FUNCTIONAL SAFETY CERTIFICATE

This is to certify that the

IRmax & IR Plus Gas Detectors

manufactured by

Crowcon Detection Instruments Limited
172 Brook Drive
Milton Park, Abingdon
Oxfordshire
OX14 4SD
United Kingdom

have been assessed by CSA Group Testing UK Ltd with reference to the CASS methodologies and found to meet the requirements of

IEC 61508:2010 Routes 1H & 1S, Systematic Capability (SC2)
EN 50271:2018

as an element/subsystem suitable for use in safety related systems performing safety functions up to and including

IEC 61508:2010 SIL 2 capable with HFT=0 (1oo1)*
EN 50271:2018 (including additional optional SIL 1 capability)

when used in accordance with the scope and conditions of this certificate.

* This certificate does not waive the need for further functional safety verification to establish the achieved Safety Integrity Level (SIL) of the safety related system

Certification Decision: James Lynskey

Initial Certification : 2025-01-27
This certificate re-issued : N/A
Renewal date : 2030-01-26

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Product description and scope of certification

IRmax and IR Plus gas detectors monitor toxic and flammable gas such as methane or propane in industrial applications. The two variants use the same sensor technology. The IR Plus includes additional window and mirror heaters for use in a high humidity environment.

The IRMax and IR Plus are compatible with an output 4-20mA (sink or source) control system. The supply voltage is between 12V to 30V DC. The IRmax and IR Plus includes an optional Modbus interface. This option is included in the FMEDA assessments but not available for use as a safety function.

Figures 1 and 2 show the complete assembly of the IRmax & IR Plus gas detectors.

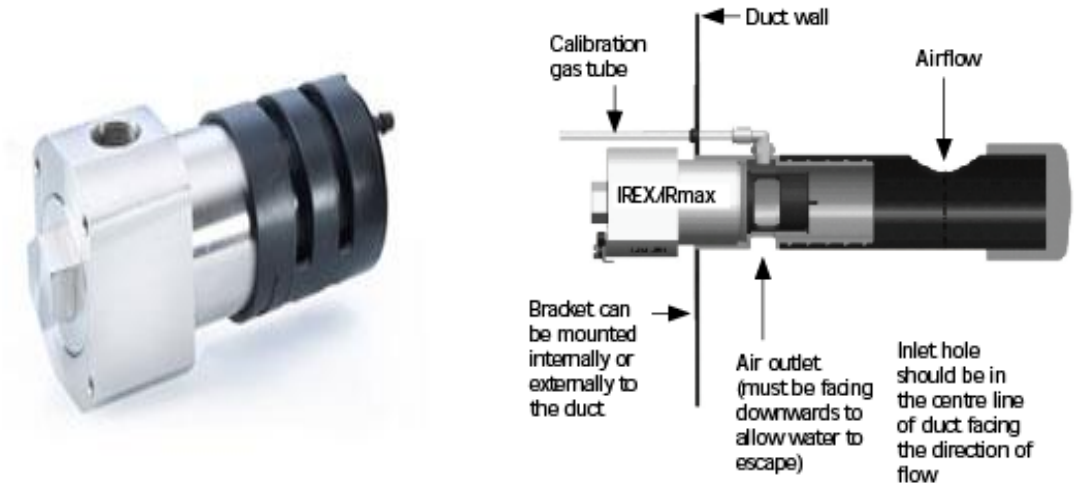

Figure 1: IRmax Assembly

Figure 2: IR Plus Assembly

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The products shown in Figures 2 and 3 has been assessed to IEC 61508:2010 under reports R56A22353A (Random Hardware Safety Integrity) and R56A22353B (Hardware Systematic Safety Integrity), R56A22353S (Software) and R80184017A (Software Modification).

The products have also been assessed to EN 50271:2018 via R56A22353S (Software) and R80184017A (Software Modification).

The products have been assessed to EN 50402:2005/A1:2008 (SIL 2) via R56A22353C and via IEC 61508 assessments R56A22353A (Random Hardware Safety Integrity) and R80184017A (Software Modification). **The products have <u>not</u> been assessed to EN 50402:2017.**

Element Safety Function

The safety function of the certified equipment is:

'To measure the concentration of flammable gas by means of a 4-20mA output to an accuracy of 10%.

