MAC50
MAC95
MAC140
MAC141

Including expansion modules

Integrated Servo Motors

User Manual

JVL Industri Elektronik A/S

LB0047-14GB

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1 Introduction

1.1 Features

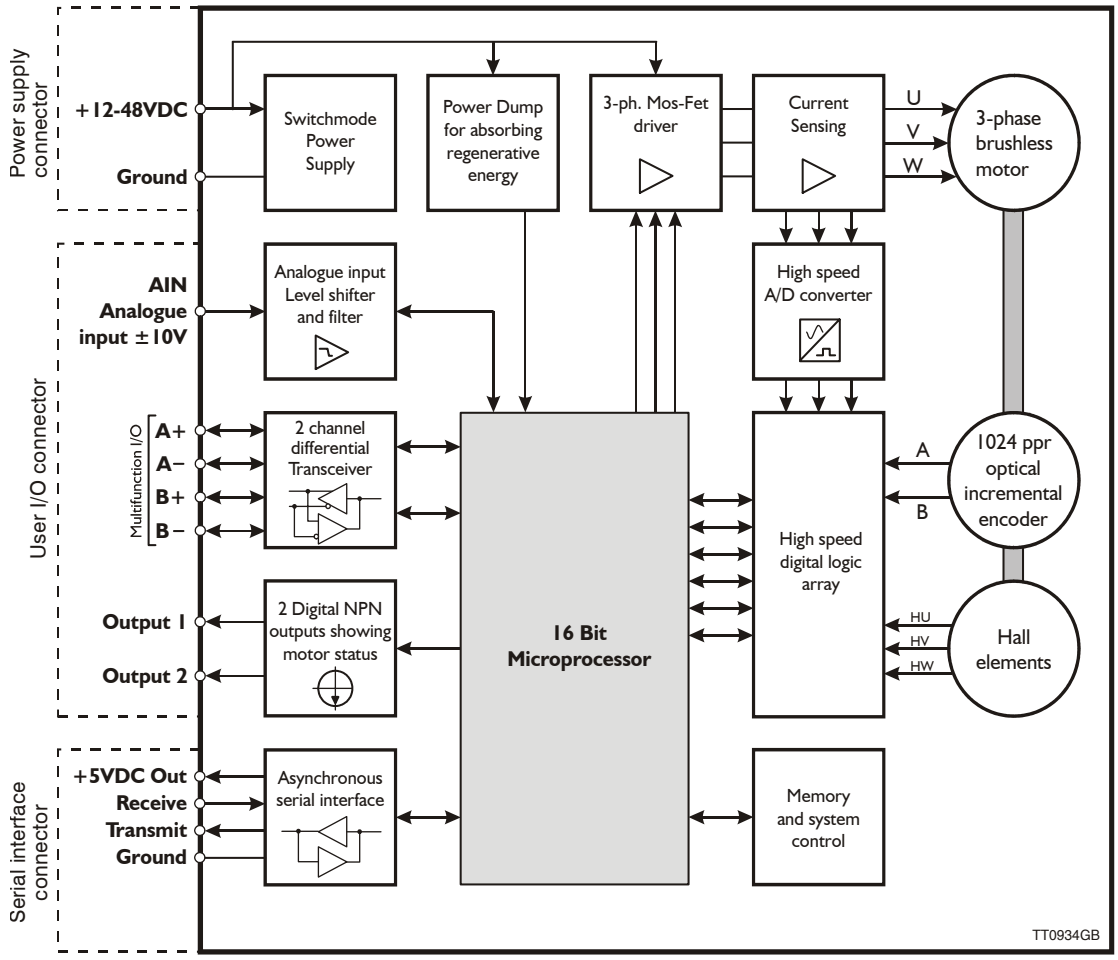
The MAC series of brushless servo motors with integrated electronics represents a major step forward in motion control systems. All of the necessary electronics for a servo system are integrated into the motor itself.
Traditional motor systems typically have the controller and drive electronics placed 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.
- Fewer possibilities for wiring errors.

Main Features:
- Low cost and high performance make the MAC series ideal for high-volume applications
- Pulse and direction inputs make it possible to replace step motors.
- Quadrature input for gearing applications.
- ±10V input for controlling speed and torque
- 2 ch. Quadrature output to master controller when used as driver.
- Accepts position and velocity commands sent via RS232/422 interface.
- Wide supply voltage range 12 to 48VDC.
- Excellent efficiency compared to step motors.
- High resolution (4096 cpr) compared to cost.
- Wide variety of expansion modules which can be mounted internally:
  Profibus DP module
  CAN-bus module
  Ethernet module
  Stand-alone positioning module
  Module with AMP military connectors
  Custom-designed modules on request
- 2 Outputs for *In position* and *Error* indication.
- 4.th order digital filter which only needs a single inertia adjustment.
- Standard NEMA23 flange.
- Built-in sensors make the motor stay stationary when powering up.
- Easy and simple Windows program available for installation/setup.
- High-efficiency MosFet power stage keeps temperature at a low level.
- CE approved. UL pending.

1.2 Overall description

Basic MAC motor block diagram including motor and feedback devices



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.

1.2 Overall description

Motor Type	Continuous Torque	Peak Torque	Power (cont.)	Speed	Flange	Total length
MAC50	0.11Nm	0.32 Nm	46 Watt	4000 RPM	NEMA23 57x57mm (2.3"x2.3")	111.2 mm
MAC95	0.22 Nm	0.62 Nm	92 Watt	4000 RPM	NEMA23 57x57mm (2.3"x2.3")	130.5 mm
MAC140	0.32 Nm	0.9 Nm	134 Watt	4000 RPM	NEMA23 57x57mm (2.3"x2.3")	152.5 mm
MAC141	0.48 Nm	1.59 Nm	134 Watt	2700 RPM	NEMA23 57x57mm (2.3"x2.3")	172.0 mm

The MAC motor is available in 4 different sizes: MAC50, MAC95, MAC140 and MAC141, with continuous power ratings from 46W to134W. The basic functions and I/O features are the same for all models.

1.2.1 Basic modes/functions in the MAC motor.

The MAC motor offers the following functions.

- **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.

- **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.

(continued next page)

- **Velocity/Analogue 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.

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

1.3 Expansion modules overview

JVL has produced a wide variety of expansion modules to adapt the MAC motor to almost any kind of application. The expansion module is easily mounted inside the motor. Only one expansion module can be mounted.
The table below gives a brief overview of the features offered by the basic MAC motor and the features that are available in each expansion module.

MAC Motors feature overview including expansion modules

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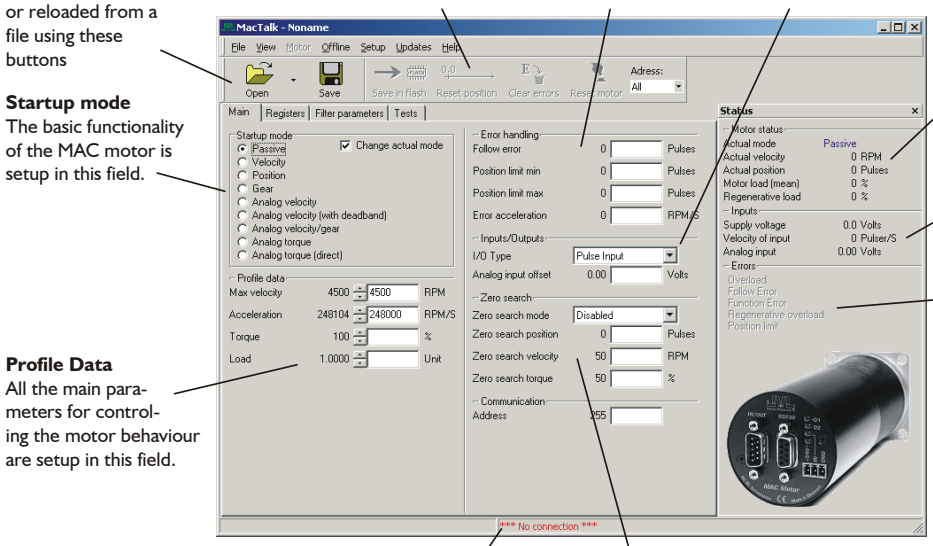
Feature / Type	**Unbalanced async. serial interface** For setup/sending commands	**Balanced async. serial interface** For setup/sending commands	**± 10V Analogue input** For controlling speed/torque Also used for zero search	**Pulse inputs** Accepts pulse and direction or quadrature encoder signal	**Pulse outputs** 90 degree phase shifted outputs from internal encoder	**Digital user inputs** For control of program flow or motor start/stop	**Digital user outputs** For indicating the motor status or as output from the program	**Ext. connector type**	**Protection class**
Basic MAC motors									
MAC50,95,140,141-A01 Basic MAC motors IP42	5V TTL 19.2kbaud Full Duplex	RS422 19.2kbaud Full Duplex	✓	RS422 2.5Mhz or 150kHz (LP)	RS422 4096 cpr	No	Motor stat. 2 x NPN 25mA	AMP Molex JST	IP42
MAC50,95,140,141-A02 Basic MAC motors IP55	5V TTL 19.2kbaud Full Duplex	RS422 19.2kbaud Full Duplex	✓	RS422 2.5Mhz or 150kHz (LP)	RS422 4096 cpr	No	Motor stat. 2 x NPN 25mA	AMP Molex JST	IP55 (1)
MAC50,95,140,141-A03 Basic MAC motors IP67	5V TTL 19.2kbaud Full Duplex	RS422 19.2kbaud Full Duplex	✓	RS422 2.5Mhz or 150kHz (LP)	RS422 4096 cpr	No	Motor stat. 2 x NPN 25mA	AMP Molex JST	IP67 (1)
Expansion modules									
MAC00-B1 Connector module w/DSUB connectors	RS232 19.2kbaud Full Duplex	RS422 or RS485 19.2k Full Duplex	✓	RS422 2.5Mhz or 150kHz (LP)	RS422 4096 cpr	No	Motor stat. 2 x PNP 100mA	DSUB Plug-able	IP42
MAC00-B2 Connector module w/cable glands	RS232 19.2kbaud Full Duplex	RS422 or RS485 19.2k Full Duplex	✓	RS422 2.5Mhz or 150kHz (LP)	RS422 4096 cpr	No	Motor stat. 2 x PNP 100mA	Cable Gland	IP42
MAC00-CS Conn. module w/cable glands No electronic features added	5V TTL 19.2kbaud Full Duplex	RS422 19.2kbaud Full Duplex	✓	RS422 2.5Mhz or 150kHz (LP)	RS422 4096 cpr	No	Motor stat. 2 x NPN 25mA	Cable Gland	IP67 (1)
MAC00-FP2 Profibus DP w/cable glands	RS232 19.2kbaud Full Duplex	No	✓	No	No	6 Inputs Opto isol. 5-30V	2 Outputs PNP 100mA	Cable Gland	IP67 (1)
MAC00-R1 Nano PLC w/ DSUB connect.	RS232 19.2kbaud Full Duplex	RS485 19.2kbaud Half Duplex	✓	No	No	6 Inputs Opto isol. 5-30V	4 Outputs PNP 300mA	DSUB Plug-able	IP42
MAC00-R3 Nano PLC w/cable glands	RS232 19.2kbaud Full Duplex	RS485 19.2kbaud HalflDuplex	✓	No	No	6 Inputs Opto isol. 5-30V	4 Outputs PNP 300mA	Cable Gland	IP67 (1)

1) IP55 or IP67 protection class is only possible if basic MAC motor and expansion module both are the same IP class

Please note that JVL can offer specially developed expansion modules if the available standard modules do not match the needs of special application. Please contact your nearest distributor to verify if your application can benefit from a specially developed expansion module.

1.4 Setting up the MAC motor



1.4.1 MacTalk

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, zero search 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.
- Saving all current parameters to disc.
- Restoring all parameters from disc.
- Saving all parameters permanently in the motor.
- Updating the motor firmware or MacTalk software from the internet or a file.

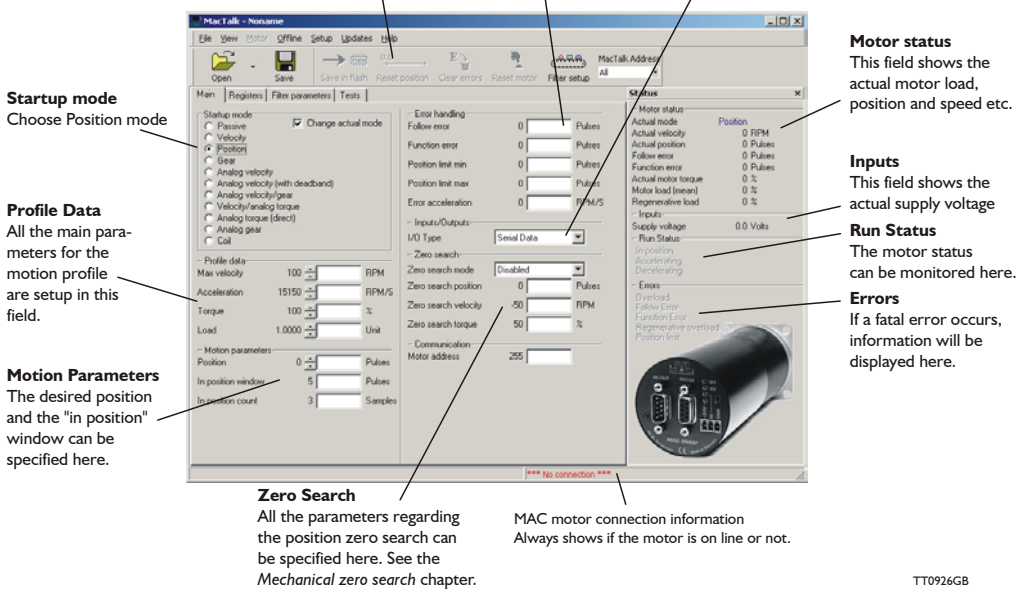
The main window of the program changes according to the selected mode, thus only showing the relevant parameters for operation in the selected mode.
The following pages describe the actual window for each mode and how the parameters affect the MAC motor operation.

2 Function description

2.1 Using Position mode

2.1.1 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 be 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.

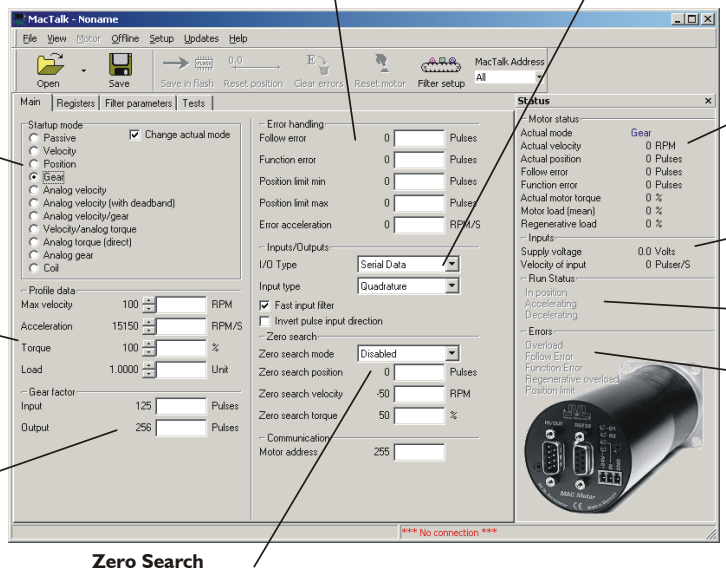
Input/Outputs The multifunction I/O terminals can be defined here. In Position mode these terminals can either work as a quadrature output from the internal encoder or as a serial RS422 interface for commands sent from a master controller. See also the Multifunction I/O general description, page 30.

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.

2.2 Gear Mode

Main parameters used in gear mode



Error Handling
Use these fields to define error limits for the maximum follow error etc.

Input/Outputs
The *I/O Type* must be setup as pulse input. The *input type* must also be setup for the actual pulse type (quadrature or pulse/dir.).

Startup mode
Choose "Gear mode"

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

Inputs
This field shows the actual supply voltage and velocity at pulse input

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

Run Status
The motor status can be monitored here.

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

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

Zero Search
Zero search can also be used. During zero search the gear mode will be set inactive. See also the *Zero Search* chapter.

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2.2.1 Gear Mode - overall description

In gear mode the motor is following an pulse signal applied to the Multifunction I/O terminals. The ratio between the incomming pulses and the motor movement can be adjusted to a desired value. An ratio from 1024:1 down to 1:1024 can be choosen. Typically this mode is used if the MAC motor is adapted into an application where a movement need to be syncronized with an external movement. Another typical application is replacement of stepper motors since the MAC motor in Gear Mode can work like a stepper motor using pulse and direction.

Following setup must be done to work in gear mode (listed after importance).

Startup Mode Select Gear Mode in this field.

Gear Factor This field defines the ratio between incomming pulses and the motor movement. If the prefered motor direction needs to be inversed the sign in the "output" field must be inversed.
Eksample : 1024 must be -1024 to inverse the movement direction.

Input/Outputs The multifunction I/O terminals must be set to "pulse input" since the the gear mode is using the incomming 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 choose "pulse-direction" if it is a stepper motor signal. See also Multifunction I/O general description, page 30.

(Continued next page)

2.2 Gear Mode

Profile data

In gear mode the motor movement is fundamentally controlled from the external signal source but through the 4 parameters in the "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 teoretically should give a MAC motor speed of 10000 RPM the speed can be limited to 4000 RPM (max. allowed speed for the MAC). Alternatively the motor will be unstable and go in error within some time since it is not able to run 10000 RPM. Notice that no pulses are lost if the velocity is limited. They are just remembered and used when the input frequency goes down to a level where the motor is able to follow.

"Acceleration"
The acceleration parameter can be usefull in systems where the signal source instantanously is applying a high frequency without any acceleration. Under this condition the MAC motor will take care of making a controlled acceleration and deceleration. Notice that no pulses are lost if the acceleration is limited. They are just remembered and used when motor velocity reach a level corresponding to the input frequency.

"Torque"
The maximum torque can be limited in the range 0-100%. 100% corresponds to the peak torque of the MAC motor used.

"Load"
The Load parameter is the overall gain in the position/velocity filter and makes sure 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 (returned energy from the motor) can be monitored here.

Inputs

The supply voltage can be measured here.

Zero search

In typical gear mode applications the motor is just moving relatively without any absolute zero point, but for applications that need a specific mechanical zero position, the general zero search in the MAC motor can be used. Please consult the chapter Mechanical zero search, page 18.

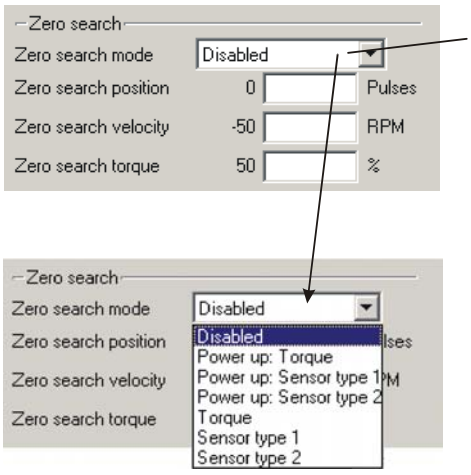
Example 1: Encoder input.
An external encoder feeds the MAC motor. The I/O type is set to "Pulse input" and "Input type" is set to "Quadrature" in order to decode the encoder signal. The encoder is connected to the A and B terminals (Multifunction I/O's). See also User I/O, page 28.
The resolution on this encoder is 500 ppr. The MAC motor itself has 1024 ppr (fixed). 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 1024. Now the ratio between the external encoder and the MAC motor will be 1:1. Make sure that the "Profile data" is set to proper values in order not to limit the motor operation unintended.

Example 2: Pulse and direction input.
A stepper motor system is replaced by a MAC motor meaning that the MAC motor is receiving a pulse and direction signal which is a very common signal format in stepper 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 User I/O, page 28.
The MAC motor is replacing a stepper system with 400 steps per rev. which means that when the pulse source produce 400 pulses it expects the MAC motor to rotate one resolution.
The MAC motor itself has 1024 ppr (fixed). 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 rising and falling edge of the input signal.
The *Output* parameter is set to 1024. Now the MAC motor will move 1 revolution if 400 pulses is applied to the pulse input. Make sure that the "Profile data" is set to proper values in order not to limit the motor operation unintended.

2.3 Mechanical zero search

2.3.1 Mechanical zero search 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 3 different Zero search modes which can be selected in the MacTalk main window or by sending a command at one of the serial interfaces.



Select the Zero search mode using this field. The selected format will be used as follows :
- Immediately after ther motor is powered up (only the "Power up ...." Formats)
- If a search is initiated via the serial interface or
- From an expansion module (MAC00-R1, R3 or FP2).

Please note that the 3 formats for "Power up" Zero search must not be selected if an expansion module is used (MAC00-R1, R3 or FP2). If an automatic zero search after "Power up" is required when using one of these modules, the function must be enabled on the product tab for the actual module. (See also the chapters describing the expansion modules)

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The menu offers 7 choices:

Disabled (default)	The Zero search is disabled.
Power up: Torque	Similar to "Torque" but the Zero search will automatically be started after power up.
Power up: Sensor type 1	Similar to "Sensor type 1" but the Zero search will automatically be started after power up.
Power up: Sensor type 2	Similar to "Sensor type 2" but the Zero search will automatically be started after power up.
Torque	The Zero search 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 Zero search torque is defined as the zero position.
Sensor type 1	The Zero search function will start seeking for Zero until an external sensor is activated. The point at which the sensor is activated is defined as zero. The active sensor level can be changed by changing the sign at the value specified in the *Zero search torque* field.
Sensor type 2	Like above (Sensor type 1) but after the sensor is activated the direction of movement is reversed and the point at which the sensor is disabled is defined as zero.

The following sections explain in detail the functionality of the 3 fundamental Zero search modes.

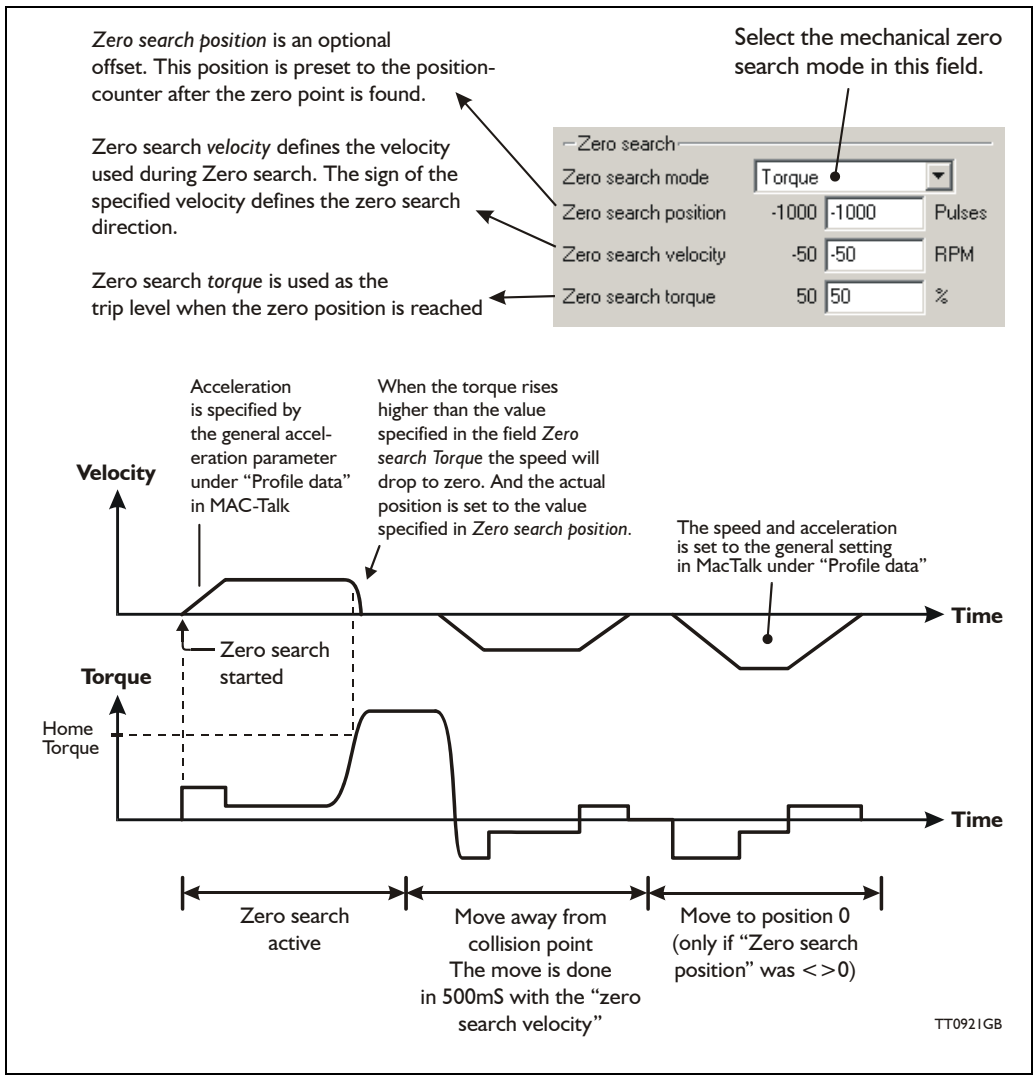
2.3.2 Starting a Zero search

If the Zero search mode is set to *Disabled,* no Zero search is done at any time.
If one of the 3 modes *Power up: Torque, Sensor type 1* or *Sensor type 2* is selected, the respective Zero search mode will be executed every time the MAC motor is powered up.
The Zero search can also be initiated by sending a specific command via one of the serial interfaces — please consult the technical manual (LB0048-xx) for more details.

2.3 Mechanical zero search

2.3.3 "Torque" Zero search

Torque Zero search is carried out according to the following illustration.



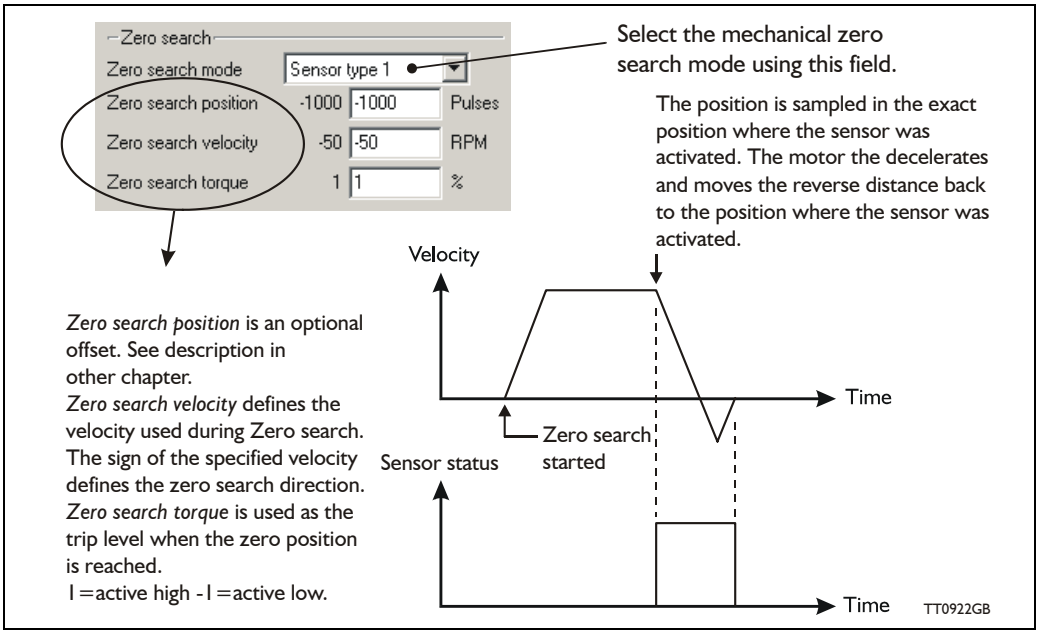
The Zero search method using a torque as a reference, is a cheap, simple way to find the mechanical zero position, but please be aware of following critical points.

- Make sure that the Zero search 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 Zero search 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.

2.3 Mechanical zero search

2.3.4 "Sensor type 1" Zero search

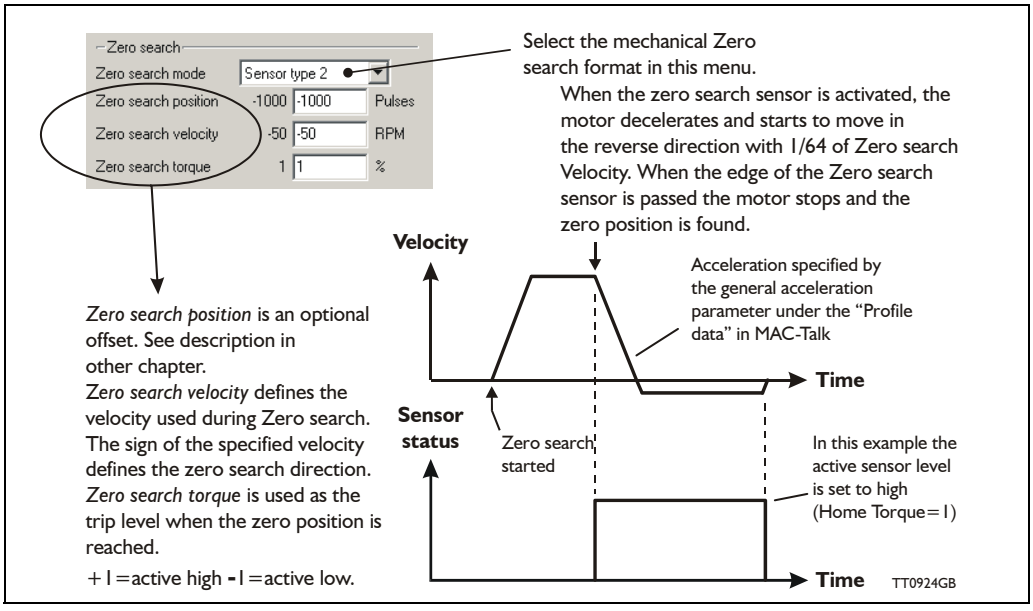
Sensor type 1 zero search is carried out according to the following illustration.



The Zero sensor must be connected to the analogue input (AIN), which during Zero search functions as a digital input. For connection information, see Analogue input., page 28.

2.3.5 "Sensor type 2" Zero search

Sensor type 2 zero search is carried out according to the following illustration.



The Zero sensor must be connected to the analogue input (AIN), which during Zero search functions as a digital input.
For connection information, see Analogue input., page 28.

