



SIL is an established system of measurement standards to indicate the performance required of a safety system. It is part of a functional safety plan that includes techniques, technologies, standards and procedures that help operators protect against hazards. Functional safety adopts a life-cycle approach to industries that deal with hazardous processes and includes plans from concept through to decommissioning.

The requirement to meet a given SIL standard is becoming increasingly common in many industrial process environments. It can be a complicated and arduous undertaking to establish and maintain compliance. This is true in both new plant construction and upgrades to the safety systems in an existing plant. Once established, ongoing testing and verification of safety system performance are required for the operational lifetime of the plant.

A plant will have a Safety Instrumented System (SIS) that is made up of a number of Safety Instrumented Functions (SIF). An SIF consists of three sections: Sensors, Logic Solver and Final Elements. SIL applies to the SIF as a whole because a failure of any component compromises the safety function. However, when analysing the performance of the system, it is acceptable to assess the performance of each section separately. The majority of Logic Solvers and Sensors have built-in, automatic testing systems. Final Elements often require additional testing equipment and regimes to test and prove their level of performance.

Assessing the performance of the final elements is a complicated process for the end user. Data for the various components must be gathered, a suitable design must be formulated and then testing regimes applied to the design. This can be a lengthy process involving multiple vendors and a variety of lengthy calculations.

Vendors try and assist in this process by having products independently certified as "Suitable for Use" at particular SIL levels by independent organisations such as TÜV. However, the end user must still conduct all the necessary calculations to ensure that the selected Final Elements as a whole adhere to the requirements for the particular SIL level required.

Rotork's experienced team can provide a variety of products and engineering services that help establish, maintain and verify the Final Elements of an SIS system, often facilitating a reduction of plant operating expense.

How Can Rotork Help?

Certified Products

- Pneumatic actuators.
- Hydraulic actuators.
- Electro-hydraulic actuators.
- Electric actuators.
- Smart Valve Monitor partial stroke testing system.
- Solenoid control systems.

Certified Personnel

- TÜV certified Functional Safety Professionals.
- International network of IEC 61508 specialists.

SIL System Design Services

- Final element design services for green field sites.
- Retrofit solutions for plant upgrades.
- Final element SIL verification calculations.

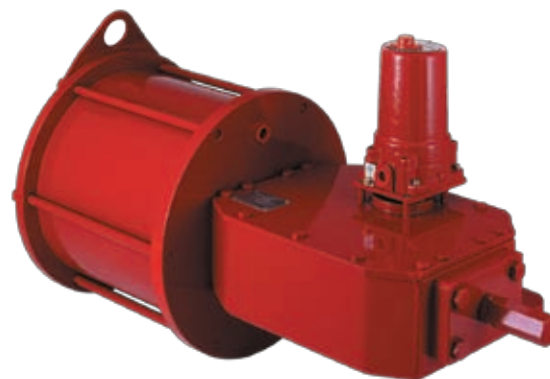
SIL Products

GP/GH (Pneumatic and Hydraulic Actuators)

GP (pneumatic) and GH (hydraulic) range scotch yoke actuators are designed to provide a rotary, quarter-turn movement for either on/off or modulating duty. The rugged yet compact design is available with two different yoke designs. The classic symmetric yoke delivers peak torque at both ends of stroke. Alternatively, they can be supplied with canted torque arms designed to deliver peak torque at only one end of stroke. Use of canted arms can often reduce actuator size, weight and cost for valves with appropriate torque demand characteristics.

- Pneumatic and hydraulic actuators in double-acting and spring-return configurations.
- Corrosion resistant cylinders.
- Actuators certified to IP 66M/67M.
- Actuators certified to ATEX 94/9/EC.
- Actuators certified in accordance with PED 93/27/EC.
- Torque output to 600,000 Nm (5.3 million lbf-in).
- Compatible with SVM partial stroke testing.

For further information see publication F100.



SIL Rating	3
Hardware Fault Tolerance (HFT)	0
Safe Failures (λ_s)	217*
Dangerous Detected Failures (λ_{DD})	16**
Dangerous Undetected Failures (λ_{DU})	6*
Safe Failure Fraction (SFF)	97.5%
Hardware Type	A

CP (Pneumatic Actuators)

CP range pneumatic actuators are a versatile, modular, scotch yoke design available in both double-acting and spring-return configurations. The compact and efficient design yields high torques even at low pressures. The design concepts found in Rotork's large, heavy-duty actuators has been applied to the CP range, which brings heavy-duty actuator qualities to small, quarter-turn actuators.

The actuator body is of rugged, ductile cast iron available in four body sizes. Cylinders are manufactured from carbon steel, electroless nickel-plated.

- Pneumatic and hydraulic actuators in double-acting and spring-return configurations.
- Corrosion resistant cylinders.
- Actuators certified to IP 66M/67M.
- Actuators certified to ATEX 94/9/EC.
- Actuators certified in accordance with PED 93/27/EC.
- Torque output to 4,500 Nm (39,800 lbf-in).
- Compatible with SVM partial stroke testing.

