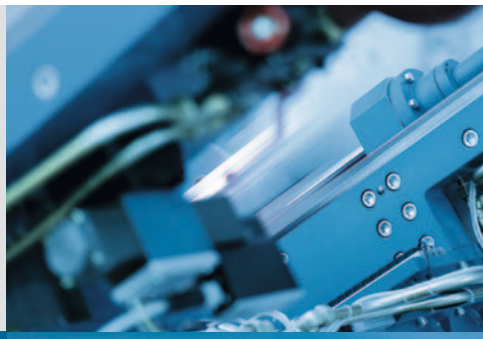
Rexroth
Bosch Group

Multi axis Motion Control MAC-8 from Rexroth



Optimum control for complex applications

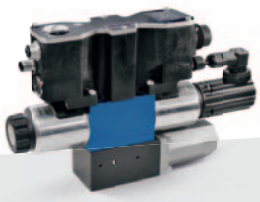
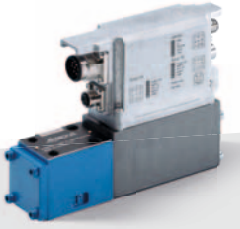
The New MAC-8:
Ready for demanding Applications

When it comes to performance there are no upper limits! Rexroth's new multi-axis control is proof of this. Even when used as a stand-alone, it can control up to 32 electric or hydraulic axes. And using cross communication to link them together means that several controls can be used to drive almost any number of axes.

In the MAC-8 Rexroth brings together all the special features of hydraulic drive technology, something which means considerably more straightforward engineering. Keynote applications are already prefabricated. This modular motion control, currently the most powerful available, is thus capable of linking up more than 100 closed-loop control axes, for instance in a continuous casting system, by adopting a process-orientated approach.

Only Rexroth has mastered hydraulics and control technology to this degree of complexity and is therefore able to carry out the most sophisticated motion control tasks in real time.

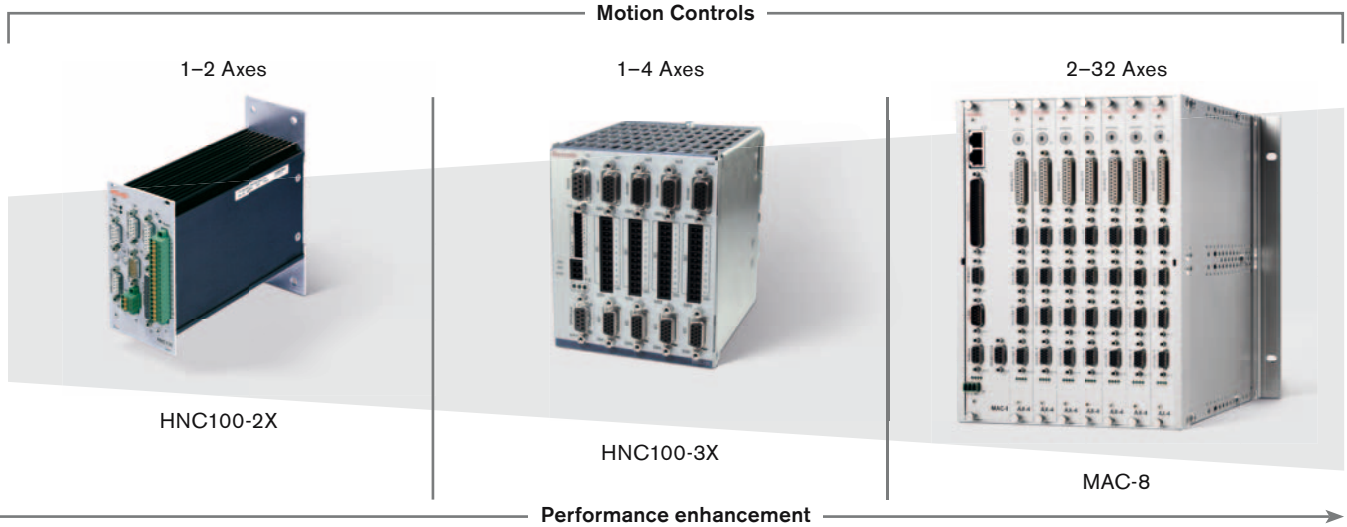
Axis Controllers

PQ Controller	1 Axis	1 Axis	1 Axis
			
SYDFE	IAC-P	IAC-R	HACD

It is primarily when it comes to complex, customized applications that the MAC-8 proves itself in terms of its high performance capability. It is here that the branch know-how of the Rexroth specialists, stretching back over a number of years, really makes itself felt. With their extensive experience of automation gained from comparable applications all over the world, they support users in planning, developing and implementing complex drive and control tasks. This ideal combination of process knowledge and high-end control makes the MAC-8 a natural first choice for all such applications.

The MAC-8 supersedes the many-times proven MX 4. The new control is distinctly more compact, yet at the same time features substantially enhanced computational capability. The fact that all interfaces are integrated in the processor ensures rapid exchange of data and very high quality of motion. The processors are derived from the automotive industry and communications engineering. This means guaranteed large-scale production benefits and thus long-term supply capability.

Overview of current axis controllers and motion controls



The New MAC-8: Rising to New Challenges

Conventional controls rapidly encounter their limits as soon as things become demanding and complicated. The combination of a large number of axes needing to be controlled in real time and process-specific parameters stored in the process control used to require expensive special solutions.

With the MAC-8 Rexroth offers a new multi-axis control, which makes a number of things simpler precisely for applications of this type.

