

## NEW Digital Axis Motion Controllers 2009





Atos developments on digital electronics focus the integration of axis cards functions into proportional electrohydraulics either in integral format or panel mounting.

New digital controllers can be easily configured to best manage position, speed or force, in closed-loop, of any electrohydraulic axis, piloted by a digital proportional valve.

They improve the motion performances, simplify the automation architecture and may interface by fieldbus the machine main control unit.

The following table shows a synthetic comparison of new digital axis controllers, from simple to top solutions.

### New Digital Axis Motion Controllers: a synthetic comparison

				
Main Function	Pressure / Flow Control	Integral Axis Control	Eurocard Axis Control	Modular Axis Control
Format	Integral to valve	Integral to valve	Eurocard	DIN Rail Mounting
Valve's Driver function	✱	✱		
Nr. of controlled Axis	1	1	1	1 (2)
Internal programmable cycles		simple	complete	extended
Graphic programming software	✱	✱	✱	✱
Operator Panel			✱	
Position control		✱	✱	✱
Synchronism				(✱)
Position Transducer interface - Analog		1	1	1 (2)
Position Transducer interface - SSI		1	1	1 (2)
Position Transducer interface - Encoder		1	1	1 (2)
Alternate Pressure / Flow control	✱	✱ option	✱ option	✱ option
Pressure Transducer interface - Analog	1/2	1/2	2	1/2 (2/4)
Performance parameters setting : Dither, PID	✱	✱	✱	✱
Valve parameters setting : Bias, Ramp, Scale Linearization	✱ factory preset	✱ factory preset	✱	✱
Compensation of hydraulic system behaviour				✱
Serial interface	✱	✱	✱	✱
CANopen fieldbus interface	✱	✱	✱	✱
PROFIBUS DP fieldbus interface	✱	✱	✱	✱
Powerlink fieldbus interface	✱			✱
Ethernet interface				✱
Digital Input	1	up to 2	9	12 (24) + modules
Digital Output	1	up to 2	8	12 (24) + modules
Auxiliary Analog Input	2	up to 2	6	1+modules
Auxiliary Analog Output	2	2	3	1+modules
Bosch Rexroth equivalent codes with electrical connection compatibility as:	IAC-P pin to pin	IAC-R pin to pin	HACD pin to pin	HNC-100 - - - -

Gray background = alternative selection for position transducers and communication interfaces

The following four pages contain detailed descriptions of controller's main functions, features and performances.

## **/S\* option = Pressure/Flow alternate control for standard valves**

Tec. table G210-9/E, preseries available from November '08

### **/SP pressure control option by pressure transducer**

The simple solution for Pressure/Flow alternate control is to add the /SP option on standard Atos digital drivers E-RI-TES (LES), integral to proportional valves with integral position transducer: it adds a pressure control, closed-loop, to the basic functions of proportional directional valves or cartridges.

An analog pressure transducer must be installed on the hydraulic line and a pressure reference command will be supplied to the valve's driver in addition to the main signal referred to the valve's spool/poppet position.

The dynamics of the switching from pressure to flow control and vice versa can be optimized thanks to specific software setting, in order to avoid instability or vibrations. A dedicated and programmable algorithm within the digital software selects which control will be active time by time.

Function is as follows :

**Flow control** : is active when the actual system pressure is lower than the input command value - the valve works normally to regulate flow by controlling in closed-loop the spool/poppet through its integral position transducer.

**Pressure control** : is activated when the actual pressure grows up to the pressure command value - the driver reduces the valve's flow regulation (spool/poppet position) in order to keep the system pressure stable; if the pressure tends to decrease under its command value, the flow control returns active. The pressure control can be adapted to different inertial and elastic system's characteristics, by up to four PID parameters setting. The PID sets are stored into the driver and can be switched by the machine control units during the axis motion cycle by means of on/off inputs or by fieldbus.

**3-way directional valves or cartridges** – see the first two typical sketches

New proportional /SP valves perform the P/Q alternate control providing better dynamics and accuracy in comparison with conventional solutions, which use two different proportional valves, for pressure and for flow control.

