The MAC motor®. AC-servo motor with Integrated driver MAC50, 95, 140 and 141

The MAC series of brushless servo motors with integrated electronics represents a major step forward. All the necessary electronics in a servo system are integrated in the motor itself.

In the past, a traditional motor system has typically been based on a cen ller unit located remote from the motor. This configuration however has the negative effect that installation costs are a major part of the total expense of building machinery.

The basic idea of the MAC motors is to minimize these costs but also to make a component that is much better protected against electrical noise which can be a typical problem when using long cables between the controller and motor.

The servo motor, hall sensor, encoder and electronics are specially developed by JVL so that together they form a closed unit in which the power driver and controller are mounted inside the motor in a closed section.

The advantages of this solution are:

- De-central intelligence.
- Simple installation. No cables between motor and driver.
- EMC safe. Switching noise remains within motor.
- Compact. Does not take space in cabinet. Typically a 3/5 core cable is used from PLC or similar to MAC motor.
- 12-48VDC power.
- Low price.

Interface possibilities to the MAC motor:

- From PC/PLC with drive-commands via RS232/RS485/ RS422
- Pulse/direction or quadrature inputs.
- 10 bit ±10V input for speed or torque control. A+B en coder output.
- Register mode via 4 inputs or serial commands
- Option for µPLC built-in with IF THEN ELSE commands.
- Option for Fieldbus. Profibus DP, Canbus, Devicenet,

The MAC motor can be controlled with ±10V for speed or torque control with encoder feedback to one master motion controller.

Furthermore the MAC motor can replace an arbitrary step or servo system, being based on pulse and direction signals. There is a built-in electronic gear so that the MAC motor can simulate all possible step resolutions.

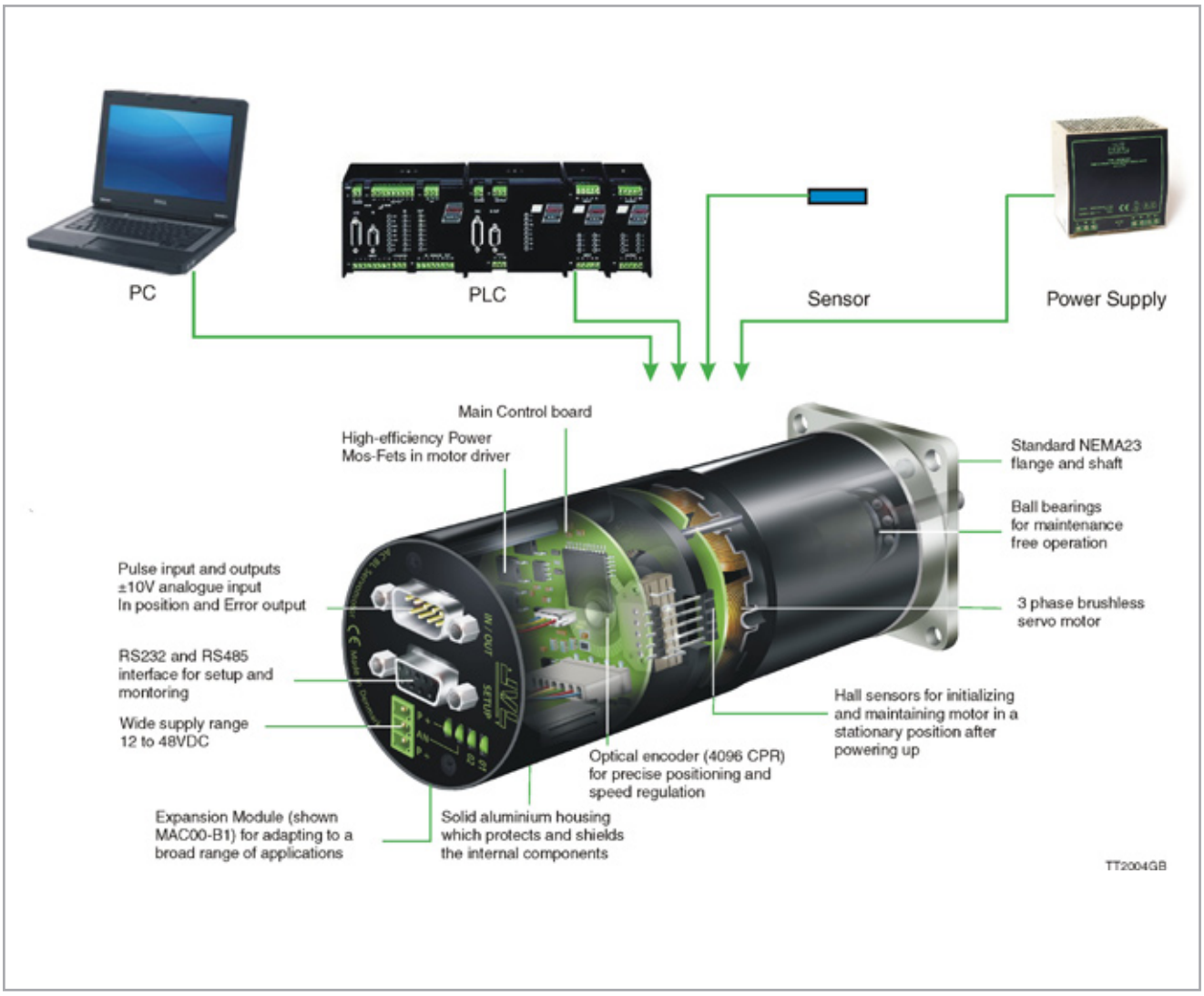
The MAC motor can thus replace all step- and servo-systems without change in the PLC/PC/controller software. Adaptation/replacement of existing step motor/servo systems can therefore be achieved quickly.

