SAFETY MANUAL FOR SPOOL VALVES

- **DP/DPP 3204**
- **DP/DPP 3206**
- **DP/DPP 3208**
- **DP/DPP 3212**
- **DP/DPP 5204**
- **DP/DPP 5206**
- **DP/DPP 5208**
- **DP/DPP 5212**

STC-SM-DP

3					
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SUMMARY

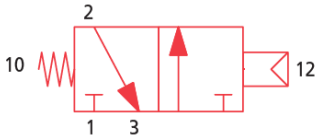
0 INTRODUCTION

Purpose of this Safety Manual, written in compliance with IEC 61508-2, Annex D, is to give all the necessary information to the system integrator for a correct use of the product in Safety Instrumented Systems for SIL classified applications.

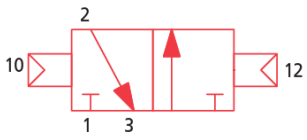
1 SAFETY FUNCTION SPECIFICATION

The Safety Functions for "3/2 Spool Valve" used in safety-related services duties for a Single effect Actuator/Double Effect Actuator can be defined as follow:

PNEUMATIC / SPRING



DOUBLE PNEUMATIC



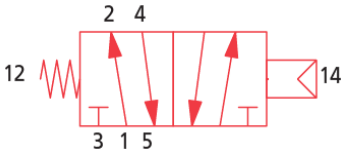
3/2 DP Pneumatic/Spring:
When the inputs at the connected devices (solenoid valve etc.) go to zero, there isn't pressure on Pilot Signal (12), and the spring (10) commutates the position of the spool valve, closing the supply line (1-2) and discharging the cylinder chamber of the actuator to the exhaust (3).

NOTE: The safety function is performed in same way, both for discharging a chamber of single/double effect actuator, or for charging the chamber of an double acting actuator. In both cases, the safety function must be performed when the Pilot Signal (12) goes to zero and the spring(10) commutates the position.

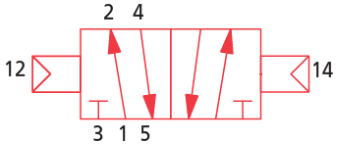
3/2 DP Double Pneumatic:
With a spool valve double pneumatic, there are two inputs devices (solenoid valves), for two different Pilot Signals (10, 12). As in one device the pressure goes to zero and in the second increases, the pressure modifies the position of the spool valve closing the supply line (1-2) and discharging the cylinder chamber of the actuator to the exhaust (3).

The Safety Functions for "5/2 Spool Valve" used in safety-related services duties for a Double effect Actuator can be defined as follow :

PNEUMATIC / SPRING



DOUBLE PNEUMATIC



5/2 DP Pneumatic/Spring:
When the inputs at the connected devices (solenoid valve etc.) goes to zero, there isn't pressure on Pilot Signal (14), and the spring (12) commutates the position of the spool valve, closing the supply line (1-4) and discharging a cylinder chamber of the actuator from exhaust (5), and opens a second charging line (1-2) to charge a second chamber of the actuator.

5/2 DP Double Pneumatic:
With a spool valve double pneumatic, there are two inputs devices (solenoid valves), for two different Pilot Signals (12, 14), as in one device the pressure goes to zero and in the second increases, the pressure modifies the position of the spool valve, closing the supply line (1-4) and discharging a cylinder

chamber of the actuator to the exhaust (5), and opens a second charging line (1-2) to charge a second chamber of the actuator.