2.3 Mechanical zero search

2.3.6 Making a Zero point offset.

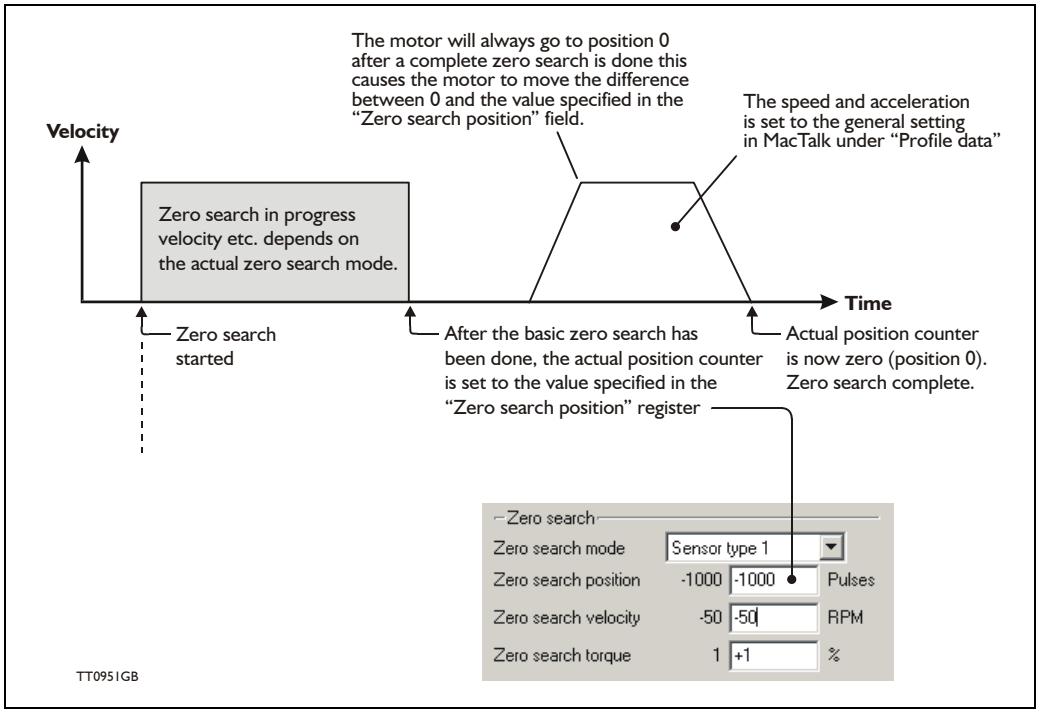
Common for all the zero search modes, it can optionally be chosen to define the zero-point as a value other than zero (position 0).
When is it useful to use the zero point offset?.

- If it is desired that the position interval under normal operation is always “nice” positive values from 0 to x instead of a mixture of negative and positive values. This can happen 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 zero search.

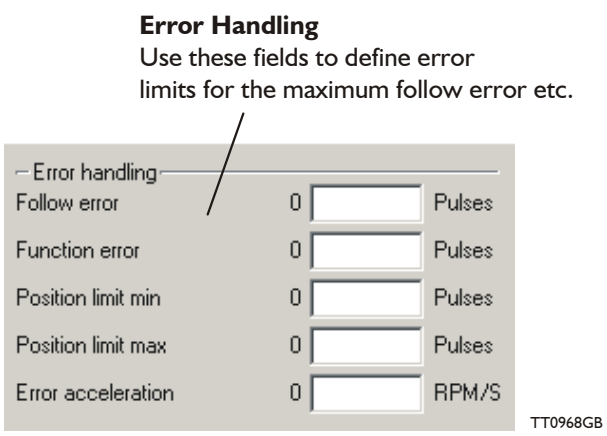
The offset value must be specified in the “Zero search position” field.
The total zero search will be done in following order.

1. The zero search is started either automatically (power up) or initiated by command from the interface or via an expansion module.
2. The basic zero search is completed and the position counter is set to the value specified in the “Zero search position” field.
3. If the zero search position value is different from position, the motor will now move to position 0.
4. The zero search 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.



2.4 Error Handling



2.4.1 Error handling

The MAC motor contains 5 fundamental parameters used for protection related purposes. They will all have effect regardsless which operation mode the motor is setup to use.

Follow error
It can be defined how what the maximum difference must be between the actual position of the motor and the desired position. Depending on the setting of the servofilter etc. this position difference will change. For protection it can be usefull to define that the difference not is allowed to be more than for example 500 counts (the motor has 4096 counts per rev. fixed). If a mechanical collision occur the position difference will typically be passed and cause an follow error making the motor passive with no further movement. Default is 0 meaning that the feature is disabled.

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

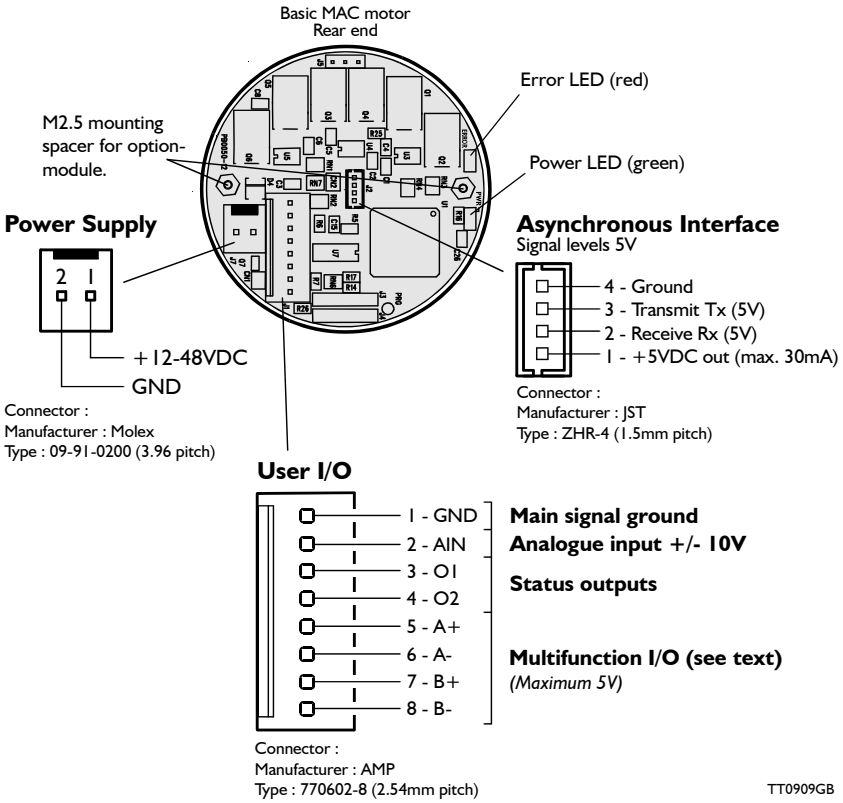
Position limit min. and max.
Same like physical limit switches but made in software. Default is 0 meaning that the feature is disabled.

Error acceleration
If a fatal error occur it can be convenient to use a controlled deceleration instead of a sudden stop. If the inertia in the system is high og the mechanical parts is weak a sudden stop can cause damages and unintended behaviour. Use this parameter to define the deceleration during af fatal error. Default is 0 meaning that the feature is disabled.

3 Hardware description

3.1 Connector overview

Connector overview for the basic MAC motors



3.1.1 Connector description

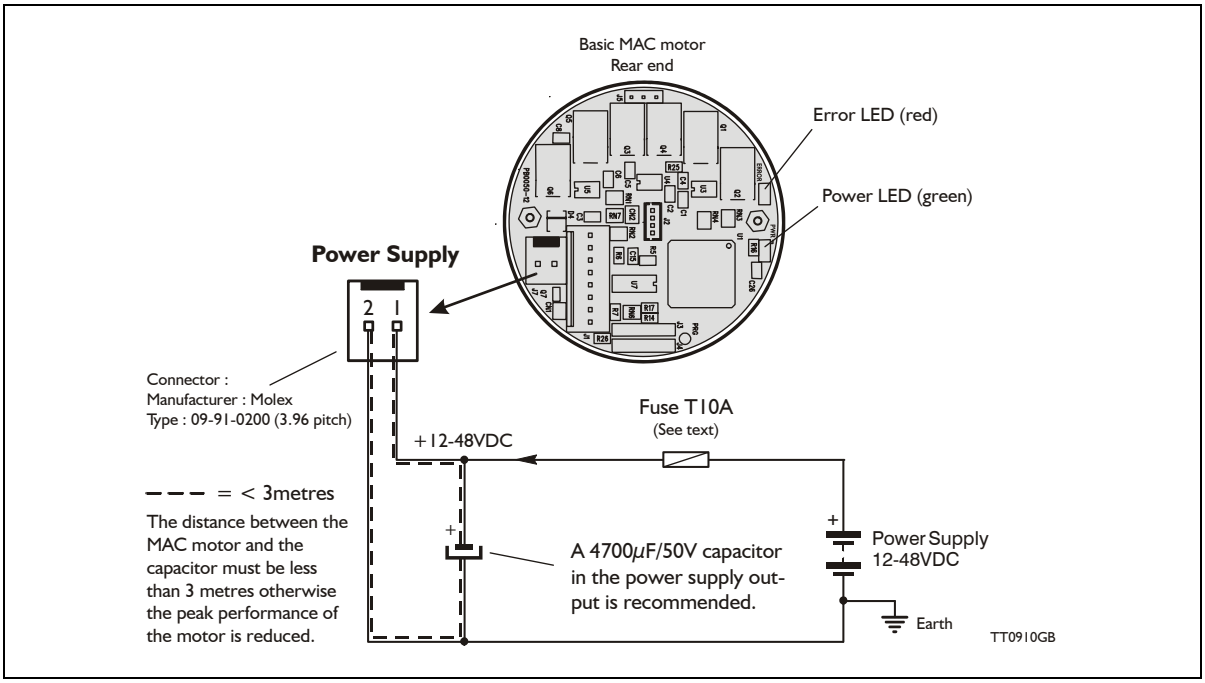
The basic MAC motor is equipped with 3 connectors.

- **Power Supply**
  Connect the main supply to this connector. The voltage must be within the range 12 to 48VDC nominal.

- **User I/O**
  This connector includes all the main I/O necessary to run the motor in gear mode, velocity mode, etc. An analogue input (±10V) can be used for velocity or torque control or it can be used for a Zero search sensor. 2 Status outputs are also available to show the actual status of the motor. Terminals 5 to 8 are multifunction terminals, where the specific function of the terminals depends on the motor setup.
  The functions can be *only one* of following:
  1. Encoder output - The internal encoder-pulses are output as a quadrature signal.
  2.Pulse inputs - When the motor is set to Gear mode, it will follow pulses at the A and B inputs. 2 input formats can be selected: pulse and direction or quadrature.
  3. RS422 communication - A master controller can send commands, for example velocity or position commands. This interface is intended for permanent connection.

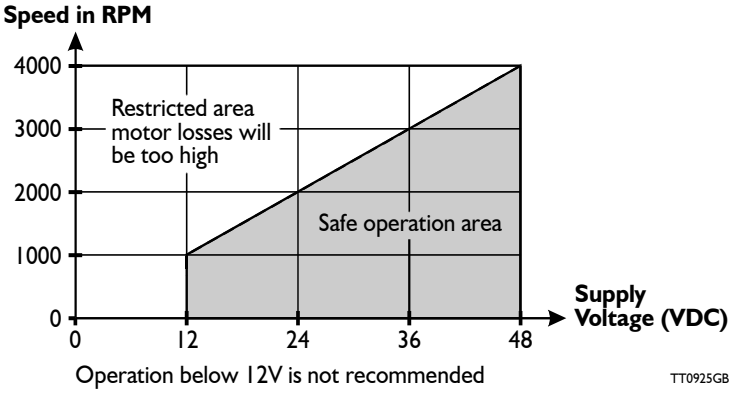
- **RS232 Interface**
  The motor setup and monitoring is done via this interface. The windows-based *MacTalk* software must be installed on a computer and used for this purpose.
  It is also possible to send position, velocity and other commands from, for example, a PLC if *MacTalk* is not used.

3.2 Power Supply



3.2.1 Power supply

The power supply must be connected to the terminals marked +48V and GND.
The supply voltage can be in the range 12VDC up to 48VDC; however the maximum speed of the motor (4000 RPM) is based on 48VDC. A lower voltage will decrease speed performance.
This curve below shows the relationship between voltage and recommended speed.



If a supply voltage lower than 48VDC is used, it will not influence the motor torque unless the corresponding speed at this voltage is overridden. The MAC motor continuously measures the actual supply voltage and optimises the current control filter. This feature ensures that the motor always produces full torque within the safe area of operation.

3.2.2 Power supply grounding

No additional grounding/earthing of the motor is necessary since the complete motor housing is connected directly to pin 2 of the Power Supply connector.
The overall earthing of the system must be done at a central point close to the power supply.

3.2.3 Dimensioning power supply and fuse.

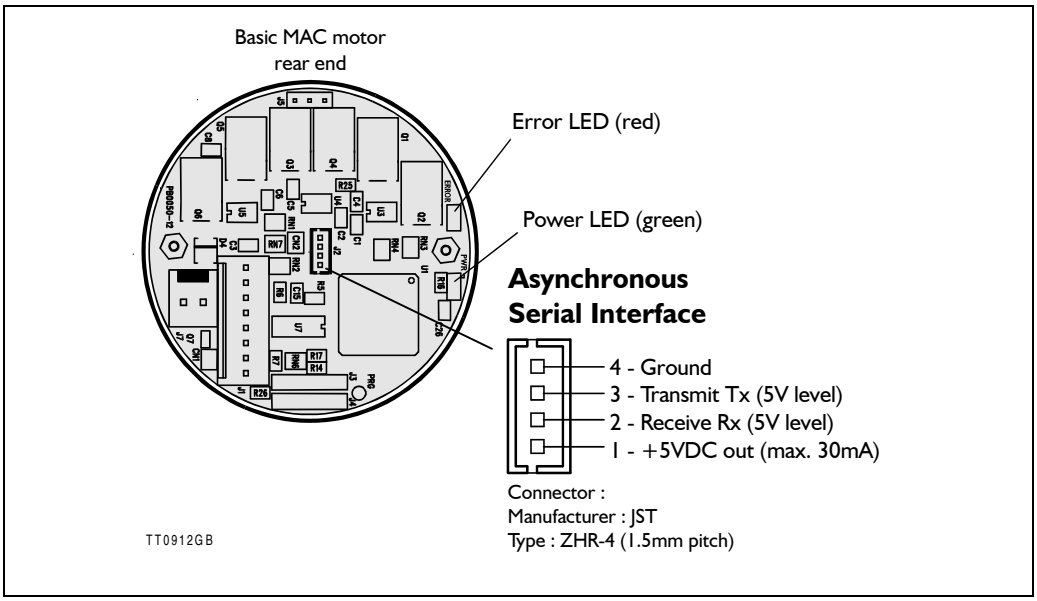
The power supply must be dimensioned according to the actual motor size (MAC50, 80, or120). The size of the pre-fuse also depends on the actual model of the MAC motor. Use the following table to select the power supply and fuse ratings.

Desired voltage	MAC50		MAC95		MAC140 or 141	
-	Supply rating	Fuse size	Supply rating	Fuse size	Supply rating	Fuse size
12VDC	20W	T4A	40W	T6.3A	60W	T10A
24VDC	40W	T4A	80W	T6.3A	160W	T10A
48VDC	80W	T4A	160W	T6.3A	320W	T10A

3.3 Serial interface

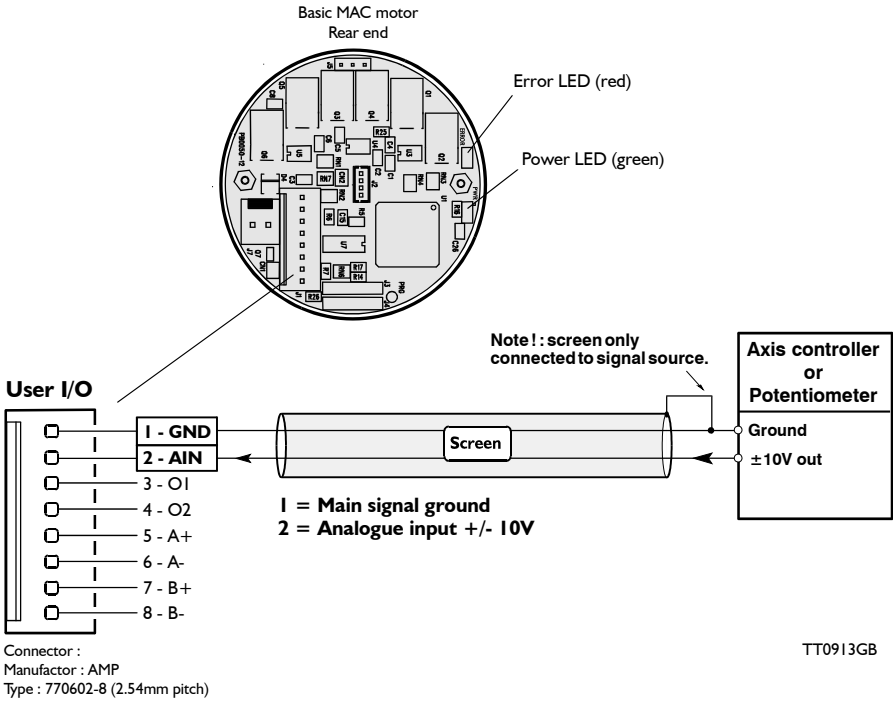
3.3.1 Interface Connection

The Controller Interface is based on an asynchronous serial interface.
3 interface signals, Rx, Tx and ground are used. The interface can be used directly with the serial COM port of any standard PC or PLC by using the optional cable type RS232-9-1-MAC which has an integrated RS232 converter. Another possibility is to use one of the expansion modules for the MAC motor which also include an RS232 and RS485 converter. See also Accessories, page 101.



3.3.2 RS232 Interface signal levels

Please note that the signal levels are 0 to +5VDC and are thus not according to the RS232 standard which requires +/-12V nominal at the RX and TX signals. However the protocol used is equivalent to the RS232 protocol.
If the Basic MAC motor is implemented in an OEM application where an internal processor communicates with the MAC motor, the TX and RX terminals can normally interface directly.



3.4.1 Analogue input.

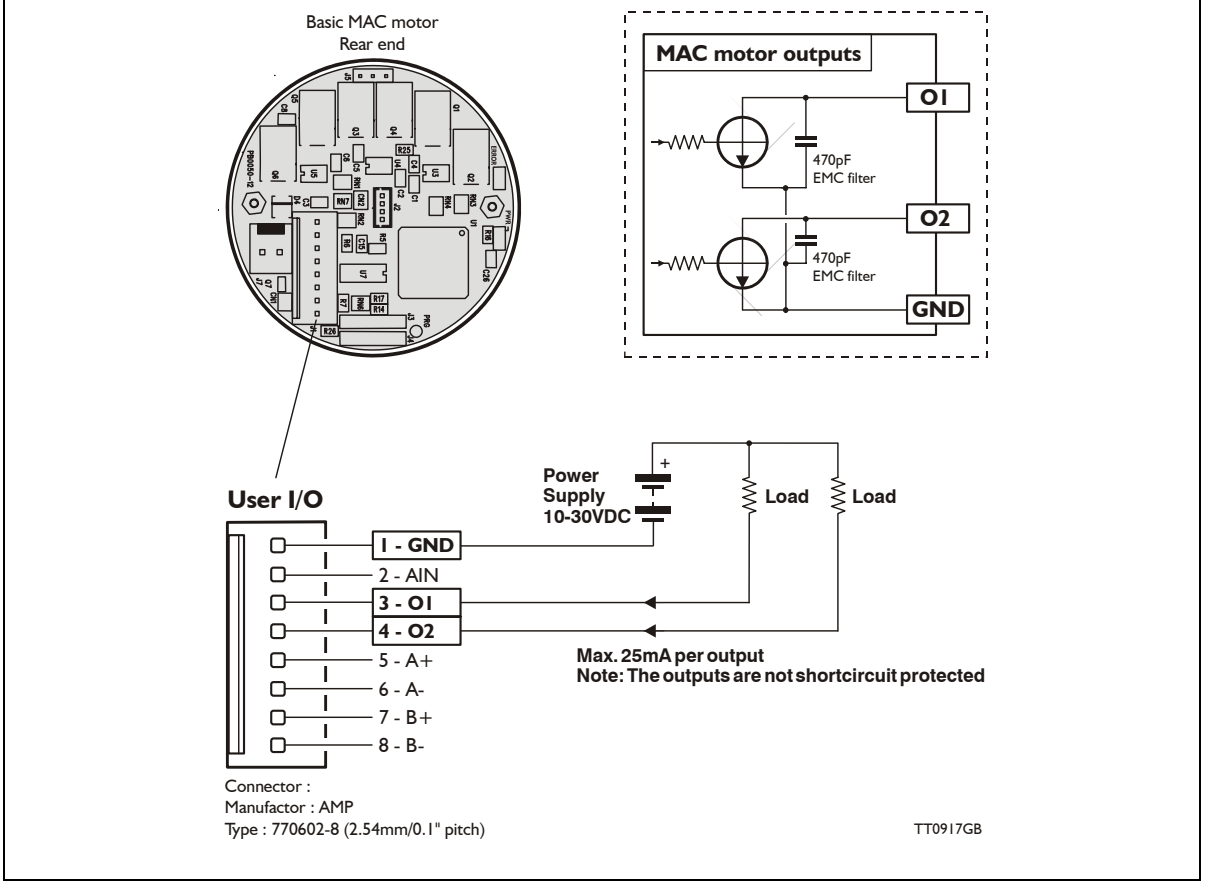
The analogue input can be used for two purposes in the basic MAC motor.

1. As an analogue control input when the MAC motor is used for either velocity control or torque control.
2. As a Zero Sensor input when the MAC motor is used in position or gear mode. For further information see Mechanical zero search, page 18

These 5 modes modes will use the analogue input as reference.

The input is automatically used as an analogue ±10V input when the Start-up mode in the MacTalk main window is set to Analogue Torque, Velocity or Velocity/Gear as shown in the accompanying illustration.

Status outputs of the MAC motor

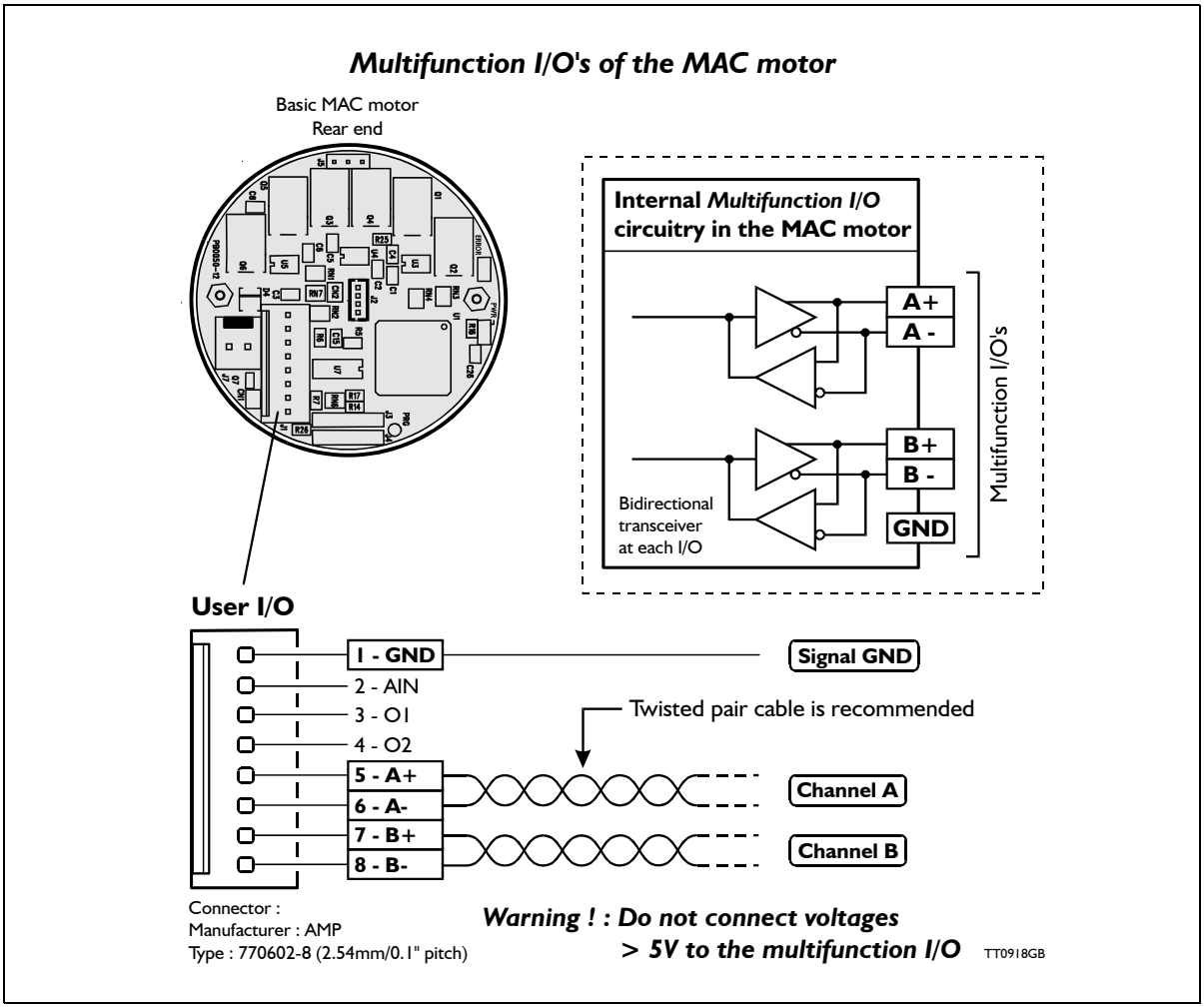


3.4.2 Status Outputs

The status outputs O1 and O2 indicate the actual status of the MAC motor.
Each output is an NPN type, which means that the load must be placed between the output and a positive supply. Note that several of the expansion modules for the MAC motor offer PNP output (source output). For further details about a specific expansion module, please see other sections of this manual.

O1 This output functions as an "In Position" or "at velocity" output depending on which mode is selected. The position interval can be setup using the MacTalk program.

O2 This output is normally passive but if a fatal error occurs, it will be activated to indicate that normal operation of the motor has been interrupted and no further operation is possible until a reset or power down has been made.
A fatal error can be one of the following conditions:



3.4.3 Multifunction I/O general description

The Multifunction I/O can be set up for different purposes depending on the actual mode of operation of the MAC motor.

- Pulse inputs
  When the motor is set to Gear mode, it will follow pulses at the A and B inputs. 2 input formats can be selected: pulse and direction or quadrature.
- Encoder output
  The internal encoder-pulses are output as a quadrature signal.
- RS422 communication
  A master controller can send commands, for example velocity or position commands. This interface is intended for permanent connection.

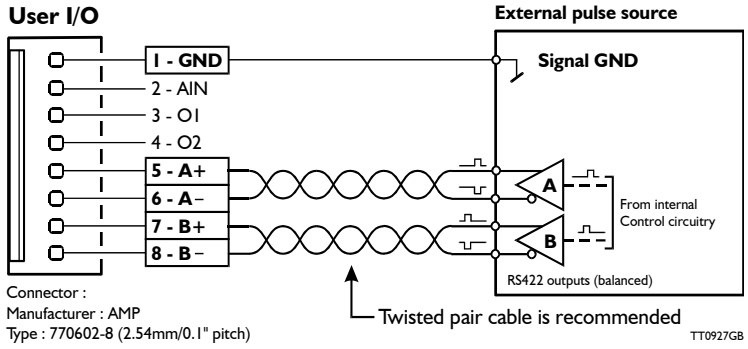
3.4.4 Multifunction I/O used as pulse inputs

The Multifunction I/O can be setup as pulse inputs, which is necessary to run the MAC motor in *Gear* mode or *Analogue velocity/gear* mode.
When the motor is set to Gear mode, it will follow pulses at the A and B inputs.
2 input formats can be selected.

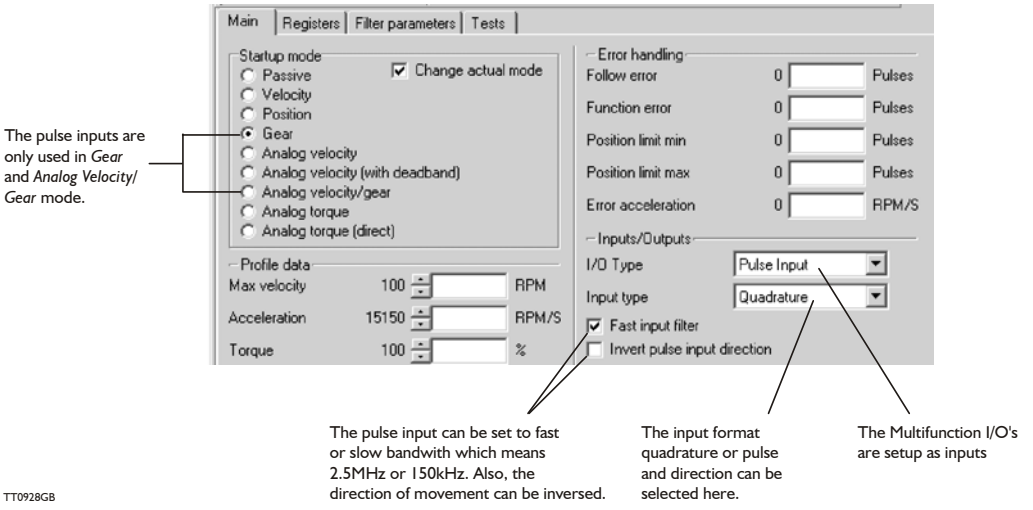
Pulse and direction. The A input must be applied with the pulses and the B input must be applied with the direction signal.

Quadrature. Also called encoder format. The pulses at the A and B channel are 90 degree phase-shifted to determine direction.

