TRIO-HP/3AC/1KDC/20KW/BI CAN BUS Protocol V1.00

Data sheet
111472_en_00

1 Description

This document describes the CAN-based communication protocol for communication between the controller with CAN communication module and one or more power modules.

The controller, as the higher-level controller, always handles communication with the bus devices on the linear CAN bus.

The CAN-based communication protocol supports the following communication methods:

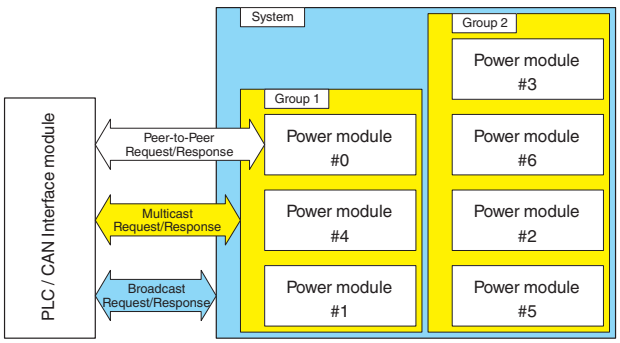
– Peer-to-peer
– Multicast
– Broadcast

Supported power modules

The following TRIO-HP... power modules are currently supported by the CAN-based communication protocol:

Item designation	Item No.
TRIO-HP/3AC/1KDC/20KW/BI	1560712

Figure 1 Overview of the communication methods



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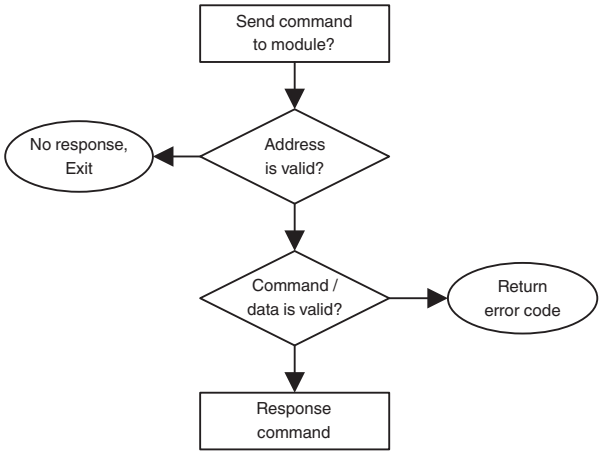
2 Basic principles

2.1 CAN protocol

- Uses the extended frame mode CAN 2.0B
- The bit rate is 125 kbps
- 120 Ω termination resistors for terminating the CAN bus
- In AC/DC power grid mode or DC/AC on-grid mode, a maximum of 48 power modules are supported in parallel operation
- In DC/AC off-grid mode, a maximum of 8 power modules are supported in parallel operation

2.2 Communication process



2.3 Data type

Send the bytes in an increasing sequence. Begin with byte 0. Depending on the command number, the data type of the command can contain fixed-point or floating-point numbers.

2.3.1 Fixed-point number

A fixed-point number can take up a length of 1 to 4 bytes. The detailed format can be found in Section 3.3 Command description.

2.3.2 Floating-point number

The storage format of the floating-point number is 4 bytes and is sent in the following sequence: sign bit, code, mantissa high bit, and mantissa low bit.

The floating-point number uses the IEEE 32-bit standard format for floating-point numbers (standard format for floating-point numbers for the C programming language), whereby the length is 32 bits and the format is structured as follows:

D31	D30-D23	D22-D16	D15-D8	D7-D0
Sign of the floating-point number	Code	Mantissa high bit	Mantissa middle bit	Mantissa low bit

If the code is E and the mantissa is M, then: floating-point number = $\pm(1+M\times2^{-23})\cdot2^{E-127}$. Whether the floating-point number is positive or negative depends on the value of the sign bit (S). S = 1 means that the floating-point number is negative, and S = 0 means that the floating-point number is positive.

Example: If the 32-bit floating-point number is 43H, FAH, 00H, and 00H (S = 0, E = 135, M = 0x7A0000 = 61×2^{17}), the value of the floating-point number is $(1+61\times2^{17}\times2^{-23})\cdot2^{135-127}= 500$.

If the floating-point number is 40.0, then the transmission sequence is 42, 20, 00, 00.

If the floating-point number is 2.40, then the transmission sequence is 40, 19, 99, 9A.

3 Application frame format and data definition

3.1 Frame format

Communication between the higher-level controller with CAN communication module and one or more power modules takes place via CAN 2.0B frames.

