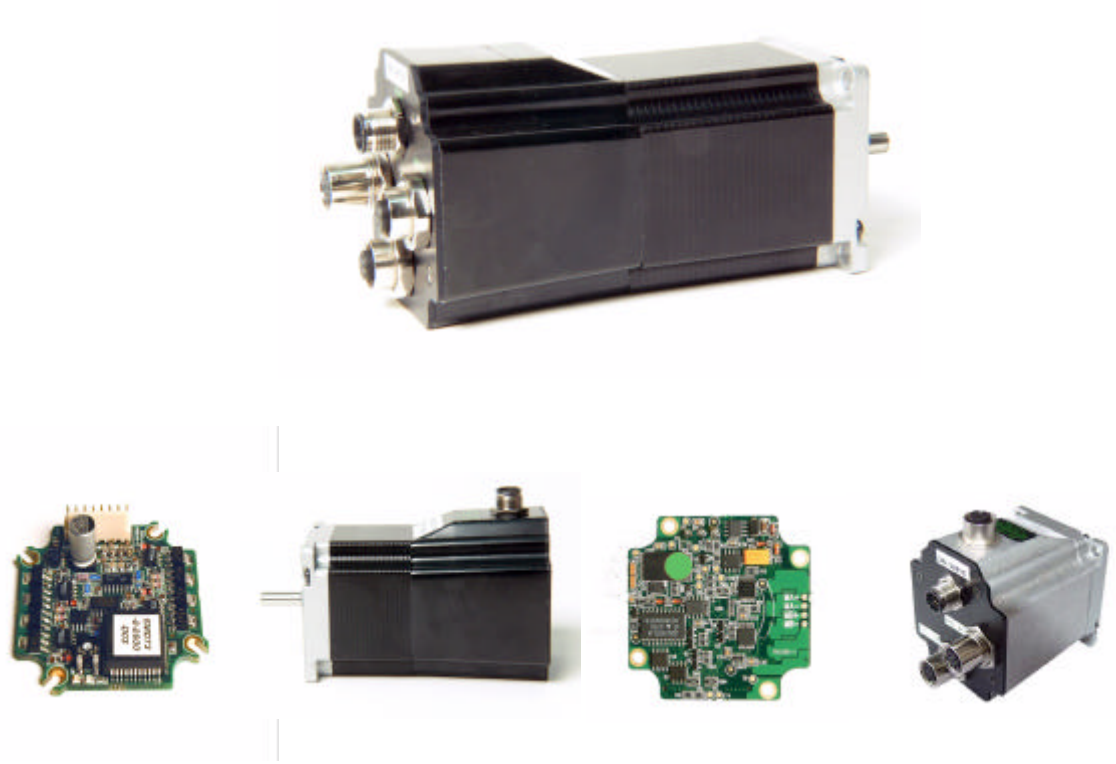
MIS231, MIS232 and MIS234

Integrated Step Motors, QuickStep, and Step Motor Controller SMC75

User Manual



JVL Industri Elektronik A/S

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Important
User Information

Warning

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

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

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Contents

1 Introduction

This user manual describes the set-up and use of the **Integrated step motors, QuickStep types MIS231, MIS232 and MIS234** and the **SMC75 Step Motor Controller.**

The QuickStep motors types MIS231, 232 and 234 can be delivered either for pulse /direction control or for positioning and speed control.

For pulse/direction control, the QuickStep motors are delivered with the **Step Motor Driver SMD73** built in. For further information on this driver, reference should be made to the data-sheet for these drivers (LD0057) and the Technical Note (LS0003).

For positioning and speed control, the Quick Step motors are delivered with **Step Motor Controller SMC75** built in.

Both the driver SMD73 and the controller SMC75 can also be delivered separately as PCB boards for own use by the customer, and can be delivered in a metal housing with M12 connectors corresponding to the housing built together with the complete integrated motor.

Complete QuickStep motor with SMC75 built-in

SMD73 PCB

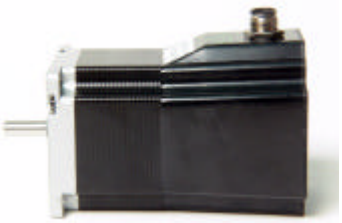
QuickStep motor with SMD73

SMC75 PCB

SMC75 in housing

1.1 Features pulse/direction (SMD73)

SMD73



MIS231 with pulse/direction

The QuickStep series of Stepper motors with integrated electronics represents a major step forward.
All the necessary electronics in a stepper system are integrated in the motor itself.

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

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

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

The advantages of this solution are:

- De-central intelligence.
- Simple installation. No cables between motor and driver.
- EMC safe. Switching noise remains within motor. (Noise can however be introduced in the DI/DO).
- Compact. Does not take space in cabinet.
- Low-cost alternative to separate step or servo motor and driver.

In the past decade, pulse/direction interfaces have become increasingly popular for the control of step and servo motors. This is due to the fact that pulse/direction signals provide a simple and reliable interface which is 100% digital, precise, and offers immediate response. When a pulse is sent, the motor instantaneously moves 1 step forward.
For example, if the motor has a resolution of 200 steps/revolution, it will move 1.8 degrees. By changing the frequency of the applied pulse signal, it is possible to accelerate the motor.

By counting the number of pulses, the motor's position can be determined without any error whatsoever. The direction input is used to determine the motor's direction of rotation. JVL's QuickStep motors with pulse/direction interface offer the following advantages:

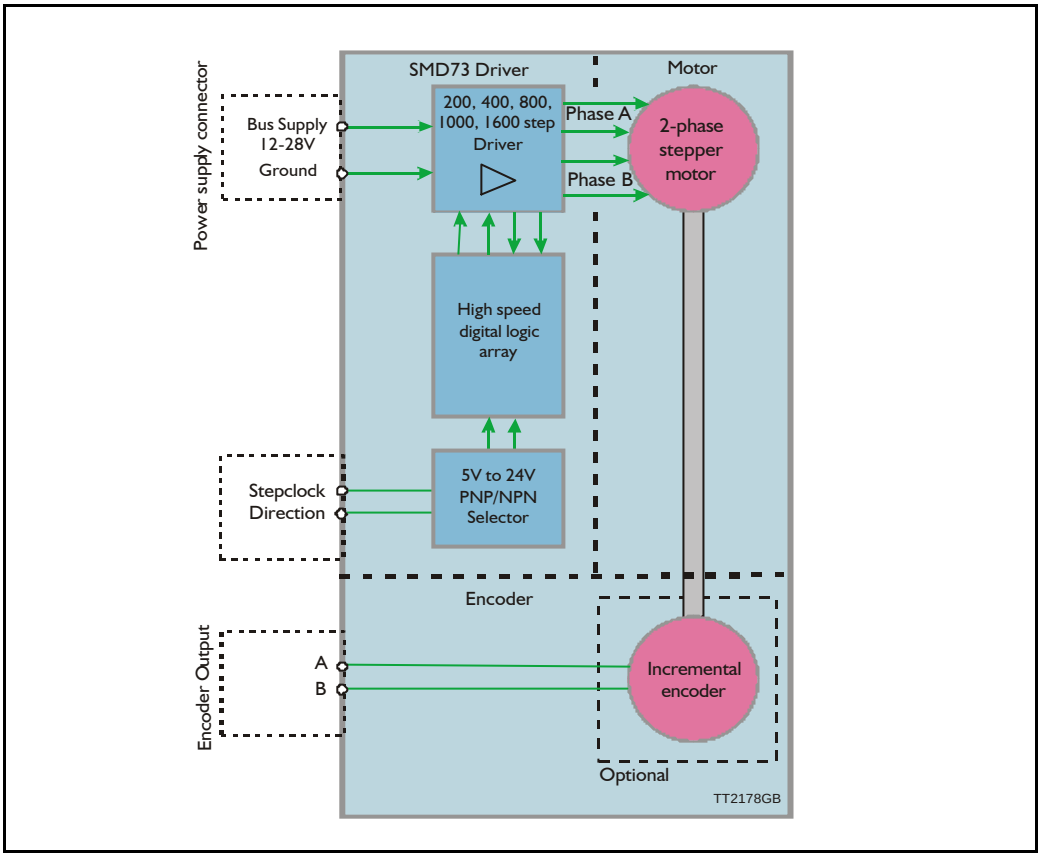
- Very simple technology that is easy to understand and apply.
- High stability and low cost because the technology is simple with few components.
- Only one cable with 4 wires is required, so cabling costs are a minimum.
- No controller in the control cabinet.
- All positioning and control is performed by the PLC, so there is no duplication of software or cabling.
- Robust IP67 connector and IP55 motor housing for applications in demanding environments.
- Thermally protected against current overload and short-circuit.
- Reacts instantaneously. The motor starts within microseconds.
- 5V or 24V PNP/NPN inputs ensure compatibility with any controller.
- Step resolution of 200, 400, 800, 1000 or 1600 pulses/revolution.
- Supply voltage 12-28 VDC.
- Possibility for encoder feedback.

All the required electronics are integrated in the motor itself in a single compact unit. The motor can be supplied with the connector either on the back or side of the housing. M12 connector is standard, but cable glands or DSUB connector can be delivered on request.

For further information on the pulse/direction driver see SMD73 Data-sheet and Technical Note.

1.1 Features pulse/direction (SMD73)

1.1.1 Block diagram, Pulse/Direction Version (SMD73)



1.1.2 Driver Connections

Versions with pulse and direction control:
Connections for versions with 1 M12 connector. (See also SMD73 data-sheet)

M12 5 pin male	Description	JVL cable WI1000M12 F5TxxN
1	P+ (12-28VDC)	Brown
2	Pulse	White
3	P-	Blue
4	Direction	Black
5	Signal Ground	Grey

xx: 05 for 5 metre and 20 for 20 metre cable.

Versions with cable glands and 5 m cable

Colour Code	Description
Red	P+ (12-28VDC)
Black	P-
Blue	Direction
White	Pulse
Shield	Signal ground

1.2Features positioning - speed control (SMC75)

SMC75

SMC75 mounted in a housing

MIS232 with controller

The compact step motor controller SMC75 is designed for positioning and speed control of stepper motors. SMC75 is a PCB with dimensions 57x57mm and mounted with SMD electronics on both sides.

It is mounted directly in the housing of the JVL QuickStep motors MIS 231, 232 and 234, forming a complete integrated step motor. It may also be used with other types of step motors according to customers requirements. The basic features of the controller are:

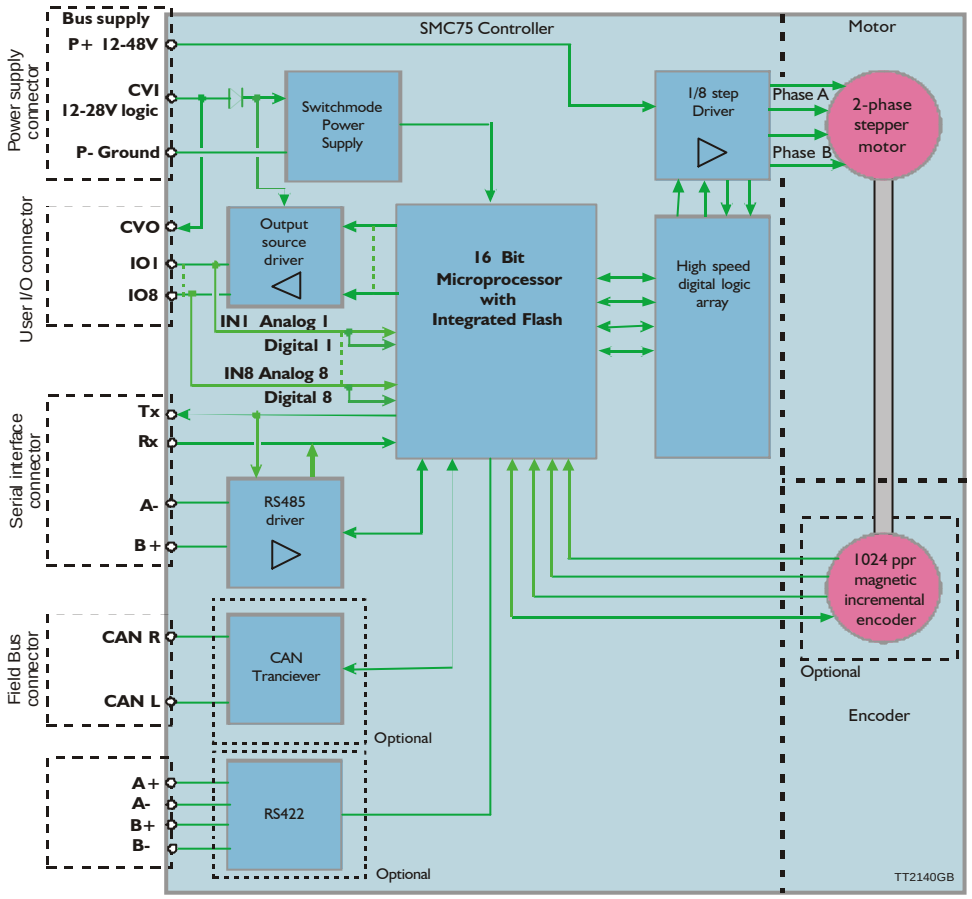
- Serial RS485 or 5V serial position controller
- Position controller with graphic programming.
- Option for CANbus, CANopen DS-301/ DSP-402 or DeviceNet (under development).
- A dual supply facility is available so that position and parameters are maintained at emergency stop
- Gear mode
- MACmotor protocol so MACmotor and Quickstep motors can be connected on the same RS485 bus
- Command for easy PLC/PC setup and communication
- Power supply 12-48VDC
- Fixed 1600 pulses/rev.
- Built-in μprocessor with 8 In/Out that can be configured as inputs, PNP outputs or analogue inputs. 5V serial and RS485 interface for set up and programming.
- MODBUS interface.
- 9.6 to 1Mb communication
- Driver technology is improved as compared to SMD73 and supply voltage is 12-48VDC.

When used with the QuickStep motor or mounted on any other step motor the advantages of the controller are:

- De-central intelligence.
- Simple installation. No cables between motor and driver.
- EMC safe. Switching noise remains within motor.
- Compact. Does not take space in cabinet.
- Low-cost alternative to separate step or servo motor and driver.
- Stall detect by means of magnetic encoder with resolution of up to 1024 pulses/rev.
- Interface possibilities to the SMC75 controller:
- From PC/PLC with serial commands via 5V serial or RS485.
- Pulse/direction input. Encoder output.
- CANopen, DeviceNet
- 8 I/O, 5-28VDC that can be configured as Inputs, Outputs or analogue inputs
- Future option for Profibus DP, Ethernet, Bluetooth and Zigbee wireless

1.2Features positioning - speed control (SMC75)

1.2.1 Block diagram, Positioning/Speed Control (SMC75)



1.3 General description

The QuickStep motors are currently available in 4 different models: MIS230, MIS231, MIS232 and MIS234, with continuous torque ratings from 0.5 to 2.9 Nm. The basic functions and I/O features are the same for all models. MIS34x models up to 12.0 Nm are under development.

Motor Type	MIS230	MIS231	MIS232	MIS234	MIS340	MIS341	MIS342	MIS343	Unit
Torque	0.5	1.1	1.6	2.9	3.2	4.6	8.0	12.0	Nm
Inertia	0.12	0.3	0.48	0.96	1.0	1.4	2.7	4.0	$kgcm^2$
Flange	NEMA23 (57x57 mm)				NEMA34 (87x87mm)				
Length	82	96	118.5	154	105	120	158	196	mm
Shaft Ø	6.35	6.35	6.35	10.0	9.53	9.53	14.0	14.0	mm
Shaft radial play	Max. 0.02 (450g load)				Max. 0.02 (450g load)				mm
Shaft axial play	Max. 0.08 (450g load)				Max. 0.08 (450g load)				mm
Max radial force	7.5 (20mm from flange)				22 (20mm from flange)				kg
Max axial force	1.5				6				kg
Weight	0.7	0.9	1.2	1.8	2.1	2.7	4.2	5.8	kg

1.3.1 Basic modes/functions in the QuickStep motor

The QuickStep motor offers the following functions:

Mode	Description
Passive	The motor will be in a completely passive state but communication is active and internal registers can be setup. Motor shaft can be turned by hand.
Velocity	The motor velocity can be controlled using MacTalk software or by setting register 5(V_SOLL) using serial or program commands.
Position	The motor position can be controlled using MacTalk or by setting register 3 (P_SOLL) using serial or program commands.
Gear	The motor position and velocity can be controlled by pulse and direction or encoder signals at the inputs “IN1” and “IN2”. The gear ratio can be set to a large ratio by using register14 (GEAR1) and register 15 (GEAR2).

1.4 Step Motor Controller SMC75

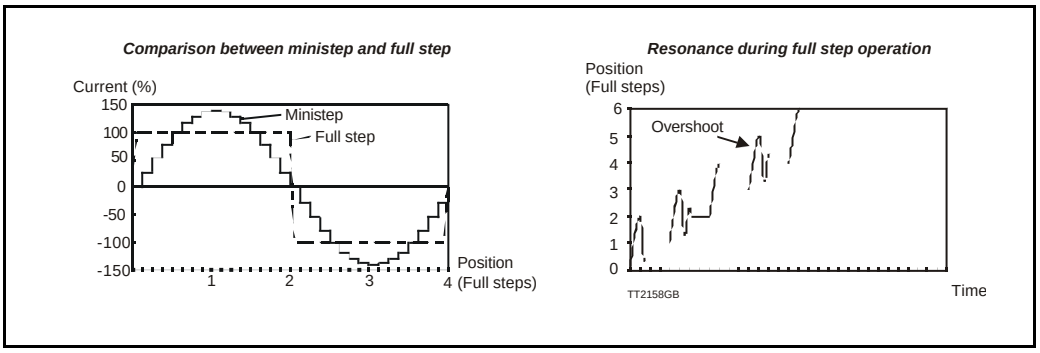
Step Motor Controller SMC75 is a mini-step driver with fixed 1600 pulses/rev., which has been designed for driving step motors with phase currents of up to 3 Amp/phase (RMS).
The Controller SMC75 is available in 2 different versions for various applications. It is built into the QuickStep Integrated Step Motors, but for OEM and low-cost applications it can be delivered as a PCB or in its own housing with M12 connectors. For easy mounting and service, the version with M12 connectors is recommended. A version with cable glands can be used for high volume and low cost applications.

	Order no.	PCB	BOX	CANopen	IO	RS485	M12	Cable Glands
	SMC75A1	X			8	1		
	SMC75A1AC	X		X	8	1		
	SMC75A1M3		X		4	2	X	
	SMC75A1M5		X		8	1	X	
	SMC75A1M6		X	X	8	1	X	
	SMC75A1W0		X		8	1		X

Other combinations and features are also possible for OEM use. See " MIS23x: M12 connections" on page13. for further information.

The "box" version which is built into a black aluminium casing provides a very robust construction that is insensitive to mechanical vibration and electrical noise.

The advantage of using a ministep driver instead of a conventional full-step or half-step driver is that mechanical resonance problems are significantly minimised. Resonance most often occurs at slow motor speeds and results either in loss of motor torque or the appearance of significant harmonics. The principle of the ministep technique is to drive the motor using a sinusoidal current in the interval between 2 physical full steps. This reduces the step velocity between each step and thus damps any resonance significantly.

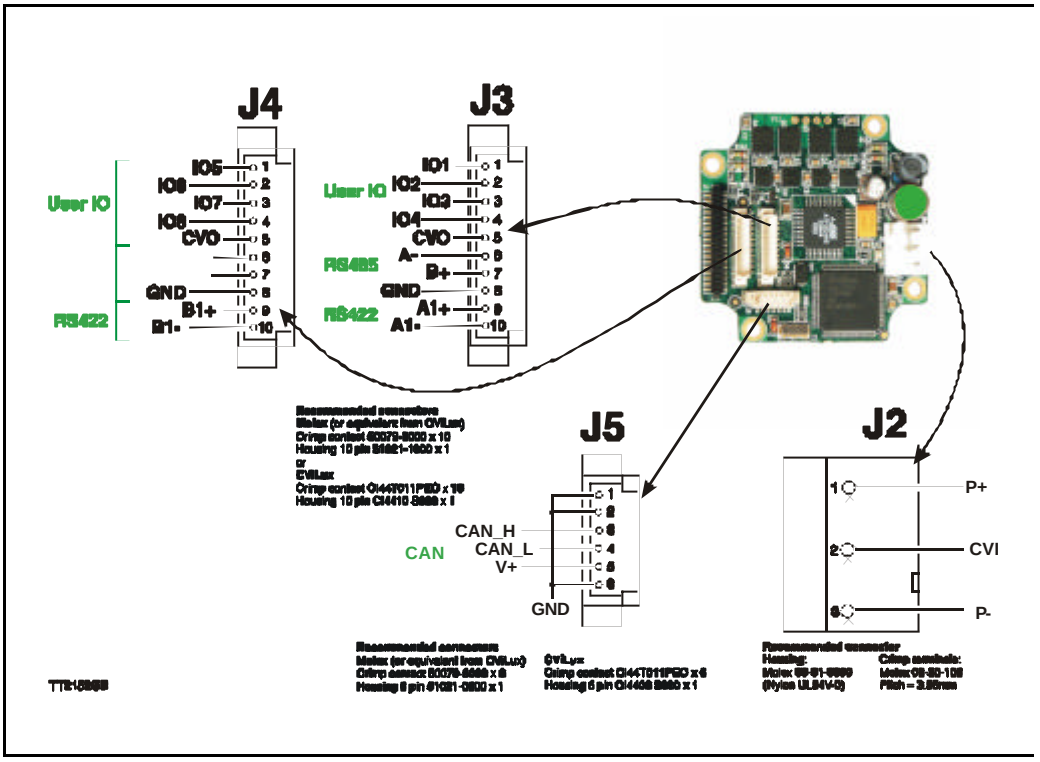


Both 2-phase and 4-phase step motors can be connected to the Controller, which utilises the "Bipolar Chopper" principle of operation, thus giving optimum motor performance.

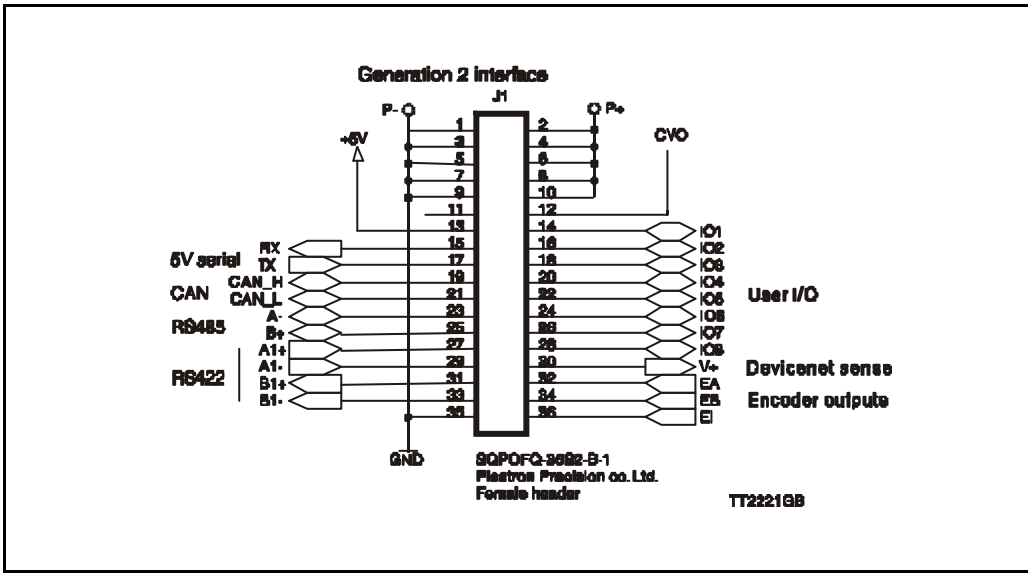
1.5 SMC75 Controller connections

1.5.1 SMC75 Connector overview

The connections to the various connectors of the SMC75 PCB board is shown below. Note that GND and P- are connected together internally.



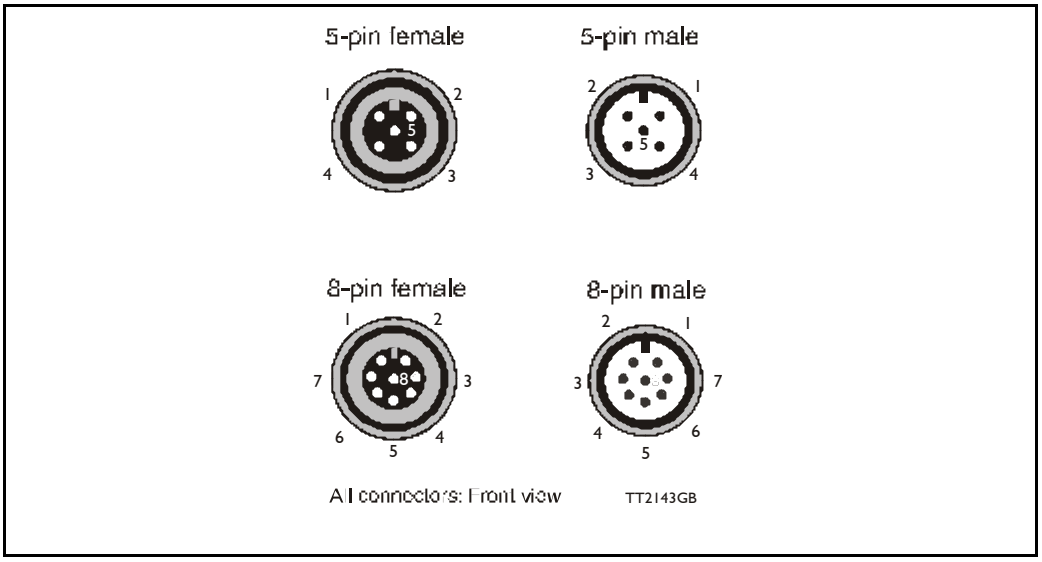
The figure below shows the generation 2 connector for future or special purposes. Please contact JVL for further information.



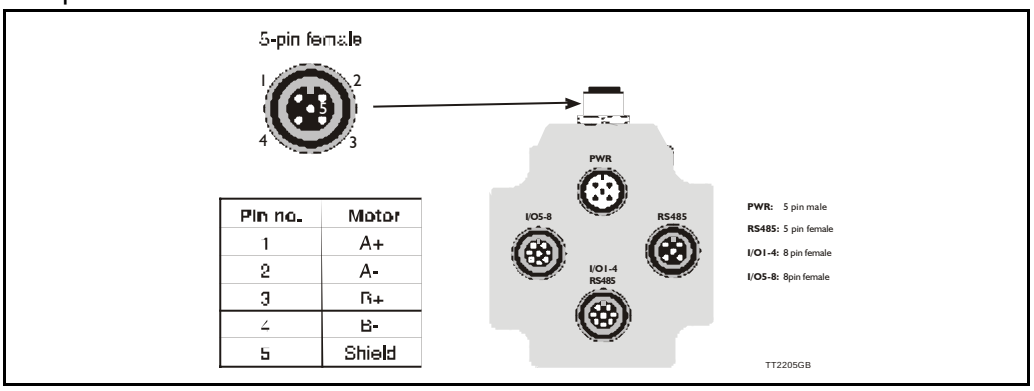
1.5 SMC75 Controller connections

1.5.2 MIS23x: M12 connections

M12 connectors



Example of SMC75 controller connections.



Pin no.	Motor
1	A+
2	A-
3	B+
4	B-
5	Shield

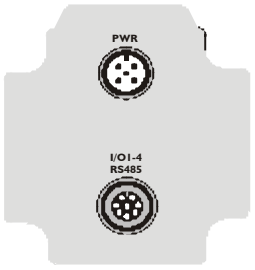
5- pole connector	
Pin no.	**Colour**
1	Brown
2	White
3	Blue
4	Black
5	Grey

8-pole connector	
Pin no.	**Colour**
1	White
2	Brown
3	Green
4	Yellow
5	Grey
6	Pink
7	Blue
8	Red

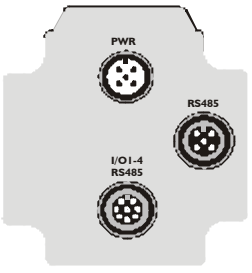
Colour code for standard cables

1.5 SMC75 Controller connections

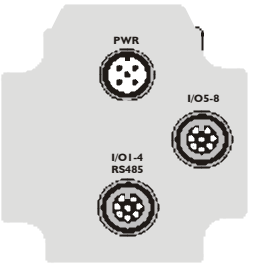
MIS23xAz**M2**N075
RS485 serial communication and few local I/O.



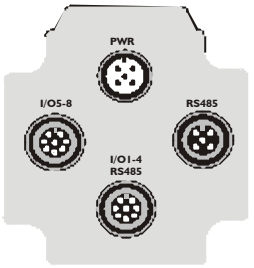
MIS23xAz**M3**N075
RS485 serial communication in network. Up to 32 MAC and QuickStep on the same network. Few local I/O.



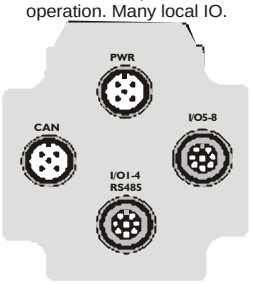
MIS23xAz**M4**N075
RS485 serial communication and many local I/O.



MIS23xAz**M5**N075
RS485 serial communication in network. Up to 32 MAC and QuickStep on the same network. Few local I/O.



MIS23xAz**M6**N075
MIS23xAz**M7**N075
RS485 and CANopen/Devicenet operation. Many local IO.



PWR: 5 pin male

RS485: 5 pin female

CAN: 5 pin male

I/O1-4: 8 pin female

I/O5-8: 8pin female

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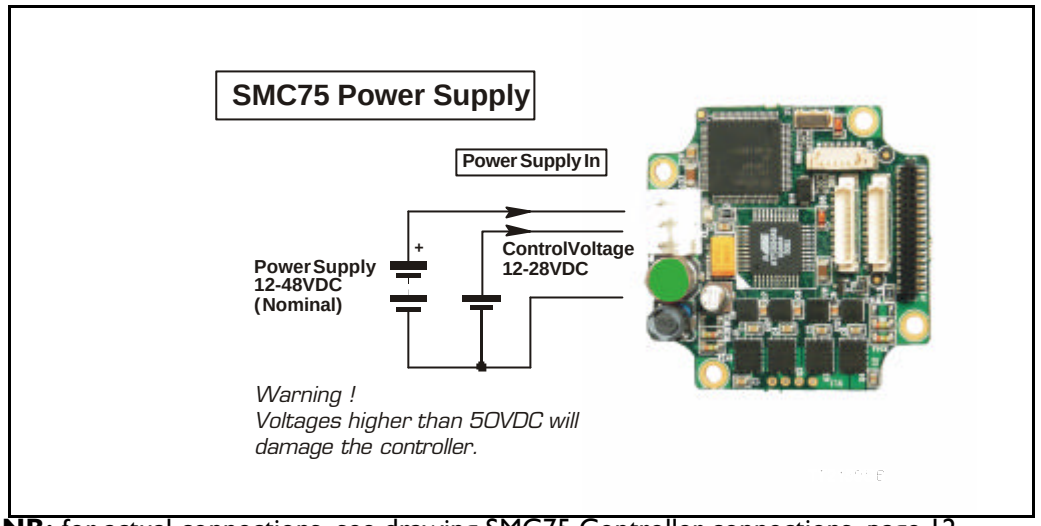
Versions with positioning and speed control

Quick Step M12 Connector overview	**CANopen/Device-Net Male 8pin**	**RS485/5V serial Female 5pin**	**IO1-4 Female 8pin**	**IO5-8 Female 8pin**	**Power Male 5pin**	**Function**
#MIS23xAzM2N075				X	X	RS485, 4IO
MIS23xAzM3N075		X		X	X	2xRS485, 4IO
#MIS23xAzM4N075			X	X	X	RS485, 8IO
MIS23xAzM5N075		X	X	X	X	2xRS485, 8IO
MIS23xAzM6N075	X		X	X	X	CANopen, RS485, 8IO
MIS23xAzM7N075	X		X	X	X	DeviceNet, RS485, 8IO
M12 Pin 1	CAN_SHLD	B+ (RS485)	IO1	IO5	P+ (12-48VDC)	
M12 Pin 2	CAN_V+	A- (RS485)	IO2	IO6	P+ (12-48VDC	
M12 Pin 3	CAN_GND	B+ (RS485)	IO3	IO7	P-	
M12 Pin 4	CAN_H	A- (RS485)	GND IO-	GND 10-	CVI+ (12-28VDC)	
M12 Pin 5	CAN_L	GND	B+ (RS485)	Not used	P-	
M12 Pin 6	-	-	A- (RS485)	Not used	-	
M12 Pin 7	-	-	IO4	IO8	-	
M12 Pin 8	-	-	CVO+ (Out)	CVO+ (Out)	-	
M12 connector solder terminals	WI1008-M12F5SS1	WI1008-M12M5SS1	WI1008-M12M8SS1	WI1008-M12M8SS1	WI1008-M12F5SS1	
M12 cables 5m.	WI1006-M12F5S05R	WI1000-M12M5T05N	WI1000-M12M8T05N	WI1000-M12M8T05N	WI1000-M12F5T05N	

#: Only >50pcs order. x=: 1~1Nm, 2~1.6Nm, 3~2.5Nm.
z=: 1~6.35mm shaft, 3~10.0mm shaft (only if x=3)



NB: for actual connections, see drawing SMC75 Controller connections, page 12.

2.1 Power Supply SMC75

2.1.1 General Aspects of Power Supply

Powering of the Controller is relatively simple.
To ensure that powering of the Controller is as simple as possible, only a driver and control voltage are connected to the Controller. Internal supply circuitry ensures the correct supply voltages for the driver, control circuits, etc.
The motor can be operated with the same power supply if using 12 – 28VDC for both Driver and control voltage

2.1.2 Power Supply (P+)

The Driver section requires a supply voltage in the range 12-48VDC nominal. It is strongly recommended to use a voltage as high as possible since it will give the best torque performance of the motor at high speeds.
For optimum performance, it is recommended that a capacitance of minimum 1000μF is connected to the power supply. It should be mounted as close as possible to the motor. Similarly, it is recommended that 0.75mm cable is used to connect the power supply to the Controller. If the Controller supply voltage falls below10V, the internal reset circuitry will reset the driver. Provision should therefore be made to ensure that the supply voltage is always maintained at a minimum of 12V, even in the event of a mains voltage drop. The Controller is protected against incorrect polarity connection but not over-voltage.

2.1.3 Control Voltage (CVI)

The control voltage should be in the range12-28VDC and is used to supply the microprocessor circuit and the user output driver.
This input is used as supply to the microprocessor, encoder and output driver. To ensure that position and parameters are maintained after an emergency stop, the control voltage should be maintained under the emergency stop.

2.1.4 Power Supply Grounding

It is recommended that the housing is connected to ground or common 0 VDC. The overall earthing of the system must be done at a central point close to the power supply.

2.1.5 Dimensioning power supply and fuse

The power supply must be dimensioned according to the actual motor size.
The size of the pre-fuse also depends on the actual model of the MIS motor.

2.1 Power Supply SMC75

Use the following table to select the power supply and fuse ratings.

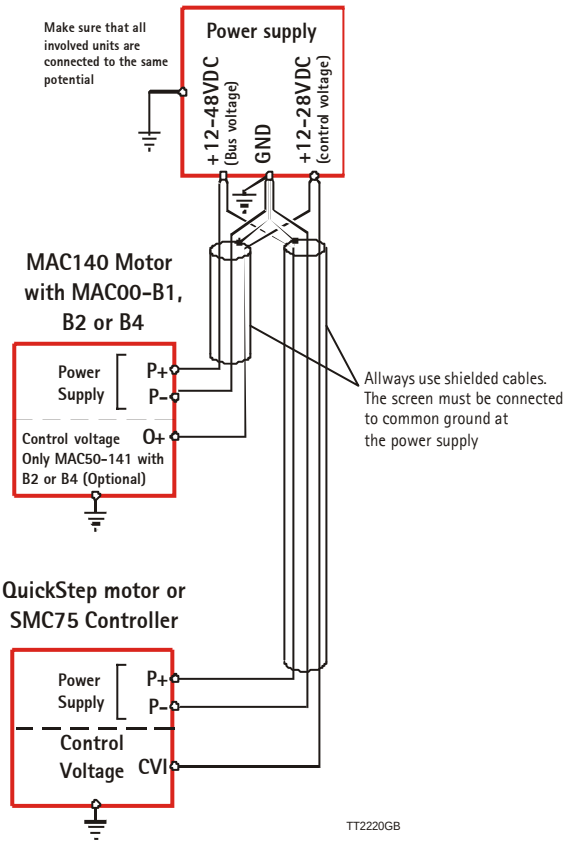
Desired voltage	MIS231		MIS232		MIS234	
-	Supply rating	Fuse size	Supply rating	Fuse size	Supply rating	Fuse size
12VDC	20W	T4A	40W	T6.3A	60W	T10A
24VDC	40W	T4A	80W	T6.3A	160W	T10A
48VDC	80W	T4A	160W	T6.3A	320W	T10A
Recommended power supply	PSU24-075 PSU48-240 PSU40-4		PSU24-240 PSU48-240 PSU40-4		PSU24-240 PSU48-240 PSU40-4	

See also the appendix which shows the standard power supplies that JVL offers.

2.1.6 General power supply description

The supply voltage can be chosen in the range 12VDC to 48VDC. However the maximum torque 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 300RPM if for example 24VDC is used as supply.

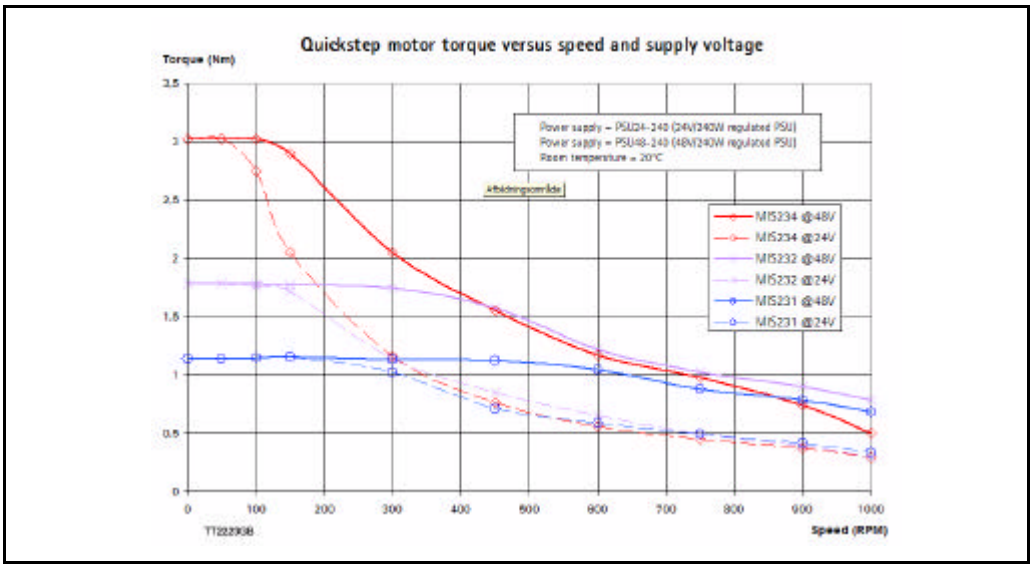
Power supply connections to a MAC140 or a QuickStep motor



2.1 Power Supply SMC75

2.1.7 Select Your Power Supply

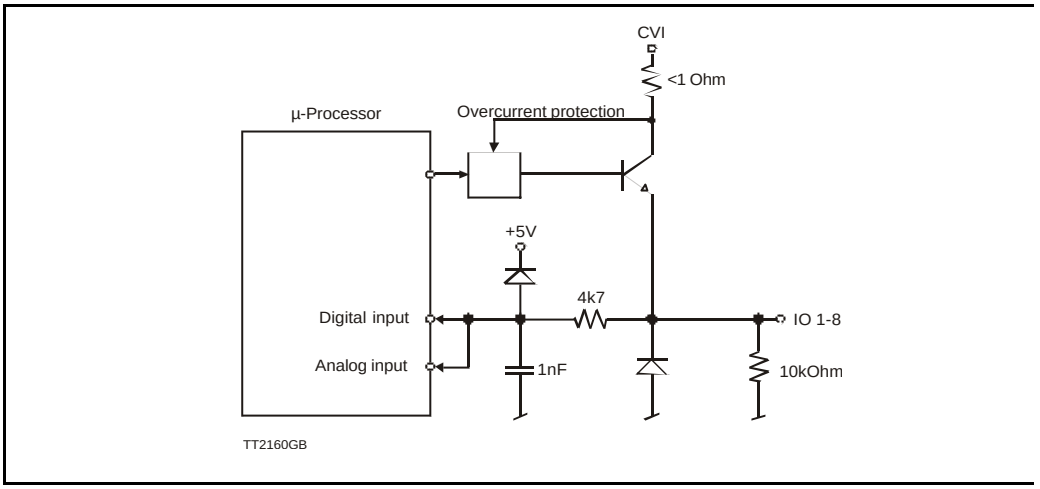
We recommend the use of 48VDC or the highest possible voltage to supply the motor. As seen in the chart below, it is clear that the torque below 100 RPM is independent of supply voltage. But above 300-500 RPM, the torque at 24VDC is half compared to the torque at 48VDC.
Additionally, higher voltage gives better current and filter regulation and thereby better performance. If there is a tendency for motor resonance, a lower supply voltage can be a solution to the problem.



2.2 SMC75 Inputs

The SMC75 has 8 inputs/outputs that each can be set individually to input, output or analog input 0-5VDC via MacTalk or software commands. See Using MacTalk, page 43, for setup.
This means for example that it is possible to have 4 inputs, 3 outputs and one analog input.

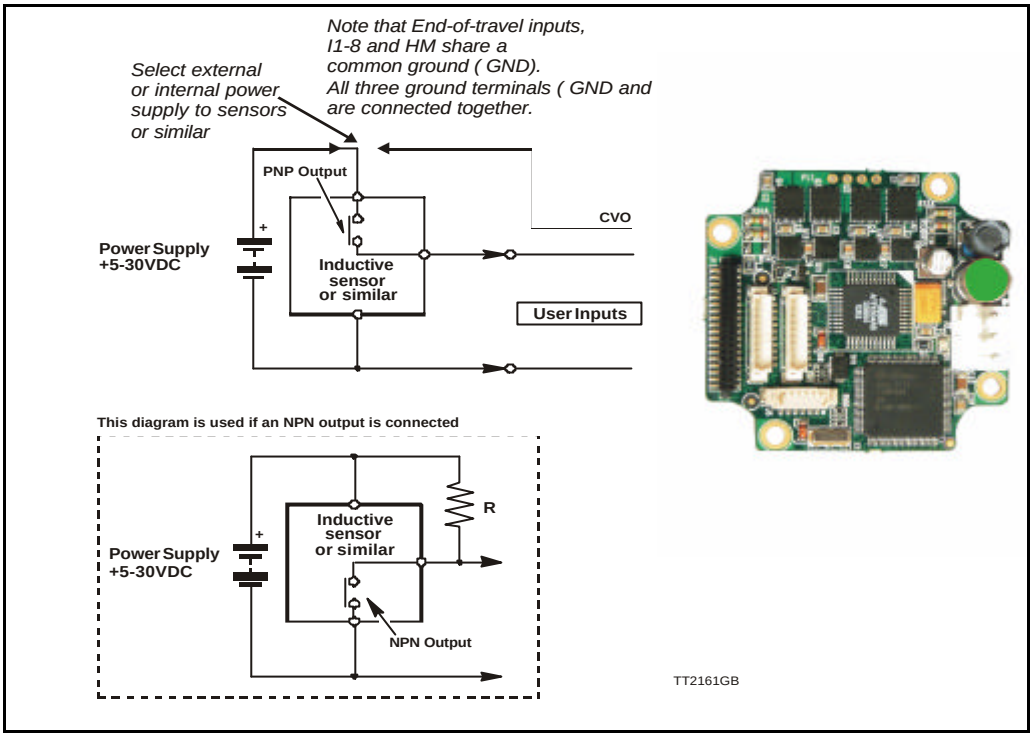
Input/output functional diagram:



2.2.1 Inputs

- Inputs are TTL to 28VDC compliant.
- Over-current protection and thermal shut-down.
- 10 kOhm input resistance.
- No galvanic isolation.
- High speed Pulse/direction on Input 1 and Input 2 for gear mode.
- High speed incremental counter on Input 1 and Input 2.
- Positive and negative limit can be selected to any input 1 to 8.
- Zero search input can be selected to any input 1 to 8.
- Digital filter can be enabled for each input selectable from 0 to 100ms. If disabled, the response time is 100μs.
- Analog filter can be selected for all Analog inputs.