Output currents <3.6mA and >21mA are reserved for revealed failures.'

Note 1: HART signal used with IRmax & IR Plus is not part of the safety function and it has no effect on the 4-20 mA output signal, however, the parts failure effects have been considered in the overall FMEDA assessment. A restriction in use condition applies.

Note 2: IRmax & IR Plus can have the option of Modbus external connector. This option is not part of the safety function, however, the parts failure effects have been considered in the overall FMEDA assessment. A restriction in use condition applies.

Certified Data in support of use in safety functions

The assessment has been carried out with reference to the *Conformity Assessment of Safety-related Systems* (CASS) methodology using the Route 1_H approach.

Based on the documents submitted by Crowcon Detection Instruments Limited the Failure Mode and Effect Analysis (FMEA) of the IRmax and IR Plus gas detectors have been verified as evidence of conformity to IEC 61508-2:2010 in respect of 'hardware safety integrity'. Failure rates were calculated from Item toolkit using RDF2000 or Faradip.three.

The results in Table 1a and Table 1b summarize the IRmax and IR Plus FMEA assessments and the achieved safety integrity level.

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Table 1a. The assessment finds that the IRmax gas detectors achieved the following results:

Safety Function: *IRmax: Safety Function* *To measure the concentration of flammable gas by means of a 4-20mA output to an accuracy of 10%. Output currents <3.6mA and >21mA are reserved for revealed failures.*		
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4		
Architectural constraints & Type of product A/B		**HFT = 0** **TYPE B**
Safe Failure Fraction (SFF)		**95%**
Random hardware failures: [h^{-1}]	λ_{DD} λ_{DU}	9.74E-06 5.06E-07
Random hardware failures: [h^{-1}]	λ_{SD} λ_{SU}	1.95E-08 8.59E-08
Diagnostic coverage (DC)		95%
PFD @ PTI = 8760 Hrs. MTTR = 8 Hrs.		2.30E-03
Probability of Dangerous failure (High Demand - PFH) [h^{-1}]		5.06E-07
Hardware safety integrity compliance		Route 1_H
Systematic safety integrity compliance		Route 1_S **See report R56A22353B**
Systematic Capability (SC1, SC2, SC3, SC4)		**SC 2**
Hardware safety integrity achieved		**SIL 2**

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Table 1b. The assessment finds that the IR Plus gas detectors achieved the following results:

Safety Function: *IR Plus : Safety Function* *To measure the concentration of flammable gas by means of a 4-20mA output to an accuracy of 10%. Output currents <3.6mA and >21mA are reserved for revealed failures.*			
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4		WO HART With RS485	With HART With RS485
Architectural constraints & Type of product A/B		**HFT = 0**	**HFT = 0**
Safe Failure Fraction (SFF)		**98%**	**98%**
Random hardware failures: [h^{-1}]	λ_{DD} λ_{DU}	4.86E-07 7.74E-09	4.88E-07 7.74E-09
Random hardware failures: [h^{-1}]	λ_{SD} λ_{SU}	0.00E+00 1.20E-10	0.00E+00 1.20E-10
Diagnostic coverage (DC)		**98%**	**98%**
PFD @ PTI = 8760 Hrs. MTTR = 8 Hrs.		3.79E-05	3.94E-05
Probability of Dangerous failure (High Demand - PFH) [h^{-1}]		7.74E-09	7.74E-09
Hardware safety integrity compliance		Route 1_H	
Systematic safety integrity compliance		Route 1_S **See report R56A22353B**	
Systematic Capability (SC1, SC2, SC3, SC4)		**SC 2**	
Hardware safety integrity achieved		**SIL 2**	

Note 1: The failure data:

1) The PFD_{AVG} figure shown is for illustration only assuming a proof test interval of 8760 hours and MTTR of 8 hours. Refer to IEC 61508-6 for guidance on PFD_{AVG} calculations from the failure data.
2) The verified failure rates used in the safe failure fraction and diagnostic coverage do not include (λ no parts or no effect) failures in the calculation.

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The failure data above is supported by the base information given in Table 2 below.

