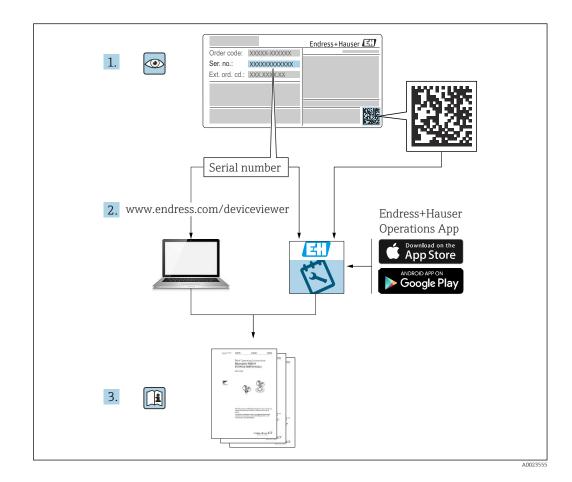
# Functional Safety Manual iTHERM ModuLine TM1x1, iTHERM SurfaceLine TM611









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# 1 Declaration of Conformity

|                        |   |   | 2                 |
|------------------------|---|---|-------------------|
|                        | SIL_00327_04.25   | Endress + Hauser  | <u>z</u>          |
| (a)                    | Herstellererklärung - Man   | ufacturer Declaration   | 1                 |
|                        | Funktionale Sicherheit - Functional Safety accordi<br>Beiblatt 1/ NE130 Formblatt B1 - Supplement 1 /   |   |                   |
|                        | Endress+Hauser Wetzer GmbH+Co. KG, Ober   | re Wank 1, 87484 Nesselwang   |                   |
| 16<br>5                | erklärt als Hersteller, dass die folgenden Thermor<br>declares as manufacturer, that the following therr  |   |                   |
| . 9                    | iTHERM ModuLine TM111, iTHE<br>ModuLine TM151, iTHERM Surfa   |   | N                 |
| ж.<br>Т                | in Verbindung mit den Transmittern - in combinat<br>iTEMP<br>iTEMP  | MT82 oder - or  |                   |
| n na<br>sh<br>St<br>St | für den Einsatz in sicherheitsrelevanten Anwe<br>entsprechend IEC61508:2010 geeignet sind.<br>are suitable for use in safety-instrumented system<br>IEC61508:2010.<br>In sicherheitsrelevanten Anwendungen gemäß I<br>Handbuchs zur Funktionalen Sicherheit zu beacht | ns up to SIL2 (HFT=0) or SIL3 (HFT=1) accord<br>EC 61508 und IEC 61511 sind die Angabe<br>en. | ding to<br>en des |
| ¢                      | In safety instrumented systems according to IEC 6<br>Manual have to be followed.  | 1506 and IEC 61511, the instructions of the   | Salety            |
| .8                     |   | • 4. A.   |                   |
|                        | Nesselwang, 11.02.2025<br>Endress+Hauser Wetzer GmbH+Co. KG   |   |                   |
| n<br>An an             | ppa. N. E   | E.M   | 2.2<br>-          |
| 25                     | ppa. Harald Müller<br>Director Technology   | i.V. Eva Rizzo<br>Head of Department Technology Safety  |                   |
|                        |   |   | 1/3               |

