User Manual

MAC Motors generation III
Integrated Servo Motors

MAC404, 604, 802, 804, 1004, 1202, 1403, 1404
Including options

Preliminary Edition

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Important
User Information

Warning

The MAC series of products are used to control electrical and mechanical components of motion control systems.
You should test your motion system for safety under all potential conditions. Failure to do so can result in damage to equipment and/or serious injury to personnel.

Please contact your nearest JVL representative in case of technical assistance. Your nearest contact can be found on our web site www.jvl.dk

JVL A/S
Bregnerødvej 127
DK-3460 Birkerød
Denmark
Tlf. +45 45 82 44 40
Fax. +45 45 82 55 50
e-mail: jvl@jvl.dk
Internet: http://www.jvl.dk

Contents

1 Introduction

This user manual covers the newest **MAC motor generation III** from JVL.
The motors covered in this user manual are:

MAC404
MAC604
MAC802
MAC804
MAC1004
MAC1202
MAC1403
MAC1404

Please notice that this user manual DOES NOT cover the previous MAC motor generation I and II.

1.1 Features

The MAC series of brushless servo motors with integrated electronics represents a major step forward in motion control systems. All of the necessary electronics for a servo system are integrated into the motor itself.
Traditional motor systems typically have the controller and drive electronics placed some distance away from the motor. This increases machine costs and has the negative effect that installation time and costs are a major part of the total expense of building machinery.
The basic idea of the MAC motor is to minimise 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 a controller and motor.
All user inputs and outputs are filtered, which means that the MAC motors will work properly even in an environment with a high level of electrical noise.

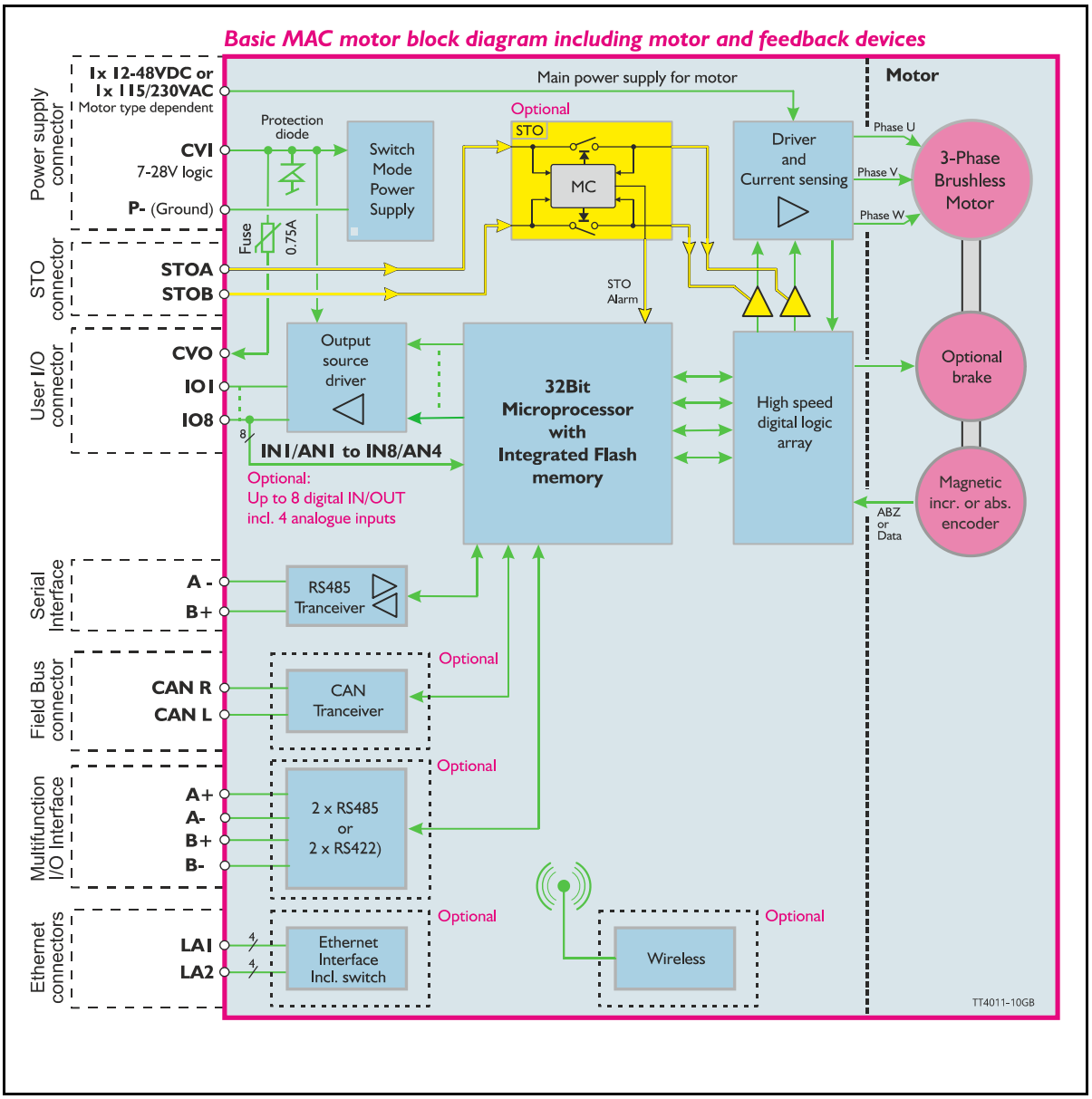
The major advantages are:

- Lower installation costs
- Faster installation
- Quiet and maintenance-free operation
- Replacement for pneumatic solutions
- Replacement for step motors, offering much faster response
- Great flexibility due to many I/O possibilities and many functions.
- Less machine space required.
- Smaller risk for wiring errors.

Main Features:

- Wide variety of connectivity:
  - Industrial Ethernet - 4 protocols
  - CAN-Open® (planned)
  - ePLC w/graphic programming
  - Custom designed interfaces on request
- Pulse and direction inputs make it possible to replace step motors.
- Quadrature input for gearing applications.
- 0-5V input for controlling speed and torque
- 2 ch. Quadrature output to master controller when used as driver.
- Accepts position and velocity commands sent via RS485 interface.
- Wide supply voltage range AC or DC
  - DC supplied: 12-48VDC nominal
  - AC supplied: 115 or 230 VAC, 47-63 Hz
- Excellent efficiency compared to step motors.
- IP55 as standard and IP65 also available
- Low cost and high performance make the MAC series ideal for high-volume applications
- Outputs for *In position* and *Error* indication.
- High order digital filter which only needs a single inertia adjustment.
- Standard PAM60 and PAM80 flanges.
- Absolute Multi Turn feedback (optional).
- Easy and simple Windows program - MacTalk available for installation/setup.
- High-efficiency power stage keeps temperature at a low level.
- CE approved. UL pending.

1.2 Overall description



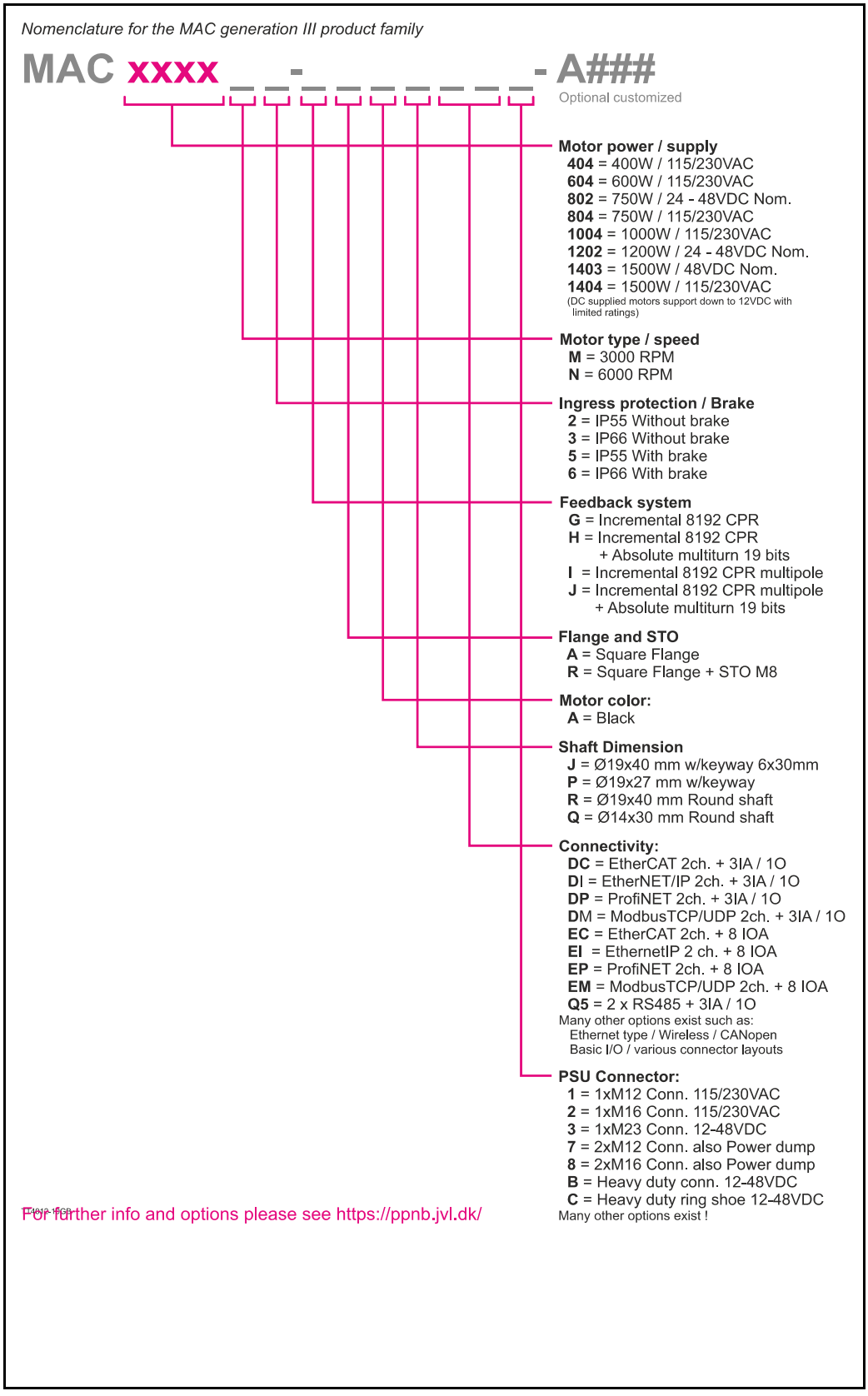
1.2.1 Internal function overview

All the internal building blocks of the MAC motor are shown in the illustration above. The central microprocessor takes care of all the processes in the motor via the various I/O blocks such as the serial interface, differential transceiver (Multifunction I/O) and the motor driver sections.

Please notice that the all MAC motors covered by this user manual have 2 supply inputs This offers the possibility to remove energy to the motor but keep having the control core active and thereby keeping position values and other dynamic parameters intact during a power down situation such as emergency stop.

1.2 Overall description

1.2.2 Type number nomenclature



1.2.3 MAC motor generation III family overview

The MAC generation III is divided in 2 supply groups.

- Low voltage DC 12-48VDC
- High voltage AC 115 and 230VAC

Following motors are available for low voltage DC supply **12-48VDC**

Basic Motor Type	Continuous Torque	Peak Torque	Power (cont.)	Nom. Speed	Flange	Total length
MAC802	**2.39 Nm** (450.6 oz-in)	**7.17 Nm** (1352.3 oz-in)	**750 Watt @24VDC**	**3000 RPM @24VDC**	**PAM80 80x80mm** (3.14" x 3.14")	**Nom. xxx.x mm** (x.xx")
MAC1202	**3.82 Nm** (541.0 oz-in)	**11.46 Nm** (1622.9 oz-in)	**1200 Watt @24VDC**	**3000 RPM @24VDC**	**PAM80 80x80mm** (3.14" x 3.14")	**Nom. xxx.x mm** (x.xx")
MAC1403	**4.78 Nm** (676.9 oz-in)	**14.33 Nm** (2029.3 oz-in)	**1500 Watt @48VDC**	**3000 RPM @48VDC**	**PAM80 80x80mm** (3.14" x 3.14")	**Nom. xxx.x mm** (x.xx")

Following motors are available for high voltage AC supply **115 and 230VAC**

Basic Motor Type	Continuous Torque	Peak Torque	Power (cont.)	Nom. Speed	Flange	Total length
MAC404	**1.27 Nm** (180.3 oz-in)	**3.82 Nm** (540.9 oz-in)	**400 Watt**	**3000 RPM**	**PAM60 60x60mm** (2.86" x 2.86")	**Nom. 170.0 mm** (6.69")
MAC604	**1.91 Nm** (270.5 oz-in)	**5.73 Nm** (811.4 oz-in)	**600 Watt**	**3000 RPM**	**PAM60 60x60mm** (2.86" x 2.86")	**Nom. 186.5 mm** (7.34")
MAC804	**2.39 Nm** (450.6 oz-in)	**7.17 Nm** (1352.3 oz-in)	**750 Watt**	**3000 RPM**	**PAM80 80x80mm** (3.14" x 3.14")	**Nom. xxx.x mm** (x.xx")
MAC1004	**3.18 Nm** (450.6 oz-in)	**9.55 Nm** (1352.3 oz-in)	**1000 Watt**	**3000 RPM**	**PAM80 80x80mm** (3.14" x 3.14")	**Nom. 197.6 mm** (8.89")
MAC1404	**4.78 Nm** (676.9 oz-in)	**14.33 Nm** (2029.3 oz-in)	**1500 Watt**	**3000 RPM**	**PAM80 80x80mm** (3.14" x 3.14")	**Nom. xxx.x mm** (x.xx")

Please notice that the complete MAC motor range covers from 50W up to 4500kW in continuous power. Visit www.jvl.dk to see the complete range.

1.2.4 Basic modes/functions in the MAC motor

The MAC motor offers the following basic function modes.

- **Passive mode.**
  The motor will be in a completely passive state but communication is active and internal registers can be set up.

- **Velocity mode.**
  The motor velocity can be controlled using MacTalk software or by sending commands via the serial interface.

- **Position mode**
  The motor position can be controlled using MacTalk or by sending position commands via the serial interface.

- **Gear mode**
  The position of the motor is controlled by the multifunction I/O, which is configured as input. Either a pulse and direction signal can be applied or a quadrature A and B signal from, for example, an incremental encoder.
  This mode is very powerful if the MAC motor is used to upgrade a step motor system or if the motor is used in electronic gear applications such as a flying saw where an external encoder tracks the position of a moving object.

- **Gear Follow Mode**
  Same mode as gear mode, except that the input pulses are not buffered so that control strictly follows the input pulses.

- **Analogue Velocity Mode**
  The motor velocity is controlled by a voltage applied at the ±10V analogue input. This mode can be used in several applications but typical applications include maintaining variable but constant speed in feeding mechanisms or as a slave driver in multi-axis systems with a master position controller for several axes.

- **Analogue Velocity (with deadband) Mode.**
  Same function as Analogue Velocity Mode but a deadband around zero is inserted. The deadband is +/-600mV. This feature is useful if a potentiometer or similar device is used to control the speed of the motor, since the motor will be stationary if the input voltage is almost at zero.

- **Analogue Velocity/Gear Mode.**
  This mode is similar to Gear mode but it is possible to increase or decrease the position of the motor by adjusting the voltage applied to the ±10V input. A typical application is feeding mechanisms that require "on-the-fly" adjustment.

- **Velocity/Analogue torque Mode.**
  The motor torque is fully controlled by a voltage applied at the ±10V analogue input. This mode is useful if the motor is used for winding applications where a constant torque is required in the process. Another typical application is as a slave driver in multi-axis systems with a master position controller for several axes. The update frequency is 521 Hz. Use Analogue Torque (Direct) if a higher bandwidth is required.

- **Analogue Torque (Direct) Mode.**
  Same function as Analogue Torque mode but the update frequency is much higher (7812Hz). Please note that the top speed and acceleration are NOT controlled in this mode. Use Analogue Torque Mode if this limitation is required.

- **Analogue Gear Mode.**
  This mode is somewhat similar to *Gear mode* or *Analogue Velocity/Gear mode*. The position of the motor is controlled by the multifunction I/O, which is configured as input. Either a pulse and direction signal can be applied or a quadrature A and B signal from, for example, an incremental encoder.
  The gear ratio specified will determine the basic gear ratio between the applied pulses and the motor movement. The special feature in this mode is that the basic gear ratio can be changed +/-5% depending on the voltage applied to the analogue input.
  +10V will adjust the gear ratio +5% higher and -10V will lower the gear ratio 5%.
  A typical application is feeding mechanisms that require "on-the-fly" adjustment.

- **Coil Mode.**
  Similar to gear mode but the position range can be limited in such a manner that the motor changes direction every time the upper limit is reached and also if the lower limit is reached. Both limits can be adjusted. The mode is intended to be used for controlling a wire/cable guider on a winding machine. The guide will follow the position of the coil driven by a "main motor" and using this mode it is possible to feed the wire in a very precise position regardless of the speed at which the "main motor" is running.

- **Analogue bi position mode**
  The motor will move a certain distance or go to one of 2 positions depending on the voltage at the analogue input. The voltage at the analogue input will be seen as a digital signal, meaning either logic low or logic high.
  The distance or positions can be set up in 2 internal registers and saved permanently in the motor.

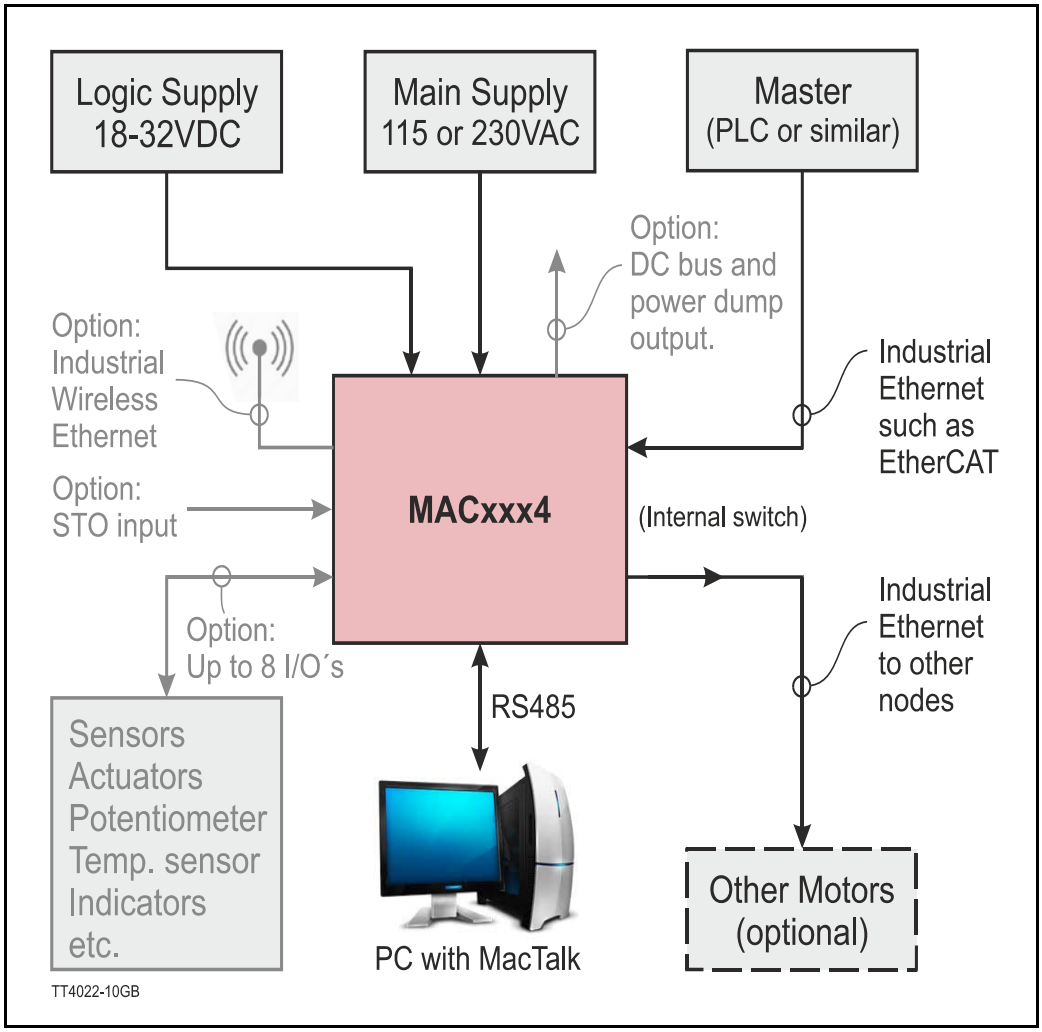
- **Analogue to position**
  The position of the motor will change proportionally with the voltage at the analogue input, between the zero position and a predefined position.
  A typical application could be controlling a valve position using a voltage or a current control signal

2 Installation

2.1 Connector Overview

Only MACxxx4

2.1.1 Connector overview (115/230VAC supplied versions)



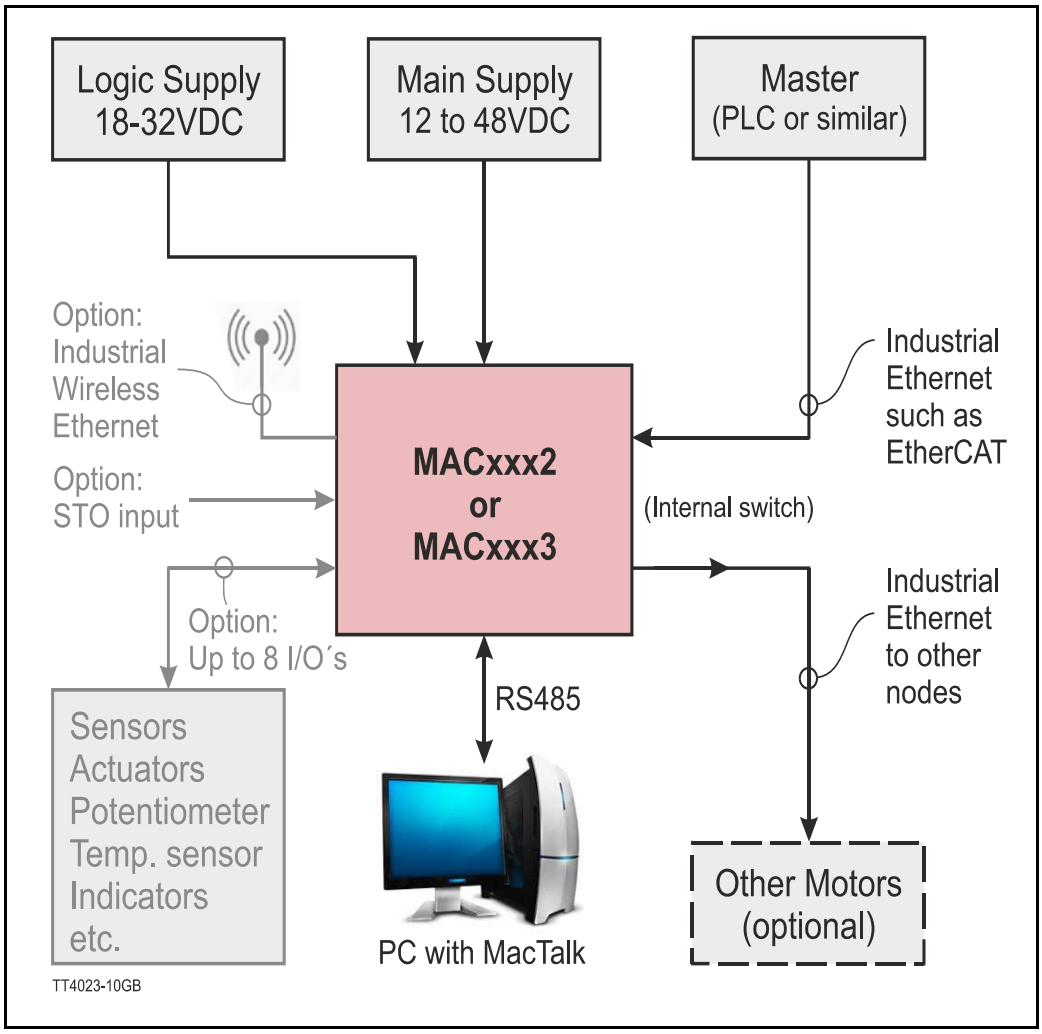
The block diagram above illustrate all the external connections that are possible at a MAC G3 motor with 115/230VAC supply.
Most is the same as for the 24/48VDC supplied types except for the main supply it self and the optional "DC bus and power dump output" which is only available at the AC supplied motors.

At the next pages detailed info about all connectors are presented and how to use.

2.1 Connector Overview

Only MACxxx2/xxx3

2.1.2 Connector overview (24/48VDC supplied versions)



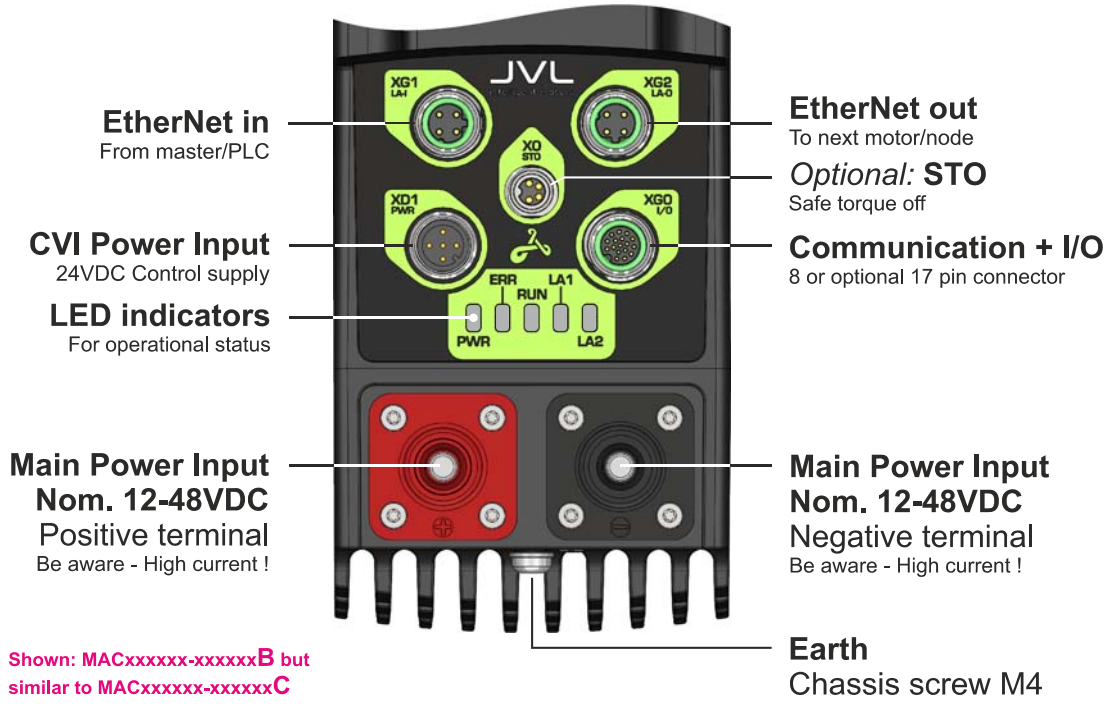
The block diagram above illustrate all the external connections that are possible at a MAC G3 motor with 24/48VDC supply.
Most is the same as for the 115/230VAC supplied types except for the main supply voltage which is nominal 24VDC (MACxxx2) or 48VDC (MACxxx3).

At the next pages detailed info about all connectors are presented and how to use.

2.1 Connector Overview

Only MACxxx2/xxx3

2.1.3 Connectors MACxxx2 and 3 (24/48VDC supplied versions)



2.1.4 Connector description including options.

The MACxxxx2 and xxx3 motors offers robust M8, M12 and "heavy duty power" connectors which makes it ideal for automation applications and use in a harsh invironment.
The connectors offer solid mechanical protection and are easy operate.
This chapter covers a MAC with all connector options, such as STO (safe torque off), extended I/O connector.
Following tables gives the relevant information about each connector and the pins, wire colours and a short description of the signals available.

Please notice: When connecting the a cable to one of the M12 connectors it must be tightened with 0.6 Nm to prevent ingress of fluids and/or particles in the connector which can cause malfunction.

The connector layout:

"Main Power Input" - Main power for the motor - Heavy duty connectors				
Signal name	**Description**	**Pin no.**	**JVL Cable**	**Isolation group**
M+	RED terminal - +12-48VDC (positive)	1	WP080x and others	4
M-	BLACK terminal - Ground (negative)	2	WP070x and others	4
Be aware that this is the main supply for the motor and these terminal is isolated from any other connector or terminals at the motor. The current can be up to **60ARMS** (continously) and the up to **200A !** peak during motor acceleration. Be careful when dimensioning the power supply circuit and consult the power supply chapter in this manual for further details.				

(Continued next page)

"LA-I" (XG1) Ethernet In connector - M12 - 4pin female connector "D" coded				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1046-M12 M4TM4TxxT**	**Isolation group (See note)**
Tx0_P	Ethernet Transmit channel 0 - positive terminal	1	-	2
Rx0_P	Ethernet Receive channel 0 - positive terminal	2	-	2
Tx0_N	Ethernet Transmit channel 0 - negative terminal	3	-	2
Rx0_N	Ethernet Receive channel 0 - negative terminal	4	-	2
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

"LA-O" (XG2) Ethernet Out connector M12 - 4 pin female connector "D" coded				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1046-M12 M4TM4TxxT**	**Isolation group (see note)**
Tx1_P	Ethernet Transmit channel 1 - positive terminal	1	-	3
Rx1_P	Ethernet Receive channel 1 - positive terminal	2	-	3
Tx1_N	Ethernet Transmit channel 1 - negative terminal	3	-	3
Rx1_N	Ethernet Receive channel 1 - negative terminal	4	-	3
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

"PWR" (XD10) - Power input. M12 - 5pin male connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1000-M12F5TxxN**	**Isolation group**
-	Not used	1	Brown	1
-	Not used	2	White	1
P-	Main supply ground. Connect with pin 5 *	3	Blue	1
CVI	Control and user output supply +7-32VDC. **DO NOT connect >32V to this terminal!**	4	Black	1
P-	Main supply ground. Connect with pin 3 *	5	Grey	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1.5 Connector option - "STO"

If the motor is called MACxxxxx-x**R**xxxxx it contain the STO function and have the M8 STO connector included. The table below describes the connections.

"STO" (X0) connector M8 - 4 pin male connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1010-M08M4TxxP**	**Isolation group (see note)**
STOA	STO channel A	1	Brown	1
GND	Ground for the STO signals	2	Inner screen	1
STOB	STO channel B	3	Black	1
24V out	DO NOT CONNECT !	4	(do not exist)	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1.6 Connector option I/O - 8 pin connector

If the motor is called MACxxxxx-xxxx**D**xx or MACxxxxx-xxxx**Q**xx it contain the basic I/O connector with RS485 communication and a small portion of I/O's in a 8 pin M12 connector. The table below describes the connections.

"I/O" (XG0) - RS485 + I/O connector - M12 - 8pin female connector.				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1000-M12 M8T**xx**N**	**Isolation group (See note)**
IN1	Digital input 1 (24V) or analogue input 0-5V	1	White	1
IN2	Digital input 2 (24V) or analogue input 0-5V	2	Brown	1
OUT1	Digital output max. 300mA. Supplied from CVO.	3	Green	1
GND	Ground intended to be used together with the other signals in this connector	4	Yellow	1
RS485: B0-	RS485 MacTalk interface. Leave open if unused	5	Grey	1
RS485: A0+	RS485 MacTalk interface. Leave open if unused	6	Pink	1
IN3	Digital input 3 (24V) or analogue input 0-5V	7	Blue	1
CVO	Supply output. Connected internally to the **CVI** terminal in the PWR connector. Max 700 mA. **DO NOT connect >30V to this terminal!**	8	Red	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1.7 Connector option I/O - 17 pin connector

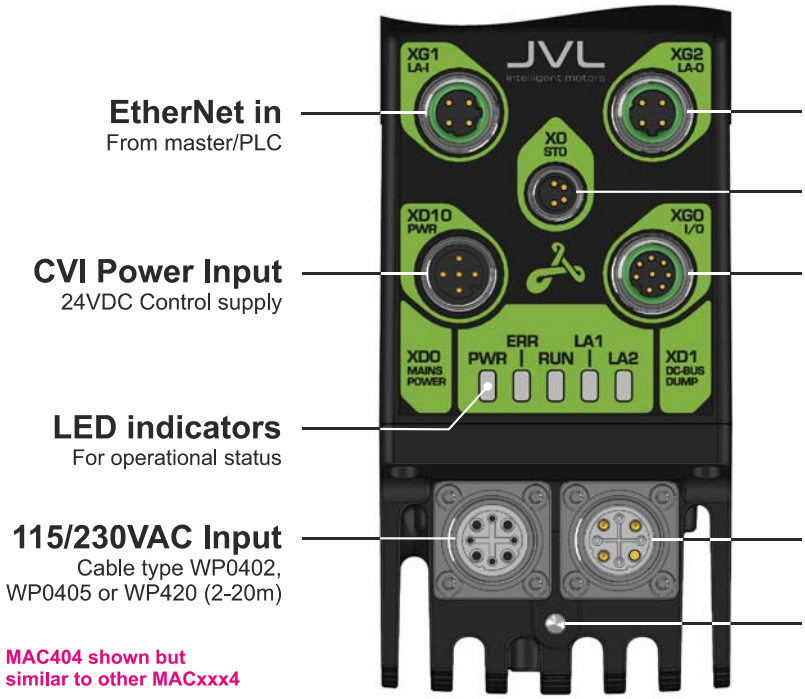
If the motor is called MACxxxxx-xxxx**E**xx it contain the extended I/O connector with RS485 communication in a 17 pin M12 connector. The table below describes the connections.

"I/O" (XG0) RS485 + I/O connector - M12 - 17pin female connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1009M12 M17T**xx**N**	**Isolation group (see note)**
IO1	I/O channel 1. Can be used as input or output 350mA	1	Brown	1
GND	Ground intended to be used together with the other signals in this connector	2	Blue	1
IO2	I/O channel 2. Can be used as input or output 350mA	3	White	1
IO3	I/O channel 3. Can be used as input or output 350mA	4	Green	1
RS422: B1-	RS422 I/O terminal B-	5	Pink	1
IO4	I/O channel 4. Can be used as input or output 350mA	6	Yellow	1
RS422: A1-	RS422 I/O terminal A-	7	Black	1
RS422: B1+	RS422 I/O terminal B+	8	Grey	1
CVO	Supply output. Connected internally to the **CVI** terminal in the PWR connector. **DO NOT connect >30V to this terminal!**	9	Red	1
RS422: A1+	RS422 I/O terminal A+	10	Violet	1
IO5	I/O channel 5. Can be used as input or output 350mA	11	Grey/pink	1
IO6	I/O channel 6. Can be used as input or output 350mA	12	Red/blue	1
IO7	I/O channel 7. Can be used as input or output 350mA	13	White/Green	1
IO8	I/O channel 8. Can be used as input or output 350mA	14	Brown/Green	1
RS485: B0-	RS485 MacTalk interface. Leave open if unused	15	White/Yellow	1
GND	Ground intended to be used together with the other signals in this connector	16	Yellow/brown	1
RS485: A0+	RS485 MacTalk interface. Leave open if unused	17	White/grey	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1 Connector Overview

Only MACxxx4

2.1.8 Connectors MACxxx4 (115/230VAC supplied versions)



2.1.9 Connector description including options.

The MAC motors offers robust M8, M12 and M16 connectors which makes it ideal for automation applications and use in a harsh invironment. The connectors offer solid mechanical protection and are easy operate.
This chapter covers a MAC with all connector options, such as STO (safe torque off), extended I/O connector and optional M16 connector for external DC bus and/or power dump.
Following tables gives the relevant information about each connector and the pins, wire colours and a short description of the signals available.

The connector layout:

"PWR" (XD10) - Power input. M12 - 5pin male connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1000-M12F5TxxN**	**Isolation group**
-	Not used	1	Brown	1
-	Not used	2	White	1
P-	Main supply ground. Connect with pin 5 *	3	Blue	1
CVI	Control and user output supply +7-30VDC. **DO NOT connect >30V to this terminal!**	4	Black	1
P-	Main supply ground. Connect with pin 3 *	5	Grey	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

Please notice: When connecting the a cable to one of the M12 connectors it must be tightened with 0.6 Nm to prevent ingress of fluids and/or particles in the connector which can cause malfunction.

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"LA-I" (XG1) Ethernet In connector - M12 - 4pin female connector "D" coded				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1046-M12 M4TM4TxxT**	**Isolation group (See note)**
Tx0_P	Ethernet Transmit channel 0 - positive terminal	1	-	2
Rx0_P	Ethernet Receive channel 0 - positive terminal	2	-	2
Tx0_N	Ethernet Transmit channel 0 - negative terminal	3	-	2
Rx0_N	Ethernet Receive channel 0 - negative terminal	4	-	2
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

"LA-O" (XG2) Ethernet Out connector M12 - 4 pin female connector "D" coded				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1046-M12 M4TM4TxxT**	**Isolation group (see note)**
Tx1_P	Ethernet Transmit channel 1 - positive terminal	1	-	3
Rx1_P	Ethernet Receive channel 1 - positive terminal	2	-	3
Tx1_N	Ethernet Transmit channel 1 - negative terminal	3	-	3
Rx1_N	Ethernet Receive channel 1 - negative terminal	4	-	3
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

"MAINS POWER" (XD0) connector M16 - 4 pin male connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WP0402**	**Isolation group (see note)**
Neutral	Neutral used for 115 or 230VAC phase input	A	Blue	4
L1	115VAC supply input	B	Red	4
L2	230VAC supply input	C	Brown	4
PE (Earth)	Protective earth terminal	Earth	Green/Yellow	4
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1.10 Connector option - "STO"

If the motor is called MACxxxxx-x**R**xxxxx it contain the STO function and have the M8 STO connector included. The table below describes the connections.

"STO" (X0) connector M8 - 4 pin male connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1010-M08M4TxxP**	**Isolation group (see note)**
STOA	STO channel A	1	Brown	1
GND	Ground for the STO signals	2	Inner screen	1
STOB	STO channel B	3	Black	1
24V out	DO NOT CONNECT !	4	(do not exist)	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1.11 Connector option I/O - 8 pin connector

If the motor is called MACxxxxx-xxxx**D**xx or MACxxxxx-xxxx**Q**xx it contain the basic I/O connector with RS485 communication and a small portion of I/O's in a 8 pin M12 connector. The table below describes the connections.

"I/O" (XG0) - RS485 + I/O connector - M12 - 8pin female connector.				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1000-M12 M8TxxN**	**Isolation group (See note)**
IN1	Digital input 1 (24V) or analogue input 0-5V	1	White	1
IN2	Digital input 2 (24V) or analogue input 0-5V	2	Brown	1
OUT1	Digital output max. 300mA. Supplied from CVO.	3	Green	1
GND	Ground intended to be used together with the other signals in this connector	4	Yellow	1
RS485: B0-	RS485 MacTalk interface. Leave open if unused	5	Grey	1
RS485: A0+	RS485 MacTalk interface. Leave open if unused	6	Pink	1
IN3	Digital input 3 (24V) or analogue input 0-5V	7	Blue	1
CVO	Supply output. Connected internally to the **CVI** terminal in the PWR connector. Max 700 mA. **DO NOT connect >30V to this terminal!**	8	Red	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1.12 Connector option I/O - 17 pin connector

If the motor is called MACxxxxx-xxxx**E**xx it contain the extended I/O connector with RS485 communication in a 17 pin M12 connector. The table below describes the connections.

"I/O" (XG0) RS485 + I/O connector - M12 - 17pin female connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WI1009M12 M17TxxN**	**Isolation group (see note)**
IO1	I/O channel 1. Can be used as input or output 350mA	1	Brown	1
GND	Ground intended to be used together with the other signals in this connector	2	Blue	1
IO2	I/O channel 2. Can be used as input or output 350mA	3	White	1
IO3	I/O channel 3. Can be used as input or output 350mA	4	Green	1
RS422: B1-	RS422 I/O terminal B-	5	Pink	1
IO4	I/O channel 4. Can be used as input or output 350mA	6	Yellow	1
RS422: A1-	RS422 I/O terminal A-	7	Black	1
RS422: B1+	RS422 I/O terminal B+	8	Grey	1
CVO	Supply output. Connected internally to the **CVI** terminal in the PWR connector. **DO NOT connect >30V to this terminal!**	9	Red	1
RS422: A1+	RS422 I/O terminal A+	10	Violet	1
IO5	I/O channel 5. Can be used as input or output 350mA	11	Grey/pink	1
IO6	I/O channel 6. Can be used as input or output 350mA	12	Red/blue	1
IO7	I/O channel 7. Can be used as input or output 350mA	13	White/Green	1
IO8	I/O channel 8. Can be used as input or output 350mA	14	Brown/Green	1
RS485: B0-	RS485 MacTalk interface. Leave open if unused	15	White/Yellow	1
GND	Ground intended to be used together with the other signals in this connector	16	Yellow/brown	1
RS485: A0+	RS485 MacTalk interface. Leave open if unused	17	White/grey	1
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

2.1.13 Connector option DC-BUS/DUMP

If the motor is called MACxxxxx-xxxxxx**8** it contain the extra and optional connector for external DC bus and power dump resistor. The table below describes the connections.

"DC-BUS/DUMP" (XD1) connector M16 - 4 pin female connector				
Signal name	**Description**	**Pin no.**	**JVL Cable WP0402**	**Isolation group (see note)**
BO	Internal DC bus output	A	White	4
PD	Output to external power dump resistor	B	Yellow	4
CM	DC bus common (high voltage ground)	C	Brown	4
PE (Earth)	Protective earth terminal	Earth	Green/Yellow	4
Connector housing/metal is connected to earth and at JVL supplied cables also to the cable screen.				

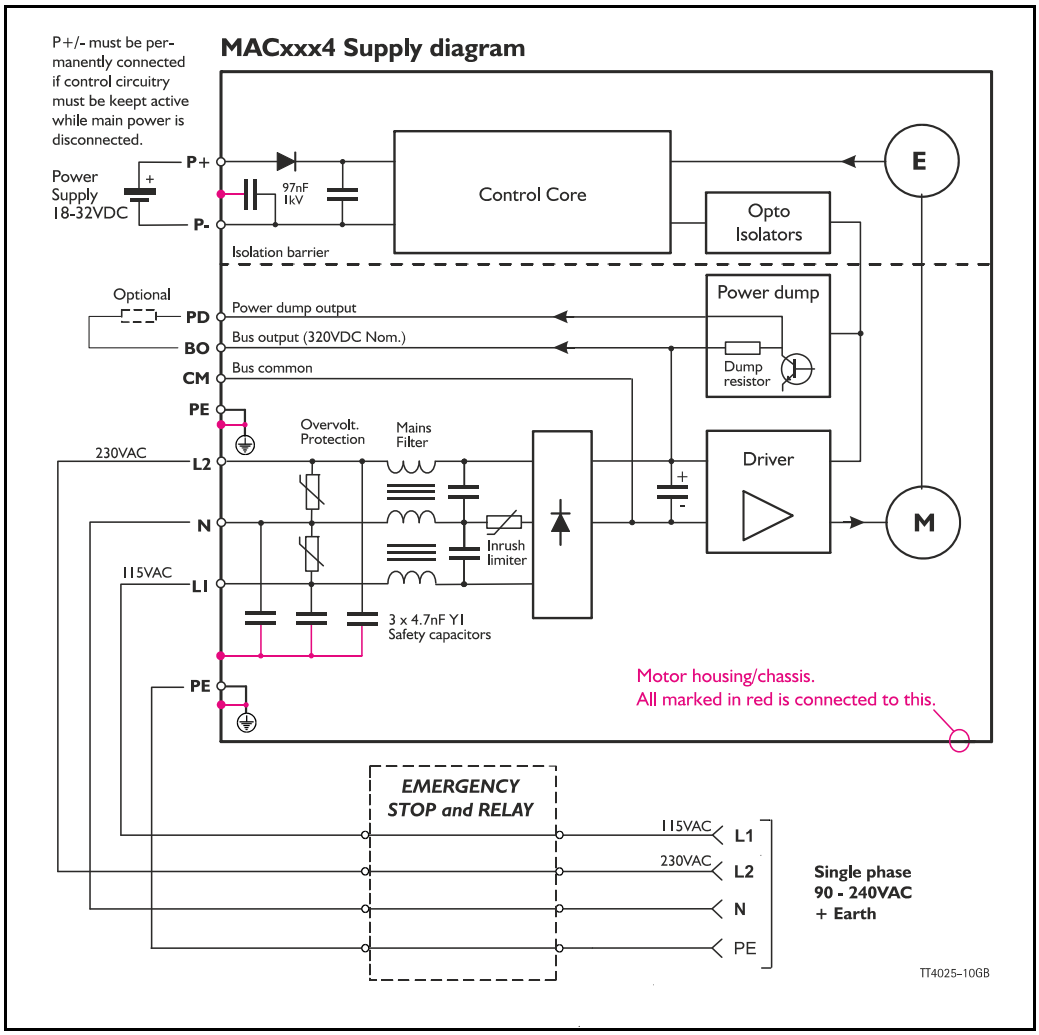
Note:
The term "Isolation group" in all the tables, indicate which terminals/circuits that a galvanic connected to each other. In other words group 1, 2, 3 and 4 are all fully independently isolated from each other. Group 5 correspond to the housing of the motor which may also be connected to earth via the DC or AC input supply. Group 5 is isolated from all electrical circuitry inside the motor.

2.2 Power Supply

Only MACxxx4

2.2.1 Power supply circuitry (115/230VAC supplied versions)

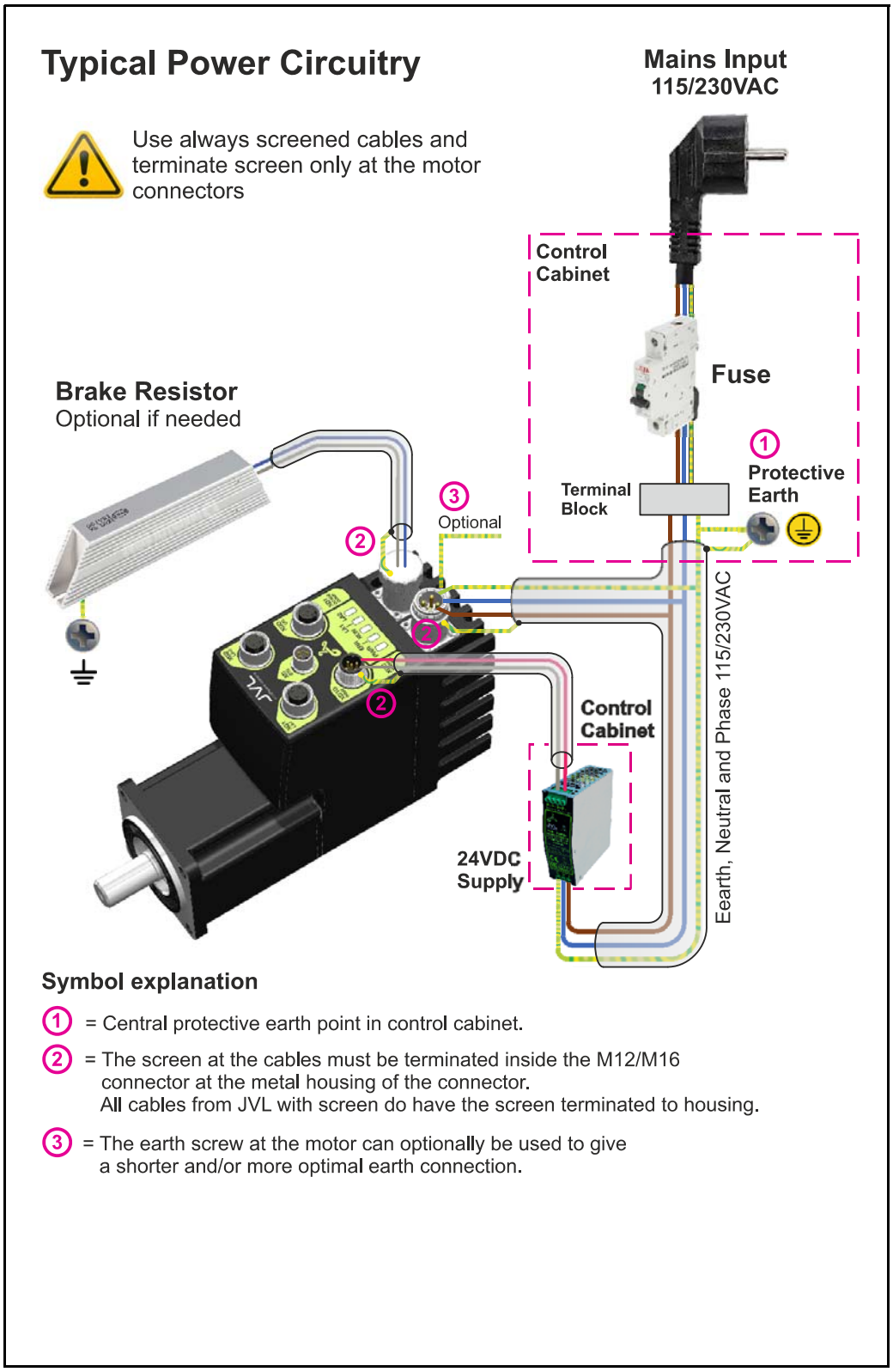
The supply at the MACxxx4 motors is split into 2 individual circuits with full galvanic isolation between the circuits.
The control circuitry requires a voltage in the range 18 to 32VDC and the power circuity must be supplied with 90 to 240VAC. Having 2 independent supply circuits offers the feature that the supply voltage for the power circuitry (90-240VAC) can be removed for safety reasons, while the control circuitry can continue operating and thus keep the position counter updated and keep other vital functions such as communication active.



The circuit above is shown with an emergency relay (box) which can be omitted if the application does not require this safety feature. There are shown examples of Emergency stop and relay. *See "Emergency stop" on page 162.*
The internal power dump is intended to cover 90% of all applications but if the error message "overvoltage" is monitored, an external power dump resistor must be connected between the terminals *PD* and *BO*.

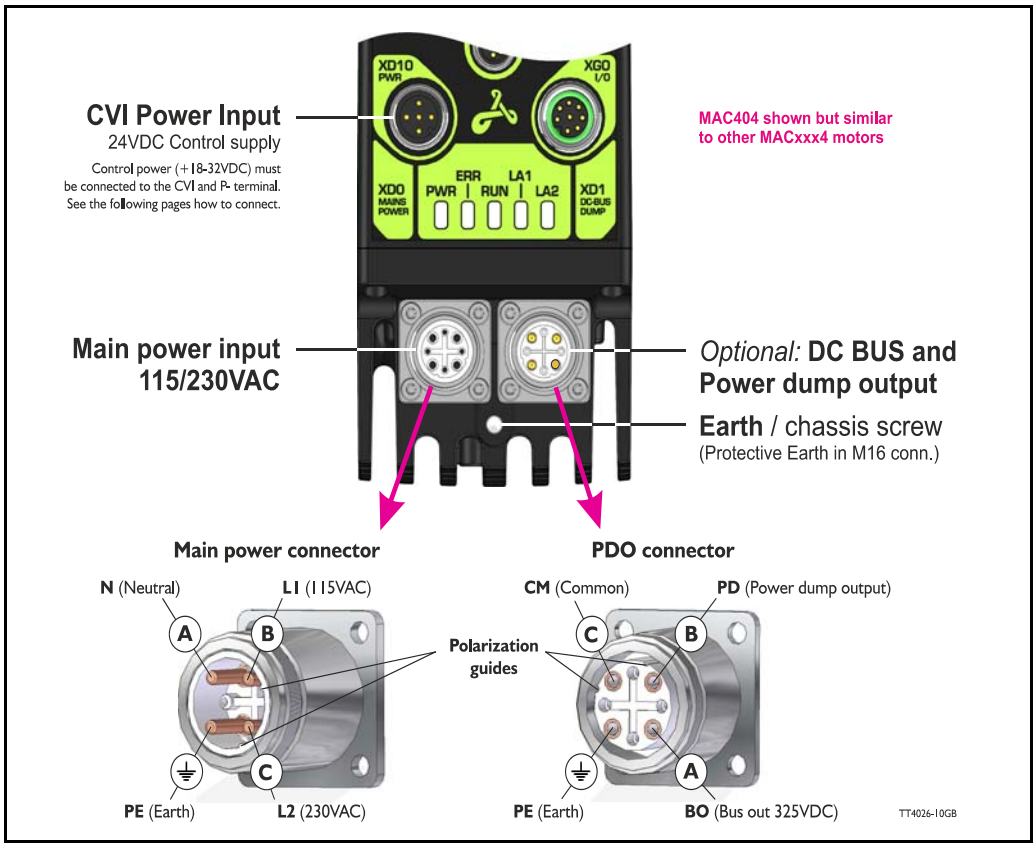
2.2.2 How to connect power supply and related components

Below is shown how to connect the MAC motor to the mains supply and also how to connect the control voltage 24V and an optional brake resistor if needed.



2.2.3 Power connectors at the motor (115/230VAC supplied versions)

The power supply needed for the MACxxx4 motors are seperated in 2 circuits.
The control power nom. 24VDC and the 115/230VAC main supply.
The following pages describe how to connect the main supply 115/230VAC. See the following pages for how to connect the 24VDC control power.



Main power connector terminal descriptions:

L1	115VAC input (phase)	WARNING: Please be aware that high voltage is present also when terminal is unconnected!
L2	230VAC input (phase)	WARNING: Please be aware that high voltage is present also when terminal is unconnected!
N	115/230VAC input (neutral).	
PE	Earth must be used with power input terminal L1, L2 and N.	

