



FUNCTIONAL SAFETY CERTIFICATE

This is to certify that the

TVL/TVH/TVF Switchboxes

manufactured by

Topworx Emerson Machinery Equipment (Shenzhen) Co. Ltd
3300 Fern Valley Road
Louisville
Kentucky 40213
USA

101 Building 2, COFCO Park,
Honglang North 2nd Road,
Xin'an Street, Bao'an District,
Shenzhen 51801, China

Emerson AFCP Poland Sp. z o. o Asco Valve (Shanghai) Co. Ltd
Kurczaki 132
Łódź 93-3331
Poland

No.480, Xin Miao No.3 Road
Xiao Qiao Town, Song Jiang District
Shanghai 201612, China

Ascoval Indústria e Comércio Ltda
Rua Goiatuba 81, Jardim Mutinga – Barueri
São Paulo, 06465-010y, Brazil

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

IEC 61508-2:2010 Systematic Capability (SC3)

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

Used as a Controller – up to and including SIL 2*
Used as an Indicator – up to and including SIL 3*

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 : 29/04/2015
This certificate issued : 25/03/2024
Renewal date : 15/06/2029

This certificate may only be reproduced in its entirety, without any change.

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CSA Group Testing UK Ltd
Unit 6 Hawarden Industrial Park,
Hawarden, CH5 3US, United Kingdom
Tel: +44 (0) 1244 670900
Email: ukinfo@csagroup.org
Web: www.csagroupuk.org

Product description and scope of certification

The TVL/TVH/TVF are a series of switchboxes that can be attached to a range of rotary and linear valves and actuators. The switchboxes are typically used within hazardous areas to act as pneumatic valve controllers and/or valve position monitors. The TVL/TVH/TVF switchboxes have numerous communication capabilities via simple switches, DeviceNet, AS-Interface and Profibus (all communication protocols are not considered and not included in the assessment of the safety functions).



TVL:

The TVL switchboxes carry certifications for IECEx, ATEX and UL. They feature an aluminum enclosure designed for mounting to pneumatic actuators.



TVH:

The TVH switchboxes carry certifications for IECEx, ATEX and UL. They feature a stainless steel enclosure designed for mounting to pneumatic actuators.



TVF:

The TVF switchboxes carry certifications for IECEx, ATEX and UL. They feature an aluminum base and resin lid enclosure designed for mounting to pneumatic actuators.

Modules in the Equipment

The assessment of the TVL/TVH/TVF switchboxes has been split up into two functions, the assessment of the switchboxes as a valve controller and the assessment of the switchboxes as valve position indicators. See below for a full description of each of the two functions.

TVL/TVH/TVF switchboxes – Valve controllers

The TVL/TVH/TVF switchboxes consist of the following parts when used as valve controllers:

- Pilot/Solenoid (part in controller safety function)
- Spool Valve (part in controller safety function)

TVL/TVH/TVF switchboxes – Valve position indicators

The TVL/TVH/TVF switchboxes consist of the following parts when used as valve indicators:

- Shaft (part in indicator safety function)
- Sensor Module (see Annex A for a full list of sensor module options covered by this certificate)
- Electronic Output via sensor (part in indicator safety function)
- Indicator Beacon (part in indicator safety function)

Element Safety Function

The safety functions of the TVL/TVH/TVF switchboxes are defined as:

TVL/TVH/TVF switchboxes as a controller:

- 1) To close off (relieve) pneumatic pressure to the spool valve (used as a controller).
- 2) To open (admit) pneumatic pressure to the spool valve (used as a controller).

TVL/TVH/TVF switchboxes as an indicator:

- 3) To provide an indication of the monitored valve position (used as an indicator).

Note 1: The safety functions (1) and (2) are solely independent of the indicator hardware.

Note 2: Safety function (3) has been assessed for two configurations. The first with a general switch/sensor being used for the electrical output and the second with a pre-certified 'GO™ Switch', this certified switch has been assessed by Sira.

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.

As part of the product assessment and supporting evidence of conformity in respect of '*hardware safety integrity*' against the requirements of IEC 61508-2, TopWorx Inc have submitted the TVL/TVH/TVF switchboxes for FMEA analysis to attain safety integrity level up to SIL 3 capability. The components failure rates have been sourced by Sira using RIAC Automated Data book. The TVL/TVH/TVF switchboxes have been analysed in three different modes of operation:

Table 1: Safety function 1 results.

