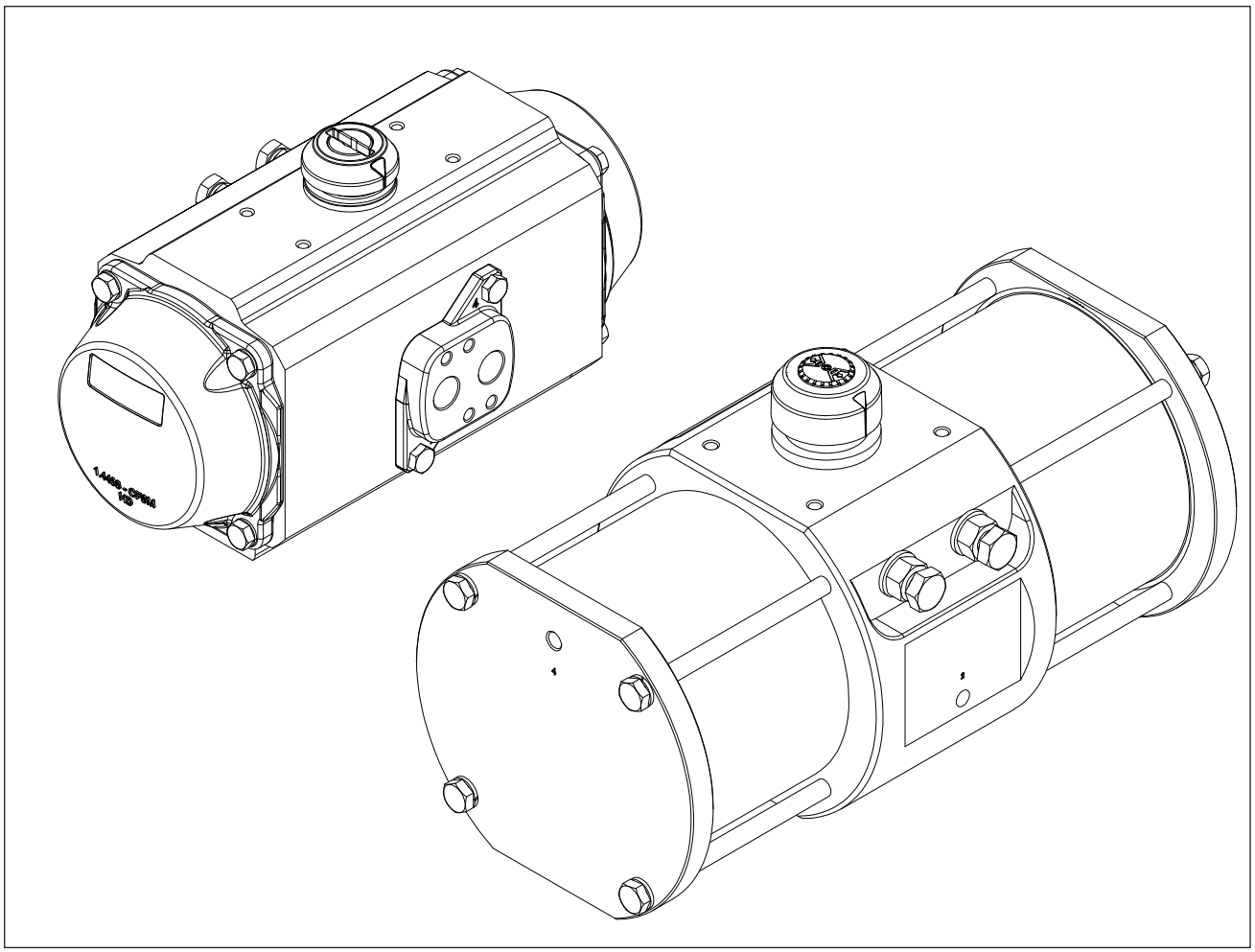
SAFETY MANUAL

SH AT-RP-SS EN

Original instructions



Stainless Steel Series

Rack&Pinion actuators
SS AT054U → SS AT654 models

Edition July 2025

Definition of signal words

⚠ DANGER

Hazardous situations which, if not avoided, will result in death or serious injury

⚠ WARNING

Hazardous situations which, if not avoided, could result in death or serious injury

NOTICE

Property damage message or malfunction

Note

Additional information

Tip

Recommended action

Content

1 Introduction

1.1 Scope

This safety manual contains information, safety-related characteristics and warnings concerning the functional safety in accordance with IEC 61508-2 Annex D and EN 17955, and concerning the application in the process industry in accordance with IEC 61511. It does not contain any particular details on other safety requirements, such as explosion protection or electrical safety.

