SP104

Technical Specifications for Modbus Area Mapping

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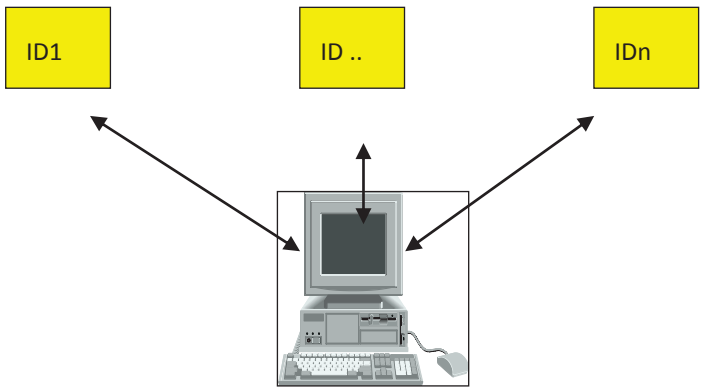
1. Introduction

Modbus is a field bus that can be used to interface several types of devices and to read/write analogue values and digital statuses. The type of connection determines the maximum number of connections that can be used. Modbus devices can be divided into master and slave devices (or clients). Master devices can query slaves while clients can only acquire statuses and values from external equipment. Modbus is generally used in industrial plants and specifically in automated installations where temperature, pressure and other types of sensors provide values that can be read and processed by masters. Data is stored using memory areas in which each value is stored at a specific address on the corresponding slave.

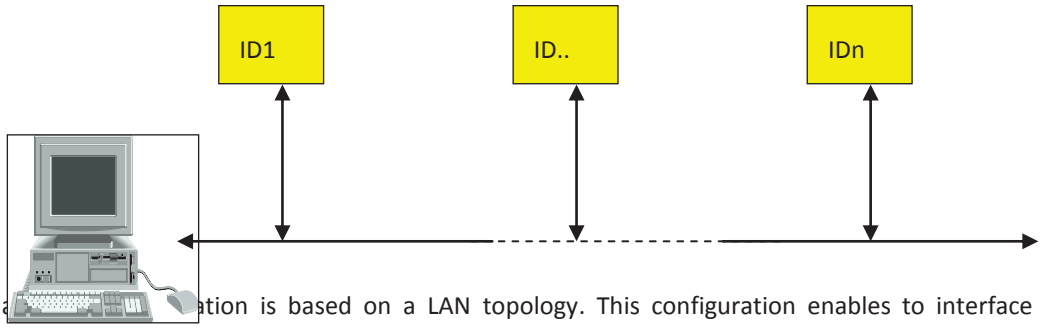
2 Connections

Request a MODBUS connection kit from Siel for Modbus communications for **Lopower**, **SafePower** and **Flexipower** devices delivered before March 2008 only. The kit is not required for all other SIEL devices since they come with a Modbus protocol interface.

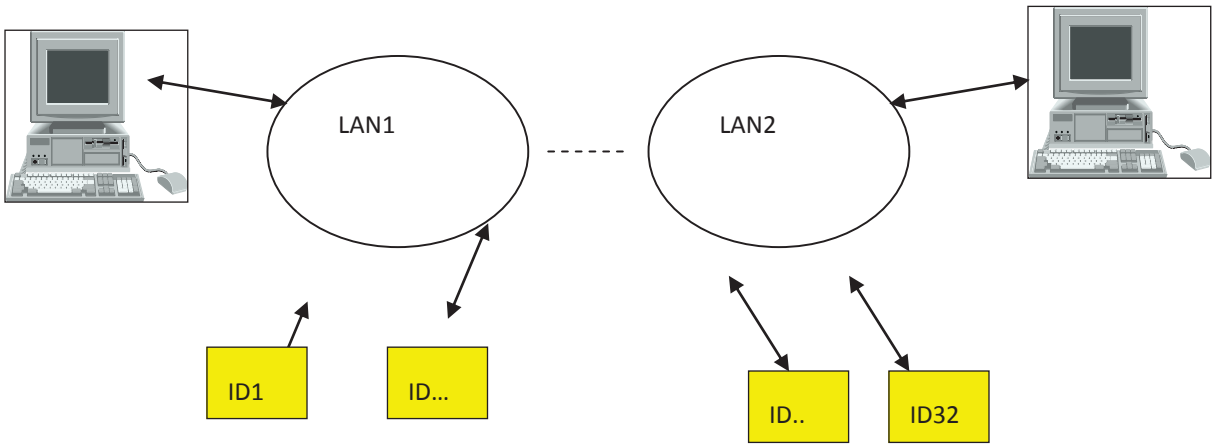
The MODBUS connection kit supplied by SIEL enables to connect a maximum of 16 devices using the OCS3 protocol and a dual optical fiber connection. To simplify the description of components, we shall call Modbus side the section that interfaces with the Modbus protocol through the RS232 or RS485 port or the LAN for the MODBUS/TCP protocol; and Device Side the section that specifically connects to Siel's equipment. Connections on the Modbus side generally use the RS232 port, which enables to connect one Modbus client at a time to each serial port or, in other words, to create a star connection (Figure 1).



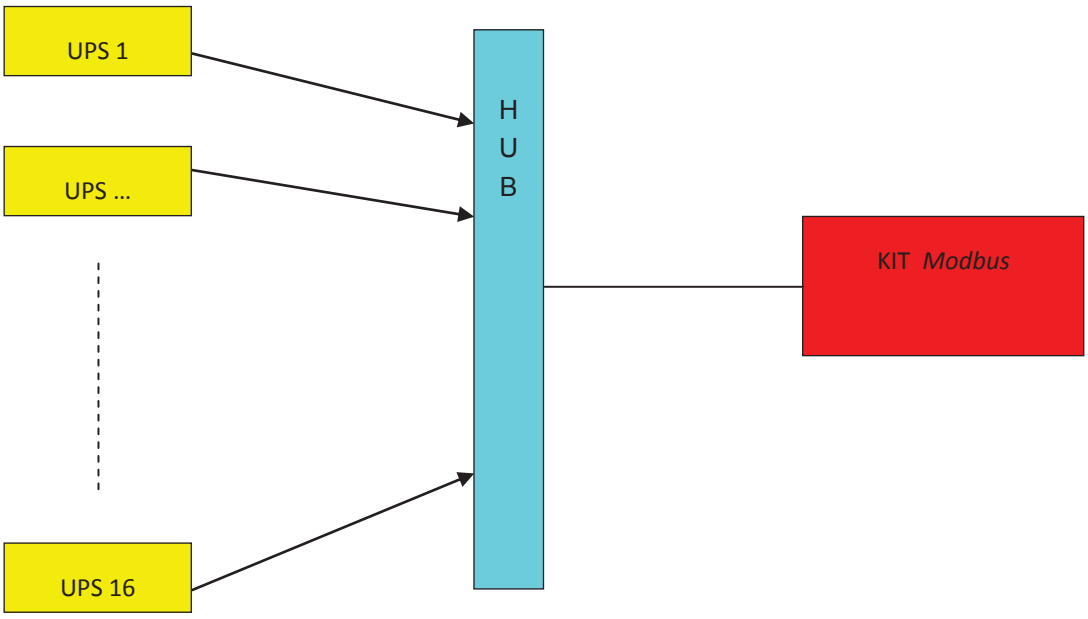
The second configuration uses the RS485 port that, unlike port RS232, enables to connect a maximum of 32 devices and therefore to connect a larger number of clients to each RS485 port (Figure 2).



