The Barb-A-Watt

QRP Power Meter, SWR Meter and Dummy Load

Construction and Operations Manual

The latest version of this manual can be downloaded from:

GitHub - WB2CBA/Barb-A-Watt-QRP-POWER-and-SWR-Monitor

Version 2.3	31st August 2024	Initial Release SMD Version

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Introduction

The 'Barb-A-Watt' is a QRP RF Power and SWR monitor to be used as a companion measuring device for simultaneously measuring:

- RF power output from a QRP transceiver.
- RF power to the antenna.
- SWR; and
- Power output efficiency

It also has a built-in dummy load that can be used to measure up to 15 Watts of RF output power.

This version of the Barb-A-Watt uses surface mounted devices (SMD's) as an upgrade from earlier versions which used through hole components. Both work in the same way, however the use of pre-installed SMD's simplifies the construction time and enables an increase in the power handling of the dummy load to 15 Watts from the earlier 10-Watt version.

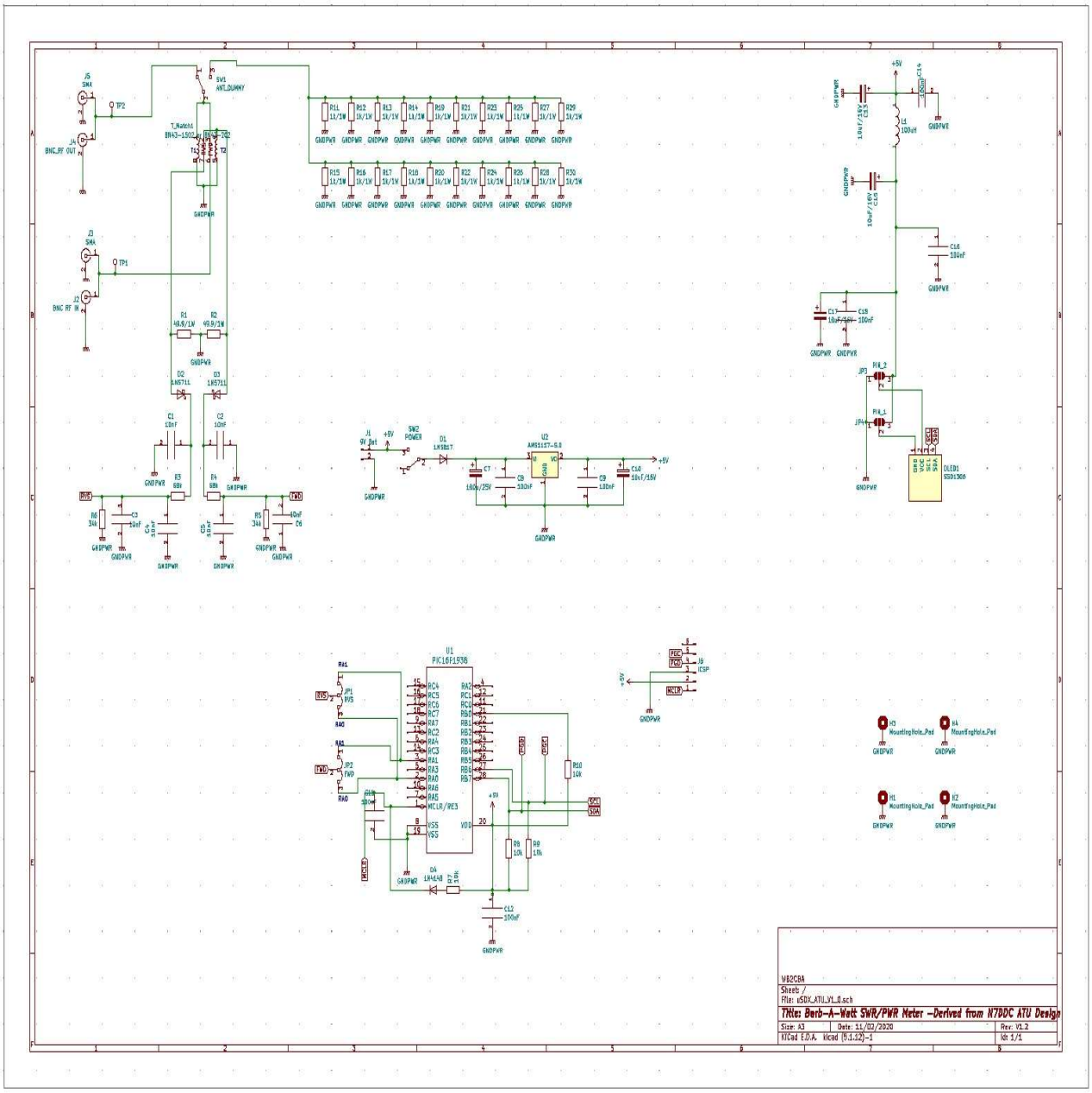
The Barb-A-Watt is based on the N7DDC (David Fainitski's) ATU-100 project. David was kind enough to modify ATU-100 firmware specifically for the Barb-A-Watt to create an accurate RF power and SWR measuring device at QRP levels.

The Barb-A-Watt was designed by Barbarossa Asuroglu WB2CBA (Aka 'Barb') as a companion product for QRP operations, and QRP project development. The Barb-A-Watt overcomes the accuracy limitations of higher power SWR and Power meters when used with QRP power levels.

The power meter is rated at 20 Watts when connected to an antenna or external load, however the internal dummy load is limited to 15 Watts.

