PC10
J1939 SLAVE

Features

CANopen BUS
12V and 24V power supply supported
Electronic protection from short circuit
4 bypass circuits for emergency
Up to 12 power outputs with current sense
3 high current outputs
Up to 8 digital inputs
Up to 8 analog inputs
Up to 4 low side outputs
Operating temperature range: -20 to +85°C
Splash proof (IP65)
Molex connectors MX150L series

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J3 PIN	FUNCTION
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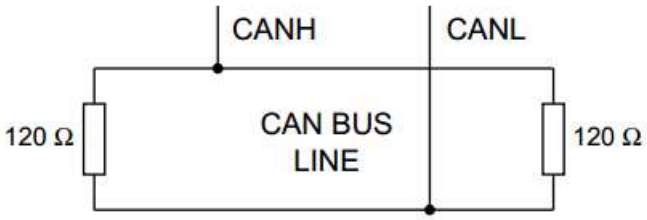


Each end of the CAN bus is terminated with 120Ω resistors in compliance with the standard to minimize signal reflections on the bus. You may need to place a 120Ω resistor between CAN-L and CAN-H.

2. PC10 Technical Specifications

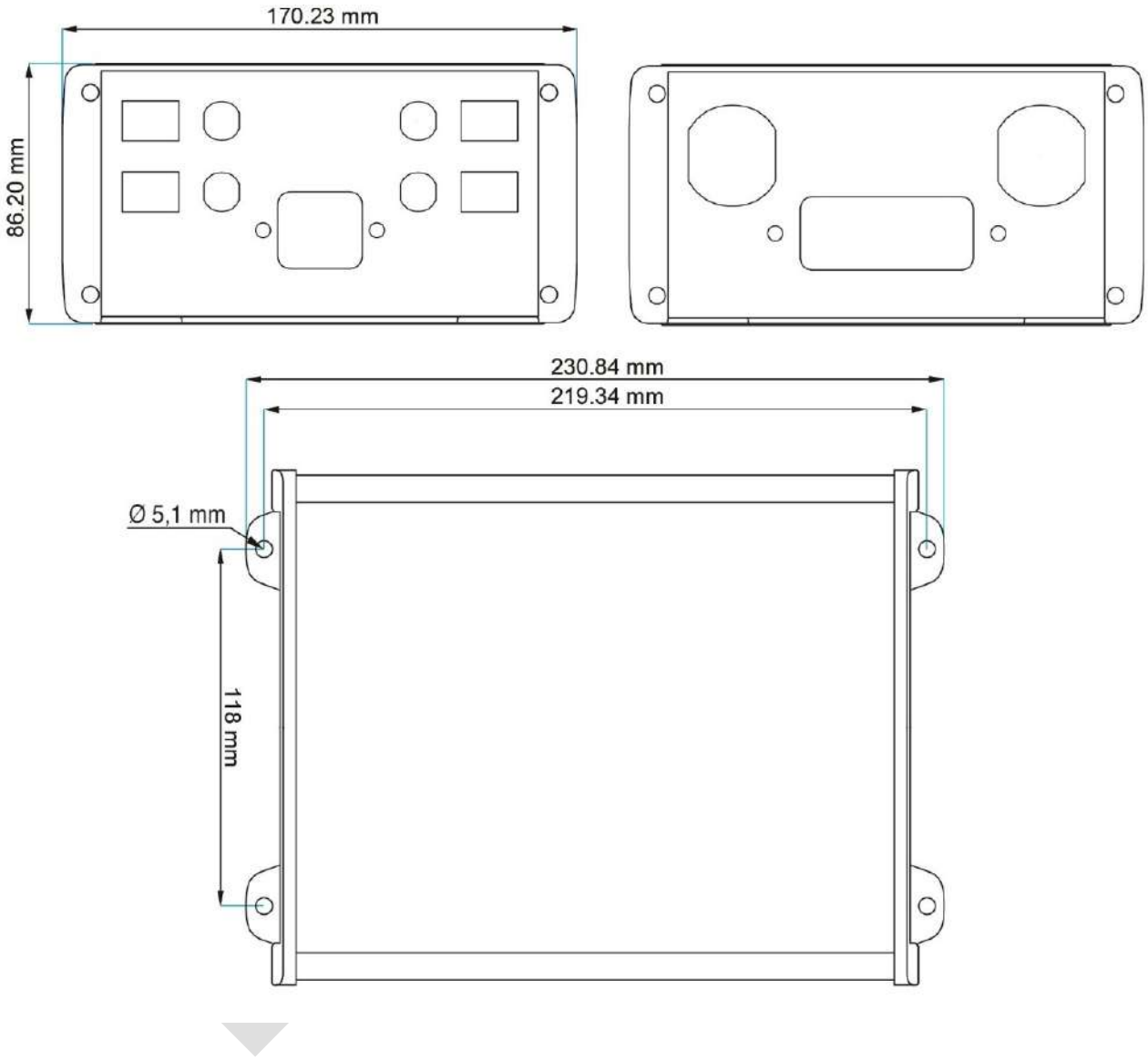
Electrical	Value	Unit
Supply Voltage (Battery Voltage)	8-32	V
Maximum input current	100	A
Maximum current single pin high side	20 or 15 see pin assignment table	A
Maximum current single pin low side	20 or 15 see pin assignment table	A
Maximum Digital input voltage	Battery Voltage	V
Digital input low voltage max	5,5	V
Analog input voltage	0-14	V
Inverse supply polarity protection	Not protected	N/A
Environmental	**Value**	**Unit**
Storage temperature range	-40 to +85	°C
Operating temperature range	-20 to +85	°C
Humidity	0 to 98	%

