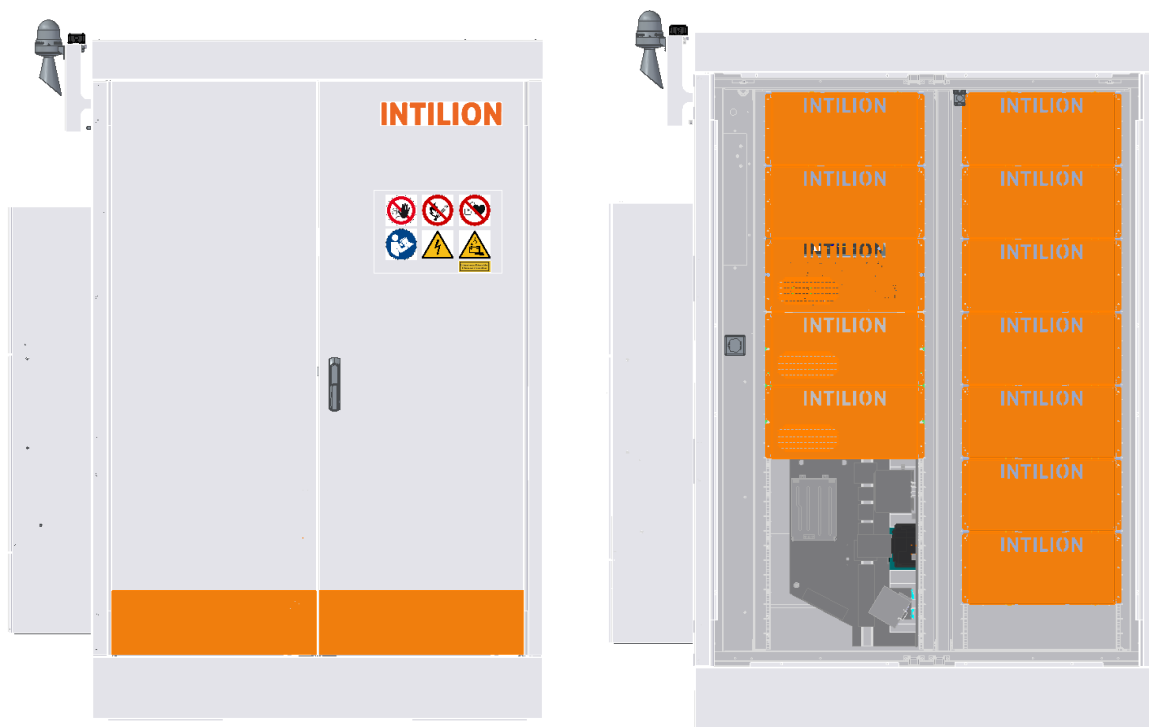# MODBUS REGISTERS

INTILION

INTILION | scalebloc energy
INTILION | scalebloc power
INTILION | scalebloc power boost

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Content

1   Introduction

INTILION | scalebloc supports communication via Modbus TCP/IP interface. The physical interface being the **XF13** terminal of the "first" or "master" INTILION | scalebloc.

If connected to an external EMS (Energy Management System), the battery storage system works like a "slave" in the Modbus topology with the following configurations:

Standard configuration	
Port	502
IP address	192.168.2.2
Subnet mask	255.255.255.0

The following four features are supported:

Supported function codes	
0x03	Read holding registers
0x04	Read input registers
0x06	Write holding register
0x10	Write holding registers

2   Version information

Function code **0x04** (read input registers)