2.3 SMC75 User Inputs



NB: For actual connections, see SMC75 Controller connections, page 12.

2.3.1 General

The Controller is equipped with a total of 8 digital inputs. Each input can be used for a variety of purposes depending on the actual application. Each of the inputs can be detected from the actual program that has been downloaded to the Controller or via serial commands.
The Inputs are not optically isolated from other Controller circuitry. All of the Inputs have a common ground terminal, denoted *GND*. Each Input can operate with voltages in the range 5 to 30VDC. Note that the Inputs should normally be connected to a PNP output since a positive current must be applied for an input to be activated.
Note that CVO is available as CVI on the I/O connectors. This provides the facility that local sensors can be supplied directly from the controller.

2.3.2 Connection of NPN Output

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

Supply Voltage	Recommended Resistance R
5-12VDC	1kOhm / 0.25W
12-18VDC	2.2kOhm / 0.25W
18-24VDC	3.3kOhm / 0.25W
24-30VDC	4.7kOhm / 0.25W

2.3.3 End-of Travel Limit Inputs: General

Any of the 8 inputs can be used as limit inputs. The input can be set from MacTalk or via register NL_Mask, page 86 or PL_Mask, page 86.

Positive limit (PL)
Activation of the Positive limit *(PL)* Input will halt motor operation if the motor is moving in a positive direction. The motor can however operate in a negative direction even if the *PL* Input is activated.

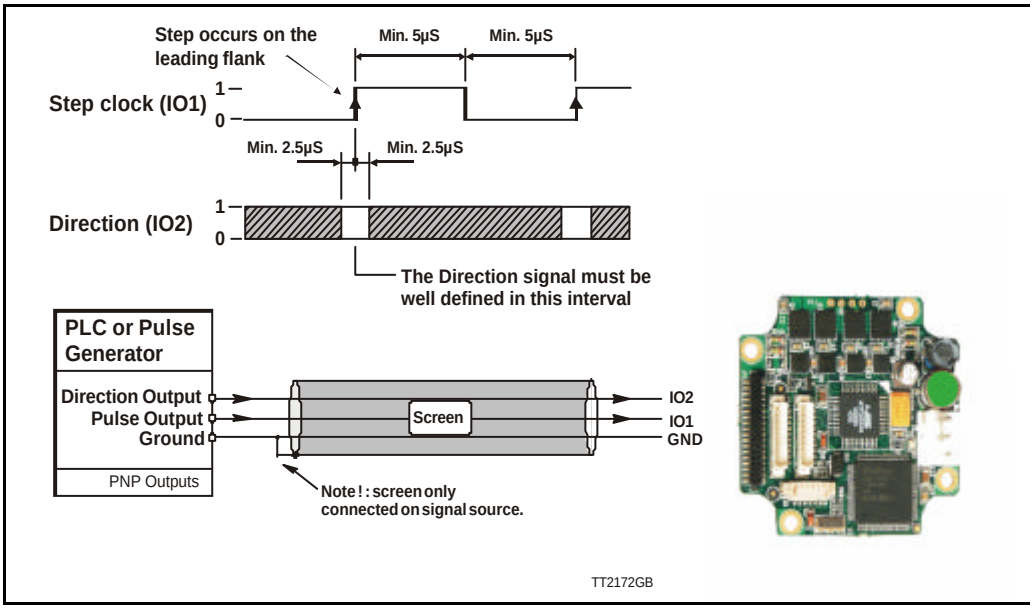
Negative limit (NL)
Activation of the Negative limit *(NL)* Input will halt motor operation if the motor is moving in a negative direction. The motor can however operate in a positive direction even if the *NL* Input is activated.

A bit will be set in the Controller's warning register if either the *NL* or *PL* Inputs has been activated or are active. See *Section 9.2.26*, page 78.

2.3.4 Step Pulse and Direction Inputs

If gear mode is selected, then IO1 and IO2 can be used as Step Pulse and Direction Inputs. The Step Pulse Input (IO1) is used for applying pulse signals which make the motor move. One signal pulse corresponds to a single ministep. The Direction Input (IO2) determines the direction of the motor movement. If logic "1" is applied to the Direction Input, the motor moves forward. If logic "0" is applied to the Input, the motor moves backwards.
The Step Pulse and Direction Inputs are not optically isolated from other Driver circuitry and must be driven either by a push-pull driver or a PNP (source) driver. The Inputs can handle voltages in the range 0 to 30 V, which makes the controller well suited for industrial applications, for example in PLC systems.
It is recommended that shielded cable is always used for connection to the Step Pulse and Direction Inputs.
Both inputs must be controlled from a "Source-driver". This means that they share a common ground — see above illustration.
The Driver executes the step on the leading flank of the Step Input pulse — see above illustration. If gear mode is selected, then IO1 and IO2 can be used as step pulse and Direction Inputs or encoder inputs

.



2.3.5 Home Input

Any of the 8 inputs can be used as Home input for the zero search function. A zero-search occurs when the Controller receives the seek zero search command by changing Mode_Reg (*Section 9.2.2*, page 71)

The Home Input can be set from MacTalk or via register Home_Mask (*Section 9.2.63*, page 86)

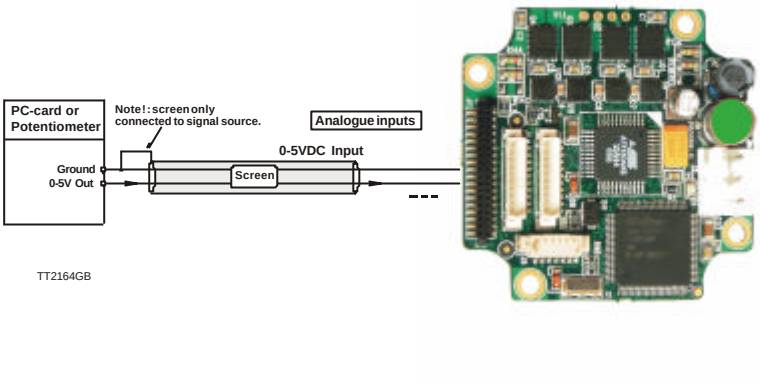
It is possible to see when a zero-search is finished by reading a bit in Status bits (*Section 9.2.20*, page 77

2.3.6 Digital inputs

All of the eight I/O signals can be used as digital inputs. The sampled and possibly filtered value of each input is stored in the Input's register (register 18). Unlike the analog inputs, there is only one value for each digital input, so it must be configured to be either unfiltered or filtered.
Unfiltered (high-speed) digital inputs are sampled every 100 μS (micro-seconds).
Filtered digital inputs are sampled every milli-second, and the filter value can be set in the range 1 to100 mS, so the filtered input must be sampled to have the same logical value for that number of samples in a row. Once an input has changed state after passing the filtering, it will again take the same number of samples of the opposite logical level to change it back. For example, if the filter is set to 5 mS and the start value is 0 (zero), the input will remain at zero until three samples in succession have been read as 1 (one). If the signal immediately drops down to 0 again, it will take three samples of zero in succession before the register bit gets set to zero.

Note that filtering of the digital inputs does load the micro-controller, so if filtering of the digital inputs is not needed, ALL the inputs can be selected as high-speed to reduce the load.

2.4 SMC75 Analogue Inputs

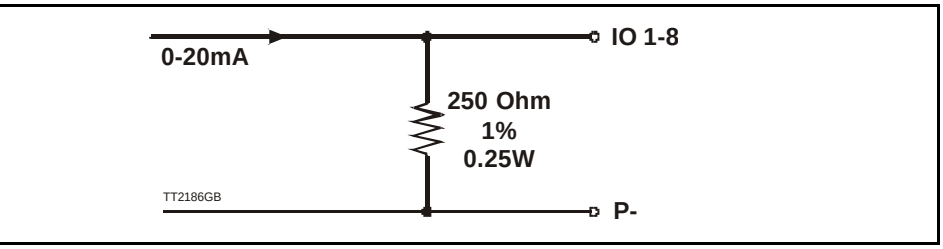


NB: For actual connections, see SMC75 Controller connections, page 12.

2.4.1 General

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

In these modes of operation, the motor is controlled to produce a velocity or position, etc., which is determined by, and proportional to, the voltage applied to the Analogue Input.
The Analogue Inputs share a common internal supply with the GND and P- terminal and are not optically isolated from all other inputs and outputs. The Analogue Inputs are protected against voltage overload up to 30V peak and have a built-in filter which removes input signal noise. See Analog input filters, page 25.
Always use shielded cable to connect the source used to control an Analogue Input since the motor, etc., can easily interfere with the analogue signal and cause instability.
The Controller is equipped with 8 analog-to-digital converters (ADC) which convert the detected analogue signal level. The ADCs have a resolution of 10bit.
In order to use the Analogue Inputs as 0-20 mA inputs, a 250 Ω, 1% resistor must be connected between IO 1-8 and GND.



2.4 SMC75 Analogue Inputs

2.4.2 Analog input filters

The SMC75-based products, like the MIS motors have 8 general-purpose I/Os, that can be used as both digital inputs, digital outputs and analog inputs. When an I/O is configured to be an input, it simultaneously has both a digital value (high or low) and an analog value in the range 0.00 to 5.00 Volts. Input voltages higher than 5.0 Volts will be internally limited and read as 5.00 Volts.

The inputs use a resolution of 10 bits, which means that in the raw motor units a value of 5.00 Volts reads out as the value 1023. This gives a resolution of 5.00/1023 = 4.8876 mV per count.

The eight values from the analog inputs are maintained by the SMC75 firmware in the registers 89...96 as raw, unfiltered values with the fastest possible update frequency, and additionally in the registers 81...88 as filtered values. The firmware does not use any of the values for dedicated functions. It is always up to the program in the motor to read and use the values.

The analog filtered values are typically used to suppress general noise or to define how quickly the input value is allowed to change, or in some cases to limit the input voltage range. A typical example is an analog input that is connected to a manually controlled potentiometer, so an operator can regulate the speed of the machine by turning a knob. In many environments, this setup is subject to noise, which could make the motor run unevenly, and cause too sharp accelerations or decelerations when the knob is turned.

The filter functions supported in the SMC75 firmware always use three different steps.

Confidence check
First the raw input value is compared to two Confidence limits: Confidence Min and Confidence Max. If the new value is either smaller than the Confidence Min limit or larger then the Confidence Max limit, it is simply discarded (not used at all), and the value in its associated register is unchanged. This is done to eliminate noise spikes. Confidence limits can only be used if not all of the measurement range is used. Values of 0 for Confidence Min and 1023 for Confidence Max will effectively disable the confidence limits.

Slope limitation
After a new sample has passed the Confidence limit checks, its value is compared with the last filtered value in its associated register. If the difference between the old and the new value is larger than the Max Slope Limit, the new value is modified to be exactly the old value plus or minus the Max Slope Limit. This limits the speed of change on the signal. Since the samples come at fixed intervals of 10 mS, it is easy to determine the number of Volts per millisecond. A value of 1023 will effectively disable slope limitation.

Filtering
After a new sample has both passed the confidence limits checks and has been validated with respect to the slope limitation, it is combined with the last filtered value by taking a part of the new sample and a part of the old filtered value, adding them together and writing the result back to the final destination register – one of the registers 81...88. For instance a filter value of 14 would take 14/64 of the new sample plus 50/64 of the old value. A filter of 64 would simply copy the new sample to the rule, thus disabling the filtering. This completes the filtering of the analog inputs.

Confidence alarms
If either of the Confidence Min or Confidence Max limits is used, it may be possible that no new samples are accepted, which means that the filtered value will never change even though there is a change in the input voltage. For instance, if the Confidence Min limit is set to 2.0 V, and the actual input voltage is 1.50 V, the filtered value may continue to read out 0.00 V (or the last value it had before exceeding the confidence limits).
To help troubleshooting in cases like this, each input has a status bit that is set if at least half of the new samples during the last second lie outside either confidence limit. It is not possible to see which of the confidence limits is violated. The status bits are updated once per second.

Slope alarms
If the Max Slope limit is used (by setting its value lower than 1023), it may be possible that many samples have their value limited. This is not necessarily an error in itself, but can be a sign of a fault causing a noisy signal, or it can be a sign that the Max Slope limit is set too low, which can have implications if the analogue voltage is used to control the motor speed, torque, etc.
To help troubleshooting in cases like this, each input has a status bit that is set if at least half of the new samples during the last second were limited by the Max Slope setting. The status bits are updated once per second.

Example of analog input filter operation:
Note that even though the examples use units rather than Volts, decimal values are used, since the motor uses a much higher resolution internally to store the units.
Also note that as long as the slope limitation is in effect, the result will keep a constant slope even when using a filter. When the slope limitation is no longer in effect, the filter will cause the value to approach the final result more slowly as it approaches the result.

Confidence Min = 0, Confidence Max = 500, Max Slope = 10, Filter = 8, Old filtered value = 0.

Sample 1 = 100	Confidence OK, slope limit to 0 + 10 = 10, result = 10*(8/64)+0*(56/64) = **1.25** units.
Sample 2 = 100	Confidence OK, slope limit to 1.25 + 10 = 11.25, result = 11.25*(8/64)+1.25*(56/64) = **2.5** units.
Sample 3 = 100	Confidence OK, slope limit to 2.5 + 10 = 12.5, result = 12.5*(8/64)+2.5*(56/64) = **3.75** units.
Sample 4 = 800	Confidence error, keep old value, result = **3.75** units.
	…and so on until the result gets ~= **95.0** units…
Sample 78 = 100	Confidence OK, no slope limitation needed, result = 100*(8/64)+95*(56/64) = **95.625** units.
Sample 79 = 100	Confidence OK, no slope limitation needed, result = 100*(8/64)+95.625*(56/64) ~= **96.171875** units.
Sample 80 = 100	Confidence OK, no slope limitation needed, result = 100*(8/64)+96.171875*(56/64) ~= **96.65** units.
Sample 81 = 100	Confidence OK, no slope limitation needed, result = 100*(8/64)+96.65*(56/64) ~= **97.07** units.

Sample 82 = 100 Confidence OK, no slope limitation needed,
result = 100*(8/64)+97.07*(56/64) ~= **97.44** units.

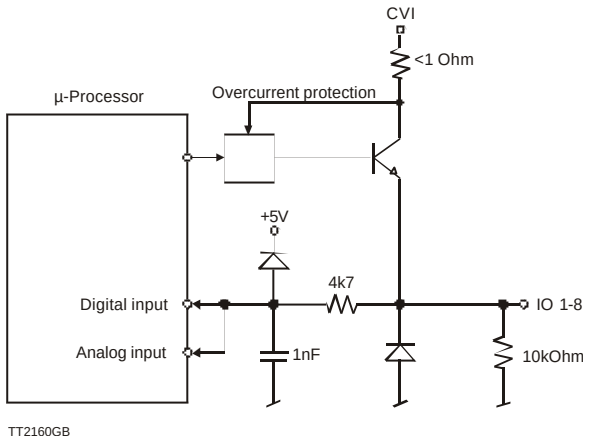
Sample 83 = 100 Confidence OK, no slope limitation needed,
result = 100*(8/64)+97.44*(56/64) ~= **97.76** units.

..98.04, 98.28, 98.49, 98.68, 98.85, 99.00, 99.12, 99.23, 99.33, 99.41, 99.48, 99.55, 99.60, 99.65, 99.70, 99.74, 99.77, 99.80, 99.82, 99.84, 99.86, 99.88, 99.90, 99.91, 99.92, 99.93, 99.94, 99.95, 99.95, 99.96, 99.96, 99.97, 99.97, 99.98, 99.98, 99.98, 99.98, 99.99, 99.99, 99.99, …….100.0

2.5 SMC75 User Outputs

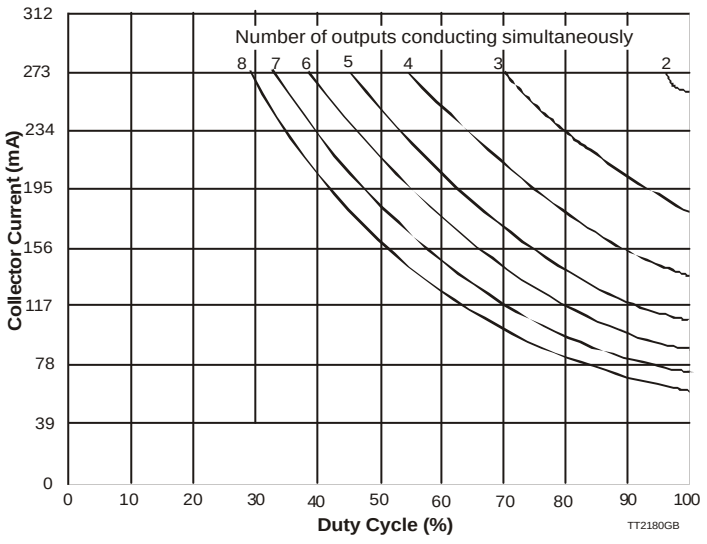
The SMC75 has 8 inputs/outputs that each can be set individually to input, output or analog input 0-5V via MacTalk or software commands.
This means that it for example is possible to have 4 inputs, 3 outputs and one analog input.

Input/output functional diagram:

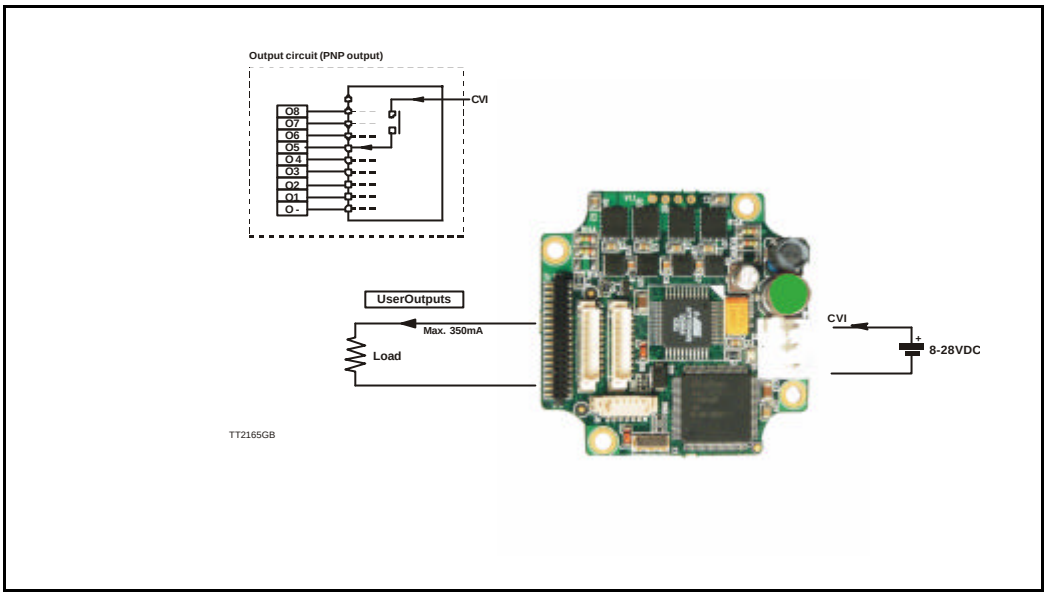


- Outputs are Source (PNP) outputs and 5-28VDC compliant
- No galvanic isolation
- Short-circuit to ground protected that shuts down all outputs and sets Error bit in software
- In Position and Error signal can be selected to be on any outputs 1 to 8
- Optional Encoder outputs
- 75 to 350 mA output current that depends on number of outputs activated and on duty cycle. (See diagram)
- Internal ground clamp diodes

Allowable output current as a function of duty cycle



2.5 SMC75 User Outputs



NB: For actual connections, see SMC75 Controller connections, page 12.

2.5.1 General

The Controller is equipped with a total of 8 digital outputs. Each output can be used for a variety of purposes depending on the Controller's basic mode of operation. The Outputs are not optically isolated from other Controller circuitry. The output circuitry is powered from the internal power supply CVI. The output circuitry operates with voltages in the range 5-28VDC. Each output can supply a continuous current up to 350mA. The Outputs are all source drivers, i.e. if a given Output is activated, contact is made between the control voltage (CVI) and the respective output terminal. See above illustration.

2.5.2 Overload of User Outputs

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

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

If one or more outputs are short circuited, MacTalk will show Error "Output Driver" and Bit2 will be set in Err_Bits *Section 9.2.25*, page 78.

2.6 SMC75 Special Outputs

2.6.1 Error Output

Error output can be selected as one of the 8 outputs. This selection is done in MacTalk or by setting a bit in register Error_Mask, *Section 9.2.67*, page 87
The Driver's Error Output enables a PLC or other equipment in a motion control system to verify that the Driver is functioning correctly.
Under normal operation, the Error Output has a status of logic "1", but if the Driver is short-circuited or the temperature exceeds 85 degrees Centigrade, the Output is switched to logic "0".

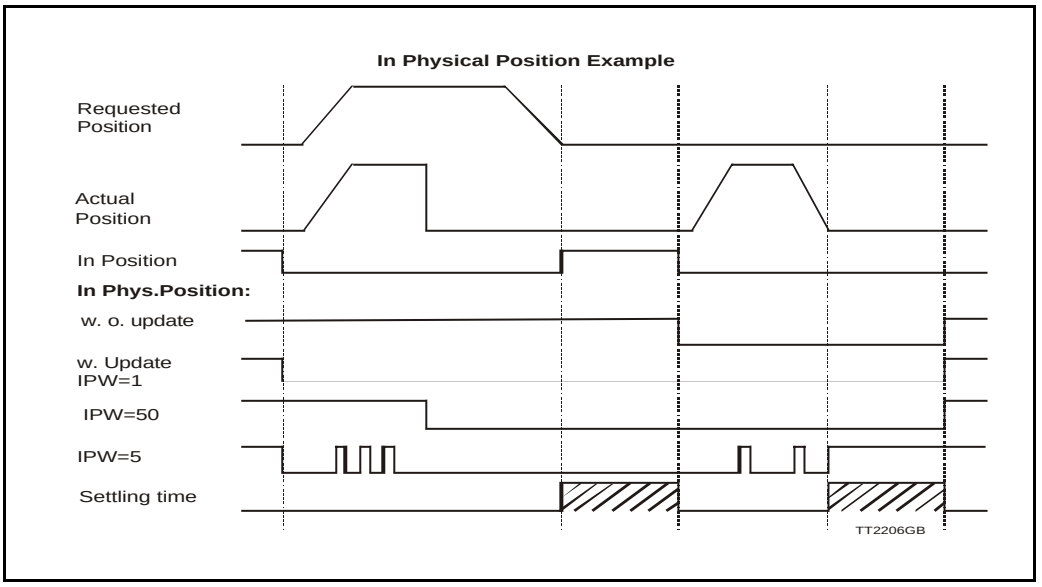
2.6.2 In Position Output

In Position Output can be selected as one of the 8 outputs.
This selection is done in MacTalk or by setting a bit in register 137 (bit 0-7) InPos_Mask, *Section 9.2.66*, page 87.
When the motor is running, the output will be inactive. When the motor is at stand-still, the output will be active.

2.6.3 In Physical Position Output"

In physical position can be selected as one of the 8 outputs.
This selection is done in MacTalk or by setting a bit in register 137 (bit 8 – 15) InPos_Mask, *Section 9.2.66*, page 87.

This signal is used together with MIS motors with an internal or external encoder for positioning.
This signal can be selected to be continuously updated and will then indicate if the motor is inside the "In Position Window" all the time.
If continuous update of the "In Physical Position" is not selected and the autocorrection is used, this signal is changed after a move and when a check has been made of the position after the "settling time between retries" if the motor is inside the "In Position Window".



See also Auto Correction, page 32.

2.6 SMC75 Special Outputs

2.6.4 Pulse/Direction Outputs

Any number of the outputs can be configured to follow the pulse and direction signals used internally in the motor. This can be used for accurate synchronization of two or more motors.

See the register description for registers 108 and 109 in PulseDirMask, page 82 and PulseDirMod, page 83

2.6.5 Encoder Outputs (only from version 2.0)

If the motor is equipped with a built-in encoder, it is possible to obtain the incremental signal and the index pulse out on the user outputs. Please note that the voltage typically is 24VDC PNP. Therefore a resistor to ground should be connected.
A 2 channel encoder with 256 pulses/revolution will give a total of1024 pulses/revolution.

Output	Encoder designation
06	A
07	B
08	Index

2.7 Auto Correction

AutoCorrection is used in motors with a built-in encoder only. It is only used in position mode to re-try a movement if the decoder position is too far from the target after the pulse generator has stopped moving the motor – this will happen for instance if the movement was physically blocked, the torque of the motor was insufficient, or a bad value for start velocity or acceleration were used. It might also be used to handle occasional mechanical oscillations.

The AutoCorrection system will first wait (unconditionally) for a certain time to allow the initial movement to settle mechanically before testing for the target position. It will then attempt a normal movement, using the same values for velocities and acceleration as the movement that failed. It will continue until the encoder position is within the target window, or the selected number of retries has expired.

Note that AutoCorrection will only start after the value of the P_SOLL register is changed. In other words, changing P_SOLL (not just writing the same value again) will reload the maximum number of retries and set the Auto Correction Active status bit. The Auto Correction Active status bit will remain set until either the position is within the target window or the max number of retries has been exhausted.

Also note that if the motor is used to control other motors by sending out the pulse and direction signals on digital outputs, any extra movements caused by AutoCorrection will send out additional steps to the other motors.

Registers affected:

-Register 33, IN_POSITION_WINDOW, specifies how many steps from the target position the encoder must report before AutoCorrection is attempted.

- Register 34, IN_POSITION_COUNT, specifies the maximum number of retries. A value of 0 (zero) effectively disables AutoCorrection.

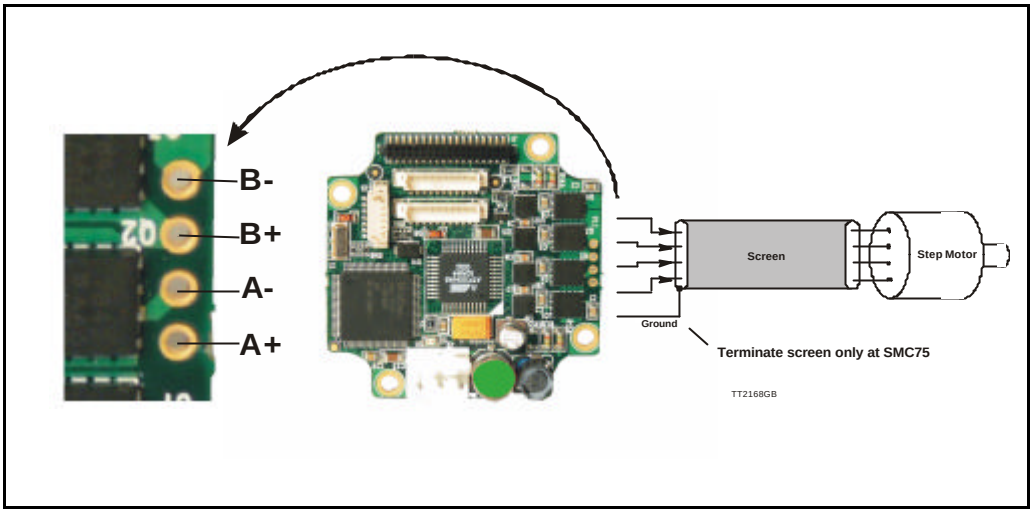
-Register 110, SETTLING_TIME, specifies the number of milli-seconds to wait after a movement before testing the encoder position against IN_POSITION_WINDOW. In the present firmware versions, SETTLING_TIME will be used in AutoCorrection mode only.

-Register 25, STATUSBITS, will still set bit 4 after the pulse generator has output all the pulses to reach the target position (a theoretical In-Position). In AutoCorrection mode, bit 2 will be set to reflect if the internal encoder position is within +/- IN_POSITION_WINDOW steps from the target position P_SOLL (a physical In-Poition). Also bit 1 will be set when AutoCorrection is active. Higher layer software can use this bit to detect when AutoCorrection has either completed or given up.

-Register 124, SetupBits, bit 1 can be set to have the firmware maintain the InPhysical Position bit 1 in register 25 all the time, also during a movement. If this bit is not set, the InPhysicalPosition bit will only be maintained after the motor has stopped moving.

-Register 137, INPOS_Mask, is used to select the outputs to reflect the status of the two bits InPosition (bit 4 in the STATUSBITS register) and InPhysical Position (bit 2 in the STATUSBITS register). The 8 lowest bits will select the mask for InPosition and the 8 highest bits will select the mask for InPhysicalPosition. Any combination of bits can be set to have zero, one or more outputs reflect each of the two InPosition bits. The MacTalk program only supports setting a single output for each bit, however, since this is the normal case.

2.8 SMC75 Connection of motor



2.8.1 Cabling

For SMC75 controllers that supply a phase current in the range 0 to 3 A, it is recommended that 0.5mm² cable (minimum) is used to connect the motor to the controller. (0.75mm² is recommended.)

Motor cable lengths should not exceed 10 metres because of impedance loss. It is possible to use longer cables but motor performance will decrease.
Cables should be securely connected since a poor connection can cause heating and destruction of the connector. Similarly, tinned conductors should be avoided.

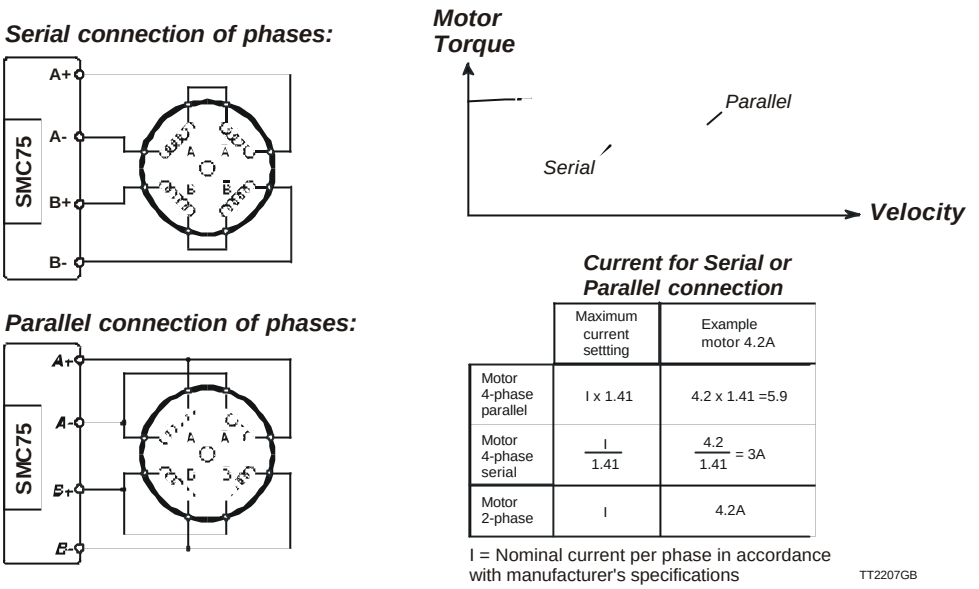
Important!
To minimise spurious noise emission from the motor cables and to fulfil CE requirements, shielded cable must be used.
If shielded cable is not used, other electronic equipment in the vicinity may be adversely affected.

The removable connector must never be removed while a voltage is connected as this will significantly reduce the lifetime of the connector. Note also that the connector's lifetime is reduced by repeated connecting/disconnecting since the contact resistance of the pins is increased.

Note that P- is connected to the chassis and functions as the main ground on the Controller.

See also Motor Connections *Section 12.4*, page 163, which describes how various models of motor should be connected to the Controller.

2.8 SMC75 Connection of motor



Current for Serial or Parallel connection

	Maximum current settting	Example motor 4.2A
Motor 4-phase parallel	I x 1.41	4.2 x 1.41 =5.9
Motor 4-phase serial	$\frac{I}{1.41}$	$\frac{4.2}{1.41}$ = 3A
Motor 2-phase	I	4.2A

I = Nominal current per phase in accordance with manufacturer's specifications

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2.8.2 Connection of Step Motor

Various types of step motor are available:

1. 2-phase Bipolar (4 connectors)
2. 4-phase Bipolar/Unipolar (8 connectors)
3. 4-phase Unipolar (6 connectors).

Note that Type 3 motors indicated above (Unipolar motors) produce 40% less torque. This motor type can be used with success but is not recommended if a 4 or 8 wire motor is available instead. This section will not describe the unipolar type further.

2-phase or 4-phase motors can be connected to the Controllers as follows:

2-phase Motors (4 wires).
This type of motor can be directly connected to the Controller's motor terminals.
The Controller current adjustment must not exceed the manufacturer's specified rated current for the motor.

4-phase Motors (8 wires).
This type of motor can be connected to the Driver in one of the following two ways:

1. Serial connection of phases.
2. Parallel connection of phases.

Selection of serial or parallel connection of the motor phases is typically determined by the speed requirements of the actual system.
If slow speeds are required (typically less than 1 kHz), the motor phases can be connected in serial. For operation at higher speeds (greater than 1 kHz), the motor phases can be connected in parallel.

2.8 SMC75 Connection of motor

2.8.3 Serial Connection

Using serial connection of the phases, a motor provides the same performance (up to 1kHz) as parallel connection, but using only approximately half the current. This can influence the selection of Controller model and enables a Controller rated for a lower motor current to be used. See illustration on previous page.
If the phases of a 4-phase step motor are connected in series, the motor's rated phase current should be divided by 1.41. For example, if the rated current is 4.2A, the maximum setting of the Controller phase current must not exceed 3 A when the motor phases are connected in series.

2.8.4 Parallel Connection

With parallel connection of motor phases, a motor will provide better performance at frequencies greater than 1kHz compared to serially connected phases, but requires approximately twice the current. This can influence the choice of Controller since it is necessary to select a Controller that can supply twice the current used for serial phase connection. See illustration on previous page.
When the phases of a 4-phase motor are connected in parallel, the specified rated current of the motor must be multiplied by a factor of 1.41. For example, if the rated current is 2.0A, the maximum setting of the Controller phase current must not exceed 2.83A when the phases are connected in parallel.

It should be noted that the lower the self-induction of the motor the better, since this influences the torque at high speeds. The torque is proportional to the current supplied to the motor.

The applied voltage is regulated by the Controller so that the phase current is adjusted to the selected value. In practice this means that if a motor with a large self-inductance (e.g. 100mH) is used, the Controller cannot supply the required phase current at high speeds (high rotational frequencies) since the output voltage is limited.

2.9 Handling noise in cables

2.9.1 About noise problems

The MIS family of motors eliminates the traditional problems with noise from long motor cables that emit noise and feedback cables that are sensitive to noise from external sources.

However, it is still necessary to be aware of noise problems with communications cables and the 8 general-purpose inputs and outputs.

Whenever a digital signal changes level quickly, a noise spike is generated, and is transferred to the other wires in the same cable, and to a lesser degree to wires in other cables located close to the cable with the switching signal. A typical example is when a digital output from the MIS motor changes from low to high to drive a relay. If this digital output signal is transmitted in a multi-wire cable together with the RS-485 signals, there is a high risk that the RS-485 signal will be affected to the extent that the communication will fail, and require software retries.

If communication is used during operation, and operation includes either digital input signals or digital output signals, some precautions must be taken to avoid noise problems.

The following sections describe a number of measures which can be taken to solve noise problems. In most installations, no special measures will be required, but if noise problems are experienced – and/or must be avoided – it is highly recommended the instructions below are followed.

2.9.2 Use short cables

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

2.9.3 Use separate cables

Avoid running digital signals in the same multi-wire cables as RS-485 communication signals.

On some models of the MIS motors, the same connector contains both RS-485 signals and I/O signals – typically the I/Os 1-4.

In many applications, far from all inputs and outputs are used. If only up to four I/Os are required, consider using only I/Os 5-8 which are typically available via another connector on the motor.

2.9.4 Use filters

If more than 4 I/Os are needed, consider using I/Os 1-4 for inputs and I/Os 5-8 for outputs. It is normally possible to install a hardware filter on the digital input signals before they enter the cable. With such a (good) filter, noise on the RS-485 signals will not be a problem.

It is also possible to use filters on the outputs, but it is more difficult. It can be done by using short cables from the motor to the filters, and then using longer cables from the filters to the output targets. It may be easier to use a short cable from the motor to a splitter box, and then split the I/Os in one cable and the RS-485 signals in another cable.

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

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

2.9 Handling noise in cables

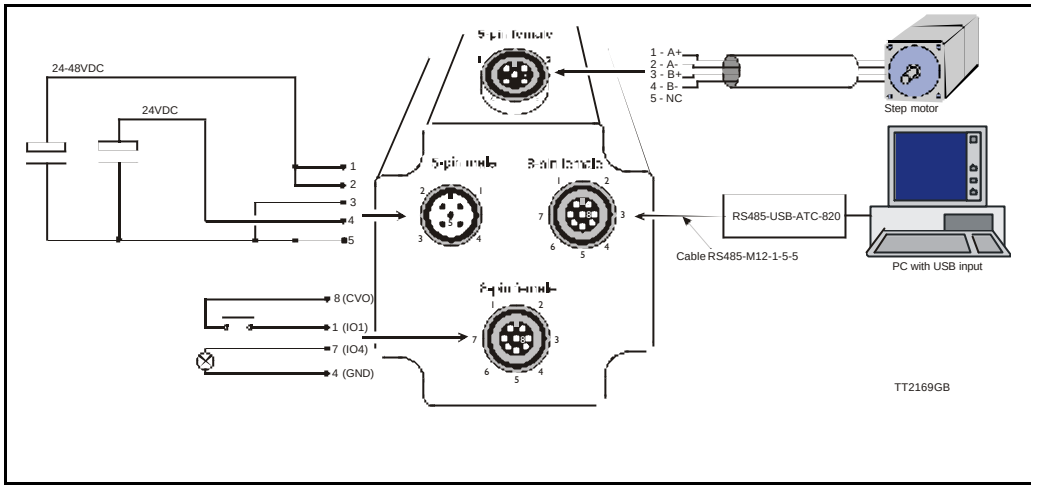
As an alternative, a connector with a short cable can be used with the resistor soldered between the two wires carrying A- and B+.
Use individually shielded cables.

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

2.9.6 Use simple shielding

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

2.10 Quick Start (SMC75A1MxAA)



2.10.1 Getting started with the SMC75A1MxAA and MacTalk

1. Connect the cables and Power supply as shown above. Use RS485-M12-1-5-5 cable if the PC has an RS485 interface, or use the converter RS485-USB-ATC-820 if the PC has a USB interface.

2. Switch on the SMC75.

3. Start MacTalk and wait 5 seconds until it automatically is connected to the motor. If "no connection" occurs, check the serial cables and the Mactalk set-up. The Baud rate should be 19200 and the correct com port selected.

4. When a connection has been established, key in values of "running current" and "standby current" under "Driver Parameters". Remember to press "Enter" after each parameter is keyed in. Actual motor values can be seen to the left of the input field.

5. Set "Startup mode" to select "Position" to enable the motor driver. There should now be current in the motor phases. Depending on the standby current, the motor shaft will be fixed. Some current regulation noise should be heard from the motor.

6. The motor and I/O status can be seen to the left under "Status".

7. At "Motion Parameter", key in 1600 counts at "Position". The motor will now turn one revolution at the speed specified by "Max Velocity".

3.1.1 Serial Interfaces

The Controller has 2 serial interfaces:

- RS485 (A and B) balanced for up to 32 units in multi-axis applications and MODBUS communication. (Standard)
- CANbus -CANopen DS-301/DSP-402,
- DeviceNet under development

CANbus and RS485 can be used at the same time.

4.1.1 RS485 - General description when using a QuickStep motor

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

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

1 Use twisted pair cable.

2 Use shielded cable.

3 Make sure that the GND is also connected.

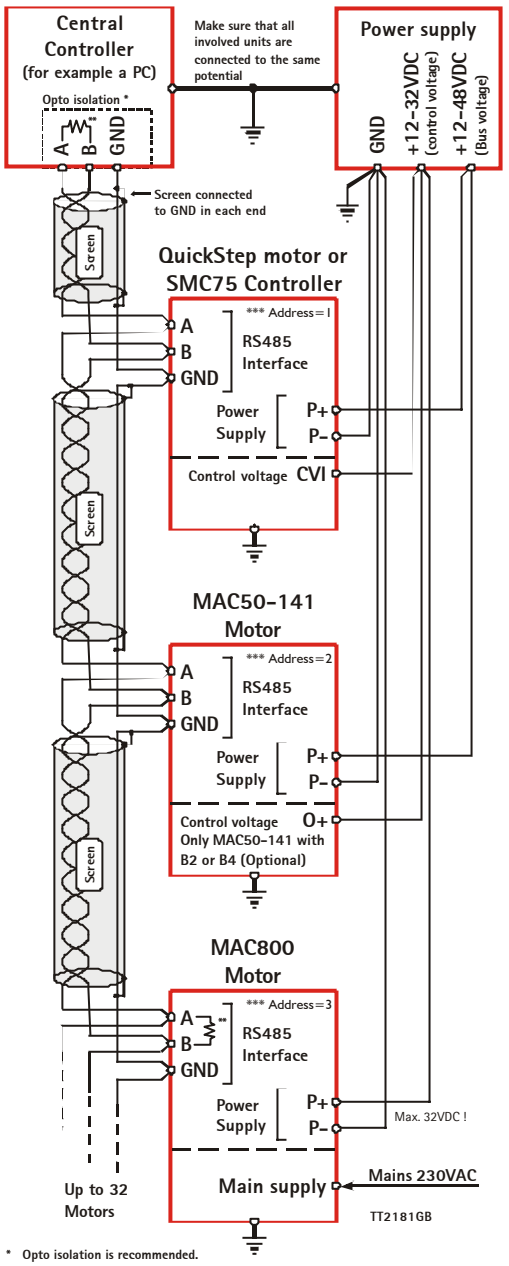
4 Ensure that all units have a proper connection to safety ground (earth) in order to refer to the same potential.

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

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

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

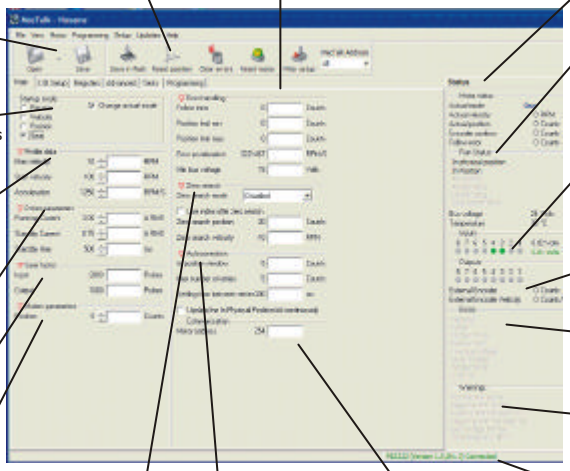
RS485 network with 1 x QuickStep, 1 x MAC140 and 1 x MAC800 mounted with MAC00-B1, B2 or B4 modules.



* Opto isolation is recommended.

** The last unit in each end of the line must be terminated. The MAC00-B1, B2 and B4 contain this feature. See the individual module descriptions. The QuickStep motor does not have a resistor built-in, the resistor has to be mounted externally, for instance in the M12 connector.

*** Each unit connected must be setup with an address via The MacTalk program. If only one unit is connected no address is needed.



