imc FBG-Temp

Fiber optic temperature sensor using FBG technology (Fiber Bragg Grating)

The fiber-optic temperature sensor imc FBG-Temp is especially suited for use with the CAN measurement module imc CANSAS*fdx*-FBG-T8, a fiber-optic interrogator which can measure 8 independent channels or sensors of this type.

The sensor is based on a single-mode type optic fiber with an inscribed fiber Bragg grating ("FBG"). It is integrated in a very thin glass capillary housing. This makes it extremely responsive and allows to install it in the smallest of spaces.

Thus, these sensors are suitable for measurements directly inside e-motor windings, for example. They easily tolerate the prevailing conditions of high voltage, strong alternating magnetic fields and limited space.

Highlights

- Fiber Bragg Grating technology (FBG) guarantees immunity to environmental conditions such as high voltage, lightning, electromagnetic interference (EMC, EMI/ESD), radioactivity, etc.
- Inherent galvanic isolation allows measurements in protected and hazardous environments (e.g., e-mobility, HV, hybrid) and avoids the special equipment and training for involved personnel that would be required for conventional measurement technology
- Extremely miniaturized design with glass capillary housing
- Glass fiber principle also allows measurement over very long distances
- Individually calibrated (with certificate)

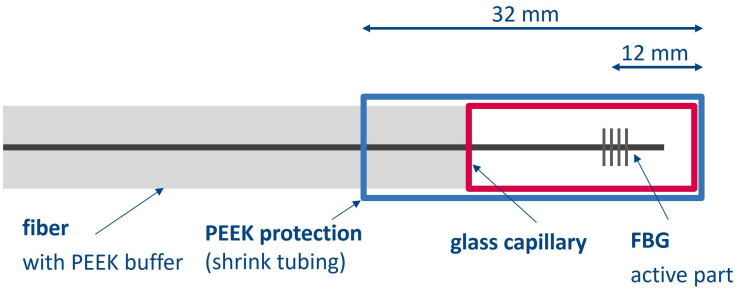
Typical applications

- E-mobility, electric and hybrid vehicles, battery technology
- Measurements on high-voltage components such as batteries, fuel cells, power supply circuits, power electronic components, etc.
- Measurements directly in the windings of electric motors and machines

Mechanics

The sensors are based on a temperature-sensitive fiber (FBG), housed in a glass capillary, where it is mechanically highly decoupled (suspended).

A sheath of PEEK heat shrink tubing protects this construction and in particular the mechanically sensitive area at the transition between fiber and glass capillary. The sensor tip with a total length of approx. 35 mm is therefore particularly robust and very well suited for adhesive mounting.



The active zone of the sensor (FBG grid) is encapsulated in the glass capillary and mechanically stress-free decoupled. This guarantees fast-response temperature sensitivity, independent of mechanical stress or strain (cross-sensitivity).

Notes on handling

Mounting, for example by gluing or inserting into blind holes, should be done very carefully to avoid damage.

The passive fiber cable must be protected against damage such as buckling, crushing and compressing: While only a slight undercutting of the minimum specified bending radii during the measurement leads to possible temporary signal errors, very drastic bending and squeezing can irreversibly damage the fiber!

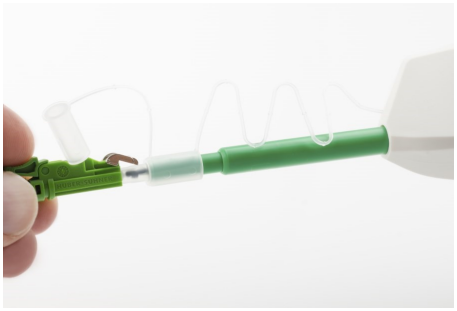
The passive part of the fiber cable even far away from the active sensor, can lead to slight measurement deviations under the influence of mechanical bending. These effects are not due to a strain sensitivity of the active sensor part, but to changes in the optical polarization behavior of the signal. This is specified in the technical data of the associated measuring instrument as "reproducibility", which also includes repeated mating cycles of the connectors. Wire fixation is recommended.

Fiber optics technology in general requires a minimum of pollution on the connectors in order to minimize possible parasitic reflections. It is therefore strongly recommended to clean the connectors on both sides with a cleaning tool, which is available as an accessory, before each mating operation. The connectors are specified for a nominal 1000 mating operations. Excessive wear on the device connectors can be prevented if necessary by the use of an additional short extension ("sacrificial cable"), to be easily replaced.

