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Technical report

of the

Type testing

of the Interlocking device amGard Pro

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Report no. FW85442T

Revision: 1.4, Date 14.08.2018

Test body

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Revision history

Revision	Date	Author	Status	Modifications
1.0	12.03.2014	T. Kreten	initial	
1.1	02.10.2014	T. Kreten	final	Deletion of EX and UX (Section 7 of Nomenclature)
1.2	23.11.2015	T. Kreten	final	Addition of proNet-Module
1.3	06.02.2018	T. Kreten	final	Addition of Slim line Models
1.4	14.08.2018	T. Kreten	final	Addition of next proNet-Module

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1 Target of Evaluation (ToE)

On May 21st, 2013 Fortress Interlocks Ltd requested TÜV SÜD Rail GmbH to test and certify the Interlocking device amGard Pro from Fortress Interlocks Ltd. The Project No. related to this Technical Report was as follows: 717507670.

Fortress Interlocks Ltd. designs and manufactures safety access and control systems. The Fortress Interlocks Ltd. safety locking systems to be tested and certified are part of the amGard Pro range of interlocks and safety gate switches

The amGard Pro system replaces all adaptations normally fitted within a guarding system, such that additional hardware like door catches, actuators, closing mechanisms, internal release mechanisms, key functions including authorised access and deadlocks are no longer needed. All of these separate functions can be incorporated into amGard Pro configurations, resulting in the most flexible safety interlock solution available for today's industrial environment.

In January 28th, 2015, Fortress Interlocks Ltd requested TÜV SÜD Rail GmbH to test the addition of the PROFINET / PROFIsafe communication module "proNet". The project number was 717510243.

In August 3rd, 2017, Fortress Interlocks Ltd requested TÜV SÜD Rail GmbH to test the addition of the SLIM-models. The project number was 717515408.

In October 18th, 2017, Fortress Interlocks Ltd requested TÜV SÜD Rail GmbH to test the addition of the Ethernet/IP - CIP Safety communication module of "proNet". Within this addition, the PCB was modified from two to 3 boards. This change was mainly done to make the product easier to use by our customers. The project number was 717515799.

2 Scope of Testing

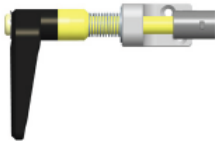
2.1 Test specimen

The subsystems to be inspected, amGard Pro Actuators, are commonly used within the Fortress Interlocks safety access and control systems. They belong to the „ amGard Pro “ series of Fortress Interlocks. The series offers modular safety gate switch interlocks for heavy duty applications in hazardous operating conditions. Its modular construction allows easy configuration.

Following **amGard Pro Actuators** are available and content of the inspection scope:

- **proAT Tongues TA, TK** (Short AT Tongue allows padlocks through the tongue to work as a lock out and tag out)
- **proAM Handles MA, MI** (AM Handle with internal Release)
- **proSlidebar Options TN, TS, TI, TM, TG, TF**
- **proHandle Options EN, EH** (internal release handle only works with units with no locking)
- **proRelease IR Handle EI** (allows emergency release – only to be used with I6 and I7 head)

proAM Handle



proSlidebar Options



proHandle Options



proRelease IR Handle



Figure 1: Handle, proHandle and Slidebar examples of amGard Pro

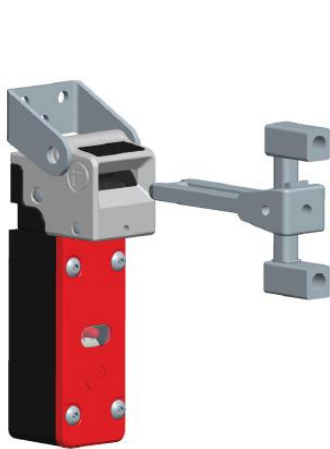


Figure 2: Basic "Body" of amGard Pro

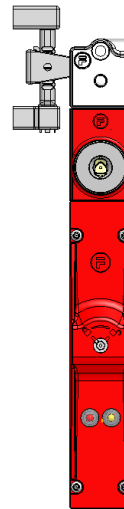


Figure 3: Basic "Body" of amGard Pro Slimline



Figure 4: PROFINET / PROFI-safe communication module proNet

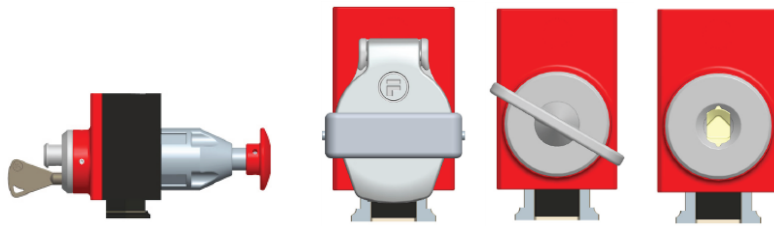


Figure 5: Examples of different Extension Modules of amGard Pro



Figure 6: Examples of different Switching / Locking Bodies of amGard Pro

2.1.1 Nomenclature of amGard Pro

xx	x	xx	xx	EKxx	SKxxx	AKxxx	xx	xxx	xxxxxxxx	xxxxxxxx	xxxx
1	1a	2	3	4	5	6	7	7a	8	9	10

With:

1

Actuator

MA	AM Handle standard
MI	AM Handle with Internal Lever
TA	AT Tongue standard (62.5mm)
TK	Shortened AT Tongue (53.5mm)
TN	TA Tongue Slidebar without a spring
TS	TA Tongue Slidebar with a return spring
TI	TA Tongue Slidebar with Internal Handle but no return spring
TM	TK Tongue Slidebar with Internal Handle and protruding lockout
TG	TK Tongue Slidebar with Internal Handle
TF	TA Tongue Slidebar with fixed Internal Handle
EN	proHandle with external Access Handle and Red Internal Handle
EH	proHandle with external Access Handle but no Internal Handle
EI	proIR Handle with external Access Handle and Red Internal Handle to allow for Internal Escape Release (only to be used with I6, I7, A6 or A7 head)
SA	AT Tongue for Slimline S6 head (34.5mm)

