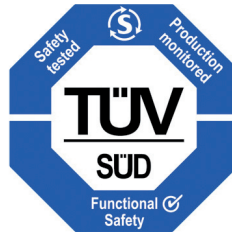


SFCM option

IQ Pro - Option SFCM Actuator Safety Manual

rotork[®]
Controls



Safety Function Control Module (SFCM assembly)

This safety manual defines the set up, operation and maintenance of the IQ Pro and IQT Pro actuator ranges fitted with the Safety Function Control Module (SFCM) option, designed for SIS applications requiring functional Safety Integrity Level (SIL) up to SIL3 to Standard IEC61508.

TÜV Approval Certificate: Z10 07 09 64590 001

⚠ WARNING Failure to apply the procedures detailed in this manual will invalidate the safety function certification.

This manual must be read in conjunction with E170E3 for IQ and E175E3 for IQT.

Established Leaders in Actuation Technology

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1. Overview

This document is the Safety Manual for the IQ *Pro* actuator fitted with the SFCM option. It contains detailed information on design requirements, installation, commissioning and validation of the actuator within the Safety Instrumented System (SIS) plus through-life operation, proof testing and maintenance requirements. It also provides guidance on indication settings

that may be used but are not part of the safety function of the actuator.

It is the responsibility of the site manager to determine whether the measures contained within this document are sufficient or necessary.

1.1 Safety Function Types

The following safety functions are available with actuators fitted with the SFCM option:

IQ & IQT Safety function 1 - Stayput

- The actuator shall not move without a valid remote open or remote close signal.
- If an internal failure is detected, the actuator will give an alarm signal.

Notes:

Redundant channels shall be used for remote open and close input signals and both signals must be present to be determined as valid.

Safety function 1 is a high-demand mode safety function.

IQ Only Safety function 2 - ESD

- If the ESD signal is active the actuator will perform the commissioned ESD action.
- If an internal failure is detected, the actuator will give an alarm signal.

Notes:

Three phase mains power shall be available to the actuator for the duration of the ESD safety function.

Safety function 2 – ESD is a low-demand mode safety function.

1.2 Applicable actuator Types

IQ - *Pro* Actuators including option SFCM are designed for isolating valve duty with a SIS safety function 1 or 2 requirement. Mid travel positioning is possible but is not considered in the safety assessment.

isolating or modulating valve duty with a SIS safety function 1 requirement only. Mid travel positioning is possible but is not considered in the safety assessment.

IQT - *Pro* Actuators including option SFCM are designed for

The SFCM option requires actuator firmware revision V212 or later for operation.

	Type	Duty	Power supply	Duty rating	Starts/Hr	Basic Circuit Diagram	Plus 4-20mA Indication**
Safety Function 1: Stayput	IQ	Multi-turn Isolating & ¼ Turn isolating*	3 phase only	S2 - 25%	60	3000S000	3060S000
	IQT	¼ turn Isolating	1, 3 phase or 24V DC	S2 - 20%	60	6000S000	6060S000
	IQTM	¼ turn Modulating	1, 3 phase or 24V DC	S4 - 50%	1200	7000S000	7060S000
	IQTF	Part-turn Isolating	1, 3 phase or 24V DC	S2 - 20%	60	6000S000	6060S000
Safety Function 2: ESD	IQ	Multi-turn Isolating & ¼ Turn isolating*	3 phase supply only	S2 - 25%	60	3000S000	3060S000

* requires addition of second stage gearbox

** Where a 4-20mA position feedback signal is required, option CPT is available. CPT Output signal is not part of the safety function. CPT is 24V DC (nominal) loop powered and will output 4mA on loss of actuator power supply irrespective of position.

Table 1

SFCM option

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1.3 IQ Pro - SFCM Option Reliability Data

The reliability data provided covers the complete actuator up to and including the actuator output drive assembly. It does not include the valve, valve drive components or second stage gearboxes.

The integrity/reliability of the electrical power supply and user derived control signals are not included in the actuator reliability assessment.

Safety Function 1: Stayput	IQ	IQT
Type	B	B
HFT Hardware fault tolerance	0	0
λ_{sd} Safe detected failure rate	2603.7×10^{-9}	2599.29×10^{-9}
λ_{su} Safe undetected failure rate	9935.8×10^{-9}	9928.76×10^{-9}
λ_{dd} Dangerous detected failure rate	0.32×10^{-9}	0.32×10^{-9}
λ_{du} Dangerous undetected failure rate	33.32×10^{-9}	50.32×10^{-9}
PFH Probability of failure per hour	33.64×10^{-9}	50.64×10^{-9}
SIL Safety Integrity Level	2	2
SFF Safe failure Fraction	99.7	99.6

Table 2

Safety Function 2: ESD	IQ	
Combined subsystem Types	A	B
HFT Hardware fault tolerance	0	1
SFF Safe Failure Fraction (subsystems)	85.02%	99.8%
λ_{sd} Safe detected failure rate	1359.8×10^{-9}	
λ_{su} Safe undetected failure rate	8674.4×10^{-9}	
λ_{dd} Dangerous detected failure rate	609.13×10^{-9}	
λ_{du} Dangerous undetected failure rate	933.32×10^{-9}	
PFH Probability of failure on demand (per annum)	4.1×10^{-3}	
SIL Safety Integrity Level	2	
MTTR Mean time to repair*	12 Hours	
TI Proof Test interval*	12 months	

Table 3 * Approval for SIL 2 applications based on the stated periods. Users must ensure these intervals are not exceeded in service.

1.4 IQ Pro - SFCM Operating Principle

The actuator has two operational safety functions which may be applied or combined dependent on the required Safety Instrumented System (SIS) safety function. The safety function

is determined by the action required and therefore by the remote control signal type:

Safety Function	Action (refer to 1.1)	Control signal type
1	To Stayput	Dual Remote open or close signal
2	To perform the commissioned ESD safety function (open, close or Stayput)	ESD signal
1 & 2	To Stayput, else to perform the commissioned ESD safety function	Dual Remote open or close signal and ESD signal (ESD has priority)

Table 4

The IQ *Pro* SFCM actuator is designed to operate under remote open/closed and ESD control by using standard IQ control logic. In addition to standard control it includes a dual redundant Safety Function Control Module - SFCM. This monitors applied input signals and the standard control logic and will bypass it to carry out the set safety function and indicate a fault status should an invalid logic condition be detected. If the actuator setup or control settings are such that the actuator is unavailable to carry out the set safety function or the set safety function could be overridden, for example if set to local control, it will also indicate fault status.

For safety function 1 (high demand) valid remote open and close signals (24V DC) comprise a control signal input with the appropriate conditional control input signal applied simultaneously - i.e. 2 signals required to open and 2 signals required to close. A single input signal only is deemed invalid and will result in fault indication.