**4-way directional valves** – see the third typical sketch showing a 4-way proportional /SP valve performing the motion control of a double acting cylinder. The pressure control is integrated just adding a pressure transducer and using a dedicated spool with specific design in central position to get stable pressure regulation, static and dynamic. A simple and competitive one-way force control is so introduced on the actuator.

Innovative solutions have been developed on this basis, like for example the V9 spools family developed to perform, with one only digital valve, the "Injection, Holding and Counter-pressure Processes" in Plastic Injection Presses. The axis card of the Machine's Electronic Unit manages the motion whilst the /SP option performs the additional pressure control.

Other Plastics dedicated spools have been developed for Mould Closing and for Ejectors axis.

### **/SL force control option by load cell**

The /SL option may be added on 4-way directional valve's drivers to get a force control when an analog load cell is installed on the actuator, see hydraulic sketch at side.

A force command reference signal will be supplied to the digital driver in addition to the main command signal referred to the valve's spool position. The same algorithm of /SP option selects time by time which control to activate. Other features as per /SP valves.

A successful application has been realized by Atos for a Fatigue Testing System for aircraft structures where speed and force were controlled to define time dependant curves. /SL valves performed push and pull force controls with high dynamics, accuracy and repeatability also optimizing the switching from force to flow control and vice versa.

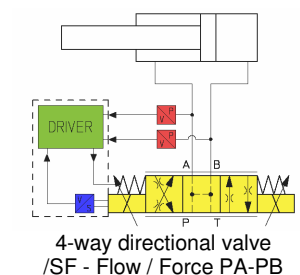
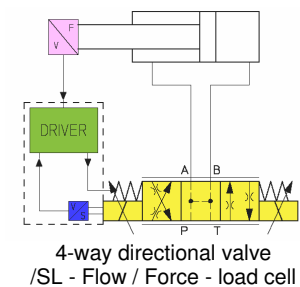
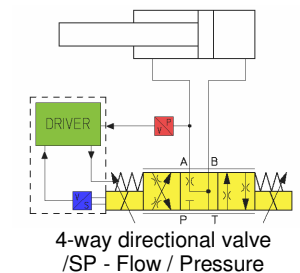
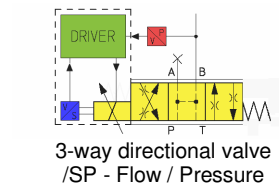
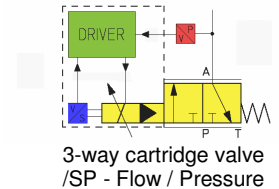
### **/SF force control option by pressure transducers**

The /SF option has the same functionality as the /SL one, in this case two pressure transducers are applied to the ports of a double acting cylinder to measure the actuator force, see sketch at side.

The pressure transducers give valuable advantages against load cells in terms of market availability at competitive costs, easy introduction on existing layout and simpler transducer 's interfacing to system.

Vice versa the load cells are more accurate because they are not influenced by the cylinder's seals friction (stick slip and dynamic) and by the pressure turbulence effect of the oil flow.

Proportional valves with /SF force option are used for the compensation of the calendar roller deflection in paper industry, to allows a constant paper thickness along the hollow roller. Another typical application is the load balancing in machine tools, particularly for big size grinding machines.



#### **legend:**

- pressure transducer
- valve position transducer
- load cell

## Z-RI - Axis Motion Controller

Tec. table G330-0/E, prototypes from December '08

New Z-RI Atos digital controllers are integral to proportional 4-way directional valves with integral transducer, direct or pilot operated. They perform the basic driver functions plus the position closed-loop control of the linear/rotative actuator to which the proportional valve is connected, see hydraulic sketch at side.

