A Guide to
Operating,
Circuit functions,
Basic Troubleshooting
And Repair of the
SW-6B QRP Radio Set

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Foreword from the author:

Amateur radio, as a hobby, is growing worldwide. One thing I've noticed is that a significant number of these new hams have little to no background in radio/electronics. Many new hams have a license but no real *understanding* of how the technology of ham radio works.

That is to say, a large number of folks entering this hobby have no clue on how to perform basic troubleshooting of or repair of the radios they use in enjoying the hobby. With wide spread use of surface mount devices, most lack the equipment, let alone the skills to repair an ailing rig.

There are, however, a great many things the average 'HAM' operator/hobbyist *can* do at home with minimal tools and equipment to effect repairs on a rig that is out of service. Even experienced hams will need at least some technical data and a parts list prior to attempting a repair.

Happily, Dale Yu, BA4TB published not only an operations manual, but also a schematic set on the Internet to go with the SW-6B radio from the beginning. The work you are reading now adds detailed circuit descriptions, basic troubleshooting steps and possible fixes, in addition to an appropriate Parts Breakdown for sourcing repair parts in North America.

I wrote this manual with the view of the new ham trying to fix what are the *most likely* problems with a dead radio, quite literally, on the kitchen table with very minimal equipment. The Manual covers the most common items that might need repair in the lifetime of the rig. I have included an expanded Operations manual at the beginning so all required technical information resides in a single document.

This manual specifically covers the SW-6B, model 6B1a board. Venus has a history of making product improvement upgrades as a matter of ongoing processes. Ensure you check the board version to ensure you have the correct data.

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About the Author:

Mr. Koehler first tested for and received his FCC Commercial Radiotelephone license with a RADAR endorsement in 1977. He received his Amateur Radio Service license on the next test cycle. This was back when FCC employees gave the test in person.

After spending 22+ years as a USAF Master Technician working on radio/electronics, maintaining a wide variety of communications equipment to the component level. Mr. Koehler went on to spend another 10 years working with telecommunication equipment as a technician, technical writer, quality manager and finally, a supervising manager.

His published works include many articles in "73" Magazine, Site (later, Above Ground Level) Magazine and multiple other industry periodicals. He was also a Contributing Editor for Mobile Radio Technology magazine for a number of years. He has penned Technical Manuals for the MFJ-9200, SW-3B and the G-CORE G1M radio sets.

He has a Bachelor of Science degree from the University of the State of New York, with multiple Associate degrees, to include an Associate of Science in Communications Technology.

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A pair of schematics for the SW-6B is attached as an Annex to this document to allow the reader to use the 'zoom" function of most PDF readers.

This Guide focuses on the new amateur population providing simplified:

- Diagrams of important systems and sub-systems.
- Troubleshooting and maintenance steps that may be taken with minimal test equipment. I explain how to use the listed test equipment and how to build some of your own.
- A *How Do I* section of links to videos on line showing how to use test equipment and make tests.
- A *limited* parts listing for those items *most likely* to need replacement at some point in the life of the radio set. I'll explain *how* to replace those parts and hopefully allow you to get your rig up and running.
- I also provide at least one source (available at the time of this writing) and common part numbers to source the parts for yourself in the future.

Please note the list of parts; part numbers and parts source were current at the time this was written.

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SW-6B Operating Instructions – modified.

This is an *expanded comments* version of the excellent manual provided by Dale.

Warning: Before attempting to operate your SW-6B radio on air, *read through the entire manual*. Failing to adhere to prescribed setup and operating recommendations could result in permanent damage to your radio!

BEFORE powering up the radio, perform the Basic Maintenance and Testing of Radio Procedure T1 – Acceptance testing. This is for radios *with installed optional battery*.

Initial power up

After connecting a known good antenna or dummy load, key or paddles, headphones and then finally connecting the power supply, turn the radio on via the **on/off** switch.
The initial splash screen displays:

Then, after system initialization, the screen displays the current settings:

(MEM) Memory number or **(VFO) VFO** (8 memory locations per band)

Operating Mode (CW/**CWR**/USB/LSB) (**CW R**everse covered in detail later)

Supply Voltage (xx.x VDC input voltage on either power port). (Range 8 to 14 VDC, polarity protected)

Frequency

Receive**:** (1) 3-5MHz, (2) 5-6MHz, (3) 6-8MHz, (4) 8-16MHz, (5) 16-22MHz. (receive sensitivity peaks at 80m, 60m only)

Transmit: (1) 3.5-3.8 MHz/80M, (2) 5.35-5.368 MHz/60M, (3) 7.0-7.2 MHz/40M, (4) 14.0-14.35 MHz/20M. (5) 18.068-18.168 MHz/17M, 21.0-21.45 MHz/15M (shared 17M & 15M).

S meter display (relative)

Band in use (80/60/40/20/17+15)

SW-6B controls and functions:

ON/OFF – Push up to turn on the SW-6B radio set**.**

Band switch (BAND)

The switch labeled BAND on the right side of the panel is a band selector switch. Switch positions 1, 2, 3, 4 and 5 correspond to 80m, 60m, 40m, 20m, 17m/15m bands respectively (17m and 15m share a common band).

M/V/S button

Pressing this button alternates the display between Memory mode (**M**) and VFO (**V**)mode as seen on the display. The display will show M-# or V-#. # represents the numbers 1 thru 8.

In Memory mode, the VFO control is used to change memory locations.

In VFO Mode, the VFO control is used to change the displayed frequency.

Pressing and then holding the **M/V/S** button for *more* than two seconds will display SAVE and the current frequency and mode will be stored in the memory # location displayed.

The last *stored* frequency and operating mode will be displayed each time the unit is turned on.

RIT/M button

RIT / XIT use: Press the **RIT/M** button briefly to enter the RIT/XIT (offset) function.

- To switch *between* RIT and XIT, briefly press the **VFO** control.
- Moving the VFO knob changes the amount of offset in both RIT and XIT.
- Turning the VFO knob *clockwise, increases* the offset, turning the VFO knob anticlockwise decreases the offset. The function, when active, shows on the screen on the right side of the top display line. This also shows the direction of offset (+ or -) from the displayed VFO frequency and the amount of offset.

The carrot (triangle) indicates steps selected for offset tuning. RIT changes will be in 10 Hz/step and XIT changes will be in 100 Hz/step.

Pressing the **RIT/M** button for *more* than 1 second will change the operating mode, and every time the button is pressed for *2 seconds* the operating mode will change in the order of: CW, CWR, USB, LSB.

Keyer settings:

Speed adjustment knob – (**SPEED**)

The SPEED knob near the bottom left of the panel controls the keyer speed. It increases keyer speed in WPM in by turning clockwise and slower by turning counterclockwise. You adjust this *by ear,* no speed is indicated.

OP/TUNE Tuning Switch for SWR indicator:

This switch is used to employ the Tayloe type SWR indicator. When the switch in in the **TUNE** position, a 50 ohm bridge is placed in line with the antenna connector. Following your antenna tuner instructions, tune for maximum noise in receive.
When transmitting (a series of "dits" is recommended) the LED above the switch will glow if there is not a correct match. Making fine adjustments of the tuner will cause the LED to fully extinguish or grow very dim.
When the LED is fully extinguished, or very dim, you have a good match between the SW-6B radio set and the antenna. If a fully resonant antenna is employed, the LED will remain dim or dark.

When you have completed the tuning process, place the switch back into the OP position.

NOTE – If you wish to operate at lower power levels, you may leave the switch in the **TUNE** position or reduce the output RF power..

<u>VFO control</u>:

The frequency of the **VFO** is changed by the **<u>large knob</u>** to the left of the display. Pressing down on this VFO control provides several other functions.

- Turning the large VFO knob *clockwise*, <u>raises</u> the displayed frequency.
- Turning the large VFO knob *counter-clockwise*, <u>lowers</u> the displayed frequency.

The **VFO** frequency change <u>steps</u> are 100KHz, 1KHz, 100Hz and 10Hz. The steps for RIT/XIT are a bit different:

- **RIT Steps:** 10-Hz steps (+ to – 9 KHz) (**R**eceiver **I**ncremental **T**uning)
- **XIT steps**: 100 Hz steps (+ to – 30 KHz) (**X**(trans)mitter **I**ncremental **T**uning)

RIT

XIT

Note the carrot (triangle) above the listed frequency shows the steps in use. By <u>briefly</u> pressing down the VFO control, the carrot moves to the next digit to the right.

NOTE - The frequency steps will change to the opposite direction (R to L) if the VFO control is pressed for *more* than 1 second.

VFO Display Frequency Resolution: to 10-Hz.

NOTE - If the VFO control is pressed down while in MEM mode, the radio set will enter the VFO mode.

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VFO Display: OLED, variable brightness

Screen brightness settings:

Press and hold the **M/V/S** button and **RIT/M** button at the same time to change screen brightness.

Rotate the VFO control to change the screen brightness. The brightness of the display has 5 levels, Level 1 is the darkest and Levels 5 is the brightest.

Press and hold the **M/V/S** button and **RIT/M** button again at the same time to Exit the screen brightness setting state.

Transmit indicators:

The permitted transmitting frequencies are: 3.5-3.8MHz, 5.35-5.368MHz, 7.0-7.2MHz, 14- 14.35MHz, 18.068-18.168MHz, and 21.0-21.45MHz. When transmitting *within* the listed frequency ranges, the display will show the word **TX**, and the S-meter under the display is changed to show the relative transmit power with a **P**.

There are 3 pips on the (P) bar graph on the transmit power scale.

The first pip is roughly 1 Watt of RF power.
The second pip is roughly 3 Watts of RF.
The final pip to the far right of the bar graph, is roughly 5 Watts of RF.

NOTE - The radio detects the RF voltage output to the antenna port, the power displayed is more accurate *only* when the SWR at the antenna port is close to 1:1 (ie matched or resonant antenna).

The red LED labeled as **OP** at the top right of the panel, above the **TUNE** switch flashes when the SW-6B radio set transmits.

- **Operating Modes:** Transmit - A1 (CW) **only**. Receive - A1, (CW/CWR) A3J (LSB or USB) AM reception is possible with careful tuning in USB/LSB mode.
- **Filter**: CW/CWR, SSB in two steps with automatic switching. CW filter bandwidth ~400Hz, SSB bandwidth ~2KHz.
- **T/R Switching:** Fully QSK capable

Sidetone - ~600 Hz (fixed offset)

Sidetone Volume adj: Use a small flathead screwdriver to adjust volume at point **ST**.

External Power Supply
Any 10 to 14 V DC power supply or battery may be connected to the radios coaxial power jack labeled **10-14VDC** with the supplied co-axial cord.
The sleeve (outside) of the power connector must be negative (**-**). Reverse-polarity protection at the main DC input is provided.

Charge:
The CHARGE connector is for charging the internal battery. , please only use the supplied lithium battery charger for the built-in battery charging (if you don't have a built-in battery installed in the interface can be used as a second external power supply interface).