Register	Type	Description	
4900	ASCII	Manufacturer	#1 and #2 letter: 'IN'
4901	ASCII	Manufacturer	#3 and #4 letter: 'TI'
4902	ASCII	Manufacturer	#5 and #6 letter: 'LI'
4903	ASCII	Manufacturer	#7 and #8 letter: 'ON'
4904	ASCII		Spare
4905	ASCII		Spare
4906	ASCII	System name	#1 and #2 letter
4907	ASCII	System name	#3 and #4 letter
4908	ASCII	System name	#5 and #6 letter
4909	ASCII	System name	#7 and #8 letter
4910	ASCII	System name	#9 and #10 letter
4911	ASCII	System name	#11 and #12 letter
4912	ASCII	System name	#13 and #14 letter
4913	ASCII	System name	#15 and #16 letter
4914	ASCII	System name	#17 and #18 letter
4915	ASCII	System name	#19 and #20 letter
4916	ASCII	Serial number	#1 and #2 number
4917	ASCII	Serial number	#3 and #4 number
4918	ASCII	Serial number	#5 and #6 number
4919	ASCII	Serial number	#7 and #8 number
4920	ASCII	Serial number	#9 and #10 number
4921	ASCII	Serial number	#11 and #12 number
4922	ASCII	Serial number	#13 and #14 number
4923	ASCII	Serial number	#15 and #16 number
4924	ASCII	Serial number	#17 and #18 number
4925	ASCII		Spare
4926	ASCII	Software version	#1 and #2 digit
4927	ASCII	Software version	#3 and #4 digit
4928	ASCII	Software version	#5 and #6 digit
4929	ASCII	Software version	#7 and #8 digit
4930	ASCII	Software version	#9 and #10 digit
4931	ASCII	Software version	#11 and #12 digit
4932	ASCII	Software version	#13 and #14 digit
4933	ASCII	Software version	#15 and #16 digit
4934	ASCII	Software version	#17 and #18 digit
4935	ASCII		Spare
4936	ASCII		Spare

3 System information

Function code **0x04** (read input registers)

Register	Type	Resolution	Unit	Description
5000	UINT	0.1	V	Mean battery voltage
5001	INT	1	A	Sum of battery currents
5002	UINT	0.1	%	System SoC
5003	UINT	0.001	V	Minimum cell voltage
5004	UINT	0.001	V	Maximum cell voltage
5005	INT	0.01	℃	Minimum module temperature
5006	INT	0.01	℃	Maximum module temperature
5007				Spare
5008	UINT			Error code
5009	UINT			Error code
5010	UINT			Error code
5011	UINT			Error code
5012	UINT			Error code
5013	UINT	1	Bit	Battery fan in SB#16 to SB#01
5014	UINT	1		No. of INTILION | scaleblocs in the system
5015	UINT	1		No. of available INTILION | scaleblocs
5016	UINT	1		System mode
5017	UINT	0.1	kW	Internal power target
5018	UINT	1		System heartbeat
5019	UINT	1	GWh	Charged energy
5020	UINT	1	MWh	
5021	UINT	1	KWh	
5022	UINT	1	GWh	Discharged energy
5023	UINT	1	MWh	
5024	UINT	1	KWh	
5025	UINT	1	kWh	Chargeable energy
5026	UINT	1	kWh	Dischargeable energy
5027	UINT	0.1	kW	Maximum charging power
5028	UINT	0.1	kW	Maximum discharging power
5029	UINT	1	min	Remaining runtime incl. current active power
5030	UINT	1	kW	Charging power over 60 min
5031	UINT	1	kW	Charging power over 10 min
5032	UINT	1	kW	Charging power over 5 min
5033	UINT	1	min	Time during which can be charged with P_nominal x 50 %
5034	UINT	1	min	Time during which can be charged with P_nominal x 10 %
5035	UINT	1	kW	Discharging power over 60 min
5036	UINT	1	kW	Discharging power over 10 min
5037	UINT	1	kW	Discharging power over 5 min
5038	UINT	1	min	Time during which can be discharged with P_nominal x 50 %
5039	UINT	1	min	Time during which can be discharged with P_nominal x 10 %

5040	INT	0.1	kW	Active power
5041	INT	0.1	kvar	Reactive power
5042	INT	0.1	kVA	Apparent power
5043	UINT	0.1	kVA	Maximum apparent power
5044				Spare
5045				Spare
5046				Spare
5047				Spare
5048				Spare
5049				Spare
5050				Spare