! *NOTICE*

Risk of malfunction due to incorrect installation or start-up of the pneumatic actuators.

➔ Refer to the mounting and operating instructions on how to install and start-up the pneumatic actuators.

➔ Follow the warnings and safety instructions written in the mounting and operating instructions.

1.2 Premises

This safety manual provides the necessary information to design, install, verify and maintain a Safety Instrumented Function (SIF) when using the AIR TORQUE Stainless Steel series (in the following mentioned only as "SS"). The "SS" series pneumatic actuators are to be intended as a pneumatic device for remote operation of industrial valves when is pneumatically energized and or de-energized, and in any case the "SS" series pneumatic actuators are to be intended to be part of a final element subsystem where the final element subsystem (consisting of a valve, positioner, actuator etc.) is connected to the safety rated logic solver which is actively performing the Safety Function as well as any automatic diagnostics designed to diagnose potentially dangerous failures of the actuator and any other final element components, (i.e. Partial Valve Stroke Test).

Anyway, the subject of this safety manual are just "SS" series pneumatic actuators. Not subject of the safety manual are the driven valves, power and compressed air supply or the control of the actuators from the system as well as the control valves. Unambiguous assignments in a SIL can be only given to complete safety-related systems. Herein the "SS" series pneumatic actuators are only one component.

1.3 Safety Responsibilities

The safety of design and operation of a safety-related system, in which the "SS" series pneumatic actuators are implemented, must be ensured by manufacturer and operator as following:

1.3.1 Device Manufacturer Responsibility

- Safe design of the "SS" series pneumatic actuators
- Guarantee product performance by monitoring the production process
- Providing of all safety-related information to the operator of the overall system
- Compliance with all regulations and guidelines that allow a safe commissioning

1.3.2 Operator's Responsibility (planners, constructors, system integrators, end users and operators of safety-instrumented system)

- Training of the personnel working on the overall system
- Maintaining the safe operation of the overall system
- Compliance with all regulations and guidelines regarding occupational safety
- Ensuring of periodic test of the overall system by qualified employees
- Observe instructions in the use and maintenance manual
- Definition of time intervalls for testing and maintenance in accordance with this Safety Manual

1.4 Terms, abbreviation and definition

Term	Definition
Safety	Freedom from unacceptable risk of harm.
Functional Safety	The ability of a system to carry out the actions necessary to achieve or to maintain a defined safe state for the equipment / machinery / plant / apparatus under control of the system.
Basic Safety	The equipment must be designed and manufactured such that it protects against risk of damage to persons by electrical shock and other hazards and against resulting fire and explosion. The protection must be effective under all conditions of the nominal operation and under single fault condition.
Safety Assessment	The investigation to arrive at a judgment - based on evidence - of the safety achieved by safety-related systems.
Fail-Safe State	When the actuator move the attached valve to a safe state when it loses electrical or pneumatic energy. For the single acting actuators, where solenoid valve is de-energized, supply pressure to the actuator is discontinued and spring are extended.
Fail Safe	Failure that causes the actuator to go to the defined fail-safe state without a demand from the process
Fail Dangerous	Failure that does not respond to a demand from the process (i.e. being unable to go to the defined fail-safe state).
Fail Dangerous Undetected	Failure that is dangerous and that is not being diagnosed by automatic diagnostics.
Failures in Time (FIT)	Number of failures in time. 1 FIT = (1 Failures/10^9 hr)
Partial Stroke Test (PST) Period	Interval in which a Partial Stroke Test (PST) shall be performed. Failures can be uncovered during PST.
Mission Time (T mission)	Expected operating lifetime expressed in hours for device to provide safety function.
Fail No Effect	Failure of a component that is part of the safety function but that has no effect on the safety function
Low demand Mode ref. IEC 61508-4 § 3.5.16	Where the safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and where the frequency of demands is no greater than one per year
High demand mode ref. IEC 61508-4 § 3.5.16	Where the safety function is only performed on demand, in order to transfer the EUC into a specified safe state, and where the frequency of demands is greater than one per year
Dangerous failure	Failure with the potential to set the safety-related system to a dangerous or inoperative state.
Safety-related system	A safety-related system carries out the safety functions needed to establish or maintain a safe state, e.g. in a plant. Example: Pressure measuring instrument, logic unit (e.g. limit switch) and valve form a safety-related system.
Safety function	A defined function carried out by a safety-related system in order to establish or maintain a safe state of the plant, under consideration of a specified dangerous incident. Example: Pressure limit monitoring
Utilization rate ref. EN 17955 § 3.9	Total movements of the mechanical compliant item per year

