15. If the battery is empty it should be in the Charge State.

2.7. Modbus/TCP

Modbus/TCP implementation of the Efore Opus system supports two simultaneous client-server connections at a time. Server side will end connection, if there is over 1 minute interval between messages. It is recommended for client side to send messages to server at least once in 30 seconds.

Server of the Opus system will wait for Modbus requests on Modbus default TCP port 502

Following modbus functions can be used:

- read multiple registers (fc 3)
- read/write registers (fc 23)

2.7.1. Memory Areas

'Holding registers' area is used to provide information about the system. Each memory address holds 16 bits of data and the data can be only read. Writing to 'holding registers' area is discarded. Because these are holding registers, address range is 4:0001 – 4:0039. Unused areas between the used data areas can be read. They are set to '0'.

Other memory areas are not used and will return illegal data address if they are tried to read/write.

The first memory address contains data version counter. It is a counter that is incremented every time data is updated. Data is updated before replying to Modbus/TCP read requests. Therefore two consecutive reads returns different data version counter value (if the first memory address is read). Counter runs from 0 to 65535 and is then restarted from 0. Data version counter is linked to a connection. If there are two simultaneous connections to a server each will have their own independent counter that starts from 0.

Memory Address	Data Field
1	Data version counter
2	Operating mode
3	Battery test state
4	Boost charge state
- - -	
10	System Voltage (0,1 V)
11	Load current (0,1 A)
12	Battery current (0,1 A)
13	Total rectifier current (0,1 A)
14	Total inverter current (0,1 A)
15	Maximum battery temperature (0,1 C)
16	Maximum system temperature (0,1 C)
- - -	
30	System voltage alarms
31	System fault alarms

Memory Address	Data Field
32	Miscellaneous system alarms
33	Rectifier alarms
34	Inverter system alarms
35	Other modules alarms
36	Battery alarms
37	Low voltage disconnection alarms
38	External alarms

2.7.2. Operation modes

Operation mode field describes current mode of the system in a following way. If the corresponding bit is high, the state is active. Temperature compensation can be active simultaneously with the boost charge.

Memory Address	Bit	Data
2	0	Float charge active
	1	Battery test active
	2	Boost charge active
	3	Temperature compensation active
	4-15	Unused

If the battery test is active, more specific data can be found in its field.

Memory Address	Bit	Data
3	0	Periodic battery test
	1	Manual battery test
	2	Natural battery test
	3	Remote battery test
	4-15	Unused

If the boost charge is active, more specific data can be found in its field.

Memory Address	Bit	Data
4	0	Automatic boost charge
	1	Periodic boost charge
	2	Manual boost charge
	3	Remote boost charge
	4-15	Unused

2.7.3. Measurements

Each of these measurements are stored in their own 16 bit memory address. Their value is multiplied with 10 to show first decimal. This makes the range to -3.276,8 - +3.276,8.

Memory Address	Data Field
10	System Voltage (0,1 V)
11	Load current (0,1 A)
12	Battery current (0,1 A)
13	Total rectifier current (0,1 A)
14	Total inverter current (0,1 A)
15	Maximum battery temperature (0,1 C)
16	Maximum system temperature (0,1 C)

2.7.4. Alarms

Alarms are divided into several logical groups and memory addresses.

Memory Address	Bit	Data	
30		System voltage alarms	
	0	Mains fault	Mains Fault alarm activates when all the rectifiers report a mains fault.
	1	Phase fault	Phase Fault alarm activates when all the rectifiers in a certain mains phase report a mains fault.
	2	Low system voltage	Low System Voltage alarm activates when the measured system voltage drops too low
	3	High system voltage	High System Voltage alarm activates when the measured system voltage is too high
	4	Float charge deviation	System voltage deviates more than specified from the set value.
	5	Inverter system mains fault	Inverters Mains Fault alarm activates when bypass switch reports a mains supply fault.
	6-15	Unused	

