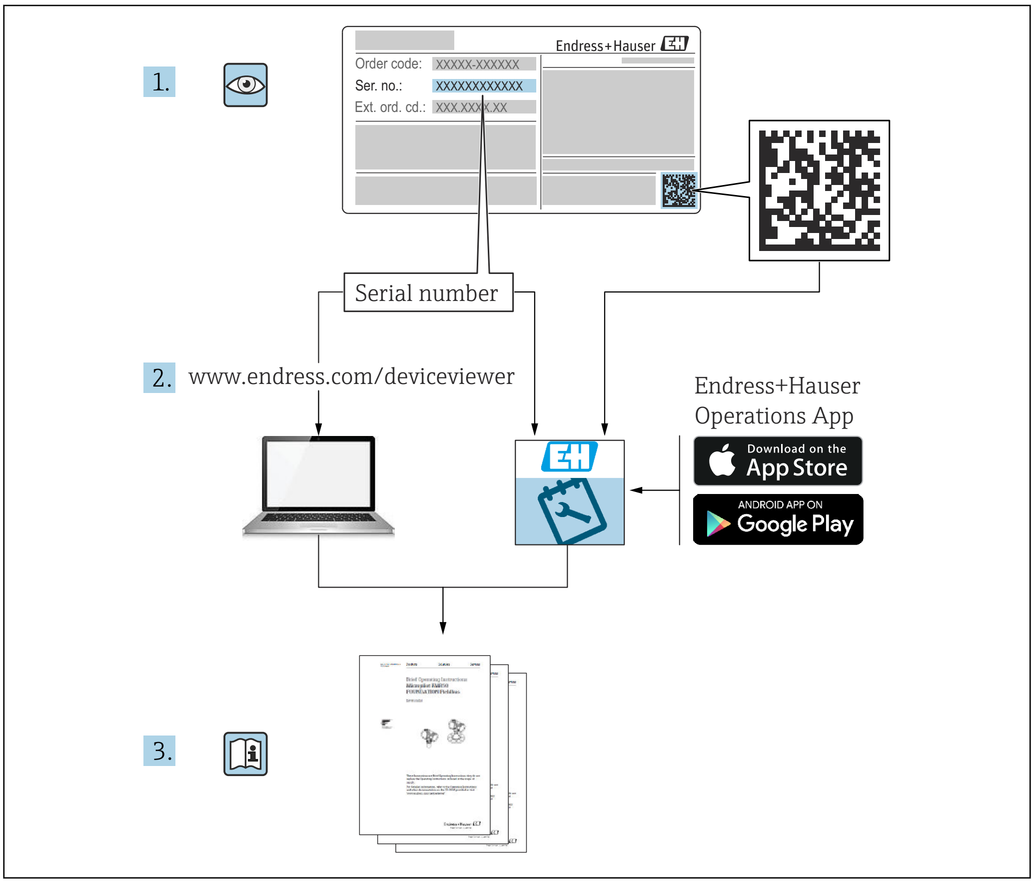
FY01102T/09/EN/02.24-00
71696506
2024-06-21

Functional Safety Manual
iTHERM ModuLine TM1x1, iTHERM SurfaceLine TM611

Endress+Hauser
People for Process Automation


1.
Endress+Hauser
Order code: XXXXX-XXXXXX
Ser. no.: XXXXXXXXXXXX
Ext. ord. cd.: XXX.XXXX.XX
Serial number
2.
www.endress.com/deviceviewer
Endress+Hauser
Operations App
Download on the
App Store
ANDROID APP ON
Google Play
3.

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1 Declaration of Conformity

SIL_00327_04.25

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Herstellererklärung - Manufacturer Declaration

Funktionale Sicherheit - Functional Safety according to IEC 61508:2010
Beiblatt 1/ NE130 Formblatt B1 - Supplement 1 / NE130 Form B.1

Endress+Hauser Wetzer GmbH+Co. KG, Obere Wank 1, 87484 Nesselwang

erklärt als Hersteller, dass die folgenden Thermometer
declares as manufacturer, that the following thermometers

iTHERM ModuLine TM111, iTHERM ModuLine TM131, iTHERM ModuLine TM151, iTHERM SurfaceLine TM611

in Verbindung mit den Transmittern - in combination with the transmitters
iTEMP TMT82 oder - or
iTEMP TMT162

für den Einsatz in sicherheitsrelevanten Anwendungen bis SIL2 (HFT=0) bzw. SIL3 (HFT=1) entsprechend IEC61508:2010 geeignet sind.
are suitable for use in safety-instrumented systems up to SIL2 (HFT=0) or SIL3 (HFT=1) according to IEC61508:2010.

In sicherheitsrelevanten Anwendungen gemäß IEC 61508 und IEC 61511 sind die Angaben des Handbuchs zur Funktionalen Sicherheit zu beachten.
In safety instrumented systems according to IEC 61508 and IEC 61511, the instructions of the Safety Manual have to be followed.

Nesselwang, 11.02.2025
Endress+Hauser Wetzer GmbH+Co. KG

ppa. Harald Müller
Director Technology

i.V. Eva Rizzo
Head of Department Technology Safety

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1.1 Safety-related characteristic values

SIL_00327_04.25

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Allgemein			
Gerätebezeichnung und zulässige Ausführungen	TM111, TM131, TM151, TM611 (Bestellmerkmal "Weitere Zulassungen": Option LA "SIL")		
Sicherheitsbezogenes Ausgangssignal	4...20mA		
Fehlerstrom	≤ 3,6 mA oder ≥ 21,0 mA		
Bewertete Messgröße / Funktion	Temperatur / Spannung / Widerstand		
Sicherheitsfunktion(en)	sichere Messung		
Gerätetyp gem. IEC 61508-2	☑ Typ A	☐ Typ B	
Betriebsart	☑ Low Demand Mode	☑ High Demand	☐ Continuous Mode
Sicherheitshandbuch	SD02427T, FY01102T, SD01172T, FY01105T, SD01632T, FY01106T		
Art der Bewertung (nur eine Variante wählbar)	☑	Vollständige entwicklungsbegleitende HW/SW Bewertung inkl. FMEDA und Änderungsprozess nach IEC 61508-2, 3	
	☐	Bewertung über Nachweis der Betriebsbewährung HW/SW inkl. FMEDA und Änderungsprozess nach IEC 61508-2, 3	
	☐	Auswertung von Felddaten HW/SW zum Nachweis "Frühere Verwendung" gem. IEC 61511	
	☐	Bewertung durch FMEDA gem. IEC 61508-2 für Geräte ohne Software	
Bewertung durch / Zertifikatsnummer	TM1x1/TM611: Z10 012833 0008 TMT82: Z10 012833 0005 TMT162: Z10 012833 0004		
Prüfungsunterlagen	Entwicklungsdokumente, Testreports, Datenblätter		

SIL - Integrität			
Systematische Sicherheitsintegrität		☐ SIL 2 fähig	☑ SIL 3 fähig
Hardware Sicherheitsintegrität	Einkanaliger Einsatz (HFT = 0)	☑ SIL 2 fähig	☐ SIL 3 fähig
	Mehrkanaliger Einsatz (HFT ≥ 1)	☐ SIL 2 fähig	☑ SIL 3 fähig

Kennzahlen	Thermometer und Transmitter
TM1x1, TM611 mit TMT82	siehe Kap. 1.2.1 (FY01102T)
TM1x1, TM611 mit TMT162	siehe Kap. 1.2.2 (FY01102T)

Erklärung	
☑	Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden sicherheitsrelevanten systematischen Fehlern sicher.

