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Keeping the World Flowing
for Future Generations

Models 4500A, 4850A, 4890A

A rotork Brand
FAIRCHILD
precision pneumatic & motion control

Instruction manual supplement

Volume boosters SIL safety manual

CE Ex

Contents

This manual contains important safety information. Please ensure it is throughly read and understood before installing, operating or maintaining the equipment.

Rotork reserves the right to modify, amend and improve this manual without notice.

Rotork is not responsible for damage or injury caused by the failure to observe the instructions contained herein.

Model 4500A

Model 4850A

Model 4890A

This manual supports Safety Instrumented System (SIS) installation, operation and verification.

⚠ WARNINGS:

This safety manual is intended for use in conjunction with the Fairchild Industrial Products Booster installation manuals:

4500A PUB103-166
4850A PUB103-182
4890A PUB103-106

These manuals provide the operating specification for use. This information is available online at www.**rotork**.com.

Using the equipment outside the specifications indicated in the supporting literature could result in premature failure, personal injury or property damage.

Product support and service

Servicing of the Fairchild volume boosters must be performed at the Fairchild Factory in order to satisfy and maintain the Functional Safety requirements for the SIL certification.

System design, installation and verification shall be carried out by competent personnel as defined in IEC 61511.

1.1 Scope and purpose of the SIL safety manual

The safety manual provides the information required to implement a safety instrumented function using the volume boosters per standards IEC 61508 and IEC 61511.

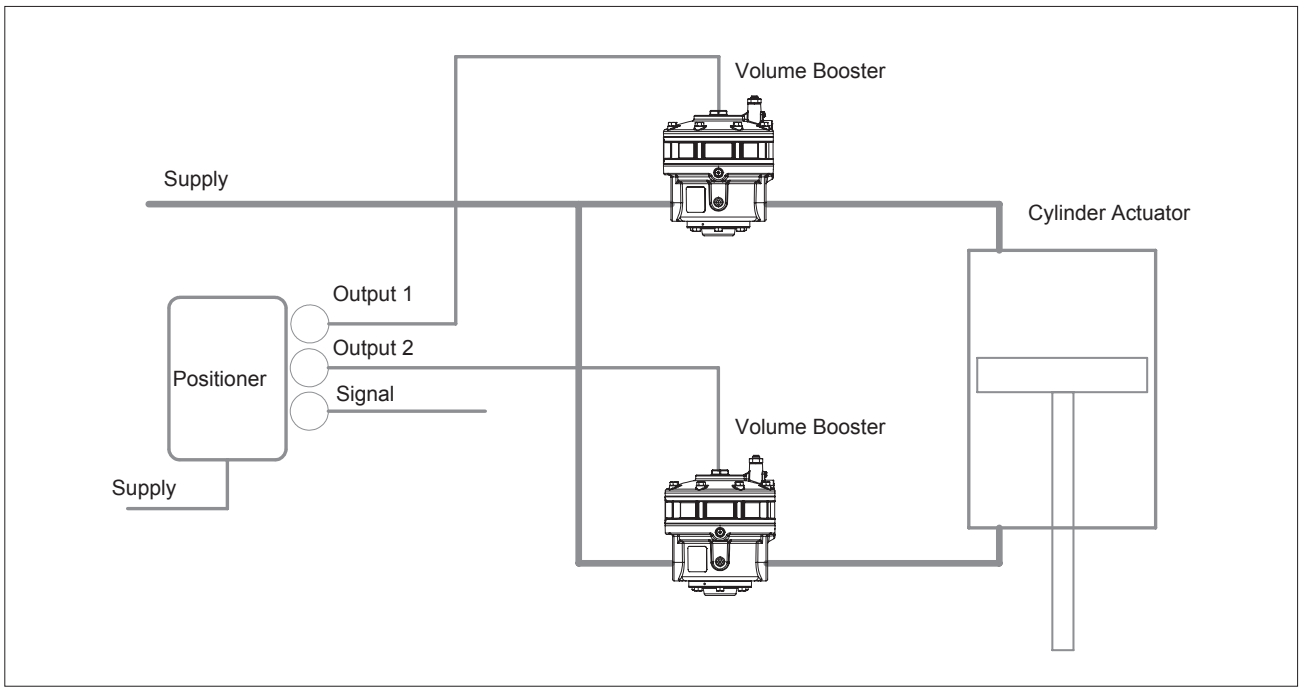
1.2 Scope of volume booster SIL

- The volume boosters, valves, are suitable for use in a safety-instrumented system up to and including SIL2 according to IEC 61508. Under consideration of the minimum required hardware fault tolerance HFT = 1, the valves may be used in a redundant structure up to and including SIL3. The volume boosters are suitable for SIL 2, HFT = 0, in a Safety Instrumented System (SIS). The boosters are suitable for SIL 3, HFT = 1, in a Safety Instrumented System (SIS) when used in a redundant structure.
- The valves are appraised suitable for use in both modes of operation, Low Demand or High Demand (continuous) operation:
    - Low Demand – refer to Table 2 for **PFDavg**, Average Probability of Failure per Demand
    - High Demand – refer to Table 1 for **PFH**, Average Probability of Failure per Hour