For safety function 2 (low demand) a valid ESD signal comprises removal of 24V DC from the single ESD input; i.e. a remote ESD contact breaking. Refer to the circuit diagram for connection details.

Where applications require combined safety functions 1 & 2, Safety function 2 - ESD will have priority.

The SFCM includes a status relay contact providing remote indication that the SFCM has detected an invalid or fault condition and has performed the safety function, or, the safety function cannot be applied or could be overridden. The actuator LCD display also provides fault status indication.

Tables 5 and 6 provide an overview of the conditions monitored by the SFCM, respective actions and the LCD/status relay output:

1.5 Safety Function 1 – Stayput operation

Control	Remote Open/Close Control signal status	Control Status/Failure mode	Applied logic	SFCM	Action	LCD/Status output
Any - Power Off	None or Any combination	Control unavailable	Valid	N/A	Stayput	N/A
Local	None or Any combination	Local control available	Invalid –safety function can be locally overridden	Active	Overridden	Err/Fault
Stop (+ ESD set to Stayput)	None	No Failure	Valid	Inactive	Stayput	OK
Stop (+ ESD set to Stayput)	Any combination	Remote control unavailable	Invalid	Active	Stayput	Err/Fault
Remote	Open + Open Conditional signals	No failure	Valid	Inactive	Open	OK
Remote	Close + Close Conditional signals	No failure	Valid	Inactive	Close	OK
Remote	Open or close signal only	Spurious signal (external)	Invalid - single control input	Active	Stayput	Err/Fault
Remote	Open or Close conditional signal only	Spurious signal (external)	Invalid - single control input	Active	Stayput	Err/Fault
Remote	None	Spurious signal (internal)	Invalid - detected hardware/firmware fault	Active	Stayput	Err/Fault

Table 5

Notes.

- ESD will take priority over any local and remote signals applied.
- Remote control signals must be “push to run” type; actuator will respond only when both a control and conditional signal are applied. Removal of one or both signals will cause the actuator to stop.

- For each direction, control and conditional signals must be applied simultaneously for operation. Signals applied individually at intervals of more than 250msec apart will result in Err/fault status indication being set for the period exceeding 250msec.



1.6 Safety Function 2 – ESD operation

Control	Remote Open/Close Control signal status	Control Status/Failure mode	Applied logic	SFCM	Action	LCD/Status output
Any - Power Off	None or ESD	Control unavailable	Valid	N/A	Stayput	N/A
Local	None	Local control available	Invalid - actuator can be moved from configured safety function position	Active	Overridden	Err/Fault
Local	ESD	Local control unavailable	Invalid - actuator can be moved from configured safety function position if ESD is removed	Active	ESD	Err/Fault
Stop	None or ESD	ESD action unavailable	Invalid	Active	Stayput	Err/Fault
Remote	ESD active	No failure	Valid ESD safety function required by SIS	Inactive	ESD	OK
Remote	ESD (spurious)	Spurious signal fault (external)	Valid undetected /safe failure	Inactive	ESD	OK
Remote	None	Spurious signal fault (internal)	Invalid undetected hardware/firmware fault	Active	ESD	Err/Fault
Remote	None	Spurious signal fault (internal)	Invalid detected hardware/firmware fault	Active	Stayput	Err/Fault
Remote	ESD (when configured for close or open only)	Valve fault (eg obstructed)	Invalid-failure to reach configured ESD position	Active	ESD	Err/Fault
Remote	ESD	Actuator fault (eg main logic/firmware, torque/position sensing)	Invalid - detected hardware/firmware fault	Active	ESD	Err/Fault

Table 6

Notes.

1. The safety function of the actuator is only valid when the actuator is selected to remote control. ESD signals take priority over any local and remote signals applied.
2. The ESD signal must be derived by removal of the 24V DC signal and therefore it is not possible to detect an external spurious control signal fault.
3. For ESD signals, the actuator will perform the ESD action for as long as the ESD signal is active.

For ESD signals, in the event of a detected internal hardware/firmware failure, the SFCM will take control and torque protection, position limits, stall protection and phase rotation correction may be bypassed. This means that the actuator may stall in attaining the configured valve ESD position or attempting to reach the configured valve ESD position (for example if the valve is obstructed).

⚠ WARNING The valve must be designed to ensure its structure can safely withstand actuator developed stall torque and thrust for linear valve types.

It should be noted that the inclusion of the Safety Function Control Module (SFCM) restricts the control options that can be included in the actuator and determines the remote control and ESD control circuits that may be used. Refer to Remote control / ESD circuits.

2. Design Requirements

2.1 Actuator selection and sizing

The selection of actuator type and size is dependent on the valve type and its required operating forces (torque and/or thrust). It is the responsibility of the valve manufacturer/supplier to specify the required valve type and operating forces. For retrofit applications, it is the responsibility of the design engineer to specify the valve type and its operating forces. Actuator performance data is provided on the unit nameplate and on its individual test certificate. Actuator performance data is published in publication E110E. For actuator-gearbox combinations selected by Rotork, the combination performance data will be specified on the supplied combination data sheet.

The following selection and sizing design principles/conditions are applied and the installer must verify their suitability for the selected valve in performing its safety function within the SIS:

- Refer to essential health and safety information provided in E170E3 (IQ) & E175E3 (IQT).
- The supplied actuator has been sized based on its rated torque/thrust being at least equal to the required valve operating torque/thrust for the specified operating time.
- No additional safety factors have been added unless expressly requested.
- The actuator must only be fitted to the valve selected at the design stage.
- Changes in process conditions to those specified at the design stage may affect actuator sizing requirements and must be referred to the valvemaking/supplier or design engineer.
- Valve operation under the specified process operating conditions must be verified.

If the SFCM option takes over the control in order to carry out an ESD to a predetermined end of travel (safety function 2) the actuator may, in the worst case, stall against the valve or gearbox stops for a time up to the total stroke time plus 3 seconds. The following design principles/conditions must therefore be applied:

- The valve and/or valve drive components must be capable of safely withstanding the supplied actuator stall torque and/or developed thrust at stall torque.
- For design purposes, IQ stall torque shall be considered to be at least 3 times supplied actuator/actuator-gearbox combination rated torque.

2.2 Actuator Power

The actuator electrical power supply integrity does not fall within the scope of the actuator reliability assessment. Users must ensure the integrity of the actuator power supply meets the requirements of the target SIL for the SIS. For actuator electrical supply data and requirements, refer to publication E130E for IQ and E135E for IQT.