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

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

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

Driver Parameters
These fields are used to define standby and running current.

Gear Factor
The gear ratio can be entered here

Motion Parameters
The distance the motor has to run is entered here

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

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

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

Autocorrection
The parameters used to get the correct position, if it is a motor with encoder

Communication
The actual address of the motor can be entered here

TT2145GB

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

Run status
Shows what the status of the motor is. The Bus voltage for the motor and the temperature of the SMC75 is also shown

Inputs
The status of the digital inputs are shown her and the analogue value

Outputs
The status of the outputs are shown here and can be activated by the cursor

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

Warnings
Here different warnings are shown

Help Line
Left area: If parameters entered are outside their normal values, errors are shown here.
Right area: Here it is possible to see if a motor is connected, the type, version and serial no.

5.1 Using the MacTalk software

5.1.1 MacTalk introduction

The MacTalk software is the main interface for setting up the MIS motor for a specific application.

The program offers the following features:

- Selection of operating mode of the MIS motor.
- Changing main parameters such as speed, motor current, zero search type, etc.
- Monitoring in real time the actual motor parameters, such as supply voltage, input status, etc.
- Changing protection limits such as position limits.
- 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.

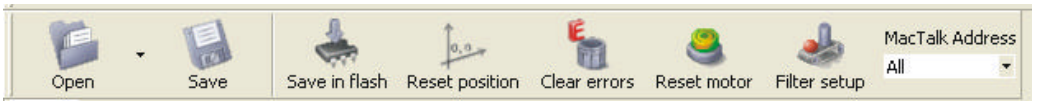
The main window of the program changes according to the selected mode, thus only showing the relevant parameters for operation in the selected mode.

The following pages describe the actual window for each mode and how the parameters affect MIS motor operation.

5.1 Using the MacTalk software

5.1.2 Toolbar description

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



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

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

Save in flash
The complete actual setup in the basic motor will be saved permanently in the flash memory. If the motor is powered down or reset, the saved setup will be used.

Reset position
Resets the position counter to 0. The content of the position counter can be monitored in the right side of the main screen as “Actual position”.

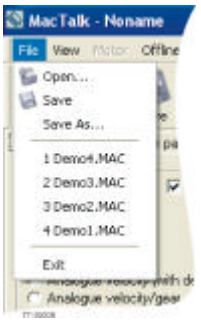
Clear errors
Clears all the errors (if any). Please note that if an error is still present, the motor will remain in the actual error state.

Reset motor
Reset the motor. Same as performing a power off / on operation.

Filter Setup
For specifying the filter setup of the analogue inputs.

MacTalk Address
Only if more than one motor is connected to the same interface. The address specified in this field will determine which motor is communicated with.

5.1.3 Saving or opening a setup file to/from disc



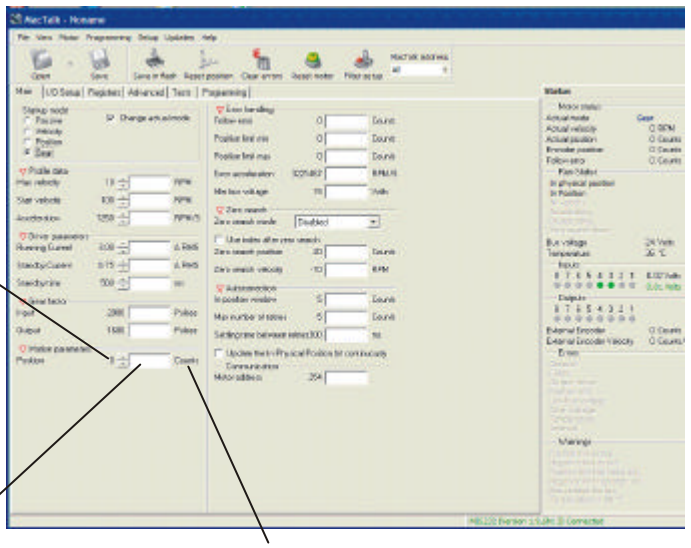
The complete motor setup can be saved to disc or opened from disc and transferred to the motor. The setup files can be saved anywhere on the hard disc or a floppy disc. Saving and opening a file over a network is also possible.
The setup files use the extension *.MAC*. By default, the setup files are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

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

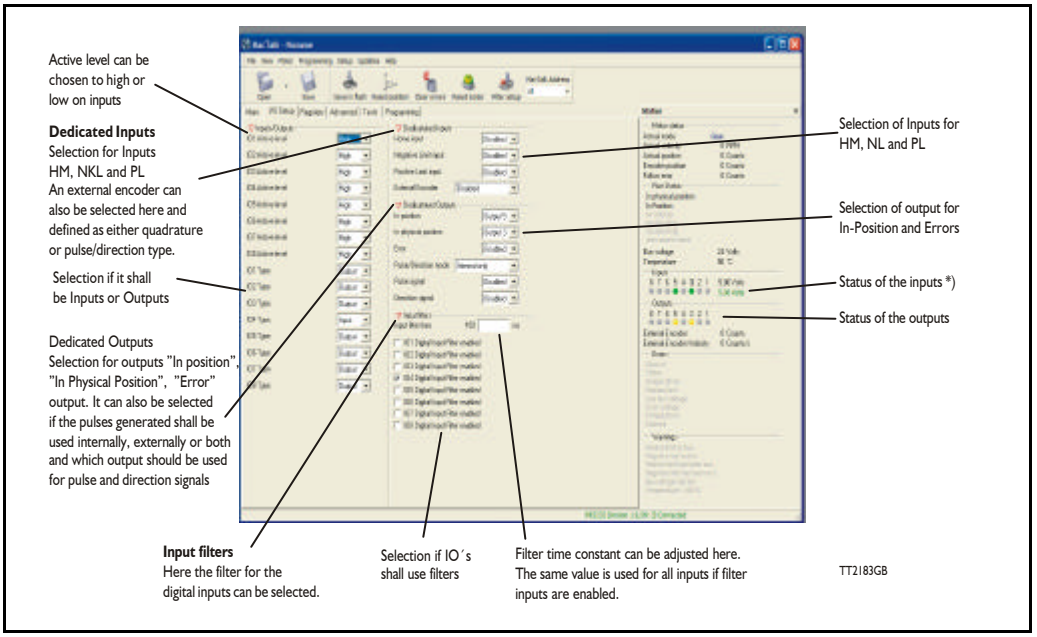
From motor to file
Use *Save* or *Save as* to save the actual motor setup as a setup file. Make sure that the motor is on-line with MacTalk; otherwise only the MacTalk default setup is saved.

5.1 Using the MacTalk software

5.1.4 Main Screen

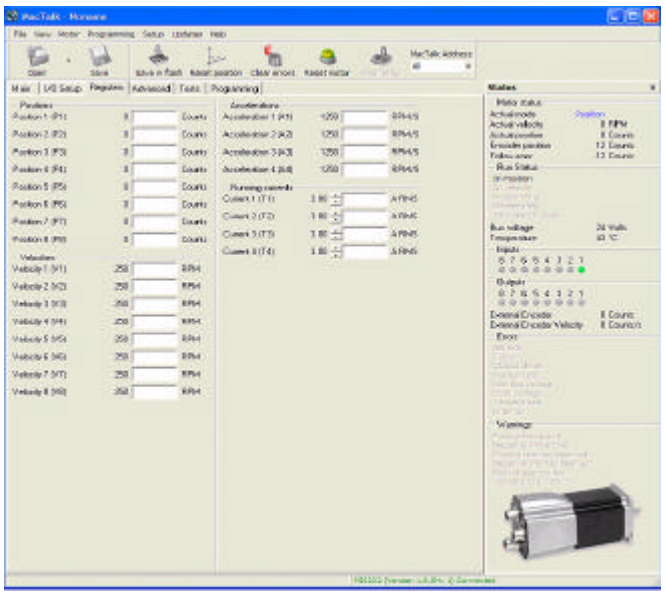


5.1.5 IO Screen



*) The analogue value of certain inputs can be read. Click at the input lamp and the ana-logue value will be shown. The upper value is the actual value and the lower value the filtered value.

5.1.6 Register Screen

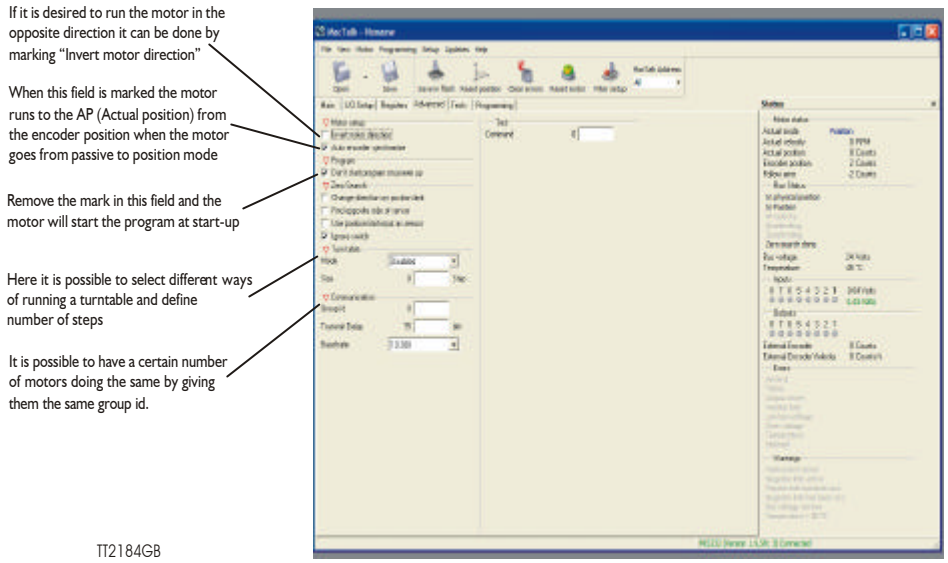


These registers can be used with FastMac commands. For example, the motor can run to position P2 using velocity V2, acceleration/deceleration A2, running current T2, using only a one byte command.

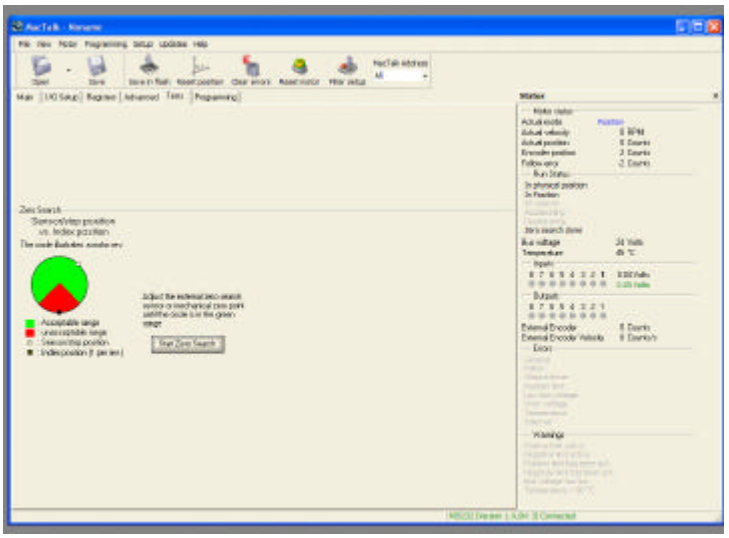
These values are not updated automatically. To update, place the cursor at the specific register value to the left of the box for new values, and click. Otherwise they only update at motor reset or power up.

5.1 Using the MacTalk software

5.1.7 Advanced Screen



5.1.8 Test Screen

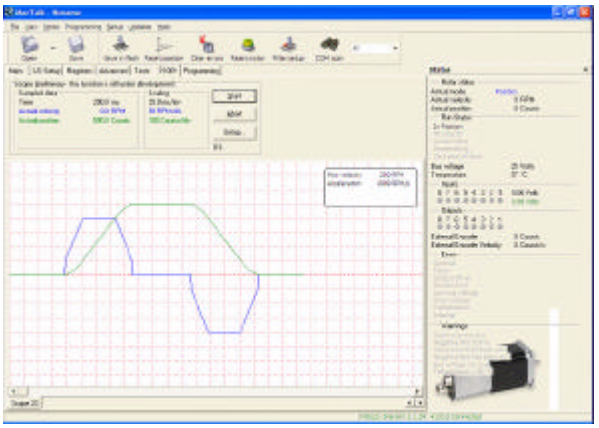


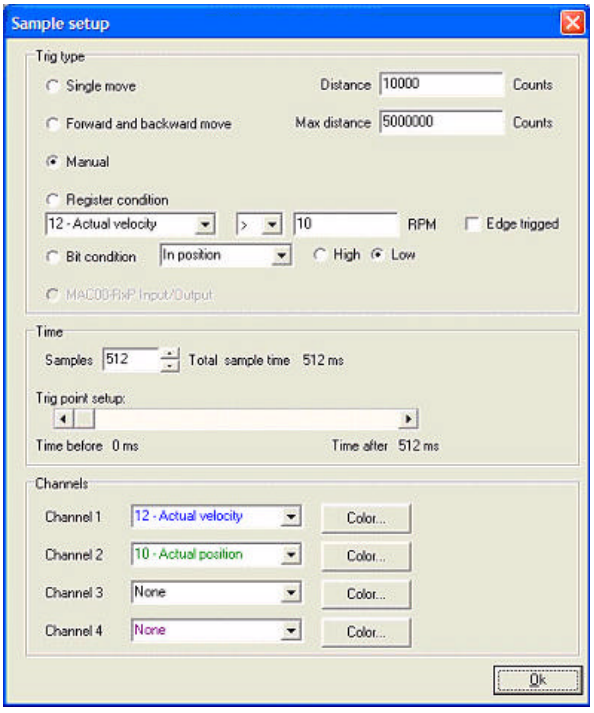
This screen is used for adjusting the Zero search sensor to the correct position when using the index pulse of an encoder. The index pulse should be in the green area. If not, the sensor has to be adjusted.

5.1 Using the MacTalk software

5.1.9 Scope Function

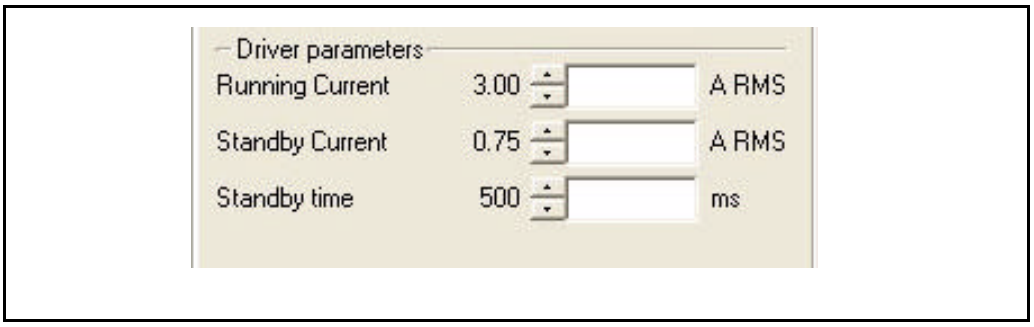
The Scope function is an excellent and necessary function for testing a new application or finding errors in an existing system.
The Setup has to be selected to set up the Scope function correctly before use. Most registers in SMC75 can be selected for viewing, different trigger functions can be selected, saving and loading scope pictures is possible, etc.





6 Adjustment of motor phase current

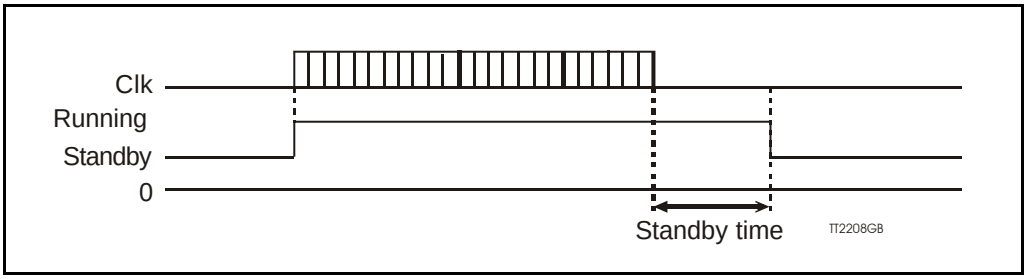
The current supplied to each of the step motor's phases can be adjusted for standby and running currents by changing the values of standby and running currents under "Driver parameters".



The Driver automatically switches between the two currents by detecting the presence of step-pulses. If a rising edge is detected at the step-clock, the "Move current" is selected. If no rising edge is detected during the period specified by "Standby time" at the step-clock input, the current is automatically switched back to "Standby current".

Values for the two currents are typically adjusted so that the Operating Current is significantly higher than the Standby Current, since the motor must be supplied with more power to drive its load during acceleration and constant operation than when it is stationary.

Note that the maximum Standby Current normally will be set to 50% or lower of the maximum current for the actual driver type. The only overriding consideration that must be made in the adjustment of motor phase currents is that the thermal output of the motor must not exceed the maximum operating temperature of the step motor.



	MIS231	MIS232	MIS234	Unit
Standby Current	0-3000	0-3000	0-3000	mA
Running Current	0-3000	0-3000	0-3000	mA
Torque	0-1.1	0-1.6	0-2.9	Nm

If a MIS232 motor is used and the current is set to 3000 mA, the motor will be able to deliver a torque of 1.6 Nm at low speed. If the current is set to 1000 mA, the motor will be able to deliver 0.53Nm.
See Run_Current, page 73 for information about Running Current and Standby_Current, page 74 for information about Standby Current.

7 Modes

The QuickStep motor offers the following modes of operation:

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

Velocity : The motor velocity can be controlled using MacTalk software or by setting register 5 (V_SOLL) using serial or program commands.

Position : The motor position can be controlled using MacTalk software or by setting register 3 (P_SOLL) using serial or program commands.

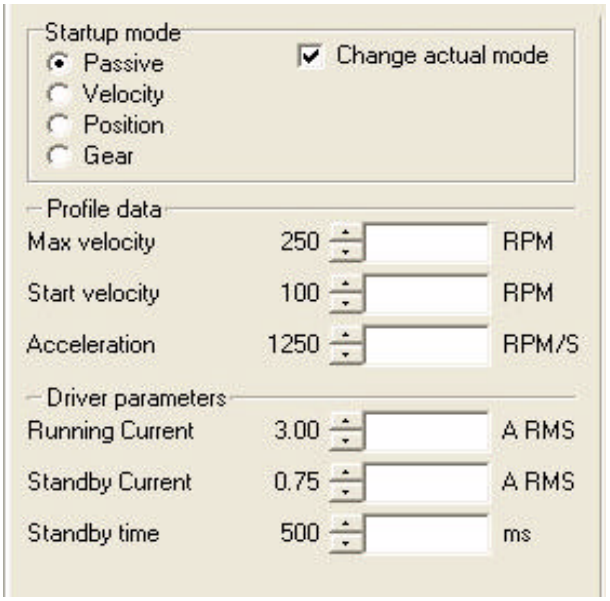
Gear : The motor position and velocity can be controlled by pulse and direction or encoder signals at IN1 and IN2.
The gear ratio can be set to a large ratio using register 14 (GEAR1) and register 15 (GEAR2).

Zero search type 1 and type2:
Searches for sensor to define a zero position (Reference point).

7.1 Passive Mode

7.1.1 Passive Mode

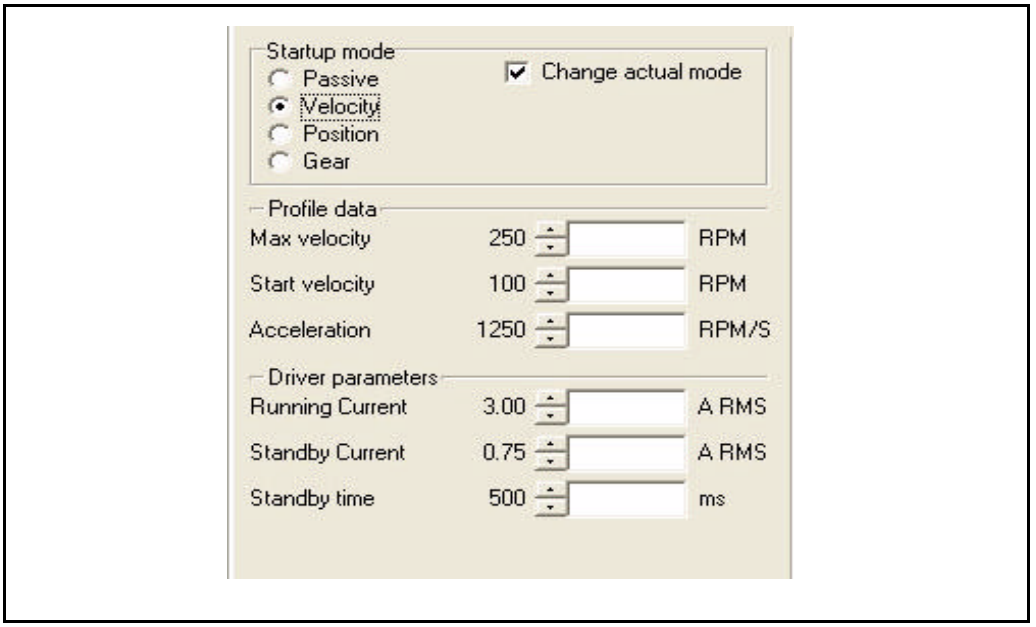
After power up, the controller will start up in passive mode. This means that it is possible to communicate and read/write to/from registers, but no current is supplied to the motor. It should thus be possible to turn the motor shaft as no voltage is connected to the motor. If there is encoder feed-back, the encoder counter will always register the correct position.



7.2 Velocity Mode

7.2.1 Velocity Mode

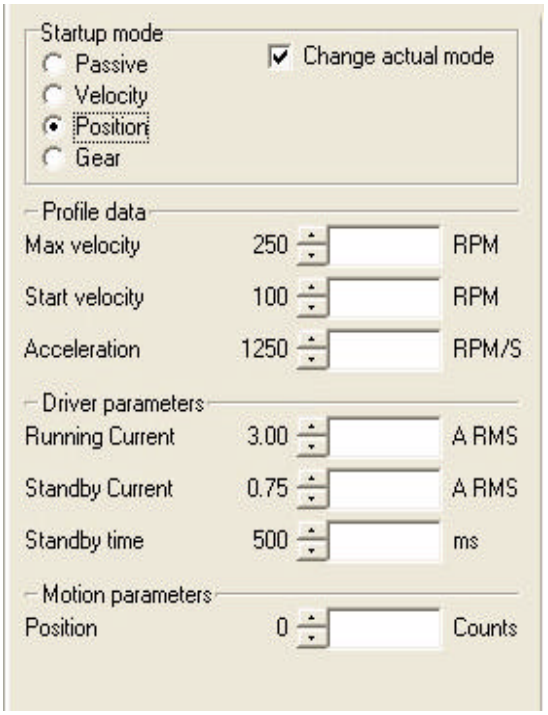
In this mode, the QuickStep motor controls the motor velocity via the Max Velocity setting. This mode is typically used for simple tasks or for applications in which an overall unit, such as a PC-board or PLC, controls velocity and positioning.



7.3 Positioning Mode

7.3.1 Positioning Mode

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

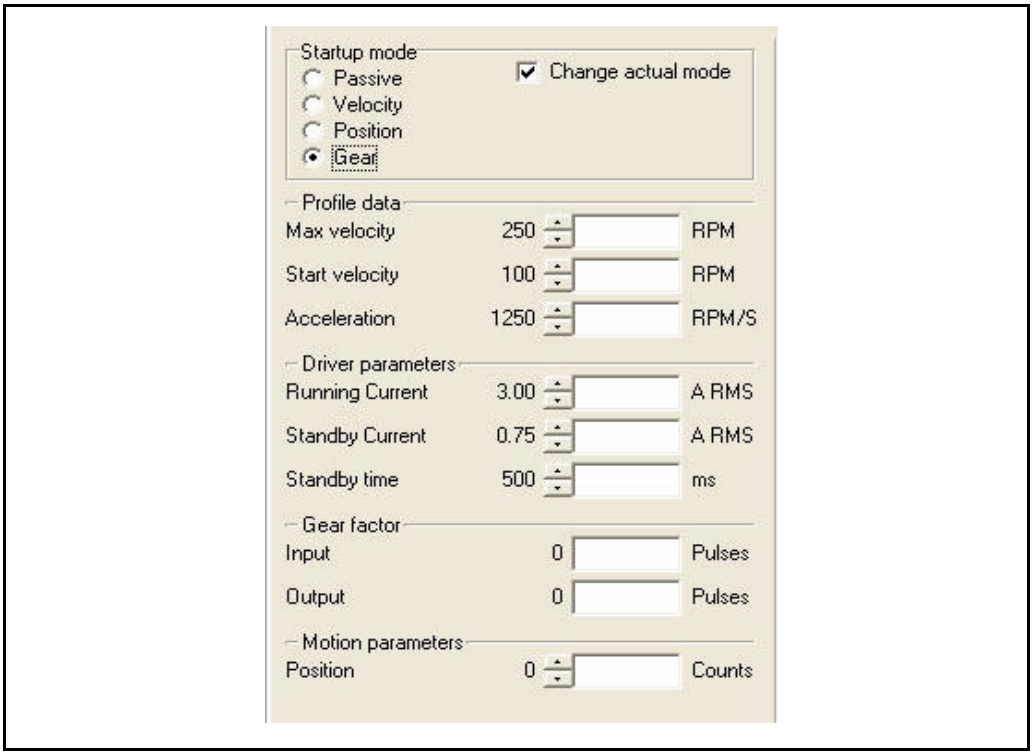


7.4 Gear Mode

7.4.1 Gear Mode

In this mode, the QuickStep motor functions as in a step motor driver. The motor moves one step each time a voltage pulse is applied to the step-pulse input. Velocity, acceleration and deceleration are determined by the external frequency, but can be limited and controlled by the QuickStep motor. In addition, the QuickStep motor also provides a facility for electronic gearing at a keyed-in ratio.

Start velocity is not used in this mode.
The digital input filter is not used in this mode at input 1 and 2.

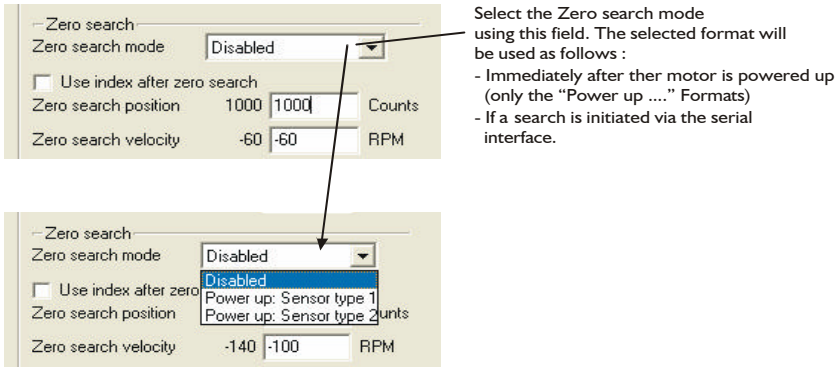


Example:
The motor has a resolution of1600 pulses/rev. and the encoder 500 pulses/rev.
If one revolution of the encoder should result in one motor revolution, the Input must be set to 500 and the Output to1600.
If the motor must run 5 revolutions because there is a gear with a reduction of 5:1, the output must be set to 5x1600 = 8000 instead.

7.5 Zero search modes

7.5.1 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 MIS motor offers 2 different Zero search modes which can be selected from the MacTalk main window or by sending a command via one of the serial interfaces.



The menu offers 3 options:

Disabled (default)	The Zero search is disabled.
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.

The following sections explain in detail the functionality of the 2 fundamental Zero search modes.

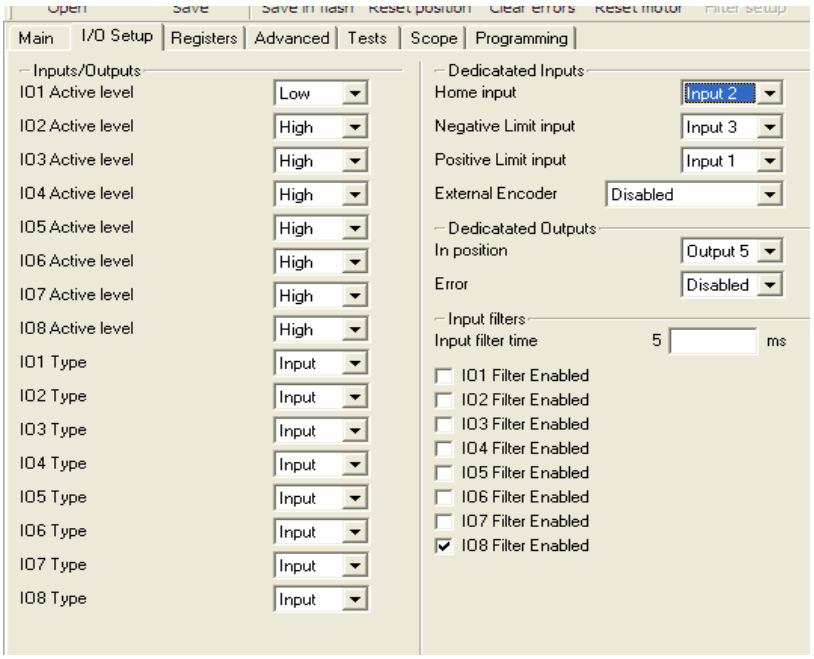
7.5.2 Starting a Zero search

If the Zero search mode is set to *Disabled,* no Zero search is done at any time unless written in a program.
If one of the 2 modes *Power up: Sensor type 1* or *Sensor type 2* is selected, the respective Zero search mode will be executed every time the MIS motor is powered up if no program is started up. If a program has been made and is running, the Zero search command must be executed within the program to execute a Zero search.

The MIS motor´s zero search facility is very flexible. The inputs for reference and limit switches must be set up correctly before use.
The active levels must also be set up correctly.

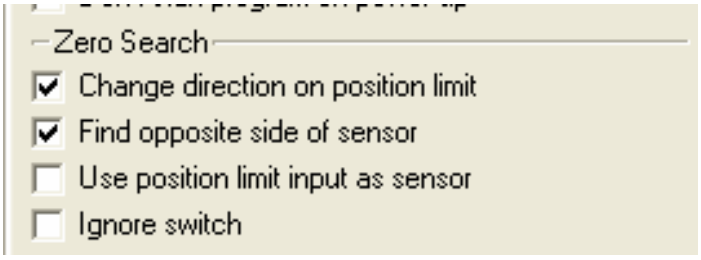
7.5 Zero search modes

7.5.3 I/O Set Up



Important information: Each of the 8 pins can be defined as inputs or outputs. The active digital input level for each input is also defined in the above screen. Furthermore, it is possible to set up a filter for each input to avoid noise interfering with the program. The inputs for Home, Negative Limit and Positive Limit and outputs for In Position and Error are also selected here.
If an external encoder is used, it must be enabled here

7.5.4 Advanced

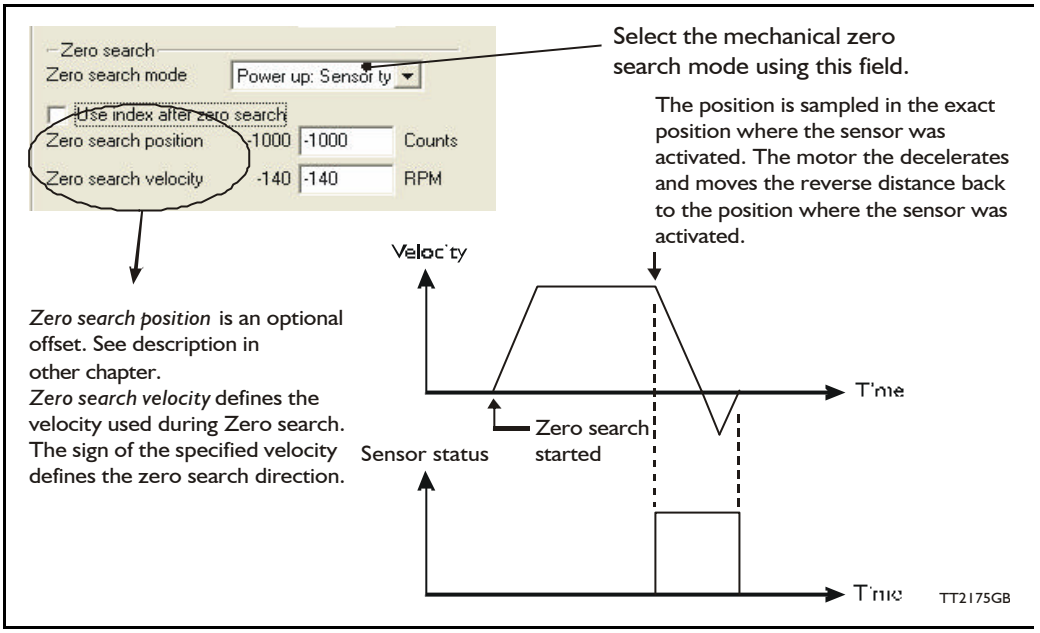


There are several ways to perform a Zero search:

- Start from both sides of the reference sensor in a system with limit switches without having position limit problems.
- to go to the opposite side of the sensor and use this position as zero position.
- use a position limit as reference position. In this case the zero search position must be be different from 0 or the motor enters passive mode.
- ignore the reference switch input and use the actual position or index pulse as zero position before using the zero search position.

7.5.5 "Sensor type 1" Zero search

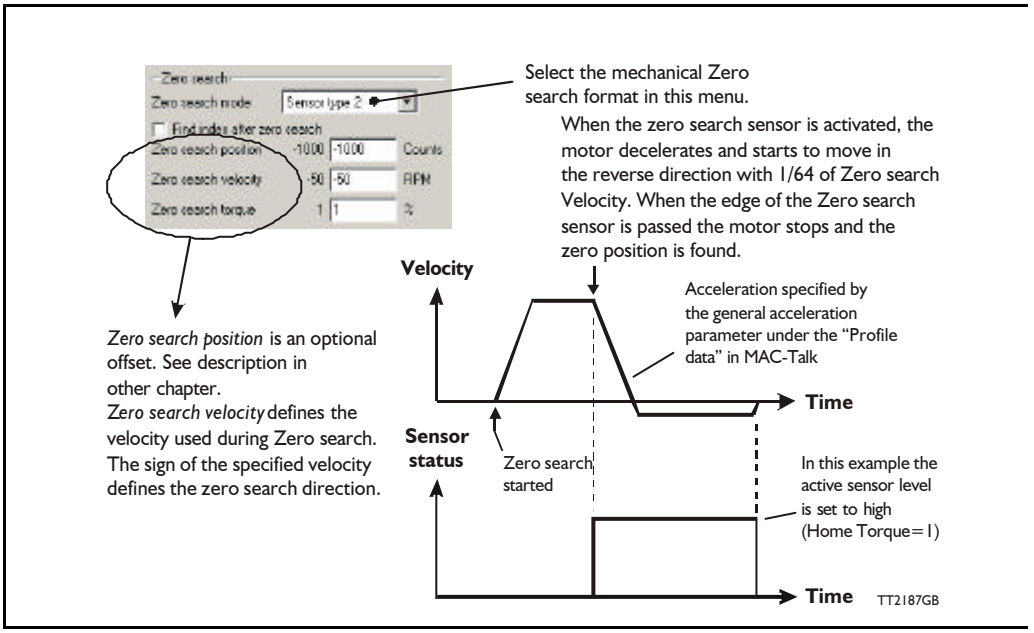
Sensor type 1 zero search is carried out according to the following illustration.



The Zero sensor must be connected to a user input
For connection information, see SMC75 User Inputs, page 21

7.5.6 "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 a user input. For connection information, see SMC75 User Inputs, page 21.

7.5 Zero search modes

7.5.7 Making a Zero point offset

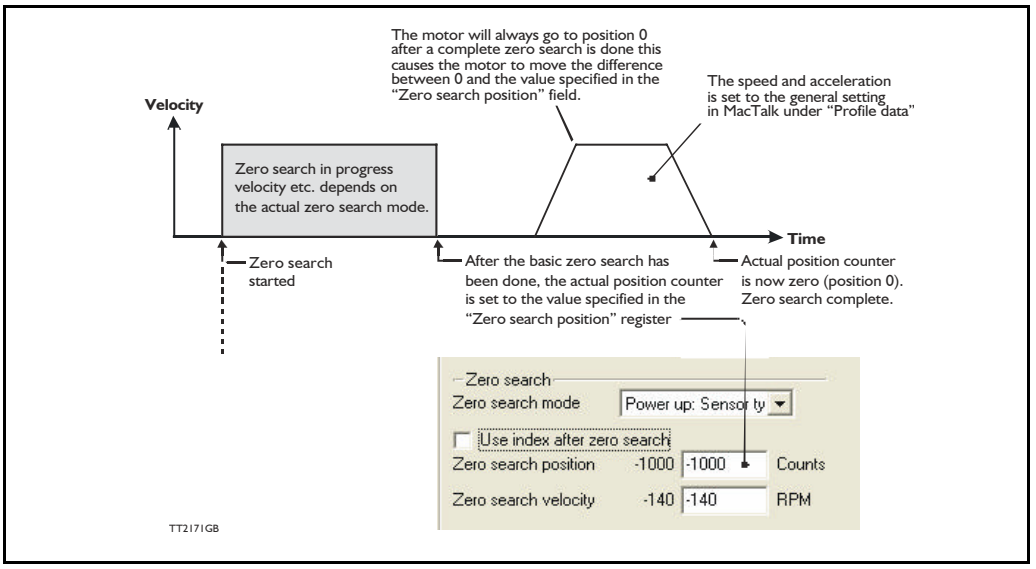
Common for all the zero search modes, it is possible to optionally define the zero-point as a value other than zero (position 0).
When is it useful to use the zero point offset?

- If it is required 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 complete zero search will be performed in the following order.

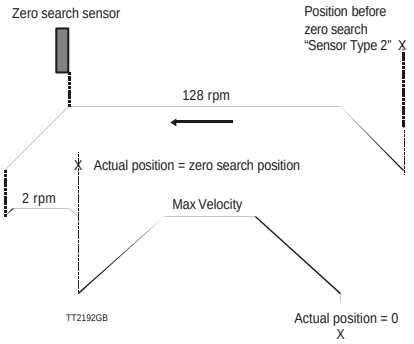
1. The zero search is started either automatically (power up) or initiated by a command from the serial interface.
2. The basic zero search is completed and the position counter is set to the value specified in the “Zero search position” field.
3. If the zero search position value is different from position, the motor will now move to position 0.
4. The zero search is now complete and the motor will switch to normal operation, i.e. the mode selected in the “Startup mode” field in the main window.

The illustration below shows the complete zero-search cycle.

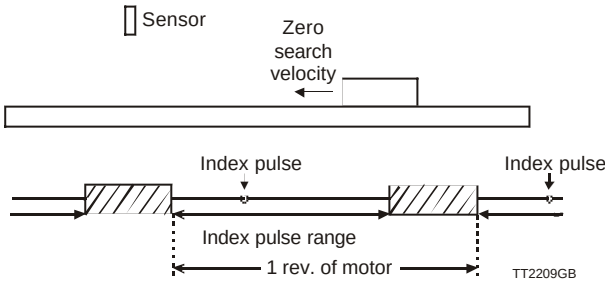


Ensure several tests are made to ensure the white dot is located in the acceptable interval each time.

Example: Zero search velocity = -128 rpm
Zero search position = - 10000 counts

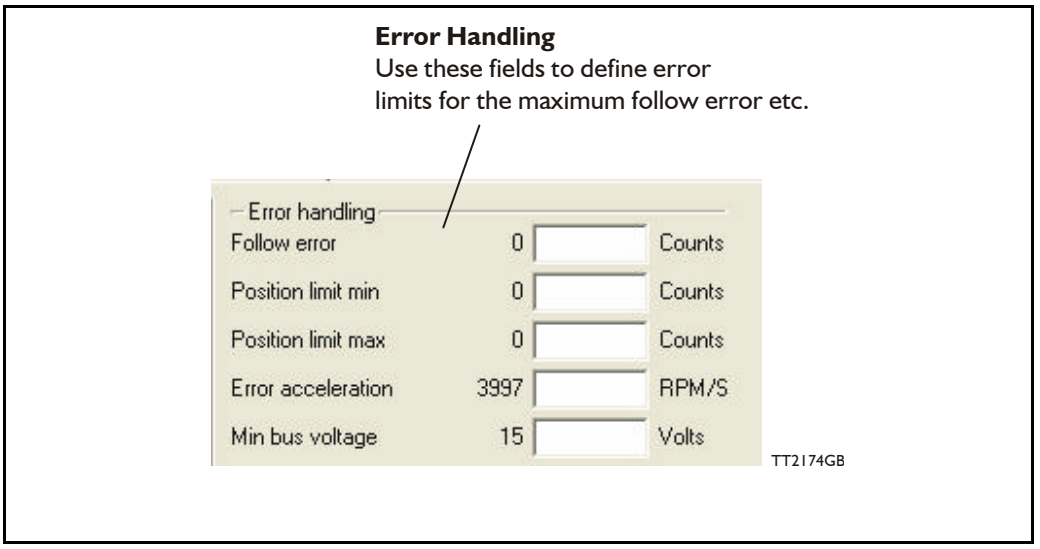


7.5.8 Zero search with index pulse



If the MIS motor is equipped with an encoder, it is also possible to use the index pulse of the encoder. This gives a much more precise zero position than just running for a sensor. The accuracy of the sensor signal depends on how far the sensor is located away from the measuring item and on the velocity.
The index pulse can be used with or without the sensor. This must be defined on the advanced tab. If the MIS motor is set to use the index pulse, the MIS motor always runs to the sensor first and then index pulse.

The sensor must be placed at the right position. This can be done using MacTalk. Select the type of sensor movement to be used in the main tab screen. In the advanced tab, choose not to start the program automatically after reset. Then select Save in Flash. Go to the Test tab and press "Start Zero Search". The motor now rotates at the zero search velocity towards the sensor, and when this has been found the motor continues to the index pulse. The circle at the Test tab indicates the location of the index pulse according to the sensor. The index pulse must be in the green area. If the index pulse is in the red area, the sensor must be moved slightly and the procedure repeated.



The MIS motor contains 5 fundamental parameters which are used for protection related purposes. They all have effect regardless of which mode of operation the motor is set to use.

Follow error
(Only for MIS with internal encoder)
Follow error is the difference between the target position and the encoder position. The target position is the position generated. Default is 0. (Function disabled).

Position limit min. and max.
Same as physical limit switches but implemented in software. Default is 0 meaning that the feature is disabled. If one parameter is different from 0, both values are activated.

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

Min. bus voltage
This is the level of P+ at which the motor goes into error state “low bus voltage”.

9 Registers

9.1 Introduction and register overview

All of the motor registers can be accessed either through the RS485 interface or over CANopen.
When accessing registers over CANopen, they are mapped to object indexes 2012 and 2014 (hex) with the sub-index equal to the register number 1...255. Use index 2012 for the 32-bit registers and index 2014 for the 16-bit registers.
For example to access register 3, P_SOLL, use index 2012, subindex 3. To access register 5, V_SOLL, use index 2014, subindex 5. This is described in more detail in CANopen Introduction, page 121.
All of the registers can be accessed over CANopen with the same Read/Write access restrictions as when using the RS485 interface.
Some registers are tagged as R for Read-only. There are different reasons for this, such as protecting the serial number from being changed or indicating that the value in registers, such as Analog Inputs, will never be read by the motor but always overwritten using the latest sampled values.

In the following sections and examples, positions, velocity and acceleration are based on a 200 step motor running with 1/8 steps.