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| Gerätebezeichnung und zulässige Ausführungen       TM111, TM131, TM151, TM611       (Bestellmerkmal "Weitere Zulassungen": Op<br>LA"SIL")         Sicherheitsbezogenes Ausgangssignal       420mA   | IL_00327_04.7      | 22                                      |                   |             | Er                        |                            | SS + Hau<br>e for Process Au |           |             |
|---|--------------------|---|-------------------|-------------|---------------------------|----------------------------|------------------------------|-----------|-------------|
| Gerätebezeichnung und zulässige Austuhrungen       LA "SIL")         Sicherheitsbezogenes Ausgangssignal       420mA         Fehierstrom       ≤ 3,6 m A oder ≥ 21,0 mA         Bewertete Messgröße / Funktion       Temperatur / Spannung / Widerstand         Sicherheitsfunktion(en)       sichere Messung         Gerätetpg gem. IEC 61508-2       ☑ Typ A       □ Typ B         Betriebsart       ☑ Low Demand Mode       ☑ High Demand       □ Continuous Mo         Sicherheitshandbuch       SD02427T, FY01102T, SD01172T, FY01105T, SD01632T, FY01106T         Sicherheitshandbuch       SD02427T, FY01102T, SD01172T, FY01105T, SD01632T, FY01106T         Auswertung von Feldaten HW/SW Bewertung inkl.       FMEDA und Änderungsprozess nach IEC 61508-2, 3         Image: Provide the Ward of the State   | Allgemein          |   |                   |             |                           |                            |                              |           |             |
| Sicherheitsbezogenes Ausgangssignal       420mA         Fehlerstrom       ≤ 3,6 mA oder ≥ 21,0 mA         Bewerttet Messgröße / Funktion       Temperatur / Spannung / Widerstand         Sicherheitsfunktion(en)       sichere Messung         Gerätetyp gem. IEC 61508-2       Ø Typ A       Typ B         Betriebsart       Ø Low Demand Mode       Ø High Demand       Continuous Mo         Sicherheitshandbuch       SD02427T, FY01102T, SD01172T, FY01105T, SD0163ZT, FY01106T       SD02427T, FY01102T, SD01172T, FY01105T, SD0163ZT, FY01106T.         Art der Bewertung<br>(nur eine Variante wählbar)       Ø       Vollständige entwicklungsbegleitende HW/SW Bewertung inkl.<br>FMEDA und Änderungsprozess nach IEC 61508-2, 3       Bewertung über Nachweis der Betriebsbewährung HW/SW linkl. FMED<br>und Änderungsprozess nach IEC 61508-2, 3         Bewertung (nur eine Variante wählbar)       Bewertung über Nachweis der Betriebsbewährung HW/SW zum Nachweis "Frühere Verwendur<br>gem. IEC 61511       Auswertung von Felddaten HW/SW zum Nachweis "Frühere Verwendur<br>gem. IEC 61508-2, 3         Bewertung durch / Zertifikatsnummer       TM1x1/TM611: 210 012833 0008       TM1x2: 710 012833 0008         Früfungsunterlagen       Entwicklungsdokumente, Testreports, Datenblätter       SIL 2 fähig       SIL 3 fäh         Berdesscherheitsintegrität       Einkanaliger Einsatz (HFT ≈ 1)       SIL 2 fähig       SIL 3 fäh         Hardware Sicherheitsintegrität       Einkanaliger Einsatz (HFT ≈ 1)   | Gerätebezeichnung  | und zulässige Ausfüh                    |                   |             |                           | 11 (Beste                  | Ilmerkmal "Weit              | ere Zulas | sungen": Op |
| Fehlerstrom       ≤ 3,6 mA oder ≥ 21,0 mA         Bewertete Messgröße / Funktion       Temperatur / Spannung / Widerstand         Sicherheitsfunktion(en)       sichere Messung         Gerätetyp gem. IEC 61508-2       Ø Typ A       □ Typ B         Betriebsart       Ø Low Demand Mode       Ø High Demand       □ Continuous Mo         Sicherheitshandbuch       SD02427T, FV01105T, SD0132T, FV01105T, SD0132T, FV01105T, SD01632T, FV01102T, SD01632T, FV01102T, SD01632T, FV01102T, SD01632T, FV01102T, SD01632T, FV01102T, SD01632T, SD005         Bewertung durch / Zertifikatsnummer       TM1x1, TM611 mit TMT62       Selexertung durch FMEDA gem. IEC 61508-2, 3         Bewertung durch / Zertifikatsnummer       TM182: Z10 012833 00005       TM1162: Z10 012833 00005       TM1162: Z10 012833 00005         Früfungsunterlagen       Entwicklungsdokumente, Testreports, Datenblätter       SIL 2 fähig       SIL 2 fähig       SIL 3 fä         Hardware Sicherheitsintegrität <td< td=""><td>Sicherheitsbezogen</td><td>es Ausgangssignal</td><td></td><td></td><td></td><td></td><td></td><td>к.<br/>К</td><td></td></td<>   | Sicherheitsbezogen | es Ausgangssignal                       |                   |             |                           |                            |                              | к.<br>К   |             |
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| Betriebsart       Image: Continuous Mooge       Image: Continuous Mooge         Sicherheitshandbuch       SD02427T, FY01102T, SD01172T, FY01105T, SD01632T, FY01106T         Art der Bewertung<br>(nur eine Variante wählbar)       Vollständige entwicklungsbegleitende HW/SW Bewertung inkl.<br>FMEDA und Änderungsprozess nach IEC 61508-2, 3         Bewertung über Nachweis der Betriebsbewährung HW/SW inkl. FMED.<br>und Änderungsprozess nach IEC 61508-2, 3       Bewertung über Nachweis der Betriebsbewährung HW/SW inkl. FMED.<br>und Änderungsprozess nach IEC 61508-2, 3         Bewertung durch / Zertifikatsnummer       TM1x1/TM611: Z10 012833 0008<br>TM152: Z10 012833 0004       Frühere Verwendu<br>gem. IEC 61508-2 für Geräte ohne Software         Prüfungsunterlagen       Entwicklungsdokumente, Testreports, Datenblätter       SIL 2 fähig       SIL 3 fä<br>Mehrkanaliger Einsatz (HFT = 0)         Systematische Sicherheitsintegrität       Image: Einsatz (HFT = 1)       SIL 2 fähig       SIL 3 fä<br>Mehrkanaliger Einsatz (HFT = 1)         Hardware Sicherheitsintegrität       Siehe Kap. 1.2.1 (FY01102T)       SIL 2 fähig       SIL 3 fä<br>SI SIL 3 fä         Hardware Sicherheitsintegrität       Siehe Kap. 1.2.2 (FY01102T)       SIL 2 fähig       SIL 3 fä         Hardware Sicherheitsintegrität       Siehe Kap. 1.2.2 (FY01102T)       SIL 3 fä         TM1x1, TM611 mit TMT82       siehe Kap. 1.2.2 (FY01102T)       SIL 3 fä         TM1x1, TM611 mit TMT162       siehe Kap. 1.2.2 (FY01102T)       SIL 3 fä <td></td> <td></td> <td>sic</td> <td>here</td> <td>Messung</td> <td>Die Chiefer</td> <td></td> <td>1</td> <td>14</td>  |                    |   | sic               | here        | Messung                   | Die Chiefer                |                              | 1         | 14          |
| Betriebsart       ☑ Low Demand Mode       ☑ High Demand       ☐ Continuous Mo         Sicherheitshandbuch       SD02427T, FY01102T, SD01172T, FY01105T, SD01632T, FY01106T         Art der Bewertung<br>(nur eine Variante wählbar)       ☑       Vollständige entwicklungsbegleitende HW/SW Bewertung inkl.<br>FMEDA und Änderungsprozess nach IEC 61508-2, 3         □       Bewertung über Nachweis der Betriebsbewährung HW/SW inkl. FMED/<br>und Änderungsprozess nach IEC 61508-2, 3       □         □       Auswertung von Felddaten HW/SW zum Nachweis "Frühere Verwendur<br>gem. IEC 61511       □         □       Bewertung durch FMEDA gem. IEC 61508-2, 3       □         0       Auswertung von Felddaten HW/SW zum Nachweis "Frühere Verwendur<br>gem. IEC 61511       □         0       Bewertung durch FMEDA gem. IEC 61508-2 für Geräte ohne Software<br>TM1162: Z10 012833 0008       □         Prüfungsunterlagen       Entwicklungsdokumente, Testreports, Datenblätter       SIL 2 fähig       □ SIL 2 fähig       □ SIL 3 fä         9       Systematische Sicherheitsintegrität       □       SIL 2 fähig       □ SIL 3 fä         Hardware Sicherheitsintegrität       □       SIL 2 fähig       □ SIL 2 fähig       □ SIL 3 fä         Hardware Sicherheitsintegrität       □       □       SIL 2 fähig       □ SIL 3 fä         Hardware Sicherheitsintegrität       □       □       SIL 2 fähig       □ SIL 3 fä   |                    |   |                   | Г Тур       | A                         | 🗖 Тур В                    |                              | -         | s.          |
| Art der Bewertung<br>(nur eine Variante wählbar)       Image: Constant of the second of th  | Betriebsart        |   |                   |             |                           | -                          |                              | Cor       | tinuous Mo  |
| Art der Bewertung<br>(nur eine Variante wählbar)       FMEDA und Änderungsprozess nach IEC 61508-2, 3         Bewertung über Nachweis der Ed fisbewährung HW/SW inkl. FMED.<br>und Änderungsprozess nach IEC 61508-2, 3       Image: State St                                 |                    | :h                                      | SD                | 024         | 27T, FY01102T, SD011      | 72T, FY011                 | 05T, SD01632T                | FY0110    | 6T          |
| Art der Bewertung<br>(nur eine Variante wählbar)       Image: Construction of the Constru |                    |   | 5                 | 7           |                           |                            |                              |           | inkl.       |