The frame format is illustrated in the following table:

Description	Code
Start of frame	SOF (1 bit)
Arbitration field	Identifier (11 bits)
	SRR
	IDE
	Identifier (18 bits)
	RTR
Control field	Reserved (1 bit)
	Data length (4 bits)
Data field	Data (0-8 bytes)
CRC field	CRC (16 bits)
Ack field	Ack (2 bits)
End of frame	(7 bits)

The data length in this protocol is 8 bytes. The controllable part is comprised of the identifier and the data.

Identifier		Data		
3 bits Leading zero	29 bits Identifier	Byte 0	...	Byte 7
4 bytes		8 bytes		

3.2 Identifier

28-26	25-22	21-16	15-8	7-0
Error code (3 bits)	Device no. (4 bits)	Command no. (6 bits)	Target address (8 bits)	Source address (8 bits)

3.2.1 Error code

Error code	Description
0x00	Normal
0x01	/
0x02	Command invalid
0x03	Data invalid
/	/
0x07	Start of processing

3.2.2 Device number

Device no.	Description
0x0A	Protocol between the controller with CAN communication module and the individual power module
0x0B	Protocol between the controller with CAN communication module and a module group

3.2.3 Command number

Detailed information can be found in Section 3.3 Command description.

3.2.4 Target address/source address

Note

The module number is assigned automatically and depends on the internal serial number of the module. If a module is removed from the CAN bus during operation, the remaining modules retain their module number. If a new module is added to the CAN bus, the addressing is restarted.

Peer-to-peer

Describes equal-authority communication between the charging controller and individual power modules. The request/response pattern is reciprocal.

For peer-to-peer addressing, the target address is the automatically assigned module address. Set the device number to the value 0x0A.

Multicast

Describes the communication between the charging controller and a group of power modules. The charging controller sends a request with a group address. Depending on the command sent, individual or all modules in the group respond. Set the device number to the value 0x0B.

Note

If several modules are connected to different loads, it is recommended that the power modules are grouped into different groups.

Broadcast

Describes the communication between the charging controller and the entire system. The charging controller sends a request as a broadcast message.

For broadcast addressing, the target address is 0x3F. Set the device number to the value 0x0A.

	Target address/source address							
	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Power module	Reserved (0.0)		Module address: 00~0x3B, broadcast address: 3F					
Charging controller	Charging controller address: 0xF0~0xF8, default address: 0xF0							

3.3 Command overview

Note

The following table provides an overview of the supported commands of the CAN-based communication protocol for communication between the controller with CAN communication module and one or more power modules.

Read/ write	Command number	Data							
		Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Read	0x23	0x10	0x01			System voltage on DC side [mV]			
Read	0x23	0x10	0x02			System current on DC side [mV]			
Read	0x23	0x10	0x10					Number of power modules	
Read	0x23	0x11	0x01			Power module voltage on DC side [mV]			
Read	0x23	0x11	0x02			Power module current on DC side [mA]			
Read	0x23	0x11	0x03			Power module voltage on AC side (A-B) [mV]			
Read	0x23	0x11	0x04			Power module voltage on AC side (B-C) [mV]			
Read	0x23	0x11	0x05			Power module voltage on AC side (C-A) [mV]			
Read	0x23	0x11	0x06			Power module ambient temperature [m°C]			
Read	0x23	0x11	0x10				Status 1.3	Status 1.2	Status 1.1
Read	0x23	0x11	0x11					Status 2.2	Status 2.1
Read	0x23	0x11	0x20					Module group number	
Read	0x23	0x21	0x01			Voltage on AC side, phase A [mV]			
Read	0x23	0x21	0x02			Voltage on AC side, phase B [mV]			
Read	0x23	0x21	0x03			Voltage on AC side, phase C [mV]			
Read	0x23	0x21	0x04			Current on AC side, phase A [mA]			
Read	0x23	0x21	0x05			Current on AC side, phase B [mA]			
Read	0x23	0x21	0x06			Current on AC side, phase C [mA]			
Read	0x23	0x21	0x07			AC frequency [mHz]			
Read	0x23	0x21	0x08			Active power on AC side [mW]			
Read	0x23	0x21	0x09			Active power on AC side, phase A [mW]			
Read	0x23	0x21	0x0A			Active power on AC side, phase B [mW]			
Read	0x23	0x21	0x0B			Active power on AC side, phase C [mW]			
Read	0x23	0x21	0x0C			Reactive power on AC side [mVar]			
Read	0x23	0x21	0x0D			Reactive power on AC side, phase A [mVar]			
Read	0x23	0x21	0x0E			Reactive power on AC side, phase B [mVar]			
Read	0x23	0x21	0x0F			Reactive power on AC side, phase C [mVar]			
Read	0x23	0x21	0x10			Apparent power on AC side [mVA]			
Read	0x23	0x21	0x11			Apparent power on AC side, phase A [mVA]			
Read	0x23	0x21	0x12			Apparent power on AC side, phase B [mVA]			
Read	0x23	0x21	0x13			Apparent power on AC side, phase C [mVA]			
Write	0x24	0x10	0x01			System voltage on DC side [mV]			
Write	0x24	0x10	0x02			System current on DC side [mA]			
Write	0x24	0x11	0x01			Power module voltage on DC side [mV]			
Write	0x24	0x11	0x02			Power module current on DC side [mA]			
Write	0x24	0x11	0x10					Operational readiness (on/off)	
Write	0x24	0x11	0x20					Green LED flashing	
Write	0x24	0x11	0x21					Module deactivation (on/off)	
Write	0x24	0x11	0x22					Slow startup of the output current (on/off)	
Write	0x24	0x11	0x23					DIP switch function: Module or group number	
Write	0x24	0x11	0x03					Setting the module group number	

