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Conext CL125 Inverter Modbus Interface Guide

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Application Note

Objective

The objective of this Application Note is to describe the CL125 inverter's Modbus communication capability and how its implementation can quickly and easily interface the inverter with any third-party Modbus devices.

You must be familiar with the Modbus protocol and with serial communications in general.

⚠ DANGER

RISK OF FIRE, ELECTRIC SHOCK, EXPLOSION, AND ARC FLASH

This Application Note is in addition to, and incorporates by reference, the relevant product manuals for each product in the Conext CL125 Inverter. Before reviewing this Application Note you must read the relevant product manuals. Unless specified, information on safety, specifications, installation, and operation is as shown in the primary documentation received with the product. Ensure you are familiar with that information before proceeding.

Failure to follow these instructions will result in death or serious injury.

Introduction

Modbus is a simple and robust open communication protocol used to provide interoperability between products from many different vendors.

The CL125 inverter performs Modbus communications according to the Modbus register definition.

Key Points

- The inverter can communicate via the RS-485 serial communication only. The RS-485 allows for multiple devices on the same bus and same network.
- All communications on the network conform to a Master/Slave scheme. The Master can be a data logger or any monitoring solution. In this scheme, information and data are transferred between a Modbus Master and up to 31 Slave devices.
- The Master device initiates and controls all the information transfer on the Modbus serial bus network. There is only one master for any Modbus network.
- A Slave device never initiates a communication sequence, and must remain silent unless addressed specifically by the Master.
- All the communication activity on the Modbus serial bus network occurs in the form of packets. A packet is a serial string of up to 255 8-bit bytes.
- All packets transmitted by the Master are requests. All the packets transmitted by a Slave are responses.
- At most, one Slave can respond to a single request from a Master.
- The CL125 photo-voltaic grid tie inverters support the Modbus communication protocol.

Related Documents

Table 1 Document references

Document title	Document number	Version
Modbus Application Protocol Specification	From www.modbus.org	1.1b
Conext CL125 Owners Guide	975-0793-01-01	--
Modbus over Serial Line Specification and Implementation Guide	From www.modbus.org	1.02
Modbus Map: Conext CL125	503-0271-01-01	A
SunSpec Alliance Interoperability	Specification Common Models.	1.5
SunSpec Alliance Interoperability	Specification Inverter Models.	1.1

Modbus Physical Layer

The Conext CL125 Inverter supports the Modbus communication protocol via two physical interfaces: **RS-485_1** and **RS-485_2**. The location of the terminals on the communication card are shown in Figure 1, where RS-485 connection can be wired through RS-485 bus terminal connectors.

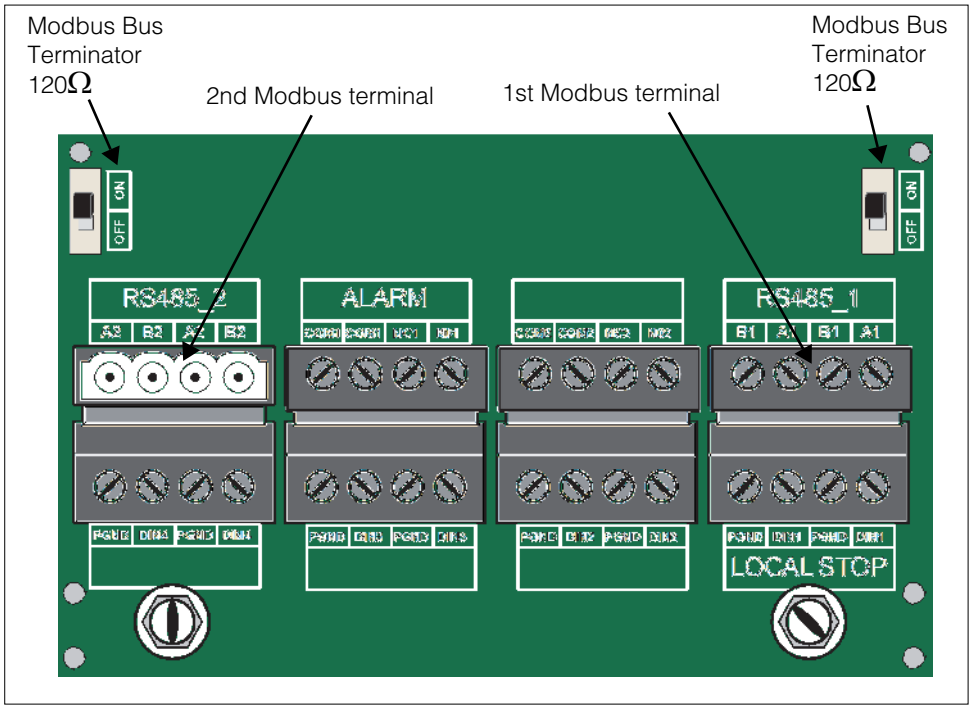

Figure 1 Communication Connector Locations RS485_1 and RS485_2

Modbus RS485 Connection

The RS-485 bus is a multi-drop bus and can be implemented as a daisy chain. As shown in the below figure. The RS485 Bus terminals and connectors are provided to ease the daisy chain connection. Either port can be connected to the upstream or downstream devices.

NOTICE

RISK OF EQUIPMENT DAMAGE

Make sure the other end of the Modbus (RS485) connection is also Modbus (RS485). Connection to any other type of communication port, such as Ethernet, may result in equipment damage.

Install a surge protection device on the RS485 line.

Failure to follow these instructions can result in equipment damage.

