4.3 Expansion Module MAC00-FC2/FC4

MAC00-FC4
With M12 connectors

MAC00-FC2
With cable glands

TT1005GB

4.3.1 CAN-Open Introduction

The MAC00-FC2 and FC4 expansion module is CAN-Open slaves. With this module all the registers in the MAC motor can be accessed over a CAN-Open network. The module implements an object dictionary that follows the CiA DS-301 standard. The module contains a number of static mapped PDO's that can be used to access the most common registers. The MAC00-FC2 and FC4 also supports the DSP-402 standard from CiA.

The expansion modules MAC00-FC2 and FC4 can be mounted on the standard MAC motors MAC50, MAC95, MAC140, MAC141, MAC400 and MAC800.

Both modules offer the same functions but with the following hardware differences:

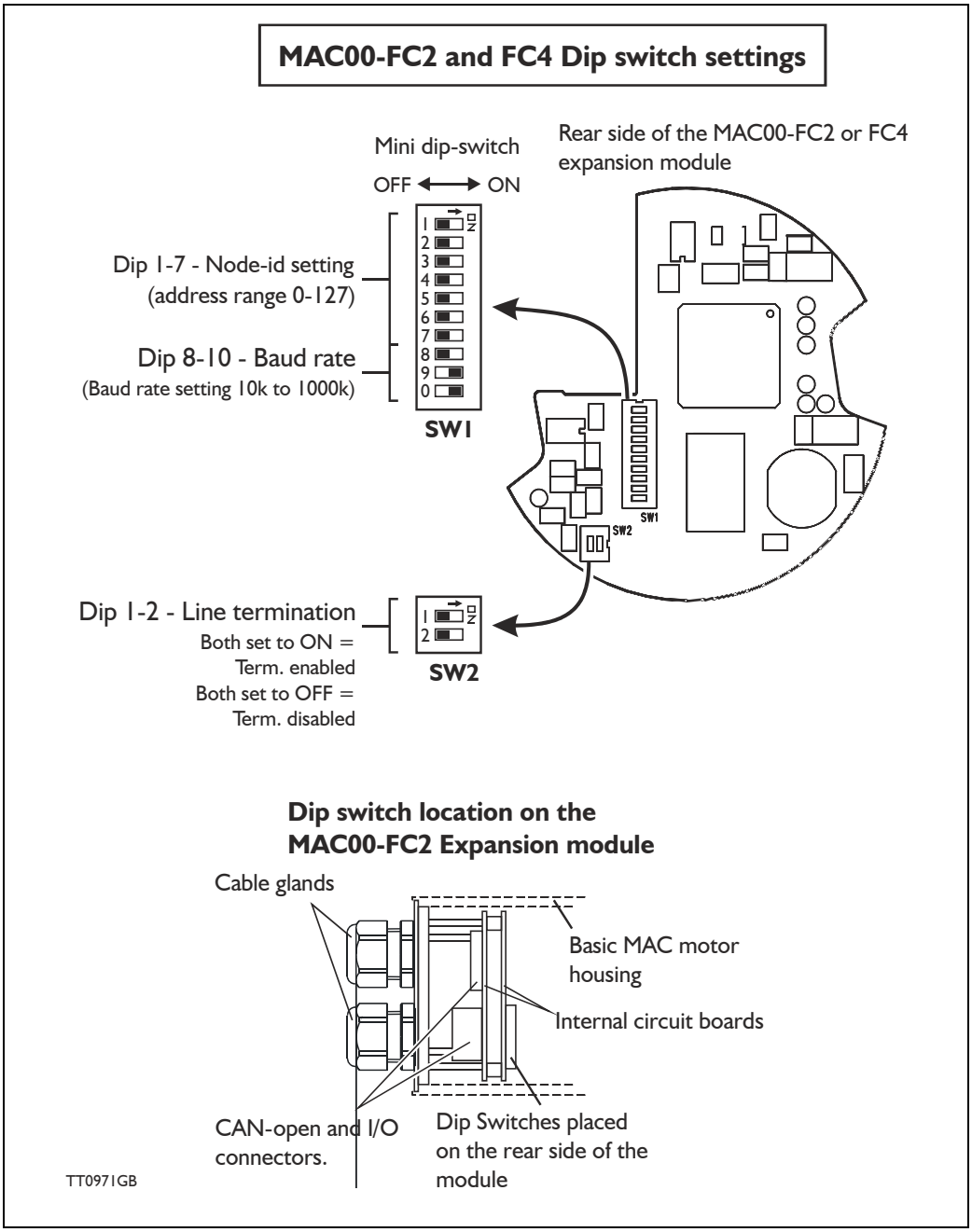
Type	Protection class	Connectors		
		I/O and interface	Power supply	Bus interface
MAC00-FC2	IP67	Cable glands (Mini crimp connectors internally	Cable glands (Screw terminals internally)	Cable glands x 2 (Screw terminals internally)
MAC00-FC4	IP67	M12	M12	M12 (x2)