Whereas the majority of controls manufacturers rely on distributed intelligence and therefore need to organize synchronization of the axes by means of a bus, Rexroth made the decision, with the new MAC-8, to opt specifically for a central modular concept. This permits unlimited access to all process values, actuators and sensors in real time. In order to cope with the requirements of the hydraulics, a control may, for example, need to activate valves and pumps on a drive simultaneously and adapt the gain to the active areas of a cylinder or combination of cylinders. The MAC-8 is optimally prepared for these functions and offers the customer a high level of flexibility with intelligent programming.

Synchronism
Here the control will regulate any groups, variable in relation to running time, with up to 32 axes in active and passive synchronism. At the same time, the synchronism offsets to the axes can be varied dynamically. Even during travel axes or groups of axes can be connected to the synchronizing group or disconnected from it.

Interpolating Movements
Interpolation is invariably necessary when axes need to move in a defined relationship to one another. The axes always reach their destination at the same time, even when the distance varies. Interpolation sections with varying distances can also be traveled, even without an intermediate stop, using a fading technique. This makes it possible to specify a dynamic target that is able to track any curves. By specifying a transformation matrix the geometric dependencies of real axes on Cartesian, virtual axes can also be mapped. The MAC-8 will support 4 interpolation groups, each with up to 32 axes.

Linked Axes
Linked axes incorporate a number of physical relationships. This means that, with forming applications using high internal pressure, the position or force of a clamping cylinder is dependent on the water pressure generated by the pressure intensifier. In the case of flying shears or the pre-acceleration of die cushions, start time and acceleration are being continuously calculated in relation to an approaching axis, specifically in order to arrive at a rendezvous position and speed. For these requirements the MAC-8 offers ready functions that are able to generate the following ratios

- Position/free value
- Speed/position
- Force/time
- Force/position
- Force/free value

Complex Sequences
Every problem needs an answer. The MAC-8 provides a powerful programming language together with a high processing speed for up to 32 parallel processes. Its syntax, oriented towards high-level languages, guarantees clarity in the source code even where extensive applications are concerned.

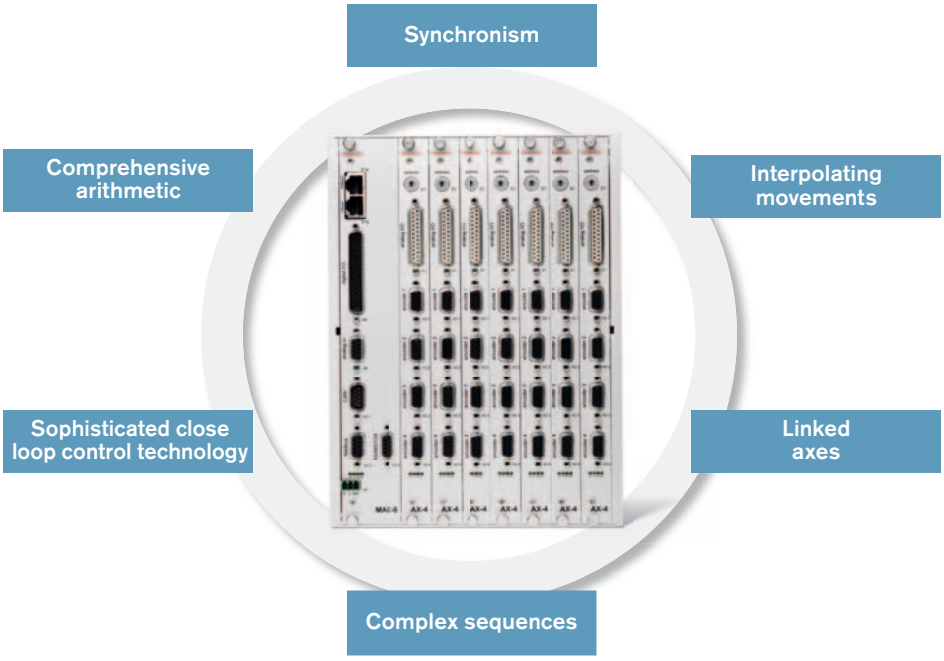
Sophisticated closed-loop control technology
Here too the high level of flexibility and the power of the MAC-8 is evident. The control is especially suited to extensive dynamic closed loop control systems with real time data exchange beyond the confines of the axes. At the same time, the command value, actual position value, actual force value and output value, among others, can be freely configured and linked up.

This means that it is possible to control drives with a number of actuators (valves).

Even the company's own special controllers can be implemented using the existing programming language. At the same time, you have access to all the process values and blocks featured in the standard controller. And, of course, it goes without saying that, even with all this, the special features of the hydraulics are taken into account.

Types of closed-loop control:
- Following up controller
- State controller
- Position-dependent braking
- Speed controller
- Pressure/force controller, automatic change over
- Freely programmable controller