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General			
Device designation and permissible types	TM111, TM131, TM151, TM611 (Order code for "Additional approval": Option LA "SIL")		
Safety-related output signal	4…20mA		
Fault current	≤ 3,6 mA oder ≥ 21,0 mA		
Process variable/function	Temperature, Voltage, Resistance		
Safety function(s)	safe measuring		
Device type acc. to IEC 61508-2	☑ Type A	☐ Type B	
Operating mode	☑ Low Demand Mode	☑ High Demand	☐ Continuous Mode
Safety manual	SD02427T, FY01102T, SD01172T, FY01105T, SD01632T, FY01106T		
Type of evaluation (check only one box)	☑	Complete HW/SW evaluation parallel to development incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of "Proven-in-use" performance for HW/SW incl. FMEDA and change request acc. to IEC 61508-2, 3	
	☐	Evaluation of HW/SW field data to verify „prior use" acc. to IEC 61511	
	☐	Evaluation by FMEDA acc. to IEC61508-2 for devices w/o software	
Evaluation through / certificate no.	TM1x1/TM611: Z10 012833 0008 TMT82: Z10 012833 0005 TMT162: Z10 012833 0004		
Test documents	development documents, test reports, data sheets		
SIL - Integrity			
Systematic safety integrity		☐ SIL 2 capable	☑ SIL 3 capable
Hardware safety integrity	Single channel use (HFT = 0)	☑ SIL 2 capable	☐ SIL 3 capable
	Multi-channel use (HFT ≥ 1)	☐ SIL 2 capable	☑ SIL 3 capable
key figures	Thermometer and Transmitter		
TM1x1, TM611 with TMT82	see Chapter 1.2.1 (FY01102T)		
TM1x1, TM611 with TMT162	see Chapter 1.2.2 (FY01102T)		

Declaration	
☑	Our internal company quality management system ensures information on safety-related systematic faults which become evident in the future

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1.2 Use as a safe measuring system

The temperature transmitter must be combined with a suitable sensor to implement a safe measuring system. The code numbers required for the system design for one year can be found in the following tables.

1.2.1 Code numbers iTHERM TM1x1 and iTHERM TM611 with iTEMP TMT82

Single channel operation

	λ_{du}	λ_{dd}	λ_{su}	λ_{sd}	SFF	PFD_{avg}
Headtransmitter	40 FIT	258 FIT	127 FIT	3 FIT	91%	$1.75 \cdot 10^{-4}$

		closed coupled, low stress		closed coupled, high stress		extension wire, low stress		extension wire, high stress	
		Sensor	Sensor + TMT82	Sensor	Sensor + TMT82	Sensor	Sensor + TMT82	Sensor	Sensor + TMT82
Thermocouple	λ_{du}	6 FIT	46 FIT	119 FIT	159 FIT	109 FIT	149 FIT	2180 FIT	2220 FIT
	λ_{dd}	94,1 FIT	352,1 FIT	1881,0 FIT	2139 FIT	891 FIT	1149 FIT	17820 FIT	18078 FIT
	λ_{su}	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT
	λ_{sd}	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT
	SFF	94%	94% / 91%	94%	94% / 91%	89%	89% / 91%	89%	89% / 91%
	PFD_{avg}		$2.0 \cdot 10^{-4}$		$7.0 \cdot 10^{-4}$		$6.5 \cdot 10^{-4}$		$9.7 \cdot 10^{-3}$
RTD 2-/3-wire	λ_{du}	9 FIT	49 FIT	180,7 FIT	220,7 FIT	98,8 FIT	138,8 FIT	1976 FIT	2016 FIT
	λ_{dd}	38,9 FIT	296,9 FIT	779,3 FIT	1037,3 FIT	376,2 FIT	634,2 FIT	7524 FIT	7782 FIT
	λ_{su}	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT
	λ_{sd}	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT
	SFF	81%	81% / 91%	81%	81% / 91%	79%	79% / 91%	79%	79% / 91%
	PFD_{avg}		$2.1 \cdot 10^{-4}$		$9.7 \cdot 10^{-4}$		$6.1 \cdot 10^{-4}$		$8.8 \cdot 10^{-3}$
RTD 4-wire	λ_{du}	6,4 FIT	46,4 FIT	128,8 FIT	168,8 FIT	74,3 FIT	114,3 FIT	1486 FIT	1526 FIT
	λ_{dd}	43,6 FIT	301,6 FIT	871,2 FIT	1129,2 FIT	425,7 FIT	683,7 FIT	8514 FIT	8772 FIT
	λ_{su}	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT
	λ_{sd}	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT
	SFF	87%	87% / 91%	87%	87% / 91%	85%	85% / 91%	85%	85% / 91%
	PFD_{avg}		$2.0 \cdot 10^{-4}$		$7.4 \cdot 10^{-4}$		$5.0 \cdot 10^{-4}$		$6.7 \cdot 10^{-3}$

SFF	Typ A, HFT 0	Typ A, HFT 1	Typ A, HFT 2	Typ B, HFT 0	Typ B, HFT 1	Typ B, HFT 2
< 60%	SIL1	SIL2	SIL3	---	SIL1	SIL2
60% - < 90%	SIL2	SIL3	SIL4	SIL1	SIL2	SIL3
90% - < 99%	SIL3	SIL4	SIL4	SIL2	SIL3	SIL4
>99%	SIL3	SIL4	SIL4	SIL3	SIL4	SIL4

1 FIT = $1 \cdot 10^{-9}$ h

PFD_{avg}:
- (green) $< 2.5 \cdot 10^{-3}$
- (yellow) $> 2.5 \cdot 10^{-3}$
- (red) $> 1 \cdot 10^{-2}$

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Operation in single-channel mode is limited to 2 000 m.

Two channel operation

Headtransmitter

λ_{du}	λ_{dd}	λ_{su}	λ_{sd}	SFF	PFD_{avg}
40 FIT	258 FIT	127 FIT	3 FIT	91%	$1.75 \cdot 10^{-4}$

		low stress		high stress		low stress		high stress	
		closed coupled				extension wire			
		2x Sensor	2x Sensor + TMT82	2x Sensor	2x Sensor + TMT82	2x Sensor	2x Sensor + TMT82	2x Sensor	2x Sensor + TMT82
Thermo-couple	λ_{du}	10,7 FIT	50,7 FIT	70 FIT	110 FIT	158 FIT	198 FIT	3160 FIT	3200 FIT
	λ_{dd}	189,3 FIT	447,3 FIT	3786 FIT	4044 FIT	1842 FIT	2100 FIT	36840 FIT	37098 FIT
	λ_{su}	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT
	λ_{sd}	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT
	SFF	95%	95% / 91%	98%	98% / 91%	92%	92% / 91%	92%	92% / 91%
	PFD_{avg}		$2.2 \cdot 10^{-4}$		$4.8 \cdot 10^{-4}$		$8.7 \cdot 10^{-4}$		$1.4 \cdot 10^{-2}$
RTD 2-/3-wire	λ_{du}	7,7 FIT	47,7 FIT	154 FIT	194 FIT	83,6 FIT	123,6 FIT	1672 FIT	1712 FIT
	λ_{dd}	88,1 FIT	346,1 FIT	1766 FIT	2024 FIT	866,4 FIT	1124,4 FIT	17328 FIT	17586 FIT
	λ_{su}	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT
	λ_{sd}	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT
	SFF	92%	92% / 91%	92%	92% / 91%	91%	91% / 91%	91%	91% / 91%
	PFD_{avg}		$2.1 \cdot 10^{-4}$		$8.5 \cdot 10^{-4}$		$5.4 \cdot 10^{-4}$		$7.5 \cdot 10^{-3}$
RTD 2-/3-wire + TC	λ_{du}	9,2 FIT	49,2 FIT	184 FIT	224 FIT	120,8 FIT	160,8 FIT	2416 FIT	2456 FIT
	λ_{dd}	138,7 FIT	396,7 FIT	2776 FIT	3034 FIT	1354,2 FIT	1612,2 FIT	27084 FIT	27342 FIT
	λ_{su}	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT	0 FIT	127 FIT
	λ_{sd}	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT	0 FIT	3 FIT
	SFF	94%	94% / 91%	94%	94% / 91%	92%	92% / 91%	92%	92% / 91%
	PFD_{avg}		$2.2 \cdot 10^{-4}$		$9.8 \cdot 10^{-4}$		$7.0 \cdot 10^{-4}$		$1.1 \cdot 10^{-2}$

SFF	Typ	A			B		
	HFT	0	1	2	0	1	2
< 60%		SIL1	SIL2	SIL3	---	SIL1	SIL2
60% - < 90%		SIL2	SIL3	SIL4	SIL1	SIL2	SIL3
90% - < 99%		SIL3	SIL4	SIL4	SIL2	SIL3	SIL4
>99%		SIL3	SIL4	SIL4	SIL3	SIL4	SIL4

