gridconnect®

grid 45

Modbus
User Guide

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Operation of this equipment in a residential area is likely to cause interference in which case the user, at his or her own expense, will be required to take whatever measures may be required to correct the interference.

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OVERVIEW

Introduction

The GRID45 OEM module is a powerful, Wi-Fi + Ethernet co-processor module that can be used in a wide variety of IIoT applications. It is designed to be a simple, easy to integrate add-on module to a host processor that provides all the necessary communication interfaces. The GRID45 is a fully integrated network solution in a small form factor module.

The module has a 32-bit CPU, memory, RJ45 wired Ethernet interface, Wi-Fi with external antenna interface, Bluetooth capable, and serial UART with RS232 and RS485 capability. The Wi-Fi interface supports a SoftAP for easy wireless configuration. The module comes with a robust serial tunneling application or optional Modbus TCP firmware. Other premium industrial protocols are also available. A complete evaluation board is available for testing and proof of concept.

A Web Manager provides a browser-based configuration and diagnostic tool. Configuration and device status can also be accessed via the setup menu through the serial line or a network port. The unit's configuration is stored in nonvolatile memory and is retained without power.

Hardware Description

The GRID45 module starter kit contains the following items:

- GRID45 module and evaluation board
- USB cable for easy serial communication with a PC
- +5VDC Power Supply (or similar power supply)

See the corresponding hardware user manual for specific information about the GRID45 module you are using.

Additional Documentation

The following guides are available for download on the internet.

Title	Description and Location
GRID45 Modbus User Guide	This document providing Quick Start instructions and describing the Modbus firmware configuration and operation. www.gridconnect.com
GRID45 Evaluation Kit User Guide	Provides the information needed to use the GRID45 Evaluation Kit. www.gridconnect.com
GRID45 Module Data Sheet	Documentation for the GRID45 module hardware. www.gridconnect.com

QUICK START

Follow these instructions to get your unit up and running fast.

You must first establish a network connection to the unit. This can initially be done using the wired Ethernet port or using the Wi-Fi interface. The configuration is done via an Internet browser. Once the network connection is established, the browser can be used to login to the unit directly and perform configuration.

To start with a Wi-Fi connection jump to the section on Wi-Fi Setup.

Ethernet Setup

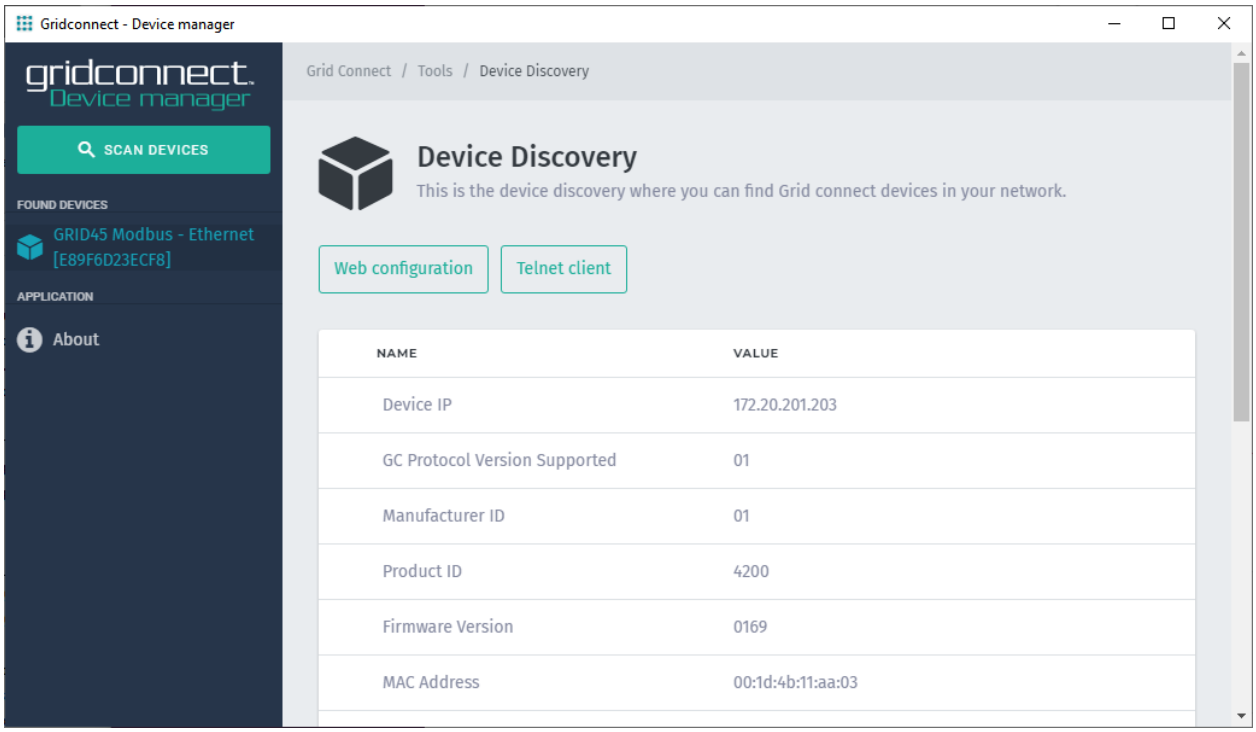
The following sections will detail the steps for basic setup of the GRID45 module over Ethernet.

1. Connect an Ethernet cable for your network to the RJ45 port.
2. Connect power to the GRID45 module host unit.

By default, the GRID45 module will attempt to get its network parameters for the Ethernet interface from a local DHCP server.

