WESTLOCK
CONTROLS

SAFETY MANUAL
PROJECT: ACCUTRAK

Containing:

V3 SPDT mechanical switches,

DPDT mechanical switches,

Magnum XT-90 Proximity switches,

& Inductive Proximity Sensor (NJ2-V3-N)

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Revision History

Revision	Revision
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Rev-4	Rev-5

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1.0 Purpose and Scope

This document provides an overview of the user responsibilities for installation, operation and maintenance of an Accutrak position monitor containing limit switches / sensors in order to maintain the designed Safety Integrity Level. Items that will be addressed are proof testing, repair and replacement of the related components, lifetime, environmental and application limits and parameter settings.
Using an Accutrak assembled with either V3 SPDT Mechanical switches, DPDT Mechanical switches, Magnum XT-90 Proximity switches or Inductive Proximity Sensor (NJ2-V3-N).

2.0 Using the V3 SPDT mechanical, Magnum XT-90 Proximity Switch & Inductive Proximity Sensor (NJ2-V3-N)

All of the above named switch / sensor types use the same principle of the shaft cam activating the switch / sensor at a preset rotation.

The V3 SPDT mechanical switch – The shaft cam has a dwell that is eccentric to the shaft creating a 'high' point that depresses the switch roller / lever. This intern will change the SPDT changeover from COM / NC to COM / NO. When the product rotates back to the original position then the cam dwell is reduced allowing the switch to return to the COM / NC state.

The Magnum XT-90 Proximity switch – The shaft cam has an encapsulated magnet that is eccentric to the shaft creating a 'magnetic field'. When the shaft rotates and the magnetic field is in the region of the switch reed, the SPDT changeover changes from COM / NC to COM / NO. When the product rotates back to the original position then the cam magnet rotates away from the switch reed which over powers the magnetic field allowing the switch to return to the COM / NC state.

The inductive Proximity sensor - The shaft cam has a dwell that is eccentric to the shaft. At the 'high' point there is a 'trigger' of metallic material. When this rotates into the target field of the sensor, the sensor detects the change in the internal coil impedance by the presence of the trigger. This intern will change the state of the inductive sensor output. When the product rotates back to the original position then the cam trigger leaves the target field allowing the sensor output to return to the fail state.

The V9 DPDT mechanical switch – The shaft cam has a dwell that is eccentric to the shaft creating a 'high' point that depresses the switch roller / lever. This intern will change the DPDT changeover from COM / NC to COM / NO simultaneously. When the product rotates back to the original position then the cam dwell is reduced allowing the switch to return to the COM / NC state.

2.1 Diagnostic Response Time

An Accutrak that contains either V3 SPDT Mechanical switches and Magnum XT-90 Proximity switches, when used in a SPDT wiring configuration, has automatic diagnostic abilities by the monitoring of the both the open and closed contacts. The DPDT mechanical switch contains two switch circuits. The actual response time for the action of either type of switch is immediate and the diagnostic response time is related to the refresh rate of the host interface.

Similarly the Inductive Proximity Sensor (NJ2-V3-N) has diagnostic abilities by the nature of monitoring the high and low output states.

2.2 Installation and Maintenance

Before installation and use, it is recommended that end user registers this product by contacting Westlock Controls sales department and quoting the unique serial number located on the internal wiring diagram.
By The installation of this Accutrak position monitor shall be as per the I.O.M supplied. It is essential that the Accutrak is used within the environmental and certification parameters. It is recommended that a periodic visual and operation evaluation is carried at least once a year or every 1 million cycles. If the shaft requires lubrication then a suitable (NLGI 2) rated grease such as Rocol Sapphire Lo Temp 2 should be used. Please note that if any other lubricant other than Rocol Sapphire Lo Temp 2 then is shall be compatible with the shaft 'O'ring material.
When using the Accutrak product within a safety system it should be noted that switch contact ratings should be no more than 60% of the switch vendors ratings, and that any non-resistive load must have transient protection added by the end user.

2.3 Proof Test.

The objective of proof testing is to detect failures within the Accutrak 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 either switch type maybe applied. The proof tests must be performed more frequently 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.

Step	Action
1	**Following Management of Change procedures for the site, take note of the switch contact status (COM – N/O or COM – N/C). For the inductive proximity the sensor status would result in HI or LOW outputs.**
2	Stroke the actuator and / or the valve to a desired position and check the opposite contacts from STEP 1 for continuity or electrical parameters.
3	Adjust cam position if necessary and take corrective action to ensure that the installation is carried out using the service air pressure.
4	Records any failures if the SIF inspection database. Restore the loop to full operation.

