Functional Safety Assessment Report

Product assessed:	TX6373 Toxic Gas Detector with 4-20mA output
Manufacturer:	Trolex Ltd
Report number:	RPT14007-1AA
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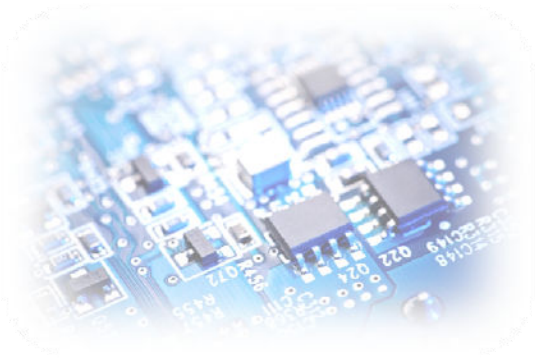

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This is an abridged version (intended for open disclosure) of the full report RPT14007-1A, rev 1.0 (43 pages, client confidential). It may only be reproduced in its entirety and without change

1 Scope of assessment

This report is a summary of an independent assessment of the TX6373 Toxic Gas Detector against the requirements of IEC 61508-2:2010 according to the 'Route 2_H' and the 'Route 2_S' approach (also known as 'proven in use') from this Standard. The objective of meeting these requirements is to qualify the product for use in representative applications performing safety functions assigned with a Safety Integrity Level (SIL). The information in this document is extracted from the full product assessment report RPT14007-1A, rev 0.2 (43 pages, client confidential).

The evaluations included:

- Hardware and systematic safety integrity of the TX6373 based on analysis and statistical inference from field failure data for a large number of units gathered from end-users over several years of service in specific subsystem configurations
- Associated product documentation (e.g., the safety manual) to support the unit's selection and integration into safety-related systems in similar applications and environments
- Functional safety management within Trolex to support the ongoing monitoring and validity of the product's reliability performance and integrity applicable to future sales of the unit

The assessment has been carried out with reference to the *Conformity Assessment of Safety-related Systems* (CASS) methodology (www.cass.uk.net).

2 Compliance statements

Results of the assessment confirm that:

1) The versions and configurations of the TX6373 identified in this report comply with the relevant requirements of IEC 61508-2:2010
2) The stated safety function of this product when configured in the manner described in this report is suitable for use in safety instrumented functions up to and including:

    - **SIL 2** when used in a 'Low Demand' safety function [1]
    - **SIL 1** when used in a 'High Demand' safety function [1]

The functional safety data (below) must be taken into account by integrators and end-users, including compliance with the restrictions in use (below) and all other provisions in the Safety Manual.

System integrators and end users responsible for other lifecycle phases (system specification, integration, installation, commissioning, operation, maintenance, etc) need to perform assessments on the complete scope of their activities to ensure the overall safety function is achieved and maintained.

[1] Low Demand and High Demand modes of operation are defined in IEC 61508-4, 3.5.16

3 Summary of the verified functional safety data

The product, configuration and safety manual that have been assessed are shown in Table 1.

PRODUCT INFORMATION	DETAILS
Product identification	TX6373.01.12 / TX6373.84.01.12 / TX6373.02.12 / TX6373.84.02.12 Toxic Gas Sensor
Product specification	Contained in the TX6373 User Manual, issue M, 10/14
Product configuration	4-20mA outputs; Sensor types: CO, H_2S, SO_2, H_2, NH_3, NO_2, Cl_2, NO, O_2
System configuration	2/3-wire (current loop) or 4-wire powered connection; power supply and load as specification (noting Group I certified equipment requirements)
Element Safety Function	To produce a 4-20mA output that correlates with a specific toxic gas concentration range
Safety Manual	TX6373 Installation and operating data (section 11) issue M, 10/14

Table 1: Basic element information

Modifications to the product or it's documentation (e.g., Safety Manual) shall require re-assessment in order not to invalidate the compliance statements in this report.

The hardware failure data for the TX6373 element safety function based on the analysis of field failure data, using the single-sided χ^2 (chi-square) estimation method at 90% confidence, is shown in Table 2.

PARAMETER	VALUE
Dangerous failure rate (λ_D)	3.1E-07
Safe failure rate (λ_S)	N/R [1]
Safe failure fraction (SFF)	N/R [1]
Element type	Type B
Hardware fault tolerance (internal architecture)	0
Diagnostic coverage (DC)	60%
Diagnostic test interval	N/A [2]
Probability of Failure on Demand (PFD_{AVG}) [1 year proof test; 24hr MTTR]	1.4 E-03 [3]
Probability of Failure on Demand (PFD_{AVG}) [3mth proof test; 24hr MTTR]	3.5 E-04 [3]
Probability of dangerous Failure per Hour (PFH)	3.1E-07

Table 2: Hardware failure data

[1] Not required by Route 2_H
[2] This parameter is determined by the controller being used
[3] No credit has been taken for effectiveness of the diagnostics in this value

4 Additional information relevant to the assessment

Hardware safety integrity

Meets the requirements for Route 2_H (IEC 61508-2, 7.4.4.3) based on component reliability data fed back from end users, increased confidence levels and hardware fault tolerance for specified safety integrity levels

Systematic safety integrity

Meets the requirements for Route 2_S (IEC 61508-2, 7.4.10) based on proven-in-use evidence in restricted and specified configurations;
Meets systematic capability level: SC 2

Management of functional safety

This product is manufactured and supplied under a quality management system that includes the relevant aspects of functional safety management from IEC 61508 that apply to Route $2_H/2_S$

5 Restrictions and conditions of use

Restrictions in use

The Safety Manual shall be strictly complied with to ensure validity of the failure data and systematic safety integrity. The following *additional* restrictions and conditions apply when the unit used in SIL applications:

1. The host controller must monitor the TX6373 output at an appropriate frequency for the application (safety time) and initiate a safe action (e.g., process shutdown, evacuation, etc) or be repaired within the MTTR assumed in the PFD calculations shown in the table above if an out-of-range (low) output signal is indicated
2. If the MTTR or the proof test interval (T_1) is different from those assumed in this document, then the PFD_{AVG} must be re-calculated and the SIL capability re-verified accordingly (refer to Safety Manual)
3. The display is for indication only and is not part of the safety function
4. The environmental limits are restricted to: +20 to +40 deg C; relative humidity < 90%
5. IEC 61508-2, 7.4.4.3.1c limits use to SIL 1 in high or continuous mode of operation when used in a non-redundant configuration
6. The unit must be calibrated at commissioning and at 3 month intervals during operation and the sensor head replaced as indicated by the calibration check

Proof Testing

Periodic proof tests of the element safety function must be performed to identify any dormant dangerous failures, particularly when used in 'low demand' safety functions – refer to Safety Manual, section 9. (Note that calibration alone does not operate the 4-20mA signal). Faults identified by this test must be repaired within the MTTR and the unit returned to full working order. Details of the proof test are contained in the safety manual.