The third a ation is based on a LAN topology. This configuration enables to interface a Modbus client for each valid address of the LAN, which means that it is possible to take advantage of the expansibility of the LAN (Figure 3).



The connections on the Device side are made using a dual optical fiber cable for each device and by connecting the hub to the Modbus KIT. To be able to connect several devices (by default a maximum of 16 are supported), each UPS shall have to have a unique code that identifies it univocally within the OCS3 protocol.



3 Modbus commands

3.1 Modbus area reading commands

The structure of the Modbus protocol changes according to the type of connection used; if RS232 or RS485 are used, the frame sent by the master has the following format:

Id	*Value*	*Meaning*
1	xx	Slave address used for communications
2	***03***	Function to be run – 03 = Register read request
3	xx	Start address H byte
4	xx	Start address L byte
5	xx	H byte of the number of registers that have to be read
6	xx	L byte of the number of registers that have to be read
7	xx	H byte of the CRC16 of the previously sent values
8	xx	L byte of the CRC16 of the previously sent values

The "client" responds with a message containing the requested register data, two bytes for each requested register. Following is the frame sent as the response:

Id	*Value*	*Meaning*
1	xx	Slave address (the proper address)
2	***03***	Function to be run – 03 = Register read request
3	xx	Number of bytes sent – 2 bytes per requested address
4	xx	H byte in the first requested register
5	xx	L byte in the first requested register
6	xx	H byte in the nth requested register
7	xx	L byte in the nth requested register
x	xx	H byte in the last requested register
x	xx	L byte in the last requested register
x	xx	H byte of the CRC16 of the previously sent values
x	xx	L byte of the CRC16 of the previously sent values

3.2 Modbus area reading commands

Only for Fuel Cell Inverter there are some writeable Registers through a Modbus Function **Preset Single Register (07)** used to write one single Register at a time.

The frame sent by the master has the following format:

Id	*Value*	*Meaning*
1	xx	Slave address used for communications
2	***06***	Function to be run – 06 = Single register read request
3	xx	H byte of the address to be written
4	xx	L byte of the address to be written
5	xx	H byte of the value to be assigned
6	xx	L byte of the value to be assigned
7	xx	H byte of the CRC16 of the previously sent values
8	xx	L byte of the CRC16 of the previously sent values

Once the sent variable is edited, the client responds with an identical frame. Following is the frame sent as the response:

Id	*Value*	*Meaning*
1	xx	Slave address (the proper address)
2	***06***	Function run – 06 = Single register write request
3	xx	H byte of the written address
4	xx	L byte of the written address
5	xx	H byte of the assigned value
6	xx	L byte of the assigned value
7	xx	H byte of the CRC16 of the previously sent values
8	xx	L byte of the CRC16 of the previously sent values

If the address is wrong or if the value is out of the predefined range, the client will answer with an exception.

4 Communication port settings

The communication port used to connect the device must be set as follows:

- **Baudrate:** 9600
- **Data Bit:** 8
- **Parity:** None
- **Stop bit:** 1

5 Modbus area mapping

5.1 Generic Modbus Area Mapping

Modbus area for SIEL/SIAC devices is a set of 30 16 bit Registers (Holding Register) in the range 2000- 2029 (in Modbus protocol) or 2001-2030 (in JBUS protocol). **Only in case** of old generation UPS (Safepower, Lopower and Flexipower delivered before March 2008), it's mandatory to use a Modbus kit (J0000171) and the Modbus area available to read values are divided into a 30 16-bit registers (Holding Register) divided as follows:

SIEL Device Number	Initial register	Final register	Notes
1	2001	2030	
2	2031	2060	
3	2061	2090	
4	2091	2120	
5	2121	2150	
6	2151	2180	
7	2181	2210	
8	2211	2240	
9	2241	2270	KIT MODBUS J0000171
10	2271	2300	
11	2301	2330	
12	2331	2360	
13	2361	2390	
14	2391	2420	
15	2421	2450	
16	2451	2480	

5.2 Soleil DSP-DSPX Modbus Area Mapping

Modbus area for SIEL/SIAC Soleil DSP and Soleil DSPX devices is a set of 37 16 bit Registers (Holding Register) in the range 2000- 2029 (in Modbus protocol) or 2001-2037 (in JBUS protocol).

Registers in the 2029 to 2035 range (Modbus protocol) can be written using the Modbus single write command (06).

To implement Smart Grid control, write parameters are found in registers 2030 – 2038.

