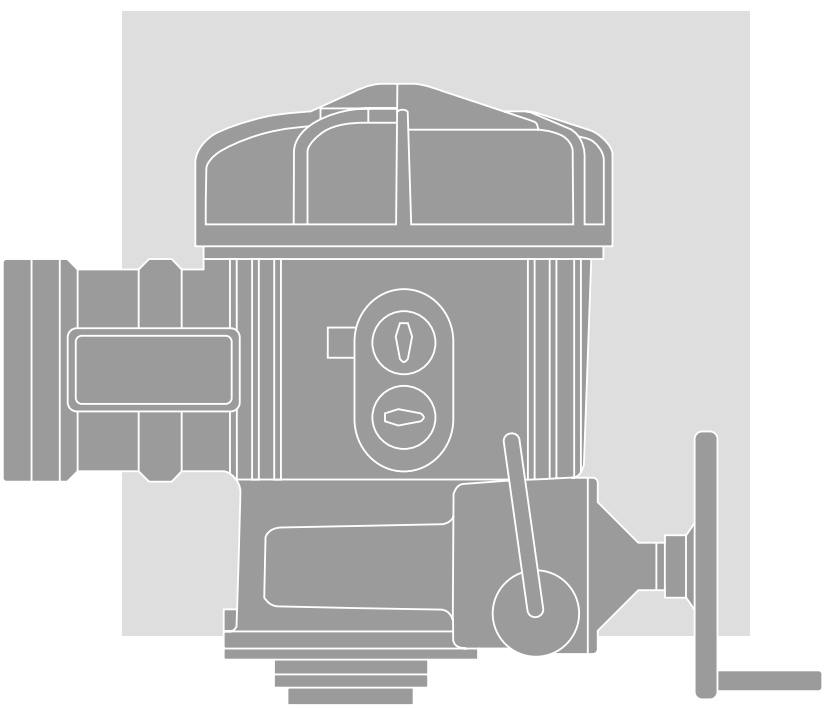
rotork

THE 'AQ' RANGE

ELECTRICAL SPECIFICATIONS CONTROL SYSTEMS AND POSITION INDICATION OPTIONS



Publication E520E issue 7/02

FEATURES OF THE 'AQ' RANGE

Standard Features

The Rotork AQ series of part turn actuators provides an integral control system in a double sealed, IP68 (NEMA 6) watertight electrical enclosure.

Power supplies

The AQ actuator can be operated by any standard specified single or three phase AC supply. Models can also be supplied to operate from a 24 volts DC supply.

All the above voltages are subject to a ± 10% tolerance. The motor is S2 rated for a 20% duty cycle according to IEC 34.2. with up to 30 starts per hour.

For fully modulating applications requiring up to 1200 starts/hour, a fixed output speed version designated the AQM is available.

AQ actuators fitted with folomatic control may be used for applications requiring up to 1200 starts/hour over their standard output speed range.

Local push button station

The pushbutton station consists of a rotary control button (open/close) and a lockable 3 position selector (local/stop/remote). The buttons are integrally mounted on the side of the main casting.

Valve travel limitation

The actuator is designed to 'torque off' against it's own mechanical stops to provide end of travel limit. Because these stops are externally adjustable it is possible to set the end of travel limits travel for control purposes without removing the electrical covers.

Auxiliary limit switches

The basic actuator is fitted with one open and one close auxiliary limit switch for indication purposes. These switches are single pole changeover type and connect to three terminals.

Local valve position indication

Local continuous dial indication of valve position. Illuminated green - closed, white - intermediate, red - open.

Protection Facilities

Direction corrector circuit

The DCC ensures that the motor turns in the correct direction irrespective of the polarity of the supply connected to the power terminals. Thus the actuator will always run in the direction signalled. Valves and system will suffer no damage due to incorrect power connection. This effect is the equivalent to the 'Syncrophase' feature in the 1600 Series 'A' Range multi-turn actuators and is inherent in all AQ models -3 phase, 1 phase. (DC actuators will not operate unless polarity of supply is correct).

Single phasing protection (3 phase models)

On 3 phase models, motor overheating due to one phase being de-energized is avoided entirely. Only two of the three phases are connected to the internal circuit. Provision is made to terminate the third phase.

Anti-hammer protection

Torque switch hammer, which is often a problem in the presence of a continuous control signal, is prevented from occurring, even in mid-travel. The tripping of the torque sensor triggers a circuit to inhibit re-energization of the motor in the same direction until the opposite signal has been applied.

Instantaneous reversal protection

An automatic soft start circuit limits the current surges when an actuator is signalled to reverse its direction instantaneously. This facility removes shock loads which would otherwise cause unnecessary wear to actuator/valve couplings.

Opto-isolators

These are incorporated to interface with remote control inputs. They protect the logic circuits from high voltage transients which may appear at the actuator terminals. The current drawn by the actuator circuits from each externally fed control signal is approximately 5mA at 24 volts and will be in proportion at other voltages.

Motor transformer thermostat

This disconnects the control circuit if the maximum permitted winding temperature is reached. This protection is independent of ambient temperature variation and motor currents. This provides optimum usage of motor thermal capacity.

Monitor relay

The monitor relay provides an alarm signal to indicate the operational status of the actuator.

Standard control options

The control facilities of the actuator provide a considerable increase in the versatility of the basic Syncropak concept. The use of an opto-isolator interface gives the advantage of low current requirement with the resulting benefit of small cable size.

Remote control internal 24v DC supply

Remote control from pulsed signals should have a minimum pulse length of 1.5 secs. For remote control using the actuator self maintaining facility, the signal should have a minimum duration of 300 mS to ensure actuator response. The guaranteed time for the maximum signal which will be ignored is 5 mS.

