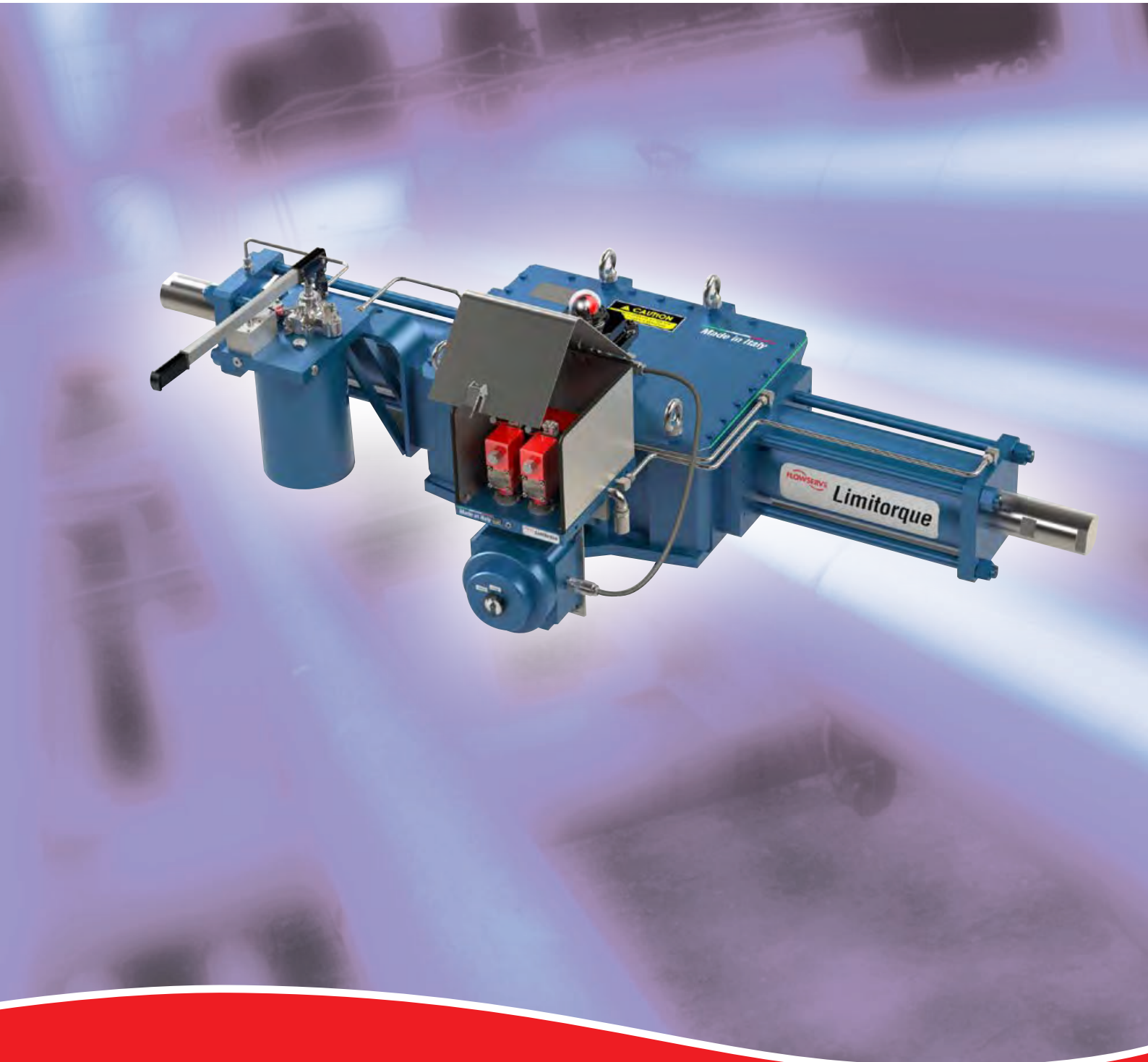
FLOWSERVE

Limitorque™ LDG

Limitorque Direct Gas Powered Scotch Yoke Heavy-Duty Actuator



Experience In Motion

Limitorque Fluid Power Systems

Introduction

The Limitorque Fluid Power family of heavy-duty actuators presents the Limitorque Direct Gas Scotch Yoke Actuators LDG.

Today's industry requirements are more rigorous than ever before. Nowhere is this more evident than in the oil and gas industry, where new requirements are incorporated into project specifications almost every day and emphases on personnel safety and equipment uptime is the norm.

The Limitorque Direct Gas (LDG) actuator has been specifically designed to operate on high pressure pneumatic supply, including pipeline gases, nitrogen and any other equivalent high pressure source. This makes it a robust and efficient way of providing reliable pipeline valve automation, even when no external motive power supplies are present. Based on Limitorque's high efficiency scotch-yoke modules, the self-contained system includes both the gas powered actuation unit and the high pressure gas control circuit.

The LDG range of Limitorque direct gas powered actuators are available in both spring-return and double-acting configurations. They are suitable for actuating ball, butterfly and plug valves or any other quarter-turn application.

LDG gas powered actuators deliver up to 300 kNm (221 000 ft-lb)* of precisely controlled torque. The LDG

is available in a selection of standard as well as special material executions, upon request.

The actuator features a 25-year design life, depending on service conditions, proper installation, operation and maintenance. In order to achieve this industry-leading design life, in-field maintenance is prescribed to be performed every six years of operation. For high-cycle applications, more frequent maintenance of replaceable wear surfaces, as outlined in EN 15714, may be required.

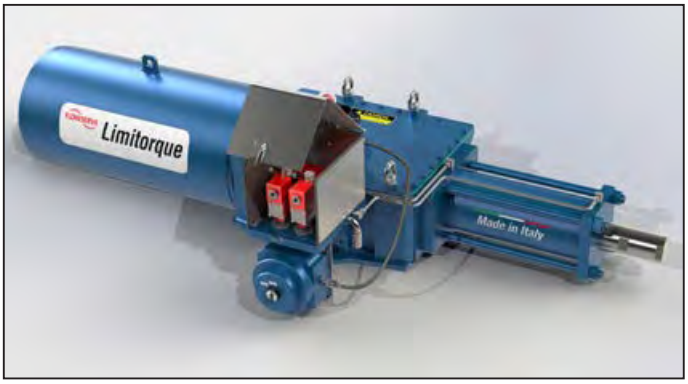
To complete the actuation package, LDG actuators are supplied with the on board Medium-High Pressure Control group (MHPC) including both local and remote operation configurations and multiple optional functionalities are available to meet all pipeline application requirements.

Limitorque also provides engineering design services for mounting hardware, ensuring that your actuation solution is ready to handle the toughest challenges.

* For higher torque ranges, consult factory.

Key Benefits

- Reduced equipment footprint due to compact dimensions and design.
- Improved Lifespan with 25 years design life and maintenance interval up to 6 years or as prescribed in EN 15714 for high-cycle applications.
- Robust ,cost effective modular construction for minimizing repair expenses and maximizing process availability.
- Simplified on-site maintenance for standard activities such as replacement of scotch yoke sliding block without removing the actuator from the valve.
- Reduced environmental impact through Limitorque's high pressure rated MHPC control group that minimizes gas consumption and exhaust.



LDG: Limitorque Direct Gas Heavy-Duty Scotch Yoke Actuators

With a design life of 25 years* and a maintenance interval up to six years*, the LDG range is a high pressure pneumatic heavy-duty actuator, with an output torque up to 300 kNm (221 000 ft-lb). Enhanced performance is achieved by using a superior scotch yoke support design that significantly reduces transverse loads. LDG actuators feature modular construction to minimize repair time and initial cost while maximizing process availability.

Features

- Spring Return Single Acting (Fail Close CW and Fail Open CCW) and Double Acting (Fail Last / Fail As Is) executions
- True modular design for flexible and easy field conversion from Fail Close CW to Fail Open CCW configuration or vice versa
- Symmetrical and canted scotch yoke types to perfectly fit valve torque requirement
- Fabricated carbon steel scotch yoke housing, high pressure pneumatic cylinder and spring can, providing the most rugged actuator available; different materials of construction for polar or offshore applications upon request
- ENP Lined Cylinders with Chrome Plated Piston Rod; Stainless Steel Cylinders, Tie Rods and Spool Pieces available upon request
- Available for use in safety integrated systems up to and including SIL Level 3 in accordance with IEC 61508
- Suitable for use in on/off and modulating valve application, in general service, isolation service and safety applications such as ESD or HIPPS
- On board Medium-High Pressure Control group (MHPC) including both local and remote operation configurations and multiple optional functionalities are available to meet all pipeline application requirements
- MHPC components are all rated for full system pressure. High pressure rating of controls and actuator power cylinder eliminates need for pressure reducer, reducing system complexity, eliminating risks of gas condensation and freezing, allowing higher torque output with smaller overall dimensions and reducing gas use and exhaust.
- Dedicated MHPC control component enclosure in stainless steel with integral teminal box in anodized aluminium
- MHPC anodized aluminium piping manifold simplifies piping and wiring assembly and minimizes leak paths in gas control circuit.
- A full range of accessories including switchboxes, ESD & PST functionalities, custom control functions, fire protection systems and hydraulic manual overrides are available for the LDG

Specifications

- Available in standard single-acting spring return and double-acting configurations, in torque ranges up to 300 kNm (221 000 ft-lb); contact factory for larger sizes
- 105 barg (1500 PSIG) maximum allowable working pressure (MAWP) for both LDG actuator and MHPC control group
- -29°C to 100°C (-20°F to 212°F) standard operating temperature range; Low temperature -60°C (-76°F) and high temperature 160°C (320°F) ranges available upon request (polar, cold, arid and tropical temperature requirements in accordance with IEC 60721)
- End mounted adjustable travel stops ± 5°, available also in an enclosed protected version upon request

Key Certifications and Standards Compliance

- Certified according to ATEX 94/9/EC Ex II 2GD c IIC T6
- IP66/IP66M and IP67/IP67M configurations (MHPC is IP67)
- Standard output valve interface in compliance with ISO 5211
- Actuator spring design in compliance with EN 13906
- Corrosion protection in compliance with ISO 12944-2 and EN 15714-4; optionally available up to and including C5-M
- Available in compliance with NACE specification MR0175 for sour gas applications
- Available in compliance with PED 97/23/EC, ASME BPVC Sec. VIII Div. 1, EN 13445-3 Part 2 for Unfired Pressure Vessels
- Manufactured and tested in compliance with ISO 9001 and EN 15714-4

* Depending on service conditions, proper installation, operation and maintenance.

LDGAvailable Configurations

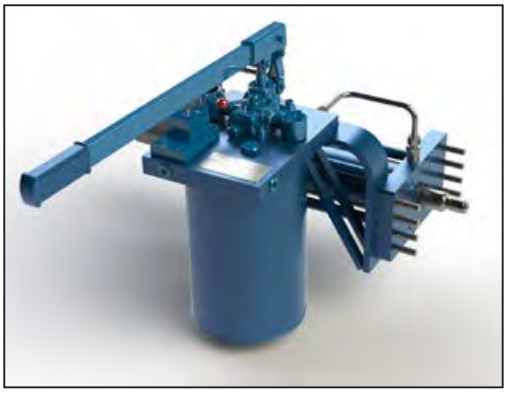
LDG Double Acting

LDG Single Acting – Fail Close (CW)

LDG Single Acting – Fail Open (CCW)

