



Technical Newsletter # 2

1. Introduction – Communications & Update Time

This document describes the available communications interfaces in the MAC motor range – including communications speed and inter-connectivity – as well as Update Times.

NEW improved functionality: we have steadily improved the design of the basic MAC motors and the expansion modules and now ALL expansion modules communicate **internally** with the basic motor with at least **1 Mb/s** (only exception is the FSx which only communicate internally at 19,2 kb/s @MAC050..141 respectively at up to 230 kb/s or 44444 kb/s or 1 Mb/s @MAC400..3000). Ethernet modules have **internally 2 Mb/s** when mounted @MAC400..3000.

2. External Communications Interfaces in MAC motor[®]s

The available communications interfaces in the MAC motors depend on both the expansion module and the motor size. "Mini MAC motors" or "Mini" in short, covers the MAC050..MAC141 (50 W...134 W). "Big MAC motors" or "Big" in short, covers the range MAC400..MAC3000 (400 W...3000 W).

Interface		RS232	RS485 MacTalk ¹	RS485 Modbus	RS422	USB	Fieldbus /Ethernet
Module (MAC00-)	Mini	•	•	(•) ⁴	•		
	Big	•	•	•	•		
B41, Basic (only f/Big)	÷ Mini						
	Big	•	•	•	•	•	
Rx (R4, ...), Nano-PLC	Mini	•	•				
	Big	•	•				
FCx, CAN Open FPx, Profibus	Mini	•					•
	Big	•					•
Px, Process Control ²	÷ Mini						
	Big	•		• (2-wire)			
Ex4, Ethernet	Mini	•					•
	Big	•					•
FSx, Serial Comm. ³	Mini	•	•	(•) ⁴	•		
	Big	•	•	•	•		

Note 1): RS485 "MacTalk" means MacTalk-protocol, not the software tool installed on a PC.

Note 2): The Px, Process Control, module runs RS485 Modbus but only 2-wire RS485 (2-wire + Ground).

Note 3): The FSx module only runs a subset of the Mactalk protocol.

Note 4): HMI and PLC connection using the Modbus (RS485) protocol: Only ONE "Mini MAC" motor can be connected – and ONLY at fixed speed of 1 Mb/s (since it's based on RS422) !



3. Communications Speed in MAC motor[®]s - Overview

The communications speed to the MAC motors depends both on the motor and the module used. To clarify matters this newsletter has been written.

Please note that using a standard PC for communication with our motors only support up to 115 kb/s (std COM port). Using an USB COM port up to 230 kb/s is supported e.g. via JVL's USB-to-RS485 converter (which can go even higher up to 921 kb/s but this is only supported in QuickStep[®] integrated stepper motors and SMC75/85 stepper motor controllers).

Speeds in BPS (b/s)	B1/B2/B4		B41		Rx (nanoPLC)	
	Mini	Big	-Mini	Big	Mini	Big
RS 485 - ext.	19.2 k Mactalk	9.6 k...1 M Mactalk ⁵⁾	-	9.6 k...1 M Mactalk ⁵⁾	19.2 k Mactalk	
RS 232 - ext.	19.2 k Mactalk	9.6 k...1 M Mactalk or Modbus	-	9.6 k...1 M Mactalk or Modbus	19.2 k Mactalk	
Modbus - ext.	1 M RS422	9.6 k...2 M RS485/RS422	-	9.6 k...2 M RS485/RS422	NA	

"Mactalk" means Mactalk-protocol, not the software tool installed on a PC.

⁵⁾ Speeds higher than 19.2 kb/s (Mactalk protocol) only possible with 700µs pause after each telegram

Speeds in BPS (b/s)	FCx (CANopen)		FDx (DeviceNet)		FPx (Profibus)	
	Mini	Big	Mini	Big	Mini	Big
Bus/Net - ext.	1 M CAN	1 M CAN	1 M DN	1 M DN	12 M Profi	12 M Profi
RS 232 - ext.	19.2 k		19.2 k		19.2 k	
Modbus - int. (IF2)	1 M RS422		1 M RS422	1 M RS422	1 M RS422	1 M RS422

Speeds in BPS (b/s)	Px (Process)		FS1/FS4		Ex4 + Ex41 (Ethernet)	
	-Mini	Big	Mini	Big	Mini	Big
Bus/Net - ext.	-	9.6 k...2 M RS485 Opto-isolat. Modbus	9.6...230 k RS485 isol. ⁶⁾ - or - DMX 250 k Internally 19.2 k buffered!		Mini MAC -A009 only: 100 M	100 M
RS 232 - ext.	-	9.6 k...1 M Mactalk or Modbus	19.2 k ⁷⁾		19.2 k Mactalk	19.2 k Mactalk
Modbus - ext./int.	-	9.6 k...2 M internal (IF3)	1 M RS422 external	9.6 k...2 M RS485/RS422 ext. (IF2)	-	2 M RS485/RS422 int. (IF2/ IF4)

⁶⁾ Contact JVL if you need higher speeds.