| Art der Bewertung<br>(nur eine Variante wählbar)       und Änderungsprozess nach IEC 61508-2, 3         Auswertung von Felddaten HW/SW zum Nachweis "Frühere Verwendung<br>gem. IEC 61511         Bewertung durch / Zertifikatsnummer       Imital Auswertung von Felddaten HW/SW zum Nachweis "Frühere Verwendung<br>gem. IEC 61511         Bewertung durch / Zertifikatsnummer       TM1x1/TM611: Z10 012833 0008<br>TMT82: Z10 012833 0004         Prüfungsunterlagen       Entwicklungsdokumente, Testreports, Datenblätter         SIL - Integrität       Imital Size Ziang Imital Size Z  |                    |   |                   |             | FMEDA und Anderung        | sprozess na                | ch IEC 61508-2,              | 3         | inkl EMED   |
| Image: IEC 61511       gem. IEC 61511       Bewertung durch FMEDA gem. IEC 61508-2 für Geräte ohne Software       TM1x1/TM611: Z10 012833 0008       TMT82: Z10 012833 0004       Prüfungsunterlagen       Entwicklungsdokumente, Testreports, Datenblätter       SIL - Integrität       Systematische Sicherheitsintegrität       Hardware Sicherheitsintegrität       Mehrkanaliger Einsatz (HFT = 0)       Mehrkanaliger Einsatz (HFT = 1)       SIL 2 fähig       Siehe Kap. 1.2.1 (FY01102T)       TM1x1, TM611 mit TMT62       siehe Kap. 1.2.2 (FY01102T)       Erklärung       Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden   | Art der Bewertung  |   |                   |             | und Änderungsprozess      | s nach IEC 6               | 1508-2, 3                    |           |             |
| □       Bewertung durch FMEDA gem. IEC 61508-2 für Geräte ohne Software         TM1x1/TM611: Z10 012833 0008       TMT82: Z10 012833 0005         Prüfungsunterlagen       Entwicklungsdokumente, Testreports, Datenblätter         SIL - Integrität       SIL 2 fähig       SIL 3 fä         Hardware Sicherheitsintegrität       Einkanaliger Einsatz (HFT = 0)       SIL 2 fähig       SIL 3 fä         Kennzahlen       Thermometer und Transmitter       SIL 2 fähig       SIL 3 fä         TM1x1, TM611 mit TMT82       siehe Kap. 1.2.1 (FY01102T)       SIL 2 fähig       SIL 3 fä         Erklärung       Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden       Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden  | (nur eine Variante | wählbar)                                |                   |             |                           | aten HW/S                  | W zum Nachweis               | "Früher   | e Verwendur |
| TM1x1/TM611: Z10 012833 0008         Bewertung durch / Zertifikatsnummer         TM1x1/TM611: Z10 012833 0005         TMT162: Z10 012833 0004         Prüfungsunterlagen         Entwicklungsdokumente, Testreports, Datenblätter         SIL - Integrität         Systematische Sicherheitsintegrität         Hardware Sicherheitsintegrität         Einkanaliger Einsatz (HFT = 0)         Ø SIL 2 fähig         Mehrkanaliger Einsatz (HFT ≥ 1)         SIL 2 fähig         Markanaliger Einsatz (HFT ≥ 1)         SIL 2 fähig         Markanaliger Einsatz (HFT ≥ 1)         Markanaliger Einsatz (HFT ≥ 1)         SIL 2 fähig         SIL 2 fähig  |                    |   |                   | -           |                           | DA com IE                  | C 61509-2 für G              | vräte ohr | a Software  |
| Bewertung durch / Zertifikatsnummer     TMT82: 210 012833 0005<br>TMT162: 210 012833 0004       Prüfungsunterlagen     Entwicklungsdokumente, Testreports, Datenblätter       SIL - Integrität     SIL 2 fähig       Systematische Sicherheitsintegrität     ISIL 2 fähig       Hardware Sicherheitsintegrität     Einkanaliger Einsatz (HFT = 0)       Mehrkanaliger Einsatz (HFT = 1)     ISIL 2 fähig       ISIL 2 fähig     ISIL 3 fä       Kennzahlen     Thermometer und Transmitter       TM1x1, TM611 mit TMT82     siehe Kap. 1.2.1 (FY01102T)       IM1x1, TM611 mit TMT162     siehe Kap. 1.2.2 (FY01102T)   |                    |   |                   |             |                           |                            | C 01508-2 Tul O              | ate off   | ie soltware |
| Prüfungsunterlagen     Entwicklungsdokumente, Testreports, Datenblätter       SIL - Integrität     Einkanaliger Einsatz     Image: Sill - 2 fähig     Image: Sill - 2 fähig       Systematische Sicherheitsintegrität     Einkanaliger Einsatz     (HFT = 0)     Image: Sill - 2 fähig     Image: Sill - 2 fähig       Hardware Sicherheitsintegrität     Einkanaliger Einsatz     (HFT = 0)     Image: Sill - 2 fähig     Image: Sill - 2 fähig       Kennzahlen     Thermometer und Transmitter     Sill - 2 fähig     Image: Sill - 2 fähig     Image: Sill - 2 fähig       TM1xl, TM611 mit TMT82     siehe Kap. 1.2.1 (FY01102T)     siehe Kap. 1.2.2 (FY01102T)     Image: Sill - 2 fähig     Image: Sill - 2 fähig       Erklärung     Unser firmeninternes Qualitätsm-agement stellt die Information von zukünftig bekanntwerdendendendendendendendendendendendendend   | Bewertung durch /  | Zertifikatsnummer                       | TA                | <b>NT82</b> | : Z10 012833 0005         | 0008                       | ,<br>,                       | 1         | ÷           |
| Systematische Sicherheitsintegrität     □ SIL 2 fähig     ☑ SIL 3 fälig       Hardware Sicherheitsintegrität     Einkanaliger Einsatz (HFT = 0)     ☑ SIL 2 fähig     □ SIL 3 fälig       Mehrkanaliger Einsatz (HFT = 1)     □ SIL 2 fähig     □ SIL 3 fälig     ☑ SIL 3 fälig       Kennzahlen     Thermometer und Transmitter       TM1x1, TM611 mit TMT82     siehe Kap. 1.2.1 (FY01102T)       TM1x1, TM611 mit TMT162     siehe Kap. 1.2.2 (FY01102T)   | Prüfungsunterlage  | n i i i i i i i i i i i i i i i i i i i | En                | itwic       | dungsdokumente, Testr     | eports, Dat                | enblätter                    |           |             |
| Hardware Sicherheitsintegrität       Einkanaliger Einsatz (HFT = 0)       ☑ SIL 2 fähig       □ SIL 3 fä         Mehrkanaliger Einsatz (HFT = 1)       □ SIL 2 fähig       ☑ SIL 3 fä         Kennzahlen       Thermometer und Transmitter         TM1x1, TM611 mit TMT82       siehe Kap. 1.2.1 (FV01102T)         TM1x1, TM611 mit TMT162       siehe Kap. 1.2.2 (FV01102T)         Erklärung       Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden  | SIL - Integrit     | tät                                     |                   |             |                           |                            | No. 1 State                  |           |             |
| Hardware Sicherheitsintegrität     Mehrkanaliger Einsatz (HFT ≥ 1)     □ SIL 2 fähig     ☑ SIL 3 fä       Kennzahlen     Thermometer und Transmitter       TM1x1, TM611 mit TMT82     siehe Kap. 1.2.1 (FY01102T)       TM1x1, TM611 mit TMT162     siehe Kap. 1.2.2 (FY01102T)   | Systematische Sich | erheitsintegrität                       |                   |             |                           |                            |                              |           | 🗹 SIL 3 fä  |
| Kennzahlen       Thermometer und Transmitter         TM1x1, TM611 mit TMT82       siehe Kap. 1.2.1 (FY01102T)         TM1x1, TM611 mit TMT162       siehe Kap. 1.2.2 (FY01102T)   | Hardware Sicherhe  | itsinteorität                           |                   | _           |                           |                            |                              |           |             |
| 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   |                    |   |                   |             |                           | and the state of the state | SIL 2 fähig                  |           | ☑ SIL 3 fä  |
| TM1x1, TM611 mit TMT162     siehe Kap. 1.2.2 (FY01102T)       Erklärung     Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden  |                    |   |                   |             |                           | mitter                     |                              |           |             |
| Erklärung Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden  |                    |   |                   |             |                           |                            |                              |           | 1           |
| Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden  | TM1x1, TM611 mi    | t TMT162                                | sie               | ehe K       | ap. 1.2.2 (FY01102T)      |                            |                              |           |             |
| Unser firmeninternes Qualitätsmanagement stellt die Information von zukünftig bekanntwerdenden sicherheitsrelevanten systematischen Fehlern sicher.   | Erklärung          |   |                   |             | 1 A 1                     |                            |                              |           |             |
| sicherheitsrelevanten systematischen Fehlern sicher.  | N                  | Unser firmeninterne                     | es Qualitätsmanag | jeme        | nt stellt die Information | ı von zukünt               | ftig bekanntwerd             | enden     |             |
|   |                    | sicherheitsrelevante                    | en systematischen | Fehl        | ern sicher.               |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            |                              |           |             |
|   |                    |   |                   |             |                           |                            | 147<br>197                   |           |             |