Manual Overrides

- Hydraulic Hand-Pump



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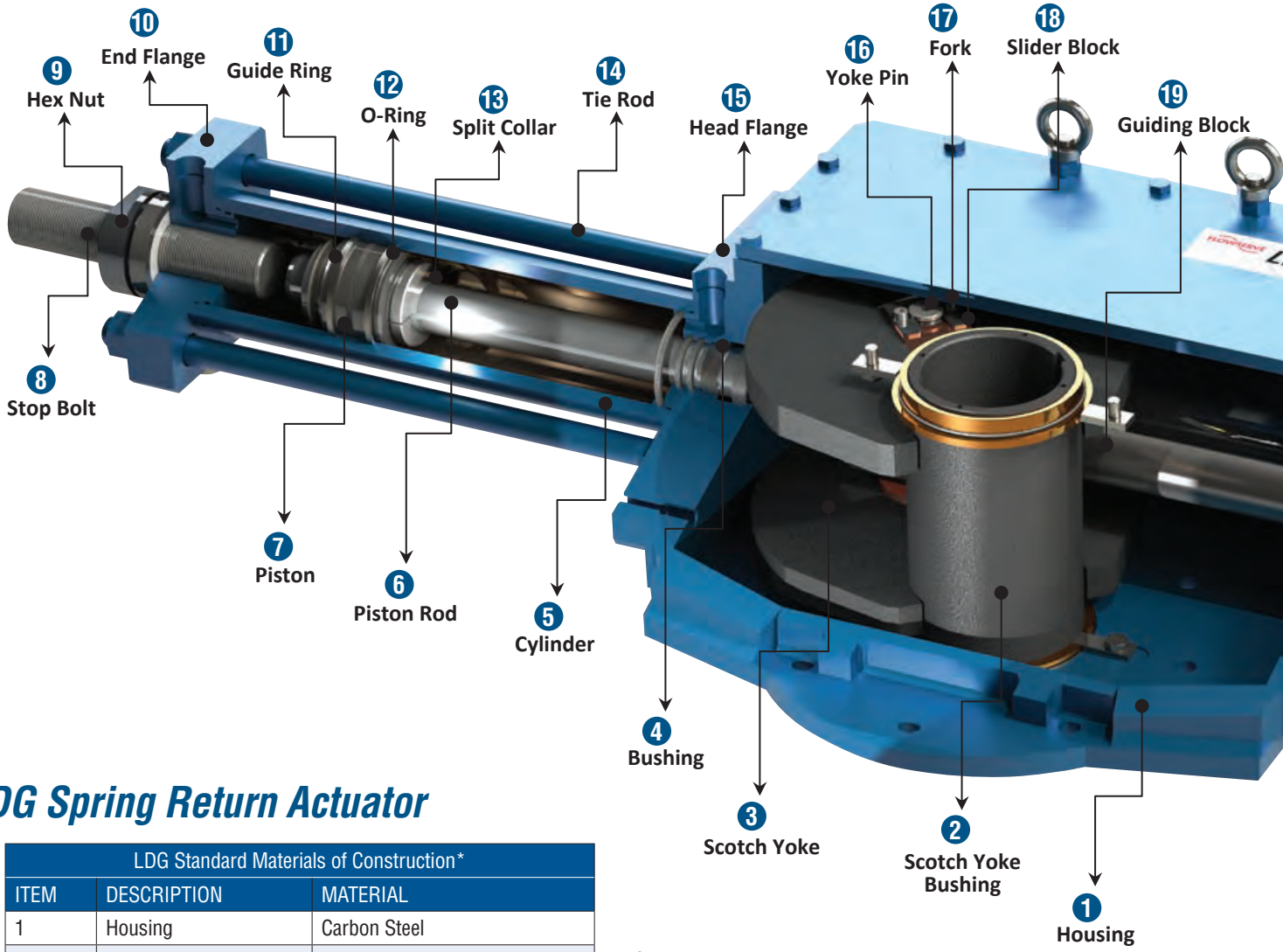
Anatomy of Limitorque LDG Actuator

The LDG range of Limitorque Gas Powered actuators is a robust, modular Scotch yoke design, available in both spring return and double acting configurations. The design philosophy introduced on the heavy-duty LPS actuator has been adopted for the LDG ranges, delivering enhanced performance and high reliability. The LDG is available in a selection of standard as well as in different and special material executions, upon request.



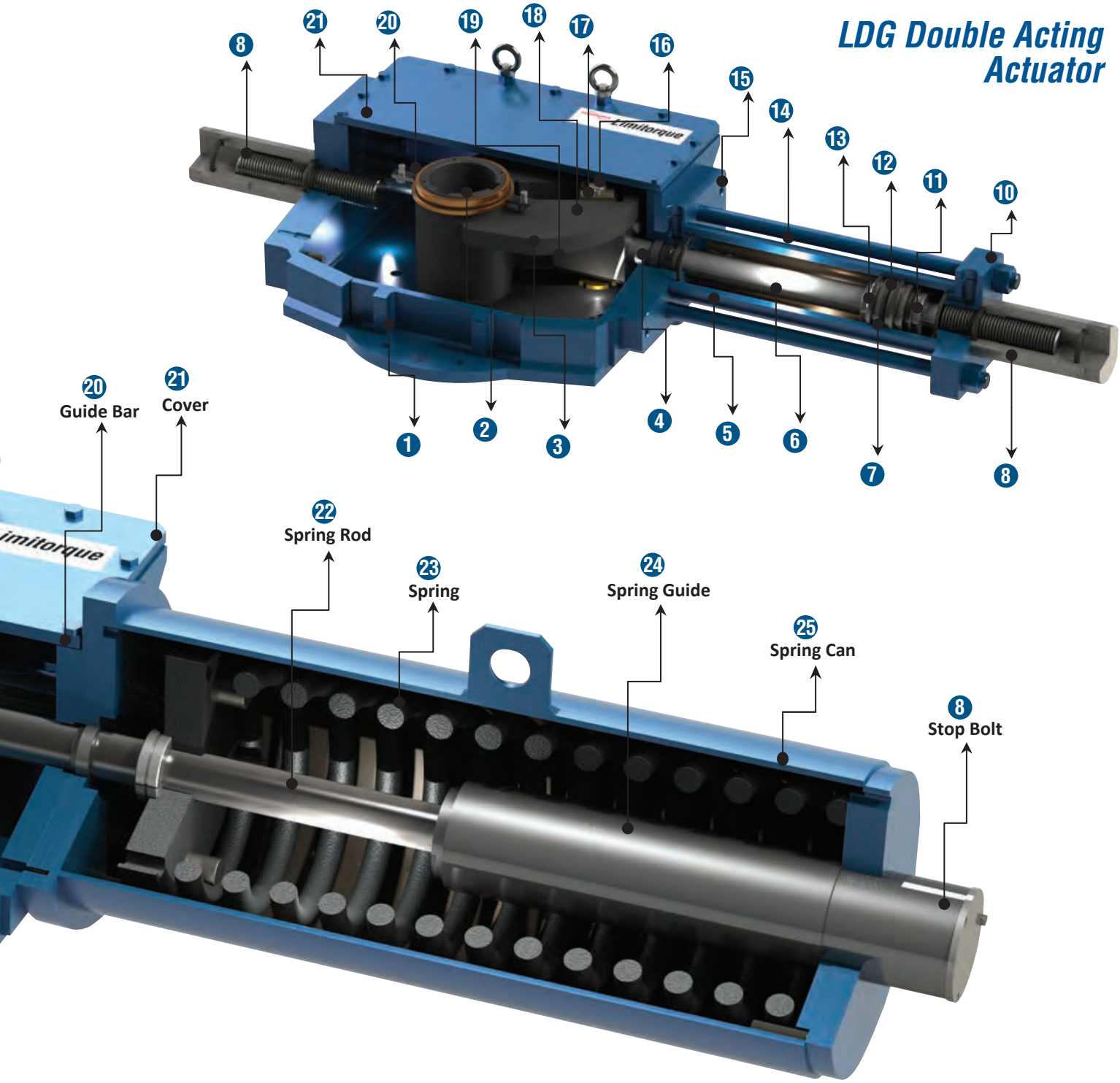
LDG Spring Return Actuator

LDG Standard Materials of Construction*		
ITEM	DESCRIPTION	MATERIAL
1	Housing	Carbon Steel
2	Scotch Yoke Bushing	Carbon Steel
3	Scotch Yoke	Carbon Steel
4	Bushing	PTFE + Steel
5	Cylinder	Carbon Steel (with treatment)
6	Piston Rod	Alloy Steel (chrome plated)
7	Piston	Carbon Steel (with treatment)
8	Stop Bolt	Carbon Steel (with treatment)

* Special or different materials available upon request

ITEM	DESCRIPTION	MATERIAL
9	Hex Nut	Carbon Steel
10	End Flange	Carbon Steel
11	Guide Ring	PTFE + Graphite
12	O-Ring	NBR
13	Split Collar	Alloy Steel

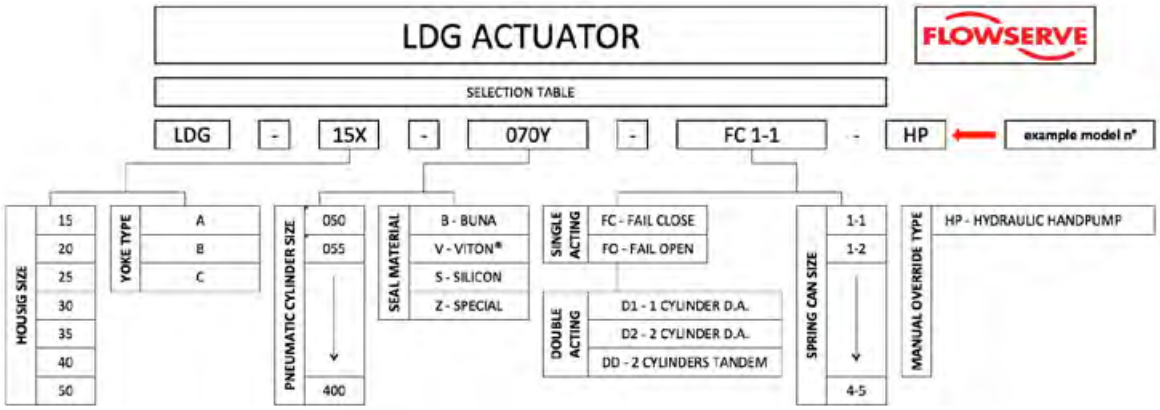
LDG Double Acting Actuator



ITEM	DESCRIPTION	MATERIAL
14	Tie Rod	Alloy Steel (with treatment)
15	Head Flange	Carbon Steel
16	Yoke Pin	Alloy Steel
17	Fork	Carbon Steel
18	Slider Block	Bronze
19	Guiding Block	Carbon Steel
20	Guide Bar	Alloy Steel (chrome plated)

ITEM	DESCRIPTION	MATERIAL
21	Cover	Carbon Steel
22	Spring Rod	Alloy Steel
23	Spring	Spring Steel
24	Spring Guide	Carbon Steel
25	Spring Can	Carbon Steel

LDG Actuator Selection Table



Seals Material

Code	Material	Temperature Range	Climate Classification According to IEC60721
B	Buna	Std Temp: -29°C to +100°C (-20°F to 212°F)	Tropical and Arid
V	Viton ®	Hi Temp: up to +160°C (320°F)	
S	Silicon	Low Temp: down to -40°C (-40°F)	Temperate
Z	Other	Special Applications - Consult Factory	Cold & Polar

LDG Sizing and Selection

Due to the Scotch yoke mechanism, LDG actuators have a particular U-shaped output torque curve, whether powered by a fixed supply pressure or the spring.

In sizing of actuators powered directly by pipeline gas, care must be taken to evaluate the valve torque requirements against the actuator output torques at the varying pressures in the actual pipeline.

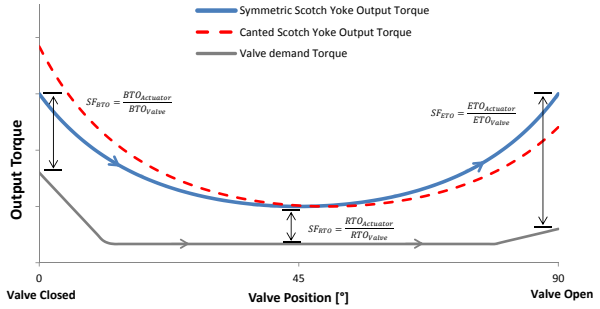
For a proper actuator model selection, the safety factors between actuator output torque and valve torque requirement shall be calculated at least in six points along the valve stroke, and as minimum, at the minimum and maximum pipeline normal operating pressures.

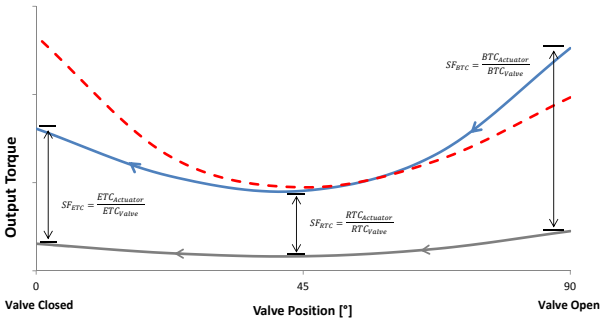
In addition, a final check is necessary to guarantee that actuator Maximum Output Torque does not exceed valve Maximum Allowable Stem Torque (MAST).

The minimum set of parameters and features necessary for an optimal actuator selection:

- Valve torques at minimum and maximum pipeline pressure, including MAST
- Type of actuator:
  – Single Acting/Spring Return: Fail Safe Close (CW) or Fail Safe Open (CCW)
  – Double Acting configuration for Fail Last or Fail As Is
- Minimum and Maximum gas supply pressure to the actuator
- Gas composition (H2S content) in case of sour gas applications
- Safety Factors requested by the project or by a specific application
- Working Temperature range
- Open/Close stroking times
- Additional options (manual override, limit switches, specific functional requirements such as line-break, low or high pressure trip, etc, others as applicable)

*Viton is a registered trademark of E. I. du Pont de Nemours.





Detailed output torque graphs covering the full valve stroke are available for both spring return and double acting actuators.

Definitions

BTO	Break to open torque	BTC	Break to close torque
RTO	Running to open torque	RTC	Running to close torque
ETO	End to open torque	ETC	End to close torque
MAST	Maximum allowable stem torque	SF	Safety factor

LDG Torque and Pressure Table

Model	MOT Maximum Operating Torque Nm (ft-lbf)	MOP Maximum Operating Pressure Barg (PSIg)	MAWP Maximum Allowable Workng Pressure Barg (PSIg)
LDG-15	6000 (4425)	Variable for every cylinder size	Variable for every cylinder size
LDG-20	12000 (8851)		
LDG-25	21000 (15489)		
LDG-30	40500 (29871)		
LDG-35	75000 (55317)		
LDG-40	150000 (110634)		
LDG-50	300000 (221268)		
LDG-60	Consult Factory		

Control System Options

Limitorque offers a selection of standard and custom controls packages for most applications, including:

- Torque limiting devices
- Pneumatic and electronic line-break systems
- High / Low pressure pilots
- ESD function

Flowserve Solutions

In addition to providing actuators and controls, Flowserve and Limitorque lead the industry with all the solutions that our customers need to maintain efficiency and productivity.

