



SELPRO

 SELPRO FRIENDLY EC CONTROLLERS



approved controller
for
ebmpapst products

MODBUS



MODBUS (RTU) Description & Connections



ebmpapst



Overview

“**Communication Bus**” means the external connection between two or more units which ensures data exchange in numeric format (digital).

The bus is usually realized in the “serial” form, connecting different units with a simple screened cable composed of only a few conductors.

The “**Communication Buses**” are laid out in Fig 1.1; each device (1) has a bus (5) serial type interface in compliance with standard **RS485**. More than one unit is connected (3,4,5,6) to a remote PC (2) which acts as “**master**” to the communications system. The master station is the only one which can take the initiative to interrogate the other connected stations. The latter respond only if interrogated, meaning they function in “**slave**” mode. Hence the bus is of the “**mono-master**” type, only a master station can take the initiative, meaning the PC connected in (daisy-chain) cascade to the slave stations (controlled equipment) up to a maximum of 32 stations.

The exchange of information occurs two ways, in one alternating direction or always using the same duplex cable (5); this procedure is known as “**half duplex**”. All stations, both PC master (2) and slave stations (1) can transmit and receive, but not simultaneously: when the PC master transmits, the slave stations receive, when the slave station receiving the previous command transmits the reply, the master PC receives and the other slave stations remain in stand-by without interfering. For this to occur, each station shall have a univocal address reserved for it.

The logic standard chosen for the protocol is “**MODBUS RTU**.” A program in the PC periodically interrogates the slave stations one at a time, or after request by operator, receives data, displays it properly on screen and/or files it for subsequent processing. The data received are input and output values of the interrogation device, values of the internal variables, i.e.: processing of inputs or pre-settings, etc. Moreover, it is possible to send commands or modify the adjustments of the slave unit interrogated.

The program in the PC, representing the master station, has been realized for Windows environment. The connection of the PC to the RS485 communication serial bus occurs through a special adaptor.

As mentioned, the master station has been realized by using a PC (2); there are two possibilities to interface it to RS485 serial line: an external adaptor (8) which transforms the signals from port RS232 or USB serial (usually available in all PCs) into signals for RS485, or a board (7) to be mounted inside the PC equipped with a RS485 interface.

Technical specifications of the communications bus

Physical standard	ANSI/TIA/EIA-RS485
Logic standard	MODBUS, RTU procedure
Transmission procedure	Serial , Half duplex
Type of connection	Multipoint : all stations receive the signal transmitted from any station
maximum n° of stations	32
Maximum distance	1000m (between first and last station) with 24AWG cable
Transmission speed	can be selected 4,800 , 9,600 , 19200 , 38400 bit/s
Control procedures	Monomaster
Management software	For master station based on PC, versions for Windows environment