Parameters are set up via the RS232 port from a Windows program.
The supply voltage is 24VDC which is industry standard.

The motor can be delivered in 3 models: 46, 92 or 134W. A NEMA23 flange is standard so that the MAC motor can replace a step motor directly without mechanical changes.

The connector can be chosen as DSUB, Phoenix connector, Military plug or cable out. Backlash free and planetary gears in ratios of 3, 5, 10, 20, 100 can be delivered from stock.

System and feature overview



Modes of Operation (Basic Motor)

Gear Mode

In this mode the MAC motor functions as in a step motor system. The motor moves one step each time a voltage pulse is applied to the step-pulse input. Velocity, acceleration and deceleration are determined by the external frequency. Use of an encoder enables monitoring and adjustment during motor operation – a feature that is not possible with a standard step motor system. In addition, the MAC motor also provides a facility for electronic gearing at a keyed-in ratio with analogue speed offset.

Positioning Mode

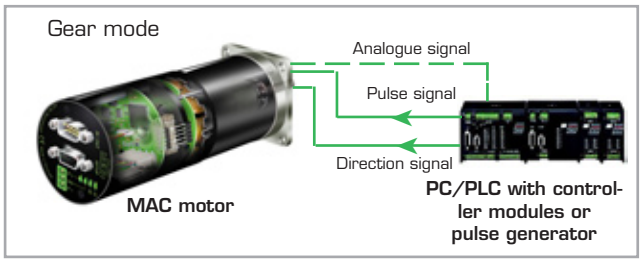
In this mode the MAC motor positions the motor via commands sent over the RS422 or serial interface. Various operating parameters can be changed continuously while the motor is running. This mode of operation is used primarily in systems where the Controller is permanently connected to a PC/PLC via the interface. This mode is also well suited for setting up and testing systems.

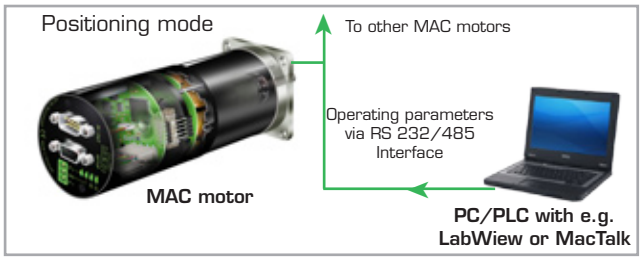
Serial Mode (FastMac)

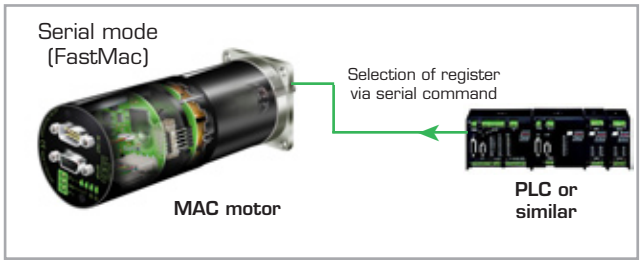
In this mode the MAC motor's registers contain the parameter sets, positions, velocities, etc., required for the actual system. The registers can be selected and executed by a single byte sent via the serial interface. This mode provides maximum utilisation of the MAC motor's features since the MAC motor itself takes care of the entire positioning sequence.

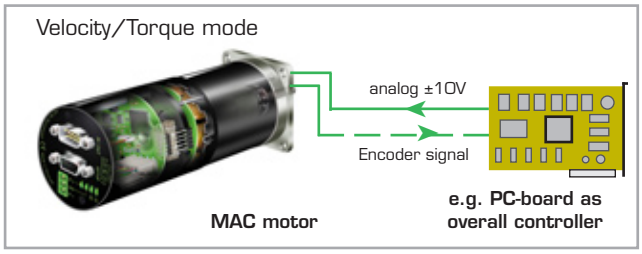
Velocity / Torque Mode

In this mode the MAC motor controls the motor velocity/torque via the analogue input. This mode is typically used for simple tasks or for applications in which an overall unit, such as a PC-board or PLC, controls velocity and positioning. Encoder A and B signals can be connected to the overall controller to close the servo loop.







