

# Bettis RTS Electric Actuator

## Safety Manual



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# Section 1: General

## 1.1 Area of Application

Bettis RTS actuators mentioned in Table 1, are designed for the application in safety-related systems where IEC 61511 is applied.

## 1.2 Standards

All mentioned actuators and control systems comply with and their safety codes are calculated after IEC 61508.

## 1.3 Valid Device Types

Table 1. Valid Device Types

| Type A | Without PVST | With PVST |
|--------|--------------|-----------|
| FL     | SIL 1        | SIL 3 AC  |
| FQ     | SIL 1        | SIL 3 AC  |
| Type B | Without PVST | With PVST |
| CM     | -            | SIL 1     |

## 1.4 Terminology

General:

Table 2. Terminology

| Terms                        | Definition                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SIL (Safety Integrity Level) | One out of four discreet levels to specify safety requirements for safety functions, which are applied to E/E/PE safety systems. The highest level is SIL 4, the lowest is SIL 1.                                                                                                                                                                                                                                                                                                                                                                                                       |
| Safety Integrity             | The probability that a safety system will conduct all required safety functions within a given time span.                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Safety Function              | A function, which is carried out by an E/E/PE safety system, a safety system of other technologies or other facilities for risk management, to provide a safe situation despite a critical failure.                                                                                                                                                                                                                                                                                                                                                                                     |
| E/E/PE Safety-Related System | All failure modes of each component are known.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Operating Modes              | A safety-related system is intended, concerning its requirement rate, which can take the following forms: <ul style="list-style-type: none"><li>Operating mode with low demand rate: Where the rate of demand on the safety-related system is not more than once per year and is not greater than twice the frequency of the periodic test.</li><li>Operating mode with high demand rate or operating mode with continuous demand: Where the demand rate on the safety-related system is more than once per year or is greater than twice the frequency of the periodic test.</li></ul> |

**Table 2. Terminology (Continued)**

| Terms                                        | Definition                                                                                                                                                                                                 |
|----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Actuator Types                               | <ul style="list-style-type: none"> <li>Type A – “Non-complex” element - All failure modes are well defined.</li> <li>Type B – “Complex” element - Using microcontrollers or programmable logic.</li> </ul> |
| AC (Architectural Constraints)               | Calculated values are within the range of hardware architectural constraints for the corresponding SIL level but do not imply that all related IEC 61508 requirements are fulfilled.                       |
| <b>Safety Indices</b>                        |                                                                                                                                                                                                            |
| $\lambda_s$ (Safe Lambda)                    | Non-hazardous failure rate (per hour) of one channel of a subsystem                                                                                                                                        |
| $\lambda_D$ (Dangerous Lambda)               | Dangerous failure rate                                                                                                                                                                                     |
| $\lambda_{DU}$ (Dangerous Undetected Lambda) | Rate of unknown dangerous failure                                                                                                                                                                          |
| $\lambda_{SU}$                               | Rate of non-hazardous failures (per hour) of one channel of a subsystem                                                                                                                                    |
| $\lambda_{DD}$ (Dangerous Detected Lambda)   | Failure rate of detected failures (sum of all failure rates of one channel of a subsystem).                                                                                                                |
| DC (Diagnostic Coverage)                     | Decreasing the possibility of dangerous hardware failure by automatic performance of diagnostic tests.                                                                                                     |
| MTBF                                         | Mean Time Between Failure                                                                                                                                                                                  |
| MTTR                                         | Mean Time to Restoration                                                                                                                                                                                   |
| MRT                                          | Mean Repair Time – Average time which is needed to repair                                                                                                                                                  |
| SFF                                          | Safe Failure Fraction – Average amount of dangerous failures on demand                                                                                                                                     |
| $PFD_{avg}$                                  | Average probability of dangerous failure on demand                                                                                                                                                         |
| HFT                                          | Hardware Failure Tolerance                                                                                                                                                                                 |
| $T_{proof}$                                  | Time of proof                                                                                                                                                                                              |
| PTC                                          | Proof Test Coverage                                                                                                                                                                                        |
| FIT                                          | Failure in Time – Amount of failures per $10^9$                                                                                                                                                            |

## 1.5 End-User Responsibility

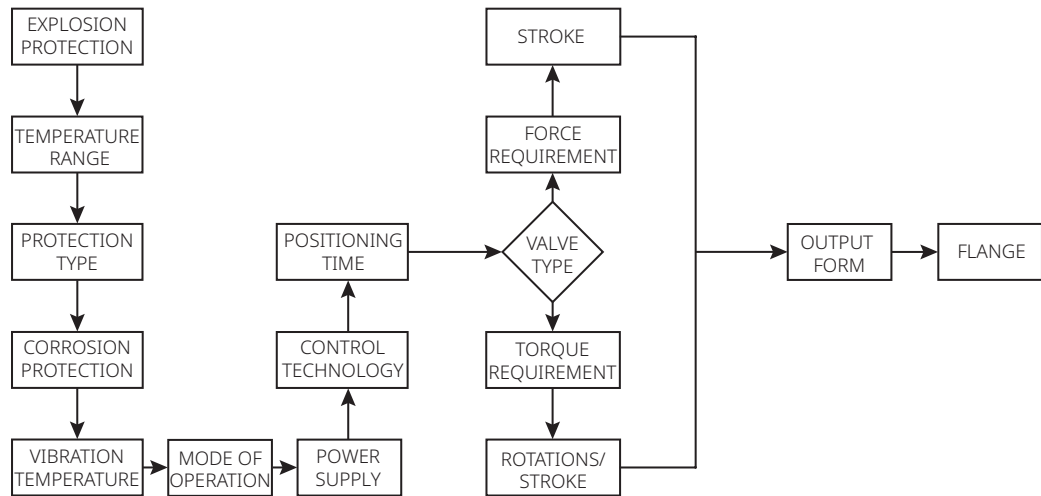
All actuator specifications must be provided by the end customer or user.