# 1.1 Safety-related characteristic values

2/3

A005782

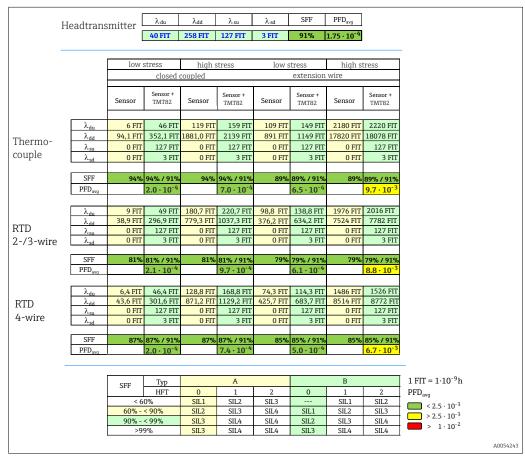
|                | 4 2<br>-                    |   | E                                       | Endress + Ha<br>People for Process /                          |                         |  |  |  |  |  |
|----------------|-----------------------------|---|---|---|-------------------------|--|--|--|--|--|
| General        |                             |   |   |   | Lan Hacher Con          |  |  |  |  |  |
| Device design  | ation and permissible types |   | 111, TM131, TM151,                      | TM611 (Order code for "A                                      | Additional approval": C |  |  |  |  |  |
| Safety-related | d output signal             |   | 'SIL")<br>20mA                          |   | 8                       |  |  |  |  |  |
| Fault current  | a output signal             |   | ,6 mA oder ≥ 21,0 mA                    |   |                         |  |  |  |  |  |
| Process varial | ble/function                |   | nperature, Voltage, Re                  |   |                         |  |  |  |  |  |
| Safety functio |                             |   | e measuring                             |   |                         |  |  |  |  |  |
|                | cc. to IEC 61508-2          |   | Type A                                  | Type B  |                         |  |  |  |  |  |
| Operating mo   |                             |   | Low Demand Mode                         | High Demand   | Continuous Mo           |  |  |  |  |  |
| Safety manua   |                             |   |   | D01172T, FY01105T, SD016                                      | 32T, FY01106T           |  |  |  |  |  |
|                | S & 3                       | Ø   | Complete HW/SW                          | evaluation parallel to develop                                | oment incl.             |  |  |  |  |  |
|                |                             |   |   | e request acc. to IEC 61508-2<br>en-in-use" performance for H |                         |  |  |  |  |  |
| Type of evalu  |                             |   | change request acc                      | to IEC 61508-2, 3   |                         |  |  |  |  |  |
| (check only o  |                             |   |   | SW field data to verify "prior u                              | use" acc. to            |  |  |  |  |  |
|                |                             |   |   |   | viene w/n n-ft          |  |  |  |  |  |
|                |                             |   | Evaluation by FMEI                      | DA acc. to IEC61508-2 for de                                  | wices w/o software      |  |  |  |  |  |
| Evaluation th  | rough / certificate no.     |   | 1×1/TM611: Z10 012<br>T82: Z10 012833 0 |   |                         |  |  |  |  |  |
|                |                             | TM  | T162: Z10 012833 00                     | 004   |                         |  |  |  |  |  |
| Test documer   |                             | dev   | elopment documents,                     | test reports, data sheets                                     |                         |  |  |  |  |  |
| SIL - Inte     |                             |   |   |   |                         |  |  |  |  |  |
| Systematic sa  | fety integrity              |   | ala abaanad                             | SIL 2 capa  |                         |  |  |  |  |  |
| Hardware saf   | ety integrity               |   | gle channel use (HFT)                   |   |                         |  |  |  |  |  |
| key figur      | ·ec                         |   | ermometer and T                         |   |                         |  |  |  |  |  |
|                | 11 with TMT82               | and the second se | see Chapter 1.2.1 (FY01102T)            |   |                         |  |  |  |  |  |
|                |                             |   | see Chapter 1.2.2 (FY01102T)            |   |                         |  |  |  |  |  |
| TM1x1, TM6     |                             | see   | chapter 1.2.2 (1 1011                   |   |                         |  |  |  |  |  |
|                |                             | see   | chapter 1.2.2 (11011                    |   |                         |  |  |  |  |  |
| Declarat       | ion                         | ÷ .   |   | 8   | retornatic faulte which |  |  |  |  |  |
|                | ion                         | uality manageme   |   | ormation on safety-related sy                                 | rstematic faults which  |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | vstematic faults which  |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | vstematic faults which  |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | rstematic faults which  |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | rstematic faults which  |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | stematic faults which   |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | rstematic faults which  |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | stematic faults which   |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | stematic faults which   |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | stematic faults which   |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | stematic faults which   |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   |                         |  |  |  |  |  |
| Declarat       | Our internal company o      | uality manageme   |   | 8   | rstematic faults which  |  |  |  |  |  |