The selection of the electronic interface for one of the following position transducers, integral or external to the actuator, is required in the controller's code :

- potentiometer analog ( voltage signal )
- inductive analog ( voltage or current signal )
- magnetosonic analog ( voltage or current signal )
- magnetosonic digital ( SSI serial interface )
- linear or rotative encoder digital ( TTL signal logics )

Two main functional command modes can be selected by software :

- real time external command reference input – analog or digital by fieldbus communication
- internal generations of simple motion profiles sequence, programmable by Atos PC software, which are then sequenced by the external machine electronic control unit

Available interfaces:

- Up to 2 analog input for reference command signals, position (default) and pressure if /S\* option is selected
- Up to 2 analog output for monitor, position (default) and optionally pressure (/S\*)
- Up to 2 on-off input for logic communication with the machine electronic control unit: selection of motion sequences and inhibit command in front of machine alarm situation
- Up to 2 on/off output for controller fault detection and axis status diagnostics
- 1 communication interface ( Serial, CANopen or PROFIBUS DP )

Additional functionalities:

- full software setting of the controller including the compensation of the main hydraulic system characteristics, closed-loop PID gains and max windows error
- electronic compensation function for actuator's seal's friction
- separate power supply for the controller circuit and for the solenoid output stage, to allow the safety emergency stop of the axis while maintaining active the controller and the fieldbus communication with the machine electronic control unit
- the full range of /S\* options is available, to combine pressure or force closed-loops to the original position control: in this case additional interfaces are available for connection of 1 load cell or 1-2 pressure transducers
- real time oscilloscope function to dynamically analyse the valve and axis performances
- detailed diagnostics of the axis status, faults and performance
- software setting of safety predefined procedures in case of faulty conditions

The digital valve with integral Z-RI axis controller can be delivered already assembled on Atos servocylinder and wired to the relevant transducer, to realize a smart motion units, called "Servoactuator".

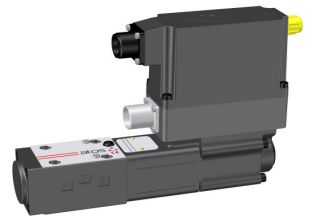
This execution speed up the installation and the start-up of the electrohydraulic axis and simplify the overall machine control architecture.

The integral construction and the limited number of electrical interfaces may involve customizing of the mechanics, firmware and software, thus requiring technical cooperation with leading customers, a detailed presales analysis is ever required.

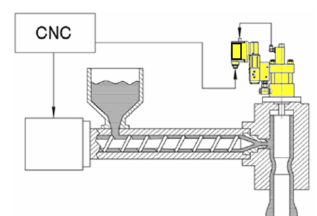
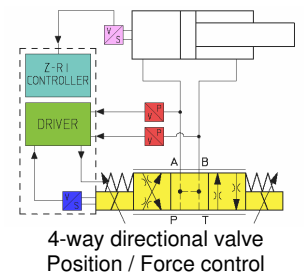
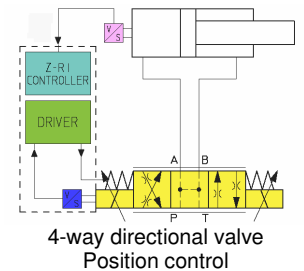
In the sketch at side are shown two typical examples of Z-RI applications :

**Parison:** the Parison servoactuator integrates the 4-way servoproportional valve with Z-RI controller, to manage the position closed-loop control of the parison axis in plastic blow moulding machines; the machine electronic central unit supplies in real time the position analog command signal to the controller and obtain the parison actual position by the controller's monitor analog interface.

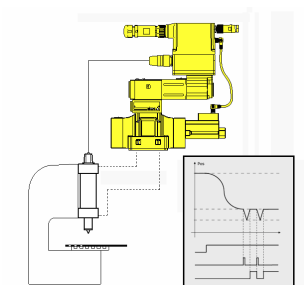
**Sheet Punching:** the controller is integrated on a pilot operated 4-way directional valve to manage the punching axis position. It generates the motion sequences and the relevant closed-loop control. The machine electronic central unit synchronizes punching and sheet movements through the controller's on-off interface: input (start a new cycle) and output (cycle ended).



Atos valve with Z-RI controller



Parison Control



Punching Axis

legend:

- pressure transducer
- valve position transducer
- cylinder position transducer

## Z-ME-KZ - Axis Motion Eurocard Controller

Tec. table G340-0/E, prototypes from March '09

New Z-ME-KZ Atos controllers are axis cards conforming to the latest development of modern automation technology, designed for electrohydraulic applications.

The Eurocard execution of this controller extends the quantity of available electronic interfaces and functionalities thus obtaining a more flexible and general purpose hydraulic motion control unit.

