Tibbo Modbus Gateway Manual (TMGM)

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Introduction to Tibbo Modbus Gateways (MG)

Last update: 12MAR2018

Manual Update History

Modbus is everywhere — it is virtually synonymous with industrial control! Sensors, meters, valves, actuators, and myriad other devices are queried and controlled through their "Modbus registers."

Tibbo Modbus Gateways seamlessly route Modbus requests and replies between Modbus TCP, Modbus RTU, and Modbus ASCII Masters and Slaves. The flexibility and adaptability of Tibbo Modbus Gateways allow you to use them in practically any Modbus system.

Modbus Primer

"Modbus is a serial communications protocol originally published by Modicon (now Schneider Electric) in 1979 for use with its programmable logic controllers (PLCs). Modbus has become a de facto standard communication protocol and is now a commonly available means of connecting industrial electronic devices." — Wikipedia article on Modbus (https://en.wikipedia.org/wiki/Modbus).

Messages

All Modbus communications are achieved by sending messages (packets).

Modbus RTU, ASCII, and TCP

Modbus RTU, Modbus ASCII, and Modbus TCP are three most common types of Modbus communication protocols. All three are supported by Tibbo Modbus Gateways.

Modbus RTU and Modbus ASCII use serial (RS232 or RS485) communications. Modbus RTU messages comprise binary data blocks separated (framed) by idle periods. Modbus ASCII transmissions rely on the leading colon (":") and trailing newline (CR/LF) for message framing. Tibbo Modbus Gateways come equipped with up to four serial ports. Available port types include RS232, RS485, and universal RS232/422/485 ports.

Modbus TCP devices use TCP/IP protocol for Modbus message transmission. Just like with Modbus RTU, Modbus TCP messages are binary blocks separated (framed) by idle periods. All Tibbo Modbus Gateways feature an Ethernet port for TCP communications with Modbus TCP devices. Our Gateways may optionally be equipped with Wi-Fi ports as well.

Masters and Slaves

A Modbus device can be either a Master or a Slave. Modbus Masters initiate all communications with Slaves and do not communicate with other Masters. Modbus

Slaves are completely passive and communicate only by sending responses to requests from Masters. Master requests contain commands for Slaves to process.

Each time a Master sends a request to a specific Slave, it must wait for a reply. All Slaves are expected to reply within a certain time period. A Master is not supposed to send the next request until the previously addressed Slave replies or the waiting period ends. A Slave may send either a "normal" reply or an "exception" reply. A "normal" reply is sent when the command from the Master is successfully received. An "exception" reply is sent when the command received from the Master is not supported or some error has occurred.

Masters can also send so-called broadcast requests to all Slaves. Broadcast requests are processed by all Slaves they reach. Slaves never reply to broadcast requests.

Slave IDs

Each Modbus Slave in a Modbus system is assigned a unique ID. Allowed ID numbers are from 1 to 247. ID number 0 is used for broadcasting the same request to all available Slaves. ID numbers 248 through 255 are reserved and should not be used. Whenever a Master sends a request, this request includes the ID of the intended recipient (or 0 if the Master is sending a broadcast message). Modbus Masters do not have IDs.

Bridging Together Modbus RTU, Modbus ASCII, and Modbus TCP Devices

Tibbo Modbus Gateways allow Modbus RTU, Modbus ASCII, and Modbus TCP devices to talk to each other.

Achieving this goal requires our Modbus Gateways to seamlessly route Modbus messages between these three types of Modbus devices. Tibbo Modbus Gateways provide several routing methods and configuration parameters (settings) defining the handling of Modbus messages as they pass through the Gateways.

Tibbo Modbus Gateway App

Tibbo Modbus Gateways comprise select* Tibbo BASIC/C-programmable devices running an open-source *Modbus Gateway app* (firmware) developed by Tibbo. The app is written in Tibbo BASIC and C, using a development software called Tibbo IDE (TIDE).

Feel free to modify or borrow from the Modbus Gateway app in any way you please. Anything is possible — from a simple logo replacement to a deeper rework of features. Chop the code up, slice it and dice it, put it back together, or turn it into something else entirely. Have no time or desire to write your own code? Contract Tibbo to do this for you!

Here is the URL for the Modbus Gateway project page: http://tibbo.com/programmable/applications/modbus-gateway.html.

Follow the **Open GitHub Repository link** to view the source files for this project.

The **Compiled Binaries link** will take you to the downloads page that contains ready-to-use binary files for Tibbo devices that can run the Modbus Gateway app.

Upgrading the Modbus Gateway App topic explains how to upload new application binary into your Modbus Gateway.

If your goal is to modify the Modbus Gateway app, i.e. work with the app's sources, you will need to install our **Tibbo IDE (TIDE)** software.

You can download this software here: http://tibbo.com/support/downloads/tide.html.

A separate manual, called *TIDE, TiOS, Tibbo BASIC, and Tibbo C Manual* contains all the info you will need to create (or modify) apps that run on programmable Tibbo devices.

Here is the link for viewing this Manual online: http://docs.tibbo.com/taiko/.

The Manual also installs alongside **TIDE** and you can access it by clicking **F1** inside the **TIDE's** window.

** Not all programmable devices offered by Tibbo can run the Modbus Gateway app. To see what hardware is suitable for the task, read the Supported Tibbo Hardware section.*

Tibbo Modbus Gateway Features

The following is a list of features offered by compatible Tibbo devices running the Modbus Gateway app:

- 100/10Mb Ethernet port.
- Optional Wi-Fi port:
  - Support for WEP/WPA/WPA2 security.
  - Automatic switchover to the Wi-Fi port whenever the Ethernet interface becomes inactive (the Ethernet cable is unplugged).
- Selection of static IP or IP configuration via DHCP.
- Serial ports:
  - TPS2(G2)- and TPS3(G2)-based Gateways:
    - Up to four RS232, TS485, or RS232/422/485 ports;
    - Baudrates of up to 460,800bps;
    - None*/even/odd/mark/space parity modes;
    - 7* or 8 bits/character;
    - Optional RTS/CTS flow control.
  - DS1101- and DS1102-based Gateways:
    - Up to three RS232 channels;
    - One RS485 channel (DS1102 only);

    - Baudrates of up to 921,600bps;
    - None/even/odd/mark/space parity modes;
    - 7 or 8 bits/character;
    - Optional RTS/CTS flow control.
- Support for up to 8 TCP masters and up to 4 TCP slaves.
- Flexible routing:
  - Routing of Modbus TCP, Modbus RTU, and Modbus ASCII messages in any direction:
    - Modbus TCP --> Modbus RTU or ASCII;
    - Modbus RTU or ASCII --> Modbus TCP;
    - Modbus TCP --> Modbus TCP;
    - Modbus RTU or ASCII --> Modbus RTU or ASCII.
  - Slave ID-based routing (works for all types of Modbus Masters);
  - TCP port-based routing (for Modbus TCP Masters only); four ports are available;
  - Slave ID shifting.
- Support for Modbus exceptions:
  - Timeout exception;
  - Routing error exception.
- Configuration:
  - Via the DS Manager utility;
  - Via the web interface.
- Status indication:
  - Using LEDs;
  - On a display (when present).
- Operation monitoring:
  - Gateway configuration can be monitored using SNMP protocol;
  - Gateway activity and byte-level flow can be monitored using IO Ninja software running a specially designed plugin.
- 12V or 24V power; Optional PoE power.

** Second-generation TPS devices ("G2" devices) do not support the combination of the 7 bits/character mode and the "none" parity mode.*

Ethernet, Wi-Fi, and Serial Ports

The following ports are available on Tibbo Modbus Gateways:

- All Gateways come equipped with a 100/10Mb Ethernet port.
- All Gateways may be ordered with an optional Wi-Fi port.
- Depending on the hardware, your Gateway may have up to four serial ports (or serial channels). You can choose between RS232, RS485, as well as "universal" RS232/422/485 ports.

Automatic Switchover Between Ethernet and Wi-Fi Ports

The Wi-Fi port of your Mobile Gateway is only active when the Ethernet port is *inactive*. The Ethernet port is active when a live Ethernet cable is plugged into the port (the yellow Ethernet Link LED is on). As soon as the Ethernet link is lost, the Gateway switches to using the Wi-Fi port (provided that the Wi-Fi port is enabled). Once the Ethernet link is restored, the Gateway returns to using the Ethernet port again.

Slave ID-based Routing

Slave ID-based routing is available to all types of supported Modbus devices, i.e., Modbus RTU, Modbus ASCII, and Modbus TCP devices.

ID-based routing rules are edited on the Slave ID-based routing settings page (tab). With Slave ID-based routing, you define up to eight ranges of Modbus IDs and specify the destination for each range (with possible ID shifting if necessary).

With slave ID-based routing, the Gateway will receive incoming requests from Modbus Masters:

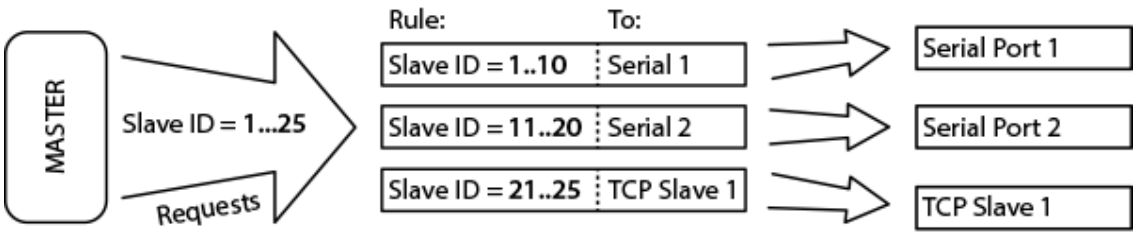
- On all active serial ports (channels).
- On any of the four TCP ports.

The destination Modbus Slave for each range of IDs can be:

- One of the active serial ports (channels).
- One of the four Modbus TCP Slaves on the IP network. A dedicated page (tab) — TCP Slave Settings — allows you to set the IP address and port for each of the four Modbus TCP Slaves.

For example, you may specify that...

- Requests with IDs from 1 to 10 should be routed to the serial port 1;
- Requests with IDs from 11 to 20 should be routed to the serial port 2;
- Requests with IDs from 21 to 25 should be routed to the TCP Slave 1.



Note that ID-based routing has *lower* priority than the TCP port-based routing. Meaning, if both routing methods are engaged and produce conflicting routing results, then port-based routing takes precedence.

TCP Port-based Routing

Port-based routing is only available for routing requests from (and replies to) Modbus TCP Masters.

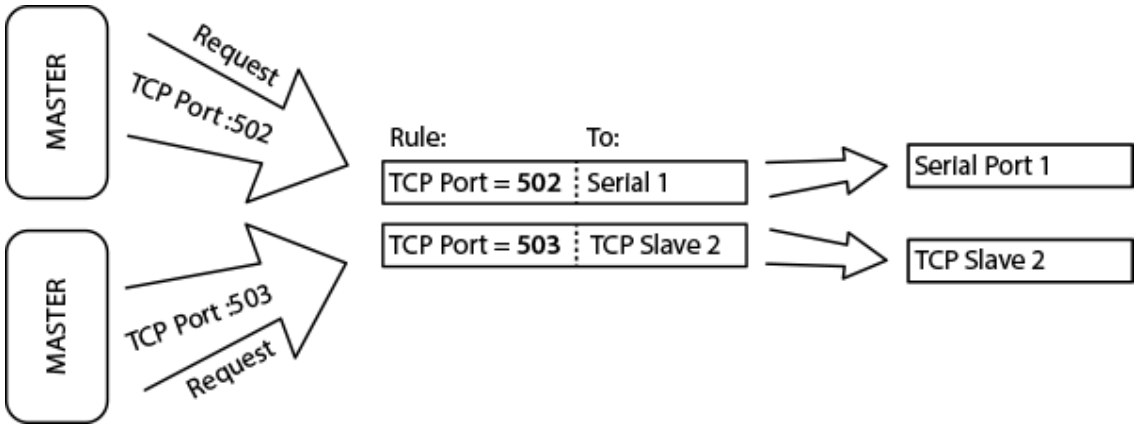
Port-based routing rules are edited on the port-based routing settings page (tab). With port-based routing, you can enable up to four listening ports on the Modbus Gateway and specify the destination for each listening port (with possible ID shifting if necessary).