PDO connector terminal descriptions (optional connector):

PD	Power dump out - see also *Connecting an external power dump resistor, page 25*.
BO	Bus output (nom. 325VDC).
CM	Common. Ground for the internal DC-bus.
PE	Earth must be used with the DC-bus and the PD terminals.

.....

Note: Please use screened cables only. The screen must be connected to the metal connector housing which is also internally connected to the earth terminal.

CAUTION - Risk of electric shock. Disconnect all power and wait 5 min. before servicing

2.2.4 MACxxx4 Grounding

Make sure that the machine part on which the MACxxx4 is mounted is properly grounded to the main part (body) of the machine in order to avoid major ground/earth current to flow through the motor and cause interference to other signal groups.

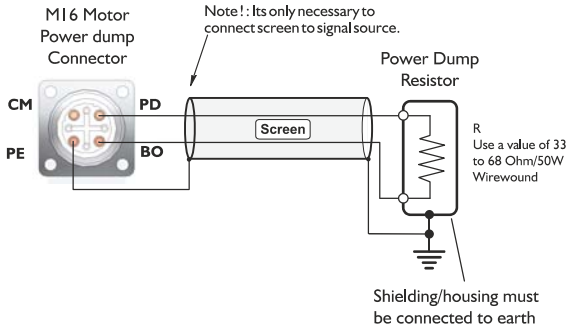
The 115/230VAC power supply connector contain an protective earth connection but if needed the designated earth screw placed near the power connector can also be used.

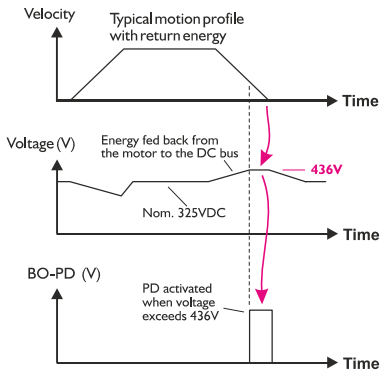
2.2.5 Emergency stop

Please consult the chapter: *Emergency stop considerations, page 162*

2.2.6 Connecting an external power dump resistor

External power dump connection.
Only MACxxx4 motors with 115/230VAC supply





Terminal description for the "Dump" connector.
CM = Common. Is internally connected to the ground of the DC bus. Is only intended to be used if multiple motors share DC-bus.
BO = Bus output. The internal DC bus is connected to this terminal.
PD = Power Dump output. Behind this terminal is placed a switch (IGBT transistor) which connect the terminal to the internal bus ground if the voltage become higher than 436VDC.

If the return energy is too high and the used power dump resistor is not able to keep down the voltage below **467V** the motor will report an overvoltage error and go in passive mode in order to protect it self.

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The internal power dump can absorb following

Motor size	Max. energy	Peak energy	Motor types
400 - 600W	4W	1460W	MAC404 and MAC604
750 - 1500W	10W	1460W	MAC804, 1004 and 1404

The above values areconsidered as appropriate for most applications.
However should a situation occur in which the connected load inertia is too large or the deceleration too fast, the internal power dump will not be able to absorb all the returned energy and will report the error message "regenerative overload".
In this situation the only possible solutions are as follows:

1. Decrease the acceleration/deceleration parameter.
2. Lower the attached load inertia.
3. Connect an external power resistor.

The drawing above shows how to connect an external power resistor. A wirewound type is recommended since it will be able to absorb higher peak power than other types of resistors. Do not use a film based resistor since it will not be able to absorb higher peak power than the nominal rating which is typical very low.

Warnings: Ensure that the resistor value is between 33 to 68 Ohm/50W since the output otherwise can be damaged. Also avoid short-circuit of the output.

CAUTION - Risk of electric shock. Disconnect all power and wait 5 min. before servicing

2.2.7 Sizing the external pre-fuse (115/230VAC supplied versions)

Below recommended sizing of the pre-fuse connected in the power supply line before the motor.

Motor size	Fuse size when supply 115VAC	Fuse size when supply 230VAC	Motor type
400W	T10A	T6.3A	MAC404
600W	T15A	T8A	MAC604
750W	T15A	T10A	MAC804
1000W	T15A	T10A	MAC1004
1500W	T20A	T12A	MAC1504

Melt type fuses recommended:
For **115V** supply voltage:
To met UL requirements, the prefuse must be a class RK5 such as the type FRN-R-xx from manufacturer: Cooper Bussmann INC. The rating must be according to the table above.

For **230V** supply voltage:
Melt fuse: type gG, Do or Dz in the phase line Rated for 600V/150kA. The rating must be according to the table above.

Automatic fuses recommended:
If an automatic fuse is used for either 115 or 230VAC then choose “Class D”. The rating must be according to the table above.

.....

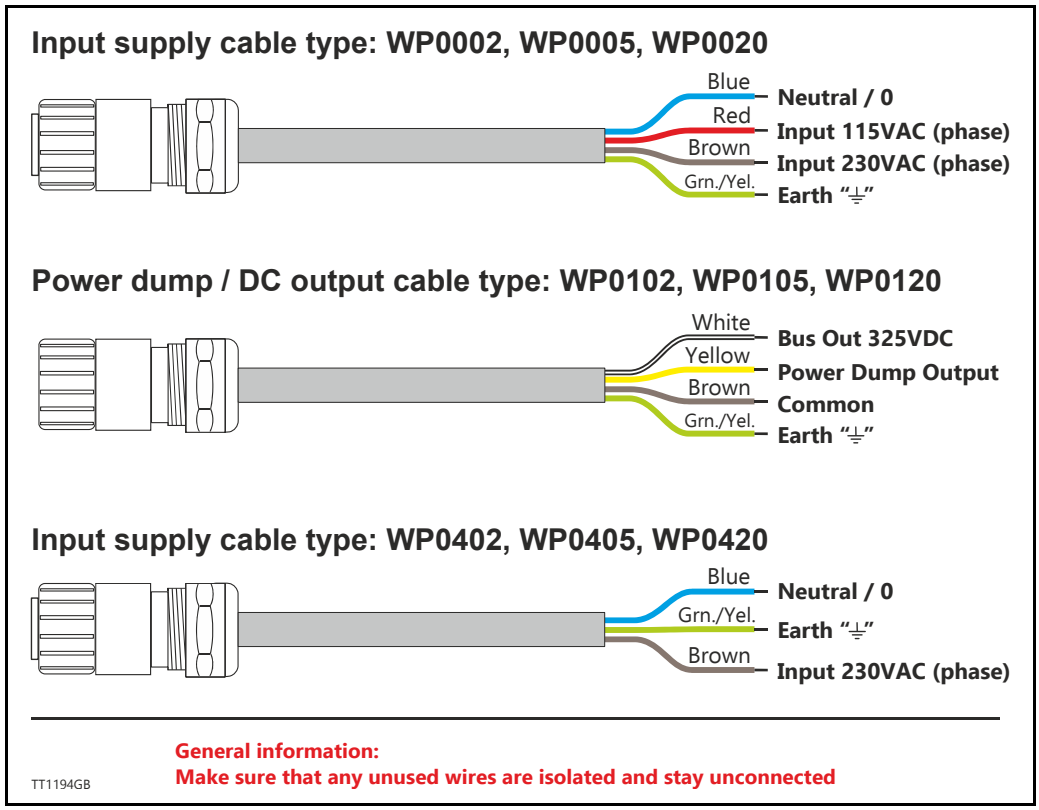
In general it must be tested that the actual fuse used can withstand also that the motor for a short while can deliver 300% peak energy which will stress the fuse for a short while and over time the life time can be reduced. Therefore in general use only slow acting fuses which are robust to short overloads.

2.2.8 Power cable accessories (115/230VAC supplied versions)

The following standard cables can be supplied by JVL

JVL no.	Type	Description
WP0002	MACxxx4	115/230VAC power cable 2 m. Straight M16 conn and free end. Female
WP0005	MACxxx4	115/230VAC power cable 5 m. Straight M16 conn and free end. Female
WP0020	MACxxx4	115/230VAC power cable 20 m. Straight M16 conn and free end. Female
WP0102	MACxxx4	Brake resistor cable 2 m. Straight M16 conn and free end. Male
WP0105	MACxxx4	Brake resistor cable 5 m. Straight M16 conn and free end. Male
WP0120	MACxxx4	Brake resistor cable 20 m. Straight M16 conn and free end. Male
WP0402	MACxxx4	230V power cable with earth 2m. Straight M16 conn and free end. Female
WP0405	MACxxx4	230V power cable with earth 5m. Straight M16 conn and free end. Female
WP0420	MACxxx4	230V power cable with earth 20m. Straight M16 conn and free end. Female

Please use the illustration below when connecting the cables.
Warning: Please notice that it can be fatal connecting 230V to the 115V input.



2.2.9 Power connector parts (115/230VAC supplied versions)

Manufacturer: Hummel AG - Germany.
General web: http://www.hummel-group.com
US web: http://www.sealconusa.com

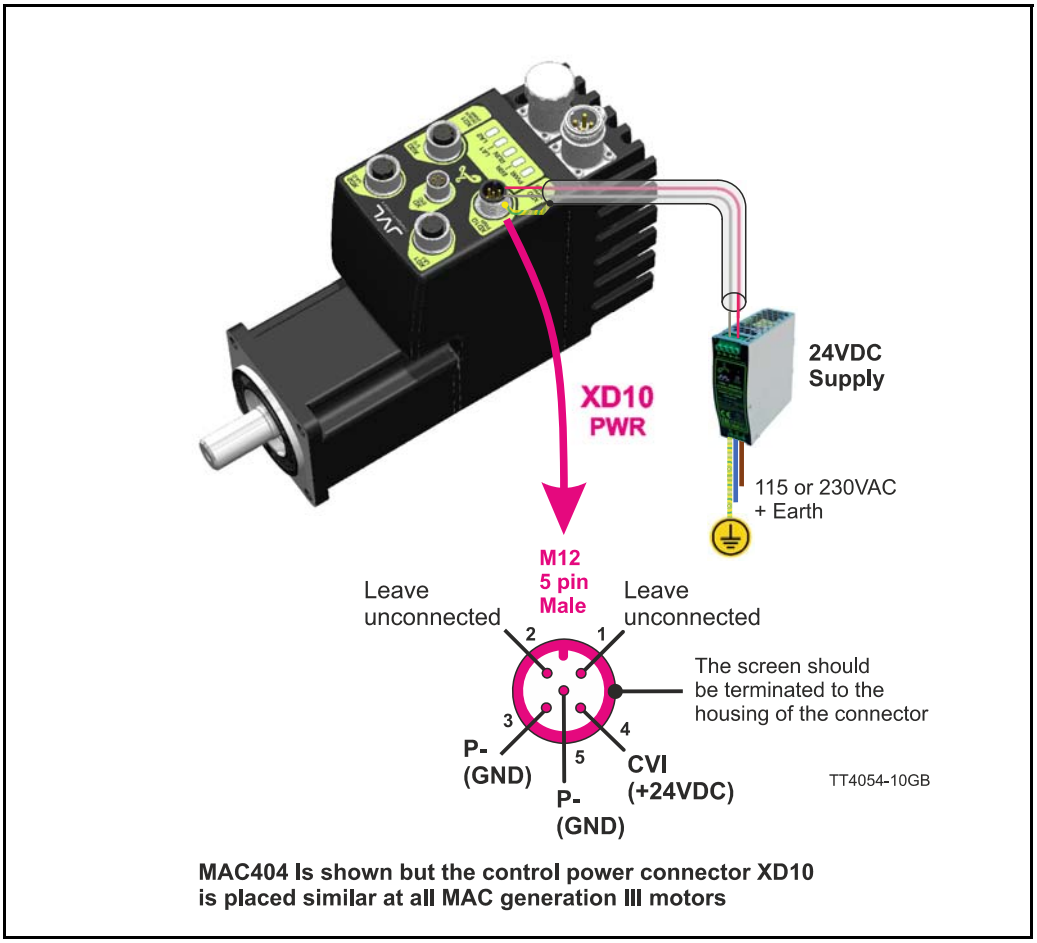
Used for	Part description	Hummel part no.	JVL part no.
Power 115/230VAC	Connector kit with all necessary connector parts. Contains: 1pcs. WG0227 4pcs. WG0229, 1pcs. WG0230		MAC400-CONKIT1-PWR
Brake resistor/DC bus	Connector kit with all necessary connector parts. Contains: 1pcs. WG0226 4pcs. WG0228, 1pcs. WG0230		MAC400-CONKIT1-DCPD
Individual connector components:			
Power 115/230VAC	M16 Female conn insert nylon Accepts 3 + PE crimp sockets **Use 1 pcs. per connector.**	7003.9431.02	WG0227
Power 115/230VAC	M16 Crimp socket (female) Accepts 0.34 to 1.5mm² wires / AWG16 to AWG22. **Use 4 pcs. per connector.**	7010.9816.02	WG0229
Power 115/230VAC	M16 Straight metal housing Accepts cable with outer dia. 5.0 to 9.0mm / 0.2" to 0.53" **Use 1 pcs. per connector.**	7810.4000.00	WG0230
Power 115/230VAC	Optional - same as above but 90 degree housing.	7830.4000.00	WG0231
Brake resistor/DC bus	M16 Male conn insert nylon. Accepts 3 + PE crimp pins. **Use 1 pcs. per connector.**	7003.9431.01	WG0226
Brake resistor/DC bus	M16 Crimp pin (male) Accepts 0.34 to 1.5mm² wires / AWG16 to AWG22. **Use 4 pcs. per connector.**	7010.9816.01	WG0228
Brake resistor/DC bus	M16 Straight metal housing Accepts cable with outer dia. 5.0 to 9.0mm / 0.2" to 0.53" **Use 1 pcs. per connector.**	7810.4000.00	WG0230
Brake resistor/DC bus	Optional - same as above but 90 degree housing.	7830.4000.00	WG0231
Brake resistor/DC bus	Metal protection cap. Mounted if connector is not in use	7010.9001.62	WG0224
-	Crimp tool	7.000.900.904	Not for sale

2.3 Control Power Supply

2.3.1 How to connect the control voltage input.

Beside the main power to the motor in form of 115/230VAC or 12-48VDC (depending at the type of motor) it is always necessary also to connect control power (CVI).

CVI The control voltage input is supplying all the internal control circuits including the microprocessor, encoder and user I/O circuitry. The voltage needed must be in the range 7-30 VDC which also support battery driven applications. Supply current is below 250 mA (voltage dependant and no user outputs activated).



MAC404 Is shown but the control power connector XD10 is placed similar at all MAC generation III motors

2.3.2 CVI supply Precautions.

The CVI supply is not critical since the supply current is quite small (<250 mA). Only make sure that the voltage stay at 24 VDC nominal and do not exceed 30 VDC.
A CVI voltage down to 7 VDC is also possible but a software setup is needed to allow this.

Warning: A supply voltage at CVI than 35VDC will cause permanent damages.

2.4 User I/O

Option !

2.4.1 How to see which I/O options exist

The MAC motor offers an optional number of I/O's covering up to 8 I/O's were each I/O terminal can be used as either a digital input or a digital output. 4 of the I/O's can also be used as analogue inputs 0-5VDC.

Different options exist depending on the motor type number.
In the below table can be seen which options that are available.

Extract from nomenclature for the MAC generation III product family

MAC xxxx _ _ - _ _ _ _ _ _ _ _ _ _

Type of I/Os and connectors available

	Digital IN	Digital OUT	Analog IN	Connector type
D_	3	1	3	8 pin M12 A-coded
E_	8	8	4	17 pin M12 A-coded
QA	8	8	4	17 pin M12 A-coded
Q5	3	1	3	8 pin M12 A-coded
W_	8	8	4	17 pin M12 A-coded

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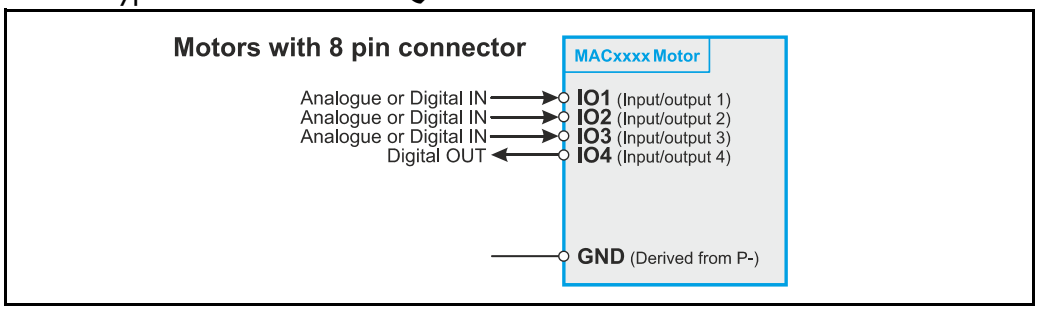
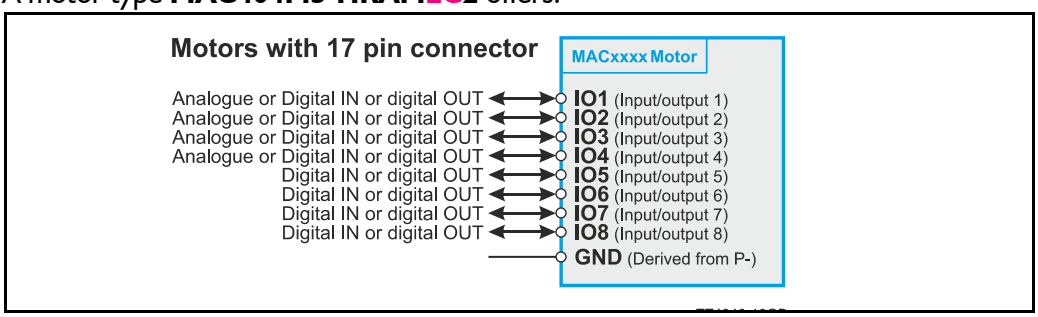
Examples:
A motor type **MAC404M2-HAAQDC2** offers:



A motor type **MAC404M5-HRAMEC2** offers:



2.4.2 Digital User Inputs

If the a MAC motor is equipped with digital user inputs this chapter describe how to use the inputs.
Please also see *How to see which I/O options exist, page 30*.

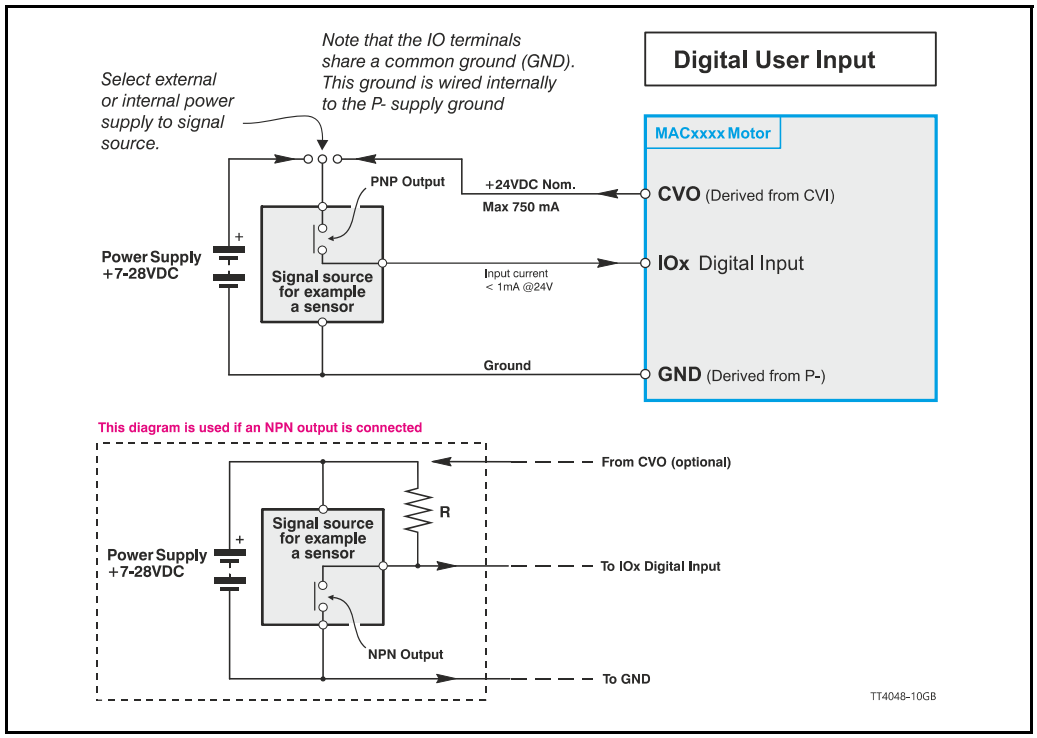
They physical layout of the connectors where the I/O's are present can be seen in chapter *Connector Overview, page 12*.

Depending at the actual I/O option for the motor it may have 3 or 8 digital inputs.

The input offer following main features:

- Inputs are TTL to 30 VDC compliant. Trigger levels LTL=2.3 V and UTL 2.65 V.
- High input impedance (>10 kOhm)
- No galvanic isolation but very robust against noise and spikes/surges.
- Zero search input can be selected to any input.
- Limit switch inputs

The diagram below illustrate how to connect an external device to the input



2.4.3 General input description

The motor is optionally equipped with a number of digital inputs. Each input can be used for a variety of purposes depending on the actual application. Each of the inputs can be read/detected from the actual ePLC program that has been downloaded to the motor or via serial commands over the Modbus interface or optionally Ethernet interface.

The Inputs are not optically isolated from other circuitry in the control section (low voltage) of the motor.
All of the Inputs have a common ground terminal, denoted *GND*. Each Input can operate with voltages in the range 5 (TTL) to 30VDC. Note that the Inputs should normally be connected to a PNP output since a positive current must be applied for an input to be activated.
Note that CVO (control voltage output) is internally connected to the CVI supply terminal in the PWR connector. This provides the facility that local sensors can be supplied directly from the controller. CVO is internally fused to a maximum allowable current of 750 mA

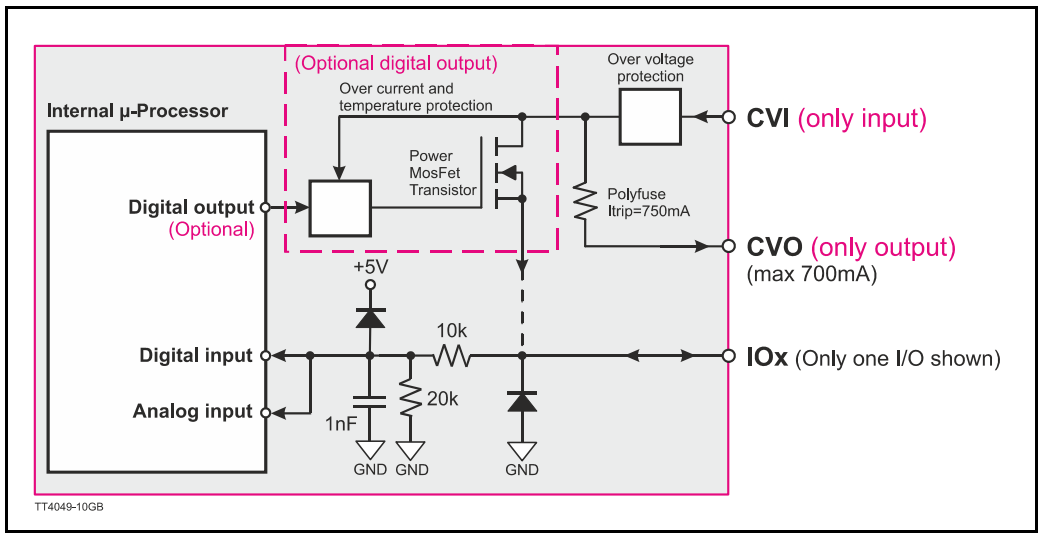
2.4.4 Connection of NPN Output

If an Input is connected to an NPN output, a Pull-Up resistor must be connected between the Input and the + supply. See also the illustration above.
The value of the resistance used depends on the supply voltage. The following resistances are recommended:

Supply Voltage	Recommended Resistance R
5-12VDC	1kOhm / 0.25W
12-18VDC	2.2kOhm / 0.25W
18-24VDC	3.3kOhm / 0.25W
24-28VDC	4.7kOhm / 0.25W

2.4.5 Internal circuitry behind the input and output terminal

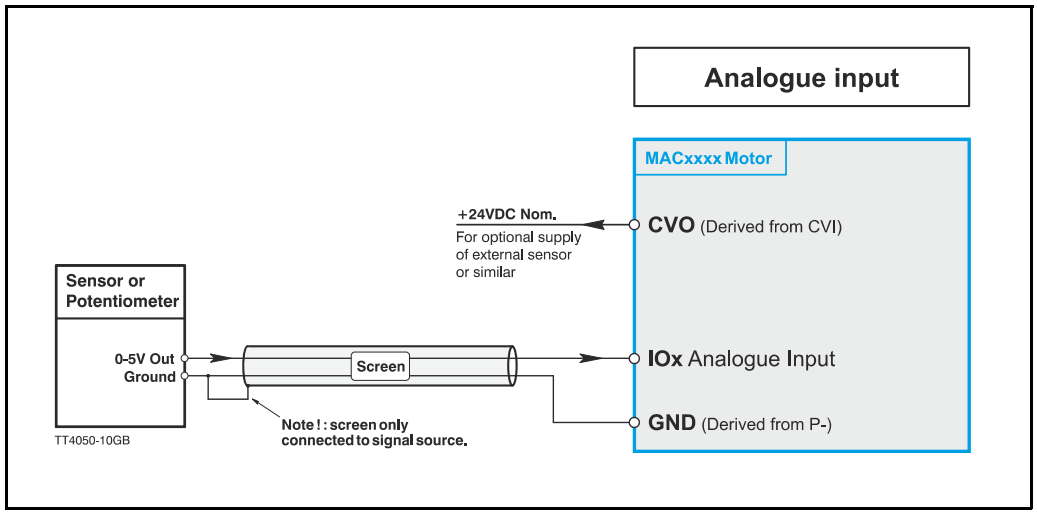
Input/output functional diagram:



The I/O terminal is well protected with clamping diodes, fuse and high frequency filter to withstand exposure of electrical noise and other typical disturbances in an industrial environment.

2.5 Analogue Inputs

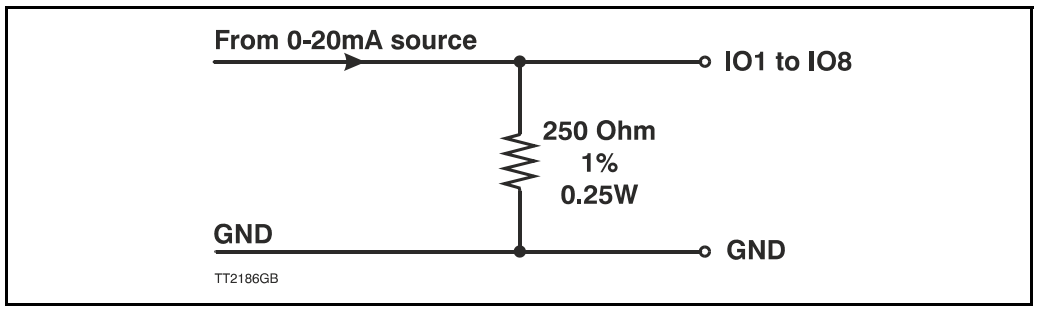
Option !



2.5.1 General

The 0-5V Analogue Inputs are used for example when the motor is operated as a stand-alone unit. In this kind of application it can be an advantage to use a potentiometer, joy-stick or other device for adjusting speed, position, acceleration, etc.

In these modes of operation, the motor is controlled to produce a velocity or position, etc., which is determined by, and proportional to, the voltage applied to the Analogue Input.
The Analogue Inputs share a common internal supply with the GND and P- terminal and are not optically isolated from all other inputs and outputs. The Analogue Inputs are protected against voltage overload up to 30V peak and have a built-in filter which removes input signal noise.
Always use shielded cable to connect the source used to control an Analogue Input since the motor, etc., can easily interfere with the analogue signal and cause instability.
The Controller is equipped with 8 analogue-to-digital converters (ADC) which convert the detected analogue signal level. The ADCs have a resolution of 12bit.
In order to use the Analogue Inputs as 0-20 mA inputs, a 250 Ω, 1% resistor must be connected between IO 1-8 and GND.



Please notice: The number of available I/O terminals available may differ depending at which motor type and connector configuration you are using. Please consult the chapter *How to see which I/O options exist, page 30*

2.6 User Outputs

Option !

2.6.1 User outputs

If the a MAC motor is equipped with digital user output(s) this chapter describe how to use the output(s).
Please also see *How to see which I/O options exist, page 30*.

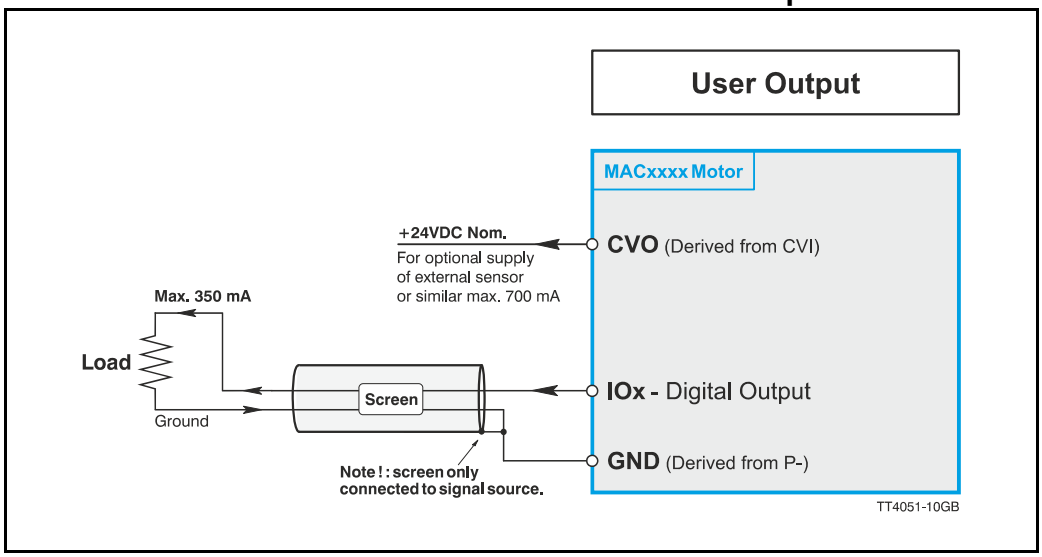
They physical layout of the connectors where the I/O's are present can be seen in chapter *Connector Overview, page 12*.

Depending at the actual I/O option for the motor it may have 1 or 8 digital outputs.

The output(s) offer the following main features:

- Over current and over temperature protected.
- Short-circuit to ground protected that shuts down all outputs and sets Error bit in software.
- Protected to handle heavy inductive loads.
- No galvanic isolation but very robust against noise and spikes/surges.
- Output current up to 350mA per output.
- The Outputs are Source outputs and 7-30VDC compliant
- Optional *"In Position"* and *"Error"* signals can be selected to be on any outputs 1 to 8

Below illustrates how to connect an external load to an output



2.6.2 General

The motor is equipped with a 1 or 8 digital outputs (depending on which option).
Each output can be used for a variety of purposes depending on the motor's basic mode of operation. The Outputs are not galvanically isolated from other circuitry in the motor. The output circuitry is powered from the control voltage supply terminal CVI.

2.6 User Outputs

Option !

The output circuitry operates with voltages in the range 7-30 VDC.
Each output can supply a continuous current up to 350 mA (max).
The outputs are all source drivers, i.e. if a given output is activated, contact is made between the control voltage (CVI) and the respective output terminal. See above illustration.

2.6.3 Overload of User Outputs

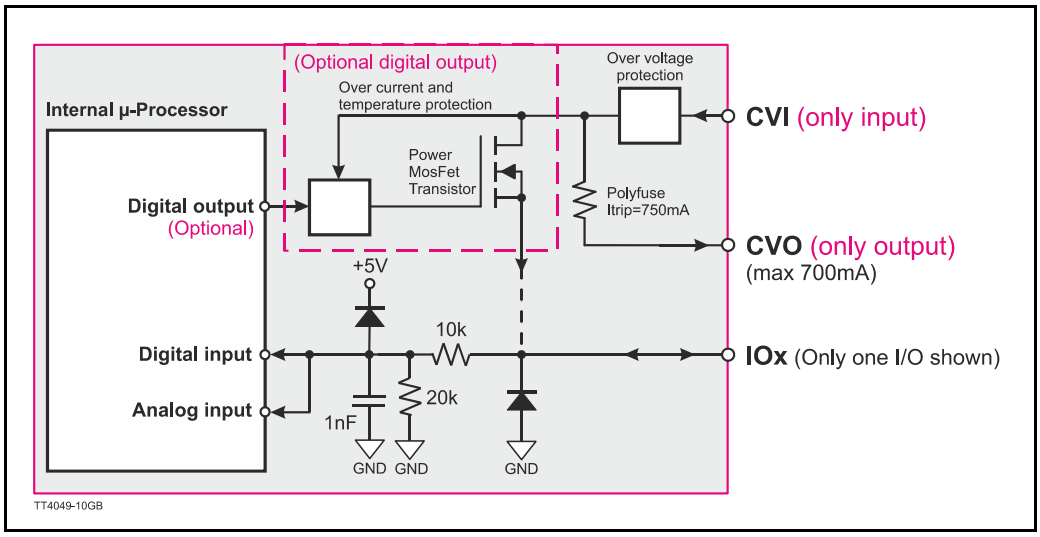
All of the outputs are short-circuit protected, which means that the program and the motor is stopped and the output is automatically disconnected in the event of a short circuit. The output will first function normally again when the short-circuit has been removed.

Note: Do not connect a voltage greater than 30 VDC to the CVI terminal as the output circuitry may be seriously damaged and the unit will require factory repair.

If one or more outputs are short circuited, MacTalk will show Error "Output Driver" and Bit 2 will be set in the register *Err_Bits*.

2.6.4 Internal circuitry behind the input and output terminal

Input/output functional diagram:



The I/O terminal is well protected with clamping diodes, fuse and high frequency filter to withstand exposure of electrical noise and other typical disturbances in an industrial environment.

2.7 Serial interfaces overview

2.7.1 Serial interfaces

The Controller has optionally 2 serial interfaces:

- RS485 (Balanced interface - 2 wire) for up to 32 units in multi-axis applications and Modbus communication. (Standard)
- Optional: Ethernet interface for Industrial Ethernet protocols such as EthernetIP, EtherCAT, ProfiNET, ProfiDrive and others. See also *Industrial Ethernet, page 100*

Ethernet and RS485 can be used at the same time.

Please notice: The number of available I/O terminals available may differ depending at which motor type and connector configuration you are using. Please consult the chapter *Connector Overview, page 12*

2.8 RS485 Interface

2.8.1 RS485 - General description when using a QuickStep motor

The RS485 interface offers more noise immune communication compared to a USB or RS232 interface. Up to 32 motors can be connected to the same interface bus.

When connecting the RS485 interface to a central controller, the following rules must be followed:

1 Use twisted pair cable.

2 Use shielded cable.

3 Make sure that the GND is also connected.

4 Ensure that all units have a proper connection to safety ground (earth) in order to refer to the same potential.

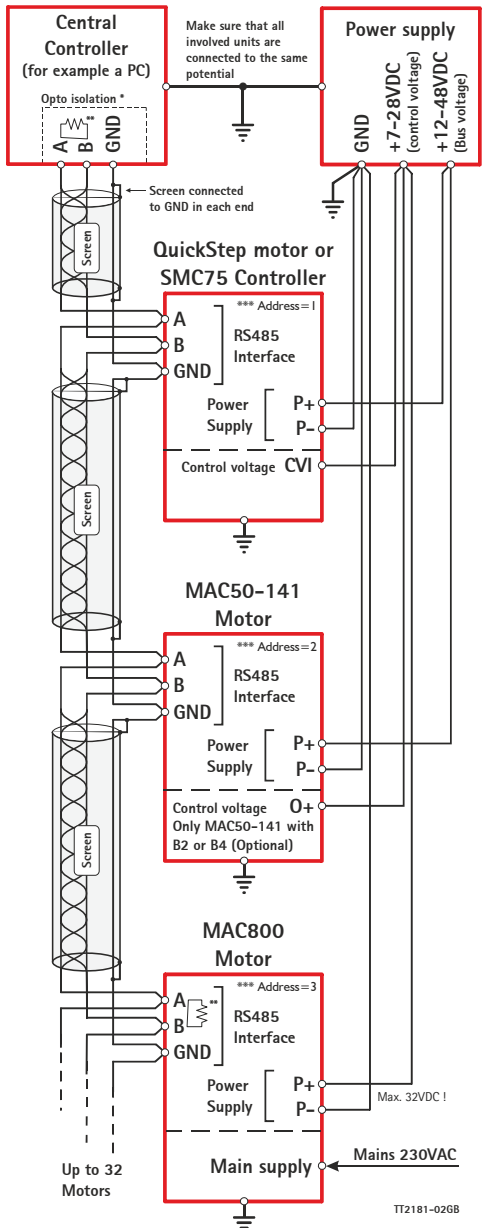
5 The last unit in each end of the network must be terminated with a 120 Ohm resistor between A and B.

6 Ensure that the supply lines are made individually in order to reduce the voltage drop between the motors.

7 Central Controller RS485 interface:
If available, it is strongly recommended a type with optical isolation is used.

The default configuration:
Data bits = 8
Baud rate = 19200
Stop bit = 1
Parity = None

RS485 network with 1 x QuickStep, 1 x MAC140 and 1 x MAC800 mounted with MAC00-B1, B2 or B4 modules.



* Opto isolation is recommended.
** The last unit in each end of the line must be terminated. The MAC00-B1, B2 and B4 contain this feature. See the individual module descriptions. The QuickStep motor does not have a resistor built-in, the resistor has to be mounted externally, for instance in the M12 connector.
*** Each unit connected must be setup with an address via The MacTalk program. If only one unit is connected no address is needed.

2.9 EMC considerations

2.9.1 EMC considerations

The MAC family of motors eliminates the traditional problems with noise from long motor cables that emit noise and feedback cables that are sensitive to noise from external sources.
However, it is still necessary to be aware of noise problems with communications cables and the 8 general-purpose inputs and outputs.
Whenever a digital signal changes level quickly, a noise spike is generated, and is transferred to the other wires in the same cable, and to a lesser degree to wires in other cables located close to the cable with the switching signal. A typical example is when a digital output from the MAC motor changes from low to high to drive a relay. If this digital output signal is transmitted in a multi-wire cable together with the RS-485 signals, there is a high risk that the RS-485 signal will be affected to the extent that the communication will fail, and require software retries.
If communication is used during operation, and operation includes either digital input signals or digital output signals, some precautions must be taken to avoid noise problems.
The following sections describe a number of measures which can be taken to solve noise problems. In most installations, no special measures will be required, but if noise problems are experienced – and/or must be avoided – it is highly recommended the instructions below are followed.

2.9.2 Use short cables

The shorter a cable is, the less noise problems it will induce. Be sure to keep the cables as short as possible. Instead of curling up the cables, cut them off at the minimum required length.

2.9.3 Use separate cables

Avoid running digital signals in the same multi-wire cables as RS-485 communication signals.
On some models of the MAC motors, the same connector contains both RS-485 signals and I/O signals – typically the I/Os 1-4.
In many applications, far from all inputs and outputs are used. If only up to four I/Os are required, consider using only I/Os 5-8 which are typically available via another connector on the motor.

2.9.4 Use filters

If more than 4 I/Os are needed, consider using I/Os 1-4 for inputs and I/Os 5-8 for outputs. It is normally possible to install a hardware filter on the digital input signals before they enter the cable. With such a (good) filter, noise on the RS-485 signals will not be a problem.
It is also possible to use filters on the outputs, but it is more difficult. It can be done by using short cables from the motor to the filters, and then using longer cables from the filters to the output targets. It may be easier to use a short cable from the motor to a splitter box, and then split the I/Os in one cable and the RS-485 signals in another cable.

2.9.5 Use termination (resistors) on the RS-485 signals

RS-485 is typically used to connect a single master PC or PLC to one or more motors in a chain. Both ends of the chain must have a 120 Ohms termination resistor connected between the A- and B+ signals. There is typically a terminating resistor in the master PC or PLC, but there is no termination inside the motors. Therefore an external resistor must be connected at the end of the cable out of the last motor in the chain. If the last motor has no connection cable, a connector with a resistor soldered between the A- and B+ pins should be used.

As an alternative, a connector with a short cable can be used with the resistor soldered between the two wires carrying A- and B+.
Use individually shielded cables.

In some installations, it will be necessary to have RS-485 signals in the same multi-wire cables as fast-switching digital signals. In addition to keeping cable lengths to a minimum and using termination resistors, high-quality cables, where each wire is shielded from the other wires in the cable, should be used. This is typically done using a metal foil wrapped around each wire. These types of cables are more expensive, but the overall cost and noise immunity requirements may justify the solution instead of splitting cables.

2.9.6 Use simple shielding

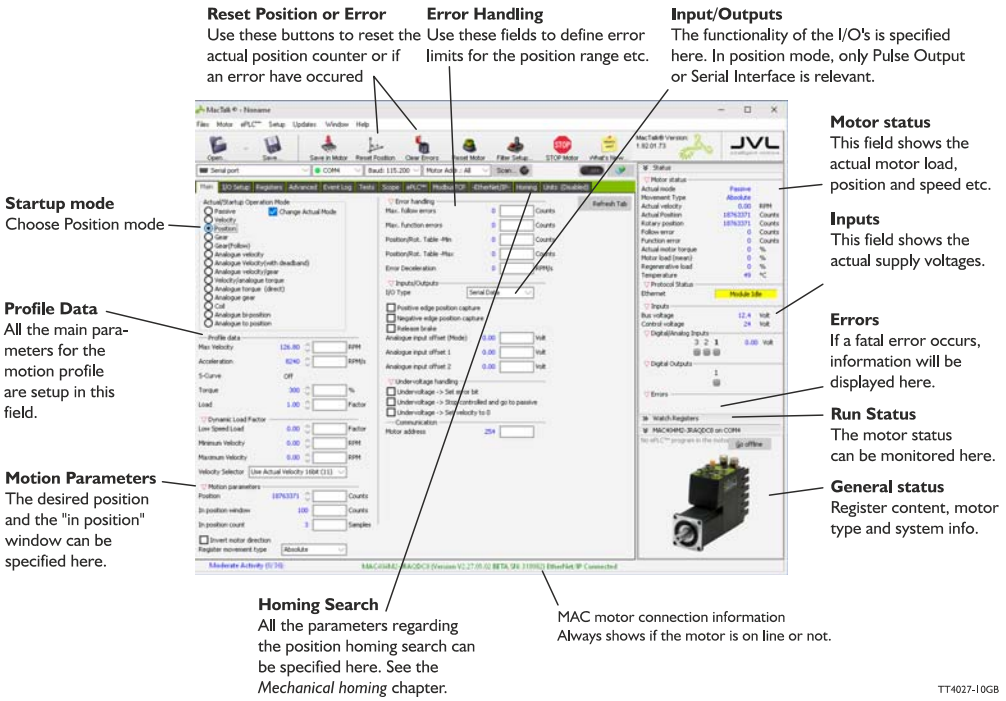
Using cables with only a single shield shared by all the signal wires will also improve noise problems to some degree, but will not guarantee completely stable operation for mixed signal cables. If a cable carries only RS-485 or only digital I/O, this simple and inexpensive form of shielding is recommended.

3 Functions

3.1 Using Position mode

3.1.1 Position mode

Follow the description below to set up the MAC motor in Position mode.
The MacTalk program is used to set up the motor initially. During normal operation, positioning commands can either be given through MacTalk or via one of the serial interfaces. the main window in MacTalk is as follows when position mode is selected.



Startup Mode Select position mode in this field.

Reset Position The counter which keeps track of the actual position can reset using this button.

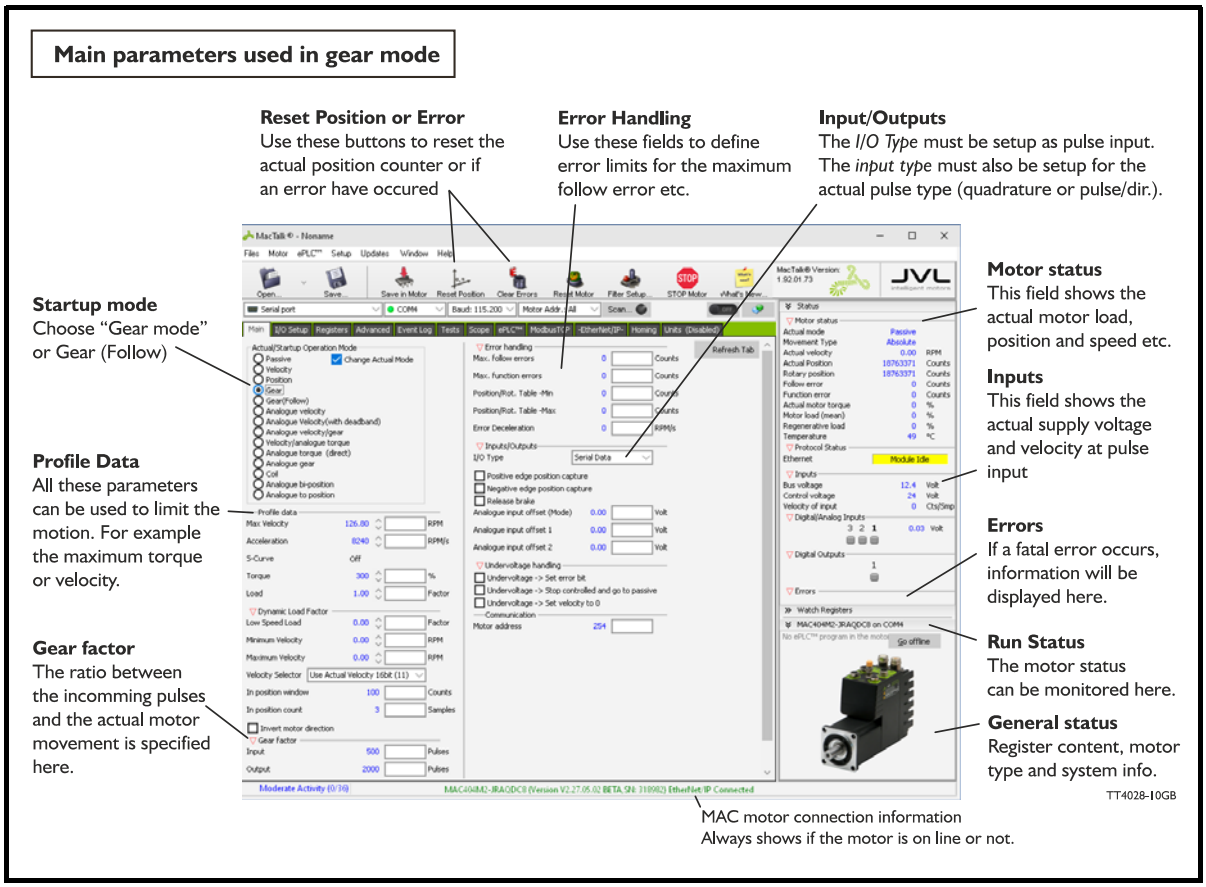
Error Handling Worst case limits for the position range can be set up here. Please consult the Error Handling chapter for details.

Input/Outputs The multifunction I/O terminals can be defined here. In Position mode these terminals can either work as a quadrature output from the internal encoder or as a serial RS422 interface for commands sent from a master controller. See also the *Multifunction I/O general description, page 117*.

Motor Status The actual mode, speed, position, position error, load torque, load current, regenerative energy (returned energy from the motor) can be monitored here.

Inputs The supply voltage can be measured here.

3.2 Gear Mode



3.2.1 Gear Mode - overall description

In gear mode, the motor follows a pulse signal applied to the Multifunction I/O terminals. The ratio between the incoming pulses and the motor movement can be adjusted to a desired value. A ratio from 1024:1 down to 1:1024 can be selected. Typically this mode is used if the MAC motor is incorporated into an application where movement needs to be synchronized with an external movement. Another typical application is the replacement of step motors, since the MAC motor in Gear Mode can work like a step motor using pulse and direction.

The following setup must be done to operate in gear mode (listed according to importance).

Startup Mode Select Gear Mode in this field.

Gear Factor This field defines the ratio between incoming pulses and the motor movement. If the preferred motor direction needs to be reversed, the sign in the "output" field must be inverted. Example: 1024 must be -1024 to reverse the direction of movement.

Input/Outputs The multifunction I/O terminals must be set to "pulse input" since gear mode uses the incoming pulses at this input to control the motor movement. Also the "Input type" must be selected. Choose "Quadrature" if an incremental encoder is connected or "pulse-direction" if it is a step motor signal. See also *Multifunction I/O general description, page 117*.

3.2 Gear Mode

Profile data

In gear mode, motor movement is fundamentally controlled from the external signal source, but via the 4 parameters specified in "Profile data" field it is possible to add limitations to speed, etc.

Velocity
The velocity field can be used to limit the maximum speed of the motor. Example - if an external encoder is producing a frequency which theoretically should give a MAC motor speed of 10000 RPM, the speed can be limited to 4000 RPM (max. allowed speed for the MAC). The motor will be unstable and go in error within some time since it is not able to run at 10000 RPM. Note that no pulses are lost if the velocity is limited. They are simply remembered and used when the input frequency falls to a level at which the motor is able to follow.

Acceleration
The acceleration parameter can be useful in systems in which the signal source instantaneously applies a high frequency without any acceleration. Under this condition, the MAC motor will take care of making a controlled acceleration and deceleration. Note that no pulses are lost if the acceleration is limited. They are simply remembered and used when motor velocity reaches a level corresponding to the input frequency.

Torque
The maximum torque can be limited in the range 0-300%. 300% corresponds to the rated peak torque of the MAC motor used.

Load
The Load parameter is the overall gain in the position/velocity filter and ensures that the motor is stable with the actual mechanical inertia used in the application. See also the filter setup chapter for further details.

Error Handling

Worst case limits for the position range and follow error (maximum position error) can be set up here. Please consult the Error Handling chapter for details.

Motor Status

The actual mode, speed, position, position error, load torque, load current, regenerative energy (energy returned from the motor) can be monitored here.

Inputs

The supply voltages can be measured here.

Homing

In typical gear mode applications the motor is moving relatively without any absolute zero point, but for applications that require a specific mechanical zero position, the general *Homing* in the MAC motor can be used. Please consult the chapter *Mechanical Homing, page 50*.

Example 1: **Encoder (quadrature) input.**
An external encoder feeds the MAC motor. The I/O type is set to "Pulse input" and "Input type" is set to "Quadrature" in order to decode the encoder signal. The encoder is connected to the A and B terminals (Multifunction I/O's). See also *Multifunction I/O used as pulse inputs, page 118*.
The resolution of the external encoder is 500 ppr (pulses per rev.).
The MAC motors have 2048 ppr (8192 counts/rev).
If this application requires that the MAC motor rotates 1 rev. each time the external encoder has rotated 1 rev., the *Input* parameter is set to 500 (external encoder) and the *Output* parameter is set to 2048. Now the ratio between the external encoder and the MAC motor will be 1:1. Ensure the "Profile data" is set to proper values in order not to limit motor operation unintentionally.

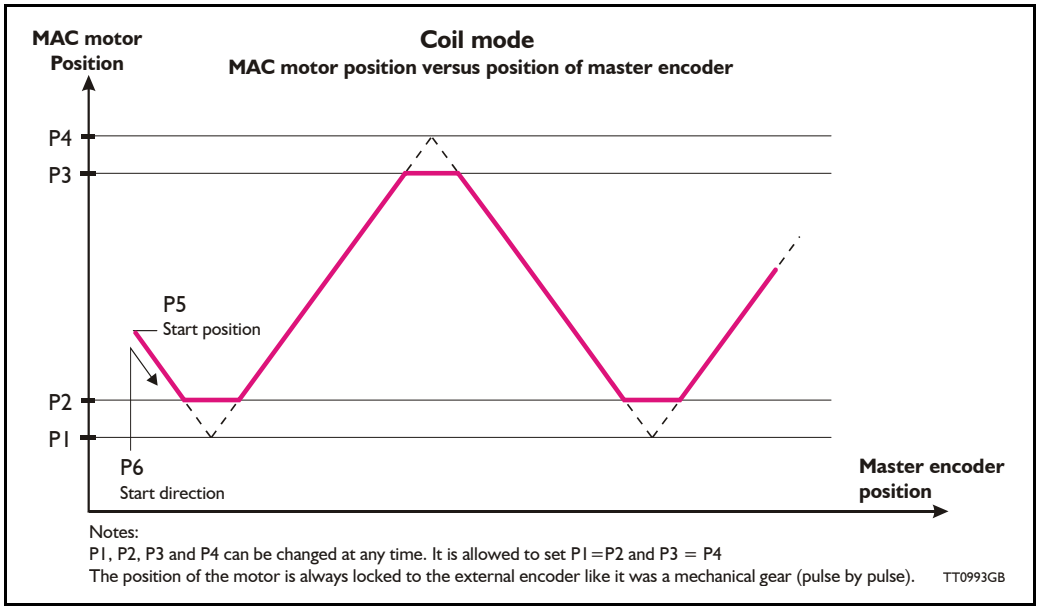
Example 2: **Pulse and direction input.**
A step motor system is replaced by a MAC motor, meaning that the MAC motor receives a pulse and direction signal which is a very common signal format in step motor applications.
The I/O type is set to "Pulse input" and "Input type" is set to "Pulse-direction" in order to decode the input signal. The pulse signal is connected to the A terminals (Multifunction I/O) and the direction signal is connected to the B terminals (Multifunction I/O's).
See also *Multifunction I/O used as pulse inputs, page 118*.
The MAC motor is replacing a step motor system with 400 steps per revolution, which means that when the pulse source produce 400 pulses, it expects the MAC motor to rotate one revolution.
The MAC motors have 8192 cpr. If this application requires that the MAC motor rotates 1 revolution each time 400 pulses are received, the *Input* parameter is set to 800 since the MAC motor detects on both the rising and falling edge of the input signal.
The *Output* parameter is set to 8192 since the number of counts (edges) on the internal encoder is 8192. Now the MAC motor will move 1 revolution if 400 pulses is applied to the pulse input. Ensure the "Profile data" is set to proper values in order not to limit motor operation unintentionally. The following table can be used as guide for setting up typical gear ratio:

Pulse and direction gear ratio setup - "Commonly used ratios"		
Applied number of pulses per MAC motor revolution.	**Input register**	**Output register**
200	400	8192
400	800	8192
500	1000	8192
800	1600	8192
1000	2000	8192
4096	8192	8192
8192 (Same as motor resolution)	16384	8192

3.3 Coil Mode

3.3.1 Coil Mode - overall description

The Coil Mode is similar to gear mode but the position range can be limited in such a manner that the motor changes direction every time 2 predefined limits (upper and lower) are reached. Both limits are fully adjustable. The mode is intended to be used for controlling a wire/cable guider on a winding machine. The guide will follow the position of the coil driven by a "main motor" like it was mechanically connected by a transmission, and by using this mode it is possible to steer the wire to the desired position at the coil, also when the "main motor" changes speed. Since Coil Mode is very similar to Gear mode, it is recommended that the gear mode setup instructions are followed before using the additional features described in this section. See *Gear Mode, page 43*.