- Aftermarket Parts and Services
- Business Assesments
- Actuator Inspection, Maintenance and Repair
- Engineering and Technical Services
  - Engineering Support and Technical Assessments
  - Equipment Performance Analysis and Upgrades
- Education and Training
  - On-site and Online Trainings
- Asset Data Management and Optimization Solutions

Limitorque Additional Product Range Offering

Electric Actuators and Controls

- MX — Non-intrusive, electronic multi-turn actuators
- QX — Non-intrusive, electronic quarter-turn actuators
- Master Station, Controller for redundant networked actuators
- Network Controls, Modbus, Profibus DP/PA, Foundation Fieldbus, DeviceNet, HART
- L120 — Electro-mechanical, Multi-turn electric actuators with integral & network controls
- SMB — Electro-mechanical, Multi-turn electric actuators for nuclear and severe duty service

Fluid Power Actuators

- Scotch Yoke Pneumatic actuators — LPS
- Compact Scotch Yoke Pneumatic actuators — LPC
- Scotch Yoke Hydraulic actuators — LHS/LHH
- Direct Gas actuators — LDG
- Compact Scotch Yoke Hydraulic actuators — LHC*
- Linear Pneumatic actuators — LPL
- Linear Hydraulic actuators — LHL
- Gas Over Oil actuators — LGO*
- Electro-Hydraulic actuators — LEH*
- Standard and Customized Controls
- Application Engineering Support

Gearboxes

- V – Bevel gearboxes for manual or motorized operation
- WG – Worm gearboxes for manual or motorized operation
- SR – Spur gearboxes for manual or motorized operation

One Flowserve Solution

Flowserve brands for most common control accessories:

- Digital Positioners
  - Logix™
  - PMV™
- Analog Positioners
  - PMV
  - Accord™
- Diagnostic Software
  - ValveSight™
- Valve Controllers
  - Automax™
  - Worcester Controls™
- Limit Switch Boxes
  - Worcester Controls
  - PMV
  - Automax
  - Accord

* Contact Flowserve for product availability and additional information.

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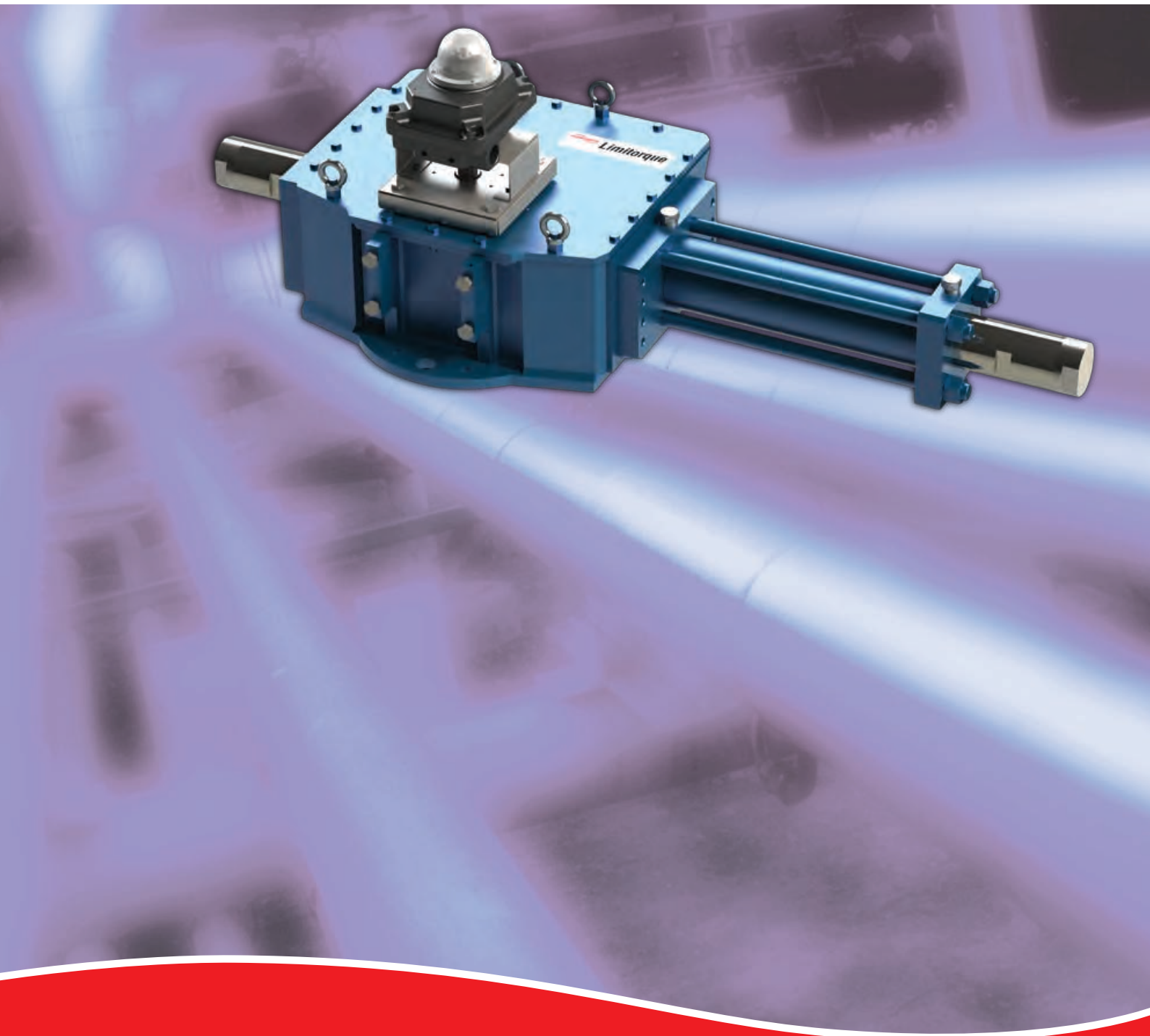
Limitorque™ LHS and LHH

Limitorque Hydraulic Scotch Yoke Heavy-Duty Actuator



Experience In Motion

Limitorque Fluid Power Systems

The Limitorque Fluid Power family of heavy-duty actuators presents the Limitorque Hydraulic Scotch Yoke Actuators Series LHS and LHH.

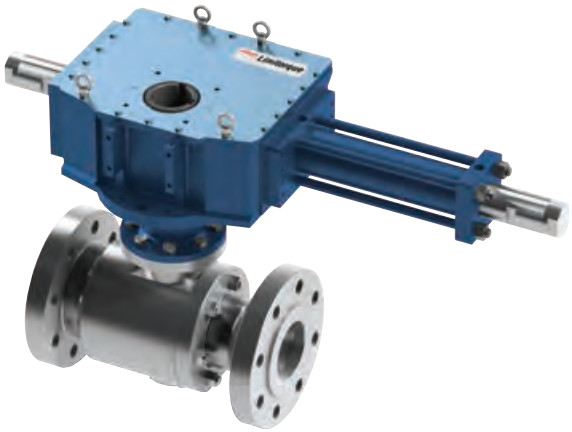
Today's industry requirements are more rigorous than ever before. Nowhere is this more evident than in the oil and gas industry, where new requirements are incorporated into project specifications almost every day and emphases on personnel safety and equipment uptime is the norm.

To more aggressively meet these demands, Flowserve Limitorque is offering the LHS and LHH Hydraulic Scotch Yoke Heavy-Duty Actuator—specifically designed to meet or exceed the latest and most rigorous of these requirements. This makes Limitorque Scotch Yoke Hydraulic Actuators the most technically advanced and market-compliant actuators available anywhere in the world.

The LHS and LHH ranges of Limitorque hydraulic actuators area robust, modular Scotch yoke design, available in both springreturn and double-acting configurations. They are suitable for actuating ball, butterfly and plug valves or any other quarter-turn application.

LHS and LHH hydraulic actuators deliver up to 300 kNm (221 000 ft-lb) of precisely controlled torque. The LHS and LHH are available in a selection of standard as well as in different and special material executions, upon request.

The same design philosophy, introduced on heavy-duty LPS actuators, has been adopted for the LHS and LHH ranges, delivering enhanced performance and high reliability.



The actuator features a 25-year design life, depending on service conditions, proper installation, operation and maintenance. In order to achieve this industry-leading design life, in-field maintenance is prescribed to be performed every six years of operation. For high-cycle applications, such as control valve operation, more frequent maintenance of replaceable wear surfaces, as outlined in EN 15714, may be required.

To complete the actuation package, LHS and LHH actuators are available with accessories, such as lockout modules, manual overrides and control panels, like hydraulic power units, accumulator racks, self-contained units and other electro-hydraulic solutions.

Limitorque also provides engineering design services for mounting hardware, ensuring that your actuation solution is ready to handle the toughest challenges.

* For higher torque ranges, consult factory.

LHS and LHH: Limitorque Hydraulic Heavy-Duty Scotch Yoke Actuators

With a design life of 25 years* and a maintenance interval up to six years*, the LHS and LHS are hydraulic heavy-duty actuators, with an output torque up to 300 kNm (221 000 ft-lb). Enhanced performance is achieved by using a superior Scotch yoke support design that significantly reduces transverse loads. LHS actuators feature modular construction to minimize repair time and initial cost while maximizing process availability.

Features

- Spring Return Single Acting (Fail Close CW and Fail Open CCW) and Double Acting (Fail Last / Fail As Is) executions
- True modular design for flexible and easy field conversion from Fail Close CW to Fail Open CCW configuration or vice versa
- Symmetrical and canted scotch yoke types to perfectly fit valve torque requirement
- Fabricated carbon steel scotch yoke housing, hydraulic cylinder and spring can, providing the most rugged actuator available; different materials of construction for polar or offshore applications upon request
- ENP Lined Cylinders with Chrome Plated Piston Rod; Stainless Steel Cylinders, Tie Rods and Spool Pieces available upon request
- Available for use in safety integrated systems up to and including SIL Level 3 in accordance with IEC 61508
- Suitable for use in on/off, modulating and control valve application in general service, protective service and safety applications such as ESD or HIPPS
- Full range of accessories and control systems: switchboxes, positioners; ESD and PST functionalities; hydraulic power units, accumulator racks, self-contained units, integrated electro-hydraulic solutions; fire protection; manual and hydraulic overrides

Specifications

- Available in standard single-acting spring return and double-acting configurations, in torque ranges up to 250 kNm (184 000 ft-lb); contact factory for larger sizes
- 207 barg (3000 PSIG) maximum allowable working pressure (MAWP); 345 barg (5000 PSIG) version upon request
- -29°C to 100°C (-20°F to 212°F) standard operating temperature range; Low temperature -60°C (-76°F) and High temperature 160°C (320°F) ranges available upon request (polar, cold, arid and tropical temperature requirements in accordance with IEC 60721)
- End mounted adjustable travel stops ± 5°, available also in an enclosed protected version upon request

Key Certifications and Standards Compliance

- Certified according to ATEX 94/9/EC Ex II 2GD c IIC T6
- NEMA 4 and NEMA 4X configurations, per NEMA 250
- IP66/IP66M and IP67/IP67M configurations
- Standard output valve interface in compliance with ISO 5211
- Actuator spring design in compliance with EN 13906
- Corrosion protection in compliance with ISO 12944-2 and EN 15714-4; optionally available up to and including C5-M
- Available in compliance with NACE specification MR0175 for sour gas applications
- Available in compliance with PED 97/23/EC, ASME BPVC Sec. VIII Div. 1, EN 13445-3 Part 2 for Unfired Pressure Vessels
- Manufactured and tested in compliance with ISO 9001 and EN 15714-4

*Depending on service conditions, proper installation, operation and maintenance.