2.3 Actuator Control

Refer to the circuit diagram and control connection drawing supplied with the actuator

In order to meet the requirements of SIL 2 for safety function 1, the actuator must be controlled for opening and closing using 2 standing input signals. Application of only one signal is invalid and will raise an error status feed back on the display and status relay.

For safety function 2, a single, standing ESD signal derived from a normally closed contact (break to ESD) is required. ESD operation will override any existing open or close (local or remote) signal while applied, in order to carry out the configured ESD action (open, close or Stayput). ESD will not override an actuator selected to stop control.

Control signal integrity does not fall within the scope of the actuator reliability assessment. Users must ensure the integrity of control signals meets the requirements of the target SIL for the SIS.

2.4 Actuator Indication

The SFCM option includes a fault status relay indication. For status indications refer to tables 5 and 6. Contacts will make on indication of a fault condition.

- Indication Contacts

The actuator has 4 configurable contacts, S1 to S4 available for indication, including open and closed position, limit indication and intermediate position indication (configurable). A full list of available functions is provided in publication E170E3. Default configuration for S1 to S4 are shown in Table 9, p13.

- Analogue 4-20mA position indication

Where the CPT option is fitted - refer to actuator circuit diagram, a 4-20mA loop-powered signal is available for analogue position indication. The CPT must be powered from an external source with a nominal supply of 24V DC. On loss of main actuator power supply, the CPT output will default to 4mA regardless of actuator position.

- Monitor Relay

The monitor relay will indicate one or more of the following conditions:

- Loss of one or more of the power supply phases.
- Loss of control circuitry supply.
- Actuator selected to "Local" or "Stop" control.
- Thermostat tripped.

The monitor relay is not configurable. Refer to actuator circuit diagram for connections.

Note:

Indication outputs S1 to S4, Monitor Relay and the CPT analogue position signal do not fall within the scope of the actuator reliability assessment. Users must ensure the integrity of indication meets the requirements of the SIL target for the SIS. If necessary, limit position indication should be derived from devices external to the actuator and driven directly from the valve obdurator.



2.5 Environmental

The environmental conditions in respect of enclosure rating, temperature, vibration (seismic and plant induced) etc must not exceed those stated in the actuator specification. Refer to E110E for general information and the actuator nameplate and test certificate for details. Temperature range for actuators including the SFCM is -40° to +70°C. Operation outside these ambient temperatures will invalidate safety assessment approval.

For hazardous locations, the actuator enclosure certification must meet the requirements of the location in respect of zone, gas group and temperature "T" rating. Refer to actuator nameplate.

2.6 Safety Instrumented System (SIS) Assessment for SIL2 & SIL3 Applications

The actuator is fit for use in a SIS requiring SIL2 for safety function 1.- Stayput or safety function 2 - ESD providing the instructions contained in this manual are fully implemented. Refer to Section 1.3 for actuator reliability data. It is the responsibility of the SIS design engineer to carry out an overall SIL calculation of the SIS.

Where SIL 3 is required a 1oo2 (1 out of 2) configuration must be employed – refer to IEC61508, part 6, clause 2.2.2 for information. Figures 1 & 2 show a typical 1oo2 application applied to process valves and actuators. The full loop calculation of PFD, PFH etc in this configuration is the responsibility of the SIS design engineer.

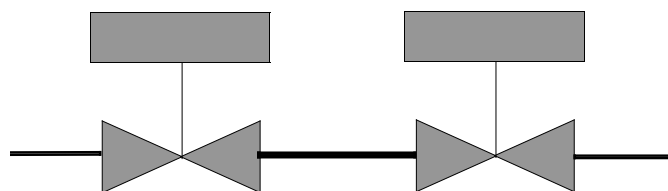


Fig1 1oo2 - valve process isolation

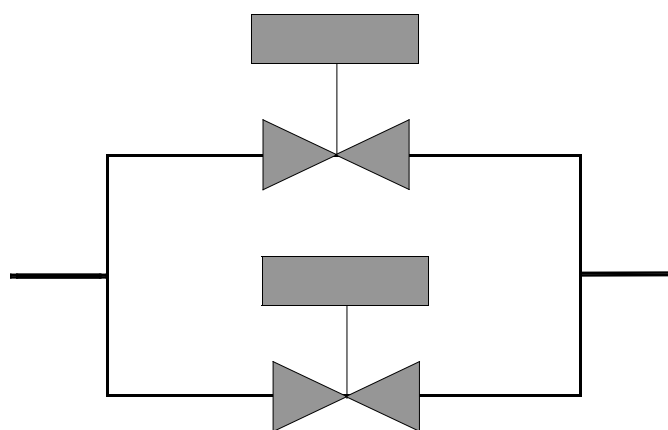


Fig2 1oo2 - process valve by-pass

3. Installation

IQ Range: Refer to the Health and Safety requirements and instructions detailed in sections 4, 5 and 6 in the supplied IQ Installation and Maintenance Instructions E170E3.

IQT Range: Refer to the Health and Safety requirements and instructions detailed in sections 4, 5 and 6 in the supplied IQT Installation and Maintenance Instructions E175E3.

4. Commissioning

4.1 Important Information

Commissioning must be completed and verified under any of the following circumstances:

- When the actuator is installed on to the valve for the first time.
- When valve & actuator are installed into the process for the first time.
- When the actuator has been mechanically disconnected from the valve for any reason.
- When the actuator has been electrically disconnected from the supply.
- When the phase rotation has or may possibly have changed.
- When any actuator settings have been adjusted or changed.
- When process conditions change beyond those outlined in the design specification for valve and/or actuator.

The actuator is despatched with ESD safety function set to **"Stayput"**. Links are also fitted to provide the ESD signal input required for normal control (ESD not active) which must be retained until commissioning is complete. Refer to circuit diagram.

Set to Stayput and with ESD input links fitted allows the valvemakersupplier and site installer to set and test basic operational settings required by the valve. Only after these settings and any secondary indication settings have been made and verified should the ESD function be set if it is required. On completion of ESD setup, the links must removed and replaced with the remote ESD circuit. If safety function 1 only is required then no further commissioning is required and the links, as supplied, should be retained.

