# RTU-AO4 – 4 Channel Analogue Out Modbus RTU Module

**Documentation Issue 1.2**

# Features

- 4-20mA Out x 4 Channels
- Each channel independently Isolated
- Wide Loop Voltage Compatibility
- Software Modbus registers for
  - Current Channel setting
  - Channel calibration setting registers to accommodate line drift over time
  - Baud Rate
- Modbus Address selection via external "Push-On" jumper link setting
- Factory Reset Via "Push-On" link setting
- Integrated Watchdog and Power "Brown-Out" detect and correct

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# Safety and ESD Precautions

Before first use, refer to this manual.

Before first use, make sure that all cables are connected properly

Please ensure proper working conditions, according to the device specifications e.g. Supply voltage, ambient temperature, maximum power consumption requirements.

Ensure all wiring and connector terminals are securely fastened so as to avoid short circuits or other such damage.

Before making any modifications to wiring connections or PCB settings, turn off the power supply.

**Caution -** Component damage. Circuit boards contain electronic components that are extremely sensitive to static electricity. Ordinary amounts of static electricity from clothing or the work environment can destroy the components located on these devices.
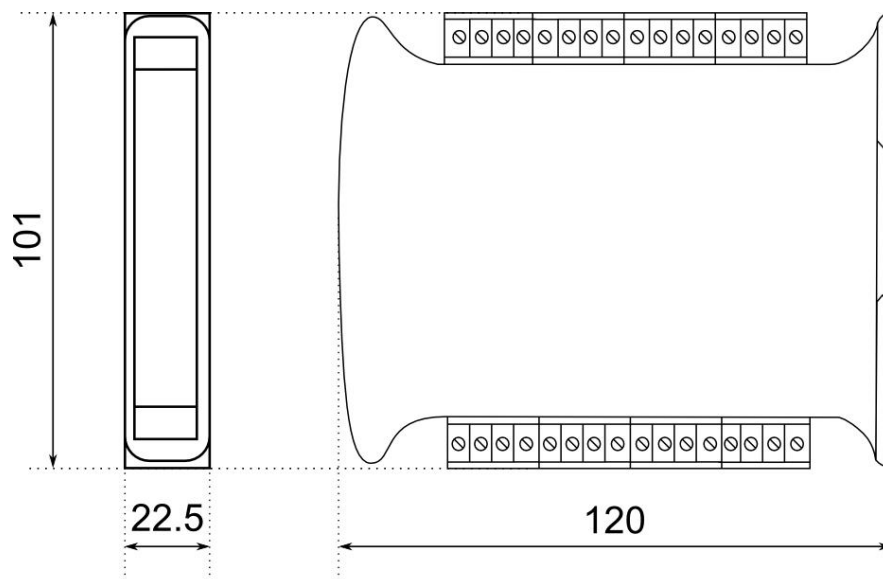
Do not touch the components without antistatic precautions, especially along the connector edges.

*Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.*

# Specifications

| | | |
|---|---|---|
| **Power Supply** | Voltage | 6-28 VDC |
| | Maximum Current | 10mA @12V Max |
| **Analogue Output** | No of Outputs | 4 Channels |
| | Output range | 0 to 20.4mA |
| | Loop Voltage range | 9 to 33V |
| | Accuracy | ± 0.016 mA / 16µA |
| | DAC Output Resolution | 12 Bit |
| **Environmental Conditions** | Operating Temperature | -20°C to +70°C |
| | Storage Temperature | -40°C to +85°C |
| | Humidity | 0 .. 90 %<br>(non-condensing) |
| **Isolation** | Isolation | 1500 Vrms<br>(Between CPU/Power and each output channel) |
| **Dimensions** | Height/ Length | 120x101 mm |
| **Communication** | Protocol | Modbus RTU |
| | Baud | 9600-57600<br>(19200 Factory Default) |
| | Address | 1-31 |
| **EMC** | Rating | Class A (Industrial) |
| | Immunity | EN 61000-6-2 |
| | Emissions | EN 61000-6-4 |
| **IP** | IP Rating | IP20 |