Finding the device on the network

1. Run the Grid Connect Device Manager software on a PC to find the GRID45 module on the network and determine its IP address which was assigned by your network's DHCP server. If you have not yet installed the Device Manager software you can download the installer from www.gridconnect.com
2. Upon launch, Device Manager will search for GRID45 series devices on the network. Select the GRID45 module from the found devices on the local network. (You may also click on the Scan Devices icon if your device isn't found immediately.)
3. Note the device IP address.
4. Access Web configuration by entering the device IP address in the address bar of a browser or clicking on the Web configuration icon in the Device manager. Proceed to the later section on GRID45 Module Web Configuration.


Gridconnect - Device manager
gridconnect.
Device manager
SCAN DEVICES
FOUND DEVICES
GRID45 Modbus - Ethernet [E89F6D23ECF8]
APPLICATION
About
Grid Connect / Tools / Device Discovery
Device Discovery
This is the device discovery where you can find Grid connect devices in your network.
Web configuration
Telnet client
NAME
VALUE
Device IP
172.20.201.203
GC Protocol Version Supported
01
Manufacturer ID
01
Product ID
4200
Firmware Version
0169
MAC Address
00:1d:4b:11:aa:03

Wi-Fi Setup

The following sections will detail the steps for basic setup of the GRID45 module over Wi-Fi.

1. Connect an antenna to the w.FL connector on the GRID45 module.
2. Connect power to the GRID45 module host unit.

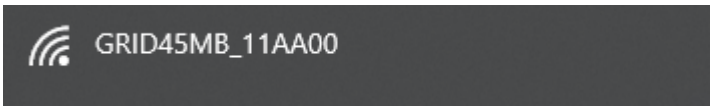
Finding the wireless SSID

By default, the Soft AP mode is enabled with a SSID of GRID45MB_xxxxxx, where xxxxxx are the last six hex digits of the unique GRID45 module serial number. An SSID of GRID45_xxxxxx is used when serial tunnel firmware is loaded. The serial number is derived from the module's base MAC address which is provided on the MAC address label on the module. For example, if the serial number on the label were 001D4B1BCD30, then the SSID would be GRID45MB_1BCD30.

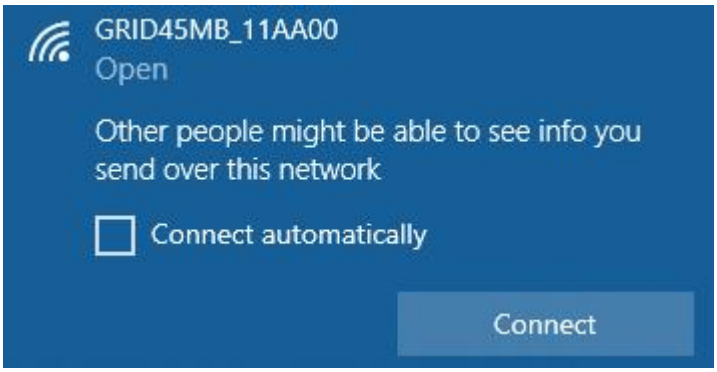
When power is applied to the GRID45, the wireless module will broadcast its own unique SSID. A WI-FI connection must be established before any useful communication can be made with the GRID45. Use a Wi-Fi enabled device to scan for available wireless networks.

Note: The following images were captured in Windows 10

Click on the wireless network connection status icon in the tool tray.



Click on the GRID45MB SSID link to display the connect screen.

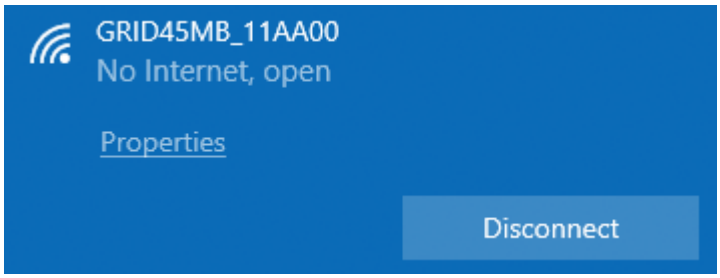


Making the Wi-Fi Connection

The default security for the GRID45 module Soft AP is open.

Click the 'Connect' button to establish the connection.

When the connection is made, the GRID45 module Soft AP network will show as connected.

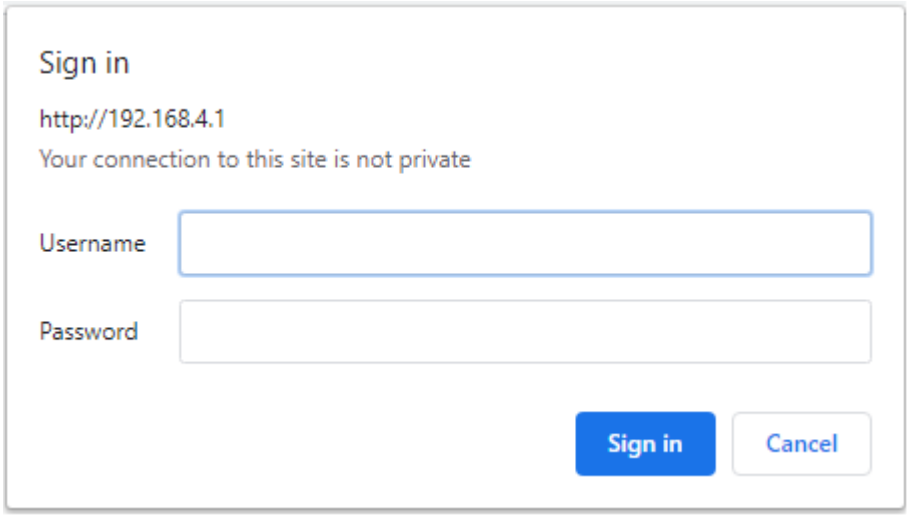


Access Web configuration by opening a web browser and navigate to the IP address 192.168.4.1. Continue to the GRID45 Module Web Configuration section below.