1 FIT = $1 \cdot 10^{-9}$h

PFD_{avg}

- (green) < $2.5 \cdot 10^{-3}$
- (yellow) > $2.5 \cdot 10^{-3}$
- (red) > $1 \cdot 10^{-2}$

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1.2.2 Code numbers iTHERM TM1x1 and iTHERM TM611 with iTEMP TMT162

Single channel operation

	λ_{du}	λ_{dd}	λ_{su}	λ_{sd}	SFF	PFD_{avg}
Transmitter	29 FIT	269 FIT	139 FIT	0 FIT	93%	$1.3 \cdot 10^{-4}$

		closed coupled				extension wire			
		low stress		high stress		low stress		high stress	
		Sensor	Sensor + TMT162	Sensor	Sensor + TMT162	Sensor	Sensor + TMT162	Sensor	Sensor + TMT162
Thermo-couple	λ_{du}	6 FIT	35 FIT	119 FIT	148 FIT	109 FIT	138 FIT	2180 FIT	2209 FIT
	λ_{dd}	94 FIT	363 FIT	1881 FIT	2150 FIT	891 FIT	1160 FIT	17820 FIT	18089 FIT
	λ_{su}	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT
	λ_{sd}	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT
	SFF	94%	94% / 93%	94%	94% / 93%	89%	89% / 93%	89%	89% / 93%
	PFD_{avg}		$1.5 \cdot 10^{-4}$		$6.5 \cdot 10^{-4}$		$6.1 \cdot 10^{-4}$		$9.7 \cdot 10^{-3}$
RTD 2-/3-wire	λ_{du}	9 FIT	38 FIT	181 FIT	210 FIT	99 FIT	128 FIT	1976 FIT	2005 FIT
	λ_{dd}	39 FIT	308 FIT	779 FIT	1048 FIT	376 FIT	645 FIT	7524 FIT	7793 FIT
	λ_{su}	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT
	λ_{sd}	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT
	SFF	81%	81% / 93%	81%	81% / 93%	79%	79% / 93%	79%	79% / 93%
	PFD_{avg}		$1.7 \cdot 10^{-4}$		$9.2 \cdot 10^{-4}$		$5.6 \cdot 10^{-4}$		$8.8 \cdot 10^{-3}$
RTD 4-wire	λ_{du}	6 FIT	36 FIT	129 FIT	158 FIT	74 FIT	104 FIT	1486 FIT	1515 FIT
	λ_{dd}	44 FIT	313 FIT	871 FIT	1140 FIT	426 FIT	695 FIT	8514 FIT	8783 FIT
	λ_{su}	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT
	λ_{sd}	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT
	SFF	87%	87% / 93%	87%	87% / 93%	85%	85% / 93%	85%	85% / 93%
	PFD_{avg}		$1.6 \cdot 10^{-4}$		$6.9 \cdot 10^{-4}$		$4.5 \cdot 10^{-4}$		$6.6 \cdot 10^{-3}$

SFF	Typ	A			B		
	HFT	0	1	2	0	1	2
< 60%		SIL1	SIL2	SIL3	---	SIL1	SIL2
60% - < 90%		SIL2	SIL3	SIL4	SIL1	SIL2	SIL3
90% - < 99%		SIL3	SIL4	SIL4	SIL2	SIL3	SIL4
>99%		SIL3	SIL4	SIL4	SIL3	SIL4	SIL4

1 FIT = $1 \cdot 10^{-9}$h

PFD_{avg}
- (green) $< 2.5 \cdot 10^{-3}$
- (yellow) $> 2.5 \cdot 10^{-3}$
- (red) $> 1 \cdot 10^{-2}$

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Operation in single-channel mode is limited to 2 000 m.

Two channel operation

Transmitter	λ_{du}	λ_{dd}	λ_{su}	λ_{sd}	SFF	PFD_{avg}
	29 FIT	269 FIT	139 FIT	0 FIT	93%	$1.3 \cdot 10^{-4}$

		closed coupled				extension wire			
		low stress		high stress		low stress		high stress	
		2 x Sensor	2 x Sensor + TMT162	2 x Sensor	2 x Sensor + TMT162	2 x Sensor	2 x Sensor + TMT162	2 x Sensor	2 x Sensor + TMT162
Thermo-couple	λ_{du}	11 FIT	40 FIT	70 FIT	99 FIT	158 FIT	187 FIT	3160 FIT	3189 FIT
	λ_{dd}	189 FIT	458 FIT	3786 FIT	4055 FIT	1842 FIT	2111 FIT	36840 FIT	37109 FIT
	λ_{su}	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT
	λ_{sd}	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT
	SFF	95%	95% / 93%	98%	98% / 93%	92%	92% / 93%	92%	92% / 93%
	PFD_{avg}		$1.7 \cdot 10^{-4}$		$4.3 \cdot 10^{-4}$		$8.2 \cdot 10^{-4}$		$1.4 \cdot 10^{-2}$
RTD 2-/3-wire	λ_{du}	8 FIT	37 FIT	154 FIT	183 FIT	84 FIT	113 FIT	1672 FIT	1701 FIT
	λ_{dd}	88 FIT	357 FIT	1766 FIT	2035 FIT	866 FIT	1135 FIT	17328 FIT	17597 FIT
	λ_{su}	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT
	λ_{sd}	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT
	SFF	92%	92% / 93%	92%	92% / 93%	91%	91% / 93%	91%	91% / 93%
	PFD_{avg}		$1.6 \cdot 10^{-4}$		$1.3 \cdot 10^{-4}$		$7.4 \cdot 10^{-4}$		$7.5 \cdot 10^{-3}$
RTD 2-/3-wire + TC	λ_{du}	9 FIT	38 FIT	184 FIT	213 FIT	121 FIT	150 FIT	2416 FIT	2445 FIT
	λ_{dd}	139 FIT	408 FIT	2776 FIT	3045 FIT	1354 FIT	1623 FIT	27084 FIT	27353 FIT
	λ_{su}	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT	0 FIT	139 FIT
	λ_{sd}	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT	0 FIT
	SFF	94%	94% / 93%	94%	94% / 93%	92%	92% / 93%	92%	92% / 93%
	PFD_{avg}		$1.7 \cdot 10^{-4}$		$9.3 \cdot 10^{-4}$		$6.6 \cdot 10^{-4}$		$1.1 \cdot 10^{-2}$

SFF	Typ	A			B		
	HFT	0	1	2	0	1	2
< 60%		SIL1	SIL2	SIL3	---	SIL1	SIL2
60% - < 90%		SIL2	SIL3	SIL4	SIL1	SIL2	SIL3
90% - < 99%		SIL3	SIL4	SIL4	SIL2	SIL3	SIL4
>99%		SIL3	SIL4	SIL4	SIL3	SIL4	SIL4

1 FIT = $1 \cdot 10^{-9}$h

PFD_{avg}

- (green) $< 2.5 \cdot 10^{-3}$
- (yellow) $> 2.5 \cdot 10^{-3}$
- (red) $> 1 \cdot 10^{-2}$

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2 About this document

2.1 Document function

This Safety Manual applies in addition to the Operating Instructions, Technical Information and Ex-specific Safety Instructions. The supplementary device documentation must be observed during installation, commissioning and operation. The requirements specific to the protection function are described in this Safety Manual.

General information on functional safety (SIL) is available at: www.endress.com/SIL

2.2 Symbols

2.2.1 Safety symbols

DANGER

This symbol alerts you to a dangerous situation. Failure to avoid this situation will result in serious or fatal injury.

WARNING

This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in serious or fatal injury.

⚠ CAUTION
This symbol alerts you to a potentially dangerous situation. Failure to avoid this situation can result in minor or medium injury.

NOTICE
This symbol alerts you to a potentially harmful situation. Failure to avoid this situation can result in damage to the product or something in its vicinity.

