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# DECLARATION OF CONFORMITY
## Konformitätserklärung
## Déclaration de Conformité
## Försäkran om Överensstämmelse

SIL 2

**INOR Process AB, P.O. Box 9125, SE-20039 Malmö, SWEDEN**

declares in sole responsibility, that the product
erklärt in alleinger Verantwortung, dass das Produkt
déclare sous sa seule responsabilité que le produit
försäkrar härmed, att produkten

| | |
|---|---|
| **2-Wire Temperature Transmitters** | **IPAQ C520S and IPAQ R520S**<br>Including the following options:<br>Einschliesslich der Optionen:<br>Incluant en option:<br>Inklusive följande optioner:<br>C520XS and R520XS (X = Ex-approved version) |

is suitable for the use in a safety-related application up to SIL 2 according to IEC 61508:2010 provided that the safety instructions are observed (see Safety Manual). *A consideration according to SIL 3 has not been conducted.*

*An application in a higher SIL level (up to SIL 3) is in principle possible by suitable proof of operational reliability according to IEC 61511-1 - 2017 Chap. 11.5.4. The end user is solely accountable for providing the required proof, he holds ultimate responsibility.*

The assessment of the safety critical and dangerous random errors lead to the following parameters:

sind unter Beachtung der Sicherheitshinweise im Sicherheitshandbuch für den Einsatz in sicherheitsgerichteten Applikationen bis SIL 2 nach IEC 61508:2010 geeignet. Eine Betrachtung nach SIL 3 hat nicht stattgefunden.

Ein Einsatz in einem höherwertigen SIL Level (bis SIL 3) ist prinzipiell durch einen geeigneten Nachweis der Betriebsbewährung gem. IEC 61511-1 – 2017 Kap. 11.5.4 möglich. Die erforderlichen Nachweise sowie die Verantwortung liegt hierbei in alleiniger Verantwortung des Betreibers. Die Untersuchung der sicherheitsrelevanten und gefährlichen, zufälligen Fehler führt zu folgenden Kenndaten:

peuvent être utilisés pour des applications de sécurité fonctionelle jusqu'á SIL 2 selon IEC 61508 :2010 en respectant les consignes de sécurité spécificées dans le Safety Manual. La prise en comte des exigences SIL 3 n'ont pas été prises en compte.

Une utilisation dans une application de niveau SIL supérieur (jusqu'à SIL 3) est en principe possible en prouvant la fiabilité opérationnelle selon les exigences IEC 61511-1 - 2017 Chap. 11.5.4. L'utilisateur final est le seul responsable pour fournir les justifications demandées. Il est le seul responsable final.

L'évaluation des défaillances aléatoires et dangereuses pour la sécurité donne les valeurs suivantes :

är användbara för säkerhetsapplikationer upp till SIL 2 enligt IEC 61508:2010 förutsatt att säkerhetsföreskrifterna följs (se Safety Manual). Någon bedömning enligt SIL 3 krav har inte gjorts.

Bedömningen av kritiska och slumpmässiga farliga fel har lett fram till följande parametrar:

**Type B device, Hardware Fault Tolerance HFT = 0**

IPAQ C/R 520(X)S with 4 ... 20 mA output signal

| Only Electronic | Fail safe detected $\lambda_{SD}$ | Fail safe undetected $\lambda_{SU}$ | Fail dangerous detected $\lambda_{DD}$ | Fail dangerous undetected $\lambda_{DU}$ | SFF (1) | PFDavg T[proof] 1 year | PFH |
|---|---|---|---|---|---|---|---|
| **Worst-case configuration** | 0 FIT | 0 FIT | 397 FIT | 40 FIT | 90,0 % | 2,02E-04 | 4,04E-08 1/h |