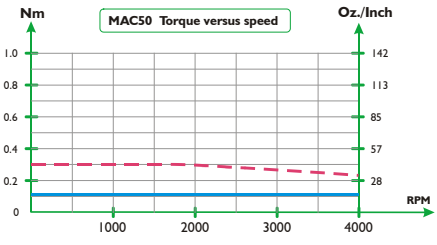


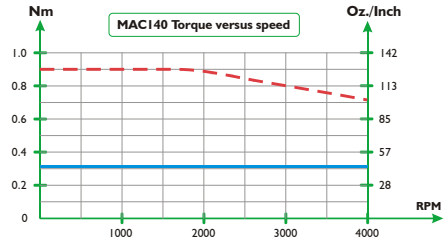
Torque versus speed

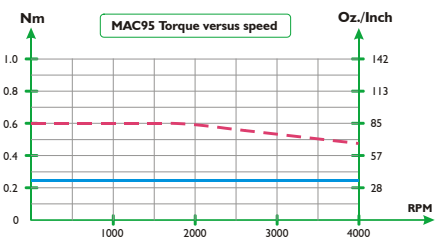
Conditions:
Supply voltage = 48VDC
Ambient temperature = 20°C
Torque setting = 100%
Load setting = 1.0

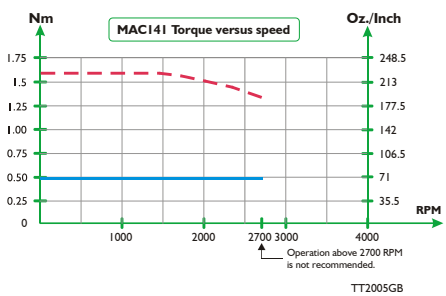
Operation above 4000 RPM can be done, but the losses in the motor make it impossible to operate in this area continously Please notice that 2700 RPM is the maximum recommended speed for the MAC141.

= Peak Torque
= Average Torque









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Software, MacTalk

Setup save/open
The complete setup can be either saved or reloaded from a file using these buttons

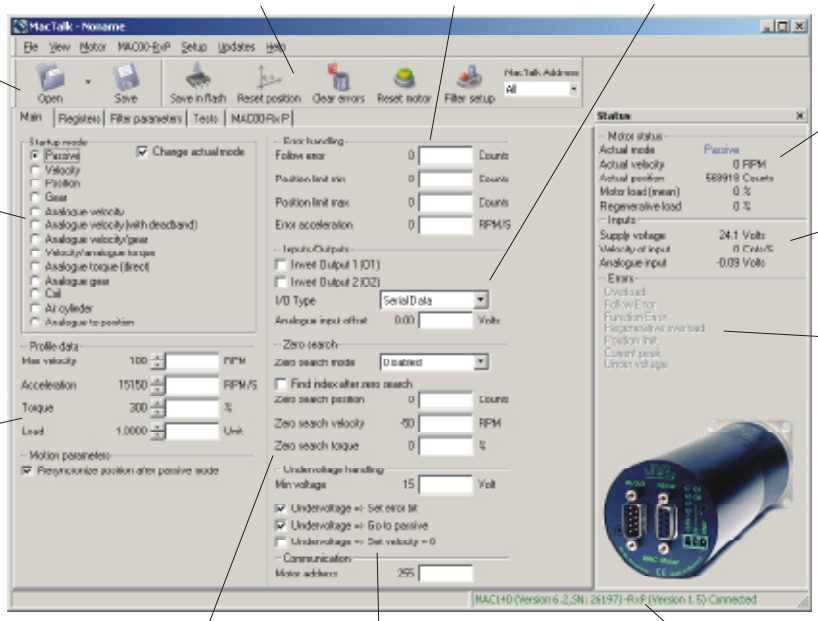
Startup mode
The basic functionality of the MAC motor is setup in this field.

Profile Data
All the main parameters for controling the motor behaviour are setup in this field.

System control
Use these buttons to save data permanently, reset the motor etc.

Error Handling
Use these fields to define error limits for the position range etc.

Input/Outputs
The functionality of the I/O's is specified here.



Motor status
This field shows the actual motor load, position and speed etc.

Inputs
This field shows the actual supply voltage, the speed at the pulse input and the voltage at the analogue input.

Errors
If a fatal error occurs, information will be displayed here.

Zero Search
All the parameters regarding the position zero search can be specified here.

Undervoltage handling
Determine what must happening if the supply voltage gets too low..

MAC motor connection information Always shows if the motor is on line or not.

