KISTLER
measure. analyze. innovate.

FSI temperature monitoring system

Type 2549A...
with cockpit software

High-speed optical system to map and examine thermal behavior of powertrain components

This unique temperature monitoring system is based on Fiber Segment Interferometry (FSI) and supports multiple fiber sensors for precision measurement of temperatures on electric vehicle powertrain components such as battery packs. Each 4-channel interrogator can address up to 88 individual measuring segments, precisely centered on the test regions of interest. The high number of temperature segments brings examination of thermal processes to the next level and visualization of the data in time-resolved heat maps allows an imaging-like view of the gathered data.

Fig.1: 2549A FSI interrogator base unit

Features of the FSI temperature monitoring system

- **Compact** – the sensor is typically 1.6 mm in diameter, but may vary depending on requirements. Due to the small dimensions and mass, sensors can be applied to or inside a structure with little intrusion.
- **Robust** – the sensor fibers are passive without any electronic components and are non-conductive. The sealed structure is perfectly suited for operation in harsh environments or applications including high-voltages, extended temperatures, and immersion cooling.
- **Scalable** – Number and geometry of the sensing segments, number of sensor fibers and interrogators operated in a network can be tailored to perfectly match the different requirements.
- **Immunity** – FSI sensing elements are intrinsically safe and are immune to interference from electrostatic, electromagnetic or radio frequency sources.
- **Multiplexing** – Many measurement segments can be inscribed into a single sensor fiber to minimize cable mass and volume.
- **Remote sensing** – the distance between interrogator and sensing elements can be several kilometers/miles without the risk of signal to noise degradation.
- **Ease of installation** – One connector and a single, flexible fiber for multiple test points reduces cost of installation and potential sources of errors. It also means less down time for test stands and prototypes.

Fig.2: 2069A10 FSI temperature sensor

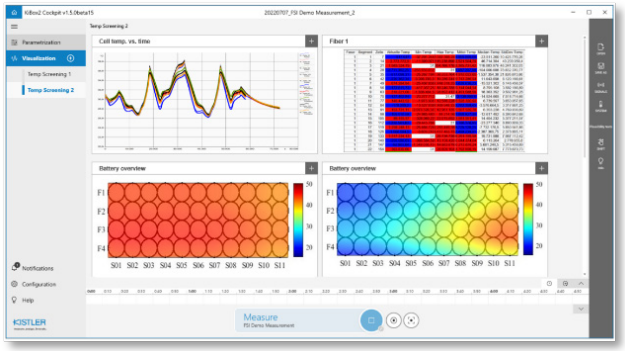

Fig.3: Software 2549A10 FSI temperature monitoring application

9831D_003-635e-10.23

Description

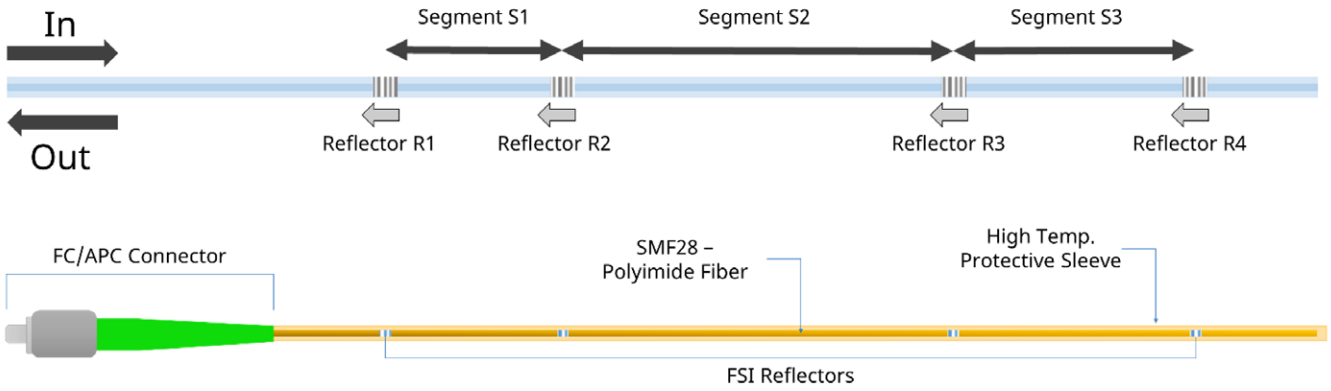

Fig.4: FSI measurement principle (top) and FSI temperature sensor (bottom)

FSI sensing elements are inscribed in the core of the optical fiber. Laser light from the FSI interrogator resonates between these reflectors and the resulting interference patterns in the returning light are measured and analyzed. From these interferograms, the length of each segment can be measured rapidly, and with nanometric precision. These length changes are calibrated against the measurement of interest like temperature.