4   INTILION | scalebloc information

Function code **0x04** (read input registers)

Register	Type	Resolution	Unit	Description
5051	UINT	1	Bit	INTILION | scalebloc error code
5052	UINT	1	Bit	INTILION | scalebloc error code
5053	UINT	0.1	V	INTILION | scalebloc battery voltage
5054	INT	0.1	A	INTILION | scalebloc battery current
5055	UINT	0.1	%	INTILION | scalebloc SoC
5056	UINT	1		Operating state
5057	UINT	1		Position of the lowest cell voltage
5058				Spare
5059	UINT	1		Position of the highest cell voltage
5060				Spare
5061	UINT	0.001	V	Lowest cell voltage
5062				Spare
5063	UINT	0.001	V	Highest cell voltage
5064				Spare
5065	UINT	0.001	V	Mean cell voltage
5066	UINT	1		Module with the lowest temperature
5067				Spare
5068	UINT	1		Module with the highest temperature
5069				Spare
5070	UINT	0.1	℃	Lowest module temperature
5071				Spare
5072	UINT	0.1	℃	Highest module temperature
5073				Spare
5074	UINT	0.1	℃	Mean module temperature
5075	UINT	0.1	kW	Maximum discharging power
5076	UINT	0.1	kW	Maximum charging power
5077	UINT	0.1	kVA	Maximum apparent power
5078				Spare
5079				Spare
5080				Spare
5081				Spare
5082				Spare
5083				Spare
5084				Spare
5085	INT	0.1	°C	Cabinet temperature
5086	INT	0.1	°C	Cabinet temperature
5087	INT	0.1	kW	Active power
5088	INT	0.1	kvar	Reactive power
5089	UINT	0.1	V	Voltage L1
5090	UINT	0.1	V	Voltage L2
5091	UINT	0.1	V	Voltage L3
5092	INT	0.1	A	Current L1
5093	INT	0.1	A	Current L2
5094	INT	0.1	A	Current L3
5095	UINT	0.001	Hz	Frequency

5096				Spare
5097	INT	0.1	°C	Inverter temperature
5098				Spare
5099	UINT	0.1	%	INTILION | scalebloc SoH

The data of all the other INTILION | scaleblocs in the system is accordingly stored in registers 5101 to 5250.

Example:

One "master" INTILION | scalebloc and three "slave" INTILION | scaleblocs:

Registers	5051 to 5100	"Master" INTILION | scalebloc
Registers	5101 to 5150	"Slave" INTILION | scalebloc 1
Registers	5151 to 5200	"Slave" INTILION | scalebloc 2
Registers	5201 to 5250	"Slave" INTILION | scalebloc 3

5 Grid parameters from energy meter

If an energy meter is connected to INTILION | scalebloc, then the following parameters can be read.

Function code **0x04** (read input registers)

Register	Type	Resolution	Unit	Description
6000	UINT	0.1	V	Voltage L1-N
6001	UINT	0.1	V	Voltage L2-N
6002	UINT	0.1	V	Voltage L3-N
6003	UINT	0.1	V	Voltage L1-L2
6004	UINT	0.1	V	Voltage L2-L3
6005	UINT	0.1	V	Voltage L3-L1
6006	INT	0.1	A	Current L1
6007	INT	0.1	A	Current L2
6008	INT	0.1	A	Current L3
6009	UINT	0.1	Hz	Frequency
6010	INT	0.1	kW	Active power L1
6011	INT	0.1	kW	Active power L2
6012	INT	0.1	kW	Active power L3
6013	INT	0.1	kVA	Apparent power L1
6014	INT	0.1	kVA	Apparent power L2
6015	INT	0.1	kVA	Apparent power L3
6016	INT	0.1	kvar	Reactive power L1
6017	INT	0.1	kvar	Reactive power L2
6018	INT	0.1	kvar	Reactive power L3
6019	DINT	1	kWh	Energy L1
6020				
6021	DINT	1	kWh	Energy L2
6022				
6023	DINT	1	kWh	Energy L3
6024				