The following table provides the necessary commissioning steps in the order that must be followed with the relevant section of instruction and the organisation (or their nominated agent) normally responsible:

Step	Operation	Safety Function	Instruction (see section)	Responsibility
1	Set direction to close, open/close seating actions torque values and open/close limit positions	1 & 2	4.2 Basic Commissioning - valve settings	Valvemaker/supplier
2	Verify valve operation	1&2	5.1 Valve setting validation	Valvemaker/supplier
3	Set indication	N/A	4.3 Secondary Commissioning – indication settings	End user
4	Safety function set up	1&2	4.4 General safety Function Commissioning	End user
5	Verify Stayput safety function operation	1	5.2 Safety Function validation	End user
6	ESD Safety Function commissioning	2	4.5 ESD Safety Function - learning setup	End user
7	Verify ESD safety function	2	5.2 Safety Function validation	End user

Table 7

Note:

The actuator is despatched with the ESD function set to "Stayput". This setting allows commissioning of basic settings to be undertaken. If the ESD function is subsequently set to Open or Close, the display will flash "Err" when "Local"

or "STOP" is selected and access to setup is prevented. To re-set the ESD function to "Stayput" and allow basic setting configuration refer to Section 4.6.

4.2 Basic Commissioning - valve settings

The following procedures must be followed in order. The entered settings must be set as specified by the valvemaker/supplier and/or the responsible design engineer.

The setting tool is provided to make settings. For instructions on its use refer to section 7.2 in E170E3 for IQ or E175E3 for IQT.

Entering the Actuator Setting Procedure

With the actuator securely mounted on the valve, the mains supply on and "STOP" control selected, using the supplied setting tool:

PRESS THE ↓ KEY.

The actuator upper display will remain the same and the lower display will change to Torque value. This will be represented by Torque = XX% and a bar graph.

PRESS THE ↓ KEY.

The actuator display will change and the password protection display will be seen.



The Actuator Function Settings can be protected by the Use of a Password

Setting Mode - Password

To enable setting and adjustment of the actuator functions the correct password must be entered. The factory set (default) password is [Id]. If the actuator has previously been set with a site password this must be entered.

Use the + or - keys to scroll through the available passwords 00–FF (hexadecimal).

With the correct password displayed,

PRESS THE ↵ KEY.

Two "setting" bars will appear and will remain visible on every function display screen. In addition, "Password Correct" will be displayed for 3 seconds.



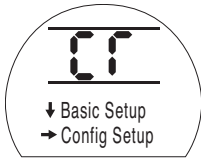
*Default Password,
Setting Mode Enabled*

PRESS THE ↓ KEY.

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The procedure branch **[Cr]** (crossroad) display can now be seen.



To access the Basic Settings **press the down arrow key.**

C1 Direction to Close

The actuator can be configured to be clockwise or anti-clockwise to close. Manually operate actuator and valve to establish correct closing direction.

Using the **+** or **-** key, display the character conforming to correct closing direction.



[C] in the Setting Field and **Clockwise** text indicating Clockwise to Close (Default)



[A] in the Setting Field and **Anticlockwise** indicating Anti-clockwise to Close

Having ensured that the display corresponds to the established closing direction

PRESS THE ↵ KEY.

The displayed option will flash (stored), indicating that it has been set.

PRESS THE → KEY.

C2 Close Action

The actuator can be configured to close on torque for seating valves and limit for non-seating valves.

Refer to valve manufacturer for recommended setting.

In the absence of valvemaker instructions refer to the following table:

Valve type	Close	Open
Wedge gate	"torque"	"limit"
Globe	"torque"	"limit"
Butterfly	"limit"	"limit"
Thru conduit	"limit"	"limit"
Ball	"limit"	"limit"
Plug	"limit"	"limit"
Sluice gate	"limit"	"limit"
Penstock	"limit"	"limit"
Parallel slide	"limit"	"limit"

Table 8

Using the **+** or **-** key, display the required option.



[CL] in the Setting Field indicating Close on Limit (default).



[Ct] in the Setting Field indicating Close on Torque.

Having selected the required option

PRESS THE ↵ KEY.

The displayed option will flash (stored), indicating that it has been set.

PRESS THE ↓ KEY.

NOTE: When set to close on torque, the actuator will apply the level of torque as set for **[tC]** in seating the valve

C3 Open Action

The actuator can be configured to open on torque for back seating valves or limit for non back seating valves.

Refer to valve manufacturer for recommended setting. In the absence of valvemaking instructions set "Open Limit".

Using the + or - key, display the required option.



[OL] in the Setting Field Indicating Open on Limit (default).



[Ot] in the Setting Field Indicating Open on Torque.

Having selected the required option

PRESS THE ← KEY.

The displayed option will flash (stored), indicating that it has been set.

PRESS THE ↓ KEY.

tC Close Torque

The value of torque available in the close direction can be configured.

Refer to valve manufacturer for recommended value.

The closing torque value can be varied between 40% and Rated (100%), in 1% increments.

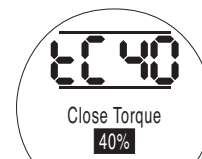
Using the + and - keys, display the recommended value. In the absence of a recommended torque value, try a low setting and increase until satisfactory valve operation is achieved.

If the actuator fails to complete a closed valve operation due to the set torque being reached, "Torque Trip CL" will be displayed. This may indicate a valve or process problem or change. It is the responsibility of the user to ensure the valve and process conditions are within specified operational limits before increasing the Set Close torque value.

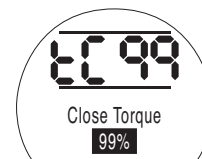
PRESS THE ← KEY.

The displayed value will flash (stored), indicating that it has been set. Should the set level of torque be developed in closing, the actuator will torque trip and stop.

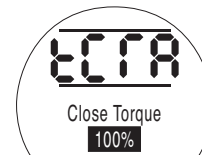
NOTE: Rated torque is quoted on the actuator nameplate.



40% of Rated Torque



99% of Rated Torque



Rated Torque

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tO Open Torque

The value of torque available in the open direction can be configured.

Refer to valve manufacturer for recommended value.

The opening torque value can be varied between 40% and Rated, in 1% increments. In addition "Boost" can be configured when no open torque protection is required.

BOOST SHOULD NOT BE SELECTED WHEN THE ACTUATOR HAS BEEN CONFIGURED TO OPEN ON TORQUE (refer to [C3]) UNLESS BACK SEATING AT RATED TORQUE IS ACCEPTABLE.

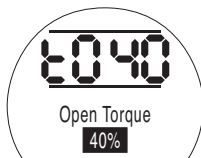
Using the + and - keys, display the recommended torque value. In the absence of a recommended torque value, try a low setting and increase until satisfactory valve operation is achieved.

If the actuator fails to complete an open valve operation due to the set torque being reached, "Torque Trip OP" will be displayed. This may indicate a valve or process problem or change. It is the responsibility of the user to ensure the valve and process conditions are within specified operational limits before increasing the Set Open torque value.

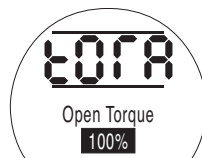
NOTE: Rated torque is quoted on the actuator nameplate. Boost torque is at least 140% of Rated torque.

PRESS THE  KEY.