Control Signal Threshold Voltages to be a minimum for 'ON' 17V DC -20V AC, maximum for 'OFF' 3V.

A 24V DC supply for remote control is built into the actuator, simplifying long-distance control. Logic circuits present only light current switching requirements so voltage drop and induction problems over long control lines are virtually eliminated. See page 8 for recommended connections. Maximum external load to be taken from terminals 4 and 5 = 2.4W.

Remote control from any normal external AC or DC supply

Externally powered remote control from any of the following voltages without the need for interposing relay and without prior specification: 20V -120V AC or DC.

Positive or negative switching

Actuators can be supplied suitable for either positive or negative switching. Unless otherwise specified actuators will be supplied for positive switching.

Speed control

On standard AQ actuators an integral potentiometer is provided to set the desired operating time. The AQM actuator has a fixed output speed. See publication E510E for performance details.

Emergency shutdown

A terminal is provided for connection of a remote ESD signal. This will override any existing command, other than a local stop, regardless of the actuator being switched to local or remote. The actuator can be supplied either for opening or closing on ESD signal. The signal must 'make' on ESD and be self maintained. If required it is possible to bypass the motor transformer thermostat.

Optional extras

End of travel limit switches (control)

One open and one close limit switch may be fitted and used to control the limits of valve travel if desired. These switches should be set to trip after any auxiliary switches that may be fitted and are directly connected to the control circuit PCB.

Independent auxiliary limit switches

Four independently adjustable limit switches may be fitted. Each switch is independently adjustable to any valve position.

Folomatic controller

The Folomatic enables standard AQ actuators to control the position of a valve in proportion to an analogue current or voltage signal.

A voltage derived from the actuator position sensor is electronically compared with a voltage proportional to the input signal. The difference between them (error) triggers the open or close contactor via logic circuits to drive the actuator in the direction which will cancel the error. Valve position is therefore automatically adjusted in proportion to analog signal. Unnecessarily frequent switching is prevented by the Motion Inhibit feature.

To facilitate fast response without the tendency to overshoot signalled position a sophisticated control algorithm is utilised. The actuator's speed automatically decreases as the signalled position is approached.

For small errors the actuator moves slowly whilst for large errors the valve speed is increased.

The folomatic circuit board is mounted in the main electrical housing.

For applications requiring Folomatic on 24V DC powered actuators, apply to Rotork.

Application

Reversing motor-driven electro-mechanical actuators are suitable for proportional control in automatic control loops in which the system rate of change is relatively slow, and high accuracy continuous modulation is not essential; level controls in water and sewage treatment plants are typical applications. Motor operated regulating valves are driven through wormgear mechanisms which must be self-locking and are therefore mechanically inefficient. Frequent operation will cause rapid wear of these components. The control systems should therefore be designed to avoid this.

The Folomatic can be configured to suit the following

Signals	0-5mA	or	0-5V
(with live or dead zero)	0-10mA	or	0-10V
	0-20mA	or	0-20V

Potentiometer: Between 0.5k and 1Ok ohm, fed from Folomatic control unit at 7V.

As standard, the Folomatic is arranged for closing on minimum signal with clockwise output of the actuator for closing of the valve. If specified opening on minimum signal can be arranged.

Position corresponding to low input signal:	Closed limit. or percentage Open, or Open limit.
Position corresponding to high input signal:	Closed limit, or percentage Open, or Open limit.
Deadband:	0-9.9% of travel between Open and Closed limit positions.
Motion Inhibit time:	2-25 secs. between actuator movements
Action on loss of input signal (current and voltage only and with live zero only);	Stay-put, or move to high signal position or move to low signal position.

Motion inhibitor

This digital sub-circuit incorporates an electronic timer which disallows further movement for a set time once the actuator has reached a rest position.

Accuracy

The Folomatic positioner accuracy is 1%. Because of the inevitable backlash in industrial valves, particularly as wear develops; absolute accuracy cannot be high, particularly where a large deadband has to be set.

Deadband

Adjustable from 1% to 12.5% approx.

Input resolution

The maximum signal change required to cause response in the same direction (i.e. not through deadband) is 1%.

Position feedback

Actuator position feedback to the Folomatic unit is derived from a 5k ohm potentiometer housed in the switch mechanism compartment. For a continuous remote position indication, an additional potentiometer is required. Apply to Rotork giving supply details.

Connections

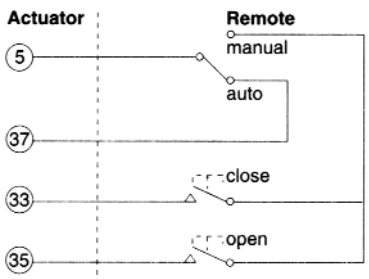
The Folomatic modules are internally wired to the actuator circuits.

Terminals are provided for customer's signal connections as follows:

Analog signal to terminals 12 (+ve) and 9 (-ve) or for potentiometer 9 and 18 with wiper to 12. (Select 'Open/Close' priority DIL switches on main PCB to obtain required failure mode on loss of signal).

Manual/auto selection

Facilities are provided for connecting in a remotely mounted manual/auto selector switch transfer control from the Folomatic to the customer's open and close pushbutton contacts; if required. Typical connections for actuators wired to standard Rotork diagrams are shown below assuming remote controls fed from actuator control supply.



Note: remove link 5-37

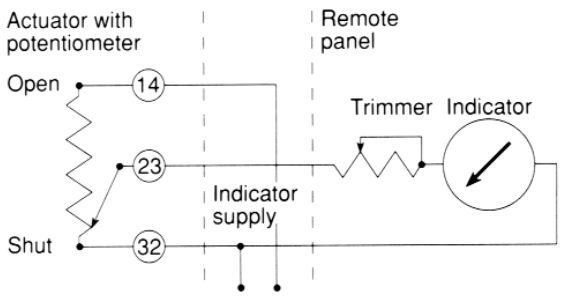
Two speed operation

This feature may be added to the main circuit board to slow the final portion of closure to one quarter of the maximum opening and closing speed. This facilitates rapid closing of valves whilst reducing the possibility of hydraulic shock within the pipework system. The independent auxiliary limit switch assembly option must also be fitted.