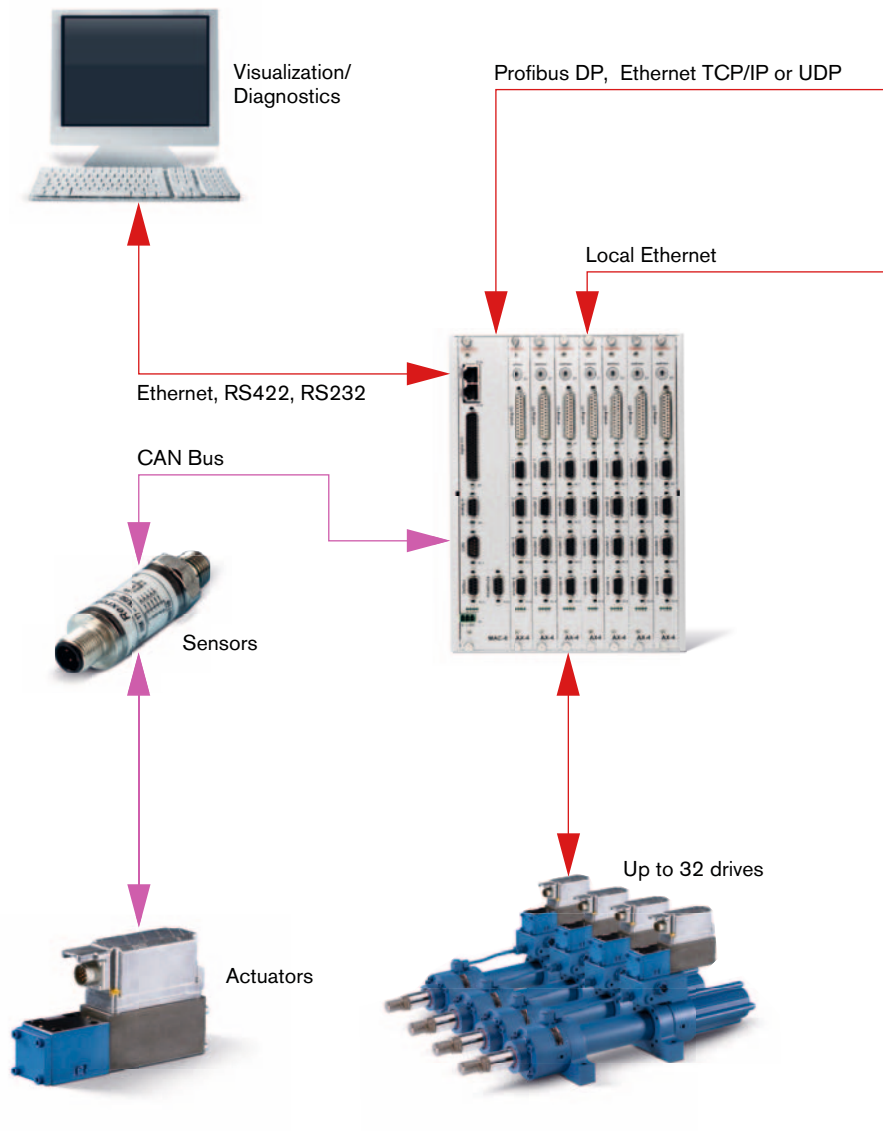
Comprehensive Arithmetic
The data for an application must be easy to organize and lend itself to rapid and flexible processing. All variables, whether they are integers or real arithmetic, inputs, flags or outputs, process values or system parameters, can be programmed in the MAC-8 by means of symbols. For large quantities of data, dimensionable fields are available. Access to these as well as all other variables is possible by indexing. The basic operators, trigonometric functions and their hierarchy correspond to a major extent to those of the high-level language "C". Functions for copying or setting default values for larger quantities of data are also available. In this way it is possible to carry out optimum calculations for process-dependent data.



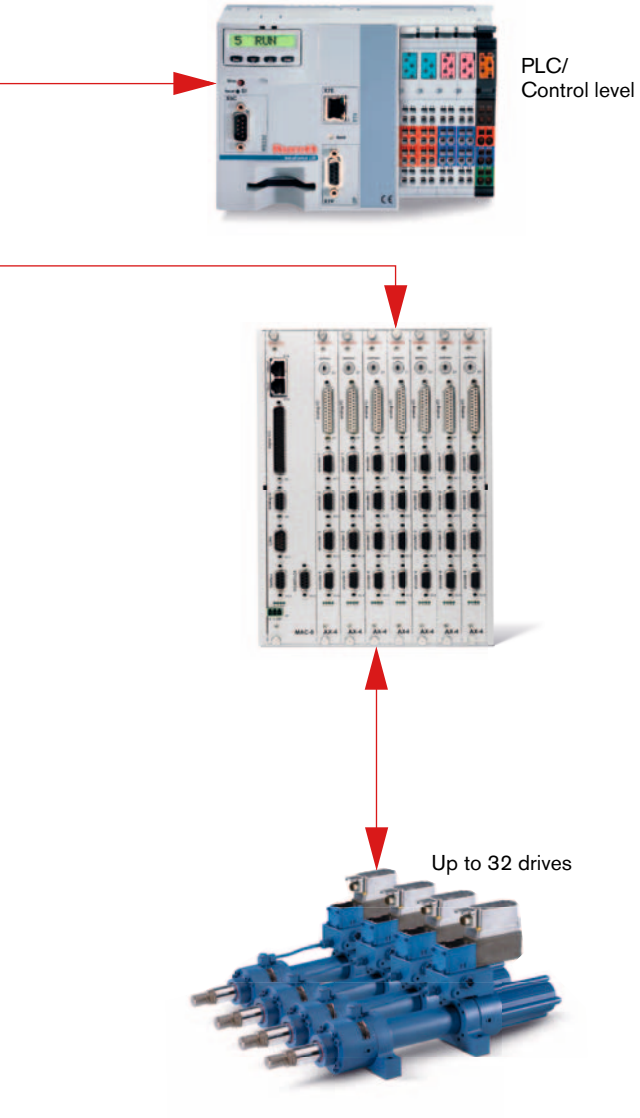
The New MAC-8:
Powerful – Alone or in Combination

The MAC-8 NC control system can be used both as an independent automation system and as an intelligent multi-axis controller networked via a fieldbus. At the same time, the boundaries are fluid. Where machines or installations are logically or spatially distributed, a local Ethernet network of MAC-8 controls can be built up and these will communicate with one another in real time.

