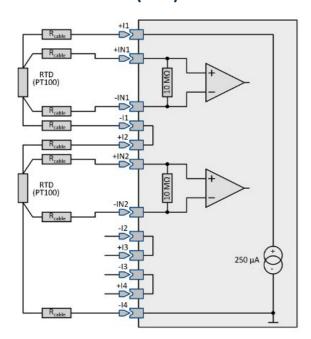
8.3.7.2.1 Thermocouple measurement



The common thermocouple types make use of linearization by characteristic curve.

The cold-junction compensation necessary for thermocouple measurements is built into the imc thermo-plug (ACC/DSUBM-T4 107)).

8.3.7.2.2 PT100 (RTD) - Measurement



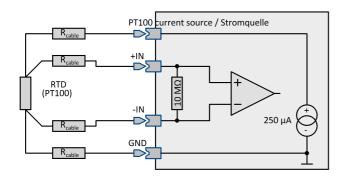
Along with thermocouples, **PT100** sensors can also be connected, in **4-wire configuration**. An extra reference current source feeds an entire chain of up to four serially connected sensors.

The imc-thermo plug (ACC/DSUBM-T4) 476 has 4 contacts which are available for the purpose of 4-wire measurements. These current-supply contacts are internally wired so that the reference current loop is automatically closed when all four PT100 units are connected. This means that the –I contact of one channel is connected to the +I contact of the next channel (see the sketch imc thermoplug 107). Therefore, for channels not connected to a PT100 sensor, a wire jumper must be used to connect the respective "+Ix" and "-Ix" contacts.

Normal DSUB-15 plugs don't come with these extra "auxiliary contacts" for 4-wire connections. This means that you must take steps to ensure that the reference current flows through all PT100 units. Only "+I1" (DSUB(9), Terminal K1, "(RES.)") and "-I4" (DSUB(6), Terminal K10, "(GND)") are available as a contact or DSUB-15 pin, respectively. The connections "-I1 = +I2", "-I2 = +I3", and "-I3 = +I4" must be wired externally.

PT100 sensors are fed from the module and don't have or even require an arbitrarily adjustable reference voltage in the sense of an externally imposed common mode voltage. It is also not permissible to set one up, for instance by grounding one of the four connection cables: the PT100 reference current source is referenced to the device's frame (CHASSIS), and is thus not isolated.

Using the ISOF-8 with LEMO connections (ISOF-8-L) the following schematic could be helpful:



Each connected sensor is feed individually form a separate reference voltage supply.

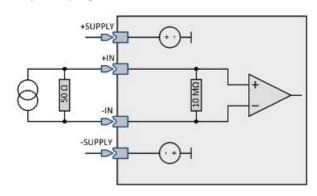
8.3.7.3 Current fed sensors

At the DSUB-15 sockets, a permanent <u>5 V supply voltage for external sensors</u> [251] is available. This voltage source is grounded to the measurement device's frame. <u>The description of measurement with ICP sensors is presented here.</u> [237] For the measurement of current-fed sensors we recommend the expansion plug <u>ACC/DSUBM-ICP2I-BNC(-F,-S)</u> [237].

8.3.7.4 Current measurement

• Current: ±40 mA, ±20 mA, ±10 mA in 3 ranges

A special plug: **ACC/DSUBM-14** with a built-in shunt (50 Ω) is needed for current measurement.



For current measurement with the special shunt-plugs ACC/DSUB(M)-I4, inputs ranging only up to max. ±25 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.

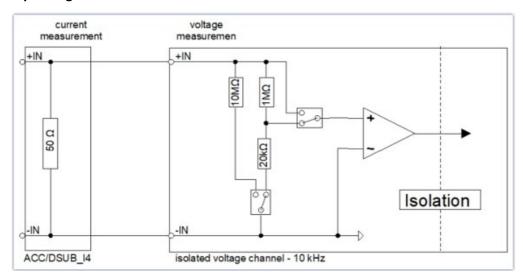


Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc software interface.

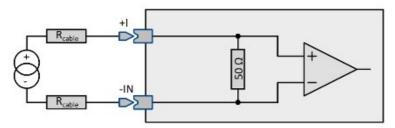
The scaling factor is entered as 1/R and the unit as A (e.g. $0.02 \text{ A/V} = 1/50 \Omega$).

Input stage block schematic



8.3.7.5 Current measurement with internal shunt

ISOF-8-L: ISOF-8 variant with LEMO plug



8.3.8 LV-16 Voltage, Current (20 mA), IEPE/ICP

The LV-16 comes with 16 differential, non-isolated input channels which can be used for measuring <u>voltage</u> 186. In addition, <u>current</u> 186 measurement by means of a shunt plug and the use of an <u>IEPE (ICP)</u> 186 expansion plug are provided for. The channels each come with 5th order ("analog", fixed-configuration) anti-aliasing filters, whose cutoff frequency is 6.6 kHz.

Technical details: LV-16 Voltage, Current (20 mA), IEPE/ICP 384

8.3.8.1 Voltage measurement

• Voltage ranges: ±250 mV, ±1 V, ±2.5 V, ±10 V

The input impedance is 10 M Ω referenced to system ground or 20 M Ω differential. The inputs are DC-coupled. The corresponding connection terminal is designated <u>ACC/DSUBM-U4 [474]</u>

8.3.8.2 Current measurement

• Current ranges: ±5 mA, ±20 mA, ±50 mA

For current measurements, a special plug with a built-in **shunt** (50 Ω) is needed ACC/DSUBM-14 4741.

For current measurement with the special shunt-plugs ACC/DSUBM-I4, input ranging only up to max. ±50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.



Note

Configuration is carried out in the voltage mode, but an appropriate scaling factor is entered which allows direct display of current values (0.02 A/V = $1/50 \Omega$).

8.3.8.3 Current fed sensors

At the DSUB-15 sockets, a permanent <u>5 V supply voltage for external sensors</u> [251] is available. This voltage source is grounded to the measurement device's frame. <u>The description of measurement with ICP sensors is presented here.</u> [237] For the measurement of current-fed sensors we recommend the expansion plug <u>ACC/DSUBM-ICP2I-BNC(-F,-S)</u> [237].

8.3.8.4 Bandwidth

The channels' max. sampling rate is 20 kHz (50 μ s sampling interval). The analog bandwidth (without digital low-pass filtering) is 6.6 kHz (-3 dB).

8.3.8.5 Connection

The LV-16 module is normally equipped with four DSUB-15 connectors (4 channels / connector) and occupies two module slots in the system.

Pin configuration of the DSUB-15 474.

8.3.9 LV3-8: Voltage, Current (20 mA), IEPE/ICP

The LV2-8, LV3-8 is a universal amplifier for 8 channels, respectively, for voltage and current measurement tasks (20 mA), with sampling rates of up to 100 kHz per channel. The LV3-8 is a advanced development of LV2-8 and differ in the bandwidth (LV2-8: 14 kHz; LV3-8: 48 kHz). Unless any limitations are mentioned, the following description also applies to the LV3-8.

In particular, the high bandwidth of 48 kHz, the input ranges from 50 V to 5 mV and the low signal noise predestine this device for high-performance voltage measurements.



Reference

8.3.9.1 Voltage measurement

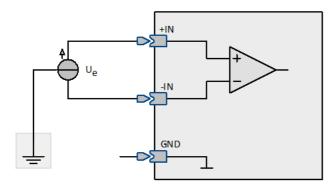
• Voltage: ±5 mV to ±50 V

In the voltage ranges ± 50 V and ± 20 V, a voltage divider is in operation; the resulting input impedance is 1 M Ω . In the voltage ranges ± 10 V to ± 5 mV, by contrast, the input impedance is 20 M Ω . When the device is deactivated, it drops to about 1 M Ω .

The input configuration is differential and DC-coupled.

8.3.9.1.1 Voltage source with ground reference

The voltage source itself already is referenced to the device's ground. The voltage source is at the same potential as the device ground.





Example

The unit is grounded. Thus, the input GND is at ground potential. If the voltage source itself is also grounded, it is referenced to the device ground.

It isn't any problem if, as it may be, the ground potential at the voltage source deviates from the ground potential of the device itself by a few degrees. The maximum permitted common mode voltage must not be exceeded.



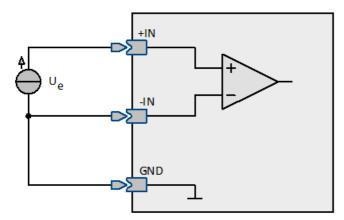
Note

In this example, the negative signal input -IN may not be connected to the ground contact GND in the device. Otherwise, a ground loop would result, through which interference could be coupled in.

In this case, a true differential (but not isolated!) measurement is performed.

8.3.9.1.2 Voltage source without ground reference

The voltage source itself has no reference to unit's ground, but instead, its potential floats freely vis-à-vis the device ground. If a ground reference cannot be established, it's also possible to connect the negative signal input –IN to the ground contact GND.





Example

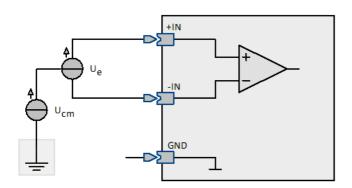
A voltage source which isn't grounded (e.g. a battery) and whose contacts have no connection to ground potential is measured. The device is grounded.



Note

When –IN and GND are connected, be sure that the signal source's potential can actually be drawn to the device ground's potential without an appreciable current flowing. If the source can't be brought to that potential level (because it turns out to be at fixed potential after all), there is a risk of permanent damage to the amplifier. If IN and GND are connected, a single end measurement is performed. This isn't a problem unless a ground reference already existed.

8.3.9.1.3 Voltage source at other, fixed potential



In the input ranges <20 V, the common mode voltage Ucm must lie within the range ±10 V. It is reduced by one-half of the input voltage.

8.3.9.1.4 Voltage measurement: With taring

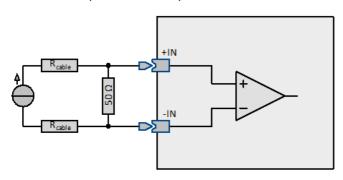
With voltage measurement, it's possible to tare a zero offset to restore correct zero. For this purpose, select the menu item *Settings -> Amplifiers* (balance etc.)..., and on the screen's index card *Common*, under *Balancing*, select the option *Tare* for the desired channel. The input range correspondingly is reduced by the amount of the zero adjustment. If the initial offset is so large that it's not possible to adjust it by means of the device, a larger input range must be set.

8.3.9.2 Current measurement

• Current: e.g. ±50 mA to ±1 mA

For current measurement, the DSUB plug ACC/DSUBM-I4 must be used. This plug is not included in the standard package. It contains a 50 Ω shunt.

In addition, voltage can be measured via an externally connected shunt. The appropriate scaling must be set in the user interface. The value 50 Ω is only a suggestion. The resistance should be sufficiently precise. Make note of the shunt's power consumption.



In this configuration, too, the maximum common mode voltage must be located within the range: ±10 V. This can generally only be assured if the current source is also already referenced to ground.

If the current source has no ground reference, there is a danger of the unit suffering unacceptably high overvoltage. It may be necessary to create a ground reference, for instance, by grounding the current source.



Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc operating software.

The scaling factor is entered as 1/R and the unit as A (0.02 A/V = $1/50 \Omega$).

8.3.9.3 Current fed sensors

At the DSUB-15 sockets, a permanent <u>5 V supply voltage for external sensors</u> [251] is available. This voltage source is grounded to the measurement device's frame. <u>The description of measurement with ICP sensors is presented here.</u> [237] For the measurement of current-fed sensors we recommend the expansion plug <u>ACC/DSUBM-ICP2I-BNC(-F,-S)</u> [237].



Note

LV3-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

The use of plastic plugs (ACC/DSUB-ICP2, ACC/DSUB-ICP4) in connection with triaxial sensors is not possible.

When using the two channel ICP plug: ACC/DSUBM-ICP2I-BNC(-S/-F) in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

8.3.9.4 Bandwidth

The max. sampling rate: 100 kSamples/s (10 µs sampling interval) and analog bandwidth: 48 kHz (-3 dB).

8.3.9.5 Connection

Pin configuration of the DSUB-15 [474] or the LEMO plug [481]

8.3.10 OSC-16 Isolated: Voltage, current (20 mA), temperature

Parameter	Value	Remarks
Inputs	16	
Measurement modes		recommended plug:
OSC-16	voltage measurement	ACC/DSUBM-U4
	current measurement	ACC/DSUBM-I4
	thermocouples, RTD (PT100)	ACC/DSUBM-T4

The OSC-16 has 16 isolated and differential input channels. They have enhanced isolation properties, with channel-to-channel isolation and common mode voltage of up to 60 V (with a test voltage of 300 V).

Highlights:

- Ideally for measurement with passiv sensors
- Optimal aliasing-free noise suppression of even 50 Hz interference
- Supports imc Plug & Measure

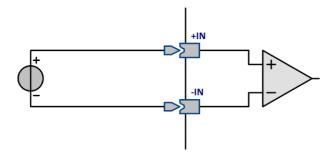
The OSC-16 is based on a scanner concept with block isolation, in which a multiplexer is combined with an isolated measuring amplifier. This scheme is very well suited to measure passive sensors. Application in conjunction witch active source and active temperature calibration devices in particular may impose particular limitations that are discussed in detail below.



Reference

Technical details OSC-16 392

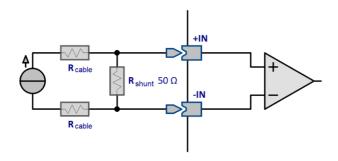
8.3.10.1 Voltage measurement



• ±60 V to ±50 mV in eleven ranges

The (static) input impedance in the ranges $\leq \pm 2$ V is 10 M Ω , otherwise 1 M Ω . The input configuration is differential and DC-coupled. The standard connector is used for voltage measurement (ACC/DSUBM-U4); the thermoconnector (ACC/DSUBM-T4) is also supported. The connection schemes for isolated and non-isolated signal sources are indistinguishable.

8.3.10.2 Current measurement



• ±40 mA to ±1 mA in six ranges

relevant particularly for sensors with 0 mA to 20 mA or 4 mA to 20 mA output
For current measurement, a shunt is built into the imc shunt-plug (ACC/DSUBM-I4)

For current measurement with the special shunt-plugs ACC/DSUBM-I4, input ranging only up to max. ±50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.



Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc software.

The scaling factor is entered as 1/R and the unit as A (0.02 A/V = $1/50 \Omega$).

8.3.10.3 Temperature measurement

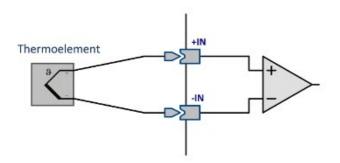
The input channels are designed for measurement with thermocouples and PT100-sensors. Any combinations of the two sensor types can be connected.



Reference

- For a full description about temperature measurement see here. 105
- PT100 or thermocouples can be measured with the imc plug <u>ACC/DSUBM-T4 loop</u>. Alternatively thermocouples can be recorded with two pin thermo plugs.

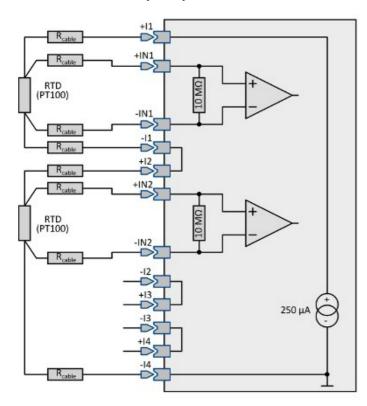
8.3.10.3.1 Thermocouple measurement



The common thermocouple types make use of linearization by characteristic curve.

The cold-junction compensation necessary for thermocouple measurements is built into the imc thermo-connector (ACC/DSUBM-T4 106).

8.3.10.3.2 PT100 (RTD) - Measurement



Along with Along with thermocouples, **PT100** sensors can also be connected, in **4-wire configuration**. An extra reference current source feeds an entire chain of up to four serially connected sensors.

The imc thermo plug has four terminals which are offered for a 4-wire measurement. These current-supply contacts are internally wired so that the reference current loop is automatically closed when all four PT100 units are connected. The -I contact of one channel is wired to the +I contact of the next channel, see the schematic of the imc thermo plug 107.

Normal DSUB-15 plugs don't come with these extra auxiliary contacts for 4-wire measurement. Make sure that the reference current flows through all PT100 measuring points. Only +I1 and -I4 are available as a contact or DSUB-15 pin. The connections -I1 = +I2, -I2 = +I3, and -I3 = +I4 must be wired externally.

PT100 sensors are fed from the module and don't have or even require an arbitrarily adjustable reference voltage in the sense of an externally imposed common mode voltage. It is also not permissible to set one up, for instance by grounding one of the four connection cables: the PT100 reference current source is referenced to the device's frame (CHASSIS), and is thus not isolated.

8.3.10.4 Connection

DSUB-15 plugs (CRC/OSC-16, CRSL/OSC-16-D), LEMO-plugs (CRSL/OSC-16-L) or thermocouple sockets type-K (CRC/OSC-16-T) are available.

Pin configuration of the DSUB-15 474.

8.3.11 SC2-32 Voltage, Current (20 mA), IEPE/ICP

The module SC2-32 comes with 32 differential, non-isolated input channels which can be used for measuring voltage. In addition, current measurement by means of a shunt plug and the use of an ICP-expansion plug are provided for.

The module is built as a "scanner" which enables the maximum aggregate sampling rate of 400 kHz to be distributed among the amount of activated channels (up to 32). The maximum sampling rate for a single channel can extend up to 100 kHz.

The channels each come with 5th order ("analog", fixed-configuration) anti-aliasing filters, whose cutoff frequency is 28 kHz (-3 dB). This means that for a channel sampled at 100 kHz, nearly aliasing-free measurement in the sense of the Sampling Theorem is ensured.

For low channel sampling rates (esp. when many channels are active), appropriately adapted (digital) low-pass filter are implemented. This procedure then no longer stringently adheres to the condition for the Sampling Theorem, since the cutoff frequency of the "primary" analog filter (28 kHz) is not adapted to the lower channel sampling rate; however, the properties of this affordable module are perfectly adequate for a number of applications.

• Input ranges: ±250 mV, ±1 V, ±2,5 V, ±10 V

Analog bandwidth: 28 kHz (-3 dB); 20 kHz (-0,1 dB)

Maximum aggregate sampling rate:
 400 kHz

• High sampling rate per channel: 100 kHz for voltage channels

• Impedance: 20 MΩ differential

• Supports imc Plug & Measure

Along with voltage measurement, current measurement via a shunt plug, temperature measurement and the use of an ICP expansion plug are all provided for.

Technical details of the SC2-32 396.

8.3.11.1 Voltage measurement

Voltage ranges: ±250 mV, ±1 V, ±2,5 V, ±10 V

The input impedance is 10 M Ω referenced to system ground or 20 M Ω differential. The inputs are DC-coupled. The corresponding connection terminal is designated ACC/DSUBM-U4.

8.3.11.2 Current measurement

• Current ranges: ±5 mA, ±20 mA, ±50 mA

For current measurements, a special plug with a built-in shunt (50 Ω) is needed (ACC/DSUBM-I4). Configuration is carried out in the voltage mode, but an appropriate scaling factor is entered which allows direct display of current values (20 mA/V = 1/50 Ω).



Note

For current measurement with the special shunt-plugs ACC/DSUBM-I4, input ranging only up to max. ±50 mA (corresponding to 2 V or 2.5 V voltage ranges) are permitted due to the measurement shunt's limited power dissipation in the case of static long-term loading.

8.3.11.3 TEDS

The SC2-32 is supporting TEDS. The appropriate plugs are: for voltage ACC/DSUBM-TEDS-U4, for current ACC/DSUBM-TEDS-I4.

The DSUB 37-variant provides also the 5 V-supply - but there is no 37-pin plug for TEDS or current measurement available from imc.

8.3.11.4 External +5 V supply voltage

At the DSUB-15 plugs, there is a 5 V supply voltage available for external sensors or for the ICP-expansion plug. This source is not isolated; its reference potential is identical to the overall system's ground reference.

The +5 V supply outputs are electronically protected internally against short-circuiting and can each be loaded up to max. 160 mA (short-circuit limiting: 200 mA). The sensor's reference potential, in other words its supply-ground connection is the terminal "GND".

8.3.11.5 Optional sensor supply module

The SC2-32 can be enhanced with the sensor supply unit SUPPLY, which provides an adjustable supply voltage for active sensors.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The technical specification of the SUPPLY 446.

8.3.11.6 Connection

The SC2-32 module is normally equipped with eight DSUB-15 plugs (4 channels / plug) and thus occupies 4 module slots in the system.

In custom devices, modules having two DSUB-37 connections can also be used.

In contrast to the normal configuration, in the DSUB-15 plugs belonging to the SC2-32 model, Pin1 is NOT connected to the device ground (CHASSIS), but to the DSUB-plug housing itself. When the imc terminal plug is used, this makes no difference, since in such cases the respective "CHASSIS"-terminals are connected appropriately. This must only be taken into account when using personally assembled, commercially available DSUB-plugs (for example, for connecting the cable shielding).

Pin configuration DSUB-15 474-plug and variety 8/2 479.

8.4 Universal measurement amplifier

Order Code	CRFX	CRXT	CRC CRSL	Channels per module	Remarks
	width	width	slots needed		
<u>UNI2-8</u> 195	61.62 mm	64.5 mm	2	8	voltage, current (20 mA), temperature, strain gauges, IEPE/ICP
<u>UNI-4</u> 217	43.3 mm	34 mm	2	4	isolated: voltage, current (20 mA), temperature, strain gauges, IEPE/ICP

8.4.1 UNI2-8: Voltage, Current (20 mA), Temperature, Bridge, IEPE/ICP

To supply external sensors or bridges the module is equipped with a <u>sensor supply</u> and with an adjustable supply. Supports <u>TEDS</u> (Transducer Electronic Data Sheets).

The measurement inputs whose terminals are DSUB plugs (ACC/DSUBM-UN2 476) are for voltage, current, bridge, PT100 and thermocouple measurements. In addition the use of an IEPE/ICP-expansion plug is possible. They are non-isolated differential amplifiers. They share a common voltage supply for sensors and measurement bridges. In the LEMO model, there is no thermocouple measurement or capture of IEPE/ICP sensor data.

Technical details of the UNI2-8 407.

8.4.1.1 Voltage measurement

Voltage: ±50 V to ±5 mV; DSUB-plug: ACC/DSUBM-UNI2

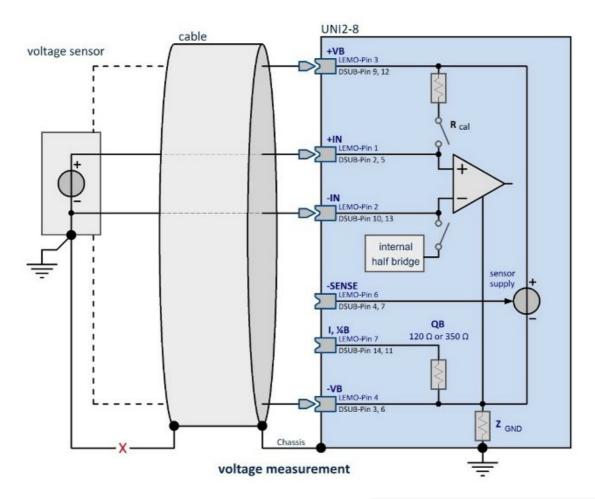
Within the voltage measurement ranges ± 50 V and ± 25 V, a voltage divider is in effect; the resulting input impedance is 1 M Ω .

By contrast, in the voltage ranges ± 10 V and ± 5 mV, the input impedance is 20 M Ω . For the deactivated device, the value is approx. 1 M Ω .

In the input ranges <25 V, the common mode voltage¹ must lie within the ±10 V range. The range is reduced by half of the input voltage. The input configuration is differential and DC-coupled.

The common mode voltage is the arithmetic mean of the voltages at the inputs +IN and -IN, referenced to the device ground. For instance, if the potential to ground is +10 V at +IN and +8 V at -IN, the common mode voltage is +9 V.

8.4.1.1.1 Voltage source with ground reference



LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

The voltage source itself already has a connection to the device's ground. The potential difference between the voltage source and the device ground must be fixed.



Example

The device is grounded. Thus, the input -VB is also at ground potential. If the voltage source itself is also grounded, it's referenced to the device ground. It doesn't matter if the ground potential at the voltage source is slightly different from that of the device itself. But the maximum allowed common mode voltage must not be exceeded.

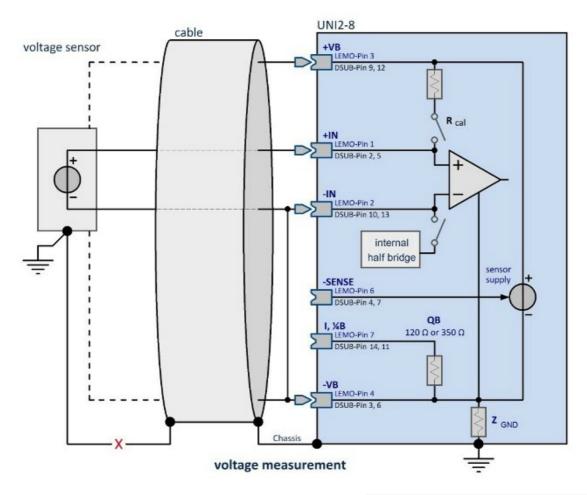


Warning

In this case, the negative signal input -IN may not be connected with the device ground -VB. Connecting them would cause a ground loop through which interference could be coupled in.

In this case, a genuine differential (but not isolated!) measurement is carried out.

8.4.1.1.2 Voltage source without ground reference



LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

The voltage source itself is not referenced to the amplifier ground but is instead isolated from it. In this case, a ground reference must be established. One way to do this is to ground the voltage source itself. Then it is possible to proceed as for Voltage source with ground reference 1960. Here, too, the measurement is differential. It is also possible to make a connection between the negative signal input and the device ground, in other words to connect -IN and -VB.



Example

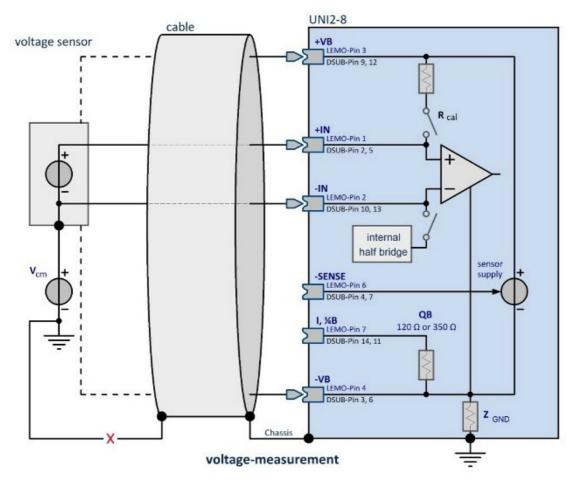
An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The device module is grounded.



Warning

If -IN and -VB are connected, care must be taken that the potential difference between the signal source and the device doesn't cause a significant compensation current. If the source's potential can't be adjusted (because it has a fixed, overlooked reference), there is a danger of damaging or destroying the amplifier. If -IN and -VB are connected, then in practice a single-ended measurement is performed. This is no problem if there was no ground reference beforehand.

8.4.1.1.3 Voltage source at a different fixed potential



LEMO is the 7-pin LEMO (standard pinning) 48h DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

The common mode voltage (V_{cm}) has to be less than ±10 V. It is reduced by ½ input voltage.



Example

Suppose a voltage source is to be measured which is at a potential of 120 V to ground. The system itself is grounded. Since the common mode voltage is greater than permitted, measurement is not possible. Also, the input voltage difference to the amplifier ground would be above the upper limit allowed. For such a task, the UNI2-8 cannot be used.

8.4.1.2 Bridge measurement

Measurement of measurement bridges such as strain gauges. The measurement channels have an adjustable DC voltage source which supplies the measurement bridges. The supply voltage for a group eight inputs is set in common. The bridge supply is asymmetric, e.g., for a bridge voltage setting of VB=5 V, Pin +VB is at +VB=5 V and Pin -VB at -VB=0 V. The terminal -VB is simultaneously the device's ground reference.

Per default 5 V and 10 V can be selected as bridge supply. As an option the amplifier can be build with 2.5 V bridge supply. Depending on the supply set, the following input ranges are available:

Bridge voltage [V]	Measurement range [mV/V]	
10	±1000 to ± 0.5	
5	±1000 to ± 1	
2.5	±1000 to ± 2	

Fundamentally, the following holds: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals the sensor emits and thus the measurement's **signal-to-noise ratio** and drift quality. The limits for this are determined by the maximum available current from the source and by the **dissipation** in the sensor (temperature drift!) and in the device (power consumption!)

- For typical measurements with **strain** gauges, the ranges 5 mV/V to 0.5 mV/V are relevant.
- There is a maximum voltage which the **potentiometer sensors** are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

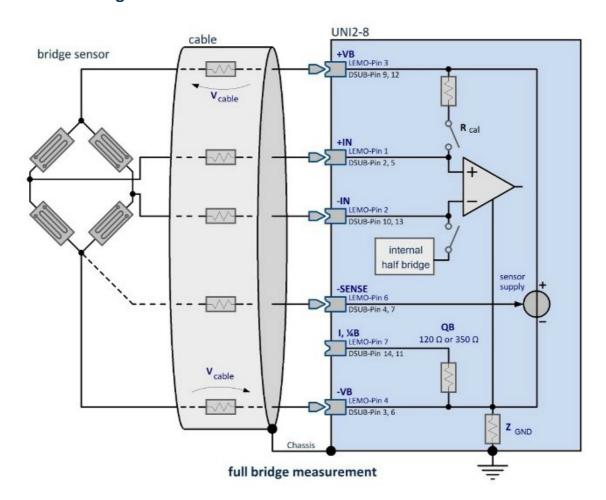
Bridge measurement is set by selecting as measurement mode either *Bridge: Sensor* or *Bridge: strain gauge* in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where quarter bridge, half bridge and full bridge are the available choices.



Note

We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

8.4.1.2.1 Full bridge



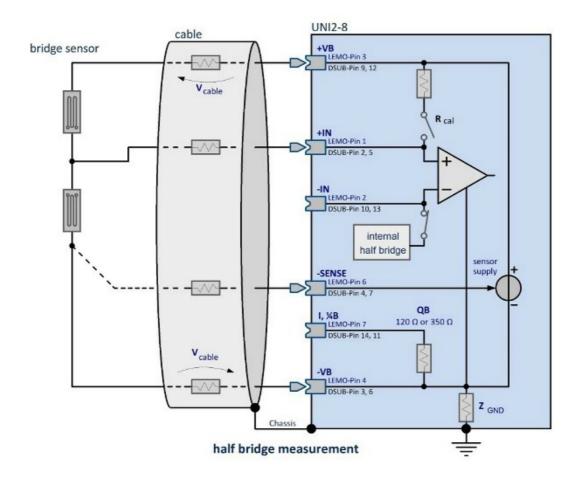
LEMO is the 7-pin LEMO (standard pinning) 474 DSUB 15-pin DSUB standard pinning 474 is ca. 500 kΩ for CRFX, else 0 Ω

A full bridge has four resistors, which can be four correspondingly configured strain gauges or one complete sensor which is a full sensor internally. The full bridge has five terminals to connect. Two leads +VB and -VB serve supply purposes, two other leads +IN and -IN capture the differential voltage. The 5th lead SENSE is the Sense lead for the lower supply terminal, which is used to determine the single-sided voltage drop along the supply line. Assuming that the other supply cable +VB has the same impedance and thus produces the same voltage drop, no 6th lead is needed. The Sense lead makes it possible to infer the measurement bridge's true supply voltage, in order to obtain a very exact measurement value in mV/V.

Please note that the maximum allowed voltage drop along a cable may not exceed approx. 0.5 V. This determines the maximum possible cable length.

If the cable is so short and its cross section so large that the voltage drop along the supply lead is negligible, the bridge can be connected at four terminals by omitting the Sense line.

8.4.1.2.2 Half bridge



LEMO is the 7-pin LEMO (standard pinning) 48+ DSUB 15-pin DSUB standard pinning 474+ is ca. 500 k Ω for CRFX, else 0 Ω

A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has 4 terminals to connect. For information on the effect and use of the SENSE lead, see the description of the <u>full bridge</u> 201.

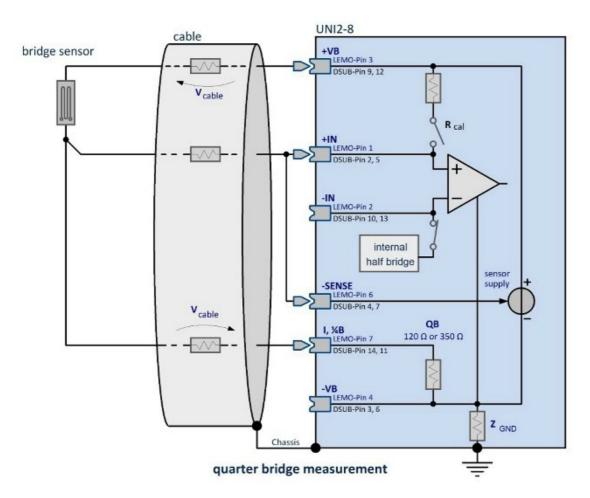
The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a full bridge.



Note

It is important that the measurement signal of the half bridge is connected to +IN. The -IN access leads to implausible measured values and influences the neighbor channels.

8.4.1.2.3 Quarter bridge



LEMO is the 7-pin LEMO (standard pinning) 48 Ω 15-pin DSUB standard pinning 47 Ω 48 is ca. 500 k Ω for CRFX, else 0 Ω

A quarter bridge can consist of a single strain gauge resistor, whose nominal value can be 120 Ω or 350 Ω . UNI2-8 internally completes an additional 120 Ω that can be switched to a 350 Ω quarter bridge.

For quarter bridge measurement, only 5 V can be set as the bridge supply.

The quarter bridge has 4 terminals to connect. Refer to the description of the <u>full bridge</u> |201 for comments on the SENSE lead. Note that at the quarter bridge the sense line is connected to +IN and -SENSE jointly. There is **no voltage drop** on the cable between the **quarter bridge and +IN and SENSE** because there is no current flowing into the high impedance inputs of +IN and SENSE. The current through the **quarter bridge** flows off **to I_1/4B** and causes a **voltage drop** there, which can be detected at -**SENSE**.

If the sensor supply is equipped with the option "±15 V", a quarter bridge measurement is not possible. The pin I 1/4Bridge for the quarter bridge completion is used for -15 V instead.

8.4.1.2.4 Sense and initial unbalance

The **SENSE** lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then **SENSE** must be connected in the terminal plug according to the sketches above.

A bridge measurement is a relative measurement (**ratiometric procedure**) that calculates what fraction of the supplied bridge excitation voltage is given off from the bridge (typically in the 0.1% range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the bridge **supply's actual magnitude** is not relevant and need not necessarily lie within the measurement's specified overall accuracy.

Any initial unbalance of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set.

Possible initial unbalance

input range [mV/V]	bridge balancing (VB = 2.5 V) [mV/V]	bridge balancing (VB = 5 V) [mV/V	bridge balancing (VB = 10 V) [mV/V
±1000	200	500	240
±500	500	100	700
±200	40	400	60
±100	140	20	200
±50	200	70	10
±20	20	100	35
±10	30	14	50
±5	7	18	7
±2	9	3,5	10
±1	-	4,5	2
±0,5	-	-	5

8.4.1.2.5 Balancing and shunt calibration

The amplifier offers a variety of possibilities to trigger bridge balancing:

- Balancing / shunt calibration via user interface of the software (channel and/or amplifier balance)
- Balancing / shunt calibration via display 81 (see software manual)
- In shunt calibration, the bridge is unbalanced by means of a 59.8 k Ω or 174.7 k Ω shunt (between +VB and +IN). The results are:

Bridge resistance	120 Ω	350 Ω
59.8 kΩ	0.5008 mV/V	1.458 mV/V
174.7 kΩ	0.171 mV/V	0.5005 mV/V

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.



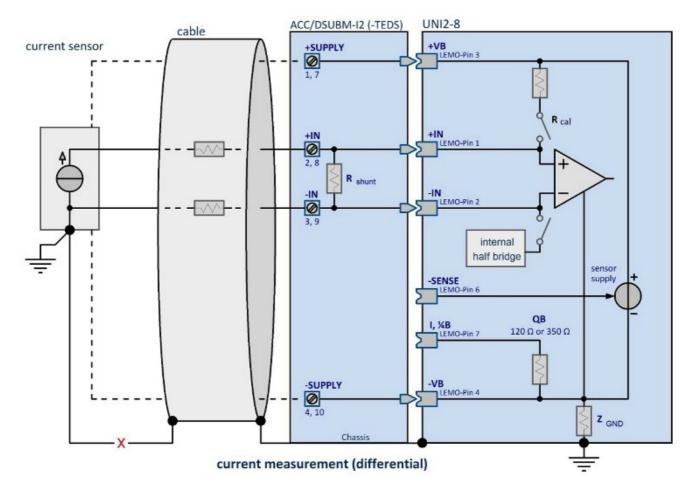
Note

 We recommend setting channels which are not connected for voltage measurement at the highest input range. Otherwise, if unconnected channels are in quarter- or half-bridge mode, interference may occur in a shunt calibration!

8.4.1.3 Current measurement

8.4.1.3.1 Differential current measurement

Only for devices with DSUB-15 sockets in combination with imc plug ACC/DSUBM-12 4761.



LEMO is the 7-pin LEMO (standard pinning) 48⁺
DSUB 15-pin DSUB standard pinning 47⁺
is ca. 500 kΩ for CRFX, else 0 Ω

The ACC/DSUBM-I2 comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. Appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor needs an adequate level of precision. Pay attention to the shunt's power consumption.

The maximum common mode voltage must be in the range ±10 V for this circuit, too. This can generally only be ensured if the current source itself already is referenced to ground. If the current source is ungrounded a danger exists of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

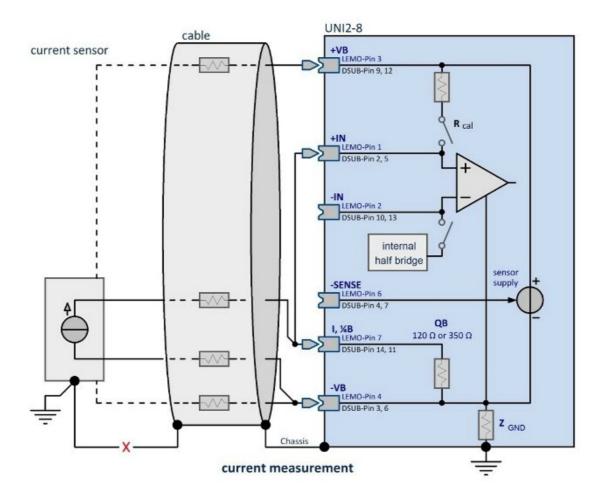
The sensor can also be supplied with a software-specified voltage via Pins +VB and -VB.



Note

- Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc DEVICES interface.
- The scaling factor is entered as 1/R and the unit as A (0.02 A/V = $1/50 \Omega$).

8.4.1.3.2 Ground-referenced current measurement



LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

• Current: e.g. ±50 mA to ±1 mA

In this circuit, the current to be measured flows through the $120\,\Omega$ shunt in the amplifier. Note that here, the terminal -VB is simultaneously the device's ground. Thus, the measurement carried out is single-end or ground referenced. The potential of the current source itself may be brought into line with that of the units ground. In that case, be sure that the device unit itself is grounded.

In the settings interface, set the measurement mode to current.

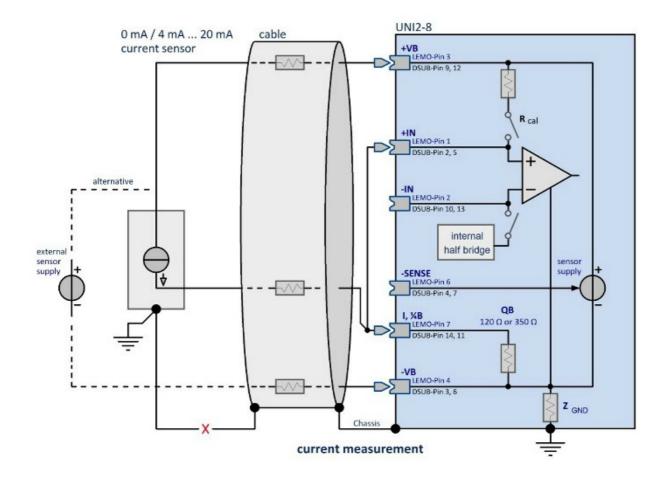
Note that the jumper between +IN and +I; ¼Bridge should be connected right inside the plug.



Note

For an (optional) sensor supply with ±15 V ground referenced current measurement is not possible. The pin I;%Bridge is used as -15 V pin.

8.4.1.3.3 2-wire for sensors with a current signal and variable supply



LEMO is the 7-pin LEMO (standard pinning) 48th DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

• e.g. for pressure transducers 4 mA to 20 mA.

Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal.

In the settings dialog on the index card *Universal amplifiers / General*, a supply voltage is set for the sensors, usually 24 V. The channels must be configured for current measurement.

The signal is measured between +IN and -VB. A wire jumper must be positioned between pins +IN and +I, ¼Bridge inside the plug.

The sensor is supplied with power either via terminals +VB and +I; ¼Bridge or via an external sensor supply.



Note

There is a voltage drop across the resistances of the leadwires and the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω * 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a leadwire with a large enough cross-section.

8.4.1.4 Temperature measurement

The amplifier channels are designed for direct measurement with **thermocouples** and **PT100-sensors**. Any combinations of the two sensor types can be connected.



Note

A temperature measurement is a voltage measurement whose measured values are converted to physical temperature values by reference to a characteristic curve. The characteristic curve is selected from the base page of the imc Software configuration dialog. Amplifiers which enable bridge measurement, must first be set to Voltage mode (DC), in order for the temperature characteristic curves to be available on the base page.

8.4.1.4.1 Thermocouple measurement

The cold junction compensation necessary for thermocouple measurement is built-in the imc plug ACC/DSUBM-UNI2 (DSUB-15), ACC/TH-LEM-150 (LEMO) und im CAN/UINST-PT100 (ITT VEAM) and is measured automatically.



Note

• In the imc software user interface, the option isolated thermocouple (default setting) must be activated under Settings - Configuration - Amplifier. This only is available with Coupling DC.



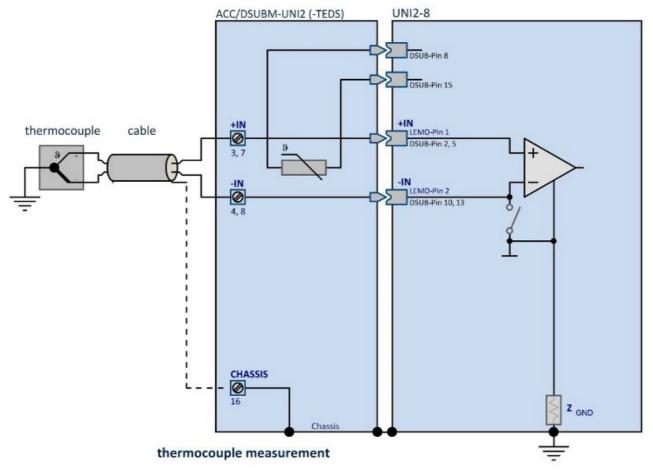
Reference

Please find here a description of the available thermocouples 1051.

8.4.1.4.1.1 Thermocouple mounted with ground reference

The thermocouple is mounted in such a way that it already is in electrical contact with the device ground / chassis. This is ensured by attaching the thermocouple to a grounded metal body, for instance. The thermocouple is connected for differential measurement. Since the unit is grounded itself, the necessary ground reference exists.

In the operating software, don't activate the option "*Isolated thermo couple*" at the amplifier tab.



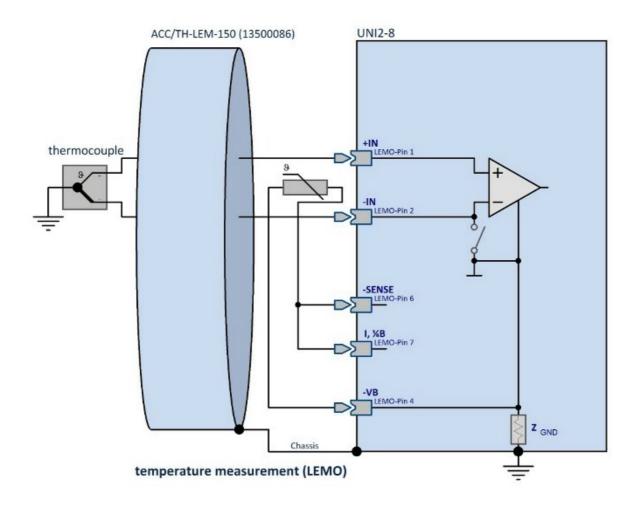
LEMO is the 7-pin LEMO (standard pinning) 48th DSUB 15-pin DSUB standard pinning 474h is ca. 500 k Ω for CRFX, else 0 Ω

It is not a problem if the ground potential at the thermocouple differs from that of the device units by a few volts. However, the maximum allowed common mode voltage may not be exceeded.



Note

- The negative signal input -IN may not be connected to amplifier ground point -VB. Connecting them would cause a ground loop through which interference could be coupled in.
- If you accidentally activate the option "Isolated thermocouple" on the Amplifier page, there is a danger that a large compensation current will flow through the thermocouple's (thin) line and the connector plug. Compensation currents are a danger with every single-ended measurement. For that reason, single-ended measurement is really only allowed -and only then really necessary- if the thermocouple has no ground reference of its own.
- Note that with <u>LEMO connection [481]</u> an external PT100 must be integrated in the connector as cold junction compensation. In addition, the *ACC/TH-LEM-150* connector is available as an accessory: a LEMO. 1B connector with integrated cold junction compensation.
 For ITT VEAM the integrated cold junction compensation *CAN/UINST-PT1100* is provided for the corresponding CAN/UINST-7 connector.

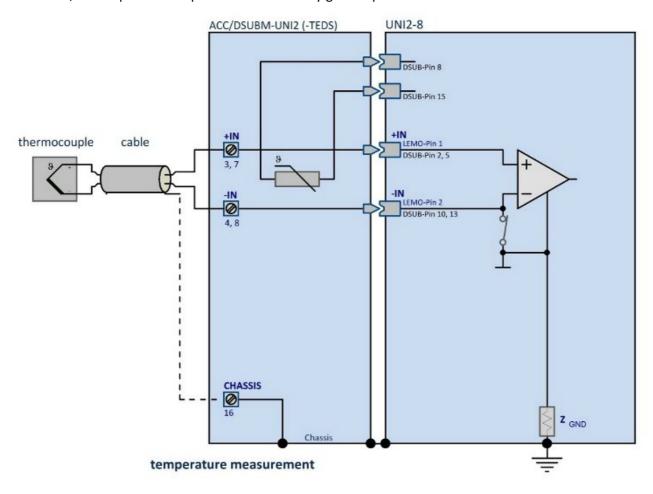


LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

8.4.1.4.1.2 Thermocouple mounted without ground reference

The thermocouple is installed with electrical isolation from the device's Ground / Chassis and is therefore not connected with the device's ground. This is achieved by, among other techniques, having the thermocouple adhere to non-conducting material. As a result, the thermocouple's voltage floats freely against the amplifier ground voltage.

In this case, the amplifier must provide the necessary ground potential.



LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

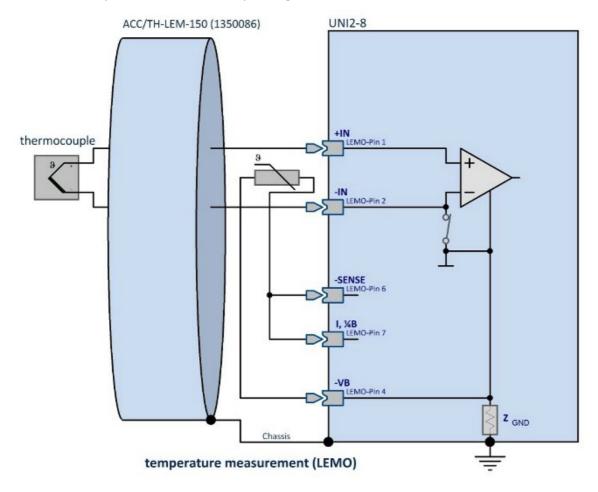
In the operating software, activate "*Isolated thermo couple*" at the amplifier tab. In this measurement mode, the unit itself provides the ground reference by having Terminals -IN and -VB connected internally. This connection is only made in the Thermocouple mode and not with voltage measurements.



The thermocouple itself may not be ground referenced!

If it was mounted with a ground reference, there is a danger that a large compensation current will flow through the thermocouple's (thin) line and the connector plug. Compensation currents are a danger with every single-ended measurement. For that reason, single-ended measurement is really only allowed -and only then really necessary- if the thermocouple has no ground reference of its own.

Note that with <u>LEMO connection [481]</u> an external PT100 must be integrated in the connector as cold junction compensation. In addition, the *ACC/TH-LEM-150* connector is available as an accessory, a LEMO. 1B connector with integrated cold junction compensation. For ITT VEAM the integrated cold junction compensation *CAN/UINST-PT1100* is provided for the corresponding CAN/UINST-7 connector.

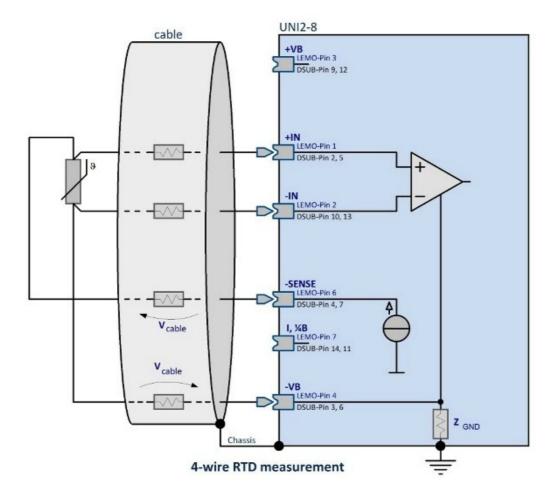


LEMO is the 7-pin LEMO (standard pinning) 481DSUB 15-pin DSUB standard pinning 474is ca. 500 k Ω for CRFX, else 0 Ω

8.4.1.4.2 PT100/ RTD measurement

Along with thermocouples, **PT100** can be connected directly in **4-wire-configuration** (DSUB-plug: <u>ACC/DSUBM-UNI2</u> 474). The 4-wire measurement returns more precisely results than the 3-wire measurement since it does not require the resistances of both leads which carry supply current to have the same magnitude and drift. The 2-wire measurement provides the most inaccurate results due to the cable resistances. Each sensor is fed by its own current source with approx. 1.2 mA.

8.4.1.4.2.1 PT100 in 4-wire configuration



LEMO is the 7-pin LEMO (standard pinning) 481DSUB 15-pin DSUB standard pinning 474is ca. 500 k Ω for CRFX, else 0 Ω

The PT100 is supplied with constant current via two lines (-SENSE and -VB). The other two serve as Sense-leads. By using the lines (+IN und -IN), the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error. The 4-wire configuration is the most precise way to measure with a PT100.



Note

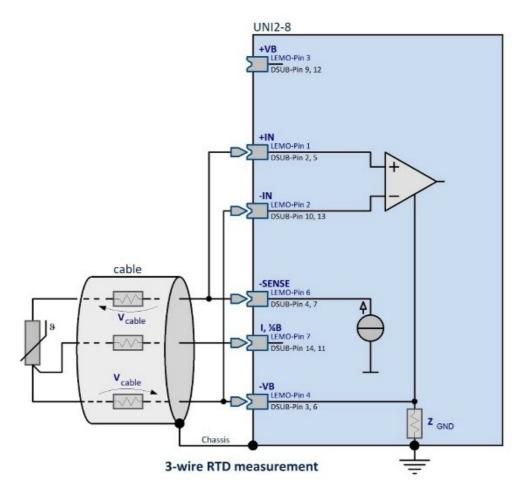
4-wire measurement is not possible with order option:

• sensor supply with ±15 V

8.4.1.4.2.2 PT100 in 2-wire configuration

PT100 in 4-wire configuration must be set in the software. The connection is the same as for the 4-wire configuration, but +IN must be connected to -SENSE and -IN to -VB via bridges in the plug. The **cable resistances** of the supply lines are recorded in addition to the RTD and **lead to the most inaccurate measurement** and are therefore not recommended.

8.4.1.4.2.3 PT100 in 3-wire configuration



LEMO is the 7-pin LEMO (standard pinning) 481 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

The PT100 is supplied with constant current via two lines (-SENSE and -VB). Another line (I, 1/4B) measures the voltage across the supply line and uses it to compensate for parasitic voltage drops. It is assumed that the resistances of the supply lines have the same size and the same temperature drift.

It is important, that the connection between +IN to -SENSE and -IN to -VB is made directly at the module.



Note

3-wire measurement is not possible with order option:

• sensor supply with ±15 V

8.4.1.4.3 Open sensor detection

The amplifier comes with the ability of open sensor detection.

Thermocouple: If at least one of the thermocouple's two lines breaks, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range in a defined pattern. The actual value reached depends on the particular thermocouple. In the case of Type K thermocouples, this is around -270°C. If the system is monitoring a cutoff level with a certain tolerance, e.g. Is the **measured value <-265°C**, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location.

The open sensor detection is also triggered if a channel is parameterized for "Thermocouple" and measurement starts without any thermocouple being connected. If a thermocouple is later connected after all, it would take the period of a few measurement samples for transients in the module's filter to subside and the correct temperature to be indicated. Note also in this context that any thermocouple cable's connector which is recently plugged into the amplifier is unlikely to be at the same temperature as the module. Once the connection is made, the temperatures begin to assimilate. Within this phase, the Pt100 built into the plug may not be able to indicate the real junction temperature exactly. This usually takes some minutes to happen.

RTD/Pt100: If the leads to the Pt100 are broken, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range, to about 200°C, in a defined pattern. If the system is monitoring a cutoff level with a certain tolerance, e.g. Is the **measured value <-195°C**, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location. In case of a short-circuit, the nominal value returned is also that low.

In this context, note that in a 4-wire measurement a large variety of combinations of broken and shorted leads are possible. Many of these combinations, especially ones with a broken Sense lead, will not return the default value stated.

8.4.1.5 Current fed sensors

For measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) [237].



Note

UNI2-8 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

The use of plastic plugs (ACC/DSUB-ICP2, ACC/DSUB-ICP4) in connection with triaxial sensors is not possible.

8.4.1.6 Userdefined characteristic curves

Userdefined characteristic curves created e.g. by imc SENSORS, can be proceeded.



Note

Support for UNI2-8 as of imc DEVICES 2.8R4 and imc STUDIO 4.0R2.

8.4.1.7 Sensor supply module

UNI2-8 channels are enhanced with a sensor supply unit, which provides an adjustable supply voltage for active sensors. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for all measurement inputs per module.

The supply outputs are electronically protected internally against short circuiting to ground. The reference potential, in other words the sensor's supply ground contact, is the terminal GND.

The supply voltage can only be set for all measurement inputs in common. The voltage selected is also the supply for the measurement bridges. If a value other than 5 V or 10 V is set, bridge measurement is no longer possible!

8.4.1.8 Bandwidth

The channels' maximum sampling rate is 100 kHz(10 μ s).

The analog bandwidth (without digital low-pass filtering) is 48 kHz (-3 dB).

8.4.1.9 Connection

Find here the pin configuration of the <u>DSUB-15 plugs</u> 474 and the <u>LEMO-plugs</u> 481.

8.4.2 UNI-4 isolated: Voltage, Current (20 mA), Temperature, Bridge, IEPE/ICP

This module offers maximum flexibility and versatility. The 4 channels allow the measurement of voltage and current and the connection of IEPE (ICP)-sensors and also the measurement of temperature (thermocouples, PT100 and PT1000), bridges and strain gauges (full-, half- and quarter bridge with internal completion: 120 Ω , 350 Ω and 1 k Ω).

Supply voltages of 0.25 V to 24 V can be configured separately for each channel, for the purpose of powering external sensors or of bridge measurement.

The channels are individually isolated for voltage, current and thermocouple measurement. Each channel is equipped with its own simultaneous A/D converter and adjustable filter (e.g. anti-aliasing filter).

Parameter Value		Remarks		
Measurement modes DSUB		ACC/DSUBM-UNI2 for all modes		
isolated measurement modes:	voltage (differential)			
	current measurement	with shunt-plug (ACC/DSUBM-I2)		
	Thermocouples			
non-isolated measurement	voltage (single-end)			
modes:	current measurement	with internal shunt		
	bridge-sensor			
	strain gauges			
	PT100/PT1000			
	(3- and 4-wire connection)			
	current fed sensors	ACC/DSUB-ICP2,		
	(IEPE/ICP)	ACC/DSUB-ICP-BNC		
		(ICP™-, Deltatron®-, Piezotron®-Sensors)		
	Charge	with charge amplifier (ACC/DSUB-Q2), only with CRC, CRSL		
		(ACC/DSOB-Q2), only with CRC, CRSL		
Measurement modes LEMO		T		
isolated measurement modes:	voltage (differential)			
	thermocouples	with ACC/TH-LEM-150		
non-isolated measurement	voltage (single-end)			
modes:	current	with internal shunt		
	bridge-sensor			
	strain gauges			
	PT100/PT1000			
	(3- and 4-wire connection)			

Technical details of the UNI-4 398.

8.4.2.1 Voltage measurement (differential)

Voltage: ±2.5 mV to ±60 V

Within the voltage ranges ≥ 5 V a voltage divider is in effect; the resulting input impedance is 1 M Ω .

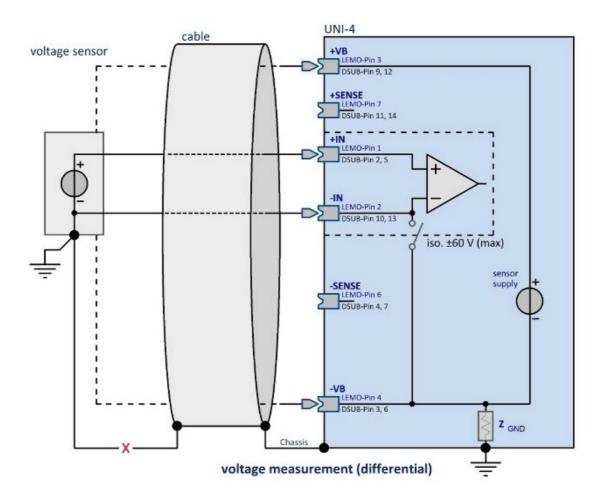
Within the voltage ranges ≤ 2 V the resulting input impedance is 10 M Ω .

The input is differential and DC-coupled.



Note

When using an isolated channel (with or without supply), one should make sure that the common mode potential is "defined", one way or another: Using an isolated channel on an isolated signal source usually does not make sense. The very high common mode input impedance of this isolated configuration (>1 G Ω) will easily pick up enormous common mode noise as well as possibly letting the common mode potential drift to high DC-level. These high levels of common-mode noise will not be completely rejected by the amplifier's common-mode (isolation-mode) rejection.



So, as a **general rule**: isolated amps should be used in environments where the common-mode level is high but "well defined" in terms of a low (DC-) impedance to (non-isolated) system ground (CHASSIS).

If, in turn, the signal source itself is isolated, it can be forced to a common-mode potential, which is the potential of the measurement equipment. This is the case with a microphone: the non-isolated power supply will force the common mode potential of the microphone and amp-input to system ground instead of leaving it floating, which would make it susceptible to all kinds of noise and disturbance.

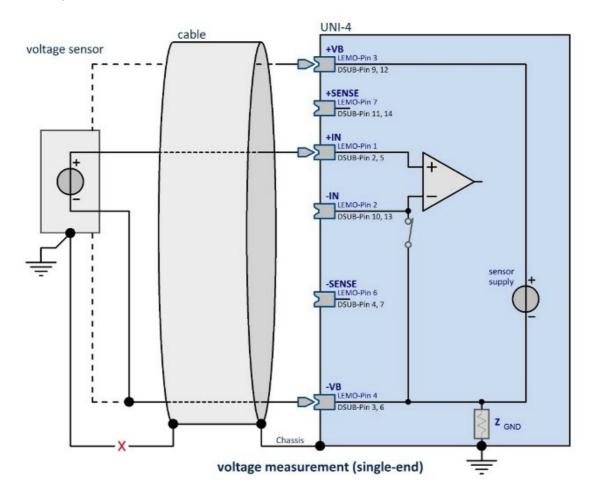
8.4.2.2 Voltage measurement (single-end)

Voltage: ±2.5 mV to ±10 V

Within the voltage ranges ≥ 5 V a voltage divider is in effect; the resulting input impedance is 1 M Ω .

Within the voltage ranges ≤ 2 V the resulting input impedance is 10 M Ω .

The input is DC-coupled.



LEMO is the 7-pin LEMO (standard pinning) 48 DSUB 15-pin DSUB standard pinning 474 is ca. 500 kΩ for CRFX, else 0 Ω

The voltage source itself is not referenced to the ground of the measurement system. The potential of the voltage source is floating free against the ground of the device. In this case, a ground reference must be established. One way to do this is to connect the voltage source with the system.



Example

An ungrounded voltage source is measured, for instance a battery whose contacts have no connection to ground. The device module is grounded.



Note

Important: When connecting active sensors that are supplied via +VB, a reverse current via the connection cable to -VB is generated. This reverse current creates a voltage drop across the cable impedance which influences the measurement result.

8.4.2.3 Bridge measurement

Measurement of measurement bridges such as strain gauges.

The measurement channels have an adjustable DC voltage source which supplies the measurement bridges. The supply voltage for each channel is set individually. The bridge supply is asymmetric, e.g., a bridge voltage setting of VB=5 V provide 5 V at pin +VB and 0 V at pin -VB. The pin -VB is simultaneously the device's ground reference.

Fundamentally, the following applies: For equal physical modulation of the sensor, the higher the selected bridge supply is, the higher are the absolute voltage signals which the sensor emits and thus the measurement's signal-to-noise ratio and drift quality. The limits for this are determined by the maximum available current from the source and by the dissipation in the sensor (temperature drift!) and in the device (power consumption!)

- For typical measurements with strain gauges, the ranges 5 mV/V to 0.5 mV/V are particularly relevant.
- There is a maximum voltage which the Potentiometer sensors are able to return, in other words max. 1 V/V; a typical range is then 1000 mV/V.

Bridge measurement is set by selecting as the measurement mode either Bridge: Sensor or Bridge: Strain gauge in the operating software. The bridge circuit itself is then specified under the tab Bridge circuit, where quarter bridge, half bridge and full bridge are the available choices.

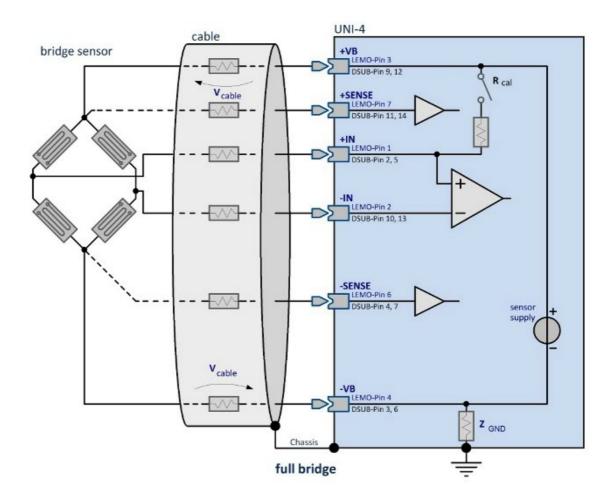
SENSE line:

In order to compensate unbalanced cable resistance in the supply lines measuring a full-bridge or a half-bridge, it is possible to connect two SENSE lines +SENSE and -SENSE for each case.

With balanced cable resistance in the supply lines, a connection of one SENSE line -SENSE is sufficient.

With bridge supply voltages ≥5 V, the connection configuration is automatically recognized by the UNI-4 in preparation for the measurement. Changing this configuration during a running measurement can lead to inaccuracy in the measurement result. With a bridge supply voltage <5 V, the connection configuration is also recognized and taken into account during the measurement.

8.4.2.3.1 Full bridge



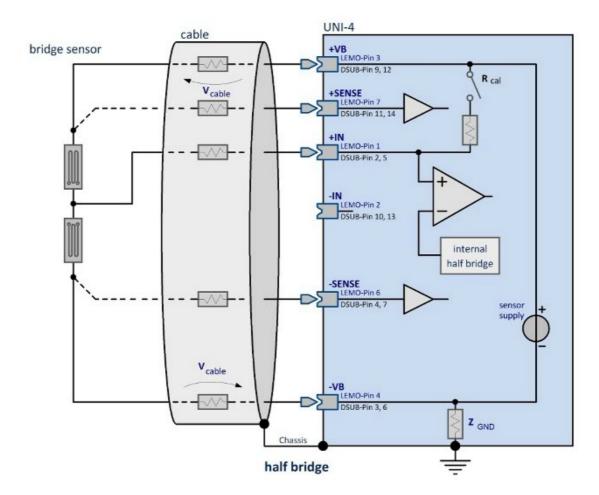
LEMO is the 7-pin LEMO (standard pinning) $\boxed{48}$ DSUB 15-pin DSUB standard pinning $\boxed{474}$ $Z_{GND} is ca. 500 k\Omega for CRFX, else 0 \Omega$

A full bridge has four resistors, which can be four correspondingly configured strain gauges or one complete sensor which is a full sensor internally.

