E-Tech®

Modbus

DriveE-Tech/ Mini / COMPACT & Solar Drives

Franklin Electric

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1. Introduction

1.1. Purpose of the manual

The purpose of this manual is to provide users with detailed information on the installation, operation, and maintenance of the device.

WARNING
Carefully read the installation, use and maintenance manual before installing and using the product.

WARNING
Failure to follow the instructions may result in damage to the product, the system in which it is installed and, in the worst cases, damage to property or persons with even fatal consequences.

NOTE
Store the manual in a protected and easily accessible place next to the installation location for possible consultation. A digital copy of this manual can be downloaded from the manufacturer's website or via the QR code shown on the product itself.

1.2. Presentation

Modbus is a serial communication protocol. Simple and robust, it has become a standard communication protocol and is a commonly available way to connect industrial electronic devices. Modbus allows communication between many devices connected to the same network. Modbus is often used to connect a supervisory computer with a remote terminal (RTU) in supervisory control and data acquisition systems (SCADA). The development and updating of Modbus protocols is managed by the Modbus organization, an association of users and vendors of Modbus compliant devices that seeks to guide the adoption and evolution of Modbus.

Modbus communication is performed on devices using the RS485 Modbus serial port (if available). Modbus communication is based on the master-slave configuration in which the central unit (PLC, PC or BMS) is the master in the network and the devices are the slaves. The master is therefore able to monitor and program the slaves that send or receive messages based on the Modbus protocol.

1.3. Symbols

TIP
This symbol indicates a TIP or recommendation.

NOTE
This symbol indicates a NOTE or an indication or concept to be emphasised.

CAUTION
This symbol indicates CAUTION, thus an indication which failure to respect can lead to minor or moderate damage.

WARNING
This symbol indicates a WARNING, thus an indication which, in the event of non-compliance, may lead to serious, even fatal damage to persons or things.

DANGER
This symbol indicates an ELECTRICAL HAZARD, which if not avoided will result in death or electrocution.

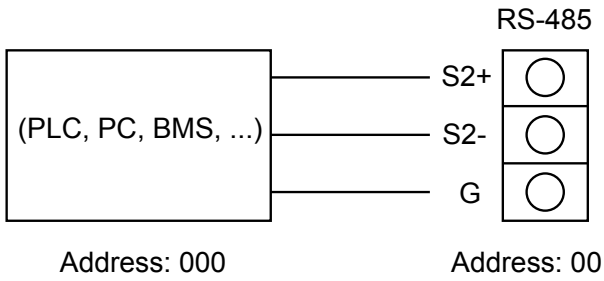
2. Communication protocols

It is possible to choose between four protocols:

- N81: 1 start bit, 8 data bits, 1 stop bits, no parity
- N82: 1 start bit, 8 data bits, 2 stop bits, no parity
- E81: 1 start bit, 8 data bits, 1 stop bit, even parity
- O81: 1 start bit, 8 data bits, 1 stop bit, odd parity

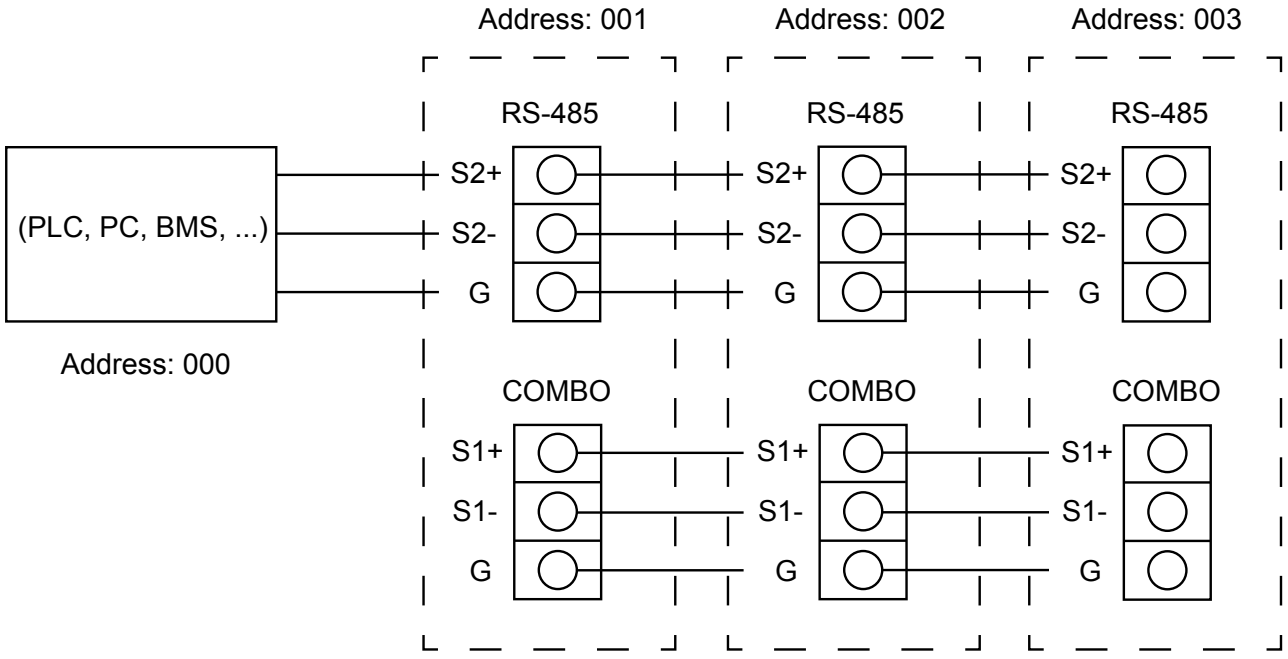
3. Electrical connections

Figure 1. Single device application



The slave device with address 001 is connected to the external master device with address 000 through the terminals RS-485: S2 +, S2-, G

Figure 2. Application with two or more devices in COMBO



In a group consisting of two or more devices connected together in COMBO, each device in the group has a COMBO address ranging from 001 to 008 and is connected to the external master device with address 000 through the terminals RS-485: S2 +, S2-, G

NOTE
It is recommended to use twisted and shielded cable with suitable termination resistors for communication through the RS-485 serial.

4. Programming

The parameters relating to the programming of the device are found in the menu Connectivity parameters.

