Manual

HIMatrix®F

Functional Safety Data

MTTF, PFD and PFH

Contact

Document designation	Description
HI 800 578 D, Rev. 4.00 (2023)	German original document
HI 800 579 E, Rev. 4.00.00 (2025)	English translation of the German original document

Table of Contents

1 HIMatrix Functional Safety Data in Accordance with IEC 61508

The following chapter lists the values for MTTF, PFH and PFD in accordance with IEC 61508.

General	
Safety manual	HI 800 023 E, in the latest edition
Test standards	IEC 61508, Part 1 - 7:2010 IEC 61511, Part 1 - 3:2004
Certificate	EC Type-Examination Certificate 01/205/5236.01/16
Certified by	TÜV Rheinland Industrie Service GmbH

Table 1:   General Information (IEC 61508)

1.1 Functional Safety Data for the HIMatrix Compact Controllers, Remote I/Os and F60 Modules

The values indicated in the following tables were calculated in accordance with the IEC 61508 requirements and a detailed analysis (FMEDA).

Calculating the Functional Safety Data

The HIMatrix system is composed of highly complex modules. These modules are composed of different functional units (submodules) and different architectures (1oo1, 1oo2, etc.). These different functional units and architectures are taken into account when calculating the functional safety data. The results are examined and approved by TÜV Rheinland as part of the SIL certification of the modules.

No conclusions on the internal functional units and architectures can be drawn from the failure rates listed below (λ_S, λ_{DD}, λ_{DU}). The failure rates for a module are obtained by adding the failure rates of all module components, taking the internal structures into account. Determining the PFD/PFH value based on these failure rates results in a more conservative result.

Calculating the Safety Function

The calculation of the safety function performed by a user must be based on the following assumptions:

Parameter	Value / description
Type	B element
HFT	0 (internal redundant architectures)
MTTR = MRT	8 h
β factor	2 %
β_D factor	1 %
Mode of operation	Low demand / high demand
Safe state	In accordance with the de-energize to trip principle, see Chapter 1.1.1 In accordance with the energize to trip principle, see Chapter 1.1.2

Table 2:   Calculation Assumptions (IEC 61508)

---

i   All HIMatrix components must meet the operating requirements specified in the corresponding manuals as well as in the safety manual.

1.1.1   De-Energize to Trip Principle

1.1.1.1   Compact Controllers

The proof test interval T_1 indicated for the HIMatrix compact controllers is 10 years (T_1 = 10 years).

The following table shows the values for the HIMatrix compact controllers:

Controller	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
F30 03, F30 034	28.25	1.84E-06	1.25E-06	4.41E-09	5.40E-05	8.77E-10	99.86 %	3
F35 03, F35 032, F35 034	23.97	2.15E-06	1.40E-06	5.62E-09	5.84E-05	9.70E-10	99.84 %	3

Table 3:   Functional Safety Data for the HIMatrix Compact Controllers (De-Energize-to-Trip Principle)

1.1.1.2   Remote I/Os.

The proof test interval T_1 indicated for the remote I/Os is 10 years (T_1 = 10 years).

The following table shows the values for the HIMatrix remote I/Os:

Remote I/O	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
F1 DI 16 01	116.09	5.29E-07	2.83E-07	1.34E-09	2.55E-05	5.20E-10	99.84 %	3
F1 DI 16 014	66.80	7.45E-07	5.11E-07	2.78E-09	2.95E-05	5.93E-10	99.78 %	3
F2 DO 16 01	84.08	6.11E-07	3.26E-07	1.89E-09	2.11E-05	4.22E-10	99.80 %	3
F2 DO 16 014	47.58	8.95E-07	6.13E-07	3.79E-09	2.46E-05	4.83E-10	99.75 %	3
F2 DO 4 01	75.01	7.30E-07	3.48E-07	2.23E-09	3.34E-05	6.99E-10	99.79 %	3
F3 AIO 8/4 01	59.60	9.78E-07	5.92E-07	2.52E-09	4.15E-05	8.45E-10	99.84 %	3
F3 AIO 8/4 014	38.74	1.25E-06	9.78E-07	7.80E-09	1.95E-04	4.31E-09	99.65 %	3
F3 DIO 20/8 02	65.83	7.03E-07	4.16E-07	2.66E-09	3.39E-05	7.08E-10	99.76 %	3
F3 DIO 20/8 024	45.64	9.33E-07	6.56E-07	4.12E-09	3.72E-05	7.64E-10	99.74 %	3
F3 DIO 16/8 01								
2-pole	47.39	9.82E-07	4.88E-07	3.49E-09	4.76E-05	1.02E-09	99.76 %	3
1-pole	57.58	9.82E-07	4.88E-07	3.49E-09	4.76E-05	1.02E-09	99.76 %	3
F3 DIO 16/8 014								
2-pole	35.11	1.23E-06	7.44E-07	5.19E-09	5.09E-05	1.08E-09	99.74 %	3
1-pole	40.41	1.23E-06	7.44E-07	5.19E-09	5.09E-05	1.08E-09	99.74 %	3
F3 DIO 8/8 01	41.72	9.47E-07	6.60E-07	5.22E-09	3.66E-05	7.69E-10	99.68 %	3
F3 DIO 8/8 014	32.78	1.18E-06	8.96E-07	6.63E-09	3.95E-05	8.18E-10	99.68 %	3

Table 4:   Functional Safety Data for the Remote I/Os (De-Energize-to-Trip Principle)

The proof test interval T_1 indicated for the remote I/Os with relay outputs is 3 years (T_1 = 3 years).

The following table shows the values for the HIMatrix remote I/Os with relay outputs:

Remote I/O	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
F2 DO 8 01	69.05	7.79E-07	3.72E-07	2.32E-09	1.17E-05	6.74E-10	99.80 %	3
F2 DO 8 014	48.29	9.80E-07	6.00E-07	3.75E-09	1.30E-05	7.23E-10	99.76 %	3
F2 DO 16 02	61.49	9.35E-07	4.21E-07	2.85E-09	1.94E-05	1.23E-09	99.79 %	3

Table 5:   Functional Safety Data for the Remote I/Os with Relay Outputs (De-Energize-to-Trip Principle)

1.1.1.3 Modular F60 System

The proof test interval T_1 indicated for the HIMatrix F60 modules is 10 years (T_1 = 10 years).

The following table shows the values for the HIMatrix F60 modules:

Module	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
AI 8 01	64.22	6.41E-07	3.95E-07	3.83E-09	1.01E-05	2.24E-10	99.63 %	3
AI 8 014	65.96	6.17E-07	3.87E-07	3.75E-09	9.54E-06	2.12E-10	99.63 %	3
AO 8 01	88.19	6.23E-07	4.15E-07	2.55E-09	5.96E-05	1.31E-09	99.76 %	3
CIO 2/4 01	65.76	5.88E-07	3.42E-07	2.41E-09	2.15E-05	4.63E-10	99.74 %	3
CIO 2/4 014	70.95	5.63E-07	3.21E-07	2.20E-09	2.11E-05	4.54E-10	99.75 %	3
CPU 03	42.76	1.19E-06	1.02E-06	2.63E-09	3.16E-05	3.83E-10	99.88 %	3
CPU 034	42.78	1.19E-06	1.02E-06	2.63E-09	3.15E-05	3.82E-10	99.88 %	3
DIO 24/16 01	180.64	4.03E-07	1.65E-07	7.43E-10	2.06E-05	4.46E-10	99.87 %	3
DIO 24/16 014	172.92	4.24E-07	1.68E-07	7.47E-10	2.04E-05	4.41E-10	99.87 %	3
PS 01	102.86	9.93E-07	1.16E-07	7.54E-10	3.40E-05	7.54E-10	99.93 %	3
PS 014	99.15	1.03E-06	1.19E-07	8.36E-10	3.76E-05	8.36E-10	99.93 %	3
DI 32 01	683.77	1.16E-07	4.40E-08	1.72E-10	7.20E-06	1.57E-10	99.89 %	3
DI 32 014	683.77	1.16E-07	4.40E-08	1.72E-10	7.20E-06	1.57E-10	99.89 %	3
DO 8 01	112.37	5.24E-07	2.48E-07	2.50E-09	7.24E-05	1.62E-09	99.68 %	3
MI 24 01	66.10	7.93E-07	3.92E-07	3.11E-09	2.19E-05	4.76E-10	99.74 %	3
MI 24 014	65.35	7.78E-07	3.99E-07	3.21E-09	2.00E-05	4.35E-10	99.73 %	3

