

Digital multi-axis NC control

RE 30156/03.12
Replaces: 04.05

1/16

Type VT-MAC8

Component series 1X



H 7304

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Information on available spare parts:
www.boschrexroth.com/spc

Features

The MAC8 is the digital Rexroth multi-axis NC control in modular design. It consists of a master card with no, 2 or 4 axis controllers and can be extended with up to seven slave cards for four axes each, if necessary. It is thus the perfect solution for complex control tasks with up to 32 interpolatable axes. Using local Ethernet, more MAC8 can be connected. The MAC8 communicates with the superior PLC machine control via field bus (PROFIBUS DP or CAN) or via Ethernet. It has special hydraulic control characteristics and is able to control the movements of the machine or machine parts in a completely automatic manner and can thus also accept PLC tasks. Sensors and actuators can also be analyzed and/or activated via CAN bus.

Areas of application:

- Presses (tube forming, metal / ceramic, powder, plastic, deep drawing, glass presses, press brakes, die cushion controls, IHF (internal high pressure forming, etc.)
- Materials handling (container crane, balance crane, train/truck lift, belt drive, etc.)
- Steelworks and rolling mill technology (continuous caster, curved casting machine, mold oscillation, roll stand, 3-roll bending machine, turn over cooling bed, flying shears, ladle car, molding plants, etc.)
- Testing technology (weld testing machine, shock absorber testing system, tube testing press, etc.)
- Special machinery (coal distributors, thick sheet turning equipment, engine turning system, etc.)

Process connection

32 digital inputs, 24 digital outputs, PROFIBUS DP, CANopen, TCP-IP, UDP, PROFINET RT, EtherNet/IP

Connection / visualization

- By means of "OPC server"
- By means of "Active X" elements
- Interfaces: RS485 or Ethernet

Programming

- User programming with PC
- Extensive diagnosis and debugging tools
- Comfortable data administration on the PC
- High level language oriented
- 32 NC programs which can be executed in parallel
- High execution speed due to compiled programs
- Fast integer and real arithmetics
- Exponential and angle functions

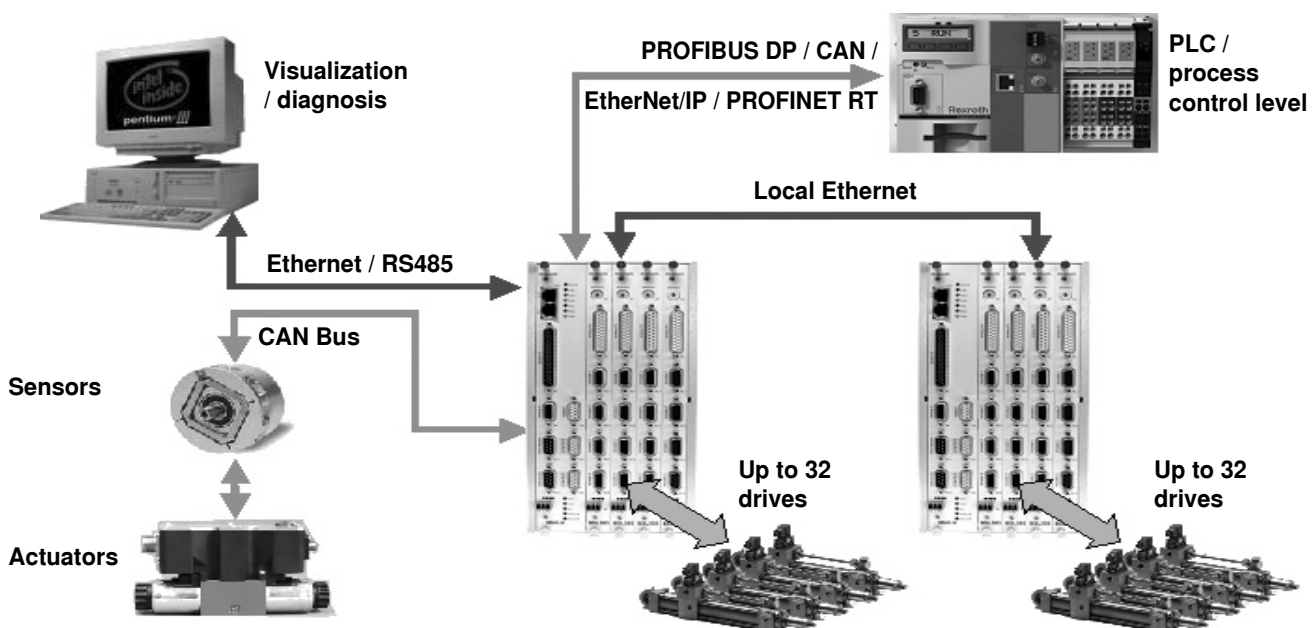
Hydraulic axes

- Measuring system Incremental or absolute (SSI)
Analog ± 10 V and 4 to 20 mA, ± 10 mA and ± 20 mA
- Control output Analog ± 10 V and 4 to 20 mA, ± 10 mA and ± 20 mA

Closed-loop control

- Following controller
- State controller
- Path-dependant braking
- Synchronization controller up to 32 axes (different variants)
- Pressure / force controller

System overview



Ordering code for system

VT-MAC 8-1X/ S				M		AX4		*
System with								Further details in the plain text
1 slot	= 1							
5 slots	= 5							4-axis slave
8 slots	= 8							Number
Bus variant							0 to 7 =	Master
No field bus	= A							
PROFIBUS DP slave connection	= P					1 =		without axis module, with RS485
PROFINET RT / EtherNET/IP slave connection	= E					2 =		2-axis version, with RS485
						4 =		4-axis version