Parameter	Default	Description
P125 Communication	MODBUS	• MODBUS • BACNET
P098 Address RS-485 XXX	1	Address from 1 to 247
P099 Baudrate XXXXX	9600	Baudrate from 1200 bps to 57600 bps
P100 Data format XXXXX	N81	Data format: N81, N82, E81, O81
P024 EEPROM write ON/OFF	OFF	Setting the writing mode of the parameters transmitted via: ON: the datum is saved in EEPROM OFF: the datum is not saved in EEPROM

CAUTION
An excessive writing in the EEPROM memory (> 1 million cycles) will lead to the damage of the latter and it will be necessary to replace it to make the device operational again.

5. Function codes

- **0x01 Read Coil Status**
  READING COMMAND

Table 1. REQUEST

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x01	Read Coil Status reading registers
Register address: most significant byte	0x0F	
Register address: least significant byte	0xB0	Modbus index 0x0FB1 ATTENTION! Modbus indexes are addressed starting from zero, therefore register 0x0FB1 is addressed as 0x0FB0
Number of registers: most significant byte	0x00	
Number of registers: least significant byte	0x14	
Error Check CRC: most significant byte	0x3E	
Error Check CRC: least significant byte	0xF6	Error checking: CRC algorithm

Table 2. REPLY

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x01	
Number of bytes containing the requested data	0x03	
First byte of data	0x00	Coil registers from 0x0FB1 to 0X0FB8
Second byte of data	0x03	Coil registers from 0x0FB9 to 0X0FC0
Third byte of data	0x01	Coil registers from 0x0FC1 to 0X0FC4
Error Check CRC: most significant byte	0x38	
Error Check CRC: least significant byte	0xE0	Error checking: CRC algorithm

- **0x02 Read Discrete Input**
  READING COMMAND

Table 3. REQUEST

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x02	Read Discrete Input reading registers
Register address: most significant byte	0x23	
Register address: least significant byte	0x28	Modbus index 0x2329 ATTENTION! Modbus indexes are addressed starting from zero, therefore register 0x2329 is addressed as 0x2328
Number of registers: most significant byte	0x00	
Number of registers: least significant byte	0x14	
Error Check CRC: most significant byte	0xF3	
Error Check CRC: least significant byte	0x89	Error checking: CRC algorithm

Table 4. REPLY

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x02	
Number of bytes containing the requested data	0x03	
First byte of data	0x00	Discrete input registers 0x2329 to 0X2321
Second byte of data	0x00	Discrete input registers from 0x2332 to 0X233A
Third byte of data	0x00	Discrete input registers from 0x233B to 0X233F
Error Check CRC: most significant byte	0x78	
Error Check CRC: least significant byte	0x4E	Error checking: CRC algorithm

- **0x03 Read Holding Registers**
  READING COMMAND
  Example: read the measured value

Table 5. REQUEST

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x03	Read Holding Registers reading registers
Register address: most significant byte	0x14	
Register address: least significant byte	0x1F	Modbus index 0x1420 ATTENTION! Modbus indexes are addressed starting from zero, therefore register 0x1420 is addressed as 0x141F
Number of registers: most significant byte	0x00	
Number of registers: least significant byte	0x01	
Error Check CRC: most significant byte	0xB0	
Error Check CRC: least significant byte	0x3C	Error checking: CRC algorithm

Table 6. REPLY

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x03	
Bytes number	0x02	
Data read: most significant byte	0x00	
Data read: least significant byte	0x23	23 hexadecimal means 35 decimal and therefore the measured value is 3.5 bar
Error Check CRC: most significant byte	0xF9	
Error Check CRC: least significant byte	0x9D	Error checking: CRC algorithm

- **0x04 Read Input Registers**
  READING COMMAND
  Example: Read the measured value of the frequency

Table 7. REQUEST

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x04	Read Input Registers reading registers
Register address: most significant byte	0x14	
Register address: least significant byte	0x23	Modbus index 0x1424 ATTENTION! Modbus indexes are addressed starting from zero, therefore register 0x1424 is addressed as 0x1423
Number of registers: most significant byte	0x00	
Number of registers: least significant byte	0x01	
Error Check CRC: most significant byte	0xC5	
Error Check CRC: least significant byte	0xF0	Error checking: CRC algorithm

Table 8. REPLY

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x04	
Bytes number	0x02	
Data read: most significant byte	0x00	
Data read: least significant byte	0x32	32 hexadecimal means 50 decimal and therefore the value read is 50 Hz
Error Check CRC: most significant byte	0x38	
Error Check CRC: least significant byte	0xE5	Error checking: CRC algorithm

- **0x05 Force Single Coil**
  WRITING COMMAND
  Example: setting P043 Autorestart = ON

Table 9. REQUEST

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x05	Force Single Coil write register
Register address: most significant byte	0x0F	
Register address: least significant byte	0xB2	Modbus index 0x0FB3 ATTENTION! Modbus indexes are addressed starting from zero, therefore register 0xFB3 is addressed as 0x0FB2
Status of the bit	0xFF	0x00 = False; 0xFF = True
	0x00	Always at 0x00
Error Check CRC: most significant byte	0x2F	
Error Check CRC: least significant byte	0x09	Error checking: CRC algorithm

Table 10. REPLY

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x05	Force Single Coil write register
Register address: most significant byte	0x0F	
Register address: least significant byte	0xB2	Modbus index 0x0FB3 ATTENTION! Modbus indexes are addressed starting from zero, therefore register 0xFB3 is addressed as 0x0FB2
Status of the bit	0xFF	0x00 = False; 0xFF = True
	0x00	Always at 0x00
Error Check CRC: most significant byte	0x2F	
Error Check CRC: least significant byte	0x09	Error checking: CRC algorithm

- **0x06 Write Single Register**
  WRITING COMMAND
  Example: set the “set value” to 4.5 bar.

Table 11. REQUEST

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x06	Write Single Register write register
Register address: most significant byte	0x04	
Register address: least significant byte	0x1B	Modbus index 0x041C ATTENTION! Modbus indices are addressed starting from zero, therefore register 0x041C is addressed as 0x041B
Data set: most significant byte	0x00	
Data set: least significant byte	0x2D	2D Hexadecimal means 45 Decimal, therefore the “set value” parameter must be set to 4.5 bar
Error Check CRC: most significant byte	0x38	
Error Check CRC: least significant byte	0xE0	Error checking: CRC algorithm

Table 12. REPLY

Device address	0x01	Address set in the menu Connectivity parameters
Function (command)	0x06	
Register address: most significant byte	0x04	
Register address: least significant byte	0x1B	
Data set: most significant byte	0x00	
Data set: least significant byte	0x2D	2D Hexadecimal means 45 Decimal, therefore the “set value” parameter is set at 4.5 bar
Error Check CRC: most significant byte	0x38	
Error Check CRC: least significant byte	0xE0	Error checking: CRC algorithm

6. Exception codes

In the event of an error, the devices will return the byte of the requested function by setting the most significant bit at 1, followed by a byte indicating the type of exception.