The operation and all maintenance protocols of SIL actuators have to be under the operating manual and the safety manual. The actuator must undergo service by an Emerson-certified technician in calculated maintenance intervals (see Section 7.3).

## Section 2: Project Development

Before placing an order for an RTS actuator the following specifications must be defined.

**Figure 1. Project Development Overview**



### **⚠ WARNING**

In the event of incorrect commissioning, none of the specified SIL levels can be guaranteed.

### **⚠ CAUTION**

The use of an incorrectly designed drive can lead to damage to the respective safety-related system. If guidance is needed, please contact your local Emerson sales representative.

## 2.1 Specifications

It is strongly recommended to calculate higher specifications to provide the possibility of higher forces, to ensure safe opening and closing in case of malfunction.

### 2.1.1 Connection Possibilities

- Mechanical (flange with coupling)  
The giving valves must have the same flange size as the actuator flange, the same as the shaft/stem must be the same size as the driving part.  
On-request custom-built applications are possible.
- Electrical (power plug-connection terminals)  
If an explosion-proof actuator is needed, only screw terminals are permitted.

## 2.2 Environmental Conditions

An actuator, embedded in a safety-relevant system, is used under specific operating and environmental conditions. The correct definition of those parameters is vital in the prevention of possible lasting damage.

The following parameters must be set:

- Operating mode
  - Continuous duty (S2 after EN 60034)
  - Periodic Intermittent duty (S4 after EN 60034)
  - Other operating modes are available, on special request.
- Protection class
  - IP 67 after EN 50629 (standard design)
  - IP 65 (explosion-proof design)
  - Other protection classes are available, on special request.

Depending on the actuator model, different temperature ranges are available:

**Table 3. Environmental Temperature**

| Actuator Model | Temperature Range       | Ex-Proof |
|----------------|-------------------------|----------|
| CM/FQ/FL       | -40 to +60°C (Standard) | -        |
| CM/FQ/FL       | -40 to +60°C (Standard) | X        |

The possible temperature range correlates also with other actuator specifications (e.g., operating mode).

For further information please contact a member of the Emerson sales team.

- Vibration resistance
- Corrosion protection

Basis corrosion protection C2 is standardized on request an upgrade up to C5 is possible.

## 2.3 Configuration

All safety-related parameters and functions are set and defined during production, and validated during final inspection.

Customer requests and changes must be stated during commissioning. The interference or change of basic properties (after delivery) by the customer will influence the integrity of implemented safety functions and the given safety indicators cannot be guaranteed.

**Table 4. Configuration Possibilities**

| Protection Device | Description                                                                                                                          | Actuator Type |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------|---------------|
| Shut Down Torque  | <ul style="list-style-type: none"><li>• Torque monitoring</li><li>• Can be set independently clockwise or counterclockwise</li></ul> | CM/FQ/FL      |
| Motor Temp.       | Monitoring the temperature of motor winding                                                                                          | CM/FQ/FL      |
| Input Fuse        | Input security of the frequency converter CM, (also with additional thermal fuse possible)                                           | CM/FQ/FL      |

## 2.4 Packing, Transport and Storage

Depending on the order, actuators may be delivered packed or unpacked. Special packing requirements must be specified when ordering. Exercise extreme care when removing or repacking equipment.

For each actuator, an inspection report is generated upon final inspection. In particular, this comprises a full visual inspection, calibration of the torque measurement in connection with an extensive run examination and a functional test of the microcontrollers.

### 2.4.1 Delivery Conditions

For each actuator, an inspection report is generated upon final inspection. In particular, this comprises a full visual inspection, calibration of the torque measurements in connection with an extensive run examination and a functional test of the microcontroller.

These inspections are conducted and documented according to the quality system and can be made available if necessary. The basic setting of the end position must be performed after assembly on the actuator.

Actuators are ready for use after installation. Depending on customer requirements, the actuator is filled with oil.

# Section 3: Safety-Relevant Systems and Functions

## 3.1 Safety-Relevant Systems

SIL is an assessment of the complete system application and cannot be specified for a part of the system. For example, the components of an actuator may comply with the respective SIL but they are not an independent safety system without the respective measuring device.

The SIL level specified by Emerson corresponds to the prescribed SIL calculation, and only forms a meaningful safety system with a necessary measuring and monitoring system.

## 3.2 Safety-Relevant Functions

The following functions were taken into account when calculating the safety-related key figures:

- Safety position:  
Safely moving to a pre-defined safety position  
(Emergency OPEN, Emergency CLOSE, etc.)