When coiling a thick thread compared to the coil, and the number of windings per layer are few, it is preferable to stop the traverse motion while one winding is coiled at the top of the previous winding at the edges. Therefore the edges can be cut off at the positions given by registers P2 and P3, as shown in the illustration above.

When starting a new coil, you must specify the starting position, and the starting direction of the MAC motor to achieve repeatability. The starting position, related to the basic function shown in the illustration above, is given by the value of register P5. The starting direction is given by the value of register P6, which value must be +1 or -1 for either a positive or negative direction.

A typical setup could be:

P1 = 10000	Left position limit of basic function
P2 = 12000	Left cut off position
P3 = 58000	Right cut off position
P4 = 60000	Right position limit of basic function
P5 = 12000	Starting position (at left edge)
P6 = 1	Start traversing right (positive direction)

Positioning at the start position is initiated by setting the analogue input, (AIN), high. When setting this input low, the MacMotor will resume normal coiling function.

The rules for setting up P1 - P6 are:

P1 <= P2 <= P3 <= P4
P1 <= P5 <= P4
P6 = +1 or -1

3.3.2 The gear ratio in coil mode

The gearing ratio must be specified in the exact same manner as GEAR mode, using the Input and Output registers. See *Gear Mode - overall description, page 43*.

3.3.3 Initiating Homing in coil mode

The MAC motor can be set up to make an initiating *Homing* at power up. When using the sensor *Homing* modes, the *Homing* function uses the analogue input as zero sensor input and the coiling function uses the signal to sense the 'go to start position command'. Still the two signals can be coupled in parallel if the *Homing* sensor is activated away from normal working area (Normally open).

In conjunction with the above setup for registers P1...P6, the setup for the *Homing* could therefore be:

Homing type: "Sensor 1"
Homing velocity: -100
Homing position: -2000
Start mode: Coil Mode

Having ended the power-up *Homing*, you must give the MAC motor an initial startposition command before starting the first coil process.

3.3.4 Filter setup in coil mode

Recommended filter setting for this application (using the filter selector).
Please note that the filter setting can also depend on other factors such as the inertia, friction etc. in the actual system.

Current filter: Medium or high.
Position filter: x-y coordinate = 3, 3 (fast, almost hard)
Follow error type: Static, degree = 75%

Remember load factor to finely adjust the LOAD factor (MacTalk main tab).

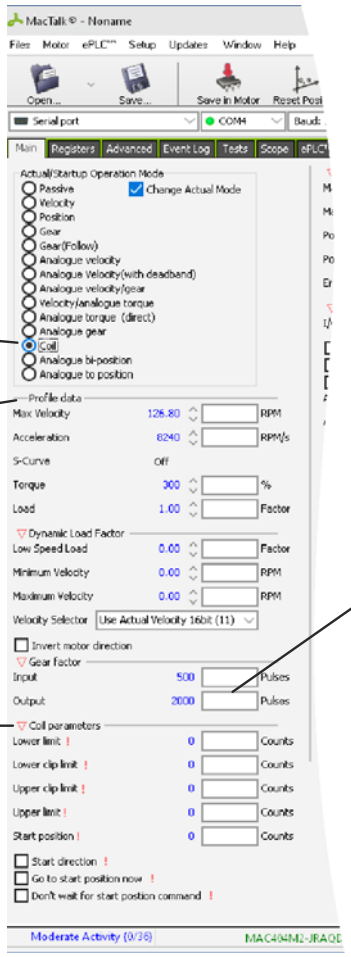
Other settings, (recommended):

- Max velocity: Set limit higher than the normal speed used
- Acceleration: Set high value (example 300000 RPM/sec)
- Torque: 300%
- Gear factor: Set value
- Follow error: 0
- Function error: 0

3.3.5 Register overview in MacTalk

The following screen is shown in MacTalk when selecting Coil Mode.

Main parameters used in coil mode



Startup mode
Choose "Coil mode"

Profile Data
All these parameters can be used to limit the motion. For example the maximum torque or velocity.

Coil mode parameters
Set P1 to P6 in this field according to the description in this chapter.
Also start direction and how to start is set here

Gear factor
The ratio between the incomming pulses and the actual motor movement is specified here.

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The general setup, such as selecting maximum velocity, gear ratio and input type setup, is similar to Gear Mode. Only the Coil Mode parameters differ from Gear Mode.
For details of the overall setup, please See *Gear Mode, page 43*.

3.4 Analogue bi position mode

3.4.1 Analogue Bi-position Mode - overall description

For primitive positioning purposes, the basic MAC motor offers the Analogue bi-position mode. The Analogue bi-position mode offers:

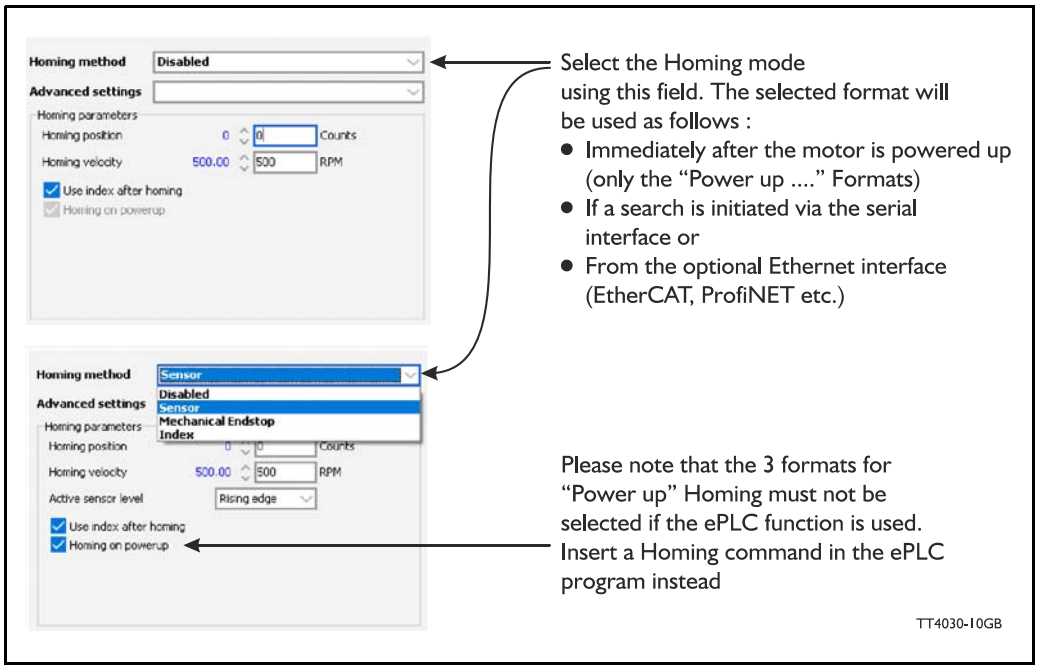
The motor will move a certain distance or go to one of 2 positions depending on the voltage at the analogue input. The voltage at the analogue input will be seen as a digital signal meaning either logic low or logic high.
The distance or positions can be setup in 2 internal registers and saved permanently in the motor.

Concerning the trigger level at the input and how to change please consult *Analogue input, page 114*

3.5 Mechanical Homing

3.5.1 Mechanical Homing modes

In all positioning systems there is a requirement to be able to find a mechanical zero position after the system is powered up or at specific times during operation. For this purpose the MAC motor offers 5 different *Homing* modes which can be selected in the MacTalk main window or by sending a command at one of the serial interfaces.
The 5 different *Homing* modes can in addition be selected to be started automatically after power up of the motor or done by sending a command during normal operation to the motor.



The menu offers 11 choices:

Type	Precision	Ext. sensor needed
Disabled (no *Homing*)	-	-
Power up: Torque	Low	No
Power up: Sensor type 1	Medium	Yes
Power up: Sensor type 2	High	Yes
Power up: Enc. Index	High	No
Power up: Enc. quick index	Medium	No
Torque	Low	No
Sensor type 1	Medium	Yes
Sensor type 2	High	Yes
Enc. Index	High	No
Enc. quick index	Medium	No

3.5 Mechanical Homing

3.5.2 Overall Homing mode descriptions

Disabled (default)
The *Homing* is disabled.

Mechanical Endstop
The *Homing* will start searching for Zero until a mechanical "collision" occurs. The point at which the motor torque is equal to the specified value of the *Homing* torque is defined as the zero position.

Sensor
The *Homing* function will start seeking for Zero until an external sensor is activated. The point at which the sensor is activated is defined as zero.

Index
The *Homing* function will move exactly 1.5 motor revolution and detect where the internal encoder index pulse is detected. The position where the index pulse was found is defined as zero. 4 different settings possibilities. *Standard Forward*/*Reverse* and *Quick Forward*/*Reverse*. *Standard* is more precise but slower than *Quick*.

The following sections explain in detail the functionality of the 5 fundamental *Homing* modes.

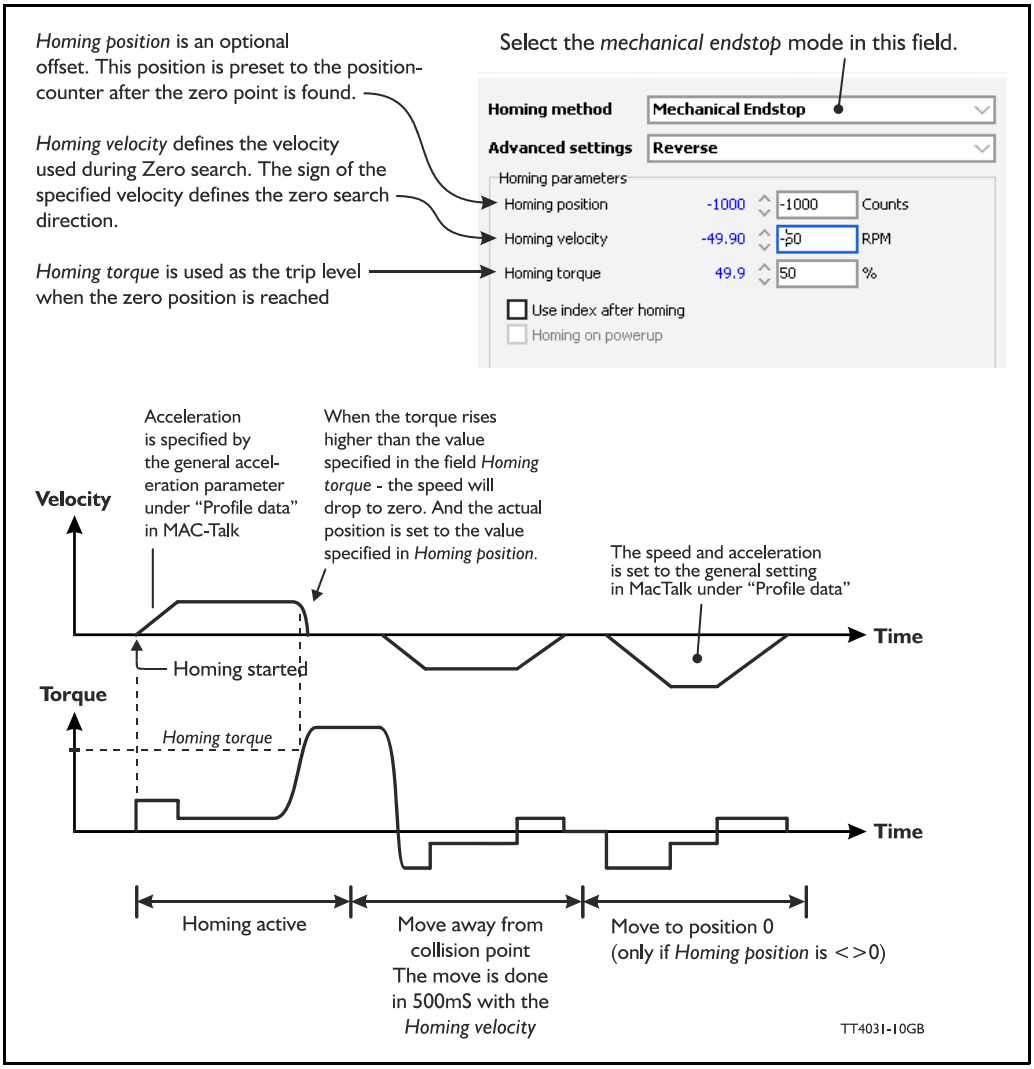
3.5.3 Starting a Homing

If the *Homing* mode is set to *Disabled,* no *Homing* is done at any time.
If *Homing on powerup* is selected *Homing* mode will be executed every time the MAC motor restarted / power cycled.
The *Homing* can also be initiated click on the *Start Homing* button on the *Homing page*.
A similar button is present on the *Tests* page.
A command is also available via one of the serial interfaces.
For more details or see the individual detailed *Homing* descriptions in the next pages.

3.5 Mechanical Homing

3.5.4 Mechanical Endstop

Mechanical Endstop is carried out according to the following illustration.

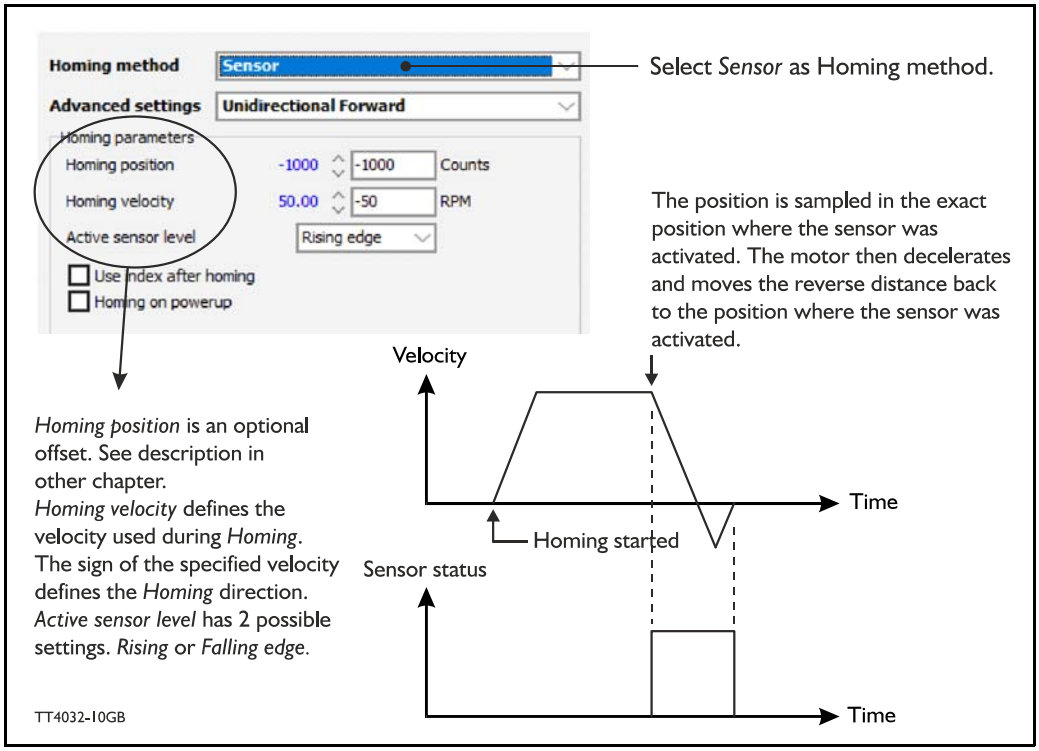


The *Homing* method using a *Mechanical Endstop* as a reference is a cheap, simple way to find the mechanical zero position, but please be aware of following critical points.
- Make sure that the *Homing torque* is set to a proper value higher than the mechanical friction in the system in order to avoid a faulty zero point being found. It is a good idea to let the motor run in velocity mode with the same velocity and observe what the actual motor torque is. This value can be observed in the status area in the right side of the main window. Set the *Homing torque* to a value 10-20% higher than the actual torque observed during this procedure.
- To improve the repeatability precision of the zero point make sure that the mechanical "collision" point is as stiff and well-defined as possible.

3.5 Mechanical Homing

3.5.5 Sensor Homing

Homing using *Sensor* is carried out according to the following illustration.



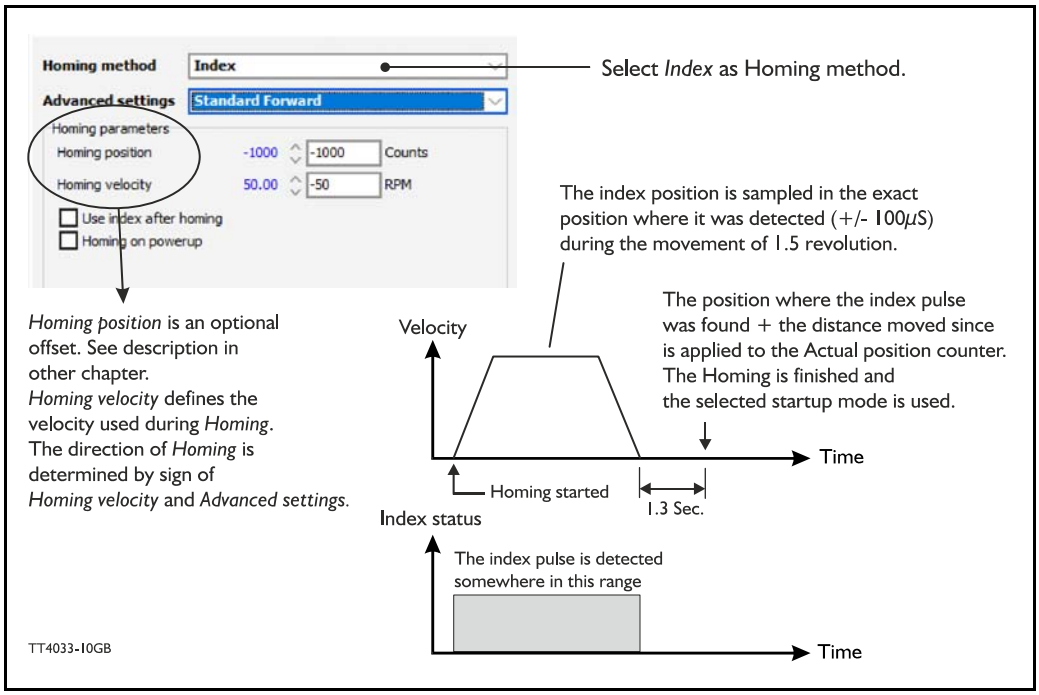
The Zero sensor must be connected to one of the analogue inputs (AIN), which during *Homing* functions as a digital input.
For connection information and electrical specification, see *Analogue input, page 114*.

3.5.6 Index Homing

The internal encoder in the MAC motor also contains a so called index pulse which is a very short (4 counts) distance which is only present (active) one time per motor revolution. For applications where the working range is always less or equal one revolution this pulse can be used as the mechanical zero avoiding having any external sensors involved which simplify the mechanics and the cabling.

This *Homing* mode has four possible settings *Standard Forward*, *Standard Reverse*, *Quick Forward or Quick Reverse*. Standard mode is slower but also with a much better precision since the index pulse is sampled with a tolerance of +/- 100µS but will need a few seconds to do depending on the *Homing* speed and overall acceleration used.

When the *Index Homing* is carried out the motor will be moving exactly 1.5 revolution in total. Then a pause of 1.3 seconds is used to stabilize the motor position and do various calculations.



3.5.7 Homing configuration via motor registers.

When the configuration is done by channels other than MacTalk such as Ethernet, Profibus, CANopen etc. or just a simple interface connection to the basic motor the following description must be followed.

Start the *Index Homing* Standard:
Write the decimal value 25 into the MODE_REG (register 2). This will immediately start the *Homing*. The value is expressed in 32 bits unsigned.

Start the *Index Homing* Quick:
Write the decimal value 26 into the MODE_REG (register 2). This will immediately start the *Homing*. The value is expressed in 32 bits unsigned.

Set the Homing velocity:
Write the velocity value into the register V_HOME (register 40). Notice that the sign will determine the *Homing* direction.
A velocity expressed as 100 RPM must be written as 277 (1 RPM = 2.77). The value is expressed in 32 bits signed.

Concerning setting of *Homing* position see *Making a Zero point offset, page 56*

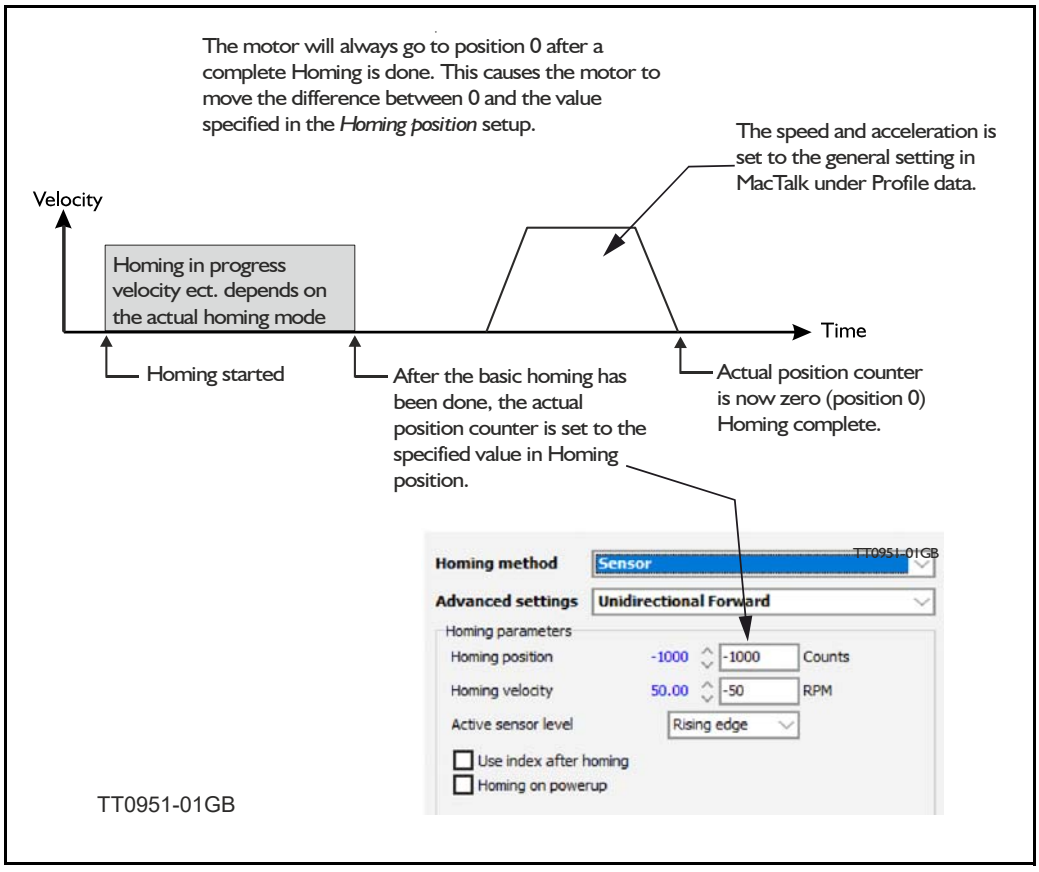
3.5.8 Making a Zero point offset

Common for all the *Homing* modes, it can optionally be chosen to define the zero point as a value other than zero (position 0).
When is it useful to use the zero point offset?
- If it is desired that the position interval under normal operation is always convenient positive values from 0 to +n, instead of a mixture of negative and positive values. This can occur if the zero point sensor is placed a long distance away from the normal positioning interval or inside the normal positioning interval.
- If an automatic move to an initial position is desired after a power-up *Homing*.

The offset value must be specified in the "*Homing* position" field.
The total *Homing* will be performed in following order.

1. The *Homing* is started either automatically (power up) or initiated by command from the interface or via an expansion module.
2. The basic *Homing* is completed and the position counter is set to the value specified in the *Homing position* field.
3. If the *Homing* position value is different from position, the motor will now move to position 0.
4. The *Homing* is now completed and the motor will switch to normal operation which means the mode selected in the "Startup mode" field in the main window.

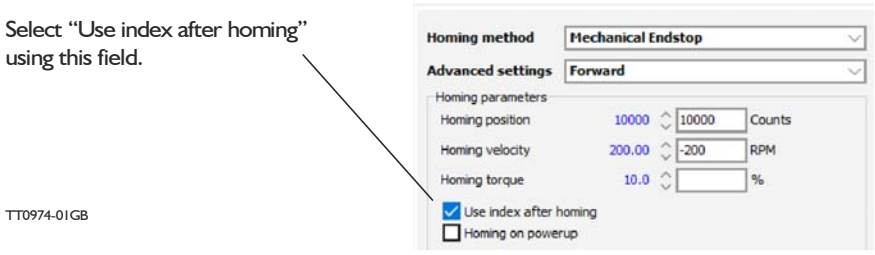
The illustration below shows the complete cycle.



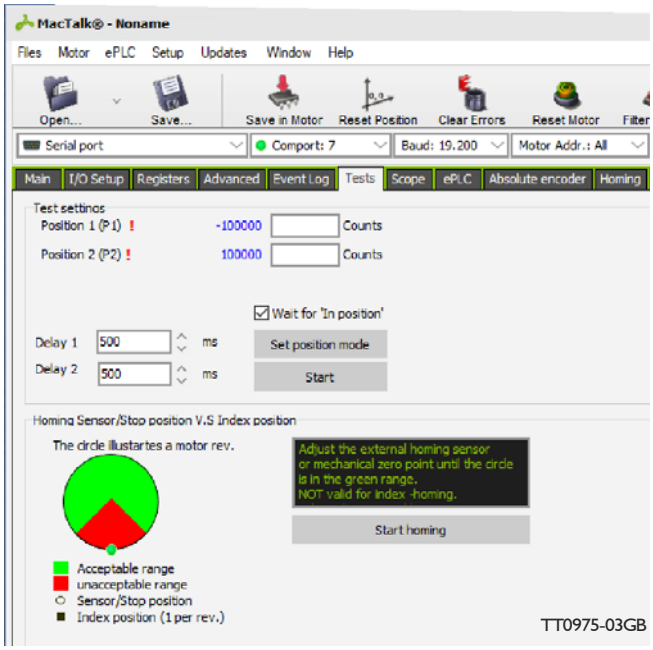
3.5 Mechanical Homing

3.5.9 Find index position after Homing

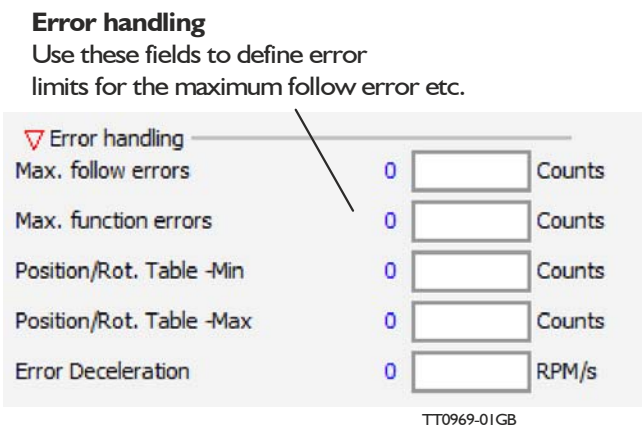
The motor offers 2 unique points per revolution called the index points. These points are found by the internal hall sensors and are always the same.
By enabling *Use index after homing* feature, an extra precise zero point can be defined. This feature is intended to be used if the external sensor does not offer the desired precision. The feature can be used after each of the basic *Homing* modes including the *Mechanical Endstop Homing* mode.
Enable the *Use index after homing* feature in the *Homing* window.



When the feature is selected, it is very important that the external *Homing* sensor is adjusted to the correct position range with a certain margin to the index points to ensure the same index is always found during every *Homing*. If the external sensor is activated too close to the index points, it can cause the motor to finalize the *Homing* with reference to the wrong index point, which in practice will constitute an error of 0.5 motor revolution. Adjustment of the *Homing* point must be done regardless of which of the *Homing* methods is selected.
The illustration below shows the MacTalk ***Tests*** tab which must be used for adjusting the *Homing* point.



3.6 Error messages and error handling



3.6.1 Error messages and error handling

The MAC motor incorporates 5 fundamental parameters used for protection-related purposes. They all have effect regardless of the operation mode the motor is set up to use.

Follow error
It is possible to define the maximum allowable difference between the actual position of the motor and the desired position. Depending on the setting of the servo filter etc., this position difference will change. For protection it can be useful to define that the difference is not allowed to exceed for example 500 counts (the motor has 8192 counts per rev. fixed). If a mechanical collision occurs, the position difference will typically be exceeded and cause a follow error making the motor passive with no further movement. The default is 0, meaning that the feature is disabled.

Function error
Similar to Follow Error but the number of difference counts is only measured from the point where the peak torque is reached, making it impossible for the motor to follow the commanded movement. Default is 0, meaning that the feature is disabled.

Position limit min. and max.
Same as the physical limit switches but performed by software. Default is 0, meaning that the feature is disabled.

Error acceleration
If an unrecoverable error occurs, it can be expedient to use a controlled deceleration instead of a sudden stop. If the inertia in the system is high and the mechanical parts are weak, a sudden stop can cause damage and unintended behaviour. Use this parameter to define the deceleration during an unrecoverable error. Default is 0, meaning that the feature is disabled.

3.6 Error messages and error handling

3.6.2 Monitoring errors and warnings

When using the MacTalk PC-program any error or warning is shown in 'Status' field at the main tab.

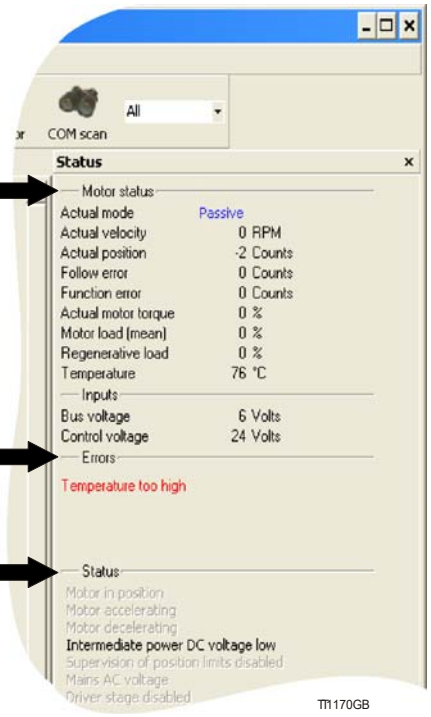
General error and warning monitoring area

In this area actual values for the motor operation is monitored continously. Most of these monitored values will trip a corresponding error message.

Example : The error message 'Overload' will be tripped if the the monitored value 'Motor load (mean)' gets above 99%. Therefore make sure that the value during normal operation have a proper margin to 100%.

Actual error(s) are shown here if any

Warnings and status information are presented here



3.6.3 Error message 'Overload'

The following list show the possible error messages, the cause of the error and possible actions to prevent the error from happening.
Each error can also be monitored by reading the error status register (register 35) by using software packages like the OCX driver or MacRegIO.

Message no. / Message	**I / 'Overload'**
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The calculated accumulated load of the motor and electronics above limit. The actual level of losses can be observed in the 'Motor load (mean)' field (see the screen dump above).
Possible cause of this error	The motor has been loaded above maximum continuous torque rating for too long time, causing a critical internal temperature.
Solutions to avoid error	- Reduce average motor load. - Reduce the speed and/or acceleration. - Adjust servo filter to a stable behaviour during any event. - Make sure that the supply voltage is at the specified level.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 0 / 'I2T_ERR'

3.6 Error messages and error handling

3.6.4 Error message 'Follow error'

Message no. / Message	**2 / 'Follow error'**
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The actual difference between the actual motor position and the intended position is higher than the value specified in the 'Maximum follow error' field in MacTalk.
Possible cause of this error	The motor has been applied too high a load or the 'maximum follow error' value have been set at an unrealistic low value in regards to the actual hardness of the servo filter.
Solutions to avoid error	- Increase the ''Maximum follow error' value. - Adjust the servo filter hardness to a more aggressive value. - Make sure that the torque setting is not limiting the motor movement. - Set the 'Maximum follow error' to 0 (default) which will disable the detection of this error type.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 1/ 'FLW_ERR'

3.6.5 Error message 'Function error'

Message no. / Message	**3 / 'Function error'**
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	If the actual load torque of the motor gets higher than the specified torque setting permits it will cause the motor to slip away from where it is supposed to be. If the number of motor counts missing in this situation gets higher than the value specified in the 'Maximum function error' field in MacTalk it will trigger the 'function error'. If the actual motor torque never reaches the value specified in the 'torque' field this error will never be triggered. The above condition is valid when the motor is operated in Position mode, Bi-position mode, or Analogue to position mode.
Possible cause of this error	The motor has been applied too high a load or the 'maximum function error' value have been set at an unrealistic low value in regards to the 'torque' setting.
Solutions to avoid error	- Increase the 'Maximum follow error' value. - Adjust the servo filter hardness to a more aggressive value. - Make sure that the torque setting is not limiting the motor movement. - Set the 'Maximum function error' to 0 (default) which will disable the detection of this error type.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 2 / 'FNC_ERR'

3.6 Error messages and error handling

3.6.6 Error message 'Regenerative overload'

Message no. / Message	4 / 'Regenerative overload'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The amount of power dissipated in the motors built-in power dump (breaking) resistor is above safe limit. This error is tripped if the 'Regenerative load' is >99%. The regenerative load value can be monitored in the 'Motor status field'.
Possible cause of this error	The returned amount of energy from the motor has been too high. This can typically happen if: - The motor decelerate a large load inertia too fast. - The motor is forced backwards. - The servo filter or 'Load' parameter is not adjusted to a stable motor operation and the motor tends to oscillate causing energy to flow forward and backward from/to the motor. In all situations the motor will start to work as a generator that generate energy backward into the drive electronics.
Solutions to avoid error	- Decrease the load inertia. - Decrease the top speed and/or the acceleration value. - Make sure that the supply voltage is within nominal range in order to leave extra capacity at the internal capacitors.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 3 / 'UIT_ERR'

Error message 5, 6 and 7 do not exist since bits are used for other status purposes.

3.6.7 Error message 'Position Limit Exceeded'

Message no. / Message	8 / 'Position Limit Exceeded'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The actual position of the motor is outside the value(s) specified in the 'position limit min.' or 'position limit max.' specified in the 'error handling' area of the main tab in MacTalk.
Possible cause of this error	The motor has been commanded outside the value(s) specified in the 'position limit min.' or 'position limit max.' registers. Be aware that the error can happen even if the motor is in passive mode and the motor is forced outside this range.
Solutions to avoid error	- Set the position limits described above to more realistic values. - Make sure that the position limits also cover worst case situation such as position overshot (if using a soft filter).
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 7 / 'PLIM_ERR'

3.6 Error messages and error handling

3.6.8 Error message 'Temperature too high'

Message no. / Message	9 / 'Temperature too high'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The temperature has been higher than 84°C (183F) which is not allowed. Please note that this error is only available in MAC400, MAC402, MAC800, MAC1200, MAC1500, MAC3000 and MAC4500 since MAC050-141-A do not include a temperature measurement circuit.
Possible cause of this error	- The ambient temperature is higher than allowed - max is +40°C/104°F. - The motor is build into an environment where it can not dissipate enough heat. - The motor is not mounted on a proper mechanical structure where heat can be dissipated.
Solutions to avoid error	- Make precautions to decrease the surrounding ambient temperature. - Lower the speed and or load on the motor.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 8 / 'DEGC_ERR'

3.6.9 Error message 'Low AC-voltage'

Message no. / Message	10 / 'Low AC-voltage'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The mains supply is not connected or the mains voltage is too low. Please note that this message is only available in MAC400, 402, 800, 1200, 1500, 3000 and 4500 since MAC050-141-A/F do not include AC supply.
Possible cause of this error	- The mains supply is not connected correctly. - The external fuse has blown.
Solutions to avoid error	- Make sure that the external fuse is OK and that the mains supply is connected correctly according to the chapter *Power Supply, page 21*.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power. See also the chapter *Under Voltage Handling, page 70*.
Error bit / Firmware name	Bit 9 / 'UV_ERR'

Error message 11 do not exist since bits are used for other status purposes.

3.6 Error messages and error handling

3.6.10 Error message 'Phase error'

Message no. / Message	12 / 'Phase error'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The motor phase current has been measured to be Out of Range and the motor driver is shut down to prevent permanent failure. Please note that this message is only available in MAC050 to MAC141-A.
Possible cause of this error	- The servo filter (control loop) is unstable. - The motor has been physically blocked. - The motor has been running into a sudden mechanical collision.
Solutions to avoid error	- Make sure that the servo filter is not set to an extreme unrealistic setting compared to the nature of the actual load. See also *Servo filter adjustment, page 71*. - Avoid that the motor during normal operation is meeting a mechanical collision or an extreme overload situation.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 11 / 'IX_ERR'

3.6.11 Error message 'Overvoltage on bus'

Message no. / Message	12 / 'Overvoltage on bus'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The internal bus-voltage has been higher than 450VDC (MAC402: 63V) which is not allowed in order to prevent damages of the motor. Please note that this message is only available in MAC400, MAC402, MAC800, MAC1200, MAC1500, MAC3000 and MAC4500.
Possible cause of this error	- The internal brake resistor is not sufficient to handle the amount of returned energy from the motor. Use an external resistor or if already present lower the value of the resistor. - The mains supply voltage is too high.
Solutions to avoid error	- Make sure that the mains voltage is within specified voltage range. - If this error only happens during a motor movement the error can probably be avoided by connecting an external power dump resistor or decrease the ohmic value if a resistor is already present. See also *Connecting an external power dump resistor, page 25*.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 11 / 'OV_ERR'

3.6 Error messages and error handling

3.6.12 Error message 'UnderVoltage on Bus' (only MAC050 to 141-A)

Message no. / Message	13 / 'UnderVoltage on Bus'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The voltage of the DC power supply has been measured to be lower than the limit selected in the register 'Min voltage'. This has resulted in an error as configured in the setup of 'Under-voltage handling'. See also *Under Voltage Handling, page 70*. Please note that this message is only available in MAC050 to MAC141-A.
Possible cause of this error	- The current rating of the external power supply is too small. - The power supply is not able to deliver the required peak currents that the motor need. This is a typical problem when using switch mode power supply. - The power cable is under dimensioned. - The under voltage min. setting must be decreased.
Solutions to avoid error	- Use a power supply with a higher current rating. - Use a power cable with at least 0,75mm² wires (up to cable lengths of 10m. If the power cable is longer, use 1,5mm² or use multiple wires in parallel. - Connect a capacitor across the supply line close to the motor. Especially if using a switch mode power supply this will help.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 12 / 'UV_ERR'

3.6.13 Error mess. 'Peak error, motor overcurrent' (only MAC404 to 1404)

Message no. / Message	13 / 'Peak error, motor overcurrent'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The motor phase current has been measured to be Out of Range and the motor driver is shut down to prevent permanent failure. Please note that this message is only available in MAC404, 604, 802, 804, 1004, 1202, 1403 and MAC1404.
Possible cause of this error	- The servo filter (control loop) is unstable. - The motor has been physically blocked. - The motor has been running into a sudden mechanical collision. - The actual AC supply voltage is too low to run the motor at the actual speed.
Solutions to avoid error	- Make sure that the servo filter is not set at an extreme unrealistic setting compared to the nature of the actual load. See also *Servo filter adjustment, page 71*. - Avoid that the motor during normal operation is meeting a mechanical collision or an extreme overload situation.
How to return to normal operation	- This error type is not software resetable. Cycle the control voltage (24VDC).
Error bit / Firmware name	Bit 12 / 'IPEAK_ERR'

3.6 Error messages and error handling

3.6.14 Error message 'Overspeed' (only MAC404 to MAC1404)

Message no. / Message	14 / 'Overspeed'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The actual velocity (speed) has been higher than allowed. Please note that this message is only available in MAC400, 402, 800, 1200, 1500, 3000 and MAC4500.
Possible cause of this error	- Velocity too high. - Servofilter is not stiff enough and speed may overshoot during start and/or stop or when sudden load changes happens. This error is triggered at 4300 RPM (MAC404 and MAC604) and 3600 RPM (MAC802, 804, 1004, 1202, 1403 and 1404).
Solutions to avoid error	- Make sure that the velocity setting is within specified range (0-3000 RPM nominal). - Make sure that the servo filter is set to stable setting in order to avoid overshoots during acceleration or similar. See also *Servo filter adjustment, page 71*.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 13 / 'SPEED_ERR'

Error message 15 do not exist since bits are used for other status purposes.

3.6.15 Error message 'SSI Read error' (only MAC050 to 141-A)

Message no. / Message	16 / 'SSI Read error'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	An external SSI encoder has been enabled but communication with the encoder has failed.
Possible cause of this error	- The encoder is not connected correctly. - The format chosen is not compatible with the actual encoder. - Improper cabling have been used.
Solutions to avoid error	- Use proper cabling between the motor and the external SSI encoder. A screened cable with twisted pair wires is recommended. - Make sure that the right SSI format is selected.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the power.
Error bit / Firmware name	Bit 15 / 'SSI_ERR'

3.6 Error messages and error handling

3.6.16 Error message 'Internal Encoder error' (only MAC404 to MAC1404)

Message no. / Message	16 / 'Internal Encoder error'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	A malfunction in the internal encoder has been detected.
Possible cause of this error	- The encoder disc is broken because the motor have been exposed to mechanical shock. Typical the shaft have been hit very hard during mounting of the motor.
Solutions to avoid error	- Do not expose the shaft or the motor for mechanical shocks.
How to return to normal operation	Return the motor for service.
Error bit / Firmware name	Bit 15 / 'INDEX_ERR'

3.6.17 Error message 'Invalid Filter settings'

Message no. / Message	17 / 'Invalid Filter settings'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The servo filter settings are not within valid ranges.
Possible cause of this error	- The setup file used has been corrupted. - The setup file used is an old type not compatible with the actual motor version.
Solutions to avoid error	- Select a new filter or contact your JVL.
How to return to normal operation	- Correct the servo filter setting. See also *Servo filter adjustment, page 71*. - Cycle the 24VDC power.
Error bit / Firmware name	Bit 16 / 'OLD_FILTER'

3.6.18 Error mess. 'Control voltage unstable'

Message no. / Message	18 / 'Control voltage unstable'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	The control voltage (24VDC at the P+ and P- terminals) has been unstable and detected outside the specified voltage range for a too long time.
Possible cause of this error	- The control voltage has been detected outside the nominal voltage range. - The voltage has been applied too slowly with variations.
Solutions to avoid error	- Make sure that the voltage is stable in the specified voltage interval. - Make sure that the voltage is applied in less than 500mS.
How to return to normal operation	- Cycle the 24VDC power. A reset will not clear the error.
Error bit / Firmware name	Bit 17 / 'U24V '

3.6 Error messages and error handling

3.6.19 Error message 'PWM locked'

Message no. / Message	21 / 'PWM Locked'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	An unrecoverable error has occured and the motor output driver is shut down in order to prevent any further damages. This error always takes place in combination with one or more other errors. These errors can be one of following: - *"Peak error, motor over current"* (Bit 12) The motor current has been significantly higher than allowed during normal operation. - *"Internal Encoder Error"* (Bit 15). The internal encoder has a fault. - *"Invalid Filter settings"* (Bit 16). The actual filter used is an old version or corrupted because wrong values have been transferred to the motor. - *"Control voltage unstable"* (Bit 17). The 24V control voltage has been unstable.
Possible cause of this error	This error is always followed by other error messages. See individual description of these errors. See also error condition above.
Solutions to avoid error	- See other error messages that follows this error.
How to return to normal operation	- This error type is not software resetable. Cycle the control voltage (24VDC).
Error bit / Firmware name	Bit 20 / 'PWM_LOCKED'

3.6.20 Error message 'Modbus Com. Error'

Message no. / Message	22 / 'Modbus Com. Error'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	Modbus communication has not been possible due to a communication error.
Possible cause of this error	- The motor is setup as master but it has not been possible to reach a slave motor. - The motor is setup as a slave but do not receive any position information
Solutions to avoid error	- If the actual system is a master/slave configuration, make sure that a slave motor is present. - Make sure that the cabling is made in a proper manner with twisted pair wires and screened cable. - Make sure that the opposite unit in the communication system uses same parameters such as baudrate etc. - Adjust the time out register.
How to return to normal operation	- The error is cleared if error free communication is re-established but the motor need to be re-entered in the desired operation mode. - Try to save actual settings and restart the motor by a reset or cycle the power (24VDC).
Error bit / Firmware name	Bit 21 / 'COM_ERR'

3.6 Error messages and error handling

3.6.21 Error message 'Current loop error'

Message no. / Message	23 / 'Current loop error'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	Error only relevant when using the MAC00-P5 module. The 4-20mA input at the MAC00-P5 module has been detected lower than 2,0mA which is outside normal range.
Possible cause of this error	- Cable fault. - Fault in the external 4-20mA source that feed the MAC00-P5 current input.
Solutions to avoid error	- Check the cable feeding the 4-20mA input. - Make sure that the 4-20mA signal stay at a level higher than 2,0mA.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the 24VDC power.
Error bit / Firmware name	Bit 22 / 'CURLOOP_ERR'

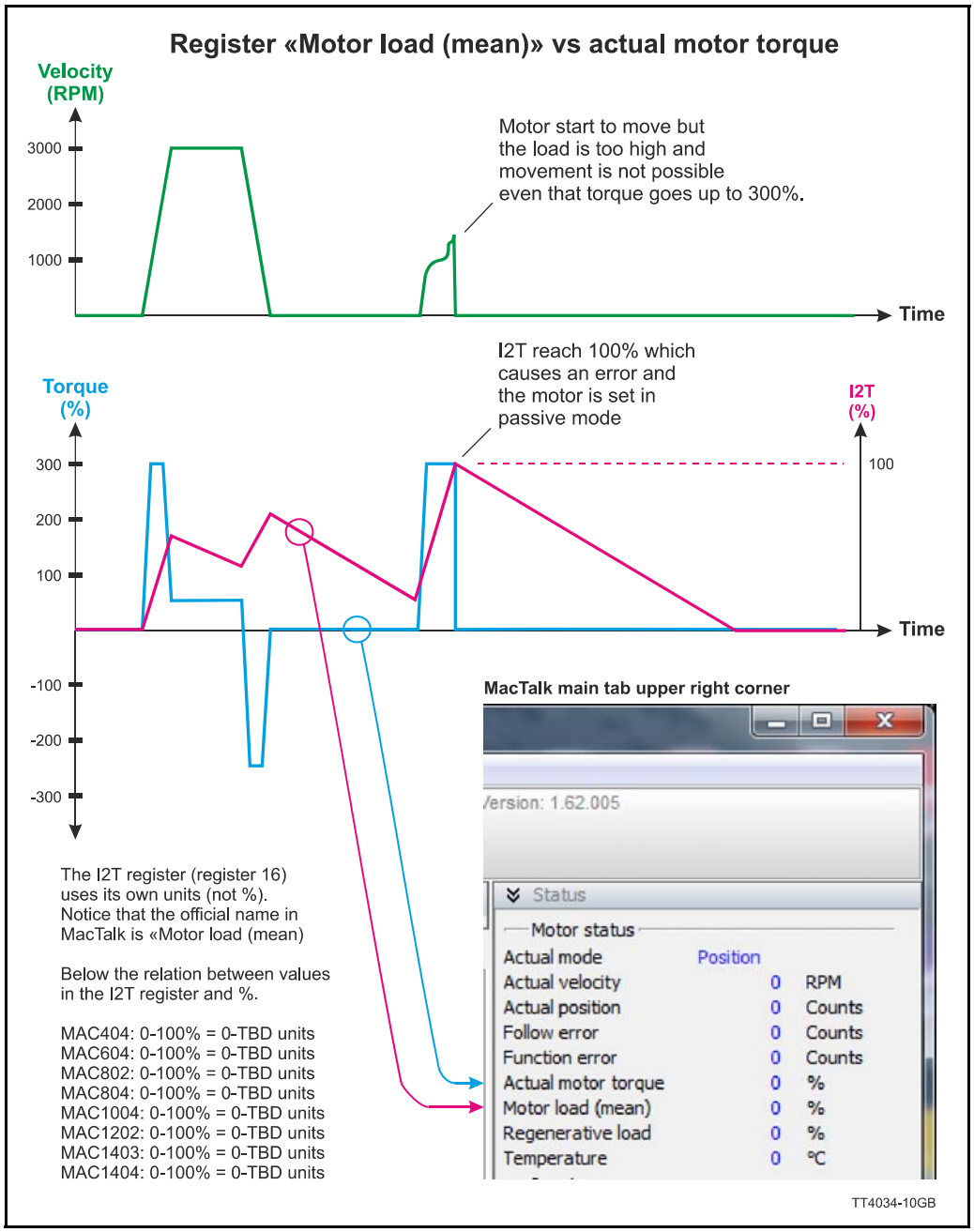
3.6.22 Error message 'Slave error'

Message no. / Message	24 / 'Slave Error'
Type / Motor action	Unrecoverable error / Motor is set in passive mode.
Error condition	- Modbus communication with a slave motor has not been possible due to a communication error. - A connected slave motor has discovered an error. See the slave error register.
Possible cause of this error	- The motor is setup as master but it has not been possible to reach a slave motor. - A connected slave motor has discovered an error. See the slave error register.
Solutions to avoid error	- If the actual system is a master/slave configuration make sure that a slave motor is present. - Make sure that the cabling is made in a proper manner with twisted pair wires and screened cable. - Make sure that the opposite unit in the communication system uses same parameters such as baudrate etc.
How to return to normal operation	- Reset the motor, clear the error bit(s) in register 35 or cycle the 24VDC power.
Error bit / Firmware name	Bit 23 / 'SLAVE_ERR'

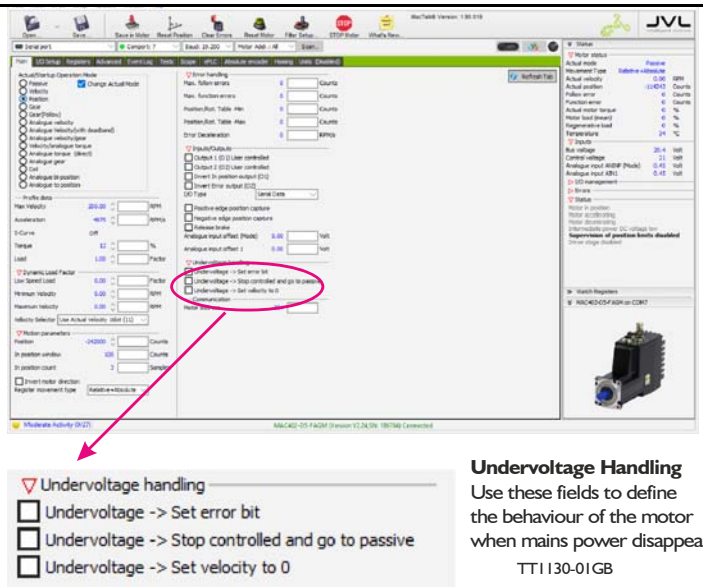
3.7 How to monitor motor torque and load

3.7.1 Monitoring motor torque and load

All the MAC motors contain a register that continuously is updated with the actual motor load integrated over some time.
The register is called I2T (melt integral) - the name in MacTalk is “Motor load (mean)”. The motor can produce up to 300% torque as long as the I2T register do not reach 100%. If it reaches 100% the motor will go in passive mode and an overload error is reported. The I2T register can also be useful to monitor the load over time to see if mechanics starts to have an unintended higher friction compared to the installation date.



3.8 Under Voltage Handling



Undervoltage Handling
Use these fields to define the behaviour of the motor when mains power disappear.

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3.8.1 Undervoltage handling

The MAC motor offers the possibility to define the behaviour during and after the mains-voltage disappear. This situation could for example be during an emergency stop which causes the mains supply to be cut while the control voltage is still applied to the motor. 3 options exist:

3.8.2 Undervoltage -> Set error bit

Default = Off.
If this option is selected an under voltage will be handled like an error situation and the corresponding error bit will be set. The motor is stopped using the “error deceleration’ before the motor is switched to passive mode, like any other error situation.
When the main power is re-applied the motor will stay in passive mode and report and under voltage error. To get the motor back in normal operation the error must be cleared and a operation mode must be selected.
If this function is activated it will have first priority and the error deceleration will be used compared to the 2 other options “Undervoltage -> Stop controlled and go to passive” and “Undervoltage -> Set velocity to 0” which both uses normal deceleration.

3.8.3 Undervoltage -> Stop controlled and go to passive

Default = Off
This option makes the motor decelerating according to the normal acceleration parameter and go to passive mode when the mains power is removed. When main power is re-applied the motor stay in passive mode. To get the motor back in normal operation an operation mode must be selected.

3.8.4 Undervoltage -> Set velocity to 0

Default = Off.
This option simply just set the velocity to 0 causing the motor to decelerate and stay stationary (except in “torque direct mode”) when mains power is removed. The velocity setting will stay at 0 also after the main power is re-applied. A velocity value (>0RPM) must be written into the velocity register to get the motor moving again.

