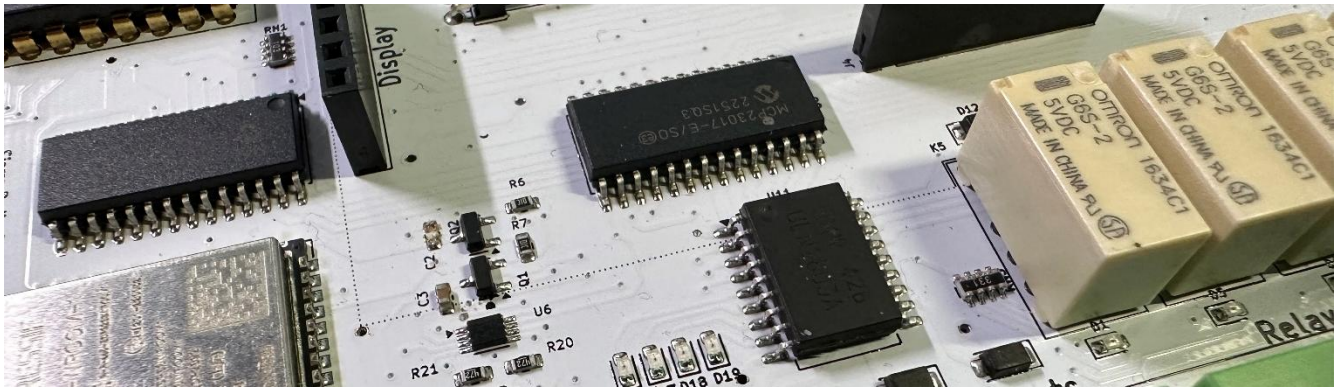


Sierra Radio Systems
Station Controller

RF Watt Meter Module Reference Manual

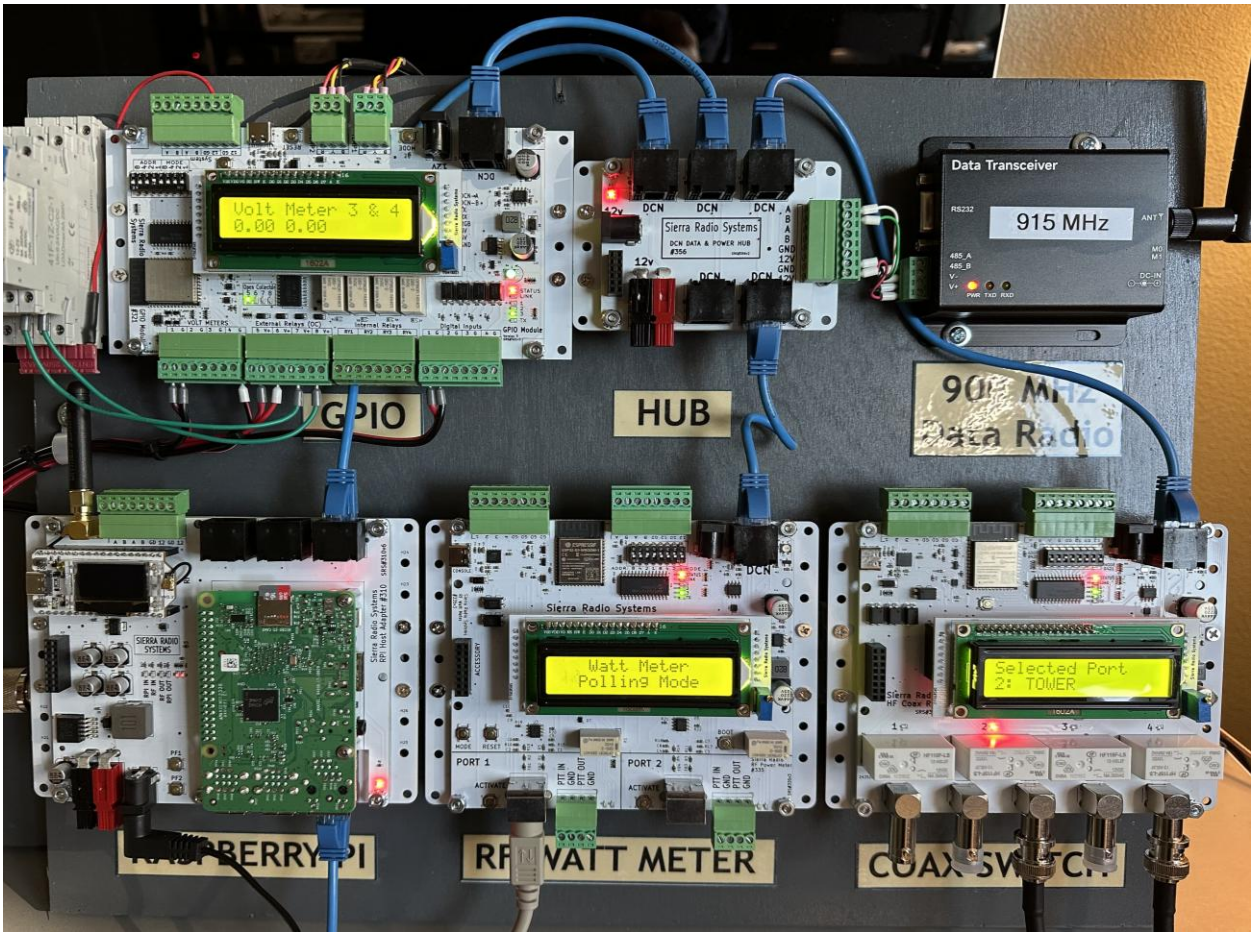
SIERRA RADIO SYSTEMS

sierraradio.net

Version 1

Typical Hardware Installation

This example shows a typical system mounted to a plywood board using DIN rails and clips.