6 Modbus area mapping table

Each device has a table with the values that can be obtained from single registers:

6.1 TABLE FOR SIEL UPS UNITS

Register	Content	Description
1	VRN	Star output voltage for phase R (V)
2	VSN	Star output voltage for phase S (V)
3	VTN	Star output voltage for phase T (V)
4	IRout	Output current for phase R (A)
5	ISout	Output current for phase S (A)
6	ITout	Output current for phase T (A)
7	Vbatt	Battery voltage (V)
8	Ibatt	Battery current (A)
9	Fout	Output frequency (0.1 Hz)
10	Auton	Autonomy %
11	Tbat	Battery temperature (°C)
12	VAR	Star input voltage for phase R (V)
13	VAS	Star input voltage for phase S (V)
14	VAT	Star input voltage for phase T (V)
15	IAR	Input current for phase R (A)
16	IAS	Input current for phase S (A)
17	IAT	Input current for phase T (A)
18	PA	Active power (KW)
19	Pnom	Rated power (KVA)
20	Alarms - Statuses 1	Bit0 Switching blocked Bit1 Static changeover switch fault Bit2 Rectifier fault Bit3 Rectifier overtemperature Bit4 Inverter overload Bit5 Battery alarm Bit6 Battery low Bit7 Inverter overtemperature

		Bit8 Load switched to backup supply Bit9 Backup supply OK Bit10 Rectifier enabled Bit11 Battery OK Bit12 Load switched to inverter Bit13 Inverter synchronized with backup supply Bit14 Inverter OK Bit15 Rectifier mains unsuitable (Setting the bit to 1 validates the description)
21	Alarms - Statuses 2	Reserved
22	Spare	Reserved
23	Spare	Reserved
24	Spare	Reserved
25	Spare	Reserved
26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	EQUIP	Type of equipment
30	UPS type	Type of UPS

6.2 TABLE FOR SIEL RECTIFIERS

The table below describes the configuration of a rectifier with two braches; if the rectifier has one branch only, see the description of rectifier 1.

Register	Content	Description
1	Tbatt 1	Temperature of branch 1 battery (°C)
2	Tbatt 2	Temperature of branch 2 battery (°C)
3	Iout 1	Output current of branch 1 (A)
4	Iout 2	Output current of branch 2 (A)
5	Ibatt 1	Current of branch 1 battery (A)
6	Ibatt 2	Current of branch 2 battery (A)
7	VINR1_R	Input voltage of rectifier 1, phase R (V)
8	VINR1_S	Input voltage of rectifier 1, phase S (V)
9	VINR1_T	Input voltage of rectifier 1, phase T (V)
10	VINR2_R	Input voltage of rectifier 2, phase R (V)
11	VINR2_S	Input voltage of rectifier 2, phase S (V)
12	VINR2_T	Input voltage of rectifier 2, phase T (V)
13	VoutR1	Rectifier output voltage 1 (V)
14	VoutR2	Rectifier output voltage 2 (V)
15	ALMSTR1	Bit0 Battery 2 low Bit1 External limitation on rectifier 1 Bit2 External limitation on rectifier 2 Bit3 Rectifier 1 in fast charge Bit4 Rectifier 2 in fast charge Bit5 Rectifier 1 in buffer mode Bit6 Rectifier 2 in buffer mode Bit7 Rectifier 1 running Bit8 Rectifier 2 running Bit9 Battery 1 low Bit10 Current limitation on rectifier 1 Bit11 Current limitation on rectifier 2 Bit12 Bit13

		Bit14 Bit15 (Setting the bit to 1 validates the description)
16	ALMSTR2	Bit0 Max output voltage of rectifier 2 Bit1 No mains supply Bit2 Overtemperature on rectifier 2 Bit3 Max output voltage of rectifier 1 Bit4 Battery alarm for rectifier 1 Bit5 Battery alarm for rectifier 2 Bit6 Overtemperature on rectifier 1 Bit7 Static stop for rectifier 1 Bit8 Static stop for rectifier 2 Bit9 Low system insulation Bit10 Varistor fuses tripping Bit11 BATTERY TEST FAILED Bit12 Bit13 Bit14 Bit15 (Setting the bit to 1 validates the description)
17	ALMSTR3	Bit0 Operation from power generator Bit1 Battery temperature sensor fault, rectifier 1 Bit2 Battery temperature sensor fault, rectifier 2 Bit3 Opening of electric protections, rectifier 1 Bit4 Opening of electric protections, rectifier 2 Bit5 Opening of disconnecting switch/fuse, battery 1 Bit6 Opening of disconnecting switch/fuse, battery 2 Bit7 Common protections tripped Bit8 Opening of output on rectifier 2 Bit9 Low voltage on loads Bit10 Opening of output, rectifier 1 Bit11 Closing of continuity teleruptor Bit12 Low battery discharge teleruptor tripping Bit13

		Bit14 Bit15 (Setting the bit to 1 validates the description)
18	ALMSTR4	Reserved
19	ALMSTR5	Reserved
20	ALMSTR6	Reserved
21	ALMSTR7	Reserved
22	ALMSTR8	Reserved
23	Spare	Reserved
24	Spare	Reserved
25	Spare	Reserved
26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	EQUIP	Type of equipment
30	RECT type	Type of RECTIFIER

6.3 TABLE FOR SIEL SOLAR CONVERTERS

Register	Content	Description
1	Statuses of alarms 1	Bit 0 None Bit 1 IGBT inverter desaturation Bit 2 Inverter current fast limitation Bit 3 Inverter fault Bit 4 Mains frequency out of range Bit 5 Mains voltage out of range Bit 6 Overtemperature inside machine Bit 7 Fault on inverter IIC microprocessor Bit 8 Closed Mains contactor. Bit 9 Desaturation of IGBT DC/DC converter Bit 10 Fast DC/DC converter current limitation Bit 11 DC/DC converter disabled Bit 12 Insufficient irradiation Bit 13 1=50Hz 0=60Hz Bit 14 Fault on DC/DC converter IIC microprocessor Bit 15 1=MAN 0=AUT (Setting the bit to 1 validates the description)
2	Statuses of alarms 2	Bit 0 Loss of insulation Bit 1 AUX1 Bit 2 AUX2 Bit 3 AUX3 Bit 4 High internal temperature Bit 5 Emergency Power Off Bit 6 Unit enabled Bit 7 Presence of operator Bit 8 Bit 9 Bit 10 Bit 11 Bit 12

		Bit 13 Bit 14 Bit 15 (Setting the bit to 1 validates the description)
3	VinRN	Star mains voltage for phase R (V)
4	VinSN	Star mains voltage for phase S (V)
5	VinTN	Star mains voltage for phase T (V)
6	IR	Mains current for phase R (A)
7	IS	Mains current for phase S (A)
8	IT	Mains current for phase T (A)
9	Pout	Power transmitted to mains (KW)
10	T_amb	Internal temperature (°C)
11	T_cell	Temperature of cells (°C)
12	Vcell	Voltage of cells (V)
13	Icell	Current of cells (A)
14	Irr_or.	Horizontal irradiation (W/m^2)
15	Irr_inc.	Slanted irradiation (W/m^2)
16	E_KW	Energy (tenths of KWh)
17	E_MW	Energy (MWh)
18	H_USE_H	Hours of operation (hours), upper section
19	H_USE_L	Hours of operation (hours), lower section
20	Spare	Reserved
21	Spare	Reserved
22	Spare	Reserved
23	Spare	Reserved
24	Spare	Reserved
25	Spare	Reserved
26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	Spare	Reserved
30	Spare	Reserved