Potentiometric position transmitter

A potentiometer, gear driven from the actuator output, provides the simplest and most economical method of transmitting an analogue electrical signal for remote valve position indication and may be connected directly to a voltmeter-type position indicating instrument (see section on CPT for Current Signals).

For analogue voltage signal applications, unstabilised AC or DC supplies may normally be used. Scale adjustment must be possible to allow for voltage drop. The scale adjustment should allow for anything between 75% and 100% of full travel of the potentiometer to correspond with 100% valve travel. It is therefore important that full scale deflection of a voltmeter should not be 100% of supply voltage but 75% of it, the trimming resistor catering for the remainder. The trimmer should be located adjacent to the indicator for ease of scale setting; it is not provided as part of the actuator.



Standard potentiometer rated at 1 watt with resistance values of 5k or 25k ohms for a maximum voltage of 50V or 125V respectively.

Current position transmitter

An electronic transducer mounted in the main electrical compartment provides a 4-20mA analogue position indication signal. This is fed from the internal 24 volts DC supply.

Zero and span adjustments are provided over the following ranges:

Zero: 3.22 - 5.5mA.
Span: 17.7 - 34.34mA.

The maximum total external impedance must not exceed 200 ohms.

Pak-scan

The field unit for Pak-scan, the Rotork two wire control system, is mounted on the main circuit board assembly, inside the main electrical compartment. The Pak-scan facility can be provided without increasing the overall size of the actuator. (See publication S110E).

Failsafe battery pack

The failsafe battery pack is housed in a bolt-on weatherproof (IP55) enclosure containing a rechargeable battery, charging unit and control and protection circuits. (See publication E510E for general details).

Upon mains failure, battery powered operation is enabled and an internal pre-set selector enables one of the following responses to be chosen:

Fail Closed
Fail Open

Stay-put, to await a local or externally fed remote signal to close or to open. Refer to Rotork if internally fed remote control on mains failure is required.

Notes :

a. Battery supply is automatically disconnected 30 minutes after power failure.
b. If Folomatic is fitted, this will cease to function during the loss of AC power.
c. If CPT is fitted, this will continue to give output of valve position until battery supply is disconnected.

Mains failure indication

On mains failure the 24V DC supply normally available at actuator terminals 4 and 5 is lost and this could therefore be used as the basis for indication of mains failure. Alternatively, where the actuator has been selected for Fail Open or Fail Close on loss of AC power, the monitor relay will de-energise and the relay contact can be used to give an alarm signal.

Charger

The integral battery charger unit provides three levels of charge dependent on the battery condition and these are indicated by different colours of a lamp:

Boost: Constant 500mA, red lamp.

Intermediate: nominal 35V, amber lamp

Float: nominal 33V, green lamp
Battery disconnected: lamp off

Typical recharge times are as follows:
Following complete discharge: 4 hours
After 1 operation (AQ860) : 1 hour

Battery

28V, 2.5 A.h sealed lead acid.
Float life: 8 years at 20°C, 3 years at 40°C
Storage life: 1 year at 20°C

'AQ' RANGE CONTROLS CONSTRUCTION

The three phase or single phase supply is transformed and rectified. (If a 24V DC supply is used, it by-passes the transformer but goes into the DC power supply unit to ensure protection against reverse polarity).

The internally generated DC is then fed to the motor via two reversing relays which decide the direction of rotation of the motor and provide electrical braking when the circuit is interrupted, hence greatly reducing overrun.

The switching transistor is a power transistor switching at high frequency. The ratio of transistor 'on' to 'off' time will regulate the voltage to the motor. This ratio is monitored by the speed controller which takes into consideration the load applied to the motor, the speed required and the supply voltage. The speed controller consists of a state of the art laser trimmed thick film hybrid circuit.

Speed measurement is obtained by switching off the transistor, allowing the motor to free-wheel, and then measuring the generated voltage (principle of a tacho meter).

The current is sensed and used for the torque measurement.