Multifunction I/O's used as balanced pulse input



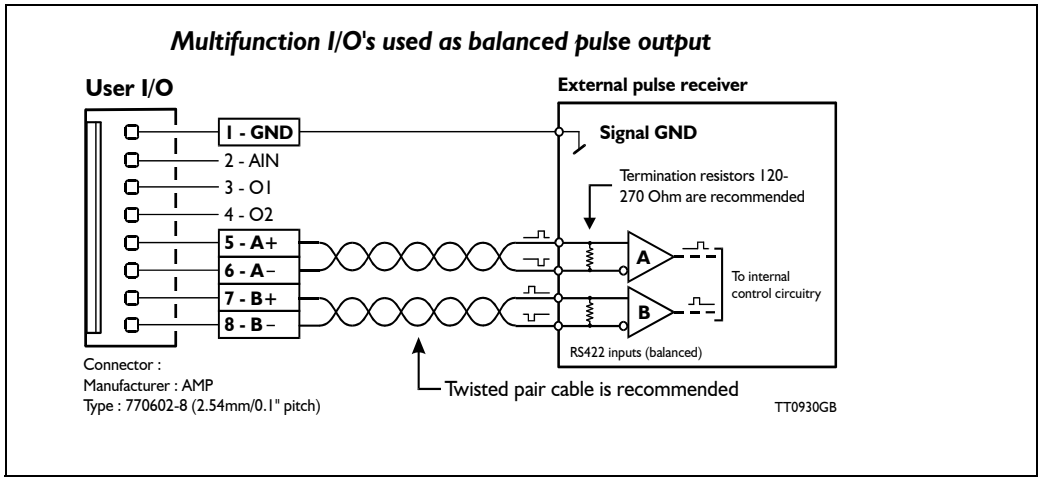
The Multifunction I/O's must be set up in MAC-Talk to function as inputs. Also, an input filter and the preferred direction of movement can be selected.



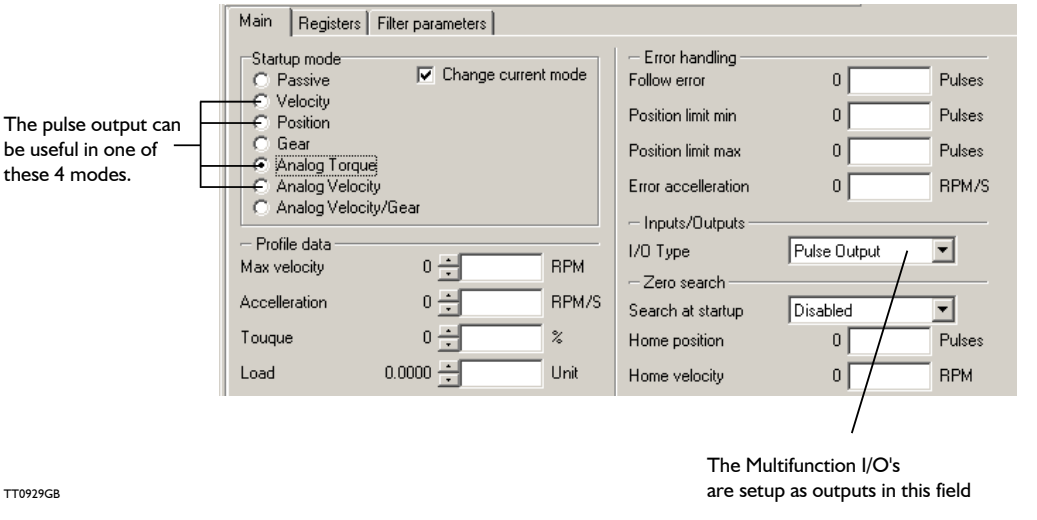
See also the descriptions of Gear and Analog Velocity/Gear modes for further details about functionality.

3.4.5 Multifunction I/O used as pulse outputs

The Multifunction I/O can be set up as pulse outputs. When this configuration is selected, the internal encoder signal will be available at the outputs.
This can be useful in modes in which the internal encoder signal must be used as feed-back to external electronics for monitoring the real-time position, or as a part of a closed-loop regulation.
This feature is especially relevant in the following 4 modes: *Velocity*, *Position, Analogue Torque* and *Analogue Velocity*.
A quadrature signal will appear at the A and B channel. Quadrature means that the two channels are 90 degree phase shifted either positively or negatively, which determine the actual direction of movement of the motor.



The Multifunction I/O's must be set up in MAC-Talk to function as pulse outputs.

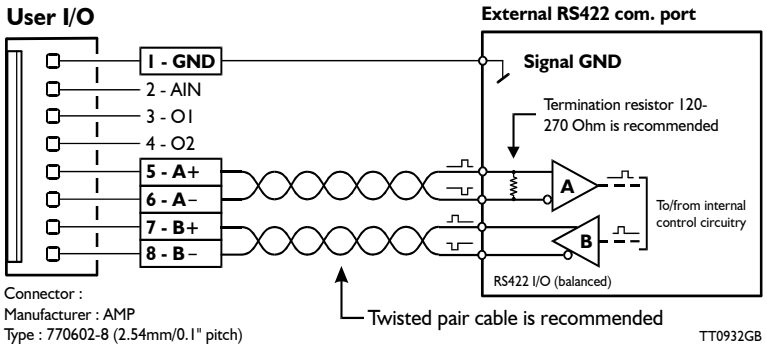


See also the respective mode descriptions for further details about functionality.

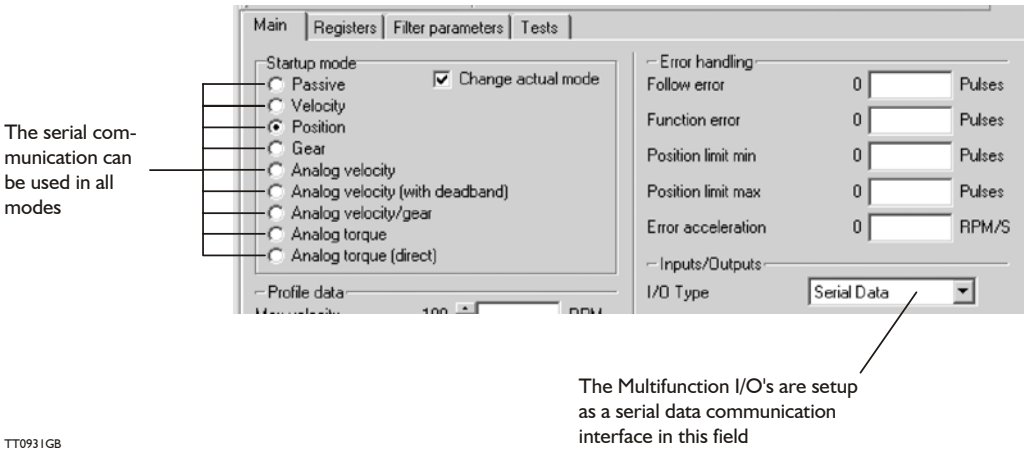
3.4.6 Multifunction I/O used as serial communication interface

The Multifunction I/O can be set up as a serial communication interface.
When this configuration of the Multifunction I/O is selected, the A and B channels function as a receive and transmit channel via which commands to the MAC motor can be transmitted from for example a PC or PLC.
This feature can be used in all modes of operation.
The communication protocol is described in the MAC motor *Technical Reference Guide,* which must be requested separately and is not part of this user manual. See also Serial communication, page 93.

Multifunction I/O's used as balanced serial interface

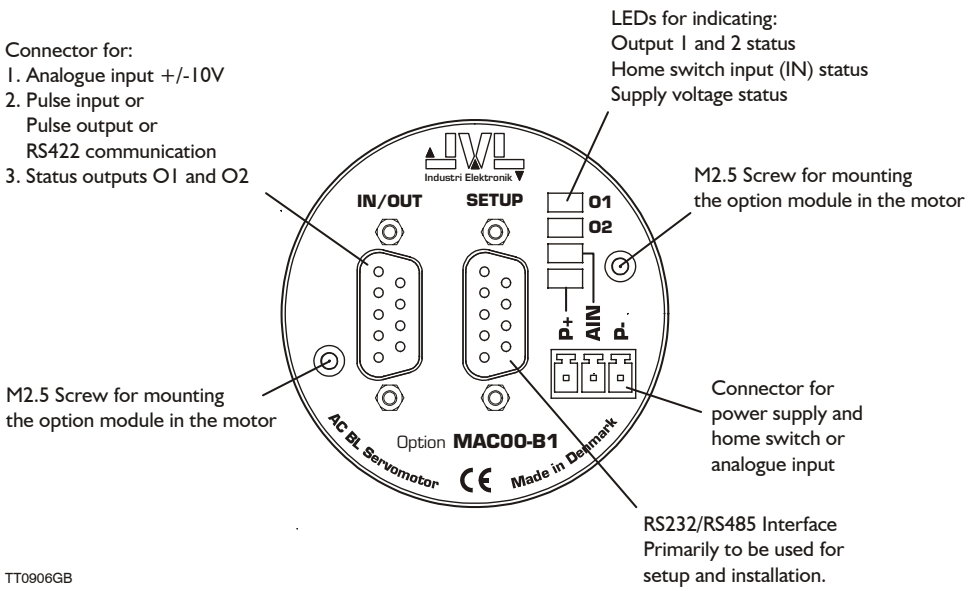


The Multifunction I/O's must be set up in MAC-Talk to function as a serial communication interface.



4 Expansion Modules

4.1 Expansion Module MAC00-B1

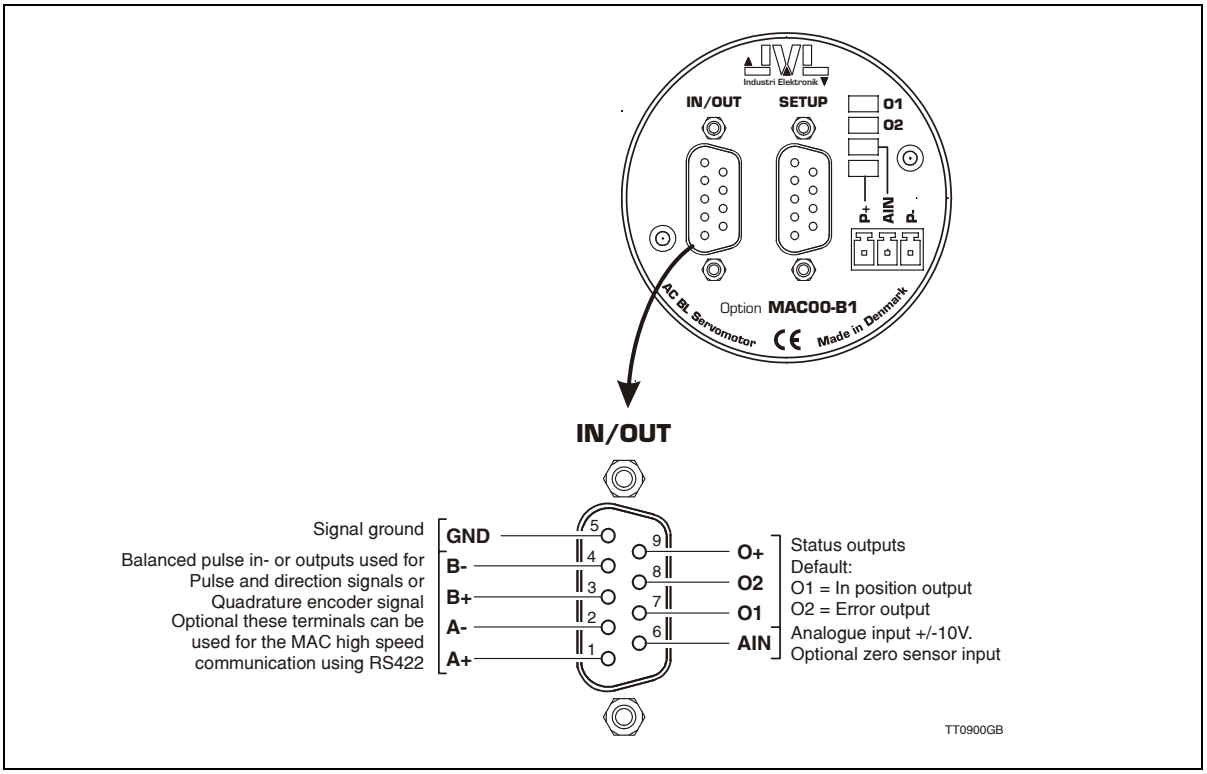


4.1.1 General description

The MAC00-B1 expansion module is an industrial interface that mates with the standard MAC motor and offers a number of feature enhancements including:

- Standard 9 pin D-SUB connectors for more reliability.
- Addition of a Zero switch input for locating a mechanical zero point of the actuator when used in position related modes.
- Plugable screw terminal connector for power supply and Zero switch.
- LEDs to indicate:
  O1 and O2 output status.
  Zero switch (analogue input) status.
  Input power status.
- Full RS232 protocol support for use with standard 9-pin serial cable.
  Note: The basic MAC motor is only equipped with a low-voltage serial interface that requires the use of the RS232-9-1-MAC option cable which has integrated electronics to boost the voltage levels.
- Full RS485 protocol support for multipoint communication up to 100m.
- Sourcing (PNP) outputs for status signals O1 and O2 instead of sinking (NPN).

4.1 Expansion Module MAC00-B1

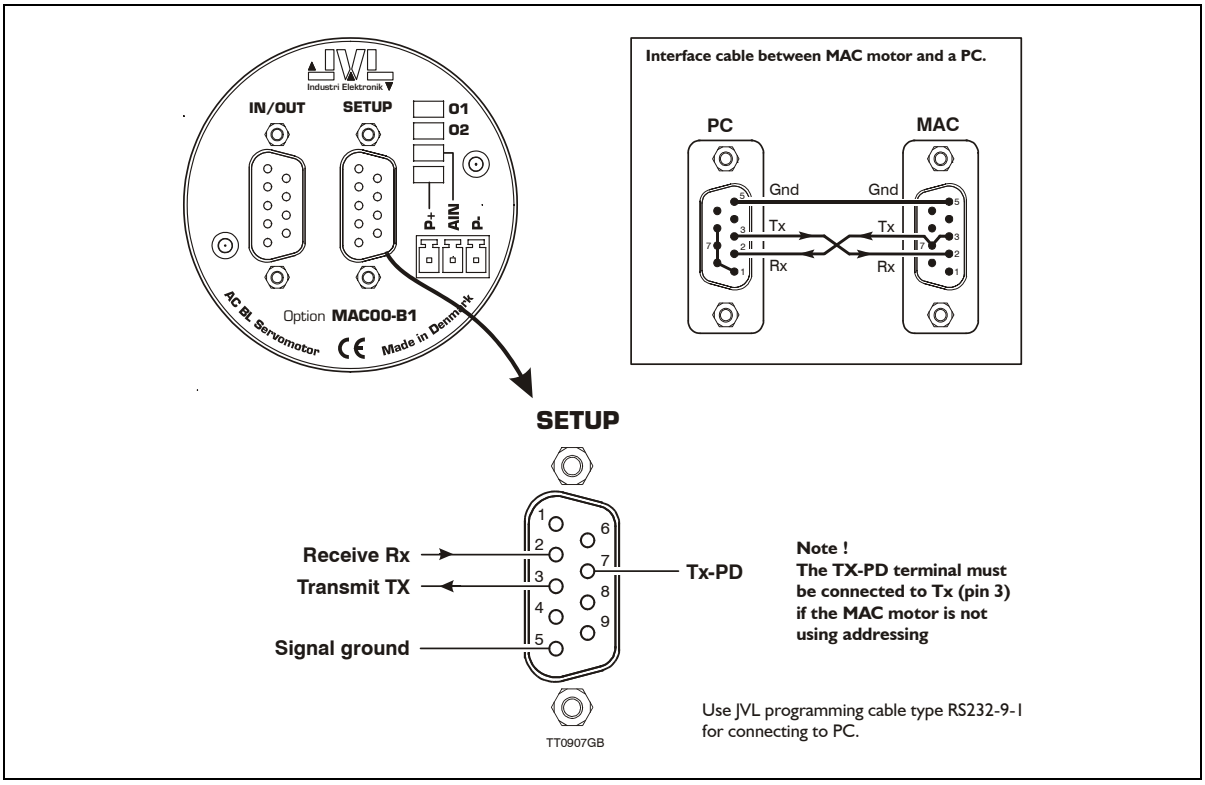


4.1.2 IN/OUT Description

The functionality of these terminals is the same as for the basic MAC motor.
The signals available are the following:

- Pulse inputs - for functional description please refer to Multifunction I/O used as pulse inputs, page 31.
- Pulse outputs - for functional description please refer to Multifunction I/O used as pulse outputs, page 32.
- RS422 interface - for functional description please refer to Multifunction I/O used as serial communication interface, page 33.
- Analogue input - for functional description please refer to Analogue input., page 28.

4.1 Expansion Module MAC00-B1



4.1.3 RS232 Interface

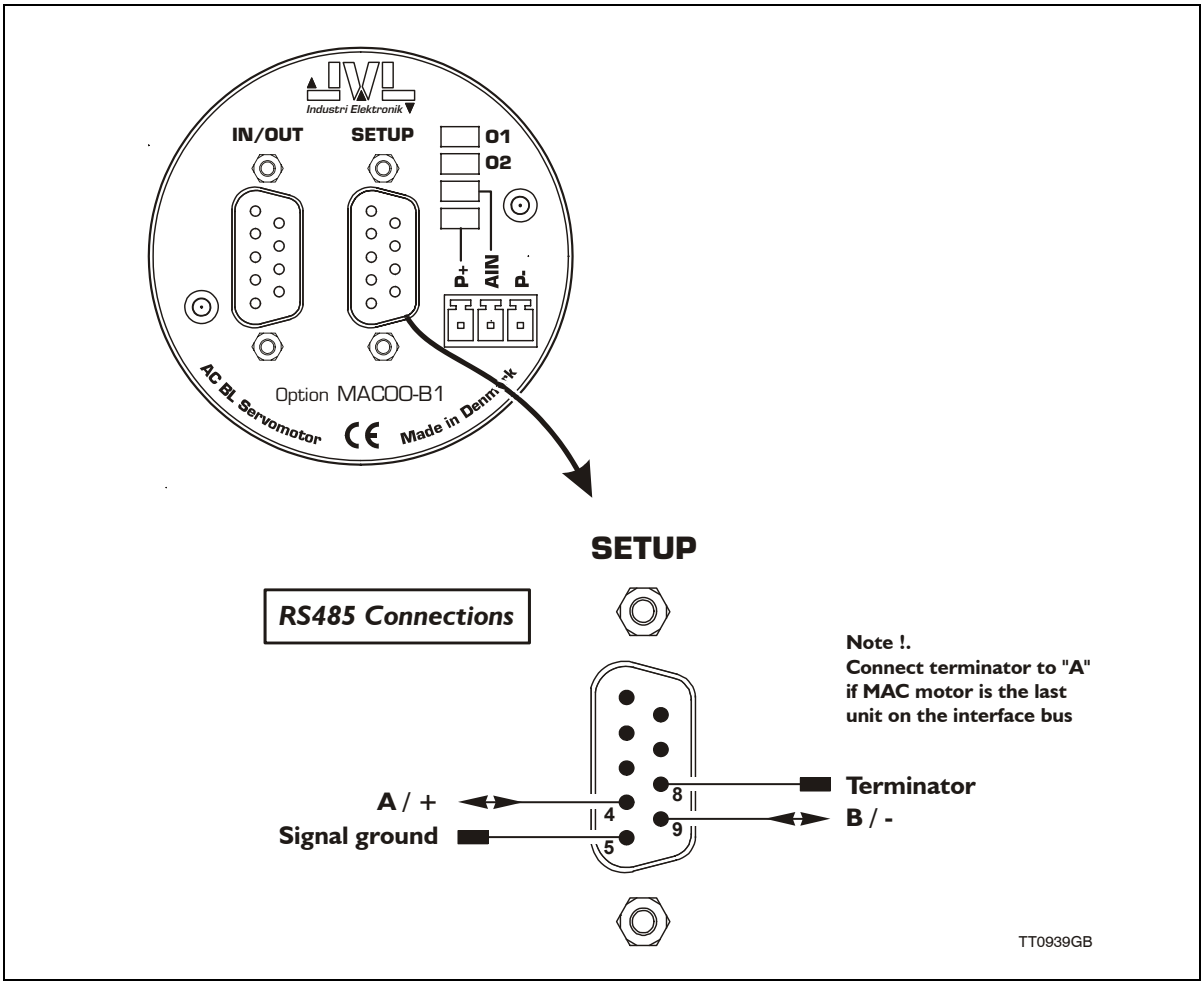
The expansion module includes an RS232 converter which makes it possible to connect the MAC motor directly to, for example, a PC.
JVL can supply programming cable type RS232-9-1 (3m). Other lengths are also available. The interface cable length should not exceed 10 metres.

Note:The basic MAC motor does not fully support RS232 since the interface signals are only 5V levels. See also the basic description - Serial interface, page 27.

4.1.4 MAC motor communication protocol

The MAC motor uses “binary” communication protocol which makes it possible to access all the internal registers. Please consult Serial communication, page 93 for further details.

4.1 Expansion Module MAC00-B1



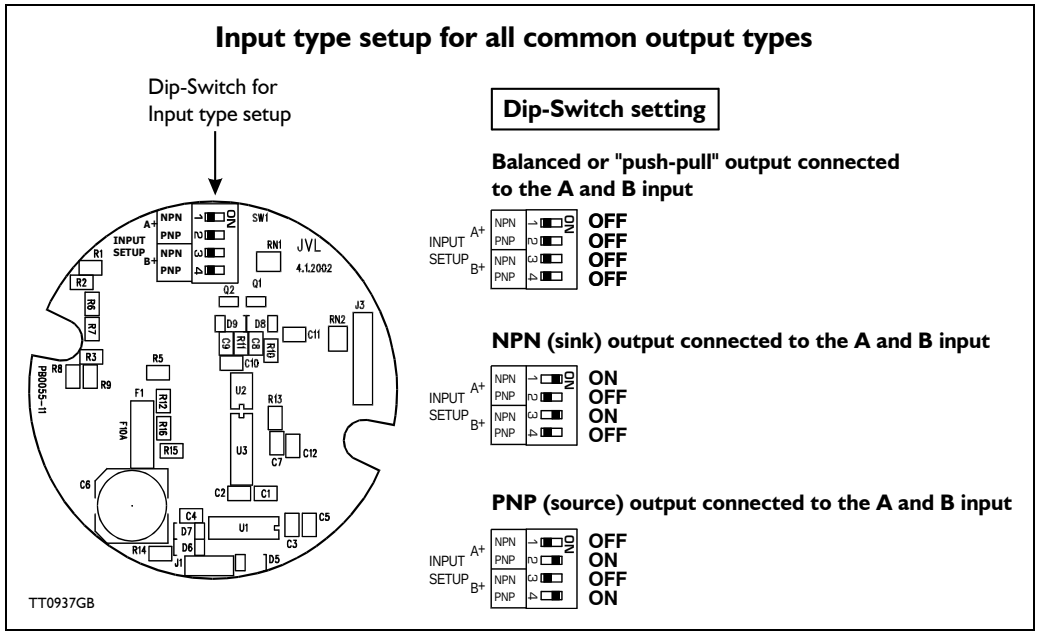
4.1.5 RS485 Interface

The MAC00-B1 module also includes an RS485 interface, in addition to the normal RS232 interface. The RS485 interface is intended for purposes where 1 to 32 MAC motors are connected on the same interface in a noisy environment.

The communication protocol is exactly the same as that for RS232 communication. The only difference is the balanced signal lines, and the fact that all communication is half-duplex, which means that the units at the communication line cannot send and receive at the same time, unlike RS232 communication.

The RS485 interface makes it possible for up to 32 units to be connected to the same interface bus. On the last MAC motor on the interface, the terminal marked Terminator (pin 8) must be shorted to the A terminal (pin 4).

4.1 Expansion Module MAC00-B1



4.1.6 Multifunction I/O - Setup as pulse input.

When the I/O is setup as pulse input (se also Multifunction I/O used as pulse inputs, page 31) the input can be setup in 2 formats.

Pulse and direction. The A input must be applied with the pulses and the B input must be applied with the direction signal.

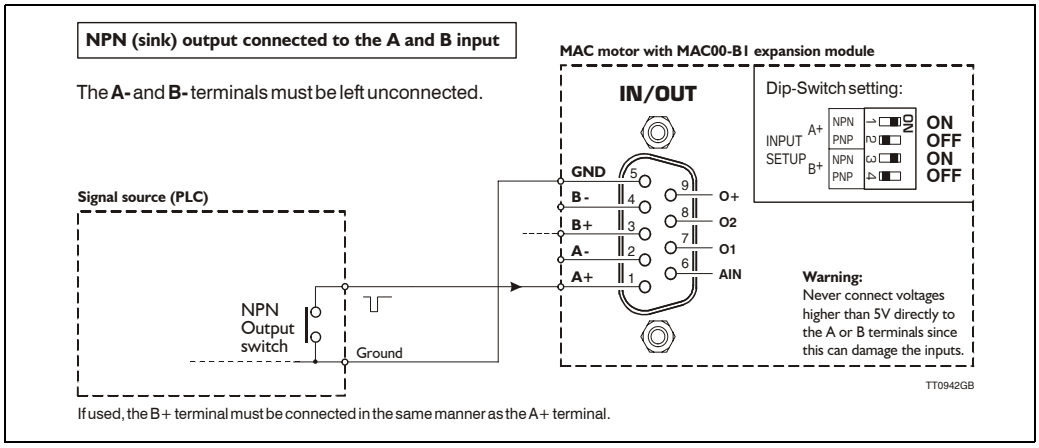
Quadrature. Also called encoder format. The pulses at the A and B channel are 90 degree phase-shifted to determine direction.

The illustration above shows how to set up the Multifunction I/O terminals as balanced/ push pull, NPN or PNP input. The illustrations below show examples of connections each of these signal types.

4.1.7 Connect NPN signal source to the Multifunction I/O

The drawing below shows how to connect an NPN source to the MAC00-B1 multifunction I/Os. The diagram shows the A channel. The B channel must be connected in the same manner. Please keep the A- and B- terminals unconnected to maintain proper function.

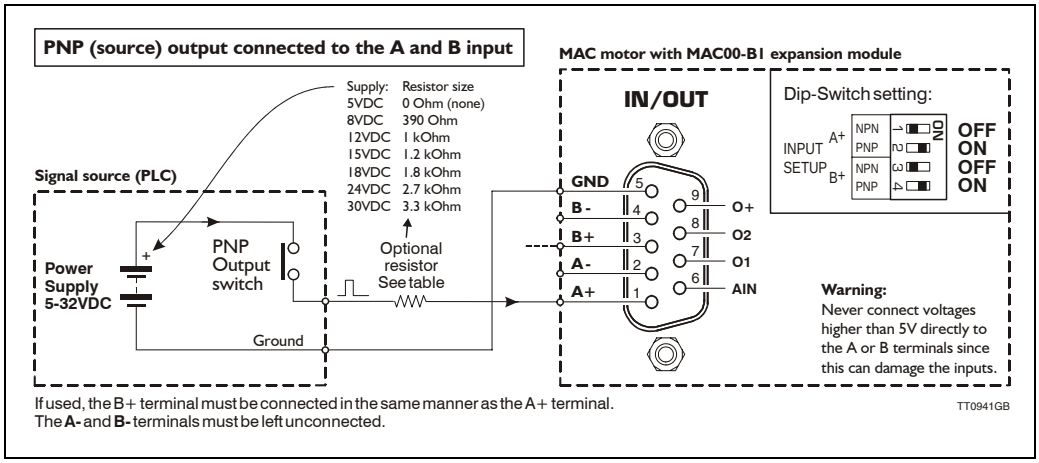
Warning: Voltages above 5V must under no circumstance be connected directly to the input since it will damage the input permanently.



4.1 Expansion Module MAC00-B1

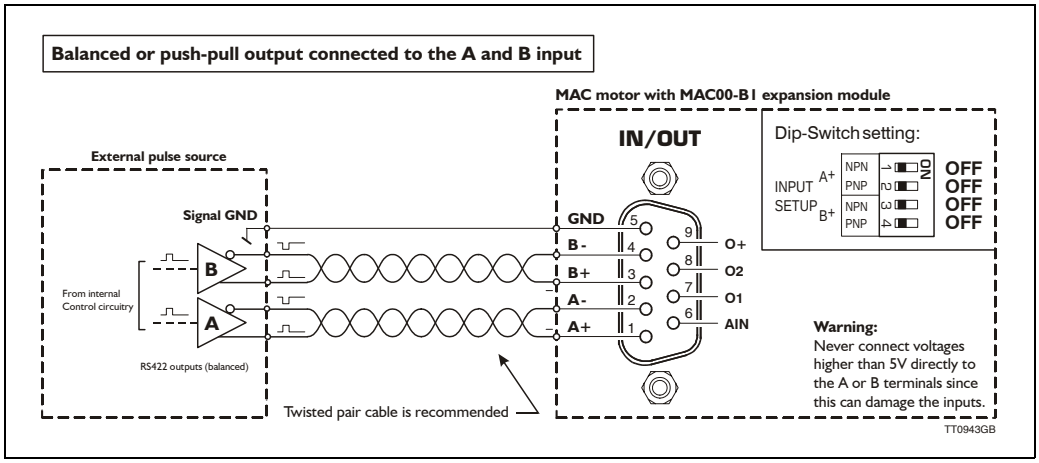
4.1.8 Connect PNP signal source to the Multifunction I/O

The drawing below shows how to connect a PNP source to the MAC00-B1 multifunction I/Os. The diagram shows the A channel. The B channel must be connected in the same manner.
Please keep the A- and B- terminals unconnected to maintain proper function.
Warning: Voltages above 5V must under no circumstance be connected directly to the input since it will damage the input permanently. Use a proper resistor as indicated in the table below.

