Smart positioner

YT-3300 / 3301 / 3302 / 3303 / 3350

YT-3400 / 3410 / 3450

YT-3700 / 3702 / 3750

SIL Safety Instruction.

Supplement to product manual

May. 2020

Rotork YTC Limited

Ver 1.08

Table of contents

1 Introduction

1.1 Purpose of this document

This document contains information and safety instructions that the user will require when using the electro pneumatic positioner in safety-related systems.

This document is for system planners, constructors, service & maintenance engineers and personnel who will perform commissioning the device.

1.2 Field of Application

The application includes control valve with pneumatic positioners with positioning control up to SIL2 level in accordance with the safety engineering requirements of IEC61508.
positioners are suitable for SIL2 at HFT=0 and for SIL3 at HFT=1

In the event of an electrical power failure, the single-acting positioner depressurizes the actuator chamber, and the movement of actuator's return spring, as a result, moves the valve to the predefined, safe end position (either OPEN or CLOSED). For double-acting positioner, it depressurizes the actuator through Out1 port and pressurizes the actuator through Out2 port in order to moves the valve to the predefined, safe end position (either OPEN or CLOSED)

1.3 Required documentation

This document only defines YT-3300/3301/3302/3303/3350, YT-3400/3410/3450 and YT-3700/3702/3750 positioner's safety functions.
This document only applies in conjunction with YT-3300/3301/3302/3303/3350, YT-3400/3410/3450 and YT-3700/3702/3750 Product Manual.

1.4 Further information

The contents of these instructions shall not become part of or modify any prior existing agreement, commitment or legal matter.

Any statements contained herein do not create new warranties or modify the existing warranty.

The content reflects the technical status at the time of printing.

Rotork YTC Limited reserves the right to make technical changes in the course of further development.

2 Acronyms and abbreviations

Acronym	Full term in English	Description
HFT	Hardware Fault Tolerance	Hardware fault tolerance: Ability of a function unit (Hardware) to continue executing a required function in the presence of faults or deviations.
MTBF	Mean Time Between Failures	Average period between two failures
MTTR	Mean Time To Repair	Average period between the occurrence of a fault in a device or system and the repair
PFD	Probability of Failure on Demand	Probability of dangerous failures of a safety function on demand
PFDavg	Average Probability of Failure on Demand	Average probability of dangerous failures of a safety function on demand
SIL	Safety Integrity Level	The international standard IEC 61508 defines four discrete Safety Integrity Levels (SIL 1 to SIL 4). Each level corresponds to a range of probability for failure of a safety function. The higher the Safety Integrity Level of the safety-related system, the lower the probability that it will not execute the required safety functions.
SFF	Safe Failure Fraction	Proportion of safe failures: Proportion of failure without the potential to bring the safety-related system into a dangerous or non-permissible functional status.
FIT	Failure in Time	Frequency of failure Number of faults within 10^9 hours
TI	Test Interval	Testing interval of the protective function
λsd	Failure rate for all safe detected failures	Overall rate for all safe detected failures.
λsu	Failure rate for all safe undetected failures	Overall rate for all unsafe detected failures.
λdd	Failure rate for all dangerous detected failures	Overall rate for all dangerous detected failures
λdu	*Failure rate for all dangerous undetected failures*	*Overall rate for all dangerous undetected failures*

3 Relevant standards

Standard	English	German
IEC 61508, Part 1 to 7	Functional safety of electrical / electronic / programmable electronic safety-related systems (Target group: Manufacturers and Suppliers of Devices).	