2.2.2 Symbols for certain types of information and graphics

Tip
Indicates additional information

Reference to documentation

Reference to graphic

▶
Notice or individual step to be observed

1., 2., 3.
Series of steps

↳
Result of a step

1, 2, 3, ...
Item numbers

A, B, C, ...
Views

2.3 Supplementary device documentation

For an overview of the scope of the associated Technical Documentation, refer to the following:
- *Device Viewer* (www.endress.com/deviceviewer): Enter the serial number from the nameplate
- *Endress+Hauser Operations app*: Enter serial number from nameplate or scan matrix code on nameplate.

The following document types are available in the download area of the Endress+Hauser website (www.endress.com/downloads):

2.3.1 Further applicable documents

- Operating Instructions iTHERM ModuLine: BA01915T
- Operating Instructions iTHERM SurfaceLine: BA02366T
- Operating Instructions iTEMP TMT82: BA01028T
- Operating Instructions iTEMP TMT162: BA01801T
- Technical Information iTHERM ModuLine TM111: TI01445T
- Technical Information iTHERM ModuLine TM131: TI01373T
- Technical Information iTHERM ModuLine TM151: TI01707T
- Technical Information iTHERM SurfaceLine TM611: TI01801T
- Safety Instructions iTHERM ModuLine TM1x1: XA00044R
- Safety Instructions iTHERM ModuLine TM1x1: XA01799T
- Safety Instructions iTHERM ModuLine TM1x1: XA01817T
- Safety Instructions iTHERM SurfaceLine TM1611: XA03256T
- Safety Instructions iTHERM SurfaceLine TM1611: XA03258T
- Functional Safety Manual iTEMP TMT82: SD01172T/FY01105T
- Functional Safety Manual iTEMP TMT162: SD01632T/FY01106T

Technical Information (TI)

Planning aid
The document contains all the technical data on the device and provides an overview of the accessories and other products that can be ordered for the device.

Operating Instructions (BA)

Your reference guide
These Operating Instructions contain all the information that is required in various phases of the life cycle of the device: from product identification, incoming acceptance and storage, to mounting, connection, operation and commissioning through to troubleshooting, maintenance and disposal.

Brief Operating Instructions (KA)

Guide that takes you quickly to the 1st measured value
The Brief Operating Instructions contain all the essential information from incoming acceptance to initial commissioning.

Safety Instructions (XA)

Depending on the approval, the following Safety Instructions (XA) are supplied with the device. They are an integral part of the Operating Instructions.

The nameplate indicates the Safety Instructions (XA) that are relevant to the device.

Certificate

The associated certificate is available in the Endress+Hauser Device Viewer (Section 2.3) or can be found in the Declaration of Conformity (Section 1) of the applicable Functional Safety Manual. This certificate must be valid at the time of delivery of the device.

3 Design

3.1 Permitted device types

The details pertaining to functional safety in this manual relate to the device versions listed below and are valid as of the specified firmware and hardware versions.

Unless otherwise specified, all subsequent versions can also be used for safety functions.

A modification process according to IEC 61508:2010 is applied for any device modifications.

Any exemptions from possible combinations of features are saved in the Endress+Hauser ordering system.

Valid device versions for safety-related use:

3.1.1 Order codes

Product root: TM131-	Product root: TM151-
Code: 010 "Approval" Version: all	**Code: 010 "Approval"** Version: all
Code: 020 "Thermowell" Version: all	**Code: 020 "Thermowell"** Version: all
Code: 030 "Thermometer Design" Version: all	**Code: 030 "Thermometer Design"** Version: all
Code: 050 "Process Connection; Material" Version: all	**Code: 040 "Thermowell Material"** Version: all
Code: 060 "Thermowell Diameter; Material" Version: all	**Code: 050 "Process/Thermowell Connection"** Version: all
Code: 070 "Tip Shape" Version: all	**Code: 060 "Immersion Length U"** Version: all
Code: 080 "Immersion Length U" Version: all	**Code: 070 "Geometry Wetted Parts"** Version: all
Code: 090 "Removable Neck Length E" Version: all	**Code: 080 "Lagging Length T"** Version: all
Code: 100 "Lagging Length T" Version: all	**Code: 090 "Removable Neck Length E"** Version: all
Code: 110 "Sensor Type; Measuring Range; Material" Version: all except Y	**Code: 100 "Sensor Type; Measuring Range; Material"** Version: all except Y
Code: 130 "Sensor Standard; Classification" Version: all	**Code: 110 "Sensor Standard; Classification"** Version: all
Code: 140 "Electrical Connection" Version: only 2E, 2G, 3D, 3F, 3I	**Code: 120 "Electrical Connection"** Version: only 2E, 2G, 3D, 3F, 3I
Code: 150 "Terminal Head; Material; Protection Class" Version: all	**Code: 130 "Terminal Head; Material; Protection Class"** Version: all
Code: 170 "Cable Entry Terminal Head" Version: all	**Code: 140 "Cable Entry Terminal Head"** Version: all
Code: 480 "Device Model" Version: all	**Code: 480 "Device Model"** Version: all
Code: 560 "Second Transmitter (Mounted)" Version: only GF	**Code: 500 "Additional Design Options"** Version: all
Code: 570 "Service" Version: all	**Code: 520 "Special Root Diameter D1"** Version: all
Code: 580 "Test, Certificate, Declaration" Version: all	**Code: 530 "Special Tip Diameter D2"** Version: all
Code: 590 "Additional Approval" Version: Option LA must be selected	**Code: 540 "Special Bore Diameter Di"** Version: all
Code: 600 "Additional Option" Version: all	**Code: 545 "Special Tip Thickness B"** Version: all
Code: 610 "Accessory Mounted" Version: all	**Code: 550 "Thermometer Connection Ge1"** Version: all
Code: 630 "Calibration Thermometer" Version: all	**Code: 560 "Second Transmitter (Mounted)"** Version: only GF
Code: 640 "Calibration Points >= 0 oC" Version: all	**Code: 570 "Service"** Version: all
Code: 650 "Calibration Points <= 0 oC" Version: all	**Code: 580 "Test, Certificate, Declaration"** Version: all
Code: 850 "Firmware Version" Version: none	**Code: 590 "Additional Approval"** Version: Option LA must be selected
Code: 895 "Marking" Version: all	**Code: 600 "Additional Option"** Version: all
	Code: 610 "Accessory Mounted" Version: all

Product root: TM131-	Product root: TM151-
	Code: 630 "Calibration Thermometer" Version: all **Code: 640 "Calibration Points >= 0 oC"** Version: all **Code: 650 "Calibration Points <= 0 oC"** Version: all **Code: 850 "Firmware Version"** Version: none **Code: 895 "Marking"** Version: all

Product root: TM111-	Product root: TM611-
Code: 010 "Approval" Version: all **Code: 040 "Insert Diameter"** Version: all **Code: 050 "Process Connection; Material"** Version: all **Code: 080 "Immersion Length U"** Version: all **Code: 100 "Lagging Length T"** Version: all **Code: 110 "Sensor Type; Measuring Range; Material"** Version: all except Y **Code: 130 "Sensor Standard; Classification"** Version: all **Code: 140 "Electrical Connection"** Version: only 3D, 3F, 3I **Code: 150 "Terminal Head; Material; Protection Class"** Version: all **Code: 170 "Cable Entry Terminal Head"** Version: all **Code: 480 "Device Model"** Version: all **Code: 560 "Second Transmitter (Mounted)"** Version: only GF **Code: 570 "Service"** Version: all **Code: 580 "Test, Certificate, Declaration"** Version: all **Code: 590 "Additional Approval"** Version: Option LA must be selected **Code: 600 "Additional Option"** Version: all **Code: 610 "Accessory Mounted"** Version: all **Code: 630 "Calibration Thermometer"** Version: all **Code: 640 "Calibration Points >= 0 oC"** Version: all **Code: 650 "Calibration Points <= 0 oC"** Version: all **Code: 850 "Firmware Version"** Version: none **Code: 895 "Marking"** Version: all	**Code: 010 "Approval"** Version: all **Code: 020 "Thermometer Design"** Version: Only A and Y **Code: 030 "Pipe Outer Diameter; Material; Form"** Version: all **Code: 040 "Neck Length E"** Version: all **Code: 050 "Sensor Type; Measuring Range; Material"** Version: all except Y **Code: 060 "Sensor Standard; Classification"** Version: all **Code: 070 "Electrical Connection"** Version: only 3D, 3F, 3I **Code: 080 "Terminal Head; Material; Protection Class"** Version: all **Code: 090 "Cable Entry Terminal Head"** Version: all **Code: 100 "Wire; Sheath** Version: all **Code: 110 "Length Extension Wires: Cable Probe** Version: all **Code: 480 "Device Model"** Version: all **Code: 560 "Second Transmitter (Mounted)"** Version: only GF **Code: 570 "Service"** Version: all **Code: 580 "Test, Certificate, Declaration"** Version: all **Code: 590 "Additional Approval"** Version: Option LA must be selected **Code: 600 "Additional Option"** Version: all **Code: 610 "Accessory Mounted"** Version: all **Code: 630 "Calibration Thermometer"** Version: all **Code: 640 "Calibration Points >= 0 oC"** Version: all **Code: 650 "Calibration Points <= 0 oC"** Version: all **Code: 850 "Firmware Version"** Version: none