Safety Function 1: 'To close off (relieve) pneumatic pressure to the spool valve (used as a controller)'		
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4	<u>TVL/TVH/TVF switchbox</u> (as a controller)	Verdict
Architectural constraints & Type of product A/B	HFT (1001) = 0	Type A
Safe Failure Fraction (SFF)	64%	SIL 2
Random hardware failures: [h ⁻¹]	λ_{DD} 0.00E+00 λ_{DU} 7.88E-08	
Random hardware failures: [h ⁻¹]	λ_{SD} 0.00E+00 λ_{SU} 1.39E-07	
Diagnostic coverage (DC)	0%	
PFD @ PTI = 8760Hrs MTTR = 8 Hrs	3.46E-04	SIL 3
Average Freq' of Dangerous failure (High Demand - PFH)	7.88E-08	SIL 3
Hardware safety integrity compliance	Route 1 _H	
Systematic safety integrity compliance	See report R70005301B	
Systematic Capability (SC1, SC2, SC3, SC4)	SC3	
Hardware safety integrity achieved	SIL 2 achieved for low demand SIL 2 achieved for high demand	

Table 2: Safety function 2 results.

Safety Function 2: 'To open (admit) pneumatic pressure to the spool valve (used as a controller)'		
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4	<u>TVL/TVH/TVF switchbox</u> (as a controller)	Verdict
Architectural constraints & Type of product A/B	HFT (1001) = 0	Type A
Safe Failure Fraction (SFF)	36%	Both SIL 1
Random hardware failures: [h ⁻¹]	λ_{DD} 0.00E+00 λ_{DU} 1.39E-07	
Random hardware failures: [h ⁻¹]	λ_{SD} 0.00E+00 λ_{SU} 7.88E-08	
Diagnostic coverage (DC)	0%	
PFD @ PTI = 8760Hrs MTTR = 8 Hrs	6.10E-04	Both SIL 3
Average Freq' of Dangerous failure (High Demand - PFH)	1.39E-07	Both SIL 3
Hardware safety integrity compliance	Route 1 _H	
Systematic safety integrity compliance	See report R70005301B	
Systematic Capability (SC1, SC2, SC3, SC4)	SC3	
Hardware safety integrity achieved	SIL 1 achieved for low demand SIL 1 achieved for high demand	

Table 3: Safety function 3 results – using a general switch/sensor for the electrical output.

Safety Function 3: 'To provide an indication of the monitored valve position (used as an indicator)'		
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4	<u>TVL/TVH/TVF switchbox</u> (as an indicator)	Verdict
Architectural constraints & Type of product A/B	HFT (1001) = 0	Type A
Safe Failure Fraction (SFF)	89%	Both SIL 2
Random hardware failures: [h ⁻¹]	λ_{DD} 4.56E-07 λ_{DU} 5.36E-08	
Random hardware failures: [h ⁻¹]	λ_{SD} 0.00E+00 λ_{SU} 0.00E+00	
Diagnostic coverage (DC)	89%	
PFD @ PTI = 8760Hrs MTTR = 8 Hrs	2.39E-04	Both SIL 3
Average Freq' of Dangerous failure (High Demand - PFH)	5.36E-08	Both SIL 3
Hardware safety integrity compliance	Route 1 _H	
Systematic safety integrity compliance	See report R70005301B	
Systematic Capability (SC1, SC2, SC3, SC4)	SC3	
Hardware safety integrity achieved	SIL 2 achieved for low demand SIL 2 achieved for high demand	

Table 4: Safety function 3 results – using a certified GO™ Switch for the electrical output

Safety Function 3: 'To provide an indication of the monitored valve position (used as an indicator)'		
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4	<u>TVL/TVH/TVF switchbox</u> (as an indicator)	Verdict
Architectural constraints & Type of product A/B	HFT (1001) = 0	Type A
Safe Failure Fraction (SFF)	90%	Both SIL 3
Random hardware failures: [h ⁻¹]	λ_{DD} 4.59E-07 λ_{DU} 5.40E-08	
Random hardware failures: [h ⁻¹]	λ_{SD} 0.00E+00 λ_{SU} 4.33E-09	
Diagnostic coverage (DC)	90%	
PFD @ PTI = 8760Hrs MTTR = 8 Hrs	2.40E-04	Both SIL 3
Average Freq' of Dangerous failure (High Demand - PFH)	5.40E-08	Both SIL 3
Hardware safety integrity compliance	Route 1 _H	
Systematic safety integrity compliance	See report R70005301B	
Systematic Capability (SC1, SC2, SC3, SC4)	SC3	
Hardware safety integrity achieved	SIL 3 achieved for low demand SIL 3 achieved for high demand	