Connection diagram of communication buses

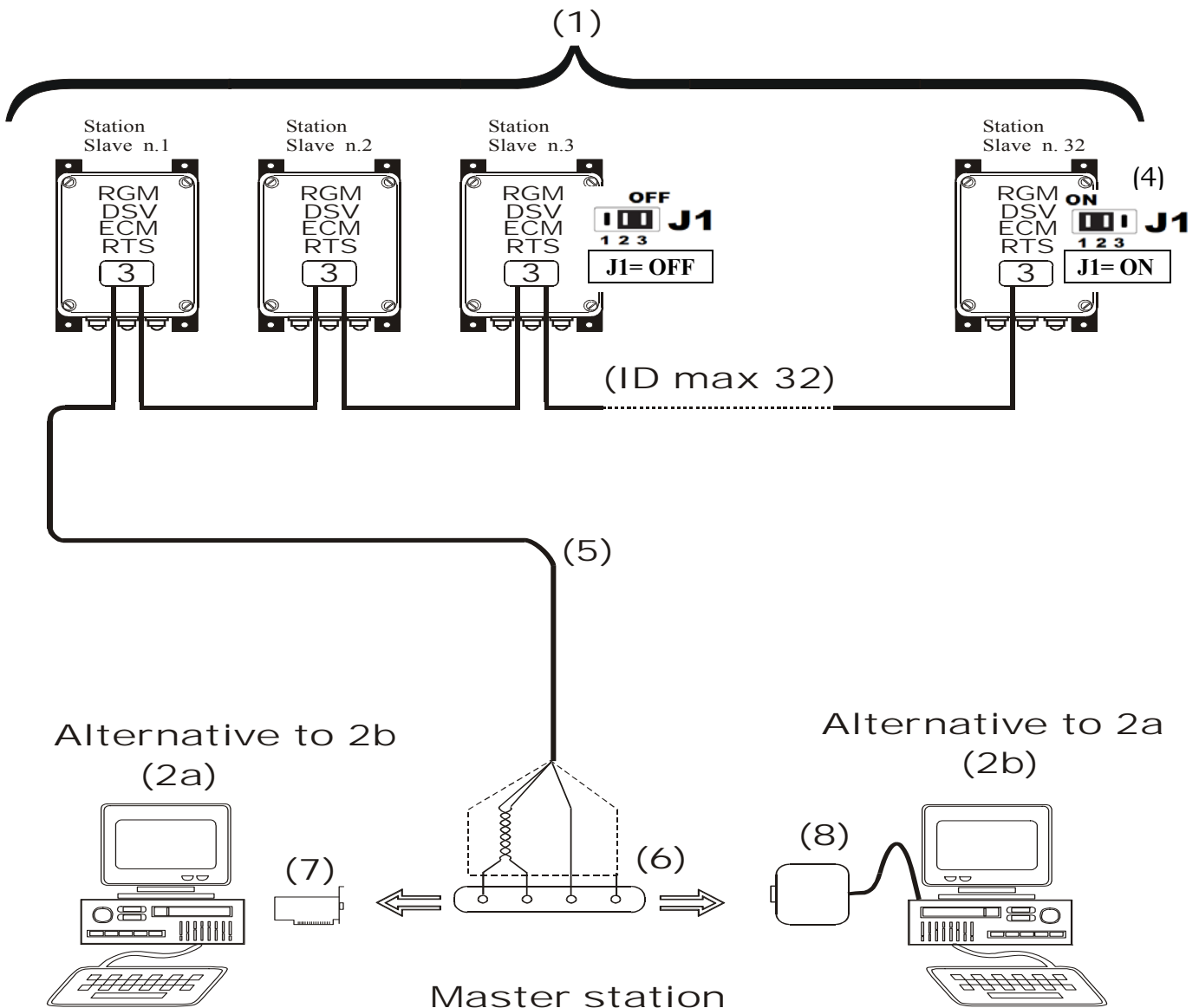


Fig. 1

- | | | | |
|----|--|---|--|
| 1 | ECM device (Slave stations) | 5 | Screened cable for Communication Buses |
| 2a | Master Station realized with PC equipped with internal board | 6 | Connector from Bus to PC |
| 2b | Master station realized with PC and external adaptor | 7 | Custom board with port RS485 |
| 3 | Wiring diagram with support terminal board | 8 | External adaptor RS232 /RS485 |
| 4 | J1 determines the ending of the bus connection | | |

As mentioned before, each station shall have a univocal reserved address; the address is input during installation through a keyboard and display for each device.

Right after inputting the address, each machine shall be visibly marked with the assigned address number in order to avoid any confusion when the system is used.

By default the address is input at the highest number (247)

Physical connection

Interface

The latest generation Selpro controllers, can be equipped with the RS-485 isolated serial interface (D+ , D- , GND) to avoid any problems due to grounding.

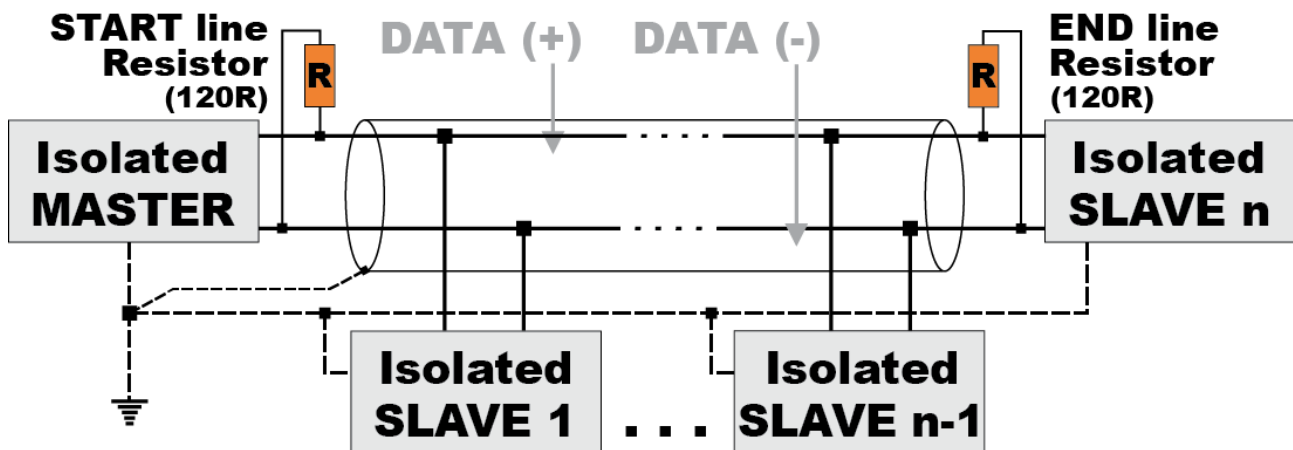
Line

The RS485 isolated interface has three terminal boards called: D+ (DATA+) / D- (DATA -) / REF (Ground reference). Links between all units part of the communication installation are made through parallel connection: all D+ terminals shall be connected like the D- and REF terminals as well.