The full bridge can be connected with five wires or six. By means of the SENSE line, a voltage drop across the supply line can be detected. It is possible to determine the measurement bridge's actual supply voltage by means of the SENSE line in order to detect an exact measurement value in mV/V.

Please note that the max allowed voltage drop along one cable must never be greater than one quarter of the adjusted supply voltage. This determines the max cable length.

8.4.2.3.2 Half bridge



LEMO is the 7-pin LEMO (standard pinning) 48 h
DSUB 15-pin DSUB standard pinning 47 h
is ca. 500 kΩ for CRFX, else 0 Ω

A half bridge may consist of two strain gauges in a circuit or a sensor internally configured as a half bridge, or a potentiometer sensor. The half bridge has four terminals to connect. For information on the effect and use of the SENSE lead, see the description of the <u>full bridge</u> 221.

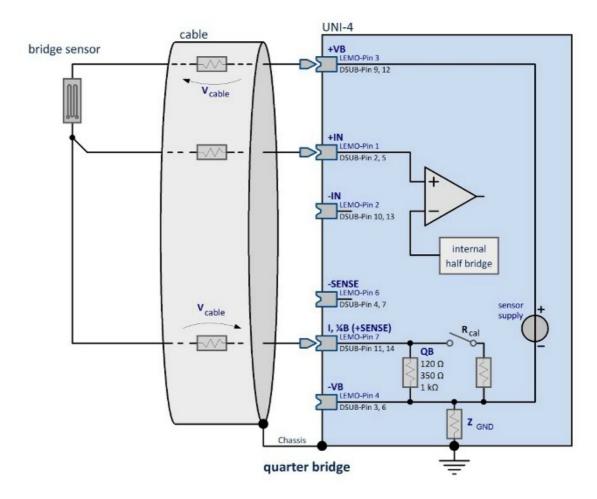
The amplifier internally completes the full bridge itself, so that the differential amplifier is working with a full bridge.



Note

It is important that the measurement signal of the half bridge is connected to +IN. Using the -IN terminal leads to implausible measured values and affects the neighboring channels.

8.4.2.3.3 Quarter bridge



A quarter bridge can consist of a single strain gauge resistor: 120 Ω , 350 Ω or 1 k Ω .

The UNI-4 internally completes the quarter bridge that can be changed from 120 Ω to 350 Ω or 1 k Ω .

The quarter bridge has 3 wires to be connected. Refer to the description of the full bridge for comments on the SENSE lead.

8.4.2.3.4 Sense and initial unbalance

The **SENSE** lead serves to compensate voltage drops due to cable resistance, which would otherwise produce noticeable measurement errors. If there are no sense lines, then UNI-4 SENSE must be connected in the terminal plug according to the sketches above.

A bridge measurement is a relative measurement (**ratiometric procedure**) that calculates what fraction of the supplied bridge excitation voltage is given off from the bridge (typically in the 0.1% range, corresponding to 1 mV/V). Calibration of the system in this case pertains to this ratio, the bridge input range, and takes into account the momentary magnitude of the supply. This means that the bridge supply's actual magnitude is not relevant and need not necessarily lie within the measurement's specified overall accuracy.

Any initial unbalance of the measurement bridge, for instance due to mechanical pre-stressing of the strain gauge in its rest state, must be zero-balanced. Such an unbalance can be many times the input range (bridge balancing). If the initial unbalance is too large to be compensated by the device, a larger input range must be set. Please observe the UNI-4 data sheet

Max possible initial unbalance

VB = 2.5 V		,	VB = 5 V	VB = 10 V		
input range [mV/V]	bridge- balancing [mV/V]	input range [mV/V]	bridge- balancing [mV/V]	input range [mV/V]	bridge- balancing [mV/V]	
800	75	1.000 *	513 *	1.000 *	513 *	
400	475	400	38	500 *	256 *	
200	304	200	238	200	19	
100	152	100	152	100	119	
40	91	50	76	50	76	
20	45	20	45	25	38	
10	17	10	23	10	23	
4.0	10	5.0	8.5	5.0	11	
2.0	12	2.0	5.0	2.5	4.3	
1.0	13	1.0	6.0	1.0	2.5	
		0.5	6.5	0.5	3.0	
				0.25	3.3	

^{*} configured with divider, input impedance (1 $M\Omega$) will cause non-linearity

8.4.2.3.5 Balancing and shunt calibration

The amplifier offers a variety of possibilities to trigger bridge balancing:

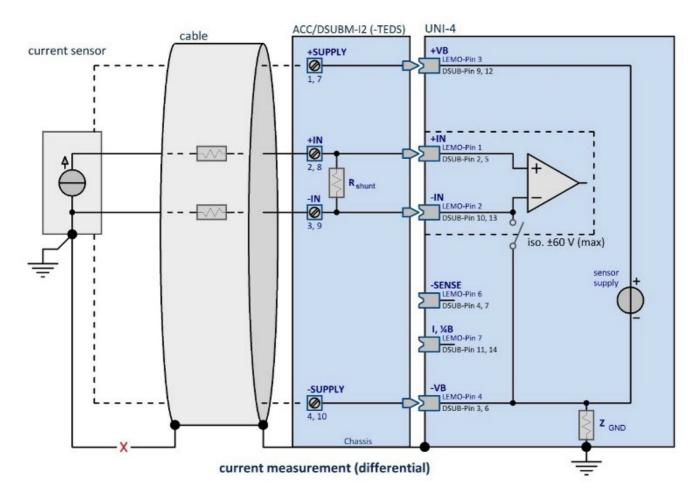
- Balancing / shunt calibration via graphical user interface of device software (channel balance respectively amplifier balance)
- Balancing / shunt calibration by means of the <u>Display</u> [81] (see software manual)
- In shunt calibration, the bridge is unbalanced by means of a 59.8 k Ω or 174.7 k Ω shunt (between +VB and +IN). The results are:

Bridge resistance	120 Ω	350 Ω	
59.8 kΩ	0.5008 mV/V	1.458 mV/V	
174.7 kΩ	0.171 mV/V	0.5005 mV/V	

The procedures for balancing bridge channels also apply analogously to the voltage measurement mode with zero-balancing.

8.4.2.4 Current measurement

8.4.2.4.1 Differential current measurement



• Current: e.g. ±50 mA to ±1 mA

For current measurement, the DSUB plug ACC/DSUBM-I2 can be used. This plug comes with a 50 Ω shunt and is not included with the standard package. It is also possible to measure a voltage via an externally connected shunt. The appropriate scaling must be set in the user interface. The value 50 Ω is just a suggestion. The resistor must provide an adequate level of precision. Pay attention to the shunt's power consumption.

The maximum common mode voltage must also be reflected in this arrangement. In general, this can only be ensured if the current source itself is already referenced to ground. If the current source is ungrounded, there is a risk of exceeding the maximum allowed overvoltage for the amplifier. The current source may need to be referenced to the ground, for example by being grounded.

The sensor can also be supplied with a software-specified voltage via Pins +VB and -VB.

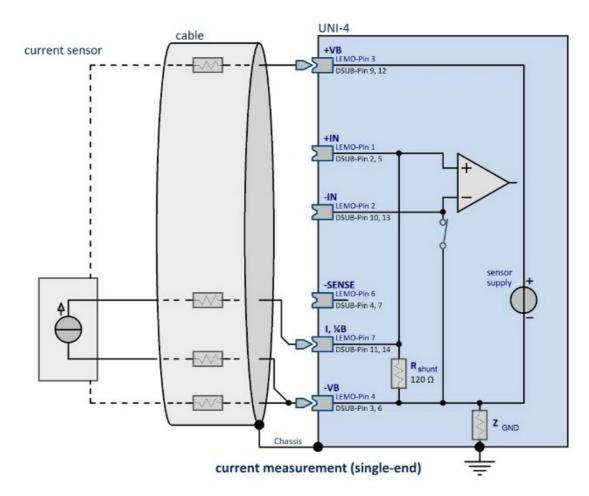


Note

Since this procedure is a voltage measurement at the shunt resistor, voltage measurement must also be set in the imc operating software interface.

The scaling factor is entered as 1/R and the unit as A (0.02 A/V = $1/50 \Omega$)

8.4.2.4.2 Ground-referenced current measurement



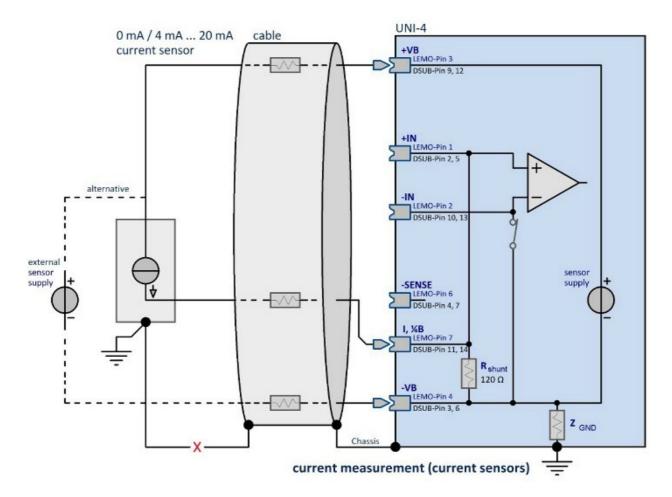
LEMO is the 7-pin LEMO (standard pinning) 481DSUB 15-pin DSUB standard pinning 474is ca. 500 k Ω for CRFX, else 0 Ω

• Current: ±50 mA to ±1 mA

In this circuit, the current to be measured flows through the 120 Ω shunt in the amplifier. Note that here, the terminal -VB is simultaneously the device's ground. Thus, the measurement carried out is single-end or ground referenced. The potential of the current source itself may be brought into line with that of the unit's ground. In that case, be sure that the device unit itself is grounded.

In the settings interface, set the measurement mode to Current.

8.4.2.4.3 2-wire for sensors with a current signal and variable supply



LEMO is the 7-pin LEMO (standard pinning) $\boxed{48}$ DSUB 15-pin DSUB standard pinning $\boxed{474}$ Z_{GND} is ca. 500 kΩ for CRFX, else 0 Ω

• E.g. for pressure transducers 4 mA to 20 mA.

Transducers which translate the physical measurement quantity into their own current consumption and which allow variable supply voltages can be configured in a two-wire circuit. In this case, the device has its own power supply and measures the current signal. The channels must be configured for current measurement.

The sensor is supplied with power either via terminals +VB and I, 1/4B or via an external sensor supply.



Note

There is a voltage drop both across the resistance on the line side and across the internal measuring resistance of 120 Ω which is proportional to the amperage. This lost voltage is no longer available for the supply of the transducer (2.4 V = 120 Ω * 20 mA). For this reason, you must ensure that the resulting supply voltage is sufficient. It may be necessary to select a lead wire with a large enough cross-section.

8.4.2.5 Temperature measurement

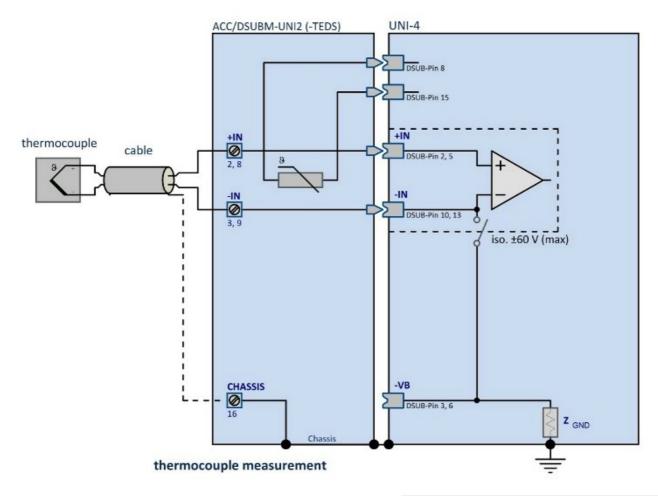
The amplifier channels are designed for direct measurement with thermocouples, PT100 and PT1000-sensors. Any combinations of the two sensor types can be connected.



Note

A temperature measurement is a voltage measurement whose measured values are converted to physical temperature values by reference to a characteristic curve. The characteristic curve is selected from the Base page of the imc software configuration dialog. Amplifiers which support a bridge measurement must first be set to voltage mode (DC), in order for the temperature characteristic curves to be available on the base page.

8.4.2.5.1 Thermocouple measurement

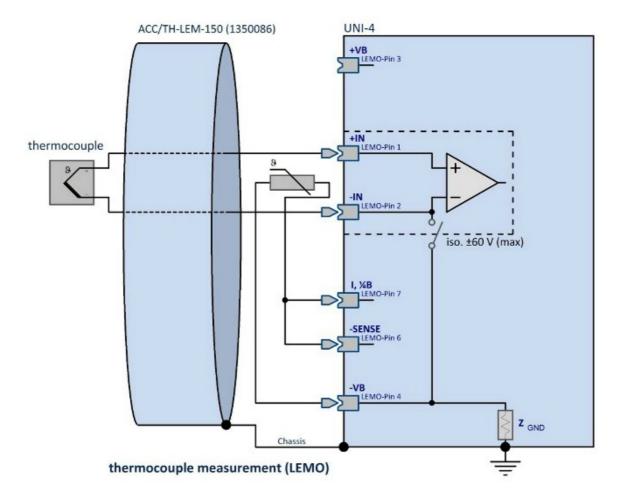


LEMO is the 7-pin LEMO (standard pinning) 48 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

The common types of thermocouples are supported by characteristic curve linearization.

When using standard UNI-4 DSUB variant we recommend the imc plug: **ACC/DSUBM-UNI2**, with built-in cold-junction compensation.

Note that with <u>LEMO connection [481]</u> an external PT100 must be integrated in the plug as cold junction compensation. In addition, the *ACC/TH-LEM-150* plug is available as an accessory, a LEMO.1B plug with integrated cold junction compensation.



However, if the temperature processes in the device's environment are not stable, a PT100 in the plug is absolutely necessary. This is certainly the case if:

- there is draught
- if the module is used on-board a vehicle
- if cables with terminals of different temperature are connected
- if the ambient temperature is fluctuating
- whenever reliable and precise measurement is required.



Notes

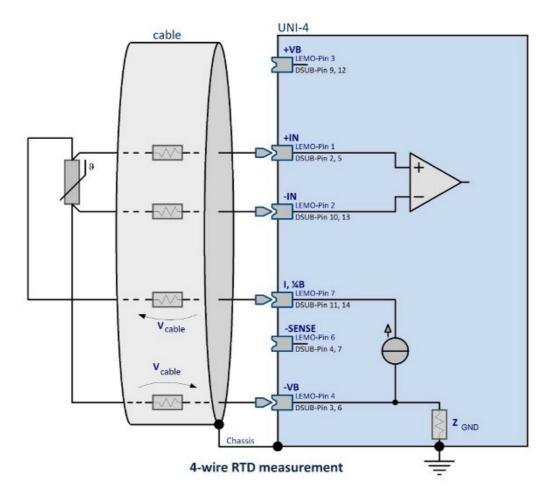
- In the imc software user interface, the option isolated thermocouple (default setting) must be activated under Settings Configuration Amplifier. This is only available with DC Coupling.
- Find here a description of thermocouples concerning DIN and IEC 1051.

8.4.2.5.2 PT100-, PT1000 measurement

• DSUB-plug: ACC/DSUBM-UNI2 474

PT100/PT1000 can be connected in a 4-wire configuration or 3-wire configuration. The 4-wire configuration is the most precise way to measure with a PT100/PT1000. The 4-wire measurement returns more precise results since it does not require the resistances of both leads carrying supply current to have the same magnitude and drift. Each sensor is fed by its own current source with approx. $250 \, \mu A$.

8.4.2.5.2.1 PT100 in 4-wire configuration



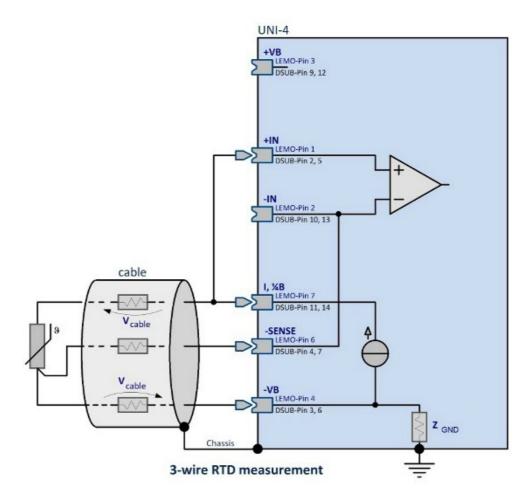
LEMO is the 7-pin LEMO (standard pinning) 48 DSUB 15-pin DSUB standard pinning 474 is ca. 500 k Ω for CRFX, else 0 Ω

Select in the software the PT100 in 4-wire configuration (input coupling = differential).

The PT100 is supplied by 2 lines. The other two serve as Sense-leads. By using the Sense-leads, the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error.

The 4-wire configuration is the most precise way to measure with a PT100. The module performs a genuine differential measurement.

8.4.2.5.2.2 PT100 in 3-wire configuration



LEMO is the 7-pin LEMO (standard pinning) 481DSUB 15-pin DSUB standard pinning 474is ca. 500 k Ω for CRFX, else 0 Ω

Select in the software the PT100 in 3-wire configuration (input coupling = single-end).

The PT100 is supplied by 2 lines. An additional line serves as the Sense-lead. By means of the Sense-lead, the voltage at the resistor itself can be determined precisely. The voltage drop along the conducting cable thus does not cause any measurement error.

It is important that the connection between +IN to I_1/4B is made directly at the module.

3-wire configuration is not always as precise as 4-wire configuration. When in doubt, 4-wire configuration is preferable.

8.4.2.5.3 Probe-breakage recognition

The amplifier comes with the ability of probe-breakage recognition.

Thermocouple: If at least one of the thermocouple's two lines breaks, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range in a defined pattern. The actual value reached depends on the particular thermocouple. In the case of Type K thermocouples, this is around 270°C. If the system is monitoring a cutoff level with a certain tolerance, e.g. if the measured value is <-265°C, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location.

The probe-breakage recognition is also triggered if a channel is parameterized for "Thermocouple" and measurement starts without any thermocouple being connected. If a thermocouple is later connected after all, it would take the period of a few measurement samples for transients in the module's filter to subside and the correct temperature to be indicated. Note also in this context that any thermocouple cable's plug which is recently plugged into the amplifier is unlikely to be at the same temperature as the module. Once the connection is made, the temperatures begin to assimilate. Within this phase, the PT100 built into the plug may not be able to indicate the real junction temperature exactly. This usually takes some minutes to happen.

RTD/PT100: If the leads to the PT100 are broken, then within a short time (only a few samples), the measurement signal generated by the amplifier approaches the bottom of the input range, to about 200°C, in a defined pattern. If the system is monitoring a cutoff level with a certain tolerance, e.g. if the measured value is <-195°C, then it's possible to conclude that the probe is broken, unless such temperatures could really occur at the measurement location. In case of a short-circuit, the nominal value returned is also that low.

In this context, note that in a 4-wire measurement a large variety of combinations of broken and shorted leads are possible. Many of these combinations, especially ones with a broken Sense lead, will not return the default value stated.

8.4.2.6 Current fed sensors

For measurement of current-fed sensors we recommend the expansion plug ACC/DSUBM-ICP2I-BNC(-F,-S) [237].



Note

UNI-4 with DSUB-15 sockets

Triaxial sensors are only supported when using a metal plug ACC/DSUB**M**-ICP2I-BNC(-F, -S) plugged on the measuring amplifier.

The use of plastic plugs (ACC/DSUB-ICP2, ACC/DSUB-ICP4) in connection with triaxial sensors is not possible.

8.4.2.7 Sensor supply voltage

UNI-4 channels are enhanced with a sensor supply unit, which provides an adjustable supply voltage for active sensors. This supply voltage is galvanically isolated. The selected supply voltage is set individually for each measurement channel.

The supply outputs are internally electronically protected against short circuiting. The reference potential, in other words the sensor's supply ground contact, is the terminal (clamp) -VB, that is internally bridged to clamp GND.

8.4.2.8 Bandwidth

The channels' maximum sampling rate is 100 kHz (10 μ s).

The analog bandwidth (without digital low-pass filtering) is 48 kHz (-3 dB).

8.4.2.9 Connection

The module is equipped with DSUB-15 plugs (CRFX/UNI-4) or LEMO plugs (CRFX/UNI-4-L). Find here the pin configuration of the DSUB-plugs 474 and the LEMO-plugs 481.

8.5 Bridge Balancing or Taring

Almost all modern amplifiers have the ability to compensate for an offset. Besides the conventional <u>bridge</u> <u>balancing</u> ₂₃₄, for normal voltage amplifiers this includes the capability to perform <u>taring</u> ₂₃₃. With taring, the value indicated is simply subtracted, which means that the resulting input range is shifted. Taring is also available for bridge amplifiers, but we recommend bridge balancing instead, since it leaves the input range symmetrical.

The operating software imc STUDIO provides a Setup page for configuring and performing bridge balancing and taring.

- Page: Setup > "Channel balance" > Tab: "Balance"
- Here, you can perform the balancing procedure for one or more channels. Balancing then happens automatically on the amplifier card. If multiple channels are selected, each amplifier card is balanced in parallel, while a card's individual channels are balanced in series. This means that balancing either one or multiple amplifier cards takes the same amount of time.
- When performing balancing by means of the command "Execute device action", the balancing types
 defined here can be used.



Reference

Channel balance

Additional notes and descriptions appear in the imc STUDIO-manual in the section: "Setup pages - Configuring device" > "Channel balance"

8.5.1 Taring

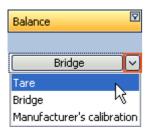
The sensor's offset in the voltage mode is reset to zero (tare or zero-balancing). The value measured is subtracted from the indicated value. This amounts to a pure calculation, similar to manual input of an offset value on the Processing page in the Settings\Configuration dialog. This means that taring has no effect on the amplifier's electrical behavior.

Example:

Input range = ± 10 V, Value indicated before taring = 3 V Input range after taring= -13 V to 7 V

Operation using the program imc STUDIO:

To perform an adjustment, first select the channel and in the column "Balance" using the button a right, the desired action.



Adjustment only starts once you click on the button after making your selection. The input range correspondingly is reduced by the amount of the zero adjustment. If the initial offset is so large that it's not possible to adjust it by means of the device, a larger input range must be set.



Note

Notes on hardware: balancing with setted offset

Zeroing with adjusted offset leads to different results with CRFX/CRXT modules and amplifiers installed in imc CRONOScompact, imc C-SERIES or imc SPARTAN:

- CRFX/CRXT: Zeroing adjusts the channel in the physical unit, e.g. 0 bar. This applies to all modules for the acquisition of analog voltages with 16 or 24 bits, except UNI-4.
- imc CRONOScompact, imc C-SERIES, imc SPARTAN, CRFX/UNI-4: The electrical value is balanced, i.e. the entered offset is retained. After the adjustment, the physical value is displayed with a negative offset. This ensures that an offset entered subsequently is not overwritten. If you wish for the balancing to determine the offset, **only enter the factor**, and then subsequently balance the offset by means of the Balancing function. Adaptation to the behavior of CRFX/CRXT is in preparation.

8.5.2 Bridge balancing

A significant characteristic of bridge measurements is the fact that the actual measurement signal is attended by an offset which can be **multiples of the input range**. Measurement bridges, consisting for instance of wire strain gauges (WSGs), respond to minuscule changes in their components' resistance (in the μ V/V = ppm = parts-permillion = 1E-6 range). The static initial asymmetry (offset) due to the components' production tolerances or assembly conditions, by comparison, can be in the range of mV/V, in other words in the range of the total input range or even multiples of it.

Since the offset also depends on the sensor connected it can't be calibrated for the device, but must be balanced **before starting the measurement**. The precondition for this is that the sensor used must be set up in the system the same way for the balancing as for the measurement and **may not be stimulated dynamically**.

Balancing the bridges restores the symmetry of the physical input range, which does not possible by means of taring [233].

Chapter 8

8.6 Overdriving a measurement range

Generally, all conditioning modules (amplifiers) of the imc CRONOS series allow linear operation up to minimum 100% of the selected nominal full scale range. The numerical implementation of imc CRONOS data structures however, theoretically allows the representation of twice the nominal range (±2xFS).

The analog signal path usually allows for some additional overdriving margin, even without leaving the linear transmission range. Overdriving behavior is also determined by analog and numerical limits of the ADC and numerical limits of subsequent signal processing. Additionally, certain internal reserves in signal range are necessary to account for characteristic filter settling and overshoot, as well as calibration headrooms. All these aspects lead to slightly varying limits and behavior with respect to hard or soft saturation or increasing nonlinearities. These can depend on actual module type, chosen measurement mode and range.

To facilitate easy identification of overrange status, some imc CRONOS modules implement the following behaviour:

If some internal signal exceeds its allowable range, which will typically be the case at aprox 105% of full scale range (±1.05 x FS), then the output and displayed data value will be forced to exactly (±2 x FS). This serves an an explicit indicator for an invalid operating condition. It is intended as a "warning flag" to prompt the user for selecting an appropriate measurement range. As such it is considered an extra feature and benefit, that will assist in avoiding any invalid measurement data, as in an overdriving case, a relieable relation between displayed data and real world signals can no longer be guaranteed.

Additionally, in the case of BR2-4 146, the overrange "flagging" will incorporate a "monoflop" behaviour: any detected illegal overrange state will be extended and flagged to a minimum duration of 200 μ s.

In this context, it is important to be aware, that any detected internal overdriving might refer to an unfiltered raw input signal, not yet subjected to digital filtering or other signal processing. This is why it is well possible, that a low pass (or AAF) filtered channel might still appears to be within the nominal range, while the raw input and thus internal nodes, containing significant high frequency content, could already exceed the allowable range. Such a case would be characterized by a displayed signal that would instantly jump from maybe 80% FS to 200% FS.

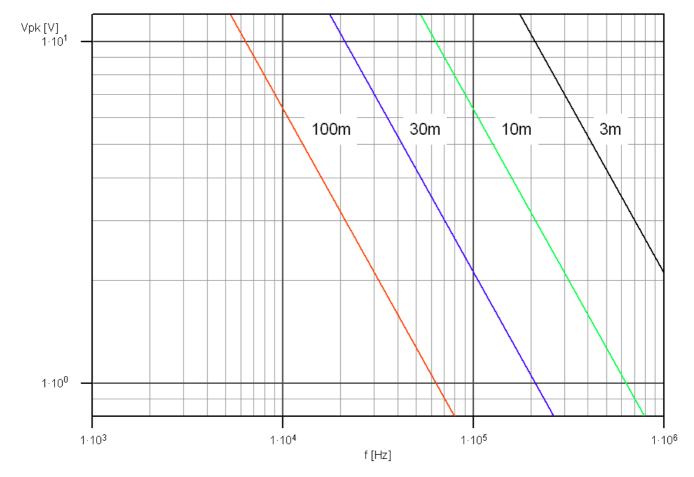
These type of overrange limitations are in fact a natural and inevitable charactersitic of any data acquisition and measurement system — either analog or digital. Especially when dealing with wide band signals, and low pass signal conditioning, it has to be guaranteed that analog and digital linear signal ranges are covered with sufficient headroom in all relevant stages of the signal chain.

In practical applications, this means that the measurement range has to be chosen by taking in account sufficient headroom margin, to cover the maximum levels under all expected conditions. If in doubt, an unfiltered measurement, temporarily deselecting any low pass or anti-aliasing filter, might unveil unexpected peak levels and verify a correct setting.

8.7 Measurement with current-fed sensors (IEPE)

With current-fed sensors (e.g. ICP™-, DELTATRON®-, PIEZOTRON®-, PIEZOBEAM®-sensors), the capacitive burden on the signal due to the cable capacitance can lead to clipped amplitudes for higher frequencies. To avoid signal distortion, try to:

- 1. keep the cable short,
- 2. use a low-capacitance cable,
- 3. use a less sensitive sensor.



Maximum signal amplitudes as a function of the signal frequency and the cable length, with a 4 mA feed and a capacitance of 100 pF/m.

8.7.1 Supply current

The exact magnitude of the supply current is irrelevant for the measurement's precision. Values of 2 mA tend to be adequate. Only in the case of very high bandwidth and amplitude signals in conjunction with very long cables, supply currents may be a concern, as considerable currents are need to dynamically charge the capacitive load of the cable.

dynam. current headroom: I = 4 mA

cable capacity (typ. coax-cable): $C = L \cdot 100 \text{ pF/m}$

max. signal slew rate (full-power): $dU/dt = 5 V \cdot 2 \cdot \pi \cdot 25 \text{ kHz}$

-> max. cable length: $L_{max} = 4 \text{ mA} / (100 \text{ pF/m} \cdot 5 \text{ V} \cdot 2 \cdot \pi \cdot 25 \text{ kHz}) = 50 \text{ m}$

Up to a **max. cable length of 50 m**, no limitations are to be expected as long as the conditions above are fulfilled. Find here the description of the ICP-plug [237] and here technical specs: ACC/DSUB-ICP. [457]

8.8 Measure with IEPE/ICP expansion plug

In general, imc plug is a plug with imc housing (formerly plastic today metal), which enables the connection of the sensors to the inputs of the measuring amplifier via a DSUB-15 plug connection. A distinction is made between terminal plugs and expansion plugs. While a terminal plug makes the amplifier characteristics or a subset of them accessible, the use of an expansion plug allows the amplifier characteristics to be changed.

In order to fulfill different measuring tasks, imc provides a variety of measuring amplifiers. It should be noted that the properties of the measuring amplifier used are changed (in the desired way) by the connected expansion plug. This expansion must be made known to the measuring system via the operating software.

8.8.1 IEPE/ICP-Sensors

The IEPE/ICP-channels are specially designed for the use of current-fed sensors in 2-wire-configuration.

IEPE, Integrated Electronics Piezo Electric, is the standard for piezoelectric transducers. IEPE (ICP)-sensors are typically employed in vibration and solid-borne sound measurements and are offered by various manufacturers as solid-borne sound microphones or accelerometers under different (trademarked) product names, such as: PCB: ICP-Sensor, KISTLER: Piezotron-Sensor, Brüel&Kjaer: DeltaTron-Sensor. The commonly used name ICP (Integrated Circuit Piezoelectric) is actually a registered trademark of the American manufacturer "PCB Piecotronics".

This sensor type is fed with a constant current of typically 4 mA and delivers a voltage-signal consisting of a DC-component (typ. ± 12 V) superimposed with an AC-signal (max. ± 5 V). Typical source resistance values (internal resistance) of ICP sensors are on the order of magnitude of max. ± 100 Ω .

8.8.2 ACC/DSUB-ICP2 and ACC/DSUB-ICP4

As a special accessory for voltage channels, an ICP expansion plug is available. This plug can be used to directly connect current-fed ICP-sensors also at voltage channels. The ACC/DSUB-**ICP4** is equipped with four channels and the ACC/DSUB-**ICP2** with two channels, see the DSUB-15 pin configuration 476.

This (active) expansion plug having the same dimensions as the imc DSUB-plug, comes with additional conditioning equipment built into its housing and having the following **features**:

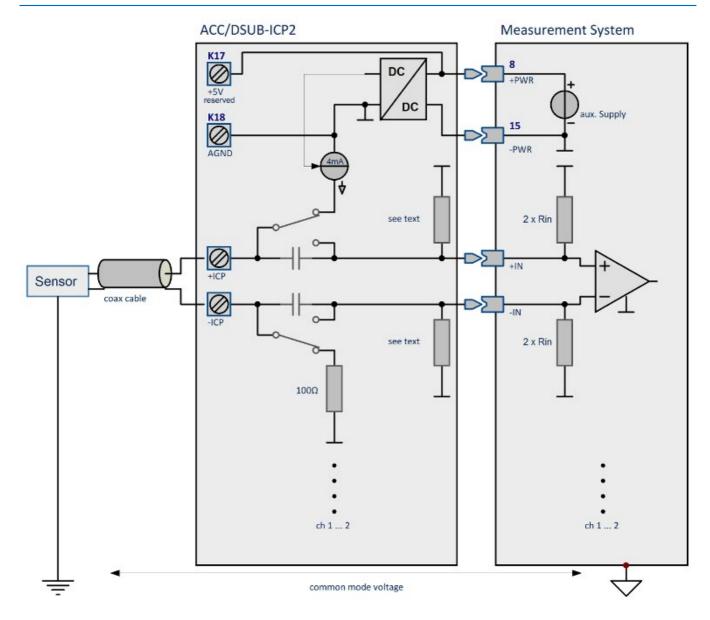
- Individual current sources for the current-fed IEPE/ICP-sensors
- Each source: 4.2 mA (typ.), voltage swing: max. 25 V, see technical details: ACC/DSUB-ICP 457
- Differential AC-coupling to block the signal's DC-component (approx. +12 V), typical with IEPE/ICP

- Each channel can be switched to DC-coupled voltage measurement or current-fed IEPE/ICP measurement (AC-coupled); ex-factory the **DIP-Switch** for each channel inside the plug is switched to IEPE/ICP measurement (AC-coupled)
- For the supply of this expansion plug, the amplifier used provides a voltage of 5 V. This voltage is short-circuit proof and independent of the voltage supply [144]. The maximum load is 1.35 W. The ICP2 plug requires a maximum of 500 mW for its internal needs, the ICP4 plug requires 1 W. This means that the 5 V pin has 0.85 W or respectively 0.35 W available.



Note

The two channel plugs ACC/DSUB-ICP2 in all variants can also be used with amplifiers that provide four channels on one DSUB-15 socket. In this case only the odd channel numbers (1, 3, 5, 7) can be used.



DIP-Switch position ICP (DIP-Switch inside of the expansion plug):

- The AC-coupling is already provided by the ICP-plug, the voltage channel is DC-coupled.
- The measurement range must be adapted to the signal's AC-component, it can be adjusted within the range: ±5 V to ±250 mV
- The combination of the built-in coupling capacitor (2 x 220 nF corresponding to 110 nF diff.) with the impedance of the IEPE/ICP-plug (2 MΩ diff.) and the input impedance constitutes a high-pass filter. When connecting the plug or sensor, be aware of the transients experienced by this high-pass filter, caused by the sensor's DC-offset (typ. +12 V). It is necessary to wait until this phenomenon decays and the measured signal is offset-free!
- When the ICP-expansion plug is used, a considerable offset can occur (in spite of AC-coupling), which can be traced to the (DC-) input currents in conjunction with the voltage amplifier's DC input impedance. This remainder, too, can be compensated by high-pass filtering with imc Online FAMOS.

DIP-Switch position Volt (DIP-Switch inside of the expansion plug):

- The voltage channel is DC-coupled, the current source de-coupled.
- The voltage channel's input impedance is reduced by parallel connection with the IEPE/ICP-plug's impedance.

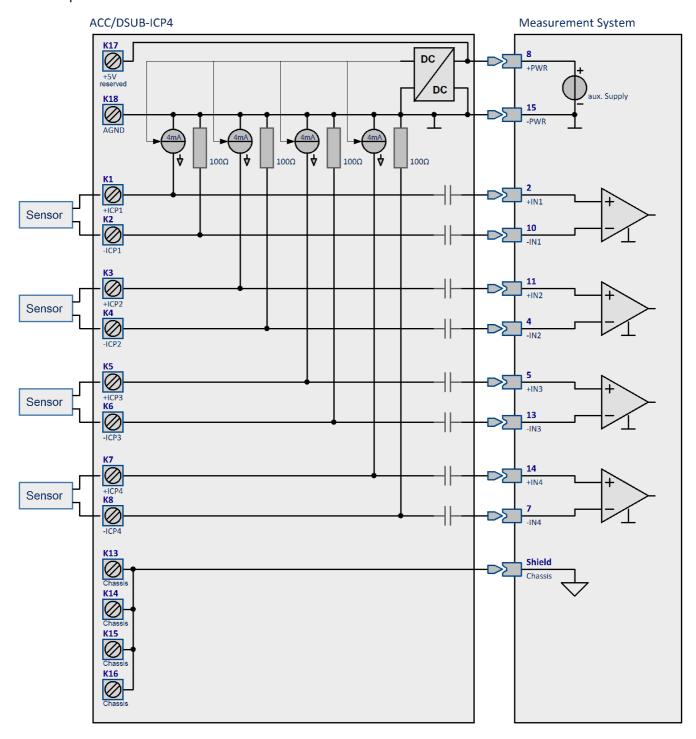
The voltage amplifiers' different input impedance values (with / without input divider) depend on the voltage range selected. The resulting high-pass cutoff frequencies and the time necessary for the 12 V-offset to decay to $10 \, \mu V$ are shown.

Range	diff. R_in	Result impedance	tau	fg	Settling (10 μV)
≥±5 V	1 ΜΩ	0.7 ΜΩ	73 ms	2.2 Hz	1.0 s
≤±2 V	10 ΜΩ	1.7 ΜΩ	18 ms	0.9 Hz	2.6 s

In terms of the shielding and grounding of the connected IEPE/ICP-sensor, note:

• We recommend using multicore, shielded cable, where the shielding (at the plug) is connected to the plug "CHASSIS", or can be connected to the pull-relief brace in the plug.

The following circuit schematic display an entire plug. The DIP switches are not included in order to achieve a more simple schematic.



8.8.3 ACC/DSUBM-ICP2I-BNC(-F,-S)

This expansion plug is used to extend imc measurement amplifiers with DSUB-15 sockets with an IEPE conditioning which allows the direct connection of 2 current-fed IEPE/ICP sensors, e.g. IEPE microphones, accelerometers of the type ICP™-DeltaTron®- or PiezoTron® etc.

The IEPE conditioning comprises 4 mA current supply and AC coupling and is channel-individually isolated. This ensures good ground loop suppression and allows operation of transducers that are either grounded or mounted with isolation towards CHASSIS ground.

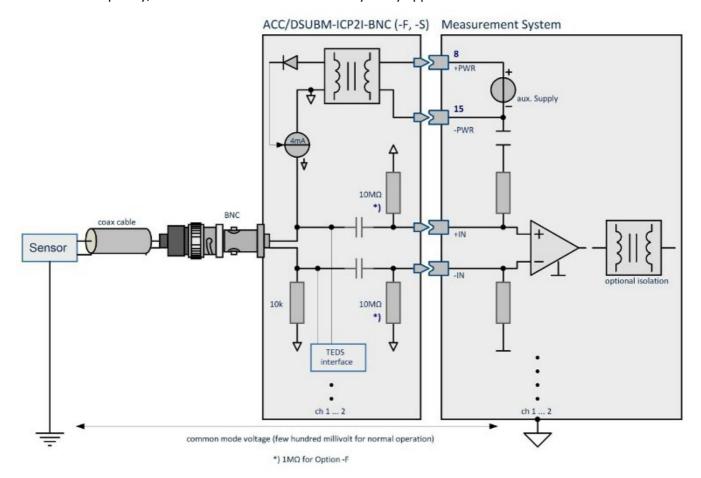
The expansion plug can be operated in conjunction with isolated and non-isolated voltage and bridge amplifier modules.

It has a TEDS interface for reading out information from the sensor, as long as it supports TEDS (Transducer Electronic Data Sheets according to IEEE 1451.4, Class I, MMI). Thanks to the isolated TEDS interface readout is also supported for grounded transducers as well as with triaxial sensors that have one single common ground lead. Furthermore (and independent from the sensor) the TEDS interface is also used to allow automatic detection of a connected plug by the involved amplifier (supported depending on amplifier type).

IEPE/ICP sensors deliver alternating AC signals which are superimposed on a static offset and decoupled by means of a high-pass ("HP", AC coupling, RC circuit). After connection and activation of the plug, full settling of this AC coupling can take well beyond 10 seconds.

Two variants of the expansion plug are available:

- The **S variant** (slow) achieves minimum cutoff frequency, thus limits the lower bandwidth of the sensor as little as possible. However, the transient response after plugging in (activation) can take longer (>10 seconds).
- The **F variant** (fast) settles faster (approx. 1 second) and therefore does not quite reach the minimum cutoff frequency, but with < 1 Hz is sufficient for very many applications in this form.



ACC/DSUBM- Expansion plug vs. dedicated ICP amplifiers

In contrast to dedicated IEPE/ICP mode amplifier types such as QI-4, AUDIO2-4 or ICPU2-8, this extension plug can provide IEPE support for more universal type amplifiers. This added flexibility comes at the expense of a somewhat limited handling comfort.

In particular it is important to be aware that the presence of the plug will dynamically change the properties and capabilities of the associated channel, which needs to be communicated to the host amplifier and the control software. The TEDS functionality is used for this detection process (independent of any sensor specific TEDS data!), which has certain implications for handling and operation.

Basic functionality (ICP-operation) does not require software support and has no associated requirements. However, for support of **sensor TEDS functionality** and for improved **offset performance** it is required that the plug is recognized and supported by the operation software. In particular this involves the activation of an additional digital high pass filter to remove some small residual offset that results from the high impedance AC coupling.

Supported amplifier types (full support vs. basic functionality)

Amplifi	er resp.	CRFX, CRXT	CRC, CRSL	C-SERIES	
Device	family				\checkmark Software support with variant differentiation (-F/-S),
UNI2-8	CS-7008-FD	**	✓	~	full support of TEDS sensors including
DCB2-8	CS-5008-FD	* *	✓	✓	sensors of the type DS2431 and a improved offset performance
B-8		**	✓	✓	✓ Software support without variant
LV3-8	CS-1208-FD	**	✓	✓	differentiation (-F/-S),
ISO2-8	CS-4108-FD	Х	Х	Х	support of TEDS sensors except
ISOF-8		Х	Х		sensors of the type DS2431 and a improved offset performance
UNI-4		**	Х		X only basic functionality (ICP-operation),
BR2-4		Х	Х		no support of TEDS sensors and
SC2-32			Х		no improved offset performance
LV-16	CS-1016-FD		Х	Х	amplifier is not part of this device family

The variant differentiation (-S/-F) function is only supported in the CRFX and CRXT device platform:

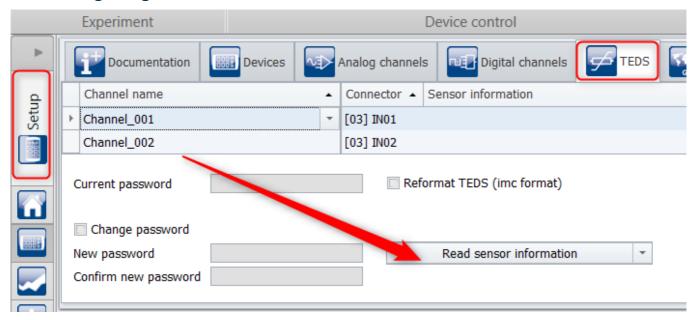
- Amplifier types with full software support (especially UNI2-8, DCB2-8, B-8, LV3-8, UNI-4) also have matched transient response in the CRFX/CRXT context (digital high pass selected accordingly).
- In the CRC and C-SERIE context, on the other hand, although the lower AC cutoff frequency is determined by the connector variant (-S/-F), the settling time is relatively long for both variants because the additional digital high-pass is fixed at low cutoff frequency in both cases.
- The fast variant therefore does not settle quickly!
- On the other hand, in conjunction with amplifier types that do not offer software support (e.g. ISO2-8, ISOF-8, BR2-4, UNI-4 in CRC context, etc.), the extension plugs are not recognized at all and are therefore not extended with additional digital high-pass. Therefore the behavior is only determined by the analog RC time constants. Thus, both cutoff frequency and settling time are clearly differentiated in the sense of slow/fast, and the fast variant also settles fast. However, the improved zero point accuracy due to the digital high pass is omitted.



Reference

Technical Specs: ACC/DSUBM-ICP2I-BNC(-F,-S) 458

8.8.3.1 Plug recognition via TEDS function



Expansion plug without TEDS Information of the sensor

When using the IEPE/ICP-expansion plug without any sensor connected, or in conjunction with a simple passive sensor without any TEDS memory, the software acknowledges this procedure with "apparent" error messages which in reality, however, just reflect the fact that no TEDS data of the actual sensor are recognized.

Typical expected and normal "error"-messages occurring in conjunction with valid recognition of the ICPexpansion plug:

6305 The sensor is not connected correctly! Typically when a passive sensor is connected, or in case of short circuit.

6318 The sensor is not connected directly, or is not making sensor information available! Typically when BNC terminal are left open / unused.

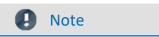
These two messages are actually the expected response to successful detection of the plug without sensor information!

Triggering of plug recognition via "Download" (only CRC, C-SERIES)



With the CRC/C-SERIES, plug recognition is automatically triggered during the "Download" process. This Download only identifies the plug and error messages regarding non-existent sensor information 244 are omitted.

Therefor the measurement mode must be set to the compatible setting "Voltage, DC-coupling", otherwise an incompatible coupling is reported.



The software is optimized so that the repeated execution of the *Download* function is only effective if the device settings have been changed. The plug attachment is not registered as a change in the device settings. In case of doubt it may therefore be necessary to force a new download, e.g. by switching a channel parameter back and forth.

Expansion plug in conjunction with/without TEDS-capable sensor

When a **sensor with its own TEDS memory** is connected, its read out properties are recognized, such as the scaling and the unit. Only in this case, where there is valid TEDS information about the sensor itself, the input coupling of the channel will be displayed as "AC with current supply".

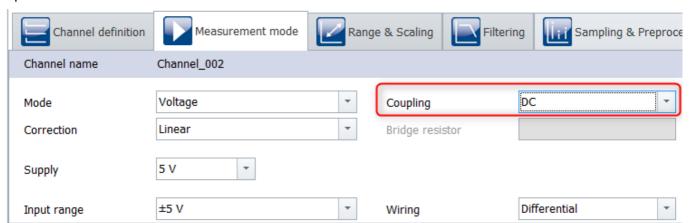
This AC coupling is also displayed if the sensor information is not read via TEDS, but when an ICP sensor is linked to the channel via the imc SENSORS database (drag&drop):



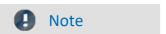
ICP expansion plug with TEDS information from the sensor or from the imc SENSORS database

IEPE/ICP-sensor without TEDS information

In the simple case of an IEPE/ICP-sensor *without TEDS memory*, all of the amplifier's regular input couplings remain available, although among these, it is necessary to always select "*Voltage, DC-coupling*". All other couplings are invalid in connection with the expansion plug and cause the associated error messages to appear upon Download.



Erkannter ICP-Erweiterungsstecker, aber keine weiteren Sensorinformationen: Spannungsmodus DC-Kopplung



ICP-sensor without TEDS

When using a simple **sensor without TEDS memory**, the recognition procedure will displayed with the <u>messages above (#6305, #6318) [244]</u>, and the input coupling of the downstream amplifier will be displayed (*Voltage, DC-coupling*). However, the **expansion plug's AC-coupling and current feed**, as well as the digital high-pass filter, are actually in effect!

8.8.3.2 Software recognition

The ICP expansion plug supports ICP transducers with integrated TEDS memory (Class I MMI). The plug itself is also recognized via the TEDS functionality. The TEDS mechanism is used for plug recognition even when the actually used transducer that is connected to the plug does not support TEDS and does not incorporate any TEDS memory at all.

Depending on the device family involved, identification of the plug and the sensor, as well as resetting, are initiated/triggered by various circumstances:

Device family	Abbr.	Plug detection is caused by bei	Function
imc CRONOScompact, imc C-SERIES	CRC, CS, CL	Plug detection always takes place automatically every time the measurement is downloaded or under after changing the configuration upon start.	Download Start
		Reading of sensor data, however, is only possible via the TEDS function. The plug recognition is then updated as well.	TEDS
imc CRONOS <i>flex,</i> imc CRONOS-XT	CRFX, CRXT	No physical identification upon download, neither plug nor sensor.	Download
		Time of identification can be controlled by the function: "TEDS – read sensor information"	TEDS
		The system not only attempts to read the sensor-TEDS memory, but will also attempt to identify any intermediate expansion plug.	

Additionally, with all device families: Plug detection by the device itself, always upon *Power-Up*.

8.8.3.3 Further information

Verifying successful plug recognition

The successful identification of the expansion plug can especially be seen in the fact that the attempt to configure a bridge mode (e.g., half-bridge) will lead to the following message upon download:

- 6328 The input coupling set is not supported by the imc clamp terminal connected! (message for **CRFX**)
- 6329 All channels of the connected imc clamp terminal require the same input coupling*: AC with current feed or DC!

 (message for CRC/C-SERIES)

^{*} As of imc STUDIO version 5.2 R15 the input coupling has been renamed to: "IEPE".

Only with CRFX: Alternatively, you can obtain verification with CRONOS*flex* by pulling out the plug, forcing a "*Download*" (e.g. toggling the input range and returning it to original setting). This will lead to the following message:

6334 The required imc clamp terminal ACC/DSUB-ICP is not connected!

This test only works with **CRFX!** With **CRC** and **C-SERIES** however, it is not possible to do a check in this way: Here, successful plug recognition cannot be checked explicitly, but instead a new plug recognition is forced with each Download procedure. Thus, the no longer present plug along with its information would be deleted.

Deleting/resetting the plug recognition

Conversely, in order to delete this "hidden" information about a recognized ICP expansion plug, the plug must be physically disconnected and (particularly with CRFX) TEDS readout function must explicitly be forced. This leads to the regular "error" message (expected and correct behavior!):

6319 Either the imc terminal plug is not connected correctly or is unsuitable for the sensor communication!

Thus, software is forced to verify the presence of the plug, which fails as expected and resets the status to "without ICP expansion plug".

Plug vs. Sensor info

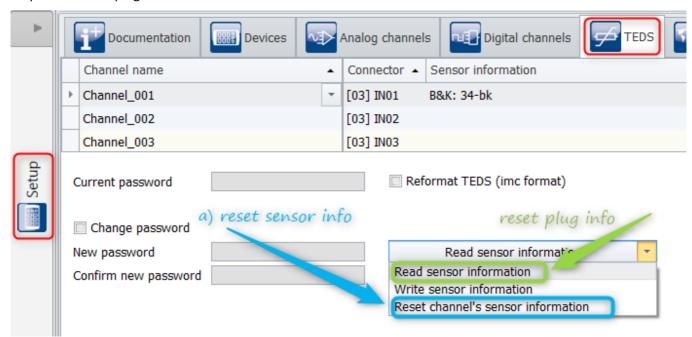
When resetting the recognition, there is a distinction between two stages:

a) Resetting the **Sensor-information**

Using the TEDS-function "Reset channel's sensor information". This does **NOT** delete the **plug** information!

b) Resetting the plug recognition

By **unplugging the plug** and using the TEDS-function "*Read sensor information*". Only after completion of this process is the plug information deleted!



Reset sensor- and plug info

Special note regarding the **CRC/C-SERIES**: As long as no SENSOR data are used, but only the plug recognition is to be reset, it is sufficient in this case to unplug the plug and to force a repeat of the Download procedure. Not applicable to CRFX.

Firmware-Update / behavior upon starting

In all device families, as a rule the stand-alone device performs plug recognition **upon Power-Up.** in order to be able to take into account any plug-specific processes for possible autostart configurations. If this has not been successfully verified, an automatic measurement will not be started and a corresponding error message is stored on the onboard flash (device memory). Therefore the plug must always be plugged in correctly at the time of Power-Up.

In contrast to this, the following applies to a **firmware update**: When a firmware update is performed, **the plug should not be plugged** in! The firmware update may change the properties of the amplifier. The reboot during the firmware update causes a new readout and the verification described above is missing. For this reason, if you are prompted to perform a firmware update, ensure that any expansion plugs are disconnected, before clicking on "*OK*" to initiate the update.

8.8.3.4 List of possible error messages and their causes

Alongside the routine status messages described above, other errors can occur, e.g., in conjunction with the loading of experiments which had been created with expansion plugs connected, or in conjunction with TEDS information from the sensor itself. The following notes are intended to help in trouble shooting.

2363 Combination of coupling and input setting not allowed

Cause: The channel settings (generated via TEDS or expansion plug) contradict the module properties.

This condition can occur when a device (with default properties) is to be run with an experiment which had been created in conjunction with expansion plugs (other properties). In order to resolve the problem, restore the hardware setup associated with the experiment or modify your experiment /create a new experiment.

This can also happen, when sensor-TEDS cause inappropriate channel settings. In order to fix this problem reset the sensor information $\frac{1}{247}$:

TEDS-function: "Reset channel's sensor information"

Alternatively, you can import the appropriate sensors (TEDS) with appropriate coupling:

TEDS-function: "Read sensor information"

or make settings via the sensor database:

in conjunction with imc SENSORS: drag&drop from the tool window "Sensors"

6305 The sensor is not connected correctly

In conjunction with the ICP expansion plug:

Correct recognition of the expansion plug, however without using a sensor having its own active TEDS-memory: not an error!

In conjunction with "normal" TEDS sensors (e.g., with the ACC/DSUBM-TEDS-xxx clamp terminals):

Cause: As described in the message. Most often, the issue is reversed polarity. Switch around the two contacts of the 1Wire chips and try again.

6310 After preparation of the device, the imc terminal plug at the channel was switched!

Cause: A plug with plug information had been detected in the past and is affecting the module properties (modes, correction values). Message 6310 indicates that the expected plug has been disconnected and replaced. If this happened intentionally, the sensor information can be reset: [247]

TEDS-function: "Reset channel's sensor information".

6318 The sensor is not connected directly, or is not making sensor information available!

Cause: Reading of sensor information (TEDS) was unsuccessful.

In conjunction with the ICP expansion plug:

Correct recognition of an expansion plug, without connected sensor (BNC open): not an error!

In conjunction with "normal" TEDS sensors, or ICP sensors having their own active TEDS memory:

Possibly either the TEDS memory type (1Wire-type) or the format is not supported. For clarification, please contact the Hotline.

6319 Either the imc terminal plug is not connected correctly or is unsuitable for the sensor communication!

Cause: The reading of sensor information (TEDS) was unsuccessful because TEDS is not supported by the plug or by the amplifier, or the plug was disconnected.

In conjunction with ICP- (or Q) expansion plug:

When using the function "Read TEDS sensor information": In case of intentional disconnection of the plug for purposes of resetting the plug recognition: **not an error!** When attempting to recognize an actually connected plug: Possibly, this plug is not supported by this particular amplifier. For clarification, please contact the Hotline.

If the message appears in conjunction with the Downloading of a test, then evidently a previously recognized expansion plug has been disconnected. If that was done intentionally, then you should <u>explicitly reset the plug recognition by using:</u>

247

TEDS-function: "Read sensor information".

6328 The input coupling set is not supported by the imc plug connected!

Also: **6329** All channels of the connected imc clamp terminal require the same input coupling: AC with current supply or DC! (The coupling mode "AC with current supply" has been renamed to "IEPE" as of imc STUDIO version 5.2 R15.)

Cause: An expansion plug has been recognized which requires specific settings for the coupling (e.g., an ICP-plug requires either DC coupling or AC with current supply; no kind of bridge circuit would be allowed).

In order to fix the problem, make an appropriate setting for the amplifier: If you have already set the affected channels to "passive" for this purpose, then Downloading of the test is sufficient.

8.9 External sensor supply

8.9.1 CRFX/SEN-SUPPLY-4 module

The SEN-SUPPLY-4 module provides high-performance ±15 V power to operate 4 sensors. It is designed especially for the purpose of using modern Fluxgate current transducers such as LEM Ultrastab types as well as precision current clamp.

As a passive module it can be operated/combined with any amplifier types by hooking up to the amplifier inputs via patch cables (LEMO.1B).

It can be used both in conjunction with CRFX-modules (aggregate modules snapped together), as well as in stand-alone operation, and with amplifiers and devices belonging to other device families such as imc CANSAS, imc C-SERIES, etc.



Reference

- Technical Specs 447
- Pin configuration: LEMO 482 and DSUB-9 484

Click-mechanism and power supply

The signals for the EtherCAT system and power supply, which are routed on the module connector, are looped through the module, but not used. The module is supplied with power (20 V to 50 V DC) exclusively from the separate LEMO.1B (2-pin) socket and not from the click connector. This voltage also has no contact on the module connector.

The power supply input is compatible with the POWER-HANDLE or UPS-module for imc CRONOSflex: The supply for the SEN-SUPPLY-4 module is not routed through the supply line of the click connector. Instead, the permanently regulated and (in conjunction with UPS-function) buffered 50 V output voltage of the POWER-HANDLE can be used via one of its 5 auxiliary outputs ("AUX" on the rear panel, LEMO.1B.304; corresponding connection cables are available). The primary supply voltage of the POWER-HANDLE can always lie within the wide range of 10 V to 50 V DC suitable for vehicle use!

Status-LED

Each of the four supply connections has a status LED. This has two functions:

- 1. If an overload is detected, the status LED lights up red for at least two seconds, otherwise it lights up green.
- 2. Some sensors output the status of the sensor via a separate "Fail" port. The "FAIL" signal at the DSUB-9 socket is connected to the corresponding sensor connection: The LED lights up green when the "FAIL" signal = GND. If the voltage at the FAIL contact is not GND (0 V) or if the connection is open, the LED lights up red.

External sensor supply Chapter 8

8.9.2 External +5 V supply voltage

For a majority of the imc measuring modules there is a **5 V supply voltage** available for an external sensors or for the IEPE/ICP expansion plug. This source is not isolated; its reference potential is identical to the overall system's ground reference.

The +5 V supply outputs are electronically protected internally against short-circuiting and can each be loaded up to max. 160 mA (short-circuit limiting: 200 mA, refer to the data sheet of the used module). The sensor's reference potential, in other words its supply-ground connection is the terminal "GND". The <u>used pins 474</u> at the DSUB-15 plug Vcc=+5 V and GND fulfill a double function for amplifiers, that can be used for temperature measurement. They provide the supply for the build in cold junction compensation of the thermo plug (ACC/DSUBM-T4 107). In this case, the 5 V supply can not be used for external sensors.

8.9.3 Sensor supply module

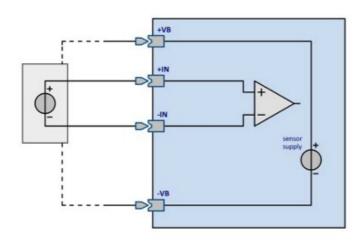
The SEN-SUPPLY module is available as a plug-in module (occupying one slot) with a selectable sensor supply voltage. Via a switch at the front panel of the module the supply voltage can be selected. There is a maximum power of 3 W available. Find here technical details of the <u>SEN-SUPPLY</u> 446 module.

Some modules can optionally be equipped with an adjustable sensor supply. This will not cause an enlargement of the width of those modules. In order to differentiate between the modules we add a suffix to the name of the module: "..-SUPPLY, e.g. ISO2-8-SUPPLY 372.



Note

Important: The settings are made via software interface. Make sure that the sensor supply is not set too high before connecting a sensor. Otherwise, the sensor could suffer damage.



The sensor supply is unipolar and can be led out with DSUB-15 plugs at +VB and -VB (or +SUPPLY and -SUPPLY, see typing label in your plug). Only five selectable settings are available per module. The configurations can be taken from the respective module data sheet. The voltage can be set globally for all channels of a module. All channels of a module form a channel group.

A bipolar supply voltage of ±15 V instead of the unipolar 15 V is available as special request. The sensor supply voltage is in this variant not isolated (to CHASSIS). This is also recommendable in most cases. With this ±15 V option the pin 6 is the reference at least with the U4 plug 474.



Example

+15 V via pin 6: GND and pin 3: +VB (+SUPPLY), -15 V via pin 6: GND and pin 12: -VB (-SUPPLY), +30 V via pin 12: -VB -(SUPPLY) and pin 3: +VB (+SUPPLY). Each table with the pinning in chapter "*Pin configuration*" list in a foot note the reference, if there is a reference.

If an isolated, active sensor is both fed with an isolated supply and measured with an isolated channel, then (due to isolation drift or capacitive interference coupling) an uncontrolled common mode voltage will emerge unless a common mode voltage is imposed from outside (or, for instance, by targeted grounding) which may be too

External sensor supply Chapter 8

strong interference to suppress. Only if the sensor to be supplied with power is already affected with a common mode voltage due to the measurement setup, or if the -SUPPLY return lines are already exposed to uncontrolled ground loops, an isolated sensor supply may be advisable.

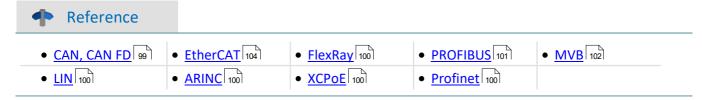


Note

The supply voltage is set on each channel group and does apply to **all inputs** of this group. For the number of channels per group is depending on the type of amplifier.

8.10 Fieldbus interfaces

The supported fieldbus interfaces available at imc are described in the chapter "Device properties". The devices are equipped with the desired fieldbus at the imc factory. Subsequent expansion or replacement is not planned.



8.11 DI, DO, DAC, HRENC and SYNTH

Digital modules	CRXT	Slots needed in CRC, CRSL:	Channels per module	Bandwidth	Remarks
DAC-8 277					analog outputs
		1	8	50 kHz	with CRC, CRSL
			8	5 kHz	with CRFX, see "digital CRFX modules" [253]
DI2-16 256	~	1	16	30 kHz	isolated: digital inputs
DO-16 270, DO-16-	~			10 kHz	isolated: digital outputs
HC 273		1	16	5 kHz	with CRFX, see "digital CRFX modules" [253]
DI16-DO8-ENC4 260		2	16/8/4	10 kHz / 500 kHz	isolated: digital in / out incremental counter channels
DI8-DO8-ENC4- DAC4 269		2	8/8/4/4	10 kHz / 500 kHz	isolated: digital in / out incremental counter channels + analog out
DIO-HV-4 257		2	4		high isolated: high voltage digital in / out
ENC-4 278		1	4		incremental counter channels
FRQ-4, FRQ2-4 284		1	4	500 kHz	frequency modulated signals
HRENC-4 285	~	1	4	500 kHz	incremental counter channels

8.11.1 Digital CRFX Modules DIO, Pulse Counter and DAC

This family of modules provides in- and output of digital signals and extend imc CRONOS flex systems with the capability to control measurement environments such as test stands.

imc CRONOS flex DIO, Pulse Counter, DAC modules					fea	features and specs					
	size	connector	digital I/O		DAC pulse cour		e counter				
module name CRFX/xxx	width	standard connector	input Bits	high voltage	output Bits	high current	analog outputs	counter inputs	quadrature mode chan	counter frequency	analog sin/cos mode
Base Unit extension	1000	Control of the Control of		1202	10/10	2000	A1500 A	1000	000000		122310
DI16-DO8-ENC4	+40mm	DSUB-15	16		8			4	2	32 MHz	
DI8-DO8-ENC4-DAC4	+40mm	DSUB-15	8		8		4	4	2	32 MHz	
flex modules: pulse counte HRENC-4	4	DSUB-15					-	4	4	256 MHz	0
flex modules: digital I/O, D/	AC (*)	D20B-12						**	4	200 IVINZ	-
DI2-16		DSUB-15	16			_					
DI2-32	2	DSUB-15	32								
DI-16-HV (110V)	2	Terminal blocks	16								
DO-16-HC	1	DSUB-15			16						
DO-32-HC	2	DSUB-15			32						
DI2-16-DO-16-HC	2	DSUB-15	16		16						
DAC-8	1	DSUB-15					8				
DO-16-HC-DAC-8	2	DSUB-15			16		8				

Prosa:

Digital I/O: galvanically isolated, configurable to 24V / 5V(TTL/COMOS) Level, output: 0.7A sink, high current: sink and source 0.7A Pulse Counter: full analog input conditioning (500 kHz analog bandwidth, differential input, analog filter, Software adjustable threshold levels) modes: event counter, differential and absolute angle and displacement, time, pulse width (PWM), phase difference, frequency, speed, RPM

16-channel modules provide 16 Bit of the same type (DI or DO).

32-channel modules can be chosen as pure DO or DI type modules or as a combined one (16+16). Those modules are implemented as "Double-modules" acting as two logical modules with their respective IDs displayed on two 7-segment-displays.

The 7-segment-display at the front of each logical module display the assigned address in HEX format with the prefix "d". This "d" stands for digital module. Every added module will be recognized by the Base Unit and will be addressed automatically with the next free address. You can change this automatically assigned address via the imc operating software. Please find a detailed description in the software manual, see chapter of the "Module properties". The maximum amount of possible digital modules in on measurement system find here 288.

The modules that are integrated into a Base Unit are not equipped with a 7-segment-display at the front and are addressed ex-factory with "d0".

8.11.2 CRFX/DI-16-HV

16 digital input for high voltage (110 V / 24 V)

This imc CRONOSflex Module (CRFX/DI-16-HV) is equipped with digital inputs that can sample signals conforming to either 24 V or 110 V logic standards.