For further information see publication F200.



SIL Rating	3
Hardware Fault Tolerance (HFT)	0
Safe Failures (λ_s)	770*
Dangerous Detected Failures (λ_{DD})	9**
Dangerous Undetected Failures (λ_{DU})	3*
Safe Failure Fraction (SFF)	99.6%
Hardware Type	A

Established Leaders in Actuation Technology

IQ Pro (Electric Actuators)

Rotork's IQ Pro with SFCM (or SIL-card) is the only SIL certified electric actuator in the world. The IQ is ideal for applications where it is not possible or practical to install pneumatic or hydraulic tubing and cost is critical. The IQ Pro with SFCM is TÜV certified suitable for use at SIL2 or SIL 3 in a 1oo2 (one out of two) configuration.

In addition the SIL card is an ideal retrofit solution for plants undergoing a SIL re-assessment. The SIL card can be retrofitted to any IQ Pro actuator supplied since 2001 and would replace the existing network card to provide a hard-wired operation. This provides the end-user with a simple and cost effective means of upgrading an existing plant's SIL performance.

For safety applications the SIL card provides a second safety function that improves the performance of the actuator to prevent incorrect operation in non-ESD operation. By comparing the process input signal to the actuator with the output action, the SIL card can ensure that not only are the actuator internal assemblies functioning correctly, but also that the control system as a whole is performing the correct operation.

For further information see publication E1121.



SIL Rating	2 (1oo1) 3 (1oo2)
Hardware Fault Tolerance (HFT)	0 @ SIL2 1 @ SIL3
Safe Failures (λ_s)	10,030*
Dangerous Detected Failures (λ_{DD})	0.32**
Dangerous Undetected Failures (λ_{DU})	33*
Safe Failure Fraction (SFF)	91.4%
Hardware Type	B

EH (Electro-Hydraulic Actuators)

The EH range is a self-contained electro-hydraulic valve actuation solution. The actuator incorporates sophisticated electronics that provide non-intrusive set-up and interrogation via an infra-red hand held remote. They are suitable for on/off, modulating and emergency shutdown duties and are compatible with all major digital communication systems including Rotork's own Pakscan.

- Linear thrusts up to 5,500 kN (1.2 million lbf), quarter-turn torque output up to 600,000 Nm (5.3 million lbf-in).
- Power supply: single-phase, three-phase or 24 VDC.
- LCD display for position, pressure, diagnostics and fault indication.
- Partial stroke test capability.
- Watertight or explosionproof: ATEX, FM, CSA IEC and GOST.
- Separate, double-sealed terminal compartment.

For further information see publication F700.



SIL Rating	3
Hardware Fault Tolerance (HFT)	0
Safe Failures (λ_s)	2,800*
Dangerous Detected Failures (λ_{DD})	160**
Dangerous Undetected Failures (λ_{DU})	17*
Safe Failure Fraction (SFF)	99.4%
Hardware Type	A

* Measured in FITs (Failures In Time). 1 Fit = 10^{-9} failure/hour.

**Detected by partial stroke test.

RC (Compact Pneumatic Actuators)

The RC range is an extremely compact pneumatic actuator. It's scotch yoke design is particularly suited for valves with high start or end torque requirements. The aluminium body is available in both double-acting and spring-return configurations with output torque up to 4,400Nm (38,700 lbf-in). An optional manual override is available.

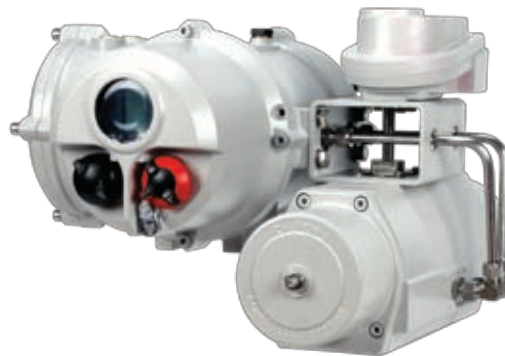


- Extremely compact scotch yoke pneumatic actuator.
- Double-acting and spring-return configurations.
- Contained spring module for safety and convenience.
- Torque output to 4,400 Nm (39,000 lbf-in).
- Valve mounting dimensions per ISO 5211/ DIN 3337.
- Compatible with SVM partial stroke testing.

For further information see publication F211.

SI (Electro-Hydraulic Actuators)

The SI range is a self-contained electro-hydraulic valve actuation solution available for both quarter-turn and linear applications. The actuators incorporate sophisticated electronics that provide non-intrusive set-up and interrogation via an infra-red hand held remote. They are suitable for on/off, modulating and emergency shutdown duties. Skilmatic actuators are compatible with all major digital communication systems including Rotork's own Pakscan.



