Cavotec Micro-control

MC-MB2-PN Interface Specification

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1 General

1.1 Revision history

Revision	Description
1	First revision
2	Added dynamic polling description, see section 4.1.5

1.2 Purpose

This document will be used by both customers and CMC when developing and maintaining the MC-MB2-PN and the IO-Controller software.

The document only describes how the data exchange and error handling in this communication link is handled. The layout of the user data from/to the terminals is described in a separate system specific document. Note that the interface specification is not complete without this system specific document.

1.3 References

[1] MAN-14-001 Product manual MC-MB2

[2] Anybus IPconfig - Utility for module TCP/IP configuration
Made by HMS Industrial Networks, see http://www.anybus.com

1.4 Terms and abbreviations

CMC	Cavotec Micro-control.
Terminal	The portable part of a radio remote control system.
Base	The stationary part of a radio remote control system.
DCP	Discovery and basic Configuration Protocol, part of PROFINET standard used to configure station names and IP addresses.
MC-MB2-PN	A base unit made by CMC using the modular MB2 hardware. This document specifies the PROFINET IO fieldbus interface on this unit.
PROFINET	Protocol for exchanging automation data over Industrial Ethernet.
PROFINET IO	PROFINET for IO data exchange. Fieldbus described in IEC 61158/IEC 61784.
IO-Controller	PROFINET IO-Controller
IO-Device	PROFINET IO-Device
0x…	All numbers starting with 0x are hexadecimal numbers.
Downlink data	Data sent from the IO-Controller to MC-MB2-PN.
Uplink data	Data sent from MC-MB2-PN to the IO-Controller.
IO-SPEC	The system specific document describing the fieldbus interface for a specific remote control system.

1.5 Quick start guide

To successfully install and integrate a MC-MB2-PN unit into a system, do the following:

	System type	
Step	**Duplex/Simplex**	**Polled**
Configure network parameters in MC-MB2-PN	Section 2.2 and 2.3	Section 2.2 and 2.3
Connect MC-MB2-PN to PROFINET	Section 2.1	Section 2.1
Configure the IO-Controller using PROFINET configuration tool	Section 5.1	Section 5.1

Add software in the IO-Controller to update the downlink watchdog counter	Section 3.2.2	Section 4.2.2
Add software in the IO-Controller to monitor the uplink watchdog counter	Section 3.1.2	Section 4.1.2
Add software in the IO-Controller to monitor MC-MB2 status information	Section 3.1.1	Section 4.1.1
Add software in the IO-Controller to handle terminal data	Section 3.1.3 and 3.2.3	Section 4.1.6 and 4.2.3

See the IO-SPEC to find the system type for your remote control system.

When the IO-Controller is configured, the MC-MB2-PN will start to communicate with it. By using your IO-Controller monitoring tools, you will be able to see the uplink watchdog counter. The MC-MB2-PN will still indicate E010 (fieldbus update failure) because the downlink watchdog counter is not updated. As long as E010 is indicated, the MC-MB2-PN will not establish communication with the terminal(s), and no data from any terminal is available.

When update of the downlink counter is implemented in the IO-Controller, the E010 error will disappear and the radio remote control system will be fully operational.

1.6 Safety precautions

The IO-Controller shall monitor the uplink watchdog counter, the MC-MB2-PN status byte and the terminal status byte as specified in chapter 3 and 4. The IO-Controller shall bring the system to a safe state if this information indicates that valid data from the remote control is not available.

Cavotec Micro-control takes no responsibility for the consequences if this is not implemented as specified in this manual.

2 Interface description

2.1 PROFINET interface

The MC-MB2-PN connects directly to the PROFINET using the industry standard RJ45 interface. Fitted with 2 physical ports and an internal switch, the MC-MB2-PN allows line or bus topologies without the need for external switches.

The MC-MB2-PN is a DAP v2.0 IO-Device fully compliant with the PROFINET standard as specified in IEC 61158 and IEC 61784. The MC-MB2-PN Ethernet interface operates at 100Mbit, full duplex, as required by PROFINET.

The MC-MB2-PN is delivered with a GSDML-file used to configure the IO-Controller.

2.2 IP configuration

The IP configuration can be set up in two ways:

- Using the Anybus IPconfig [2] tool.
- Via the DCP protocol.

When delivered, the IP settings are normally:

- DHCP disabled
- IP address: 192.168.0.2
- Gateway address: 192.168.0.2
- Netmask: 255.255.255.0

The recommended method is to use the DCP protocol to set up the IP configuration from the IO-Controller configuration software.