Memory Address	Bit	Data	
31		System fault alarms	
	0	Earth fault	The alarm is activated if the measured power line to PE resistance is less than the given value..
	1	Load fuse fault	Load fuse has tripped

Memory Address	Bit	Data	
	2	Battery fuse fault	Battery fuse has tripped
	3	Rectifier overload	There are not enough redundant rectifiers in the system
	4	Inverter overload	There are not enough redundant inverters in the system.
	5	Bus fault	This alarm activates if all the modules in a communication bus stop communicating with the system controller
	6	DCP Bus Fault	This alarm activates if there is communication problem in the distributed controller bus.
	7	Shunt fault	This alarm activates if a current shunt is not properly configured or the current measurement is not inside reasonable limits.
	8	System over temperature	System Over Temperature alarm activates when ambient temperature is too high
	9	No system temperature sensor	This alarm activates if there is no system temperature sensor available.
	10-15	Unused	

Memory Address	Bit	Data	
32		Miscellaneous system alarms	
	0	Boost charge active	This alarm activates when any Boost Charge mode is active.
	1	Configuration conflict	This alarm activates if there are problems in system configuration
	2	Inventory full	This alarm activates if the system cannot handle all the modules installed to the system
	3-15	Unused	

Rectifier alarms' field shows if any rectifier module in the system has any alarms. i.e. communication error on one module will set communication error alarm in 'Rectifier alarms' field.

Memory Address	Bit	Data	
33		Rectifier alarms	
	0	Communication	System Controller is unable to

Memory Address	Bit	Data	
		error	communicate with a module.
	1	Nvram fault	Module reports a NVRAM fault in itself.
	2	Config fault	Some of module configuration is missing.
	3	Module fault	The self-diagnostics of a system module indicate that the module is faulty and should be replaced.
	4	Bad firmware	Module has a bad firmware and it should be updated.
	5	Rectifier fault	The self-diagnostics of a rectifier module indicate that the rectifier module is faulty and should be replaced.
	6	Rectifier over voltage	Rectifier module reports too high DC voltage.
	7	Rectifier over temperature	Rectifier module reports too high internal temperature.
	8	Rectifier mains fault	Rectifier module reports either too low or high Mains Voltage.
	9	Rectifier wrong voltage version	The alarm is activated if any rectifier in the system has different voltage group than the value of Rectifiers Voltage Group parameter.
	10-15	Unused	

‘Inverter system alarms’ field shows if any inverter/bypass module in the system has any alarms. i.e. communication error on one module will set communication error alarm in ‘Inverter system alarms’ field.

Memory Address	Bit	Data	
34		Inverter system alarms	
	0	Communication error	System Controller is unable to communicate with a module.
	1	Nvram fault	Module reports a NVRAM fault in itself.
	2	Config fault	Some of module configuration is missing.
	3	Module fault	The self-diagnostics of a system module indicate that the module is faulty and should be replaced.
	4	Bad firmware	Module has a bad firmware and it should be updated.
	5	Inverter system fault	This alarm activates when there is a critical error in the inverter subsystem.

Memory Address	Bit	Data	
	6	Inverter fault	An inverter module reports a critical fault in the module itself.
	7	Bypass fault	Bypass module reports a critical fault in the module itself.
	8-15	Unused	

Other modules alarms field shows if any other module than rectifier or inverter in the system has any alarms. i.e. communication error on one module will set communication error alarm in 'Other modules alarms' field.

