Keeping the World Flowing
for Future Generations

Electrical data for SI3 and SI4 range actuators

Introduction

This guide is provided to assist in the sizing of the actuator power supply cable, circuit protection devices and calculation of electrical diversity. It also provides electrical data on holding the actuator in position and the draw on the Emergency Shut Down (ESD) signal(s) when utilised.

Below are the nominal voltages and frequencies available:

DC	Single-phase		Three-phase	
	50 Hz	60 Hz	50 Hz	60 Hz
24	-	110	380	380
-	-	120	400	400
-	230	230	415	415
-	-	-	440	440
-	-	-	-	480
-	-	-	-	575

Glossary

- **Inrush** – current draw at the nominal voltage during the initial start of the motor/pump. The motors are sized to produce an inrush duration of less than 200 ms. The motor/pump operates under a no load condition for the first 500 ms after movement is commanded.
- **Rated pressure (current)** – the current required by the actuator to produce the rated output pressure/torque, as specified in the product brochure.
- **Rated pressure (power factor)** – the power factor is the ratio between the real power and the apparent power, where the apparent power is the product of the voltage and current.
- **Rated pressure (real power)** – the power that the actuator will actually consume to produce the rated output torque.
- **Bypass solenoid** – the bypass solenoid is used to reduce the demands on the motor when the motor starts. The bypass provides a path back to the reservoir for the hydraulic oil. 500 ms after the start of the motor the bypass solenoid will close directing the oil towards the actuator.
- **Bleed solenoid(s)** – the bleed solenoid(s) are used to control the return of hydraulic oil to the reservoir. When they open any pressure in the system will be released and the actuator will move in the spring direction.

Design philosophy

Manifold configuration 1

The SI3 has an integrated motor fitted, which is directly coupled to a gear pump which will generate hydraulic pressure when commanded to. The hydraulic pressure generated will then operate the actuator in one direction of travel (away from the fail-safe position).

Actuators designed for valve automation have bespoke characteristics. Unlike conventional motors, actuators are only short time duty rated and loading is not constant. It can vary from light running to fully rated and even higher when unseating 'sticky' valves. Applying traditional motor protection is flawed and can lead to spurious tripping or no protection at all. If valve jams, the generated actuator pressure will increase, when the pressure reaches a pre-defined limit the actuator software will stop the motor. A pressure relief valve is used for added protection and will open to prevent damage to the valve and prevent the motor from stalling. Due to the fact the motor is not directly (mechanically) connected to the valve, it is not possible to stall the motor under normal conditions.

Manifold configuration 2

The SI4 can either have an integrated or third party motor fitted, which is directly coupled to a gear pump which will generate hydraulic pressure when commanded to. This hydraulic pressure generated will then charge an accumulator(s), which can then operate the actuator in one direction of travel (away from the fail-safe position).

Accumulator charging is not constant, it can vary from carrying out a full charge (zero to set pressure) to re-charging a small amount back to the set pressure. When the accumulator pressure reaches a pre-defined limit the motor will be stopped. A pressure relief valve is used for added protection and will open to prevent damage to the accumulator and prevent the motor from stalling. Due to the fact the motor is not directly (mechanically) connected to the valve, it is not possible to stall the motor under normal conditions.

Duty cycle

SI3 and SI4 actuators conform with the duty performance stated in EN15714-2 Industrial Valves – Actuators (Part 2: Electrical actuators for industrial valves – Basic requirements):

- Class A (on-off)
  – Up to 70°C: 15 cycles per hour @ 100 % rated torque
- Class B (positioning)
  – Up to 70°C: 30 starts/hour @ 100 % rated torque
- Class C (modulating)
  – < 40°C: 300 starts/hour @ 75 % rated torque
  – > 40°C: 300 starts/hour @ 40 % rated torque

Rotork recognises the bespoke nature of actuator design and has therefore incorporated comprehensive protection in the motor and control package.