The MAC00-FC2 module can also be delivered with cable in selected lengths. Cables with M12 connectors can also be offered for the MAC00-FC4 module.
The pages in the first part of this section concern the common features of both modules. Please consult the last pages in this section to see specific information about each module (for example connection diagrams).

4.3 Expansion Module MAC00-FC2/FC4

4.3.2 Node-id, baud rate and termination setup.

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



4.3 Expansion Module MAC00-FC2/FC4

The address can be set according to the following table:

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

Table continued on next page

4.3 Expansion Module MAC00-FC2/FC4

Address table continued from last page

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

If the node-id is set to 127 then the node address will be set to the same as the motor address (can be defined in MacTalk).

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

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

4.3.3 Object dictionary

	Index (hex)	Sub Index	Type	Read only	Default	Description
Command	2010	0	UNSIGNED8			Execute a MAC00-FCx command
Module parameters	2011	0	UNSIGNED8	X	7	Subindex count
		1	UNSIGNED8	X		Input status IN1 - IN4, NL, PL
		2	UNSIGNED8			Ouput
		3	UNSIGNED8	X		Motor Status
		4	UNSIGNED16	X		Last Motor Error
		5	UNSIGNED8			Output setup
		6	UNSIGNED8			Input active level
		7	UNSIGNED8			Input setup
Motor parameters	2012	0	UNSIGNED8	X	254	Subindex count
		n	UNSIGNED32			Access to the motor parameter n
FastMac Command	2013	0	UNSIGNED8			Executes a FastMac command
DSP-402	2100	0	UNSIGNED16		1000	Defines the torque limit used during homing with DSP-402

4.3 Expansion Module MAC00-FC2/FC4

4.3.4 Object 2010h

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

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

4.3.5 Object 2011h – Subindex 1 Input status

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

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

4.3.6 Object 2011h – Subindex 2 Outputs

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

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

4.3.7 Object 2011h – Subindex 3 Motor status

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

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

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

4.3 Expansion Module MAC00-FC2/FC4

4.3.8 Object 2011h – Subindex 4 Last motor status

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

4.3.9 Object 2011h – Subindex 5 Output setup

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

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

4.3.10 Object 2011h – Subindex 6 Input active level

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

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

4.3.11 Object 2011h – Subindex 7 Input setup

With this object the dedicated function of the inputs can be enabled When the corresponding bit is 0 the input work as a normal input. When the corresponding bit is 1 the dedicated function of the input will be enabled. When the end limit inputs NL or PL is enabled and one of these are activated, the error action will be executed. The error action is defined in object 2011h subindex 8.

Bit	7	6	5	4	3	2	1	0
Input	Reserved		PL	NL	Reserved			

4.3.12 Object 2011h – Subindex 8 Setup bits

This object is used for auxillary setup of the module.

Bit	7	6	5	4	3	2	1	0
Setup	Endless relative	Error action	Reserved				SCAN_ V_IST	SCAN_ P_IST

SCAN_P_IST: When this bit is 1 the P_IST is scanned all the time. The transmit PDO21 will then send the last scanned position instead of reading the position.
SCAN_V_IST: When this bit is 1 the V_IST is scanned all the time. The transmit PDO22 will then send the last scanned velocity instead of reading the velocity.

