

General specification multi-turn electric actuators with controls

1. General

The actuators shall be suitable for use on a nominal _volt, _ phase, _Hz power supply and are to incorporate motor, integral reversing starter, local control facilities and terminals for remote control and indication connections housed within a self-contained, sealed enclosure.

As a minimum the actuators should meet the requirements set out in EN15714-2 and ISA SP96.02.

Standard actuator commissioning of torque levels and position limits shall be carried out through physical adjustment of a mechanical switch mechanism interface. The switch mechanism shall include switches to adequately control the integral motor of the actuator.

An alternative switch mechanism may be offered, providing full digital feedback of torque and position to the control interface. This digital switch mechanism should ensure that commissioning becomes a non-intrusive process that maintains the integrity of the enclosure whilst including as few as possible moving parts.

In order to maintain the integrity of the enclosure configuration of the indication contacts etc. shall be carried out without the removal of any actuator covers. It should be possible to configure the actuator with the local controls however an alternative method of configuration should also be provided using an Infrared or *Bluetooth*® wireless interface. When applicable, supplementary configuration tools must meet the enclosure protection and certification levels of the actuators. In addition, provision shall be made for the protection of configured actuator settings by a means independent of access to the commissioning method. Provision shall be made to disable *Bluetooth*® communications or only allow a *Bluetooth*® connection initiated by an Infra-Red command for maximum security.

The actuator shall include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel irrespective of the connection sequence of the power supply.

2. Actuator Sizing

The actuator shall be sized to guarantee valve closure at the specified differential pressure and temperature. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal. For linear operating valves, the operating speed shall be such as to give valve closing and opening at approximately 10-12 inches per minute unless otherwise stated in the data sheet. For 90° valve types the operating time will be specified.

One actuator frame size (matching external dimensions) shall be available covering output speeds from 9 to 192 rpm for a given torque range, to avoid over sizing and unnecessary weight load on the valve stem, flange and yoke assembly. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight over sizing of actuators. Actuators must be selected to provide sufficient torque required for safe valve operation. Actuator rated output torque must be available at 90 % of nominal build voltage.

In order to enable proper sizing of applicable electric equipment, actuator supplier has to disclose load value (Amps) at rated actuator torque. A locked rotor current figure must also be provided to ensure maximum potential starting conditions can be accommodated. Actuator shall be capable of opening and closing the valve against full differential pressure within specified time on valve data sheet.

3. Environmental

Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from -30°C (-22°F) to 70°C (140°F), up to 100% relative humidity. Actuators shall be built with suitable alternative seals, lubrication and bearings should a lower ambient temperature range be required.

4. Enclosure

Actuators shall be O-ring sealed, watertight to IP68 8m for 96hrs, NEMA 4 & 6. The motor and all other internal electrical elements of the actuator shall be protected from ingress of moisture and dust when the terminal cover is removed for site cabling. If required, the actuator manufacturer should ensure the ingress protection rating of the actuator is maintained whilst the terminal compartment is removed. The actuator shall be able to complete 10 operations during submersion.

5. Motor

The motor shall be an integral part of the actuator, designed specifically for valve actuator applications. It shall be a low inertia high torque design, capable of delivering rated torque when power is turned on. All motors shall be of high starting torque type to facilitate 'unseating' of the valve. Each motor shall have a rating plate marked in accordance with IEC 34.1 as far as applicable.

Standard isolating duty actuators shall include class F insulated motors with a class B temperature rise giving a time rating of 15 minutes at 40°C (104°F) at an average load of at least 33% of maximum valve torque. Temperature shall be limited by 2 thermostats embedded in the motor stator windings and integrated into its control. Electrical and mechanical disconnection of the motor should be possible without draining the lubricant from the actuator gearcase.

6. Motor Protection

Protection shall be provided for the motor as follows:

- Stall - the motor shall be de-energized within 8 seconds in the event of a stall when attempting to unseat a jammed valve.
- Over temperature - thermostat will cause tripping of the motor. Auto-reset on cooling.
- Single phasing - lost phase protection.
- Direction – phase rotation correction.

7. Gearing

The actuator gearing shall be totally enclosed in an oil-filled gearcase suitable for operation at any angle. Grease lubrication is not permissible. All drive gearing and components must be of metal construction and incorporate a lost-motion hammer blow feature. To ensure immediate drive output response, modulating duty actuators should not include a hammer blow feature. For rising spindle valves the output shaft shall be hollow to accept a rising stem, and incorporate thrust bearings of the ball or roller type at the base of the actuator. The design should be such as to permit the opening of the gearcase for inspection or disassembled without releasing the stem thrust or taking the valve out of service. For 90° operating type of valves drive gearing shall be self-locking to prevent the valve back-driving the actuator.

8. Hand Operation

A handwheel shall be provided for emergency operation, engaged when the motor is declutched by a lever or similar means, the drive being restored to electrical operation automatically by starting the motor. The handwheel or selection lever shall not move on restoration of motor drive. Provision shall be made for the hand/auto selection lever to be locked in both hand and auto positions. It should be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

Clockwise operation of the handwheel shall provide closing movement of the valve unless otherwise stated in the data sheet. For linear valve types the actuator handwheel drive must be mechanically independent of the motor drive and should be such as to permit valve operation in a reasonable time with a manual force not exceeding 400N through stroke and 800N for seating/unseating of the valve.