3. Mechanical Features

- Extruded aluminum housing

- End-panel power and I/O connections 2 x 5,7mm power lugs Amphenol SurLok Plus™ with sealed plug.
- 16 pin Molex MX150L connectors (Molex part # 19427-0049). Mates with 16 pin receptacle (Molex part # 19418-0030) using 14-16 gauge contact (Molex part #19420-0009)
- One 4 pin can bus connector Molex MX150L (Molex #19427-0032). Mates with 4pin receptacle (Molex part # 19418-0004) using 14-16 gauge contact (Molex #19420-0009)

Mechanical Dimension



4. Electrical Loads Connection

HIGH side switch:

The electrical device is connected between an output pin of the PowerCore and ground.

The output pin state can be HIGH (pin voltage at battery voltage) or OFF (pin floating).

The ground can be connected either to one of the ground pins of the PowerCore or directly to the battery's negative pole.

The electrical device is ON when the pin state is HIGH and the current consumption of the electrical device is read by the PowerCore.

LOW side switch:

The electrical device is connected between an output pin of the PowerCore with Low Side Drive feature and the positive battery pole.

The output pin state can be LOW (pin voltage at ground) or OFF (pin floating).

The current flowing in the low side switch is not read by the PowerCore. A 25A fuse protects the circuit, but a lower current threshold is needed, the connection to the battery's positive pole should be made through a fuse.

The electrical device is ON when the pin state is LOW.

H-Bridge connection:

The electrical device is connected between two output pins of the PowerCore.

The state of each output pin can be HIGH (pin voltage at battery voltage), LOW (pin voltage at ground) or OFF (pin floating).

This connection is common for DC motor to invert the power supply polarity to change the direction of the motor's rotation.

5. Bypasses

The bypasses are intended a backup for the system, in the unlikely case of a system failure. Every load controller is equipped with 4 ON/OFF rocker switches which, when set to ON position, bypasses the electronic circuitry, to guarantee that said channel will be able to operate even in the remote case of a general failure of the electronic board.

Bypass circuits are protected by cartridge fuses 6,3 x 32 mm.

Default configuration is no fuses in fuse holders.