Endless relativ: When this bit is 1 the endless relative position mode is used when doing relative positioning in DSP-402. When using this mode absolute positioning can no longer be used. Error action: 0= set motor in passive mode, 1 = stop motor by setting velocity to zero.

4.3.13 Object 2012h – Motor parameters

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

4.3.14 Object 2013h – Subindex 0 FastMac command.

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

4.3.15 Receive PDO's

The PDO's 1-20 are reserved for use with the DSP-402 (CAN-Open motion control profile). The following receive PDO's are available:

Receive PDO 21:
This PDO can be used to update the position. The data in the PDO is written directly to the position register and if the motor is in position mode, it will start moving to that position.

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

Receive PDO 22:
With this PDO it's possible to update the velocity, acceleration and torque.

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

Receive PDO 23:
This PDO sets a new operating mode for the motor.

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

Receive PDO 24:
This PDO updates the outputs.

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

4.3.16 Transmit PDO's

The transmit PDO's 1-20 are reserved for use with the DSP-402 (CAN-Open motion control profile).
All the transmit PDO's support synchronous transmission, and the 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				Motor Status	Inputs	Reserved	Reserved
Object	2012h, sub 10				2011h, sub 3	2011h, sub 1		

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	Reserved	Reserved	Reserved
Object	2012h, sub 12							

Transmit PDO 23:
With this PDO the actual torque can be read.

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

Transmit PDO 24:
With this PDO the value of the analog input can be read.

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

Transmit PDO 25:
With this PDO the motor status, inputs and last error can be read.
This PDO also supports asunchronous transmission. If this PDO is in asynchronous mode, it will be transmitted every time the run status or inputs is changed.

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

4.3 Expansion Module MAC00-FC2/FC4

4.3.17 Transmission time

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

PDO number	21	22	23	24	25
Receive PDO	8.5ms	21ms	<1ms	<1ms	-
Transmit PDO	12.5ms (<1ms)*	10.5ms (<1ms)**	10.5ms	10.5ms	<1ms

* : Notice that Transmit PDO21 is faster if the P_IST scanning is enabled. (See object 2012h subindex 8).

** : Notice that Transmit PDO22 is faster if the V_IST scanning is enabled. (See object 2012h subindex 8).

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

4.3.18 Emergency object

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

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

4.3 Expansion Module MAC00-FC2/FC4

4.3.19 DSP-402 Support

Introduction

The MAC00-FCx supports the DSP-402 standard from CiA (http://www.can-cia.com/). Please referrer to this standard for details on the functions.
The DSP-402 is only a standard proposal and might be changed in the future. We reserve 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 the mandatory functions are supported.
The following operation modes is supported:

- Profile position mode
- Velocity mode
- Homing mode

Precondition

Before the DSP-402 mode can be used the firmware in the FCx module must be updated to at least version 1.3.
The start mode of the motor must be set to passive.
No power up zero searches must be selected.
If absolute movement is used the "resynchronize after passive mode" must be set.
When using the DSP-402 mode manipulating parameter with object 2012h or 2013h can corrupt the behavior of the DSP-402 functions. Also be aware that manipulating parameters in MacTalk should be avoided when using DSP-402.

4.3 Expansion Module MAC00-FC2/FC4

4.3.20 Supported objects

This is 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	10
Motor_catalog_number	6403	0	VISIBLE_STRING	X	MACxxx
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	45
Drive_catalog_number	6503	0	VISIBLE_STRING	X	MACxxx
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	2
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		
Position_window	6067	0	UNSIGNED32		
Position_window_time	6068	0	UNSIGNED16		
Max_motor_speed	6080	0	UNSIGNED32		
Profile_velocity	6081	0	UNSIGNED32		
Profile_acceleration	6083	0	UNSIGNED32		
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_s	6099	1	UNSIGNED32		
Homing_speeds_Speed_during_search_for_z	6099	2	UNSIGNED32		
Homing_acceleration	609A	0	UNSIGNED32		