6.4 TABLE FOR SIEL SOLAR DSP – DSPX INVERTERS

Register	Content	Description
1	Statuses of alarms 1	Bit 0 AC Power limitation for overtemperature Bit 1 Desaturation of IGBT inverter Bit 2 Inverter overcurrent Bit 3 Inverter Fault Bit 4 Mains frequency out of range Bit 5 Mains voltage out of range Bit 6 Overtemperature inside machine Bit 7 Signalling-DSP board communication fault Bit 8 Mains contactor energized Bit 9 Bit 10 Bit 11 Bit 12 Insufficient irradiation Bit 13 1=50Hz 0=60Hz Bit 14 EEPROM communication fault Bit 15 1=MAN 0=AUT ***(Setting the bit to 1 validates the description)***
2	Statuses of alarms 2	Bit 0 Loss of insulation Bit 1 Bit 2 GFDI (ground fault device interruptor) trip Bit 3 Bit 4 CAN communication fault Bit 5 Emergency Power Off Bit 6 Unit Enabled Bit 7 Presence of operator Bit 8 Inverter in power generation Bit 9 Inverter enabled Bit 10 Inverter disabled Bit 11 External protection trip Bit 12 Bit 13 DC Input overvoltage Bit 14 Bit 15 ***(Setting the bit to 1 validates the description)***
3	VinRN	Phase R star mains voltage (V)
4	VinSN	Phase S star mains voltage (V)
5	VinTN	Phase T star mains voltage (V)
6	IR	Phase R mains current (I)
7	IS	Phase S mains current (I)
8	IT	Phase T mains current (I)
9	Pout	Power transmitted to mains (KW)
10	T_amb	Internal temperature (°C)

11	T_cell	Cells Temperature (°C)
12	Vcell	Cells voltage (V)
13	Icell	Cells current (A)
14	Irr_or.	Horizontal irradiation (W/m^2)
15	Irr_inc.	Slanted irradiation (W/m^2)
16	E_KW	Energy (decades di KWh)
17	E_MW	Energy (MWh)
18	H_USE_H	Hours of operation (hours), upper section
19	H_USE_L	Hours of operation (hours), lower section
20	A_Input	Analog Input (% - 0 a 100 values)
21	A_Output	Analog output (% - 0 a 100 values)
22	Statuses of alarms 3	Bit 0 Bit 1 Remote Power Limitation Bit 2 Contactor Fault Bit 3 Contactor A Fault note 1 Bit 4 Contactor B FAULT note 1 Bit 5 Inverter / Grid Unbalance Current note 1 Bit 6 Remote Control active (Smart Grid) Bit 7 Bit 8 Bit 9 Bit 10 Bit 11 Bit 12 Bit 13 Bit 14 Bit 15 ***(Setting the bit to 1 validates the description)***
23	Spare	Reserved
24	Spare	Reserved
25	Spare	Reserved
26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	Spare	Reserved
30	POW_Limitation	Reserved.
31	P(f) Function	Enabling Power Derating for Over Frequency P=f(f) 15 = Disabled 170 = Enabled
32	Remote_Power_Limitation	***Power limitation from 0% to 100% (0..100 step 1%)***

33	Q(P) Function	Enabling Reactive Power Generation as a function of Active P generation Q = f(P) 15 = Disabled 160 = CEI 021/016 Curve A 170 = CEI 021/016 Curva B (cosfi = 0.9) 180 = Fixed Cosfi 190 = Remote fixed cosfi
34	Q(Vac) Function	Enabling Reactive Power Generation for Over / Under Voltage Q = f(Vac) 15 = Disabled 170 = Cei 021/016 Curve A 160 = Cei 021/016 Curve B with Hysteresis
35	Enable Reactive Q SetPoint	***Enabling Reactive Power Q setpoint***
36	Reactive Q SetPoint	***Reactive Power Q setpoint***
37	RMS V L1 at pdc delivery point	Phase 1 RMS value - point of connection (MV or HV)
38	RMS V L2 at pdc delivery point	Phase 2 RMS value - point of connection (MV or HV)
39	RMS V L3 at pdc delivery point	Phase 3 RMS value - point of connection (MV or HV)
40	Qout	Reactive Power Q generated (under/over excited) (KVAR)
41	Remote Controller Keep Alive	Remote Keep Alive Signal

Note 1: Alarm status only used for inverter with single control and double module (400kVa - 440kVa - 500kVA - 660kVA)

In the SMART GRID design, registers mapped from 31 to 36 were included and described below:

- ***Register 31 P(f) Function:*** Enables/disables the automatic generated power limitation function in mains over-frequency conditions, as required by CEI021 and CEI016.

  15 = Function disabled

  170= function enabled

- ***Register 32 Remote_Power_Limitation:*** Sets a generated P active power limitation as a percent of inverter nominal Power Pn from 0 to 100% with 1% step

- ***Register 33 Q(P) Function:*** Enables the various Q reactive power generation curves as a function of P active power, specifically:

15 = Function disabled

160 = Q (P) curve A CEI021/CEI016

170 = Q (P) curve B CEI021/CEI016

180 = Q (P) enabled fixed power factor Q = % Pgenerated

190 = Q reactive power remote control

Register 34 Q(Vac) Function: Enables Q reactive power generation as a function of VAC mains voltage read at inverter output or "pdc" delivery point

15 = Function disabled

160 = Q (P) curve B CEI021/CEI016 (with hysteresis)

170 = Q (Vac) curve A CEI021/CEI016

- ***Register 35 Enable Reactive Q Setpoint:*** Enables the Q reactive power reference as a % of Sn rated apparent power

  15 = Use of reactive reference disabled

  170 = Use of reactive reference enabled

- ***Register 36 Reactive Q Setpoint:*** Set a value of reactive power Q as a percentage of the nominal apparent power (Sn) or of the genarted active power (Pgen)

  - Is referred as percentage of "Sn" when register 35 is enabled (Enable Reactive Q Setpoint)
  - Is referred as percentage of "Pgen" when register 36 is set to 180

  NB: *With both registers enabled, register 35 takes priority*

  The settable range is +10000 / -10000 (+100% / -100%) 1bit = 0,01 %

- ***Positive set point:*** the generator supplies reactive power supplying current after voltage (over-excitation function).

