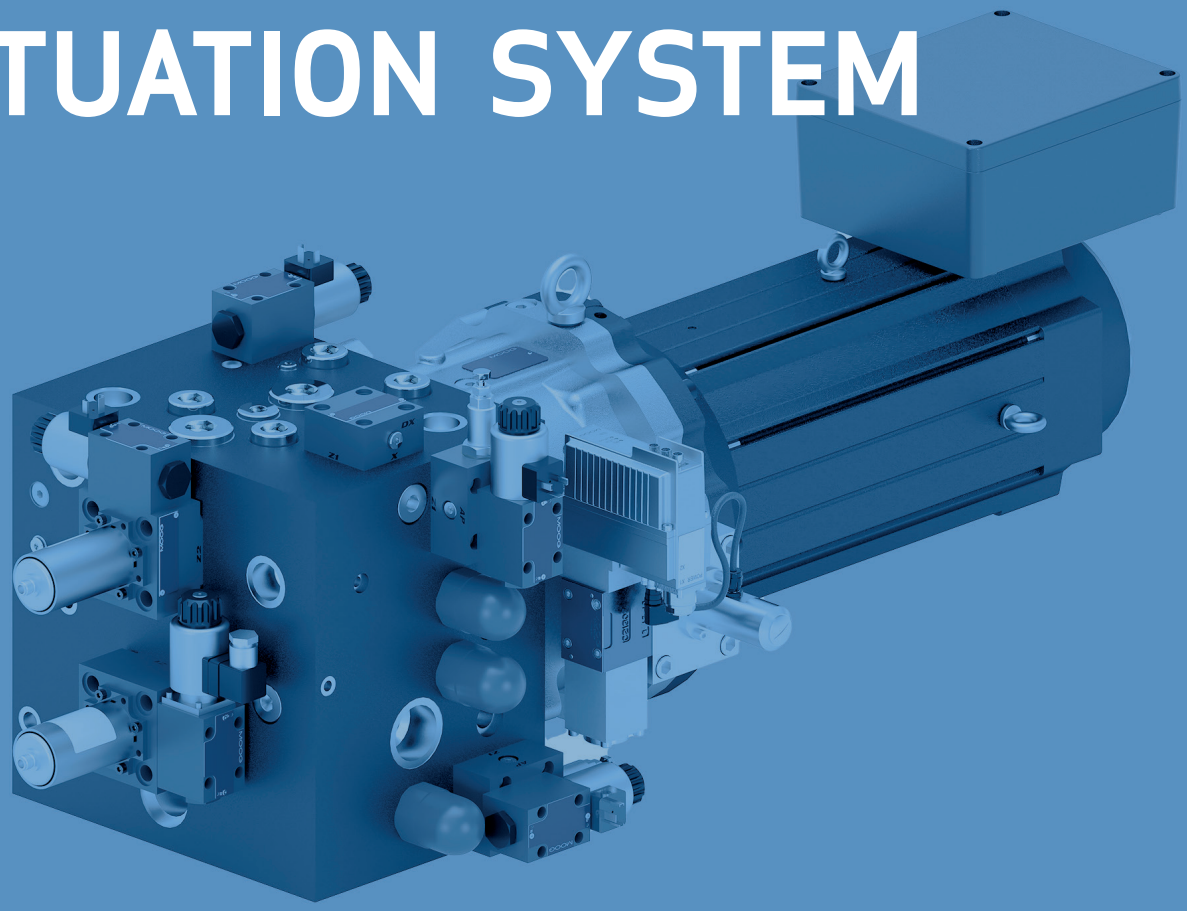
MODULAR ELECTROHYDROSTATIC ACTUATION SYSTEM



Rev. -, October 2020

A COMPACT, ENERGY EFFICIENT AND HIGH FORCE ALTERNATIVE TO TRADITIONAL ACTUATION SYSTEMS.

WHAT MOVES YOUR WORLD

MOOG

If demanding motion systems and highly flexible designs are required, then Moog expertise is here to assist you. Through our collaborative approach, our creativity and first class technology, we help you to solve even the most complex motion tasks, increase the performance of your products and create solutions that far exceed today ´s expectations.

THE ELECTROHYDROSTATIC ACTUATION SYSTEM (EAS)

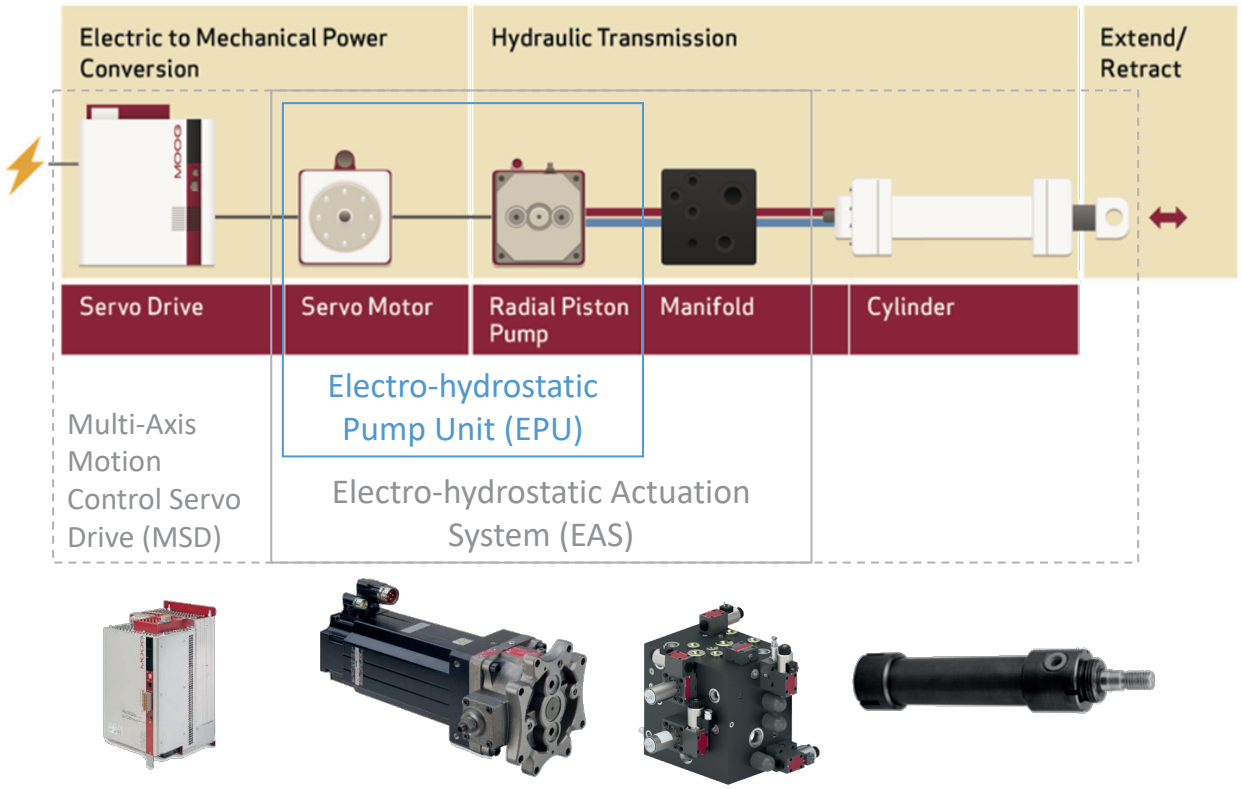
Moog has designed its compact Electrohydrostatic Actuation System (EAS) to generate largely linear motion by means of the electrohydrostatic pump unit, comprised of a variable speed servo motor and a fixed or variable displacement pump along with a manifold and cylinder. The energy input into the power train is provided by a servo drive.