Antenna
Any resonant / well-matched (50 Ohm) antenna may be connected to the ANT jack BNC connector. An external antenna tuner is required for antennas that are not resonant at the selected frequency. The radio does **not** provide for any adjustments other than audio /RF gain, keyer speed and VFO. High SWR *will* damage the radio. Use care when tuning any antenna. I strongly suggest using a series of 'dits' to reduce the chance of damage to the final amplifier while tuning.

Headphones
A stereo headset can be connected to the PHONE jack. Impedance should be 8-32 Ohms. A *stereo* connector ***must*** be used. A MONO headphone plug will SHORT the output! Alternatively, you may use a mini stereo amplified speaker. While 8-32 ohms is recommended, a 4 ohm stereo speaker will work – just barely.
I also recommend a set if earphones with a 90^o connector to reduce strain to the jack.

Key/Paddle
If using a stereo plug for a **straight key**, both ring and sleeve must be connected together for use. A monaural plug may also be used with a straight key. The radio is set to detect the type of key used. With paddles and a stereo plug, the internal keyer is automatically enabled on power up and annunciated with the Morse letter "A". .

3.5mm stereo plug

TIP. Connects to DOT paddle or one side of straight key contact

RING. Connects to DASH paddle or straight key ground

SLEEVE. Connects to paddle or straight key ground

Key Operation
When power is applied with a paddle connected or **no** key is present, the letter "A" will be heard in the headphones upon power up. The letter "M" is heard if a straight key is connected on power up. Connect the key *prior to power up* to ensure the radio senses the type of key in use.

AF GAIN
Used to set volume of received signal. Turn control clockwise to increase volume. Exercise caution if using "earbuds". This also functions with the internal speaker.

RF GAIN
Provides variable attenuation of incoming (RF) signal to the first mixer. Useful in noisy band conditions.

Power Switch
Used to turn radio set on and off. Located after the reverse-protection diode.

M1, M2 buttons:

M1 and M2 are two auto-call buttons, two auto-call messages can be pre-stored respectively.

Briefly press the M1 or M2 button, then release immediately to automatically *start the stored content*. The memory characters are manually input by the user, as described below. To cancel the auto-call during the auto-call process, briefly press the M1 or M2 button and then release it.

Loading memory:

NOTE: This operation is *not* available when using the straight keys, you must use paddles..

1. *Press and Hold* the M1 or M2 button for about 2 seconds.
2. After hearing the Morse code letter **I**, release the M1 or M2 button.
3. Enter your message string (~20 characters)
4. Quickly press the same (M1 or M2) button to Exit, you will hear the More character **E**..

M1 and M2 can be pre-stored independently.

When in the memory loading mode, the display will show the word TX but the SW-6B radio set will not transmit, this is normal.

Storage capacity for automatic messages: The automatic call storage capacity in the radio can store about 20 characters, because the length of each character's code is different, so the number of characters that the memory can store is also different. These memories *cannot* be daisy-chained.

If the number of characters entered exceeds the content that the memory can hold, the radio will not be able to store it.
At this point. the memory will be emptied of the contents of the memory. S

Battery System:

The radio has both a power connector and Charge connector; these tie into a common bus internally. The Charge port is used to charge the optional, internal Li-ion battery pack. Both ports are diode protected from reverse polarity.

The Charge port connects to the battery via an internal plug, allowing the battery to be removed, if desired, without affecting operation of the radio set.

The state of battery charge is monitored and shown on the display if operating from the optional battery. The battery may be charged when the SW-6B radio set turned off.

NOTE – if the voltage present on the power connector (10 – 14 VDC) falls below the voltage of the internal battery the radio will take power from the battery.

End Operation Instructions

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Recommended tools & test equipment:

You will need some *minimum test equipment* to perform any troubleshooting on the SW-6B, multi-band HF radio set. These are:

Multimeter. Sometimes called a V-O-M for a Volt, Ohm, Milliammeter. This is an 'analog' instrument – it has a meter. You may also see meters called a DMM, for Digital MultiMeter. This unit is used to measure voltage at several points within the radio set. I've made measurements listed with both a VOM and DDM. Any differences because of the meter type are identified.

The meter used must be a *quality* unit, with a listed input impedance of *at least* 20K ohms/volt, with 1M ohm/volt preferred. A quality DDM may be found new at a cost of under $50 USD and can be used for other tasks, such as checking fuses or confirming power is present at a connector.

- Test leads for your meter should have a **sharp point** to allow measurement at a specific pin on a small SMD device without shorting across to any other pin.
- The test leads should have a way to clip at least one lead to the chassis ground.
- The test leads should be color-coded, usually red and black, to indicate polarity.

Resistive Dummy Load. Used to terminate the transmitter chain, this will both prevent damage from transmitting into an unterminated connecter and allow a way to determine output power. If you don't have one, look at the end of the maintenance section. I show you there how to build a suitable dummy load for a few dollars.

For testing, a 50 ohm dummy load may be made with a pair of 100 ohm, 2 watt composite resistors soldered in parallel and a BNC panel mount. BNC male to male adapter allows use on this radio.

Wattmeter *and* Dummy load. A nice kit is available from Pacific Antennas and Kits for under $20. This dummy load also allows use of your DMM to read power out. (See Dummy Load - Pacific Antenna (qrpkits.com)). The SW-6B radio set RF power indicator is *relative*, not exact.

Signal tracer or Oscilloscope. I've been building or repairing radios since 1970 and I still don't have one of these at home for shack use. What to do? I use a small (portable) *general coverage receiver* equipped **with a BFO**, specifically an ATS-909. Most tests with the radio are just to see if a signal is present or not. In newer digital radios, generally something either works or it doesn't. If I can hear something on the tracer radio, I can keep going. If you have a main station rig, it is perfect for this use as well.

Continue

Signal Generator. While nice to have, there are alternatives for a new ham:
A low-cost antenna analyzer, such as the MFJ 207, can serve as a signal source.
There are multiple "DDS kits" to be found on line that may be used as a basic signal generator. One such kit is the N3ZI kit – http://www.pongrance.com/super-dds.html - about $89 USD.
If you have another HF rig, feed it into a dummy load at low power, and then use it as a signal source.
Used commercial equipment may be found from time to time, but maintenance, manuals and ongoing calibration can be problematic for the amateur radio operator.
Finally, a wire antenna can provide a small, broadband signal for use in very basic troubleshooting.

Hand tools:
Screwdrivers (small and very small). Since the radio set SW-6B is small, your screwdrivers are going to be typically called a "Jeweler's screwdriver set" or the like. .

Small needle nosed pliers. The kind with a wire cutter are nice to have.

Adjustable wrench (spanner). It is used to remove the BNC connector from the chassis cover plate, an unlikely occurrence.

Non-metallic tools, to assist with removing the circuit board from the case and a screwdriver adjust the SIDETONE.

An ESD- safe soldering iron and ESD-safe work surface.

-An ESD-safe soldering iron will be marked as such and on low-cost units is usually distinguished by a 3 prong AC connector. If you plan on attempting your own repairs as a matter of course, investing in a better grade unit, often called a soldering "station", is a worthwhile investment.

-I use a roll-up ESD safe pad to work on. This pad has a snap connection for my wrist-strap so I and the work surface, stay at the same potential. You may be tempted to skip this expense, please don't. Cost is only about $30 USD for a nice unit.

Solder pump and soldering wick. You will need these to be able to remove any installed active devices. I have a spring powered solder pump that is nice for fast work. Wicking works as well, it's just not as fast.

Solder pump – an under $4 USD example is from New Egg. They call it a "Solder Sucker Desoldering Pump Vacuum Soldering Iron 19cm Repairing Tool". Wow.

Solder wicking may be found on-line at Mouser Electronics or DigiKey. Get the Static Dissipative (SD) rated wicking. It's sold by the roll. *Get a couple*...

Magnifying lenses – you *will* need them. A headband unit with dual lenses allows working hands-free

Safety glasses for soldering! No joke, get 'em, wear 'em! *Save your eyesight...*

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2.0 Warnings page

This radio contains Electro-Static Sensitive Devices (**ESD**). Use an appropriate conductive/grounded work surface when preforming repairs.

If you will be soldering anything on this radio, use of an ESD – safe rated soldering iron with proper grounding is *a must have*.

- These kinds of iron may be found on-line, offered by multiple Vendors.

Use a personal ESD grounding device for yourself before beginning work on the radio.

Perform soldering only in a well-ventilated area!

ALWAYS wear eye protection when soldering! The eyes you save will be your own.

DO NOT key the radio without connection to an antenna, dummy load or into a high SWR load – *you will damage transmitter components*.
If using an external tuner, avoid extended key down times when making adjustments.

NOTE: – Placing the TUNE/OP switch in the TUNE position inserts a 50 ohm load across the transmitter output. This is not suitable for extend, key down, transmit times.

While the DC input is diode protected, use of a fuse – 2 amp – inline on the DC input cable is strongly recommended..

Before any power on tests are made, ensure you have a set of phones and a dummy load attached to the radio or main board **before** applying power.

I STRONGLY suggest that operators remove the DC supply and antenna connections when the radio is not in active use.

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3.0 <u>Basic radio overview / Concept of Operations</u>

3.1 <u>Radio Overview</u>

The radio set SW-6B is a lightweight, rugged, miniature, single-conversion transceiver that operates (transmits) on six internationally allocated high frequency bands within the Amateur Radio Service. It may be powered with any *stable* DC source between 10 and 14 VDC. Please note that ANY 'ripple' in the power supply will be heard on the transmitted signal.

Power consumption in is minimal, about 70 mA. With the internal speaker on, the radio draws ~100 mA. Actual current used will vary slightly based on input voltage.

The radio set SW-6B also offers broadband reception from 3.5 to 22 MHz in the so-called shortwave bands. This broadband feature also allows reception of WWV on 5, 10 and 15 Mhz for frequency check, time and weather reports. Reception of International Shortwave Broadcasts using USB mode is possible with careful tuning.

The unit is all digital. The VFO control provides for tuning in 10 Hz, 100 Hz. 1kHz, 100KHz increments. The RIT/XIT function permits receiver offset tuning in 10 Hz increments and transmitter offset tuning in 100 Hz increments.

In addition to manual tuning via the rotary encoder, eight memories *per band* are provided to store frequency/mode. Changing between stored Memory and the VFO is by a pushbutton. Changing between Memory locations is via the VFO control. A slide switch is used to change between bands.

Placement of the operator controls and connectors only on the *front* of the chassis clearly puts this radio in the class generally known as *Trail Friendly*. With both the bottom and sides of the chassis free of control ports, you may place the radio set upright, on a stand or tilt the radio set for the best viewing angle and not impact any connections. While seemingly a minor detail, this flexibility is a nice touch for operating in the field.

The high-contrast OLED digital display is large enough to read in bright light. The brightness level of the display is adjustable in five steps. .

The receiver is single conversion, with a crystal ladder filter to reduce noise and adjacent signal interference. The Beat Frequency Oscillator (BFO) is fixed and operates at 4.914 MHz. The BFO injection signal to the second mixer signal is provided directly by the Si5351 DDS source. Very clever and ensures the BFO signal tracks the VFO exactly.