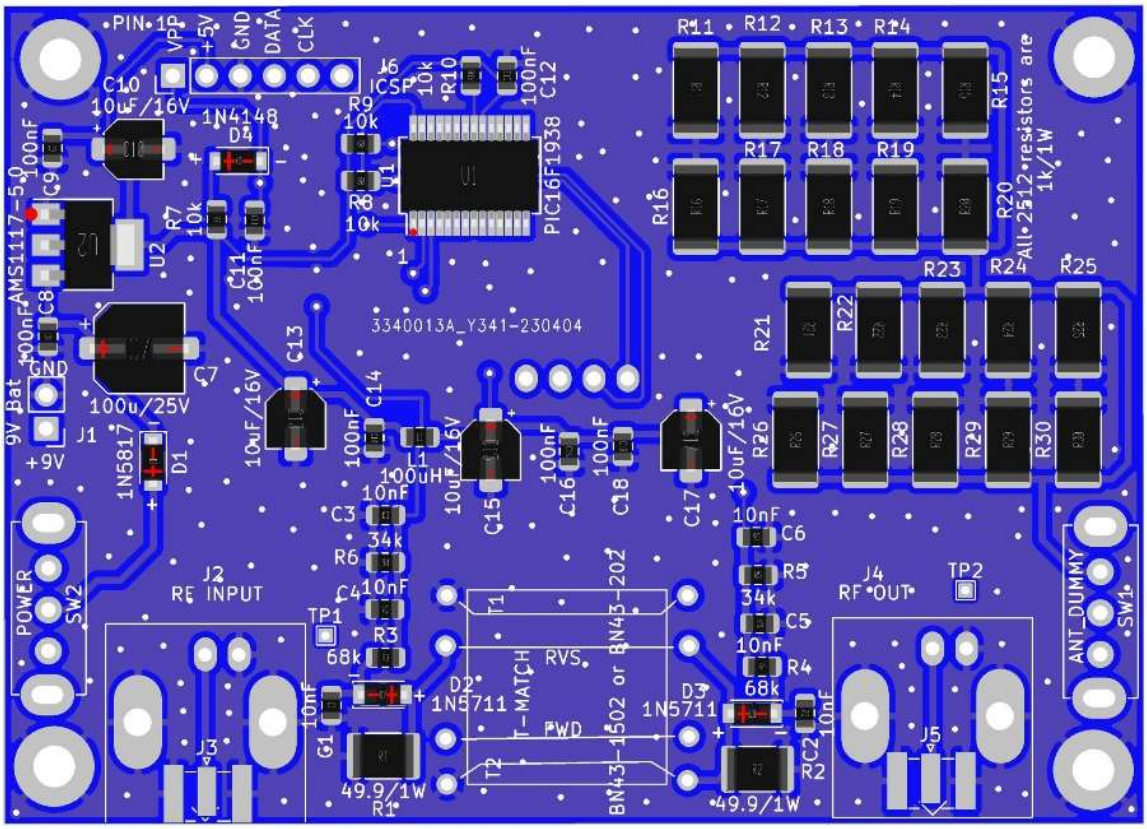
CAUTION: DO NOT EXCEED 15 WATTS with the built in Dummy Load!

Schematic Diagram

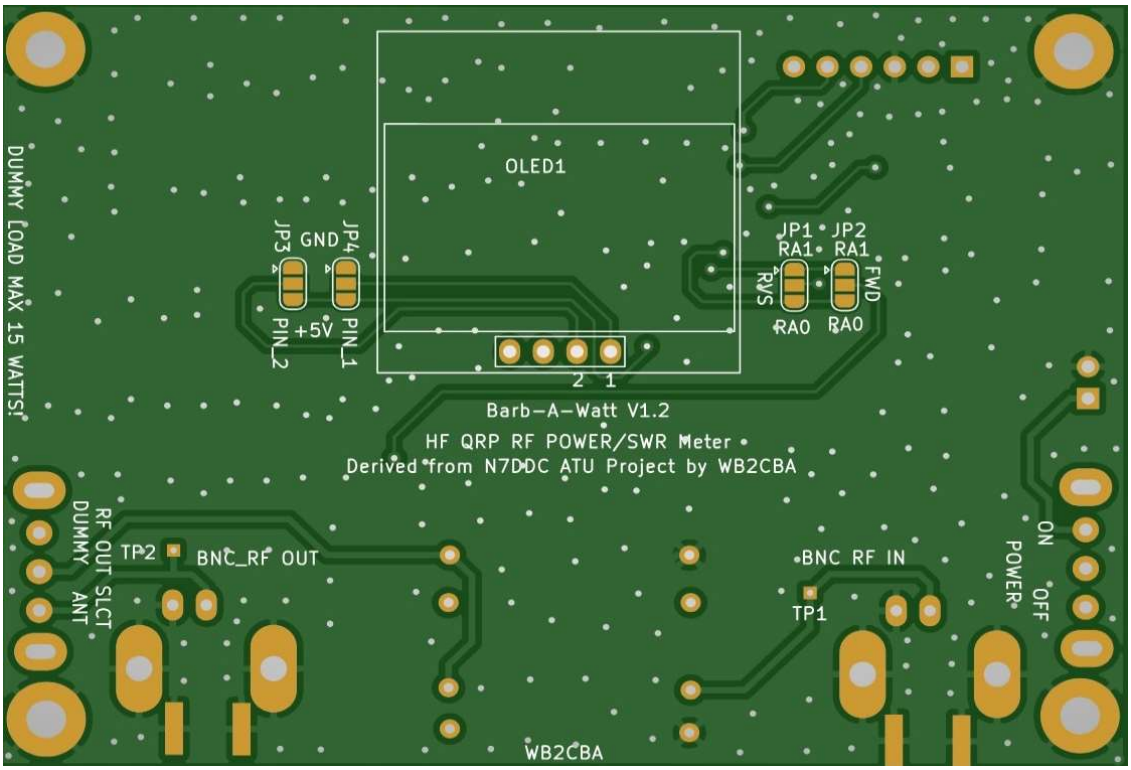


SMD PCB Layout

Component Side



Solder Side:



Brief Description

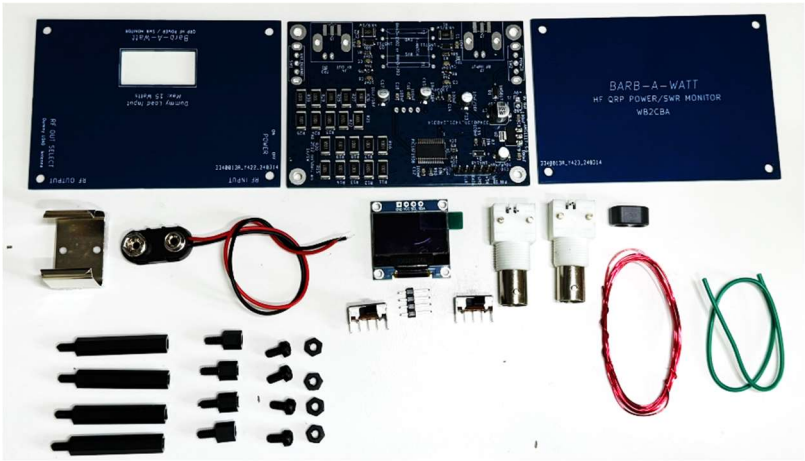
The SWR meter uses a tandem match consisting of two 5 turn coils on each side of a BN43-1502 binocular core. A forward and reverse line is passing the RF signal to the output and the PIC processor measures power and the return loss as SWR. These values are then displayed on the 128 x 64 OLED display for easy readability.