9.1.1 Register Overview.

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
1	PROG_VERSION	16bit	R	-	*	Major*16+ Minor+16384	"Status bar"
2	Mode_Reg	16bit	R/W	0,1,2,3, 13,14,15	0	-	Current Mode
3	P_SOLL	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	steps	Position
5	V_SOLL	16bit	R/W	-1023-1023	250	RPM	Max velocity
6	A_SOLL	16bit	R/W	1-65535	131	9.54 RPM/s^2	Acceleration
7	RUN_CURRENT	16bit		0-511	511	5.87mA	Running Current
8	STANDBY_TIME	16bit	R/W	1-65535	500	ms	Standby Time
9	STANDBY_ CURRENT	16bit	R/W	0-511	128	5.87 mA	Standby Current
10	P_IST	32bit	R/W	(-2^{31})-$(2^{31}-1)$	-	Steps	Actual Position
12	V_IST	16bit	R	0-1023	-	RPM	Actual Velocity
13	V_START	16bit	R/W	1-1023	100	RPM	Start Velocity
14	GEAR1	16bit	R/W	(-2^{15})-$(2^{15}-1)$	1600	Steps	Output
15	GEAR2	16bit	R/W	(-2^{15})-$(2^{15}-1)$	2000	Counts	Input
16	ENCODER_POS	32bit	R/W	(-2^{31})-$(2^{31}-1)$	-	Steps	Encoder position
18	INPUTS	16bit	R	-	-	Special	Inputs
19	OUTPUTS	16bit	R/W	-	0	Special	Outputs
20	FLWERR	32bit	R	(-2^{31})-$(2^{31}-1)$	-	Steps	Follow Error
22	FLWERRMAX	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Follow Error Max
24	COMMAND	16bit	R/W	0-127, 256, 257	0	-	N/A
25	STATUSBITS	16bit	R	-	-	Special	Run Status
26	TEMP	16bit	R		-2.27 uses offset		Temperature
27	Reserved	-	-	-	-	-	
28	MIN_P_IST	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Position Limit Min
30	MAX_P_IST	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Position Limit Max
32	ACC_EMERG	16bit	R/W	1-65535	10000	9.54 RPM/s^2	Error Acceleration

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
33	IN_POSITION _WINDOW	16bit-	R/W	0-65535	5	Steps	
34	IN_POSITION _COUNT	16bit-	R/W	0-65535	0	Counts	
35	ERR_BITS	16bit	R/W		0	Special	Errors
36	WARN_BITS	16bit	R/W		0	Special	Warnings
37	STARTMODE	16bit	R/W	-	0	-	Startup Mode
38	P_HOME	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Zero Search Position
40	V_HOME	16bit	R/W	-1023-1023	-50	RPM	Zero Search Velocity
41	Reserved	-	-	-	-	-	
42	HOMEMODE	16bit	R/W	0,13,14	0	-	Zero Search Mode
43-48	Reserved	-	-	-	-	-	
49-64	Pn	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Position n (Pn)
65-72	Vn	16bit	R/W	0-1023	250	RPM	Velocity n (Vn)
73-76	An	16bit	R/W	1-65535	131	9.54 RPM/s^2	Acceleration n (An)
77-80	Tn	16bit	R/W	0-511	511	5.87 mA	Current n (Tn)
81-88	AnalogFiltered	16bit	R	0-1023	0	4.888mV	N/A
89-96	AnalogInput	16bit	R	0-1023	-	4.888 mV	N/A
97	BUSVOL	16bit	R	0-1023	-	109 mV	Bus Voltage
98	MIN_BUSVOL	16bit	R/W	0-1023	15	109 mV	Min Bus Voltage
99	ENCODER_TYPE	16bit	R	0-10	-	-	“Tooltip on motor”
100	AFZUP_WriteBits	16bit	R/W	-	0	Special	N/A handled on the Filter Setup screen
101	AFZUP_Read Index	16bit	R/W	0, 1-8, 32768-32775	0	Special	N/A handled on the Filter Setup screen
102	AFZUP Conf Min	16bit	R/W	0-1022	0	4.888 mV	Confidence Min
103	AFZUP_Conf Max	16bit	R/W	1-1023	1023	4.888 mV	Confidence Max
104	AFZUP_ Max Slope	16bit	R/W	2-1023	1023	4.888 mV	Max Slope
105	AFZUP_Filter	16bit	R/W	1-64	64	64th of new sample	Filter (on the Filter setup screen)
106	FilterStatus	16bit	R	0-65535	0		N/A (shown grafically)
107	Reserved	-	-	-	-	-	
108	PulseDirMask	16bit	R/W	0-65535	0	Bitmask	Pulse signal Direction signal
109	PulseDirMode	16bit	R/W	0-2	0	-	Pulse/Direction mode
110	SettlingTime	16bit	R/W	0-32676	0	ms	Settling time between retries
111	Reserved	-	-	-	-	-	
112-115	SAMPLE1-4	16bit	R/W	-	0	-	N/A
116	REC_CNT	16bit	R/W	-	0	-	N/A
117	S_TIME	16bit	R/W	-	1	ms	N/A
118	S_CONTROL	16bit	R/W	-	0	-	NA
119	BUF_SIZE	16bit	R	-	-	-	N/A
120	INDEX_OFFSET	16bit	R	0-1599	-	Steps	Tests-
122	HOME_BITS	16bit	R/W	-	0	Special	Advanced-Zero Search
123	Reserved	16bit	R/W	-	-	-	N/A

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
124	SETUP_BITS	16bit	R/W	-	0	Special	Don´t start program after power up. Invert motor direction. External Encoder Enable DSP 402 Support Auto encoder synchronize
125	IOSETUP	16bit	R/W	-	0	Special	Inputs/Outputs
126	TURNTABLE_ MODE	16bit	R/W	-	0	Special	Turn Table -Mode
127	TURNTABLE_ SIZE	32bit	R/W	-	0	Steps	Turn Table - Size
129	NL_MASK	16bit	R/W	-	0	IO Mask	Dedicated Inputs Negative Limit Input
130	PL_MASK	16bit	R/W	-	0	IO Mask	Dedicated Inputs - Positive Limit Input
131	Reserved	16bit	R/W	-	0		
132	HOME_MASK	16bit	R/W	-	0	IO Mask	Dedicated inputs. Home Input
133 -134	Reserved	-	-	-	-	-	
135	INPUT_FILTER_ MASK	16bit	R/W	-	0	IO Mask	IOx digital input filter enabled
136	INPUT_FILTER_ CNT	16bit	R/W	-	5	ms	Input filter time
137	INPOS_MASK	16bit	R/W	-	0	IO MASK	Dedicated Outputs - In Position
138	ERROR_MASK	16bit	R/W	-	0	IO Mask	Dedicated Outputs - Error
139-143	Reserved	-	-	-	-	-	
144	P_NEW	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Counts	N/A
146	BAUD_RATE	16bit	R/W	0-5	1	-	Baud Rate
147	TX_DELAY	16bit	R/W	0-255	15	Bits	Transmit Delay
148	GROUP_ID	16bit	R/W	0-255		-	Group ID
149	GROUP_SEQ	16bit	R	0-255	-	-	N/A
150	MY_ADDR	16bit	R/W	0-254		-	Motor Address
151	MOTORTYPE	16bit	R	64-xx		-	“Status Bar”
152	SERIAL- NUMBER	32bit	R	-	-	-	“Status Bar”
154	CHECKSUM	32bit	R	0-65535	-		
156	HARDWARE_ REV	16bit	R	0-65535	-	Major*16+ Minor+16384	“Tooltip on Motor”
157	MAX_VOLTAGE	16bit	R	0-100	*	Volt	“Tooltip on Motor”
158	AVAILABLE_IO	16bit	R	-	-	IO MASK	N/A
159	BOOTLOADER_ VER	16bit	R	0-65535	-	Major*16+ Minor+16384	“Tooltip on Motor”
160	NOTSAVED	16bit	R/W	0-65535	0	-	N/A
161-164	Reserved						
165	OPTION_BITS	16bit	R	0-65535	-	-	“Tooltip on motor”
166	FBUS_NODE ID	16bit	R/W	0-255	5	-	Fieldbus - Node ID
167	FBUS_BAUD	16bit	R/W	0-8	2	-	Fieldbus - Baud Rate
168	Reserved	16bit	-	-	-	-	

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
169	Reserved	16bit	-	-	-	-	
170	EXT_ENCODER	32bit	R/W	(-2^{31})-$(2^{31}-1)$	-	Counts	External Encoder
172	EXT_ENCODER_ VEL	16bit	R	(-2^{15})-$(2^{15}-1)$	-	Counts 16ms	External Encoder Velocity

The following parameters are only available when the CanOpen option is installed and only used for DSP-402							
Reg	**Name**	**Size**	**Access**	**Range**	**Default**	**Unit**	**Description**
180	ControlWord	16bit	R/W	0-65535	0	-	Object 6040 subindex 0
181	StatusWord	16bit	R	0-65535	0	-	Object 6041 subindex 0
182	ModeOfOperation	16bit	R/W	0-255	0	-	Object 6060 subindex 0
183	ModeOfOperationDisplay	16bit	R	0-255	0	-	Object 6061 subindex 0
184	TargetPosition	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	-	Object 607A subindex 0
186	ActualPosition	32bit	R	(-2^{31})-$(2^{31}-1)$	0	-	Object 6064 subindex 0
188	TargetVelocity	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	-	Object 60FF subindex 0
190	ActualVelocity	32bit	R	(-2^{31})-$(2^{31}-1)$	0	-	Object 606C subindex 0
192	DigitalOutputs	16bit	R/W	0-65535	0	-	Object 60FE subindex 1 (Low 16bit)
194	DigitalInput	16bit	R	0-65535	0	-	Object 60FD subindex 1 (Low 16bit)

9.2 Register Descriptions

9.2.1 Prog_Vers

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
1	PROG_VERSION	16bit	R	-	*	Major*16+ Minor+16384	"Status bar"

Description: The firmware version. The Bit 14 is set to indicate that the type is SMC75. Bit 0-3 is the minor version and bit 4-7 is the major version.

Example: The firmware version 1.7 will have the value 0x4017 (16407)

9.2.2 Mode_Reg

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
2	Mode_Reg	16bit	R/W	0,1,2,3,11, 13,14,15	0	-	Current Mode

Description: Controls the operating mode of the motor. The following modes can be selected:

0: Passive
1: Velocity mode
2: Position mode
3: Gear mode
13: Zero search type 1
14: Zero search type 2
15: Safe mode

Passive mode (0)
In this mode, the motor current is turned off and the motor will not react to any position/ velocity commands.

Velocity mode (1)
When the motor is in velocity mode, the controller accelerates the motor to the velocity in V_SOLL. V_SOLL can be changed at any time and the move will decelerate/accelerate accordingly.
It is permissible to change A_SOLL and V_START during a movement, but the changes will first take effect after the motor has stopped. Please note that if the motor needs to change direction, it will decelerate and stop, and the new A_SOLL and V_START will be activated.

Position mode (2)
When the motor is in position mode, the controller will always try to move until P_IST = P_SOLL.
The movement will follow the profile specified by V_SOLL, A_SOLL and V_START.
P_SOLL can be changed at any time and the motor will move accordingly.
V_SOLL can also be changed during a movement.
It is permissible to change A_SOLL and V_START during a movement, but the changes will first take effect after the motor has stopped. Please note that if the motor needs to change direction, it will decelerate and stop, and the new A_SOLL and V_START will be active.

Gear mode (3)
The GEAR mode works as position mode, but has an additional feature. The input on the external encoder is multiplied with GEAR1/GEAR2 and added to P_SOLL. Any remainder of the result is saved and used next time the external encoder changes.
The result is that this mode can be used as an electronic gear.
When using gear mode, it is not recommend to set V_START below 10 rpm. This can gives problems at low speeds, because the motor will lag behind when doing the first step. It will then accelerate in order to catch up.

NOTE: Time from the first input pulse to the first step is typically 30-60μs if not on standby. 72-102μs if on standby.

Zero search type 1 (13)
When the operation mode is set to 13, the controller will start the search for the zero point. See "Sensor type 1" Zero search, page 60 for details.

Zero search type 2 (14)
When the operation mode is set to 15, the controller will start the search for the zero point. See "Sensor type 2" Zero search, page 60 for details.

Safe mode (15)
This mode is similar to passive mode, but also allows the "save in flash" and "reset" commands. Safe mode cannot be entered/exited directly; this must be done using the serial commands ENTER/EXIT SAFEMODE.

Example:
Writing MODE_REG=2 will set the motor in position mode. When P_SOLL is changed, the motor will move to this position with the specified max velocity (V_SOLL) and acceleration (A_SOLL).
Writing MODE_REG=13 will start a zero search for a sensor. When the search is completed, the MODE_REG will automatically be changed to the mode specified in START_MODE.

9.2.3 P_Soll

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
3	P_SOLL	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Position

Description: The desired position. When in position mode, the motor will move to this position. This value can be changed at any time. The maximum possible position difference is 231-1. If relative movement is used, the P_SOLL will just wrap at 231-1 and the motor will move correctly. Please note that the turntable function changes the behaviour of P_SOLL. See Turntable_Mode, page 85.

Example: If P_SOLL = -800 and then P_SOLL is set to 800, the motor moves one revolution forward.
If P_IST = 231-100 (2147483548) and P_SOLL is set to -231+100 (2147483548), the motor will move 200 steps in the positive direction.

9.2.4 V_Soll

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
5	V_SOLL	16bit	R/W	-1023-1023	250	RPM	Max velocity

Description: The maximum velocity allowed. When in velocity mode, the motor will run constantly at this velocity. Specify a negative velocity to invert the direction. This value can be changed at any time.

Example: V_SOLL = 250, will limit the velocity to 250 RPM.

9.2.5 A_SOLL

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
6	A_SOLL	16bit	R/W	1-65535	131	9.54 RPM/s^2	Acceleration

Description: The acceleration/deceleration ramp to use. If this value is changed during at movement, it will first be active when the motor stops or changes direction.

Example: A_SOLL = 105, will set the acceleration to 1000 RPM/s.

9.2.6 Run_Current

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
7	RUN_CURRENT	16bit	R/W	0-511	511	5.87mA	Running Current

Description: This register sets the running current for the motor. 511 is the maximum possible current, corresponding to 3A RMS. The running current is active when the motor is running and after it stops until the specified standby time has elapsed.
See Standby_Time, page 73.
When the RUN_CURRENT is changed, the new motor current will be set instantly.

Example: RUN_CURRENT = 100, will set the running current to 0.59A RMS.

9.2.7 Standby_Time

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
8	STANDBY_TIME	16bit	R/W	1-65535	500	ms	Standby Time

Description: This register sets the standby time. This time is the time from the last step has been performed until the current changes from running to standby. When a new request for a move is received the current changes from standby to running with no delay.

Example: STANDBY_TIME = 200, will result in the controller switching to the standby current after 200ms.

9.2.8 Standby_Current

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
9	STANDBY_ CURRENT	16bit	R/W	0-511	128	5.87 mA	Standby Current

Description: This register set the standby current for the motor. 511 is the maximum possible value, corresponding to 3A RMS. The standby current is active when the motor has stopped and the specified Standby time has elapsed. See Standby_Time, page 73. When the STANDBY_CURRENT is changed, the new motor current will be set instantly.

Example: STANDBY_CURRENT = 50, will set the running current to 0.29A RMS.

9.2.9 P_Ist

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
10	P_IST	32bit	R/W	(-2^{31})-$(2^{31}-1)$	-	Steps	Actual Position

Description: This register shows the actual position of the motor. This is updated each time the motor makes a step. If P_IST is changed when in position mode or gear mode, the motor will move until P_IST = P_SOLL. When P_IST reaches $2^{31}-1$, it will wrap around to -2^{31}. Please note that the turntable function changes the behaviour of P_IST.
See Turntable_Mode, page 85.

Example: P_IST = 1000, P_SOLL = 1000. P_IST is set to 500. The motor will move 500 steps forward and P_IST will again be 1000.

9.2.10 V_Ist

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
12	V_IST	16bit	R	0-1023	-	RPM	Actual Velocity

Description: This register shows the actual velocity of the motor. The velocity is positive when running in a positive direction and negative when running in a negative direction.

Example: If V_SOLL = 400 and a movement of -10000 steps is done, V_IST will be -400 during the move and when the move is complete V_IST will be 0.

9.2.11 V_Start

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
13	V_START	16bit	R/W	±1-1023	100	RPM	Start Velocity

Description: The start velocity. The motor will start the acceleration at this velocity. It will also stop the deceleration at this velocity. If |V_SOLL| is lower that V_START the motor will not accelerate at all, but start to run at V_SOLL instantly. The motor will actually start the movement with an internal V_START = V_SOLL.
If V_START is changed during a movement, it will first be active when the motor stops or changes direction. This also means that if V_SOLL is changed to a value below V_START, while the motor is in motion, the motor will decelerate to V_START and run at that velocity.

Example: V_START = 100, V_SOLL = 200, MODE_REG = 1. The motor will accelerate from 100 RPM to 200 RPM.
V_SOLL is now changed to 50. The motor will decelerate to 100 RPM and continue at 100 RPM.
V_SOLL is now changed to -50 RPM. The motor will stop and start at -50 RPM.

9.2.12 GEAR1

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
14	GEAR1	16bit	R/W	(-2^{15})-$(2^{15}-1)$	1600	Steps	Output

Description: When the gear mode is active, the input from the external encoder is multiplied by GEAR1 and divided by GEAR2.

Example: GEAR1 = 1600, GEAR2 = 2000. If 2000 steps are applied to the input, the motor will turn 1 revolution.
If one step is applied, the motor will not move (but the remainder will be 0.8)
If another step is applied, the motor will move 1 step (and the remainder will be 0.6).
If another step is applied, the motor will move 1 step (and the remainder will be 0.4)
And so on.

9.2.13 GEAR2

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
15	GEAR2	16bit	R/W	(-2^{15})-$(2^{15}-1)$	2000	Counts	Input

Description: The denominator of the gear factor. See GEAR1 for details.

9.2.14 Encoder_Pos

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
16	ENCODER_POS	32bit	R/W	(-2^{31})-$(2^{31}-1)$	-	Steps	Encoder position

Description: If the internal encoder option is installed, this register shows the position feedback from the encoder.
This value is initialized to zero at power-up and modified by the firmware when a zero search is performed.
The value can be used internally by the AutoCorrection system to retry a movement in position and gear modes.

9.2.15 Inputs

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
18	INPUTS	16bit	R	-	-	Special	Inputs

Description: This register shows the status of the digital inputs. Bit 0-7 shows whether IO 1-8 is active or inactive. The active level can be set using IOSETUP. See Iosetup, page 85. Bits 8-15 are not used and will always be 0. The inputs can be filtered or unfiltered. See Input_Filter_Mask, page 87.
Note that all of the inputs have a digital state and an analog value at the same time. This register shows their digital state only. Note that the digital inputs can be filtered by setting bits in register 135 (Input_Filter_Mask , page 87).

Bit	7	6	5	4	3	2	1	0
Function	IO8	IO7	IO6	IO5	IO4	IO3	IO2	IO1

9.2.16 Outputs

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
19	OUTPUTS	16bit	R/W	-	0	Special	Outputs

Description: This register shows the status of the outputs. Bit 0-7 shows whether IO 1-8 is active or inactive. The active level can be set using IOSETUP. See Iosetup, page 85. Please note that the output driver for each output also has to be enabled. This is also done using IOSETUP. The register can be changed in order to change the status of the outputs.

9.2.17 Flwerr

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
20	FLWERR	32bit	R	(-2^{31})-$(2^{31}-1)$	-	Steps	Follow Error

Description: When the encoder option is installed, this register shows the encoder deviation from the calculated position (P_IST).

9.2.18 Flwerrmax

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
22	FLWERRMAX	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Follow Error Max

Description: The maximum allowed value in FLWERR before an error is triggered. If FLWERRMAX = 0, the error is disabled. See register 35 (Err_Bits, page 78) for a description of the error bit.

9.2.19 Command

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
24	COMMAND	16bit	R/W	0-127, 256, 257	0	-	N/A

Description: Used to issue commands to the motor. 0-128 are the normal FastMac commands. The values 128-255 are reserved.
Command 256 will activate a new baud rate on the serial ports, and command 257 will synchronize the internal encoder position to the actual motor position.

9.2.20 Statusbits

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
25	STATUSBITS	16bit	R	-	-	Special	Run Status

Description: Status bits:
Bit 0: Reserved
Bit 1: AutoCorrection Active
Bit 2: In Physical Position
Bit 3: At velocity
Bit 4: In position
Bit 5: Accelerating
Bit 6: Decelerating
Bit 7: Zero search done
Bit 8-15: Reserved
Actual run status bits for the motor.

9.2.21 Temp

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
26	TEMP	16bit	R	0...127	-	-2.27 - uses offset	Temperature

Description: Temperature measured inside the motor electronics.
The approximate temperature in degrees Celsius is calculated from the value in this register using the formula: Tc = 2.27 * Value.

9.2.22 Min_P_Ist

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
28	MIN_P_IST	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Position Limit Min

Description: Position limit for movement in the negative direction. The motor can be configured to stop automatically when it reaches this position.

9.2.23 Max_P_Ist

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
30	MAX_P_IST	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Position Limit Max

Description: Position limit for movement in the positive direction. The motor can be configured to stop automatically when it reaches this position.

9.2.24 Acc_Emerg

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
32	ACC_EMERG	16bit	R/W	1-65535	10000	9.54 RPM/s^2	Error Acceleration

Description: The motor will use this acceleration during an emergency stop.

9.2.25 Err_Bits

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
35	ERR_BITS	16bit	R/W		0	Special	Errors

Description: Error bits:
Bit 0: General error. Will always be set together with one of the other bits.
Bit 1: Follow error
Bit 2: Output driver error. Bit is set if one of the outputs is short circuited.
Bit 3: position Limit error
Bit 4: Low bus voltage error
Bit 5: Over voltage error
Bit 6: Temperature too high (90°C)
Bit 7: Internal error (Self diagnostics failed)
If any of these bits are set, the motor is in a state of error, and will not move until all the errors have been cleared. Some of the errors can be cleared by writing zero to this register. Other errors will require hardware fixes or intervention, such as allowing the motor cool down or adjusting the power supply voltage.

9.2.26 Warn_Bits

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
36	WARN_BITS	16bit	R/W		0	Special	Warnings

Description: Warning bits:
Bit 0: Positive limit active. This bit will be set as long as the positive limit is active.
Bit 1: Negative limit active. This bit will be set as long as the negative limit is active.
Bit 2: Positive limit has been active
Bit 3: Negative limit has been active
Bit 4: Low bus voltage
Bit 5: reserved
Bit 6: Temperature has been above 80°C
These bits provide information on both the actual state and remembered state of the end position limits, the supply voltage and the temperature. These are used for diagnostic purposes as well as handling position limit stops, also after the motor may have left the end position mechanically.

9.2.27 Startmode

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
37	STARTMODE	16bit	R/W	-	0	-	Startup Mode

Description: The motor will switch to this mode after power up. This is also the mode that is used when a zero search has been completed. See Mode_Reg, page 71 for a list of possible modes.

9.2.28 P_Home

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
38	P_HOME	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Zero Search Position

Description: The zero point found is offset with this value.

9.2.29 V_Home

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
40	V_HOME	16bit	R/W	-1023-1023	-50	RPM	Zero Search Velocity

Description: The velocity used during zero search. Set a negative velocity to search in the negative direction.

9.2.30 Homemode

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
42	HOMEMODE	16bit	R/W	0,13,14	0	-	Zero Search Mode

Description: Selects the zero search that should start on power up.
A value of 13 will use sensor type 1, while a value of 14 will use sensor type 2.

9.2.31 Pn

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
49-64	Pn	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Steps	Position n (Pn)

Description: These eight general-purpose position registers are referred to as P1 ... P8 and can be used to make absolute or relative movements in several different ways, either from the user program or via the serial interfaces. See also the sections on FastMac commands, and the P_NEW register description (P_New, page 88).

9.2.32 Vn

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
65-72	Vn	16bit	R/W	0-1023	250	RPM	Velocity n (Vn)

Description: These eight general-purpose Velocity registers are referred to as V1...V8 and can be used to change the velocity in several different ways, either from the user program or via the serial interfaces. See also the sections on FastMac commands.

9.2.33 An

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
73-76	An	16bit	R/W	1-65535	131	9.54 RPM/s^2	Acceleration n (An)

Description: These four general-purpose Acceleration registers are referred to as A1... A4 and can be used to change the acceleration in several different ways, either from the user program or via the serial interfaces. See also the sections on FastMac commands.

9.2.34 Tn

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
77-80	Tn	16bit	R/W	0-511	511	5.87 mA	Current n (Tn)

Description: These four general-purpose Torque registers are referred to as T1...T4 and can be used to change the velocity in several different ways, either from the user program or via the serial interfaces. See also the sections on FastMac commands. They select the current in the motor windings used during movement.

9.2.35 AnalogFiltered

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
81-88	AnalogFiltered	16bit	R	0-1023	0	4.888mV	N/A

Description: These eight registers hold the software-filtered analog value of each of the eight I/Os: IO-1 to IO-8. Their values are updated every ten milliseconds. See the AFZUP_xx registers 100-106 for the filter parameters. Important: Also read the section on Analog filters in this manual.
To use the unfiltered values of the inputs for faster updates, but with no noise immunity, use registers 89-96 instead (AnalogIn, page 80).
An input voltage of 5.00 Volts corresponds to a register value of 1023.

9.2.36 AnalogIn

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
89-96	AnalogInput	16bit	R	0-1023	-	4.888 mV	N/A

Description: These eight registers hold the unfiltered analog value of each of the eight I/Os: IO-1 to IO-8. Their values are updated approximately every 182 micro-seconds.
To use the filtered values of the inputs for better noise immunity, use registers 81-88 instead (AnalogFiltered, page 80).
An input voltage of 5.00 Volts corresponds to a register value of 1023.

9.2.37 Busvol

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
97	BUSVOL	16bit	R	0-1023	-	109 mV	Bus Voltage

Description: The supply voltage inside the motor is continually measured and stored in this register. This value is the basis for the warnings and errors of Low Bus Voltage and Over Voltage.

9.2.38 Min_Busvol

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
98	MIN_BUSVOL	16bit	R/W	0-1023	15	109 mV	Min Bus Voltage

Description: Trigger point for under-voltage

9.2.39 Encoder_Type

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
99	ENCODER_TYPE	16bit	R	0-10	-	-	“Tooltip on motor”

9.2.40 Afzup_WriteBits

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
100	AFZUP_WriteBits	16bit	R/W	-	0	Special	N/A handled on the Filter Setup screen

Description: When changing values for the analog input filter parameters, this register is used in combination with registers 102-106. First, all of the registers 102-106 must be loaded with the values to be used for one or more analog input filters. Then the lower eight bits in this register are set to select which inputs the parameters in registers 102-106 should control. The firmware will detect this and copy the parameter values from registers 102-106 to internal storage. Once this has been completed, the firmware sets bit 15 in this register to show that registers 102-106 are free to receive new values for programming the remaining inputs with other filter parameters. To use the same filtering for all analog inputs, this register can be loaded with 255 (hex FF).

9.2.41 Afzup_ReadIndex

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
101	AFZUP_Read Index	16bit	R/W	0, 1-8, 32768-32775	0	Special	N/A handled on the Filter Setup screen

Description: This register makes it possible to read back the analog input filter parameters for one analog input at a time. To select a new input, write a value of 1 to 8 to this register and wait for bit 15 to be set high. When bit 15 has been set by the firmware, the registers 102-106 have been loaded with the filter parameters currently used by that analog input.

9.2.42 Afzup_ConfMin

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
102	AFZUP Conf Min	16bit	R/W	0-1022	0	4.888 mV	Confidence Min

Description: The minimum confidence limits for analog inputs are set and read back using this register in combination with the read and write 'command' registers 100 and 101.
If a new raw sample value is less than the value in this register, it is simply discarded and the filtered input value in registers 81-88 will not change. A value of zero in this register will effectively disable the minimum confidence check.

9.2.43 Afzup_ConfMax

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
103	AFZUP_Conf Max	16bit	R/W	1-1023	1023	4.888 mV	Confidence Max

Description: The maximum confidence limits for analog inputs are set and read back using this register in combination with the read and write 'command' registers 100 and 101.
If a new raw sample value is larger than the value in this register, it is simply discarded and the filtered input value in registers 81-88 will not change. A value of 1023 in this register will effectively disable the maximum confidence check.

9.2.44 Afzup_MaxSlope

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
104	AFZUP_ Max Slope	16bit	R/W	2-1023	1023	4.888 mV	Max Slope

Description: The maximum slopes per sample for analog inputs are set and read back using this register in combination with the read and write 'command' registers 100 and 101.
If a new raw sample value on an analog input lies farther from the previous filtered value in registers 81-88, the new sample will be modified to lie at most MaxSlope units from the filtered value. This is used to suppress noise and limit acceleration. Note that the value is optionally filtered after being slope limited, in which case the effective slope limitation will be divided by the filter ratio. A value of 1023 will effectively disable slope limitation.

9.2.45 Afzup_Filter

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
105	AFZUP_Filter	16bit	R/W	1-64	64	64^{th} of new sample	Filter (on the Filter setup screen)

Description: The final filtering of new samples on the analog inputs can be selected using this register in combination with the read and write 'command' registers 100 and 101. The final filtered value results from taking Filter/64 of the new sample plus (64-Filter)/64 of the old value and storing the result in registers 81-88. A value of 64 effectively disables this filtering, so the new sample simply replaces the old value.

9.2.46 FilterStatus

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
106	FilterStatus	16bit	R	0-65535	0		N/A (shown grafically)

Description: This register contains status bits for the analog input filters. The lowest eight bits hold confidence errors for each of the eight inputs, while the highest eight bits hold the status of their slope errors.
The filter status is updated each second. The confidence error bit will be set if more than half of the samples within the last second fell outside either of the confidence limits. The slope errors will be set if more than half of the samples within the last second were slope limited.

9.2.47 PulseDirMask

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
108	PulseDirMask	16bit	R/W	0-65535	0	Bitmask	Pulse signal Direction signal

Description: The pulse and direction signals used to control the motor directly attached to the SMC75 board can also be optionally output to digital outputs and used to control other stepper motors. The value in this register selects one of three operating modes: Mode 0 in which the pulse/direction signals are used only internally to control the motor attached directly to the SMC75 board. Mode 1 in which the signals are not used internally but output to the digital outputs selected in register 109. Mode 2 where the signals are used both internally and sent out on the digital outputs.
See register 109 (PulseDirMod, page 83) for more information.

9.2.48 PulseDirMod

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
109	PulseDirMode	16bit	R/W	0-2	0	-	Pulse/Direction mode

Description: When enabled by register 108, this register defines which of the eight digital outputs are used to transmit the pulse and direction signals. The lowest eight bits select which outputs will carry the pulse signal, while the highest eight bits select the outputs that carry the direction signal. More than one output can be selected for each type of signal, but the MacTalk program supports only one output for each signal. The outputs selected here must be manually configured to operate as outputs using register 125 (Iosetup, page 85).

9.2.49 SettlingTime

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
110	SettlingTime	16bit	R/W	0-32676	0	ms	Settling time between retries

Description: When the internal encoder option is installed and register 34, InPositionCount, is non-zero so AutoCorrection is enabled, the value in this register defines how many milliseconds to wait after each movement attempt before testing whether the encoder position is within the target window as defined in register 33. This waiting time is often necessary to allow mechanical oscillations to die out.

9.2.50 Sample 1-4

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
112-115	SAMPLE1-4	16bit	R/W	-	0	-	N/A

Description: Up to four registers can be set up to be sampled into buffers for diagnostic purposes. These registers define which registers are sampled. All of the registers 1-255 can be sampled. A value of zero in any of these four registers will cause the corresponding sample buffer to contain zeroes.
See registers 116-119 for more information on the sampling system.
Most users will use MacTalk to handle sampling.

9.2.51 Rec_Cnt

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
116	REC_CNT	16bit	R/W	-	0	-	N/A

Description: This value specifies the number of samples to take for each of the sampled registers selected in registers 112-115. This value must never be set larger than the value in the read-only register 119. Sampling will stop automatically after the specified number of samples has been taken.

9.2.52 S_Time

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
117	S_TIME	16bit	R/W	-	1	-	N/A

Description: This value selects the time in milliseconds between samples of the registers selected in registers 112-115.

9.2.53 S_Control

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
118	S_CONTROL	16bit	R/W	-	0	-	NA

Description: This value controls the sample system. It can assume three different values:
A value of zero is set by the firmware after all sampling has completed.
A value of one will initialize the sample system.
A value of two will start a new sample sequence and set this register to zero at completion.
The sampled values are read back using the command hex 53 SMC75_READSAMPLE.

9.2.54 Buf_Size

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
119	BUF_SIZE	16bit	R	-	-	-	N/A

Description: This read-only register contains the maximum length of the sample buffers used to sample the registers selected in registers 112-115. Register 116 should never be set to a value higher than the value in this register.

9.2.55 Index_Offset

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
120	INDEX_OFFSET	16bit	R	0-1599	-	Steps	Tests-

Description: This register can be selected to receive the absolute value of the internal encoder where the Zero search/home position was found during homing. This is selected by bit 0, Use Index, in register 122. It requires that the internal encoder option is installed.

9.2.56 Home_Bits

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
122	HOME_BITS	16bit	R/W	-	0	Special	Advanced-Zero Search

Description: Bit 0: Search for index
Bit 1: Change direction on limit.
Bit 2: Search for opposite side of sensor
Bit 3: Use Limit switch as sensor
Bit 4: Ignore switch (Used for searching only for index)
Contains configuration bits, that define how Zero search/homing should be carried out.

9.2.57 Setup_Bits

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
124	SETUP_BITS	16bit	R/W	-	0	Special	Don´t start program after power up. Invert motor direction. External Encoder Enable DSP 402 Support Auto encoder synchronize

Description: Bit 0: Invert direction.
Bit 1: Don't start program after power up.
Bit 3,2: Select encoder input type. 0 = Disabled, 1 = Quadrature, 2 = Pulse/direction
Bit 4: Enable DSP 402 support
Bit 5: Synchronize to encoder after passive
These individual bits are used to control various functions in the firmware.

9.2.58 Iosetup

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
125	IOSETUP	16bit	R/W	-	0	Special	Inputs/Outputs

Description: This register controls the eight IOs: IO-1 to OI-8. These pins can be used either in input mode as combined digital and analog inputs or used in output mode as digital outputs. The lowest eight bits in this register can be used to individually invert the active level of the digital inputs. The highest eight bits are used to select the corresponding pin as an output.

9.2.59 Turntable_Mode

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
126	TURNTABLE_ MODE	16bit	R/W	-	0	Special	Turn Table -Mode

Description: In turntable mode, the motor controls the revolution of a turntable that has the number of positions specified in register 127, TurntableSize. This means the same position will be reached after rotating this number of steps in either direction.
This register selects one of three modes that define how the motor should move to a new position when the P_SOLL register is changed.

If the value of this register is zero, the motor will not operate in turntable mode.

In mode 1, the motor will always move to a new position by turning in a positive direction. So to move one step backwards, it must instead move TurntableSize-1 steps forward.

In mode 2, the motor will always move to a new position by turning in a negative direction.

In mode 3, the motor will move in the direction that takes the smallest number of steps to reach the new position.

Note that the motor will not move at all if the new position in register P_SOLL is either negative or larger than the value of register 127, TurntableSize.

9.2.60 Turntable_Size

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
127	TURNTABLE_ SIZE	32bit	R/W	-	0	Steps	Turn Table - Size

Description: If turntable mode is selected in register 126, the number of steps needed for a full revolution of the turntable is set in this register. Note that the register P_SOLL must always have a value between zero and the value in this register minus one. Negative values are not allowed for P_SOLL or TurntableSize.

9.2.61 NL_Mask

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
129	NL_MASK	16bit	R/W	-	0	IO Mask	Dedicated Inputs Negative Limit Input

Description: Selects which one of the eight IO pins to use for the dedicated function of Negative Position Limit.
Exactly one bit must be set, and the IO pin must be configured in register 125 as an input.
Example: If input 7 is to be used for the Negative Input Limit, write 26 = 64 to this register.

9.2.62 PL_Mask

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
130	PL_MASK	16bit	R/W	-	0	IO Mask	Dedicated Inputs - Positive Limit Input

Description: Selects which one of the eight IO pins to use for the dedicated function of Positive Position Limit.
Exactly one bit must be set, and the IO pin must be configured in register 125 as an input.
Example: If input 8 is to be used for the Positive Input Limit, write 27 = 128 to this register.

9.2.63 Home_Mask

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
132	HOME_MASK	16bit	R/W	-	0	IO Mask	Dedicated inputs. Home Input

Description: Selects which one of the eight IO pins to use for the dedicated function of Home Input.
Exactly one bit must be set, and the IO pin must be configured in register 125 as an input.
Example: If input 2 is to be used for the Home Input, write 21 = 2 to this register.

9.2.64 Input_Filter_Mask

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
135	INPUT_FILTER_MASK	16bit	R/W	-	0	IO Mask	IOx digital input filter enabled

Description: This register controls filtering of each of the eight IO pins that are used as digital inputs. If the bit corresponding to the input number is set in this register, the input value will be filtered to a new logical level is only accepted after that level has been measured on the hardware pin for the number of milliseconds specified in register 136. If the bit is not set, the input will be updated directly from the hardware value every 100 microseconds. Please read the section on Digital Input filters in this manual.

9.2.65 Input_Filter_Cnt

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
136	INPUT_FILTER_CNT	16bit	R/W	-	5	ms	Input filter time

Description: The filtering of all of the eight digital inputs is controlled by the value in this register together with register 135. The input must be sampled at the same value for the specified number of milliseconds in this register to be accepted as the new filtered value. See also the section on Digital Input Filters in this manual.

9.2.66 Inpos_Mask

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
137	INPOS_MASK	16bit	R/W	-	0	IO MASK	Dedicated Outputs - In Position

Description: Selects which one of the eight IO pins to use for the dedicated function of In Position Output.
Exactly one bit must be set, and the IO pin must be configured in register 125 as an output.
The In Position output will then be set after a movement has completed.

Example: If output 1 is to be used for the In Position Output, write 20 = 1 to this register.

9.2.67 Error_Mask

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
138	ERROR_MASK	16bit	R/W	-	0	IO Mask	Dedicated Outputs - Error

Description: Selects which one of the eight IO pins to use for the dedicated function of Error Output.
Exactly one bit must be set, and the IO pin must be configured in register 125 as an output.
The Error Output will set be set when any error is set.
See register 35 (Err_Bits, page 78) for more information on errors.

Example: If output 3 is to be used for the Error Output, write 22 = 4 to this register.

9.2.68 P_New

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
144	P_NEW	32bit	R/W	(-2^{31})-$(2^{31}-1)$	0	Counts	N/A

Description: This register can be used to change both of the registers P_SOLL and P_IST in one operation. This can be used to correct or offset the current position without performing a movement. The register value can be copied to P_IST and P_SOLL using FastMac command 23, or it can be added with sign to both of these registers using FastMac command 24.

9.2.69 Baud_Rate

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
146	BAUD_RATE	16bit	R/W	0-5	1	-	Baud Rate

Description: The baud rate on the serial port.
0 : 9600 baud
1 : 19200 baud (default)
2 : 38400 baud
3 : 57600 baud
4 : 115200 baud
5 : 230400 baud
6 : 460800 baud
7 : 921600 baud
The firmware will automatically update the baud rate after this value is changed over the serial interface (RS485) once the motor has finished transmitting all data bytes that are queued.

9.2.70 Tx_Delay

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
147	TX_DELAY	16bit	R/W	1-255	15	Bits	Transmit Delay

Description: The time to wait before the response is transmitted. The unit corresponds to the time of one bit at the current baud rate.
Many PLCs and communications processors require a minimum delay after they have sent a command to the motor before they are able to receive the response.

9.2.71 Group_Id

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
148	GROUP_ID	16bit	R/W	0-255	-	-	Group Id

Description: The group ID of the motor. The motor will accept data from a group write command only if the group ID number in the command matches this number. The idea is that several motors can have the same group ID so they can be updated with new register values in parallel to save transmission time.

9.2.72 Group_Seq

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
149	GROUP_SEQ	16bit	R	0-255	-	-	N/A

Description: The last received group write sequence.

9.2.73 My_Addr

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
150	MY_ADDR	16bit	R/W	0-254		-	Motor Address

Description: The motor address. Data communicated over the serial interface will only be accepted if the address byte in the command is either equal to this value or has the value 255, which means broadcast to all motors.

9.2.74 Motortype

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
151	MOTORTYPE	16bit	R	64-xx		-	“Status Bar”

Description: The motor type.
64: SMC75
65: MIS231
66: MIS232
67: MIS234
This value is read-only and is programmed into the motor during manufacturing.

9.2.75 Serial_Number

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
152	SERIAL-NUMBER	32bit	R	-	-	-	“Status Bar”

Description: The serial number of the motor.
This value is read-only and is programmed into the motor during manufacturing.

9.2.76 Checksum

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
154	CHECKSUM	32bit	R	0-65535	-		

Description: Firmware checksum.
This value is read-only and is programmed into the motor during firmware update.

9.2.77 Hardware_Rev

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
156	HARDWARE_REV	16bit	R	0-65535	-	Major*16+ Minor +16384	"Tooltip on Motor"

Description: The revision of the hardware. This value is read-only and is programmed into the motor during manufacturing.

9.2.78 Max_Voltage

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
157	MAX_VOLTAGE	16bit	R	0-100	*	Volt	"Tooltip on Motor"

Description: The maximum allowed voltage on the bus. If the bus voltage exceeds this value, the motor will enter an error state.
This value is read-only and is programmed into the motor during manufacturing. It reflects the rating of the hardware components. Supplying a higher voltage can damage the electronics components permanently. If in doubt, it is strongly recommended to first supply 24 Volts and connect the motor to MacTalk. In MacTalk this value can be read by holding the mouse cursor over the image of the motor in the lower right of the main window.

9.2.79 Available_IO

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
158	AVAILABLE_IO	16bit	R	-	-	IO MASK	N/A

Description: Defines what IO that are available on the connector.
This value is read-only and is programmed into the motor during manufacturing. Service personnel may ask for this value to identify the type of connector board mounted on the motor. The values are not documented here.

9.2.80 Bootloader_Ver

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
159	BOOTLOADER_ VER	16bit	R	0-65535	-	Major*16+ Minor +16384	"Tooltip on Motor"

Description: The version of the boot-loader.
This value is read-only and is programmed into the motor during manufacturing

9.2.81 Notsaved

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
160	NOTSAVED	16bit	R/W	0-65535	0	-	N/A

Description: This register is not used internally, but will always be 0 after power on. Please note that MacTalk uses this register

9.2.82 Option_Bits

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
165	OPTION_BITS	16bit	R	0-65535	-	-	“Tooltip on motor”

Description: This register contains information about what options are available. Bit 0-7 defines the options available in the hardware (or licensed). Bit 8-15 defines the options available in the firmware.

Bit 0,8 : CanOpen fieldbus
Bit 1,9 : DeviceNet fieldbus

9.2.83 Fbus_Node Id

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
166	FBUS_NODE ID	16bit	R/W	0-255	5	-	Fieldbus - Node ID

Description: The node id on the fieldbus interface.

9.2.84 Fbus_Baud

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
167	FBUS_BAUD	16bit	R/W	0-8	2	-	Fildbus - Baud Rate

Description: The baudrate used on the fieldbus interface.
0 : 1000 kbit/s
1 : 800 kbit/s (unsupported)
2 : 500 kbit/s
3 : 250 kbit/s
4 : 125 kbit/s
5 : 100 kbit/s
6 : 50 kbit/s
7 : 20 kbit/s
8 : 10 kbit/s

9.2.85 Ext_Encoder

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
170	EXT_ENCODER	32bit	R/W	(-2^{31})-$(2^{31}-1)$	-	Counts	External Encoder

Description: This register counts the encoder input on IN1+IN2. The type of input is selected using SETUP_BITS bit 2+3.