For example, if the reading of some holding registers (hex 03) was requested but there is an exception, the device will return the hex code 83, followed by the byte with the exception code.

Possible exceptions are listed below:

Exception code	Meaning	Description
01	Illegal function	The requested function is not implemented in the device.
02	Illegal register address	The address requested with the function is not available.
03	Illegal data value	The entered data exceeds the allowed ranges.
06	Busy device	The device is busy and cannot perform the requested function. This exception is sent if you try to change some parameters when the inverter is in the ON state. See "Changing parameters with inverter ON".

7. Parameter modification with inverter ON

It is possible to modify some parameters even when the inverter is in the ON state, that is when the display shows “Inv: ON”.

If you try to modify a parameter for which no modification is allowed while the inverter is running ("Inv: ON"), an exception with code 6 (MODBUS), code 40 (BACNET) will be returned. To modify this parameter, the inverter must be stopped and only when the message “Inv: OFF” appears will it be possible to modify it.

8. Use in conjunction with COMBO

If RS-485 communication is used with the COMBO functionality enabled in a group of two or more machines with the control mode set to "Constant value" or "Constant value 2 set" it is important to send the pressure set **only** to

the inverter set as COMBO Master (COMBO address 0). Sending the pressure set to the inverters set as Slave (COMBO address 1, 2, etc.) will cause the COMBO Master (COMBO 0) to re-send its pressure set. Example:

	COMBO address	RS-485 address	Pressure set
Inverter A	0 (COMBO Master)	10	3 bar
Inverter B	1 (COMBO Slave)	11	3 bar
Inverter C	2 (COMBO Slave)	12	3 bar

If in this configuration a pressure set of 2 bar is sent to inverter B (COMBO 1, RS-485 address 11), inverter A (COMBO 0, RS-485 address 10) will force the set to 3 bar again.

To change the pressure set of the entire COMBO group, simply send the new pressure value **only** to inverter A (COMBO 0, RS-485 address 10). The latter will send the new set via COMBO protocol to all other connected inverters.

In the event of a fault in inverter A (COMBO Master), the COMBO system will automatically make one of the other two inverters (B or C) the new COMBO Master, changing its COMBO address.

For example, if inverter B becomes the new COMBO Master, its COMBO address will go from 1 to 0 (the RS-485 address will always remain 11), while inverter C will always remain a COMBO slave with address 2:

	COMBO address	RS-485 address	Pressure set
Inverter A			
Inverter B	0 (new COMBO Master)	11	3 bar
Inverter C	2 (COMBO Slave)	12	3 bar

It is therefore important to check, in case of failure of the COMBO Master, which inverter of the group has been replaced by reading register 5197 (MODBUS), AI 46 (BACNET) and proceeding to send the new pressure sets only to the new COMBO Master.

With the automatic replacement of the COMBO Master by the COMBO system, the RS-485 addresses **not** will be modified and will therefore remain the same.

9. Modbus RTU registers

The implemented Modbus RTU registers are divided as follows:

Register number	Log type	Data type	Available functions (dec)
From 1001 to 4000	Holding	16 bit	03, 06, 16
From 4001 to 5000	Coil	1 bit	01, 05, 15
From 5151 to 9000	Input	16 bit	04, 03
From 9001 to 10000	Discrete	1 bit	02

Holding registers 1001, 1073, 1076 and 1083 can also be read and modified as single bits by means of the corresponding Coil registers.

The Input registers 5162, 5211, 5212, 5213, 5214, 5215 can also be read as single bits by means of the corresponding Discrete registers

10. Index list

Holding Register

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AV	Description	Value range	Steps	Changeable with INV: ON
03E9	1001	03, 06, 16	AV0	Engine start / stop	0 = OFF 1 = ON		Yes

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AV	Description	Value range	Steps	Changeable with INV: ON
03EA	1002	03, 06, 16	AV1	Main / auxiliary control mode	0 = Main 1 = Auxiliary		Yes
03EC	1004	03, 06, 16	AV3	Password 1 (left digit)	0 - 9		Yes
03ED	1005	03, 06, 16	AV4	Password 1 (middle digit)	0 - 9		Yes
03EE	1006	03, 06, 16	AV5	Password 1 (right digit)	0 - 9		Yes
03F0	1008	03, 06, 16	AV7	Password 2 (left digit)	0 - 9		Yes
03F1	1009	03, 06, 16	AV8	Password 2 (middle digit)	0 - 9		Yes
03F2	1010	03, 06, 16	AV9	Password 2 (right digit)	0 - 9		Yes
041B	1051	03, 06, 16	AV50	P001 Language	0 = Italian 1 = English 2 = Deutsch 3 = Francais 4 = Espanol 5 = Polski 6 = РуссЬОй		Yes
041C	1052	03, 06, 16	AV51	P002 Set value	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
041D	1053	03, 06, 16	AV52	P003 Delta start	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
041E	1054	03, 06, 16	AV53	P004 Full scale sensor	0.1 - 999.9 [unit]	(1 – 9999) / 10	Yes
041F	1055	03, 06, 16	AV54	P005 Rated motor frequency	0 - 500 [Hz]		No
0420	1056	03, 06, 16	AV55	P006 Operating frequency	P022 Min motor frequency - P039 Max motor frequency		Yes
0421	1057	03, 06, 16	AV56	P007 Rated motor voltage	50 - 460 [V]		No
0422	1058	03, 06, 16	AV57	P008 Voltage boost	0 - 5,0 [%]	(0 – 50) / 10	No
0423	1059	03, 06, 16	AV58	P009 Ramp up time	1,0 - 300,0 [sec]	(10 – 3000) / 10	No
0424	1060	03, 06, 16	AV59	P010 Ramp down	1,0 - 300,0 [sec]	(10 – 3000) / 10	No
0425	1061	03, 06, 16	AV60	P011 PWM	1 = 2,5 [KHz] 2 = 4 [KHz] 3 = 6 [KHz] 4 = 8 [KHz] 5 = 10 [KHz]		No
0426	1062	03, 06, 16	AV61	P012 Ramp freq. min motor	1,0 - 30,0 [sec]	(10 – 300) / 10	No
0427	1063	03, 06, 16	AV62	P013 Set value 2	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
0428	1064	03, 06, 16	AV63	P014 Kp	1 - 9999		Yes
0429	1065	03, 06, 16	AV64	P015 Ki	0 - 20000		Yes
042A	1066	03, 06, 16	AV65	P016 Min alarm value	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
042B	1067	03, 06, 16	AV66	P017 Rated motor current	Model dependent		No