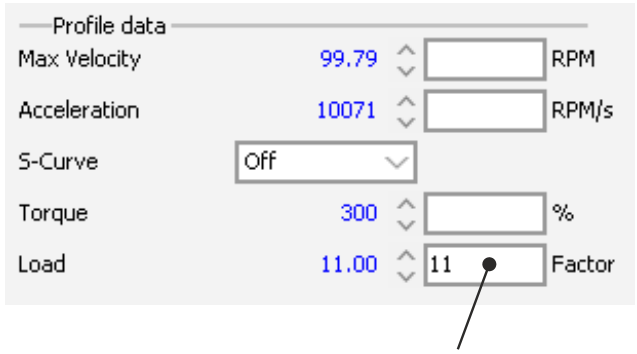
3.9 Servo filter adjustment

3.9.1 Servo filter adjustment

The MAC motor contains a higher-order digital filter regulation core. The purpose of the filter is to ensure that the desired speed, torque and/or position are achieved and secondly that stability is obtained.
The motor's default setting (when delivered) is normally appropriate for most applications. The only necessary adjustment is the *LOAD* parameter which is available via the *Main* setup in the MacTalk software. For more demanding applications, the *Filter selector* can be used.

3.9.2 Adjusting the LOAD parameter

The LOAD parameter must be increased proportional to the inertia of the payload in the system. The default value of the LOAD parameter is 1.0000.
The proper LOAD value must be determined as follows.
LOAD=(Motor inertia+Load inertia)/Motor inertia.



Adjust **Load** according to the attached inertia.

Example:
A system uses a MAC1004. The MAC1004 has a motor inertia of 1.8kg/cm² (according to data in appendix).
If the inertia of the payload attached to the motor is 18kg/cm² (motor intertia x 10) the Load needs to be adjusted to LOAD=(Motor inertia+Load inertia)/Motor inertia
LOAD=(1.8 + 18) / 1.8 = **11**

If the load inertia is not fully known, it is highly recommended to slowly increase the LOAD parameter until the motor starts to be unstable and noisy. Then decrease the value 20-30% to obtain a certain safety margin. Remember to save the adjustment permanently in the motor by pressing the "Save in Motor" button.

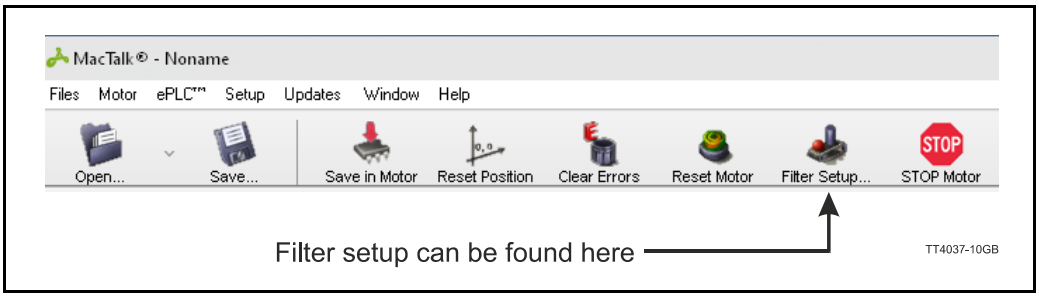
3.9.3 Exceptions when adjusting LOAD

Precautions must be taken if the transmission from the motor to the load is elastic or involves a certain amount of backlash. A typical situation where precautions must be taken is when using a belt drive actuator, since the motor's forces may have to be transmitted past a gear, for example, and then the belt until the payload is finally met. This "transmission chain" is typically very elastic and the gear will contain a certain amount of backlash. The main problem is that the motor does not directly "see" the final payload.
When the motor starts to rotate, it will not "sense" the payload before the backlash distance is passed and the belt is tightened. It is therefore not a linear system and the LOAD cannot be increased as much as in theory.

3.9 Servo filter adjustment

3.9.4 Filter selector basics

If the desired motor response cannot be achieved using only the LOAD parameter, the filter selector can be used.
The filter selector can be found in the MacTalk upper toolbar.

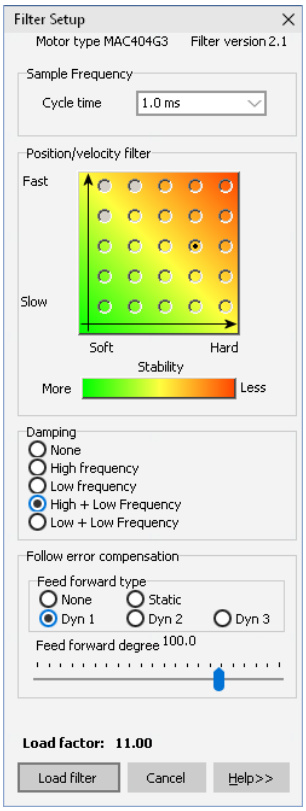


Using the Filter selector, the "personality" of the motor response can be optimised to specific applications. The following overall behaviour can be adjusted:

- Follow error during movement and/or when the motor is stationary.
- Stability with a high load inertia.
- Stability if the load inertia changes during operation.
- Motor noise

The function and options in the filter selector is the same for the complete MAC motor range MAC404, 604, 802, 804, 1004, 1202, 1403 and 1404.

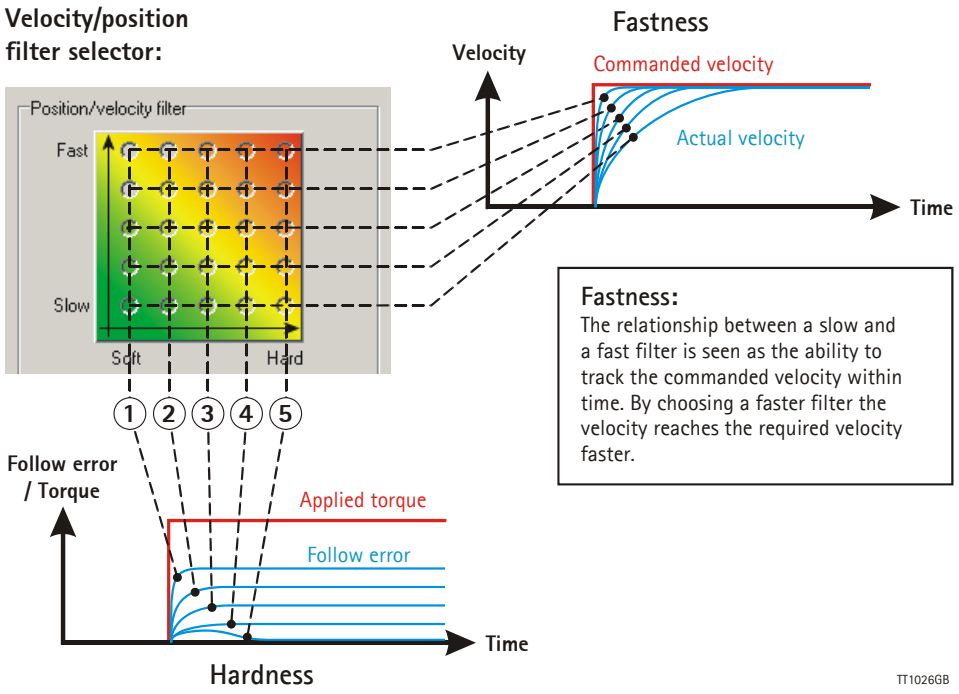
Filter setup dialog:



3.9 Servo filter adjustment

3.9.5 Adjusting the Position/Velocity filter

The Position/Velocity filter is the main filter which sets up the main response performance of the motor.



Fastness:
The relationship between a slow and a fast filter is seen as the ability to track the commanded velocity within time. By choosing a faster filter the velocity reaches the required velocity faster.

Hardness:
The follow error is decreased by choosing a harder filter but the stability is also decreased.
The 5 levels of hardness will affect the motor torque in the following manner.
In case of certain follow error the torque is integrated up to 300% (full torque).

300% motor torque is produced when these follow errors are present:
Column 1 : Follow error of 8000 counts
Column 2 : Follow error of 2000 counts
Column 3 : Follow error of 500 counts
Column 4 : Follow error of 125 counts
Column 5 : Follow error of 1 count (no error is accepted)

3.9 Servo filter adjustment

3.9.6 Damping

In almost any application it can be useful to damp (suppress) certain oscillations.
The damping selector can be used for this purpose.
The following damping types are available:

- **None**
  Damping feature is disabled.

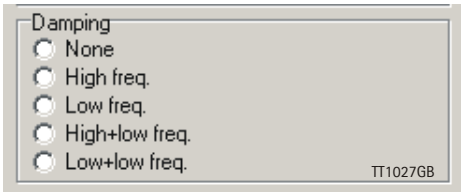
- **Low frequency**
  When selecting *Low frequency*, oscillations caused by a poor mechanical transmission can be reduced. Poor mechanical transmission means backlash in the coupling or elastic toothbelts, etc. The filter becomes more tolerant to variations in the inertia which normally can cause the motor to become unstable.

- **High frequency**
  When selecting *High frequency,* oscillations at higher frequencies will be reduced. This can typically occur if the filter starts to oscillate at a frequency related to the sample frequency. Often this can be heard as an audible noise.

- **High+Low frequency**
  This is a combination of High and Low frequency settings.

- **Low+Low frequency**
  This setting is similar to Low frequency but adds extra tolerance to variations in the inertia.

Damping selector:



3.9 Servo filter adjustment

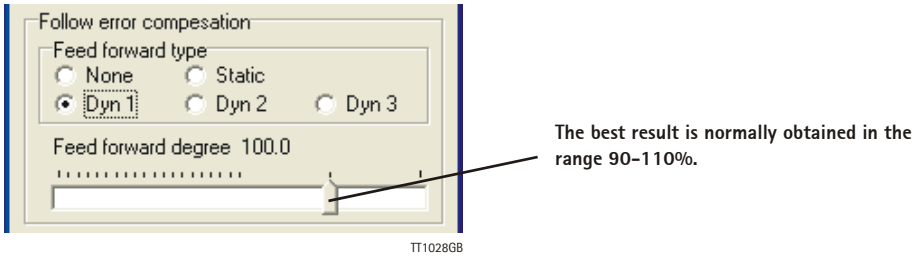
3.9.7 Follow error compensation

This feature makes it possible to achieve a minimum position error during movement (dynamically). The 2 main types are:

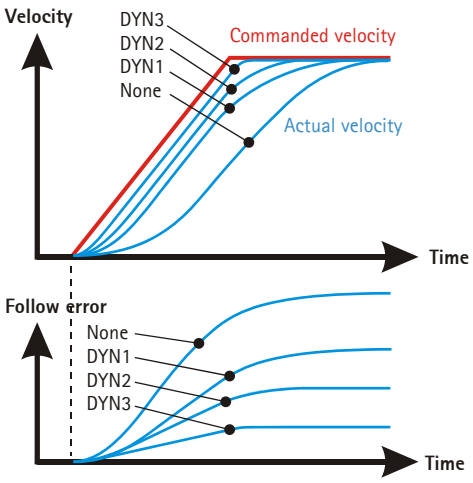
- **Static**
  Will reduce follow error at constant speed, which can be useful for electronic gear applications since the motor will follow exactly what is demanded without any position error.

- **Dynamic**
  Will reduce follow error during acceleration or deceleration (speed changes). This feature is intended to be used for applications which require that a commanded speed or target position is reached as fast as possible but without any overshoots etc. The Dynamic compensation provides 3 levels (Dyn 1 to 3). Using a higher Dyn number, the filter order is increased and better performance may be possible, but will depend on the actual application.

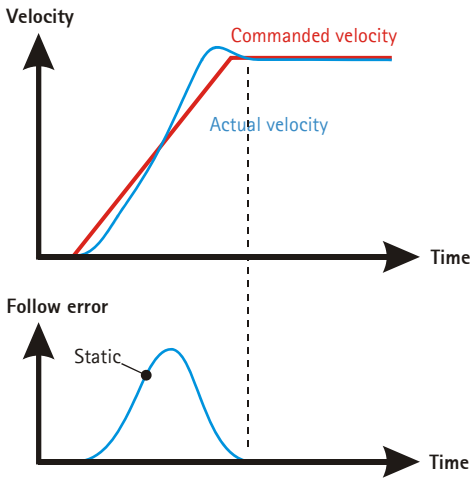
Follow error compensation:



Dynamic follow error compensation



Static follow error compensation



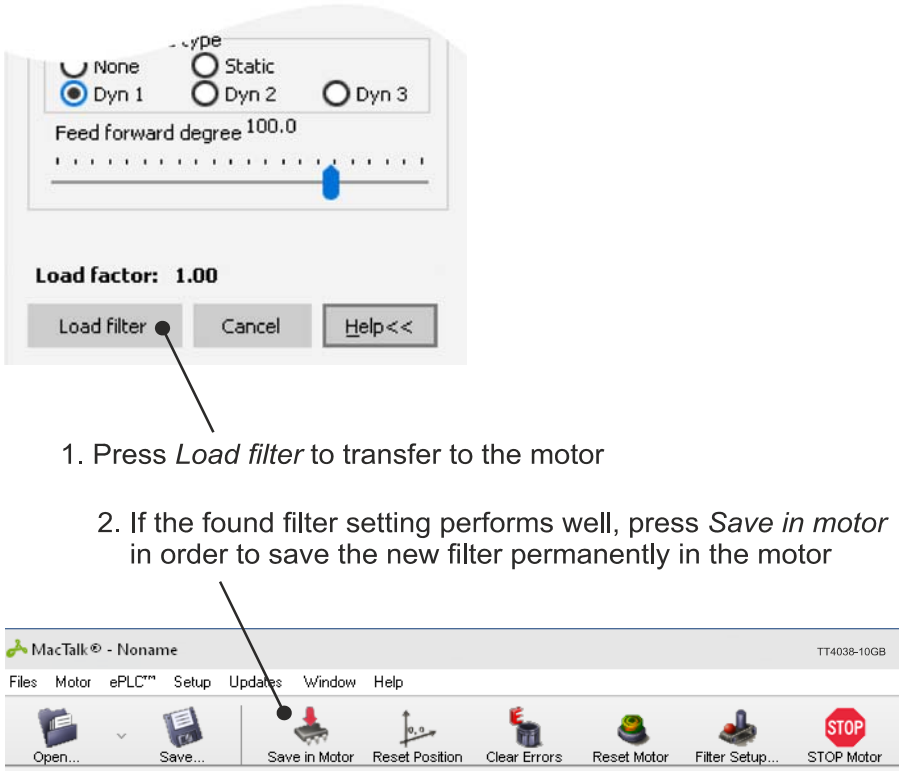
Please note that if one of the 5 slowest main filters has been chosen, the dynamic compensation level *Dyn 3* NOT available.

3.9 Servo filter adjustment

3.9.8 Transferring and saving the filter

After setting the filter choices, the filter can be transferred to the motor.

Transferring and saving the filter setting:



The complete setup including the filter configuration can also be saved to and later recalled from file by using the *Open* and *Save* buttons in the toolbar.

3.9.9 Additional adjustment

Now the desired filter is set up in the motor and the performance can be tested. Further improvement may be required and typically it may be necessary to experiment in order to obtain an optimum result.
Please note that the LOAD parameter must still be used to adjust the inertia ratio between the motor and load. See also *Adjusting the LOAD parameter, page 71*.

3.10 Absolute Multi Turn Encoder

Only MACxxxx-yy-Hzzzzzz and MACxxxx-yy-Jzzzzzz

3.10.1 Introduction

The Absolute Multi Turn encoder is an **option** for the MAC404, MAC604, MAC802, MAC804, MAC1004, MAC1202, MAC1403 and MAC1404 motors.

The option offers the advantage that once the mechanical zero point is defined there will be no need for any *Homing* or initialization sequence after power up since the motor always knows where it is with reference to the original defined zero point regardless that power have been removed for shorter or longer time.

Please notice that **ONLY** MAC motors with the "H" og "J" extension contains this feature (MACxxxx-yy-Hzzzzzz or MACxxxx-yy-Jzzzzzz).

The built-in Multi Turn Encoder is using an energy harvesting technology with the advantage that no battery is used to hold the position after power off. A battery needs replacement after a certain operating time or a certain number of charging and recharging cycles. In other words the used technology in the MAC motors, is a maintenance free solution.

3.10.2 Absolute Multi Turn encoder resolution

The total position range for the encoder is 32 bits which include single and multi turn information. This gives:

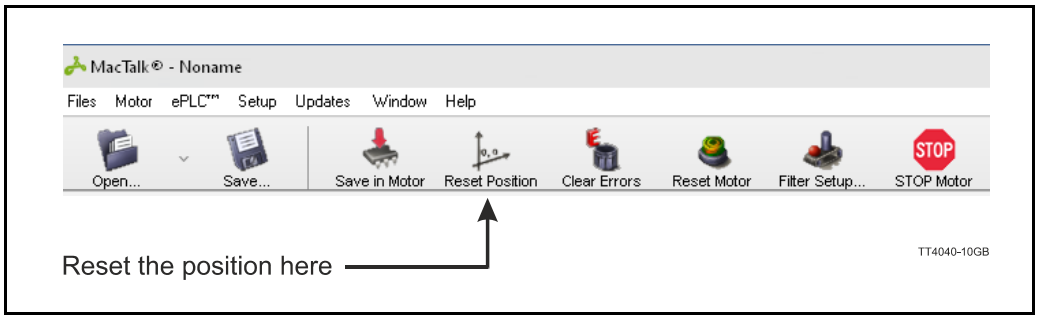
13 bits single turn information = 8192 counts per revolution and
19 bits multi turn information = ±262144 revolutions.

3.10 Absolute Multi Turn Encoder

Only MACxxxx-yy-Hzzzzzz and MACxxxx-yy-Jzzzzzz

3.10.3 How to setup the mechanical zero point.

When the mechanical system is at the desired "0" point position (Home) the position counter can be reset to 0 by using the *"Reset Position"* bottom in the MacTalk program.



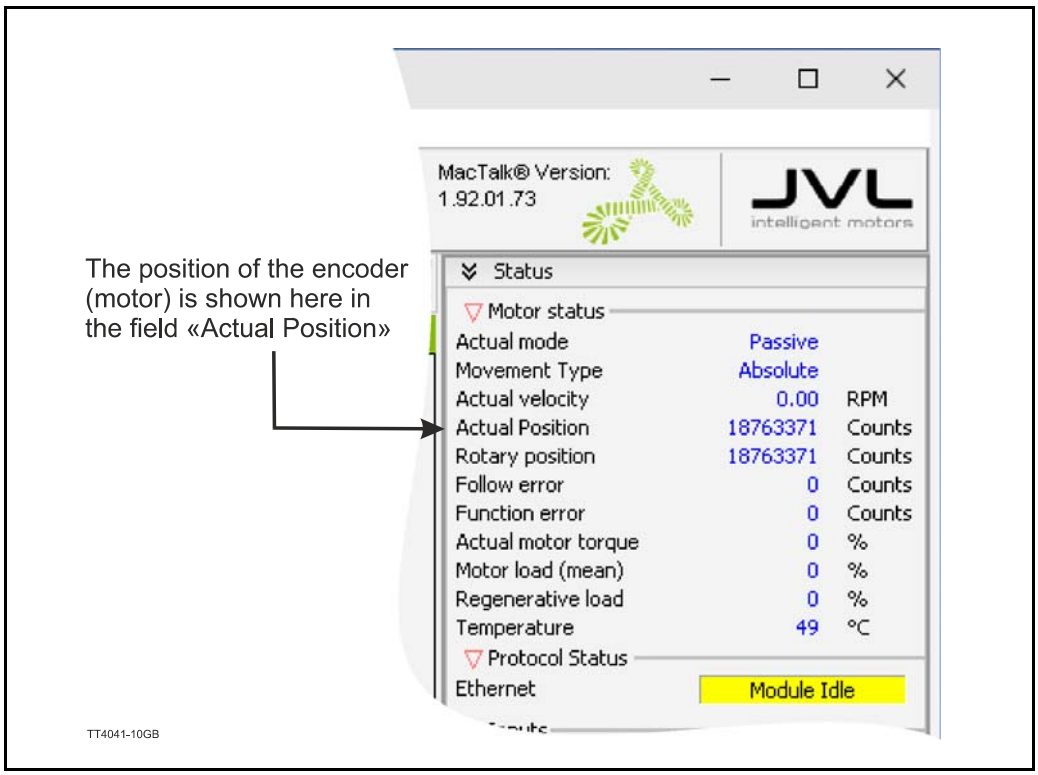
Procedure for adjusting the zero point:

1. Mount the motor in the application and move it to the intended mechanical zero position where the actual position register should be 0.

2. Press the *"Reset Position"* button to reset the *"Actual position"* (P_IST). The actual position counter is now saved permanently to this new position (0).

3.10.4 How to read out the actual position.

The actual encoder (motor) position is always available in the main tab of MacTalk. See below.



3.10 Absolute Multi Turn Encoder

Only MACxxxx-yy-Hzzzzzz and MACxxxx-yy-Jzzzzzz

3.10.5 Resetting or presetting the position when NOT using MacTalk.

The procedure for resetting or presetting the *"Actual position"* counter is as follows.

When the configuration is done by channels other than MacTalk such as over Ethernet, CAN-open etc. or just a simple interface connection to the basic motor the following description must be followed.

The *"Actual Position"* register is available as follows.

Register 10, Actual Position.

The register is a read and write register which means that it can also be overwritten with a new value that will be remembered also after power have been removed from the motor.

Please notice: Do not write to the Actual Position register - register 10 during motor movement since it can cause the value in the position counter to be very unprecise and accumulate an un-intended deviation in position.

3.10 Absolute Multi Turn Encoder

Only MACxxxx-yy-Hzzzzzz and MACxxxx-yy-Jzzzzzz

3.10.6 Extended encoder operation - endless relative moves.

In some applications the motor keeps moving in one direction with a certain length per move.
Since the position counter have a limited working range this kind of operation will sooner or later cause an overflow/wrap around situation.

To avoid the overflow/wrap around situation the actual motor position can be offset via a command. This offset can be done at any time without losing any position information.

This feature is very helpful since the position counter will stay inside the working range.

Follow this setup sequence for doing a relative position offset:

1. To specify the offset distance write the desired offset distance (counts) to register 4 (P_NEW).

2. To actually offset the position value, one of the following actions can be done
   - Write 248 to register 211 (COMMAND) or alternatively...
   - Set bits 6 land 8 in register 36 (CNTRL_BITS) without changing the other bits.

This will add the value given in point 1 above to both the actual position and the target position.

To actually perform a relative movement, there are two safe options and one not so safe/ precise.

Option 1, relative moves using P_SOLL.

1. Prepare for relative movement using register 3 (P_SOLL) by executing FastMac command 117 (96+21). This only has to be done once after start up. It selects what will happen when a position register, one of P1 through P8, is activated by a FastMac command.
2. Prepare the relative distance to move by writing it to one of the general purpose P1 through P8 position registers.
3. Execute a FastMac command that 'activates' the Px register. See the section for your specific MAC00-xx interface module on how to execute FastMac commands.

This type of relative movement will set P_SOLL (target position)= P_IST (actual position)+ Px in a safe way that avoids the type of error described in option 3 below. Note that P_SOLL and P_IST will sooner or later exceed the operating range if this method is used repeatedly, so you will need to use the relative position offset method described for the absolute encoder in Extended Encoder operation.

Option 2, relative moves using P_FNC.

1. Prepare for relative movements using P_FNC by executing FastMac command 118 (96+22). This only has to be done once after start up. It selects what will happen when a position register, one of P1 through P8, is activated by a FastMac command.
2. Prepare the relative distance to move by writing it to one of the general purpose P1 through P8 position registers.
3. Execute a FastMac command that 'activates' the Px register. See the section for your specific MAC00-xx interface module on how to execute FastMac commands.

This type of relative movement will not change P_SOLL, so no wrap-around handling is needed.

3.10 Absolute Multi Turn Encoder

Only MACxxxx-yy-Hzzzzzz and MACxxxx-yy-Jzzzzzz

Option 3 (the unprecise one):
Write a value to the target position register 3 (P_SOLL) that is the actual position plus/minus the distance to move. This is unsafe/inaccurate because the actual position may have changed in the time it took to read the value, do the calculation and write back the new target position. This may still work on some applications, or even be desirable, but note that a position error might accumulate over time.

In some applications, it may be useful to prepare several position distances in the different P1 through P8 registers, and then activate them using different FastMac commands.

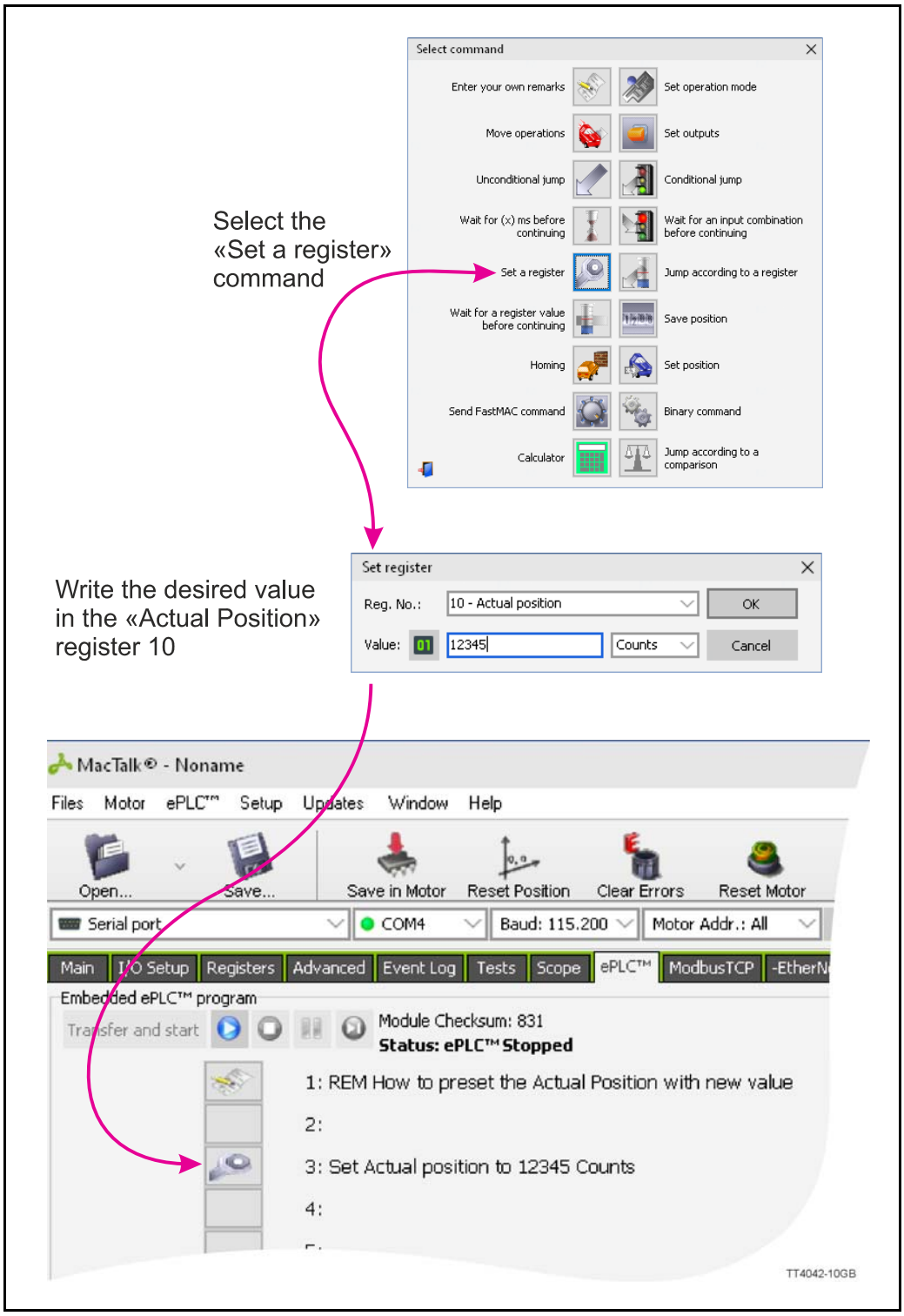
3.10 Absolute Multi Turn Encoder

Only MACxxxx-yy-Hzzzzzz and MACxxxx-yy-Jzzzzzz

3.10.7 ePLC programming - Resetting or presetting to new position.

If a ePLC program is resetting the encoder zero point or another position must be preset into the register, it can be done as follows.

1. Select the “Set a register” command
2. Select register 10 - “Actual Position” and type the desired new value
3. Press OK and the command will be inserted in the ePLC program ready for execution.



3.11 Electro Mechanical brake

Only MACxxxx-y5-zzzzzzz and MACxxxx-y6-zzzzzzz

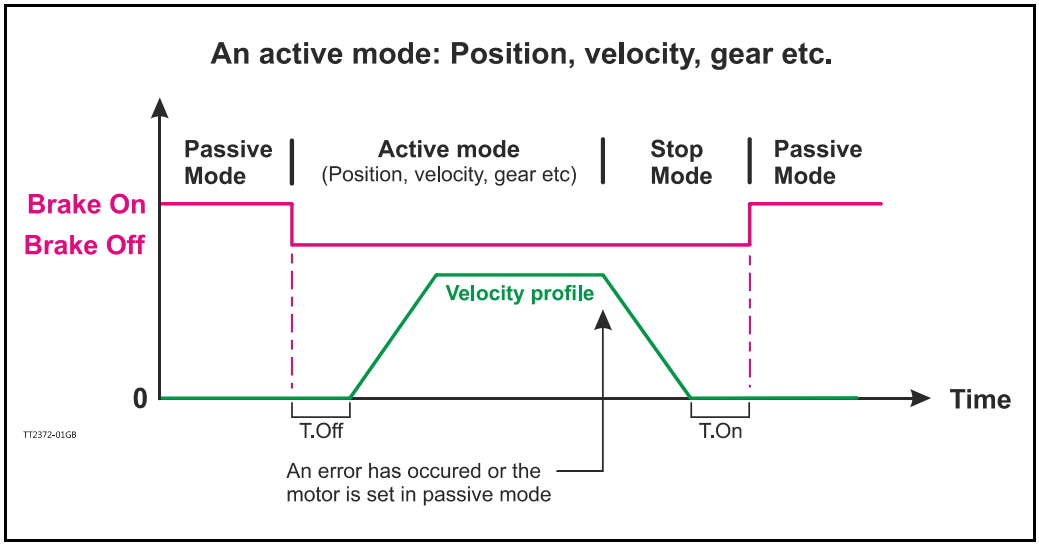
This section is only for MAC motors with the -5 or -6 brake option.
The motors will have the number **MACxxxx-y5-zzzzzzz** or **MACxxxx-y6-zzzzzzz**

3.11.1 Brake Introduction

The motor can be equipped with a electro mechanical brake to hold the position in Passive mode and power off situations where the motor has no torque. This is often desired to keep mechanics in position for example if it's a vertical movement.
The brake control always takes care that the brake is activated (hold the motor) if a situation occurs where the motor is not powered and therefore can slip away from the desired position.
This will typically be in situations like when the motor is in Passive mode or an error has occurred which will cause the motor to be power less and not able to keep its position in a controlled manner.
No involvement from users side is needed to activate and de-activate the brake.

3.11.2 Brake timing

The brake is always active in Passive mode because the motor has zero torque. When changing to an active mode, the standby current is applied and the brake is disabled. The brake needs some milliseconds to release and therefore there will be a short delay (typically ~40 ms) before the motor can move. The brake is always off in active modes.
When changing to Passive mode the motor goes into Stop mode to decelerate according to the "Deceleration"-ramp. When "Actual velocity" is 0, the brake is activated and also here a short delay makes sure that the brake is active before the motor goes passive.
The "Deceleration"-ramp is determined via the "Error Deceleration" if set to a value different from 0. Otherwise it will use the "Acceleration" value set i register 6 as "Deceleration.



3.11.3 Brake register

Setting bit 7 in Reg. 36 makes it possible to disable the brake, so that the motor can run freely regardless which mode or condition the motor is in.

3.12 Rotary table option

3.12.1 General description

The Rotary table option, also sometimes called Dividing head, Indexing table or turntable option, makes the motor work in three different ways that limits the actual position and target position to a smaller position range than normal. This is useful for supporting some mechanical systems.

One of the strong features of this is the motor's ability to calculate the shortest movement to a new target position automatically.
The option can also be used to have the motor always move in the same direction for any target position value even if the new target position value is below the old position in this case the motor will turn in the configured CW or CCW direction until it returns to the lower target position.
The actual position will not overflow even when always running in the same position for any length of time.

The general idea is to define a range of positions by a Minimum and a Maximum value that can be freely selected within the normal position range of the motor (-67 million count to + 67 million counts). Whenever the actual position exceeds the maximum it will wrap around and continue from the minimum position while still running in the same direction.

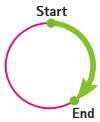
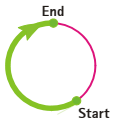
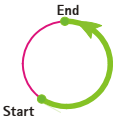
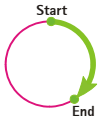
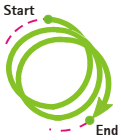
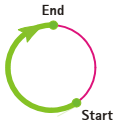
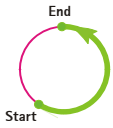
Also when moving below the minimum position it will wrap around and continue to count down from the maximum position.

During operation the motors main operation mode is usually set to Position mode (MODE_REG = 2), and the motor is commanded to a new target position by writing a new value to the Target Position, register 3, P_SOLL. See also - *Modes other than Position mode, page 89*

The value written to P_SOLL should be within the rotary table position range. If the value is outside the working range specified by *"Turn table pos. min."* or *"Turn table pos. max"* it will be clipped to be within the values specified by *"Turn table pos. min."* or *"Turn table pos. max"*. To make a full turn in CW or CCW mode, a multiturn operation is supported see following illustration. The registers normally used for software position limits are used to define the rotary table working range in rotary table operation.

3.12 Rotary table option

The 5 operation options for the Rotary Table operation are shown in the following scheme:

Basic setup: Working range min./max= 0 to 7999 counts equal to one revolution. Examples based on MAC800	**Situation 1**	**Situation 2**
1 Singleturn CW rotation	 Setup : Start position 0 Target postion = 3000	 Setup : Start position 3000 Target postion = 0
2 Singleturn CCW rotation	 Setup : Start position 0 Target postion = 5000	 Setup : Start position 5000 Target postion = 0
3 Shortest path	 Setup : Start position 0 Target postion = 3000	 Setup : Start position 0 Target postion = 5000
4 Multiturn CW rotation	 Setup: Start position 0 Target postion = 19000 Result: P_SOLL = 3000 since the remainder after 19000 / 8000 is 3000.	 Setup : Start position 3000 Target postion = -1000 Result: Actual position (P_SOLL) =0 since the value is limited to the working range minimum
5 Multiturn CCW rotation	 Setup : Start position 5000 Target postion = 12345 Result: Actual position (P_SOLL) = 7999 since the value is imited against the working range maximum	 Setup: Start position 0 Target postion = -21000 Result: P_SOLL = 5000 since the remainder after 21000 / 8000 is 5000. TT1186GB

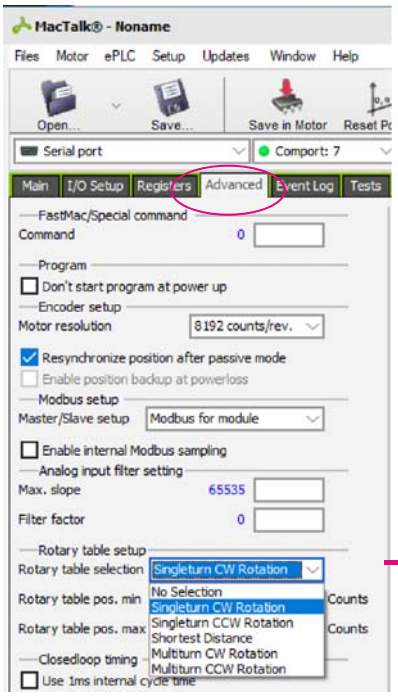
Note 1: In general, Actual position (P_SOLL) will be modified to be within the valid rotary table position working range if a value outside this range is written to the Actual position register (P_SOLL).

Note 2: When using the multiturn options (4 and 5) the position is limited as follows:
- Multiturn CW rotation (4). Values below working range minimum are limited to the minimum.
- Multiturn CCW rotation (5). Values above working range maximum are limited to the maximum.

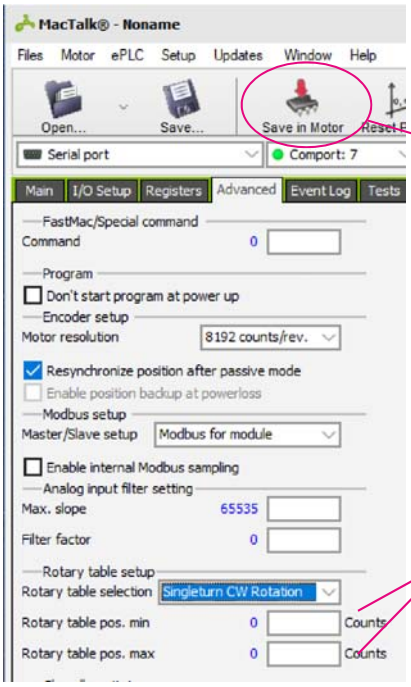
3.12 Rotary table option

3.12.2 Configuration via MacTalk.

When using MacTalk for configuration the following parameters are used:



The desired *Rotary table selection* is selected here at the *Advanced* tab.



After the setup is done please remember to save it in the permanent memory by pressing the *Save in Motor* button.

The working range can be defined here after selecting the type of turn table mode. Minimum is the lowest position possible to reach and maximum is the highest position that can be reached. Both in encoder counts. Both values are refering to the zero position found during the optional *Homing* or alternatively the zero point defined if using an absolute multiturn encoder.

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3.12.3 Configuration via motor registers.

When the configuration is done by channels other than MacTalk such as Ethernet, Profibus, CAN-open etc. or just a simple interface connection to the basic motor the following description must be followed.
The main rotary table operation is selected by bits 24 and 25 in Register 39, HW_SETUP. An addition the option to support multiturn rotary table operation is selected by bit 26 in

Register 39, HW_SETUP.
Register 28, MIN_P_IST
Holds the minimum position for the rotary table working range.

Register 30, MAX_P_IST
Holds the maximum position for the rotary table working range.
Note that the firmware will swap the min. and max. values if the minimum is larger than the maximum at start-up.

Register 39, HW_SETUP
Bits 24, 25 and 26 only. The value of bits 25 and 24 define the rotary table options:

Bit 26	Bit 25	Bit 24	Operation selected
0	0	0	No Rotary table operation (normal motor operation with full position range)
0	0	1	Always CW rotary table operation.
0	1	0	Always CCW rotary table operation.
0	1	1	Shortest path rotary table operation.
1	0	0	Illegal setting.
1	0	1	Always CW rotary table operation with multiturn operation.
1	1	0	Always CCW rotary table operation with multiturn operation.
1	1	1	Illegal setting.

Bit 26 in register 39, HW_SETUP, select the multiturn operation. This bit is used only with the CW and CCW operations and allows complete turns to end at the same mechanical position as it started from by specifying a target position, P_SOLL, that lies outside the rotary table position range. For instance, if the working range is 0 - 7999 (a range of 800 valid positions, one full motor shaft revolution on the MAC800/1200) and the current target position is at 3000 writing 11000 (3000 + 8000) will make the motor perform exactly one full turn and leave both P_SOLL and P_IST_TURNTABLE at 300 afterwards.

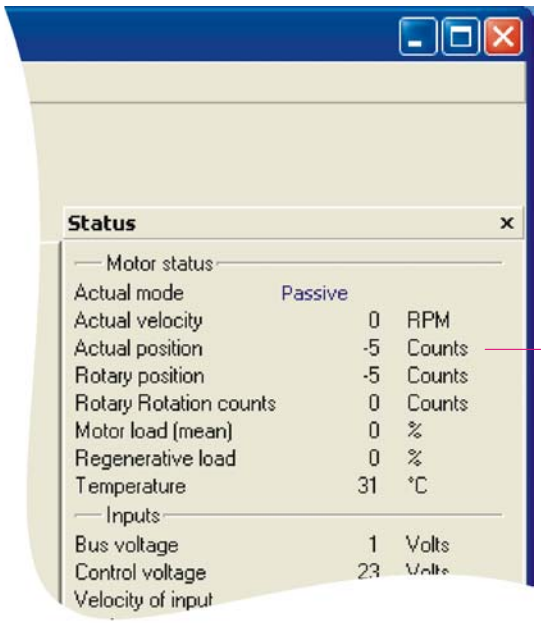
In general, P_SOLL will be modified to be within the valid rotary table position working range if a value outside this range is written to P_SOLL.

Important: Please remember to save the setup in permanent memory (Save in Motor) before the setup is applied and used by the motor.

3.12 Rotary table option

3.12.4 Status read out via MacTalk.

When status read out is done via the MacTalk program data is presented as follows:



"Actual position" is indicating the position and stays within the min. and max. limits defined.

3.12.5 Status read out via motor registers.

When status read out is done by channels other than MacTalk such as Ethernet, Profibus, CAN-open etc. or just a simple interface connection to the basic motor the following description must be followed.

Register 25, P_IST_TURNTABLE

Holds the actual position within the rotary table working range.

Register 27, TURNTAB_COUNT

Is a counter that keeps track of wrap-arounds since the last reset of the motor. This register can be written to another value by the user at any time.

Register 10, P_IST

Is still the 'real' actual position 'inside' the motor but should generally not be used in rotary table operation. P_IST will be modified by the firmware as a result of writes to P_SOLL.

3.12.6 Rotary table notes

- Start up positions.

Normally the motors will start up with a zero value in P_IST and P_SOLL when using a standard encoder or with the position read from an absolute encoder (possibly offset by the P_OFFSET register).

In case the rotary table position range does not include the start up value, the start up value is modified by adding or subtracting N times the number of valid position in the rotary table position range until it is inside this range.

- Valid position range.
Whenever the motor needs to perform a wrap-around it moves the value of P_IST outside the valid rotary table position range.

For normal operation, without multiturn:
When operation *"Always CW"* is selected P-IST can temporarily be moved up to one full working range below MIN_P_IST.
When operation *"Always CCW"* is selected P-IST can temporarily be moved up to one full working range above MAX_P_IST.

With Shortest Path , P_IST can be moved both one full working range above MAX_P_IST or below MIN_P_IST.
When setup for operation as either *"Multiturn CW rotation"* or *"Multiturn CCW rotation"* the number of ranges P_IST can temporarily move outside the working range depends on the value written to P_SOLL and will be the number of full turns required plus one. This is important to keep in mind if it causes P_IST to exceed the motors absolute position working range of -67 million to + 67 million.

- Modes other than Position mode
With the HW_SETUP bits 24 and/or 25 set main motor modes other than Position mode also work slightly different.

The software position limits do not cause the motor to go into Passive mode if/when P_IST exceeds any of these limits.

Register 25, P_IST_TURNTAB is still updated to show the actual position relative to the rotary table position range - even while P_IST gets outside MIN_P_IST or MAX_P_IST.

One common way to do manual adjustment of the motor is to make a JOG function by using Velocity mode. After a JOG function the P_IST may be left outside the rotary table position range, so switching back to Position mode may cause the motor to move 'unexpectedly'. It is generally recommended to set the maximum velocity V_SOLL, to zero when exiting a JOG operation and update P_IST and P_SOLL to desired values before setting V_SOLL back to a non-zero value.

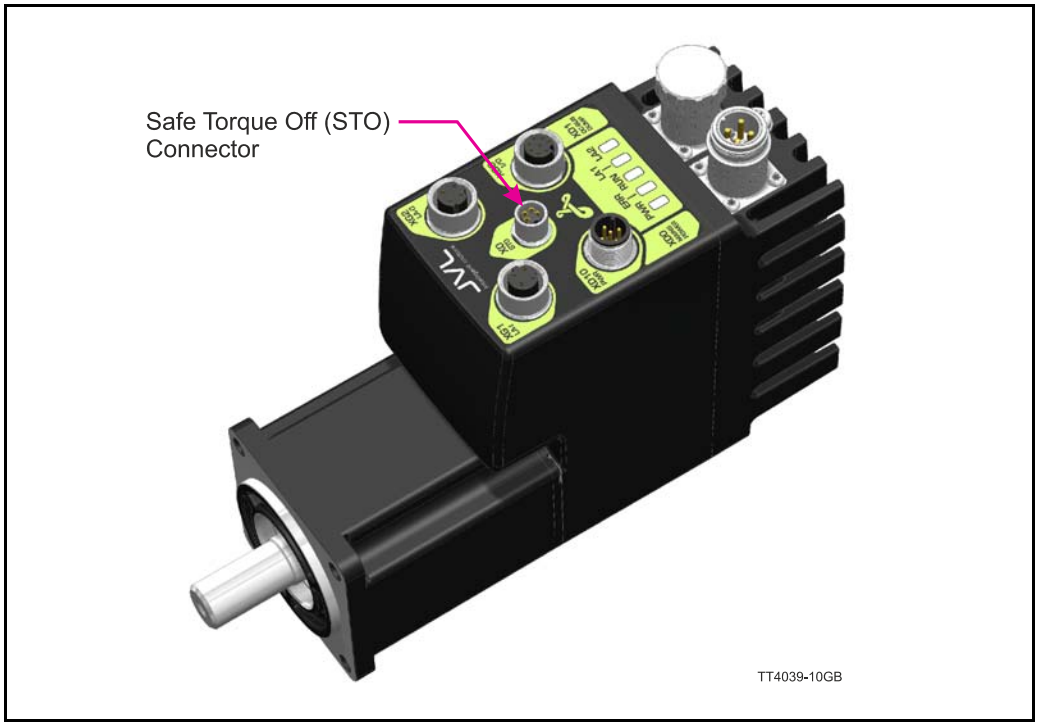
3.13 Safe Torque Off (STO)

Only MACxxxx-yy-zRzzzzz

3.13.1 Introduction to the STO function.

The STO function can be used for disabling the energy to the motor. The motor will thereby be set in a state where it produces no torque.
The STO function have its own input connector mounted at the top of the motor.
It is a 2 input system (redundant) and it is required that both inputs are activated (applied with a voltage) before the motor is energized and can operate normally.
The STO option is available at MAC404, 604, 802, 804, 1004, 1202, 1403, and 1404.

The STO input connector is placed as shown below. The illustration is based on the MAC404 motor but the STO connector is placed similar at the other MAC motors mentioned above.



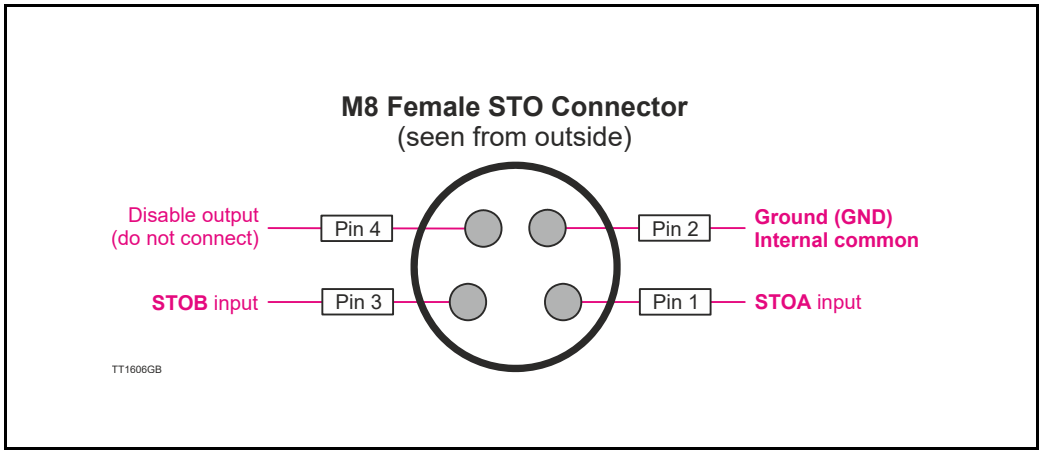
Important general information:

- The STO function is not approved by any third party laboratory (only pending)
- Please notice that removing the energy from the motor by use of the STO function do not necessarily stop the motor rotation since any attached load inertia will have an influence when the movement is stopped fully.
- The person that install and service the motor must have a general knowledge concerning electrical equipment and safety functions.
- The STO function is considered as functional and reliable for 20 years.

3.13.2 How to connect and use the STO function

The STO connector is a 4-pin M8 female.

The STO connector contains the 2 enable inputs STOA and STOB. Both inputs must be applied nominal +24VDC in order to energize the motor and make any motor movement possible.
If only one of the inputs is not applied +24VDC the internal STO circuit will immediately remove the energy from the motor.
The illustration below shows the pin-out of the connector.



3.13.3 Disabling the STO function.

If the STO function is not needed the plug JVL type ***WI1010-M08M4STO*** must be inserted in the STO connector.
The need of this external plug to disable the STO function is to obtain a high safety level and make sure that no misunderstandings will occur concerning whether the STO function is active or not.

3.13.4 STO cabling.

JVL offers a standard 5m long cable with 4-pin M8 connector in one end and flying leads in the other end.
The part no. is ***WI1010-M08M4T05P***

3.13.5 Behaviour of the motor operation if STO is activated

When one or both of the STO signals are removed it will forces the motor in passive mode and an STO error will be shown.

The motor will be forced into passive mode (motor not energized) fully independently of any software function or operation mode it was in just before the STO signal(s) were removed.

Also the bus voltage readout will show a bus voltage of exactly 100VDC which indicates that the STO has been activated.

3.14 Silent mode

3.14.1 Introduction

For applications where it's required that the motor is very silent the "Silent Mode" can be used.

Normally a MAC motor can be slightly noisy because the controller that controls the motor current is setup to a very responsive and dynamic behaviour in order to control the motor movement very fast and precise.
The drawback of this is that the motor will generate a certain extend of audible noise.

By activating the Silent mode, the current controller is simply set to a less responsive and dynamic behaviour. Also the efficiency and peak torque is lowered a bit especially at higher velocities.
The motor will therefore react in a slower manner which is often not a problem if the feature is enabled only when the motor is at a standstill.

The feature is available from firmware release 2.21.

Please notice that only following motor types that support the Silent mode MAC402, MAC1000, MAC1200, MAC1500 to MAC4500.
Following are NOT supported: MAC050-141 Gen.1., MAC400 and MAC800

3.14.2 How to enable Silent Mode

The internal register 246 (bits 7:4) is used to enable and adjust the degree of noise reduction.
Please note that the other bits in this 32 bit register are used for other purposes so avoid overwriting these since this can cause unexpected behaviour of the motor.
The Silent Mode setup is saved similar to other registers by using "Save in Motor"

Register 246 - SETUP_BITS2

TT1600-01GB

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

Bit 31 - 8 and Bit 3 - 0: Is used for other purposes - do not overwrite these bits

Bit 7 - 4: Silence degree

Value (hex)	Function / Influence
0 (default)	Silence mode disabled - normal motor function
1	Silence mode enabled level 1 - Minimum noise reduction
2	Silence mode enabled level 2
3	Silence mode enabled level 3
4	Silence mode enabled level 4
5	Silence mode enabled level 5
6	Silence mode enabled level 6
7	Silence mode enabled level 7
8	Silence mode enabled level 8
9	Silence mode enabled level 9
A	Silence mode enabled level 10
B	Silence mode enabled level 11
C	Silence mode enabled level 12
D	Silence mode enabled level 13
E	Silence mode enabled level 14
F	Silence mode enabled level 15 - Maximum noise reduction

At the moment its not possible to control the silent mode from the MacTalk.

(Continued on next page.)

3.14.3 Changing PWM frequency

An additional improvement in noise can also be done by changing the PWM frequency. This improvement is however, mostly relevant at the larger motor sizes MAC1500 and up to MAC4500 since they use a PWM frequency at 5kHz as default.
The background noise from 5kHz can be very audible depending on how the motor is mounted.

The following motors support this feature:
MAC1500, MAC3000 and MAC4500.

In all other motors this feature have no effect.

The PWM frequency can be changed according to following steps.

1. Start writing -7777777 (decimal) to register 204 - SERIAL_NUMBER.
   This is a key that opens for the possibility to change the PWM frequency.

2. For changing the PWM to 10kHz write 0x1051 (hexadecimal) to register 211, COMMAND_REG.
   For changing the PWM to 20kHz write 0x1052 (hexadecimal) to register 211, COMMAND_REG.
   For changing the PWM back to 5kHz write 0x1050 (hexadecimal) to register 211, COMMAND_REG.

The PWM frequency setting can not be saved permanent in the motor.

Please note that the power dissipation and thereby the motor temperature will increase by changing the PWM frequency.
Make sure to run tests in the actual application to be sure that the motor temperature is kept at a reasonable level in order to avoid too early temperature errors.

At the moment it is not possible to control the PWM frequency from the MacTalk program.

3.15 High resolution velocity

3.15.1 Introduction

This feature offers the possibility to obtain 2 things:

1. The motor velocity and acceleration can be set with a 64 times higher resolution than normally.

2. The positioning range is expanded to full 32 bits.

3.15.2 Function description

Traditionally, the JVL MAC motors have used an internal resolution 16 times higher than the physical encoder resolution of 8000/8192 pulses per revolution.
This allows the user to select target/maximum velocity and acceleration with a 16 times higher resolution.
However, some applications need an even higher resolution than the default resolution for the motors

This feature offers 1024 times higher velocity resolution than the physical encoder.
This can be accomplished by setting a bit in the setup bits register.
This will have the following effects:

1. The Velocity registers get a 64 times higher resolution.
2. The Acceleration registers get a 64 times higher resolution.
3. The valid position ranges in Position and Gear modes are expanded from +/-67million counts to +/- 2147 million counts.
4. The internal Position registers get a 64 times higher scaling.
5. The internal Position registers change from 32 bit to 64 bit.

The following paragraphs list more details, including all registers affected.
The scaling of the Actual Velocity and Actual Position registers are NOT changed and has the same resolution regardless if the high resolution velocity is enabled or not.