- ***Negative set point:*** the generator supplies reactive power supplying current before voltage (under-excitation function).

- ***Registers 37, 38, 39:*** They are the effective "RMS" values of the three phase voltages, L1, L2 and L3 respectively, at the inverter connection, HV or HHV connection "pdc" delivery point. (120kV – 132kV – 150kV – 220kV – 380kV)
  Settings for the three voltage values have 1bit = 10V resolution
  I.e.: 150Kv ---> Value = 15000

- ***Register 40 Reactive Qout:*** Generated reactive power 1bit=1KVar

- ***Register 41 Remote Controller Keep Alive:*** The keep alive signal for remote regulation (Register 33 = 190 or regulation Q=f(Vac) at pdc for HV/HHV connections). To keep remote regulation alive, the register must be alternately written with 0 or 100 at an interval that varies from a minimum of 2 sec and maximum of 30 sec.

6.5 TABLE FOR SIEL MONOPHASE SOLAR INVERTERS

Register	Content	Description
1	Statuses /Alarms 1	Bit 0 None Bit 1 None Bit 2 None Bit 3 Inverter fault Bit 4 Mains frequency out of range Bit 5 Mains voltage out of range Bit 6 Overtemperature inside machine Bit 7 None Bit 8 Closed Mains contactor. Bit 9 None Bit 10 Desaturation of IGBT DC/DC converter Bit 11 None Bit 12 Insufficient irradiation Bit 13 1=50Hz 0=60Hz Bit 14 None Bit 15 0=MAN 1=AUT (Setting the bit to 1 validates the description)
2	Statuses/Alarms 2	Bit 0 Loss of insulation Bit 1 AUX1 Bit 2 AUX2 Bit 3 AUX3 Bit 4 High internal temperature Bit 5 None Bit 6 Unit enabled Bit 7 Presence of operator Bit 8 Inverter Generating Bit 9 Inverter Enabled

		Bit 10 Inverter Disabled Bit 11 Bit 12 Bit 13 Bit 14 Bit 15 (Setting the bit to 1 validates the description)
3	Vout	Mains voltage (V)
4	Spare	Reserved
5	Spare	Reserved
6	Iout	Mains current (tenths of A)
7	Spare	Reserved
8	Spare	Reserved
9	Pout	Power transmitted to mains (W)
10	T_amb	Internal temperature (°C)
11	Spare	Reserved
12	Vcell	Cells Voltage (V)
13	Icell	Current of cells (tenths of A)
14	Spare	Reserved
15	Spare	Reserved
16	E_KW	Energy (tenths of KWh)
17	E_MW	Energy (MWh)
18	H_USE_H	Hours of operation (hours), upper section
19	H_USE_L	Hours of operation (hours), lower section
20	FW_Ver	It is RS485 Modbus Card FW Version
21	Spare	Reserved
22	Spare	Reserved
23	Spare	Reserved
24	Spare	Reserved

25	Spare	Reserved
26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	Spare	Reserved
30	Spare	Reserved

6.6 TABLE FOR SIEL 10TL SOLAR INVERTERS

Register	Content	Description
1	Statuses of alarms 1	Bit 0 Bit 1 Bit 2 Bit3 Inverter Fault Bit 4 Mains frequency out of range Bit 5 Mains voltage out of range Bit 6 Overtemperature inside machine Bit 7 Communication Problem with Inverter Bit 8 Closed Mains contactor. Bit 9 Bit 10 Bit 11 DC/DC converted idle Bit 12 Insufficient irradiation Bit 13 1=50Hz 0=60Hz Bit 14 EEPROM Communication Error Bit 15 1=MAN 0=AUT (Setting the bit to 1 validates the description, free bit have value= 0)
2	Statuses of alarms 2	Bit 0 Loss of insulation Bit 1 Bit 2 Bit 3 Bit 4 Bit 5 Bit 6 Unit enabled (always at 1) Bit 7 Bit 8 Inverter Generating Bit 9 Inverter Enabled Bit 10 Inverter disabled

		Bit11 Bit 12 Bit 13 Input Converter DC Overvoltage Bit 14 Bit 15 (Setting the bit to 1 validates the description, free bit have value= 0)
3	VinRN	Star mains voltage for phase R (V)
4	VinSN	Star mains voltage for phase S (V)
5	VinTN	Star mains voltage for phase T (V)
6	IR	Mains current for phase R (in A if FW_Ver = 1.xx, in tenths of A in FW_Ver 2.xx or updated versions)
7	IS	Mains current for phase S (in A if FW_Ver = 1.xx, in tenths of A in FW_Ver 2.xx or updated versions)
8	IT	Mains current for phase T (in A if FW_Ver = 1.xx, in tenths of A in FW_Ver 2.xx or updated versions)
9	Pout	Power transmitted to mains (in kW if FW_Ver = 1.xx, in W in FW_Ver 2.xx or updated versions)
10	T_amb	Internal temperature (°C)
11	Spare	Reserved (read value = 0xFFFF)
12	Vcell	Cells Voltage (V)
13	Icell	Cell current (in A if FW_Ver = 1.xx, in tenths of A in FW_Ver 2.xx or updated versions)
14	Spare	Reserved (read value = 0x0000)
15	Spare	Reserved (read value = 0x0000)
16	E_KW	Energy (tenths of KWh)
17	E_MW	Energy (MWh)
18	H_USE_H	Hours of operation (hours), upper section
19	H_USE_L	Hours of operation (hours), lower section
20	FW_Ver	It is RS485 Modbus Card FW Version
21	Spare	Reserved

22	Spare	Reserved
23	Spare	Reserved
24	Spare	Reserved
25	Spare	Reserved
26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	Spare	Reserved
30	Spare	Reserved