2 CONFIGURATION OF THE PRODUCT

The product is named and coded as follow:

3/2 – ¼" BODY - 3/2 – CORPO ¼"

SIZE CONNESSIONI	FUNCTION FUNZIONE	OPERATOR AZIONAMENTO	RETURN RIPOSIZIONAMENNTO	MODEL MODELLO
¼" NPT	3/2	Pilot /Pneumatico	Spring / Molla	DP32SS04N
¼" NPT	3/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP32SS04N

3/2 – ½" BODY- 3/2 – CORPO ½"

SIZE CONNESSIONI	FUNCTION FUNZIONE	OPERATOR AZIONAMENTO	RETURN RIPOSIZIONAMENNTO	MODEL MODELLO
3/8" NPT	3/2	Pilot /Pneumatico	Spring / Molla	DP32SS06N
3/8" NPT	3/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP32SS06N
½" NPT	3/2	Pilot /Pneumatico	Spring / Molla	DP32SS08N
½" NPT	3/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP32SS08N
3/4" NPT	3/2	Pilot /Pneumatico	Spring / Molla	DP32SS12N
3/4" NPT	3/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP32SS12N

5/2 – ¼" BODY - 5/2 – CORPO ¼"

SIZE CONNESSIONI	FUNCTION FUNZIONE	OPERATOR AZIONAMENTO	RETURN RIPOSIZIONAMENNTO	MODEL MODELLO
¼" NPT	5/2	Pilot /Pneumatico	Spring / Molla	DP52SS04N
¼" NPT	5/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP52SS04N

5/2 – ½" BODY - 5/2 – CORPO ½"

SIZE CONNESSIONI	FUNCTION FUNZIONE	OPERATOR AZIONAMENTO	RETURN RIPOSIZIONAMENNTO	MODEL MODELLO
3/8" NPT	5/2	Pilot /Pneumatico	Spring / Molla	DP52SS06N
3/8" NPT	5/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP52SS06N
½" NPT	5/2	Pilot /Pneumatico	Spring / Molla	DP52SS08N
½" NPT	5/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP52SS08N
3/4" NPT	5/2	Pilot /Pneumatico	Spring / Molla	DP52SS12N
3/4" NPT	5/2	Pilot /Pneumatico	Pilot /Pneumatico	DPP52SS12N

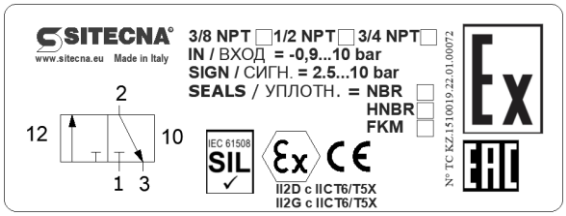
NOTE:

- For Body Material Anticorodal Aluminium Alloy replace “SS” with “AL”;
- For Low Temperature -55°C please insert after “N” “ the code ”-HN”

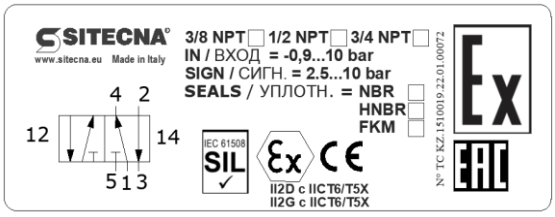
3 SERVICE CONDITION LIMITATIONS (LIMITATION OF USE)

The service condition limitations (Max Inlet Pressure 10 bar and range of temperature -55°C + 90°C), the type of material, are included on valve label (see the sample below).

DP3/2



DP5/2



Also we have a “TRACE NUMBER” for the material traceability.

NOTE For Double Acting Actuators Applications:
All the requirements of IEC 61511-1 par. 11.2.11 shall be met.
For this reason, as a pressure switch or pressure transmitter mounted downstream the Spool Valves or upstream the Spool Valves (signal line) would be ineffective, the corresponding tubing connections' length shall be reduced at a minimum.

4 EXPECTED LIFETIME

Valves lifetime strongly depends on operating conditions and on materials of construction. As a general rule, the customer selects the main materials of construction.

For normal service conditions, the expected lifetime can be considered an average of 20 years.

The above value is valid only if prescriptions in paragraph 6 of this manual are respected.