These building blocks make up Moog's Modular EAS, a dynamic and attractive solution for the industrial machine manufacturing market that combines the best of two worlds, electrohydraulic (EH) and electromechanical (EM) actuation. Automation engineers moving toward electromechanical actuation in pursuit of energy efficiency and environmental cleanliness and seeking to combine this with the high-power density of electrohydraulic actuation, will find the modular EAS an attractive solution.

Our global engineering teams can help customers select and integrate these standardized modules as building blocks able to meet a range of unique application requirements across a number of industries. If desired, the system modules can be modified by our engineering experts to meet specific customer requirements, however specialized. The modular EAS is a key future technology that is suitable for a broad range of applications.

Advantages

The modular EAS is highly flexible with good scalability and variability that can be easily adapted to most types of industrial manufacturing machinery. The system's interfaces are standardized to facilitate simplified machine design. Our engineering experts assess both the onsite installation conditions and module dimensions in advance, meaning that machine design can be identified early in the project planning phase. All system spare parts are also standardized, resulting in simple, fast maintenance and reduced machine down time for our customers.



TECHNOLOGY OVERVIEW

In EM actuation systems a frequency-controlled servo motor drives a mechanical actuator via a mechanical gearbox. In EH resistance control systems, a central hydraulic power unit (HPU) drives one or more hydraulic actuators (cylinder, hydraulic motor), controlled by servo valves. Electrohydrostatic actuation systems feature a frequency-controlled servo motor that drives a hydraulic actuator via hydrostatic transmission, thereby combining the advantages of EM and EH technology. Principally, this allows for the electrical coupling of several machine axes in a common electrical intermediate circuit (DC-Bus), and enables demand driven energy distribution that includes an energy recovery capability. Combining EM and EH technology also improves application safety, with the optional use of safety certified servo drives and/or a certified hydraulic safety valve enabling the creation of a safety-oriented application up to performance level e (PI e).

Applications

The EAS is suitable for a range of industrial manufacturing machinery. It can be used on metal pressing applications from forging, powder and sheet metal presses to hot forming, punching and isostatic press machines. The system can also be used successfully in wood and paper milling, testing and power generation applications as a result of good decentralization of the machine axes. The EAS can deliver high-performance to the industrial marine sector, on operational mobile machinery and on injection and blow molding machinery in the plastics sector. It simultaneously reduces oil requirements for HPUs by between 50 and 90 %, thereby reducing machine cost of ownership significantly.

Features	**Benefits**
High force capability and force density	Provides an attractive alternative to EH and EM actuation
Low noise emission	Quiet machine operation
Environmentally clean due to 50 to 90 % lower oil requirement	Lowers maintenance and operating costs
Small number of components	Reduced risk of breakdown and faster maintenance
Offsite testing and commissioning	Short commissioning times
Decentralized system	Eliminates any need for a large HPU and reduces piping; lowers machine footprint
4-quadrant operation	Low energy consumption due to energy recuperation and power on demand
Effective energy management system	Reduces infeed from grid Reduces costs per part
Low mass inertia of the EPU	High dynamics

