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Ingeteam

R&D STANDARDS

FEASIBILITY AND USER REQUIREMENTS DOCUMENTS
FUNCTIONALITY SPECIFICATIONS
AAA0030IMB03_F

INGETEAM UNIT COMMANDS SPECIFICATION

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1. INTRODUCTION

This document describes a general Functionality Requirement Specification (FRS) for INGETEAM Unit commands. These command functionalities are implemented by means of using MODBUS (MB) standard communication. More precisely, by means of using a specific range of Holding Registers(HR). In order to implement this protocol, only standard MB function codes, 03 (0x03) Read HRs, 16 (0x10) Write Multiple HRs, 06 (0x06) Write Single HR are used.

2. FRS FOR INGETEAM UNIT COMMANDS USING HOLDING REGISTERS

Although in some literature, HR addresses are mapped from 40001onwards, herein this is dismissed and it is only mentioned as MB PDU address. Hence, INGETEAM documentation will stand for a HR map using the parameter Starting Address (SA) 0x0000 to 0xFFFF.

2.1 General Requirement specifications for Ingeteam Unit commands

2.1.1 Register Map Address for Unit Commands

There are registers that are both readable and writeable (RW) whereas other ones are only readable (R).Our Modbus Registers start on 40001, thus we must take this register as reference. So, if we want to access to 41001 Modbus Register, we have to enter the following direction: 41001-40001=1000=0x03E8. INGETEAM MB HR command addresses' range starts at SA 1000d (0x03E8). The addresses' range for commands will be defined from SA 1000d to 1122d. This is the standard maximum range for sending a multiple HR writing order in the same frame.

In order to execute commands, data must be written at addresses 1000d and 1001d, specifying command code and command data. After every single modification of address 1000d, the unit will reset the command execution.

After writing any register within the range of registers, any writing at address 1000d will be interpreted as the execution of a command with the data specified within range of the unit command.The address range defined for INGETEAM Unit commands is shown indocument AAA0030ICA21xx.pdf

Modbus Register	Address	Description	MIN	MAX	TYPE
41001	1000	Command Code	0	32	R/W
41002	1001	Command Data 1	-	-	R/W
41003	1002	Command Data 2	-	-	R/W
41004	1003	Reserved	-	-	R
41005	1004	Reserved	-	-	R
41006	1005	Active Power Reduction Reference	-32767	32767	R
41007	1006	Tan(φ) Reference	-32767	32767	R
41008	1007	Reactive Power Reduction Reference	-32767	32767	R
41009	1008	Cos(φ) target	-26214	26214	R
41010	1009	External Signal (for Permissive/Restrictive Fac Thresholds)	0	1	R
41011	1010	Inverter Strategy Mode	0	3	R
41012	1011	Inverter Operation Mode	0	4	R
41013	1012	AC Power Limit [W]	0	2^{32}	R
41014	1013				
41015	1014	V_{BAT} Voltage Reference [V]	330	1000	R
41016	1015	Frequency Reference [0.01·Hz]	4500	6500	R
41017	1016	AC RMS Voltage Reference [V]	180	255	R
41018	1017	Reserved	-	-	R

2.1.2 Command code specification

Cmd code	Command Meaning	Data 1 Parameter	Data 1 limits	Data 2 Parameter	Data 2 limits	1PLAY TLM	3PLAY	1PLAY STORAGE
0	No Command	-	-	-	-	n/a	n/a	n/a
1	Change Phi tangent target	Phi tangent reference %Pnom Fractional Int16 (1) (3) (6)	Max: 0.75 (24876) Min: -0.75 (-24876)	-	-	_	_	_
2	Read Phi tangent target	(not used)	(not used)	-	-	n/a	n/a	_
3	Change Pac Injection Derating	Inverter Power in %Pnom Fractional Int16 (2) (3)	Max: 100% (32767) Min: 0% (0) for PV inverters Min: -100% (-32767) for Battery inverters	-	-	_	_	_
4	Read Pac Injection Derating	(not used)	(not used)	-	-	n/a	n/a	n/a
5	Stop inverter	(not used)	(not used)	-	-	_	_	_
6	Start Inverter	(not used)	(not used)	-	-	_	_	_
7	Stand-by mode	(not used)	(not used)	-	-	n/a	n/a	_
8	Change active power target	Inverter Power in Int16 (2) (3)	Max: 100% (32767) Min: -100% (-32767)	-	-	_	_	n/a
9	Change reactive power target	Inverter Power in Int16 (3) (4) (6)	Max: 100% (32767) Min: -100% (-32767)	-	-	_	_	_
10	Change phi cosine target	Phi cosine reference in Int16 (3) (5) (6)	Max: 0.8 (26214) Min: -0.8 (-26214)	-	-	_	_	_
11	Disable reactive, phi tangent and phi cosine power target	(not used)	(not used)	-	-	_	_	_
12	External Signal (for Permissive/Restrictive Fac Thresholds)	0: Permissive Thresholds 1: Restrictive Thresholds if Local Command is High	Max: 1 Min: 0	-	-	_F	n/a	_S
13	Inject reactive power without DC source	React. power in (KVAr/10)	Nominal power of the inverter div 10	-	-	n/a	n/a	n/a
14	Stop reactive power injection without DC source	(not used)	(not used)	-	-	n/a	n/a	n/a
15	Grid Support Operating Mode	0: On-grid. Current Source 1: Off-grid. Voltage Source. Generation in V LOADS and V GRID	Max:2 Min: 0	-	-	n/a	n/a	_