The Barb-A-Watt is powered by a standard 9V PP3 battery and draws approx. 10mA during operation. The 9V battery is ideal for portable operation.

There are two slide switches. Looking from the top, the left side slide switch is the power ON and OFF switch. The right-hand side slide switch is for directing the RF output to either the internal dummy load or the RF output (Antenna) socket.

Bill of Materials

List of Parts included in the kit:



1 x SMD populated PCB with the microprocessor firmware loaded.

1 x Top face panel

1 x Bottom face panel

2 x slide switches

1 x 128x64 OLED Display

1 x 4 Pin Male Header

1 x BN43-1502 (or BN43-202) Binocular Toroid

2 x BNC Connectors

1 x 9V Battery Clip#

1 x 9v Battery Connector

12” (300mm) - AWG 24 (0.5 mm) enamel copper wire

3” (~75mm) of insulated solid core copper wire

4 x 6 mm (or 5mm) standoff #

4 x 25 mm (or 20mm) standoff #

8 x M3 screws (typically 4 x M3 14mm machine screw, 4 x M3 6mm plastic screws – actual supplied may vary slightly depending upon stock) #

1 x Strip of double-sided tape to fix battery to bottom panel #

- Actual components supplied may vary between kits.

Tools Required

You will need the following tools to build the Barb-A-Watt:

- Soldering Iron and Solder (An ESD Protected soldering iron is recommended to prevent potential static discharge damage to the PIC Controller)
- Wire Cutters
- Philips Head #1 Screwdriver
- Modeling knife (for scraping enamel off the magnet wire)
- Wire strippers

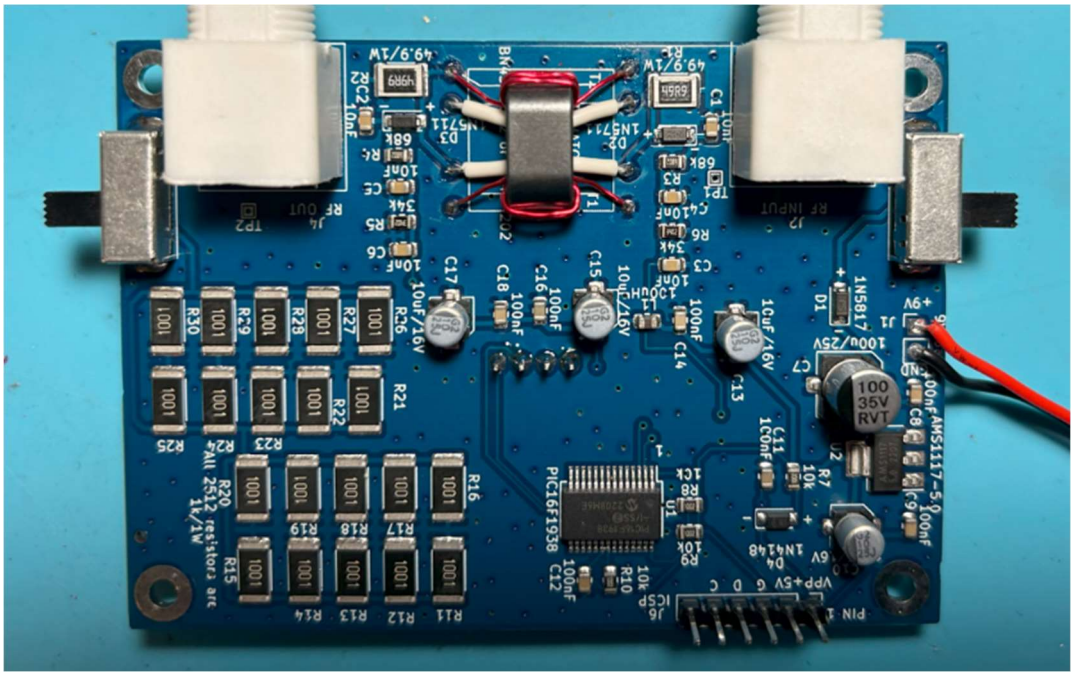
Construction Overview

The use of pre-mounted SMD components simplifies the construction process. The board is supplied with the PIC microprocessor firmware pre-installed. Kit construction requires the following activity and is listed in the recommended assembly order:

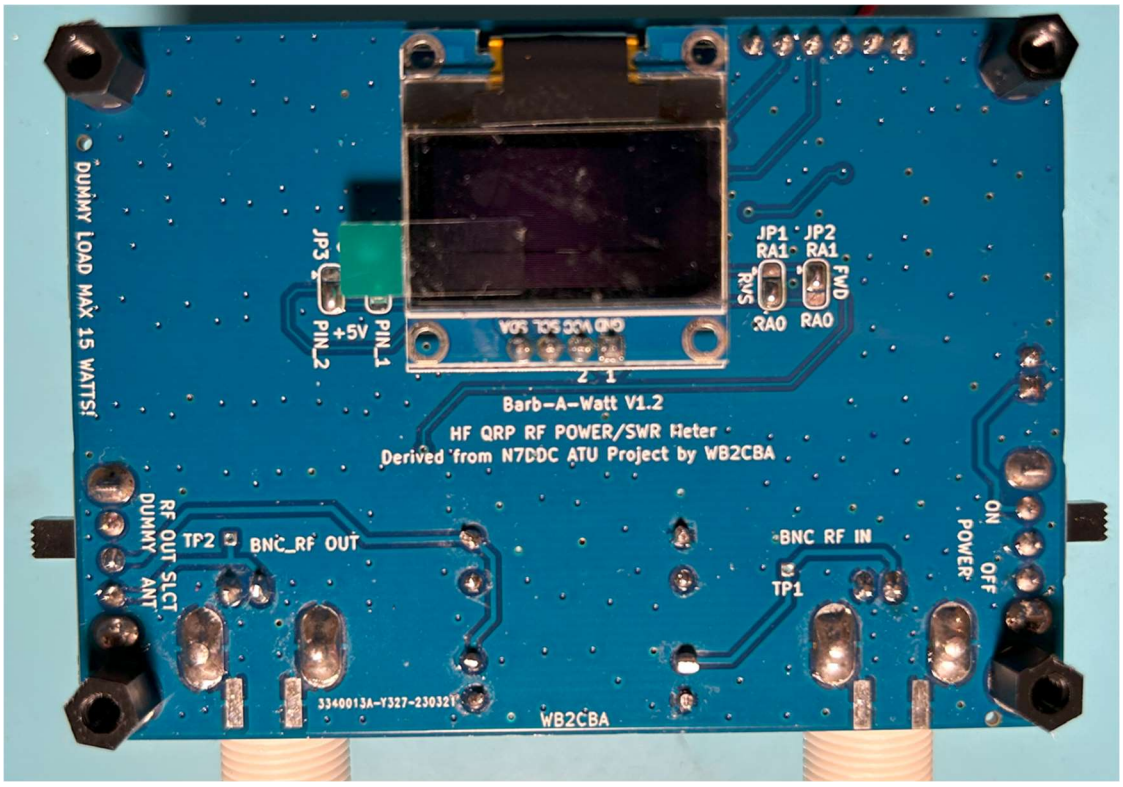
- Winding the BN43-1502 binocular core used for SWR sensing and soldering it with the sensing wires to the main PCB.
- Soldering 7 components to the main board:
  - 2 x Micro Switches
  - 2 x BNC Connectors
  - 1 x 128 x 64 OLED Screen using the 4-pin header
  - 9v Battery connector lead.
- Attaching the 9v battery / battery holder to the bottom cover.
- Assembly of the main PCB, top and bottom covers with the supplied standoffs and screws.

This is an easy to build kit and can be accomplished by a novice kit construction with basic soldering skills, although winding the toroid can be a little tricky so follow the toroid winding instructions carefully. As a guide an intermediate kit builder should easily build this kit in approx. one hour.

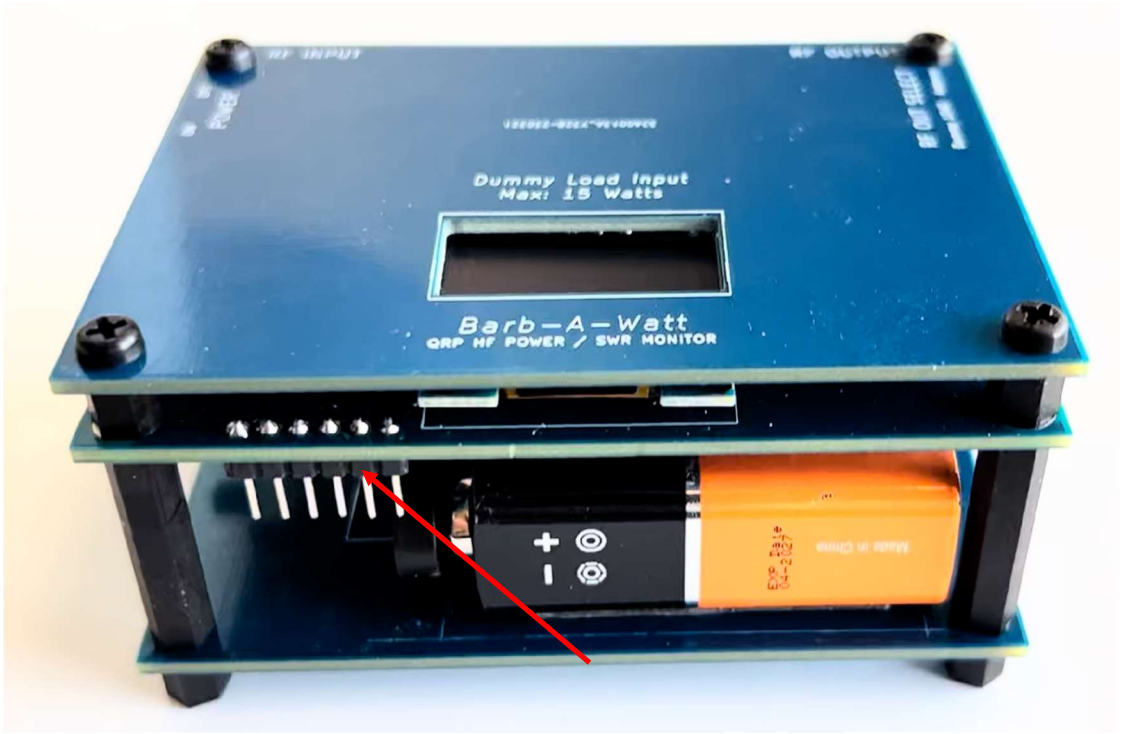
The completed component side of the BAW is shown below:



The completed ‘Screen Side’ of the board is shown below:

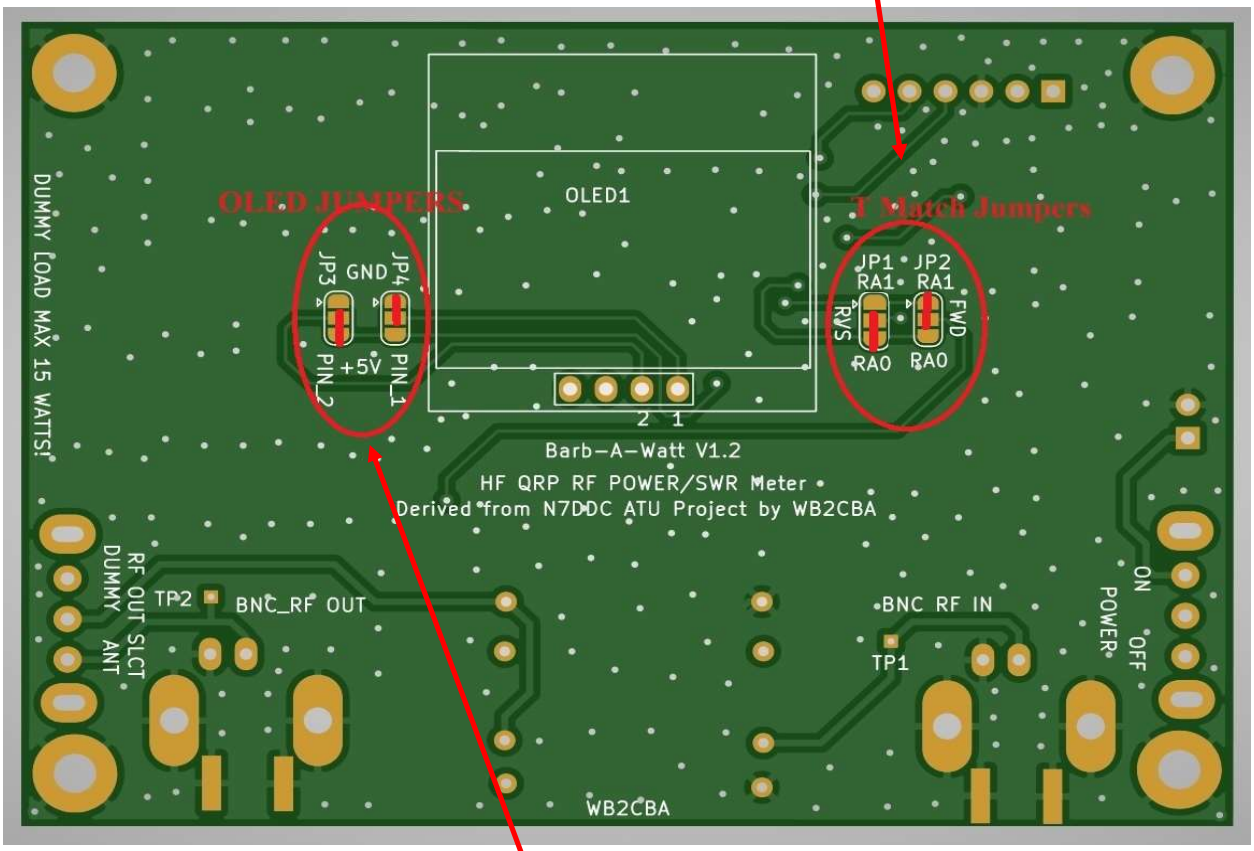


The fully assembled Barb-A-Watt is shown below:



Note: The above examples show the installation of a 6-pin header to enable programming of the microprocessor – these are not required as the latest boards are supplied with the processor preprogrammed.

There are two jumpers on the solder side of the board named FWD and RVS. These are added for test purposes:



The second set of jumpers are for the OLED VCC and GND pins depending on OLED type shipped with the kit. All these jumpers are pre-soldered before shipping.

NOTE: The OLED Display and T Match Jumpers are pre-soldered as shown above. Do not unsolder or change the jumper settings

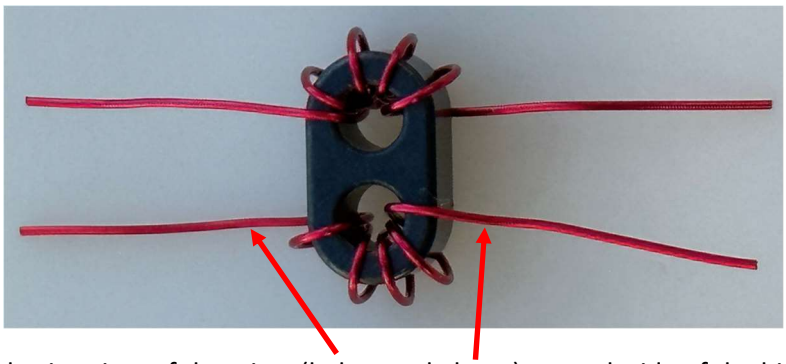
Building The Barb-A-Watt:

When building the Barb-A-Watt it is recommended that construction be undertaken in the following stages:

1. Wind and install the binocular toroid.
2. Solder the slider switches, BNC connectors and 9v Battery leads.
3. Install the OLED display and Pin Headers.
4. Install the 9v Battery.
5. Assemble the Barb-A-Watt.

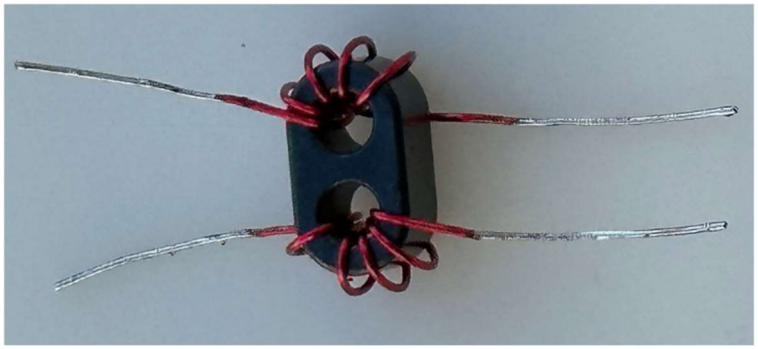
Stage 1: Wind and install the binocular toroid

To wind the BN43-1502 inductor core start at one side of the core and feed the enamel copper wire 5 times through the hole. Every time the enamel copper wire goes through the hole counts as one turn. After completing 5 turns in the first hole now start from the second hole on the opposite side of binocular core at the second hole. When winding the toroid, try and keep the wire as close as practical to the toroid. When you finish it should look like the example in the photo below:

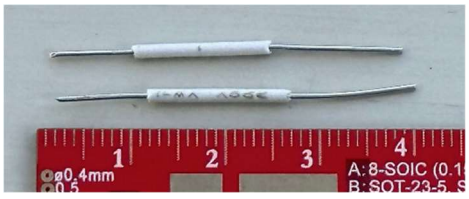


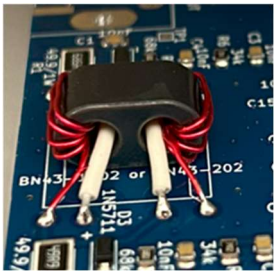
NOTE: the entry and exit points of the wires (below and above) on each side of the binocular toroid. Wind your binocular toroid in the same manner. Ensure that the windings do not overlap and are evenly spaced.