As with all Rexroth controls, the MAC-8 also features open interfaces and communicates with other controls via Profibus DP, Ethernet TCP/IP or Ethernet UDP. The MAC-8 integrates the field level with CANopen. For visualization purposes it uses standardized PC technologies and state-of-the-art software such as OPCServer or ActiveX.



2 Axes 4 Axes 32 Axes



Process Link
- **32 digital inputs**
- **24 digital outputs**
- **Profibus DP**
- **CANopen**
- **TCP/IP**
- **UDP**

Link-Up/Visualization
- **OPC Server**
- **ActiveX Element**
- **Interfaces: RS422, RS232 or Ethernet**

The New MAC-8: Modular Intelligence

One significant advantage of modular open motion control lies in the fact that it is scalable. This means that the level of control is only ever as great as is necessary for the specific application.

Master card

- Communication
- Data management
- Sequential control via NC Interpreter
- Axis management
- Axis synchronism
- Axis interpolation

The modular MAC-8 Motion Control consists of a rack with either 1, 5 or 8 slots, a master card and up to 7 slaves. The MAC-8 can therefore be configured from 2 – 32 axes in steps of 2 axes at a time.

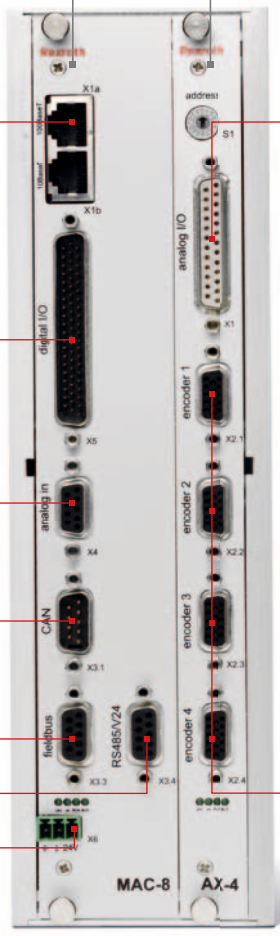
The master card, together with integrated slave, is capable of controlling up to 4 axes on its own, assuming all global tasks such as, for example, sequential control for the machine process, interpolation or axis synchronism. The stringent requirements in terms of real time capability when communicating with the slaves are met by means of a parallel back (rear) panel bus.

The slave cards, of which there may be up to 7, undertake command value generation, axis control and monitoring, as well as local sequential control.

The control supports incremental and absolute position measuring systems with SSI interface as well as analog measuring systems.

Master without axes

Fast Ethernet 100BaseT	X1a
Ethernet 10BaseT	X1b
32 x digital inputs	X5
24 x digital outputs	
8 x analog inputs +/- 10 V	X4
1 x CAN-Bus (Can Open)	X3.1
1 x Profibus DP (optional)	X3.3
1 x RS422 und 1 x RS232	X3.4
18 … 36 V power supply	



Slave card

4 axis controllers for
- Command value generation
- Axis control
- Axis monitoring
- Local sequential control

Slave for 4 axes

X1 **Analog Signals**

Axis	Channel	Type
1	input A	U/I
	input B	U/I
	input C	I
	output	U/I
2	input A	U/I
	input B	U/I
	input C	I
	output	U/I
3	input A	U/I
	input B	U/I
	input C	I
	output	U/I
4	input A	U/I
	input B	U/I
	input C	I
	output	U/I

X2.1 – X2.4 **Sensor inputs**

Axis	Plug	Type
1	X2.1	Inc/SSI
2	X2.2	Inc/SSI
3	X2.3	Inc/SSI
4	X2.4	Inc/SSI

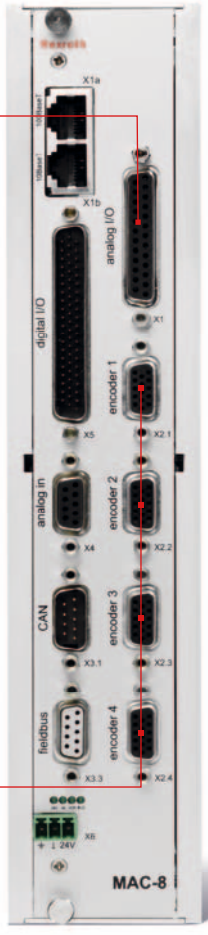
Hardware master with 4 axes

Analog Signals X1

Axis	Channel	Plug [type]
1	input A	U/I
	input B	U/I
	output	U/I
2	input A	U/I
	input B	U/I
	output	U/I
3	input A	U/I
	input B	U/I
	output	U/I
4	input A	U/I
	input B	U/I
	output	U/I