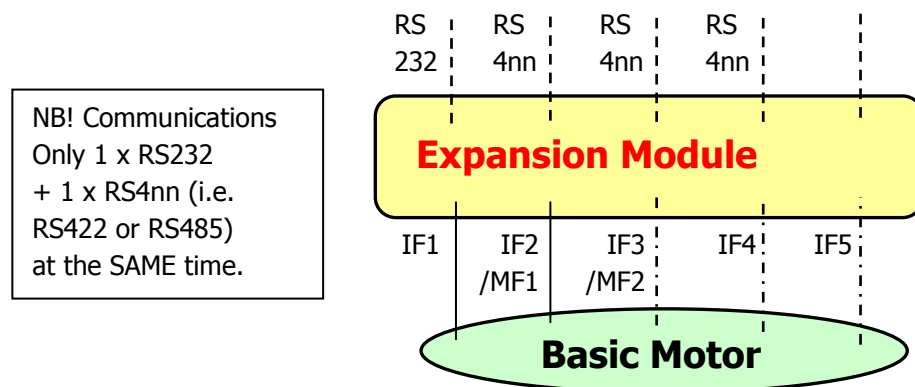
⁷⁾ For advanced options: contact JVL.



4. Communications Speed in MAC motor[®]s - Advanced

NB! The rest of this document is very technical and intended for Motion Control Specialists only.

The communications speed to the MAC motors depends both on the motor and the module used. To clarify JVL's modular concept of the MAC motor[®] integrated servo motors means that you have a Basic Motor and an Expansion Module which adapts the motor to the application:



All motors have the **internal interfaces** IF1 and IF2, whereas the IF3, IF4 and IF5 are only present in MAC400... MAC3000, and so far IF5 is used only in Ethernet module types Ex41. IF2 and IF3 are also referred to as MF1 and MF2 (Multi Function) since they can sometimes be used for input/output functions (e.g. digital input/output or Pulse-Direction or Encoder In/Out).

As of March 2014 **the fastest external communications speeds** are:

MAC 050/095/140/141 ("Mini") – 1 Mb/s Modbus on RS422 (B1/B2/B4 modules) or 1 Mb/s CANopen (FCx) or DeviceNet (FDx) or 12 Mb/s Profibus (FPx). Please note: Modbus speed is **fixed** at 1 Mb/s only.