Selection aid

Part Ordering code	Analog In	RS232 (V24) RS485	CANopen	PROFINET RT / EtherNet/IP	PROFIBUS DP	Analog I/O	Encoder plug
AM 1	X	X	X				
AM 2	X	X	X			X	2X
AM 4	X		X			X	4X
PM 1	X	X	X		X		
PM 2	X	X	X		X	X	2X
PM 4	X		X		X	X	4X
EM 4	X		X	X		X	4X

Components

Material no.	Type	Designation
R901075726	VT-MAC8-1X/K-AM1	Master card without axis controller
R901075728	VT-MAC8-1X/K-AM2	Master card with 2 axis controllers
R901075730	VT-MAC8-1X/K-AM4	Master card with 4 axis controllers
R901075732	VT-MAC8-1X/K-PM1	Master card with PROFIBUS DP, without axis controller
R901075734	VT-MAC8-1X/K-PM2	Master card with PROFIBUS DP, with 2 axis controllers
R901075738	VT-MAC8-1X/K-PM4	Master card with PROFIBUS DP, with 4 axis controllers
R901275171	VT-MAC8-1X/K-EM4	Master card with PROFIBUS RT / EtherNet/IP, with 4 axis controllers
R901075752	VT-MAC8-1X/K-AX4	Slave card with 4 axis controllers
R901075757	VT-MAC8-1X/K-DUMMY	Blank location cover for a slot
R901075714	VT-MAC8-1X/K-RACK1	Empty rack with one slot (master card)
R901075722	VT-MAC8-1X/K-RACK5	Empty rack with 5 slots (1 master, 4 slaves)
R901075725	VT-MAC8-1X/K-RACK8	Empty rack with 8 slots (1 master, 7 slaves)
R901052075	KABELSATZ MAC8/ABS/SF/3M	Cable absolute value encoder SSI (X2), 3 meters, open end
R901052153	KABELSATZ MAC8/INC/24V/SF3M	Cable incremental encoder 24V (X2), 3 meters, open end
R901052152	KABELSATZ MAC8/INC/5V/SF/3M	Cable incremental encoder 5V (X2), 3 meters, open end
R901052141	KABELSATZ MAC8/AE/SF/3M	Cable analog inputs (X4), 3 meters, open end
R901052069	KABELSATZ MAC8/AEA/SF/3M	Cable analog inputs/outputs (X1), 3 meters, open end
R901052150	KABELSATZ MAC8/DEA/SF/3M	Cable digital inputs/outputs (X5), 3 meters, open end
R901074828	KABELSATZ MAC8/PC/RS232/5M	Cable PC MAC8 RS232 interface (X3.4), 5 meters
R901269556	SYS-MAC8-2X-D/E	Installation CD for the MAC8 programming system

Software project planning

Program creation with MACpro

- Windows version with integrated editor with command highlighting
- Project group creation for managing the individual programs on the slots with automatic switch-over
- Global header files for joint definitions
- Programs can be organized in modules (files)
- Nesting depth for up to 50 subroutines
- Change-oriented compiling and transmission to the MAC8
- Reference list of the variables and subroutines used
- Automatic version comparison PC <-> MAC8
- Saving of different desktop settings
- Program stored in the flash

Debugging

- Online help for "Syntax", "Tools" and "Keys"
- Tracing of program execution (Trace)
- Process variable tracing by means of trend
- Program view (View) with search functions
- Function level display (call hierarchy)
- 5 break points are managed
- Stop / start / continue and single step (single, step, step-over) of individual or all programs
- Saving of the memory image (program with data)

View of variables

- All variable windows can be selected by means of "Hot keys" or the menu, flexible window size
- Configurable variable window (mix variables) with hexadecimal, decimal, binary and floating point representation. Easy transmission of any variable from the program view to the tracing window and structuring by means of comments
- Setup window with all axis-specific process variables
- System parameter assistant

Acquisition of measured data

- 64 recording channels with start and stop trigger
- Recording option for all process variables
- Graphical and numeric presentation (DBF format) of the recorded channels
- Endless data recording (trend)

Commissioning functions

- Inputs can be simulated
- Outputs can be set
- Analog output variables can be set
- Jog mode for controller optimization
- Activation / deactivation of individual controller components

Project-related management of the:

- Programs
- Configurable programming user interface
- System parameters
- Measured data

MACpro system requirements:

- IBM PC or compatible system
- Windows NT, Windows 2000, Win XP, Windows 7
- Processor from 300 MHz
- At least 256 MB RAM
- At least 100 MB of available hard disk capacity

The installation is effected from CD
(SYS-MAC8-2X-D/E with material no. **R901269556**)

Overview of the controller functions

Position controller:

- Following controller
- Substitutional closed-loop control (position / pressure)
- Force limitation in positive and negative direction
Direction-dependent gain adjustment
- "Inflected" gain characteristic curve
- Fine positioning
- Residual voltage principle
- Compensation of zero point errors
- State feedback
- Command value feedforward
- Limitation of the control output via the NC program

- "Path-dependant braking"
- External controller function via NC program
- Following operation
- Velocity override
- Gain modification via the NC program possible
- Interpolation of up to 32 axes
- Pre-acceleration
- Force / path; force / time curves
- Position/ input value curves
- Coordinate transformation of the spatial axes

Overview of the controller functions (continued)

State controller:

- Velocity feedback
- Acceleration feedback
- Pressure feedback
- External feedback

Pressure / force controller:

- PID controller
- I share can be switched via window
- Differential pressure evaluation
- P / Q pilot control
- Different modes for transition from position to force controller

Velocity controller:

- PI controller
- I share switchable via window

Synchronization controller:

- Synchronization of any groups with up to 32 axes, which can be changed during runtime
- Active synchronization with force limitation and/or parallel making way
- Passive synchronization, tilt compensation control, with definable average counterforce
- Synchronization offsets of the axes can be changed dynamically
- Axes can be dynamically added to or removed from the synchronized group (also during operation)
- Relative synchronization, also in opposite direction

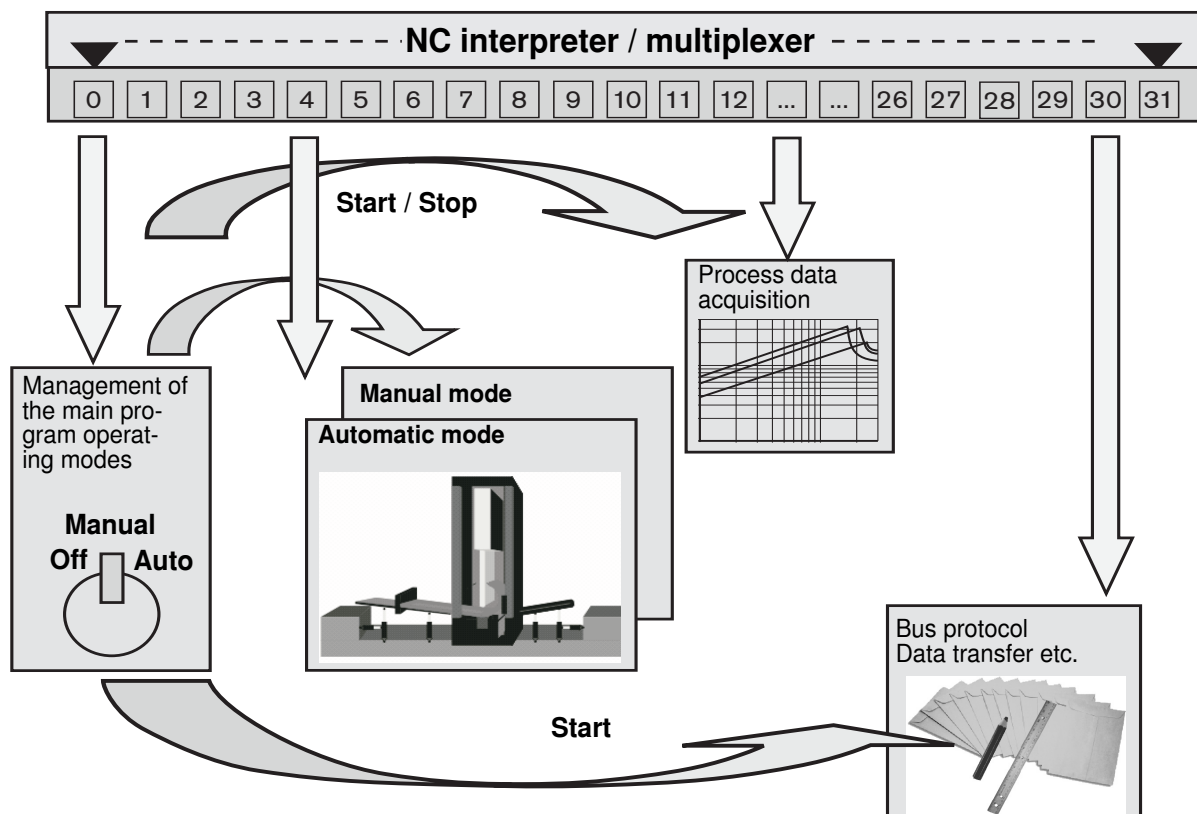
Monitoring functions:

- Dynamic following error monitoring
- Traversing range limits (electronic end switches)
- Cable break monitoring for incremental and SSI encoder
- Cable break monitoring for sensors with output 4 to 20 mA
- Valve monitoring
- Encoder voltage monitoring

NC interpreter

The NC interpreter organizes the execution of the 32 parallel NC programs. In this connection, each program works in a sequential manner. Switch-over between the parallel programs is in each case effected after processing of one program line. In case of commands waiting for an event (e.g.: "WAIT", "POS"), the next program is activated immediately after the event request in order not to hinder execution of the

other programs. All system resources are available for all programs (I/O, axes, variables etc.). Programs can start, stop or delay each other. This concept allows for the perfect imaging of the sequence control of the machine in the NC program of the MAC8.



ECL-Win programming language

The MAC8 data organization: Numeric variables (integer): V: Standard variables P: Local variables N: Process variables Fields (integer): A: User defined fields S: System parameters Real variables: R: Floating point figures Logic variables: I: Inputs O: Outputs F: Process flags	Program sequence control: IF ELSE Instruction WHILE Loop {..} Command block [..] Bundling of commands BEGIN END Program definition Label JUMP <Label> or <Subroutine> START/STOP/BREAK/CONT<Program> WAIT <Time> or <Condition>
Signs and operators: <num. signs> {"-" "!" "#"} <num. operator> {"*" "/" "+" "-" "&" " " "^" "<<" ">>"} <num. real operator> {"sin" "cos" "tan" "asin" "acos" "atan" "sqrt" <log. operator> {"&" " " "^"} <num. comp.operator> {"<=" ">=" "<" ">" "="}	Data manipulation: DIM Field declaration COPY Field copying function SET Assign variable MSET Preset fields PSET Assign local variable
Compiler instructions: "," <Comment> "#include" <File name> "#module" <File name> "#define" <Name> <Text> "#global" <File name>	Axis/process functions: AXINIT Initialize axes AXSET Take over axis data STOP Cancel axis movement HALT Immediate halt of axis movement POS HALT Immediate halt of axis movement BREAK Interrupt axis movement CONT Resume axis movement EQUIT Acknowledge axis error LOCK Lock axis control UNLOCK Unlock control OVER Determine axis override ACC Axis acceleration ($\pm$) VEL Axis velocity POS Position axis SYNCH Define synchronized axes LIN Linear interpolation FORCE Force control DAC Voltage output FUNC Axis functions SIMU Simulation of axis HOME Referencing TABLE Process curve creation VIRTUAL Define virtual axes REAL Inverse calculation formula for VIRTUAL FREEZE Freeze axis velocity For the operating parameters not listed here, you can usually enter a constant, a variable or a term!
Acquisition of measured values: TIMER Timer TRACE Oscilloscope function	
Dialog command (control box or terminal): DIALOG Start dialog WINDOW Define window DISPLAY Output variable or text INPUT Input definition LEVEL User level READ_KEY Softkey query SSET String assignment	
Special commands: CALL <Address> Call C function START/STOP TASK Start C task	