		2: Off-grid. Voltage Source. Generation only in V LOADS						
16	Digital Outputs Relays	0: Open digital output relay_1 1: Close digital output relay_1 2: Open digital output relay_2 3: Close digital output relay_2	Max: 3 Min: 0	-	-	n/a	n/a	_
17	Change Power reduction and reactive power target	Inverter Power in %Pnom Fractional Int16 (2) (3)	Max: 100% (32767) Min: -100% (-32767)	-	-	n/a	_L Min: 0%	n/a
		Reactive Power in Fractional Int16 (3) (4) (6)	Max: 100% (32767) Min: -100% (-32767)	-	-	n/a	_L	n/a
18	Self-Consumption Activation	0: Normal mode 1: Self-Consumption mode to EMS Manager 2 : Self-Consumption mode to CG Wattmeter	Max:2 Min: 0	-	-	n/a	n/a	n/a
19	Inverter Operation mode	0: Current Source. PQ control 1: Current Source. Vbat control 2: Voltage Source. V/f control 3: Voltage Source. Transition to current source 4: Current Source. Vbat control with blackstart	Max: 4 Min: 0	-	-	n/a	n/a	n/a
20	DC Voltage target	DC Voltage in Int16 (7)	Max: 100% (32767) Min: 0% (0)	-	-	n/a	n/a	n/a
21	Frequency target	Frequency in Int16, hundredths of Hz	Max: 6500 Min: 4500	-	-	n/a	n/a	n/a
22	AC RMSVoltage target	Voltage in Int16, tenths of Volt	Max: 6900 Min: 0	-	-	n/a	n/a	n/a
23	Manual Pac ramp	Power per second (W/s) in Int16	Max: 32767 Min: 0	-	-	_	_	_S
24	Battery Commands	0: Stop lithium battery 1: Start lithium battery 2: Stand-by lithium battery 3: Stop Equalization 4: Start Equalization 5: Start Emergency Charge 6: Wake-Up lithium Battery	Max:5 Min: 0	-	-	n/a	n/a	_
25	Change Strategy Mode	0: Stand Alone 1: Grid Support 2: Back Up 3: Self-Consumption without EMS	Max:3 Min: 0	-	-	n/a	n/a	_
26	Battery Control Values	0: Battery charge current 1: Battery discharge current 2: Battery charge voltage 3: Battery SOC 4: SOCmax	Max:15 Min: 0	0: [50A, 0A] 1: [50A, 0A] 2: [450V, 45V] 3: [100%, 0%] 4: [100%, SOCgrid]	-	n/a	n/a	_U

		5: SOCgrid 6: SOCmin 7: SOCrecx 8: SOCdescx 9: Charge power from grid 10: Grid power 11: Battery discharge voltage 12: Battery voltage x10(8) 13: Battery current 14: Battery temperature 15: Battery voltage x100(8)		5: [SOCmax, SOCmin] 6: [SOCgrid, SOCdescx] 7: [SOCmin, SOCdescx] 8: [SOCrecx, 0%] 9: [6000W, 0W] 10: [6000W, -6000W] 11: [450V, 40V] 12: [450.0V,0.0V] Res:0.1V 13: [50A,-50A] 14: [80.0ºC,-20.0ºC] Res:0.1ºC 15: [320.00V,0.00V] Res:0.01V				
27	Reset Partial Counters	(not used)	(not used)	-	-	n/a	n/a	n/a
28	Pac AbsortionDerating	Pac AbsortionDerating value.(2)(3)	Min: 0 Max: 32767 (100%)	Pac Injection DC Source 0: Solar PV and AC Grid 1: Only AC Grid	Min: 0 Max:1	n/a	n/a	_X
29	Pac Injection Derating specifying DC Source.	Pac Injection Derating value.(2)(3)	Min: 0 Max: 32767 (100%)	Pac Injection DC Source 0: Battery and Solar PV 1: Only Solar PV	Min: 0 Max:1			_M
30	Start Autotest	(not used)	(not used)	-	-	n/a	n/a	_R
31	Stop Autotest	(not used)	(not used)	-	-	n/a	n/a	_R
32	Start Fan Test	(not used)	(not used)	-	-	n/a	n/a	_R
33	Disable Network Algorithms (7)	0:Reconnection Time 1: Voltage Connection Limits 2: Frequency Connection Limits 3: Soft Start 4: VacHAvg Protection 5: Pac vs Over Fac Algorithm 6: Pac vs Under Fac Algorithm 7: Pac vs Over Vac Algorithm (and CEI 021 case) 8: Pac vs Under Vac Algorithm 9: Qac vs Vac Algorithm 10: Cosφ vs Vac Algorithm 11: Low Voltage Ride Through (LVRT) 12: High Voltage Ride Through (HVRT) ---------- 100: All Algorithms	Min: 0 Max:100	0: Return to Config Value 1: Disable Algorithm	Min: 0 Max:1			_V

NOTES:

n/a: not applicable or not available.