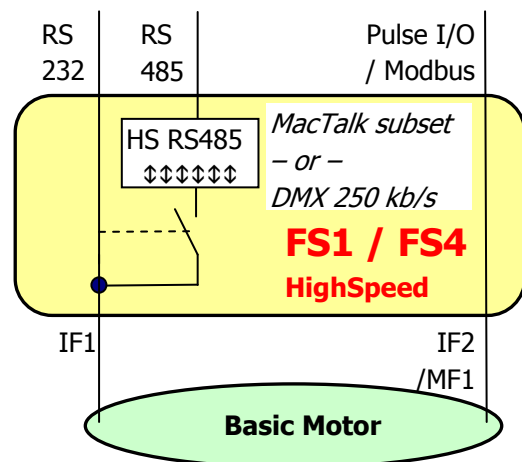
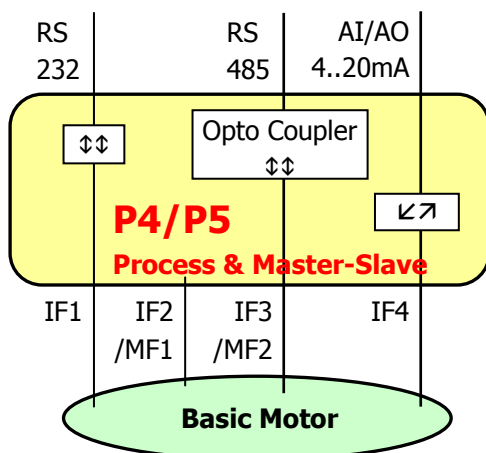
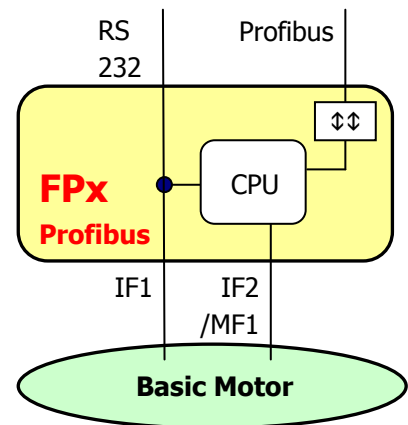
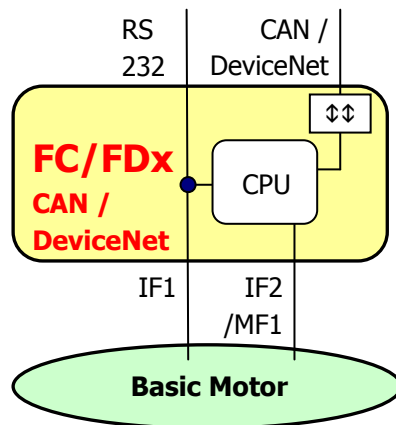
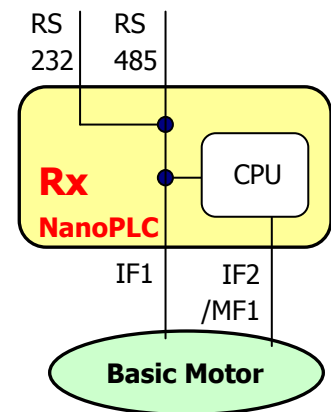
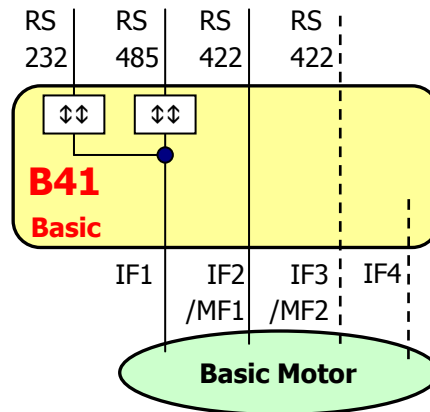
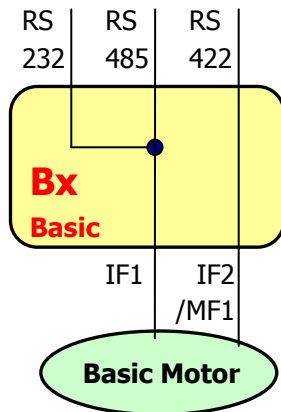
MAC 400..3000 ("Big") – 2 Mb/s Modbus on RS422 or RS485 (B1/B2/B4/B41 modules) or 100 Mb/s Ethernet (internally 2 Mb/s, Ex4 and Ex41). Modbus speed is selectable in the range 9.6 kb/s ... 2 Mb/s.

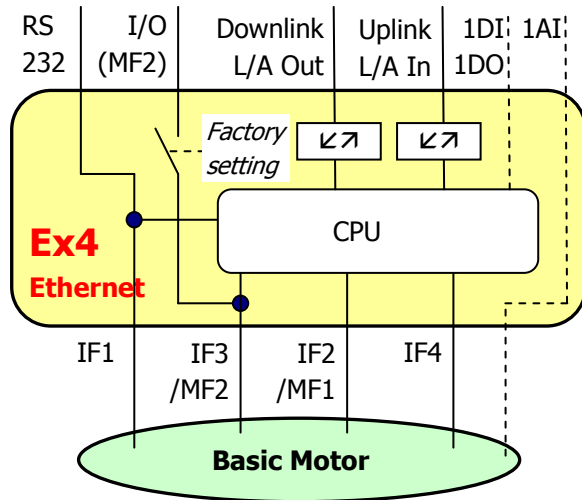
NB! MAC 400..3000 (minimum FirmWare v2.07) can on-the-fly change speed of the Mactalk-protocol (via RS232 or RS485). This is also used by the new Scope function in the MacTalk[®] PC software.

Also please note that modules are designated in this document only with their last 2 or 3 characters omitting the preceding "MAC00-". E.g. the MAC00-B41 module is referred to as only B41.