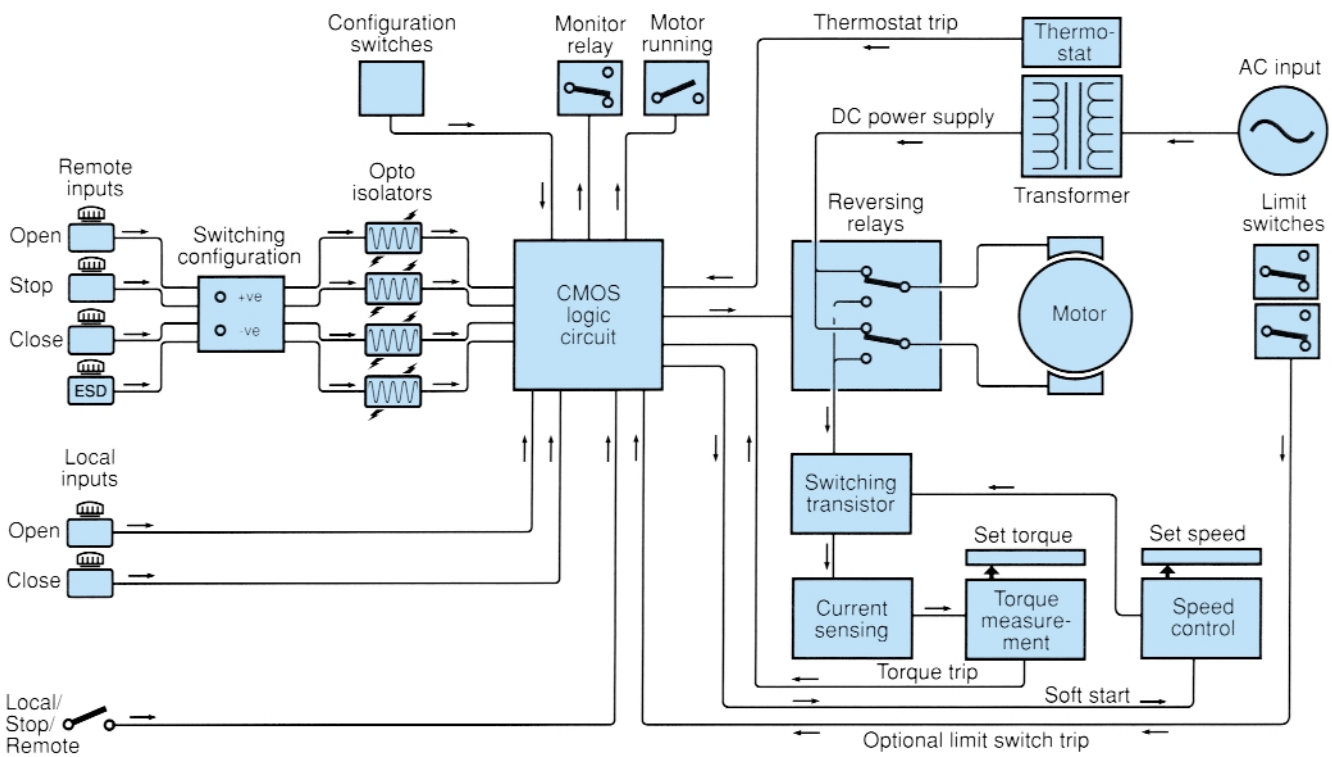
An application specific integrated circuit controls practically all functions. It receives and transmits the orders to open or close from the local or remote pushbutton station to the appropriate reversing relay. It receives and transmits the orders to stop from the limit switches, torque trip device, thermostat, or from the local or remote controls.

It also controls the soft-start of the motor by first closing the appropriate relay before allowing the current into the motor, so increasing the life of the relay and letting the current rise progressively to avoid a high surge.

In the event of a valve blockage, a further protection circuit ensures that the valve must first be electrically reversed away from the obstruction, minimising any further damage.

A time delay prevents the torque trip functioning during the initial stage so as to permit acceleration of the motor .

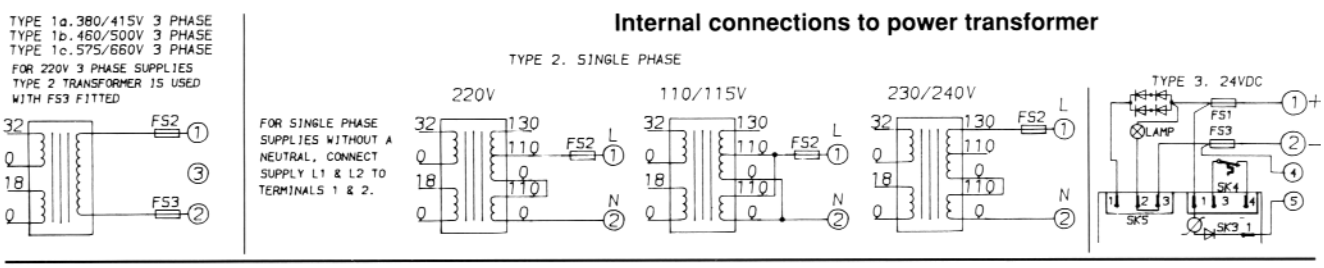
Finally, it gives indication of status; availability through monitor relay; motor running or not running through the auxiliary relay. This indication, combined with the auxiliary limit switches, will enable complete remote supervision.