The filter may be set for *narrow* (CW/CWR) and *wide* (USB/LSB). This bandwidth change is controlled by a simple pushbutton and is automatic, depending on the mode selected. Receiver performance is impressive, with Minimum Discernable Signal (MDS) levels of 0.1 to 0.2 microvolts (-127 dBm @ 50 ohms) typical.

The transmitter is a classic Master Oscillator/Power Amplifier (MOPA) type fed directly by the DDS system. The transmitted signal passes through a 74ACT00 (Quad 2-Input NAND Gate) device in lieu of a conventional driver chain. This then feeds a single power amplifier.

The transmitter final amplifier (PA), is a robust IFR510 (Q8). The PA is robust enough that a 'protection diode' is unneeded. The antenna is attached via a BNC connector mounted on the front of the unit.

The internal keyer supports iambic keying via a set of operator-supplied paddles. Use of a straight key is supported as well. (See Operation Manual above for more on keys). A keyer memory allows automated calling of CQ w/Operator callsign at the push of a button. Keyer speed is easily adjusted on the fly via a front panel control.

Operating on a DC input between 10 and 14 Volts DC, the radio transmits with a nominal power of five watts output with 12.8 DCV applied. The power input is protected against reverse polarity. External power supplies should be able to provide up to 2 amperes of current with no AC ripple. A simple battery pack made up of eight "AA" (or 10 NiMH) batteries provides ample power. The radio supports an optional, internal, Li-ion battery pack as well.

The radio boasts a Tayloe type SWR indicator, which contains a resistive bridge protecting the PA device during tune up. This is switched in and out of the antenna circuit with a single (TUNE) switch.

Please note that the unit transmitted power output drops off with lower input (supply) voltage. The SWR indicator may be safely left in the TUNE mode as well, to reduce output power during operations.

BRIGHTNESS setting -

Switches S2/S3 are used for RIT/M and M/V/S. Pressed together they control the brightness function. If pressed together at power up, they will cause the radio to boot into calibration mode.

A note about 60 Meter operation. In North America, this is a channelized allocation. Take the time and use the provided Memory location to store the 5 authorized channel frequencies – *before* you start operations on the 60 Meter band.

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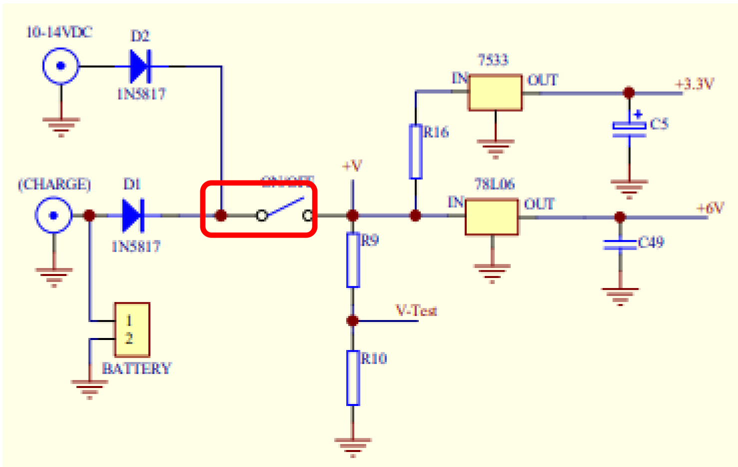
continues

3.2 <u>DC power busses and protection:</u>

The SW-6B uses three voltages to operate. These are: DC input voltage; +6 VDC regulated via an a 78L06, a 3 lead device and +3.3 VDC regulated via a 7533, also a 3 lead device. Note the dual, diode protected input connectors.
These input connectors are a common 4.0 x 1.7mm coaxial connector.



One power buss is unregulated, the DC input. The applied DC voltage is measured in the PIC controller at PIN 20 (V-TEST). This also serves to monitor the state of the internal battery, if installed and in use. This input buss directly feeds the transmitter PA section (Q8) via L4/C4/C15 network and to the Filter board to power the relay used to switch bands..

!**WARNING**!

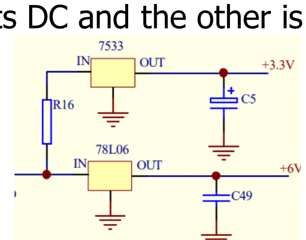
Please note that the supplied battery charger MUST be used to charge the optional battery pack - when installed. There is NO diode protection in Charge mode.

The rated RF output power of 5 watts is easily obtained at 12.8VDC. While the radio will operate below 10 VDC input, this **<u>is</u>** **<u>not</u>** a recommended practice.

<u>DO NOT</u> exceed the 14 VDC limit on DC input power.
Operation above this voltage *may* damage parts of the unit.

3.3 DC Voltage regulation:

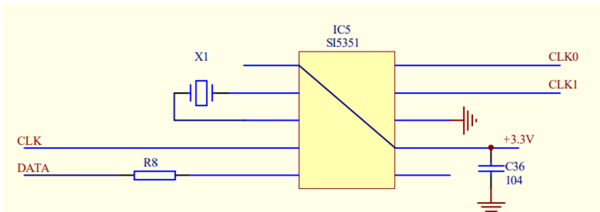
The two additional power busses present are regulated. One buss is regulated for +3.3 Volts DC and the other is regulated for +6 Volts DC.



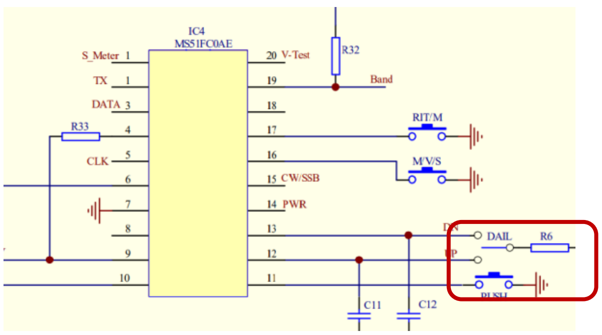
Regulation for each of the DC busses is provided by a small (SMD) solid state regulator device. These three lead devices are robust and provide excellent regulation as power varies in situations with marginal batteries, such as on extended transmit.

3.4 DDS VFO sub-system

The **D**irect **D**igital **S**ynthesis (DDS) sub-system of the SW-6B radio set is based the popular Silicon Labs Si5351 chip. The Si5351 is a low power, DDS device capable of producing two outputs, CLK0/CLK1 using the installed 27MHz crystal (X1) as the reference oscillator.



The DDS output is determined by the MCU per the rotary encoder inputs (Dial).



With the clock source provided, the DDS chip has an output resolution *better than 10 Hz.* The DDS system is controlled by the PIC (IC4) chip using a I2C (two wire) interface. The system provides a stable, accurate signal.

There is a calibration procedure available/provided for the DDS system. This procedure is covered in detail later, in the Maintenance section.

Output of the DDS system ranges from a low of 3.500 MHz to a high end of 26.015 MHz. The output of this subsystem is isolated to eliminate loading.

On **transmit**; the DDS system output frequency is identical to the displayed VFO value (+ or – any XIT setting) . The DDS system output is fed to PIN 1 of the 74ACT00 as CLK0 from the Si55351 chip.

On **receive**; the DDS output frequency is VFO value **plus** 4.914 MHz.

(Except on 80M, where the BFO input is MINUS 4.915 MHz.) The CLK 0 goes to the first mixer (NE602). See Frequency Chart below for details.

The BFO injection signal, 4.915 MHz, feeds the second mixer (NE602) as CLK1. This offset matches the first conversion scheme to allow the crystal filter to function.

The Si5351 is controlled via a 2 line serial interface from the PIC MS51FC0AE Master Control Unit (MCU). I don't have a way to read the embedded MCU code, and even if I did, I still wouldn't put the code in this manual.

Currently, the manufacturer does not offer a replacement MCU chip. Specialized tools are required for any SMT device replacement, so this topic is not covered in this manual.

Frequency chart for DDS system for selected frequencies

Band & test frequency	**Transmit** VFO setting	**DDS output**
80 Meters 3.600	3.600	3.600
60 Meters 5.332.00 MHz	5.332.00	5.332.0 *USA
40 Meters 7.100 MHz	7.100 MHz	7.100 MHz
20 Meters 14.100 MHz	14.100 MHz	14.100 MHz
17 Meters 18.100 MHz	18.100 MHz	18.100 MHz
15 Meter 21.100 MHz	21.100 MHz	21.100 MHz
Band & test frequency	**Receive** VFO setting	**DDS output**
80 Meters 3.600 MHz	3.600 MHz	8.515 MHz
60 Meters 5.332.0 MHz	5.332.00 MHz.0	10.247 MHz
40 Meters 7.100 MHz	7.100 MHz	12.015 MHz
20 Meters 14.100 MHz	14.100 MHz	19.015 MHz
17 Meters 18.100 MHz	18.100 MH	23.015 MHz
15 Meter 21.100 MHz	21.100 MHz	26.015 MHz

NOTE – Measured with radio set in CW mode @ frequency shown in VFO settings column

NOTE - BFO signal is provided by the Si5351 (CLK1) at 4.915 MHz.

NOTE – Center frequency of crystal filter is nominally 4.915 MHz.

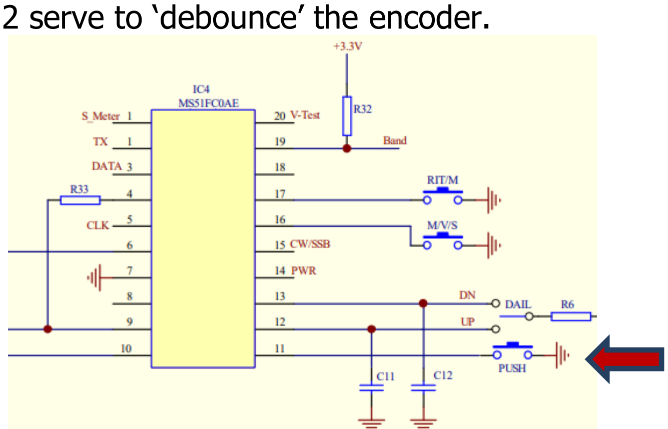
* Denotes **USA** 60M band allocation. May be different in your Zone. Check to be certain.

In USB mode, the radio transmits 600Hz ABOVE the displayed frequency.
In LSB mode, the radio transmits 600 Hz BELOW the displayed frequency.

3.5 PIC control of the Si5351 DDS system

The DDS chip is controlled by two lines from the PIC controller, PIN 14 and 15. These lines feed in the Si5153 chip on PIN 3 and 5 (DATA/CLK) respectfully.

The PIC controller senses VFO changes via rotary switch (Dial). The selection(s) tie back to the PIC controller, inputs PIN 12 & 13. PUSH is the button on the rotary encoder. C11 and C112 serve to 'debounce' the encoder.