LHS and LHH Available Configurations

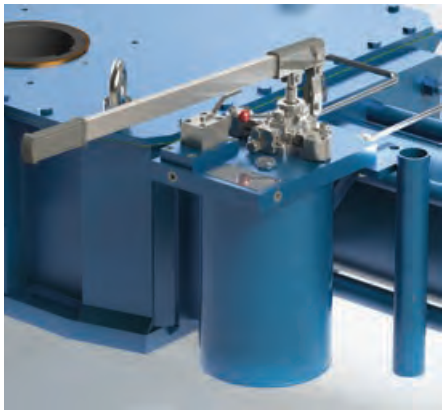
LHS/LHH Double Acting

LHS/LHH Single Acting – Fail Close (CW)

LHS/LHH Single Acting – Fail Open (CCW)

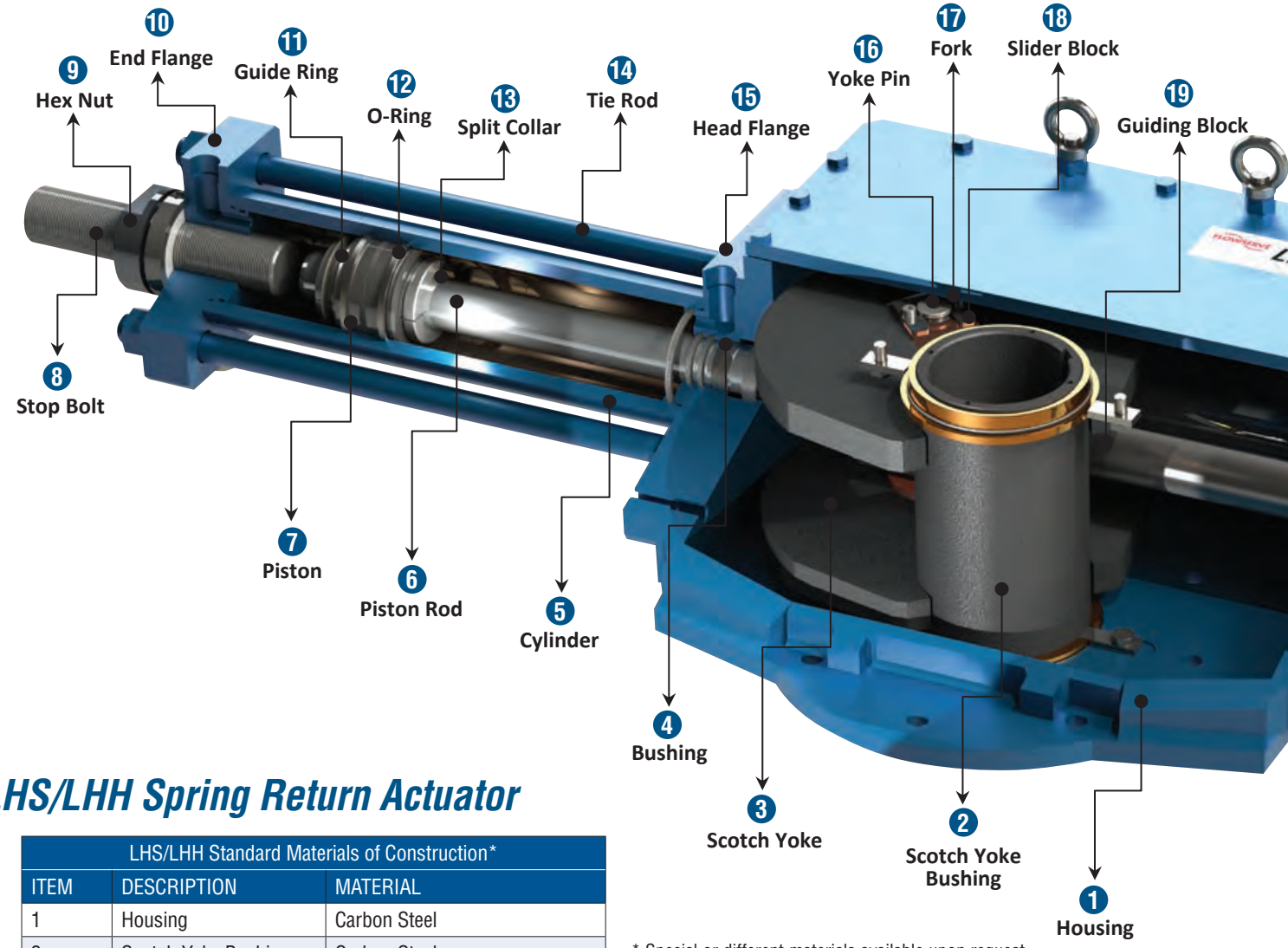
Manual Overrides

- Hydraulic Hand-Pump as standard
- Hand-wheel upon request



Anatomy of Limitorque LHS/LHH Actuator

The LHS/LHH ranges of Limitorque hydraulic actuators are a robust, modular Scotch yoke design, available in both spring return and double acting configurations. The design philosophy introduced on the heavy-duty LPS actuator has been adopted for the LHS/LHH ranges, delivering enhanced performance and high reliability. The LHS/LHH are available in a selection of standard as well as in different and special material executions, upon request.



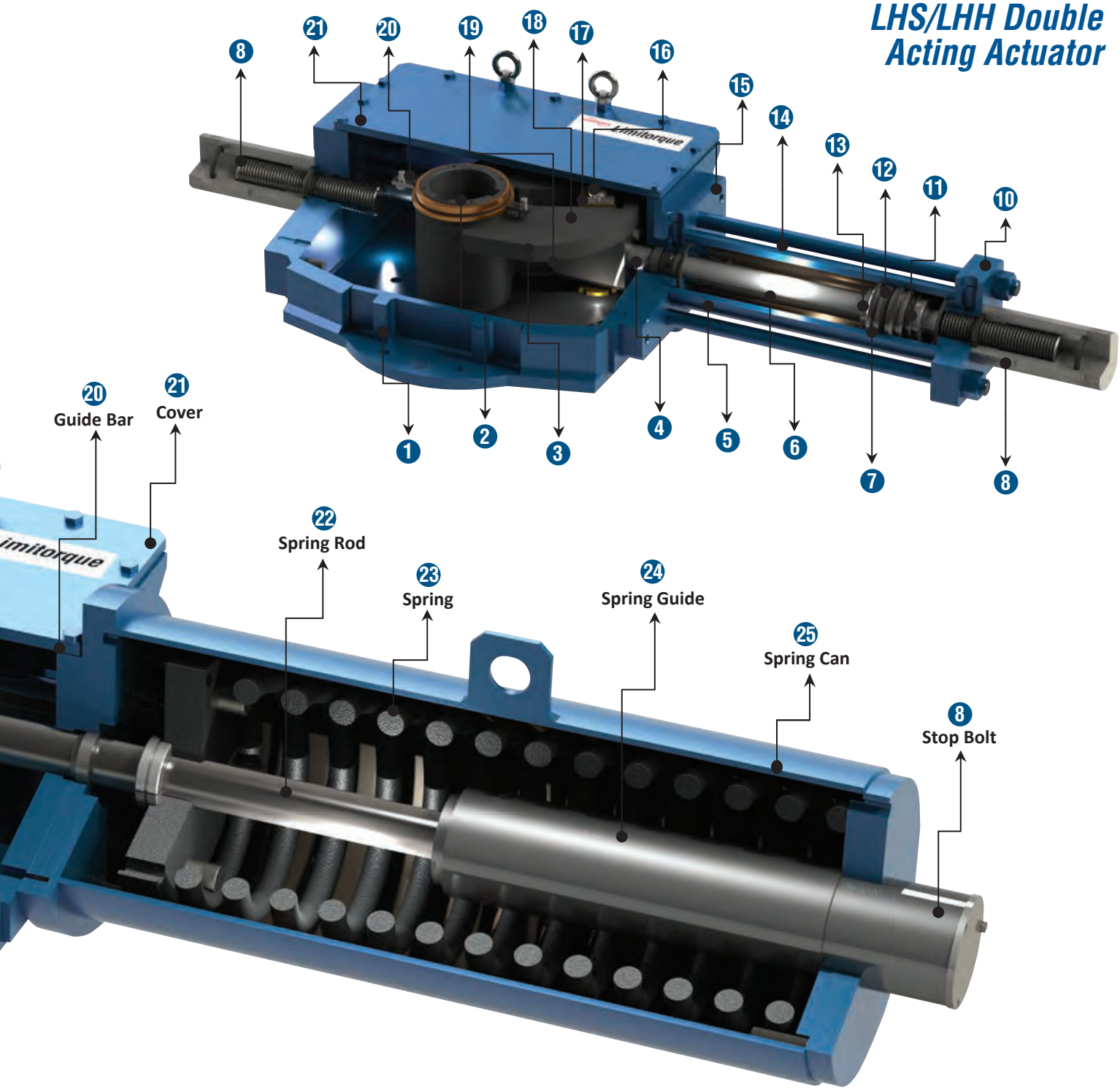
LHS/LHH Spring Return Actuator

LHS/LHH Standard Materials of Construction*		
ITEM	DESCRIPTION	MATERIAL
1	Housing	Carbon Steel
2	Scotch Yoke Bushing	Carbon Steel
3	Scotch Yoke	Carbon Steel
4	Bushing	PTFE + Steel
5	Cylinder	Carbon Steel (with treatment)
6	Piston Rod	Alloy Steel (chrome plated)
7	Piston	Carbon Steel (with treatment)
8	Stop Bolt	Carbon Steel (with treatment)

* Special or different materials available upon request

ITEM	DESCRIPTION	MATERIAL
9	Hex Nut	Carbon Steel
10	End Flange	Carbon Steel
11	Guide Ring	PTFE + Graphite
12	O-Ring	NBR
13	Split Collar	Alloy Steel

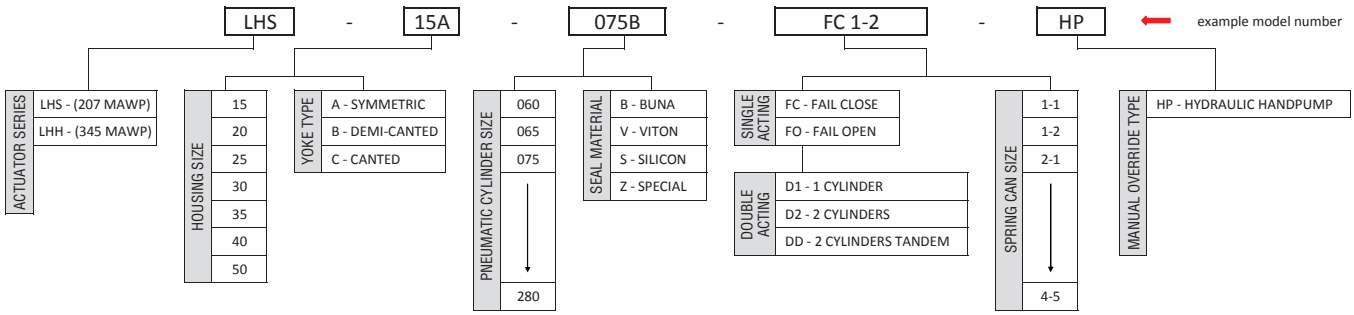
LHS/LHH Double Acting Actuator



ITEM	DESCRIPTION	MATERIAL
14	Tie Rod	Alloy Steel (with treatment)
15	Head Flange	Carbon Steel
16	Yoke Pin	Alloy Steel
17	Fork	Carbon Steel
18	Slider Block	Bronze
19	Guiding Block	Carbon Steel
20	Guide Bar	Alloy Steel (chrome plated)

ITEM	DESCRIPTION	MATERIAL
21	Cover	Carbon Steel
22	Spring Rod	Alloy Steel
23	Spring	Spring Steel
24	Spring Guide	Carbon Steel
25	Spring Can	Carbon Steel

LHS and LHH Actuator Selection Table



Seals Material

Code	Material	Temperature Range	Climate Classification According to IEC60721
B	Buna	Std Temp: -29°C to +100°C (-20°F to 212°F)	Tropical and Arid
V	Viton ®	Hi Temp: up to +160°C (320°F)	
S	Silicon	Low Temp: down to -40°C (-40°F)	Temperate
Z	Other	Special Applications - Consult Factory	Cold & Polar

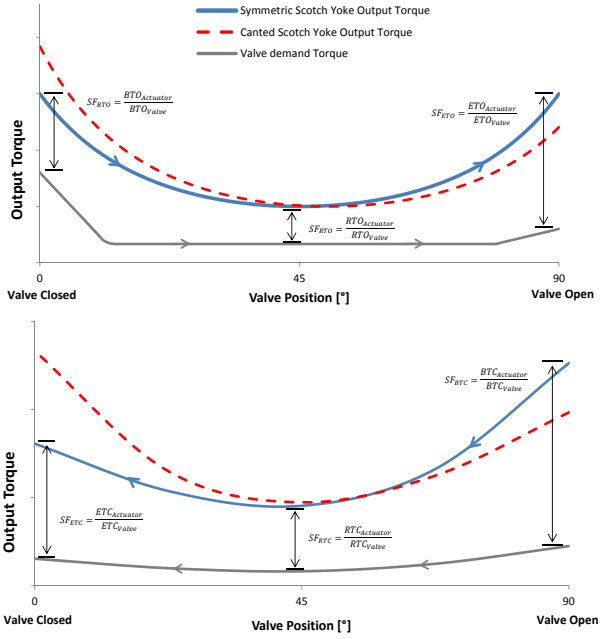
LHS and LHH Sizing and Selection

Due to the Scotch yoke mechanism, LHS/LHH actuators have a particular U-shaped output torque curve, whether powered by a fixed supply pressure or the spring.

For a proper actuator model selection, the safety factors between actuator output torque and valve torque requirement shall be calculated at least in six points along the valve stroke. In addition, a final check is necessary to guarantee that actuator Maximum Output Torque does not exceed valve Maximum Allowable Stem Torque (MAST).

The minimum set of parameters and features necessary for an optimal actuator selection:

- Valve torques, including MAST
- Type of actuator:
  - Single Acting/Spring Return: Fail Safe Close (CW) or Fail Safe Open (CCW)
  - Double Acting configuration for Fail Last or Fail As Is
- Minimum, Normal and Maximum Hydraulic Supply Pressure to the actuator
- Safety Factors requested by the project or by a specific application
- Working Temperature range
- Open/Close stroking times
- Additional options (manual override, control panel, limit switch box, positioner, …)



Detailed output torque graphs covering the full valve stroke are available for both spring return and double acting actuators.

Definitions

BTO	Break to open torque	BTC	Break to close torque
RTO	Running to open torque	RTC	Running to close torque
ETO	End to open torque	ETC	End to close torque
MAST	Maximum allowable stem torque	SF	Safety factor

*Viton is a registered trademark of E. I. du Pont de Nemours.