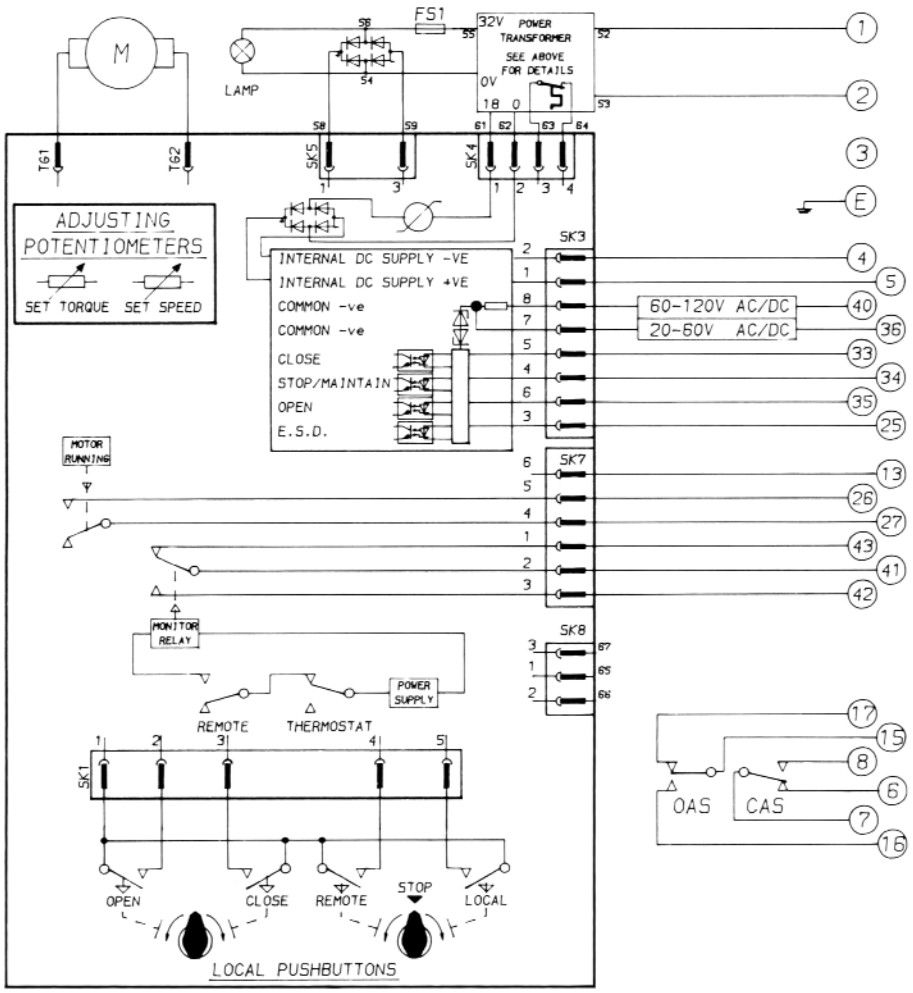


ACTUATOR CONTROL CIRCUITS

Wiring diagram QP20P00

Circuit is drawn for a valve in the fully closed position.





OAS - Open auxilliary switch
CAS - Close auxilliary switch

FS1 90mm long motor 10A
120mm long motor 25A
FS2 7.5A quick blow
FS3 AC supplies 7.5A quick blow
DC supply
9mm long motor 10A
12mm long motor 25A

Switch	Term No.	Open	Intermediate	Shut
OAS	15-16	■		
	15-17		■	■
CAS	7-8	■	■	
	7-6			■

■ switch made

For typical remote control indicating, monitoring and alarm circuits see page 8.

Wires are identified at each end by terminal number or by wire number.

Control signal threshold voltages:

Minimum 'ON' 20V.
Maximum 'OFF' 3 V.

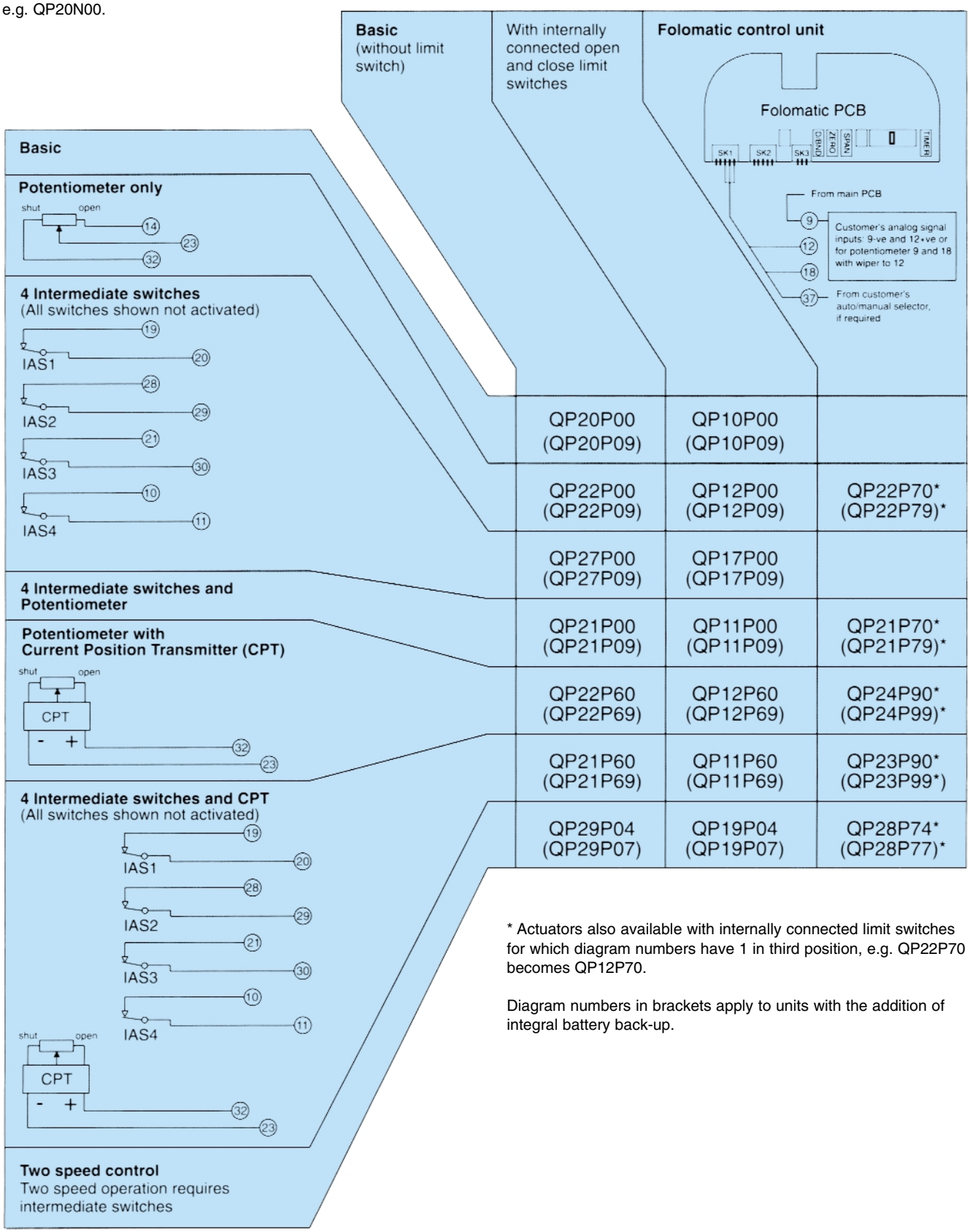
Minimum control signal 300mS to ensure latching-in of actuator self-maintaining circuits. (1.5 secs for pulsed signals if to be used throughout travel).

