FUNCTIONAL SAFETY CERTIFICATE

This is to certify that the

IQ3 Valve Actuator

manufactured by

Rotork Controls Ltd
(A Division of Rotork PLC)
Brassmill Lane
Bath, BA1 3JQ
UK

have been assessed by Sira Certification Service with reference to the CASS methodologies and found to meet the requirements of

IEC 61508-2:2010

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

SIL 2 capable with HFT = 0 (1oo1)*
SIL 3 capable with HFT = 1 (1oo2)*

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	: 17 July 2014
This certificate issued	: 08 October 2019
Renewal date	: 07 October 2024

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Product description and scope of certification

The IQ3 range is a family of electric valve actuators categorized by output torque and speed at a specified supply voltage (three-phase (IQ) single-phase (IQS) or a 24VDC). The scope of the certificate is based on the assessment of the three-phase (IQ) type. IQ3 range is designed to "provide local and remote operation of industrial valves and dampers of all types. As well as providing normal process control of valves, remote control may include emergency shutdown (ESD) operation to open or close a valve or to ensure a valve does not move spuriously, as a priority.

The IQ3 design comprises a gearcase and covers cast in LM20/25 aluminium alloys, bolted to a cast iron base providing connection to the valve or gearbox. Output movement is derived from an electrical motor driving a worm and wheel gear running in an oil bath. The motor is controlled by an electronics control module incorporating provision for internal control power and motor switching. Actuators include a hand/auto clutch engaged handwheel for manual operation in case of loss of power supply.

IQ3 SIL Actuators are designed to operate in standard form from -40°C to 70°C, with options down to -50°C. SIL variants are only supported to -40°C to +70°C. In addition, builds certified for use in hazardous areas under the ATEX directive, international Standard IEC Ex, North American NFPA – NEC and CSA standards. The IQ3 actuators can be powered by three-phase (IQ) single-phase (IQS) or a 24VDC (IQD) power supply. They are available for modulating applications using the IQM and IQML (3 phase only) variants.

The IQ3 Valve Actuators range consists of the following module:

Figure 1. IQ3 Valve Actuators.

Modules in the equipment:

The assessment of the IQ3 actuator has been grouped by electronic modules and mechanical modules.

Module one – Electronic Module
The electronic modules of the IQ3 actuator comprise the following:
a) Absolute Encoder
b) User Interface Board
c) Control Board
d) Power Supply module (including motor switching module)

Module two – Mechanical Module
The mechanical modules of the IQ3 actuator comprise the following:
a) Electronics Interface -looms/connectors

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b) Terminal Bung
c) Electronics Cover
d) Terminal Cover
e) Gearbox
f) Base
g) Manual hand wheel
h) Drive Motor
i) Piezo torque sensor

Element Safety Function

The safety function of the certified equipments is:

A) In static mode: The actuator will not move on the application of a remote open, close or ESD signal unless the motor enable signal is applied.
B) In dynamic mode: The actuator will stop its function if the motor enable signal is removed.

Note: *The above configuration of the SF is considered for remote control option.*

Table 1 below provides an overview of how the various control signals will affect the (Stayput) safety function once the actuator is configured for SIL operations.

Table 1: Affect of input signals during SIL (Stayput or not move) configuration.

Control Selection	Open/Close remote signal	Drive Enable	Display Indication	Operation	valid
Local or Stop	Open or Close	Yes	% open Position – MOTOR ENABLE LOSS	NO	✓
Remote	No	No	% open Position - MOTOR ENABLE LOSS	NO	✓
Remote	Open	No	% open Position - MOTOR ENABLE LOSS	NO	✓
Remote	Open	Yes	% open Position	YES -Open	✓
Remote	No	Yes	% open Position	STOPS - NO	✓
Remote	Close	No	% open Position - MOTOR ENABLE LOSS	NO	✓
Remote	Close	Yes	% open Position	Yes - Close	✓
Remote	No	Yes	% open Position	STOPS - NO	✓
Local	ESD	No	% open Position - MOTOR ENABLE LOSS	NO	✓
Stop	ESD	No	% open Position – MOTOR ENABLE LOSS	NO	✓
Local	ESD	Yes	% open Position	ESD	✓
Stop	ESD	Yes	% open Position	ESD*	✓
Remote	ESD	Yes	% open Position	ESD	✓

Notes:
1. The safety function of the actuator is only valid when the actuator is selected to remote control.
2. The ESD signals take priority over any local and remote signals applied
3. Remote control open, close and ESD signals must be "push to run" type; actuator will respond only when both a control and Drive Enable signals are applied. Removal of signal(s) will cause the actuator to stop.
* When ESD is user configured to override Stop selected control

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[1] using the Route 1_H[2] approach.