6   Setpoint specification

Supported function codes	
0x03	Read holding registers
0x06	Write holding register
0x10	Write holding registers

Register	Type	Resolution	Unit	Setpoint specification
9000	UINT	1	Bit	System control
9001	INT	0.1	kW	Setpoint active power
9002	INT	0.1	kvar	Setpoint reactive power
9003	UINT	1		Watchdog
9004	UINT			Operating modes
9005	UINT	0.1	V	Reference voltage in GFO
9006	UINT	0.001	Hz	Reference frequency in GFO

7 Description

INTILION | scalebloc sends and receives the parameters only as integers. In order to be able to process decimal values, the integers must be multiplied by the resolution. A few examples:

Register	Type	Resolution	Unit	Transmitted value	Actual value
5000	UINT	0.1	V	7264	726.4 V
5001	INT	1	A	65461	-75 A
5005	INT	0.01	°C	2351	23.51°C
4900	ASCII			0x494E	'IN'

Mean battery voltage (register 5000):

Mean battery voltage of all INTILION | scaleblocs in the system.

Sum of battery currents (register 5001):

Sum of all battery currents. Here, a negative current corresponds to a charging current.

System SoC (register 5002):

The state of charge (SoC) of all INTILION | scaleblocs corresponds to the charging state of the batteries. The value ranges from 0 % (discharged battery) to 100 % (fully charged battery).

Minimum/Maximum cell voltage (register 5003 – 5004):

The lowest and highest cell voltage of all INTILION | scaleblocs.

Minimum/Maximum module temperature (register 5005 – 5006):

The lowest and highest module temperature of all INTILION | scaleblocs.

Error code (5008 – 5012):

The software knows three types of error messages:

Warning (value 20000 to 29915)	If INTILION	scalebloc is in the "Warning" state, then the system continues to be operable. However, some system features may be compromised. After resolving the warning, the system resumes automatically.
Error (value 10000 to 19915)	If INTILION	scalebloc is in the "Error" state, then charging and discharging power is limited. After resolving the problem, the system automatically resumes.
Critical (value 100 to 9915)	If INTILION	scalebloc is in the "Alarm" state, then the system has the operating mode Alarm" which means that it is not possible to charge or discharge energy. After resolving the critical error, the system must be reset.

For more detailed information, see "Fehlerliste_scalebloc_05-03_EN.pdf".

Battery fan (register 5013):

The individual bits indicate in which INTILION | scalebloc the battery fans are active. If bit 0 is true, then the fans are active.

No. of INTILION | scaleblocs in the system (register 5014):

Total number of INTILION | scaleblocs in the system.

No. of available INTILION | scaleblocs (register 5015):

No. of INTILION | scaleblocs which are operable.

System mode (register 5016):

The different modes of the (battery) system:

10 -> Booting	System is booting.
12 -> Com error	Communication problem in the system.
15 -> Configuration	Configuration and commissioning must be conducted.
20 -> Waiting	System waits for start signal.
30 -> Starting	System is starting.
40 -> Run	System is running.
41 -> Partial run	System is running, but at least one INTILION	scalebloc is not running.
42 -> Partial com error	System is running, but at least one INTILION	scalebloc has communication problems.
80 -> System in alarm	System in alarm state.
130 -> Grid starting	System starts grid-forming operation.
140 -> Grid forming	System in GFO mode.

Internal power target (register 5017):

The power setpoint sent to the system by the application.

System heartbeat (register 5018):

The value is increased by one each second. It counts from 0 to 1000.

Charged and discharged energy (register 5019 – 5024):

Energy charged and discharged since commissioning.

Chargeable and dischargeable energy (register 5025 – 5026):

Energy that can still be charged to the battery or discharged from the battery, respectively, until the battery has reached its maximum or minimum SoC.

Maximum Charging and discharging power (register 5027 – 5028):

Maximum power of charging and discharging the system. It depends for example from the battery's state of charge or the temperature.