Technical data

Operating voltage	U_B	18 to 36 VDC / max 3.6 A
Current consumption	Master without axis	500 mA
	Master with axes	800 mA
	Slave	400 mA
Processor		MPC860 and MPC555
Memory		16 MB SDRAM, 16 MB Flash, 8 KByte DPR 4 MB Flash (MPC555) 2 MB SRAM (MPC555)
Analog inputs: – Voltage inputs (differential inputs) • Input voltage • Input resistance • Resolution – Current inputs • Input current / input resistance • Leakage current • Resolution	U_E R_E I_E / R_E I_V	±10 V, 12 bits with 4-fold oversampling Max. +10 V to –10 V 160 kΩ 5 mV 4 to 20 mA / 100 Ω ±20 mA / 500 Ω 12 μA 4 μA
Analog outputs: – Voltage outputs • Output voltage • Output current • Load – Current outputs • Output current normalized • Load • Resolution	U_{nom} I_{max} R_{min} I_{nom} R_{max}	±10 V PWM (pulse width modulation) 10 mA 2 kΩ ±20 mA 500 Ω 1 mV
Serial interfaces	Standard	RS232 (V 24) (19.2 KBaud) RS485 (115 KBaud)
	Optional	PROFIBUS DP (max. 12 MBaud) CANopen (max. 1 MBaud)
Switching inputs	Quantity	32
	Logic level	log 0 (low) 0 V to +5 V log 1 (high) +10 V to 36 V
	R_E	3 kΩ ±10 %
Switching outputs	Quantity	24
	Logic level	log 0 (low) 0 V to +5 V; log 1 (high) +10 V to 36 V; current carrying capacity up to 50 mA

Technical data (continued)

Digital position transducers		
– Incremental transducer		
• Transducer with TTL output		
Input voltage	log 0	0 to 1 V
	log 1	2.8 to 5.5 V
Input current	log 0	–0.8 mA (with 0 V)
	log 1	0.8 mA (with 5 V)
Max. frequency referring to Ua 1	$f_{\max}$	250 kHz, 24 bit
SSI position transducers		
– Coding		Gray-Code
– Data width		Adjustable up to max. 28 bit
– Line receiver (TTL)		$f_{\max}$ 250 kHz
– Input voltage	log 0	0 to 1 V
	log 1	2.5 to 5.5 V
– Input current	log 0	–0.5 mA (with 0 V)
	log 1	0.5 mA (with 5 V)
– Line driver		
– Output voltage	log 0	0 to 0.5 V
	log 1	2.5 to 5.5 V
Admissible operating temperature range		0 to 50 °C
Storage temperature range		–20 to 70 °C
Weight:		
– Rack 1	<i>m</i>	1000 g
– Rack 5	<i>m</i>	1800 g
– Rack 8	<i>m</i>	2500 g
– Master card	<i>m</i>	400 g
– Slave card	<i>m</i>	350 g
– Blank cover	<i>m</i>	100 g

Pin assignment master card VT-MAC8

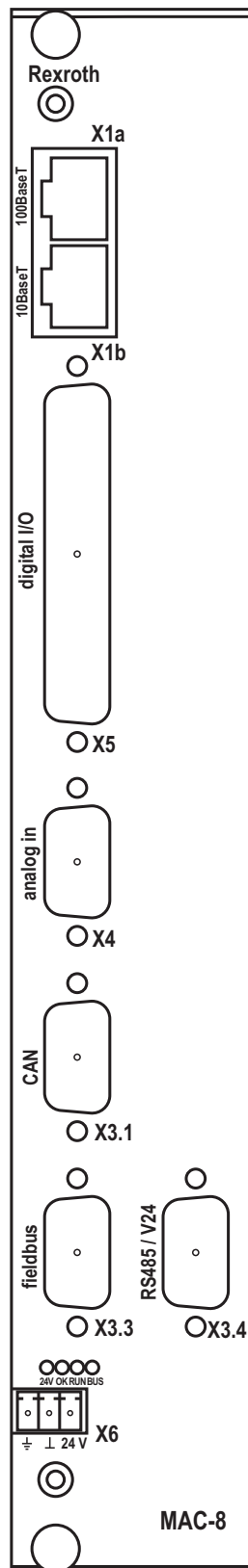
Front plate shows: VT-MAC8-1X/K-PM1

X1a RJ-45; 100BaseT Ethernet	
Pin	
1	TPO+
2	TPO-
3	TPI+
4	75K-GND
5	75K-GND
6	TPI-
7	75K-GND
8	75K-GND

X1b RJ-45; 10BaseT Ethernet	
Pin	
1	TPO+
2	TPO-
3	TPI+
4	n.c.
5	n.c.
6	TPI-
7	n.c.
8	n.c.