1.5 Acronymus

Acronyms	Designation	Description
SIS	Safety Instrumented System	Implementation of one or more Safety Instrumented Functions. A SIS is composed of any combination of sensor(s), logic solver(s), and final element(s).
SIF	Safety Instrumented Function	A set of equipment intended to reduce the risk due to a specific hazard (a safety loop).
SIL	Safety Integrity Level	One of four discrete levels for specifying the safety integrity requirements of the safety functions to be allocated to the E/E/ PE safety-related systems, where SIL 4 has the highest level of safety integrity and SIL 1 has the lowest.
MRT	Mean Repair Time ref. IEC 61508-4 § 3.6.22	Expected overall repair time. This includes the time needed to initiate the repair and fully complete the repair. This does not include the time needed to detect the failure.
HFT	Hardware Fault Tolerance	Capability of a functional unit to continue executing the demanded function in case of faults or deviations.
λ_{SD}	Failure rate for all safe detected failures	
λ_{SU}	Failure rate for all safe undetected failures	
λ_{DD}	Failure rate for all dangerous detected failures	
λ_{DU}	Failure rate for all dangerous undetected failures	
PFDavg	Average Probability of dangerous Failure on Demand	Mean unavailability of an E/E/PE safety-related system to perform the specified safety function when a demand occurs.
PFH	Average frequency of dangerous failure per hour [h-1] ref. IEC 61508-4 § 3.6.19	Average frequency of a dangerous failure of a E/E/PE safety related system to perform the specified safety function over a given period of time
TI	Test interval between life testing of the safety function	Time interval between functional tests of the safety function
FMEDA	Failure Modes, Effects and Diagnostic Analysis.	
MOC	Management of Change. These are specific procedures often done when performing any work activities in compliance with government regulatory authorities.	

1.6 Related Documents

- Pneumatic Actuator product catalogue and technical data sheets,
- Installation, maintenance and operating instruction manual for Stainless Steel “SS” series actuators
- SIL Certificate

1.7 Relevant Standards

- EC 61508 Parts 1-2 and 4-7: Functional safety of electrical/electronic/ programmable electronic safety-related systems
- IEC 61511 Parts 1: Functional safety - Safety instrumented systems for the process industry sector
- EN 17955:2024: Industrial valves - Functional safety of safety-related automated valves

2 Device description

The “SS” series pneumatic actuators are designed to meet ISO 5211 and EN 15714-3 requirements.

This series of pneumatic actuators are available in double acting (D) and spring return (S..) functions.

The output torque for double acting is from 18,3 Nm to 1.966 Nm at 5.5 bar supply pressure, while for spring return version the output torque is from 7,9 Nm to 865 Nm at the maximum spring set configuration.

Actuator models range: from SB/SC AT054U to SB/SC AT654, double acting and single acting (spring return).

In double acting version (air requested for both opening and closing operations), the safety function is determined by specific plant measures (e.g. by providing an auxiliary circuit equipped with compressed air reservoir), the actuator is controlled by 5/2 way valve.

In single acting (spring return) version, the safety function is provided by the springs force action when actuator is de- energized in case of loss of supply pressure (when power supply fails), the actuator is controlled by 3/2 way valve.

Available versions:

- standard 90° rotation
- standard greater 90° rotation
- Fast Acting 90° rotation
- Fast Acting greater 90° rotation
- R50/R100 stroke adjustment for 90° rotation
- R50/R100 stroke adjustment for greater 90° rotation

For others details see also §3.2 Environmental and Application limit

3 Designing a SIF using the AIR TORQUE Stainless Steel "SS" series actuators

3.1 Safety Function

In case of dangerous situation, a safety-related system will perform defined safety function. In this situation the actuator will be activated so that the actuator and the operated valve shall move to its fail-safe position.