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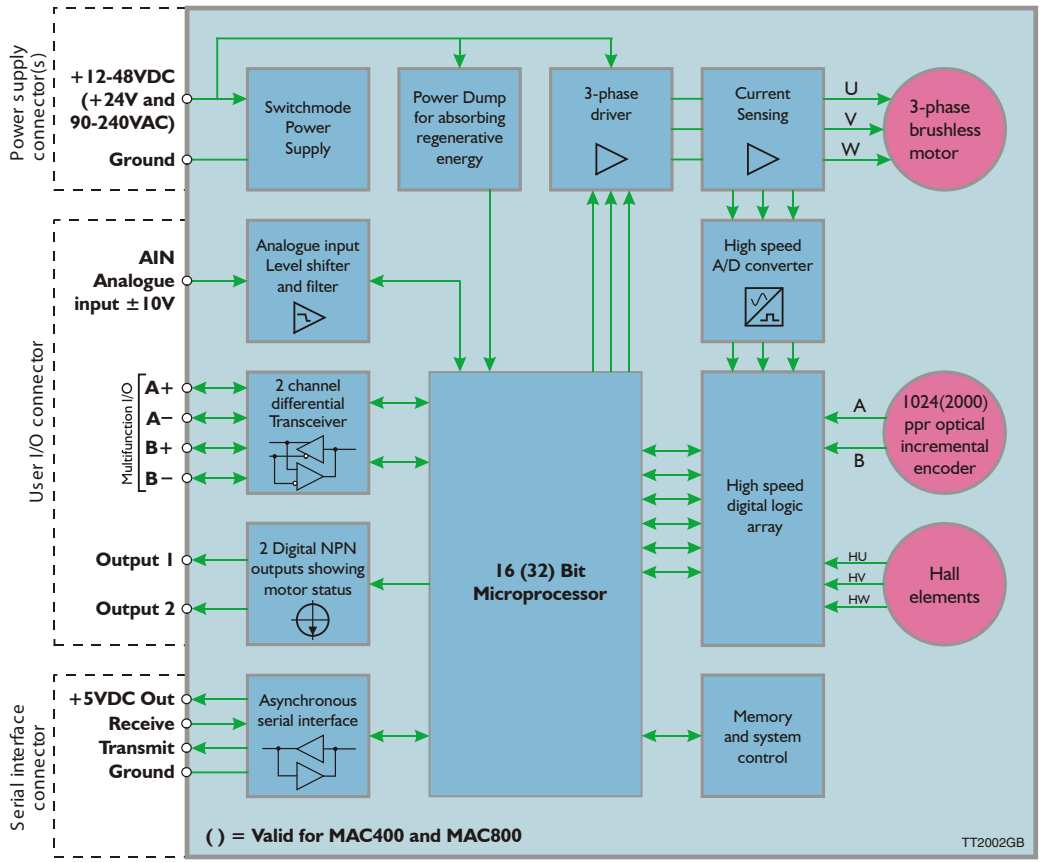
Block diagram

Basic MAC motor block diagram including motor and feedback devices



Expansion modules

The JVL Integrated motors utilizes the unique module concept. Plug in expansion modules adapt the motor to the application. You can choose connector type, D-Sub., cable glands or M12 connectors and you can choose freely between Profibus, DeviceNet, CANopen or nano PLC communication. A High Speed and wireless module add to the possibilities. This means that you have possibilities as with no other motors on the market, and also important, you only pay for what you need. Moreover, if you do not find the feature you need, please contact us, and we will develop your own module. All modules can be delivered with or with cables of up to 20m length.

Basic Modules

MAC00-CS

Low cost module, connection directly to basic motor, serial communication not RS232.

- Low cost module
- Cable connected directly to basic motor connector
- User I/O connection
- 10 or 20 meter cable
- NPN outputs

MAC00-B1

General purpose module w/ Sub-D connectors:

- Ideal for pulse/direction, ±10V input or RS232/422/485 interface
- Standard D- Sub conn.
- Home switch input
- LEDs to indicate status, Home switch status, Input power status
- PNP outputs

MAC00-B2

General purpose module w/Cable Glands: otherwise same as –B1, but with IP67 protection.

MAC00-B4

General purpose module w/M12 connectors: otherwise same as –B1, but with IP67 protection and USB interface.

- Dual supply support for MAC50-141

Programmable Modules

MAC00-R1

Nano-PLC Module w/Sub-D connectors: Stand-alone operation with 8 DI + 4 DO, RS232/485.

- Ideal for stand-alone operation with sequential program execution
- 8/4 Opto isolated in-/out. 5-30VDC
- Outputs up to 200mA. 10-30VDC
- LEDs to indicate output status Home+power status
- RS232/RS485 interface

MAC00-R3

Nano-PLC Module w/Cable Glands: otherwise same as –R1.

- IP67

MAC00-R4

Nano-PLC Module w/M12 connectors: otherwise same as –R1.

- IP67

Bus Modules

MAC00-FC4

CAN bus Module w/M12 connectors: Bus, 4 DI/DO and RS232.

- Control and setup
- Logic I/O for high speed start/stop
- CANbus/CANopen DS301/DSP402
- Optional with cable bushes (MAC00-FC2)
- End limit inputs
- Dual supply support for MAC50-141

MAC00-FD4

DeviceNet Module w/M12 connectors: Bus, 4 DI/DO and RS232.

- End limit inputs
- Dual supply support for MAC50-141

MAC00-FP2

Profibus Module w/ Cable Glands: Bus, 6 DI + 2 DO and RS232.