## 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



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

| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  |              | Headtrans          | smitter               | $\lambda_{du}$              | $\lambda_{dd}$       | $\lambda_{su}$            | $\lambda_{sd}$       | SFF                    | PFD <sub>avg</sub>        | ļ                    |  |
|--|--------------|--------------------|-----------------------|-----------------------------|----------------------|---------------------------|----------------------|------------------------|---------------------------|----------------------|--|
|  |              | incuation          | JIIIICICI             | 40 FIT                      | 258 FIT              | 127 FIT                   | 3 FIT                | 91%                    | $1.75 \cdot 10^{-4}$      | 1                    |  |
| $\frac{1}{2x \text{ Sensor}} = \frac{1}{2x \text{ Sensor}} + \frac{1}{2x \text{ Sensor}} $   |              |                    |                       |                             |                      |                           |                      |                        |                           | •                    | _  |
| $\frac{1}{2x Sensor} = \frac{1}{2x Sensor} + \frac{1}{2x Sensor} = \frac{1}{2x Sensor} + \frac{1}{2x Se$   |              |                    |                       |                             |                      |                           |                      |                        | 1                         |                      |  |
| Thermo-<br>touple $\frac{\lambda_{da}}{\lambda_{da}} = 10.7 \text{ FT} \frac{2x \text{ Sensor}^2}{1 \text{ MTB2}^2} \frac{2x \text{ Sensor}^2}{2x \text{ Sensor}^2} \frac{2x \text{ Sensor}^2}{1 \text{ MTB2}^2} \frac{2x \text{ Sensor}^2}{1 \text{ Sensor}^2} \frac{2x \text{ Sensor}^2}{1 \text{ Sensor}^$   |              |                    | low                   |                             |                      | stress                    | low                  |                        |                           | stress               |  |
| $\frac{2x  Sensor}{harrow} \frac{2x  Sensor}{harrow} \frac{2x  Sensor}{harrow} \frac{2x  Sensor}{harrow} \frac{1}{100  FT} \frac{2x  Sensor}{2x  Sensor} \frac{1}{100  FT} \frac{1}{10$  |              |                    |                       | closed                      | coupled              |                           |                      | extension              | 1 wire                    |                      |  |
| $\frac{2x  Sensor}{harrow} \frac{2x  Sensor}{harrow} \frac{2x  Sensor}{harrow} \frac{2x  Sensor}{harrow} \frac{1}{100  FT} \frac{2x  Sensor}{2x  Sensor} \frac{1}{100  FT} \frac{1}{10$  |              |                    |                       | 0.0                         |                      |                           |                      |                        |                           |                      |  |
| Thermo-<br>touple $\frac{\lambda_{du}}{\lambda_{dd}} = \frac{10, 7 \text{ FT}}{50,7 \text{ FT}} = \frac{50,7 \text{ FT}}{50,7 \text{ FT}} = \frac{70 \text{ FT}}{110 \text{ FT}} = \frac{158 \text{ FT}}{158 \text{ FT}} = \frac{196 \text{ FT}}{3160 \text{ FT}} = \frac{3200 \text{ FT}}{3209 \text{ FT}}$ $\frac{\lambda_{du}}{\lambda_{dd}} = \frac{10,7 \text{ FT}}{127 \text{ FT}} = \frac{50,7 \text{ FT}}{127 \text{ FT}} = \frac{70 \text{ FT}}{127 \text{ FT}} = \frac{100 \text{ FT}}{127 \text{ FT}} = \frac{100 \text{ FT}}{3680 \text{ FT}} = \frac{3200 \text{ FT}}{3209 \text{ FT}}$ $\frac{\lambda_{du}}{\lambda_{dd}} = 0 \text{ FT} = 127 \text{ FT}} = 0 \text{ FT} = 127 \text{ FT}} = 0 \text{ FT} = 127 \text{ FT}} = 0 \text{ FT}} = 320 \text{ FT}} = \frac{127 \text{ FT}}{127 \text{ FT}} = 0 \text{ FT}} = 320 \text{ FT}} = \frac{127 \text{ FT}}{127 \text{ FT}} = 0 \text{ FT}} = 320 \text{ FT}} = 320 \text{ FT}}$ $\frac{57 \text{ F}}{95\%} = 95\% + 95\% + 91\% = 98\% + 98\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 92\% + 91\% = 92\% + 91\% + 92\% + 92\% + 92\% + 92\% + 92\% + 91\% + 92\% +$  |              |                    | 2x Sensor             |                             | 2x Sensor            |                           | 2x Sensor            |                        | 2x Sensor                 |                      |  |
| Thermo-<br>bouple $\lambda_{dd}$ 189,3 FTT 447,3 FT 3786 FT 4044 FT 1842 FT 2100 FT 36840 FT 37098 FT<br>$\lambda_{sg}$ 0 FT 127 FT 0 FT 127 FT 0 FT 127 FT 0 FT 127 FT<br>0 FT 3 FT 0 FT 3 FT<br>0 FT 3 FT 0 FT 122 FT 1712 FT<br>$\lambda_{sd}$ 0 FT 127 FT 47,7 FT 154 FT 194 FT 83,6 FT 123,6 FT 1672 FT 1712 FT 17586 FT 124,4 FT 17328 FT 17586 FT 127 FT 0 FT 3 FT 0 FT 127 FT 0 FT 1 3 FT 0 FT 3 FT 0 FT 127 FT 0 FT 1 3 FT 0 FT 3 FT 0 FT 3 FT 0 FT 3 FT 0 FT 127 FT 0 FT 1   |              |                    |                       |                             |                      | INTIOL                    |                      |                        |                           | IIIIOL               |  |
| Thermo-<br>bouple $\lambda_{dd}$ 189,3 FTT 447,3 FT 3786 FT 4044 FT 1842 FT 2100 FT 36840 FT 37098 FT<br>$\lambda_{sg}$ 0 FT 127 FT 0 FT 127 FT 0 FT 127 FT 0 FT 127 FT<br>0 FT 3 FT 0 FT 127 FT 123,6 FT 123,6 FT 123,6 FT 122,6 FT 122   |              | $\lambda_{du}$     | 10,7 FIT              | 50,7 FIT                    | 70 FIT               | 110 FIT                   | 158 FIT              | 198 FIT                | 3160 FIT                  | 3200 FIT             |  |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  | 'le e 1100 c |                    |                       |                             |                      |                           |                      |                        |                           |                      |  |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  |              |                    |                       |                             |                      |                           |                      |                        |                           |                      |  |
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$  | ouple        |                    |                       |                             |                      |                           |                      |                        | 1                         |                      |  |
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$  |              |                    |                       |                             |                      |                           |                      |                        |                           |                      |  |
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$  |              | SFF                | 95%                   | 95% / 91%                   | 98%                  | 98% / 91%                 | 92%                  |                        | 92%                       | 92% / 91%            |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              | PFD <sub>avg</sub> |                       | $2.2 \cdot 10^{-4}$         |                      | $4.8 \cdot 10^{-4}$       |                      | 8.7 · 10 <sup>-4</sup> |                           | $1.4 \cdot 10^{-2}$  |  |
| $\begin{array}{c ccccccccccccccccccccccccccccccccccc$  |              |                    |                       |                             |                      |                           |                      |                        |                           |                      |  |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  |              |                    | 7,7 FIT               |                             | 154 FIT              | 194 FIT                   | ,                    |                        |                           |                      |  |
| $\frac{\lambda_{su}}{\lambda_{sd}} = \frac{0.011}{0.011} \frac{127.011}{127.01} \frac{0.011}{0.011} \frac{127.011}{127.011} \frac{0.011}{0.011} \frac{127.011}{127.011} \frac{0.011}{0.011} \frac{127.011}{127.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{127.010}{0.011} \frac{0.011}{0.011} \frac{127.010}{0.011} \frac{0.011}{0.011} \frac{127.011}{0.011} \frac{0.011}{0.011} \frac{0.011}{0.01$   | TD           |                    |                       |                             |                      |                           |                      |                        |                           |                      |  |
| $\frac{\lambda_{sd}}{SFF} = \frac{92\%}{92\%} / \frac{91\%}{91\%} = \frac{92\%}{92\%} / \frac{91\%}{91\%} = \frac{92\%}{91\%} / \frac{91\%}{91\%} / \frac{91\%}{91\%} / \frac{91\%}{91\%} = \frac{91\%}{91\%} / \frac{91\%}{91\%} / \frac{91\%}{91\%} / \frac{91\%}{91\%} = \frac{91\%}{91\%} / \frac{91\%}{91\%} / \frac{91\%}{91\%} = \frac{92\%}{92\%} / \frac{91\%}{91\%} = \frac{100\%}{91\%} = \frac{100\%}{90\%} = \frac{100\%}{90\%} = \frac{100\%}{91\%} = \frac{100\%}{91\%} = \frac{100\%}{90\%} = \frac{10\%}{90\%} = $                       |              |                    | 0 FIT                 | 127 FIT                     | 0 FIT                | 127 FIT                   | 0 FIT                | 127 FIT                | 0 FIT                     | 127 FIT              |  |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  | -/3-wire     | $\lambda_{sd}$     | 0 FIT                 | 3 FIT                       | 0 FIT                | 3 FIT                     | 0 FIT                | 3 FIT                  | 0 FIT                     | 3 FIT                |  |
| $ \begin{array}{c c c c c c c c c c c c c c c c c c c $  |              | CEE                | 0.5.51                | 000/ / 0500                 | 0.555                | 0000 10000                | 0.555                | 010/ / 055             | 0.55                      | 010/ / 010/          |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              |                    | 92%                   |                             | 92%                  |                           | 91%                  |                        | 91%                       |                      |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              | FFD <sub>avg</sub> |                       | 2.1 • 10                    |                      | 8.2 · 10 ·                |                      | 5.4 · 10 *             |                           | 7.5 • 10 -           |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              | λdu                | 9,2 FIT               | 49,2 FIT                    | 184 FIT              | 224 FIT                   | 120,8 FIT            | 160,8 FIT              | 2416 FIT                  | 2456 FIT             |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              | $\lambda_{dd}$     | 138,7 FIT             | 396,7 FIT                   | 2776 FIT             |                           |                      |                        | 27084 FIT                 | 27342 FIT            |  |
| $\frac{SFF}{PFD_{avg}} = \frac{1}{2.2 \cdot 10^{-4}} = \frac{94\%}{94\%} = \frac{94\%}{94\%} = \frac{92\%}{92\%} = $ | :-/3-wire    |                    |                       |                             |                      |                           |                      |                        |                           |                      |  |
| $\begin{array}{ c c c c c c c c c c c c c c c c c c c$   | - TC         | $\lambda_{sd}$     | 0 FIT                 | 3 FIT                       | 0 FIT                | 3 FIT                     | 0 FIT                | 3 FIT                  | 0 FIT                     | 3 FIT                |  |
| $\begin{array}{ c c c c c c c c c c c c c c c c c c c$   |              | CEE                | 0/9/                  | 0494 4 0194                 | 0/9/                 | 0494 40394                | 029/                 | 029/ / 019/            | 0.201                     | 0.2% / 0.1%          |  |
| $\begin{array}{ c c c c c c c c c c c c c c c c c c c$   |              |                    | 94%                   |                             | 94%                  |                           | 92%                  |                        | 92%                       |                      |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              |                    |                       | 2.2.10                      | L                    | 2.0.10                    |                      | 7.0.10                 |                           | 11 10                |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              | PFD <sub>avg</sub> |                       |                             |                      |                           |                      |                        |                           |                      | _  |
| $ \begin{array}{ c c c c c c c c c c c c c c c c c c c$  |              | PFD <sub>avg</sub> |                       |                             |                      |                           |                      |                        |                           |                      |  |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              | PrD <sub>avg</sub> | SFF                   | Тур                         |                      | А                         | -                    |                        | В                         |                      | $1 \text{ FIT} = 1 \cdot 10^{-9} \text{ h}$            |
| $\begin{array}{c c c c c c c c c c c c c c c c c c c $   |              | PFD <sub>avg</sub> |                       | HFT                         |                      | 1                         |                      | -                      | 1                         |                      |  |
| > 1.10-2   |              |                    | < 6                   | HFT<br>0%                   | SIL1                 | 1<br>SIL2                 | SIL3                 |                        | 1<br>SIL1                 | SIL2                 | PFD <sub>avg</sub>                                     |
|  |              |                    | < 6<br>60% -          | HFT<br>0%<br>< 90%          | SIL1<br>SIL2         | 1<br>SIL2<br>SIL3         | SIL3<br>SIL4         | <br>SIL1               | 1<br>SIL1<br>SIL2         | SIL2<br>SIL3         | $PFD_{avg}$ < 2.5 · 10 <sup>-3</sup>                   |
|  |              | PrD <sub>avq</sub> | < 6<br>60% -<br>90% - | HFT<br>0%<br>< 90%<br>< 99% | SIL1<br>SIL2<br>SIL3 | 1<br>SIL2<br>SIL3<br>SIL4 | SIL3<br>SIL4<br>SIL4 | SIL1<br>SIL2           | 1<br>SIL1<br>SIL2<br>SIL3 | SIL2<br>SIL3<br>SIL4 | $PFD_{avg} < 2.5 \cdot 10^{-3} \\ > 2.5 \cdot 10^{-3}$ |