2.3 Station name

PROFINET requires each IO-Device to have a unique station name. This name is used by the IO-Controller to recognize the IO-Device. Use the IO-Controller configuration tool to set a unique name using the DCP protocol.

When delivered, the station name is normally set to 'mc.base.pn'.

2.4 Error handling

Any error in the MC-MB2-PN or in the terminal is handled by the MC-MB2-PN unit, and causes the MC-MB2-PN to report an appropriate error status to the IO-Controller.

Errors in the PROFINET communication is detected by using two «watchdog counters», one for uplink data and one for downlink data. For the downlink data, the procedure is:

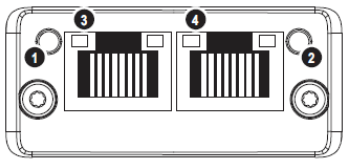
- The IO-Controller increments the downlink watchdog counter, at least every 500ms.
- This watchdog counter is transferred via the PROFINET network to the MC-MB2-PN.
- The MC-MB2-PN continuously monitors this counter. If the IO-Controller fails to update this counter within a timeout (default 2000ms), it means that the IO-Controller has stopped or the communication is faulty. The MC-MB2-PN detects this error condition, brings the system to a safe state and indicates "E010". As long as E010 is indicated, the MC-MB2-PN will not establish communication with the terminal(s).

A similar error handling procedure shall be implemented in the IO-Controller to monitor the uplink watchdog counter.

2.5 Status LEDs

The PROFINET plug-in module has LEDs installed for PROFINET status indication:

#	Item
1	Network Status LED[a]
2	Module Status LED[a]
3	Link/Activity LED (port 1)
4	Link/Activity LED (port 2)



a. Test sequences are performed on the Network and Module Status LEDs during startup.

Network Status LED		
LED state	**Description**	**Comments**
Off	Offline	- No power - No connection with the IO-Controller
Green	Online (RUN)	- Connection with IO-Controller established - IO-Controller in RUN state
Green, flashing	Online (STOP)	- Connection with IO-Controller established - IO-Controller in STOP state

Module Status LED		
LED state	**Description**	**Comments**
Off	Not initialized	No power or module not initiated
Green	Normal operation	
Green, 1 flash	Diagnostic event(s)	Diagnostic event(s) present
Green, 1Hz	DCP flash	Used by engineering tools to identify the node on the network
Red	Exception error	Module in exception state

Red, 1 flash	Configuration error	Expected identification differs from real identification
Red, 2 flashes	IP address error	IP address not set. See section 2.2
Red, 3 flashes	Station name error	Station name not set. See section 2.3
Red, 4 flashes	Internal error	Module has encountered a major internal error

Link/Activity LED		
LED state	**Description**	**Comments**
Off	No Link	No link, no communication present
Green	Link	Ethernet link established, no communication present
Green, flickering	Activity	Ethernet link established, communication present

For MC-MB2-PN status indication, please refer to the product manual [1].

3 Duplex and Simplex systems

3.1 Uplink data

The MC-MB2-PN slave occupies an input area of up to 256 bytes like this:

Byte Offset	Size	Description
0	1	MC-MB2-PN status byte
1	1	Uplink watchdog counter
2 – X	Up to 254	Uplink data from terminal

3.1.1 MC-MB2-PN status byte

The MC-MB2-PN status byte is divided into the following fields:

Bit	Interpretation
0 – 3	MC-MB2-PN status
4 – 7	Terminal number

MC-MB2-PN status	
Value	**Interpretation**
0	Terminal absent. There is no communication with the terminal.
1	Terminal present.
2	Terminal blocked. Waiting for start key from terminal.
7	Active stop. The terminal active stop logic has been activated.
0xA	Fieldbus update failure. Fieldbus communication has stopped or the IO-Controller has failed to update the downlink watchdog counter.
other	Other values shall not occur. If they do, the IO-Controller shall bring the system to a safe state.

When the MC-MB2-PN status is different from 1, the uplink data area contains all 0's. The IO-Controller shall bring the system to a safe state when this occurs.

Terminal number	
Value	**Interpretation**
0	The MC-MB2-PN is not locked, and is scanning all configured terminals.
1 – 0xF	The MC-MB2-PN is locked to terminal number 1 to 15.

3.1.2 Uplink watchdog counter

This watchdog counter is incremented by the MC-MB2-PN for each valid data update, or at least every 500 milliseconds. The IO-Controller shall bring the system to a safe state if this counter has not been updated for 1 second. See section 2.4.

3.1.3 Uplink data from terminal

The size and the layout of the uplink data area is described in the IO-SPEC.