The maximum line length for free wiring is 500 mt. and the maximum distance between two devices is 400 mt.

The maximum line length for wiring in bus topology is 1.000 mt.

With bus wiring, a terminator of **120R (ohm) / ≤ 0,25W** must be fitted to the beginning and the end of the line.



The line which connects all REF terminals shall be grounded in one point only, preferably at the PC which shall act as master station.

In this same point the screen of the cable is connected to the REF terminal.

The use of a termination resistance equal to a value of 120R placed at the two physical ends of the line is required for proper functioning.

The speed of communication 4800, 9600, 19200, 38400 bit/s adopted allow for extremely satisfying performance levels, even while remaining below the limitations prescribed by standard RS485. This ensures the line wiring can be made using a twisted and shielded average quality duplex cable: as long as the total range of the line does not exceed 200nF

The total length of the line can reach at least 1000 meters.

For the data line, use a suitable cable, i.e.: **ITC BELDEN 15S7D Serial Cable for LAN Networks.**



PRODUCT SHEET



Part Num.

15S7D

Description

1X2XAWG22+1XAWG22 S(FTP) DOUBLE SHEAT
RS485 CANBUS

Family

Serial and BUS cables for electronics and automation

Technical specifications	
Conductor	Tinned copper 7x0,25 mm
Conductor resistance	50 Ohm/Km
Insulation	Foam Polyethylene diam. 1,6mm
Color code	White/Orange Blue
1° Screen	Al/Pet foil coverage 100%
Drain wire	Tinned copper 7x0,20 mm
2° Screen	Tinned copper braid coverage 65%
Inner Jacket	FR and Oil proof PVC diam. 7,6, gray colour
Outer Jacket	LD Polyethylene UV res. diam. 9,0, black colour
Nom. Impedance	120 ± 15 Ohm
Nom. Capacitance	36 pF/m
Nom. Velocity propagation	78%
Screening efficiency	>85 dB
Voltage Withstanding	C-4 (U0=400v)
Test Voltage	4,5 kVac
Temperature rating	-20 / +80°C
Min. bending radius	10 x O.D.
Weight	8,4 Kg/100m
Notes	Suitable for outdoor installation, underground and in humid environments.

Electrical Features

Frequency (MHz)	Atten. (dB/100m)
1	1,65

More info...

Conditionnement	Standards
M100	IEC 60332.1
B500	IEC 20-22 III
	CEI-UNEL 36762
	EIA RS-485

Applications

Professional balanced cables for industrial networks, Field, Lon, Can, Mod, Inter - BUS.
Support the main transmission protocols such as EIA RS-232, EIA RS-422, EIA RS-485.
Suitable for coexistence with 450/750V power cables and 0.6/1kV.

Markings

Date, ITC, article, meters

Communication protocol

The protocol adopted ensures the equipment itself can be remote controlled, read all the internal variables and in some cases modify the values.

Such function is realized through a subset of the MODBUS-RTU protocol (“Remote Terminal Unit” mode) based on standards described in these documents:

- **MODBUS Over Serial Line : Specification and Implementation Guide V 1.0**
- **MODBUS Application Protocol Specification V 1.1b**

These documents can be found at the website www.modbus.org which belongs to the organization which defines the “ModBus” standards. MODBUS is a trademark registered by AEG Schneider Automation Inc.

Not all functional codes prescribed in these documents have been implemented, but only those corresponding to significant internal variables of the equipment application program. Such data is accessible through “Holding” and “Input” registers.

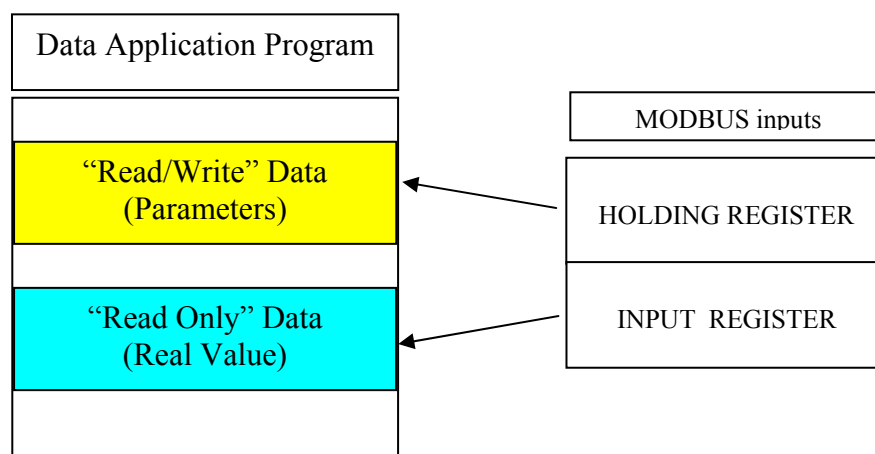
Format of data and access procedures

The internal variables of the application program are organized and available in the format of a single 16 bit register.