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AV	Description	Value range	Steps	Changeable with INV: ON
042C	1068	03, 06, 16	AV67	P018 Control mode	0 = Fix speed 1 = Constant value 2 = MPPT 3 = Fix speed 2 values 5 = External speed 7 = Constant value 2 set		No
042D	1069	03, 06, 16	AV68	P019 Offset AN1 1	0 - 99,9 [%]	(0 – 999) / 10	Yes
042E	1070	03, 06, 16	AV69	P020 Dry run cosphi	0 - 1,00	(0 – 100) / 10	Yes
042F	1071	03, 06, 16	AV70	P021 Frequency min control	P022 Min motor frequency - P039 Max motor frequency		Yes
0430	1072	03, 06, 16	AV71	P022 Min motor frequency	10 - P039 Max motor frequency		No
0431	1073	03, 06, 16	AV72	Boolean variable 2	Boolean variable definition		No
0432	1074	03, 06, 16	AV73	P039 Max motor frequency	10 - P005 Rated motor frequency		No
0433	1075	03, 06, 16	AV74	P040 Operating frequency 2	P022 Min motor frequency - P039 Max motor frequency		Yes
0434	1076	03, 06, 16	AV75	Boolean variable 1	Boolean variable definition		No
0435	1077	03, 06, 16	AV76	P057 Start delay AUX	0 - 99 [sec]		Yes
0436	1078	03, 06, 16	AV77	P058 Delta stop	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
0437	1079	03, 06, 16	AV78	P059 Value set update	1 - 99 [sec]		Yes
0438	1080	03, 06, 16	AV79	P060 Stop delay	1 - 99 [sec]		Yes
0439	1081	03, 06, 16	AV80	P061 Max alarm value	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
043A	1082	03, 06, 16	AV81	P062 Address COMBO COMBO	0 - 7		No
043B	1083	03, 06, 16	AV82	P063 Digital input 1 1,2,3,4	Definition of digital inputs		Yes
043C	1084	03, 06, 16	AV83	P079 Dig. input 2/3 delay	1 - 99 [sec]		Yes
043D	1085	03, 06, 16	AV84	P019 Offset AN1 2	0 - 99,9 [%]	(0 – 999) / 10	Yes
043E	1086	03, 06, 16	AV85	P019 Offset AN1 3	0 - 99,9 [%]	(0 – 999) / 10	Yes
043F	1087	03, 06, 16	AV86	P019 Offset AN1 4	0 - 99,9 [%]	(0 – 999) / 10	Yes
0440	1088	03, 06, 16	AV87	P083 Unit	• 0 = bar • 1 = psi • 2 = atm • 3 = m3/h • 4 = l/min • 5 = gpm • 6 = °C • 7 = °F • 8 = °K • 9 = m • 10 = cm • 11 = in • 12 = ft • 13 = %		No
0441	1089	03, 06, 16	AV88	P084 Min value sensor	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
0442	1090	03, 06, 16	AV89	P085 Control ramp	1,0 - 300,0 [sec]	(10 – 3000) / 10	Yes
0443	1091	03, 06, 16	AV90	P086 V/f linear quadratic	0 - 100 [%]		No
0444	1092	03, 06, 16	AV91	P087 Delta control	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
0445	1093	03, 06, 16	AV92	P088 Restarts delay	1 - 99 [min]		Yes
0446	1094	03, 06, 16	AV93	P089 Periodic autorun	0 - 99 [h]		Yes

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AV	Description	Value range	Steps	Changeable with INV: ON
0447	1095	03, 06, 16	AV94	P090 AN1, AN2 function	0 = Independent 1 = Selectable 2 = Difference 1-2 3 = Higher value 4 = Lower value		Yes
0448	1096	03, 06, 16	AV95	P091 Compensation	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
0449	1097	03, 06, 16	AV96	P092 Compensation set 2	0 - 999.9 [unit]	(0 – 9999) / 10	Yes
044B	1099	03, 06, 16	AV98	P094 MPPT: voltage gap	0,1 - 99,9 [V]	(1 – 999) / 10	No
044C	1100	03, 06, 16	AV99	P095 MPPT: time gap	0,1 - 3,0 [sec]	(1 – 30) / 10	No
044D	1101	03, 06, 16	AV100	P096 MPPT: frequency gap	0,1 - 99,9 [Hz]	(1 – 9999) / 10	No
044E	1102	03, 06, 16	AV101	P097 Open circuit voltage PV	150 - 850 [V]		No
044F	1103	03, 06, 16	AV102	P098 Address RS-485	1 - 247 MODBUS 1- 127 BACNET		Yes
0450	1104	03, 06, 16	AV103	P099 Baudrate	0 = 1200 [bps] 1 = 2400 [bps] 2 = 4800 [bps] 3 = 9600 [bps] 4 = 14400 [bps] 5 = 19200 [bps] 6 = 38400 [bps] 7 = 57600 [bps]		Yes
0451	1105	03, 06, 16	AV104	P100 Data format	0 = N81 1 = N82 2 = E81 3 = O81		Yes
0452	1106	03, 06, 16	AV105	P101 Alternance period	0 - 99 [h]		Yes
0453	1107	03, 06, 16	AV106	P102 Motor type	0 = Threephase asynchronous 1 = Synchronous PM		No
0454	1108	03, 06, 16	AV107	P103 Motor resistance	0,01 - 655,00 [Ohm]	(1 – 65500) / 10	No
0455	1109	03, 06, 16	AV108	P104 Motor inductance	0,01 - 655,00 [mH]	(1 – 65500) / 10	No
0456	1110	03, 06, 16	AV109	P105 FOC dynamics	30 - 500		No
0457	1111	03, 06, 16	AV110	P106 FOC speed	0 - 10		No
0458	1112	03, 06, 16	AV111	P107 Flow Measure	0 = None; 1 = Frequency proport.; 2 = AN2 4-20mA; 3 = AN3 pulse		Yes
0459	1113	03, 06, 16	AV112	P108 Rated Flow	1 – 9999 [m3/h x 10] 1 – 9999 [l/pulse x 10]		Yes
045A	1114	03, 06, 16	AV113	P109 Min stop flow	0 – 9999 [m3/h x 10]		Yes
045B	1115	03, 06, 16	AV114	P110 Full scale solarimeter	0 – 9999 [W/m2]		Yes
045C	1116	03, 06, 16	AV115	P111 Min stop irradiation	0 – 9999 [W/m2]		Yes