- Control and setup through 12Mbit/s profibus-DP
- Logic I/Os for High speed start/stop In position indication Home switch
- LEDs to indicate status
- End limit inputs
- Dual supply support for MAC50-141

MAC00-FP4

Profibus Module w/M12 connectors: Bus, 4 DI/DO and RS232.

- End limit inputs
- Dual supply support for MAC50-141

High Speed Multi-Axis Modules

MAC00-FS1

High Speed Multi-axis Module w. D-Sub connectors and opto-isolated RS485.

- 9.6 - 460.8kbit
- Up to 255 axes (with repeaters)
- Command broadcast
- Pulse input or output
- Dual supply support for MAC50-141

MAC00-FS4

As module FS1 but with M12 connectors

MAC00-FR4

High Speed Multi-axis Module w. M12 connectors: RS485 bus w/up to 255 axes.

- Multiaxis operation
- Compatible with SMCopen IEC 61131-3 automation software
- Advanced motion profiles for robot and xyz tables
- 4I/4O for user purposes
- Open hardware with PIC18F6520 for own sw.
- Dual supply support for MAC50-141

Wireless Modules

MAC00-FB4

Bluetooth Module w/M12 connectors. Controlled from PC, PDA, Cellphone or PLC with Bluetooth

- Standard Bluetooth SPP profile
- Pulse input or output
- External connector for antenna
- Dual supply support for MAC50-141

Technical Data

GENERAL					
Technology	AC-servomotor with built-in 1024 PPR encoder, hall sensor and 3 phase servo amplifier/controller.				
Controller capacity		MAC50	MAC95	MAC140	MAC141
	Rated output @ 4000RPM	46W	92W	134 W	134W
	Rated Torque RMS (Nm)	0.11Nm	0.22Nm	0.32Nm	0.48Nm
	Peak Torque (Nm)	0.32Nm	0.62Nm	0.90Nm	1.59Nm
	Torque @ 200 RPM with 20:1 gear	2.0 Nm	4.1 Nm	6.0Nm	9.0Nm
	Inertia ($kgcm^2$)	0.075	0.119	0.173	0.227
	Length (mm)	112	131	153	172
	Weight (kg) (without expansion module)	0.6	0.85	1.1	1.33
Speed range	0-4000RPM with full torque @ 48VDC. Max 4000 RPM (0-2700 RPM for MAC141)				
Amplifier control system	Sinusoidal wave PWM control. 15.7kHz switching.				
Filter	4th order filter with only one inertia load factor parameter to be adjusted. Expert tuning also available				
Feedback	Incremental A and B encoder 4096 CPR. (Physical 1024 PPR)				
Input power supply	Single supply 12-48VDC. (absolute max. 50VDC) Active/not active (no load) = 3.7W/3.1W				
Control mode	* ±10V Speed and Torque. A+B encoder outputs * Pulse/direction and 90° phase shifted A+B (Incremental). * RS422 or RS232 (5V) position and parameter commands * Gear mode with analog input speed offset + various options * Sensor zero search or mechanical zero search. * Analogue to position.				
Flange and shaft dimension	NEMA23 compatible. Front: 58mm*58mm. Rear: Ø58. Shaft Ø6,35mm				
POSITION (pulse inputs)					
Command input pulse	Pulse/direction or 90° phase shifted A+B. RS422. Logic 0 ≤2.0V. Logic 1≥3.0V. Max. voltage at A+, A-, B+, B- = 5.5V.				
Input frequency	0-2.5 MHz or 0-150kHz with input filter				
Electronic gear	A/B: A= -10000 to 10000, B=1 to10000. Simulation of all step resolutions for easy replacement of step motor systems				
Following error register	32 bit				
In position width	0-32767 pulse				
Position range	32 bit. Infinity, Flip over at $\pm 2^{31}$ pulses.				
POSITION (serial communication)					
Communication facility	From PLC, PC etc via RS422 or asynchronous serial port RS232 with special cable. MacTalk JVL commands, special commands with high security.				
Communication baud rate	19200 bit/sec. (19.2kBaud)				
Position range	±67 000 000				
Speed range	0-4000 RPM. Digital resolution 0.477 RPM				
Acceleration range	248 – 397364 RPM/sec				
Addressing	Point to point on RS422. Up to 32 units on the same serial RS232/RS485 interface with built-in expansion module. Address range 1-254				
Number of parameters.	Standard 85. With MacRegIO software 156 (Only for experts)				
Speed variance	Max ±4 RPM variance between command and actual speed.				
SPEED/ TORQUE					
Analogue speed/torque input.	12 bit. ±10V. 10kOhm input resistance. Voltage range max. –10 to +32VDC. Offset typical ±50mV				
Analogue input tolerance.	Typical ±1%. Max. 5% (Possible to make software adjustment to minimize gain and offset errors)				
Sampling rate at analogue input	521 Hz				
Encoder output signals	A+,A-,B+,B-, RS422. Line driver 5V outputs (SN75176). 90° Phase shifted.				
Analogue speed input	+voltage -> CW rotation. Shaft view				
Zero speed determination.	0 - rated speed.				
Speed variance at rated speed	Initial error @20°C: ±0.5%	Power Supply: ±10%: 0.0%			
	Load 0-300%: ±0.0% Ambient temperature 0-40°C: ±0.1%				
Torque limit in speed mode	0-300% by parameter				
Analogue torque input	+voltage (positive torque) -> CW rotation. Shaft view				
Torque control accuracy	±10% @ 20°C (Reproducibility)				
VARIOUS					
Fatal error brake	Controlled deceleration by fatal error.				
Regenerative	Integrated power dump. 3W can be absorbed continuously. External attachment is possible				
Protective functions.	Error trace back. Overload (I^2t), follow error, function error, regenerative overload (over voltage), software position limit. Abnormality in flash memory, under voltage, over current				
LED functions	Power (Green LED), Error (Red LED)				
Output signals	2 general purpose NPN 30V/25 mA outputs. Error and In position.				
Zero search	1: Automatic zero search with sensor connected to input (2 formats) 2: Mechanical zero search without sensor. (Torque controlled)				
Shaft load maximum	Radial load: 75N (20mm from flange). Axial load: 15N.				
Standards	CE approved. UL pending				
Protection	IP42 or IP67 (IP55 on request)				
Usage / Storage Temperature	Ambient 0 to +40°C / -20 to +85°C (Humidity 90%)				
Basic motor connector: (Other functions available with expansion modules)	**RS232** serial interface	**IN/OUT:** User I/O connector			**Power**
	1: +5VDC out	1: Ground	5: A+ MultifunctionI/O		1:P+
	2: Receive Rx (5V)	2: Analog in	6: A- Multifunction I/O		2:P-
	3: Transmit Tx (5V)	3: Output1 (Error)	7: B+Multifunction I/O		
	4: Ground	4: Output2 (In pos.)	8: B- Multifunction I/O		