Continued next page

4.3 Expansion Module MAC00-FC2/FC4

Name	Index (hex)	Sub Index	Type	Read only	Default
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_increm	608F	1	UNSIGNED32		
Position_encoder_resolution_Motor_revolutio	608F	2	UNSIGNED32		
Velocity_encoder_resolution	6090	0	UNSIGNED8	X	2
Velocity_encoder_resolution_Encoder_increm	6090	1	UNSIGNED32		
Velocity_encoder_resolution_Motor_revolutio	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
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		

4.3.21 Factors

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

Example:
We have a MAC motor with a 3.5:1 gear box connected to a belt drive. The diameter of the drive wheel is 12.4 cm. We want the unit of positions to be in milimeters.

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

The parameters should be set to this:

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

Please notice that it isn't necessary to set the encoder resolution. This is automatically set by the module.

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

Example 1:
We have a MAC800 with 8000 counts/revolution.
We want the user unit of the velocity to be in RPM.

The parameters should be set to this:

Object	Name	Value
6094h subindex 1	Velocity encoder factor - Numerator	8000
6094h subindex 2	Velocity encoder factor - Divisor	60

Example 2:
A MAC800 which have 8000 counts/revolution and the same belt drive as in the example under position factor.
We want the user unit of the velocity to be in mm/s.

The parameters should be set to this:

Object	Name	Calculated value	Value
6094h subindex 1	Velocity encoder factor - Numerator	389.56/(3.5*8000) =0.013913	13913
6094h subindex 2	Velocity encoder factor - Divisor	1	1000000

Acceleration factor
This factor is used to convert the user unit into the internal unit (counts/sec^2).
The factor is adjusted with the object 6097h.

Example 1:
We have a MAC800 with 8000 counts/revolution.
We want the user unit of the velocity to be in RPM/s.

The parameters should be set to this:

Object	Name	Value
6097h subindex 1	Acceleration encoder factor - Numerator	8000
6097h subindex 2	Acceleration encoder factor - Divisor	60

Example 2:
We have a MAC800 with 8000 counts/revolution and the same belt drive as in the example under position factor.
We want the user unit of the velocity to be in mm/s^2.
The parameters should be set to this:

Object	Name	Calculated value	Value
6097h subindex 1	Acceleration encoder factor - Numerator	389.56/(3.5*8000) =0.013913	13913
6097h subindex 2	Acceleration encoder factor - Divisor	1	1000000

4.3.22 Changing operation mode

The change of operation mode is only possible when the operation mode isn't enabled. There is one exception and that is 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.

4.3.23 Profile position mode

This mode can be used to do position where a move profile can be set up. The acceleration and maximal velocity can be programmed.
In this mode both absolute and relative move is supported. This is selected with the bit 6 (abs/rel) in the status word. When relative move is selected the type of relative move is dependant on the setup in object 2011h subindex 8.
It's also possible to select to different movement modes. This is done with the 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 is not activated before 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.

Please notice:
- The torque limit that is used during the profile can be set with the object 6072h.
- The register L1 (object 2012 subindex 81) is used to select the load factor when the profile is started. If another load factor is need this register must be set correctly.

4.3.24 Velocity mode

In this mode the motor runs with 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.
Please notice:
- The torque limit can be set with the object 6072h.

4.3.25 Homing mode

When this mode different homing sequences can be initiated. The standard homing modes from 3-34 is supported.
The home sensor must be connected to the AIN input on the module.
If the end limit inputs shall be active during the homing they must be enabled with object 2011h subindex 7.
The sensors should be connected to the appropriate inputs NL and PL.
The torque limit used during homing is selected with object 2100h. The unit of this is object is the same as other torque objects, ex. Object 6072h.

There are also 4 manufacturer specific methods. These are listed in the table below.

Method	Uses index	Description
-1	Yes	Torque homing in negative direction and afterward homing on the index pulse.
-2	Yes	Torque homing in positive direction and afterward homing on the index pulse.
-3	No	Torque homing in negative direction.
-4	No	Torque homing in positive direction.