GRID45 MODULE WEB CONFIGURATION

Web Manager Entry

After navigating the browser to the GRID45 module's web interface you should have the following prompt:

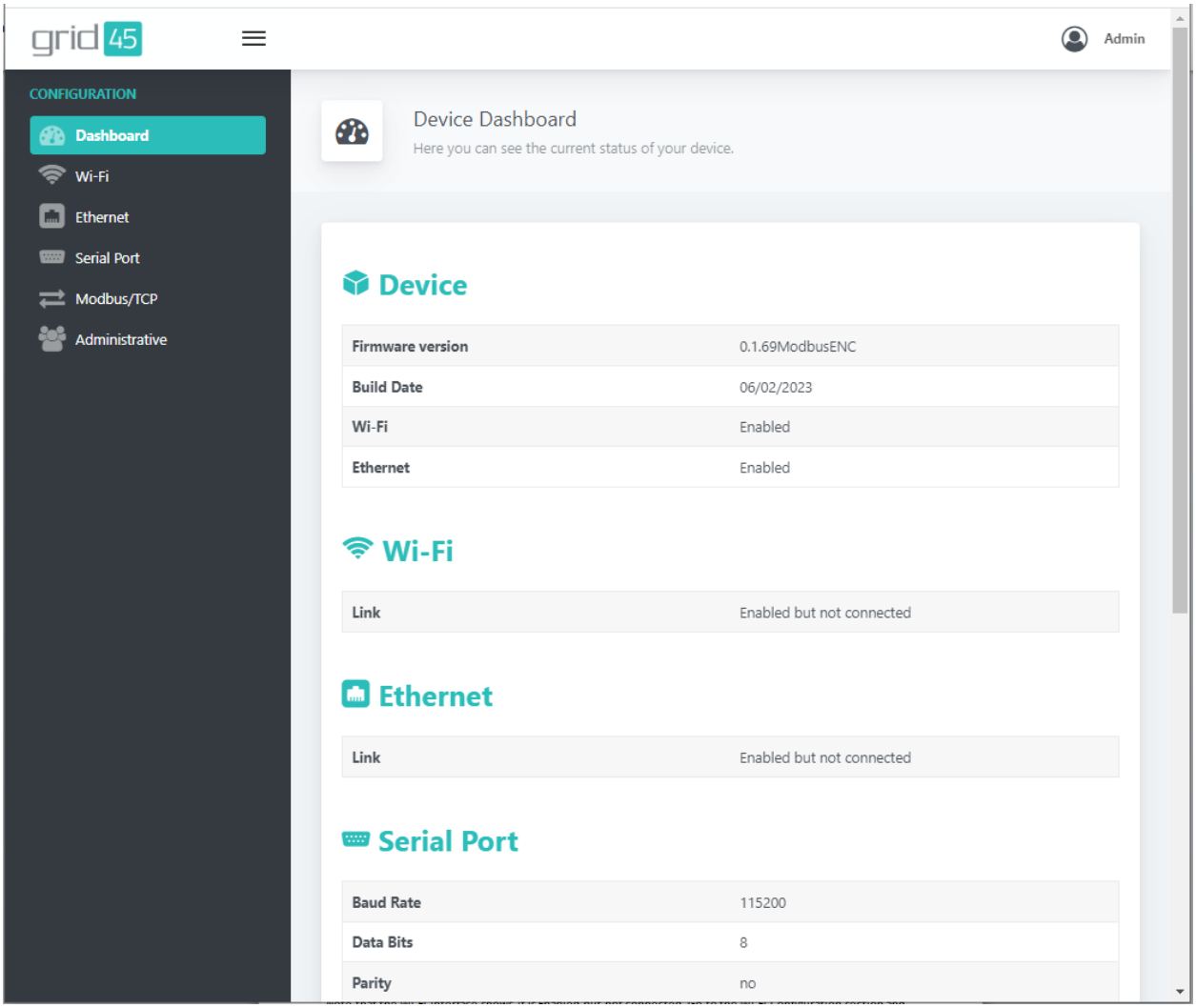


By default you should leave the User Name and the Password blank. Click "Sign in" to access the Web configuration pages.

If other Username and Password configuration settings have already been saved to the module then you should enter those security parameters instead.

Upon entering the correct Username and Password, you will see the Device Dashboard.

Device Dashboard



Note that the Wi-Fi Interface shows it is Enabled but not connected. Go to the Wi-Fi Configuration section and follow the steps to configure this interface. If you do not intend to use the Wi-Fi interface of the GRID45 or there is no external antenna attached then you should disable the Wi-Fi interface.

Go to the Ethernet Configuration section and follow the steps to configure the Ethernet interface.

Go to the Serial Port Configuration and adjust the settings to match your serial device.