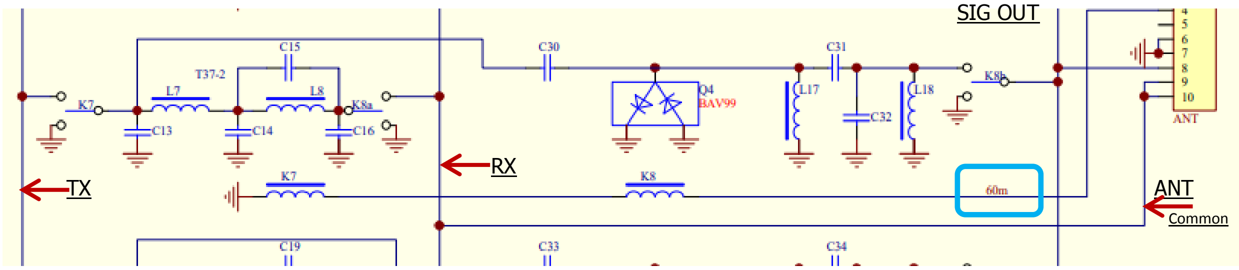
3.6 Receiver

- Signal path.

The desired signal enters the antenna and enters the receiver via the BNC connector. The signal then enters the Filter daughterboard via PINS 9 and 10.

Depending the setting of the Band switch, one of five possible filter sets are chosen via a set of relays (K-1 thru K-10)

Let's examine the signal path for **60 Meters** (shown below).

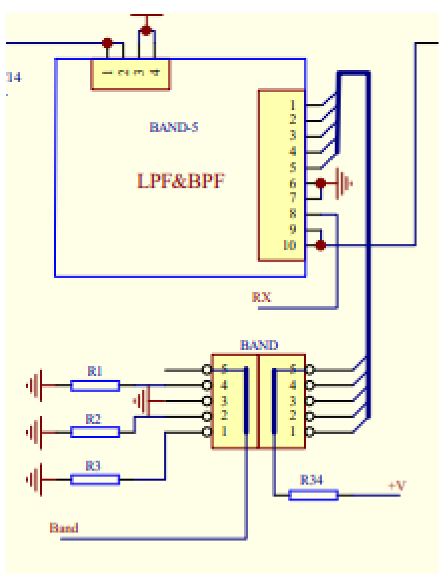


The RX IN signal is applied to a common **ANT**enna buss, from PINS 9 and 10 to the input of the BAND set of relays.

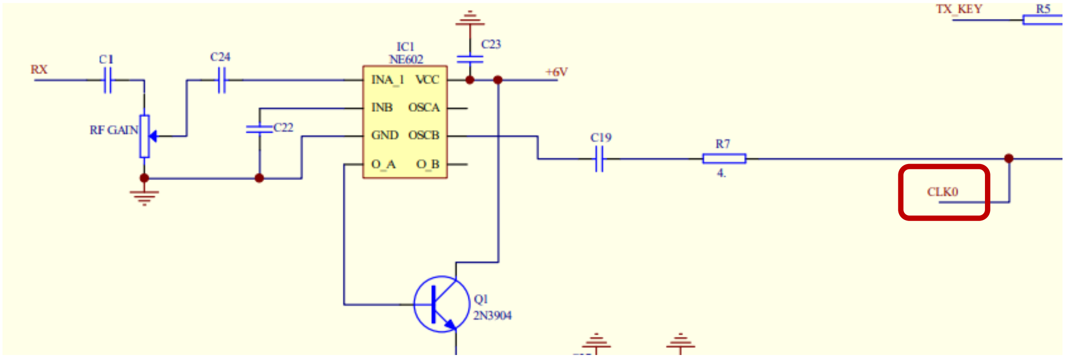
For 60M, RLY K8a is connected to this common **RX** buss. From the Pin "a" of the relay, the signal goes thru the filter C13/14/15/16 and L7 and 8. The signal is coupled, via C30 to the next filter, C31/32 and L17 and 18. The signal then goes out to the receive chain, via K8, Pin "b" to common SIG OUT buss feeding **PIN 8** of the Relay daughterboard interface.

NOTE The Transmit path is much the same, with the transmit signal going to the common TX buss, then out via K7, thru the same filter, then onto the ANT buss feeding Pins 9 and 10. The BAV99 (Q4) protects the receiver.

The filters are chosen by relay activation via the BAND switch.



Leaving the Filter daughterboard via **PIN 8** (RX), the signal enters IC 1, Pin INA (PIN 1), the first of two NE602A mixers, via C1/24 and RF GAIN control.
There, the incoming RF is mixed with a signal from the DDS sub-system, **CLK0,** input at OSCB via R2/C19**.** The CLK0 frequency is set by the VFO control (+ or – RIT settings).

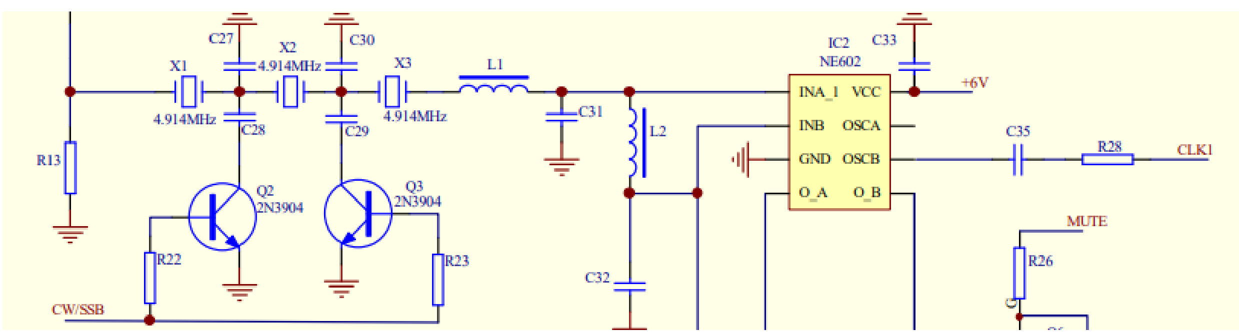


The output of the NE602, Pin O_A, now contains the two original signals (RF and DDS) ***plus*** the sum and difference of the two signals.

This is the *Intermediate Frequency* or IF. This complex output feeds through a buffer amplifier Q1 into the ladder filter, a matched set of three crystals. The crystals in the filter are marked as 4.914 MHz.

The ladder filter, acting as a high-Q, series resonant circuit, then feeds the signal, centered on 4.914 MHz, into L1&2/C31 and then on into IC2, the second NE602 mixer, Pin INA_1.

This filtered signal (IF) is mixed with the BFO signal (CLK1) from the DDS sub-system. This BFO injection frequency is set by the MCU and there is always a 4.914 MHz difference from the VFO output (CLK0).

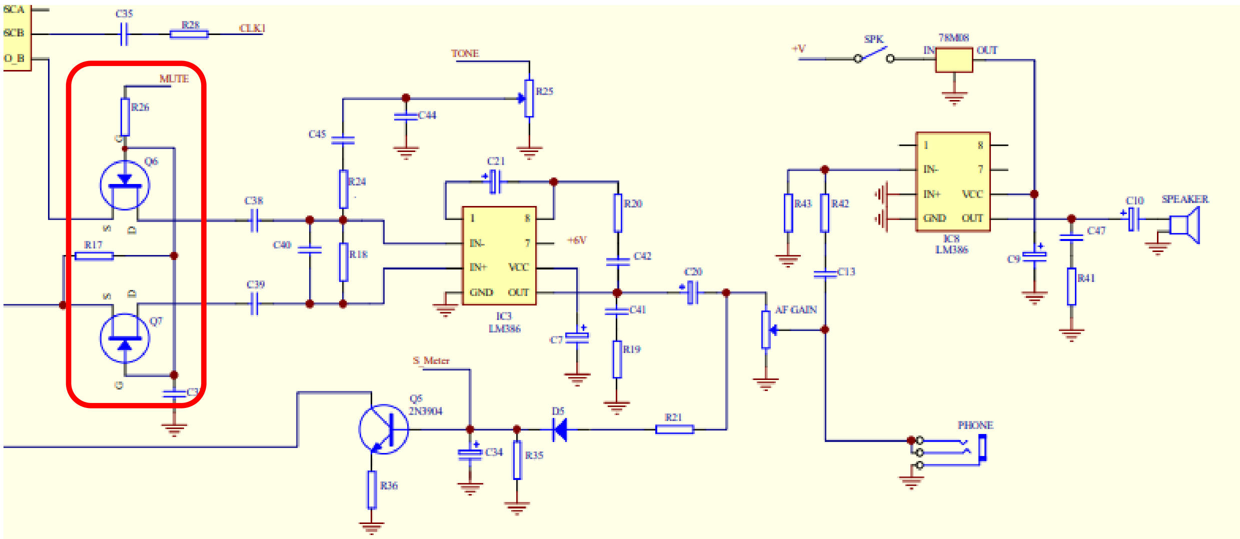


I'll note here this schema provides a very stable BFO injection frequency as it "tracks" *exactly* the VFO frequency. The VFO and BFO signals are both derived from the same source. In other rigs, the BFO is often an independent crystal oscillator that cannot exactly track with minor variations in the VFO output due to temp etc. The schema used here ensures the desired RX signal stays *centered* in the crystal ladder filter passband.

A happy side benefit, CWR is available as a mode and the radio has a reduced parts count.

Again, the output of the second mixer has both original signals ***plus*** the sum and difference of the mixer input.

One of those output products is the recovered audio (AF) or CW note from the signal that entered at the beginning. This goes to the audio chain. This audio chain is a fixed gain audio amplifier (IC3), fed via **Q6/Q7**, a set of Unijunction transistors that serve as a fast audio switch for T/R muting.



The amplified audio output then enters the Volume Control potentiometer **AF** and on to the Phone output jack. The internal speaker is activated via the **SPK** switch. The volume control remains in use with the internal speaker.

AGC:

The takeoff from one side of the volume potentiometer feeds into Q5 via diode D5(1N60). This 'DC' voltage is fed into IC2, PIN INB – the second mixer, as part of the audio-derived AGC system.

The <u>transmit sidetone</u> is fed into the LM386 while the RX signal is muted by Q9/Q10. The sidetone comes from IC6 (12F629) Pin 7, the keyer sub-system. There is an adjustment for sidetone volume, R25, accessed thru the front panel.

This double mixer scheme, with crystal filter is vastly superior to the simple Direct Conversion (DC) receivers of an earlier age.

This circuit architecture allows filtering of unwanted noise and out-of-band signals, such as shortwave broadcasters. It is also inherently a low-noise system.

By changing the BFO injection frequency slightly via the CW/CWR choice, it is possible to move an interfering signal outside of the crystal filter passband for removal. This function is possible due to the DDS subsystem providing the BFO injection signal.

Changing the MODE (USB/LSB) switches Q2/Q3, which alters the filter passband as noted earlier.

Finally, the experienced operator will quickly see the **XIT offset** function, up to 30 Khz, can be used for so-called split operation where warranted or required.

Discussion on receiver and filtering scheme:

The DDS system, **in receive**, feeds the first mixer a signal that is offset from the desired (displayed) frequency.

