

Hydrostatic Bearing Actuators

The World of Ride Simulators

Servotest Hydrostatic Bearing Actuators are double-ended, fatigue and robust, with a dynamic force range of 5KN to 5000KN and a stroke range of 50mm to 500mm.

Rated for operation at 210 bar supply pressure, Servotest actuators are designed to work with pressures of up to 280bar.

Modular in design, they provide many options on stroke, force, flow capacity, and accessories for a wide range of dynamic and static test applications including vibration, shock, fatigue, and resonance testing of materials, components and complete assemblies and structures.

They can be supplied in either the standard square bodied or the latest round bodied design, depending on application.



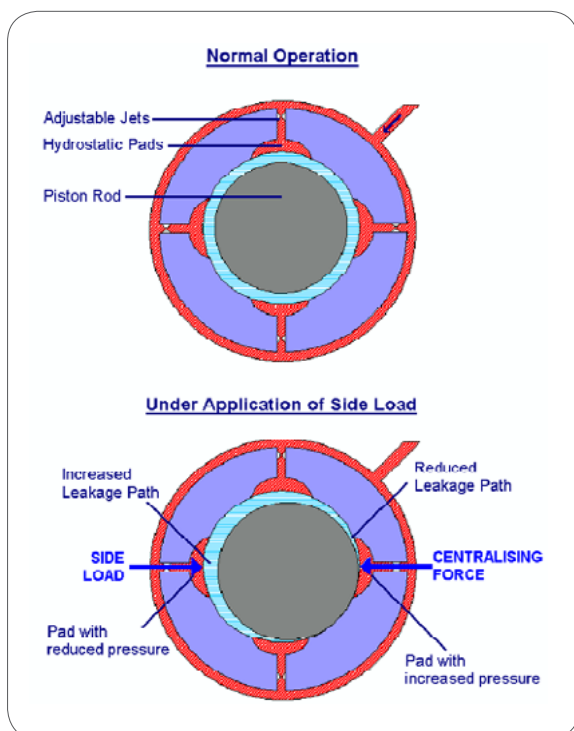
A world of experience...

Servotest is a World Class Test and Motion Simulation Company, with experience of operating around the globe, for multi national corporations, smaller specialist companies and Government Departments. Since the 1950's our engineers and equipment have been at the forefront of our industry. Product and Service quality is maintained by a program of continuous training and

development of our engineers and equipment. We operate in all of the key industry sectors for our marketplace, including Automotive, Marine, Civil Engineering, Aviation, Defence, Aerospace and Traction. The company holds both ISO14001 and 9001 Quality accreditation marks and is a member of many national and international trade organizations.

Reliability and Maintenance

The hydrostatic bearing actuators are fatigue rated for continuous operation and long trouble free life in excess of 50×10^8 cycles. They are easy to maintain, the only items requiring periodic attention are the oil filters and low pressure seals. The filters can be replaced on site by the customer without any need to dismantle the actuator. One of the low pressure seals can be reached without any dismantling and the other is made easily accessible by removing the transducer housing.



Hydrostatic bearing principle of operation

Construction

A hydrostatic bearing actuator consists of a hollow hard-chromed alloy steel piston rod, housed inside a steel cylinder, which is machined to close tolerances. Internal and external threads are provided at the upper rod end for attachment of vibration tables, load cells or mounting fixtures. Pressure equalising grooves are machined into the piston and no piston seals are fitted, giving friction free movement. High strength aluminium alloy front and rear bearing heads incorporate hydrostatic bearing pads, which provide a self-centring force on the rod and prevent metal-to-metal contact so that side load capacity is increased and friction is eliminated.

Hydraulic snubbing sections are also incorporated into the bearing heads to prevent damage to the actuator in the event of piston rod overtravel, resulting from a system failure or incorrect usage.

Low-pressure seals, constructed from Nitrile based material, are fitted at each end of the actuator, to retain the oil leakage from the hydrostatic bearings. This oil is collected in annular galleries and returned to the system either through internal oilways to the return ports or through a special drain hose, depending on the actuator design. A range of servo valve manifolds enables the use of up to six Moog 76 series two stage valves, or 3 stage servovalves for large flows depending on the actuator performance required. The valves and associated manifold are mounted directly on the actuator cylinder, to minimise the volume of oil between valve and piston and hence reducing the compressible volume and maximise the hydraulic resonant frequency.