Read/ write	Com- mand number	Data							
		Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Write	0x24	0x11	0x26					DC levels parallel operation/series operation	
Write	0x24	0x11	0x32			DC discharge voltage, lower limit [mV]			
Write	0x24	0x11	0x34						Voltage stabi- lization mode
Write	0x24	0x21	0x05			Power factor setting			
Write	0x24	0x21	0x06			Output voltage on AC side per phase [mV]			
Write	0x24	0x21	0x07			Output frequency on AC side [mHz]			
Write	0x24	0x21	0x08			Reactive power at output [mVar]			
Write	0x24	0x21	0x10					Operating mode of the power module	
Write	0x24	0x21	0x17					Reactive power setting mode	

3.4 Command description

Note
In the following table, please note the abbreviations Mdl (power module) and Ctrl (controller) in the listed examples.

Note
For read commands (e.g., voltage, current, power, and frequency), the measured value is output at the terminals.

3.4.1 Reading data fields

Command no.	Reading data fields								
0x23	**Reading system information** Peer-to-peer: No Multicast: Yes, response only from group coordinator Broadcast: Yes, response from system coordinator								
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x10	0x01	0	0	0	0	0	0
	Response	0x10	0x01	0	0	Vo: System voltage on DC side [mV]			
	Example	Ctrl transmits: Mdl responds:	02 A3 3F F0 02 A3 F0 3F	10 01 00 00 00 00 00 00 10 01 00 00 00 0A AE 60		Read system voltage on DC side Response Uo: 700 V			
	Request	0x10	0x02	0	0	0	0	0	0
	Response	0x10	0x02	0	0	Io: System current on DC side [mV]			
	Example	Ctrl transmits: Mdl responds:	02 A3 3F F0 02 A3 F0 3F	10 02 00 00 00 00 00 00 10 02 00 00 00 00 C3 50		Read system current on DC side Response Io: 50 A			
	Request	0x10	0x10	0	0	0	0	0	0
	Response	0x10	0x10	0	0	0	0	Number of power modules	
	Note	Multicast addressing: The module returns the number of power modules in the group Broadcast addressing: The module returns the number of power modules in the system							
	Example	Ctrl transmits: Mdl responds:	02 E3 02 F0 02 E3 F0 02	10 10 00 00 00 00 00 00 10 10 00 00 00 00 00 05		Read number of power modules in group 2 5 power modules detected in group 2			