For example, for spring return actuator when the actuator is de-energized, the actuator and valve shall move to its fail- safe position (depending on Fail direction specified fail-closed or fail-open).

⚠ WARNING

Risk of failure of the safety function

➔ It is user responsibility to verify if the actuator is equipped with manual override device or others accessories (e.g., lock-out system, gear-boxes, 100% travel stop adjustment etc.) that cannot permit to perform the requested safety function.

➔ The actuator SIL capability may be invalidated.

3.2 Environmental and Application Limits

The designer of a SIF must verify that the product is rated and selected for the usage within the expected environmental and application limits. For usage in safety-related applications, it is important the designer to check the material suitability considering working and on-site conditions. However, the compatibility of the operating medium with the materials of construction must be verified.

⚠ WARNING

Risk of malfunction due to incorrect selection or wrong installation and operating conditions.

➔ Only use valves in safety-instrumented systems if the necessary conditions in the plant are fulfilled.

The "SS" series actuators are:

- intended for use in Indoor, Outdoor and/or Hazardous Area (ATEX directive 2014/34/EU),
- available in different temperature configurations:
  - ST, suitable for a temperature range from –40°C (-40°F) up to +80°C (+176°F),
  - HT suitable for a temperature range from –15°C (+5°F) up to +150°C (+302°F),
  - LLT2 suitable for a temperature range from –60°C (-76°F) up to +80°C (+176°F),
- suitable for operating pressure up to 8bar (116 psi),
- IP tested, rated up to IP68,
- available in different surface finishing suitable for different environmental conditions (Pharmaceutical / Industrial / Chemical plant / Offshore / Coastal / and other areas).

Refer to installation, maintenance and operating instruction manual, brochure and technical datasheets for service data and relevant information, of the "SS" series actuators.

The use outside the application limits or with incompatible material of the "SS" series actuators, may compromise the safety functions and the reliability of the provided data becomes invalid.

3.3 Design Verification

A FMEA was conducted to evaluate the fault avoidance and fault controlling measures in the relevant steps of the actuator life cycle. Possible failures in the design phase as well as during the manufacturing and assembling were contemplated herein. Failures that do not affect the safety function (no effect) were not considered.

Furthermore, the suitability of the design is proven by the positive result of a type examination as well as an endurance test and the adequate field feedback of the product.

3.4 SIL Capability

3.4.1 Systematic Safety Integrity IEC 61508-4 § 3.5.6

For standard and special version/type of "SS" pneumatic actuators, the achievable failure rates when used in a redundant structure (multi-channel architecture) allow the usage up to and including a Safety Integrity Level SIL 3 (for SIL 3 application HFT = 1 is required).

Standard and special version/type of "SS" pneumatic actuators, fulfills the safety relevant constrains for usage in single channel system up to and including Safety Integrity Level SIL 2. See the product related certificates.

These are intended to achieve sufficient integrity against systematic errors of design by the manufacturer. A Safety Instrumented Function (SIF) designed with this product must not be used at a SIL level higher than the statement without "prior use" justification by end user or diverse technology redundancy in the design.

The development and manufacturing process and the functional safety management applied by the manufacturer in the relevant lifecycle phases of the product has been inspected and assessed as suitable for the use in applications with a maximum Hardware Safety Integrity Level of 3 (SC 3), IEC 61508-4 § 3.6.22.

A complete report for the achieved Safety Integrity Level (SIL) of the "SS" series pneumatic actuators is available at AIR TORQUE S.p.a..

The achieved Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) design must be verified by the designer (constructors or system integrators of safety-instrumented system) via a calculation of PFDavg considering architecture, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of all products included in the SIF. Each subsystem must be checked to assure compliance with minimum hardware fault tolerance (HFT) requirements.

i ***Note***

The architecture and the interval between proof tests must be considered concerning the safety integrity level.

3.4.2 Hardware Safety Integrity IEC 61508-4 § 3.5.7

Standard and special version/type of "SS" pneumatic actuators are classified as a Type A Device, having a hardware fault tolerance HFT of 0. According to 61508-2, 7.4.4.3, route 2_H was used for the "SS" pneumatic actuators. See the product related Certificate.