It must be possible to deliver the actuator rated torque to the valve through the handwheel mechanism. Position limit indication shall remain active in manual operation as well as motor operation, thus allowing a signal to be provided when the set position has been reached. Intermediate position shall remain available during manual operation provided this feature is supplied within the selected actuator.

9. Drive Interface

The actuator shall be furnished with a drive bushing easily detachable for machining to suit the valve stem or gearbox input shaft. The drive bush shall be positioned in a detachable base of the actuator. Thrust bearings shall be sealed for life and the base shall be capable of withstanding five times the rated thrust of the actuator.

The actuator shall have an appropriate mounting flange according to ISO 5210 or MSS SP-102.

10. Local Controls

The actuator shall incorporate local controls for electrical operation and configuration purposes. This shall consist of a selector switch for Open/Close and a Local/Stop/Remote mode selector switch, lockable in any one of the following three positions: local control only, stop (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

The local controls and display shall be rotatable through increments of 90 degrees to suit valve and actuator orientation. Should the required actuators be mounted in a difficult or inaccessible location, it shall be possible to separate the control module (including motor switchgear) from the actuator body. A remote mounting kit shall include a wall bracket and the required electrical plug and socket connections, suitable for distances up to 100 m cable length.

All field wiring connections and the main actuator power supply must be wired to a multi pin plug and socket for customer connection. Terminal compartment shall provide sufficient space to accommodate the maximum possible number of incoming wires. A minimum of three cable entries must be provided for motor power cable and digital/analogue inputs and outputs. Each cable entry shall be properly sealed by cable glands during site installation. Cable glands shall be chosen by contractor, responsible for wiring during commissioning phase.

Each actuator shall provide an adequately sized internal and external connection for grounding.

11. Torque and Limits

Torque and turns limitation to be adjustable as follows:

- Position setting range – multi-turn: 2.5 to 8,000 turns, by means of a digitally sensed absolute encoder with resolution to 7.5 deg. of actuator output.
- Position setting range – multi-turn: 2.5 to 1,500 turns, by means of a mechanical drive mechanism suitable for high vibration and temperature environments.
- Torque setting: 40% to 100% rated torque.

Position measurement – Absolute position measurement should be incorporated within the actuator. The technology must be capable of reliably measuring position even in the case of a single fault. The design must be simple with the minimum amount of moving parts (no more than 5).

Measurement of torque shall be from direct measurement of reactive force on the motor shaft. Methods of determining torque-using data derived from the motor such as motor speed, current, flux etc are not acceptable.

A means for automatic “torque switch bypass” to inhibit torque off during valve unseating shall be provided.

The electrical circuit diagram of the actuator should not vary with valve type remaining identical regardless of whether the valve is to open or close on torque or position limit.

12. Remote Valve Position and Status Indication

Four potential free contacts shall be provided which can be selected to indicate any position of the valve. Provision shall be made for the selection of a normally closed or normally open contact form. Contacts shall maintain and update position indication during handwheel operation if the main power supply is maintained.

The contacts shall be rated for 5mA to 5A, 120V AC, 30V DC.

As an alternative to providing valve position indication any of the four above contacts shall be selectable to signal one of the following:

- Valve opening, closing or moving
- Thermostat tripped, lost phase
- Motor tripped on torque in mid travel, motor stalled
- Remote selected
- Actuator being operated by handwheel
- Actuator fault

Provision shall be made in the design for an additional eight contacts having the same functionality.

A configurable monitor relay shall be provided as standard, which can be used to indicate either Availability or Fault. The relay should be a spring return type with a Normally Open / Normally Closed contact pre-wired to the terminal bung.

The Monitor (availability or fault) relay, being energized from the control transformer will de-energise under any one or more the following conditions:

Available Mode

- Loss of main or customer 24V DC power supply
- Actuator control selected to local or stop
- Motor thermostat tripped
- Actuator internal fault

Fault Mode

- Loss of main or customer 24V DC power supply
- Motor thermostat tripped
- Actuator internal fault

Provision shall be made in the design for the addition of a contactless transmitter to give a 4-20mA analogue signal corresponding to valve travel and / or torque for remote indication when required. The transmitter will auto range to the set limits.

13. Local Position Indication

The actuator display shall include a dedicated numeric/symbol digital position indicator displaying valve position from fully open to fully close in 0.1% increments. Valve closed and open positions shall be indicated by symbols showing valve position in relation to the pipework to ensure that valve status is clearly interpreted. With mains power connected, the display shall be backlit to enhance contrast at all ambient light levels and shall be legible from a distance of at least 5m (16ft).

Red, green, and yellow LEDs corresponding to open, closed and intermediate valve positions shall be included on the actuator display when power is switched on. The yellow LED should also be fully programmable for on/off, blinker and alarm indication. The digital display shall be maintained and updated during handwheel operation.