Mounting Methods

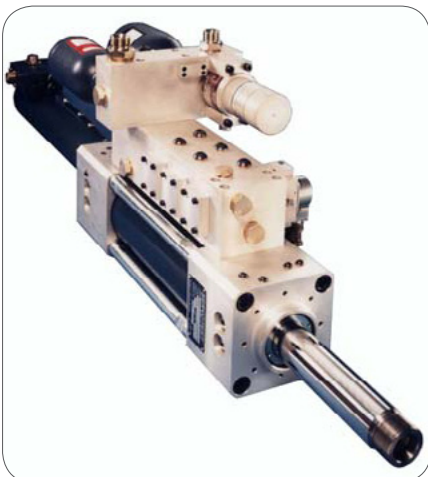
Several mounting methods are available, depending on the test application. Servotest actuators can be freely supported by self-aligning bearings, trunnion mounts, gimbals, or flange mounts and mounted in load frames, vibration stands or incorporated directly into a special test rig.

Preload Section

For many components or structures the loading pattern comprises of two components, a mean load, or preload, and an alternating load. The preload can either be a tensile or compressive load and is usually constant.

All servo-controlled actuators have the capability of exerting a load composed of both these components, providing that the sum of the two components does not exceed the maximum rating of the actuator. However, in applications involving high velocities and high levels of mean load, the preload actuator can reduce by as much as half the size of the hydraulic power supply and the energy consumed during a test.

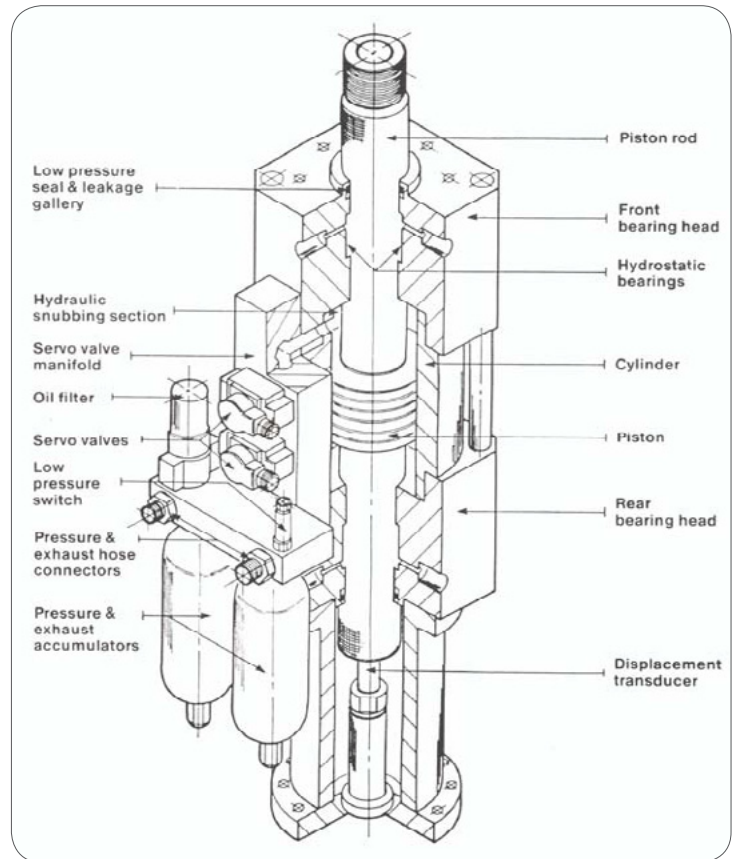
In these cases a compressive pre-load is fitted by applying pressure to the base of the piston. This pressure is maintained at a constant value with large accumulators, controlled via a pressure feedback transducer and low flow servovalve.



Actuator Range

Based on years of experience and development Servotest 050, 065, 080, and 0100mm rod dia. type actuators are of low aspect ratio design to give high flexural rigidity and low stress levels. The three different piston rod sizes are double-ended, fatigue rated hydrostatic bearing actuators.

Designed to satisfy a wide spectrum of applications Servotest actuators allow the integration of piston rod fixtures and wheel pan assemblies for use on 4 Poster Ride Simulators - Please refer to 4 Poster Brochure. The actuator/wheel-pan assemblies are a proven design specifically for high cycle, long life, and low maintenance applications. Servotest Wheel pan units are renowned world wide for extreme reliability in many similar tough applications.