**(1) Reference: *exida* FMEDA report "INOR 08/11-47 R002 V4R4"**

**(2) FIT = Failure rate [1/h]**

**(3) RISE full assessment report "Functional safety assessment of IPAQ C520*/R520* according to IEC 61508:2010".**

| | |
|---|---|
| For a complete set of figures we refer to the:<br>Für eine komplette Reihe von Zahlen, die wir auf:<br>Pour un ensemble complet de chiffres que nous référer à :<br>För en komplett sammanställning av parametrar, se: | C520S, C520XS, R520S and R520XS<br>SIL Safety Manual, 86B520S001. |

| | | |
|---|---|---|
| Malmö,<br>2023-03-21 | Managing Director<br>Geschäftsführer<br>Directeur Général<br>Verkställande Direktör | .....<br>Tobias Schulten |

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# TYPE EXAMINATION CERTIFICATE SC0266-13

# Temperature transmitter "IPAQ C520*/R520* "

**Issued to**

## INOR Process AB

Box 9125, SE-200 39 MALMÖ, Sweden
Reg.number 556346-9385
VAT.number SE556346938501

**Product name**

IPAQ C520*/R520*

**Product description**

The IPAQ C520*/R520* are programmable transmitters designed primarily for temperature measurements in the process industry. They are two-wire, 4-20 mA current loop transmitters with power supply via the current loop.
IPAQ C520*/R520* have dual sensor input channels to make elaborate supervision and diagnostics possible.

| IPAQ C520*/R520* temperature transmitter | Description |
|---|---|
| IPAQ C520S | SIL |
| IPAQ C520XS | Ex i and SIL |
| IPAQ R520S | SIL |
| IPAQ R520XS | Ex i and SIL |

**Certificate**

The product(s) described in this certificate have been type-examined by RISE and found to fulfil the requirements for SIL 2 of the standard IEC 61508:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems, part 1-3 for the following element safety function:

- Provide measurement values of the measured unit (typically temperature) with a maximum deviation from specified accuracy on 2%

The certification is based on a functional safety assessment according to IEC 61508 described in RISE report P116607:A dated 2022-12-06 and safety manual for IPAQ C520*/R520*in the currently valid revision.
Note: The SIL (Safety Integrity Level) reached for the complete safety function must be determined by the end user.


**RISE Research Institutes of Sweden AB | Certification**
Box 857, SE-50115 Borås, Sweden
+46 10 516 50 00 | certifiering@ri.se | www.ri.se

## Marking

Each product that conforms in all respects with the original item type-examined may display the text 'Type examined by RISE'. When this marking is applied the marking shall also contain reference to the standard IEC 61508:2010, the reached SIL (Safety Integrity Level) of the item, the number of this certificate and the serial number or equivalent of the item.

## Validity

This certificate is valid until not later than 2027-12-12. The validity of this certificate can be verified by RISE.

## Miscellaneous

Other terms and conditions are set out in RISE certification rules for type-examination, SPCR 123. This issue replaces all earlier issues.

Martin Tillander


# Failure Modes, Effects and Diagnostic Analysis

Project:

Universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520*

Customer:

INOR Process AB
Malmö
Sweden

Contract No.: INOR 08/11-47

Report No.: INOR 08/11-47 R002

Version V4, Revision R4; November 2018

Stephan Aschenbrenner

## Management summary

This report summarizes the results of the hardware assessment carried out on the universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520* in hardware version 11 and software versions IPM-SW 01.02.02 and OPM-SW 01.02.03. Table 1 gives an overview of the different configurations that belong to the considered universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520*.

The hardware assessment consists of a Failure Modes, Effects and Diagnostics Analysis (FMEDA). A FMEDA is one of the steps taken to achieve functional safety assessment of a device per IEC 61508. From the FMEDA, failure rates are determined and consequently the Safe Failure Fraction (SFF) is calculated for the device. For full assessment purposes all requirements of IEC 61508 must be considered.

**Table 1: Configuration overview**

| | |
|---|---|
| IPAQ C520S | Head mounted, dual input 2-wire temperature transmitter, SIL suitable |
| IPAQ C520XS | Head mounted, dual input 2-wire temperature transmitter,<br>SIL suitable and intrinsically safe |
| IPAQ R520S | Rail mounted, dual input 2-wire temperature transmitter, SIL suitable |
| IPAQ R520XS | Rail mounted, dual input 2-wire temperature transmitter,<br>SIL suitable and intrinsically safe |

For safety applications only the described versions were considered. All other possible output variants or electronics are not covered by this report.