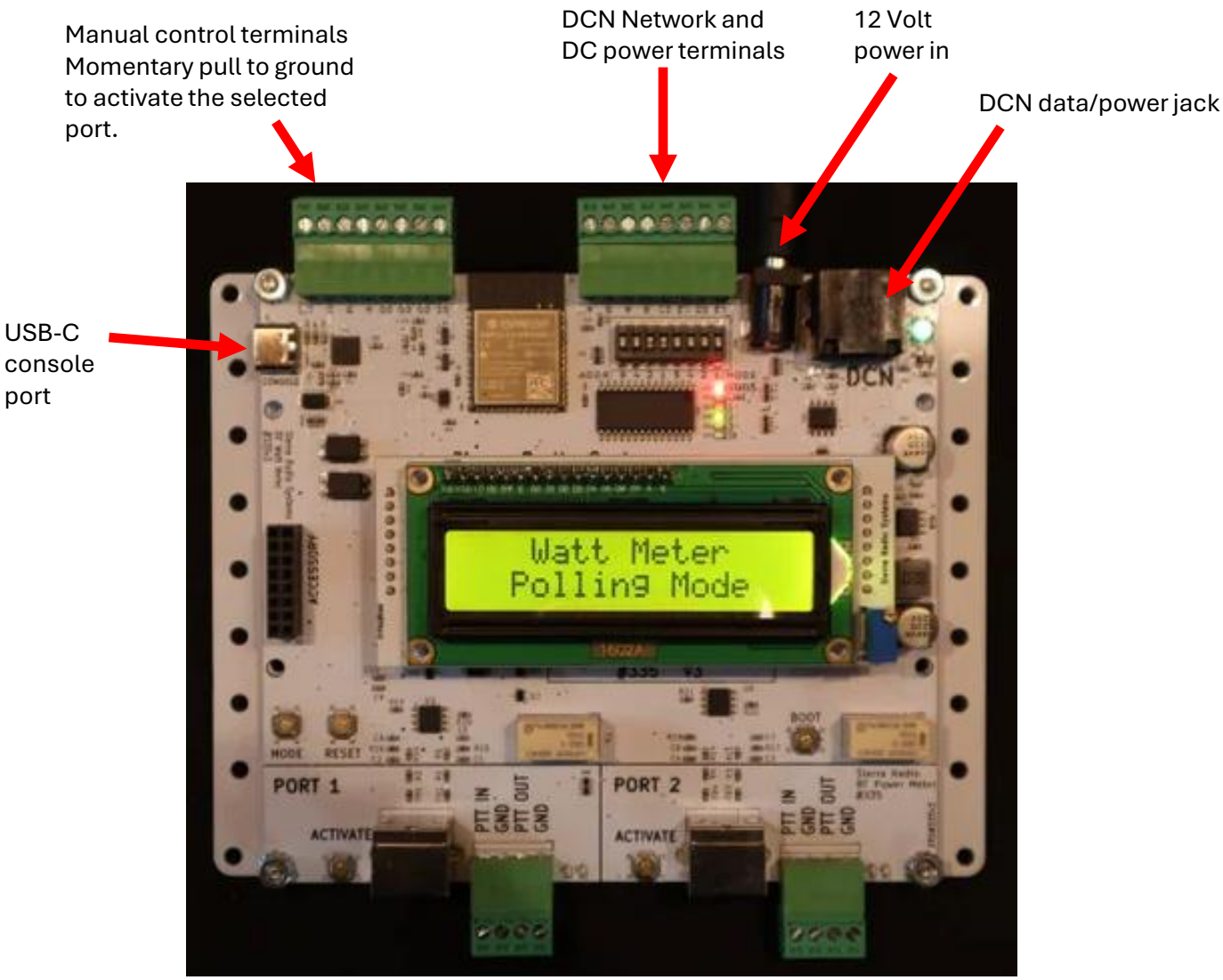
In the example pictured above you can see a full system including from top left:

- Optional 6A slim DIN rail mount SPDT relays
- GPIO Module
- Optional 5 port DCN power and data hub
- Optional 900 MHz DCN data radio

On the bottom row from the left:

- Raspberry Pi Module
- RF Watt Meter Module
- Coax Relay Module

Watt Meter Control Module

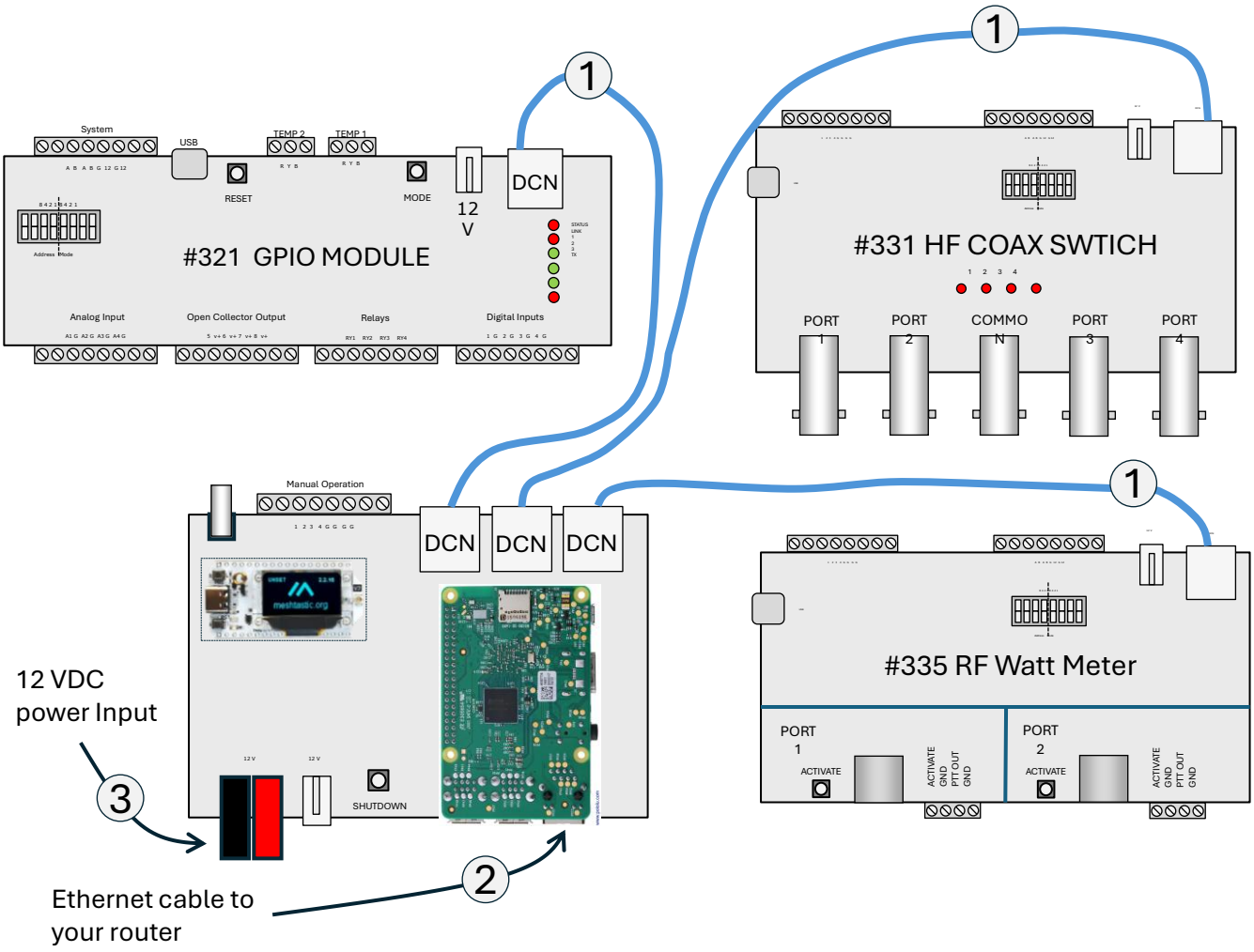


Port 1 & 2

Activate button – Manually activate RF power measurement on this port

PTT In – used in repeater systems to indicate if the transmitter is in transmit
PTT Out – Pull to ground to key repeater

6 pin mini DIN – RF directional coupler jack



In this example, you only need three connections to get your system up and running.

1. CAT6 cables between the Raspberry Pi host adapter module and each of the control modules. These provide power and data to the control modules.

2. Ethernet cable from your router to the network jack on the Raspberry Pi

3. 12 VDC power input to the powerpole or 2.1mm barrel jack.

Configuring Your Watt Meter

The watt meter control module supports three different models of directional coupler or RF sensor. By default, the watt meter assumes both port 1 and port 2 are configured to use a WaveNode model HF-1 directional coupler.

WaveNode Sensor Model	Frequency Range	Maximum RF Power	Model Number For Watt Meter Controller Settings
HF-1	1.8-60 MHz	2,000 Watts	1
LP-1	1.8-60 MHz	60 Watts	2
UHF-1	120-470 MHz	300 Watts	3

Selecting the watt meter sensor type and setting other parameters can be done through the USB-C console serial port on the watt meter. To do this you will need to connect your computer to the USB-C port and use a simple “dumb terminal” program to send commans to the watt meter module. We recommend using Putty for Windows, Minicom for Linux or similar program for the Mac.