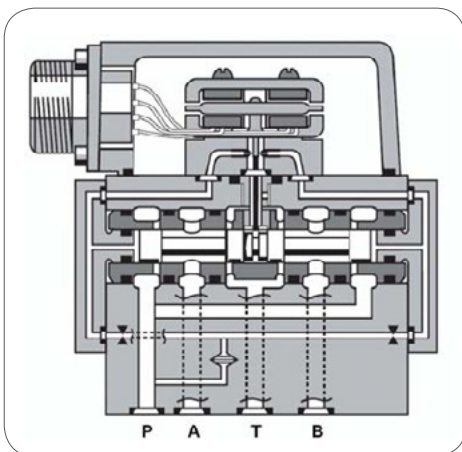
Typical Servotest Hydrostatic Bearing Actuator



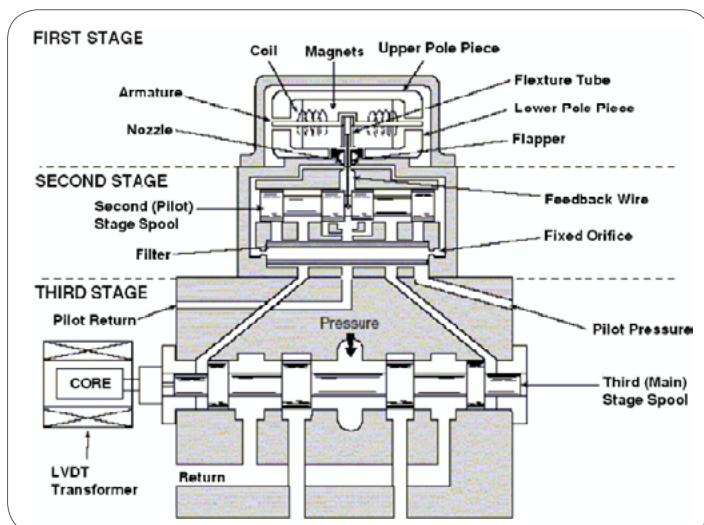
Servovalves – Two-stage

Servotest use either the Moog 770 series small body or the Moog 760 series Servovalves on the hydrostatic bearing actuators. These valves are used because of their high frequency response and good resolution at very low flow rates. The use of both these types of valves enables the arrangement of multiple valves in parallel on the same manifold to give increased flow capacity but without any loss of frequency response.

Both valves are conventional two-stage, four way flow control, with a flapper/nozzle first stage with a dry torque motor and a closed centered single spool second stage with cantilevered spring mechanical feedback. There is also an integral oil filter to protect the first stage.



Two-stage valve



Three-stage valve

Servovalves – Three-stage

Three-Stage valves typically provide larger flows than are possible with two-stage valves. Three stage valves consists of a Moog two stage servovalve that acts as the pilot valve for the Servotest designed third stage spool. The spool assembly of the three stage servovalve includes spool centring springs, to return the spool to its null position in the event of loss of signal to the pilot servovalve. The spool is also fitted with a spool displacement transducer, allowing a feedback path to the electronic control system. The third stage spool assembly has been designed to allow fluid flows in the range of 250 to 1200 liters per minute per valve. Multiple valves can be used in parallel allowing very large fluid flows.

Servotest three stage servovalves are fitted with a separate filter that feeds the pilot valve and hydrostatic jets. The hydraulic fluid filter is fitted with an “element clogged” indicator, enabling a visual warning to be given in the event of the filter element becoming blocked due to the quantity of contamination removed from the hydraulic fluid.

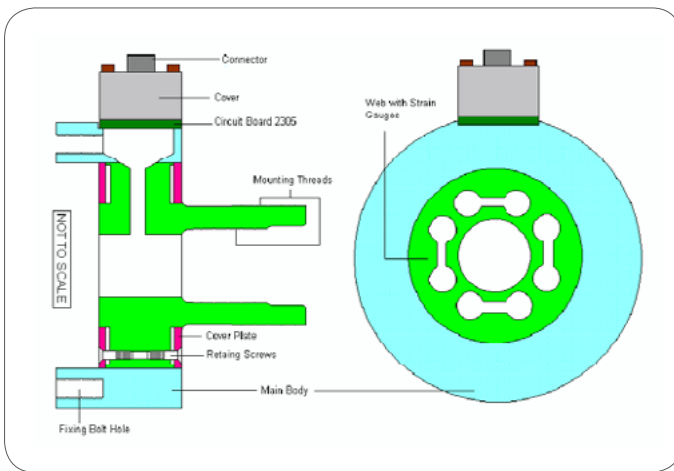
A cross manifold provides mounting facilities for pressure and exhaust accumulators, an oil filter to protect the servovalve and a low pressure interlock switch.

Pressure accumulator is fitted close to the servo valve pressure port to give instantaneous flow to meet peak demands, while an exhaust accumulator is fitted close to the exhaust port to smooth pulsation in the return line.