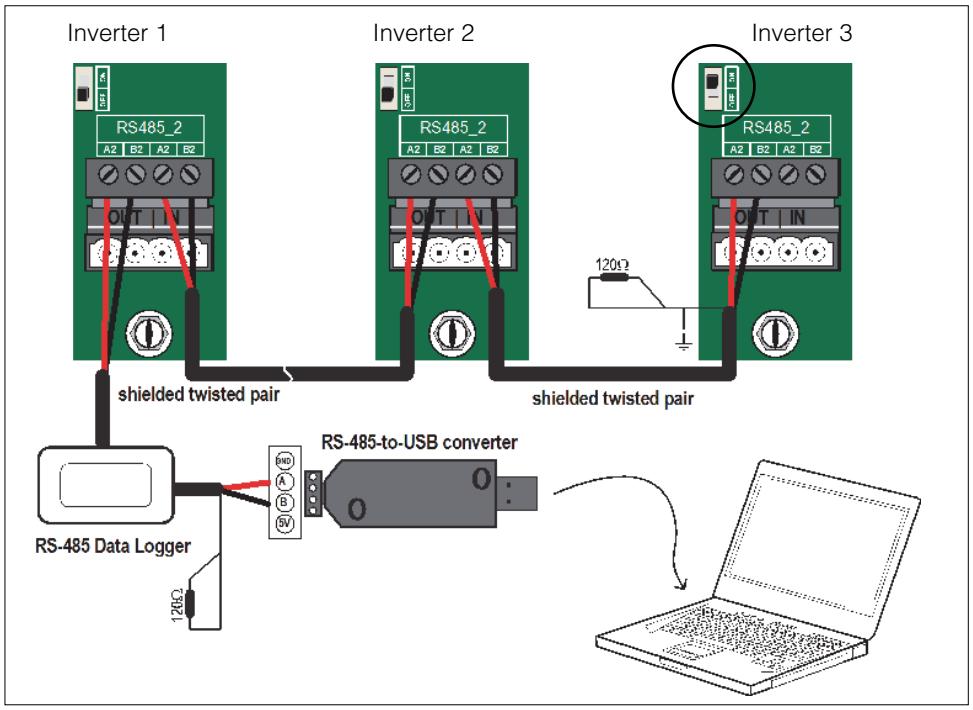

Figure 2 Modbus Daisy Chain Illustration

NOTE:

- Using the incorrect pin out for the RS-485 cable and interchanging the GND pins may result in discontinuity on the network and poor communication.
- It is recommended to use 24 AWG, 1.5 STP cable.

Communication Parameters for RS485

Table 2 shows the communication parameters used by the RS-485 Modbus interface on the inverter.

These parameters must be set identically on the Modbus Master device or PC program used to communicate with the inverter. To determine how to set the communication parameters of the Modbus Master device, see the documentation that accompanies the device.

Table 2 Data format for the RS485 connection

Parameter	Values
Baud rate	9600 (default), 19200
Data bits	8
Stop bits	1 (default), 2
Parity	None (default), Odd, Even
Appliance interface	RS-485 two-wire cable connection
Slave address	1 – 247, 1 (default)

Inverter Configuration

Setting the Modbus slave address through eConfigure CL125 APP

The Modbus Slave address (or Inverter ID) must be unique for each device on the Modbus network. The Modbus Slave address may be read and/or modified via the eConfigure CL125 APP. The Inverter address is selected using the menus shown below. Once the desired inverter address and baud rate is selected, press back button to confirm the address and baud rate. The Inverter address can be any number between 1 and 247.

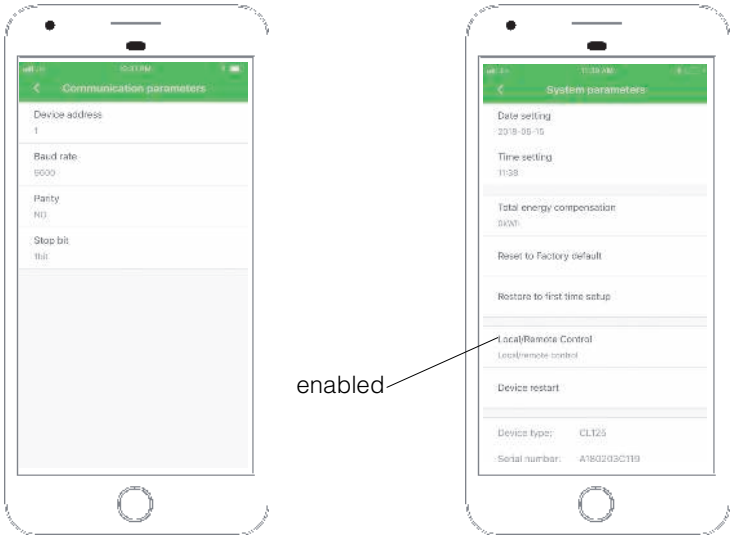

Figure 3 Setting Parameters Using eConfigure CL125 APP

Modbus Map: Conext™ CL125 Device

503-0271-01-01
Revision A

Notice of Confidentiality

The information contained in this document is confidential and is the exclusive property of Schneider Electric. It may not be disclosed to any person without the express written consent of Schneider Electric.

⚠ WARNING

UNINTENDED OPERATION

The use of this product with Modbus communications requires expertise in the design, operation, and programming of the device. Only qualified persons should program, install, alter, and commission this product.

When writing values to the device, you must ensure other persons are not working with the device.

Failure to follow these instructions can result in death or serious injury, and/or equipment damage.

⚠ WARNING

LOSS OF CONTROL

Do not assign the same address to two Modbus devices. The entire serial bus may behave unexpectedly if the master device cannot communicate with all the slave devices on the bus.

Failure to follow these instructions can result in death or serious injury, and/or equipment damage.

Overview

This document describes the structure of the Modbus register address map, which is used to configure, control, and monitor the Conext CL125. The information in this document is intended for use only by qualified persons who have a detailed technical understanding of the Modbus protocol.

The Modbus map is divided into rows of Modbus registers. Each row indicates the Modbus register address, its name, data type, data range, units, and applicable notes as required.

External Modbus Master devices can read and write the Modbus registers to configure, control, or monitor the device remotely.

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Document Applicability

The Conext CL125 Device Modbus Map applies to the following products, as listed in Table 1.