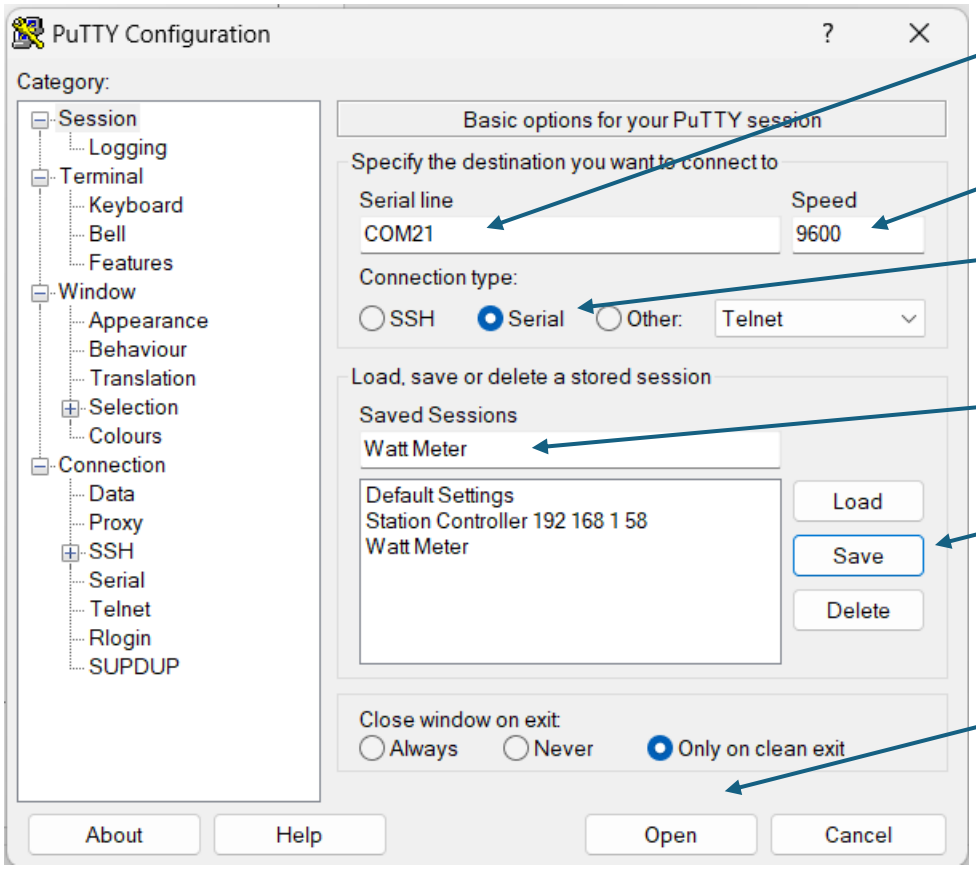
For Putty go to https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html

When you plug your USB-C cable into the watt meter module and PC, a new serial port will be added to your system. On Windows you can determine the COM port number by looking at the “Computer Management” utility. At the Windows search bar, type “computer” and you should see Windows pop up an option to select Computer Management. Launch this program. Click on “Device Manager” then click on “Ports”. All the available serial ports will be shown. The watt meter will present itself as a SiLabs serial device. Take note of the COM port number. We will need that for the Putty terminal program.

Launch Putty, configure the serial port parameters and “open” a connection to the serial port.

- You must select “Serial” as your connection type.
- Enter COMxx on the host name field where xx is the port number you noted in the Computer Management utility. For example “com21”.
- Set the baud rate to 9600
- Enter a name for this connection in the “Saved Sessions” field. This can be any text like Watt Meter.
- Then click on the “open” button and you will be connected to the watt meter.

Configuring the Putty session



Enter the COM port number.

Enter 9600

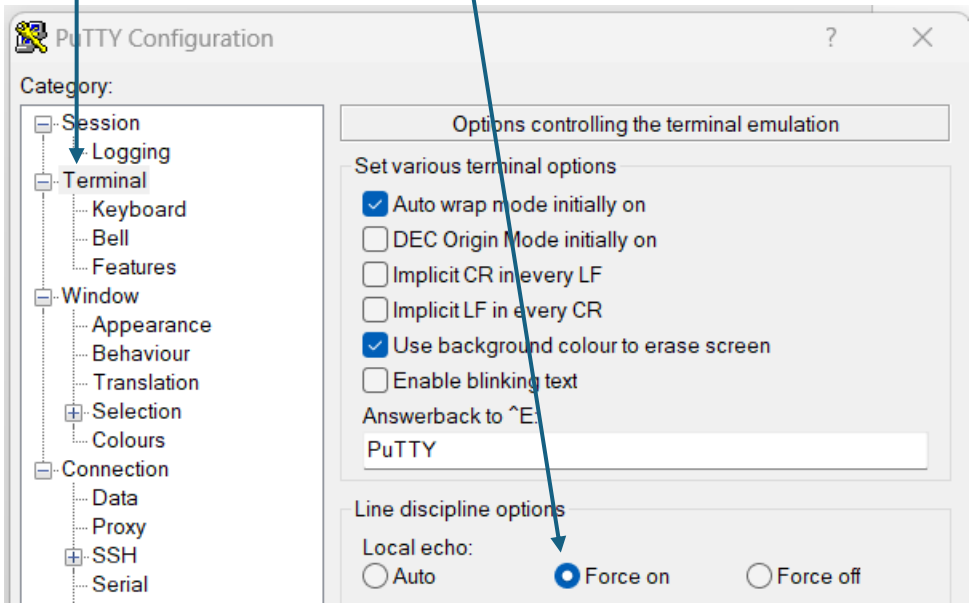
Select Serial

Enter connection name

Click save

Click open

Select the “Termainal” menu. Turn on local echo.



Operating Modes

The Watt Meter module can be deployed in two operating modes: Polling Mode and Streaming Mode.