### 3.2.1 Partial/Full Valve Stroke Test (PVST/FVST)

The Partial Valve Stroke Test and the Full Valve Stroke Test are safety functions, which supports fault-free operation of an RTS actuator, if all maintenance intervals are carried out regularly and correctly and the respective operating instructions are observed.

PVST is the operation of the valve through a portion of its total stroke range. This short stroke operation checks that the valve is not seized in the current position. The limited stroke of the valve is intended to be short enough so as not to interfere with the operating flow of the system. The purpose of PVST is to provide a diagnostic check of the SIF function. Partial valve stroke testing is performed at a rate at least ten times faster than the expected demand rate. For SIL 2 safety functions, the partial valve stroke test is at least SIL 1 compliant.

A distinction is made between a PVST and an FVST in that the travel range of a PVST is variable and can be freely set by the user. With an FVST, the travel range is fixed at 100%.

The PVST/FVST may be triggered internally or externally.

### 3.2.2 Handwheel for Fail-Safe Actuators

#### CAUTION

For SIL-rated systems, a manipulation of the safety function needs to be prevented. That being said, handwheels on fail-safe actuators is not allowed to be used for SIL applications. Please consult your notified body if a padlock on the handwheel is enough that the whole fail-safe actuator including the handwheel is seen as SIL-rated component.

The manual operation is only possible if the actuator is delivered with the optional handwheel. This option allows an adjustment of the valve in de-energized state.

#### CAUTION

The manual mode is intended to be activated only when the drive is in the fail-safe position. Activating the manual mode while the actuator is not in fail-safe position may damage components of the fail-safe brake assembly.

#### CAUTION

By activating the manual drive the fail-safe function is disabled.

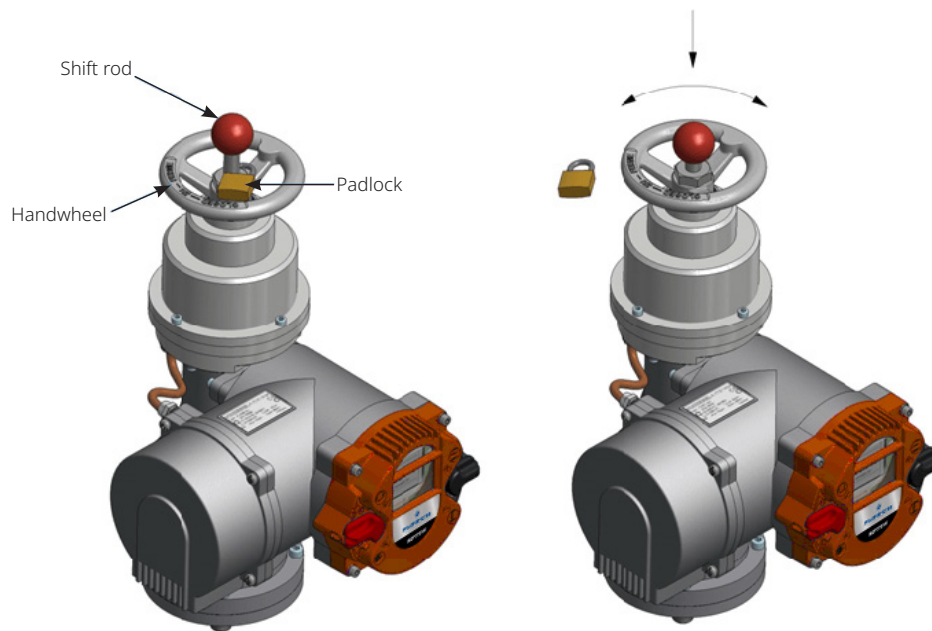
#### NOTE:

By activating the manual drive the electrical function of the drive is disabled. In normal operation, the handwheel (see Figure 2) has no effect, it rotates idly by.

#### CAUTION

Manual operation with mechanical or electromechanical equipment (such as: lever, drilling machine, etc.) is NOT ALLOWED, as this may damage the product.

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**Figure 2. RTS Fail-Safe Actuator Handwheel**

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**Activate manual operation**

To activate manual mode:

- The padlock has to be removed.
- The shift rod has to be pushed all the way into the actuator.

For easier clutch engagement move the handwheel easily back and forth. Through the engagement, the actuator is automatically electrically disabled and the display shows "manual override".

**Deactivate manual operation**

The following steps are done to exit the manual mode and to enable the automatic mode again:

- The actuator must be driven to the fail-safe position by handwheel.
- The shift rod is then pulled up to de-couple the handwheel.
- Lastly, the shift rod is secured with the padlock.

## 3.3 2 Channel Build

To enhance the overall SIL capacity of a system one might use two actuators at the required position. In case of malfunctions, this system build enables a safe operation instead of a whole shutdown. System failures will be detected and therefore repaired more quickly with less operation disturbance.

The specific design of such a redundant system is highly dependent on the structure of an already existing system.

## 3.4 Input and Output Interfaces

### 3.4.1 Binary Inputs

The controller of RTS type actuators is equipped with 5 freely parameterizable binary inputs. The binary inputs are also effective when the actuator is controlled via Fieldbus.