Table 1 Applicable Products

Product ID	Product Description
PVSCL125E	Conext CL125
PVSCL125A	eConfigure CL125 APP

Supported Modbus Data Types

Table 2 lists the supported data types.

Table 2 Modbus Data Types

Format	Data Type	Range
UINT16	16-bit unsigned integer	0 to 65,535
INT16	16-bit signed integer	-32,768 to +32,767
UINT32	32-bit unsigned integer	0 to 4,294,967,295
INT32	32-bit signed integer	-2,147,483,648 to +2,147,483,647
UINT8	8-bit unsigned character	0 to 255

Modbus RS485 Logical Layer

Modbus Packet Structure

Every Modbus packet consists of four fields:

- Slave address field
- Function field
- Data field
- Error check field (checksum)

NOTE:

The values shown in the packets are in hexadecimal format.

In Table 3 that shows the packet structure, the DATA field of the packet is shown in cells with white background.

Table 3 Modbus Packet Structure

Address	Function Code	Data	Checksum

Slave address field

The slave address field of a Modbus packet is one byte in length and uniquely identifies the slave device involved in the transaction. Valid addresses range between 1 and 247.

A slave device performs the command specified in the packet when it receives a request packet with the slave address field matching its own address.

A response packet generated by the slave has the same value in the slave address field.

Function field

The function field of a Modbus request packet is one byte in length and tells the

addressed slave which function to perform. Similarly, the function field of a response packet tells the master what function the addressed slave has just performed.

Data field

The data field of a Modbus request is of variable length, and depends on the function. This field contains information required by the slave device to perform the command specified in a request packet or data being passed back by the slave device in a response packet.

Data in this field is contained in 16-bit registers. Registers are transmitted in the order of high-order byte first, low-order byte second.

Example

A 16-bit register contains the value 0x12AB. This register is transmitted:

- High order byte = 0x12
- Low order byte = 0xAB

This register is transmitted in the order 12 AB.

Error check field (checksum)

The checksum field lets the receiving device determine if a packet is corrupted with transmission errors. In Modbus RTU mode, a 16-bit Cyclic Redundancy Check (CRC-16) is used.

The sending device calculates a 16-bit value, based on every byte in the packet, using the CRC-16 algorithm. The calculated value is inserted in the error check field.

The receiving device performs the calculation, without the error check field, on the entire packet it receives. The resulting value is compared to the error check field. Transmission errors are indicated when the calculated checksum does not equal the checksum stored in the incoming packet. The receiving device ignores a bad packet.

Packet Communications

This section describes the Modbus functions supported by the inverter.

Table 4 Data format for the RS485 connection

Function (Decimal/Hex)	Meaning	Action	See...
03/03h	Read Holding Registers	Reads a value from one or more consecutive holding registers in the inverter.	“Function 03: Read Holding Registers Example” on page 4
04/04h	Read input registers	This function code is used to read from 1 to 125 contiguous input registers in a remote device. Input registers are read-only.	
06/06h	Write Holding Registers	Writes a value into one holding register in the inverter.	Function 06h

Table 4 Data format for the RS485 connection

Function (Decimal/Hex)	Meaning	Action	See...
16/10h	Write Multiple Registers	Writes a value into one or more consecutive holding registers in the inverter.	"Function 16: Write Multiple Registers writes example" on page 5

Function 03: Read Holding Registers Example

To read the inverter parameter values, a master must send the slave device (inverter) a Read Holding Registers request packet.

The Read Holding Registers request packet specifies a start register and number of registers to read. (You can read 1 or more registers.) The start register may be from 0 to 65535 (0xFFFF).

NOTE: Addresses are 0-based ("on the wire" addressing) and not 1-based ("traditional" addressing).

The inverter responds with a packet containing the values of the registers in the range defined in the request.

Table 5 Read Holding Registers Packet Structure

Request packet (master to slave)	Response packet (slave to master)
Unit ID/slave address (1 byte)	Unit ID/slave address (1 byte)
03 (function code) (1 byte)	03 (function code) (1 byte)
Start register (sr) (2 bytes)	Byte count (2 x nr) (1 byte)
# of registers to read (nr) (2 bytes)	First register in range (2 bytes)
CRC checksum	CRC checksum (2 bytes)

Example

The inverter is configured as a Modbus slave device with slave address 5. The master requests to read the grid voltage. This parameter is made available in the Modbus map at address 0x138F with a scaling factor of 0.1

Table 6 Request Packet

Slave	Function	Start register		# of registers (3)		CRC Checksum	
05	03	13	8F	00	01	B0	E1

Table 7 Response Packet

Slave	Function	Byte count	Register 1		CRC Checksum	
05	03	02	03	E8	49	3A

The master retrieves the data from the response:

- Register 0x138F: 0x03EA = 1000

Function 16: Write Multiple Registers writes example

The Write Multiple Registers command packet allows a Modbus master to configure or control the slave inverter.

A Write Multiple Registers data-field request packet contains a definition of a range of registers to write to, and the values that are written to those registers.

The slave inverter responds with a packet indicating that a write was performed to the range of registers specified in the request.

The Preset Multiple Registers request and response packet formats are shown in the following example transaction.

Table 8 Preset Multiple Registers packet structure

Request packet (master to slave)	Response packet (slave to master)
Unit ID/slave address (1 byte)	Unit ID/slave address (1 byte)
16 (function code) (1byte)	16 (function code) (1 byte)
Start register (sr) (2 bytes)	Start register (sr) (2 bytes)
# of registers to write (nr) (2 bytes)	# of registers written (nr) (2 bytes)
Byte count (2 x nr) (1 byte)	CRC checksum (2 bytes)
First register in range (2 bytes)	
Second register in range (2 bytes)	

NOTE: Except for the register data fields, the Preset Registers Response packet has the same fields as the Read Registers Request packet.

Example

Under “Active Power Control” section enable the “power limitation switch” and write the required value to “power limitation setting” registers of the inverter at Modbus address 05 (0x05).