Polling Mode
In some applications like remote HF station control or repeater power monitoring, you may want to sample the RF power from time to time. For example for an HF remote station you may test the forward and reflected power when you start a session using the radio and not be concerned about it after that. After all you are just checking to make sure the radio is putting out proper power and the antenna system is working as it should
This use case is similar to a repeater system where you expect a typical forward and minimal reflected power but want to check from time to time to make sure nothing has gone wrong with the antenna system. In these use cases, you may want to sample the power every 30 seconds or even less frequently.
In these use cases, the Watt Meter Module is configured to operate in Polling Mode. The rate of polling is fully programmable in the Node Red dashboard. You typically poll the Watt Meter Module over the DCN along with all the other modules on your network. Deciding the poling rate is a tradeoff between the number of devices sharing the network and the goal of minimizing the congestion on the network so important data is not lost.

There are two ways to trigger a watt meter measurement cycle. The full test method and the quick test method.

Full Test Method
This method is triggered with a WM1 or WM2 command. This is a full RF power measurement cycle. This test typically takes 5-10 seconds to perform and return the wattage in an UPDATE packet format. When triggered, the watt meter board will close the PTT out relay keying the transmitter, wait a short time for the transmitter to settle down, usually 1 second. The watt meter then samples the RF power several times and returns the RF power in watts in the UPDATE packet. Then there is a short delay and then the transmitter PTT line goes inactive unkeying the transmitter. The LCD display then show the forward and reflected power.
This mode is ideal for measuring constant power transmitters like a repeater or an HF radio in CW mode.

Quick Test Method
This method is triggered with a WM command. The goal is to take a quick sample of power and return the value to the dashboard. This is similar to the WM1 and WM2 commands but differs in some important ways. This command will return both Port 1 and Port 2 watt meter values. There is no PTT output and no settling time before or after the sample.
This method is used by the dashboard to take a quick snapshot of power in the RF samplers every time the dashboard polls the watt meter module.

Operating Modes

Streaming Mode

Other applications require the watt meter to show RF power measurements more frequently. For example if you are setting the output power of a transmitter you may want to see the watt meter update at least one per second. Streaming mode lets you constantly send measurement data from the watt meter module to the dashboard without the dashboard asking the module for the latest measurements. The Watt Meter Module sends data at about one sample per second. Streaming mode works great if the only control module on the network is the one Watt Meter Module. In a typical remotely controlled station, you will have more than one module in which case you can not share the same physical DCN channel.

To properly implement streaming with multiple control modules, you will want to put the device streaming on it's own physical channel leaving all the devices being polled on the main DCN channel. This is very easy to do. Simply add a USB to RS-485 dongle to the Raspberry Pi or other Node Red dashboard computer and wire it directly to the Watt Meter Module that is streaming. When you add the USB dongle, the computer will create a new serial port device. On a Raspberry Pi, the default DCN network runs on /dev/ttyS0 and the Node Red dashboard sends and receives all data on this serial port. The newly added USB dongle will appear as a new device typically called /dev/ttyUSB0. You will want to change the UART assigned to the serial input and output nodes in your watt meter tab of the Station Controller dashboard. You will also want to change the speed of the serial port to 115200 baud. That's it on the dashboard side.

The final step is to set the Watt Meter Module to streaming mode. To do this simply flip MODE button 4 into the up position. This is the 3rd switch from the right side of the 8 position DIP switch.

Now you are in streaming mode !

Watt Meter Configuration Commands

When connected to the watt meter using the USB port, there is no need to format commands with the full addressed packet format that you would see on the DCN. This means all commands can be refixed with a //

Command: **WMCONFIG** Assign RF sensor types to each port.
Syntax: //WMCONFIG,x,y
Where x is the port number 1 or 2
Where y is the sensor type 1, 2 or 3

Command: **WM** Get watt meter sensor values.
Syntax: //WM
Return: Watt meter values for both port 1 and 2.
Details: The watt meter controller takes an immediate reading of forward and reflected power on both ports and returns the values in an UPDATE packet format.

Command: **WM1** Run test on Port 1
Syntax: //WM1
Return: Watt meter values for port 1.
Details: The watt meter keys the transmitter by pulling the PTT OUT pin to ground then reads the forward and reflected power on port 1 and returns the values in an UPDATE packet format.

Command: **WM2** Run test on Port 2
Syntax: //WM2
Return: Watt meter values for port 2.
Details: The watt meter keys the transmitter by pulling the PTT OUT pin to ground then reads the forward and reflected power on port 2 and returns the values in an UPDATE packet format.

Command: **WMLIST** List watt meter calibration table for port 1
Syntax: //WMLIST,1
Return: Table of watt meter calibration points.
Details: This table shows the list of RF wattage points and their current calibration values for port 1.

Command: **WMLIST** List watt meter calibration table for port 2
Syntax: //WMLIST,2
Return: Table of watt meter calibration points.
Details: This table shows the list of RF wattage points and their current calibration values for port 2.

Command: **WMINIT** Initialize watt meter calibration tables
Syntax: //WMINIT,x,y
Where x is port 1 or 2 and y is sensor type 1, 2 or 3
Sensor type 1 = WaveNode HF-1
Sensor type 2 = WaveNode LP-1
Sensor type 3 = WaveNode UHF-1
Example: //WMINIT,1,3 Will reset port 1 to sensor type 3 (UHF-1) to factory defaults
Return: None.
Details: This command will load the default calibration values into the flash memory.