Sensor inputs X2.1 – X2.4

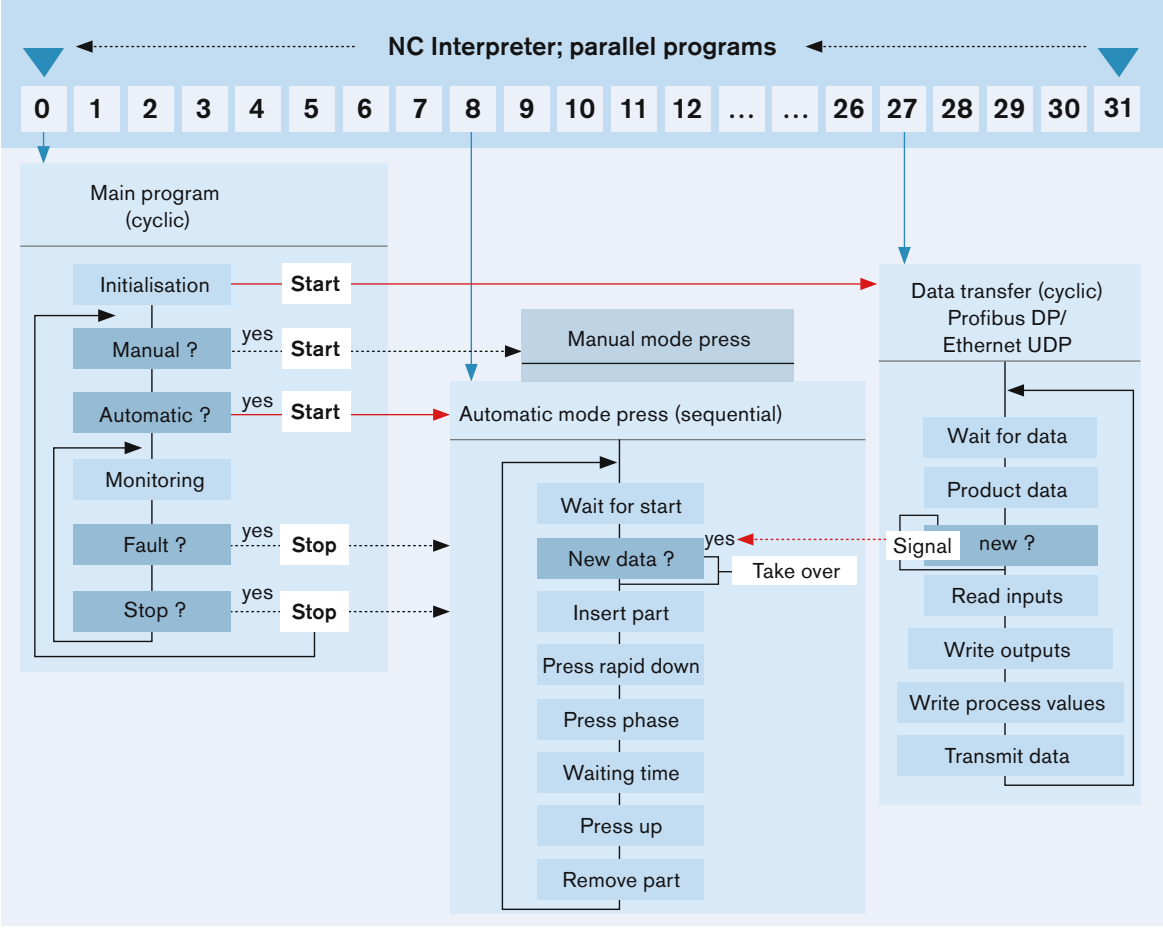
Axis	Plug	Type
1	X2.1	Inc/SSI
2	X2.2	Inc/SSI
3	X2.3	Inc/SSI
4	X2.4	Inc/SSI