The organization of variables on each bit shall not be provided.

The MODBUS access to data contained in the registers occurs through the following MODBUS functions per register:

- READ INPUT register (functional code 4)
- READ HOLDING register (functional code 3)
- WRITE SINGLE register (functional code 6)
- WRITE MULTIPLE register (functional code 16)



The data corresponding to the internal variables of the controller are arranged without interruption in the memory areas reserved to Holding and Input registers, starting from the register with MODBUS 100 address.

1.0 Frame protocol

Data are transferred using the Modbus protocol defined in these specifications exclusively in an environment defined as a Master/Slave system.

The orderly progression of data is defined by the Master.

A slave is required to respond to its command prompt.

For this reason, it is important to ensure that no slave address is assigned more than once when constructing a system.

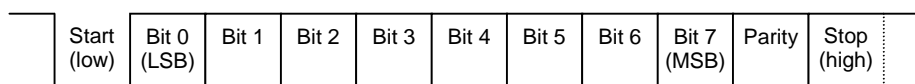
A twisted pair wire with RS485 standard should preferably be used.

Only RTU transmission mode is supported (see MODBUS over Serial Line Specification & Implementation guide V1.0, chapter 2.5.1)

ASCII transmission mode is not supported!

1.1 Structure of a Byte

According to the MODBUS over Serial Line Specification & Implementation guide V1.0. a byte has the following structure:



The parity bit has the parity "Even".

This means that the number of all data bits, including the parity bit with the value 1 ("high") is even (i.e. 0, 2, 4, 6, 8).

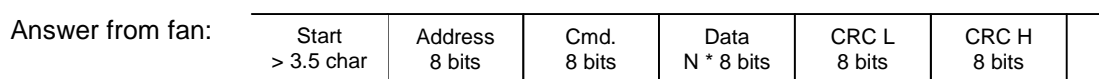
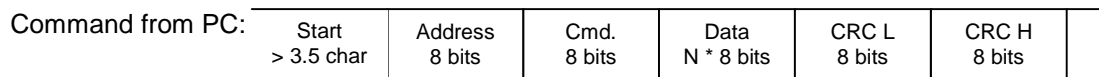
"Odd parity" and "No parity" are not supported!

The transmission rate is 19,200 baud.

This value is equivalent to the basic setting corresponding to the MODBUS over Serial Line Specification & Implementation guide V1.0. Other transmission rates are not supported!

1.2 Communications process

The MODBUS over Serial Line Specification & Implementation guide V1.0 defines the following framework for the transmission protocol:



In contrast to the general specifications, the maximum telegram length is 17 bytes!

1.2.1 Command from PC

Initial synchronisation:

A transmission pause of at least 3.5 bytes is used for initial synchronisation.
The following byte is then interpreted as the first byte of a frame (i.e. address).
The pause between the individual bytes of a frame may be a maximum of 1.5 bytes.

Address:

The address field has a size of 8 bits.
The address values 1..247 are permissible
The address 0 is reserved for broadcast commands (i.e. commands to all fans in the network).

Command:

The following commands from the "MODBUS Application Protocol Specification V1.1" general specifications are supported:

Code	Command
0x03	Read holding register
0x04	Read input register
0x06	Write single register
0x10	Write multiple register

Other commands are not supported.

Data:

Depending on the command concerned, the number of data bytes and their meaning may differ.
Please refer to 0 data byte.

CRC L / CRC H:

A CRC checksum is defined via the complete telegram.
The polynomial for defining the checksum is $1 + x^2 + x^{15} + x^{16}$ (i.e. XOR link to 0xA001).
The initial value is 0xFFFF.

The low byte of checksum is transmitted first, then the high byte.

More detailed information about calculating the checksum can be found in the "MODBUS over Serial Line Specification & Implementation guide V1.0".

1.2.2 Answer from fan

A fan will only answer if:

- it receives a message through its own address.
No answer will be sent to a broadcast address.
- the telegram length is at most 17 bytes.
- the correct number of data bytes have been sent so that the telegram can be interpreted.
- the checksum has been correctly recognised.

Initial synchronisation:

After the command from the PC has been completed, the fan will wait for *at least* one transmission pause of 3.5 bytes. Depending on the command and on the processing time, the pause may be much longer (until the fan has received all the data it has requested)

Address:

The address is repeated by the command from the PC (i.e. its own fan address)

Command:

If the command can be processed, the command code will be repeated.

If the command cannot be processed, the fan will answer with an exception.

Here, the MSB is set to command.