6.7 TABLE FOR SIEL WIND WAVE INVERTERS:

Register	Content	Description
1	Statuses of alarms 1	Bit 0 AC power derating for overtemperature Bit 1 IGBT inverter desaturation Bit 2 Inverter current fast limitation Bit 3 Inverter fault Bit 4 Mains frequency out of range Bit 5 Mains voltage out of range Bit 6 Overtemperature inside machine Bit 7 No DSP-Signalling Communication Bit 8 Closed Mains contactor. Bit 9 Desaturation of IGBT DC/DC converter Bit 10 DC/DC converter fast current limitation Bit 11 DC/DC converter idle Bit 12 Minimum DC voltage Bit 13 1=50Hz 0=60Hz Bit 14 Fault on DC/DC converter IIC microprocessor Bit 15 1=MAN 0=AUT (Setting the bit to 1 validates the description)
2	Statuses of alarms 2	Bit 0 Loss of insulation Bit 1 Configurable Digital Input 1 Bit 2 Configurable Digital Input 2 Bit 3 Configurable Digital Input 3 Bit 4 NO CAN Communication Bit 5 Emergency Power Off Bit 6 Unit enabled Bit 7 Presence of operator Bit 8 Inverter Generating Bit 9 Inverter Enabled Bit 10 Inverter disabled Bit 11 External protection trip Bit 12 Configurable Digital Output Bit 13 Input Converter DC Overvoltage

		Bit 14 Minimum DC power Bit 15 Maximum power protection triggered (Setting the bit to 1 validates the description)
3	VinRN	Star mains voltage for phase R (V)
4	VinSN	Star mains voltage for phase S (V)
5	VinTN	Star mains voltage for phase T (V)
6	IR	Mains current for phase R (A)
7	IS	Mains current for phase S (A)
8	IT	Mains current for phase T (A)
9	Pout	Power transmitted to mains (KW)
10	T_amb	Internal temperature (°C)
11	T_cell	Temperature of cells (°C)
12	Vcell	Voltage of cells (V)
13	Icell	Current of cells (A)
14	Irr_or.	Horizontal irradiation (W/m^2)
15	Irr_inc.	Slanted irradiation (W/m^2)
16	E_KW	Energy (tenths of KWh)
17	E_MW	Energy (MWh)
18	H_USE_H	Hours of operation (hours), upper section
19	H_USE_L	Hours of operation (hours), lower section
20	A_Input	Analog Input (represented in % - value from 0 to 100)
21	A_Output	Analog Output (represented in % - value from 0 to 100)
22	Spare	Reserved
23	Spare	Reserved
24	Spare	Reserved
25	Spare	Reserved

26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	Spare	Reserved
30	Spare	Reserved

6.8 TABLE FOR SIEL FUEL CELL INVERTERS

Register	Content	Description
1	Statuses of alarms 1	Bit 0 AC power derating for overtemperature Bit 1 IGBT inverter desaturation Bit 2 Inverter current fast limitation Bit 3 Inverter fault Bit 4 Mains frequency out of range Bit 5 Mains voltage out of range Bit 6 Overtemperature inside machine Bit 7 No DSP-Signalling Communication Bit 8 Closed Mains contactor. Bit 9 Desaturation of IGBT DC/DC converter Bit 10 DC/DC converter fast current limitation Bit 11 DC/DC converted idle Bit 12 Minimum DC voltage Bit 13 1=50Hz 0=60Hz Bit 14 Fault on DC/DC converter IIC microprocessor Bit 15 1=MAN 0=AUT (Setting the bit to 1 validates the description)
2	Statuses of alarms 2	Bit 0 Loss of insulation Bit 1 Configurable Digital Input 1 Bit 2 Configurable Digital Input 2 Bit 3 Configurable Digital Input 3 Bit 4 NO CAN Communication Bit 5 Emergency Power Off Bit 6 Unit enabled Bit 7 Presence of operator Bit 8 Inverter Generating Bit 9 Inverter Enabled Bit 10 Inverter disabled Bit 11 External protection trip Bit 12 Configurable Digital Output Bit 13 Input Converter DC Overvoltage

		Bit 14 Bit 15 (Setting the bit to 1 validates the description)
3	VinRN	Star mains voltage for phase R (V)
4	VinSN	Star mains voltage for phase S (V)
5	VinTN	Star mains voltage for phase T (V)
6	IR	Mains current for phase R (A)
7	IS	Mains current for phase S (A)
8	IT	Mains current for phase T (A)
9	Pout	Power transmitted to mains (KW)
10	T_amb	Internal temperature (°C)
11	T_cell	Temperature of cells (°C)
12	Vcell	Voltage of cells (V)
13	Icell	Current of cells (A)
14	Irr_or.	Horizontal irradiation (W/m^2)
15	Irr_inc.	Slanted irradiation (W/m^2)
16	E_KW	Energy (tenths of KWh)
17	E_MW	Energy (MWh)
18	H_USE_H	Hours of operation (hours), upper section
19	H_USE_L	Hours of operation (hours), lower section
20	A_Input	Analog Input (represented in % - value from 0 to 100)
21	A_Output	Analog Output (represented in % - value from 0 to 100)
22	Spare	Reserved
23	Spare	Reserved
24	Spare	Reserved
25	Spare	Reserved

26	Spare	Reserved
27	Spare	Reserved
28	Spare	Reserved
29	Spare	Reserved
30	I_Ref	Remote current reference (in % - integer value from 0 to 100) This value is writable

6.9 TABLE FOR SIEL STS

Register	Content	Description
1	VRNA	Star voltage phase R Line 1 (V)
2	VSNA	Star voltage phase S Line 1 (V)
3	VTNA	Star voltage phase T Line 1 (V)
4	VRNB	Star voltage phase R Line 2 (V)
5	VSNB	Star voltage phase S Line 2 (V)
6	VTNB	Star voltage phase T Line 2 (V)
7	VRNO	Star voltage phase R Output (V)
8	VSNO	Star voltage phase S Output (V)
9	VTNO	Star voltage phase T Output (V)
10	VRSA	Cascading voltage RS Line 1 (V)
11	VSTA	Cascading voltage ST Line 1 (V)
12	VTRA	Cascading voltage TR Line 1 (V)
13	VRSB	Cascading voltage RS Line 2 (V)
14	VSTB	Cascading voltage ST Line 2 (V)
15	VTRB	Cascading voltage TR Line 2 (V)
16	VRSO	Cascading voltage RS Output (V)
17	VSTO	Cascading voltage ST Output (V)
18	VTRO	Cascading voltage TR Output (V)
19	Statuses and alarms	Bit 0 Input disconnecting switch, line 1 Bit 1 Input disconnecting switch, line 2 Bit 2 Output disconnecting switch Bit 3 -- Bit 4 Bypass disconnecting switch, line 1 Bit 5 Bypass disconnecting switch, line 2 Bit 6 Load not supplied