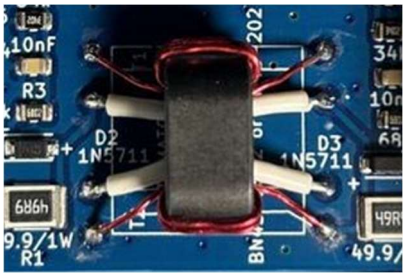
Remove the enamel coating from the wires by either sanding or scraping with a sharp modeling knife and tin the wires with solder as shown below:



Next cut two 1.5” (~35mm) insulated electrical wire. These two wires will be fed through the holes of binocular core (white wires in the photo), and soldered to the PCB as shown in the photographs below:



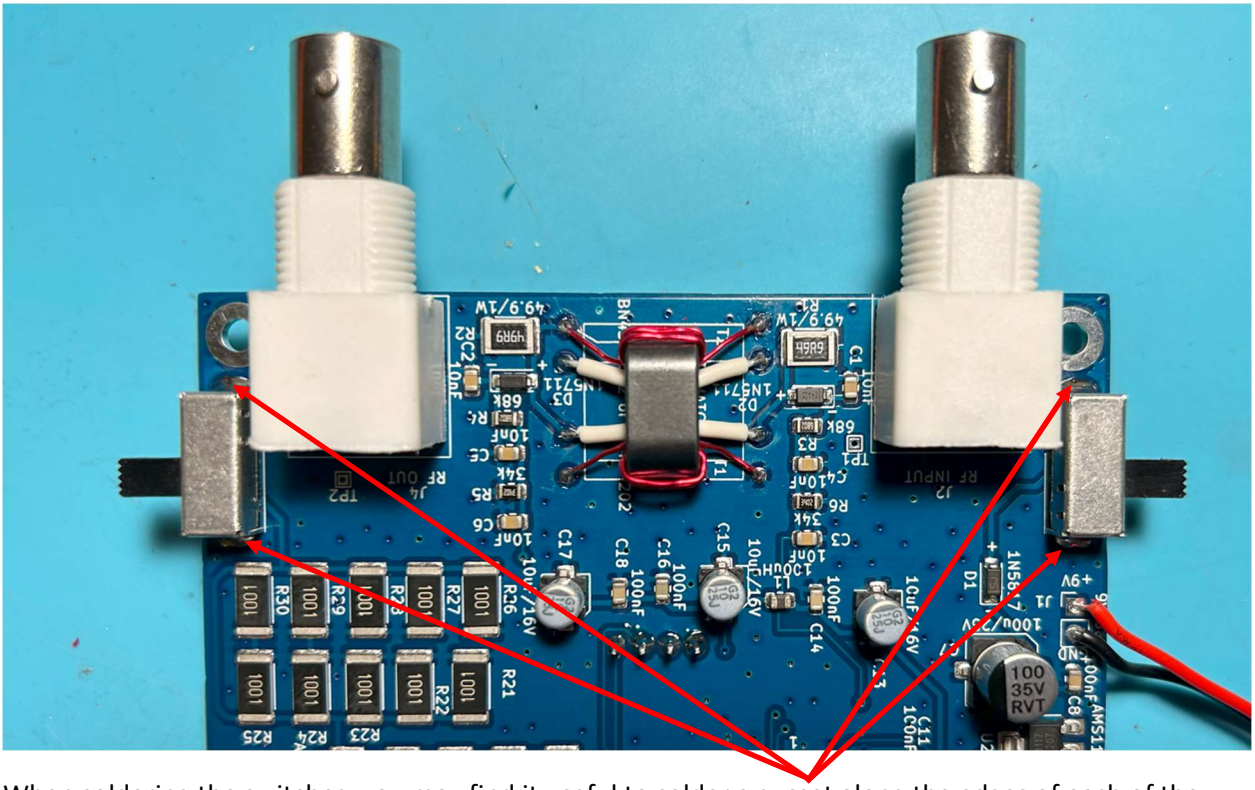




Adjust the length of these insulated through wires as needed before soldering – take your time to ensure a neat and uniform installation.

Stage 2: Solder the Slider Switches, BNC Connectors and 9v Battery Leads

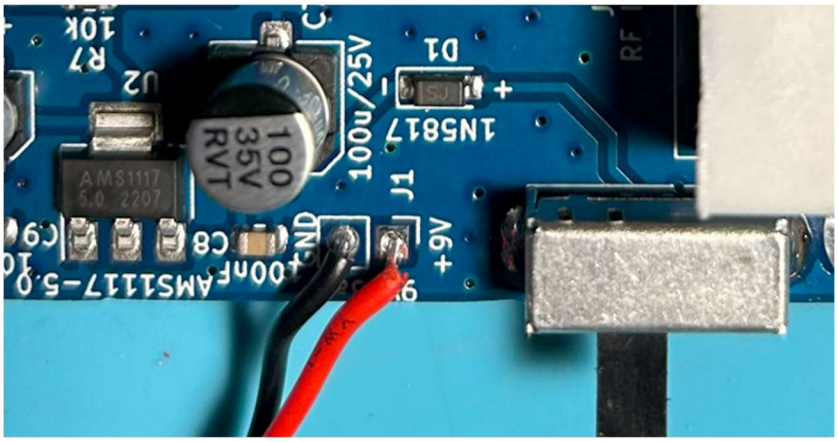
The next step is to solder the slider switches, BNC connectors and the 9v battery leads to the board. Don't use excessive heat when soldering so as not to melt or damage the components. These components are installed into the positions shown on the completed board below:



When soldering the switches, you may find it useful to solder a gusset along the edges of each of the switches on the component side of the board to make a more mechanically sound attachment to the board. Don't overheat the switch when soldering so solder quickly.

A close-up view of one of the gussets is shown below:

Next solder the 9v battery supply leads to the board as shown below:



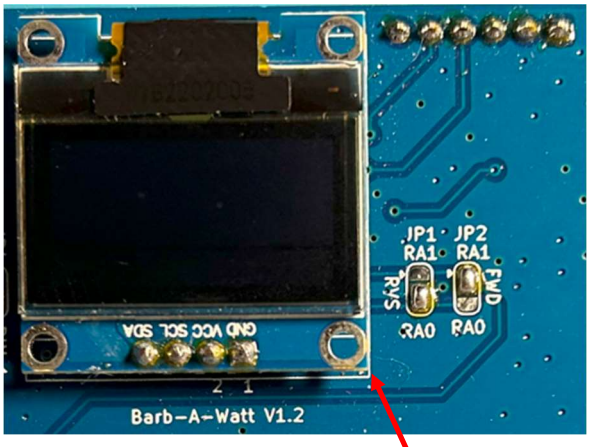
Ensure that you solder the power supply leads to the correct polarity pads on the PCB. The red positive supply lead is soldered closest to the switch as indicated on the screen print layout on the PCB.