- Intelligent, self-contained electro-hydraulic actuators.
- Linear thrusts up to 61 kN (13,700 lbf), quarter-turn torques up to 4,400 Nm (39,000 lbf-in).
- Two-position, ESD or modulating operation in spring-return or double-acting executions.
- Power supply: single-phase, three-phase or 24 VDC.
- Non-intrusive infrared setting & configuration.
- LCD display for position, pressure, diagnostics and fault indication.
- Optional bus communications via all major protocols.

- Partial stroke test capability.
- Watertight or explosionproof: ATEX, FM, CSA IEC and GOST.
- Separate, double-sealed terminal compartment.

For further information see publication F700.

SVM (Partial Stroke Testing System)

Rotork Fluid Systems' patented, Smart Valve Monitor (SVM) is the most versatile and comprehensive partial stroke valve testing system for hydraulically or pneumatically actuated on/off valves available. It tests every element of the valve/actuator/control system and has several unique features that set it apart from the solutions offered by many competing products.

SVM facilitates strategic preventive maintenance and extended shutdown intervals.

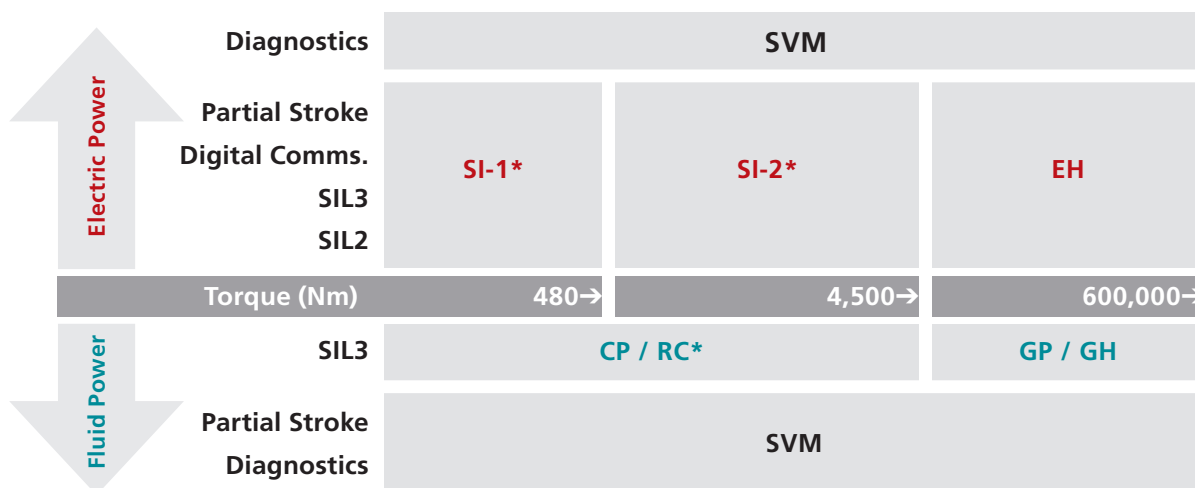
- Comprehensive valve performance monitoring system.
- Partial stroke testing in real time.
- Test all final elements as required by IEC 61508.
- Compatible with virtually any fluid power actuator.
- Assists with SIL compliance — extends shutdown intervals.
- Completely transparent to normal valve operation.
- Facilitates strategic maintenance.

For further information see publications F902 and F903.



SIL Rating	ALL
Hardware Fault Tolerance (HFT)	N/A
Safe Failures (λ_s)	24
Dangerous Detected Failures (λ_{DD})	0
Dangerous Undetected Failures (λ_{DU})	0
Safe Failure Fraction (SFF)	100%
Hardware Type	N/A

Product Selection



* SIL certification pending

SIL Design and Verification Services

Rotork's experienced engineering team can provide complete final element design solutions for SIL applications. With access to a comprehensive database of final element components, Rotork can assist with the design and selection of actuators and control systems and also prove compatibility and SIL performance when used in conjunction with a number of valve manufacturers.

New Projects

For new SIL projects, this can include selection of the required control components backed-up by independently assessed performance data to provide the user with definitive testing regimes for both partial stroke and shutdown proof testing. This affords operators the maximum possible plant production up-time and provides verifiable data to prove that the required SIL rating is being met.

SIL Retrofit Upgrades

In the wake of recent incidents in a variety of industries many plants are undergoing a re-assessment of their SIL ratings. Operators sometimes discover that their plant is no longer up to the required standard. This can lead to untimely and costly replacement programmes for valves and actuators.

Rotork has the capability to assist plant operators with the assessment of existing equipment and, in conjunction with the retrofit of products such as our SVM Smart Valve Monitor for fluid power actuators or the SFCM for our electrically powered IQ actuators, provide cost effective solutions for SIL upgrades. In fact, cost savings have often been made in the productivity of the plant by facilitating strategic maintenance and extending compulsory maintenance shutdown intervals.