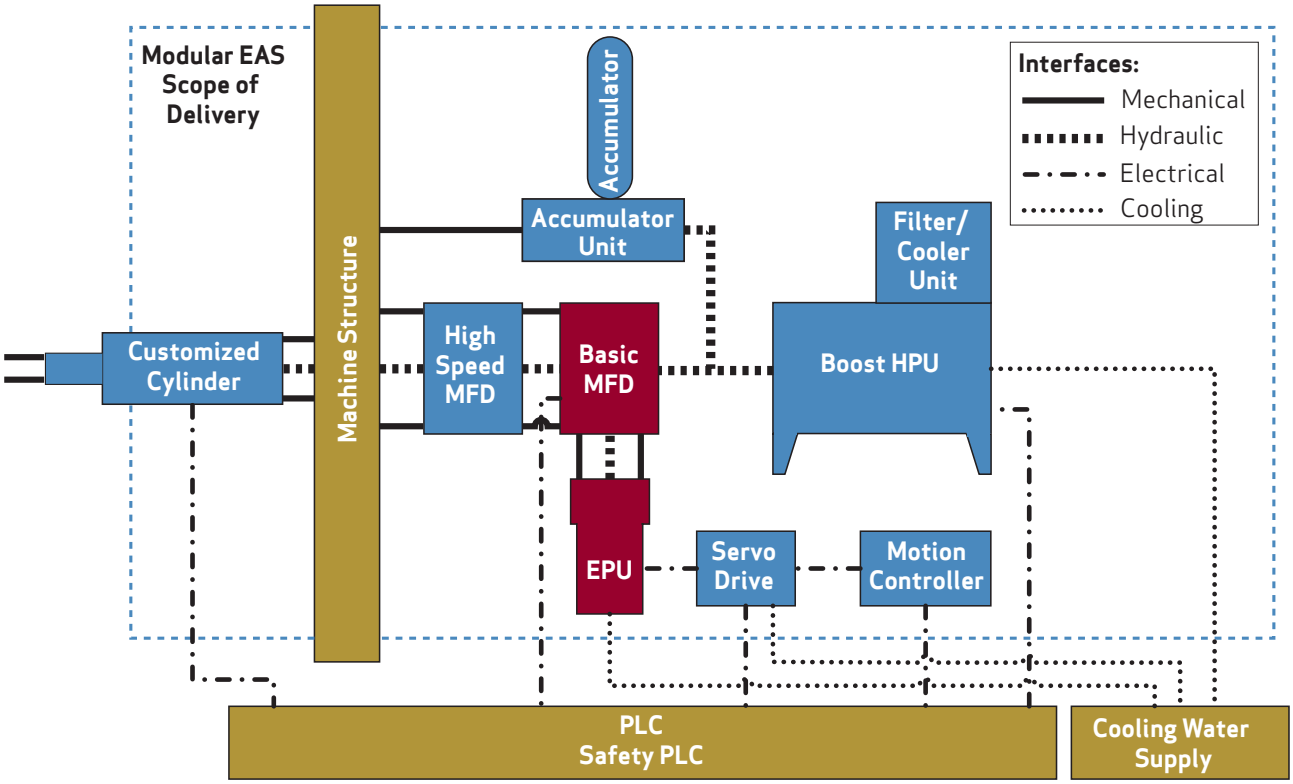
MODULAR EAS SCOPE OF DELIVERY

The Modular EAS's standardized modules provide a wide number of options. To ensure that the system meets application requirements we combine these options with standard components like the cylinder, which can be customized if desired.

The system's smallest scope of delivery consists of a basic manifold and an EPU delivered as an assembled and tested unit.

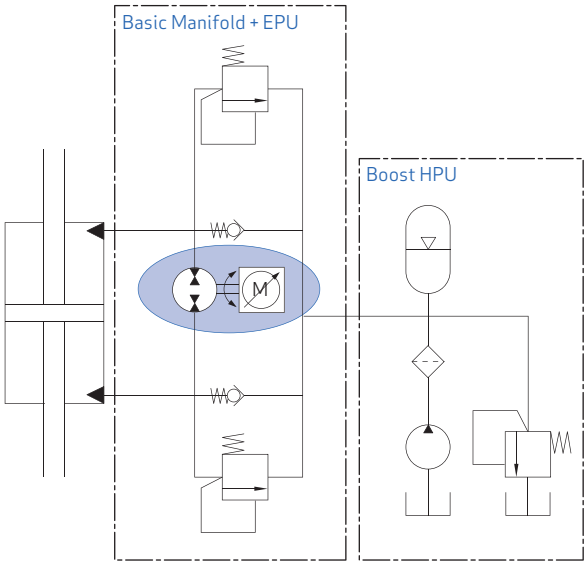
The Modular EAS also contains a standardized small boost HPU optimized for the EAS, along with a servo drive, a motion controller and motion control software.

The full scope of delivery is detailed in the diagram below.



MODULE: BASIC MANIFOLD WITH EPU

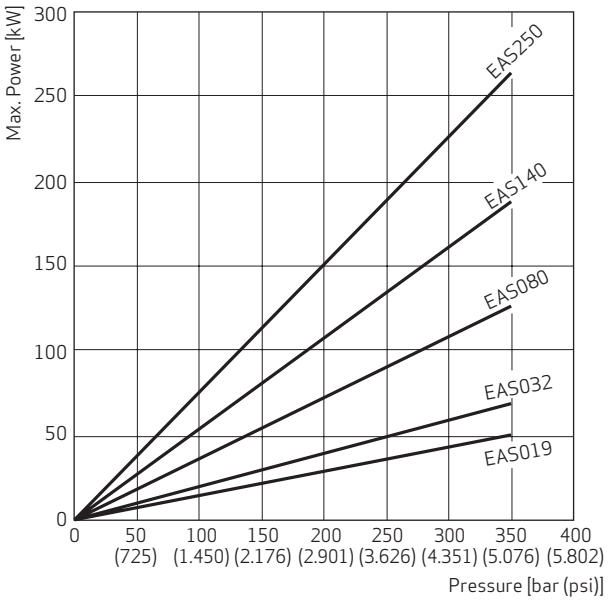
The basic manifold includes the hydraulic system's main functions such as overload and pump anti-cavitation protection, as well as the hydraulic interfaces for a small boost HPU. This module also includes the EPU and the cylinder. Both the components and the system design are adapted and optimized to the EPU's drive power. The EAS system's peak and continuous power does not depend on the basic manifold, but on the EPU and the drives used.