The destination Modbus Slave for each listening port can be:

- One of the four available serial ports (channels).
- One of the four Modbus TCP Slaves on the IP network. A dedicated page (tab) — TCP Slave Settings — allows you to set the IP address and port for each of the four Modbus TCP Slaves.

For example, you may specify that...

- Requests to port 502 should be routed to the serial port 1;
- Requests to port 503 should be routed to the TCP Slave 2.



Note that TCP port-based routing has *higher* priority than the slave ID-based routing. Meaning, if both routing methods are engaged and produce conflicting routing results, then port-based routing takes precedence.

Slave ID Shifting

Slave ID shifting is very useful for situations when you need to work with Modbus Slaves that do not allow ID changing (or allow ID changing in a limited range).

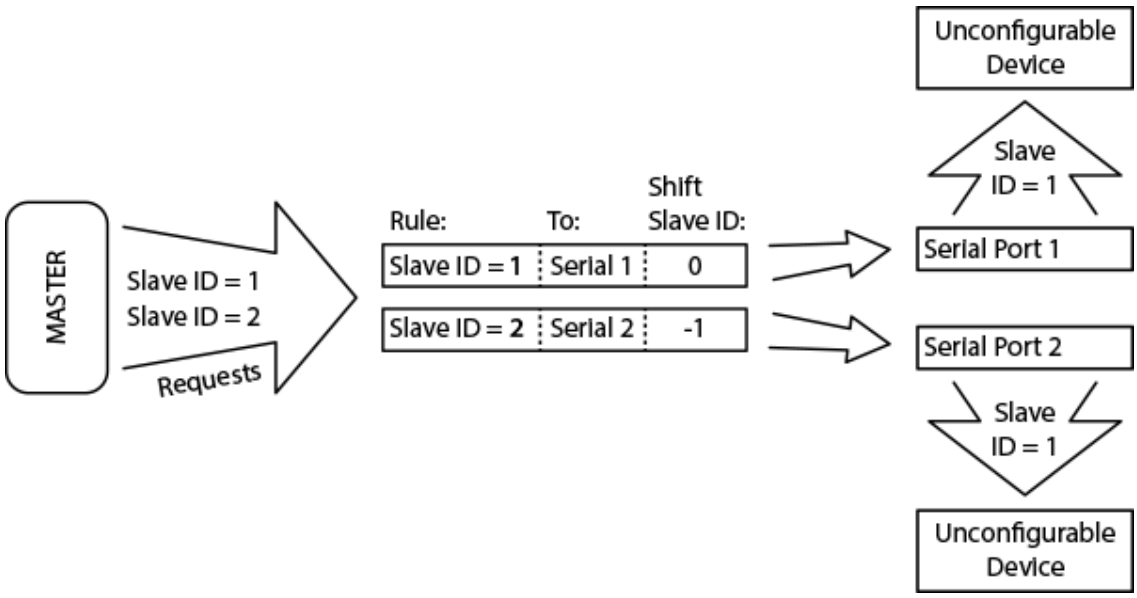
For example, suppose you have a Modbus TCP Master that needs to work with two Modbus RTU Slaves located on serial ports 1 and 2. Obviously, the Master needs the IDs of these Slaves to be different, for example, 1 and 2, but it just so happens that both Slaves have the same fixed ID equal to 1. No problem, ID shifting to the rescue!

For the above example, use the Slave ID-based routing:

- Configure the first ID range as follows:
  - ID From = 1

- ID To = 1
- ID Shift = 0
- Destination = Serial 1

- Configure the second ID range as follows:
  - ID From = 2
  - ID To = 2
  - ID Shift = -1
  - Destination = Serial 2



ID shift for the first range is 0, which means that there is no shift. When the Modbus TCP Master sends a request to the Slave with ID = 1, this request will be forwarded, unchanged, to serial port 1. ID shift for the second range is -1, which means that 1 will be subtracted from the ID of any request in this range. When the Modbus TCP Master sends a request to the Slave with ID = 2, this request will be forwarded to serial port 2. The ID number in this request will be modified: -1 will be added to the original ID specified by the Master. Therefore, the resulting ID field in the routed message will be set to 1, just as needed by the intended recipient of the request!

ID shifts can be positive, as well as negative. It is possible to use ID shifting with Slave ID-based routing and TCP port-based routing.

Supported Tibbo Hardware

The Modbus Gateway app runs best on our second-generation TPS2 and TPS3 devices.

It is also possible to run the app on our DS1101 and DS1102 serial controllers.

The app can also run on several other programmable Tibbo devices, including Tibbo IoT modules.

TPS2(G2) and TPS3(G3)

The Modbus Gateway app runs best on our second-generation TPS2 and TPS3 devices. These are TPS2(G2), TPS2L(G2), and TPS3(G3) controllers.

These devices belong to the Tibbo Project System (TPS) family. The power and flexibility of TPS come from Tibbits® — miniature I/O blocks that plug into the mainboards of TPS devices. You can find the product introduction here: http://tibbo.com/tps.html.

TPS devices are documented in our *Programmable Hardware Manual (PHM)*.

Here is the link for viewing the TPS documentation online: http://docs.tibbo.com/phm/index.html?tibbo_project_system.htm.

You can also download *Programmable Hardware Manual* to your PC: http://tibbo.com/support/downloads/documentation.html.

In this section:

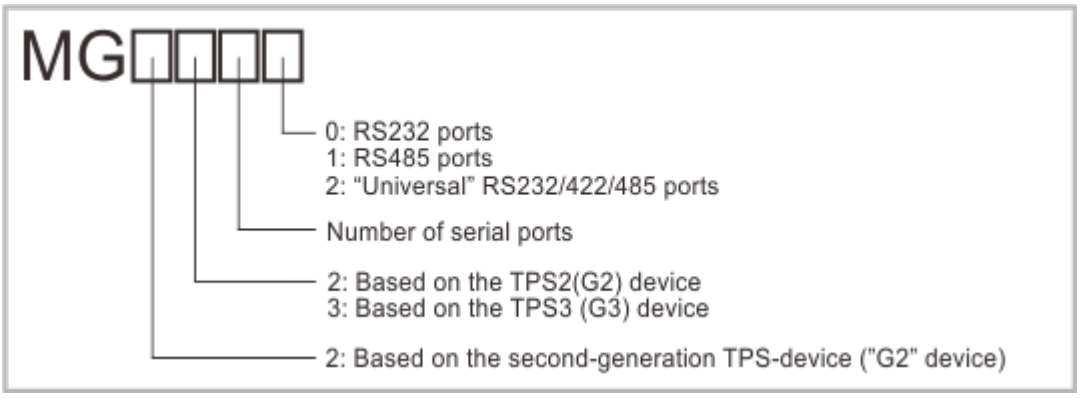
- Learn about standard TPS-based Modbus Gateway configurations.
- Read about possible ways of customizing your Modbus Gateway.
- Learn about our Online Configurator — an in-browser tool used to create custom TPS configurations.
- Learn how to fork an existing (standard) configuration.

Standard Configurations

To get you started, we have defined several "standard" TPS-based Modbus Gateway configurations. These configurations are only "standard" in the sense that they represent, in our view, typical configurations that you, our customer, would expect to be available. You can find the up-to-date list of available configurations here: http://tibbo.com/store/tps/standard.html (look under "TPS-based 4-port Modbus Gateways"). You can place an immediate order for any of these devices, and they will arrive with the Modbus Gateway app already loaded.

All standard Gateways come equipped with four serial ports. Depending on the model, the serial ports can be of the RS232, RS485, or "universal" RS232/422/485 type. All Gateways can optionally be equipped with Wi-Fi ports ("G" option). TPS2(G2) gateways can optionally be ordered with the 320x240 color TFT display ("D" option). The display conveniently shows the Gateway's status information.

Model Numbering Scheme



Examples:

- **MG2240G**: Modbus Gateway based on the TPS2(G2) device, having four serial ports of the RS232 type (using Tibbits #01), and equipped with the Wi-Fi port.
- **MG2241GD**: Modbus Gateway based on the TPS2(G2) device, having four serial ports of the RS485 type (using Tibbits #05), and equipped with the Wi-Fi port and 320x240 color TFT display.
- **MG2342**: Modbus Gateway based on the TPS3(G2) device, having four serial ports of the universal RS232/422/485 type (using Tibbits #02).

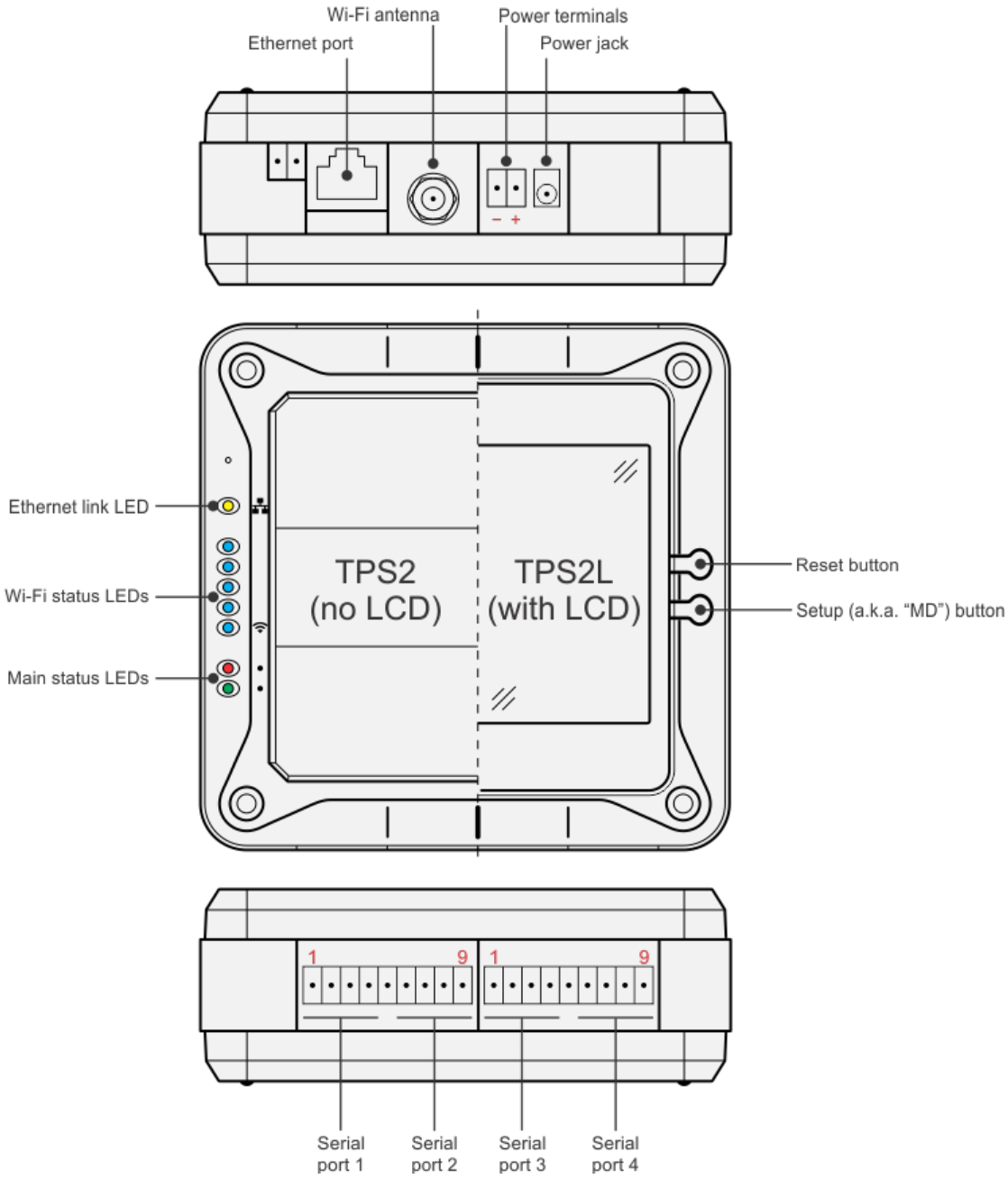
Next in this section:

- Standard TPS2(G2)-based Modbus Gateways
- Standard TPS3(G2)-based Modbus Gateways

TPS2(G2)-based Modbus Gateways

Our standard TPS2(G2)-based Modbus Gateways feature four RS232 (MG2240) or RS485 (MG2241) serial ports. Tibbits #01 are used to implement RS232 ports. RS485 ports are "made" with Tibbits #05.