(1)Int16 bit phi tangent: 32767 is equal to 1, -32767 I equal to -1. (Tan*32767)

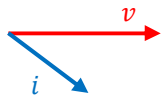
(2)Int16 Inverter power: 100% of max power: 32767. -100% of max power: -32767.

(3)When any Command that uses Command Data parameter is executed, Command Data must be modified at the same time as Command Code is modified (0x10 Modbus function). If 0x06 Modbus function is used, Command Data must be modified first.

(4)Int16 Inverter reactive power: 100% of max reactive power: 32767. -100% of max reactive power: -32767 (%/100*32767).

(5)Int16 bit phi cos: 32767 is equal to 1, -32767 I equal to -1. (Cos*32767)

(6)Reactive Control works as a Generator. When the inverter is commanded with a positive reactive value (tangent, cosine or reactive value) injected current will be delayed from voltage (equivalent to a capacitor). Otherwise, if reactive value is negative, injected current will be leadingthe voltage (equivalent to an inductor).

Type of current	Effect on the grid	Reactive sign	Tangent / Cosine sign	Fasorial diagram
The current is deliveredlagging from the voltage	The grid voltage goes up.	Q > 0	Positive	
The current is deliveredleading from the voltage	The grid voltage goes down.	Q < 0	Negative	

(7)For more information on the Operation Parameters, check the AAA0030IMB08 document.

(8)For nominal battery voltages greater than 320 V, specify the battery voltage measurement with a precision of x10 (it cannot be used x100). For voltages lower than 320V is highly recommended specifying the battery voltage measurement with a precision of x100.

2.2 Practical Examples:

This subchapter shows some practical examples managing the inverter commands and using the Modbus RTU communication system.

Every example is made considering an inverter with Modbus node nº 1.

2.2.1 CMD1: Change Tan φ Target.

This command changes the Phi Tangent Target.

Using 0x10 function:

TanφTarget	Data 1	Data1Hex	MODBUS frame
0.75 (Max Allowed)	$0.75 * 32767 = 24575$	5FFF	01 10 03 E8 00 02 04 00 01 5F FF + CRC
0 (Cosφ = 1)	$0 * 32767 = 0$	0	01 10 03 E8 00 02 04 00 01 00 00 + CRC
-0.75 (Min Allowed)	$-0.75 * 32767 = -24575$	A001	01 10 03 E8 00 02 04 00 01 A0 01 + CRC

Answer: 01 10 03 E8 00 02+CRC

Using 0x06 function:

TanφTarget	Data 1	Data1 Hex	MODBUS frame
0.75 (Max Allowed)	$0.75 * 32767 = 24575$	5FFF	01 06 03 E9 5F FF + CRC 01 06 03 E8 00 01 + CRC
0 (Cosφ = 1)	$0 * 32767 = 0$	0	01 06 03 E9 00 00 + CRC 01 06 03 E8 00 01 + CRC
-0.75 (Min Allowed)	$-0.75 * 32767 = -24575$	A001	01 06 03 E9 A0 01 + CRC 01 06 03 E8 00 01 + CRC

First Answer: 01 06 03 E9 +Data Hex+CRC

Second Answer: 01 06 03 E8 00 01+CRC

2.2.2 CMD3: Change Pac Injection Derating.

PV inverters:

CMD 3 changes the Active Power Reduction Target of the inverter.

Using 0x10 function:

P/Pn(%) DeratingTarget	Data	Data Hex	MODBUS frame
60 %	$\frac{60}{100} * 32767 = 19660$	4CCC	01 10 03 E8 00 02 04 00 03 4C CC+ CRC
20 %	$\frac{20}{100} * 32767 = 6553$	1999	01 10 03 E8 00 02 04 00 03 19 99 + CRC
100 % (No Derating)	$\frac{100}{100} * 32767 = 32767$	7FFF	01 10 03 E8 00 02 04 00 03 7F FF + CRC

Answer: 01 10 03 E8 00 02+CRC

Using 0x06 function:

P/Pn(%) Reduct. Target	Data	Data Hex	MODBUS frame
60 %	$\frac{60}{100} * 32767 = 19660$	4CCC	01 06 03 E9 4C CC + CRC 01 06 03 E8 00 03 + CRC
20 %	$\frac{20}{100} * 32767 = 6553$	1999	01 06 03 E9 19 99 + CRC 01 06 03 E8 00 03 + CRC
100 % (No Derating)	$\frac{100}{100} * 32767 = 32767$	7FFF	01 06 03 E9 7F FF + CRC 01 06 03 E8 00 03 + CRC

First Answer: 01 06 03 E9 +Data Hex+CRC

Second Answer: 01 06 03 E8 00 03+CRC

Ingecon Sun Storage 1Play:

CMD 3 changes the Active Power Reduction Target.

