KAI-201
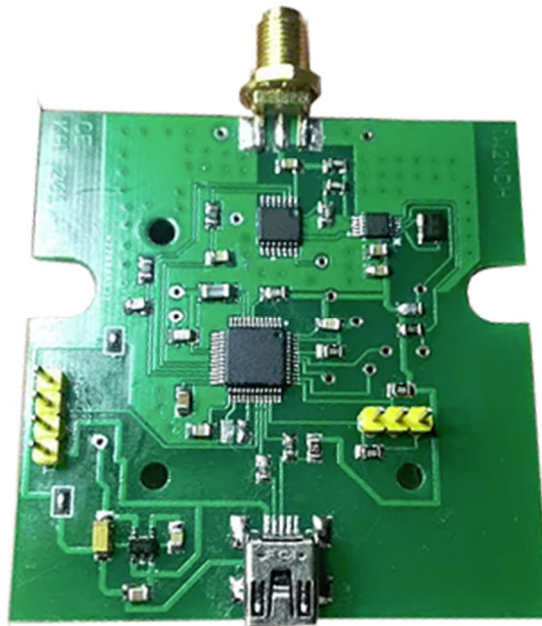
-Antenna Analyzer-

-Signal Generator-

<u>KIT</u>

Assembly and User's Manual

-WSPR Transmitter-
available in KAI-201X kit

The KAI-201 is two pieces of test equipment assembled on a 58X57mm printed circuit board. Using highly optimized firmware, it provides an Antenna Analyzer (500 KHz to 170 MHz) and a square wave signal generator with a frequency range of 100 KHz to 200 MHz

The antenna analyzer is compatible with third party programs freely available on the internet. Recommended is the excellent AntennaScope2 program from Rig Experts™. With the addition of an HC-06 BlueTooth module the antenna analyzer can be operated remotely and is compatible with Open60©, an Android application also available free for download on the internet.

The signal generator is controlled via commands from a simple terminal program.

ASSEMBLY

Antenna Analyzer:

To assemble the KAI-201 install the pc board in an enclosure of choice and the antenna analyzer is ready for use. See **Antenna Analyzer** under OPERATION.

Signal Generator:

Use of the signal generator function requires no further assembly. See **Signal Generator** under OPERATION.

BlueTooth:
The KAI-201 is set up to allow the installation of an HC-06 BlueTooth module for remote operation. Install a 4-pin SIP (male or female depending on your BT module) as shown below. Connect a SPST switch between the pad in the circle below and ground. Plug the BT module to the SIP socket/pins. Close the SPST switch to activate the BT module. Connect Vcc and Ground on the BT module to a voltage source between 3.6 and 5VDC. This voltage source can be a lithium ion battery (3.7VDC), three 1.5VDC alkaline batteries (4.5VDC), or a regulated 5VDC power supply.
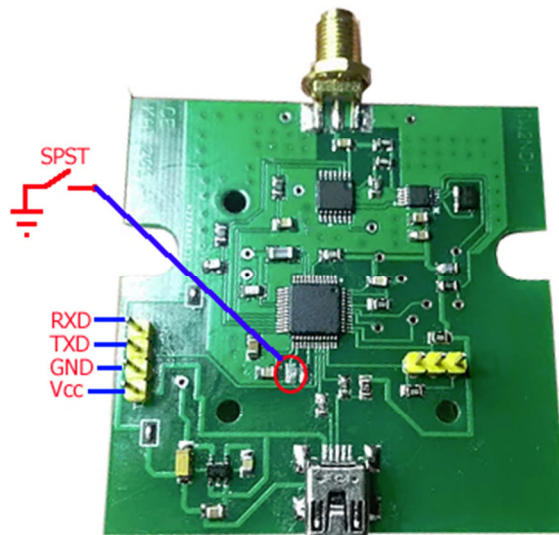
NOTE: Before installing the BT module in the analyzer it must be configured for a baud rate of 38400. Most HC-06 BT modules have a default baud rate of 9600.

While the BlueTooth module is active, the KAI-201 will NOT connect with your computer. To return to computer operation, open the SPST switch and then connect the KAI-201 to the computer.

OPERATION

Antenna Analyzer:

For ease of operation it is recommended to download the AntennaScope2 program available from the Rig Expert™ website (Version 1.0.11 located in the "OLD" folder) and install on your computer.

Connect the KAI-201 to a computer via the USB port. Then start AntScope2 and, in the lower left hand corner of the screen, select SETTINGS. From the pop-up window that appears, select the measurement system of choice, the ITU region where you are located, your language of choice, and finally select Manual Detection. In the drop-down menu for Manual Detection, select the comm port where the analyzer is connected. Leave the other selections unchanged. Close the pop-up window. Close AntScope2 and remove the USB cable between the analyzer and computer.