This test will detect approximately 99% of possible DU failures in the Accutrak (Proof Test Coverage).
The person(s) performing the proof test on the Accutrak proximity switch should be trained in SIS operations, including bypass procedures, position monitor maintenance and company Management of Change procedures. Tools required are: Refer to the I.O.M supplied with the Accutrak.

2.4 Repair and replacement.

When replacing either type of switch / sensor it is essential that the instructions for that specific Accutrak variation are followed. Failure to follow these instructions may impair the reliability.

2.5 Reliability data and lifetime limit.

A detailed Failure Mode, Effects, and Diagnostics Analysis (FMEDA) report is available from Westlock Controls UK Ltd. This report details all failure rates and failure modes, common cause factors for applications with redundant devices and the expected lifetime of an Accutrak.

- An Accutak with either switch type is intended for low demand mode applications up to SIL3 for use in a simplex (1oo1) configuration, depending on the PFD_{AVG} calculation of the entire Safety Instrumented Function.
- The development process of an Accutrak containing either switch type is suitable up to SIL2, allowing redundant use of the transmitter up to this Safety Integrity Level, depending the PFD_{AVG} calculation of the entire Safety Instrumented Function.

- When using an Accutrak containing either switch type in a redundant configuration, a common cause factor should be included in reliability calculations.
  For details see the FMEDA report.

- The reliability data listed in the FMEDA report is only valid for the useful life time of an Accutrak containing either switch type. The failure rates of an Accutrak containing either switch type may increase sometime after this period. Reliability calculations based on the data listed in the FMEDA report for mission times beyond the lifetime may yield results that are too optimistic, i.e. the calculated Safety Integrity Level will not be achieved.

  Table 1 below details the failure rates for the V3 SPDT mechanical switch (5) and the Magnum XT-90 proximity switch (9) all of which can be used within the following series of enclosures; 2200, 2600, 3300, 3400, 3500, 8300, 8400 and 8500.

Table 1 Failure rates according to IEC 61508 in FIT

Switch Circuit QTY (Option Code)	λ_{SD}	λ_{SU}[1]	λ_{DD}	λ_{DU}	SFF[2]
1 Switch Circuit (5, 6,7 or 9)	0	11	0	94	--
2 Switches Circuits (5, 6, 7 or 9)	0	23	0	119	--
3 Switches Circuits (5, 6, 7 or 9)	0	34	0	149	--
4 Switches Circuits (5, 6, 7 or 9)	0	45	0	174	--
6 Switches Circuits (5, 6, 7 or 9)	0	68	0	229	
8 Switches Circuits (6)	0	80	0	239	--
1 Switch Circuit (5, 6, 7 or 9) w/PVST	11	0	86	8	--
2 Switches Circuits (5, 6, 7 or 9) w/PVST	23	0	110	9	--
3 Switches Circuits (5, 6, 7 or 9) w/PVST	34	0	139	10	--
4 Switches Circuits (5, 6, 7 or 9) w/PVST	45	0	163	11	--
6 Switches Circuits (5, 6, 7 or 9) w/PVST	68	0	216	13	--
8 Switches Circuits (6) w/PVST	80	0	225	14	--

[1] It is important to realize that the No Effect failures are no longer included in the Safe Undetected failure category according to IEC 61508, ed2, 2010

[2] Safe Failure Fraction needs to be calculated on (sub) system level.

2.6 Environmental and Application limits.

Accutrak position monitors are certified to various protection methods and environmental temperature limitations. These can be found on the product label (found on the outside of the cover) and on the supporting IOM delivered with each unit. If the Accutrak position monitor is used outside of the application limits then the reliability data listed in 2.5 becomes invalid.

2.7 Reporting a failure.

Any failures that are detected and that compromise functional safety should be reported to the Safety Office / QA Supervisor within Westlock Controls.

3.0 Terms and Abbreviations.

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

Further definitions of terms used for safety techniques and measures and the description of safety related systems are given in IEC 61508-4.

FMEDA	Failure Modes, Effects and Diagnostic Analysis
HFT	Hardware Fault Tolerance
Low demand mode	Mode, where the frequency of demands for operation made on a safety-related system is no greater than one per year and no greater than twice the proof test frequency.
PFD_{AVG}	Average Probability of Failure on Demand
SFF	Safe Failure Fraction, the fraction of the overall failure rate of a device 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 the E/E/PE safety-related systems where Safety Integrity Level 4 has the highest level of safety integrity and Safety Integrity Level 1 has the lowest.
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).