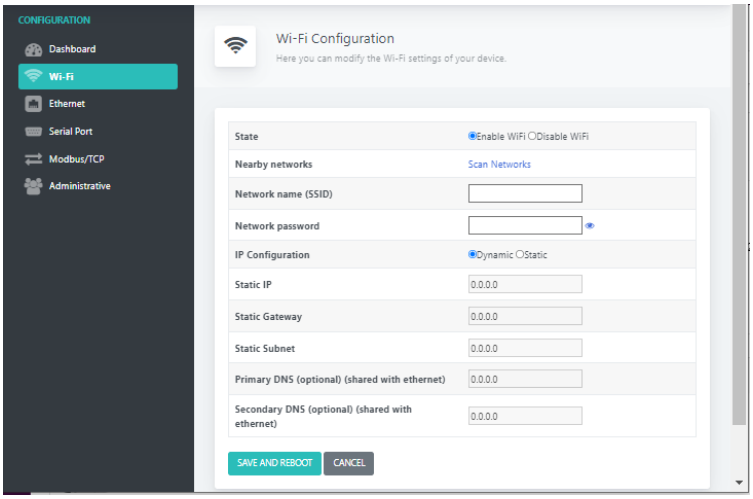
Go to the Modbus/TCP Configuration and verify the settings are appropriate for your Modbus/TCP client. The default settings do not normally need to be adjusted.

At this point, the GRID45 is configured and ready to access Modbus devices with a Modbus/TCP client program like ModScan.

Wi-Fi Configuration

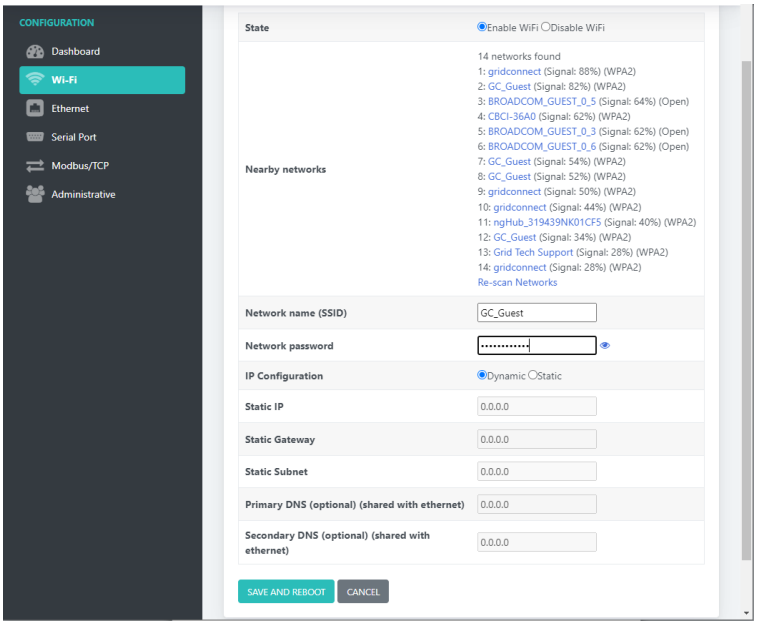
To communicate with the GRID45 module on your local Wi-fi network you will need to configure the wireless network interface. If you do not intend to use the Wi-Fi interface of the GRID45 or there is no external antenna attached then you should set the State to Disable Wi-Fi.

Select and click on the Wi-Fi menu option (left side).



Click on Scan Networks. This displays a scan of the wireless networks within range of the device (2.4GHz band only). The available networks sorted by signal strength are shown.

Click on the matching network name (SSID) for your Wi-Fi. In the following example, “GC_Guest” has been selected. You may also enter the Network name (SSID) directly.



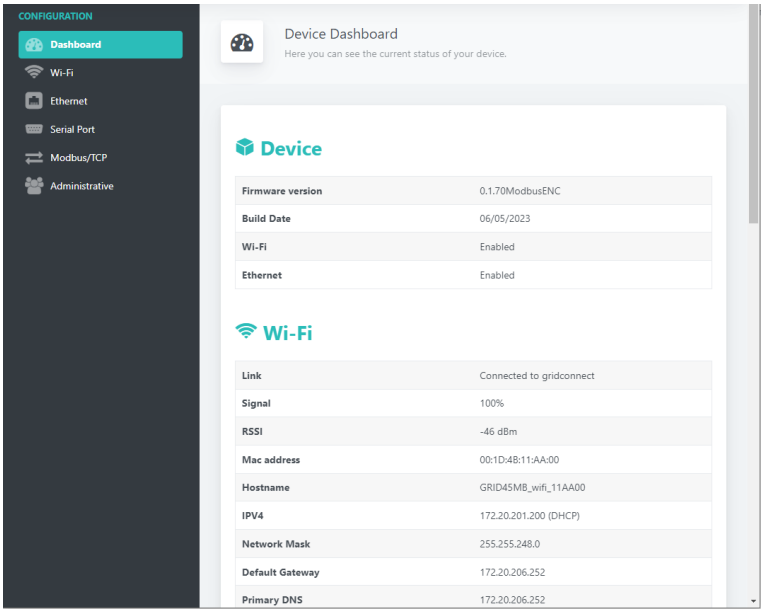
Enter the Network password (passphrase). Choose the type of IP Configuration, Dynamic (DHCP) or Static IP

address. If Static, then enter the IP settings. Click the **SAVE AND REBOOT** button when finished.

The device will reboot and startup with the new configuration.