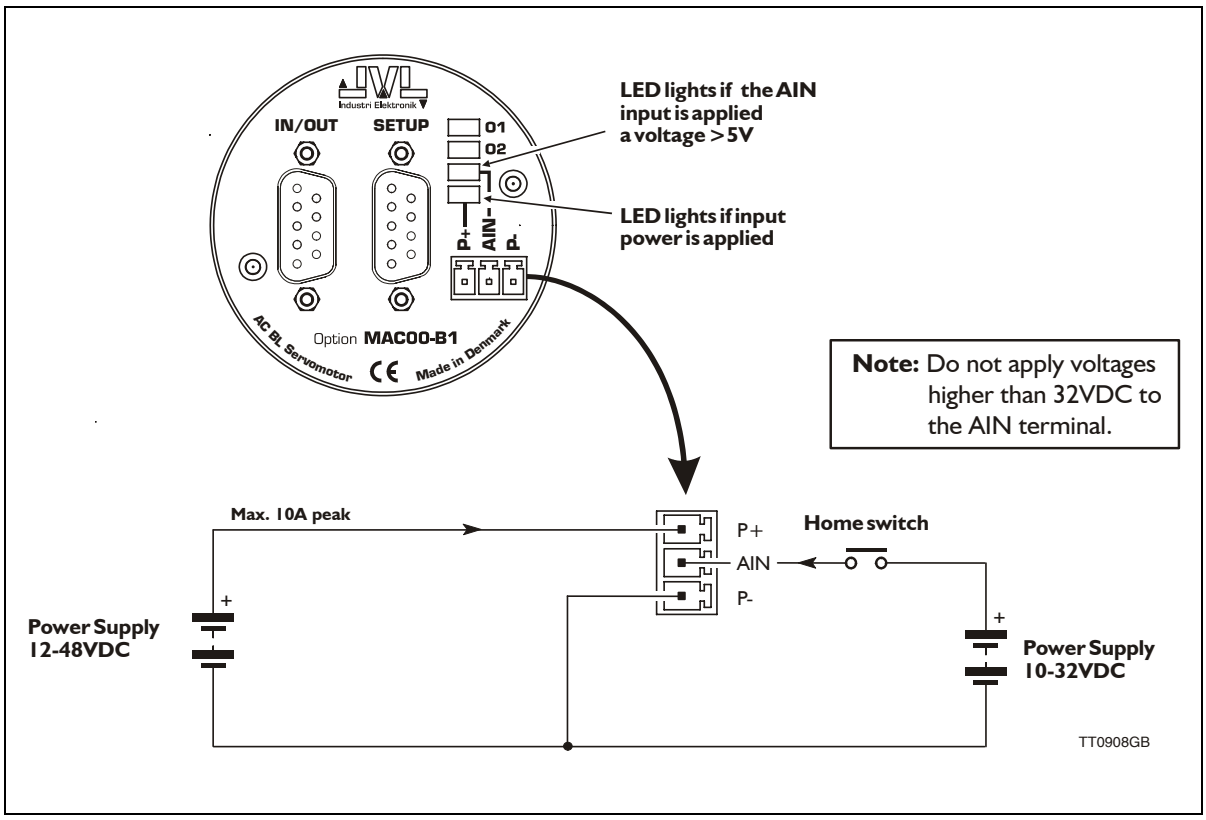


4.1.9 Connect a balanced/push-pull signal to the Multifunction I/O

The drawing below shows how to connect a balanced or push pull signal source to the MAC00-B1 multifunction I/Os. Use twisted pair cable for the balanced signals to ensure noise immunity.
Warning: Voltages above 5V must under no circumstance be connected directly to the input since it will damage the input permanently. Use a proper resistor as indicated in the table below.



4.1 Expansion Module MAC00-B1



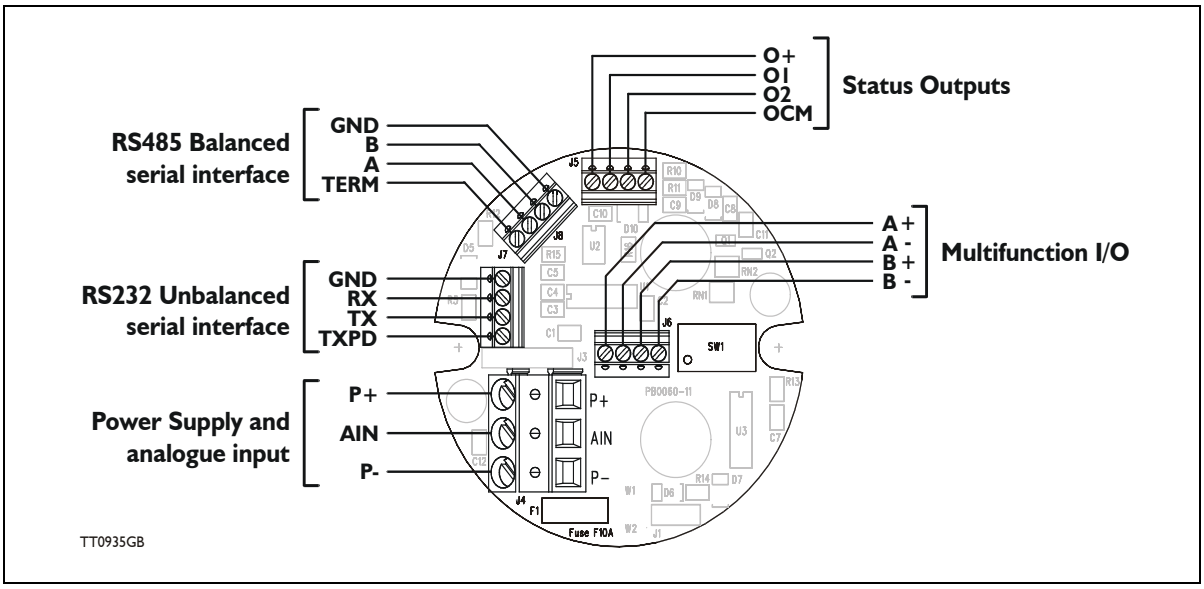
4.1.10 Power Supply

The power supply must be connected to the terminals marked +48V and GND.
The supply voltage can be chosen in the range 12VDC to 48VDC, however the maximum speed of the motor (4000 RPM) is based on 48VDC. A lower voltage will decrease the speed/torque performance, and in general it is not recommended to run the motor at more than 2000 RPM if for example 24VDC is used as supply.

4.1.11 Zero switch input

An external Zero switch can be connected to this input.
The voltage range at this input must remain between 0 and 30V.
For further information see Mechanical zero search, page 18

4.2 Expansion Module MAC00-B2



4.2.1 General description MAC00-B2

The MAC00-B2 expansion module is an industrial interface that mates with the standard MAC motor and offers a number of feature enhancements including:

- Protection IP67 if mounted at basic MAC motor (IP67 type: MACxxx-A3).
- Direct cable connection through sealed compression cable glands.
- Addition of a Zero switch input for locating a mechanical zero point of the actuator when used in position related modes.
- Screw terminals (internal) for all signal lines, power supply and Zero switch.
- Full RS232 protocol support
  Note: The basic MAC motor is only equipped with a low-voltage serial interface that requires the use of the RS232-9-1-MAC option cable which has integrated electronics to boost the voltage levels.
- Full RS485 protocol support for multipoint communication up to 100m.
- Sourcing (PNP) outputs for status signals O1 and O2 instead of sinking (NPN).

4.2 Expansion Module MAC00-B2

4.2.2 MAC00-B2 option with cables

The MAC00-B2 type number only covers the basic module without any cables.
If a number is added after the basic type number, for example MAC00-B2-10, this suffix indicates that the module is fitted with 2x10m of cable. 1 cable covers the power supply and analogue input and the other cable covers all the signal lines, i.e. RS232, RS485, status outputs and multifunction I/O.

Power cable - Cable 1

Power Supply	
Signal name	**Wire colour**
P+	Yellow / Brown
AIN	Green
P-	White

Signal cable - Cable 2

Multifunction I/O		RS485 Interface	
Signal name	**Wire colour**	**Signal name**	**Wire colour**
B-	Brown/Green	TERM *	Purple
B+	White/Green	A	Yellow/Brown
A-	Grey/Pink	B	White/Yellow
A+	Red/Blue	GND	Black
Status Outputs		**RS232 Interface**	
Signal name	**Wire colour**	**Signal name**	**Wire colour**
O+	Red	TXPD **	Green
O1	Grey	TX	Yellow
O2	Pink	RX	White
OCM	Blue	GND	Brown

* Connect to the A terminal if the module is the only or the last node at the line in order to terminate the line.
** Connect to the TX terminal if the module is the only or the last node at the line in order to terminate the line.

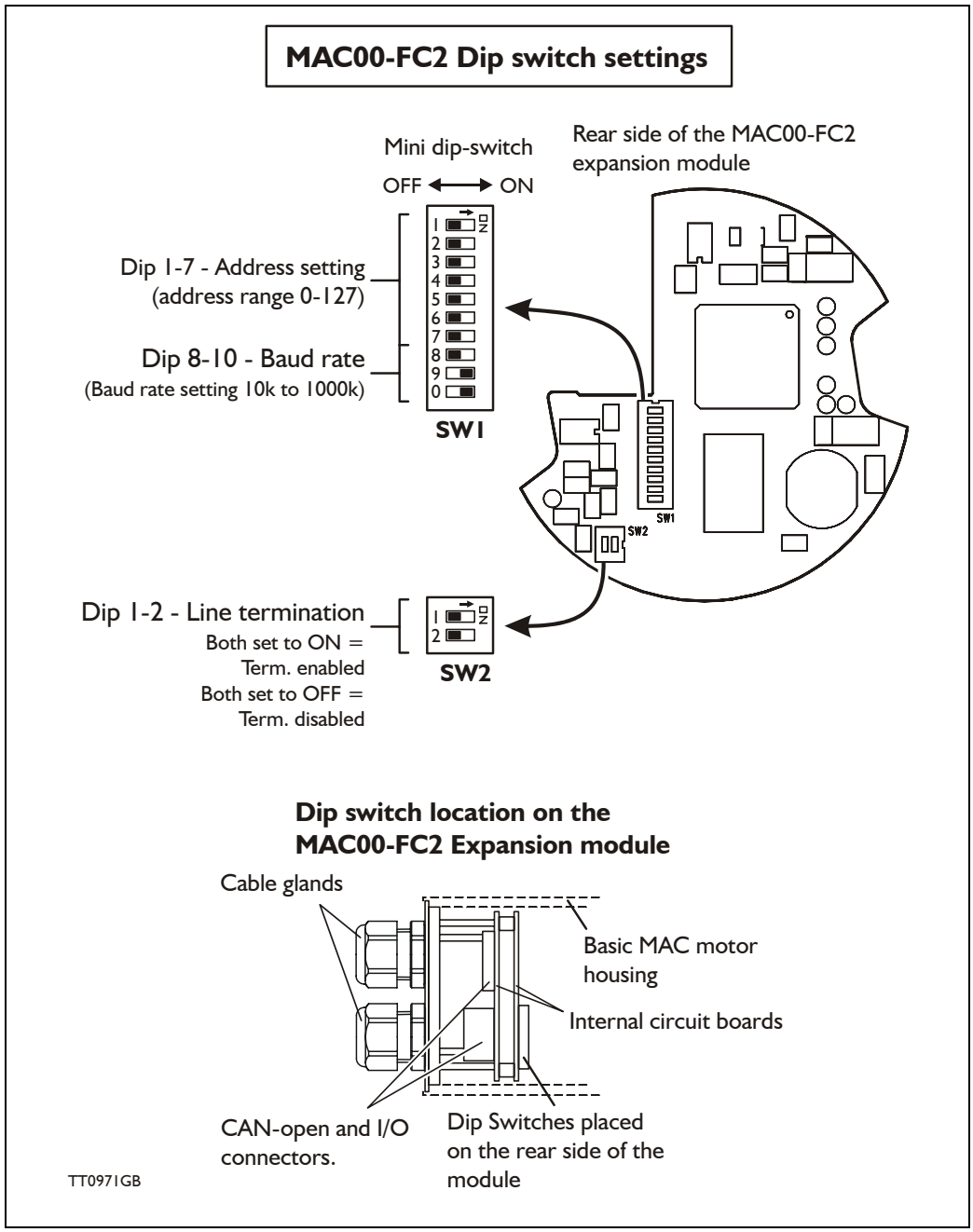
4.3 Expansion Module MAC00-FC2

4.3.1 CanOpen Introduction

The MAC00-FCx module is a CAN-Open slave. With this module all the registers in the MAC motor can be accessed over a CAN-Open network. The module implements an object dictionary that follows the CiA DS-301 standard. The module contains a number of static mapped PDO's that can be used to access the most common registers.

4.3.2 Address, baud rate and termination setup.

The 10 way dip switch (SW1) is used to select the node ID and the baudrate. Switch 1-7 selects the node ID, and switch 8-10 selects the baudrate. The 2 way dip switch (SW2) is used to enable termination. When both switched are on, the termination is enabled.



4.3 Expansion Module MAC00-FC2

The address can be set according to the following table:

Address	Dip Switch no. (SW1)							Address	Dip Switch no. (SW1)						
	7	6	5	4	3	2	1		7	6	5	4	3	2	1
0	Reserved (illegal setting)							32	OFF	**ON**	OFF	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	OFF	OFF	OFF	**ON**	33	OFF	**ON**	OFF	OFF	OFF	OFF	**ON**
2	OFF	OFF	OFF	OFF	OFF	**ON**	OFF	34	OFF	**ON**	OFF	OFF	OFF	**ON**	OFF
3	OFF	OFF	OFF	OFF	OFF	**ON**	**ON**	35	OFF	**ON**	OFF	OFF	OFF	**ON**	**ON**
4	OFF	OFF	OFF	OFF	**ON**	OFF	OFF	36	OFF	**ON**	OFF	OFF	**ON**	OFF	OFF
5	OFF	OFF	OFF	OFF	**ON**	OFF	**ON**	37	OFF	**ON**	OFF	OFF	**ON**	OFF	**ON**
6	OFF	OFF	OFF	OFF	**ON**	**ON**	OFF	38	OFF	**ON**	OFF	OFF	**ON**	**ON**	OFF
7	OFF	OFF	OFF	OFF	**ON**	**ON**	**ON**	39	OFF	**ON**	OFF	OFF	**ON**	**ON**	**ON**
8	OFF	OFF	OFF	**ON**	OFF	OFF	OFF	40	OFF	**ON**	OFF	**ON**	OFF	OFF	OFF
9	OFF	OFF	OFF	**ON**	OFF	OFF	**ON**	41	OFF	**ON**	OFF	**ON**	OFF	OFF	**ON**
10	OFF	OFF	OFF	**ON**	OFF	**ON**	OFF	42	OFF	**ON**	OFF	**ON**	OFF	**ON**	OFF
11	OFF	OFF	OFF	**ON**	OFF	**ON**	**ON**	43	OFF	**ON**	OFF	**ON**	OFF	**ON**	**ON**
12	OFF	OFF	OFF	**ON**	**ON**	OFF	OFF	44	OFF	**ON**	OFF	**ON**	**ON**	OFF	OFF
13	OFF	OFF	OFF	**ON**	**ON**	OFF	**ON**	45	OFF	**ON**	OFF	**ON**	**ON**	OFF	**ON**
14	OFF	OFF	OFF	**ON**	**ON**	**ON**	OFF	46	OFF	**ON**	OFF	**ON**	**ON**	**ON**	OFF
15	OFF	OFF	OFF	**ON**	**ON**	**ON**	**ON**	47	OFF	**ON**	OFF	**ON**	**ON**	**ON**	**ON**
16	OFF	OFF	**ON**	OFF	OFF	OFF	OFF	48	OFF	**ON**	**ON**	OFF	OFF	OFF	OFF
17	OFF	OFF	**ON**	OFF	OFF	OFF	**ON**	49	OFF	**ON**	**ON**	OFF	OFF	OFF	**ON**
18	OFF	OFF	**ON**	OFF	OFF	**ON**	OFF	50	OFF	**ON**	**ON**	OFF	OFF	**ON**	OFF
19	OFF	OFF	**ON**	OFF	OFF	**ON**	**ON**	51	OFF	**ON**	**ON**	OFF	OFF	**ON**	**ON**
20	OFF	OFF	**ON**	OFF	**ON**	OFF	OFF	52	OFF	**ON**	**ON**	OFF	**ON**	OFF	OFF
21	OFF	OFF	**ON**	OFF	**ON**	OFF	**ON**	53	OFF	**ON**	**ON**	OFF	**ON**	OFF	**ON**
22	OFF	OFF	**ON**	OFF	**ON**	**ON**	OFF	54	OFF	**ON**	**ON**	OFF	**ON**	**ON**	OFF
23	OFF	OFF	**ON**	OFF	**ON**	**ON**	**ON**	55	OFF	**ON**	**ON**	OFF	**ON**	**ON**	**ON**
24	OFF	OFF	**ON**	**ON**	OFF	OFF	OFF	56	OFF	**ON**	**ON**	**ON**	OFF	OFF	OFF
25	OFF	OFF	**ON**	**ON**	OFF	OFF	**ON**	57	OFF	**ON**	**ON**	**ON**	OFF	OFF	**ON**
26	OFF	OFF	**ON**	**ON**	OFF	**ON**	OFF	58	OFF	**ON**	**ON**	**ON**	OFF	**ON**	OFF
27	OFF	OFF	**ON**	**ON**	OFF	**ON**	**ON**	59	OFF	**ON**	**ON**	**ON**	OFF	**ON**	**ON**
28	OFF	OFF	**ON**	**ON**	**ON**	OFF	OFF	60	OFF	**ON**	**ON**	**ON**	**ON**	OFF	OFF
29	OFF	OFF	**ON**	**ON**	**ON**	OFF	**ON**	61	OFF	**ON**	**ON**	**ON**	**ON**	OFF	**ON**
30	OFF	OFF	**ON**	**ON**	**ON**	**ON**	OFF	62	OFF	**ON**	**ON**	**ON**	**ON**	**ON**	OFF
31	OFF	OFF	**ON**	**ON**	**ON**	**ON**	**ON**	63	OFF	**ON**	**ON**	**ON**	**ON**	**ON**	**ON**

Table continued on next page

4.3 Expansion Module MAC00-FC2

Address table continued from last page

Address	Dip Switch no. (SW1)							Address	Dip Switch no. (SW1)						
	7	6	5	4	3	2	1		7	6	5	4	3	2	1
64	ON	OFF	OFF	OFF	OFF	OFF	OFF	96	ON	ON	OFF	OFF	OFF	OFF	OFF
65	ON	OFF	OFF	OFF	OFF	OFF	ON	97	ON	ON	OFF	OFF	OFF	OFF	ON
66	ON	OFF	OFF	OFF	OFF	ON	OFF	98	ON	ON	OFF	OFF	OFF	ON	OFF
67	ON	OFF	OFF	OFF	OFF	ON	ON	99	ON	ON	OFF	OFF	OFF	ON	ON
68	ON	OFF	OFF	OFF	ON	OFF	OFF	100	ON	ON	OFF	OFF	ON	OFF	OFF
69	ON	OFF	OFF	OFF	ON	OFF	ON	101	ON	ON	OFF	OFF	ON	OFF	ON
70	ON	OFF	OFF	OFF	ON	ON	OFF	102	ON	ON	OFF	OFF	ON	ON	OFF
71	ON	OFF	OFF	OFF	ON	ON	ON	103	ON	ON	OFF	OFF	ON	ON	ON
72	ON	OFF	OFF	ON	OFF	OFF	OFF	104	ON	ON	OFF	ON	OFF	OFF	OFF
73	ON	OFF	OFF	ON	OFF	OFF	ON	105	ON	ON	OFF	ON	OFF	OFF	ON
74	ON	OFF	OFF	ON	OFF	ON	OFF	106	ON	ON	OFF	ON	OFF	ON	OFF
75	ON	OFF	OFF	ON	OFF	ON	ON	107	ON	ON	OFF	ON	OFF	ON	ON
76	ON	OFF	OFF	ON	ON	OFF	OFF	108	ON	ON	OFF	ON	ON	OFF	OFF
77	ON	OFF	OFF	ON	ON	OFF	ON	109	ON	ON	OFF	ON	ON	OFF	ON
78	ON	OFF	OFF	ON	ON	ON	OFF	110	ON	ON	OFF	ON	ON	ON	OFF
79	ON	OFF	OFF	ON	ON	ON	ON	111	ON	ON	OFF	ON	ON	ON	ON
80	ON	OFF	ON	OFF	OFF	OFF	OFF	112	ON	ON	ON	OFF	OFF	OFF	OFF
81	ON	OFF	ON	OFF	OFF	OFF	ON	113	ON	ON	ON	OFF	OFF	OFF	ON
82	ON	OFF	ON	OFF	OFF	ON	OFF	114	ON	ON	ON	OFF	OFF	ON	OFF
83	ON	OFF	ON	OFF	OFF	ON	ON	115	ON	ON	ON	OFF	OFF	ON	ON
84	ON	OFF	ON	OFF	ON	OFF	OFF	116	ON	ON	ON	OFF	ON	OFF	OFF
85	ON	OFF	ON	OFF	ON	OFF	ON	117	ON	ON	ON	OFF	ON	OFF	ON
86	ON	OFF	ON	OFF	ON	ON	OFF	118	ON	ON	ON	OFF	ON	ON	OFF
87	ON	OFF	ON	OFF	ON	ON	ON	119	ON	ON	ON	OFF	ON	ON	ON
88	ON	OFF	ON	ON	OFF	OFF	OFF	120	ON	ON	ON	ON	OFF	OFF	OFF
89	ON	OFF	ON	ON	OFF	OFF	ON	121	ON	ON	ON	ON	OFF	OFF	ON
90	ON	OFF	ON	ON	OFF	ON	OFF	122	ON	ON	ON	ON	OFF	ON	OFF
91	ON	OFF	ON	ON	OFF	ON	ON	123	ON	ON	ON	ON	OFF	ON	ON
92	ON	OFF	ON	ON	ON	OFF	OFF	124	ON	ON	ON	ON	ON	OFF	OFF
93	ON	OFF	ON	ON	ON	OFF	ON	125	ON	ON	ON	ON	ON	OFF	ON
94	ON	OFF	ON	ON	ON	ON	OFF	126	ON	ON	ON	ON	ON	ON	OFF
95	ON	OFF	ON	ON	ON	ON	ON	127	ON	ON	ON	ON	ON	ON	ON

The baud rate can be set according to the following table:

Baud rate	Dip Switch no. (SW1)		
	10	9	8
1000 kbit	OFF	OFF	OFF
500 kbit	OFF	OFF	**ON**
250 kbit	OFF	**ON**	OFF
125 kbit	OFF	**ON**	**ON**
100 kbit	**ON**	OFF	OFF
50 kbit	**ON**	OFF	**ON**
20 kbit	**ON**	**ON**	OFF
10 kbit	**ON**	**ON**	**ON**

4.3.3 Object dictionary

	Index (hex)	Sub Index	Type	Read only	Default	Description
Command	2010	0	UNSIGNED8			Execute a MAC00-FCx command
Module parameters	2011	0	UNSIGNED8	X	7	Subindex count
		1	UNSIGNED8	X		Input status IN1 - IN4, NL, PL
		2	UNSIGNED8			Ouput
		3	UNSIGNED8	X		Motor Status
		4	UNSIGNED16	X		Last Motor Error
		5	UNSIGNED8			Output setup
		6	UNSIGNED8			Input active level
		7	UNSIGNED8			Input setup
Motor parameters	2012	0	UNSIGNED8	X	254	Subindex count
		n	UNSIGNED32			Access to the motor parameter n
FastMac Command	2013	0	UNSIGNED8			Executes a FastMac command

4.3 Expansion Module MAC00-FC2

4.3.4 Object 2010h

When writing to this object (sub index 0) it is possible to execute some special commands for the MAC00-FCx module.
The following commands are available:

Number	Function
0	No operation
1	Reset limit error
2	Reset communication error
3-255	Reserved

4.3.5 Object 2011h – Subindex 1 Input status

This object is used to read out the actual value of the inputs.

Bit	7	6	5	4	3	2	1	0
Input	Reserved		PL	NL	IN4	IN3	IN2	IN1

4.3.6 Object 2011h – Subindex 2 Outputs

With this object the outputs can be controlled.
The value written to this object is directly shown on the outputs, if the output is not used for its default function (see subindex 5).

Bit	7	6	5	4	3	2	1	0
Output	Reserved						O2	O1

4.3.7 Object 2011h – Subindex 3 Motor status

With this object the status of the motor can be monitored.

Bit	7	6	5	4	3	2	1	0
Data	Reserved	Decele-ration	Accele-ration	In position	Reserved	Limit switch Error	Discon-nected	Motor Error

Bit 6: Equals 1, if the velocity is decreasing.
Bit 5: Equals 1, if the velocity is increasing.
Bit 4: Equals 1, if the motor is in the commanded position.
Bit 2: Equals 1, if a limit switch has been actived.
Bit 1: Equals 1, if there is a communication error between the MAC00-FC and the motor. This could occur if the motor was reset due to a voltage drop.
Bit 0: Equals 1, if there is a fatal motor error, read subindex 4, to get extended information.

4.3.8 Object 2011h – Subindex 4 Last motor status

When a fatal motor error occurs the ERR_STAT register from the MAC motor is received and can be read from this object. Please refer to the register overview in the "serial interface" section.

4.3.9 Object 2011h – Subindex 5 Output setup

This object is used to control the function of the outputs. When bit x = 0 then the output is controlled by the object 2011h, subindex 2.
When bit x = 1, then the output is controlled by the default function. The default function for O1 is "In position" and for O2 "Error".

Bit	7	6	5	4	3	2	1	0
Output	Reserved						O2	O1

4.3.10 Object 2011h – Subindex 6 Input active level

With this object the active level of the inputs can be selected. When bit x = 0 the input is active low and when bit x = 1 the input is active high.
The default setup for the output is active high.

Bit	7	6	5	4	3	2	1	0
Input	Reserved		PL	NL	IN4	IN3	IN2	IN1

4.3.11 Object 2011h – Subindex 7 Input setup

Reserved for future options.

4.3.12 Object 2012h – Motor parameters

With this object all the registers of the MAC motor can be accessed. All the registers are accessed as 32 bit. When reading and writing to 16 bit registers, the values are automatically converted in the module. Please refer the "serial Interface" section or the technical manual for a description of the registers.

4.3.13 Object 2013h – Subindex 0 FastMac command.

When writing to this object a FastMac command is executed. Please refer to the MAC00-FPx section for a description of the FastMac commands.

4.3.14 Receive PDO's

The following receive PDO's are available:

Receive PDO 1:
This PDO can be used to update the position. The data in the PDO is written directly to the position register and if the motor is in position mode, it will start moving to that position.

Byte	0	1	2	3	4	5	6	7
Data	P_SOLL				Reserved	Reserved	Reserved	Reserved
Object	2012h, sub 3							

Receive PDO 2:
With this PDO it's possible to update the velocity, acceleration and torque.

Byte	0	1	2	3	4	5	6	7
Data	V_SOLL		A_SOLL		T_SOLL		Reserved	Reserved
Object	2012h, sub 5		2012h, sub 6		2012h, sub 7			

Receive PDO 3:
This PDO sets a new operating mode for the motor.

Byte	0	1	2	3	4	5	6	7
Data	MODE_REG		Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Object	2012, sub 2							

Receive PDO 4:
This PDO sets a new operating mode for the motor.

Byte	0	1	2	3	4	5	6	7
Data	FastMac Command	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Object	2013h, sub 0							

Receive PDO 5:
This PDO updates the outputs.

Byte	0	1	2	3	4	5	6	7
Data	Output data	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Object	2011h, sub 2							

4.3.15 Transmit PDO's

All the transmit PDO's support synchronous transmission, and the PDO 5 also supports asynchronous transmission.

Transmit PDO 1:
With this PDO the actual position can be read.

Byte	0	1	2	3	4	5	6	7
Data	P_IST				Reserved	Reserved	Reserved	Reserved
Object	2012h, sub 10							

Transmit PDO 2:
With this PDO the actual velocity can be read.

Byte	0	1	2	3	4	5	6	7
Data	V_IST		Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Object	2012h, sub 12							

Transmit PDO 3:
With this PDO the actual torque can be read.

Byte	0	1	2	3	4	5	6	7
Data	VF_OUT		Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Object	2012h, sub 121							

Transmit PDO 4:
With this PDO the value of the analog input can be read.

Byte	0	1	2	3	4	5	6	7
Data	ANINP		Reserved	Reserved	Reserved	Reserved	Reserved	Reserved
Object	2012h, sub 122							

Transmit PDO 5:
With this PDO the motor status, inputs and last error can be read.
This PDO also supports asunchronous transmission. If this PDO is in asynchronous mode, it will be transmitted every time the run status or inputs is changed.

Byte	0	1	2	3	4	5	6	7
Data	Motor Status	Inputs	Last motor error		Reserved	Reserved	Reserved	Reserved
Object	2011h, sub 3	2011h, sub 1	2011h, sub 4					

4.3 Expansion Module MAC00-FC2

4.3.16 Transmission time

Due to the internal communication between the motor and the MAC00-FCx the PDO's takes a certain time to process. This table shows the processing time for the PDO's

PDO number	1	2	3	4	5
Receive PDO	8.5ms	16ms	6.5ms	<1ms	<1ms
Transmit PDO	12.5ms	10.5ms	10.5ms	10.5ms	<1ms

If the recived PDO's is transmitted faster than the internal processing time, an internal queue overflow occurs (See emergency object). If the SYNC object interval is smaller that the processing time of the active transmit PDO's an internal queue overflow error occurs.

