Document owner			
Name	**Function**	**Date**	***Signature or Electronic Approval***
C. Brembati	R&DM	01/09/2022	Claudio Brembati
J. de los Reyes	FSM	28/11/2023	John Paul de los Reyes

Verification			
Name	**Function**	**Date**	***Signature or Electronic Approval***
G. Resmini	FSM	29/06/2020	Gianantonio Resmini
F. Cattaneo	TM	28/11/2023	Fabrizio Cattaneo

Approval for correct format / visual / System integration			
Name	**Function**	**Date**	***Signature or Electronic Approval***
N. Baez Saenz	Supplier Quality Manager	29/06/2020	Nelyda Baez Saenz

Approval for content and implementation			
Name	**Function**	**Date**	***Signature or Electronic Approval***
A.Maffi	TM	26/06/2020	Alberto Maffi
F. Cattaneo	TM	01/09/2022	Fabrizio Cattaneo
F. Cattaneo	TM	28/11/2023	Fabrizio Cattaneo

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Date:	**Rev.:**	**Section**	**Notes**
29/06/2020	00	N/A	First issue
01/09/2022	01	All and in particular par. 2 and 9.	Inclusion of Filter Booster
258/11/2023	02	Par. 2 and 3	Updated Filter booster configuration Updated Product Label

INDEX

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(S) SPECIFICATION

The safety function is defined as follows:

- De-energize-to-trip operation – DETT (to discharge a chamber of a single acting or double acting pneumatic actuator): when the pressure on the signal port goes to zero, the booster allows the discharge of the cylinder chamber to the exhaust, and the actuator goes towards the safety position.
- Energize-to-trip operation – ETT (to charge a chamber of a double acting pneumatic actuator): when the pressure on the signal port goes to the system operating pressure (2,5 barg), the booster allows the air supply to reach the cylinder chamber of the actuator, which goes to the safety position, until the equalization between the output pressure and the signal pressure, when the three ports (IN, OUT, EXHAUST) are not in communication, and the chamber of the actuator remains pressurized.

The choice of the safety function to be implemented is responsibility of the system integrator.

2. CONFIGURATION OF THE PRODUCT

The configuration of the product is described in general way on the relevant sections of Installation, Maintenance and Instructions Manual: sectional drawing, part list and component description. The product is named and coded as follow:

VOLUME BOOSTER

SA | 17 | 3B | VB | R2 | L

Version	
SA	Aluminium with epoxy coating paint
SS	Stainless steel AISI 316L

Size and connections	
3A	TG3 - 1/4" NPT
3B	TG3 - 1/2" NPT
4A	TG4 - 3/4" NPT
4B	TG4 - 1" NPT

Flow regulators options	
	without flow regulators
RS	with exhaust flow regulator
RM	with inlet flow control regulator
R2	with bi-directional flow control regulators

Temperature options	
	Standard (-30°C ... +80°C)
L	Low temperature (-50°C ... +80°C)
Z	Low temperature (-60°C ... +80°C)
H	High temperature (-5°C ... +150°C)
EF	EPDM-FDA (-40°C ... +100°C)

FILTER BOOSTER

SS | 17 | 3B | VFB | A | L

Version	
SS	Stainless steel AISI 316L

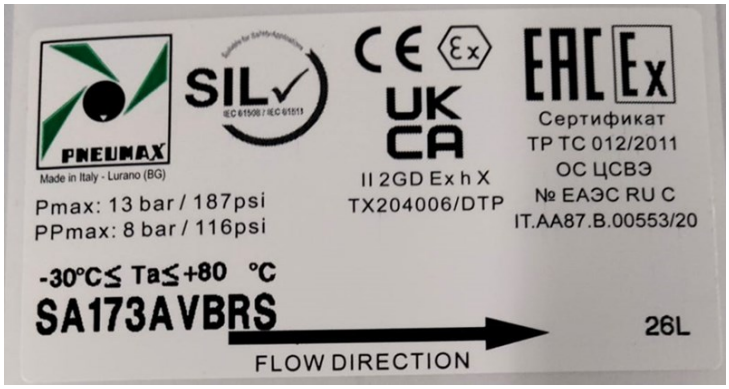
Size and connections	
3A	Size 3 - 1/4" NPT
3B	Size 3 - 1/2" NPT
4A	Size 4 - 3/4" NPT
4B	Size 4 - 1" NPT