As part of the product assessment and supporting evidence of conformity in respect of *'hardware safety integrity'* against the requirements of IEC 61508-2, Rotork have submitted the IQ3 Actuator

[1] www.61508.org.
[2] Refer to IEC 61508-2, 7.4.4, for a definition of this term

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for FMEA verification to attain SIL 2 capability. The components failure rates have been sourced by Rotork using RIAC Automated Data book, field data, Handbook of Reliability Prediction Procedures for Engineers (RPPFME) and manufacturer's data. The failure modes allocated to components in the Rotork FMEA were correctly implemented as required in IEC 62380. The IQ3 Actuator has been verified in 5 size variants; 1, 2, 3, 4 and 5. Tables 2 and 3 summarise the FMEA verification for the variants previously stated in both 1oo1 and 1oo2 configurations.

Table 2. The assessment finds that the IQ3 Mechanical module (1oo1) achieved the following results

Safety Function: A) In static mode: The actuator will not move on the application of a remote open, close or ESD signal unless the motor enable signal is applied. B) In dynamic mode: The actuator will stop its function if the motor enable signal is removed. ***Note:*** *The above configuration of the SF is considered for remote control option.*				
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4		IQ3 actuator Sizes 1- 3	IQ3 actuator Sizes 4-5	**Verdict**
Architectural constraints & Type of product A/B		**HFT=0**		**Type A**
Safe Failure Fraction (SFF)		**93%**	**97%**	**Both SIL 3**
Random hardware failures: [h^{-1}]	λ_{DD} λ_{DU}	0.00E+00 9.84E-07	0.00E+00 9.28E-07	
Random hardware failures: [h^{-1}]	λ_{SD} λ_{SU}	0.00E+00 1.35E-05	0.00E+00 3.07E-05	
Diagnostic coverage (DC)		0%	0%	
PFD @ PTI = 8760Hrs MTTR = 8 Hrs		**4.32E-03**	**4.07E-03**	**Both SIL 2**
Average Freq' of Dangerous failure (High Demand - PFH)		9.84E-07	9.28E-07	**Both SIL 2**
Hardware safety integrity compliance		Route 1_H		
Systematic safety integrity compliance		See report R70004934B		
Systematic Capability (SC1, SC2, SC3, SC4)		**SC2** (See report R70004934B)		
Hardware safety integrity achieved		**SIL 2 achieved for low demand with HFT (1oo1)** **SIL 2 achieved for high demand with HFT (1oo1)**		

Table 3. The assessment finds that the IQ3 Mechanical module (1oo2) achieved the following results:

Safety Function: A) In static mode: The actuator will not move on the application of a remote open, close or ESD signal unless the motor enable signal is applied. B) In dynamic mode: The actuator will stop its function if the motor enable signal is removed. ***Note:*** *The above configuration of the SF is considered for remote control option.*				
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4		IQ3 actuator Sizes 1- 3	IQ3 actuator Sizes 4-5	**Verdict**
Architectural constraints & Type of product A/B		**HFT=1**		**Type A**
Safe Failure Fraction (SFF)		**96%**	**99%**	**Both SIL 3**
Random hardware failures: [h^{-1}]	λ_{DD} λ_{DU}	0.00E+00 1.07E-07	0.00E+00 1.00E-07	
Random hardware failures: [h^{-1}]	λ_{SD} λ_{SU}	0.00E+00 2.61E-06	0.00E+00 1.13E-05	

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Diagnostic coverage (DC)	0%	0%	
PFD @ PTI = 8760Hrs MTTR = 8 Hrs	**4.52E-04**	**4.25E-04**	**Both SIL 3**
Average Freq' of Dangerous failure (High Demand - PFH)	1.07E-07	1.00E-07	**Both SIL 2**
Hardware safety integrity compliance	Route 1_H		
Systematic safety integrity compliance	See report R70004934B		
Systematic Capability (SC1, SC2, SC3, SC4)	**SC2** (See report R70004934B)		
Hardware safety integrity achieved	**SIL 3 achieved for low demand with HFT (1oo2)** **SIL 2 achieved for high demand with HFT (1oo2)** **SIL 2 (1oo2) for high demand due to λ_{DU}**		

Note 1: The failure data:

1) Failure rates stated in the above tables are in units of failures per hour
2) 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.
3) The internal architecture is based on HFT (1oo1).
4) Environment / stress criteria used in the FMEDA: 'Ground; stationary; non-weather protected' conditions.
5) The failure rates do not include no parts failures and no diagnostics functions.