Valid firmware version:

- iTEMP TMT162 from 04.01.00 or higher
- iTEMP TMT82 from 01.02.00 or higher

Valid hardware version (electronics):

- iTEMP TMT162 from 04.01.00 or higher
- iTEMP TMT82 head transmitter from 01.00.07 or higher
- iTEMP TMT82 DIN rail transmitter from 01.00.04 or higher

3.2 Identification marking

SIL-certified devices are marked with the SIL logo (SIL) on the nameplate.

3.3 Safety function

The device's safety function is to ensure safe measurement and includes the measurement of a medium's temperature.

3.3.1 Safety-related output signal

The device's safety-related signal is the 4 to 20 mA analog output signal as per NAMUR NE43. All safety measures refer to this signal exclusively.

In addition, the device also communicates via HART® for information purposes and comprises all the HART® features with additional device information. HART® communication is not part of the safety function.

The safety-related output signal is fed to a downstream logic unit, e.g. a programmable logic controller or a level switch where it is monitored for the following:

- Exceeding or dropping below a predefined limit value
- Occurrence of a fault, e.g. failure current (≤ 3.6 mA, ≥ 21 mA), signal line interruption, or short circuit

NOTICE

In an alarm condition

▶ Ensure that the equipment under control achieves or maintains a safe state.

3.3.2 Safe measurement

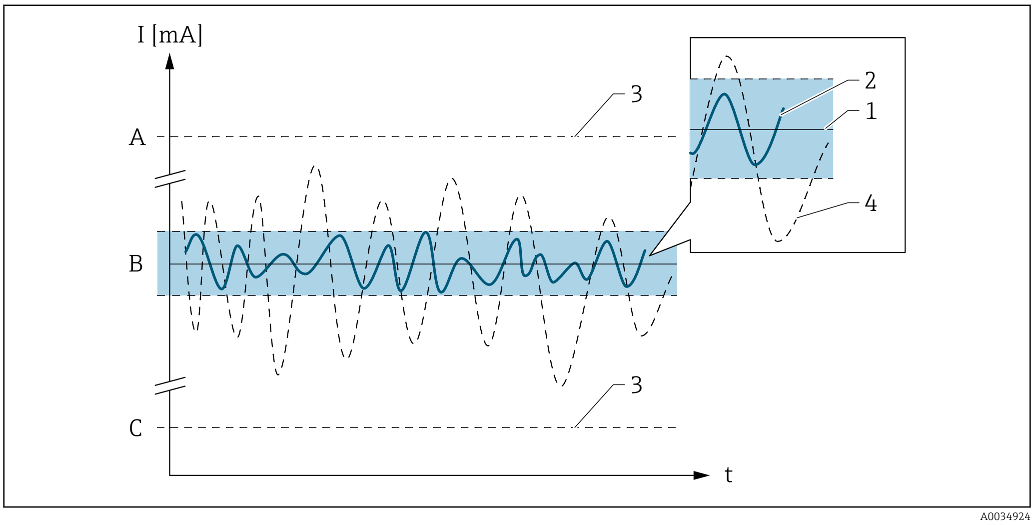
The transmitter's safety function comprises a transmitted current output signal proportional to the voltage, resistance or temperature value.

All safety functions can be used in combination with all sensor configurations from the "Structure of the measuring system" section → 24. Note here that only the measured value of a single sensor or the value of a function (average/difference of the two measured values) can be output at the current output at any given time.

3.4 Basic conditions for use in safety-related applications

The device must be used correctly for the specific application, taking into account the medium properties and ambient conditions. Carefully follow instructions pertaining to critical process situations and installation conditions from the Operating Instructions. The application-specific limits must be observed. The specifications in the Operating Instructions and the Technical Information must not be exceeded.

3.4.1 Random failures in accordance with IEC/EN 61508



A HI alarm ≥ 21 mA
B SIL error range ±2%
C LO alarm ≤ 3.6 mA

No device error
- No failure
- No impact on the safety-related output signal
- Impact on measurement uncertainty:
  1 – within the specification (TI, BA etc.)

λ_S (Safe)
- Safe failure
- No impact on the safety-related output signal: output signal enters the safe state
- Impact on the measurement uncertainty:
  - 2 - Moves within the specified SIL error band B
  - 3 – Has no effect

λ_{DD} (Dangerous detected)
- Dangerous, detected failure
- Impact on the safety-related output signal: results in a failure mode at the output signal
- Impact on the measurement uncertainty:
  3 – Has no effect

λ_{DU} (Dangerous undetected)
- Dangerous and undetected failure
- Impact on the safety-related output signal: can be outside the defined error range B
- Impact on the measurement uncertainty:
  4 – May be outside the specified error range

3.4.2 Restrictions for safety-related use

Basic conditions and restrictions for the device:

Operation in single-channel mode is limited to 2 000 m.

Sensors, wiring scheme and temperature ranges
- The maximum application temperatures specified for the different sensor types must be observed.
- The impact resistance and vibration resistance of the temperature transmitter and temperature sensor must be taken into account.

The temperature ranges are described in the "Technical Data" section in the corresponding operating manual.

Detailed information:
- Operating Instructions iTHERM ModuLine: BA01915T
- Operating Instructions iTHERM SurfaceLine TM611: BA02366T
- Operating Instructions iTEMP TMT82: BA01028T
- Operating Instructions iTEMP TMT162: BA01801T

The following restriction also applies for safety-related use:
- Strong, pulse-like EMC interference on the power supply line may cause short-term (<1 s) deviations in the output signal (≥ ±1 %). For this reason, filtering with a time constant of ≥ 1 s should be performed in the downstream logic unit.
- The specified error range (safety measurement error) is sensor-specific and is defined according to FMEDA (Failure Modes, Effects and Diagnostic Analysis) on delivery. It contains all the influencing factors described in the Technical Information:
  - Non-linearity
  - Non-repeatability
  - Hysteresis
  - Zero error
  - Temperature drift

The safety-related failures are classified into different categories according to IEC/EN 61508 (see table → 🗎 16). The table shows the implications for the safety-related output signal and the measurement uncertainty.

Response times:
- The information regarding typical response times is based on a measurement according to DIN EN 60751 in water with a flow velocity of 0.4 m/s.
- The response time t90 is indicated. This is the time the temperature sensor needs to indicate 90 % of the temperature increase.
- The total response time consists of the response time of the temperature sensor, including the thermowell, and the response time of the temperature transmitter.

The response times are described in the "Technical Data" section in the corresponding operating manual.

Detailed information:
- Operating Instructions iTHERM ModuLine: BA01915T
- Operating Instructions iTHERM SurfaceLine TM611: BA02366T
- Operating Instructions iTEMP TMT82: BA01028T
- Operating Instructions iTEMP TMT162: BA01801T

These are typical values from standard design (according to DIN 43772, for example) and must be used as reference values.

Prior to using the thermometer, the user must check whether the entire response time for the particular application guarantees the safe shutdown of the entire system.

3.5 Safety measured error

The following values do not take into account deviations caused by EMC. In the event of non-negligible EMC interference, an additional deviation of 1 % from the span must be added to the values above.