**Table 5. Binary Inputs**

|                                     |                               |
|-------------------------------------|-------------------------------|
| Amount                              | 5                             |
| Nominal Voltage:                    | 24 V DC towards common ground |
| Threshold voltage for set input     | > 10 V (8.5 V typical)        |
| Threshold voltage for non-set input | > 7 V (8.5 V typical)         |
| Maximum voltage                     | 30 V DC                       |
| Current consumption at 24 V DC      | Typical 10.5 mA               |

**NOTE:**

Binary Inputs are galvanically isolated from the internal circuitry.

**Table 6. Binary Input Default Settings**

|                          |                         |
|--------------------------|-------------------------|
| Input 1: Open            | Input 2: Close          |
| Input 3: Stop            | Input 4: Emergency Open |
| Input 5: Emergency Close | -                       |

Representation on the display:

A set input is visible on the binary input status display and is shown as 1.

### 3.4.2 Binary Outputs

The controller of RTS actuators is equipped with 8 freely parameterizable outputs. In the case of external supply, the binary outputs are galvanically isolated from the rest of the control. Unless otherwise specified, the default binary output settings are as follows.

**Table 7. Binary Output Default Set**

|                        |                          |                  |
|------------------------|--------------------------|------------------|
| Output 1: Ready        | Output 2: Open           | Output 3: Closed |
| Output 4: Running Open | Output 5: Running Closed | Output 6: Torque |
| Output 7: Local        | Output 8: Remote         | -                |

**Table 8. Binary Inputs**

|                                                                        |                                                             |
|------------------------------------------------------------------------|-------------------------------------------------------------|
| Amount                                                                 | 8                                                           |
| Nominal Voltage:                                                       | 24 V DC nominal range: 11 to 35 V DC                        |
| Maximum voltage drop at set output                                     | 1 V                                                         |
| Output voltage at non-set output                                       | <1 V                                                        |
| Maximum current per output                                             | 500 mA (short circuit proof)                                |
| Maximum permissible total current for all outputs                      | 4 A                                                         |
| Fuse (Fuse FL2, see relevant spare parts list in MAN-02-04-60-0359-EN) | 4 A time-lag (Littelfuse® 454 NANO <sup>2</sup> ® Slo-Blo®) |

**NOTE:**

Binary Inputs are galvanically isolated from the internal circuitry.

Representation on the display:

The display shows the control of the outputs and not the status of the outputs themselves, i.e. the supply of the binary outputs is not considered in the display. A switched-through output is shown as 1.

### 3.4.3 Analog Output - Position Feedback (Optional)

The ER position output is used for feedback on the current position of the actuator employing 0 to 20 or 4 to 20 mA and can also be retrofitted at any time through SmartCode. If this option is not activated, only the message "inactive" appears when reaching the menu item. An adjustment to the end positions or the setting range is not necessary. An automatic adjustment is made by setting the travel end positions. Even in the case of torque seating, no further adjustment is necessary, because the controller only uses the travel end position for calculation, regardless of whether it is defined by the torque or the travel end position.

The standard factory setting is: 4 mA at 0% position; 20 mA at 100% position.

### 3.4.4 Analog Input - Positioner (Optional)

The SR positioner option is used to control the electric actuator through a 0 to 20 or 4 to 20 mA. The SR is used to control the position of the actuator, i.e. the positioner ensures that the actual value, and thus, the position of the actuator follows the setpoint value. For an optimum adaptation of the control behavior, it is possible to parameterize various other positioner options.

### 3.4.5 Analog Input 2 - PID controller (Optional)

The optional PID controller is used to control a process variable (external actual value).

### 3.4.6 Other Options

Following optional interfaces are available upon request:

- Modbus® RTU
- Modbus TCP
- PROFIBUS
- PROFINET
- EtherNet/IP
- HART®
- Relay outputs

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**NOTE:**

Please consult MAN-02-04-60-0359-EN for optional components.

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## Section 4: Safety-Relevant Codes

### 4.1 General

The safety-related key figures listed here are based on the already-mentioned safety functions. Safety functions are based on failure modes, effects and diagnostic analysis (FMEDA) following IEC 61508-2. All failure rates for installed components were taken from the field return data and the EXIDA database.

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**NOTE:**

An actuator can only act as part of a safety function. When calculating the  $PFD_{avg}$ , the proportion of the actuator should not exceed 25%.

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**NOTE:**

The operator of the actuator is responsible for ensuring the energy supply. This was therefore not taken into account in the calculation.

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The system operator is obliged to rectify all MTTRs immediately, as otherwise the integrity of the system can no longer be guaranteed.

## 4.2 Calculation Basis

All elements of the electromechanical drive systems are classified as type A elements (according to 7.4.3.1.2 in IEC 61508-2), with a fault tolerance of 0.

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**NOTE:**

For fail-safe actuators, base actuators without handwheels were used as basis for the calculation of the safety indices.

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The control system is classified as a type B element (according to 7.4.3.1.3 in IEC 61508-2), also with a fault tolerance of 0.