The actuator display shall include a large segment element with two lines of text information, alarm and configuration icons. The text display shall be selectable between English and other languages such as: Spanish, German, French, and Italian. Provision shall be made to upload a different language without removal of any covers or using specialized tools not provided as standard with the actuator.

Data logger menus should as a minimum be able to display on the local LCD the following information:

- Maximum temperature
- Minimum temperature
- Total starts
- Maximum opening torque
- Maximum closing torque
- Motor running time
- Average torque
- Open contactor starts
- Close contactor starts
- Maximum powered on time
- Number of power ups

The main display shall be capable of indicating 3 different home-screens of the following configuration:

- Position and status
- Position and torque
- Position and demand (positioning)

The local controls and display shall be rotatable through increments of 90 degrees to suit valve and actuator orientation.

14. Integral Starter and Transformer

The reversing starter, control transformer and local controls shall be integral with the valve actuator, suitably housed to prevent breathing and condensation. The starter shall be mechanically and electrically interlocked suitable for isolating duty. Alternative solid state contacts (thyristors) shall be available for modulating duty. All starters shall be rated appropriately for the respective motor size. The controls supply transformer shall be fed from two of the incoming three phases and incorporate overload protection. It shall have the necessary tapping and be adequately rated to provide power for the following functions:

- Energising of the contactor coils.
- 24V DC or 110V AC output for remote controls (maximum 5W/VA)
- Supply for all the internal electrical circuits.

15. Remote Control Facilities

The necessary control, wiring and terminals shall be provided integral to the actuator enclosure. Open and close external interlocks shall be made available to inhibit local and remote valve opening / closing control. It shall be possible to configure the interlocks to be active in remote control only.

Remote control signals fed from an internal 24V DC (or 110VAC) supply and/or from an external supply between 20V and 60 VDC or 40V and 120VAC, to be suitable for any one or more of the following methods of control:

- Open, Close and Stop control
- Open and Close maintained or “push to run” (inching) control
- Overriding Emergency Shut-down to open/close (or stop) valve from a normally closed or open contact
- Two-wire control, energise to close (or open), de-energise to open (or close).

It shall be possible to reverse valve travel without the necessity of stopping the actuator. The motor starter shall be protected from excessive current surges during rapid travel reversal. The internal circuits associated with the remote control and monitoring functions are to be designed to withstand simulated lightning impulses of up to 2kV.

Provision shall be made for operation by distributed control system utilising the following fieldbus systems:

- Profibus
- Modbus
- Foundation Fieldbus
- HART

16. Monitoring Facilities

Facilities shall be provided for monitoring actuator operation and availability as follows:

Actuator text display indication of the following status/alarms:

- Closed Limit, open limit, moving open, moving closed, stopped
- Torque trip closing, torque trip opening, motor stalled
- ESD active, interlock active
- Thermostat trip, phase lost, 24V supply lost, local control failure
- Configuration error, position sensor failure
- Power loss inhibit

Integral data logger to record and store the following operational data:

- Maximum and minimum temperature
- Motor running time
- Opening contactor starts
- Closing contactor starts
- Total open/closed operations
- Maximum recorded opening and closing torque values
- Maximum power on time
- Number of power up events

The data logger shall record and store the aforementioned data on a non-volatile memory medium to ensure power failure does not impact on data integrity.

Data logger information shall be accessed via optional non-intrusive *Bluetooth®* communication and data displayed on the local LCD. Optional secure *Bluetooth®* tools shall be available for downloading datalog and actuator configuration files from the actuators and subsequently uploading to a PC. The actuator manufacturer shall supply PC software to enable actuator configuration files and data log files to be viewed/edited and analysed.

17. Wiring and Termination

Internal wiring shall be tropical grade PVC insulated stranded cable of appropriate size for the control and 3-phase power. Each wire shall be clearly identified at each end. The terminals shall be fixed in a terminal block of high tracking resistance compound.

The terminal compartment shall be separated from the inner electrical components of the actuator by means of a plug and socket arrangement and shall accommodate all field wiring connections to the actuator. The terminal compartment shall be provided with a minimum of 3 threaded cable entries with provision for an additional 2 extra conduit entries.

All wiring supplied as part of the actuator to be contained within the main enclosure for physical and environmental protection. External conduit connections between components are not acceptable unless they are provided from the actuator manufacturer as an approved option. A detailed wiring diagram and terminal plan shall be provided with every unit. The terminal plan shall be suitable for the contractor to inscribe cable core identification alongside terminal numbers.

18. Commissioning Kit

Each actuator shall be supplied with a start-up kit comprising installation instruction manual, electrical wiring diagram and cover seals to make good any site losses during the commissioning period.

19. Performance and Test Certificate

Each actuator must be performance tested and individual test certificates shall be supplied free of charge. The test equipment should simulate a typical valve load, and the following parameters should be recorded.

- Current at maximum torque setting
- Torque at max. torque setting
- Flash test voltage
- Actuator output speed or operating time.

In addition, the test certificate should record details of specification such as gear ratios for both manual and automatic and second stage gearing if provided, drive closing direction, wiring diagram number.