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AV	Description	Value range	Steps	Changeable with INV: ON
045D	1117	03, 06, 16	AV116	P112 Control mode aux	0 = Fix speed 1 = Constant value 2 = MPPT 3 = Fix speed 2 values 5 = External speed 7 = Constant value 2 set		No
045E	1118	03, 06, 16	AV117	P113 Rated motor current start/aux	Model dependent		No
045F	1119	03, 06, 16	AV118	P114 Voltage boost START/AUX	0 - 100 [%]		No
0460	1120	03, 06, 16	AV119	P115 Pipe fill ramp			Yes
0461	1121	03, 06,16	AV120	P116 Unit AN4	• 0 = bar • 1 = psi • 2 = atm • 3 = m3/h • 4 = l/min • 5 = gpm • 6 = °C • 7 = °F • 8 = °K • 9 = m • 10 = cm • 11 = in • 12 = ft • 13 = %		Yes
0462	1122	03, 06,16	AV121	P117 Full scale sensor AN4	0.1 - 999.9 [unit]	(1 – 9999) / 10	Yes
0463	1123	03, 06,16	AV122	P118 High Level Alarm	0 - 30000 [units]		Yes
0464	1124	03, 06,16	AV123	P119 Fill OFF Level	0 - 30000 [units]		Yes
0465	1125	03, 06,16	AV124	P120 Fill ON Level	0 - 30000 [units]		Yes
0466	1126	03, 06,16	AV125	P121 Low Level Alarm	0 - 30000 [units]		Yes
0467	1127	03, 06,16	AV126	P122 Min start irradiation	0 – 9999 [W/m2]		Yes
0468	1128	03, 06,16	AV127				
0469	1129	03, 06,16	AV128	P124 Output filter	• 0 = None • 1 = dV/dt • 2 = Sin		No
046A	1130	03, 06, 16	AV129	P125 Communication	• 0 = MODBUS • 1 = BACNET		Yes
046B	1131	03, 06, 16	AV130	P126 Max master	1 - 127		Yes
046C	1132	03, 06, 16	AV131	P127 AN3 function	• 0 = External set • 1 = PT100 • 2 = PT1000		Yes
046D	1133	03, 06, 16	AV132	P128 PT Warning	P130 PT restart - P129 PT alarm		Yes
046E	1134	03, 06, 16	AV133	P129 PT alarm	P128 PT Warning - 340		Yes
046F	1135	03, 06, 16	AV134	P130 PT restart	0 - P128 PT Warning		Yes
0470	1136	03, 06, 16	AV135	P131 Dry run parameter	• 0 = Cosphi • 1 = Current • 2 = Pressure		Yes

Coil Register

HEX	DEC	Functions	Description	Value 0	Value 1	Changeable with INV: ON
0FA1	4001	01, 05, 15	Engine start / stop	OFF	ON	Yes
0FB3	4019	01, 05, 15	P043 Autorestart	OFF	ON	Yes
0FB4	4020	01, 05, 15	P044 Rotation sense	Hours	Counterclockwise	No
0FB5	4021	01, 05, 15	P045 Pump DOL 1	OFF	ON	No
0FB6	4022	01, 05, 15	P046 Pump DOL 2	OFF	ON	No

HEX	DEC	Functions	Description	Value 0	Value 1	Changeable with INV: ON
0FB7	4023	01, 05, 15	P047 External set enabling	OFF	ON	Yes
0FB9	4025	01, 05, 15	P049 COMBO	OFF	ON	No
0FBA	4026	01, 05, 15	P050 Alternance	OFF	ON	No
0FBF	4031	01, 05, 15	P055 COMBO synchrony	OFF	ON	No
0FC0	4032	01, 05, 15	P056 PI control	Direct	Reverse	No
0FC1	4033	01, 05, 15	BTLE connection	OFF	ON	Yes
0FC2	4034	01, 05, 15	P024 EEPROM write	OFF	ON	Yes
0FC3	4035	01, 05, 15	START / STOP lock through keyboard	OFF	ON	Yes
0FD1	4049	01, 05, 15	P063 Digital input 1 1	Normally closed	Normally open	Yes
0FD2	4050	01, 05, 15	P063 Digital input 1 2	Normally closed	Normally open	Yes
0FD3	4051	01, 05, 15	P063 Digital input 1 3	Normally closed	Normally open	Yes
0FD4	4052	01, 05, 15	P063 Digital input 1 4	Normally closed	Normally open	Yes

Input Register

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AI	Description	Value range	Steps
141F	5151	04, 03	AI0	Language	0 = Italian 1 = English 2 = Deutsch 3 = Francais 4 = Espanol 5 = Polski 6 = РуссЮй	
1420	5152	04, 03	AI1	Measured value	0 - 999.9 [unit]	(0 – 9999) / 10
1421	5153	04, 03	AI2	Set value (updated)	0 - 999.9 [unit]	(0 – 9999) / 10
1422	5154	04, 03	AI3	Bus voltage (DC)	0 - 999 [V]	
1423	5155	04, 03	AI4	Motor current	0 - 268,0 [A]	(0 – 2680) / 10
1424	5156	04, 03	AI5	Frequency	0 - 999,9 [Hz]	(0 – 9999) / 10
1425	5157	04, 03	AI6	Power	0 - 65500 [W]	W * 100
1426	5158	04, 03	AI7	Module temperature	0 - 100 [°C]	
1427	5159	04, 03	AI8	PCB temperature / Input current	0 - 100 [°C] 0 - 25,5 [A]	(0 – 255) /10
1428	5160	04, 03	AI9	Motor power factor	0 - 1,00	(0 – 100) / 100
1429	5161	04, 03	AI10	State	Definition of Status byte	
142A	5162	04, 03	AI11	Alarm L	Alarm definition (low word)	
142B	5163	04, 03	AI12	Saved alarm 1 (last)	0 – 31 (if 65535 no alarms saved)	
142C	5164	04, 03	AI13	Saved alarm 2	0 – 31 (if 65535 no alarms saved)	
142D	5165	04, 03	AI14	Saved alarm 3	0 – 31 (if 65535 no alarms saved)	