The connection is realized via 4 terminal blocks of 4 bits each. The logic standard of each group of 8 Bit can be set via a switch.

Highlights

- isolated 4 Bit groups
- input level is configurable



CRFX/DI-16-HV

Technical Specs: CRFX/DI-16-HV 433

A switch sets the logic standard (and thus threshold level) for each 8-bit group.

Logic-level	configuration	LOW level	HIGH level	
24 V	switch of terminal (24 V)	<10.1 V	>15.1 V	
110 V	switch to terminal (110 V)	<48.3 V	>56.3 V	

The input stage has Schmitt-trigger characteristics, meaning switching thresholds with hysteresis. The thresholds specified correspond to the following cases:

- LOW-level: maximum signal level clearly identified as LOW; for the transition HIGH > LOW
- HIGH-level: minimum signal level clearly identified as HIGH; for the transition LOW > HIGH

The minimum hysteresis value is 0.4 V (TTL/CMOS-logic) or 1.6 V (24 V-logic).

The common reference ground of each 4-bit group is located at "0V_1", "0V_2", "0V_3" and "0V_4".

Internal pull-down-resistors provide a well-defined LOW-level in case of open inputs.

8.11.2.1 Data format, asynchronous polling mode

The system's names for the digital inputs are Din02_Bit01..16 and can be renamed in the usual way, if desired.

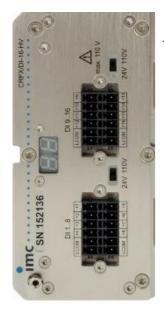
If the digital inputs are activated for data capture (as 16-bit ports), then, like all other channels, they generate a data stream at the corresponding sampling rate.

These can be displayed in **curve windows**, using any of the usual display styles, such as curve plots, waterfall, readout of single values, etc. Regarding the display, they are equivalent to any other channels. Of course, it is also possible to jointly display digital and analog channels in a shared curve window.

Available channels include both the individual bits *DIn02_BIT01* ... *DIn02_BIT16* with a Boolean input range (1 / 0), as well as the complete *16-bit port* as channel *DIn02*, which can assume values in the range 0 to 65535 (unsigned Integer).

Only synchronous data recorded in this form are available as a data set which can be saved to the hard drive. An additional data reduction mode is available which only generates data upon transition to a new signal state. In this mode, processing of the data in imc Online FAMOS is only possible under limited circumstances.

8.11.2.2 Pin configuration



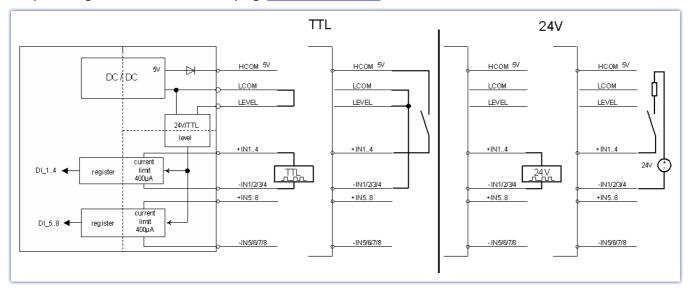
The common reference ground of each 4-bit group is located at LCOM

8.11.3 DI2-16: Digital Inputs

The DI2-16 possesses 16 digital inputs which can take samples at rates of up to 10 kHz. Every group of four inputs has a common ground reference (-IN1/2/3/4 or -IN5/6/7/8) and are not mutually isolated. However, this input group is isolated from the other input groups, the power supply and CAN-Bus.

Technical details of the DI2-16: Digital Inputs 416.

The pin configuration of the DSUB-15 plug: ACC/DSUBM-DI4-8 4741.



8.11.3.1 Input voltage

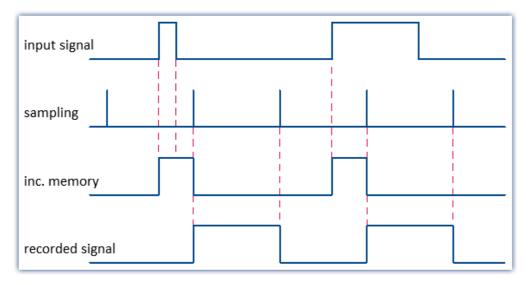
The input voltage range can be set for a group of 8 channels to either 5 V (TTL-range) or 24 V. The switching is accomplished by means of a jumper at the ACC/DSUB(M)-DI4-8 connector:

- If LEVEL and LCOM are jumpered, all 8 bits work with 5 V and a threshold of 1.7 V to 1.8 V.
- If LEVEL is not bridged with LCOM, 24 V and a threshold of 6.95 V to 7.05 V are valid.

Thus, an unconnected connector is set by default for 24 V. This prevents 24 V from being applied to the voltage input range of 5 V.

8.11.3.2 Sampling interval and brief signal levels

The digital inputs can be recorded in the manner of an analog channel. It isn't possible to select individual bits for acquisition; all 8 bits (digital port) are always recorded. The hardware ensures that the brief HIGH level within one sampling interval can be recognized.



8.11.4 DIO-HV-4: Digital Inputs and Digital Outputs

The imc CRONOScompact CRC/DIO-HV-4 Module is equipped with 4 isolated digital inputs and 4 isolated digital outputs, build as relay contacts.



Warning! Do not damage the safety seal!

The DIO-HV-4 Module was inspected for compliance with the safety guidelines per

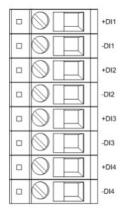
DIN EN 61010-1 prior to delivery and subjected to a high-voltage test. The module is sealed after having passed these final tests.

If the safety seal is damaged, safe work cannot be ensured.

Any intervention, for instance temporary removal of the module, makes re-inspection for safety.



8.11.4.1 DIO-HV-4: Digital Inputs

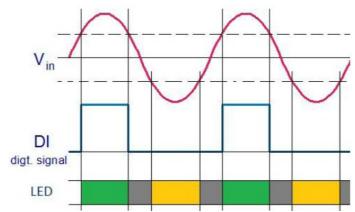


The four digital inputs are galvanically isolated in between each other and from the measurement system.

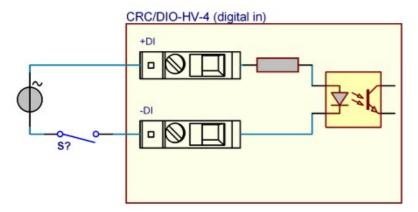
These mainly serve to process 230 $\rm V_{\rm eff}$ voltages, but it is also possible to monitor lower DC or AC voltages.

Technical details: Digital Inputs 421

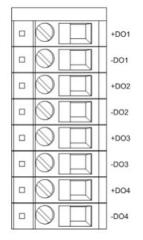
If the signal is above the switching threshold (typ. 16 V), the state of the input bit = 1 is displayed and the LED shines green. Below the switching threshold (typ. 16 V), the state is = 0 and the LED is off. Below - 16 V the LED shines yellow.



Digital input connection scheme for a 230 V voltage



8.11.4.2 DIO-HV-4: Digital Outputs



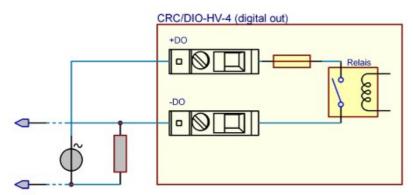
The four digital outputs are build as relays contacts.

The contact are insulated from the measurement system.

If a digital output bit is set, the relay contact closes and the LED shines.

Technical details: Digital Outputs 422

Example for a digital output with switched voltage and pull-down resistor.



The measurement module offers no internal reference voltage. That has to be connected externally.

8.11.4.3 DIO-HV-4: Connection

For the appropriate cable cross.sections, please see the technical specs (PHOENIX spring-clasp 2,5-H/SA-5).

8.11.5 DI16-DO8-ENC4: Digital Multiboard

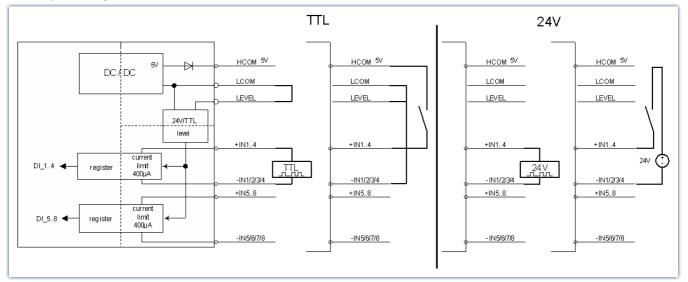
There are 16 binary inputs, 8 binary outputs and 4 incremental counter inputs available.

8.11.5.1 Digital Inputs

The DI potion possesses 16 digital inputs which can take samples at rates of up to 10 kHz. Every group of four inputs has a common ground reference and are not mutually isolated. However, this input group is isolated from the second input group, the power supply and CAN-Bus, but not mutually.

The technical specification of the digital inputs 417.

The pin configuration of the ACC/DSUB(M)-DI4-8 474.



Open inputs are set to have LOW voltage by means of pull-down resistors

8.11.5.1.1 Input voltage

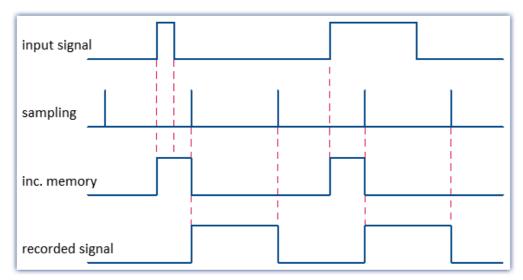
The input voltage range for a group of eight digital inputs can be set for either 5 V (TTL-range) or 24 V. The switching is accomplished by means of a jumper at the ACC/DSUBM-DI4-8 plug:

- If LEVEL and LCOM are jumpered, all 8 bits work with 5 V and a threshold of 1.7 V to 1.8 V.
- If LEVEL is not bridged with LCOM, 24 V and a threshold of 6.95 V to 7.05 V are valid.

Thus, an unconnected connector is set by default for 24 V. This prevents 24 V from being applied to the voltage input range of 5 V.

8.11.5.1.2 Sampling interval and brief signal levels

The digital inputs can be recorded in the manner of an analog channel. It isn't possible to select individual bits for acquisition; all 16 bits (digital port) are always recorded. The hardware ensures that the brief HIGH level within one sampling interval can be recognized.



8.11.5.2 Digital outputs

The digital outputs DO_01..08 provide galvanically isolated control signals with current driving capability whose values (states) are derived from operations performed on measurement channels using imc Online FAMOS. This makes it easily possible to define control functions.



Reference

The <u>technical specification of the digital outputs</u> 418. The pin configuration of the <u>ACC/DSUB(M)-DO8 474</u>.

Important characteristics:

- available levels: 5 V (internal) or up to 30 V with external power supply
- current driving capability: HIGH: 15 mA to 22 mA LOW: 700 mA
- short-circuit-proof to supply or to reference potential HCOM and LCOM
- configurable as open-drain driver (e.g. as relay driver)
- default-state at system power-on:
 HIGH (Totem-Pole mode) or high-impedance (Open-Drain mode)

The eight outputs are galvanically isolated as a group from the rest of the system and are designed as Totem-Pole drivers. The eight stages' ground references are connected and are accessible as a signal at LCOM.

HCOM represents the supply voltage of the driver stage. It is generated internally with a galvanically isolated 5 V-source (max. 1 W). Alternatively, an external higher supply voltage can be connected (max. +30 V), which then determines the drivers' output level.

The control signal OPDRN on the DSUB plug can be used to set the driver type for the corresponding 8-bit-group either Totem-Pole or Open-Drain.

In Totem-Pole mode, the driver delivers current in the HIGH-state. In the Open-Drain configuration, conversely, it has high impedance in the HIGH-state, in LOW-state, an internally (HCOM) or externally supplied load (e.g. relay) is pulled down to LCOM (Low-Side Switch). With Open-Drain mode, the external supply driving the load, need not be connected to HCOM but only to the load.

Inductive loads (relays, motors) should be equipped with a clamp diode in parallel for shorting out switch-off transients (anode to output, cathode to positive supply voltage).

Power-up response:

0)	deactivated	high-Z (high resistance)

1) power-up high-Z (high resistance) High- and LowSide switch inactive

2) first write access With "Prepare measurement" following Reset or Power-up (setting

procedure): activation of the output state with the mode set by the

programming pin "OPDRN"



Example

wire jumper between programming pin "OPDRN" and LCOM (-> Totem-Pole driver type) Initialization (first setting procedure) with 0 (LOW)

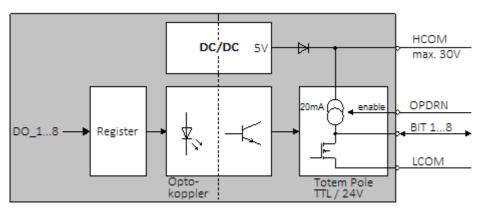
 \rightarrow resulting startup sequence: High-Z \rightarrow LOW, without intermediate HIGH state !! Without further steps the default initialization state while preparing measurement is: "LOW".

If a different state is desired, there are several options:

- Set the bit in imc Online FAMOS in the control command "OnInitAll".
- Set the bit before the "Prepare" action via imc STUDIO. E.g. via the Data Browser or also automated via the **command** "Set variable".

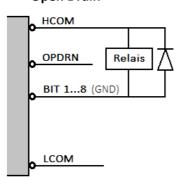
When "preparing" (reconfiguring) **imc Online FAMOS wins** and the value in the imc STUDIO variable is overwritten.

8.11.5.2.1 Block schematic

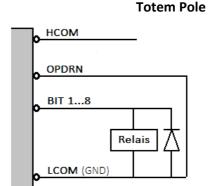


8.11.5.2.2 Possible configurations

Open Drain



5 V (internal)



Device off: no continuity/high impedance

(138 kΩ), 0 V at output

Device booting: no continuity/high impedance

(138 k Ω), 0 V at output

After booting process:

no continuity/high impedance, 0 V at output, but all DO Bits = 1

DO Bit = 0 -> 5 V

DO Bit = 1 -> 0 V

Device off: no continuity/high impedance

Device booting: no continuity/high impedance,

0 V at output

After booting process:

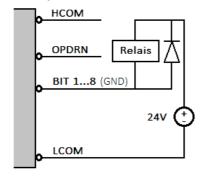
no continuity/high impedance,

0 V at output, but all DO Bits = 1

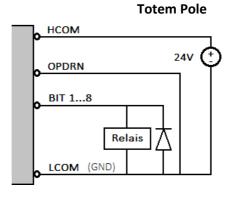
DO Bit = 0 -> 0 V

DO Bit = 1 -> 5 V

Open Drain



24 V



Device off: no continuity/high impedance

(1.5 $M\Omega$), 0 V at output

Device booting: no continuity/high impedance

 $(1.5 M\Omega)$, 0 V at output

After booting process:

no continuity/high impedance (1.5 $M\Omega$),

0 V at output but all DO Bits = 1

DO Bit = 0 -> 24 V

DO Bit = 1 -> 0 V

Device off: no continuity/high impedance (1.5 M Ω)

Device booting: no continuity/high impedance

 $(1.5 M\Omega)$, 0 V at output

After booting process:

no continuity/high impedance (1.5 $M\Omega$),

0 V at output, but all DO Bits = 1

DO Bit = 0 -> 0 V

DO Bit = 1 -> 24 V

With **Totem Pole**, a maximum of **22 mA** load current is possible, totally independently of any externally connected voltage.

Open Drain is able to switch currents of up to **700 mA**. When using the internal 5 V power supply, note that the limit on total current at all outputs is 200 mA.

8.11.5.3 Incremental counter channels

You can find a general description in the chapter of the "Incremental Counters Channels 116".



Reference

The technical specification of the incremental counter channels [419].

The pin configuration of the ACC/DSUBM-ENC-4 [474].

8.11.5.3.1 Sensor types, synchronization

Index signal denotes the synchronization signal SYNC which is globally available to all four channels in common. If its function Encoder w/o zero impulse is not activated, the following conditions apply: After the start of a measurement the counters remain inactive until the first positive slope arrives from SYNC. This arrangement is independent of the release-status of the Start-trigger condition.

The index signal is armed for each measurement!



Note

If a **sensor without an index track** (Reset signal) is used, *Encoder w/o zero impulse* must be selected, otherwise the counters will remain in reset-state and will never be started because the enabling start-impulse will never occur!!

Incremental encoder sensors often have an index track (index signal, zero marker pulse) which emits a synchronization-signal once per revolution. The **index signal** is differential and set by the comparator settings of the **first** Incremental counter channel of the module. Its bandwidth is limited to 20 kHz by a permanently low-pass filter. If the input remains open, an (inactive) HIGH-state will set in.

The measurement types Linear Motion, Angle, RPM and Velocity are especially well adapted for direct connection to incremental encoder sensors. These consist of a rotating disk with fine gradation in conjunction with optical scanning and possibly also with electric signal conditioning.

One differentiates between single track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B (C and D). By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported.

The actual time or frequency information, however, is derived exclusively from the A(C) -track!

The measurement types Event, Frequency, and Time always are measured by single-track encoders, since in these cases no evaluation of direction or sign would make any sense. The sensor must simply be connected to the terminal for Track A (C).

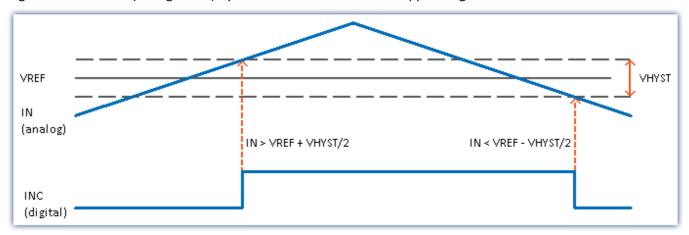
Since many signal encoders require a supply voltage, +5 V are provided at the connector socket for this purpose (max. 300 mA). The reference potential for this voltage, in other words the supply-ground connection for the sensor, is CHASSIS.

8.11.5.3.2 Comparator conditioning

The incremental counter channels' special properties make special demands on the signal quality: The very high time-resolution of the detector or counter means that even extremely short impulses which sampling measurement procedures (as at the digital inputs) would miss are captured and evaluated. Therefore the digital signals must have clean edges in order not to result in distorted measurements. Missed pulses or bounces could otherwise lead to drop-outs in the time measurements, or enormous "peaks" in the rpm-measurements.

Simple sensors such as those based on induction or photosensitive relays often emit only unconditioned analog signals which must be evaluated in terms of a threshold value condition. Furthermore long cables, ground loops or interference, can make the processing of even conditioned encoder signals (such as TTL-levels) difficult. The device, however, can counteract this using its special three-step conditioning unit.

To begin with, a high-impedance differential amplifier ($\pm 10 \text{ V}$ range, $100 \text{ k}\Omega$) enables reliable measurement from a sensor even along a long cable, as well as effective suppression of common mode interference and ground loops. A (configurable) filter (in preparation) at the next stage offers additional suppression of interference, adapted to the measurement set-up. Finally, a comparator with configurable threshold and hysteresis acts as a digital detector. The (configurable) hysteresis is an extra tool for suppressing noise:



If the analog signal exceeds the threshold VREF + VHYST/2. the digital signal changes its state (\uparrow : 0 \Rightarrow 1) and at the same time reduces the threshold which must be crossed in order to change the state back to 0 by the amount VHYST (new threshold: VREF - VHYST/2). The magnitude of the hysteresis therefore represents the maximum level of noise and interference that would not cause a spurious transition.

The threshold VREF is set to 1.5 V, the hysteresis VHYST is 0.5 V. State transitions are therefore detected at the signal amplitudes:

1.75 V (
$$\leftarrow$$
 0 \rightarrow 1) and 1.25 V (\downarrow 1 \rightarrow 0).

In future device versions, the threshold and hysteresis will be globally adjustable for all four channels within the range:

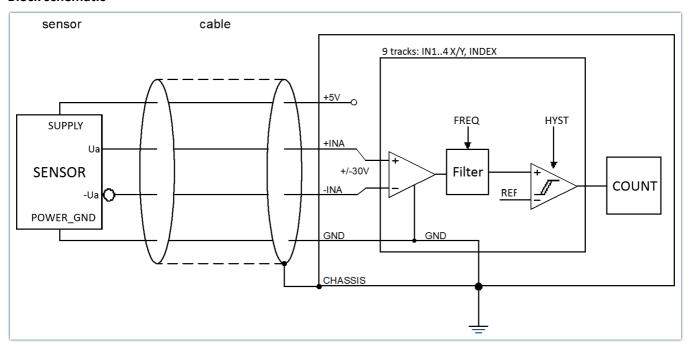
• VREF = ±10 V VHYST = +100 mV .. +4 V

Corner frequencies of the (2-pole) low-pass filter will be jointly configurable for both of a channel's tracks to the values: Low-pass filter: 20 kHz, 2 kHz, 200 Hz

8.11.5.3.3 Structure

Complete conditioning with individual differential inputs is provided for 4 tracks: they can be used for four channels with single-track encoders or for two channels with dual-track encoders.

Block schematic



Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B. By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported. The actual time or frequency information, however, is derived exclusively from the A-track!

Like the other channels, the Index-channel is fully conditioned. If its function is activated, it can take effect on all four channels.

8.11.5.3.4 Channel assignment

The plug used is the $\frac{ACC/DSUBM-ENC-4}{268}$. This plug enable all four incremental encoders to be connected at the same terminal.

As a prerequisite for the input differential amplifier to find the correct working point, the sensor must be ground referenced, i.e. it must have low resistance to ground (GND, CHASSIS, PE). This is not to be confused with the sensor's common mode voltage, which may be up to +25 V/-12 V (even for the –IN input!). It also does not matter that a differential measurement is configured for the high-impedance differential input. If this electrical connection to the system ground (CHASSIS) does not exist initially because the sensor is electrically isolated, then such a connection must be set up, for instance in the form of a wire jumper between the sensor's GND and POWER GND contacts!

The 5 V (max. 100 mA, 300 mA upon request) supply voltage which the module provides at the terminals +5 V and GND can be used to power the sensors. If more voltage or supply power is needed, the sensor must be supplied externally, which means that it is absolutely necessary to ensure that this supply voltage is referenced to system ground!

8.11.5.3.5 Incremental counter track configuration options

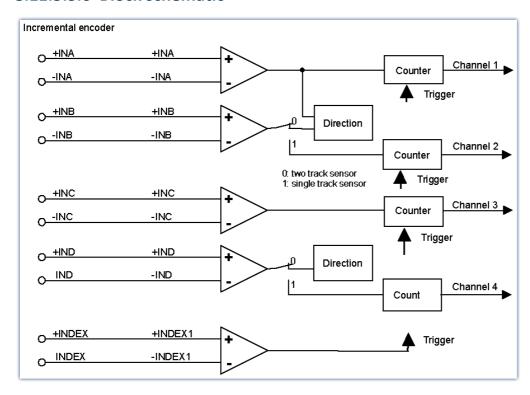
Mode	Channel 1	Channel 2	Channel 3	Channel 4
single-track encoder	•	•	•	•
dual-track encoder				
single-track encoder		shows signal value 0	•	•
dual-track encoder	•			
single-track encoder	•	•		shows signal value 0
dual-track encoder			•	
	•			
single-track encoder		shows signal value 0		shows signal value 0
dual-track encoder	•		•	



Reference

Please observe the notes on **two-point scaling** in the section "<u>Single-track / Dual-track encoder law</u>". Affects both the devices belonging to the imc C-SERIES, and also any devices belonging to the imc SPARTAN and imc CRONOS families which are equipped with the digital multiboard: DI16-DO8-ENC4 or the DI8-DO8-ENC4-DAC4.

8.11.5.3.6 Block schematic



8.11.5.3.7 Connection

See the connection description of the ENC-4 apply 282.

You can find here the pin configuration of the ACC/DSUB(M)-ENC-4 474.

8.11.6 DI8-DO8-ENC4-DAC4: Digital Multiboard

The digital multiboard is equipped 8 digital inputs, 8 digital outputs, 4 inputs for incremental encoders and 4 analog outputs.

The description of the digital inputs and outputs and the incremental counter part conform to the description of the <u>DI16-DO8-ENC4 module</u> added by the contents of this chapter and another difference is that the number of digital inputs is limited to 8.

8.11.6.1 Analog outputs

The analog outputs DAC 01 to 04 provide 4 analog output channels to be used as dynamic control and actuator signals. The outputs can be defined as the results of calculations performed by imc Online FAMOS on data from combinations of measurement channels.

The pin configuration of the corresponding DSUB-15: ACC/DSUBM-DAC4 [474].

The technical specification of the module DAC-4 420.

Highlights

- ± 10 V level at max. ± 10 mA driver capability and 250 Ω load
- ensured startup level 0 V without undefined transient states
- short-circuit protected against ground.

8.11.7 DO-16: Digital Outputs

The digital outputs DO_01..08 and DO_09..16 provide galvanically isolated control signals with current driving capability whose values (states) are derived from operations performed on measurement channels using imc Online FAMOS. This makes it easily possible to define control functions.



Reference

Technical details of the DO-16: Digital Outputs 423.

Find here the pin configuration of the DSUB-15: ACC/DSUBM-DO8 474.

Important characteristics:

- available levels: 5 V (internal) or up to 30 V with external power supply
- current driving capability: HIGH: 15 mA to 22 mA
 LOW: 700 mA
- short-circuit-proof to supply or to reference potential HCOM and LCOM
- configurable as open-drain driver (e.g. as relay driver)
- default-state at system power-on:

HIGH (Totem-Pole mode) or high-impedance (Open-Drain mode)

The eight outputs are galvanically isolated as a group from the rest of the system and are designed as Totem-Pole drivers. The eight stages' ground references are connected and are accessible as a signal at LCOM.

HCOM represents the supply voltage of the driver stage. It is generated internally with a galvanically isolated 5 V-source. Alternatively, an external higher supply voltage can be connected (max. +30 V), which then determines the drivers' output level.

The control signal OPDRN on the DSUB plug can be used to set the driver type for the corresponding 8-bit-group: either Totem-Pole or Open-Drain:

In Totem-Pole mode, the driver delivers current in the HIGH-state. In the Open-Drain configuration, conversely, it has high impedance in the HIGH-state, in LOW-state, an internally (HCOM) or externally supplied load (e.g. relay) is pulled down to LCOM (Low-Side Switch). With Open-Drain mode, the external supply driving the load, need not be connected to HCOM but only to the load.

Inductive loads (relays, motors) should be equipped with a clamp diode in parallel for shorting out switch-off transients (anode to output, cathode to positive supply voltage).

Power-up response:

0) deactivated high-Z (high resistance)

1) power-up high-Z (high resistance) High- and LowSide switch inactive

2) first write access With "Prepare measurement" following Reset or Power-up (setting

procedure): activation of the output state with the mode set by the

programming pin "OPDRN"



Example

wire jumper between programming pin "OPDRN" and LCOM (-> Totem-Pole driver type) Initialization (first setting procedure) with 0 (LOW)

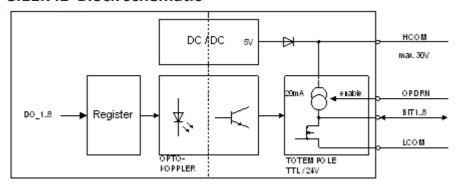
 \rightarrow resulting startup sequence: High-Z \rightarrow LOW, without intermediate HIGH state !! Without further steps the default initialization state while preparing measurement is: "LOW".

If a different state is desired, there are several options:

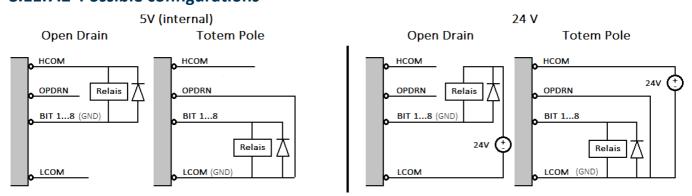
- Set the bit in imc Online FAMOS in the control command "OnInitAll".
- Set the bit before the "Prepare" action via imc STUDIO. E.g. via the Data Browser or also automated via the **command** "Set variable".

When "preparing" (reconfiguring) **imc Online FAMOS wins** and the value in the imc STUDIO variable is overwritten.

8.11.7.1 Block schematic



8.11.7.2 Possible configurations



With **Totem Pole**, a maximum of **22 mA load current** is possible, totally independently of any externally connected voltage.

Open Drain is able to set up to 700 mA current of each output. When using the internal $\bf 5 \ V$ power supply, note that the limit on current at each output is $\bf 20 \ mA$.

8.11.7.3 Notes on exerting control through imc Online FAMOS

The maximum output frequency depends on the DO-16 unit's switching time. At 165 μ s, the theoretical value is 6 kHz. If control is exerted from imc Online FAMOS, be aware that calls for output must be made sufficiently early. If long calculations are involved, for instance of FFTs or filters, the call will not be made in time.

A reliable output rate can only be achieved with the function "Synchronous Task" under imc Online FAMOS Professional, which halts the calculations with an interrupt.

If output is lined to a channel as the clock pulse provider, there is another effect which can be observed. For instance, a channel is sampled at 10 kHz and this is used along with the function Sawtooth for control purposes: DOut02_Bit01=greater(SawTooth(Channel_02, 0, 1, 2), 0.5)

With a RAM buffering period of 10 s, the resulting FIFO size is 100,000 values. The system divides the FIFOS into 64 k blocks. If 64 k aren't enough, two blocks are set up. In such a case, imc Online FAMOS receives two values upon every FIFO call; this means that the pulse rate is divided in half. To prevent this effect, the RAM buffer duration must be reduced to 2 s, for example.

8.11.8 DO-16-HC Digital high current outputs

16 isolated control signals provide an enhanced current bearing capacity. The signals' states can be generated by imc Online FAMOS as the result of calculation operations or influenced by your measurement device's trigger mechanism. This makes it possible to create control commands by extremely easy-to-use means.

Fields of application:

• 24 V industrial applications and automotive (8 V to 28 V)

Benchmarks:

- Max. 0.7 A High-Side AND Low-Side drive, I_limit typ. 1.4 A
- Ext. supply voltage required: 8 V to 28 V
- With open-drain mode (low side drive): no external supply required!
- Programmable for High-Side, Low-Side and Totem-Pole: Pin "OPDRN":

open: open drain (low side drive) like DO-16 LCOM: totem pole (complementary) like DO-16

LCOM over 10 k: open source (high side drive) not supported by DO-16

- Configuration 5 V TTL / CMOS:
- internal 5 V supply used; external supply not necessary!
- internal 5 V not sufficient for operating High Side driver (≥8 V required!)
- therefore: operation in open-drain mode with external pull-up (typ. 1 k .. 10 K, min. 250R)
- due to diode decoupling of LCOM_1-4 / 5-8:
 - → wire jumper LCOM = LCOM_1-4 = LCOM_5-8

2 x isolated 8-bit groups

- DSUB plug separate HCOM and LCOM pins for 4 bits each
- xCOM 1-4 and xCOM_5-8 each blocked by diodes in order to achieve current sharing
- additional LCOM pin only for mode programming

Protection against:

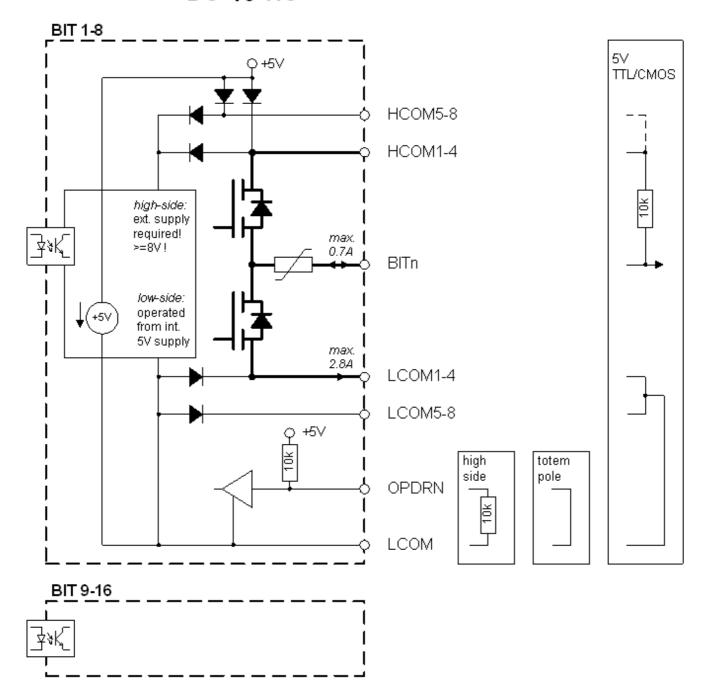
- Short circuit I_limit typ. 1.4 A, max. 2 A (@25°C)
- Surge current
- Load dump / inductive load switching
- Current / capacitive load switching (typ. 2 x I_nom)
- Reverse battery: protection against reverse voltage between output
- no protection against reverse connection of LCOM HCOM

Technical details of the DO-16-HC 424.

Pin configuration: ACC/DSUBM-DO-HC-8 476

8.11.8.1 Schematic diagram

DO-16-HC

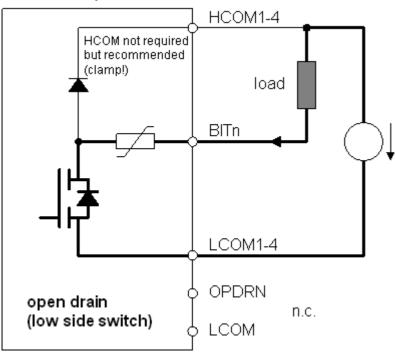


8.11.8.2 Configuration of driver mode

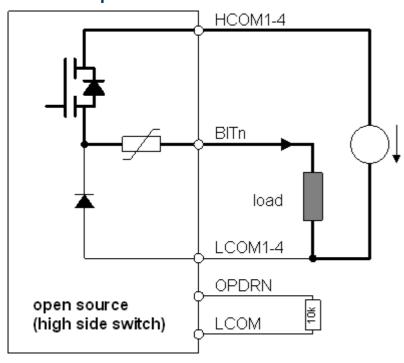
mode	active switch	OPDRN-Pin	driver supply	HCOM (supply)	required initial state for passive power-up	remarks
open drain	low side drive	float	internal	not required	1	
totem pole	complementary drive	LCOM	external	external (8 V to 28 V)	0	
open source	high side drive	LCOM via 10 k	external	external (8 V to 28 V)	0	

mode	active switch	OPDRN-Pin	driver supply	HCOM (supply)	required initial state for passive power-up	
TTL / CMOS	low side drive	float	internal	internal (5 V)	0	ext. Pullup required

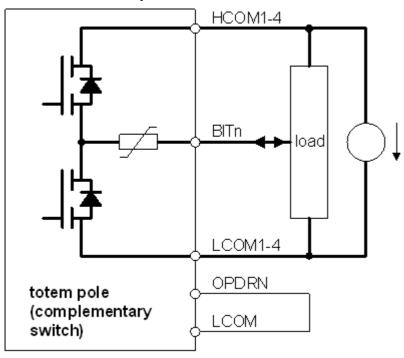
8.11.8.2.1 Open drain mode



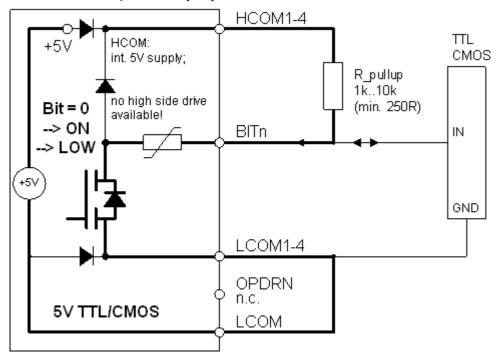
8.11.8.2.2 Open source mode



8.11.8.2.3 Totem pole mode



8.11.8.2.4 TTL / CMOS (5V) mode



8.11.9 DAC-8: Analog outputs

The analog outputs DAC 01 to 08 provide 8 analog output channels to be used as dynamic control and actuator signals. The outputs can be defined as the results of calculations performed by imc Online FAMOS on data from combinations of measurement channels.

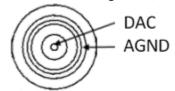
Highlights (DAC)

- ±10 V level at max. ±10 mA and 250 Ω driver capability
- ensured startup level 0 V without undefined transient states
- short-circuit protected against ground.

Technical details of the DAC-8: Analog outputs 415.

Pin configuration: Standard plug 474 (ACC/DSUBM-DAC4).

The **BNC variant**, e.g. CRFX/DAC-8-BNC or CRSL/DAC-8-BNC is configured as follows:



8.11.10 ENC-4 Incremental counter channels

The ENC-4 serves to measure signals representing time or frequency-based signals.

In contrast to the analog channels as well as to the digital inputs, the channels are not sampled at a selected, fixed rate, but instead time intervals between edges (transitions) of the digital signal are measured.

The counters used (set individually for each of the 4 channels) achieve time resolutions of up to 31 ns (32 MHz); which is far beyond the abilities of sampling procedures (under comparable conditions). The "sampling rate" which the user must set is actually the rate at which the system evaluates the results of the digital counter or the values of the quantities derived from the counters.

Find here the <u>description of the incremental counter channels</u> and the description of the <u>slope conditions</u> here 1231. Technical details of the ENC-4 here. 425



Notes

• The maximum number of incremental counter channels is set at 16 per device. It is not possible to integrate more than four ENC-4 into one system!

8.11.10.1 Sensor types, synchronization

Index signal denotes the synchronization signal SYNC which is globally available to all four channels in common. If its function Encoder w/o zero impulse is not activated, the following conditions apply: After the start of a measurement the counters remain inactive until the first positive slope arrives from SYNC. This arrangement is independent of the release-status of the Start-trigger condition.

If a sensor without an index track (Reset signal) is used, *Encoder w/o zero impulse* must be selected, otherwise the counters will remain in reset-state and will never be started because the enabling start-impulse will never occur!!

The index signal has to be connected to CON2 (channels IN3 and IN4)!

Incremental encoder sensors often have an index track (index signal, zero marker pulse) which emits a synchronization-signal once per revolution. The **index signal** is differential and set by the comparator settings of the **first** Incremental counter channel of the module. Its bandwidth is limited to 20 kHz by a permanently low-pass filter. The input is located on Pin 6 and 13. If the input remains open, an (inactive) HIGH-state will set in.

The measurement types Linear Motion, Angle, RPM and Velocity are especially well adapted for direct connection to incremental encoder sensors. These consist of a rotating disk with fine gradation in conjunction with optical scanning and possibly also with electric signal conditioning.

One differentiates between single-track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B (C and D). By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported.

The actual time or frequency information, however, is derived exclusively from the A(C) -track!

The measurement types Event, Frequency, and Time always are measured by single-track encoders, since in these cases no evaluation of direction or sign would make any sense. The sensor must simply be connected to the terminal for Track A (C).

Since many signal encoders require a supply voltage, +5 V are provided at the plug for this purpose (max. 300 mA). The reference potential for this voltage, in other words the supply-ground connection for the sensor, is CHASSIS.

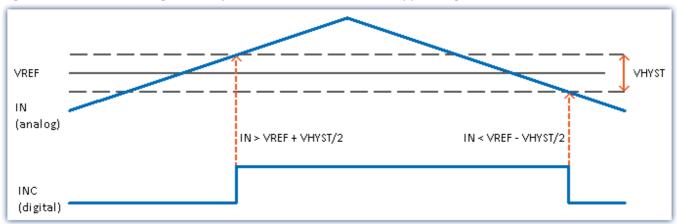
For the older module INK4, this +5 V supply voltage is not protected. It is the imc CRONOS-system supply itself and should be protected with an external fuse.

8.11.10.2 Comparator conditioning (threshold, hysteresis)

The incremental counter channels' special properties make special demands on the signal quality: The very high time-resolution of the detector or counter means that even extremely short impulses which sampling measurement procedures (as at the digital inputs) would miss are captured and evaluated. Therefore the digital signals must have clean edges in order not to result in distorted measurements. Missed pulses or bounces could otherwise lead to drop-outs in the time measurements, or enormous "peaks" in the rpm-measurements.

Simple sensors such as those based on induction or photosensitive relays often emit only unconditioned analog signals which must be evaluated in terms of a threshold value condition. Furthermore long cables, ground loops or interference, can make the processing of even conditioned encoder signals (such as TTL-levels) difficult. *imc CRONOS System family*, however, can counteract this using its special three-step conditioning unit.

To begin with, a high-impedance differential amplifier ($\pm 10 \text{ V}$ range, $\pm 100 \text{ k}\Omega$) enables reliable measurement from a sensor even along a long cable, as well as effective suppression of common mode interference and ground loops. A (configurable) filter (in preparation) at the next stage offers additional suppression of interference, adapted to the measurement set-up. Finally, a comparator with configurable threshold and hysteresis acts as a digital detector. The (configurable) hysteresis is an extra tool for suppressing noise:



If the analog signal exceeds the threshold VREF + VHYST/2. the digital signal changes its state (\leftarrow : 0 \Rightarrow 1) and at the same time reduces the threshold which must be crossed in order to change the state back to 0 by the amount VHYST (new threshold: VREF - VHYST/2). The magnitude of the hysteresis therefore represents the maximum level of noise and interference that would not cause a spurious transition.

The threshold VREF is set to 1.5 V, the hysteresis VHYST is 0.5 V. State transitions are therefore detected at the signal amplitudes:

In future device versions, the threshold and hysteresis will be globally adjustable for all four channels within the range:

Threshold (VREF) = $\pm 10 \text{ V}$	Hysteresis (VHYST) = 100 mV 4 V	Requirement: (VREF +VHYST/2) < 10 V
---------------------------------------	---------------------------------	--------------------------------------

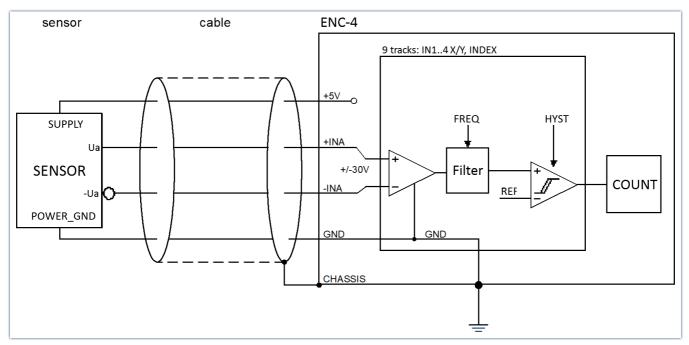
Corner frequencies of the (2-pole) low-pass filter will be jointly configurable for both of a channel's tracks to the values:

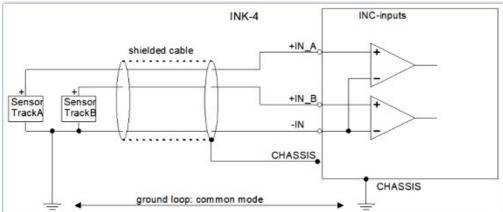
Low-pass filter: 200 Hz, 2 kHz, 20 kHz or without (500 kHz bandwidth)

Structure

Complete conditioning is provided for all 8 tracks of the 4 channels: for each channel, the two tracks (A and B or C and D) of a dual-track encoders can be connected, in which case the differential inputs of each pair of tracks share a common reference (neg. input).

Block schematic

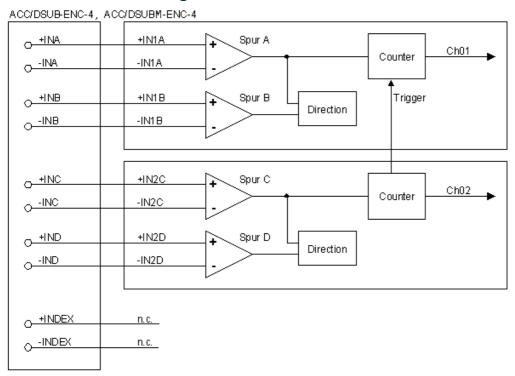


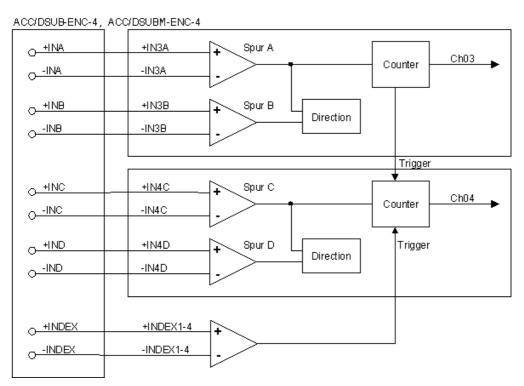


One differentiates between single-track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B. By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported. The actual time or frequency information, however, is derived exclusively from the A-track!

Like the other channels, the Index-channel is fully conditioned. If its function is activated, it can take effect on all four channels. The DSUB-15 terminal sockets are each occupied by 2 channels. In order to prevent accidental short-circuiting due to incorrect wiring, the index-channel occupies only the second DSUB-15 socket, together with Channels 3 and 4. The first socket, occupied by Channels 1 and 2, has no contact to the Index-channel at its corresponding pins! However, in the interest of uniformity, imc terminal plugs all are labeled ±INDEX!

8.11.10.3 Channel assignment





The condition for the input differential amplifier reaching the correct working point is that the sensor be ground referenced, meaning that is has low impedance towards ground (GND, CHASSIS, PE). This is not to be confused with the sensor's common mode potential, which may be as much as ±30 V (even for the –IN input!). This also applies if differential measurement is configured for the high-impedance differential input. If this galvanic contact to the system (CHASSIS) doesn't exist for an isolated sensor, such a connection must be created, for instance as a jumper between GND (device) and the sensor's POWER_GND!

The 5 V (max. 100 mA, 300 mA as option) supply voltage provided at the terminals "+5 V, GND" can be used to supply sensors. if a greater voltage or supply power is required, the sensor must be supplied externally, and you must make sure to provide a galvanic connection between this supply voltage and the system ground!

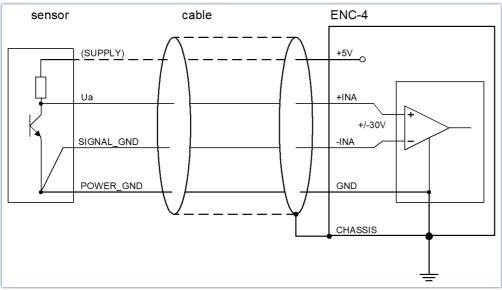
8.11.10.4 Connection

Each of the 4 incremental counter channels has an A and B-track (C and D) for connecting a dual-track encoders. If a single-track encoder is used, it must be connected to the A-track and the positive B-track must be shorted with the negative B-track. If the index-input is not used, the positive index channel must be shorted with the negative index-channel.

The pin configuration of the DSUB-15 plug 474.

8.11.10.4.1 Connection: Open-Collector Sensor

Simple rotary encoder sensors are often designed as an Open-Collector stage, which emit a Signal that moves between condition 0 V and SUPPLY. In this case the signal teshold should be adjusted to the half SUPPLY-voltage:

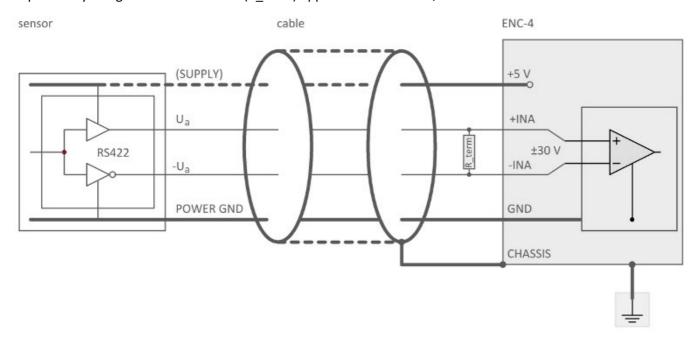


Sensor with Open-Collector output

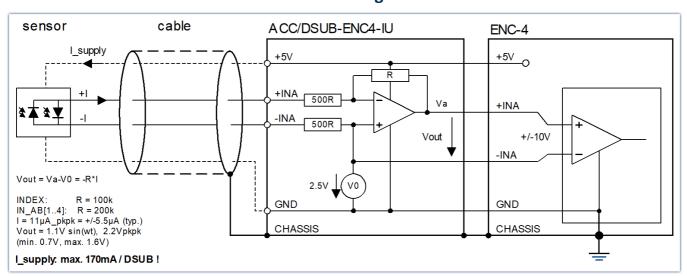
8.11.10.4.2 Connection: Sensors with RS422 differential line drivers

Commercially available rotary encoders are often equipped with differential line drivers, for instance as per the EIA-standard RS422. These deliver a complementary (inverse) TTL-level signal for each track. The sensor's data are evaluated differentially between the complementary outputs. The threshold to select is 0 V, since the differential evaluation results in a bipolar zero-symmetric signal: 3.8 to 5 V (HIGH) or –3.8 to -5 V (LOW). Ground loops as pure common mode interference are suppressed to the greatest possible extent.

The illustration below shows the circuiting. The reflection response and thus the signal quality can be further improved by using terminator resistor (R_term) approx. 90 Ω to 150 Ω , we recommend 126 Ω .



8.11.10.4.3 Connection: Sensors with current signals



For a rotational encoder working with current signals, the current/voltage terminal ACC/DSUB(M)-ENC-4-IU 474 can be used. It is possible to power the sensor from the ENC-4 module. The pertinent specifications are:

max. supply current: 320 mA / module

The resulting input voltage for the ENC-4 can not be measured at the terminals but directly at the pins of the DSUB plug.

8.11.11 FRQ2-4 Frequency modulated signals

This amplifier is especially designed for sensors that are able to convert electrical, physical dimensions in frequency. These sensors spent in a "state of rest" (input parameter = 0) a frequency not equal zero.

FRQ-4 FRQ2-4

Measurement mode: frequency (TTL-level) frequency (TTL-level)
Sampling rate: max. 50 kHz per channel max. 50 kHz per channel

Input range: 1 kHz, 2.5 kHz, 5 kHz, 10 kHz, 20 kHz

	1
measurement	center
range ±	frequency
3 kHz,	6 kHz,
5 kHz,	10 kHz,
12 kHz,	24 kHz,
30 kHz,	60 kHz,
50 kHz,	100 kHz,
120 kHz	240 kHz

Furhter specs: please see page 426

The center frequency will be provided by operating software after selection of the measurement range.

Corresponding to the noise in the input variable, the output frequency signal is also noisy. This can be reduced using the adjustable filter. This filter is not to be confused with the filter setting for an incremental counter input: there, the output variable is filtered to eliminate interfering signal pulses. By contrast, with the FRQ-4, the resulting physical quantity is filtered.

By taring, this rest state is defined as zero position (Setup page "Channel balance"). Frequencies below the defined rest state value are then interpreted as negative values of the physical variable.

8.11.11.1 Connection

Recommended plug

• for FRQ-4: ACC/DSUB(M)-ENC4 474 and

• for FRQ2-4: ACC/DSUBM-FRQ2 474.

8.11.12 HRENC-4: High Resolution Incremental Counter

The HRENC-4 module serves to measure signals whose time- or frequency information is to be captured. In contrast to the case with analog channels, to actual measurement does not consist of repeated sampling at a fixed time interval. Instead, digital counters are used to determine either the count of pulses occurring or the time intervals between defined signal slope events. For the time measurement/ maximum frequency, a resolution of approx. 3.9 ns (256 MHz) is achieved.

When using two-track sine/cosine signal encoders, conversion to digital values for determining the rotation direction and the absolute count of increments (full periods) is performed. Additionally, detailed information about the position can be gained by analog evaluation of the sine/ cosine signal, which results in yet further increased resolution.

Features:

- The HRENC-4 is both a digital comparator and serves the purpose of analog evaluation (sine / cosine signals).
- Fully conditioned (differential input and filter)
- 256 MHz measurement time resolution
- Feedback of revolution speed etc. to precise time measurement

For two-track sine signal generator

Besides including the technical equipment of an ENC-4 unit, the HRENC-4 also comes with analog analysis capability. Normally, incremental encoders emit simple square-wave signals, whose pulse sequence is evaluated according to certain criteria. In this case, it is adequate for the incremental counter's input amplifier to clearly detect the pulses on the basis of either a HIGH or LOW voltage level.

Two-track sine/cosine signal generators output the pulse sequence as a <u>continuous sine/cosine plot</u> [289]. Technical details HRENC-4 [429].

8.11.12.1 Sensor types, synchronization

Index signal denotes the synchronization signal SYNC which is globally available to all four channels in common. If its function Encoder w/o zero impulse is not activated, the following conditions apply: After the start of a measurement the counters remain inactive until the first positive slope arrives from SYNC. This arrangement is independent of the release-status of the Start-trigger condition.

The zero impulse is set back before each measurement.

If a sensor without an index track (Reset signal) is used, *Encoder w/o zero impulse* must be selected, otherwise the counters will remain in reset-state and will never be started because the enabling start-impulse will never occur!!

The index signal has to be connected to CON1 (channels IN1 and IN2)! (first plug, female)!

Incremental encoder sensors often have an index track (index signal, zero marker pulse) which emits a synchronization-signal once per revolution. The **index signal** is differential and set by the comparator settings of the **first** incremental counter channel of the module. Its bandwidth is limited to 20 kHz by a permanently low-pass filter. The input is located on pins 6 and 13. If the input remains open, an (inactive) HIGH-state will set in.

The measurement types Linear Motion, Angle, RPM and Velocity are especially well adapted for direct connection to incremental encoder sensors. These consist of a rotating disk with fine gradation in conjunction with optical scanning and possibly also with electric signal conditioning.

One differentiates between single-track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B (C and D). By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported.

The actual time or frequency information, however, is derived exclusively from the A(C) -track!

The measurement types Event, Frequency, and Time always are measured by single-track encoders, since in these cases no evaluation of direction or sign would make any sense. The sensor must simply be connected to the terminal for Track A (C).

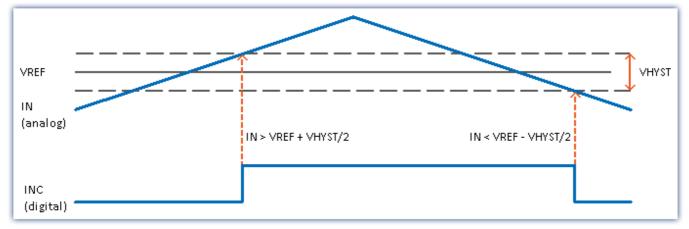
Since many signal encoders require a supply voltage, +5 V are provided at the plug for this purpose (max. 300 mA). The reference potential for this voltage, in other words the supply-ground connection for the sensor, is CHASSIS.

8.11.12.2 Comparator conditioning (threshold, hysteresis)

The incremental counter channels' **special properties make special demands** on the signal quality: The very high time-resolution of the detector or counter means that even extremely short impulses which sampling measurement procedures (as at the digital inputs) would miss are captured and evaluated. Therefore the digital signals must have clean edges in order not to result in distorted measurements. Missed pulses or bounces could otherwise lead to drop-outs in the time measurements, or enormous "peaks" in the rpm-measurements.

Simple sensors such as those based on induction or photosensitive relays often emit only unconditioned analog signals which must be evaluated in terms of a threshold value condition. Furthermore long cables, ground loops or interference, can make the processing of even conditioned encoder signals (such as TTL-levels) difficult. The imc CRONOS-measurement system, however, can counteract this using its special three-step conditioning unit.

To begin with, a high-impedance differential amplifier ($\pm 10 \text{ V}$ range, $100 \text{ k}\Omega$) enables reliable measurement from a sensor even along a long cable, as well as effective suppression of common mode interference and ground loops. A (configurable) filter (in preparation) at the next stage offers additional suppression of interference, adapted to the measurement set-up. Finally, a comparator with configurable threshold and hysteresis acts as a digital detector. The (configurable) hysteresis is an extra tool for suppressing noise:



If the analog signal exceeds the threshold VREF + VHYST/2. the digital signal changes its state (\leftarrow : 0 \Rightarrow 1) and at the same time reduces the threshold which must be crossed in order to change the state back to 0 by the amount VHYST (new threshold: VREF - VHYST/2). The magnitude of the hysteresis therefore represents the maximum level of noise and interference that would not cause a spurious transition.

The threshold VREF is set to 1.5 V, the hysteresis VHYST is 0.5 V. State transitions are therefore detected at the signal amplitudes:

1.75 V (\uparrow : 0 \Rightarrow 1) und 1.25 V (\downarrow : 0 \Rightarrow 1).

In future device versions, the threshold and hysteresis will be globally adjustable for all four channels within the range:

Input	Threshold	Hysteresis (VHYST) = 100 mV 10 V	Requirement:
(VREF) = ±10 V	(VREF) = ±10 V		(VREF +VHYST/2) < 10 V
Input	Threshold	Hysteresis	Requirement:
(VREF) = ±1.5 V	(VREF) = ±1.5 V	(VHYST) = 100 mV 1.5 V	(VREF +VHYST/2) < 10 V

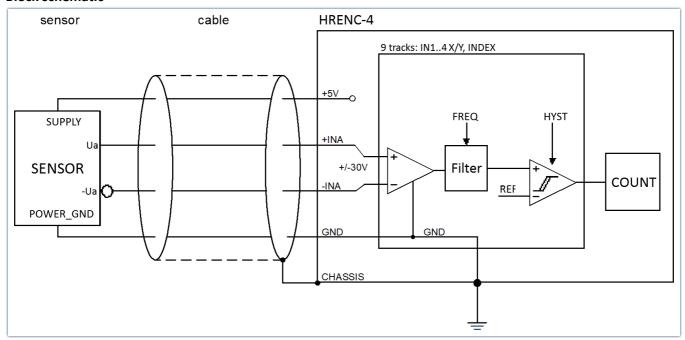
Corner frequencies of the (2-pole) low-pass filter will be jointly configurable for both of a channel's tracks to the values:

• Low-pass filter: 200 Hz, 2 kHz, 20 kHz or without (500 kHz bandwidth)

Structure

Complete conditioning is provided for all 8 tracks of the 4 channels: for each channel, the two tracks (A and B or C and D) of a **dual-track encoder** can be connected, in which case the differential inputs of each pair of tracks share a **common reference** (negative input).

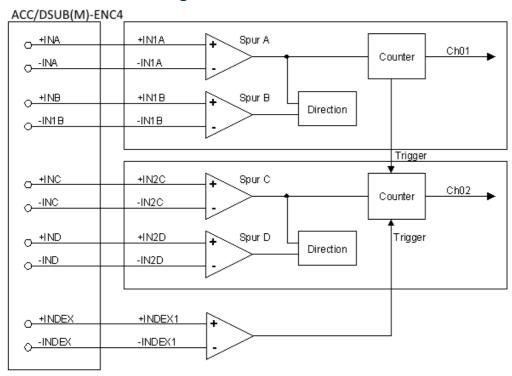
Block schematic



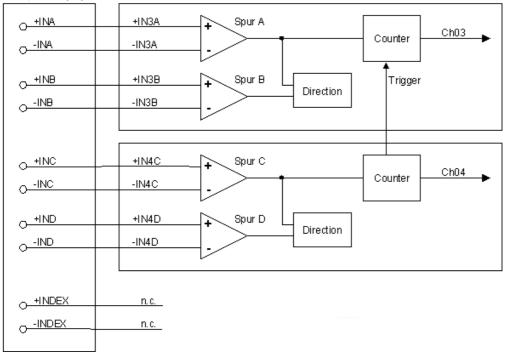
One differentiates between single track and dual-track encoders. Dual-track encoders (quadrature encoders) emit two signals offset by 90° of phase, the tracks A and B. By evaluating the phase information between the A and B-track, the direction of turning can be determined. If the corresponding encoder type is selected, this functionality is supported. The actual time or frequency information, however, is derived exclusively from the A-track!

Like the other channels, the Index-channel is fully conditioned. If its function is activated, it can take effect on all four channels. The DSUB-15 terminal sockets are each occupied by 2 channels. In order to prevent accidental short-circuiting due to incorrect wiring, the **index-channel** occupies **only the first DSUB-15 socket**, together with Channels 1 and 2. The second socket, occupied by Channels 3 and 4, has no contact to the Index-channel at its corresponding pins! However, in the interest of uniformity, imc terminal plugs all are labeled ±INDEX!

8.11.12.3 Channel assignment



ACC/DSUB(M)-ENC4



The condition for the input differential amplifier reaching the correct working point is that the sensor be ground referenced, meaning that is has low impedance towards ground (GND, CHASSIS, PE). This is not to be confused with the sensor's common mode potential, which may be as much as ±30 V (even for the –IN input!). This also applies if differential measurement is configured for the high-impedance differential input. If this galvanic contact to the system (CHASSIS) doesn't exist for an isolated sensor, such a connection must be created, for instance as a jumper between GND (device) and the sensor's POWER_GND!

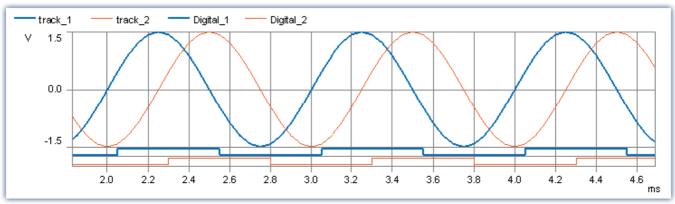
The 5 V (max. 300 mA) supply voltage provided at the terminals "+5 V, GND" can be used to supply sensors. if a greater voltage or supply power is required, the sensor must be supplied externally, and you must make sure to provide a galvanic connection between this supply voltage and the system ground!

8.11.12.4 Content of high resolution incremental counter measurement

Normally, incremental encoder emit simple square-wave signals, whose pulse sequence is evaluated according to certain criteria. In this case, it is adequate for the incremental counter's input amplifier to clearly detect the pulses on the basis of either a HIGH or LOW voltage level.

Two-track sine/cosine signal generators output the pulse sequence as a continuous sine/cosine plot. The HRENC is capable of converting the instantaneous sine/cosine tracks into the angle. This makes a substantially increased resolution possible, which depends on the input amplifier's resolution and on the saturation degree of the input range.

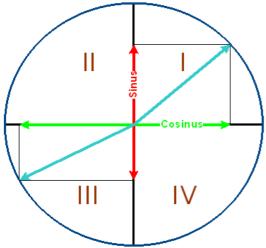
Additionally, the HRENC converts the analog signals to digital values, used for determining the direction of rotation and the discrete progress (complete periods).



Increased resolution by analysis of analog intermediate values

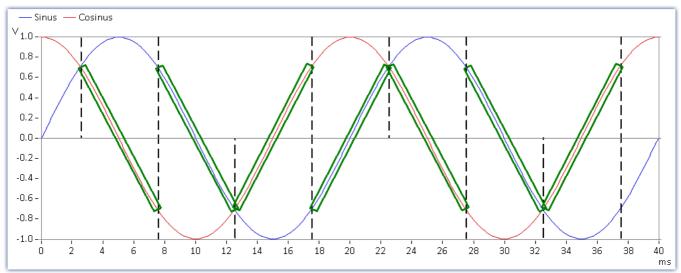
Increasing the resolution by analysis of analog intermediate values delivers better results and offers more possible applications than pulse multiplication by evaluation of all signal transitions. For this type of resolution improvement, incremental encoder sensors are used which generate two sinusoidal signals offset by 90°. Every sine wave's period is the result of the continually changing influence of the segmentation on the sensor's signal output during the rotational motion. These incremental encoder sensors are referred to as SinCos sensors. In explanation, consider an incremental rotation sensor whose angle increments consist of an evenly partitioned circular disc. Sampling both tracks yields the exact angular position of the rotating test object at every sampling point. In an orthogonal system featuring the sine and cosine functions, such as the SinCos sensor returns, every point on the circle can be represented.

The sin-/cos-shaped signals partition the respective angle increments into 4 quadrants (90°). Simultaneous capture of both signals enables certain determination of the respective quadrant.



Orthogonal system for determining position in a circle

For high resolution, the signal segments evaluated must be as linear as possible. For this reason, the regions of the SinCos sensor's signals marked in the figure below are sampled in order to increase the resolution, since those regions of the sinusoidal signal provide clear recognition of the direction, at high resolution. Thus, the resolution is increased by a factor of 256, and the precision by a factor of 10.



Signal segments used for evaluating analog intermediate values

Both signals are sampled at any given time. Just the information on the quadrant in which the signal currently resides provides much higher resolution for determining the position than the simple pulse counting performed by a single-track incremental encoder sensor. The tangent derived from the ratio of the sine and cosine values provides information independent on the amplitude. This is necessary in order to be able to use incremental sensors even with unknown amplitude and achieve high resolution, since the amplitude can change over time with attrition. Furthermore, there are many SinCos sensors whose signal plot depends on the frequency. With opto-electronic SinCos sensors, the signal suffers bandwidth limiting as the frequency increases, and a decreasing upper harmonic component causes its shape to change from triangular to sinusoidal. Asymmetry of the sensor signal due to tolerances in the manufacture of the sensors presents yet another problem. Both attrition and sensor production tolerances make calibration of the sensors necessary. For instance, the known winding-down pattern after shutoff of an axle having great mass inertia could be used to record a signal's exact course as it progresses through angles of rotation.