Motor design

Integrated motors are designed specifically for the SI3 and SI4 actuator range and have the following features:

AC

- 4 pole asynchronous motors
- Induction windings with run capacitor (single-phase only)
- Squirrel-cage configuration low inertia rotors
- Motor speeds of 1400 rpm @ 50 Hz and 1680 rpm @ 60 Hz
- Totally Enclosed Non-Ventilated (TENV)
- Class F insulation
- Class B temperature rise
- Dual embedded thermostats (132 °C)
- Sealed/lubricated for life bearings
- Integral to the actuator

DC

- 2 pole 1500 rpm
- Permanent Magnet DC motor (PMDC)
- Brushed high efficiency motor
- Class F insulation
- Class B temperature rise
- Dual embedded thermostats (132 °C)
- Sealed/lubricated for life bearings
- Fully self-contained

Third party motors for the SI4 actuator range are specified to meet the application requirements. Consult Rotork for details.

All motors meet the requirements of EN15714-2 (electric actuators) and comply with IEC 60034 and NEMA MG1 where applicable.

Motor control protection

The primary protection device is an integrated pressure transducer. By direct physical measurement of the actuator's pressure and therefore the output torque, effective motor and more importantly valve protection is achieved.

In the event of a blockage preventing the valve from moving, the system pressure will increase, the actuator will measure this increase in pressure and stop the motor/pump. A pressure relief valve is fitted as a back up to the pressure transducer, this will relieve excess pressure back to the tank.

The motor is also protected by two thermostats embedded in the motor winding providing over temperature protection if the duty exceeds the actuator rating. When motor temperature has significantly reduced the thermostats will automatically reset allowing for control of the actuator again.

Additionally actuator stall, phase rotation and lost phase protection is included in the standard control protection package.

Using pressure as the primary means of protection along with thermostats and the control protection, eliminated the requirement for traditional motor protection methods and their inherent weaknesses when applied to short time duty, variable load actuators.

Power supply cable sizing

When sizing cable it is important to use the inrush figure in this document to make sure the voltage drop is limited to a maximum 10 % of nominal voltage under starting conditions.

Fuse/protection selection

Due to the unique nature of the actuator duty and taking into account the comprehensive control protection of the SI3 and SI4, sizing of fuses or trip devices should be based on protecting the supply cable under fault conditions.

If required, protection may be enhanced by sizing trip devices to disconnect somewhere between 5 and 10 seconds at inrush current. This will reduce the risk of severe motor and supply cable heating under extended stall conditions while preventing spurious trips under normal operation. It should be noted that sizing trip devices in this manner may not be possible while meeting other criteria and is purely designed to protect against extreme fault conditions such as jammed contactor when the standard control protection cannot de-energise the motor. All other operating conditions are fully protected by the standard built-in control protection.

Frequency converters and UPS

Frequency converters for variable speed drives are not normally recommended as a suitable supply for SI3 and SI4 actuators. Where Uninterruptible Power Supply (UPS) systems are required for back-up operation, the power supply should have negligible harmonic distortion and should output a true sine wave. In general terms, actuators are designed to operate on power supplied conforming to recognised international standards, such as EN 50160.

Tolerances

The following tolerances may be accommodated for short term operation. It is not intended that long term operation is undertaken at supply voltage levels other than the nominal nameplate values of the supplied actuator. In general, the electrical power supply should conform to EN 50160 (Voltage characteristics of electricity supplied by public distribution networks) or equivalent.

The voltage drop developed on actuator starting must be minimised by ensuring supply capacity and cable are sufficiently sized. The starting voltage drop calculation shall be based on the inrush currents published.