The power limitation switch and power limitation setting are available at the registers start from 0x138E.

The value 0xAA enables the Power limitation switch to ON condition and value of 0226h reduces the active power percentage to 55%.

Table 9 and Table 10 show the request packet and response from inverter.

Table 9 Request packet

Slave	Function (Hex)	Start register		# of registers	Byte count	Register 1		CRC checksum	
05	10	13	8E	0002	04	0x0 0AA	0x0 226	16	D9

Table 10 Response packet

Slave	Function	Start register		# of registers		CRC checksum	
05	10	13	8E	00	02	24	E3

Broadcasts over RS485

Broadcast request packets from the master are supported. Broadcasts are valid only with Function code16 and 06 are triggered by setting the slave address to in the request packet to zero (0). All slaves will receive and execute the request, but will not respond.

NOTE: Broadcast is valid only on RS485 Modbus connection and after the broadcast, it is recommended to read back the registers and confirm the values written are valid.

Modbus Data Types

This section describes the data types supported by the inverter. The available formats may vary, depending on your inverter type and firmware.

Table 11 Modbus data types

Format	Data type	Range
UINT16	16-bit unsigned integer	0 to 65,535
INT16	16-bit signed integer	-32,768 to +32,767
UINT32	32-bit unsigned integer	0 to 4,294,967,295
INT32	32-bit signed integer	-2,147,483,648 to +2,147,483,647
UINT8	8-bit unsigned character	0 to 255

16-bit integer format

The unsigned and signed 16-bit integer formats are the smallest addressable units when using the Modbus protocol. Each input register to the module corresponds to one 16-bit Modbus holding register output.

32-bit integer format

To accommodate values that can reach beyond the 16-bit range, the Modbus Slave module provides a 32-bit integer format as an output option.

A 32-bit register is passed via communications as two 16-bit registers—one high-order register and one low-order register.

High-order register

- $register_{high}$ = value/65536

Low-order register

- $register_{low}$ = value modulus 65536

Example on unsigned 32-bit

The “Energy production Lifetime” is a 32-bit value and stored across two modbus registers at an address 0x138B as shown.

Assume the value is 234591 is stored in unsigned 32-bit integer format:

- $Register_{low(0x138B)}$ = 0x945F
- $Register_{high0x138C}$ = 0x0003
- value = $register_{high}$ x 65536 + $register_{LOW}$
- 234591 = 0x0003945F

8-bit unsigned character format

The 8-bit Unsigned Character format is used to encode ASCII strings within the Modbus registers.

The characters are stored in the order they occur within the string, and populate the Most Significant Byte (MSB) of the Modbus 16-bit register followed by the Least Significant Byte (LSB) of the Modbus 16-bit register. For example, the ASCII string “LCD_CL125”.

Table 12 Modbus ASCII string encoding example

Register 1		**Register 2**		**Register 3**	
0x1359		0x135A		0x135B	
4c	43	44	5F	43	4c

Modbus Error Responses

If the inverter receives an unsupported Modbus request, it returns an exception response informing the Modbus master of the nature of the error.

The Modbus Error Response message has two fields that differentiate it from a normal response: Function Code Field and Data Field.

Function Code Field

In a normal response, the inverter echoes the function code of the original request in the function code field of the response. All the function codes have a most-significant bit (MSB) of 0 (their values are all below 0x80).

In an exception response, the inverter sets the MSB of the function code to 1. This makes the function code value in an exception response exactly 0x80 higher than the value for a normal response. For example, a normal response of 0x03 (Read Holding Registers), becomes 0x83 (Unable to Read Holding Registers).

Data Field

In an error response, the inverter uses the data field of the response packet to return an error code to the Modbus Master. Four error codes are supported, as shown in Table 13.

Table 13 Modbus error codes

Error code	Error name	Error description
01	Illegal Function	The inverter does not support the function code specified in the Modbus Request Packet.
02	Illegal Address	The address range specified in the Modbus Request Packet contains an illegal register address. **NOTE:** Refer to Table 4 for supported function
03	Illegal Data Value	The Modbus Request Packet contains an illegal number of bytes in the data field. **NOTE:** All unused address contains a value 0xFF and no exception occurs in Conext CL.
04	Slave Device Failure	An unrecoverable error occurred while the inverter (slave) was attempting to perform the requested action

Registers

Section 1: Operation Variables

Table 14 Operation Variables - Modbus Addresses and Registers

Modbus Address	Register Description	Data Type	Default Value/ Data Range	Units	Notes
0x1355	Protocol No.	U32			
0x1357	Protocol ver.	U32			
0x1359	LCD Software Version	str30			Data type: UTF-8
0x1368	DSP software version	str30			
0x137D	SN (Serial Number)	str10			Data type: UTF-8
0x1387	Device type code	U16	335		Value for Conext CL125
0x1388	Nominal output power	U16		0.1kW	
0x1389	Output type	U16	2:3P3L		1 = 3P4L system 2 = 3P3L system
0x138A	Daily power yields	U16		0.1 kWh	
0x138B	Total power yields	U32		kWh	
0x138D	Total running time	U32		h	
0x138F	Internal temperature	S16		0.1DegC	
0x1390	Total Apparent Power	U32		VA	
0x1392	DC Voltage1	U16		0.1V	
0x1393	DC current1	U16		0.1A	
0x1398	Total DC power	U32		W	
0x139A	A-B line voltage Or Phase A voltage	U16		0.1 V	L-L voltage
0x139B	B-C Line Voltage Or Phase B Voltage	U16		0.1 V	L-L voltage
0x139C	C-A Line Voltage Or Phase C Voltage	U16		0.1 V	L-L voltage
0x139D	Phase A current	U16		0.1 A	
0x139E	Phase B current	U16		0.1 A	
0x139F	Phase C current	U16		0.1 A	
0x13A6	Total active power	U32		W	
0x13A8	Reactive power	sint32		var	
0x13AA	Power factor	S16		0.001	>0 (leading) <0 (lagging)
0x13AB	Grid frequency	U16		0.1 Hz	
0x13AD	Inverter operating state	U16			Refer to “Device States (register address: 0x13AD)” on page 15.