		Bit 7 Load supplied by line 1 Bit 8 Load supplied by line 2 Bit 9 Epo Bit 10 Delta V (High DV alarm) Bit 11 No preferential mains Bit 12 Preferential mains for line 1 Bit 13 Preferential mains for line 2 Bit 14 SCR fault lines 1 and 2 Bit 15 System forced to bypass on line 1 (Setting the bit to 1 validates the description)
20	Statuses and alarms	Bit 0 System forced to bypass on line 2 Bit 1 Protections triggered Bit 2 Overheating Bit 3 Fan fault Bit 4 Overload Bit 5 Line 1 above maximum threshold Bit 6 Line 1 below minimum threshold Bit 7 Line 2 above maximum threshold Bit 8 Line 2 below minimum threshold Bit 9 Incorrect threshold setting Bit 10 Bypass fault Bit 11 SCR fault line 1 Bit 12 SCR fault line 2 Bit 13 Short Circuit alarm Bit 14 Energy return alarm mains 1 Bit 15 Energy return alarm mains 2 (Setting the bit to 1 validates the description)
21	IROut	Output current for phase R (A)
22	ISOut	Output current for phase S (A)
23	ITOut	Output current for phase T (A)
24	Pout	Power supplied at output (kVA)
25	FA	Mains 1 frequency (tenths of Hz)

26	FB	Mains 2 frequency (tenths of Hz)
27	Spare	Reserved
28	Spare	Reserved
29	Spare	Reserved
30	Spare	Reserved

6.10 TABLE FOR SIEL CSP12 PARALLEL BOX:

Register	Content	Description
1	VBUS	Average voltage of the 12 strings (V)
2	IBUS	Total string current (tenths of A, see note 1)
3	PBUS	Total string power (tenths of KW, see note 1)
4	Statuses and alarms	Bit 0: string 1 status (see note 2 for decoding) Bit 1: string 1 status (see note 2 for decoding) Bit 2: string 1 status (see note 2 for decoding) Bit 3: string 2 status (see note 2 for decoding) Bit 4: string 2 status (see note 2 for decoding) Bit 5: string 2 status (see note 2 for decoding) Bit 6: string 3 status (see note 2 for decoding) Bit 7: string 3 status (see note 2 for decoding) Bit 8: string 3 status (see note 2 for decoding) Bit 9: string 4 status (see note 2 for decoding) Bit 10: string 4 status (see note 2 for decoding) Bit 11: string 4 status (see note 2 for decoding) Bit 12: string 5 status (see note 2 for decoding) Bit 13: string 5 status (see note 2 for decoding) Bit 14: string 5 status (see note 2 for decoding) Bit 15: not used
5	Statuses and alarms	Bit 0: string 6 status (see note 2 for decoding) Bit 1: string 6 status (see note 2 for decoding) Bit 2: string 6 status (see note 2 for decoding) Bit 3: string 7 status (see note 2 for decoding)

		Bit 4: string 7 status (see note 2 for decoding) Bit 5: string 7 status (see note 2 for decoding) Bit 6: string 8 status (see note 2 for decoding) Bit 7: string 8 status (see note 2 for decoding) Bit 8: string 8 status (see note 2 for decoding) Bit 9: string 9 status (see note 2 for decoding) Bit 10: string 9 status (see note 2 for decoding) Bit 11: string 9 status (see note 2 for decoding) Bit 12: string 10 status (see note 2 for decoding) Bit 13: string 10 status (see note 2 for decoding) Bit 14: string 10 status (see note 2 for decoding) Bit 15: not used
6	Statuses and alarms	Bit 0: string 11 status (see note 2 for decoding) Bit 1: string 11 status (see note 2 for decoding) Bit 2: string 11 status (see note 2 for decoding) Bit 3: string 12 status (see note 2 for decoding) Bit 4: string 12 status (see note 2 for decoding) Bit 5: string 12 status (see note 2 for decoding) Bit 6: varistor status (‘1’ = alarm) Bit 7: Insulation status (‘1’ = alarm) Bit 8: System status (‘1’=alarm) Bit 9: communicating with box Bit 10: Generic alarm (‘1’= if at least one alarm triggered) Bit 11: not used Bit 12: not used Bit 13: not used

		Bit 14: not used Bit 14: not used Bit 15: not used

Note 1: divide the value by 10 to obtain the measurement in A and KW.

Note 2: string status and alarm decoding.

Bit 2 Bit 5 Bit 8 Bit 11 Bit 14	Bit 1 Bit 4 Bit 7 Bit 10 Bit 13	Bit0 Bit 3 Bit 6 Bit 9 Bit 12	Meaning	Status (S) or Alarm (A)
0	0	0	String not connection	S
0	0	1	Connected and being generated	S
0	1	0	Connected and not being generated	S
0	1	1	String current out of range	A
1	0	0	Fuse alarm on positive pole	A
1	0	1	Fuse alarm on negative pole	A

6.11 Weather Station

The weather station is an optional device connected to the containers or which can be monitored via TGS2 system with set Modbus address **78**.

Its Modbus mapping is:

Register	Content	Description
778	Cell temperature	Value expressed in °C
779	Ambient temperature	Value expressed in °C
780	Irradiation	Value expressed in W/m2
781	Wind Speed	Value expressed in m/s

6.12 Receiver device or Auxiliary Contact Unit

The receiver is an optional auxiliary device that collects auxiliary contacts in the receiver.

Its default modbus address is: **77** in Containers and **130** if supplied as an auxiliary contact device in a monitoring system with TGS2.

Its Modbus mapping is:

Register	Content	Description
778	QMT VEI on/off (on Receiver) Average switch status (on auxiliary contact unit)	If the register is 0 (closed contact) the switch is ON If the register is 1 (open contact) the switch if OFF, in alarm
779	QMT trip(on Receiver) Auxiliary contact 1 (on auxiliary contact unit)	Tied to CEI 0-16 protection If the register is 1 (closed contact) the device is in alarm
786	Input aux 1(on Receiver) Auxiliary contact 2 (on auxiliary contact unit)	Backup digital input If the register is 1 (open contact) the device is in alarm
787	Input aux 2(on Receiver) Auxiliary contact 3 (on auxiliary contact unit)	Backup digital input If the register is 1 (open contact) the device is in alarm

6.13 Internal container auxiliary contact device

An auxiliary contact device is included in containers for the various possible container settings summarised in the following three paragraphs.

This model is independent of the Container size.

Its default modbus address is: **73**.

6.14 Standard configuration container

The standard container has a disconnecting switch called QC1 and a fuse in addition to some standard data.