Models and Options

Fiber-optic sensors and connectors		
Order Code	**Description**	**Article-No.**
FBG/FBG-TEMP	Temperature Sensor FBG-Temp, FBG Technology	12600035
FBG/SMF28-E2000-10M	Fiber optic extension cable E2000/APC, 10 m length (incl. coupler)	12600014
FBG/SMF28-E2000-5M	Fiber optic extension cable E2000/APC, 5 m length (incl. coupler)	12600015
FBG/SMF28-E2000-3M	Fiber optic extension cable E2000/APC, 3 m length (incl. coupler)	12600020
FBG/E2000-COUPLER-10	E2000 coupler (10 pcs.)	12600021
FBG/E2000-CAP-10	Protective caps for E2000 input jacks (10 pcs)	12600xxx
FBG/FIBER-CLEAN	Cleaning tool for fiber-optic connectors	12600016
FBG/FIBER-CHECKER	for visual localization of defective fibers for 2.5 mm ferrules: DIN, E2000, FC, SC, ST	12600027

Cleaning tool



To clean the sensor-side plug, simply remove the ***upper protective cap*** from the tool and insert the tip into the open plug socket. Cleaning process by pushing and locking movement ("click").

To clean the socket on the appliance side, the ***entire tip*** (grommet) of the tool must be removed. Then do not insert it in the middle, but in the lower part of the socket. Cleaning also by pushing and locking movement.

Reference Tips for handling

https://www.youtube.com/watch?v=scM7NGy-cQc
A separate document with a detailed description of the handling is available on request.

Included accessories

- Calibration certificate of the temperature sensors with sensor parameters for configuration in the imc CANSAS Software.

Technical Specs - FBG-Temp

General		
Parameter	**Value**	**Remarks**
Measurement mode	temperature	
Compatible measurement devices	imc CANSAS*fdx*-FBG-T8	8-channel fiber-optic interrogator; measurement module with CAN output
Technology	Fiber Bragg Grating glass-fiber, single-mode type SMF 28	
Connector	fiber optic connector type E2000 / APC	plug E2000 with locking mechanism and integrated protective cover
Sensor characteristics	individually parameterized sensor characteristics	5th order polynomial, individual calibration certificate
Sensitivity	9.5 pm/K (6.13 ppm/K)	typical linear sensitivity at 23 °C
Thermal response time	<0.1 s	T_90 (settling to 90 %)
Operating temperature range	-40 °C … +220 °C	usable measurement range
Calibrated operating range	-40 °C … +190 °C	for specified accuracy
Temperature range for storage, installation and assembly	-40 °C … +250 °C	tolerated by the sensor without irreversible damage (connector E2000: up to +85°C)

Fiber-optic FBG parameter		
Parameter	**Value**	**Remarks**
Bragg wavelength λ_0	1550 nm ±0.5 nm	
Reflectivity	70 % ±20	
Full width at half maximum	400 … 700 pm	FWHM
Side lobe suppression	>15 dB	SLRS

Measurement accuracy		
Parameter	**Value**	**Remarks**
Absolute measurement accuracy	±0.7 °C	when using the individual calibration parameters (certificate). Comprises the accuracy and reproducibility of the individually calibrated sensor characteristic curve. Applies to the entire specified measurement range

Mechanics		
Parameter	**Value**	**Remarks**
Mounting	glue crimping encapsulation	Methacrylat glue (MMA) e.g. "ERGO 1665" Cyanoacrylat glue e.g. "Scotch-Weld SF100"
Maximum load	50 kg	
Dimensions Length Active part Diameter	 32 ± 2 mm 12 ± 2 mm below tip 1.35 ± 0.2 mm	of the sensor with PEEK shrink tubing active FBG grating at sensor tip
Encapsulation	glass capillary PEEK shrink tubing	
Min. allowed bending radius	 5 mm ≤ 1 turn 10 mm ≤ 10 turns	at the passive fiber; max. 1 turn with minimum radius
Sensor cable diameter	0.9 ± 0.03 mm	sheating of the fiber on full length ("buffer"): PEEK, light brown
Cable length	900 ± 100 mm	with connector type E2000 / APC; extendable with E2000 coupling and optical patch cables
Pressure resistance	20 km above sea level	max. height
Fluid resistance	non-aggressive liquid and gaseous media (e.g., water, oil, diesel, petrol...)	other media upon request

Isolation		
Parameter	**Value**	**Remarks**
Technology	glass fiber based, metal free	completely insensitive to electromagnetic fields and interference
Isolation properties Resistance per unit length Isolation voltage	 277 GΩ/m 30 kV	