Command no.	Reading data fields							
0x23	**Reading power module information** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: No							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x11	0x01	0	0	0	0	0	0
	Response	0x11	0x01	0	0	Vo: Power module voltage on DC side [mV]			
	Example	Ctrl transmits: Mdl responds:	02 A3 00 F0 02 A3 F0 00	11 01 00 00 00 00 00 00 11 01 00 00 00 07 A1 20		Read power module #0, voltage on DC side Power module #0, Vo: 500 V			
	Request	0x11	0x02	0	0	0	0	0	0
	Response	0x11	0x02	0	0	Io: Power module current on DC side [mA]			
	Request	0x11	0x03	0	0	0	0	0	0
	Response	0x11	0x03	0	0	Power module phase voltage on AC side (A-B) [mV]			
	Example	Ctrl transmits: Mdl responds:	02 E3 02 F0 02 E3 F0 00	11 03 00 00 00 00 00 00 11 03 00 00 00 04 BA F0		Read power module #2, phase voltage on AC side (A-B) Group #2, module #0, phase voltage: 310 V			
	Request	0x11	0x04	0	0	0	0	0	0
	Response	0x11	0x04	0	0	Power module phase voltage on AC side (B-C) [mV]			
	Request	0x11	0x05	0	0	0	0	0	0
	Response	0x11	0x05	0	0	Power module phase voltage on AC side (C-A) [mV]			
	Request	0x11	0x06	0	0	0	0	0	0
	Response	0x11	0x06	0	0	Power module ambient temperature [m°C]			
	Request	0x11	0x10	0	0	0	0	0	0
	Note	Temperature measurement is performed on the device front next to the fans							
	Response	0x11	0x10	0	0	0	Status 1		
							Status 1.3	Status 1.2	Status 1.1
	Note	For a description of the status bits, see Section 3.5 Status description							
	Request	0x11	0x11	0	0	0	0	0	0
	Response	0x11	0x11	0	0	0	0	Status 2	
							0	Status 2.2	Status 2.1
	Note	For a description of the status bits, see Section 3.5 Status description							
	Request	0x11	0x20	0	0	0	0	0	0
	Response	0x11	0x20	0	0	0	0	Module group number	

Command no.	Reading data fields								
0x23	**Reading power module information on AC side** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: No								
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x21	0x01	0	0	0	0	0	0
	Response	0x21	0x01	0	0	Voltage on AC side, phase A – neutral [mV]			
	Request	0x21	0x02	0	0	0	0	0	0
	Response	0x21	0x02	0	0	Voltage on AC side, phase B – neutral [mV]			
	Request	0x21	0x03	0	0	0	0	0	0
	Response	0x21	0x03	0	0	Voltage on AC side, phase C – neutral [mV]			
	Request	0x21	0x04	0	0	0	0	0	0
	Response	0x21	0x04	0	0	Current on AC side, phase A [mA]			
	Example	Ctrl transmits: Mdl responds:	02 A3 00 F0 02 A3 F0 00	21 04 00 00 00 00 00 00 21 04 00 00 00 00 13 88		Read module #0, current from phase A Response Module #0, current from phase A is 5 A			
	Request	0x21	0x05	0	0	0	0	0	0
	Response	0x21	0x05	0	0	Current on AC side, phase B [mA]			
	Request	0x21	0x06	0	0	0	0	0	0
	Response	0x21	0x06	0	0	Current on AC side, phase C [mA]			
	Request	0x21	0x07	0	0	0	0	0	0
	Response	0x21	0x07	0	0	AC frequency [mHz]			
	Request	0x21	0x08	0	0	0	0	0	0
	Response	0x21	0x08	0	0	Active power on AC side [mW]			
	Example	Ctrl transmits: Mdl responds:	02 E3 02 F0 02 E3 F0 00	21 08 00 00 00 00 00 00 21 08 00 00 00 E4 E1 C0		Read group #2, active power Response Group #2, module #0, active power is 15 kW			
	Request	0x21	0x09	0	0	0	0	0	0
	Response	0x21	0x09	0	0	Active power on AC side, phase A [mW]			
	Request	0x21	0x0A	0	0	0	0	0	0
	Response	0x21	0x0A	0	0	Active power on AC side, phase B [mW]			
	Request	0x21	0x0B	0	0	0	0	0	0
	Response	0x21	0x0B	0	0	Active power on AC side, phase C [mW]			
	Request	0x21	0x0C	0	0	0	0	0	0
	Response	0x21	0x0C	0	0	Reactive power on AC side [mVar]			
	Request	0x21	0x0D	0	0	0	0	0	0
	Response	0x21	0x0D	0	0	Reactive power on AC side, phase A [mVar]			
	Request	0x21	0x0E	0	0	0	0	0	0
	Response	0x21	0x0E	0	0	Reactive power on AC side, phase B [mVar]			
	Request	0x21	0x0F	0	0	0	0	0	0
	Response	0x21	0x0F	0	0	Reactive power on AC side, phase C [mVar]			
	Request	0x21	0x10	0	0	0	0	0	0
	Response	0x21	0x10	0	0	Apparent power on AC side [mVA]			
	Request	0x21	0x11	0	0	0	0	0	0
	Response	0x21	0x11	0	0	Apparent power on AC side, phase A [mVA]			
	Request	0x21	0x12	0	0	0	0	0	0
	Response	0x21	0x12	0	0	Apparent power on AC side, phase B [mVA]			
	Request	0x21	0x13	0	0	0	0	0	0
	Response	0x21	0x13	0	0	Apparent power on AC side, phase C [mVA]			