4.3 Expansion Module MAC00-FC2

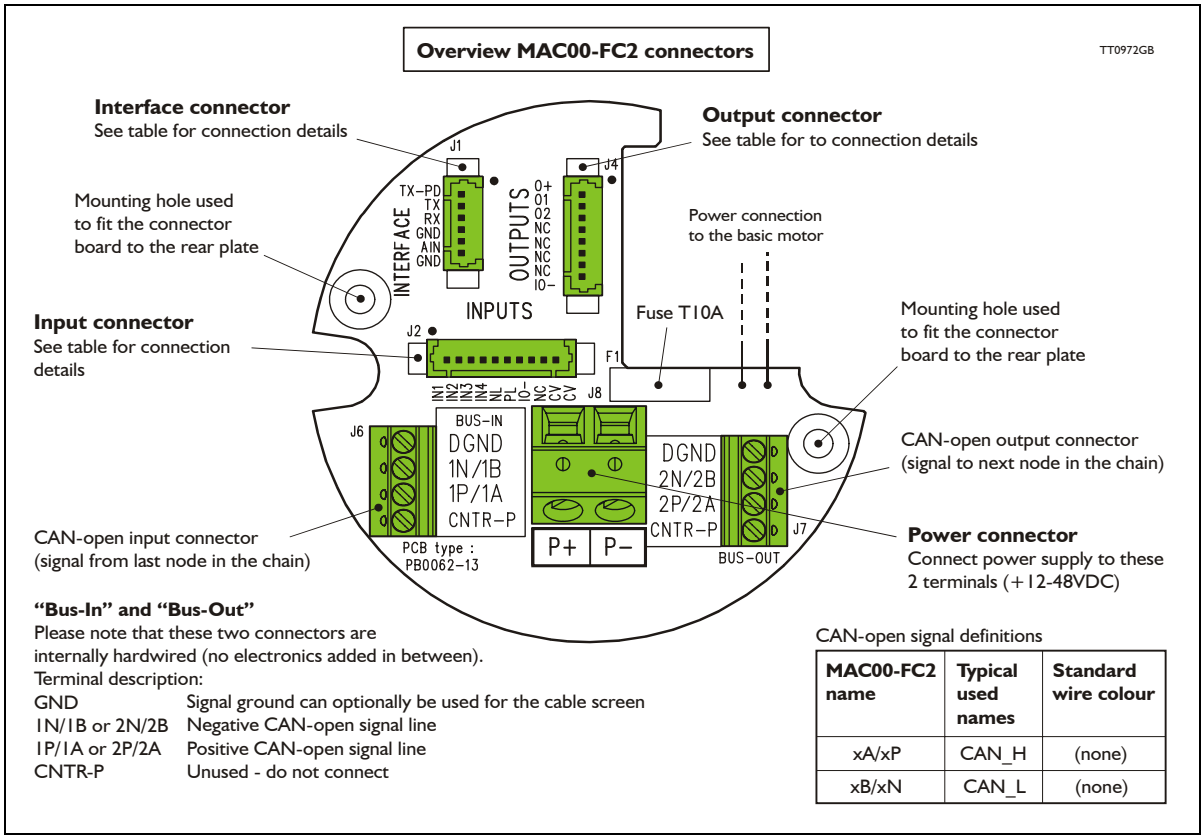
4.3.17 Emergency object

The MAC00-FC supports the EMC object (Emergency).
The following error codes can be generated:

Errorcode 1001h: Generic error - Motor error
Errorcode 1002h: Generic error - Limit switch error
Errorcode 1003h: Generic error - Internal communication error
Errorcode 1004h: Generic error - Queue overflow in communication queue.

4.3.18 MAC00-FC2 Connectors.

The illustration below shows all the internal connectors in the module. The profibus and power connectors are easy to use screw terminals. If the I/Os are used, they require a JVL cable type WG0402 (2m), WG0410 (10m) or WG0420 (20m). See also the appendix for cable and connector accessories.



"Bus-In" and "Bus-Out"
Please note that these two connectors are internally hardwired (no electronics added in between).
Terminal description:

GND	Signal ground can optionally be used for the cable screen
1N/1B or 2N/2B	Negative CAN-open signal line
1P/1A or 2P/2A	Positive CAN-open signal line
CNTR-P	Unused - do not connect

CAN-open signal definitions

MAC00-FC2 name	Typical used names	Standard wire colour
xA/xP	CAN_H	(none)
xB/xN	CAN_L	(none)

4.3 Expansion Module MAC00-FC2

4.3.19 MAC00-FC2 with cables (optional)

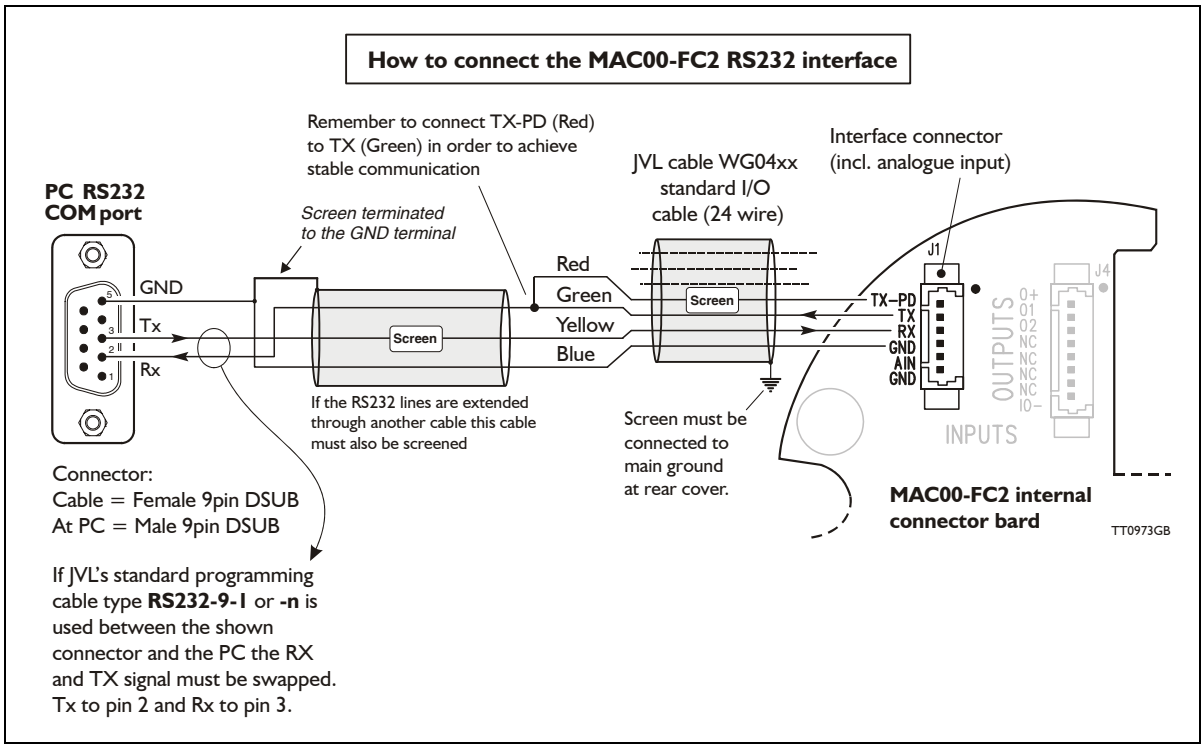
The MAC00-FC2 type number only covers the basic module without any cables.
If a number is added after the basic type number, for example MAC00-B2-10, this suffix indicates that the module is fitted with 10 m of cable in the I/O. The I/O cable covers all the signal lines, which means RS232, Digital input 1-4, Limit inputs NL and PL and the Digital outputs 1-4.

Digital Inputs - Internal connector J2			
Signal name	**Pin no.**	**Description**	**Wire colour**
IN1	1	Digital input 1	Red/black
IN2	2	Digital input 2	Green/black
IN3	3	Digital input 3	Violet
IN4	4	Digital input 4	Violet/white
NL	5	Negative limit input - If not used, do not connect.	Grey
PL	6	Positive limit input - If not used, do not connect.	Grey/black
IO-	7	I/O ground. This ground is shared with the output ground	Pink/black
NC	8	(Reserved)	Black/white
CV	9	Secondary supply. Used during emergency stop	Light green
CV	10	Secondary supply. Used during emergency stop	White
Digital Outputs - Internal connector J4			
Signal name	**Pin no.**	**Description**	**Wire colour**
O+	1	Supply for outputs - Must be connected to an ext. supply.	Red/white
O1	2	Digital output 1 - PNP output	Green/white
O2	3	Digital output 2 - PNP output	Yellow/black
NC	4	(Reserved)	Blue/white
NC	5	(Reserved)	Orange/white
NC	6	(Reserved)	Brown/white
NC	7	(Reserved)	Pink
IO-	8	I/O ground. This ground is shared with the input ground	Black
Interface - including analogue input - Internal connector J1			
Signal name	**Pin no.**	**Description**	**Wire colour**
TXPD	1	Transmit pull-down (Connect to TX if addr. not used)	Red
TX	2	RS232 Transmit	Green
RX	3	RS232 Receive	Yellow
GND	4	Ground for RS232	Blue
AIN	5	Analogue input +/-10V or Zero sensor input	Orange
GND	6	Ground for AIN	Brown
Cable Screen			
The cable-screen is internally connected to motor housing. Externally it must be connected to earth.			
Unused wire			
Orange/Black - is not used internally. It must be left unconnected.			

4.3 Expansion Module MAC00-FC2

4.3.20 How to connect the RS232 interface.

The illustration below shows how to connect the MAC00-FC2 directly to a PC COM port. The drawing is based on the standard cables from JVL type WG0402, WG0410 or WG0420. See also Accessories, page 101 for a complete list of cables and connectors.
If the MAC motor is connected to the same RS232 line as other motors, the terminal TX-PD should only be connected at one of the motors.
If one of JVL's standard RS232 cables (RS232-9-1 or -n) is used between the shown DSUB connector and the PC com port the RX and TX pins must be swapped since they are crossing in these standard cable.



4.4 Expansion Module MAC00-FP2

4.4.1 MAC00-FP2 Introduction

The MAC00-FP2 is a profi-DP slave. It is capable of running at baud-rates up to 12Mbit. All the registers[1] of the MAC motor can be read and written.

The module includes 6 inputs, 2 of which are end-limit inputs. These can be read from the profibus. The end-limit inputs can automatically halt the motor. The other inputs can be used to activate different movements.

The MAC motor is controlled by writing to the input data (9 bytes).

4.4.2 Output data (Master->Slave)

The MAC00-FP2 contains 9 bytes of output data.

Address	Name	Description
0	Write data 3 (MSB)	Data to write to register
1	Write data 2	--- " ---
2	Write data 1	--- " ---
3	Write data 0 (LSB)	--- " ---
4	Write register selector	The register to write
5	Read register selector	The register to read
6	Direct register	Direct FlexMac command
7	Command	Bits for commanding reads/write
8	Input setup	Bits for input setup

Write data

For 16 bit registers, the data must be placed in Write data 0 and Write data 1.
For 32 bit registers, the data must be placed in Write data 0-3.

Write register selector

The number of the register to write to should be placed here. The register must be in the range 1-255.

Read register selector

The number of the register to read from should be placed here. The register must be in the range 1-255.

Direct register

This register can be used to execute a FlexMac[2] command. When writing to this Register, the command will be executed immediately. The bit 0-6 is the command, and bit 7 is not used. If the same command is to be executed twice, bit 7 can be toggled. The command is accepted when the "Last direct register", in the output data, has the same value as this register.

[1] A list of registers can be found in Serial Quick Guide (MacTalk protocol), page 94.
[2] The FlexMac commands are described in FlexMac commands, page 62.

4.4 Expansion Module MAC00-FP2

Command

Bit	7	6	5	4	3	2	1	0
Function	Write Toggle	Read Toggle	Write 32 bit	Read 32 bit	Auto write	Auto read	Reserved	Reserved

Bit 7 (Write toggle) is used for writing data to the selected register (Write register selector). When this bit is toggled, writing is executed. The write command is accepted when Bit 7 in the command status (output data byte 7) is equal to this bit.

Bit 6 (Read toggle) is used for reading data from the selected register (Read register selector). When this bit is toggled, reading is executed. The read command is accepted when Bit 6 in the command status (output data byte 7) is equal to this bit.

Bit 5 (Write 32 bit) Set this to 1 if writing to a 32 bit register and 0 if writing to a 16 bit register.

Bit 4 (Read 32 bit) Set this to 1 if reading from a 32 bit register and 0 if reading from a 16 bit register.

Bit 3 (Auto write) When this bit is 1, the data written in write data 0-3, is transferred to the MAC motor immediately, regardless of the write toggle bit.

Bit 2 (Auto read) When this bit is 1, the data in read data 0-3 is updated all the time, regardless of the read toggle bit.

Bit 1and Bit 0 should be 0.

Input setup

Bit	7	6	5	4	3	2	1	0
Function	-	Reset end limit	PL Enable	NL Enable	Input mode			

Bit 6 (Reset end-limit) When this bit is 1, the end limit condition is reset, if no end limits are activated.

Bit 5 (PL Enable) When this bit is 1, the positive end-limit is enabled.

Bit 4 (NL Enable) When this bit is 1, the negative end-limit is enabled.

Bit 3-0 (Input mode) these bits select the current input mode. See section Input modes, page 60 for details.

4.4 Expansion Module MAC00-FP2

4.4.3 Input data (Slave->Master)

The MAC00-FP2 contains 8 bytes of input data.

Address	Name	Description
0	Read data 3 (MSB)	Data read from register register
1	Read data 2	--- " ---
2	Read data 1	--- " ---
3	Read data 0	--- " ---
4	Motor status	Status bits for the motor
5	Input status	Status of inputs
6	Last direct register	Last accepted direct FlexMac command
7	Command Status	Status bits for commands

Read Data

For 16 bit registers, the read value will be placed in Read data 0 and Read data 1.
For 32 bit registers, the read value will be placed in Read data 0-3.

Motor status

Bit	7	6	5	4	3	2	1	0
Function	-	Decelerating	Accelerating	In position	-	-	-	Error

Bit 6 (Decelerating) this bit is 1 when the motor is decelerating.

Bit 5 (Accelerating) this bit is 1 when the motor is accelerating.

Bit 4 (In position) this bit is 1 when the motor has reached its commanded position.

Bit 0 (Error) this bit is 1 when a motor error has occurred.

Input status

Bit	7	6	5	4	3	2	1	0
Function	-	-	PL	NL	IN4	IN3	IN2	IN1

Bit 5 (PL) Positive limit input.

Bit 4 (NL) Negative limit input.

Bit 3-0 (INx) user inputs.

Last direct register

See Direct register, page 57 for details.

Command status

Bit	7	6	5	4	3	2	1	0
Function	Write Toggle	Read Toggle	-	-	Status			

Bit 7 (Write Toggle) this bit indicates when writing is completed. See Command, page 58 for details.

Bit 6 (Read Toggle) this bit indicates when reading is completed. See Command, page 58 for details.

Bit 3-0 (Status) These bits indicate the status of the MAC00-FP2. The following status codes are possible:

Code	Description
0	OK – Idle
1	Executing Input
2	Executing Output
3	Limit switch active
4	Profi error
5	Connecting to MAC motor

4.4.4 Input modes

The 4 user inputs can be used to execute different move commands.
The following input modes can be selected:

Mode	Description
0	Passive
1	Absolute+Relative
2-14	Reserved
15	Custom

Passive mode (0)

When this mode is selected, the user inputs are ignored.
The inputs can be read in output data 5 for other purposes.

Absolute + Relative mode (1)

When this mode is selected. the inputs have the following functions:

IN1: Selects the absolute position in position register 1.
IN2: Selects the absolute position in position register 2.
IN3: Moves relative the distance in position register 3.
IN4: Moves relative the distance in position register 4.

The action is executed when an inactive-to-active transition is detected on the input.

Custom mode (15)

When this mode is selected, the action of each input can be selected with the slave parameters. See “Slave parameters” on page 61.

4.4 Expansion Module MAC00-FP2

4.4.5 Slave parameters

When configuring the profibus, it is possible to set some parameters for the slave. These parameters are setup during startup and cannot be changed during operation.

XX Input level

Using these parameters, the input level of the inputs IN1, IN2, IN3, IN4, NL and PL can be selected.

Possible values:

Active high : The input will be active, when a signal is applied.
Active low : The input will be active, when no signal is applied.

End-limit action

With this parameter, the action when an end limit is activated can be selected.

Possible values:

Velocity = 0 : When the end-limit is activated, the velocity will be set to 0, and the motor will decelerate and stop. If the motor should run again, the user must manually set a new velocity.
Passive mode : When the end-limit is activated, the actual mode will be changed to passive. In passive mode the motor is short-circuited and can be rotated.

Input debounce

Using this parameter, an input filter can be activated.

Possible values:

Disabled No filtering will be done on the inputs.
Enabled The inputs are filtered, resulting in better noise immunity but slower response. When the filter is enabled, there will be a delay at the input of about 5ms.

Input x action

Using these parameters, up to 3 actions can be assigned to each input.
These action are used when the custom input mode is selected. See “Input modes” on page 60.
The action is defined by a FlexMac command. See “FlexMac commands” on page 62.

Possible values are 0-127, where 0 represents no action.

4.4 Expansion Module MAC00-FP2

4.4.6 FlexMac commands

Using the FlexMac commands, it is possible to activate a set of registers and set the mode of the motor using a single command. The command is composed of two parts. The first part is mode that the motor should use.
The following 4 modes can be selected:

Value	Motor mode after command	Format
0	<No change>	Command = 0 + Register N
32	Velocity	Command = 32 + Register N
64	Position	Command = 64 + Register N
96	<No change>	Command = 96 + Sub-command N

The second part of the command is a register number or sub-command number.
The following table shows the register numbers:

N	Register	N	Register	N	Register	N	Register
0	P1	8	V1	16	A1	24	L1
1	P2	9	V2	17	A2	25	L2
2	P3	10	V3	18	A3	26	L3
3	P4	11	V4	19	A4	27	L4
4	P5	12	V5	20	T1	28	Z1
5	P6	13	V6	21	T2	29	Z2
6	P7	14	V7	22	T3	30	Z3
7	P8	15	V8	23	T4	31	Z4

The following table shows the sub-commands:

N	Command	N	Command
0	No operation	16	Start search zero
1	Reset error	17	No operation
2	P_SOLL = 0	18	No operation
3	P_IST = 0	19	Reserved
4	P_FNC = 0	20	Select absolute position mode
5	V_SOLL = 0	21	Select relative position mode using P_SOLL
6	T_SOLL = 0	22	Select relative position mode using P_FNC
7	Reset IN_POS, ACC,DEC	23	No operation
8	P_FNC = (FLWERR - P7) * 16	24	No operation
9	P_FNC = (FLWERR - P8) * 16	25	No operation
10	Reserved	26	No operation
11	Reserved	27	No operation
12	Activate P0,V0,A0,T0,L0,Z0	28	No operation
13	Activate P1,V1,A1,T1,L1,Z1	29	No operation
14	Activate P2,V2,A2,T2,L2,Z2	30	Reserved
15	Activate P3,V3,A3,T3,L3,Z3	31	Reserved

Examples of FlexMac commands

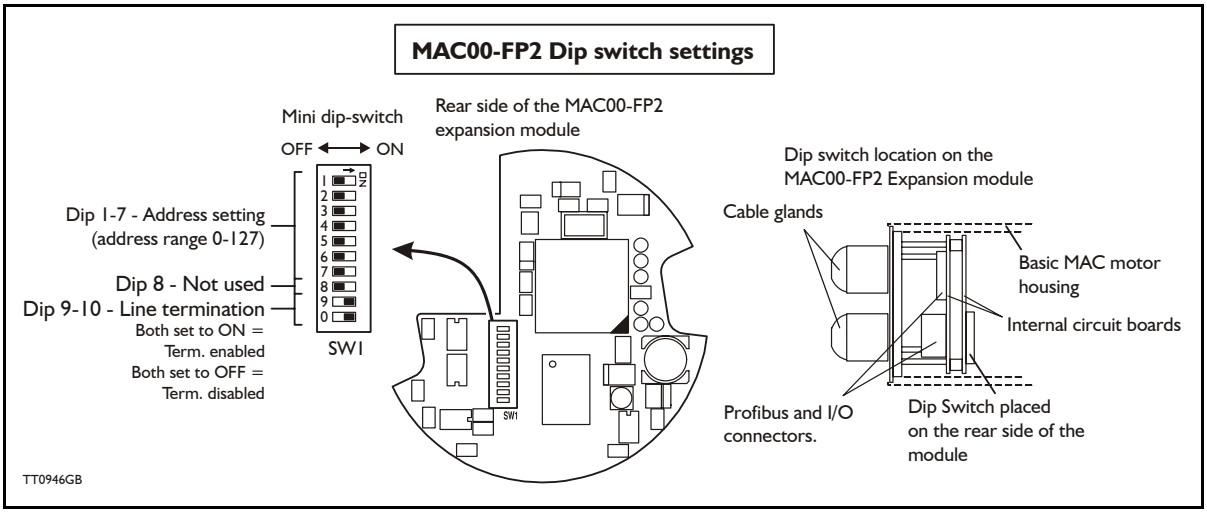
Activate register A4 without changing the mode:
0 + 19 = FlexMac command 19

Activate register P5 and change to position mode
32 + 4 = FlexMac command 36

Activate register T3 and change to velocity mode
64 + 30 = FlexMac command 94

Activate P0,V0,A0,T0,L0 and Z0 without changing the mode:
96 + 12 = FlexMac command 108

4.4 Expansion Module MAC00-FP2

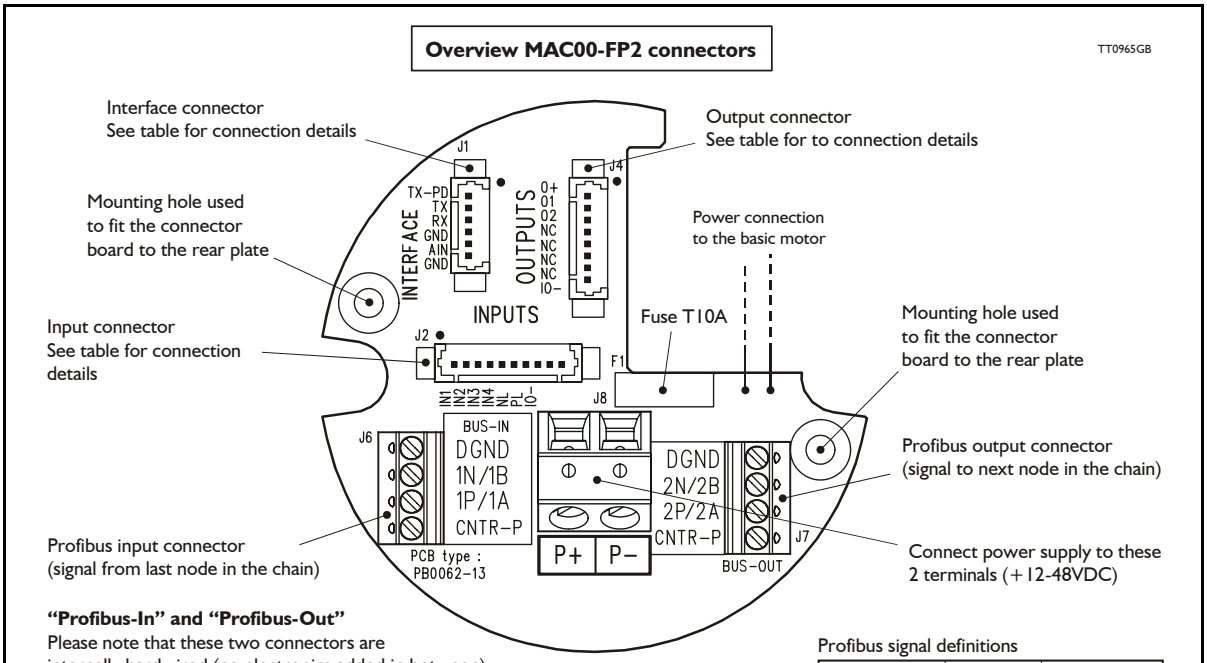


4.4.7 MAC00-FP2 Address and termination setup.

Each unit connected to the Profibus must be set up with a unique address.
The illustration above shows how the address and termination can be set on the internal dip switch. The dip switch is located on the internal circuit board.

4.4.8 MAC00-FP2 Connectors.

The illustration below shows all the internal connectors in the module. The profibus and power connectors are easy to use screw terminals. If the I/Os are used, they require a JVL cable type WG0402 (2m), WG0410 (10m) or WG0420 (20m). See also the appendix for cable and connector accessories.



"Profibus-In" and "Profibus-Out"
Please note that these two connectors are internally hardwired (no electronics added in between).
Terminal description:

GND	Signal ground can optionally be used for the cable screen
1N/1B or 2N/2B	Negative profibus signal line
1P/1A or 2P/2A	Positive profibus signal line
CNTR-P	Direction output to external repeater station (optional)

Profibus signal definitions

MAC00-FPx name	Siemens name	Standard wire colour
xA/xP	B	Red
xB/xN	A	Green

4.4 Expansion Module MAC00-FP2

4.4.9 MAC00-FP2 option with cables

The MAC00-FP2 type number only covers the basic module without any cables.
If a number is added after the basic type number, for example MAC00-B2-10, this suffix indicates that the module is fitted with 10 m of cable in the I/O. The I/O cable covers all the signal lines, which means RS232, Digital input 1-4, Limit inputs NL and PL and the Digital outputs 1-4.
Please note the WG0420 table below is not valid for cables delivered before 1.10.2002.
See WG0420 (old versions delivered before 1.10.2002), page 103

Digital Inputs - Internal connector J2

Signal name	Pin no.	Description	Wire colour
IN1	1	Digital input 1	Red/black
IN2	2	Digital input 2	Green/black
IN3	3	Digital input 3	Violet
IN4	4	Digital input 4	Violet/white
NL	5	Negative limit input - If not used, do not connect.	Grey
PL	6	Positive limit input - If not used, do not connect.	Grey/black
IO-	7	I/O ground. Shared with the output ground (O-)	Pink/black
NC	8	(Reserved)	Black/white
CV	9	Secondary supply. Used during emergency stop *	Light green
CV	10	Secondary supply. Used during emergency stop *	White

Digital Outputs - Internal connector J4

Signal name	Pin no.	Description	Wire colour
O+	1	Supply for outputs - Must be connected to an ext. supply.	Red/white
O1	2	Digital output 1 - PNP output	Green/white
O2	3	Digital output 2 - PNP output	Yellow/black
NC	4	(Reserved)	Blue/white
NC	5	(Reserved)	Orange/white
NC	6	(Reserved)	Brown/white
NC	7	(Reserved)	Pink
IO-	8	I/O ground. This ground is shared with the input ground	Black

Interface - including analogue input - Internal connector J1

Signal name	Pin no.	Description	Wire colour
TXPD	1	Transmit pull-down (Connect to TX if addr. not used)	Red
TX	2	RS232 Transmit	Green
RX	3	RS232 Receive	Yellow
GND	4	Ground for RS232	Blue
AIN	5	Analogue input +/-10V or Zero sensor input	Orange
GND	6	Ground for AIN	Brown

Cable Screen

The cable-screen is internally connected to motor housing. Externally it must be connected to earth.

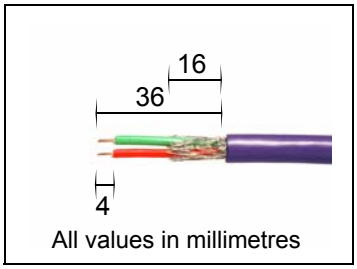
Unused wire

Orange/Black - is not used internally. It must be left unconnected.

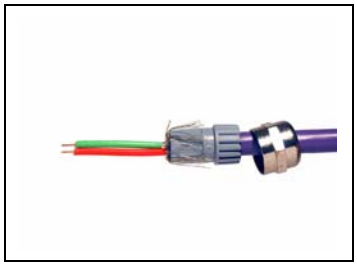
* The VC terminals is only available at modules with serial number >25000

4.4.10 Assembly instructions for profi cables

Remove the insulation from the cable, as shown in the accompanying picture.

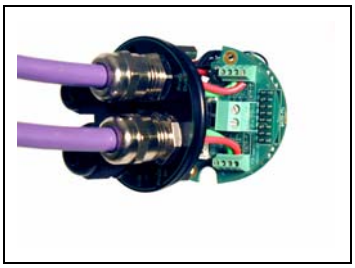


Fit the plastic part of the gland on the cable, and fold the screen around it. Remember to feed the cable through the nut in the first place.



Feed the cables through the cable glands in the rear plate of the module, and tighten the nuts.

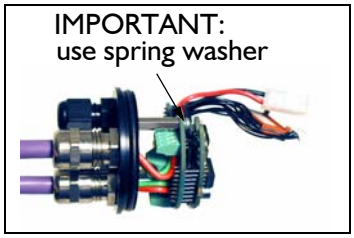
Screw the wires into the module. The red wire must go into the 1P/1A or 2P/2A terminal, and the green must go into the 1N/1B or 2N/2B terminal.
PLEASE NOTE that Siemens normally names the green wire P and the red N. The input and output terminals can be swapped if required. The is no difference between input and output on the board which means that it is purely hard-wired.



Attach the circuit board to the rear plate with the two screws. REMEMBER to use the spring washers included.

The table below shows the difference between Siemens naming conventions and the naming on the MAC00-FPx.

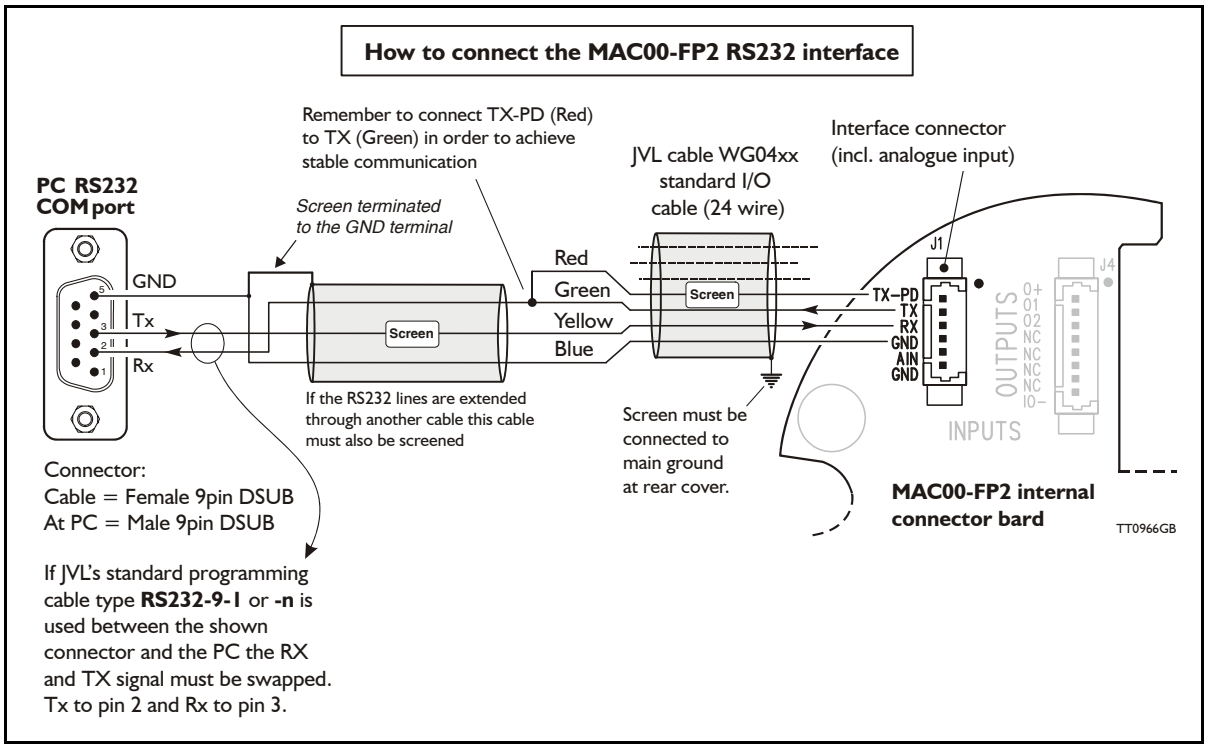
MAC00-FPx name	Siemens name	Standard wire colour
xA/xP	B	Red
xB/xN	A	Green



4.4 Expansion Module MAC00-FP2

4.4.11 How to connect the RS232 interface.

The illustration below shows how to connect the MAC00-FP2 directly to a PC COM port. The drawing is based on the standard cables from JVL type WG0402, WG0410 or WG0420. See also Accessories, page 101 for a complete list of cables and connectors.
If the MAC motor is connected to the same RS232 line as other motors, the terminal TX-PD should only be connected at one of the motors.
If one of JVL's standard RS232 cables (RS232-9-1 or -n) is used between the shown DSUB connector and the PC com port the RX and TX pins must be swapped since they are crossing in these standard cable.