The accuracy classes of the sensors are valid for the following temperature ranges:

Temperature ranges

Sensor type	Class B	Class A	Class AA
Pt100 (TF) iTHERM StrongSens	−50 to +400 °C (−58 to +752 °F)	−30 to +300 °C (−22 to +572 °F)	0 to +150 °C (−58 to +302 °F)
Wire-wound sensor (WW)	−196 to +400 °C (−321 to +752 °F)	−100 to +400 °C (−328 to +742 °F)	−50 to +250 °C (−58 to +482 °F)

Permitted temperature ranges for thermocouples in conjunction with functional safety:

Sensor type according to IEC 60584 / ASTM E230 / ANSI MC96.1	Class 1 and 2 / special and standard
J (Fe-CuNi)	0 to 600 °C (32 to 1 112 °F)
K (NiCr-NiAl) N (NiCrSi-NiSi)	0 to 800 °C (32 to 1 472 °F)

Detailed information:
- Technical Information iTHERM ModuLine TM111: TI01445T
- Technical Information iTHERM ModuLine TM131: TI01373T
- Technical Information iTHERM ModuLine TM151: TI01707T
- Technical Information iTHERM SurfaceLine TM611: TI01801T

Detailed information:
- Functional Safety Manual iTEMP TMT82: SD01172T/FY01105T
- Functional Safety Manual iTEMP TMT162: SD01632T/FY01106T

Validity of data for safety measured error:

- Total permitted temperature range of the transmitter in the SIL mode
- Defined range of the supply voltage
- Limited safety measuring range of sensor element
- Accuracy includes all linearization and rounding errors
- Observe the minimum span of each sensor.
- Specifications are 2σ values, i.e. 95.4 % of all measured values are within the specifications.

3.6 Dangerous undetected failures in this scenario

An incorrect output signal that deviates from the value specified in this manual but is still in the range of 4 to 20 mA, is considered a "dangerous, undetected failure".

3.7 Useful lifetime of electrical components

The established failure rates of electrical components apply within the useful lifetime as per IEC 61508-2:2010 section 7.4.9.5 note 3.

In accordance with DIN EN 61508-2:2011 section 7.4.9.5 (national footnote N3), appropriate measures taken by the manufacturer and operator can extend the useful lifetime.

However, the useful lifetime may be significantly shorter if the device is operated at higher temperatures or out of specification.

Detailed information:
- Functional Safety Manual iTEMP TMT82: SD01172T/FY01105T
- Functional Safety Manual iTEMP TMT162: SD01632T/FY01106T

As the maximum application temperature influences the drift behavior of the sensors, a recalibration should be performed or the inserts should be replaced at regular intervals for reliable and accurate temperature measurement. The intervals are listed in the table below:

Max. application temperature	Resistance thermometer	Thermocouple
200 °C (392 °F)	5 years	5 years
400 °C (752 °F)	2 years	2 years
600 °C (1 112 °F)	-	2 years
800 °C (1 472 °F)	-	1 year

The testing intervals indicated here are suggestions. Special conditions at the place of use may require the user to significantly shorten the application duration.

4 Commissioning (installation and configuration)

4.1 Requirements for personnel

The personnel for installation, commissioning, diagnostics and maintenance must fulfill the following requirements:
- ▶ Trained, qualified specialists must have a relevant qualification for this specific function and task.
- ▶ Personnel must be authorized by the plant owner/operator.
- ▶ Be familiar with federal/national regulations.
- ▶ Before starting work: personnel must read and understand the instructions in the manual and supplementary documentation as well as the certificates (depending on the application).
- ▶ Personnel must follow instructions and comply with general policies.

The operating personnel must fulfill the following requirements:
- ▶ Personnel are instructed and authorized according to the requirements of the task by the facility's owner-operator.
- ▶ Personnel follow the instructions in this manual.

4.2 Installation

The mounting and wiring of the device and the permitted orientations are described in the Operating Instructions pertaining to the device.

Correct installation is a prerequisite for safe operation of the device.

4.3 Commissioning

The commissioning of the device is described in the Operating Instructions pertaining to the device.

Prior to operating the device in a safety instrumented system, verification must be carried out by means of a test sequence as described in **the section "Proof testing"**.

4.4 User operation

The operation of the device is described in the Operating Instructions pertaining to the device.

4.5 Parameter configuration for safety-related applications

4.5.1 Adjustment of the measuring point

Adjustment of the measuring point is described in the associated Operating Instructions.

Preset parameters:

▶ Check the factory preset parameters for accuracy according to the desired measuring range and correct them if necessary.

4.5.2 Device protection

The devices can be protected against external influences as follows:

- Software write protection
- Hardware write protection

The application of these methods is described in the associated Operating Instructions.

4.5.3 Locking in Expert mode

The SIL locking of the device is described in the associated Functional Safety Manual.

4.5.4 Unlocking a SIL device

When SIL locking is active on a device, the device is protected against unauthorized operation by means of a locking code and, as an additional option, by means of a hardware write protection switch. The device must be unlocked to change parameter configuration.

⚠ DANGER

▶ Unlocking the device deactivates diagnostic functions, and the device may not be able to carry out its safety function when unlocked. Therefore, independent measures must be taken to ensure that there is no risk of danger while the device is unlocked.

The SIL unlocking of the device is described in the associated Functional Safety Manual.

5 Operation

5.1 Device behavior during power-up

The behavior of the device when powered up is described in the associated Operating Instructions.

5.2 Device behavior when safety function is requested

The device outputs a current value. This value must correspond to a limit value, which must be monitored and processed by a connected logic unit. The behavior of the device is described in the associated Functional Safety Manual.

5.3 Safe states

The system adopts the safe state depending on the error detected. The behavior of the device is described in the associated Functional Safety Manual.

Safe state / output current:
- I ≤ 3.6 mA (low alarm)
  or
- I ≥ 21.5 mA (high alarm)

5.4 Device behavior in the event of alarms and warnings

The output current on alarm can be set to a value of ≤ 3.6 mA or ≥ 21 mA. In some cases, output currents of ≤ 3.6 mA may occur, regardless of the configured failure current setting.

Examples include:
- Power supply failure
- Cable break
- Malfunctions in the current output itself, where the fault current ≥ 21 mA cannot be set

In some other cases, (e.g. cabling short circuit), output currents ≥ 21.0 mA occur irrespective of the configured failure current.

For alarm monitoring, the downstream logic unit must be able to detect HI-alarms (≥ 21 mA) and LO-alarms (≤ 3.6 mA).

5.5 Alarm and warning messages

The behavior of the device in case of alarms and warnings is described in the associated Functional Safety Manual.

Error codes for alarm and warning messages:

The relationship between error code and diagnostic behavior is explained in the table in the "Diagnostics and troubleshooting" section in the associated Operating Instructions for the relevant transmitter.

Detailed information:
- Operating Instructions iTEMP TMT82: BA01028T, Section 9.5
- Operating Instructions iTEMP TMT162: BA01801T, Section 9.3

6 Proof testing

The safety-related functionality of the device in the SIL mode must be verified during commissioning, when changes are made to safety-related parameters, and also at appropriate time intervals. This enables this functionality to be verified within the entire safety instrumented system. The time intervals must be specified by the operator.

⚠ CAUTION

The safety function is not guaranteed during a proof test

Suitable measures must be taken to guarantee process safety during the test.
- ▶ The safety-related output signal 4 to 20 mA must not be used for the safety instrumented system during testing.
- ▶ A completed test must be documented; the reports provided in the Appendix can be used for this purpose (see Section 8.2).
- ▶ The operator specifies the test interval and this must be taken into account when determining the probability of failure PFD_{avg} of the sensor system.

If no operator-specific proof testing requirements have been defined, the following is a possible alternative for testing the transmitter depending on the measured variable used for the safety function.

Information on the test sequences for the transmitter is provided in the associated Functional Safety Manual.

The following test sequences are recommended at regular intervals for the device:

Component: terminal head
Visual inspection of the head and gaskets for damage and wear

Component: insert
The insulation resistance of the measuring circuit in relation to the protection fitting must be measured every 12 months (only for non-grounded sensors in the case of thermocouples; in the case of several sensors the insulation check must also be performed between the individual circuits). The minimum insulation resistance at room temperature should be 100 V at 100 MΩ.