Table 14 Operation Variables - Modbus Addresses and Registers

Modbus Address	Register Description	Data Type	Default Value/ Data Range	Units	Notes
0x13AE	Fault/Alarm time: Year	U16			Registers (0x13AE-0x13B3) are valid only when operating state is in Alarm (0x5500 or 0x9100).
0x13AF	Fault/Alarm time: Month	U16			
0x13B0	Fault/Alarm time: Day	U16			
0x13B1	Fault/Alarm time: Hour	U16		hrs	
0x13B2	Fault/Alarm time: Minute	U16		min	
0x13B3	Fault/Alarm time: Second	U16		sec	
0x13B4	Fault/Alarm code 1	U16			Refer to “Alarm Codes” on page 16.
0x13B8	Normal Reactive Output Power	U16		0.1kvar	
0x13CE	Impedance to the ground in parallel connection	U16	1-20000 (65535: invalid)	1kΩ	
0x13D8	Device Work state	U32			Refer to “Operation State Bit Map” on page 24.
0x13F8	Daily running time	U16		1min	
0x13F9	Present country	U16			Refer to “Country Code Information” on page 24.
0x1407	Monthly power yields	U32		0.1kWh	
0x1419	Negative voltage to the ground	S16	(-10000 - 10000)	0.1V	
0x141A	Bus voltage	U16	0-15000	0.1V	
0x141B	Grid frequency	U16		0.01Hz	
0x141F	Fan Status	U16			Bit wise status of internal Fans, 0 = Working, 1= Fault

Section 2: Configuration Parameters

Read configuration parameters using Modbus function code 0x4h.

Write configuration parameters using Modbus function codes 0x6h or 0x10h.

Table 15 Configuration Parameters

Modbus Address	Register Description	Data Type	Data Range	Units	Notes
0x1387	System clock Year	U16	2018-2036		Year value
0x1388	System clock Month	U16	1-12		Month Value
0x1389	System clock Day	U16	0-31		Day value
0x138A	System clock Hour	U16	0-23		Hour value in 24 hour format

Table 15 Configuration Parameters

Modbus Address	Register Description	Data Type	Data Range	Units	Notes
0x138B	System clock Minute	U16	1-59		Minute value
0x138C	System clock Second	U16	1-59		Seconds value
0x138D	Start/Stop Inverter	U16	0xCF: Start 0xCE: Stop 0xBB: Emergen cy stop		
0x138E	Active Power control	U16	0xAA: Enable; 0x55: Disable		Enable this option to do Active power control. To setup active power limit permanent (across inverter power reset), Enable the "Active setup permanent" option using the CL125 App. This is recommend only if Active power limits are not changed frequently.
0x138F	Active Power limit in %	U16	0 -1000	0.001	Available when the power limitation switch (0x138E) is set to 0xAA
0x139A	Power factor setting	U16	-1000 – (-800) 800 – 1000	0.001	Available when the reactive power adjustment switch (0x13AB) is set to power factor setting valid (0xA1) > 0 means leading < 0 means lagging
0x139B	Reserved	U16			
0x13A9	Reserved	U16	NA	NA	NA
0x13AA	Reserved	U16			
0x13AB	Reactive power adjustment mode	U16	0x55: OFF, power factor returns to 1, reactive power percentage is 0; 0xA1: Enable Pf mode: power factor settings; 0xA2: Enable Reactive power percentage setting; 0xA3: Enable Q(P) curve configuration; 0xA4: Enable Q(U) curve configuration		
0x13AC	Reactive power percentage setting	S16	0 – 1000 0 – (-1000)	0.1%	Available when the reactive power adjustment switch (0x13AB) is set to Reactive power percentage setting valid (0xA2). To setup Reactive power limit permanent (across inverter power reset), Enable the "Reactive setup permanent" option using the eConfigure CL125 APP. This is recommend only if Active power limits are not changed frequently.
0x13AE	Active Power limit	U16	0-1250	0.1kW	Available when the power limitation switch (0x138E) is enabled

Table 15 Configuration Parameters

Modbus Address	Register Description	Data Type	Data Range	Units	Notes
0x13AF	Reactive power adjustment	S16	620 ~ 620	0.1	Available when the reactive power adjustment switch (0x13AB) is set to Reactive power percentage setting valid (0xA2)
0x13B0	Reserved	U16			
Not applicable for Country = Italy					
0x13BA	Lower Power	U16	0 - 500; default: 500	0.1	Lower Power < Upper Power
0x13BB	Upper Power	U16	500 - 1000; default: 1000	0.1	
0x13BC	Upper limit-PF(Cap)	U16	900 - 1000; default: 1000	0.001	
0x13BD	Lower limit-PF_Ind	U16	900 - 1000; default: 900	0.001	
0x13BE	Reserved	U16			
0x13D8	Lower U Limit	U16	800 - 1000; default: 800	0.1	
0x13D9	Upper U Limit	U16	1000 - 1200; default: 1150	0.1	
0x13DA	U1 Limit	U16	900 - 1100; default: 800	0.1	U1 Limit+Hysteresis < U2 Limit-Hysteresis
0x13DB	U2 Limit	U16	1000 - 1100; default: 1050	0.1	
0x13DC	Hysteresis	U16	0 - 50; default:0	0.1	
0x13DD	Lower Q/Sn	U16	(Ind) 0 - 500; default: 250	0.1	
0x13DE	Upper Q/Sn	U16	(Cap) 0 – 500; default: 250	0.1	
0x13DF	Reserved	U16			