9.2.86 Ext_Encoder_Vel

Reg	Name	Size	Access	Range	Default	Unit	MacTalk name
172	EXT_ENCODER _VEL	16bit	R	(-2^{15})-$(2^{15}-1)$	-	Counts 16ms	External Encoder Velocity

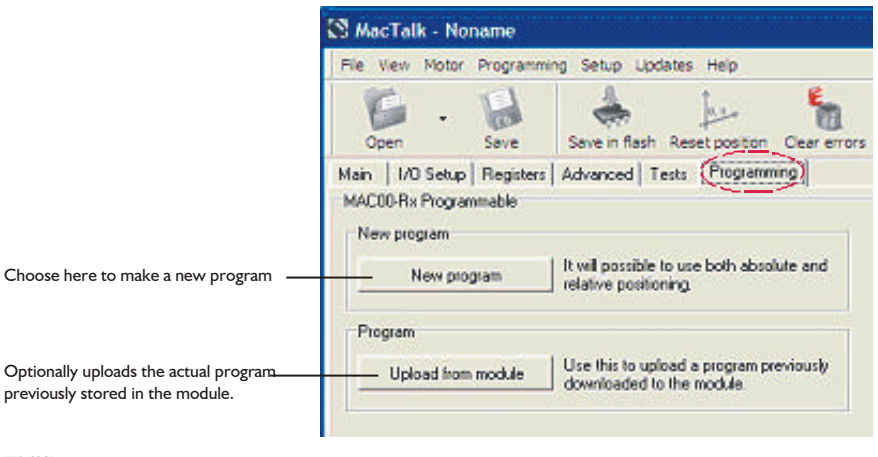
Description: This register is updated with the velocity of the external encoder input. The velocity is measured every 16ms.

10 Programming

10.1 Getting started with programming

When using the SMC75, almost any kind of program can be created using a set of user friendly icons.

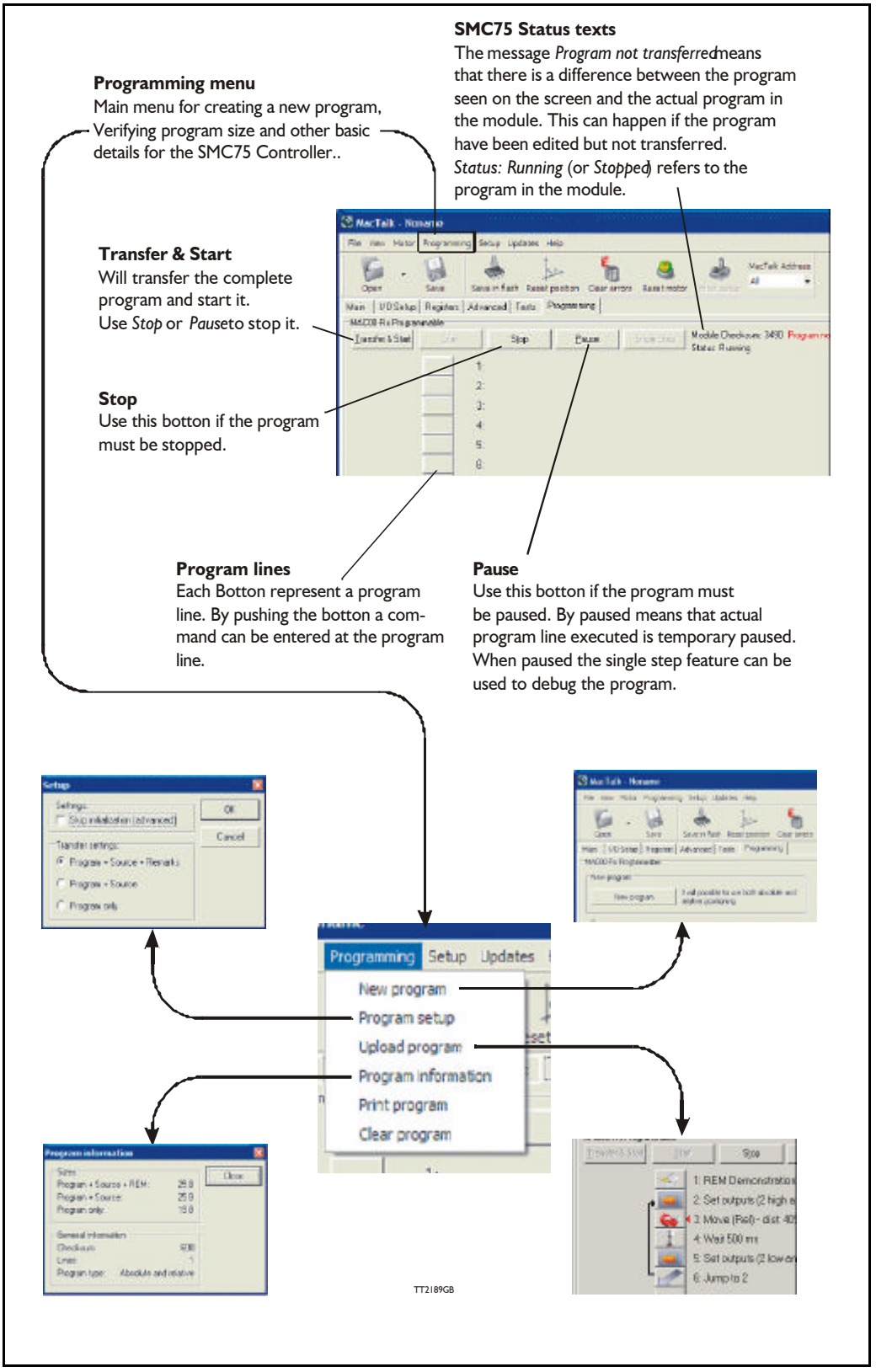
Make the required choice on the Programming tab.



After making one of these 2 choices, the program window will be opened.

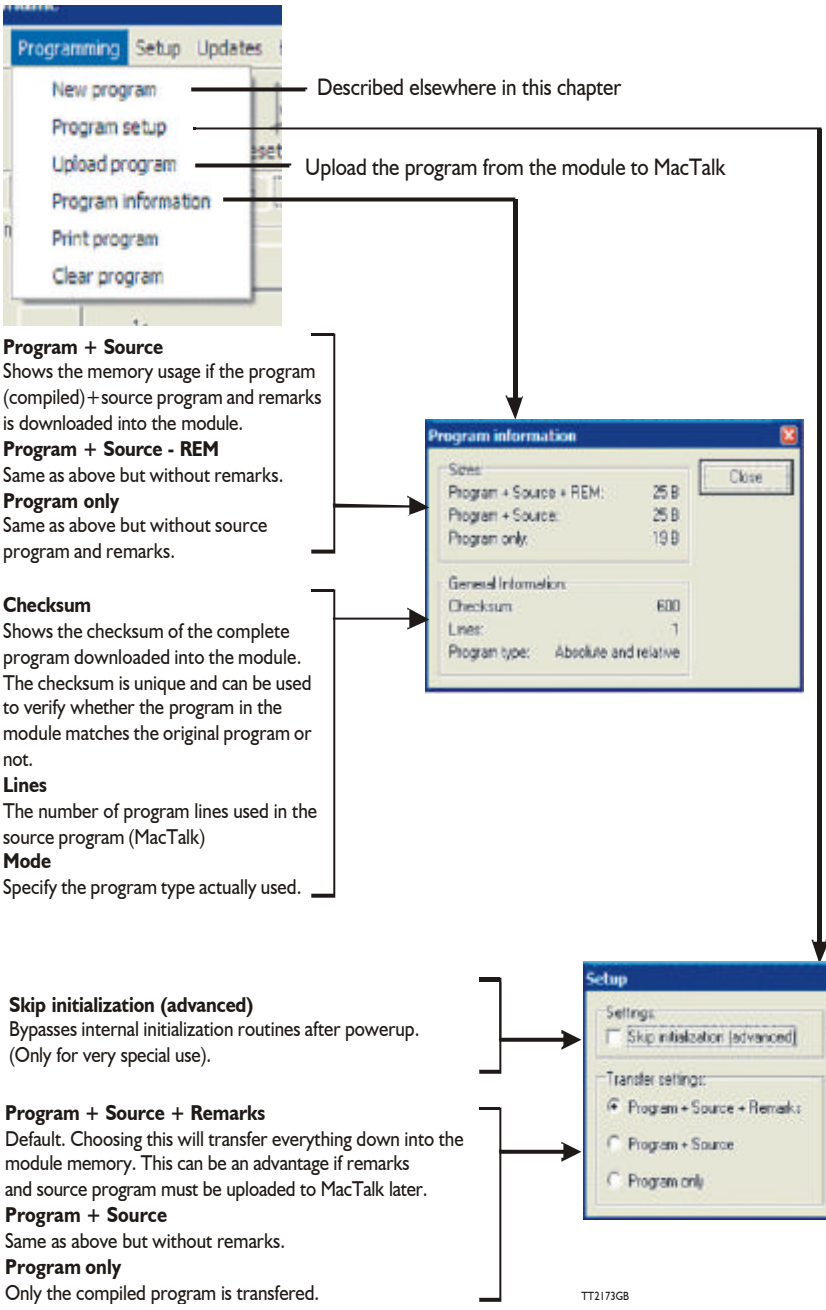
10.2 Programming Main window

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



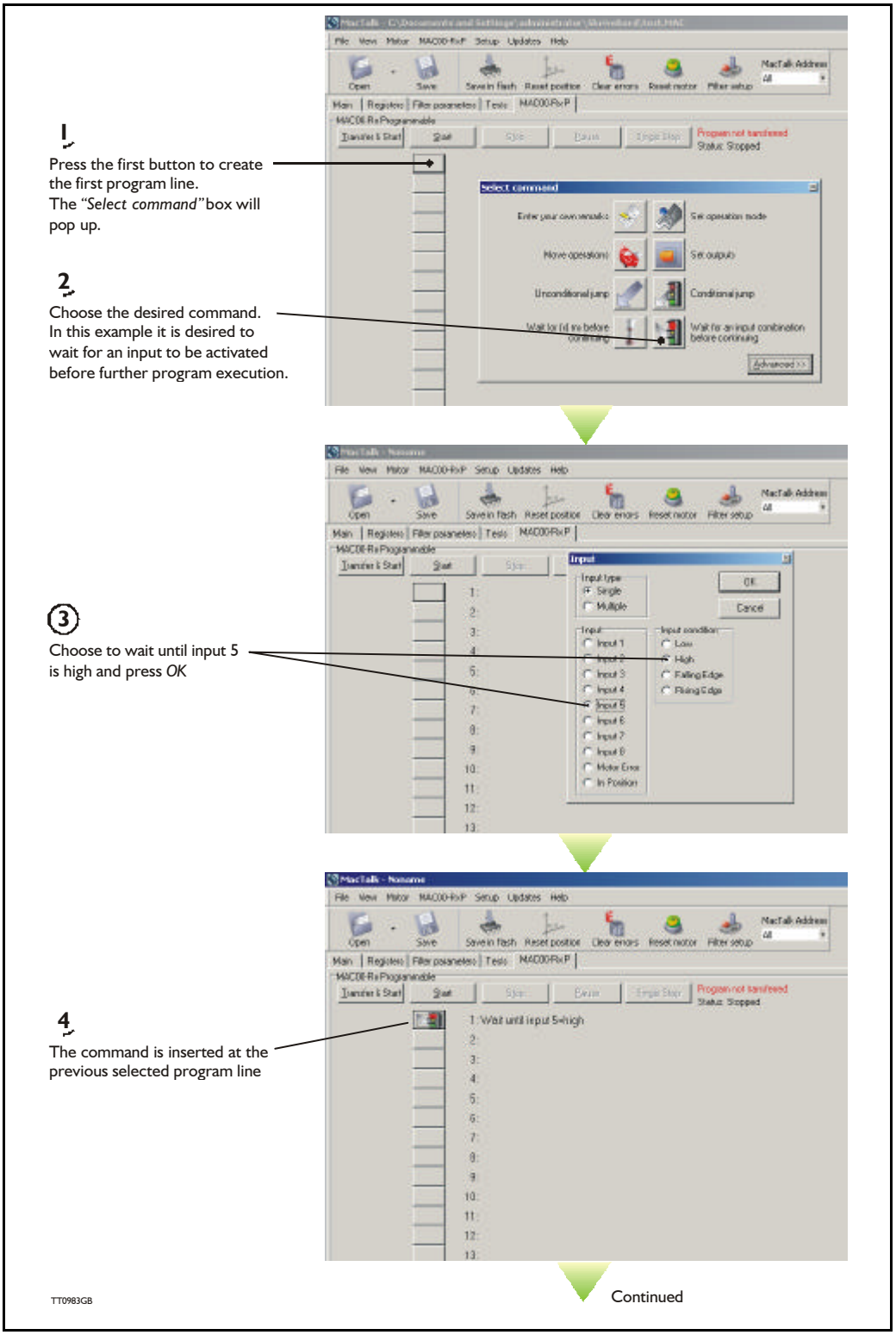
10.3 Programming menu

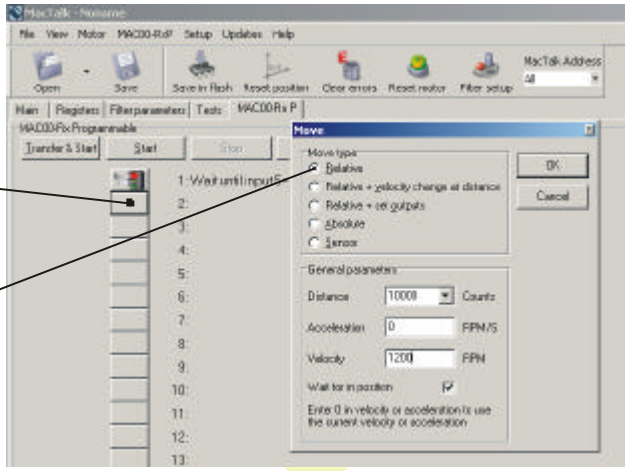
The menu found at the top of the main window gives access to the following options:



10.4 How to build a program

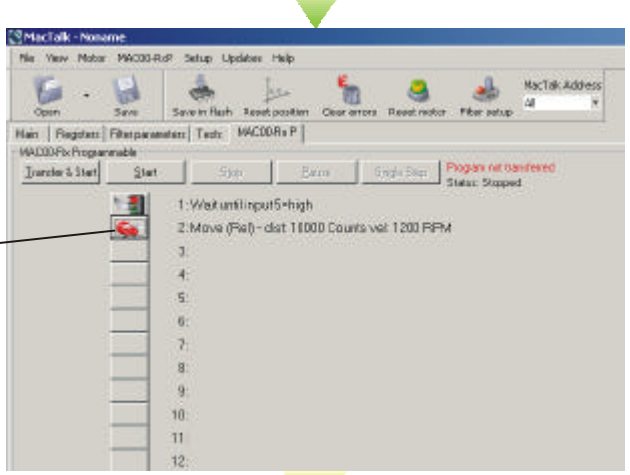
When choosing New program in the Programming menu or entering MacTalk for the first time, programming can be started.
Press the button at line 1 and a tool box will pop up.





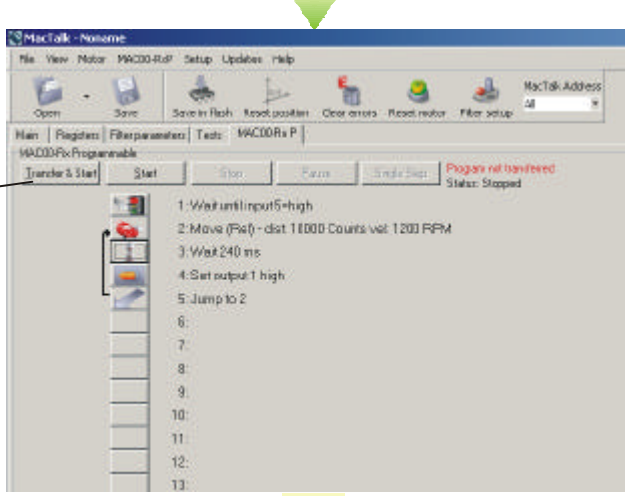
⑤ Press the second button to create the second program line

⑥ Choose the movement type needed.
Relative: Move x counts forward with reference to the actual position.
Absolute: Move to the x position with reference to the zero search position.



⑦ The relative move command just entered is converted into a program line.

⑧ Multiple program lines are entered by the user forming the last part of the program.



⑨ Now the program is finished.
Press the *"Transfer & Start"* button.
Now the program will be transfered and stored permanently in the module.
The program will be executed immidiately

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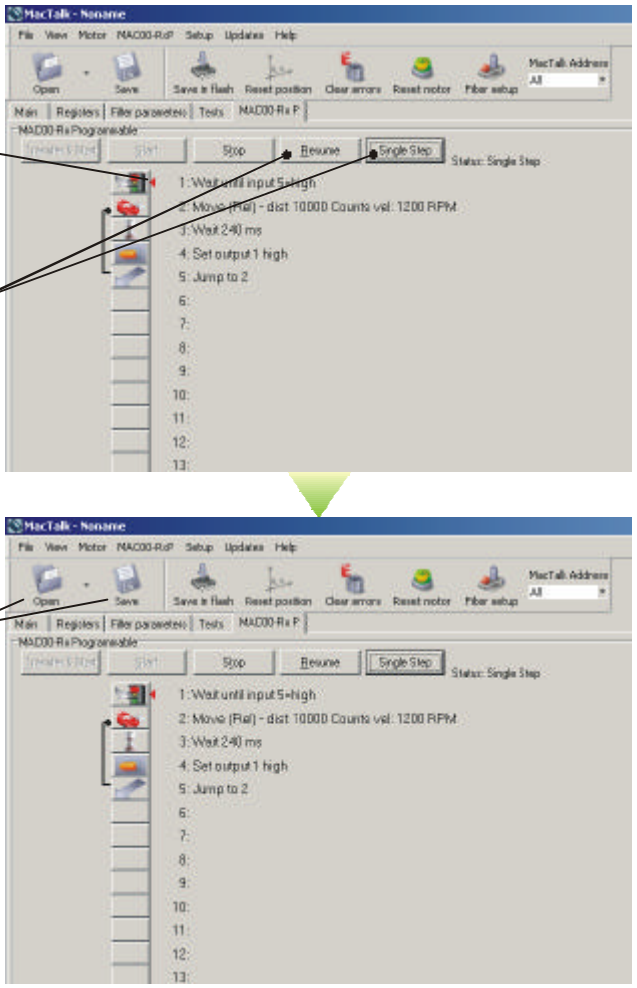
Continued

(10) Now the program is running continuously. The actual program line which is executed is shown by the small red arrow.

(11) By choosing the "Pause" button, the program is paused. After it is paused, it is possible to single step through each program line which can be a useful feature to debug the program since the action in each line can be closely observed.

(12) When the program is finished, it can be saved on the harddisc or floppy disc. Please be aware that when saving the program it is the complete program including the overall setup of the motor such as servofilter, I/O setup etc. Everything is stored in a file with the extension *.MAC*. Later it can be opened and restored in the motor.



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10.5 General programming hints

When programming and saving programs the following hints may be useful to ensure that the program behaves as expected.

1. When transferring the program to the module, it is saved permanently in memory and the program will be executed each time the motor is switched on.
2. Before beginning to program, ensure that the basic parameters for controlling acceleration, torque, safety limits, etc. are set to proper values. When saving the program on the hard-disk or to floppy disc, all of these basic parameter settings will be saved together with the program as a complete motor setup package.
3. A program line can be edited by double-clicking on the command text.
4. When the cursor is placed on top of the command icon, an edit menu will be shown by right-clicking.

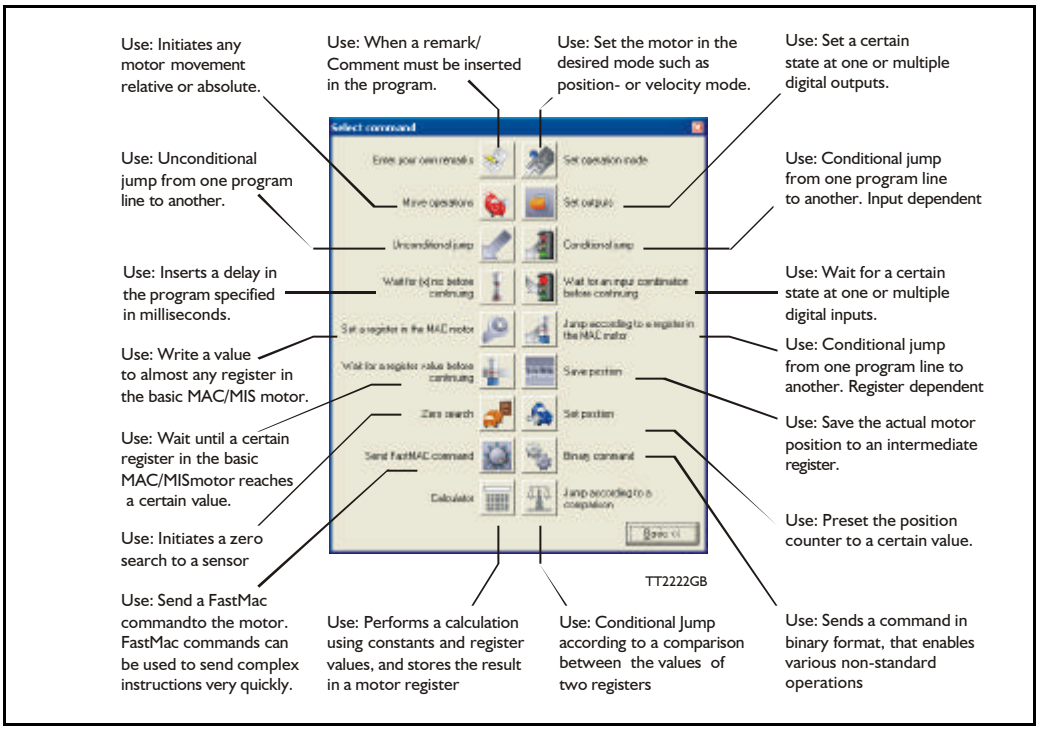
10.6 Command toolbox description

The toolbox used for programming covers 14 different command types.

The basic idea of the commands is to provide easy access to the most common functions of the motor. Some functions may seem to be missing at first glance, but the buttons “Set register in the QuickStep motor” or “Wait for a register value before continuing” give direct access to 50 registers in the basic QuickStep motor, such as the gear ratio or the actual torque register.

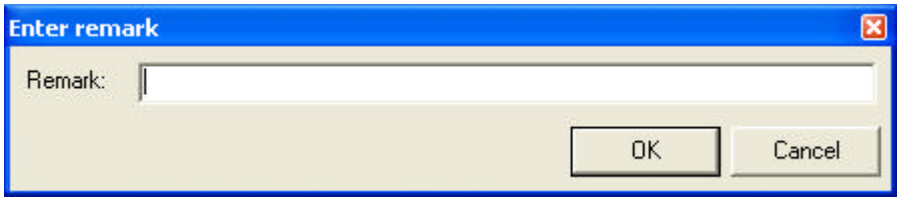
In total, this gives a very powerful programming tool since >95% of a typical program can be built using the simple command icons, while the remaining 5% is typically achieved by accessing the basic motor registers directly.

The following gives a short description of all 14 command icons.

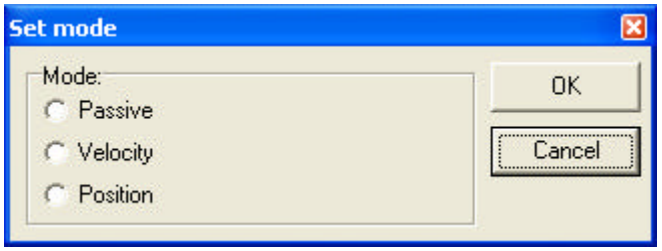


10.7 Graphic programming command reference

10.7.1 Enter your own remarks

Icon:	
Dialog:	
Function:	Inserts a remark/comment in the source code. The program line will not do anything, but can make the source code easier to read. This can be very important if other programmers have to review or work on the code, or if the program is only worked on infrequently.

10.7.2 Set operation mode

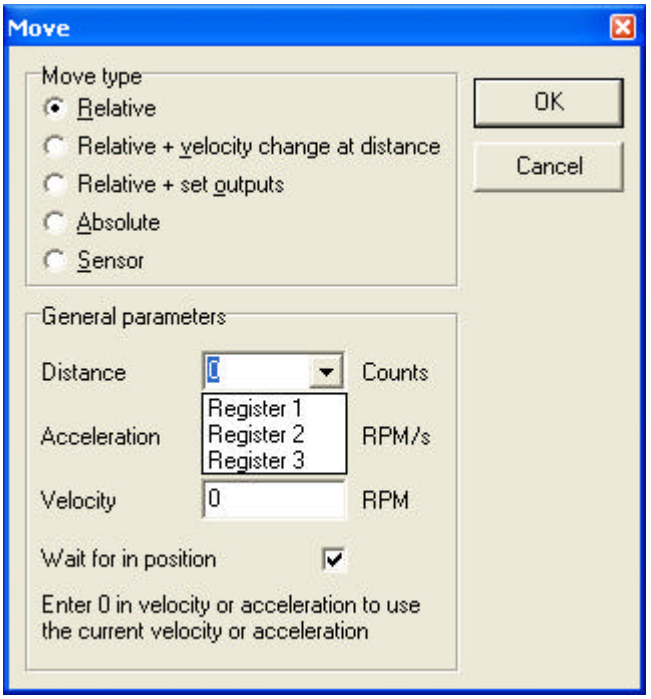
Icon:	
Dialog:	
Function:	Sets the operating mode of the motor. When the program encounters a program line with this command, the motor's operating mode will be set to the specified mode. This allows you to use different operating modes in different parts of the program. For a detailed description of the individual operating modes, refer to section 1.3.1., Basic modes/functions in the QuickStep motor, page 10.

10.7.3 Move operations

Icon:	
Function:	The Move command is very flexible, with five different operating modes. Each mode is described in its own section below.

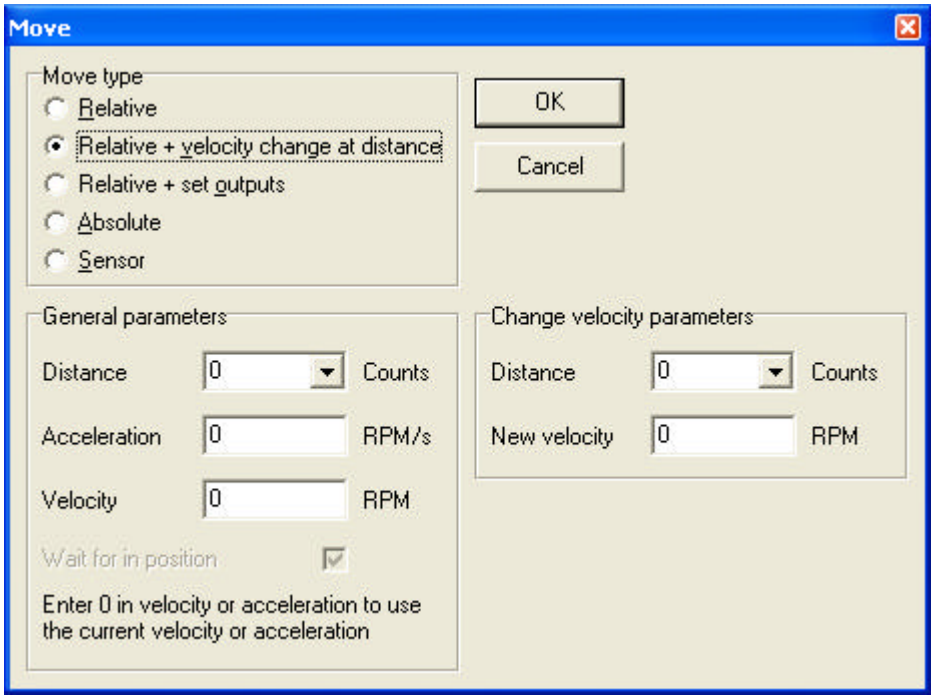
10.7 Graphic programming command reference

10.7.4 Move (Relative)

Icon:	
Dialog:	
Function:	Performs a movement relative to the current position. The distance moved is measured in encoder counts, and can either be entered directly or taken from three registers in the user memory area. For further information on using these memory registers, refer to the sections on the 'Save position' and 'Set position' commands. Note that if you specify a velocity, motor register no. 5 (V_SOLL) will be overwritten with this velocity value. Also, if you specify an acceleration, motor register no. 6 (A_SOLL) will be overwritten with the acceleration value specified. Register no. 49 (P1) is always overwritten by this command. If the 'Wait for in position' option is checked, the program will wait until the motor has finished the movement, before proceeding to the next program line. If this option is not checked, the program will start the movement, then immediately start executing the next command. The motor will finish the movement on its own, unless given other instructions by the program.

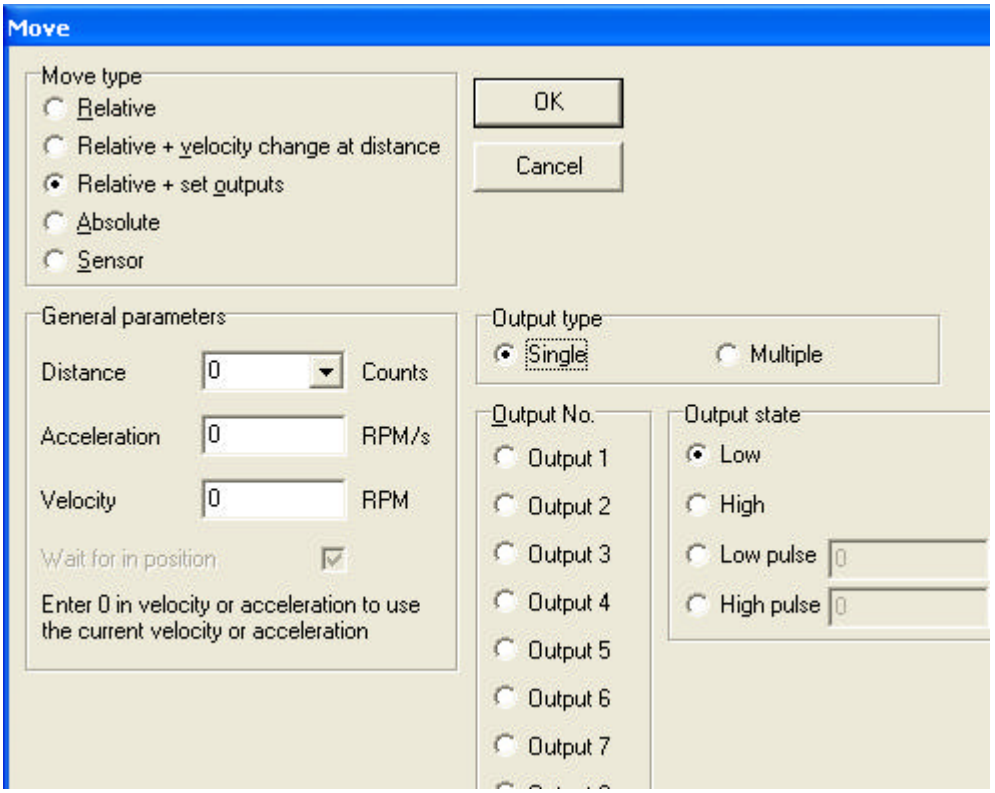
10.7 Graphic programming command reference

10.7.5 Move (Relative + velocity change at a distance)

Icon:	
Dialog:	
Function:	Performs a relative movement, and changes velocity at a specified distance before reaching the new position. The distances are measured in encoder counts and can either be entered directly, or taken from three memory registers in the RxP module. For further information on using these memory registers, refer to the sections on the 'Save position' and 'Set position' commands. Note that motor register no. 5 (V_SOLL) will always be overwritten with the value specified in the 'New velocity' field. Also, if you specify an acceleration, motor register no. 6 (A_SOLL) will be overwritten with the acceleration value specified. Register no. 49 (P1) is always overwritten by this command. This command always waits until the movement is finished, before proceeding to the next line in the program.

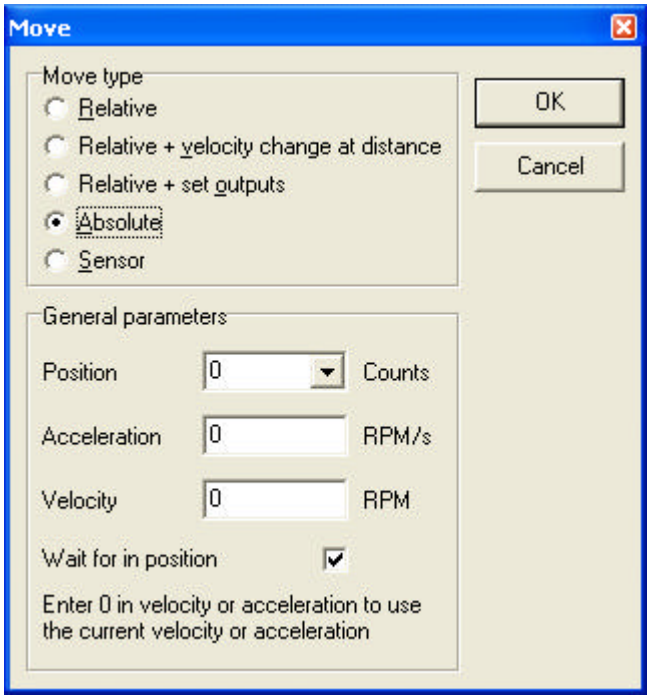
10.7 Graphic programming command reference

10.7.6 Move (Relative + set outputs)

Icon:	
Dialog:	
Function:	Performs a movement relative to the current position, and sets one or more outputs when the operation is completed. The distance moved is given in encoder counts and can either be entered directly, or can be taken from one of three memory registers in the user memory area. For further information on using these memory registers, refer to the sections on the 'Save position' and 'Set position' commands. Note that if you specify a velocity, motor register no. 5 (V_SOLL) will be overwritten with this velocity value. Also, if you specify an acceleration, motor register no. 6 (A_SOLL) will be overwritten with the acceleration value specified. Register no. 49 (P1) is always overwritten by this command. This command always waits until the movement is finished, before proceeding to the next line in the program.

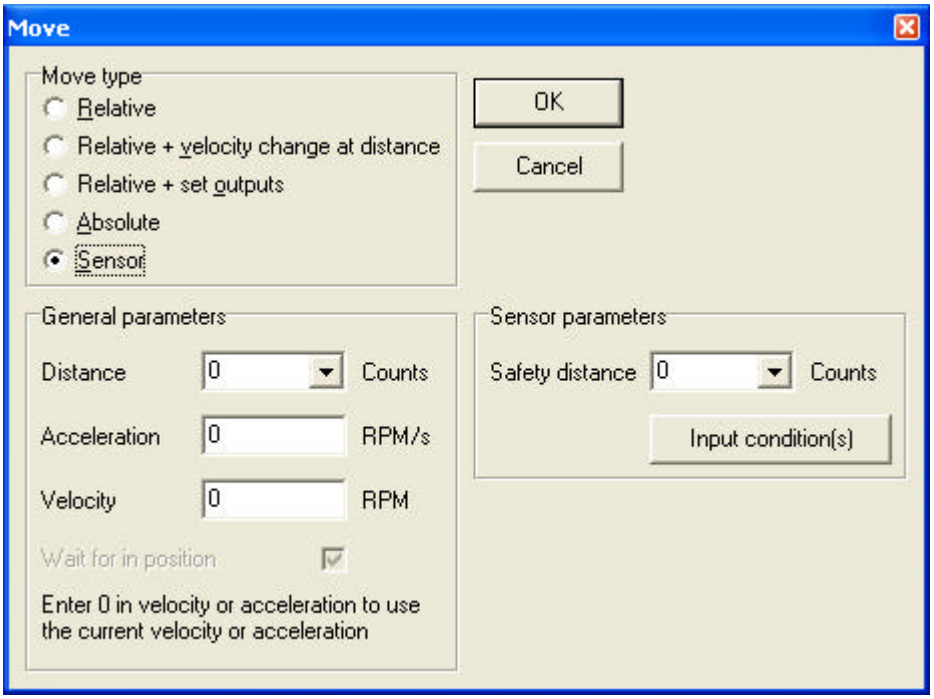
10.7 Graphic programming command reference

10.7.7 Move (Absolute)

Icon:	
Dialog:	
Function:	Moves to an absolute, non-relative position. The position is given in encoder counts and can either be entered directly, or can be taken from one of three memory registers in the user memory area. For further information on using these memory registers, refer to the sections on the 'Save position' and 'Set position' commands. Note that if you specify a velocity, motor register no. 5 (V_SOLL) will be overwritten with this velocity value. Also, if you specify an acceleration, motor register no. 6 (A_SOLL) will be overwritten with the acceleration value specified. If the 'Wait for in position' option is checked, the program will wait until the motor has finished the movement before proceeding to the next program line. If this option is not checked, the program will start the movement, then immediately start executing the next command. The motor will finish the movement on its own, unless given other instructions by the program.

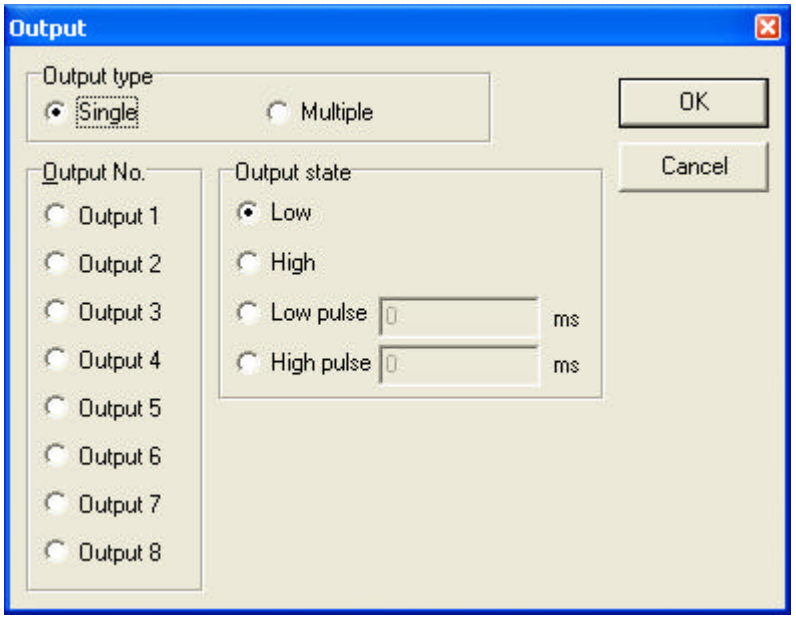
10.7 Graphic programming command reference

10.7.8 Move (Sensor)

Icon:	
Dialog:	
Function:	Performs a movement in the direction specified until an input condition is satisfied. The motor then moves the distance specified before stopping. The motor will not move farther than the Safety distance specified, regardless of whether the input condition is satisfied. The distances are measured in encoder counts and can either be entered directly, or taken from three memory registers in the user memory area. For further information on using these memory registers, refer to the sections on the 'Save position' and 'Set position' commands. Note that if you specify a velocity, motor register no. 5 (V_SOLL) will be overwritten with this velocity value. Also, if you specify an acceleration, motor register no. 6 (A_SOLL) will be overwritten with the acceleration value specified. Register no. 49 (P1) is always overwritten by this command. This command always waits until the movement is finished before proceeding to the next line in the program.

10.7 Graphic programming command reference

10.7.9 Set outputs

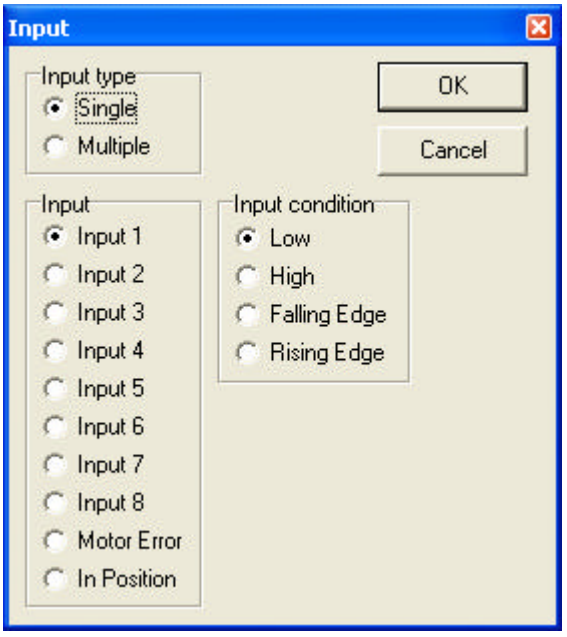
Icon:	
Dialog:	 
Function:	Sets one or more outputs. When setting a single output, you can set it to high, low, or you can specify the length (in milliseconds) of a pulse to send out on that output. When setting multiple outputs, you can specify whether to set each output high, low, or leave it in its current state.

10.7 Graphic programming command reference

10.7.10 Unconditional jump

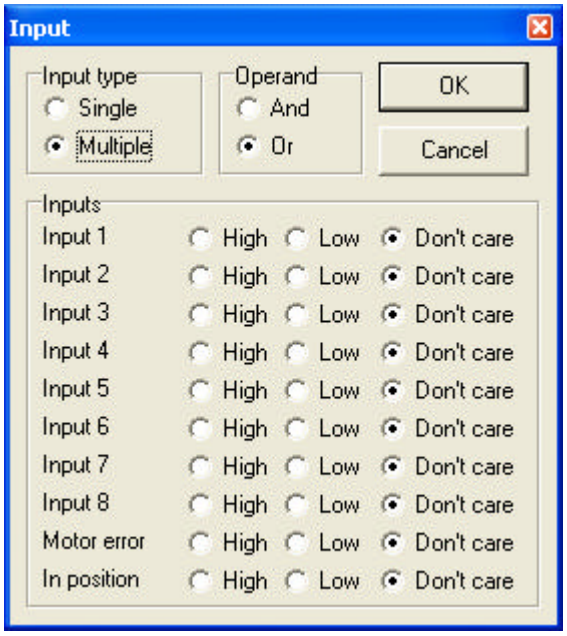
Icon:	
Dialog:	None. After selecting this command, the mouse cursor changes. The next program line that you click on will become the destination for the jump.
Function:	Jumps to another line in the program.

10.7.11 Conditional jump (single input)

Icon:	
Dialog:	
Function:	Tests for an input condition before either jumping to another line in the program or moving on to the next line in the program. If the condition is met, the command jumps to the specified program line. If the condition is not met, the program proceeds to execute the next line in the program. When 'Input type' is set to 'Single', the command can test a single input for one of four possible conditions: the input is low, the input is high, the input has transitioned to low (Falling Edge), or the input has transitioned to high (Rising Edge). If transitions are tested for, the transition must have taken place during the last 30 microseconds. After pressing the OK button, the dialog will disappear, and the mouse cursor will change. The next program line that you click on will then become the destination of the jump command.

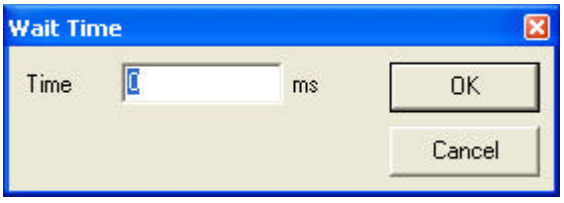
10.7 Graphic programming command reference

10.7.12 Conditional jump (multiple inputs)

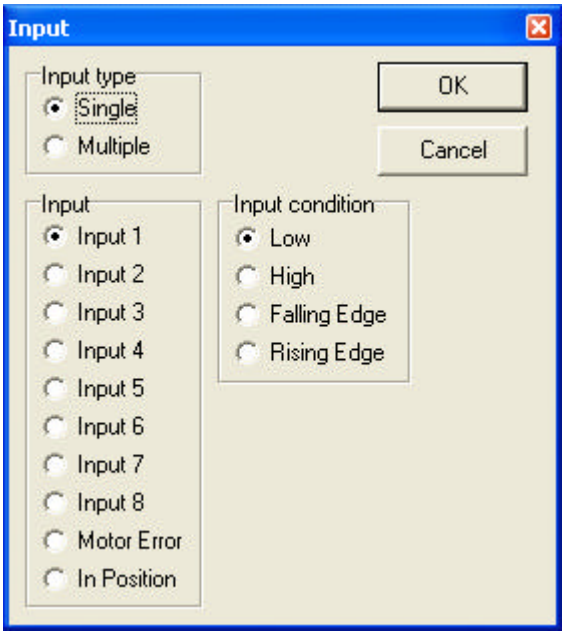
Icon:	
Dialog:	
Function:	Tests for an input condition before either jumping to another line in the program or moving on to the next line in the program. If the condition is met, the command jumps to the specified program line. If the condition is not met, the program proceeds to execute the next line in the program. When 'Input type' is set to 'Multiple', multiple inputs can be tested for being either high or low. The 'Operand' setting determines whether one or all of the inputs must meet their test criterion. If set to 'And', all inputs must match their test settings. If set to 'Or', only one input need match its test setting. Inputs that are set to 'Don't care' are not tested. After pressing the OK button, the dialog will disappear, and the mouse cursor will change. The next program line that you click on will then become the destination of the jump command.