SN	SA Tongue Slidebar without a spring
SS	SA Tongue Slidebar with a return spring
SI	SA Tongue Slidebar with Internal Handle but no return spring
SF	SA Tongue Slidebar with fixed Internal Handle
SD	Hand operated sprung actuator
HS	Short Reach Hinged handle with SA Tongue for front-facing Slimline S6 head
HL	Long Reach Hinged handle with SA Tongue for front-facing Slimline S6 head

1a Handling

1	Front Facing
2	Left Hand Facing
3	Rear Facing
4	Right Hand Facing

2 Head Module

C6	Cap Module – To terminate assemblies without heads
M6	ProAM Head
M7	proAM Head with Drop-Down Lockout
M8	proAM Head with Lockout Clip
T6	proAT Head
T7	proAT Head with Drop-Down Lockout
T8	proAT Head with ATL Lockout Clip
I6	proIR Head with internal Escape Release function (only in conjunction with EI Handle)
I7	proIR Head with internal Escape Release function (only in conjunction with EI Handle) and with Drop-Down Lockout
S6	Slimline Head

3 Push IR – Internal Escape Release Module

R1	Push IR with external Key Reset (up to 40mm panel thickness)
R2	Push IR with external Key Reset (up to 60mm panel thickness)
R3	Push IR with external Key Reset (up to 80mm panel thickness)
R4	Push IR with external Key Reset (variable length – for panel thickness over 80mm and up to 1000mm)
R6	Push IR with Internal Pull Reset (up to 40mm panel thickness)
R7	Push IR with Internal Pull Reset (up to 60mm panel thickness)
R8	Push IR with Internal Pull Reset (up to 80mm panel thickness)

R9	Push IR with Internal Pull Reset (variable length – for panel thickness over 80mm and up to 1000mm)
RW	Push IR with external Keyless Push Reset (up to 40mm panel thickness)
RX	Push IR with external Keyless Push Reset (up to 60mm panel thickness)
RY	Push IR with external Keyless Push Reset (up to 80mm panel thickness)
RZ	Push IR with external Keyless Push Reset (variable length – for panel thickness over 80mm and up to 1000mm)

4 Extracted Key Adaptor Module

Lx	Standard EK Adaptor type
Rx	Releasing EK Adaptor type (must be used if a Push IR, EI Handle or I6, I7, A6, A7 Head has been used to ensure Escape Release function is correct)
x1	Standard Lock style with no Dustcover (CLIN)
x2	Standard Lock style with Dustcover (CLIS)
x3	Standard Lock style with Padlockable Dustcover (CLIL)
x6	Masterable Lock style with no Dustcover (MLIN)
x7	Masterable Lock style with Dustcover (MLIS)
x8	Masterable Lock style with Padlockable Dustcover (MLIL)

5 Safety Key Adaptor Module

Lxx	Standard SK Adaptor type
Rxx	Releasing SK Adaptor type (must be used if a Push IR, EI Handle or I6, I7, A6, A7 Head has been used to ensure Escape Release function is correct)
x1x	Standard Lock style with no Dustcover (CLIN)
x2x	Standard Lock style with Dustcover (CLIS)
x3x	Standard Lock style with Padlockable Dustcover (CLIL)
x6x	Masterable Lock style with no Dustcover (MLIN)
x7x	Masterable Lock style with Dustcover (MLIS)
x8x	Masterable Lock style with Padlockable Dustcover (MLIL)
xxX	1-9 Amount of Safety Key Adaptor Modules required

6 Access Key Adaptor Module

Lxx	Standard AK Adaptor type
Rxx	Releasing AK Adaptor type (must be used if a Push IR, EI Handle or I6, I7, A6, A7 Head has been used to ensure Escape Release function is correct)
x1x	Standard Lock style with no Dustcover (CLIN)
x2x	Standard Lock style with Dustcover (CLIS)

x3x	Standard Lock style with Padlockable Dustcover (CLIL)
x6x	Masterable Lock style with no Dustcover (MLIN)
x7x	Masterable Lock style with Dustcover (MLIS)
x8x	Masterable Lock style with Padlockable Dustcover (MLIL)
xxX	1-9 Amount of Safety Key Adaptor Modules required

7 Electrical Switching Unit

SL	Short LOK Solenoid Body – Standard
SR	Short LOK Solenoid Body – Releasing style (must be used if a Push IR, EI Handle or I6, I7, A6, A7 Head has been used to ensure Escape Release function is correct)
LL	Long LOK Solenoid Body – Standard
LR	Long LOK Solenoid Body – Releasing style (must be used if a Push IR, EI Handle or I6, I7, A6, A7 Head has been used to ensure Escape Release function is correct)
ZL	Slimline LOK Solenoid Body – Standard
ZR	Slimline LOK Solenoid Body – Releasing style (must be used if a Push IR, EI Handle or I6, I7, A6, A7 Head has been used to ensure Escape Release function is correct)
ST	STOP Safety Switch Body – Standard
FT	Foot Adaptor – To terminate mechanical configurations with no Electrical Switching unit