There is one group of nine terminal blocks per two serial ports.



Terminal block assignment is as follows. Notice how there are two separate serial ports per one group of 9 terminal blocks:

MG Model -->	**MG2240**	**MG2241**	
Tibbit used -->	**Tibbit #01**	**Tibbit #05**	
Terminal block #	**RS232**	**RS485**	
1	**TX** (output)	**485+**	This is a separate serial port
2	**RX** (input)	**485-**	
3	**RTS** (output)	---	
4	**CTS** (input)	---	
5	**GND**	**GND**	

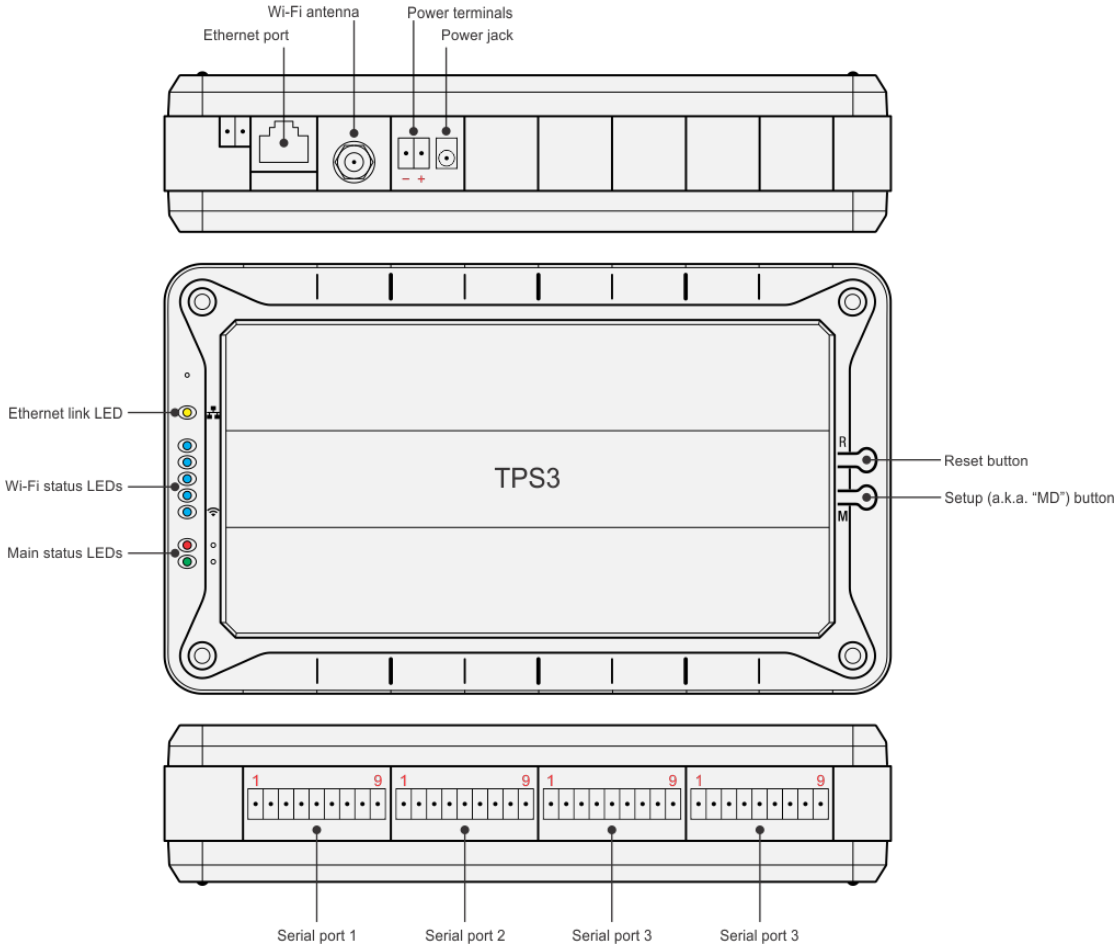
6	**TX** (output)	**485+**	This is a separate serial port
7	**RX** (input)	**485-**	
8	**RTS** (output)	---	
9	**CTS** (input)	---	

TPS2(G2)-based Gateways are powered using our standard 12V power adapters. Gateways equipped with Wi-Fi ports are supplied with external Wi-Fi antennas.

TPS2(G2) devices have a number of status LEDs. For more information on the device states displayed by the Modbus Gateway app see Understanding LED Signals.

TPS3(G2)-based Modbus Gateways

Our standard TPS2(G2)-based Modbus Gateways — MG2342 — feature four universal RS232/422/485 ports. Tibbits #02 are used to implement them. We also can supply models with RS232-only (MG2340) or RS485-only (MG2341) serial ports.



Terminal block assignment is as follows:

MG Model -->	MG2340	MG2341	MG2342		
Tibbit used -->	Tibbit #01	Tibbit #05	Tibbit #02		
Terminal block #	RS232	RS485	RS232	RS422	RS485
1	**TX** (output)	**485+**	**TX** (output)	**TX+** (output)	**TX+** (output)
2	**RX** (input)	**485-**	**RX** (input)	**RX-** (input)	**RX-** (input)
3	**RTS** (output)	---	**RTS** (output)	**RTS+** (output)	---
4	**CTS** (input)	---	**CTS** (input)	**CTS+** (input)	---
5	**GND**	**GND**	**GND**	**GND**	**GND**
6	**---**	---	**DTR** (output)	**TX-** (output)	**TX-** (output)
7	**---**	---	**DSR** (input)	**RX+** (input)	**RX+** (input)
8	**---**	---	**---**	**RTS-** (output)	---
9	---	---	---	**CTS-** (input)	---

TPS3(G2)-based Gateways are powered using our standard 12V power adapters. Gateways equipped with Wi-Fi ports are supplied with external Wi-Fi antennas.

TPS3(G2) devices have a number of status LEDs. For more information on the device states displayed by the Modbus Gateway app see Understanding LED Signals.

Custom Configurations

The main advantage of TPS devices is their near-infinite configurability. Since all I/O functions are implemented as Tibbits, you can modify our "standard" configurations in many different ways.

Here are some ideas on how you can "deviate from the standard":

- Have less than four serial ports (for example, three) when you need less than four serial ports.
- On the TPS3, replace "universal" serial ports (Tibbit #02) with lower-cost RS232 (Tibbit #01) and RS485 (Tibbit #05) ports.
- Switch from using terminal block connectors (Tibbit #20) to DB9M connectors (Tibbit #19).
- Replace the 12V power supply (Tibbit #10) with 12/24/48V power supply (Tibbit #25).
- Add a power-over-Ethernet (PoE) option (Tibbit #23).
- Add I/O — our Modbus Gateway app is open-source and can be easily extended with extra functions and features. You can also contract Tibbo to work on the app for you! So, why not add...

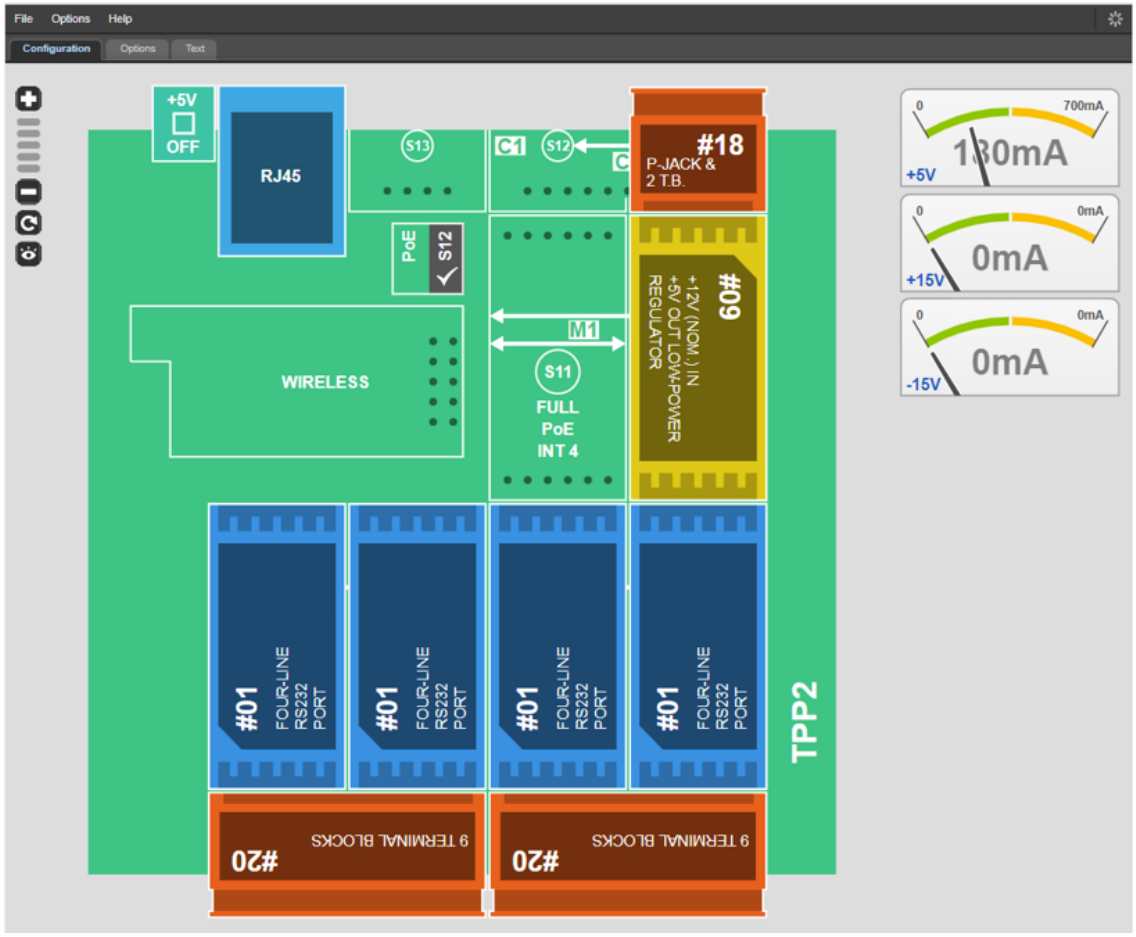
- Digital inputs (Tibbits #04);
- Relays (Tibbits #03, #06, #07);
- Sensors, such as temperature (Tibbit #29) or humidity (Tibbit #30) sensors,
- And so on!

Online Configurator

To aid you in defining custom TPS devices we have created an *Online Configurator*. You can access it here: http://tibbo.com/store/tps/custom.html.

To start, click the **LAUNCH CONFIGURATOR TO START A NEW PROJECT button**. In order to be able to save your custom configurations, you need to register and log on to tibbo.com website.

The Configurator allows you to select a Tibbo Project Board (TPP), "insert" Tibbits into the board's sockets and specify additional options. These include choosing whether or not you wish to add a Tibbo Project Box (TPB) enclosure, DIN rail mounting kit, and so on. You can also select if your system will ship fully assembled or as a parts kit.



The Configurator watches out for errors and makes sure you specify a valid system. For example, it verifies that the total power consumption of your future TPS device does not exceed the available power budget. The Configurator also checks the placement of Tibbits, ensuring that there are no mistakes in their arrangement.

Completed configurations can be kept private, shared with other registered users, or made public for everyone to see. Any valid TPS configuration can be immediately ordered from our online store.