Bypass 1	Bypass 2	Bypass 3	Bypass 4
J1-3	J1-5	J1-9	J1-16

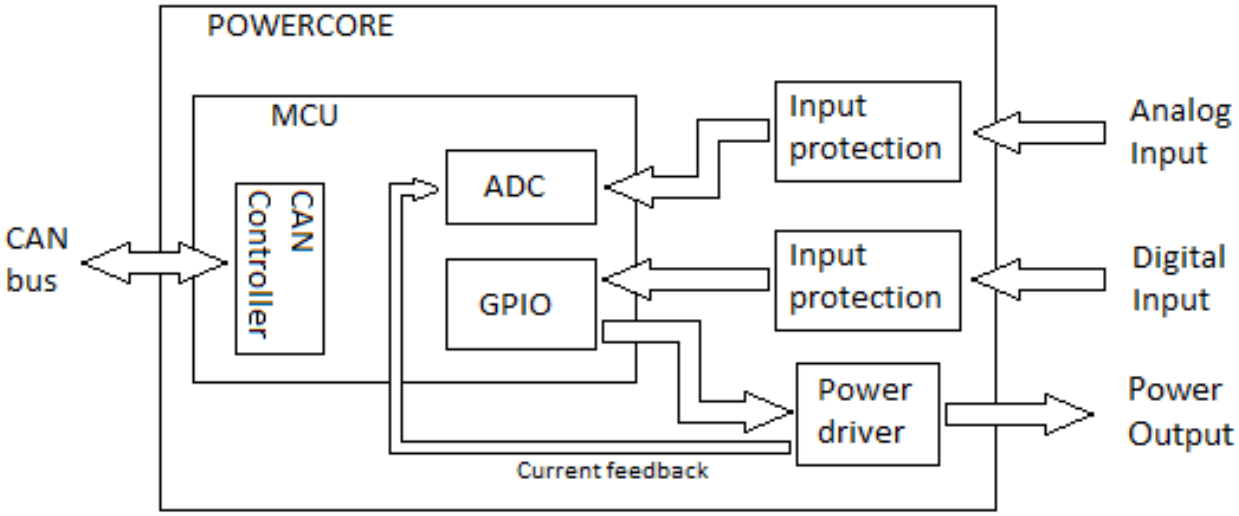
6. Pin Assignment

Connector	Pin	Function	Rating	High Current Driver	Low Side Driver	Level Sense	Analog Sense	Optional Relay Contact	Optional Diode Protection	By-Pass
J1	1	I/O	15		X		X		X	
J1	2	I/O	15		X	X	X		X	
J1	3	I/O	20	X		X	X		X	X
J1	4	I/O	15				X		X	
J1	5	I/O	15			X	X		X	X
J1	6	I/O	15			X	X		X	
J1	7	I/O	15			X	X		X	
J1	8	I/O	15			X	X		X	
J1	9	I/O	20	X	X	X			X	X
J1	10	O	15					X	X	
J1	11	O	15					X	X	
J1	12	GND	NA							
J1	13	GND	NA							
J1	14	GND	NA							
J1	15	GND	NA							
J1	16	I/O	20	X	X	X			X	X
J3	1	CAN L	NA							
J3	2	CAN H	NA							
J3	3	GND	NA							
J3	4	BUS PWR	15							