Its Modbus mapping is:

Register	Content	Description
777	High temperature alarm	The alarm is triggered if this register's bit 6 is high.
786	QC1	Value = 0 => Alarm on Value = 1 => Alarm off
787	Contact not used	
794	Backup input	Not used in this configuration
795	UPS On Battery	Value = 1 => UPS in Battery
802	Trafo temperature alarm	Value = 0 => Alarm on
803	Trafo temperature protection	Value = 0 => Protection triggered
810	Main auxiliary switch	Value = 1 => Switch open (alarm)
811	UPS switch open	Value = 0 => UPS switch open (alarm)
819	Fire alarm	Value = 1 => Alarm on (optional alarm)
820	Contact not used	
826	Contact not used	
827	Door open alarm	Value = 1 => Alarm on
834	Settable input 1	Value = 1 => Alarm on (open contact)
835	Settable input 2	Value = 1 => Alarm on (open contact)

Notes: In the standard configuration, the fire alarm is an optional alarm that can be enabled during application build. They are thus included in all Container Standard 2 versions.

6.15 Container in configuration with driven switch

The container with driven switch has an input disconnecting switch called QBT with two interface protection signals called QBT Trip and CEI 0-16 interface.

Its Modbus mapping is:

Register	Content	Description
777	High temperature alarm	The alarm is triggered if this register's bit 6 is high.
786	QBT on/off	Value = 1 => Alarm on Value = 0 => Alarm off
787	QBT trip	Value = 0 => Alarm on Value = 1 => Alarm off
794	CEI 0-16	Value = 0 => Alarm on Value = 1 => Alarm off
795	UPS On Battery	Value = 1 => UPS in Battery
802	Trafo temperature alarm	Value = 0 => Alarm on
803	Trafo temperature protection	Value = 0 => Protection triggered
810	Main auxiliary switch	Value = 1 => Switch open (alarm)
811	UPS switch open	Value = 0 => UPS switch open (alarm)
819	Fire alarm	Value = 1 => Alarm on
820	Contact not used	
826	Contact not used	
827	Door open alarm	Value = 1 => Alarm on
834	Settable input 1	Value = 1 => Alarm on (open contact)
835	Settable input 2	Value = 1 => Alarm on (open contact)

Notes: In standard configurations, fire alarms and CEI 0 16 are optional alarms to be enabled during application build. Thus there are 4 options for each for this container model.

6.16 Meter device

SIEL interfaces with some meters on the market and reads values from these at the following addresses:

6.16.1 Carlo Gavazzi meter

EM24 and EM26 Carlo Gavazzi meters can be monitored.

Its Modbus mapping is:

Description	Address	Notes
Active energy transmitted to the grid (in tenths of kWh – low part)	62	Total active energy transmitted to the grid = ((High part * 65536) + (Low part))/10
Active energy transmitted to the grid (in tenths of kWh – high part)	63	
Rective energy transmitted to the grid (in tenths of kWh – low part)	64	Total reactive energy transmitted to the grid = ((High part * 65536) + (Low part))/10
Reactive energy transmitted to the grid (in tenths of kWh – high part)	65	
Active energy drawn from the grid (in tenths of kWh – low part)	92	Total active energy drawn from the grid = ((High part * 65536) + (Low part))/10
Active energy drawn from the grid (in tenths of kWh – high part)	93	

P.S.. Meters can be included in containers with set modbus addresses:

75 Machine 1 meter

76 Machine 2 meter

6.16.2 Actaris SL7000 meter

Actaris SL7000 meters can be read via Modbus only if interfaced with a Datalogger supplied by SIEL that reads meter impulse outputs and is correctly tested.

In this case, readable parameters are:

Description	Notes

Active energy transmitted to the grid	This value is Double, expressed in kWh with a significant figure. The final value must be equal to the **Active energy transmitted to the grid impulse meter** (INT32) x **Active energy transmitted to the grid impulse weight factor** (DOUBLE)
Reactive energy transmitted to the grid	This value is Double, expressed in kWh with a significant figure. The final value must be equal to the **Reactive energy transmitted to the grid impulse meter** (INT32) x **Reactive energy transmitted to the grid impulse weight factor** (DOUBLE)
Active energy drawn from the grid	This value is Double, expressed in kWh with a significant figure. The final value must be equal to the **Active energy drawn from the grid impulse meter** (INT32) x **Active energy drawn from the grid impulse weight factor** (DOUBLE)
Reactive energy drawn from the grid	This value is Double, expressed in kWh with a significant figure. The final value must be equal to the **Reactive energy drawn from the grid impulse meter** (INT32) x **Reactive energy drawn from the grid impulse weight factor** (DOUBLE)

The above variables are found at modbus address:

Address	Description	Unit of measurement	Value format
7146	Active energy transmitted to the grid impulse meter	Impulses	32 bit integer
7148	Active energy drawn from the grid impulse meter	Impulses	32 bit integer
7150	Reactive energy transmitted to the grid impulse meter	Impulses	32 bit integer
7152	Reactive energy drawn from the grid impulse meter	Impulses	32 bit integer
7178	Active energy transmitted to the grid impulse weight factor	kWh/Impulse	Float 32bit
7180	Active energy drawn from the grid impulse weight factor	kWh/Impulse	Float 32bit
7182	Reactive energy transmitted to the grid impulse weight factor	kWh/Impulse	Float 32bit
7184	Reactive energy drawn from the grid impulse weight factor	kWh/Impulse	Float 32bit

7 Data value format

7.1 FLOAT 32 BIT

The lowest register contains the most significant part of the float number.

The Float IEEE number format:

B3	B2	B1	B0
SEEEEEEE	EMMMMMMM	MMMMMMMM	MMMMMMMM

Modbus register code

Register A+1		Register A+1	
B3 (MSB)	B2	B1	B0 (LSB)

Example

The number 5000.0 is coded in single precision IEEE format as 459C4000H

B3	B2	B1	B0
45H	9CH	40H	00H

7.2 Modbus register coding with be

Register A+1		Register A+1	
45H	9CH	40H	00H
459CH (decimal 17820)		4000H (decimal 16384)	

7.2.1 32 BIT INTEGER WITHOUT SIGN

32 bit integer format:

Number 12345678H will be coded as follows in Modbus registers:

Register A+1		Register A+1	
12 (MSB)	34	56	78 (LSB)

P.S. Meters can be included in containers with set modbus addresses:

75 Machine 1 meter

76 Machine 2 meter