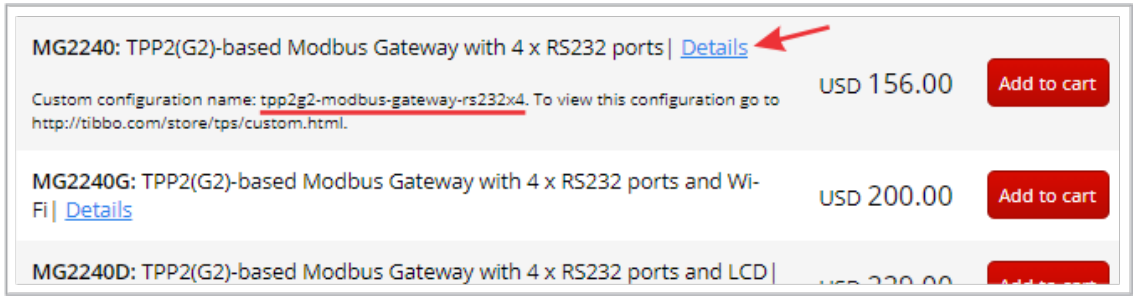
Forking Standard Configurations

Perhaps the easiest way to create a Modbus Gateway configuration you require is by "forking" an existing configuration. For example, you can take one of our standard Gateway configurations published on Tibbo website, modify it, save it under a new name, and order this new configuration from our online store.

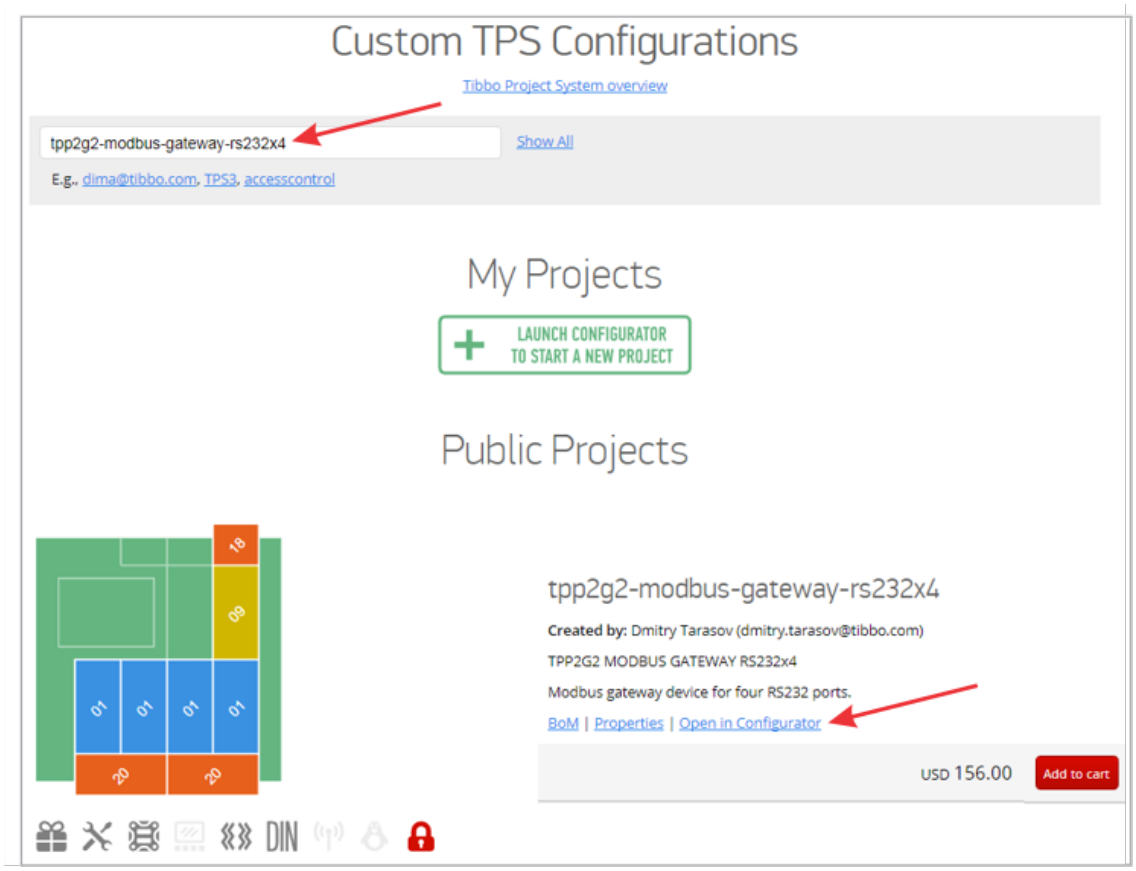
To start with this process, you will need to find out the name of the standard configuration first.

Follow these steps:

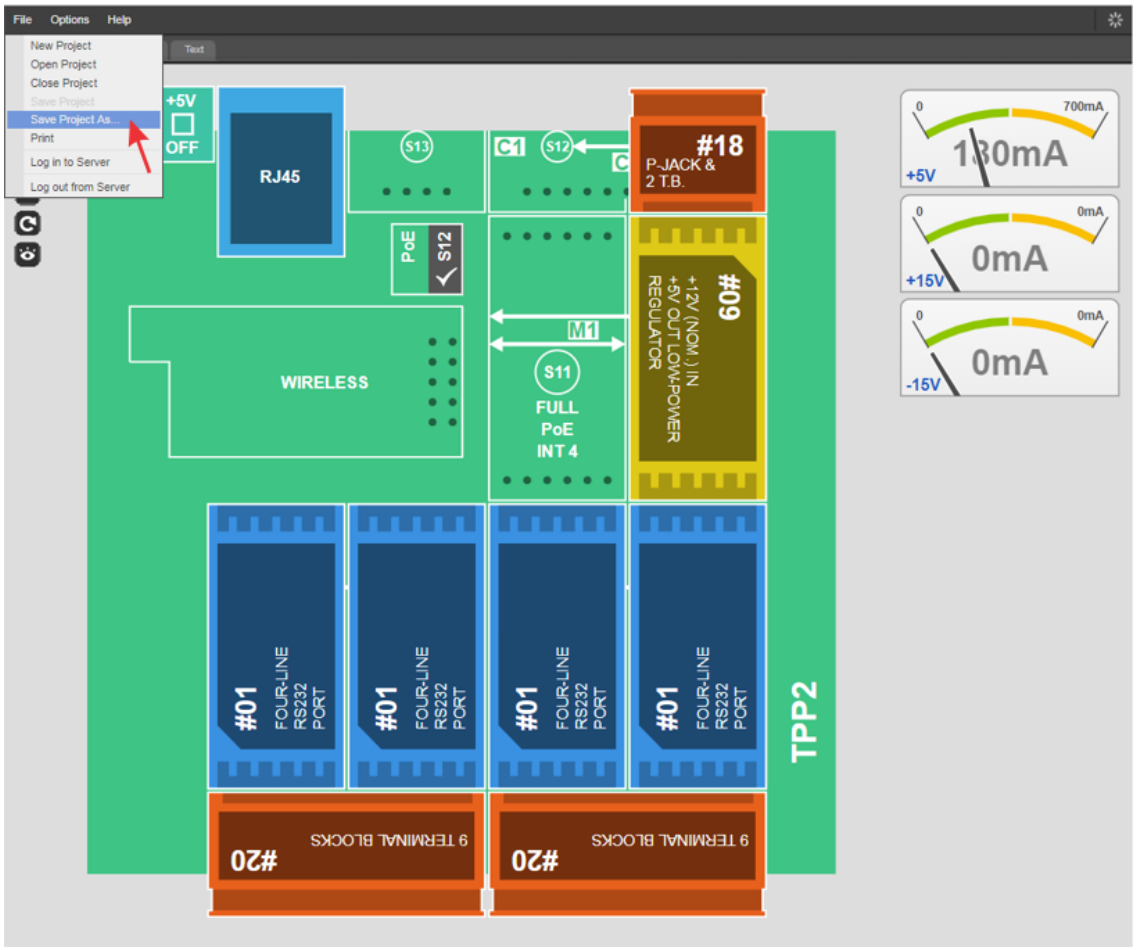
- Open the page listing Standard TPS-based Modbus Gateway configurations: http://tibbo.com/store/tps/standard.html.
- Select one configuration that you want to fork, for example, MG2240G.
- Click **Details**.



- Note the name of this configuration (it is "tpp2g2w-modbus-gateway-rs232x4").
- Go to the custom configurations page: http://tibbo.com/store/tps/custom.html.
- Paste the configuration's name into the search box.
- Click **Open in Configurator**.



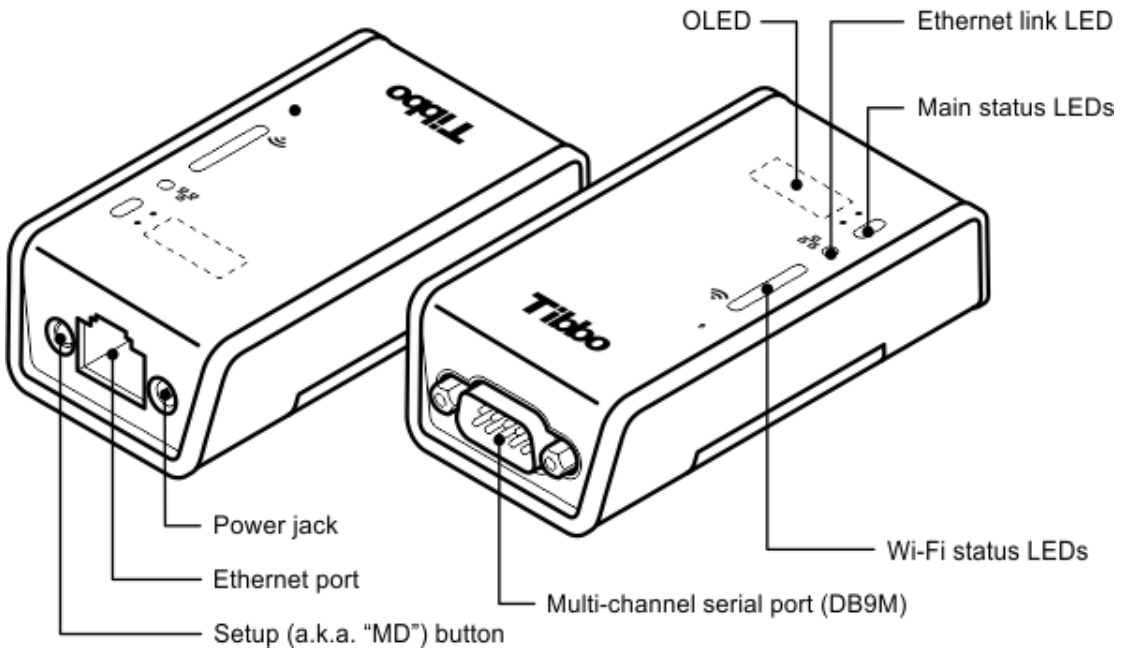
- Make required changes.
- Save the configuration under a new name.



- Refresh the custom configurations page.
- Click **Add to cart** to order your new TPS configuration from our online store.

DS1101 and DS1102

The Modbus Gateway app can run on our DS1101 and DS1102 programmable serial controllers. These devices belong to our DS110X product family. You can find the DS110X introduction here: http://tibbo.com/programmable/controllers.html.



DS110X hardware is documented in our *Programmable Hardware Manual (PHM)*.

Here is the link to the DS110X documentation online: http://docs.tibbo.com/phm/index.html?ds110x.htm.

You can also download the *Programmable Hardware Manual* to your PC: http://tibbo.com/support/downloads/documentation.html.

Both the DS1101 and DS1102 can optionally be equipped with:

- A Wi-Fi port ("G" option);
- A power-over-Ethernet (PoE) power supply ("P" option);
- A 96x32 OLED ("D" option). The display conveniently shows the Gateway's status information.

DS1101X controllers are powered using our standard 12V power adapters.