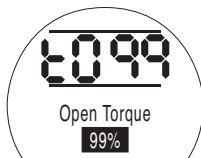
The displayed value will flash (stored), indicating that it has been set. Should the set level of torque be developed in opening, the actuator will torque trip and stop.



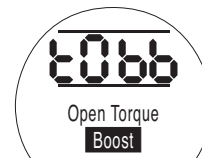
40%



Rated



99%



Boost

PRESS THE  KEY.

CL Close limit.

Using the handwheel move the actuator to the valve close position.

With [LC] displayed



Set Closed Limit

Move valve manually to the closed position. Allow for overrun by winding actuator output open by 1/2 to 1 turn.

PRESS THE  KEY.

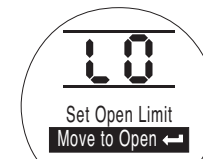
The two bars will flash (stored) and the closed indicator lamp will illuminate, indicating closed limit position has been set.

To check closed limit position hand wind valve open until the amber lamp illuminates. Wind the valve back closed until the closed lamp illuminates at the set limit position. Note that if the close action [C2] was set to "torque" [Ct], the actuator will seat the valve with the set close torque [tC] at a position past the set limit position.

OL Open limit.

NOTE: When in checking mode Set Limit Open [LO] does not appear.

With [LO] displayed



Set Open Limit

Move valve manually to the open position. Allow for overrun by winding actuator output closed by 1/2 to 1 turn.

PRESS THE  KEY.

The two bars will flash (stored) and the open indicator lamp will illuminate, indicating open limit position has been set.

PRESS THE  KEY.

The open symbol should now appear.

Return to positional display

Select Remote control using the red selector knob to exit setting procedure. If the procedure has been followed as described, the display will indicate open limit position (100%). Select "STOP" control.

4.3 Secondary Commissioning – indication settings

Note: Indication outputs S1 to S4, Monitor Relay and the CPT analogue position signal do not fall within the scope of the actuator reliability assessment. Users must ensure the integrity of indication meets the requirements of the SIL target for the SIS. If necessary, position indication should be derived from devices external to the actuator and driven directly from the valve obdurator.

Fault Status Relay

The SFCM option includes fault status relay indication. For safety function fault status indication refer to tables 5 and 6. Relay will de-energise and contacts break on indication of a fault condition. The status relay is not configurable. Refer to supplied actuator circuit diagram for connection details.

Monitor Relay

The monitor relay will indicate one or more of the following conditions:

- Loss of one or more of the power supply phases.
- Loss of control circuitry supply.
- Actuator selected for local control.
- Thermostat tripped.
- Local / Remote control pushbutton set to Local STOP.

The monitor relay is not configurable. Refer to supplied actuator circuit diagram for connection details.

Contacts S1-S4

The actuator has 4 configurable contacts, S1 to S4 available for indication, including open and closed position, limit indication and intermediate position indication (configurable). A full list of available functions is provided in publication E170E3.

Unless specified with order, contacts S1 to S4 will be set to the defaults shown below:

Contact	Function	Contact
S1 [r1]	[CL] – Closed Limit	[NO] - Normally open
S2 [r2]	[OP] – Open Limit	[NO] – Normally open
S3 [r3]	[CL] – Closed Limit	[NC] – Normally closed
S4 [r4]	[OP] – Open Limit	[NC] – Normally closed

Table 9

If fault coverage is required, the 4 configurable relays can be set to operate as follows:

- Close limit.
- Open limit.
- Centre column rotating (indicates when the actuator is moving).
- Torque switch tripped (indicates the actuator has torque tripped mid travel and failed to reach the limit position).

Option CPT

If the CPT option is fitted - refer to actuator circuit diagram, a 4-20mA loop powered signal is available for analogue position indication. The CPT must be powered from an external source with a nominal supply of 24VDC. On loss of main actuator power supply, the CPT output will default to 4mA regardless of actuator position.

SFCM option

IQ Pro - Option SFCM Actuator Safety Manual

4.4 General Safety Function Commissioning

The following procedures must be followed in order. **Mandatory settings are indicated and must not be changed. Configurable settings must be set as required for the SIS.**

The setting tool is provided to make settings. For instructions on its use refer to section 7.2 in E170E3 for IQ or E175E3 for IQT.

The following actuator control mode configuration functions must be set.

Note that "M" is a mandatory configuration. Functions marked "S" are configurable as required by the SIS safety function.

Code	Function	Configuration	Default	Mandatory / Selectable
A1	ESD Direction	Open, Close or Stayput	Stayput	S (M)*
A2	ESD Contact Type	NC (Normally closed)**	NC	M
A3	ESD override motor thermostat	Off	Off	M
A4	ESD override Interlocks	Off	Off	M
A5	ESD override local stop	Off	Off	M
A6	Local maintain	On / Off	On	S
A7	2-Wire control	Off	Off	M
A8	Interlocks	Off	Off	M
A9	Conditional Control	On	On	M
At	Torque switch bypass	On / Off	Off	S

Table 10

* For Safety Function 1 - Stayput operation only, A1 must be set to Stayput.

** Selecting A2 to be a normally closed contact (**NC**) without a signal input on terminal 25 (refer to circuit diagram) will cause the actuator to be in "ESD". If set to local or remote, the actuator will carry out the configured ESD function (open, close or Stayput). If the system ESD signal is not available, a temporary signal can be provided by linking actuator terminal 5 to 25 and terminal 4 to 31.

Entering the Actuator Setting Procedure

With the actuator securely mounted on the valve, the mains supply on and "STOP" control selected, using the supplied setting tool:

PRESS THE ↓ KEY.

The actuator upper display will remain the same and the lower display will change to Torque value. This will be represented by Torque = XX% and a bar graph.

PRESS THE ↓ KEY.

The actuator display will change and the password protection display will be seen.



The Actuator Function Settings can be protected by the Use of a Password

Setting Mode – Password

To enable setting and adjustment of the actuator functions the correct password must be entered. The factory set (default) password is **[1d]**. If the actuator has previously been set with a site password this must be entered.

Use the **+** or **-** keys to scroll through the available passwords 00–FF (hexadecimal).

With the correct password displayed,

PRESS THE ↵ KEY.

Two “setting” bars will appear and will remain visible on every function display screen. In addition, “Password Correct” will be displayed for 3 seconds.



*Default Password,
Setting Mode Enabled*

PRESS THE ↓ KEY.

The procedure branch **[Cr]** (crossroad) display can now be seen.



To access the Secondary Settings **PRESS THE → KEY.**

The set up screen for contact S1 [r1] will be displayed:



PRESS THE ↓ KEY 4 times to display A1.