32767 (100%) equals to max charge power

-32767 (-100%) equals to max discharge power.

Command Data 2 has no meaning.

Using 0x10 function:

P/Pn (%) Reduct. Target	Data 1	Data 1 Hex.	Communication frame
60% charge	$\frac{60}{100} * 32767 = 19660$	4CCC	01 10 03 E8 00 02 04 00 03 4C CC + CRC
100% charge	$\frac{100}{100} * 32767 = 32767$	7FFF	01 10 03 E8 00 02 04 00 03 7F FF + CRC
20% discharge	$\frac{20}{100} * 32767 = 6553$ $\rightarrow 2^{16} - 6553 = 58983$	E667	01 10 03 E8 00 02 04 00 03 E6 67 + CRC
100% discharge	$\frac{100}{100} * 32767 = 32767$ $\rightarrow 2^{16} - 32767 = 32769$	8001	01 10 03 E8 00 02 04 00 03 80 01 + CRC

Answer: 01 10 03 E8 00 02 + CRC

Using 0x06 function:

P/Pn (%) Reduct. Target	Data 1	Data 1 Hex.	Communication frame
60% charge	$\frac{60}{100} * 32767 = 19660$	4CCC	01 06 03 E9 4C CC + CRC 01 06 03 E8 00 03 + CRC
20% discharge	$\frac{20}{100} * 32767 = 6553$ $\rightarrow 2^{16} - 6553 = 58983$	E667	01 06 03 E9 E6 67 + CRC 01 06 03 E8 00 03 + CRC
100% charge	$\frac{100}{100} * 32767 = 32767$	7FFF	01 06 03 E9 7F FF + CRC 01 06 03 E8 00 03 + CRC

First Answer: 01 06 03 E9 + Data Hex. + CRC

Second Answer: 01 06 03 E8 00 03 + CRC

2.2.3 CMD5: Stopping the inverter.

Command Code stops the inverter. Command Data has no meaning.

Desired action	Data Hex.	Communication frame
Stop the inverter	-	01 10 03 E8 00 01 02 00 05 + CRC

Answer: 01 10 03 E8 00 01+CRC

2.2.4 CMD6: Starting the inverter.

Command Code starts the inverter. Command Data has no meaning.

Desired action	Data Hex.	Communication frame
Start the inverter	-	01 10 03 E8 00 01 02 00 06 + CRC

Answer: 01 10 03 E8 00 01+CRC

2.2.5 CMD 7: Standby the inverter

Command Code switch on/off standby the inverter. Command Data has no meaning.

Desired action	Data Hex.	Communication frame
Standby the inverter	-	01 10 03 E8 00 01 02 00 07 + CRC

Answer: 01 10 03 E8 00 01+CRC

2.2.6 CMD 9: Change Reactive Power Target

Using this command we will be able to change the Reactive Power Target.

The reactive power target must be given as percentage of maximum power of this inverter. For instance, if we want 2600 Var and the inverter's maximum power is 6000 W, the following conversion must be done:

$$100 \cdot \frac{2600}{6000} = 43.33\,\%$$

After that, the desired target must be escalated to 32767.

$$\frac{43.33\%}{100\%} \cdot 32767 = 14199 = 0x3777$$

We can do it either using 0x10 or 0x06 functions.

Using 0x10 function:

Q/Pmax(%) Target	Data	Data Hex	MODBUS frame
80 %	$\frac{80}{100} * 32767 = 26213$	6666	01 10 03 E8 00 02 04 00 09 66 66 + CRC
-100 %	$\frac{-100}{100} * 32767 = -32767$	80 01	01 10 03 E8 00 02 04 00 09 80 01 + CRC
0 %	$\frac{0}{100} * 32767 = 32767$	0	01 10 03 E8 00 02 04 00 09 00 00 + CRC

Answer: 01 10 03 E8 00 02+CRC

Using 0x06 function:

Q/Pmax(%) Target	Data	Data Hex	MODBUS frame
80 %	$\frac{80}{100} * 32767 = 26213$	6666	01 06 03 E9 66 66 + CRC 01 06 03 E8 00 09 + CRC
-100 %	$\frac{-100}{100} * 32767 = -32767$	80 01	01 06 03 E9 80 01 + CRC 01 06 03 E8 00 09 + CRC
0 %	$\frac{0}{100} * 32767 = 32767$	0	01 06 03 E9 00 00 + CRC 01 06 03 E8 00 09 + CRC

First Answer: 01 06 03 E9 +Data Hex+CRC

Second Answer: 01 06 03 E8 00 09+CRC

2.2.7 CMD 10: Change Cos φ Target

Using this command we will be able to change the Phi Cosine Target.

The desired target must be multiplied by 32767.

We can do it either using 0x10 or 0x06 functions.