The failure rates used in this analysis are from the *exida* Electrical & Mechanical Component Reliability Handbook (see [N2]) for Profile 2.

The failure rates for the universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520* do not include failures resulting from incorrect use of the universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520*, in particular humidity entering through incompletely closed housings or inadequate cable feeding through the inlets.

The universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520* are considered to be Type B[1] elements with a hardware fault tolerance of 0. For Type B elements with a hardware fault tolerance of 0 the SFF has to be ≥ 90% for SIL 2 elements according to table 2 of IEC 61508-2.

It is assumed that the connected safety logic solver is configured as per the NAMUR NE43 signal ranges, i.e. the universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520* communicate detected faults by an alarm output current ≤ 3,6mA or ≥ 21mA. Assuming that the application program in the safety logic solver does not automatically trip on these failures, these failures have been classified as dangerous detected failures. The following table shows how the above stated requirements are fulfilled for the worst case configuration of the universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520*.

[1] Type B element: "Complex" element (using micro controllers or programmable logic); for details see 7.4.4.1.3 of IEC 61508-2.

**Table 2: Summary – IEC 61508:2010 failure rates**

| | ***exida* Profile 2** [2] |
|---|---|
| **Failure category** | **Failure rates (in FIT)** |
| **Fail Safe Detected ($\lambda_{SD}$)** | **0** |
| **Fail Safe Undetected ($\lambda_{SU}$)** | **0** |
| **Fail Dangerous Detected ($\lambda_{DD}$)** | **397** |
| Fail detected (detected by internal diagnostics) | 309 |
| Fail high (detected by safety logic solver) | 65 |
| Fail low (detected by safety logic solver) | 23 |
| Annunciation detected ($\lambda_{AD}$) | 0 |
| **Fail Dangerous Undetected ($\lambda_{DU}$)** | **40** [3] |
| Annunciation undetected ($\lambda_{AU}$) | 1 |
| No effect | 152 |
| No part | 46 |
| **Total failure rate (safety function)** | **437 FIT** |
| **SFF** | **90%** |
| **$DC_D$** | **90%** |
| **MTBF** | **179 years** |
| **SIL AC** [4] | **SIL 2** |

The failure rates are valid for the useful life of the universal dual-input 2-wire transmitters IPAQ C520* and IPAQ R520* (see Appendix 2).

[2] For details see Appendix 3.

[3] This value corresponds to a PFH of 4.04E-08 1/h. A fault reaction time of 5 minutes requires also that a connected device can detect the output state within a time that allows reacting within the process safety time.

[4] SIL AC (architectural constraints) means that the calculated values are within the range for hardware architectural constraints for the corresponding SIL but does not imply all related IEC 61508 requirements are fulfilled.

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Single RTD 2/3w sensor | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 436 | 49 | 89,9 % | 2,44 E-04 | 4,57 E-04 | 1,09 E-03 | 2,16 E-03 | 4,90 E-08 | (SIL 2) |
| Close coupled high stress | 0 | 0 | 1184 | 213 | 84,8 % | 1,05 E-03 | 1,97 E-03 | 4,74 E-03 | 9,36 E-03 | 2,13 E-07 | (SIL 2) |
| Extension wires low stress | 0 | 0 | 777 | 135 | 85,2 % | 6,63 E-04 | 1,25 E-03 | 3,00 E-03 | 5,93 E-03 | 1,35 E-07 | (SIL 2) |
| Extension wires high stress | 0 | 0 | 7997 | 1940 | 80,5 % | 9,45 E-03 | 1,79 E-02 | 4,31 E-02 | 8,52 E-02 | 1,94 E-06 | (SIL 1) |

$\lambda_{SD}$ = Fail safe detected
$\lambda_{SU}$ = Fail safe undetected
$\lambda_{DD}$ = Fail dangerous detected
$\lambda_{DU}$ = Fail dangerous undetected