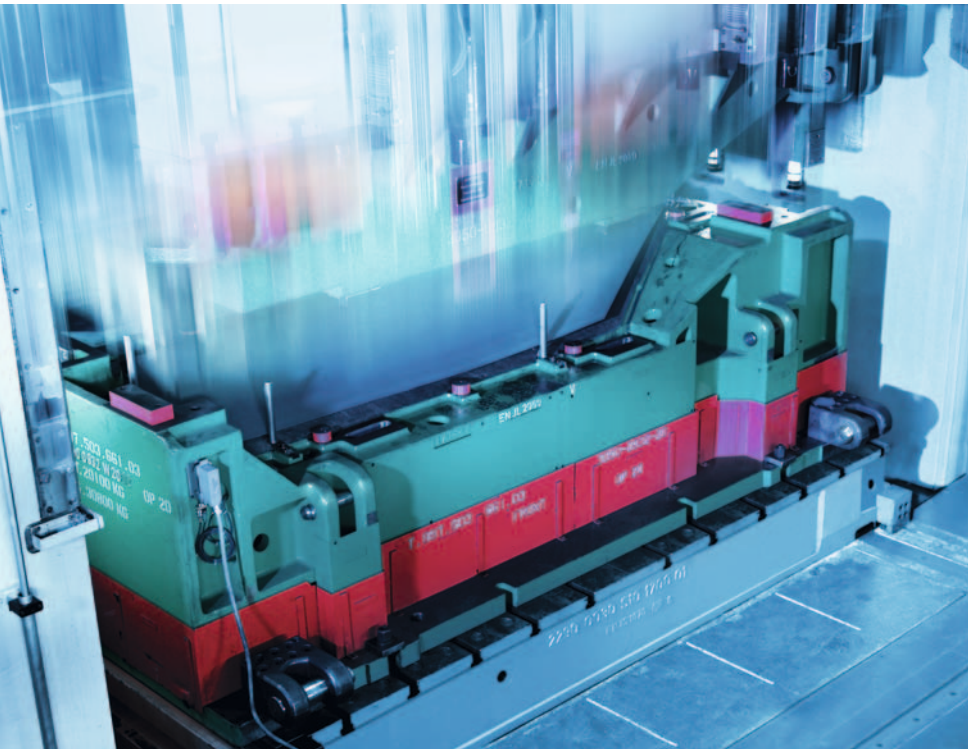


Plugs X1a, X1b,
X5, X4, X3.1, X3.3
and power supply as for
master without axes

The New MAC-8: Reducing Complexity, Increasing Productivity

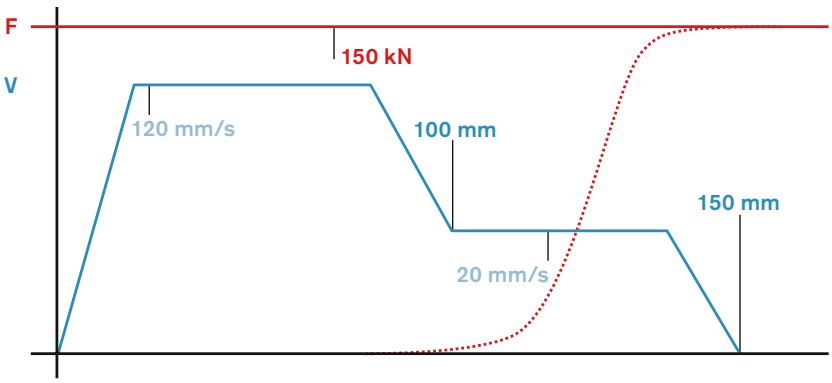
Whereas most motion controls offer the cyclic processing capability of a PLC, NC controls primarily operate sequentially. Both have their advantages. With the new MAC-8, both variants are available at the same time with a single programming interface. Cyclic programming is used for operating mode, condition and fault monitoring; this reacts immediately to any changes and initiates responses accordingly. The sequences are represented using sequential programming without having to take fault conditions into account. By separating sequence and monitoring, complexity is significantly reduced with a marked increase in the quality and clarity of the program.





With the MACpro engineering tool new projects start immediately with a ready program framework which takes into account the breakdown into monitoring and sequence. At the same time, a range of sample projects makes it easier to solve the required tasks.

ECL, the programming language used for the MAC-8, applies English syntax as with “Pascal”, “Basic” or “C”, and this is self-documenting and thus easy to learn.



Example

force c x0 = 150.000	Apply force
acc x0 = 50%	Apply acceleration
vel x0 = 120.000	Apply speed
pos l a x0 = 100.000, Vrest 20.000	1st part positioning
pos a x0 = 150.000	2nd part positioning

List of Commands

Program Sequence Control:

IF ELSE	Command
WHILE	Loop
{..}	Instruction block
[..]	Command group
BEGIN END	Program definition
Label JUMP	<Label> or <sub-program>
START/STOP/BREAK/CONT	<Program>
WAIT	<Time> or <Condition>

Data Manipulation:

DIM	Field dimension
COPY	Copy function for fields
SET	Assign variable
MSET	Set default values
PSET	Allocate local variable
Compiler Instructions	
;	<Comment>
#include	<Filename>
#module	<Filename>
#define	<Name> <Text>

Axis/Process Functions:

AXINIT	Initialize axes
AXSET	Take over axis system data
STOP	Cancel axis movement
HALT	Axis movement rapid stop
BREAK	Interrupt axis movement
CONT	Continue axis movement
EQUIT	Acknowledge axis fault
LOCK	Block axis control
UNLOCK	Release axis control
OVER	Set axis override
ACC	Axis acceleration (+/-)
VEL	Speed of axis
POS	Move axis into position
TRIG	Define trigger points
LIN	Linear interpolation
FORCE	Force control
DAC	Voltage output
SYNCH	Synchronism
FUNC	Axis function
SIMU	Simulation
HOME	Reference movement
TABLE	Calculate process curves
VIRTUAL	Define virtual axes
REAL	Formula for back-calculation to VIRTUAL

Miscellaneous Commands:

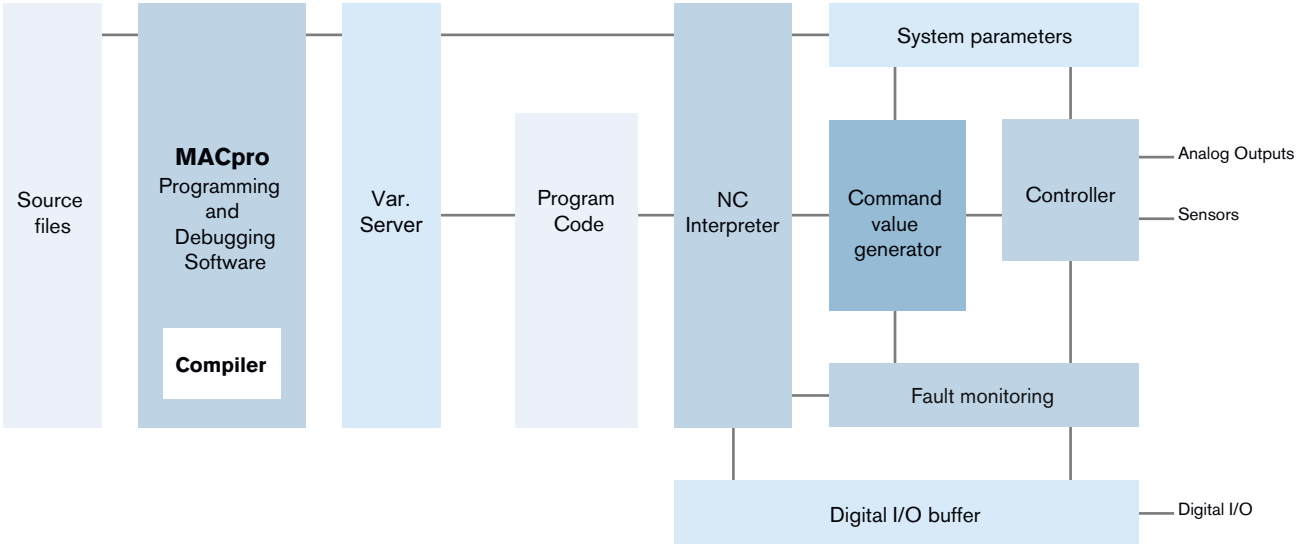
TIMER	Timer
TRACE	Oscilloscope function
DIALOG	Operating device dialog
CALL	Call up C program
START TASK	
STOP TASK	Start/Stop customer tasks

The New MAC-8: Intuitive Operation with MACpro

On the MAC-8, modern technologies and an intuitive user interface ensure efficient and successful programming and operation. Thanks to the MACpro tools, the operator is in a position to successfully meet the high requirements of the automation sector – using state-of-the-art technology – as well as devising professional and innovative project solutions.