# RTU Module Pin Out

**1 – 0V**
**2 – DC IN**

QUICK.COM

**3 – 0V**
**2 – RS485 B**
**1 – RS485 A**

**8 – CH4 –**
**7 – CH4 +**
**6 – CH3 –**
**5 – CH3 +**
**4 – CH2 –**
**3 – CH2 +**
**2 – CH1 –**
**1 – CH1 +**

# Status LEDs & Modbus ID



**Modbus Address ID Link Setting**
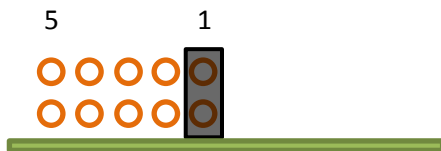


**Status LEDs**

|        | Top      | Bottom    |
|--------|----------|-----------|
| Green  | Power On | Modbus Rx |
| Red    | -        | Modbus Tx |

| Link No  | Address Setting       |
|----------|-----------------------|
| 1        | Modbus Address +1     |
| 2        | Modbus Address +2     |
| 3        | Modbus Address +4     |
| 4        | Modbus Address +8     |
| 5        | Modbus Address +16    |
| No Links | Use factory defaults* |

\* Factory Default setting :

- Address Id = 1
- Baud Rate = 19200 8N1

# Modbus Address ID Selection Link

| Addr | 5 | 4 | 3 | 2 | 1 |
|------|-----|-----|-----|-----|-----|
| 0* | OFF | OFF | OFF | OFF | OFF |
| 1 | OFF | OFF | OFF | OFF | ON |
| 2 | OFF | OFF | OFF | ON | OFF |
| 3 | OFF | OFF | OFF | ON | ON |
| 4 | OFF | OFF | ON | OFF | OFF |
| 5 | OFF | OFF | ON | OFF | ON |
| 6 | OFF | OFF | ON | ON | OFF |
| 7 | OFF | OFF | ON | ON | ON |
| 8 | OFF | ON | OFF | OFF | OFF |
| 9 | OFF | ON | OFF | OFF | ON |
| 10 | OFF | ON | OFF | ON | OFF |
| 11 | OFF | ON | OFF | ON | ON |
| 12 | OFF | ON | ON | OFF | OFF |
| 13 | OFF | ON | ON | OFF | ON |
| 14 | OFF | ON | ON | ON | OFF |
| 15 | OFF | ON | ON | ON | ON |
| 16 | ON | OFF | OFF | OFF | OFF |
| 17 | ON | OFF | OFF | OFF | ON |
| 18 | ON | OFF | OFF | ON | OFF |
| 19 | ON | OFF | OFF | ON | ON |
| 20 | ON | OFF | ON | OFF | OFF |
| 21 | ON | OFF | ON | OFF | ON |
| 22 | ON | OFF | ON | ON | OFF |
| 23 | ON | OFF | ON | ON | ON |
| 24 | ON | ON | OFF | OFF | OFF |
| 25 | ON | ON | OFF | OFF | ON |
| 26 | ON | ON | OFF | ON | OFF |
| 27 | ON | ON | OFF | ON | ON |
| 28 | ON | ON | ON | OFF | OFF |
| 29 | ON | ON | ON | OFF | ON |
| 30 | ON | ON | ON | ON | OFF |
| 31 | ON | ON | ON | ON | ON |

* Invokes Factory Default setting:

- Address Id = 1
- Baud Rate = 19200 8N1

# Analogue Output Wiring

An external power supply is required to power the loop, this can be between 9-33V DC

The RTU Analogue channel should be wired in "High Side" configuration as the Analogue Out section is power from the loop voltage.

Each of the Analogue Output channels features a low-voltage drop bridge rectifier so the wiring order for the RTU channel (for positive and negative pins) below is not critical and reduces the risk of damage due to incorrect wiring.

In 2-Wire sensor configuration the Analogue channel should be placed in-line with the positive power feed to the sensor, in this mode both the Analogue Out channel and the sensor draw their power from the loop power feed so be sure to use a high enough loop voltage to avoid offset errors (i.e. AO Power + Sensor power <4mA). In most cases a 24V loop power supply is sufficient.