The "SS" pneumatic actuators are typically one of several devices that can be used in a final element assembly. When the final element assembly consists of many components (pneumatic actuator, valve, solenoid, quick exhaust valve, etc.) the SIL must be verified for the entire assembly using failure rates from all components.

This analysis must account for any hardware fault tolerance and architecture constraints.

3.4.3 Pneumatic actuator Specific Parameters

Results of Assessment

Route of Assessment	$2_H / 1_S$
Type of Sub-system	Type A
Mode of Operation	Low Demand Mode High Demand Mode (see remark)
Utilization rate	Low and High Utilization Rate
Hardware Fault Tolerance	HFT = 0
Systematic Capability	**SC 3**

The following assumptions have been done:

- $\lambda_{DU} = \lambda_D \cdot (1\text{-}DC)$
- Diagnostic Coverage DC = 0 %
- Proof Test Interval T_1 = 1 year
- MRT = 72 h
- β = 10 %

Average probability of a failure on demand has been calculated with the following formulas from IEC 61508-6, B.3.2.2:

- $PFD_{avg,1oo1} = \lambda_{DU} \cdot (½\, T_1 + MRT)$
- $PFD_{avg,1oo2} = 2\,((1 - \beta) \cdot \lambda_{DU})^2 \cdot t_{CE} \cdot t_{GE} + \beta \cdot \lambda_{DU} \cdot (½\, T_1 + MRT)$
- $t_{CE} = (½\, T_1 + MRT)$
- $t_{GE} = (⅓\, T_1 + MRT)$

The given failure rates remain valid for the usage in High Demand Mode if the number of demands does not exceed $n_{op,maximum}$ = 50 1/year.

In the following tables are represented:

- Dangerous failure rate λ_D [FIT]
- Probability of failure on demand PFD_{avg} single channel 1oo1
- Probability of failure on demand PFD_{avg} double redundant channels 1oo2

Version Std 90°

Failure rates

models:	from SB/SC AT054U to SB/SC AT654			
Version / Type / Safety Function:	λ_D [FIT]		PFD_{avg} 1oo1 (T_1)	PFD_{avg} 1oo2 (T_1)
Std 90° / Spring Return	2.70 E-08/h	27	1.20 E-04	1.20 E-05
Std 90° / Double Acting	2.10 E-08/h	21	9.35 E-05	9.35 E-06

Version Std greater 90° rotation

Failure rates

models:	from SB/SC AT054U to SB/SC AT654			
Version / Type / Safety Function:	λ_D [FIT]		PFD_{avg} 1oo1 (T_1)	PFD_{avg} 1oo2 (T_1)
Std greater 90° rotation / Spring Return	2.70 E-08/h	27	1.20 E-04	1.20 E-05
Std greater 90° rotation / Double Acting	2.10 E-08/h	21	9.35 E-05	9.35 E-06

R50/R100

Failure rates

models:	from SB/SC AT054U to SB/SC AT654			
Version / Type / Safety Function:	λ_D [FIT]		PFD_{avg} 1oo1 (T_1)	PFD_{avg} 1oo2 (T_1)
R100 / Spring Return	2.70 E-08/h	27	1.20 E-04	1.20 E-05
R100 / Double Acting	2.10 E-08/h	21	9.35 E-05	9.35 E-06

R50/R100 - greater 90° rotation

Failure rates

models:	from SB/SC AT054U to SB/SC AT654			
Version / Type / Safety Function:	λ_D [FIT]		PFD_{avg} 1oo1 (T_1)	PFD_{avg} 1oo2 (T_1)
R100 greater 90° rotation/ Spring Return	2.70 E-08/h	27	1.20 E-04	1.20 E-05
R100 greater 90° rotation/ Double Acting	2.10 E-08/h	21	9.35 E-05	9.35 E-06

Fast Acting

Failure rates

models:	from SB/SC AT054U to SB/SC AT654			
Version / Type / Safety Function:	λ_D [FIT]		PFD_{avg} 1oo1 (T_1)	PFD_{avg} 1oo2 (T_1)
Fast Acting 90° rotation/ Spring Return	2.70 E-08/h	27	1.20 E-04	1.20 E-05
Fast Acting 90° rotation/ Double Acting	2.10 E-08/h	21	9.35 E-05	9.35 E-06