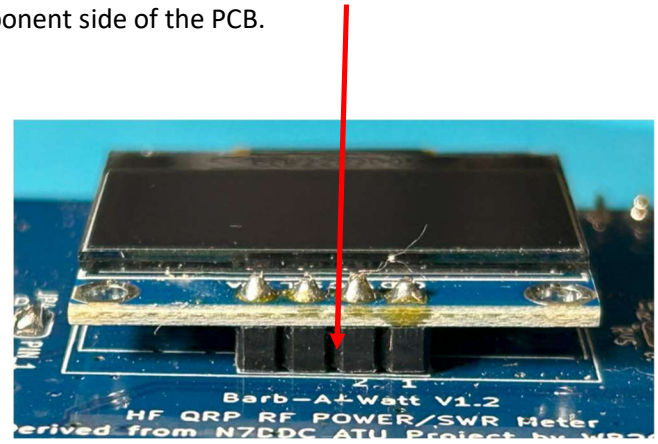
Stage 3: Install the OLED Display and Pin Headers

The OLED display is soldered onto the **solder side of the PCB** using the 4-pin header. It is good practice to use a tiny strip of double-sided tape stuck to OLED display's component side for two purposes: It makes sure the OLED display is correctly aligned with the viewing window on the Top Cover and as an electrical isolator to prevent any short circuit with the PCB and jumpers below the OLED display. *(If you take care and solder the OLED parallel to the PCB on the horizontal plane the OLED will not touch the PCB due to the spacers on the header pins, but a strip of insulating tape underneath the OLED would add an extra level of protection).*

Take care to ensure that the OLED display is soldered parallel to the main PCB and **don't overhead the pin headers** during soldering to avoid melting the plastic spacers.

The 4-pin header is installed with the black spacer positioned between the PCB and the display with the longer header pins protruding through to the component side of the PCB.

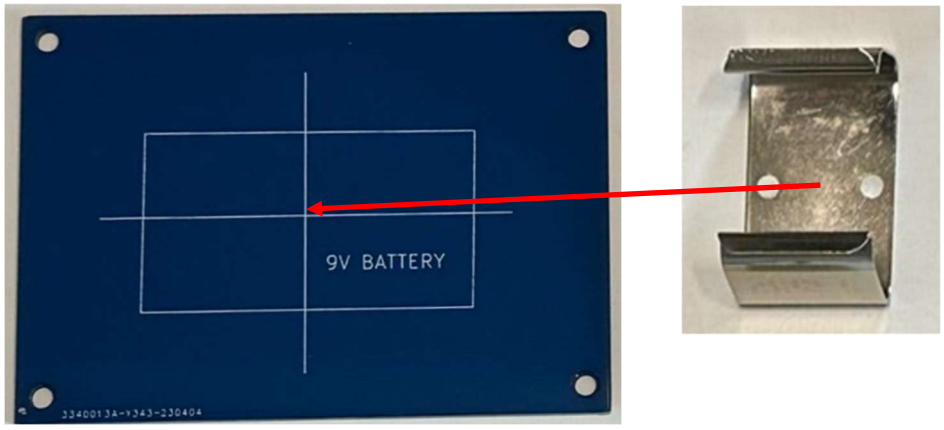




Correct alignment of the OLED display can be assured by lining it up with the outline printed on the PCB. The ground and VCC pins on the OLED display align with the '1' and '2' identifiers on the PCB.

Stage 4: Install the 9v Battery

The bottom panel has a screen print which shows the position of the battery if you are using the battery clip to hold the battery in place. This clip should be attached centrally to the bottom panel using double sided tape. The 9v battery is then installed lying flat into the clip.



The use of the clip does make the Barb-A-Watt a little tall and you will need to use 25mm spacers when assembling the unit in Stage 5 to ensure that the battery or the clip doesn't contact the component side of the main PCB.

An alternate way of mounting the battery is to secure the battery directly to the bottom panel using double sided tape which provides for a more compact Barb-A-Watt. If you choose to use this technique, you will only require 20mm spacers between the panels and you position the battery on the bottom panel as shown below:

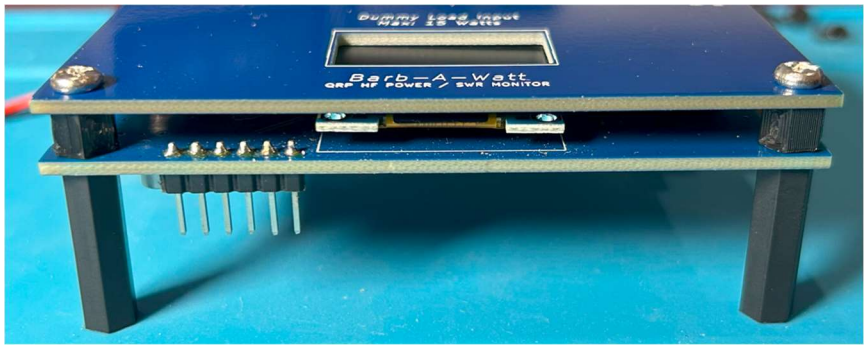
The 9v battery is positioned **3mm** from the longer edge and **6-7mm** from the shorter side of the panel to avoid interference with the main PCB components. Using this method provides a lower profile Barb-A-Watt but does mean that you need to replace the double-sided tape each time you install a new battery.

As the Barb-A-Watt draws only approx. 10mA when switched on, changing the 9v battery should not be a regular occurrence during normal operation as the battery has a capacity of ~500mAH. If you forget to switch it off, then you may well be replacing the battery more frequently 😊.

Stage 5: Assemble the Barb-A-Watt

To assemble the Barb-A-Watt use the provided screws and spacers to enclose the top and bottom boards around the main PCB such that the finished product looks something like that shown below.

Various combinations of screws can be used with the spacers. Here is an example assembled using both metal machine screws and plastic screws.