Memory Address	Bit	Data	
35		Other modules alarms	
	0	Communication error	System Controller is unable to communicate with a module.
	1	Nvram fault	Module reports a NVRAM fault in itself.
	2	Config fault	Some of module configuration is missing.
	3	Module fault	The self-diagnostics of a system module indicate that the module is faulty and should be replaced.
	4	Bad firmware	Module has a bad firmware and it should be updated.
	5-15	Unused	

Memory Address	Bit	Data	
36		Battery alarms	
	0	Battery block low voltage	This alarm activates if a battery block voltage is measured to be below the configured limit..
	1	Battery block high voltage	This alarm activates if a battery block voltage is measured to be above the configured limit.
	2	Battery String Asymmetry	This alarm activates if voltage measurement of any of the battery block in a battery string differs too much from the average block voltage in the battery string.
	3	Automatic boost charge fault	Automatic Boost Charge Fault is activated if ABC Time Limit is exceeded before battery charge current drops below Stop Current.
	4	Battery Test Fault	Battery Test Fault is activated if battery voltage drops below Stop Voltage before

Memory Address	Bit	Data	
			the Battery Test Time Limit or Discharge Limit is exceeded.
	5	Battery Over Temperature	This alarm activates if any of the battery temperature sensors indicate that battery temperature is above the configured limit.
	6	No Battery Temperature Sensor	Battery Temperature Compensation feature is enabled but there is no battery temperature sensor. .
	7	Battery Temperature Sensor Fault	A battery temperature measurement is not inside reasonable limits.
	8-15	Unused	

Memory Address	Bit	Data	
37		Low voltage disconnect alarms	
	0	Load LVD Disconnect Warning	This alarm warns that a Load LVD may be disconnecting shortly.
	1	Load LVD Disconnect Imminent	This alarm warns that a Load LVD is about to disconnect in about ten seconds..
	2	Battery LVD Disconnect Warning	This alarm warns that a Battery LVD may be disconnecting shortly.
	3	Battery LVD Disconnect Imminent	This alarm warns that a Battery LVD is about to disconnect in about ten seconds.
	4	Contactor Fault	Load or Battery LVD contactor is not responding to control commands.
	5-15	Unused	

Memory Address	Bit	Data	
38		External alarms	
	0	Ext. Alarm Group 1	An external alarm connected to external alarm group 1 is active..
	1	Ext. Alarm Group 2	An external alarm connected to external alarm group 2 is active.
	2	Ext. Alarm Group 3	An external alarm connected to external alarm group 3 is active..

Memory Address	Bit	Data	
	3	Ext. Alarm Group 4	An external alarm connected to external alarm group 4 is active.
	4-15	Unused	

2.8. EchoAgent

EchoAgent provides connection to EchoVault Performance and SLA Management Solution from Creanord. It is possible to send all events, including alarms, to EchoVault with EchoAgent. If secure connection between EchoAgent and EchoVault is needed, customer specific certificate can be installed through an administration menu. EchoAgent uses certificates for encrypted communication with EchoVault server. In order for certificates to work, system clock need to be in correct time. I.e. creation time of certificates cannot be in future comparing to system clock. EchoAgent needs a separate license to work.

3. PRINCIPLES OF OPERATION

3.1. Parameter System

Because of highly flexible design of VIDI+, it can be used in many different applications with different voltage, current and power levels, battery types, etc. However, flexibility often entails complexity. One of the main objectives in the design of the VIDI+ controller has been to hide this complexity from the user.

One of those points is the parameter system of VIDI+. All modern power system controllers have quite a collection of parameters. This is true for VIDI+ also. In VIDI+, those parameters are also interlinked. This means that a parameter may affect default, minimum, and maximum values of other parameters, in what are called parameter dependencies.

For example, the Float Charge Voltage parameter depends on the following parameters:

Identifier	Name	Description
CellMinV	Minimum Cell Voltage	
CellMaxV	Maximum Cell Voltage	
CellFloatV	Float Charge Voltage of a Cell	
BlocksPerString	Voltage Version	Number of blocks per string
CellsPerBlock	Cells Per Block	Number of cells per block

The default value of Float Charge Voltage is determined by the following formula:

def{FloatV} = CellFloatV * BlocksPerString * CellsPerBlock

For example, in a 48 V system with lead-acid batteries, this would be:

def{FloatV} = 2.27 V * 4 * 6 = 54.48 V

CellFloatV, BlocksPerString, and CellsPerBlock are called master parameters for the FloatV parameter. FloatV is called a dependent parameter for the master parameters.