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AI	Description	Value range	Steps
142E	5166	04, 03	AI15	Alarm saved 4	0 – 31 (if 65535 no alarms saved)	
142F	5167	04, 03	AI16	Alarm saved 5	0 – 31 (if 65535 no alarms saved)	
1430	5168	04, 03	AI17	Alarm saved 6	0 – 31 (if 65535 no alarms saved)	
1431	5169	04, 03	AI18	Alarm saved 7	0 – 31 (if 65535 no alarms saved)	
1432	5170	04, 03	AI19	Alarm saved 8	0 – 31 (if 65535 no alarms saved)	
1433	5171	04, 03	AI20	Power hours (most significant word)	0 - 2^32 [sec]	
1434	5172	04, 03	AI21	Power hours (least significant word)		
1435	5173	04, 03	AI22	Inverter life (most significant word)	0 - 2^32 [sec]	
1436	5174	04, 03	AI23	Inverter life (least significant word)		
1437	5175	04, 03	AI24	Engine life (most significant word)	0 - 2^32 [sec]	
1438	5176	04, 03	AI25	Engine life (least significant word)		
1439	5177	04, 03	AI26	Frequency range 1 (most significant word)	0 - 2^32 [sec]	
143A	5178	04, 03	AI27	Frequency range 1 (least significant word)		
143B	5179	04, 03	AI28	Frequency range 2 (most significant word)	0 - 2^32 [sec]	
143C	5180	04, 03	AI29	Frequency range 2 (least significant word)		
143D	5181	04, 03	AI30	Frequency range 3 (most significant word)	0 - 2^32 [sec]	
143E	5182	04, 03	AI31	Frequency range 3 (least significant word)		
143F	5183	04, 03	AI32	Frequency range 4 (most significant word)	0 - 2^32 [sec]	
1440	5184	04, 03	AI33	Frequency range 4 (least significant word)		
1441	5185	04, 03	AI34	Total range (most significant words)	(0 – 99999999) [m3 x10]	
1442	5186	04, 03	AI35	Total range (least significant words)		
1443	5187	04, 03	AI36	Current flow	0 – 9999 [m3/h x10]	
1444	5188	04, 03	AI37	Irradiation	0 – 9999 [W/m2]	
1445	5189	04, 03	AI38	MAC address (word 1, MSW)	2 bytes (ASCII character)	
1446	5190	04, 03	AI39	MAC address (word 2, MSW)	2 bytes (ASCII character)	
1447	5191	04, 03	AI40	MAC address (word 3, MSW)	2 bytes (ASCII character)	
1448	5192	04, 03	AI41	MAC address (word 4, MSW)	2 bytes (ASCII character)	
1449	5193	04, 03	AI42	MAC address (word 5, MSW)	2 bytes (ASCII character)	
144A	5194	04, 03	AI43	MAC address (word 6, MSW)	2 bytes (ASCII character)	
144D	5197	04, 03	AI46	COMBO address	0 – 7 (255 = COMBO OFF)	
144E	5198	04, 03	AI47	SW ctrl / LCD version		
144F	5199	04, 03	AI48	SW pw / INV version		
1450	5200	04, 03	AI49	Model Code (tens + units)		
1451	5201	04, 03	AI50	Rated motor voltage max		
1452	5202	04, 03	AI51	Motor rated current max		
1453	5203	04, 03	AI52	PV open circuit voltage max		
1454	5204	04, 03	AI53	HW version		
1455	5205	04, 03	AI54	Model Code (hundreds + thousands)		
1457	5207	04, 03	AI56	AN1 value (analog input 1)	0 - 32736	
1458	5208	04, 03	AI57	AN2 value (analog input 2)	0 - 32736	
1459	5209	04, 03	AI58	AN3 value (analog input 3)	0 - 32736	

MODBUS HEX	MODBUS DEC	MODBUS Functions	BACnet AI	Description	Value range	Steps
145A	5210	04, 03	AI59	AN4 value (analog input 4)	0 - 32736	
145B	5211	04, 03	AI60	Status of digital inputs	Definition of digital inputs	
145C	5212	04, 03	AI61	State relays	Status Relays definition	
145D	5213	04, 03	AI62	Alarm H	Alarm definition (high word)	
145E	5214	04, 03	AI63	Warning L	Definition of warning (low word)	
145F	5215	04, 03	AI64	Warning H	Warning definition (high word)	
1460-1467	5216-5223	04, 03	AI65-AI72	Warning saved 1-8	0 – 31 (if 65535 no warning saved)	
1468	5224	04, 03	AI73	Measured value AN4	0 - 999.9 [unit]	(0 – 9999) / 10
1469	5225	04, 03	AI74	Input current	0 - 99,9 A	
146A	5226	04, 03	AI75	Starter/auxiliary motor current (single-phase 3-wire motor)	0 - 99,9 A	
146B	5227	04, 03	AI76	Rectified input voltage	0 - 999 V	
146C	5228	04, 03	AI77	PTC temperature	0 - 999 °C / °F	
146D-1474	5229-5236	04, 03	AI78-AI85	Alarm saved 9-16	0 – 31 (if 65535 no alarm saved)	
1475-147C	5237-5244	04, 03	AI86-AI93	Warning saved 9-16	0 – 31 (if 65535 no warning saved)	
147D-149C	5245-5276	04, 03	AI94-AI125	Alarm Inverter Hours 1-16 (MSW) Alarm Inverter Hours 1-16 (LSW)	0 – 2^{32} sec 0 – 2^{32} sec	
149D-14BC	5277-5308	04, 03	AI126-AI157	Inverter warning hours 1-16 (MSW) Inverter warning hours 1-16 (LSW)	0 – 2^{32} sec 0 – 2^{32} sec	
14BD	5309	04, 03	AI158	Minor firmware versions (ctrl/LCD + pw/INV)	4 MSB: pw/INV 4 LSB: ctrl/LCD	
14BE	5310	04, 03	AI159	ctrl/LCD bootloader version		
14BF	5311	04, 03	AI160	Bootloader version pw/INV		
14C0	5312	04, 03	AI161	IOT firmware version		
14C1	5313	04, 03	AI162	Minor IOT firmware version		
14C2	5314	04, 03	AI163	IoT hardware version		
14C3	5315	04, 03	AI164	IOT bootloader version		
14C4	5316	04, 03	AI165	Display firmware version		
14C5	5317	04, 03	AI166	Minor display firmware version		
14C6	5318	04, 03	AI167	Display hardware version		
14C7	5319	04, 03	AI168	Display bootloader version		
14C8-14D1	5320-5329	04, 03	AI169-AI178	Inverter serial number word (0-9)	big endian	