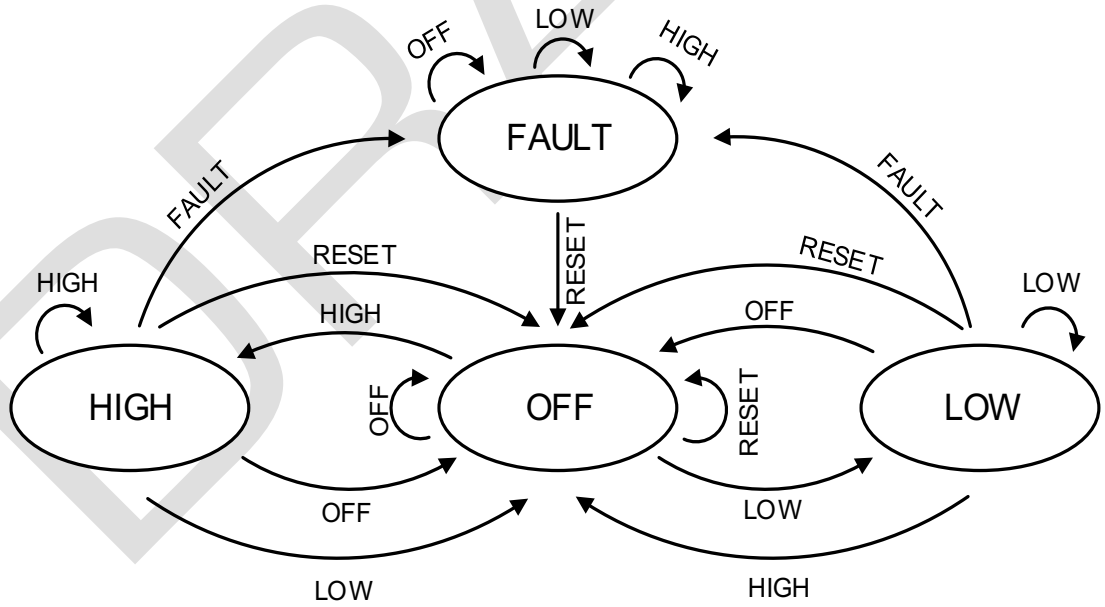
Function Summary

- **O:** Output high side pin
- **I/O:** Input / output high side pin
- **GND:** Internally connected to Negative terminal of the batteries
- **BUS PWR:** Power supply for the bus
- **CAN-L, CAN-H:** CAN bus signals.

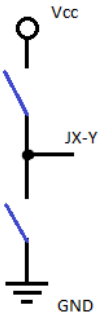
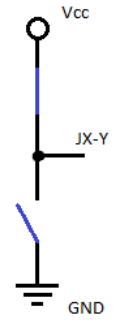
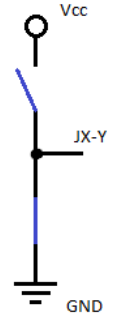
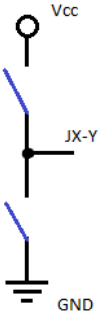
7. Hardware Block Diagram



8. Output State Machine Diagram



The output pin can be set to one of the 4 states available:

Output state	Pin voltage	Equivalent Circuit
OFF	Floating	
HIGH	Battery Voltage	
LOW	Ground Voltage	
FAULT	Floating	

To avoid cross conduction, the system does not allow to change the state of an output pin from HIGH to LOW and from LOW to HIGH. The pins must be always set to OFF for at least 300 milliseconds before the polarity can be changed.

As a measure of protection when using inductive loads, longer delays are added so a current peak during the transient period does not active the system's protection against overcurrent.

Each output circuit is protected against short circuits and overcurrent. If a failure event occurs, the pin goes into the FAULT state. To exit the FAULT state, a reset command is needed to return the pin to its initial OFF state.

The LOW state is applicable only on the output pins that have a low side driver (refer to the pin assignment table).

9. Message header description

The 29-bit CAN identifier used in J1939 is structured in the following way:

Priority	Reserved	Data Page	PDU Format	PDU Specific	Source Address
3 bits	1 bit	1 bit	8 bits	8 bits	8 bits

The proprietary format used by PC10 is defined as follows:
Priority = **6**.
Reserved = **0**.
Data page = **0**.
PDU Format = EFh (the message is addressable).
PDU Specific = Destination Address.

Parameter Group Number:
61184 (EF00h) used for command type messages;
59904 (EA00h) used for request type messages.

An example of CAN identifier of messages sent to the PC10 is 18EF2100h where:
21h is the destination address (PC10)
00h is the source address.

An example of CAN identifier of messages sent by the PC10 is 18EFFF21h where:
FFh refers to broadcast messages (no specific destination address)
21h is the source address (PC10).

10. General Data Format

The proprietary protocol has defined a general format for the data fields in the PGN 61184. The format consists of:
1 header field (2 bytes)
1 command byte
8 bytes (the remaining field) are defined specifically for each command.

The data length is 8 bytes, unused bits and bytes are set to all 1's (0xFF).