The oil filter connects with the hydraulic system upstream of the servo valves and hydrostatic bearings. It provides 10 micron filtration of impurities. These may enter the system when the flexible hoses to the actuator are disconnected or if particles are eroded from the inner surface of the hoses

Safety

Fitted as a safety precaution the low-pressure switch provides an electrical interlock, which prevents the electronics from being switched off while there is still pressure in the system. In the event of mains power failure when the electronics are automatically transferred to battery power for a controlled shut down, the switch detects the safe low-pressure level and causes the battery supply to be switched off if exceeded.



Safety Accessories

Servotest hydrostatic bearing actuators, designed for full compatibility with a complete range of accessories, from fixtures, joints, Load Cells, to displacement, velocity and pressure transducers.

LVDT

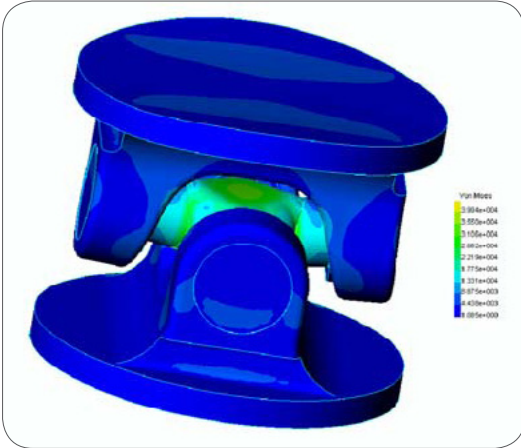
A Linear Variable Displacement Transducer (LVDT) monitors the piston rod displacement and outputs a feedback signal to the electronic control equipment for closed-loop displacement control. LVDTs are co-axially mounted within the piston rod to maximise accuracy and protection.

Load Cells

For load control, a fully compatible Servotest load cell is fitted to the piston rod end. The Servotest LC range of Load Cells are precisionmade force transducers for tension and compression through zero measurement. They are available in a wide range of sizes from 2.5kN to 5000kN, and are fully compatible with the standard range of Servotest Linear Actuators and Test Machines. All accessories that fit the actuator piston rod will fit the load cell, and the load cell can be attached to an actuator or load frame without using special adapters. Non-standard sizes, even outside this range, can be supplied to special order.

Bearings and Joints

Servotest offers a variety of actuator joints and bearings matching the requirements of Seismic, automotive, and aerospace industries.



There are four types of bearings/joints:

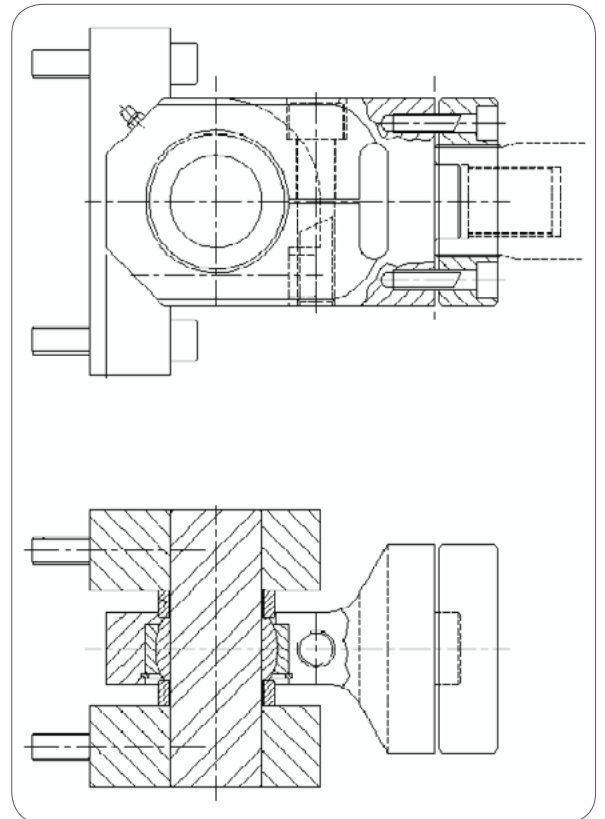
Servotest Cardan Bearings

Widely used in MAST systems (Seismic applications) and many applications, where zero backlash, high stiffness, & long life are required. Servotest designed bearing can undergo axial and side loads. The housings and pins are machined to give zero working clearance and this, combined with the oil bath lubrication, will give a very long life with freedom from fretting and wear. Using cageless full complement roller bearings, which have high load carrying capacity, the dimensions of the bearings and hence the bearing assembly are minimised. CARDAN friction coefficient is between 0.002 and 0.004 with a 'stiction' component of less than 10nM per joint. Cardan type bearings are pre-loaded to give zero backlash.