Table 6: Functional Safety Data for the F60 Modules (De-Energize-to-Trip Principle)

1.1.2   Energize to Trip Principle

1.1.2.1   Compact Controllers

The proof test interval T_1 indicated for the HIMatrix compact controllers is 10 years (T_1 = 10 years).

The following table shows the values for the HIMatrix compact controllers:

Controller	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
F30 03 F30 034	28.25	1.66E-06	1.54E-06	6.27E-09	1.89E-04	3.88E-09	99.80 %	3
F35 03, F35 032, F35 034	23.97	1.89E-06	1.77E-06	7.30E-09	1.86E-04	3.79E-09	99.80 %	3

Table 7:   Functional Safety Data for the Compact Controllers (Energize to Trip Principle)

1.1.2.2   Remote I/Os.

The proof test interval T_1 indicated for the remote I/Os is 10 years (T_1 = 10 years).

The following table shows the values for the HIMatrix remote I/Os:

Remote I/O	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
F1 DI 16 01	116.09	4.40E-07	3.72E-07	1.60E-09	3.78E-05	7.83E-10	99.80 %	3
F1 DI 16 014	66.80	6.59E-07	5.97E-07	3.03E-09	4.12E-05	8.46E-10	99.76 %	3
F2 DO 16 01	84.08	5.64E-07	4.83E-07	2.72E-09	1.08E-04	2.36E-09	99.74 %	3
F2 DO 16 014	47.58	8.47E-07	7.70E-07	4.62E-09	1.12E-04	2.42E-09	99.71 %	3
F2 DO 4 01	75.01	7.03E-07	4.86E-07	3.32E-09	1.33E-04	2.93E-09	99.72 %	3
F3 AIO 8/4 01	59.60	8.47E-07	7.23E-07	2.84E-09	7.63E-05	1.61E-09	99.82 %	3
F3 AIO 8/4 014	38.74	1.09E-06	9.67E-07	4.26E-09	7.90E-05	1.65E-09	99.79 %	3
F3 DIO 20/8 02	65.83	6.49E-07	5.79E-07	3.59E-09	1.25E-04	2.74E-09	99.71 %	3
F3 DIO 20/8 024	45.64	8.83E-07	8.17E-07	5.09E-09	1.31E-04	2.87E-09	99.70 %	3
F3 DIO 16/8 01								
2-pole	47.39	9.33E-07	7.48E-07	5.81E-09	2.93E-04	6.51E-09	99.66 %	3
1-pole	57.58	8.27E-07	6.43E-07	4.75E-09	1.98E-04	4.38E-09	99.68 %	3
F3 DIO 16/8 014								
2-pole	35.11	1.19E-06	1.00E-06	7.51E-09	2.96E-04	6.57E-09	99.66 %	3
1-pole	40.41	1.08E-06	8.95E-07	6.44E-09	2.01E-04	4.44E-09	99.67 %	3
F3 DIO 8/8 01	41.72	9.02E-07	8.13E-07	6.47E-09	3.68E-04	8.19E-09	99.62 %	3
F3 DIO 8/8 014	32.78	1.13E-06	1.05E-06	7.88E-09	3.69E-04	8.20E-09	99.64 %	3

Table 8:   Functional Safety Data for the Remote I/Os (Energize to Trip Principle)

The proof test interval T_1 indicated for the remote I/Os with relay outputs is 3 years (T_1 = 3 years).