The following assumptions were made during the calculation:

- Error rates are assumed to be constant, errors due to wear and tear were not taken into consideration.
- Fault propagation is not relevant.
- Both the torque and the end position signal were measured by a PLC.
- The device was installed according to the operating instructions.
- PVST: The safety function is performed with at least 10 times the speed expected in a normal field operation.
- The check of the SIF using PVST includes a position measurement.
- To be able to guarantee SIL 2 for the safety functions, the PVST must be at least designed for SIL 1.
- Sufficient tests were carried out before the product was dispatched to detect possible delivery and/or production errors that could restrict the operation and functionality of the device.
- All materials are designed for the applicable operating mode.
- MTTR is set at 24 hours.
- For the calculation, the time in which a dangerous fault was diagnosed by a PVST is assumed to be 730 hours.
- The degree of stress for average industrial components that are used outdoors is medium and can be compared with EXIDA profile 4 for mechanical components and profile 3 for electrical components.
- Only the mentioned products with the respective safety functions were used.

## 4.3 Safety Indices

See SIL manufacturers declaration.

# Section 5: Installation, Commissioning, Operating and Decommissioning

## 5.1 Installation and Commissioning

Please observe the relevant operating instructions of the actuator.

It should be noted that installation and commissioning may only be carried out by trained specialist personnel.

To ensure the SIL level, it is necessary to document the installation and commissioning (installation report and acceptance test certificate) for installation and commissioning.

## 5.2 Operating

Safe operation is only guaranteed if the drive is used in the operating mode according to the original project planning and is subjected to regular maintenance.

## 5.3 Notification

### 5.3.1 LED-Patterns

See Section 6.2.2, LED Display of MAN-02-04-60-0359-EN.

## 5.4 Testing

### 5.4.1 Safety-Relevant Tests

It is recommended to carry out brief visual inspections and safety checks several times a year to ensure smooth operation.

## 5.5 Lifetime

The safety-related key figures given here apply for a period of up to 10 years.

## 5.6 Decommissioning

Please observe the relevant operating instructions of the actuator in Section 3.2, Storage and Section 3.3, Long-Term Storage of MAN-02-04-60-0359-EN.

## Section 6: Error Diagnostics

Please observe the relevant operating instructions of the actuator (see Section 12, Troubleshooting of MAN-02-04-60-0359-EN).

# Section 7: Maintenance and Inspections

## 7.1 General

### **WARNING**

Maintenance work on open actuators may only be conducted if these are de-energized. Reconnection during maintenance is strictly prohibited.

### **WARNING**

Work on the electrical system or equipment must be carried out only in accordance with electrical regulations, either by a qualified electrician or by specially instructed personnel under the control and supervision of a qualified electrician.

### **NOTE:**

It is recommended that the maintenance of an actuator is carried out by an Emerson specialist.

## 7.2 Inspections

Regular inspection of the actuator is recommended to avoid possible malfunctions.

**Table 9. Tests**

| Tests      | Interval                                                |
|------------|---------------------------------------------------------|
| Proof-test | Once per year                                           |
| PVST       | 10 times as often as required by the safety requirement |

## 7.3 Proof-Test

### Sight Test

Pay attention to the following during the visual inspection:

- Pay attention to increased running noises.
- Check the condition of the housing for damage or cracks.
- For actuators with output drive types A, B and C according to DIN 3210 or A, B1, B2 and C according to DIN ISO 5210, re-grease through the existing grease nipple at least every 6 months.
- Cable glands must be checked at regular intervals for tight fit and leak tightness.

If the visual inspection indicates, that the effectiveness of the sealing elements of the cable entry has suffered from damage or aging (e.g., ingress of dust or water), such elements must be replaced, preferably by using the original spare parts from the manufacturer of the equipment or by using cable entries of comparable quality and the same Ex or IP protection class. In this case, it is recommended to carry out maintenance to be able to guarantee safety integrity.

### Testing the safe approach from predefined positions:

- Safe OPEN
- Safe CLOSE

### Procedure:

- Start position at 50%.
- Execute travel command (OPEN/CLOSE/Emergency Position).
- Check the actuator response according to the checklist.

## 7.3.1 PVST/FVST

### External Trigger

- Adjustable parameters:
  - Start Position (default: 0%, 100%) 0% or 100% depending on the travel direction to be tested (PVST: the start position can be adapted to the specific application).
  - Test Range (default 30%, adjustable in 1% steps)
    - FVST: always 100% (to cover the complete travel range of the actuator).
    - PVST: 30% is recommended. However, at least 10% must be covered.
  - Resting time (default 5 secs, adjustable from 1 to 100 sec). Can be selected freely.
- Prerequisites:
  - All parameters must be defined in advance (see Table 10, Parameter Settings for PVST).
  - The actuator has to be in the starting position.
  - No error message must be present at the start of the test.
- Procedure:
  - Move the actuator to the start position.
  - Move through the travel range (opening or closing direction).
  - Stop
  - Resting time
  - Move back to start position.
  - Stop
  - Check the status of the actuator.
- Analysis:

In the event of a positive PVST/FVST, no error is displayed on the actuator control unit.

  - It is essential to pay attention to the duration of the safety function. (This is drive-specific and can be defined from the respective output speed.)
  - Possible errors:

Please refer to the relevant operating instructions of the actuator.

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#### NOTE:

To ensure the reproducibility of a manual PVST/FVST, it is recommended to define the variables mentioned above in the internal factory documentation so that the safety function can be carried out uniformly.