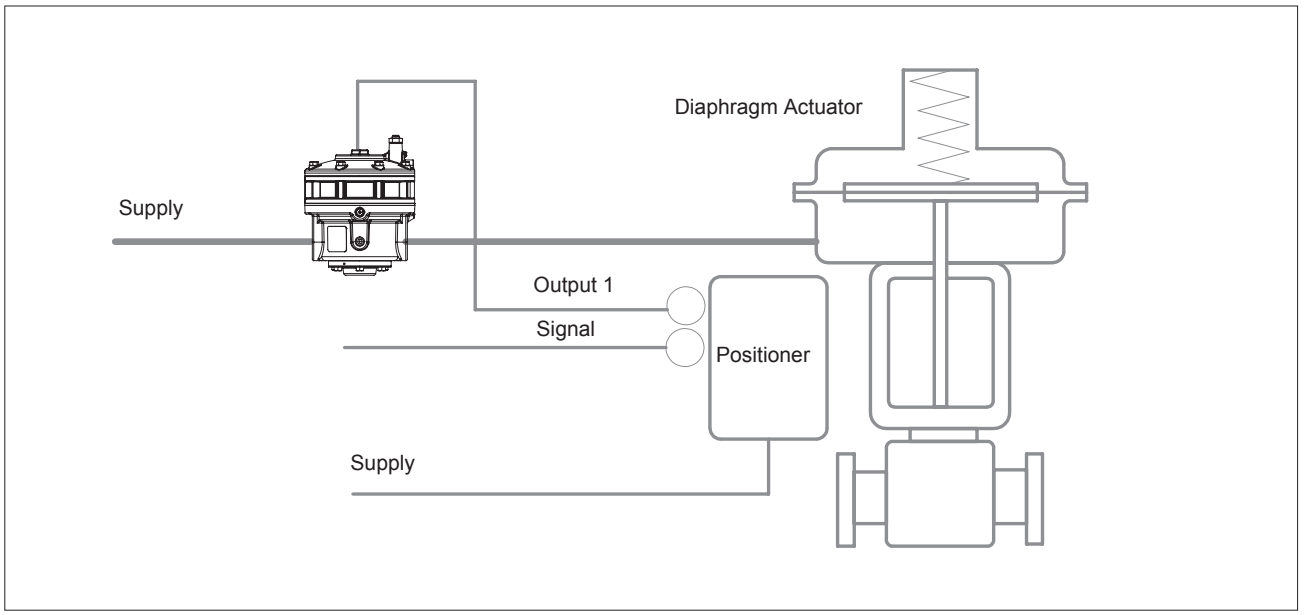
1.3 Intended safety function

The volume boosters are used with a positioner and a pneumatic actuator or control valve diaphragm actuator. Whether the valve in the SIF, Safety Instrumented Function, is being used in a Low or High Demand Mode, the valve will be directed to fully open or fully close to implement the required safety action. The valve is capable of very quick response due to the high Cv of up to 9 in both the supply and exhaust directions.

Examples of volume booster installations:



Volume booster with double acting positioner and cylinder actuator



Volume booster with single acting positioner and diaphragm actuator

2.1 Assessment guide

- The volume boosters are classified as Type A in accordance with IEC 61508-2, Section 7.4.4.1.2
- The volume boosters are suitable for SIL 2, HFT = 0, in a Safety Instrumented System (SIS).
- The boosters are suitable for SIL 3, HFT = 1, in a Safety Instrumented System (SIS) when used in a redundant structure.
- The Device-Specific values found in Certificate **V 456 2014 C2 and Annex V7 456 2014 C2** must be used in the SIS assessment.
- The SIS application of the volume boosters can be used in low or high demand mode.
- The volume booster safe state can be either Hi, Supply on demand to input pressure to fully stroke the safety valve, or Lo, Exhaust for 0 psig to the volume booster.
- The SIL installation must take into account the information found in the following:
    - SIL Safety Manual – this manual
    - Fairchild Volume Booster TUV SIL certificate **V_456_2014_C2 Rev01** and Annex **V7 456 2014 C2 Rev01**
    - Fairchild Volume Booster TUV Report **V 4562014T1 Rev01** with Annex
    - FMEA and report containing Failure Rates for the volume boosters is available for SIL verification calculations.
    - Installation instructions and/or the sales literature which contain the volume boosters operating specifications and environmental information
- Safety Instrumented Function (SIF) verification must be performed for all the components in the SIF including the volume booster.

2.2 Installation of the 4500A, 4850A, 4890A volume boosters

A maximum supply pressure of up to 250 psig can be used for outputs up to 150 psig. Verify parameters against the nameplate for proper pressure supply requirements. Caution should be used in connecting the pneumatic connections properly to prevent hose released at these higher pressures. The supply medium must be a clean, dry, non-corrosive gas that meets the requirements of ISA standard 7.0.01.

