C1002s

100A Current Sensor Module

Description

The C1002s module is used to measure bidirectional DC currents up to 100A and is ideal for off-grid setups. Using one channel to measure solar current and one channel for load current, it is possible to create a coulomb counting based algorithm to accurately estimate battery capacity.

The current transformers are a bidirectional, hall effect, open loop device based on the measuring principle of the hall effect, with a galvanic isolation between primary and secondary circuit. It provides accurate electronic measurement of DC currents in the range of 0—±150. The loop hole size is 21 mm.

It can be configured and controlled by any Modbus RTU master device over RS-485.

Material

Base	Nylon (Light Gray)

Dimensions & Weight

Length	112 mm
Width	40 mm
Height	88 mm
Weight	215 g

Features

- **Dual Current Channels**
  Bidirectional Hall Effect and Open Loop DC Current Transformers
- **Wide Measurement Range**
  Measure current in the range of +150 to -150 A with 12-bit Accuracy
- **RS-485 Modbus RTU Compatible**
  Interface with any Modbus RTU Master Device over RS-485

Conformity

Emissions	CISPR 22, Class A CISPR 32, Class A
Electrostatic Discharge	IEC EN 61000-4-2
Electrical Fast Transient	IEC EN 61000-4-4
Surge Immunity	IEC EN 61000-4-5

Device Calibration and Operation

In order to get accurate results, you may need to calibrate the current sensors. However, they come factory calibrated and usually do not require adjustment other than a possible small change to the zero-offset.

To set the zero-offset, make sure there is no current flowing through the wire, and read the CURRENTxRAW register value. Save this value in the CHxOFFSET register.

The default multiplier and divider give a range of +100A to -100A DC. The CURRENT1 register contains a positive value for currents flowing from up to down (solar to battery or load to battery) and a negative value for current flowing in the opposite direction. The register is calibrated with a multiplier of 100 (1A = 100). The sensors themselves give a maximum accuracy of about 30 mA with the 12-bit ADC.

Measurements are taken at approximately 1 kHz, and once a second the current output values are recalculated using the following formula (replace x with 1 or 2 for the respective channel):

*CURRENTx = (ADC Reading – CHxOFFSET) * CHxMUL / ChxDIV*

Additionally, if the CHxINVERT register is set to 1, CURRENTx is multipled by -1. If CHxINVERT is set to 0, no additional processing happens.

Modbus Interface

The C1002s module supports Modbus RTU over RS-485 and operates at fixed settings as follows:

- Baud Rate: 9600 bps
- Parity: None
- Stop Bits: 1
- Default ID: 1

While the default slave ID of this module is set to 1, it can be changed via Modbus register 10000.

There are two RJ45 sockets connected on opposite ends, which are used for providing power to the C1002s module, and for interfacing with the RS-485 bus. Devices can be daisy-chained together easily using this method with standard CAT5e/CAT6 networking cables. When used in conjunction with a Wattmon Data Logger, any standard Ethernet cable (straight through) can be used to connect with the C1002s to the Wattmon.

One of the RJ45 connectors has two LED indicators. The left LED indicates that the module is powered, and the right LED blinks when a data packet is transmitted. The second LED will blink slowly if the Modbus communication stops for a period over 30 seconds.

Physical Connectivity

When using the C1002s module with a third-party Modbus master, a custom patch cable may be required. To make such a cable, cut one end of a networking cable and wire it up as described in the table below. A power supply of 5V DC will be needed to power the module through the cable.

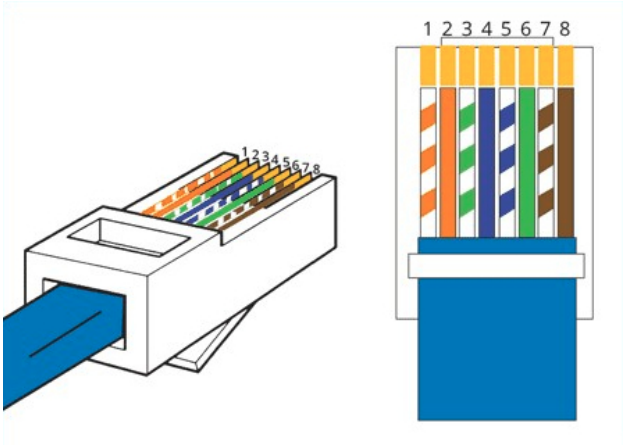

Figure 1: RJ45 Pinout

Pin	Description
1,2	GND (WHITE-orange, ORANGE-white)
3	Not Connected
4	A (D+) (BLUE-white)
5	B (D-) (WHITE-blue)
6	Not Connected
7,8	5V DC (WHITE-brown, BROWN-white)

MODBUS 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 the tables that show the packet structure, the white background denotes the *Data* field of the packet.

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 255.

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 a 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.

Modbus Functions

This module supports the following functions:

FUNCTION 3 – READ HOLDING REGISTERS

FUNCTION 4 - READ INPUT REGISTERS

FUNCTION 6 - WRITE SINGLE REGISTER

FUNCTION 16 - WRITE MULTIPLE REGISTERS

FUNCTION 17 - REPORT SLAVE ID

Function 04 : Read Input Register

To read the current parameter values, a Modbus master device must send the slave device (C1002s) a Read Input Registers request packet.

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

MODBUS INPUT REGISTERS MAP

Address (Decimal)	Register Name	Description
3000	CURRENT1	Calibrated Current Channel 1
3001	CURRENT1RAW	Raw ADC value of Calibration for Channel 1
3002	CURRENT2	Calibrated Current Channel 2
3003	CURRENT2RAW	Raw ADC value of Calibration for Channel 2

Each of the 10 channels has two registers: the calibrated current and the raw ADC value. The Raw ADC is 12-bit and will vary between 0 and 4096. The calibrated current will use the calibration constants stored in the EEPROM (accessible via function 03) to calculate the value. Note that the scale factor needs will depend on the calibration constants, but usually will be set to 100.

For example, a value of 103 for Channel 1 would indicate a current of 1.03A.

Function 03 : Read Holding Register

To read the calibration parameter values, a Modbus master must send the slave device (C1002s) a Read Holding Registers request packet.

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

MODBUS HOLDING REGISTERS MAP

Address (Decimal)	Name	Description
4000	CH1OFFSET	Zero-Offset for Channel 1. This is normally factory calibrated but may vary slightly depending on conditions and cable length.
4001	CH1MUL	Multiplier Value for Current 1
4002	CH1DIV	Divisor Value for Current 1
4003	CH1INVERT	Invert Current Direction for Channel 1
4004	CH2OFFSET	Zero-Offset for Channel 2
4005	CH2MUL	Multiplier Value for Current 2

4006	CH2DIV	Divisor Value for Current 2
4007	CH2INVERT	Invert Current Direction for Channel 2
10000	ADDR	Slave Address. This can be set using the WRITE SINGLE REGISTER (Function 6) to set the slave address and is Write Only. To read the slave address, use the REPORT SLAVE ID function.

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