To get an idea of the improvement in resolution, the following two tables show how many RPM one count in the Target Velocity registers means for supported sample times and encoder resolutions. Values are in RPM per count:

The formula is RPM/Count = (sample_frequency_in_Hz * 60) / (encoder_resolution * (1024 or 16)).

Classic resolution (default):

Sample time	**Sample frequency**	**Encoder resolution** (RPM/count)	
		Encoder used 8000 CPR	Encoder used 8192 CPR
1.0 ms	1000 Hz	0.468750000	0.457763671
1.3 ms	769.23 Hz	0.360576562	0.352125901
2.0 ms	500 Hz	0.23437500	0.228881835
2.6 ms	384.61 Hz	0.180288281	0.176062950

Note: Only MAC800-1200 in some versions are available with 8000 CPR encoder. All other motors are with 8192 CPR encoders.

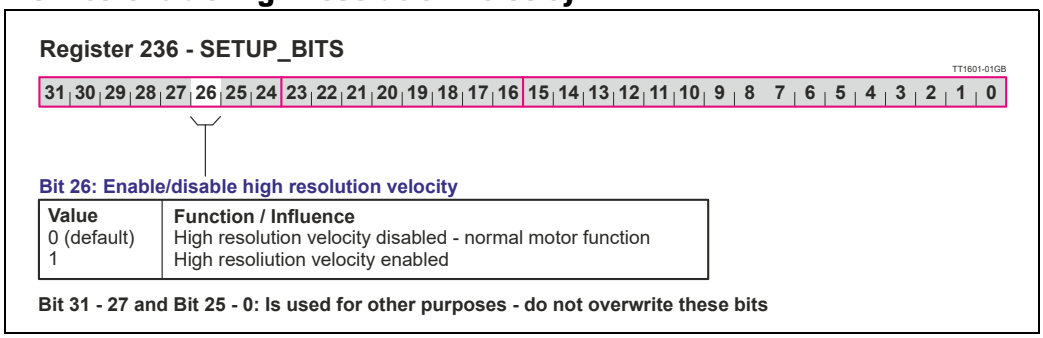
3.15 High resolution velocity

High resolution:

Sample time	Sample frequency	Encoder resolution (RPM/count)	
		Encoder used 8000 CPR	Encoder used 8192 CPR
1.0 ms	1000 Hz	0.007324218	0.007152557
1.3 ms	769.23 Hz	0.005634014	0.005501967
2.0 ms	500 Hz	0.003662109	0.003576278
2.6 ms	384.61 Hz	0.002817007	0.002750983

Note: Only MAC800-1200 in some versions are available with 8000 CPR encoder. All other motors are with 8192 CPR encoders.

3.15.3 How to enable high resolution velocity



The general, simple way of using this option is to set bit-26 (value 0x4000000) in register 236, SETUP_BITS, and then Save in Motor.
After a following reset, the target velocity and acceleration registers then work with 64x higher resolution compared to the default resolution.

For example, to set a velocity of 3000 RPM using a sample time of 1.0 ms and an encoder resolution of 8000 PPR, set register 5, V_SOLL, to 3000/0.007324218 = 409600 counts.

It is strongly recommended to keep the bit either set or cleared during entire operation in the application.
If the bit changes when the motor is in an active mode, this will result in corrupted positions. However, it is possible to change the bit without saving to flash or performing a reset. This should ONLY be done when the motor is in Passive mode.
One of the consequences of using high-resolution velocity, acceleration is that the internal position register 8, P_FNC, gets to be a 64-bit value, and will occupy both register numbers 8 and 9. The INDEX_OFFSET register traditionally in register 9 is then moved to register 277. It is recommended to avoid writing directly to P_FNC when in high-resolution mode, but instead set it indirectly through FastMac commands and Control Bits that calculate it from other register, like Register 4, P_NEW.
P_FNC is primarily used in relative movements.
Please be aware of marginal rounding differences between classic mode and high-resolution modes. This can mean some applications must be fine-tuned to reach the same maximum velocity and acceleration.

3.15 High resolution velocity

The following registers are influenced by bit-26 in register 236, SETUP_BITS:

Register number	Short name	MacTalk name	Description, when in high-resolution mode:
5	V_SOLL	Max Velocity	Scaled 64 times higher
6	A_SOLL	Acceleration	Scaled 64 times higher
8	P_FNC	Internal Position	64-bit, Scaled 64 times higher – low word
9	P_FNC_HI	Internal Position	64-bit, Scaled 64 times higher – high word
9	INDEX_ OFFSET	Index position	Moved to register 277 in high-resolution mode
28	MIN_P_IST	Position/ Rot.table -Min	Unchanged scaling, operation range 64x higher
30	MAX_P_IST	Position/ Rot.table – Max	Unchanged scaling, operation range 64x higher
32	ACC_EMERG	Error Deceleration	Scaled 64 times higher
40	V_HOME	Homing Velocity	Scaled 64 times higher
43	P_REG_P	-	Activated Px register can use full range
44	V_REG_P	-	Activated Vx register must be scaled 64x higher
45	A_REG_P	-	Activated Ax register must be scaled 64x higher
49,51,53, 55, 57,59, 61,63	POS0-POS7	P1–P8	Unchanged scaling, operation range 64x higher
65-72	VEL0-VEL7	V1-V8	Activated register must be scaled 64x higher
73-76	ACC0-ACC3	A1-A4	Activated register must be scaled 64x higher
165	G_FNC	-	64-bit, Scaled 64 times higher – low word
236	SETUP_ BITS	<various checkmarks>	Bit-26, value 0x4000000 selects high-res mode.
276	INDEX_ OFFSET	Index position	Moved from Register 9 in high-res mode,
277	G_FNC_HI	-	64-bit, Scaled 64 times higher – high word

Operations, where one or more of the changed registers scaling is used:
Relative position using P_FNC
FastMac command 04: P_FNC = 0
FastMac command 08: P_FNC = (FLWERR - P7) * 16 or 1024
FastMac command 09: P_FNC = (FLWERR – P8) * 16 or 1024

FastMac commands 12, 13, 14, 15: Activate four sets of P, V, A, T, L, Z registers.
FastMac command 16: Relative position using P_FNC
FastMac command 17: Relative position offset P7
FastMac command 18: Relative position offset P8
FastMac command 23: Synchronize positions using P_NEW, absolute
FastMac command 24: Synchronize positions using P_NEW, relative

3.15 High resolution velocity

All Rotary Table operations
Velocity mode
Position mode
Gear Position mode
Analogue Velocity mode
Stop mode (entered automatically before changing to Passive mode)
Sensor based Homing modes
Torque based Homing modes
Analogue Velocity mode
Analogue Velocity with dead-band mode
Velocity limited analogue torque mode
Analogue gear mode
Coil mode
Analogue bi-position mode
Analogue-to-position mode
Gear Follow mode
Index Homing mode 1 (slow, high precision)
Index Homing mode 2 (fast, lower precision)

Synchronize Positions (manually)
Synchronize Positions (manually, using P_NEW)
In-Position status bit calculation (also at-velocity status bit calculation)

3.16 How to update the motor firmware

The firmware in the motor can be updated directly from the internet at any time by using MacTalk.
It is recommended always to use the latest version of the firmware available for the actual MAC motor used since it will contain the latest features and bugs may have been found and corrected. Below is shown how to make an update of the firmware.

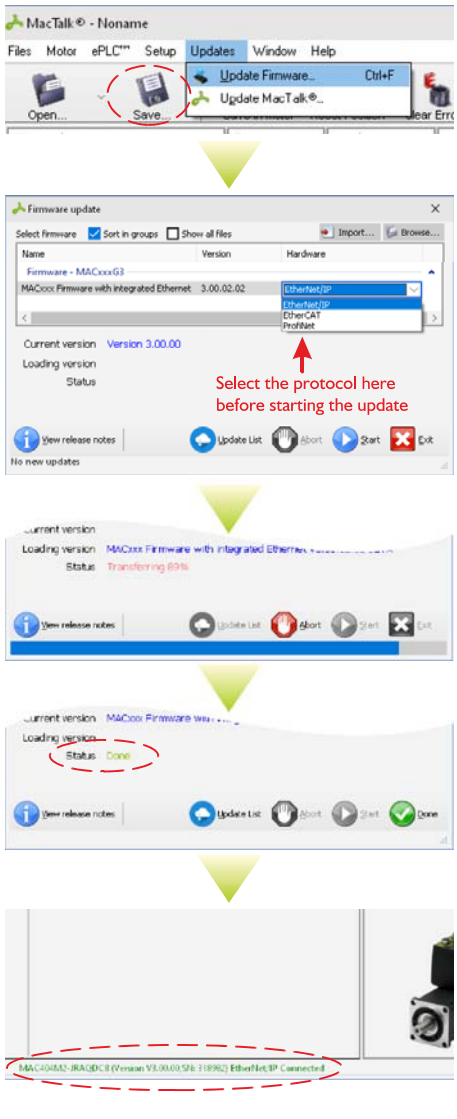
Step 1
The firmware update will erase the existing user setup of the motor. Use the Save button to save the existing setup before updating the motor. Then choose the *Update Firmware* in the *Updates* menu.

Step 2
The first list shown is only the newest firmwares related to the actual motor connected.
If the Ethernet option is present a list of protocols is also shown. Choose the right protocol from list.
To see all files also older versions enable the checkbox *"Show all files"*.
Select the right firmware, «Firmware MACxxxG3».
Press *Start* to download the selected firmware.
The progress counter will now rise from 0 to 100%.

Step 3
When the download process is finished, the status shows "*Done*".

Step 4
The on-line information shown in the lower right side of the MacTalk main window will now show the complete type of firmware and version.

The firmware update is now fully completed. Please remember that the settings of the motor is set back to default. But can be reinstalled by opening the user setup file made initially in this update sequence.



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Hint!: Some older products may not start after pushing the "start" button showed above. If this is the case simply switch off power wait 5 seconds and re-apply power. The update should now start.

4 Industrial Ethernet

4.1 Industrial Ethernet

4.1.1 Industrial Ethernet modules

The documentation for the industrial Ethernet interface is very extensive and has therefore been placed as a separate user manual **LB0056**.

The complete user manual can be downloaded using this link: www.jvl.dk

Following Ethernet protocols are available:

EtherCAT
- JVL drive profile available on MAC (8 x 32 bit cyclic read/write registers)

EthernetIP
- JVL drive profile available on MAC (8 x 32 bit cyclic read/write registers)

ModbusTCP/UDP
- JVL drive profile available on MAC (8 x 32 bit cyclic read/write registers)

PROFInet
- JVL drive profile available on MAC (8 x 32 bit cyclic read/write registers)
- PROFIdrive standard telegram 1, 2, and, 3 supported
- PROFIdrive Application Class 1 supported (Real Time)
- PROFIdrive Application Class 4 supported (Real Time + Isochronous Real Time)

Soon also available:
- **Powerlink**
- **Sercos III.**

5 MacTalk Setup Software

5.1 Installation of MacTalk

5.1.1 Obtain the latest version of MacTalk

MacTalk is available for online purchase at:
https://www.jvl.dk/523/software-mac-motor
You will receive the MacTalk SW along with a license.

5.1.2 Installation of MacTalk

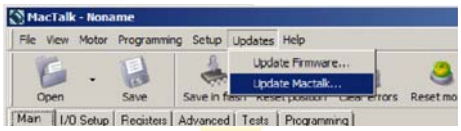
Once you have obtained the MacTalk software / commissioning tool, it is time for installation. This is done by running the downloaded MacTalk Setup file.
Ex. *MAC_TALK_1_90_019_INSTALL.zip*

5.1 Installation of MacTalk

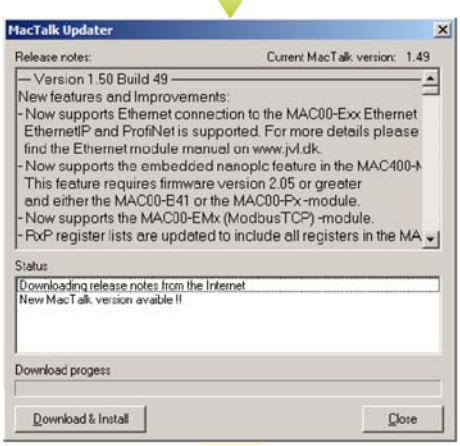
5.1.3 Update MacTalk version

MacTalk can be updated directly from the internet at any time. It is recommended always to use the latest version of MacTalk since it support the latest features and bugs may have been found and corrected. Below is shown how to make an update of MacTalk.

Step 1
Choose the *Update MacTalk* in the *Updates* menu.

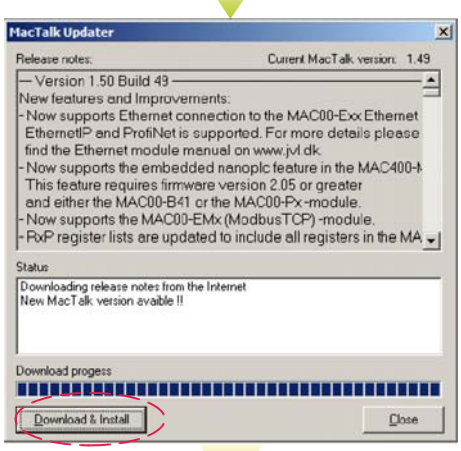


Step 2
MacTalk will now check if newer version exist on the JVL server. If a newer version exist it will automatically be downloaded and the release notes can be seen in the window.

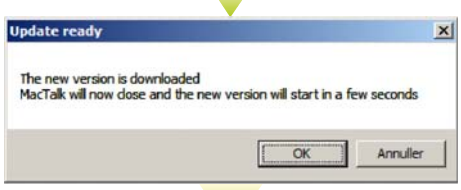


Step 3
Press the *Download & Install* button to download the selected latest MacTalk.
The progress counter will now rise from 0 to 100%.

The new version is now located in the same directory as the MacTalk which was installed in the first place.
The old version is automatically deleted.



Step 4
When the download process is finished, the status shows "*Update ready*".
Press "*OK*" in order to start the new version of MacTalk.



Step 5
After MacTalk have restarted the version number of the new MacTalk can be observed in the top of the screen.
The complete update is finished !.

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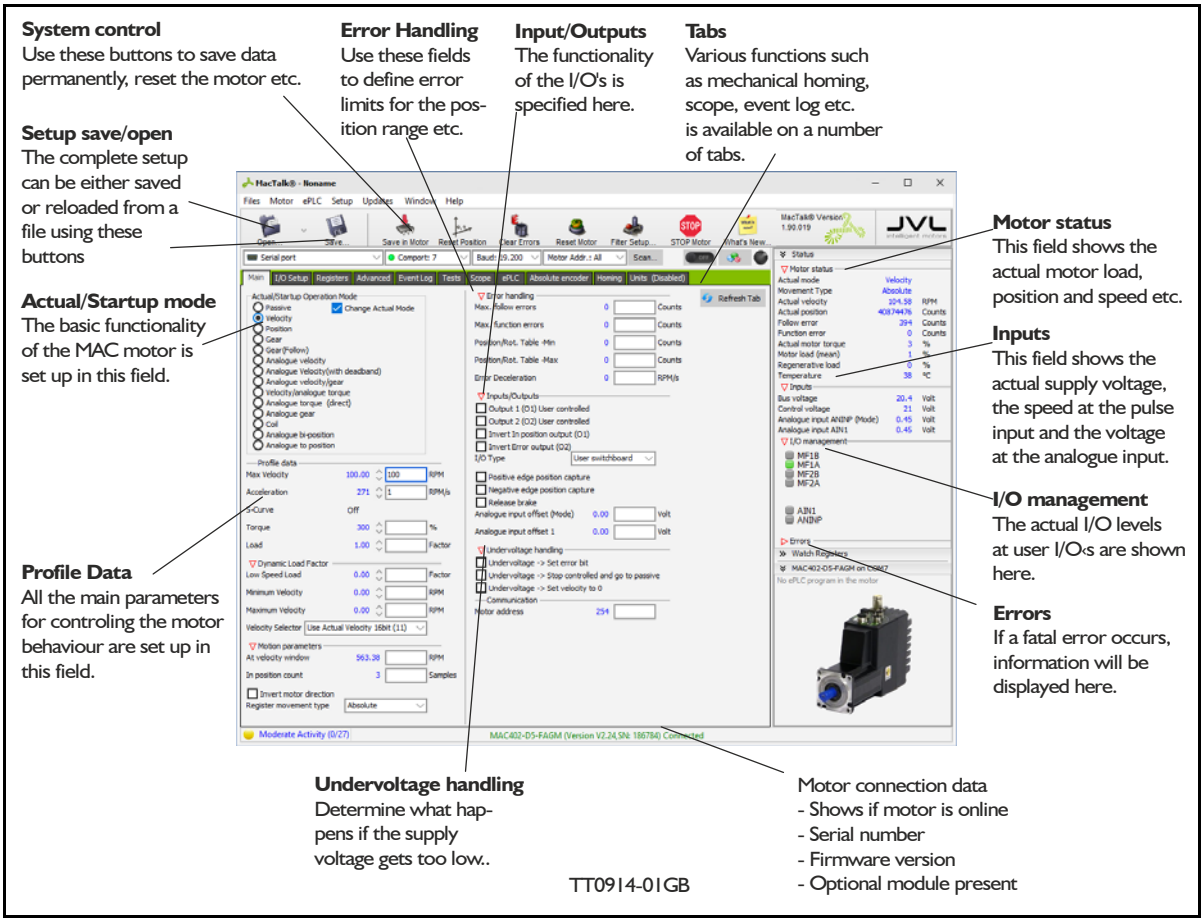
5.1 Installation of MacTalk

5.1.4 Uninstallation of MacTalk

Uninstallation of MacTalk SW can either be done by running unins000.exe in the MacTalk installation folder. (Ex. C:\Program Files (x86)\JVL\MacTalk\unins000.exe) or the usual windows method. Settings -> Apps -> Select MacTalk 1.90.019 and click on the Uninstall button.

5.2 Using MacTalk to setup the motor



5.2.1 MacTalk introduction

The MacTalk software is the main interface for setting up the MAC motor for a specific application.
The program offers the following features:

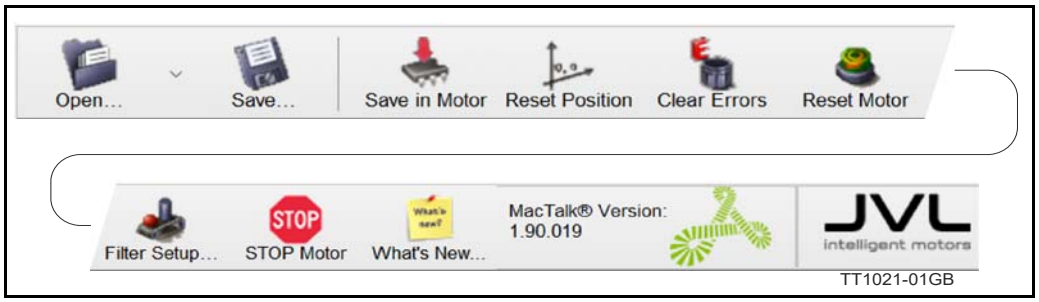
- Choice of the operating mode of the MAC motor.
- Changing main parameters such as speed, motor torque, Homing type, etc.
- Monitoring the actual motor parameters in real time, such as motor load, supply voltage, voltage at the analogue input, etc.
- Changing protection limits such as position limits, maximum position error.
- Determine what should happen if the supply voltage gets too low.
- Saving all current parameters to file.
- Restoring all parameters from file.
- Saving all parameters permanently in the motor.
- Updating the motor firmware or MacTalk software from the internet or a file.

The main window of the program changes according to the selected mode, thus only showing the relevant parameters for operation in the selected mode.
The following pages describe the actual window for each mode and how the parameters affect the MAC motor operation.

5.2 Using MacTalk to setup the motor

5.2.2 Toolbar description

The toolbar at the top of the MacTalk window contains the most commonly used features.



[Open...]
Opens a setup file downloads the setup to the motor. If no motor is connected, the setup is shown in MacTalk and can be edited and saved again.

[Save...]
Saves the actual setup from the motor to a file. If no motor is connected, the actual off-line settings (including module setup and program) will be saved.

[Save in Motor]
The complete current setup of the basic motor will be saved permanently in flash memory in the motor. If the motor is powered down or reset, the saved setup will be used.

[Reset Position]
For motors with incremental encoder, *Actual position* counter is set to zero.
For motors with absolute encoder, *Abs Enc. offset* is set to *Actual position* multiplied by -1.
If saved in motor then the *Actual position* will be zero.
The content of the position counter can be monitored in the right side of the main screen as *Actual position*.

[Clear Errors]
Clears all the errors (if any). Please note that if an error is still present, the motor will remain in the actual error state.

[Reset Motor]
Reset the motor. Same as doing a power off / on operation.

[Filter Setup...]
Short-cut to the servo filter setup screen.

[STOP Motor]
Stops the motor immediately using a controlled deceleration ramp and puts the motor into passive mode. If an active ePLC program running, this is stopped as well.
This button shall be considered as a functional stop button and is available also by using the keyboard short-cut CTRL+F8.

Warning! Do not consider this button as an appropriate Emergency stop. Always fit an Emergency stop circuitry to your motor setup.

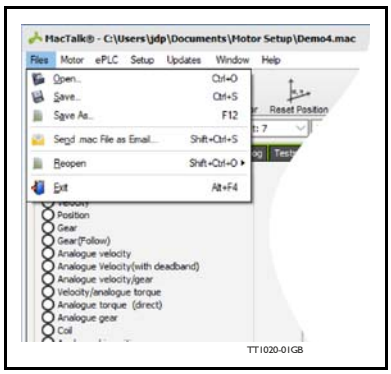
[What's New...]
Shows what have been added changed since last MacTalk® version.

5.2 Using MacTalk to setup the motor

5.2.3 Saving or opening a setup file to/from file

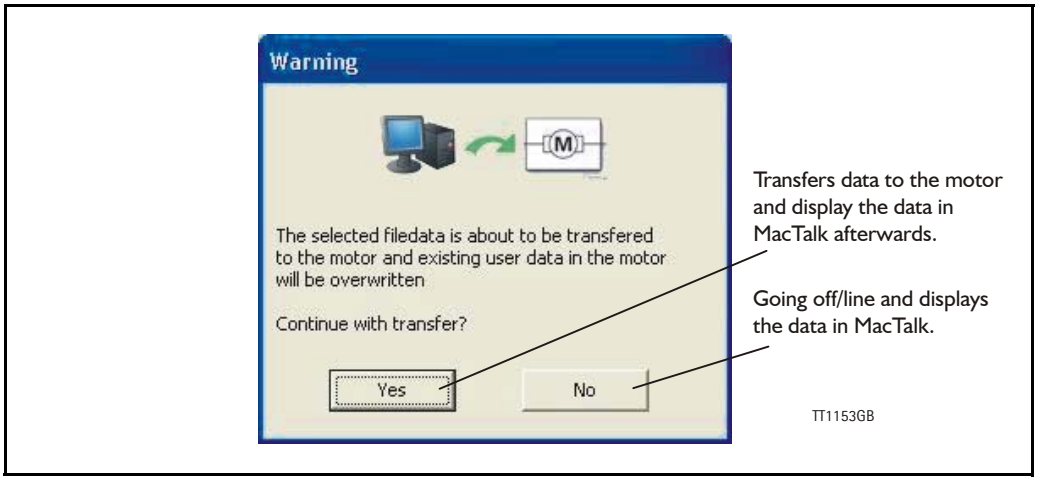
The complete motor setup can be saved to file, or retrieved from file, and transferred to the motor. The setup files can be saved anywhere on any media. Saving and opening a file over a network drive is also possible.
The setup files use the extension *.MAC*. By default, the setup files are saved in the same directory where MacTalk itself is also installed. Other directories can be selected.

From file to motor.
Use *Open* to select a file containing the desired motor setup. When opening the file the setup will simultaneously be sent to the motor.
Remember to use the *Save in Motor* button if the setup must be permanently saved in the motor.

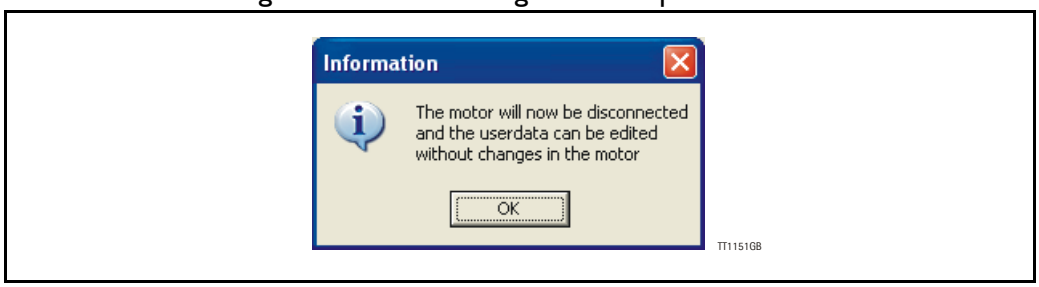


From motor to file.
Use Save or Save as to save the actual setup in a motor as a setup file. Make sure that the motor is on-line with MacTalk, otherwise only the MacTalk default setup is saved.

In case where a motor is present and a file is opened, the user is prompted for keeping the connection or going offline and displaying the file content. The following message box appears.



If the user decides to go offline the following textbox is presented.

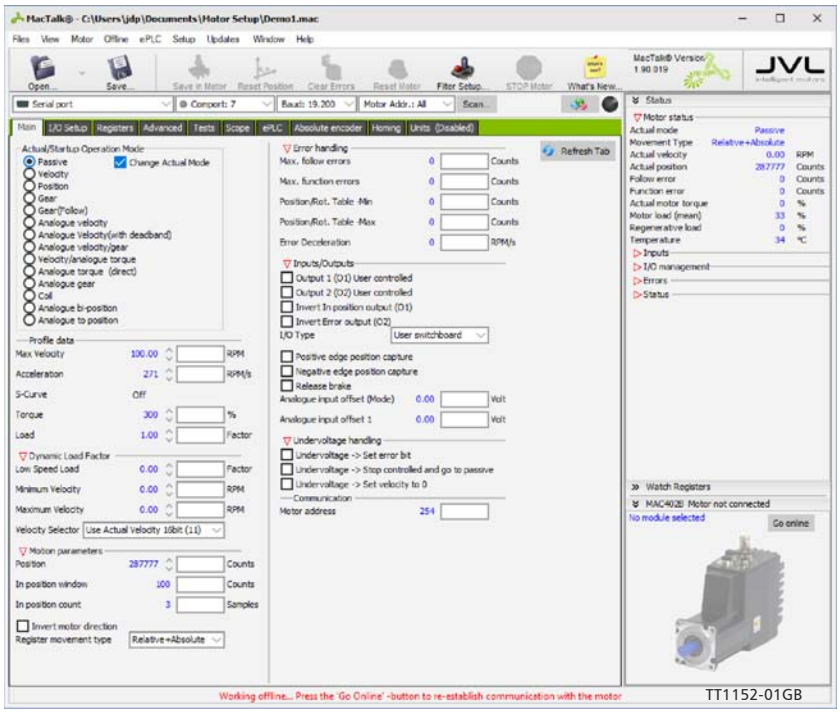


Pressing "OK" disconnects the motor from the PC application and all data can be edited without any interruption in the motor. The following MacTalk view is presented.

5.2 Using MacTalk to setup the motor

5.2.4 Working offline

As seen in the bottom info line, the motor is disconnected and the file data is currently present in MacTalk. To re-establish communication with the motor, simply press the *Go Online* button and if any data has been changed a warning box appears enabling the user to save current data before re-establishing communication with the motor as this will overwrite existing data in MacTalk.



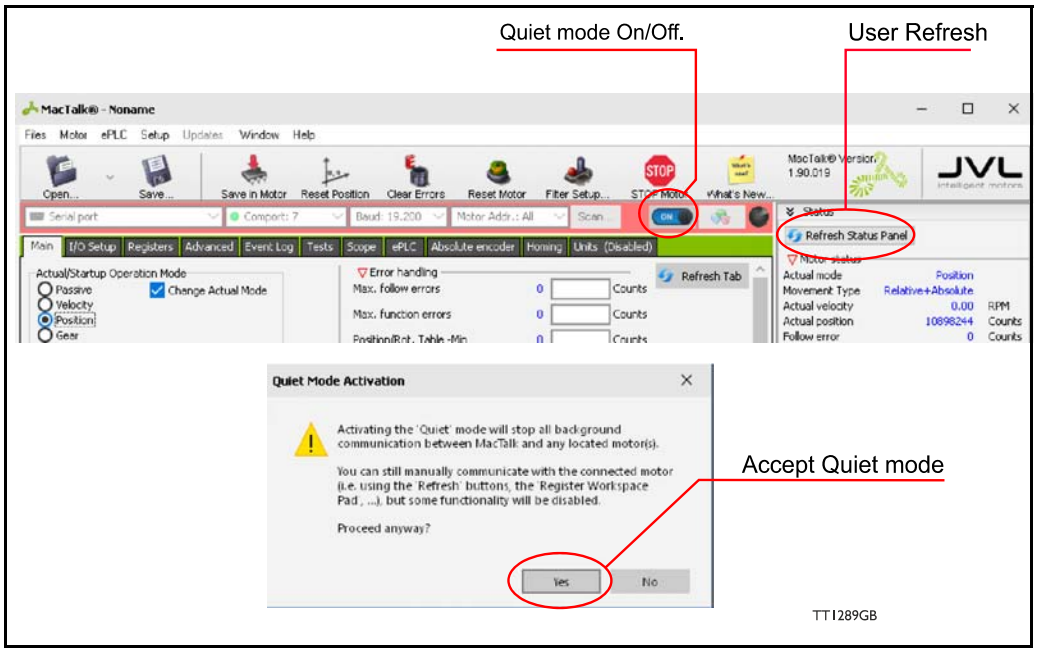
If data is changed in MacTalk the user is warned that current data in MacTalk may be overwritten and needs to be saved. The following warning message box appears.

Choosing “No” will immediately upload all motor data, pressing “Yes” will save all data in the open file.

5.2 Using MacTalk to setup the motor

5.2.5 MacTalk in "Quiet" mode

By activating "Quiet" mode, all live communication with the motor stops. It does not mean that it is not connected, but simply that value are not refreshed without user refresh/request.
All setup changes made in the setup, will be communicated to the motor and setup result will be read and presented in MacTalk.

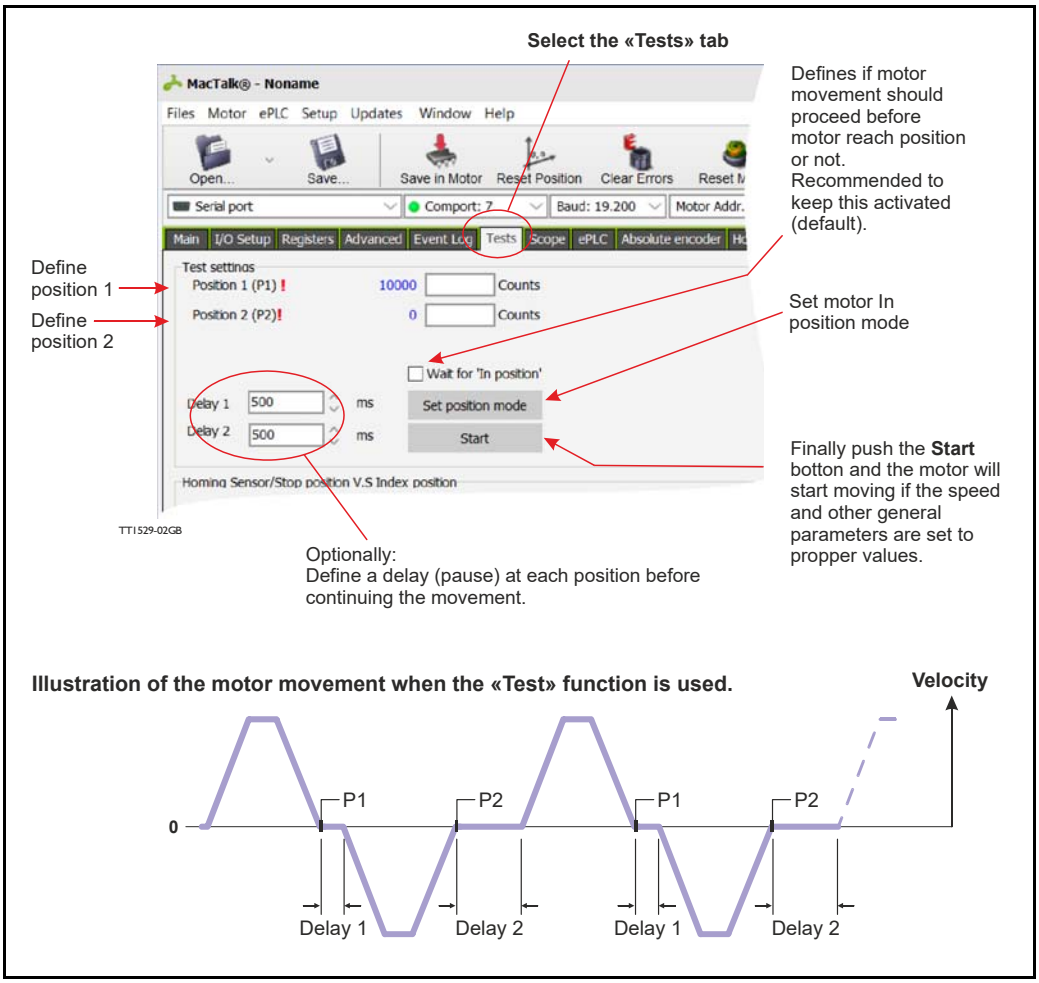


Background functionality, such as overload protection, is still active in the motor. The internal ePLC program will also continue to run.

5.2 Using MacTalk to setup the motor

5.2.6 Motor "TEST" function

When setting up a servo system its convenient to test the that the motor movement is stable and smooth.
For this purpose the TEST tab can be used.
At this tab its possible to setup the motor in position mode and define 2 positions where the motor can move cyclic in between. A delay between each motion can also be defined.
The speed and acceleration used during this process is the general parameters defined at the Main tab. All parameters can be changed dynamically during operation.



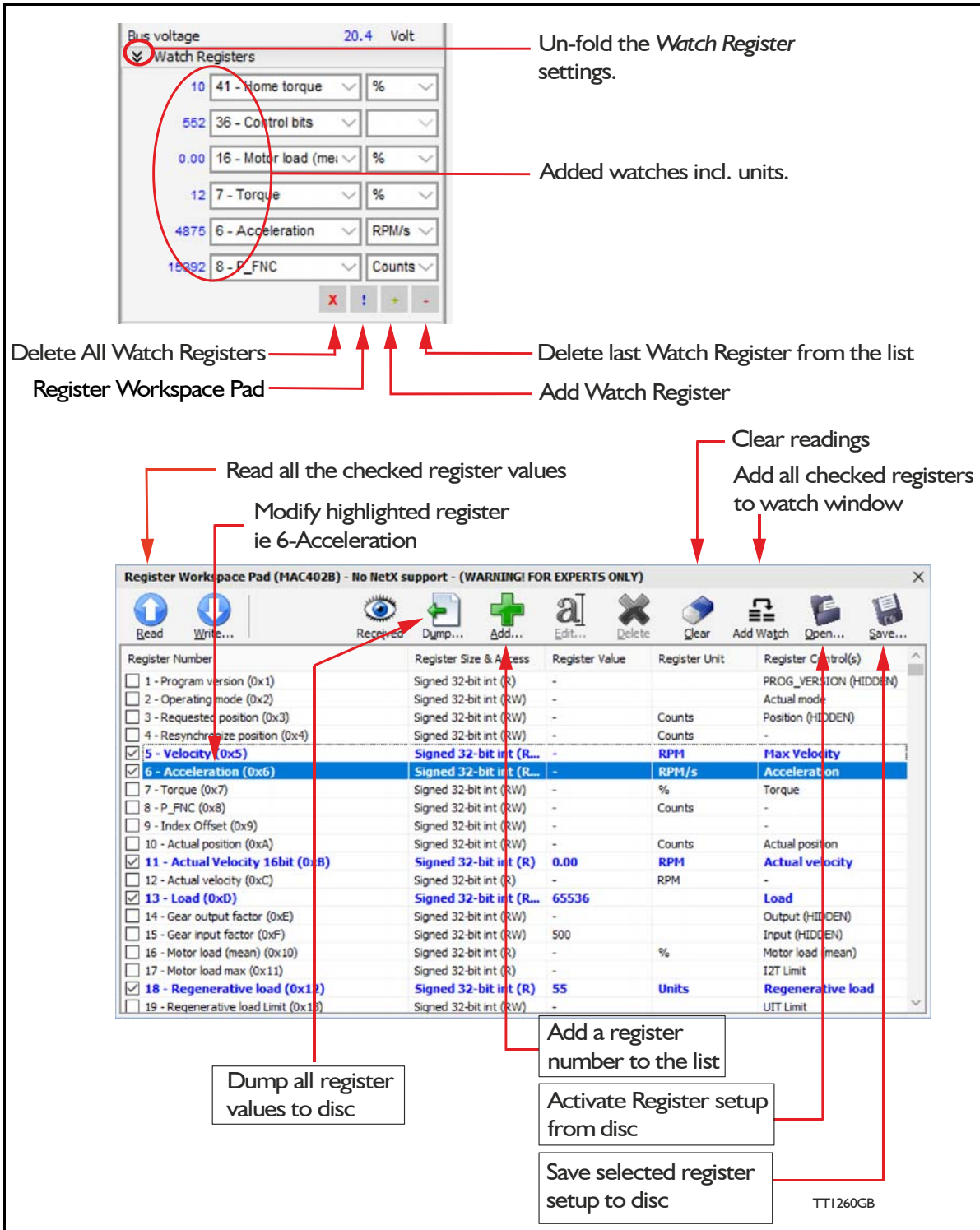
Please notice that the movement is fully controlled by MacTalk.
If the communication cable is unplugged the movement will stop at the last demanded position. Also some slight timing variations may exist depending at the windows operation system and which other application running at the PC at the same time.

Important: Make sure that no other communication takes place, when using the Test function since it may interrupt the function of the test.

5.2 Using MacTalk to setup the motor

5.2.7 Watch registers

Watch Registers are mainly used to extend the presentation of register values, but also to examine register values during ex. running ePLC programs.
Watch register setup can be saved as separate files which can be reloaded after restart. These files are independent of the usual motor configuration.



5.2 Using MacTalk to setup the motor

5.2.8 Register Workspace Pad

The *Register Workspace Pad* is activated via the **[!]** button in the *Watch Registers* window. See figure on the previous page.

The *Register Workspace Pad* presents all the defined registers in the motor. All these registers can be selected and added to the *Watch Registers* window.

[Add...]
Button enables adding of non-predefined motor registers.
Beware the limitation of these registers. If the register number is larger than 511, it will not be part of the normal MacTalk® configuration. It is however possible to save the *Watch Registers* via the **[Save...]** button and later use **[Open...]** to reinsert the register set.

[Read...]
Reads and presents all the selected motor registers.

[Write...]
Opens a dialogue where the highlighted motor register is presented for writing. For obvious reasons, only Writeable registers will change their values. The write dialogue is straight forward to alter a Decimal/Binary register value.
An underlying calculator can be used for simple calculations such as: + - * /, but also for more complex arithmetic: left/right rotation and many other operations.

[Dump...]
Creates a file containing all register values read from the motor. The file is a plain ASCII file and looks more or less as the *Register Workspace Pad* content.

[Edit...] and **[Delete]**
Only valid for user defined registers.

[Clear]
Clears the content of all register values. (Not the register selection)

[Add Watch]
Adds all the selected registers to the *Watch Registers* window.

[Open...]
Opens a previously saved register selection list.

[Save...]
Save a register selection list inclusive the user added registers.

[Received]
Presents all register values received since the start of MacTalk®.

5.2.9 Watch register value

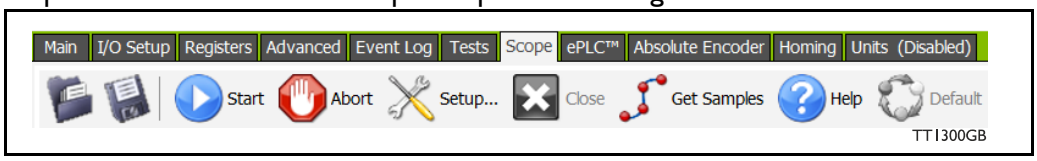
Via double clicking on the value in the watch window a *Watch Register Magnifier* pops up. This window shows the actual value of the register. Select between DEC, HEX, BIN or OCT under *Settings->Value Format*.
Via *Settings->Capture->Start* is it possible to follow the value of the register in a graphical representation.
Sampling of data can be set-up to be based upon changes or on a timer.
Captured data can be saved to a file (Text or CSV) via *File->Save Captured as...*

5.3 MacTalk Scope usage

5.3.1 Scope buttons

The Scope function is a 8/4 channel oscilloscope that is, a very good and necessary function for testing a new application or finding errors in an existing system.
The Setup has to be selected to set up the Scope function correctly before use. Almost all registers in the MAC motors can be chosen for viewing and many different trigger functions can be selected. Saving and loading scope recorded data is possible.

Scope buttons to control the Scope setup and recording.



5.3.2 Scope Sample view

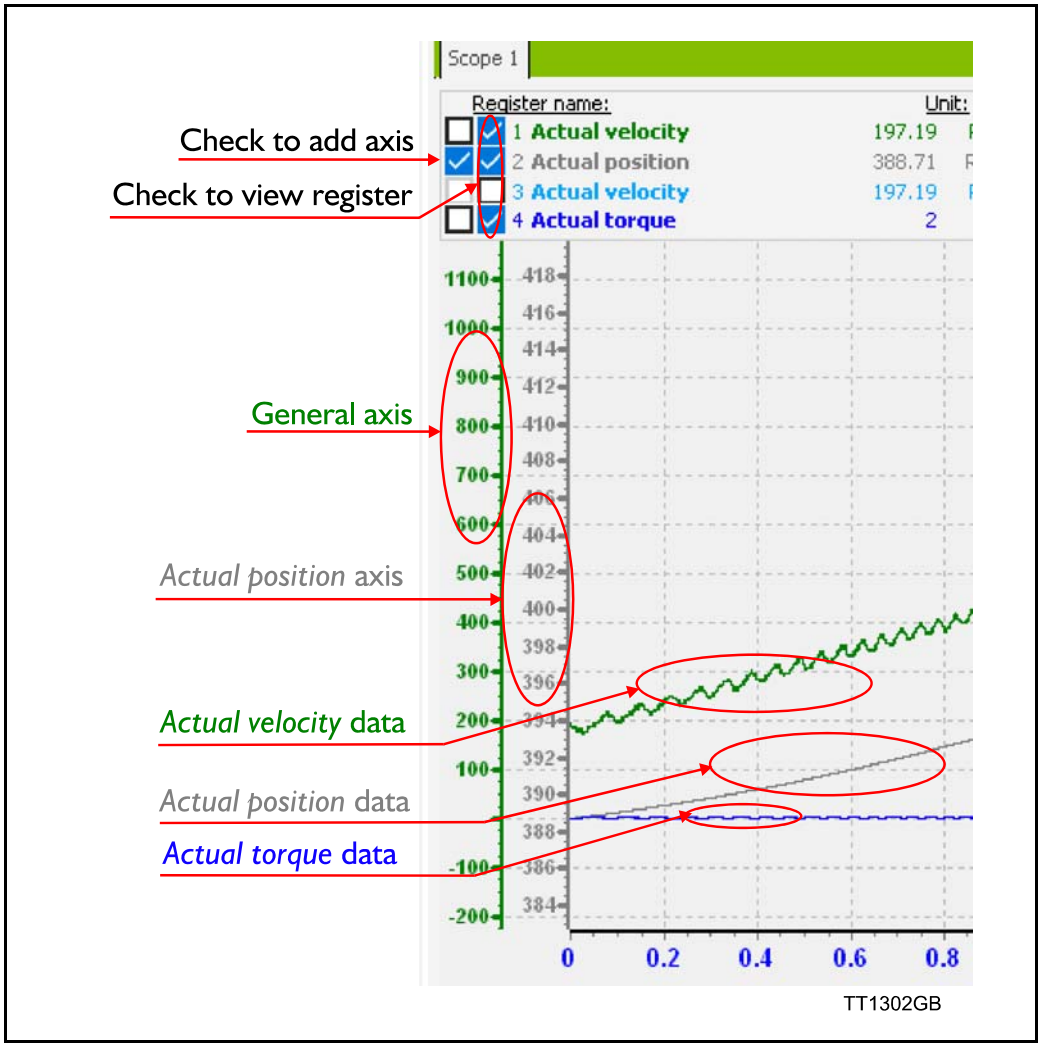
Zoom and Pan is possible to examine specific data.
Zoom: Click, hold and drag left mouse key to the right downwards. The selected rectangle will be the zoomed view.
Pan: The zoomed view can be panned in all direction: Click and hold the right mouse button while moving the view area.
To restore the entire scope data view: Click, hold and drag left mouse key to the left upwards.

The **Default** icon can also be used. All settings will return to default view of data.

Different colours can be applied to the graph data and scales. Double click on the 'Register name' and select the preferred colour.

5.3 MacTalk Scope usage

In ***Scope Sample view*** is possible to select which of the sampled register values to show or hide. The ***General scale*** will adapt to the sampled data.
It is also possible and show or hide scales for each sampled register.



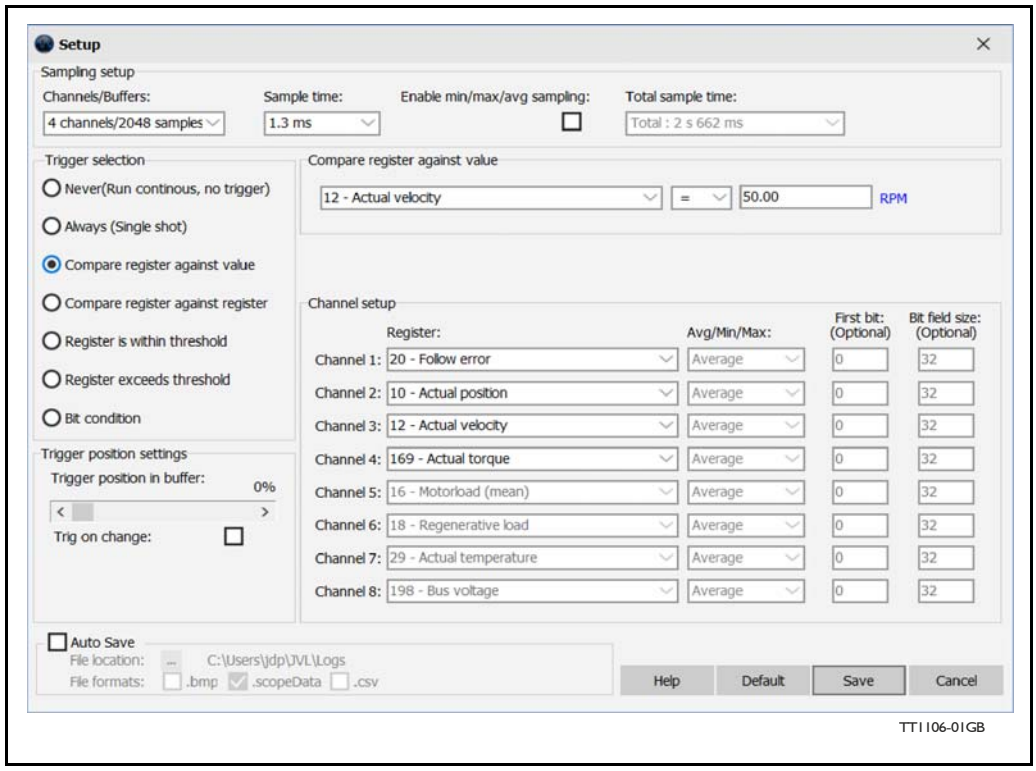
Note that values for ***Actual torque*** is very hard to see variation. In this specific case, it would be a good idea to add a scale for ***Actual torque***.

5.3 MacTalk Scope usage

5.3.3 Sampling Setup

In Sampling setup it is possible to select between recording of 4 or 8 register values. Along with the channel count it is possible to choose different sample counts (512, 1024 and 2048 samples).
Selection of sample time impacts the total sample time along with number of channels, samples. You can select 100uS or 1.3mS.
If extended recording time is preferred, you can so by activating ***Enable min/max/avg sampling*** and select the desired ***Total sample time***.

The entire scope setup is part of the general setup and will be saved along with all other motor setup.

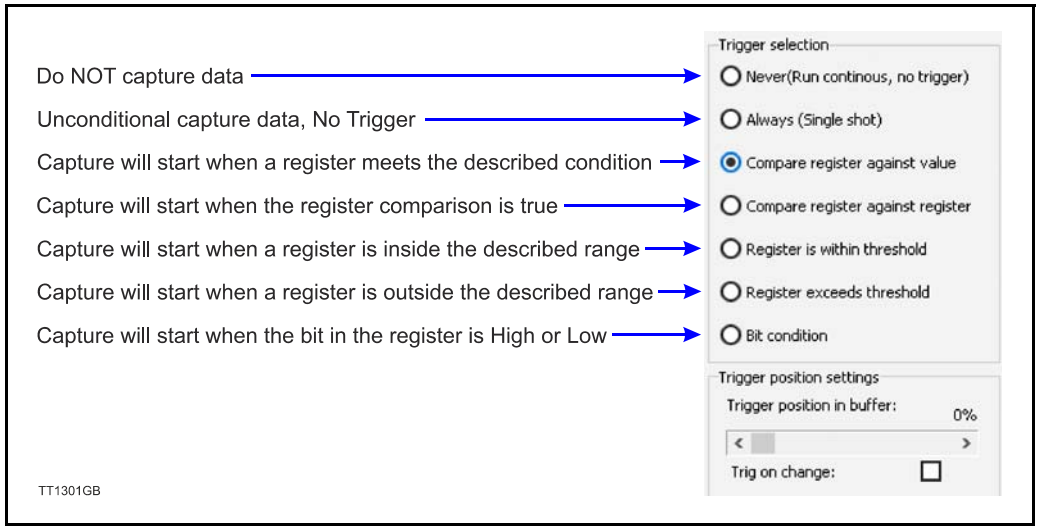


When saving scope data using the ***MacTalk® Scope Data Format*** (.scopeData), you will be able to reload the recording back into MacTalk.
Reloaded scope data can still be saved as .CSV or .BMP, if needed.

5.3 MacTalk Scope usage

5.3.4 Scope trigger setup

The scope trigger is rather complex with many possible configurations.
First you have to make a trigger selection.



Never (Run continuous, no trigger:
The default mode where no data is captured.
The purpose of this mode is to be able to load previous scope data for preview.

Always (Single shot):
Capture data directly after Start without any trigger condition.

Compare register against value:
Capture will start when a register value meets the described condition.
Possible comparison selection is: '=', '!=', '>', '>=', '<' or '<='.
A typical scenario: Trigger recording of data, when the *Actual velocity* exceeds 1000rpm

Compare register against register:
Same as above, but where value is the contents of another register.
Possible comparison selection is: '=', '!=', '>', '>=', '<' or '<='.
A typical scenario: Trigger recording of data when the *Regenerative load = Regenerative load limit*.

Register is within threshold:
Capture will start when a register value meets the described condition.
A typical scenario: Trigger recording of data, when the *Actual velocity* is inside the range 900rpm to 1000rpm

Register is exceeds threshold:
Capture will start when a register value meets the described condition.
A typical scenario: Trigger recording of data, when the *Actual velocity* is outside the range 900rpm to 1000rpm

Bit condition:
Capture will start when a bit in a register changes to High or Low.
A typical scenario: Trigger recording of data, when *Error/status Bit 24* is set or reset.

5.3.5 Trigger position setting

Trigger position in buffer can be selected from 0% to 100%
0% means that the data recorded starts exactly at the trigger condition.
If you want to record data prior to the trigger point, then you need to select a higher percentage.
100% means that all data is prior to the trigger point.
NB! If the trigger condition occurs before the buffer is full, the available data will be presented.

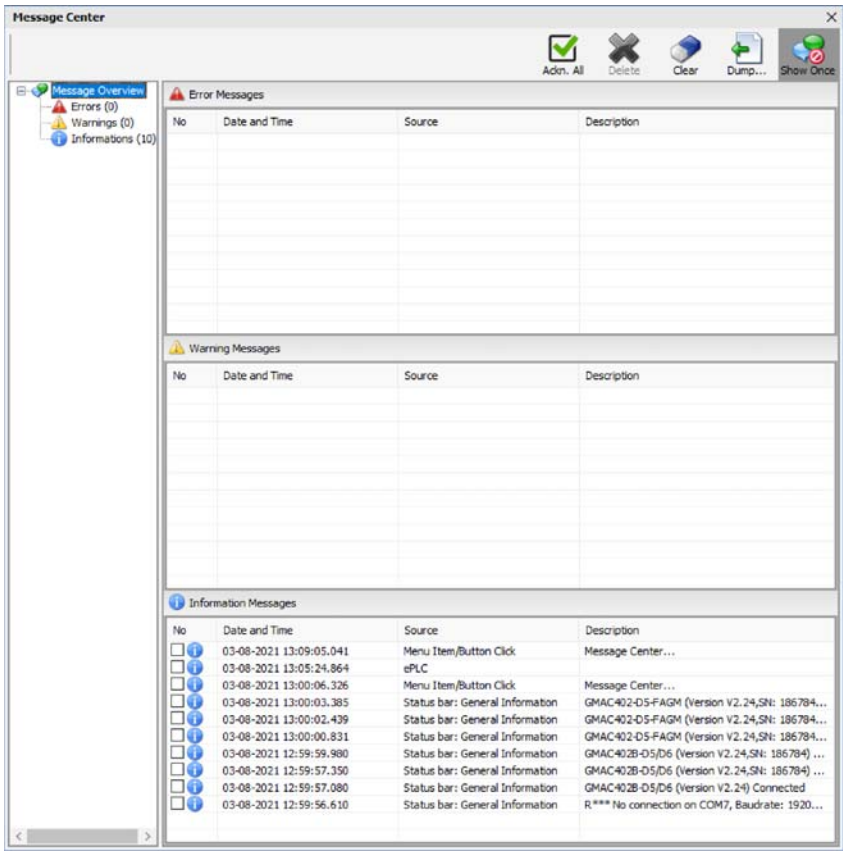
5.3.6 Trig on change

When selected, then the trigger point will occur when the value passes the threshold from the right value.
Ex. Trigger point is *Actual velocity* > 600rpm
Motor is running at 700rpm when scope is started.
Now the trigger is not armed before the *Actual velocity* has been under 600rpm.
Subsequently the trigger will be activated when the *Actual velocity* again rises beyond 600rpm.