LHS/LHH Torque and Pressure Table

Model	MOT Maximum Operating Torque Nm (ft-lb)	MOP Maximum Operating Pressure barg (PSIG)	MAWP Maximum Allowable Working Pressure barg (PSIG)
LHS/LHH-15	6000 (4425)	Variable for every cylinder size.	LHS: 207 barg (3000 psig) LHH: 345 barg (5000 psig)
LHS/LHH-20	12 000 (8851)		
LHS/LHH-25	21 000 (15 489)		
LHS/LHH-30	40 500 (29 871)		
LHS/LHH-35	75 000 (55 317)		
LHS/LHH-40	150 000 (110 634)		
LHS/LHH-50	300 000 (221 268)		
LHS/LHH-60	Consult Factory	Consult Factory	

* MAWP 410 barg (6000 psig) available upon request

Control System Options

Limitorque offers a selection of standard and custom controls packages for most applications, including:

- Hydraulic Control Panels
- Hydraulic Power Units (HPU)
- Hydraulic Accumulators Racks
- Self-Contained Units (SCU)
- Electro-Hydraulic Integrated Solutions, upon request

Hydraulic Control System

Flowserve Solutions

In addition to providing actuators and controls, Flowserve and Limitorque lead the industry with all the solutions that our customers need to maintain efficiency and productivity.

- Aftermarket Parts and Services
- Business Assesments
- Actuator Inspection, Maintenance and Repair
- Engineering and Technical Services
  - Engineering Support and Technical Assessments
  - Equipment Performance Analysis and Upgrades
- Education and Training
  - On-site and Online Trainings
- Asset Data Management and Optimization Solutions

Limitorque Additional Product Range Offering

Electric Actuators and Controls

- MX — Non-intrusive, electronic multi-turn actuators
- QX — Non-intrusive, electronic quarter-turn actuators
- Master Station, Controller for redundant networked actuators
- Network Controls, Modbus, Profibus DP/PA, Foundation Fieldbus, DeviceNet, HART
- L120 — Electro-mechanical, Multi-turn electric actuators with integral & network controls
- SMB — Electro-mechanical, Multi-turn electric actuators for nuclear and severe duty service

Fluid Power Actuators

- Scotch Yoke Pneumatic actuators — LPS
- Compact Scotch Yoke Pneumatic actuators — LPC
- Scotch Yoke Hydraulic actuators — LHS/LHH
- Compact Scotch Yoke Hydraulic actuators — LHC*
- Linear Pneumatic actuators — LPL
- Linear Hydraulic actuators — LHL
- Direct Gas actuators — LDG*
- Gas Over Oil actuators — LGO*
- Electro-Hydraulic actuators — LEH*
- Standard and Customized Controls
- Application Engineering Support

Gearboxes

- V — Bevel gearboxes for manual or motorized operation
- WG — Worm gearboxes for manual or motorized operation
- SR — Spur gearboxes for manual or motorized operation

One Flowserve Solution

Flowserve brands for most common control accessories:

- Digital Positioners
  - Logix™
  - PMV™
- Analog Positioners
  - PMV
  - Accord™
- Diagnostic Software
  - ValveSight™
- Valve Controllers
  - Automax™
  - Worcester Controls™
- Limit Switch Boxes
  - Worcester Controls
  - PMV
  - Automax
  - Accord

* Contact Flowserve for product availability and additional information.

To find your local Flowserve representative
or for more information about Flowserve Corporation, visit www.flowserve.com or call USA 1 800 225 6989 or International +1 972 910 0774

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FLOWSERVE

Limitorque™ LPS

Limitorque Pneumatic Scotch Yoke Heavy-Duty Actuator

Experience In Motion

FLOWSERVE

Quality, Dependability and Productivity

Flowserve Limitorque makes valve control easier in ways as diverse as the applications in which its products are used. LPS pneumatic actuators deliver up to 300 kNm (221 270 ft-lb) of precisely controlled torque — safely automating valves for all types of applications, including HIPPS (High-Integrity Pressure Protection Systems).*

Available in a wide range of materials suitable for use in the most demanding conditions, LPS actuators are complemented by a comprehensive range of control systems, including ESD, PST, Line-Break and Quick-Closing options. A suite of standard controls systems is available for short delivery, but the Limitorque engineering team can design custom solutions for the largest and most complex customer requirements.

Today's industry requirements are more rigorous than ever before. Nowhere is this more evident than in the Oil and Gas industry where new requirements are incorporated into project specifications almost every day. Limitorque has addressed these demanding requirements in the design of their latest product, the LPS actuator. This makes the LPS the most technically advanced and market-compliant actuator available anywhere in the world.

The LPS actuator features a 25-year design life depending on service conditions, proper installation, operation and maintenance. In order to achieve this industry-leading design life, in-field maintenance is prescribed to be performed every six years of operation. For high-cycle applications, such as control valve operation, more frequent maintenance of the replaceable wear surfaces, as outlined in EN 15714, may be required.

To complete the automation package, LPS actuators are available with accessories such as lockout modules and gear overrides. Limitorque provides engineering design services for mounting hardware, ensuring that your actuation solution is ready to handle the toughest challenges.

* For higher torque ranges, consult factory.

LPS Limitorque Pneumatic Heavy-Duty Scotch Yoke Actuators

LPS actuators provide up to 300 kNm (221 270 ft-lb) of heavy-duty torque. Enhanced performance is achieved by using a superior scotch yoke support design that significantly reduces transverse loads. LPS actuators feature modular construction to minimize repair time and initial cost while maximizing process availability.

Features

- Spring Return Single Acting (Fail Close CW and Fail Open CCW) and Double Acting (Fail Last / Fail As Is) executions
- True modular design for flexible and easy field conversion from Fail Close CW to Fail Open CCW configuration or vice versa
- Scotch yoke housing design optimized to facilitate field maintenance and to provide extended design life
- Symmetrical and canted scotch yoke types to perfectly fit valve torque requirement
- Fabricated carbon steel scotch yoke housing, pneumatic cylinder and spring can, providing the most rugged actuator available; different materials of construction for polar or offshore applications upon request
- ENP Lined Cylinders with Chrome Plated Piston Rod; Stainless Steel Cylinders, Tie Rods and Spool Pieces available upon request
- Increased maximum valve stem acceptability to allow direct coupling with valves
- Suitable for use in on/off, modulating and control valve application in general service, protective service and safety applications such as ESD or HIPPS
- Full range of accessories: switchboxes, positioners; ESD and PST functionalities; custom control panels; fire protection; quick exhaust and dampers; manual and hydraulic overrides*

LPS Single Acting with Jackscrew Light (-JL)

LPS Single Acting with Enclosed Handwheel (-JS)

LPS Single Acting with Bevel Gear Handwheel (-BG)

LPS Single Acting with Hydraulic Handpump (-HP)

Specifications

- Available in standard single-acting spring return and double-acting configurations, in torque ranges up to 300 kNm (221 270 ft-lb); contact factory for larger sizes
- Maximum allowable working pressure (MAWP): 12 barg (174 PSIG)
- Suitable supply medium: instrument air, nitrogen or sweet gas; contact factory for sour gas applications
- -29°C to 100°C (-20°F to 212°F) standard operating temperature range; Low temperature -60°C (-76°F) and high temperature 160°C (320°F) ranges available upon request (polar, cold, arid and tropical temperature requirements in accordance with IEC 60721)
- End mounted adjustable travel stops ± 5°, available also in an enclosed protected version upon request

Key Certifications and Standards Compliance

- Certified according to ATEX 94/9/EC Ex II 2GD c IIC T6
- IP66/IP66M and IP67/IP67M configurations per EN 60529
- SIL 3 certified in accordance with IEC 61508
- Available in compliance with PED 97/23/EC, ASME BPVC Sec. VIII Div. 1, EN 13445-3 Part 2 for Unfired Pressure Vessels
- NEMA4 and NEMA4X per NEMA 250
- Available valve interface in compliance with ISO 5211
- Actuator spring design in compliance with EN 13906
- Corrosion protection in compliance with ISO 12944-2 and EN 15714-3; optionally available up to and including C5-M
- Available in compliance with NACE specification MR0175 for sour gas applications
- Manufactured and tested in compliance with ISO 9001 and EN 15714-3
- Certified according to CU TR and GOST-R

* Sandwich De-Clutchable Worm gear manual override available as option upon request

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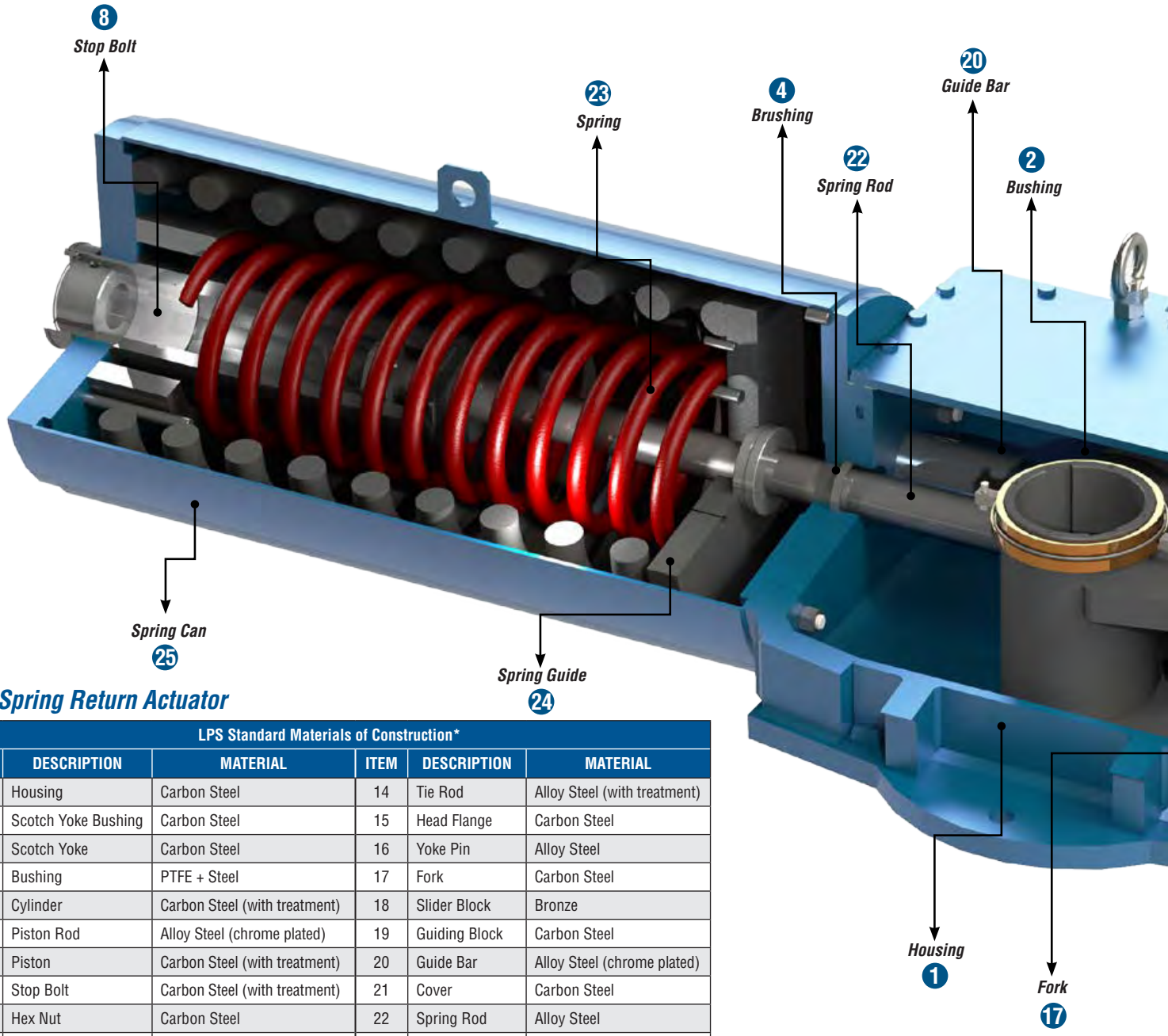
Anatomy of Limitorque LPS Actuator

The Limitorque Pneumatic Scotch Yoke (LPS) Heavy-Duty Actuator is designed to meet the industry's most recent and stringent safety and performance standards for oil and gas applications. Heavy-duty design features a robust construction with high-strength materials that deliver maximum force while minimizing localized stresses. With a maximum allowable working pressure of 12 barg (174 psig), the Scotch yoke actuator provides up to 300 kNm (221 270 ft-lb) of precisely controlled torque. The actuator is available in single-acting spring return and double-acting configurations.