SinCos sensors have long been in use to improve resolution, but only for pulse multiplication purposes and not for evaluation of analog intermediate values. For this type of analysis, a weighted comparison of the two signals is performed. By means of appropriate weighting, pulses could be generated for every angle (q) given an ideal signal pattern. Furthermore, the reference position is independent of the signal amplitude.

8.11.12.5 Software settings

Besides the dialog elements familiar from ENC-4, the following settings options are available in the mode *Displacement*(diff) and *Angle*(diff):

8.11.12.5.1 Input

Selection of the input voltage range: 1.5 V and 10 V

To achieve higher resolution, the input range should be utilized to the greatest extent possible.

8.11.12.5.2 Signalshape

The default selection Rectangle (digital) corresponds to the conventional functioning of the ENC-4. Sine (analog) activates conversion of the discrete instantaneous values.



Note

In analog operation, too, an appropriate value must be set for the hysteresis. This is required for conversion to a digital signal. An appropriate setting of the switching level is also important, since this is considered the sine/cosine-signal's DC-component.

8.11.12.6 Functioning

A measurement of the sinusoidal (analog) counter signals is performed. These counter signals are, on the one hand, converted to binary signals (pulses) based on the threshold values set in the user interface (switching level with hysteresis), and on the other hand processed directly in order to achieve much higher counter resolution. For this purpose, the fact that the information content of an ideal sine/cosine-shaped incremental encoder signal theoretically has infinite resolution is exploited. The resolution of the analog counter signal is 12 bits, corresponding to a maximum possible pulse multiplication of 4096 (212).



Note

The 12-bit analog resolution applies to the (adjustable) analog input range. To achieve a counter signal resolution of 12 bits requires that the input range be fully utilized. Otherwise, the resolution of the Sin/Cossignal is reduced accordingly.



Example

Example 1

Using the software imcDevices, the input range is set as \pm 10 V. The counter returns signals with 5 V peak value: 5 V $\sin(\omega t)$, 5 V $\cos(\omega t)$

The input range is only half utilized, i.e. $\frac{1}{2}$ of the input range is lost (1/2^1). This means that the analog resolution is reduced by one bit to 11 bits (2-12 / 2-1 = 2-11).

If only \pm 2.5 V of the input range is utilized, i.e. $\frac{1}{2}$ of the input range ($\frac{1}{2}$), two bits have already been lost (analog resolution: 10 bits).

The sign is determined from the logical pattern of the counter signals converted to squarewave pulses, and the pulses are counted with the respective correct sign.

At the moment of sampling (according to the sampling interval set in the user interface), the exact location is determined based on the analog signals (position in the sine-/cosine signal). The exact progress is then determined as the summation of the signed pulses plus the difference between the exact positions of the sine curve at the current sampling point and the and at the previous sampling point.

The resolution of the measurement results is then 2^{15} in relation to the maximum amount of pulses possible within a sampling interval (periods of the sinusoidal counter signals). This is because the maximum amount of pulses possible within a sampling interval determines the input range, which has a resolution of 2^{15} subdivisions. Any modification is made in terms of powers of two, and at least one pulse per sampling interval is captured (1, 2, 4, 8, 16 ...)



Example

Example 2

max. pulses per sampling interval	Input range end value (pulses)
0.02	1
2.4	4
3.5	4
5	8
24.3	32

The actual input range and thus the actual resolution depend on how a pulse interpreted.



Example

Example 3

A two-track rotation counter to be used to measure an angle returns 3600 Sin/Cos-periods per revolution, i.e. per Sin/Cos-period 0.1° . No RPM-values above 3000 min-1 are expected. The sampling interval is set to 500 μ s From this, it follows that:

A maximum of 90 signal periods occur per sampling interval, because

3000 revs min-1/ 60 = 50 revs s-1

50 revs s-1 * 3600 signal periods / rev = 180000 signal periods / s

180000 signal periods / s * 0.5 ms = 90 signal periods within one sampling interval

The resulting input range end value (in signal periods) is then 128 signal periods (next power of two).

This resolution is 128 signal periods / $2^{15} = 0,004$ signal periods (2^8 signal periods). The pulse multiplication achieved is 256.

The physical interpretation of a signal period, i.e. as an angle is

1rev / 3600 signal periods or 360°/ 3600 signal periods = 0.1° / signal period

The resulting physical input range for this application with the sampling interval set is thus 12.8° (approx. 0.036 U), because:

128 signal periods * 0.1° / signal period = 12.8°

The resolution is 0.0004° (approx. 1 µU), because:

0,004 signal periods * 0,1° / signal periods = 0.0004°

By comparison, regular counting of the counter pulses would yield a resolution of only 0.1° and the use of an evaluation algorithm with pulse multiplication only a resolution of 0.025°.

By increasing the sampling rate, the resolution could be improved further, e.g. to $0,0002^{\circ}$ at 200 μ s (pulse multiplication of 512) or to 0.0001° at a 100 μ s sampling rate (pulse multiplication of 1024).

In addition to the ability to set the analog input range for capture of the Sin/Cos counter signal, it is also possible to configure input low-pass filters. The frequency specified then denotes the -3 dB-point, i.e. the frequency at which the level of the Sin/Cos counter is already attenuated by a factor of 0.71. Due to the filter properties, it is also possible that some of the analog resolution is lost.



Example

Example 4

Using the software imc STUDIO, the input rant is set to \pm 1.5 V and a 200 Hz low-pass filter is set. The counter returns signals with 1 V peak values. Signal frequencies of over 200 Hz can occur.

At 200 Hz the input level is attenuated to 0.707 V, i.e. the analog resolution is already reduced to about 11 bits. At even higher signal frequencies, the resolution drops further. If the attenuated input signal is already too low to ensure that the switching level (the specified hysteresis) is exceeded, no measurement is possible at all.

Note: Along with the signal levels, the signal phase shift also changes. This is not critical in many applications, however.

8.11.12.7 Connection

ENC-4 and HRENC-4 use the ACC/DSUB(M)-ENC4 474.

8.11.13 SYNTH-8: 8 channel signal generator, synthesizer and realtime PID controller

This expansion module provides 8 analog voltage outputs (DAC) to serve as programmable signal generator, synthesizer and for replay of arbitrary signal sequences. Such waveforms can either interactively defined or loaded as datasets for multiple segments.

Furthermore this module can act as programmable PID controller for realtime closed loop control applications. Its internal and exclusively dedicated processor can operate up to 16 independent and extensively configurable controllers. These operate independently and in parallel and can also be arbitrarily cascaded. Setpoints and inputs to the controllers can be selected from measurement channels, virtual channels and variables of the imc system. The controller outputs can be assigned to the 8 analog outputs in order to drive actuators.



Note

- Similar to the fieldbus interfaces, the SYNTH module is a configuration option: Devices can only be equipped ex-factory at time of order. Exchanging or retrofitting the module to existing systems in the field and by the user is not supported.
- The digital inputs and outputs are not implemented in the current software.



Reference

For details on operation, refer to the manual: "Synthesizer_Manual.pdf".

In the following sections you will find:

- Technical details of the SYNTH-8 434
- Pin configuration of the DSUB-15 474

9 Technical Specs

All devices described in this manual are intended at least for normal ambient conditions according to IEC 61010-1. In addition, the extended ambient conditions apply according to the explicitly stated technical data.

The data sheets in this chapter "Technical Specs" correspond to the separately managed data sheets. In addition to the tables, the separate data sheet contains module and device photos, drawings with dimensions, accessories and imc part numbers. This additional information would go beyond the scope of this manual. In individual cases it may happen that we publish a new data sheet before there is a new manual edition. The valid data sheets are always available on the imc website:

www.imc-tm.com/download-center/product-downloads

The specified technical data refer to the reference conditions, such as the specified preferred position of use (see respective technical data sheet) and an ambient temperature of 25 °C as well as compliance with the specifications for use (see <u>Precautions for operation</u> 15) and for grounding and shielding.

For device variants with BNC connection technology in particular (established for certain measurement tasks), gapless shielding is not initially guaranteed due to the design, as the negative pole of the measurement input is directly connected out as a coaxial outer conductor. Any interference coupled to the measuring lines thus has an asymmetrical effect on the measuring input. As a result, the accuracy specifications specified in the tables may be exceeded during the fault. Appropriate measures are taken to meet the EMC requirements for these devices as well. For the acceptance criterion A, a measuring accuracy of 2 % is assumed in the unshielded case for the reasons mentioned. If significant RF interference is to be expected in the measurement environment and if the limited accuracy is insufficient, the shielding measures shall be implemented in accordance with the above sections, i.e. the coaxial test lead shall be shielded.



Note

HV amplifiers

HV amplifiers are a special case in the shielding concept. For these, the above-mentioned limitation relating to unshielded measurement connections does not apply.

9.1 Hardware Feature

Hardware features and their dependencies of imc software versions:

• minimum low pass filter with imc CRONOSflex (CRFX)

In combination with the new software version the minimum low pass filter of the following amplifiers are improved:

CRFX Module	imc STUDIO 4.0	as of imc STUDIO 5.0 R1
CRFX/UNI-4 398	50 Hz to 20 kHz	10 Hz to 20 kHz
CRFX/UNI2-8 407	50 Hz to 20 kHz	10 Hz to 20 kHz
CRFX/LV3-8 386	50 Hz to 20 kHz	10 Hz to 20 kHz
CRFX/ICPU2-8 362	50 Hz to 20 kHz	10 Hz to 20 kHz
<u>CRFX/ISO2-8</u> 368	20 Hz to 5 kHz	2 Hz to 5 kHz
CRFX/DCB2-8 341	50 Hz to 5 k Hz	10 Hz to 5 kHz
<u>CRFX/B-8</u> 341	50 Hz to 20 kHz	10 Hz to 20 kHz

CRFX Module	imc STUDIO 5.0 R1	as of imc STUDIO 5.0 R3
CRFX/ISOF-8	50 Hz to 20 kHz	10 Hz to 20 kHz

Unless otherwise indicated, the technical specs given in the followings tables are valid.

Hardware Feature Chapter 9

• Characteristic curve linearization - user defined

Support of sensor characteristic curves is enabled for following devices:

Amplifier		Device				
	CRSL	CRC	CRFX	CRXT		
ISO2-8	• as of 2.7 R3	• as of 2.7 R3	• as of 2.8 R5	• as of 2.13 R1		
ISOF-8			• as of 2.9 R2	• as of 2.13 R1		
UNI-4	• as of 2.8 R7	• as of 2.7 R3	• as of 2.8 R5	• as of 2.13 R1		
SC2-32	• as of 2.7 R3	• as of 2.7 R3				
ICPU2-8	Ø	• as of 2.8 R7	• as of 2.8 R5	• as of 2.13 R1		
UNI2-8	Ø	• as of 2.8 R7	• as of 2.8 R5	• as of 2.13 R1		
DCB2-8	Ø	• as of 2.8 R7	• as of 2.8 R5	• as of 2.13 R1		
B-8	Ø	• as of 2.8 R7	• as of 2.8 R5	• as of 2.13 R1		
LV3-8	Ø	• as of 2.8 R7	• as of 2.8 R5	• as of 2.13 R1		

Device	Firmware
Cx-41xx-FD	• as of 2.9 R6
SPAR-N	• as of 2.8 R7

•:	Feature supported	imc
ø:	Feature currently not supported	imc
:	Amplifier not available for this device series	imc
		imc

imc STUDIO 4.0	included firmware 2.8 R3
imc STUDIO 5.0 R1	included firmware 2.8 R5
imc STUDIO 5.0 R3	included firmware 2.8 R7
imc STUDIO 5.0 R6	included firmware 2.9 R2
imc STUDIO 5.2 R10	included firmware 2.13 R1

Power consumption Chapter 9

9.2 Power consumption

Power consumption of imc CRONOSflex Modules

	Power supply / max. number of modules							
	direct click connection PoE				οE			
					CRFX/POWER			
	CRFX		()	()	ЪО	()	48V	50V
	×CF	Z	AC/DC	AC/DC	X	AC/DC	PoE, 4	PoE, 5
	<u> </u>	KFZ	AC	AC	S	AC	Po	Ьо
	V_DC	12,0 V	15,0 V	24,0 V	50,0 V	48,0 V	48,0 V	50,0 V
imc CRONOS <i>flex</i> Module P	P_max	37,20 W	46,50 W	74,40 W	100 W	148,80 W	16,80 W	17,50 W
CRFX/LV3-8 6,4 W		5,8	7,3	11,6	15,6	23,3	2,6	2,7
CRFX/LV3-8 + ICP-Plug 8,8 W		4,2	5,3	8,5	11,4	17,0	1,9	2,0
CRFX/LV3-8 + SUPPLY 12,4 W		3,0	3,8	6,0	8,1	12,0	1,4	1,4
CRFX/UNI2-8 10,1 W		3,7	4,6	7,4	10,0	14,8	1,7	1,7
CRFX/DCB2-8 / B8 10,0 W		3,7	4,7	7,4	10,0	14,9	1,7	1,8
CRFX/ISO2-8 7,0 W		5,3	6,6	10,6	14,2	21,2	2,4	2,5
CRFX/ISO2-8 + ICP-Plug 9,2 W		4,1	5,1	8,1	10,9	16,2	1,8	1,9
CRFX/ISO2-8 + SUPPLY 12,4 W		3,0	3,8	6,0	8,1	12,0	1,4	1,4
CRFX/ISOF-8 8,8 W		4,3	5,3	8,5	11,4	17,0	1,9	2,0
CRFX/ISOF-8 + ICP-Plug 10,9 W		3,4	4,3	6,8	9,2	13,7	1,5	1,6
CRFX/UNI-4 7,0 W		5,3	6,6	10,6	14,3	21,3	2,4	2,5
CRFX/UNI4 + SUPPLY (120R) 8,5 W		4,4	5,5	8,8	11,8	17,5	2,0	2,1
CRFX/UNI4 + SUPPLY (0,5W) 10,8 W		3,4	4,3	6,9	9,3	13,8	1,6	1,6
CRFX/HV-4U 5,8 W		6,4	8,0	12,8	17,2	25,5	2,9	3,0
CRFX/HV-2U2I 5,8 W		6,4	8,0	12,8	17,2	25,5	2,9	3,0
CRFX/HISO-8 7,3 W		5,1	6,4	10,2	13,7	20,4	2,3	2,4
CRFX/BR2-4 9,3 W		4,0	5,0	8,0	10,8	16,0	1,8	1,9
CRFX/ICPU2-8 7,4 W		5,0	6,3	10,1	13,6	20,2	2,3	2,4
CRFX/AUDIO2-4 7,4 W		5,1	6,3	10,1	13,6	20,2	2,3	2,4
CRFX/HRENC-4 7,4 W		5,0	6,3	10,1	13,5	20,1	2,3	2,4
CRFX/DI2-16 3,9 W		9,6	12,0	19,2	25,9	38,5	4,3	4,5
CRFX/DI2-16 + SUPPLY 4,7 W		7,9	9,9	15,8	21,3	31,7	3,6	3,7
CRFX/DI2-16-DO-16-HC 4,3 W		8,7	10,9	17,4	23,4	34,9	3,9	4,1
CRFX/DI2-16-DO-16-HC + SUPPLY + LOAD 7,8 W		4,8	6,0	9,6	12,9	19,2	2,2	2,3
CRFX/DI2-32 4,4 W		8,5	10,6	16,9	22,7	33,8	3,8	4,0
CRFX/DI2-32 + SUPPLY 6,1 W		6,1	7,7	12,3	16,5	24,5	2,8	2,9
CRFX/DI-16-HV 3,9 W		9,6	12,0	19,2	25,9	38,5	4,3	4,5
CRFX/DO-16-HC 3,7 W		10,0	12,5	19,9	26,8	39,9	4,5	4,7
CRFX/DO-16-HC + LOAD 6,4 W		5,8	7,3	11,6	15,6	23,3	2,6	2,7
CRFX/DO-16-HC-DAC-8 7,1 W		5,3	6,6	10,5	14,2	21,1	2,4	2,5
CRFX/DO-16-HC-DAC-8 + LOAD 11,7 W		3,2	4,0	6,3	8,5	12,7	1,4	1,5
CRFX/DO-32-HC 4,1 W		9,0	11,3	18,0	24,2	36,0	4,1	4,2
CRFX/DO-32-HC + LOAD 9,5 W		3,9	4,9	7,9	10,6	15,7	1,8	1,8
CRFX/DAC-8 6,7 W		5,6	7,0	11,2	15,0	22,3	2,5	2,6
CRFX/DAC-8 + LOAD 8,7 W		4,3	5,4	8,6	11,5	17,2	1,9	2,0
	Min	3	3	6	8	12	1	1
	Max	9	12	19	26	39	4	4



Note

- Due to the flexible combinations, the number of supported modules is defined with one position after decimal point.
- A maximum length of 85 cm of attached (clicked) modules should not be passed! Mounting elements can be used for more stability.
- The power consumption of an imc CRONOS-XT module is the same as that of the corresponding imc CRONOSflex module.

Power consumption Chapter 9

9.3 Basic systems technical specs

9.3.1 imc CRONOSflex Base Unit (CRFX)

"✓" standard; "O" optional; "-" not available

Parameter	CRFX-400	CRFX-2000G(P)	Remarks
Max. aggregate sampling rate	400 kS/s	2000 kS/s	data rate of analog channels ¹
Terminal connections			
PC / network	RJ45	RJ45	max. 100 m cable with 100 MBit (according to IEEE 802.3)
Ethernet TCP/IP	100 MBit	1 GBit	
System bus for flex-modules (EtherCAT)		045 odule connector	max. 100 m cable between 2 modules
Flash removable storage	CF-Card slot	CFast-Card slot	can also be read out via network
USB 2.0 (Host)	-	~	for alternative storage media instead of CFast: such as ext. HDD, USB stick etc.
Internal hard drive (HDD)	0	0	option, only ex factory: SSD or magnetic; 400 kS/s data storage achievable with 16 bit / sample
Internal WiFi (WLAN) adaptor (optional)	1 antenna IEEE 802.11g max. 54 MBit/s 2.4 GHz	2 antennas IEEE 802.11n max. 300 MBit/s dual band (2.4 / 5 GHz)	
Sync	В	NC	isolated (marked with yellow ring)
External display	DSI	JB-9	
External GPS module	DSU	JB-9	
Power supply	type LEMO.1B (2-pin)		compatible with LEMO.EGE.1B.302 multicoded 2 notches compatible with connectors FGG.1B.302 (standard) or FGE.1B.302 (E-coded, 48 V)
Remote control terminal	type LEM(D.1B (6-pin)	connector LEMO FGG.1B.306
Module connector	2 x 20-pin		direct connection of modules (click) supply and system bus

²⁰⁰⁰ kS/s achievable with deactivated process vector, without trigger and in 16 Bit mode only.
When using the process vector a maximum of 128 active analog channels (monitor channels do count as well) at 2 kS/s per channel plus one fieldbus interface are possible. Each additional fieldbus interface might reduce the aggregate sampling rate of analog channels by a maximum of 200 kS/s.

Power supply	CRFX-xxx	CRFX-xxx-I	Remarks	
DC supply input	-	✓	galvanically isolated of housing (CHASSIS)	
Isolated system-electronics	-	✓	USB, display and GPS	
Power supply	10 V to 50 V DC	20 V to 50 V DC		
Power-on threshold (typ.)	10.0 V	20.0 V	min. input voltage required for power-on (open circuit)	
Shutdown threshold (typ.)	9.2 V	18.1 V	input voltage at which the automatic deactivation is triggered (data backup protected by internal UPS buffering)	
Power consumption	CRFX-400: typ. 20 W CRFX-2000G(P): typ. 35 W		depending on model and equipment (e.g. fieldbus, HDD)	
AC/DC power adaptor	48 V DC, 150 W 110-230 V AC 50-60 Hz		included in delivery	
Pass through power		onnector and herCAT): PoEC	min. 42 V required for PoEC	
Pass through power limits				
Directly connected imc CRONOS <i>flex</i> modules via module connector	 3.1 A (max.), equivalent power with chosen DC power input: 149 W at 48 V DC (standard AC/DC power adaptor resp. DC/DC Power Handle) 37 W at 12 V DC (typ. DC input voltage) 			
Power-over EtherCAT (PoEC) for remote imc CRONOS <i>flex</i> modules	 350 mA (max., corresp. to IEEE 802.3), equivalent power with DC power input: 17.5 W at 50 V DC (e.g. DC/DC Power Handle) 16.8 W at 48 V DC (e.g. AC/DC power adaptor) 			

16.8 W at 48 V DC (e.g. AC/DC power adaptor)
14.7 W at 42 V DC (minimum voltage for PoEC)

Note: minimum system power of 42 V DC required for PoEC

UPS and Data integrity	Value	Remarks
Autarkic operation without PC	✓	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is available
Auto data-saving upon power outage	✓	buffering (UPS) with "auto-stop" auto-stop of measurement, data storage and automatic shutdown
UPS	integrated	Super-Caps, CRFX-xxx: delivery since Q2/2017 before: Lead gel batteries ² CRFX-xxx-I: Super-Caps at all times
Charging time of the Super-Caps	6 min.	minimum required active operation for full UPS functionality
UPS coverage	CRFX base unit	no buffering of directly connected CRFX modules (to be covered by separate UPS module CRFX/HANDLE-xx)
UPS delay	0 s	"buffer-time constant": required duration of a continuous outage that will trigger auto shutdown procedure

² see reference to lead batteries on device identification plate

Data acquisition, trigger	Value	Remarks
Channel individual sampling rates	selectable in 1–2–5 steps	
Number of sampling rates: analog channels, DI and counter	2	usable simultaneously in one configuration
Number of sampling rates: fieldbus channels	arbitrary	
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	for all channels of the types: analog, DI and counter (incremental counter) and CAN	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	~	e.g. logical combination of multiple channel events (threshold, transition) to create triggers that start and stop acquisition of assigned channels
Multi.triggered data acquisition	✓	multiple trigger-machines and multi-shot
Max. Trigger events per CRFX module	8	each CRFX module
Multi-triggered data acquisition	✓	Multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

Maximum ch	Maximum channel count per device								
Active channels within a systems		5	12	Active channe Total number monitor chann	of analog, c	_		rtual channels,	as well as
of which active analog channels		19	8 (1)	channels + mo (1): 128 with incl. output (onitor chanr nimc CRONO	iels) S <i>flex</i> (CRFX) ype DAC-8 ai	and imc CR nd DIO-Port	ation (sum of pi ONOS-XT (CRXT), ss of type DI / DO	ŕ
Fieldbus channels		10	000	Number of defined channels (active and passive); Currently activated channels are limited by the total number of activated channels (512).			of		
Process vector variables		8	00	_			_	measured valu	
			without n	nonitor channe	ls		with mo	nitor channels	
Channel type	determined by	limit (aktive+passive)		activated	total activated		nit -passive)	activated	total activated
Analog channels	system- expansion	Channel	240	198		Channel Monitor	240 240	198	
Incremental	system-	Channel	16	16		Channel	16	16	
counter	expansion	Channel	10	10		Monitor	16	16	
DIO/DAC-	system-	Port	16	16		Port	16	16	
Ports	expansion	Port	10	10	512	Monitor	16	16	512
Fieldbus	flexible	Channel	1000	512		Channel	1000	512	
channels	HEXIDIE	Chamilei	1000	312		Monitor	1000	312	
Virtual channels (OFA)	flexible	-	-	512		-	-	512	

Occupancy for ports (examples):

- one DO module (e.g. DO-16) occupies 1 port
- one DI8-DO8-ENC4-DAC4 module occupies 3 ports (1)
 - one DAC module (e.g. DAC-8 or DAC-4) occupies 1 port

Monitor-ports: DI-ports (respectively channels) have monitor-ports, DO/DAC-ports in contrary do not have monitor-ports

Storage, signal processing			
Parameter	Value	Remarks	
Removable flash storage	CF (CRFX-400) CFast, USB (CRFX-2000GP)	recommended media available at imc; the specified operating temperature range of the media is relevant	
Storage on NAS (network storage)	~	alternatively to onboard Flash storage SMBv2+3	
Arbitrary memory depth with pre- and post trigger	~	maximum pretrigger limited by size of Circular Buffer RAM; posttrigger only limited by available mass storage (Flash)	
Circular buffer mode	~	cyclic overwrite of circular buffer memory on mass storage media	
Synchronization	DCF 77 GPS IRIG-B NTP PTP	Master / Slave via external GPS-receiver TTL via network for CRFX-2000GP devices	
Extensive real-time analysis and control functions	imc Online FAMOS included in standard delivery	device-option, licensed via activation code	

Operating conditions	Operating conditions			
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (standard)	-10°C to +55°C	without condensation		
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		

9.3.2 imc CRONOS-XT Base Unit (CRXT)

Parameter	Value	Remarks
Max. aggregate sampling rate	2000 kS/s	data rate of analog channels ¹
Terminal connections		
PC / network Ethernet TCP/IP	RJ45 1 GBit	sealed
Flash removable storage	CFast-Card Slot	can also be read out via network
Internal WiFi (WLAN) adaptor (optional)	2 antennas IEEE 802.11n max. 300 MBit/s dual band (2.4 / 5 GHz)	for antennas or cables wit RP-SMA
Sync	XT-Con (4-pin)	
Sync NTP / PTP	RJ45	PTP requires appropriate switch
External display	XT-Con (7-pin)	
External GPS module	XT-Con (7-pin)	
Power supply	XT-Con (2-pin)	is not located on the base unit itself, but on the power module option, which must always be explicitly combined
Remote	XT-Con (6-pin)	remote control main switch

Power supply	Power supply			
Parameter	Value	Remarks		
DC supply input	galvanically isolated	of housing (CHASSIS)		
		remote control signals ("REMOTE") and forwarding the supply ("Power via CAN") on supply potential		
Isolated system-electronics	galvanically block isolated	of housing and power supply input; applies to accessible interface connections such as Display, GPS (except Remote)		
Power supply	10 V to 35 V DC			
Power-on threshold (typ.)	10.9 V	min. input voltage required for power-on (open circuit)		
Shutdown threshold (typ.)	9.9 V	input voltage at which the automatic deactivation is triggered (data backup protected by internal UPS buffering)		
Power consumption	typ. 23 W	depending on model and equipment e.g. with CAN FD-Interface		
Max. current via internal power supply bus	5.5 A	Determines the minimum required supply voltage respectively the maximum system expansion. An Excel assistant is available for estimating the limits and boundary conditions.		
AC/DC power adaptor	24 V DC, 150 W 110-230 V AC 50-60 Hz	connection: XT-Con (2-pin) included in delivery		

²⁰⁰⁰ kS/s applies to a configuration without any trigger and a 16-bit resolution.
Due to the modules' sampling rate of 5 kHz, sampling rates < 5 kHz may result in a lower effective total sampling rate.</p>
Please refer to the notes in the manual in the chapter Sampling rate under Properties.

[&]quot;✓" standard; "O" optional; "-" not available

Data integrity	Value	Remarks
Autarkic operation without PC	✓	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is available
Auto data-saving upon power outage	~	buffering (UPS) with "auto-stop", data storage and automatic shutdown
UPS	integrated	Super-Caps
Charging time of the Super-Caps	6 min.	minimum required active operation for full UPS functionality
UPS coverage	CRXT base unit	no buffering of directly connected CRXT modules
UPS delay	0 s	"buffer-time constant": required duration of a continuous outage that will trigger auto shutdown procedure

Maximum channel count per	Maximum channel count per device		
Active channels	512	including their monitor channels; active channels of the current configuration in total	
Active analog inputs	128	including their monitor channels including also channels of DAC-8 and ports of DI-16, DO-16	
Analog inputs (active + passive)	240 (+240 monitor channels)		
Fieldbus channels (active + passive)	1000	including their monitor channels	
Incremental counter channels	16 (+16 monitor channels)		
DIO-Ports (digital IO) and DAC-Ports (analog outputs)	16	example: DI-16 module is equal to one DIO-Port	
Process vector variables	800		

Data acquisition, trigger		
Channel individual sampling rates	selectable in 1-2-5 steps	
Number of sampling rates: analog channels, DI and counter	2	usable simultaneously in one configuration
Number of sampling rates: fieldbus channels	arbitrary	
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	for all channels of the types: analog, DI and counter (incremental encoder)	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	~	e.g. logical combination of multiple channel events (threshold, edge) to create triggers that start and stop acquisition of assigned channels
Max. Trigger events per CRXT module	8	each CRXT module

Data acquisition, trigger		
Multi-triggered data acquisition	✓	Multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

Storage, signal processing			
Parameter	Value	Remarks	
Removable flash storage	CFast	recommended media available at imc; the specified operating temperature range of the media is relevant	
Storage on NAS (network storage)	~	alternatively to onboard Flash storage SMBv2+3	
Arbitrary memory depth with pre- and post trigger	~	maximum pretrigger limited by size of Circular Buffer RAM; posttrigger only limited by available mass storage (Flash)	
Circular buffer mode	~	cyclic overwrite of circular buffer memory on mass storage media	
Synchronization	DCF 77	Master / Slave	
	GPS	via external GPS-receiver	
	IRIG-B	TTL	
	NTP	via network	
	PTP		
Extensive real-time analysis and	~		
control functions	imc Online FAMOS included in standard delivery	device-option, licensed via activation code	

Operating conditions			
Parameter	Value	Remarks	
Shock resistance	MIL-STD-810F IEC 60068-2-27, IEC 61373, Cat.1		
Vibration resistance	MIL-STD-810F Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure IEC 60068-2-64, IEC 61373, Cat.1		
Ingress Protection	IP67	The actual degree of protection depends on the connection technology (see CRXT module data sheets). The CRXT module with the lowest degree of protection determines the degree of protection of the entire system.	
Operating temperature	-40°C to 85°C condensation allowed		
Pollution degree	2		
Dimensions (W x H x D) XT3	91.5 x 130 x 186.5 mm	CRXT housing: XT3 incl. optional CAN FD interface	
Weight	2.1 kg	incl. optional CAN FD interface	

Power via CAN - CRXT/CAN-POWER-1

Parameter	Value	Remarks
Output voltage	10 V to 35 V DC	according to supply voltage; the base unit can supply further CANSAS modules via the optional CAN connections "CAN 1" and "CAN 2"
Output current	1 A (max.)	both CAN nodes together permanently
Short circuit protection (4)	unlimited duration	to reference ground of the output voltage; automatic restart
Isolation	isolated	opposite housing (system ground, CHASSIS)

4 Depending on the performance of the power supply of the measuring system, a short circuit can cause repercussions on the measuring system (e.g. short interruption of the supply of clicked CRXT amplifiers). After removing the short-circuit, the operability of the system is automatically restored.

9.3.2.1 CRXT/POWER-X

General technical specs			
Parameter	Value	Remarks	
Input supply voltage	7 V to 35 V DC	e.g. via AC/DC adaptor or vehicle power supply via XT-CON supply socket	
	30 V to 35 V DC	"PoEC" via M8 EtherCAT socket	
		no supply possible via M8 EtherCAT-OUT socket	
Switch-on threshold (typ.)	8.5 V DC	min. input voltage required to switch on with CRXT base unit clicked on	
Output voltage	34 V DC V _{in} - 0.3 V DC	internal device intermediate circuit (click connection and PoEC) 7 V to 31 V DC input 31 V DC to 35 V DC input	
Output power	70 W	Supply of the connected device and further slaves via PoEC (M8)	
		of which	
	50 W	Supply via PoEC (M8)	
Efficiency	>90 % (typ.)	10 V to 35 V DC input output power > 35 W	
Overload / short circuit protection: output	unlimited duration (reversible)	to reference ground of the output voltage; automatic restart	
Overload protection input	fuse 16 A		
Isolation	isolated from CHASSIS, no input-to-output isolation	to housing (CHASSIS). the connected and supplied CRXT modules, however, provide galvanic block isolation to the input supply circuit	
Power supply socket (input)	XT-Con (2-pin)		
Remote control socket	XT-Con (6-pin)	remote control signals ("REMOTE") are referred to power supply input potential	
EtherCAT-socket	2x M8 (4-pin)		
Power-over-EtherCAT (PoEC) Current limit	1.5 A	for imc CRONOS components in connection with imc CRONOS-XT (CRXT, M8)	
		no PoEC functionality supported in conjunction with imc CRONOSflex (CRFX, RJ45)	
Status-LED	POWER (Tri-Color) LIMIT (Tri-Color)	operating mode overload	

9.3.3 imc CRONOScompact (CRC)

Parameter	CRC-400	CRC-400GP	Remarks
Max. aggregate sampling rate	400 kS/s	400 kS/s	data rate of channels of the internal CRC modules
Max. aggregate sampling rate in		400 kS/s	via internal CRC modules
conjunction with CRFX-Interface (device type "CRC-2000G(P)")		2000 kS/s	data rate analog channels ¹ , total: internal CRC modules + external CRFX modules
Terminal connections			
PC / network	RJ45	RJ45	max. 100 m cable with 100 MBit (according to IEEE 802.3)
Ethernet TCP/IP	100 MBit	1 GBit	
Option CRFX-Interface:	-	0	device type: "CRC-2000GP",
system bus for external <i>flex</i> -modules (CRFX, EtherCAT)		RJ45	max. 100 m cable between 2 modules
Flash removable storage	CF-Card slot	CFast-Card slot	can also be read out via network
USB 2.0 (Host)	-	~	for alternative storage media instead of CFast: such as ext. HDD, USB stick etc.
Internal hard drive (HDD)	0	0	option, only ex factory: SSD or magnetic; 400 kS/s data storage achievable with 16 bit / sample
Internal WiFi (WLAN) adaptor (optional)	1 antenna IEEE 802.11g max. 54 MBit/s 2.4 GHz	2 antennas IEEE 802.11n max. 300 MBit/s dual band (2.4 / 5 GHz)	
Sync	В	NC	isolated (marked with yellow ring)
External display	DSU	JB-9	
External GPS module	DSU	JB-9	
Power supply	type LEMO.2B (2-pin)		compatible with LEMO.FGG.2B.302
Remote (remote controlled main power switch)	DSUB-15		
Programmable status indicator	6 LED	(green)	triggering via imc Online FAMOS
Measurement inputs		actual system uration	typically DSUB-15

²⁰⁰⁰ kS/s achievable with deactivated process vector, without trigger and in 16 Bit mode only.
When using the process vector a maximum of 128 active analog channels (monitor channels do count as well) at 2 kS/s per channel plus one fieldbus interface are possible. Each additional fieldbus interface might reduce the aggregate sampling rate of analog channels by a maximum of 200 kS/s.

Power supply	CRC-xxx	CRC-AC-RACK	Remarks
DC supply input	✓	✓	galvanically isolated of housing (CHASSIS)
AC/DC power adaptor	✓	-	included in delivery
	24 V DC, 150 W 110-230V AC 50-60 Hz		
AC power supply	-	✓	internal AC/DC power adaptor,
		85-250 V AC	standard AC mains inlet
		50-60 Hz	(Appliance coupler IEC-60320 C14)
UPS	✓	~	
Optional Li-Ion UPS	0	-	extended battery capacity
DC supply voltage	10 V to	32 V DC	
Power-on threshold (typ.)	10	.9 V	min. input voltage required for power-on (open circuit)
Shutdown threshold (typ.)	9.	8 V	input voltage at which internal UPS buffering is activated respectively the delayed automatic deactivation is triggered
Power consumption	<13	0 W	depending on model and equipment

UPS and Data integrity	Value	Remarks
Autarkic operation without PC	~	
Self start (Automatic data acquisition operation)	configurable	timer, absolute time, automatic start when power supply is available
Auto data-saving upon power outage	*	buffering (UPS) with "auto-stop": auto-stop of measurement, data storage and automatic shutdown
UPS	integrated	with automatic charge control
UPS coverage	complete system including plug-in modules (amplifier)	
Shutdown delay with power outage	30 s (default), configurable	"buffer-time constant": required duration of a continuous outage that will trigger auto shutdown procedure
Minimum charging time for 1 min. buffer duration	≤10 min.	typ., 23°C, for empty battery
Charging time ratio: charging- and discharging duration	buffer time * (total power / 12 W)	worst case example: total power consumption of system 100 W, buffer duration 1 min., resulting charging time ≤ 48 min. (charging ratio 48:1)
UPS batteries	Value	Remarks
Battery type	NiMH	
Effective buffer capacity	≥55 Wh	typ., 23°C, battery fully charged
Max. buffer duration	>30 min.	total buffer duration depending on device variant total power consumption ≤110 W
Charging time for complete battery recovery	36 h	device activated
UPS-takeover threshold (typ.)	9.8 V 11.1 V	takeover internal buffer battery switch back to external supply

Data acquisition, trigger	Value	Remarks
Channel individual sampling rates	selectable in 1–2–5 steps	
Number of sampling rates: analog channels, DI and counter	2	usable simultaneously in one configuration
Number of sampling rates: fieldbus channels	arbitrary	
Number of sampling rates: virtual channels	arbitrary	data rates generated via imc Online FAMOS (e.g. via reduction)
Monitor channels	for all channels of the types: analog, DI and counter (incremental counter) and CAN	doubled channels with independent sampling and trigger settings
Intelligent trigger functions	~	e.g. logical combination of multiple channel events (threshold, transition) to create triggers that start and stop acquisition of assigned channels
Multi.triggered data acquisition	✓	multiple trigger-machines and multi-shot
Independent trigger-machines	48	start/stop, arbitrary channel assignment

Maximum ch	Maximum channel count per device								
Active channe systems	els within a	5	Active channels of the of Total number of analog monitor channels, if an		of analog, d	rrent configuration: digital, fieldbus and virtual channels, as well as			
of which ac	tive analog	19	channels + monitor channel 198 ⁽¹⁾ (1): 128 with imc CRONOSfl		iels) S <i>flex</i> (CRFX) ype DAC-8 ai	e DAC-8 and DIO-Ports of type DI / DO,			
Fieldbus chan	nnels	10	Number of defined channel 1000 Currently activated channel activated channels (512).			·		of	
Process vecto	or variables	8	Single value variables, each containing the last measured values. A process vector variable is automatically created for each channel.						
			without n	nonitor channe	ls	with monitor channels			
Channel type	determined by		limit act		total activated	limit activated (aktive+passive)		activated	total activated
Analog	system-	Channel	240	198		Channel	240	198	
channels	expansion	Chamilei	240	150		Monitor	240	130	
Incremental	system-	 Channel	16	16		Channel	16	16	
counter	expansion	Cridinici		10		Monitor	16	16	
DIO/DAC-	system-	Port	16	16	540	Port	16	16	540
Ports	expansion				512	Monitor	16	16	512
Fieldbus channels	flexible	Channel	1000	512		Channel Monitor	1000	512	
Virtual channels (OFA)	flexible	-	-	512		-	-	512	

Occupancy for ports (examples):

(1)

- one DO module (e.g. DO-16) occupies 1 port
- one DI8-DO8-ENC4-DAC4 module occupies 3 ports
- one DAC module (e.g. DAC-8 or DAC-4) occupies 1 port

Monitor-ports: DI-ports (respectively channels) have monitor-ports, DO/DAC-ports in contrary do not have monitor-ports

Storage, signal processing			
Parameter	Value	Remarks	
Removable flash storage	CF (CRC-xxx) CFast, USB (CRC-xxxGP)	recommended media available at imc; the specified operating temperature range of the media is relevant	
Storage on NAS (network storage)	✓	alternatively to onboard Flash storage SMBv2+3	
Arbitrary memory depth with	✓	maximum pretrigger limited by size of	
pre- and post trigger		Circular Buffer RAM; posttrigger only	
		limited by available mass storage (Flash)	
Circular buffer mode	✓	cyclic overwrite of circular buffer memory	
		on mass storage media	
Synchronization	DCF 77	Master / Slave	
	GPS	via external GPS-receiver	
	IRIG-B	πL	
	NTP	via network	
	PTP	for CRC-xxxGP devices	
Extensive real-time analysis and	~		
control functions	imc Online FAMOS included in standard delivery	device-option, licensed via activation code	

Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to 50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (Standard)	-10°C to +55°C	without condensation		
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		

9.3.3.1 Specs of Li-Ion UPS-module

Charging time for complete battery recovery Capacity of each Li-ion battery Operating temperature range Operation (discharge)	Value 3 h 98 Wh ⁴	Remarks device must be switched on Nominal ratings at 21°C The available effective capacity depends on load and temperature. At temperatures below 0°C the
Capacity of each Li-ion battery Operating temperature range		Nominal ratings at 21°C The available effective capacity depends on load
Operating temperature range	98 Wh ⁴	The available effective capacity depends on load
' '		usable capacity is reduced to a fraction of nominal values at 21°C.
' '		Example (at approx. 40 W load):
' '		approx. 85% at -10°C approx. 55% at -20°C
Operation (discharge) -20		
	0°C to +69°C	operational temperature range of UPS buffering functionality
		To protect the batteries at temperatures above 60°C the UPS buffer time constant is reduced to 15 seconds, regardless of configured setting
-10	0°C to +50°C	specified temperature range as rated by Smart Battery manufacturer!
		Manufacturers of the individual Li-ion cells used in the Smart Battery, specify a discharging temperature range of -20°C to +60°C
+	75°C ± 5°C	battery disconnect: internal protection circuitry of the Smart Batteries prevent discharge
Charge 0	°C to +45°C	above +45°C a charge of the batteries is inhibited (green charge level indicator LED stops flashing)
Storage -20	0°C to +60°C	
Passive temperature fuse (tolera	+93°C	Once triggered, the passive temperature fuse
Relative Humidity	ince: +0°C, -5°C)	cannot be reset thus irreversibly rendering the battery useless!

<u>Note:</u> Due to the inevitable leakage and self-discharge of the Smart Batteries we recommend a regular recharging cycle at least every 3 months that a device has not been in use (device must be switched on for charging).

⁽⁴⁾ As of delivery date FEB-2019, before that 69 Wh

9.3.4 imc CRONOS-SL

General technical specs

"✓": standard-equipped; "O" optional; "-": not available

Normal position		
Housing	imc CRONOS-SL-2	imc CRONOS-SL-4
Housing type	portable housing	portable housing
IP-degree of protection (#1)	IP65	IP65
Dimension (WxHxD in mm) with handles, feet and interconnections	286 x 80 x 352 (#2)	286 x 116 x 352 (#2)
Weight (kg)	6.5	8
Free module slots (#3)	2	4
Modular expansion	√	✓
Max. number of channels (#4)	16	32

- (#1) when used with IP65 plugs respectively with protective cover for not used sockets the socket is IP65 certified even without protective cover (special fabrication)
- (#2) without base and handholds (D in mm 280)
- (#3) DI16-DO8-ENC4 needs no additional slot
- (#4) The maximum number of channels depends on the amplifier configuration; please contact us for detailed consultation.

Terminal connection	imc CRONOS-SL-2	imc CRONOS-SL-4	
PC connector: Ethernet TCP/IP	10/100 MBit, approvable cable length for 100 MBit Ethernet max. 100 m according IEEE 802		
CF-card slot	1		
Synchronization of multiple devices	BNC		
GPS connection	DSUB-9		
Hand-held terminal connection	DSUB-9		
Remote connection	DSUB-15		
Measurement signal terminals	appropriately equipped with signal conditioning, typically DSUB connectors		

Current supply	imc CRONOS-SL-2	imc CRONOS-SL-4
Power supply	10 V to 32 V DC	10 V to 32 V DC
LEMO plug	FGG.1B.302 CLAD62ZN	FGG.1B.302 CLAD62ZN
DC-input isolated	✓	✓
110 V / 230 V power adapter	√	✓
Battery buffering / UPS	√	✓
UPS buffer time/ power outage	30 s	30 s
Battery operation	typ. 15 min.	typ. 40 min.
Automatic charge control	✓	✓

Current supply	imc CRONOS-SL-2	imc CRONOS-SL-4	
Automatic measurement operation with autostart – no PC necessary	✓	✓	
Auto-data saving upon power outage	✓	✓	
Power consumption (with UPS battery fully charged)	depending on amplifier (typ. 50 W)	depending on amplifier (typ. 60 W)	

Operating conditions	imc CRONOS-SL-2	imc CRONOS-SL-4			
Operating temperature	-40°C to 85°C w	-40°C to 85°C with condensation			
Storage temperature	-40°C	to 85°C			
Shock resistance	MIL-STD-810F 60 g, 11 ms half sine	MIL-STD-810F 60 g, 6 ms half sine			
	IEC 60068-2-27, IEC 61373, Cat.2 300 m/s² (approx. 30 g), 18 ms half sine	IEC 60068-2-27, IEC 61373, Cat.2 300 m/s² (approx. 30 g), 18 ms half sine			
Vibration resistance	Rail Cargo Vib U.S. Highway Truck	MIL-STD-810F Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
	IEC 60068-2-64,	IEC 60068-2-64, IEC 61373, Cat.2			
Condensation protection		✓			

Factory configuration options	imc CRONOS-SL-2	imc CRONOS-SL-4
imc Online FAMOS	,	/
Display intern		-
Digital inputs)
Digital outputs)
Incremental inputs)
Analog-outputs	0	
Signal Synthesizer	0	
Fieldbus-Interface (e.g. CAN-Bus))
Analog measurement channels	mod	lular
	see list of imc CRONOS-SL modules for voltage, current, ICP, thermocouples, PT100, strain gauges, measurement bridges, incremental encoder, high voltage and current probes	
Sensor supply	Either provided by the signal conditioning module or available separately as a supply module	

Device properties and hardware options	all imc CRONOS-SL variants
Maximum aggregate sampling rate	400 kHz
Time bases	2
Per-channel sampling rates	✓
Sampling rate adjustable in 1-, 2-, 5 steps	✓
Monitor channels	✓
Multi-triggered (multi-shot) data acquisition	✓
Extensive intelligent trigger functions	✓
arithmetic mean, min, max, mean value,	✓
extensive real-time calculation and control functions	O (with imc Online FAMOS - Personal Analyzer)
External hand-held terminal for display of measured data and status messages	О
External GPS receiver	0
Wireless LAN	✓
Characteristic curve for temperature measurement	temperature table according IPTS-68

Data storage	imc CRONOS-SL-2	imc CRONOS-SL-4
internal hard drive (#5)	0	
Compact Flash-Card	✓	,
Software selectable storage to removable drive (option) and/or PC	✓	
Software selectable storage to internal hard drive (option) and/or PC	✓	
Any memory depth with pre- and post triggering	✓	
Circular buffer memory	✓	
Synchronous, multi-triggered records	✓	

^(#5) CF-card slot is omitted; extended temperature (ET) is omitted

"✓": standard-equipped; "O" optional; "-": not available

The integration of an internal hard drive (only ex-factory) will increase the power consumption.

⁴⁰⁰kSamples/s data storage on internal hard drive apply for 16 Bit per sample.

For more information please refer the data sheet of the storage media.

9.4 Synchronization and time base

Time base of individual device without external synchronization			
Parameter Value typ. min. / max. Remarks			Remarks
Accuracy RTC		±50 ppm 1 μs (1 ppm)	not calibrated (standard devices), at 25°C calibrated devices (upon request), at 25°C
Drift	±20 ppm	±50 ppm	-40°C to +85°C operating temperature
Ageing		±10 ppm	at 25°C; 10 years

Time base of individual device with external synchronization					
Parameter	GPS	DCF77	IRIG-B	NTP	PTP ⁽⁴⁾
Supported formats	NMEA / PPS ⁽¹⁾		B000, B001, B002, B003 ⁽²⁾	Version ≤4	Version 2
Precision		±1 μs			<1 µs under good conditions
Jitter (max.)		±8 μs			
Voltage level	TTL (PPS ⁽¹⁾) RS232 (NMEA)	5 V TTL Pegel			
Input impedance	1 kΩ (pull up)	20 kΩ (pull up)			
Input connection	DSUB-9 "GPS" not isolated	BNC "SYNC" (isolated) (test voltage 300 V, 1 min.)		RJ45	"LAN"
Cable shield connection		BNC: isolated Signal-GND (marked with a yellow ring)			

Synchronization of multiple devices via DCF (Master/Slave)				
,				
Parameter	Value typ.	min. / max.	Remarks	
Max. cable length		200 m	BNC cable type RG58 (propagation delay of cable needs to be considered)	
Max. number of devices		20	only slaves	
Common mode SYNC not-isolated	0 V		with non-isolated BNC connector: devices must have the same ground voltage level, otherwise signal integrity issues (signal artifacts and noise) may result. Available optional external isolation: see ISOSYNC	
SYNC isolated		max. 50 V	with isolated BNC connector: SYNC-signal is already internally isolated, for reliable operation even with different ground voltage level (ground loops)	
Voltage level	5 V			
DCF input/output	"SYNC" connection		BNC	

ISOSYNC (optional external device for an isolated decoupling of the SYNC signal)			
Isolation strength 1000 V 1 minute (test voltage)			
Delay	5 μs		@ 25°C
Temperature range		-35°C to +80°C	

¹⁾ PPS (Pulse per second): signal with an impulse >5 ms is required; max. current = 220 mA

⁽²⁾ Using BCD information only

⁽³⁾ Max. value, concerning the following condition: first-synchronization

⁽⁴⁾ Only available for devices with "-GP" suffix and in conjunction with imc STUDIO 5.0 R5 or higher. Please read the Software manual for detailed information of the PTP synchronization (chapter: "External clock: PTP").



Reference

Synchronization and time base

Please find in the software manual a detailed description of **PTP** synchronization in the chapter: "External Clocks: PTP".



Note

Concerning all devices with a serial number less than 140000: The DCF77 signal can only be processed if it is configured as "active low". For devices with a serial number higher than 140000 and using imc firmware 2.8R3 or higher: both settings of the external synchronization signal "active low" or "active high" can be processed.

9.5 Audio and Vibration

9.5.1 CRFX/AUDIO2-4(-MIC): IEPE/ICP, Voltage

Inputs, measurement modes, terminal connection			
Parameter	Value	Remarks	
Inputs	4		
Measurement modes	voltage measurement		
	current fed sensors	ICP™-, DELTATRON®-, PIEZOTRON®-Sensors	
Terminal connection	4x BNC 4x LEMO	one channel per socket microphone supply AUDIO2-4-MIC 322	

Sampling rate, Bandwidth, Filter, TEDS				
Parameter	Value	Remarks		
Sampling rate	≤100 kHz	per channel		
Bandwidth	0 Hz to 49 kHz	-3 dB		
	0 Hz to 46 kHz	-0.1 dB		
Filter (digital)				
cut-off frequency	50 Hz to 20 kHz			
characteristic		low pass or high pass filter: 8th order		
order		band pass: LP 4th and HP 4th order Bessel, Butterworth		
		Anti-aliasing filter: Cauer 8.order		
		with $f_{cutoff} = 0.4 f_{s}$		
Resolution		output format is selectable for		
		each channel individually:		
	16 Bit	a) 16 Bit Integer		
	24 Bit	b) 32 Bit Float (24 Bit Mantissa)		
TEDS - Transducer Electronic	conforming to IEEE 1451.4			
Data Sheet	Class 1 MMI			

General				
Parameter	Value typ.	min. / max.	Remarks	
Isolation		≤100 V	channel to case (chassis) and channel-to-channel ¹ , test voltage 500 V _{RMS} , 1 min.	
Overvoltage protection		±150 V ±50 V	continuous, differential input (BNC) range >±2.5 V and device switched off range ≤±2.5 V	
Input coupling	AC, DC, AC with current feed			
Input configuration	differential, isolated		galvanically isolated to System-GND (case, CHASSIS) and channels among each other	
Input impedance	1 MΩ >10 MΩ	±1 %	range >±2.5 V and device switched off range ≤±2.5 V	
Lower cut-off frequency	<0.2 Hz	±20 %	-3 dB; AC-coupling, voltage measurement	

 $^{^{\}mbox{\scriptsize 1}}$ no isolation with optional microphone supply (AUDIO2-4-MIC)

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Ranges	±100 V, ±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V to ±5 mV		
Gain error	0.002 %	≤0.05 %	of the measured value, at 25 °C
Gain drift	2 ppm/K·∆T _a	13 ppm/K·∆T _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature
Offset error	0.002 %	≤0.05 % ≤0.1 %	of the range, DC coupling range >±10 mV range ≤±10 mV
Offset drift	±85 μV/K·ΔT _a	±200 μV/K·ΔΤ _a	ranges >±2.5 V
	±2 μV/K·Δ T_a	±7 μV/K·ΔT _a	ranges ±2.5 V to ±500 mV
	±0.35 μV/K·Δ T_a	±0.9 μV/K·ΔΤ _a	range $\leq \pm 250 \text{ mV}$ $\Delta T_a = T_a - 25^{\circ}C $; with $T_a = \text{ambient temperature}$
Non-linearity	10 ppm	≤20 ppm	ата - п а
CMRR (common mode rejection ratio)	PP	223 pp	Isolation test voltage, 70 V _{RMS}
range: ±50 V to ±2.5 V	-100 dB		50 Hz
	-74 dB		1 kHz
range: ±2.5 V to ±5 mV	-146 dB		50 Hz
	-120 dB		1 kHz
Noise			DC-coupling; bandwidth:
	$1.8~\mu V_{RMS}$		0.1 Hz to 50 kHz
	$0.3~\mu V_{RMS}$		0.1 Hz to 1 kHz
	$0.1~\mu V_{RMS}$		0.1 Hz to 10 Hz
THD (Total Harmonic Distortion)	-100 dB		signal frequency ≤1 kHz
Signal-to noise ratio			(A-weighted), ≤100 ksps
			bandwidth 20 Hz to 20 kHz
	-105 dB		range ±100 V
	-106 dB		range ±1 V
	-97 dB		range ±100 mV
	-72 dB		range ±5 mV

Sensor supply			
Parameter	typ.	min. / max.	Remarks
Constant current	4.2 mA	±10 %	
Compliance voltage	25 V	>23 V	
Source impedance	280 kΩ	>100 kΩ	is parallel to input resistor

Power supply of the module			
Parameter Value		Remarks	
Input supply voltage	10 V to 50 V DC		
Power consumption	9 W 11 W	10 to 50 V DC AUDIO2-4 AUDIO2-4-MIC	
Isolation	60 V	nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	

Terminal connections of the module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked)	
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)
	Equivalent power with chosen DC power input:
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)
	37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC)	
for remote <i>flex</i> modules	350 mA (maximum current according to IEEE 802.3)
	Equivalent power with chosen DC power input:
	• 17.5 W @ 50 V DC (e.g. Power Handle)
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
	14.7 W @ 42 V DC (minimum voltage for PoEC)
	Note: minimum system power of 42 V DC required for PoEC

Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (standard)	-10°C to +55°C without condensation			
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		
Dimensions	62 x 118 x 186 mm	WxHxD		
Weight	ca. 0.9 kg (CRFX/AUDIO2-4), 1.2 kg (CRFX/AUDIO2-4-MIC)			

Microphone supply

CRFX/AUDIO2-4-MIC with a supply module for microphones			
Value typ.	min. / max.	Remarks	
±14 V	±3 %		
	≥3 mA	permanent short circuit proof	
±60 V	±3 %		
	≥3 mA	permanent short circuit proof	
+200 V	±0.2 %	permanent short circuit proof	
	<300 μΑ	Attention! Risk of electric shock	
	±14 V	±14 V ±3 % ≥3 mA ±60 V ±3 % ≥3 mA +200 V ±0.2 %	

Block isolation of the CRFX microphone supply			
Parameter	Value	Remarks	
Block isolation	60 V	entire microphone supply isolated from the housing (CHASSIS, PE)	
Isolation impedance	500 kΩ 1 nF		
Internal reference ground	-SUPPLY		
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing	

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Find here the description AUDIO2-4 125

9.5.2 CRFX/QI-4: charge and audio module

Inputs, measurement modes, terminal connections			
Parameter	Value	Remarks	
Inputs	4+4	2 per channel	
Measurement modes	voltage measurement		
	charge measurement		
	current fed sensors	(ICP™-, DELTATRON®-, PIEZOTRON®-Sensors)	
Terminal connection	8x BNC	4 for charge measurement (Q) and	
		4 for voltage measurement or IEPE (U),	
		optionally charge or voltge	

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	Value	Remarks	
Sampling rate	≤100 kHz	per channel	
Bandwidth	0 Hz to 49 kHz	-3 dB	
	0 Hz to 46 kHz	-0.1 dB	
Filter (digital)			
cut-off frequency characteristic order	50 Hz to 20 kHz	low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Bessel, Butterworth	
Resolution	16 Bit 24 Bit	output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)	
TEDS - Transducer Electronic Data Sheet	conforming to IEEE 1451.4 Class 1 MMI		

General			
Parameter	Value typ. min. / max.		Remarks
Isolation	≤100 V		channel to case (chassis) and channel-to-channel ² test voltage 500 V _{RMS} , 1 min.
Overvoltage protection	<±1 V		charge measurement voltage measurement
	±150 V ±50 V		range >±2.5 V and device switched off range ≤±2.5 V
Input coupling	AC, DC, AC with current feed		
Input configuration	differential, isolated		to system ground (protection ground) and channel-to-channel
Input impedance	1 MΩ >10 MΩ		range >±2.5 V and device switched off range ≤±2.5 V
Lower cut-off frequency	0.2 Hz	±20 %	-3 dB; AC-coupling voltage measurement

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Ranges	±100 V, ±50 V, :	±25 V, ±10 V,	
	±5 V, ±2.5 V, ±2	l V to ±5 mV	
Gain error	0.002 %	≤0.05 %	of reading
Gain drift	2 ppm/K· ΔT_a	13 ppm/K·∆T _a	$\Delta T_a = T_a - 25$ °C ; with $T_a = $ ambient temperature
			of the range, DC-coupling
Offset error	0.002 %	≤0.05 %	range >±10 mV
		≤0.1 %	range ≤±10 mV
Offset drift	±85 μV/K·Δ T_a	±200 μV/K·ΔT _a	ranges >±2.5 V
	±2 μV/K·Δ T_a	±7 μV/K·ΔT _a	ranges ±2.5 V to ±500 mV
	±0.35 μV/K·Δ T_a	±0,9 μV/K·ΔΤ _a	range ≤±250 mV
			$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature
Non-linearity	10 ppm	≤20 ppm	
THD (Total Harmonic Distortion)	-100 dB		signal frequency ≤1 kHz
Isolation voltage rejection			Isolation test voltage, 70 V _{RMS}
range: ±50 V to ±2.5 V	-100 dB		50 Hz
	-74 dB		1 kHz
range: ±2.5 V to ±5 mV	-146 dB		50 Hz
Tunge: 12.5 v to 15 mv	-120 dB		1 kHz
	-120 05		1 KHZ (A-weighted), ≤100 ksps
Signal-to noise ratio			bandwidth 20 Hz to 20 kHz
Signal-to hoise ratio	-105 dB		range ±100 V
	-106 dB		range ±1 V
	-97 dB		range ±100 mV
	-72 dB		range ±5 mV
			DC-coupling; bandwidth:
Noise	$1.8~\mu V_{RMS}$		0.1 Hz to 50 kHz
	$0.3~\mu V_{RMS}$		0.1 Hz to 1 kHz
	$0.1~\mu V_{RMS}$		0.1 Hz to 10 Hz

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Charge measurement QI-4 (standard)			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	1	;; ±50,000 pC; C; ±10 pC	
Overload resistance max. signal slope		±5,000,000 pC <±0.01 C/s	permanently
Gain error	0.04 % 0.1 %	0.2 % 0.5 %	of reading ranges 100 nC to 100 pC ranges 50 pC to 10 pC
Gain drift	0.01 ppm/K·ΔT _a		$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature
Offset error DC-coupling	0.02 %	0.05 % 0.2 pC	the higher value applies of range after reset process, without incurring overload ¹
Drift with DC-coupling	±0.005 pC/s	±0.05 pC/s	ΔT _a =25°C
Duration of the reset process	500 ms		
Bandwidth, higher cut-off frequency	48 kHz 30 kHz 10 kHz		Ck = Sensor- plus cable capacitance -3 dB ±0,1 dB; Ck <1 nF ±0,1 dB; Ck <10 nF
Bandwidth, lower cut-off frequency DC-coupling	quasi static		
AC-coupling, ranges: ±100 nC to ±25 nC ±10 nC to ±2500 pC ±1000 pC to ±10 pC	0.2 Hz 0.3 Hz 1.4 Hz		
Noise, ranges:	0.5.00		bandwidth: 0.1 Hz to 1 kHz
±100 nC to ±25 nC ±10 nC to ±2500 pC ±1000 pC bis ±10 pC	0.5 pC _{rms} 0.12 pC _{rms} 0.05 pC _{rms}		

Charge measurement QI-4-1UC			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	±1,000,000 pC; ±500,000 pC; ±250,000 pC; ±100 pC		

An overload of the measurement inputs is applied the moment the charge passes the measurement ranges before the reset process is initiated. If that happens the reset process has to be executed two times in a period of ca. 30 s.

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Sensor supply			
Parameter	Value typ.	min. / max.	Remarks
Constant current	4.2 mA	±10 %	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	is parallel to input resistor

Power supply of the module		
Input supply voltage	10 V to 50 V DC	
Power consumption	10 W	10 V to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module			
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked) imc CRONOS <i>flex</i> Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOSflex Modules	350 mA (maximum current corresponding IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

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Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature	-10°C to +55°C	without condensation		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B			
	MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		
Dimensions	62 x 118 x 186 mm	WxHxD		
Weight	1.2 kg			

Please find here the QI-4 description. 128

9.6 Strain Gauges and Bridges

9.6.1 ACI-8: Dynamic strain measurement

Inputs, Modes		
Parameter	Value	Remarks
Inputs	8	
Measurement Mode	voltage	AC voltage on current fed strain gauge
Suitable sensor type	strain gauge	single STRG-sensor, 2-wire connection
		dynamic strain measurement
Scaling	voltage [V]	primary scaling of measured data output (includes correction values for selected current feed)
Scaling for strain measurement	strain [μeps] = voltage / (I·R_STRG·k)	scaling factor to be entered in operating software imc STUDIO
		I: selected nominal value of supply current
		R_STRG: nominal strain gauge impedance
		k: k-factor of strain gauge sensor
Terminal connection	LEMO.ERN.1S.303.GLN	1 channel per plug
		reserviert 3
		recommended plug: FFA.1S.303.CLA
Connection of cable shield	rotary switch on front panel: 1. case (CHASSIS) 2. +IN 3IN 4. not connected (float)	default setting of the switch = 1 cable shield will be internally connected accordingly (only for special applications)

Sampling rate, Bandwidth, Filter			
Parameter	Value typ.	min. / max.	Remarks
Sampling rate	≤100 kHz		per channel max system throughput of all module channels: 800 kHz including monitor channels
Bandwidth		0.5 Hz to 48 kHz	-3 dB
Filter			
frequency	10 Hz to 20 kHz		
characteristic	Butterworth, Bessel		
order	8th order		low pass or high pass
	low- and high pass each 4th order		band pass
Anti-Aliasing Filter	Cauer 8th order		with $f_{cutoff} = 0.4 f_a$
Resolution			output format is selectable for each channel individually:
	16 Bit		a) 16 Bit Integer
	24	Bit	b) 32 Bit Float (24 Bit Mantissa)

General			
Parameter	Value typ. min. / max.		Remarks
Isolation (measurement inputs)	galvanically isolated		only switch position 1 or 4 channel-to-channel and against system ground (housing, CHASSIS)
nominal rating	60 V		peak or DC
test voltage	±100 V (10 sec.)		
isolation impedance	10 MΩ, <1 nF		to system ground, to drain off electrostatic charge
	20 MΩ, 680 pF		channel-to-channel
	10 MΩ, 850 pF		against system ground
Input coupling	AC		
Input configuration	differential, isolated		internally connected current source

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	±250 mV, ±100 m\	V, ±50 mV, ±25 mV,	
	±10 mV [*] , ±5 i	mV*, ±2,5 mV*	* deduced from ±25 mV input range
Gain error			of reading
		±0.1 % ±0.15 %	± 250 mV, ± 100 mV, ± 50 mV ± 25 mV, ± 10 mV*, ± 5 mV*, ± 2.5 mV* * gain error equivalent to ± 25 mV input range
Gain drift		50 ppm/K·ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a = $ ambient temperature
Isolation Mode Rejection Ratio	109 dB		50 Hz
Voltage noise		60 μVss	bandwidth: 50 kHz, ±250 mV range short-circuited input: without noise of current sources
Input capacity	330 pF		in parallel to internal impedance of the current source

Current supply			
Parameter	Value typ.	min. / max.	Remarks
Current feed	16 mA, 8 mA	A, 4 mA, 2 mA	
	0	mA	current source can be deactivated for diagnosis
Max. compliance voltage	10	0 V	across total load / source impedance: (Strain gauge + cable)
Current feed error		±2 %	Does NOT affect accuracy of measurement! Actual current values will be assessed with individual correction values. These are accounted for by the firmware with voltage measurement already
Residual current with deactivated current feed	110 μΑ		
Temperature drift		50 ppm/°C	
Noise	300 μVss	400 μVss	2 mA, 100 Ω load
Current source bandwidth	50 kHz		load: 1 kΩ
Source impedance	1 ΜΩ		

Power supply of the module			
Parameter	Value typ.	min. / max.	Remarks
Power supply	10 V to 50 V DC		
Power consumption	8 W	12 W	

Terminal connections of the module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked)	
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)
	Equivalent power with chosen DC power input:
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)
	37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC)	
for remote imc CRONOSflex	
Modules	350 mA (maximum current corresponding to IEEE 802.3)
	Equivalent power with chosen DC power input:
	• 17.5 W @ 50 V DC (e.g. Power-Handle)
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
	• 14.7 W @ 42 V DC (minimum voltage for PoEC)
	Note: minimum system power of 42 V DC required for PoEC

Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (standard)	-10°C to +55°C without condensation			
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		
Dimensions	82 x 118 x 186 mm	WxHxD		
Weight	1.15 kg			

Find here the description of the ACI-8.

