



## **FMEDA including SFF determination and PFD calculation**

Project:

Transformer Isolated Barriers KF\*\*-SR2-\*\*\*

Customer:

**Pepperl+Fuchs GmbH**  
Mannheim  
Germany

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## Management summary

This report summarizes the results of the FMEDAs carried out on the transformer isolated barriers KF\*\*-SR2-\*\*\*. '\*\*\*' and '\*\*\*\*' stand for the different versions that are available. Table 1 gives an overview and explains the differences.

Depending on the setting of switch S1/S2 (two channel unit) or only S1 (single channel unit) the mode of operation can be configured. The results given in this report are meant for S1/S2 (two channel unit) or only S1 (single channel unit) in position I which is considered to be the normal mode of operation and S1/S2 (two channel unit) or only S1 (single channel unit) in position II which is considered to be the inverse mode of operation. For safety reasons the third switch S3 shall always be set to LB/SC<sup>1</sup> activated (position I).

A FMEDA is one of the steps taken to achieve functional safety certification 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 certification purposes all requirements of IEC 61508 must be considered.

**Table 1: Version overview**

Type	Supply voltage	Number of channels	Output contacts per channel	Error contact <sup>2</sup>	Housing
KFD2-SR2-Ex2.W <sup>3</sup>	24 VDC	2	1 change over	-	DIN-rail
KFD2-SR2-Ex1.W	24 VDC	1	1 change over	-	DIN-rail
KFD2-SR2-Ex1.W.LB	24 VDC	1	1(2) change over	yes	DIN-rail
KFA4-SR2-Ex2.W	100 VAC	2	1 change over	-	DIN-rail
KFA4-SR2-Ex1.W	100 VAC	1	1 change over	-	DIN-rail
KFA4-SR2-Ex1.W.LB	100 VAC	1	1(2) change over	yes	DIN-rail
KFA5-SR2-Ex2.W	115 VAC	2	1 change over	-	DIN-rail
KFA5-SR2-Ex1.W	115 VAC	1	1 change over	-	DIN-rail
KFA5-SR2-Ex1.W.LB	115 VAC	1	1(2) change over	yes	DIN-rail
KFA6-SR2-Ex2.W	230 VAC	2	1 change over	-	DIN-rail
KFA6-SR2-Ex1.W	230 VAC	1	1 change over	-	DIN-rail
KFA6-SR2-Ex1.W.LB	230 VAC	1	1(2) change over	yes	DIN-rail
KFD2-SR2-Ex2.2S <sup>4</sup>	24 VDC	2	2 normally open	-	DIN-rail

The failure rates are based on the Siemens standard SN 29500.

According to table 2 of IEC 61508-1 the average PFD for systems operating in low demand mode has to be  $\geq 10^{-3}$  to  $< 10^{-2}$  for SIL 2 safety functions. However, as the modules under consideration are only one part of an entire safety function they should not claim more than 10% of this range, i.e. they should be better than or equal to  $10^{-3}$ .

The KF\*\*-SR2-\*\*\* boards are considered to be Type B components.

<sup>1</sup> LB: Lead Breakage, SC: Short Circuit

<sup>2</sup> Error message output for LB/SC (Lead Breakage / Short Circuit) at the input.

<sup>3</sup> W: change over contact

<sup>4</sup> 2S: 2 normally open contacts per channel

For Type B components the SFF has to be 90% to < 99% according to table 3 of IEC 61508-2 for SIL 2 (sub-) systems with a hardware fault tolerance of 0.

However, according to the requirements of IEC 61511-1 draft d1FDIS 15/08/01 section 11.4.4 and the assessment described in section 5.1 a SFF of 60% to < 90% is sufficient for SIL 2 (sub-) systems being Type B components and having a hardware fault tolerance of 0.

The following table shows which boards (considering one input and one output being part of the safety function) fulfill this requirement.

**Table 2: Summary of all considered KF\*\*-SR2-\*\*\* boards<sup>5</sup>**

Name	T[Proof] = 1 year	T[Proof] = 2 years	T[Proof] = 5 years	SFF
KFD2-SR2-Ex2.W	PFD <sub>AVG</sub> = 3.17E-04	PFD <sub>AVG</sub> = 6.33E-04	PFD <sub>AVG</sub> = 1.58E-03	> 74 %
KFD2-SR2-Ex1.W	PFD <sub>AVG</sub> = 3.17E-04	PFD <sub>AVG</sub> = 6.33E-04	PFD <sub>AVG</sub> = 1.58E-03	> 74 %
KFD2-SR2-Ex1.W.LB	PFD <sub>AVG</sub> = 3.17E-04	PFD <sub>AVG</sub> = 6.33E-04	PFD <sub>AVG</sub> = 1.58E-03	> 74 %
KFA4-SR2-Ex2.W	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA4-SR2-Ex1.W	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA4-SR2-Ex1.W.LB	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA5-SR2-Ex2.W	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA5-SR2-Ex1.W	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA5-SR2-Ex1.W.LB	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA6-SR2-Ex2.W	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA6-SR2-Ex1.W	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFA6-SR2-Ex1.W.LB	PFD <sub>AVG</sub> = 2.85E-04	PFD <sub>AVG</sub> = 5.70E-04	PFD <sub>AVG</sub> = 1.42E-03	> 71 %
KFD2-SR2-Ex2.2S	PFD <sub>AVG</sub> = 3.70E-04	PFD <sub>AVG</sub> = 7.39E-04	PFD <sub>AVG</sub> = 1.85E-03	> 74 %

The boxes marked in yellow (   ) mean that the calculated PFD values are within the allowed range for SIL 2 according to table 2 of IEC 61508-1 but do not fulfill the requirement to not claim more than 10% of this range, i.e. to be better than or equal to  $10^{-3}$ . The boxes marked in green (   ) mean that the calculated PFD values fulfill this requirement to be better than  $10^{-3}$ .

The two channels on each module shall not be used to increase the hardware fault tolerance needed for a higher SIL as they contain common components.

<sup>5</sup> The results are based on the FMEDAs carried out at the “two channel” versions but are considered to be the same for the “one channel” versions as also for the “two channel” versions only one channel was considered. The table represents the results of the normal mode of operation. The values of the inverse mode of operation are equal or slightly better.