3.4.2 Transmitting data fields

Com-mand no.	Transmitting data fields							
0x24	**Setting system voltage and system current (DC)** Peer-to-peer: No Multicast: Yes, response from every power module in the group Broadcast: Yes, response from system coordinator							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x10	0x01	0	0	Setpoint – system voltage on DC side [mV]			
Response	0x10	0x01	0	0	Setpoint – system voltage on DC side [mV]			
Note	Multicast addressing: System output voltage for the entire group Broadcast addressing: System output voltage for the entire system Only for AC/DC mode							
Example	Ctrl transmits: 02 A4 3F F0 10 01 00 00 00 0A D5 70 Set all power modules to Vo 710 V Mdl responds: 02 A4 F0 3F 10 01 00 00 00 0A D5 70 System coordinator responds Vo 710 V							
Request	0x10	0x02	0	0	Setpoint – system current on DC side [mA]			
Response	0x10	0x02	0	0	Setpoint – system current on DC side [mA]			
Note	Multicast addressing: Total current of the group Broadcast addressing: Total current of the system For AC/DC mode: Sets the output current. For DC/AC mode: Limitation of the input current. Note: In DC/AC on-grid mode, the input current is limited and the device does not switch off when the limit is reached. In DC/AC off-grid mode, the device switches off when the limit is reached. It is therefore recommended to set the maximum current limit in this mode.							
Example	Ctrl transmits: 02 E4 02 F0 10 02 00 00 00 00 13 88 Set group #2, total current to 5 A (if there are 2 power modules in a group, then the Io of each power module is 2.5 A) Mdl responds: 02 E4 F0 02 10 02 00 00 00 00 13 88 Group coordinator from group #2 responds: Set DC output voltage is 5 A							
0x24	**Setting voltage and current (DC) of a power module** Peer-to-peer: No Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x11	0x01	0	0	Setpoint – power module voltage on DC side [mV]			
Response	0x11	0x01	0	0	Setpoint – power module voltage on DC side [mV]			
Example	Ctrl transmits: 02 A4 3F F0 11 01 00 00 00 0B 71 B0 Set Vo 750 V DC on all power modules Mdl responds: No response Ctrl transmits: 02 E4 02 F0 11 01 00 00 00 0A D5 70 Set group #2 to Vo 710 V DC Mdl responds: 02 E4 F0 00 11 01 00 00 00 0A D5 70 Response Group #2, module #0: Vo 710 V DC							
Note	Only for AC/DC mode							
Request	0x11	0x02	0	0	Setpoint – power module current on DC side [mA]			
Response	0x11	0x02	0	0	Setpoint – power module current on DC side [mA]			
Example	Ctrl transmits: 02 A4 00 F0 11 02 00 00 00 00 13 88 Set DC-side current value of module #0 to 5 A Mdl responds: 02 A4 F0 00 11 02 00 00 00 00 13 88 Response Module #0 current on DC side 5 A							
Note	For AC/DC mode: Sets the output current. For DC/AC mode: Limitation of the input current. Note: In DC/AC on-grid mode, the input current is limited and the device does not switch off when the limit is reached. In DC/AC off-grid mode, the device switches off when the limit is reached. It is therefore recommended to set the maximum current limit in this mode.							

Com-mand no.	Transmitting data fields							
0x24	**Enabling/disabling operational readiness** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x11	0x10	0	0				On/off
Response	0x11	0x10	0	0				On/off
Note	0xA0: on; 0xA1: off (default)							
Example	Ctrl transmits: 02 A4 3F F0 11 10 00 00 00 00 00 A1 Switch off all power modules Mdl responds: No response Ctrl transmits: 02 A4 00 F0 11 10 00 00 00 00 00 A0 Switch on power module #0 Mdl responds: 02 A4 F0 00 11 10 00 00 00 00 00 A0 Response power module #0 ON Ctrl transmits: 02 E4 02 F0 11 10 00 00 00 00 00 A1 Switch off power module of group #2 Mdl responds: 02 E4 F0 00 11 10 00 00 00 00 00 A1 Response power module #0 OFF							
0x24	**LED of a power module – flashing green** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x11	0x20	0	0	0	0	0	Green LED flashing
Response	0x11	0x20	0	0	0	0	0	Green LED flashing
Note	0xA0: off; 0xA1: flashing							
Example	Ctrl transmits: 02 A4 00 F0 11 20 00 00 00 00 00 A1 Switch on power module #0, green LED Mdl responds: 02 A4 F0 00 11 20 00 00 00 00 00 A1 Power module #0, green LED is on							
0x24	**Enabling/disabling module deactivation** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: No							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x11	0x21	0	0	0	0	0	Deactivation on/off
Response	0x11	0x21	0	0	0	0	0	Deactivation on/off
Note	0xA1: deactivation on; 0xA0: deactivation off (default) If an output power is required that is lower than the maximum system power, individual modules can be deactivated for efficiency reasons. Operational readiness is disabled for the deactivated module. The operational readiness of the deactivated module cannot be restored using the “Enable/disable operational readiness” command. Example: In a system with 3x 20 kW modules, only 40 kW of output power is required. A module can be deactivated using this command. When transmitting a broadcast to the system with the required output power, the operational readiness of the deactivated module remains disabled and the remaining two modules operate at full power and therefore with higher efficiency.							
0x24	**Slow startup of the output current** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x11	0x22	0	0	0	0	0	Slow startup
Response	0x11	0x22	0	0	0	0	0	Slow startup
Note	0xA1: activated; 0xA0: deactivated. The function allows the output current to reach the set current in 5 s.							

