SAFETY MANUAL

Supplement to BETA Installation & Operational Manual

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1 Introduction

This Safety Manual provides information necessary to install, test and maintain a BETA Pressure or Temperature switche with a Safety Instrumented Function (SIF).
This manual provides necessary requirements for meeting the requirements of IEC 61508 or IEC 61511 Functional Safety Standards.

1.1 Related documents

This manual only applies in conjunction with the following documentation:

- BETA General Bulletin
- BETA Installation & Operational Manual
- BETA Chemical Resistance Chart

This document is according to the requirements of

- IEC 61508-1:2010
  Functional safety of electri-cal/electronic/programmable electronic safety-related systems - Part 1: General requirements.
- IEC 61508-2:2010 - Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 2: Requirements for electrical/electronic/ programmable electronic safety-related systems
- Quality management system acc ISO 9001:2015

IMPORTANT

- A BETA Pressure and Temperature switch may only be used for applications described in the BETA General Bulletin.
- Correct, reliable operation of the BETA switch requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

1.2 Acronyms

HFT	Hardware Fault Tolerance
PFDavg	Average Probability of Failure on Demand
SFF	Safe Failure Fraction, the fraction of the overall failure rate of a Beta switch that results in either a safe fault or a diagnosed unsafe fault.
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, discrete level (one out of a possible four) for specifying the safety integrity requirements of the safety functions to be allocated to safety-related systems.
SIS	Safety Instrumented System – Implementation of one or more Safety Instrumented Functions

2 BETA switch description

The BETA Pressure and Temperature switch is a high quality switch, based on a self-aligning diaphragm-piston-springloaded-rod combination which actuates a switching element at a certain increasing or decreasing setpoint. A limited piston travel protects the safety function of the switch against overpressure. The process fluid or gas is separated safely by a diaphragm with a static o-ring seal and retained by a process connection. These parts, which are in contact with the process medium directly, are available in an extensive range of materials and sizes (see General Bulletin).

2.1 Safety Function

The safety function is defined as that the BETA switch actuate or de-actuate a device in circuit in which the switch is installed on the setted process pressure or temperature.
As a result the switch stands for functional safety and ensures that the equipment works safely when combined with other safety-related components, such as actuators and control units.

2.1.1 Environmental and application limits

The designer of a SIS must check that the BETA switch is rated for use within the expected environmental limits.

IMPORTANT

- Please check for material compatibility considering on-site environmental conditions and limits as well as chemical contaminants conditions.
- A BETA switch used outside of the environmental, application limits or using incompatible materials, the reliability of the safety function becomes invalid.
- Please consult your BETA representative for the selection of wetted part materials, used in aggressive (process related) environments. See also the BETA Chemical Resistance Chart.

3 Design Verification

A detailed Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is available. This report details all failure rates and failure modes as well as the expected lifetime. This is also listed in the Assessment report.
The achieved Safety Integrity Level (SIL) of an entire Safety Instrumented Function (SIF) design must be verified by the designer of the SIS, in which the switch will be used, has to assure that this calculated Safety Integrety Level is suitable for the targeted safety level.
The PFD_{AVG} considering architecture, proof test interval, proof test effectiveness, any automatic diagnostics, average repair time and the specific failure rates of the switch is calculated.

Each subsystem must be checked to assure compliance with minimum Hardware Fault Tolerance (HFT) requirements. The failure rate data listed on the BETA SIL certificate is only valid for the useful life time of a BETA switch.

4 SIL Capability

4.1 General safety requirements

- All SIS components, including the BETA switch, must be operational before the process starts-up. Verify and confirm the correct notification on the nameplate that the BETA switch is suitable for use in a safety application.
- Proof tests, prescribed on predefined time intervals, must be carried out by qualified staff members.
- Results of proof tests must be recorded and reviewed periodically as a part of the system safety and maintenance program.
- Prevent to exceed environmental conditions as ambient temperature as mentioned in the General Bulletin. Ambient temperature is an ambigious definition. Please consider the amount of heat transfer from the process medium to ambient through the air around the Beta switch and parts within the Beta switch.

4.2 Systematic Integrity

The product has met manufacturer design process requirements of Safety Integrity Level, as determined by the external accredited specialist. 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.

5 Installation and Maintenance

5.1 Qualified Personnel

Installation, setting and testing may only be performed by qualified personnel. Within the context of the safety notes in this documentation, qualified personnel is authorized to commission systems in accordance with established safety practices and standards.