The command byte is then, for example, 0x83 for the command "Read holding register (0x03)".

Data:

Depending on the command concerned, the number of data bytes and their meaning may differ.
Please refer to 0 data byte.

CRC L / CRC H:

A CRC checksum is defined via the complete telegram.

The way the checksum is defined is no different from the procedure described above for the command from PC.

1.3 Data bytes

1.3.1 Read holding register

Command code: 0x03

This command is used to write the content of a number of holding registers. Holding registers are parameters that can be both read- and write-accessed

Command from PC:

4 data bytes are transmitted:

- 1st holding register MSB address
- 1st holding register LSB address
- Number of MSB addresses to be read
- Number of LSB addresses to be read

The description of the holding registers can be found at a later point.

Answer from fan:

The following data bytes are transmitted:

- Byte count (number of addresses to be read * 2)
- Data in 1st holding register MSB
- Data in 1st holding register LSB

Optional:

- Data from the following holding registers (0..n)

Exception codes:

In case of error, only one data byte (the exception code) will be transmitted

Exception codes:

- 0x02: Permissible range of the holding registers 0xD000 ... 0xD37F exceeded
0x03: Maximum telegram length for answer (17 bytes) exceeded
i.e. either more than 6 holding registers or 0 holding registers were requested.
0x04: A holding register cannot be read due to a defect in the electronics

1.3.2 Read input register

Command code: 0x04

This command is used to write the content of a number of input registers. Input registers are parameters that only have read access

Command from PC:

4 data bytes are transmitted:

- 1st input register MSB address
- 1st input register LSB address
- Number of MSB addresses to be read
- Number of LSB addresses to be read

The description of the input registers can be found at a later point.

Answer from fan:

The following data bytes are transmitted:

- Byte count (number of addresses to be read * 2)
- Data in 1st holding register MSB
- Data in 1st holding register LSB

Optional:

- Data from the following input registers (0..n)

Exception codes:

In case of error, only one data byte (the exception code) will be transmitted

Exception codes:

- 0x02: Permissible range of the input registers 0xD000 ... 0xD01F exceeded
0x03: Maximum telegram length for answer (17 bytes) exceeded
i.e. either more than 6 input registers or 0 input registers were requested.

1.3.3 Write single register

Command code: 0x06

This command is used to describe the content of *one* holding register.

Command from PC:

4 data bytes are transmitted:

- Holding register MSB address
- Holding register LSB address
- MSB data to be written
- LSB data to be written

The description of the holding registers can be found at a later point.

Answer from fan:

4 data bytes are transmitted:

- Holding register MSB address
- Holding register LSB address
- MSB data to be written
- LSB data to be written

Exception codes:

In case of error, only one data byte (the exception code) will be transmitted

Exception codes:

- 0x02: Permissible range of the holding registers 0xD000 ... 0xD37F exceeded
0x04: The holding register cannot be written due to a defect in the electronics
- There is no write protection in this authorisation level (password).

1.3.4 Write multiple register

Command code: 0x10

This command is used to write the content of *several* holding registers.

Command from PC:

The following data bytes are transmitted:

- Holding register MSB address
- Holding register LSB address
- Number of MSB addresses to be written
- Number of LSB addresses to be written
- Byte count (number of addresses to be written * 2)
- Data to be written in 1st MSB holding register
- Data to be written in 1st LSB holding register

Optional:

- Data to be written to the following holding registers (0..n)

The description of the holding registers can be found at a later point.

Answer from fan:

4 data bytes are transmitted:

- Holding register MSB address
- Holding register LSB address
- Number of MSB addresses to be written
- Number of LSB addresses to be written

Exception codes:

In case of error, only one data byte (the exception code) will be transmitted

Exception codes:

- 0x02: Permissible range of the holding registers 0xD000 ... 0xD37F exceeded
- 0x03: - The number of maximum possible registers has been exceeded
i.e. either more than 123 holding register data or 0 holding register data were defined.
- Byte count $\neq 2 * \text{number of registers}$
- Number of data bytes $\neq \text{byte count}$
- 0x04: The holding register cannot be written due to a defect in the electronics
- There is no write protection in this authorisation level (password).

1.3.5 Other commands

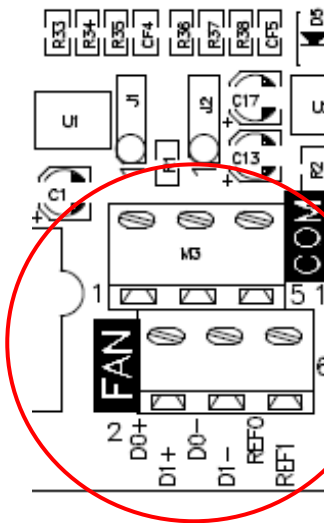
All other commands are not supported.

A command is always answered with exception code 0x01.

