Failure Modes, Effects and Diagnostic Analysis

Project:
FLS-IR3-HD-XXXX and FLS-IR3-H2-HD-XXXX flame detectors

Customer:
Fire & Gas Detection Technologies Inc.
Anaheim, CA
USA

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Management summary

This report summarizes the results of the hardware assessment carried out on the FlameSpec-IR3-(H2)-HD flame detectors with hardware versions as listed in the drawings referenced in section 2.5.1 and software version F100P0010.38.

FlameSpec-IR3-HD (FLS-IR3-HD-XXXX [1])	The FlameSpec-IR3-HD flame detector provides ultra-fast response and reliable detection of all types of hydrocarbon fires (visible and non-visible). The detector addresses slow growing fires as well as fast eruption of fire using triple IR (IR3) technology.
FlameSpec-IR3-H2-HD (FLS-IR3-H2-HD-XXXX [1])	The FlameSpec-IR3-H2-HD flame detector provides ultra-fast response and reliable detection of hydrogen (H_2) fires. The detector addresses slow growing fires as well as fast eruptions of fire using triple IR (IR3) technology.

The following two safety functions have been evaluated.

SF01	Normal detection of flame
SF02	Fast detection of flame

As the differences in terms of failure rates between these two safety functions are relatively small only the worst-case results are presented in this report.

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

The failure modes used in this analysis are from the *exida* Electrical Component Reliability Handbook (see [N2]). The failure rates used in this analysis are the basic failure rates from the Siemens standard SN 29500 (see [N3]). This failure rate database is specified in the safety requirements specification from Fire & Gas Detection Technologies Inc. for the FlameSpec-IR3-(H2)-HD flame detectors.

The FlameSpec-IR3-(H2)-HD flame detectors element can be considered to be Type B[2] elements with a hardware fault tolerance of 0 according to IEC 61508.

The failure rates are valid for the useful life of the considered FlameSpec-IR3-(H2)-HD flame detectors (see Appendix A) when operating as defined in the considered scenarios.

The failure rates listed in this report do not include failures due to wear-out of any components. They reflect random failures and include failures due to external events, such as unexpected use, see section 4.2.3.

The following tables show how the above stated requirements are fulfilled for the FlameSpec-IR3-(H2)-HD flame detectors.

[1] The model number includes several options that are defined by the suffix XXXX.
First X defines the certification type (A – ATEX and FM or others)
Second X defines housing type (S – Stainless steel, A – Aluminum)
Third X defines the conduit entry thread type (1 – M25, 2 – ¾ NPT)
Fourth X is optional and is 1.

[2] Type B element:
"Complex" element (using micro controllers or programmable logic); for details see 7.4.4.1.3 of IEC 61508-2:2010

Table 1: Failure rates and safety metrics according to IEC 61508 – current output

Failure category	Failure rates (in FIT)
Safe Detected (λ_{SD})	15
Safe Undetected (λ_{SU})	377
Dangerous Detected (λ_{DD})	576
Dangerous Undetected (λ_{DU})	69
Total failure rate (safety function)	1037
SFF	93%
SIL AC [3]	SIL 2

Table 2: Failure rates and safety metrics according to IEC 61508 – relay output

Failure category	Failure rates (in FIT)
Safe Detected (λ_{SD})	15
Safe Undetected (λ_{SU})	522
Dangerous Detected (λ_{DD})	448
Dangerous Undetected (λ_{DU})	171
Total failure rate (safety function)	1156
SFF	85%
SIL AC [2]	SIL 1

[3] 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. In addition, it must be shown that the device has a suitable systematic capability for the required SIL and that the entire safety function can fulfill the required PFD_{AVG} values.