These controllers have to be interfaced to a 4-way proportional directional valve, analog or digital, connected with the actuator to be controlled. They generate an analog voltage/current signal to command the valve's electronic driver.

To realize the position control, they require the connection to the actuator's position transducer, integral or external type. This axis card can be interfaced with any of the transducers available for the Z-RI controllers without any selection requirement.

Available interfaces:

- 6 analog input ( voltage or current, software selectable )
- 3 analog output ( voltage or current, software selectable )
- 9 on/off input ( 1 enable + 8 programmable )
- 8 on/off output ( 1 status + 7 programmable )

The above interfaces are all simultaneously available to allow communication with the machine control unit for motion sequences selection, inhibit in front of machine alarm situation, diagnostics, etc. They can also be connected to auxiliary transducers (e.g. temperature) or dedicated to the management of auxiliary safety solenoid valves to realize safe system configuration in case of failure or alarm.

Additional functionalities are the same of Z-RI-TEZ plus:

- Dedicated RS232 interface for connection with Atos PC programming software
- Separate communication interface for fieldbus : CANopen or PROFIBUS DP
- front panel display and buttons for quick operation of parameter programming and diagnostic without requiring the PC software
- internal generation of advanced motion profiles sequences, programmable by Atos PC software, which are then sequenced by the external machine electronic control unit

Pressure or force closed-loop controls can be combined to the main position control by simple software setting. In this case additional pressure transducers or load cell have to be installed in the hydraulic system and connected to the relevant analog interfaces available on the controller, see sketch at side.

The Z-ME-KZ axis cards are particularly indicated for motion control of a single axis with multiple interfacing to the machine auxiliary subsystems, like proximity sensors and safety valves and circuits, manual commands by operators during start up and emergencies, management of motion sequences coordinated with other axis.

Thanks to the flexible general purpose controller's structure and to the Atos easy PC programming software, the Z-ME-KZ axis cards can be simply adapted and optimized by distributors or customers to any specific application.

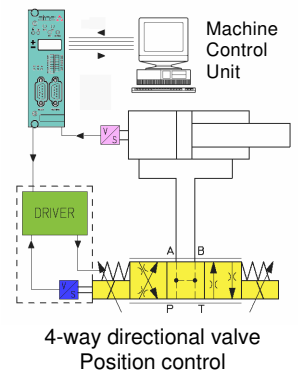
Dedicated trainings will be available for customers to get acquainted with innovative solutions.

For standard and repetitive applications with requirements of integration with machine automation and high number of interfaces, the Z-ME-KZ axis cards can be directly supplied by Atos to leading OEMs with firmware and software customized to their specific application requirements. A detailed presales analysis will be strictly required .

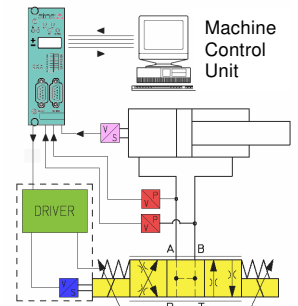
The Atos Z-ME-KZ digital controller performs the same functions of the BoschRexroth (BRR) HACD axis card and has similar software settings.



Atos Z-ME-KZ axis card



4-way directional valve  
Position control



4-way directional valve  
Position / Force control

**legend:**

- pressure transducer
- valve position transducer
- cylinder position transducer

Z-ME-KZ controller

## Z-BM-HZ - Modular Axis Motion Controller in Din Rail format

Tec. table G350-0/E, prototypes from June '09

New Z-BM-HZ Atos controllers are powerful high performances axis cards with modular assembling on DIN Rail panel support. Their basic functions are similar to the Z-ME-KZ controllers but thanks to the extended computation capabilities they can control up to two hydraulic axes with independent motion cycle or synchronized.

The Z-BM-HZ modular design permit to widely configure the on-off and analog interfaces according to the specific application requirements and to manage also an unlimited number of auxiliary logics like proximity sensors, safety valves and circuits, manual commands by operators during start up and emergencies, management of motion sequences coordinated and/or synchronized with other axes.

The motion cycle can be programmed into the axis card with many motion commands and functions, alternating many different control loops (position, speed, acceleration and force) contemporary active on the electrohydraulic axis.