Performance of Basic Manifold Module

Basic manifold	Max. pump flow [l/min (gpm)]	Max pressure [bar (psi)]	Max. power [kW]
EAS019	85 (22.5)	350 (5,000)	50
EAS032	118 (31.2)	350 (5,000)	67
EAS080	216 (57.1)	350 (5,000)	126
EAS140	322 (85.1)	350 (5,000)	183
EAS250	450 (118.9)	350 (5,000)	262

Basic Manifold Power Curve

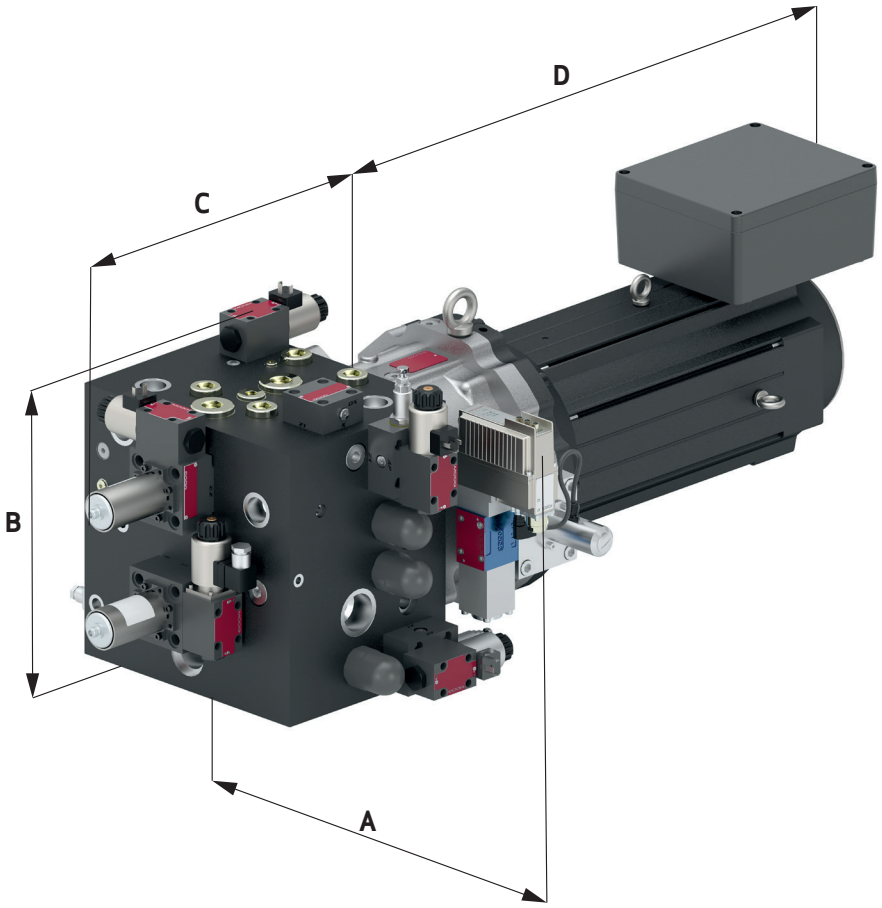


The hydraulic system can be adapted to specific machinery requirements with a number of possible options. These options include safety related functions (to meet DIN EN ISO 16092 standard requirements), such as safe set up and load protection of the hanging axes. They also include the EPU's displacement adjustment, decompression, motor oil cooling among others.

Due to the hydraulic system's flexible configuration, the compact basic manifold can be flanged or piped onto systems with equal area or differential cylinders, with a number of possible alignments.

MODULE: BASIC MANIFOLD WITH EPU

Dimensions including Attachments



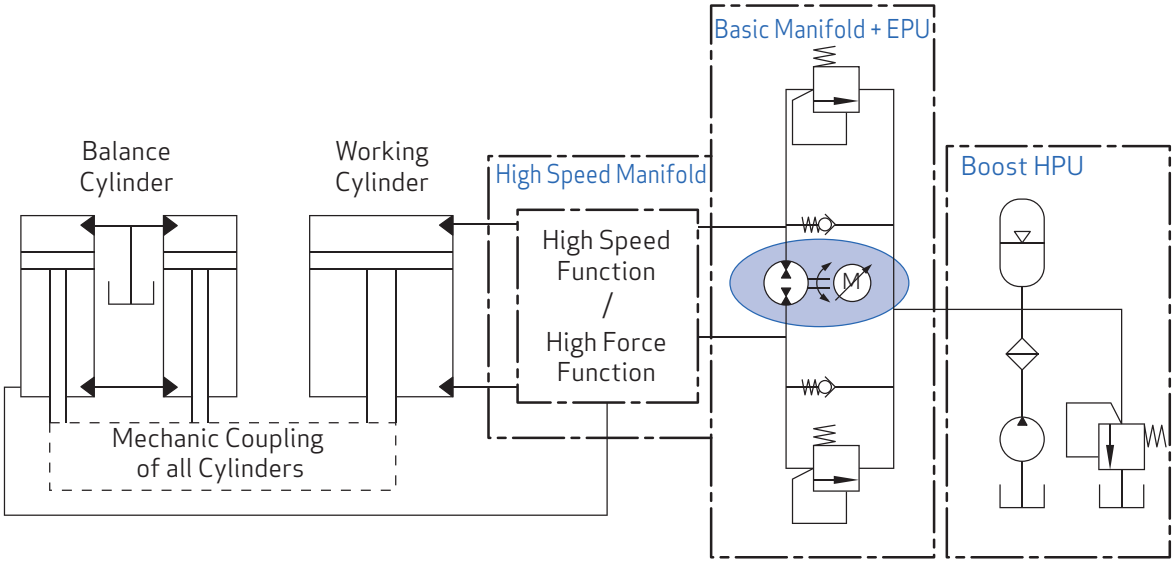
Basic manifold	A [mm (in)]	B [mm (in)]	C [mm (in)]	D[1)] mm (in)]
EAS019	400 (15.7)	280 (11.0)	415 (16.3)	447 – 729 (17.6 – 28.7)
EAS032	380 (15.0)	370 (14.6)	405 (15.9)	472 – 754 (18.6 – 29.7)
EAS080	510 (20.1)	400 (15.7)	405 (15.9)	715 – 851 (28.1 – 33.5)
EAS140	630 (24.8)	480 (18.9)	515 (20.3)	864 – 987 (34.0 – 38.9)
EAS250	610 (24.0)	530 (20.1)	515 (20.3)	936 – 1,264 (36.9 – 49.8)

[1)]Length D varies depending on the EPU used. Minimum and maximum length given.