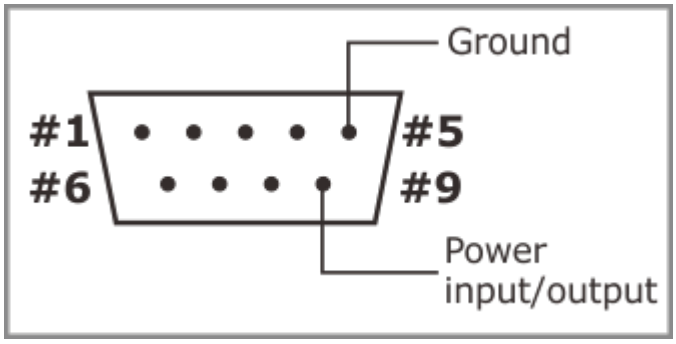
There are several status LEDs. For more information on the device states displayed by the Modbus Gateway app see Understanding LED Signals.

Serial Port Pin Assignments

The DS1101 and DS1102 are identical to each other, with one exception: The DS1101 has the RS232 port, while the DS1102 has a universal RS232/422/485 port.

Pin assignments below list additional TX and RX lines (for example, TX2 and RX2) next to "traditional" functions such as RTS and CTS. This is because the serial ports of DS1101 and DS1102 devices offer multiple serial channels.

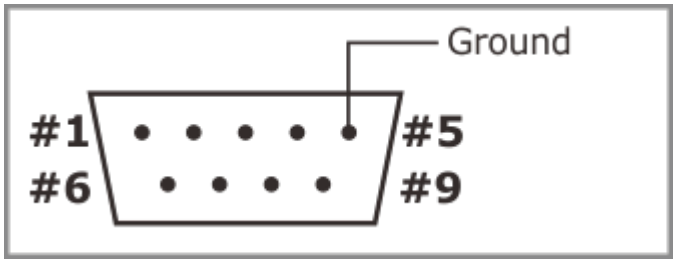
Serial Port of the DS1101



#1	**RX4** (input, commonly DCD)
#2	**RX** (input)
#3	**TX** (output)
#4	**TX3** (output, commonly DTR)
#5	**Ground**
#6	**RX3** (input, commonly DSR)
#7	**TX2** (output, commonly RTS)
#8	**RX2** (input, commonly CTS)
#9	Power input/output ("12VDC")*

** An attached serial device can be powered through this pin — there is an internal relay that can pass the power received into the power jack to pin 9 of the serial port. The Power on Pin 9 setting enables or disables this power output. Alternatively, the DS1101 can itself be powered through this pin if the attached serial device provides such power on pin 9.*

Serial Port of the DS1102



	RS232	RS422	RS485
#1	*<No connection>*	**TX2-** (output, commonly RTS-)	<No connection>
#2	**RX** (input)	**RX-** (input)	**RX-** (input)
#3	**TX** (output)	**TX+** (output)	**TX+** (output)
#4	**TX3** (output, commonly DTR)	**TX-** (output)	**TX-** (output)
#5	**Ground**	**Ground**	**Ground**
#6	**RX3** (input, commonly DSR)	**RX+** (input)	**RX+** (input)

#7	**TX2** (output, commonly RTS)	**TX2+** (output, commonly RTS+)	*<No connection>*
#8	**RX2** (input, commonly CTS)	**RX2+** (input, commonly CTS+)	*<No connection>*
#9	*<No connection>*	**RX2-** (input, commonly CTS-)	*<No connection>*

Multi-Channel Serial Ports

Both the DS1101 and DS1102 have a single DB9 connector but offer several RS232 *channels*. We define a serial channel as including at least the RX and TX signals. The standard serial port has six "important" signals: RX, TX, CTS, RTS, DSR, and DTR. The CTS/RTS and DSR/DTR signal pairs of the DS1101 and DS1102 can alternatively be used as independent serial channels RX2/TX2 and RX3/TX3. If your Modbus device does not require any other signals but RX and TX (as is usually the case), then a single controller can give you three independent RS232 channels! This applies to the DS1101, as well as DS1102 in the RS232 mode. The DS1102 only offers a single channel in the RS485 mode.

RS232 Mapping Options (DS1101 and DS1102)

Tibbo has defined 15 port mapping options (channel arrangements). These are our standard mapping options that we use for all apps that run on DS1101 and DS1102 devices.

Mapping option	Available signals	Pins on the DB9M connector						
		#2	**#3**	**#8**	**#7**	**#6**	**#4**	**#1 (DS1101 only)**
Option 0	RX/TX/CTS/RTS/DSR/DTR	RX	TX	CTS	RTS	DSR	DTR	---
Option 1	RX/TX/CTS/RTS/DSR/DTR + RX/tx	RX	TX	CTS	RTS	DSR	DTR	RX4
Option 2	RX/TX/CTS/RTS + RX/TX + RX/tx	RX	TX	CTS	RTS	RX3	TX3	RX4
Option 3	RX/TX/CTS/RTS + RX/TX/CTS/rts	RX	TX	CTS	RTS	RX3	TX3	CTS3
Option 4	RX/TX/CTS/RTS + RX/TX/DSR/dtr	RX	TX	CTS	RTS	RX3	TX3	DSR3
Option 5	RX/TX/DSR/DTR + RX/TX + RX/tx	RX	TX	RX2	TX2	DSR	DTR	RX4
Option 6	RX/TX/DSR/DTR + RX/TX/CTS/rts	RX	TX	RX2	TX2	DSR	DTR	CTS2
Option 7	RX/TX/DSR/DTR + RX/TX/DSR/dtr	RX	TX	RX2	TX2	DSR	DTR	DSR2
Option 8	RX/TX + RX/TX + RX/TX + RX/tx	RX	TX	RX2	TX2	RX3	TX3	RX4

Option 9	RX/TX/CTS/rts + RX/TX + RX/TX	RX	TX	RX2	TX2	RX3	TX3	CTS
Option 10	RX/TX/DSR/dtr + RX/TX + RX/TX	RX	TX	RX2	TX2	RX3	TX3	DSR
Option 11	RX/TX/CTS/RTS + RX/tx/CTS/RTS	RX	TX	CTS	RTS	CTS4	RTS4	RX4
Option 12	RX/TX/CTS/RTS + RX/tx/DSR/DTR	RX	TX	CTS	RTS	DSR4	DTR4	RX4
Option 13	RX/TX/DSR/DTR + RX/tx/CTS/RTS	RX	TX	CTS4	RTS4	DSR	DTR	RX4
Option 14	RX/TX/DSR/DTR + RX/tx/DSR/DTR	RX	TX	DSR4	DTR4	DSR	DTR	RX4

As you can see, both the DS1101 and DS1102 have at least three channels: RX/TX, RX2/TX2 (CTS/RTS), and RX3/TX3 (DSR/DSR). The DS1101 additionally has the RX4 line but no TX4. Since Modbus applications require both the RX and TX lines, you can disregard this "half-channel."

Of all the options presented in the table above, two stand out as "very useful" for the Modbus Gateway app:

- **Option 0**, because it represents the standard serial port arrangement.
- **Option 8**, because it offers three simple serial channels with just the RX and TX lines in each channel (which is usually enough for Modbus devices).

RS422 and RS485 (DS1102 only)

You can only use the mapping option 0 in these modes.

Configuration

Tibbo Modbus Gateways offer two configuration methods:

- Using the DS Manager utility;
- Using the web interface.

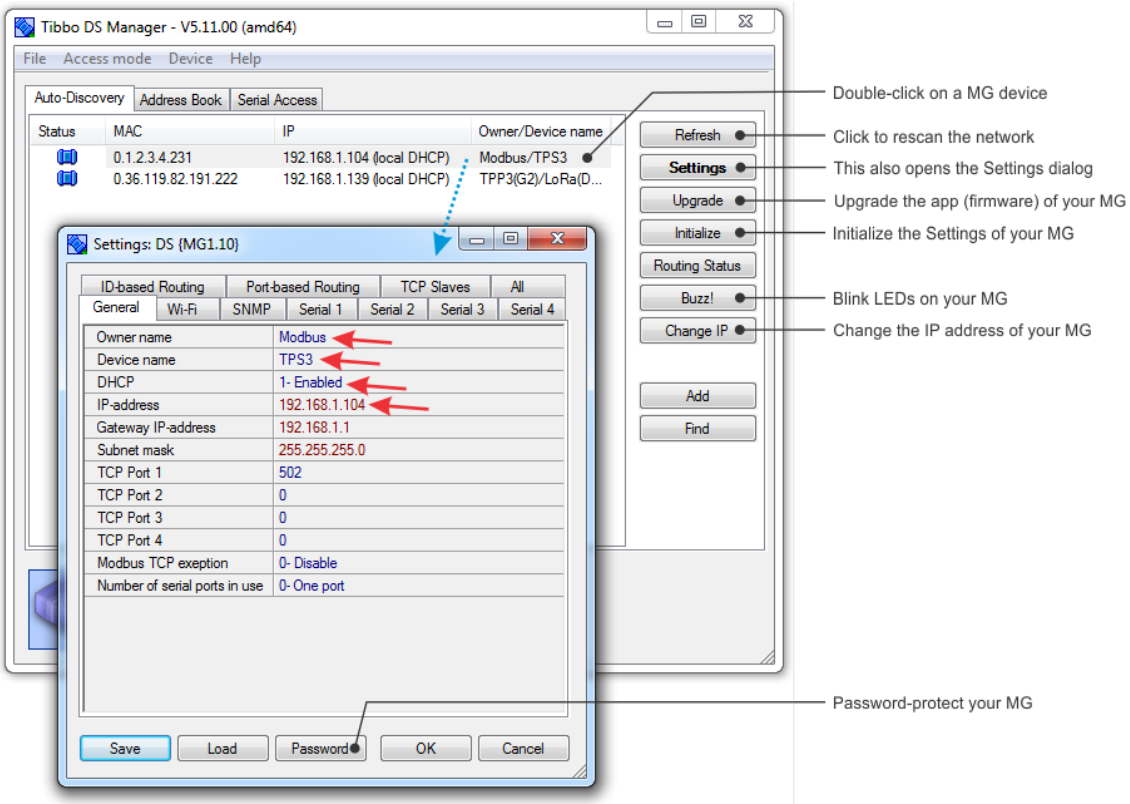
Using DS Manager

The **DS Manager** utility is used to locate, setup, manage, monitor, and upgrade the firmware of compatible Tibbo devices. This utility is a part of the **Tibbo Device Server Toolkit (TDST)** for Windows.

More information on the **DS Manager** can be found here: http://tibbo.com/soi/software.html#ds-manager.

You can download **TDST** here: http://tibbo.com/support/downloads/tdst.html.

Configuration using the **DS Manager** is the primary method of setting up a Tibbo Modbus Gateway. This is because the **DS Manager** allows you to discover and configure all compatible Tibbo devices connected to a local LAN segment. This includes devices without valid IP addresses (devices with default IPs).



How to use the **DS Manager**:

- Make sure your Modbus Gateway is connected to the same LAN segment as your Windows PC.
- Install **TDST** and run the **DS Manager** utility — it will automatically discover and display the list of compatible Tibbo devices found on your LAN segment.
- If necessary, click **Refresh** to rescan the network.
- If the **DS Manager** shows a large list and you are not sure "what is what", click on an entry in the list, then click **Buzz!** The red and green status LEDs on the corresponding devices will blink.
- Double-click on a Tibbo Modbus Gateway displayed in the list (or select it in the list and click **Settings**). The **Settings dialog** will open. Notice how the settings are grouped into several tabs.
- Edit the settings and click **OK** to close the dialog. New setting values will be sent to the Gateway, after which it will reboot.
- To password-protect the settings of your Modbus Gateway, click on the **Password button** in the **Settings dialog**.
- The main window of the **DS Manager** also has a button for **initializing** your Modbus Gateway (i.e. restoring all settings to their default factory values).
- Finally, there is an **Upgrade button** for uploading new application (firmware) into your Modbus Gateway.

The first sensible step to take on a new Modbus Gateway is to configure its IP address. Either enable DHCP (it is found in the **General tab** of the **Settings dialog**) or set the desired (and valid) IP address manually. You can do this through the

Settings dialog (the setting is on the **General tab**), or by using the **Change IP button** found in the main window.