10.7 Graphic programming command reference

10.7.13 Wait for (x) ms before continuing

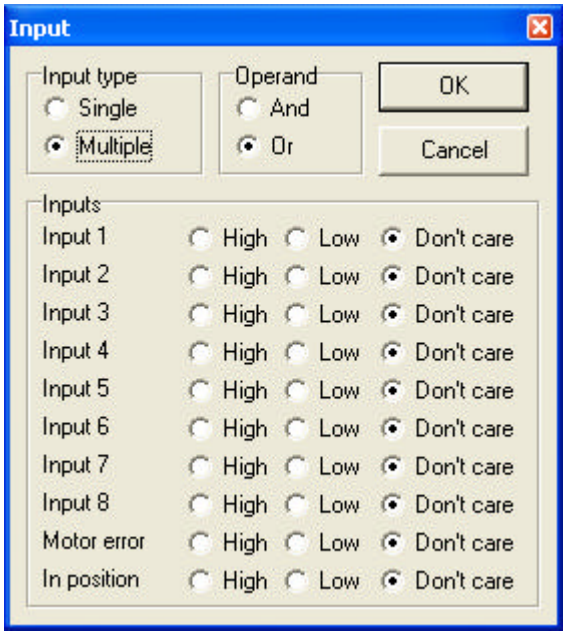
Icon:	
Dialog:	
Function:	Causes the program to pause for a number of milliseconds before continuing. The maximum pause that can be specified is 65535 milliseconds. The minimum pause that can be specified is 0 milliseconds. Note that this command overwrites Timer 1 in the RxP module's memory.

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

Icon:	
Dialog:	
Function:	Waits for a specified input condition to occur. The next line in the program will not be executed until the input condition has been met. If 'Input type' is set to 'Single', the command will wait for one of four things to happen on the specified input: that the input tests as high, that the input tests as low, that the input transitions from high to low (Falling Edge), or that the input transitions from low to high (Rising Edge). The input is tested with 30 microsecond intervals.

10.7 Graphic programming command reference

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

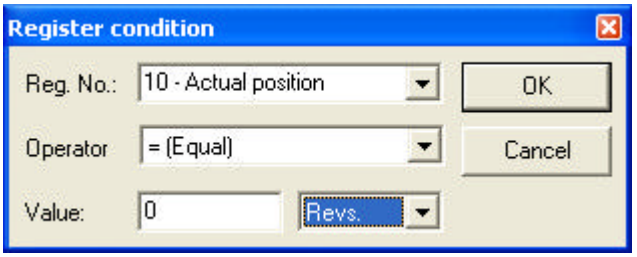
Icon:	
Dialog:	
Function:	Waits for a specified input condition to occur. The next line in the program will not be executed until the input condition has been met. If 'Input type' is set to 'Multiple', multiple inputs can be tested for being either high or low. The 'Operand' setting determines whether one or all of the inputs must meet their test criterion. If set to 'And', all inputs must match their test settings. If set to 'Or', only one input need match its test setting. Inputs that are set to 'Don't care' are not tested. The inputs are tested with 30 microsecond intervals.

10.7 Graphic programming command reference

10.7.16 Set a register in the MIS motor

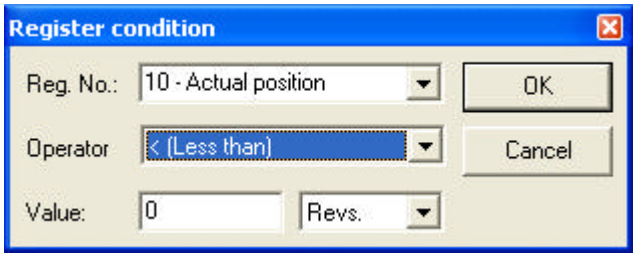
Icon:	
Dialog:	
Function:	Sets a register in the motor to a specified value. The register is selected from a list of known, user-accessible registers. The value can either be entered as native motor units or it can be entered as generic engineering units. The dialog above provides an example: register no. 3 (P_SOLL, or Requested position, depending on your preference) can either be set to an integer number of encoder counts, or it can be set to a non-integer number of revolutions.

10.7.17 Jump according to a register in the MAC motor

Icon:	
Dialog:	
Function:	Tests a register in the motor against a specified value before either jumping to another line in the program or moving on to the next line in the program. If the condition is met, the command jumps to the specified program line. If the condition is not met, the program proceeds to execute the next line in the program. The value can either be entered as native motor units, or it can be entered as generic engineering units. The dialog above provides an example: register no. 10 (P_IST, or Actual position, depending on your preference) must be equal to 0 revolutions if the jump is to be executed. The position that the register is tested against can be specified as an integer number of encoder counts or can be specified as a non-integer number of revolutions. After pressing the OK button, the dialog will disappear and the mouse cursor will change. The next program line that you click on will then become the destination of the jump command.

10.7 Graphic programming command reference

10.7.18 Wait for a register value before continuing

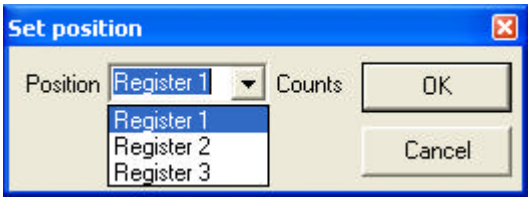
Icon:	
Dialog:	
Function:	Tests a register in the motor against a specified value and waits until the specified condition is met. The value can either be entered as native motor units or can be entered as generic engineering units. The dialog above provides an example: register no. 10 (P_IST, or Actual position, depending on your preference) must be less than 0 revolutions, before the program will continue. The position that the register is tested against can be specified as an integer number of encoder counts, or can be specified as a non-integer number of revolutions.

10.7.19 Save position

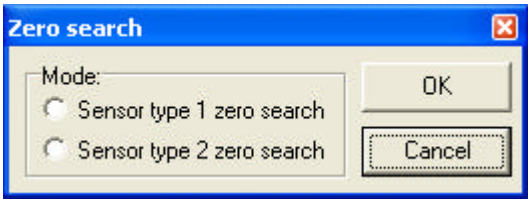
Icon:	
Dialog:	
Function:	Saves the current position from register no. 10 (P_IST) to one of three locations in the user memory area. The saved position(s) can then be used whenever a position or distance is needed in a move command.

10.7 Graphic programming command reference

10.7.20 Set position

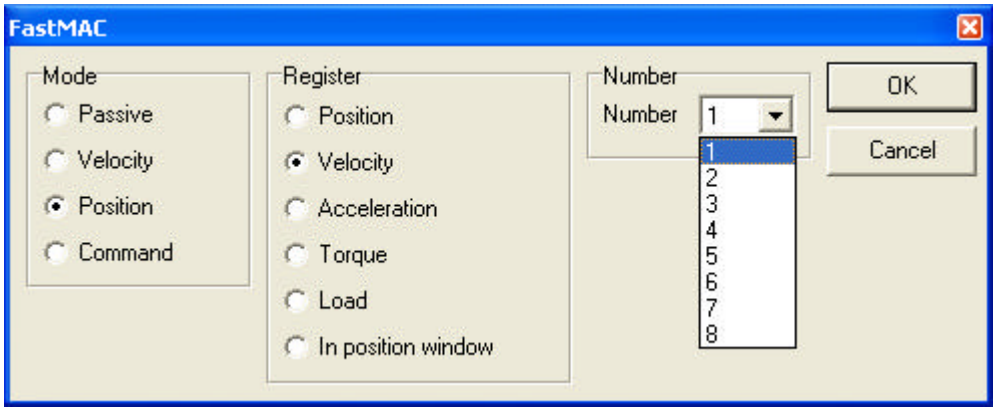
Icon:	
Dialog:	
Function:	Sets the current position stored in register no. 10 (P_IST) to one of three position values stored in the user memory area. This is the reverse of the 'Save position' command.

10.7.21 Zero search

Icon:	
Dialog:	
Function:	Initiates a zero search. The program waits until the zero search has completed before proceeding to the next command. For a detailed description of how to set up a zero search, refer to Zero search modes, page 58

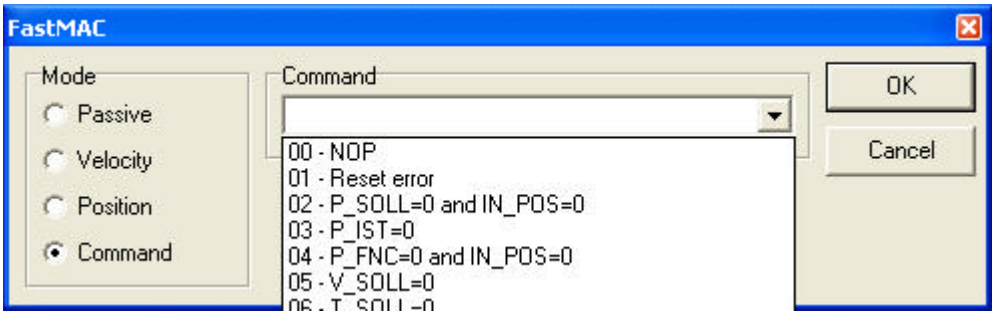
10.7 Graphic programming command reference

10.7.22 Send FastMAC command (change mode and activate register)

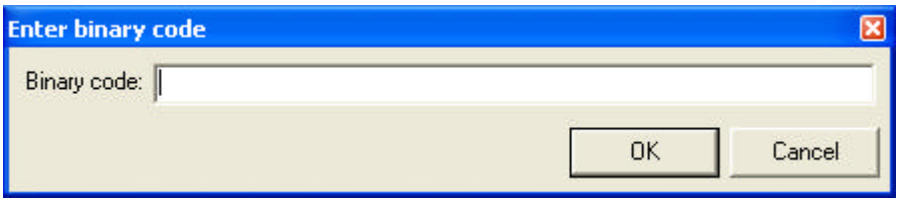
Icon:	
Dialog:	
Function:	FastMAC commands are also sometimes referred to as FlexMAC commands. The advantage of these commands is a very low communication overhead. FastMAC/FlexMAC commands are described in detail in section 4.5.7 of the MAC user manual, JVL publication no. LB0047-20GB. However, a brief summary is in order. If 'Mode' is set to 'Passive', 'Velocity', or 'Position', the motor will switch to that mode. Also, one of the passive motor registers will be activated, in the sense that its value will be written to the corresponding active motor register, which actually controls motor behaviour. In the example above, the value in register no. 65 (V1) will be written to register no. 5 (V_SOLL). Move operations will then take place at that velocity.

10.7 Graphic programming command reference

10.7.23 Send FastMAC command (macro command)

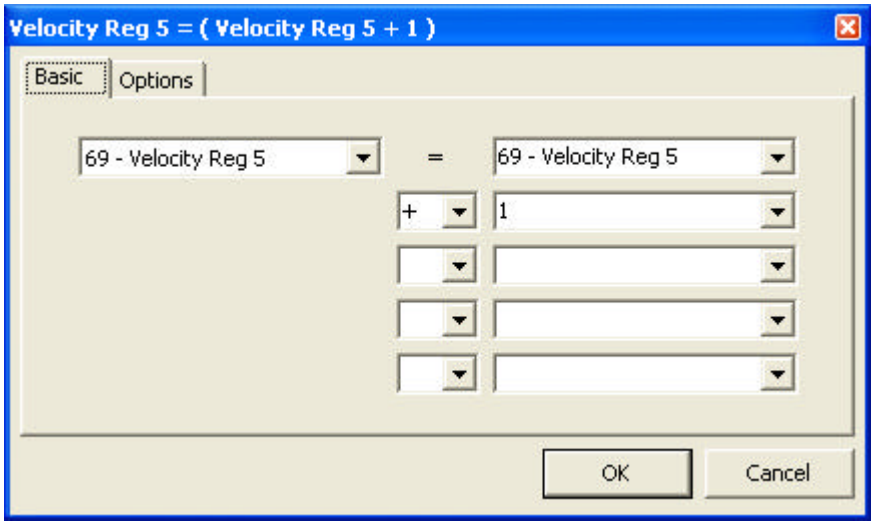
Icon:	
Dialog:	
Function:	If 'Mode' is set to 'Command', the motor does not necessarily change mode but it can be commanded to carry out a series of predetermined operations. Describing all of the FastMAC commands is beyond the scope of this section but for example, using a single command it is possible to activate four different sets of registers, each controlling position, velocity, acceleration, torque, load factor, and in-position window. For further details, refer to section 4.5.7 of the MAC user manual.

10.7.24 Binary command

Icon:	
Dialog:	
Function:	MacTalk SMC75 programs are sent to the motor in a compact, binary format, which is then interpreted by the SMC75's firmware. The existing set of graphic commands covers most situations, but when special needs arise, anything that can be done with SMC75 programs can be done with a binary command. If special needs arise that are not covered by the other commands, contact JVL for assistance.

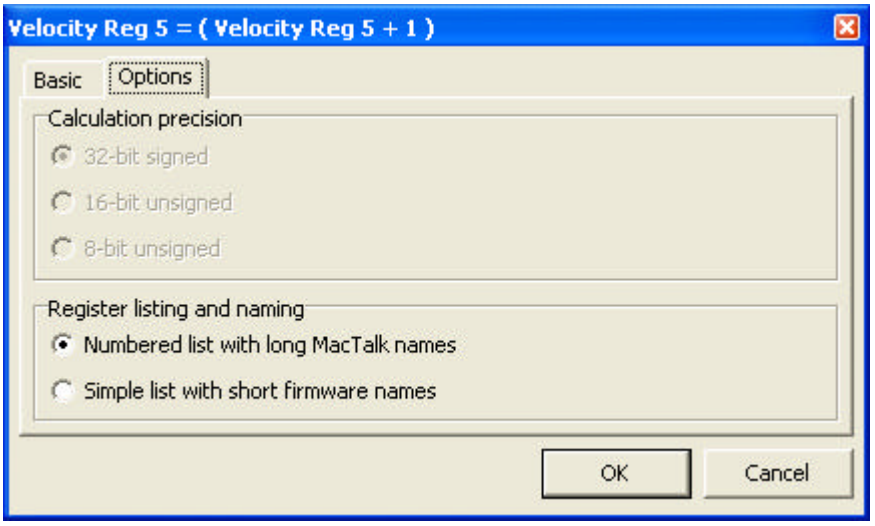
10.7 Graphic programming command reference

10.7.25 Calculator (basic)

Icon:	
Dialog:	
Function:	Performs a calculation using register values, constants, and the four basic arithmetic operations: +, -, * and /. The result is stored in a register. Arithmetic operations take place in the order that they are specified. Operands/arguments can be either integer constants or registers. The caption of the dialog box shows the resulting expression in traditional infix format. It is continuously updated as you type in the expression. Note that if you write a value to a register using this command, that value is always measured in native motor units. Conversion from generic engineering units is only supported for the commands 'Set a register in the MAC motor', 'Jump according to a register in the MAC motor', and 'Wait for a register value before continuing'.

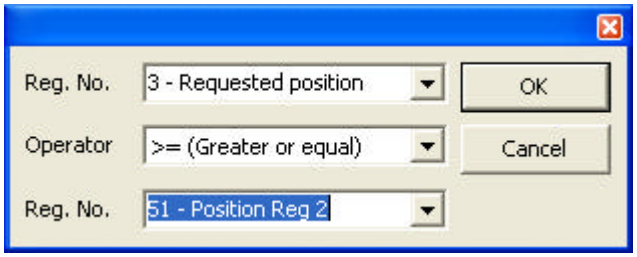
10.7 Graphic programming command reference

10.7.26 Calculator (options)

Icon:	
Dialog:	
Function:	The options tab contains various settings that affect the operation of the Calculator command. 'Calculation precision' is currently preset to 32-bit precision and cannot be changed. This is not an error, and should not be reported. 'Register listing and naming' provides an alternative method of entering data into the dialog by selecting 'Simple list with short firmware names'. Instead of selecting, for example, '3 – Requested position' to access register no. 3, you can simply type 'P_SOLL'. If you wish to enter a constant, you simply enter the digits – the dialog will not mistake the constant for a register number. If you are in doubt about a register name, look at the expression in the caption of the dialog box. A recognized register name will appear in the expression. An unrecognized register name will appear as a zero. You can switch between the two methods of data entry at any time.

10.7 Graphic programming command reference

10.7.27 Jump according to a comparison

Icon:	
Dialog:	
Function:	Compares two registers with each other before either jumping to another line in the program or moving on to the next line in the program. If the condition is met, the command jumps to the specified program line. If the condition is not met, the program proceeds to execute the next line in the program. Any two registers can be compared with each other but the command does not do anything beyond comparing the registers numerical values measured in native motor units. To ensure that comparisons are meaningful, it is preferable to compare registers that hold the same type of information in the same binary format. In the example above, two position registers are compared. Both hold position information, both are 32-bit wide, and both measure position in encoder counts. Such a comparison will always yield meaningful, predictable results. For other types of registers, see the relevant register sections.

11 CANopen Introduction

This chapter deals with JVL's Step motor controller SMC75, which is used with the MIS231, MIS232 and MIS234 motors on a CANopen network.

The chapter covers the following main topics:

- General introduction: a section with general information about CANopen. See section 11.1.1 to section 11.1.5.

- Setting up the Baud-rate, node-id and termination of the CAN bus. Covers also the wiring of the CAN bus. See section 11.2.1 to section 11.2.6.

- Using CanOpenExplorer.
  See section 11.3.1 to section 11.3.3.

- Survey of Communication specific objects and manufacturer specific objects in the DS301standard. Communication objects consist of the general information about the settings in the module, while the Manufacturer specific objects consist of the settings of input/output and the motor parameters. This section also covers the settings of the transmit and receive PDOs in the module. See section 11.4.1 to section 11.4.6.

- Survey of objects which are used in the DSP-402 standard. See section 11.5.1 to section 11.5.7.

- Section with more detailed explanations of the CANopen theory, particularly DS-301.
  See section 11.6.1 to section 11.6.7.

11.1 General information about CANopen

11.1.1 Introduction

A CanOpen option is available for the SMC75. When this option is installed, the SMC75 includes a CANopen slave. Through the CANopen slave, all the registers of the SMC75 can be accessed. The SMC75 implements an object dictionary that follows the CiA DS-301 standard.

The SMC75 contains a number of statically mapped PDOs that can be used to access the most common registers.

It also supports the DSP-402 (motion profile) standard, and the motor can be controlled using this as well.

The SMC75 Controller is designed to be used on a CANbus, CANopen DS-301 and CANopen DSP-402. Do not use the module together with CANKingdom or DeviceNet.

11.1.2 CiA membership

CiA (CAN in Automation) is a non-profit society. The object of the society is to promote CAN (Controller-Area-Network) and to provide a path for future developments of the CAN protocol. CiA specifications cover physical layer definitions as well as application layer and device profile descriptions.

In order to receive the CAN standard, is it necessary to obtain CiA membership. The membership fee depends on a company's number of employees. Membership runs from January 1st until December 31st and is renewed automatically unless cancelled in writing by the end of a calendar year. Companies applying for membership after July 1st pay 50% of annual membership.

A PDF application form can be downloaded from http://www.can-cia.org/cia/application.html.

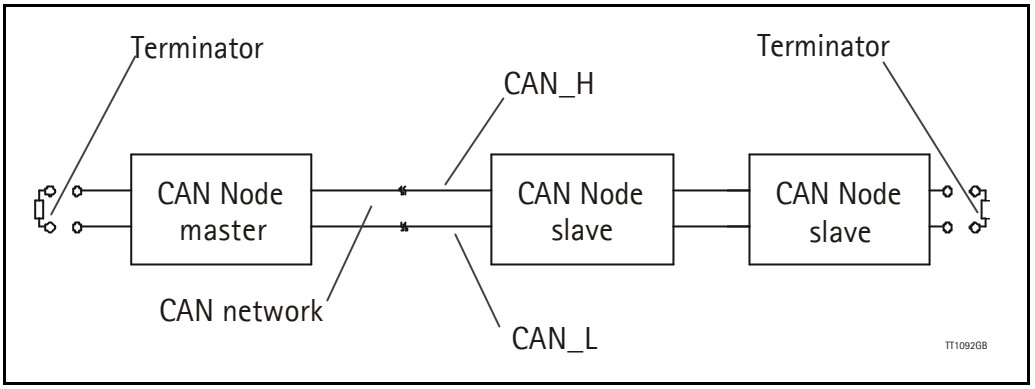
Note: Once you have received a license from CIA, standards will be sent on a CD and are downloadable via member login. All of the CiA specifications can be ordered from the following URL:

www.can-cia.org/downloads/ciaspecifications/

11.1.3 CANopen network

The CAN bus is a serial bus with multi-master capabilities where different products from different manufacturers can communicate with each other. These include, for example, devices such as PLCs, motors, sensors and actuators. Some message types have higher priority and are sent first, for time-critical applications. New devices can easily be integrated on an existing bus, without the need to reconfigure the entire network. The devices are connected through a 2-wire bus cable with ground, and data is transmitted serially.

11.1 General information about CANopen



11.1.4 CANopen, general information

CANopen is a CAN-based, higher-level protocol. The purpose of CANopen is to give an understandable and unique behaviour on the CAN network. The CAN network is the hardware level of the system, and CANopen is the software level. CANopen is based on the communication profile described in CiA DS-301, and specifies all of the basic communication mechanisms.

CiA DS-301contains message types on the lowest software level. The DSP-402 CANopen standard defines the device profile and the functional behaviour for servo drive controllers, frequency inverters and stepper motors. The DSP-402 constitutes a higher software level, and it uses the DS-301 communication, but makes the device independent of the manufacturer. Not all JVL functionality is available.

The CANbus with real-time capabilities works in accordance with the ISO11898 standard. The major performance features and characteristic of the CAN protocol are described below:

Message-oriented protocol:
The CAN protocol does not exchange data by addressing the recipient of the message, but rather marks each transmitted message with a message identifier. All nodes in the network check the identifier when they receive a message to see whether it is relevant for them. Messages can therefore, be accepted by none, one, several or all participants.

Prioritisation of messages:
As the identifier in a message also determines its priority for accessing the bus, it is possible to specify a correspondingly rapid bus access for messages according to their importance. Especially important messages can thus gain access to the bus without a prolonged wait-time, regardless of the loading on the bus at any instant.

This characteristic means that important messages are transmitted with high priority even in exceptional situations, thereby ensuring proper functioning of a system even during phases of restricted transmission capacity.

11.1 General information about CANopen

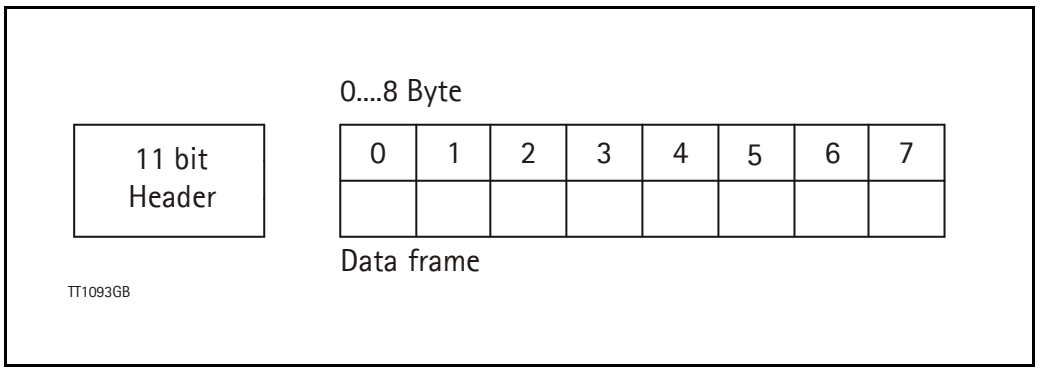
Multi-Master capability:
Bus access rights are not issued by a mean-level control unit (bus master) per network. Instead, each network node can start to send a message with equal rights as soon as the bus has become free. If several participants access the bus at the same time, an arbitration process allocates each participant the bus access right in line with the priority of the message they want to send at that particular moment. Each participant can therefore communicate directly with every other participant. As the transmission of a message can be initiated by the message source itself, then in the case of event-controlled transmission of messages, the bus is only occupied when a new message is on-hand.

No-loss bus arbitration:
As the bus is accessed at random under the CAN protocol, it is possible that several participants try to occupy the bus at the same time. In other random bus access routines, this causes the destruction of suppressed messages. In order to solve such a bus access conflict, a repeated occupation of the bus is required using an appropriate triggering strategy. The CAN protocol therefore deploys a routine to ensure that the message with the highest priority at any given time is sent without any destruction of message contents.

Short block length:
The maximum data length of a CAN message is limited to 8 bytes. This data length is usually sufficient to transmit the information occurring in the lowest field area in a CAN message.

11.1.5 Header

A CAN message transmits the communications object and a variety of management and control information. The management and control information bits are used to ensure error-free data transmission, and are automatically removed from the received message and inserted before a message is sent. A simplified CANopen message could be as in the figure below:



The two bit fields “Header” and “Data” form the simplified CANopen message. The 11-bit Header is also designated as the identifier or as the COB-ID (Communication Object identifier).

11.1 General information about CANopen

JVL uses the 11-bit format type CAN A, but not the 29-bit format type CAN B.

The COB-ID carries out two tasks for the controller communications object.
- Bus arbitration: Specification of transmission priorities.
- Identification of communications objects.

The COB-ID comprises two sections:
- Function code, 4 bits in size (0....15)
- Node address (Node ID), 7 bits in size (0....127).

The function code classifies the communications objects, and controls the transmission priorities. Objects with a small function code are transmitted with high priority. For example, in the case of simultaneous bus access an object with the function code "1" is sent before an object with the function code "3".

Node address:
Every device is configured before network operation with a unique 7-bit long node address between 1 and 127. The device address "0" is reserved for broadcast transmissions, in which messages are sent simultaneously to all devices.

PDO, SDO, EMCY, NMT and heartbeat use the header frame for communication on the CANopen bus.

11.2 Connection and setup of the CAN bus

11.2.1 Connecting the SMC75 Controller to the CAN bus

Before you connect the Controller SMC75 to the CAN-bus, the Baud-rate, the Node-ID and the termination must be selected.

On the serial bus it is possible to set a transmission speed (Baud-rate) of max.1000 Kbit/s and a min. of 10 Kbit/s. The Baud-rate depends on the cable length, and the wire cross-section. The table below gives some recommendations for networks with less than 64 nodes. Recommended bus cable cross-sections are according to CIA.
:

Bus Distance (m)	Cross-section (mm^2)	Terminator (Ohms)	Baud-rate (Kbit/s)
25	0.25-0.34	120	1000
100	0.34-0.6	150-300	500
250	0.34-0.6	150-300	250
500	0.5-0.6	150-300	125
500	0.5-0.6	150-300	100
1000	0.75-0.8	150-300	50

The bus wires may be routed in parallel, twisted and/or shielded, depending on EMC requirements. The layout of the wiring should be as close as possible to a single line structure in order to minimize reflections. The cable stubs for connection of the bus node must be as short as possible, especially at high bit rates. The cable shielding in the housing must have a large contact area. For a drop cable, a wire cross-section of 0.25 to 0.34 mm^2 would be an appropriate choice in many cases.

For bus lengths greater than 1 km, a bridge or repeater device is recommended. Galvanic isolation between the bus nodes is optional.

11.2.2 Necessary accessories for SMC75 Controller:

The EDS file for the SMC75 is available for download at JVL's web-site, http://www.jvl.dk, under the downloads menu, Field bus Interface Specifications Files. EDS means Electronic Data Sheet. This file contains the information about SMC75 settings that are required to configure the setup and program in the master. The SMC75 is a slave module on the CAN-bus. The master can, for example, be a PLC or a PC.

If you are using a PLC as master, then make sure it is provided with a CANopen communications module, and that the correct programming tools are available. For support of the PLC master, the PLC vendor is recommended.

If you are using a PC as master, JVL provides some tools that can help when installing and using the SMC75 Controller.

11.2 Connection and setup of the CAN bus

The latest firmware for the SMC75 is available at JVL's web-site under the menu downloads/firmware. In the site's programs menu, the software CanOpen Explorer is also available, but note that this is not a free-ware program. Please contact your JVL representative for further information.

CanOpen Explorer can be used to load the EDS file and operate with the motor. The CanOpenExplorer software must use a special dongle for communication with the PC. For further information about the dongle, see An overall method for communication test, page 130. The PC must be provided with a CANopen communications module.

11.2.3 EDS (Electronic data Sheet)

In order to give the user of CANopen more support, the device description is available in a standardised way, and gives the opportunity to create standardised tools for configuration of CANopen devices, designing networks with CANopen devices, and managing project information on different platforms. The EDS file are ASCII-coded.

11.2.4 Setting the node id and baud rate

The node id is set using MacTalk. It is located in register 162. The baud rate is also set using MacTalk and is located in register 163.

11.2 Connection and setup of the CAN bus

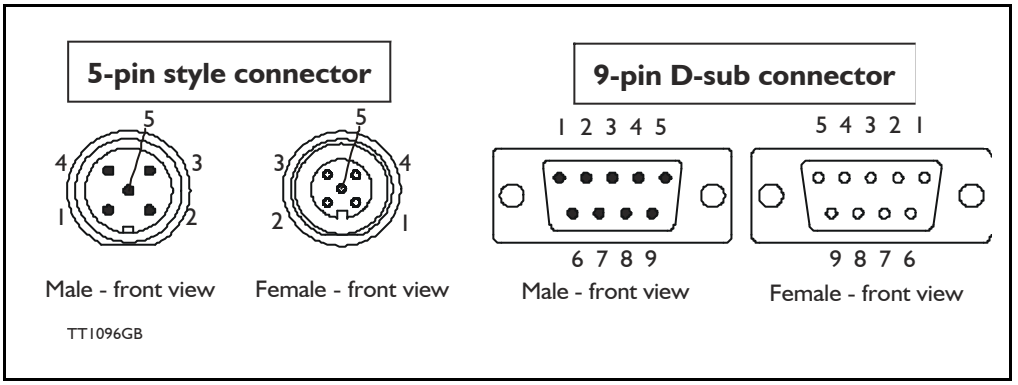
11.2.5 Bus termination

In order to guarantee correct operation of the CAN bus, bus terminating resistors must be provided at both ends of the bus cable.

CAN bus connectors:
The SMC75 does not use 9-pin D-sub connectors and none of the cables JVL supplies are provided with a 9-pin D-sub connector, but the PIN configuration is also shown in the table below.

Signal	Description	SMC75	D-sub
-	Reserved		Pin 1
CAN_L	CAN_L bus line (Low)	Pin 5	Pin 2
CAN_GND	CAN Ground	Pin 3	Pin 3
-	Reserved		Pin 4
(CAN_SHLD)	Optional CAN Shield	Pin 1	Pin 5
(GND)	Optional CAN Ground		Pin 6
CAN_H	CAN_H bus line (High)	Pin 4	Pin 7
-	Reserved (error line)		Pin 8
CAN_V+	Optional CAN ext. + supply	Pin 2	Pin 9

The figure below shows the 9-pin D-sub and 5-pin style connectors.



11.2 Connection and setup of the CAN bus

11.2.6 SMC75 connectors, rear plate layout

The MIS motors offer IP67 protection and M12 connectors which make them ideal for automation applications where no additional protection is desired. The M12 connectors offer solid mechanical protection and are easy to unplug.

The connector layout:

"PWR" - Power input. M12 - 5-pin male connector

Signal name	Description	Pin no.	JVL Cable WI1000M12 F5A05N	Isolation group
P+	Main supply +12-48VDC. Connect with pin 2 *	1	Brown	1
P+	Main supply +12-48VDC. Connect with pin 1 *	2	White	1
P-	Main supply ground. Connect with pin 5 *	3	Blue	1
CV	Control voltage +12-28VDC.	4	Black	1
P-	Main supply ground. Connect with pin 3 *	5	Grey	1

* Note: P+ and P- are each available at 2 terminals. Ensure that both terminals are connected in order to split the supply current in 2 terminals and thereby avoid an overload of the connector.

"BUS1" - CAN-open interface. M12 - 5-pin male connector

Signal name	Description	Pin no.	Cable: user supplied	Isolation group
CAN_SHLD	Shield for the CAN interface - internally connected to the motor housing	1	-	2
CAN_V+	Reserved for future purpose - do not connect	2	-	2
CAN_GND	CAN interface ground	3	-	2
CAN_H	CAN interface. Positive signal line	4	-	2
CAN_L	CAN interface. Negative signal line	5	-	2

"BUS2" - CANopen interface. M12 - 5-pin female connector

Signal name	Description	Pin no.	Cable: user supplied	Isolation group
CAN_SHLD	Shield for the CAN interface - internally connected to the motor housing	1	-	2
CAN_V+	Reserved for future purpose - do not connect	2	-	2
CAN_GND	CAN interface ground	3	-	2
CAN_H	CAN interface. Positive signal line	4	-	2
CAN_L	CAN interface. Negative signal line	5	-	2

"IO" - I/Os and R485 interface. M12 - 8-pin female connector.

Signal name		Description	Pin no.	JVL Cable WI1000-M12 M8A05N	Isolation group
IO1	IO5	I/O terminal 1	1	White	3
IO2	IO6	I/O terminal 2	2	Brown	3
IO3	IO7	IO terminal 3	3	Green	3
GNDIO	GNDIO	Ground for I/O	4	Yellow	3
B+	Tx	RS485 (5V serial)	5	Grey	3
A-	Rx	RS485 (5V serial)	6	Pink	3
IO4	IO8	I/O terminal	7	Blue	3
CVO	CVO	Out	8	Red	3

Cable Screen

Some standard cables with M12 connector offer a screen around the cable. This screen on some cables is fitted to the outer metal at the M12 connector. When fitted to the SMC75 controller, this means that the screen will have contact with the complete motor housing and thereby also the power ground (main ground).

11.3 Using CanOpenExplorer

11.3.1 The CanOpenExplorer program

The CanOpenExplorer is a program that was developed for internal use only, especially in production, but the program offers features that are very convenient and which make it very easy to start up the MIS motor when this is supplied with an SMC75 CANopen Controller module.

The program can write and send SDOs, PDOs, SYNC and heartbeat messages, and also can read EDS files.

11.3.2 An overall method for communication test

Depending on the type of master and software solution available, the following components must be available:

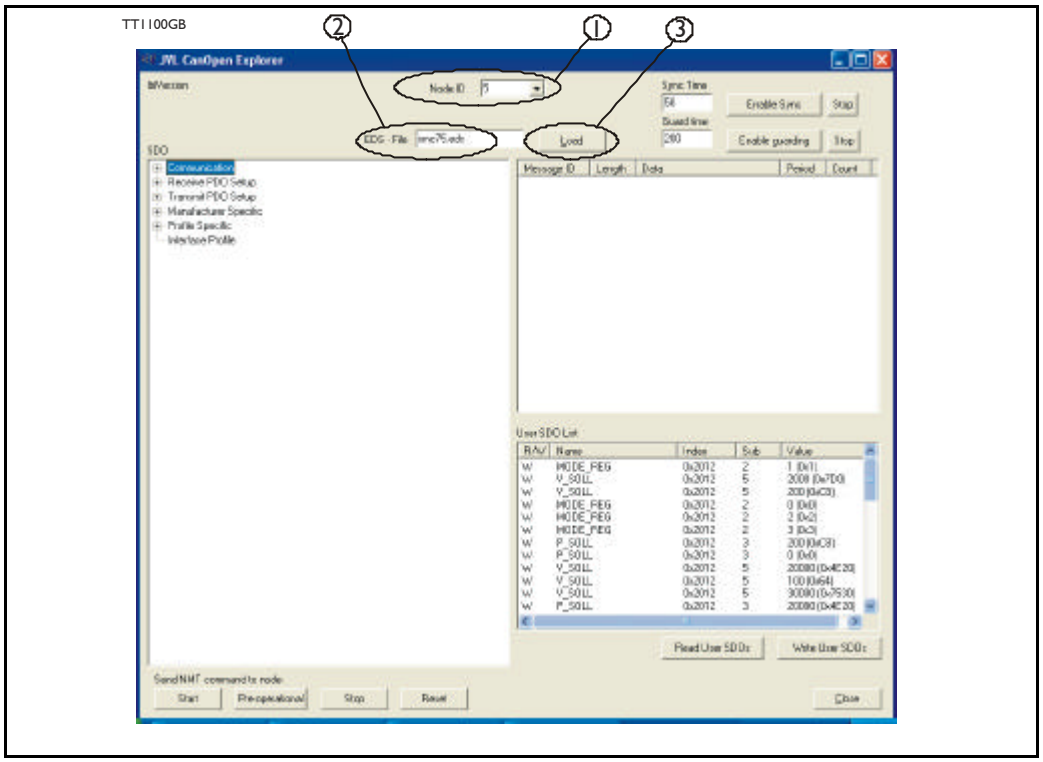
PLC: PLC with a CANopen module and software that can communicate with this module.
The CANopen module must be connected to a CAN bus, as shown in section 11.2.6. To set up the master, download the EDS file from the JVL web site (see section 11.2.2). This file contains all register set-up data for the SMC75 Controller. For details of the node-ID and the Baud-rate, see section 11.2.4. The power supply must be connected to the motor as shown in section 11.2.6.

PC: PC with a CAN adaptor and software that can communicate with this module, or if the CanOpen Explorer software is used, the PCAN-USB Dongle from Peak-system that is connected to a USB port on the PC. The Peak systems web site address is http://www.peak-system.com. This includes a list of distributors. To set up the master, download the EDS file from the JVL web-page, see section 11.2.2. This file contains all register set-up data for the SMC75. For details of the node-ID and the Baud-rate, see section 11.2.4. The power supply must be connected to the motor as shown in section 11.2.6.

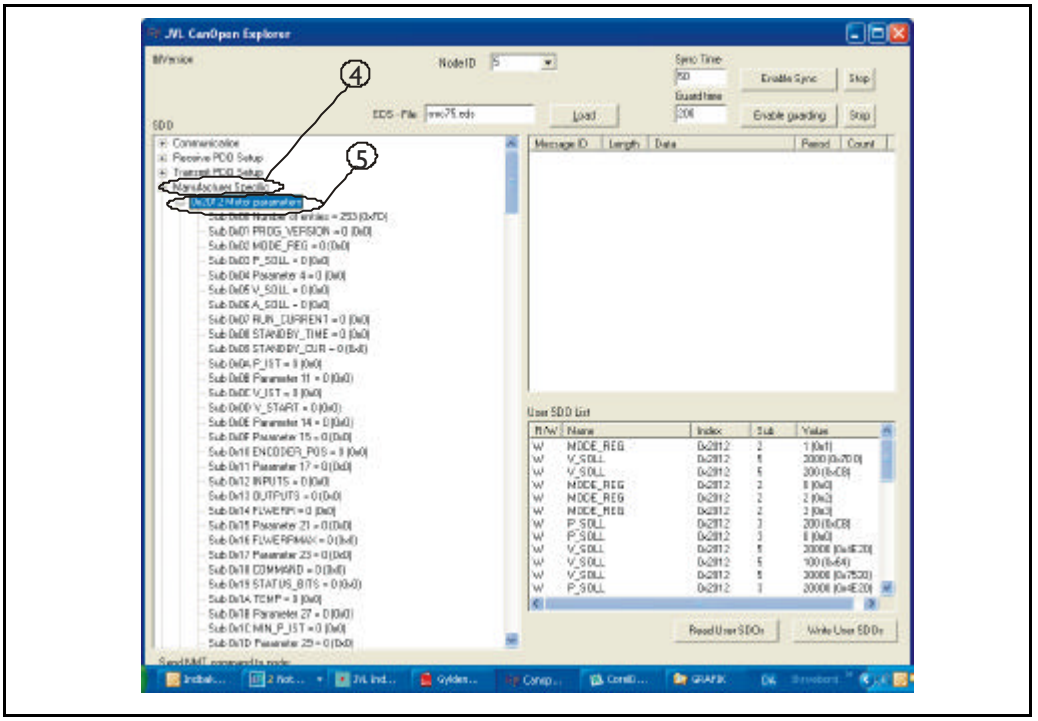
If CanOpenExplorer is used, see the following method for testing the motor communication:

-Install CanOpenExplorer
-Connect the motor to the USB port via the Dongle.
-Connect power supply, see section section 11.2.6 or section 2.
-Run the CanOpenExplorer program on the PC.

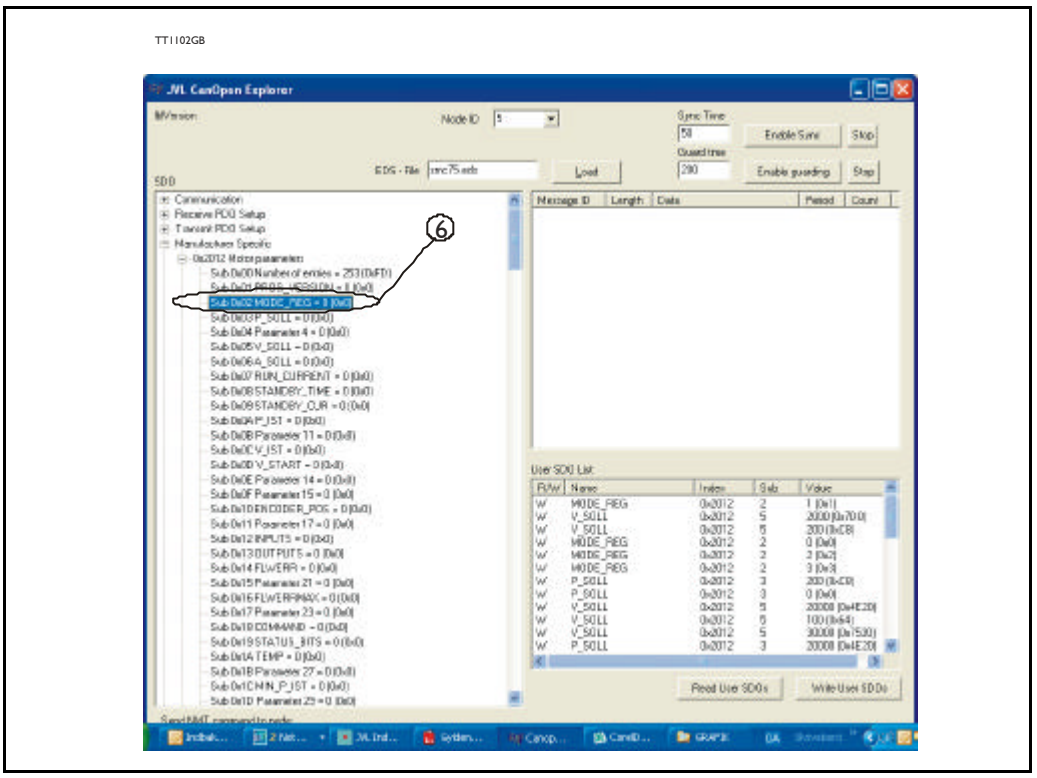
1: Select the correct node ID in the slave using MacTalk. See section 11.2.4.
2: Select the EDS file. For all the MIS motors this file is SMC75.eds.
3: Load the EDS file by pressing load.