Using 0x10 function:

Cos φ Target	Data	Data Hex	MODBUS frame
0.8(Max Allowed)	$0.8 * 32767 = 26213$	6666	01 10 03 E8 00 02 04 00 0A 66 66 + CRC
1	$1 * 32767 = 32767$	7FFF	01 10 03 E8 00 02 04 00 0A 7F FF + CRC
-0.8(Min Allowed)	$-0.8 * 32767 = -26213$	999B	01 10 03 E8 00 02 04 00 0A 99 9B + CRC

Answer: 01 10 03 E8 00 02+CRC

Using 0x06 function:

Cos φ Target	Data	Data Hex	MODBUS frame
0.8(Max Allowed)	$0.8 * 32767 = 26213$	6666	01 06 03 E9 66 66 + CRC 01 06 03 E8 00 0A + CRC
1	$1 * 32767 = 32767$	7FFF	01 06 03 E9 7F FF + CRC 01 06 03 E8 00 0A + CRC
-0.8(Min Allowed)	$-0.8 * 32767 = -26213$	999B	01 06 03 E9 99 9B + CRC 01 06 03 E8 00 0A + CRC

First Answer: 01 06 03 E9 +Data Hex+CRC

Second Answer: 01 06 03 E8 00 0A+CRC

2.2.8 CMD 11: Disable Reactive Power, Tan φ and Cos φ Targets.

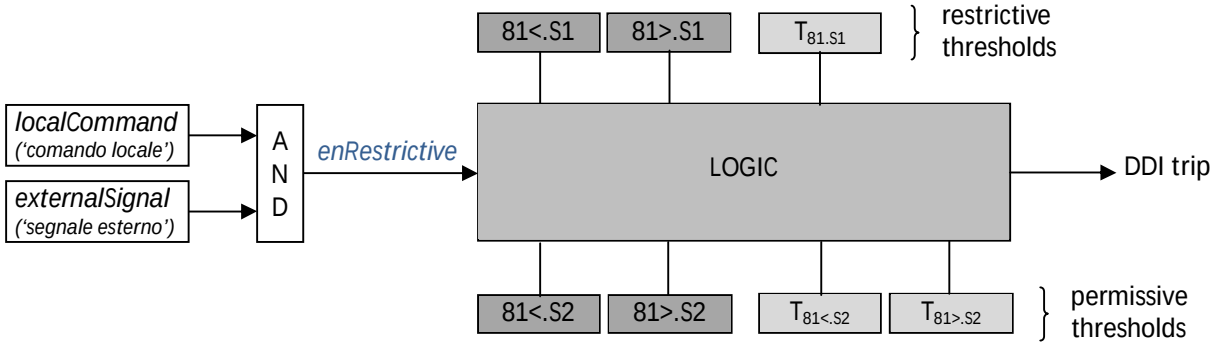
In this command the data has no meaning, only selecting the command the given Q, Tan φ or Cos φ Targets will be disabled.

Desired action	Data Hex.	Communication frame
CMD 11	-	01 10 03 E8 00 01 02 00 0B + CRC

Answer: 01 10 03 E8 00 01+CRC

2.2.9 CMD 12: External Signal for Permissive/Restrictive Fac Thresholds.

Some regulations such as CEI 0-21 for plants with a total power less than 6kW, which have got an internal PI, requires including a functionality which is able to change the Fac thresholds when necessary. This order is given by a local command (which is a bit in the configuration of the inverter) and an external signal (which is given by remote), as is described on the schema below:



- Both *localCommand* and *externalSignal* must be implemented: *localCommand* is a parameter to set depending on the distributor requests, while *externalSignal* is an external trigger for the restrictive threshold enabling
- If *enRestrictive*is true, the logic enables the restrictive thresholds; in this condition the permissive thresholds are not used. Both the restrictive thresholds have the same time delay ($T_{81.S1}$), equals to 0.1 s.
- If *enRestrictive*is false, the logic enables only the permissive thresholds; each threshold has a different time delay, that must be configurable as follows: $T_{81<.S2}$ = { 0.1 s, 4.0 s } and $T_{81>.S2}$ = { 0.1 s, 1.0 s}.

For changing the value of the external signal:

Using 0x10 function:

- To set to High(setting the restrictive thresholds if the local command is high):

  01 10 03 E8 00 02 04 00 0C 00 01+ CRC

  Answer: 01 10 03 E8 00 02+CRC
- To set to Low (setting the permissive thresholds):

  01 10 03 E8 00 02 04 00 0C 00 00+ CRC

  Answer: 01 10 03 E8 00 02+CRC

2.2.10 CMD 13: Enable Night Injection Mode.

This command allow to maintain the inverter connected to the grid when the irradiance of the sun its near to cero. The inverter will keep responding to the reactive power set point during the night. Once the inverter detects that the power coming from the panels is almost cero, it will disconnect the DC Switch, avoiding extra power consumption from the grid.

Once the irradiance of the sun start in the morning then the inverter will measure an increase of the PV voltage the inverter will close the DC Switch and start injecting power to grid.