AntScope2 is now configured to work with your antenna analyzer. Reconnect the antenna analyzer to the computer and start the AntScope2 program. When the analyzer is recognized by the program the SINGLE/CONTINUOUS selection in the RUN box will change from being grayed out to white. The antenna analyzer is now ready to make measurements.

Most AntScope2 functions are self-explanatory and detailed descriptions of these functions can be found on several websites. For this reason this manual will not go in to further detail. While not necessary, one recommendation is that the Calibrate function located in the SETTINGS menu be performed. This needs to be performed only once since the calibration results are saved in the program for subsequent use. To perform the calibration will require an open, short, and 50 ohm load source to complete. Construction of these three sources is quite simple and can be assembled on the connector of choice – SMA, BNC, PL-259, etc.
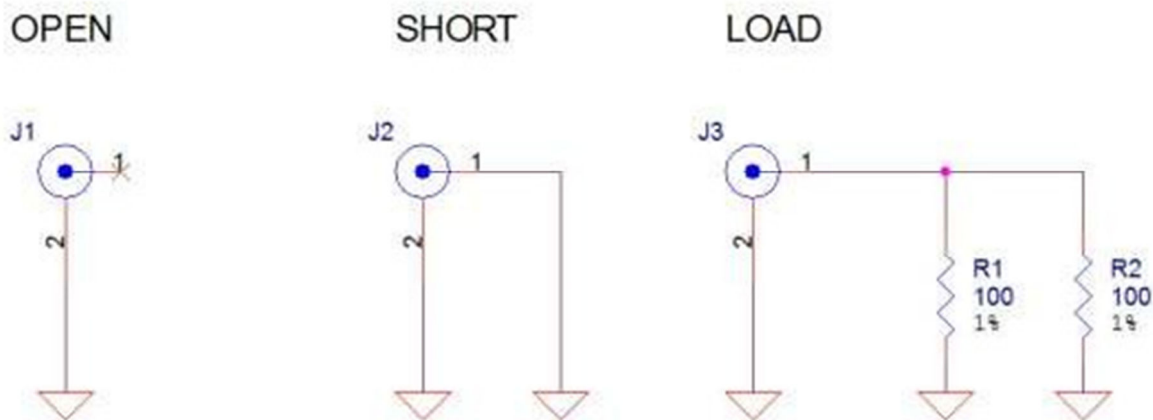
Following are screenshots of SWR sweeps for a 10-40 meter EFHW antenna tuned for 40 meters and a 2 meter two-element ARDF Yagi antenna.

Signal Generator:

The signal generator is also controlled thru any simple terminal program set for 38400,8,n,1. The output is a square wave signal selectable from 100 KHz to 200 MHz. There are three commands to control the signal generator.

To start the signal generator, first enter the desired output frequency. The command for this is 'fqXXXXXXXXX' where X is the frequency in Hertz. As an example, to generate a signal at 100 MHz, the command would be 'fq100000000' (note there is no space or colon (:) between 'fq' and the frequency.

Once the frequency has been entered, to start the signal enter 'on' in the command line of the terminal program.

To stop the signal generator, enter the command 'off' in the command line.

WSPR Transmitter

The KAI-201X has a built in WSPR transmitter. To activate this feature requires the installation to two switches and an LED – all provided in the kit. The difference between the KAI-201 and KAI-201X is that the KAI-201X uses a 16 MHz crystal for the processor clock and controls the precise timing required by WSPR monitoring stations. The KAI-201 uses the internal processor clock and cannot maintain the timing stability required for WSPR operation.

Installation of the two switches and the LED are straight forward. The toggle switch provided is installed between the two pads shown below. The momentary pushbutton switch is installed on the pc board itself. The LED is installed between the two pads as shown below. The WSPR transmitter is activated by closing the toggle switch and pressing the momentary switch. When transmitting, the LED will light and remain lit during the 1 minute 50 second transmit period. To stop the WSPR transmitter, open the toggle switch and again press the momentary switch. This will return the KAI-201X to antenna analyzer or frequency generator mode.
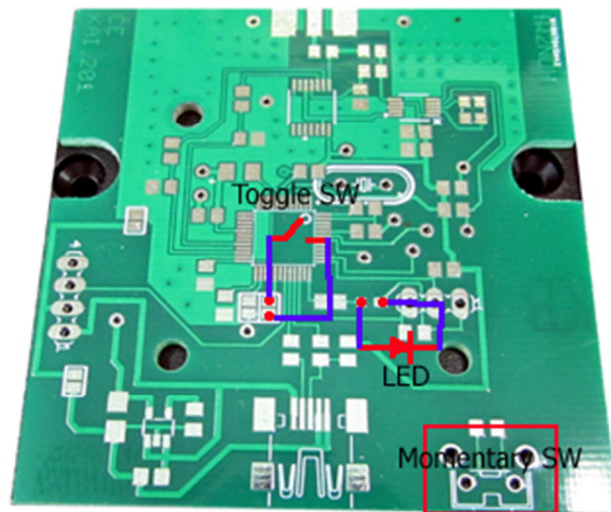
The WSPR transmitter can be used for real time antenna evaluation, comparison of one antenna to another, and to evaluate propagation conditions.