X4 Analog in		
Pin		Pin
1	U_{in1C}	
	U_{in2C}	6
2	U_{in3C}	
	U_{in4C}	7
3	AGND	
	U_{in1D}	8
4	U_{in2D}	
	U_{in3D}	9
5	U_{in4D}	

X6 Voltage supply	
Pin	
1	Shield
2	GND
3	+24 V



X3.1 CANopen		
Pin		Pin
1	n.c.	
	n.c.	6
2	CAN_Lx	
	CAN_Hx	7
3	GNDCANx	
	n.c.	8
4	n.c.	
	n.c.	9
5	n.c.	

X3.3 PROFIBUS DP		
Pin		Pin
1	n.c.	
	VP	6
2	n.c.	
	n.c.	7
3	RxD/TxD -P	
	RxD/TxD -N	8
4	CNTR -P	
	n.c.	9
5	DGND	

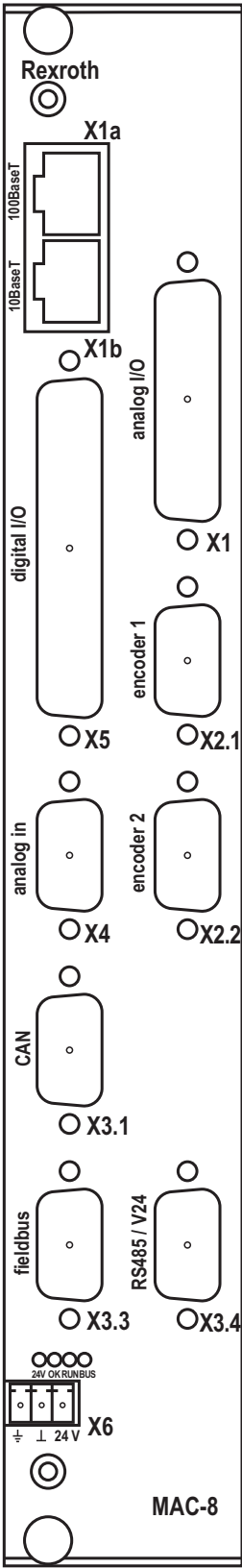
Notice:

Please use straight Profibus connector

X3.4 RS232 (V24)		
Pin		Pin
1	GND	
	RxD	6
2	TxD	
RS485		
	GND	7
3	5 V	
	RxD+	8
4	RxD-	
	TxD+	9
5	TxD-	

Pin assignment master card VT-MAC8

Front plate shows: VT-MAC8-1X/K-PM2

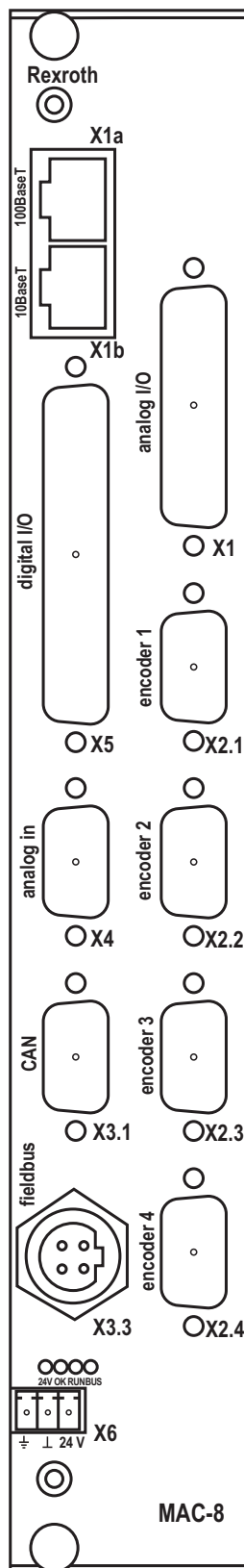


X5		Digital I/O			
Pin	Description	Pin	Description	Pin	Description
		22	Reserved		
43	Reserved			1	Reserved
		23	In0	2	In1
44	In2			3	In4
		24	In3	4	In7
45	In5			5	In10
46	In8	25	In6	6	In13
		26	In9	7	In16
47	In11			8	In19
48	In14	27	In12	9	In22
49	In17			10	In25
		28	In15	11	In28
50	In20	29	In18	12	In31
51	In23	30	In21	13	Out2
		31	In24	14	Out5
52	In26			15	Out8
53	In29	32	In27	16	Out11
		33	In30	17	Out14
54	Out0			18	Out17
55	Out3	34	Out1	19	Out20
56	Out6	35	Out4	20	Out23
57	Out9	36	Out7		
58	Out12	37	Out10	21	0 V
		38	Out13		
59	Out15	39	Out16		
60	Out18	40	Out19		
61	Out21				
62	0 V	41	Out22		
		42	0 V		

Notice:
The pins marked with "reserved" must not be connected.