**(1)** The numbers listed are for reference only. The SFF, PFDavg and PFH must be determined for the complete **Safety Instrumented Function (SIF)**
**(2)** SIL AC (architectural constraints) means that the calculated values are within the range for hardware architectural constraints for the corresponding SIL level
**(3)** It is assumed that proof testing is performed with a proof test coverage of 99%.
**(4)** The PFDavg was calculated for profile 2 using Markov modeling. The results must be considered in combination with PFDavg values of other devices of the Safety Instrumented Function (SIF) in order to determine suitability for a specific Safety Integrity Level (SIL)
For SIL 1 applications, the PFDavg value needs to be < $10^{-1}$ for the SIF
For SIL 2 applications, the PFDavg value needs to be < $10^{-2}$ for the SIF
**(5)** FIT: Failure rate [1/h]
**(6)** PFH = $\lambda_{DU}$ (Fail dangerous undetected)

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dual RTD 3w sensor (*) | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 492 | 41 | 92,3 % | 2,08 E-04 | 3,85 E-04 | 9,19 E-04 | 1,81 E-03 | 4,10 E-08 | SIL 2 |
| Close coupled high stress | 0 | 0 | 2300 | 57 | 97,6 % | 3,27 E-04 | 5,75 E-04 | 1,32 E-03 | 2,55 E-03 | 5,70 E-08 | SIL 2 |
| Extension wires low stress | 0 | 0 | 1338 | 50 | 96,4 % | 2,71 E-04 | 4,88 E-04 | 1,14 E-03 | 2,22 E-03 | 5,00 E-08 | SIL 2 |
| Extension wires high stress | 0 | 0 | 19207 | 230 | 98,8 % | 1,56 E-03 | 2,56 E-03 | 5,55 E-03 | 1,05 E-02 | 2,30 E-07 | (SIL 1) |

(*): Sensor drift monitoring is activated

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Single RTD 4w sensor | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 445 | 43 | 91,2 % | 2,16 E-04 | 4,02 E-04 | 9,62 E-04 | 1,89 E-03 | 4,30 E-08 | SIL 2 |
| Close coupled high stress | 0 | 0 | 1347 | 90 | 93,7 % | 4,62 E-04 | 8,52 E-04 | 2,02 E-03 | 3,97 E-03 | 9,00 E-08 | (SIL 2) |
| Extension wires low stress | 0 | 0 | 892 | 45 | 95,2 % | 2,36 E-04 | 4,31 E-04 | 1,02 E-03 | 1,99 E-03 | 4,50 E-08 | SIL 2 |
| Extension wires high stress | 0 | 0 | 10297 | 140 | 98,7 % | 9,16 E-04 | 1,52 E-03 | 3,34 E-03 | 6,38 E-03 | 1,40 E-07 | (SIL 2) |

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dual RTD 4w sensor (**) | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 497 | 40 | 92,6 % | 2,03 E-04 | 3,76 E-04 | 8,97 E-04 | 1,76 E-03 | 4,00 E-08 | SIL 2 |
| Close coupled high stress | 0 | 0 | 2392 | 45 | 98,2 % | 2,72 E-04 | 4,67 E-04 | 1,05 E-03 | 2,03 E-03 | 4,50 E-08 | SIL 2 |
| Extension wires low stress | 0 | 0 | 1397 | 41 | 97,1 % | 2,29 E-04 | 4,07 E-04 | 9,40 E-04 | 1,83 E-03 | 4,10 E-08 | SIL 2 |
| Extension wires high stress | 0 | 0 | 20387 | 50 | 99,8 % | 7,28 E-04 | 9,45 E-04 | 1,60 E-03 | 2,68 E-03 | 5,00 E-08 | SIL 2 |