Fast Acting - greater 90° rotation

Failure rates

models:	from SB/SC AT054U to SB/SC AT654			
Version / Type / Safety Function:	λ_D [FIT]		PFD_{avg} 1oo1 (T_1)	PFD_{avg} 1oo2 (T_1)
Fast Acting greater 90° rotation/ Spring Return	2.70 E-08/h	27	1.20 E-04	1.20 E-05
Fast Acting greater 90° rotation/ Double Acting	2.10 E-08/h	21	9.35 E-05	9.35 E-06

3.5 Safety integrity level determination

The achievable safety integrity level (SIL) is determined by the following safety-related characteristics:

- Average probability of failure on demand (PFDavg)
- Hardware fault tolerance (HFT)

The following table in accordance with IEC 61508 and IEC 61511 shows how the safety integrity level (SIL) depends on the average probability of failure on demand (PFDavg). It is based on low demand mode of operation, i.e. the frequency of demands on a safety-related system is no greater than once per year.

Safety integrity Level (SIL)	**PFD_{avg} (Low Demand Mode)**
4	**$\geq 10^{-5}$ to $< 10^{-4}$**
3	**$\geq 10^{-4}$ to $< 10^{-3}$**
2	**$\geq 10^{-3}$ to $< 10^{-2}$**
1	**$\geq 10^{-2}$ to $< 10^{-1}$**
PFD_{avg} in Low Demand Mode of operaation according to IEC 61508-1, Table 2	

The sensor, logic unit and final element form a safety-related system that performs a safety function. Example:

	SENSOR	LOGIC UNIT	FINAL ELEMENT
	e. g. pressure measuring instrument	e. g. PLC	e. g. actuator and valve
PFD_{avg}	≤ X%	≤ X%	≤ X%

The average probability of failure on demand (PFDavg = sum of sensor, logic unit and final element failures) must be within the range of the demanded safety integrity level (SIL) in case of demand as listed in the above table.

The failure rate data listed in the certificates and FMEA (Failure Mode and Effect Analysis) reports are only valid for the useful life time of an "SS" series actuator

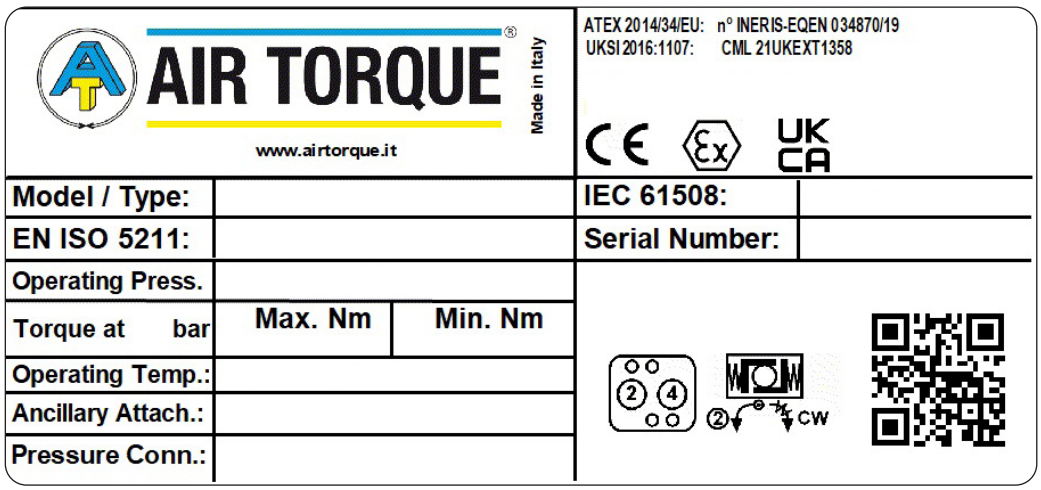
In order to determine whether pneumatic actuator is suitable for the usage in a certain safety-related system, it is necessary to define the PFDavg value of the overall system. Usually, it is presumed that a final element (valve + actuator + solenoid valve) uses up to 50% of the total available PFDavg value.

3.6 Connection of the Stainless Steel "SS" series actuator to the SIS Logic-solver

The "SS" series pneumatic actuator may be connected to the safety rated logic-solver which may actively perform the safety function as well as automatic diagnostics designed to diagnose potentially dangerous failures within "SS" series actuator (i.e. partial stroke test).