The failure data above is supported by the base information given in Table 4 below.

Table 4

1	Product identification:	IQ3 Valve Actuators , sizes (1 to 5)
2	Functional specification:	The actuator shall not move on the application of a remote open, close or ESD signal unless the motor enable signal is applied
3-5	Random hardware failure rates:	Refer to previous table above
6	Environment limits:	Temperature range: -40°C to +70°C operational
7	Lifetime/replacement limits:	Refer to installation, operation and maintenance (I, O & M) instructions.
8	Proof Test requirements:	Refer to Safety Manual
9	Maintenance requirements:	Refer to Safety Manual
10	Diagnostic coverage:	Refer to previous tables above
11	Diagnostic test interval:	No PST diagnostic function is implemented, Refer to Safety Manual
12	Repair constraints:	None, other than compliance with the I, O & M instructions
13	Safe Failure Fraction:	Refer to previous tables above
14	Hardware fault tolerance (HFT):	(1oo1)
15	Highest SIL (architecture/type A/B):	Type A, SIL 2 with HFT (1oo1) =0), SIL 3 with HFT (1oo2) in low demand mode
16	Systematic failure constraints:	IQ3 is software controlled. But the SF is unaffected by the SW changes.
17	Evidence of similar conditions in	Not applicable

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	previous use:	
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:	Not applicable
21	Systematic capability:	Up to SC2
22	Systematic fault avoidance measures:	Refer to systematic failures introduced during the realization lifecycle from 61508-2 Annex B. see report R70004934B
23	Systematic fault tolerance measures:	Diagnostic can be available via PST (To be reviewed)
24	Validation records:	Functional testing assessed in Sira report R70004934A & R70004934B

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 R70004934B

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 5: Certified documents

Document no.	Rev	Date	Document description
10331*	2	29/03/2019	Absolute Encoder
10771*	15	11/10/2019	Control Board
10113*	8	29/03/2019	User Interface Board
10226*	16	19/06/2019	Power Module 1-3 240V
10225*	19	19/06/2019	Power Module 1-3 220V
10232*	18	19/06/2019	Power Module 4-5 660V
10231*	17	19/06/2019	Power Module 4-5 240V
10230*	19	19/06/2019	Power Module 4-5 220V

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. Sira 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. Sira 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. Sira may need to perform a re-assessment if modifications are judged to affect the product's functional safety certified herein.

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3. On-going lifecycle activities associated with this product (e.g., modifications, corrective actions, field failure analysis) shall be subject to surveillance by Sira in accordance with 'Regulations Applicable to the Holders of Sira Certificates'.

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. Selection of this equipment for use in safety functions and the installation, configuration, overall validation, maintenance and repair shall only be carried out by competent personnel, observing the manufacturer's conditions and recommendations in the user documentation.
2. 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.
3. A proof test interval of 1 year.

General Conditions and Notes

1. This certificate is based upon a functional safety assessment of the product described in Sira Test & Certification Assessment Reports R70004934A & R70004934B.
2. If certified product or system is found not to comply, Sira Certification Service should be notified immediately at the address shown on this certificate.
3. The use of this Certificate and the Sira Certification Mark that can be applied to the product or used in publicity material are subject to the 'Regulations Applicable to the Holders of Sira Certificates' and 'Supplementary Regulations Specific to Functional Safety Certification'.
4. This document remains the property of Sira and shall be returned when requested by the issuer.
5. The IQ3 range of actuators has a local display to indicate the percentage position and has volt free contacts to remotely indicate status. These features are purely for indication and are not considered in the safety function.
6. The actuator can only perform its safety function in the presence of a mains supply. Therefore, integrity of this supply is to be ensured by the end user.
7. No part of the Functional safety related aspects stated in the instruction manual shall be changed without approval of the certification body.
8. 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
01	07/10/2014	R70004934A & R70004938B	Certificate updated to extend valid date for full 5 years period. All major non conformities related to safety function 1 'stayput' are now closed.
02	18/06/2015	R70004934A & R70004938B	Certificate update to identify the correct report references in 'General conditions and notes' section, this is a non-technical change.
03	12/11/2015	R70004934A & R70004938B	Certificate updated to correct the operating (-40 to +70) temperature stated on page 2 and in table 4.
04	08/10/2019	R70216260B	Reissued following successful recertification.

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