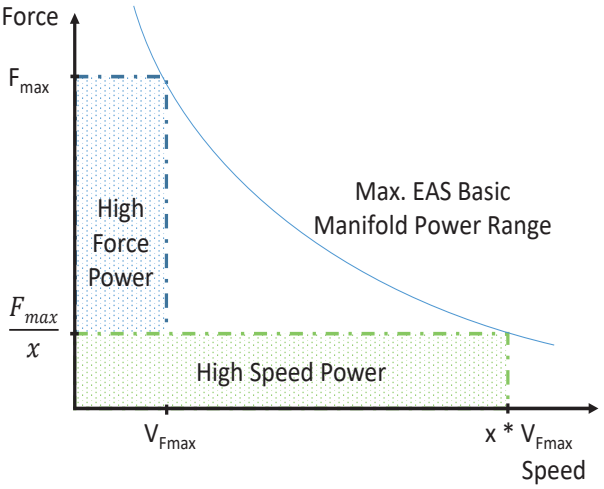
MODULE: HIGH-SPEED MANIFOLD

The High-Speed Manifold extends the basic system by way of a hydraulic gearbox with cylinders having more than two active areas, such as a working and a balancing cylinder. Cylinder areas are adapted in order to achieve the customer's specific transmission ratio. High-speed functionality can be reached with just one differential cylinder and a regenerative hydraulic circuit.

The hydraulic gearbox ratio is determined by the cylinders' area ratio and the EPU's displacement adjustment. The hydraulic system accommodates a broad range of area ratios to achieve high-speed movement with low force, and slow movement with high force (see graph "High Force / High Speed Area Ratio at Maximum EAS Basic Manifold Power"). As standard, the cylinder area ratios (see table "Area / Speed / Force Ratio of Cylinder") have been designed as high-speed modules for the basic manifold. This transmission can be combined with the EPU's dual or proportional displacement to achieve additional, distinct or proportional transmission operating points.



High Force / High Speed Area Ratio at Maximum EAS Basic Manifold Power



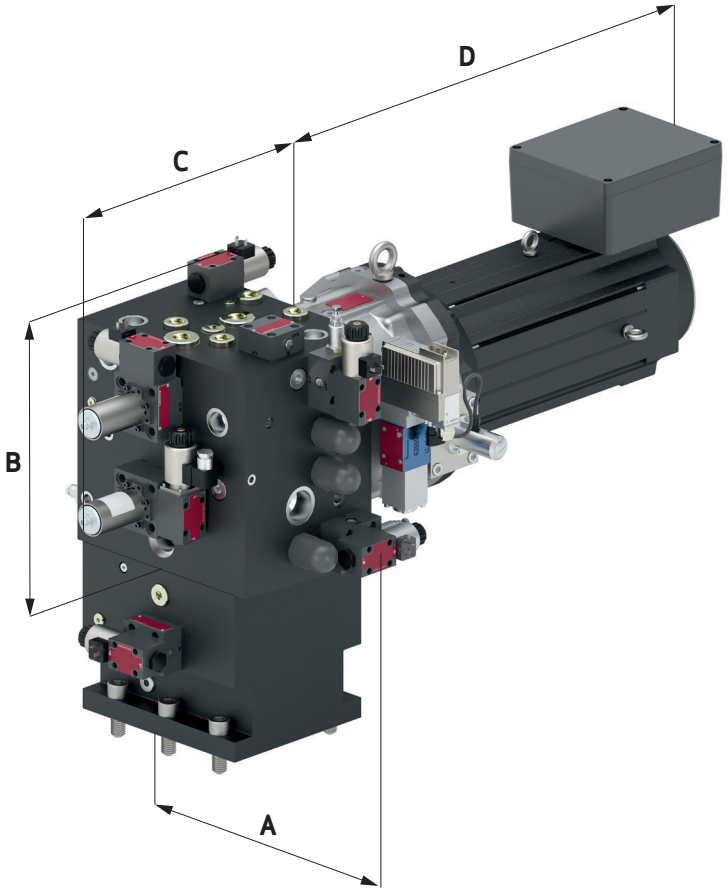
Area / Speed / Force Ratio of Cylinder

High-Speed Manifold Interface 1:			
EAS series	**S1**	**M1**	**L1**
EAS019	x = 15	x › 20	-
EAS032	x = 7	x = 15	-
EAS080	x = 4	x = 10	x = 20
High Speed Manifold Interface 2:			
EAS series	**M2**	**L2**	
EAS140	x = 7	x = 15	
EAS250	x = 4	x = 10	

x = area ratio of cylinder

MODULE: HIGH SPEED MANIFOLD

Dimensions High Speed Manifold plus EPU



		A [mm (in)]	B [mm (in)]	C [mm (in)]	D[1)] [mm (in)]
EAS019	**S1**	490 (19.3)	535 (21.1)	415 (16.3)	447 – 729 (17.6 – 28.7)
	M1	570 (22.4)			
	L1	685 (27.0)	565 (22.2)		
EAS032	**S1**	460 (18.1)	620 (24.4)	405 (15.9)	472 - 754 (18.6 – 29.7)
	M1	480 (18.9)			
	L1	685 (27.0)	650 (25.6)		
EAS080	**S1**	520 (20.5)	650 (25.6)	405 (15.9)	715 – 851 (28.1 – 33.5)
	M1	545 (21.5)			
	L1	685 (27.0)	680 (26.8)		
EAS140	**M2**	630 (24.8)	780 (30.7)	515 (20.3)	864 – 987 (34.0 – 38.9)
	L2	695 (27.4)	800 (31.5)		
EAS250	**M2**	650 (25.6)	830 (32.7)	515 (20.3)	936 – 1,264 (36.9 – 49.8)
	L2	695 (27.4)	850 (33.5)		

[1)] Length D varies depending on the EPU used. Minimum and maximum length given.