This offset is nominally ~600Hz + 4.914 MHz for CW/CWR by default. The DDS signal and the received signal are mixed in the NE602. The BFO offset is changed for LSB/USB, as is the filter bandwidth.

Since the crystals in the ladder filter act as a narrow passband filter, the desired signal is present at the output of the filter, L1.

The crystals act as a series resonant circuit and are much smaller the equivalent capacitor, coil and resistor of such a complex circuit.

The Q or bandwidth of the ladder filter is changed by use of a set of 'shunt' or swamping capacitors – C27/C28/C29/C30 controlled by Q2/Q3. The bandwidth is changed by these capacitors as the transistors are switched by the MCU when selecting CW/CWR or USB/LSB. This B/W change is triggered by the MCU via the state (HI/LOW) of the Pin 15 (CW/SSB) line .

Why does this matter? In the test equipment section, I stated I use a portable general coverage radio, an ATS 909 to be exact, as a signal tracer. With the BFO active in the ATS909, the DDS, BFO and mixer products can be heard as a tone on the radio. Since the portable radio used is fairly accurate, I can quickly see if the DDS system is working and on frequency, the filter has an output and the BFO system is working and on frequency by setting the radio to listen for the expected signal.

The DDS sub-system has a Chart of frequencies for the DDS chip in both transmit and receive states.

For the receiver to work correctly, the BFO must be offset correctly to maximize the receiver performance. Since the BFO injection signal is produced by the Si5351 *as a programmed offset*, no BFO adjustment is possible – or ever required. The BFO signal will track exactly the VFO signal. The value set for RIT doesn't matter, the BFO injection frequency offset is a fixed value 4.915 MHz.

3.6.3 Audio switching, muting and side-tone:

Unlike many of the contemporary QRP radios on the market, the radio set SW-6B does **not** use relays for T/R switching, muting or side-tone. It is also one of the few that offers a real, audio derived AGC function. Automatic Gain Control or AGC is what moderates the signals of nearby strong stations as you are working a station.

When the radio is keyed, the keyer chip, IC6, performs several functions.

IC6, Pin 7 changes state. Pin 7 (TONE) is connected to the MCU. This state change indicates to the MCU that the radio has been keyed. The Pin 10 line connects to Q4, which switches and provides the MUTE trigger to Q6/Q7.

This, in turn, causes the second mixer output to the LM386 audio amp to drop off. IC6, Pin 7 produces the sidetone, which feeds into the fixed gain LM386 via C44/45.

The keyer chip also changes state on Pin 8. The line, IC 7, Pin 2 which enables the transmitter chain. This allows the VFO signal (CLK0) to pass through IC 7, the driver device to the transmitter power amplifier Q8.

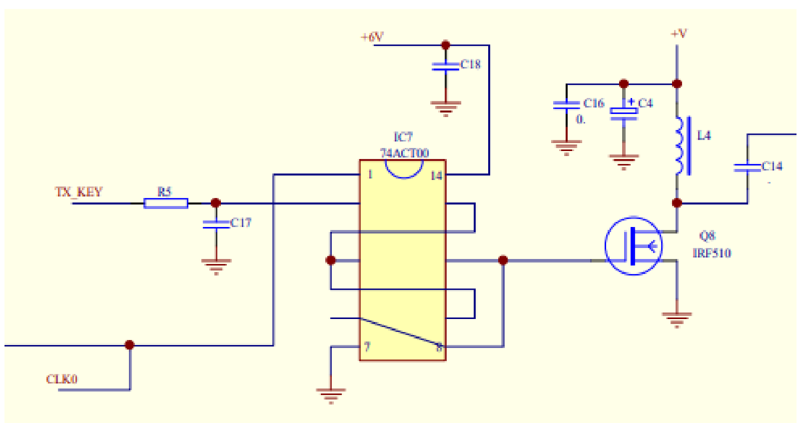
M1 and M2, are momentary pushbuttons, activating the stored memory.

Finally, Q6/Q7 switch quickly enough to avoid the annoying 'thump' often heard on other QRP radios when switching from receive to transmit and back. This pair also switches fast enough to allow full QSK operation, a nice touch.

3.7 Transmitter

Signal path for final amplifier.

As mentioned earlier, the transmitter is a simple MOPA type. The signal from the DDS sub-system, CLK0, is fed into IC 7, Pin 1, a 74ACT00 chip. This signal then drives Q3, the power amplifier. This permits a simple, low parts count transmitter. Transmitter spectral purity filtering is performed in the Filter daughterboard as discussed earlier.



The PA is powered by the DC input voltage, via L4/C4. Transmitter output power is directly related to the DC input voltage. To reduce power, you will need to reduce the input voltage; the only other means to control power output is to leave the radio set in TUNE.

The transmitter signal then enters the passband Filter daughterboard. All capacitors and inductors in the transmitter are fixed. There are **no** adjustments possible by the operator nor are any needed.

If you don't have a resonant antenna, then some kind of matching unit is *required*. A mismatched antenna produces high Voltage, Standing Wave Ratio (VSWR).

The current SW-6B radio set uses a IRF510 MOSFET power transistor and is both robust and stable enough to not require a 'SWR protection' diode.

Just the same, if using an external antenna tuner, use a series of dits to tune the antenna. The transmitter uses an LED as a positive indicator of transmission.

Any time you are testing, always have a 50 ohm dummy load connected to the BNC connector or between the ANT pad and ground. continue

Troubleshooting Basic Radio Problems:

4.1. Radio does not function with external power supplied.

Reminder – Click link (blue text) to view relevant illustration for test point.

Test condition: Attach headphones, dummy load, antenna/dummy load and then power lead. Activate on/off switch to ON.

Confirm trouble:– No sound in headphones. Display remains blank, backlight on display does not function.

Test Steps/Results/Action:

CAUTION!

If in-line fuse on DC supply cable blows repeatedly, **STOP**. An internal short will cause the in-line fuse will blow repeatedly.

If C-4, C-16, or Q8 are shorted, the DC supply is shorted as well. If either of the regulators' have failed, this is generally not a shorted condition.

Confirm the power cable has voltage at the co-axial connector prior to start of testing.

Quick Check 1: Disconnect power cable from DC supply. Attach an ohm meter in place of the power supply/battery. That is to say, connect the meter to the input side of the power cable, then the power cable to the radio.

When the power switch is activated, the ohm meter should read *around* 36K ohms.

NOTE - If the reading is at or above 36K then *drops*, it is an indication that C-4, an electrolytic capacitor, is charging.

- If meter indicates **an open** (zero on a VOM or 1. on most DMM), *reverse* the ohm meter leads as the reverse polarity protection diode is blocking your reading .
- ~36K ohms is indicated, go to (**TS1** below).
- Short (zero) indicated, go to Quick Check 2.

Quick Check 2 - Check reverse protection diode D1/D2 using VOM. Then check Q8, then C-4 for shorts. See Ill #Diode D1/D2

(**TS1**) Check DC supply:

- Remove DC feed connector and measure voltage and polarity present at power cable connector:
  -DC supply may be below 10 volts.
  -DC supply may be not be present (cable/connector broken).
  -DC supply at connector may have wrong polarity (must be + center/- on exterior).

Action: Correct issue with DC supply, if found.

If DC feed voltage is correct, to go **TS2** below

(**TS2**) Find SW9/ON-OFF switch. Check for supply voltage at *center pin* of power switch. Is the supply voltage present?.

No? Fault. See Action item 1.

NOTE – The power cable connector (4.0mm x 1.7mm) and installed jack may not fully match due to wear. Wiggle the connector to see if voltage appears. If supply voltage does appear, replace supply cable or connector.

1) Find diode D1 Check for supply voltage at output side of diode Is input voltage present?

Yes? Continue.

No? Fault. See Action item 2.

2) Find +6 VDC regulator. Is 6 VDC +/- 5% found here at the 78L06?

Yes? Continue.

No? Fault See Action item 3.

3) Find +3.3VDC regulator. Is 3.3 VDC found at the 7533? (marked as U1)

Yes? End of test. All DC supplies test as operational.

No? Fault. See Action item 4.

Action items:

(1) Supply voltage not present at J1. Possible fix, replace J1, or power cable.

(2) Supply voltage not present. Possible fix, test/replace diode D1.

(3) +6VDC not present at Test Point. Possible fix, replace 78L06.

(4) +3.3VDC not present at Test Point. Possible fix, replace 7533.

DC power is required for radio to function. If you are unsure how to replace these board mounted devices, *seek help*.

4.2. No received signal is heard /check audio path:

Confirm by: Attach known good: Power, headphones and dummy load or known good antenna. Attach adjustable signal source to dummy load. There may be no sound in headphones. Volume control moves easily. Display operates normally, backlight on display functions.

Test Steps/Results/Action:

1) Switch on Speaker. If noise present, headphone jack likely inoperative or internal cable to header damaged.

If no noise, continue.

2) Find LM386 (IC3). Carefully touch a test lead **to PIN 2**. (The circuit board trace from this pin leads to top of C40/R18). Is there noise like a 60 Hz hum heard in speaker /then phones?

Yes? Continue.

No? Additional testing required. See item 3.

3) Find cable feeding the Phone Jack.

On Ohmmeter, select lowest value for Ohms, measure between the Tip and Sleeve/Ring and Sleeve of jack. Is a popping noise heard in headphones?

No? See Action item 4.

Yes? All audio subsystems appear functional. Continue.

Action items:

(2) Path from first mixer to audio output assumed functional.

If not, see Test DDS.

(3) Path to audio output appears functional.

See Test First mixer. See Test Second mixer. See Confirm BFO.

(4) Phone Jack may be inoperative. Possible fix –Replace the Phone jack.

Action: If these steps fail to correct problem, start repair actions.

If Phones jack was replaced, restart checks at top of this tree.

4.3. No RF output

Confirm by: Attach known good: Power, headphones and dummy load. There may be sound in headphones. Display operates normally. Signals are heard with antenna attached.

- Set VFO to listed test frequency (example – 14.100MHz). When keyed into the dummy load, no apparent signal is transmitted or display indicates no output or very low output. Sidetone may be audible in headphones when keyed with either a straight key or a set of paddles.
- Alternatively, set tracer/radio to test frequency as above. A very loud tone should be heard when the SW-6B radio set is keyed. A very weak or no tone indicates a possible fault.

Test Steps/Results/Action:

1) Confirm DC power is correct at supply. Must measure between 8VDC and 15VDC. Is supply voltage between 8 and 15VDC ?

Yes? – Continue.

No? – Fault. Correct supply voltage before any more testing.

2) Confirm DC supply voltage is present at C4. Is supply voltage is present?

Yes? – Continue.

No? – Fault. L7 appears to be open. Replace L7 (10 uH).

3) Test DDS to confirm output frequency is correct. Is DDS on correct frequency?

Yes? – Continue.

No? – Fault.

5) Check that Q8 has power.

-Attach headphones, dummy load and then power.