Pin assignment master card VT-MAC8

Front plate shows: VT-MAC8-1X/K-EM4



X1 Analog I/O on master card			
Pin		Pin	Description
1	n.c.		
	n.c.	14	
2	AGND		Analog ground
	n.c.	15	
3	n.c.		
	AGND	16	Analog ground
4	$I_{U_{in1A}}$		Current / voltage input 0.. 20 mA / ± 10 V
	$I_{U_{in1B}}$	17	Current / voltage input 0.. 20 mA / ± 10 V
5	$I_{U_{in2A}}$		Current / voltage input 0.. 20 mA / ± 10 V
	$I_{U_{in2B}}$	18	Current / voltage input 0.. 20 mA / ± 10 V
6	AGND		Analog ground
	$I_{U_{in3A}}$	19	Current / voltage input 0.. 20 mA / ± 10 V
7	$I_{U_{in3B}}$		Current / voltage input 0.. 20 mA / ± 10 V
	$I_{U_{in4A}}$	20	Current / voltage input 0.. 20 mA / ± 10 V
8	$I_{U_{in4B}}$		Current / voltage input 0.. 20 mA / ± 10 V
	AGND	21	Analog ground
9	U_{out1}		± 10 V
	U_{out2}	22	± 10 V
10	U_{out3}		± 10 V
	U_{out4}	23	± 10 V
11	AGND		Analog ground
	I_{out1}	24	± 20 mA
12	I_{out2}		± 20 mA
	I_{out3}	25	± 20 mA
13	I_{out4}		± 20 mA

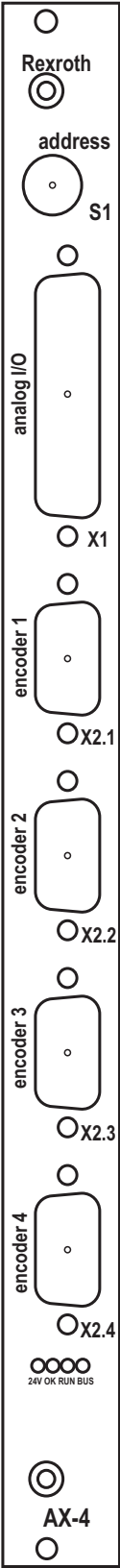
X2.x Encoder plug		
Pin	INC	SSI
1	/Ua 2	
2		+Clk
3	Ua 0	
4	/ Ua 0	
5	Ua 1	
6	/ Ua 1	
7		-Clk
8	Ua 2	
9		-Data
10	0 V	0 V
11		+Data
12	Reserved	Reserved
13	n. c.	n. c.
14	Reserved	Reserved
15	n. c.	n. c.

X3.3 PROFINET RT / EtherNet/IP	
Pin	
1	TPO+
2	TPI+
3	TPO-
4	TPI-

Notice:

The pins marked with "reserved" must not be connected.

Pin assignment slave card VT-MAC8-1X/K-AX4



X1 Analog I/O on slave card			
Pin		Pin	Description
1	I _{in1C}		Current / voltage input ±20 mA / ±10 V
	I _{in2C}	14	Current / voltage input ±20 mA / ±10 V
2	AGND		Analog ground
	I _{in3C}	15	Current / voltage input ±20 mA / ±10 V
3	I _{in4C}		Current / voltage input ±20 mA / ±10 V
	AGND	16	Analog ground
4	IU _{in1A}		Current / voltage input 0...20 mA / ±10 V
	IU _{in1B}	17	Current / voltage input 0...20 mA / ±10 V
5	IU _{in2A}		Current / voltage input 0...20 mA / ±10 V
	IU _{in2B}	18	Current / voltage input 0...20 mA / ±10 V
6	AGND		Analog ground
	IU _{in3A}	19	Current / voltage input 0...20 mA / ±10 V
7	IU _{in3B}		Current / voltage input 0...20 mA / ±10 V
	IU _{in4A}	20	Current / voltage input 0...20 mA / ±10 V
8	IU _{in4B}		Current / voltage input 0...20 mA / ±10 V
	AGND	21	Analog ground
9	U _{out1}		±10 V
	U _{out2}	22	±10 V
10	U _{out3}		±10 V
	U _{out4}	23	±10 V
11	AGND		Analog ground
	I _{out1}	24	±20 mA
12	I _{out2}		±20 mA
	I _{out3}	25	±20 mA
13	I _{out4}		±20 mA

X2.x Encoder plug		
Pin	INC	SSI
1	/Ua 2	
2		+Clk
3	Ua 0	
4	/ Ua 0	
5	Ua 1	
6	/ Ua 1	
7		–Clk
8	Ua 2	
9		–Data
10	0 V	0 V
11		+Data
12	Reserved	Reserved
13	n. c.	n. c.
14	Reserved	Reserved
15	n. c.	n. c.

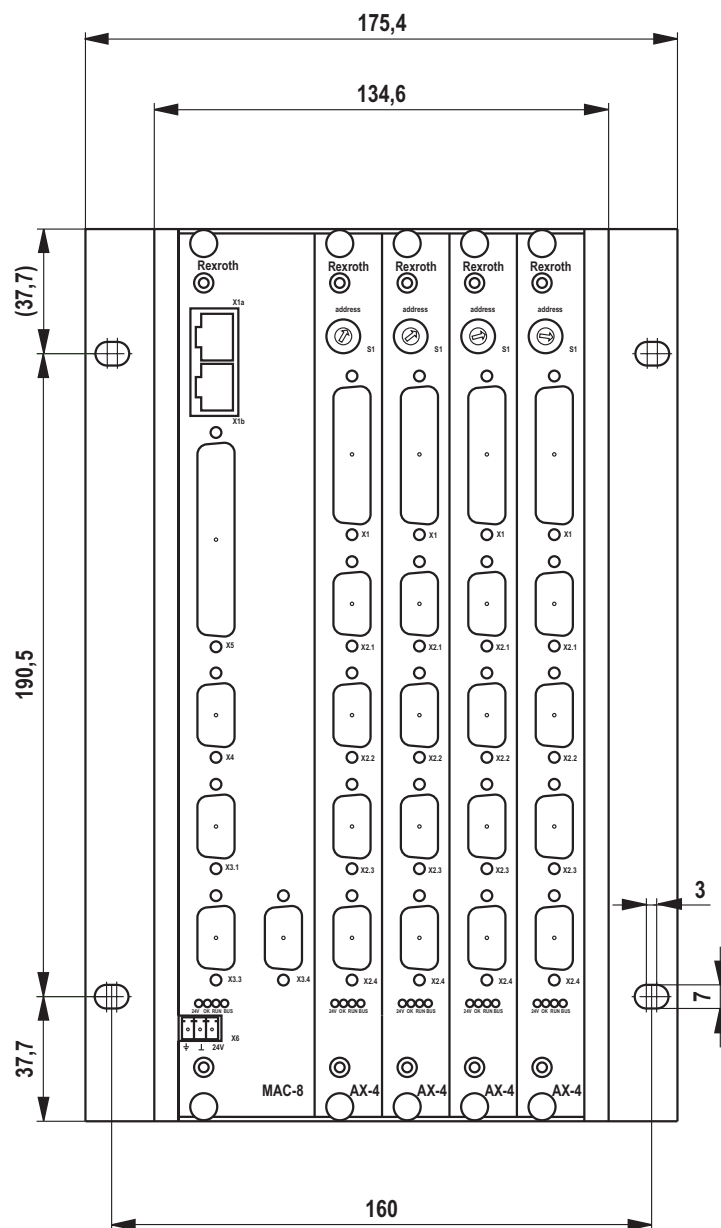
S1 Address	
	Slot
2	Slot 2
3	Slot 3
4	Slot 4
5	Slot 5
6	Slot 6
7	Slot 7
8	Slot 8
0 - 1	Not allowed
9 - F	Not allowed