Connection RS-485 MODBUS for ECM (EC-Manager)

Terminal board **M3** is used for the electrical connections of the two isolated serial lines RS485, called “COM0” and “COM1,” both managed by the “Modbus RTU protocol with these functions:

- **COM0** : to be connected to “**PC Host**”, managed by the ModBus RTU protocol in “**SLAVE**” mode as illustrated in the aforesaid documents in par. 1.1 .
- **COM1** : to be connected to one or more “**EC ebm-papst fans**” managed with ModBus RTU protocol in “**MASTER**” mode as illustrated in documents mentioned in par. 1.1.



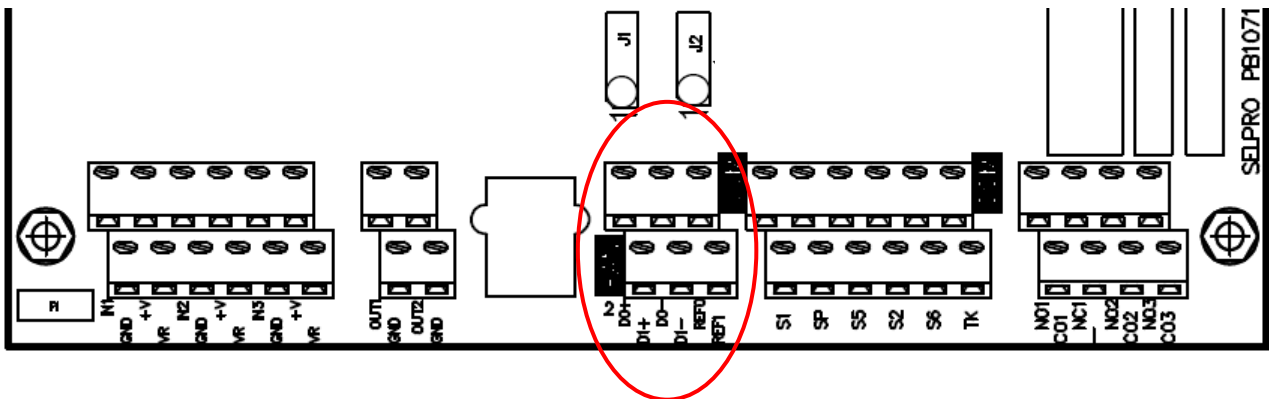
Terminal Board M3		Description	
1	D0+	In/Out Straight COM_0	COM 0 SLAVE Input
3	D0-	In/Out Denied COM_0	
5	REF0	Reference Mass COM_0 (isolated from REF0)	
2	D1+	In/Out Straight COM_1	COM 1 MASTER Output
4	D1-	In/Out Denied COM_1	
6	REF1	Reference mass COM_1 (isolated from REF1)	

Serial COM 0			Serial COM 1		
	Pos.	Ending 120 ohm		Pos.	Ending 120 ohm
	2-3	Excluded		2-3	Excluded
	1-2	Inserted		1-2	Inserted

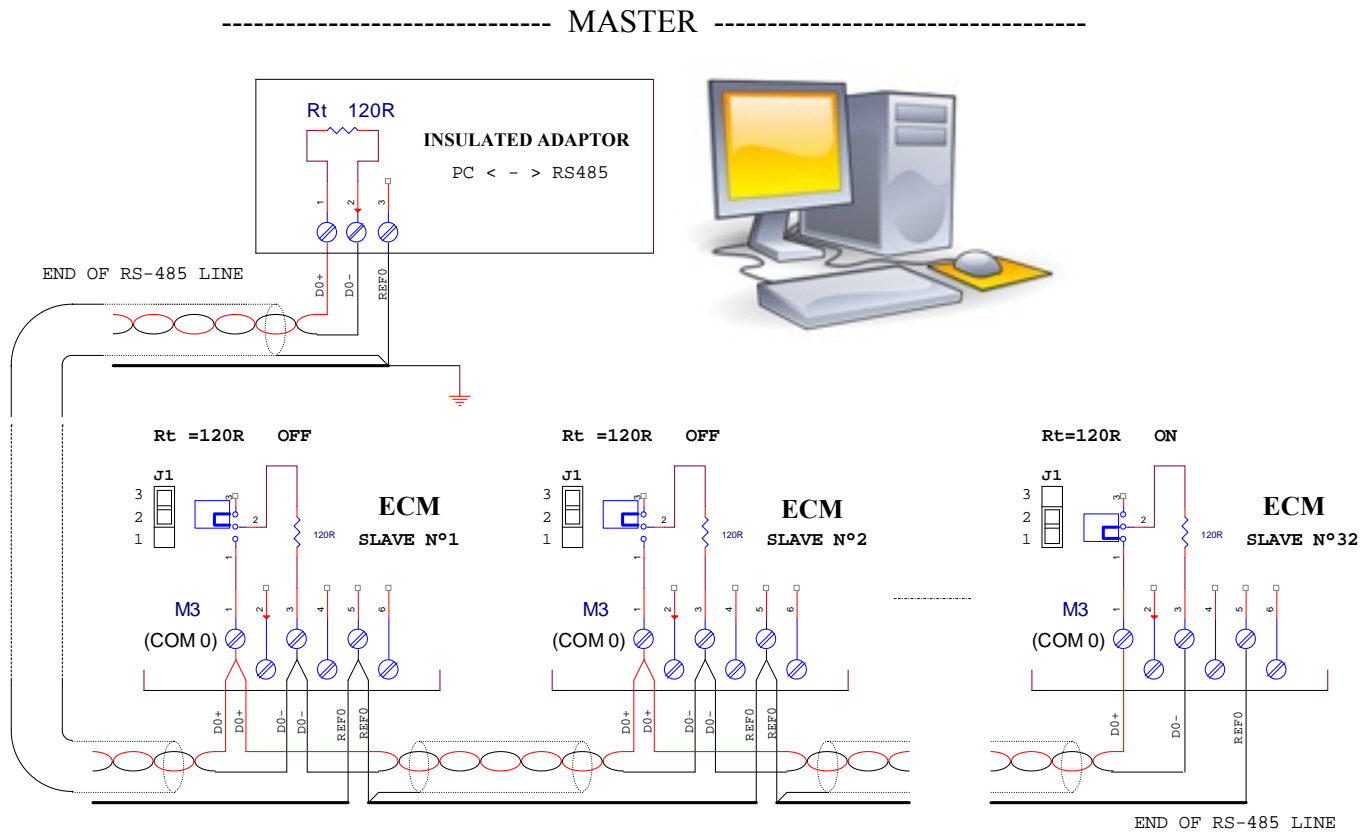
N.B. Jumper J1 should be placed as illustrated here below