Configuring for WSPR:

To use the WSPR transmitter it must first be configured with your call sign, location, and transmitted RF level. This is accomplished by connecting the analyzer to a terminal program, such as Termite, via the USB port and entering specific commands.

Configure the terminal program for 38400 Baud, 8, N, 1 as indicated in the picture above. Verify communications between the terminal program and the analyzer by entering the command 'ver' in the command block. If connected correctly, the response will be 'AA-170 401'.

Once communications with the analyzer is confirmed, there are four commands which may be given:
setwsprhelp
setwsprcall
setwsprband
setwsprcor

Entering "setwsprhelp" into the command line gives a response of the commands available and the required formats for data entry.

The first command to be entered will set your call sign, grid designator, and RF output level. This command need only be entered once as long as there are no changes to the data. The command and format is:

setwsprcall:callsign:grid:dBm
The call sign must be a 6-character entry with the third character a number.

Call sign examples: 6 character callsign – AA1BCD. 5-character callsign – spaceA0BCD or KI7XXspace. 4 character call sign – spaceW6XXspace.

The grid designator will be the 4 character grid square designator for your location.
The dBm entry will be 10 for the KAI-200 WSPR transmitter. This represents 10mW and is the lowest value reported by the monitoring stations. Your actual RF output is approximately 4dBm square wave.

ACTUAL EXAMPLES:
6 character callsign, enter 'setwsprcall:KB1ABC:DN13:10
5 character callsign, enter 'setwsprcall: W0XYZ:DN13:10
4 character callsign, enter 'setwsprcall: K1AB :DN13:10

When correctly entered, the response from the terminal program will be:
Call: *CALLSIGN*: Grid: DN13 dBm: 10
When the command is accepted the results will be stored in EEPROM on the analyzer and remain until changed.

The second command is to select the desired band of operation. There are 12 choices of frequencies and it must be noted that not all available frequencies are legal in all countries. Please check the bands authorized for your location and license class.

The command to select the desired band is:
setwsprband:number:0 thru 11
If the command is accepted, the response from the terminal program will be 'Band selected: Number'.

As an example, to select the 40 meter band the command would be 'setwsprband:3' and the response would be 'Band selected:3". This entry will remain in memory until another band is selected.

The available frequency bands are as follows:

0 = 1838100, 1 = 3570100, 2 = 5288700, 3 = 7040100, 4 = 10140200, 5 = 14097100,
6 = 18106100, 7 = 21096100, 8 =24926100, 9 = 28126100, 10 = 50294500, 11 = 70092500

To monitor the WSPR signal you can tune a receiver in Upper Sideband 1500 Hz below the transmitted frequency.

The final command available for WSPR setup is to allow for minor adjustment to the selected transmit frequency. Power on the KAI-201 for at least 10 minutes prior to making this adjustment.

The command is 'setwsprcor:'. To adjust the transmitted frequency to within a few Hertz connect the RF output of the analyzer to a frequency counter capable of measuring the specified frequency. Close the toggle switch and press the momentary switch briefly. Note the transmitted frequency shown on the frequency counter.

Subtract the number shown from the desired frequency to obtain the difference and multiply this by 100. If the frequency displayed on the counter is lower than the desired frequency, enter the difference as a negative number. Conversely if the displayed frequency is higher than the desired frequency, enter the difference as a positive number.

Example: 40 meter band is selected. When keyed, the frequency counter indicates a frequency of 704000. The desired frequency is 740100. Subtracting the displayed frequency from the selected frequency gives a difference of 100 Hz. Multiply 100 X 100 gives a result of 10000.

The transmitted frequency is below the selected frequency. Therefore the correction factor entry

will be a negative number.

The command for this example would be 'setwsprcor:-10000'. After entering this correction, place the analyzer back in transmit mode (close the toggle switch and press the momentary switch) and check the results. If further tweaking is required, repeat the steps above until the transmit frequency is within a couple of Hertz of the selected frequency.

Once configured the analyzer may be disconnected from the terminal program.

Operating in WSPR mode:

WSPR requires fairly accurate timing in regards to starting and stopping transmissions. The standard is to begin transmitting at the start of an even minute. To gain this timing accuracy you can use your computer clock as a source. Of course the computer clock itself is not necessarily accurate but there are programs available that can connect your computer to various worldwide timing standards via the internet. One such program is Dimension 4 and is available at this website -> http://www.thinkman.com/dimension4/download.htm. Once installed and set up the computer clock may be used to know precisely when to start the WSPR transmitter .