MAC motor selection chart

MAC Motors feature overview including expansion modules

Type \ Feature	Unbalanced async. serial interface For setup/sending commands	Balanced async. serial interface For setup/sending commands	±10V Analogue input For controlling speed/torque Also used for zero search	Pulse inputs Accepts pulse and direction or quadrature encoder signal	Pulse outputs 90 degree phase shifted outputs from internal encoder	Digital user inputs For control of program flow or motor start/stop	Digital user outputs For indicating the motor status or as output from the program	Ext. connector type	Protection class	Integrated brake
Basic MAC motors										
MAC50,95,140,141-A1 Basic MAC motors IP42	5V TTL 19.2kbaud Full Duplex	RS422 3) 19.2kbaud Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3) 4096 cpr	No	Motor stat. 2 x NPN 25mA	AMP Molex JST	IP42	
MAC50,95,140,141-A3 Basic MAC motors IP67	5V TTL 19.2kbaud Full Duplex	RS422 3) 19.2kbaud Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3) 4096 cpr	No	Motor stat. 2 x NPN 25mA	AMP Molex JST	IP67 1)	
MAC400/800-D2/D5 Basic MAC motors IP55 or IP65	5V TTL 19.2kbaud Full Duplex	RS422 3) 19.2kbaud Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3) 8192/ 8000 cpr	No	Motor stat. 2 x NPN 25mA	AMP Molex JST	IP55/ 65	
MAC400/800-D3/D6 Basic MAC motors IP55 or IP65	5V TTL 19.2kbaud Full Duplex	RS422 3) 19.2kbaud Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3) 8192/ 8000 cpr	No	Motor stat. 2 x NPN 25mA	AMP Molex JST	IP55/ 65	✓
Expansion modules										
MAC00-CS Conn. module w/cable glands No electronic features added	5V TTL 19.2kbaud Full Duplex	RS422 3) 19.2kbaud Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3)	No	Motor stat. 2 x NPN 25mA	Cable Gland	IP67 1)	
MAC00-B1 Connector module w/DSUB connectors	RS232 19.2kbaud Full Duplex	RS422 3) 19.2k Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3)	No	Motor stat. PNP 10-32V 100mA	DSUB	IP42	
MAC00-B2 Connector module w/cable glands 2)	RS232 19.2kbaud Full Duplex	RS422 3) RS485 19.2k Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3)	No	Motor stat. PNP 10-32V 100mA	Cable Gland	IP67 1)	
MAC00-B4 Connector module w/M12 connectors	RS232 19.2kbaud Full Duplex	RS422 3) RS485 19.2k Full Duplex	✓	RS422 3) 2.5Mhz or 150kHz (LP)	RS422 3)	No	Motor stat. PNP 10-32V 100mA	M12	IP67 1)	
MAC00-R1 Nano PLC w/ DSUB connect.	RS232 19.2kbaud Full Duplex	RS485 19.2kbaud Half Duplex	✓	No	No	6 Inputs Opto isol. 5-30V	4 Outputs PNP 10-30V 300mA	DSUB	IP42	
MAC00-R3 Nano PLC w/cable glands 2)	RS232 19.2kbaud Full Duplex	RS485 19.2kbaud HalfDuplex	✓	No	No	6 Inputs Opto isol. 5-30V	4 Outputs PNP 10-30V 300mA	Cable Gland	IP67 1)	
MAC00-R4 Nano PLC w/M12 connectors	RS232 19.2kbaud Full Duplex	RS485 19.2kbaud HalfDuplex	✓	No	No	6 Inputs Opto isol. 5-30V	4 Outputs PNP 10-30V 300mA	M12	IP67 1)	
MAC00-FS1 High speed serial RS485 Multiaxis	RS232 19.2kbaud Full Duplex	RS485 460 kBaud Opto isol.	✓	RS422 3) 2.5MHz or 150kHz	RS422 3)	4 Inputs Opto isol. 5-30V	2 Outputs PNP 10-32V 25mA	DSUB	IP42	
MAC00-FR4 High speed serial RS485 Multiaxis. Interf. to IEC61131-1	No	RS485 230kbaud Opto isol.	✓	No	No	4 Inputs Opto isol. 5-30V	4 Outputs PNP 10-30V 300mA	M12	IP67 1)	
MAC00-FP2 Profibus DP w/cable glands 2)	RS232 19.2kbaud Full Duplex	No	✓	No	No	6 Inputs Opto isol. 5-30V	Motor status PNP 10-32V 25mA	Cable Gland	IP67 1)	
MAC00-FP4 Profibus DP w/M12 connectors	RS232 19.2kbaud Full Duplex	No	✓ 4)	No	No	4 Inputs Opto isol. 5-30V 4)	Motor status PNP 10-32V 25mA 4)	M12	IP67 1)	
MAC00-FC4 CANopen w/M12 connectors	RS232 19.2kbaud Full Duplex	No	✓ 4)	No	No	4 Inputs Opto isol. 5-30V 4)	2 Outputs PNP 10-32V 25mA 4)	M12	IP67 1)	
MAC00-FD4 DeviceNet w/M12 connectors	RS232 19.2kbaud Full Duplex	No	✓ 4)	No	No	4 Inputs Opto isol. 5-30V 4)	2 Outputs PNP 10-32V 25mA 4)	M12	IP67 1)	
MAC00-FB4 Bluetooth module	RS232 19.2kbaud Full Duplex	RS422 3) RS485 19.2k Full Duplex	✓	RS422 3) 2.5MHz or 150kHz (LP)	RS422 3)	No	Motor stat. PNP 10-32V 100mA	M12	IP67 1)	