Table 5: Safety function 3 results – using a SD36 MiniGO Switch for the electrical output

Safety Function 3: 'To provide an indication of the monitored valve position (used as an indicator)'		
Summary of IEC 61508-2 Clauses 7.4.2 and 7.4.4	<u>TVL/TVH/TVF switchbox (as an indicator)</u>	Verdict
Architectural constraints & Type of product A/B	HFT (1001) = 0	Type A
Safe Failure Fraction (SFF)	90%	Both SIL 3
Random hardware failures: [h ⁻¹]	λ_{DD} 4.59E-07 λ_{DU} 5.40E-08	
Random hardware failures: [h ⁻¹]	λ_{SD} 0.00E+00 λ_{SU} 4.33E-09	
Diagnostic coverage (DC)	90%	
PFD @ PTI = 8760Hrs MTTR = 8 Hrs	2.40E-04	Both SIL 3
Average Freq' of Dangerous failure (High Demand - PFH)	5.40E-08	Both SIL 3
Hardware safety integrity compliance	Route 1 _H	
Systematic safety integrity compliance	See report R70005301B	
Systematic Capability (SC1, SC2, SC3, SC4)	SC3	
Hardware safety integrity achieved	SIL 3 achieved for low demand SIL 3 achieved for high demand	

Note 3: 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 (1001).
- 4) Environment / stress criteria used in the FMEDA: 'Ground; stationary; non-weather protected' conditions.
- 5) The failure rates do not include no parts failures.

The failure data above is supported by the base information given in Table 5 below.

Table 5

1	Product identification:	TVL/TVH/TVF switchboxes.
2	Functional specification:	<ol style="list-style-type: none"> 1) To close off (relieve) pneumatic pressure to the spool valve (used as a controller). 2) To open (admit) pneumatic pressure to the spool valve (used as a controller). 3) To provide an indication of the monitored valve position (used as an indicator).
3-5	Random hardware failure rates:	Refer to tables 1-5 of this document.
6	Environment limits:	Temperature range: up to +95°C operational
7	Lifetime/replacement limits:	Refer to installation, operation and maintenance (I, O &

		M) instructions.
8	Proof Test requirements:	Refer to Safety Manual ES-03781-1.
9	Maintenance requirements:	Refer to Safety Manual ES-03781-1.
10	Diagnostic coverage:	Refer to tables 1-5 of this document.
11	Diagnostic test interval:	The Diagnostic test is a part of the normal test of the elements safety function and should be performed at a regular interval (as specified in the safety manual) this is a condition of safe use.
12	Repair constraints:	None, other than compliance with the I, O & M instructions
13	Safe Failure Fraction:	Refer to tables 1-5 of this document.
14	Hardware fault tolerance (HFT):	(1oo1), HFT=0.
15	Highest SIL (architecture/type A/B):	Refer to tables 1-5 of this document.
16	Systematic failure constraints:	
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:	Not applicable
21	Systematic capability:	Up to SC3 see report R70005301B.
22	Systematic fault avoidance measures:	Refer to systematic failures introduced during the realization lifecycle from 61508-2 Annex B. see report R70005301B.
23	Systematic fault tolerance measures:	None, other than compliance with the I, O & M instructions
24	Validation records:	Functional testing assessed in Sira report R56A28091A and R70005301B.

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 R70005301B

Identification of certified equipment

The certified equipment and it's safe use is defined in the manufacturer's documentation listed in Table 6 below.

Table 6: Certified documents

Sira Reference	Document no.	Rev	Date	Document description
FS01	CERT-ES-04334	1	01/02/2014	BOM and assembly drawings of the TVL/TVH/TVF switchboxes.
FS02	ES-03425-1	1	2013	Datasheet of the TVL/TVH/TVF switchboxes.
FS03	CERT-ES-03781-1	1	2014	Safety manual for the TVH/TVL/TVF series switchboxes. Document has been reviewed by Sira as shown in annex D of this report.
-	ES-03890-1	6	25/06/2013	36 Series TVL/TVH/TVF

Additional Manufacturing Facilities

The following locations have been assessed by CSA Group UK and were found to be in conformance to IEC61508:2010 and follow the same level of rigor and process quality and control as TopWorx Inc (USA).