A1 ESD action



An active ESD signal applied to the actuator will override any existing or applied local or remote control signal. The default action under an active ESD signal is to stay put **[SP] Stay Put**.

⚠ For safety function 1 – Stayput operation only , A1 must be set [SP] Stay Put.

⚠ It is essential that the ESD “set” action for [A1] (refer to 4.5) and the “learnt” action are the same (Open, Close or Stayput) and meet the SIS safety function for ESD. Failure to do so will result in error alarms during an ESD action.

⚠ For safety function 2 – ESD or combined safety function 1 & 2, A1 must be configured for the ESD action required for the SIS:

Press the **+** or **-** key to select the required ESD action:

[CL] Close on ESD

[SP] Stay Put on ESD

[OP] Open on ESD

[OF] Off ESD function disabled.

PRESS THE ↵ KEY.

The displayed option will flash (stored) indicating that it has been set.

A2 ESD Contact Type

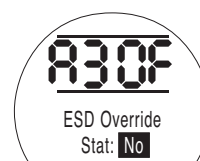


The default setting for ESD Contact Type is **[nC] Normally Closed**. The ESD signal must be removed to activate ESD.

THIS IS A MANDATORY SETTING AND MUST NOT BE CHANGED

PRESS THE → KEY.

A3 ESD Override Thermostat



The default setting for ESD Override Thermostat is **[OF] No** during ESD.

The motor thermostats remain in circuit and enabled during ESD.

THIS IS A MANDATORY SETTING AND MUST NOT BE CHANGED

PRESS THE → KEY.

SFCM option

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A4 ESD Override Interlocks



The default setting for ESD Override Interlocks is **[OF] No**. ESD action will not override an active interlock applied to the actuator.

THIS IS A MANDATORY SETTING AND MUST NOT BE CHANGED

PRESS THE → KEY.

A5 ESD Override Local Stop



The default setting for ESD Override Interlocks is **[OF] No**. ESD action will not override local STOP applied to the actuator.

THIS IS A MANDATORY SETTING AND MUST NOT BE CHANGED

PRESS THE → KEY.

A6 Maintain Local Control



The default setting for Local Actuator Pushbutton control is self-maintained **[On] Yes**. If non-maintained actuator pushbutton control is required (jogging, inching, push to run), press the + or - key. The display will change to **[OF] No**.

PRESS THE ← KEY.

The displayed option will flash (stored) indicating that it has been set.

PRESS THE → KEY.

A7 2-Wire Remote Priority

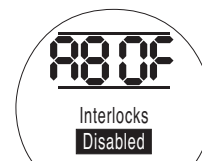


The default setting for 2-wire Remote Priority is **[SP] Stay Put**. If an open and closed remote control signal are applied simultaneously the actuator will stay put (stop if running).

THIS IS A MANDATORY SETTING AND MUST NOT BE CHANGED

PRESS THE → KEY.

A8 Interlocks



The default setting for interlocks is **[Of] Disabled**.

THIS IS A MANDATORY SETTING AND MUST NOT BE CHANGED

PRESS THE → KEY.

A9 Conditional Control

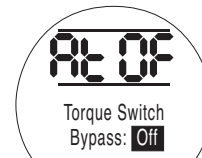


The default setting for conditional control is **[ON] Enabled**.

THIS IS A MANDATORY SETTING AND MUST NOT BE CHANGED

PRESS THE → KEY.

At Torque Switch Bypass



The default setting for Torque Switch Bypass is **[OF] Off**, the torque switches are not bypassed during the unseating movement. To bypass the torque switches during the unseating movement press the + or - key. The display will change to **[On]**.

PRESS THE ← KEY.

The displayed option will flash (stored) indicating that it has been set. The torque switches will be bypassed from closed limit to 5% open when opening and from open limit to 95% when closing. Bypassing the torque switches makes torque in excess of rated and up to actuator stall available for unseating a "sticky" valve. Outside these positions the torque setting will revert to the values set for **[tc] Close Torque** and **[to] Open Torque**.

Return to positional display.

Select Remote control momentarily, using the red selector knob to exit setting procedure and then select Stop control. The display will indicate the current actuator position.

4.5 ESD Safety Function Commissioning

For applications requiring actuator safety function 2 – ESD to open or to close, the SFCM must “learn” the required ESD action for the valve stroke with the applied phase rotation. This is to ensure that if the standard actuator control fails, the SFCM can take over, by-passing standard control to ensure that the ESD action takes place. The learning process for the required ESD action is achieved by replicating the ESD action using local control when in commissioning mode. If ESD is required to Stayput, this action must also be included in the learning process. The steps laid out in sections 4.2, 4.3 and 4.4 must be completed before safety function commissioning takes place.

⚠ It is essential that the ESD “set” action for [A1] (refer to 4.4) and the “learnt” action are the same (open, close or Stayput) and meet the SIS safety function for ESD. Failure to do so will result in error alarms during an ESD action.

The following steps must be carried out in order:

1. Select Local using the red selector knob.
2. Power up the actuator - the actuator display will flash “Err”.



Local control selected – the display flashes Err

3. For ESD to open or to close, in local control, move actuator to opposite end of travel to that required for ESD:

ESD safety function to close - move actuator to the open position

ESD safety function to open - move actuator to the close position

For ESD safety function to Stayput – do not move.

4. To enter ESD commissioning mode, turn the red selector knob between “Local” and “Stop” following the sequence:

Local → Stop → Local → Stop → Local → Stop → Local

No more than 5 seconds must elapse between each state in the sequence, otherwise the sequence must be restarted.

When commissioning mode is entered, the display will indicate “Init”.



Commissioning mode initialised

Commissioning mode will remain initialised for 30 seconds if there is no operation and for 30 seconds after operation stops. The Module stays in commissioning mode until either the actuator is put in Remote, or the actuator is not moved for 30 seconds.

The fault relay output signal is set when the actuator is in commissioning mode.

5. Within 30 seconds of initialising commissioning mode, in local control, run actuator to the required ESD position in one continuous operation until it stops at the set limit position. If ESD Stayput is required, do **NOT** move the actuator.
6. Escape from commissioning mode by selecting “Remote” on the red selector knob or by waiting for 30 seconds after movement has ceased. Actuator display will stop flashing “Init”.

⚠ WARNING – If commissioning mode is initialised but no movement takes place before commissioning mode times out, ESD will be set to Stayput.

⚠ WARNING – If the actuator is electrically disconnected from the power supply, the ESD learning mode procedure must be carried out when reconnection takes place.

⚠ WARNING – If the actuator is mechanically removed from the valve, the ESD learning mode procedure must be carried out when it is replaced.