State: Enable or Disable the Wi-Fi interface. If disabled, then the SoftAP will also be disabled. The SoftAP can be disabled separately on the Administrative settings page.
Network Name (SSID): Give the name of your Wi-Fi network.
Network password: Give the password or passphrase of your Wi-Fi network.
IP Configuration: The device will use Dynamic network settings from a local DHCP server or Static network settings assigned manually. Choose the Static option and the following settings will be made changeable.
Static IP: Sets the IP address of the device on the network (required). Make sure the IP address is unique on the network and outside the range that may be assigned by a DHCP server.
Static Gateway: Sets the IP address of the gateway on the local network. The gateway IP address only needs to be set if the device will communicate outside the local subnet.
Static Subnet: Sets the subnet mask that determines the size of the local subnet (required). Example: 255.0.0.0 for Class A, 255.255.0.0 for Class B, and 255.255.255.0 for Class C.
Primary DNS: Sets the IP address of the DNS server used as primary. The Modbus firmware does not currently use DNS.
Secondary DNS: Sets the IP address of the DNS server used as secondary. The Modbus firmware does not currently use DNS.

If the connection was successful, the Dashboard will show the Wi-Fi Link status as Connected.



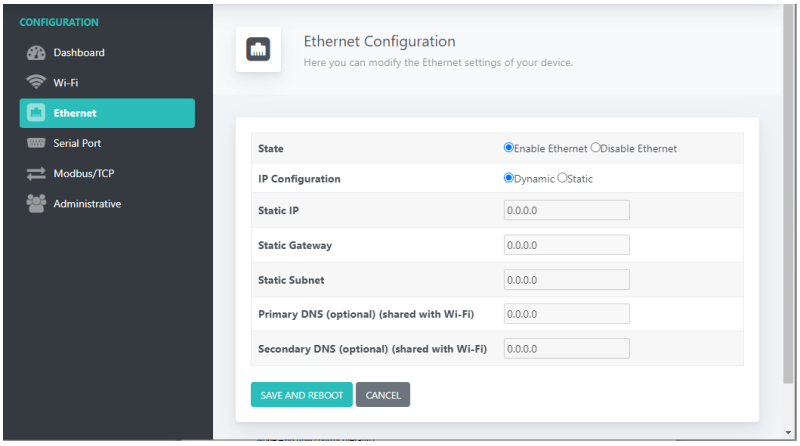
Note the IP address assigned to the module's Wi-Fi interface.

Note the MAC address used for the Wi-FI interface is the module's base MAC address.

Ethernet Configuration

By default the Ethernet interface will use DHCP to dynamically obtain an IP address and other network parameters. You will need to configure the Ethernet interface if you require static network parameters or if there is no DHCP server on the network.

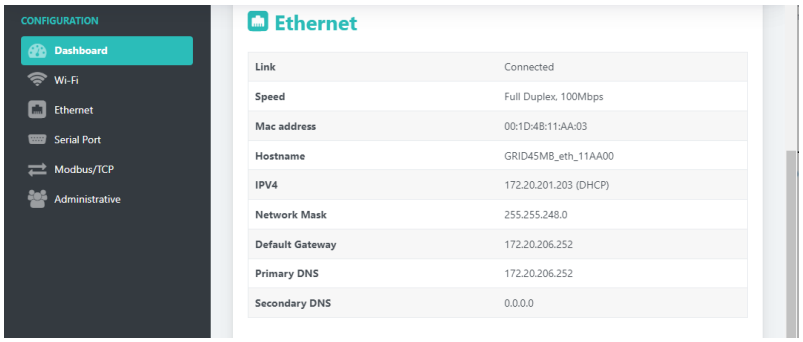
Select and click on the **Ethernet** menu option (left side).



Change the IP Configuration option to Static. Be sure to set the Static IP to an available address on your network. You will need to set the Static Subnet and if the module communicates outside the local subnet you will need to set the Static Gateway IP address. The DNS settings are not used for Modbus/TCP.

Click **SAVE AND REBOOT** to save settings permanently.

State: Enable or Disable the wired Ethernet interface
IP Configuration: The device will use Dynamic network settings from a local DHCP server or Static network settings assigned manually. Choose the Static option and the following settings will be made changeable.
Static IP: Sets the IP address of the device on the network. Make sure the IP address is unique on the network and outside the range that may be assigned by a DHCP server.
Static Gateway: Sets the IP address of the gateway on the local network. The gateway IP address only needs to be set if the device will communicate outside the local subnet.
Static Subnet: Sets the subnet mask that determines the size of the local subnet (required). Example: 255.0.0.0 for Class A, 255.255.0.0 for Class B, and 255.255.255.0 for Class C.
Primary DNS: Sets the IP address of the DNS server used as primary. The Modbus firmware does not currently use DNS.
Secondary DNS: Sets the IP address of the DNS server used as secondary. The Modbus firmware does not currently use DNS.

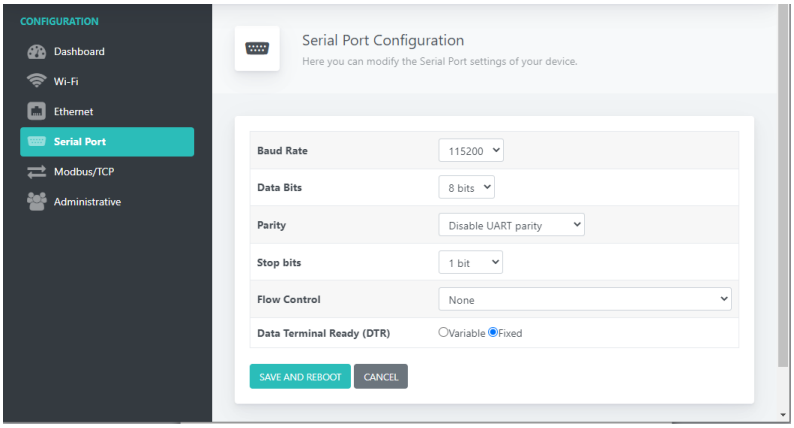


Note the MAC address used for the Ethernet interface and displayed in the Dashboard is the module's base MAC address + 3.