HYDRAULIC SYSTEM

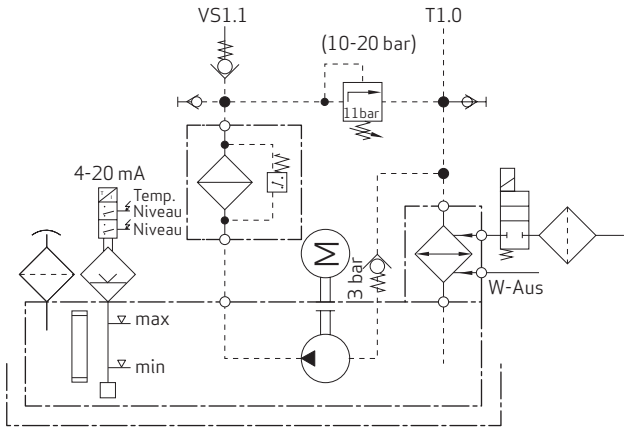
General Technical Data

EAS series	EAS019	EAS032	EAS080	EAS140	EAS250
Maximum pump flow for Basic Manifold	85 l/min (22.5 gpm)	118 l/min (31.2 gpm)	216 l/min (57.1 gpm)	322 l/min (85.1 gpm)	450 l/min (118.9 gpm)
Standard area ratio for High Speed Manifold	<15 … >20	7 … >20	4 … 20	7 … 15	4 … 10
Maximum system pressure	350 bar (5,000 psi)				
Maximum pump housing pressure	10 bar (145 psi)				
EPU motor pump unit					
Pump version	Radial piston pump, fixed, dual or proportional displacement				
Motor version	Brushless servo motor, natural or liquid (water/oil) cooled				
Temperature range					
Ambient	-15 to +60 °C (5 to 140 °F)				
Fluid	-15 to +80 °C (5 to 176 °F)				
Seal material	NBR (standard), FKM				
Preload system	Open preload system, closed circuit on request				
Operating fluid	Mineral oil according to DIN 51524, HFD and others upon request				
Viscosity	Permissible viscosity operational range from 12 to 100 mm^2/s (12 to 100 cSt). Recommended hydraulic fluid viscosity class VG 46 to VG 100 according to ISO 3448. Maximum viscosity 500 mm^2/s (500 cSt) during start-up with electric motor at 1,800 rpm				
System filtration	• NAS 1638, class 9 • ISO 4406 class 20/18/15; obtained with filter fineness of β20 = 75				
Standard pressure sensor	0 to 400 bar, 4 to 20 mA, M12 x 1				
Standard temperature sensor	-25 to 100 °C (-13 to 148 °F), 4 to 20 mA, M12 x 1				
Mounting option to cylinder	Flange mounting or piping				
Mounting option to frame	Flange mounting interface				
Installation position	Any				
Installation note	To avoid pump damage the housing pressure p_L must not exceed the pressure in the low-pressure line (p_A or p_B) by more than 1 bar. Design the drain line with the lowest possible pressure losses. Preload pressure on the boost HPU should be monitored.				

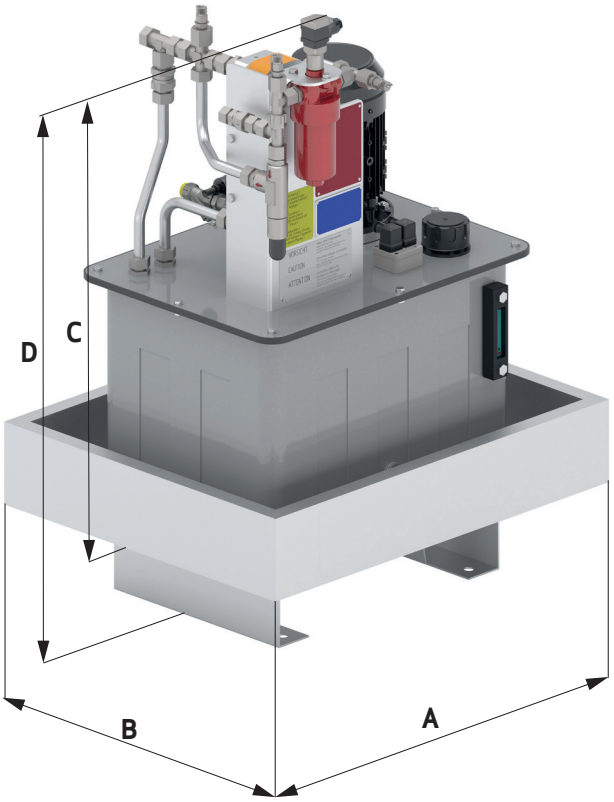
MODULE: SMALL BOOST HYDRAULIC POWER UNIT (HPU)

Moog's small Boost Hydraulic Power Unit for EAS systems is a compact and modular system, comprised only of standardized components while also having a small footprint. The HPU includes the EAS system's 5 µm filter and water-cooling unit and operates with low noise levels (<63 dBA).

Hydraulic Schematic



Dimensions



General Technical Data and Dimensions

HPU Size	HPU40	HPU70	HPU100	HPU160	HPU250
Art. No.	X800-12509	X800-12510	X800-12511	X800-12512	X800-12513
Tank size	40 l	70 l	100 l	160 l	250 l
Max. flow @ 50Hz	9 l/min (2.4 gpm)	14 l/min (3.7 gpm)	27 l/min (7.1 gpm)	36 l/min (9.5 gpm)	60 l/min (15.9 gpm)
Cooling power	5 kW	8 kW	15 kW	20 kW	30 kW
Pressure	9-16 bar (130.5 – 232.1 psi)				
Motor speed	1,450 rpm				
Oil tray WAR	Optional				
A [mm (in)]	768 (30.2)		893 (35.2)	1,070 (42.1)	1,270 (50.0)
B [mm (in)]	625 (24.6)		720 (28.3)	850 (33.5)	950 (37.4)
C [mm (in)]	829 (32.6)	923 (36.3)	966 (38.0)	1,068 (42.0)	1,163 (45.8)
D [mm (in)]	979 (38.5)	1,073 (42.2)	1,116 (43.4)	1,218 (48.0)	1,313 (51.7)
Pipe VS-Port	12L	15L	18L	22L	28L
Pipe T-Port	15L	18L	22L	28L	35L
Recommended viscosity	20 to 200 mm^2/s (cSt)				
Viscosity	15 to 500 mm^2/s (cSt)				
Ambient temperature	0 to 50 °C (0 to122 °F)				
Water entry temperature	30 °C (86 °F)				
Mains supply	400 V / 50 Hz				
Surface treatment	Oil tray and tank primed. Colored tank cover is optional				