-Using voltmeter, confirm supply voltage is present on Pin 2 of Q8 as seen on main circuit board. Is supply voltage present?
Yes? – Continue.
No? – Additional testing required. See **Test Q8**.

7) Check that C4 (100 uF electrolytic capacitor) is not shorted. This is only possible from front of main circuit board. If shorted, replace.
(**NOTE** – this check requires removing front panel and lifting Q8 for access.

After all checks are performed and results are normal, additional troubleshooting will require advanced test equipment.

4.4. No or low audio output

Confirm by: Attach known good: Power, headphones and dummy load. There may be some sound in headphones. Display operates normally, backlight on display functions. Signals *may* be heard with antenna attached.

Test Steps/Results/Action:

1) No audio. Check audio path using steps from Para 4.2

2) If some audio is heard, but at a low volume, no matter where the volume control is set. Use one test lead to bypass the volume control.

-Find C20, which leads to the pin connecting to the potentiometer. Find C13, which leads to the pin connecting to the potentiometer. See Illustration.

-Short between these two leads, this will bypass the potentiometer.

-Volume should be 'loud'. Did audio output increase?
Yes? – Fault. Replace potentiometer.
No? – see replace LM-386.

4.5. Radio doesn't key or keys erratically

Confirm by: Attach known good: Power, headphones, key and dummy load. There may be sound in headphones. Display operates normally indicating a Band/frequency, backlight on display functions. Press key or paddle. Radio doesn't transmit or transmits erratically.

This space intentionally left blank

continue

Test Steps/Results/Action:

1) No transmit. Using VOM, confirm that a short develops on Tip to Sleeve on key plug when key is pressed. If using paddles, check both Tip and Ring to Sleeve for a short when paddle contact closes.

-Did VOM indicate a short when key/paddle contact closed?
Yes – Continue testing.
No – Fault. Assuming key or paddle contacts are clean, check, then replace or repair cable.

2) Erratic transmit (drops out with key pressed)
Remove DC power, headphones. Remove radio from case. Locate R29 and R30. The trace leads back to IC 6, pins 2 and 3. See Illustration.
IC-6 is the keyer chip. Connect **dummy load**, headphones and power. Grounding either pin 2 **or** pin 3 at IC6 should cause the radio to transmit. Using test lead, short between R29 or R30 and ground. Radio should transmit.

-Did radio transmit when pin 2 or 3 is grounded at key jack?
Yes – Fault. Confirm header cable has continuity.
No – Fault. Possible bad IC6

4.6. Display is dead, displays "funny characters" or has no backlight

Confirm when radio is powered up that boot screen displays, then current frequency displays. If display does not show correct information (numbers), it may have faulted.

1) Check DC supply. If OK, continue.

2) Check voltages on display. See Illustration.
-Pin 2 to ground should have +3.3 VDC. (PIN 1 and 2)
-Confirm ground is present.
Is +3.3VDC found on correct pin?
No? Confirm L3 is not open and C 6 is not shorted. Fault. See Action item 1.
Yes? If +3.3VDC tests good. Fault. See Action item 1.

Action:

1) Replace display.
NOTE – Currently I don't have a good P/N – I'm working with Dale on this.

continue

4.7. Radio is off frequency (display doesn't match measured output signal)

Confirm by: Attach known good: Power, headphones and dummy load. There may be sound in headphones. Display operates normally indicating a Band, backlight on display functions. Signals may be heard with antenna attached.

Set VFO to listed test frequency (example – 14.100MHz). When keyed into the dummy load, no apparent signal is transmitted, tracer/radio hears no signal. Tuning tracer/radio to a different frequency may yield a tone, indicating Transmitter is off frequency. Sidetone audible in headphones when keyed with either a straight key or a set of paddles.

Alternatively, set tracer/radio to test frequency as above. A very loud tone should be heard when SW-6B is keyed. A very weak or no tone indicates a possible fault.

Check receive by setting signal source to listed test frequency using tracer/radio as confirmation. *Ensure RIT/XIT is not active*. A loud tone should be heard.

1) Check DDS subsystem. If DDS shows as good in testing for receive, but off frequency for transmit, the MCU is faulted. The same is true for the opposite symptom, good frequency on transmit, off frequency on receive.

> Does receiver or transmitter appear to be off frequency?
> Receiver – Check that the RIT is not active. RIT not active? See Action item 1.
> Transmitter – Transmitter off frequency? Yes – See Action item 1.

Action:

1) Check MCU calibration.

Use a **calibrated** frequency counter to measure the frequency at the **TEST point** on the PCB board (near the power socket). Turn the large knob to adjust the frequency until the frequency counter display 10.000.00MHz. Press the M/V/SAV button to exit. This is covered in TASK #8.

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Return to ToC

Testing specific radio sub-systems:

Test DDS

Test Steps/Results/Action:

1) Attach power, headphones and dummy load. Using Chart below, set VFO as shown. Set signal tracer/radio to frequency listed in chart below.

(NOTE – unless you have a precision/calibrated test receiver, tune up/down from the listed frequency a couple of KHz to find tone.)

- Place the tracer/radio input lead near IC5. Is a tone heard at listed setting?
  No. See Action item 1.
  Yes? End of test, DDS system appears to be functional.

-If possible, set tracer/radio to 27 MHz. Is a tone heard?
  No. See Action item 1.
  Yes? End of test, DDS system and reference crystal appear functional.

(1) This test indicates the DDS system is inoperative.
Action: Repair of the DDS system/Master reference Oscillator requires additional (and expensive) tools and techniques, putting any repair beyond the scope of this manual.

Band	Receive VFO setting	Set test RX to:
40 Meters	7.100 MHz	12.015 MHz
20 Meters	14.100 MHz	19.015 MHz

Test First mixer

Test Steps/Results/Action:

1) Attach power, headphones, dummy load and antenna/signal source. Set signal source to 14.100 MHz. Set signal tracer/radio to 4.915 MHz.

(Use listed test settings for other bands from Chart above.)

- Place the tracer/radio input lead **near L4**, a large coil. Is a tone heard at listed setting?

NOTE – A loud 1 KHz tone will be heard due to the 4.914 MHz BFO injection signal. As you adjust the signal source, a second, much weaker, tone will be heard. This second tone is the output of the first mixer after passing through the filter. This second tone will vary in frequency as you adjust the signal source. The louder (BFO) tone will not change regardless of signal source setting.

-No second tone is heard. See item A.
-Yes, second tone heard. End Test: First mixer appears to be functional.

(A) This test indicates the first mixer is inoperative. If mixing is not occurring, no mixing product will be present. Possible fix: Replace NE602 chip.

Action: replace NE602

Test Second mixer // Test Audio path:

Test Steps/Results/Action

1) Ensure First mixer has passed test above.

2) Find LM386 (IC3).

-Carefully touch unconnected test lead to PIN 2. (The circuit board trace from this pin leads to R18). (See Illustration) Is noise like a 60 Hz hum heard?

-A noticeable 60HZ hum is heard in phones. Yes. See item A. End of test.

(A) If the First mixer is good and the audio path is good, this indicates a fault in the second mixer. If mixing is not occurring, no mixing product (audio) will be present. Possible fix: Replace NE602 chip.

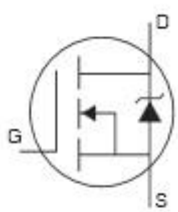
Action: replace NE602

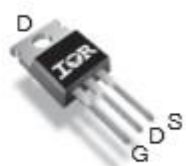
xTesting Q8 with Ohm meter

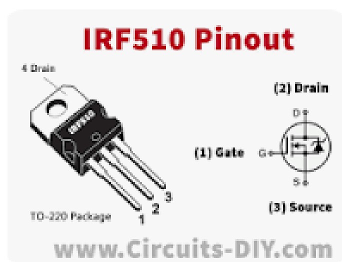
Testing Q8 (IFR510) with Ohm meter

I've provided a link showing how to lest a MOSFET device. You still use the ohmmeter, but only with the diode test function.

If a photo is worth a thousand words, a video is even better. https://www.youtube.com/watch?v=gloikp9t2dA







IF510 pinout.

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Return to ToC

Basic Maintenance and Repair of the radio:

Common steps for every Task.

1) Remove main circuit board from case
2) Install main circuit board back into case.
3) Minimum checks before power up after maintenance.
5) Replacement of DC feed protection diode
6) Replacement of Q8 (transmitter final)
7) Replacement of DDS encoder.
8) Calibrate DDS system

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Return to Main ToC

Basic Maintenance and Repair of the radio Tasks

Task preparation – a common set of steps for every Task:

- *Read the entire Task* in advance to ensure you understand what is required, that you have the correct items (parts and tools) and space on hand to perform the Task.
- Clear work area and set up ESD-safe work surface.
- Place small container near work surface to hold removed screws etc.
- Set out required tools (and solder, pump, etc)
- If required by the Task, plug in ESD-safe soldering iron to begin heating to operating temperature.
- Don safety glasses.

How do I:

Use an ohmmeter/DVM?

https://www.youtube.com/watch?v=3bsdbnyf1Ss

Test an electrolytic capacitor?

https://www.youtube.com/watch?v=wrJXdJbX5zg

Test a diode?

https://www.youtube.com/watch?v=mMXDa5hVzXA

Test a N-channel MOSFET power device (Q8)

https://www.youtube.com/watch?v=RkWy1EirEu8

How do I desolder a part?

Desoldering | Soldering Basics | Soldering for Beginners (youtube.com)

Return to ToC

TASK 1 – Acceptance Testing of Radio set –unboxing checks

(NOTE – if your radio does *not have* the optional battery, skip this TASK.

Required by:

Task performed to ensure radio is ready and safe for operation.

Tools required:

- Non-metallic miniature screwdriver or non-metallic. A small wooden skewer will work in a pinch.
- Voltmeter, VoM, in DC

Begin Task:

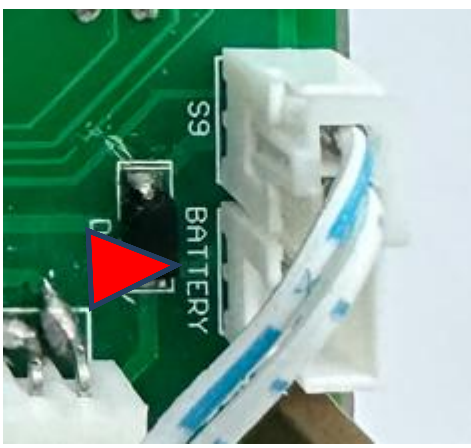
Step 1: Inspect exterior of radio for damage – dents or the like. Check the battery charger is undamaged.

Step 2: Remove radio set from case (See Steps 1, 2 and 3 in Task T2 below) and

inspect optional battery for damage. If battery appears damaged – **STOP!**

- Carefully remove battery cable from circuit board and place battery in a safe location, one away from anything flammable. Contact Vendor via email for instructions.

** If battery is undamaged, Ensure battery cable to circuit board is fully seated.



Result - Two lead connector is fully seated in socket.