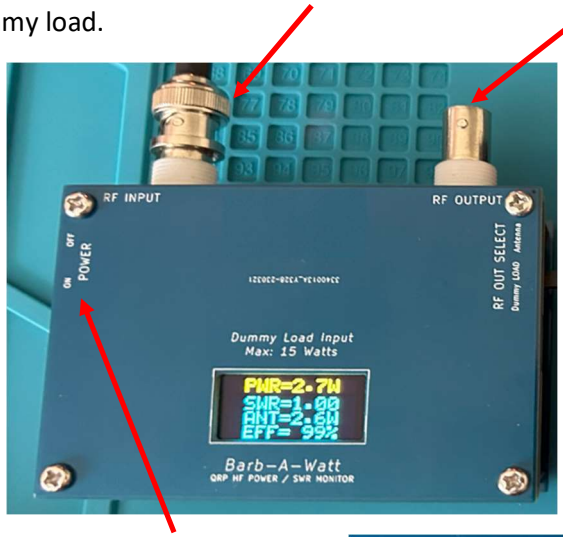


In this example the longer machine screw extends through the top panel and 5mm spacer, through the main board and into the 20mm spacer. The shorter plastic screws secure the bottom panel to the 20mm spacer and provide a plastic non scratch foot on the bottom of the Barb-A-Watt.

Using The Barb-A-Watt:

Using the Barb-A-Watt is the same as using any regular Power/SWR meter.

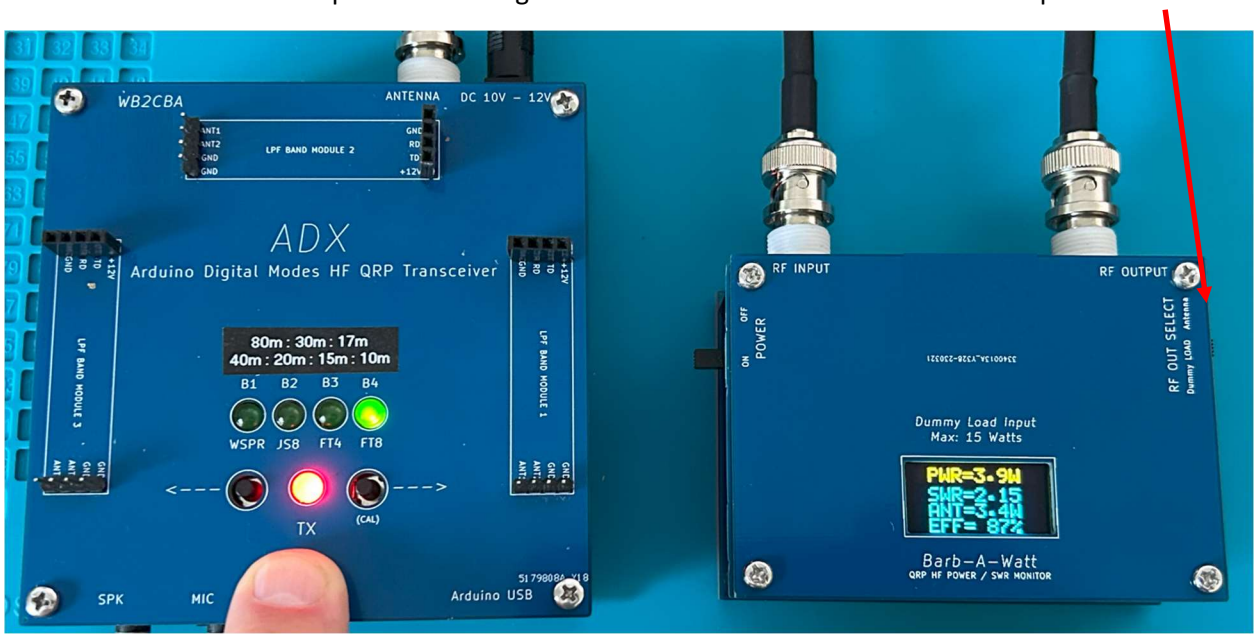
The **transceiver antenna output** is connected to the RF Input and Barb-A-Watt RF output is connected to the antenna or external dummy load.



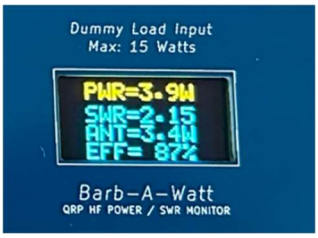
When the power switch is switched to the ON position (with the 9v battery installed), after a delay of approx. 2 seconds you are greeted with a splash screen as shown. After a further 2 seconds the flash screen is replaced with the measurement screen as shown to the right of the flash screen.

The RF input power can be switched between the internal dummy load (Max. 15W) or the external RF output port (Max. 20W). In this example the Barb-A-Watt is measuring output power from a QRP transmitter using the internal dummy load, after switching the output switch the Dummy Load position:

In this example the Barb-A-Watt is measuring the SWR of an external antenna after connecting the antenna to the RF OUTPUT port and moving the RF OUT SELECT Switch to the Antenna position.



The measurement screen shows four measured values:



- RF **Power** input from the Tx (Max 20W or 15W to dummy load)
- SWR
- Actual RF power output to the **Ant**enna (or dummy load)
- Actual RF output **Eff**iciency in %.

The power meter calibration is hard coded in software, there is no user adjustable parameter to calibrate the power meter.

In summary the Barb-A-Watt can be used in two different scenarios:

- As a **classic RF power meter with an internal dummy load** by sliding right slide switch to the Dummy Load position. This is ideal for use during construction and/or testing of QRP radios.

CAUTION: DO NOT EXCEED 15 WATTS RF POWER WITH THE INTERNAL DUMMY LOAD

- As an **RF POWER and SWR meter** when connecting to an antenna (or external dummy load), after switching the RF OUT SELECTOR switch to the Antenna position. In this mode the Barb-A-Watt is a good companion for real time QRP QSO Antenna and RF power monitoring in the shack and/or portable operation. To conserve the battery the power can be switched off and the Barb-A-Watt left in circuit during normal operation and switched on when you want to check the power and SWR periodically.

CAUTION: DO NOT EXCEED 20 WATTS RF POWER WHEN USING WITH AN EXTERNAL ANTENNA

Acknowledgement:

A special thank you to David Fainitski, N7DDC for his contribution and help with the Barb-A-Watt firmware. The Barb-A-Watt is based on David's ATU-100 project and David was kind enough to modify ATU-100 firmware specifically for the Barb-A-Watt to create an accurate RF power and SWR measuring device.

Thank you to Richard Hinsley, VK2ARH for putting together and updating this Barb-A-Watt Construction and Operations manual for the SMD version.

Barb, WB2CBA
08/2024