If unchecked, the trigger is based on a static value evaluation.

5.4 Message Center

Message Center can be accessed via a click on the Icon, Window -> Message Center or via keyboard short-cut Shift+Crtl+F9.
Message Center is recording 3 types of events: Errors, Warnings and Informations. Informations is mainly user interactions, but also events occurring during execution of ePLC programs.
The idea behind the Message Center is to track what happened prior to a Warning or an Error.
This enables the user to create flawless ePLC programs and valid motor setup.



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5.5 ePLC usage

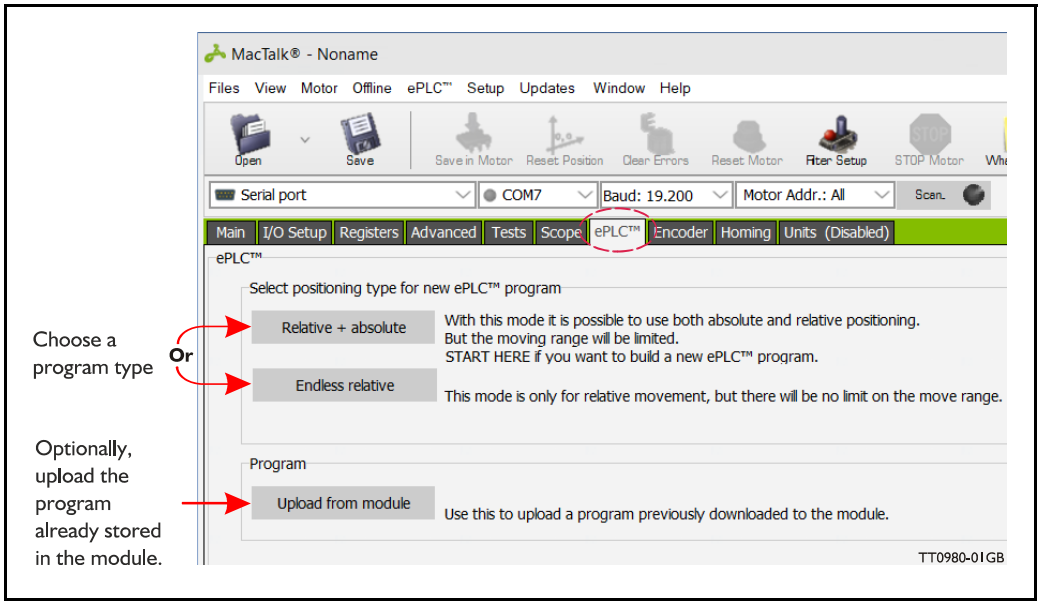
5.5.1 Introduction to ePLC

Using the ePLC functionality in a MAC motor, almost any kind of program can be created using a set of user-friendly icons.
To create a program, first of all it must be determined whether the application requires that the motor always stays within the allowed position range which is +/- 67.108.863 counts or if the application requires that the motor mostly moves in only one direction, meaning that sooner or later it will pass the maximum limit of counts mentioned above.

Typical applications for the two program types are:

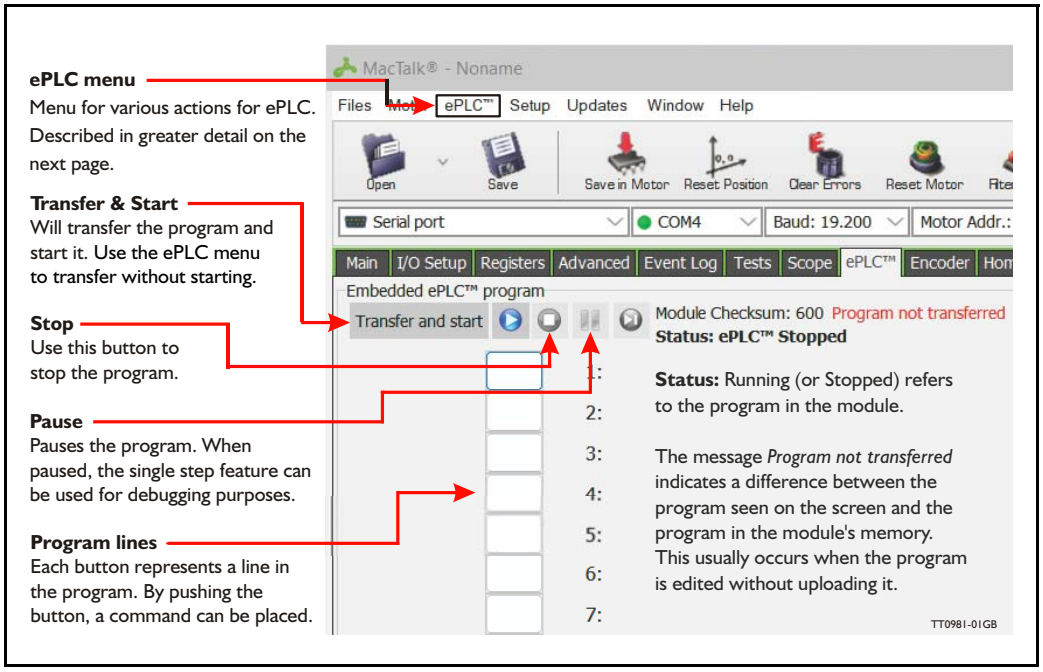
Relative + Absolute	XY tables Pick and place robots Valve actuators
Endless relative	Dispensers for film, labels etc. Dosing pumps Turntables Torque-controlled screw machines

Select the program positioning type when creating a new program in the ePLC tab, or choose to upload the program stored in the module.



5.5.2 ePLC Main window

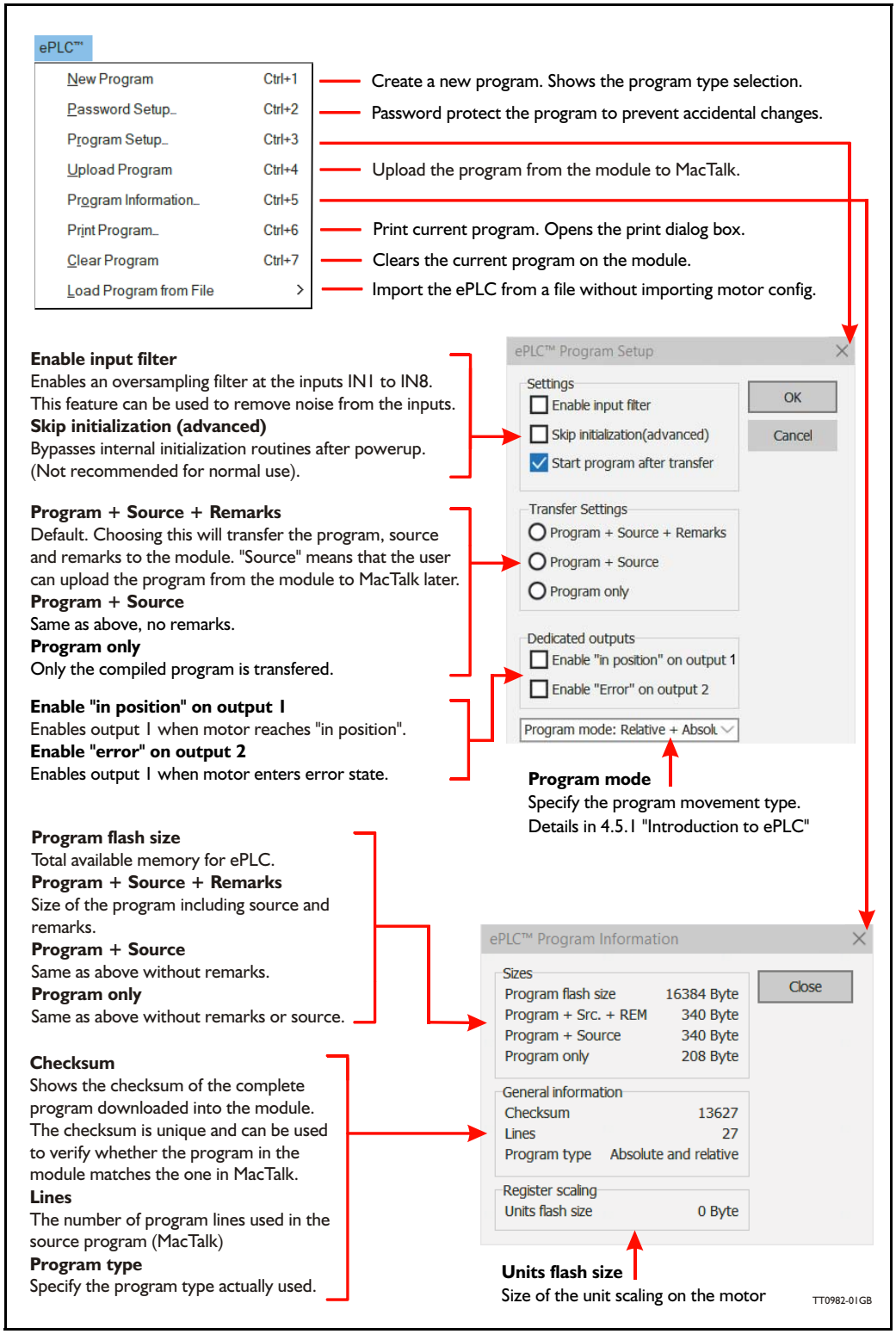
The main window for creating a new program or editing a program is shown below:



5.5 ePLC usage

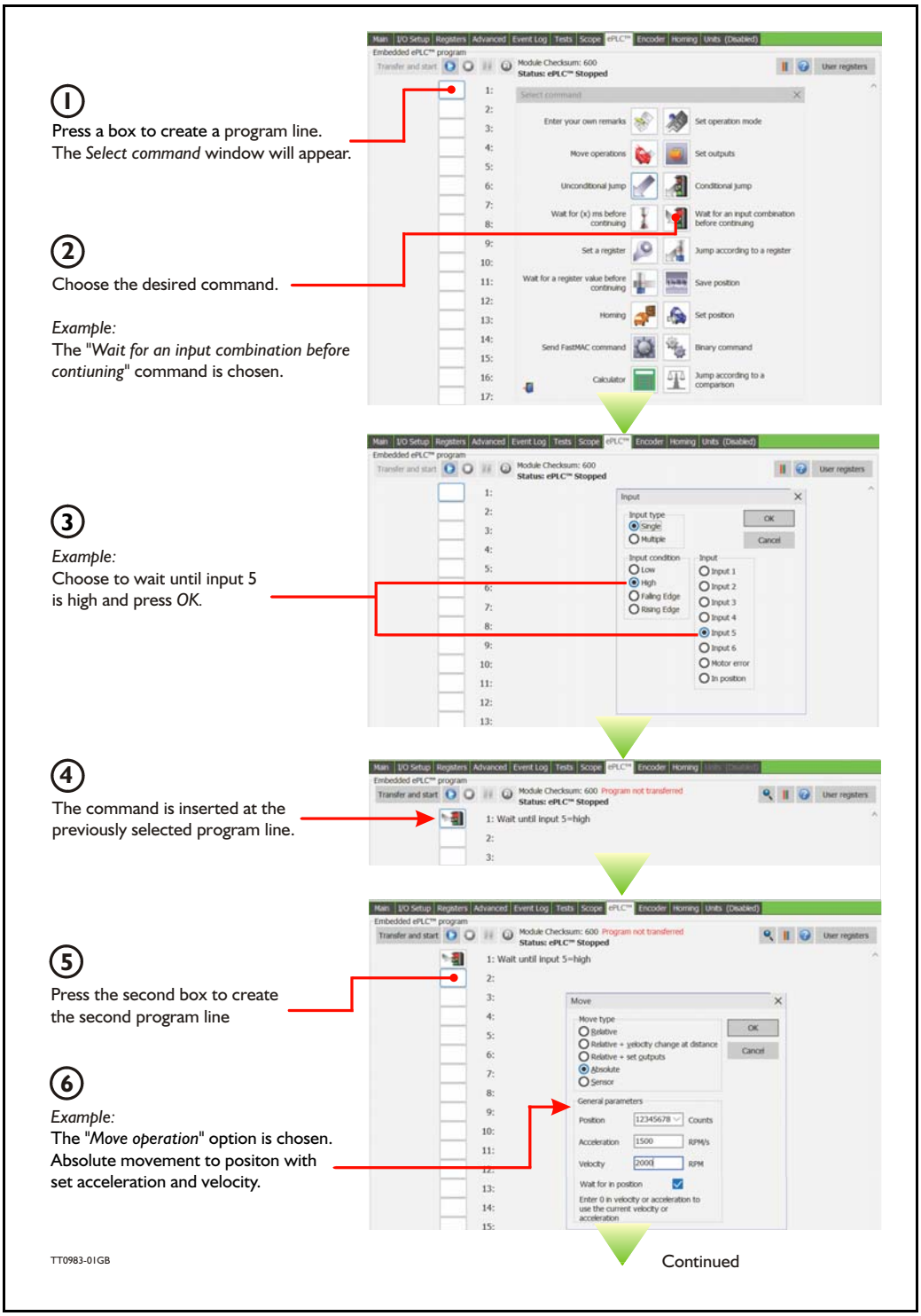
5.5.3 ePLC menu

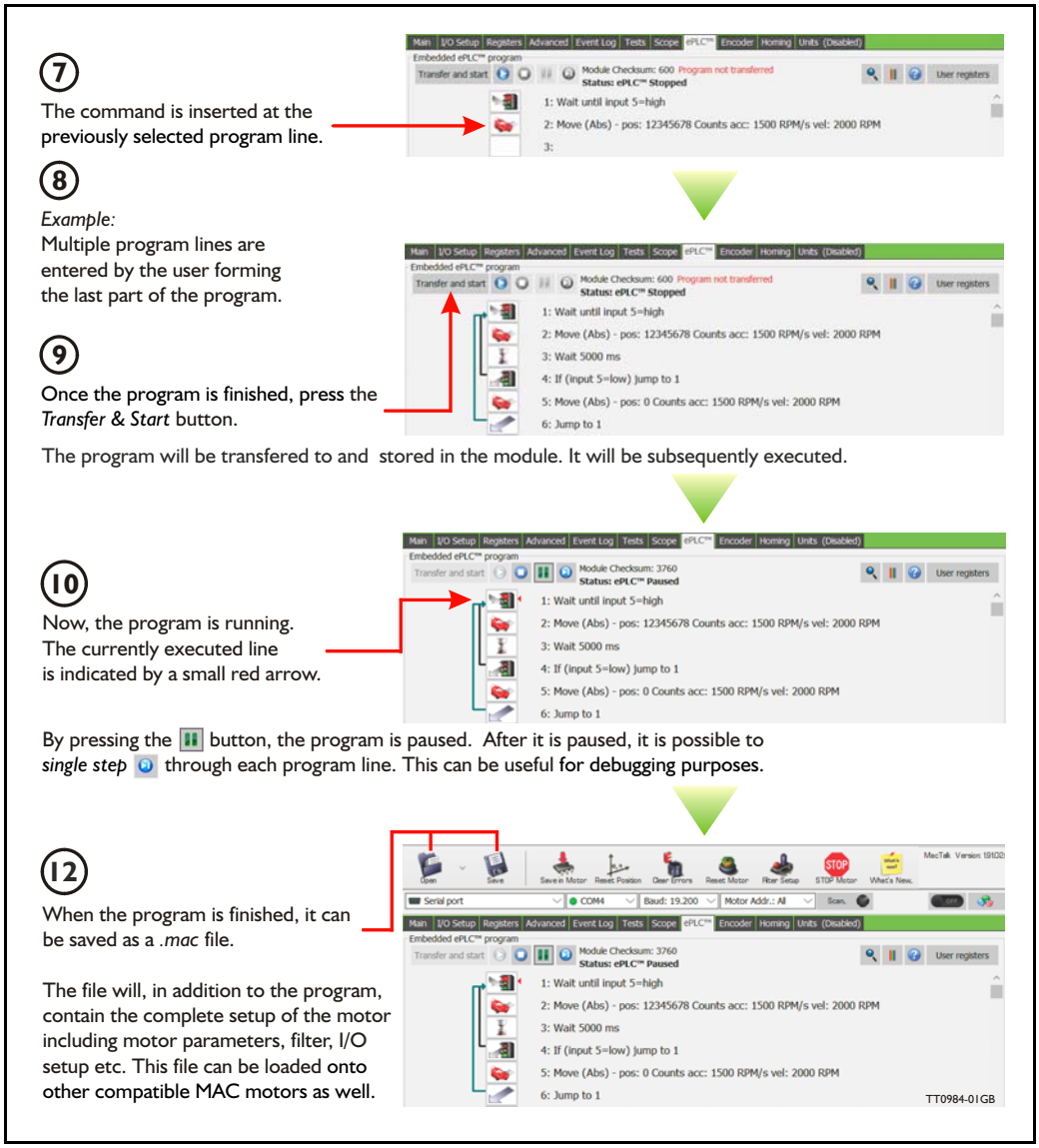
The ePLC menu, found in the menu bar, contains the following options:



5.5.4 How to build a program

When choosing *New program* in the ePLC menu or entering the ePLC tab for the first time, a program can be built. Press the button at line 1 and a window will appear.





5.5.5 General programming tips

When a program is built and saved, the following tips may be useful to ensure that the program behaves as expected.

1. When transferring the program to the module, it is saved permanently in the memory. The program will be executed each time the motor is switched on.

2. Before making a program, ensure that the basic parameters for controlling acceleration, torque, safety limits, etc. are set to the desired values. When saving the program as a file, all these basic parameters will be saved together with the program as a complete motor setup.

3. A program line can be edited by double-clicking the command text.

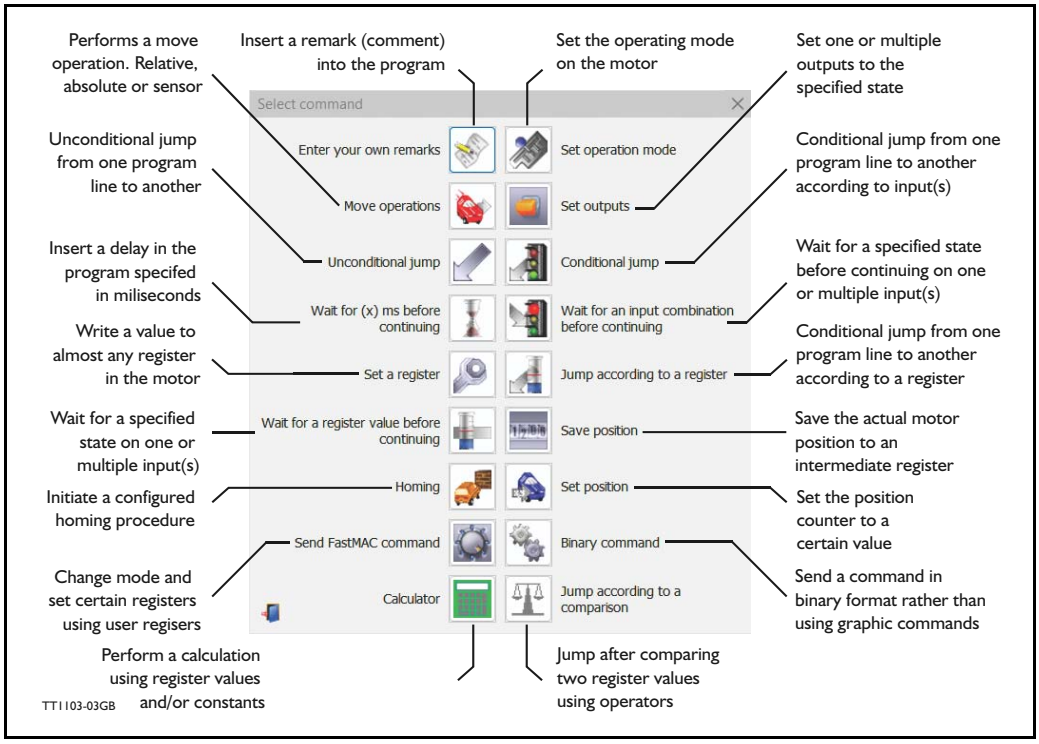
4. When the cursor is placed on top of the command icon, a menu can be called up with a right-click. Here, it is possible to edit, insert, remove, copy, paste and more.

5.5.6 "Select command" window overview

Pressing any empty line in the ePLC tab opens the "Select command" window, the command toolbox. The toolbox comprises of 18 different command icons used when creating programs.

The commands give easy access to the most commonly used functions in the motor. Some functions are deceptively simple. For example, the "Set register in the MAC motor" or "Wait for a register value before continuing" give direct access to over 50 registers in the MAC motor. In total, the command toolbox is very powerful since most of a typical program can be built using the simple command icons. The remaining part is obtained by accessing the motor registers.

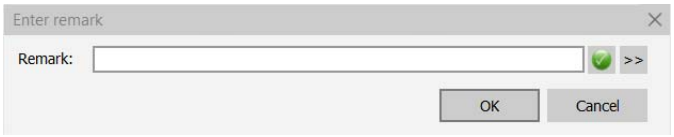
A short description of all command icons can be found below. For more detailed descriptions of the commands, see the following section.



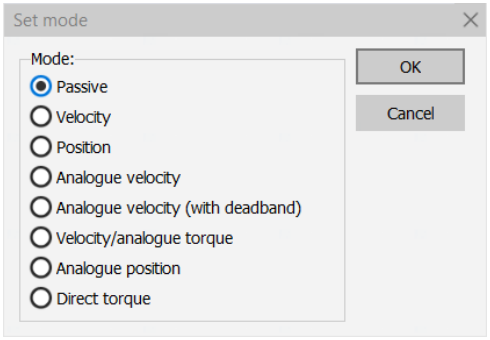
5.5.7 ePLC command descriptions

In the following section, detailed descriptions of each command available in the “Select command” window are given. Each subsection is labelled after the command’s name and will show the icon, dialog box and a short description of the function.

5.5.7.1 Enter your own remarks

Icon:	
Dialog:	
Function:	Inserts a remark/comment in the source code. The program line will not be executed. This can be especially useful if other users are involved in using the program, or if the program is worked on infrequently.

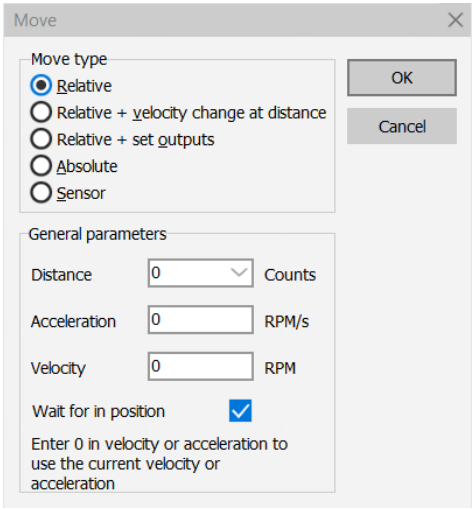
5.5.8 Set operation mode

Icon:	
Dialog:	
Function:	Sets the operating mode of the motor to the specified mode. This allows using different operating modes in different parts of the program, or in conjunction with jumps. For a detailed description of the individual operating modes, see *Using Position mode, page 42* to *Analogue bi position mode, page 49*.

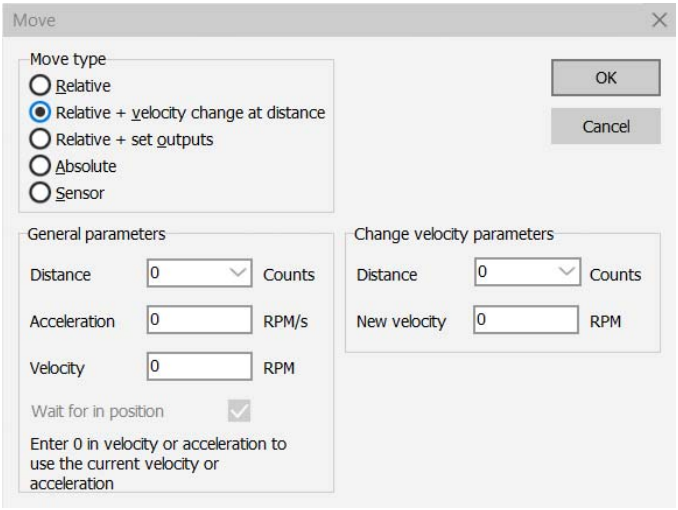
5.5.9 Move operations

Icon:	
Function:	The *Move* command offers a great deal of flexibility, with five different movement types. Each type will be described in its own section.

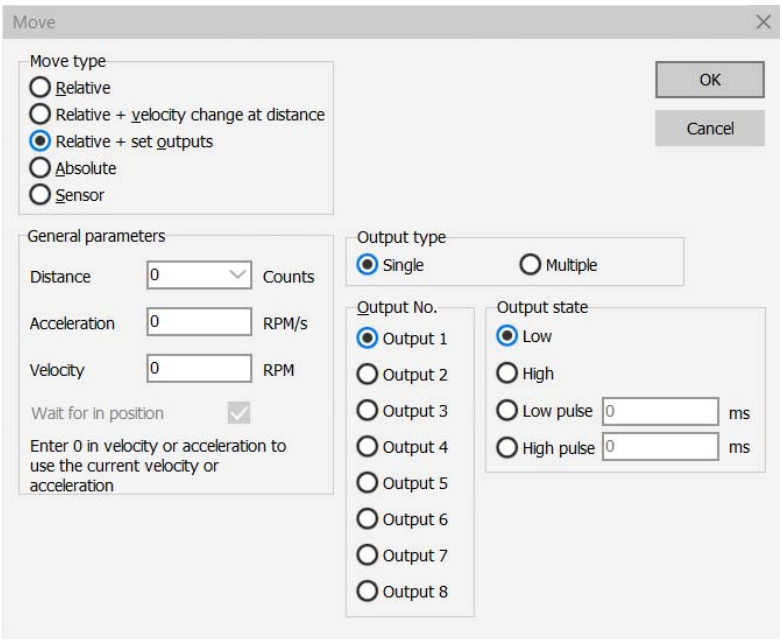
5.5.10 Move Relative

Icon:	
Dialog:	
Function:	Moves the motor relative to its current position. The distance is measured in encoder counts, and can either be entered directly, or taken from three memory registers in the module. For further information on using these memory registers, refer to the sections on the “Save position” and “Set position” commands. Note that if a velocity and/or acceleration is specified in the command, register 5 (Max velocity, V_SOLL) and/or register 6 (Acceleration, A_SOLL) will be overwritten to the entered value. Register 49 (P1) is always overwritten by this command. If the “Wait for in position” option is checked, the program will wait until the motor has finished the movement before proceeding to the next program line. If this option is not checked, the program will start the movement, then immediately start executing the next command. The motor will still finish the movement on its own unless it is given instructions to stop or move elsewhere.

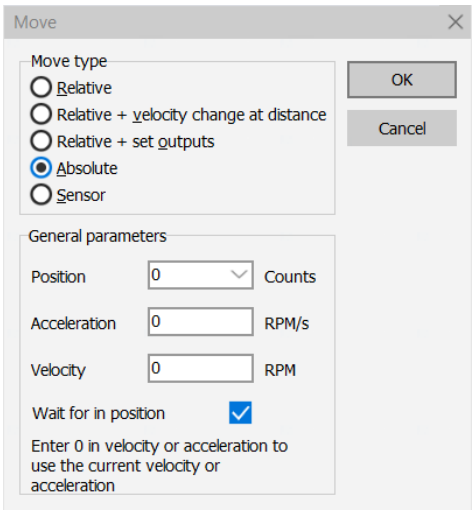
5.5.11 Move (Relative + velocity change at a distance)

Icon:	
Dialog:	
Function:	Performs a motor movement relative to the current position, but changes the velocity after a specified distance. The *"General parameters"* distance is the total distance moved, whereas the speed is changed after moving the *"Change velocity parameters"* distance. Therefore, the latter value must be smaller than the former. The distance is measured in encoder counts, and can either be entered directly, or taken from three memory registers in the module. For further information on using these memory registers, refer to the sections on the "Save position" and "Set position" commands. Note that if a velocity and/or acceleration is specified in the command, register 5 (Max velocity, V_SOLL) and/or register 6 (Acceleration, A_SOLL) will be overwritten to the entered value. Register 49 (P1) is always overwritten by this command. This command always causes the program to wait until the movement is finished before executing the next command.

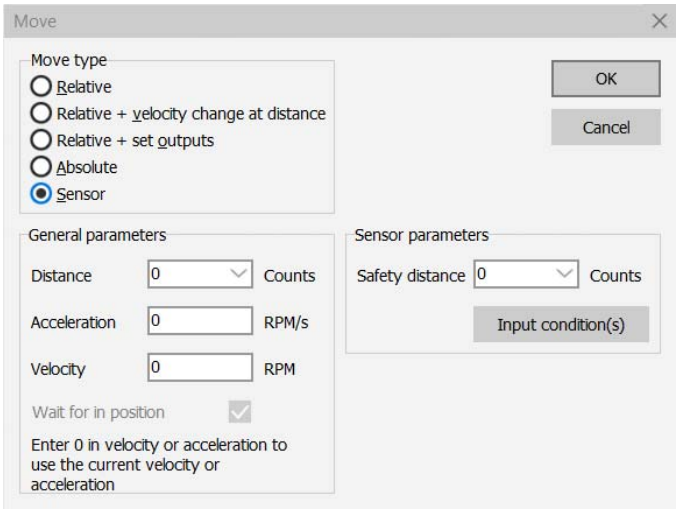
5.5.12 Move (Relative + set outputs)

Icon:	
Dialog:	
Function:	Performs a motor movement relative to the current position, and sets one or more outputs on when the operation is completed. The distance is measured in encoder counts, and can either be entered directly, or taken from three memory registers in the module. For further information on using these memory registers, refer to the sections on the “Save position” and “Set position” commands. Note that if a velocity and/or acceleration is specified in the command, register 5 (Max velocity, V_SOLL) and/or register 6 (Acceleration, A_SOLL) will be overwritten to the entered value. Register 49 (P1) is always overwritten by this command. This command always causes the program to wait until the movement is finished before executing the next command.

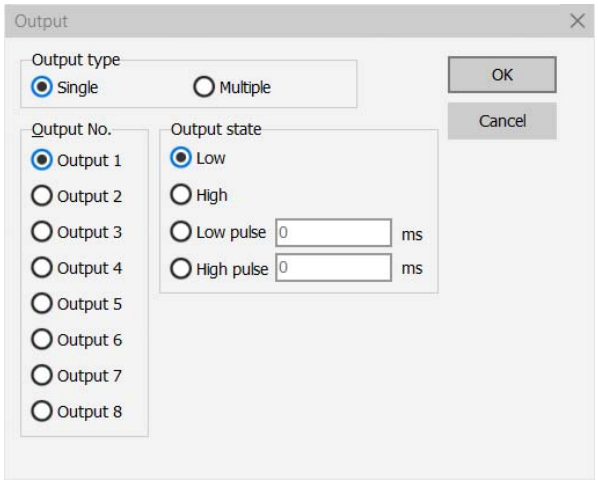
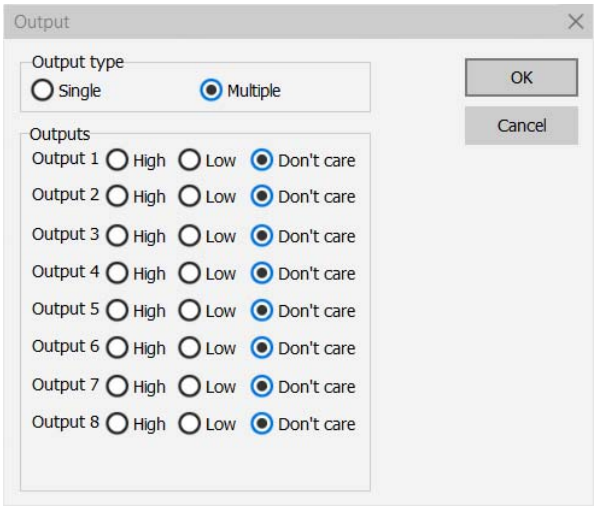
5.5.13 Move (Absolute)

Icon:	
Dialog:	
Function:	Moves to an absolute (non-relative) position. The motor will move to the exact position specified. The position is measured in encoder counts, and can either be entered directly, or taken from three memory registers in the module. For further information on using these memory registers, refer to the sections on the “Save position” and “Set position” commands. Note that if a velocity and/or acceleration is specified in the command, register 5 (Max velocity, V_SOLL) and/or register 6 (Acceleration, A_SOLL) will be overwritten to the entered value. Register 49 (P1) is always overwritten by this command. If the “Wait for in position” option is checked, the program will wait until the motor has finished the movement before proceeding to the next program line. If this option is not checked, the program will start the movement, then immediately start executing the next command. The motor will still finish the movement on its own unless it is given instructions to stop or move elsewhere.

5.5.14 Move (Sensor)

Icon:	
Dialog:	
Function:	Performs a movement in the direction specified by using a positive or negative velocity value. The motor moves until an input condition is satisfied, then moves the distance specified before stopping. The motor will not move farther than the safety distance specified regardless of whether the input condition is satisfied. The distance is measured in encoder counts, and can either be entered directly, or taken from three memory registers in the module. For further information on using these memory registers, refer to the sections on the “Save position” and “Set position” commands. Note that if a velocity and/or acceleration is specified in the command, register 5 (Max velocity, V_SOLL) and/or register 6 (Acceleration, A_SOLL) will be overwritten to the entered value. Register 49 (P1) is always overwritten by this command. This command always causes the program to wait until the movement is finished before executing the next command.

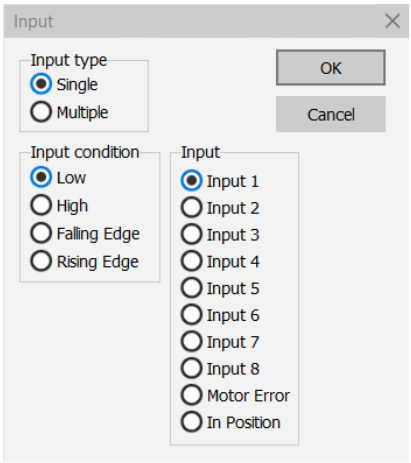
5.5.15 Set outputs

Icon:	
Dialog:	 
Function:	Sets one or more outputs. When setting a single output, it is possible to specify the length (in milliseconds) of a low/ high pulse. When setting multiple outputs, it is possible to set the state for each output. “Don’t care” leaves the output in its current state.

5.5.16 Unconditional jump

Icon:	
Function:	Jumps to another line in the program. After selecting this command, the user must select the destination line. The source line (the line in which this command is placed) is indicated in a text box next to the cursor. The next line that is clicked on will become the jump destination.

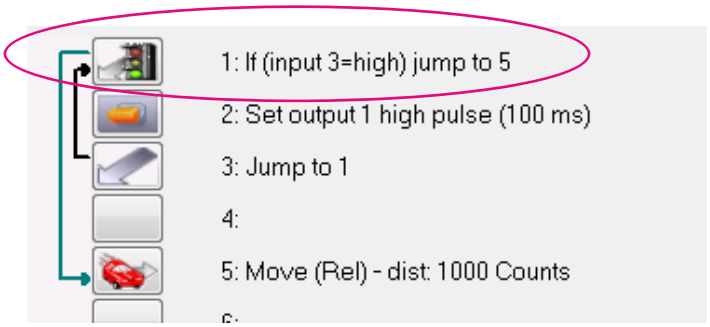
5.5.17 Conditional jump (single input)

Icon:	
Dialog:	
Function:	Jumps to the specified line in the program if the specified input condition is met. If the condition is not met, the program proceeds to execute the next line in the program. When “Single” is selected as the “Input type”, the command can use four states to trigger the jump: The input is low, the input is high, the input transitioned to low (falling edge), or the input transitioned to high (rising edge). In case an input transition being selected, the transition must have taken place during the last 30 microseconds before the command is executed. After selecting the input condition, the user must select the destination line. The source line (the line in which this command is placed) is indicated in a text box next to the cursor. The next line that is clicked on will become the jump destination.

Examples are given on the following page.

Conditional jump example 1 - Jump controlled by an input level
In the program example below, the command is used in line 1. The program will jump to line 5 if *input 3* is active (supplied with voltage).

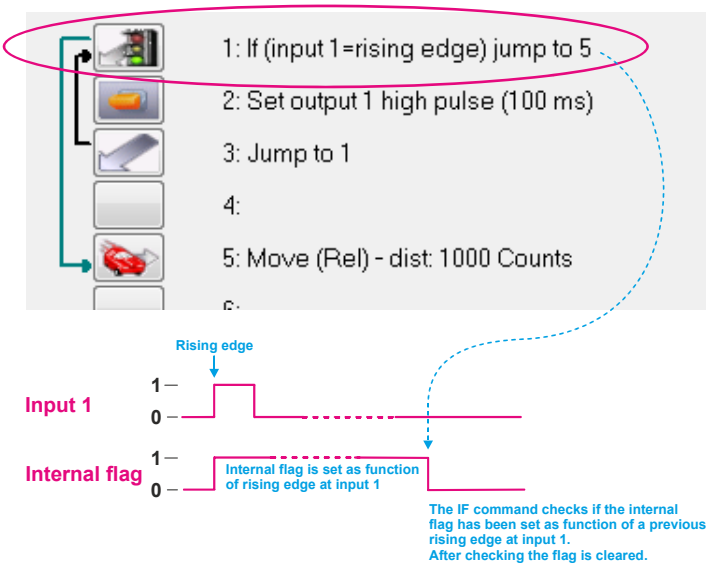
If *input 3* is not active at the time of execution, the program proceeds to line 2.



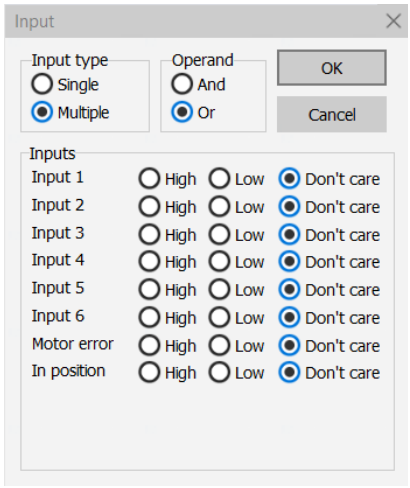
Conditional jump example 2 - Jump controlled by input transition
In the program example below, the command is used in line 1.The program will jump to line 5 if *input 3* has shifted from inactive (0) to active (1).

The function uses an internal flag which is set whenever a rising edge (change from inactive to active in the last 30 microseconds) has been detected.

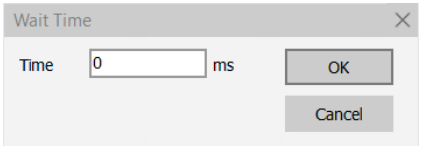
If no shift is detected, the program proceeds to line 2.



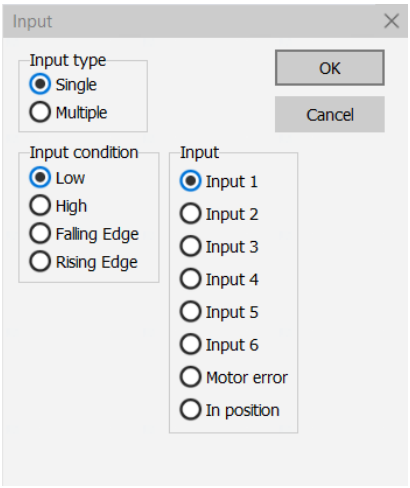
5.5.18 Conditional jump (multiple input)

Icon:	
Dialogue:	
Function:	Jumps to the specified line in the program if the specified input condition is met. If the condition is not met, the program proceeds to execute the next line in the program. When “Multiple” is selected as the “Input type”, multiple outputs can trigger the jump depending on its/their state(s); high or low. The “Don’t care” option will ignore the state of the output. If the “Operand” setting is set to “And”, all inputs must match the chosen state. If set to “Or”, the jump is triggered if any input matches the chosen state. After selecting the input condition, the user must select the destination line. The source line (the line in which this command is placed) is indicated in a text box next to the cursor. The next line that is clicked on will become the jump destination.

5.5.19 Wait for (x) ms before continuing

Icon:	
Dialogue:	
Function:	Pauses the program for the specified time (indicated in milliseconds) before continuing. Value range: 0 to 32767 ms. Note: This command overwrites the “Timer 1” register.

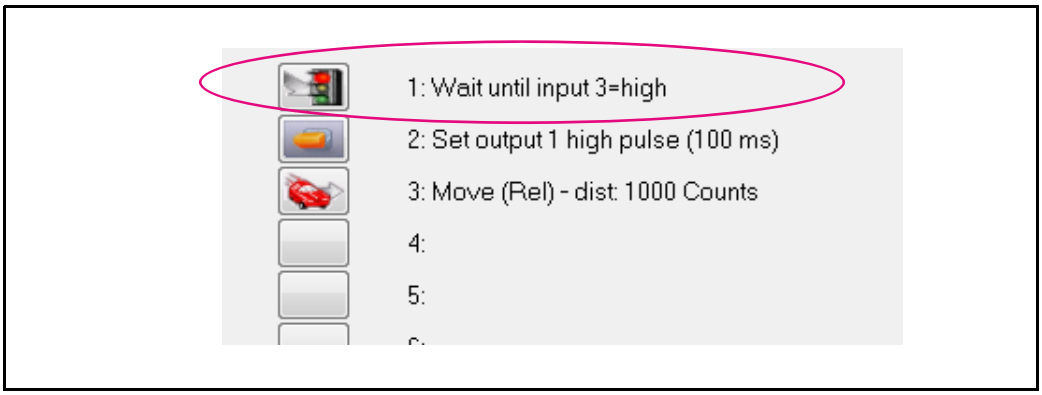
5.5.20 Wait for an input combination before continuing (single input)

Icon:	
Dialogue:	
Function:	Waits for a specified input condition to occur.The next line in the program will not be executed until the input condition has been met. When “Single” is selected as the “Input type”, the command can wait for one of four states: The input is low, the input is high, the input transitioned to low (falling edge), or the input transitioned to high (rising edge). In case an input transition being selected, the transition must have taken place during the last 30 microseconds before the command is executed. The inputs are measured in 30 microsecond intervals.

Examples are given on the following page.

Conditional wait example 1 - Wait for input level
In the program example below, the command is used in line 1.
The program will wait until *input 3* is active (supplied with voltage).

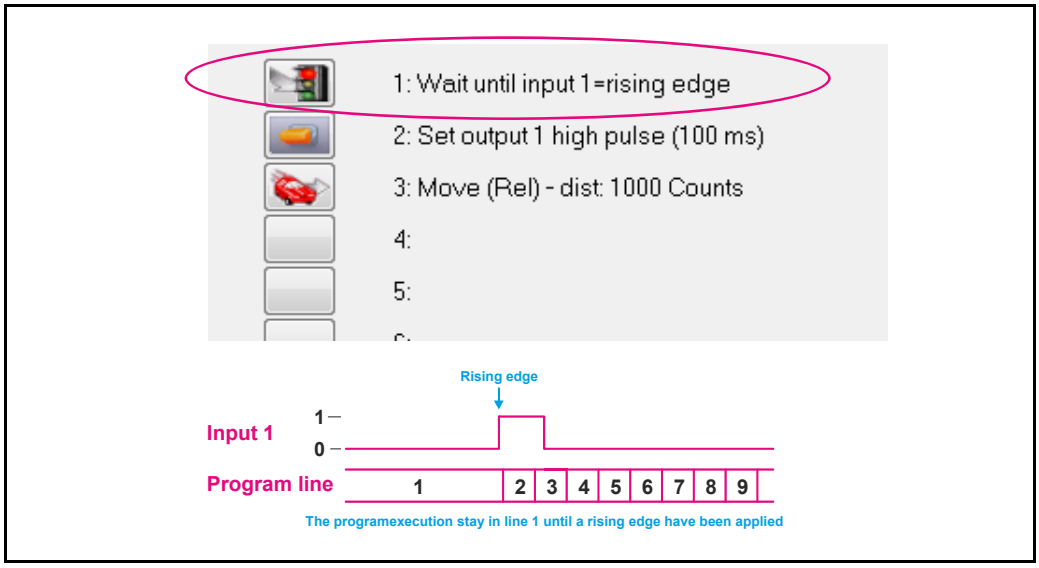
If *input 3* is not active at the time of execution, the program stays on line 1 until it becomes active.



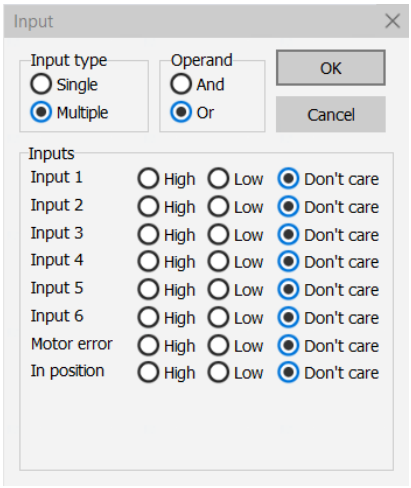
Conditional wait example 1 - Wait for input transition
In the program example below, the command is used in line 1.The program will stall until *input 1* has shifted from inactive (0) to active (1).

The function uses an internal flag which is set whenever a rising edge (change from inactive to active in the last 30 microseconds) has been detected.

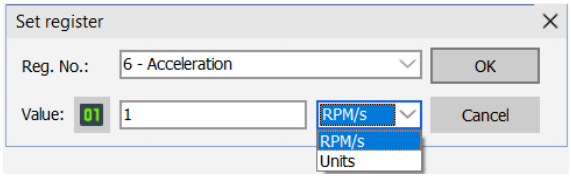
If no shift is detected, the program continues to wait.



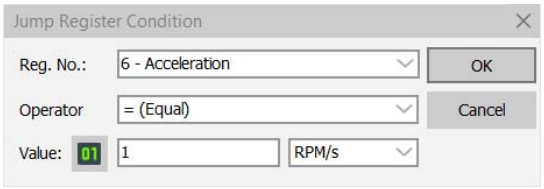
5.5.21 Wait for an input combination before continuing (multiple inputs)

Icon:	
Dialogue:	
Function:	Waits for the specified input state(s) to occur.The next line in the program will not be executed until the input conditions have been met. When “Multiple” is selected as the “Input type”, multiple outputs can end the wait depending on its/their state(s); high or low. The “Don't care” option will ignore the state of the output. If the “Operand” setting is set to “And”, all inputs must match the chosen state. If set to “Or”, the jump is triggered if any input matches the chosen state. The inputs are tested in 30 microsecond intervals.

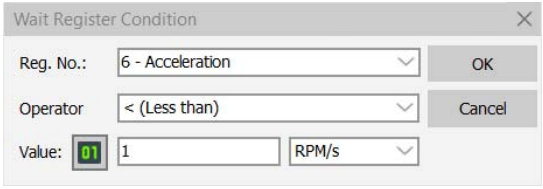
5.5.22 Set register value

Icon:	
Dialogue:	
Function:	Sets a chosen register to a specified value. The register can be selected from a list of user-accessible registers. The value can be entered as MacTalk units (e.g. RPM, RPM/s, etc.) or native motor units (e.g. counts, units etc.) by choosing the desired option in the drop-down menu.

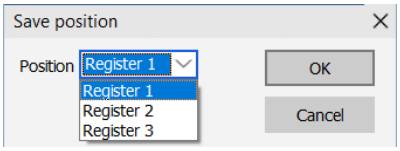
5.5.23 Jump according to a register

Icon:	
Dialogue:	
Function:	Jumps to the specified line in the program if the specified register condition is met. If the condition is not met, the program proceeds to execute the next line in the program. The condition is set up by choosing a register, an operator and a value. The register can be selected from a list of user-accessible registers. The operator is chosen from the drop-down menu and includes options such as equal (=), less than (<), less than or equal (<=) and not equal (<>). The value can be entered as MacTalk units (e.g. RPM, RPM/s, etc.) or native motor units (e.g. counts, units etc.) by choosing the desired option in the drop-down menu. After selecting the input condition, the user must select the destination line. The source line (the line in which this command is placed) is indicated in a text box next to the cursor. The next line that is clicked on will become the jump destination.

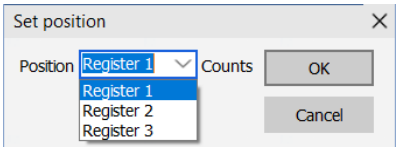
5.5.24 Wait for register value before continuing

Icon:	
Dialogue:	
Function:	Waits until the specified register condition is met. The next line in the program will not be executed until the register condition has been met. The condition is set up by choosing a register, an operator and a value. The register can be selected from a list of user-accessible registers. The operator is chosen from the drop-down menu and includes options such as equal (=), less than (<), less than or equal (<=) and not equal (<>). The value can be entered as MacTalk units (e.g. RPM, RPM/s, etc.) or native motor units (e.g. counts, units etc.) by choosing the desired option in the drop-down menu.

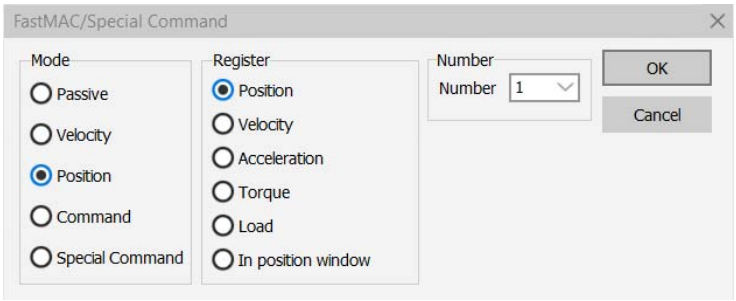
5.5.25 Save position

Icon:	
Dialogue:	
Function:	Saves the current position, *Actual position* (P_IST), register 10, in one of three dedicated position registers. Register x = Actual position. The saved position(s) may be used in move commands, or in the *"Set position"* command.

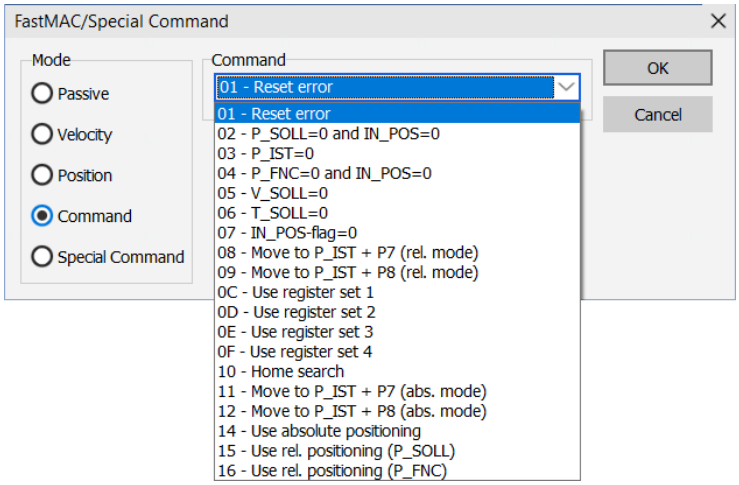
5.5.26 Set position

Icon:	
Dialogue:	
Function:	Sets the current position, *Actual position* (P_IST), register 10), to one of the three dedicated position registers. Actual position = Register x This command is the inverse *"Save position"* command.

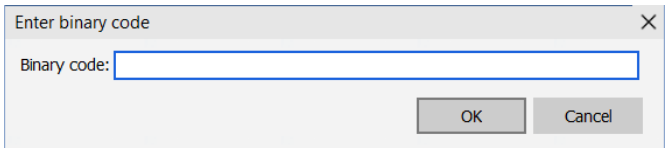
5.5.27 Send FastMAC command (change mode and activate register)

Icon:	
Dialogue:	
Function:	FastMAC commands allows the user to accomplish several tasks. Here, the mode changing and register activation functionality is explained. When *"Passive"*, *"Velocity"*, or *"Position"* mode is chosen, the command allows the user to set mode and change a register to a value from a user register using a single command. The execution time is lower compared to using multiple commands to accomplish the same task. By choosing a *Mode*, *Register* and *Number*, the motor can be set into a mode with the chosen register set to the chosen value. The user registers are registers 49-88 and can be found in the *"Registers"* tab of MacTalk, where their value can also be set. For example, the command in the picture shown above will set the motor to Position mode and set the requested position to the value written in Position 1 (P1), register 49.

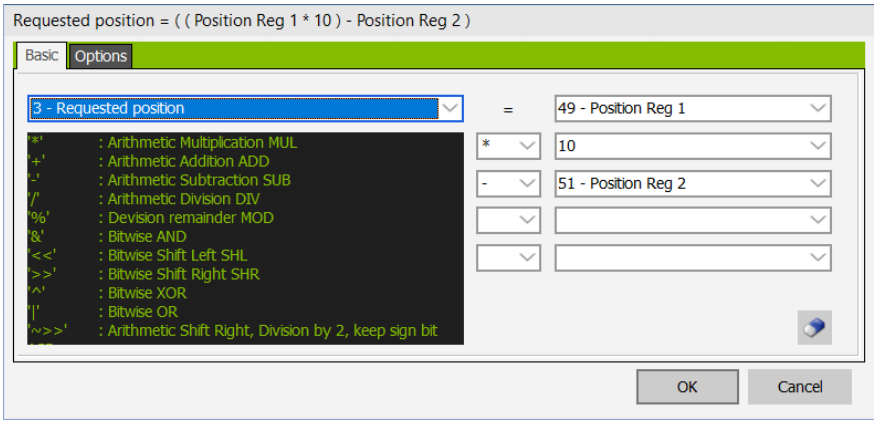
5.5.28 Send FastMac command (command)

Icon:	
Dialogue:	
Function:	FastMAC commands allows the user to accomplish several tasks. Here, the command sending functionality is explained. When *"Command"* or *"Special command"* mode is chosen, the motor does not change mode but can be ordered to carry out various operations. Among these commands are the reset error command, activating homing, synchronizing position and activating user register sets (e.g. setting the requested position to P1, velocity to V1, acceleration to A1 and torque to T1 if set 1 is chosen).

