1 Function description

The standstill monitor KFD2-SR2-**.W.SM can be operated with the function of a standstill monitor with start-up override or as a standstill monitor with direction of rotation signalling. The function is selected using DIP switch 3.

The limit values for standstill detection can be selected using DIP switches 1 and 2 (for details see data sheet).

The device is equipped with 2 inputs and has a maximum input frequency of 2000 Hz

- The current firmware version is 2v0.
- The current hardware version is 1v0.

Function start-up override

The input pulses at input 1 are used for the standstill monitoring. The input is monitored for lead faults (LB – lead breakage/SC – short-circuit) (for Ex version).

Input 2 is used to trigger the start-up override. Two time intervals are available (5 s and 20 s). In this case the device reverts to the "no standstill" condition for the duration of the start-up override. No lead monitoring takes place in this condition.

Function direction of rotation signal

In this case both inputs are used for the standstill monitoring. If one of the two channels fails, then the remaining functional input is used for the standstill monitoring. In addition, a direction of rotation is determined via the sequence of the input signals of the two overlapping input signals. This direction of rotation is output via relay 2. Both inputs are monitored for lead faults (in the Ex version).

Behaviour in the event of a fault

- Monitoring for lead faults (in the Ex version)
- Continuous monitoring of the device for internal memory faults

On the occurrence of a fault, both relays revert to the safe condition, the red LEDs signal the fault and a collective error is output via the Power Rail (Ex devices only).

2 Use of the KFD2-SR2-**2.W.SM in the context of SIL2 applications

Make sure, that in the critical condition of the application the relays have dropped out (are passive). Then, in the case of power failure (dropped out relay) a safety "GO state" (relay pulled in) cannot occur.

This behaviour shall be tested before commissioning the system.

Example 1

The protective screen of a rotating shaft should remain locked until the shaft is at a standstill. The safety-critical condition is the rotating shaft (risk of injury). For this reason the locking of the protective screen should be achieved by means of a dropped out (passive) relay. The relay does not pull in (become active) until the shaft has stopped (safety GO state). This device function is only achieved with "standstill monitoring with start-up override" (S3 = I) and control of the protective screen with relay 2.

Example 2

The cooling of a critical process by means of a fan/coolant pump is to be monitored. The safety-critical state is the standstill of the fan/pump (overheating). For this reason the triggering of an alarm is achieved by means of a dropped out (passive) relay. As long as the fan or the pump is running (safety GO state) the relay is pulled in (active). This device function can be achieved with "standstill monitoring with start-up override" (S3 = I) and "standstill monitoring with direction of rotation signal" (S3 = II) with relay 1.

Further information on boundary and ambient conditions is provided in the associated data sheet.

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3 Safety and installation instructions

The standstill monitor KFD2-SR2-**2.W.SM must only be operated by trained specialist personnel and in accordance with the data sheet.

The protection of the operating personnel and of the plant is only guaranteed when these devices are used for their intended application. Any other operation than that described in the data sheet and the safety instructions places the safety and function of the devices and connected systems in question.

In the event that faults cannot be eliminated, the devices should be switched off and protected against inadvertent restart. The devices must only be repaired by the manufacturer Pepperl+Fuchs. Interventions within the devices and modifications to them are dangerous and are therefore not permissible. Such actions will render any claims against the warranty null and void and will also negate the approval in accordance with SIL2.

Malfunctioning of the devices should be reported to the manufacturer Pepperl+Fuchs.

The standstill monitors are constructed to protection class IP21 and must accordingly be protected against adverse ambient conditions (water, small foreign bodies, etc.).

4 Failure rates

The failure rates and related characteristics are given in section 6 and the FMEDA. The mean probability of failure PFD is given in section 5.

The standstill monitor KFD2-SR2-**2.W.SM is categorised for the Safety Integrity Level SIL2. In the assessment of a complete system in which the standstill monitor is to be used, the failure rate of the complete loop must be considered.

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5 Product life and maintenance

Product life is limited by the following parameters:

- Mechanical life of the relay of at least 2.5 x 10^5 operating cycles at maximum permissible load (500 VA) in accordance with the data sheet.

  At a contact loading of approx. 50 mW the life is approx. 5 x 10^6 operating cycles.
- Life of the flash memory: approx. 12 years
- Life of the Elko: approx. 15 years

For devices, which are used in the "Low Demand Mode", the appraisal has to be made in the context of the maintenance of the total system, but after 5 years at the latest.

PFD for devices with lead breakage detection after 5 years: **5.62E-4**

PFD for devices without lead breakage detection after 5 years: **5.81E-4**

For the detection of random faults, which have been categorised by the FMEDA as "undetected dangerous", the following tests are to be carried out during the maintenance intervals:

- Application of a frequency smaller than 10 % of the set limit frequency -> the relay must switch in accordance with the data in the data sheet.
- Application of a frequency greater than 10 % of the set limit frequency + associated hysteresis -> relay must switch in accordance with the data in the data sheet.
- When examining the switching states of the relay, a check has to be made in the dropped out condition to check whether the normally closed contact (NC) has a low resistance and the normally open contact (NO) has a high resistance (welding of the contacts).
- When examining the switching states of the relay, a check has to be made in the pulled in condition to check whether the normally closed contact (NC) has a high resistance (welding of the contacts) and the normally open contact (NO) has a low resistance (only necessary in the sense that it is available).

By means of these tests 95 % of all faults that have been categorised as "undetected dangerous" can be detected.

An early fault detection is not included in the functionality of the KFD2-SR2-**2.W.SM.