The 4500A (1:1 ratio), 4850A and 4890A must have the integral bypass valve adjusted to provide optimal response due to the variations in valve positioner and actuator sizes. This will provide the best response for the SIF operation in response to a fail-safe command.

The safety function of the SIF must be validated after installation.

2.3 Volume booster operation and maintenance

The useful lifetime is five (5) years under the conditions of High and Low Demand, maintenance, operating conditions and storage are followed per the products' specifications. Up to 1.5 years in proper storage can be added to the useful lifetime prior to installation.

If air leakage is detected from the volume booster under steady state conditions, take immediate action by replacing the volume booster. Report the incident to Fairchild Industrial Products Company in support of continuous improvement and collection of failure data for future SIL reviews.

2.4 Periodic inspection, test and repair

Regular scheduled PMs should be scheduled to closely monitor correct operation in the SIF system. This can consist of proof tests and partial valve stroke tests (PVST) as an effective way to reduce the PFDavg of the booster as well as the valve and actuator connection. The results should be recorded for review against future tests.

⚠ WARNINGS:

To avoid personal injury or property damage, appropriate measures must be taken to ensure the safety of the process any time the SIF needs to be disabled, such as to perform a proof test or to take corrective actions.

1. Proof tests are full-stroke tests that are manually initiated. As part of the test, the capability of the SIF to achieve the defined state must be verified. The proof test interval must be established for the SIF based on the failure rates of all the elements within the safety function and the risk reduction requirements. This determination is a critical part of the design of the SIS. A proof test includes the following steps:
    a. Check air filters to ensure they are operating properly.
    b. Inspect the unit for any loose screws, contamination or other visible signs of incorrect mechanical conditions.
    c. Listen for air leaks when equipment is in a steady state condition.
    d. Apply the safe command to the SIF to force the valve to the Fail-Safe state and verify that this is achieved within the required time.
    e. Restore the SIF to normal operation.
2. Replace unit if the useful lifetime of operation has been reached.
3. Repairs can only be performed at the factory if abnormal performance has been detected.

2. Installation and maintenance

Table 1. High Demand Mode

Derived values for High Demand Mode			
Dangerous Failure Rate	λD	1.21 E-08	1/h
		12	FIT
MTBF (Dangerous Failures)	MTBFD	82.6 E06	h
		9429	y
Safe Failure Rate	λS	3.65 E-07	1/h
		365	FIT
Total Failure Rate	λS + λD	3.77 E-07	1/h
		377	FIT
MTBF total		2.65 E06	h
		303	y
Lambda Dangerous Detected	λDD	0	1/h
Lambda Dangerous Undetected	λDU	1.21 E-08	1/h
Lambda Safe Detected	λSD	0	1/h
Lambda Safe Undetected	λSU	3.65 E-07	1/h
Average Probability of Failure per Hour	**PFH**	**1.21 E-08**	

Table 2. Low Demand Mode

Derived Values for Low Demand Mode			
Assumed Demands per Year	nop	1	1/y
Proof Test Interval	Ti	1	y
Average Probability of Failure per Demand	**PFDavg**	**1.36 E-06**	

Useful lifetime under specified operating conditions

If the manufacturer's specification according to maintenance, operating conditions and storage are obeyed, the useful lifetime is five years, with an additional period of maximum 1.5 years for storage before first use.

3. Terms, abbreviations and acronyms

SIF	Safety Instrumented Function: This is an instrument safety loop that performs a safety function which provides a defined level of protection (SIL) for a specific hazard by automatic means and which brings the process to a safe state.
SIL	Safety Integrity Level: Is a statistical analysis called a Risk/Process Hazard Analysis (PHA). FMEA, FMEDA or FMECA are used to determine in the case of an individual instrument in the SIF the ability to meet the safety standard required for a particular process. The SFF and PFDavg are particularly important to the safety analysis.
SIS	Safety Instrumented System: Composed of sensors, Logic Solver, and a final control element which are independent of the BPCS, Basic Process Control System, whose function is to monitor the process and prevent a safety related event.
SFF	Safe Failure Fraction: fraction of the overall random failure rate of a device that results in a safe fault or a diagnosed unsafe fault.
PFDavg	Average probability of failure on Demand. Relevant for Low Demand Mode where Safety Systems are typically working in the background, monitoring a process, and are not required to act until a Safety Limit is exceeded.
PFH	Average Probability of Failure per Hour. Relevant for High Demand (Continuous) Mode is the numerical value of a failure of the safety function per hour.
PVST	Partial Valve Stroke Test: This test is initiated to determine if a valve is sticking at its' defined normal position or if it is not sticking and able to move. Sensors detect this movement to verify action. Typically this will not impact the process system.
Useful Life	The estimated life span of an instrument in a safety function application.
Low Demand Mode	Low demand mode, as defined in 3.5.16 of IEC 61508-4, is where the frequency of demands for operation made on a safety-related system is no greater than one per year.
High Demand Mode	High demand or continuous mode, as defined in 3.5.16 of IEC 61508-4, is where the frequency of demands for operation made on a safety-related system is greater than one per year. Continuous is regarded as very high demand.

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