Byte 0	04h
Byte 1	1Bh
Byte 2	Command
Byte 3-7	Data required for each specific command

11. Default Settings

Setting	Default status or level	How to change
Baud rate	250kbit/s	Command 6Fh
Source address	21h	Command 70h
PC10 identifier	21h	Command 70h
JX-Y output current threshold	10A	Command 0Ah
J3-4 output current threshold	5A	Command 0Ah
Heartbeat message	Disable	Command 75h
Pin state acknowledgment	Disable	Command 73h

12.Set single pin state (01h)

This message is sent to the PowerCore to set the state of one single output pin.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	01h	Set single pin state
Byte 3	XXh	XX: pin number 01h: J1-1 02h: J1-2 03h: J1-3 04h: J1-4 05h: J1-5 06h: J1-6 07h: J1-7 08h: J1-8 09h: J1-9 0Ah: J1-10 0Bh: J1-11 0Ch: J1-16 0Dh: J3-4 CAN bus power
Byte 4	YYh	YYh: state 00h: OFF 01h: LOW[1] 02h: HIGH 03h: RESET
Byte 5,6,7	FFh	Not used

Examples:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 01 01 01 FF FF FF	J1-1 LOW
To PowerCore	18EF2100h	Ext	04 1B 01 01 00 FF FF FF	J1-1 OFF
To PowerCore	18EF2100h	Ext	04 1B 01 06 02 FF FF FF	J1-6 HIGH
To PowerCore	18EF2100h	Ext	04 1B 01 06 00 FF FF FF	J1-6 OFF
To PowerCore	18EF2100h	Ext	04 1B 01 0A 03 FF FF FF	J1-10 RESET
To PowerCore	18EF2100h	Ext	04 1B 01 0C 00 FF FF FF	J1-16 OFF

[1] Refer to the Pin assignment table at page 6 for the pins supporting LOW state.

13. Set multiple pin state (02h)

This message is sent to the PowerCore to set the state HIGH or OFF of more output pins at the same time.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	02h	Set multiple pin state
Byte 3	J1-8 J1-7 J1-6 J1-5 J1-4 J1-3 J1-2 J1-1	'1'= set HIGH; '0'= set OFF
Byte 4	0 0 0 J3-4 J1-16 J1-11 J1-10 J1-9	'1'= set HIGH; '0'= set OFF
Byte 5	00h	Not used
Byte 6,7	00h	Not used

Examples:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 02 01 00 00 00 00	Set J1-1 HIGH and other outputs OFF
To PowerCore	18EF2100h	Ext	04 1B 02 C0 10 00 00 00	Set J1-7, J1-8 and J3-4 HIGH and other outputs OFF
To PowerCore	18EF2100h	Ext	04 1B 02 03 00 00 00 00	Set J1-1 and J1.2 HIGH and other outputs OFF
To PowerCore	18EF2100h	Ext	04 1B 02 00 00 00 00 00	Switch OFF all the outputs

14. Fault message event (03h)

This message is sent by the PowerCore when an overcurrent or a fault condition is detected.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	03h	Fault message
Byte 3	XXh	XX: pin number 01h: J1-1 02h: J1-2 03h: J1-3 04h: J1-4 05h: J1-5 06h: J1-6 07h: J1-7 08h: J1-8 09h: J1-9 0Ah: J1-10 0Bh: J1-11 0Ch: J-16 0Dh: J3-4 CAN bus power
Byte 4	01h	Fault condition detected
Byte 5	YYh	PC10 identifier
Byte 6,7	FFh	Not used

Examples:

Direction	Identifier	Format	Message	Data
From PowerCore	18EFFF21h	Ext	04 1B 03 01 01 21 FF FF	J1-1 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 02 01 21 FF FF	J1-2 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 03 01 21 FF FF	J1-3 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 04 01 21 FF FF	J1-4 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 05 01 21 FF FF	J1-5 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 06 01 21 FF FF	J1-6 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 07 01 21 FF FF	J1-7 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 08 01 21 FF FF	J1-8 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 09 01 21 FF FF	J1-9 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 0A 01 21 FF FF	J1-10 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 0B 01 21 FF FF	J1-11 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 0C 01 21 FF FF	J1-16 fault state
From PowerCore	18EFFF21h	Ext	04 1B 03 0D 01 21 FF FF	J3-4 CAN bus power fault state

Configuration commands

In this section it is shown a list of control messages to configure the PowerCore and/or modify default settings. Where applicable, changes take effect immediately and are stored in non-volatile memory address unless otherwise noted.