The following table shows the values for the HIMatrix remote I/Os with relay outputs:

Remote I/O	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
F2 DO 8 01	69.05	6.82E-07	5.70E-07	3.43E-09	5.60E-05	3.80E-09	99.73 %	3
F2 DO 8 014	48.29	8.87E-07	7.94E-07	4.84E-09	5.72E-05	3.84E-09	99.71 %	3
F2 DO 16 02	61.49	7.68E-07	6.87E-07	4.81E-09	7.48E-05	5.16E-09	99.67 %	3

Table 9:   Functional Safety Data for the Remote I/Os with Relay Outputs (Energize to Trip Principle)

1.1.2.3 Modular F60 System

The proof test interval T_1 indicated for the HIMatrix F60 modules is 10 years (T_1 = 10 years).

The following table shows the values for the HIMatrix F60 modules:

Module	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
AI 8 01	64.22	5.51E-07	4.86E-07	4.10E-09	2.25E-05	4.91E-10	99.61 %	3
AI 8 014	65.96	5.31E-07	4.73E-07	4.02E-09	2.18E-05	4.76E-10	99.60 %	3
AO 8 01	88.19	5.20E-07	5.17E-07	3.58E-09	1.70E-04	3.79E-09	99.66 %	3
CIO 2/4 01	65.76	5.48E-07	3.82E-07	2.81E-09	7.97E-05	1.77E-09	99.70 %	3
CIO 2/4 014	70.95	5.23E-07	3.61E-07	2.60E-09	7.93E-05	1.76E-09	99.71 %	3
CPU 03	42.76	1.14E-06	1.07E-06	3.09E-09	5.20E-05	8.42E-10	99.86 %	3
CPU 034	42.78	1.14E-06	1.07E-06	3.09E-09	5.18E-05	8.37E-10	99.86 %	3
DIO 24/16 01	180.64	3.79E-07	1.88E-07	9.80E-10	5.65E-05	1.25E-09	99.83 %	3
DIO 24/16 014	172.92	3.88E-07	2.03E-07	1.11E-09	6.19E-05	1.37E-09	99.81 %	3
PS 01	102.86	5.56E-07	5.53E-07	3.48E-09	1.57E-04	3.48E-09	99.69 %	3
PS 014	99.15	5.76E-07	5.72E-07	3.96E-09	1.78E-04	3.96E-09	99.66 %	3
DI 32 01	683.77	9.07E-08	6.94E-08	4.29E-10	1.87E-05	4.13E-10	99.73 %	3
DI 32 014	683.77	9.07E-08	6.94E-08	4.29E-10	1.87E-05	4.13E-10	99.73 %	3
MI 24 01	66.10	6.53E-07	5.32E-07	3.65E-09	4.65E-05	1.01E-09	99.69 %	3
MI 24 014	65.35	6.41E-07	5.35E-07	3.74E-09	4.43E-05	9.63E-10	99.68 %	3

Table 10: Functional Safety Data for the F60 Modules (Energize to Trip Principle)

The proof test interval T_1 indicated for the HIMatrix F60 relay module is 3 years (T_1 = 3 years).

The following table shows the values for the HIMatrix F60 relay modules:

Module	MTTF in years	λ_S / h^{-1}	λ_{DD} / h^{-1}	λ_{DU} / h^{-1}	PFD	PFH / h^{-1}	SFF	SIL
DO 8 01	112.37	3.87E-07	3.84E-07	3.87E-09	7.08E-05	5.08E-09	99.50 %	3

Table 11: Functional Safety Data for the F60 Relay Module (Energize to Trip Principle)

2 HIMatrix Functional Safety Data in Accordance with EN ISO 13849

The following chapter lists the values in accordance with EN ISO 13849.