7a Electrical Switching Unit Options

Voltage Options	
0xx	No Voltage (for FT Foot Adaptors only)
1xx	110V
2xx	230V
4xx	24V
5xx	100V
6xx	115V
7xx	48V
8xx	ASi Network Enabled
Sxx	Split Voltage unit - 110V Solenoid / 24V Control (LOK only)
Cxx	Split Voltage unit - 24V Solenoid / 100V Control (LOK only)
Pxx	proNet Network Enabled unit (for use with N type Option Pods)
Solenoid and Switch type	

x0x	STOP Safety Switch (ST / EX / UX)
x1x	Power-To-Unlock (PTU) – With Key Override
x2x	Power-To-Unlock (PTU) – With Knob Override
x3x	Power-To-Unlock (PTU) – With Screwdriver Override
x6x	Power-To-Lock (PTL) – With Solenoid Monitor Only (24V, 110V & ASi only)
x7x	Power-To-Lock (PTL) – With Solenoid Monitor and Safety (ZL, ZR only)
Switching type	
xx1	Standard & Sourcing
xx2	Standard & Sinking
xx3	Standard & Sourcing (with 3 x Normally Closed switches)
xx4	Standard & Sourcing (with Yellow and Green LEDs)
xx6	Un-Monitored Solenoid & Sourcing
xx7	Un-Monitored Solenoid & Sourcing (with Yellow and Green LEDs)
xx8	Standard & Sourcing – Solenoid switches 1 NO 1NC, Head switches 1NO 1NC

8 Option Pod or proLOK+ Long LOK Options

Keyswitch Option Pod types	
BK0x	Standalone Keyswitch Option Pod (with no holes on top of POD enclosure)
BK1x	Keyswitch Option Pod (with one hole on top of POD enclosure for fitment to pro-STOP Safety switch unit)
BK2x	Keyswitch Option Pod (with two hole on top of POD enclosure for fitment to SL, SR, LL or LR proLOK Solenoid unit)
BKx1	Keyswitch Option Pod – with Standard Lock style, no Dustcover (CLIN)
BKx2	Keyswitch Option Pod – with Standard Lock style and Dustcover (CLIS)
BKx3	Keyswitch Option Pod – with Standard Lock style and Padlockable Dustcover (CLIL)
BKx6	Keyswitch Option Pod – with Masterable Lock style, no Dustcover (CLIN)
BKx7	Keyswitch Option Pod – with Masterable Lock style and Dustcover (CLIS)
BKx8	Keyswitch Option Pod – with Masterable Lock style and Padlockable Dustcover (CLIL)
Control Option Pod types	
B0xxxxx	Standalone Option Pod (with no holes on top of POD enclosure)
B1xxxxx	Option Pod (with one hole on top of POD enclosure for fitment to proSTOP Safety switch unit)
B2xxxxx	Option Pod (with two holes on top of POD enclosure for fitment to SL, SR, LL or LR proLOK Solenoid unit)

Y0xxx0N	Standalone Slimline Option Pod (with no holes on top of POD enclosure) – With Pushbutton selections wired with Common Power Supply
Y1xxx0N	Slimline Option Pod (with one hole on top of POD enclosure for fitment to proSTOP Safety switch unit or ZL, ZR Slimline LOK unit) – With Pushbutton selections wired with Common Power Supply
W0xxx0N	Standalone Slimline Option Pod (with no holes on top of POD enclosure) – With Pushbutton selections Individually Wired (volt-free contacts)
W1xxx0N	Slimline Option Pod (with one hole on top of POD enclosure for fitment to proSTOP Safety switch unit or ZL, ZR Slimline LOK unit) – With Pushbutton selections Individually Wired (volt-free contacts)
L0xxxxx	proLOK+ Long Lok unit information
N0xxxxN	Standalone proNet Option Pod with PROFINET and PROFI-safe (with no holes on top of POD enclosure)
N1xxxxN	proNet Option Pod with PROFINET and PROFI-safe (with one hole on top of POD enclosure for fitment to proSTOP Safety switch unit)
N2xxxxN	proNet Option Pod with PROFINET and PROFI-safe (with two holes on top of POD enclosure for fitment to SL, SR, LL or LR proLOK Solenoid unit)
N3xxxxN	Standalone proNet Option Pod with Ethernet/IP and CIP Safety (with no holes on top of POD enclosure)
N4xxxxN	proNet Option Pod with Ethernet/IP and CIP Safety (with one hole on top of POD enclosure for fitment to proSTOP Safety switch unit)
N5xxxxN	proNet Option Pod with Ethernet/IP and CIP Safety (with two holes on top of POD enclosure for fitment to SL, SR, LL or LR proLOK Solenoid unit)
Pushbutton and Control Elements	
0	Blanking Plug (No Pushbutton selected)
1	Red Lamp
2	Yellow Lamp
3	Green Lamp
6	Blue Lamp
7	White Lamp
E	Emergency Stop – twist-to-reset
H	Emergency Stop – twist-to-reset with additional monitoring contacts
P	Emergency Stop – pull-to-reset
U	Emergency Stop – illuminated twist-to-reset
L	Latching Selector Switch – illuminated
M	Momentary Selector Switch – illuminated
V	Latching Selector Switch – 1 NO, 1 NC
A	Latching Keyswitch – 90 degree

R	Red Illuminated Pushbutton – non-latching
Y	Yellow Illuminated Pushbutton – non-latching
G	Green Illuminated Pushbutton – non-latching
B	Blue Illuminated Pushbutton – non-latching
W	White Illuminated Pushbutton – non-latching
K	Black Pushbutton – non-latching
	Non-Contact Switch options (B type Option Pods only)
xxxxxx N	No Non-Contact Switch selected
xxxxxx C	Coded Magnet Non-Contact Switch – Left hand orientation
xxxxxx D	Coded Magnet Non-Contact Switch – Right hand orientation
xxxxxx S	RFID Non-Contact Switch – Left hand orientation
xxxxxx T	RFID Non-Contact Switch – Right hand orientation