2.2.11 CMD 14: Disable Night Injection Mode.

If the system needs to disable the Night injection functionality, it's possible just sending this command.

2.2.12 CMD 15: Grid Support Operating Mode.

Command Code set the inverter ready to work in off-grid or on-grid mode. This command only will have effect if the inverter is configured as Grid Support Mode (CMD 25).

Command Data 2 has no meaning.

Desired action	Data 1 Hex.	Communication frame
CurrentSource (On-grid)	0	01 10 03 E8 00 02 04 00 0F0000 + CRC
Voltage Source.Generation inVLoads and Vgrid (Off-grid)	1	01 10 03 E8 00 02 04 00 0F0001 + CRC
Voltage Source.Generation only inVLoads (Off-grid)	2	01 10 03 E8 00 02 04 00 0F0002 + CRC

Answer: 01 10 03 E8 00 02+CRC

2.2.13 CMD 16: Digital Outputs Relays

Command Code manages the two digitals outputs.

Command Data 1 chooses the open/start for each digital output. Command Data 2 has no meaning.

Digital Outputs Relays	Data 1	Data 1 Hex.	Communication frame
Digital Output_1	Open	0	01 10 03 E8 00 02 04 00 100000 + CRC
	Close	1	01 10 03 E8 00 02 04 00 100001 + CRC
Digital Output_2	Open	2	01 10 03 E8 00 02 04 00 100002 + CRC
	Close	3	01 10 03 E8 00 02 04 00 100003 + CRC

2.2.14 CMD 24: Battery Commands

Command Code manages the battery system and with the Command Data 1 chooses the function. Command Data 2 has no meaning.

Desired action	Data 1 Hex.	Communication frame
Stop battery	0	01 10 03 E8 00 02 04 00 180000 + CRC
Start battery (Operational)	1	01 10 03 E8 00 02 04 00 180001 + CRC
Standby battery	2	01 10 03 E8 00 02 04 00 180002 + CRC
Stop Equalization	3	01 10 03 E8 00 02 04 00 180003 + CRC
Start Equalization	4	01 10 03 E8 00 02 04 00 180004 + CRC
Start Emergency Charge	5	01 10 03 E8 00 02 04 00 180005 + CRC

2.2.15 CMD 25: Change Strategy Mode

Command Code set the inverter ready to work in different strategies.

Command Data 1 choose the strategy. Command Data 2 has no meaning.

Desired action	Data 1 Hex.	Communication frame
Stand Alone	0	01 10 03 E8 00 02 04 00 190000 + CRC
Grid Support	1	01 10 03 E8 00 02 04 00 190001 + CRC
Back Up	2	01 10 03 E8 00 02 04 00 190002 + CRC
Self-Consumption	3	01 10 03 E8 00 02 04 00 190003 + CRC

2.2.16 CMD 26: Battery Control Values

Command Code set the inverter ready to work with the dynamic battery control values. This command is applied when the battery is configured as “Lead-Acid” or “Ingeteam RS485 Protocol”.

> **Note**: if the battery is configured as “Ingeteam RS485 Protocol” the inverter should receive this command periodically. Inverter stops charging/discharging battery within 2 seconds (configurable timeout) after loss of communication occurs.
>
> Timeout can be changed by Ingecon Sun Manager PC software.

Command Data 1 chooses the control parameter.

Command Data 2 set the value of the selected data 1 parameter.

Desired action	Data 1 Hex.	Data 2 Hex.	Communication frame
Battery charge current [10A]	0x00	0x0A [10]	01 10 03 E8 00 03 06 00 1A 00 00 00 0A + CRC
Battery discharge current [50A]	0x01	0x32 [50]	01 10 03 E8 00 03 06 00 1A 00 01 00 32 + CRC
Battery charge voltage [140V]	0x02	0x8C [140]	01 10 03 E8 00 03 06 00 1A 00 02 00 8C+ CRC
Battery SOC [70%]	0x03	0x46 [70]	01 10 03 E8 00 03 06 00 1A 00 03 00 46+ CRC
SOC max [100%]	0x04	0x64 [100]	01 10 03 E8 00 03 06 00 1A 00 04 00 64+ CRC
SOC grid [80%]	0x05	0x50 [80]	01 10 03 E8 00 03 06 00 1A 00 05 00 50+ CRC
SOC min [60%]	0x06	0x3C [60]	01 10 03 E8 00 03 06 00 1A 00 06 00 3C+ CRC
SOC recx [54%]	0x07	0x36 [54]	01 10 03 E8 00 03 06 00 1A 00 07 00 36+ CRC
SOC descx [50%]	0x08	0x32 [50]	01 10 03 E8 00 03 06 00 1A 00 08 00 32+ CRC
Charge power from grid [0W]	0x09	0x00 [0]	01 10 03 E8 00 03 06 00 1A 00 09 00 00+ CRC
Grid power [3000W]	0x0A	0xBB8 [3000]	01 10 03 E8 00 03 06 00 1A 00 0A 0B B8 + CRC
Battery discharge voltage [100V]	0x0B	0x64 [100]	01 10 03 E8 00 03 06 00 1A 00 0B 00 64 + CRC
Battery voltage x10 [120.5V]	0x0C	0x4B5 [1205]	01 10 03 E8 00 03 06 00 1A 00 0C 04 B5 + CRC
Battery current [20A]	0x0D	0x14 [20]	01 10 03 E8 00 03 06 00 1A 00 0D 00 14 + CRC
Battery temperature [21.8ºC]	0x0E	0xDA [218]	01 10 03 E8 00 03 06 00 1A 00 0E 00 DA + CRC
Battery voltage x100 [48.53V]	0x0F	0x12F5 [4853]	01 10 03 E8 00 03 06 00 1A 00 0F 12 F5 + CRC