#### Two channel operation

#### 1.2.2 Code numbers iTHERM TM1x1 and iTHERM TM611 with iTEMP TMT162

|            |                                  | L               | $\lambda_{du}$                | $\lambda_{dd}$      | $\lambda_{su}$         | $\lambda_{sd}$ | SFF                    | PFD <sub>avg</sub>  |                        |   |
|------------|----------------------------------|-----------------|-------------------------------|---------------------|------------------------|----------------|------------------------|---------------------|------------------------|---|
| ransmitter |                                  | [               | 29 FIT                        | 269 FIT             | 139 FIT                | 0 FIT          | 93%                    | $1.3 \cdot 10^{-4}$ |                        |   |
| —          |                                  |                 |                               |                     |                        |                |                        |                     |                        |   |
|            |                                  | low :           | stress                        | high s              | stress                 | low s          | stress                 | high st             | tress                  |   |
|            |                                  | <u> </u>        | closed c                      | oupled              |                        |                | extension              | wire                |                        |   |
|            |                                  |                 | Sensor                        |                     | Sensor                 |                | Sensor                 |                     | Sensor                 |   |
|            |                                  | Sensor          | + TMT162                      | Sensor              | + TMT162               | Sensor         | + TMT162               | Sensor              | + TMT162               |   |
|            | <u></u>                          | ( FIT           | 35 FIT                        | 119 FIT             | 148 FIT                | 109 FIT        | 138 FIT                | 2180 FIT            | 2209 FIT               |   |
| Thermo-    | $\lambda_{du}$<br>$\lambda_{dd}$ | 6 FIT<br>94 FIT | 363 FIT                       | 119 FIT<br>1881 FIT | 2150 FIT               | 891 FIT        |                        | 17820 FIT           |                        |   |
| couple     | $\lambda_{su}$                   | 94 FI1<br>0 FIT | 139 FIT                       | 0 FIT               | 139 FIT                | 0 FIT          | 139 FIT                | 0 FIT               | 139 FIT                |   |
|            | $\lambda_{sd}$                   | 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 <sub>avg</sub>               | ļ               | 1.5 · 10 <sup>-4</sup>        |                     | 6.5 · 10 <sup>-4</sup> |                | 6.1 · 10 <sup>-4</sup> |                     | $9.7 \cdot 10^{-3}$    |   |
|            | $\lambda_{du}$                   | 9 FIT           | 38 FIT                        | 181 FIT             | 210 FIT                | 99 FIT         | 128 FIT                | 1976 FIT            | 2005 FIT               |   |
|            | λ <sub>dd</sub>                  | 39 FIT          | 308 FIT                       | 779 FIT             | 1048 FIT               | 376 FIT        | 645 FIT                | 7524 FIT            | 7793 FIT               |   |
| RTD        | $\lambda_{su}$                   | 0 FIT           | 139 FIT                       | 0 FIT               | 139 FIT                | 0 FIT          | 139 FIT                | 0 FIT               | 139 FIT                |   |
| 2-/3-wire  | $\lambda_{sd}$                   | 0 FIT           | 0 FIT                         | 0 FIT               | 0 FIT                  | 0 FIT          | 0 FIT                  | 0 FIT               | 0 FIT                  |   |
|            | SFF                              | 040/            | 81% / 93%                     | 010/                | 81% / 93%              | 70%            | 79% / 93%              | 79%                 | 79% / 93%              |   |
|            | PFD                              | 01%             | 1.7 · 10 <sup>-4</sup>        | 0176                | 9.2 · 10 <sup>-4</sup> | 1970           | 5.6 · 10 <sup>-4</sup> | 1976                | 8.8 · 10 <sup>-3</sup> |   |
|            | avy                              |                 |                               |                     |                        | I              | 0.0 .0                 |                     | 0.0 10                 |   |
|            | $\lambda_{du}$                   | 6 FIT           |                               | 129 FIT             | 158 FIT                | 74 FIT         |                        |                     |                        |   |
| RTD        | $\lambda_{dd}$                   | 44 FIT          | 313 FIT                       | 871 FIT             | 1140 FIT               | 426 FIT        | 695 FIT                |                     | 8783 FIT               |   |
| 4-wire     | $\lambda_{su}$<br>$\lambda_{sd}$ | 0 FIT<br>0 FIT  | 139 FIT<br>0 FIT              | 0 FIT<br>0 FIT      | 139 FIT<br>0 FIT       | 0 FIT<br>0 FIT | 139 FIT<br>0 FIT       |                     | 139 FIT<br>0 FIT       |   |
|            |                                  |                 |                               |                     |                        |                |                        |                     |                        |   |
|            | SFF                              | 87%             | 87% / 93%                     | 87%                 | 87% / 93%              |                | 85% / 93%              |                     | 85% / 93%              |   |
|            | PFD <sub>avg</sub>               |                 | <b>1.6 · 10</b> <sup>-4</sup> |                     | 6.9 · 10 <sup>-4</sup> |                | $4.5 \cdot 10^{-4}$    |                     | 6.6 · 10 <sup>-3</sup> |   |
| -          |                                  |                 |                               |                     |                        |                |                        |                     |                        | _   |
|            |                                  | SFF             | Тур                           |                     | А                      |                |                        | В                   |                        | $1 \text{ FIT} = 1 \cdot 10^{-9} \text{ h}$ |
|            |                                  |                 | HFT                           | 0                   | 1                      | 2              | 0                      | 1                   | 2                      | PFD <sub>avg</sub>                          |
|            |                                  | < 6<br>60% -    | 0%<br>< 90%                   | SIL1<br>SIL2        | SIL2<br>SIL3           | SIL3<br>SIL4   | SIL1                   | SIL1<br>SIL2        | SIL2<br>SIL3           | < 2.5 · 10 <sup>-3</sup>                    |
|            |                                  | 90% -           |                               | SIL2                | SIL4                   | SIL4           | SIL1                   | SIL2<br>SIL3        | SIL4                   | > 2.5 · 10 <sup>-3</sup>                    |
|            |                                  |                 | 9%                            | SIL3                | SIL4                   | SIL4           | SIL3                   | SIL4                | SIL4                   | > 1.10-2                                    |