Note that the use of DHCP, although convenient, is not always a good idea: if the Gateway is going to route requests from Modbus TCP Masters, then these Masters will need to know its IP address. Since DHCP does not guarantee that the IP address stays the same, it is not advisable to enable DHCP for Gateways that will handle traffic from Modbus TCP Masters.

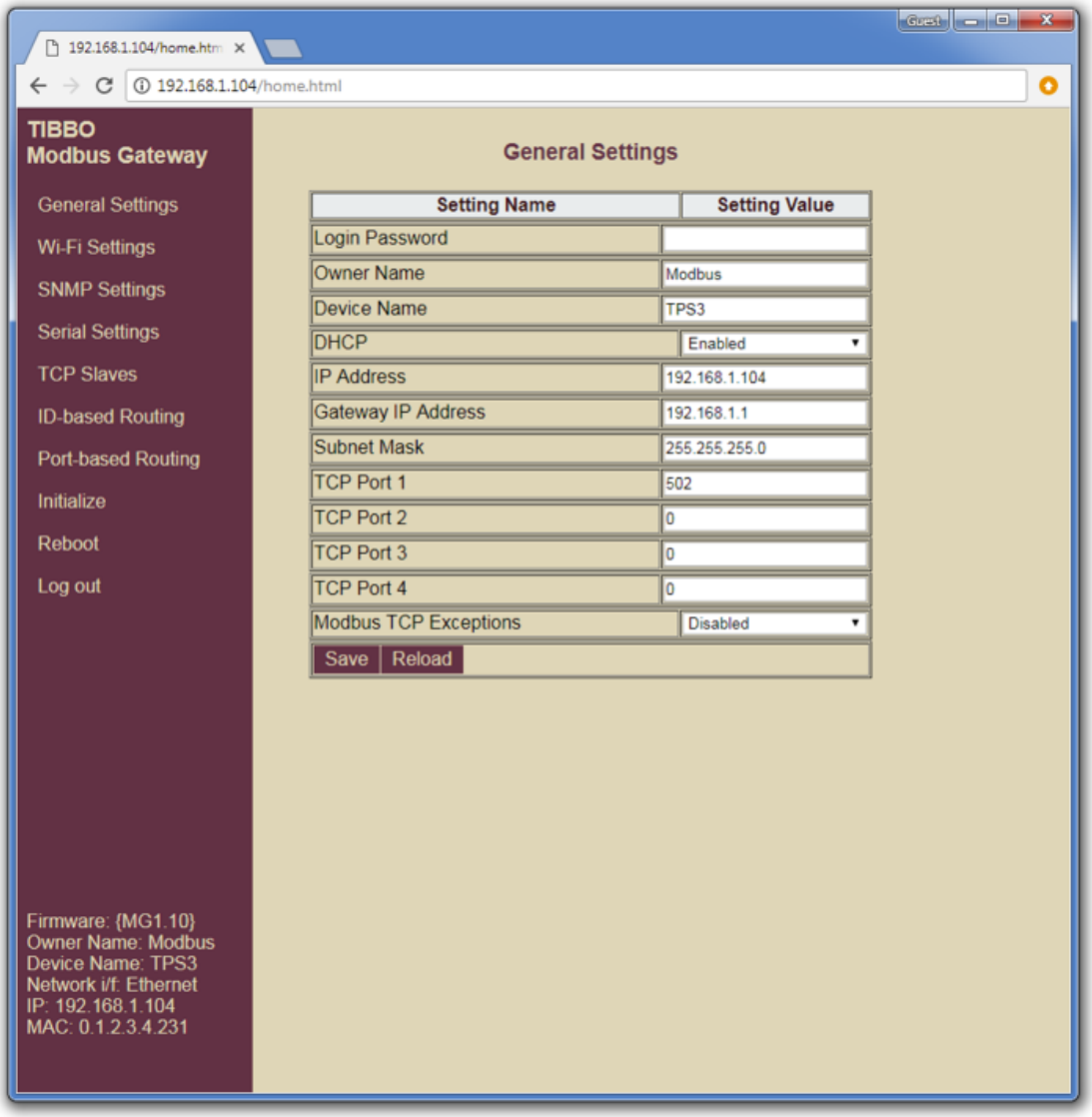
One other step you may want to take right away is setting the **Owner name** and **Device name**. These names are displayed in the **DS Manager's** device list next to IP addresses of discovered devices. Owner and device names greatly simplify device identification.

Using Web Interface

The web interface provides all the controls offered by the DS Manager, except the ability to find out the IP address of your Modbus Gateway. Since accessing the Gateway via a browser is contingent upon assigning a valid IP address to it and knowing this IP, the use of **DS Manager** is unavoidable, at least for the initial configuration of said IP.

Once the IP address of your Gateway has been properly configured, point your web browser to this address. You will first be presented with a login screen. Click **Log In** — there is no password by default. You can set the password later. The password is the same password that you set in the **DS Manager**.

Like the **DS Manager**, the web interface also groups settings. Generally speaking, there is a dedicated web page for every setting tab displayed by the **DS Manager**. There is one exception: The **Serial Settings page** of the web interface allows you to setup all serial ports (channels). The **DS Manager** has separate tabs for each serial channel (port) instead.



Available Settings

Settings are grouped together:

- Into tabs in the DS Manager's **Settings dialog**;
- Into pages of the web interface.

The following setting groups are found on your Modbus Gateway.

- General settings
- Wi-Fi settings
- SNMP settings
- Serial settings
- TCP Slave settings

- Slave ID-based routing settings
- Port-based routing settings

General Settings

Find these settings:

- In the **General tab** of the DS Manager's **Settings dialog**;
- On the **General Settings page** of the web interface.

The following settings are available:

- **Login Password**: Set this password to prevent unauthorized access to your Gateway's configuration (settings). The same password is used for **DS Manager** and web browser access. This setting is only displayed on the **General Settings** page of the web interface. To set or change the password through the **DS Manager**, click the **Password** button found in the **Settings** dialog.

- **Owner Name** and **Device Name**: Allow you to set convenient device identifiers. **DS Manager** displays them in the device list (the list of discovered devices).

- **DHCP** (for the Ethernet port): Enables/Disables IP address configuration using DHCP.

Automatic IP configuration is not suitable for your system if the Ethernet port of your Modbus Gateway will be receiving requests from Modbus TCP Masters. In this case, you will need to assign your Gateway's Ethernet port a fixed static IP.

- **IP Address** (of the Ethernet port):
  - With the DHCP *enabled*, shows the current IP address assigned to the Ethernet port of your device.
  - When the DHCP is *disabled*, allows you to set the desired static IP address assigned to the Ethernet port of your device.

- **Gateway IP address** (of the Ethernet port).

- **Subnet Mask** (of the Ethernet port).

- **TCP Port 1**, **TCP Port 2**, **TCP Port 3**, **TCP Port 4**: Listening TCP Ports. These ports are there to receive requests from Modbus TCP Masters:
  - If you are using Slave ID-based routing, direct your traffic from Modbus TCP Masters to any (combination) of the four TCP ports.
  - If you are using TCP port-based routing, direct the traffic from different Modbus TCP Masters to different TCP ports, as required by the port-based routing rules you specify.

- **Modbus TCP Exceptions**:
  - When *Disabled*, the Gateway does not generate any exceptions (but does transparently route exceptions returned by Modbus Slaves).
  - When *Enabled*, the Gateway generates:
    - "Gateway target device failed to respond" (timeout) exceptions if the target Slave did not reply;
    - "Gateway path unavailable" if the target slave was not found.

- **Serial interface** (DS1102 only): Sets the mode of the serial port:
  - *RS232 (full-duplex)*;
  - *RS485 (half-duplex)*;
  - *RS422 (full-duplex)*.

- **Serial Port Configuration** (DS1101 and DS1102 only): Selects the desired channel configuration (mapping).

- **Power on Pin 9** (DS1101 only): The DS1101 allows you to optionally output 12V power on pin 9 of its DB9 connector. With pin 9 power *enabled* you can power attached Modbus RTU or ASCII device right through the DS1101 (provided that the power source powering the DS1101 has sufficient spare power).

Wi-Fi Settings

Find these settings:

- In the **Wi-Fi tab** of the DS Manager's **Settings dialog**;
- On the **Wi-Fi Settings page** of the web interface.

The following settings are available:

- **Wi-Fi Mode**:
  - *Disabled* — the Wi-Fi port is permanently shut down.
  - *Enabled (on demand)* — the Wi-Fi port activates and connects to an access point as soon as the Ethernet cable is unplugged; Wi-Fi port is shut down as soon as live Ethernet cable is detected again.
  - *Enabled (permanently)* — the Wi-Fi port is always active and attempts to stay associated with an access point at all times. Communicating through the Wi-Fi port still becomes possible only when the Ethernet port is unplugged. Wi-Fi communications are terminated as soon as live Ethernet cable is detected again. Compared to *Enabled (on demand)*, this option allows for a swifter Ethernet-to-Wi-Fi switchover because it has the Wi-Fi interface ready and associated with an access point even before the switchover becomes necessary.

- **Access Point Name**.

- **Security**: *Disabled*, *WEP64*, *WEP128*, *WPA-PSK*, or *WPA2-PSK*.

- **Password**: This is the password for the access point.

- **DHCP**:(for the Wi-Fi port): Enables/Disables IP address configuration using DHCP.

Note: automatic IP configuration is not suitable for your system if the Wi-Fi port of your Modbus Gateway will be receiving requests from Modbus TCP Masters. In this case, you will need to assign your Gateway's Wi-Fi port a fixed static IP.

- **IP Address** (of the Wi-Fi port):
  - With the DHCP *enabled*, shows the current IP address assigned to the Wi-Fi port of your device.
  - When the DHCP is *disabled*, allows you to set the desired static IP address assigned to the Wi-Fi port of your device.

- **Gateway IP address** (of the Wi-Fi port).

- **Subnet Mask** (of the Wi-Fi port).

SNMP Settings

Find these settings:

- In the **SNMP tab** of the DS Manager's **Settings dialog**;
- On the **SNMP Settings page** of the web interface.

The following settings are available:

- **SNMP**: *Disabled* or *Enabled*.

- **Community Name**: Specifies the community string used for the SNMP Agent. This text password is used to (weakly) authenticate queries to agents of managed network devices.

- **Contact**: An optional text field that can be used to specify emergency contact name or telephone number.

- **Location**: An optional text field that can be used to specify the device's location.

Serial Settings

Find these settings:

- In the four **Serial tabs** of the DS Manager's **Settings dialog**;
- On the **Serial Settings page** of the web interface.

The following settings are available:

- **Serial Interface** (TPS2(G2) and TSP3(G2) only): Allows you to select the mode of the serial port. Available choices are:
  - o TPS2(G2):
    - *None* (this serial port is not in use);
    - *Tibbit #01, RS232 (full-duplex)* – available on all four serial ports;
    - *Tibbit #02, RS232 (full-duplex)* – only available for serial ports 1 and 3;
    - *Tibbit #02, RS485 (half-duplex)* – only available for serial ports 1 and 3;
    - *Tibbit #02, RS422 (full-duplex)* – only available for serial ports 1 and 3;
    - *Tibbit #05, RS485 (half-duplex)* – available on all four serial ports.
  - o TPS3(G2):
    - *None* (this serial port is not in use);
    - *RS232 (full-duplex)*;
    - *RS485 (half-duplex)*;
    - *RS422 (full-duplex)*.

- **Modbus Serial Type**: *Master RTU*, *Master ASCII*, *Slave RTU*, or *Slave ASCII*.

- **Reply Timeout** (in steps of 1/2 seconds): Maximum reply time allotted to Modbus Slave(s) on this serial port. If the reply is not received within this time limit, the Gateway will "give up" on waiting. If Modbus TCP exceptions are enabled, the Gateway will generate the "Gateway target device failed to respond" exception.

- **Flow Control**: *None* or *RTS/CTS*. Although the use of the RTS/CTS flow control in Modbus devices is rare, we have provided this setting anyway.

- **Baudrate**: various standard baud rates.

- **Parity**: *None**, *Even*, *Odd*, *Mark*, *Space*.