Command: **WMLOAD** Load calibration vales from flash to the current table in RAM.
Syntax: //WMLOAD,x
Where x is port 1 or 2
Example: //WMINIT,1 Will load calibration values from flash memory into the current table in RAM.
Return: None.
Details: This command will load the default calibration values into the flash memory.

Command: **WMCLEAR** Clear the current calibration table for the designated port
Syntax: //WMCLEAR,x Where x is the port either 1 or 2
Example: //WMCLEAR,1 This will clear the current calibration values in RAM for port 1
Return: None.
Details: The current watt meter calibration table for the designated port (n) will be cleared.

Command: **WMSAVE** Save the current calibration vales from RAM to the Stored calibration table in flash memory.
Syntax: //WMSAVE,x Where x is port 1 or 2
Example: //WMSAVE,1 Will save current calibration values in RAM to flash memory.

Command: **KEY** Key the PTT out relay. Normally used to key the transmitter.
Syntax: //KEY,x,y Where x is port 1 or 2 and y is the key up time in seconds.
Example: //KEY,1,4 Will key the port 1 transmitter for 4 seconds.

Command: **COUNT** Return the count totals for all channels.
Command: **COUNT,x,y** Turn event counting on channel x on (1) or off (0)
Example: //COUNT,2,1 Turn on counting on channel 2.

Command: **RESETCOUNT,x** Reset count on channel x to 0.

Command: **INITCOUNT** Reset all counters to 0.

Typical Watt Meter Configuration Examples

Scenario 1 – New device setup.
To set up a new wattmeter or return a watt meter to factory defaults
Setting port 1 for an HF-1 sensor and port 2 for a UHF-1 sensor.

```
//WMCONFIG,1,1      Set port 1 to type 1 (HF-1)
//WMCONFIG,2,3      Set port 2 to type 3 (UHF-1)
//WMINIT,1,1        Initialize port 1 table in flash
//WMINIT,2,3        Initialize port 2 table in flash
//WMLOAD,1          Load port 1 table into RAM for use
//WMLOAD,2          Load port 2 table into RAM for use
```

Scenario 2 – Automatically adjusting a calibration point.
Let's say the default 100 watt HF sensor calibration value seems to be off a bit. You an generate a RF carrier of the proper wattage and set the calibration point value using the command below

```
//WMSAMPLE,1,100
```

Executing this command will sample the wattage, read the ADC value and put the value in the Current Calibration Table in RAM.

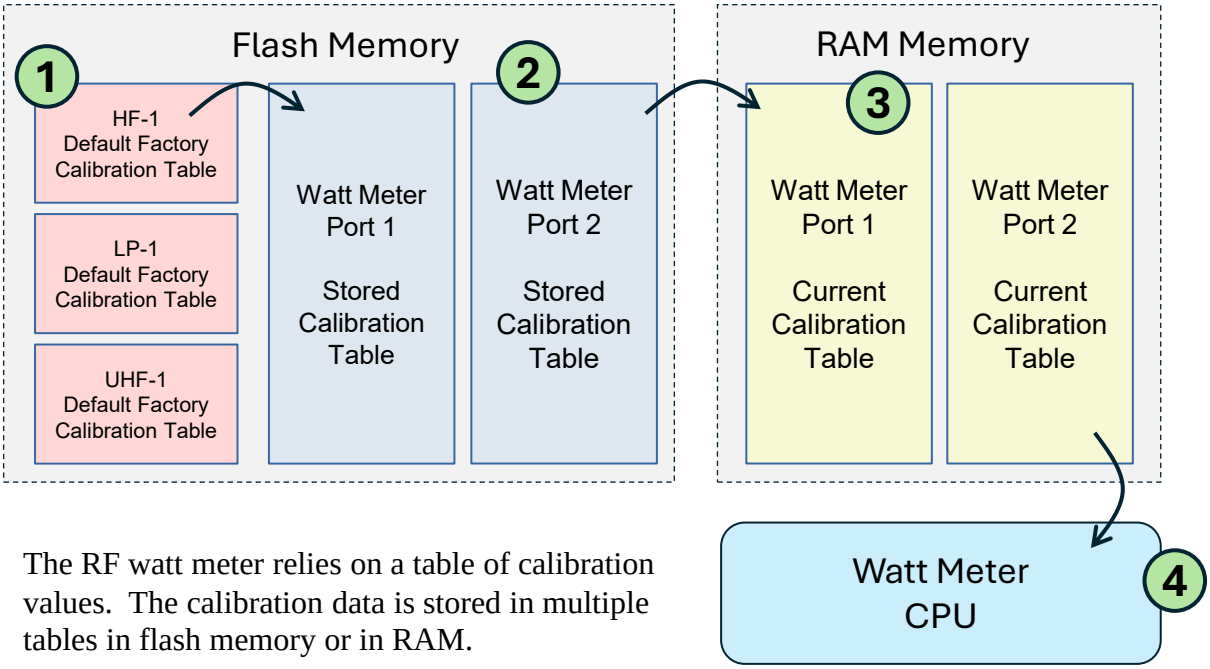
To commit that value for future use, you want to store that value in flash with the command:
//SAVE,1
This will move all values in the Current Calibration Table to the Flash memory for port 1.