Notice:
Address the card according to the slot.

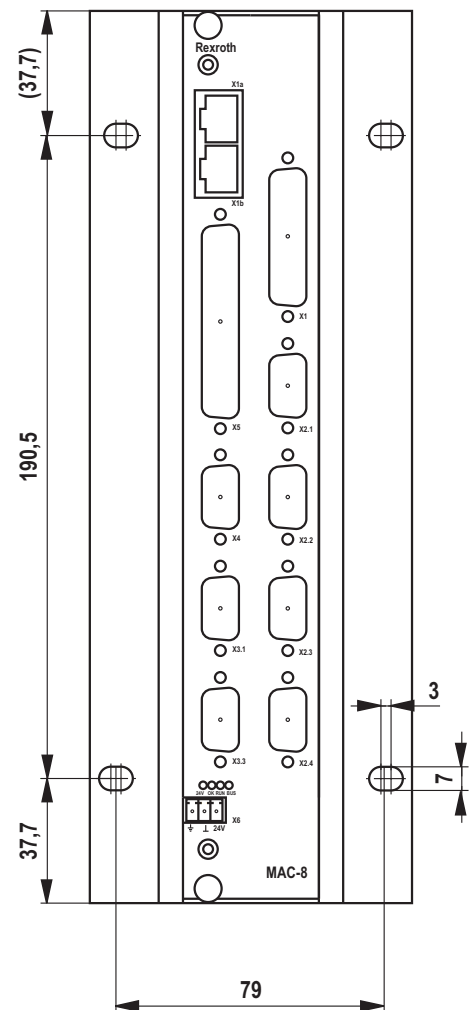
Notice:
The pins marked with "reserved" must not be connected.