5.2 Installation

- The BETA switch must be installed as outlined in the installation and operations manual.
- The BETA switch must be accessible easily for visual and preventative inspection and must allow proof testing.
- Beta BV only can be held liable to malfunction of the set point if this set point is defined and adjusted in the Beta manufacturing.
- If no specific set point is ordered, the switch is adjusted on mid range.

5.3 Mounting

Warning
If cover, seals and/or electrical wiring are damaged, misaligned or missing, ingress protection level can not longer be garantueed.

- The BETA switch must be mounted in accordance with the installation and operations manual.
- If excessive vibration is expected, precautions shall be taken using appropriate damping mounts or reinforcement brackets.
- The selected mounting point should minimize excessive shock, vibration or temperature fluctuation.

5.4 Maintenance

- The BETA switch can provide years of reliable service as long as the appropriate preventative maintenance is performed consequently.
- Implement the BETA switch in to the regular condition-based maintenance program, including
    - Periodic inspections, with pre-defined intervals.
    - Control on external corrosion.
    - Control on contamination buildup on the switching element, wiring connections and process connections.

6 Proof test procedure

According to IEC 61508-2, a regular executed proof test shall be undertaken to reveal potential failing of the safety function. Proof testing is needed to maintain the integrity of the safety instrumented function (SIF) and verifies the status of the safety function.
The objective of proof testing is to detect failures within a BETA switch 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 system in which the BETA switch is applied.
Within the customer proof test schedule the Beta switch has to be tested as in § 6.1.

6.1 Procedure sequence

IMPORTANT Take notice of site safety precautions for process and personal safety!

Proof test procedure sequence
• Inspect the BETA switch for any visible mechanical damage, any outside corrosion on the process connection and housing or contamination. • Inspect the integrity of the electrical connections of the switch. Especially inspect the integrity of the terminal block and earth terminal. Take personal safety precautions against electrical hazards.
Test the switch setpoint and compare the result with the defined setpoint for the safety function. The setpoint must be tested by increasing or decreasing the process pressure or temperature. Because every SIS has is own layout of tubing and tubing connections, no uniform description can be given to separate the switch from the SIS. Generally, a switch is connected to the SIS using a T-valve. Separate the switch from the process if closed. Depending on the pressure needed, separate the switch from the process by closing the T-valve and release the pressure. For high pressures or temperatures, detach the switch form the SIS and do the test on a separate test site, equiped with relevant tooling.
• Connect the T-valve to a pressure measuring device after closing the line of the process to the BETA switch.
• Apply a pressure to reach a defined in- or decreasing setpoint value and verify that the switching element, e.g. micro switch, goes into the NO or NC state at the defined setpoint.
• Repeat the former procedure steps three times; average the results and rate the repeatability (See General Bulletin, repeatability ± 0.2% FS)
• When the BETA switch fails the proof test, the switch must be taken out of the SIS for a repair or for replacement.
Important note **Never change the setpoint without a written permission and/or approval of the responsible department. Each changed setpoint must be administered, approved and labelled before the process startsup.**
• When the BETA switch passes the proof test, please open the valve to reset the process settings and to activate the safety function of the switch into the SIS.
The testresults must be recorded and administered. Any detected failure which compromises the safety function, must be reported to the responsible safety and/or Customers Maintenance department immediately to take further action.

6.2 Specific conditions

6.2.1 Qualified personnel and tooling

- Qualified personnel performing the proof test of the switch is trained in SIF/SIS operations, including bypass procedures, equipment and Beta switch (SIF) maintenance and Management of change procedures.
- Qualified personnel is trained and certified to perform the proof test on a BETA switch according to the test procedure as prescribed by customer's Maintenance department.
- Tooling to perform the proof test, such as pressure measurement indicators, must be checked, calibrated, certified and administrated on a regular interval under supervison of customer's Maintenance department.

7 Hazardous events

Customer is responsible for the actual information about hazardous events for plant operators. Related to the severity of any hazard, the information must be distributed to the affected parties.

8 Life cycle

A proper life cycle time prediction depends on many factors. Customer should be aware of failure mechanisms within the use of the switch.
The life time of the switch is connected with e.g. the applied strain, shock/vibration, environmental circumstances
The typical life cycle time of the BETA switch has been estimated for 10 to 15 years or 100,000 full cycles..

9 BETA BV Notification

Any failures that are detected and that compromises the safety function must be reported to

- BETA BV customer service via 2sales@beta-b.nl or to
- BETA BV Verrijn Stuartlaan 22, NL-2288 EL Rijswijk, The Netherlands.