Scenario 3 – Manually adjusting a calibration point.
Let's say the default 100 watt HF sensor calibration value is 3910 and you believe the reading is low. You would like to lower the calibration value. Generate a 100 watt carrier and sample the value using the command //WMSAMPLE,1
This will sample the power on port 1 and return an ADC value which you will put into the calibration table manually.

```
//WMFORCE,1,100,9850
Set port 1 100 watt calibration value to 9850
```

Watt Meter Configuration Commands

The RF watt meter relies on a table of calibration values. The calibration data is stored in multiple tables in flash memory or in RAM.



The RF watt meter relies on a table of calibration values. The calibration data is stored in multiple tables in flash memory or in RAM.

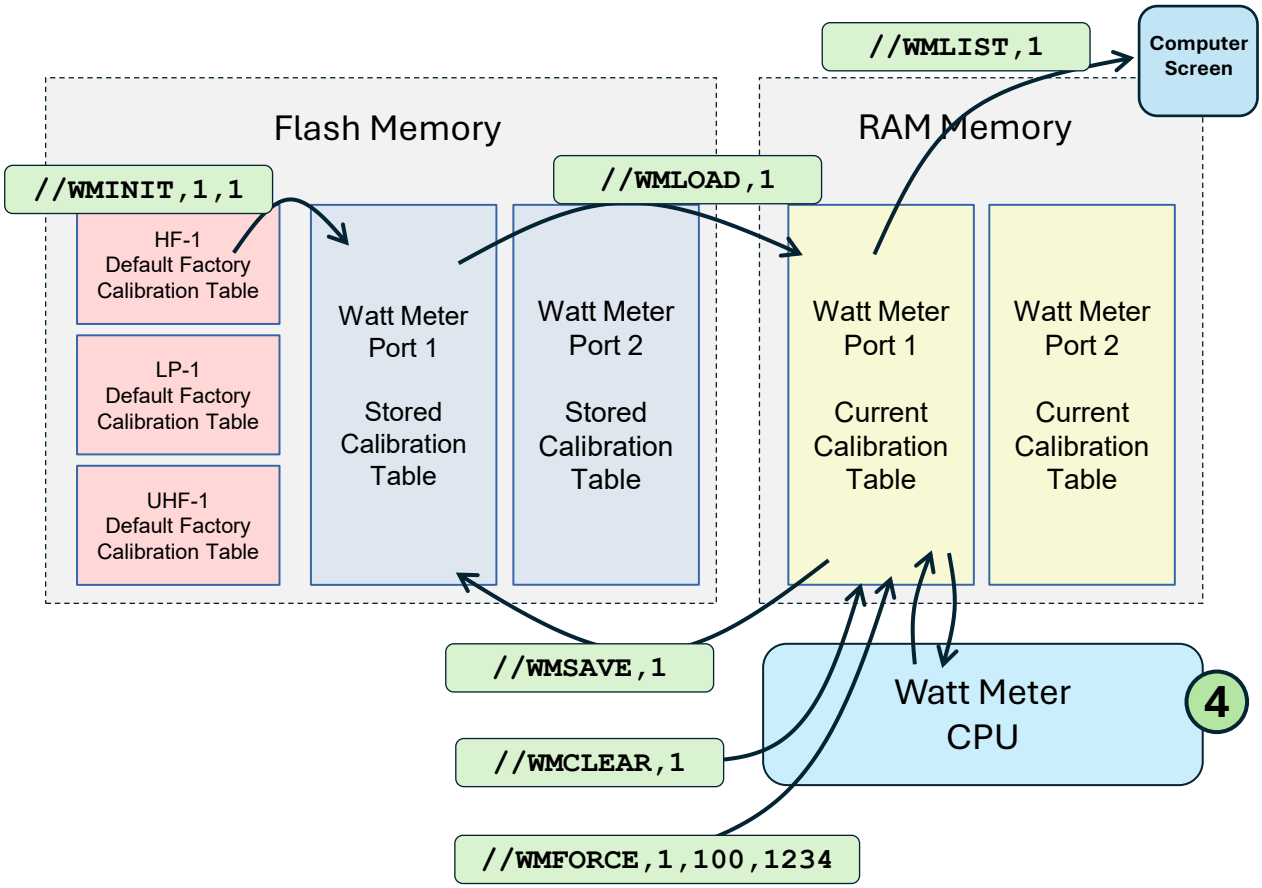
1. Default calibration values are determined at the factory for each supported sensor model and are hard coded into the controller firmware. It is always possible to reload these default values to the current calibration tables.

2. When you select a watt meter sensor type for each port, the default calibration table is copied from the factory calibration table to the stored calibration table.
If any changes are made to your specific watt meter device, those new calibration values are stored in the “Stored Calibration Table”. This way every time you boot the watt meter, your customized values are used.

3. The watt meter operates on a copy of the watt meter calibration table stored in RAM. When the watt meter boots, the values are transferred from the Stored calibration table to the Current calibration table. The watt meter measurement algorithm uses the values in the Current calibration table to make the wattage calculations.

Watt Meter Configuration Command Functions

These watt meter commands are used to create or modify calibration table data.