9 Second Option Pod options (If fitted)

Keyswitch Option Pod types	
BK2x	Keyswitch Option Pod (with two hole on top of POD enclosure for fitment to first assembled Option Pod unit or proLOK+ Long LOK unit)
BKx1	Keyswitch Option Pod – with Standard Lock style, no Dustcover (CLIN)
BKx2	Keyswitch Option Pod – with Standard Lock style and Dustcover (CLIS)
BKx3	Keyswitch Option Pod – with Standard Lock style and Padlockable Dustcover (CLIL)
BKx6	Keyswitch Option Pod – with Masterable Lock style, no Dustcover (CLIN)
BKx7	Keyswitch Option Pod – with Masterable Lock style and Dustcover (CLIS)
BKx8	Keyswitch Option Pod – with Masterable Lock style and Padlockable Dustcover (CLIL)
BA1_	AS-i Option Pod with Control only PCB
BA2_	AS-i Option Pod with Safety only PCB
BA3_	AS-i Option Pod with 1 x Safety and 1 x Control PCB
BA4_	AS-i Option Pod with 2 x Safety only PCB
BA5_	AS-i Option Pod with 1 x Control and 2 x Safety PCB
BA6_	AS-i Option Pod with 3 x Safety only PCB
BA7_	AS-i Option Pod with 1 x Control and 3 x Safety PCB
Control Option Pod types	
B2xxxxx	Option Pod (with two holes on top of POD enclosure for fitment to first assembled Option Pod unit or proLOK+ Long LOK unit)
Y1xxx0N	Slimline Option Pod (with one hole on top of POD enclosure for fitment to first as-

	sembled Slimline Option Pod unit) – With Pushbutton selections wired with Common Power Supply
W1xxx0N	Slimline Option Pod (with one hole on top of POD enclosure for fitment to first assembled Slimline Option Pod unit) – With Pushbutton selections Individually Wired (volt-free contacts)
N2xxxxN	proNet Option Pod with PROFINET and PROFIsafe (with two holes on top of POD enclosure for fitment to first assembled Option Pod unit or proLOK+ Long LOK unit)
N5xxxxN	proNet Option Pod with Ethernet/IP and CIP Safety (with two holes on top of POD enclosure for fitment to first assembled Option Pod unit or proLOK+ Long LOK unit)
Pushbutton and Control Elements	
0	Blanking Plug (No Pushbutton selected)
1	Red Lamp
2	Yellow Lamp
3	Green Lamp
6	Blue Lamp
7	White Lamp
E	Emergency Stop – twist-to-reset
H	Emergency Stop – twist-to-reset with additional monitoring contacts
P	Emergency Stop – pull-to-reset
U	Emergency Stop – illuminated twist-to-reset
L	Latching Selector Switch – illuminated
M	Momentary Selector Switch – illuminated
V	Latching Selector Switch – 1 NO, 1 NC
A	Latching Keyswitch – 90 degree
R	Red Illuminated Pushbutton – non-latching
Y	Yellow Illuminated Pushbutton – non-latching
G	Green Illuminated Pushbutton – non-latching
B	Blue Illuminated Pushbutton – non-latching
W	White Illuminated Pushbutton – non-latching
K	Black Pushbutton – non-latching
Non-Contact Switch options (for B type Option Pods only)	
xxxxxxN	No Non-Contact Switch selected
xxxxxxC	Coded Magnet Non-Contact Switch – Left hand orientation
xxxxxxD	Coded Magnet Non-Contact Switch – Right hand orientation

xxxxxxS	RFID Non-Contact Switch – Left hand orientation
xxxxxxT	RFID Non-Contact Switch – Right hand orientation

10 Quick Disconnect Connector Options

XXXX	Lefthand Connector – Righthand Connector (Righthand Connector, not applicable for STOP, Slimline LOK or Slimline POD units)
00	No Connector
D1	5 Pin, M12 Male Connector
D2	12 Pin, 1-1/18" Male Connector
D3	8 Pin, M12 Male Connector
D4	7 Pin, 1-16" UN2 Male Connector
D5	5 Pin, M12 Male Connector
D6	14 Pin, M16 Male Connector
D7	10 Pin, M12 Male Connector
D8	12 Pin, M12 Male Connector
D9	12 Pin, M23 Male Connector
E1	4 Pin, M12 Male Connector
E2	8 Pin, 1-16" UN2 Male Connector
E3	10 Pin, 1-1/8" Male Connector
E4	19 Pin, 1-1/8" Male Connector
F2	19 Pin, M23 Male Connector
PFxx	proNet Connector Options (for N type Option Pods only)

2.2 Tests

The amGard Pro was examined with regard to the following testing operations:

- I. Functional safety including
 - Analysis of the system structure (System-FMEA)
 - Analysis of the hardware (FMEDA¹ on component or block level, quantitative analysis)
 - Test of the error prevention measures
 - Mechanical tests
 - Functional tests

- II. Electrical safety

¹ Failure Mode, Effects and Diagnosis Analysis



- III. Susceptibility to environmental errors including
 - Climate and temperature, IP degree of protection
 - Mechanical effects
- IV. Electromagnetic compatibility
 - Immunity
- V. Safety information in the product documentation (safety manual, operating instructions)

3 Basis of Testing

The regulations and guidelines which form the basis of the type testing are listed below.