Rod End Bearings

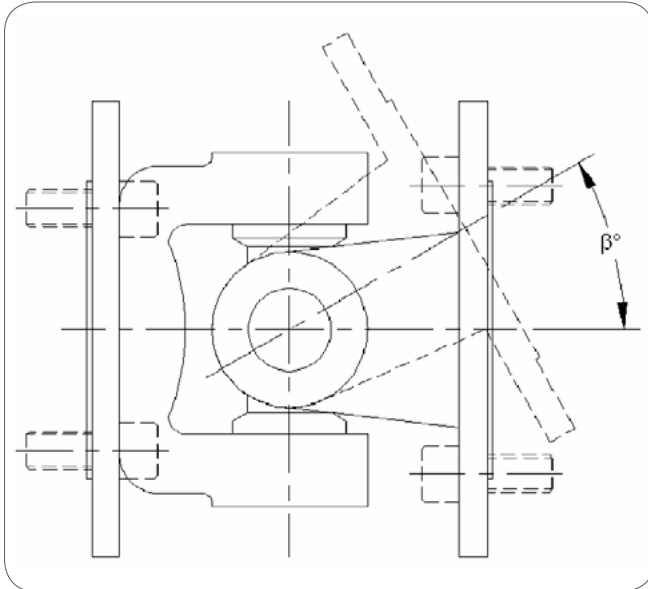
Self aligning bearing assembly for mounting to the reaction point and the specimen for use with Pseudodynamic testing application, Steering Test Machine. The simple design features anti backlash capabilities and is designed to operate under a wide range of loads - from 20KN (compatible with 40mm rod size actuator) to 1000KN (suited for the 200mm rod size actuator).



Bearings and Joints (cont.)

Hooke Joints

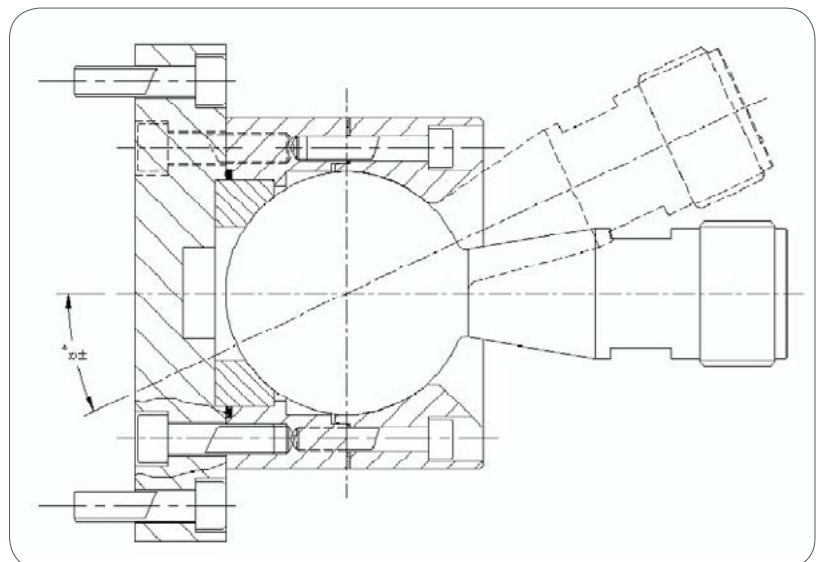
Lower cost UJ joint for applications without zero loading or where a small backlash is acceptable.



Plain Spherical Bearings

Spherical steel ball joint housed in hardened steel bearings pads.

Backlash free ball joints are the ideal connection elements for dynamic testing in conjunction with Servotest hydraulic actuators. Ball joints are used to protect actuators from unwanted side loads, while oscillating loads are applied to the test object, the ball joints allow rotation of the test object. The nominal angle of ball joints are +/- 19 or 25 degree in each axis. Servotest also offers connection flanges and adapters to suit actuator and bearing interface.



PULSAR Actuator Control Node

Servotest hydrostatic bearing actuators are controlled via Servotest PULSAR digital Controller, which offers the user the very latest in digital control for servohydraulic test and simulation systems. It employs state-of-the-art real-time control techniques to ensure optimum accuracy. The system is based on a revolutionary I/O system, using distributed fibre-optic technology.

Each actuator control node box can contain up to six transducer modules, in addition to the standard motherboard and FPGA board. Some feature an integral carrier module for transducer excitation.