`//WMINIT,1,1`	Initialize calibration table with factory default values.
`//WMLOAD,1`	Load stored calibration table into the current calibration table that the watt meter will use in operation.
`//WMLIST,1`	List all calibration values on the screen.
`//WMSAVE,1`	Save current calibration values to flash memory.
`//WMCLEAR,1`	Clear all calibration values in the current calibration table
`//WMFORCE,1,100,1234`	Manually enter a specific calibration value into the current calibration table.

Custom Calibration Procedure

Calibrating the watt meter is as simple as replacing a measurement in the calibration table and storing the new value in the flash memory. This can be done for all calibration points in the calibration table.

Calibration Points

The calibration table consists of a calibration point, or reference wattage and a measurement made by the analog to digital converter onboard the watt meter module.

Calibration Slot	Type 1 HF-1	Type 2 LP-1	Type 3 UHF-1
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	15	15	15
12	20	20	20
13	30	30	30
14	40	40	40
15	50	50	50
16	60	60	60
17	70		70
18	80		80
19	90		90

Calibration Slot	Type 1 HF-1	Type 2 LP-1	Type 3 UHF-1
20	100		100
21	200		200
22	300		300
23	400		
24	500		
25	600		
26	700		
27	800		
28	900		
29	1000		
30	1100		
31	1200		
32	1300		
33	1400		
34	1500		
35	1600		
36	1700		
37	1800		
38	1900		
39	2000		

Watt Meter Algorithm

When making a measurement with the watt meter, the ADC will produce a number that represents the measurement voltage. The watt meter will determine the calibration points above and below the measured value. The wattage is determined interpolating the ADC value between the two calibration points and convert that value into a wattage.

The user can set any or all of the calibration point values to different ADC values. This allows the user to “trim” the values of the watt meter or to even characterize a completely different RF sensor.

To determine calibration values, the user must generate an RF carrier set to the value to be calibrated, then read the ADC values using the dumb terminal program on the USB-C port, then save that value in the respective calibration point in the calibration table.

Making Calibration Measurements

Decide which calibration point needs to be adjusted. Let's use the example that we want to calibrate the 100 watt calibration point on a type 1, HF-1, RF sensor.

Follow these steps:

- Connect your PC with dumb terminal program to the USB-C port.
- Connect the Antenna port of the RF sensor to a 50 Ohm dummy load.
- Apply a steady 100 watt CW RF carrier to the watt meter.
- Using Putty or similar terminal program, enter the following commands:

  `//WMCONFIG,1,1`
  This will set port 1 to a sensor type 1 (HF-1)
  The first argument "1" refers to port 1
  The second argument "1" refers to sensor type 1

  `//WMSAMPLE,1,100`
  This will measure the power on port 1 and store the measured value into the calibration table in RAM
  The first argument "1" refers to port 1
  The second argument "100" refers to calibration point for 100 watts

  `//WMSAVE,1`
  Save the calibration values in RAM to the non-volatile flash memory
  The argument "1" refers to port 1

- Unkey the transmitter.

To confirm the new value is set, you can restore values from flash to RAM then list the values with these commands:

`//WMLOAD,1`
`//WMLIST,1`

You should see your new calibration value for the 100 watt calibration point in the table now.

DIP SWITCH CONFIGURATIONS

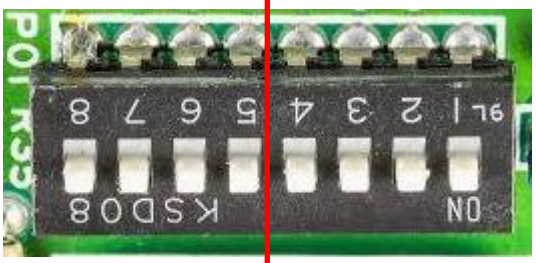
Note that the DIP switch is upside down when viewed from the normal orientation of the watt meter module.

Address Switch Position

1 2 3 4

Mode Switch Position

1 2 3 4



Pay no attention to the numbers or the reference to "ON" on the DIP switch itself.

Address DIP Switch Settings

Address Position 1 = Address value 8
Address Position 2 = Address value 4
Address Position 3 = Address value 2
Address Position 4 = Address value 1

To set the device address, set the switches in the upward direction to indicate adding that bit position value.

For example: An address of 02 would be

DOWN DOWN UP DOWN

Typical Address Configurations

```
 01   DOWN DOWN DOWN UP
 02   DOWN DOWN UP   DOWN
 03   DOWN DOWN UP   UP
 04   DOWN UP   DOWN DOWN
 05   DOWN UP   DOWN UP
ETC…
```

Mode DIP Switch Settings

Mode Position 1
UP = Initialize WM1 module to factory defaults on boot.
DOWN = Normal operation. Does nothing.

Mode Position 2
UP = Streaming mode on.
DOWN = Streaming mode off.

Mode Position 3
UP = DCN port 115200 baud rate.
DOWN = OFFDCN port 9600 baud rate.

Mode Position 4
UP = Stream raw ADC values.
DOWN = Normal operation. Does nothing.

Typical Mode Configurations

Factory default	DOWN	DOWN	DOWN	DOWN
Streaming data at 115200 baud	DOWN	UP	UP	DOWN
Streaming data at 9600 baud	DOWN	UP	DOWN	DOWN