Serial Port Configuration

The serial port can be configured for different baud rates, data bits, parity, stop bits and flow control. To make the serial port settings you should do the following.

Select and click on the Serial Port menu option (left side).



Match the configuration parameters to your serial device. Click **SAVE AND REBOOT** to save settings permanently.

Baud Rate: standard serial baud rates from 300 – 921600 are selectable
Data Bits: settings of 5 – 8 data bits are available. Modbus/RTU requires 8 data bits and Modbus/ASCII requires at least 7 data bits.
Parity: choose between Disable, Even and Odd parity.
Stop Bits: choose between 1, 1.5 and 2 stop bits
Flow Control: choose from the following options…

None – no flow control (default)
Hardware RX flow control using RTS – GRID45 can signal host processor to stop transmitting
Hardware TX flow control using CTS – host processor can signal GRID45 to stop transmitting
Hardware flow control using RTS and CTS – bi-directional hardware flow control
Software flow control using XON/XOFF – Software flow control sends special control characters XOFF (transmit off) and XON (transmit on) to stop and start the other serial device from transmitting. It should only be used for ASCII protocols.
RS485 flow control using RTS – for transmit enable signal on RS485 half-duplex line, active high

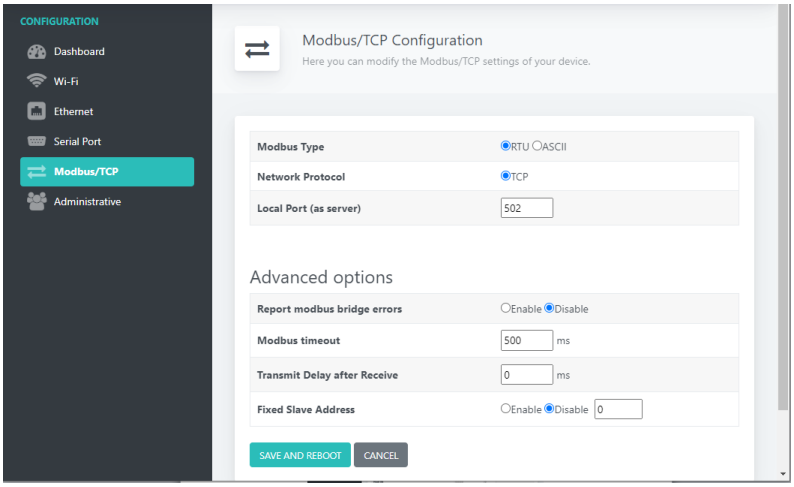
Note: the RTS pin (output) is CP1/GPIO33 and the CTS pin (input) is CP3/GPIO13.

Data Terminal Ready (DTR): Set to Variable to make the DTR serial output signal active (low) while a Modbus/TCP connection is established; with no TCP connection the DTR signal is inactive (high). If set to Fixed, then the DTR signal is active (low) all the time.
Note: the DTR pin (output) is CP2/GPIO14.

Modbus/TCP Configuration

To accomplish a Modbus bridge the serial port settings and one of the network interface settings must be configured for proper operation.

Select and click on the Modbus/TCP menu option (left side).



Click **SAVE AND REBOOT** to save settings permanently.

Modbus Type: RTU (binary) or ASCII Modbus serial protocol

Network Protocol: Currently only TCP available

Local Port (as server): TCP port number (default = 502 which is the standard Modbus/TCP port) The default port number can be modified if needed for local routing or if required by the Modbus/TCP partner.

Advanced Options

These advanced options offer additional controls over how the Modbus/TCP server operates.

Report Modbus bridge errors: Setting this to Enable causes the Modbus bridge to report Modbus serial response timeouts by returning a Gateway exception code 0B hex defined in Modbus/TCP as “Target Device Failed to Respond”. When disabled the Modbus bridge is silent about timeouts and reports nothing to the client.

Modbus timeout: This sets the serial timeout for a response from a connected serial server.

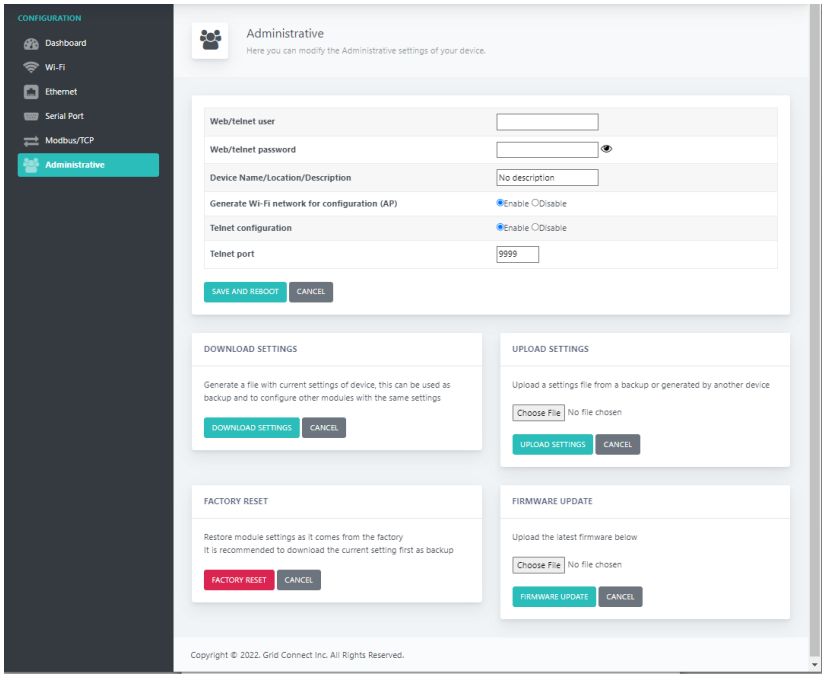
Transmit delay after receive: This feature inserts a delay between the previous Modbus serial response and the next Modbus request. This feature is particularly useful when using RS485 2-wired serial protocol (half-duplex). The delay gives ample time for the RS485 server devices to turn their transmitters off and their receivers back on. Normally this should be set to 0 – change it only if you are having problems. Raising this value can produce additional message delays.