Command no.	Transmitting data fields							
0x24	**Setting DIP switch function** Peer-to-peer: No Multicast: No Broadcast: Yes, without response							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x11	0x23	0	0	0	0	0	Group number/module number
	Note	0xA0: group number (default); 0xA1: module number To execute the command, the operational readiness of all modules must be disabled. By default, the DIP switch sets the group number of the module and the module number is assigned automatically. The DIP switch is used to set the module number using the command. The following command is used to set the group number via the CAN bus.							
0x24	**Setting the group number (only if DIP switch function is changed to module number)** Peer-to-peer: Yes Multicast: No Broadcast: Yes, without response							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x11	0x03	0	0	0	0	0	Group number
	Response	0x11	0x03	0	0	0	0	0	Group number
	Note	To set the group number, the operational readiness of the module must be disabled.							
	Example	Ctrl transmits: 02 A4 3F F0 11 23 00 00 00 00 00 A1 Switch the DIP switches of all modules in the CAN bus to set the module number Mdl responds: No response Ctrl transmits: 02 A4 3F F0 11 03 00 00 00 00 00 02 Assign all modules to group 2 Mdl responds: No response Ctrl transmits: 02 A4 01 F0 11 03 00 00 00 00 00 03 Assign module #1 to group 3 Mdl responds: 02 A4 F0 01 11 03 00 00 00 00 00 03 Response Module #1 assigned to group 3							
0x24	**Setting DC power levels to parallel operation/series operation** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x11	0x26	0	0	0	0	0	Operating mode DC levels
	Response	0x11	0x26	0	0	0	0	0	Operating mode DC levels
	Note	0xA2: automatic mode; 0xA1: series operation; 0xA0: parallel operation; for further information, see documentation accompanying the product Default value: series operation (0xA1) The operating mode can only be switched if operational readiness is disabled.							
	NOTE: Avoid DC overvoltage in automatic or parallel operation In parallel operation, the applied DC voltage at the DC connection terminal blocks must not exceed 500 V DC. In automatic mode, a voltage of more than 500 V DC may be applied if operational readiness is disabled, or the applied voltage must slowly increase to over 500 V DC (e.g., a connected battery whose voltage increases to over 500 V DC when charging is permitted). For detailed information, please refer to the packing slip of the product.								
	Example	Ctrl transmits: 02 A4 3F F0 11 26 00 00 00 00 00 A1 Set all modules to series operation of the DC power level Mdl responds: No response Ctrl transmits: 02 A4 00 F0 11 26 00 00 00 00 00 A2 Set module #0 to automatic operation of the DC power levels Mdl responds: 02 A4 F0 00 11 26 00 00 00 00 00 A2 Module #0 responds Set automatic operation of the DC power levels							