Unit dimensions (dimensions in mm)**VT-MAC8-1X/K-RACK5**

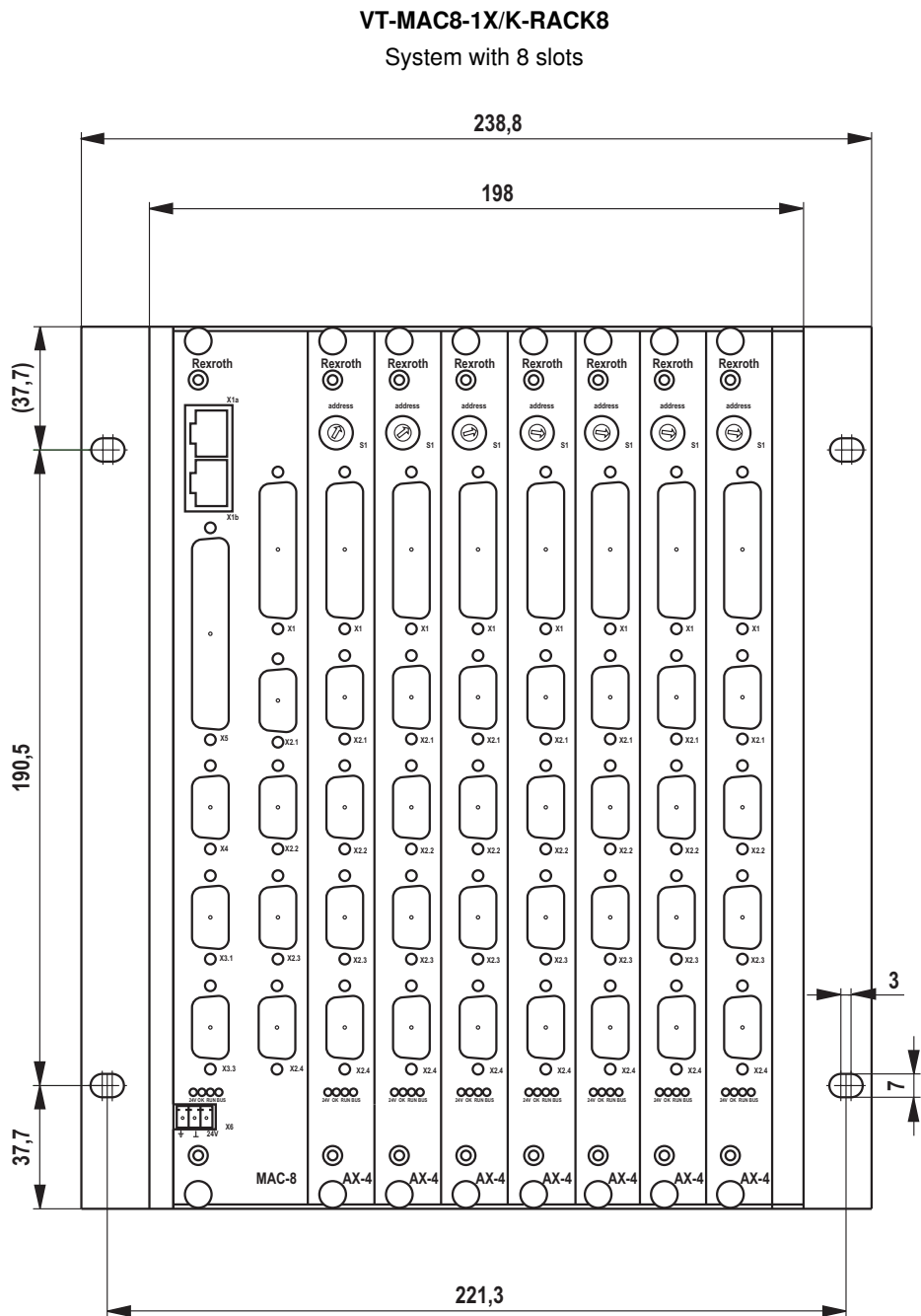
System with 5 slots

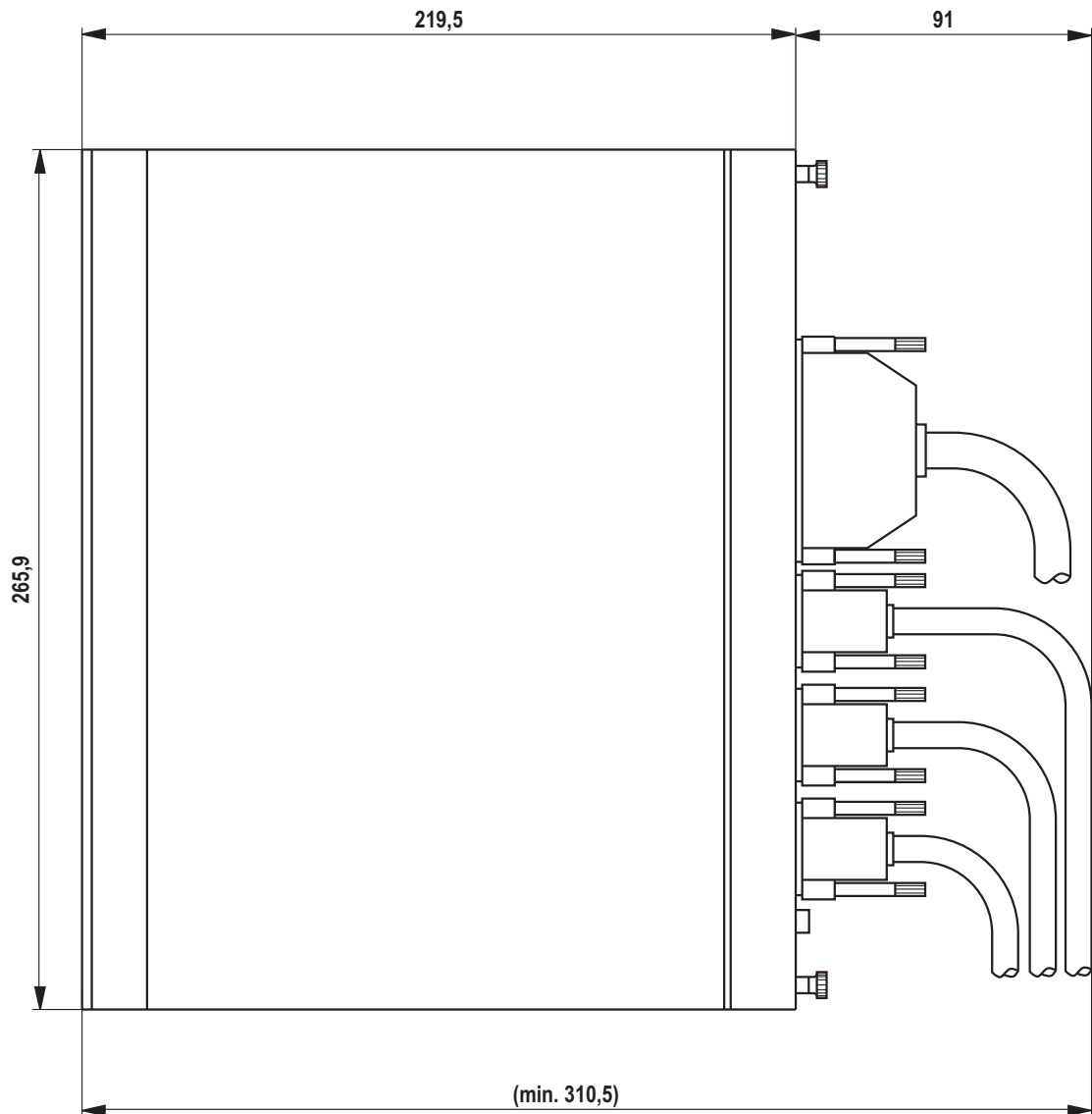
**VT-MAC8-1X/K-RACK1**

System with 1 slot



Unit dimensions (dimensions in mm)



Unit dimensions (dimensions in mm)**VT-MAC8-1X/K-RACK1/5/8**

Notes