Fixed Slave Address: Modbus/TCP includes a Unit ID field, which is used to address multiple Modbus servers at a single IP address. This option allows you to force a fixed slave address for Modbus serial communication and ignore the Unit ID field, but note that this restricts you to a single serial server device.

Administrative Configuration

The GRID45 module has an Administrative page for setting service options and updating firmware as well as factory reset, saving and restoring configuration settings.

Select and click on the Administrative menu option (left side).



Web/telnet user: sets the user name for configuration access via web manager and telnet.
Web/telnet password: sets the password for configuration access via web manager and telnet. It also sets the Wi-Fi passphrase for the Soft AP interface. The password must be a minimum of 8 characters.
Device Name/Location/Description: allows setting of a 22 character string to describe the device's name, location, function or other. This string is displayed by the Grid Connect Device manager software.
Generate WiFi network for configuration (AP): enable or disable the module's Soft AP interface. The Soft AP interface on the module enables a Wi-Fi client on a mobile device or PC to connect one-on-one with the module.
Telnet configuration: enable or disable the module's Telnet configuration.
Telnet port: set the TCP port number for Telnet configuration (default = 9999).

Click **SAVE AND REBOOT** to save settings permanently.

Download Settings

Click the DOWNLOAD SETTINGS button to download a file containing the module's current settings for backup or for loading on other modules for duplicating the settings. The downloaded file is in JSON format and named GRID45Settings.json. The file can be renamed after download.
Note: Be careful not to duplicate the IP address on multiple modules on the network.

Upload Settings

This is used to restore configuration from a previous download. Click the Choose File button and navigate to the stored configuration file and Open. Then click the UPLOAD SETTINGS button to upload the file. The module will store the configuration and reset.
Note: The module may initialize with a new IP address stored in the configuration file.

Factory Reset

Click the FACTORY RESET button to restore the module configuration to factory defaults and the module will reset.
Note: The module may initialize with a new IP address.

The configuration can also be reset to factory defaults in hardware by pulling the Factory Reset pin high at power-on/reset for at least 1 second and then releasing the pullup, allowing the firmware to reset the configuration and initialize. The Factory Reset pin should by default have a weak pull-down to GND using a 10K ohm resistor for example.
Note: the Factory Reset pin (input) is -/GPIO39.

Firmware update

This is used to update the module's firmware. Click the Choose File button and navigate to the stored firmware file and Open. Take care when choosing new firmware and only load firmware suitable for the module and recommended by Grid Connect technical support. Then click the FIRMWARE UPDATE button to upload the file and wait. The module will upload and store the new firmware. The upload may take around 30 seconds and may not display a progress indicator. After a successful upload the module will display a success screen and reset.

OPERATION

Asynchronous Serial

The GRID45 module supports asynchronous serial communication. This serial communication does not require a transmitted clock signal (asynchronous). Data is transmitted one byte or character at a time. Each transmitted byte consists of a start bit, 5 to 8 data bits, optional parity bit and 1 to 2 stop bits. Each bit is transmitted at the configured baud rate or data rate (eg 9600 baud). The data rate determines the length of time each bit value is maintained on the line which is referred to as the bit time. The transmitter and receiver(s) must be configured with identical settings for successful data transfer to occur.

The serial line starts in the idle state. The start bit changes the serial line to the active state for one bit time and provides the synchronization point for the receiver. The data bits follow the start bit. A parity bit can be added which is set to even or odd. The parity bit is added by the transmitter to make the number of data 1 bits an even or odd number. The parity bit is checked by the receiver to help validate the data bits were received accurately. The stop bit(s) return the serial line to an idle state for a guaranteed number of bit times before the next byte is started.

The GRID45 module's serial interface is at 3.3 Volt (TTL) voltage levels for direct connection to another microprocessor. An external transceiver is required to adapt the serial interface to RS232, RS485 or other transmission level standards.

RS232

RS232 communication requires an external transceiver such as a MAX232 chip on the module's serial lines. RS232 is a telecommunication standard for point-to-point serial communication. The physical interface uses asynchronous serial with voltage levels in the +/- 15 volt range, but most RS232 ports only transmit at +/- 5 volts. The most common RS232 interface connector is a DB9, either DTE (male) or DCE (female). A 3 wire interface is the minimum required for two-way communication: Transmit data, Receive data and Ground.