Table 2: Base information for the IRmax and IR Plus Gas Detectors

1	Product identification:	IRmax & IR Plus Gas Detectors
2	Functional specification:	***'To measure the concentration of flammable gas by means of a 4-20mA output to an accuracy of 10%.*** ***Output currents <3.6mA and >21mA are reserved for revealed failures.'***
3-5	Random hardware failure rates:	Refer to table 1a and 1b of this certificate.
6	Environment limits:	**IRmax** (see M07028) Operating temperature -40°C to +75 °C. Operating Relative Humidity: 0–95% in M07028 (tested to EN 60079-29-1:2007 clause 5.4.9 at 90±2.4% RH) ***Note: for high humidity environments IR Plus is recommended.***
		IR Plus (see M07031): Operating temperature: -40°C to +70°C Operating Relative Humidity: 0–100% Condensing for temperature changes of up to 30 degree C/hour
7	Lifetime/replacement limits:	IRmax/ IR Plus Estimated Working Life: 15 years (assumes annual proof test)
8	Proof Test requirements:	Refer to Installation, Operating and Maintenance instructions (M07028, M07031)
9	Maintenance requirements:	Refer to Installation, Operating and Maintenance instructions (M07028, M07031)
10	Diagnostic coverage:	IRmax: 95% diagnostic coverage. IR Plus:98% diagnostic coverage.
11	Diagnostic test interval:	Refer to Installation, Operating and Maintenance instructions (M07028, M07031)
12	Repair constraints:	Refer to Installation, Operating and Maintenance instructions (M07028, M07031)
13	Safe Failure Fraction:	IRmax: 95% SFF IR Plus:98% SFF
14	Hardware fault tolerance (HFT):	HFT=0 See Table 1 above
15	Highest SIL (architecture/type A/B):	Type B, SIL2.
16	Systematic failure constraints:	The hardware safety integrity assessment was based on a proof test interval of 1 year. For further information refer to Installation, Operating and Maintenance instructions (M07028, M07031)
17	Evidence of similar conditions in previous use:	Not applicable.
18	Evidence supporting the application under different conditions of use:	Not applicable.
19	Evidence of period of operational use:	Not applicable.
20	Statement of restrictions on functionality:	See hardware safety integrity report R56A22353A

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21	Systematic capability (SC1, SC2, SC3)	SC2 - See systematic report R56A22353B and software reports R56A22353S (Software) and R80184017A (Software Modification).
22	Systematic fault avoidance measures:	Compliance with techniques and measures from IEC 61508-2 Annex B to SIL 2 - See systematic report 56A22353B.
23	Systematic fault tolerance measures:	Compliance with techniques and measures from IEC 61508-2 Annex A to support the SFF achieved – see hardware safety integrity report R56A22353A.
24	Validation records:	All documents that have been used in support of the hardware have been documented in section 5.24 of report R56A22353A; this includes the FMEA document and insertion tests. Software validation is documented in sections 3.9 and 3.5 of R80184017A.

Management of functional safety

The assessment has demonstrated that the product is supported by an appropriate functional safety management system that meets the relevant requirements of IEC 61508-1:2010 clause 6, see report R56A22353B.

Identification of certified equipment

The certified equipment and it's safe use is defined in the manufacturer's documentation listed in Table 3 below.

Table 3: Certified documents

Document Number	Rev	Date	Description
ECAD-000253-CD	2	09 Jul 2024	IRmax & IR Plus HOST Schematic
ECAD-000253-PL	2	09 Jul 2024	IRmax & IR Plus HOST Parts List
ECAD-000214-CD	1	18 Jan 2024	IR Plus Window Heater Schematic
ECAD-000214-PL	1	18 Jan 2024	IR Plus Window Heater Parts List
6764 Irmax i-Module-CD	4	23 Oct 2023	iModule Dual Pyro Schematic
6764 Irmax i-Module-PL	4	23 Oct 2023	iModule Dual Pyro Parts List
6672 Irmax Terminal Board-CD	5	23 Jan 2017	IRmax Terminal Board Schematic (with RS485)
6672 Irmax Terminal Board-PL	5	23 Jan 2017	IRmax Terminal Board Parts List (with RS485)
6657 Irmax Terminal Board-CD	11	21 Nov 2023	IRmax Terminal Board Schematic (WO RS485)
6657 Irmax Terminal Board-PL	11	21 Nov 2023	IRmax Terminal Board Parts List (WO RS485)
ECAD-000235-CD	1	05 Apr 2024	IR Plus Terminal Schematic
ECAD-000235-PL	1	05 Apr 2024	IR Plus Terminal Parts List
M07028	9	Jan 2025	IRmax Product (Installation Operations and Maintenance) Manual
M07031	2	15 Jan 2025	IR Plus Product (Installation Operations and Maintenance) Manual