9.6.2 BR2-4 Strain gauges, LVDT, Voltage, IEPE/ICP

Inputs, measurement modes, terminal connection			
Parameter	Value	Remarks	
Inputs	4		
Measurement modes	bridge sensor	ACC/DSUBM-B2	
DSUB-15	strain gauge	full-, half- and quarter bridge	
	LVDT	inductive transducers (CF)	
	voltage measurement	voltage or bridge mode globally	
		selected for all four channels	
	current measurement	with current plug: ACC/DSUBM-12	
	current-fed sensors IEPE/ICP	with IEPE/ICP extension plug (DSUB-15):	
		ACC/DSUBM-ICP2I-BNC-S/-F, isolated,	
		basic functionality (ICP-operation)	
Measurement modes	full, half- and quarter bridge		
LEMO	LVDT		
	voltage measurement		
Terminal connection			
DSUB-15	2x DSUB-15	2 channels per plug	
	or		
LEMO	4x LEMO.1B.307(308)	1 channel per plug	

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	Value	Remarks	
Sampling rate	20 kHz (max) (CRC, CRSL) ≤100 kHz (CRFX)	per channel	
Bandwidth	8.6 kHz (DC) 3.9 kHz (CF) (CRC, CRSL)	-3 dB -3 dB	
	14 kHz (DC) (CRFX)	-3 dB -3 dB	
Filter			
cut-off frequency characteristic order	2 Hz to 5 kHz (CRC, CRSL) 20 Hz to 10 kHz (CRFX)	Butterworth, Bessel low pass filter 8. order Anti-aliasing filter: Cauer 8. order with f _{cutoff} = 0.4 f _s	
Resolution CRC, CRSL CRFX	16 Bit 16 Bit 24 Bit	internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)	
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor)	
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed <u>overview of supported device</u> family 296	

General	Value typ.	min. / max	Remarks
Overvoltage protection		±50 V ±80 V	long term (differential- and SENSE-inputs) short-term
Input impedance	10 MΩ 1 MΩ		range ±5 mV to ±2 V range ±5 V to ±50 V and for deactivated device
Input current		40 nA	
Input capacitance	300 pF		
Auxiliary supply			for IEPE (ICP)-expansion plug
voltage	+5 V	±5 %	independent of integrated
available current	>0.26 A	>0.2 A	sensor supply, short circuit proof
internal resistance	1.0 Ω	<1.2 Ω	power per DSUB-plug

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V ±500 mV / ±250 mV / ±100 mV ±50 mV / ±25 mV / ±10 mV / ±5 mV		
Gain error	0.02 %	≤0.05 %	of reading (measurement value)
Gain drift	60 ppm / K	<100 ppm / K	
Offset drift	0.02 %	≤0.05 % ≤0.1 % ≤0.2 %	of measurement range range ≥±25 mV range = ±10 mV range = ±5 mV
Input offset-drift	0.05 μV / K	0.3 μV / K	DC voltage measurement
Non-linearity	<200	ppm	
Common mode voltage (max.)	±50 V ±2.8 V		ranges ±50 V to ±5 V ranges ±2 V to ±5 mV
Common mode rejection ratio (CMRR) range: ±5 mV to ±25 mV ±50 mV to ±100 mV ±250 mV to ±2 V ±5 V to ±50 V ±5 mV to ±2 V ±5 V to ±50 V all ranges SNR (signal to noise ratio)	>120 dB >110 dB 95 dB 95 dB >54 dB >90 dB >68 dB >50 dB >90 dB >88 dB >82 dB >75 dB >69 dB		DC f ≤ 50 Hz f = 5 kHz full-scale / rms-noise full bandwidth ranges ±100 mV to ±50 V range ±50 mV range ±25 mV range ±10 mV range ±5 mV
Input noise, voltage (RTI)	16 nV/√Hz _{rms} 16 μV _{pk-pk} 2 μV _{rms} 0.6 μV _{pk-pk}		DC-Mode (range ±5 mV) spectral noise density 1 kHz 0 Hz to 10 kHz 0 Hz to 10 kHz 0.1 Hz to 10 Hz

Current measurement with shunt plug			
Parameter	Value	Remarks	
Input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA ±400 μA / ±200 μA / ±100 μA		
Shunt impedance	50 Ω	shunt plug ACC/DSUBM-I2, not for LEMO version	

Bridge measurement				
Parameter	Value typ. min. / max.		Remarks	
Mode	DC, CF			
Sensors	LVDT, strain gauge: full-, half-, quarter bridge piezo-resistive bridge transducer potentiometer		directly connectable	
Measurement mode	full-, half-, q	uarter bridge		
Input ranges	±1 mV/V to ±400 mV/V ±2 mV/V to ±800 mV/V		for bridge voltage: 5 V 2.5 V 1 V	
Bridge supply DC CF (5 kHz)	1 V; 2.5 V;	V (symmetric) 5 V (peak)	set globally for 4-channel groups corresponding to ±0.5 V, ±1.25 V, ±2.5 V corresponding to RMS: 0.7 V; 1.8 V; 3.5 V	
Internal quarter-bridge completion	120 Ω, 350 Ω		selectable	
Min. bridge impedance	120 Ω , 10 mH full bridge 60 Ω , 5 mH half bridge		bridge supply = 1 V to 5 V, I _{load} ≤ 42 mA	
Bridge impedance (max.)	5	kΩ		
Gain error		05 %	of measurement value	
Offset after bridge balance		02 %	of the range	
Input offset-drift	0.01 μV/V / K	0.06 μV/V / Κ	DC full bridge (Bridge supply=5 V, 1 mV/V range) without ext. bridge offset	
Drift of bridge balance	50 ppm/K	<90 ppm/K	of compensated offset value	
Equivalent offset drift corresponding to balanced ext. bridge offset	0.05 μV/V/K 0.09 μV/V/K		full bridge (DC or CF), ext. bridge offset = 1 mV/V 1 mV/V input range	
Half-bridge drift (int. half-bridge)	0.05 μV/V/K	1 μV/V/K	DC or CF	
Bridge balancing range	≥measurement range not less than: ≥±5 mV/V ≥±10 mV/V ≥±25 mV/V		for bridge supply = 5 V for bridge supply = 2.5 V for bridge supply = 1 V	
Cable length (max.)			A = 0.14 mm ² , R = 130 mΩ/m, 65 Ω	

Bridge measurement			
Parameter	Value typ. min. / max.		Remarks
Cable-Compensation			
full bridge / half bridge	4-wire-to	echnique	any cable
	3-wire-to	echnique	for symmetric (similar) cables
	with shunt	-calibration	one-time non-adaptive compensation
quarter bridge	full compensation	in 3-wire-technique	including Gain-Correction!
Automatic shunt-calibration	0.5 (mV/V	for 120 Ω and 350 Ω bridges
Input noise (bridge)			range: 1 μV/V (bridge voltage = 5 V)
DC full bridge	3 μV/V _{pkpk} ,	$0.39~\mu V/V_{rms}$	0 Hz to 10 kHz
	0.9 μV/V _{pkpk} ,	$0.12~\mu V/V_{rms}$	1 kHz, lowpass filter
	0.3 μV/V _{pkpk} ,	$0.04~\mu V/V_{rms}$	100 Hz, lowpass filter
	0.1 μV/V _{pkpk}		10 Hz, lowpass filter
DC half-/quarter bridge	3.3 μV/V _{pkpk} ,	$0.45~\mu V/V_{rms}$	0 Hz to 10 kHz
	1.1 μV/V _{pkpk} ,	$0.15~\mu\text{V/V}_{\text{rms}}$	1 kHz, lowpass filter
	0.35 μV/V _{pkpl}	$_{v}$, 0.05 μ V/V $_{rms}$	100 Hz, lowpass filter
	0.3 μ	V/V _{pkpk}	10 Hz, lowpass filter
CF full bridge, half bridge	3.5 μV/V _{pkpk} ,	0.47 μV/V _{rms}	0 Hz to 10 kHz
	1.7 μV/V _{pkpk} ,	$0.22~\mu\text{V/V}_{\text{rms}}$	1 kHz, lowpass filter
	0.6 μV/V _{pkpk} ,	$0.07~\mu\text{V/V}_{\text{rms}}$	100 Hz, lowpass filter
	0.3 μ\	V/V _{pkpk}	10 Hz, lowpass filter

The following technical statements only apply for this CRONOSflex module!

Block isolation			
Parameter	Value	Remarks	
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)	
Isolation impedance	500 kΩ 1 nF		
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground	
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing	

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of the imc CRONOSflex module				
Parameter	Value typ.	min. / max.	Remarks	
Power supply	10 V to 50 V DC			
Power consumption	9.3 W		10 V to 50 V DC including bridge sensors (120 Ω 5 V all channels)	
Isolation	60 V		nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC		supply via EtherCAT network cable	

Terminal connections of the imc CRONOS flex module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked)	
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)
	Equivalent power with chosen DC power input:
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)
	37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC)	
for remote imc CRONOSflex	350 mA (maximum current corresponding IEEE 802.3)
Modules	Equivalent power with chosen DC power input:
	• 17.5 W @ 50 V DC (e.g. Power Handle)
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
	14.7 W @ 42 V DC (minimum voltage for PoEC)
	Note: minimum system power of 42 V DC required for PoEC

Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (standard)	-10°C to +55°C	without condensation		
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		
Dimensions	43.3 x 118 x 186 mm	WxHxD		
Weight	ca. 820 g			

Find here the description of the BR2-4: Strain gauges, LVDT, Voltage, IEPE/ICP 146.

9.6.3 LVDT-8: LVDT Bridge mode, Voltage

Inputs, Measurement modes			
Parameter Value		Remarks	
Inputs	8		
Measurement modes	LVDT bridge mode voltage measurement	Carrier Frequency mode (CF) 5 kHz	
Terminal connection LVDT-8	4x DSUB-15	2 channels per plug, recommended plug: ACC/DSUBM-B2	
LVDTC-8	2x DSUB-26-HD	4 channels per plug, recommended plug: ACC/DSUBM-HD-B4	

Sampling rate, Bandwidth, Filter			
Parameter	Value	Remarks	
Sampling rate	max. 100 kHz	per channel	
Bandwidth	0 Hz to 50 Hz	allowable bandwidth of mechanical signal	
Filter (digital) Frequency Characteristic Order	1 Hz to 20 Hz	Butterworth, Bessel low pass 6 th order	
Resolution	16 Bit	internal processing 24 Bit	

General			
Parameter	Value typ. min. / max.		Remarks
Isolation (nominal rating)	±60 V (nominal)		galvanically block isolated to System-GND (case, CHASSIS) no channel-to-channel isolation
Max. common mode voltage	±!	5 V	channel-to-channel
Overvoltage protection	ESD 2 kV transient protection		
Input current			voltage mode, static
operating conditions	0.2 nA 25 nA		
on overvoltage condition	1 mA		
power off	≤5 mA		
Non-linearity	<30 ppm		±2 V range, voltage mode
Auxiliary supply	+5 V (max. 160 mA / plug) non isolated		only with DSUB-15 variant

LVDT measurement				
Parameter	Value typ. min. / max.		Remarks	
Mode	(CF	carrier frequency (5 kHz)	
Bridge configuration	full b	oridge	LVDT transformer type transducers ("Schaevitz", transformator principle)	
	half I	bridge	inductive half bridge transducers	
Input ranges		nV/V, ±200 mV/V, mV/V, ±20 mV/V	bridge supply = 2.5 V	
	1	mV/V, ±500 mV/V, 00 mV/V, ±50 mV/V	bridge supply = 1 V	
Bridge excitation voltage (VB)	2.5 \	/, 1 V	peak, sine wave, individually selectable per channel	
	max.	28 mA	short circuit proof	
Minimum transducer	50 Ω,	10 mH	bridge supply = 1 V	
impedance	120 Ω,	10 mH	bridge supply = 2.5 V	
Cable compensation	dual wi	re sense	adaptive compensation	
Offset compensation range		≥±100% of range	of selected range	
		9%	±2000 mV/V (bridge supply = 1 V)	
		9%	±800 mV/V (bridge supply = 2.5 V)	
Input impedance	6.7 ΜΩ	±1%		
Gain error	<0.025%	<0.05%	of the measured value	
Gain drift		15 ppm/K·ΔT _a	$\Delta T_a = T_a - 25 \text{ °C} $; with $T_a = \text{ambient temperature}$	
Offset error	<0.02%	<0.05%	of input range after automatic bridge balancing	
Offset drift		1 μV/V /K·ΔT _a	full bridge, no ext. bridge offset	
			$\Delta T_a = T_a - 25 \text{ °C} $; with $T_a = \text{ambient temperature}$	
Half-bridge drift	0.5 μV/V /°C	1 μV/V /°C	internal half bridge completion	
Max. lead wire resistance	<6	0 Ω	single cable	
	<46	50 m	with cable: 0.14 mm^2 , $130 \text{ m}\Omega/\text{m}$, AWG26	
Input noise	5 μV/V _{rms}		bridge mode (bridge supply = 1 V) bandwidth 0.1 Hz to 50 Hz	

Voltage measurement				
Parameter	Value typ. min. / max.		Remarks	
Input ranges	±5 V, ±2 V, ±	1 V, ±500 mV		
Input coupling	Γ	OC .		
Input configuration	diffe	rential		
Input impedance (differential)	6.7	ΜΩ	ranges ≤±2 V	
	1	ΜΩ	range ±5 V	
Gain error	<0.025%	<0.05%	of reading, 25°C	
Gain drift		15 ppm/K·∆T _a	ranges ≤±2 V	
		50 ppm/K·ΔT _a	range ±5 V	
			$\Delta T_a = T_a - 25 \text{ °C} $; with $T_a = \text{ambient temperature}$	
Offset error	<0.02%	<0.05%	of range	
Offset drift		0.6 μV/K·ΔT _a	ranges ≤±2 V	
		30 μV/K·ΔT _a	range ±5 V	
			$\Delta T_a = T_a - 25 ^{\circ}C $; with $T_a =$ ambient temperature	
CMRR	>95 dB (50 Hz)		$R_{\text{source}} = 0 \Omega$	
Input noise			bandwidth 0.1 to 50 Hz	
	<2.6 μV _{rms}			
	<15 μV _{pkpk}			

9.6.4 DCB(C)2-8, B(C)-8 Strain gauges, Voltage, IEPE/ICP

Parameter	Value	Remarks
Inputs	8	
Measurement modes	voltage measurement	
DSUB-15	current measurement	shunt-plug ACC/DSUBM-I2(-IP65) or single end (internal shunt)
	bridge sensor strain gauges current-fed sensors (IEPE/ICP)	full, half, quarter bridge with DSUB-15 extension plug: e.g.
Measurement modes	voltago moasuroment	ACC/DSUBM-ICP2I-BNC-S/-F, isolated
DSUB-26-HD	voltage measurement current measurement	ACC/DSUBM-HD-I4 shunt-plug or Single-ended (internal shunt)
	bridge sensor strain gauges	full, half, quarter bridge
Measurement modes LEMO	voltage measurement bridge sensor strain gauges current measurement	full, half, quarter bridge Single-ended (internal shunt)
Terminal connection DSUB-15 DSUB-26-HD LEMO	4x DSUB-15 2x DSUB-26-HD 8x LEMO.1B.307	2 channels per plug 4 channels per plug 1 channel per plug
Sampling rate, Bandwidth, Fi	Iter, TEDS	
Parameter	Value	Remarks
Sampling rate	≤100 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels
Bandwidth	0 Hz to 5 kHz (DCB2-8) 0 Hz to 48 kHz (B-8)	-3 dB -3 dB
Filter (digital) cut-off frequency characteristic order	1 Hz to 2 kHz (DCB2-8 in CRC, CRSL) 10 Hz to 5 kHz (DCB2-8 in CRFX) 10 Hz to 20 kHz (B-8)	Butterworth, Bessel (digital) low pass or high pass filter 8th order band pass, LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with f _{cutoff} = 0.4 f _s
Resolution CRC, CRSL CRFX, CRXT	16 Bit 16 Bit 24 Bit	internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS only with DSUB-15	conforming IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor) see notes in chap. TEDS 82
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed <u>overview of supported device</u> <u>family [296]</u>

General				
Parameter	Value typ.	min. / max.	Remarks	
Overvoltage protection		±40 V	permanent	
Input coupling	Г	OC .		
Input configuration	differential			
Input impedance	20 MΩ ±1%			
Auxiliary supply			only with DSUB-15 variant for IEPE/ICP expansion plug	
voltage	+5 V	±5%	independent of integrated	
available current	0.26 A	0.2 A	sensor supply, short-circuit protected	
internal resistance	1.0 Ω	<1.2 Ω	power per DSUB-plug	

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Input range	±10 V, ±5 V, ±2.5	5 V, ±1 V ±5 mV		
Gain error	0.02%	0.05%	of the measured value, at 25°C	
Gain drift	(10 ppm/K)·∆T _a	(30 ppm/K)·ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a = $ ambient temperature	
Offset error	0.02%	≤0.05% ≤0.06% ≤0.15%	of the input range at 25°C range >±50 mV range ≤±50 mV range ≤±10 mV	
Offset drift	(±0.7 μV/K)·ΔT _a (±0.1 μV/K)·ΔT _a	(±6 μV/K)·ΔΤ _a (±1.1 μV/K)·ΔΤ _a	range $\pm 10 \text{ V}$ to $\pm 0.25 \text{ V}$ range $\leq \pm 0.1 \text{ V}$ $\Delta T_a = T_a - 25^{\circ}\text{C} $; with $T_a = \text{ambient temperature}$	
Nonlinearity	10 ppm	50 ppm		
CMRR (common mode rejection ratio)	110 dB 138 dB	>90 dB >132 dB	DC and f≤60 Hz range ±10 V to ±50 mV range ±25 mV to ±5 mV	
Noise (RTI)	0.6 μV _{RMS} 0.14 μV _{RMS}	1.0 μV _{RMS} 0.26 μV _{RMS}	bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz	

Current measurement with shunt plug				
Parameter	Value typ.	min. / max	Remarks	
Input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA			
Shunt impedance	50) Ω	external plug ACC/DSUBM-I2	
Over load protection		±60 mA	permanent	
Input configuration	differential			
Gain error	0.02%	0.06% 0.1%	of reading, at 25°C plus error of 50 Ω shunt	
Gain drift	(15 ppm/K)·∆T _a	(55 ppm/K)·∆T _a	$\Delta T_a = T_a - 25$ °C ; with $T_a = $ ambient temperature	
Offset error	0.02%	0.05%	of range, at 25°C	
Noise (current)	0.6 nA _{RMS} 0.15 nA _{RMS}	10 nA _{RMS} 0.25 nA _{RMS}	bandwidth 0.1 Hz to 1 kHz bandwidth 0.1 Hz to 10 Hz	

Current measurement with internal shunt				
Parameter	Value typ.	min. / max	Remarks	
Input range	±50 mA, ±20 mA, ±10 mA, ±5 mA, ±2 mA, ±1 mA			
Shunt impedance	12	0 Ω	internal	
Over load protection		±60 mA	permanent	
Input configuration	Single-ended		internal current backflow to -VB	
Gain error	0.02%	0.06%	of reading, at 25°C	
Gain drift	(15 ppm/K)·ΔT _a	(55 ppm/K)·∆T _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a = $ ambient temperature	
Offset error	0.02%	0.05%	of range, at 25°C	
Noise	0.6 nA _{RMS}	10 nA _{RMS}	bandwidth 0.1 Hz to 1 kHz	
(current)	0.15 nA _{RMS}	0.25 nA _{RMS}	bandwidth 0.1 Hz to 10 Hz	

Bridge measurement			
Parameter	Value typ. min. / max.		Remarks
Mode	D)C	
Measurement modes	full-, half-, q	uarter bridge	bridge supply ≤5 V with quarter bridge
Input ranges		/, ±500 mV/V, ±100 mV/V	
bridge supply: 10 V	±0.	5 mV/V	
bridge supply: 5 V	±1	. mV/V	
bridge supply: 2.5 V	±2	. mV/V	(as an option)
bridge supply: 1 V	±5	mV/V	(as an option)
Bridge excitation voltage	10 V 5 V	±0.5% ±0.5%	The actual value will be dynamically captured and compensated for in bridge mode.
(as an option)	(2.5 V and 1 V)		
Min. bridge impedance	120 Ω, 10 mH full bridge 60 Ω, 10 mH half bridge		
Max. bridge impedance	5 kΩ		
Internal quarter bridge completion	120 Ω	, 350 Ω	internal, switchable per software
Input impedance	20 ΜΩ	±1%	differential, full bridge
Gain error	0.02%	0.05%	of reading
Offset error	0.01%	0.02%	of input range after automatic bridge balancing
automatic shunt calibration	0.5 mV/V	±0.2%	for 120 Ω and 350 Ω
Cable resistance for bridges	<6 Ω		10 V excitation 120 Ω
(without return line)	<12 Ω		5 V excitation 120 Ω

Sensor supply				
Parameter	Value ty	Value typ. max.		Remarks
Configuration options	5 selectable settings		ings	The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage Isolation - applies for imc CRON	Voltage (+1 V) (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	(+1 V) 580 mA 0.6 W (+2.5 V) 580 mA 1.5 W +5.0 V 580 mA 2.9 W +10 V 300 mA 3.0 W +12 V 250 mA 3.0 W +15 V 200 mA 3.0 W +24 V 120 mA 2.9 W (±15 V) 190 mA 3.0 W		set jointly for all eight channels upon request, also 2.5 V and 1 V settings are available, for example by replacing the +12 V or +15 V setting. An arbitrary set of 5 setting can be chosen preferred selections: +24 V, +12 V, +10 V, +5.0 V, +2.5 V +15 V, +10 V, +5.0 V, +2.5 V, +1 V upon request, special order: +15 V can be replaced by ±15 V. This eliminates the internal current- and quarter bridge measurement.
Isolation	non isolated		· · ·	output to case (CHASSIS)
Block isolation only applies for imc CRONOSflex				
Block isolation		60 V		Isolation of the entire global sensor supply (for a 8 channels, reference ground: "-VB") as well as the internal electronics
Short-circuit protection	unli	imited durat	ion	to output voltage reference ground: "-VB"
Accuracy of output voltage	<pre>unlimited duration <0.25 %</pre>			at terminals, no load at 25 °C over entire temperature range plus with optional bipolar output voltage
Compensation of cable resistances	3-line control: SENSE line as refeed (-VB: supply ground)			calculated compensation with bridges
Max. capacitive load	>4000 μF >1000 μF >300 μF			2.5 V to 10 V 12 V, 15 V 24 V

The following technical statements only apply for this CRONOSflex module!

Block isolation			
Parameter	Value	Remarks	
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)	
Isolation impedance	500 kΩ 1 nF		
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground	
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing	

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of this CRONOS flex module			
Parameter	Value	Remarks	
Input supply voltage	10 V to 50 V DC		
Power consumption	10 W	10 to 50 V DC	
		incl. 120 Ω 5 V load to all channels	
Isolation	60 V	nominal isolation specification of the supply	
		input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	

Terminal connections of the module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked) imc CRONOS <i>flex</i> Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC) for remote imc CRONOS <i>flex</i> Modules	350 mA (maximum current corresponding IEEE 802.3) Equivalent power with chosen DC power input: • 17.5 W @ 50 V DC (e.g. Power Handle) • 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) • 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions			
Parameter	Value	Remarks	
Operating environment	dry, non corrosive environment within specified operating temperature range		
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1	
Ingress protection rating	IP20		
Pollution degree	2		
Operating temperature (standard)	-10°C to +55°C	without condensation	
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed	
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B		
	MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure		
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request	
Dimensions	62 x 118 x 186 mm (DSUB-26 variant: 43.3 mm width)	WxHxD	
Weight	ca. 878 g (DSUB-26 variant: ca. 815 g)		

The description of the DCB(C)2-8: Strain gauges, Voltage, IEPE/ICP. 133 The description of the B(C)-8 amplifier 145.

9.7 Voltage, Current and Temperature

9.7.1 C-8: Voltage, temperature, current (20 mA)

Inputs, measurement nodes, terminal connection			
Parameter	Value	Remarks	
Inputs	8		
Measurement modes DSUB-15	voltage measurement current measurement thermocouple measurement PT100 temperature measurement	ACC/DSUBM-I4	
Measurement modes LEMO	voltage measurement current measurement PT100 temperature measurement	with external shunt	
Measurement mode Thermocouple terminal socket (-2T)	thermocouple type-K	miniature thermocouple terminal	
Terminal connection DSUB-15	2x DSUB-15 or	4 channels per plug	
LEMO	8x LEMO.1B.307 or	1 channel per plug	
-2T	8x miniature thermocouple terminal	1 channel per plug	

Sampling rate, bandwidth, filter, TEDS			
Parameter	Value	Remarks	
Sampling rate per channel	≤20 kHz	update rate max. 100 Hz	
Bandwidth	0 Hz to 20 Hz	-3 dB	
Filter (digital)			
cut-off frequency characteristic order	1 Hz to 50 Hz	Butterworth low pass: 6th order Anti-aliasing filter: Butterworth 6th order f _{cutoff} = 0.5 f _s	
TEDS - Transducer Electronic Data Sheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported DS2431 (typ. IEPE/ICP sensor) see notes in chap. TEDS 82	

General				
Parameter	Value typ.	min. / max.	Remarks	
Overvoltage protection		±80 V	long term to chassis	
	±250 V		<1 ms	
Input coupling	DC			
Input configuration	differential			
Input impedance	1 ΜΩ	±1%	range ±50 V to ±2.5 V	
	492 kΩ	>135 kΩ	range ±1 V to ±50 mV	
	79 kΩ	>75 kΩ	range ±25 mV to ±2.5 mV	

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Input range	±50 V, ±25 V, ±10 V, ±5 V, ±2.5 V, ±1 V, ±500 mV, ±250 mV,, ±2.5 mV		
Gain error	0.01%	≤0.05% ≤0.02% ≤0.05%	of reading ±50 V to ±250 mV ±100 mV to ±25 mV ±10 mV to ±2.5 mV
Gain drift	5 ppm/K·ΔT _a	20 ppm/K·ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $ $T_a = ambient temperature$
Offset error	0.01% 0.005% 0.01% 0.02%	≤0.05% ≤0.01% ≤0.05% ≤0.1%	of measurement range ±50 V to ±250 mV ±100 mV to ±25 mV ±10 mV to ±5 mV ±2.5 mV
Offset drift	±4 μV/K ±0.07μV/K	<±12 μV/K <±0.16 μV/K	±50 V to ±2.5 V ±1V to ±2.5 mV
Signal-to noise ratio	95 dB 90 dB 86 dB	>90 dB >86 dB >82 dB	bandwidth 0.1 Hz to 10 Hz ±50 V to ±10 mV ±5 mV ±2.5 mV
Common mode voltage ±50 V to ±2.5 V ±1 V to ±2.5 mV	50 V 2 V	<30 V <1 V	with differential input voltage: ±50 V ±1 V
Common mode rejection ratio (CMRR) ±50 V to ±2.5 V ±1 V to ±2.5 mV	70 dB 120 dB	>54 dB >100 dB	common mode test voltage: ±50 V ±1 V

Temperature measurement - Thermocouples			
Parameter	Value typ.	min. / max.	Remarks
Measurement mode	J, T, K, E,	N, S, R, B	
Measurement range	-270°C b	is 1370°C is 1100°C ois 500°C	type K
Resolution	0.06	53 K	J, T, K, E, N, S, R, B
Measurement error	0.2 K	<0.6 K <±1 K	type J, T, K, E, L (for all other types see specifications of voltage measurement) range -150°C to 1100°C otherwise
Drift	0.02 K/K·ΔT _a		$\Delta T_a = T_a - 25^{\circ}C $ $T_a = ambient temperature$
Cold junction compensation error		±0.15 K	DSUB (standard)
drift of cold junction comp.	±0.001 K/K·ΔT _a		$\Delta T_a = T_a - 25$ °C with $T_a =$ ambient temperature
Input impedance	100 kΩ		differential

Temperature measurement - PT100				
Parameter	Value typ.	min. / max.	Remarks	
Input range		o 850°C, o 150°C		
Resolution	0.00	63 K		
Error		<±0.1 K <±0.05%	-200°C to 850°C, four-wire connection plus of reading	
Drift		±0.01 K/K·ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $ with $T_a =$ ambient temperature	
Sensor supply	625 μΑ			
Input impedance	20 ΜΩ	±1%	differential	
Signal-noise ratio		>85 dB	bandwidth 0.1 Hz to 10 Hz	
Bandwidth	0 Hz to	10 Hz	-3 dB	

Find here the description of the C-8.

9.7.2 HISO-8-L, HISO-8-T-8L and HISO-8-T-2L

Inputs, measurement modes, terminal connection			
Parameter	Value	Remarks	
Inputs	8		
Measurement modes		all measurement modes isolated individually	
CRFX/HISO-8-L	voltage measurement		
	current measurement (20 mA)		
	PT100, PT1000 measurement		
Measurement modes			
CRFX/HISO-8-T-8L and CRFX/HISO-8-T-2L(-OR)	thermocouple measurement type K		
Terminal connection	8x LEMO.1P REDEL (5-pin) high-voltage proof plug	1 channel per plug / HISO-8-L	
	8x LEMO.2P REDEL (2-pin) high-voltage proof plug	1 channel per plug / HISO-8-T-8L	
	2x LEMO.2P REDEL (8-pin) high-voltage proof plug	4 channels per plug / HISO-8-T-2L(-OR)	

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	Value	Remarks	
Sampling rate	≤100 kHz	per channel	
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels	
Bandwidth	0 Hz to 11 kHz	-3 dB	
	0 Hz to 8 kHz	-0.2 dB	
Filter		digital filter	
type	low-, high-, band pass, AAF		
characteristic	Butterworth, Bessel		
cut-off frequency	20 Hz to 5 kHz	1 - 2 - 5 steps	
order	8th order 4th + 4th order	low pass, high pass band pass: low- and high pass	
anti-aliasing filter (AAF)	low pass Cauer 8th order with $f_{cutoff} = 0.4 f_{s}$	automatically adapted to selected sampling rate \mathbf{f}_{s}	
Resolution			
CRC	16 Bit	internal processing 24 Bit	
CRFX		output format is selectable for each channel individually:	
	16 Bit	a) 16 Bit Integer	
	24 Bit	b) 32 Bit Float (24 Bit Mantissa)	

General				
Parameter	Value typ.	min. / max.	Remarks	
Isolation strength (common mode)		,	per IEC (EN) 6101	0-1:2001
Automotive operating voltage additional transient over voltage	800 V 500 V		impulse according	g ISO 7637-2
Main power supply measurement categories assessment voltage	_	T II O V		
General pollution degree test voltage against system ground		2 00 V	1 min	
Overvoltage protection	±100 V ±600 V		differential measi permanent transient e.g.automotive lo	·
	ESD 2 kV		human body mod	lel
CMRR (common mode rejection ratio) / IMR	>105 dB (50 Hz) >65 dB (5 kHz) >70 dB (50 Hz) >30 dB (5 kHz)		ranges ≤±2 V ranges ≥±5 V	$R_{\text{source}} = 0 \Omega$
Input coupling)C		
Input configuration		al, isolated	galvanically isolat CHASSIS)	ed to System-GND (case,
Input impedance	6.7 MΩ 1 MΩ		ranges ≤±2 V ranges ≥±5 V and with device d	eactivated
	50 Ω		current input	
Input current normal operation		1 nA	bias for operating con	ditions
in case of overvoltage		1 mA	V _{in} >5 V for ranger or deactivated	

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±5 V, ±2 V, ±	±60 V, ±50 V, ±25 V, ±10 V, ±5 V, ±2 V, ±1 V, ±500 mV, ±250 mV, ±100 mV, ±50 mV		
Gain error	<0.02%	<0.05%	of the measured v	alue, at 25°C
Gain drift		15 ppm/K 50 ppm/K	ranges ≤±2 V ranges ≥±5 V	over entire temperature range
Offset error	0.02%	≤0.05%	of the range, at 25	°C
Offset drift	0.3 μV/K·∆T _a	0.6 μV/K·∆T _a	ranges ≤±2 V	
	10 μV/K·∆T _a	30 μV/K·∆T _a	ranges ≥±5 V ΔT _a = T _a -25°C an	nbient temperature T _a
Linearity error	<120	<120 ppm		
Noise voltage (RTI)	2.5 μV _{rms}		Bandwidth: 0.1 Hz	to 1 kHz
	12 μV _{pkpk}			
Channel isolation	>1 GΩ,	<40 pF	to system ground	
	>1 GΩ,	<10 pF	channel-to-channe	el
Crosstalk	>165 dE	3 (50 Hz)	ranges ≤±2 V	R _{source} ≤100 Ω
	>92 dB	(50 Hz)	ranges ≥±5 V	

Current measurement with internal shunt			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	±10 mA, ±20	mA, ±40 mA	
Shunt resistor	50	Ω	internal
Gain error	<0.02%	<0.05%	of the measured value, at 25°C
Offset error	0.02%	≤0.05%	of range
Offset drift	6 nA/K· Δ T _a 12 nA/K· Δ T _a		$\Delta T_a = T_a - 25^{\circ}C $ ambient temperature T_a
Linearity error	<120 ppm		

Temperature measurement - Thermocouples			
Parameter	Value typ.	min. / max.	Remarks
Measurement mode	typ	e K	
Input ranges	-270°C to	o 1370°C	
	-270°C to	o 1100°C	
Resolution	1/16 K (0.0625 K) 32 bit float (24 Bit mantissa)		with selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)
Bandwidth	0 Hz to 1 kHz		
Measurement error	<±0.6 K		type K, range: -150°C to 1200°C
		<±1.0 K	otherwise
Temperature drift	±0.02 K/K·⊿T _a		$\Delta T_a = T_a -25$ °C ambient temperature T_a
Error of the cold junction temperature		<±0.5 K	
Drift of cold junction temperature	±0.001 K/K·∆T _a		$\Delta T_a = T_a - 25^{\circ}C $ ambient temperature T_a

Temperature measurement – PT100, PT1000			
Parameter	Value	Remarks	
Measurement mode	PT100, PT1000	4-wire configuration individual current sources, isolated	
Input ranges	-200°C to +850°C -200°C to +250°C		
Bandwidth	0 Hz to 1 kHz		
Measurement error offset gain	<±0.25 K <±0.05 %	-200°C to +850°C, four-wire measurement of measured value (corresponding resistance)	
Temperature drift	±0.01 K/K· ΔΤ _a	$\Delta T_a = T_a - 25^{\circ}C $ ambient temperature T_a	
Excitation current (PT100)	250 μΑ		

The following technical statements only apply for the CRONOS flex module!

Power supply			
Parameter	Value	Remarks	
Input supply voltage	10 V to 50 V DC		
Power consumption	7.3 W	10 to 50 V DC	
Isolation	60 V	nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	

Terminal connection			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits				
Directly connected (clicked) imc CRONOSflex Modules	3.1 A (maximum current)			
	Equivalent power with chosen DC power input:			
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)			
	37 W @ 12 V DC (typical vehicle supplied DC input)			
Power over EtherCAT (PoEC) for remote				
imc CRONOS <i>flex</i> Modules	350 mA (maximum current corresponding IEEE 802.3)			
	Equivalent power with chosen DC power input:			
	• 17.5 W @ 50 V DC (e.g. Power Handle)			
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)			
	• 14.7 W @ 42 V DC (minimum voltage for PoEC)			
	Note: minimum system power of 42 V DC required for PoEC			

Operating conditions					
Parameter	Value	Remarks			
Operating environment	dry, non corrosive environment within specified operating temperature range				
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1			
Ingress protection rating	IP20				
Pollution degree	2				
Operating temperature (standard)	-10°C to +55°C	without condensation			
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed			
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure				
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request			
Dimensions	82 x 118 x 186 mm	WxHxD			
Weight	1.2 kg				

Find here the description of the HISO-8 1591.

9.7.3 HVBOX-8-T-10M

Input / Output				
Parameter Value		Remarks		
Inputs HVBOX-8-10M	terminals (Cu) for two sensors (PT100/1000) or voltage signals			
Inputs HVBOX-8-T-10M	terminals for 4 thermocouple type K	labelling in the box: CH = green wire = + AL = white wire = -		
Output Connector plug	1x 8-pin LEMO.2P (Redel)	for CRFX/HISO-8-T-2L, CANFX/HISO8-T-2L, CANFX/HISO8-4L		
Cable length	10 m	HV rated		

Isolation				
Parameter	Value	Remarks		
Isolation against accessible parts (case)	300 V CAT II	reinforced isolation		
	800 V CAT 0			
Isolation of the measurement		basic isolation		
channels against each other	300 V			
(sensors)	CAT II			
	800 V			
	CAT 0			
Isolation test voltage	AC 3000 V	1 min.		
Operating temperature range	-20 °C to +80 °C			
Ingress protection class	IP65	only when the box is closed and when all gable glands properly sealed with cables		

Dimensions, Weight					
Parameter Value Remarks					
External dimensions, W x H x D	160 x 75 x 77 mm	w/o screwings, w/o cable			
Weight	1.2 kg				



Reference

HVBOX-8

Please find here the description of the connection box 162.

9.7.4 HV2-2U2I High isolated: Voltage, Current probe

General

Measurement modes and categories				
Parameter	Value	Remarks		
Inputs	4	2 inputs for voltage		
		2 inputs for current measurement		
Measurement modes	voltage measurement			
	current measurement	e.g. current probes, rogowski coil		
Measurement categories	600 V _{RMS} (CAT III) / 1000 V _{RMS} (CAT II)	conformant to EN 61010-1, EN 61010-2-030		
Pollution Degree	2	according to EN 60664		
Terminal connection				
	2x safety banana jacks			
	2x 3-pin Phoenix terminals	KGG-PC 4/3-F BK		

Sampling rate, Bandwidth, Filter			
Parameter	Value typ.	min. / max.	Remarks
Sampling rate	≤100	0 kHz	per channel
Maximum system throughput	800 kH	z (CRFX)	of all CRFX module channels
Bandwidth	0 Hz to	48 kHz	-3 dB
Filter			digital filter
type	low pass, high pa	ss, band pass, AAF	
characteristic	Butterworth, B	essel and Cauer	
cut-off frequency	10 Hz to	20 kHz	in steps of 1, 2, 5
order	8th o	order	low pass, high pass
	4. + 4. order		band pass: high- and low pass
Anti-aliasing filter (AAF)	low pass Cauer 8th order		
	with $f_{cutoff} = 0.4 \cdot f_{s}$		
Resolution			
CRC	16	Bit	internal processing 24 Bit
CRFX			output format is selectable for
			each channel individually:
	16 Bit		a) 16 Bit Integer
	24 Bit		b) 32 Bit Float (24 Bit Mantissa)
Isolation strength		5.4 kV _{RMS}	50 Hz, test voltage

Measurement modes

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±1000 V, ±500 V, ±250 V, , ±2.5 V		nominal	
	1000 V _{RMS} , 500 V _{RMS} , 250 V _{RMS} ,,		RMS continuous	
	2.5 V _{RMS}			
	±1414 V _{PK} , ±707	V _{PK'} , ±354 V _{PK'} , ,	peak measurement range (valid measurements):	
	±3.	4 V _{PK}	≥nominal range * √2	
Max. Overvoltage protection		±1450 V	differential, continuous with operating temperature up to 70°C	
Input impedance	21	MΩ		
Input coupling	С)C	isolated	
Gain error	0.02%	≤0.05%	of the reading, at 25°C	
Gain drift	±25 ppm/K·ΔT _a	±60 ppm/K·ΔT _a	$\Delta T_a = T_a - 25$ °C ; with $T_a =$ ambient temperature	
Offset error			of range	
	0.02%	≤0.05%	ranges >±5 V	
		≤0.1%	range ±5 V	
	0.04%	≤0.2%	range ±2.5 V	
Offset drift	±20 mV/K·ΔT _a	±35 mV/K·ΔT _a	range >±100 V	
	±2.0 mV/K·ΔT _a	±3.5 mV/K·ΔT _a	range ≤±100 V	
	±0.1 mV/K·ΔT _a	±0.5 mV/K·ΔT _a	range ≤±10 V	
			$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
IMRR (isolation mode rejection ratio)				
	160 dB	130 dB	DC	
	80 dB	70 dB	50 Hz	
	54 dB	44 dB	1 kHz	
Bandwidth	0 Hz to 30 kHz		<±0.03 dB	
		0 Hz to 48 kHz	-3 dB	
Phase error		<±1°	0 Hz to 20 kHz	
Signal noise			bandwidth: 0.2 Hz to 48 kHz	
	3.8 mV _{RMS}		range ±250 V	
	0.6 mV _{RMS}		range ±2.5 V	

Channels for current measurement with current probes				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±5 V, ±2.5 V, ±	1 V, , ±50 mV	modulation range ≥ range · √2	
Overvoltage protection	±10	00 V	long-term	
Input impedance	20	ΜΩ	isolated	
Gain error	0.02%	≤0.05%	of the reading	
Gain drift	±10 ppm/K·ΔT _a	±25 ppm/K·ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
Offset error	0.02%	≤0.05%	of the measurement range	
Offset drift	±10 μV /K·ΔT _a	±100 μV /K·ΔT _a	range >±0.5 V	
	±50 μV /K·ΔT _a	±20 μV /K·ΔΤ _a	range ≤±0.5 V	
			$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
IMRR (isolation mode rejection ratio)				
	160 dB	160 dB	DC	
	145 dB	126 dB	50 Hz	
	125 dB	100 dB	1 kHz	
Bandwidth	0 Hz to 30 kHz		<±0.03 dB	
		0 Hz to 48 kHz	-3 dB	
Phase error		<±1°	0 Hz to 4 kHz	
Signal noise	$1\mu V_{RMS}$	LSB	bandwidth: 0.1 Hz to 48 kHz	

Current measurement with AC current clamp				
Parameter	Value typ.	min. / max.	Remarks	
Input range	10 A ₂ , 5 A ₂ , , 2.5 A ₂		RMS-values, crest factor up to V2	
Measurement error	0.3%	≤0.8%	50 Hz, sine, line centered	
		±1 mA		
Bandwidth	40 Hz to 2 kHz		<±0.1%	
Phase error	±1°	<±3°	40 Hz to 1 kHz	

Channels for current measurement with Rogowski coil (AC)				
Parameter	Value typ.	min. / max.	Remarks	
Measurement principle			Internal signal conditioning includes integrator stage	
Usable sensors (Rogowski coil)	50 μV/A at 50 Hz		Current probes without active signal conditioning (no batteries required)	
Input range	500 (A/s)/V, 1 (kA/s)/V, 2.5 (kA/s)/V, , 50 (kA/s)/V		the GUI display this value as an integrated value	
Overload protection	±55 V		long-term	
Gain error	0.02%	≤0.08%	of the reading at 50 Hz plus error of the sensor	
Gain drift	±40 ppm/K·ΔT _a	±100 ppm/K·ΔT _a	$\Delta T_a = T_a - 25$ °C ; with $T_a =$ ambient temperature	
			plus error of the sensor	
Bandwidth	0.5 Hz to 30 kHz		<±0,1%	
		0.1 Hz to 48 kHz	-3 dB	

Current measurement with Rogowski coil			
Parameter	Value typ.	min. / max.	Remarks
Sensor (accessory)	flexible current transducer		please finde in the price list a detailed list of available accessories
Input range	5 kA _≈ , 2,5 A _≈ ,, 50 A _≈		RMS-values, crest factor <1.5
Overload protection			long-term, crest factor < 1.5
		≤60 kA _≈	f≤1 kHz
		≤1 kA _≈	f ≤ 50 kHz
Measurement error	0.3%	≤1%	
		±1 A	



Reference

Please find here the description of the HV2-2U2I module. 164

9.7.5 HV2-4U High isolated: Voltage

Measurement modes and categories				
Parameter	Value	Remarks		
Inputs	4			
Measurement modes	voltage measurement	safety banana sockets		
Measurement categories	600 V _{RMS} (CAT III) / 1000 V _{RMS} (CAT II)			
Pollution Degree	2			

Sampling rate, Bandwidth, Filter				
Parameter	Value typ.	min. / max.	Remarks	
Sampling rate	≤100) kHz	per channel	
Bandwidth	0 Hz to	48 kHz	-3 dB	
Filter (digital)				
cut-off frequency	10 Hz to	o 20 kHz		
characteristic			Butterworth, Bessel	
order			low pass filter: 8th	
			Anti-aliasing filter: Cauer 8.order with $f_{cutoff} = 0.4 f_{s}$	
Resolution				
CRC	16	Bit	internal processing 24 Bit	
CRFX			output format is selectable for each channel individually:	
		Bit Bit	a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)	
Isolation strength		5.4 kV _{RMS}	50 Hz, test voltage	

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	±1000 V, ±500 V, ±250 V, , ±2.5 V		nominal
	1000 V _{RMS} , 500 \	/ _{RMS} , 250 V _{RMS} ,,	RMS continuous
	2.5	V_{RMS}	
	±1414 V _{PK} , ±707	V _{PK} , ±354 V _{PK} , ,	peak measurement range (valid measurements):
	±3.4	4 V _{PK}	≥nominal range * √2
Max. Overvoltage protection		±1450 V	differential, continuous with operating temperature up to 70 °C
Input impedance	2 1	ИΩ	
Input coupling	D	С	isolated
Gain error	0.02%	≤0.05%	of the reading, at 25°C
Gain drift	±25 ppm/K ⋅⊿T _a	±60 ppm/K ⋅⊿T _a	$\Delta T_a = T_a - 25^{\circ}C $; ambient temperature T_a
Offset error			of range
	0.02%	≤0.05%	ranges >±5 V
	0.04%	≤0.2%	range ±2.5 V
Offset drift	±20 mV/K ⋅⊿T _a	±35 mV/K ⋅⊿T _a	range >±100 V
	±2.0 mV/K ⋅⊿T _a	±3.5 mV/K ⋅⊿T _a	range ≤±100 V
	±0.1 mV/K ⋅⊿T _a	±0.5 mV/K ⋅⊿T _a	range ≤±10 V
			$\Delta T_a = T_a - 25^{\circ}C $; ambient temperature T_a
IMRR (isolation mode rejection ratio)			
	160 dB	130 dB	DC
	80 dB	70 dB	50 Hz
	54 dB	44 dB	1 kHz
Bandwidth	0 Hz to 30 kHz		<±0.03 dB
		0 Hz to 48 kHz	-3 dB
Phase error		<±1°	0 Hz to 20 kHz
Signal noise			bandwidth: 0.2 Hz to 48 kHz
	3.8 mV _{RMS}		range ±250 V
	0.6 mV _{RMS}		range ±2.5 V



Reference

Please find here the description of the module. 164

9.7.6 ICPU2-8: Voltage, IEPE/ICP

Inputs, measurement modes, terminal connection			
Parameter	Value	Remarks	
Inputs	8		
Measurement modes	voltage measurement IEPE-sensor with current-fed		

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	Value typ. min. / max.		Remarks
Sampling rate	≤100 kHz		per channel
Maximum system throughput	800 kH	z (CRFX)	of all CRFX module channels including monitor channels
Bandwidth		48 kHz 30 kHz	-3 dB -0.1 dB
Filter (digital)	0112 10	30 KH2	0.1 db
cut-off frequency	10 Hz to	o 20 kHz	
characteristic order	10 Hz to 20 kHz		Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with f _{cutoff} = 0.4 f _s
Filter cut-off frequency (high pass, 3 rd order,-3 dB)	0.43 Hz 1.06 Hz		CRFX/ICPU2-8 standard version ICP, ranges ≤±10 V ICP, ranges >±10 V
	0.07 Hz 0.13 Hz		special version CRFX/ICPU2-8(-D)-70mHz * ICP, ranges ≤±10 V ICP, ranges >±10 V
With CRC:			
Filter cut-off frequency (high pass, 3th order,-3 dB)	0.48 Hz		ICP, ranges ≤±10 V
Resolution CRC, CRSL CRFX, CRXT	16 Bit 16 Bit 24 Bit		internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
TEDS	conforming to IEEE 1451.4 Class I Mixed Mode Interface		TEDS-data and analog signal shared wire ² supports TEDS type DS2433 not supported DS2431 (typ. IEPE sensor)
Characteristic curve linearization	(max. 1023 su _l	lefined oporting points) -X modules) 295	

^{*} The special versions are available on request. However, they should only be used when actually needed, as the settling times are correspondingly extended (up to the minute range).

General			
Parameter	Value typ.	min. / max.	Remarks
Overvoltage protection		±50 V	continuous channel to chassis
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS; input range ≤±10 V
Input coupling	AC, DC, AC with current feed (ICP)		
Input configuration	differential Single-ended		software-configurable
Input impedance range >±10 V	333 kΩ 0.67 MΩ 1 MΩ		at DC-voltage resp. 50 Hz ICP (Single-ended) AC (differential) DC (differential)
range ≤±10 V	908 kΩ 1.82 MΩ 20 MΩ		ICP (Single-ended) AC (differential) DC (differential)

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	-	′, ±10 V, ±5 V, V,, ±5 mV	
Gain error	0.02%	≤0.05%	of the reading, at 25°C
Gain drift	(+20 ppm/K)·ΔT _a	(+80 ppm/K)·ΔT _a	$\Delta T_a = T_a - 25$ °C ; with $T_a =$ ambient temperature
Offset error	0.02%	≤0.05% ≤0.06% ≤0.15%	of the input range, at 25°C >±50 mV ≤±50 mV ≤±10 mV
Offset drift	(±40 μV/K)· Δ T _a (±0.7 μV/K)· Δ T _a (±0.1 μV/K)· Δ T _a	(±200 μV/K)· Δ T _a (±6 μV/K)· Δ T _a (±1.1 μV/K)· Δ T _a	ranges > $\pm 10 \text{ V}$ range $\pm 10 \text{ V}$ bis $\pm 0.25 \text{ V}$ ranges $\leq \pm 0.1 \text{ V}$
CMRR (common mode rejection ratio) Input ranges: ±50 V to ±10 V Input ranges: ±5 V to ±50 mV Input ranges: ±25 mV to ±5 mV	62 dB 92 dB 120 dB	>46 dB >84 dB >100 dB	common mode voltage (DC60 Hz): ±50 V ±10 V ±10 V
Noise	14 nV/√Hz 0.4 μV _{rms}		DC coupling 1 kHz bandwidth 0.1 Hz to 1 kHz
Constant current supply	Value typ.	min. / max.	Remarks
ICP current sources	4.2 mA/channel	±10%	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

The following technical statements only apply for this CRONOSflex module!

Block isolation			
Parameter	Value	Remarks	
Block isolation	60 V	all internal electronics isolated (incl. ICP current sources) from the housing (CHASSIS, PE)	
Isolation impedance	500 kΩ 1 nF		
Internal reference ground	-IN	all channels with one common, galvanically connected reference ground: in ICP-mode: -IN as reference for current source, In voltage-mode not externally accessible	
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing	

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply (CRFX)			
Parameter	Value	Remarks	
Input supply voltage	10 V to 50 V DC		
Power consumption	7.4 W	10 V to 50 V DC	
Isolation	60 V	nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	

Terminal connections of the module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked) imc CRONOSflex Modules	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W @ 48 V DC (e.g. AC/DC line adaptor) • 37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote imc CRONOS <i>flex</i> Modules	350 mA (maximum current, corresponding to IEEE 802.3) Equivalent power with chosen DC power input: 17.5 W @ 50 V DC (e.g. Power Handle) 16.8 W @ 48 V DC (e.g. AC/DC line adaptor) 14.7 W @ 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (standard)	-10°C to +55°C	without condensation		
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		
Dimensions	62 x 118 x 186 mm	WxHxD		
Weight	1 kg			

The description of the ICPU2-8 173.

¹ ICP is a registered trade mark of PCB Piezotronics Inc., Delta Tron is a registered trade mark of Bruel & Kjaer Sound and Vibration; PIEZOTRON, PIEZOBEAM is a registered trade mark of Kistler

 $^{^2\,\}text{Only galvanically insulated sensors. For more detailed information, please refer to chapter "MMI-TEDS" in imc CRONOS manual.}$

9.7.7 ICPU-16: Voltage, IEPE/ICP

Parameter	Value	Remarks
Inputs	16	
Measurement modes	voltage measurement	
	current fed sensors IEPE/ICP	(e.g. ICP™-, DELTATRON®-Sensors)
Terminal connection	BNC	

Sampling rate, bandwidth, filter, TEDS			
Parameter	Value		Remarks
Sampling rate	≤20	kHz	per channel
			total sampling rate 320 ksps
Bandwidth	0 kHz t	o 5 kHz	-0.1 dB
	0 kHz to	6.6 kHz	-3 dB (analog 5. order AAF)
Filter (digital) cut-off frequency characteristic, order	2 Hz to 5 kHz		Butterworth, Bessel (digital) low pass filter 8. order Anti-aliasing filter: Cauer 8. order with f _{cutoff} = 0.4 f _s
Filter cut-off frequency (high-pass, 3rd order, -3 dB)	0.43 Hz	±5%	AC, differential AC, single end with current source
TEDS - Transducer Electronic Data Sheets	conforming to IEEE 1451.4 Class II MMI		

General				
Parameter	Value typ.	min. / max.	Remarks	
Overvoltage protection		±40 V	permanently	
Input coupling	DC AC, ICP		AC-coupling (or ICP) means a high pass filter at the input. To avoid drifting of the module, a high pass filter is always calculated, even if the user selects "without filter".	
Input configuration	differential single-end		software-configurable	
Input impedance			at DC-voltage resp. 50 Hz	
	908 kΩ		ICP (single-end)	
	1.82 ΜΩ		AC (differential)	
	20	ΜΩ	DC (differential)	

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±10 V, ±5 V, ±2.5 V, ±1 V, ±500 mV, ±250 mV			
Gain error	0.02 %	≤0.05 %	of the reading	
Gain drift	(±8 ppm/K)·ΔT _a	(±30 ppm/K)·ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
Offset uncertainty	0.02 %	≤0.05 %	of range	
Offset drift	(±18 μV/K)·ΔT _a (±2 μV/K)·ΔT _a	(±45 μV/K)·ΔΤ _a (±5 μV/K)·ΔΤ _a	± 10 V to ± 2.5 V ± 1 V to ± 250 mV $\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
Max. common mode voltage		±12 V		
Common mode rejection ranges: ±10 V to ±2.5 V ±1 V to ±250 mV	-90 dB -108 dB	-80 dB -97 dB	common mode test voltage: $\pm 10 \text{ V}_{=}$ and 7 V_{rms} , 50 Hz	
Channel to channel crosstalk range ±10 V to ±2.5 V ±1 V to ±250 mV	-90 dB -116 dB		test voltage: $\pm 10 \text{V}_{\text{a}}$ and 7V_{rms} , 0 Hz to 50Hz; range: $\pm 10 \text{V}$	
Noise	12 μV _{rms}		bandwidth: 0.1 Hz to 1 kHz	

Constant current supply			
ICP current sources	4.2 mA/channel	±10 %	
Compliance voltage	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

Find here the description of the ICPU-16 176.

9.7.8 ISO2-8 Isolated: voltage, current (20 mA), temperature

Inputs, measurement modes, terminal connection				
Parameter	Value	Remarks		
Inputs	8			
Measurement modes	voltage measurement			
DSUB-15	current measurement	shunt plug (ACC/DSUBM-I4)		
	thermocouple, RTD (PT100)	thermo plug (ACC/DSUBM-T4)		
	current fed sensors	with IEPE DSUB-15 extension plug: ACC/DSUB-ICP4, not isolated ACC/DSUBM-ICP2I-BNC-S/-F ¹ , isolated, basic functionality (ICP-operation)		
Measurement modes	voltage measurement			
LEMO	current measurement	differential (internal shunt)		
	RTD (PT100)			
Terminal connection				
Standard	2x DSUB-15 or	4 channels per plug		
LEMO	8x LEMO.1B.307	1 channel per plug		

Sampling rate, Bandwidth, Filter, TEDS				
Parameter	Value	Remarks		
Sampling rate	≤100 kHz	per channel		
	≤10 kHz	at temperature measurement		
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels		
Bandwidth	0 Hz to 11 kHz 0 Hz to 8 kHz 0 Hz to 1 kHz	-3 dB -0.2 dB -0,1 dB at temperature measurement		
Filter (digital) cut-off frequency characteristic type and order	2 Hz to 5 kHz	Butterworth, Bessel low pass filter: 8th order high pass filter: 4th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with f _{cut-off} = 0.4 f _a		
Resolution CRC, CRSL CRFX, CRXT	16 Bit 16 Bit 24 Bit	internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)		
TEDS - Transducer Electronic DataSheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor)		
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed <u>overview of supported device</u> family 2961		

When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used. Only the IEPE base functionality is supported by this module, see also TD

ACC/DSUBM-ICP2I-BNC.

General			
Parameter	Value typ.	min. / max.	Remarks
Isolation	galvanically isolated		channel-to-channel and against system ground (housing, CHASSIS, PE), as well as against common reference of all PT100 current sources and TEDS.
			not isolated when using ICP plug and PT100 mode
nominal rating	±6	60 V	
test voltage	±300	V (10 s)	
Overvoltage protection	±6	60 V	differential input voltage, continuous
	ESD	2 kV	human body model
	transient protection: automotive load dump ISO 7637		R _i =30 Ω, t _d =300 μs, t _r <60 μs
Input coupling	DC		
Input configuration	differenti	al, isolated	
Input impedance	6.7	' ΜΩ	range ≤±2 V and temperature mode
	1	ΜΩ	range ≥±5 V or device powered down
	50	0 Ω	with shunt plug ACC/DSUBM-I4
Input current			for operation
operating conditions		1 nA	V _{in} > 5 V on ranges <±5 V
on overvoltage condition		1 mA	or device powered-down
Auxiliary supply			for IEPE/ICP plug
voltage	+5 V	±5 %	independent of optional
available current	>0.26 A	>0.2 A	sensor supply, short circuit proof
internal resistance	1.0 Ω	<1.2 Ω	power per DSUB-plug

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Voltage input ranges	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV			
Gain error	<0.02 %	<0.05 %	of the measured val	ue, at 25 °C
Gain drift		6 ppm/K·ΔT _a 50 ppm/K·ΔT _a	ranges ≤±2 V ranges ≥±5 V	over full temp. range
Offset error	0.02 %	<0.05 %	of the measurement range, at 25°C	
Offset drift		2.5 ppm/K·ΔT _a	over entire temperature range $\Delta T_a = T_a -25$ °C ; with $T_a = $ ambient temperature	
Non-linearity	<120 ppm		range ±10 V	
Signal noise	2.5 μV _{rms} 20 μV _{pkpk}		bandwidth 0.1 Hz to in the range: ±50 m\	·
IMR (isolation mode rejection)	140 dB	>130 dB	range ≤±2 V	R_{source} = 0 Ω, f=50 Hz
	64 dB	>60 dB	range ≥±5 V	
Channel isolation			channel-to-ground /	CHASSIS (case)
			channel-to-channel	

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Channel isolation	>165 dB (50 Hz)		range ≤±2 V	R _{source} ≤100 Ω
(crosstalk)	` ′		range ≥±5 V	

Current measurement with shunt plug				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±40 mA / ±20 mA / ±10 mA ±5 mA / ±2 mA / ±1 mA			
Shunt impedance	50	Ο Ω	external plug ACC/DS	SUBM-I4
Input configuration	differential			
Gain error	<0.02 % <0.05 % <0.1%		of the measured valuadditional error of 50	-
Gain drift		6 ppm/K·ΔT _a	ranges ≤±2 V	over entire temp. range
		50 ppm/K·ΔT _a	ranges ≥±5 V	
Offset error	0.02 %	<0.05 %	of the measurement range	
Offset drift		2.5 ppm/K·∆T _a	over entire temperat $\Delta T_a = T_a - 25^{\circ}C $; with	ure range T _a = ambient temperature

Current measurement with internal shunt (variant with round connector etc.)				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±40 mA / ±20) mA / ±10 mA		
Shunt impedance	50	Ο Ω	internal	
Input configuration	differential			
Gain error	<0.02 %	<0.05 %	of the measured value, with 25 °C	
Gain drift		30 ppm/K·∆T _a	over entire temperature range	
Offset error	0.02 %	<0.05 %	of the measurement range	
Offset drift		2.5 ppm/K·ΔT _a	over entire temperature range $\Delta T_a = T_a -25$ °C ; with $T_a =$ ambient temperature	

Temperature measurement - thermocouples				
Parameter	Value typ.	min. / max.	Remarks	
Measurement mode	R, S, B, J, 1	Γ, Ε, Κ, L, N		
		С	special variant DSUB-15: additional type C (W5Re/W26Re)	
Measurement range	-270°C t	to 1370°C to 1100°C to 500°C	type K	
	0°C to	2320°C	type C (special variant, 24 bit mode)	
Resolution	0.063 K	(1/16 K)	16-Bit integer	
Measurement error		<±0,6 K	type K, range -150°C to 1200°C type T, range -150°C to 400°C type N, range 380°C to 1200°C	
		<±1.0 K	type K, range -200°C to -150°C type T, range -200°C to -150°C	
		<±1.5 K	type N, range -200°C to 380°C	
Temperature drift	±0.02 K/K·ΔT _a		$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
Error of cold junction compensation		<±0.15 K	with ACC/DSUBM-T4	
Temperature drift	±0.001 K/K·ΔT _a		$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	

Temperature measurement – PT100				
Parameter	Value	Remarks		
Measurement range	-200°C to +850°C			
	-200°C to +250°C			
Resolution	0.063 K (1/16 K)			
Gain error	<±0.05%	of measured value (corresponding resistance)		
Offset error	<±0.2 K	with 4-wire configuration		
Offset drift	±0.01 K/K ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature		
Sensor feed	250 μΑ	non-isolated		

Sensor supply (ISO2-8(-L)-SU	PPLY)			
Parameter	Value ty	Value typ. max.		Remarks
Configuration options	5 s	5 selectable settings		The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
0) / II			
Output voltage	Voltage (+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	Current 580 mA 580 mA 300 mA 250 mA 200 mA 120 mA 190 mA	Netpower 1.5 W 2.9 W 3.0 W 3.0 W 3.0 W 2.9 W 3.0 W	set jointly for all eight channels optional, special order: +12 V or 15 V can be replaced by +2.5 V preferred selection with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V Special order: +15 V can be replaced by ±15 V With the LEMO variant, TEDS support is omitted with this choice, see manual.
Isolation - applies for imc CRONG	DS <i>compact</i> and ii	mc CRONOS	-SL systems	
Isolation Standard: option, upon request:		non isolated isolated		output to case (CHASSIS) nominal rating: 50V, test voltage (10sec.): 300 V, not available with option ±15 V
Block isolation only applies for ir	nc CRONOS <i>flex</i>			300 V, not available with option ±13 V
Block isolation		60 V		Isolation of the entire global sensor supply (for all 8 channels, reference ground "-SUPPLY, GND") as well as the internal additional electronics from housing (CHASSIS, PE)
Short-circuit protection	un	limited dur	ation	to output voltage reference ground
Accuracy of output voltage	<0.25 %	<0.25 % 0.5 % 0.9 % 1.5 %		at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage
Max. capacitive load		>4000 μF >1000 μF >300 μF		2.5 V to 10 V 12 V, 15 V 24 V

The following technical statements only apply for this CRONOSflex module!