3.7 General Requirements

The system's response time shall be less than process safety time. The "SS" series pneumatic actuator is only one part of the final element of a SIS. All elements of the SIF must be selected to meet safety response time. All SIS components including the "SS" actuator must be operational before process start-up. User shall verify that the "SS" pneumatic actuator is suitable for use in safety applications by confirming the "SS" actuator's label is properly marked (see below example).



Personnel performing maintenance and testing on the "SS" series actuator shall be competent to do so. Results from the proof tests shall be recorded and reviewed periodically.

4 Installation and commissioning

4.1 Installation

The “SS” series pneumatic actuator must be installed as per standard practices outlined in the Installation Manual. The environment must be checked to verify that environmental conditions do not exceed the ratings.

The “SS” series pneumatic actuator must be accessible for physical inspection.

4.2 Physical Location and Placement

The “SS” series pneumatic actuator shall be accessible with sufficient room for pneumatic connections and for manual proof testing. Pneumatic piping to the valve shall be kept as short and straight as possible to minimize the air- flow restrictions and potential clogging. Long or kinked pneumatic tubes may also increase the valve closure time. The “SS” pneumatic actuator shall be mounted in a low vibration environment. If excessive vibration can be expected special precautions shall be taken to ensure the integrity of pneumatic connectors or the vibration should be reduced using appropriate damping mounts.

4.3 Mechanical and pneumatic installation and Connections

- ➔ During mechanical and pneumatic installation, the mounting and operating instructions of the corresponding device must be followed.
- ➔ On sizing actuators, note that the actuator must provide sufficient torque to overcome the closing torque in closed position as well as the dynamic torque in open position. The actuator sizing, include also verification of the permissible torques for the valve shaft, shaft adapter etc. as a result, the max. torque of the actuator (air or spring torque) must not exceed these torques under any circumstances. The ISO 5211 and EN 15081 requirements must be respected.
- ➔ Recommended piping for the inlet and outlet pneumatic connections to the “SS” pneumatic actuator is minimum 1/4” (depending on actuator size and air volume) stainless steel or PVC tubing. The length of tubing between the pneumatic actuator and the control device, such as a solenoid valve, shall be kept as short as possible and free of kinks. Direct mount on actuator air connections interface of the control device is recommended.
- ➔ The process air capacity shall be sufficient to move the “SS” pneumatic actuator within the required time.
- ➔ The minimum requirements for the operating medium (power supply) according to ISO 8573-1 are: pressure dewpoint ≤ -20°C (or at least 10 °K below ambient temperature), maximum particle size < 30 microns.
- ➔ To prevent corrosion of the actuator springs, measures must be taken to prevent water or moisture entering the actuator.
- ➔ The process air pressure shall meet the requirements set forth in the installation manual. Important Verification: Function and operating time (open and closing time) shall be verified after installation. Effect of different operating pressure shall be considered for the verification.

5 Operation and maintenance

⚠ WARNING

Risk of dangerous failure due to malfunction in the event of emergency (pneumatic actuator does not move to the fail-safe position).

➔ Only use devices in safety-instrumented systems that have passed the proof test according to the test plan drawn up by the operator.

⚠ WARNING

Risk of failure of the safety function

➔ It is user responsibility to verify if the actuator is equipped with manual override device or others accessories (e.g., lock-out system, gear-boxes, 100% travel stop adjustment etc.) that cannot permit to perform the requested safety function.

➔ The actuator SIL capability may be invalidated.

Tip

We recommend to perform the proof tests based on a checklist.

5.1 Proof test without automatic testing

The scope of proof testing is to detect failures within the "SS" pneumatic actuator that are not detected by any automatic diagnostics of the system. Of main concern are undetected failures that prevent the safety instrumented function from performing its intended function. The frequency of proof testing, or the proof test interval, is to be determined in reliability calculations for the safety instrumented functions for which the "SS" pneumatic actuator is applied. The proof tests must be performed more frequently than or as frequently as specified in the calculation in order to maintain the required safety integrity of the safety instrumented function. The following proof test is recommended.

The results of the proof test should be recorded and any failures that are detected and that compromise functional safety should be reported to AIR TORQUE S.p.a.. The suggested proof test consists of a full stroke of the Stainless Steel "SS" pneumatic actuator The person(s) performing the proof test of an "SS" pneumatic actuator should be trained in SIS operations, including bypass procedures, pneumatic actuator maintenance and company Management of Change procedures. No special tools are required.