Note: the request-type messages have 3-bytes data length. (See ISO 11783-3 for further details)

Note 2: for some commands the set values are kept at the startup.

15. a) Set Output current threshold (0Ah)

This command sets for each output pin the current threshold. Refer to the pin assignment table to check the maximum currents of each pin. If it is set a value too high, the threshold is set at the maximum value supported for the selected pin. The default thresholds are 5A for J-3 and 10A for the other outputs.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	0Ah	Output current threshold
Byte 3	XXh	XX: pin number 01h: J1-1 02h: J1-2 03h: J1-3 04h: J1-4 05h: J1-5 06h: J1-6 07h: J1-7 08h: J1-8 09h: J1-9 0Ah: J1-10 0Bh: J1-11 0Ch: J1-16 0Dh: J3-4 CAN bus power
Byte 4	YYh	Threshold value in ampere (A)
Byte 5,7	00h	Not used

Examples:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 0A 06 0F 00 00 00	Set pin 6 threshold current to 15A
To PowerCore	18EF2100h	Ext	04 1B 0A 08 06 00 00 00	Set pin 8 threshold current to 6A

b) Read Output current threshold (0Ah)

The following message sent to the device allows to require the output current threshold value set for the selected pin.

Identifier	18EA2100h	
Byte 0	0Ah	Read output current threshold
Byte 1	00h	single frame
Byte 2	XXh	Pin number

Answer:

Identifier	18EA0021h	
Byte 0	0Ah	Command byte
Byte 1	00h	Single frame
Byte 2	06h	Command understood
Byte 3	XXh	Pin number
Byte 4	YYh	Threshold current value [A]
Byte 5,7	00h	Not used

Examples:

Direction	Identifier	Format	Message	Data
To PowerCore	18EA2100h	Ext	0A 00 01	Read pin J1-1 threshold current
From PowerCore	18EA0021h	Ext	0A 00 06 01 0A 00 00 00	10A
To PowerCore	18EA2100h	Ext	0A 00 0D	Read pin J3-4 threshold current
From PowerCore	18EA0021h	Ext	0A 00 06 0D 05 00 00 00	5A

16.Read Digital Input 8-bit (0Bh)

The following message sent to the PowerCore allows to read the digital input value.
Note: the digital input is applicable only on output pins listed in the table below.

Identifier	18EA2100h	
Byte 0	0Bh	Read digital input 8-bit
Byte 1	00h	single frame
Byte 2	XXh	XX: pin number 02h: J1-2 03h: J1-3 05h: J1-5 06h: J1-6 07h: J1-7 08h: J1-8 09h: J1-9 0Bh: J1-16

Answer:

Identifier	18EA0021h	
Byte 0	0Bh	Command byte
Byte 1	00h	Single frame
Byte 2	06h	Command understood
Byte 3	XXh	Pin number
Byte 4	YYh	Digital input value
Byte 5,7	00h	Not used

17. Read analog input (0Ch)

The message sent to the PowerCore allows to read the analog input values with 8-bit resolution. 14V=FFh.