Component: thermometer thermowell
- Visual inspection of the thermowell and extension neck for damage, leaks, corrosion and wear.
- Visual inspection of sealing points for leaks.

For iTHERM TM611 only: component: coupling element
- Visual inspection of the coupling element for proper installation and good thermal contact with the pipeline
- Visual inspection of the pipeline and coupling element for damage, corrosion, and wear

6.1 Test sequence A, B, C

Proof testing procedure

The procedure for proof testing is described in the associated Functional Safety Manual.

Detailed information:
- Functional Safety Manual iTEMP TMT82: SD01172T/FY01105T
- Functional Safety Manual iTEMP TMT162: SD01632T/FY01106T

6.2 Verification criterion

If one of the test criteria from the test sequences described above is not fulfilled, the device may no longer be used as part of a safety instrumented system.
- The purpose of proof-testing is to detect dangerous undetected device failures (λ_{DU}).
- This test does not cover the impact of systematic faults on the safety function, which must be assessed separately.
- Systematic faults can be caused, for example, by process material properties, operating conditions, build-up or corrosion.
- As part of the visual inspection, for example, ensure that all of the seals and cable entries provide adequate sealing and that the device is not visibly damaged.

7 Repair and error handling

7.1 Maintenance

Maintenance instructions and instructions regarding calibration may be found in the Operating Instructions pertaining to the device.

Alternative monitoring measures must be taken to ensure process safety during configuration, proof-testing and maintenance work on the device.

7.2 Repair

Repairs or replacements of components may only be carried out by the customer's qualified personnel. If **original spare parts** from Endress +Hauser, which can be ordered by the end customer, are used, the relevant Installation Instructions must be observed.

A proof test must always be performed after every repair.

Spare parts are grouped into logical kits with the associated Installation Instructions.

Document the repair with the following information:
- Serial number of the device
- Date of the repair
- Type of repair
- Person who performed the repair

Device inspection following repair:

Sensor with or without process connection
Proof testing, test sequence A or B

Seal sets for the sensor
Proof testing, test sequence A or B

Display
Visual inspection to establish if all parts are present and mounted correctly and to verify that the device is in the "Good" state.

Electronic insert (transmitter)
Proof testing, test sequence A or B

Housing cover
Visual inspection to establish if all parts are present and mounted correctly and to verify that the device is in the "Good" state.

Cable gland
Proof testing, test sequence A or B

Seal kits for housing covers
Visual inspection to establish if all parts are present and mounted correctly and to verify that the device is in the "Good" state.

Securing clamps, housing
Visual inspection to establish if all parts are present and mounted correctly and to verify that the device is in the "Good" state.

Installation Instructions are supplied with the original spare part and can also be accessed in the Download Area at www.endress.com

Send in replaced components to Endress+Hauser for fault analysis.

When returning the defective component, always enclose the "Declaration of Hazardous Material and Decontamination" with the note "Used as SIL device in a safety instrumented system".

Information on returns: http://www.endress.com/support/return-material

7.3 Modification

Modifications are changes to SIL devices that are already delivered or installed:
- **Modifications to SIL devices by the user are not permitted because they can impair the functional safety of the device**
- Modifications to SIL devices may be performed onsite at the user's plant following approval by theEndress+Hauser manufacturing center
- Modifications to SIL devices must be performed by personnel authorized to do so by Endress+Hauser
- Only **original spare parts** fromEndress+Hauser may be used for modifications
- All modifications must be documented in the Endress+Hauser Device Viewer (www.endress.com/deviceviewer)
- All modifications require a change nameplate or replacement of the original nameplate.

If only the orientation or installation conditions are affected, re-commissioning must be carried out according to Section 4.

7.4 Decommissioning

When decommissioning, the requirements according to IEC 61508-1:2010 section 7.17 must be observed.

Safe decommissioning of the device:

▶ Analyze the necessary steps for decommissioning.

The overall system is safe. Safe decommissioning of the device is ensured.

7.5 Disposal

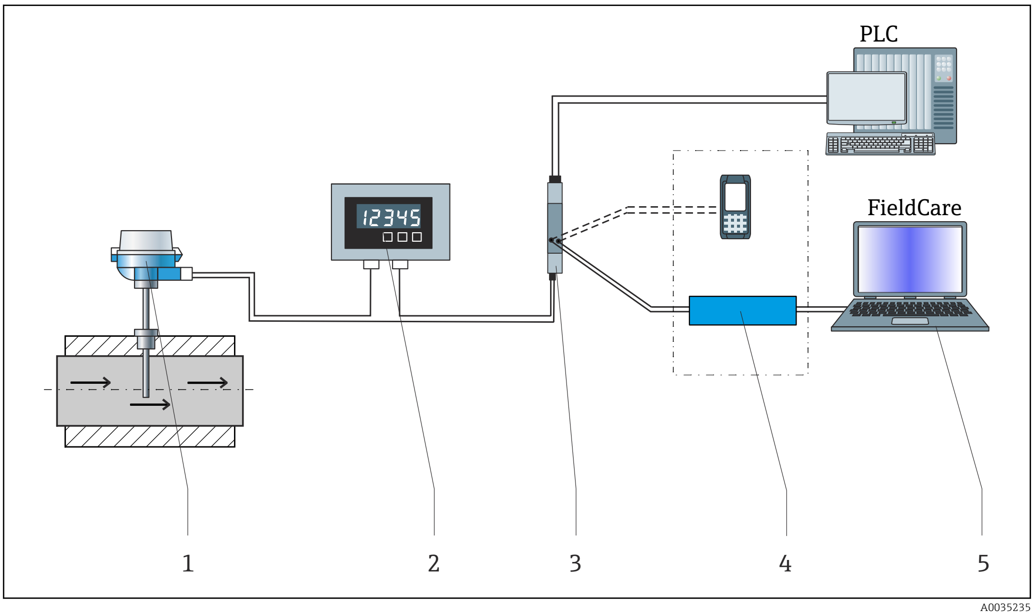
If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return them to the manufacturer for disposal under the applicable conditions.

8 Appendix

8.1 Structure of the measuring system

8.1.1 System components

An example of the devices in the measuring system is shown in the following graphic.



1 Example of application, measuring point layout with additional Endress+Hauser components

1 Installed iTHERM ModuLine thermometer with HART® communication protocol
2 RIA15 loop-powered process indicator: The process indicator is integrated in the current loop and displays the measuring signal or HART® process variables in digital form. The process indicator does not require an external power supply and is powered directly via the current loop.
3 RN Series active barrier: The active barrier (24 V_{DC}, 30 mA) has a galvanically isolated output for supplying voltage to loop-powered transmitters. The universal power supply works with an input supply voltage of 20 to 250 V DC/AC, 50/60 Hz, which means that the active barrier can be used in all international power grids.
4 Communication examples: HART® Communicator (handheld device), FieldXpert, Commubox FXA195 for intrinsically safe HART® communication with FieldCare via a USB port.
5 FieldCare is an FDT-based plant asset management tool from Endress+Hauser.

In a thermometer with a transmitter, a analog signal (4 to 20 mA) proportional to the particular sensor value is generated and fed to a downstream logic unit (e.g. PLC, level switch). This unit detects whether the measured value exceeds or falls below a predefined limit value.

For fault monitoring, the logic unit must recognize both HI alarms (≥21 mA) and LO alarms (≤3.6 mA).

