

TECH NOTE :: Temperature compensation of FBG based sensors in catman

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Introduction

The following document describes the implementation of temperature compensation of strain measurements based on Fiber Bragg Grating (FBG) technology using catman v5.5.

Note:

Fundamentals on temperature compensation are described on the «HBK FS_TECH NOTE_temperature compensation_v2».

For assigning optical sensors from the database on a catman project, care must be taken on the correct selection of the sensor as they are dependent on the used interrogator.

Sensors for FS22	
Sensordatabase.sdb	
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FS22 Search	
Advanced	•
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Optical acceleration sensor (FS22)	
e Optical strain sensor (FS22)	
▶ <mark>°C</mark> Optical temperature sensor (FS22)	
Channel info Sensor database	Ŷ





TECH NOTE - Temperature compensation of FBG

Temperature compensation within strain sensors adaptation

Temperature compensation of strain sensors using temperature measurements

Example description:

One FS62WSS Weldable Strain Sensor and one FS63WTS Weldable Temperature Sensor, both with armored cable, installed side by side. CTE of the specimen is 12 (µm/m)/°C.

Prerequisites:

At least one sensor is defined as a temperature sensor (electrical or optical) and delivering temperatures in °C.

Sensor adaptation:

For adapting a strain sensor:

opue				
Sensor				
1530.1650	Reference wavelength (nm)		Measure	
0.7600	Gage factor			
Temperatu	re compensation			
With temper	ature channel		-	
7.6	Temperature cross sensitivit	ty (TCS) in	µm/m/°C	
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 use the "with temperature channel" option for temperature compensation;

Fill in the gauge factor (k) of the strain sensor as given on the sensor characteristic sheet. The gauge factor corresponds to the sensitivity of the strain sensor: $\varepsilon = \frac{1}{k} \cdot \frac{\Delta \lambda}{\lambda} \cdot 10^6$;

 Fill in the temperature cross sensitivity (TCS) of the strain sensor as given on the characteristic sheet. It corresponds to the thermally induced strain measurement on the sensor in (μm/m)/^oC;

Fill in the specimen's thermal expansion coefficient (CTE), in (μm/m)/^oC;

 Select the temperature channel from your project that corresponds to the temperature the strain sensor is at;

Measure the reference wavelength of the strain sensor and the reference temperature of the temperature channel.



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Temperature compensation of strain sensors using an optical FBG dummy strain sensor

Example description:

Two FS62WSS Weldable Strain Sensor with armored cable. One installed on the measurement point and the other one, next to the first one, installed on the same material free from strain.

Prerequisites:

The sensor to be used for temperature compensation is a dummy strain sensor, ie, it is a strain sensor of the same type, configured as wavelength, installed on the same material of the specimen under test and free from mechanical strain.

Sensor adaptation:

For adapting a strain sensor:



Note:

For catman projects using FS22 interrogators, strain sensors show, at the moment, two additional temperature compensation options that are no longer being used as they are fitting to old sensors from the discontinued OP Line.

Temperature compensation not covered within sensors adaptation

Temperature compensation of strain sensors using a non-calibrated HBK FiberSensing temperature sensor

Example description:

One FS62WSS Weldable Strain Sensor and one FS63WTS Weldable Temperature Sensor that does not have a calibration certificate, both with armored cable, installed side by side. CTE of the specimen is 12 $(\mu m/m)/^{\circ}C$.

Prerequisites:

The strain sensor is configured as strain sensor without temperature compensation ($\varepsilon = \frac{\Delta \lambda}{\lambda_0} \cdot \frac{1}{k} \cdot 10^6$); below

named as «STRAIN_NO_COMP».

The temperature sensor is configured as wavelength (λ_{TC}); below named as «TEMP_WL»; reference wavelength should be the sensors' wavelength at the instant of zero strain (λ_{0TC}).