Recalibration is not necessary.

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6 Validation

The validation of the SIL2 capability of the standstill monitor KFD2-SR2-**2.W.SM took place in the context of an assessment with EXIDA. The appropriate documents are available on the Internet or directly from Pepperl+Fuchs.

The value 0 has been taken as the hardware fault tolerance in accordance with Table B in EN 61508-2 (7.4.3.1.3).

The failure rates used are based on the "Basic Failure Rates" from the Siemens Standard SN29500.

In addition, the following assumptions have been made:

- Failure rates are constant, wear has not been taken into account.
- Fault propagations are not relevant.
- After a "Safe Failure" the repair time is 8 hours.
- The "Low Demand Mode" has been assumed.
- The failure rates of external power supplies have not been accounted for.
- Connected sensors have not been accounted for in the failure rates.
- Output 1 has been considered to be the safety-relevant output.
- Either the classification MIL-HNBK-217F or IEC 645-1 class C (max. temperature corresponds to the manufacturer's data) with an average ambient temperature of 40°C can be taken as the ambient condition.
- The test time, within which the logic control unit must react to a "Dangerous Detected" failures, is one hour.

The following SFF and failure rates have been determined for the standstill monitor KFD2-SR2-**2.W.SM:

With lead fault detection

λ_{sd} = 11 FIT

λ_{su} = 248 FIT

λ_{dd} = 90 FIT

λ_{du} = 26 FIT

SFF = 91.25 %

DC_S = 4.25 %

DC_D = 77.59 %

Without lead fault detection

λ_{sd} = 9 FIT

λ_{su} = 247 FIT

λ_{dd} = 90 FIT

λ_{du} = 27 FIT

SFF = 90.91 %

DC_S = 3.52 %

DC_D = 76.92 %

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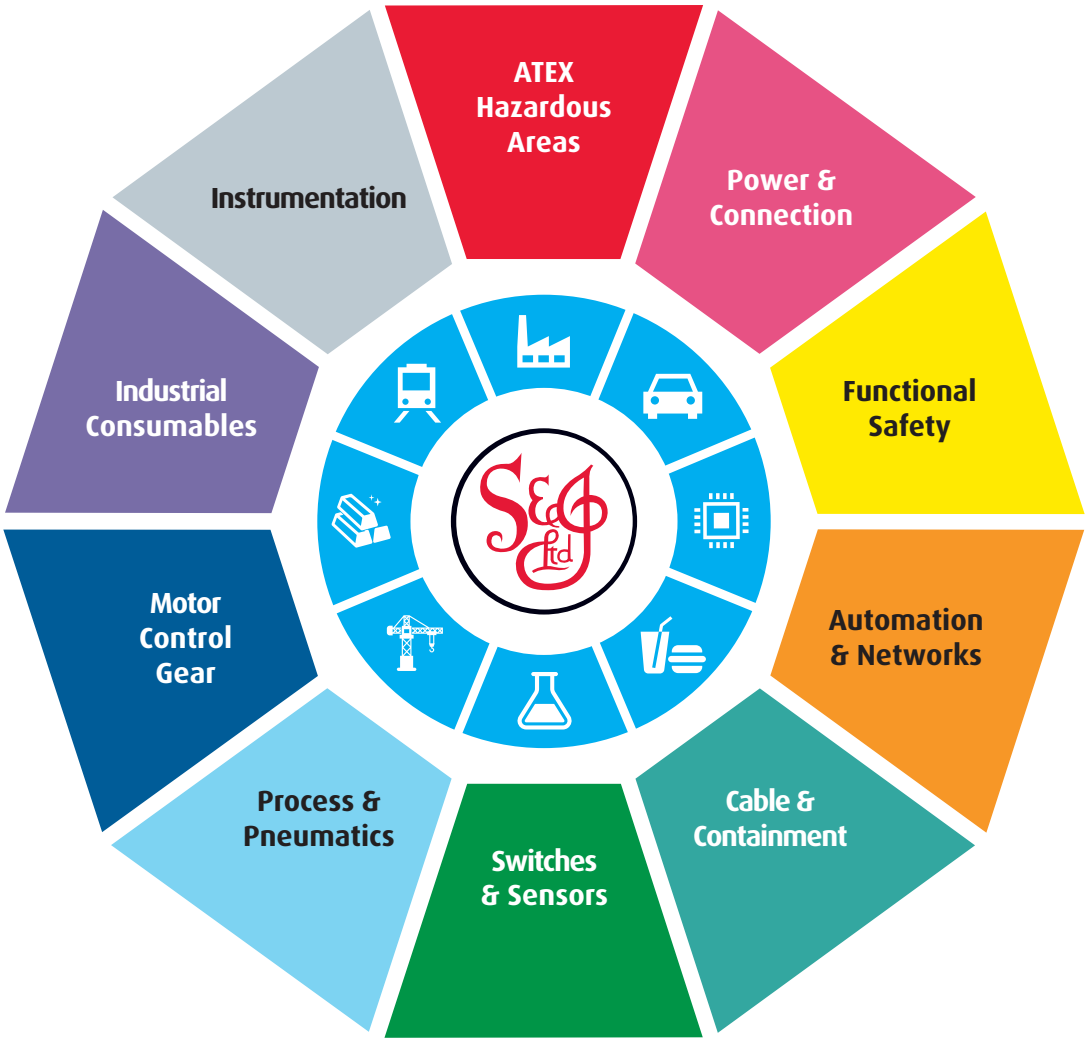

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