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This certificate covers the following firmware versions:

Table 4: Firmware Versions

Subsystem	Software Rev	Image Checksum/CRC32
i-Module	V5 i2.10	0x4926
IRmax Host	V4 i1.09	0xA1C5
IR Plus Host	V5 i1.09	0x4F99

Conditions of Certification

The validity of the certified base data is conditional on the manufacturer complying with the following conditions:

1. The manufacturer shall analyse failure data from returned products on an on-going basis. CSA Certification Service shall be informed in the event of any indication that the actual failure rates are worse than the certified failure rates. (A process to rate the validity of field data should be used. To this end, the manufacturer should co-operate with users to operate a formal field-experience feedback programme).
2. CSA shall be notified in advance (with an impact analysis report) before any modifications to the certified equipment or the functional safety information in the user documentation is carried out. CSA may need to perform a re-assessment if modifications are judged to affect the product's functional safety certified herein.
3. On-going lifecycle activities associated with this product (e.g., modifications, corrective actions, field failure analysis) shall be subject to surveillance by CSA in accordance with 'Regulations Applicable to the Holders of CSA Group Testing UK Ltd Certificates'.
4. Beta Release Certificates with release a reviewer approval have been provided. However, Software Release Certificates SRC1296 and SRC184 must record suitable release review approval before the firmware versions shown above are released to production.
5. EN 60079-19-1:2016 performance test compliance has been shown for Methane (see CSA project 80121751). To claim compliance against IEC 61508:2010, EN 50402:2005/2008 and EN 50271:2018 with Propane, relevant gas test reports by CSA (or another accredited body) must show full compliance against EN 60079-29-1:2016.

Conditions of Safe Use

The validity of the certified base data in any specific user application is conditional on the user complying with the following conditions:

1. The user shall comply with the requirements given in the manufacturer's user documentation in regard to all relevant functional safety aspects such as application of use, installation, operation, maintenance, proof tests, maximum ratings, environmental conditions, and repair.
2. Selection of this product for use in safety function and the installation, configuration, overall validation, maintenance and repair shall only be carried out by competent personnel, observing all the manufacturer's conditions and recommendations in the user documentation.
3. All information associated with any field failures of this product should be collected under a dependability management process (e.g., IEC 60300-3-2) and reported to the manufacturer.
4. The safety device is to have an independent power supply, it must not share the same power supply as non-safety devices that may cause a fault to the safety device.
5. A proof test interval of 1 year.

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6. **Compliance has been demonstrated for use as a measuring function for explosion protection due to the measurement of Methane concentration only**. Compliance shall not be claimed for the measurement of Propane (see Conditions of Certification 5).

General Conditions and Notes

1. This certificate is based upon a functional safety assessment of the product described in CSA Test & Certification Assessment Report R56A22353A and any further reports referenced (R56A22353B. R56A22353S & R80184017A).
2. If the certified product or system is found not to comply, CSA Group Testing UK Ltd should be notified immediately at the address shown on this certificate.
3. The use of this Certificate and the CSA Certification Mark that can be applied to the product or used in publicity material are subject to the 'Regulations Applicable to the Holders of CSA Group Testing UK Ltd Certificates' and 'Supplementary Regulations Specific to Functional Safety Certification'.
4. This document remains the property of CSA and shall be returned when requested by the issuer.
5. No part of the Functional safety related aspects stated in the instruction manual shall be changed without approval of the certification body.
6. This certificate will remain valid subject to completion of two surveillance audits within the five year certification cycle, and upon receipt of acceptable response to any findings raised during this period. This certificate can be withdrawn if the manufacturer no longer satisfies scheme requirements.

Certificate History

Issue	Date	Report no.	Comment
0	27 Jan 2025	R56A22353A v3.1, R56A22353B v1.2, R56A22353S v1.0, R80184017A v 1.2	The release of prime certificate.

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