4.4.12 GSD file for the MAC00-FP2.

The GSD file must be used to configure the PLC or master controller used for the Profibus communication. The file is shown here but is also available on disc. Please contact your nearest JVL representative.

GSD file:

```
; COM PROFIBUS V 3.3, GSD'-Xport
; Time Stamp: 01/31/00, 12:36:39
#Profibus_DP
; <Unit-Definition-List>
GSD_Revision=1
Vendor_Name="JVL IND EL"
Model_Name="MAC00-FP"
Revision="0.0"
```

```
Ident_Number=0x06BC
Protocol_Ident=0
Station_Type=0
Hardware_Release="1.1"
Software_Release="1.2"
9.6_supp=1
19.2_supp=1
93.75_supp=1
187.5_supp=1
500_supp=1
1.5M_supp=1
3M_supp=1
6M_supp=1
12M_supp=1
MaxTsdr_9.6=60
MaxTsdr_19.2=60
MaxTsdr_93.75=60
MaxTsdr_187.5=60
MaxTsdr_500=100
MaxTsdr_1.5M=150
MaxTsdr_3M=250
MaxTsdr_6M=450
MaxTsdr_12M=800
Implementation_Type="VPC3"
Bitmap_Device="DPLINK_"

; Slave-Specification:
Freeze_Mode_supp=0
Sync_Mode_supp=0
Auto_Baud_supp=1
Min_Slave_Intervall=1
Max_Diag_Data_Len=8
Modul_Offset=0
Slave_Family=0
OrderNumber="MAC00-FPx"

; UserPrmData: Length and Preset:
PrmText=1
Text(0)="Active low"
Text(1)="Active high"
EndPrmText

PrmText=2
Text(0)="Velocity = 0"
Text(1)="Passive mode"
EndPrmText

PrmText=3
Text(0)="Disabled"
Text(1)="Enabled"
EndPrmText
```

```
ExtUserPrmData=1 "IN1 Input level"
Bit(0) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

ExtUserPrmData=2 "IN2 Input level"
Bit(1) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

ExtUserPrmData=3 "IN3 Input level"
Bit(2) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

ExtUserPrmData=4 "IN4 Input level"
Bit(3) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

ExtUserPrmData=5 "NL Input level"
Bit(4) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

ExtUserPrmData=6 "PL Input level"
Bit(5) 1 0-1
Prm_Text_Ref=1
EndExtUserPrmData

ExtUserPrmData=7 "Endlimit action"
Bit(0) 0 0-1
Prm_Text_Ref=2
EndExtUserPrmData

ExtUserPrmData=8 "Input 1 Action"
UnSigned8 0 0-255
EndExtUserPrmData

ExtUserPrmData=9 "Input 2 Action"
UnSigned8 0 0-255
EndExtUserPrmData

ExtUserPrmData=10 "Input 3 Action"
UnSigned8 0 0-255
EndExtUserPrmData

ExtUserPrmData=11 "Input 4 Action"
UnSigned8 0 0-255
EndExtUserPrmData
```

```
ExtUserPrmData=12 "Input debounce"
Bit(1) 0 0-1
Prm_Text_Ref=3
EndExtUserPrmData

ExtUserPrmData=13 "Input noise filter"
Bit(2) 0 0-1
Prm_Text_Ref=3
EndExtUserPrmData

Max_User_Prm_Data_Len=15
User_Prm_Data_Len=15
User_Prm_Data=0x0,0x3F,0x0,0,0,0,0,0,0,0,0,0,0,0,0

Ext_User_Prm_Data_Const(0) = 0x0,0x3F,0x0,0,0,0,0,0,0,0,0,0,0,0,0
Ext_User_Prm_Data_Ref(1)=1
Ext_User_Prm_Data_Ref(1)=2
Ext_User_Prm_Data_Ref(1)=3
Ext_User_Prm_Data_Ref(1)=4
Ext_User_Prm_Data_Ref(1)=5
Ext_User_Prm_Data_Ref(1)=6
Ext_User_Prm_Data_Ref(2)=7
Ext_User_Prm_Data_Ref(2)=12
Ext_User_Prm_Data_Ref(2)=13
Ext_User_Prm_Data_Ref(3)=8
Ext_User_Prm_Data_Ref(4)=8
Ext_User_Prm_Data_Ref(5)=8
Ext_User_Prm_Data_Ref(6)=9
Ext_User_Prm_Data_Ref(7)=9
Ext_User_Prm_Data_Ref(8)=9
Ext_User_Prm_Data_Ref(9)=10
Ext_User_Prm_Data_Ref(10)=10
Ext_User_Prm_Data_Ref(11)=10
Ext_User_Prm_Data_Ref(12)=11
Ext_User_Prm_Data_Ref(13)=11
Ext_User_Prm_Data_Ref(14)=11

; <Module-Definition-List>
Module="MAC00-FP" 0x13,0x10,0x10,0x10,0x10,0x23,0x20,0x20,0x20,0x20,0x20
EndModule
```

4.5 Expansion Module MAC00-R1/3

4.5.1 Expansion modules MAC00-R1 & R3 overall description

The expansion modules MAC00-R1 and R3 can be mounted on the standard MAC motors MAC50, MAC95, MAC140 and MAC141.
These option modules are also called "nanoPLC" modules as they perform like a little programmable logic controller with a small number of digital I/Os.

The module makes it possible to perform simple positioning, speed and/or torque control via 6 digital inputs which all are galvanically isolated and can be operated with 24V control signals from for example a PLC or external sensors.
Typical applications for these expansion modules are stand-alone systems where the MAC motor must be able to operate as a complete positioning system without the need for an external PLC or computer. Applications typically include:

- Replacement for pneumatic cylinders.
- Dispenser systems
- Turn tables
- Simple pick and place systems
- Machine adjustment/setup.

The MAC00-R1 and R3 offer the same functions but with the following hardware differences:

Type	Protection class	Connectors		
		I/O and interface	Power supply	LEDs at I/O
MAC00-R1	IP42	DSUB 9 pole	3 pole Phoenix	Yes
MAC00-R3	IP67	Cable glands	Cable glands	No

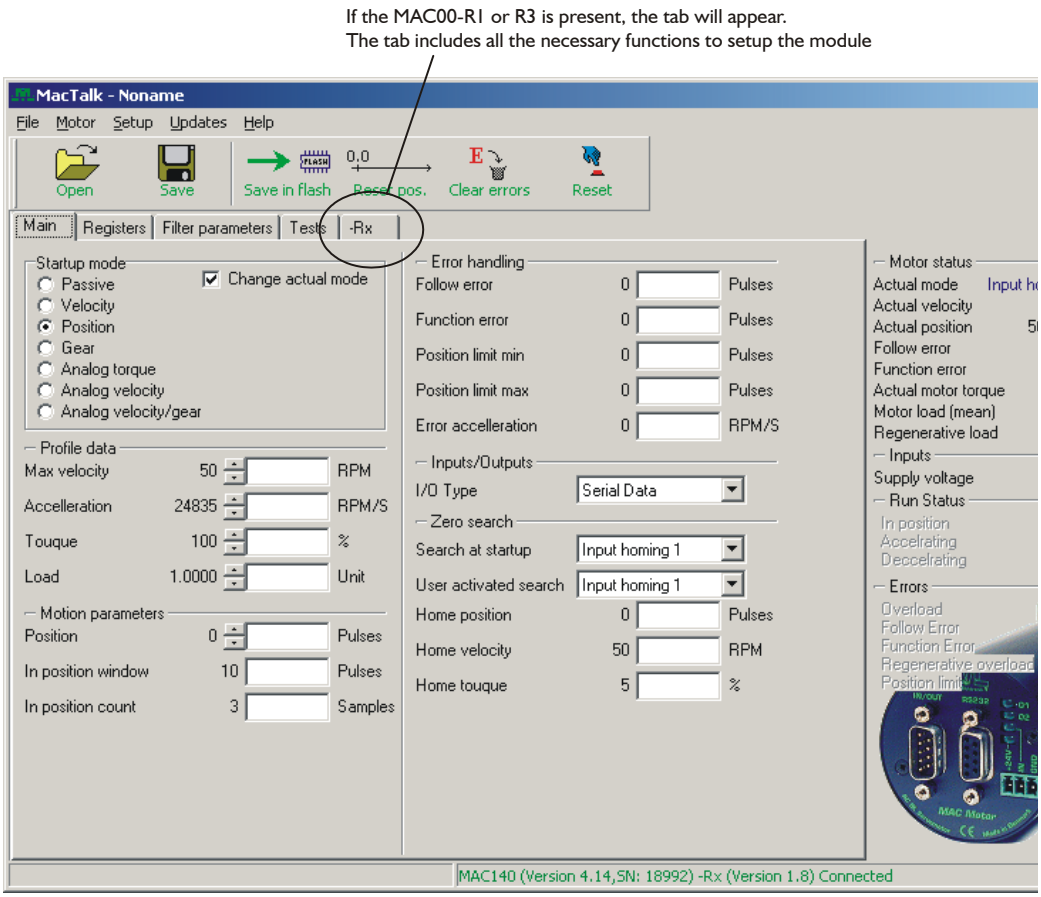
The MAC00-R3 module can also be delivered with cable in selected lengths.

The pages in the first part of this section concern the common features of both modules. Please consult the later pages in this section to see specific information about each module (for example connection diagrams).

4.5 Expansion Module MAC00-R1/3

4.5.2 How can I get in contact with the MAC00-R1 or R3 module?

When the MAC00-R1 or R3 is installed in the MAC motor, the main window in MacTalk will include the extra features shown below.

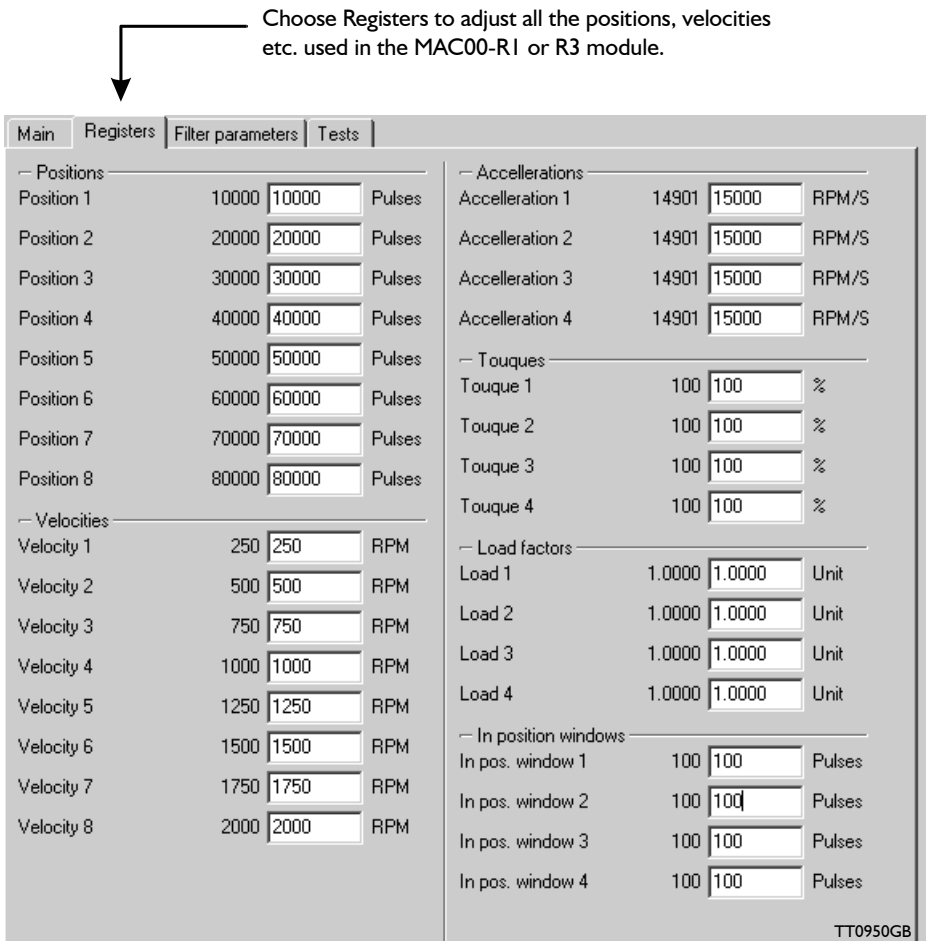


TT0949GB

If the module is installed in the motor but is not recognised by the MacTalk software, the internal cables and connectors must be checked.

4.5 Expansion Module MAC00-R1/3

4.5.3 How is motion data setup in the nanoPLC?



Each format in the nanoPLC uses position data, velocity data, torque data, etc., from the tab “Registers” shown above. The default of these registers is set up to ensure that the motor will move and do what is intended in the individual formats.
If any of the values are changed, the change can be saved using the “Save in Flash” button at the top of the main screen to ensure that the changes are saved permanently.

4.5 Expansion Module MAC00-R1/3

4.5.4 Setting up a "format" in the MAC00-R1 or R3 module.

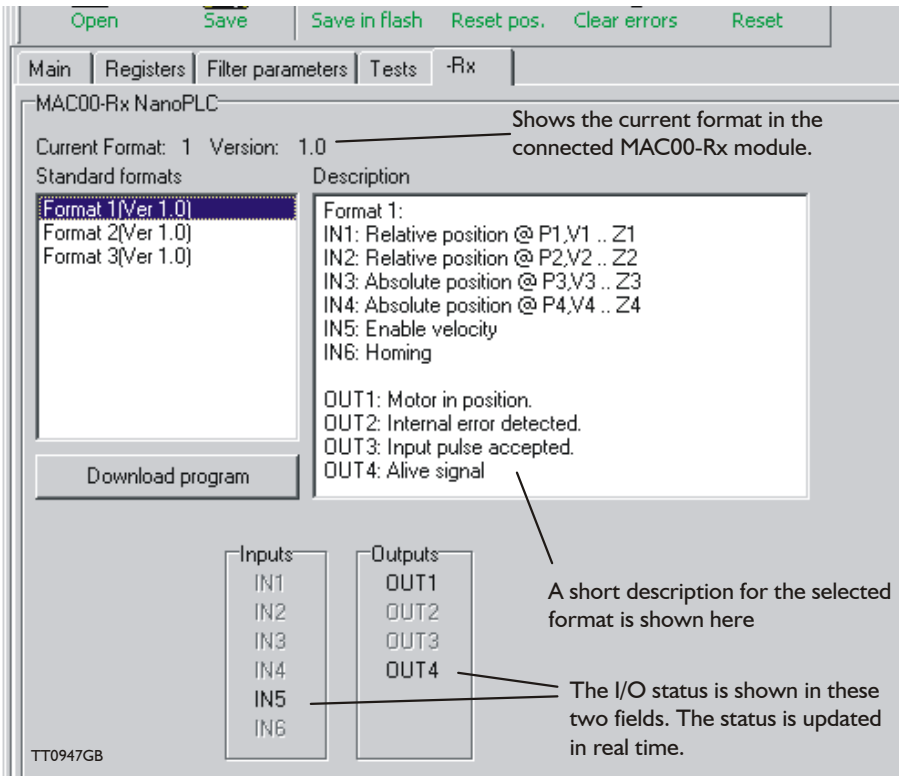
The expansion module can operate in the following formats:

Format 1 2 relative and 2 absolute positioning functions including zero search and enable input. Note that continuous movements in one direction are not possible in this format since the position counter will overflow. Use format 3 instead.

Format 2 Relative and absolute positioning using a pointer at 3 inputs. Also one enable torque, one enable velocity and one zero search input are available.

Format 3 4 relative positions including zero search. This format is optimised for dispenser applications. One enable input and a zero search input are available. Continuous movements in one direction is possible in this format since the position counter is never overflowed.

The formats can be chosen and set up using the MacTalk software.

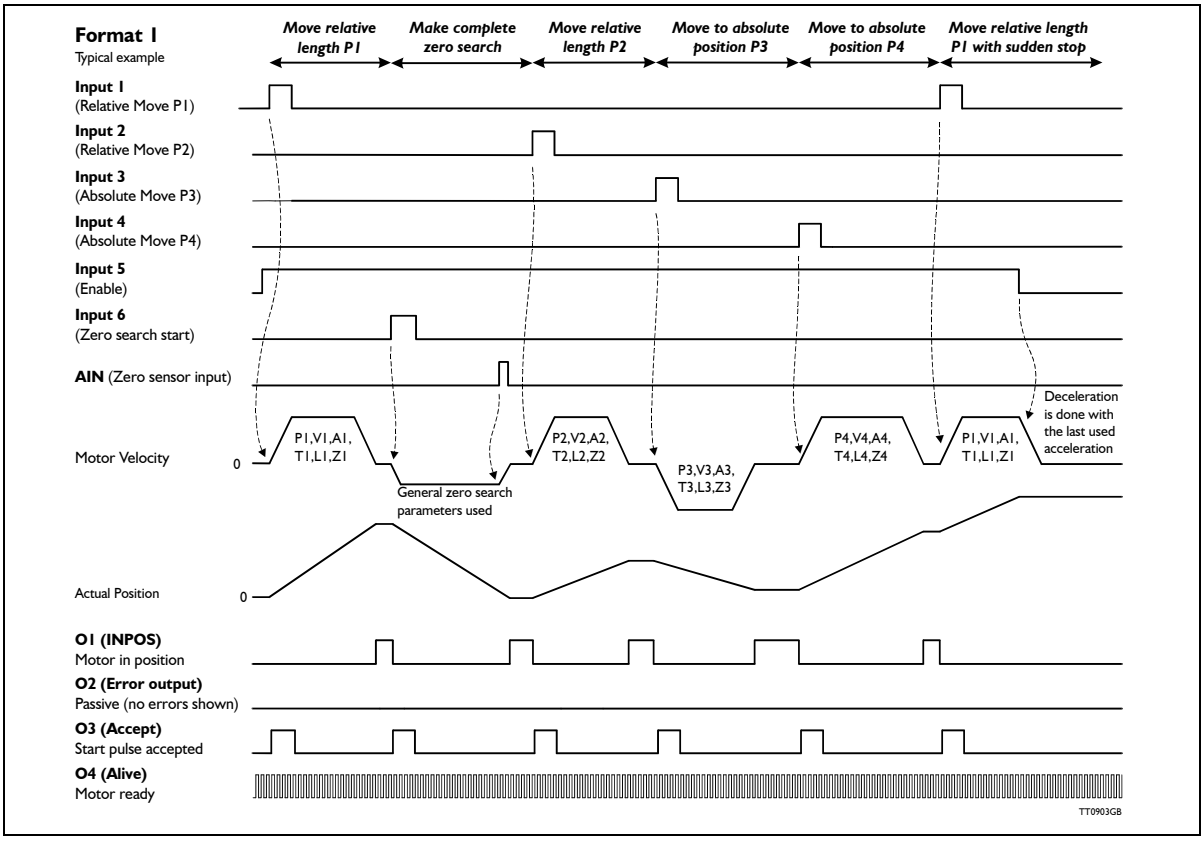


Select and download the format in 3 steps

1. Select the -Rx tab in the MacTalk program
2. Select the right format from the list of standard formats.
3. Press download format and the format will be set up in the MAC motor.
   A bar at the bottom will indicate that the transfer process is in progress:

The transfer takes 1-3 seconds. The format is stored permanently in the motor.
Now the MAC motor and MAC00-R1 or R3 are set up with the chosen format.
The current format shown at the top of the screen should now correspond to the downloaded format.
The following pages describe how the different formats work.

4.5 Expansion Module MAC00-R1/3



4.5.5 Format 1 description

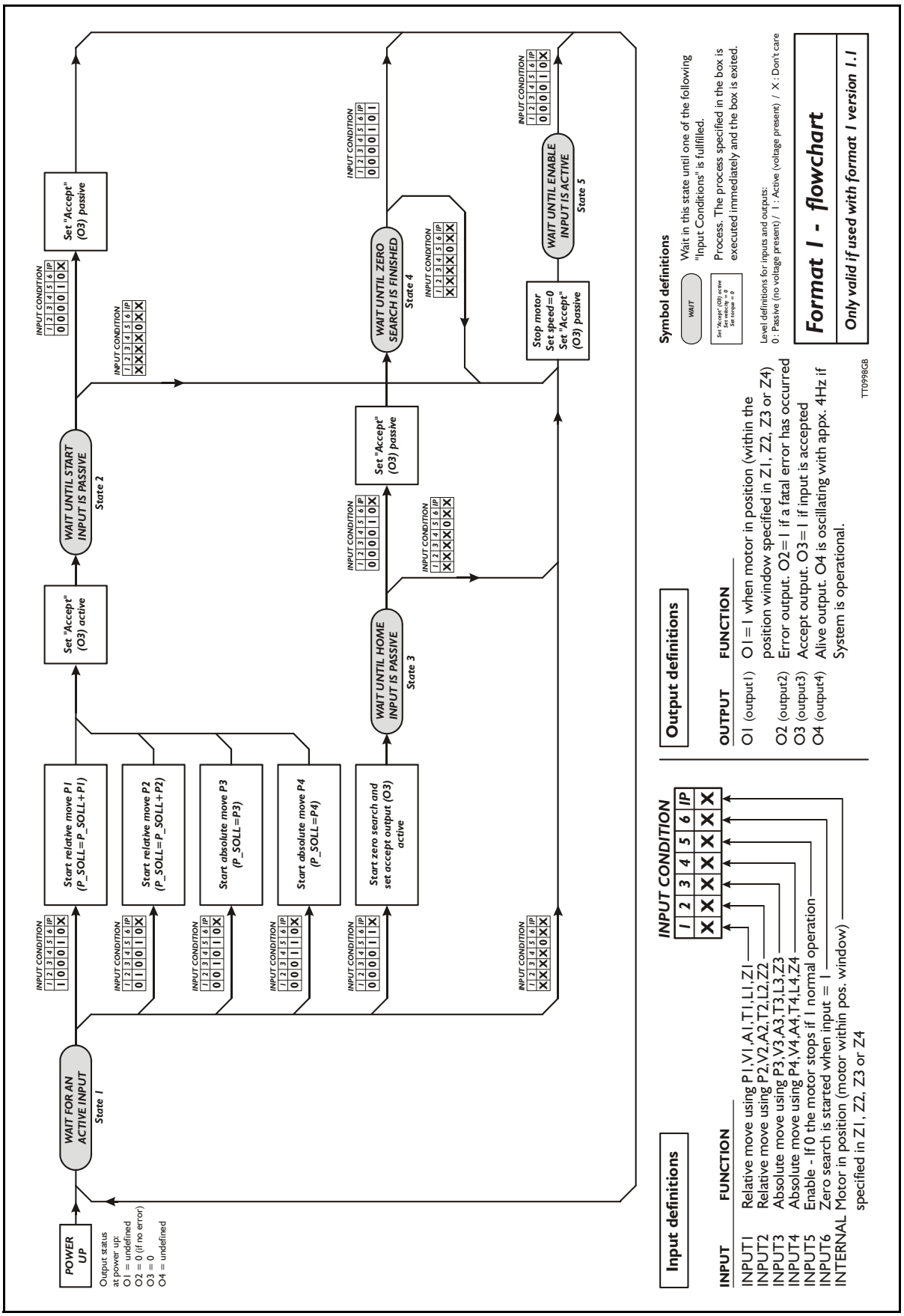
Format 1 can be used for applications where the motor must move a certain distance or to a certain position when an input is activated. Input 5 is used as an enable input and input 6 is used for commanding a mechanical zero search.
Each of the distances and the velocities used must be specified in the basic MAC motor setup. Please consult the beginning of this chapter to see how to configure the basic setup using the MacTalk windows softwar.
Warning : Note that continuous movements in one direction are not possible in this format since the position counter will overflow. Use format 3 instead.
In format 1 the standard registers are used as follows:

Input	Position	Velocity	Accel.	Torque	Load factor	In Pos. Win.
IN1	P1 (relative)	V1	A1	T1	L1	Z1
IN2	P2 (relative)	V2	A2	T2	L2	Z2
IN3	P3 (absolute)	V3	A3	T3	L3	Z3
IN4	P4 (absolute)	V4	A4	T4	L4	Z4
IN5	-	-	-	-	-	-
IN6	Use the general zero search registers in the main setup.					

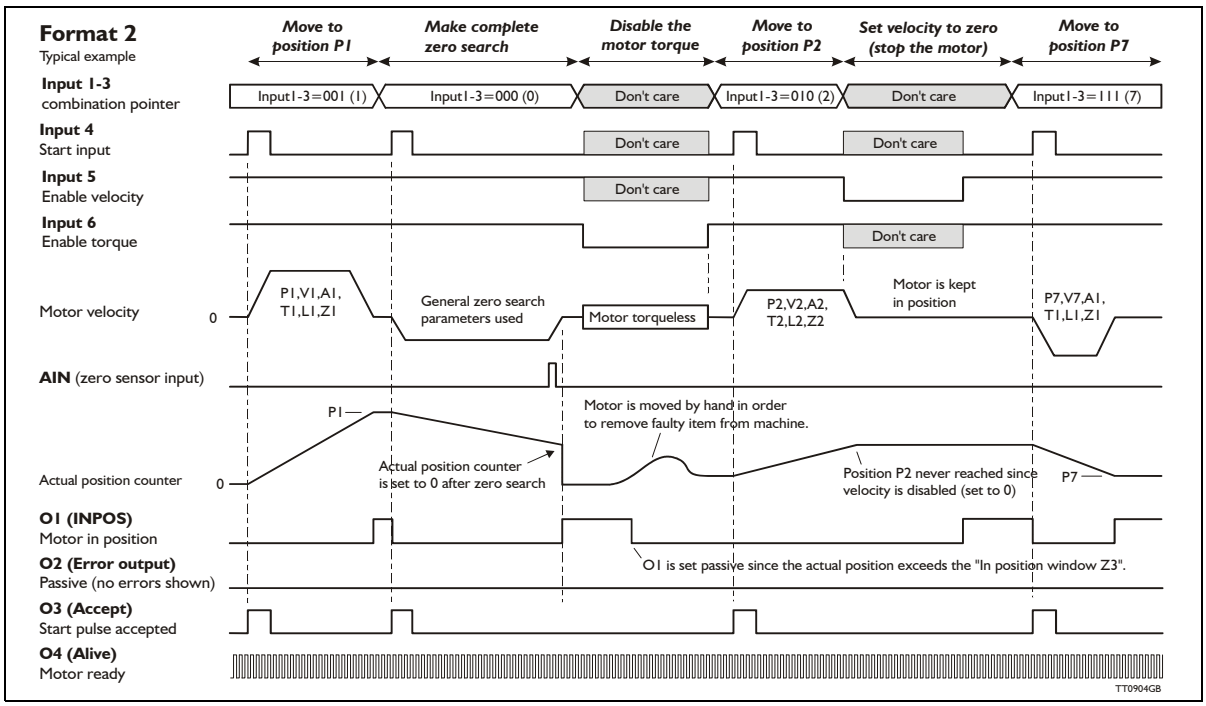
4.5.6 Format 1 inputs and outputs.

The functions of the inputs are described above.
4 outputs are available. Output 1 (O1) is activated when the motor is in position and output 2 (O2) is activated in case a fatal fault occurs. In the example, O2 is passive (logic 0) since no fatal errors occurs. Output 3 confirms when the input signal is accepted.
Output 4 is a “live” output which means that independent of motor operation it is oscillating at approximately 4 Hz. It will only stop oscillating if the internal hardware has a fault.

4.5 Expansion Module MAC00-R1/3



4.5 Expansion Module MAC00-R1/3



4.5.7 Format 2 description

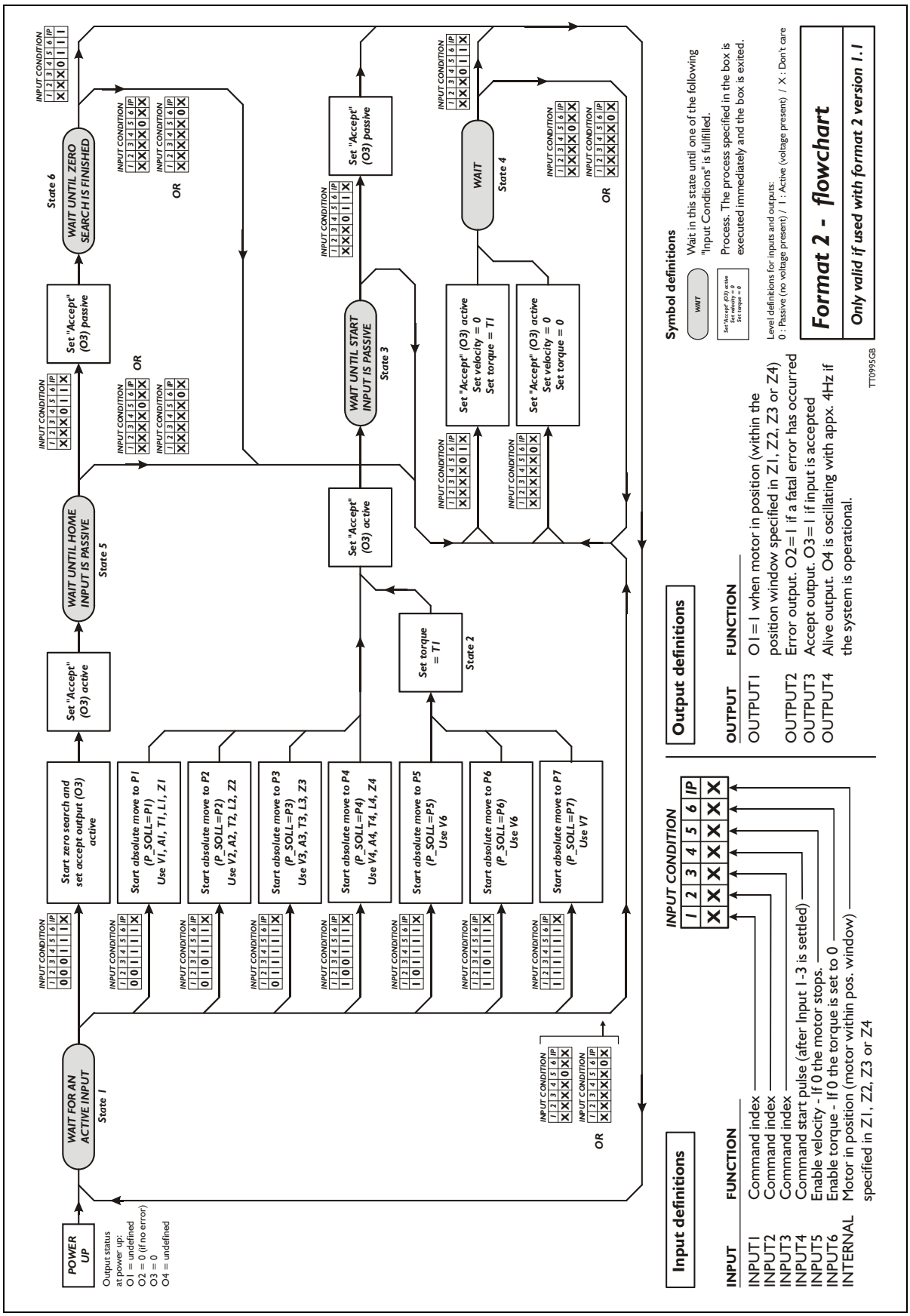
Format 2 can be used for applications in which a PLC selects up to 7 different positions by setting up a binary combination at inputs 1 to 3 of the MAC motor. The motor will move to the desired position when the start input is activated. Alternatively, the motor can be started and will run until one of the enable inputs is set passive. Each input commination will select an individual group of motion registers. The table below shows the registers that are chosen for each combination. Please consult the beginning of this chapter for details on how to perform the register setup using the MacTalk windows software.