4 Terms and definitions

Terms	Explanation
Dangerous failure	A failure that has the potential to place the safety-related system in a dangerous state or render the system inoperative.
Safety-related system	A safety-related system performs the safety functions that are required to achieve or maintain a safe condition, e.g., in a plant. Example: pressure meter, logics unit (e.g., limit signal generator) and valve form a safety-related system.
Safety function	A specified function that is performed by a safety-related system with the goal, under consideration of a defined hazardous incident, of achieving or maintaining a safe condition for the plant. Example: limit pressure monitoring

5 Defining the Safety Integrity Level (SIL)

The achievable Safety Integrity Level is defined by the following safety-related parameters:

- Average probability of hazardous failures for a safety function on demand (PFDavg)
- Hardware Fault Tolerance (HFT)
- Fraction of failures that do not have the potential to put the safety-related system in a hazardous or fail-to-function state (SFF)

The specific safety-related parameters for defines YT-3300/3301/3302/3303/3350, YT-3400/3410/3450 and YT-3700/3702/3750 positioners as part of a safety function are listed in the section "Safety-related parameters".

The following table shows the dependence of the safety Integrity Level (SIL) on the Average Probability of Failure on Demand (PFDavg).

The table applies the "low demand mode", i.e. the safety-related system is check at most once a year

Safety Integrity Level (SIL)	PFDavg (low demand mode)
4	$\geq 10^{-5}$ ... $< 10^{-4}$
3	$\geq 10^{-4}$ ... $< 10^{-3}$
2	$\geq 10^{-3}$ ... $< 10^{-2}$
1	$\geq 10^{-2}$ ... $< 10^{-1}$

6 Safety-related system

Sensor, logics unit and actuator (positioner, pneumatic actuator and valve) form a safety-related system that performs a safety function.

The Average Probability of Failure on Demand (PFDavg) is usually divided between the sensor, logics unit and actuator sub-system.

Typical division of the Average Probability of Failure on Demand (PFDavg) into sub-system

Sensor (e.g., pressure meter)	Logics unit (e.g., PLC)	Actuator (e.g., valve)
$\leq 35\%$	$\leq 15\%$	$\leq 50\%$

Functional description

If the electrical current signal which is being supplied to the positioner is blocked, the pneumatic signal could not be delivered to torque-motor module, which is installed inside of the positioner. Depending on the positioner's acting type (either single or double), following safety function will be activated.

Single-action : The positioner depressurizes the related actuator through Out1 port according to return spring in pilot valve and the return spring moves the valve to a safe end position. (either OPEN or CLOSE)

Double-action : The positioner depressurizes the related actuator through Out1 port and pressurizes the related actuator through Out2 port according to return spring in pilot valve and the return spring moves the valve to a safe end position in pre-selected direction.
(either OPEN or CLOSE)

7 Information for the safety function

Important

Safety-related systems without a self-locking function must be monitored or set to an otherwise safe condition after performing the safety function within MTTR (8 hours).

The device lifecycle must be evaluated according to the specified MTBF.

8 Periodic checks

Safety checks

The Safety function for the entire safety loop must be checked regularly in accordance with IEC 61508.

The test intervals are determined when calculating the individual safety loops of a plant(PFDavg's).

On the defines YT-3300/3301/3302/3303/3350, YT-3400/3410/3450 and YT-3700/3702/3750 positioners the following specific
checks should be carried out :

1. Connect the set value of below 0.5 mA.
   - Check whether the valve moves to the appropriate safety position – "tight closing".
2. Check the screen in the pneumatic connections for contamination and clean them if necessary.

Functional checks

We recommend that the functioning of the positioner is checked at regular intervals of one year.

Check at least the following:

1. Connect the set value of 4 mA.
   - Check whether the valve moves to the appropriate end position.
   - Check the locally displayed internal, digitized values for the setpoint and position.
2. Connect the set value of 20 mA.
   - Check whether the valve moves to the appropriate end position.
   - Check the locally displayed internal, digitized values for the setpoint and position.

Repairs

When you send a defective device to the repair department, include information describing the error and, if possible, the cause.

Important

When ordering replacement devices always provide the serial number of the original device (on the name plate)

Maintenance

For devices under operating conditions with low requirements (LDM), a service life of 5 years plus a storage period of 1.5 years from the date of production is confirmed, considering the compliance with the requirements for operating the devices described in the safety manual and the installation and operating instructions.