4.6 Setting ESD safety function to Stayput allowing other actuator settings to be adjusted.

The actuator has to be set for ESD safety function "Stayput" to allow access to configurable settings using the setting tool.

The following steps must be carried out in order:

1. Select Local using the red selector knob.
2. Power up the actuator - the actuator display will flash "Err".



Local control selected – the display flashes Err

3. To enter ESD commissioning mode, turn the red selector knob between "Local" and "Stop" following the sequence:

Local → Stop → Local → Stop → Local → Stop → Local

No more than 5 seconds must elapse between each state in the sequence, otherwise the sequence must be restarted.

When commissioning mode is entered the display will indicate "Init"



Commissioning mode initialised

4. DO NOT MOVE THE ACTUATOR. The Module stays in commissioning mode until either the actuator is put in Remote or the actuator is not moved for 30 seconds.
5. Escape from commissioning mode by selecting "Remote" on the red selector knob or by waiting for 30 seconds.

Actuator display will stop flashing "Init".

The actuator is now set to ESD Stayput and commissioning/ adjustment of settings can now take place. Refer to Section 4.1.

⚠ WARNING – If ESD is required to open or to close, the ESD safety function must be re-commissioned on completion of other adjustments. Refer to Section 4.5

4.7 Control Option Availability and Settings

For IQ and IQT actuators fitted with the SFCM option, control options Interrupter Timer, Folomatic, Pakscan, Profibus, Foundation Fieldbus, DeviceNet and Modbus are not permitted. In addition, control option IR Setting Tool Control [Or] must be selected OFF. The default setting for [Or] is [OF] – Disabled.

Protection option Power Loss Inhibit [OS] may be selected on or off as required. The default setting for [OS] is [OF] – Disabled.

Option Extra Indication relays is not permitted with actuators fitted with the SFCM option.

4.8 Default Configuration

All IQ and IQT functions are configured to a set of Rotork default (standard) settings before despatch. When the SFCM option is fitted, the default settings will be as shown in table 11. When requested, alternative settings specified with the order will be used.

When site commissioning takes place, entered settings overwrite Rotork defaults and these "current" settings are used for operation along with the remaining unadjusted defaults.

Should difficulty be encountered during commissioning, the default settings can be reinstated, returning the actuator configuration to its original manufactured state. Site commissioning must then begin again.

There are two levels of default:

- d1 Rotork standard or customer specified Basic and Configuration Settings.**
- d2 Limit positions only – factory set limits.**

If d1 is entered, all Basic and Configuration Settings except limit positions will return to their default setting. See table 11. Basic settings (except limits) and Configuration Settings must then be checked and reset as required. The actuator must now be completely re-commissioned. Refer to section 4.

If d2 is entered, the limits will be reset with the actuator positioned at 50%. Limits must then be set to the suit the valve. The actuator must now be completely re-commissioned. Refer to section 4.

Rotork standard [d1] Default settings for IQ fitted with SFCM option:

- [P?]** Password Unaffected – will remain as set
- [Ir]** IrDA – Insight [On] IrDA Enabled

The Rotork standard default settings are subject to change without notice.

To reinstate [d1] settings, with [d1] displayed.

PRESS THE  KEY.

The setting bars will flash, indicating the [d1] default settings have been reinstated.

The actuator must now be completely re-commissioned. Refer to section 4.

To reinstate factory set limits (actuator positioned at 50%) with [d2] displayed,

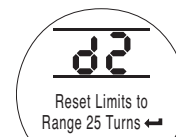
PRESS THE  KEY.

The setting bars will flash, indicating the [d2] default limits have been reinstated.

The actuator must now be completely re-commissioned. Refer to section 4.



[d1] displayed



[d2] displayed

Basic Settings		
Function	IQ [d1] Default setting	IQT [d1]Default setting
[C1] Close Direction	[C] Clockwise	[C] Clockwise
[C2] Close Action	[Cl] Close on Limit	[Ct] Close on torque
[C3] Open Action	[Cl] Open on Limit	[Ct] Open on torque
[tC] Close Torque	[40] 40% of rated	[40] 40% of rated
[tO] Open Torque	[40] 40% of rated	[40] 40% of rated
Configuration Settings		
Function	IQ [d1] Default setting	IQT [d1]Default setting
[r1] Indication Contact S1	[Cl]/[nO] Close, Normally Open	[Cl]/[nO] Close, Normally Open
[r2] Indication Contact S2	[OP]/[nO] Open, Normally Open	[OP]/[nO] Open, Normally Open
[r3] Indication Contact S3	[Cl]/[nC] Close, Normally Closed	[Cl]/[nC] Close, Normally Closed
[r4] Indication Contact S4	[OP]/[nO] Open, Normally Closed	[OP]/[nO] Open, Normally Closed
[A1] ESD Action	[SP] Stay put on ESD	[SP] Stay put on ESD
[A2] ESD Contact Type	[nC] Normally Closed (Break for ESD)	[nC] Normally Closed (Break for ESD)
[A3] ESD Thermostat Override	[OF] Thermostats Active during ESD	[OF] Thermostats Active during ESD
[A4] ESD Override Interlocks	[OF] Interlocks Active during ESD	[OF] Interlocks Active during ESD
[A5] ESD Override Local Stop	[OF] Local Stop Active during ESD	[OF] Local Stop Active during ESD
[A6] Maintained Local Control	[On] Maintains in Local Control	[On] Maintains in Local Control
[A7] 2-wire Remote Control	[SP] Stay Put on 2-wire signal	[SP] Stay Put on 2-wire signal
[A8] Interlocks	[OF] I/L function disabled	[OF] I/L function disabled
[A9] Conditional Control	[ON] Function Enabled	[ON] Function Enabled
[At] Torque Switch Bypass	[OF] Function disabled	[OF] Function disabled
[OE] Option Extra Indication Contacts	[OF] Function disabled	[OF] Function disabled
[OI] Option CPT	[HI] 4mA at Closed	[HI] 4mA at Closed
[Od] Remote Source	[rE] Standard control	[rE] Standard control
[OJ] Option Interrupter Timer	[OF] Function disabled	[OF] Function disabled
[Or] Setting Tool Local Control	[OF] Setting Tool Control disabled	[OF] Setting Tool Control disabled
[OS] Power Loss Inhibit	[OF] Protection off	[OF] Protection off

Table 11



5. Verification

It is important that actuator operation is verified to ensure the required safety function is achieved. In order to confirm actuator operation with the valve working under design conditions, it is desirable that the process is live during verification. Remote open/close and/or ESD control circuits should be wired and available. Refer to drawing RWS320 supplied with the actuator.

The IQ Pro actuator includes a datalogger which records operational torque reference profiles for analysis of valve performance. Refer to E170E3/E175E3 section 11.