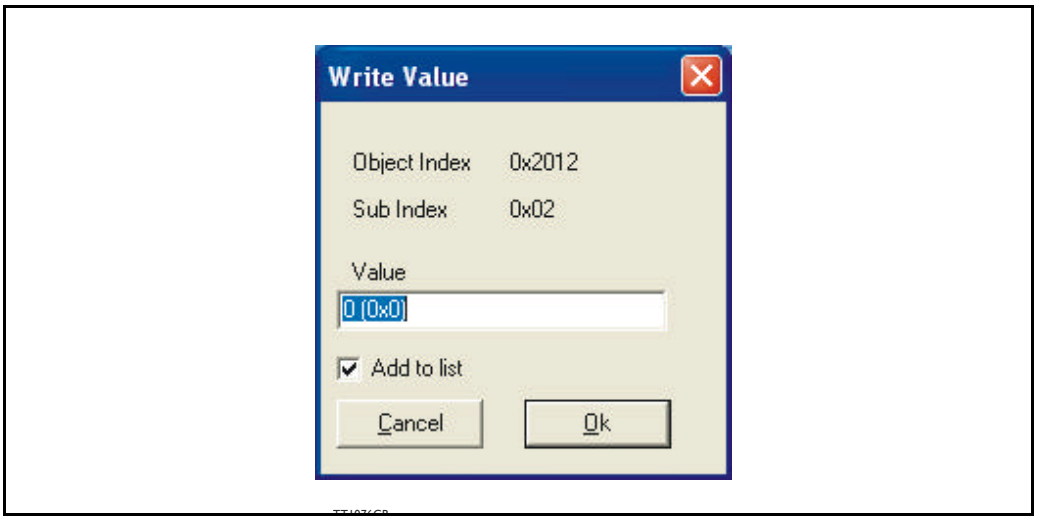
4: Select here on the +the manufacturer specific register.
5: Select thereafter the object 0x2012. Object 0x2012 contains the motor parameters.



6: Point to the sub register 0x02, which is the register that determines in which mode the motor will operate.



Press W on the keyboard. The following screen appears:



7: Type 02 in the window, and press OK.

8: Click on the sub register 0x05, which is the register to choose the velocity the motor will use. Press W on the keyboard, type 100 in the window, and press OK. The value 100 is in RPM.

9: Click on the sub register 0x03, which is the register to choose the distance the motor will run. Press W on the keyboard, type 20000 in the window, and type OK. The value 20000 is in Steps

Now the motor shaft will rotate slowly, until the motor has counted 20000 Encoder pulses. If you want to stop the motor, then click on sub register 0x02 and write 0 in the window, and the motor will switch to passive mode. If using other software, the test could be described as, (using object 2012h):

Sub-register	Name	Width	Unit	Operation	Value
02h	Mode_Reg	16 bit		Set up the motor in position mode	02h
05h	V_SOLL	16 bit	RPM	Sets up the desired velocity	100h
03h	P_SOLL	32 bit	Steps	The motor rotates the desired numbers of encoder pulses	20000
02h	Mode_Reg	16 bit		Sets the motor to passive mode	00h
Returning the motor with higher velocity					
02h	Mode_Reg	16 bit		Set up the motor in position mode	02h
05h	V_SOLL	16 bit	RPM	Sets up the desired velocity	200h
03h	P_SOLL	32 bit	Steps	The motor rotates the desired numbers of Steps	-20000
02h	Mode_Reg	16 bit		Sets the motor in passive mode	00h

11.3.3 How to use CanOpenexplorer

After startup, the name and details of the HW-interface, such as PCAN_USB should appear upper left.

When you turn on a motor/CAN node after having started CanOpenexplorer, the Data Window (large centre right), will contain a message with the number 0x7xx, where xx is the node ID. For example: 0x704 will indicate node 4. Set the Node ID field top centre to that value (4).

Ensure that the correct EDS_file is loaded. The program loads a hard-coded default file - either smc75.eds or mac00-fc.eds. It is also possible to load another EDS file by writing the file name in the “EDS file” field, top centre, and pressing the load button. Note that the EDS view (large centre left panel) will add the new file at the bottom but will not clear any existing file(s) that are loaded.

Normal operation will be to select an object in the EDS view pane, and press either R for read or W for write. Pressing R should read the value (successful if no error pops up). Pressing W for write will pop up a small window in which the present value is displayed in both decimal and hex. It is then possible to write a new value either in decimal or hex using a 0x prefix, such as 0x185 to enable the first TPDO on node 5 (by clearing the high bit). If the “Add to list” checkbox is checked, the object will be added to the user SDO list as a write SDO. Pressing A performs a read and adds it to the user SDO list pane (lower right) as a read SDO.

The SDOs in the user SDO pane can be rearranged by dragging them with the mouse. Double-clicking on a user SDO list will execute the operation, either reading or writing. The bus state can be changed using the NMT buttons, lower left, e.g. to Operational to enable PDOs.

The button Read User SDOs will read all of the “R” type objects in the user SDO list. This is useful for updating a large number of values in the EDS view.

The button Write User SDOs will write all of the “W” type objects in the user SDO list. This is useful for automated testing.

Entries can be deleted from the user SDO list by selecting them with the mouse and pressing the delete key.

The sync Time field (top right) sets the time in milliseconds for the SYNC messages to be sent out. SYNCs can be started and stopped using the buttons Enable Sync and the Stop button to the right.

The Guard Time field below the Sync Time field works like SYNC - just for the Guarding message.

The close button exits the program after saving the list of user SDOs, which will be automatically reloaded at the next program start.

11.4 Objects in the DS301 standard

11.4.1 DS301 specified Communications objects

The DS301 specified Communications objects are shown in the table below. To obtain the default value in CanOpenExplorer, press R on the keyboard, and the actual value will be shown.

Name	Index (hex)	Sub Index	Data Type	Read only	Default	Description
Device type	1000		UNSIGNED32	X	0x40192	Contains information about the device type. See note at top of next page. Mandatory.
Error Register	1001		UNSIGNED8	X		This is the mapping error register, and it is part of the emergency object. If any of the sub indices are high, an error has occured. See also section 11.4.2. Mandatory
		0				Generic error. Mandatory
		1				Current
		2				Voltage
		3				Temperature
		4				Communication (Overrun)
		5				Device profile specific
		6				Reserved
		7				Manufactor specific
Reservation register	1004					Reservation of PDOs
		0		X		Reserved numbers of PDOs
		1		X		Reserved numbers of syncPDOs
		2		X		Reserved numbers of asyncPDOs
Manufacturer device name	1008		VISIBLE STRING	X	JVL A/S	
Manufacturer hardware version	1009		VISIBLE STRING	X		
Manufacturer software version	100A		VISIBLE STRING	X		Example: Version x.x

Name	Index (hex)	Sub Index	Data Type	Read only	Default	Description
Guard time	100C		UNSIGNED16			Informs about the Guard time in milliseconds. Is only mandatory if the module does not support heartbeat
Life time factor	100D		UNSIGNED8			Is the factor that guard time is multiplied with to give the life time for the node quarding protocol
Heartbeat time	1017		UNSIGNED8			If the Heartbeat timer is not 0, Heartbeat is used.
Identity object	1018		IDENTITY	X		Contain general information about the module
		0	1..4	X	4h	Number of entries. Mandatory
		1	UNSIGNED32	X	0x0117	Vendor ID, contains a unique value allocated to each manufactor. 117h is JVLs vendor ID. Mandatory.
		2	UNSIGNED32	X	0x0200	Product Code, identifies a specific device version. SMC75 has the product code 200H
		3	UNSIGNED32	X		Revision number.
		4	UNSIGNED32	X		Serial number

Note regarding "device type" (index 1000):
The device type register is composed of 2 16-bit registers. One register describes which device profile the module supports, and the other states which type of motors the module supports, and possible I/O module. The default value 0192h denotes that the DSP402 Device profile is supported, and the value 0004h denotes that the SMC75 Controller supports stepper motors.

11.4.2 Emergency object

The EMCY (emergency) object is used to transfer an error message to the CANopen master, or also to another node which can process the error message. The reaction on the emergency object is not specified. An emergency object is transmitted only once per "error event".

The SMC75 supports the EMC object (Emergency).
The following error codes can be generated:

Errorcode 1001h: Generic error - Motor error
Errorcode 1002h: Generic error - Position error
Errorcode 1003h: Generic error - Follow error
Errorcode 1004h: Generic error - Low

Transmit PDO25:
Use Transmit PDO25 in asynchronous mode to read the status of the error.

In the SMC75, no error control is enabled when the modules are started up because if there is any fault in the system, it is impossible to get in contact with the module. After the module has started up and there is communication between the master and the slave, turn on the required error control mechanism in the communication objects, see section 11.4.1.

11.4 Objects in the DS301 standard

11.4.3 Object dictionary

Name	Index (hex)	Sub Index	Type	Read only	Default	Description
Motor parameters	2012	0	Unsigned8	x	254	Subindex count
		n	Unsigned32			Access to the 32 bit motor register, n
Motor parameters	2014	0	Unsigned8	x	254	Subindex count
		n	Unsigned16			Access to the motor register n, but as 16bit

Writing to these objects in CANopenExplorer is done by pressing W on the keyboard when the register in folder Manufacturer is selected. Reading is done by pressing R.

Object 2012h – Motor parameters
With this object, all the registers of the MIS 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.

Object 2014h – Motor parameters (16 bit)
Works as 2012h, but the parameters are accessed as 16-bit. If writing to a 32bit parameter, the 16-bit value will be treated as signed.

11.4.4 Enable and Disable PDOs

In the CANOpen profile, it is only possible to have four transmit and four receive PDOs enabled at the same time. In the SMC75 controller, all PDOs are disabled when the module is booted up. The user must choose which PDOs the application will use and enable these.

To enable or disable a PDO, it is necessary to write to the MSB (bit 31) in the PDO COB-ID entry in the PDO communication parameter Record. The COB-ID register is sub-index 1h, and the value range of this register is UNSIGNED32.

The PDOs are enabled when bit 31 is 0, and is disabled when bit 31 is 1.

11.4.5 Receive PDOs

The PDO 1-20 are reserved for use with DSP-402.
The following receive PDOs are available:

Receive PDO 21:
This PDO can be used to update the position, velocity and acceleration. 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.

11.4 Objects in the DS301 standard

The table below shows default values of the COB-ID:

PDO	Sub-index	Type	Description	Default	Access type
21	1	Receive	COB-ID	Nodeid+0x80000200	r/w
	1	Transmit	COB-ID	Nodeid+0x80000180	r/w
22	1	Receive	COB-ID	Nodeid+0x80000300	r/w
	1	Transmit	COB-ID	Nodeid+0x80000280	r/w
23	1	Receive	COB-ID	Nodeid+0x80000400	r/w
	1	Transmit	COB-ID	Nodeid+0x80000380	r/w
24	1	Receive	COB-ID	Nodeid+0x80000500	r/w
	1	Transmit	COB-ID	Nodeid+0x80000480	r/w
25	1	Transmit	COB-ID	Nodeid+0x80000480	r/w

Byte	0	1	2	3	4	5	6	7
Data	P_SOLL				V_SOLL		A_SOLL	
Object	2012h, sub 3				2014h, sub 5		2014h, sub 6	

Receive PDO 22:
With this PDO it is possible to update the running current and operating mode.

Byte	0	1	2	3	4	5	6	7
Data	RUN_CURRENT		MODE_REG					
Object	2014h, sub 7		2014h, sub 2					

Receive PDO 23:
This PDO can be used to issue a Motor command.

Byte	0	1	2	3	4	5	6	7
Data	Motor Command		Reserved	Reserved	Reserved	Res.	Res.	Res.
Object	2014h, sub 24							

Receive PDO 24:
This PDO updates the outputs.

Byte	0	1	2	3	4	5	6	7
Data	Output data		Reserved	Reserved	Reserved	Res.	Res.	Res.
Object	2014h, sub 19							

11.4 Objects in the DS301 standard

11.4.6 Transmit PDOs

The PDOs 1-20 are reserved for use with DSP-402.
All of the transmit PDOs support synchronous transmission. PDO 25 also supports asynchronous transmission.

Transmit PDO 21:

With this PDO the actual position can be read.

Byte	0	1	2	3	4	5	6	7
Data	P_IST				V_IST		Motor error	
Object	2012h, sub 10				2014h, sub 12		2014h, sub 35	

Transmit PDO 22:

With this PDO the actual velocity can be read.

Byte	0	1	2	3	4	5	6	7
Data	V_IST		Reserved	Reserved	Reserved	Res.	Res.	Res.
Object	2014h, sub 12							

Transmit PDO 23:

With this PDO the value of the analog inputs 1-4 can be read.

Byte	0	1	2	3	4	5	6	7
Data	ANALOG1		ANALOG2		ANALOG3		ANALOG4	
Object	2014h, sub 89		2014h, sub 90		2014h, sub 91		2014h, sub 92	

Transmit PDO 24:

With this PDO the value of the analog inputs 4-8 can be read.

Byte	0	1	2	3	4	5	6	7
Data	ANALOG5		ANALOG6		ANALOG7		ANALOG8	
Object	2014h, sub 93		2014h, sub 94		2014h, sub 95		2014h, sub 96	

Transmit PDO 25:

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

Byte	0	1	2	3	4	5	6	7
Data	Inputs		Motor error		Res.	Res.	Res.	Res.
Object	2014h, sub 18		2014h, sub 35					

11.5 Objects used in the DSP-402 standard

11.5.1 DSP-402 Support

Introduction
The SMC75 supports the DSP-402 standard from CiA (http://www.can-cia.com/). Please refer to this standard for details of the functions.

The DSP-402 is only a standard proposal and might be changed in the future. JVL therefore reserves the right to change future firmware versions to conform to new versions of the standard.

Not all of the functionality described in DSP-402 is supported, but all mandatory functions are supported.

The following operation modes are supported:
- Profile position mode
- Velocity mode
- Homing mode

Preconditions
The start mode of the motor must be set to passive.
No power up zero searches must be selected.
When using the DSP-402 mode, manipulating parameters with object 2012h or 2014h can corrupt the behaviour of the DSP-402 functions. Also be aware that manipulating parameters in MacTalk should be avoided when using DSP-402.

11.5 Objects used in the DSP-402 standard

Supported objects

The following table gives the additional object dictionary defined for DSP-402 support.

Name	Index (hex)	Sub Index	Type	Read only	Default
Device data					
Motor_type	6402	0	UNSIGNED16	X	9
Motor_catalog_number	6403	0	VISIBLE_STRING	X	SMC75
Motor_manufacturer	6404	0	VISIBLE_STRING	X	JVL A/S
http_motor_catalog_address	6405	0	VISIBLE_STRING	X	www.jvl.dk
Supported_drive_modes	6502	0	UNSIGNED32	X	37
Drive_catalog_number	6503	0	VISIBLE_STRING	X	SMC75
Drive_manufacturer	6504	0	VISIBLE_STRING	X	JVL A/S
http_drive_catalog_address	6505	0	VISIBLE_STRING	X	www.jvl.dk
Digital I/O					
Digital_inputs	60FD	0	UNSIGNED32	X	
Digital_outputs	60FE	0	UNSIGNED8	X	
Digital_outputs_Physical_outputs	60FE	1	UNSIGNED32		
Digital_outputs_Bit_mask	60FE	2	UNSIGNED32		
Device Control					
Abort_connection_option_code	6007	0	INTEGER16		
Error_code	603F	0	UNSIGNED16		
Controlword	6040	0	UNSIGNED16		
Statusword	6041	0	UNSIGNED16	X	
Quick_stop_option_code	605A	0	INTEGER16		
Modes_of_operation	6060	0	INTEGER8		
Modes_of_operation_display	6061	0	INTEGER8	X	
Profile Position parameters					
Position_actual_value	6064	0	INTEGER32	X	
Target_position	607A	0	INTEGER32		
Software_position_limit	607D	0	UNSIGNED8	X	2
Software_position_limit_Min_position_limit	607D	1	INTEGER32		
Software_position_limit_Max_position_limit	607D	2	INTEGER32		
Max_motor_speed	6080	0	UNSIGNED32		
Profile_velocity	6081	0	UNSIGNED32		
Profile_acceleration	6083	0	UNSIGNED32		

11.5 Objects used in the DSP-402 standard

Name	Index (hex)	Sub Index	Type	Read only	Default
Quick_stop_deceleration	6085	0	UNSIGNED32		
Motion_profile_type	6086	0	INTEGER16		
Profile velocity mode					
Velocity_sensor_actual_value	6069	0	INTEGER32	X	
Velocity_demand_value	606B	0	INTEGER32	X	
Velocity_actual_value	606C	0	INTEGER32	X	
Velocity_window	606D	0	UNSIGNED16		
Velocity_window_time	606E	0	UNSIGNED16		
Target_velocity	60FF	0	INTEGER32		
Max_torque	6072	0	UNSIGNED16		
Homing mode					
Home_offset	607C	0	INTEGER32		
Homing_method	6098	0	INTEGER8		
Homing_speeds	6099	0	UNSIGNED8	X	2
Homing_speeds_Speed_during_search_for_switch	6099	1	UNSIGNED32		
Homing_speeds_Speed_during_search_for_zero	6099	2	UNSIGNED32		
Homing_acceleration	609A	0	UNSIGNED32		
Factors					
Position_notation_index	6089	0	INTEGER8		
Position_dimension_index	608A	0	UNSIGNED8		
Velocity_notation_index	608B	0	INTEGER8		
Velocity_dimension_index	608C	0	UNSIGNED8		
Acceleration_notation_index	608D	0	INTEGER8		
Acceleration_dimension_index	608E	0	UNSIGNED8		
Position_encoder_resolution	608F	0	UNSIGNED8	X	2
Position_encoder_resolution_Encoder_increments	608F	1	UNSIGNED32		
Position_encoder_resolution_Motor_revolutions	608F	2	UNSIGNED32		
Velocity_encoder_resolution	6090	0	UNSIGNED8	X	2
Velocity_encoder_resolution_Encoder_increments_per_second	6090	1	UNSIGNED32		
Velocity_encoder_resolution_Motor_revolutions_per_second	6090	2	UNSIGNED32		
Gear_ratio	6091	0	UNSIGNED8	X	2
Gear_ratio_Motor_revolutions	6091	1	UNSIGNED32		
Gear_ratio_Shaft_revolutions	6091	2	UNSIGNED32		
Feed_constant	6092	0	UNSIGNED8	X	2

11.5 Objects used in the DSP-402 standard

Name	Index (hex)	Sub Index	Type	Read only	Default
Feed_constant_Feed	6092	1	UNSIGNED32		
Feed_constant_Shaft_revolutions	6092	2	UNSIGNED32		
Position_factor	6093	0	UNSIGNED8	X	2
Position_factor_Numerator	6093	1	UNSIGNED32		
Position_factor_Feed_constant	6093	2	UNSIGNED32		
Velocity_encoder_factor	6094	0	UNSIGNED8	X	2
Velocity_encoder_factor_Numerator	6094	1	UNSIGNED32		
Velocity_encoder_factor_Divisor	6094	2	UNSIGNED32		
Acceleration_factor	6097	0	UNSIGNED8	X	2
Acceleration_factor_Numerator	6097	1	UNSIGNED32		
Acceleration_factor_Divisor	6097	2	UNSIGNED32		
Polarity	607E	0	UNSIGNED8		

11.5.2 Factors

Position factor
The position factor is the relation between the user unit and the internal position unit (steps).
The position factor is automatically calculated when the feed constant (Obj. 6092h) and gear ratio (Obj. 6091h) are set.

Example:
A MIS232 Motor with a 3.5:1 gear box is connected to a belt drive. The diameter of the drive wheel is 12.4 cm.
The unit of position is required to be in millimetres.

The perimeter of the drive wheel is 389.56mm (124mm*pi)

The parameters should be set as follows:

Object	Name	Value
6091_h subindex 1	Gear ratio - Motor revolutions	35
6091_h subindex 2	Gear ratio - Shaft revolutions	10
6092_h subindex 1	Feed constant - Feed	38956
6092_h subindex 2	Feed constant - Shaft revolutions	100

11.5 Objects used in the DSP-402 standard

Velocity encoder factor
This factor is used to convert the user unit into the internal unit (RPM).
The factor is adjusted with the object 6094h.

Example 1:
An MIS232 has1600 counts/revolution.
We want the user unit of velocity to be in RPM. This is the same as the internal unit.

The parameters should be set as follows:

Object	Name	Value
6094_h subindex 1	Velocity encoder factor - Numerator	1600
6094_h subindex 2	Velocity encoder factor – Divisor	1600

Example 2:
We have an MIS232 that uses RPM as the internal velocity and the same belt drive as in the above Position factor example.
We want the user unit of velocity to be in mm/s.

The parameters should be set as follows:

Object	Name	Calculated value	Value
6094_h subindex 1	Velocity encoder factor - Numerator	(60*3.5)/389,56 = 0.53907	53907
6094_h subindex 2	Velocity encoder factor – Divisor	1	100000

Acceleration factor
This factor is used to convert the user unit into the internal unit (9.54 RPM/s).
The factor is adjusted with the object 6097h.

Example 1:
We have an MIS232 with 1600 counts/revolution.
We want the user unit of acceleration to be in RPM/s.

The parameters should be set as follows:

Object	Name	Value
6097_h subindex 1	Acceleration encoder factor - Numerator	100
6097_h subindex 2	Acceleration encoder factor – Divisor	954

Example 2:
We have an MIS232 with 1600 counts/revolution and the same belt drive as in the above Position factor example.
We want the user unit of acceleration to be in mm/s2.

The parameters should be set as follows:

Object	Name	Calculated value	Value
6097_h subindex 1	Acceleration factor- Numerator	(3,5*60)/389,56 = 0.53907	53907
6097_h subindex 2	Acceleration factor - Divisor	9.54	954000

11.5.3 Changing operation mode

Change of operation mode is only possible when the operation mode is not enabled. There is one exception and that is when changing from homing mode to profile position mode. This is possible when the homing sequence is completed and can be done even though the operation mode is enabled.

11.5.4 Profile position mode

This mode can be used for positioning in which a move profile can be set up. The acceleration and maximum velocity can be programmed.

In this mode both absolute and relative movement is supported. This is selected using bit 6 (abs/rel) in the status word. It is also possible to select different movement modes. This is done with bit 5 (change set immediately) in the status word. When this bit is 0 and a move is in progress, the new set-point is accepted, but the new set-point and profile are not activated until the previous movement is finished. When this bit is 1, the new set-point is activated instantly and the motor will move to the new position with the new profile parameters.

11.5.5 Velocity mode

In this mode the motor runs at a selected velocity. A new velocity can be selected and the motor will then accelerate/decelerate to this velocity.
The maximum slippage error is not supported in this mode.

11.5.6 Homing mode

Using this mode, different homing sequences can be initiated. The standard homing modes from 1-34 are supported. Before starting the homing, the inputs must be configured properly using MacTalk or parameters 125,129,130,132.

11.5 Objects used in the DSP-402 standard

11.5.7 Supported PDOs

Receive PDOs

PDO no.	Mapping object index	Mapping object name	Comment
1	6040_h	Controlword	controls the state machine
2	6040_h 6060_h	Controlword Modes of operation	controls the state machine and modes of operation
3	6040_h $607A_h$	Controlword Target position	controls the state machine and the target position (pp)
4	6040_h $60FF_h$	Controlword Target velocity (pv)	controls the state machine and the target velocity (pv)
7	6040_h $60FE_h$	Controlword Digital outputs	controls the state machine and the digital outputs

Transmit PDOs

PDO no.	Mapping object index	Mapping object name	Event driven
1	6041h	Statusword	Yes
2	6041h 6061h	Statusword Modes of operation display	Yes
3	6041h 6064h	Statusword Position actual value	No
4	6041h 606Ch	Statusword Velocity actual value	No
7	6041h 60FDh	Statusword Digital inputs	Yes

11.6 More details of CANOpen Theory

11.6.1 CANopen DS-301 device profiles

Standardized devices in CANopen have their characteristics described in a device profile. For each device profile, particular data and parameters are strictly defined. Data and parameters are known as objects in CANopen. Objects perform all processes in CANopen; they can perform various tasks, either as communications objects or as device-specific objects where they are directly related to the device. A communication object can transport data to the bus control and establish connection, or supervise the network devices.

The application layer makes it possible to exchange meaningful real-time-data across the CAN network. The format of this data and its meaning must be known by the producer and the consumer(s). There are encoding rules that define the representation of values of data types and the CAN network transfer syntax for the representations. Values are represented as bit sequences. Bit sequences are transferred in sequences of octets (byte). For numerical data types, the encoding is with the lowest byte first.

Every object is described and classified in the object dictionary (or index) and is accessible via the network. Objects are addressed using a 16-bit index so that the object dictionary may contain a maximum of 65536 entries.

Index (Hex)	Object	Supported by MAC00-FC2/FC4
0000-	Not used	
0001-001F	Static data types	
0020-003F	Complex data types	
0040-005F	Manufacturer specific Data Types	
0060-0FFF	Reserved for further use	
1000-1FFF	Communication Profile area DS301	Yes
2000-5FFF	Manufacturer specific profile area	Yes
6000-9FFF	Standardised Device Profile area (DSP-402)	Yes
A000-FFFF	Reserved for further use	

Index 0001-001F:
Static data types contain type definitions for standard data types like boolean, integer, floating point, etc. These entries are included for reference only, they cannot be read or written.

Index 0020-003F:
Complex data types are predefined structures that are composed out of standard data types and are common to all devices.

Index 0040-005F:
Manufacturer-specific data types are also structures composed of standard data types but are specific to a particular device.

Index 1000-1FFF:
The communication Profile area contains the parameters for the communication profile on the CAN network. These entries are common to all devices.

Index 2000-5FFF:
The manufacturer-specific profile area, for truly manufacturer-specific functionality.

Index 6000-9FFF:
The standardised device profile area contains all data objects common to a class of devices that can be read or written via the network. The drives profile uses entries from 6000h to 9FFFh to describe the drive parameters and the drive functionality. Within this range, up to 8 devices can be described. In such a case, the devices are denominated Multi Device Modules. Multi Device Modules are composed of up to 8 device profile segments. Using this feature it is possible to build devices with multiple functionality. The different device profile entries are shifted with 800h.

A 16-bit index is used to address all entries within the object dictionary. In the case of a simple variable, this index references the value of the variable directly. In the case of records and arrays however, the index addresses the whole data structure. To allow individual elements of structures of data to be accessed via the network, a sub-index has been defined. For single object dictionary entries such as Unsigned8, Boolean, Integer32, the value of the sub-index is always zero. For complex object dictionary entries such as arrays or records with multiple data fields, the sub-index refers to fields within a data-structure pointed to by the main index. Index counting starts with one.

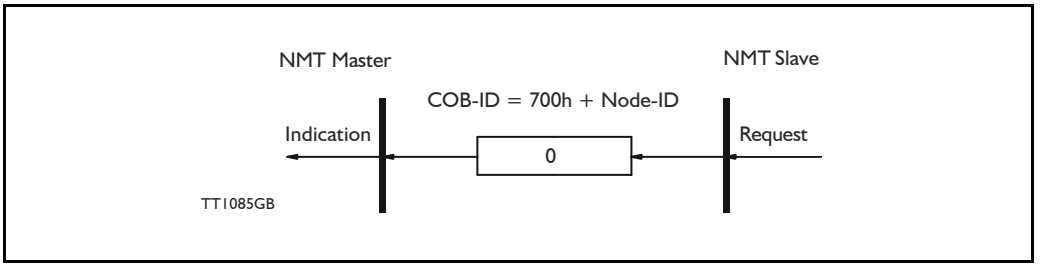
The DS-301standard constitutes the application and the communications profile for a CANopen bus, and is the interface between the devices and the CAN bus. It defines the standard for common data and parameter exchange between other bus devices, and it controls and monitors the devices in the network. The table below lists some of the communications profile objects:

Data Transfer	Parameter Transfer	Special functions	
PDO			**P**rocess **D**ata **O**bjects
	SDO		**S**ervice **D**ata **O**bjects
		SYNC	**Sync**hronisation
		EMCY	**Em**ergen**cy**

The access from the CAN network is done through data objects PDO (Process Data Object) and SDO (Service Data Object).

11.6.2 Boot up telegram

After the initialization phase, a CANopen slave logs on with a boot up message. The node address of the slave is contained in this. This allows a CANopen master to know which slaves are connected to the network. The protocol uses the same identifier as the error control protocols. See the figure below:



One data byte is transmitted with value 0.

11.6 More details of CANOpen Theory

11.6.3 PDO (Process Data Object)

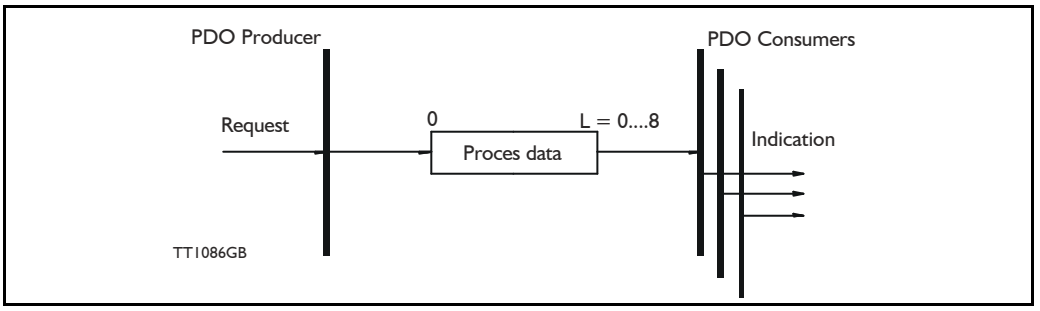
PDO: Performs real-time transfers, and the transfer of PDOs is performed without a protocol. PDOs are used in two ways: for data transmission and for data reception. PDOs can bundle all objects from the object data directory, and a PDO can handle max 8 bytes of data in the same PDO. The PDO can consist of multiple objects.
Another PDO characteristic is that it does not reply when it is receiving data, in order to make data transfer fast. It has a high priority identifier.

PDO connections follow the Producer/Consumer model, whereby a normal PDO connection follows the Push model and an RTR connection the Pull model.

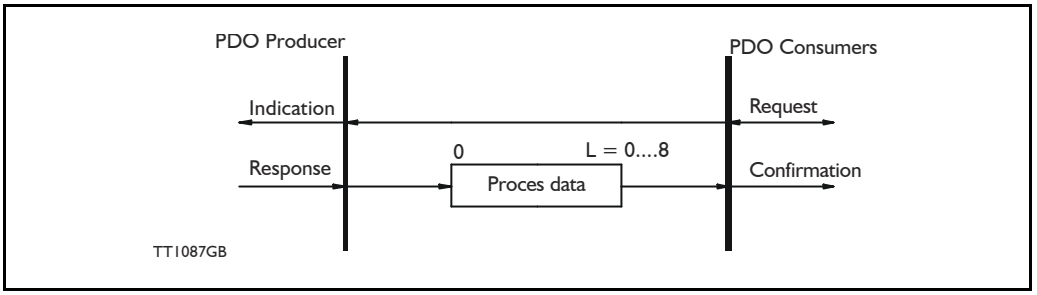
Objects are mapped in a PDO. This mapping is an agreement between the sender and receiver regarding which object is located at which position in the PDO. This means that the sender knows at which position in the PDO it should write data and the receiver knows where it should transfer the data to that is received.

The PDOs correspond to entries in the Device Object Dictionary and provide the interface to the application objects. Data type and mapping of application objects into a PDO are determined by a corresponding PDO mapping structure within the Device object Dictionary. The number and length of PDOs of a device are application specific and must be specified within the device profile

Write PDO service:
The Write PDO service is unacknowledged. A PDO producer sends its PDO to the PDO consumer. There can be 0 or more consumers in the network. For receive PDOs the SMC75 Controller is the consumer and for Transmit PDOs, the producer.
The following figure shows a Write PDO service:



Read PDO service:
The read PDO service is an acknowledged service. One of the several PDO consumers send an RTR message to the network. After it has received the RTR message, the PDO producer sends the requested PDO. This service is used for RTR queries. Using this service, an actual value can be interrogated independently of the selected cycle time. The following figure shows a read PDO service:



PDO identifier:
In the CAN-Open profile, it is only possible to have four transmit and four receive PDOs enabled at the same time. In the SMC75 controller, all PDOs are disabled when the module is booted up. The user must choose which PDOs the application will use and enable these.

The PDO configuration can be seen either in the EDS-file or in the CanOpen Explorer program, where the communication and the mapping parameters are shown.

There are two standard methods to map the PDOs in CANopen: static mapping and dynamic mapping. In static PDO mapping all PDOs are mapped in accordance with some fixed, non-modifiable setting in the relevant PDO. In dynamic PDO mapping, the setting of a PDO can be modified. It is also allowable to have a flexible combination of different process data during operation. The SMC75 controller uses only static mapping.

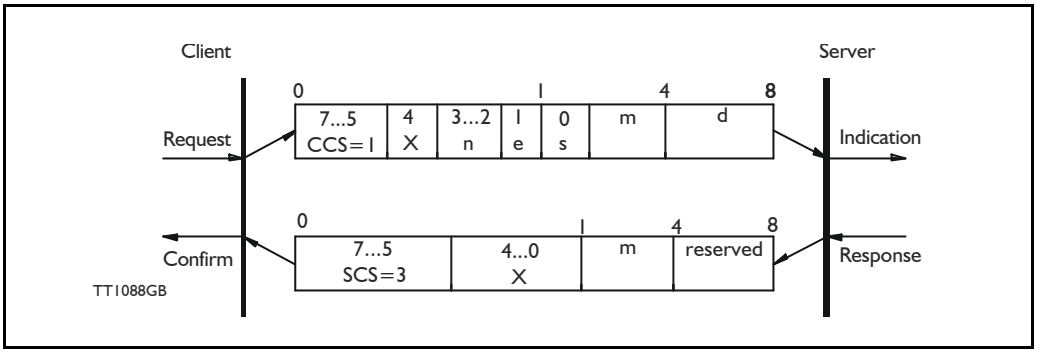
11.6.4 SDO (Service Data Objects)

SDO: can access all entries in the object directory but they are normally used in the initialization during the boot up procedure. Some SDOs characteristics are:

- Confirmed transfer of objects
- Data transfer/exchange is always non-synchronous
- Values greater than 4 bytes are transferred (Normal transfer)
- Values not more than 4 bytes are transferred (Expedited transfer)

Basically an SDO is transferred as a sequence of segments. Prior to transferring the segment, there is an initialization phase where client and server prepare themselves for transferring the segment. For SDOs, it is also possible to transfer a dataset of up to four bytes during the initialisation phase. This mechanism is called an expedited transfer.

Download SDO protocol:
The download SDO protocol is used to write the values of the object directory into the drive.



Upload SDO protocol:
The upload SDO protocol is used to read the values in the object directory of the drive.

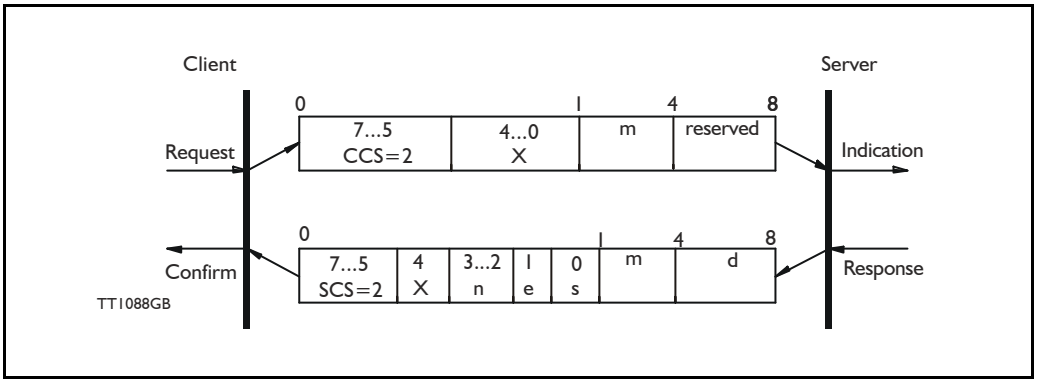


Table for upload and download SDO protocol.

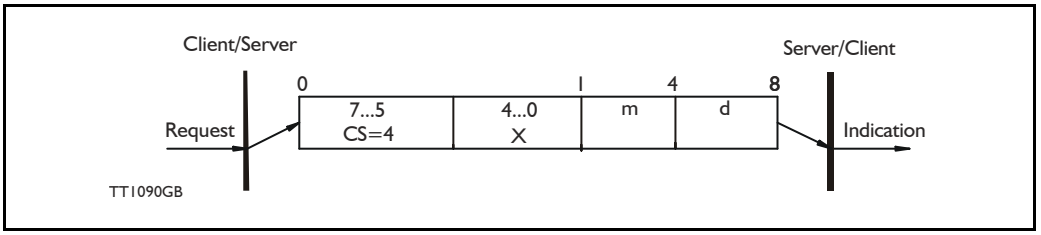
	CCS:	SCS:	n:	e:	s:	m:
Down-load	1: Initiate down-load request	3: Initiate download response	Only valid if e=1 and s=1 otherwise 0. If valid it indicates the number of bytes in d that do not contain data. Bytes [8-n,7] do not contain data	Transfer type: 0= normal transfer 1= expedited transfer	Size indica-tor: 0=data set size is not indicat-ed 1=data set size is indicated	Multiplexer. It reprен-sents the index/sub-index of the data to be transfer by the SDO
Upload	2: Initiate upload request	2: Initiate upload response	Only valid if e=1 and s=1 otherwise 0. If valid it indicates the number of bytes in d that do not contain data. Bytes [8-n,7] do not contain data	Transfer type: 0= normal transfer 1= expedited transfer	Size indica-tor: 0=data set size is not indicat-ed 1=data set size is indicated	Multiplexer. It reprен-sents the index/sub-index of the data to be transfer by the SDO

CCS: Client command specified.
SCS: Server commander specified.

Table for upload and download SDO protocol (continued)

	d:	X:	Reserved:
Download	**e=0, s=0:** d is reserved for further use **e=0, s=1:** d contains the number of bytes to be downloaded. Byte 4 contains the lsb and byte 7 contains the msb **e=1, s=1:** d contains the data of length 4-n to be downloaded, the encoding depends on the type of the data referenced by index and sub-index.	not used, always 0	Reserved for further use, always 0
Upload	**e=0, s=0:** d is reserved for further use **e=0, s=1:** d contains the number of bytes to be uploaded. Byte 4 contains the lsb and byte 7 contains the msb **e=1, s=1:** d contains the data of length 4-n to be uploaded, the encoding depends on the type of the data referenced by index and sub-index.	not used, always 0	Reserved for further use, always 0

Abort SDO transfer protocol:
SDO tasks which the SMC75 controller cannot process are responded to using an abort SDO protocol. If the module does not respond in the expected time, the CANopen master also sends an abort SDO.
The following figure shows an abort SDO transfer protocol:



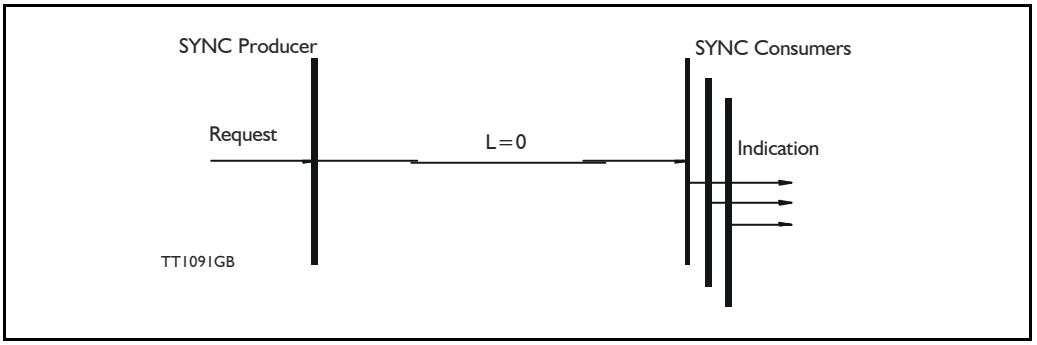
There are various abort codes in CANopen. These are listed in the table below:

Abort code	Description
0503 0000h	Toggle bit not alternated
0504 0000h	SDO Protocol timed out
0504 0001h	Client/server command specified not valid or unknown
0504 0002h	Invalid block size (block mode only)
0504 0003h	Invalid sequence number (block mode only)
0504 0004h	CRC error (block mode only)
0504 0005h	Out of memory
0601 0000h	Unsupported access to an object
0601 0001h	Attempt to read a write-only object
0601 0002h	Attempt to write a read-only object
0602 0000h	Object does not exist in the object dictionary
0604 0041h	Object cannot be mapped to the PDO

Abort code	Description
0604 0042h	The number and length of the objects to be mapped would exceed PDO length
0604 0043h	General parameter incompatibility reason
0606 0000h	Access failed due to a hardware error
0607 0010h	Data type does not match, length of service parameter does not match
0607 0012h	Data type does not match, length of service parameter too high
0607 0013h	Data type does not match, length of service parameter too low
0609 0011h	Sub-index does not exist
0609 0030h	Value range of parameter exceeded (only for write access)
0609 0031h	Value of parameter written too high
0609 0032h	Value of parameter written too low
0609 0036h	Maximum value is less than minimum value
0800 0000h	General error
0800 0020h	Data cannot be transferred or stored to the application
0800 0021h	Data cannot be transferred or stored to the application because of local control
0800 0022h	Data cannot be transferred or stored to the application because of the present device state
0800 0023h	Object dictionary dynamic generation fails or no object dictionary is present (e.g. object dictionary is generated from file and generation fails because of a file error).

11.6.5 SYNC (Synchronisation Object)

A SYNC producer sends the synchronization object cyclically a broadcast telegram. The SYNC telegram defines the basic clock cycle of the network. The time interval of the SYNC telegram is set using the object Communication Cycle period (1006h). In order to obtain a precise (accurate) cycle between the SYNC signals, the SYNC telegram is sent with a high-priority identifier. This can be modified using the object (1005h). The SYNC transfer applies the producer/consumer push model and is non-confirmed.



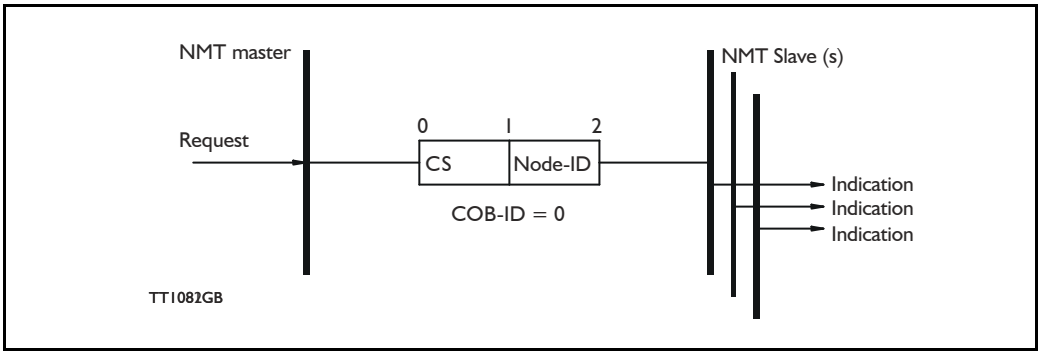
The SYNC does not carry any data (L=0). The identifier of the SYNC object is located at object 1005h.

11.6 More details of CANOpen Theory

11.6.6 NMT (Network Management services)

The Network Management is structured according to nodes and follows a master-slave structure. NMT objects are used for executing NMT services. Through NMT services, nodes are initialised, started, monitored, reset or stopped. All nodes are regarded as NMT slaves. An NMT slave is uniquely identified in the network by its Node-ID. NMT requires that one device in the network fulfils the function of the NMT master. The NMT master controls the state of the NMT slaves. The state attribute is one of the values (Stopped, Pre-operational, Operational, Initialising). The module control services can be performed with a certain node or with all nodes simultaneously. The NMT master controls its own NMT state machine via local services which are implementation dependent. The Module Control Service, except Start Remote Node, can be initiated by the local application.

A general NMT protocol:



Where **CS** is the NMT command specified. The Node-ID of the NMT slave is assigned by the NMT master in the Node Connect protocol, or 0. If 0, the protocol addresses all NMT slaves.

