Basics for digital proportional electrohydraulics

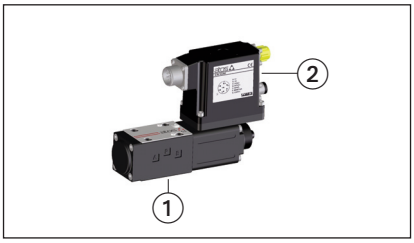
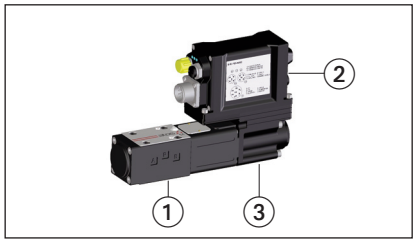
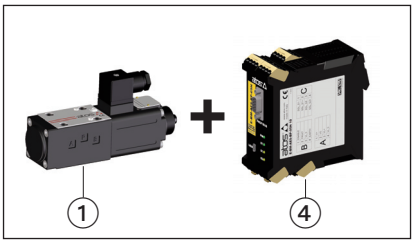
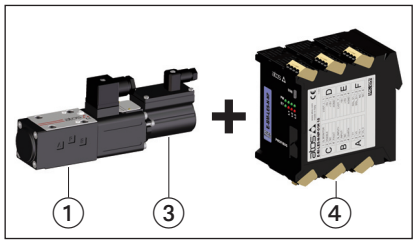
Digital electrohydraulics enables new functionalities within the conventional control architectures and represents the fundamental premise to realize machines with high technological contents.
The digital electronics integrates several logic and control functions (distributed intelligence) and allows the introduction into the hydraulic system of the most modern fieldbus communication networks.

The integration of advanced digital technologies into Atos proportional valves brings important advantages and innovative features:
- better performances of electrohydraulic components: hysteresis, response time, linearity, repeatability, valve to valve reproducibility
- numerical software setting of hydraulic parameters (scale, bias, ramp, compensation of non-linearities) for full valve to valve reproducibility
- advanced diagnostics (alarms history, built-in oscilloscope function) and computer assisted maintenance
- industry 4.0 connectivity through direct interfacing with fieldbus networks

Atos digital components range includes:
- proportional valves and drivers, see sections 1 and 2
- proportional p/Q pumps, see 4.3
- axis controls and servoactuators, see section 5

1 PROPORTIONAL VALVES CONFIGURATION

PERFORMANCES →

VALVES / DRIVERS	WITHOUT TRANSDUCER	WITH TRANSDUCER
	The valve regulation is performed by modulating the current supplied to the solenoid, without any feedback of the regulated value. The regulation accuracy is affected by the operating conditions.	The valve regulation is performed by modulating the current to the proportional solenoid according to the feedback signal from the LVDT or pressure transducer. The regulation accuracy is very high and it is independent to the hydraulic conditions.
ON-BOARD On-board digital drivers simplifies the electrical wiring and they are factory preset to assure repetitive regulation characteristics.		
OFF-BOARD Off-board digital drivers are the ideal solution for remote cabinet installation in applications with critical temperatures or vibrations.		

① Proportional valve ② On-board driver ③ Transducer ④ Off-board driver

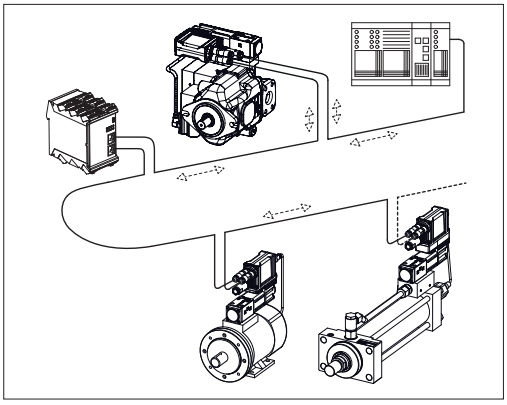
2 PROPORTIONAL VALVES CLASSIFICATION - with on-board or off-board driver