- Answer: 01 10 03 E8 00 03+CRC

Desired action	Description
Battery charge current	Maximum current, the battery can deliver during charging process.
Battery discharge current	Maximum current, the battery can deliver during discharging process.
Battery charge voltage	Maximum voltage during charging process. CV mode.
Battery SOC	Synthesis of SOC of all batteries connected to the power bus.
SOC max	Maximum SOC that the battery is charged from the renewable sources.
SOC grid	Maximum SOC that the battery is charged from the auxiliary grid input.
SOC min	Maximum SOC that the battery can deliver during discharging process.
SOC recx	Value at which, once passed, the unit starts as long as the SCO descx has been previously reached.
SOC descx	Minimum limit for switching to the shutdown status.
Charge power from grid	Maximum battery charging power from the auxiliary grid input.
Grid power	Maximum power injected into the grid.
Battery discharge voltage	Minimum voltage during discharging process to protect battery deep discharge.
Battery voltage x10	Current voltage measured, Vx10, in the battery bank terminals.
Battery current	Algebraic sum of all batteries current connected to the power bus
Battery temperature	Current temperature of all batteries
Battery voltage x100	Current voltage measured, Vx100, in the battery bank terminals. This value is used to control the battery voltage, just at the battery terminals, during charging/discharging process (CV mode). **See note below**.

Note: It is recommended to send to the inverter “Battery voltage x100” value to have high precision during charging process (constant voltage mode). This value is used to control the battery voltage just at the battery terminals. For that, the BMS should send to the inverter this value always, from beginning of the battery wake-up. Otherwise, the inverter will use its own voltage measurement to control the battery voltage.

2.2.17 CMD28: Pac AbsortionDerating.

This command limits the Pac absorbed from the grid specifying from which energy Source is wanted to obtain the charge of the battery.

Data 1: Pac absorption derating value:

The derating value must be specified as percentage of maximum power of this inverter. For instance, if we want 2600 W and the inverter's nominal power is 6000 W, the following conversion must be done:

$$100 \cdot \frac{2600}{6000} = 43.33\,\%$$

After that, the desired target must be escalated to 32767.

$$\frac{43.33\%}{100\%} \cdot 32767 = 14199 = 0x3777$$

Data 2: DC Source:

With this data, the energy Source for charging the battery can be specified.

Two possibilities are offered:

- 0: From PV and AC Grid.
- 1: Only from AC Grid.

Warning: This data2 only is meaningful for the GRID SUPPORT operation mode.

Examples:

Using 0x10 function:

Desired action	Data 1	Data 1 Hex	Data 2	MODBUS frame
60 % Derating, Solar Panel+Grid	$\frac{60}{100} * 32767 = 19660$	4CCC	0	01 10 03 E8 00 03 06 00 1C 4C CC 00 00 + CRC
60 % Derating, Only Grid Panel	$\frac{60}{100} * 32767 = 19660$	4CCC	1	01 10 03 E8 00 03 06 00 1C 4C CC 00 01 + CRC
20 % Derating, Solar Panel+Grid	$\frac{20}{100} * 32767 = 6553$	1999	0	01 10 03 E8 00 03 06 00 1C 19 99 00 00 + CRC

100 % (No Derating),Only from grid	$\frac{100}{100} * 32767 = 32767$	7FFF	1	01 10 03 E8 00 03 06 00 1C 7F FF 00 01 + CRC

- Answer: 01 10 03 E8 00 03+CRC

2.2.18 CMD29: Pac Injection Derating specifying DC Source.

This command limits the Pac injected from the grid specifying from which DC Source is wanted to obtain that power.

Two data are required:

Data 1: Pac injection derating value:

The derating value must be specified as percentage of maximum power of this inverter. For instance, if we want 2600 W and the inverter's nominal power is 6000 W, the following conversion must be done:

$$100 \cdot \frac{2600}{6000} = 43.33\,\%$$

After that, the desired target must be escalated to 32767.

$$\frac{43.33\%}{100\%} \cdot 32767 = 14199 = 0x3777$$

Data 2: DC Source:

With this data, the DC Source for obtaining the injected Pac can be specified.

Two possibilities are offered:

- 0: Battery and Solar Panels.
- 1: Only from Solar Panels.

Warning: This data2 only is meaningful for the GRID SUPPORT operation mode.