E.S.D. control signal voltage must be equal to or greater than all other remote signal voltages. The signal must 'make' on ESD and be self maintained.

OPTIONAL FEATURES

Standard actuator diagrams

The diagrams cover units suitable for remote control systems with positive switching. For negative switching, fifth digit of diagram number changes to N, e.g. QP20N00.



* Actuators also available with internally connected limit switches for which diagram numbers have 1 in third position, e.g. QP22P70 becomes QP12P70.

Diagram numbers in brackets apply to units with the addition of integral battery back-up.

REMOTE CONTROL CIRCUITS FOR AQ

The 8-switch selector on the PCB enables various different remote control functions to be chosen. Unless specific requirements are stated with the order, actuators will be supplied with all the switches in the 'ON' position giving the functions as shown in the following table.

DIL switch	ON	OFF
1	ESD	No ESD
2	T'stat by-pass	No T'stat by-pass
3	Both close priority	Both open priority
4	Else stayput	
5	ESD close	ESD open
6	Clockwise to close	Anti-clockwise to close
7	Maintain in local	No maintain in local
8	Failsafe open or close (if fitted)	No failsafe open or close

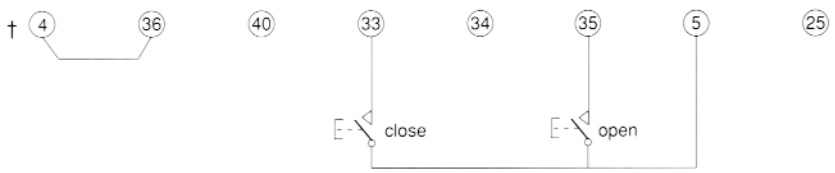
The typical remote control circuits shown apply to actuators with switches in the 'ON' positions unless otherwise stated.

All circuits are drawn for valve fully shut.

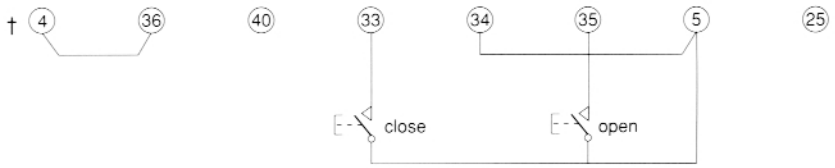
Internally fed 24V DC circuit

Forms 1a to 1e show typical connections for some of the remote control circuits which can be used with the 24V DC supply available at actuator terminals 4 and 5.

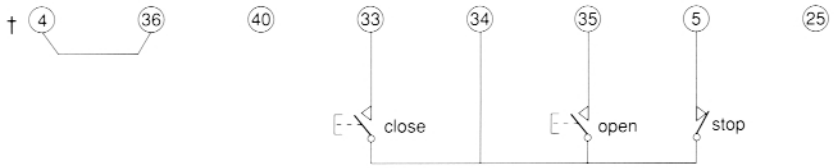
Form 1a
open/close push-to-run control
(Local control remains self-maintained. For local control push to run PCB selection: SW7 -> off)



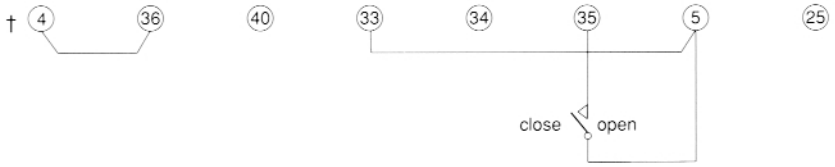
Form 1b
open/close maintained control with mid-travel reversal. Customer to link 5 -34



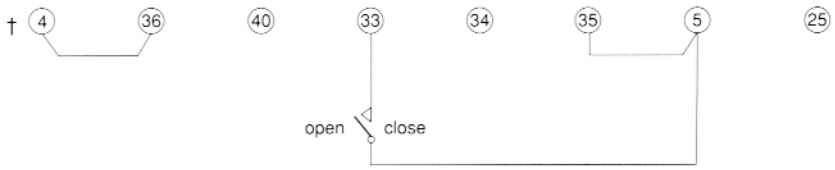
Form 1c
open/stop/close maintained control



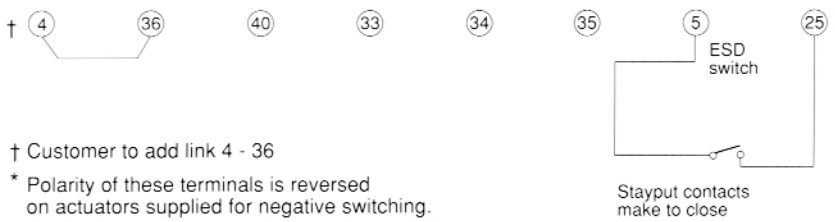
Form 1d
Two-wire control; energize to open, de-energize to close
(PCB selection: SW3 & 4 -> off)
Customer to link 5 - 33



Form 1e
Two-wire control: energize to close, de-energize to open. Customer to link 5 -35



Form 1f
Emergency shut-down overriding any existing signal to close valve. (May be added to any of circuts **a** to **e** above).
(For ESD to open PCB selection: SW5 -> off.
If thermostat is to be over-ridden, SW2 -> on).
Note. ESD signal must be equal to or greater than all other remote control signal voltages.