Input	Position	Velocity	Accel.	Torque	Load factor	In Pos. Win.
IN1-3=0	Zero search is selected - The general zero search registers in the main setup will be used.					
IN1-3=1	P1 (absolute)	V1	A1	T1	L1	Z1
IN1-3=2	P2 (absolute)	V2	A2	T2	L2	Z2
IN1-3=3	P3 (absolute)	V3	A3	T3	L3	Z3
IN1-3=4	P4 (absolute)	V4	A4	T4	L4	Z4
IN1-3=5	P5 (absolute)	V1	A1	T1	L1	Z1
IN1-3=6	P6 (absolute)	V1	A1	T1	L1	Z1
IN1-3=7	P7 (absolute)	V1	A1	T1	L1	Z1
IN4	Start input - If this input is set active, a positioning is started. Motion data is chosen by IN1 - 3.					
IN5	Enable velocity. If this input is set to logic 0 (passive), the velocity is set to 0. If the input is activated it has no influence on the motion.					
IN6	Enable torque. If this input is set to logic 0 (passive), the torque and velocity is set to 0. If the input is activated it has no influence on the motion.					

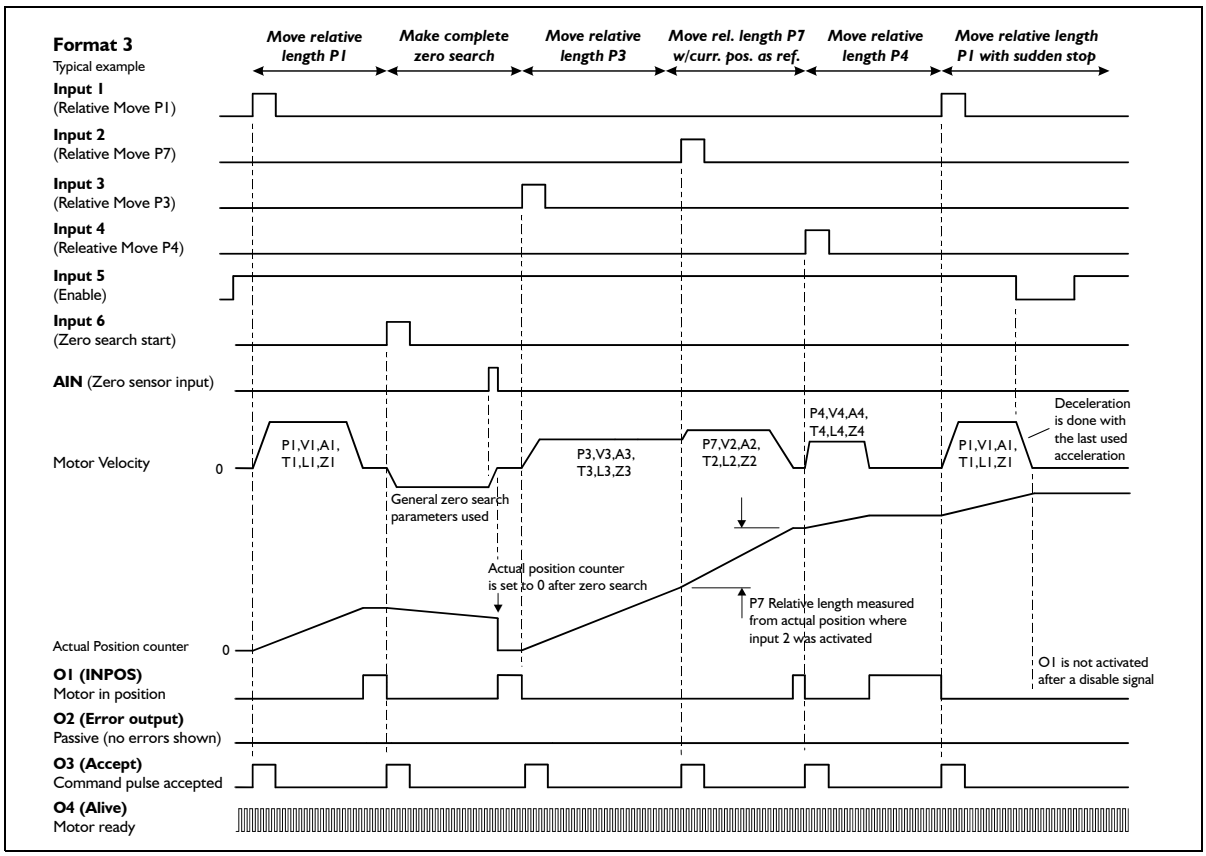
4.5.8 Format 2 inputs and outputs.

The functions of the inputs are described above. 4 Outputs are available. O1 is activated when the motor is in position and O2 is activated if a fatal fault occurs. In the example, O2 is passive (logic 0) since no fatal error occurs. O3 confirms when the input signal is accepted. O4 is a “live” output which means that independent of motor operation it is oscillating at approximately 4 Hz. It will only stop oscillating if the internal hardware has a fault.

4.5 Expansion Module MAC00-R1/3



4.5 Expansion Module MAC00-R1/3



4.5.9 Format 3 Description

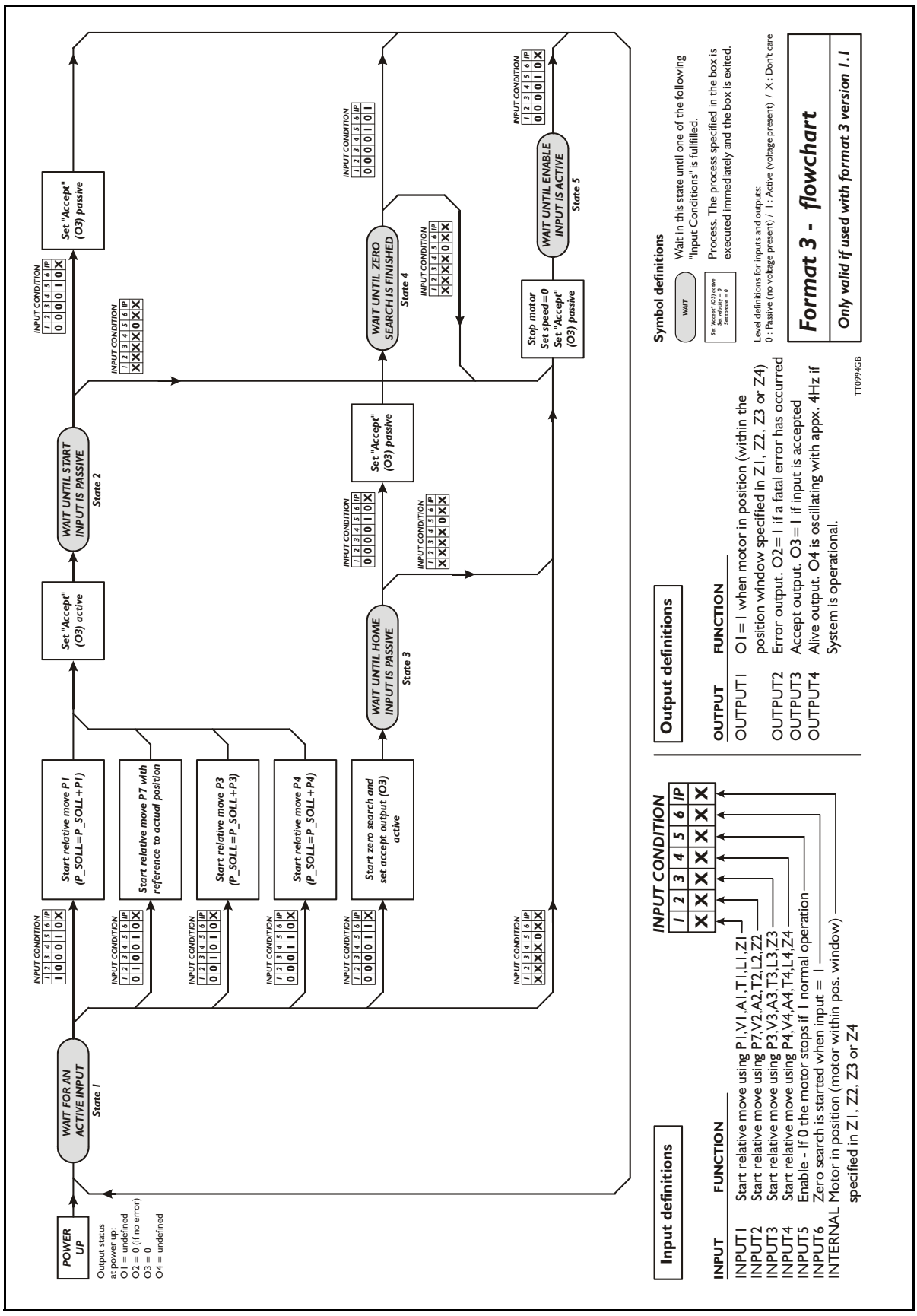
Format 3 can be used for applications in which the motor must move a certain distance when an input is activated. Input 5 is used as an enable input and input 6 is used for commanding a mechanical zero search.
Each of the distances and other motion data must be specified in the basic MAC motor setup. Please consult the beginning of this chapter to see how to carry out the basic setup using the MacTalk windows software.
Please note that IN2 is special since the relative movement is done with reference to the actual position. In format 3 the standard registers are used as follows:

Input	Position	Velocity	Accel.	Torque	Load factor	In Pos. Win.
IN1	P1 (relative)	V1	A1	T1	L1	Z1
IN2	P7 (relative)	V2	A2	T2	L2	Z2
IN3	P3 (relative)	V3	A3	T3	L3	Z3
IN4	P4 (relative)	V4	A4	T4	L4	Z4
IN5	Enable input. If set to passive, the velocity is set to 0. If the input is set to active, it has no influence on the motion.					
IN6	Zero search is started - The general zero search registers in the main setup will be used.					

4.5.10 Format 3 inputs and outputs.

The functions of the inputs are described above. 4 outputs are available. O1 is activated when the motor is in position and O2 is activated if a fatal fault has occurred. In the example, O2 is passive (logic 0) since no fatal error occurs. O3 confirms when the input signal is accepted. O4 is a "live" output which means that independent of motor operation it is oscillating at approximately 4 Hz. It will only stop oscillating if the internal hardware has a fault.

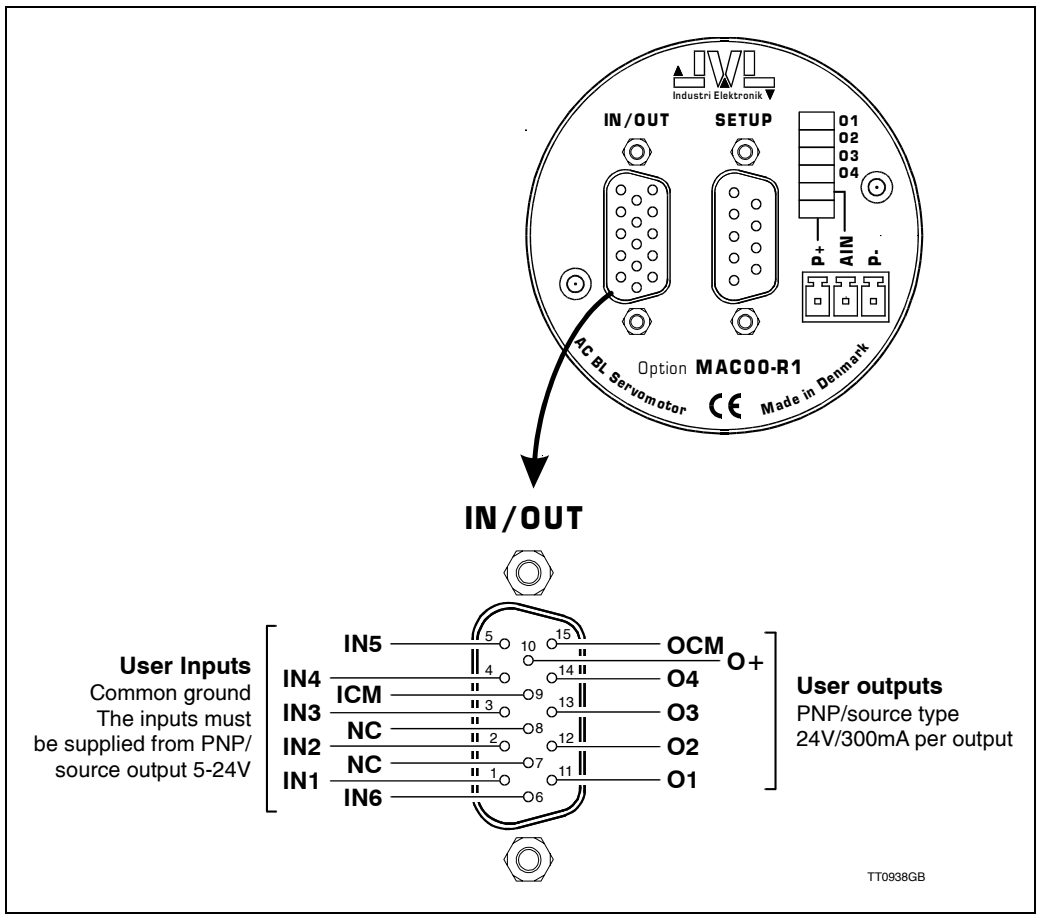
4.5 Expansion Module MAC00-R1/3



4.5 Expansion Module MAC00-R1/3

4.5.11 Expansion MAC00-R1 hardware description

The illustration below shows the I/O connections on the MAC00-R1 expansion module.



All inputs have a common ground ICM and all the outputs uses the OCM as ground. The O+ is the supply terminal for the output circuitry and must be supplied with a voltage from 6-32VDC. The outputs are short-circuit protected.
The input and output circuitry is optically isolated from each other and also from the other parts of the MAC00-R1 or R3.

4.5 Expansion Module MAC00-R1/3

4.5.12 General description MAC00-R3

The MAC00-R3 expansion module is an industrial interface that mates with the standard MAC motor and offers a number of feature enhancements including:

- Protection IP67 if mounted at basic MAC motor (IP67 type: MACxxx-A3).
- Direct cable connection through sealed compression cable glands.
- Addition of a Zero switch input for locating a mechanical zero point of the actuator when used in position related modes.
- Miniature connectors (internal) for all signal lines including RS232/485 interface and zero search switch. Molex 3.96mm connector for power supply.
- Full RS232 protocol support
  Note: The basic MAC motor is only equipped with a low-voltage serial interface that requires the use of the RS232-9-1-MAC option cable which has integrated electronics to boost the voltage levels.
- Full RS485 protocol support for multipoint communication up to 100m.
- Sourcing (PNP) outputs for status signals O1 and O2 instead of sinking (NPN).

4.5 Expansion Module MAC00-R1/3

4.5.13 MAC00-R3 option with cables

The MAC00-R3 type number only covers the basic module without any cables.
If a number is added after the basic type number, for example MAC00-R3-10, this suffix indicates that the module is fitted with 2x10m of cable. 1 cable comprises the power supply and analogue input. The other cable covers all the signal lines, i.e. RS232, RS485, status outputs and multifunction I/O.

Power cable - Cable 1 - JVL type no. WG0211 (2m) or WG0320 (20m)

Power Supply		
Signal name	**Description**	**Wire colour**
P+	Positive supply terminal +12 to 48VDC	Red
P-	Negative supply terminal (ground)	Black (or white)
Screen	Screen to minimize noise	Screen (connected internally to P-)

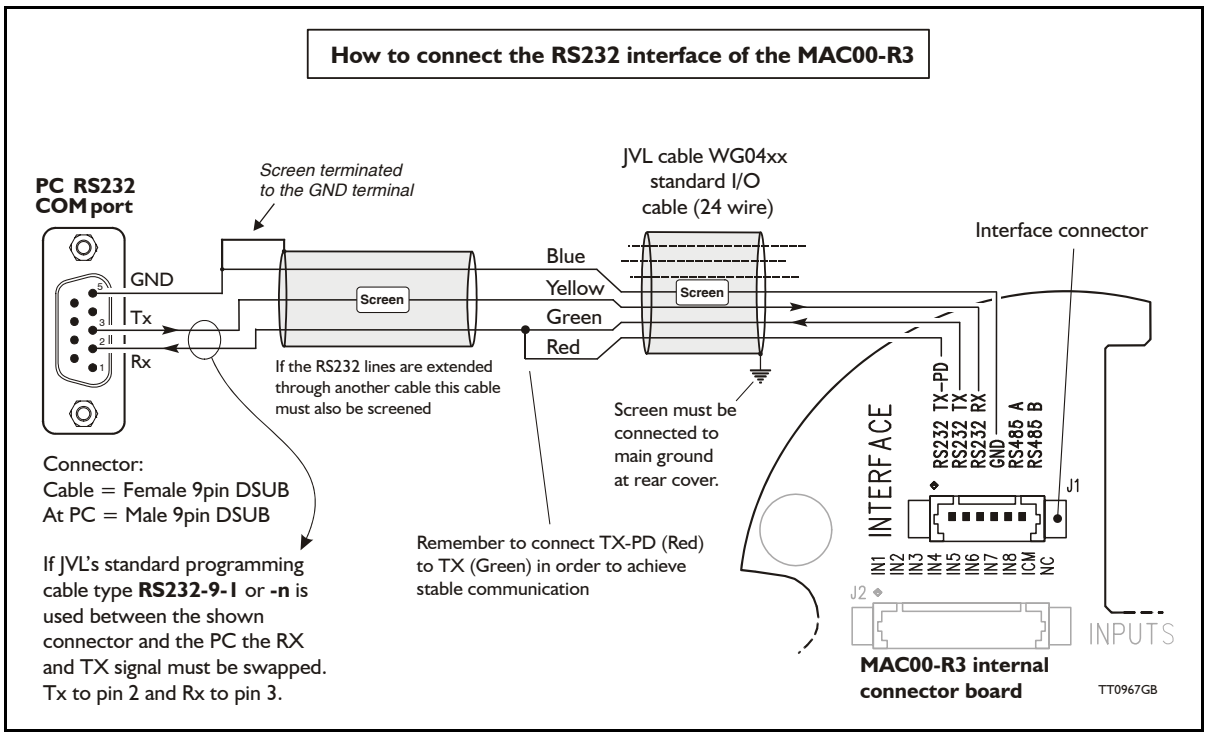
Please note that the WG0420 table below is not valid for cables delivered before 1.10.2002. See WG0420 (old versions delivered before 1.10.2002), page 103
Signal cable - Cable 2- JVL type no. WG0420 (20m).

Digital Inputs - Internal connector J2		
Signal name	**Description**	**Wire colour**
IN1	Digital input 1	Red/black
IN2	Digital input 2	Green/black
IN3	Digital input 3	Violet
IN4	Digital input 4	Violet/white
IN5	Digital input 5	Grey
IN6	Digital input 6	Grey/black
IN7	(Reserved)	Pink/black
IN8	(Reserved)	Black/white
ICM	Input ground. This ground is used for IN1 to IN8	Light green
NC	Reserved for future features - Do not connect this wire.	White
Digital Outputs - including analogue input - Internal connector J4		
Signal name	**Description**	**Wire colour**
O+	Supply for outputs - Must be connected to an ext. supply.	Red/white
OCM	Output ground. This ground is used together with O1-O4	Green/white
O1	Digital output 1 - PNP output	Yellow/black
O2	Digital output 2 - PNP output	Blue/white
O3	Digital output 3 - PNP output	Orange/white
O4	Digital output 4 - PNP output	Brown/white
AIN	Analogue input +/-10V (also used for zero search sensor).	Pink
GND	I/O ground. This ground is shared with the input ground	Black
Interface - Internal connector J1		
Signal name	**Description**	**Wire colour**
TXPD	Transmit pull-down	Red
TX	RS232 Transmit - If not used do **NOT** connect !	Green
RX	RS232 Receive - If not used do **NOT** connect !	Yellow
GND	Ground for RS232 and RS485	Blue
RS485 A	RS485 Positive channel - If not used do **NOT** connect !	Orange
RS485 B	RS485 Negative channel - If not used do **NOT** connect !	Brown
Cable Screen		
The cable-screen is internally connected to motor housing. Externally it must be connected to earth.		
Unused wire		
Orange/Black - is not used internally. It must be left unconnected.		

4.5 Expansion Module MAC00-R1/3

4.5.14 Connecting the RS232 interface of the MAC00-R3 module.

The illustration below shows how to connect the MAC00-R3 directly to a PC COM port. The drawing is based on the standard cables from JVL, type WG0402, WG0410 or WG0420. See also Accessories, page 101 for a complete list of cables and connectors. Please remember to connect the TX and TX-PD wires from the MAC00-R3 together to achieve stable operation.
If the MAC motor is connected at the same RS232 line as other motors, the terminal TX-PD should only be connected at one of the motors.
If one of JVL's standard RS232 cables (RS232-9-1 or -n) is used between the shown DSUB connector and the PC com port the RX and TX pins must be swapped since they are crossing in these standard cable.



5 Appendix

5.1 Technical Data

All data are specified for the basic MAC motor only, i.e. without any expansion module mounted.

Description	Min.	Typical	Max.	Units
Supply				
Supply Voltage (DC)	12		50	V DC
Average current consumption measured at 48VDC (Specified at speed <4000 RPM except MAC141 <2700 RPM)			2 (MAC50) 4 (MAC95) 6 (MAC140) 6 (MAC141)	ADC
Average current consumption measured at 24VDC (Specified at speed <2000 RPM except MAC141 <1350 RPM)			2 (MAC50) 4 (MAC95) 6 (MAC140) 6 (MAC141)	ADC
Peak supply current - worst case during operation			15	APk.
Internal power dump consumption capacity continuously		3		W
Power Consumption in “Init. mode” (motor passive) - All motor types.	2.3 @12V		2.8 @48V	W
Motor performance MAC50...				
Speed range	0		4000	RPM
Rated power (at max. speed)		46		W
Continuous torque measured at ambient temperature=25°C	-	0.11 (15.6)	-	Nm (Oz/Inch)
Peak torque measured at ambient temperature=25°C	-	0.32 (45.3)	-	Nm (Oz/Inch)
Rotor inertia		0.075		kg/cm²
Motor performance MAC95...				
Speed range	0		4000	RPM
Rated power (at max. speed)		92		W
Continuous torque measured at ambient temperature=25°C	-	0.22 (31.2)	-	Nm (Oz/Inch)
Peak torque measured at ambient temperature=25°C	-	0.62 (87.8)	-	Nm (Oz/Inch)
Rotor inertia		0.119		kg/cm²
Motor performance MAC140...				
Speed range	0		4000	RPM
Rated power (at max. speed)		134		W
Continuous torque measured at ambient temperature=25°C	-	0.32 (45.3)	-	Nm (Oz/Inch)
Peak torque measured at ambient temperature=25°C	-	0.9 (127.5)	-	Nm (Oz/Inch)
Rotor inertia		0.173		kg/cm²
Motor performance MAC141...				
Speed range	0		2700	RPM
Rated power (at max. speed)		134		W
Continuous torque measured at ambient temperature=25°C	-	0.48 (68.2)	-	Nm (Oz/Inch)
Peak torque measured at ambient temperature=25°C	-	1.59 (225.8)	-	Nm (Oz/Inch)
Rotor inertia		0.227		kg/cm²

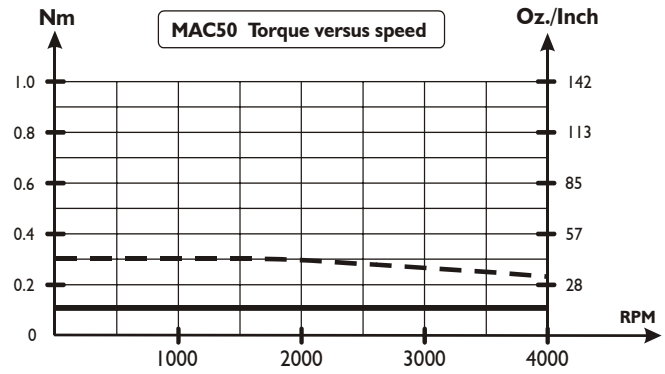
5.1 Technical Data

All data are specified for the basic MAC motor only, i.e. without any expansion module mounted.

Description	Min.	Typical	Max.	Units
Multifunction I/O - used as pulse input				
Logic 0	0		2.0	V
Logic 1	3.0		5.2	V
Bandwidth CLK input (A): 50% duty-cycle w/slow input filter	0		150	kHz
Bandwidth CLK input (A): 50% duty-cycle w/fast input filter	0		2.5	MHz
Logic outputs (O1 and O2)				
Logic 0 - Specified with load < 25mA	0		1.0	V
Logic 1 - Pull-up resistor must be applied externally	-		30 *	V
Load current (sink)			-25	mA
Analogue input (AIN)				
Voltage range	-10		+32	VDC
Input impedance		10		kOhm
Offset	-50		+50	mVDC
Miscellaneous:				
Basic resolution per revolution	-	4096	-	Pulses/rev.
Operating Temperature Range (ambient)	0		40	°C
Weight MAC50-A1		650		grams
Weight MAC95-A1		900		grams
Weight MAC140-A1		1150		grams
Weight MAC141-A1		1320		grams

* Depending on external pull-up voltage.

5.2 Torque Curves

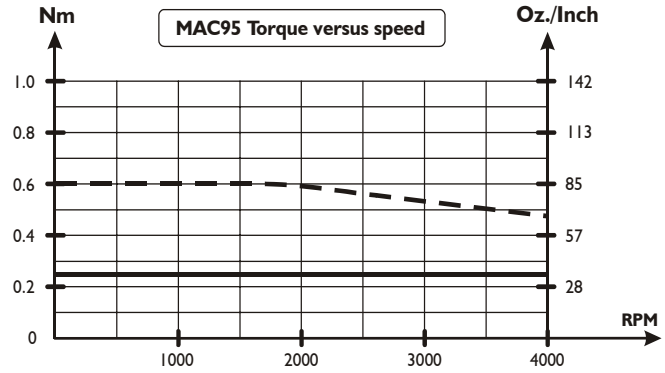


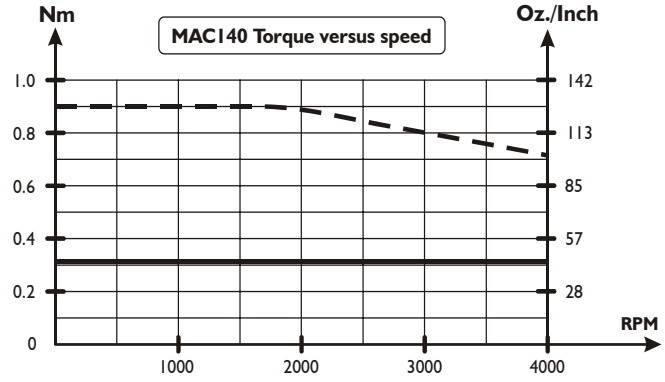
Conditions:
Supply voltage = 48VDC
Ambient temperature = 20°C
Torque setting = 100%
Load setting = 1.0

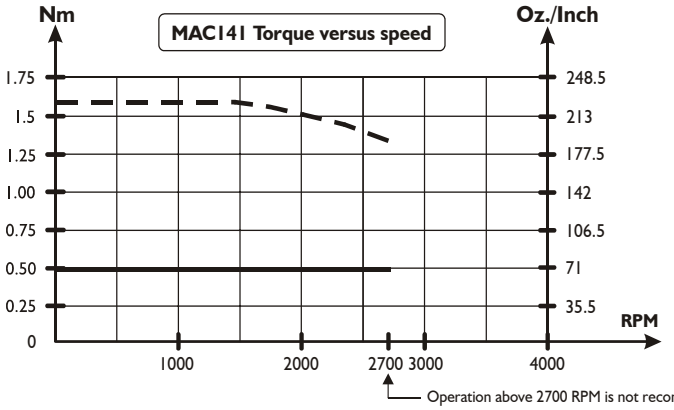
Operation above 4000 RPM can be done, but the losses in the motor make it impossible to operate in this area cyclicly Please note that 2700 RPM is the maximum recommended speed for the MAC141.