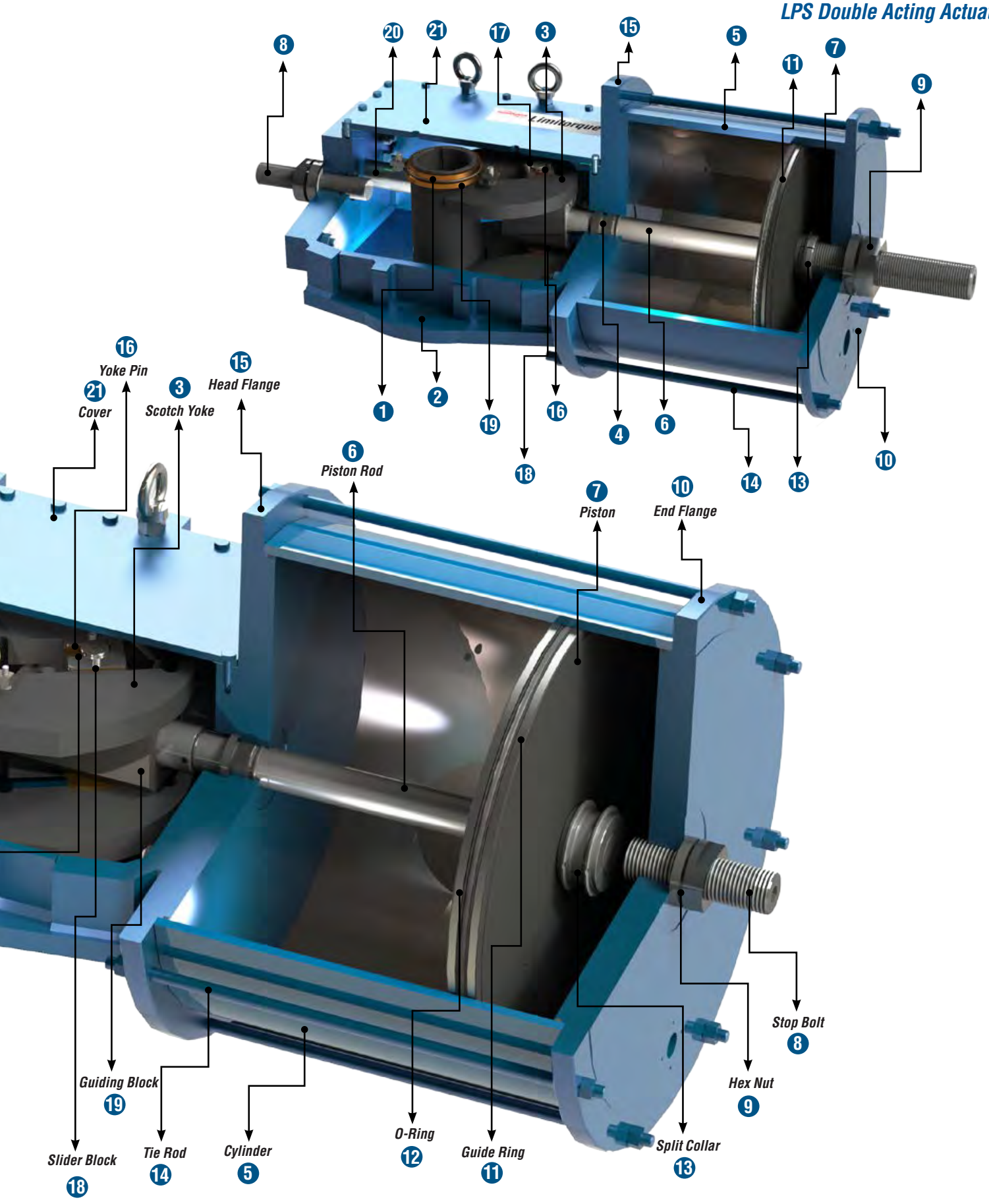


LPS Spring Return Actuator

LPS Standard Materials of Construction*					
ITEM	DESCRIPTION	MATERIAL	ITEM	DESCRIPTION	MATERIAL
1	Housing	Carbon Steel	14	Tie Rod	Alloy Steel (with treatment)
2	Scotch Yoke Bushing	Carbon Steel	15	Head Flange	Carbon Steel
3	Scotch Yoke	Carbon Steel	16	Yoke Pin	Alloy Steel
4	Bushing	PTFE + Steel	17	Fork	Carbon Steel
5	Cylinder	Carbon Steel (with treatment)	18	Slider Block	Bronze
6	Piston Rod	Alloy Steel (chrome plated)	19	Guiding Block	Carbon Steel
7	Piston	Carbon Steel (with treatment)	20	Guide Bar	Alloy Steel (chrome plated)
8	Stop Bolt	Carbon Steel (with treatment)	21	Cover	Carbon Steel
9	Hex Nut	Carbon Steel	22	Spring Rod	Alloy Steel
10	End Flange	Carbon Steel	23	Spring	Spring Steel
11	Guide Ring	PTFE + Graphite	24	Spring Guide	Carbon Steel
12	O-Ring	NBR	25	Spring Can	Carbon Steel
13	Split Collar	Alloy Steel			

*Special or different materials available upon request

LPS Double Acting Actuator



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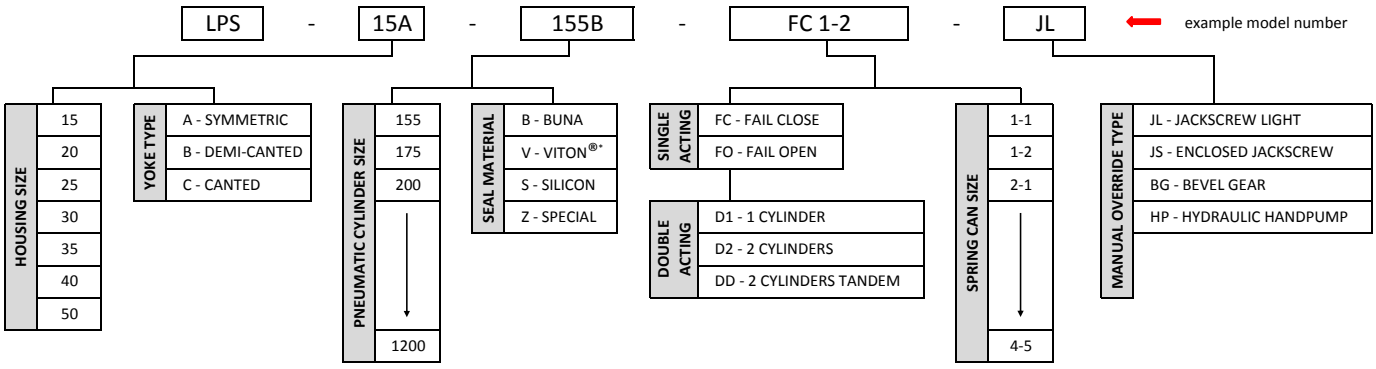
LPS Actuator Selection Table



Seals Material

Code	Material	Temperature Range	Climate Classification According to IEC60721
B	Buna	Std Temp: -29°C to +100°C (-20°F to 212°F)	Tropical and Arid
V	Viton ®*	Hi Temp: up to +160°C (320°F)	
S	Silicon	Low Temp: down to -40°C (-40°F)	Temperate
Z	Other	Special Applications - Consult Factory	Cold & Polar

*Viton is a registered trademarks of E. I. du Pont de Nemours

LPS Torque and Pressure Table

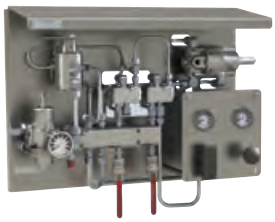
Model	MOT Maximum Operating Torque Nm (ft-lb)	MOP Maximum Operating Pressure barg (PSIG)	MAWP Maximum Allowable Working Pressure barg (PSIG)
LPS-15	6000 (4425)	Variable for every cylinder size.	12 barg (174 psig)*
LPS-20	12 000 (8851)		
LPS-25	21 000 (15 489)		
LPS-30	40 500 (29 871)		
LPS-35	75 000 (55 317)		
LPS-40	150 000 (110 634)		
LPS-50	300 000 (221 268)		
LPS-60	Consult Factory	Consult Factory	

LPS Manual Overrides

Suffix	Description	LPS Actuator Model						
		LPS-15	LPS-20	LPS-25	LPS-30	LPS-35	LPS-40	LPS-50
-JL	Jackscrew Light Handwheel	✓	✓	-	-	-	-	-
-JS	Enclosed Jackscrew Handwheel	✓	✓	-	-	-	-	-
-BG	Bevel Gear Handwheel	-	-	✓	✓	-	-	-
-HP	Hydraulic Manual Hand Pump	✓	✓	✓	✓	✓	✓	✓

Control System Options

Limitorque offers a selection of standard and custom controls packages for most applications to fill customers' needs for short lead-time, low-cost solutions.



- PST
- ESD
- Quick-closing
- Modulating/CV functionality
- Quick exhaust valve with flow regulator suitable for closed loop assembly, when required
- Cylinder integral quick exhaust valve (double acting fast actuator)
- Pneumatic booster (¼ in, ½ in, 1 in size, AL and 316 SS)
- 3/2 and 5/2 pneumatic piloted valve with manual reset and override (¼ in, ½ in, 1 in size, AL and 316 SS)
- Unidirectional and bidirectional flow regulator valve (¼ in, ½ in, 1 in size, AL and 316 SS)
- Compact fittings to reduce pipe and control dimensions (¼ in, ½ in, 1 in size, AL and 316 SS)

Flowserve Solutions

In addition to providing actuators and controls designed to meet or exceed all of today's rigorous requirements, Flowserve and Limitorque lead the industry with all of the essential related solutions that our customers need to maintain peak efficiency and productivity.

- Aftermarket Parts and Services
- Business Assesments
- Actuator Inspection, Maintenance and Repair
- Engineering and Technical Services
  - Engineering Support
  - Technical Assessments
  - Equipment Performance Analysis and Upgrades
- Education and Training
  - On-site Training
  - Online Training
- Asset Data Management and Optimization Solutions

Limitorque Additional Product Range Offering

Electric Actuators and Controls

- CEA — Compact Electric Actuator
- MX — Non-intrusive, electronic multi-turn actuators
- QX — Non-intrusive, electronic quarter-turn actuators
- Master station, controller for redundant networked actuators
- Network controls, Modbus, Profibus DP/PA, Foundation Fieldbus, DeviceNet, HART
- L120 — Electro-mechanical, multi-turn electric actuators with integral and network controls
- SMB — Electro-mechanical, multi-turn electric actuators for nuclear and severe duty service

Gearboxes

- V — Bevel gearboxes for manual or motorized operation
- WG — Worm gearboxes for manual or motorized operation
- SR — Spur gearboxes for manual or motorized operation

Fluid Power Actuators

- Scotch yoke pneumatic actuators — LPS
- Compact Scotch yoke pneumatic actuators — LPC
- Scotch yoke hydraulic actuators — LHS
- Compact Scotch yoke hydraulic actuators — LHC*
- Linear pneumatic actuators — LPL
- Linear hydraulic actuators — LHL*
- Direct gas actuators — LDG
- Gas over oil actuators — LGO*
- Electro-hydraulic actuators — LEH*
- Standard and customized controls
- Application engineering support

*Contact Flowserve for product availability and additional information.

One Flowserve Solution

Flowserve brands for most common control accessories:

- Digital Positioners
  - Logix™
  - PMV™
- Analog Positioners
  - PMV
  - Accord™
- Diagnostic Software
  - ValveSight™
- Valve Controllers
  - Automax™
  - Worcester Controls™
- Limit Switch Boxes
  - Worcester Controls
  - PMV
  - Automax
  - Accord

To find your local Flowserve representative
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FCD LFENBR0001-05-A4 October 2016

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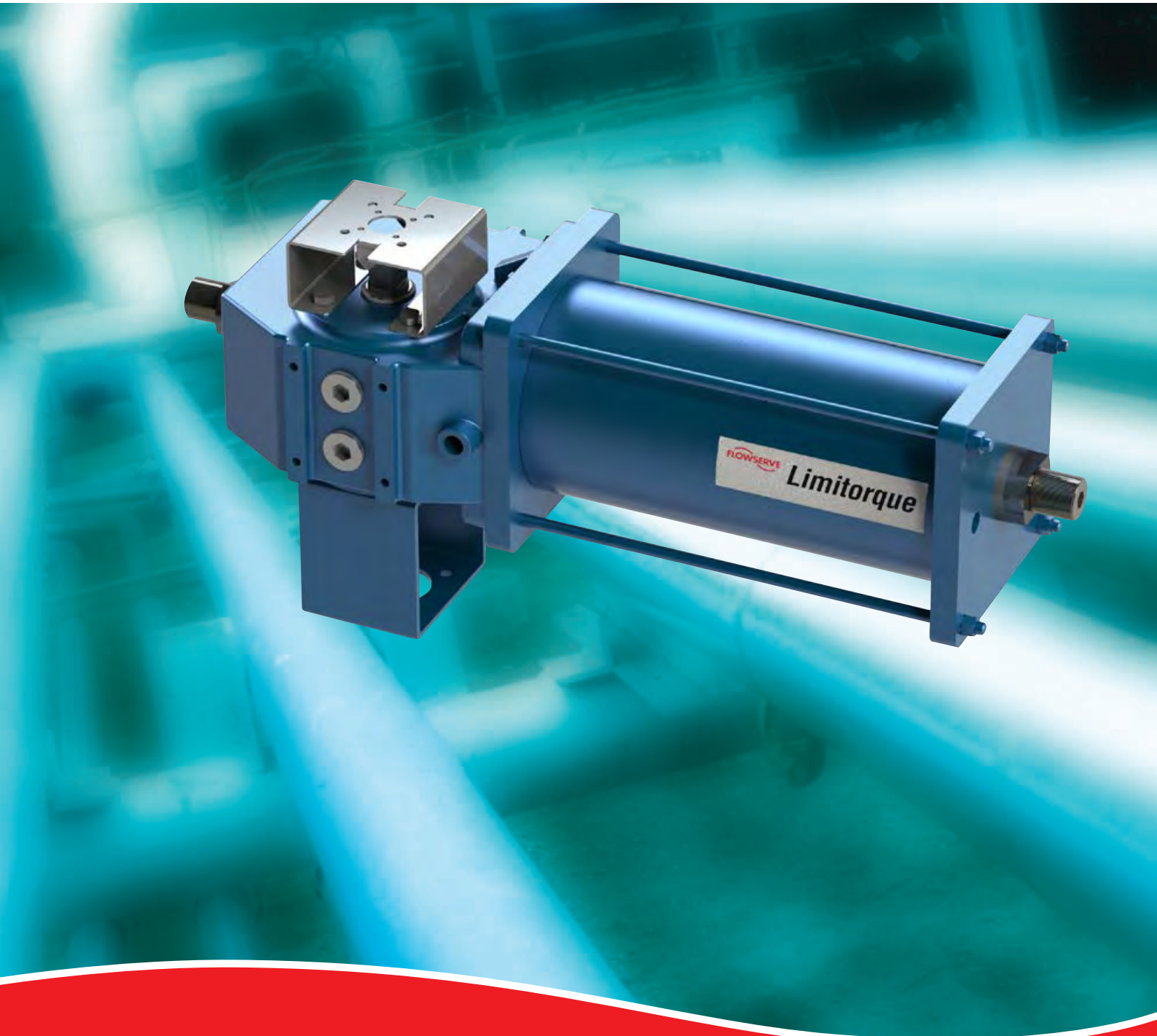
Limitorque® LPC

