A10

10-Channel ADC Module

Description

The A10 module can be used to measure up to 10 individual DC voltages in relation to the common ground rail. This can be used to measure a large number of items, such as individual battery voltages in a 48V pack, or to measure high voltage battery banks of up to 300V DC, and also the DC voltage from a solar panel.

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

Models

The A10 Module comes in three different variants:

- **A10-5V**
  Has a voltage rating of 0-5V DC. It can be used to measure instrumentation or sensors
- **A10-12V**
  Has a voltage rating of 0-15V DC. It is used primarily to measure 12V batteries or other low-voltage devices.
- **A10-300V**
  Has a voltage rating of 0-330V DC. It is used to measure high voltage battery banks or solar panels.

Features

- **10 Analog Voltage Inputs**
  Measure 10 individual DC Voltages in Relation to a Common Ground
- **RS-485 Modbus RTU Compatible**
  Interface with any Modbus RTU Master Device over RS-485
- **Monitor 3 Voltage Ranges**
  Available in three factory set ranges of 0-5V, 0-12V and 0-300V DC

Material

Base	Nylon (Light Gray)

Dimensions & Weight

Length	112 mm
Width	40 mm
Height	38 mm
Weight	60 g

Connector Details

Pin	Name	Description
1	GND	Ground Reference for Voltage Inputs
2	V1	Analog Voltage Input 1
3	V2	Analog Voltage Input 2
4	V3	Analog Voltage Input 3
5	V4	Analog Voltage Input 4
6	V5	Analog Voltage Input 5
7	V6	Analog Voltage Input 6
8	V7	Analog Voltage Input 7
9	V8	Analog Voltage Input 8
10	V9	Analog Voltage Input 9
11	V10	Analog Voltage Input 10
12	3V	3.3V Output

Modbus Interface

The A10 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 in parallel, which are used for providing power to the A10 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 patch cable (straight through) can be used to connect with the A10 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 A10 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.

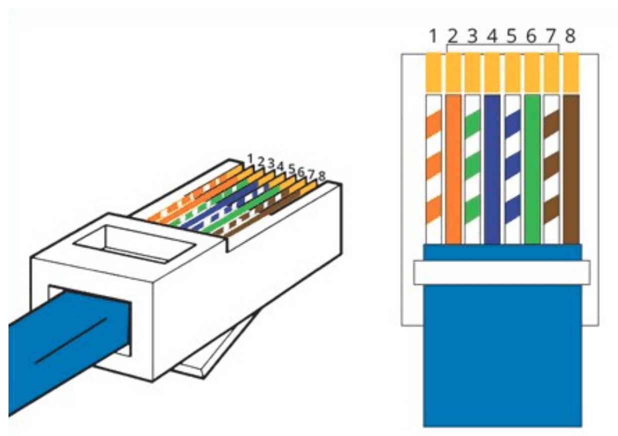

Figure 1: RJ45 Pinout

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 voltage parameter values, a Modbus master device must send the slave device (A10) 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	V1	Calibrated Voltage 1 (x SF)
3001	V1 Raw ADC	Raw ADC value of V1
3002	V2	Calibrated Voltage 2 (x SF)
3003	V2 Raw ADC	Raw ADC value of V2
3004	V3	Calibrated Voltage 3 (x SF)
3005	V3 Raw ADC	Raw ADC value of V3
3006	V4	Calibrated Voltage 4 (x SF)
3007	V4 Raw ADC	Raw ADC value of V4
3008	V5	Calibrated Voltage 5 (x SF)
3009	V5 Raw ADC	Raw ADC value of V5
3010	V6	Calibrated Voltage 6 (x SF)
3011	V6 Raw ADC	Raw ADC value of V6
3012	V7	Calibrated Voltage 7 (x SF)
3013	V7 Raw ADC	Raw ADC value of V7
3014	V8	Calibrated Voltage 8 (x SF)
3015	V8 Raw ADC	Raw ADC value of V8
3016	V9	Calibrated Voltage 9 (x SF)
3017	V9 Raw ADC	Raw ADC value of V9
3018	V10	Calibrated Voltage 10 (x SF)
3019	V10 Raw ADC	Raw ADC value of V10

Each of the 10 channels has two registers: the calibrated voltage and the raw ADC value. The Raw ADC is 12-bit and will vary between 0 and 4096. The calibrated voltage 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 10.

For example, a value of 103 for V1 would indicate a voltage of 10.3V

Function 03 : Read Holding Register

To read the calibration parameter values, a Modbus master must send the slave device (A10) 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	V1 Offset	Offset to 0 volts
4001	V1 Mul	Calibration multiplier for V1
4002	V1 Div	Calibration Divider for V1
4003	V1 Type	0 = Normal mode, 2=Max mode
4004	V2 Offset	Offset to 0 volts
4005	V2 Mul	Calibration multiplier for V2
4006	V2 Div	Calibration Divider for V2
4007	V2 Type	0 = Normal mode, 2=Max mode
4008	V3 Offset	Offset to 0 volts
4008	V3 Mul	Calibration multiplier for V3
4009	V3 Div	Calibration Divider for V3
4010	V3 Type	0 = Normal mode, 2=Max mode
4011	V4 Offset	Offset to 0 volts
4012	V4 Mul	Calibration multiplier for V4
4013	V4 Div	Calibration Divider for V4
4014	V4 Type	0 = Normal mode, 2=Max mode
4015	V5 Offset	Offset to 0 volts
4016	V5 Mul	Calibration multiplier for V5
4017	V5 Div	Calibration Divider for V5
4018	V5 Type	0 = Normal mode, 2=Max mode
4019	V6 Offset	Offset to 0 volts
4020	V6 Mul	Calibration multiplier for V6
4021	V6 Div	Calibration Divider for V6
4022	V6 Type	0 = Normal mode, 2=Max mode
4023	V7 Offset	Offset to 0 volts
4024	V7 Mul	Calibration multiplier for V7
4025	V7 Div	Calibration Divider for V7

4026	V7 Type	0 = Normal mode, 2=Max mode
4027	V8 Offset	Offset to 0 volts
4028	V8 Mul	Calibration multiplier for V8
4029	V8 Div	Calibration Divider for V8
4030	V8 Type	0 = Normal mode, 2=Max mode
4031	V9 Offset	Offset to 0 volts
4032	V9 Mul	Calibration multiplier for V9
4033	V9 Div	Calibration Divider for V9
4034	V9 Type	0 = Normal mode, 2=Max mode
4035	V10 Offset	Offset to 0 volts
4036	V10 Mul	Calibration multiplier for V10
4037	V10 Div	Calibration Divider for V10
4038	V10 Type	0 = Normal mode, 2=Max mode
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.

Channel Configuration Options

Each channel has four registers that can be used to configure the calibrated voltage output read by the corresponding input register.

The calibrated voltage is calculated using this formula:

VOLTAGE=OFFSET + RAWADC * MUL / DIV

Additionaly, the Type register can be set to 2 to record the maximum value since the last modbus read command. This can be used to capture pulses that last for a short duration. The ADC for each channel is sample several hundred times a second so even short pulses can be recorded.

Cynergy
Maitreye, Auroville
605 101 Tamil Nadu, India
Phone: (+91) 413 262 2059
Website: http://www.wattmon.com