**: Sensor drift monitoring is activated; Only for IPAQ R520S / R520XS

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Single TC sensor | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 492 | 45 | 91,6 % | 2,27 E-04 | 4,22 E-04 | 1,01 E-03 | 1,98 E-03 | 4,50 E-08 | SIL 2 |
| Close coupled high stress | 0 | 0 | 2297 | 140 | 94,3 % | 7,24 E-04 | 1,33 E-03 | 3,15 E-03 | 6,19 E-03 | 1,40 E-07 | (SIL 2) |
| Extension wires low stress | 0 | 0 | 1297 | 140 | 90,3 % | 7,00 E-04 | 1,31 E-03 | 3,13 E-03 | 6,16 E-03 | 1,40 E-07 | (SIL 2) |
| Extension wires high stress | 0 | 0 | 18397 | 2040 | 90,0 % | 1,02 E-02 | 1,90 E-02 | 4,56 E-02 | 8,98 E-02 | 2,04 E-06 | (SIL 1) |

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dual TC sensors (*) | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 597 | 41 | 93,6 % | 2,10 E-04 | 3,88 E-04 | 9,21 E-04 | 1,81 E-03 | 4,10 E-08 | SIL 2 |
| Close coupled high stress | 0 | 0 | 4387 | 50 | 98,9 | 3,44 E-04 | 5,61 E-04 | 1,21 E-03 | 2,30 E-03 | 5,00 E-08 | SIL 2 |
| Extension wires low stress | 0 | 0 | 2387 | 50 | 97,9% | 2,96 E-04 | 5,13 E-04 | 1,16 E-03 | 2,25 E-03 | 5,00 E-08 | (SIL 2) |
| Extension wires high stress | 0 | 0 | 40197 | 240 | 99,4 % | 2,11 E-03 | 3,15 E-03 | 6,27 E-03 | 1,15 E-02 | 2,40 E-07 | (SIL 1) |

(*): Sensor drift monitoring is activated

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Single TC + Single RTD 2/3W (*) | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 544 | 41 | 93,0 % | 2,09 E-04 | 3,87 E-04 | 9,20 E-04 | 1,81 E-03 | 4,10 E-08 | SIL 2 |
| Close coupled high stress | 0 | 0 | 3343 | 54 | 98,4 % | 3,38 E-04 | 5,72 E-04 | 1,27 E-03 | 2,45 E-03 | 5,40 E-08 | SIL 2 |
| Extension wires low stress | 0 | 0 | 1862 | 50 | 97,4 % | 2,83 E-04 | 5,00 E-04 | 1,15 E-03 | 2,23 E-03 | 5,00 E-08 | SIL 2 |
| Extension wires high stress | 0 | 0 | 29702 | 235 | 99,2 % | 1,83 E-03 | 2,85 E-03 | 5,91 E-03 | 1,10 E-02 | 2,35 E-07 | (SIL 1) |

(*): Sensor drift monitoring is activated

| Sensor Type | Failure category [FIT] (5) | | | | SFF | PFDavg (4) @ Tproof (3) = | | | | PFH | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Single TC + Single RTD 4W (**) | $\lambda_{SD}$ [FIT] | $\lambda_{SU}$ [FIT] | $\lambda_{DD}$ [FIT] | $\lambda_{DU}$ [FIT] | SFF (1) | 1 year | 2 years | 5 years | 10 years | PFH (6) | SIL AC (2) |
| Close coupled low stress | 0 | 0 | 547 | 40 | 93,2 % | 2,04 E-04 | 3,78 E-04 | 8,98 E-04 | 1,77 E-03 | 4,00 E-08 | SIL 2 |
| Close coupled high stress | 0 | 0 | 3390 | 48 | 98,6 % | 3,11 E-04 | 5,19 E-04 | 1,14 E-03 | 2,18 E-03 | 4,80 E-08 | SIL 2 |
| Extension wires low stress | 0 | 0 | 1892 | 45 | 97,7 % | 2,60 E-04 | 4,55 E-04 | 1,04 E-03 | 2,02 E-03 | 4,50 E-08 | SIL 2 |
| Extension wires high stress | 0 | 0 | 30292 | 145 | 99,5 % | 1,42 E-03 | 2,05 E-03 | 3,93 E-03 | 7,08 E-03 | 1,45 E -07 | (SIL 2) |

**: Sensor drift monitoring is activated; Only for IPAQ R520S / R520XS