Section 3: SunSpec Registers

Table 16 SunSpec Modbus Registers

Modbus Registers (Hex)	Name	Data Type	Data Range	Units	Notes
		Common Block (Common Elements			
0x9C40	C_SunSpec_ID	U32	1400204883		Value as per SunSpec Specification
0x9C42	C_SunSpec_DID	U16	1		SunSpec common model
0x9C43	C_SunSpec_Length	U16	66		
0x9C44	C_Manufacturer	STR*32	'Schneider Electric'		Manufacturer Name

Table 16 SunSpec Modbus Registers

Modbus Registers (Hex)	Name	Data Type	Data Range	Units	Notes
0x9C54	C_Model	STR*32	'PVSCL125'		Inverter Models Supported
0x9C64	C_Options	STR*16	'CL125'		Models Short Name
0x9C6C	C_Version	STR*16	'Vxx_Vxx_A_01'		LCD Firmware version
0x9C74	C_SerialNumber	STR*32	'xx xxx xxx xxx'		Inverter Serial Number
0x9C84	C_DeviceAddress	U16	1		Inverter Modbus Address
		Device Specific Block (Inverter Models)			
0x9C86	C_SunSpec_DID	U16	103		Value for 3-Phase inverter as per SunSpec
0x9C87	C_SunSpec_Length	U16	50		
0x9C88	I_AC_Current	U16		0.1A	
0x9C89	I_AC_CurrentA	U16		0.1A	
0x9C8A	I_AC_CurrentB	U16		0.1A	
0x9C8B	I_AC_CurrentC	U16		0.1A	
0x9C8C	I_AC_Current_SF	S16	-1		Scaling factor equivalent to divide by 10
0x9C8D	I_AC_VoltageAB	U16		0.1V	
0x9C8E	I_AC_VoltageBC	U16		0.1V	
0x9C8F	I_AC_VoltageCA	U16		0.1V	
0x9C90	I_AC_VoltageAN	U16	NA	NA	
0x9C91	I_AC_VoltageBN	U16	NA	NA	
0x9C92	I_AC_VoltageCN	U16	NA	NA	
0x9C93	I_AC_Voltage_SF	S16	1		Scaling factor equivalent to divide by 10
0x9C94	I_AC_Power	S16			
0x9C95	I_AC_Power_SF	S16	-1	10	Scaling Factor equivalent to multiple by 10
0x9C96	I_AC_Frequency	U16			
0x9C97	I_AC_Frequency_SF	S16	-2	0.01Hz	Scaling Factor equivalent to divide by 100
0x9C98	I_AC_VA	S16			
0x9C99	I_AC_VA_SF	S16	1	10	Scaling Factor equivalent to multiply by 10
0x9C9A	I_AC_VAR	S16			
0x9C9B	I_AC_VAR_SF	S16	1	10	Scaling Factor equivalent to multiple by 10
0x9C9C	I_AC_PF	S16			

Table 16 SunSpec Modbus Registers

Modbus Registers (Hex)	Name	Data Type	Data Range	Units	Notes
0x9C9D	I_AC_PF_SF	S16	-3		Scaling Factor equivalent to divide by 1000
0x9C9E	I_AC_Energy_WH	U32			
0x9CA0	I_AC_Energy_WH_SF	S16	2		Scaling Factor equivalent to multiple by 100
0x9CA1	I_DC_Current	U16	A		
0x9CA2	I_DC_Current_SF	S16	-1		Scaling Factor equivalent to multiple by 10
0x9CA3	I_DC_Voltage	U16	A		
0x9CA4	I_DC_Voltage_SF	S16	-1	NA	Scaling Factor equivalent to multiple by 10
0x9CA5	I_DC_Power	S16			
0x9CA6	I_DC_Power_SF	S16	2		Scaling Factor equivalent to multiple by 100
0x9CA7	I_Temp_Cab	S16			
0x9CAA	I_Temp_Other	S16	NA	NA	NA
0x9CAB	I_Temp_SF	S16	-1		Scaling Factor equivalent to divide by 10
0x9CAC	I_Status	U16			SunSpec Operating status 1: (Off) 2: (Wait for PV voltage) 3: (Starting) 4: (MPP) 5: (Regulated) 6: (Shutting down) 7: (Error) 8: (Standby)
0x9CAD	I_Status_Vendor	U16	NA	NA	NA

Table 16 SunSpec Modbus Registers

Modbus Registers (Hex)	Name	Data Type	Data Range	Units	Notes
0x9CAE	I_Event_1	BIT32			Bit0: Grounding/isolation fault Bit1: DC voltage high Bit2: NA (AC Disconnect Open) Bit3: NA (DC Disconnect Open) Bit4: Offline/Grid shutdown Bit5: NA (Enclosure opened) Bit6: Manual shutdown Bit7: Temperature high Bit8: Frequency high Bit9: Frequency low Bit10: AC voltage high Bit11: AC voltage low Bit12: NA (Fuse opened) Bit13: Temperature low Bit14: Data storage or communication failure Bit15: Hardware self-check error

Section 4: Device States (register address: 0x13AD)

The Operation State of the inverter is available at register 0x13AD.

Table 17 Device States

Work or Operating State	Values
Run	0x0
Stop	0x8000
Key stop	0x1300
Emergency Stop	0x1500
Standby	0x1400
Initial standby	0x1200
Starting	0x1600
Alarm run	0x9100
Derating run	0x8100
Dispatch run	0x8200
Fault	0x5500
Communicate fault	0x2500

Section 5: Alarm Codes

NOTE: If the problem persists, contact technical support at: http://solar.schneider-electric.com/tech-support.