TECH NOTE - Temperature compensation of FBG

Computational channel:

		Select the formula option;
Edit computations	×	Define an appropriate naming and unit:
Close Help about computation channels	-	Type the corresponding elgebraic formula:
Formulas 🥀 👯 🎹 🏔 🖽 😨 😪 🛒		rype the corresponding algebraic formula:
Formula editor Preferined formulas Linearization Statistics		$\Delta \lambda 1$ $\Delta \lambda_{TC} TCS + CTE$
Name Strain compensated	Unit µm/m	$\varepsilon = \frac{1}{\lambda_0} \cdot \frac{1}{k} \cdot 10^6 - \frac{1}{\lambda_{0TC}} \cdot \frac{1}{TCF_{TC}} <=>$
Form fie From fie Form fie From f	• •	$\lambda_{TC} - \lambda_{0_{TC}} TCS + CTE$
No formula collection loaded		$\varepsilon_{compensated} = \varepsilon_{strain no comp} - \frac{1}{\lambda_{0TC}} \cdot \frac{1}{TCF_{TC}}$
Edit expression STRAIN_NO_COMP-((TEMP_WL-1564.959)/1564.959)*((7.36+12)/30)	~	- Reference wavelength of the temperature sensor (λ_{0TC}) ;
7 8 9 / (P<	• ^	characteristic sheet, in (μm/m)/°C;
C	v	 CTE of the specimen under test material, in (μm/m)/ºC;
		 TCF of the Temperature sensor as present on the characteristic sheet, in (µm/m)/°C;
		 Create computation.

Temperature compensation of strain sensors using a strain sensor applied to a different material

Example description:

Two FS62WSS Weldable Strain Sensor with armored cable. One installed on the measurement point and the other one, next to the first one, installed on a material free from strain. CTE of the specimen is 12 (μ m/m)/°C and CTE of the compensation plate is 16 (μ m/m)/°C.

Prerequisites:

The strain sensor is configured as strain sensor without temperature compensation ($\varepsilon = \frac{\Delta \lambda}{\lambda_0} \cdot \frac{1}{k} \cdot 10^6$); below named as «STRAIN_NO_COMP».

The compensation strain sensor is configured as strain without temperature compensation ($\varepsilon_{TC} = \frac{\Delta \lambda_{TC}}{\lambda_{0TC}} \cdot \frac{1}{k_{TC}} \cdot 10^6$); below named as «STRAIN_TC».

Computational channel:

		Select the formula option;
Edit computations	×	Define an appropriate naming and unit;
Close Help about computation channels		Type the corresponding algebraic formula
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Formula editor Predefined formulas Linearization Statistics		$\Delta \lambda = \Delta \lambda = \frac{\Delta \lambda}{10^6} \Delta \lambda_{TC} = \frac{1}{10^6} \left(\frac{TCS + CTE}{TCS + CTE} \right)$
Name Strain compensated	Unit µm/m	$\mathcal{E} = \frac{1}{\lambda_0} \cdot \frac{1}{k} \cdot \frac{10}{k} = \frac{1}{\lambda_{0TC}} \cdot \frac{1}{k_{TC}} \cdot \frac{10}{k_{TC}} \cdot \frac{1}{TCS_{TC} + CTE_{TC}} $
Last in use Intrain_1-strain 2_1*((7.6+12)/(16+7.6))	• 0	TCS + CTE
From file In formula collection loaded	• 0 🖙 🖬 🖬	$\varepsilon_{compensated} = \varepsilon_{strain no comp} - \varepsilon_{TC} \cdot \overline{TCS_{TC} + CTE_{TC}}$
Edit expression		- Reference wavelength of the temperature
STRAIN_NO_COMP-STRAIN_TC*((7.6+12)/(7.6+16))		sensor $(\lambda_{0 \ TC})$;
	M	- TCS of the strain sensor and of the strain
7 8 9 / (= <> < POW SQRT Additional functions		
4 5 6 X) > <= >= EXP LN E POUD DIVISION		sensor to be used for compensation as
0 . C + e ABS INT TAN LOG	~	present on the characteristic sheet, in
Help about algebraic functions Which operators?		(um/m)/ºC:
		CTE of the encoimen under test and of the
		- UTE of the specimen under test and of the
		compensation materials, in (µm/m)/ºC;
		Create computation