Block isolation			
Parameter	Value	Remarks	
Block isolation	60 V	all internal additional-electronics (PT100-current sources, TEDS, sensor supply) isolated from the housing (CHASSIS, PE)	
Isolation impedance	500 kΩ 1 nF		
Internal reference ground	GND, TEDS_GND, -I4, -SUPPLY	PT100 current sources and TEDS for all channels with one common, galvanically connected reference ground	
External reference ground	CHASSIS, metal housing	internal additional-electronics as an entity, galvanically isolated from housing	

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of the imc CRONOS <i>flex</i> module			
Parameter	Value	Remarks	
Input supply voltage	10 V to 50 V DC		
Isolation	60 V	nominal isolation specification of the supply input	
Power over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	
Power consumption		10 to 50 V DC	
CRFX/ISO2-8	7.0 W	CRFX/ISO2-8	
	9.2 W	CRFX/ISO2-8 with 2x ACC/DSUB-ICP4	
	12.4 W	CRFX/ISO2-8(-L)-SUPPLY (Sensor-Supply 3 W netto)	

Terminal connections of the imc CRONOSflex module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked)	
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)
	Equivalent power with chosen DC power input:
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)
	37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC)	
for remote imc CRONOS <i>flex</i>	
Modules	350 mA (maximum current corresponding to IEEE 802.3)
	Equivalent power with chosen DC power input:
	• 17.5 W @ 50 V DC (e.g. Power-Handle)
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
	• 14.7 W @ 42 V DC (minimum voltage for PoEC)
	Note: minimum system power of 42 V DC required for PoEC

Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (standard)	-10°C to +55°C	without condensation		
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B			
	MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		
Dimensions	43.3 x 118 x 186 mm (width of the LEMO variant is: 62 mm)	WxHxD		
Weight	ca. 740 g (DSUB-15 variant)			

The description of the 1502-8

9.7.9 ISO2-8(-16)-2T Isolated: Thermocouple

Channels, measurement modes, terminal connection			
Parameter	Value	Remarks	
Channels	8 16	ISO2-8-2T CRC variant as well as for CRFX ISO2-16-2T only for CRFX	
Measurement mode	temperature measurement thermocouples type K		
Terminal connection Measurement input	miniature thermocouple terminal connector	2-pin, female	
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20-pin	direct connection of modules (click) supply and system bus	

Sampling rate, Bandwidth, Filter		
Parameter	Value	Remarks
Sampling rate	≤10 kHz	per channel
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels
Bandwidth	0 Hz to 1 kHz	-0.1 dB ISO2-8-2T
	0 Hz to 2 kHz	-0.1 dB ISO2-16-2T
Resolution CRC, CRSL CRFX	16 Bit 16 Bit 24 Bit	internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)
Filter (digital) cut-off frequency, characteristic, order	2 Hz to 500 Hz CRFX/ISO2-16-2T 2 Hz to 5 kHz CRC/CRFX/ISO2-8-2T	Butterworth, Bessel low pass filter: 8th order high pass filter: 4th order band pass: LP 8th and HP 4th order Anti-aliasing filter: Cauer 8.order with f _{cutoff} = 0.4 f _a

Temperature measurement - thermocouples				
Parameter	Value typ.	min. / max.	Remarks	
Measurement range	temperature range: -200°C to +1200°C type K			
Resolution	· ·		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)	
Measurement error		<±0.6 K	type K, range -150°C to 1200°C	
		<±1.0 K	type K, range -200°C to -150°C	
Temperature drift	±0.02 K/K·∆T _a		ΔT_a = $ T_a$ -25°C $ $ ambient temperature T_a	
Error of cold junction compensation		<±0.15 K		
Temperature drift	±0.001 K/K·ΔT _j		$\Delta T_j = T_j - 25^{\circ}C $ cold junction temp. T_j	

General				
Parameter	Value	Remarks		
Isolation	galvanically isolated	channel-to-channel and against system ground (housing, CHASSIS, PE)		
nominal rating	±60 V	channel to case		
test voltage	±300 V (10 sec.)			
Overvoltage protection	±60 V	differential input voltage (continuous)		
	ESD 2 kV	human body model		
	transient protection: automotive load dump ISO 7637	R _i =30 Ω, t _d =300 μs, t _r <60 μs		
Input coupling	DC			
Input configuration	differential, isolated	galvanically isolated to System-GND (housing, CHASSIS)		
Input impedance	6.7 MΩ			



Note

Technical Specs for all imc CRONOSflex modules

The technical data regarding operating conditions, power supply and connections of the imc CRONOS flex (CRFX) modules are the same as for the $\frac{|SO2-8|}{|372|}$ variant.

CRFX-ISO2-8(-16)-2T			
Parameter	Value	Remarks	
Power consumption	10 W	10 V to 50 V DC	
Dimensions	62 x 118 x 186 mm	WxHxD	
Weight	1.1 kg (CRFX/ISO2-16-2T)		



Reference

Please finde here the description of the ISO2-8 177

9.7.10 ISOF-8 voltage, current (20 mA), temperature, IEPE/ICP

Inputs, measurement modes, terminal connection				
Parameter	Value	Remarks		
Inputs	8			
Measurement modes DSUB-15	voltage measurement current measurement thermocouple, RTD (PT100) current fed sensors IEPE/ICP	shunt plug (ACC/DSUBM-I4) thermo plug (ACC/DSUBM-T4) IEPE/ICP expansion plug (ACC/DSUB-ICP4, not isolated ACC/DSUBM-ICP2I-BNC-S/-F ¹ , isolated)		
Measurement modes LEMO	voltage measurement current measurement RTD (PT100)	differential (internal shunt)		
Terminal connection Standard	2x DSUB-15 or	4 channels per plug		
LEMO	8x LEMO.1B.307	1 channel per plug		

Sampling rate, bandwidth, filter, TEDS			
Parameter	Value	Remarks	
Sampling rate	≤100 kHz	per channel	
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels	
Bandwidth	0 Hz to 48 kHz 0 Hz to 46 kHz	-3 dB -0.2 dB	
Filter (digital) cut-off frequency characteristic order	10 Hz to 20 kHz	Butterworth, Bessel low pass filter: 8th order high pass filter: 4th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with f _{cutoff} = 0.4 f _a	
Resolution CRC, CRSL CRFX, CRXT	16 Bit 16 Bit 24 Bit	internal processing 24 Bit output format is selectable for each channel individually: a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)	
TEDS - Transducer Electronic Data Sheets	conforming to IEEE 1451 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported DS2431 (typ. IEPE/ICP sensor)	
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed <u>overview of supported device</u> family 296	

¹ When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used. Only the IEPE base functionality is supported by this module, see also TD ACC/DSUBM-ICP2I-BNC.

General			
Parameter	Value typ.	min. / max.	Remarks
Isolation	galvanically isolated		channel-to-channel and against system ground (housing, CHASSIS), as well as against common reference of all PT100 current sources and TEDS.
nominal rating	±6	0 V	Isolation with IEPE/ICP connector:
test voltage	±300 V	(10 sec.)	depends on plug type
Overvoltage protection	±1	00 V	differential input voltage (continuous)
	ESD	2 kV	human body model
		orotection: d dump ISO 7637	R _i =30 Ω, t _d =300 μs, t _r <60 μs
Input coupling	DC		
Input configuration	differential, isolated		
Input impedance	6,7	ΜΩ	range ≤±2 V or temperature mode
	11	ΜΩ	range ≥±5 V or device powered down
	50	0 Ω	current mode (shunt-plug) (ACC/DSUBM-I4)
Input current			
operating conditions on overvoltage condition	1 mA	2.4 nA	for operation V _{in} >5 V on ranges <±5 V or device powered-down
Auxiliary supply			for IEPE/ICP plug
voltage	5 V	±5%	independent of optional
available current internal impedance	>0.26 A 1.0 Ω	>0.2 A <1.2 Ω	sensor supply, short circuit proof power per DSUB-plug

Voltage measurement				
Parameter	Value typ. min. / max.		Remarks	
Input ranges	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV / ±25 mV			
Gain error	<0.025%	<0.05%	of the measured value, a	at 25°C
Gain drift		30 ppm/K·ΔT _a 60 ppm/K·ΔT _a	ranges ≤±2 V ranges ≥±5 V	over full temperature range
Offset error	0.02 %	<0.05 %	of the range	
Offset drift		2.5 ppm/K·ΔT _a	over entire temperature	e range
			$\Delta T_a = T_a - 25^{\circ}C $; with $T_a = 1$	= ambient temperature
Nonlinearity	<120 ppm			
Input voltage noise			range ±25 mV	
	$2.6 \mu V_{rms} / 22 \mu V_{pkpk}$		bandwidth 0.1 Hz to 48	kHz
	$0.5 \mu V_{rms} / 3.5 \mu V_{pkpk}$ β		bandwidth 0.1 Hz to 1 k	Hz
	0.1 µ	V_{pkpk}	bandwidth 0.1 Hz to 10	Hz
		/√Hz	spectral noise density	
CMRR (common mode rejection	>145 dE	3 (50 Hz)	ranges ≤±2 V	R _{source} = 0 Ω
ratio) / IMR	>80 dB	(50 Hz)	ranges ≥±5 V	
Channel isolation	>1 GΩ, < 40 pF		channel-to-ground / CH	ASSIS (case)
	>1 GΩ, < 10 pF		channel-to-channel	
Channel isolation (crosstalk)	>155 dB (50 Hz) >92 dB (50 Hz)		ranges ≤±2 V ranges ≥±5 V	R _{source} ≤100 Ω

Current measurement with shunt plug				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±40 mA / ±2	0 mA / ±10 mA		
Shunt impedance	5	50 Ω	external plug ACC/I	DSUBM-I4
Gain error	<0.07 % <0.15 %		of the measured va	lue, at 25 °C
Gain drift		30 ppm/K·ΔT _a	ranges ≤±2 V	over full temperature
		60 ppm/K·∆T _a	ranges ≥±5 V	range
Offset error	10 μV		range ±25 mV	
Offset drift	0.7 μV/K·ΔΤ _a		range ±25 mV	
	•		$\Delta T_a = T_a - 25^{\circ}C $; wit	h T _a = ambient temperature

Current measurement with internal shunt (variant with round connector etc.)			
Parameter	Value typ. min. / max. F		Remarks
Input ranges	±40 mA / ±20) mA / ±10 mA	
Shunt impedance	50	Ω	internal
Input configuration	differential		
Gain error	<0.02 %	<0.05 %	of the measured value, with 25°C
Gain drift		40 ppm/K·ΔT _a	over entire temperature range
Offset error	0.02 %	<0.05 %	of the measurement range
Offset drift		2.5 ppm/K ·∆T _a	over entire temperature range $\Delta T_a = T_a -25$ °C ; with $T_a =$ ambient temperature

Temperature measurement - thermocouples				
Parameter	Value typ.	min. / max.	Remarks	
Measurement mode	R, S, B, J, 1	Γ, Ε, Κ, L, N		
Measurement range	-270°C bis 1370°C -270°C bis 1100°C -270°C bis 500°C		type K	
Resolution	0.063 K (1/16 K)		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)	
Measurement error		<±0.6 K	type K, value -150°C to 1100°C	
(gain + offset)		<±1.0 K	else	
Drift		±0.02 K/K·ΔT _a	type K, range -270°C to 1100°C	
(gain + offset)		±0.05 K/K·ΔT _a	type K, range -270°C to 1370°C	
			$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
Error of cold junction compensation		<±0.15 K	with ACC/DSUBM-T4	
Cold junction drift	±0.001 K/K·ΔT _a		$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	

Temperature measurement – PT100				
Parameter	Value	Remarks		
Measurement range	-200°C to +850°C			
	-200°C to +250°C			
Resolution	0.063 K (1/16 K)	16-Bit integer		
Measurement error	<±0.05%	of the measured value		
Offset error	<±0.2 K	4-wire connection		
Offset drift	±0.01 K/K·ΔT _a	range -200°C to 250°C		
	±0.02 K/K·ΔT _a	range -200°C to 850°C		
		$\Delta T_a = T_a - 25$ °C ; with $T_a =$ ambient temperature		
Sensor feed (PT100)	250 μΑ	non-isolated		

Sensor supply (ISOF-8-SUPPL	Y, ISOF-8-L-SU	JPPLY)		
Parameter	Value ty	/p.	max.	Remarks
Configuration options	5	5 selectable settings		5 settings only
				Default ranges: +5 V to +24 V
Output voltage	Voltage	Current	Netpower	set globally for all channels of a module
	(+2.5 V)	580 mA	1.5 W	special order, +12 V or 15 V can be replaced
	+5.0 V	580 mA	2.9 W	by +2.5 V;
	+10 V	300 mA	3.0 W	default selection with 2.5 V:
	+12 V	250 mA	3.0 W	+2.5 V, +5.0 V, +10 V, +12 V, +24 V
	+15 V	200 mA	3.0 W	
	+24 V	120 mA	2.9 W	Special order: +15 V can be replaced by
	(±15 V)	190 mA	3.0 W	±15 V. With the LEMO variant, TEDS support
				is omitted with this choice, LEMO pin 5
				(TEDS) is then GND, pin 3 is +15 V and pin 4
				15 V, see manual.
Isolation - applies for imc CRONO	OS <i>compact,</i> imo	CRONOS-SL a	nd PL systems	
Isolation				
standard:		non isolated	l	output to case (CHASSIS, PE)
option, upon request:		isolated		nominal rating: 50 V, test voltage (10 sec.):
				300 V, not available with option ±15 V
Block isolation only applies for ir	nc CRONOS <i>flex</i>			
Block isolation		60 V		Isolation of the entire global sensor supply
				(for all 8 channels, reference ground "-
				SUPPLY, GND") as well as the internal
				additional electronics from housing
				(CHASSIS, PE)
applies for imc CRONOScompact	, imc CRONOS-S	SL and PL syste	ms	
Short-circuit protection	ι	ınlimited dura	tion	to output voltage reference ground
Accuracy of output voltage				at terminals, no load
, ,	<0.25 9	%	0.5 %	at 25 °C
			0.9 %	over entire temperature range
			1.5 %	plus with optional bipolar output voltage
Max. capacitive load		>4000 μF		2.5 V to 10 V
•		>1000 μF		12 V, 15 V
		>300 μF		24 V

The following technical statements only apply for this CRONOSflex module!

Block isolation				
Parameter	Value	Remarks		
Block isolation	60 V	all internal additional-electronics (PT100-current sources, TEDS, sensor supply) isolated from the housing (CHASSIS, PE)		
Isolation impedance	500 kΩ 1 nF			
Internal reference ground	GND, TEDS_GND, -I4, -SUPPLY	PT100 current sources and TEDS for all channels with one common, galvanically connected reference ground		
External reference ground	CHASSIS, metal housing	internal additional-electronics as an entity, galvanically isolated from housing		

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Power supply of the module		
Input supply voltage	10 V to 50 V DC	
Power consumption	10 W	10 V to 50 V DC
Isolation	60 V	nominal isolation specification of the supply input
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable

Terminal connections of the module			
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

	System bus
Pass through power limits	
Directly connected (clicked)	
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)
	Equivalent power with chosen DC power input:
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)
	37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC)	
for remote modules	350 mA (maximum current corresponding to IEEE 802.3)
	Equivalent power with chosen DC power input:
	• 17.5 W @ 50 V DC (e.g. Power-Handle)
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
	• 14.7 W @ 42 V DC (minimum voltage for PoEC)
	Note: minimum system power of 42 V DC required for PoEC

Operating conditions					
Parameter	Value	Remarks			
Operating environment	dry, non corrosive environment within specified operating temperature range				
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1			
Ingress protection rating	IP20				
Pollution degree	2				
Operating temperature (standard)	-10°C to +55°C	without condensation			
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed			
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure				
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request			
Dimensions	43.3 x 118 x 186 mm	WxHxD			
Weight	714 g				

Find here the description of the ISOF-8 182

9.7.11 LV-16 Voltage, Current (20 mA), IEPE/ICP

Parameter	Value	Remarks
Inputs	16	differential, analog, non isolated
Measurement modes (DSUB)	voltage measurement	
	current measurement	with shunt plug (ACC/DSUBM-I4)
	current fed sensors (IEPE/ICP)	with DSUB-15 expansion plug
		ACC/DSUB-ICP4, not isolated
		ACC/DSUBM-ICP2I-BNC-S/-F ¹ , isolated
Measurement modes (LEMO)	voltage measurement	
	current measurement	with external shunt
Terminal connection		
Standard	4x DSUB-15 socket	
	4 channels per plug	
LEMO	16x LEMO / 1 channel per socket	

Sampling rate, Bandwidth, Filter, TEDS				
Parameter	Value	Remarks		
Sampling rate	≤20 kHz	per channel		
Bandwidth	0 Hz to 6.6 kHz	-3 dB (analog AAF 5th order)		
	0 Hz to 5 kHz	-0.2 dB		
Filter (digital) cut-off frequency characteristic order	2 Hz to 5 kHz	Butterworth, Bessel (digital) low pass filter 8. order Anti-aliasing filter: Cauer 8. order with f _{cutoff} = 0.4 f _s		
Resolution	16 Bit	internal processing 24 Bit		
TEDS	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) see notes in chap. TEDS 82		

General				
Parameter	Value typ. min. / max.		Remarks	
Overvoltage protection	±40 V		permanent channel to chassis	
Input coupling	D	С		
Input configuration	differential			
Input impedance	20 ΜΩ		differential, >10 kΩ off-state	
Auxiliary supply			for IEPE/ICP-extension plug	
voltage	+5 V ±5%		independent of integrated sensor	
available current	0.26 A 0.2 A		supply, short-circuit protected power	
internal resistance	1.0 Ω	<1.2 Ω	per DSUB-plug	

¹ When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

Voltage measurement				
Parameter	Value typ. min. / max. F		Remarks	
Input ranges	· · · · · · · · · · · · · · · · · · ·	V, ±2.5 V, mV, ±250 mV		
Gain: error	0.02 %	≤0.05 %	of reading	
drift	±8 ppm/K·ΔT _a	±30 ppm/K×DTa	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a = $ ambient temperature	
Offset: error drift	0.02 % (±18 μV/K)·ΔΤ _a (±2 μV/K)·ΔΤ _a	≤0.05 % (±45 μV/K)·ΔΤ _a (±5 μV/K)·ΔΤ _a	of range $ \pm 10 \text{ V to } \pm 2.5 \text{ V} $ $ \pm 1 \text{ V to } \pm 250 \text{ mV} $ $ \Delta T_a = T_a - 25^{\circ}\text{C} ; \text{ with } T_a = \text{ambient temperature} $	
Max. common mode voltage		±12 V		
Common mode rejection Ranges $\pm 10 \text{ V to} \pm 2.5 \text{ V}$ $\pm 1 \text{ V to} \pm 250 \text{ mV}$	-90 dB -108 dB	-80 dB -97 dB	common mode test voltage: $\pm 10 \text{ V}_{=}$ and 7 V_{rms} , 50 Hz	
Channel to channel crosstalk Ranges $10 \text{ V to } \pm 2.5 \text{ V}$ $\pm 1 \text{ V to } \pm 250 \text{ mV}$	-90 dB -116 dB		test voltage: $\pm 10 \text{ V}_{=}$ and 7 V _{rms'} 0 Hz to 50 Hz; range: $\pm 10 \text{ V}$	
Noise	12 μV _{rms}		bandwidth: 0.1 Hz to 1 kHz	

Current measurement					
Parameter	Value typ.	min. / max.	Remarks		
Input ranges	±50 mA, ±20 mA	, ±10 mA, ±5 mA	50Ω shunt in terminal plug		
Max. over load	±60) mA	permanent		
Input configuration	differ	ential	50 Ω shunt plug (ACC/DSUBM-I4)		
Gain:			of reading		
error	0.02 % ≤0.06 % ≤0.1 %		plus error of 50 Ω shunt		
drift	(±20 ppm/K)·∆T _a	(±55 ppm/K)·∆T _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a = $ ambient temperature		
Offset:					
error	0.02 % ≤0.05 %		of range		
drift	(±30 nA/K)·ΔT _a	(±60 nA/K)·ΔT _a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a = $ ambient temperature		

Find here the description of the LV-16 Voltage, Current (20 mA), IEPE/ICP 1861. Technical data of the sensor supply (option) 4461.

9.7.12 LV3-8 Voltage, Current (20 mA), IEPE/ICP

Inputs, measurement modes, terminal connection				
Parameter	Value	Remarks		
Inputs	8			
Measurement modes	voltage measurement			
DSUB	current measurement	shunt plug (ACC/DSUBM-I4)		
	current feed sensors	with DSUB-15 expansion plug:		
		ACC/DSUB-ICP4, not isolated		
		ACC/DSUBM-ICP2I-BNC-S/-F ¹ , isolated		
Measurement modes	voltage measurement			
LEMO	current measurement	with external shunt		
Terminal connection				
Standard	2x DSUB-15	4 channels per plug		
LEMO	8x LEMO.1B.307	1 channel per plug		

Sampling rate, Bandwidth, Filter, TEDS				
Parameter	Value	Remarks		
Sampling rate	≤100 kHz	per channel		
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels		
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz	-3 dB -0.1 dB		
Filter (digital)				
cut-off frequency	10 Hz to 20 kHz			
characteristic order		Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order		
		with $f_{\text{cutoff}} = 0.4 f_{\text{s}}$		
Resolution CRC, CRSL CRFX, CRXT	16 Bit	internal processing 24 Bit output format is selectable for each channel individually:		
	16 Bit 24 Bit	a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)		
TEDS	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor) see notes in chap. TEDS 82		
Characteristic curve linearization	user defined (max. 1023 supporting points) (only with CRFX modules) 295	see detailed <u>overview of supported device</u> family 296		

¹ When using the two-channel IEPE plug in combination with the analog inputs, which provide four channels per socket, only channels 1 and 3 can be used.

General				
Parameter	Value typ.	min. / max.	Remarks	
Overvoltage protection			permanent, differential	
		±80 V	input range >±10 V or device switched off	
		±50 V	input range ≤±10 V	
Input coupling	DC			
Input configuration	differential			
Input impedance	1 ΜΩ		range >±10 V	
	20 ΜΩ		range ≤±10 V	
Auxiliary supply			for IEPE/ICP expansion plug	
voltage	+5 V	±5%	independent of optional	
available current	>0.26 A	>0.2 A	sensor supply, short circuit proof	
internal resistance	1.0 Ω	<1.2 Ω	power per DSUB-plug	

Voltage measurement				
Parameter	Value typ. min. / max.		Remarks	
Input ranges		.0 V, ±5V, ±2.5 V, . ±5 mV		
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS; input range ≤±10 V	
Gain error	0.02 %	0.05 %	of the reading	
Gain drift	10 ppm/K·ΔT _a	30 ppm/K·∆T _a	$\Delta T_a = T_a - 25 \text{ °C} $; $T_a = \text{ambient temperature}$	
Offset error	0.02 %	≤0.05 % ≤0.06 % ≤0.15 %	of the range, at 25 °C >±50 mV ≤±50 mV ≤±10 mV	
Offset drift	$\pm 40 \mu V/K \cdot \Delta T_a$ $\pm 0.7 \mu V/K \cdot \Delta T_a$ $\pm 0.1 \mu V/K \cdot \Delta T_a$	$\pm 200 \mu V/K \cdot \Delta T_a$ $\pm 6 \mu V/K \cdot \Delta T_a$ $\pm 1.1 \mu V/K \cdot \Delta T_a$	range >±10 V range ±10 V to ±0.25 V range ≤±0.1 V $\Delta T_a = T_a-25 ^{\circ}C $; $T_a =$ ambient temperature	
Nonlinearity	30 ppm	≤90 ppm		
Common mode rejection ranges ±50 V to ±25 V ±10 V to ±50 mV ±20 mV to ±5 mV	80 dB 110 dB 138 dB	>70 dB >90 dB >132 dB	Common mode voltage (DC60 Hz): ±50 V ±10 V ±10 V	
Noise	3.6 μV _{rms} 0.6 μV _{rms} 0.14 μV _{rms}	5.5 μV _{rms} 1.0 μV _{rms} 0.26 μV _{rms}	bandwidth 0.1 Hz to 50 kHz 0.1 Hz to 1 kHz 0.1 Hz to 10 Hz	

Current measurement with shunt plug				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	±50 mA, ±20 mA	, ±10 mA, ±5 mA,	50 Ω shunt in terminal plug	
	±2 mA	, ±1 mA		
Shunt impedance	50	Ο Ω	external plug ACC/DSUBM-I4	
Over load protection		±60 mA	permanent	
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS	
Input configuration	differ	ential	50 Ω shunt in terminal plug	
Gain error	0.02 %	≤0.06 %	of reading	
		≤0.1 %	plus error of 50 Ω shunt	
Gain drift	+15 ppm/K·ΔT _a	+55 ppm/K·∆T _a	$\Delta T_a = T_a - 25 \text{ °C} $; $T_a = \text{ambient temperature}$	
Offset error	0.02 %	≤0.05 %	of the range	
Current noise			Bandwidth:	
	40 nA _{rms}	70 nA _{rms}	0.1 Hz to 50 kHz	
	0.7 nA _{rms}	12 nA _{rms}	0.1 Hz to 1 kHz	
	0.17 nA _{rms}	0.3 nA _{rms}	0.1 Hz to 10 Hz	

Sensor supply module (LV3-8			•	In
Parameter	Value ty	Value typ. max.		Remarks
Configuration options	5 s			The sensor supply module always has 5 selectable voltage settings. default selection: +5 V to +24 V
Output voltage	Voltage	Current	Notnower	set jointly for all eight channels
	(+2.5 V) +5.0 V +10 V +12 V +15 V +24 V (±15 V)	+5.0 V 580 mA 2.9 W +10 V 300 mA 3.0 W +12 V 250 mA 3.0 W +15 V 200 mA 3.0 W +24 V 120 mA 2.9 W		optional, special order, +12 V or 15 V can be replaced by +2.5 V preferred selection with 2.5 V: +2.5 V, +5.0 V, +10 V, +12 V, +24 V optional, special order: +15 V can be replaced by ±15 V
option, upon request:		isolated		nominal rating: 50V, test voltage (10sec.): 300 V, not available with option ±15 V.
Block isolation only applies for in	mc CRONOS <i>flex</i>			
Block isolation		60 V		Isolation der gesamten globalen Sensorversorgung (für alle 8 Kanäle, Bezug "- SUPPLY, GND") sowie der internen Messelektronik gegenüber Gehäuse (CHASSIS, PE
Short-circuit protection	un	limited dur	ation	to output voltage reference ground
Accuracy of output voltage	<0.25 %	<0.25 % 0.5 %		at terminals, no load at 25°C
			0.9 %	over entire temperature range
			1.5 %	plus with optional bipolar output voltage
Max. capacitive load		>4000 μF >1000 μF >300 μF		2.5 V to 10 V 12 V, 15 V 24 V

The following technical statements only apply for this CRONOSflex module!

Block isolation				
Parameter	Value	Remarks		
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)		
Isolation impedance	500 kΩ 1 nF			
Internal reference ground	GND, TEDS_GND, -SUPPLY	all channels with one common, galvanically connected reference ground		
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing		

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of the module					
Parameter	Value	Remarks			
Input supply voltage	10 V to 50 V DC				
Power consumption		10 to 50 V DC			
	6.4 W	CRFX/LV3-8			
	8.8 W	CRFX/LV3-8 with 2x ACC/DSUB-ICP4			
	12.4 W	CRFX/LV3-8-SUPPLY, CRFX/LV3-8-L-SUPPLY (Sensor-Supply 3 W netto)			
Isolation	60 V	nominal isolation specification of the supply input			
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable			
Terminal connections of the mod	dule				
Parameter	Value	Remarks			
EtherCAT connection	2x RJ45	system bus for expanded imc CRONOS <i>flex</i> components			
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply			
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus			

Pass through power limits			
Directly connected (clicked)			
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)		
	Equivalent power with chosen DC power input:		
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)		
	37 W @ 12 V DC (typical vehicle supplied DC input)		
Power over EtherCAT (PoEC)			
for remote imc CRONOSflex			
Modules	350 mA (maximum current, corresponding to IEEE 802.3)		
	Equivalent power with chosen DC power input:		
	• 17.5 W @ 50 V DC (e.g. Power Handle)		
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)		
	14.7 W @ 42 V DC (minimum voltage for PoEC)		
	Note: minimum system power of 42 V DC required for PoEC		

Operating conditions					
Parameter	Value	Remarks			
Operating environment	dry, non corrosive environment within specified operating temperature range				
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1			
Ingress protection rating	IP20				
Pollution degree	2				
Operating temperature (standard)	-10°C to +55°C	without condensation			
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed			
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure				
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request			
Dimensions	43.3 x 118 x 186 mm (width of the LEMO variant is: 62 mm)	WxHxD			
Weight	640 g (DSUB-15 variant) 1000 g (LEMO variant)				

The description of the LV3-8: Voltage, Current (20 mA), IEPE/ICP 187.

9.7.13 OSC-16 Isolated: Voltage, current (20 mA), temperature

Parameter	Value	Remarks
Inputs	16	
Measurement mode	voltage measurement	standard plug (ACC/DSUBM-U4)
DSUB-15	current measurement	current plug (ACC/DSUBM-I4)
	thermocouple measurement RTD (PT100)	Thermo-plug (ACC/DSUBM-T4)
Measurement mode OSC-16-T	temperature measurement	two pin thermo-sockets
	thermocouple type-K	
Terminal connection		
DSUB-15	4x DSUB-15	4 channels per plug
	or	
OSC-16-T	16x thermo-sockets one channel per plug	

Sampling rate, Bandwidth, TEDS				
Parameter	Va	lue	Remarks	
Sampling rate	≤500 Hz / channel		internal sampling: 2 Hz with additional interpolation: 5Hz for higher rates:output of doubled values	
			max. allowable input signal frequency: 1 Hz	
	≥10 Hz ((100 ms)	filter / bandwidth like at 2 Hz / 5 Hz, additional values are duplicated	
Bandwidth	1	Hz	-0.01 dB	
Resolution	16	bit		
Noise suppression @ 50 Hz (±2%) at sampling rate:	49 Hz t	o 51 Hz	noise frequency	
1 Hz	68	dB	recommended sampling rate 1 Hz	
> 1 Hz	34	dB	other sampling rates > 1 Hz	
Bandwidth / max. signal freq. vs. noise suppression @ 50 Hz	Bandwidth and noise max. signal suppression frequency ≥60 dB		suppression of ≥60 dB is achieved for:	
at sampling rate:				
0.5 Hz 1 Hz	0.25 Hz 0.5 Hz	48.5 Hz 48.5 Hz	noise frequency ≥48.5 Hz	
2 Hz 5 Hz	1 Hz 1 Hz	50 Hz 50 Hz	noise frequency ≥50 Hz	
Max. settling time	max	c. 1 s	sampling rate 5 Hz (200 ms) complete settling as a response to input step	
Synchronicity (at sampling rate)	constant time offset between two equally configured channels:			
	max. 500 ms		sampling rate ≥2 Hz	
TEDS	conforming to IEEE 1451.4 Class II MMI		esp. with ACC/DSUBM-TEDS-xx (DS2433) see notes in chap. TEDS 82	
Characteristic curve linearization	user d (max. 1023 sup	efined oporting points)	see detailed <u>overview of supported device</u> <u>family</u> 296	

General				
Parameter	Value typ.	min. / max.	Remarks	
Isolation				
nominal	±6	60 V	channel to frame (housing, CHASSIS) and channel	
test voltage	300 \	/ (10 s)	to channel	
Overvoltage protection	±6	60 V	diff. input voltage, (long term)	
	ESD	2 kV	human body model	
		protection: d dump ISO 7636	R _i =30 Ω, t _d =300 μs, t _r <60 μs	
Input coupling	[OC .		
Input configuration	differential, isolated		electrical isolation to system-GND (housing, CHASSIS)	
Input impedance	10 ΜΩ		voltage mode (range ≤±2 V), temperature mode	
	1 ΜΩ		voltage mode (range ≥ ±5 V)	
	50 Ω		current mode (shunt plug)	
Static input current	1 nA	10 nA		
Dynamic input current	0.1 mA	1.5 mA	peak dynamic input current value (typ. @100 mV, max. @2 V)	
	30 nA 600 nA		mean dynamic input current value (typ. @100 mV, max. @2 V)	
Input current upon overvoltage		1.5 mA	V _{in} > 7 V in the range ≤±2 V	
			or device deactivated	
Auxiliary supply				
voltage	+5 V	±5%	independent of integrated	
available current	>0.26 A	>0.2 A	sensor supply, short circuit proof	
internal resistance	1.0 Ω	<1.2 Ω	power per DSUB-plug	

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Input range	±60 V / ±50 V / ±25 V / ±10 V ±5 V / ±2 V / ±1 V / ±500 mV ±250 mV / ±100 mV / ±50 mV			
Gain error	<0.025%	<0.05%	of the reading, at 2	25°C
Gain drift		6 ppm/K 36 ppm/K	ranges ≤±2 V ranges ≥±5 V	over entire temp. range
Offset error		<0.05% <3 μV	of input range	
Offset drift		3 ppm/K	over entire temper	rature range
Non-linearity	<30	ppm	range: ±10 V	
Noise voltage (RTI)	<0.5 μV _{rms} <3.0 μV _{pkk} (<1 LSB)		sampling rate 5 Hz (200 ms)	
CMRR/ IMR (isolation mode rejection)	all sampling rates >110 dB (50 Hz) >95 dB (50 Hz) >65 dB (50 Hz)		range ≤±2 V range ≤±2 V range ≥±5 V	$R_{source} = 0 \Omega$ $R_{source} = 100 \Omega$ $R_{source} = 100 \Omega$
Channel isolation	<50 pF, <100 nA		Channel to protect	ion ground (CHASSIS);
Channel cross-talk damping	all sampling rates >116 dB (50 Hz) >101 dB (50 Hz)		range ≤±2 V range ≤±2 V	$R_{\text{source}} = 0 \Omega$ $R_{\text{source}} = 100 \Omega$
Suppression of square wave on neighboring channels	>123 dB @ sampling rate 200 ms		range ≤±2 V	$R_{\text{source}} = 100 \Omega$
Max. source impedance	5	kΩ		

Current measurement with shunt plug				
Parameter	Value typ.	min. / max.	Remarks	
Input range	±1 mA / ±2 mA / ±5 mA ±10 mA / ±20 mA / ±40 mA			
Shunt resistor	50 Ω		external plug ACC/DS	UBM-I4
Gain error	<0.07% <0.15%		of the reading, at 25°	С
Gain drift		6 ppm/K	ranges ≤±2 V	over entire temp. range
		36 ppm/K	ranges ≥±5 V	
Offset error	<0.05%		of input range	
Offset drift		3 ppm/K	over entire temperat	ure range

Temperature measurement - Thermocouples				
Parameter	Value typ.	min. / max.	Remarks	
Input mode	R, S, B, J,	T, E, K, L, N		
Input ranges	-270°C to 1370°C -270°C to 1100°C -270°C to 500°C		type K	
Resolution	0.063 K	(1/16 K)		
Measurement error (gain error + offset)		<±0.5 K ±0.05%	type K, range -150°C to 1200°C plus indicated value	
Drift (gain error + offset)	±0.02 K/K·ΔT _a		$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature	
Error of cold junction compensation		<±0.15 K	DSUB (ACC/DSUBM-T4)	
		<±0.5 K	thermo plug (green) type K	
		<±0.7 K	thermo plug (white) with type K	
		<±1 K	thermo plug (white) other types	
Drift of cold junction temp.	±0.001 K/K·ΔT _a		$\Delta T_a = T_a-25^{\circ}C $; with $T_a = $ ambient temperature	
Sensor breakage recognition	display: "-2000°C"		indicating unconnected input	

Temperature measurement – PT100 (RTD)				
Parameter	Value typ.	min. / max.	Remarks	
Input range	-200°C t	:o 850°C		
	-200°C to	o +250°C		
Resolution	0.063 K	(1/16 K)		
Measurement error	<±0.1 K		-200°C to +850°C,	
(gain error + offset)			4-wire configuration	
	±0.05%		plus indicated value	
Drift	±0.01 K/K·ΔT _a		$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature	
(gain error + offset)	٠			
Reference current (PT100)	250) μΑ	non-isolated (CHASSIS is Ground)	

Find here the description of the OSC-16 Isolated: Voltage, current (20 mA), temperature 1901. Technical data of the sensor supply module SUPPLY (optional) 4461.

9.7.14 SC2-32 Voltage, Current (20 mA), IEPE/ICP

Parameter	Value typ.	min. / max.	Remarks
Inputs	32		differential, analog, non isolated
Measurement modes	voltage measurement		with ACC/DSUB-ICP4
DSUB		easurement	,
	transducer w	vith constant	(e.g. ICP™-, DELTATRON®-Sensors)
	current	t supply	
Measurement modes			
LEMO	voltage me	easurement	
	current me	easurement	with external shunt
Filter (digital)			
Frequency	50 kHz, 20 kHz,	10 kHz to 20 Hz	
Characteristic			Cauer, Butterworth, Bessel
Order			low pass filter 8. order
			Anti-aliasing filter:
			Cauer 8. order with $f_{cutoff} = 0.4 f_{s}$
Sampling rate	≤100 kHz		per channel
			total sampling rate 400 kHz
Bandwidth	0 Hz to 20 kHz		-0.1 dB
	0 Hz to 28 kHz		-3 dB (analogue 5th order
			Anti-aliasing filter)
Terminal connection			
DSUB	8x DS	UB-15	4 channels per plug
	2x DSUB-37		16 channels per plug
LEMO	32x LEMO		1 channel per plug
TEDS - Transducer Electronic	conforming t	o IEEE 1451.4	esp. with ACC/DSUBM-TEDS-xx (DS2433) see
DataSheets	Class II MMI		notes in chap. TEDS 82
Characteristic curve	user d	lefined	see detailed overview of supported device
linearization	(max. 1023 sup	oporting points)	family 296

Voltage measurement				
Parameter	Value typ.	min. / max.	Remarks	
Input ranges	·	V, ±2.5 V,		
	±1 V, ±500 ľ	mV, ±250 mV		
Overvoltage protection		±40 V	permanent channel to chassis	
Input impedance	20 ΜΩ	±1%	differential,	
			>10 kΩ off-state	
Gain: error	0.02%	≤0.05%	of reading	
drift	±8 ppm/K·∆T _a	±30 ppm/K·∆T _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a = ambient temperature$	
Offset: error	0.02%	≤0.05%	of range	
drift	±20 μV/K·ΔT _a	±40 μV/K·ΔΤ _a	±10 V to ±2.5 mV	
	±1.7 μV/K·ΔΤ ₃	±3 μV/K·ΔΤ ۣ	±1 V to ±250 mV	
	a a	a a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a = ambient temperature$	
Max. common mode voltage		±12 V		
Common mode rejection			common mode test voltage:	
ranges ±10 V to ±2.5 V	-87 dB	-72 dB	$\pm 10 \text{ V}_{=}$ and 7 V _{rms} , 50 Hz	
±1 V to ±250 mV	-107 dB	-92 dB		
Channel to channel crosstalk			test voltage: ±10 V ₌ and 7 V _{rms} ,	
ranges ±10 V to ±2.5 V	-98 dB		0 Hz to 1 kHz; range: ±10 V	
±1 V to ±250 mV	-116 dB			
Noise			bandwidth:	
	$23 \mu V_{rms}$	$30 \mu V_{rms}$	0.1 Hz to 10 kHz	

Current measurement			
Parameter	Value typ.	min. / max.	Remarks
Input ranges	±50 mA, ±20 mA	A, ±10 mA, ±5 mA	50Ω shunt in terminal plug
Max. overload		±60 mA	permanent
Input configuration	differ	ential	50 Ω shunt plug
Gain: error drift	0.02% ±20 ppm/K·ΔT _a	≤0.06% ≤0.1% ±55 ppm/K·ΔT _a	of reading plus error of 50 Ω shunt $\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature
Offset: error drift	0.02% ±30 nA/K·ΔT _a	≤0.05% ±80 nA/K·ΔT _a	of range $\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature
Auxiliary supply	+5 V (max. 160 mA	/ plug) not isolated	e.g. for ICP-expansion plug

Find here the description of the SC2-32 1931.

9.8 Universal

9.8.1 UNI-4 isolated: Voltage, Current (20 mA), Temperature, Bridge, IEPE

Inputs, measurement modes, terminal connection			
Parameter	Value	Remarks	
Inputs	4		
Measurement modes DSUB		ACC/DSUBM-UNI2 for all modes	
isolated measurement modes:	voltage measurement (differential)		
	current measurement	with Shunt-plug (ACC/DSUBM-I2)	
	thermocouple measurement		
non-isolated	voltage measurement (single-end)		
measurement modes:	current measurement	with internal Shunt	
	bridge-sensor		
	strain gauges		
	PT100/PT1000		
	(3- and 4-wire connection)		
	current fed sensors (IEPE/ICP)	with DSUB-15 extension plug	
		ACC/DSUBM-ICP2I-BNC-S/-F, isolated	
Measurement modes LEMO			
isolated measurement modes:	voltage measurement (differential)		
	thermocouple measurement	with ACC/TH-LEM-150	
non-isolated	voltage measurement (single-end)		
measurement modes:	current measurement	with internal shunt	
	bridge-sensor		
	strain gauges		
	PT100/PT1000		
	(3- and 4-wire connection)		
Terminal connections			
Standard	2x DSUB-15	2 channels per plug	
LEMO	4x LEMO.1B.307	1 channel per plug	

Individual Sensor- and Bri	Individual Sensor- and Bridge supply				
Parameter	Value	Remarks			
Output-Voltage	channel-wise individually configurable	5 possible settings			
	15 V, 12 V, 10 V, 5 V, 2,5 V	standard version			
	5 settings configurable out of:	special version, special order			
	24 V, 15 V, 12 V, 10 V, 5 V, 2.5 V, 1 V, 0.5 V, 0.25 V				
Short circuit protection	unlimited duration				
Output power	0.5 W / channel	≥5 V			
	0.2 W / channel	≤2.5 V			
Accuracy	±0.2%	At the amplifier terminals, no load.			
		Does not affect the accuracy in bridge mode (live software compensation of actual value and of additional cable loss via SENSE)			
Sampling rate, Bandwidth	, Filter, TEDS				
Parameter	Value	Remarks			
Sampling rate	≤100 kHz	per channel			
Bandwidth	0 Hz to 48 kHz 0 Hz to 46 kHz	-3 dB 0.2 dB			
Filter					
cut-off frequency characteristic order	10 Hz to 20 kHz	Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8.order with f _{cutoff} = 0.4 f _s			
Resolution					
CRC, CRSL	16 Bit	internal processing 24 Bit			
CRFX		output format is selectable for			
	16 Dit	each channel individually:			
	16 Bit 24 Bit	a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)			
TEDS - Transducer	conforming to IEEE 1451.4	esp. with ACC/DSUBM-TEDS-xx (DS2433)			
Electronic DataSheets	Class II MMI	not supported DS2431 (typ. IEPE/ICP sensor) see			
Characteristic curve	user defined	see detailed <u>overview of supported device</u>			
linearization	(max. 1023 supporting points)	family 296			

General - the following statements only apply for CRC, CRSL			
Parameter	Value	Remarks	
Isolation of voltage channels	channel-wise galvanically-isolated	voltage channels isolated against each other and against system ground (housing, CHASSIS), Isolation with IEPE/ICP plug: depending on connector type	
Bridge excitation voltage isolation	not isolated	Isolated against additional electronics (all sensor power supplies, bridge and input wiring, TEDS, etc.) with common reference ground "-VB". galvanically connected with system ground (housing, CHASSIS)	
Max common mode voltage isolated mode tested:	±60 V 300 V (10 s)	against system ground (housing, CHASSIS)	
Max common mode voltage non-isolated mode	±10 V	against system ground (housing, CHASSIS)	

General only with CRFX			
Parameter	Value	Remarks	
Isolation of voltage channels	channel-wise galvanically-isolated	voltage channels isolated against each other and against system ground (housing, CHASSIS), as well as against common reference and all bridge excitation voltages "-VB"	
		Isolation with IEPE/ICP plug: depends on plug type	
Bridge excitation voltage isolation	not channel-wise isolated	isolated against additional electronics (all sensor power supplies, bridge and input wiring, TEDS, etc.) with common reference ground "-VB"	
		Block-isolated against system ground (housing, CHASSIS)	
Max common mode voltage			
isolated mode	±60 V	against internal reference ground "-VB", against system ground (housing, CHASSIS)	
tested:	300 V (10 s)		
Max common mode voltage non-isolated mode	±10 V	against internal reference ground "-VB"	
		Also for "non-isolated" mode, there is an additional global block-isolation of the entire internal measurement electronics from the housing (CHASSIS)	

General				
Parameter	Value typ.	min. / max.	Remarks	
Overvoltage protection	±100 V		differential input vol	tage (continuous)
(inputs +IN, -IN)	ESD	2 kV	human body model	
	transient protection: automotive load dump ISO 7636		R _i =30 Ω, t _d =300 μs, t	_r <60 μs
Input coupling	С	OC .		
Input impedance	10	ΜΩ	voltage mode (range temperature mode	: ≤±2 V),
	1 [ΜΩ	voltage mode (range	: ≥±5 V)
Input current operating conditions on overvoltage condition	1 mA	2.4 nA	V _{in} >5 V on ranges <	<±2 V
Input noise			range ≤±25 mV	
	$2.2~\mu V_{rms}$ / $15~\mu V_{pkpk}$		bandwidth 0.1 to 48	3 kHz
	$0.3~\mu V_{rms}$ / $2.1~\mu V_{pkpk}$		bandwidth 0.1 to 1	kHz
	$0.1~\mu V_{pkpk}$		bandwidth 0.1 to 10) Hz
	10 nV / vHz		spectral noise densit	y (at 1 kHz)
CMRR (common mode rejection ratio) / IMR	>145 dB (50 Hz) >80 dB (50 Hz)		range ≤±2 V range ≥±5 V	$R_{\text{source}} = 0 \Omega$
Spurious free dynamic range (SFDR)	>80 dB (10 kHz) >95 dB (1 kHz)		range ≤±2 V	
	>84 dB (10 kHz) >100 dB (1 kHz)		range ≥±5 V	
Auxiliary supply			for IEPE/ICP-extension	on plug
voltage	+5 V	±5%	independent of integ	
available current internal resistance	0.26 A 1.0 Ω	0.2 A <1.2 Ω	sensor supply, short- power per DSUB-plu	-

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Voltage input range	±60 V, ±50 V, ±25 V, ±10 V, ±5 V, ±2 V, ±1 V, ±500 mV, ±250 mV, ±100 mV, ±50 mV, ±25 mV, ±10 mV, ±5 mV, ±2.5 mV		with single-end mode: max. ±10 V
Input configuration	differential	/ single-end	
Gain error	<0.02%	<0.05%	of the measured value, at 25°C
Gain drift		20 ppm/K·ΔT _a	range ≤±2 V
		60 ppm/K·ΔT _a	range ≥±5 V
			$\Delta T_a = T_a-25^{\circ}C $; with $T_a = ambient temperature$
Offset error			of the range
		0.01%	range ≥±50 mV
		10 μV	range ≤±25 mV
Offset drift	0.7 μV/K·ΔT _a		range ≤±25 mV
			$\Delta T_a = T_a-25^{\circ}C $; with $T_a = ambient temperature$

Current measurement with Shunt-Plug				
Parameter	Value typ.	min. / max.	Remarks	
Current input range	±40 mA, ±20) mA, ±10 mA		
Shunt-Resistor	50	Ω	external plug ACC/DSUBM-I2	
Input configuration	differential		isolated	
Gain error	<0.02%	<0.05% <0.1%	of the measured value, at 25°C additional error of 50 Ω in plug	
Gain drift	10 ppm/K·ΔT _a	30 ppm/K·ΔT _a	$\Delta T_a = T_a - 25$ °C ; with $T_a = $ ambient temperature	
Offset error		<0.01%	of the range, at 25°C	

Current measurement with internal shunt				
Parameter	Value typ.	min. / max.	Remarks	
Current input range	· · · · · · · · · · · · · · · · · · ·	mA, ±10 mA, mA, ±1 mA		
Shunt-Resistor	12	0 Ω	internal	
Input configuration	singl	e-end	not isolated	
Gain error	<0.02%	<0.05%	of the measured value, at 25°C	
Gain drift	10 ppm/K·ΔT _a	30 ppm/K·ΔT _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a = $ ambient temperature	
Offset error		<0.01%	of the range, at 25°C	

Bridge measurement			
Parameter	Value typ.	min. / max.	Remarks
Mode	D	C	
Measurement modes	full, half, qu	arter bridge	
Measurement range			
bridge supply: 10 V	±1000 mV/V, ±500 mV/V, ±200 mV/V, ±100 mV/V, ±50 mV/V, ±25 mV/V, ±0.5 mV/V, ±0.25 mV/V		
bridge supply: 5 V	±200 mV/V,	', ±400 mV/V, . ±100 mV/V, mV/V, ±0.5 mV/V	
bridge supply: 2.5 V	1 1	mV/V, ±200 mV/V, 2 mV/V, ±1 mV/V	
(bridge supply: 1 V)	±1000 mV/V,	, ±2.5 mV/V	special order
(bridge supply: 0.5 V)	±1000 mV/V	, , ±5 mV/V	special order
(bridge supply: 0.25 V)	±800 mV/V,	, ±10 mV/V	special order
Bridge supply	0.25 V	to 10 V	selectable for each channel possible options: see above
Minimum bridge impedance	50	0 Ω) Ω 2 Ω	bridge supply = 10 V bridge supply = 5 V bridge supply = 2.5 V
Cable-Compensation			
full bridge / half bridge	4-wire-technique 3-wire-technique with shunt-calibration		any cable for symmetric (similar) cables one-time non-adaptive compensation
quarter bridge	full compensation in 3-wire-technique		including Gain-Correction!
Quarter bridge completion	120 Ω, 35	50 Ω, 1 kΩ	switched per software / bridge supply ≤5 V
Automatic shunt-calibration (calibration step)	0.5 ו	mV/V	with 120 Ω and 350 Ω
Input impedance	6.7 ΜΩ	±1%	differential, full bridge
Gain error	<0.02%	<0.05%	of the reading, at 25°C
Gain drift		20 ppm/K·∆T _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature
Offset error	within residu	ial noise band	
Offset drift		0.14 μV/V /K·ΔT _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a = $ ambient temperature
Drift half bridge	0.5 μV/V / °C	1 μV/V / °C	additional drift of internal half bridge completion
Bridge offset balancing range	≥100% of mea	surement range	
	≥±4 r	nV / V	valid for the entire meas. range
Cable resistance	<6	0 Ω	120 Ω bridge
max cable length (simple)	<46	60 m	0.14 mm², 130 mΩ / m

Temperature measurement			
Thermocouple	Value typ.	min. / max.	Remarks
Measurement mode	J, T, K, E,	N, S, R, B	
		L	available with CRC and CRFX variant
		С	only with CRFX variant available
Measurement range	-270°C t	to 1370°C to 1100°C to 500°C	type K
Resolution		(1/16 K) 4 Bit mantissa)	With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)
Measurement error			with type K
(gain + offset)		<±0.6 K <±1.0 K	range -150°C to 1100°C else
Drift		±0.02 K/K·ΔT _a	type K, range -270°C to 1100°C
(gain + offset)		±0.05 K/K·ΔΤ	type K, range -270°C to 1370°C
		a	$\Delta T_a = T_a - 25^{\circ}C $; with $T_a =$ ambient temperature
Error of cold junction compensation		<±0.15 K	with ACC/DSUBM-UNI2
Cold junction drift	±0.001 K/K·ΔT _a		$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature

Temperature measurement				
PT100 / PT1000	Value typ.	min. / max.	Remarks	
Measurement range	-200°C to 850°C -200°C to 250°C			
Resolution	0.063 K (1/16 K) 32 bit float (24 Bit mantissa)		With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)	
Measurement error	<±0.05%		of the measured value	
Offset error		<±0.1 K	4-wire connection	
Offset drift		+0.01 K/K·ΔT _a	$\Delta T_a = T_a - 25$ °C ; with $T_a =$ ambient temperature	
Sensor feed	250 μΑ			

The following technical statements only apply for this CRONOSflex module!

Block isolation			
Parameter	Value	Remarks	
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE) Exception: additional individual isolated voltage channels	
Isolation impedance	500 kΩ 1 nF		
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground	
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing	

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Power supply of this CRONOS <i>flex</i> module			
Parameter	Value	Remarks	
Input supply voltage	10 V to 50 V DC		
Power consumption	10 W	10 V to 50 V DC	
Isolation	60 V	nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	

Terminal connections of the module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches for optional individually power supply	
Module connector	2x 20 pin	direct connection of modules (click) supply and system bus	

Pass through power limits	
Directly connected (clicked)	
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)
	Equivalent power with chosen DC power input:
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)
	37 W @ 12 V DC (typical vehicle supplied DC input)
Power-over EtherCAT (PoEC) for remote imc CRONOSflex	
Modules	350 mA (maximum current, corresponding to IEEE 802.3)
	Equivalent power with chosen DC power input:
	• 17.5 W @ 50 V DC (e.g. Power Handle)
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
	14.7 W @ 42 V DC (minimum voltage for PoEC)
	Note: minimum system power of 42 V DC required for PoEC

Operating conditions			
Parameter	Value	Remarks	
Operating environment	dry, non corrosive environment within specified operating temperature range		
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1	
Ingress protection rating	IP20		
Pollution degree	2		
Operating temperature (standard)	-10°C to +55°C without condensation		
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed	
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure		
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request	
Dimensions	43.3 x 118 x 186 mm	WxHxD	
Weight	850 g		

Find here the description of the UNI-4 1217.

9.8.2 UNI2-8: Voltage, Current (20 mA), Temperature, Bridge, IEPE/ICP

Inputs, measurement modes, terminal connection			
Parameter	Value	Remarks	
Inputs	8		
Measurement modes	voltage measurement current measurement	ACC/DSUBM-UNI2 Single-ended (internal shunt) or shunt plug ACC/DSUBM-I2	
DSUB-15	bridge sensor strain gauge	full, half, quarter bridge	
	thermocouple measurement PT100 (3- and 4-wire configuration)		
	current-fed sensors (IEPE/ICP)	with DSUB-15 expansion plug: (ACC/DSUB-ICP2, not isolated ACC/DSUBM-ICP2I-BNC-S/-F, isolated)	
Measurement modes	voltage measurement		
LEMO	current measurement		
	thermocouple measurement	LEMO plug with built-in cold-junction compensation (CJC) ACC/TH-LEM-150	
	bridge sensor		
	strain gauge	full, half, quarter bridge	
	PT100 (3- and 4-wire configuration)		
Terminal connection			
DSUB-15 LEMO	4x DSUB-15 8x LEMO.1B.307	2 channels per plug 1 channel per plug	

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	Value	Remarks	
Sampling rate	≤100 kHz	per channel	
Maximum system throughput	800 kHz (CRFX)	of all CRFX module channels including monitor channels	
Bandwidth	0 Hz to 48 kHz 0 Hz to 30 kHz 0 Hz to 10 Hz	-3 dB -0.1 dB -3 dB for temperature measurement	
Filter (digital)			
cut-off frequency characteristic type and order	10 Hz to 20 kHz	Butterworth, Bessel low pass or high pass filter: 8th order band pass: LP 4th and HP 4th order Anti-aliasing filter: Cauer 8th order with f _{cutoff} = 0.4 f _s	
Resolution CRC, CRSL CRFX	16 Bit	internal processing 24 Bit output format is selectable for each channel individually:	
	16 Bit 24 Bit	a) 16 Bit Integer b) 32 Bit Float (24 Bit Mantissa)	

Sampling rate, Bandwidth, Filter, TEDS			
Parameter	Value	Remarks	
TEDS Transducer Electronic Data Sheets	conforming to IEEE 1451.4 Class II MMI	esp. with ACC/DSUBM-TEDS-xx (DS2433) not supported: DS2431 (typ. IEPE/ICP sensor) see notes in chap. TEDS	
Characteristic curve linearization	user defined (max. 1023 supporting points)	see detailed <u>overview of supported device</u> family 296	

General			
Parameter	Value typ.	min. / max	Remarks
Overvoltage protection			permanent, differential
		±80 V	input range >±10 V or device off
		±50 V	input range ≤±10 V
Input coupling	DC		
Input configuration	differential		
Input impedance	1 ΜΩ		range >±10 V
	20 ΜΩ		range ≤±10 V
Auxiliary supply			for IEPE/ICP-expansion plug
voltage	+5 V	±5 %	independent of integrated
available current	0.26 A	0.2 A	sensor supply, short-circuit protected
internal resistance	1.0 Ω	<1.2 Ω	power per DSUB-plug

Voltage measurement			
Parameter	Value typ.	min. / max.	Remarks
Input range	1	0 V, ±5 V, ±2.5 V,	
	±1 V to	o ±5 mV	
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS;
			input range ≤±10 V
Gain error	0.02 %	0.05 %	of the measured value, at 25 °C
Gain drift	10 ppm/K·ΔT _a	30 ppm/K·ΔT _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a = $ ambient temperature
Offset error			of the range, at 25 °C
	0.02 %	≤0.05 %	range >±50 mV
		≤0.06 %	range ≤±50 mV
		≤0.15 %	range ≤±10 mV
Offset drift	±40 μV/K·ΔT _a	±200 μV/K·ΔT _a	range >±10 V
	±0.7 μV/K·ΔΤ _a	±6 μV/K·ΔT _a	range ±10 V to ±0.25 V
	±0.1 μV/K·ΔΤ _a	±1.1 μV/K·ΔΤ _a	range ≤±0.1 V
			$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature
Non-linearity	30 ppm	90 ppm	
CMRR (common mode			DC and f≤60 Hz
rejection ratio)	80 dB	>70 dB	range ±50 V to ±25 V
	110 dB	>90 dB	range ±10 V to ±50 mV
	138 dB	>132 dB	range ±25 mV to ±5 mV
Noise	3.6 μV _{rms}	5.5 μV _{rms}	range 0.1 Hz to 50 kHz
	0.6 μV _{rms}	1.0 μV _{rms}	range 0.1 Hz to 1 kHz
	0.14 μV _{rms}	0.26 μV _{rms}	range 0.1 Hz to 10 Hz

Current measurement with shunt plug			
Parameter	Value typ.	min. / max.	Remarks
Input range		A, ±10 mA, ±5 mA, A, ±1 mA	
Shunt impedance	5	0 Ω	external plug ACC/DSUBM-I2
Over load protection		±60 mA	permanent
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS
Input configuration	differ	rential	
Gain error	0.02 %	0.06 % 0.1 %	of the reading, at 25 °C additional error of 50 Ω in plug
Gain drift	15 ppm/K·∆T _a	55 ppm/K·ΔT _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature
Offset error	0.02 %	0.05 %	of the range, at 25 °C
Noise			Bandwidth:
	40 nA _{rms}	70 nA _{rms}	0.1 Hz to 50 kHz
	0.7 nA _{rms}	12 nA _{rms}	0.1 Hz to 1 kHz
	0.17 nA _{rms}	0.3 nA _{rms}	0.1 Hz to 10 Hz

Current measurement with i	nternal shunt		
Parameter	Value typ. min. / max.		Remarks
Input range	· ·	, ±10 mA, ±5 mA, , ±1 mA	
Shunt impedance	12	0 Ω	internal
Over load protection		±60 mA	permanent
Maximum input voltage		-11 V to +15 V	between ±IN and CHASSIS
Input configuration	Single-	-ended	internal current sink to -VB
Gain error	0.02 %	0.06 %	of the reading, at 25 °C
Gain drift	15 ppm/K·ΔT _a	55 ppm/K·∆T _a	$\Delta T_a = T_a - 25$ °C ; with $T_a = $ ambient temperature
Offset error	0.02 %	0.05 %	of the range, at 25 °C
Noise	40 nA _{rms}	70 nA _{rms}	Bandwidth: 0.1 Hz to 50 kHz
	0.7 nA _{rms}	12 nA _{rms}	0.1 Hz to 1 kHz
	0.17 nA _{rms}	0.3 nA _{rms}	0.1 Hz to 10 Hz

Bridge measurement				
Parameter	Value typ. min. / max.		Remarks	
Mode	D	C		
Measurement modes	full, half, qu	arter bridge	bridge supply ≤5 V with quarter bridge	
Input range		′, ±500 mV/V, ±100 mV/V		
with bridge supply: 10 V	±0,	5 mV/V		
with bridge supply: 5 V	±1	. mV/V		
with bridge supply: 2.5 V	±2	mV/V	(as an option)	
with bridge supply: 1 V	±5	mV/V	(as an option)	
Bridge supply	10 V 5 V	±0.5 % ±0.5 %	The actual value will be dynamically captured and compensated for in bridge mode.	
(as an option)	2.5 V and 1 V			
Minimum bridge impedance	120 Ω full bridge 60 Ω half bridge			
Maximum bridge impedance	5	kΩ		
Quarter bridge completion	120 Ω,	, 350 Ω	internal, switchable per software	
Input impedance	20 ΜΩ	±1 %	differential, full bridge	
Gain error	0.02 %	0.05 %	of the reading, at 25 °C	
Gain drift	20 ppm/K·ΔT _a	50 ppm/K·ΔT _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature	
Offset error	0.01 %	0.02 %	of input range, at 25°C, after automatic bridge balancing	
Automatic shunt-calibration (calibration jump)	0.5 mV/V	±0.2 %	for 120 Ω and 350 Ω	

Temperature measurement - Thermocouples			
Parameter	Value typ.	min./ max.	Remarks
Measurement mode	J, T, K, E,	N, S, R, B	
Measurement range	-270 °C to 1370 °C -270 °C to 1100 °C -270 °C to 500 °C		type K
Resolution	0.063 K	(1/16 K)	16-Bit integer
Measurement error		0.06 % 0.05 %	type K of measurement range, at 25 °C of reading (total uncertainty min. 0.85 K)
Drift	0.02 K/K·ΔT _a	0.05 K/K·ΔT _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature
Error of cold junction compensation		±0.15 K	with ACC/DSUBM-UNI2, at 25 °C
Cold junction drift	±0.001 K/K·ΔT _a		$\Delta T_a = T_a-25^{\circ}C $; with $T_a = $ ambient temperature

RTD (PT100)			
Parameter	Value typ.	min. / max.	Remarks
Input range		:o 850 °C :o 250 °C	
Resolution	0.063 K		
Measurement error			
4-wire measurement		0.25 K +0.02 %	-200 °C to 850 °C of measured value of resistance
		0.1 K +0.02 %	-200 °C to 250 °C of measured value of resistance
3-wire measurement		0.42 K +0.03 %	-200 °C to 850 °C of measured value of resistance
		0.38 K +0.02%	-200 °C to 250 °C of measured value of resistance
			Precision for 3-wire mode: with individual adjustment, only (special version upon request)
Drift		0.01 K/K·ΔT _a	$\Delta T_a = T_a-25^{\circ}C $; with $T_a =$ ambient temperature
Sensor feed (PT100)	1.25 mA		

Sensor supply					
Parameter	Value typ. max.		max.	Remarks	
Configuration options	5 se	electable	e settii	ngs	always 5 selectable voltage settings default selection: +5 V to +24 V
Output voltage	Voltage	Curr	ent	Power	set jointly for all eight channels
	(+1 V) (+2.5 V) +5.0 V +10 V +12 V	580 580 580 300	mA mA mA	0.6 W 1.5 W 2.9 W 3.0 W	upon request, also 2.5 V and 1 V settings are available, for example by replacing the +12 V or +15 V setting. An arbitrary set of 5 setting can be chosen preferred selections:
	+12 V +15 V	200		3.0 W	+24 V, +12 V, +10 V, +5.0 V, +2.5 V +15 V, +10 V, +5.0 V, +2.5 V, +1 V
	+24 V (±15 V)	120 190		2.9 W 3.0 W	upon request, special order: ± 15 V can be replaced by ± 15 V. This eliminates the internal current- and quarter bridge measurement.
Isolation - applies for imc CRO	DNOScompact	, imc CF	RONOS	S-SL and PL s	ystems
Isolation	non isolated				output to case (CHASSIS)
Block isolation only applies for	or imc CRONO	Sflex			
Block isolation	60 V			Isolation of the entire global sensor supply (for all 8 channels, reference ground: "-VB") as well as the internal electronics from housing (CHASSIS, PE)	
					_
Short-circuit protection	un	limited	durati	on	to output voltage reference ground: "-VB"
Compensation of cable resistances	3-line control: SENSE line as refeed (-VB: supply ground)				calculated compensation with bridges
Accuracy of output voltage	<0.25 % 0.5 % 0.9 % 1.5 %		0.9 %	at terminals, no load at 25°C over entire temperature range plus with optional bipolar output voltage	
Max. capacitive load			>	4000 μF 1000 μF •300 μF	2.5 V to 10 V 12 V, 15 V 24 V

The following technical statements only apply for this CRONOSflex module!

Block isolation			
Parameter	Value	Remarks	
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)	
Isolation impedance	500 kΩ 1 nF		
Internal reference ground	-VB, GND, TEDS_GND	all channels with one common, galvanically connected reference ground	
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing	

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Devices or modules purchased before ca. 2012 do not feature block isolation.