The nodes connect to the hub by a combination of optical-fibre and power cables. Actuator nodes provide connection to the controller for the following transducers and devices:

Transducers: cover DC and AC excited transducers of the following common types:

- Load Cells
- Torque Transducers
- LVDT
- RVDT
- LVT
- Accelerometers
- Pressure Transducers
- Thermocouples
- Extensometers
- Optical Encoders

Devices

- Three stage EFB valve drive – with local spool loop closure
- Two stage valve drive – current mode drive, up to 4 valves
- Analogue Input for customer and system use – twin differential I/P 16-18 bit Synchronised ADCs (+/- 5 - 10Vdc)
- Analogue Output for customer and system use – twin 16 bit Synchronised DACs (+/- 5 - 10Vdc)
- Digital I/O – 16 channels of configurable logic I/O



Specification and Actuator Selection

To ensure Servotest hydrostatic actuator meets your testing applications, please follow the procedure below:

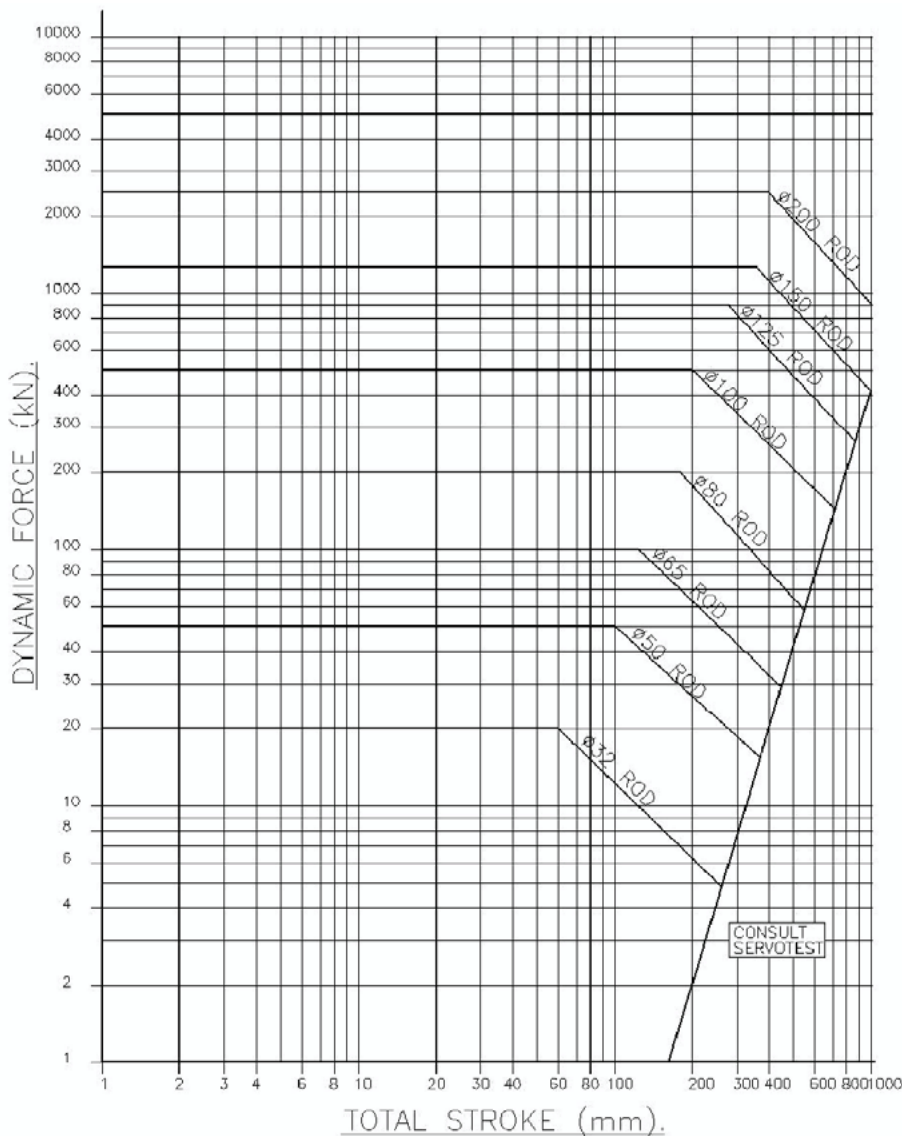
The major constraints on actuator selection is the force rating and sideload tolerance, as this status can reduce the life of the actuator and consequently distort test results.

The procedure outlined below allows you to determine the right actuator specification by considering two items:

- Side Load
- Bearing pressure

The actual output produced by any motion generating device is usually defined by the instantaneous force and rate. In the case of a hydraulic system, these parameters correspond to the pressure and rate of hydraulic fluid flow.

Accurately and smoothly controlled output force of the motion device will result in equally accurate and smooth control of acceleration, provided that the output force is used solely for the production of acceleration and only a small proportion for overcoming friction. Of the forms of friction, 'stiction' or the nonlinear force present at the motion reversal point is of far greater importance.