ELECTROHYDROSTATIC PUMP UNIT (EPU)

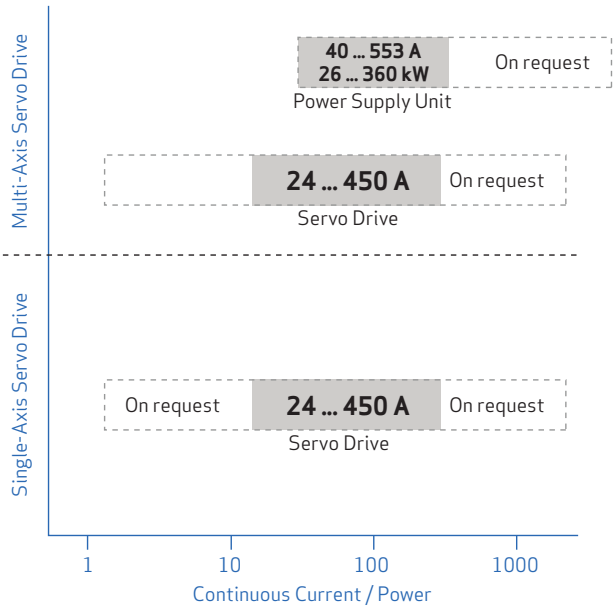
The EPU is a highly integrated, compact alternative to traditional hydraulic solutions. It can operate in 2- or 4-quadrant operations and has a mechanical interface which allows it to be connected directly to hydraulic manifolds.

General Technical Data

EPU series	**019**	**032**	**080**	**140**	**250**
Maximum flow	85 l/min (22.5 gpm)	118 l/min (31.2 gpm)	216 l/min (57.1 gpm)	322 l/min (85.1 gpm)	450 l/min (118.9 gpm)
Maximum pressure ports A and B	350 bar (5,000 psi)				
Maximum housing pressure	10 bar (145 psi)				
Pump version	Radial piston pump, fixed, dual or proportional displacement				
Motor version	Brushless servo motor, natural or liquid cooled (oil/water)				
Temperature range					
Ambient	-15 to +60 °C (5 to 140 °F)				
Fluid	-15 to +80 °C (5 to 176 °F)				
Seal material	FKM, NBR on request				
Pilot pressure supply	External				
Operating fluid	Mineral oil according to DIN 51524, HFD, others upon request				
Viscosity	Permissible viscosity operational range from 12 to 100 mm^2/s (12 to 100 cSt). Recommended hydraulic fluid viscosity class VG 46 to VG 100 according to ISO 3448. Maximum viscosity 500 mm^2/s (500 cSt) during start-up with electric motor at 1,800 rpm.				
System filtration	• NAS 1638, class 9 • ISO 4406, class 20/18/15; obtained with filter fineness of $\beta 20 = 75$				
Installation position	Any				
Installation note	To avoid pump damage the housing pressure p_L must not exceed the pressure in the low-pressure line (p_A or p_B) by more than 1 bar. The drain line should be designed with the lowest possible pressure losses.				

POWER ELECTRONICS

Servo Drive / PSU Power Range



Power for the EPU is provided by a modular drive solution. Our standard portfolio is made up of a single axis servo drive, and a multi axis version combined with a power supply unit (PSU). The standard range for the EAS is between 24 A and 450 A for the drives, and from 26 kW to 360 kW for PSUs (see graph above).

We provide several fieldbus interfaces (e.g. EtherCAT, CAN open, PROFIBUS/ PROFINET) to comply with industry standards. For application safety needs, drives are available with built-in functional safety in compliance with the IEC/EN 61508, IEC/EN 62061, EN ISO 13849-1, IEC/EN 61800-5-2 standards.

A full range of accessories is also part of the Moog portfolio, and includes mains chokes and filters, as well as braking resistors, motor cables and resolver cables.

Module: AC-AC Servo Drive

A single axis servo drive is typically used for applications with independent hydraulic actuators, which is the simplest way of driving an EAS system. The electrical power train is contained in a compact housing, which leads to a small cabinet footprint and easy commissioning. While there is no energy feedback into the grid, the internal DC bus (565 VDC) can be combined with additional braking and decompression energy storage capacities.

Module: DC-AC Servo Drive with Power Supply Unit (PSU)

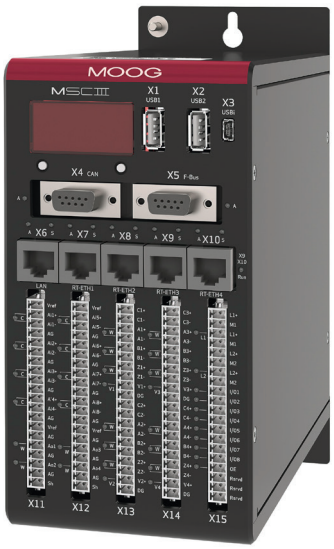
The DC-AC Servo Drive and the PSU can be used for efficient energy management in multi axis applications. Energy saving can be achieved by shifting energy between drives with a common and stabilized DC bus (650 VDC) or feeding energy back into the grid.

On each EPU axis one DC-AC Servo Drive can be combined with a shared DC bus, and it is also possible to share the DC bus with other, non-EAS applications, such as an electromechanically actuated ram.