Please notice that you should always use a home offset (object 607Ch) when using torque homing. This is to ensure that the motor moves away from the end limit. The sign of the home offset should be the opposite of homing direction. Ex. If using a negative homing direction the home offset could be 5000.

4.3.26 Supported PDO's

Receive PDO's

PDO no.	Mapping object index	Mapping object name	Comment
1	6040h	Controlword	Controls the state machine
2	6040h 6060h	Modes of operation	Controls the state machine and modes of operation
3	6040h 607Ah	Controlword Target position (pp)	Controls the state machine and the target position (pp)
4	6040h 60FFh	Controlword Target velocity (pv)	Controls the state machine and the target velocity (pv)
7	6040h 60FEh	Controlword Digital outputs	Controls the state machine and the digital outputs

Transmit PDO's

PDO no.	Mapping object index	Mapping object name	Event driven	Comment
1	6041h	Statusword	Yes	Shows status
2	6041h 6061h	Modes of operation	Yes	Shows status and the current mode of operation
3	6041h 6064h	Statusword Position actual value	No	Shows status and the current position (pp)
4	6041h 606Ch	Statusword Velocity actual value	No	Shows status and the current velocity (pv)
7	6041h 60FDh	Statusword Digital inputs	Yes	Controls the state machine and the digital inputs

4.3 Expansion Module MAC00-FC2/FC4

4.3.27 MAC00-FC2 and FC4 description of connections

The following pages descripe the different aspects in connecting the modules MAC00-FC2 and FC4.

4.3.28 MAC00-FC2 Connectors

Rear plate layout:

Expansion module MAC00-FC2 front plate

I/O
M16 cable gland
Available signals:
RS232 Interface general I/O's such as analogue input (AIN), O1, O2, IN1-IN4, NL, PL and secondary supply (optional).

BUS1
Primary CAN-open connector. M16 cable gland supporting screen

PWR
Power
M12 - 5pin male connector including:
P+, P-.

BUS2
Second CAN-open connector
M16 cable gland supporting screen.

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

Overview MAC00-FC2 connectors

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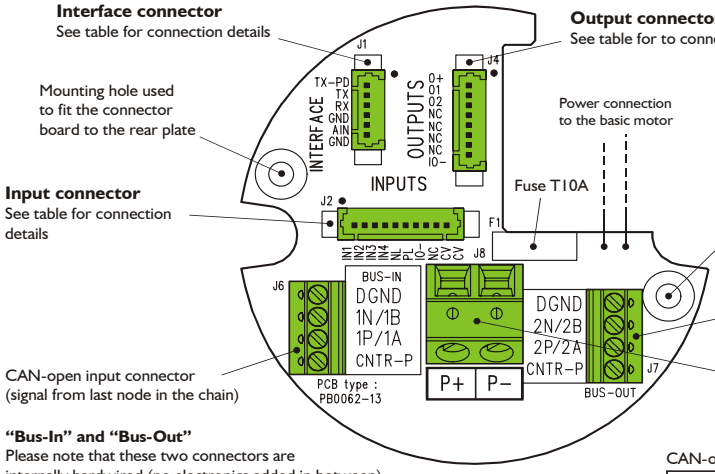


Interface connector
See table for connection details

Output connector
See table for to connection details

Mounting hole used to fit the connector board to the rear plate

Power connection to the basic motor

Fuse T10A

Input connector
See table for connection details

Mounting hole used to fit the connector board to the rear plate

CAN-open output connector (signal to next node in the chain)

CAN-open input connector (signal from last node in the chain)

Power connector
Connect power supply to these 2 terminals (+12-48VDC)