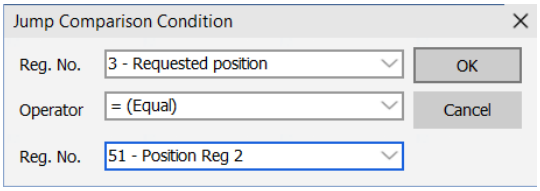
5.5.29 Binary command

Icon:	
Dialogue:	
Function:	**For advanced users only.** Allows the user to send special binary commands. All commands configured in the ePLC are sent to the motor in a compact binary format which is then interpreted by the motor. This commands allows the user to send any command to the motor in binary code. This is only to be used under special circumstances where the user has needs that are not covered by the other commands. In this case, contact JVL for assistance.

5.5.30 Calculator (basic)

Icon:	
Dialogue:	
Function:	Performs calculations using register values and/or number values using 11 different operators. The result of the calculation is stored in the chosen register, marked in blue in the picture. The title bar of the window shows the resulting expression. In the “Options” tab, it is possible to switch between “Numbered list with long MacTalk names” and “Simple list with short firmware names”. This allows the user switch between MacTalk and firmware nomenclature for the register names. For example, the user can switch between using “3 - Requested position” and “P_SOLL”. Note: The values stored in registers using this command use native motor units. For example, velocity is stored in counts per sample rather than RPM. Conversion is automatically performed in other commands such as *“Set a register”, “Jump according to a register”* and *“Wait for a register value before continuing”.*

5.5.31 Jump according to a comparison

Icon:	
Dialogue:	
Function:	Jumps to the specified line in the program if the comparison condition is met. If the condition is not met, the program proceeds to execute the next line in the program. The condition is set up by choosing a register, an operator and another register. The register can be selected from a list of user-accessible registers. The operator is chosen from the drop-down menu and includes options such as equal (=), less than (<), less than or equal (<=) and not equal (<>). The command uses native motor units (for example counts/sample rather than RPM for velocities). Therefore, it is recommended to compare registers with the same units. After selecting the input condition, the user must select the destination line. The source line (the line in which this command is placed) is indicated in a text box next to the cursor. The next line that is clicked on will become the jump destination.

6 Appendix

6.1 Technical Data

6.1.1 Generic technical data for all MAC motors generation III

Type of product	
Technology and concept	AC-servomotor (Brushless) with built-in magnetic encoder, and 3 phase servo amplifier/controller
Communication	
Basic Communication (all models)	Purpose: Monitoring, setup and dynamic change of internal parameters during motor operation. Interface type 2 wire RS485 Modbus 115 kbit/sec. (115kBaud). Address range 1-254
Industrial Ethernet - (optional)	Available now: EthernetIP, ProfiNET, EtherCAT, ModbusTCP. Upcoming: SercosIII, Powerlink.
Control Modes	
Modes available	Position mode, Velocity mode, Homing mode, Gear mode (follow ext. Encoder), Torque mode, Various modes controlled by analogue input or external I/O's.- Please see Mode descriptions in other chapter in this user manual.
Feedback / resolution:	
Internal incremental Encoder resolution	8192 counts per motor revolution. Higher resolutions may be possible on request.
Absolute Multiturn Encoder (optional)	Resolution ±262144 revolutions.
Encoder Technology	Magnetic and energy harvesting (no battery or mechanics = long lifetime)
Servo regulator	
Regulator Technology	Filter 6.th. order filter with only one inertia load factor parameter to be adjusted depending at load inertia
Sample rate (Update frequency)	Default 1.0 ms (1000 Hz) and optionally 1.3 ms, 2.0 ms or 2.6 ms
Amplifier Control System	Sinusoidal current PWM control. Sampling rate 10kHz and PWM switching frequency 10kHz.
Safety functions (optional)	
Type of safety and level	STO input (physical input) according to SIL3 - TÜV certification pending. Support for functional safety protocols: PROFIsafe - in development / CIPsafety - planned / FSoE - planned. Various FuSa functions in development for release in 2026 such as **"Stopping functions"**: STO, SS1-t, SS2-t. **"Monitoring functions"**: SS1-r, SOS, SS2-r, SLS, SSM, SDI, SLP. **"Output functions"**: SBC. All meets SIL3 / PLe.
Digital resolutions and ranges	
Positioning	Position range ±134.217.728 (±2^27) counts (default) and ±2.147.483.648 (±2^31) counts (high resolution mode)
Velocity	Speed range Nominal: ±3000 RPM. Can be set up to ±3600 RPM but triggers an over speed error if 3600 RPM is reached. The internal unit correspond to (factory default): **0.45776 RPM** (1.0ms sample rate) and **0.35211 RPM** (1.3ms sample rate). If "high resolution mode" is activated the internal unit for velocity is as follows: **0.0071256 RPM** (1.0ms sample rate) and **0.0055018 RPM** (1.3ms sample rate) Accuracy: ±0,005% (±50ppm) at ambient temperature 0-40°C: Velocity dependency of supply voltage fluctuations = ±0,0% (no influence)
Acceleration Range	Default: **458 - 732422 RPM/s** (1.0ms sample rate) and **271 - 433353 RPM/s** (1.3ms sample rate) If "high resolution mode" is activated the range is **7.15 - 732422 RPM/s** (1.0ms sample rate) and **4.23 - 433353 RPM/s** (1.3ms sample rate).
Motor Torque	Resolution when internally controlled = 10 bit = 1024 steps (0-300% torque). Resolution if controlled from Analogue input. 10bit (no sign). Sign can be introduced by adding a value in the input offset register. Scale: Torque set to 100% = Nominal motor load. 300% = Full motor peak torque (highest possible torque that can be produced). Torque control accuracy ≤ 10% @ 20°C (Reproducibility)
Digital I/O's (optional)	
Purpose and function	Can be used in general for digital signals in or out such as external sensors or activating external solonoids etc.
Number of I/O's	Up to 8 I/O (incl. 4 analogue inputs). Each can be either input or output
Input activation level	When a given I/O is used as digital input: Logic low = max. 2.5V / Logic high = min. 2.6V
Output current	When a given I/O is used as digital output: Output current up to 350 mA per output at 24V. Short circuit protected.
Multifunction I/O's (optional)	
Purpose and function	Dual RS422 port can be used as input for external encoder, or output from internal encoder, or data communication.
Max. frequency/data rate	Input frequency 0-8 MHz (8 Mbit/sec). 0-1 MHz (1 Mbit/sec.) with input filter.
Analogue Inputs (optional)	
Purpose and function	Can be setup to control velocity, torque or any other internal parameter in the motor.
Number of inputs	Up to 4 inputs. Notice that these are sharing terminals with the up to 8 digital I/O's.
Resolution	10bit (no sign). Range 0.00 -5.00V. Not galvanically isolated.
Input voltage range	Nom. input voltage IN1 to IN4 (option dependant). Voltage range max. -10 to +32VDC.
Input offset and impedance	Offset typical ±50mV and input impedance to ground = 30kOhm @0-5V
Various	
Electromechanical brake (optional)	The brake is activated automatically when the motor is passive.and not able to control the motor in position in case of i.e. error.
Default rotation direction	Positive direction -> Motor shaft rotate clockwise (Seen from shaft end). Can be inverted by motor parameter.
Protective functions	Error trace back, Overload (I^2T) - Load exceed maximum for too long time, Regenerative overload, follow error, function error, regenerative overload (over voltage), position limit exceeded. Abnormality in flash memory, under voltage, over current, temperature too high. and many others.
LED Indicators (all motor types)	The motor is equipped with 5 Bi-colour LED's: See LED chapter for explanation. LED function depends on installed motor options
Leakage current to earth	Leakage current to earth: Less than 3 mA @ 50/60 Hz
Protection Class	IP55 (standard) or IP66 (extended)
Homing Methods	1: Automatic *Homing* with sensor connected to input (2 formats) 2: Mechanical *Homing* without sensor. (Torque controlled)
Certifications and approvals	Conforms to CE regulations - find EU - Declaration of Conformity in appendix of user manual. UL File: Pending
Usage / Storage Temperature and Humidity	Ambient 0 to +40°C (32-104°F)/ Storage (power not applied): -20 to +85°C. (-4 to 185°F). Humidity Max. 90% non condensing. Temperature shut down and error message generated at 95°C (203F).

Data in red are under evaluation by JVL's R&D department

6.1 Technical Data

6.1.2 Individual technical data for each motor size/type.

Below data tables for each individual type and motor size in the MAC motor family generation III.

Data for only MAC404			
Motor data	Motor sub types	**MAC404-M1 to M3** (w/o brake)	**MAC404-M4 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	400 W	
	Rated Torque RMS / Peak Torque	1.27 Nm / 3.8 Nm	
	Inertia (kg/cm²)	0.52 kg/cm²	0.54 kg/cm²
	Maximum radial / axial force at motor shaft	Fr 245 / Fa 74 N	
	Length	170 mm ±2 mm	206 mm ±2 mm
	Weight	2 kg	2.4 kg
	Electrical / Mechanical motor time constant	2.03 / 1.23 ms	2.03 / 1.26 ms
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T6.3A@230VAC or T10A@115VAC if automatic use class D	
Brake resistor	Regenerative power dump (brake resistor circuit)	Internal 4W average / External output 25A peak	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	**YES** - Holding torque >2 Nm
	Backlash (when brake is activated)	(not relevant)	< ±0.5 degree
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	TBD dB(A)
	Timing: release and activate time	(not relevant)	50 / 20 ms.
Speed range	0-3000RPM with nom. torque. (maximum 4000RPM short-term). Speed protection trips at >4300RPM the motor will shut down.		
Input power supply	115 or 230AC (±10%), 47-63Hz for main power circuit. 18-32VDC for control circuit. Inrush current < 5A at 115/230VAC. Consumption at 115-230VAC up to 470W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC404M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC404M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Frontflange: 60x60mm. Shaft diameter Ø14mm - see also the chapter "Physical dimensions" in this user manual		

Data for only MAC604			
Motor data	Motor sub types	**MAC604-M2 to M3** (w/o brake)	**MAC604-M5 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	600 W	
	Rated Torque RMS / Peak Torque	1.91 Nm / 5.73 Nm	
	Inertia (kg/cm²)	0.84 kg/cm²	0.86 kg/cm²
	Maximum radial / axial force at motor shaft	Fr 245 / Fa 74 N	
	Length	188 mm ±2 mm	224 mm ±2 mm
	Weight	TBD kg	TBD kg
	Electrical / Mechanical motor time constant	4.86 / 1.10 ms	4.86 / 1.15 ms
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T8A@230VAC or T15A@115VAC if automatic use class D	
Brake resistor	Regenerative power dump (brake resistor circuit)	Internal 4W average / External output 25A peak	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	**YES** - Holding torque >2 Nm
	Backlash (when brake is activated)	(not relevant)	< ±0.5 degree
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	TBD dB(A)
	Timing: release and activate time	(not relevant)	50 / 20 ms.
Speed range	0-3000RPM with nom. torque. (maximum 3400RPM short-term). Speed protection trips at >3600RPM the motor will shut down.		
Input power supply	115 or 230AC (±10%), 47-63Hz for main power circuit. 18-32VDC for control circuit. Inrush current < 5A at 115/230VAC. Consumption at 115-230VAC up to 705W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC604M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC604M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Frontflange: 60x60mm. Shaft diameter Ø14mm - see also the chapter "Physical dimensions" in this user manual		

Data for only MAC802			
Motor data	Motor sub types	**MAC802-M2 to M3** (w/o brake)	**MAC802-M5 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	750 W	
	Rated Torque RMS / Peak Torque	2.39 Nm / 7.17 Nm	
	Inertia (kg/cm²)	1.36 kg/cm²	TBD kg/cm²
	Maximum radial / axial force at motor shaft	Fr 392 / Fa 147 N	
	Length	156 mm ±2 mm	TBD mm ±2 mm
	Weight	TBD kg	TBD kg
	Electrical / Mechanical motor time constant	2.03 / 1.23 ms	2.03 / 1.26 ms
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T80A@24VDC if automatic use class D	
Brake resistor	No internal brake resistor	Use external brake resistor device if needed	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	**YES**
	Backlash (when brake is activated)	(not relevant)	< ±1 degree
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	TBD dB(A)
Speed range	0-3000RPM with nom. torque. (maximum 3400RPM short-term). Speed protection trips at >3600RPM the motor will shut down.		
Input power supply	12-48VDC for main power circuit. **≥24VDC** is mandatory to run nominal speed and power. Maximum speed will be proportionally deducted with a supply lower than 24VDC. Secondary supply 8-32VDC for the control circuit (terminal CVI). Consumption at 24VDC up to 880W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC802M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC802M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Front: 80x80mm. Shaft diameter Ø19mm - see also the chapter "Physical dimensions" in this user manual		

6.1 Technical Data

Technical data for each motor size/type (continued)

Data for only MAC804			
Motor data	Motor sub types	**MAC804-M2 to M3** (w/o brake)	**MAC804-M5 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	750 W	
	Rated Torque RMS / Peak Torque	2.39 Nm / 7.17 Nm	
	Inertia (kg/cm²)	1.63 kg/cm²	1.73 kg/cm²
	Maximum radial / axial force at motor shaft	Fr 392 / Fa 147 N	
	Length	188 mm ±2 mm	227 mm ±2 mm
	Weight	TBD kg	TBD kg
	Electrical / Mechanical motor time constant	4.6 / 0.96 ms	4.6 / 1.02 ms
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T10A@230VAC or T15A@115VAC if automatic use class D	
Brake resistor	Regenerative power dump (brake resistor circuit)	Internal 10W average / External output 40A peak	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	**YES**
	Backlash (when brake is activated)	(not relevant)	< ±1 degree
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	TBD dB(A)
Speed range	0-3000RPM with nom. torque. (maximum 3400RPM short-term). Speed protection trips at >3600RPM the motor will shut down.		
Input power supply	115 or 230AC (±10%), 47-63Hz for main power circuit. 18-32VDC for control circuit. Inrush current < 5A at 115/230VAC. Consumption at 115-230VAC up to 880W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC804M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC804M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Frontflange: 60x60mm. Shaft diameter Ø14mm - see also the chapter "Physical dimensions" in this user manual		

Data for only MAC1004			
Motor data	Motor sub types	**MAC1004-M2 to M3** (w/o brake)	**MAC1004-M5 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	1000 W	MAC1004 with integrated brake is not available - use MAC804 or MAC1404
	Rated Torque RMS / Peak Torque	3.18 Nm / 9.55 Nm	
	Inertia (kg/cm²)	1.81kg/cm²	
	Maximum radial / axial force at motor shaft	Fr 392 / Fa 147 N	
	Length	198 mm ±2 mm	
	Weight	3.8 kg	
	Electrical / Mechanical motor time constant	4.86 / 1.10 ms	
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T10A@230VAC / T15A@115VAC If automatic use class D	
Brake resistor	Regenerative power dump (brake resistor circuit)	Internal 10W average External output 40A peak	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	
	Backlash (when brake is activated)	(not relevant)	
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	
Speed range	0-3000RPM with nom. torque. (maximum 3400RPM short-term). Speed protection trips at >3600RPM the motor will shut down.		
Input power supply	115 or 230AC (±10%), 47-63Hz for main power circuit. 18-32VDC for control circuit. Inrush current < 5A at 115/230VAC. Consumption at 115-230VAC up to 1175W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC1004M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC1004M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Frontflange: 60x60mm. Shaft diameter Ø14mm - see also the chapter "Physical dimensions" in this user manual		

Data for only MAC1202			
Motor data	Motor sub types	**MAC1202-M2 to M3** (w/o brake)	**MAC1202-M5 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	1200 W	
	Rated Torque RMS / Peak Torque	3.82 Nm / 11.46 Nm	
	Inertia (kg/cm²)	2.47 kg/cm²	TBD kg/cm²
	Maximum radial / axial force at motor shaft	Fr 392 / Fa 147 N	
	Length	189.5 mm ±2 mm	223.5 mm ±2 mm
	Weight	TBD kg	TBD kg
	Electrical / Mechanical motor time constant	9.2 / 0.96ms	9.2 / TBD ms
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T100A@24VDC if automatic use class D	
Brake resistor	No internal brake resistor or circuitry	Use external brake resistor device if needed	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	**YES**
	Backlash (when brake is activated)	(not relevant)	< ±1 degree
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	TBD dB(A)
Speed range	0-3000RPM with nom. torque. (maximum 3400RPM short-term). Speed protection trips at >3600RPM the motor will shut down.		
Input power supply	12-48VDC for main power circuit. **≥24VDC** is mandatory to run nominal speed and power. Maximum speed will be proportionally deducted with a supply lower than 24VDC. Secondary supply 8-32VDC for the control circuit (terminal CVI). Consumption at 24VDC up to 1400W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC1202M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC1202M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Front: 80x80mm. Shaft diameter Ø19mm - see also the chapter "Physical dimensions" in this user manual		

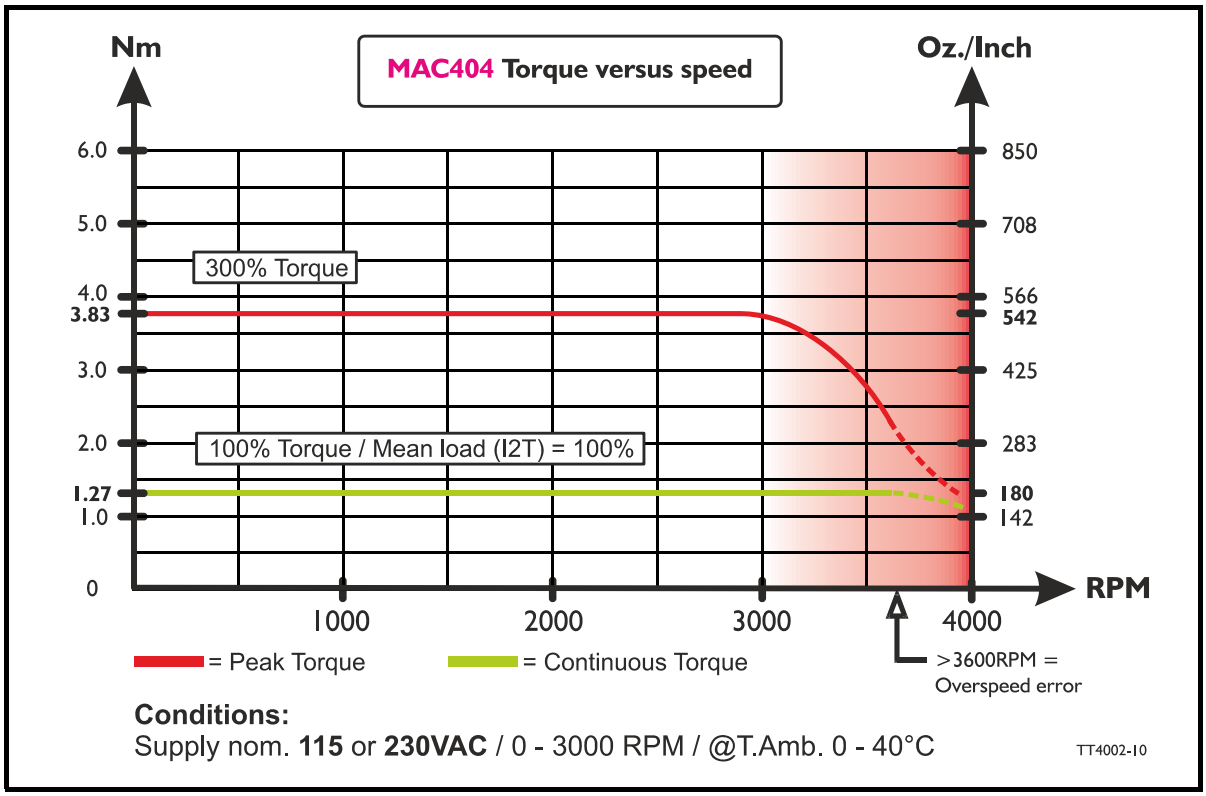
6.1 Technical Data

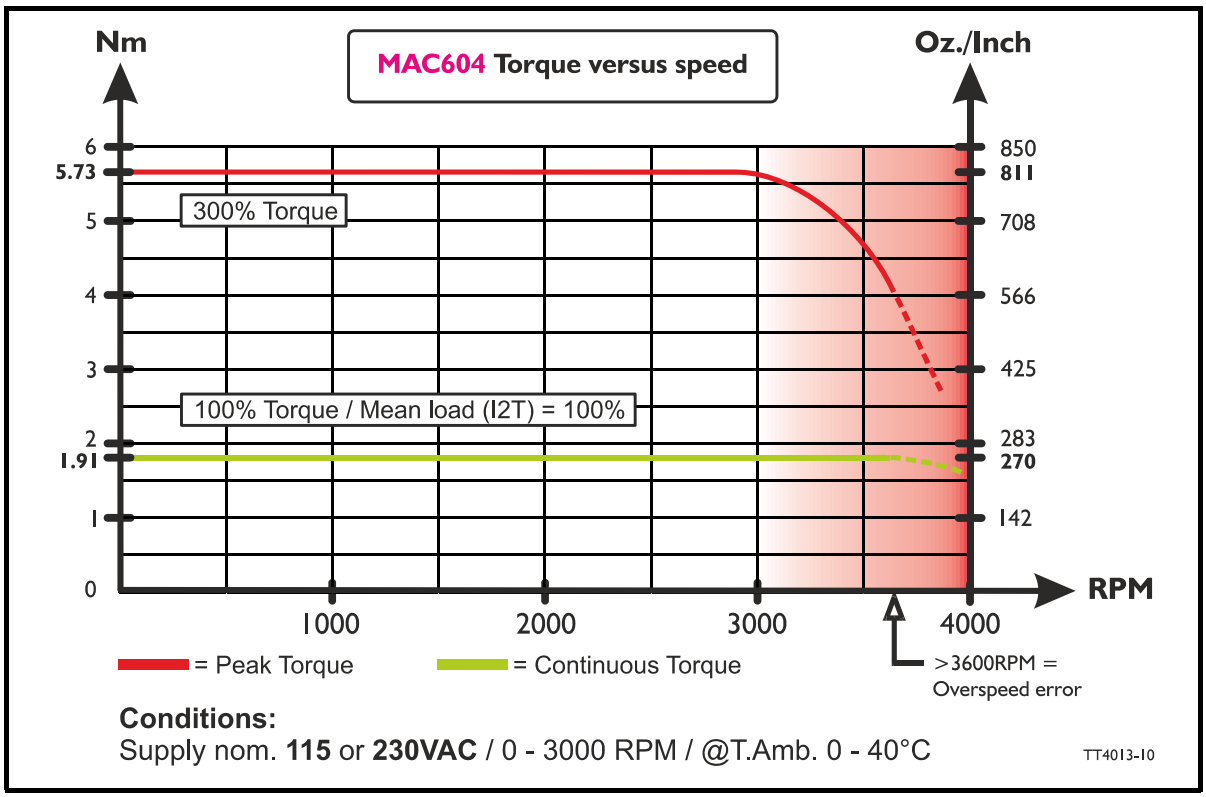
Technical data for each motor size/type (continued)

Data for only MAC1403			
Motor data	Motor sub types	**MAC1403-M2 to M3** (w/o brake)	**MAC1403-M5 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	1500 W	
	Rated Torque RMS / Peak Torque	4.78 Nm / 14.33 Nm	
	Inertia (kg/cm²)	3.15 kg/cm²	3.25 kg/cm²
	Maximum radial / axial force at motor shaft	Fr 392 / Fa 147 N	
	Length	199.5 mm ±2 mm	236.5 mm ±2 mm
	Weight	4.0 kg	5.1 kg
	Electrical / Mechanical motor time constant	10.3 / 0.85ms	10.3 / TBD ms
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T50A@48VDC if automatic use class D	
Brake resistor	No internal brake resistor or circuitry	Use external brake resistor device if needed	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	**YES**
	Backlash (when brake is activated)	(not relevant)	< ±1 degree
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	TBD dB(A)
Speed range	0-3000RPM with nom. torque. (maximum 3400RPM short-term). Speed protection trips at >3600RPM the motor will shut down.		
Input power supply	12-48VDC for main power circuit. **48VDC** is mandatory to run nominal speed and power. Maximum speed will be proportionally deducted with a supply lower than 48VDC. Secondary supply 8-32VDC for the control circuit (terminal CVI). Consumption at 48VDC up to 1760W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC1403M1, M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC1403M4, M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Front: 80x80mm. Shaft diameter Ø19mm - see also the chapter "Physical dimensions" in this user manual		

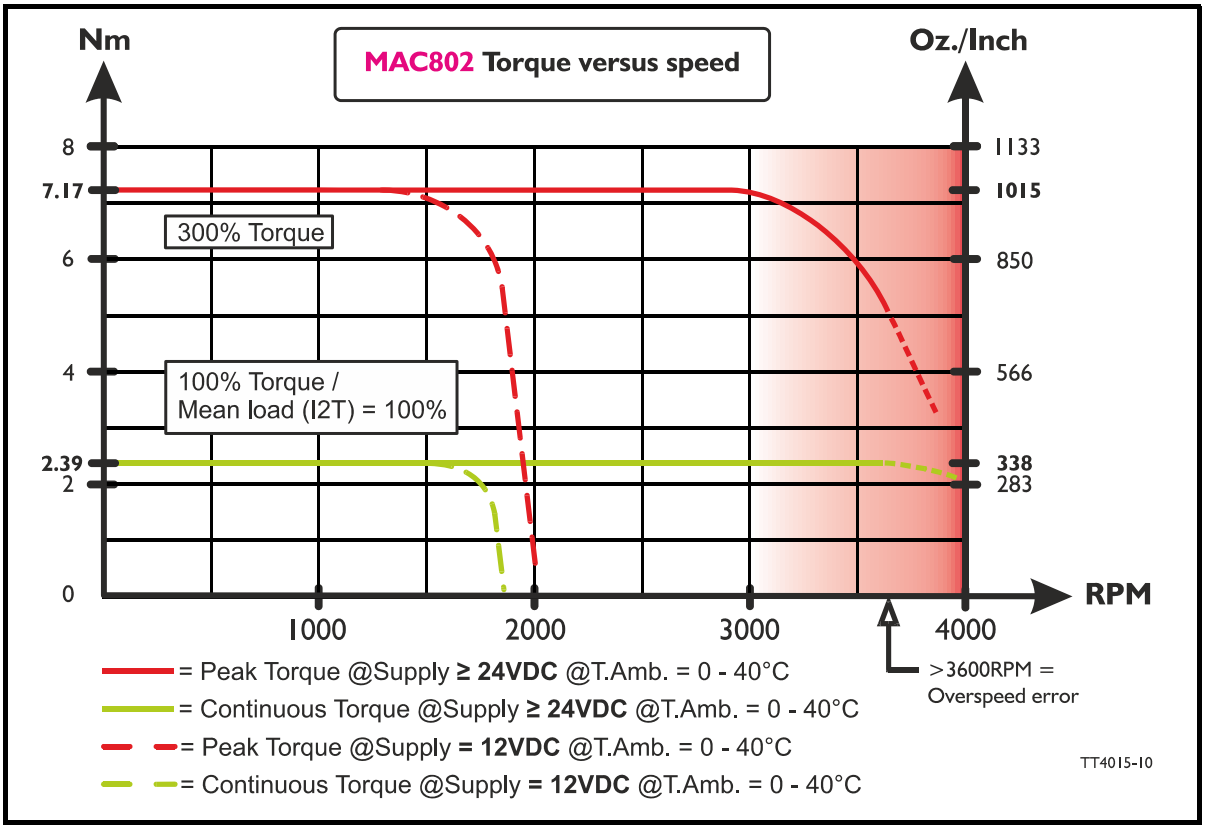
Data for only MAC1404			
Motor data	Motor sub types	**MAC1404-M1 to M3** (w/o brake)	**MAC1404-M4 to M6** (w/brake)
	Rated output @3000 RPM cont. in rated temp. range	1500 W	
	Rated Torque RMS / Peak Torque	4.78 Nm / 14.33 Nm	
	Inertia (kg/cm²)	3.15 kg/cm²	3.25kg/cm²
	Maximum radial / axial force at motor shaft	Fr 335 N/ Fa 167 N	
	Length	231 mm ±2 mm	268 mm ±2 mm
	Weight	TBD kg	TBD kg
	Electrical / Mechanical motor time constant	7.44 / 0.76 ms	7.44 / 0.78 ms
Pre-fuse	Recommended rating of the connected pre-fuse in supply	T12A@230VAC or T20A@115VAC if automatic use class D	
Brake resistor	Regenerative power dump (brake resistor circuit)	Internal 10W average / External output 40A peak	
Brake (optional)	Integrated electromagnetic safety brake	**NO**	**YES**
	Backlash (when brake is activated)	(not relevant)	< ±1 degree
	Audible brake noise level (measured in 30 cm distance)	(not relevant)	TBD dB(A)
Speed range	0-3000RPM with nom. torque. (maximum 3400RPM short-term). Speed protection trips at >3600RPM the motor will shut down.		
Input power supply	115 or 230AC (±10%), 47-63Hz for main power circuit. 18-32VDC for control circuit. Inrush current < 5A at 115/230VAC. Consumption at 115-230VAC up to 1760W average. See also power supply chapter in this user manual. Control circuitry consumption (typical): MAC1404M2 or M3 (wo/brake) = Typical 0.22A @ 24VDC(5.3W). Control circuitry consumption (typical): MAC1404M5 or M6 (w/brake) = Typical 0.54A @ 24VDC(13W).		
Flange and shaft	Front: 80x80mm. Shaft diameter Ø19mm - see also the chapter "Physical dimensions" in this user manual		

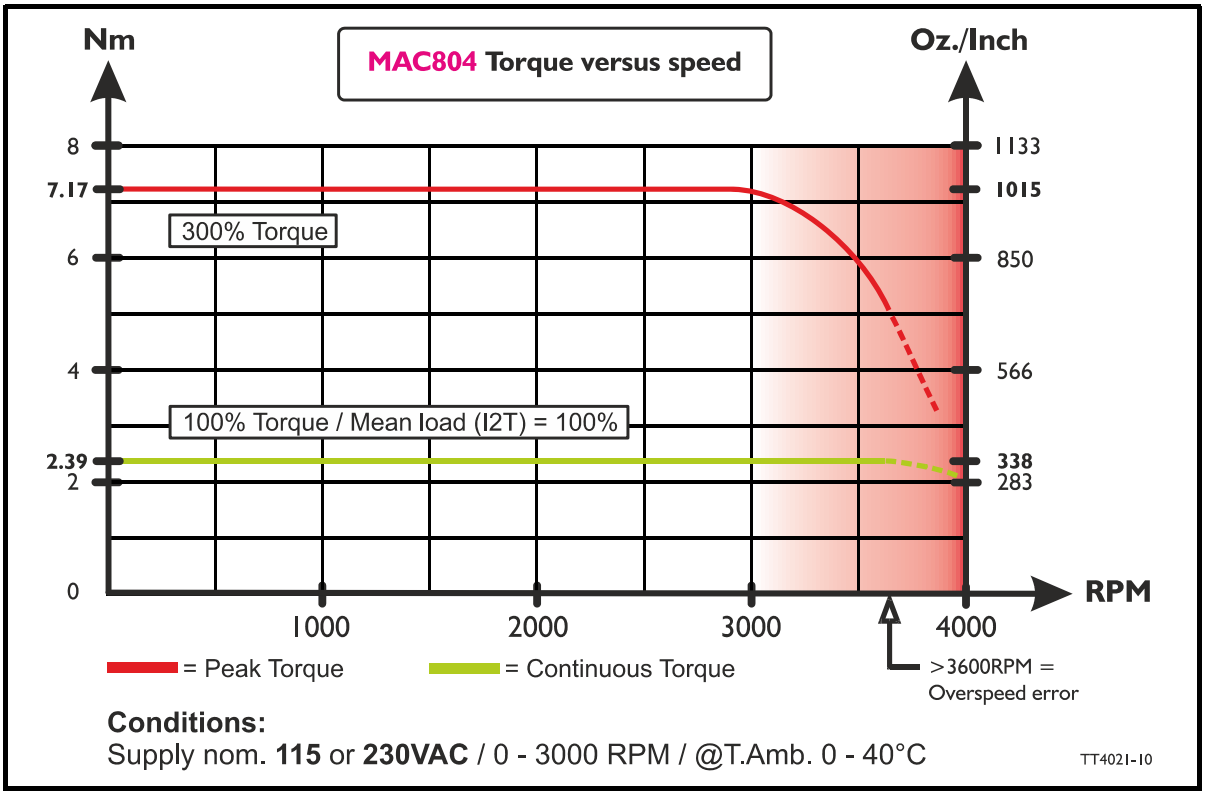
6.2 Torque Performance Curves



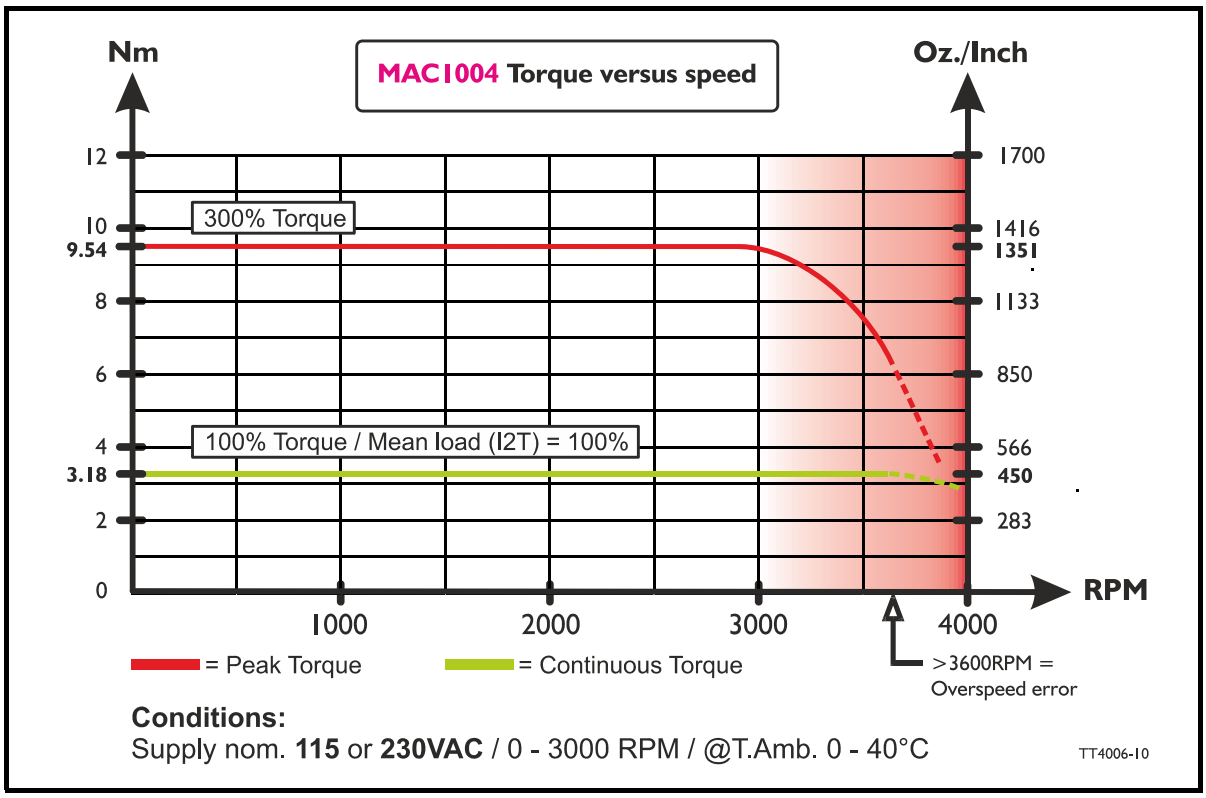


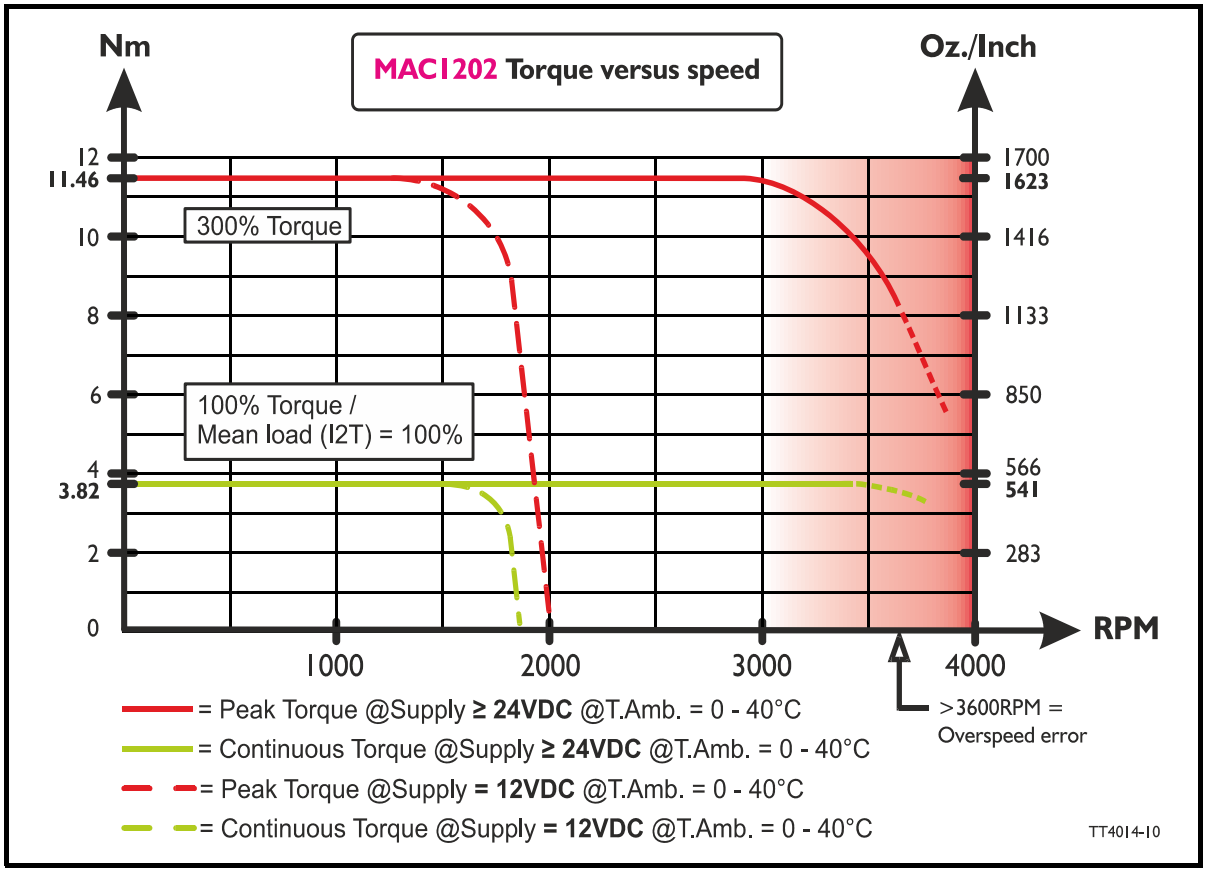
6.2 Torque Performance Curves



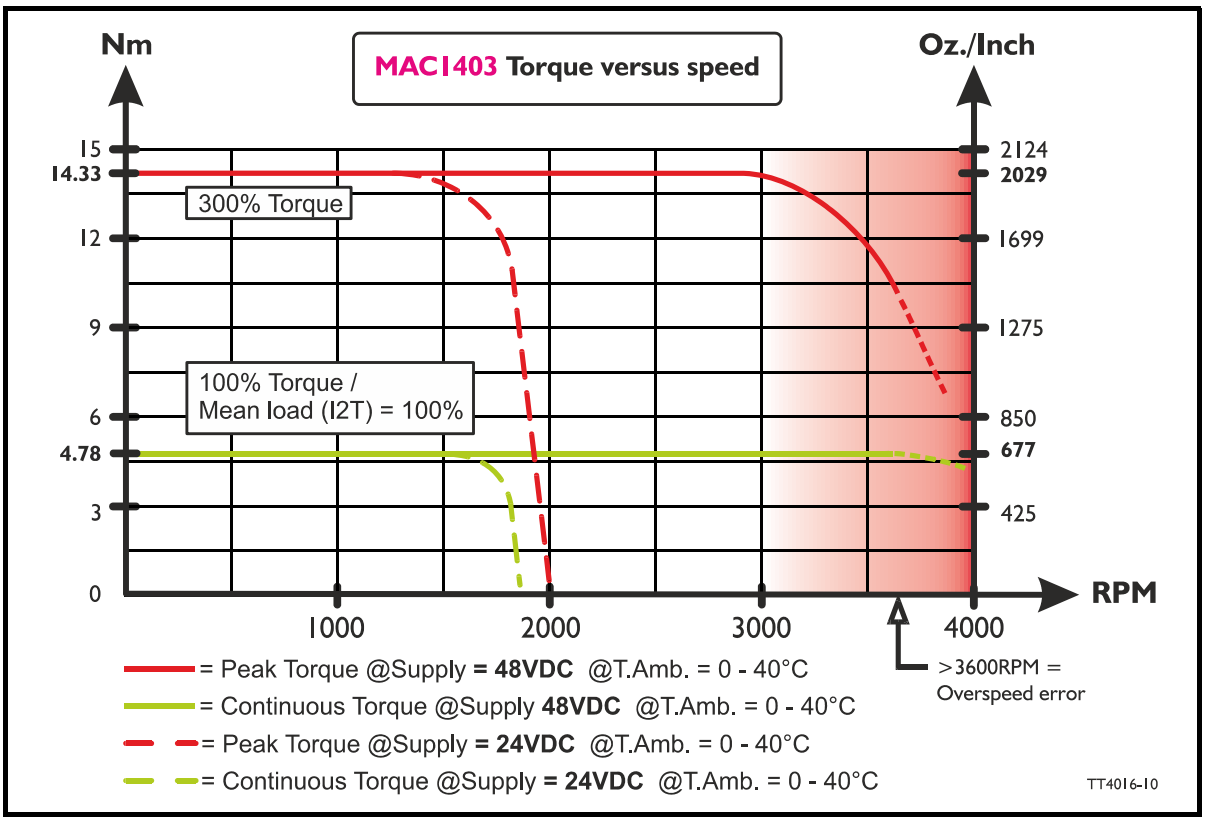


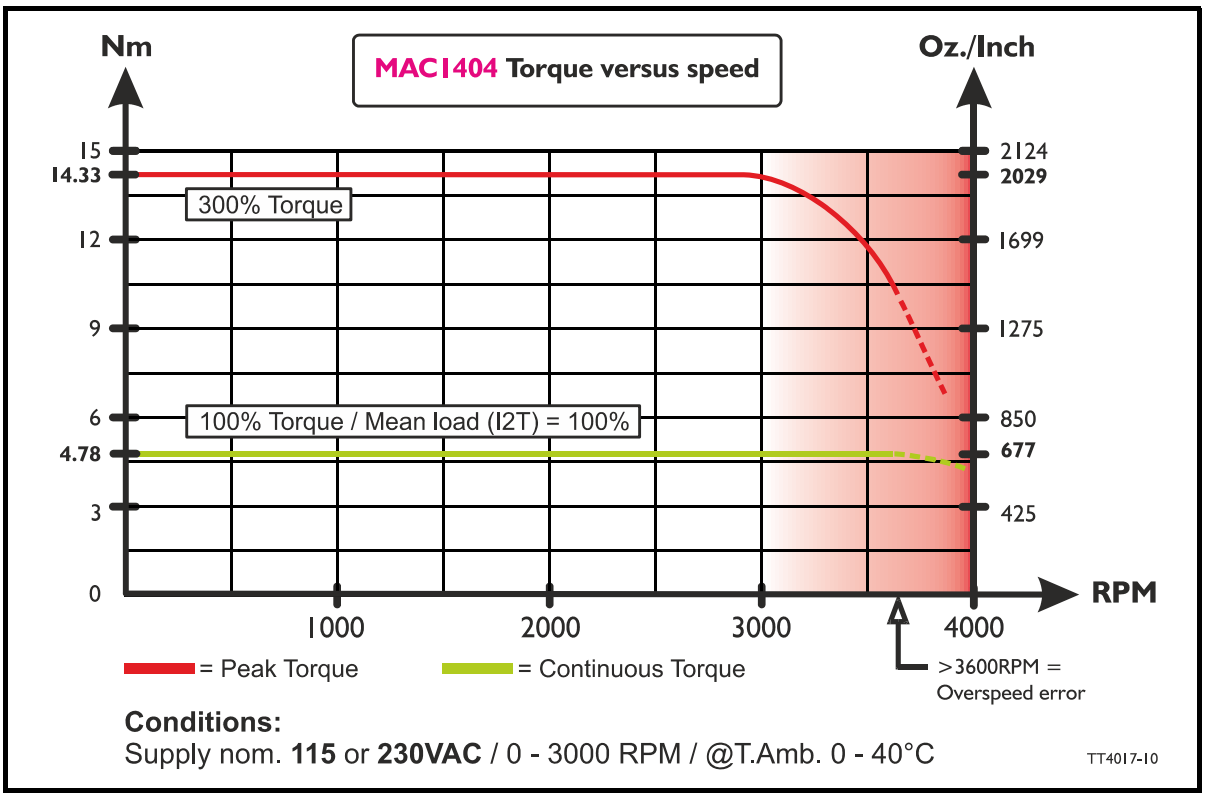
6.2 Torque Performance Curves





6.2 Torque Performance Curves

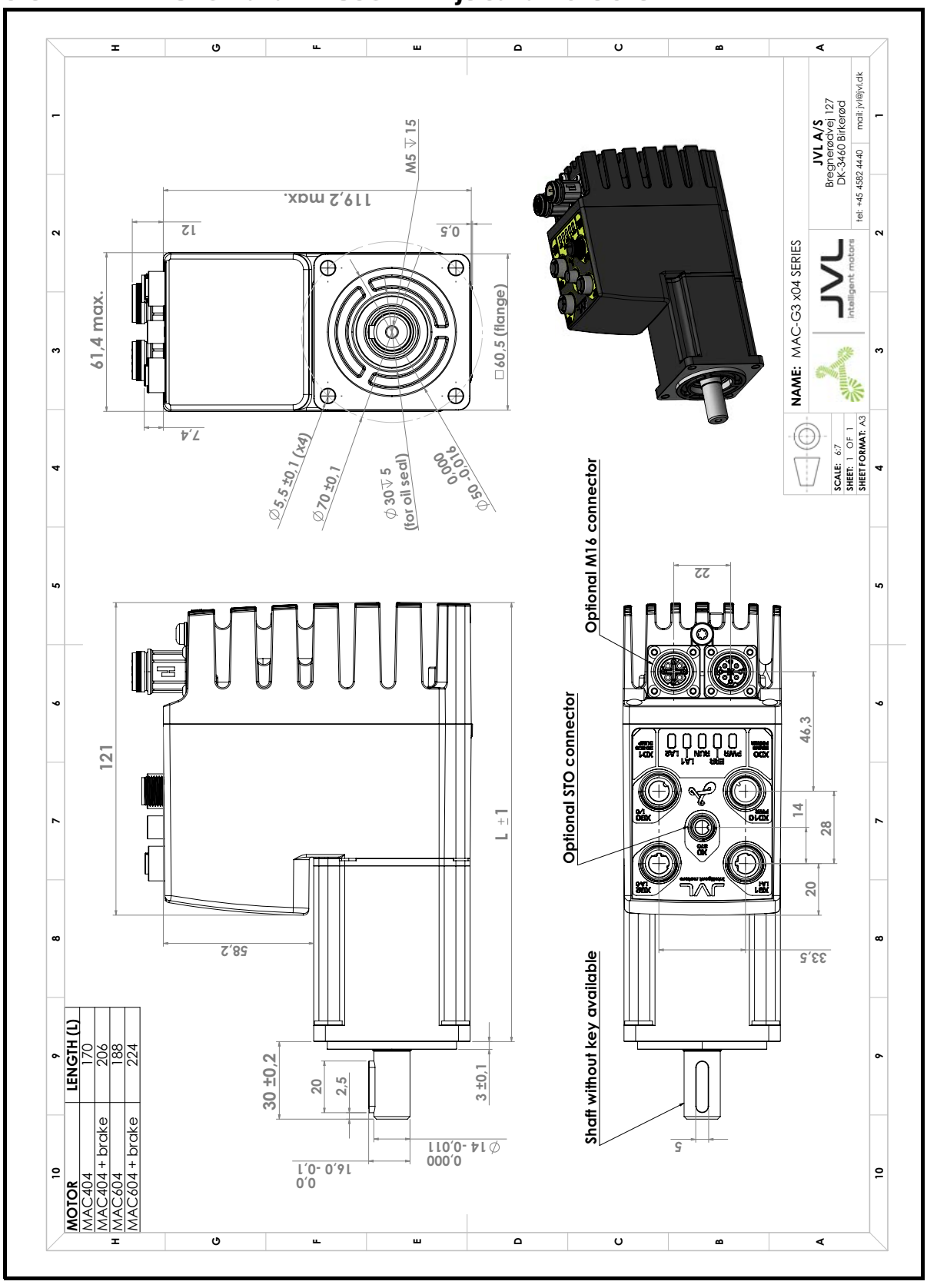




6.3 Physical dimensions

Only MAC404 and 604

6.3.1 MAC404 and MAC604 - Physical dimensions

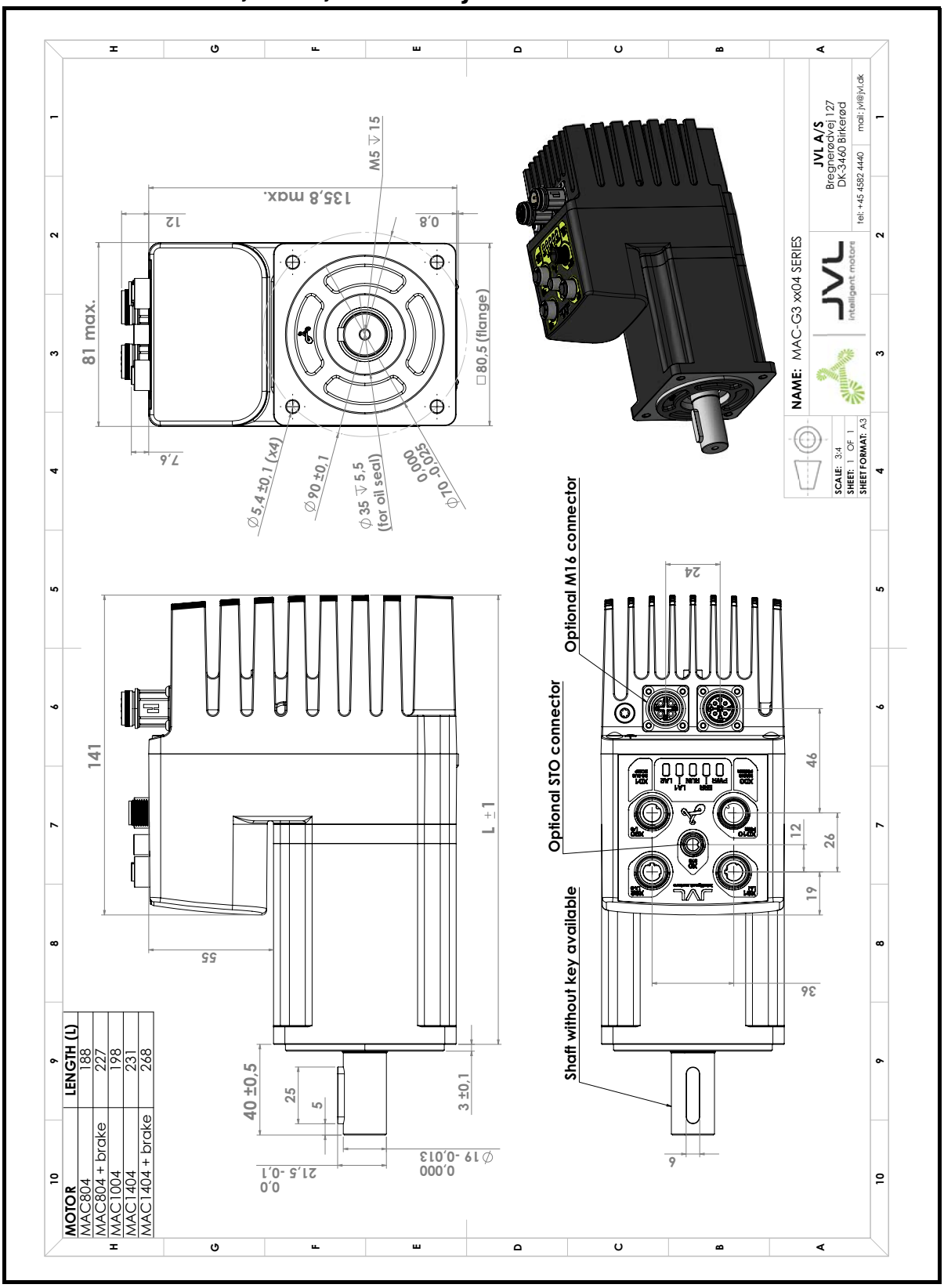


Download CAD drawings from www.jvl.dk/default.asp?Action=Details&Item=426

6.3 Physical dimensions

Only MAC08xx and 1xxx

6.3.2 MAC804, 1004, 1404 - Physical dimensions

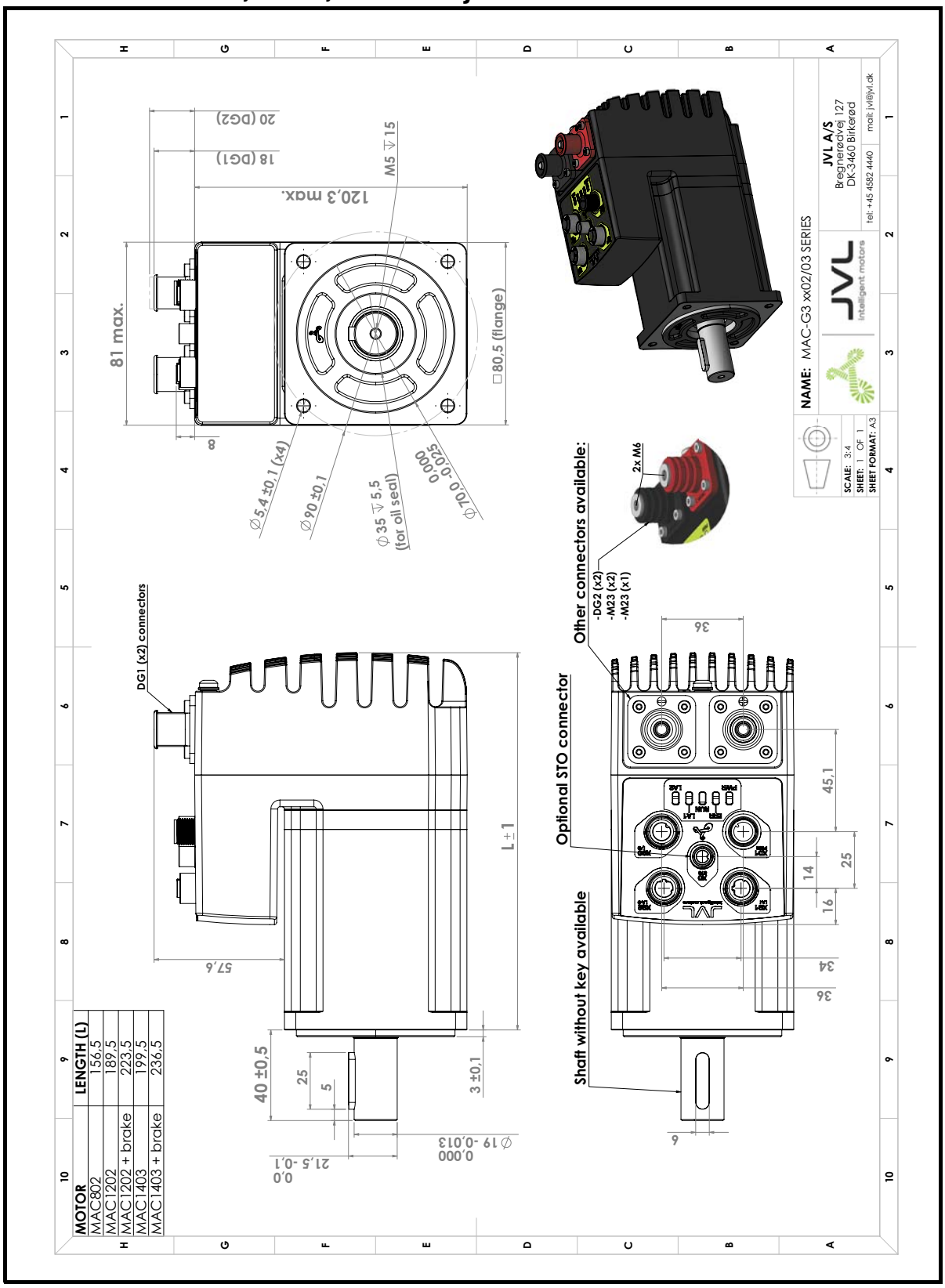


Download CAD drawings from www.jvl.dk/default.asp?Action=Details&Item=426

6.3 Physical dimensions

Only MACxxx2 and xxx3

6.3.3 MAC802, 1202, 1403 - Physical dimensions



Download CAD drawings from www.jvl.dk/default.asp?Action=Details&Item=426

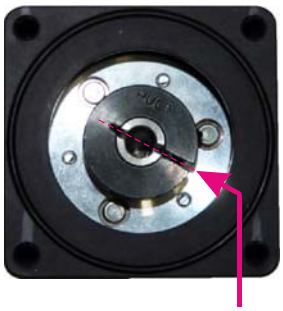
6.4 Installation Instructions

6.4.1 Mounting a gear or a brake at the motor

When a gear or a brake is to be mounted on the front end of a motor it is very important that this is done in the right way since a wrong way of mounting may have fatal influence at lifetime of the motor or gear/brake and performance.
Please follow this instruction step by step to make sure that the mounting is done with a good result.