5 FAILURE MODES AND ESTIMATED FAILURE RATES

Configuration	Safety function	λ_{DU} [1/h]	λ_{DD} [1/h]	λ_S [1/h]
3/2, 5/2 pneumatic/spring spool valve - No PST	De-Energise-To-Trip	1,53E-08	0,00E+00	1,46E-07
3/2, 5/2 pneumatic/spring spool valve - With PST	De-Energise-To-Trip	1,53E-10	1,51E-08	1,46E-07
3/2, 5/2 double pneumatic spool valve - No PST	Energise-To-Trip	1,01E-07	0,00E+00	0,00E+00
3/2, 5/2 double pneumatic spool valve - With PST	Energise-To-Trip	1,01E-09	9,99E-08	0,00E+00

Failure modes and estimated failure rates

NOTES:
1. No internal diagnostics is included in the device.
2. The failure rates are guaranteed:
    a. For the service conditions listed in par. 3
    b. For the expected lifetime declared in par. 4
    c. Considering the periodic test and maintenance included in par. 6

The failure rates are determined performing a FMEDA based on the failure rates of components taken from industrial databases (NPRD-2016/FMD97/2016, EXIDA E&MCRH and NSWC-2011), integrated with field feedback using the Bayesian statistical approach mentioned in IEC 61508-2 Par. 7.4.4.3.3.

The system for reporting failures is based on field feedback from end users, with:

- Identification of the claim/failure
- Root cause analysis to identify cause and responsibility of the failure
- Identification of the possible effect of the failure on the Safety Function
- Classification of the failure considering the failure categories of IEC 61508-2 (Safe, Dangerous, No Effect)

Customer Service, Quality and Technical Department are responsible for the procedure, according to the respective role.

6 PERIODIC TEST AND MAINTENANCE REQUIREMENTS

6.1 General

Please consider that the information in this paragraph are relevant only in regards of Reliability Tests; please refer to the Maintenance and Instructions Manual for detailed information about product maintenance, handling and storage

Tests may be carried out to increase the system reliability.
"On site" tests depend on Project/Plant facilities/requirements; however, a functional test must be executed on site, before Valve usage.

6.2 Full Stroke + Leak Test

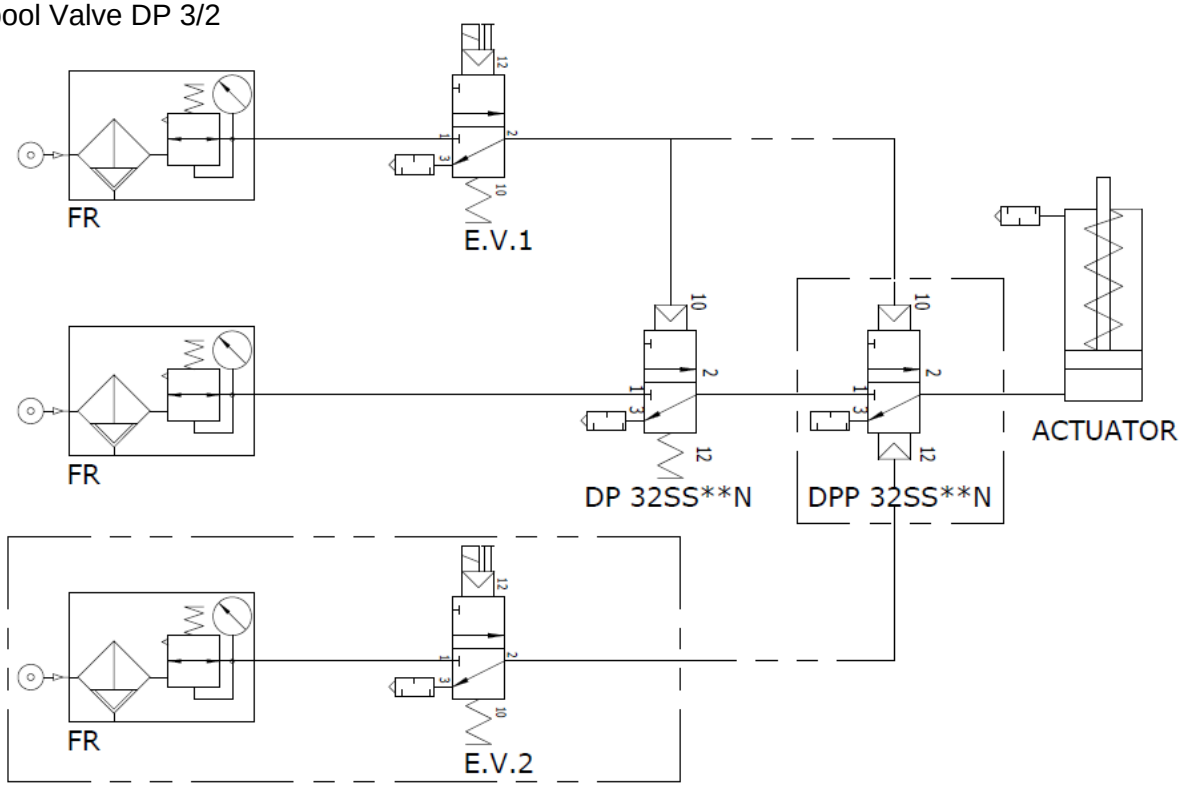
The "Full Stroke + Leak Test" ("On line") must be performed to satisfy the PFD_{AVG} (average probability of failure on demand) value.
The test frequencies will be defined from the final integrator in relation to the defined SIL level to achieve.