Table 1: Recommended Proof Test (example)

Step	Action
1	Bypass the safety function and take appropriate action to avoid a false trip.
2	Interrupt or change the signal/supply to the actuator to force the actuator and valve to perform a full stroke to the FailSafe state and confirm that the Safe State was achieved and within the correct time.
3	Restore the supply/signal to the actuator and confirm that the normal operating state was achieved.
4	Inspect the Stainless Steel "SS" pneumatic actuator for any visible damage or contamination.
5	Record the test results and any failures in your company's SIF inspection database.
6	Remove the bypass and otherwise restore normal operation.

5.2 Proof test with automatic partial stroke testing

An automatic partial valve stroke testing scheme that also performs a periodic full stroke of the "SS" pneumatic actuator and valve movement timing will detect most potentially dangerous failure modes.

It is recommended that a physical inspection (Step 2 from Table 1) is performed on a periodic basis with the time interval determined by plant conditions. A maximum inspection interval of five years is recommended.

5.3 Maintenance

The given values require periodic test and maintenance according to the mounting and operation instruction manual:

- EB AT-RP-SS

The operator is responsible for establishing an appropriate maintenance interval considering of the real working conditions and adequate test cycles.

NOTICE

Risk of malfunction due to the use of unauthorized parts.

➔ Only use original parts to replace worn parts.

Tip

Contact AIR TORQUE's After-sales Service department concerning any work not described in the section on servicing or maintenance in the associated "SS" pneumatic actuators documentation.

5.4 Repair and replacement

Repairing procedures for the "SS" pneumatic actuators are described in the Installation, Operation and Maintenance manual that must be followed. The SIL rating of the "SS" pneumatic actuator will be voided if the repair is not performed with AIR TORQUE S.p.a. OEM repair parts and serviced by a competent person.

NOTICE

Fail-safe action impaired due to incorrect repair.

➔ Service and repair work must only be performed by trained staff.

5.5 Useful Life

Useful lifetime is an engineering reliability term that describes the operational time interval where the failure rate of a device is relatively constant. It is not a term which covers product obsolescence, warranty, or other commercial issues. For normal service condition and planned minimum maintenance for the Stainless Steel "SS" pneumatic actuator the useful lifetime can be up to 25 years and over depending by real operating conditions. When field experience indicates a shorter useful lifetime than indicated, the number based on field experience should be used.

The useful lifetime is highly dependent on the subsystem itself and its operating conditions. It is the responsibility of the end user to maintain and operate the Stainless Steel "SS" pneumatic actuator per manufacturer's instructions. Furthermore, regular inspections should show that all components are clean and free from damage.

Cycle life varies by actuator size up to over 1.000.000 cycles for smaller size depending on real working conditions and maintenance intervals.

5.6 Manufacturer Notification

Any failures that are detected and that compromise functional safety should be reported to AIR TORQUE S.p.a. .

Please contact AIR TORQUE S.p.a. customer service or your local AIR TORQUE S.p.a. service representative.

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Tel.: + 39 035 682299 - Fax.: + 39 035 687791 - e-mail: info@airtorque.it - www.airtorque.it

5.7 Start-Up Checklist

The following checklist may be used as a guide to employ the AIR TORQUE "SS" series pneumatic actuators in a safety critical SIF compliant to IEC61508.

Activity	Result	Verified	
		By	Date
Design			
Target Safety Integrity Level and PFDAVG determined			
Correct valve mode chosen (Fail closed, Fail open)			
Design decision documented			
Pneumatic compatibility and suitability verified			
SIS logic solver requirements for valve tests defined and documented			
Routing of pneumatic connections determined			
SIS logic solver requirements for partial stroke tests defined and documented			
Implementation			
Physical location appropriate			
Pneumatic connections appropriate and according to applicable codes			
SIS logic solver valve actuation test implemented			
Maintenance instructions for proof test released			
Verification and test plan released			
Implementation formally reviewed and suitability formally assessed			
Verification and Testing			
Electrical connections verified and tested			
Pneumatic connection verified and tested			
SIS logic solver valve actuation test verified			
Safety loop function verified			
Safety loop timing measured			
Bypass function tested			
Verification and test results formally reviewed and suitability formally assessed			
Maintenance			
Tubing blockage / partial blockage tested			
Safety loop function tested			

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