3.2 Downlink data

Each MC-MB2-PN slave occupies an output area of up to 256 bytes like this:

Byte Offset	Size	Description
0	1	Base unit number.
1	1	Downlink watchdog counter.
2 – X	Up to 254	Downlink data to terminal. Not present on simplex systems.

3.2.1 Base unit number

The MC-MB2-PN may be configured with multiple-select functionality, allowing the IO-Controller to configure the base selection criteria. If configured, this is described in the IO-SPEC.

If multiple-select functionality is configured, the IO-Controller shall write the base unit number to this byte. If not configured, this byte is ignored.

3.2.2 Downlink watchdog counter

This watchdog counter shall be incremented by the IO-Controller, see section 2.4.

On simplex systems with no multiple-select functionality, the IO-Controller does not report any data to the MC-MB2-PN. Then the MC-MB2-PN may be configured to not monitor the downlink watchdog counter.

3.2.3 Downlink data to terminal

The size and the layout of the downlink data area is described in the IO-SPEC.

4 Polled systems

In a polled system, the MC-MB2-PN can communicate with up to 4 terminals simultaneously in 4 data slots. The number of simultaneous terminals and the size of the uplink and downlink data areas for each terminal are described in the IO-SPEC.

4.1 Uplink data

The MC-MB2-PN slave occupies an input area of up to 256 bytes like this:

Byte Offset	Size	Description
0	1	MC-MB2-PN status byte.
1	1	Uplink watchdog counter.
2	1	Uplink data area size (Y). 2)
3	1	Downlink data area size (Z). See section 4.2.
4	1	Terminal status byte for slot 1.
5	1	Terminal status byte for slot 2.
6	1	Terminal status byte for slot 3.
7	1	Terminal status byte for slot 4.
8 – (Y+7) 2)	Y 2)	Uplink data for slot 1.
(Y+8) – (2Y+7) 2)	Y 2)	Uplink data for slot 2.1)
(2Y+8) – (3Y+7) 2)	Y 2)	Uplink data for slot 3.1)
(3Y+8) – (4Y+7) 2)	Y 2)	Uplink data for slot 4.1)

1) Present only when the corresponding slot status byte is different from 0x0F.
2) Y is the number of bytes per data slot. The value for your system is described in the IO-SPEC.

4.1.1 MC-MB2-PN status byte

The MC-MB2-PN status byte is divided into the following fields:

Bit	Interpretation
0 – 3	MC-MB2-PN status
4 – 7	Always set to 0 on polled systems

MC-MB2-PN status	
Value	**Interpretation**
0xA	Fieldbus update failure. Fieldbus communication has stopped or the IO-Controller has failed to update the downlink watchdog counter.
0xF	Polled system normal mode.
other	Other values shall not occur. If they do, the IO-Controller shall bring the system to a safe state.

4.1.2 Uplink watchdog counter

This watchdog counter is identical to duplex systems. See section 3.1.2.

4.1.3 Uplink data area size

Contains number of uplink data bytes for each terminal.

4.1.4 Downlink data area size

Contains number of downlink data bytes for each terminal.

4.1.5 Terminal status byte for slot 1 to 4

The terminal status byte is divided into the following fields:

Bit	Interpretation
0 – 3	Terminal status
4 – 7	Terminal number

Terminal status	
Value	**Interpretation**
0	Terminal absent. There is no communication with the terminal.
1	Terminal present.
2	Terminal blocked. Waiting for start key from terminal.
7	Active stop. The terminal active stop logic has been activated.
0xF	Slot not used. Uplink and downlink data area for this slot does not exist.
other	Other values shall not occur. If they do, the IO-Controller shall bring the system to a safe state.

When the terminal status is different from 1, the uplink data area for the terminal contains all 0's. The IO-Controller shall bring the system to a safe state when this occurs.

Terminal number	
Value	**Interpretation**
0	Terminal uplink and downlink data area for this slot is not allocated to a specific terminal.
1 – 0xF	Terminal uplink and downlink data area for this slot is allocated to terminal 1 to 15.

If the number of simultaneous terminals in the system matches the number of configured terminals, the slot allocation is fixed. The data from terminal 1 is always reported in slot 1, terminal 2 in slot 2 and so on.

If the number of simultaneous terminals in the system is lower than the number of configured terminals, the slots are allocated dynamically as the terminals are connected and disconnected. This feature is called dynamic polling. The terminals are served in a "first come first serve" basis. When all

available slots are filled by online terminals, the MC-MB2-PN will stop scanning for other terminals. When one of the terminals disconnects, the MC-MB2-PN will after 5 seconds start scanning for a new terminal for this free slot. As the slot allocation of terminals are dynamic, the IO-Controller must monitor the terminal number part of the terminal status byte for each slot.