The following parameters can be verified:

- Correct performing of open – close and test regulation pressure;
- Internal Leakage.

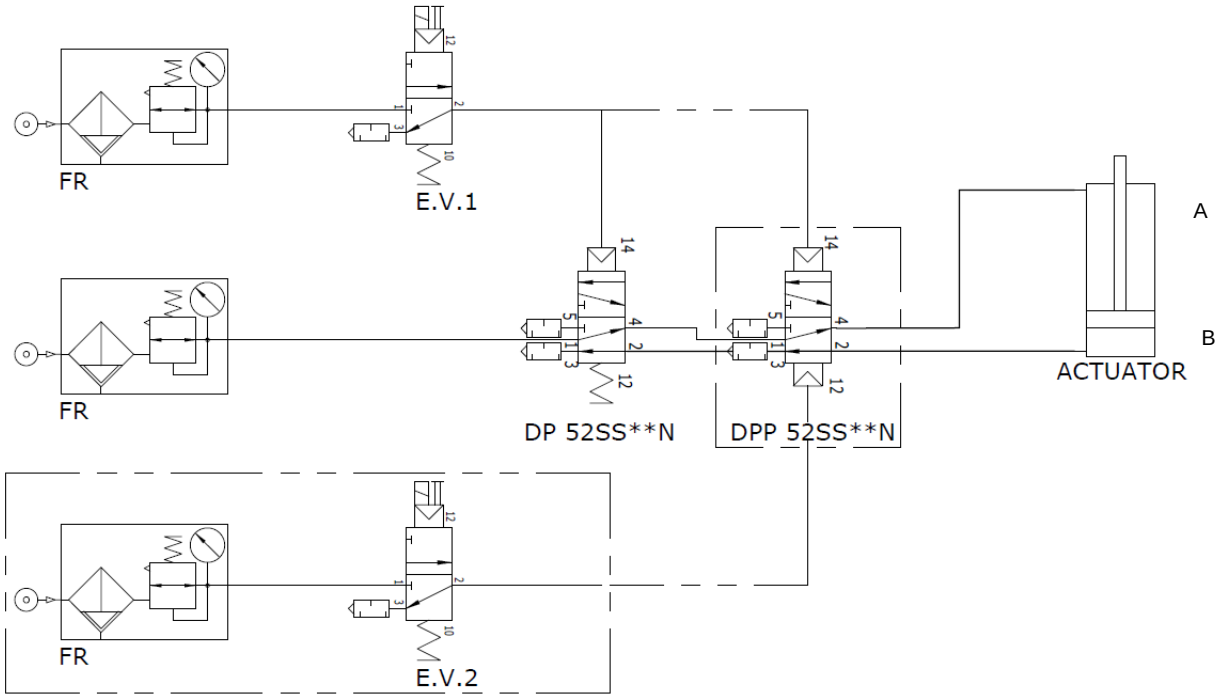
Procedure for Full Stroke Test

Spool Valve DP 3/2



- Start with the DP valve in open configuration, actuator cylinder chamber pressurized
- De-Energize the solenoid valve 1 (for a DPP Valve energize E.V.2), the spring/signal port (12) commutes the DP valve, exhausts the chamber of the actuator with the air line (2-3), and the actuator goes in safe position by the force of the spring.

Spool Valve DP 5/2



- Start with the DP valve in open configuration, actuator cylinder chamber B pressurized
- De-Energize the solenoid valve 1 (for a DPP Valve energize E.V.2), the spring/signal port (12) has commuted the DP valve, the chamber of the actuator B is discharged with the air line (2-3), the air line (1-4) charging the chamber of actuator A, and the actuator is repositioned in a initial position.

Procedure for Leak Test On Line

- Pressurize the Spool Valve increasing the pressure until 8 bar;
- Verify if there are pressure leaks.

Considering the application of the above described Full Stroke + Leak Test procedure, the "Test Coverage" can be considered 100%.

6.3 Partial Stroke Test

- The Partial Stroke Test on the ESD assembly results in full stroke on the DP. So a partial stroke test done with manual or automatic procedure with PST device, gives as a result on the DP the same test coverage reached with the Full Stroke Test.

6.4 Periodic Maintenance

The periodic maintenance is described in section 8 of the IOM Manual.

7 CLASSIFICATION

The device is classified Type A according to IEC 61508-2.

8 ARCHITECTURTAL CONSTRAINTS

For the evaluation of the conformity to the requirement of Hardware safety integrity architectural constraints of the standard IEC 61508, both Route 1_H and Route 2_H are used.