In 3 or 4-Wire sensor configuration the sensor will provide a separate wire(s) for the Analogue control signal, in this case the power feed to the sensor is separate and may be the same or different voltage rating to the loop power feed. In this configuration place the Analogue channel in line with the loop control signal.
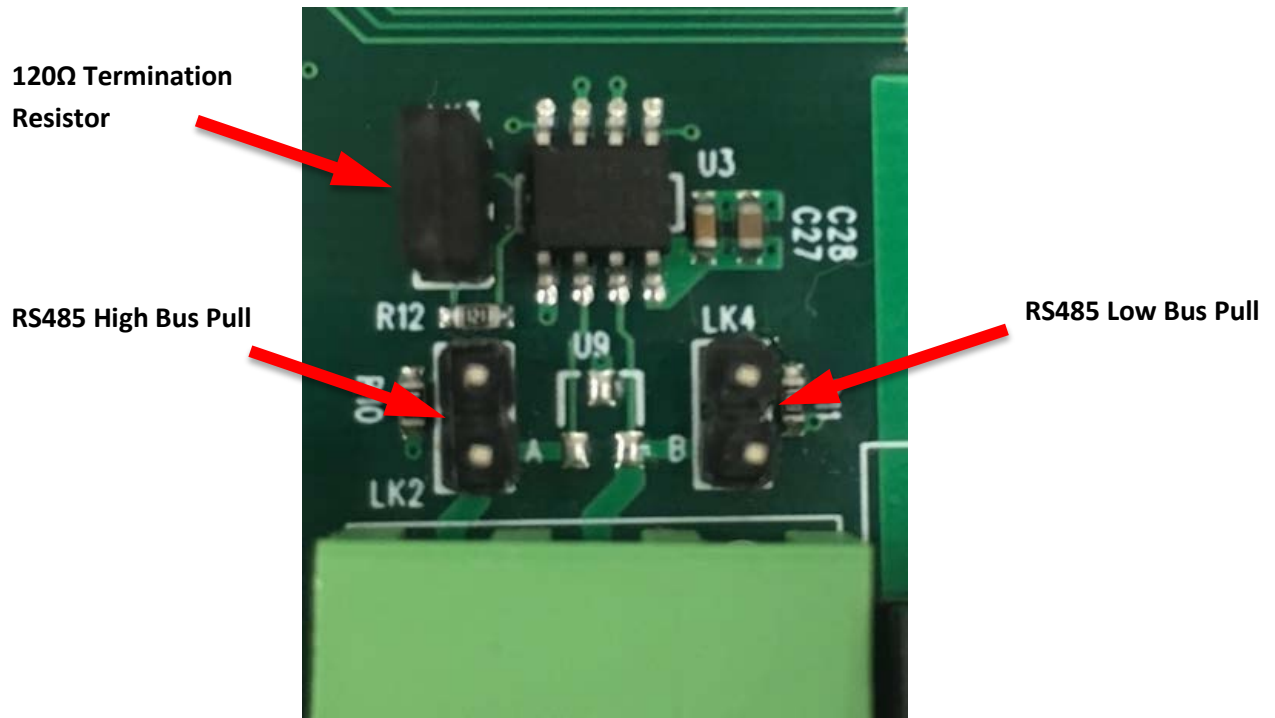
**2-Wire configuration**
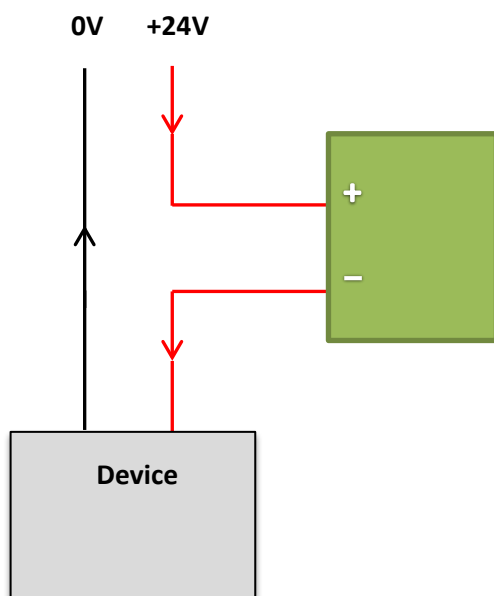
**3-Wire configuration**
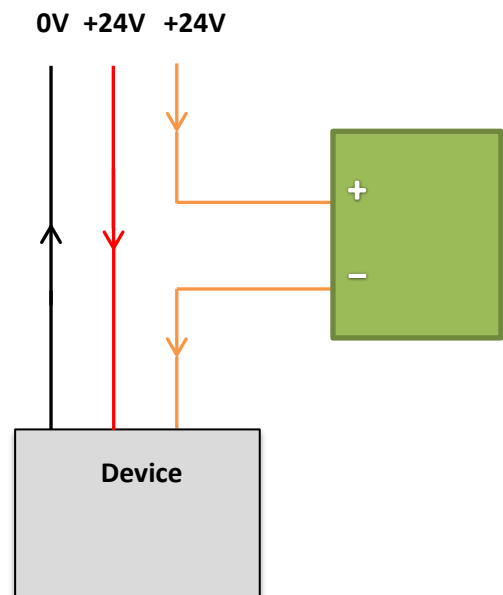
# RS485 Bus Option Links