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

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

CAN-open signal definitions

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

4.3 Expansion Module MAC00-FC2/FC4

4.3.29 MAC00-FC2 with cables (optional)

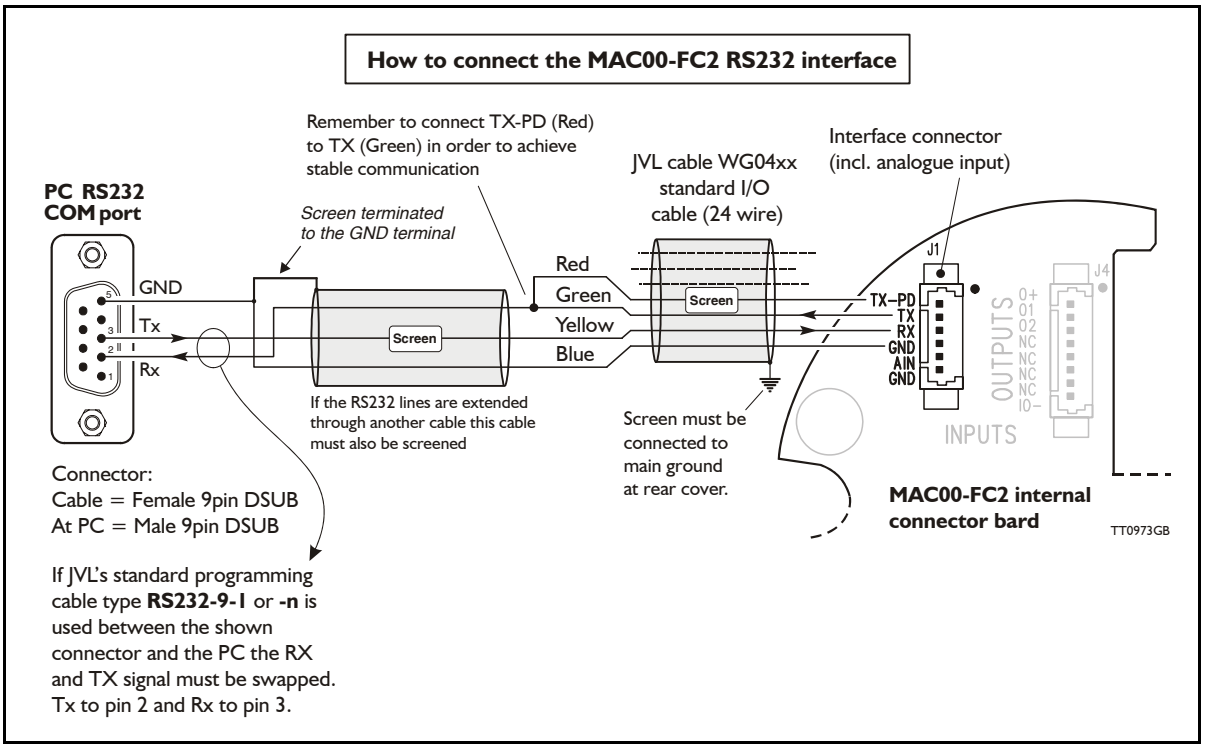
The MAC00-FC2 type number only covers the basic module without any cables.
If a number is added after the basic type number, for example MAC00-FC2-10, this suffix indicates that the module is fitted with 10 m of cable in the I/O. The I/O cable covers all the signal lines, which means RS232, Digital input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

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

4.3 Expansion Module MAC00-FC2/FC4

4.3.30 MAC00-FC2 - How to connect the RS232 interface.

The illustration below shows how to connect the MAC00-FC2 directly to a PC COM port. The drawing is based on the standard cables from JVL type WG0402, WG0410 or WG0420. See also Accessories, page 131 for a complete list of cables and connectors.
If the MAC motor is connected to the same RS232 line as other motors, the terminal TX-PD should only be connected at one of the motors.
If one of JVL's standard RS232 cables (RS232-9-1 or -n) is used between the shown DSUB connector and the PC com port the RX and TX pins must be swapped since they are crossing in these standard cable.



4.3 Expansion Module MAC00-FC2/FC4

Expansion module MAC00-FC4 front plate

BUS1
Primary CAN-open connector.
M12 - 5pin male connector including:
CAN-open interface

BUS2
Second CAN-open connector
M12 - 5pin female connector including:
CAN-open interface

PWR
Power
M12 - 5pin male connector including:
P+, P- and secondary supply (optional).