Examples:

Using 0x10 function:

Desired action	Data 1	Data 1 Hex	Data 2	MODBUS frame
60 % Derating, Batt + Solar Panel	$\frac{60}{100} * 32767 = 19660$	4CCC	0	01 10 03 E8 00 03 06 00 1D 4C CC 00 00 + CRC
60 % Derating, Only Solar Panel	$\frac{60}{100} * 32767 = 19660$	4CCC	1	01 10 03 E8 00 03 06 00 1D 4C CC 00 01 + CRC
20 % Derating, Batt + Solar Panel	$\frac{20}{100} * 32767 = 6553$	1999	0	01 10 03 E8 00 03 06 00 1D 19 99 00 00 + CRC
100 % (No Derating),Only Solar Panel	$\frac{100}{100} * 32767 = 32767$	7FFF	1	01 10 03 E8 00 03 06 00 1D 7F FF 00 01 + CRC

- Answer: 01 10 03 E8 00 03+CRC

2.2.19 CMD30: Start Autotest.

This command starts the process of Autotest whenever the autotest is enabling by configuration and it is not already running. This command consists on writing holding register with address 1000 with the value 30. This may be implemented by using function codes 0x10 and 0x06

START AUTOTEST

Desired action	Data Hex.	Communication frame
CMD 30	-	01 10 03 E8 00 01 02 00 1E + CRC_H+CRC_L 01 06 03 E8 00 1E + CRC_H+CRC_L

Answer (function 0x10): 01 10 03 E8 00 01+ CRC_H+CRC_L

Answer (function 0x06): 01 06 03 E800 1E + CRC_H+CRC_L

2.2.20 CMD31: Stop Autotest.

This command stops the process of Autotest whenever the autotest is already running. This command consists on writing holding register with address 1000 with value 31. This may be implemented by using function codes 0x10 and 0x06

Desired action	Data Hex.	Communication frame
CMD 31	-	01 10 03 E8 00 01 02 00 1F+ CRC_H+CRC_L 01 06 03 E8 00 1F+ CRC_H+CRC_L

Answer (function 0x10): 01 10 03 E8 00 01+ CRC_H+CRC_L

Answer (function 0x06): 01 06 03 E8 00 1F + CRC_H+CRC_L

2.2.21 CMD 32: Start Fan test.

This command starts the process of Fan Test. The test lasts 30 seconds. This command consists on writing holding register with address 1000 with the value 32. This may be implemented by using function codes 0x10 and 0x06

Desired action	Data Hex.	Communication frame
CMD 32	-	01 10 03 E8 00 01 02 00 20+ CRC_H+CRC_L 01 06 03 E8 00 20+ CRC_H+CRC_L

Answer (function 0x10): 01 10 03 E8 00 01+ CRC_H+CRC_L

Answer (function 0x06): 01 06 03 E8 00 20 + CRC_H+CRC_L

2.2.22 CMD 33: Disable Network Algorithms

This command can be used for disabling the network quality algorithms by communications. They can be restored back to the configured values as well

Command Data 1 chooses the control parameter.

Command Data 2 set the value of the selected data 1 parameter.

Desired Algorithm	Data 1 Hex.	Data 2 Hex.	Communication frame
Reconnection Time	0x00	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 00 00 01 + CRC
Voltage Connection Limits	0x01	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 01 00 01 + CRC
Frequency Connection Limits	0x02	0x00 [Restore]	01 10 03 E8 00 03 06 00 21 00 02 00 00 + CRC
Soft Start	0x03	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 03 00 01 + CRC

VacHAvg Protection	0x04	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 04 00 01 + CRC
Pac vs Over Fac Algorithm	0x05	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 05 00 01 + CRC
Pac vs Under Fac Algorithm	0x06	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 06 00 01 + CRC
Pac vs Over Vac Algorithm (and CEI021 case)	0x07	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 07 00 01 + CRC
Pac vs Under Vac Algorithm	0x08	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 08 00 01 + CRC
Qac vs Vac Algorithm	0x09	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 09 00 01 + CRC
CosPhi vs Pac Algorithm	0x0A	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 0A 00 01 + CRC
Low Voltage Ride Through (LVRT)	0x0B	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 0B 00 01 + CRC
High Voltage Ride Through (HVRT)	0x0C	0x00 [Restore]	01 10 03 E8 00 03 06 00 21 00 0C 00 00 + CRC
All Algorithms	0x64	0x01 [Disable]	01 10 03 E8 00 03 06 00 21 00 64 00 01 + CRC

- Answer: 01 10 03 E8 00 03+CRC

2.2.23 Readable registers.

We could read the registers using the 0x03 function:

This way, we can read many registers in a row, for instance 10 beginning at 41001.

01 03 03 E8 00 0A+CRC

Answer: 01 03 14 00 00 99 9B 00 00 00 00 00 00 4C CC 00 00 00 00 99 9A 00 00 +CRC

We can as well read only a specific register, for instance

01 03 03 ED 00 01+CRC

Answer: 01 03 024C CC+CRC

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