Quartz™ Valve Position Indicator
Rev. 1.1

Safety Manual

6/2015

StoneL®
Valve Communication Solutions

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1. General information

The Quartz series valve position indicator is used to indicate the position of a valve assembly. This device is typically used as a safety component that provides a signal output of valve position. The end user can use this information in different ways depending on the SIF or sensory input that is being instrumented.

Quartz series valve position indicator can be used in a multitude of sensor input configurations and any sub classification depending on the model and SIF being implemented for the desired Safety Function and SIL level.

The valve position can be indicated using one of the defined outputs (mechanical switches, proximity sensors, or position transmitter). The Quartz unit provides input feedback of the valve to the safety system. End user must follow all guidance identified in the Installation, Maintenance and Operating Instructions (later referred as IMO) with this safety manual to verify the products proper installation and operation of the product product.

2. Structure of valve position indicator

2.1. System components and description of use

See the IMO for the detailed technical description of the device and the system architecture.

2.2. Permitted device types

The information in this manual pertaining to functional safety applies to all device variants mentioned in the device type coding below. It is up to the end-user to verify that the correct model is selected for the intended function and the SIF.

2.3. Supplementary device documentation

Related QX/QN Installation, Maintenance and Operating Instructions listing

IMO	Applicable models	Type	Description
105196	QX_J, QX_K, QX_L, QX_P, QN_J, QN_K, QN_L, QN_P	Limit switch	Maxx-Guard models SPST
105197	QX_S, QX_H, QX_G, QX_M, QN_S, QN_H, QN_G, QN_M	Limit switch	Maxx-Guard models SPDT
105198	QX_X, QN_X	Limit switch	SST models
105199	QX_A, QN_A	Limit switch	"A" Namur sensor models for intrinsically safe applications
105201	QX_N, QN_N	Limit switch	Namur sensor models for intrinsically safe applications
105207	QX33, QN33	Limit switch	SST dual module models
105208	QX44, QN44	Limit switch	Namur Sensor (EN 60947-5-6) Dual Module
105202	QX50, QN5O	Position transmitter	4-20ma Position transmitter
105202	QXBO, QNBO	Potentiometer	10k Potentiometer
105202	QX70, QN7O	Position transmitter	High performance 4-20mA position transmitter
105202	QXCO, QNCO	Potentiometer	High performance 10k potentiometer

Table 1

These are available from StoneL or for download from
http://www.stonel.com/en/products/quartz/installation-manuals

3. Description of safety requirements

3.1. Safety function

Limit switch models: The function of the device is to provide contact inputs to the safety system that relates the position of the measured actuator / valve. In order to acheive the desired SIL safety level, redundant contacts/switches may be needed.

4-20 mA Position transmitter models: The function of this device is to provide position feedback inputs to the safety system that relates the position of the measured actuator / valve. If position transmitter produces feedback out of range(<3mA or >21mA) that is considered dangerous detected failure, the controller must perform the safety function.

10k Potentiometer models: The function of this device is to provide position feedback inputs to the safety system that relates the position of the measured actuator / valve. If the potentiometer unit transmitter produces feedback out of range (>11KΩ) that is considered dangerous detected failure, the controlled must perform the safety function.

3.2. Restrictions for use in safety-related applications

Please ensure that the valve monitor is used correctly for the application in question and that the ambient conditions are taken into account. The instructions for installation conditions, as detailed in the IMO, shall be observed. The specifications in the IMO shall not be exceeded.

3.3. Functional safety indicators

The table below shows the specific values for functional safety.

Model Series	Type	λ	λs	λd	λdd	λdu
QX_J, QN_J	A	9.93E-09	8.27E-09	1.66E-09	0	1.66E-09
QX_K, QN_K	A	1.97E-08	1.23E-08	7.38E-09	0	7.38E-09
QX_L, QN_L	A	1.97E-08	1.23E-08	7.38E-09	0	7.38E-09
QX_P, QN_P	A	9.93E-09	8.27E-09	1.66E-09	0	1.66E-09
QX_G, QN_G	A	9.93E-09	8.27E-09	1.66E-09	0	1.66E-09
QX_H, QN_H	A	9.93E-09	8.27E-09	1.66E-09	0	1.66E-09
QX_M, QN_M	A	9.93E-09	8.27E-09	1.66E-09	0	1.66E-09
QX_S, QN_S	A	1.97E-08	1.23E-08	7.38E-09	0	7.38E-09
QX_X, QN_X	A	1.60E-07	9.34E-08	6.62E-08	0	6.62E-08
QX_A, QN_A	A	2.97E-08	1.91E-08	1.07E-08	0	1.07E-08
QX_N, QN_N	A	2.90E-08	2.21E-08	6.91E-09	0	6.91E-09
QX33, QN33	A	2.73E-07	1.64E-07	1.10E-07	0	1.10E-07
QX44, QN44	A	2.02E-07	1.35E-07	6.78E-08	0	6.78E-08
QX5O, QN5O	A	1.36E-07	2.84E-08	1.07E-07	7.03E-08	3.69E-08
QXBO, QNBO	A	3.80E-08	3.50E-09	3.45E-08	3.04E-08	4.10E-09
QX7O, QN7O	A	1.31E-07	2.84E-08	1.03E-07	6.65E-08	3.64E-08
QXCO, QNCO	A	3.37E-08	3.07E-09	3.06E-08	2.70E-08	3.67E-09