The valve regulation characteristics (linear, progressive, etc.), the cylinder size and area ratio and many other physical system's characteristics can be directly set into the controller, which will then automatically compensate their effect on the motion control performances.

The Atos Z-BM-HZ digital controller completes the Atos top range of the electrohydraulic motion control units.

The following scheme represents a typical application of Z-BM-HZ2 controller performing a 2 axis synchronous motion control with limitation of the actuator's maximum force. One of the actuators is defined Master and the other Slave.

The Atos controller internally generates in real time a motion profile (position/time (21)) for the Master actuator and the max force reference (force/time (22)) for both axes; position feedback of the Master axis is then used as position reference for the Slave actuator.

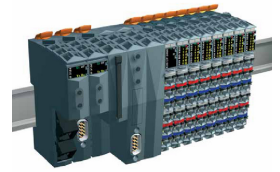
All motion profiles can be easily programmed and stored by means of Z-SW-HZ Atos unique PC software.

The feedback values, measured by the cylinder's position and the pressure transducers installed on the system, are processed to the input interfaces of Z-BM-HZ.

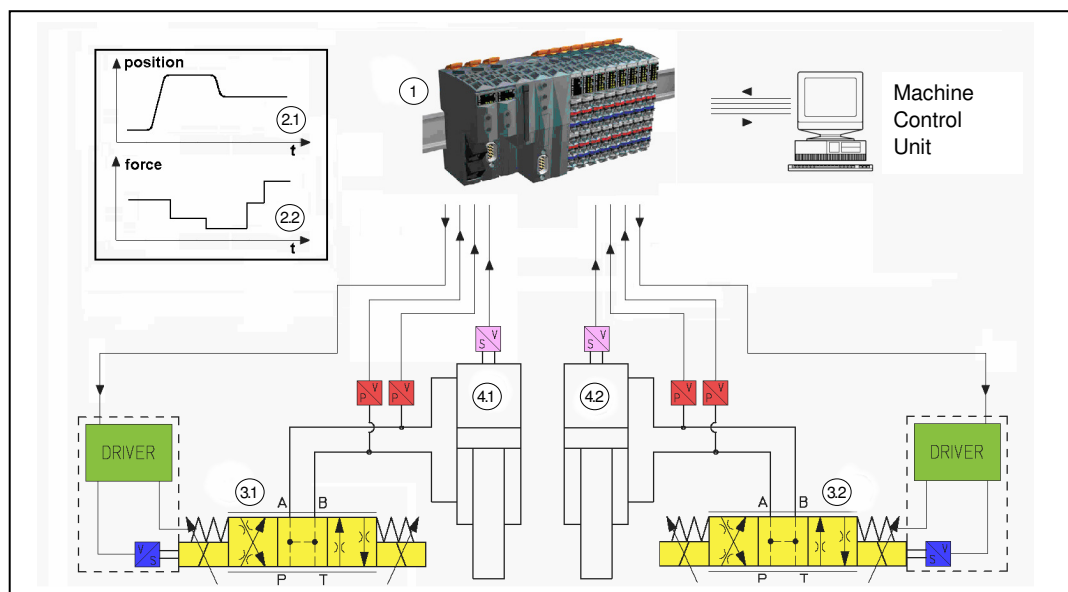
The internal processing unit runs, per each actuator, a position/speed PID closed-loop with alternate force control (PA-PB): the CPU compares the internally generated position/force references with the relevant input feedbacks and the deviations are elaborated by PID algorithm to work out the reference command signal for the electronic driver of the proportional valve (3.1) and (3.2).

The alternate force control is active during the whole motion cycle and it is activated if PA-PB reaches its max reference value.

In case the force limitation is activated on the Slave axis, this last immediately becomes Master thus avoiding possible misalignment between the 2 actuators.



Atos Z-BM-HZ axis card



### legend:

- ① Z-BM-HZ2 controller
- ②① position/time profile
- ②② force/time profile
- ③①, ③② 4-way directional valve
- ④①, ④② double acting cylinder
- ▣ pressure transducer
- ▣ valve position transducer
- ▣ cylinder position transducer