Limitorque Pneumatic Compact Scotch Yoke Actuator



Experience In Motion

Limitorque Fluid Power Systems

The Flowserve Limitorque portfolio of products makes valve control easier in so many ways — in almost as many ways as the applications they serve.

The Limitorque Pneumatic Compact (LPC) range is a robust, lightweight, modular Scotch yoke design available in both spring return and double acting configurations. It is suitable for actuating ball, butterfly and plug valves or any other quarter-turn application.

LPC compact actuators deliver up to 5500 Nm* (4057 ft-lb) of precisely controlled torque. The LPC product range is complementary to the Limitorque LPS heavy-duty pneumatic Scotch yoke actuators.

A similar design philosophy to the heavy-duty LPS was applied to the new LPC range, delivering enhanced performance and high reliability. The LPC is available in standard as well as special material configurations upon request.

LPC actuators are complemented by a comprehensive range of control systems, including ESD, PST and Quick Closing options. A suite of standard controls systems is available for short delivery, but the Limitorque engineering team can design custom solutions for the largest and most complex customer requirements.

* For higher torque ranges, consult factory.

Today's industry requirements are more rigorous than ever before. Nowhere is this more evident than in the oil and gas industry where new requirements are incorporated into project specifications almost every day. Limitorque has addressed these demanding requirements in the design of their latest fluid power products, the LPC and LPS actuators. This makes LPC and LPS the most technically advanced and market-compliant actuators available anywhere in the world.

The LPC actuator features a 25-year design life, depending on service conditions, proper installation, operation and maintenance. In order to achieve this industry-leading design life, in-field maintenance is prescribed to be performed every five years of operation. For high-cycle applications, such as control valve operation, more frequent maintenance of replaceable wear surfaces, as outlined in EN 15714, may be required.

To complete the actuation package, LPC actuators are available with accessories such as lockout modules and manual overrides. Limitorque provides engineering design services for mounting hardware to ensure that your actuation solution is ready to handle the toughest challenges.

LPC Limitorque Pneumatic Compact Scotch Yoke Actuators

With a 25-year design life* and a maintenance interval up to five years*, the LPC Limitorque Pneumatic Compact actuator is a complementary product to the available range of Limitorque LPS heavy-duty pneumatic Scotch yoke actuators.

Features

- Spring Return Single Acting (Fail Close CW and Fail Open CCW) and Double Acting (Fail Last / Fail-as-is) executions
- Easy field conversion from Fail Close CW to Fail Open CCW configuration or vice versa
- Symmetrical and Canted Scotch yoke types to perfectly fit valve torque requirement
- Housing constructed in Nodular Ductile Cast Iron; Carbon Steel or different materials of construction available upon request.
- Carbon Steel ENP lined Cylinders; Stainless Steel Cylinders, Tie Rods and Spool Pieces available upon request
- External Tie Rods cylinder construction; protected Tie Rods version available upon request for offshore applications
- Upon request, available in balanced weight configuration, with cylinder and spring installed on opposite sides of central body**
- Suitable for use in on/off, modulating and control valve application in general service, protective service and safety applications such as ESD or HIPPS
- Full range of accessories: switchboxes, positioners; ESD and PST functionalities; custom control panels; fire protection; manual overrides

Specifications

- Torque range from 50 Nm (37 ft-lb) up to 5500 Nm (4057 ft-lb)**
- Maximum allowable working pressure (MAWP): 12 barg (174 PSIG)
- -29°C to 100°C (-20°F to 212°F) standard operating temperature range; Low temperature -60°C (-76°F) and high temperature 160°C (320°F) ranges available upon request (polar, cold, arid and tropical temperature requirements in accordance with IEC 60721)
- End mounted adjustable travel stop ± 5°, available also in an enclosed protected version upon request

Key Certifications and Standards Compliance

- Certified according to ATEX 94/9/EC Ex II 2GD c IIC T6
- NEMA4 and NEMA4X per NEMA 250
- IP66/IP66M and IP67/IP67M certified
- SIL 3 certified in accordance with IEC 61508
- Available valve interface in compliance with ISO 5211
- Actuator spring design in compliance with EN 13906
- Corrosion protection in compliance with ISO 12944-2 and EN 15714-3; optionally available up to and including C5-M
- Available in compliance with NACE specification MR0175 for sour gas applications
- Available in compliance with PED 97/23/EC, ASME BPVC Sec. VIII Div. 1, EN 13445-3 Part 2 for Unfired Pressure Vessels
- Manufactured and tested in compliance with ISO 9001 and EN 15714-3
- Available according to CU TR and GOST-R

* Depending on service conditions, proper installation, operation and maintenance.

** Consult factory for other sizes or for more information.

LPC Modular Design and Accessories

LPC Spring Return Without Manual Override

LPC Spring Return With Manual Override

LPC Double Acting Without Manual Override

LPC Double Acting With Manual Override

LPC Special (Balanced Weight) Configuration, With Cylinder and Spring Installed on Opposite Sides of Central Body

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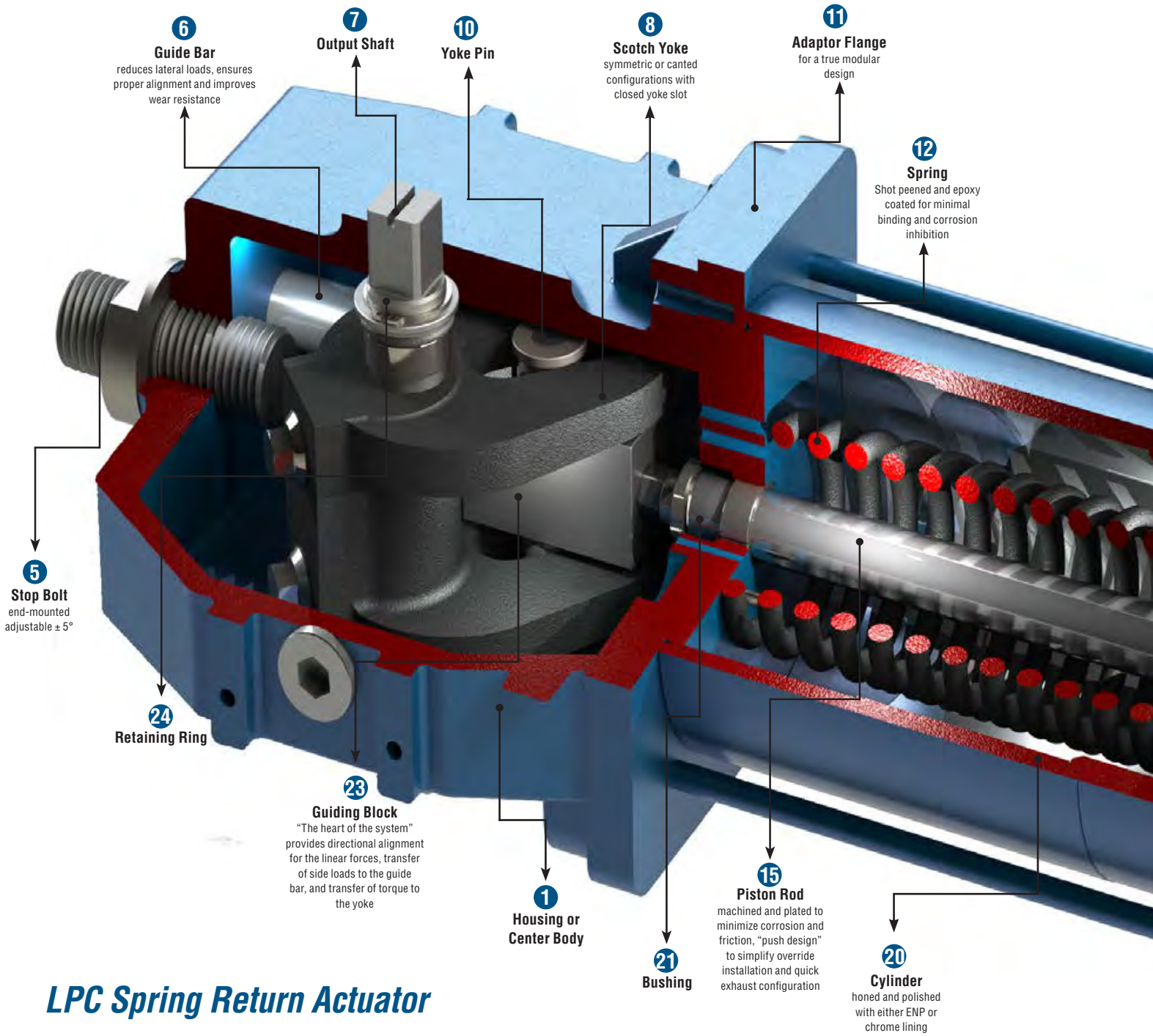
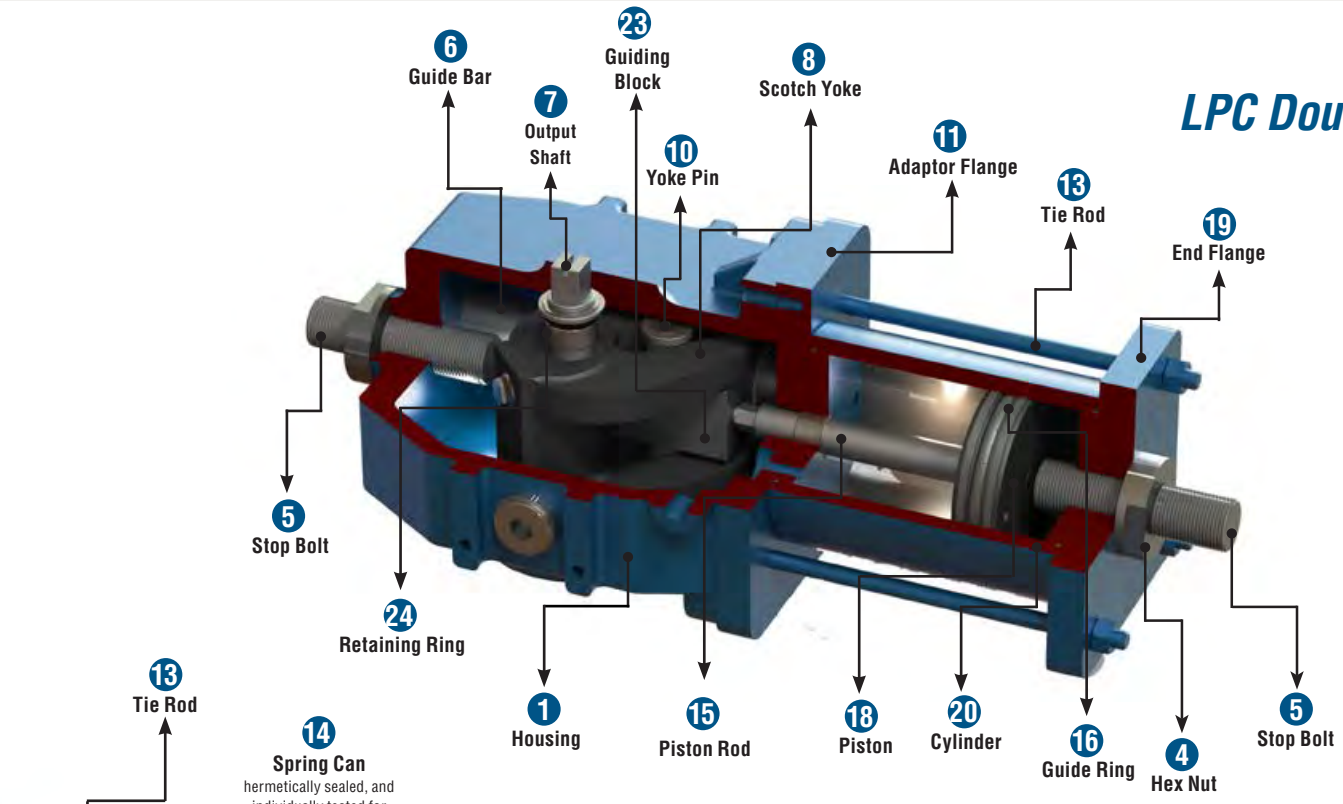
Anatomy of Limitorque LPC Actuator