= Peak Torque

= Average Torque





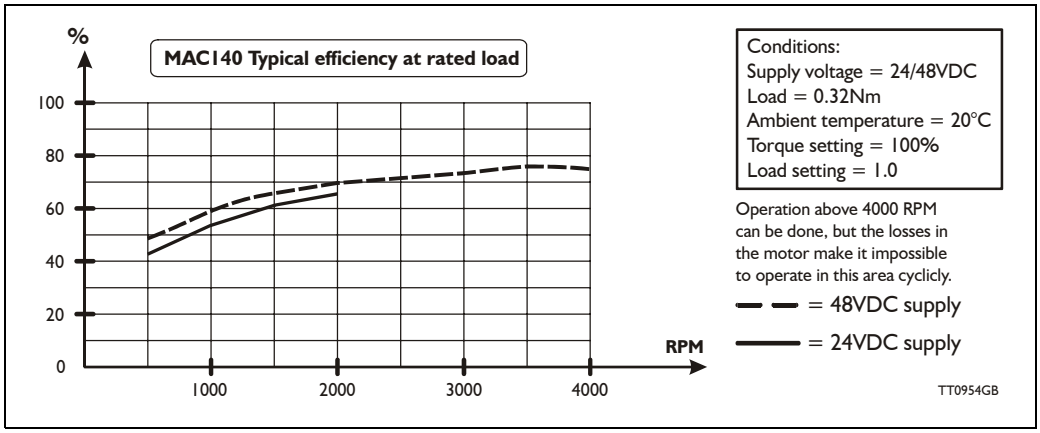


TT0911GB

5.3 Efficiency curve

5.3.1 Motor efficiency curve

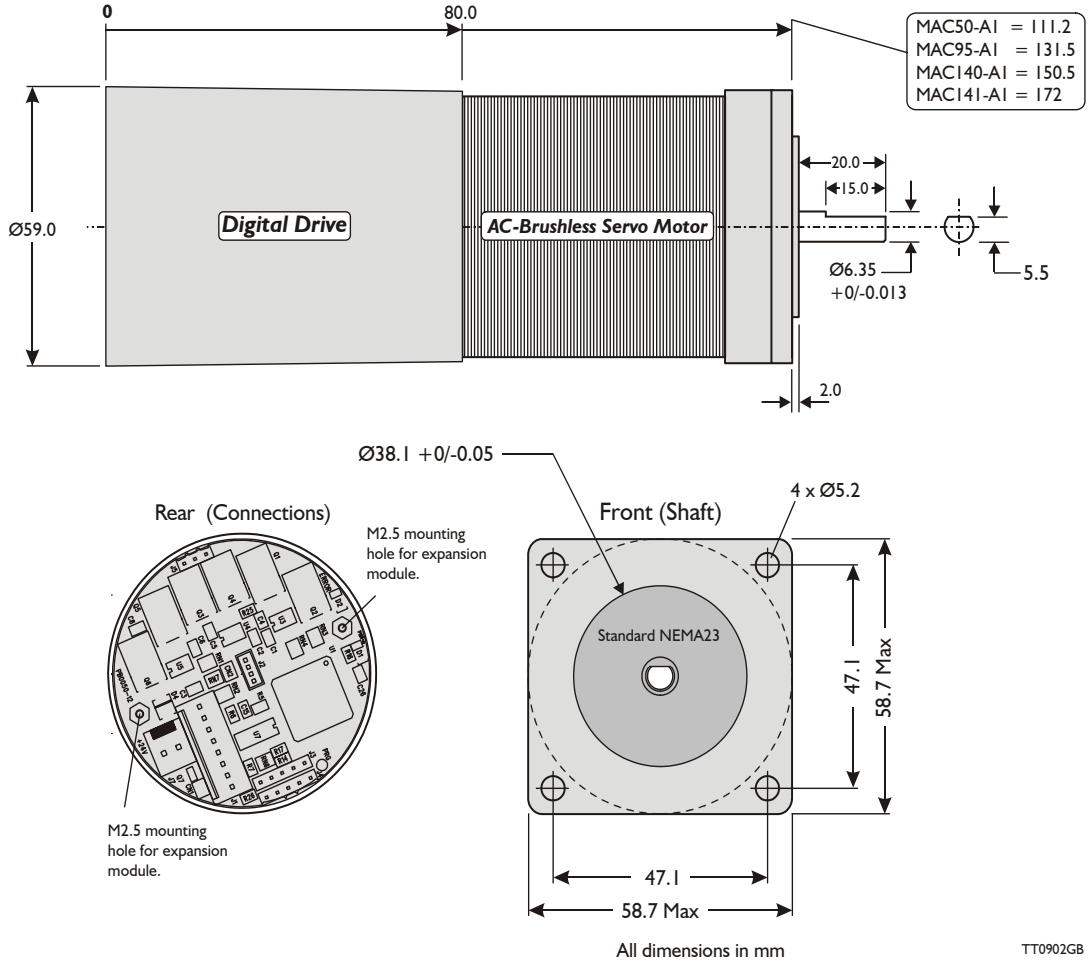
The curve below shows the efficiency of the MAC140 motor as a function of speed. The efficiency is based on the difference in the total amount of electrical power applied to the motor compared with the mechanical output power on the shaft.



The power consumption for the internal circuitry (microprocessor etc.) is typically < 3.5W. In the speed range from 0 to 500 RPM this internal power consumption starts to be a dominant part of the total power consumption.

5.4 Physical Dimensions

Physical dimensions of the basic MAC motors



5.5 Trouble-shooting guide

5.5.1 Troubles related to communication with the motor.

Problem : "RS232 - MacTalk is not communicating with the motor"

The status in 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 must normally 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.
- 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.

5.5.2 Troubles related to the setup of the motor

Problem : "The motor is not behaving like expected"

Action 1:

Check that following register are set proberly:
"Torque" : 100%
"Velocity" : >0
"Acceleration" : >0
"Load" : 1.00
"In position window" : If set too low it can cause the motor to stay stationary.
Please notice 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 done remember to switch back "I/O type" to "Serial data".

Action 2:

Load default by using the "Load default" function in the "Motor" menu.
Alternatively clean the complete memory by using the "Update Firmware" 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 wakes up with the default setup or the setting made at a much earlier stage, the save procedure has failed.

Action :

Ensure that the motor contains 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.

5.5 Trouble-shooting guide

5.5.3 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, page 25 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.

5.6 Serial communication

When using the RS232 or RS422 serial links, it is possible to access all the internal registers in the motor.
This gives the same possibilities as using the general installation and monitoring program MacTalk.
In addition to these features, many more are accessible. In total, the MAC motor contains more than 150 internal registers such as nominal velocity, actual position, etc. but please note that several registers are not for the normal user and damage may occur if the contents of these registers is changed. These registers are marked in grey in the table below.

Register number	Name	Width	Unit	Description
1	PROG_VERS.	Word	-	Shows the actual version of the firmware.
2	MODE_REG	16 bit	-	The current MAC motor mode: 0: Passive 1: Velocity 2: Position 3: Gear Mode 4: Analog Torque mode 5: Analog Velocity mode 6: Analog Velocity/Gear mode. 7-11: Reserved for special purposes 12: Torque homing 13: Input homing 1 14: Input homing 2
3	P_SOLL	32 bit	Encoder counts	The commanded position
5	V_SOLL	16 bit	Counts/sample	Desired velocity 1RPM=2.097 counts/sample.
6	A_SOLL	16 bit	Counts/sample²	The maximum allowed acceleration. 1000 RPM/s = 4.026 Pulses/Sample²
7	T_SOLL	16 bit	-	The maximum allowed torque. 1023 = 100%.
10	P_IST	32 bit	Encoder counts	The actual position
12	V_IST	16 bit	Counts/sample	Actual velocity. 1RPM=2.097 counts/sample.
14	GEARF1	Integer	-	Gear output factor. Used in gear mode
15	GEARF2	Word	-	Gear input factor. Used in gear mode
16	I2T	Word	-	Motor temperature calculated
17	I2TLIM	Word	-	Error trip level used for I2T register.
28	MIN_P_IST	Long Int.	Encoder counts	Software position limit - positive
30	MAX_P_IST	Long int.	Encoder counts	Software position limit - negative
32	ACC_EMERG	Word	Counts/sample²	The maximum allowed deceleration when a fatal error has occurred. 1000 RPM/s = 4.026 Pulses/Sample²
33	INPOSWIN	Word	Encoder counts	If actual position is within this window, the motor is in position.

34	INPOSCNT	Word	Samples	The number of samples the motor has to be within the pos. interval spec. in INPOSWIN.
35	ERR_STAT	16 bit	-	Motor status: Bit 0: Overload Bit 1: Follow error Bit 2: Function error Bit 3: Regenerative error Bit 4: In position Bit 5: Accelerating Bit 6: Decelerating Bit 7: Position limits error

5.6.1 Serial Quick Guide (MacTalk protocol)

This section describes control of the MAC motor via the serial interface (RS232/485 connector on the MAC00-B1 or equivalent module).

The interface is RS232 compatible and uses 19200 baud with 8 data bits and no parity.

The MAC motor is completely controlled by reading and writing to registers.
The registers are numbered 1-255. The width of the registers is 16 bits or 32 bits.
To protect the communication from errors, the data is transmitted twice.

First the data byte is transmitted and then an inverted version (255-x) is transmitted.

The easiest way to become familiar with the registers and MAC communication is to use the *MacRegIO* program. This program lists all of the registers, and the serial commands sent and received can be monitored.

5.6.2 Writing to a register

Controller sends	MAC motor response
<Write><Address><RegNum><Len><Data><End>	<Accept>

Block description

Block Name	Protected (1)	Example	Description
<Write>	No	52h,52h,52h	Write command
<Address>	Yes	07h,F8h (Address 7)	The address of the MAC motor
<RegNum>	Yes	05h,FAh (RegNum 5)	The register number to write to
<Len>	Yes	02h,FDh (Len = 2)	The number of data bytes
<Data>	Yes	E8h,17h, 03h,FCh (Data = 1000)	The data to write to the register
<End>	No	AAh, AAh	Command termination
<Accept>	No	11h, 11h,11h	Accept from MAC motor

(1) Protected means that these data must be sent twice, first non-inverted and then inverted.

Example 1:
Writing 600 (258h) to register 5 (16 bit) to the MAC motor with address 8.

Transmit: 52h,52h,52h - 08h,F7h - 05h,FAh - 02h,FDh - 58h,A7h,02h,FDh - AAh, AAh
Response: 11h,11h,11h

Example 2:
Write 230,000 (38270h) to register 3 (32 bit) to the MAC motor with address 7.

Transmit: 52h,52h,52h - 07h,F8h - 03h,FCh - 04h,FBh -
70h,8Fh,82h,7Dh,03h,FCh,00h,FFh - AAh, AAh
Response: 11h,11h,11h

5.6.3 Reading from a register

Controller sends	MAC motor response
<Read><Address><RegNum><End>	<Write><Address><RegNum><Len><Data><End>

Block description

Block Name	Protected (1)	Example	Description
<Read>	No	50h,50h,50h	Read command
<Address>	Yes	07h,F8h (Address 7)	The address of the MAC motor
<RegNum>	Yes	05h,FAh (RegNum 5)	The register number to read
<End>	No	AAh, AAh	Command termination
<Write>	No	52h,52h,52h	Write command
<Address>	Yes	00h,FFh (Address 0)	This will always be 0, because this is the address of the master
<RegNum>	Yes	05h,FAh (RegNum 5)	This will always be the same as requested
<Len>	Yes	04h,FBh (Len = 4)	The length will always be 4
<Data>	Yes	E8h,17h, 03h,FCh, 00h, FFh, 00h,FFh (Data = 1000)	The data read from the register
<End>	No	AAh, AAh	Command termination

(1) Protected means that these data must be sent twice, first non inverted and then inverted.

Example 1:
Reading the value of register 5 from MAC motor with address 8.

Transmit: 50h,50h,50h - 08h,F7h - 05h,F6h - AAh, AAh
Response: 52h,52h,52h - 00h,FFh - 05h,F6h - 04h,FBh - 58h,A7h,02h,FDh,00h,FFh,00h,FFh - AAh, AAh

The value of register 5 was 500 (258h).

Example 2:
Reading the value of register 3 from MAC motor with address 8.

Transmit:50h,50h,50h - 08h,F7h - 03h,FCh - AAh, AAh
Response:52h,52h,52h - 00h,FFh - 05h,F6h - 04h,FBh - 70h,8Fh,82h,7Dh,03h,FCh,00h,FFh - AAh, AAh

The value of register 3 was 230,000 (38270h).

5.6.4 Application examples

Setting mode 1 (Position mode)
This command writes 1 to register 2 (MODE_REG) on motor 8.

Transmit: 52h,52h,52h - 08h,F7h - 02h,FDh - 02h,FDh - 01h,FEh,00h,FFh - AAh, AAh
Response: 11h,11h,11h

Setting position 100,000
This command writes 100,000 to register 3 (P_SOLL) on motor 8.

Transmit:52h,52h,52h - 07h,F8h - 03h,FCh - 04h,FBh -
A0h,5Fh,86h,79h,01h,FEh,00h,FFh - AAh, AAh
Response:11h,11h,11h

Reading the motor status
This command reads register 35 (ERR_STAT) from motor 8

Transmit:50h,50h,50h - 08h,F7h - 23h,DCh - AAh, AAh
Response:52h,52h,52h - 00h,FFh - 23h,DCh - 04h,FBh -
10h,EFh,00h,FFh,00h,FFh,00h,FFh - AAh, AAh

The motor responded with ERR_STAT = 0010h - meaning “In Position”.

Setting the maximum speed
This command sets the maximum speed to 1000 RPM = 2097 pulses/sec. (2097 = 831h).
This is done by writing to register 5 (V_SOLL)

Transmit: 52h,52h,52h - 08h,F7h - 05h,FAh - 02h,FDh - 31h,CEh,08h,F7h - AAh, AAh
Response: 11h,11h,11h

Reading the actual position
This command reads register 10 (P_IST) from motor 8

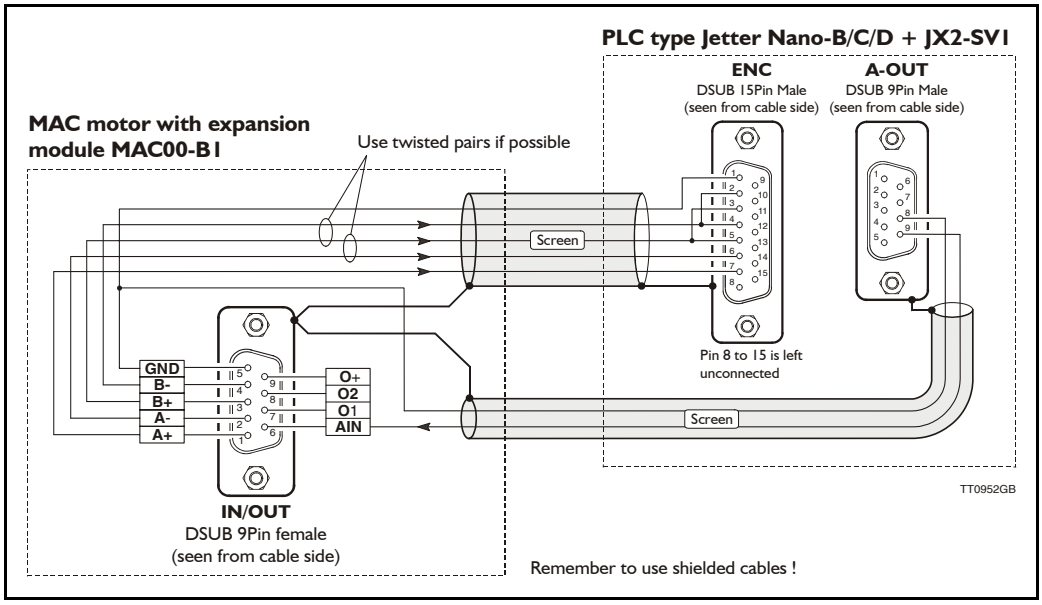
Transmit: 50h,50h,50h - 08h,F7h - 0Ah,F5h - AAh, AAh
Response: 52h,52h,52h - 00h,FFh - 0Ah,F5h - 04h,FBh -
08h,F7h,BDh,42h,03h,FCh,00h,FFh - AAh, AAh

The position was 245,000 (3BD08h)

5.7 Connecting to other equipment

5.7.1 Connecting the MAC motor to a Jetter PLC type Nano-B/C/D

In many applications a PLC is used as the central "intelligence". To adapt the MAC motor in such types of applications, an axis module on the PLC is often used. The illustration below shows how to connect the MAC motor with a Jetter PLC type Nano-B/C/D equipped with a servo axis controller module type JX2-SV1.



Connection scheme:

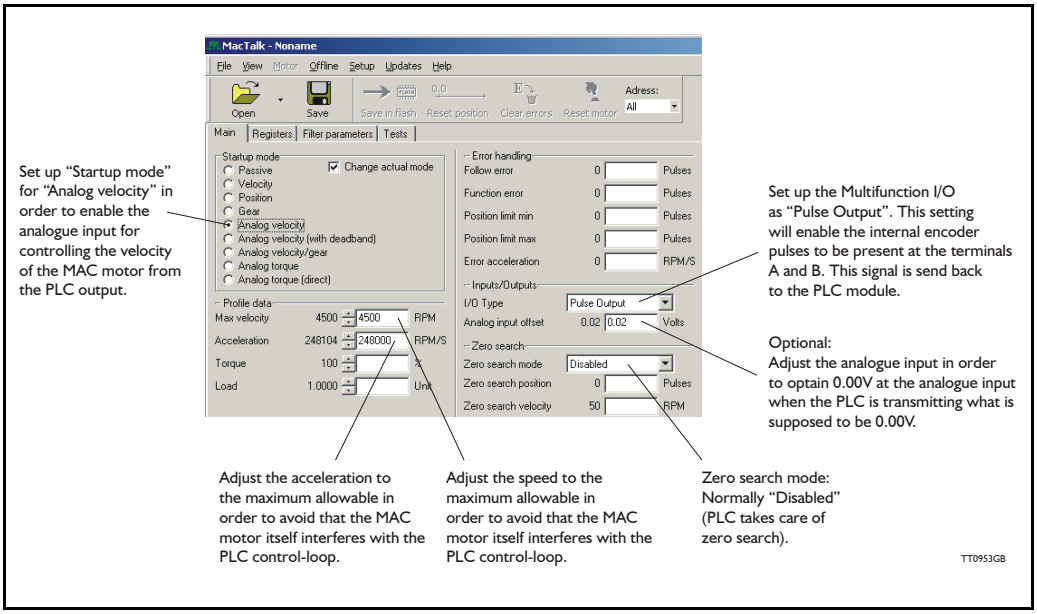
MAC motor IN/OUT 9 pole connector (MAC00-B1)	Jetter JX2-SV1 9 pole connector	Jetter JX2-SV1 15 pole connector
Pin 1		Pin 2 + 4
Pin 2		Pin 3 + 5
Pin 3		Pin 6
Pin 4		Pin 7
Pin 5	Pin 8	Pin 1
Pin 6	Pin 9	

The illustration can also be used as a common diagram for other PLC manufacturers since the fundamental principle is to feed an analogue control voltage from the axis module to the MAC motor dictating the speed or torque. The MAC motor returns the internal encoder signal back to the PLC module in order to let the PLC know what the actual velocity and/or position is.

5.7 Connecting to other equipment

5.7.2 How to set up the MAC motor for the JX2-SV1.

The following illustration shows how to set up the MAC motor. Remember to press the "Save in flash" button after the setup is done in order to save the changes permanently.



5.7.3 Setup in Jetter JX2-SV1 - Mode 2

Set up the registers as follows (when the SV1 module is placed as the first intelligent module after the CPU, i.e. module no. = 2, meaning registers are numbered 121xx):

```
12198 = 2      ; Mode (0...3)
12117 = 1024   ; Encoder lines
12118 = 2000   ; Max. speed in RPM which the MAC + SV1 combination can reach.
               ; This value will depend on the supply voltage. Please consult the
               ; description Power supply, page 25.
12121 = 1000   ; Example - ref. value for setpoint speed in register 12103.
12103 = 1000   ; Example - meaning 100.0% of maximum speed, i.e. 2000 RPM.
```

Adjust the following register values when commissioning the servo solution:

```
12116 = xxx    ; Offset value for the analogue output. The MAC motor should not drift
               ; and at nominal position 0 (zero), R12102, the SV1 must be able to
               ; to control the axis very close to actual position 0, R12109.
12110 = yyy    ; P-gain.
```

Please also follow the instructions in the JX2-SV1 user manual.

Remark: If the MAC motor is supplied by 24VDC, the setup for the MAC motor must be 3000 RPM - even though the MAC itself is not allowed to run more than 2000 RPM at this voltage. Do not worry, the SV1 module controls and limits the speed correctly. See also Power supply, page 25.

5.7 Connecting to other equipment

5.7.4 Setup in Jetter JX2-SV1 - Mode 3

Same as for mode 2 but the MAC motor must be set up in “Analogue torque direct”.
Set up the mode register: 12198 = 3; Mode (0...3)
See also - Setup in Jetter JX2-SV1 - Mode 2, page 99 - for set up of other SV1 registers.

Adjust the registers for Digital Speed Control:
12124 = xxx ; Proportional gain (speed).
12126 = xxx ; Integral gain.
12127 = xxx ; Current limitation, a value of 2047 corresponds to 10.0V.
12128 = xxx ; Present integral gain.
12129 = xxx ; Limitation of the integral gain.

Please also follow the instructions in the JX2-SV1 user manual.

5.7.5 Connect the MAC motor to Jetter PLC with JX2-SM2 axis module.

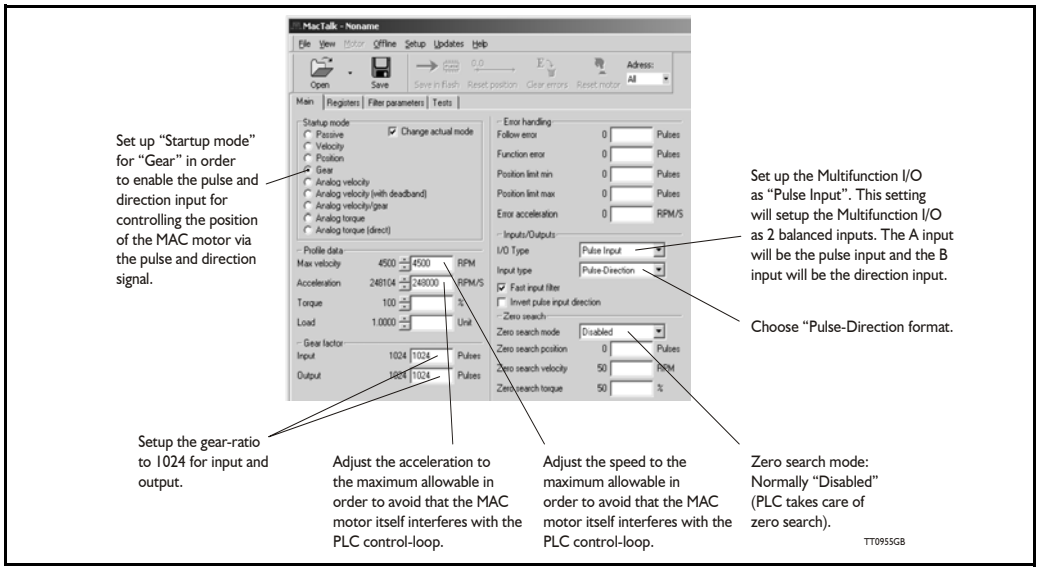
The Jetter PLC can be supplied with the module JX2-SM2 which transmits a pulse and direction signal instead of a +/-10V signal as on the JX2-SV1 module. Each pulse represent a certain distance of movement and the direction signal determines the direction.
Connection scheme:

MAC motor IN/OUT 9 pole connector (MAC00-B1)		**Jetter JX2-SM2 9 pole connector**	
Pin 1	A+	Pin 1	STEP+
Pin 2	A-	Pin 6	STEP-
Pin 3	B+	Pin 2	DIR+
Pin 4	B-	Pin 7	DIR-
Pin 5	GND	Pin 4 + 9	GND

All 4 dip-switches on the rear side of the MAC00-B1 module must be switched to position “off”.

5.7.6 How to set up the MAC motor for the JX2-SM2

The following illustration shows how to set up the MAC motor. Remember to press the “Save in flash” button after the setup is done in order to save the changes permanently.



5.8 Accessories

The following accessories are available for the MAC motor series.

5.8.1 Cables

RS232-9-1
Setup and communication cable. Length 3 m
Standard RS232 cable that is used for connecting MAC motors with an integrated expansion module to a standard computer serial COM port.
The following expansion modules include an RS232 COM port based on a 9-pole DSUB connector which matches the RS232-9-1:
MAC00-B1
MAC00-R1

RS232-9-1-MAC
Setup and communication cable. Length 3 m.
Setup and communication cable used for the BASIC MAC motor which is NOT equipped with a full RS232 interface. The cable can be used between the BASIC MAC motor and a standard RS232 COM port.

WG0302 (2m) or WG0320 (20m).
Power cable with 2 x 0.75mm^2 inner wires + screen. The colour is black.
The cable is fitted with a Molex connector at one end. The other end is open.
This cable can be used together with the following units.

MAC50 to 141	Fits directly to the 2-pole power connector inside the basic MAC motor.
MAC00-CS	Passes through the -CS module and connects to the basic MAC motor.
MAC00-R3	Passes through the -R3 module and connects to the basic MAC motor.

Optional : If the Molex connector is cut off, the cables can also be used for:

MAC00-B2	Connects to the 3-pole screw terminal named “power”.
MAC00-FP2	Connects to the 2-pole screw terminal named “power”.

WG0402 (2m) or WG0420 (20m).
I/O cable with 12 twisted pairs (24 wires)+ screen. The colour is black. The cable is fitted at one end with - 1 pcs. 6-pole connector, 1 pcs. 8-pole connector and 1 pcs. 10-pole connector. The other end is open.
The cable can be used with following units.

MAC00-FP2	Connects inside to all the I/Os +RS232 interface. Only the power and profibus connections are not covered by this cable.
MAC00-R3	Connects inside to all the I/Os +RS232/RS485 interface.

WG0502 (2m) or WG0520 (20m).
I/O cable for the basic MAC motors. The cable has 4 twisted pairs (8 wires)+ screen. The colour is black. The cable is fitted with an AMP connecter at one end which fits the 8-pole I/O connector inside the basic MAC motor. The other end is open.
The cable can be used with following units.

MAC50 to 141	Fits directly to the 8-pole I/O connector inside the basic MAC motor.
MAC00-CS	Passes through the -CS module and connects to the basic MAC motor.

5.8 Accessories

5.8.2 Connectors / connector kits

MAC00-CONKIT1

This kit contains all 3 connectors for the Basic Mac Motor.

Power connector:	JVL no. *3069-02*	Housing 2p. Pitch 3.96mm (Molex no. 09-91-0200).
	JVL no. *2478-TL*	Crimp contacts (Molex no. 08-50-0106).
RS232 Connector:	JVL no. *WG0200*	Since this connector is very small (pitch=1.5mm) it is supplied as an assembled connector with 65mm cable. WG0200 is the JVL number.
I/O Connector:	JVL no. 254H08	Housing 8p. Pitch 2.54mm (AMP no. 770602-8)
	JVL no. 4809C-P914L	Crimp contacts (AMP no. 770601-1)

By ordering this connector kit, all of the above-mentioned parts are included. Please ensure that a proper crimp tool is used when the contacts are fitted. The type numbers mentioned in brackets are the original type numbers from either Molex or AMP.

5.8.3 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.

PSU48-240

A compact switch-mode power supply with 240W 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.

5.9 Cable connection tables

5.9.1 WG0420 (old versions delivered before 1.10.2002)

Signal cable - JVL type no. WG0420 (20m)

Digital Inputs - Internal connector J2		
Signal name w/MAC00-R3	**Signal name w/MAC00-FP2**	**Wire colour**
IN1 (user input 1)	IN1 (user input 1)	Cyan
IN2 (user input 2)	IN2 (user input 2)	Blue
IN3 (user input 3)	IN3 (user input 3)	Green/Brown
IN4 (user input 4)	IN4 (user input 4)	White
IN5 (user input 5)	NL (negative limit-switch input)	Yellow/Red
IN6 (user input 6)	PL (positive limit-switch input)	Red
IN7 (user input 7)	ICM (input common / ground)	White/Red
IN8 (user input 8)	NC (no connection / not used)	Pink
ICM (input common / ground)	NC (no connection / not used)	Grey
NC (no connection / not used)	NC (no connection / not used)	Brown
Digital Outputs - including analogue input - Internal connector J4		
Signal name w/MAC00-R3	**Signal name w/MAC00-FP2**	**Wire colour**
O+ (supply to output circuitry)	O+ (supply to output circuitry)	Red/Brown
OCM (output ground)	O1 (user output 1)	Yellow/Blue
O1 (user output 1)	O2 (user output 2)	Red/Black
O2 (user output 2)	NC (no connection / not used)	Yellow
O3 (user output 3)	NC (no connection / not used)	White/Blue
O4 (user output 4)	NC (no connection / not used)	Purple
AIN (analogue input)	NC (no connection / not used)	Green
GND (ground)	OCM (output ground)	Black
Interface - Internal connector J1		
Signal name	**Description**	**Wire colour**
TXPD (RS232 transmit pull-down)	TXPD (RS232 transmit pull-down)	Red/Blue
TX (RS232 transmit)	TX (RS232 transmit)	White/Green
RX (RS232 receive)	RX (RS232 receive)	Yellow/Green
GND (ground)	GND (ground)	Blue/Black
RS485 A (RS485 interface terminal A)	AIN (analogue input)	Orange/Blue
RS485 B (RS485 interface terminal B)	GND (ground)	Orange/Green
Outer cable-screen connected to motor housing.		

5.10 CE Declaration of Conformity

EU - Declaration of Conformity

Manufacturer

Company Name:	JVL Industri Elektronik A/S
Address:	Blokken 42 DK-3460 Birkerød Denmark
Telephone:	+45 45 82 44 40
E-mail:	jvl@jvl.dk
Web:	www.jvl.dk

Hereby declare that

Product

No.:	MAC50/95/140/141
Name:	Integrated AC Servo Motor
Type:	Series -A1, -A2 and -A3
alone or combined with one of the following expansion modules:	MAC00-B1/MAC00-B2/MAC00-CS MAC00-R1/MAC00-R3/MAC00-FP2

- is in conformity with:

- COUNCIL DIRECTIVE of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility (89/336/EEC)

was manufactured in conformity with the following national standards that implements a harmonised standard:

EN 61800-3 Adjustable speed electrical power drives systems - Part 3: EMC product standard including specific test methods

March 2003

Bo V. Jessen
Technical Director
JVL Industri Elektronik A/S

TT0970GB (LX0015-01GB)

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