Step 3: Attach dummy load or resonant antenna.
Turn on radio via the ON/OFF switch. Display on radio set should show at least 10VDC in upper right corner of display.

- If the display does not indicate 10VDC – **STOP**.
- Turn off the radio. Attach supplied charger to CHARGE port. Charger RED light should illuminate. Charge times vary but this will take over an hour.
- When battery indicates more than 10VDC, with the internal speaker ON, with the radio set ON, continue.

Result - "White noise" noise should be heard in speaker. If not, advance the VOLUME control clockwise until you hear noise

Step 4. Use the BAND switch to check each band.

Result -When switched, the display should indicate a frequency appropriate for each band.

Step 5: With dummy load still attached, inset key cable and *briefly* key the radio set.

NOTE - Ensure the VFO is set with the ARS allocation for your area.

Result – The Display will show "TX", some power out (P scale), the red LED over the TUNE/OPR switch will illuminate and you will hear side-tone from speaker.

Step 6: Turn radio off

Using a long strip of electrical tape, secure the battery in place on left side of radio case. More than one tape strip will ensure no battery movement.

Now tip circuit board/panel back into case. Use care not to pinch power cable from battery pack to circuit board. .

END OF TASK

Return to ToC

TASK 2 – Remove radio circuit board from panel/case

Required by:

Task performed to gain access to front (display side) or rear of main circuit board for testing, replacement of devices or parts most notably Q8, the PA device.

Tools required:

- Screwdriver, Phillips head. One small, one medium.
- Tweezers
- Safety glasses.
- Small, segmented container for small parts.

Begin Task:

Step 1: Using fingers, gently remove the TUNE control knob by pulling straight up. Place knobs in container.

Step 2: Tip the radio onto its left side on the work surface. The BNC connector will now be at the highest point (up).

Tip: I put down a small terry towel to catch any screws dropped. Using a cookie sheet with raised edges + the towel will save time looking for dropped screws!

Step 3: To separate the front panel/circuit board, grasp the radio case with your right hand and pull 'out' on the BNC connector until the magnets break contact with the radio case. This will tip the panel out. Using your left hand again, *gently* pull on SPEED knob to separate the bottom half of the unit.

- Set the now separated metal case to the side. The LiPo battery will be resting on the work surface.

Result: You will see the circuit board and four supporting pillars, much like this.

This space intentionally left blank

- If the battery is not lying on the work surface, position battery to lay flat on the work surface. The mounting pillars will support the unit for now.

:PAUSE HERE:

Take a few minutes to examine the main board Illustration.

Note that there are 7, white colored, header connectors. Please note these are ***locking*** header connectors. Using a set of tweezers will allow the technician to compress the locking lugs together PRIOR to attempting to unseat the header.

CAUTION:

Attempting to remove the header without unlocking the clips may damage the header, header connector or board. Since these are fairly standard PC parts, repair of a broken or separate cable header is not covered in this manual.

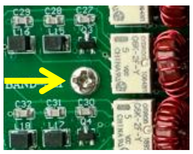
Take your time. Think it through. *Be gentle*. The time you save is from not having to repair a damaged board from being in a hurry.

:RETURN to TASK 2.:

- Trace the battery cable to the header labeled as BATTERY.

Step 4: Unlock and remove the battery cable header from board. Set the battery aside in a safe location.

Step 5: Using a Phillips head screwdriver, remove the single screw located on the Filter daughterboard. Place the screw in the segmented bin.

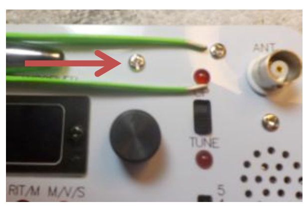


- Carefully, pulling straight up, remove the daughter board from the main circuit board. Set the board in a safe place. Multiple pins will be exposed, so exercise care in handling.

Step 6: Unlock and remove the remaining headers from main circuit board.

Step 7: There are now 4 long pillars to unscrew and set aside. Hold the short pillars under the circuit board to keep them from becoming loose.

- Flip the panel over and note three more screws remain to be removed.
- Two small Phillips head screws on each side of the display protective panel and one screw holding the PA device, Q8.



PA screw

Remove these small panel screws

- Place all loose screws into the segmented container.

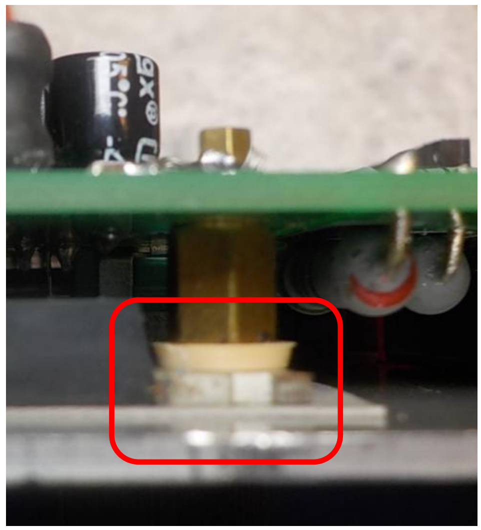
<u>Result</u> – The panel may now be separated from the main circuit board.

continue

CAUTION

- There is an isolating pad that must be placed on top Q8 for reassembly. Also note the Q8 panel screw in longer than the others.

NOTE – *Carefully* remove (white or gray) sheet and place in container. There is an insulating washer *under* Q8. Do **not** lose either one of these insulators. ***They are required for operation.***



Washer and pad under Q8

END OF TASK

Clean up the work area, secure your tools.

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Task 3 – Install main circuit board back into case

Installing main circuit board is nearly the opposite of removing the board.

Step 1: Using medium Phillips head screwdriver mount screw holding Q8 power transistor to chassis. *Ensure the heat conducting insulator is evenly COVERING Q8. Ensure the insulating washer is installed under Q8*. Inset screw in chassis. Carefully tighten the screw, but to not over-tighten.

CAUTION –the Q8 insulator/heat conducting sheet and insulating washer is *required*, otherwise, the power supply is shorted to ground.

Step 2: Replace two small screws holding the display protective plate.

Step 3: Replace long pillars with magnets.

Step 4 – Perform post-maintenance checks.

END OF TASK

Return to ToC

Task 4 – Minimum checks before power up after maintenance

1) Ensure no solder bridges exist. Remove any small bits of wire or solder that might be loose on either side of the main circuit board. A small brush may be used to clean with. Use a bright light and magnifying glass to examine area where you performed any soldering task.

2) The Q8 screw should be tight, with the white insulator in place. The white insulating heat transfer sheet MUST be in place and appear symmetrical on all sides of the heat sink for Q8. Without this item (sheet) Q8 will ground out the DC supply.

4) Attached dummy load, headphones and power cable.

Task 5 – Replacement of DC feed protection diode

1) Using solder wicking and soldering iron, remove the installed diode, if open. If shorted, this diode has no practical effect on the operation of the radio. Only the loss of reverse polarity protection is the issue.

2) Solder in replacement. Inspect area for solder bridges or splatter.

3) Recommend cleaning the area after soldering with 91% iso-alcohol to remove any residual flux. .

4) Re-install main circuit board back into chassis per Task 3 above.

NOTE - Use of the listed diode is important. Any Schottky Rectifier rated at for least 20 V and 1.0 Amp will work. The reason for a Schottky diode is the low voltage drop found on these type of devices. Any quality rectifier, even one with axial leads may be pressed into service. Common power diode will work but at the cost of the voltage lost across the device.

END of TASK

Return to ToC

Task 6 – Replacement of Q8 (transmitter final)

1) Ensure you purchased the correct transistor. Most are plainly marked.

2) Remove main board from chassis as defined in Task 2 above.

3) Carefully note the bend in the leads of Q8. This is essential when replacing the main circuit board – the hole in Q8's heat sink **must** line up with the pillar in the chassis.

4) Using solder pump or wicking, heat, then clear solder on all three tabs of the transistor. Once cleared, the transistor should be easy to remove. You may have to reheat the area – use caution not to damage the board.

5) With Q8 off of the main circuit board, test transistor / test device as shown.

6) Trim leads on replacement transistor to match the length of the leads on transistor removed from main circuit board. You may need to trim the sides of the leads of the replacement device.

7) Carefully solder replacement Q8 onto main circuit board. Examine area to ensure there are no solder bridges between circuit pads. Ensure white pad and insulating washer are in place.

HINT - If you worry about overheating the replacement Q8, clip a piece of *damp* paper toweling around the transistor while heat is applied to act as an additional heat sink.

Initial Test –

-Attach dummy load!

-Tune tracer/radio to a listed test frequency (example – 14.100 MHz)

-*Briefly* key transmitter. A very loud tone should be heard. This confirms Q8 operational. If a wattmeter is available, confirm ~5 watts output @ 12.8VDC

8) Re-install main circuit board back in chassis per Task 3 above.

END of TASK

Return to ToC

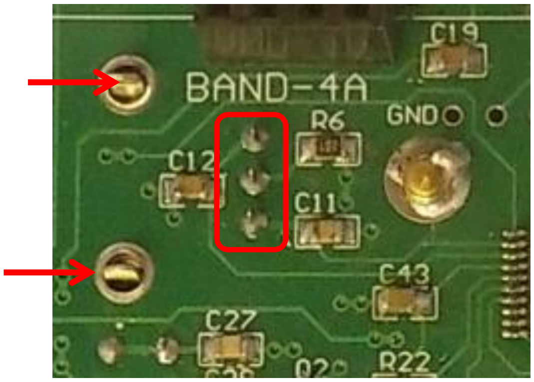
TASK 7 - Replacement of DDS encoder

1) Ensure you purchased the correct encoder..

2) Remove main board from chassis as defined in Task 2 above.

NOTE – the Si5351 chip is an ESD sensitive device. *Use caution*.

2) Using soldering wick and ESD-safe soldering iron, unsolder encoder. Remove the encoder from the board. Using this, confirm lead spacing of replacement matches item removed.



Encoder pins

NOTE - A solder pump is recommended for removing solder from mounting tabs.

4) Solder in new encoder. Examine your work to ensure no solder bridges are present between pins.

5) Connect power, phones and dummy load. Confirm encoder changes the VFO per Operations manual. Remove cables.

6) Re-install main circuit board back into chassis per Task 3 above.

END of TASK

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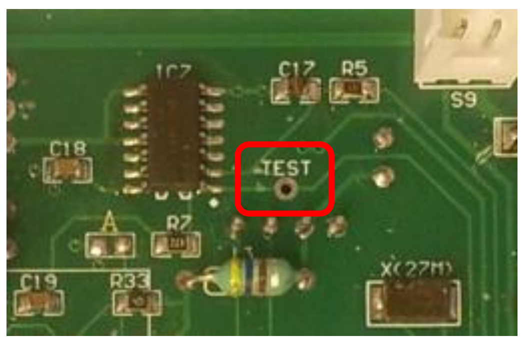
TASK 8, Calibrate DDS

Frequency Calibration

In the unlikely event the radio is off frequency, the system can be calibrated. It is strongly recommend you **do not** attempt this TASK unless you have access to a *calibrated* frequency meter.