Com-mand no.	Transmitting data fields							
0x24	**Setting lower limit for DC discharge voltage** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x11	0x32	0	0	Discharge voltage limit			
Response	0x11	0x32	0	0	Discharge voltage limit			
Note	If the set lower limit of the applied DC voltage is reached, the module switches off. Default: 45 V DC (only for DC/AC on-grid and off-grid mode)							
Example	Ctrl transmits: 02 A4 00 F0 11 32 00 00 00 04 93 E0 Module #0, set lower limit for DC discharge voltage to 300 V DC Mdl responds: 02 A4 F0 00 11 32 00 00 00 04 93 E0 Response Module #0, lower limit for DC discharge voltage 300 V DC							
0x24	**Enabling/disabling voltage stabilization mode** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x11	0x34	0	0	0	0	0	On/off
Response	0x11	0x34	0	0	0	0	0	On/off
Note	0xA0: disabled (default); 0xA1: enabled Only for grid-dependent AC/DC and DC/AC on-grid operation. If this mode is enabled, the device automatically switches from AC/DC mode to DC/AC on-grid mode and vice versa. The switchover depends on the applied voltage level on the DC side. If the applied voltage on the DC side reaches the set level from the command 0x24 0x10 0x01 or the command 0x24 0x11 0x01, the module switches to DC/AC mode. If the voltage is below the set level, the module switches to AC/DC mode.							
Example	Ctrl transmits: 02 A4 3F F0 11 34 00 00 00 00 00 A1 Enable voltage stabilization mode for all modules Mdl responds: No response Ctrl transmits: 02 A4 3F F0 10 01 00 00 00 06 1A 80 Set voltage level for all modules to 400 V DC Mdl responds: 02 A4 F0 3F 10 01 00 00 00 06 1A 80 Response by system coordinator Voltage level set to 400 V DC							
0x24	**Setting the power factor** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x21	0x05	0	0	Power factor (floating-point number)			
Response	0x21	0x05	0	0	Power factor (floating-point number)			
Note	Value range 0.8 ... 1.0; increments: 0.001 To execute the command, the setting mode of the reactive power (command 0x21 0x17) must be set to 0xA1. The command only applies to DC/AC on-grid mode.							
0x24	**Setting the output voltage on the AC side** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
	Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
Request	0x21	0x06	0	0	Setpoint – phase voltage on AC side [mV]			
Response	0x21	0x06	0	0	Setpoint – phase voltage on AC side [mV]			
Note	Value range: 220 V AC ... 277 V AC To switch the phase voltage, operational readiness must be disabled Only possible in DC/AC off-grid mode							
Example	Ctrl transmits: 02 A4 00 F0 21 06 00 00 00 03 82 70 Module #0, set AC phase voltage to 230 V AC Mdl responds: 02 A4 F0 00 21 06 00 00 00 03 82 70 Module #0 responds Set AC phase voltage to 230 V AC							

Com-mand no.	Transmitting data fields							
0x24	**Setting the output frequency on the AC side** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x21	0x07	0	0	Setpoint – output frequency on AC side [mHz]			
	Response	0x21	0x07	0	0	Setpoint – output frequency on AC side [mHz]			
	Note	Value range: 50 Hz ... 60 Hz Default: 50 Hz To switch the output frequency, operational readiness must be disabled. After transmitting the command, the input voltage on the DC side must be switched off and on again (power cycle) Only possible in DC/AC off-grid mode							
	Example	Ctrl transmits: 02 A4 00 F0 21 07 00 00 00 00 EA 60 Module #0, set output frequency to 60 Hz Mdl responds: 02 A4 F0 00 21 07 00 00 00 00 EA 60 Module #0 responds Set output frequency to 60 Hz							
0x24	**Setting the reactive power at the output** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x21	0x08	0	0	Reactive power at output [mVar]			
	Response	0x21	0x08	0	0	Reactive power at output [mVar]			
	Note	To execute the command, the setting mode of the reactive power (command 0x21 0x17) must be set to 0xA2 Only possible in DC/AC on-grid mode							
	Example	Ctrl transmits: 02 A4 00 F0 21 08 00 00 00 0F 42 40 Module #0, set reactive power to 1000 Var Mdl responds: 02 A4 F0 00 21 08 00 00 00 0F 42 40 Module #0 responds Set reactive power to 1000 Var							
0x24	**Setting the module operating mode** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x21	0x10	0	0	0	0	0	Operating mode
	Response	0x21	0x10	0	0	0	0	0	Operating mode
	Note	0xA0: AC/DC (default); 0xA1: DC/AC on-grid mode; 0xA2: DC/AC off-grid mode To switch the operating mode, operational readiness must be disabled. In AC/DC mode and in DC/AC on-grid mode, the neutral conductor must not be connected. In DC/AC off-grid mode, the neutral conductor must be connected. Example for switching from AC/DC mode to DC/AC off-grid mode: 1. Disable operational readiness 2. Disconnect the module from the grid on the AC side (the battery remains connected on the DC side) 3. Connect the AC load including the neutral conductor 4. Switch the operating mode from AC/DC mode to DC/AC off-grid mode 5. Enable operational readiness							
	Example	Ctrl transmits: 02 A4 3F F0 21 10 00 00 00 00 00 A1 Set all modules to DC/AC on-grid Mdl responds: No response Ctrl transmits: 02 A4 00 F0 21 10 00 00 00 00 00 A0 Set module #0 to AC/DC mode Mdl responds: 02 A4 F0 00 21 10 00 00 00 00 00 A0 Module #0 responds Set to AC/DC mode							