5.1 Valve setting verification

- 1 Power up the actuator and select local control. The display will indicate "Err".
- 2 Operate the actuator in both open and close directions. Ensure the actuator operates the valve fully to each end of travel and the valve is positioned or seats correctly with the set action (torque or limit). If necessary, adjust basic settings, refer to Section 4.2.

Torque profiles may be downloaded for analysis of actuator torque switch settings against operating torque requirements, refer to E170E3/E175E3 section 11.

5.2 Safety function 1 - Stayput verification.

Power up the actuator. Set the control selection to Remote and apply remote signals as indicated in following table to validate that the actuator will Stayput unless the correct control selection is made and 2 valid signals are applied:

Control Selection	Command signal applied	Interlock signal applied	Display/fault Relay Indication	Operation	Valid
Local	No	No	Err/Fault	No	✓
Stop	No	No	Err/Fault	No	✓
Remote	No	No	Position/OK	No	✓
Remote	Open (35)	No	Err/Fault	No	✓
Remote	Open (35)	Open (37)	Position/OK	Opens	✓
Remote	No	Open (37)	Err/Fault	Stops - No	✓
Remote	Close (33)	No	Err/Fault	No	✓
Remote	Close (33)	Close (38)	Position/OK	Closes	✓
Remote	No	Close (38)	Err/Fault	Stops - No	✓

Table 12

Check the display and relays status conforms to the table. Failure to perform or indicate as shown in the table indicates an error in the commissioning procedure. The control signals status or control selection and must be corrected.

5.3 Safety function 2 - ESD setting verification.

Set the control selection and apply remote signals, as indicated in following table, to confirm that the actuator will perform the set ESD action (open, close or Stayput) when the ESD signal is active and local or remote is selected:

Control Selection	ESD Command signal	Display/fault Relay	Operation	Valid
Local	No	Err/Fault	No	✓
Stop	No	Err/Fault	No	✓
Local	ESD active	Err – ESD Active /Fault	ESD	✓
Stop	ESD active	Err – ESD active/Fault	No	✓
Remote	ESD active	Position – ESD active/OK	ESD	✓

Table 13

Check the display and relays status conforms to the table. Failure to perform or indicate as shown in the table indicates a problem in the commissioning procedure. The control signals status or control selection and must be corrected.

5.4 Proof testing – Safety Function 2 – ESD

To meet TUV certification requirements for low demand ESD safety function 2, full operational proof testing must be carried out at least once per year.

The IQ Pro actuator includes a datalogger which records operational torque reference profiles for analysis of valve performance. Proof test torque profiles may be downloaded for analysis of operating torque requirements, refer to E170E3/ E175E3 section 11.

5.4.1 Safety Function 2 – Proof Testing ESD – Open or Close

1. Move actuator to opposite position to that required for ESD. Select remote control.

Apply system ESD. Actuator will move to ESD position.
Remove system ESD.

2. Move actuator to opposite position to that required for ESD.

Engage handwheel drive by depressing Hand/Auto Lever and hold engaged position using a pin in the padlock hole.

Apply system ESD. Actuator will run for approximately 3 seconds longer than the full stroke time. The actuator will then stop and display "Err".

Remove system ESD and remove pin holding lever so it returns to the neutral position. Run the actuator electrically to ensure it returns to motor drive.

5.4.2 Safety Function – Proof testing ESD – Stayput

With Remote control selected, apply valid remote open or closed signals. The actuator will move in the applied signal direction. While moving, apply ESD (remote ESD contact breaks). The actuator should stop without displaying error or status relay fault.

6 Operation

IQ and IQT operation are generally described in publications E170E3 and E175E3.

When operating as part of the SIS, the actuator must be operated only by remote control and therefore must be selected and locked in "remote". Handwheel operation must also be prevented. Padlocks with a 6mm / ¼" hasp should be used to padlock the red knob in the "Remote" position (fig 3) and the Hand–Auto lever in the neutral "up" position. These settings should be subject to the site operational procedures such as "permit to work".

⚠ WARNING If during commissioning, maintenance or testing the actuator is operated by the handwheel it is vital that it is returned to motor drive before the actuator is put back into operational service. To do this, the actuator must be operated electrically and electrical operation verified by checking output movement. The Hand-Auto lever must then be padlocked in the neutral "up" position.

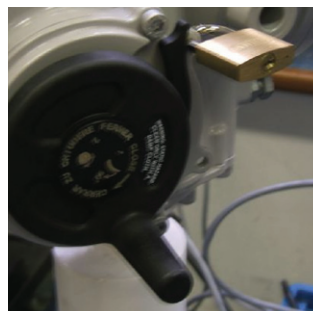


Fig 1
IQT hand-auto lever
padlocked



Fig 2
IQ hand-auto lever
padlocked



Fig 3
IQ/IQT control selector padlocked in "Remote"

7. Maintenance

Refer also to publication E170E3 (IQ) or E175E3 (IQT) for essential health and safety information.

When maintenance is to be carried out, on or around an actuator, it is essential that the actuator is electrically isolated to prevent unwanted operation.

Additional maintenance activities for safety related duty:

Check the actuator oil level once per year. Refer to publication E170E3 (IQ) or E175E3 (IQT).

⚠ WARNING Isolate the actuator power supply before any work is carried out on the actuator, valve or associated system equipment or processes.

⚠ WARNING The actuator may operate without warning and regardless of remote signal status.

⚠ WARNING The actuator is designed to perform the set safety function (open, Stayput or close) under system ESD conditions or when an actuator or control system fault is detected.

8 TÜV Certificate

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証証書 ◆ CERTIFICADO ◆ CERTIFICAT



CERTIFICATE

No. Z10 07 09 64590 001

Holder of Certificate: Rotork Controls Limited
Brassmill Lane
Bath
BA1 3JQ
UNITED KINGDOM

Factory(ies): 64590

Certification Mark:



Product: Actuators

Model(s): IQ2 Pro

Parameters:
Drive:
220VAC bis 690VAC, 50Hz
208VAC bis 600VAC, 60Hz
Power supply:
110 bis 240VDC
110 bis 230VAC
SIL Level:
1oo1 configuration: SIL 2
1oo2 configuration: SIL 3

Tested according to: IEC 61508:2000
IEC 61511:2004, parts 1 to 3
IEC 61010-1:2001
EN 61326-1/A3:2003

The listed product was tested on a voluntary basis and complies with the relating standards or directives. The certification mark shown above can be affixed on the product. The certification mark must not be altered in any way. See also notes overleaf.

Test report no.: 717501028

Date, 2007-10-02

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SFCM option

IQ Pro - Option SFCM Actuator Safety Manual

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