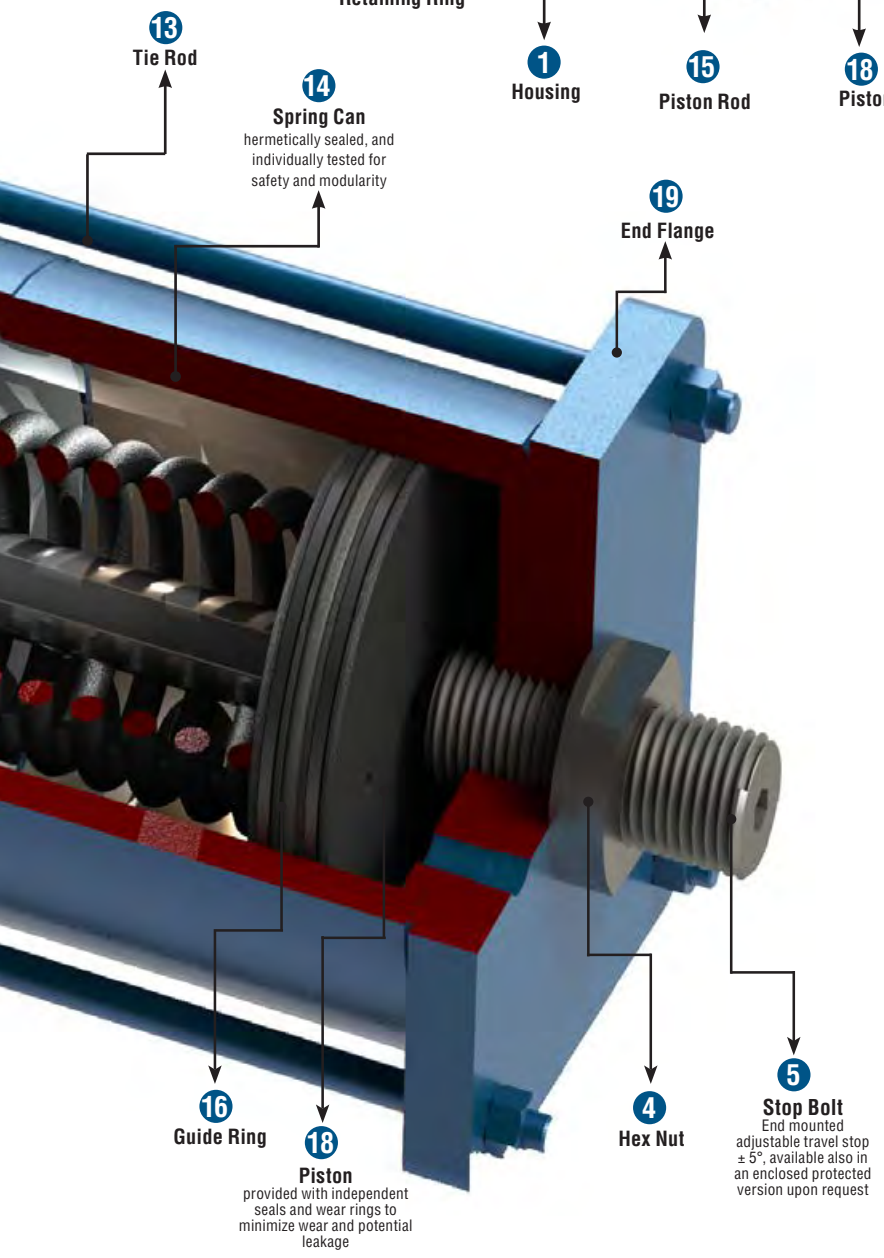
The LPC range of Limitorque Pneumatic Actuators is a robust, lightweight modular Scotch yoke design, available in both spring return and double acting configurations. The LPC product range is complementary to the already available range of Limitorque LPS heavy-duty pneumatic Scotch yoke actuators. A similar design philosophy to the heavy-duty LPS was applied to the new LPC range, delivering enhanced performance and high reliability. The LPC is available in a selection of standard as well as special materials, upon request.



LPC Spring Return Actuator

LPC Double Acting Actuator



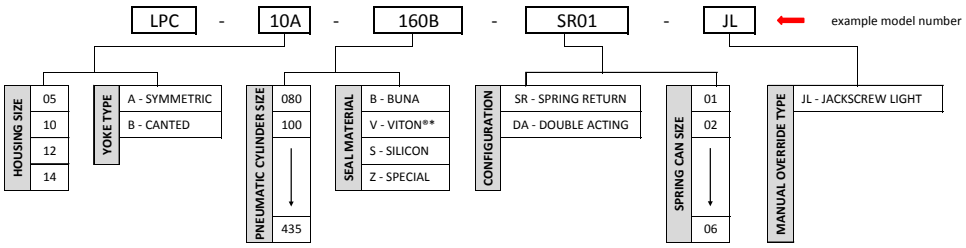


LPC Standard Materials of Construction*		
Item	**Description**	**Material**
1	Housing	Ductile Iron or Carbon Steel
2	O-Ring	NBR
3	O-Ring	NBR
4	Hex Nut	Carbon Steel
5	Stop Bolt	Carbon Steel (with treatment)
6	Guide Bar	Alloy Steel (chrome plated)
7	Shaft	Alloy Steel
8	Scotch Yoke	Ductile Iron or Carbon Steel
9	Washer	Carbon Steel
10	Yoke Pin	Alloy Steel
11	Adaptor Flange	Carbon Steel
12	Spring	Spring Steel
13	Tie Rod	Alloy Steel (with treatment)
14	Spring Can	Carbon Steel
15	Piston Rod	Alloy Steel (chrome plated)
16	Guide Ring	PTFE + Graphite
17	O-Ring	NBR
18	Piston	Carbon Steel (with treatment)
19	End Flange	Carbon Steel
20	Cylinder	Carbon Steel (with treatment)
21	Bushing	PTFE + Steel
22	O-Ring	NBR
23	Guiding Block	Carbon Steel
24	Retaining Ring	Stainless Steel

*Special or different materials available upon request

FLOWSERVE

LPC Actuator Selection Table



Seals Material

Code	Material	Temperature Range	Climate Classification according to IEC60721
B	Buna	Std Temp: -29°C to +100°C (-20°F to 212°F)	Tropical & Arid
V	Viton ®*	Hi Temp: up to +160°C (320°F)	
S	Silicon	Low Temp: down to -40°C (-40°F)	Temperate
Z	Other	Special Applications - Consult Factory	Cold & Polar

LPC Torque and Pressure Table

Model	MOT Maximum Operating Torque Nm (ft-lb)	MOP Maximum Operating Pressure barg (PSIG)	MAWP Maximum Allowable Working Pressure barg (PSIG)
LPC-05	500 (369)	Variable for every model	12 (174)
LPC-10	1600 (1180)		
LPC-12	3500 (2582)		
LPC-14	5500 (4057)		

* For higher output torques, consult factory.

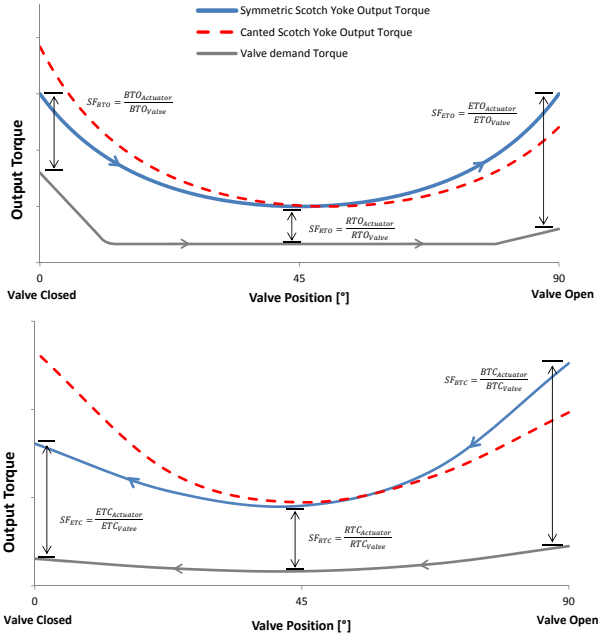
LPC Sizing and Selection

Due to the Scotch yoke mechanism, LPC actuators have a particular U-shaped output torque curve, whether powered by a fixed supply pressure or the spring.

For a proper actuator model selection, the safety factors between actuator output torque and valve torque requirement shall be calculated at least in six points along the valve stroke. In addition, a final check is necessary to guarantee that actuator Maximum Output Torque does not exceed valve Maximum Allowable Stem Torque (MAST).

The minimum set of parameters and features necessary for an optimal actuator selection:

- Valve torques, including MAST
- Type of actuator:
  - Single Acting/Spring Return: Fail Safe Close (CW) or Fail Safe Open (CCW)
  - Double Acting configuration for Fail Last or Fail As Is
- Minimum, Normal and Maximum Pneumatic Supply pressure to the actuator
- Safety Factors requested by the project or by a specific application
- Working Temperature range
- Open/Close stroking times
- Additional options (manual override, control panel, limit switch box, positioner,...)



Detailed output torque graphs covering the full valve stroke are available for both spring return and double acting actuators.

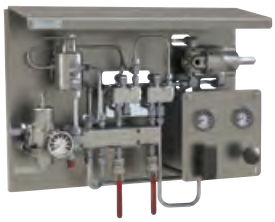
Definitions

BTO	Break to open torque	BTC	Break to close torque
RTO	Running to open torque	RTC	Running to close torque
ETO	End to open torque	ETC	End to close torque
MAST	Maximum allowable stem torque	SF	Safety factor

*Viton is a registered trademarks of E. I. du Pont de Nemours

Control System Options

Limitorque offers a selection of standard and custom controls packages for most applications to fill customers' needs for short lead-time, low-cost solutions.



- PST
- ESD
- Quick-closing
- Modulating/CV functionality
- Quick exhaust valve with flow regulator suitable for closed loop assembly, when required
- Cylinder integral quick exhaust valve (double acting fast actuator)
- Pneumatic booster (¼ in, ½ in, 1 in size, AL and 316 SS)
- 3/2 and 5/2 pneumatic piloted valve with manual reset and override (¼ in, ½ in, 1 in size, AL and 316 SS)
- Unidirectional and bidirectional flow regulator valve (¼ in, ½ in, 1 in size, AL and 316 SS)
- Compact fittings to reduce pipe and control dimensions (¼ in, ½ in, 1 in size, AL and 316 SS)

Flowserve Solutions

In addition to providing actuators and controls designed to meet or exceed all of today's rigorous requirements, Flowserve and Limitorque lead the industry with all of the essential related solutions that our customers need to maintain peak efficiency and productivity.

- Aftermarket Parts and Services
- Business Assesments
- Actuator Inspection, Maintenance and Repair
- Engineering and Technical Services
  - Engineering Support
  - Technical Assessments
  - Equipment Performance Analysis and Upgrades
- Education and Training
  - On-site Training
  - Online Training
- Asset Data Management and Optimization Solutions

Limitorque Additional Product Range Offering

Electric Actuators and Controls

- MX — Non-intrusive, electronic multi-turn actuators
- QX — Non-intrusive, electronic quarter-turn actuators
- Master station, controller for redundant networked actuators
- Network controls, Modbus, Profibus DP/PA, Foundation Fieldbus, DeviceNet, HART
- L120 — Electro-mechanical, multi-turn electric actuators with integral and network controls
- SMB — Electro-mechanical, multi-turn electric actuators for nuclear and severe duty service
- CEA - Compact Electric Actuator

Fluid Power Actuators

- Scotch yoke pneumatic actuators — LPS
- Compact Scotch yoke pneumatic actuators — LPC
- Scotch yoke hydraulic actuators — LHS
- Compact Scotch yoke hydraulic actuators — LHC*
- Linear pneumatic actuators — LPL
- Linear hydraulic actuators — LHL*
- Direct gas actuators — LDG
- Gas over oil actuators — LGO*
- Electro-hydraulic actuators — LEH*
- Standard and customized controls
- Application engineering support

Gearboxes

- V — Bevel gearboxes for manual or motorized operation
- WG — Worm gearboxes for manual or motorized operation
- SR — Spur gearboxes for manual or motorized operation

One Flowserve Solution

Flowserve brands for most common control accessories:

- Digital Positioners
  - Logix™
  - PMV™
- Analog Positioners
  - PMV
  - Accord™
- Diagnostic Software
  - ValveSight™
- Valve Controllers
  - Automax™
  - Worcester Controls™
- Limit Switch Boxes
  - Worcester Controls
  - PMV
  - Automax
  - Accord

*Contact Flowserve for product availability and additional information.

To find your local Flowserve representative
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