Command no.	Transmitting data fields							
0x24	**Selecting reactive power setting mode** Peer-to-peer: Yes Multicast: Yes, response from every power module in the group Broadcast: Yes, without response							
		Byte 0	**Byte 1**	**Byte 2**	**Byte 3**	**Byte 4**	**Byte 5**	**Byte 6**	**Byte 7**
	Request	0x21	0x17	0	0	0	0	Reactive power setting mode	
	Response	0x21	0x17	0	0	0	0	Reactive power setting mode	
	Note	The reactive power can be set in two different ways: 0xA0: No setting mode selected (default) 0xA1: Setting via the power factor (command 0x21 0x05) 0xA2: Setting via the reactive power value (command 0x21 0x08) If you want to set the reactive power via commands 0x21 0x05 or 0x21 0x08, this command must be executed first. Only possible in DC/AC on-grid mode							
	Example	Ctrl transmits: 02 A4 00 F0 21 17 00 00 00 00 00 A2 Module #0, set reactive power setting mode to reactive power value Mdl responds: 02 A4 F0 00 21 17 00 00 00 00 00 A2 Response module #0 Reactive power setting mode set to reactive power value Ctrl transmits: 02 A4 00 F0 21 17 00 00 00 00 00 A1 Module #0, set reactive power setting mode to power factor Mdl responds: 02 A4 F0 00 21 17 00 00 00 00 00 A1 Response module #0 Reactive power setting mode set to power factor							

3.5 Status description

	Bit	Description	Condition	Power module status	LED
Status 1.3	7	1: PFC circuit is OFF	1: PFC circuit is OFF	OFF	
	6	1: Overvoltage at the input	1: Vin > 535 V AC	OFF	Yellow
	5	1: Undervoltage at the input	1: Vin < 260 V AC	OFF	Yellow
	4	1: Input asymmetry	1: Input asymmetry (AC)	/	/
	3	1: Input phase lost	1: One phase lost (input overvoltage if single phase first)	/	/
	2	1: Load sharing	1: Iavg_system > 15%	/	/
	1	1: Module ID repetition	1: Module ID is present multiple times on the CAN bus	OFF	Red
	0	1: Power limitation	1: Limitation of the output power for high temperatures or low input voltages	/	/
Status 1.2	7	1: CAN command interruption	1: No CAN signal from the charging controller for 10 seconds	OFF	Flashing yellow
	6	1: Slow startup	1: Slow power module startup activated	/	/
	5	1: Overvoltage at the output	1: Vout > 1036 V DC	OFF	Yellow
	4	1: Temperature threshold value exceeded	1: Ambient temperature threshold > 78°C ±3%	OFF	Yellow
	3	1: Fan error	1: Fan error	OFF	Flashing red
	2	1: Module protection	1: Module shuts down to protect itself. For example, due to input/output voltage, or undervoltage/overvoltage, or overtemperature	OFF	Yellow
	1	1: Module error	1: Module error (e.g., short circuit at the output, fan error, internal PCB error)	OFF	Red
	0	1: DC side is OFF	1: DC side is OFF	OFF	/
Status 1.1	7				
	6				
	5	1: Discharge abnormal	1: Vout > 350 V DC, 2 seconds after OFF 1: Vout (400 ms after OFF) > 1/2 x Vout (at the time of switch-off)	OFF	/
	4	Module deactivated	1: The module is deactivated by the “Module deactivation” command	OFF	/
	3				
	2				
	1				
	0	1: Output short circuit	1: Vo < 25 V, Io > 10% for 2 seconds	OFF	Red

	Bit	Description	Condition
Status 2.2	7		
	6		
	5		
	4	E-STOP	E-STOP active
	3		
	2		
	1	AC overload	AC overload in off-grid mode
	0	Mains power mode	1: DC/AC off-grid mode (inverter) 0: DC/AC on-grid mode (inverter)
Status 2.1	7		
	6		
	5		
	4		
	3		
	2		
	1		
	0	Operating mode	1: DC/AC mode (inverter) 0: AC/DC mode (rectifier)

Note: Communication interruption

If the power module does not receive any signals from the charging controller within 10 seconds, the power module switches off.

Note: Interval time for controller requests

The interval time for control requests should be between 50 ms and 200 ms.

Note: The use of the frame with identifier 0x075XXXXX is not permitted in the charging controller

The power modules use frame 0x075XXXXX for internal communication with each other. Additional use of this frame in the charging controller is not permitted.