FSI temperature sensors consist of a micro-structured optical fiber enclosed within a protective outer sleeve or tube. This sleeve is bonded to the device under test, ensuring the fiber sensor is free to expand independently of mechanical strain effects.

Fig.5: FSI sensor fiber installation on pouch cell

Application

- Reduced wiring (replace up to 88 thermocouples with FSI temperature sensors)
- Immune to electromagnetic interference
- More cell temperatures lead to improved simulation models
- Reduced battery costs due to reduction of NTC
- Better thermal management:
  - Battery usage closer to thermal limits
  - Longer battery lifetime
  - Better fast charging – avoid lithium plating

9831D_003-635e-10.23

KISTLER
measure. analyze. innovate.

Technical data

Mechanical				
Dimensions		length	mm	295
		width	mm	275
		height	mm	92
Mass	Interrogator base unit		kg	3.5
	incl. accessories, case		kg	8

Ambient conditions			
Operating temperature		°C	0 … +40
		°F	+32 … +104
Storage temperature		°C	–20 … +70
		°F	–4 … +158
Humidity (non-condensing)		%	10 … 95
Power consumption	typ.	W	50
	max.	W	120
Mains supply voltage (using adapter)		VAC	110 … 240
Direct current input voltage		VDC	9 … 30
Pollution degree			2
Overvoltage category			II
Accreditation/conformity			CE

Measuring and Processing			
Number of sensor inputs			4
Compatible sensors			2069A...
Optical sensor connector			FC/APC 2.5mm
Max. number of measurement segments per FSI interrogator			88
Sensor operating range	min.	°C	–35
		°F	–31
	max.	°C	+110
		°F	+230
Accuracy		°C	<1.5
Resolution		°C	0.1
Segment length	min.	mm	10
	max.	mm	100
Outer sensor diameter	typ.	mm	1.6
Max. distance between interrogator and 1st measurement segment		km	>1
Sampling frequency range		Hz	1.5 … 25k

* Calibrated temperature range depends on customer requirement.
Stated resolution is intended as 2 times the signal standard deviation.
Stated accuracy is "as calibrated", assuming installation minimizes mechanical strain on sensor.

Interfaces			
CAN	Channels		1
	Standard		CAN 2.0b
	Max. Bitrate	MBit/s	1
Ethernet/LAN	Port		1
	Standard		TCP/IP
	Max. Bitrate	GBit/s	1
Data/Time synchronization			NTP, PTP, IEEE1588

File Formats	
Data file	.mdf4
Parameter file	.k2p
CAN database file	.dbc
Export file	.csv

Connections / Indicators on the front panel

Connections / Indicators on the back panel

Description	
1	Status LED – Power
2	Status LED – Ready
3	Status LED – Measuring
4	Status LED – Warning/Fault
5	Optical sensor connectors – FC/APC 2.5 mm
6	CAN – DSub, 9Pin, male
7	Power supply – LEMO B
8	Interface to cockpit, Ethernet – RJ45

9831D_003-635e-10.23

Components and type numbers for the FSI temperature monitoring system Type 2549A

Included accessories	Type/Mat. No.
• FSI interrogator base unit	2549A1
• Gigabit Ethernet cable, 1 m	
• Power supply 100…240 VAC	
• Country-specific power cable	
• One-Click connector cleaner	
• CLETOP-S connector cleaner	
• Document folder incl. QuickStart guide, Safety instructions, Calibration certificates	
• USB memory stick incl. Operating instructions and Cockpit SW	
• Carrying case with foam inlay	

Sensing elements	
FSI temperature sensor, customized	2069A...

Cockpit applications	
FSI temperature monitoring application	Software 2549A10

Optional accessories	Type/Art. No.
Cascading set / PTP switch	1200A247A1
jBEAM Powertrain edition	2848A

Services & training
(please contact Kistler for requests)

Services
- FSI interrogator calibration
- Planning, preparation and realization of on-site measurements by Kistler expert

Training
- FSI temperature monitoring system user training

9831D_003-635e-10.23