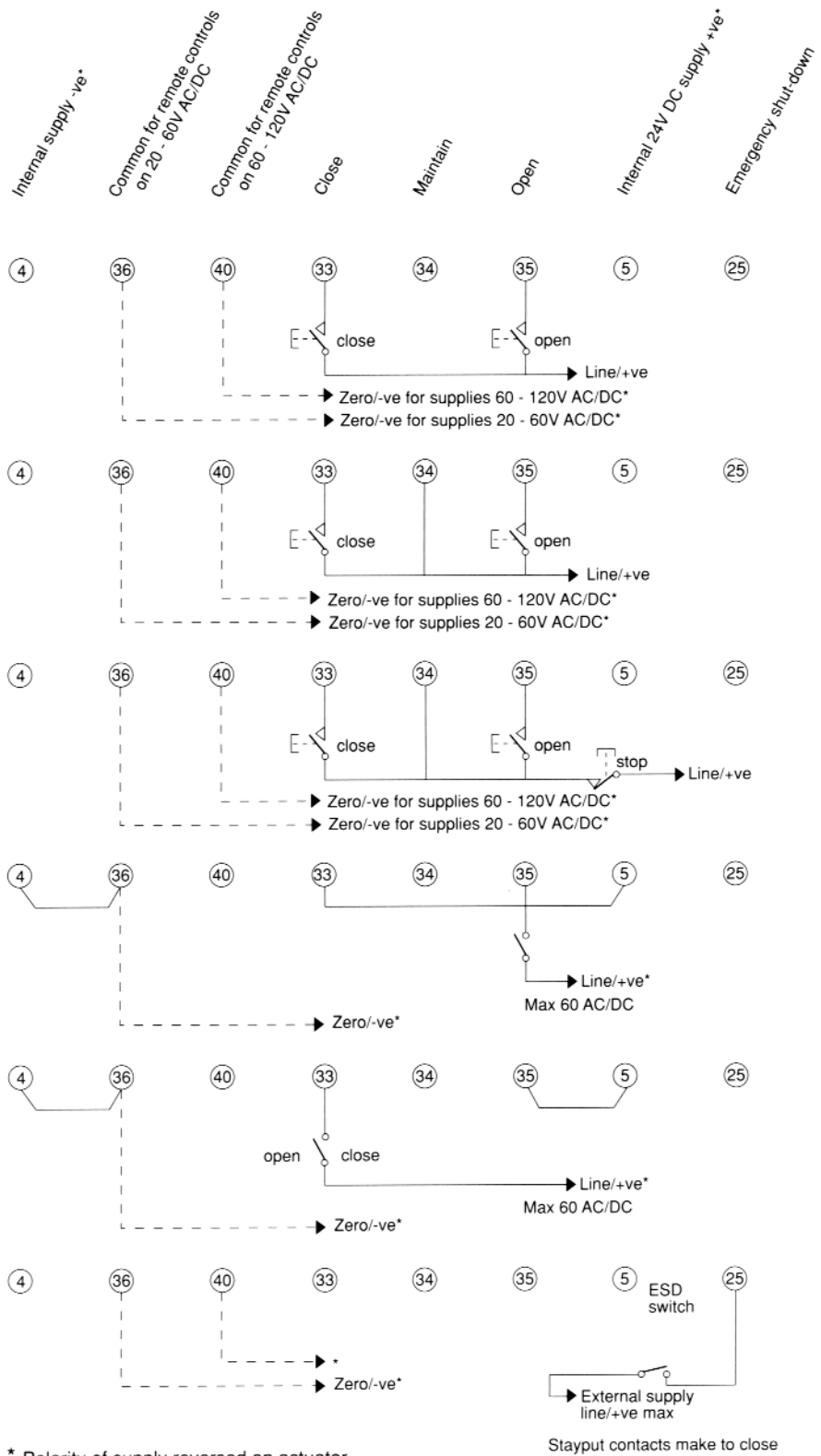
† Customer to add link 4 - 36

* Polarity of these terminals is reversed on actuators supplied for negative switching.

Fig. 3

Externally fed circuits

Where the customer prefers to use his own external supply for the remote controls, this can be connected to the actuator as shown typically in the Form 2 circuits, depending on the voltage levels applicable.



Form 2a
open/close push-to-run control (Local control remains self-maintained. For local control push to run PCB selection: SW7-> off)

Form 2b
open/close maintained control with mid-travel reversal

Form 2c
open/stop/close maintained control

Form 2d
Two-wire control; energize to open, de-energize to close (PCB selection: SW3 & 4 -> off)
Customer to link 4 - 36, 33 - 5

Form 2e
Two-wire control; energize to close, de-energize to open
Customer to link 4 - 36, 35 - 5

Form 2f
Emergency shut-down to close valve overriding thermostat and any existing signal. (May be added to any of the circuits **a** to **e** above).
(For ESD to open; PCB selection: SW5 -> off if thermostat to be overridden. SW2 -> on). Customer to link 4 - 36.
Note. ESD signal must be equal to or greater than all other remote control signal voltages.

* Polarity of supply reversed on actuator supplied for negative switching (+ve to 36 or 40)

Fig. 4

MONITORING CIRCUITS

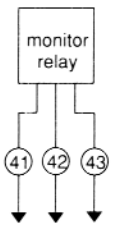
The circuits provided as standard within 'AQ' enable remote monitoring of the operational status of the actuator/valve as follows:

Status	Monitoring device/circuit				
	Monitor relay	Sequence failure circuit	Standard auxilliary switches circuit	Exact end position indication	Motor running relay
Availability of power	■	■			
Local/remote switch set to remote?*	■				
Local stop button reset?*	■	■			
Motor temperature	■	■			
Valve free of obstruction during travel?		■			
Valve still in the position last set by remote control?		■			
Motor running?					■
Has valve reached approximate end of travel?			■		
Has valve reached exact end of travel with motor switched off?				■	

*when fitted.