Table 2

λ = Total Failure Rate (λ = λs + λd)
λs = Safe Failure Rate
λd = Dangerous Failure Rate
λdd = Dangerous Detected Failure Rate
λdu = Dangerous Undetected Failure Rate

Limit switch models: The failure rates assume that idle current principle has been applied. The switch must be chosen such that an open switch must result in an action which performs the safety function. In normal operation (no safety demand) the switch is closed and a current, sourced by the controller, flows through the switch (idle current). If the current flow is interrupted, due to switch or line break etc., the safety function will be performed.

The achievable SFF of the Quartz unit depends on the configuration and number of the switches and the evaluation of the signals from the Quartz in the connected safety controller.

Position transmitter and potentiometer models: The failure rates assume the following:

- < 20% deviation from actual position is considered a safe failure
- > 20% deviation from actual position is considered a dangerous failure.
- If position transmitter produces feedback out of range(<3mA or >21mA) that is considered dangerous detected failure, the controlled must perform the safety function.
- If the potentiometer unit produces feedback out of range (>11KΩ) that is considered dangerous detected failure, the controlled must perform the safety function.

4. Installation

4.4.1. Hardware fault tolerance

The hardware fault tolerance of the standalone installation is HFT=0 . If hardware fault tolerance of >= 1 is required, then a redundant configuration of the limit switch installation shall be used. Since position transmitter and potentiometer units are not available in redundant configuration they are limited to HFT=0, therefore can only be used up to SIL2.

4.4.2. Installation and commissioning

The installation and commissioning/calibration of the device must be done by qualified technician, according to the IMO. It is important that the mechanical connection to the valve/actuator is installed correctly and securely by a qualified technician. Every parameter related to the device type in question and mentioned in the IMO needs to be checked and compared against the device settings. If any deviations exist the safety of the installation cannot be guaranteed.

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4.4.3. Orientation

Orientation of the device is described in the IMO.

4.5. Operation

See IMO for the operation of the device.
Limit switch models: The sensors are triggered by a rotating cam at a fixed distance from the sensors, this ensures that the switch points are repeatable and consistent over the full temperature range, even in high vibration environments.

Position transmitter and potentiometer models: These have a potentiometer that is driven by the rotating shaft. It is fixed to the shaft to give positive engagement to ensure that the position feedback is repeatable and consistent over the full temperature range, even in high vibration environments

4.6. Maintenance

See the IMO for maintenance instructions.

During maintenance work on the device, alternative safety function methods shall be taken to ensure process safety. This device should be considered in all SIF proof tests.

5. Repair

Any repair to the device shall be carried out under guidance by the manufacturer. Device failures must be reported to the manufacturer. The user shall provide a detailed report to the manufacturer describing the failure and any possible effects.

6. Certificate

Certificate

No.: 968/FSP 1064.02/15

Product tested	Quartz™ Valve Position Indicator/Sensor	**Certificate holder**	StoneL 26271 US Highway 59 Fergus Falls, MN 56537 USA
Type designation	QX- and QN- Models (Details see page 2 and 3)		
Codes and standards	IEC 61508 Parts 1-7:2010 (in extracts)	IEC 61511-1:2003 + Corr. 1:2004 (in extracts)	
Intended application	The Quartz™ Valve Position Indicator/Sensor can be used in a safety instrumented system (SIS) as sensor(s) to indicate the position of a valve assembly. The switches on page 2 can be used in applications up to SIL 3 acc. to IEC 61508 and IEC 61511. The configuration and number of switches (HFT = 0 or 1) depend on the target safety level (SIL) and the evaluation of the signals in the safety controller. The sensors on page 3 are not available in a redundant configuration. Due to this fact the hardware fault tolerance is 0 (HFT=0) and considering the achieved SFF of < 90%, the devices fulfill the requirements for the hardware integrity of SIL 2 of IEC 61511-1, table 6 and IEC 61508-2, table 2.		
Specific requirements	The instructions of the associated Installation, Maintenance and Operating Instructions and Safety Manual shall be considered.		