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
002	0x0002	The grid voltage exceeds the inverter's permissible range. **NOTE**: Protection time and protection thresholds depend on the utility's requirements.	Measure the grid voltage. Follow instructions in the DANGER message at the beginning of this chapter. If the grid voltage exceeds the inverter's permissible range, contact the utility company for suggestions. If the grid voltage is within the inverter's permissible range, see NOTE on Section 5.
003	0x0003	Grid transient voltage exceeds the permissible range.	This is a short term event caused by transients in the grid. Wait for the inverter to recover automatically. See NOTE on Section 5.
004	0x0004	The grid voltage is below the inverter's permissible lower limit. **NOTE**: Protection time and protection thresholds depend on the utility's requirements.	Measure the grid voltage. Follow instructions in the DANGER message at the beginning of this chapter. If the measured grid voltage is below the permissible operational limit, contact the utility company for suggestions. If the measured grid voltage is within the permissible operating range of the inverter and the event persists, see NOTE on Section 5.
005	0x0005	The grid voltage is below the utility's under-voltage protection limit.	This could be a short term event due to grid conditions. Wait for the inverter to recover automatically. See NOTE on Section 5.
006	0x0006	The AC output current exceeds the inverter's protection limit.	The inverter will resume operation when the AC output current falls below the protection limit. If the event persists, see NOTE on Section 5.

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
007	0x0007	Transient AC over current	This may be a short term event. The inverter can recover automatically. Wait for a few minutes for the inverter to recover but if the event persists, see NOTE on Section 5.
008	0x0008	The grid frequency exceeds the inverter's permissible operating upper limit.	Measure the grid frequency. Follow instructions in the DANGER message at the beginning of this chapter. If the grid frequency is within the permissible operating range of the inverter and the event persists, see NOTE on Section 5. If the grid frequency is not within the permissible operating range of the inverter, contact the utility company for suggestions.
009	0x0009	The grid frequency is below the inverter's permissible operating lower limit.	
010	0x000A	Islanding	Check whether the AC breaker at the AC combiner box is turned ON. Check whether the inverter's AC disconnect switch is turned ON. Measure the grid voltage at the AC Connection to the Inverter. Follow instructions in the DANGER message at the beginning of this chapter. Check whether AC cables are all properly connected. Check whether the grid is in service. See NOTE on Section 5.
011	0x000B	The DC component of the AC current exceeds the inverter's limit.	This may be a short term event. The inverter can recover automatically. Wait for a few minutes for the inverter to recover but if the event persists, see NOTE on Section 5.
012	0x000C	Residual current leakage detected is high.	Check whether the insulation is low on the PV array or a higher leakage current in the inverter. See NOTE on Section 5.

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
013	0x000D	A grid condition event is detected that is outside of normal operations.	This condition may occur when grid voltage exceeds or falls below the inverter's permissible operating range. Contact the utility company for suggestions. The inverter can recover automatically. Wait for a few minutes for the inverter to recover but if the event persists, see NOTE on Section 5.
014	0x000E	Average grid over-voltage (10 minutes)	This condition occurs when grid voltage exceeds the inverter's permissible operating limit for an average of 10 minutes. Contact the utility company for suggestions. The inverter can recover automatically. Wait for a few minutes for the inverter to recover but if the event persists, see NOTE on Section 5.
015	0x000F	Grid impedance exceeds inverter's limit.	Verify that the type and size of AC cables as well as transformer impedance are specified according to the CL125 Solution Guides or local electrical regulations. Wait for the inverter to recover automatically. See NOTE on Section 5.
016	0x0010	AC output overload	Wait for the inverter to recover automatically. See NOTE on Section 5.
017	0x0011	Grid voltage imbalance	Wait for the inverter to recover automatically. Test the grid voltage to confirm the imbalance. See NOTE on Section 5.
019	0x0013	High transient DC bus voltage	Wait for the inverter to recover automatically. See NOTE on Section 5.
020	0x0014	High DC bus voltage	Wait for the inverter to recover automatically. See NOTE on Section 5.
021	0x0015	PV input over current	Check the PV configuration and connection. See NOTE on Section 5.

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
022	0x0016	Over current protection	If the grid or PV current is within the permissible operating range of the inverter and the event persists, see NOTE on Section 5.
023	0x0017	PV configuration mode has changed during normal operation.	Check the PV configuration. Restart the inverter.
024	0x0018	Voltage imbalance at neutral point	Wait for the inverter to recover automatically when the deviation falls within the permissible range. See NOTE on Section 5.
025	0x0019	Transient unbalance of voltage neutral point	Wait for the inverter to recover automatically when the deviation falls within the permissible range. See NOTE on Section 5.
026	0x001A	Bus voltage is fluctuating.	Wait for the inverter to recover automatically. See NOTE on Section 5.
028	0x001C	PV reverse connection is detected.	Check that the PV cables are connected from the PV source to the inverter's PV terminals with the correct polarity.
030	0x001E	Clamp capacitance over-voltage event is detected.	Wait for the inverter to recover automatically. See NOTE on Section 5.
031	0x001F	Clamp capacitance under-voltage event is detected.	Wait for the inverter to recover automatically. See NOTE on Section 5.
032	0x0020	Clamp capacitance imbalance event is detected.	Wait for the inverter to recover automatically. See NOTE on Section 5.
033	0x0021	Clamp capacitance pre-charge ground fault is detected	Wait for the inverter to recover automatically. See NOTE on Section 5.

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
036	0x0024	Module temperature is too high.	Verify that the DC input power is not greater than the DC:AC ratio of 1.5. If it is, then reduce DC input power. Check whether the inverter is directly placed under the sun and intense sun exposure is causing the inverter's module temperature to rise. Install a proper shade to shield the inverter from direct sunlight. See NOTE on Section 5.
037	0x0025	Internal ambient temperature is too high.	Check the functionality of the fans. Replace any broken fan if necessary. Clean the air outlet grates. See NOTE on Section 5.
038	0x0026	Line tie relay contacts have welded or are open.	Wait for the inverter to recover automatically. See NOTE on Section 5.
039	0x0027	Inverter insulation resistance event (ISO-flt)	Wait for the inverter to recover automatically. Test for insulation damages in the wiring. See NOTE on Section 5.
040	0x0028	AC (or DC) over-current or DC over-voltage event is detected.	Wait for the inverter to recover automatically. See NOTE on Section 5.
041	0x0029	Current leakage sampling channel event	Wait for the inverter to recover automatically. See NOTE on Section 5.
042	0x002A	AC current imbalance	Wait for the inverter to recover automatically. See NOTE on Section 5.
043	0x002B	The ambient temperature falls below -25 °C (-13 °F)	Stop operating the inverter and disconnect it from all power sources. Wait for the ambient temperature to rise within the permissible operating range and then restart the inverter.
044	0x002C	DC/AC inversion circuit event	Wait for the inverter to recover automatically. See NOTE on Section 5.