- **Data Bits**: *7** or *8* bits/character.

- **Max Intercharacter Delay** (in steps of 10 ms): Used on serial ports (channels) when **Modbus Serial Type** (see above) is *Master RTU*, and the Gateway is receiving data from the attached Modbus RTU Master. This setting defines the maximum allowed delay between the reception of serial characters belonging to the same Modbus command being transmitted by the Modbus RTU Master. If this delay is exceeded, then the Gateway considers the next received character to belong to the next incoming Modbus command. This setting is irrelevant in the Modbus ASCII mode because Modbus ASCII messages use message framing characters and do not rely on idle periods (intercharacter delays). The setting is also irrelevant when the Gateway is sending data out through its serial ports (channels).

** TPS2(G2), TPS3(G2), EM2000, and other ARM-based devices do not support the combination of the 7 bits/character mode and the "None" parity mode.*

TCP Slave Settings

Find these settings on the **TCP Slaves** tab and page.

Up to four TCP Slave IP and port pairs can be defined.

Slave ID-based Routing Settings

Find these settings on the **ID-based Routing** tab and page.

Up to eight Slave ID-based routing rules can be defined. For each rule, you need to set the following:

- **ID From**: First Slave ID number in the range.
- **ID To**: Last Slave ID number in the range.
- **ID Shift**: Specify a positive or negative number that will be added to the contents of the ID field of each Modbus request satisfying the rule (for more info, see Slave ID Shifting). Leave at 0 to disable ID shifting.
- **Destination**: You can select one of the four serial ports (channels) or one of the four TCP Slaves.

Port-based Routing Settings

Find these settings on the **Port-based Routing** tab and page.

Up to four TCP port-based routing rules can be defined. These rules correspond to **TCP ports 1 ~ 4** that you configure in General Settings. For each rule, you need to set the following:

- **ID Shift**: Specify a positive or negative number that will be added to the contents of the ID field of each Modbus request satisfying the rule (for more info, see Slave ID Shifting). Leave at 0 to disable ID shifting.
- **Destination**: You can select one of the four serial ports (channels) or one of the four TCP Slaves.

Status Indication and Monitoring

In this section:

- Understanding LED signals
- Status info on the optional display

Understanding LED Signals

Tibbo Modbus Gateways have the following LEDs:

- A pair of Green and Red Status LEDs for displaying the general system status.
- Five blue LEDs for displaying Wi-Fi status.
- One yellow LED that shows the Ethernet link status. This LED turns on when a live Ethernet cable is plugged into the Gateway.

Main Status (Red and Green LEDs)

The following patterns are shown on the main Green and Red Status LEDs of Tibbo Modbus Gateways.

Patterns of the Modbus Gateway App

Obtaining the IP address via DHCP:

(one green flash and pause)

The system is idle:

(two green flashes and pause)

A TCP connection is being establishes:

(three green flashes and pause)

At least one TCP connection in progress but no data is being transmitted through the Gateway:

(green on)

At least one TCP connection in progress and data is being transmitted through the Gateway:

(green mostly on and turns off momentarily when data is being transmitted)

No TCP connection is in progress and data is being transmitted through the Gateway (for example, between two serial ports):

(green mostly off and turns on momentarily when data is being transmitted)

The app has encountered a setting error (restore all settings to their default values by using the **Initialize button** of the DS Manager):

(red blinking slowly)

Buffer overrun:

(red on)

Additional Patterns

These patterns are not directly related to the Modbus Gateway app. Rather, they appear when the app is not loaded, corrupted, or isn't running:

No app is loaded:

(green and red blinking fast)

No app is loaded:

(red blinking fast)

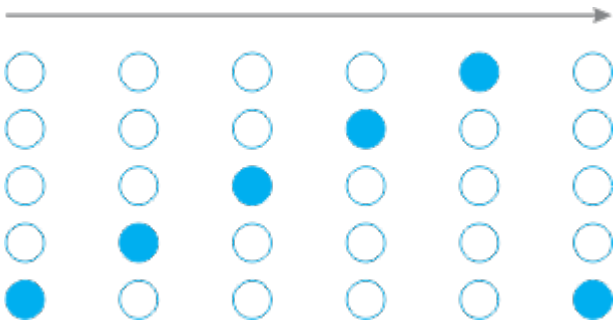
The app is not running:

(green blinking fast)

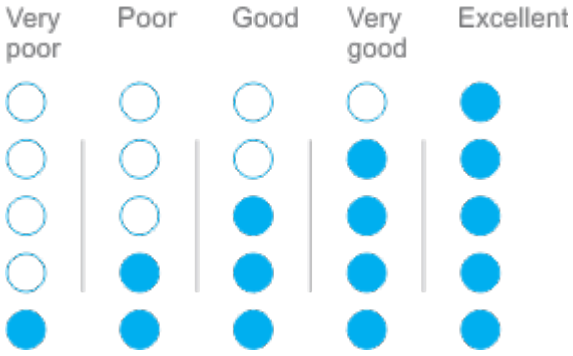
Wi-Fi Status (Blue LEDs)

Wi-Fi status is displayed on five blue LEDs:

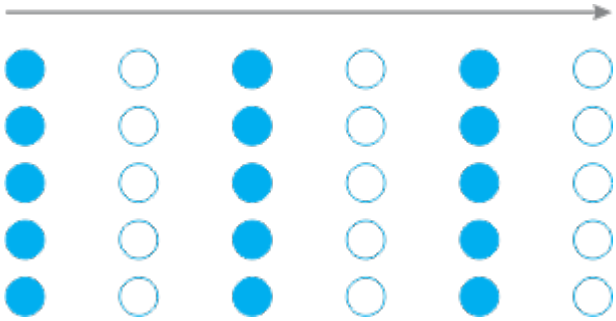
When the Wi-Fi interface is looking for or associating with an access point, blue LEDs show a running pattern:



When the Gateway is associated with an access point, blue LEDs display the signal strength:



Finally, the Wi-Fi error pattern is displayed when the Wi-Fi interface has malfunctioned. Typically, you will see this error if you attempt to enable the Wi-Fi port on a Gateway that doesn't have the Wi-Fi module installed:



Status Info on the Optional Display

TPS2(G2)-based Modbus Gateways can optionally be ordered with the available 320x240 color TFT LCD (TPS2L form factor). The LCD conveniently shows:

- Current IP address and DHCP status on the Ethernet port;
- Current Wi-Fi status, as well as IP address and DHCP status on the Wi-Fi port;
- The status of each serial port.

The DS1101 and DS1102 devices can optionally be ordered with a 96x32 monochrome OLED ("D" ordering option).

These tiny displays show relevant data on "display pages." You flip through pages using the setup (MD) button:

Operation Monitoring

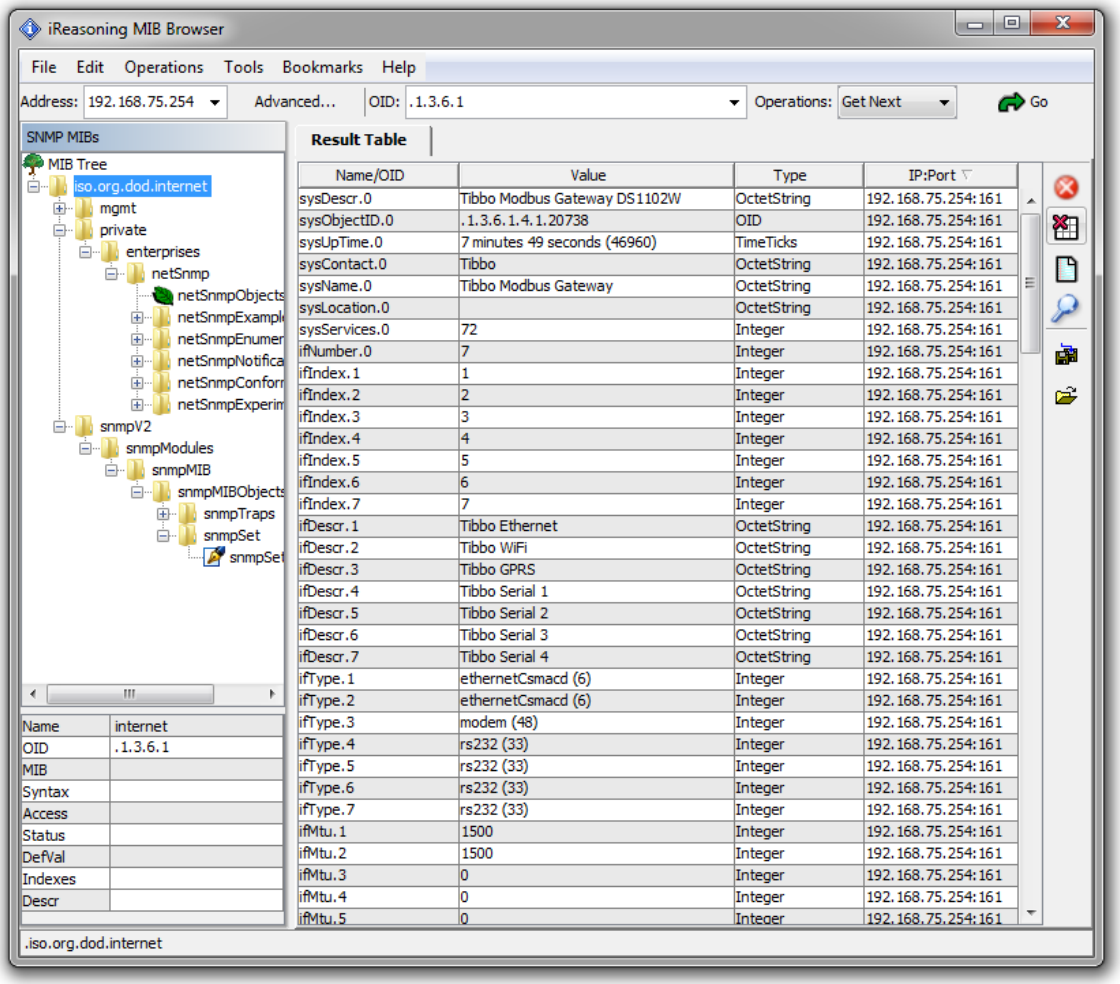
In this section:

- Configuration monitoring via SNMP protocol
- Data-level monitoring using IO Ninja

Configuration Monitoring Via SNMP Protocol

Tibbo Modbus Gateways support SNMP protocol V1 (with partial support of V2 commands). The parameter set conforms to SNMP V2.

Here is the screenshot of the **iReasoning MIB Browser window** (http://ireasoning.com/mibbrowser.shtml) showing SNMP parameters of our Modbus Gateway.