The results of the periodic test must be evaluated and, depending on this, maintenance must be provided if necessary. Especially in case of changes (e.g. ageing of the elastomers, changed switching times or leakage, etc.), maintenance or repair must be carried out by the manufacturer.

MTC = 99%

9 Safety engineering parameters

9.1 Prerequisites

- Communication via HART protocol is used only to configure and calibrate the device. It is also used for diagnostic functions but not for safety-related, critical operations.
- The compressed air supply is free of oil, water and dust in accordance with DIN/ ISO 8573-1.
- The repair period (MTTR) following a device fault is 8 hours.
- The mean temperature over a longer period of time is 40 ℃
- The positioner is used only in applications with low request rates (low demand mode).

9.2 Specific safety-related parameters

Important

The PFDav values provided in the table are valid for YT-3300/3301/3302/3303/3350, YT-3400/3410/3450 and YT-3700/3702/3750 positioners.

Results of Assessment

Route of Assessment		2_H / 1_S
Type of Sub-system		Type A
Mode of Operation		Low Demand Mode
Hardware Fault Tolerance	HFT	0

		Single Acting		Double Acting	
Lambda Dangerous Undetected Assumed Diagnostic Coverage DC = 0%	λ_{DU}	2.29 E-07 / h	229 FIT	2.68 E-07 / h	268 FIT
Mean Time To Dangerous Failure	$MTTF_D$	4.38 E+06 h	500 a	3.73 E+06 H	426 a
Average Probability of Failure on Demand 1oo1 assumed Proof Test Interval T_1 = 1 year	$PFD_{avg}(T_1)$	1.00 E-03		1.17 E-03	
Average Probability of Failure on Demand 1oo2 assumed Proof Test Interval T_1 = 1 year assumed β_{1oo2} = 10 %	$PFD_{avg}(T_1)$	1.01 E-04		1.19 E-04	

10 Glossary

Dangerous failure

Failure with the potential to bring the safety-related system into a dangerous or non-functional status.

Safety function

Defined function executed by a safety-related system with the objective of achieving or maintaining a safe system status taking into account a defined dangerous occurrence.

Example:

Limit pressure monitoring

Safety Integrity Level

Safety-related system

A safety-related system executes the safety functions that are required to achieve or maintain a safe status in a system.

It consists of a sensor, logic unit/control system and final controlling element.

Example:

A safety-related system is made up of a pressure transmitter, a limit signal sensor and a control valve.

SIL

The international standard IEC 61508 defines four discrete Safety Integrity Level (SIL) from SIL 1 to SIL 4. Each level corresponds to the probability range for the failure of a safety function. The higher the SIL of the safety-related system, the higher probability that the required safety function will work.

11. Certificate

Certificate

No.: 968/V 1155.00/20

Product tested	Electro pneumatic positioner (called smart positioner) for the control of pneumatic valve actuators	**Certificate holder**	Rotork YTC Limited 81, Hwanggeum-ro 89 Beon-gil, Yangchon-eup Gimpo-si, Gyeonggi-do, 10048 South Korea
Type designation	YT-3300 L/R, YT-3301 L/R, YT-3302 L/R, YT-3303 L/R, YT-3350 L/R YT-3400 L/R, YT-3410 L/R, YT-3450 L/R YT-3700L/R, YT-3701 L/R, YT-3702 L/R, YT-3703 L/R, YT-3750 L/R YT-3800 L/R, YT-3810 L/R, YT-3850 L/R		
Codes and standards	IEC 61508 Parts 1-2 and 4-7:2010		
Intended application	Safety Function: Single acting: Depressurize the related actuator through Out1 port according to return spring in pilot valve and the return spring moves the valve to a safe end position. Double acting: Depressurize the related actuator through Out1 port and pressurizes the related actuator through Out2 port according to return spring in pilot valve and the return spring moves the valve to a safe end position in pre-selected direction. The positioners are suitable for use in a safety instrumented system up to SIL 2 (low demand mode). Under consideration of the minimum required hardware fault tolerance HFT = 1 the positioners may be used in a redundant architecture up to SIL 3 according IEC 61508 and IEC 61511.		
Specific requirements	The instructions of the associated Installation, Operating and Safety Manual shall be considered.		