N.B.

In order to guarantee proper functioning even in an electrically disturbed environment, the two serials **RS-485 COM0** and **COM1** are isolated between each other and the rest of the components of board PB1071/2. So that functioning is not hindered, do not connect the screens of the two serial lines and with the board mass, strictly follow the instructions here below.



Serial RS-485 connection board with ECM (EC-Manager): dedicated to the connection with master unit (PC Host) . Connect the cable (twisted and shielded + continuity conductor) of the data line (the Modbus network) to terminals 1 = “D0+”, 3 = “D0-“, 5 = “REF0” as for this diagram:



N.B. It is of utmost importance to ensure the right connection of line RS485, meaning all “D+” terminals of the network should be connected together to the same cable, as for “D-“ and “REF”. The screening of the cable should be grounded and connected to REF0 only on the “PC <-> RS485” side, keeping it isolated from REF1 .

- The cable of the Modbus network should be laid from one device to the other, starting from the master unit and ending at the last device served, no other cabling method is allowed.
- Connections should be made with a suitable cable, do not exceed the maximum length of **1000m**.
- Ensure there is enough distance between the cable of the Modbus network and the other cables of the device, especially from power voltage ones
- The ends of the line (Master and last device served) should end with a 120ohm resistance: activate termination 120ohm on adaptor RS-485<-> PC Host; on the last device of the line place J1 on 2-1, on all other devices place J1 on 2-3.
- Ground the cable connecting all “REF0” terminals only next to the Master station, so that all stations are at the same potential, **PC Host** .
- Ground the screen of the cable departing adaptor RS-485<-> PC Host only next to the adaptor itself. (The screen must only be connected to the PC Host side, as for the diagram).
- The cable will be divided into segments, one for each section, connect the screen to the first section only on the RS-485<-> PC Host adaptor side, connect the screen of the second section only on the Slave N°1 side and so on.
- Do not connect the screens of the two following segments between each other (arrival with departure) and do not ground.
- Do not connect in any way whatsoever REF_0 to terminal 6 of M3.

2.0 Description of the Registers for ECM (Controller for ebm-papst protocol)

This section contains information on numeric and non-numeric data exchanged with ECM equipment based on board PB1071.

The ModBus protocol is available from the firmware version rel. 1.1 and following

List of registers with Address and concise description (ECM)

Input Register

This section contains all the information on numeric and non numeric data **reading only** contained in the “Input Register”; each register is composed by only one word (16bit).