CS =	Operation
1	Start Remote Node
2	Stop Remote Node
128	Enter Pre Operational
129	Reset Node
130	Reset Communication

Start Remote Node:
This is an instruction for transition from the Pre-Operational to Operational communications state. The drive can only send and receive process data when it is in the Operational state.

Stop Remote Node:
This is an instruction for transition from either Pre-Operational to stopped or from Operational to Stopped. In the stopped state, the nodes can only process NMT instructions.

Enter Pre Operational:
This is an instruction for transition from either Operational or Stopped state to Pre-Operational. In the Pre-Operational state, the node cannot process any PDOs. However, it can be parameterized or operated via SDO. This means set point can also be entered.

Reset Node:
This is an instruction for transition from the Operational, Pre-Operational or Stopped states to Initialization. After the Reset Node instruction, all objects (1000h-9FFFh) are reset to the Voltage On stage.

Reset Communication:
This is an instruction for transition from Operational or Stopped to Initialization. After the Reset Communication instruction, all communication objects (1000h-1FFFh) are reset to the initial state.

In the various communication states, nodes can only be accessed via CAN-Open using specific communication services. Further, the nodes in the various states only send specific telegrams. This is clearly shown in the following table:

	Initializing	Pre-Operational	Operational	Stopped
PDO			X	
SDO		X	X	
Synchronization Object		X	X	
Emergency Object		X	X	
Boot-Up Object	X			
Network Management object		X	X	X

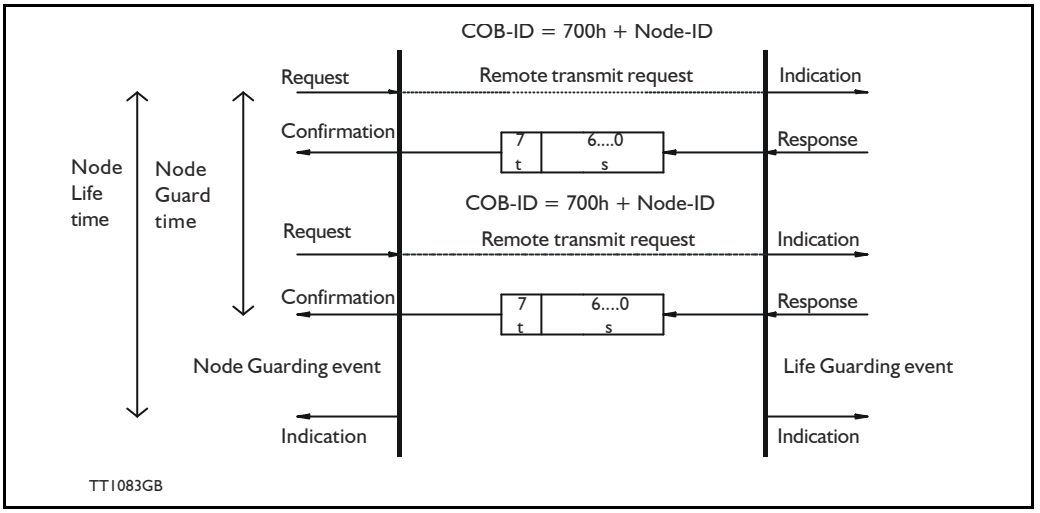
11.6.7 Error Control Services

Two possibilities exist for performing Error Control:

- Node Guarding/Life Guarding
- Heartbeat

Node Guarding/Life Guarding
With Node Guarding, the CANopen master sends each slave an RTR telegram (Remote Transmit request) with the COB-ID 1792 (700h) + node-ID.
Using the same COB-ID, the slave responds with its communications state, i.e. either Pre-Operational, Operational or stopped.
The CANopen slave also monitors the incoming RTR telegram from the master.
The cycle of the incoming RTR telegrams is set using the Guard Time Object.
The number of RTR telegrams which can fail (at a maximum) before the slave initiates a Life Guarding event is defined using the Life time factor object.
The Node Life Time is calculated from the product of the Guard Time and Life Time Factor. This is the maximum time that the slave waits for an RTR telegram.

The figure below shows a Node Guarding/Life Guarding protocol.

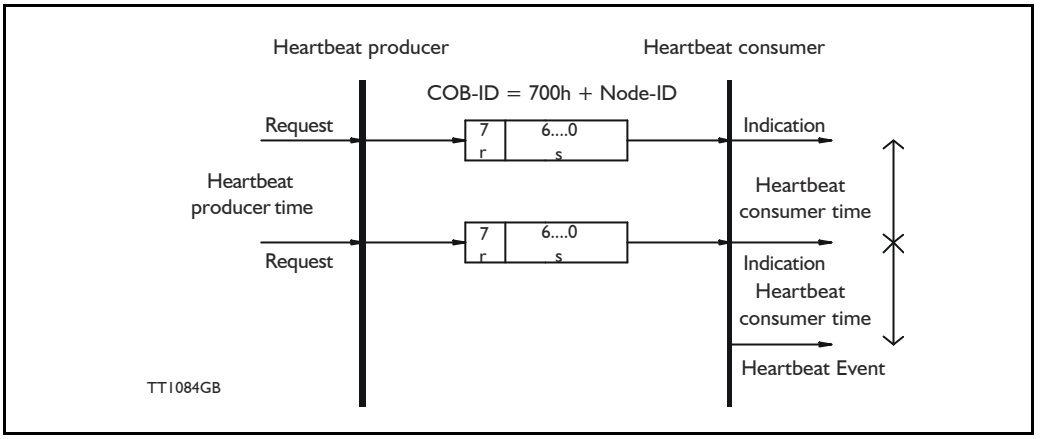


Where s is the state of the NMT slave:

s	NMT state
4	Stopped
5	Operational
7	Pre-operational

t: is the toggle bit. It alternates between 2 consecutive responses from the NMT Slave. The value of the toggle-bit of the first response after the guarding protocol becomes active is 0. The Toggle Bit in the guarding protocol is only reset to 0 when the NMT message Reset Communication is passed (no other change of state resets the toggle bit). If a response is received with the same value of the toggle-bit as in the preceding response, then the new response is handled as if it was not received.

Heartbeat:
With the Heartbeat protocol, a Heartbeat Producer cyclically sends its communications state to the CAN bus. One or more Heartbeat Consumers receive the indication. The relationship between producer and consumer is configurable via the object dictionary. The Heartbeat Consumer guards the reception of the Heartbeat within the Heartbeat Consumer time. If the Heartbeat is not received within the Heartbeat Consumer Time, a Heartbeat Event will be generated.



Where r is reserved (always 0).
s: is the state of the Heartbeat producer:

s	NMT state
0	Boot up
4	Stopped
5	Operational
7	Pre-operational

Only one communication monitoring service may be activated. This is either Node Guarding/Life Guarding or Heartbeat. If the Heartbeat Producer Time is configured on a device, the Heartbeat Protocol begins immediately. If a device starts with a value of the Heartbeat Producer Time different from 0, the Heartbeat Protocol starts with the state transition from Initialising to Pre-operational. In this case the Bootup Message is regarded as the first heartbeat message. If the Heartbeat producer time is not 0, the heartbeat protocol is used.

In the SMC75, none of the error control mechanisms is enabled when the modules are started up, because if there is any fault in the system it is impossible to contact the module. After the module has started up and there is communication between the master and the slave, activate the required error control mechanism in the object Dictionary. See section 11.4.1.

12 Appendix

12.1 Velocity accuracy

When setting a velocity in V_SOLL, the motor will not run at that exact velocity. The exact velocity can be calculated with the following formula:

$$resulting\ velocity = \frac{93750 \pm 1.1\%}{Round\left(\frac{93750}{V\_SOLL}\right)}$$

Note: The "Round" function rounds the number to the nearest integer.

Also note that the lowest possible velocity is 1.43 RPM and the highest is 1023 RPM.

12.2 Command timing

Each command has a certain execution time. The specified execution time in the following table is the maximum execution time if not using CANopen, serial communication and the motor is disabled. The actual execution may be faster.

Icon	Name	Execution time [µs]
	Remarks	0
	Set operation mode	60
	Move relative (no velocity, no acceleration)[1]	90
	Move relative+set velocity (no acceleration)[1]	150
	Move relative+set velocity+set acceleration[1]	210
	Move absolute (no velocity, no acceleration)[1]	60
	Move absolute+set velocity (no acceleration)[1]	120
	Move absolute+set velocity+set acceleration[1]	180
	Set single output (high/low)	30
	Set multiple outputs	30*number of outputs
	Unconditional jump	30
	Conditional jump (inputs)	60
	Set a register	60
	Conditional jump (register)	120
	Save position	60
	Set position	90
	Send fastMAC command	30
	Binary command	30

1) The time for all move commands is shown without waiting for in position

12.3 More about program timing

The firmware is structured so that one program instruction is executed for each pass of the main loop, which takes approximately 30 microseconds (μs) without CANopen, without serial communications and when the motor is not running. The Main Loop Time is termed MLT in the following text.

A single program line in MacTalk can generate more than one instruction. For example, assigning a constant value to a register uses two instructions: First load the value to the internal stack and then Store from the stack to the target register. The above table in section 12.2 reflects this operation.

The main loop time will vary depending on a number of factors: The motor velocity, the serial communications speed and load, whether CANopen is installed, and the CANopen communications speed and load.

Simply running the motor will load the motor up to 17% so the MLT becomes $\sim=$ 37 μs at full speed (1023 RPM).

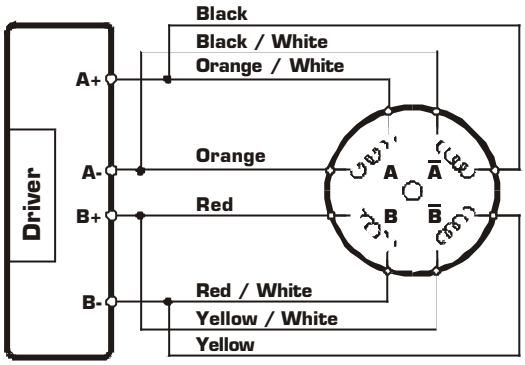
Serial communications on the RS-485 line can load the motor up to 1% at 19.200 baud, which is insignificant, but at the maximum baud rate of 921.600 the communications can load the motor up to 45%, which would result in an MLT of $\sim$60 μs.

When CANopen firmware is installed, the basic MLT will change from 30 to 90 μs with no communications.
When loading the CANbus with communications, the MLT can rise significantly. For example, when using seven transmit PDOs with an event timer value of 1 ms and a CANbus link speed of 500 kbits/s, the MLT can rise to 150-200 μs. Also using RS-485 communications at high baud rates can result in even longer MLT values. However, this scenario is very unlikely.

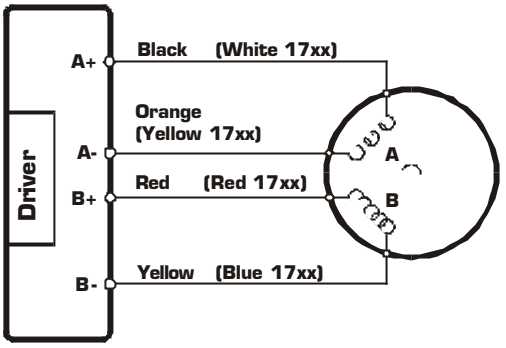
Note: In applications where program timing is critical, tests must be performed to ensure that timing is satisfactory when communication is running according to conditions used in production!

12.4 Motor Connections

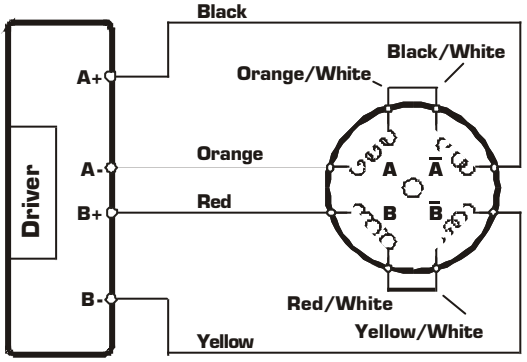
Connection of JVL and MAE motors (parallel). Type MST23x/ MST34x and HY200-xxxx-xxx-x8



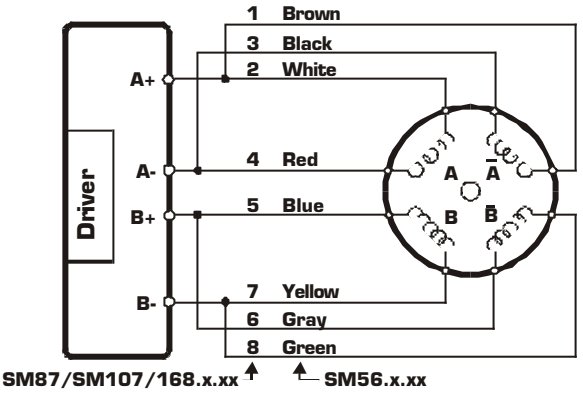
Connection of JVL and MAE 4 wire motors. Type MST17x and HY200-xxxx-xxx-x4



Connection of JVL and MAE motors (serial). Type MST23x/ MST34x and HY200-xxxx-xxx-x8

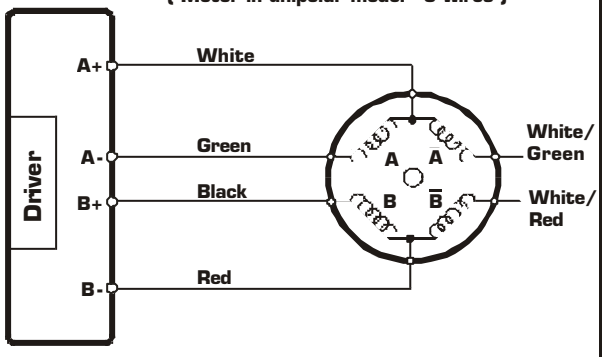


Connection of Zebotronics motor Type : SMxxx.x.xx.x (8 terminals)

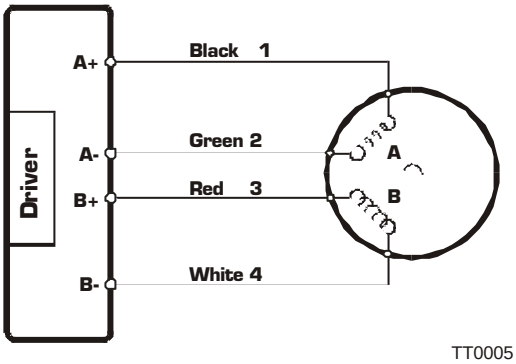


Connection of MAE motor (unipol.) Type HY200-1xxx-xxxxx6

(Motor in unipolar model - 6 wires)

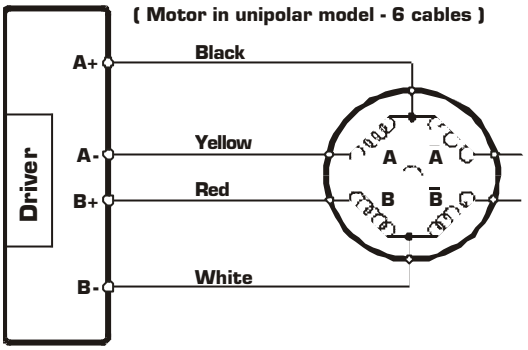


Connection of Zebotronics motor Type : SMxxx.x.xx.x (4 terminals)

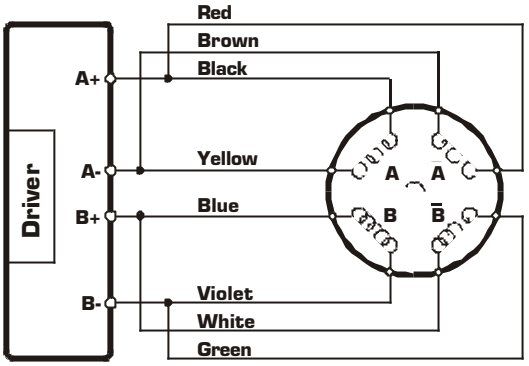


TT0005

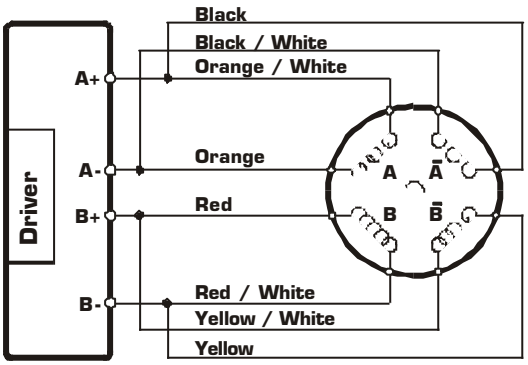
Connection of Vexta motor Type PH2xx.xxx



Connection of Phytron motor Type ZSx.xxx.x,x



Connection of Vexta stepmotor Type : PH2xx-xxx



TT0006

12.5 Serial communication

This section describes control of the SMC75 motor via the serial interface (RS232/ RS485).
The communication is not made in ASCII values and it is thus not possible to use programs like Hyperterminal to control the motor.
The interface is RS232 compatible and uses 8 data bits and no parity.
The SMC75 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 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 MacTalk communication is to use the MacRegIO program. This program lists all of the registers, and the serial commands sent and received can be monitored.

12.5.1 Supported commands

Sync	Response Sync	Description
0x50	0x52	Read register
0x51	0x52	Read register block
0x52	0x11 (Ack)	Write register
0x54	0x11 (Ack)	Enter safe mode
0x55	0x11 (Ack)	Exit safe mode
0x56	0x11 (Ack)	Write to flash
0x57	None	Reset controller
0x59	None	Group write register
0x61	0x61	Program status and command
0x62	0x11 (Ack)	Write program flash
0x63	0x63	Read program flash

12.5.2 Read register

This command can read a register. All registers are read as 32-bit. If the register is only 16-bit, the high part must be discarded.

Master sends	SMC75 Response
<Read><Address><RegNum><End>	<Write><MAddress><RegNum><Len><Data><End>

Block description

Block name	Protected	Example	Description
<Read>	No	50h,50h,50h	Read command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75
<RegNum>	Yes	05h,FAh (RegNum 5)	The register number to read
<End>	No	AAh, AAh	Command termination
<Write>	No	52h,52h,52h	Write command
<MAddress>	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

12.5.3 Read register block

Using this command it is possible to read 64 consecutive registers at once.

Master sends	SMC75 Response
<ReadB><Address><RegNum><End>	<Write><MAddress><RegNum><Len><Data><End>

Block description

Block name	Protected	Example	Description
<ReadB>	No	51h,51h,51h	Read block command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75
<RegNum>	Yes	05h,FAh (RegNum 5)	The first register to read
<End>	No	AAh, AAh	Command termination
<Write>	No	52h,52h,52h	Write command
<MAddress>	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	80h,7Fh (Len = 128)	The length will always be 128, so 64 registers is read in each block.
<Data>	Yes	E8h,17h, ..., 03h,FCh	The data read from the registers

12.5.4 Write Register

Using this command, a register can be written.

Controller sends	SMC75 Response
<Write><Address><RegNum><Len><Data><End>	<Accept>

Block description

Block Name	Protected	Example	Description
<Write>	No	52h,52h,52h	Write command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75
<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 SMC75

12.5.5 Enter safe mode

When this command is sent, the SMC75 switches to safe mode. In safe mode, no program or commands can enable the motor. The mode can only be exited using either an “Exit safe mode” or “Reset” command.

Controller sends	SMC75 response
<EntSafe><Address><End>	<Accept>

Block description

Block Name	Protected	Example	Description
<EntSafe>	No	54h,54h,54h	Enter safe mode command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75
<End>	No	AAh, AAh	Command termination
<Accept>	No	11h, 11h,11h	Accept from SMC75

12.5.6 Exit safe mode

When this command is sent, the SMC75 switches back to normal mode.

Controller sends	SMC75 response
<ExitSafe><Address><End>	<Accept>

Block description

Block Name	Protected	Example	Description
<ExitSafe>	No	55h,55h,55h	Exit safe mode command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75
<End>	No	AAh, AAh	Command termination
<Accept>	No	11h, 11h,11h	Accept from SMC75

12.5.7 Write to flash

This command writes the register values to flash memory. The values will then be retained after a power down. The command will only work if the motor is in “Safe mode” After the command is executed, the motor will reset. The response will only be transmitted if the command failed, e.g. if the motor is not in safe mode.

Controller sends	SMC75 response
<WriteFlash><Address><End>	<Accept>

Block description

Block Name	Protected	Example	Description
<WriteFlash>	No	56h,56h,56h	Write to flash command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75
<End>	No	AAh, AAh	Command termination
<Accept>	No	11h, 11h,11h	Accept from SMC75

12.5.8 Reset controller

This command resets the SMC75. No response will be transmitted from the SMC75.

Controller sends	SMC75 response
<Reset><Address><End>	None

Block description

Block Name	Protected	Example	Description
<Reset>	No	57h,57h,57h	Reset command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75
<End>	No	AAh, AAh	Command termination

12.5.9 Group write register

Using this command it is possible to write a register in several SMC75s with one command.
The command includes a sequence number which must be changed for each write. This is used so that the same command can be written several times, to ensure that all controllers received it. The last received sequence id can be read in register 148.

Controller sends	SMC75 Response
<GWrite><Group><Sequence><RegNum><Len><Data><End>	None

Block description

Block Name	Protected	Example	Description
<GWrite>	No	59h,59h,59h	Group write command
<Group>	Yes	07h,F8h (Address 7)	The group id of the SMC75s to write to.
<Sequence>	Yes	04h,FBh (Sequence 4)	The sequence number of the write.
<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

12.5.10 Program status and command

Using this command, different actions can be executed. The command also returns some information about the program state.
The table below shows the possible commands:

Command	Data 1	Data 2	Description
0	-	-	No operation
1	-	-	Start program execution
2	-	-	Stop program execution
3	-	-	Pause program execution
4	Start Address (16bit)	End Address (16bit)	Run the program until the program pointer is outside the area [Start Address,End Address] Then the program is paused
5	Set outputs (8bit)	Clear outputs (8bit)	Modifies the outputs. The bits set in the “Set outputs” data will be set and cleared for “Clear outputs”. Example: The data 0x06,0x01 sets output 2+3 and clears output 1
6			Reserved
7	Size (16 bit)		Prepare the flash for a new program. Data 1 specifies the size of the program in bytes.

The command number is placed in the first command data byte. Data 1 + Data 2 are placed in the following command data bytes.

Controller sends	SMC75 Response
<PStat><Address><Len1><Data1><End>	<PStat><MAddress><Len2><Data2><End>

12.5 Serial communication

Block description

Block Name	Protected	Example	Description
<PStat>	No	61h,61h,61h	Program status command
<Address>	Yes	07h,F8h (Address 7)	The address of the SMC75's to write to.
<Len1>	Yes	01h,FEh (Len = 1)	Length of the command data
<Data1>	Yes	01h,FEh (Start)	Command data
<MAddress>	Yes	00h,FFh (Address 0)	This will always be 0, because this is the address of the master
<Len2>	Yes	08h,F7h (Len = 8)	The length of the return data
<Data2>	Yes	09h,F6h, (Program state) 00h,FFh, 00h,FFh, (Program pointer) 00h,FFh, (Stack pointer) 00h,FFh, 00h,FFh, (Program checksum) 80h,7Fh, (Inputs) 00h,FFh (Outputs)	Data returned from SMC75
<End>	No	AAh, AAh	Command termination

The returned data has the following format:

Data offset	Size	Description
0	8 bit	Program state. See table below for states.
1	16 bit	Program pointer. The current location of the program pointer.
3	8 bit	Stack pointer
4	16 bit	Program checksum. This checksum is calculated when the program is started.
6	8 bit	Input status.
7	8 bit	Output status

Program states:

Program state	Name	Description
0	Passive	The program execution is stopped. This state is only entered shortly at power-up.
1	Running	The program execution is running
2	Single Step	A single step is in progress. The program will run until the selected program position is reached.
3	Paused	The program execution is paused, but can be resumed again.
4	Stack Ovf.	The stack pointer has overflowed
5	Program Ovf.	The program pointer has overflowed.
6	Invalid Ins.	An invalid instruction is encountered in the program.
7	Stopped	The program execution is stopped.
8	Com. Error	Internal communication error has occurred. This cannot happen on SMC75.
9	Starting Prg.	Program execution is being prepared. After this is completed the state will change to running.
10	Flash Error	The program data is corrupted.
11	Flash Checksum Error	The program data checksum is incorrect.

12.6 MIS Ordering Information

Motor Type	Size	Generation	IP and shaft	Connection	Feedback	Driver Technology	Step Resolution	mA in driver	Input format	Standby current ratio	
MIS	232	A	1	M2	N0	73	8	10	E	3	Revision September26, 2007

01 to
31 Standby current ratio (03 = 1/3 standby current) #

D 24V NPN inputs
E 24V PNP inputs
F 5V inputs

xx xx specifies mA*100/phase. See SMD73 data-sheet

0 No driver #
1 1/1 step (with 200step/rev motor 200 pulses/rev.)
2 1/2 step (with 200step/rev motor 400 pulses/rev.)
4 1/4 step (with 200step/rev motor 800 pulses/rev.)
5 1/5 step (with 200step/rev motor 1000 pulses/rev.)
8 1/8 step (with 200step/rev motor 1600 pulses/rev.)

73 SM73 driver 15-28VDC. Pulse and direction driver. (Only orders more than 10 pcs.)*
74 Driver 12-48VDC based on SMC75 technology (Future option)
75 SMC75 controller with MAC protocol. 12-48VDC and optional encoder/hall sensor feedback #
76 Controller based on SMD41 driver and SMC75 controller functionality. #
41 SMD41 driver technology 20-80VDC. Pulse and direction driver. Only MIS34x. (Future option)
42 SMD42 driver technology 30-160VDC. Pulse and direction driver. Only MIS34x. (Future option)

N0 No feedback
H1 Magnetic encoder feedback. 32 pulses/rev. Only if controller supports this feature (Future option)
H2 Magnetic encoder feedback. 256x4 pulses/rec. Only if controller supports this feature
E1 Encoder feedback. 1024 lines = 4096 pulses/rev. Only if controller supports this feature. (Future option)

M1 M12 1pcs. 5pin male . SMD73 pulse/direction driver.
M2 M12 2 pcs. 5 pin male (power). 8 pin female (RS485, 4IOA)
M3 M12 3 pcs. 5 pin male (power), 8 pin female (RS485, IOA 1-4), 5 pin female (RS485). SMC75
M4 M12 3 pcs. 5 pin male (power), 8 pin female (RS485, IOA 1-4), 8 pin female (5V serial, IOA5-8). SMC75
M5 M12 4 pcs. 5 pin male (power), 8 pin female (RS485, IOA 1-4), 5 pin female (RS485), 8 pin female (5V serial, IOA 5-8).SMC75
M6 M12 4 pcs. CANopen 5 pin male (power), 8 pin female (RS485, IOA 1-4), 8 pin female (5V serial, IOA 5-8), 5 pin male (CAN) SMC75
M7 M12 4 pcs.DeviceNet 5 pin male (power), 8 pin female (RS485, IOA 1-4), 8 pin female (5V serial, IOA 5-8), 5 pin male (Device) SMC75
W0 PG16 and no cable
W1 PG16 and 2m cable. Flying leads with shield.
EX Long hosing ready for MAC00-xx expansion board (Future option)

1 6,35mm shaft and IP42
2 6,35mm shaft and IP55 (motor shaft and body). IP65 (Rear end and connector)
3 10,0 mm shaft and IP42
4 10,0mm shaft and IP55 (motor shaft and body). IP65 (Rear end and connector)
5 14mm shaft and IP42
6 14mm shaft and IP55 (motor shaft and body). IP65 (Rear end and connector)
7 8mm shaft 52mm long for HFOS worm gear

A Motor driver for 3,0A/phase
B Motor driver for 5,2A/phase (Future option)

230 NEMA23 stepper motor
231 NEMA23 stepper motor
232 NEMA23 stepper motor
234 NEMA23 stepper motor
340 NEMA34 stepper motor (Future option)
341NEMA34 step motor (Future option)
342NEMA34 step motor (Future option)

MIS MISxxx Motor Integrated Stepper Motor.

Examples

MIS	231	A	1	W1	N0	73	8 25 D	Motor 6,35 shaft, flying leads, SMD73 driver
MIS	233	A	3	M1	N0	73	2 30 D	Motor 10mm shaft, M12 , SMD73
MIS	232	A	1	M3	N0	75		Motor 6,35mm shaft. SMC75. 3 pcs M12 connectors
MIS	234	A	3	M6	N0	75		Motor 10mm shaft. SMC75. 4 pcs M12 connectors, CANopen
MIS	232	A	1	M7	H2	75		Motor 6,35mm shaft. SMC75. 4 pcs M12 connectors. DeviceNet. Encoder H2 option
MIS	340	B	5	M1	N0	41		Motor 14,0 mm shaft. 1 pcs M12 connector. 80V driver
MIS	342	B	5	M7	N0	76		Motor 14,0 mm shaft. 4 pcs M12 connectors. 80V controller. DeviceNet. Encoder H2 option

: End of number. No more letters or numbers should be added.

*: For orders less than 10 pcs., use Controller SMC75 instead, allowing current and gear ratio to be freely programmed.

12.7 SMC75 Ordering Information

SMC75 selection chart

SMC Step motor controller

75 Version 3ARMS 12-48VDC with 8IOA and optional CANopen/DeviceNet and encoder

85 Version 12-160VDC with 8IOA and optional CANopen/Devicenet and encoder

A PCB 3ARMS (default)

B PCB 6ARMS

C PCB 9ARMS

1 Hardware version1. (default)

2 Hardware version 2.

M1 M12 2pcs. 5pin male (power). 8 pin female (RS485, 4IOA). SMC75

M2 M12 2 pcs. 5 pin male (power). 8 pin female (RS485, 4IOA). SMC75

M3 M12 3 pcs. 5 pin male (power), 8 pin female (RS485, IOA 1-4), 5 pin female (RS485). SMC75

M4 M12 3 pcs. 5 pin male (power), 8 pin female (RS485, IOA 1-4), 8 pin female (5V serial, IOA5-8). SMC75

M5 M12 4 pcs. 5 pin male (power), 8 pin female (RS485, IOA 1-4), 5 pin female (RS485), 8 pin female (5V serial, IOA 5-8).SMC75

M6 M12 4 pcs. CANopen 5 pin male (power), 8 pin female (RS485, IOA 1-4), 8 pin female (5V serial, IOA 5-8), 5 pin male (CAN)

M7 M12 4 pcs. DeviceNet 5 pin male (power), 8 pin female (RS485, IOA 1-4), 8 pin female (5V serial, IOA 5-8), 5 pin male (Device SMC75

W1 PG16 and 2m cable. Flying leads with shield.

AA No fieldbus (default). Only PCB

AC Fieldbus CANopen. Only PCB

AD Fieldbus DeviceNet. Only PCB

H1 Magnetic encoder chip 1.

H2 Magnetic encoder chip2 mounted 256x4=1024 counts (AS5040)

SMC	75	A	1	M4	H1	

Examples

SMC 75	A	1			Steppermotor controller only PCB. No housing and encoder chip
SMC 75	A	1	AC		Steppermotor controller only PCB, CANopen. No housing and encoder chip
SMC 75	A	1	AA	H2	Stepper motor controller only PCB with magnetic encoder chip type H2 mounted. No housing
SMC 75	A	1	AC	H2	Stepper motor controller only PCB with Fieldbus CANopen and magnetic encoder chip type H2 mounted. No
SMC 75	A	1	M7		Stepper motor controller in a box with connector M7 and CANopen and DeviceNet
SMC 75	A	1	M6	H1	Stepper motor controller in a box with connector M7 and CANopen and H1 magnetic sensor

12.7 SMC75 Ordering Information

QuickStep MST motor selection chart

MST Stepper motor with housing but without electronics. IP55

- 230 NEMA23 Stepper motor
- 231 NEMA23 Stepper motor
- 232 NEMA23 Stepper motor
- 234 NEMA23 Stepper motor
- 340 NEMA23 Stepper motor. (Future option)
- 341 NEMA23 Stepper motor .(Future option)
- 342 NEMA23 Stepper motor .(Future option)

- A For 3Amp. driver/controller
- B For 6 Amp. driver/controller
- C For 9 or 12 Amp. driver/controller

- 1 6.35mm shaft and IP42
- 2 6.35mm shaft and IP55 (motor shaft and body) IP65 /Rear end and connector)
- 3 10.0mm shaft and IP42
- 4 10.0mm shaft and IP55 (motor shaft and body) IP65 /Rear end and connector)
- 5 14mm shaft and IP42
- 6 14mm shaft and IP55 (motor shaft and body) IP65 Rear end and connector)

- 3 Motor type

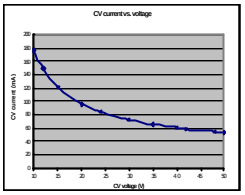
- M1 m12 connector
- W0 PG16 and no cable
- W1 PG16 and 2m cable

MST	232	A	1	3	M1	

Examples

MST	232	A	1	3	M1	Stepper motor NEMA23 with housing
MST	234	A	3	3	M1	Stepper motor NEMA23 with housing
MST	340	B	5	3	W1	Stepper motor NEMA34 with housing

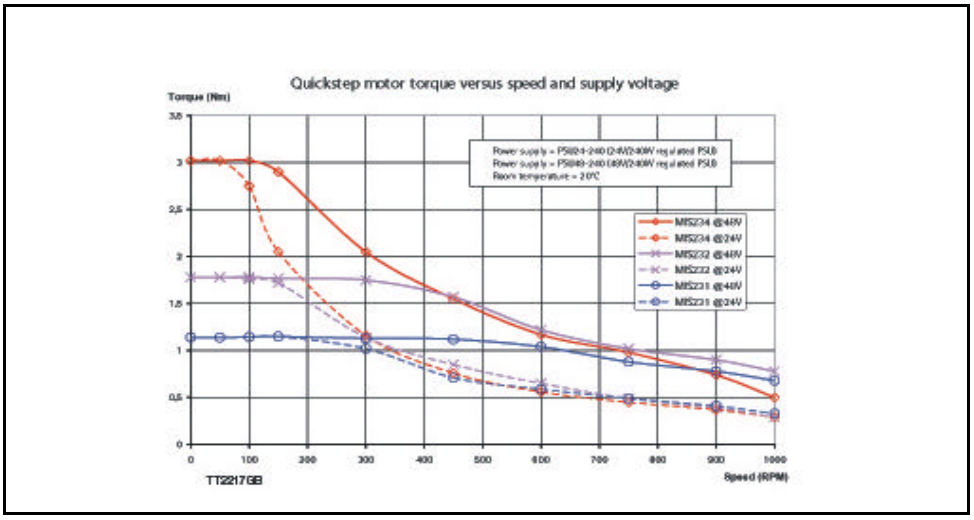
13 MIS Motor Technical Data

Supply Voltage (P+)	Voltage Range	+12 to 48VDC	
	Ampere (no motor) 5mA	Power supply current requirements = 2A (max.). Refer to illustration. Actual power supply currents will depend on voltage and load	
Control Voltage (CV)	Range	+12 to + 28VDC maintains power to control output driver and feed-back circuits (only) when input voltage is removed. If no motor connected or passive mode: 100mA.	
Analog Input	Resolution	10 Bit	
	Voltage Range	0 to +5VDC	
General Purpose I/O	Number/Type	8 Sources of output or input	
	Logic Range	Inputs and Outputs tolerant to +24VDC. Inputs TTL level compatible	
	Output Source Current	Up to 350 mA per Channel. See Chart section 2.5	
	Protection	Over Temp. Short Circuit. Transient. Over Voltage. Inductive Clamp.	
	Input Filter	0.1 or 1 to 100 ms	
Communication	Type (Standard)	RS485	
	Type (Optional)	RS422	
	Baud Rate	9.6 to 921.6 kbps	
	Type (Optional)	CANopen DSP402 (V2.0), DS301 (VS3.0), 2,0B Active	
	Isolation	None	
	Features	Node Guarding, heartbeat, SDOs, PDOs (Static mapping)	
Motion	Open Loop Configuration	Number of settings	2
		Steps per revolution	1600
	Internal Encoder (optional)	Type	Internal, magnetic, absolute 1 rev.
		Steps per Revolution	1024
		Resolution	256 Lines
	Counters	Type	Position, Encoder/32 Bit
		Edge Rate (Max.)	27.280 kHz
	Velocity	Range	1.43 to 1023 RPM
		Resolution	1 RPM
	Accel./Decel.	Range	$3x10^5$ RPM/s
		Resolution	9.54 RPM/s
	Electronic Gearing	Range/Resolution/Threshold (External Clock In)	0.00003 to 32768/32 Bit
Software	Program Storage	Type/Size	Flash 3072 Bytes
	User Registers	2248 Bytes/32 bits	
	User program variables	Up to 224	
	Math Functions	+, -, x, /, >, <, =, <=, >=, AND, OR, XOR, NOT, I, &, ^.	
	Branch Functions	Branch & Call	
	General Purpose I/O Functions	Inputs	Home, Limit Plus, Limit Minus, Analog In, General Purpose
		Outputs	Moving, Fault, general Purpose
	Party Mode Addresses	254	
	Encoder Functions	Stall Detection, Position maintenance, Find Index	
Thermal	Operating Temperature	0-45°C ambient	

13.1 SMC75 Technical Data

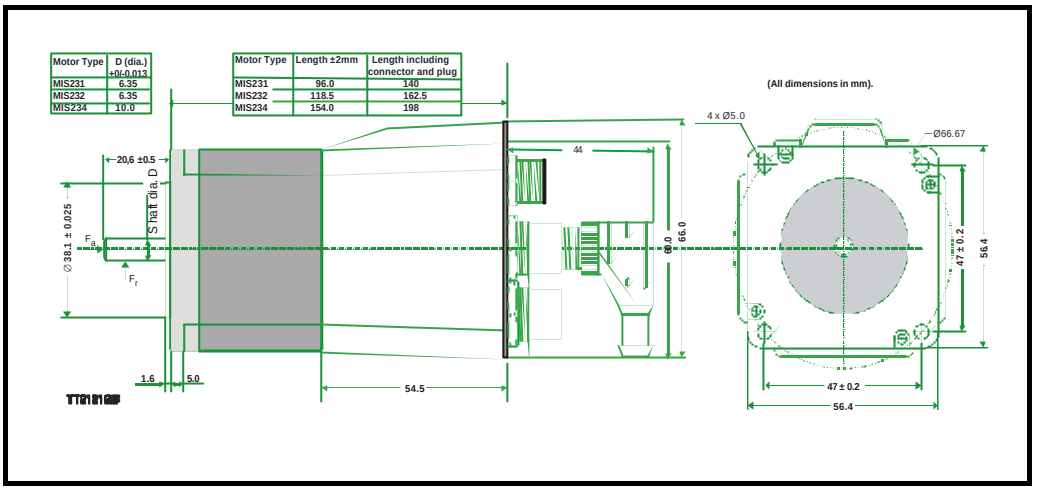
Power supply	Condition	Min.	Norm.	Max.	Unit
P+ - P-		12		48	V
PP supply current	@ 24V		125		mA
(No load)	@ 48 V		100		(RMS)
CV		7		35	V
CV supply current	@12V		160		mA
(Unconnected I/O)	@24V		90		mA
V+ for CAN		4.5	5	5.5	V
V+ supply current for CAN				1	mA
User outputs O1-O8					
Output source current pr. channel	CV = 35V				
	@ 8 sourcing			75	mA
	@ 4 sourcing			100	mA
	@ 1 sourcing			350	mA
Output sink current				0	mA
Output voltage	@ 100mA	CV – 2,4	CV- 2.2		V
User inputs I1-I8					
Input impedance			10		kOhm
Voltage applied to any input		-0.5		22	V
Analog input nominal		0		5.0	V
Logic "0"		0		0.9	V
Logic "1"		1.9		22	V
RS232 (5V)					
Tx output low level			0.45	1	V
Tx output high level		4	4.55		V
Tx output source current				1	mA
Tx output sink current				1	mA
Rx input low level		-0.5		0.9	V
Rx input high level		1.9		48	V
RS422					
Input (V_{B1+}-V_{B1-})		± 0.2		± 6	V
Input leakage current			0.7	1	mA
Output (V_{A1+}-V_{A1-})	@ 50 ohm	± 1.1	± 2.2	± 5,0	V
Output source current				60	mA
RS485					
Input (V_{A-}-V_{B-})		± 0.2		± 12	V
Input leakage current			0.7	1	mA
Output (V_{A-}-V_{B-})	@ 50 ohm	± 1.5	± 2.5	± 5.0	V
Output source current				60	mA
CAN (ISO 11898-24V)					
Voltage at any input		-36		36	V
Input (V_{CAN_H} - V_{CAN_L})	Dominant	0.9		5	V
Input (V_{CAN_H} - V_{CAN_L})	Recessive	-1.0		0.5	V
Output (V_{CAN_H}- V_{CAN_L})	Dominant	1.5		3.0	V
Output (V_{CAN_H}- V_{CAN_L})	Recessive	-500		50	mV

13.2 Torque Curves



13.3 Physical Dimensions

13.3.1 Physical dimensions MIS231, MIS232 and MIS234



13.4 Trouble-shooting guide

13.4.1 Problems related to communication with the motor

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

The status at the bottom of the screen shows "*** No Connection ***" but the power LED on the motor is lit and the serial cable is connected.

Action :

- Check that the correct COM port is selected in the MacTalk "Setup" menu.
- Check using Control Panel/System/Hardware/Device Manager/Ports (COM&LPT).
- Check that the connection to the motor is made according to specifications. If only one motor is used on the RS232 bus, 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.

14 Connection to other Equipment

The SMC75 can be connected to other JVL products. These connections are described in the following chapter.

14.1Connecting SMI30/SMC35 to MIS/SMC75

The SMI3x or the SMC35B can control the MIS/SMC75 in gear mode.

To do this, some parameters in both the SMI3x and SMC35B must be set up correctly.

In the SMI3x, the definition of the number of pulses pr. revolution, PR, can be selected freely. So normally it is recommended to set PR=1600. The SMI3x has inputs from external drivers for alarm and in Position signals. If these are not connected, set CB15=0 and CB16=0.

The SMC75 must also be configured correctly. The mode must be set to Gear Mode (Reg. 2 = 3). If gear factor input=1 and gear factor output=1, then the motor will run at 100 rpm if velocity=100 in the SMI3x/SMC35B.

The connection between the SMI3x Indexer or SMC35B Controller should be made according to the following diagram:

The Controller SMC75 must be set to gear mode and the input and output for gear factor must be adjusted according to the actual application.

14.2 Connecting SMC75 to SMD73

14.3 Connecting SMC75 to SMD41

14.4 Connecting SMC75 to MAC00B1/B4

14.5 Connection to PLC/PC Boards

15 Accessories

The following accessories are available for the MIS motor series.

15.1 Cables

15.2 Power Supplies

15.2.1 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 QuickStep motors, this unit can serve as a central power dump unit.

The capacitor offers an efficient and economical way of storing the energy returned from the motors during deceleration of high inertias. See also www.jvl.dk

15.2.2 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. See also the data-sheet LD0047 which can be downloaded from www.jvl.dk

15.2.3 Other power supplies

JVL offers a wide range of power supplies in the power range 45W to 1.5kW with output voltages 24 and 48VDC. They all uses switch-mode technology in order to minimize physical dimensions and for easy adaptation to mains voltages in the range 90 to 240VAC.

The product range covers the following types: PSU05-045, PSU24-075, PSU24-240, PSU48-240, PSU48-800, PSU48-1000, PSU48-1500.

See also the data-sheet LD0058 (overview) or LD0053 (detailed) which can be downloaded from www.jvl.dk.

15.3 Brakes and shaft reinforcement

2 brake units are available for the MAC50-141 motors. The MAB23x-01 offers a 10mm output shaft and MAB23x-02 offers a 6.35mm output shaft. Both types can be mounted directly on all the MAC50-141 motors and require 24VDC applied to release the motor

No brakes are available for the MAC400 and 800 since they are constructed with an integrated brake which is a part of the order number for the complete motor.

See also the data-sheet LD0055-xx which can be downloaded from www.jvl.dk.

16 CE Declaration of Conformity

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