Besides physical interface the RS232 standard specifies additional control signals for flow control (RTS and CTS) and modem/peer status signals (DTR, DSR, DCD). The GRID45 module with Modbus firmware has support for hardware flow control via RTS and CTS. It also supports a DTR output status.

RS485

RS485 communication requires an external transceiver(s) on the GRID45 serial lines. RS485 is a physical interface standard for point-to-point and point-to-multipoint serial communication. It is a differential signal with voltage levels of 0 – 5 volts. RS485 is normally transmitted over twisted pair wiring and supports long distance serial communication. There is no standard RS485 connector and screw terminal connections are normally used. RS485 connections are labeled (-) and (+) or labeled A and B. RS485 communication can be done half-duplex, alternating transmitter, over a single twisted pair. For full-duplex communication two separate twisted pairs are required. In some long distance wiring applications a signal ground wire is also required. RS485 pairs may also need termination on each end of long distance wiring runs.

The GRID45 module with Modbus firmware has support for RS485 transmit enable on the RTS output. The transmit enable signal can be used to enable the transmitter on the external RS485 transceiver. There are no other standard control signals for RS485.

Messaging Protocol

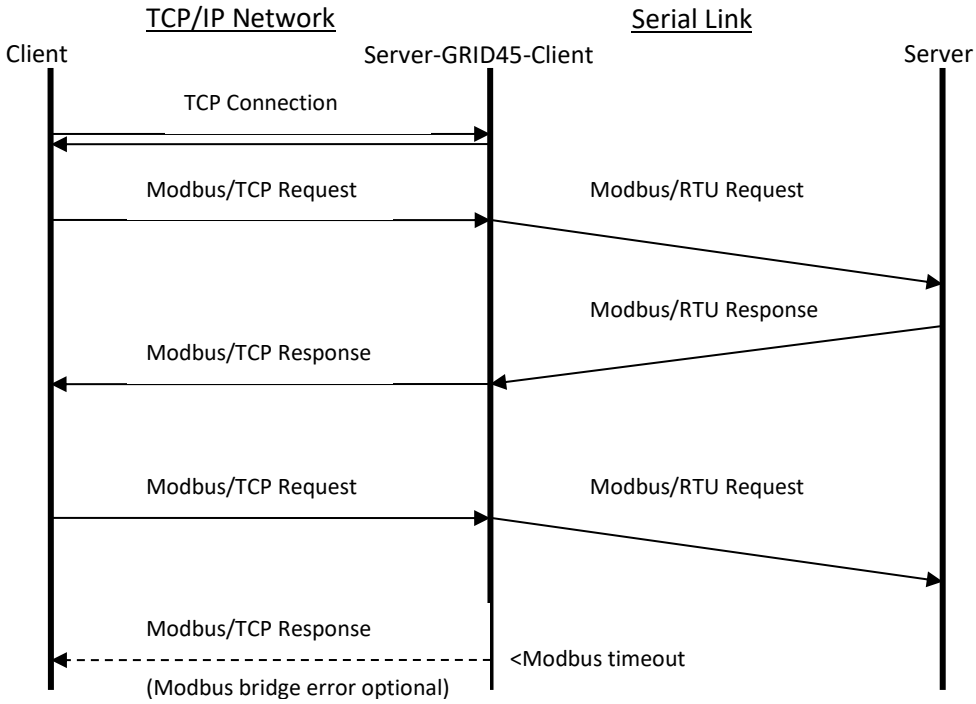
The previous sections described the physical interface protocol for the serial data signaling on a wired medium. On top of the physical interface is the messaging protocol defined for the attached serial device. The messaging protocol specifies message formats and serial line access rules that allow transfer of information between devices. Modbus/RTU and Modbus/ASCII are the serial messaging protocols supported.

Modbus Bridging

The Modbus bridging operation converts Modbus/TCP request messages into Modbus serial messages. Modbus serial response messages are converted back again to Modbus/TCP. The Modbus/TCP message format is not compatible with the Modbus serial message formats, as described below, so a bridging operation is required.

The Modbus bridge firmware operates as a protocol bridge between Modbus/TCP and the Modbus serial line protocols Modbus/RTU and Modbus/ASCII. A bridge function is necessary because Modbus/TCP messages have additional application header information and lack the serial error detection fields used in RTU and ASCII messages.

The Modbus serial protocol is either Modbus/RTU or Modbus/ASCII. Modbus/RTU is a binary protocol with CRC error detection and messages are terminated by a silent interval of at least 3.5 character times. Modbus/ASCII is a less efficient protocol that encodes each byte into 2 ASCII characters in hexadecimal format. It uses an LRC for error detection and messages are framed with a starting ‘:’ and a terminating CR-LF. Both Modbus serial protocols are designed for a single serial client and 1 or more addressable serial servers.

Modbus/TCP is an encapsulation protocol of the Modbus message over TCP/IP. The Modbus message is encoded in binary. The message is given a 6 byte header containing a transaction identifier, protocol identifier and a message length field. No error detection is added since this is taken care of by the TCP/IP layer. Modbus/TCP supports multiple TCP clients communicating with multiple servers.

The bridge listens for TCP connections in its role as a Modbus/TCP server. It supports up to 10 connections with Modbus/TCP clients on the network. It converts incoming Modbus/TCP requests for one TCP client connection at a time. The Modbus/TCP request must be converted to Modbus serial and transmitted on the serial interface. The serial server address is conveyed in the Unit ID field of the Modbus/TCP request. It will then wait for the Modbus serial server's response which is converted for Modbus/TCP and returned to the client. A timeout is reached if the server does not respond.