PERFORMANCES ↑

Valve classification	Type of valve	Transducer	Hydraulic features	Application
Servoproportionals	Directional	LVDT	Zero spool overlap	Actuator position and speed control p/Q control
High performance proportionals	Directional	LVDT	Positive spool overlap	Actuator direction and speed control p/Q control
	Flow	LVDT	Pressure compensated	System flow regulation, actuator speed control
	Pressure	Pressure	Relief Reducing Compensator	System pressure control Actuator force control Load sensing control
Proportionals	Directional	None	Positive spool overlap	Actuator direction and speed control
	Flow		Pressure compensated	System flow regulation, actuator speed control
	Pressure		Relief Reducing Compensator	System pressure control Actuator force control Load sensing control

3 FIELDBUS INTERFACES - see tech table **GS510**

Drivers with fieldbus communication interface allow an higher level of integration with the machine automation architecture: machine central unit (fieldbus master), wired with all the controlled devices (fieldbus node).



Fieldbus available:

BC = CANopen **BP** = PROFIBUS DP **EH** = EtherCAT
EW = POWERLINK **EI** = EtherNet/IP **EP** = PROFINET RT/IRT

Fieldbus interface allows:

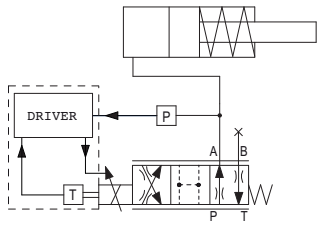
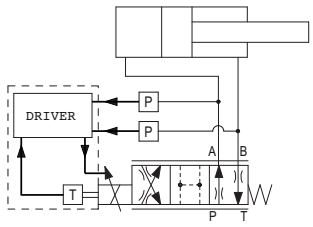
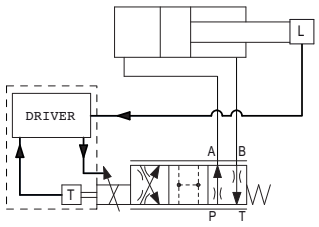
- complete diagnostic of the driver status
- improved information available for machine operation
- improved accuracy and robustness of digital transmitted information
- real time modification of the valve parameters
- direct access to all driver parameters
- costs reduction due to simpler and standardized wiring solutions
- costs reduction due to fast and simple installation and maintenance

4 p/Q CONTROLS - see tech table **FS500**

4.1 p/Q controls for servoproportional and high performance directional valves

In most of the machines functions, the typical movement of a single actuator requires direction, speed and sometime force regulations, normally performed by different type of valves.
Digital proportional valves with SP, SF, SL options add the pressure or force closed loop control to the basic directional control.
A single proportional valve with p/Q control allows to manage complex machine operations requiring high performance combined regulations (typical application: injection cycle or mould motion in plastic machinery).
The closed loop pressure or force control requires the installation in the system of one/two remote pressure transducers or a load cell, to be connected to the valve digital driver.
The option SP performs the closed loop pressure control on one side of the actuator by using one remote pressure transducer.
The other two options perform the closed loop force control by two remote pressure transducers (SF) or one load cell (SL).
Pressure/force and flow are regulated according to two different command signals.
The selection from pressure-force to flow control and vice versa is self performed by the digital driver through dedicated algorithm.

p/Q control configurations

SP = pressure control	SF = force control	SL = force control
		
one remote pressure transducer has to be installed on the actuator's port to be controlled	two remote pressure transducers have to be installed on the actuator's ports; the actuator force is calculated by the pressure feedbacks (Pa - Pb)	one load cell transducer has to be installed between the actuator and the controlled load

T valve spool transducer P pressure transducer L load cell

4.2 Proportional valves with p/Q control - with on-board or off-board driver/axis card

Valve classification	Application
Servoproportionals	SF, SL SP only in 3-way connection
High performance proportionals	SP, SF, SL

4.3 p/Q controls for variable piston pumps - see tech table **AS170**

PVPC-PERS/PES variable displacement axial piston pumps, integrate the digital combined closed loop pressure and flow control with the electronic max power limitation.
A multiple set of PID parameters can be real time selected during the axis motion via the 12 pin connector (option /S) or through the fieldbus interface, to optimize the p/Q control performances.