Monitor relay

The monitor relay will give an alarm on the following; loss of three phase supply or of one phase, motor thermostat tripped, local stop button locked off or local/remote switch set to local, all of which make the actuator not available for remote control. The monitor relay has two contacts, one normally open (terminals 41-42) and one normally closed (terminals 41-43) so that availability for remote control can be monitored.



Motor running and end position indication

The 'motor running' (fig 5), 'exact end position' (fig 6) and 'sequence failure' (fig 7) indication circuits can usually be employed without prejudice to the control facilities or vice versa. However, repeating the motor running relay and auxiliary switches by customers relays or logic circuits when necessary will enable several facilities to be used in combination.

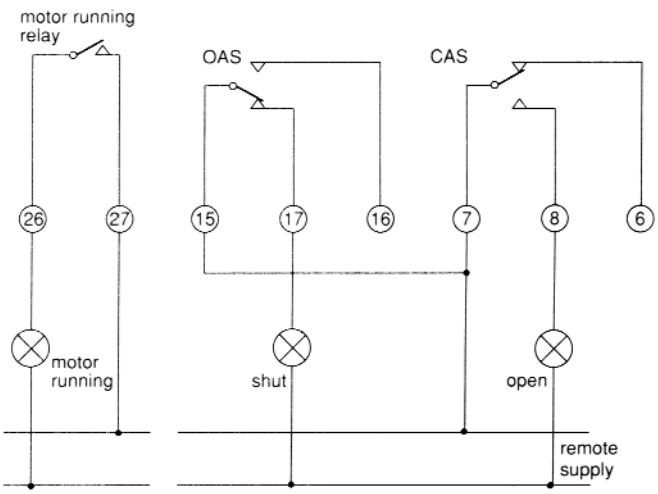


Fig 5
Connections for motor 'running' and approximate end position indication (both lamps illuminated during travel).

Exact end position indication

Particular attention is drawn to the significance of the 'exact end position' indication facility (fig 6) as compared with the normal 'approximate end position' indication (fig 5). When non-maintained push-to-run or incremental control is used, and particularly when derived from a computer, the normal end position indication from an auxiliary limit switch is inadequate. Because it must trip before the valve seats, it will cause premature disconnection of the control signal. Connecting the motor running relay with OAS and CAS gives the required result. With the valve open, for instance, the 'open' lamp will be lit by CAS. Pressing the 'close' button will close the motor running relay which will not affect the indication. Actuator movement will be indicated when OAS resets to light the 'close' lamp. Both lamps will be on during travel and the 'open' lamp will not go out until CAS has been tripped and the motor running relay also drops out. This signifies the disconnection of the relay by its travel limit or torque switch and indicates the exact moment at which the control signal should be removed.

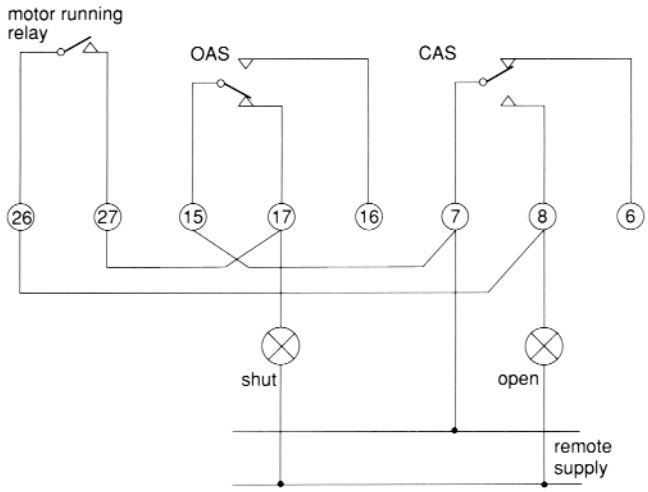


Fig. 6

Exact end position indication (both lamps illuminated during travel). Customer to link 7-15, 8-26, and 17-27.

Sequence failure alarm

Sequence failure alarm (valve stopped in mid-travel). With automatic sequencing it is important to know if the valve has failed to complete its travel. This may be due to a loss of power supply, loss of control supply, unauthorized local stop or, very rarely, valve obstruction causing torque switch trip in mid-travel. Connecting the motor running relay in parallel with auxiliary limit switches OAS and CAS as shown in fig 7 enables this failure to be detected. An alarm relay normally energized through these contacts will only be de-energized in intermediate position.

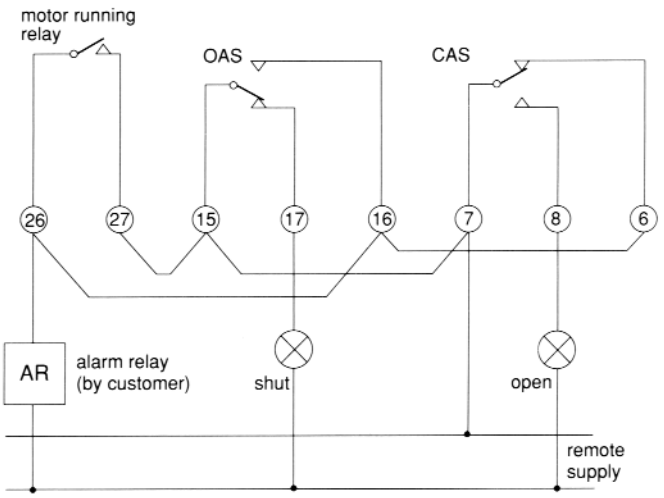


Fig. 7

Connections for 'sequence failure' alarm and approximate end position indication (both lamps illuminated during travel). Customer to link 26-16, 27-15, 15-7 and 16-6.

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Rotork Controls Limited
telephone Bath 01225 733200
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email info@rotork.com

Rotork Controls Ltd, Bath, UK

Rotork Controls Inc, Rochester, USA

A full listing of our worldwide sales and service network is available on our website at **www.rotork.com**