Route 1_H

- The device has a single channel configuration, HFT=0
- SFF (without external diagnostic tests):
  - DETT application: 90,50%
  - ETT application: 0%
- SFF (with external diagnostic tests): 99%

Route 2_H

The application of Route 2_H ("proven in use approach") is evaluated according paragraphs 7.4.10.1÷7.4.10.7 of IEC 61508-2.
Evidence was identified for each specific point.
As the device is classified as "Type A", no requirements for SFF are given for Route 2_H.

Conclusion

The device can be used in:

- single channel configuration:
  - DETT application: up to SIL 3
  - ETT application:
    - up to SIL 2 without external diagnostic tests
    - up to SIL 3 considering external diagnostic tests
- double channel configuration: up to SIL 3

9 MEAN REPAIR TIME

The Mean Repair Time (MRT) is:

- Substitution = 30 min
- Repair using the spare part kit = 120 min

The MRT considered is the Technical Mean Repair Time, i.e., it takes in consideration availability of skilled personnel and adequate tools.

10 COMMON CAUSE FACTORS

The product has a single channel configuration, HFT=0.

The β factors can be used when performing PFD_{AVG} calculations for redundant architectures.

The Common Cause factors, relevant when the product is used in redundant configuration, are:

$\beta=\beta_D=0,05$

NOTES:

- The above value is the value for 1oo2 architecture. The values for other architectures shall be calculated according to IEC 61508 Part 6, Table D.5.
- The above value is calculated in the hypothesis of redundancy without diversity

11 SYSTEMATIC CAPABILITY

The systematic capability of the device is 3.

This systematic capability is guaranteed only if the user:

1. Use the device according to the instructions for use and to the present Manual
2. Use the device in the appropriate environment (limitation of use)