Power supply of this CRONOS <i>flex</i> module			
Parameter	Value	Remarks	
Input supply voltage	10 V to 50 V DC		
Power consumption	10.1 W	10 to 50 V DC	
		incl. 120 Ω 5 V load to all channels	
Isolation	60 V	nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	

Terminal connections of the module			
Parameter	Value	Remarks	
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded, 2-notch connector for optional individual power supply	
Module connector	2x 20 pin	Click-mechanism provides direct connection of modules (supply and system bus) without additional cabling	
Pass through power limits			
Directly connected (clicked) imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)		
	Equivalent power with chosen DC power input:		
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)		
	37 W @ 12 V DC (typical vehicle supplied DC input)		
Power-over EtherCAT (PoEC) for remote imc CRONOSflex			
Modules	350 mA (maximum current according to IEEE 802.3)		
	Equivalent power with chosen DC power input:		
	• 17.5 W @ 50 V DC (e.g. Power Handle)		

16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
14.7 W @ 42 V DC (minimum voltage for PoEC)
Note: minimum system power of 42 V DC required for PoEC

Operating conditions				
Parameter	Value	Remarks		
Operating environment	dry, non corrosive environment within specified operating temperature range			
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1		
Ingress protection rating	IP20			
Pollution degree	2			
Operating temperature (standard)	-10°C to +55°C	without condensation		
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed		
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure			
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request		
Dimensions	62 x 118 x 186 mm	WxHxD		
Weight	approx. 878 g			

Find here the description of the UNI2-8. 1951

9.9 DI, DO, Pulse Counter, SYNTH and DAC modules 9.9.1 DAC-8

Parameter	Value typ.	min. / max.	Remarks
Outputs	8		
Output level	±10 V		
Load current		max. ±10 mA	short circuit protection
Resolution	16	bit	
Linearity		max. 4 LSB	14-bit no missing codes
Max. output rate	50	kHz	with CRC, CRSL
	5 l	кНz	CRFX
Analog bandwidth	50	kHz	-3 dB, low pass 2nd order
Additional system delay		μs ±100 μs RFX)	delay from setting value (imc Online FAMOS) to analog output
Accuracy	±4 LSB (16 bit)		25°C
Offset error	<10 mV	<17 mV	25°C
Offset drift	0.06 mV / K		
Total offset error		<20 mV	over entire temperature range
Gain error	<0.29 %		25°C
Gain drift	25 ppm / K		
Total gain error		<0.8 %	over entire temperature range
Block isolation only applies for ir	nc CRONOS <i>flex</i> syste	ms	
Block isolation	60) V	DAC outputs and the driver units isolated from the housing (CHASSIS, PE)
Isolation impedance	500 kΩ	1 nF	
Internal reference ground	AGND		all channels with one common, galvanically connected reference ground
External reference ground	CHASSIS, metal housing		DAC outputs as one unit (8 channels), galvanically isolated from housing
Terminal connection	DSU	B-15	standard
	ВІ	NC	CRFX/DAC-8-BNC, CRSL/DAC-8-BNC

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Find here the description of the DAC-8 277.

General only concerning the imc CRONOS flex module (CRFX/DAC-8)			
Parameter	Value typ.	min. / max.	Remarks
Input supply voltage	10 V to 50 V DC		
Power consumption	6.5 W	9 W	10 V to 50 V DC
Isolation	60 V		nominal isolation specification of the supply input
Power-over EtherCAT (PoE)	minimal 42 V	DC necessary	supply via EtherCAT network cable

9.9.2 DI2-16: Digital Inputs

Parameter	Value typ.	min. / max.	Remarks
Channels	1	6	groups of 4 Bit with common ground reference,
	(with CRFX also 32 available)		galvanic isolation between groups
Input voltage level			configurable globally for 8 Bit at DSUB using the "LEVEL" pin:
	Т	ΤL	"LEVEL": Jumper to "LCOM"
	24	l V	"LEVEL": unconnected
Max input voltage	5.5	5 V	TTL mode
	30) V	24 V mode
Input configuration	diffe	rential	groups of 4 Bit
			galvanic isolation between groups of 4 Bit
Isolation strength	±1!	50 V	to system ground (housing, CHASSIS, PE) and between groups of 4 Bit (tested $\pm 200 \text{ V}$)
Switching time			edge detection;
HIGH-LOW	34 μs	130 μs	over entire temperature range
LOW-HIGH	3 μs	30 μs	
Additional system delay	typ. 400 μs ±100 μs (CRFX)		delay from input transition to changing state available in imc Online FAMOS
Input current	(C)	max. 500 μA	
Switching threshold		тивжи осо раз	
TTL (5 V)	V _{Lmax} = 0.8 V	V _{Hmin} = 2.0 V	
24 V	V _{Lmax} = 5.0 V	V _{Hmin} = 8.0 V	
Internal supply voltage,	5 V max. 100 mA		isolated
available at user pin "HCOM"			reference ground of both "HCOM" and "LEVEL" is "LCOM"
Terminal connection	DSUB-1	5 / 8 Bit	ACC/DSUBM-DI4-8

Find here the description of the digital inputs 256.

9.9.3 DI16-DO8-ENC4: Digital Multiboard

The Multi-IO-Module: **DI16-DO8-ENC4** comes with 16 digital inputs, 8 digital outputs and 4 inputs for capture of incremental encoder signals, RPM measurements, angle, frequencies etc.

Description of DI16-DO8-ENC4 260

9.9.3.1 Digital Inputs

Parameter	Value	Remarks
Channels	16	common ground reference for each 4-channel group, isolated from the other input group
Configuration options	TTL or 24 V input voltage range	 configurable at the DSUB globally for 8 Bits: jumper from LCOM to LEVEL: activates TTL-mode LEVEL unconnected: activates 24 V-mode
Sampling rate	≤10 kHz	
Isolation strength	±50 V	tested ±200 V
		isolated to system ground, supply and channel-to-channel
Input configuration	differential	
Input current	max. 500 μA	
Switching threshold	1.5 V (±200 mV)	5 V level
	8 V (±300 mV)	24 V level
Switching time	<20 μs	
Supply HCOM	5 V max. 100 mA	electrically isolated from system (case), Configuration signal "LEVEL" is referenced to HCOM, LCOM
Terminal connection	DSUB-15	ACC/DSUBM-DI4-8

Find here the description of digital inputs 2601.

9.9.3.2 Digital outputs

Parameter	Va	lue	Remarks
Channels / bits	8 bit		Group of 8 bits, galvanically isolated; common reference potential ("LCOM") for each group
Isolation strength	±50 V		to system ground (case, CHASSIS)
Output configuration		push-pull) or	configurable at the DSUB globally for 8 Bits:
	open	-drain	• jumper from OPDRN to LCOM: totem pole
			OPDRN unconnected: open-drain
Output level	Т	ΓL	internal, galvanically isolated supply voltage
	max. U _e		by connecting an external supply voltage U _{ext} with "HCOM", U _{ext} = 5 V to 30 V
State upon system power up	high impedance (High-Z)		Independent of output configuration (OPDRN-pin)!
Activation of the output stage following system start	upon first preparation of measurement		with initial states which can be selected in the experiment (High / Low) in the selected output configuration (OPDRN-pin)
Max. output current (typ.)	HIGH LOW		
TTL 24 V-logic open-drain	15 mA 0.7 A 22 mA 0.7 A 0.7 A		external clamp diode needed for inductive load
open-drain with intern. 5 V supply	160 mA		for all outputs
Output voltage	HIGH	LOW	for load current:
TTL	>3.5 V ≤0.4 V		I _{high} = 15 mA, I _{low} ≤0.7 A
24 V-logic (U _{ext} = 24 V)	>23 V ≤0.4 V		I _{high} = 22 mA, I _{low} ≤0.7 A
Internal supply voltage	5 V, 160 m	A (isolated)	available at terminals
Switching time	<10	0 μs	
Terminal connection	DSU	B-15	ACC/DSUBM-DO8

The description of the digital outputs 222.

9.9.3.3 ENC4: Pulse counter for incremental encoder

Parameter	Va	lue	Remarks
Channels		+ 1 acks)	four single-tracks or two two-track channels one index track
Measurement modes	Angle (abs), An Frequency, Speed,	Displacement (diff), gle (diff), Event, Velocity, Time and Jeasurement	only if the sampling rate is ≤ 1 ms
Sampling rate	≤50	kHz	per channel
Time resolution of measurement	31.2	5 ns	counter frequency: 32 MHz
Data resolution	16	bits	
Input configuration	differ	ential	
Input impedance	100) kΩ	
Input voltage range	±10	0 V	differential
Common mode input range	min11 V	max. +25 V	
Switching threshold	-10 V to	o +10 V	detection level selectable per channel
Hysteresis	min. 100 mV		selectable per channel
Analog bandwidth	500	kHz	-3 dB (full power)
Analog filter	Bypass (no Filter), 20 kHz, 2 kHz, 200 Hz		selectable (per-channel) 2 nd order Butterworth
Switching delay	500) ns	signal: 100 mV squarewave
CMRR	70 dB 60 dB	50 dB 50 dB	DC, 50 Hz 10 kHz
Gain error	<1	L %	of input voltage range @ 25 °C
Offset error	<1 %		of input voltage range @ 25 °C
Overvoltage strength	±50 V		to system ground
Sensor supply	+5 V, 3	300 mA	not isolated (reference: GND, CHASSIS)
Terminal connection	DSU	B-15	ACC/DSUBM-ENC4

The description of the incremental counter channels 265.

9.9.4 DI8-DO8-ENC4-DAC4

The Multi-IO-Module: **DI8-DO8-ENC4-DAC4** comes with **8 digital inputs** and **4 analog outputs**, 8 digital outputs and 4 inputs to capture incremental encoder signals.

The technical details of the DI16-DO8-ENC4 Multi-IO-Module apply, but with the additional 4 analog outputs and only 8 digital inputs instead of 16.

Description of DI8-DO8-ENC4-DAC4 269

9.9.4.1 Analog outputs

Parameter	Value typ.	min. / max.	Remarks
Channels		4	
Output level	±1	.0 V	
Load current	max. ±10 m	nA / channel	
Resolution	16	-bit	15-bit, no missing codes
Non-linearity	±2 LSB	±3 LSB	
Max. output frequency	50 kHz		
Analog bandwidth	50	kHz	-3 dB, low pass 2nd order
Gain error	<±5 mV	<±10 mV	-40 °C to 85 °C
Offset error	<±2 mV	<±4 mV	-40 °C to 85 °C
Terminal connection	DSU	JB-15	ACC/DSUBM-DAC4

The description of the analog outputs 2001.

9.9.5 DIO-HV-4: Digital inputs

4 digital inputs			
Parameter	typ. min. / max.		remarks
channels / bits		4	each isolated
terminal connections	screw termina	l 14 to 24 AWG	American Wire Gauge
	0.2mm² t	to 2.5mm²	for rigid or flexible line
isolation test voltage	3.6 l	<v<sub>RMS</v<sub>	50 Hz, 10 s between channels and chassis
electrical safety rating measurement category	250V / CAT III		in accordance with EN 61010-1
degree of pollution	2		in accordance with IEC 60664
max. input level ue		≤600 V	peak-to-peak or DC voltage
nom. input level ue	230 V _{RMS}	/ 350 VDC	
switching level Us			Schmitt-Trigger-characteristics
unipolar low unipolar high	<16 V >16.8 V	<14 V >18 V	Hysteresis 0.04 V typ.
current input	280 μΑ	<500 μΑ	u _e = -600 V to +600 V
circuit time low → high high → low	70 μs 23 μs	<180 μs <40 μs	

Description: digital inputs 258.

9.9.6 DIO-HV-4: Digital outputs

4 digital outputs			
Parameter	typ. min. / max.		remarks
channel / bits		4	mechanical closer
terminal connection	screw termina	l 14 to 24 AWG	American Wire Gauge
	0.2 mm ²	to 2.5mm²	for rigid and flexible lines
isolation test voltage	3.61	<v<sub>RMS</v<sub>	50 Hz Sinus; 10 s
electrical safety			
rating /	250 V ,	/ CAT III	according EN 61010-1
measurement category			
degree of pollution		2	according IEC 60664
switching time	5 ms	<8 ms	
max. switching power		<1000 VA	
switching voltage	>1 VDC <250 V _{RMS}		min. switching voltage at 1 mA
max. switching current	<1 A		250 V~ cosρ=1.0 0.4
	<4 A		250 V~ cosρ=1.0
contact impedance		<50 mΩ	

Description: digital outputs 259

9.9.7 DO-16: Digital Outputs

Parameter	Value typ.	min. / max.	Remarks
Channels	1	6	two 8-bit groups, isolated, common reference potential ("LCOM") for a group
Terminal connection	DSU	B-15	ACC/DSUB-DO8
Isolation strength	±5	0 V	to system ground (protection ground)
Output configuration	totem pole (push _l	oull) <i>or</i> open-drain	configurable with wire jumper ("ODRN" - "LCOM") in the connector pod
State following system start	High resista	nce (high-Z)	Independent of output configuration (OPDRN-pin)!
Activation of the output stage following system start	upon first preparation of measurement		with initial states which can be adjusted in the experiment (High / Low) in the selected output configuration (OPDRN-pin)
Output level	T	ΓL	internal isolated supply voltage
	<i>or</i> max. U _{ext} -0.8 V		by means of connecting an external supply voltage U _{ext} with "HCOM", $U_{ext} = 5 \text{ V to } 30 \text{ V}$
Max. output current (typ.) TTL 24 V-logic open-drain open-drain with intern. 5 V supply	HIGH 15 mA 22 mA 	LOW 0.7 A 0.7 A 0.7 A	external inverse diode needed with inductive load
Output voltage TTL 24 V-logic (U _{ext} = 24 V)	HIGH >3.5 V >23 V	LOW 0.5 Ω · I _{low} 0.5 Ω · I _{low}	with load current: $I_{high} = 15 \text{ mA}, I_{low} \le 0.7 \text{ A}$ $I_{high} = 22 \text{ mA}, I_{low} \le 0.7 \text{ A}$
Internal supply voltage available at contacts	5 V, 160 mA isolated		per 8-bit group; VCC_int = 5 V
Switching time	<16	5 μs	

Find here the description of the digital outputs 270.

9.9.8 DO-16-HC

Parameter	Va	lue	Remarks
Channels	1	.6	groups of 8 Bit, isolated, common reference
	(with CRFX also 32 available)		potential ("LCOM") for each group
Isolation strength	±50 V		to system ground (housing, CHASSIS, PE) and between groups of 8 Bit
Output configuration	Totem Pole (push-pull) Open Drain (LowSide) Open Source (HighSide)		configurable at DSUB with "OPDRN" - pin: "OPDRN": wire jumper to "LCOM" "OPDRN": open "OPDRN": 10 kΩ-resistor to "LCOM"
Output level		8 V to 28 V	connection of an external supply voltage U _{ext} to "HCOM", (Totem Pole or Open-Source)
		MOS 5 V	by means of internal isolated supply voltage and external pull-up-resistors (with 5 V, only Open-Drain configuration supported, no Totem-Pole / push-pull)
		or (max. 28 V)	external supply not required for Open-Drain operation
Max. output current (typ.) Totem Pole (8 V to 28 V) Open Source (8 V to 28 V) Open Drain (max. 28 V)	<u>HIGH</u> 0.7 A 0.7 A 	LOW 0.7 A 0.7 A	no external clamping diode required for
open-drain with internal 5 V supply		20 mA	inductive load switching
Output impedance	0.5	5 Ω	sink and source
Output voltage	HIGH U _{ext} -0.5 Ω · I _{high}	LOW 0.5 Ω · I _{low}	with load current: I _{high} and I _{low} ≤0.7 A
Internal supply voltage, available at user pin "HCOM"		60 mA ated	per 8-bit group; VCC_int = 5 V, decoupled from U _{ext} by diodes on HCOM
Protection mechanisms		circuit	quick response current limiting: 1.4 A (typ.), 2 A (max.)
		overload	unlimited duration
	•	load (surge)	current limiting
Ct-t-		d (load dump)	voltage limiting
State upon system power-up		ance (High-Z)	Independent of output configuration with selectable initial states
Activation of the output stage		paration of rement	(High / Low) in the selected output configuration
Connection of internal 5 V supply to contacts	upon preparation of measurement		VCC_int = 5 V via diodes at HCOM
Switching time	<30	00 μs	
Additional system delay		us ±100 μs RFX)	Delay, until the value (imc Online FAMOS) is available for output
Terminal connection	DSU	B-15	ACC/DSUBM-DO-HC-8 with high current capacity wiring recommended (HCOM / LCOM!)

Find here the description of the DO-16-HC 273.

9.9.9 ENC-4

Parameter	Value	Remarks
Inputs	4 + 1	4 channels with 2 tracks each (A, B)
	(9 tracks)	1 index-channel, all fully conditioned
Measurement modes	Displacement (abs), Displacement (diff), Angle (abs), Angle (diff), Event, Frequency, Speed, Velocity, Time and Puls Time Measurement	only if the sampling rate is ≤ 1 ms
Terminal connection	2x DSUB-15 / 2 channels	ACC/DSUBM-ENC-4(-IP65)
	or	ACC/DSUBM-ENC-4-IU
	4x LEMO/ 1 channel	for each group of 2 channels per plug INDEX only occupied on second socket
Sampling rate	≤50 kHz	
Time resolution of measurement	33 ns	counter frequency 32 MHz (primary sampling rate)
Resolution of data	16 bit	
Frequency stability	<100 ppm deterioration <± 5ppm / year	
Input configuration	differential	
Input impedance	100 kΩ	
Input voltage range (differential)	±10 V ±30 V	linear range maximum, outside of the linear range: max. non-linearity error: 300 ns
Common mode input voltage	max. ±30 V	
Switching threshold	-10 V to +10 V	globally selectable in 0.1 V steps
Hysteresis	0 % to 40 % of threshold , min. 100 mV	globally selectable in 0.1 V steps
Analog bandwidth	500 kHz	-3 dB (full power)
Analog filter	bypass (without filter), 20 kHz, 2 kHz, 200 Hz	selectable per channel Butterworth, 2nd order per channel
CMRR	70 dB (typ.), 50 dB (min.)	DC, 50 Hz
	60 dB (typ.), 50 dB (min.)	10 kHz
Switching delay	500 ns	level: 100 mV square wave
Gain uncertainty	<1 %	of the measured value, at 25 °C
Offset	<1 %	of the range, at 25 °C
Safe voltage (max.)	±50 V	long-term
Sensor supply	+5 V, 100 mA 300 mA (optional)	reference: GND

Find here the description of the ENC-4 278.

9.9.10 FRQ2-4 Frequency modulated signals

Inputs, measurement modes, terminal connection			
Parameter	Value	Remarks	
Inputs	4	for frequency modulated signals	
Measurement mode	frequency measurement		
Terminal connections	2x DSUB-15		

General			
Parameter	Value		Remarks
Input range	measurement range ±	center frequency	The center frequency will be provided by imc software after selection of the measurement
	3 kHz, 5 kHz, 12 kHz, 30 kHz, 50 kHz, 120 kHz	6 kHz, 10 kHz, 24 kHz, 60 kHz, 100 kHz, 240 kHz	range.
Sampling rate	≤50 kHz		per channel
Filter (digital) Frequency	50 Hz to 20 kHz		filtering of output data stream (frequency values)
Time resolution of the frequency measurement	3.9 ns		primary oszillator for frequency measurement: 256 MHz
Frequency stability of the primary oszillator	<100 ppm aging <±5 ppm / year		
Resolution		integer 4 bit mantissa)	With selected data type / output format: a) 16-Bit integer b) Float (24-Bit mode)

Differential-inputs			
Parameter	Value	Remarks	
Input configuration	differential		
Input voltage range	ΠL	treshold respectively hysteresis: 0.8 1.4 V	
Input impedance	50 kΩ		
Common mode input voltage	max. ±30 V		
CMRR	70 dB (typ.), 50 dB (min.) 60 dB (typ.), 50 dB (min.)	DC, 50 Hz 10 kHz	
Overvoltage protection	±50 V	long-term	

Parameter	Value	Remarks
Sensor supply	+5 V, 300 mA / module	block isolated from housing
		(CHASSIS, PE), reference: GND

Block isolation				
Parameter	Value	Remarks		
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS)		
Isolation impedance	500 kΩ 1 nF			
Internal reference ground	GND	all channels with one common, galvanically connected reference ground		
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing		

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

Power supply of the imc CRONOS <i>flex</i> module			
Parameter	Value	Remarks	
Input supply voltage	10 V to 50 V DC		
Power consumption	9 W	10 to 50 V DC	
Isolation	60 V	nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable	

Terminal connection of the module				
Parameter	Value	Remarks		
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components		
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply		
Module connector	2x 20-pin	direct connection of modules (click) supply and system bus		

Pass through power limits	
Directly connected (clicked)	
imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)
	Equivalent power with chosen DC power input:
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)
	37 W @ 12 V DC (typical vehicle supplied DC input)
Power over EtherCAT (PoEC)	
for remote imc CRONOSflex	350 mA (maximum current, corresponding to IEEE 802.3)
Modules	Equivalent power with chosen DC power input:
	• 17.5 W @ 50 V DC (e.g. Power Handle)
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)
	14.7 W @ 42 V DC (minimum voltage for PoEC)
	Note: minimum system power of 42 V DC required for PoEC

Operating conditions					
Parameter	Value	Remarks			
Operating environment	dry, non corrosive environment within specified operating temperature range				
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50% according IEC 61010-1				
Ingress protection rating	IP20				
Pollution degree	2				
Operating temperature (standard)	-10°C to +55°C	without condensation			
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed			
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure				
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request			
Dimensions	43.3 x 118 x 186 mm	WxHxD			
Weight	740 g				

9.9.11 Technical Specs - HRENC-4

Inputs, measurement modes, terminal connection				
Parameter	Value	Remarks		
Inputs	4 + 1 (9 tracks)	4 channels with 2 tracks (X, Y) each 1 index-channel, all fully conditioned		
Measurement modes	Displacement (abs), Displacement (diff), Angle (abs), Angle (diff), Event, Frequency, Speed, Velocity, Time and Puls Time Measurement	only if the sampling rate is ≤ 1 ms		
Terminal connection	2x DSUB-15 or 4x LEMO 1B.307	2 channels per DSUB (ACC/DSUBM-ENC4) 1 channel per LEMO		

General				
Parameter Value		Remarks		
Sampling rate	≤50 kHz	per channel		
Measurement time resolution	3.9 ns	Counter frequency 256 MHz (primary sampling rate) as of imc DEVICES 2.6 R2 SP1		
Data resolution	16 bit			
Sensor supply	+5 V, 300 mA / module	block isolated from housing (CHASSIS, PE), reference: GND Block isolation only with CRFX, else: not isolated (reference: GND, CHASSIS)		

Differential-inputs				
Input configuration	differential			
Input voltage range (differential)	±10 V ±30 V	linear range maximum range		
Input impedance	50 kΩ			
Common mode input voltage	max. ±30 V			
CMRR	70 dB (typ.), 50 dB (min.) 60 dB (typ.), 50 dB (min.)	DC, 50 Hz 10 kHz		
Overvoltage protection	±50 V	long-term		
Gain error	<1 %	25°C		
Offset error	<1 %	25°C		
Analog bandwidth	500 kHz	-3 dB (full power)		
Analog filter	Bypass (without filter), 20 kHz, 2 kHz, 200 Hz	adjustable (per channel) Butterworth, 2nd order		

Digital Analysis (comparator)				
Switching threshold	-10 V to +10 V	adjustable individual for each channels		
Hysteresis	0 % to 40 % off threshold , min. 100 mV	adjustable individual for each channels		
Switching delay	500 ns	modulation: 100 mV square wave		

Analog analysis (ADC)		
SIN/COS encoder analysis	8x12 Bit A/D-converter	8 channels of simultaneous sampling
Input voltage range	±1.5 V, ±10 V	(differential)

Sensor supply (HRENC-4-SUPPLY)						
Parameter	Value typ.		max.		Remarks	
Configuration options	Or	one voltage setting			must be selected out of 7 possible settings at the time of ordering	
Output voltage	Voltage	Cur	rent	Netpower	must be selected at the time of ordering	
possible settings	+2.5 V	580	mA	1.5 W		
	+5.0 V	580	mΑ	2.9 W		
	+10 V	300	mA	3.0 W		
	+12 V	250	mΑ	3.0 W		
	+15 V	200	mΑ	3.0 W		
	+24 V	120	mA	2.9 W		
±15 V 190 mA		3.0 W				
Block isolation	60 V				Isolation of the entire global sensor supply (reference ground "-SUPPLY, GND") as well as the internal electronics from housing (CHASSIS, PE)	
Short-circuit protection	uı	nlimited	l durat	ion	to output voltage reference ground	
Accuracy of output voltage				at terminals, no load		
	<0.25 %	ó	0.5 %		at 25°C	
		0.9 % 1.5 %		0.9 %	over entire temperature range	
				1.5 %	plus with optional bipolar output voltage	
Max. capacitive load		>400	00 μF		2.5 V to 10 V	
	>1000 μF			12 V, 15 V		
	>300 μF				24 V	

Block isolation				
Parameter	Value	Remarks		
Block isolation	60 V	all internal electronics isolated from the housing (CHASSIS, PE)		
Isolation impedance	500 kΩ 1 nF			
Internal reference ground	GND	all channels with one common, galvanically connected reference ground		
External reference ground	CHASSIS, metal housing	internal electronics as an entity, galvanically isolated from housing		



Note

Block isolation for improved suppression of ground loops and related interference. Does not constitute channel-wise individual isolation. Not rated nor intended for safety of equipment and personnel.

The following technical statements only apply for the CRONOSflex module!

Terminal connection of the imc CRONOS flex module (CRFX)				
Parameter	Value	Remarks		
EtherCAT connection	2x RJ45	system bus for distributed imc CRONOS <i>flex</i> components		
Input supply plug (female)	LEMO.EGE.1B.302	multicoded 2 notches, for optional individually power supply		
Module connector	2x 20-pin	direct connection of modules (click) supply and system bus		

Power supply				
Parameter	Value	Remarks		
Input supply voltage	10 V to 50 V DC			
Power consumption		10 to 50 V DC		
	7.4 W	CRFX/HRENC-4		
	13 W	CRFX/HRENC-4-SUPPLY		
Isolation	60 V	nominal isolation specification of the supply input		
Power-over EtherCAT (PoEC)	42 V to 50 V DC	supply via EtherCAT network cable		

Pass through power limits		
Directly connected (clicked) imc CRONOS <i>flex</i> Modules	3.1 A (maximum current)	
	Equivalent power with chosen DC power input:	
	• 149 W @ 48 V DC (e.g. AC/DC line adaptor)	
	37 W @ 12 V DC (typical vehicle supplied DC input)	
Power over EtherCAT (PoEC) for remote imc CRONOSflex	350 mA (maximum current, corresponding to IEEE 802.3)	
Modules	Equivalent power with chosen DC power input:	
	• 17.5 W @ 50 V DC (e.g. Power Handle)	
	• 16.8 W @ 48 V DC (e.g. AC/DC line adaptor)	
	• 14.7 W @ 42 V DC (minimum voltage for PoEC)	
	Note: minimum system power of 42 V DC required for PoEC	

Operating conditions			
Parameter	Value	Remarks	
Operating environment	dry, non corrosive environment within specified operating temperature range		
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1	
Ingress protection rating	IP20		
Pollution degree	2		
Operating temperature (standard)	-10°C to +55°C	without condensation	
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed	
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure		
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request	
Dimensions	43.3 x 118 x 186 mm	WxHxD	
Weight	approx. 730 g		



Reference

Find here the description of the HRENC-4 2851.

9.9.12 DI-16-HV

Parameter	Value typ.	min. / max.	Remarks
Channels	-	16	groups of 4 Bit with common ground reference; galvanic isolation between groups
Configuration option		r 110 V age range	Selectable via switch at the front (separately for every input group 18 and 916)
Input configuration	differ	ential	isolated from supply, groups of 4 Bit isolated from each other
Isolation strength	±1	50 V	to system ground (housing, CHASSIS) and between groups of 4 Bit (tested ±200 V)
Switching time			edge detection;
HIGH-LOW	50 μs	max. 150 μs	over entire temperature range
LOW-HIGH	250 μs	max. 350 μs	
Additional system delay	typ. 400	μs ±100 μs	delay from input transition to changing state available in imc Online FAMOS
Input current		max. 500 μA	110 V-logic level
Switching treshold	12.6 V	(±2.5 V)	24 V-logic level
	52.3 V	′ (±4 V)	110 V-logic level
Terminal connection	4x plugable t	terminal block	FMC 1,5/ 6-ST-3,5-RF (Phoenix Contact)



Reference

Find here the description: CRFX/DI-16-HV 254

9.9.13 SYNTH-8 Signal generator, synthesizer, realtime PID controller

Outputs, measurement mode, Terminal connection		
Parameter	Value	Remarks
Outputs	8	
Measurement mode	analog signal output (Synthesizer), real time-controller (PID)	
Terminal connection	2x DSUB-15	4 channels per plug
		ACC/DSUB(M)-SYNTH-4

Output rate, bandwidth, resolution		
Parameter	Value	Remarks
Max. output rate (synthesizer mode)	80 kHz	aggregate output rate of all activated channels
Max. output rate with linear interpolation	200 kHz	aggregate output rate
Max. output rate with extended interpolation: Double / triple integral	10 kHz	per channel
Max. output rate (controller mode)	10 kHz	per channel
Analog bandwidth	50 kHz	-3 dB, 3rd order low pass bandwidth of analog driver stage
Resolution	16 Bit	
Total size of memory for all segments	1.000.000 time-stamped samples 4.000.000 equidistant samples	imc format (*.DAT or *.RAW)

Analog output			
Parameter	Value typ.	min. / max.	Remarks
Output voltage range	±1	0 V	
Isolation	no galvan	ic isolation	signal reference: AGND (system ground)
Load current / channel		±10 mA	25°C
Load current / plug		±30 mA	current for all four channels of a plug at 25°C
Gain uncertainty		<0.05%	25°C
Gain drift		5 ppm /K	over entire temperature range
Offset	<2 mV	<5 mV	25°C
Offset drift		0.05 mV /K	over entire temperature range
Sensor supply	+5 V (max. 2	00 mA / plug)	reference "LCOM"
Linearity		2 LSB	

Digital inputs			
Parameter	Value	Remarks	
Channels	2	isolated, common reference potential ("LCOM")	
Input configuration	single-end	common reference: "LCOM"	
Input level	TTL / CMOS or 24 V logic	configurable with wire jumper ("LEVEL" - "LCOM") in the connector	

Controller functions			
Parameter	Value / Function	Remarks	
Maximum number of controllers	16	independent and parallel	
Set point variable	2 set point channels per controller	selection via control signal; dynamic switching, cross-fade with time constant	
Measured process variable (actual value)	2 actual value channels per controller	selection via control signal; dynamic switching, cross-fade with time constant	
Cascade control	any number of controllers arbitrarily cascadable: 2 to max. 16 cascade levels	dynamic set point channel switching: from channel to cascaded controller output	
Assignment of controllers to analog outputs	2 controllers per analog output (DAC)	selection via control signal dynamic controller output switching, cross-fade with time constant	
PID-controller parameter	dynamically alterable during continuous operation	changing PID variables individually or jointly (synchronously) as consistent parameter set	
PID parameter sets	2 complete dynamic sets per controller	selection via control signal; dynamic switching, e.g. reference- and working parameter sets	
Linearization of controller output variable	configurable characteristic curve	correction of actuator output non-linear characteristics by means of arbitrary loadable data set	
Controller output correction	max. 8 per controller	by means of weighted state variables (e.g. measurement channels) or interactive editing	
Response to limiting and saturation of controller output	limiting of the integral component	three optional strategies: 1. limit to current I-term 2. reduce by control value 3. limit, if output and I-term have same sign	
Controller inhibit	individual controller activation (enable)	via control signal; fade in and out with time constant	
Test points (probes)	assignment of internal controller variables to channels	for display and monitoring	

Controller parameters	Functions	Remarks
Proportional (P-) component	proportional of current control error	weighting factor proportional gain K _p
Integral (I-) component	integral of control error	integral gain K _i resettable to zero by control signal, reset with time constant, can be limited in response to saturation of control value
Derivative (D-) component	derivative of current error	derivative gain K _d slope of the D-component can be limited by time constant (decay)
Feed forward control	weighted adding of the set point value to the control value	

Time constants			
Parameter	Functions	Remarks	
Time constant for D-component	low pass filter for the derivative component	decay time	
Time constant for resetting the I-component	linear decay of the integral component to zero	after activation of reset control signal	
Time constant for activation of closed-loop controller	fade in and out of the resulting control value	after state change of the enable- control signal	
Time constant for set point channel switching	smooth transition between alternative set point-channel	after switching of control signal	
Time constant for actual value channel switching	smooth transition between alternative channels for measured process variable	5	
Time constant for switching of the controller at the DAC	smooth transition between alternative changing controllers assigned to a DAC output	1	
Value limits			
Limiting of the control output value	maximum control value minimum control value (independent, asymmetrical)	applies after calculation of all components and of the characteristic curve linearization	
Slope limiting	maximum slope of control value	applies after calculation of all components and of the characteristic curve correction linearization	
Limiting of the I-component	symmetric (max. / min.)		
Limiting of the D-component	symmetric (max. / min.)		

Find here the description of the SYNTH-8 2941.

9.10 Fieldbus: Technical Details

9.10.1 CAN-Bus Interface

Parameter	Value	Remarks
Number of CAN-nodes	2	one galvanically isolated node per connector (each with CAN IN and CAN OUT)
Terminal connection	2x DSUB-9	
Topology	bus	
Transfer protocol	configurable per software:	individually for each node
	CAN High Speed (max. 1 MBaud)	according to ISO 11898
	CAN Low Speed (max. 125 KBaud)	according to ISO 11519
Operating mode	Multi Master principle	
Direction of data flow	sending and receiving	
Baud rate	5 kbit/s to 1 Mbit/s	configurable via software; maximum is depending on selected protocol (High/Low Speed)
Max. cable length at data transfer rate	25 m at 1000 kBit/s 90 m at 500 kBit/s	CAN High Speed cable delay 5.7 ns/m
Termination	120 Ω	switchable by software for each node
Isolation strength	60 V	to system ground (case, CHASSIS)
Direct access for configuration of imc CANSAS modules	yes	via the CAN node of the device, with imc STUDIO

To the <u>pin configuration 485</u> and the <u>cabling 99</u> of the CAN-Bus interface.



Note

Remote Frame

imc devices actually does not support Remote Frames (RTR) according to CAN specification.

9.10.2 CAN FD Bus Interface

Parameter	Value	Remarks
Number of CAN-nodes	2	one galvanically isolated node per connector
Terminal connection	2x DSUB-9	
Topology	bus	
Transfer protocol	configurable per software: CAN FD (ISO Standard) (max. 8 MBaud)	individually for each node current standard according ISO 11898-1:2015
	non-ISO CAN FD (Draft) (max. 8 MBaud)	former draft (Bosch)
	CAN High Speed (max. 1 MBaud)	according ISO 11898
	CAN Low Speed (max. 125 KBaud)	according ISO 11519
Operating principle	Multi Master principle	
Direction of data flow	sending and receiving	
Baud rate	5 kbit/s to 8 Mbit/s	configurable via software; maximum is depending on selected protocol (FD/High/Low Speed)
Termination	120 Ω	switchable by software for each node
Isolation strength	±60 V	to system ground and case
Direct access for configuration of imc CANSAS modules	yes	via the CAN node of the device with imc STUDIO (CAN High Speed Mode only)



Note

Remote Frame

imc devices actually does not support Remote Frames (RTR) according to CAN specification.

9.10.3 LIN-Bus Interface

Parameter	Value	Remarks
Nodes	2	for each node LIN_IN / LIN_OUT
Terminal connection	2x DSUB-9	one DSUB for each node
Topology	Bus	
Transfer protocol	LIN 2.1, LIN 2.0, LIN 1.3	LIN 1.3 and LIN 2.x specifications can run on a bus simultaneously
Operating mode	Master and/or Slave	Master: with fixed schedule table in the LDF file
Direction of data flow		
sending	Display variables, virtual bits	
receiving	LIN data in measurement channels	
Baud rate	1 to 20 kbit	
Data rate	30 kS/s	
Termination	Pull up resistor	selectable via software Master/Slave
Isolation strength	60 V	to system ground (case, CHASSIS)

To the <u>pin configuration 485</u> and the <u>cabling 100</u> of the LIN interface.

9.10.4 EtherCAT Slave Interface

Parameter	Value	Remarks
Nodes	1	
Terminal connection with CRXT all others	2x M8 2x RJ45	EtherCAT in / out
Transfer protocol	EtherCAT Specification – Part 4 Data Link Layer protocols specification EtherCAT Specification – Part 6 Application Layer protocol specification	Along with cyclical data transfer on the basis of EtherCAT, the interface is parameterized using CANopen® over EtherCAT (CoE)
Operating mode	slave	
Direction of data flow sending receiving	process vector process vector	
Max. cable length	100 m	EtherCAT 100 Mbit/s
Max. bus transfer cycle	200 μs (5 kHz)	
Max. channel count for cyclic transfer	bus cycle / 4.5 μs - 10	max. 34 channels at 200 μs bus rate
Isolation strength	standard EtherCAT specification	

To the <u>pin configuration 487</u> and the <u>cabling 104</u> of the EtherCAT interface.

9.10.5 FlexRay Interface

Parameter	Value	Remarks
Number of FlexRay nodes	1	1x channel A+B
	additional 1 cold start node	for modules type FlexRay2
Terminal connection		
Standard	1x DSUB-9 per module	optionally 2x DSUB-9 (channel A+B separately)
Topology	Bus	
Transfer protocol	FlexRay protocol specification v3.0	
	XCP- specification Universal Measurement and Calibration Version 1.2.0; Date: 2013-06-20"	 ASAM_AE_MCD-1_XCP_BS_Protocol-Layer_V1-2-0.pdf "ASAM MCD-1 (XCP); Protocol; Protocol Layer Specification; ASAM_AE_MCD-1_XCP_AS_Flexray-Transport-Layer_V1-2-0.pdf "ASAM MCD-1 (XCP on FlexRay); Protocol; FlexRay Transport Layer;
Operating mode	Sync nodes, cold start nodes or normal nodes	
Direction of data flow		
sending	Display variables, Virtual bits, Process vector variables and Ethernet bits	Cyclic and Single Shot Frames with imc Online FAMOS
Baud rate	2.5 / 5.0 or 10.0 Mbit/s	
Max. cable length at data transfer rate	see FlexRay protocol	
Data rate		per module
	max 30 kSample/s	
	max 60 kSample/s	current modules type FlexRay2
Isolation strength	60 V	to system ground (case, CHASSIS)

To the <u>pin configuration 486</u> and the <u>cabling 100</u> of the FlexRay interface.

9.10.6 PROFIBUS Interface

Parameter	Value	Remarks
Nodes	1	
Terminal connection	1x DSUB-9 per module	RS 485
Transfer protocol	DPV0, DPV1	
Operating mode	Sniffer (logging of existing bus communication)	no master, no slave
Baud rate	max. 12 Mbit/s	
Max. cable length at data transfer rate	PROFIBUS specification	
Isolation strength	60 V	to system ground (case, CHASSIS)

To the $\underline{\text{pin configuration}}$ and the $\underline{\text{cabling}}$ of the PROFIBUS interface.

9.10.7 PROFINET Interface

Profinet-Class	Value	Remarks
Node	1	
Device class	IO-DEVICE	
Functionality	CC-C	Conformance Class C
Profinet-Certification	Netload Class III certified according to PNIO-version V2.34	
Cyclic data exchange	RT, IRT	
Minimum supported bus cycle time	250 μs	Isochronous Real Time (IRT)

Network connection	Value	Remarks
Terminal connection	2x RJ45	internal network switch labeling: Port 1 and Port 2
Network	100 Mbit/s	full duplex with autonegotiation
Isolation	standard Ethernet specification	
Supported topologies	star/tree/line/circular	

Configuration options	Value	Remarks
Supported variable assignments	channels, pv-variables	assignment to Profinet variables
Max. number of pv-variables	800	general system limit for imc CRONOS devices
Endianess support	Big-Endian / Little-Endian	Byte order (Motorola/Intel), via wizard
internal data type converter	yes	
Save / Load configurations	yes	via wizard
Validation of configurations	yes	via wizard
Number of pluggable slots	40	Profinet: logical module structure "plugging" of slots = parameterization of logical units
max. pluggable output modules	20	
Size per output modules	64 Byte	
max. pluggable input modules	20	
Size per input module	64 Byte	
Maximum I/O process space	1280 Byte each	20 · 64 Byte

To the <u>pin configuration</u> and the <u>cabling</u> of the PROFINET interface.

9.10.8 XCPoE Master-Slave Interface

Parameter	Value	Remarks
Nodes	1	
Terminal connection	1x RJ45	
Transfer protocol	XCP -Part 1- Overview	Ver. 1.0; ASAM e.V.
	XCP -Part 2- Protocol Layer Specification	Ver. 1.0; ASAM e.V.
	XCP -Part 3- Transport Layer Specification XCP on Ethernet (TCP_IP and UDP_IP)	Ver. 1.0; ASAM e.V.
	XCP -Part 4- Interface Specification XCPplus	Ver. 1.0; ASAM e.V.
Operating mode	Master	A2L file can be imported (XCPplus support included)
	or Slave	A2L-file will be generated
Transmittable channel type when operating as slave	All meas. channels (analog, digital, fieldbus-, as well as virtual channels (OFA)	
Data rate per channel	max. 50 kHz max. 10 kHz	depending on system configuration Slave Master
Max. cable length	100 m	
Hardware interface (Physical Layer)	Ethernet 100 Mbit/s	
Isolation strength	standard Ethernet specification	

To the <u>pin configuration 488</u> and the <u>cabling 100</u> of the XCPoE interface.

9.10.9 IPTCom Interface

Parameter	Value	Remarks
Node	1	
Terminal connection	1x RJ45	
Operating mode	Slave	
Data transfer direction		
receive	SINT16/FLOAT-channels	
Data rate	max. 100 kS/s	total
Ethernet	100 Mbit/s	
Isolation strength	60 V	to system ground (case, CHASSIS)

9.10.10 MVB-Bus Interface

Property	Characteristics		
Node	1		
Transmission medium	Copper: twisted pair, RS485		
Terminal connection	2x DSUB-9		
Topology	Bus		
Protocol standards	IEC 61375-3-1 Electronic Railway Equipment - Train Communication Network - Part 3-1: MVB - Multipurpose Vehicle Bus IEC 61375-3-2 Electronic railway equipment - Train communication Network - Part 3-2: MVB - Multipurpose Vehicle Bus Conformance Testing		
Physical Layer	EMD Electrical Middle distance medium non-reactive tapping of data or as an option (alternatively): ESD+ Electrical short distance		
Operation mode	logging of periodical process data		
Max. cable length	200 m with up to 32 subscribers		
Redundancy	duplication: messages sent on both lines		
Gross data rate	1.5 Mbit/s		
Address room	4095 physical devices, 4095 logical ports, 8-bit station addresses for messages		
Frame size	16, 32, 64, 128 and 256 bit		
Isolation strength	500 V _{RMS} (1 min.)		

To the $\underline{\text{pin configuration}}$ and the $\underline{\text{cabling}}$ of the MVB-Bus interface.

9.10.11 ARINC-Bus Interface

Parameter	Value typ. min. / max.		Remarks
Number of Rx-channels	8	8	
Number of Tx-channels	4	4	
Terminal connection	2x DS	UB-15	
Transfer protocol	ARIN	C 429	
Baud rate	Low (12.	.5 kbit/s)	
	High (10	00 kbit/s)	
Max. voltage for each Rx connection		±29 V	to System ground (protection ground)
Max. voltage for each Tx connection	5 V 4.5 V / 5.5 V		to GND "ZERO": min -0.25 V max 0.25 V
	10 V	9 V / 11 V	differential "ZERO": min -0.5 V max 0.5 V
Isolation strength	no galvanica	ally isolation	

To the <u>pin configuration 488</u> and the <u>cabling 100</u> of the ARINC interface.

9.10.12 RoaDyn Interface

The RoaDyn® Interface provides the interface between the wheel force transducer system RoaDyn® 2000 by Kistler and an imc CRONOS measurement device. The compatible Kistler unit version is 4.01a, 4.01b and c with DSP-Type_ VC33.

Along with the RoaDyn® system's (3x force, 3x torque, angle, angular velocity, temperature, supply voltage) main channels, all additional service channels (single force components, errors etc.) are available.

Physical structure: The RoaDyn® Interface is a configuration option ("configuration module"), devices can only be equipped ex-factory with this Interface. An exchange or plug-in by the user is not allowed.

Parameter	Value	Remarks
Nodes	Interface for a Kistler 2000 system max. 4 wheels	
Terminal connection	2x BNC	Clock and Trigger
	RJ45	for the data exchange
Channels	all channels of the RoaDyn [®] system available:	
	10 main channels (3x force, 3x torque, angle, angular velocity, temperature, supply voltage	
	additionally all service and additional-channels (single force, error cases etc.)	
Transmission medium	Ethernet 100 Mbit/s	10/100 Mbit/s, approvable cable length for 100 Mbit/s Ethernet max. 100 m according IEEE 802.3
Delay of tested Kistler unit - Version: 4.01a - DSP-Type: SBC31	2 ms plus 16 Samples	complete delay is compensated in the data processing imc Online FAMOS calculates with measurement data
Sampling rate	max. 1 kHz synchronized to imc system	

9.11 Accessories

9.11.1 Sensor supply module: SEN-SUPPLY

Parameter	Value ty	yp.	. max.		Remarks
Configuration options	5 adjustable ranges		nges	The sensor supply module always got 5 selectable voltage	
					ranges.
					Default ranges: +5 V to +24 V
Output voltage	Voltage	Cur	rent	Netpower	set globally for all channels of an amplifier
	(+2.5 V)	580	mΑ	1.5 W	special order:
	+5.0 V	580	mΑ	2.9 W	+12 V can be replaced by +2,5 V.
	+10 V	300	mΑ	3.0 W	+15 V can be replaced by \pm 15 V
	+12 V	250	mΑ	3.0 W	
	+15 V	200	mΑ	3.0 W	
	+24 V	120	mΑ	2.9 W	
	(±15 V)	190	mA	3.0 W	
Isolation					
Standard:	non isolated		d	output to case (CHASSIS)	
option, upon request:	isolated			nominal rating: 50 V, Test voltage (10 sec.): 300 V, not available with option ±15 V.	
Short-circuit protection	unlimited duration		tion	to output voltage reference ground	
Accuracy of output voltage				at terminals, no load	
	<0.25 %	6		0.5 %	at 25°C
				0.9 %	over entire temperature range
				1.5 %	plus with optional bipolar output voltage
Efficiency	typ. 72%			10 V to 24 V none isolated	
	typ. 66%			5 V	
		typ.	55%		10 V to 24 V isolated
	typ. 50%			5 V	
Max. capacitive load	>4000 μF			2.5 V to 10 V	
	>1000 μF			12 V, 15 V	
		>300	0 μF		24 V

The description of the sensor supply. 251

9.11.2 CRFX/SEN-SUPPLY-4

Sensor supply				
Parameter	Value	Remarks		
Channels	4			
Terminal connection				
Sensor	DSUB-9	direct connection of current transducers (e.g. LEM Ultrastab, Danisense or current clamps)		
Amplifier	LEMO.FGG.1B.307 (plug)	direct connection of any amplifier via LEMO patch cables		
Power supply	LEMO.EGE.1B.302 (socket)	multicoded 2 notches (E-coded: 48 V) recommended plug: LEMO.FGE.1B.302		
Module connector	2x 20 pin	CRFX system bus (EtherCAT) and power supply: passed through to further directly connected (clicked) amplifiers		
Output voltage	±15 V			
Accuracy of output voltage Temperature coefficient	±2% typ. ±0.02%/K	at terminals, no load 25°C		
Output power	max. 48 W	total continuous power, 4 channels		
Current limiting	typ. 1080 mA ¹	for each channel pairs 1+2 or 3+4 (max. 2 transducer IN-1000 respectively DS600ID for each module)		
Short-circuit protection	unlimited duration	automatic restart of all channels		
Capacitive load	>470 μF	per channel		
Efficiency	typ. 80%	full load, 25°C		
Isolation	60 V	block isolation of entire global sensor supply (for all 4 channels, common reference"-SUPPLY, GND") to housing (CHASSIS, PE), as well as to power input		
Status indication	channel individual LED	display of error status from sensor (signal or switching contact) or overload of power supply		
TEDS	TEDS memory inside DSUB-9 connector (parameters and scaling information)	TEDS signals are passed to the connected (TEDS-capable) amplifiers		

the pairs k1+k2 and k3+k4 are fused together with 1080 mA; typical operating examples: 4×540 mA (e.g. $4 \times 1T-405$) with k1/k2/k3/k4

 $^{2 \}times 1080 \text{ mA}$ (e.g. $2 \times 10^{-1000} \text{ respectively DS600ID}$) with channel k1 and k3; k2/k4 thereby unused

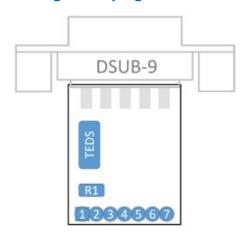
Power supply of the module			
Parameter	Value	Remarks	
Input supply voltage	20 V to 50 V DC	only via LEMO.1B socket	
Isolation	60 V	nominal isolation specification of the supply input	
Power-over EtherCAT (PoEC)	not supported	DC power supply via EtherCAT network	
Power consumption	max. 65 W	20 V to 50 V DC	

Pass through power limits		
Directly connected (clicked) imc CRONOSflex modules via module connector	3.1 A (maximum current) Equivalent power with chosen DC power input: • 149 W at 48 V DC (e.g. AC/DC line adaptor) • 37 W at 12 V DC (typical vehicle supplied DC input) Refers only to the supply power passed through (in/out). The module itself is always supplied individually from the LEMO socket	

Operating conditions			
Parameter	Value	Remarks	
Operating environment	dry, non corrosive environment within specified operating temperature range		
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1	
Ingress protection rating	IP20		
Pollution degree	2		
Operating temperature (standard)	-10°C to +55°C	without condensation	
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed	
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B		
	MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure		
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request	
Dimensions	62 x 118 x 186 mm	WxHxD	
Weight	860 g		

Plug for the sensor connection			
Parameter	Value typ.	min. / max.	Remarks
Plug	DSI	UB-9	solder connections in the plug housing
Internal load resistor Rm	1 Ω, 5 Ω, 10 Ω		SEN/DSUB9-xR: for transducers with current output
	no	one	SEN/DSUB9-NR: for sensors with voltage output
Accuracy for Rm calibrated version 10 Ω 5 Ω 1 Ω		0.009 % 0.012 % 0.036 %	
not calibrated $10~\Omega$ $5~\Omega$ $1~\Omega$		0.050 % 0.050 % 0.050 %	see separate data sheet "Calibration and TEDS"
Temperature drift	0.05 ppm/°C 0.2 ppm/°C		0 to +60 °C -55 to +125 °C
Drift due to self-heating	5 ppm / W		32.00 === 2
Long-term stability		50 ppm (= 0.005 %)	10 000 h @ 1 W
Power rating		1 W 0.8 W	+70°C +85°C
Operating temperature range	-40 to	+85°C	

Pinning of the plug for the sensor connection (SEN/DSUB9-xxR)



Pad	Signal	LEM (I _{out})	Sensor (V _{out})	Remarks
1	-SUPPLY	-SUPPLY	-SUPPLY	-15 V
2	+SUPPLY	+SUPPLY	+SUPPLY	+15 V
3	FAIL	STATUS	n.c.	open: error
4	GND	STATUS_GND	n.c.	contact with FAIL
5	GND	PWR_GND	PWR_GND	Power-GND
6	-IN	n.c.	+SIGNAL	-V _{out}
7	+IN	I_OUT	-SIGNAL	+V _{out} / +I _{out}
R1	Bridge	n.c.	0 Ω	FAIL = 0 (OK)



Reference

Please find here a short module description: <u>CRFX/SEN-SUPPLY-4</u> 2501

9.11.3 CRFX/WFT-2

Parameter	Value	Remarks
Inputs	2	for two WFT measuring wheels
Terminal connection		
LEMO	2x LEMO.ERA.1E.306	measuring wheel connection
Input supply plug (female)	1x LEMO.EGE.1B.302	multicoded 2 notches,
		for optional individually power supply
EtherCAT connection	2x RJ45	system bus for expanded
		imc CRONOS <i>flex</i> components
Module connector	2x 20 pin	direct connection of modules (click) supply and
		system bus

Parameter	Value	Remarks
Channels	36 F _x , F _y , F _z , M _x , M _y , M _z	18 analog channels per measuring wheel: forces and moments
	Umdr, Drehz, Temp	revolutions, speed, temperature
	$rot_{r}f_{x}$, $rot_{r}f_{z}$, $rot_{r}m_{x}$, $rot_{r}m_{z}$	rotating coordinate system
	Winkel, sin, cos Status, Aux	angle state, aux
Sampling rate	≤10 kHz	samplings rate and filter settings apply to all channels of a socket
Filter (digital)	low pass	
characteristic	Butterworth, Bessel	individual selectable
frequency	5 Hz to 500 Hz	with Bessel
	5 Hz to 1 kHz	with Butterworth
order	8th order	
Resolution	16 Bit	

Sensor supply for WFT-C ^X or -C ^{XS}			
Parameter	Value (typ. / max.)	Remarks	
Input supply voltage	10 V to 50 V DC		
Output voltage	12.2 V DC	no load, 25 °C	
Output power	10 W (max.)	for each channel	
Efficiency	typ. 83 %	full load, 25 °C	
Capacitive load	>800 µF	per channel	
Isolation	isolated	channel individual to housing and input nominal 60 V	
Short-circuit protection	unlimited duration	automatic restart	
Accuracy of output voltage	±1 %	at terminals, no load 25 °C	
Temperature coefficient	typ. ±0.02 % / K		

Power supply	Value	Remarks
Input supply voltage	10 V to 50 V DC	
Power consumption	5 W plus 13 W per WFT	

A separate documentation describes setup and operation of the WFT 6-component wheel.

9.11.4 Color Display

Parameter	Color Display		
Display	5.7 ² TFT		
Colors	65	536	
Resolution	320	x 240	
Backlight	L	ED	
Contrast (typ.)	60	00:1	
Brightness (typ.)	450	cd/m²	
Connection cable	RS232,	max. 2 m	
Dimensions (W x H x D)	192 x 160 x 30 mi	m (w/o connectors)	
Display area	approx. 11.5 x 8.6 cm		
Weight	approx. 1 kg		
Supply voltage	9 V to 32 V _{DC}		
	6 V to 50 V _{DC} upon request		
Power consumption	approx. 3 W wit	approx. 3 W with 100% back light	
Temperature range	-20°C to +60°C	operating temperature	
	≤+85°C	module interior temperature	
Rel. humidity	80% up	80% up to 31°C,	
	above 31°C: linear declining to 50%, according DIN EN61010-1		
Terminal connections	DSUB-9 (female) for connection to measurement device		
	3-pin Binder (metal) ESTO RD03 series 712, 3-pin for external current supply		
Miscellaneous	membrane touch panel with 15 buttons		
	robust metal frame		
	anti-reflection coated gla	ass pane to protect display	

Description the display 81 and the DSUB-9 pin configuration 444.

Included accessories article no.

• Modem cable in the extended temperature range

ACC/POWER-SUPPLY AC/DC power supply unit
 ACC/POWER-PLUG4 power plug
 1350043
 1350052

9.11.5 Power Handle (CRFX/HANDLE-POWER)

Parameter	Value	Remarks
Input supply voltage	7 V to 50 V DC	
Shutdown-threshold (typ)	5.9 V	min. input voltage (no load)
Min. required input voltage for restart (typ.)	9.5 V	min. input voltage (no load)
Output voltage	50 V DC	constant, regulated over entire input range
Output power	100 W	10 V to 50 V DC input
	70 W	V _{in} · 10 A
Output short circuit protection	continuous	
Isolation	isolated from CHASSIS, no input-to-output isolation	When connecting a CRFX base unit (with non-isolated supply input), the supply voltage is then grounded.
Power supply socket (input)	LEMO.EGE.1B.302 (female)	multicoded 2 keyways, compatible to plugs: LEMO.FGG.1B.302 (standard) LEMO.FGE.1B.302 (E-coded: 2 coding keys)
Remote control socket	LEMO.1B.306	
Auxiliary output power supply sockets	LEMO.1B.304	5 sockets for the supply of additional units and blocks that are not directly attached via module connector
UPS functionality	none	refer to NiMH or Li-Ion type UPS variant



Reference

Lead-gel or Li-lon type UPS variant

Technical Specs: Handle with Lead-gel batteries (CRFX/HANDLE-UPS-L) 453

Technical Specs: Handle with Lead-gel batteries (CRFX/HANDLE-LI-IO-L) 454

9.11.6 USV-NIMH (CRFX/HANDLE-UPS-NIMH-L)

Parameter	Value	Remarks
Input supply voltage	10 V to 50 V DC	
Shutdown-threshold (typ)	9.6 V	min. input voltage (no load)
Min. required input voltage for restart (typ.)	10.9 V	min. input voltage (no load)
Output voltage	50 V DC	constant, regulated over entire input range
Output power	100 W	10 V to 50 V DC input
Output short circuit protection	continuous	
Isolation	isolated from CHASSIS, no input-to-output isolation	When connecting a CRFX base unit (with non-isolated supply input), the supply voltage is then grounded.
Input supply terminal	LEMO.EGE.1B.302	multicoded 2 notches, compatible to connectors: LEMO.FGG.1B.302 (standard) LEMO.FGE.1B (E-coded: 2 coding keys)
Remote control terminal	LEMO.1B.306	
On/Off push button	→ 1	especially for use with imc EOS
Auxiliary output supply	LEMO.1B.304	5 terminals for the supply of additional units and blocks that are not directly attached via module connector
Weight	2.06 kg	
UPS battery type	NiMH	
UPS battery capacity	≥55 Wh	typ. 25°C, battery fully charged
UPS total buffering time	>30 min	typ. 25°C, depending on system size and configuration (rated for total system consumption of ≤100 W, gross input power)
UPS buffer time constant Selectable via manual switch	16 positions (09, AF): 0s, 1s, 2s, 5s, 10s, 30s, 1min, 2min, 5min, 10min, 30min, 1h, 2h, 5h, 10h, maximum	maximum duration of a continuous outage before triggering device shutdown
Charging power	2.5 W (typ.)	device must be switched on
Duty cycle: charge time / discharge time	discharge time · 1.2 · (system power / 2.5 W)	worst case example: system power consumption 100 W buffer time 1 min., resulting recharge time ≤48 min. (duty cycle 48:1)
Charging time for complete battery recovery	36 h	

⁽¹⁾ In connection with imc CRONOSflex, both the latching main switch on the CRFX base unit or the push button on the power handle can be used, both are "synchronized". In connection with imc EOS, the latching main switch is typically permanently pressed. The entire system is then switched on and off by the latching main switch on the power handle.

9.11.7 USV-Li-Ion (CRFX/HANDLE-LI-IO-L)

Parameter	Value	Remarks
Input supply voltage	10 V to 50 V DC	
Shutdown-threshold (typ)	9.6 V	min. input voltage (no load)
Min. required input voltage for restart (typ.)	10.9 V	min. input voltage (no load)
Output voltage	50 V DC	constant, regulated over entire input range
Output power	100 W	10 V to 50 V DC input
Output short circuit protection	continuous	
Isolation	isolated from CHASSIS, no input-to-output isolation	When connecting a CRFX base unit (with non-isolated supply input), the supply voltage is then grounded.
Power supply socket (input)	LEMO.EGE.1B.302 (female)	multicoded 2 keyways, compatible to plugs: LEMO.FGG.1B.302 (standard) LEMO.FGE.1B.302 (E-coded: 2 coding keys)
Remote control socket	LEMO.1B.306	
On/Off push button	✓ 2	especially for use with imc EOS
Auxiliary output supply socket	LEMO.1B.304	5 sockets for the supply of additional units and blocks that are not directly attached via module connector
Weight	2.34 kg	
UPS battery type	2x Li-Ion Smart Battery	
UPS battery capacity	196 Wh ³	typ. 25°C, battery fully charged
UPS total buffering time	>1 h	typ. 25°C, depending on system size and configuration (rated for total system consumption of ≤100 W, gross input power)
UPS buffer time constant Selectable via manual switch	16 positions (09, AF):	maximum duration of a continuous outage before triggering device shutdown
	0s, 1s, 2s, 5s, 10s, 30s, 1min, 2min, 5min, 10min, 30min, 1h, 2h, 5h, 10h, maximum	
Charging power	37 W (typ.)	device must be switched on temporarily higher charging power possible
Duty cycle: charge time / discharge time	discharge time · (system power / 37 W)	worst case example: system power consumption 100 W buffer time 1 min., resulting recharge time ≤3 min (duty cycle 3:1)
Charging time for complete battery recovery	6 h	

⁽²⁾ As of delivery date approx. 2023, before that handle w/o On/Off push button

⁽³⁾ As of delivery date FEB-2019, before that 138 Wh

Li-Ion Smart Battery (include	d in CRC/B-Li-IO-1 and CRC/B-Li-I	lO-2)
Parameter	Value	Remarks
Charging time for complete battery recovery	3 h	device must be switched on
Capacity of each Li-ion battery	98 Wh ⁴	Nominal ratings at 21°C The available effective capacity depends on load and temperature. At temperatures below 0°C the usable capacity is reduced to a fraction of nominal values at 21°C.
		Example (at approx. 40 W load):
		approx. 85% at -10°C approx. 55% at -20°C
Operating temperature range		
Operation (discharge)	-20°C to +69°C	operational temperature range of UPS buffering functionality
		To protect the batteries at temperatures above 60°C the UPS buffer time constant is reduced to 15 seconds, regardless of configured setting
	-10°C to +50°C	specified temperature range as rated by Smart Battery manufacturer!
		Manufacturers of the individual Li-ion cells used in the Smart Battery, specify a discharging temperature range of -20°C to +60°C
	+75°C ± 5°C	battery disconnect: internal protection circuitry of the Smart Batteries prevent discharge
Charge	0°C to +45°C	above +45°C a charge of the batteries is inhibited (green charge level indicator LED stops flashing)
Storage	-20°C to +60°C	
Passive temperature fuse	+93°C (tolerance: +0°C, -5°C)	Once triggered, the passive temperature fuse cannot be reset thus irreversibly rendering the battery useless!
Relative Humidity	≤80%	

<u>Note:</u> Due to the inevitable leakage and self-discharge of the Smart Batteries we recommend a regular recharging cycle at least every 3 months that a device has not been in use (device must be switched on for charging).

⁽⁴⁾ As of delivery date FEB-2019, before that 69 Wh

9.11.8 DSUB-15 adapter plug

Parameter	Value	Remarks
Terminal count		
Standard Special	18 20 24 25	e.g. ACC/DSUBM-B2, -U4, -UNI2, e.g. ACC/DSUBM-T4 ACC/DSUBM-TEDS-T4 ACC/DSUBM-HD-I4, HD-B4 (DSUB-26)
Housing material	metal	zinc die-cast (nickel-plated)
Connector type	DSUB-15 DSUB-HD-26	ACC/DSUBM-xx ACC/DSUBM-HD-xx
Protection level	IP20	ACC/DSUBM-xx
	IP65	ACC/DSUBM-xx-IP65
Usable wire cross section	max. 1.5 mm² corresponds to AWG 16	braided with wire end sleeve
Cable passage max. aperture at	Ø 0 mm	hath block and valley
sealing gasket	Ø 9 mm	both black and yellow with bend relief sleeve
with ACC/DSUBM-xx with ACC/DSUBM-xx-IP65	sealing gasket, black sealing gasket, yellow	with bend relief sleeve
Gasket bore length range	5 to 7.5 mm	other sizes ² upon request
Locking screws	2x M2.5 X 58 mm	ACC/DSUBM-xx, suitable for corresponding latching to the imc device
	2x M2.5 X 65 mm	ACC/DSUBM-xx-IP65 suitable for the imc SL-Series devices (imc CRONOS-SL / imc CANSAS-SL) and imc XT-Series (imc CRONOS-XT)
Dimensions (L x B x H)	118 x 55.2 x 19 mm	with bend relief sleeve
	77.5 x 55.2 x 19 mm	without bend relief sleeve
Weight	typ. 140 g	metal connector

² As of 2019-01-01, the previously used gasket bore: 4 to 6.5 mm is no longer available.

9.11.9 ACC/DSUB-ICP

Parameter	Value (m	nin / max)	Remarks
option for		5O(2)-8, LV(2,3)-8, LV- 32, UNI(2)-8	
Inputs			differential, not isolated
		4	ACC/DSUB-ICP4
		2	ACC/DSUB-ICP2
Input coupling		DC .	
	10	СР	current source, 1st order high-pass
Current drain per connector		<0.2 A	ACC/DSUB-ICP4
		<0.1 A	ACC/DSUB-ICP2
Voltage measurement			
Input voltage max.			permanent to chassis
voltage		±60 V	
ICP		-3 V to 50 V	at +IN1,, +IN2 bzw. +IN4
		±3 V	at -IN1,, -IN2 bzw. +IN4
Input impedance			depending on the measurement ranges of
voltage	1 ΜΩ		the measurement inputs differential
Voitage	10 MΩ		differential
	20 ΜΩ		
ICP	0.33 ΜΩ		single end
	0.91 ΜΩ		
ICP™-, DELTATRON®-, PIEZOTR	ON®-Sensors		
Highpass cutoff frequency			-3 dB, AC, corresponding to input
			impedance of the used measurement
			input
	3 Hz 1 Hz	±20 % ±20 %	1 ΜΩ 10 ΜΩ, 20 ΜΩ
ICP-current source	4.2 mA	±20 % ±10%	10 19122, 20 19122
Voltage swing	25 V	>24 V	
Source impedance	280 kΩ	>100 kΩ	

Find here the description of the IEPE (ICP)-expansion plug [237].