Single channel operation



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

|             |                                  |                  | $\lambda_{du}$         | $\lambda_{dd}$    | $\lambda_{su}$         | $\lambda_{sd}$      | SFF                    | PFD <sub>avg</sub>     |                        |   |     |
|-------------|----------------------------------|------------------|------------------------|-------------------|------------------------|---------------------|------------------------|------------------------|------------------------|---|-----|
| Fransmitter |                                  |                  | 29 FIT                 | 269 FIT           | 139 FIT                | 0 FIT               | 93%                    | 1.3 · 10 <sup>-4</sup> |                        |   |     |
| -           |                                  |                  |                        |                   |                        |                     |                        |                        |                        | _   |     |
|             |                                  | low              | stress<br>closed       | hiqh :<br>coupled | stress                 | low                 | stress<br>extensior    | hiqh s<br>1 wire       | tress                  |   |     |
|             |                                  | 2 x Sensor       | 2 x Sensor<br>+ TMT162 | 2 x Sensor        | 2 x Sensor<br>+ TMT162 | 2 x Sensor          | 2 x Sensor<br>+ TMT162 | 2 x Sensor             | 2 x Sensor<br>+ TMT162 |   |     |
|             | $\lambda_{du}$                   | 11 FIT           | 40 FIT                 | 70 FIT            | 99 FIT                 | 158 FIT             | 187 FIT                | 3160 FIT               | 3189 FIT               |   |     |
|             | $\lambda_{dd}$                   | 189 FIT          | 458 FIT                | 3786 FIT          | 4055 FIT               | 1842 FIT            |                        | 36840 FIT              | 37109 FIT              |   |     |
| Thermo-     | λ <sub>su</sub>                  | 0 FIT            | 139 FIT                | 0 FIT             | 139 FIT                | 0 FIT               | 139 FIT                | 0 FIT                  | 139 FIT                |   |     |
| couple      | $\lambda_{sd}$                   | 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 <sub>avg</sub>               |                  | $1.7 \cdot 10^{-4}$    |                   | $4.3 \cdot 10^{-4}$    |                     | 8.2 · 10 <sup>-4</sup> |                        | $1.4 \cdot 10^{-2}$    |   |     |
|             |                                  |                  |                        |                   |                        |                     |                        |                        |                        |   |     |
|             | $\lambda_{du}$                   | 8 FIT            | 37 FIT                 | 154 FIT           | 183 FIT                | 84 FIT              | 113 FIT                | 1672 FIT               | 1701 FIT               |   |     |
| RTD         | $\lambda_{dd}$                   | 88 FIT           | 357 FIT                | 1766 FIT          | 2035 FIT               | 866 FIT             | 1135 FIT               | 17328 FIT              | 17597 FIT              |   |     |
|             | $\lambda_{su}$                   | 0 FIT            | 139 FIT                | 0 FIT             | 139 FIT                | 0 FIT               | 139 FIT                | 0 FIT                  | 139 FIT                |   |     |
| 2-/3-wire   | $\lambda_{sd}$                   | 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 <sub>avg</sub>               |                  | 1.6 · 10 <sup>-4</sup> |                   | 1.3 · 10 <sup>-4</sup> |                     | $7.4 \cdot 10^{-4}$    |                        | 7.5 · 10 <sup>-3</sup> |   |     |
|             | <u> </u>                         | 9 FIT            | 38 FIT                 | 184 FIT           | 213 FIT                | 121 FIT             | 150 FIT                | 0/1/ PIT               | 2445 FIT               |   |     |
| RTD         | $\lambda_{du}$<br>$\lambda_{dd}$ | 9 FI1<br>139 FIT | 408 FIT                | 2776 FIT          | 3045 FIT               | 121 FI1<br>1354 FIT | 1623 FIT               | 2416 FIT<br>27084 FIT  | 27353 FIT              |   |     |
| 2-/3-wire   | $\lambda_{su}$                   | 0 FIT            | 139 FIT                | 0 FIT             | 139 FIT                | 0 FIT               | 139 FIT                | 0 FIT                  | 139 FIT                |   |     |
| + TC        | $\lambda_{sd}$                   | 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 <sub>avg</sub>               |                  | 1.7 · 10 <sup>-4</sup> |                   | 9.3 · 10 <sup>-4</sup> |                     | 6.6 · 10 <sup>-4</sup> |                        | 1.1 · 10 <sup>-2</sup> |   |     |
| -           |                                  |                  |                        |                   |                        |                     |                        |                        |                        | _   |     |
|             |                                  | SFF              | Тур                    |                   | А                      |                     |                        | В                      |                        | $1 \text{ FIT} = 1 \cdot 10^{-9} \text{ h}$ |     |
|             |                                  |                  | HFT                    | 0                 | 1                      | 2                   | 0                      | 1                      | 2                      | PFD <sub>avg</sub>                          |     |
|             |                                  | < 6              |                        | SIL1<br>SIL2      | SIL2<br>SIL3           | SIL3<br>SIL4        | SIL1                   | SIL1<br>SIL2           | SIL2<br>SIL3           | < 2.5 · 10 <sup>-3</sup>                    |     |
|             |                                  | 90% -            |                        | SIL2<br>SIL3      | SIL3<br>SIL4           | SIL4<br>SIL4        | SIL1<br>SIL2           | SILZ<br>SIL3           | SIL3<br>SIL4           | > 2.5 · 10 <sup>-3</sup>                    |     |
|             |                                  | >9               |                        | SIL3              | SIL4<br>SIL4           | SIL4<br>SIL4        | SIL2                   | SIL4                   | SIL4<br>SIL4           | > 1.10-2                                    |     |
|             |                                  |                  |                        |                   |                        |                     |                        |                        |                        |   | A00 |

Two channel operation

## 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.

#### **A**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)**

#### **Reference document**

These Operating Instructions contain all the information that is required in the various life cycle phases of the device: from product identification, incoming acceptance and storage, to installation, 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.

i

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 (I Section 2.3) or can be found in the Declaration of Conformity (I 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-   |
|--|--|
| <b>Code: 010 "Approval"</b>                                  | Code: 010 "Approval"   |
| Version: all   | Version: all   |
| Code: 020 "Thermowell"                                       | Code: 020 "Thermowell"                                       |
| Version: all   | Version: all   |
| <b>Code: 030 "Thermometer Design"</b>                        | <b>Code: 030 "Thermometer Design"</b>                        |
| Version: all   | Version: all   |
| <b>Code: 050 "Process Connection; Material"</b>              | <b>Code: 040 "Thermowell Material"</b>                       |
| Version: all   | Version: all   |
| <b>Code: 060 "Thermowell Diameter; Material"</b>             | Code: 050 "Process/Thermowell Connection"                    |
| Version: all   | Version: all   |
| <b>Code: 070 "Tip Shape"</b>                                 | Code: 060 "Immersion Length U"                               |
| Version: all   | Version: all   |
| <b>Code: 080 "Immersion Length U"</b>                        | Code: 070 "Geometry Wetted Parts"                            |
| Version: all   | Version: all   |
| <b>Code: 090 "Removable Neck Length E"</b>                   | Code: 080 "Lagging Length T"                                 |
| Version: all   | Version: all   |
| <b>Code: 100 "Lagging Length T"</b>                          | <b>Code: 090 "Removable Neck Length E"</b>                   |
| Version: all   | Version: all   |
| <b>Code: 110 "Sensor Type; Measuring Range; Material"</b>    | <b>Code: 100 "Sensor Type; Measuring Range; Material"</b>    |
| Version: all except Y  | Version: all except Y  |
| <b>Code: 130 "Sensor Standard; Classification"</b>           | Code: 110 "Sensor Standard; Classification"                  |
| Version: all   | Version: all   |
| <b>Code: 140 "Electrical Connection"</b>                     | Code: 120 "Electrical Connection"                            |
| Version: only 2E, 2G, 3D, 3F, 3I                             | Version: only 2E, 2G, 3D, 3F, 3I                             |
| <b>Code: 150 "Terminal Head; Material; Protection Class"</b> | <b>Code: 130 "Terminal Head; Material; Protection Class"</b> |
| Version: all   | Version: all   |
| <b>Code: 170 "Cable Entry Terminal Head"</b>                 | <b>Code: 140 "Cable Entry Terminal Head"</b>                 |
| Version: all   | Version: all   |
| <b>Code: 480 "Device Model"</b>                              | <b>Code: 480 "Device Model"</b>                              |
| Version: all   | Version: all   |
| <b>Code: 560 "Second Transmitter (Mounted)"</b>              | Code: 500 "Additional Design Options"                        |
| Version: only GF   | Version: all   |
| <b>Code: 570 "Service"</b>                                   | Code: 520 "Special Root Diameter D1"                         |
| Version: all   | Version: all   |
| <b>Code: 580 "Test, Certificate, Declaration"</b>            | <b>Code: 530 "Special Tip Diameter D2"</b>                   |
| Version: all   | Version: all   |
| <b>Code: 590 "Additional Approval"</b>                       | <b>Code: 540 "Special Bore Diameter Di"</b>                  |
| Version: Option LA must be selected                          | Version: all   |
| <b>Code: 600 "Additional Option"</b>                         | <b>Code: 545 "Special Tip Thickness B"</b>                   |
| Version: all   | Version: all   |
| Code: 610 "Accessory Mounted"                                | Code: 550 "Thermometer Connection Ge1"                       |
| Version: all   | Version: all   |
| <b>Code: 630 "Calibration Thermometer"</b>                   | <b>Code: 560 "Second Transmitter (Mounted)"</b>              |
| Version: all   | Version: only GF   |
| Code: 640 "Calibration Points >= 0 oC"                       | <b>Code: 570 "Service"</b>                                   |
| Version: all   | Version: all   |
| Code: 650 "Calibration Points <= 0 oC"                       | <b>Code: 580 "Test, Certificate, Declaration"</b>            |
| Version: all   | Version: all   |
| <b>Code: 850 "Firmware Version"</b>                          | <b>Code: 590 "Additional Approval"</b>                       |
| Version: none  | Version: Option LA must be selected                          |
| <b>Code: 895 "Marking"</b>                                   | <b>Code: 600 "Additional Option"</b>                         |
| Version: all   | Version: all   |
|  | Code: 610 "Accessory Mounted"<br>Version: all                |