Discrete Register

HEX	DEC	Functions	Description	Value 0	Value 1
2329	9001	02	A01 Overcurrent motor	Alarm deactivated	Active alarm
232A	9002	02	A02 Sensor fault	Alarm deactivated	Active alarm
232B	9003	02	A03 Over temperature inverter	Alarm deactivated	Active alarm
232C	9004	02	A04 Dry run	Alarm deactivated	Active alarm
232D	9005	02	A05 Under voltage	Alarm deactivated	Active alarm
232E	9006	02	A06 Over voltage	Alarm deactivated	Active alarm
232F	9007	02	A07 Max value alarm	Alarm deactivated	Active alarm
2330	9008	02	A08 Locked rotor	Alarm deactivated	Active alarm
2331	9009	02	A09 Overload inverter	Alarm deactivated	Active alarm

HEX	DEC	Functions	Description	Value 0	Value 1
2332	9010	02	A10 IGBT trip alarm	Alarm deactivated	Active alarm
2333	9011	02	A11 No load	Alarm deactivated	Active alarm
2334	9012	02	A12 Address error	Alarm deactivated	Active alarm
2335	9013	02	A13 No communication	Alarm deactivated	Active alarm
2336	9014	02	A14 Min value alarm	Alarm deactivated	Active alarm
2337	9015	02	A15 Keyboard fault	Alarm deactivated	Active alarm
2338	9016	02	A16 CPU alarm	Alarm deactivated	Active alarm
2339	9017	02	A17 Brake alarm	Alarm deactivated	Active alarm
233A	9018	02	A18 Brake temperature alarm	Alarm deactivated	Active alarm
233B	9019	02	A19 Out of step	Alarm deactivated	Active alarm
233C	9020	02	A20 Input phase loss	Alarm deactivated	Active alarm
233D	9021	02	A21 LOW LEVEL	Alarm deactivated	Active alarm
233E	9022	02	A22 ALL. TEMP. MOT.	Alarm deactivated	Active alarm
2349	9033	02	Digital input IN1	Closed contact	Contact open
234A	9034	02	IN2 digital input	Closed contact	Contact open
234B	9035	02	IN3 digital input	Closed contact	Contact open
234C	9036	02	Digital input IN4	Closed contact	Contact open
2359	9049	02	Relay 1 "STATUS"	Relay off	Active relay
235A	9050	02	Relay 2 "ALARM"	Relay off	Active relay
235B	9051	02	Relay 3 "DOL_1"	Relay off	Active relay
235C	9052	02	Relay 4 "DOL_2"	Relay off	Active relay
2369	9065	02	W01 Digital input active 1	Warning disabled	Active warning
236A	9066	02	W02 Digital input active 2	Warning disabled	Active warning
236B	9067	02	W03 Digital input active 3	Warning disabled	Active warning
236C	9068	02	W04 Digital input active 4	Warning disabled	Active warning
2379	9081	02	W05 Minimum irradiation	Warning disabled	Active warning
237A	9082	02	W18 Minimum flow	Warning disabled	Active warning
237B	9083	02	W19 Flow switch active	Warning disabled	Active warning
237C	9084	02	W20 Temp. derate	Warning disabled	Active warning
237E	9086	02	W22 EEPROM COM.	Warning disabled	Active warning
237F	9087	02	W23 EEPROM fault	Warning disabled	Active warning
2380	9088	02	W24 Low PV energy	Warning disabled	Active warning
2381	9089	02	W25 Alarm slave	Warning disabled	Active warning
2382	9090	02	W26 No water	Warning disabled	Active warning
2383	9091	02	W27 START/STOP block	Warning deactivated	Warning active
2384	9092	02	W28 HIGH LEVEL	Warning deactivated	Warning active
2385	9093	02	W29 FREQ. RESTARTS	Warning deactivated	Warning active
2386	9094	02	W30 MOT. TEMP. DERATE	Warning deactivated	Warning active
2387	9095	02	W31 VOLT. DERATE	Warning deactivated	Warning active

11. Definitions

11.1. Boolean variables definition

Boolean (or bit_array) variables are words in which each bit has a precise meaning. A machine parameter can have only two values: in the case of ON / OFF, 1 indicates ON and 0 means OFF; in the presence of the sign, 1 indicates the negative sign and 0 the positive sign; for other cases, refer to the respective string associations.

Structure of bit_array_1 (Modbus index DEC = 1076):

Bit [2] = P043 Autorestart (0 = OFF, 1 = ON)

Bit [3] = P044 Rotation sense (0 = ->, 1 = <-)

Bit [4] = P045 Pump DOL 1 (0 = OFF, 1 = ON)

Bit [5] = P046 Pump DOL 2 (0 = OFF, 1 = ON)
Bit [6] = P047 External set enabling (0 = OFF, 1 = ON)
Bit [7] = Minimum alarm value sign (0 = positive value, 1 = negative value)
Bit [8] = P049 COMBO (0 = OFF, 1 = ON)
Bit [9] = P050 Alternance (0 = OFF, 1 = ON)
Bit [10] = Compensation sign. Set 2 (0 = positive value, 1 = negative value)
Bit [11] = Compensation sign (0 = positive value, 1 = negative value)
Bit [12] = Set value sign 2 (0 = positive value, 1 = negative value)
Bit [13] = Set value sign (0 = positive value, 1 = negative value)
Bit [14] = P055 COMBO synchrony (0 = OFF, 1 = ON)
Bit [15] = P055 COMBO synchrony (0 = direct, 1 = inverse)
[it] **Struttura del bit_array_2 (Indice Modbus DEC = 1073):**
Bit [0] = BTLE connection (0 = OFF, 1 = ON)
Bit [1] = P024 EEPROM write (0 = OFF, 1 = ON)
The bits not present are not used

11.2. Definition of digital inputs

The digital inputs are configured as "normally closed" or "normally open" through the single bits that make up the word associated with the corresponding parameter.