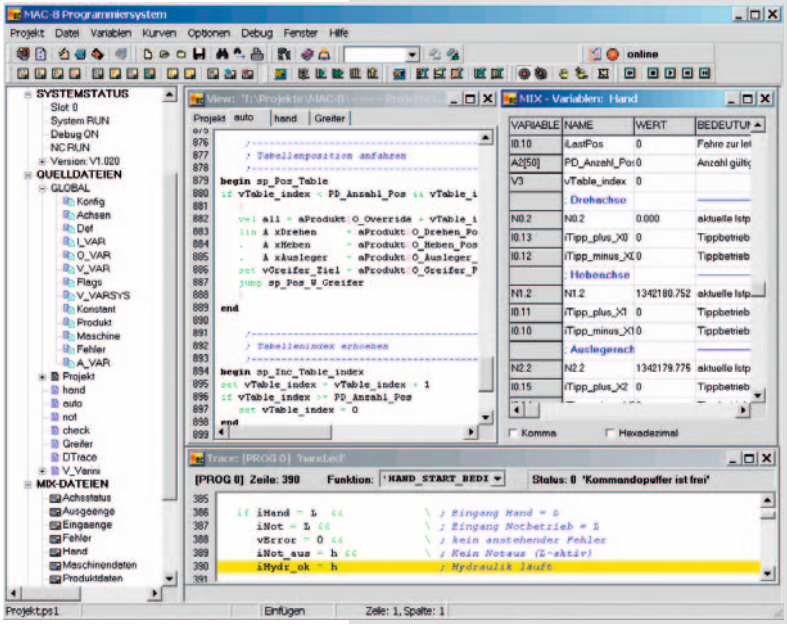
Windows NT/2000/XP

Nucleus Operating System



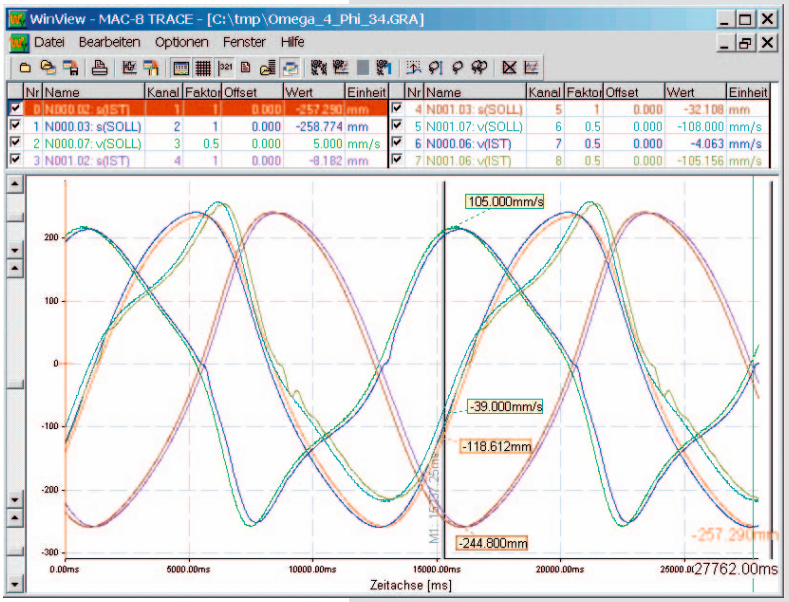
MACpro-Features

- User management
- Version management
- Project management
- Module management
- Program editor with syntax highlighting
- Trace
- Debugging toolbox
- Freely configurable variable windows
- Desktop management
- Online help for syntax, tools and keys
- Software oscilloscope
- Trend
- Memory dump
- and lots more



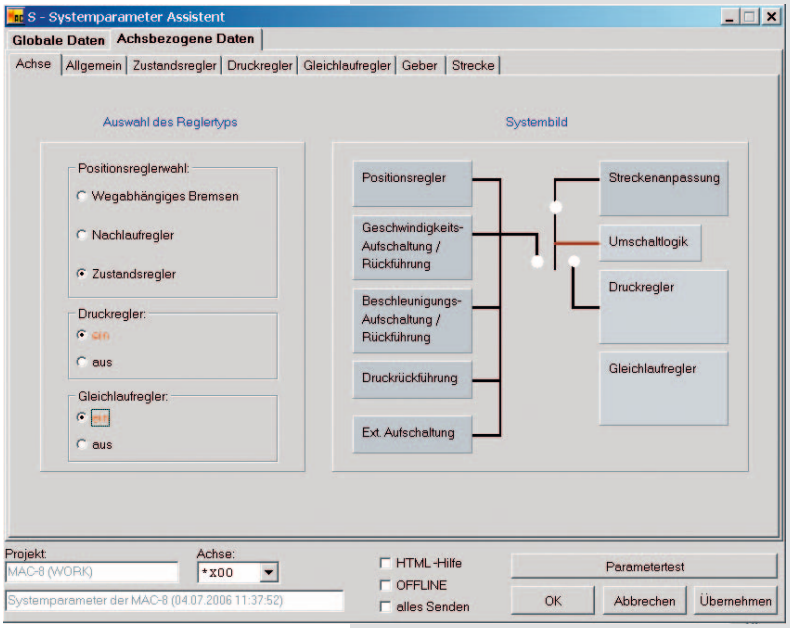
Software Oscilloscope

- 12 recording channels
- Double buffer principle
- Start and Stop Trigger
- All process values recordable
- Graphic and numerical displays
- Separate area for I/O signals
- Straightedge for measuring
- Automatic scaling of individual or all curves
- Unit-dependent scaling
- Export of curves (“DBF” or “TXT Format”)
- and lots more