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

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

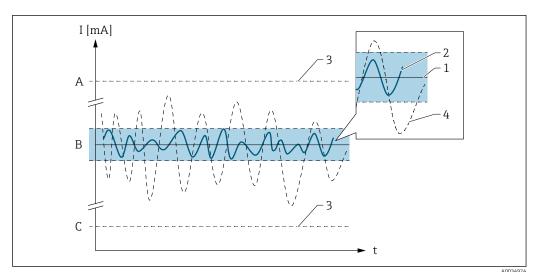
#### 3.3.2 Safe measurement

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  $\rightarrow \cong 24$ . 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  $\geq 21$  mA
- B SIL error range ±2%
- C LO alarm  $\leq 3.6$  mA

#### No device error

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

#### $\lambda_S$ (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

#### $\lambda_{DD}$ (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

#### $\lambda_{DU}$ (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:

P 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 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  $(\geq \pm 1 \%)$ . For this reason, filtering with a time constant of  $\geq 1$  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  $\rightarrow \square$  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.

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.

#### Measurement error:



The measurement errors specified for the different sensor types must be observed.

Deviations due to EMC interference are not taken into account. In the event of nonnegligible EMC interference, an additional deviation of 1 % from the span must be added to the values above.



## **Detailed information:**

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

#### **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

#### 3.5 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".

## 3.6 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 (1112 °F)             | -                      | 2 years      |
| 800 °C (1472 °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.

#### A 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:

- $I \le 3.6 \text{ mA}$  (low alarm)
- or
- $I \ge 21.5 \text{ mA}$  (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  $\leq$  3.6 mA or  $\geq$  21 mA. In some cases, output currents of  $\leq$  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  $\ge 21 \text{ mA}$  cannot be set

In some other cases, (e.g. cabling short circuit), output currents  $\geq$  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.

### **A**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<sub>avq</sub> 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 M $\Omega$ .

#### 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 ( $\lambda_{\text{DII}}$ ).
- 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



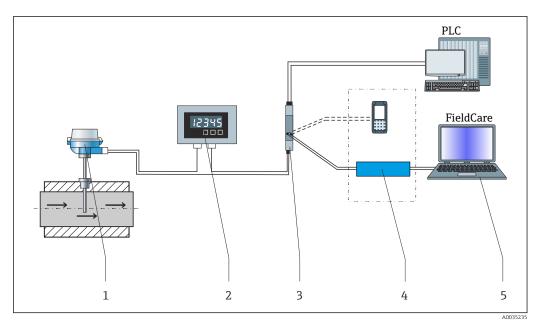
If required by the Directive 2012/19/EU on waste electrical and electronic equipment (WEEE), the product is marked with the depicted symbol in order to minimize the disposal of WEEE as unsorted municipal waste. Do not dispose of products bearing this marking as unsorted municipal waste. Instead, return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



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<sup>®</sup> 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<sub>DC</sub> 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<sup>®</sup> Communicator (handheld device), FieldXpert, Commubox FXA195 for intrinsically safe HART<sup>®</sup> 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 ( $\geq$ 21 mA) and LO alarms ( $\leq$ 3.6 mA).

#### NOTICE

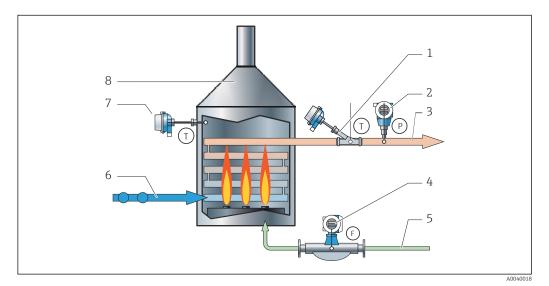
The optional display is not part of the safety function. Neither the hardware nor the software of the display has any influence on the defined safety functions of the transmitter.

#### 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  $\Omega$  at 0 °C (32 °F) and a temperature coefficient  $\alpha$  =0.003851 °C<sup>-1</sup>.

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.



- 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

 $\hfill\square$  Device parameter configuration via SIL mode activation (SiMA)

 $\hfill\square$  Commissioning check, test sequence A

 $\hfill\square$  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<br>□ Failed<br>□ Not applicable                                 |
| 2 Insert  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 3 Thermometer thermowell  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 4 Lower range value adjustment, sensor 1  |              |              | □ Passed<br>□ Failed   |
| 5 Upper range value adjustment, sensor 1  |              |              | □ Passed<br>□ Failed   |
| 6 Lower range value adjustment, sensor 2  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 7 Upper range value adjustment, sensor 2  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 8 Current value alarm   |              |              | □ Passed<br>□ Failed   |
| 9 Restart via HART  |              |              | □ Passed<br>□ Failed<br>□ Not applicable                                 |
| 10<br>• TMT82: Restart via plug-in display<br>• TMT162: Restart via proof test button |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |

## 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<br>□ Failed   |
| 2 Upper range value adjustment, sensor 1  |              |              | □ Passed<br>□ Failed   |
| 3 Lower range value adjustment, sensor 2  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 4 Upper range value adjustment, sensor 2  |              |              | □ Passed<br>□ Failed<br>□ Not applicable                                 |
| 5 Two-channel function, sensor drift  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 6 Two-channel function, backup  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 7 Channel assignment, current output  |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 8 Out of range category   |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 9 RJ / preset value   |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |
| 10 Current value alarm  |              |              | □ Passed<br>□ Failed   |
| 11 Restart via HART   |              |              | □ Passed<br>□ Failed<br>□ Not applicable                                 |
| <ul><li>12</li><li>TMT82: Restart via plug-in display</li><li>TMT162. Restart via proof-test button</li></ul> |              |              | <ul> <li>□ Passed</li> <li>□ Failed</li> <li>□ Not applicable</li> </ul> |

| 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<br>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)                            |           |         |
|                               |  |           |         |

# 8.2.4 Parameter settings for the SIL mode



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