Structure of parameters Digital input 1,2,3,4 (Modbus index DEC = 1083):

Bit [0] = Digital input IN1 (0 = Normally closed, 1 = Normally open)
Bit [1] = Digital input IN2 (0 = Normally closed, 1 = Normally open)
Bit [2] = Digital input IN3 (0 = Normally closed, 1 = Normally open)
Bit [3] = Digital input IN4 (0 = Normally closed, 1 = Normally open)
Bit [8] = Manual reset of digital input IN1 (0 = Enable, 1 = Disable); Inverter model dependent
Bit [9] = Manual reset of digital input IN2 (0 = Enable, 1 = Disable); Inverter model dependent
Bit [10] = Manual reset of digital input IN3 (0 = Enable, 1 = Disable); Inverter model dependent
Bit [11] = Manual reset of digital input IN4 (0 = Enable, 1 = Disable); Inverter model dependent

11.3. Status byte definition

This byte allows knowing in real time the machine operating status, and at the same time it shows if it is running as "Stand-alone" or in a COMBO group (the top byte of the word is currently not used).

Association states (Modbus Index DEC = 161):

Parameter	Relative strings
Status (lowercase)	0: inverter OFF, motor off, no alarm (normal status) 1: inverter OFF, motor off, alarm active 2: inverter ON, motor off, stand-by 3: inverter ON, motor off, no water 4: Inverter ON, motor off, digital input active 5: Inverter OFF, motor ON, ramp down (Stop command) 6: Inverter ON, motor ON, running 7: inverter disabled, motor ON, ramp down (alarm active) 8: inverter ON, motor ON, ramp down (stand-by) 9: inverter ON, motor ON, ramp down (no water) 10: inverter ON, motor ON, ramp down (digital input active)
Status (uppercase)	<127: Independent inverter (no address) > 127: COMBO inverter (valid address)

11.4. Alarm definition

The alarm is a word in which each bit indicates in real time the presence of a particular alarm, suitably associated with this bit.

DEC = 5162 - Alarms

Parameter	Associated strings	Associated value for identification in the alarm history
Alarm	bit0: A01 Overcurrent motor	0
	bit1: A02 Sensor fault	1
	bit2: A03 Over temperature inverter	2
	bit3: A04 Dry run	3
	bit4: A05 Under voltage	4
	bit5: A06 Over voltage	5
	bit6: A07 Max value alarm	6
	bit7: A08 Locked rotor	7
	bit8: A09 Overload inverter	8
	bit9: A10 IGBT trip alarm	9
	bit10: A11 No load	10
	bit11: A12 Address error	11
	bit12: A13 No communication	12
	bit13: A14 Min value alarm	13
	bit14: A15 Keyboard fault	14
	bit15: A16 CPU alarm	15

DEC = 5213 - Alarms

Parameter	Associated strings	Associated value for identification in the alarm history
Alarm	bit0: A17 Brake alarm	16
	bit1: A18 Brake temperature alarm	17
	bit2: A19 Out of step	18
	bit3: A20 Input phase loss	19
	bit4: A21 LOW LEVEL	20
	bit5: A22 ALL. TEMP. MOT.	21

11.5. Warnings definition

DEC = 5214 - Warning

Parameter	Associated strings	Associated value for identification in the warning history
Warning	bit0: W01 Digital input active 1	0
(LOW word)	bit1: W02 Digital input active 2	1
Warning	bit2: W03 Digital input active 3	2
(HIGH word)	bit3: W04 Digital input active 4	3

DEC = 5215 - Warning

Parameter	Associated strings	Associated value for identification in the warning history
Warning	bit0: W05 Minimum irradiation	16
(LOW word)	bit1: W18 Minimum flow	17
Warning	bit2: W19 Flow switch active	18
(HIGH word)	bit3: W20 Temp. derate	19
	bit5: W22 EEPROM COM.	21
	bit6: W23 EEPROM fault	22
	bit7: W24 Low PV energy	23
	bit8: W25 Alarm slave	24
	bit9: W26 No water	25
	bit10: W27 START/STOP block	26
	bit11: W28 HIGH LEVEL	27
	bit12: W29 FREQ. RESTARTS	28
	bit13: W30 MOT. TEMP. DERATE	29
	bit14: W31 VOLT. DERATE	30

11.6. Definition of frequency range 1, 2, 3, 4

The frequency intervals are four symmetrical intervals comprised between the maximum and the minimum frequency set in the motor parameters.

Example:

Maximum motor frequency = 50 Hz and Minimum motor frequency = 30 Hz

Frequency range = (maximum motor frequency - minimum motor frequency) / 4 = (50 - 30) / 4 = 5 Hz

Thus:

Range (1): from 30Hz to 35Hz

Range (2): from 35Hz to 40Hz

Range (3): from 40Hz to 45Hz

Range (4): from 45Hz to 50Hz

11.7. Definition of digital input status

The "digital inputs" status is a word that allows knowing in real time the logical status of the digital inputs of the machine, regardless of their NC or NO configuration.

Structure of the digital input status (Modbus Index DEC = 5211):

Bit [0] = Digital input IN1 (0 = contact closed, 1 = contact open)

Bit [1] = Digital input IN2 (0 = contact closed, 1 = contact open)

Bit [2] = Digital input IN3 (0 = contact closed, 1 = contact open); Inverter model dependent

Bit [3] = Digital input IN4 (0 = contact closed, 1 = contact open); Inverter model dependent

The other bits of the word, from bit [4] to bit [15], are read as 0.

11.8. Definition of relay status

The relay status is a word that allows knowing in real time the logical state of the digital outputs (relays).

Structure of the relay status (Modbus Index DEC = 5212):

Bit [0] = Relay 1 "STATUS" (0 = Disabled, 1 = Active)

Bit [1] = Relay 2 "ALARM" (0 = disabled, 1 = active)

Bit [2] = Relay 3 "DOL_1" (0 = Disabled, 1 = Active); Inverter model dependent

Bit [3] = Relay 4 "DOL_2" (0 = Disabled, 1 = Active); Inverter model dependent

The other bits of the word, from bit [4] to bit [15], are read as 0.