N° Register	Symbol	Description
100	-	Equipment model : DGF/WMC2 /Input configuration
101	Hw/SW	Type of control Board : PB1071 X / Version S/W : XX
102	c0	Functioning procedures
103	c1	Selection Inputs
104	c2	Type of input/s
105	c3	Conversion display
106	c4	Position of Set-Point
107	c5	Future Expansion
108	c6	Use of auxiliary relays
109	c7	Analog Output Use 0-10V N°1
110	c8	Analog Output Use 0-10V N°2
111	MBaddr	Address device on Modbus RTU
112	MBrate	Baud rate
113	MBtype	Communication parameters
114	Nfans	Number of fans Configured / Running (which respond)
115	Power	Total power absorbed by EC Motors
116	I tot	Total efficacious power absorbed by EC Motors
117	Speed	Rotation speed of EC Motors
118	T Logic	Instant temperature logic board in °C
119	Out 1	Output Value 0-10V N°1
120	Out 2	Output Value 0-10V N°2
121	Co	Value of the speed command for peripherals (EC Motors)
122	IN use	Input signal in use (or ruling)
123	SP use	Set-Point value in use
124	IN 1	Input 1 value
125	IN 2	Input 2 value
126	IN 3	Input 3 value
127	-	State of Relevant Logic Signals
128	-	State of Output Relay
129	-	Running state
130	Err	Error code
131	Err_D	Detailed error code

(1) When the adjustment unit of the equipment is in the fan management mode 0-10Vdc, these registers are not updated.

Holding Register

This section contains information on data with the possibility both of **reading** and **writing** numeric and non numeric numbers contained in the “Holding Register” ; each register is composed by only one word (16bit).

N° Register	symbol	Description
200	CMD	command from master modbus (cleared after execution)
201	VAL	value in writing relative to the last command managed
202	Datum 0	relative value of the last command managed
203	Datum 1	relative value of the last command managed
204	Datum 2	relative value of the last command managed
205	Datum 3	relative value of the last command managed
206	Datum 4	relative value of the last command managed
207	Datum 5	relative value of the last command managed
208	Datum 6	relative value of the last command managed
209	Datum 7	relative value of the last command managed
210	Datum 8	relative value of the last command managed
211	Datum 9	relative value of the last command managed
212	Datum 10	relative value of the last command managed
213	Datum 11	relative value of the last command managed
214	Datum 12	relative value of the last command managed
215	Datum 13	relative value of the last command managed
216	Datum 14	relative value of the last command managed
217	Datum 15	relative value of the last command managed
218	Lh	Limitation of MAX RPM% general nighttime
219	Lspy	Limitation of MAX RPM% during Spray function, general
220	Jh1	RPM% limit higher than VAC output voltage for jump n° 1
221	JL1	RPM% limit lower than VAC output voltage for jump n° 1
222	Jh2	RPM% limit higher than VAC output voltage for jump n° 2
223	JL2	RPM% limit lower than VAC output voltage for jump n° 2
224	-	Reserved
225	P	PID Proportional Band
226	I	PID integral component weight
227	d	PID Derivative Component weight
228	ti	PID Integration time
229	td	PID Derivation time
230	SP1	Value of Set-point N° 1 (SP 1)
231	Pb 1	Proportional band for SP1 BENCH N°1
232	hi 1	RPM% Maximum limit BENCH N°1
233	Lo 1	RPM% minimum limit BENCH N°1
234	dE 1	Soft-Start Time of acceleration/deceleration BENCH N°1
235	Sh 1	Input value which stresses the VAC ouput voltage at the maximum BENCH N°1
236	ih 1	Hysteresis on the Sh value BENCH N°1
237	So 1	Input value which stresses the VAC ouput voltage at the zero output BENCH N°1
238	io 1	Hysteresis on the So value BENCH N°1
239	USP 1	UR% Set Point per external WHITE Spray unit N°1
240	UPb 1	Proportional band UR% for Spay unit BENCH N°1

241	SP2	Value of Set-point N° 2 (SP 2) BENCH N°2
242	Pb 2	Proportional band for SP2 BENCH N°2
243	hi 2	RPM% Maximum limit BENCH N°2
244	Lo 2	RPM% minimum limit BENCH N°2
245	dE 2	Soft-Start Time of acceleration/deceleration BENCH N°2
246	Sh 2	Input value which stresses the VAC output voltage at the maximum BENCH N°2
247	Ih 2	Hysteresis on the Sh 2 value BENCH N°2
248	So 2	Input value which stresses the VAC output voltage at the zero output BENCH N°2
249	Io 2	Hysteresis on the So value BENCH N°2
250	USP 2	UR% Set Point for external Spray BENCH N°2
251	UPB 2	Proportional band UR% for Spay unit BENCH N°2

(*) Not visible if PID management is set

(**) Not visible if only Proportional management is set



EC CONTROLLERS FRIENDLY SOLUTIONS

- PLUG & PLAY
- QUICK START-UP
- MODBUS INSIDE
- CLIMATE MANAGER
- ENERGY SAVING IES
- CLM ENERGY CLS INSIDE
- THD FREE
- EXTRA dB FREE
- WARRANTY 3 YEARS
- FULL GUARD SYSTEM



approved controller for ebmpapst products

approved controller for ECblue products ZIEHL-ABEGG

MODBUS SYSTEM