Fit links below to enable the function shown

**120Ω Termination Resistor**

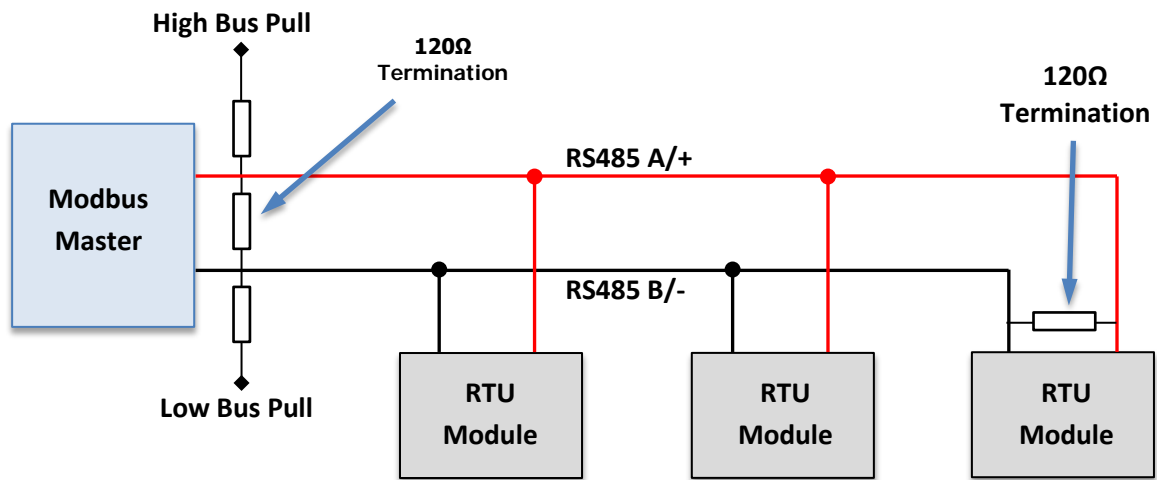**RS485 High Bus Pull**

**RS485 Low Bus Pull**

**⚠ Important: Only one set of bus data line pulls should be active, either at the master side or on a single slave**
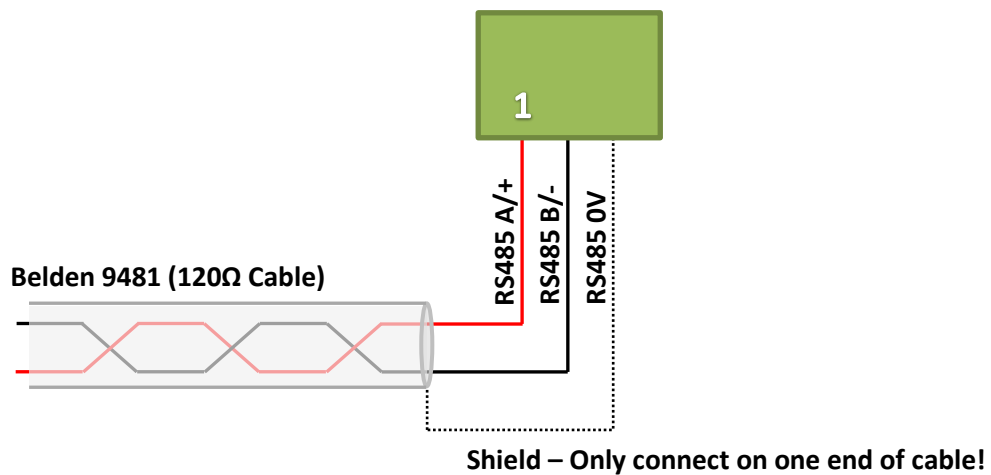
**⚠ Important: Termination resistors should only be enabled at far ends of bus**