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1) IP67 protection class is only possible if the basic MAC motor also offers IP67
2) Can be ordered without cable (eg. MAC00-CS) or with cable in metre 2, 10 or 20 (eg. MAC-CS-10).
3) Either pulse input, pulse output or serial must be chosen. Not all of them at the same time.
4) Only a total of 4 I/O terminals are available.

Planetary and cycloidal gearheads

- Sealed Ball Bearings
- High Reliability, High Efficiency Design
- NEMA Mounting Standards
- High Shaft Loading Capacity
- Low Backlash Design
- Strong, Caged Roller Bearings
- Precision Input Pinion with Balanced Clamp Collar

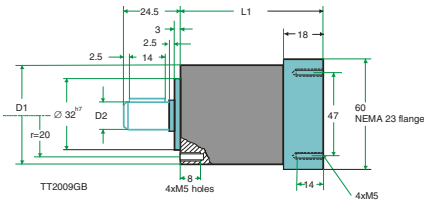
Model.	Back-lash [arc min]	Gear ratio	Effi-ciency [%]	Rated torque >10000 Hours [Nm]	Emerg stop Torque [Nm]	Inertia at motor shaft [kg*cm²]	Noise [dB(A)]	Radial load @12mm [N]	Axial load [N]	Weight [kg]	L1 [mm]	D1 [mm]	D2 [mm] (h7)
HTRG05N003MHN23106J	15	3	97	12	40	0.28	<70	500	600	1.0	68	55	12
HTRG05N005MHN23106J	15	5	97	15	45	0.17	<70	500	600	1.0	68	55	12
HTRG05N012MHN23106J	15	12	94	20	60	0.16	<70	500	600	1.2	84.8	55	12
HTRG05N020MHN23106J	15	20	94	20	60	0.16	<70	500	600	1.2	84.8	55	12
HTRG05N100MHN23106J	15	100	90	20	60	0.11	<70	500	600	1.5	98.6	55	12
HSPG60-35-SAA-N23	<1	35	>90	37	74	0.006	-	2600	3700	1.34	71.8	63	34
HSPG80-97-SAA-N23	<1	97	>90	78	156	0.027	-	4800	6900	2.10	78.8	80	46

L1: Gear length incl. flange, D2: Gear housing diameter, D2:Output shaft diameter