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## 7.3.2 Internal

### Using software to execute PVST/FVST.

- Adjustable variables:
  - Starting position  
0% or 100% depending on the intended running direction  
(PVST: the start position can be adapted to application-specific value).
  - Travel range (Default: 30%) PST: 30% are recommended, but the actuator has to travel at least 10%.
  - Pause duration (Default 5 s, possible 1 to 100 s) possible to choose accordingly.

**Table 10. Parameter Settings for PVST**

| Parameter | Menu Item   | Sub Item       | Options         | Explanation/Comments                                                                                                                                                                                                                                                 |
|-----------|-------------|----------------|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P16.1     | Stroke test | Stroke test    |                 | This parameter activates the PVST. For standard actuators (without fail-safe function), the PVST is only viable electrically by motor. For fail-safe actuators, the PVST can additionally be executed as a fail-safe operation in the fail-safe direction by spring. |
|           |             |                | 0               | No stroke test is executed.                                                                                                                                                                                                                                          |
|           |             |                | 1               | Stroke test is executed electrically.                                                                                                                                                                                                                                |
|           |             |                | 2               | Stroke test is executed in fail-safe operation by spring.                                                                                                                                                                                                            |
|           |             |                | 3               | Two stroke tests.<br>1. Test: electrically<br>2. Test: in fail-safe operation                                                                                                                                                                                        |
|           |             |                | 4               | Two stroke tests.<br>1. Test: in fail-safe operation<br>2. Test: electrically                                                                                                                                                                                        |
| P16.2     | Stroke test | Start position | 0,00 to 100,00% | Start position for the PVST. This value must be 0,00% or 100,00%. If the actuator is not in one of these positions in case of a PVST start, the test is not executed and not successfully concluded.                                                                 |
| P16.3     | Stroke test | Test range     | 0,00 to 100,00% | In this range, the actuator is moved during the PVST e.g., Start position: 100,00%, test range: 30,00% The PVST starts at 100,00% and moves the actuator to 70,00% (100,00% to 30,00%). After that, the actuator moves back to 100%.                                 |
| P16.4     | Stroke test | Resting time   | 0 to 10 s       | Amount of seconds how long the actuator remains in the end position of the PVST before moving back to the start position                                                                                                                                             |
| P16.5     | Stroke test | Speed open     | 0 to 100%       | With this parameter, it is possible to set the speed in the Open direction for the PVST as far as the actuator has this capability.                                                                                                                                  |
| P16.6     | Stroke test | Speed close    | 0 to 100%       | With this parameter, it is possible to set the speed in the Close direction for the PVST as far as the actuator has this capability.                                                                                                                                 |

**Table 10. Parameter Settings for PVST (Continued)**

| Parameter | Menu Item   | Sub Item     | Options    | Explanation/Comments                                                                                                                                                                                                                                             |
|-----------|-------------|--------------|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P16.7     | Stroke test | Time trigger |            | If this value is set greater than 0, the PVST will be repeated cyclic according to the specific set value. The start command for the PVST is set for one minute and is reset after the test till the next cyclic start.                                          |
|           |             |              | 0          | 0 Off                                                                                                                                                                                                                                                            |
|           |             |              | 1          | Every hour                                                                                                                                                                                                                                                       |
|           |             |              | 2          | Every 2 hours                                                                                                                                                                                                                                                    |
|           |             |              | 3          | Every 3 hours                                                                                                                                                                                                                                                    |
|           |             |              | 4          | Every 4 hours                                                                                                                                                                                                                                                    |
|           |             |              | 5          | Every 6 hours                                                                                                                                                                                                                                                    |
|           |             |              | 6          | Every 8 hours                                                                                                                                                                                                                                                    |
|           |             |              | 7          | Every 12 hours                                                                                                                                                                                                                                                   |
|           |             |              | 8          | Every day                                                                                                                                                                                                                                                        |
|           |             |              | 9          | Every week                                                                                                                                                                                                                                                       |
|           |             |              | 10         | Every 2 weeks                                                                                                                                                                                                                                                    |
|           |             |              | 11         | Every month                                                                                                                                                                                                                                                      |
|           |             |              | 12         | Every 2 months                                                                                                                                                                                                                                                   |
|           |             |              | 13         | Every 3 months                                                                                                                                                                                                                                                   |
|           |             |              | 14         | Every 4 months                                                                                                                                                                                                                                                   |
|           |             |              | 15         | Every 6 months                                                                                                                                                                                                                                                   |
|           |             |              | 16         | Every year                                                                                                                                                                                                                                                       |
| P16.8     | Stroke test | Maximum time | 0 to 120s  | Maximum time span for the duration of the PVST. If the test takes longer than the adjusted time it is not successful. The function is deactivated by setting the value to 0.                                                                                     |
| P16.9     | Stroke test | Start date   | yyyy-mm-dd | With this parameter, the date for the first PVST is set. Parameter is only relevant if P16.7, Time trigger, is greater than 0.                                                                                                                                   |
| P16.10    | Stroke test | Start time   | hh:mm:ss   | With this parameter the time for the first PVST is set. The value for the seconds is not relevant. The start command is active for the whole minute independent from the adjusted seconds. Parameter is only relevant if P16.7, Time trigger, is greater than 0. |
| P16.11    | Stroke test | Start test   | 0 to 1     | With this parameter, the PVST function can be started from the control menu to test the adjusted values. When the parameter is set to 1, the PVST starts once the actuator is in REMOTE mode.                                                                    |