General	
Safety manual	HI 800 023 E, in the latest edition
Test standards	EN ISO 13849-1:2015 EN 62061:2005 + Cor.:2010 + A1:2013 + A2:2015
Certificate no.	EC Type-Examination Certificate 01/205/5236.01/16
Certified by	TÜV Rheinland Industrie Service GmbH

Table 12:   General Information (EN ISO 13849)

2.1 Functional Safety Data for the HIMatrix Compact Controllers, Remote I/Os and F60 Modules

The values specified in the following tables were calculated in accordance with the
EN ISO 13849-1 and IEC 61508 requirements.

Calculating the Safety Function

The calculation of the safety function performed by a user must be based on the following assumptions:

Parameter	Value / description
Type	B element
HFT	0 (internal redundant architectures)
MTTR = MRT	8 h
β factor	2 %
β_D factor	1 %
Mode of operation	Low demand / high demand
Safe state	In accordance with the de-energize to trip principle

Table 13:   Calculation Assumptions (EN ISO 13849)

i   All HIMatrix components must meet the operating requirements specified in the corresponding manuals as well as in the safety manual.

2.1.1　Compact Controllers

With a proof test of 20 years (T_1 = 20 years), the following values are obtained for the HIMatrix compact controllers:

Controller	$PFH_{IEC\ 61508}$ / h^{-1}	PL
F30 03, F30 034	8.77E-10	e
F35 03, F35 032, F35.034	9.70E-10	e

Table 14:　Functional Safety Data for the HIMatrix Compact Controllers (EN ISO 13849)

2.1.2　Remote I/Os.

With a proof test of 20 years (T_1 = 20 years), the following values are obtained for the HIMatrix remote I/Os:

Remote I/O	$PFH_{IEC\ 61508}$ / h^{-1}	PL
F1 DI 16 01	5.20E-10	e
F1 DI 16 014	5.94E-10	e
F2 DO 4 01	6.99E-10	e
F2 DO 8 01	6.74E-10	e
F2 DO 8 014	4.84E-10	e
F2 DO 16 01	4.22E-10	e
F2 DO 16 014	4.84E-10	e
F2 DO 16 02	1.23E-09	e
F3 AIO 8/4 01	8.45E-10	e
F3 AIO 8/4 014	4.31E-09	e
F3 DIO 20/8 02	7.08E-10	e
F3 DIO 20/8 024	7.64E-10	e
F3 DIO 16/8 01	1.02E-09 [1]	e
F3 DIO 16/8 014	1.08E-09 [1]	e
F3 DIO 8/8 01	7.69E-10	e
F3 DIO 8/8 014	8.19E-10	E
[1]　The value applies to 1-pole and 2-pole connections.		

Table 15:　Functional Safety Data for the HIMatrix Remote I/Os (EN ISO 13849)

2.1.3   Modular F60 System

With a proof test of 20 years (T_1 = 20 years), the following values are obtained for the HIMatrix F60 module:

Module	$PFH_{IEC\ 61508}$ / h^{-1}	PL
AI 8 01	2.25E-10	e
AI 8 014	2.13E-10	e
AO 8 01	1.31E-09	e
CIO 2/4 01	4.63E-10	e
CIO 2/4 014	4.54E-10	e
CPU 03	3.84E-10	e
CPU 034	3.83E-10	e
DIO 24/16 01	4.46E-10	e
DIO 24/16 014	4.41E-10	e
PS 01	7.54E-10	e
PS 014	8.36E-10	e
DI 32 01	1.57E-10	e
DI 32 014	1.57E-10	e
DO 8 01	1.62E-09	e
MI 24 01	4.77E-10	e
MI 24 014	4.36E-10	e

Table 16:   Functional Safety Data for the F60 Modules (EN ISO 13849)

Appendix

Index of Tables

MANUAL
Functional Safety Data

HI 800 579 E

For further information, please contact:

HIMA Paul Hildebrandt GmbH
Albert-Bassermann-Str. 28
68782 Brühl, Germany

Phone   +49 6202 709-0
Fax   +49 6202 709-107
E-mail   info@hima.com

Learn more about HIMatrix online:

🌐 https://www.hima.com/en/products-
services/himatrix/

www.hima.com