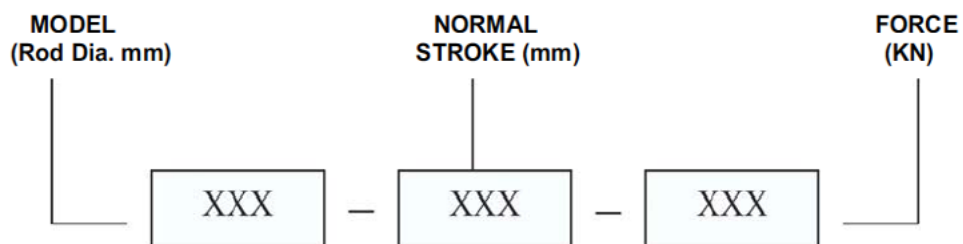
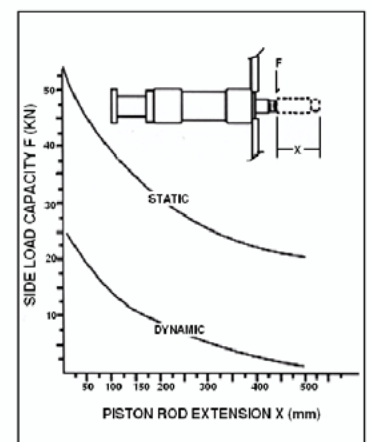
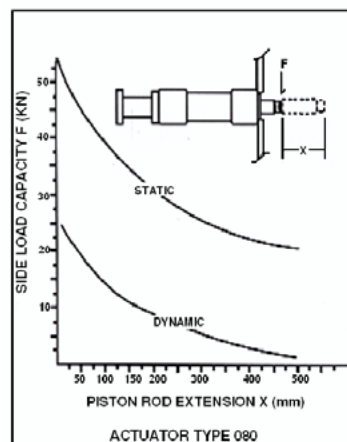
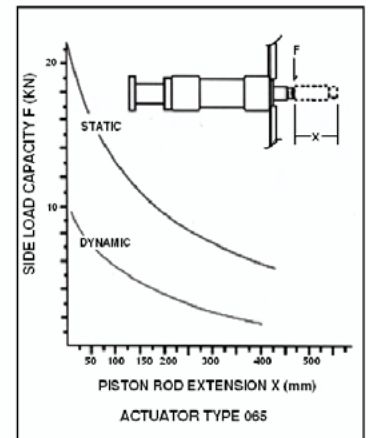
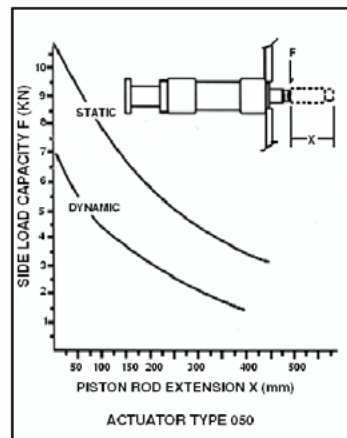
Actuator selection plot

Actuator Selection

Use the figure on page 10. to read the desired stroke and dynamic loading Force, then read off the piston rod size to ensure the piston rod bending stiffness is suitable. The graph below determines the maximum Static and Dynamic Side Load capacity.

For applications where the actuator experiences radial e.g. direct coupled MAST Systems, then the natural bending frequency must be also considered.

All applications should be reviewed with Servotest to select the most suitable actuator for your testing needs.



Example:

Servotest 080-200-80

- 80mm Rod diameter
- 200mm Stroke
- 80kN Dynamic force at 155 bar pressure

Specification Table

Hydrostatic Bearing Actuator Size: 050

Stroke (mm)	Force (kN)			
	10	15	20	25
200	050-200-10	050-200-15	050-200-20	050-200-25
300		050-300-15	050-300-20	050-300-25

Hydrostatic Bearing Actuator Size: 065

Stroke (mm)	Force (kN)				
	10	15	20	25	30
150	065-150-10	065-150-15	065-150-20	065-150-25	065-150-30
250	065-250-10	065-250-15	065-250-20	065-250-25	
300	065-300-10	065-300-15	065-300-20	065-300-25	