- Requirements:
  - Actuator must be in the previously defined starting position.
  - Executing FVST:
    - Travel range = 100%
    - Starting position 0% or 100%
  - Actuator must be in REMOTE mode.
  - PVST must be activated.
  - PVST can be initiated in 2-wire, 3-wire, analog or network mode.
  - No error messages must be present at the start of the test.
- Execution:
  - Display: STROKE TESTS
  - Actuator travels to start position  $\pm$  travel range
  - Stop
  - Pause
  - Actuator travels back to the start position
  - Stop
  - Test status in the register map
- Analysis:
  - The current status of the actuator during the PVST/FVST will be shown on the display and afterward stored in the device history.

**Table 11. Position Verification**

|             |              |                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|--------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Event Value | Bits: 0 to 5 | 5 Error Code Values: | 0 = Invalid Start Position<br>1 = Invalid Test Range<br>2 = Invalid Speed<br>3 = Invalid Resting Time<br>4 = Not in REMOTE mode<br>The Global selector switch state is not REMOTE.<br>5 = Not at Start Position<br>6 = Change Of Mode<br>The Global selector switch state changed from REMOTE to some other state.<br>7 = Abort by Command<br>The PVST was aborted by some command (e.g., Stop, Open, Close).<br>8 = Actuator Error<br>The PVST failed due to an alarm or due to over-torque.<br>9 = Max Time Reached<br>The maximum allowed time for the PVST was reached. |
|-------------|--------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## 7.4 Maintenance

Every 10,000 to 20,000 hours (about 5 years), depending on the workload:

- Change Oil
- Replace Seals
- Check all roller bearings and the worm-wheel assembly and replace them if necessary.

The maintenance interval of the drive can be determined as follows:

**Table 12. Operational Conditions and Adjustment Factors**

| Operational Condition (s)                         | Definition                                                           | Factor (Multiplier) |
|---------------------------------------------------|----------------------------------------------------------------------|---------------------|
| <i>Duty Cycle (DC)</i>                            | <i>Total of motor running time</i>                                   | -                   |
| Extremely High DC                                 | Over 1.250 hours/year                                                | 0.5                 |
| High DC                                           | Over 500 hours/year                                                  | 0.7                 |
| Extremely Low DC                                  | Less than 0.5 hours/year                                             | 0.8                 |
| <i>Ambient temperature (<math>T_{amb}</math>)</i> | <i>Permanent or long-term</i>                                        | -                   |
| Extremely changing $T_{amb}$                      | Between -10 and +50°C                                                | 0.5                 |
| Extremely high $T_{amb}$                          | Over +50°C                                                           | 0.7                 |
| Extremely low $T_{amb}$                           | Below -25°C                                                          | 0.9                 |
| <i>Output speed</i>                               | <i>At the main shaft of the actuator</i>                             | -                   |
| High speed                                        | Over 80 rev./min                                                     | 0.8                 |
| Extremely slow                                    | Very slow output speed (risk of higher wear and reduced lubrication) | -                   |
| <i>Utilization factor</i>                         | <i>Concerning nominal performance</i>                                | -                   |
| Very high                                         | Over 90%                                                             | 0.8                 |
| High                                              | Between 80% and 90%                                                  | 0.9                 |

Extremely low DC + extremely low ambient temperature + high speed + utilization factor 87% =  $0.8 \times 0.9 \times 0.8 \times 0.9 = 0.51$  reduction factor. Lubricant maintenance interval 10 years  $\times 0.51 = 5.1$  years (62 months).

### WARNING

A maintenance interval calculated in this way does not apply to the maintenance of output type A (threaded stem nut), nor to the maintenance of the linear and spindle actuator units. These must be regularly, re-greased (at least once every six months) at the lubricating nipples.

The interval determined here is the maximum duration between the maintenance. It should be noted that in the case of a negative visual inspection, maintenance must be arranged to guarantee the specified safety figures.

## Section 8: Tools and Analysis Software

All safety-relevant functions can be carried out without additional measuring equipment. Measuring software is optional. However, using the software provided by Emerson, "SMARTTOOL", together with an RTS Bluetooth® dongle, simplifies error analysis and enables remote maintenance by an Emerson specialist in case of an emergency. A detailed description of the applications and communication tools listed below can be requested at any time from the responsible Emerson sales representative.

A detailed description of the applications and communication tools listed below can be requested at any time from the responsible Emerson sales representative.