The PVPC-PES pumps allow the accurate and dynamic closed loop control of the delivered flow and the system pressure.

5 AXIS CONTROLS

The modern architecture of industrial machinery strongly increases the demand of accuracy, repeatability and performance. This leads to the need of devices that integrate to the traditional axis positioning also the pressure/force controls.

Atos focuses the integration of axis cards functions with proportional electrohydraulics either in on-board or off-board format.

They improve motion performances, simplify the automation architecture and may be integrated in the fieldbus network.

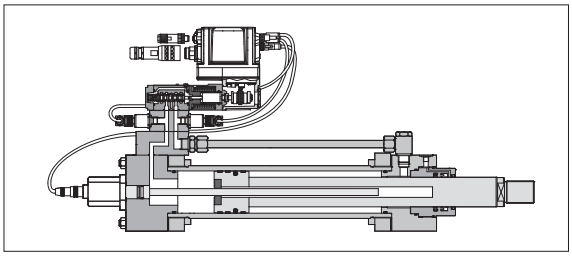
5.1 Synthetic comparison

TYPE		ON BOARD AXIS CARD AND DRIVER	AXIS CARD WITH DRIVER FUNCTION	AXIS CARD
FORMAT / MAIN FUNCTION			 DIN-rail format	 DIN-rail format
Technical table		**FS610 FS620 FS630**	**GS330**	**GS340**
Valve's driver function		●	●	n.a.
Nr. of controlled axis		1	1	1
Internal programmable cycles		simple	simple	complete
Graphic programming software		●	●	●
Position control		●	●	●
Position transducer interface:	Analog	●	●	●
	Digital (SSI or Encoder)	●	●	●
p/Q control		●	●	●
Analog transducer interface, pressure or force		2	2	2
Performance parameters setting (e.g. Dither, PID)		●	●	●
Valve parameters setting (e.g. Bias, Ramp, Scale)		● factory preset	● factory preset	●
Alternated control		●	●	●
USB interface		●	●	●
CANopen		●	●	●
PROFIBUS DP		●	●	●
EtherCAT		●	●	●
POWERLINK		●	●	●
EtherNet/IP		●	●	●
PROFINET RT/IRT		●	●	●
Digital input		1	1	3
Digital output		1	1	1
Analog input reference		2	2	2
Analog output monitor		2	2	up to 3

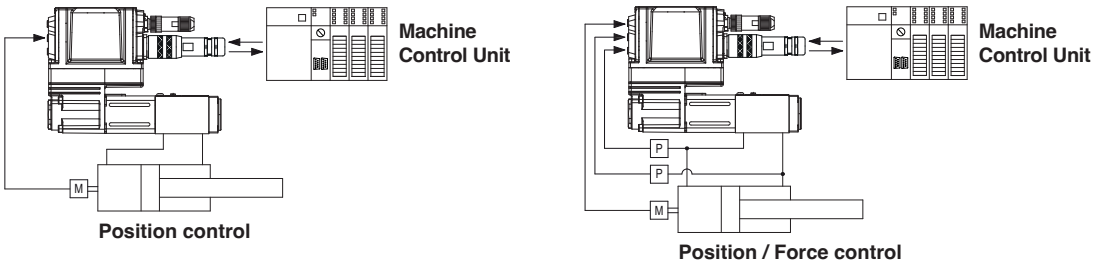
= options

5.2 Servoactuators - see tech table **FS700**

They are stand-alone units performing closed loop position plus optional alternated p/Q controls. These units are made by a servocylinder with position transducer and a servoproportional valve with on-board driver + axis card, factory assembled and tested.

