K8IQY/KU4QO MagicBox V2.5 - Use and Features

Jim Kortge, K8IQY
Mike Maiorana, KU4QO

The K8IQY/KU4QO MagicBox V2.5, is an updated version of the project designed by K8IQY in 2013 and kitted by the 4 State QRP group. In the prior version, the MagicBox could be used to connect a receiver and a transmitter together to operate as a transceiver, with all of the RF switching and Audio Muting handled by the MagicBox. It used a programmed microprocessor to control the functions within the box.

The updated version provides all of the RF Switching and Audio Muting functionality of the original, along with addition of an internal, speed adjustable, CW Keyer, power control for transmitters requiring an external power source to be switched, such as a Tuna Tin 2, and a redesign of the PIN diode RF Switching circuitry to handle higher transmitter power levels. This version has been tested up to 20 watts, with very low loss.

Two printed circuit boards are employed in this version. The first one contains the power conditioning circuitry for the system, the PIN diode RF Switching circuitry for both the connected transmitter and receiver, and connections to the second printed circuit board. On the second board is where the system control microprocessor lives, the keying circuits for both negative (ground to transmit) and positive (source keyed) powered transmitters, and the receiver audio muting and side tone injection circuits. Unlike the previous version, the microprocessor in this version is an Arduino Nano (or clone) that is programmed by the builder (using the Arduino IDE) and the underlying control code can be modified to implement desired changes or additional functionality.

All of the documentation lives on GitHub, allowing anyone to procure printed circuit boards using the supplied Gerber files, have full access to the control software, and have access to the design’s schematic diagrams, bill of materials, and even suggested sources for the parts used.

“As built” Prototype Specifications:

Receiving
Antenna port to receive port loss: ~0.25 dB maximum
Receive port to transmit port isolation: -40 to -20 dB, frequency dependent

Transmitting
Transmit port to antenna port loss: ~0.25 dB maximum
Transmit port to receive port isolation: -70 to -50 dB, frequency dependent

Transmitter power limit – Tested at 20 Watts CW for 10 seconds, 10 Watts for 1 minute

Keyer
QSK and SemiQSK operation, user selected by internal jumper
Keying speeds from 5 to 35 WPM, user adjustable
via a speed set potentiometer
Straight key operation below 5 WPM

Keying of transmitters requiring grounding of key line, up to 100 volts
Keying of transmitters requiring power to be applied up to 48 volts and 2 amperes

Audio
Receive audio port to speaker port isolation: ~90+ dB
Side tone injection (level adjustable) into receive audio chain during transmit
“Spot” function to zero receiver to transmitter frequency

Power Requirements (12 volt supply)
Receiving - 110 milliamperes
Transmitting - 160 milliamperes

How to use the MagicBox V2.5

This is a short discussion highlighting the features of the MagicBox V2.5 and how to hook it up to your receiver and transmitter.

Figure 1: MagicBox V2.5 Font Panel

Starting at the lower left of this photo, the 1st BNC connector is the antenna input to your receiver. The 2nd BNC connector is where you connect your antenna. Lastly, the 3rd BNC connector goes to the output of your transmitter. When in "receive mode", the center antenna connector is connected to the leftmost BNC, supplying signals to your receiver. When in "transmit mode", the leftmost BNC is disconnected from the antenna, and shorted to ground, and the rightmost BNC is connected through to the center BNC, so that your transmitter is connected to your antenna. 1N4007 diodes are used as PIN diodes to do that signal steering, and their sequencing is done by the Arduino Nano

board. Power to the system (12 to 13.8 volts DC) connects to the 2.1mm X 5.5mm power connector to the right of the BNC connectors.

The next row of connectors, above the BNCs, are all 1/8 inch, stereo jacks used for external signals, both inputs and outputs. The 1st of these on the left is the input connector for your paddle, or straight key. If using a paddle, the tip is "DIT", the ring is "DAH", and the sleeve is the common or ground. Either the tip or ring can be used for a straight key along with the ground.

The next two connectors are used for receive audio control. Audio FROM your receiver is connected to the leftmost of this pair, with the tip being the "HOT" lead and the ring being the ground. Audio TO your speaker or headphones connects to the rightmost of this pair. The "HOT" lead of your speaker goes to the Tip and the ground goes to the ring. Stereo headphones plug in directly. ***Note: the barrels of these two connectors can not be grounded. If mounting the MagicBox in a metal box, shrink tubing should be placed on the barrel of each of these two connectors. A non-conducting, 3D printed box is suggested.***

The next 3 connectors are for keying your transmitter. If your transmitter is keyed by grounding a line, such as a "Keyline" in a solid state transmitter, or an older cathode keyed rig, where the "Keyline" has a positive voltage on it and needs to be grounded to key the transmitter "ON", this is the connector to use. The tip is the "HOT" lead with the sleeve being the ground.

If you are using a transmitter, like a Tuna Tin Two, where the transmitter is keyed by keying the supply line, use the next pair of connectors. Connect the power supply for the transmitter to the right most of this pair, with the tip being the "HOT" lead, and the sleeve being the ground. Keyed voltage to your transmitter is available from the leftmost connector of this pair. The tip is the "HOT" lead and the ground is on the sleeve.

The red LED between the 4th and 5th connector lights when the transmitter is keyed, regardless of the keying setup used, as detailed above.

The leftmost push button on the upper level has two functions. With a "short press" a readout of the current CW speed is sent to the audio chain; a "long press", turns on the transmitter for 10 seconds for "tune up". A second push while the "tune up" function is engaged, terminates that function. Next is a SPST toggle switch used to implement the spotting function, where audio from the muted receiver is selectively mixed with the system generated side tone so that the receiver and transmitter can be set to the same frequency.

Next is a potentiometer, used to set the CW speed. When the potentiometer is set below 5 WPM, straignt key mode is automaticallyenabled.

A green LED is used to indicate when power is applied to the system, and to the right of it is a SPST toggle switch used to turn on – turn off system power.

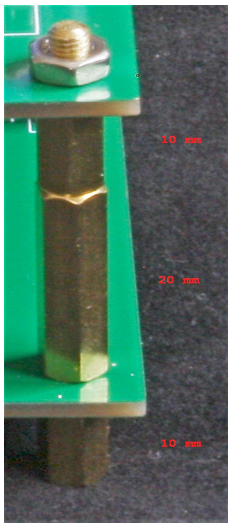
All of the connections described are clearly shown on the schematics and are labeled on the two PC Boards used in this system. Some study of these resources is suggested for a complete understanding of how the system functions.

Miscellanous Parts

Below are some sources that I used for the parts in this prototype build. They may or may not be available, as parts on Amazon come and go.

Spacers
<https://www.amazon.com/gp/product/B06Y5TJXY1/ref=ppx_yo_dt_b_asin_title_o05_s00?ie=UTF8&psc=1>

This photo shows how spacers in this set are used.



Arduino Nano Clone
<https://www.amazon.com/gp/product/B0713XK923/ref=ppx_yo_dt_b_asin_title_o04_s00?ie=UTF8&psc=1>

Dupont Connectors (10 cm, Female-Female)
<https://www.amazon.com/gp/product/B07GD312VG/ref=ppx_yo_dt_b_asin_title_o09_s00?ie=UTF8&th=1>

Case 3D Printing Filament
<https://www.amazon.com/gp/product/B08BXLQ26X/ref=ppx_yo_dt_b_asin_title_o00_s00?ie=UTF8&psc=1>