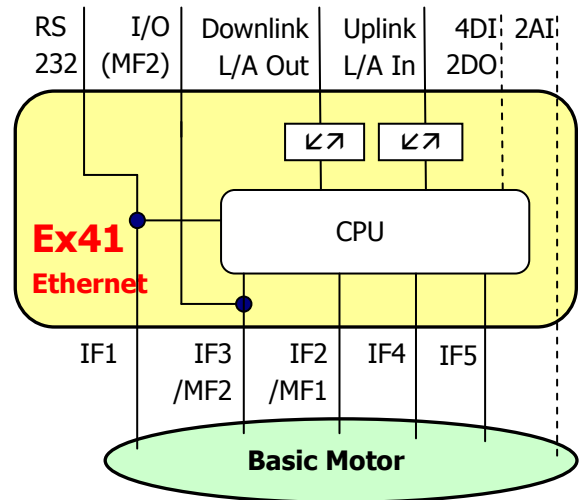
Furthermore, please notice that in order to achieve higher speeds than 19,2 kb/s using RS485 you need to implement a pause of 700 µs before each PLC telegram: then you can get up to 230 kb/s @RS485.

In order to understand the speed issue better some small drawings have been provided – please see the following pages.





NB! Ex4 is ONLY for MAC 400..3000 and special MAC 050..141 with type No. Extension -A009, e.g. "MAC140-A1AAAA-A009"



NB! Ex41 is ONLY for MAC 400..3000 !

This section covers communications speed related matters but a few comments on the Px, FSx and Ex4 modules might be in place:

P4 / P5 – Process Control & Master-Slave module

The P4/P5 is perfect for either Process control with its opto isolated interfaces and 16 bit analogue input/output – and/or for Master-Slave operation with 1 master and 1 slave, where motion is stopped in both motors if an error occurs in either the master or the slave. Master position can be controlled using either the 4-20 mA input or RS232 communication (up to 230 kb/s) or the Embedded Nano-PLC.

FS1 / FS4 – High Speed Multi Axis module

The FSx module is intended for applications where a large number of motors (up to 255) are connected to a single PC or PLC master which can also broadcast messages to ALL motors at the same time.

New positional data can be sent to 255 motors in just 133 ms. This is a very important feature in machines where multiple axes must be adjusted quickly and almost simultaneously. FSx's high speed RS485 is also opto isolated. If a few axes need to continuously update their values then the B1...B41 modules are better suited, since the internal speed (between motor and module) in FSx is only buffered.

The FSx module automatically detects if communication is taking place on RS232 and pauses the RS485 communication (as indicated on the drawing). When the RS232 is quiet again for 5 seconds, RS485 is released. In the newest FS4 modules External speeds up to 961.600 b/s are possible.

Ex4 – Ethernet modules

The industrial Ethernet modules Ex4 communicate externally with 100 Mb/s and internally (on IF2) with 2 Mb/s (1 Mb/s in MiniMAC). For most applications this is very fine and with the large telegram sizes on Ethernet, the 2 Mb/s are in general no bottleneck.

Some special applications e.g. on EtherCAT however need update times for Torque and Position values down to only 50...100 µs. For this purpose internal speed (on IF4) up to 20 Mb/s has been implemented for the 8R+8W cyclic registers (SPI) together with pauses, enabling a precise **time deterministic behaviour**.



5. Update Time in MAC 400...3000

When speaking of communications speed it is equally important to know the internal update times. It is fine to being able to communicate very fast with the motor, but if the internal update times are not equally fast it does not make too much sense. Then the fast speed will just result in the same information being repeated until the update time has elapsed, after which new information is provided.

Internally the fastest communications speed is Modbus. Response Time on Modbus with speed 1 Mb/s – from end Query to start Answer – is 100 μ s (0.1 ms) in average. When running 2 Mb/s Response Time is 50 μ s in average (range 15..70 μ s).

Thus a cycle of query and answer will take approx. 350 μ s (0.35 ms).

The motor itself will update all it's actual values each 1.0 / 1.3 / 2.0 / 2.6 ms (default is 1.3 ms). Except for the values P_QUICK (actual position, reg. 229, Read-only) which will be updated in average each 50 μ s - and VF_OUT (requested torque, reg. 169, Write) which will be updated each 100 μ s.

6. Update Time in MAC 050...141

A cycle of query and answer in MAC 050...141 will take approx. 350...1000 μ s depending on the Mode which the motor is in. The 350 μ s is only valid for Passive mode.

The motor itself will update it's actual values approx. each 1.92 ms (update frequency 521 Hz).

HOWEVER, the smaller MAC motor's have another possibility which might be useful in some applications: CAM Profiles, which will be described in a future Technical Newsletter.