Remaining runtime incl. current active power (register 5029):

Time in which the system is able to run with the current active power until the battery has reached its maximum or minimum SoC.

Charging and discharging power over x min (register 5030 – 5032 + 5035 – 5037):

Power that can be constantly charged or discharged over the time x.

Time with P_nominal (register 5033 – 5034 + 5038 – 5039):

Time over which the system can charge or discharge the percentage of nominal power.

Active, reactive, and apparent power (register 5040 – 5042):

Active, reactive, and apparent power of the system. In case of negative power, the battery is charged.

Maximum apparent power (register 5043):

Maximum apparent power with which the system can be operated.

INTILION | scalebloc error code (register 5051 - 5052):

See description of error codes. However, INTILION | scalebloc error codes only have three digits so that the following ranges apply:

– *Critical/Alarm* (value 1 to 99)

– *Error* (value 100 to 199)

– *Warning* (value 200 to 299)

INTILION | scalebloc voltage/current/SoC (register 5053 – 5055):

Battery voltage and current of INTILION | scalebloc plus the battery's state of charge.

Operating state (register 5056):

INTILION | scalebloc can have the following operating states:

0 -> Off	Knob switch 5SF2 in centre position
5 -> Testing	End of line test
10 -> Booting	Booting
12 -> Start communication	Communication setup inverter and battery
13 -> Start communication	Communication setup energy meter and external communication
15 -> Waiting for commissioning	Waiting for commissioning
20 -> Waiting	Waiting for start signal
30 -> Starting DC	INTILION	scalebloc switches on the battery.
31 -> Starting AC	INTILION	scalebloc switches on AC power circuit breaker
31 -> Starting inverter	INTILION	scalebloc switches on inverters
35 -> Starting initial operation	INTILION	scalebloc starts system test
40 -> Run	Normal state
41 -> Standby	Standby
42 -> Stopping	INTILION	scalebloc is stopped.
43 -> Reload	Battery is recharged
45 -> Commissioning / SoH calibration	Commissioning system test or SoH calibration.
80 -> Alarm – alarm message	INTILION	scalebloc in Alarm mode. After problem resolution, reset is required.
81 -> Alarm - PCB triggered	Power circuit breaker tripped. After problem

	resolution, reset is required.
82 -> Alarm – emergency stop	INTILION | scalebloc in emergency stop. After problem resolution, reset is required.
130 -> Starting DC	INTILION | scalebloc switches on the battery.
131 -> Starting inverter grid-forming	INTILION | scalebloc starts inverter in GFO.
132 -> Connecting island grid	INTILION | scalebloc connects island grid.
140 -> Grid-forming	System in grid-forming operating mode.

Lowest/highest cell voltages (register 5057 – 5065):

The lowest, highest, and mean cell voltage of the battery (register 5061. 5063 and 5065).

Registers 5057 and 5059 identify the module position of the corresponding battery cell.

Mean cell voltage (register 5065):

The average of all cell voltages of the battery.

Lowest/highest module temperature (register 5066 – 5074):

The lowest, highest, and mean module temperature of the battery (register 5070, 5072 and 5074).

Registers 5066 and 5068 identify the corresponding module.

Maximum charging and discharging power (register 5075 – 5076):

The maximum power which the system is able to charge and discharge at the time.

Maximum apparent power (register 5077):

The maximum apparent power with which the system can be operated.

Cabinet temperature (register 5085 – 5086):

Room temperatures in the INTILION | scalebloc at the exhaust duct.

Active/reactive power (register 5087 – 5088):

The active and reactive power which can be generated by the inverter.

Voltage/current/frequency (register 5089 – 5095):

Voltage, current and frequency that apply at the inverter.

Inverter temperature (register 5097):

The temperature which is measured in the inverter.

INTILION | scalebloc SoH (register 5099):

The battery's state of health (SoH). If this value is below 70 %, then the battery should be replaced.

System control (register 9000):

If the system is configured to setpoint specification, then this register is used to control the system.