To run the WSPR transmitter, close the toggle switch. At exactly the start of any even minute, press the momentary switch. The WSPR transmitter will begin transmitting. You may open the toggle switch at this time. When you wish to stop the WSPR transmissions simply press the momentary switch again.

The WSPR firmware transmits a WSPR signal with your data for approximately 1 minute and 50 seconds. It then stops transmitting for approximately 2 minutes and 10 seconds and then begins another cycle. This will run until the transmitter is turned off by pressing the momentary switch.

To discover where your transmitted signal has been spotted, you may go to a couple of websites that will display information graphically and in various charts. Two such websites are http://wsprnet.org/drupal/wsprnet/map and http://wspr.vk7jj.com/ with the second site receiving its data from the first but in a better map format with charts. Additionally you may use these sites to evaluate current propagation conditions.

BE ADVISED:
The WSPR signal is generated by the SI5351 SQUARE WAVE CLOCK. It generates spurs that are not filtered and are usually only 10/15 dB below the fundamental. It is suggested to insert a low pass filter, appropriate for the transmitted band, between the analyzer and antenna. Check local regulations regarding unattended beacons. US customers should operate in accordance with FCC Regulation Section 97.203
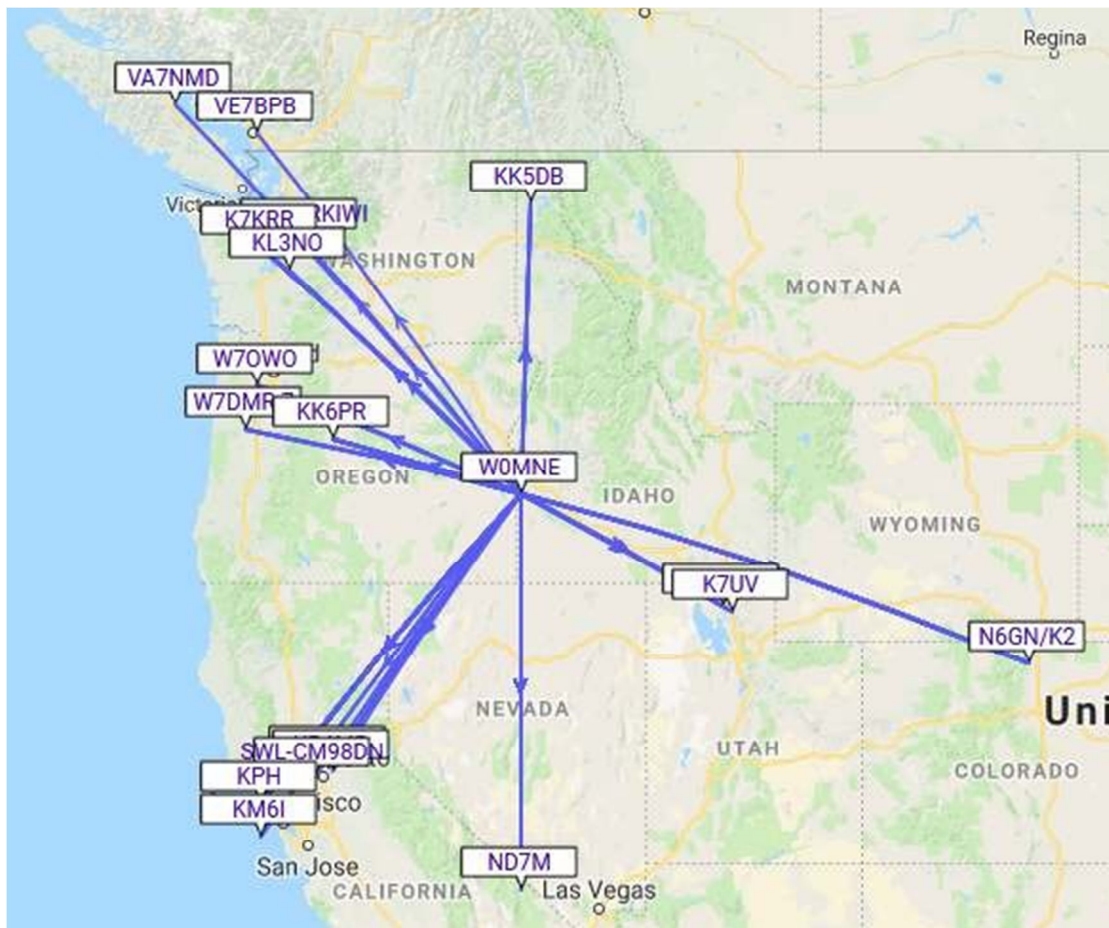
Please direct any comments or
questions to jackdev23@gmail.com