Filter pore size	
A	5 µm - Stainless steel AISI 316
B	20 µm - Stainless steel AISI 316
C	50 µm - Stainless steel AISI 316
D	5 µm - HDPE
E	20 µm - HDPE
F	50 µm - HDPE

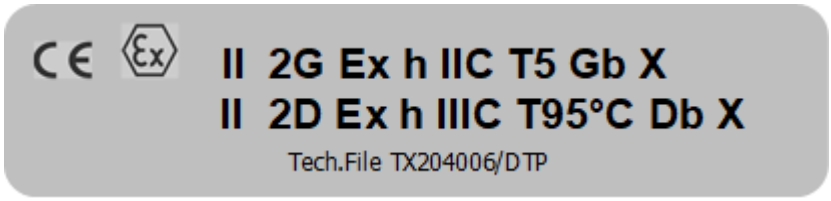
Temperature options	
	Standard (-30°C ... +80°C)
L	Low temperature (-50°C ... +80°C)
Z	Low temperature (-60°C ... +80°C)
H	Low temperature (-5°C ... +150°C)
S	Automatic drain (-5°C ... +70°C)
EF	EPDM-FDA (-40°C ... +100°C)

3. SERVICE CONDITION LIMITATIONS (LIMITATION OF USE)

The service condition limitations (P(max), T(min), T(max)) are included on product label (see the sample below).



ATEX MARKING



COMPACT ATEX MARKING

4. EXPECTED LIFETIME

Product 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 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

Please refer to the values included in the latest valid version of SIL Certificate(s) (available upon request sent to Pneumax).

NOTES:

- No internal diagnostics is included in the product.
- The failure rates are guaranteed:
  - For the service conditions listed in par. 3
  - For the expected lifetime declared in par. 4
  - 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 IOM 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 product usage.

6.2 Full Stroke Test

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

NOTE: the full stroke test is performed in conjunction with the full stroke test of the complete actuator-valve assembly.

Procedure for Full Stroke Test

- Operate the Actuator/Valve assembly for No. 2 open/close complete cycles with complete closing of the valve.
- Verify the correct performing of open – close manoeuvre (e.g. check locally, or automatically via Logic solver, the correct movement of the actuator/valve).

The following parameters can be verified

- Proper functionality
- Manouvre Times
- Booster Leakages

6.3 Partial Stroke Test

When the Partial Stroke Test of the actuator-valve assembly involves also the booster, this is a full stroke test for the booster itself.

6.4 Test Coverage / Diagnostic Coverage

Considering the application of the above described procedure, the "Test Coverage", in case of automatic procedure, can be considered > 99%.
In case of manual procedure, the "Test Coverage" shall take into account also the test imperfection and the reliability/competence of the operator.
Such a test can detect all Dangerous Failures of the Booster.

Notes:

- if the test is automatic, then the Test Coverage is PTC, but can also considered as DC
- if the test is manual, then the Test Coverage is PTC, but cannot be considered as DC

6.5 Periodic Maintenance

The periodic maintenance is described in the IOM Manual.

7. CLASSIFICATION

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

8. ARCHITECTURAL 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

- HFT=0, as the product has a single channel configuration
- SFF, without PST:
  - ≅64% in case of DETT application;
  - ≅0 in case of ETT application;
- SFF, with PST: >99%

Route 2_H

The application of Route 2_H (“field feedback”) is assessed.

As the product is classified as “Type A”, no requirements for SFF are given for Route 2_H.

In conclusion:

The product can be used in single channel configuration up to:

- SIL 2 without external diagnostic tests
- SIL 3 considering external diagnostic tests

9. MEAN REPAIR TIME

The Mean Repair Time (MRT) is indicated in the following table:

Type of device	Size	MRT [h]
Booster, Filter Booster	Any size	1

NOTE:

- The MRT considered is the time to substitute the device, taking in consideration availability of skilled personnel, adequate tools and spare parts (complete device).

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 product is 3.

This systematic capability is guaranteed only if the user:

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