3.1 European directives

No.	Standard	Title
[L1]	2006/42/EC	DIRECTIVE 2006/42/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 17 May 2006 on machinery, and amending Directive 95/16/EC (recast)

Table 2: European directives

3.2 Product standard

No.	Standard	Title
[N1]	ISO 14119: 2013	Safety of machinery — Interlocking devices associated with guards — Principles for design and selection

Table 3: Product standard

3.3 Functional safety

No.	Standard	Title
[N2]	EN ISO 13849-1: 2015 (PL e, Cat. 4)	Safety of machinery - Safety-related parts of control systems Part 1: General principles for design

Table 4: Functional safety

3.4 Electrical safety

No.	Standard	Title
[N3]	EN 60204-1: 2006	Safety of machinery - Electrical equipment of machines Part 1: General requirements
[N4]	EN 61010-1: 2010	Safety requirements for electrical equipment for measurement, control and laboratory use – Part 1: General requirements

Table 5: Electrical safety

3.5 Susceptibility to environmental errors

3.5.1 IP Code testing

No.	Standard	Title
[N5]	EN 60529/A1: 2000	Degrees of protection provided by enclosures (IP Code)

Table 6: IP Code testing

3.5.2 Mechanical testing

No.	Standard	Title
[N6]	gs-et-19: 2011	Principles of testing and certification for interlocking devices with solenoid guard-locking
[N7]	gs-et-31: 2010	Principles of testing and certification for Interlocking devices with key transfer systems
[N8]	Guideline FKM: 2002	Analytical Strength Assessment of Machine Components
[N9]	Guideline VDI 2230: 2003	Systematic Calculation of Highly Loaded Bolted Connections

Table 7: Mechanical testing

3.6 Electromagnetic compability

3.6.1 Electromagnetic immunity

No.	Standard	Title
[N10]	EN 61000-4-2: 1995	Electromagnetic compatibility (EMC) Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
[N11]	EN 61000-4-3: 2006	Electromagnetic compatibility (EMC) Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
[N12]	EN 61000-4-4: 2004	Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
[N13]	EN 61000-4-6: 2007	Electromagnetic compatibility (EMC) Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields

Table 8: Electromagnetic immunity

3.6.2 Electromagnetic emission

No.	Standard	Title
[N14]	EN 55011/A2: 2007	Industrial, scientific and medical (ISM) radio-frequency equipment - Radio disturbance characteristics - Limits and methods of measurement

Table 9: Electromagnetic emission

3.6.3 Environmental testing

No.	Standard	Title
[N15]	EN 60068-2-1: 1994	Environmental testing Part 2: Tests; Tests A: Cold
[N16]	EN 60068-2-2: 1993	Basic environmental testing procedures Part 2: Tests; Tests B: Dry Heat

No.	Standard	Title
[N17]	IEC 60068-2-3: 1984	Basic environmental testing procedures Part 2: Tests; Tests Ca: Damp Heat, steady state
[N18]	EN 60068-2-6: 1995	Environmental testing Part 2: Tests; Tests Fc: Vibration (sinusoidal)
[N19]	EN 60068-2-29: 1993	Basic environmental testing procedures – Part 2: Tests; Tests B: Dry Heat

Table 10: Environmental testing

3.7 Safety information in the product documentation (safety manual, operating instructions)

No.	Standard	Title
[N20]	EN ISO 13849-1: 2015 (PL e, Cat. 4)	Safety of machinery - Safety-related parts of control systems Part 1: General principles for design

Table 11: Safety information

4 Documents provided for testing of amGard Pro

Following documents were provided by Fortress Interlocks Ltd to be checked and evaluated by the test house.

No.	Title	Document-No./ File identifier	Revision	Date
[D1]	AMGARD PRO TA AND T6 ASSEMBLY BOM DRAWING	TUV_TA2T6	--	10.09.2013
[D2]	AMGARD PRO MA AND M6 ASSEMBLY BOM DRAWING	TUV_MA2M6	--	12.09.2013
[D3]	AMGARD PRO I6 ASSEMBLY BOM DRAWING	TUV_I6	--	13.09.2013
[D4]	AMGARD PRO PUSH IR ASSEMBLY BOM DRAWING	TUV_R1	--	24.09.2013
[D5]	AMGARD PRO ST401 ASSEMBLY BOM DRAWING	TUV_ST401	--	01.10.2013
[D6]	AMGARD PRO EH2 ASSEMBLY BOM DRAWING	TUV_EH2	--	01.10.2013
[D7]	AMGARD PRO EI2 ASSEMBLY BOM DRAWING	TUV_EI2	--	08.10.2013
[D8]	System-FMEA	Summary of Pro Modules Safety Function.xlsx		07.10.2013
[D9]	AT Head & Actuator	--	--	28.08.2013
[D10]	AM Head & Handle	--	--	28.08.2013

No.	Title	Document-No./ File identifier	Revision	Date
[D11]	Slidebar (TN / TI / TF / TS)	--	--	28.08.2013
[D12]	Slidebar for GM (TG / TM)	--	--	28.08.2013
[D13]	AmGard Pro EH / EN handle	--	--	28.08.2013
[D14]	AmGard Pro all in one handle	--	--	28.08.2013
[D15]	AmGard Pro all in one head (I6 / I7)	--	--	28.08.2013
[D16]	AmGard Pro Push IR (R1 to RZ)	--	--	28.08.2013
[D17]	AmGard Pro All Key Adaptors (EKL/R, AKL/R & SKL/R)	--	--	28.08.2013
[D18]	AmGard Pro ST (STOP)	--	--	28.08.2013
[D19]	AMGard Pro LOK Family (SL / SR / LL / LR / SE / L / E)	--	--	28.08.2013
[D20]	B0/1/2 & BA PODs	--	--	28.08.2013
[D21]	PODK (BK00/1/2)	--	--	28.08.2013
[D22]	Dust-Test	2013-020 AmGard Pro Dust test.pdf		11.09.2013
[D23]	Datasheet	proAT Tongue Datasheet.pdf		
[D24]	Datasheet	proFoot Datasheet.pdf		
[D25]	Datasheet	proLok Datasheet.pdf		
[D26]	Datasheet	proAM Handle Datasheet.pdf		
[D27]	Datasheet	proHandle Datasheet.pdf		
[D28]	Datasheet	proStop Datasheet.pdf		
[D29]	Datasheet	proLok+Datasheet.pdf		
[D30]	Datasheet	proOption Pods Datasheet1.pdf		
[D31]	Datasheet	proAM Head Datasheet.pdf		
[D32]	Datasheet	proAT Head Datasheet.pdf		
[D33]	Datasheet	proIR Datasheet.pdf		
[D34]	Datasheet	proLock Adaptor Datasheet.pdf		
[D35]	Datasheet	proSlidebar Datasheet.pdf		
[D36]	Datasheet	proCap Datasheet.pdf		
[D37]	Datasheet	proStopUX, EX Datasheet.pdf		
[D38]	Datasheet	proHead & Handle Datasheet.pdf		

