



Failure Modes, Effects and Diagnostic Analysis

Project:
Earth-Rite II

Company:
Newson Gale Ltd.
Colwick, Nottingham
UK

REPORT SUMMARY

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Management Summary

This report summarizes the results of the hardware assessment in the form of a Failure Modes, Effects, and Diagnostic Analysis (FMEDA) of the Earth-Rite II, hardware revision A. A Failure Modes, Effects, and Diagnostic Analysis is one of the steps to be taken to achieve functional safety certification per IEC 61508 of a device. From the FMEDA, failure rates and Safe Failure Fraction are determined. The FMEDA that is described in this report concerns only the hardware of the Earth-Rite II. For full functional safety certification purposes all requirements of IEC 61508 must be considered.

The Earth-Rite II is an electronic device used to measure safety ground integrity. For safety instrumented systems usage it is assumed that the relay output is used as the primary safety variable.

Table 1 gives an overview of the different versions that were considered in the FMEDA of the Earth-Rite II.

Table 1 Version Overview

Earth-Rite II RTR AC	with Road Tanker Recognition, powered from 115 or 230 V 50/60 Hz AC mains
Earth-Rite II RTR DC	with Road Tanker Recognition, powered from 10 – 30 V DC
Earth-Rite II PLUS Single Mode AC	powered from 115 or 230 V 50/60 Hz AC mains
Earth-Rite II PLUS Single Mode DC	powered from 10 – 30 V DC

The Earth-Rite II is classified as a Type A¹ device according to IEC 61508, having a hardware fault tolerance of 0.

The analysis shows that the device has a Safe Failure Fraction between 60% and 90% and therefore meets hardware architectural constraints for up to SIL 2 as a single device.

The failure rates for the Earth-Rite II are listed in Table 2 - Table 5.

¹ Type A device: "Non-Complex" subsystem (using discrete elements); for details see 7.4.3.1.2 of IEC 61508-2

Table 2 Failure rates Earth-Rite II RTR AC

Failure Category	Failure Rate (FIT)
Fail Safe Undetected	286
Fail Dangerous Detected	0
Fail Dangerous Undetected	142
Residual	118

Table 3 Failure rates Earth-Rite II RTR DC

Failure Category	Failure Rate (FIT)
Fail Safe Undetected	436
Fail Dangerous Detected	0
Fail Dangerous Undetected	147
Residual	197

Table 4 Failure rates Earth-Rite II PLUS Single Mode AC

Failure Category	Failure Rate (FIT)
Fail Safe Undetected	168
Fail Dangerous Detected	0
Fail Dangerous Undetected	70
Residual	87

Table 5 Failure rates Earth-Rite II PLUS Single Mode DC

Failure Category	Failure Rate (FIT)
Fail Safe Undetected	318
Fail Dangerous Detected	0
Fail Dangerous Undetected	76
Residual	166

These failure rates are valid for the useful lifetime of the product, see Appendix A.

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 4.2.2.

Table 6 lists the failure rates for the Earth-Rite II according to IEC 61508.

Table 6 Failure rates according to IEC 61508

Device	λ_{SD}	λ_{SU}^2	λ_{DD}	λ_{DU}	SFF ³
Earth-Rite II RTR AC	0 FIT	404 FIT	0 FIT	142 FIT	74.0%
Earth-Rite II RTR DC	0 FIT	633 FIT	0 FIT	147 FIT	81.1%
Earth-Rite II PLUS Single Mode AC	0 FIT	255 FIT	0 FIT	70 FIT	78.5%
Earth-Rite II PLUS Single Mode DC	0 FIT	484 FIT	0 FIT	76 FIT	86.4%

A user of the Earth-Rite II can utilize these failure rates in a probabilistic model of a safety instrumented function (SIF) to determine suitability in part for safety instrumented system (SIS) usage in a particular safety integrity level (SIL). A full table of failure rates is presented in section 4.4 along with all assumptions.

² It is important to realize that the Residual failures are included in the Safe Undetected failure category according to IEC 61508. Note that these failures on their own will not affect system reliability or safety, and should not be included in spurious trip calculations

³ Safe Failure Fraction needs to be calculated on (sub)system level