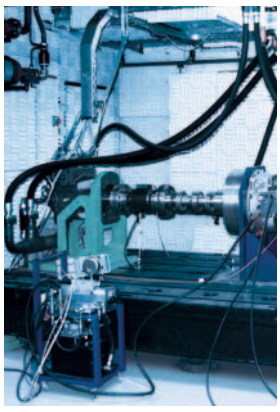
System Parameter Assistant

- Global axis management
- Controller configuration
- Controller-specific para-meterization
- Limit values and units
- Sensor configuration
- Line adaptation
- Parameter test with reset function
- Changes display
- Parameter database with version management
- Context-dependent Help



The New MAC-8:
At home in the Most Complex Machinery




Whether in presses, steelworks or rolling mill, materials handling, test engineering or special machinery, Rexroth offers optimum performance when it comes to control applications.

Presses:
- Tube forming presses
- SMC/IMC presses
- Metal/ceramic powder presses
- Glass presses
- Bending presses
- Deep drawing presses/die cushions
- Hydroforming presses
- Laboratory presses
- Ejector controls
- Block machines etc.

Steelworks and rolling mills:
- Mill stands
- Segment adjustments
- Mold oscillations
- Horizontal casting machines
- Turn over cooling beds
- Flying shears
- Casting cars
- Curved casting machines
- Triple roller bending machines
- Sand molding installations etc.′

Materials handling technology:
- Train lifts
- Truck lifts
- Container cranes
- Dockside cranes
- Belt conveyor etc.

Test Engineering:
- Weld testing machine
- Shock absorber testing system
- Tube testing presses
- Bumper straightening machine
- Leaf spring test stand etc.

Special Technology:
- Coal distributors
- Heavy plate turning equipment
- Motor turning equipment
- Screw conveyors
- Edge bending and slide device
- Stretch bending machines
- Turntables etc.

Intelligent Hydraulics in New Dimensions

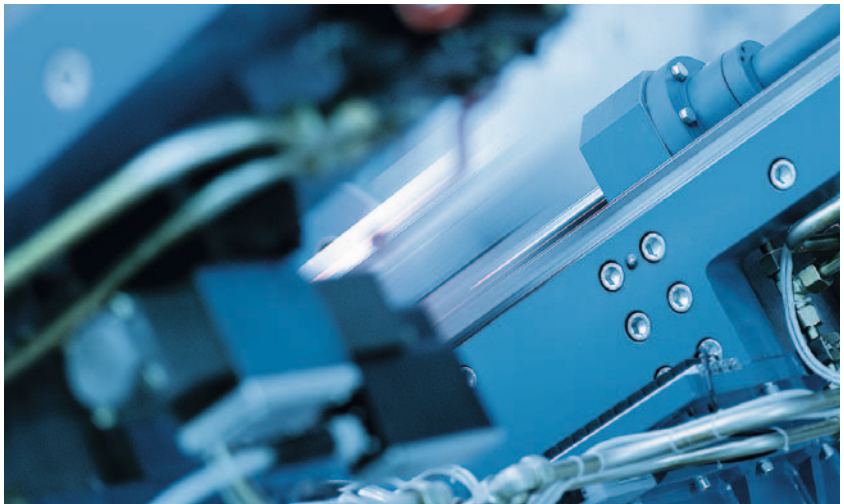
Whether it's a case of raising or lowering loads smoothly, undertaking linear or rotational movements, achieving even acceleration or accurate positioning, maintaining preset speeds, transmitting power or linking motion sequences – in fact, wherever economical power is required, this is where hydraulics comes into its own.

Rexroth is technology and market leader in industrial hydraulics with an extensive product program and proven applications know-how. With the widest selection of hydraulic products in the world, Rexroth will provide you with standard products, application-orientated systems and customized solutions of the highest quality. Furthermore, with the aid of the latest microelectronics, Rexroth has made hydraulics even more powerful than ever.

Rexroth is the ideal partner if you want to develop highly efficient machines and production facilities – from the first point of contact right through to commissioning and across the complete life cycle. Teams operating worldwide will take on the complete project design work of your systems, even producing a turnkey solution if required.

Whether it's competent support on the telephone, urgent repairs or supply of spare parts, or a callout by one of our engineers – whichever service you require, experienced personnel and a worldwide service network will guarantee that the problem is swiftly solved.

Using hydraulic drive and control technology from Rexroth will help you become more competitive than ever.



The Drive & Control Company
Rexroth is unique. No other brand on the world market can offer its customers all drive and control technologies, both on a specialized and integrated basis. We are considered to be the worldwide benchmark when it comes to drives, controls and motion. Our technological leadership is continually setting us new challenges, with approximately 28,000 employees in more than 80 countries around the world. This is possible thanks to an infrastructure designed with partnership and customer proximity in mind.

As a company Bosch Rexroth can look back on more than 200 years of tradition. As a wholly owned subsidiary of Robert Bosch GmbH, we are part of a globally operating technology group. All this is both our drive and our commitment. And it is unique – just like Bosch Rexroth. The Drive & Control Company.

Electric Drives and Controls

Hydraulics

Linear Motion and Assembly Technologies

Pneumatics

Service

Rexroth
Bosch Group

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