No.	Title	Document-No./ File identifier	Revision	Date
[D39]	Datasheet	proE Datasheet.pdf		
[D40]	Installation Instructions	EH Installation Instructions.pdf		
[D41]	Installation Instructions	Opel SBG Installation Instructions.pdf		
[D42]	Installation Instructions	proAM Head Installation Instructions.pdf		
[D43]	Installation Instructions	proE Installation Instructions.pdf		
[D44]	Installation Instructions	proIR Installation Instructions.pdf		
[D45]	Installation Instructions	proAT Head Installation Instruction.pdf		
[D46]	Installation Instructions	proHandle Installation Instructions.pdf		
[D47]	Installation Instructions	proLock Adaptor Installation Instruction.pdf		
[D48]	Installation Instructions	proLok Installation Instructions.pdf		
[D49]	Installation Instructions	proLok+Installation Instruction.pdf		
[D50]	Installation Instructions	proStop Installation Instruction.pdf		
[D51]	Installation Instructions	proStopUX, EX Installation Instructions.pdf		
[D52]	Installation Instructions	Slide Bar Installation Instructions.pdf		
[D53]	Installation Instructions	proOption Pods Installation Instructions.pdf		
[D54]	Product Information	amgard-pro_part_number_configurator_book.pdf		
[D55]	Product Information	FI-Ltd_application-guide.pdf		
[D56]	Product Information	FI-Ltd_product-catalogue.pdf		
[D57]	Product Information	FI-Ltd_product-selector.pdf		
Documents for V 1.3				

No.	Title	Document-No./ File identifier	Revision	Date
[D58]	Datasheet	proNet EthernetIP CIP Safety Datasheet V1.3 08- 06-2017	1.3	08.06.2017
[D59]	Installation Instructions	proNet EthernetIP Installa- tion Instructions 20-06- 2017 v1.0	1.0	20.06.2017

Table 12: Documentation

5 Performance and result of tests

5.1 Test reports

Following test reports were issued by TÜV SÜD Rail GmbH or other accredited test laboratories.

No.	Title1	Document-No./ File identifier	Revision	Date
[R1]	Checklist EN ISO 13849-1	Checklist EN ISO 13849		29.12.2013
[R2]	Certificate of Compliance to EN 61010-1	ETL Amgard Test CofC EN61010-1.pdf		25.08.2005
[R3]	Test report EN 61010-1	04015881		08/2005
[R4]	Certificate TÜV Rheinland	968/EZ 149.00/03		11.06.2003
[R5]	Review Report on FMEDA1on compo- nent or block level	See FW85291T	1.0	04.03.2014
[R6]	Review Report on User Manual	Review Report Manual EN ISO 13849	1.1	12.03.2014
[R7]	Manufacturer's testing laboratory	MTL Fortress Interlocks		16.03.2012
[R8]	Checklist according to ISO 14119	Checklist EN ISO 14119	1.0	17.02.2014
[R9]	Technical Report on Vibration-, shock- and environmental testing	See FW85291T	1.0	04.03.2014
[R10]	Technical Report on the Degree of Pro- tection (IP Code)	2013-052 – AmGard Pro Long LOK IP65 test TRA011271CC02A.pdf		12.06.2013
[R11]	Technical Report on the Degree of Pro- tection (IP Code)	2013-082 Pro STOP and LOK IP65 & IP66 tests – TRA011271CC01A.pdf		12.09.2012
[R12]	Salt Spray test	2013-013 Rotech test re- port LR 111766.pdf		09.09.2013

No.	Title1	Document-No./ File identifier	Revision	Date
[R13]	TECHNICAL REPORT ASSESSMENT OF THE FUNCTIONAL SAFETY REGARDING THE MECHANICAL REQUIREMENTS OF THE FORTRESS INTERLOCKS amGardpro Actuators	FW85291T	1.0	04.03.2014
[R14]	Test Report on EMC	5926-Rev1		29.02.2005
[R15]	Certificate TÜV Rheinland	968/EZ 149.08/11		10.11.2011
[R16]	EC-Declaration of Conformity 3RK205/ 3RK 1405	EC-Declaration of Con- formity 244.06		18.11.2002
[R17]	PFH-PFD of the safe AS-i transmission	3081		09.05.2011
[R18]	EC-Declaration of Conformity 3SB1, 3SB2, 3SB3	EC-Declaration of Con- formity 1804.08		14.12.1995
[R19]	Siemens Customer Letter Recommendation of the standard B10 values for the application of EN 62061			01.02.2006
[R20]	Test Certificate 3SB3	1771a		03.06.2003
[R21]	Certificate TÜV Nord	44 799 10 388170		18.10.2010
[R22]	Certificate TÜV SÜD	M6A 11 08 20132 113		07.09.2011
[R23]	Certificate TÜV SÜD	M6A 11 08 20132 102		07.09.2011
[R24]	Datasheet PSEN Mag Safety switch	Pilz technical document 524120_fl.pdf		
[R25]	SEN PSEN ma1.4a-50 Manual	PSEN_ma1_4a- 50_Oper_Manual_22120- 3FR-03.pdf		12/2009
[R26]	Berechnung B10d: Psenma1.3&PSENma1.4	Bestim- mung_B10d_Werte_PSEN ma1.3&ma1.4_(nur_2009- Mai-12).pdf Bestim- mung_B10d_Werte_PSEN ma1.3&ma1.4_(nur_2009- Mai-12).pdf	E1.0	12.05.2009
[R27]	Certificate TÜV SÜD	M6A 11 08 20132 102		07.09.2011
[R28]	SEN PSEN cs4.2a/p/M12 Manual	PSEN_cs4_2apM12_Oper _Man_22188-3FR-01.pdf		12/2009
[R29]	Bestätigung/ Confirmation	3081.pdf		28.10.2013
[R30]	Technical Report of the Implementation PROFINET / PROFIsafe communication module proNet	FW87661T	1.0	23.11.2015
Documents for V 1.3				