Voltage tolerance	+/-10%	Applies to rated torque performance only; duty cycle, speed and current draw is not guaranteed
Frequency tolerance	+/-5%	Applies to rated torque performance only; duty cycle, speed and current draw is not guaranteed
Maximum total starting volt drop	-10%	Actuators capable of starting

Mains supply consumption

SI3 and SI4 (fitted with integrated motors)

DC

Nominal voltage (VDC)	Hydraulic speed (LPM)	Inrush current (A)	Rated pressure	
			Current (A)	Power (W)
24	0.58	27	13	290

Table 1 – DC motor power consumption (hydraulic direction)

Single-phase power supply

Nominal voltage (VAC)	Frequency (Hz)	Hydraulic speed (LPM)	Inrush current (A)	Rated pressure		
				Current (A)	Power factor (Cos Ø)	Real power (W)
110	50	1.50 or 2.25	75	11.7	0.66	890
120			82	14.8	0.71	1310
230			33	4.2	0.94	920
110	60		67	9.2	0.94	980
120			73	11.0	0.91	1220
230			24	5.4	0.91	1150

Table 2 – Single-phase motor power consumption (hydraulic direction)

Three-phase power supply

Nominal voltage (VAC)	Frequency (Hz)	Hydraulic speed (LPM)	Inrush current (A)	Rated pressure		
				Current (A)	Power factor (Cos Ø)	Real power (W)
380	50	1.50 or 2.25	18	1.8	0.62	730
400			21	2.0	0.64	880
440			21	2.2	0.52	870
380	60		19	1.7	0.75	840
400			19	1.9	0.77	1010
440			18	1.9	0.81	1180
480			20	2.0	0.64	1060
575			18	1.7	0.56	950

Table 3 – 3-phase motor power consumption (hydraulic direction)

Consult Rotork for SI4 actuators with third party motors.

Fail-safe actuators

Fail mode	Solenoid valve redundancy (W)	
	No	Yes
Fail-safe (ESD and power)	7	10.5
Fail-safe (ESD)	3.5 [1]	3.5 [1]
Fail-safe (power)	7	10.5
Stayput	3.5	3.5

Table 4 – Mains power consumption (to stay-in-position)

Note: [1] The actuator will continue to hold position if the power supply is removed and the applicable ESD signal is present.

Solenoid redundancy

When solenoid redundancy is specified an additional bleed solenoid is fitted to the manifold, the Partial Stroke Test (PST) will test each bleed solenoid individually to provide early indication of a failing solenoid.

ESD supply consumption

ESD power consumption

When an ESD fail mode is specified an ESD signal(s) needs connecting to the terminal bung. When the ESD signal is removed, the actuator will perform its specified fail mode.

Single ESD

A single ESD signal is used, and when this is removed the actuator will perform its fail mode function.

Dual ESD

Dual ESD requires two ESD signals named ESD1 and ESD2, when either ESD signal is removed both bleed solenoids will de-energise and the actuator will perform its specified fail mode.

Independent ESD

Independent ESD requires two ESD signals named ESD1 and ESD2, each ESD signal controls an individual bleed solenoid. This feature is only available on manifold configuration 1.

Fail mode – fail-safe (ESD and power)

In this configuration the bleed solenoid(s) are powered directly from the main supply and when either the mains power or ESD signal is removed the actuator will perform its fail mode action.

Table 5 shows the power consumption of the ESD signal(s).

Manifold configuration	ESD signal	Mains supply	Solenoid valve redundancy (W)			
			No		Yes	
			ESD 1	ESD 2	ESD 1	ESD 2
1 and 2	Single	On or Off	0.13	N/A	0.13	N/A
	Dual		0.13	0.13	0.13	0.13
1	Independent		0.13	0.13	N/A	N/A

Table 5 – Fail-safe (ESD and power) ESD signal power consumption

Fail mode – fail-safe (ESD)

When configured as a fail-safe (ESD) the ESD signal(s) will power the solenoids directly, in the event of a loss of mains power the ESD signal(s) will also power a number of the actuator circuits increasing the load on the ESD signal(s).

Table 6 shows the power consumption for the ESD signal(s) and Table 7 shows the actuator features that will remain available.