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
047	0x002F	PV configuration mode set on the eConfigure CL125 APP does not match the design.	Disconnect the inverter from all power sources. See the *Conext CL125 Owner's Guide (document number: 975-0793-01-01)* for more information under PV Array Connection to reconnect the PV strings and reselect PV configuration mode.
048	0x0030	Phase-R current sampling channel event	Wait for the inverter to recover automatically. See NOTE on Section 5.
049	0x0031	Phase-S current sampling channel event	Wait for the inverter to recover automatically. See NOTE on Section 5.
050	0x0032	Phase-T current sampling channel event	Wait for the inverter to recover automatically. See NOTE on Section 5.
051	0x0033	Hardware over voltage or over current protection	Refer to the *Conext CL125 Owner's Guide (document number: 975-0793-01-01)* for more information.
053	0x0035	Grid voltage redundancy event is detected.	Measure the grid voltage. Follow instructions in the DANGER message at the beginning of this chapter. If the measured grid voltage exceeds the permissible operational limit, contact the utility company for suggestions. See NOTE on Section 5.
054	0x0036	Grid frequency redundancy event is detected.	Measure the grid frequency. Follow instructions in the DANGER message at the beginning of this chapter. If the grid frequency exceeds the inverter's permissible range, contact the utility company for suggestions. If the problem persists but the grid frequency is within the inverter's permissible range, contact technical support at: http://solar.schneider-electric.com/tech-support

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
055	0x0037	Inverter insulation resistance redundancy event is detected.	Wait for the inverter to recover automatically. See NOTE on Section 5.
056	0x0038	Inverter leakage current redundancy event is detected.	Check if there is a ground fault at the PV string. See NOTE on Section 5.
059	0x003B	Main DSP communication redundancy event is detected.	Wait for the inverter to recover automatically. See NOTE on Section 5.
060	0x003C	Main DSP data comparison event is detected.	Wait for the inverter to recover automatically. See NOTE on Section 5.
070	0x0046	Fan event	Stop operating the inverter by disconnecting it from all power sources. Remove and replace the fan. See the *Conext CL125 Owner's Guide (document number: 975-0793-01-01)* for more information. To know which fan is affected, refer to the fan operation status in the eConfigure CL125 APP. See Table 19. See NOTE on Section 5.
071	0x0047	AC side SPD event	For AC SPD, see NOTE on Section 5.
072	0x0048	DC side SPD event	For DC SPD, see the *Conext CL125 Owner's Guide (document number: 975-0793-01-01)* for more information.
074	0x004A	Communication event	An event has occurred in the internal communication of the inverter. However, the inverter continues feeding into the grid. See NOTE on Section 5.
075	0x004B	Solar irradiation is not sufficient for inverter operation	Wait for sufficient sunlight. If this event recurs when irradiation is sufficient, check the PV system design and adjust the connection of PV inputs.

Table 18 Alarm Codes

Alarm Code (Decimal)	Alarm Code (Hex)	Description	Note
076	0x004C	PV overload condition	Check the PV system design and adjust the connection of PV inputs.
078	0x004E	PV power event warning	Check the PV input terminals for loose connections. Tighten the connections according to torque specifications found in the *Conext CL125 Owner's Guide (document number: 975-0793-01-01)* for more information. See NOTE on Section 5.

Table 19 Fan Event Codes

Fan Event - Operation Status	Description
0 0 0 0 1	Fan 1 experienced an event.
0 0 0 1 0	Fan 2 experienced an event.
0 0 1 0 0	Fan 3 experienced an event.
0 0 0 1 1'	Fans 1 & 2 experienced an event.
0 0 1 1 1	Fans 1-3 experienced an event.
0 1 0 0 0	Fan 4 (high power) experienced an event.
1 0 0 0 0	Fan 5 (low power) experienced an event.

1 means an event is detected. **0** means fan is healthy.

Section 6: Operation State Bit Map

Table 20 Operation State Bit Map

Work State (0x13D8-0x13D9)		
State	**Corresponding address in 0x13D8-0x13D9**	**Note**
Run	0	Total run state bit BIT17
Stop	1	1
Key stop	3	3
Emergency Stop	5	5
Standby	4	4
Initial standby	2	2
Starting	6	6
Alarm run	10	Total run state bit BIT17
Derating run	11	Total run state bit BIT17
Dispatch run	12	Total run state bit BIT17
Fault	9	Total fault state bit BIT18
Communicate fault	13	Total fault state bit BIT18
Total run bit (device is grid-connected running)	17	
Total fault bit (device is in fault stop state)	18	

Section 7: Country Code Information

Table 21 Country Code Information

Code	Country Short Name	Country	Note
0	GB	Great Britain	
1	DE	Germany	
2	FR	France	
3	IT	Italy	
4	ES	Spain	
5	AT	Austria	
6	AU	Australia	
7	CZ	Czech	
8	BE	Belgium	
9	DK	Denmark	
10	GR_L	Greece Land	
11	GR_IS	Greece Island	
12	NL	Netherlands	
13	PT	Portugal	
14	CHN	China	
15	SE	Sweden	

Table 21 Country Code Information

Code	Country Short Name	Country	Note
16	Other 50Hz		
17	RO	Romania	
18	TH	Thailand	
19	TK	Turkey	
20	AU-WEST	Australia (west)	
21	Reserved		
25	Vorarlberg (Austria)	Vorarlberg	District
26-59	Reserved		
60	CA	Canada	
61	US	America	
62	Other 60Hz		
70	JP 50Hz		
71	JP 60Hz		

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