NOTICE

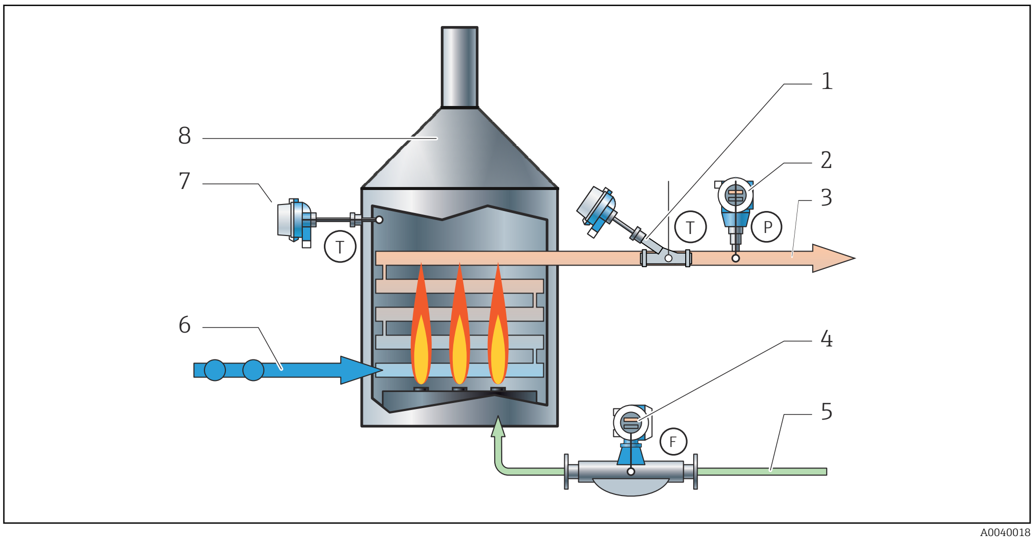
- The optional display is not part of the safety function. Neither the hardware nor the software of the display has any influence on the defined safety functions of the transmitter.

8.1.2 Description of use as a safety instrumented system

The device uses the measuring principles **resistance thermometer (RTD)** and **thermocouple (TC)**. Resistance thermometers use a Pt100 temperature sensor according to IEC 60751. The temperature sensor is a temperature-sensitive platinum resistor with a resistance of 100 Ω at 0 °C (32 °F) and a temperature coefficient α =0.003851 $°C^{-1}$.

Thermocouples are simple, robust temperature sensors that use the Seebeck effect for temperature measurement: When two electrical conductors made of different materials are joined at one point, a weak electrical voltage can be measured between the two open conductor ends if a thermal gradient is present along these conductors. This voltage is called thermoelectric voltage or electromotive force (emf). Its magnitude depends on the type of conducting materials and the temperature difference between the "measuring point" (the junction of the two conductors) and the "cold junction" (the open conductor ends).

Accordingly, thermocouples primarily only measure differences in temperature. The absolute temperature at the measuring point can be determined from these if the associated temperature at the cold junction is known or is measured separately and compensated for. The material combinations and associated thermoelectric voltage/ temperature characteristics of the most common types of thermocouple are standardized in the IEC 60584 and ASTM E230/ANSI MC96.1 standards. The device's safety-related signal is the analog 4 to 20 mA output signal in accordance with NAMUR NE43. All safety measures refer to this signal exclusively. The device additionally communicates for information only via HART and contains all HART features with additional device information.



2 *Example of the measuring arrangement*

1 *iTHERM SurfaceLine TM611*
2 *Pressure measuring cell*
3 *Finished product*
4 *Flow sensor*
5 *Fuel*
6 *Starting material*
7 *iTHERM ModuLine TM131/TM151*
8 *Furnace*

Correct installation is a prerequisite for safe operation of the device.

8.1.3 Measurement function

Galvanic isolation when connecting two sensors
If two sensors are connected to the transmitter, ensure that the sensors are galvanically isolated (not applicable to grounded thermocouples).

Two-channel functions
Two sensors can be connected to the transmitter and the transmitter can be operated in the following safe functions:

- **Averaging** function
  The measured values M1, M2 of the two sensors are output as an arithmetic mean (M1+M2)/2.
- **Difference** function
  The measured values M1, M2 of the two sensors are output as a difference (M1-M2).
- **Backup** function
  If a sensor fails, the transmitter automatically switches to the other measuring channel. For this the sensor types must be identical, e.g. two 3-wire resistance sensors (Pt100). The backup function is used to increase availability and improve the diagnostic capabilities.
  The following types of sensor are permitted in the SIL mode:
  - 2x thermocouple (TC)
  - 2x RTD, 3-wire
- **Sensor drift** function
  If redundant sensors are used, the long-term drift of a sensor can be detected, for instance. This is a diagnostic measure as the signal of the second sensor is only used for this diagnostic. If identical sensors are used, the backup function can also be used.

The configured drift/difference limit value should be at least twice the safety accuracy value.

SIL 3 configuration: homogeneous redundancy
Two temperature transmitters with one sensor per transmitter are required for a SIL 3 measuring point. The measured values of the two transmitters are evaluated in a logic unit using a safe voter.

8.2 Commissioning or proof test report

The following device-specific test report acts as a template and can be replaced or supplemented by the customer's own SIL reporting and testing system.

8.2.1 Test Report - Page 1 -

Company/contact person	
Tester	

Device information
System
Measuring points/TAG No.
Device type/order code
Serial number
Firmware version
Access code (if individual to each device)
SIL checksum

Verification information
Date/time
Performed by

Verification result	
Overall result	
☐ Passed	☐ Failed

Comment

Date Signature Signature of tester

8.2.2 Test Report - Page 2 -

Type of safety function
☐ Safe measurement

Commissioning check
☐ Device parameter configuration via SIL mode activation (SiMA)
☐ Commissioning check, test sequence A
☐ Commissioning check, test sequence B

Proof testing
☐ Test sequence A
☐ Test sequence B
☐ Test sequence C

Proof test report			
Test step	**Target value**	**Actual value**	**Result**
1 Terminal head			☐ Passed ☐ Failed ☐ Not applicable
2 Insert			☐ Passed ☐ Failed ☐ Not applicable
3 Thermometer thermowell			☐ Passed ☐ Failed ☐ Not applicable
4 Lower range value adjustment, sensor 1			☐ Passed ☐ Failed
5 Upper range value adjustment, sensor 1			☐ Passed ☐ Failed
6 Lower range value adjustment, sensor 2			☐ Passed ☐ Failed ☐ Not applicable
7 Upper range value adjustment, sensor 2			☐ Passed ☐ Failed ☐ Not applicable
8 Current value alarm			☐ Passed ☐ Failed
9 Restart via HART			☐ Passed ☐ Failed ☐ Not applicable
10 ▪ TMT82: Restart via plug-in display ▪ TMT162: Restart via proof test button			☐ Passed ☐ Failed ☐ Not applicable

8.2.3 Test Report - Page 3 -

Protocol for commissioning check			
Test step	**Target value**	**Actual value**	**Result**
1 Lower range value adjustment, sensor 1			☐ Passed ☐ Failed
2 Upper range value adjustment, sensor 1			☐ Passed ☐ Failed
3 Lower range value adjustment, sensor 2			☐ Passed ☐ Failed ☐ Not applicable
4 Upper range value adjustment, sensor 2			☐ Passed ☐ Failed ☐ Not applicable
5 Two-channel function, sensor drift			☐ Passed ☐ Failed ☐ Not applicable
6 Two-channel function, backup			☐ Passed ☐ Failed ☐ Not applicable
7 Channel assignment, current output			☐ Passed ☐ Failed ☐ Not applicable
8 Out of range category			☐ Passed ☐ Failed ☐ Not applicable
9 RJ / preset value			☐ Passed ☐ Failed ☐ Not applicable
10 Current value alarm			☐ Passed ☐ Failed
11 Restart via HART			☐ Passed ☐ Failed ☐ Not applicable
12 ▪ TMT82: Restart via plug-in display ▪ TMT162. Restart via proof-test button			☐ Passed ☐ Failed ☐ Not applicable

8.2.4 Parameter settings for the SIL mode

Parameter name	Factory setting	Set value	Checked
Enter access code	0		
Lower measuring range (4 mA)	0		
Upper measuring range (20 mA)	100		
Fault current	22.5 mA		
Failure mode	TMT82: High alarm TMT162: Low alarm		
Sensor type 1	Pt100 IEC60751		
Sensor type 2	No sensor		
Upper sensor limit 1	+850 °C		
Lower sensor limit 1	−200 °C		
Upper sensor limit 2	-		
Lower sensor limit 2	-		
Sensor offset 1	0		
Sensor offset 2	0		
Connection type 1	4-wire (RTD)		
Connection type 2	2-wire (TC)		

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