Summary of test results see back side of this certificate.

Valid until 2025-04-30

The issue of this certificate is based upon an examination, whose results are documented in Report No. 968/V 1155.00/20 dated 2020-04-30.
This certificate is valid only for products which are identical with the product tested.

TÜV Rheinland Industrie Service GmbH
Bereich Automation
Funktionale Sicherheit
Am Grauen Stein, 51105 Köln

Köln, 2020-04-30

Certification Body Safety & Security for Automation & Grid

Dipl.-Ing. Gebhard Bouwer

TÜV Rheinland Industrie Service GmbH, Am Grauen Stein, 51105 Köln / Germany
Tel.: +49 221 806-1790, Fax: +49 221 806-1539, E-Mail: industrie-service@de.tuv.com

www.fs-products.com
www.tuv.com

TÜVRheinland®
Precisely Right.

TÜVRheinland®
Precisely Right.

Holder: **Rotork YTC Limited**
81, Hwanggeum-ro, 89 Beon-gil, Yangchon-eup,
Gimpo-si,Gyeonggi-do, 10048,
South Korea

Product tested: **Smart Positioner - Pneumatic valve positioner as single or double acting version**

YT-3300 L/R, YT-3301 L/R, YT-3302 L/R,
YT-3303 L/R, YT-3350 L/R
YT-3400 L/R, YT-3410 L/R, YT-3450 L/R
YT-3700L/R, YT-3701 L/R, YT-3702 L/R,
YT-3703 L/R, YT-3750 L/R
YT-3800 L/R, YT-3810 L/R and YT-3850 L/R

Results of Assessment

Route of Assessment		2_H / 1_S
Type of Sub-system		Type A
Mode of Operation		Low Demand Mode
Hardware Fault Tolerance	HFT	0

		Single Acting		Double Acting	
Lambda Dangerous Undetected assumed Diagnostic Coverage DC = 0 %	λ_{DU}	2.29 E-07 / h	229 FIT	2.68 E-07 / h	268 FIT
Average Probability of Failure on Demand 1oo1 assumed Proof Test Interval T_1 = 1 year	**$PFD_{avg}(T_1)$**	**1.00 E-03**		**1.17 E-03**	
Average Probability of Failure on Demand 1oo2 assumed Proof Test Interval T_1 = 1 year assumed β_{1oo2} = 10 %	**$PFD_{avg}(T_1)$**	**1.01 E-04**		**1.19 E-04**	

Origin of values
The stated values are the results of a FMEDA. To support the results qualification tests on the reliability of the safety function under critical conditions have been performed. In addition, the failure rate was verified by the analysis of field feedback of the last five years.
Failure rates include failures that occur at a random point in time and are due to degradation mechanisms such as ageing.
The stated failure rates do not release the end-user from collecting and evaluating application-specific reliability data.

Systematic Capability
The development and manufacturing process and the functional safety management applied by the manufacturer in the relevant lifecycle phases of the product have been audited and assessed as suitable for the manufacturing of products for use in applications with a maximum Safety Integrity Level of 3 (SC 3).

Periodic Tests and Maintenance
The given values require periodic tests and maintenance as described in the Safety Manual.
The operator is responsible for the consideration of specific external conditions (e.g. ensuring of required quality of media, max. temperature, time of impact), and adequate test cycles.

Manufacturer:

Rotork YTC Limited

81, Hwanggeum-ro, 89 Beon-gil, Yangchon-eup,

Gimpo-si, Gyeonggi-do, 10048,

South Korea

Tel: +82-31-986-8545

Fax: +82-70-4170-4927

Email: ytc.sales@rotork.com