4.1.6 Uplink data for slot 1 to 4

The size and the layout of the uplink data area is described in the IO-SPEC.

The size of each uplink data area is found in the uplink data area size, see section 4.1.3.

4.1.7 IO-Controller programming considerations

In a polled system, the IO-Controller shall either:

- Read the layout variables and automatically adjust input and output processing to match data area sizes and number of simultaneous terminals.
- Check the layout variables against expected values, and bring the system to a safe state if a mismatch is detected.

Failing to do so may lead to a dangerous situation if one of the units (the MC-MB2-PN or the IO-Controller) is reconfigured for instance to support more terminals, without reconfiguring the other one.

4.2 Downlink data

Each MC-MB2-PN slave occupies an output area of up to 256 bytes like this:

Byte Offset	Size	Description
0	1	Reserved byte
1	1	Downlink watchdog counter
2 – (Z+1) [2]	Z [2]	Downlink data for slot 1
(Z+2) – (2Z+1) [2]	Z [2]	Downlink data for slot 2 [1]
(2Z+2) – (3Z+1) [2]	Z [2]	Downlink data for slot 3 [1]
(3Z+2) – (4Z+1) [2]	Z [2]	Downlink data for slot 4 [1]

1) Present only when the corresponding slot status byte is different from 0x0F.
2) Z is the number of bytes per data slot. The value for your system is described in the IO-SPEC. Value is also given in uplink data header, see section 4.1.

4.2.1 Reserved byte

This byte is reserved for future use. Set it to 0 to ensure compatibility with future systems.

4.2.2 Downlink watchdog counter

This watchdog counter is identical to duplex systems. See section 3.2.2.

4.2.3 Downlink data to remote control 1 to 4

The size and the layout of the downlink data area is described in the IO-SPEC.

The size of downlink data area is found in the downlink data area size, see section 4.1.4.

5 How to configure the MC-MB2-PN in the IO-Controller

5.1 Step by step instruction

To configure the PN-master:

- Load the supplied GSDML file into your configuration tool, see section 5.2.
- Add an IO-Device of type “MC-MB2-PN”. Configure the MC-MB2-PN with the desired station name and IP configuration, see section 2.2 and 2.3.
- Add modules to this modular IO-Device according to the IO-SPEC.
- Download the configuration into the IO-Controller.

5.2 GSDML file

The GSDML file to be used is: GSDML-V2.25-CMC-MC_MB2_PN2P_1_1-20141023.xml.

5.3 Selecting modules from GSDML file

The correct modules and the correct order for these modules for your system are specified in the IO-SPEC.

The modules available in the GSDML file are:

Module name in GSDML file	Uplink bytes	Downlink bytes
Uplink header for Simplex/Duplex	2	
Uplink header for Polled	8	
Uplink data, 2 bytes	2	
Uplink data, 4 bytes	4	
Uplink data, 8 bytes	8	
Uplink data, 10 bytes	10	
Uplink data, 20 bytes	20	
Downlink header for Sim/Dup/Poll		2
Downlink data, 2 bytes		2
Downlink data, 4 bytes		4
Downlink data, 8 bytes		8
Downlink data, 10 bytes		10
Downlink data, 20 bytes		20
Downlink ASCII data, 2 bytes		2
Downlink ASCII data, 4 bytes		4
Downlink ASCII data, 8 bytes		8
Downlink ASCII data, 10 bytes		10
Downlink ASCII data, 20 bytes		20
Downlink ASCII data, 40 bytes		40

The following modules must be selected:

- An uplink header module, depending on the system type (Simplex/Duplex or Polled).
- A downlink header module.
- For each terminal, uplink data modules to achieve the configured terminal uplink data size. Use the largest possible modules. E.g. to get 26 bytes, the module sizes shall be 20 + 4 + 2 bytes.
- For each terminal, downlink data modules to achieve the configured terminal downlink data size. Use the largest possible modules.
- For each terminal, downlink ASCII data modules to achieve the configured terminal downlink ASCII data size. Use the largest possible modules.

The modules must be selected in this order:

- Uplink header module.
- Uplink data modules for terminal 1, sorted with the largest module first.

- Uplink data modules for terminal 2, sorted with the largest module first.
- …..
- Downlink header module.
- Downlink data modules for terminal 1, sorted with the largest module first.
- Downlink ASCII data modules for terminal 1, sorted with the largest module first.
- Downlink data modules for terminal 2, sorted with the largest module first.
- ….