### 8.1 Hardware

Required devices for accessing SMARTTOOL:

- Bluetooth-enabled Android device
- RTS Bluetooth dongle
- RTS infrared dongle

### 8.2 Software

#### 8.2.1 SMARTTOOL

Through SMARTTOOL, the history of the drive can be read and analyzed easily, the parameters can also be read and changed. The SMARTTOOL is available in two versions:

- Android App
- Windows

# Section 9: Checklists

## 9.1 Commissioning

|                                                                                                            |             |                                                                                    |             |
|------------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------------------|-------------|
| <b>Commissioning Checklist</b><br>Functional Safety under<br>IEC 61508/61511                               |             |  |             |
| <b>Manufacturer</b>                                                                                        |             |                                                                                    |             |
| Manufacturer                                                                                               |             |                                                                                    |             |
| Address                                                                                                    |             |                                                                                    |             |
| <b>General</b>                                                                                             |             |                                                                                    |             |
| Date                                                                                                       |             |                                                                                    |             |
| Device Name/Type                                                                                           |             |                                                                                    |             |
| Actuator Serial Number                                                                                     |             |                                                                                    |             |
| Control Unit Serial Number                                                                                 |             |                                                                                    |             |
| Safety Function                                                                                            |             |                                                                                    |             |
| <b>Commissioning</b>                                                                                       |             |                                                                                    |             |
| Are all warning signs and labels clearly readable?                                                         | Yes         | No                                                                                 | Comments    |
| Is the operating manual for the actuator/control unit present?                                             |             |                                                                                    |             |
| Is the valve correctly assembled?                                                                          |             |                                                                                    |             |
| Is the wiring of the control unit and the actuator correct?                                                |             |                                                                                    |             |
| Are all protective features correctly wired and in the size?                                               |             |                                                                                    |             |
| Connecting wiring correct?<br>Are the screwed cable glands correctly adjusted and in faultless conditions? |             |                                                                                    |             |
| Is the travel and torque switch adjusted?                                                                  |             |                                                                                    |             |
| Have the commissioning and the basic settings been done according to the operating manual?                 |             |                                                                                    |             |
| Safety functions verified with Proof Test?                                                                 |             |                                                                                    |             |
| Examiner 1:                                                                                                | Examiner 2: | Examiner 3:                                                                        | Examiner 4: |
|                                                                                                            |             |                                                                                    |             |

## 9.2 Proof Test

|                                                                            |                                                                                    |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Proof-Test-Checklist1</b><br>Functional Safety under<br>IEC 61508/61511 |  |
|----------------------------------------------------------------------------|------------------------------------------------------------------------------------|

|          |                |  |
|----------|----------------|--|
| Actuator | Plant labeling |  |
|          | Type           |  |
|          | FabNr          |  |

|                     |                      |          |
|---------------------|----------------------|----------|
|                     |                      | Comments |
| General Condition   |                      |          |
| Corrosion           |                      |          |
| Mechanical Damage   |                      |          |
| Oil Leakage         |                      |          |
| Entrapment of Water |                      |          |
| Entrapment of Dust  |                      |          |
| Condition           | Reporting Unit       |          |
|                     | Terminal Compartment |          |
|                     | Control Unit         |          |
|                     | Cable Routing        |          |
|                     | Other                |          |
|                     |                      |          |
| Running Check       | End Position         |          |
|                     | Running Noise        |          |
|                     | Manual Operating     |          |

| Decision               |  |           |  |
|------------------------|--|-----------|--|
| Clearance              |  | Comments  |  |
| Repair                 |  |           |  |
| Maintenance            |  |           |  |
| Clearance not Possible |  |           |  |
| Date                   |  | Examiner: |  |

|                                                                            |                                                                                                         |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| <b>Proof-Test-Checklist2</b><br>Functional Safety under<br>IEC 61508/61511 | <br><b>EMERSON</b> ™ |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|

|          |                |  |
|----------|----------------|--|
| Actuator | Plant labeling |  |
|          | Type           |  |
|          | FabNr          |  |

|      |            |
|------|------------|
| Test | Safe Open  |
|      | Safe Close |

|                                                  | Yes | No |
|--------------------------------------------------|-----|----|
| Travel to start position                         |     |    |
| Travel command given?                            |     |    |
| Was the safety function triggered?               |     |    |
| Running Check: Running Noise                     |     |    |
| Running Check: End position correct?             |     |    |
| Error message correctly displayed?               |     |    |
| Error message correctly saved in device history? |     |    |
| End Safety function                              |     |    |

| Decision               |  |           |  |
|------------------------|--|-----------|--|
| Clearance              |  | Comments  |  |
| Repair                 |  |           |  |
| Maintenance            |  |           |  |
| Clearance not Possible |  |           |  |
| Date                   |  | Examiner: |  |

9.3 PVST

|                                                                              |                                                                                    |
|------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <p><b>PVST-Checklist</b><br/>Functional Safety under<br/>IEC 61508/61511</p> |  |
|------------------------------------------------------------------------------|------------------------------------------------------------------------------------|

|          |                |  |
|----------|----------------|--|
| Actuator | Plant labeling |  |
|          | Type           |  |
|          | FabNr          |  |

|                 |      |
|-----------------|------|
| Safety Function | PVST |
|-----------------|------|

| Test                        |                  |    |
|-----------------------------|------------------|----|
|                             | Yes              | No |
| Was the function performed? |                  |    |
| Did malfunctions occur?     |                  |    |
| Running Check               | End position     |    |
|                             | Running Noise    |    |
|                             | Manual Operating |    |

| Decision               |  |           |
|------------------------|--|-----------|
| Clearance              |  | Comments  |
| Repair                 |  |           |
| Maintenance            |  |           |
| Clearance not Possible |  |           |
| Date                   |  | Examiner: |

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