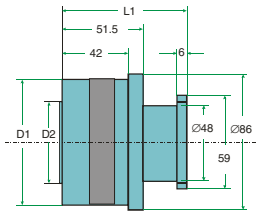
PSU00-PD1 Power Supply

Power supply and power dump resistor
Large capacitor which absorbs energy returned during deceleration so that it can be reused.
If the voltage nevertheless increases to more than about 50VDC, the energy will be dissipated in a built- in power dump resistor.
The Power Supply can feed several MAC motors, up to 1000 W total. An external transformer must be connected. (hxd: 105 x 65mm)

HTRG type gears:



HSPG type gears:



All dimensions in mm

AC servo motors MAC50, 95, 140 and 141

Ordering information

MAC140 - A 1

Motor Type
AC-brushless

Rated Output
50: 46W
95: 92W
140:134W
141:134W

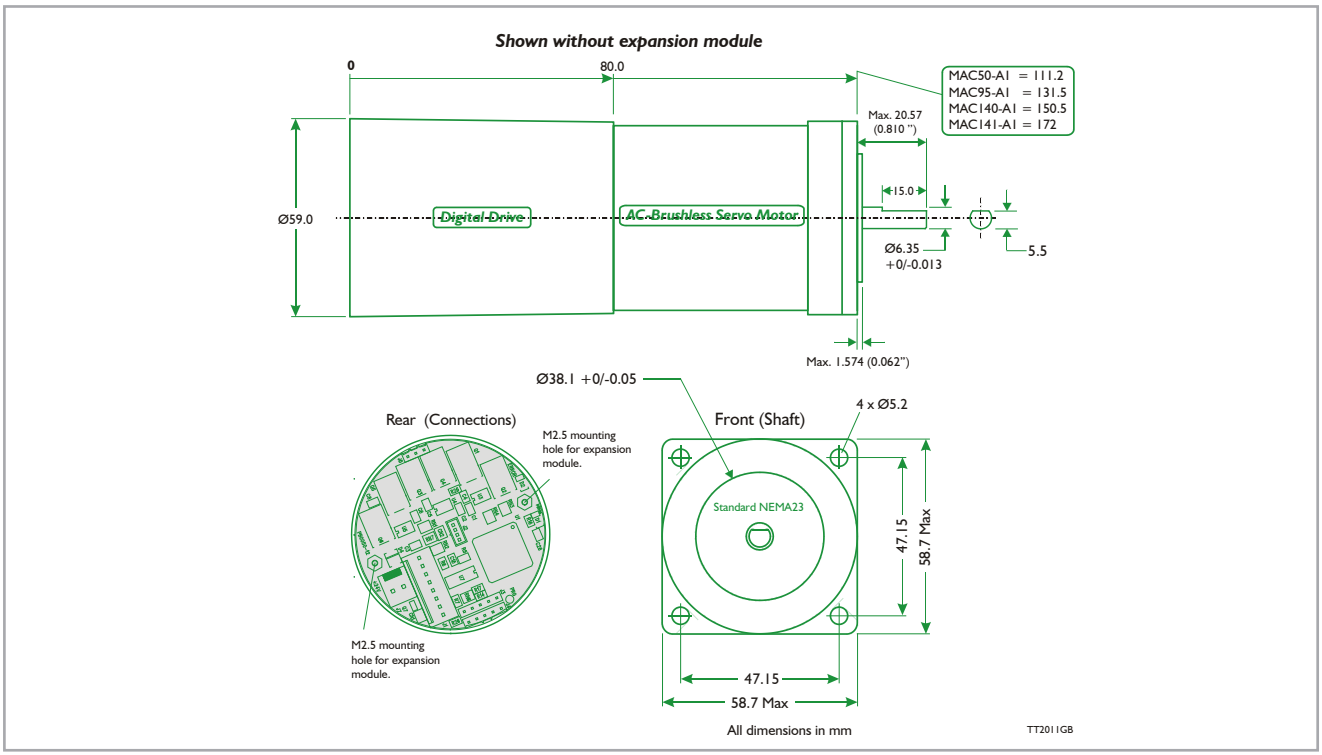
A: Standard, max. 4000 rpm

Protection
1: IP42
3: IP67 (Stainless steel flange+shaft)

Accessories

RS232-9-1	Cable for PC
RS232-9-1-Mac	Cable for PC with built in RS232 converter
MacTalk	Software for set-up of Mac motor
MacRegIO	Software for experts
MAC00-00	End cover IP42 without holes
MAC00-01	End cover IP67 with 2 cable bushes
MAC00-02	End cover IP67 with 4 cable bushes
PSU00-PD1	Power dump/Power supply
PSU40-4	Power supply, 40VDC/400W, 19"rack
TF0001	Transformer 35VAC/400W
PSU24-024	Power supply, 24V/1A
PSU48-240	Power supply, 48V/240W

Mechanical dimensions



Get started quickly!

Starter Kit (MAC140-A1-KIT): Contains all neccessary parts to get started

The kit consists of: Motor, Expansion Module, Software, PC Cable and Power Supply

MAC 140-A1
MAC00-B1
MacTalk
RS232-9-1
PSU24-024

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