I/O
M12 - 8pin female connector including:
RS232 Interface
Selectable I/O's such as analogue input, O1, O2, IN1, NL, PL.

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4.3.31 Expansion MAC00-FC4 hardware description

The MAC00-FC4 offers a IP67 protection and M12 connectors which makes it ideal for automation applications where no additional protection is desired. The M12 connectors offers a solid mechanical protection and are easy to uplug compared to the FC2 module with cable glands. The available signals are a bit restricted compared to the FC2 module since only 4 I/O terminals are available. The I/O's connected to these 4 terminals must be selected by a small dipswitch.

The connector layout:

"PWR" - Power input. M12 - 5pin 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 +12-48VDC.	4	Black	1
P-	Main supply ground. Connect with pin 3 *	5	Grey	1
* Note: P+ and P- is each available at 2 terminals. Make sure 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 - 5pin 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
CANH	CAN interface. Positive signal line	4	-	2
CANL	CAN interface. Negative signal line	5	-	2

(Continued next page)

4.3 Expansion Module MAC00-FC2/FC4

"BUS2" - CAN-open interface. M12 - 5pin 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
CANH	CAN interface. Positive signal line	4	-	2
CANL	CAN interface. Negative signal line	5	-	2

"IO" - I/O's and RS232 interface. M12 - 8pin female connector.					
Signal name	**Description**	**Function**	**Pin no.**	**JVL Cable WI1000-M12 M8A05N**	**Isolation group**
IOC	I/O terminal C.	DIP 5 = OFF : *PL* input DIP 5 = ON : *O1* output	1	White	3
Tx	RS232 interface - transmit output Important !: DIP1 must be turned ON. If addressing is used it must be turned ON at minimum one of the connected motors.		2	Brown	1
Rx	RS232 interface - receive input		3	Green	1
GND	RS232 Ground - also used with analogue input		4	Yellow	1
IOA	I/O terminal A.	DIP 2 = ON and DIP3 = OFF : *AIN* (Analogue input) DIP2 = OFF and DIP 3 = ON : *O2* (output 2) (*AIN* is the analogue input. Remember to use the GND terminal with AIN !).	5	Grey	3 (1 when used as AIN)
IOB	I/O terminal B.	DIP 4 = OFF : *IN1* (input 1) DIP 4 = ON : *O1* (output 1)	6	Pink	3
IO-	I/O ground to be used with IN1, NL, PL, O1, O2		7	Blue	3
IOD	I/O terminal D.	DIP 6 = OFF : *NL* (negative limit input) DIP 6 = ON : *O+* (output supply)	8	Red	3

Cable Screen

Some standard cables with M12 connector offers a screen around the cable. This screen is at some cables fitted to the outer metal at the M12 connector. When fitted to the MAC00-FC4 module this means that the screen will get in contact with the complete motor housing and thereby also the power ground (main ground).

Isolation groups

The MAC00-FC4 offers optically isolation at the digital inputs and outputs (IN1, NL, PL and O1-2). In the table is shown a number for each pin. This number refers to which isolation group it is connected to.
Isolation group 1 means that the terminal refers to the main ground (P-, GND and the motor housing).
Isolation group 2 means that the terminal refers to the CAN interface ground (CAN_GND).
Isolation group 3 means that the terminal refers to the I/O ground (IO-)

4.3.32 Cables for the MAC00-FC4

Following cables equipped with M12 connector can be supplied from JVL.

JVL Type no.	Description	Length (m)
WI1000-M12F5A05N	Cable with M12 **female** 5 pin 90 degree connector loose ends.	5
WI1000-M12M5A05N	Cable with M12 **male** 5 pin 90 degree connector loose ends.	5
WI1000-M12F8A05N	Cable with M12 **female** 8pin 90 degree connector loose ends.	5
WI1000-M12M8A05N	Cable with M12 **male** 8pin 90 degree connector loose ends.	5
WI1000-M12FCAP1	IP67 protection cap for M12 female connector.	-
WI1000-M12MCAP1	IP67 protection cap for M12 male connector.	-