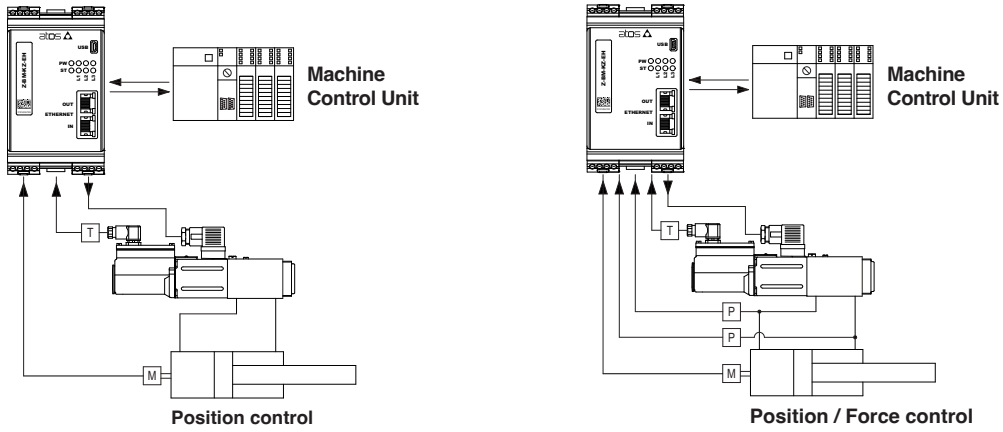


5.3 Digital servoproportionals with on-board axis card and driver, application example - see **FS610**, **FS620**, **FS630**



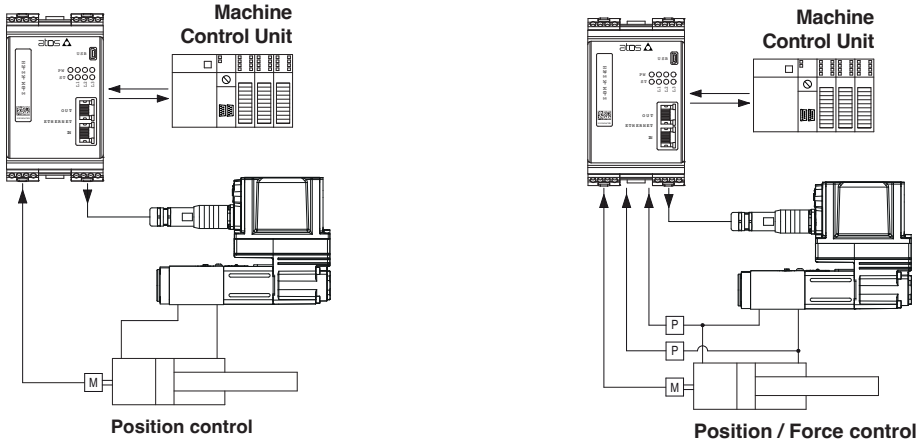
P pressure transducer M actuator position transducer

5.4 DIN-rail axis card with driver function, application example - see tech table **GS330**



P pressure transducer M actuator position transducer T valve's spool transducer

5.5 DIN-rail axis card, application example - see tech table **GS340**



P pressure transducer M actuator position transducer

6 PROGRAMMING TOOLS - see tech table **GS500**

6.1 Atos CONNECT mobile App

Free downloadable App for smartphones and tablets which allows quick access to valve main functional parameters and basic diagnostic information via Bluetooth, thus avoiding physical cable connection and significantly reducing commissioning time.
Atos CONNECT supports Atos digital valve drivers equipped with E-A-BTH adapter or with built-in Bluetooth.
It does not support valves with p/Q control or axis controls.

6.2 E-SW-SETUP & Z-SW-SETUP PC software

Free downloadable software for PC allow to set all valve functional parameters and to access complete diagnostic information of digital valve drivers and axis controls via Bluetooth/USB service port.
Atos PC software support all Atos digital valve drivers and axis controls and they are available at www.atos.com in MyAtos area.