Manifold configuration	ESD signal	Mains supply	Solenoid valve redundancy (W)			
			No		Yes	
			ESD 1	ESD 2	ESD 1	ESD 2
1	Single	On	4.8	N/A	8.4	N/A
	Dual		0.13	4.8	0.13	8.4
	Independent		4.2	4.2	N/A	N/A
	Single	Off	7.2	N/A	10.8	N/A
	Dual		0.13	7.2	0.13	10.8
	Independent		5.4	5.4	N/A	N/A
2	Single	On	8.4	N/A	12.0	N/A
	Dual		0.13	8.4	0.13	12.0
	Single	Off	10.8	N/A	14.4	N/A
	Dual		0.13	10.8	0.13	14.4

Table 6 – Fail-Safe (ESD) ESD signal power consumption

Powered circuits with mains removed

It is possible to maintain power to the actuator in the event of the mains power supply being removed. This can be achieved by either fitting an auxiliary power option card or configuring the actuators fail mode as a fail-safe ESD.

Auxiliary power

An optional auxiliary power card may be specified, in the event of a loss of mains power, an auxiliary 24 VDC supply connected to the terminal bung will seamlessly take over powering critical circuits. The power consumption on the auxiliary supply is limited to a maximum of 7.5 W.

When mains power is applied, the consumption on the auxiliary supply will be minimal as the mains supply will power all of the features listed below.

Fail-safe ESD

When the fail mode is configured as fail-safe (ESD) the actuator will take power from the ESD signal(s).

The tables below show which features will be powered from the mains during normal operation and which will be powered by the auxiliary power or ESD signal when mains power is removed.

The base configuration will draw 2.8 W when the mains supply is lost, and this number will increase as additional options are added.

Contact Rotork for values for a specific configuration.

Feature	Normal condition		
	Mains	Auxiliary power	Fail-safe (ESD)
Backlit display	✓	×	×
Position and pressure	✓	×	×
CPT analogue indication	✓	×	×
Bus network communications	✓	×	×
Maintain position	✓ [2]	×	✓
Move towards the fail-safe position	✓	×	✓
Move using accumulator power [3]	✓	×	✓
Motor/pump	✓	×	×
Accumulator charging	✓	×	×

Table 7 – Auxiliary power and fail-safe (ESD) powered features under normal conditions

Feature	Mains power removed		
	Mains	Auxiliary power	Fail-safe (ESD)
Backlit display	×	✓	✓
Position and pressure	×	✓	✓
CPT analogue indication	×	✓	✓
Bus network communications	×	✓	✓
Maintain position	×	✓ Stayput configuration only	✓
Move towards the fail-safe position	×	×	✓
Move using accumulator power [3]	×	×	✓
Motor/pump	×	×	×
Accumulator charging	×	×	×

Table 8 – Auxiliary power and fail-safe (ESD) powered features when mains power is lost

Notes:
[2] Fail-safe (ESD and power) and fail-safe (power) configurations only
[3] Manifold configuration 2 only and relies on there being sufficient charge remaining in the accumulator.

Low and extra-low power

To further reduce the power consumption, there is the option within the menus to reduce the base configuration consumption.

Low – The backlight is turned off when the actuator is inactive for 30 sec.

Extra-low – The backlight is turned off when the actuator is inactive for 5 sec, the monitor relay is inverted and the position LED's are disabled.

Power save	Base configuration consumption
Off	2.8 W
Low	2.5 W
Extra-low	2.2 W
Stayput	Stayput

Electrical data for SI3 and SI4 range actuators

A full listing of the Rotork sales and service network is available on our website.

www.rotork.com

Corporate Headquarters
Rotork plc
tel +44 (0)1225 733200
email mail@rotork.com

rotork®

Electric Actuators and Control Systems
Fluid Power Actuators and Control Systems
Gearboxes and Gear Operators
Precision Control and Indication
Projects, Services and Retrofit

PUB021-094-00
Issue 10/23