No.	Title1	Document-No./ File identifier	Revision	Date
[R31]	Delta-Checklist EN ISO 13849-1	Delta Checklist according to ISO 13849	1.0	07.12.2017
[R32]	Conformity evaluation according IXAAT Safe T100 Manual	Checkliste_Integration IXAAT EthernetIP CIP Safety	1.0	06.12.2017
[R33]	Technical report mechanics	FW85291T	1.1	19.01.2018
Documents for V 1.4				
[R34]	Technical Report of the Implementation Ethernet communication module proNet	FW87661T	1.1	03.08.2018

Table 13: Test results

5.2 System Failure Mode and Effects Analysis (System-FMEA)

The amGard Pro is an Interlocking device consisting of an Actuator, the Handle, a Head Module, the Options of a Push IR, Extracted Key Module, Safety Key Adapter, Access Key Adapter, Electrical Switching / Locking Body, options for Separate Option Pod or proLok+ Body, Key Switch Option Pod, ASi Option Pod and several Quick Disconnect Connector Options

Fault detection/exclusion is assured by means of following basic techniques:

- Over dimensioning
- two-channel control logic with external cross check
- pre-certified electronic Modules (AS-i, PROFINET / PROFIsafe)

The device opens twin NC safety circuits when the handle or tongue is opened. At the same time a NO monitoring switch closes. These circuits are intended to be used so that the measures such as redundancy, diversity and monitoring can be utilised (with the correct system). The device uses well-tried components and uses well-tried safety principles to avoid critical faults or failures.

The restart interlock function will be realised through the application as described in the user manual of the amGard Pro .

Result:

The system-FMEA as depicted in the documents [D8] to [D21] were made by Fortress Interlocks Ltd and reviewed by TÜV SÜD Rail GmbH. The results of the system-FMEA's of the amGard Pro meet the requirements according to [N1], and [N2]. These results are recorded in [R14].

5.3 Failure Mode and Effect Analysis (FMEA) and Hardware Fault Simulations (FIT)

Failure mode and effect analysis was carried out on the amGard Pro series at the mechanical level. All component failures and function-related faults in components or component groups were examined to assess their effects on the safe functioning of the interlocking device. These examinations were limited to faults in the part of the hardware which is relevant with regard to functional safety.

Practical fault simulations were carried out to provide subsequent evaluation of the knowledge obtained from the theoretical failure mode and effect analysis. The performances of these fault simulations provide information on the fail-safe characteristics of the system.

The hardware fault simulation to state the fault exclusions was carried out on-site by TÜV SÜD Rail GmbH. For the fault simulation, a number of representative fault simulations were defined by TÜV SÜD Rail GmbH based on the fault models specified in IEC 61508-2. These faults represent a series of faults which have an identical effect on the functions of the system.

The results of these faults were compared with the required characteristics which had been stipulated in the theoretical failure mode and effect analysis for the fault detection mechanisms and the fault reaction.

Result

All fault models according to [N1] and [N2] were covered. All faults which safety function can either be excluded or will be detected. See Test report [R13] or [R15] to [R27].

The FMEDA1 on component or block level and the FIT [R7] demonstrated that the system structure of the Interlocking device meets the requirements of the regulations and standards listed in clause 3 of this Technical Report.

The results of the tests to state the fault exclusions are given in the test report [R7].

5.4 Quantitative analysis

The following table depicts the values from the quantitative analysis.

	Richmeg Solenoid	Siemens 3SB3411-xx safety switch	Siemens Asi Interface	B&W AS-i I/O Module	Pilz MAG sensor	Pilz RFID sensor
AT Head & Actuator	-	-	-	-	-	-
AM Head and Handle:	-	-	-	-	-	-
Slidebar (TN / TI / TF / TS)	-	-	-	-	-	-
Slidebar for GM (TG / TM)	-	-	-	-	-	-
amGard Pro EH/EN Handle	-	-	-	-	-	-
amGard Pro all in one Handle	-	-	-	-	-	-
amGard Pro all in one Head	-	-	-	-	-	-
amGard Pro Push IR (R1 to RZ)	-	-	-	-	-	-
amGard Pro Key Adapters	-	-	-	-	-	-
amGard Pro ST (STOP)	-	M	O	-	-	-
amGard Pro LOK (SL/SR; LL/LR; SE/LE)	M	M	O	O	O	O
Option Pods	-	-	-	O	O	O
Key switch option POD	-	M	-	-	-	-

Legend:

M: Part is mandatory

O: Part is optional

Component	Category/Performance Level	MTTF _d	DC _{AVG}	Document which states safety data
Richmeg Solenoid	Solenoid position is monitored by Siemens switches.	N/A	N/A	N/A
Siemens 3SB3411-xx safety switch	Cat 4 / PL e	B _{10d} 5 x 106	DC=high	Customer_letter_B10_e_070306.pdf (11/2/14)
Siemens Asi Interface	Cat 4 / PL e	PFH = 1 x 10 ⁻⁵ PFH = 1 x 10 ⁻⁹ K.1: >2200y	DC=high	3081.pdf (28/10/13)
B&W AS-i I/O Module	Cat 4 / PL e	PFH = 8,22E-10 SFF 98,81% K.1: >2500y	DC=high	Certificate BW2426.pdf (28/10/13)
Pilz MAG sensor	Cat 4 / PL e	B _{10d} =7,349972 MTTF _d =7,349972E6/(0,1*N _{op})= 73,49972*20years=1460Years	N/A	PSEnmag_TUEV-SEUD_(BM_M6A-11-08-20132-113_R1.3_valid_2015-Okt-07).pdf (28/10/13). Bestimmung_B10d_Werte_PSEnma1.3&ma1.4_(nur_2009-Mai-12).pdf
Pilz RFID sensor	Cat 4 / PL e	PFH = 2,62·10 ⁻⁰⁹ K.1: >800y	DC=high	PSENcode_TUEV-SEUD_(BM_M6A-11-08-20132-102_R1.3_valid_2014-Dez-29).pdf (28/10/13).
IXXAT Safe T100	Cat 4 / PL e	MTTF _d > 100y PFH= 2.44 E-9	DC=high	Certificate 968/EL 724.01/14, Manual: /B1/Safety Manual – Original Instructions IXXAT Safe T100 Product Version 1.0

Table 14: Quantitative analysis

Remark: When the first value in row “MTTF_d” is PFH, the corresponding value for MTTF_d was taken from EN ISO 13849-1, Table K.1

Result:

For the electrical versions of amGard Pro , the mean time to dangerous failure (MTTF_d) resulting from the calculation is “High” according to EN ISO 13849-1 (see [N2]) (30 years ≤ MTTF_d 2500 years). The maximum value of 100 years has been taken into account.

The diagnostic coverage (DC) of the amGard Pro calculated is “High” according to EN ISO 13849-1 (99% ≤ DC).

With the values of MTTF_d and DC, amGard Pro meets the quantitative requirements of Category 4 and PL e according to EN ISO 13849-1.

5.5 Software evaluation

The software of the amGard Pro Electrical Switching / Locking Bodies is only in the already certified Modules by Siemens (3RK1...), Bihl+Wiedemann GmbH (BW2426) and Pilz (PSEN-code).

5.5.1 Analysis of the software

Not applicable, as only certified products were connected to the switches of amGard Pro .

5.6 Mechanical Testing

The testing of the light based technical functions according to the report [R13] and [R33] was done at the amGard Pro .

Fault exclusion has been successfully carried out for the following mechanical components:

- Full stainless steel bolt interlock modules for one cylinder lock (BMS), and
- Full stainless steel cylinder locks with no dustcover (CLSN).

The assessment is only valid when the component is operated in the specified conditions of use:

Operating temperature:according to [N7]

Fatigue strength:according to [N7]

Vibration level:according to to [N7]

Environmental conditions:as specified by Fortress Interlocks Ltd.

Number of cycles:as specified by Fortress Interlocks Ltd.

Result:

Fault exclusion can be granted for the mechanical components of the analysed device within the declared lifetime.

Malfunctions of the device are only expected for misuse and forced abuse by the user; wear of the components that could lead to malfunctioning is not expected when the product specifications, i.e. the maximum number of operations, are met.

It shall be considered that the evaluated subsystem – being a component of the overall system – is only one part of the safety chain. For the evaluation and guarantee of the functional safety of the safety functions, further relevant subsystems must be considered. For that case, especially the distribution of the safety-relevant functions on the individual subsystems shall be considered.

The manufacturer declared a B10d – value of 5.000.000 operations. All cycle tests were stopped at 1.000.000 operations and showed minimal signs of wear and no failures. To substantiate the B10d – value beyond 1.000.000 definitely, tests have to be performed up to 5.000.000 cycles.

The results of the mechanic tests and the systematic analysis about the operating principal are documented in the reports [R13] and [R33].

5.7 Electrical Safety

The electrical safety was tested in accordance with [N1] and the regulations related to this standard.

Result:

The results about the electrical safety are documented in report [R2]. The tests demonstrated that the amGard Pro fulfils the requirements referring to the electrical safety.

5.8 Testing of the noise immunity

The strength of the design versus electromagnetic immunity was tested in accordance with [N1] and the regulations related to this standard.

Result:

The individual tests are documented in report [R14].

The test sample worked properly during and after the test.

5.9 Testing of the noise emission

The emission of noise was tested in accordance with [N14].

Result:

The individual tests are documented in report [R14].

The test sample worked properly during and after the test.

5.10 Verification of the degree of protection

The degree of protection was tested according to [N5].

Result:

The tests for the amGard Pro are recorded in reports [R10], [R11]. The requirements in accordance with [N5] are fulfilled.

5.11 Inspection of the technical documentation

The user information [D23] to [D57] was examined to verify the completeness of the technical documentation.

Result:

The results are documented in report [R6].

The technical documentation fulfils the requirements in accordance with [L1] and [N1].



6 Summary

The test results of clause 5 showed that the ToE, as specified in clause 2.1, fulfils the requirements of clause 3 and the related standards and guidelines.

Günter Greil
Reviewer

T. Kreten
Project Manager