Expected value: (Vin × 255/14)h

Identifier	18EA2100h	
Byte 0	0Ch	Read analog input
Byte 1	00h	single frame
Byte 2	XXh	XX: pin number 01h: J1-1 02h: J1-2 03h: J1-3 04h: J1-4 05h: J1-5 06h: J1-6 07h: J1-7 08h: J1-8

Answer:

Identifier	18EA0021h	
Byte 0	0Ch	Command byte
Byte 1	00h	Single frame
Byte 2	06h	Command understood
Byte 3	XXh	Pin number
Byte 4	YYh	Expected value: (Vin × 255/14)h
Byte 5,7	00h	Not used

Examples:

Direction	Identifier	Format	Message	Data
To PowerCore	18EA2100h	Ext	0C 00 01	Read J1-1
From PowerCore	18EA0021h	Ext	0C 00 06 01 FF 00 00 00	14V
To PowerCore	18EA2100h	Ext	0C 00 07	Read J1-7
From PowerCore	18EA0021h	Ext	0C 00 06 07 B5 00 00 00	10V
To PowerCore	18EA2100h	Ext	0C 00 08	Read J1-8
From PowerCore	18EA0021h	Ext	0C 00 06 08 5A 00 00 00	5V

18. Read PowerCore electronic values (0Dh)

The following message sent to the PowerCore allows to read the analog values of the output currents, the total current and the battery voltage.

Identifier	18EA2100h	
Byte 0	0Dh	Read PowerCore electronic values
Byte 1	00h	single frame
Byte 2	XXh	XXh: pin number 01h: J1-1 current Amp 02h: J1-2 current Amp 03h: J1-3 current Amp 04h: J1-4 current Amp 05h: J1-5 current Amp 06h: J1-6 current Amp 07h: J1-7 current Amp 08h: J1-8 current Amp 09h: J1-9 current Amp 0Ah: J1-10 current Amp 0Bh: J1-11 current Amp 0Ch: J1-16 current Amp 0Dh: J3-4 CAN bus power current Amp 0Eh: battery voltage: 35,5V =FFh 0Fh: total current

Answer:

Identifier	18EA0021h	
Byte 0	0Dh	Command byte
Byte 1	00h	Single frame
Byte 2	06h	Command understood
Byte 3	XXh	Pin number
Byte 4	YYh	YYh: Current [A] Voltage=YYd×35,5/255
Byte 5,7	00h	Not used

19. Read Fault event (0Eh)

The following message sent to the PowerCore allows to read which output pins have gone into the fault condition.

Identifier	18EA2100h	
Byte 0	0Eh	Read Fault event
Byte 1	00h	single frame
Byte 2	XXh	XX: pin number 01h: J1-1 02h: J1-2 03h: J1-3 04h: J1-4 05h: J1-5 06h: J1-6 07h: J1-7 08h: J1-8 09h: J1-9 0Ah: J1-10 0Bh: J1-11 0Ch: J-16 0Dh: J3-4 CAN bus power

Answer:

Identifier	18EA0021h	
Byte 0	0Eh	Command byte
Byte 1	00h	Single frame
Byte 2	06h	Command understood
Byte 3	XXh	Pin number
Byte 4	YYh	01h: 'fault' 00h: 'not fault'
Byte 5,7	00h	Not used

Examples:

Direction	Identifier	Format	Message	Data
To PowerCore	18EA2100h	Ext	0E 00 01	Read J1-1
From PowerCore	18EA0021h	Ext	0E 00 06 01 01 00 00 00	J1-1 in fault
To PowerCore	18EA2100h	Ext	0E 00 07	Read J1-7
From PowerCore	18EA0021h	Ext	0E 00 06 07 00 00 00 00	J1-7 not in fault
To PowerCore	18EA2100h	Ext	0E 00 08	Read J1-8
From PowerCore	18EA0021h	Ext	0E 00 06 08 01 00 00 00	J1-8 in fault

20. Get software revision (2Ah)

Identifier	18EA2100h	
Byte 0	2Ah	Get software revision
Byte 1	00h	single frame
Byte 2	FFh	Not used

Answer:

Identifier	18EA0021h	
Byte 0	2Ah	Command byte
Byte 1	00h	Single frame
Byte 2	06h	Command understood (ACK)
Byte 3	XXh	SW revision ASCII
Byte 4	YYh	
Byte 5	WWh	
Byte 6	ZZh	
Byte 7	00h	

Example:

Direction	Identifier	Format	Message	Data
To PowerCore	18EA2100h	Ext	2A 00 FF	Get software revision
From PowerCore	18EFFF21h	Ext	2A 00 06 56 XX 2E XX 00	VX.X

21. Baud rate setting (6Fh)

This message is used to change the baud rate of the CAN bus. Connecting only one PowerCore to the bus when changing the baud rate is recommended. If an invalid value is chosen, then no change is done to the stored value.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	6Fh	Set baud rate message
Byte 3	02h	500kbit/s
	03h	250kbit/s
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 6F 02 FF FF FF FF	Set baud rate = 500kbit/s

22. Set Source address (70h)

This message is used to change the PowerCore CAN source Address and/or the PowerCore identifier.
Either or both the Source Address or PowerCore identifier may be changed independently.
Connecting only one PC10 to the bus during the address change is recommended. If an invalid value is chosen, then no change is done to the stored value.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	70h	Set address message
Byte 3	XXh	XX: CAN source address From 01h to FEh FFh: no change
Byte 4	YYh	YY: PC10 identifier From 00h to FEh FFh no change
Byte 5,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 70 05 21 FF FF FF	Set source address = 05h Set PowerCore identifier = 21h

23. Pin state acknowledgment (73h)

This message enables or disables the transmission of the pin state acknowledgment message. When this feature is enabled the PowerCore transmits an acknowledgment message each time a single pin state is set.
Note: available only for command (01h)

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	73h	Pin state acknowledgment
Byte 3	XXh	XX: 00h OFF (default) 01h ON
Byte 4,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 73 01 FF FF FF FF	Enable pin state acknowledgement
To PowerCore	18EF2100h	Ext	04 1B 01 0A 01 00 00 00	Set single pin state (01h)
From PowerCore	18EFFF21h	Ext	00 01 0A FF FF 21 FF FF	contact Ack message (contact 10 LOW)

Pin state acknowledgment message:

Byte 0	00h	
Byte 1	XXh	XX: state 00h: OFF 01h: LOW 02h: HIGH 03h: FAULT
Byte 2	YYh	YY: pin number
Byte 3	ZZh	PC10 identifier
Byte 4,7	FFh	Not used

24. Heartbeat (75h)

This message enables or disables the transmission of Heartbeat message. This message is designed to indicate to other devices on the bus that this unit continues to work.

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	75h	Heartbeat
Byte 3	XXh	XX: 00h Disabled (default) 01h Enabled
Byte 4	YYh	YY: Period in milliseconds ÷ 10 From 05h (50ms) to FEh (2.54 sec)
Byte 5,7	FFh	Not used

Example:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 75 01 32 FF FF FF	Set heartbeat enabled with 500ms period.

Heartbeat generated message:

Byte 0	04h	Header bytes
Byte 1	1Bh	
Byte 2	F9h	Heartbeat message
Byte 3	XXh	XX: Message counter, incremented each message sent
Byte 4	J1-8 J1-7 J1-6 J1-5 J1-4 J1-3 J1-2 J1-1	Pin state indicators Each bit represents a pin state 0: not active 1: active
Byte 5	00 00 00 J3-4 J1-16 J1-11 J1-10 J1-9	
Byte 6,7	FFh	Not used

Examples:

Direction	Identifier	Format	Message	Data
From PowerCore	18EFFF21h	Ext	04 1B F9 03 80 00 00 00	Heartbeat message with pin 8 active.
From PowerCore	18EFFF21h	Ext	04 1B F9 03 00 08 00 00	Heartbeat message with pin 12 active

25. Set CAN protocol

This set of messages are used to change to the desired CANbus protocol.

- Change from CANopen to J1939:

Direction	Identifier	Format	Message	Data
To PowerCore	615h	Std	2F FF 20 00 01	Change to J1939

- Change from J1939 to CANopen:

Direction	Identifier	Format	Message	Data
To PowerCore	18EF2100h	Ext	04 1B 80 00 FF FF FF FF	Change to CANopen

26. Revision history

Date	Manual Revision	Comment	Related SW version
21/09/2018	1.0	First release PC10 J1939	SWx.x