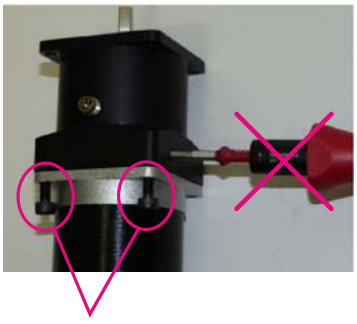
1 Step 1 - Make sure that the shaft collar is oriented correctly in order to assure that the right tension around the motor shaft is possible.
Hint: Tighten the shaft collar gently just to keep it in the right position.

The inner and outer slit is NOT aligned. Make sure they are aligned as shown at right illustration



The inner and outer slit is aligned as they should.

2 Step 2 - Mount the gear or brake at the motor but make sure to fasten the 4 shaft bolt first before fastening the shaft collar.
Its recommended to use Locktite 278 in the threats to make sure that the bolts stay in place.

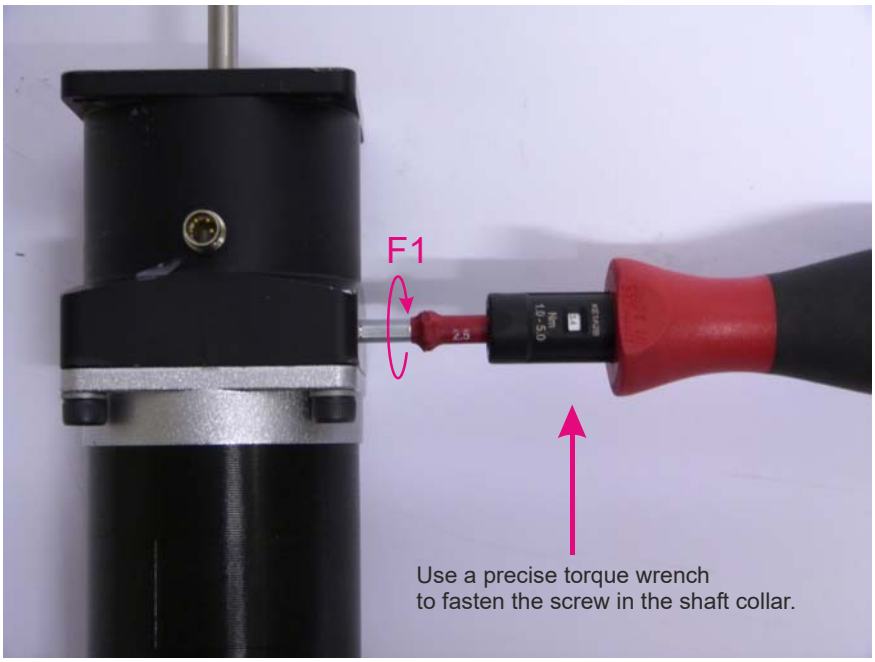


Do NOT tighten the shaft collar before the flange bolts are tightend

Flange bolts properly mounted and tightend.

TT1536-01GB

3 Step 3 - Final stage. Fasten the shaft collar with a torque of according to the scheme below.
Please notice that it can be fatal not to use the specified torque since the shaft may slip over time and cause a position offset.



Gears (Product type to be mounted)

Series	Used with motor type	Tool	Torque (F1)
HTRG05	**MAC050 to MAC141** (Ø6.35 shaft)	**Hex size 3**	**5Nm**
HTRG05	**MIS230-233** (Ø6.35 shaft)	**Hex size 3**	**5Nm**
HTRG06	**MAC050 to MAC141** (Ø6.35 shaft)	**Hex size 3**	**5Nm**
HTRG06	**MAC400-402** (Ø14 shaft)	**Hex size 3**	**11Nm**
HTRG08	**MIS340-341** (Ø9.53 shaft)	**Hex size 4**	**5Nm**
HTRG08	**MIS342** (Ø14 shaft)	**Hex size 5**	**8Nm**
HTRG08	**MAC800** (Ø19 shaft)	**Hex size 5**	**11Nm**
HTRG10	**MAC800** (Ø19 shaft)	**Hex size 5**	**11Nm**

Brakes (Product type to be mounted)

Series	Used with motor type	Tool	Torque (F1)
MAB23x	**MAC050 to MAC141** (Ø6.35 shaft)	**Hex size 2.5**	**2Nm**
MAB23x	**MIS230-233** (Ø6.35 shaft)	**Hex size 2.5**	**2Nm**
MAB34x	**MIS340-341** (Ø9.53 shaft)	**Hex size 3**	**5Nm**
			TT1537-01GB

6.4.2 Operation at higher altitudes

Since the air density at higher altitudes is lower it becomes more difficult for the motor to dissipate the heat losses to the surrounding air.

If an installation is done at more than 1000m (3281ft) the output power is de-rated as shown below in the table.

Derating of MAC or MIS motors as function of altitude									
Height above sea level (m)	=< 1000	1500	2000	2500	3000	3500	4000	4500	5000
Height above sea level (ft)	=< 3281	4921	6562	8202	9843	11483	13123	14764	16404
Power rating %	100	96	92	88	84	80	76	72	68

Example:
A MAC404 motor with a nominal power rating of 400W is operating in an altitude of 2500m above sea level.
The power rating at this level is 88% which means that the nominal power is de-rated to 352W.

Since the heat dissipation in the motor and electronics is primarily influenced by the actual torque it is recommended to lower the torque to keep within the maximum power. The speed can be kept at the nominal value.

6.4 Installation Instructions

6.4.3 Precautions when installing IPx5/x6/x7 motors

When installing MAC motors with a higher ingress protection (IPx5/x6/x7) a few rules must be respected in order to assure no ingress over time.

Please notice:
The MAC products are not covered by the warranty if the following rules/ guidance is not fully followed.

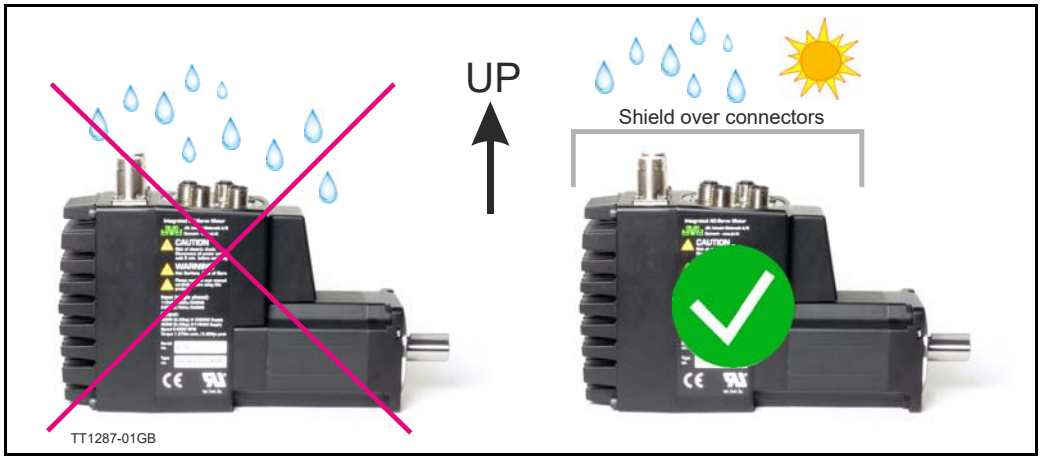
Rule 1 - Connectors

Make sure to tighten all connectors with a proper high torque to make sure that no moisture/liquids can find a way inside the connector.
All circular connectors at motors and modules including cables with matching connectors offered by JVL is guaranteed to be IP67 or higher but under the condition that they are tightened with a proper high torque.

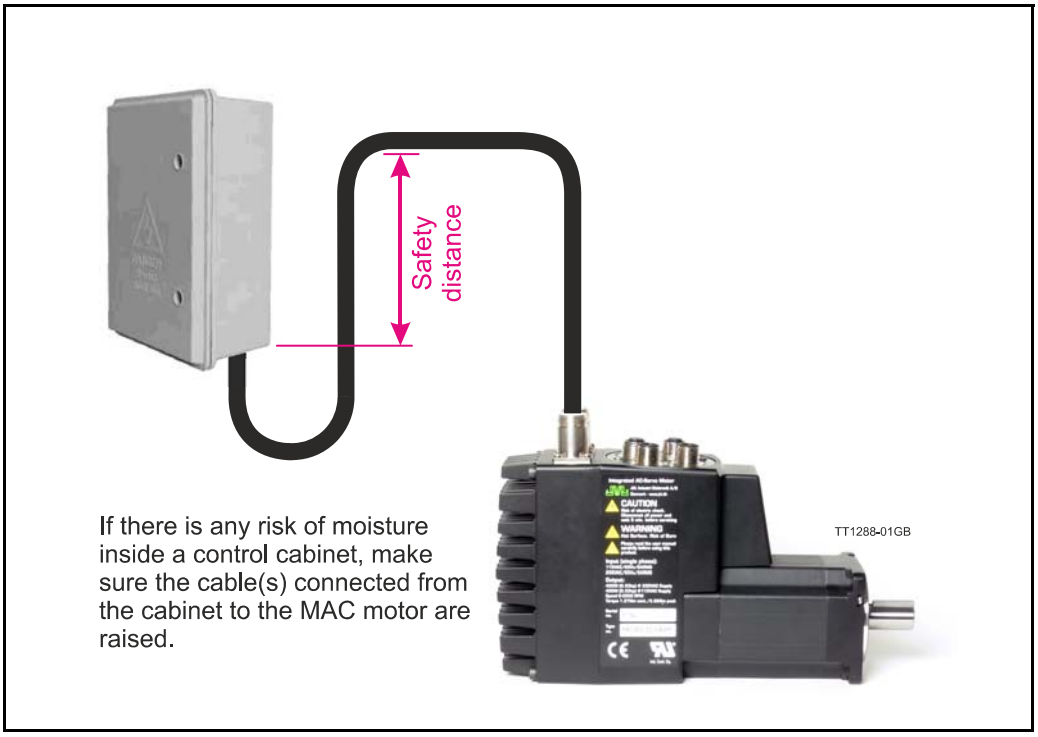
Make sure to use protective caps at unused connectors. Also make sure that the protective caps a tightened properly.

Rule 2 - Motor mounting orientation in IPx5/x6/x7 applications

Its not recommended to mount the motor with the expansion module pointing upwards since it will be more exposed to moisture that accumulate at the surface and around the connectors and can leak inside the motor over time.
If the actual application require this mounting orientation please add a shield/cup over the motor to shield the module. Also avoid direct sunlight if mounted outside in open air.



Rule 3 - Cable placement.
In certain environments where the temperature changes fast and often it may be a problem that moisture condensate inside the cabinet.
Always consider if condensation of moisture or even liquid can be present in the cabinet or similar where the cables for the MAC motor is drawn from.
If this is considered to be a risk then always make sure that the cable is placed as below with a point higher than the cabinet bottom before it connects to the motor to avoid moisture or liquid to flow inside the cable to the motor connectors.



6.5 Emergency stop considerations

6.5.1 Emergency stop

Fundamental considerations regarding the safety of machines:

In the construction of machines there are several basic requirements that a machine manufacturer or producer must fulfil. It is the machine manufacturer's responsibility to ensure that applicable regulations are fulfilled.

The following presents a broad overview of the applicable regulations in Europe (the EEC). If a machine manufacturer markets its products in other countries, it is the manufacturer's responsibility to ensure compliance with local national regulations.
It cannot therefore be assumed that a machine that is produced in accordance with European requirements will automatically also comply with regulations that are applicable in other markets, even though these are acknowledged in several countries.
The most important European regulation in this context is the Machinery Directive, which in Denmark is implemented via the Danish Working Environment Authority's Executive Order no. 561.

This Executive Order prescribes requirements to ensure that machines are safe, that a technical dossier including a health and safety risk analysis is prepared, and that the machine is supplied together with instructions for use a EC declaration of conformity and furthermore that the machine is CE marked.
The Essential Health and Safety Requirements are specified in the Directive's appendix 1. To ensure compliance with these requirements, it is advantageous to use various standards which are described later.

Overall, the most important requirement is to fulfil the Machinery Directive's requirements regarding safety integration, which in brief can be described as follows:

-**1.st. priority**: the machine's construction must ensure that is it not dangerous.

Example:
The machine construction is such that it is not possible to come into contact with rotating parts of other potentially dangerous components, either during operation, set-up or maintenance.

-**2nd priority**: in cases where it is not always possible to achieve a construction that does not present a potential hazard, additional protective measures must be incorporated to eliminate risk.

Example:
No direct access to rotating or other potentially hazardous parts and components is possible without the removal of a screen, guard, protective cover or other means of protection.

-**3rd priority**: To the extent where a machine construction and the built-in safety measures still leave some potential risk, clear warnings of hazard must be given using signs on the machine itself, and by information in the operation manual and by training if necessary.

It is the risk evaluation of the machine that determines what is necessary to fulfil the essential health and safety requirements of the Machinery Directive and thus also which protective measures are required.
It is also the risk assessment that determines whether an emergency stop function is required.

6.5 Emergency stop considerations

An emergency stop is not required only in cases where it is completely evident that an emergency stop would not prevent an injury, minimise an injury or stop an injury.
In practice this means that essentially all machines must incorporate an emergency stop function.

It must be emphasised that a machine's emergency stop function is NOT a preventive measure, but is regarded as a supplementary measure. This means that the protective measures that must be implemented as a result of the machine's risk assessment cannot be replaced by an emergency stop function.

The protective measures required must be implemented such that they are reliable, i.e. not themselves prone to error or failure. The extent to which this is required depends on the risk that the actual protective measure is designed to eliminate, i.e. the greater the hazard, the more secure and reliable the protective measure.

Protective measures and the emergency stop function are often implemented using the machine's electrical control system.

For guidelines on how the control system's safety related components can be implemented, related standards can be used.

6.5.2 EN 60204-1

DS/EN 60204-1 is applicable for the general requirements of a machine's electrical systems.
This standard defines several stop categories, paragraph 9.2.2 Stop functions in DS/EN 60204-1

There are three categories of stop function as follow:

-Stop category 0: stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop – paragraph 3.56 in DS/EN 60204-1).

-Stop category 1: a controlled stop (paragraph 3.11 in DS/EN60204-1) with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved.

-Stop category 2: a controlled stop with power left available to the machine actuators.

Requirements are given that a stop function must be incorporated (paragraph 9.2.5.3 Stop in DS/EN 60204-1)

Stop category 0 and/or category 1 and/or category 2 stop functions shall be provided as indicated by the risk assessment and the functional requirements of the machine (paragraph 4.1in DS/EN 60204-1).

NOTE: The supply disconnecting device (paragraph 5.3 in DS/EN 60204-1) when operated achieves a stop category 0. Stop functions shall override related start functions (see §9.2.5.2 in DS/EN 60204-1).

Similarly, requirements are specified for the implementation of an emergency stop function:

6.5 Emergency stop considerations

Paragraph 9.2.5.4.2 Emergency stop (DS/EN 60204-1)

Principles for the design of emergency stop equipment, including functional aspects, are given in ISO 13850.
The emergency stop shall function either as a category 0 or as a category 1 stop (paragraph 9.2.2 in DS/EN 60240-1). The choice of the stop category of the emergency stop depends on the results of a risk assessment of the machine.
In addition to the requirements for stop functions (paragraph 9.2.5.3 in DS/EN 60204-1), the emergency stop function has the following requirements:

-it shall override all other functions and operations in all modes.
-power to the machine actuators that can cause a hazardous situation(s) shall be either removed immediately (category 0 stop) or shall be controlled in such a way to stop the hazardous motion as quickly as possible (stop category 1) without creating other hazards.
-reset shall not initiate a restart.

Considerations are also given regarding the safety and reliability of control circuits:

6.5.3 Paragraph 9.4 Control functions in the event of failure

Paragraph 9.4.1 General requirements (DS/EN 60204-1)
Where failures or disturbances in the electrical equipment can cause a hazardous situation or damage to the machine or to the work in progress, appropriate measures shall be taken to minimize the probability of the occurrence of such failure or disturbances. The required measures and the extent to which they are implemented, either individually or in combination, depend on the level of risk associated with the respective application (paragraph 4.1in DS/EN 60204-1).
The electrical control circuits shall have an appropriate level of safety performance that has been determined from the risk assessment at the machine. The requirements of IEC 62061 and/or ISO 13849-1:1999, ISO 13849-2:2003 shall apply.

Measures to reduce those risks include, but are not limited to:

-Protective devices on the machine (for example. interlocks guards, trip devices),
-Protective interlocking of the electrical circuit,
-use of proven circuit techniques and components (paragraph 9.4.2.1 in DS/EN 60204-1)
-provision of partial or complete redundancy (paragraph 9.4.2.2 in DS/EN 60204-1) or diversity (paragraph 9.4.2.3 in DS/EN 60204-1),
-Provision for functional tests (paragraph 9.4.2.4 in DS/EN 60204-1).

As noted, reference is made to several other standards which describe how safety related parts of the control system can be implemented.

In practice DS/EN 954-1 can be used, although this will be superseded by DS/EN ISO 13849-1 in 2009. The principles of both standards is the same: to first determine the required level of safety and reliability of the control circuits and thereafter design the safety related components of the control system to achieve the required level.

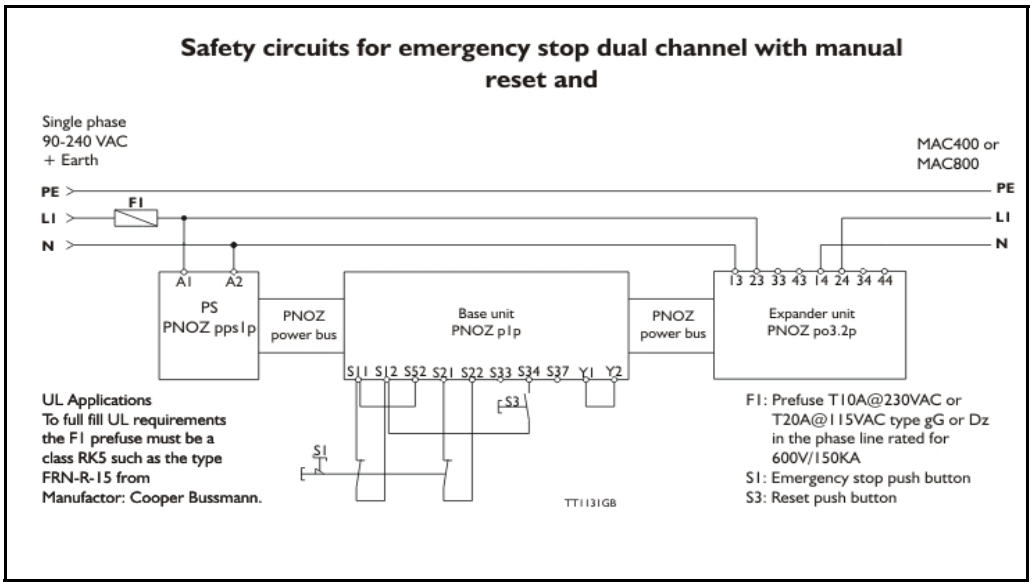
In DS/EN 954-1 the architecture of the safety related circuits is used exclusively as the goal for the level of safety. The standard prescribes 5 categories: B, 1, 2, 3, and 4, where B represents the lowest level and 4 the highest.

6.5 Emergency stop considerations

DS/EN ISO 13849-1 utilizes another criterion for safety level called "Performance level" - PL – in which both the architecture and the component's failure rate are included. 5 PL levels are defined: a, b, c, d, and e, where a represents the lowest level and e the highest. If DS/EN ISO 13849-1 is used, information regarding the components' failure rates (MTTF – mean time to failure) must be obtained from the component manufacturer.

For a more detailed description of the principles and requirements above, see the relevant standards.

The following drawings illustrates examples of the design of safety circuits for an emergency stop and enclosure system, stop category 0, which fulfils the requirements of category 4 in accordance with DS/EN 954-1.

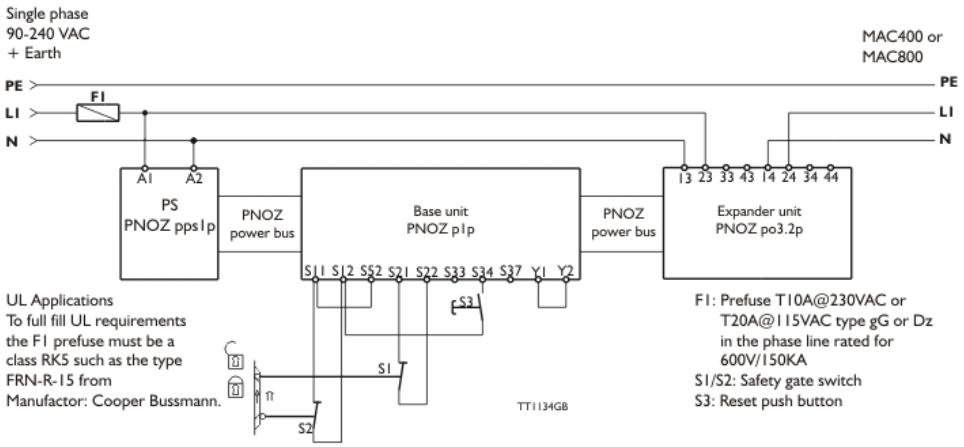


The achievable PL level in accordance with DS/EN ISO 13849 will depend on the MTTF of the components used; using the solutions shown, typically a minimum PL level d would be achieved.

6.5 Emergency stop considerations

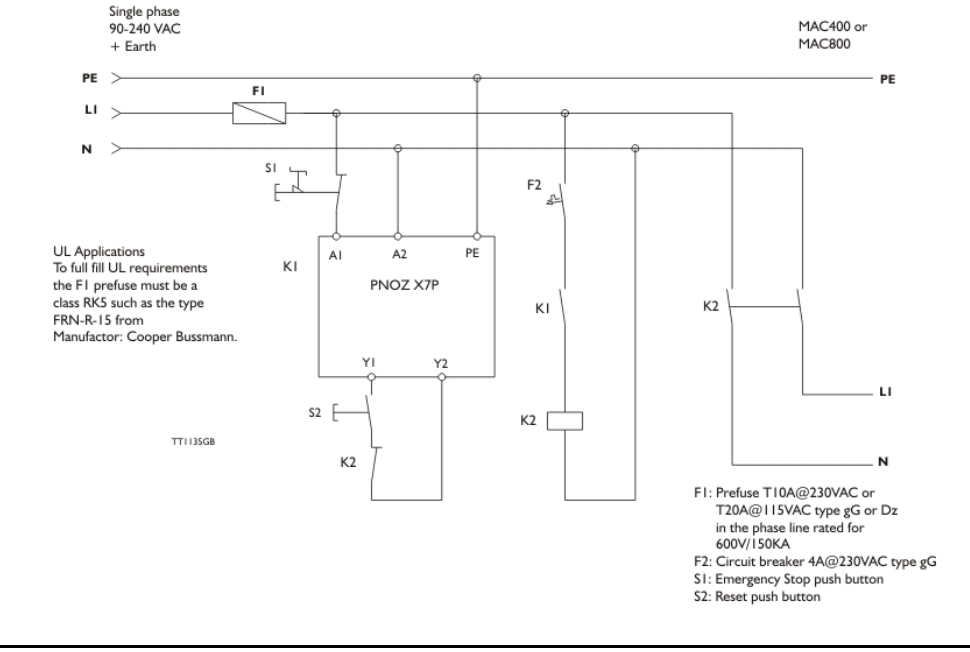
The enclosure system shown utilizes a manual reset, which is a requirement if personnel may be located inside the enclosure. If this is not the case, an automatic reset can be used.

Safety circuits for and dual safety gate control with manual reset and short circuit recognition Category 0



In the case of rotating parts in particular, it may be necessary to take component run-down into account, and therefore it is essential to ensure that access cannot be obtained to hazardous areas until the rotating part has come to a standstill. Alternatively, the enclosure can be equipped with an electro-mechanical lock that only allows the enclosure to be opened when the rotational movement has stopped. The latter solution must be implemented with the same levels of safety as those prescribed by the machine's risk assessment of the guard device implemented.

Safety circuits for and dual safety gate control with manual reset and short circuit recognition Category 2



6.5 Emergency stop considerations

The examples shown are implemented using equipment from Fa. Pilz, and have been chosen to provide the most simple cabling as possible. Other components and solutions can of course be used.

In the construction of the machine and its safety control systems, efforts should always be made to achieve solutions that ensure the requirements of control systems are as low as possible, in accordance with the principles of safety integration mentioned above.

6.6 Trouble-shooting guide

6.6.1 Troubles related to communication with the motor

Problem: "RS232 - MacTalk is not communicating with the motor"
The status at the bottom of the screen shows "*** No Connection ***" but the power LED on the motor is lit and the serial cable is connected.

Action:
-Check that the right COM port is selected in the MacTalk "Setup" menu. If a USB to RS232 converter is used, the COM port normally must be selected as COM3 or COM4.
-Check that the connection to the motor is made according to the specifications. If using only one motor on the RS232 line, the TX-PD must be shorted to TX, otherwise communication can be very unstable. See also the individual descriptions by each module in chapter 4.
-Ensure that a firmware update has not been interrupted before the communication problem was observed. If such an update is aborted/interrupted, it must be restarted and completed before the internal processor is back to normal and can handle communication.

6.6.2 Troubles related to the setup of the motor

Problem: "The motor is not behaving as expected"

Action 1:
Check that the following registers are set properly:
"Torque": 300%
"Velocity": >0
"Acceleration": >0
"Load": 1.00
"In position window": If set too low, it can cause the motor to remain stationary.
Please note that if an expansion module is mounted, it can overrule some of these parameters. Disable the expansion module by setting "I/O type" = "Pulse input" in order to disable the internal communication between the module and the motor. After the fault diagnosis/correction is complete, remember to switch "I/O type" back to "Serial data".

Action 2:
Load default by using the "Load default" function in the "Motor" menu.
Alternatively clear the complete memory by using the "Update Firmware" option in the "Updates" menu.

Problem: "The parameter setup is lost after reset"
The parameters must be saved permanently in the motor using the "Save in flash" button at the top of the main window. When activating this button, the motor will go into passive mode while the parameters are saved. After 5-10 seconds the motor will start up again with the new parameters. If the motor still starts up with the default setup or a setting made at a much earlier stage, the save procedure has failed.

Action:
Ensure that the motor has the newest firmware (>V5.1). The firmware version for the actual motor can be seen in the status bar.
Ensure also that the MacTalk program is the newest version (>V1.21).
Both Motor and MacTalk can be updated from the internet using the "Update" menu at the top of the main screen.

6.6 Trouble-shooting guide

6.6.3 Troubles related to mechanical motor behaviour

Problem: "The motor oscillates or shakes"

The movement of the motor is very unstable and/or the motor oscillates when stationary.

Action:

- Ensure that the LOAD parameter is adjusted to a proper value. Default is 1.00 but when a load is added to the motor, it can be set to a higher value. If the LOAD parameter is set to a value that is too high (or low), the motor can be very unstable.
- Check also that the maximum speed is set within the allowable range specified for the actual supply voltage - see *Power supply (only MAC050 to 141), page 91* where a graph illustrates the relationship between supply voltage and recommended speed.
- If none of the above mentioned solutions solves the problem, the filter used in the MAC motor may not be able to handle the actual load. Use the filter-optimise function or contact your nearest JVL representative.

Problem: "After power up the motor oscillates and there is no communication"

The LOAD parameter value is set too high and is causing the total supply current to rise above the limit which the power supply can handle. This situation can typically occur if the motor is dismounted from the mechanical load for which the LOAD has been adjusted. Normally the motor will start to oscillate if the LOAD is increased above 1.4-1.8. Default is 1.0 without any mechanical load connected.

Action:

The fact that the power supply is overloaded makes the supply voltage drop below the level at which the internal microprocessor in the MAC motor is operational. The only work-around solution to this is a firmware update but all the parameters will be reset to default!

Choose "update firmware" in the "Update" menu and switch on the motor. The firmware update will "catch" the motor before it starts to oscillate and refresh all the settings in the motor.

6.7 Registers

6.7.1 Internal registers in the MAC motors

https://ppnb.jvl.dk/register/macmotor_RegisterList.pdf

In order to control the operation of the motor a large number of registers exist. These are accessible via the serial communication channels or via one of the industrial bus modules such as the Ethernet modules, Profibus or CAN-open modules.

MacTalk also has access to most of these registers. MacTalk offers a more user friendly and easy to understand interface.

It may however be necessary to access the registers directly, for example in systems using one of the many industrial bus modules. For this purpose, one can use the register list.

6.8 Accessories

The following accessories are available for the MAC motor series.

6.8.1 Cables

6.8.2 Connectors / connector kits

6.8.3 Power Supplies

PSU00-PD1

Combined power dump, resistor, and capacitor unit. For a complete power supply system, only a transformer with a secondary winding supplying 32VAC is required.
For systems with up to 5-8 MAC motors, this unit can serve as a central power dump unit.
The capacitor offers an efficient and economical way of storing the energy returned from the motors during deceleration of high inertias. See also www.jvl.dk

PSU48-480

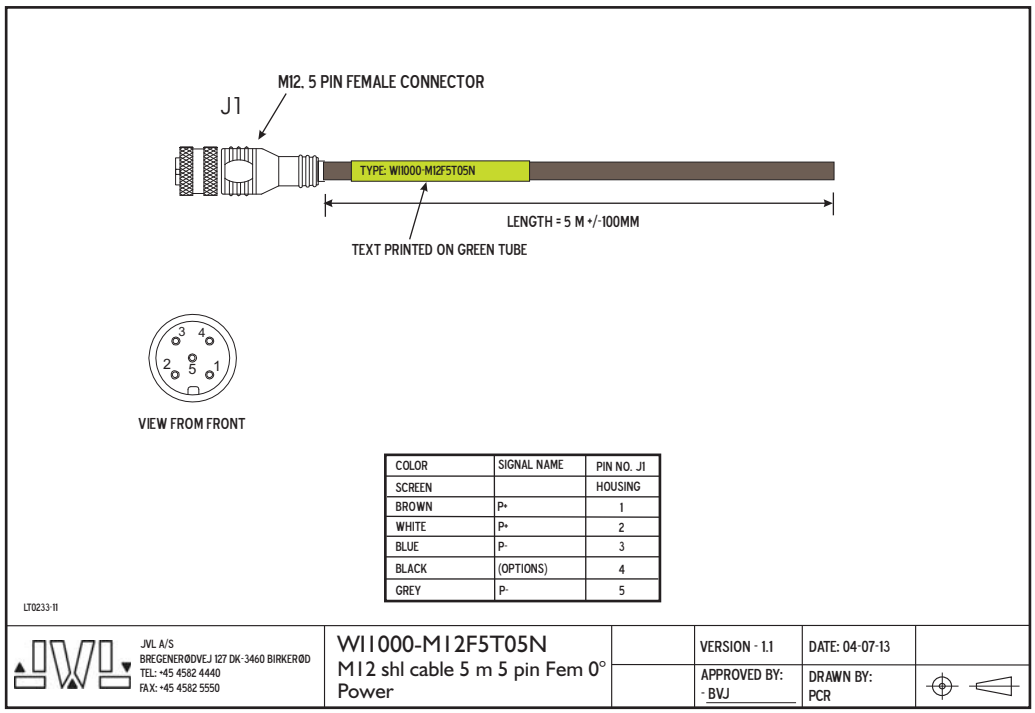
A compact switch-mode power supply with 480W output power at 48VDC.
The power supply is UL and CSA approved. It is protected against overvoltage, overtemperature and short-circuit or overload of the output. The power supply can either be mounted on a DIN rail or "wall" mounted. See also the data-sheet LD0047-xx which can be downloaded at www.jvl.dk

Other power supplies:

JVL offers a wide range of power supplies in the power range 45W up to 1.5kW with the output voltages 24 and 48VDC. They all uses switch-mode technology in order to minimize physical dimensions and for easy adaption to mains voltages in the range 90 to 240VAC.
The product range covers the following types: PSU05-045, PSU24-120, PSU24-480, PSU24-1000, PSU48-480, PSU48-1000, PSU48-1500 and PSU72-1000.
See also the data-sheet LD0058 (overview) or LD0053 (detailed) which can be downloaded at www.jvl.dk.

6.9 Cable drawings

6.9.1 WI1000-M12F5T05N - M12 Power cable 5 pin female

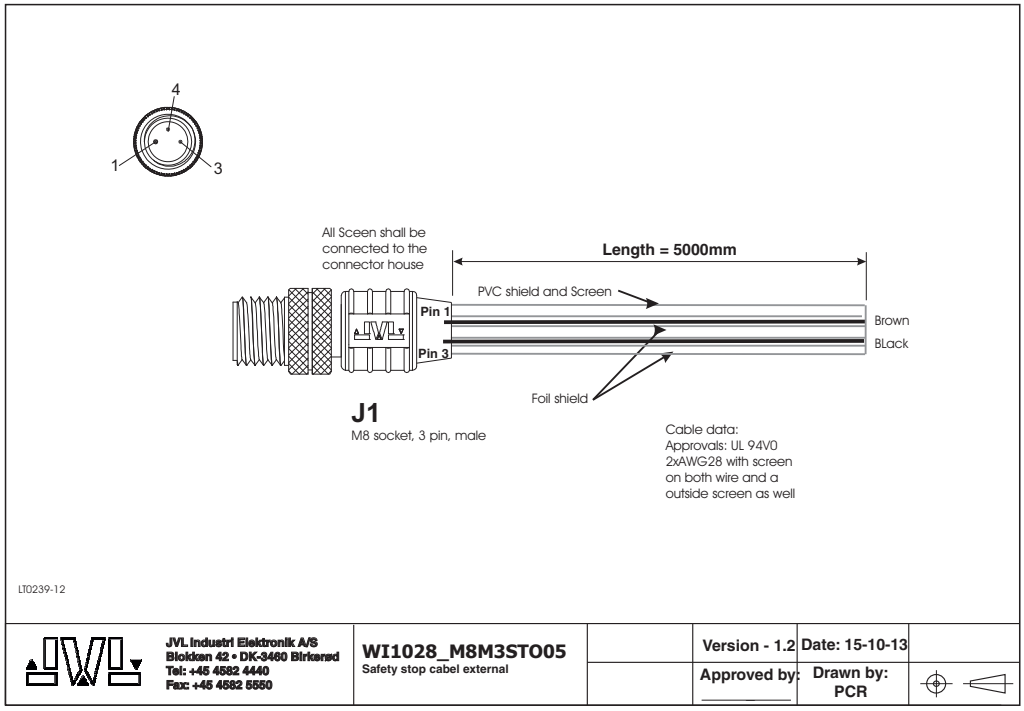


COLOR	SIGNAL NAME	PIN NO. J1
SCREEN		HOUSING
BROWN	P+	1
WHITE	P+	2
BLUE	P-	3
BLACK	(OPTIONS)	4
GREY	P-	5

LT0233-11

JVL A/S BREGENERØDVEJ 127 DK-3460 BIRKERØD TEL: +45 4582 4440 FAX: +45 4582 5550	WI1000-M12F5T05N M12 shl cable 5 m 5 pin Fem 0° Power		VERSION - 1.1 APPROVED BY: - BVJ	DATE: 04-07-13 DRAWN BY: PCR	

6.9.2 WI1028-M8M3ST005 - Safety stop cable.

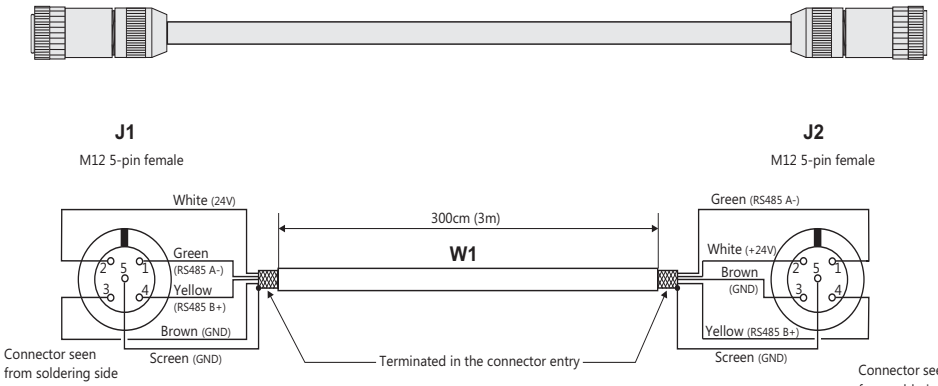


LT0239-12

JVL Industri Elektronik A/S Blokken 42 • DK-3460 Birkerød Tel: +45 4582 4440 Fax: +45 4582 5550	WI1028_M8M3ST005 Safety stop cabel external		Version - 1.2 Approved by:	Date: 15-10-13 Drawn by: PCR	

6.9 Cable drawings

6.9.3 WI1005-M12F5TF5T03P - Master/slave cable for MAC00-P4/5

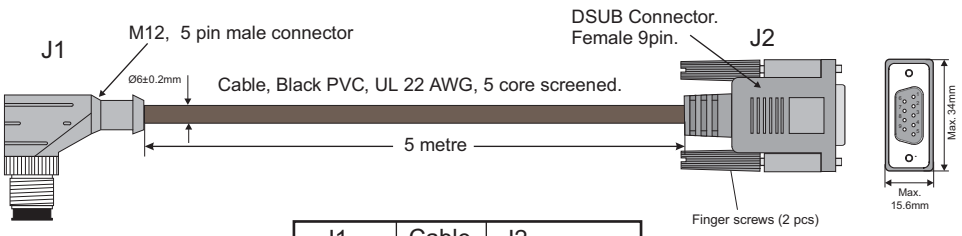


Parts List		
Pos.	JVL Part No.	Qty.
J1	WI1008-M12F5SS1	1 pcs.
J2	WI1008-M12F5SS1	1 pcs.
W1	WH0002-R2x2x0.25+SC	300cm

LT0153-12GB

JVL Industri Elektronik A/S Blokken 42 • DK-3460 Birkerød Tel: +45 4582 4440 Fax: +45 4582 5550	**WI1005-M12F5TF5T03P** **RS 485** **kommunikationskabel**		Version - 1.2 Approved by:	Date: 8-7-09 Drawn by: JVJ/BVJ	

6.9.4 RS232-M12-1-5-5 - communication cable for MAC00-B4, R4, etc.



J1	Cable	J2
Pin no.	Color	Pin no.
1	Brown	3
2	White	2
3	Blue	Blue and Black is not connected and must each be insulated
4	Black	
5	Grey	5
Not connected	Screen	Housing

J2 Pin 1, 4, 6, 7, 8, 9 must be left open

LT0056-12

JVL Industri Elektronik A/S Blokken 42 • DK-3460 Birkerød Tel: +45 4582 4440 Fax: +45 4582 5550	**RS232-M12-1-5-5** Interface cable M12 to DSUB		Version - 1.2 Approved by: BVJ - 1.2	Date: 27-9-06 Drawn by: JVJ	

6.10 Vibration and shock certificates

6.10.1 Vibration test at MAC404 and 1004

4 Test and results

4.1 Vibration - Sinusoidal

Test Method & specification

IEC 60068-2-6:2007, Test Fc: Vibration (sinusoidal).

Severity

Frequency range	:	2 - 500 Hz		
Frequency / amplitude	:	2 – 25 Hz	:	±1.6 mm
		25 - 500 Hz	:	±4.0 g
Sweep rate	:	Max. 1 octave/min.		
Number of sweeps	:	10 sweep cycles per axis.		
Number of axes	:	3 mutually perpendicular		

Procedure

The test object is energised and in normal operational mode during the exposure.

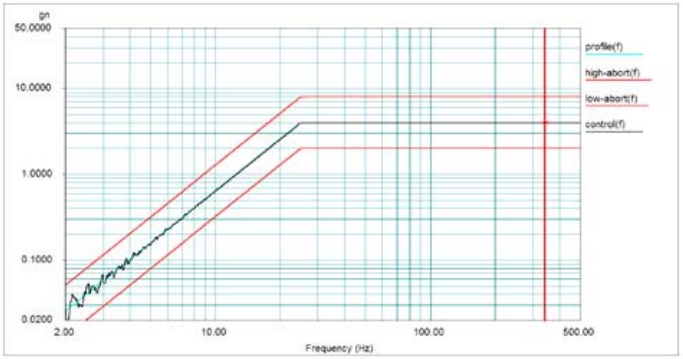
A visual inspection is performed after the exposure.

Accelerometers are placed on the test objects in order to measure the response of the test objects.

Results

No malfunction was observed during the exposure and the function of the test objects was OK during and after the exposure. No mechanical damages were observed during the visual inspection performed after the exposure.

Exposure curves and photos of the test setup are enclosed below



Curve 1 *Sweep, Z-axis. Similar in all axes and all sweeps.*

6.10 Vibration and shock certificates

6.10.2 Shock test at MAC404 and 1004

4.2 Shock

Test method & specification

IEC 60068-2-27:2008, Test Ea: Shock.

Severity

Pulse shape	:	Half-sine
Peak acceleration	:	15 g
Pulse duration	:	30 ms
Shocks per direction	:	1000
Number of directions	:	6 (± x, ± y, ± z)

Procedure

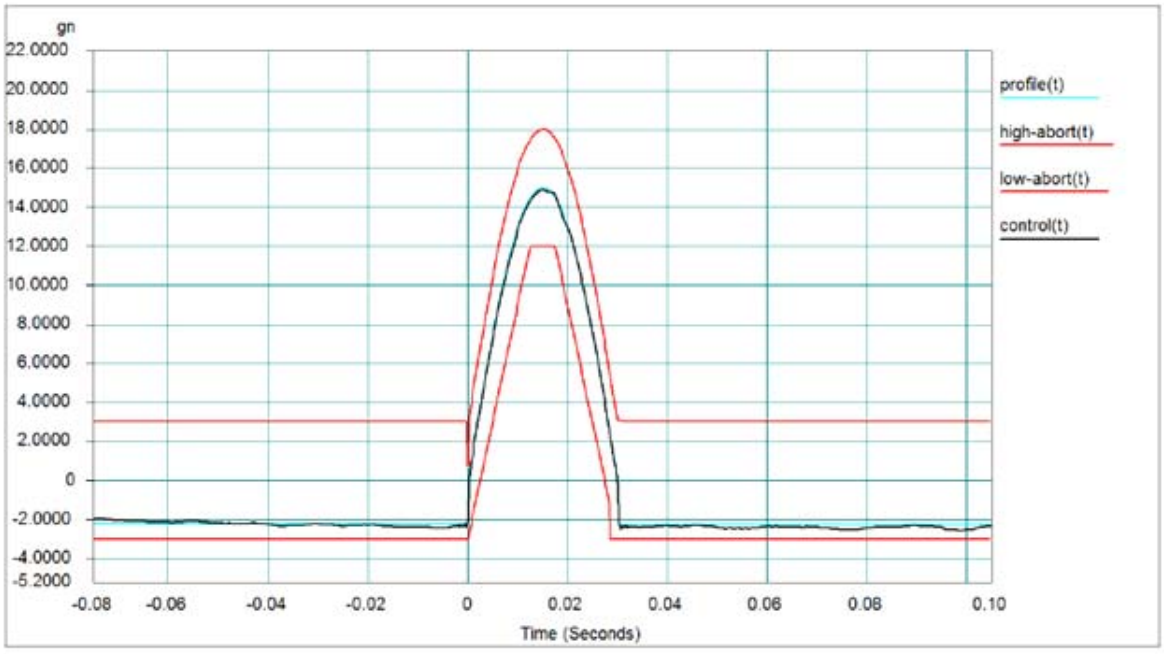
The test object is energised and in normal operational mode during the exposures. A functional test is performed after the exposure.

A visual inspection is performed after the exposure.

Results

No malfunction was observed during the exposure and the function of the test objects was OK during and after the exposure. No mechanical damages were observed during the visual inspection performed after the exposure.

Exposure curves are enclosed below. For photos of the test setup, see section 4.1.



Curve 14 *Positive shock, e.g. z-axis, similar in all axes.*

6.11 CE Declaration of Conformity

EU - Declaration of Conformity

Manufacturer

Company Name:	JVL A/S
Address:	Bregnerødvej 127, DK-3460 Birkerød Denmark
Telephone:	+45 45 82 44 40
E-mail:	jvl@jvl.dk
Web:	www.jvl.dk

Hereby declares declares, under our sole responsibility, that:

Product

No.:	MAC802, 1202, 1403
Name:	Integrated AC Servo Motor
Type:	Series M1 to M9 with power conn. type 0 to 9
Sub-types:	With connectivity Ex, Qx og Dx and/or STO

- is in conformity with:

DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility

and

DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

- is manufactured in accordance with the following standards:

EN 61800-3:2004 with A1:2012 - Adjustable Speed Electrical Power Drive Systems - Part 3: EMC requirements and specific test methods
EN 61800-5-1:2007 with A1:2017 and A11:2021 - Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy

Birkerød 16.th. July 2025

Bo V. Jessen
Technical Director
JVL A/S

LX0070-01GB

6.11 CE Declaration of Conformity

EU - Declaration of Conformity

Manufacturer

Company Name:	JVL A/S
Address:	Bregnerødvej 127, DK-3460 Birkerød Denmark
Telephone:	+45 45 82 44 40
E-mail:	jvl@jvl.dk
Web:	www.jvl.dk

Hereby declares declares, under our sole responsibility, that:

Product

No.:	MAC404, 604, 804, 1004, 1504
Name:	Integrated AC Servo Motor
Type:	Series M1 to M9 with power conn. type 0 to 9
Sub-types:	With connectivity Ex, Qx og Dx and/or STO

- is in conformity with:

DIRECTIVE 2014/30/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to electromagnetic compatibility

and

DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits

- is manufactured in accordance with the following standards:

EN 61800-3:2004 with A1:2012 - Adjustable Speed Electrical Power Drive Systems - Part 3: EMC requirements and specific test methods

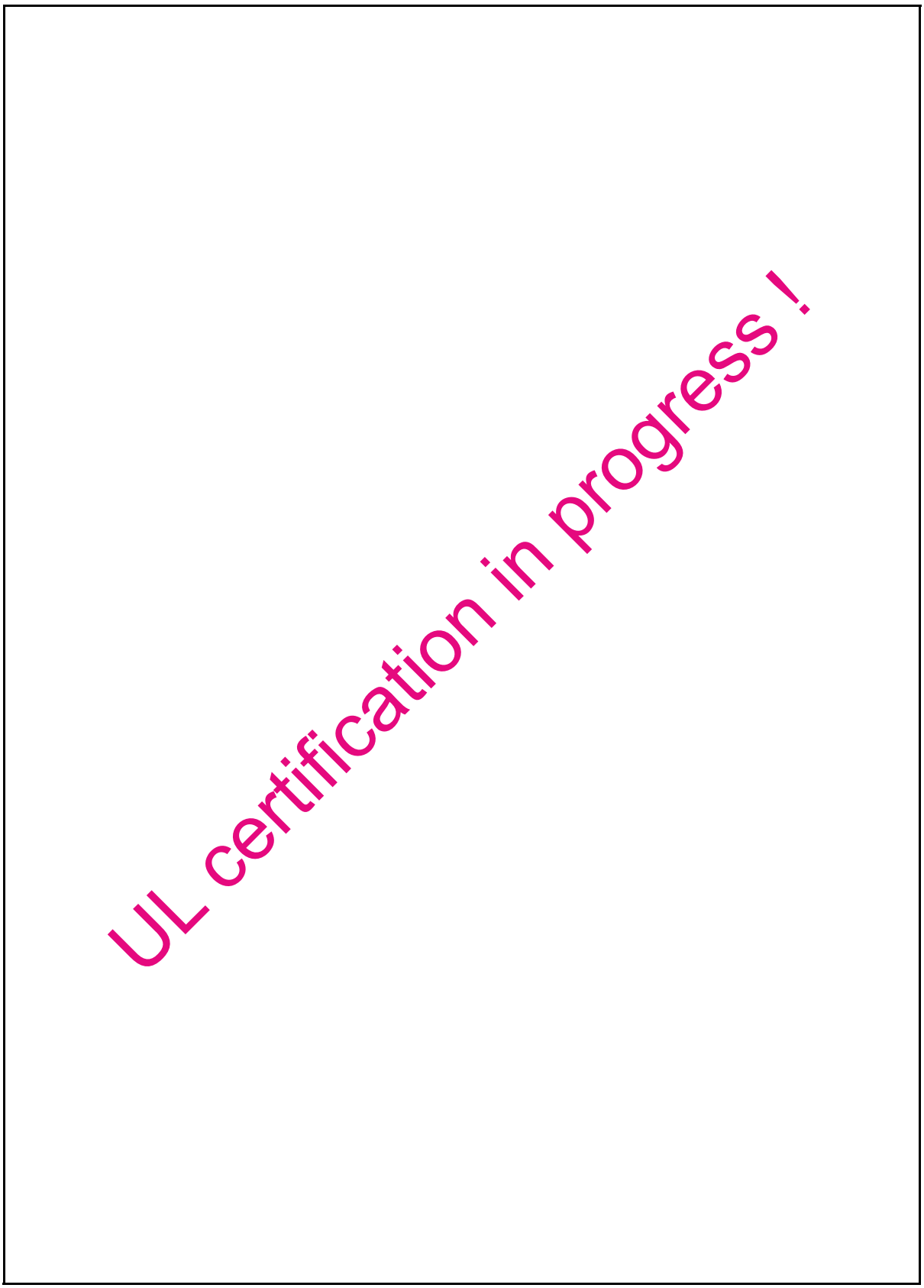
EN 61800-5-1:2007 with A1:2017 and A11:2021 - Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy

Birkerød 16.th. July 2025

Bo V. Jessen
Technical Director
JVL A/S

LX0065-02GB

6.12 UL Certificate of Compliance



Note: MAC motor generation III are UL Pending.