Register	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
9000												Reset			Stop	Start

Specification of active/reactive power (register 9001 - 9002):

Grid-connected operation:

If setpoint specification is enabled and the system state is 40 to 42, then these registers can specify the power. If the power is within the charging limit, then it is supplied by the system. In case of a negative value, the power is drawn from the gird.

Grid-forming operation:

If setpoint specification is enabled, then the system state in operating mode grid-forming has the value 140. The setpoints for active power (9001) and reactive power (9002) must be understood as offset values here.

In the island grid, these offset values can be used to increase or decrease frequency and voltage at runtime depending on the pre-defined P-f or Q-U characteristics – in addition to the power that is influenced by loads or generators. This makes it possible to actively influence the behaviour of loads and generators.

Example:

If in grid-forming operation an active power of 10 kW is specified, then the reference frequency (register 9006) materialises, when the system has a 10 kW load. If the load is below 10 kW or if power is generated, then the actual frequency (register 5095) is greater than the reference frequency. If the load is greater than 10 kW, then it is the other way round.

Watchdog (register 9003):

The register value must be changed at least once within 60 seconds, otherwise, the system stops. If this value is 0, then the watchdog is disabled.

Operating modes (register 9004):

If setpoint specification is enabled, this register can be used to switch from grid-connected to grid-forming operation and vice versa. To confirm the setting, the system must be in state 20 ("Stop" over register 9000).

Register	Bit															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
9004															GCO	GFO

If no value is specified, the system is in grid-connected operation.

Definition of reference voltage for island grid (register 9005):

In grid-forming operation, the nominal voltage changes depending on the actual reactive power according to the enabled Q-U characteristic. By definition of the reference voltage, the nominal voltage in the island grid can be set in the range of 208 to 253 V (90 to 110 % of the nominal 230 V voltage) at runtime. This causes an additive increase or decrease of voltage changes caused by the reactive power.

This effect can be used to stabilise the voltage and synchronise to an external grid.

Specification reference frequency for island grid (register 9006):

In grid-forming operation the nominal frequency changes depending on the actual active power according to the specified P-f characteristic. By definition of the reference frequency, the nominal frequency in the island grid can be set in the range of 47.5 to 52.5 Hz at runtime. This causes an additive increase or decrease of the frequency changes caused by the active power.

This effect can be used to synchronise to an external grid or to shift energy between two systems.

Spare registers

Reading the spare registers does not cause an error. The content of these registers however has no specific meaning.

8   Abbreviations

AC	Alternating Current
ACB	Air Circuit Breaker
ADR	European agreement concerning the international carriage of dangerous goods by road
BMS	Battery Management System
Cat	Category
CCCV	Constant Current Constant Voltage
Cmd	Command
COMM	Communication
DC	Direct Current
DGUV	German Social Accident Insurance
DI	Digital Input
DNS	Domain Name System
EM	Energy Meter
EMS	Energy Management System
EnFluRi	Energy Flow Direction Sensor
FNN	Network Technology/Network Operation Forum
GCO	Grid-Connected Operation
GFO	Grid-Forming Operation (stand-alone)
IP	Ingress Protection
IPC	Industrial PC
LED	Light-Emitting Diode
LTE	Long-Term Evolution
NC	Normally Closed (contact)
PFC	WAGO-Branded PLC
PGU	Power Generation Unit
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
ProdSG	German Product Safety Act
PWR	Power
RBMS	Rack Battery Management System
RCD	Residual Current Device
RCBO	Residual Current-Operated Circuit Breaker
SoC	State of Charge
SoH	State of Health
TAB	Technical Connection Conditions
TCP/IP	Transmission Control Protocol/Internet Protocol
TN-S	Terre Neutre Séparé (grid type)
UCS	Universal Configuration Software
UCTE	Union for the Co-ordination of Transmission of Electricity
UPS	Uninterruptable Power Supply
VDE	German Electrotechnology Association
WLE	Work on Live Equipment