Emerson Machinery Equipment (Shenzhen) Co. Ltd

101 Building 2, COFCO Park,
Honglang North 2nd Road,
Xin'an Street, Bao'an District,
Shenzhen 51801, China

Emerson AFCP Poland Sp. z o. o

Kurczaki 132
Łódź 93-3331
Poland

Asco Valve (Shanghai) Co. Ltd

No.480, Xin Miao No.3 Road
Xiao Qiao Town, Song Jiang District
Shanghai 201612, China

Ascoval Indústria e Comércio Ltda

Rua Goiátuba 81, Jardim Mutinga – Barueri
São Paulo, 06465-010y, Brazil

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.
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 Report R70005301A and any further reports referenced (R70005301B, R70217010B).
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.

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CSA Group Testing UK Ltd

Unit 6 Hawarden Industrial Park,
Hawarden, CH5 3US, United Kingdom
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Email: ukinfo@csagroup.org
Web: www.csagroupuk.org

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. 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
00	11/05/2015	R70005301	First certificate version issued to client as a result of assessment against IEC61508:2010.
01	15/06/2015	R70005298.	Certificate updated to include additional manufacturing facilities as a result of successful on site audit – report R70005298.
02	18/01/2018	70168119	Updated to include Q2/Q4 and G2/G4 switch variations. See Annex A.
03	04/09/2018	-	Minor changes to reflect systematic capability.
04	09/05/2019	70217010	Temporary extension for recertification activities.
05	19/07/2019	70217010	Certificate reissued following successful recertification audit.
06	07/07/2020	80043176	Certificate updates to provide results for SD36 MiniGO variant in table 5.
07	07/11/2023	80129810 - 3 80129810 - 2	Added Emerson AFCP Poland Sp. z o. o. and Asco Valve (Shanghai) Co. Ltd. manufacturing locations. Shenzhen location address has been updated and added to the cover and also "Additional Manufacturing Facilities" section has been updated with shanghai and Poland locations and removed Hungary location as requested by the customer. Also corrected S2/S4 and D2/D4 and Q2/Q4 ratings.
08	16/02/2023	80189295	Re-issued following successful recertification audit.
09	25/03/2024	80129810 - 1	Added Ascoval Indústria e Comércio Ltda manufacturing location to the certificate and updated "Additional Manufacturing Facilities" section.



Annex A

Below is a list of switch module configurations supported by this certificate:

0X - 4-20 mA Transmitter with no switches
12 - (2) Ind prox PNP N/O
22 - (2) Highly TSI18-08P-1
42 - (2) p+f model NBB2-V3-E2
44 - (4) p+f model NBB2-V3-E2
52 - (2) p+f model NBB3-V3-Z4
54 - (4) p+f model NBB3-V3-Z4
A4 - AS-interface w/ (2) p+f model NBB2-V3-E2
A5 - AS-interface w/ (2) p+f model NBB3-V3-Z4
AS - AS-Interface
DN - DeviceNet
E2 - (2) p+f NJ2+V3-N inductive NAMUR
E4 - (4) p+f model NJ2-V3-N
EX - 4-20 mA Transmitter w/ (2) p+f NJ2+V3-N inductive NAMUR
K2 - (2) Mech SPDT w/ gold contacts
K4 - (4) SPDT mechanical switches w/ gold contacts
KX - 4-20 mA Transmitter w/ (2) Mech SPDT w/ gold contacts
L2 - (2) GO™ Switches SPDT hermetic seal
L4 - (4) GO™ Switches SPDT hermetic seal
M2 - (2) Mech SPDT
M4 - (4) Mech SPDT
MX - 4-20 mA Transmitter w/ (2) Mech SPDT
N2 - P+F custom
P2 - (2) SPDT 3A max
PB - Profibus DP
R2 - (2) SPDT 200mA max
R4 - (4) SPDT 200mA max
T2 - (2) Mech DPDT
TX - 4-20 mA Transmitter w/ (2) Mech DPDT
Q2/Q4 - Ex ia rated, 30V/250mA
Q2/Q4 - 2A/120Vac, 1A/24Vdc
G2/G4 - 4A/120Vac, 3A/24Vdc
S2/S4 - 4A/120Vac, 3A/24Vdc
D2/D4 - 2A/120Vac, 1A/24Vdc