Valid until 2020-06-04

The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/FSP 1064.02/15 dated 2015-06-04.
This certificate is valid only for products which are identical with the product tested. It becomes invalid at any change of the codes and standards forming the basis of testing for the intended application.

Köln, 2015-06-04

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7. Certificate page 2

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Safety function: Sensing of the position of valves or actuators.
Opening and closing position of the switches may be configured such that an open contact results to an action into the safe direction of the SIF.

Model Series	Type	λ / 1/h	λs / 1/h	λd / 1/h	SFF
QX_J, QN_J	A	9.93E-09	8.27E-09	1.66E-09	83,3%
QX_K, QN_K	A	1.97E-08	1.23E-08	7.38E-09	62,4%
QX_L, QN_L	A	1.97E-08	1.23E-08	7.38E-09	62,4%
QX_P, QN_P	A	9.93E-09	8.27E-09	1.66E-09	83,3%
QX_G, QN_G	A	9.93E-09	8.27E-09	1.66E-09	83,3%
QX_H, QN_H	A	9.93E-09	8.27E-09	1.66E-09	83,3%
QX_M, QN_M	A	9.93E-09	8.27E-09	1.66E-09	83,3%
QX_S, QN_S	A	1.97E-08	1.23E-08	7.38E-09	62,4%
QX_X, QN_X	A	1.60E-07	9.34E-08	6.62E-08	58,4%
QX_A, QN_A	A	2.97E-08	1.91E-08	1.07E-08	64,4%
QX_N, QN_N	A	2.90E-08	2.21E-08	6.91E-09	76,2%
QX33, QN33	A	2.73E-07	1.64E-07	1.10E-07	60,1%
QX44, QN44	A	2.02E-07	1.35E-07	6.78E-08	66,8%

λ Total Failure Rate (λ = λs + λd)
λs Safe Failure Rate
λd Dangerous Failure Rate
Safe Failure Fraction SFF = λs / λ

8. Certificate page 3

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Safety function: Sensing of the position of valves or actuators and translating it into a 4-20mA value.

Diagnostic measures: In case the current is <3mA or >21mA the sensor has an internal failure and the process has to be controlled in a way to lower the risk.

Model Series	λ / 1/h	λ_S / 1/h	λ_d / 1/h	λ_{dd} / 1/h	λ_{du} / 1/h	SFF
QN5O, QX5O	1,36E-07	2,84E-08	1,07E-07	7,03E-08	3,69E-08	72,8%
QN7O, QX7O	1,31E-07	2,84E-08	1,03E-07	6,65E-08	3,64E-08	72,3%

λ total failure rate
λd Current deviates more than 20% from the "real" value (valve Position)
λs Current deviates less than 20% from the "real" value (valve Position)
λdd Current is <3mA or >21mA
λdu Current deviates more than 20% from the "real" value (valve Position), but is still within 3 to 21mA

Safe Failure Fraction SFF = $(\lambda - \lambda_{du}) / \lambda$

Note: The models listed in the table above are not available in a redundant configuration. Due to the SFF is smaller than 90% and the limitation of HFT=0, they can only be used up to SIL 2.

Safety function: Sensing of the position of valves or actuators and translating it into a 0-10kOhm value.

Diagnostic measures: In case the resistance is >11kOhm the sensor has an internal failure and the process has to be controlled in a way to lower the risk.

Model Series	λ / 1/h	λ_S / 1/h	λ_d / 1/h	λ_{dd} / 1/h	λ_{du} / 1/h	SFF
QNBO, QXBO	3,80E-08	3,50E-09	3,45E-08	3,04E-08	4,10E-09	89,2%
QNCO, QXCO	3,37E-08	3,07E-09	3,06E-08	2,70E-08	3,67E-09	89,1%

λ total failure rate
λd Resistance deviates more than 20% from the "real" value (valve Position)
λs Resistance deviates less than 20% from the "real" value (valve Position)
λdd Resistance is >11kOhm
λdu Resistance deviates more than 20% from the "real" value (valve Position), but is still below 11kOhm

Safe Failure Fraction SFF = $(\lambda - \lambda_{du}) / \lambda$

Note: The models listed in the table above are not available in a redundant configuration. Due to the SFF is smaller than 90% and the limitation of HFT=0, they can only be used up to SIL 2.