MODULE: MOTION CONTROL

We offer a complete range of motion control modules for electrohydrostatic actuation systems. Linear hydrostatic actuators provide motion control that enables industrial applications to accurately position, press or hold parts and include:

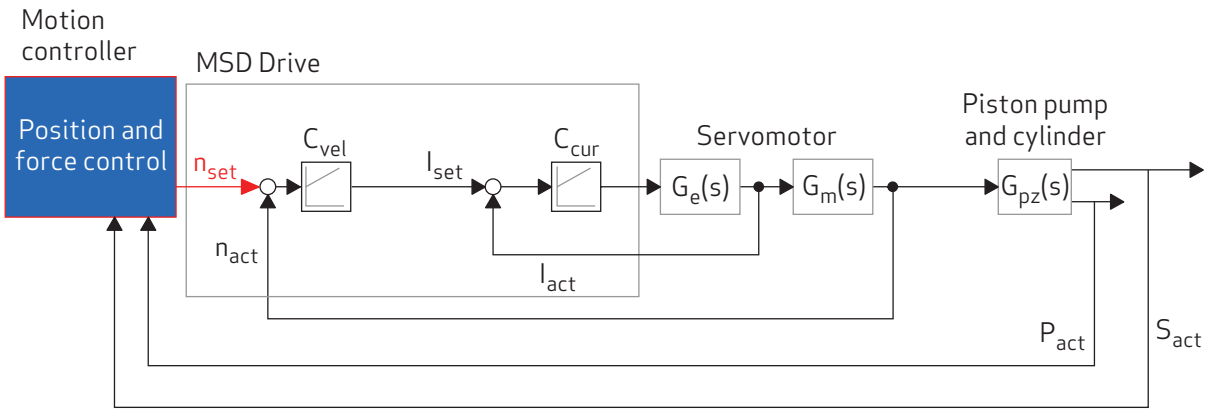
- A force or pressure control loop
- A flow control loop
- A cylinder position control loop
- A cylinder position control loop with force limitation (F/x control loop)
- Pump leakage compensation
- Variable displacement EPU support.



To support the EAS Moog offers the following software:

- Firmware (integrated with a Moog Servo Drive)
- A software function block (integrated with a Moog MSC III Controller and other compatible platforms).

Typical Structure of EAS System Control Loop



ABOUT MOOG

Hydraulic Solutions

Since Bill Moog invented the first commercially viable servo valve in 1951, Moog has set the standard for world-class hydraulic technology. Today, Moog products are used in a variety of applications - providing high power, enhanced productivity and ever better performance for some of the world's most demanding applications.

Electric Solutions

Clean operation, low noise generation, less maintenance and reduced power consumption make Moog electric solutions ideal for applications worldwide. Moog is the ideal partner for applications where transitioning technologies requires special expertise.

Hybrid Solutions

By incorporating the advantages of existing hydraulic and electric technologies - including modular flexibility, increased efficiency and cleanliness - into innovative hybrid solutions, Moog offers new performance potential in specialized applications.

Simulation Table

Flight Simulation

Moog Global Support

Moog Global Support is our promise to offer world-class repair and maintenance services delivered expertly by our trained technicians. With the reliability only available from a leading manufacturer with facilities around the world, Moog offers you service and expertise you can count on to keep your equipment operating as it should. This promise offers many benefits to our customers including:

- Reduce your downtime by keeping critical machines running in peak performance
- Protect your investment by ensuring reliability, versatility and long-life of products
- Better plan your maintenance activities and make systematic upgrades
- Leverage our flexible programs to meet the unique service requirements of your facility.

Look to Moog for Global Support including:

- Repair services using OEM parts are performed by trained technicians to the latest specifications
- Stock management of spare parts and products to prevent unplanned downtime
- Flexible programs, tailored to your needs such as upgrades, preventative maintenance and annual/multi-year contracts
- On-site services bring the expertise to you, providing quicker commissioning, set-up and diagnostics
- Access to reliable services that are guaranteed to offer consistent quality anywhere in the world.

For more information on Moog Global Support visit www. moog.com/industrial

MOOG GLOBAL SUPPORT®

More Products. More Support.

Moog designs a range of motion control products to complement those featured in this document.
Moog also provides service and support for all of our products. For more information, contact the Moog facility closest to you.

Australia
+61 3 9561 6044
Service + 61 3 8545 2140
info.australia@moog.com
service.australia@moog.com

Brazil
+55 11 3572 0400
info.brazil@moog.com
service.brazil@moog.com

Canada
+1 716 652 2000
info.canada@moog.com

China
+86 21 2893 1600
Service +86 21 2893 1626
info.china@moog.com
service.china@moog.com

France
+33 1 4560 7000
Service +33 1 4560 7015
info.france@moog.com
service.france@moog.com

Germany
+49 7031 622 0
Service +49 7031 622 197
info.germany@moog.com
service.germany@moog.com

Hong Kong
+852 2 635 3200
info.hongkong@moog.com

India
+91 80 4057 6666
Service +91 80 4057 6604
info.india@moog.com
service.india@moog.com

Ireland
+353 21 451 9000
info.ireland@moog.com

Italy
+39 0332 421 111
Service 800 815 692
info.italy@moog.com
service.italy@moog.com

Japan
+81 46 355 3767
info.japan@moog.com
service.japan@moog.com

Korea
+82 31 764 6711
info.korea@moog.com
service.korea@moog.com

Luxembourg
+352 40 46 401
info.luxembourg@moog.com

The Netherlands
+31 252 462 000
info.thenetherlands@moog.com
service.netherlands@moog.com

Russia
+7 8 31 713 1811
Service +7 8 31 764 5540
info.russia@moog.com
service.russia@moog.com

Singapore
+65 677 36238
Service +65 651 37889
info.singapore@moog.com
service.singapore@moog.com

South Africa
+27 12 653 6768
info.southafrica@moog.com

Spain
+34 902 133 240
info.spain@moog.com

Sweden
+46 31 680 060
info.sweden@moog.com

Turkey
+90 216 663 6020
info.turkey@moog.com

United Kingdom
+44 (0) 1684 858000
Service +44 (0) 1684 278369
info.uk@moog.com
service.uk@moog.com

USA
+1 716 652 2000
info.usa@moog.com
service.usa@moog.com

For product information, visit www.moog.com/industrial
For service information, visit www.moogglobalsupport.com

Modular Electrohydrostatic Actuation System
KEM/Rev. -, October 2020, Id. CDL62086-en

WHAT MOVES YOUR WORLD

MOOG