Hydrostatic Bearing Actuator Size: 080

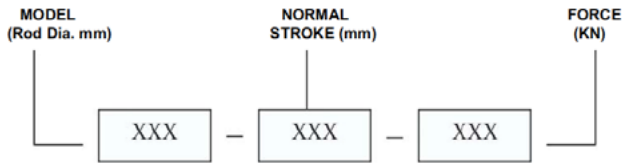
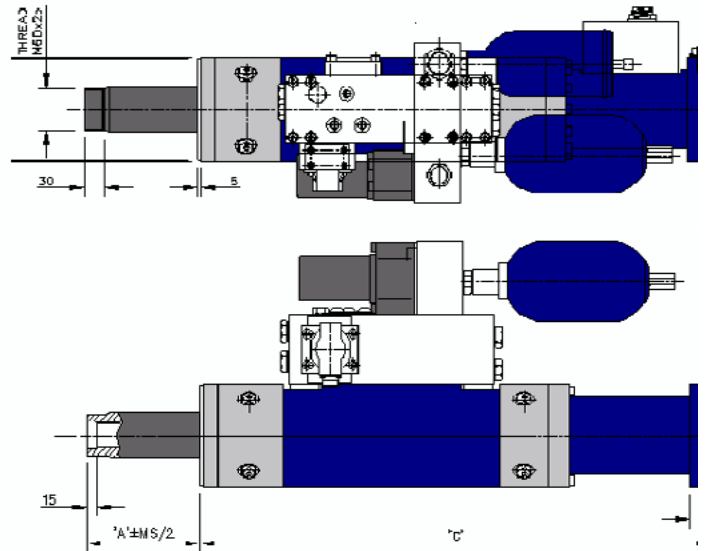
Stroke (mm)	Force (kN)					
	20	30	40	50	70	100
50	080-50-20	080-50-30	080-50-40	080-50-50		
100	080-100-20	080-100-30	080-100-40	080-100-50		
150	080-150-20	080-150-30	080-150-40	080-150-50	080-150-70	080-150-100
200	080-200-20	080-200-30	080-200-40	080-200-50		
250	080-250-20	080-250-30	080-250-40	080-250-50	080-250-70	080-250-100
300	080-300-20	080-300-30	080-300-40	080-300-50		

Hydrostatic Bearing Actuator Size: 100

Stroke (mm)	Force (kN)			
	100	160	180	250
50	100-50-100	100-50-160		
100	100-100-100	100-100-160		
150	100-150-100	100-150-160		100-150-250
200	100-200-100	100-200-160		
250	100-250-100	100-250-160		100-250-250
500			100-500-180	100-500-250

Actuators

Overall Dimensions



ACTUATOR TYPE	MAX STRK (mm)	DIM "A" (MID STRK)	DIM "C"	APPRX WEIGHT (Kg)
065-150-XX	190 (±95)	130	735	87 (50KN) - 90 (5KN)
065-250-XX	290 (±145)	180	935	104 (50KN) - 110 (5KN)
065-300-XX	340 (±170)	205	1035	113 (50KN) - 119 (5KN)

ACTUATOR TYPE	MAX STRK (mm)	DIM "A" (MID STRK)	DIM "C"	APPRX WEIGHT (Kg)
050-200-XX	240 (±120)	156	799	77 (40KN) - 83 (5KN)
050-300-XX	340 (±170)	206	999	87 (40KN) - 93 (5KN)

ACTUATOR TYPE	MAX STRK (mm)	DIM "A" (MID STRK)	DIM "C"	APPRX WEIGHT (Kg)
080-50-XX	90 (±45)	95	585	85 (100KN) - 86 (5KN)
080-100-XX	140 (±70)	120	685	96 (100KN) - 98 (5KN)
080-150-XX	190 (±95)	145	785	105 (100KN) - 108 (5KN)
080-200-XX	240 (±120)	170	885	115 (100KN) - 120 (5KN)
080-250-XX	290 (±145)	195	985	122(100KN) - 128 (5KN)
080-300-XX	340 (±170)	220	1085	136 (100KN) - 143 (5KN)

ACTUATOR TYPE	MAX STRK (mm)	DIM "A" (MID STRK)	DIM "C"	APPRX WEIGHT (Kg)
100-50-XX	110 (±55)	205	710	202 (210KN) - 215 (120KN)
100-100-XX	160 (±80)	230	810	222 (210KN) - 240 (120KN)
100-150-XX	210 (±105)	255	910	243 (210KN) - 265 (210KN)
100-200-XX	260 (±130)	280	1010	250 (210KN) - 275 (210KN)
100-250-XX	310 (±155)	305	1110	286 (210KN) - 314 (210KN)
100-300-XX	360 (±180)	330	1210	306 (210KN) - 339 (210KN)
100-400-XX	460 (±230)	380	1410	347 (210KN) - 386 (210KN)
100-500-XX	560 (±280)	430	1610	387 (210KN) - 434 (210KN)

SERVOTEST

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