7. Update Time for the Internal Control Loops

In general servo motors have 3 internal control loops: Current, Velocity and Position.

The current loop is the fastest and the motor torque is directly dependant on the current.

The velocity or speed loop is fast but normally not as fast as the current loop.

The position loop is not always in operation, e.g. when the motor is in torque or speed mode, but it can be as fast as the speed loop or somewhat slower.

Loop Cycle Time	MAC 050...141	MAC 400...3000
Current loop	127.5 μ s	100 μ s
Velocity loop	1.92 ms	1.0 / 1.3 / 2.0 / 2.6 ms
Position loop	1.92 ms	1.0 / 1.3 / 2.0 / 2.6 ms

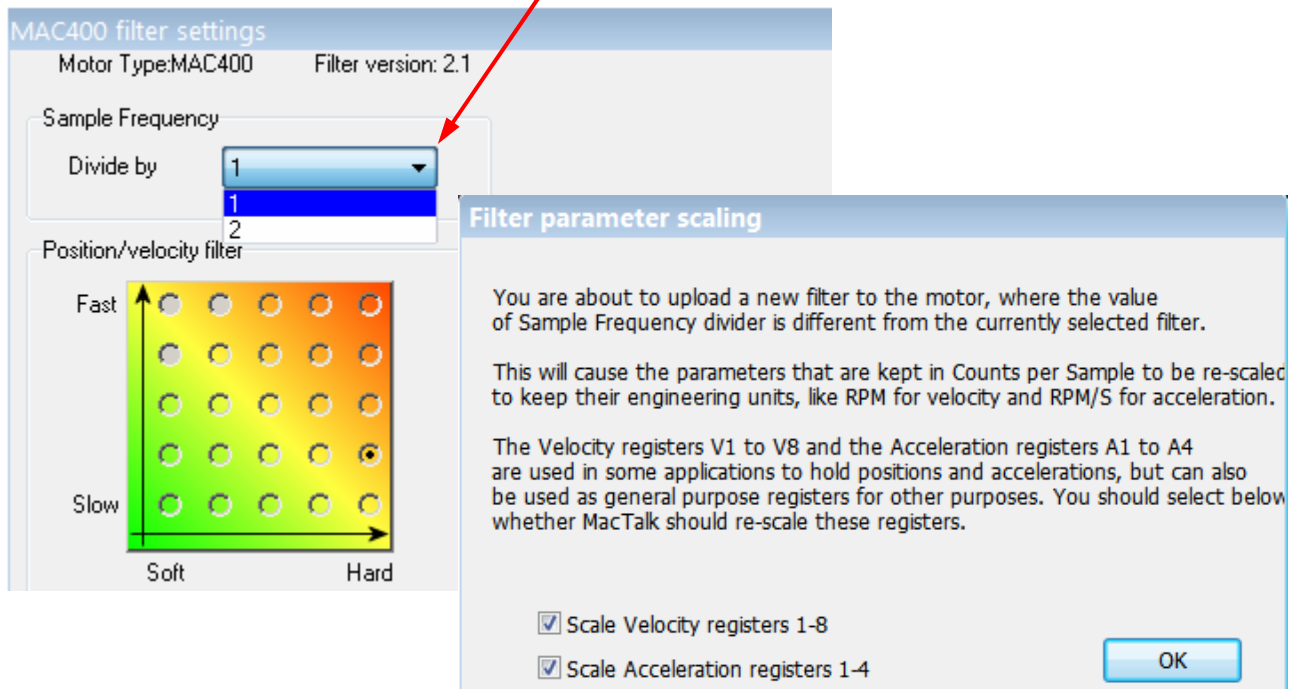
For MAC400...MAC3000 there are 4 values for both the Velocity and Position loop, where 1.3 ms is default, but in special applications with high inertia or high backlash slower control filters are often needed.



Choosing slower filters in High-Inertia and High-Backlash applications

Some applications have a **high ratio-of-inertia**, meaning that the Load inertia on the motor shaft is high compared to the motor's own rotor inertia. The larger MAC motors, starting from MAC400, can improve their performance in such cases by using slower filters.

In MacTalk you choose these slower filters (slower cycle times) as follows: Click the "Filter setup" button – in the 'Filter settings' window section 'Sample Frequency' click in the "Divide by" field and choose 2, i.e. divide sample frequency by 2 – resulting in slower filters, which are better suited for loads with high inertia or backlash.



- After your selection you will get a warning message, reminding you that parameters are scaled differently depending on Divider value.