9.11.10 ACC/DSUBM-ICP2I-BNC(-S/-F)

Parameter	Value typ.	min./ max.	Remarks
Compatible channel types	imc measuren	nent amplifier	with DSUB-15 sockets
Full support			only with CRFX, CRXT device family: software support with variant differentiation (-F/-S), full support of TEDS sensors including sensors of type DS2431 and a improved offset performance
	bridge a	mplifiers	types with 2 channels per DSUB-15
		4, DCB2-8, B-8 . Cx-50xx	imc CRONOS device series similar imc C-SERIES devices
	voltage a	amplifier	types with 4 channels per DSUB-15: first and third channel used
		3-8 12xx	imc CRONOS device series similar imc C-SERIES devices
Basic support			basic ICP operation
	_	mplifiers 2-4	types with 2 channels per DSUB-15 imc CRONOS device series
	Voltage a	amplifiers	types with 4 channels per DSUB-15: first and third channel used
			imc CRONOS device series similar imc C-SERIES devices
Inputs	2	2	BNC
Input coupling	ICP		current source, 1st order high-pass
Isolation		ise isolated (current source)	the isolation of each measurement channel depends on the amplifier used (e.g.: ISO2-8 is isolated)
Isolation voltage		≤±50 V	to system ground (CHASSIS) and channel- to channel
Max. input voltage		<±40 V	at BNC input
Constant current feed	4.2 mA	±10%	
Voltage swing	24 V	>22 V	
Current source impedance	340 kΩ	>100 kΩ	in parallel with input impedance of the amplifier
Error indication	LE	ED .	open sensor detection and short circuit detection
TEDS	conforming to IEEE 1451.4 Class I MMI supported for selected amplifier and only with CRFX / CRXT		sensor with current feed supported as of imc STUDIO 5.0R1

AC-coupling: High pass cut-off frequency (-3 dB) and typ. settling time - Note (1)			
Parameter	Value typ.		Remarks
	variant -S "slow"	variant -F "fast"	
AC-coupling	235 nF	235 nF	RC high pass in the plug
	10 ΜΩ	1 ΜΩ	The resulting high pass is formed with the additional input impedance of the amplifier (depending on type and measuring range).
Typ. settling time ts	approx. 10 s	approx. 1 s	when connecting and activating
For amplifier types with software support			detection, additional digital high pass
imc CRONOScompact (CRC), C-SERIES			
UNI2-8, DCB2-8, LV3-8	0.40 Hz	<1 Hz ts approx. 5 s	long settling time for both variants; for the F variant: settling time: ts = 5 s
imc CRONOSflex (CRFX)			
UNI2-8, DCB2-8, LV3-8	0.12 Hz	<1 Hz	time constant of the digital HP specifically matched for S- and F-variant
All other amplifier types without software support			no detection, without digital high pass
Depending on input impedance:			
10 ΜΩ	0.14 Hz	<1 Hz	e.g. ISO2-8, measurement ranges ≤2 V
1 ΜΩ	0.75 Hz	<1.5 Hz	e.g. ISO2-8, measurement ranges ≥5 V

The digital highpass is intended to suppress residual offset that can be caused by the amplifiers bias currents in conjunction with the high impedance RC circuit.



Reference

Please find here the description. 241

⁽¹⁾ The cut-off frequency and settling time is determined by the combination of an analog AC coupling (depending also on the amplifier's input impedance) and a digital high-pass (if supported).

9.11.11 ACC/DSUBM-ESD

Intermediate filter-plug for ESD suppression for any module with DSUB-15 connections.

Parameter	Value	Remarks
Suitable for modules	for any module type, e.g.: analog inputs analog outputs (DAC) counter modules (ENC) digital (DIO)	modules with DSUB-15 connectors
Inputs	15 uniformly filtered lines	usable independent of actual channel count and connected signal type
ESD-filter topology	T-filter: ferrite – capacitor - T-ferrite	uniform filter for 15 signal lines at the DSUB (inputs or outputs)
Filter components	ferrite: 500 Ω @ 100 MHz capacitor: 1 nF T-ferrite: 1 nF, 35 dB @ 100 MHz	
DC-resistance (ferrite)	65 mΩ 2 A	max. DC current for serial components
Nominal voltage	33 V _{AC}	common-mode voltage to CHASSIS
	70 V _{DC}	suitable for operation in circuits with such specified voltages
Filter attenuation	no details (in MHz range)	depending on module type, source impedance, shielding etc.
		for practically relevant source impedance's: no significant impact of relevant signal bandwidth
Terminal connection	DSUB-15 intermediate connector (male / female)	

Find here the description of the ACC/DSUB-ESD expansion plug 92

9.11.12 ACC/DSUB-ENC4-IU

Accessory: connector for incremental sensors with currents signals for use with an incremental counter interface

Parameter	Value	Remarks
Inputs	4+1	differential, non isolated
Input coupling	DC	
Range		
4 basic channels:	±12 μA	
1 index channel:	±24 μA	
Sensitivity		Vout
4 basic channels:	-0.2 V/μA	
1 index channel:	-0.1 V/μA	
Input impedance		
4 basic channels:	200 kΩ	
1 index channel:	100 kΩ	
Voltage output	differential	differential signal "+Vout" – "-Vout" analyzed by the INC-4 module
	approx. 0 V to 5 V	
Output level	+Vout = 2.5 V/μA to 0.2 V/μA	basic channels
	-Vout = 2.5 V	
Analog bandwidth		
4 basic channels:	80 kHz	
1 index channel:	50 kHz	
Supply:		supplied by the INC-4 module:
auxiliary power	5 V, 5 mA, 25 mW	DSUB-15 (14) VCC
external sensor	5 V, max. 170 mA	DSUB-15 (7) = GND
Connector plug	DSUB-15 with screw clamp in the connector housing	

Description for incremental sensors with current signals. 283

9.11.13 ACC/SYNC-FIBRE

Parameter	Value typ.	min./ max.	Remarks
Compatible with	GPS-connection imc measurement device		Modification of the GPS-connection is necessary (device preparation for SYNC-FIBRE).
			The simultaneous use of both SYNC-FIBRE and the device's SYNC plug (BNC) is not allowed. Only the SYNC-FIBRE or the SYNC plug (BNC) can be used.
Terminal connection	2x S	Γplug	FOC
	1x D:	SUB-9	connection with measurement device
Supply	5 V	±10%	out of device internal sensor supply
Power consumption	0.5 W	±10%	
Propagation Delay tPD	25 ns	75 ns	SYNC-In to Opto-Out or Opto-In to Sync-Out
Link length		500 m	Length of the fiber optic distance between two ACC/SYNC-FIBRE
Total delay		8 μs	SYNC-In first device to SYNC-Out last device
Fiber Optics plug type	9	ST	
Fiber Optics	50 / 125 μm		
	62.5 / 125 μm		
Wave length	820 nm		
General			
Extended environmental range	-40°C to + 85°C		condensation temporarily allowed

Find here the description of the ACC/SYNC-FIBRE [80].

9.11.14 IRIG-B

General			
Parameter	typ. min. / max.		Remarks
Supported IRIG formats	B120B127		Amplitude modulated (AM) signal evaluation of BCD-Time-Of-Year and BCD-Year
Input signal amplitude		max. 12 V _{SS}	Level for mark-period (high)
		min. 0.8 V _{ss}	Level for space-period (low)
Input impedance		600 Ω	
Terminal connection	DSUB	3-9 (female)	for connection with imc device
		BNC	IRIG input
IRIG-input shielding connection	Syste	em ground	
Output signal		RS232	Baud rate: 38400, no parity 8N1
Output data format	NMEA 0183		
Delay of the 1 pps-signal	<2 μs		dedicated signal for system clock synchronization of imc device
Jitter of the 1 pps-signal	±500 ns		Input signal: 12 V _{SS} without jitter
Supply power consumption	5 V, 70 mA		via DSUB connector
Operating temperature range (standard)	-40°C to +70°C		no condensation
Extended environmental range (optional)	-40°C to +85°C		condensation temporarily allowed
Storage temperature	-40°C to 85°C		
Dimensions	39 x 20 x 60		in mm, W x H x D
Weight	approx. 70 g		
imc article number	1	270059	external IRIG-B module

Find here the description of IRIG-B $\boxed{88}$.

Is only available for devices of group A5-A6 74



9.11.15 WLAN

Dual band	Value	Remarks
Standards	IEEE 802.11abgn	
Certification	WiFi certified (WMM)	
Data rate	300 Mbps 54 Mbps 11 Mbps	IEEE 802.11n IEEE 802.11a/g IEEE 802.11b
Operating frequency	2.412 GHz 2.4835 GHz channel 114, 5 MHz separation	IEEE 802.11 abgn ISM Band
	5.180 GHz 5.825 GHz 5.15 GHz 5.85 GHz	standard version version for Japan (xxx-JP)
Network type	Ad-Hoc, managed	
RF output power	+16 dBm +18 dBm +15 dBm	IEEE 802.11g IEEE 802.11n / 2.4 GHz, HT20 IEEE 802.11n / 5 GHz, HT20
Receiver sensitivity	-79 dBm -76 dBm -75 dBm	IEEE 802.11g IEEE 802.11n / 2.4 GHz, HT20 IEEE 802.11n / 5 GHz, HT20
Encryption	WEP to 104 Bit WPA-PSK TKIP/RC4 WPA2-PSK CCMP/AES	open system 8 to 63 characters ¹ 8 to 63 characters ¹
Modulation	DSSS (DBPSK, DQPSK, CCK) OFDM (BPSK, QPSK, 16-QAM, 64-QAM)	IEEE 802.11b IEEE 802.11agn
Operating temperature range (standard)	-40°C to +80°C -50°C to +95°C	operating (ET version) storage temperature range
Operating temperature range (version for Japan xxx-JP)	-40°C bis +80°C -50°C bis +95°C	operating (ET not available) storage temperature range
Power consumption	1.5 W	

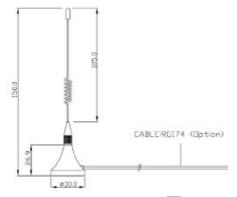
Single band	Value	Remarks
Standards	IEEE 802.11bgn	
Certification	WiFi certified (WMM)	
Data rate	150 Mbps 54 Mbps 11 Mbps	IEEE 802.11n IEEE 802.11g IEEE 802.11b
Operating frequency	2.412 GHz 2.462 GHz channel 111, 5 MHz separation	IEEE 802.11bgn ISM Band
Network type	Ad-Hoc, managed	
RF output power	+20 dBm +17 dBm	IEEE 802.11b (CCK) IEEE 802.11g (OFDM)
Receiver sensitivity	-73 dBm -86 dBm	IEEE 802.11g (54 Mbps) IEEE 802.11b (11 Mbps)
Encryption	WEP to 104 Bit WPA-PSK TKIP/RC4 WPA2-PSK CCMP/AES	open system (8 to 63 characters) ¹ (8 to 63 characters) ¹
Modulation	DSSS (DBPSK, DQPSK, CCK) OFDM (BPSK, QPSK, 16-QAM, 64-QAM)	IEEE 802.11b IEEE 802.11gn

Single band	Value	Remarks
Operating temperature range	-30°C to +85°C	operating (ET version)
Power consumption	1.5 W	

Antenna - ACC/WLAN-ANT-RP-SMA			
Parameter	Value	Remarks	
Туре	clip on antenna		
Connector	RP-SMA (female)	reverse-SMA, antenna side: female	
Flexibility	flexible joint bend and rotate	degrees of freedom for positioning	
Operating frequency	single band / dual band 2.4 GHz / 5 GHz		
Antenna gain	1.5 dBi, 2.1 dBi	2.4 GHz / 5 GHz	
Impedance	50 Ω		
Operating temperature range	-20°C to +65°C		
Mechanical dimensions	L: 108 mm / 82.5 mm diameter: 7.8 mm / 10 mm	with / without flexible joint diameter: antenna / SMA	

Antenna - ACC/WLAN-MAG-ANT-RP-SMA			
Parameter	Value	Remarks	
Туре	magnetic base antenna	with 1.5 m cable	
Connector	RP-SMA (female) with 1.5 m low loss cable	reverse-SMA, antenna side: female	
Flexibility	magnetic attachment		
Operating frequency	single band 2.4 GHz		
Antenna gain	5 dBi	2.4 GHz	
Voltage standing wave ratio	<1.6:1	characterizes cable transmission loss	
Impedance	50 Ω		
Weight	50 g		

Mechanical dimensions - ACC/WLAN-MAG-ANT-RP-SMA:



Find here the description of WiFi (WLAN) connection.

¹ Access Point required

9.11.16 NET-SWITCH-5

Ports and operating modes			
Parameter	Value	Remarks	
Number of ports	5	identical properties	
Transfer rate	10 / 100 / 1000 Mbit/s	automatically	
Modes	10BASE-Te	IEEE 802.3 Clause 14, requires Cat5 cabling	
	100BASE-TX	IEEE 802.3 Clause 25 (ex 802.3u)	
	1000BASE-T	IEEE 802.3 Clause 40 (ex 802.3ab)	
Auto-Negotiation	active	priority 1: 1000BASE-T, full-duplex priority 2: 1000BASE-T, half-duplex priority 3: 100BASE-TX, full-duplex	
		priority 4: 100BASE-TX, half-duplex priority 5: 10BASE-Te, full-duplex priority 6: 10BASE-Te, half-duplex	
Auto MDI/MDI-X	active		
Address table	4 k entries		
Operating mode	store and forward		
MTU	1500 Byte		
Accepted frame size	641518(1522) Byte	smaller or larger packets are rejected	
IEEE 1588v2 PTP clock configuration	E2E, TC, one-step	end-to-end transparent clock compatible with two-step no P2P (peer-to-peer) and no BC (boundary clock)	
PTP Transport 1	UDP IPv4 and IPv6, Ethernet		
PTP Transport 2	multicast and unicast, Ports 319 and 320	multicast: messages are forwarded to all ports	
		unicast: messages are only forwarded to the port to which the recipient is connected	
PTP domain	is not checked		

General			
Parameter	Value		Remarks
Status LED	blue	= on	
Port LED	yellow (left)	green (right)	
	off	off	no connection
	on	off	1000 Mbit/s connection, inaktive
	flashing	off	1000 Mbit/s connection, aktive
	off	on	100 Mbit/s connection, inaktive
	off	flashing	100 Mbit/s connection, aktive
	on	on	10 Mbit/s connection, inaktive
	flashing	flashing	10 Mbit/s connection, aktive

Power supply			
Parameter	Value typ.	min. / max.	Remarks
Input supply voltage	10 V to	50 V DC	
Power consumption		4 W	
Module power supply options	•	et (LEMO) or t module	imc CRONOSflex or imc BUSDAQflex imc CANSASflex

Terminal connection (front)	Value	Remarks
LAN interface	8P8C modular socket	RJ45
Interfaces for power supply	 LEMO.0B or LEMO.1B with CRFX module connector/slider 	suitable for setting up a redundant supply from 2 possible sources

Variant imc CRONOSflex (CRFX)

Terminal connections (rear side of the CRFX module)			
Parameter	Value	Remarks	
Input supply plug (female)	LEMO.EGE.1B.302	multicoded, 2-notch connector for optional individual power supply	
Module connector	2x 20 pin	system bus for distributed imc CRONOS flex components: Ether CAT not used by switch but fed through via module connector. Switch can be docked and inserted at arbitrary positions within the CRFX system (right hand side of base unit)	

Pass through power limits		
Directly connected (clicked) imc CRONOS <i>flex</i> Modules	2.1.4 (maximum current)	
inic eronos <i>jiex</i> iviodules	3.1 A (maximum current)	
	Equivalent power with chosen DC power input:	
	149 W @ 48 V DC (e.g. AC/DC line adaptor)	
	74 W @ 24 V DC (e.g. AC/DC line adaptor)	
	37 W @ 12 V DC (typical vehicle supplied DC input)	

Operating conditions	Value	Remarks
Ingress protection rating	IP20	
Pollution degree	2	
Operating temperature	-40°C to +85°C	condensation temporarily allowed
Weight	550 g	

9.11.17 CRFX/ETHERCAT-GATEWAY

Parameter	Value	Remarks
Max. ECAT bus cycle	5 kHz (200 μs)	
Supported bus cycles	5 kHz, 1 kHz, 500 Hz, 100 Hz	
Typical channel configuration of the CRFX modules	sampling rate= ECAT bus cycle, AAF	however maximum 5 kHz only one global sampling rate is allowed
Max. sampling rate	34 channels up to 5 kHz 128 channels up to 1 kHz	170 kHz total sampling rate
Terminal connections		
PC / network	RJ45	max. 100 m cable with 100 MBit (according to IEEE 802.3)
Ethernet TCP/IP	100 MBit	
System bus for <i>flex</i> modules (EtherCAT) "CRFX MODULE"	RJ45	max. 100 m cable between 2 modules warning: here is POEC power 460 available
	alternatively: module connector	
ECAT Slave Interface	2x RJ45 (IN and OUT)	
Sync	BNC	IRIG-B (isolated, TTL) typically not necessary
Power supply	type LEMO.1B (2-pin)	compatible with LEMO.EGE.1B.302 multikodiert 2 Nuten kompatibel mit Steckern FGG.1B.302 (Standard) oder FGE.1B.302 (E-kodiert, 48 V)
Remote control terminal	type LEMO.1B (6-pin)	connector LEMO FGG.1B.306
Module connector	2 x 20-pin	direct connection of modules (click) supply and system bus

Power supply			
Parameter	Value	Remarks	
Power supply	10 V to 50 V DC		
Power-on threshold (typ.)	10.0 V	min. input voltage required for power-on (open circuit)	
Shutdown threshold (typ.)	9.2 V	input voltage at which the automatic deactivation is triggered (data backup protected by internal UPS buffering)	
Power consumption	20 W	depending on model and equipment (e.g. fieldbus, HDD)	
AC/DC power adaptor	48 V DC, 150 W 110-230 V AC 50-60 Hz	included in delivery	
Pass through power	via module connector and onto RJ45 (EtherCAT): PoEC	min. 42 V required for PoEC	

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Pass through power limits	
Directly connected imc CRONOSflex modules via module connector	 3.1 A (max.), equivalent power with chosen DC power input: 149 W at 48 V DC (standard AC/DC power adaptor resp. DC/DC Power Handle) 37 W at 12 V DC (typ. DC input voltage)
Power-over EtherCAT (PoEC) for remote imc CRONOSflex modules	 37 W at 12 V DC (typ. DC input voitage) 350 mA (max., corresp. to IEEE 802.3), equivalent power with DC power input: 17.5 W at 50 V DC (e.g. DC/DC Power Handle) 16.8 W at 48 V DC (e.g. AC/DC power adaptor) 14.7 W at 42 V DC (minimum voltage for PoEC) Note: minimum system power of 42 V DC required for PoEC

Operating conditions						
Parameter	Value	Remarks				
Operating environment	dry, non corrosive environment within specified operating temperature range					
Rel. humidity	80% up to 31°C, above 31°C: linear declining to50%	according IEC 61010-1				
Ingress protection rating	IP20					
Pollution degree	2					
Operating temperature (standard)	-10°C to +55°C	without condensation				
Operating temperature (extended: "-ET" version)	-40°C to +85°C	condensation temporarily allowed				
Shock- and vibration resistance	IEC 61373, IEC 60068-2-27 IEC 60062-2-64 category 1, class A and B MIL-STD-810 Rail Cargo Vibration Exposure U.S. Highway Truck Vibration Exposure					
Extended shock- and vibration resistance	upon request	specific tests or certifications upon request				
Dimensions	90 x 118 x 186 mm	WxHxD				
Weight	approximately 1.2 kg					



Reference

Please find here the <u>description of the module</u> 97.

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9.11.18 imc APPMOD: Application module

Embedded Processor						
Parameter	Value	Remarks				
Embedded processor	Freescale Power PC MPC5200B Core CLK 384 MHz					
RAM	64 MB	total memory				
	48 MB	available for the application				
Flash	16 MB	only for the operation system				
Operating system	Linux					

General			
Parameter	Value	Remarks	
Interfaces	1x Ethernet interface and 1x serial interface	Specific applications can each use exactly one of the two interfaces. Simultaneous use of both interfaces requires a system with two interfaces.	
	3.5 mm jack plug	service-jack (RS232, 115 kBaud, Tx, Rx, GND) console for development, debugging	
Module width	requires 1 slot	fixed installation, ex factory	
Modularity	order option	upon request	
Max. amount of interfaces	3	totally in one CRFX base unit	
in one system	8	totally in one CRC system	
	1	totally in one BUSFX-4 system	
	2	totally in one BUSFX-6 system	
	3	totally in one BUSFX-8 system	
	5	totally in one BUSFX-12 system	

Ethernet Variant					
Parameter	Value	Remarks			
Terminals / Nodes	1				
Terminal connectors	1x RJ45				
Topology	bus				
Transfer protocol	TCP / IP	IEEE Norm 802.3			
Transfer medium	Ethernet				
Data flow direction	sending/receiving				
Baud rate	100 MBit	100BaseT (Half- and Full-duplex)			
	10 MBit	10BaseT (Half- and Full-duplex)			
		Auto-sensing			
Isolation strength	60 V	to system ground (CHASSIS)			

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Serial interface variant	Serial interface variant							
Parameter	Value	Remarks						
Terminals / Nodes	1							
Terminal connectors	1x DSUB-9							
Baud rate	300, 1200, 2400, 4800, 9600, 14400, 19200, 28800, 38400, 57600, 115200, 230400	special bit-rates: 14400 and 28800						
Isolation	galvanically isolated	to system ground (CHASSIS)						
Isolation strength	60 V	nominal working voltage						
Operation modes	RS 232 RS 485 / RS 422	flexibly configurable: multi-protocol transceiver						
RS232 mode								
Parameter	Value	Remarks						
Topology	point-to-point							
Transfer protocol	RS232							
Signal type	Tx, Rx, GND CTS, RTS	Basis signals Handshake, flow control						
Data flow direction	sending/receiving							
Byte format	7 or 8 data bits, 1 or 2 stop bits, none/odd/even parity							
Flow control	XON/XOFF, RTS/CTS							
RS485/422 mode								
Topology	Bus							
Transfer protocol	RS485	compatible to RS422						
Operating mode	Half- and Full-duplex	activated via software						
Signal type	2x Tx, 2x Rx, GND	basis signals, differential						
Data flow direction	sending/receiving							
Termination	120 Ω	activated via software						

10 Pin configuration

10.1 Connecting DSUB-15 adaptor plug

The **Standard plug** is a 1:1 DSUB-15 to screw terminal adapter. It can be used for all modules which come with the corresponding pin configuration.

The **Special plugs** do not offer direct adaption from the DSUB pins to the screw terminals, but instead come with extra functions:

- For current measurement (up to 50 mA) with voltage channels the **Shunt plug** (ACC/DSUBM-I2 and I4) have a built-in 50 Ω shunt. The scaling factor 0.02 A/V must be set in order to display the current value.
- For temperature measurements, a special, patented **Thermo plug** (ACC/DSUBM-T4) is available. This DSUB-15 plug is suited for measurement of voltages as well as temperatures with PT100 and thermocouples with integrated cold junction compensation (CJC). Any types of thermocouples can be connected at the differential inputs (+IN and -IN). It also has additional "auxiliary contacts" for connecting PT100 in 4-wire configurations, where the reference current loop is already pre-wired internally. The Thermo plug can also be used for normal voltage measurement.
- The IEPE/ICP plug (ACC/DSUB-ICP2 and ICP4) provide a current supply source as well as a capacitive coupling.
- The **TEDS plugs** store sensor information according to IEEE1451.4 for use with <u>imc Plug & Measure</u> (integrated TEDS chips DS 2433).



The screw terminals of the plug

- To connect the measurement leads with the screw terminals, suitable leads should have a maximum cross section of 1.5 mm² incl. cable end-sleeve.
- The terminals' screw heads only have secure electrical contact once they are tightened to a connection wire. For this reason, a control measurement (for instance with multimeter probe tips) at "open" terminals can falsely mimic a missing contact!
- Cable shielding must be connected at CHASSIS (DSUB frame) as a rule. At some plugs,
 V_{CC} (5 V) is available, with a maximum load current of typically 135 mA per plug.

10.1.1 Device models overview

		Voltage	Current	Bridge	Thermocouple	PT100	Current feed sensors IEPE (ICP)	Universal
	UNI2-8	UNI2 B2	UN12 12	UNI2 B2	UNI2	UNI2	ICP2	UNI2
	UNI-4	UNI2	UN12 12	UNI2 B2	UNI2	UNI2	ICP2	UNI2
_	DCB2-8	B2 UNI2	12	B2 UNI2			ICP2	
ie lie	BR2-4	B2	12	B2			ICP2	
宣	LV-16	U4	14					
틆	LV3-8	U4	14				ICP4	
B0	SC2-32	U4	14				ICP4	
Analog amplifier	OSC-16	U4 T4	14		T4	T4		
	C-8	U4 T4	14		T4	T4		
	ISO2-8	U4 T4	14		T4	T4	ICP4	
	ISOF-8	U4 T4	14		T4	T4	ICP4	

		INCENCODER	FREQUENCY	DIGITALIN	DIGITAL OUT	DIGITAL OUT HIGH CURRENT	RELAIS	ANALOG OUT
	ENC-4,	ENC4,						
	HRENC-4	ENC4-IU						
	FRQ2-4		FRQ2					
	DI-16			DI8				
	DIOINC	ENC4		D12-8			REL4	
les	DIO-PL2			DI8			REL4	
Digital modules	DI2-16			DI4-8				
Ë	DO-16				DO-8			
-e	DO-16-HC					DO8-HC		
gi	DAC-8							DAC4
□	DI16-DO8-ENC4	ENC4		DI4-8	DO-8			
	DI8-DO8-ENC4-DAC4	ENC4		D14-8	DO-8			DAC4

10.2 DSUB-15 pin configuration

In general: DSUB pin 1 is internally reserved.

10.2.1 Universal plug

Metal plug

ACC/D	SUBM-	UNI2
DSUB Pin	Terminal	UNIVERSAL
9	1	+VB1
3	2	-VB1
2	3	+IN1
10	4	-IN1
11	5	I1_1/4B1 ⁽¹⁾
4	6	-SENSE1
5	7	+IN2
13	8	-IN2
14	9	I2_1/4B2 ⁽¹⁾
7	10	-SENSE2
12	11	+VB2
6	12	-VB2
15	15	(GND)
8	18	(+5V)
	13	
	14	
(I)	16	CHASSIS
(I)	17	CHASSIS

The abbreviation VB stands for the bridge sensor supply and can be equated with the sensor supply, abbreviation: SUPPLY.

10.2.2 Standard plug

ACC/D	SUBM-	B2	U4
DSUB Pin	Terminal	BRIDGE	VOLTAGE
9	1	+VB1	(RES.)
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	-VB1	(+SUPPLY)
11	5	[+SENSE1_1/4B1]	+IN2
4	6	-SENSE1	-IN2
12	7	+VB2	(-SUPPLY)
5	8	+IN2	+IN3
13	9	-IN2	-IN3
6	10	-VB2	(GND) *
14	11	[+SENSE2_1/4B2]	+IN4
7	12	-SENSE2	-IN4
15	15	GND	(GND)
8	18	+5V	(+5V)
	13		
	14		
(1)	16	CHASSIS	CHASSIS
(1)	17	CHASSIS	CHASSIS

^{[]: 1/4} Bridge with UNI2-8 and DCB2-8 +SENSE with BR2-4 and UNI-4

⁽¹⁾ if the special version of the amplifier is equipped with the ± 15 V option, then this pin = -15 V

^{*} if special version with ±15 V option, then this pin 6 is the reference

ACC/D	SUBM-	ENC4, ENC4-IU	FRQ2	DO-8	REL4	DAC4
DSUB Pin	Terminal	INCENCODER	FREQUENCY	DIGITAL OUT	RELAIS	ANALOG OUT
9	1	+INA	+IN1	BIT1	IN1	
2	2	-INA	-IN1	BIT2	IN2	DAC1
10	3	+INB		BIT3	IN3	AGND
3	4	-INB		BIT4	IN4	
11	5	+INC	+IN2	BIT5	OFF1	DAC2
4	6	-INC	-IN2	BIT6	OFF2	AGND
12	7	+IND		BIT7	OFF3	
5	8	-IND		BIT8	OFF4	DAC3
13	9	+INDEX			ON1	AGND
6	10	-INDEX			ON2	
14	11	+5V	+5V	НСОМ	ON3	DAC4
7	12	GND *	GND	LCOM	ON4	AGND
15	15	(-SUPPLY)		LCOM	(GND)	
8	18	(+SUPPLY)		OPDRN	(+5V)	
	13					
	14					
(I)	16	CHASSIS	CHASSIS	CHASSIS	CHASSIS	CHASSIS
(I)	17	CHASSIS	CHASSIS	CHASSIS	CHASSIS	CHASSIS

[]: 1/4 Bridge with UNI2-8 and DCB2-8 +SENSE with BR2-4 and UNI-4

 $^{^{}st}$ if special version with ± 15 V option, then this pin 6 is the reference

ACC/D	SUBM-	DI8	DI2-8	DI4-8	PWM
DSUB Pin	Terminal	DIGITAL IN	DIGITAL IN	DIGITAL IN	TTL PULSE
9	1	BIT1	+IN1	+IN1	PWM1_OPDRN
2	2	BIT2	+IN2	+IN2	PWM2_OPDRN
10	3	BIT3	-IN1/2	+IN3	PWM1_TTL
3	4	BIT4	+IN3	+IN4	PWM2_TTL
11	5	BIT5	+IN4	-IN1/2/3/4	PWM3_OPDRN
4	6	BIT6	-IN3/4	+IN5	PWM4_OPDRN
12	7	BIT7	+IN5	+IN6	PWM3_TTL
5	8	BIT8	+IN6	+IN7	PWM4_TTL
13	9	CLK	-IN5/6	+IN8	
6	10		+IN7	-IN5/6/7/8	
14	11	НСОМ	+IN8	+HCOM	+5V
7	12	LCOM	-IN7/8	LCOM	GND
15	15	LCOM	LEVEL	LCOM	GND
8	18	LEVEL	LCOM	LEVEL	
	13				
	14				
	16	CHASSIS	CHASSIS	CHASSIS	CHASSIS
	17	CHASSIS	CHASSIS	CHASSIS	CHASSIS

¹ The DI4-8 plug is used by the latest digital input modules such as DI2-16 and the DI8-DO8-ENC4 multi-boards. In these cases, each 4-bit group has its own ground reference .

 $^{^2}$ The DI2-8 plug is used by the predecessor version DI-16. All of the plug's 8 bits share a common ground reference.

10.2.3 Special plug

Metal plug

ACC/DSUBM-T4 DSUB Terminal TH-COUPLE/RTD Pin 9 3 2 (+SUPPLY) 2 3 +IN1 10 4 -IN1 11 +IN2 4 6 -IN2 5 7 +IN3 -IN3 13 8 14 9 +IN4 10 -IN4 7 12 11 (-SUPPLY) 6 12 -I4 (GND) * 15 -13 18 +12 15 13 GND 14 +13 16 +14 17 -11 19 -12 20 CHASSIS

Metal plug

ACC/DSUBM-		14	12
DSUB Pin	Terminal	CURRENT	CURRENT
9	1	(RES.)	+SUPPLY1
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	(+SUPPLY)	-SUPPLY1
11	5	+IN2	
4	6	-IN2	
12	7	(-SUPPLY)	+SUPPLY2
5	8	+IN3	+IN2
13	9	-IN3	-IN2
6	10	(GND)	-SUPPLY2
14	11	+IN4	
7	12	-IN4	
15	15	(GND)	(GND)
8	18	(+5V)	(+5V)
	13		
	14		
(I)	16	CHASSIS	CHASSIS
(17	CHASSIS	CHASSIS

DSUB-	ICP4	ICP2
Termin al	ICP	ICP
1	+ICP1	+ICP1
2	-ICP1	-ICP1
3	+ICP2	
4	-ICP2	
5	+ICP3	+ICP2
6	-ICP3	-ICP2
7	+ICP4	
8	-ICP4	
9		
10		
11		
12		
13		
14	CHASSIS	CHASSIS
15	CHASSIS	CHASSIS
16	CHASSIS	CHASSIS
17	+5V	+5V
18	AGND	AGND

^{*} if the special version of the amplifier is equipped with the ±15 V option, then this pin 6 is the reference

Metal plug

ACC/D	SUBM-	DO-HC-8
DSUB Pin	Terminal	DIGITAL OUT HIGH CURRENT
9	1	BIT1
2	2	BIT2
10	3	BIT3
3	4	BIT4
11	5	BIT5
4	6	BIT6
12	7	BIT7
5	8	BIT8
13	9	HCOM_1-4
6	10	LCOM_1-4
14	11	HCOM_5-8
7	12	LCOM_5-8
15	15	LCOM
8	18	OPDRN
	13	
	14	
(II)	16	CHASSIS
(I)	17	CHASSIS

Metal plug

ACC/D	SUBM-	SYNTH4
DSUB Pin	Terminal	SYNTHESIZER
9	1	DOUT1
2	2	AOUT1
10	3	AGND
3	4	DOUT2
11	5	AOUT2
4	6	+5V
12	7	НСОМ
5	8	AOUT3
13	9	AGND
6	10	DIN1
14	11	AOUT4
7	12	LCOM
15	15	LEVEL
8	18	OPDRN
	13	
	14	
(I)	16	CHASSIS
(1)	17	CHASSIS

10.2.4 TEDS plug

ACC/DSU	BM-TEDS-	UNI2
DSUB Pin	Terminal	UNIVERSAL
9	1	+VB1
3	2	-VB1
2	3	+IN1
10	4	-IN1
11	5	I1_1/4B1 ⁽¹⁾
4	6	-SENSE1
5	7	+IN2
13	8	-IN2
14	9	I2_1/4B2 ⁽¹⁾
7	10	-SENSE2
12	11	+VB2
6	12	-VB2
15	15	TEDS_GND
8	18	(+5V)
	13	TEDS2
	14	TEDS1
(1)	16	CHASSIS
(II)	17	CHASSIS

ACC/DSU	BM-TEDS-	B2	U4
DSUB Pin	Terminal	BRIDGE	VOLTAGE
9	1	+VB1	(RES.)
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	-VB1	(+SUPPLY)
11	5	[+SENSE1_1/4B1]	+IN2
4	6	-SENSE1	-IN2
12	7	+VB2	(-SUPPLY)
5	8	+IN2	+IN3
13	9	-IN2	-IN3
6	10	-VB2	GND
14	11	[+SENSE2_1/4B2]	+IN4
7	12	-SENSE2	-IN4
15	15	(GND), TEDS_GND	TEDS_GND
8	18	(+5V)	(+5V)
	13	TEDS1	TEDS1
	14	TEDS2	TEDS2
(I)	16	CHASSIS	CHASSIS
(I)	17	CHASSIS	CHASSIS
	19		TEDS3
	20		TEDS4

⁽¹⁾ if the special version of the amplifier is equipped with the ± 15 V option, then this pin = -15 V

[]: 1/4 Bridge with UNI2-8 and DCB2-8

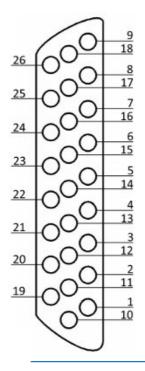
ACC/DSU	BM-TEDS-	T4
DSUB	Terminal	TH-COUPLE/RTD
9	1	+11
3	2	(+SUPPLY)
2	3	+IN1
10	4	-IN1
11	5	+IN2
4	6	-IN2
5	7	+IN3
13	8	-IN3
14	9	+IN4
7	10	-IN4
12	11	(-SUPPLY)
6	12	-14
	15	-I3
	18	TEDS4
15	13	TEDS_GND
	14	+13
	16	+14
	17	TEDS3
	19	TEDS2
	20	TEDS1
	21	-l1
	22	+12
	23	-I2
	24	CHASSIS

ACC/DSU	BM-TEDS-	14	12
DSUB Pin	Terminal	CURRENT	CURRENT
9	1	(RES.)	+SUPPLY1
2	2	+IN1	+IN1
10	3	-IN1	-IN1
3	4	(+SUPPLY)	-SUPPLY1
11	5	+IN2	
4	6	-IN2	
12	7	(-SUPPLY)	+SUPPLY2
5	8	+IN3	+IN2
13	9	-IN3	-IN2
6	10	GND	-SUPPLY2
14	11	+IN4	
7	12	-IN4	
15	15	TEDS_GND	TEDS_GND
8	18	(+5V)	(+5V)
	13	TEDS1	TEDS1
	14	TEDS2	TEDS2
	16	CHASSIS	CHASSIS
	17	CHASSIS	CHASSIS
	19	TEDS3	
	20	TEDS4	

⁽²⁾ if special version with $\pm 15~V$ option, then this pin 6 is the reference

10.3 DSUB-26 pin configuration (high density)

ACC/DSUBM-		HD-I4	HD-B4
DSUB	Klemme	CURRENT	BRIDGE
13	1	+IN2	+IN2
4	2	-IN2	-IN2
14	3		[+SENSE2_1/4B2]
5	4		-SENSE2
15	5	+IN3	+IN3
6	6	-IN3	-IN3
16	7		[+SENSE3_1/4B3]
7	8		-SENSE3
23	9	+SUPPLY3	+VB3
24	10	-SUPPLY3	-VB3
25	11	+SUPPLY4	+VB4
26	12	-SUPPLY4	-VB4
17	13	+IN4	+IN4
8	14	-IN4	-IN4
18	15		[+SENSE4_1/4B4]
9	16		-SENSE4
21	17	+SUPPLY2	+VB2
22	18	-SUPPLY2	-VB2
19	19	+SUPPLY1	+VB1
20	20	-SUPPLY1	-VB1
11	21	+IN1	+IN1
2	22	-IN1	-IN1
12	23		[+SENSE1_1/4B1]
3	24		-SENSE1



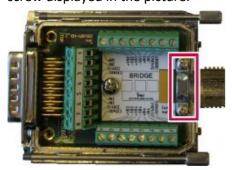


Please use the screw for a contact with Chassis.



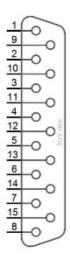
Example

The following picture shows the ACC/DSUBM-HD-B4 connector. To contact with Chassis please use marked screw displayed in the picture.



10.4 DSUB configuration of scanner SC2-32

10.4.1 Variety 8 x DSUB 15



Pin	Signal	Plug 1	Plug 2	Plug 3	Plug 4	Plug 5	Plug 6	Plug 7	Plug 8
1	reserved								
9	reserved								
2	+IN A	+IN 17	+IN 21	+IN 25	+IN 29	+IN 1	+IN 5	+IN 9	+IN 13
10	-IN A	-IN 17	-IN 21	-IN 25	-IN 29	-IN 1	-IN 5	-IN 9	-IN 13
3	+V ext								
11	+IN B	+IN 18	+IN 22	+IN 26	+IN 30	+IN 2	+IN 6	+IN 10	+IN 14
4	-IN B	-IN 18	-IN 22	-IN 26	-IN 30	-IN 2	-IN 6	-IN 10	-IN 14
12	-V ext								
5	+IN C	+IN 19	+IN 23	+IN 27	+IN 31	+IN 3	+IN 7	+IN 11	+IN 15
13	-IN C	-IN 19	-IN 23	-IN 27	-IN 31	-IN 3	-IN 7	-IN 11	-IN 15
6	reserved								
14	+IN D	+IN 20	+IN 24	+IN 28	+IN 32	+IN 4	+IN 8	+IN 12	+IN 16
7	-IN D	-IN 20	-IN 24	-IN 28	-IN 32	-IN 4	-IN 8	-IN 12	-IN 16
15	GND								
8	Vcc ICP								

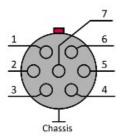
10.4.2 Variety 2 x DSUB 37

	1 +IN1	
0	20 -/N1	
~	2 +IN2	
~~	21 -IN2	
\sim	3 +IN3	
ٽ	22 -IN3	
~	4 +IN4	
~~	23 -IN4	
	5 +IN5 24 -IN5	
ٽ ا	24 - IN5	
~	6 +IN6 25 -IN6 7 +IN7 26 -IN7	
0	25 -IN6	
0	7 +IN7	
<u>ٽ</u> ہ	26 -IN7	
ິດ-	8 +ins	
صّ	27 -IN8 9 +IN9 28 -IN9 10 +IN10	
് റ-	9 +IN9	
ص_	28 -IN9	
_ o_	10 +IN10 29 -IN10	
_ّه	29 -IN10	
¯ o-	29 -IN10 11 +IN11 30 -IN11	
0-	30 -IN11	
· 0-	12 +IN12	
0-	12 +IN12 31 -IN12 13 +IN13 32 -IN13 14 +IN14	
0-	13 TIN 13	
О—	32 -IN13	
0-	14 +IN14 33 -IN14	
	33 -IN14 15 +IN15 34 -IN15	
Šo-	34 -IN15	
~	16 +IN16	
0-	16 +IN16 35 -IN16	
0	35 -IN16 17	
0-	36	
0	36 18 GND 37 Vcc ICP	
0-	37 Vcc ICP	
\sim	19	
Ŭo-	17	
DO: UE		
DSUB-37		

	1 +IN17
_ o-	20 -IN17
<u>о —</u>	2 +IN18
_ 0-	21 -IN18
<u>~</u>	3 +IN19
~ 0−	22 -IN19
\circ	4 +IN20
0	23 -IN20
0	5 +IN21
~~	24 -IN21
0	6 +IN22
~~	25 - IN22 7 + IN23
9	7 +IN23
ŏ	26 - IN23
~ o-	8 +IN24
صّ	27 - IN24
ŏо-	9 +IN25
ص ّ	28 - IN25
~ o-	10 +IN26
0	29 - IN26
~ o-	11 +IN27
0	30 -IN27
0	12 +IN28 31 -IN28
0-	
0-	
0-	32 - IN29 14 +IN30
0	33 -IN30
0-	15 +IN31
0-	34 -IN31
0-	16 +IN32
0-	35 -IN32
0	17
_ 0-	36
0_	
~ O-	18 GND 37 Vcc ICP 19
0_	19
_0	
DSUB-	97
D00B	-01

10.5 LEMO pin configuration

10.5.1 LEMO.1B (7-pin)



LEMO PIN	ISO2-8	ISOF-8(-SUPPLY, bipolar ±15 V)	C-8, OSC-16	LV3-8, LV-16, SC2-32	LV3-8-L-SUPPLY
1	+IN	+IN	+IN	+IN	+IN
2	-IN	-IN	-IN	-IN	-IN
3	+SUPPLY	+SUPPLY	+SUPPLY	+SUPPLY	+SUPPLY
4	GND (-SUPPLY*)	GND (-SUPPLY, -15 V)	GND (-SUPPLY*)	-SUPPLY (GND)	GND
5	TEDS OneWire	TEDS OneWire (SUPPLY GND)	TEDS OneWire	TEDS OneWire	TEDS OneWire
		TEDS is omitted with ±15 V option			
6	PT100 current source	PT100 current source	PT100 current source	n.c.	-SUPPLY (-15 V)
7	+I (pos. signal input for current measurement)	+I (pos. signal input for current measurement)	n.c.	n.c.	n.c.

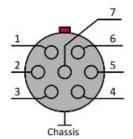
LEMO PIN	DCB2-8, B-8	UNI-8, UNI2-8	UNI-4	BR-4, BR2-4 **
1	+IN	+IN	+IN	+IN
2	-IN	-IN	-IN	-IN
3	+SUPPLY	+SUPPLY	+SUPPLY	+SUPPLY
4	-SUPPLY (GND)	-SUPPLY (GND)	-SUPPLY (GND)	-SUPPLY
5	TEDS (OneWire)	TEDS (OneWire)	TEDS (OneWire)	
6	-SENSE	-SENSE/PT100 current source	-SENSE	-SENSE
7	quarter bridge completion	quarter bridge completion / sense for PT100 3-wire configuration	+SENSE_1/4B	+SENSE

LEMO PIN	ENC-4, HRENC-4 ***	
1	+IN X	
2	-IN X	
3	+SUPPLY	
4	-SUPPLY (GND)	
5	+INDEX	
6	+IN Y	
7	-IN Y	

- sensor supply voltages available via the optional sensor supply module, see data sheet
 Default ranges: +5 V to +24 V
- ** Upon request BR2-4 with TEDS then with 8-pin LEMO (because -SUPPLY is not GND and is also not TEDS-GND)
- *** Reference of +INDEX is -SUPPLY (GND)
 sensor supply voltage 5 VDC/ 100 mA (optional 300 mA)
 other sensor supply voltages available via the optional
 sensor supply module

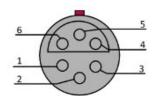
LEMO pin configuration Chapter 10

LEMO.1B (7-pin)



LEMO PIN	AUDIO2-4-MIC	SEN-SUPPLY-4	
1	reserved	+OUT	signal from the sensor, passed through to the amplifier
2	-IN / TEDS-Masse	-OUT	reference for the signal
3	polarization voltage	n.c.	pin 6 and 7 = n.c.
4	+IN TEDS GND		reference for TEDS
5	TEDS	TEDS	scaling information,
6	positive sensor supply		for analysis by TEDS-capable
7	negative sensor supply		amplifiers
housing	device ground		

10.5.2 LEMO.1E (6-pin), WFT-2



view on the plug of the cable

LEMO PIN	Signal	
1	Command OUT	
2	12 V POWER	
3	Data OUT (normal)	
4	Data OUT (invers)	
5 and 6	GND	

connection cable (H-CAB-LEM-WFT-xm: 6 m or 12 m cable length) between wheel force transducer and CRFX/WFT-2 module.

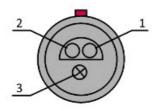


Reference

WFT-documentation

A separate documentation describes setup and operation of the measurement wheel.

10.5.3 LEMO.1S (3-pin), ACI-8



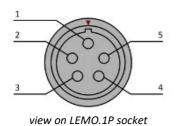
LEMO PIN	ACI-8	
1	-IN X	
2	+IN X	
3	reserved	



Reference

Please find here the ACI-8 description. 482

10.5.4 LEMO.1P (5-pin), HISO-8-L



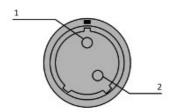
LEMO PIN	HISO-8-L	
1	+IN	
2	-IN	
3	+1	
4	+PT	
5	-PT	



Reference

Please find here the HISO-8 description. 159

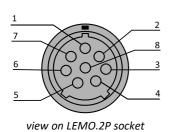
10.5.5 LEMO.2P (2-pin), HISO-8-T-8L



PIN	HISO-8-T-8L	Material
1	+IN	NiCr
2	-IN	Ni

Please find here the HISO-8 description. 159

10.5.6 LEMO.2P (8-pin), HISO-8-T-2L



IN14 / Material	IN58 / material
+IN1 / NiCr	+IN5 / NiCr
-IN1 / Ni	-IN5 / Ni
+IN2 / NiCr	+IN6 / NiCr
-IN2 / Ni	-IN6 / Ni
+IN3 / NiCr	+IN7 / NiCr
-IN3 / Ni	-IN7 / Ni
+IN4 / NiCr	+IN8 / NiCr
-IN4 / Ni	-IN8 / Ni
	+IN1 / NiCr -IN1 / Ni +IN2 / NiCr -IN2 / Ni +IN3 / NiCr -IN3 / Ni +IN4 / NiCr

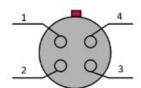


Note

Manufacture of measuring cables

To ensure that the working voltages specified for the channel isolation are reliably maintained, the cores must not be stripped too far during the manufacture of the measuring cables. The isolation of the cores must reach up to the solder cups. For a shielded cable, the exposed cable shield must be completely removed. As a rule, only suitable cables with sufficient isolation should be used.

10.5.7 LEMO.1B (4-pin), HANDLE



LEMO PIN	PIN CRFX HANDLE POWER	
1	50 V	
2 GND		
3 and 4 reserved		

LEMO.1B.304 (additional output supply socket)

10.6 DSUB-9 pin configuration

10.6.1 Display

DSUB-PIN	Signal	Description	Use in device
1	DCD	Vcc 5V	connected
2	RXD	Receive Data	connected
3	TXD	Transmit Data	connected
4	DTR	5V	connected
5	GND	ground	connected
6	DSR	Data Set Ready	connected
7	RTS	Ready To Send	connected
8	CTS	Clear To Send	connected
9	R1	Pulldown to GND	connected

Supply for the graphical display

Connector	+9 V to 32 V	- (0V)	nc
Binder	1	2	3
Souriau	В	С	A

To the <u>description</u> 81 and the <u>technical data of the displays</u> 451.

10.6.2 GPS

	SUB-9	GPS 18 LVC	GPS 18 - 5Hz	
Pin	Signal	Color	Color	
1	Vin	Red	Red	
2	RxD1*	White	White	
3	TxD1	Green	Green	
4	-	-	-	
5	GND, PowerOff	2x Black	2x Black	
6	-	-	-	
7	PPS (1 Hz clock)	Yellow	Yellow	
8	-	-	-	
9	-	-	-	

Pin configuration at measurement device. At the GPS-mouse Rx and Tx are interchanged.

10.7 DSUB-9, CRFX/SEN-SUPPLY-4

Pin	Signal	Remarks
1	-IN	signal from the sensor
2	TEDS GND	reference for TEDS (no connection with GND)
3	n.c.	reserved
4	GND	reference for supply voltage ±SUPPLY
5	-SUPPLY	-15 V: supply line to sensor
6	+IN	signal from sensor
7	TEDS	TEDS-memory in the DSUB-9 plug
8	FAIL	sensor status: connection to GND = OK
9	+SUPPLY	+15 V: power supply to sensor

Find here the <u>technical data</u> 447 of the CRFX/SEN-SUPPLY-4 module.

APPMOD Chapter 10

10.8 APPMOD

RS 232

_	
Signal	PIN
n.c.	1
RX	2
TX	3
n.c.	4
DG	5
n.c.	6
RTS	7
CTS	8
n.c.	9

RS 422 / RS 485 Full-Duplex

Signal	PIN	
Rx+	2	
Rx-	8	
TX+	3	
Тх-	7	

RS 485 Half-Duplex

Signal	PIN
+D	3
-D	7

10.9 Pin configuration of the fieldbusses

10.9.1 CAN, CAN FD Interface

DSUB-PIN	Signal	Description	Use in device
1	+CAN_SUPPLY	optional supply for a CRXT Base Unit	output current I < 1 A (permanently) both CAN nodes together,see CRXT technical specs 306
2	CAN_L	dominant low bus line	connected
3	CAN_GND	CAN Ground	connected
4	nc	reserved	do not connect
5	-CAN_SUPPLY	optional supply for a CRXT Base Unit	unused as per standard* (supply I < 1 A)
6	CAN_GND	optional CAN Ground	connected
7	CAN_H	dominant high bus line	connected
8	nc	reserved (error line)	do not connect
9	nc	reserved	do not connect

Find here the <u>technical data</u> and the <u>cabling</u> of the CAN-Bus interface.

10.9.2 LIN-Bus (DSUB-9)

DSUB-PIN	Signal	Description
3	LIN_GND	LIN Ground
6	LIN_GND	Optional LIN Ground
7	LIN_INPUT/OUTPUT	LIN bus line
1, 2, 4, 5, 8 and 9	n.c.	

Find here the <u>technical data</u> 439 and the <u>cabling</u> 100 of the LIN-Bus interface.

10.9.3 FlexRay-Bus (DSUB-9)

imc standard: One DSUB-9 socket with two channels

DSUB-Pin	Signal	Description
1	nc	
2	BM channel A	negative bus line channel A
3	GND	FlexRay ground
4	BM channel B	negative bus line channel B
5	GND	FlexRay ground
6	nc	
7	BP channel A	positive bus line channel A
8	BP channel B	positive bus line channel B
9	nc	

Option: Two DSUB-9 sockets (CON1 and CON2) with one channel each

DSUB-Pin	CON1	CON2
1	nc	nc
2	BM channel A (negative bus line channel A)	BM channel B (negative bus line channel B)
3	GND	GND
4	nc	nc
5	GND	GND
6	nc	nc
7	BP channel A (positive bus line channel A)	BP channel B (positive bus line channel B)
8	nc	nc
9	nc	nc

Find here the <u>technical data [440]</u> and the <u>cabling [100]</u> of the FlexRay-Bus interface.

10.9.4 XCPoE (RJ45)

Standard Ethernet 1x RJ45. Find here the <u>technical data [442]</u> and the <u>cabling [100]</u> of the XCPoE interface.

10.9.5 EtherCAT (RJ45, M8)

CRFX modules are connected as load to be supplied to all 8 wires of the network cable, i.e. both the 4 data lines and the 4 additional free wires. In this sense (a redundant use of data and free lines) the concept is PoEC compliant – i.e. also to standard PoEC Power-Injectors 32.

	M8 socket		
Pin	Signal		
1	+TxD	2 1	
2	+RxD	$\langle \bullet \bullet \rangle$	
3	-TxD	T••)	
4	-RxD	3 4	
		M8 socket, D-coded (view on top of the stitches) e.g. imc CRONOS-XT base (CRXT)	

RJ45 socket			
Pin	Signal		
1	+TxD		
2	-TxD		
3	+RxD		
6	-RxD	1 8	
4, 5, 7, 8	unused	view on top of the RJ45 socket	



Note

imc CRONOSflex (CRFX) Base Unit

The CRFX base, as the power master, feeds only on the free wires.

We recommend a separate transmission of data and voltage, i.e. the use of all 8 pins.



FAQ

Are all 8 pins to be used?

No, not in every case: to supply the CRFX module the 4 data pins are sufficient, for example if a power injector is used.

Yes, if a CRFX base is used as power source.

How can I prevent the transmission of Power over EtherCAT?

Use a four-wire RJ45 cable with only pins 1,2,3 and 6 connected. This way the passive PoE is not transmitted.



Reference

Find here the technical data and the cabling of the EtherCAT-Bus interface.

Accessories

EtherCAT cable (CRXT system bus or ECAT Slave)			
CRXT/CABLE-ECAT-M8-2M	EtherCAT cable CRXT, on both sides M8-plug, 2 m	11100079	
CRXT/CABLE-ECAT-M8-RJ45-2M	EtherCAT cable CRXT, on one side M8-plug to RJ-45, 2 m	11100080	
CRXT/CABLE-ECAT-M8-10M	EtherCAT cable CRXT, on both sides M8-plug, 10 m	11100086	
CRXT/CABLE-ECAT-M8-RJ45-10N	EtherCAT cable CRXT, on one side M8-plug to RJ-45, 10 m	11100087	

10.9.6 ARINC-Bus (DSUB-15)

CON 1					
ARINC-Interface with 8 Rx channels		ARINC-Interface with 8 Rx and 4 Tx channels			
DSUB Pin	Signal	Description	DSUB Pin	Signal	Description
	Standard	4x Rx		Standard 4x	Rx; 2x Tx
1	Rx1A	receiving channel 1A	1	Rx1A	receiving channel 1A
9	GND	GND	9	Tx1A	sending channel 1A
2	Rx1B	receiving channel 1B	2	Rx1B	receiving channel 1B
10	GND	GND	10	Tx1B	sending channel 1B
3	Rx2A	receiving channel 2A	3	Rx2A	receiving channel 2A
11	GND	GND	11	GND	GND
4	Rx2B	receiving channel 2B	4	Rx2B	receiving channel 2B
12	GND	GND	12	GND	GND
5	Rx3A	receiving channel 3A	5	Rx3A	receiving channel 3A
13	GND	GND	13	Tx2A	sending channel 2A
6	Rx3B	receiving channel 3B	6	Rx3B	receiving channel 3B
14	GND	GND	14	Tx2B	sending channel 2B
7	Rx4A	receiving channel 4A	7	Rx4A	receiving channel 4A
15	GND	GND	15	GND	GND
8	Rx4B	receiving channel 4B	8	Rx4B	receiving channel 4B

CON 2					
ARINC-Interface with 8 Rx channels		ARINC-Interface with 8 Rx and 4 Tx channels			
DSUB Pin	Signal	Description	DSUB Pin	Signal	Description
	Standard	4x Rx		Standard 4x	Rx; 2x Tx
1	Rx5A	receiving channel 5A	1	Rx5A	receiving channel 5A
9	GND	GND	9	Tx3A	sending channel 3A
2	Rx5B	receiving channel 5B	2	Rx5B	receiving channel 5B
10	GND	GND	10	Tx3B	sending channel 3B
3	Rx6A	receiving channel 6A	3	Rx6A	receiving channel 6A
11	GND	GND	11	GND	GND
4	Rx6B	receiving channel 6B	4	Rx6B	receiving channel 6B
12	GND	GND	12	GND	GND
5	Rx7A	receiving channel 7A	5	Rx7A	receiving channel 7A
13	GND	GND	13	Tx4A	sending channel 4A
6	Rx7B	receiving channel 7B	6	Rx7B	receiving channel 7B
14	GND	GND	14	Tx4B	sending channel 4B
7	Rx8A	receiving channel 8A	7	Rx8A	receiving channel 8A
15	GND	GND	15	GND	GND
8	Rx8B	receiving channel 8B	8	Rx8B	receiving channel 8B

Find here the <u>technical data 444</u> and <u>the cabling 100</u> of the ARINC-Bus interface.

10.9.7 PROFIBUS (DSUB-9)

DSUB-PIN	Signal	Description
3	DATA+	B-Line
5	GND	PROFIBUS Ground
8	DATA-	A-Line
1, 2, 4, 6, 7 and 9	n.c.	

Find here the <u>technical data [440]</u> and the <u>cabling [101]</u> of the PROFIBUS interface.

10.9.8 PROFINET (RJ45)

Pin configuration of the	Pin	Signal
network socket	1	TX+
type modular 8P8C	2	TX-
	3	RX+
	6	RX-
	4, 5, 7, 8	via RC to ground



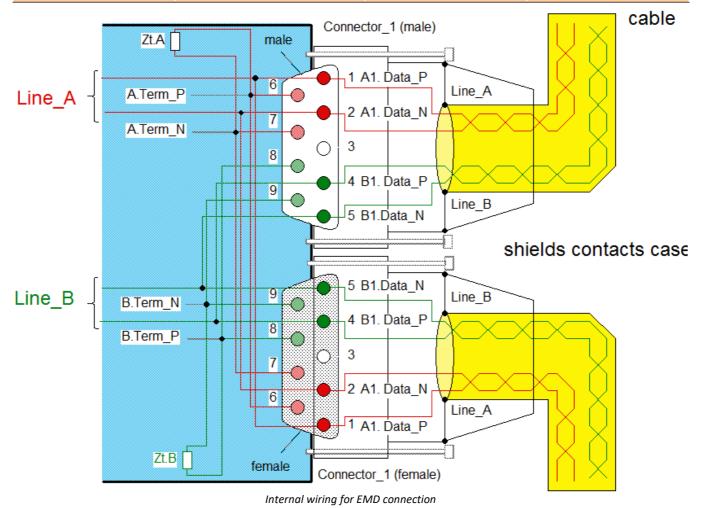
Find here the <u>technical data [441]</u> and the <u>cabling 100</u> of the PROFINET interface.

10.9.9 MVB-Bus (DSUB-9)

10.9.9.1 EMD Pin configuration - DSUB-9

EMD connection with double-occupancy. Standard DSUB-9 terminals are used.

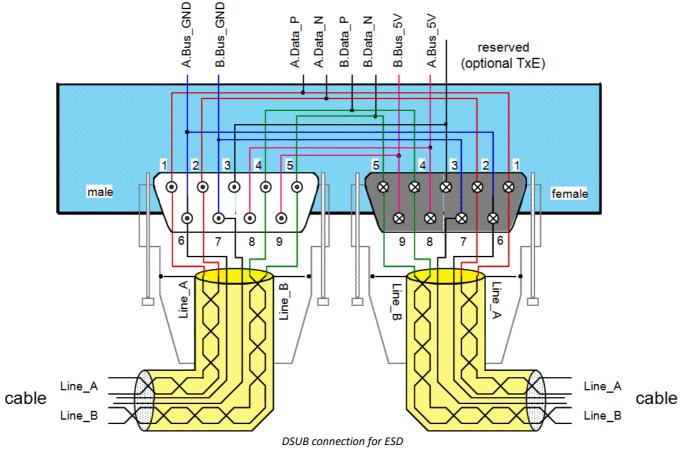
DSUB-PIN	Signal	Description	as termination terminal
1	A1. Data_P	data line A	jumper to 6
2	A1. Data_N	data line A	jumper to 7
3	NC	not connected	
4	B1. Data_P	data line B	jumper to 8
5	B1. Data_N	data line B	jumper to 9
6	Terminator A	internal	jumper to 1
7	Terminator A	interna	jumper to 2
8	Terminator B	interna	jumper to 4
9	Terminator B	interna	jumper to 5



10.9.9.2 ESD Pin configuration - DSUB-9

ESD Connection. Standard DSUB-9 terminals are used.

DSUB-PIN	Signal	Description	Termination
1	A. Data_P	Data lead A	Rm Ru Rm
2	A. Data_N	Data lead A	
3	NC	not connected	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
4	B. Data_P	Data lead B	$\begin{bmatrix} 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 & 1 $
5	B. Data_N	Data lead B	Image: square of the content
6	A.Bus_GND	Ground A	
7	B.Bus_GND	Ground B	
8	A.Bus_5V	5V Supply A	, m, m, ≪ _ w _
9	B.Bus_5V	5V Supply B	\blacktriangleleft \square $Rm = 143 \Omega$; $Ru = Rd = 383 \Omega$



Find here the technical data 443 and the cabling 102 of the MVB-Bus interface

10.10 Pin configuration of the REMOTE socket



Reference

Remote control

The assignment and the description of the modes can be found in the chapter "Start of operation 37".

XT-Con Chapter 10

10.11 XT-Con

Sealing and circular plugs/sockets (XT-Con)

The connection technology of the CRXT base units uses sealed DSUB-9 and circular plugs of type "XT-Con". This plug/socket family is available from imc as an accessory and has the following properties:

- XT-Con is mechanically compatible with sealed LEMO.1T series:
 However, the specified tightness is only guaranteed with the appropriate plugs (XT-Con) available from imc as accessories!
- XT-Con is not compatible with the LEMO.1B series:
 This LEMO plug family is not mechanically compatible and does not snap and latch!

The standard AC/DC power adaptor is not sealed. IP65 compatible adaptors are available as optional accessories, as well as sealed connector plugs for installation in vehicles, etc.

The same applies to network cables with RJ-45 plugs: The cable included in the standard scope of delivery is a non-sealed laboratory version for commissioning purposes. A cable is available as an accessory with the RJ-45 plug sealed on one side and suitable for connection to standard equipment such as computers or network switches on the other side.

The standard connection technology for amplifier modules is sealed DSUB-15 sockets. When equipped with other customer-specific plugs such as LEMO.1B, the respective IP ratings of the selected plugs apply to the complete device.

The sockets on the device side must be sealed either with the supplied sealed protective caps or with suitable sealing plugs.

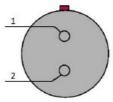
DSUB-15 Plug

For modules with DSUB-15 connection technology, the convenient imc terminal plugs for solderless screw terminal connection are available as optional accessories. These are to be used in the special IP65 version. This applies regardless of whether sealing properties are required: The simple standard terminal plugs have shorter locking screws and therefore cannot be fixed to CRXT devices. The two types are not mutually compatible, but long screws are available as accessories for retrofitting: long bolts: only for CRXT, short standard bolts: only for CRFX, CRC, C-SERIES, etc.

The DSUB plugs are made of robust metal and adapt the signals of the DSUB-15 sockets to solderless screw terminals.

Power supply

The Power Module is equipped with a XT-Con socket for an ultra-wide DC power input. The DC power input is not designed for a connection to a DC-grid according to EN 61326-1.

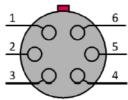


Supply, XT-Con

PIN	Signal
1	+Supply
2	-Supply

XT-Con Chapter 10

Remote



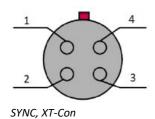
Remote,	XT-Con	

CRXT base unit		
PIN	Signal	
1	GND	
2	REMOTE switch	
3	GND	
4	REMOTE push button	
5, 6	n.c.	

CRXT/POWER-X		
PIN	Signal	
1	GND	
2	REMOTE switch	
3	GND	
4	REMOTE push button	
5	GND	
6	reserved	

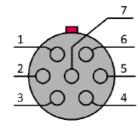
Optional accessory: CRXT/REMOTE-PLUG (11100036), XT-Con (6-pin)

SYNC



PIN	Signal
1	SYNC
2	GND
3	reserved
4	reserved

Display and GPS



Display, XT-Con

PIN	Signal
1	5V
2	RxD
3	TxD
4	CTS
5	GND
6	RTS
7	n.c.

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