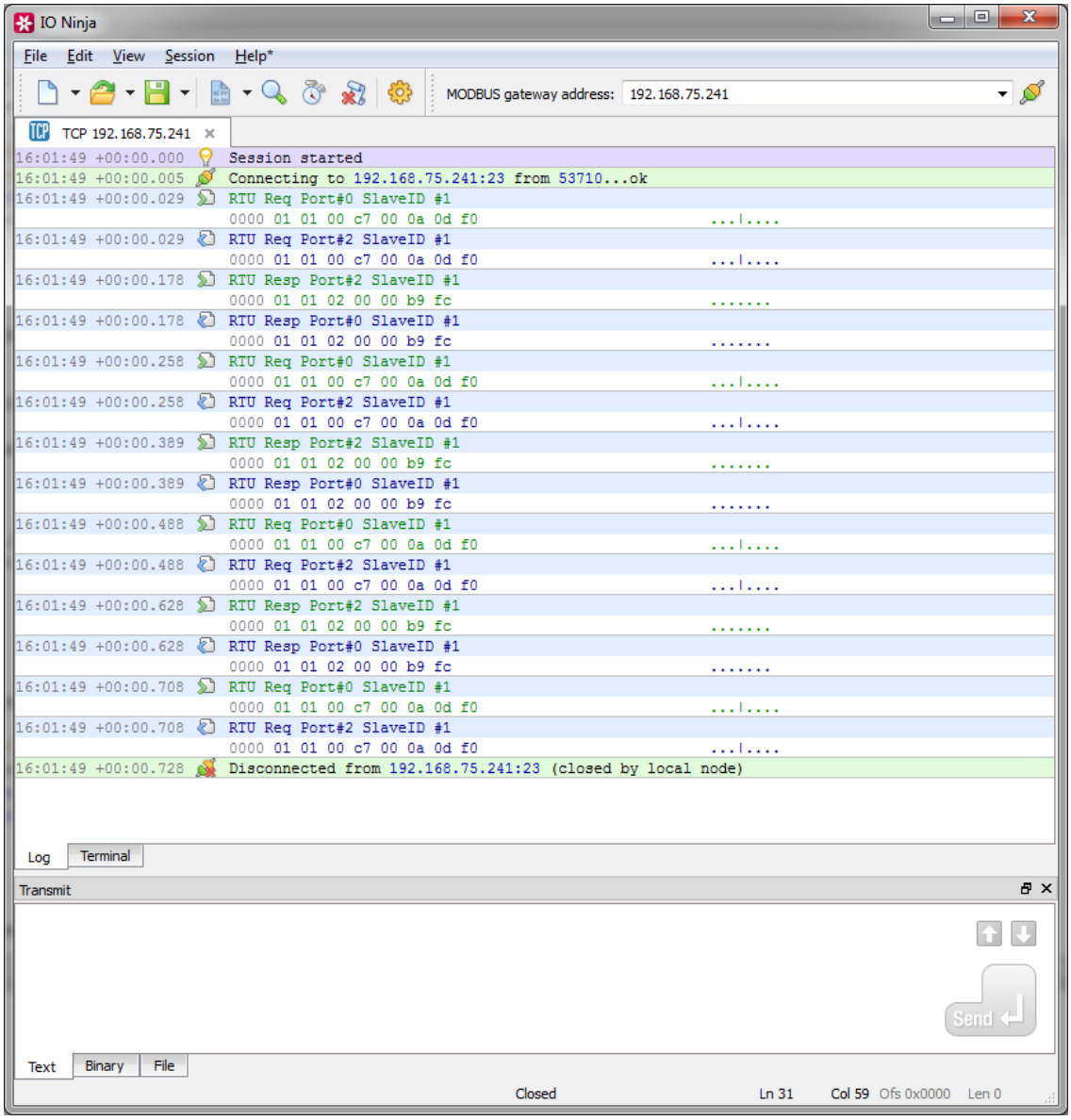
Data-level Monitoring Using IO Ninja

IO Ninja is a professional, scriptable, multi-purpose terminal emulator, network sniffer, and IO monitor. You can find an introduction to **IO Ninja** here: http://ioninja.com/.

We have developed a special **IO Ninja** plugin for monitoring traffic through Tibbo Modbus Gateways. **Tibbo Modbus Gateway Monitor** plugin connects into the TCP port 23 of your Gateway. As soon as such a connection is established, the Gateway starts sending an "annotated" copy of all traffic to **IO Ninja**.

Here is how to use the plugin:

- Install and run **IO Ninja**.
- Select **Tibbo Modbus Gateway Monitor** plugin.
- Enter the IP address of your Gateway into the **Modbus Gateway Address** textbox.
- Click **Connect**.



Upgrading the Modbus Gateway App

This section explains how to upgrade the Modbus Gateway app running on your Tibbo Modbus Gateway. In other words, it describes how to upgrade your Gateway's firmware.

Firmware upgrades can be "warm" or "cold." A warm upgrade is when your Gateway has a functioning Modbus Gateway app and you just want to upload a newer (different) version of this app. Warm upgrades rely, at least in part, on the Modbus Gateway app that is already running on your Gateway. Removing or damaging the currently loaded app bricks your device and eliminates the possibility of the next upgrade to be a warm upgrade. All you can do to save your device after it has been "bricked" is to perform a cold upgrade. Cold upgrades rely on your Gateway's *Loader* — a resident program that is always present. It is (virtually) impossible to erase the Loader, and this allows you to save a bricked device.

Here are all the ways to upgrade (or un-brick) your Modbus Gateway:

	Warm upgrades	Cold upgrades
TPS-based Gateways	Via Ethernet, using DS Manager or via Ethernet, using Device Explorer	Via Ethernet, using Device Explorer
DS1101 and DS1102-based Gateways	Via Ethernet, using Device Explorer	Via serial port, using DS Manager

Warm Ethernet Upgrades Using DS Manager

TPS-based Tibbo Modbus Gateways allow you to perform warm upgrades through the Ethernet using the DS Manager utility.

To perform a warm upgrade using the **DS Manager**:

- Download the Modbus Gateway app file (firmware file) to your PC.
- Run the **DS Manager**.
- In the **DS Manager's** device list, click on the Modbus Gateway that you want to upgrade (if necessary, click **Refresh** to rescan the network for compatible Tibbo devices).
- Click **Upgrade**.
- **Browse** to the app file and click **OK**. The upgrade process should start.

Warm Ethernet Upgrades Using Device Explorer

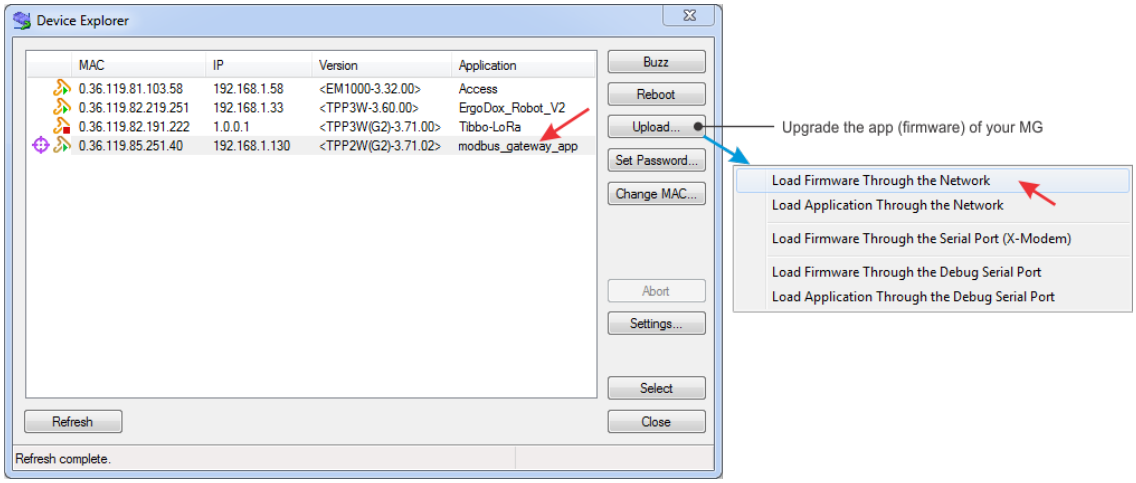
All Tibbo Modbus Gateways allow you to perform warm upgrades through the Ethernet using a software utility called the **Device Explorer**. There are two ways to get the **Device Explorer** onto your PC:

- By installing it as a standalone utility.
- By installing our **Tibbo IDE (TIDE)** software, which will also copy the **Device Explorer** onto your PC.

The installation files can be found here:
http://tibbo.com/support/downloads/tide.html.

To perform a warm upgrade using the **Device Explorer**:

- Download the Modbus Gateway app file (firmware file) to your PC.
- Make sure your Modbus Gateway is connected to the same LAN segment as your Windows PC and that the Ethernet cable plugged into the Gateway is live (the yellow Ethernet Link LED is on).
- Run the **Device Explorer**. You should see your device in the list of discovered programmable Tibbo devices. If necessary, click **Refresh** to rescan the network. Notice how the **Device Explorer** shows the names of loaded apps, and the name of your Gateway's app is *modbus_gateway_app*.



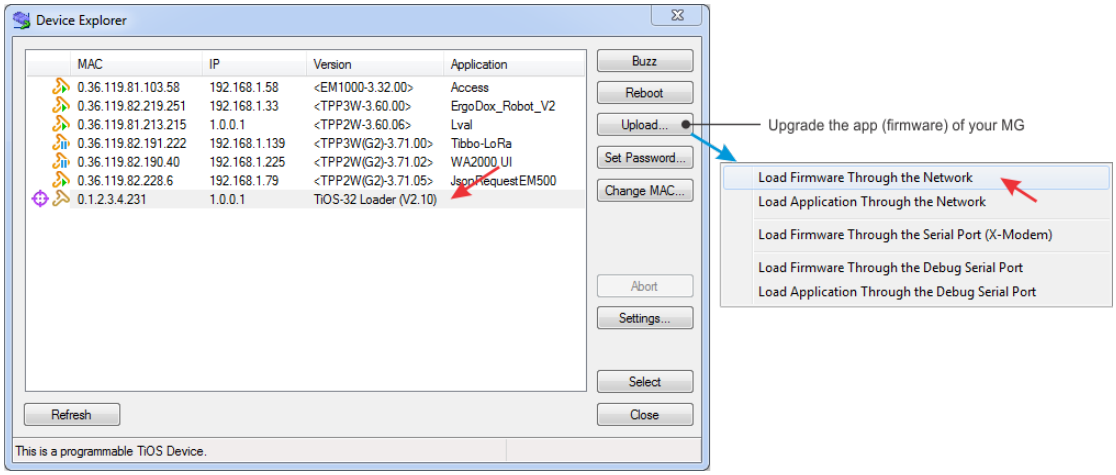
- Click on this device in the list, then click **Upload...** and select **Load Firmware Through the Network**.
- Browse to the app file and click **Open**. The upgrade process should start.

Cold Ethernet Upgrades Using Device Explorer

TPS-based Tibbo Modbus Gateways allow you to perform cold upgrades through the Ethernet using the **Device Explorer**. Warm Ethernet upgrades using this utility has already been explained in the previous section.

Cold upgrades require several additional steps:

- Download the Modbus Gateway app file (firmware file) to your PC.
- Power off your bricked TPS-based Modbus Gateway.
- Press and hold the Setup ("MD") button (the button is on the right side of your TPS device).
- Without releasing the button, power up your Gateway. The Gateway will now enter the Loader mode.
- Make sure your Modbus Gateway is connected to the same LAN segment as your Windows PC and that the Ethernet cable plugged into the Gateway is live (the yellow Ethernet Link LED is on).
- Run the **Device Explorer**. You should see your device in the list of discovered programmable Tibbo devices. The Version field for this device should say *TiOS-32 Loader (Vx.xx)*. If necessary, click **Refresh** to rescan the network.



- Click on this device in the list, then click **Upload...** and select **Load Firmware Through the Network**.
- Browse to the app file and click **Open**. The upgrade process should start. If the **Device Explorer** shows a warning telling you that you are attempting to upload an incompatible file, disregard this warning and proceed.

Cold Serial Port Upgrades Using DS Manager

Cold upgrades of DS1101 and DS1102-based Modbus Gateways are performed using the *serial mode* of the DS Manager utility.

To perform a cold upgrade, you will need the following:

- A PC with a serial (COM) port, or a USB-to-serial converter (cable).
- A DB9F-to-DB9F serial cable, such as Tibbo's **WAS-1455** cable. You can purchase this cable here: http://tibbo.com/store/accessories.html.

The procedure:

- Download the Modbus Gateway app file (firmware file) to your PC.
- Connect the serial port of your DS1101 or DS1102 to your PC's COM port or to a USB-to-serial converter cable plugged into the PC.
- Start the **DS Manager** in the *Administrator mode*. To do this:
  - o Click the **Windows Start button**;
  - o Browse to and right-click on **Tibbo DS Manager**;
  - o Choose **Run as Administrator** from the drop-down menu.
- In the **DS Manager**, switch to the **Serial Access tab**.
- Click on the serial port you will be using (for example, *COM1*).
- Click **Upgrade**.
- **Browse** to the app file and click **OK**. The DS Manager will start waiting for your DS1101/1102 to become ready.
- Power off your bricked DS1101/1102.
- Press and hold the Setup ("MD") button (the button is to the left of the Ethernet port).
- Without releasing the button, power up your DS1101/1102. The upgrade process will start.

Update history

12MAR2018

- Initial release.