# RS485 Bus Connection



# RTU Plug RS485 Wiring

# Modbus Registers – Readings

| Register | Type | Read/Wite | Description |
|---|---|---|---|
| 40001 | 16bit (Big Endian) | Read/Write | Channel 1 mA setting |
| 40002 | 16bit (Big Endian) | Read/Write | Channel 2 mA setting |
| 40003 | 16bit (Big Endian) | Read/Write | Channel 3 mA setting |
| 40004 | 16bit (Big Endian) | Read/Write | Channel 4 mA setting |

⚠ **Only function codes 0x03 (FC03) and 0x10 (FC16) are accepted by the module**

To **read** one or more registers you should use Modbus function code 3 – Read holding registers (4x Range)

To **write** one or more registers you should use Modbus function code 16 – Write multiple registers

To set an output value multiply desired mA by 100, writing 1834 to the respective channel's Modbus register gives 18.34mA output.

Valid settings are 0 to 2040  -- giving 0mA to 20.4mA range.

Note that this value setting is volatile and a system reboot or power off/on cycle will reset this value to 0

# Modbus Registers – Configuration

| Register | Type | Read/Wite | Description |
|---|---|---|---|
| 40011 | 16bit (Big Endian) | Read Only | CH1 Calibration Value |
| 40012 | 16bit (Big Endian) | Read Only | CH2 Calibration Value |
| 40013 | 16bit (Big Endian) | Read Only | CH3 Calibration Value |
| 40014 | 16bit (Big Endian) | Read Only | CH4 Calibration Value |
| 40015 | 16bit (Big Endian) | Read/Write | Modbus RTU Baud Rate |
| 40016 | 16bit (Big Endian) | Read/Write | Configuration Register |

**40011-40014    Channel Calibration Value**

This per-channel setting is the calibration value used to calculate the output value for the internal DAC, which affects the accuracy of the output mA to the programmed value over the full range.

Adjustments to this setting may be required periodically to re-calibrate the loop during the systems service life to account for drift.

Adjustments to this value, with a subsequent saving of the setting using the configuration register, will have an immediate effect on the output value

| Register Value | Channel Setting |
|---|---|
| 20015 | Factory default |
| 15000 | Lowest setting |
| 25000 | Highest Setting |

**40015 - Modbus Baud Rate**

This sets the serial baud rate of the unit – Default setting is 19200

| Register Value | Setting |
|:---:|:---:|
| 0 | 19200 |
| 1 | 9600 |
| 2 | 14400 |
| 3 | 19200 |
| 4 | 38400 |
| 5 | 57600 |

**40016 – Configuration Register**

Writing **255** to this register will cause the system to save the current configuration and reboot the unit if the baud rate setting has changed

| Register Value | Setting |
|:---:|:---:|
| 255 | Save Current Configuration Settings to EEPROM |

# Software Support

Open-Source code samples can be downloaded from the GitHub repositories below :

**RTU-RTD4 Software tool**

https://github.com/synapsertu/rtd-ao4

**Multi RTU module Logger**

https://github.com/synapsertu/rtu-log

# Modbus Utilities

The following windows and Linux command line utilities are useful for development

**Windows/Linux x86 Binary**

https://www.modbusdriver.com/modpoll.html

**Raspberry Pi/Linux**

https://github.com/epsilonrt/mbpoll

*Note that mbpoll does not use FC16 for Modbus writes