1. DDS frequency calibration If the transmit frequency of the machine is off, it can be calibrated as follows:
2. Turn off the power, press and hold the M/V/S button and RIT/M button at the same time and then turn on the power, keep holding the two buttons for about 3 seconds and then release the two buttons when the display shows the following:

3. At this time, use a calibrated frequency meter to detect the frequency of the TEST point on the PCB board (near pin 1 of IC7),



4. Rotate the large knob to adjust the frequency to the frequency meter display 10.000.00MHz, and after that, lightly press the M/V/S button to exit and enter the IF frequency calibration.
5. Alternative - IF frequency calibration The display shows the following after exiting from DDS frequency calibration:

6. At this time, inject a *calibrated* signal at the antenna, adjust the frequency to 7.023MHz, rotate the large knob to adjust the IF frequency to the maximum strength of the received signal. Tap the M/V/S button to exit the frequency calibration state.

END of TASK

Return to ToC

Data for system components

Item / Label	Nomenclature	Description
DDS encoder w/switch	Encoder, rotary, mechanical (confirm shaft length)	Sold on Venus website - $1.
SPEED/AF/RF gain control	rotary potentiometer	Custom.Made in PRC
6 volt buss regulator 78L06	Voltage regulator +6 VDC SOT-89 pkg	78L06 Newark P/N 51AC9188
3.3 volt buss regulator	7533 regulator (U1)	Newark MCP1700T-3302E/MB SOT-89-3
8.0 volt regulator	78M08 liner regulator	Mouser P/N : # 511-L78M08ABDT-TR
IC 1, IC 2 Mixer	double balanced mixer & oscillator, SMT type NE602 or equal	SA612 Newark P/N SA612AD/01,118 sub for NE602. Confirm SOT-23
IC 3, IC 8 Audio amplifier	amplifier, audio, 8 pin, SMT type, DIP LM386	LM386 Newark P/N 41K5099 SOIC-8
IC 7 Keyer (must be programmed)	--	--
D1/D2 polarity protection	1N5817 (SM5817)	Mouser 625-B140-E3/61T
IC-7 (driver)	QUADRUPLE 2-INPUT NAND GATES	Mouser P/N 595-CD74ACT00M96
Q 8 Transmitter PA	N-Channel power MOSFET TO-220AB pkg	JAMECO P/N 209234
OLED	--	Custom, made in PRC
Crystal, filter, ladder	4.9152 MHZ	Mouser P/N 774-MP042-E
Si5351	Confirm 10-MSOP	Mouser P/N 634-SI5351A-B-GTR
RF switch (Q1 to Q5) on filter board	BAV99 Toshiba	Mouser 757-BAV99LM

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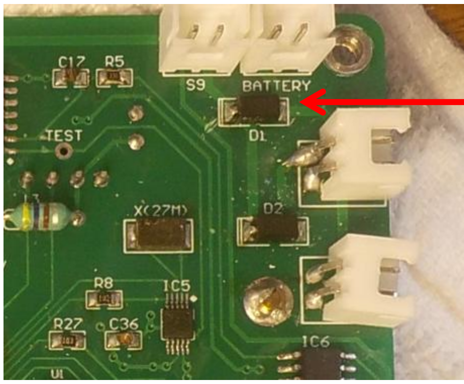
Illustrations

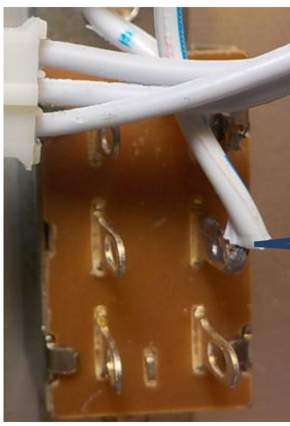
Diode D1/D2 – Reverse protection diodes



Diode D1
Output side of diode (right side)

****

SW9 power switch



Test at this pinpin

****

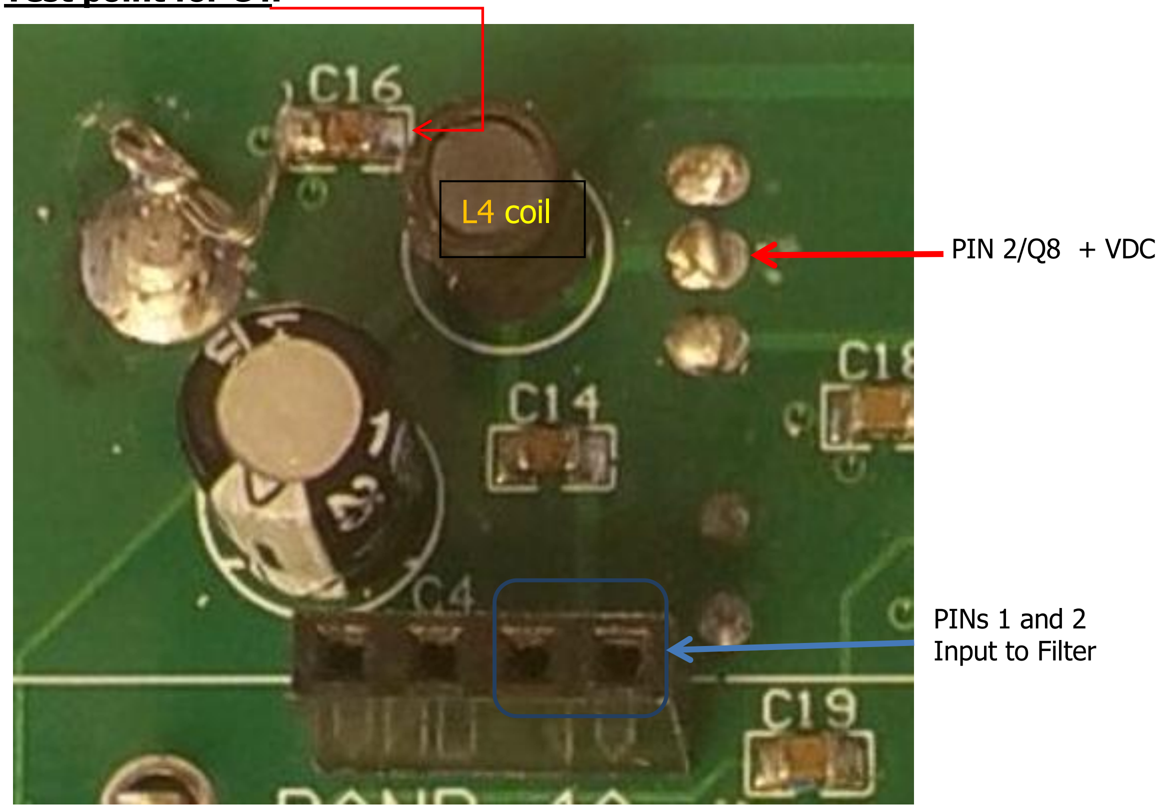
78L06, six volt regulator

7533 Regulator (U1)

3.3 VDC here

***

Test point for C4.



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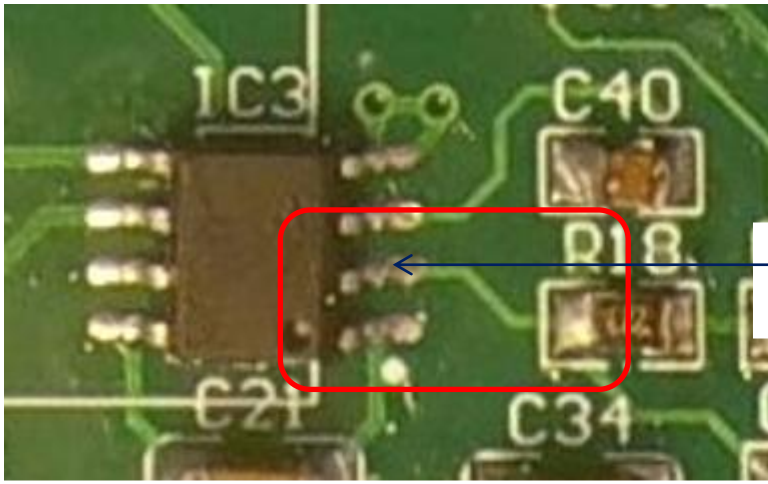
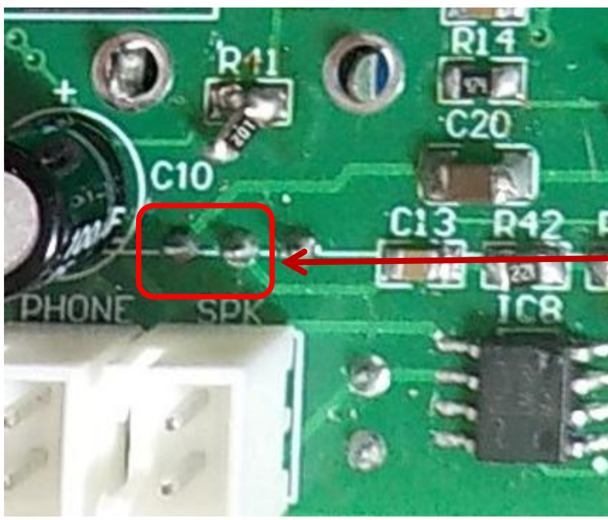
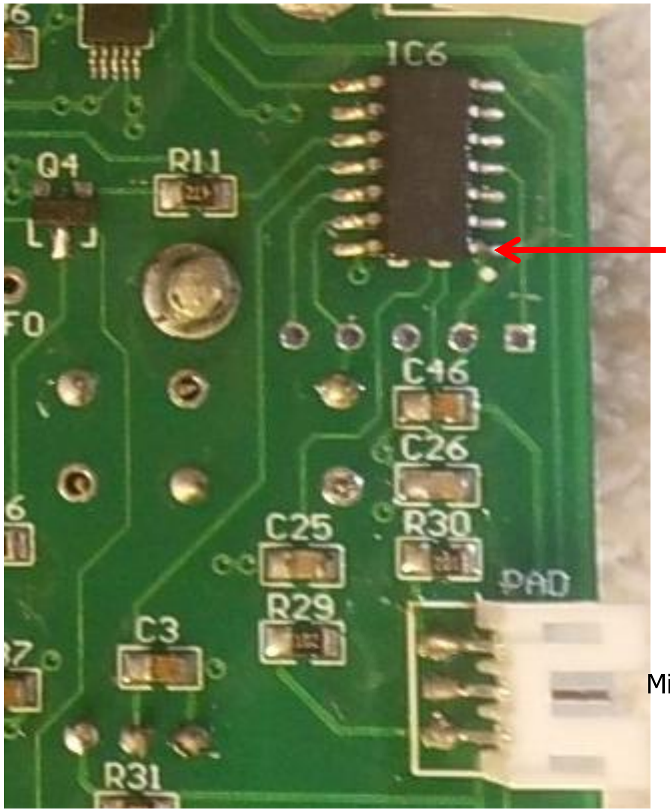
PIN 2 of IC3 (LM386)

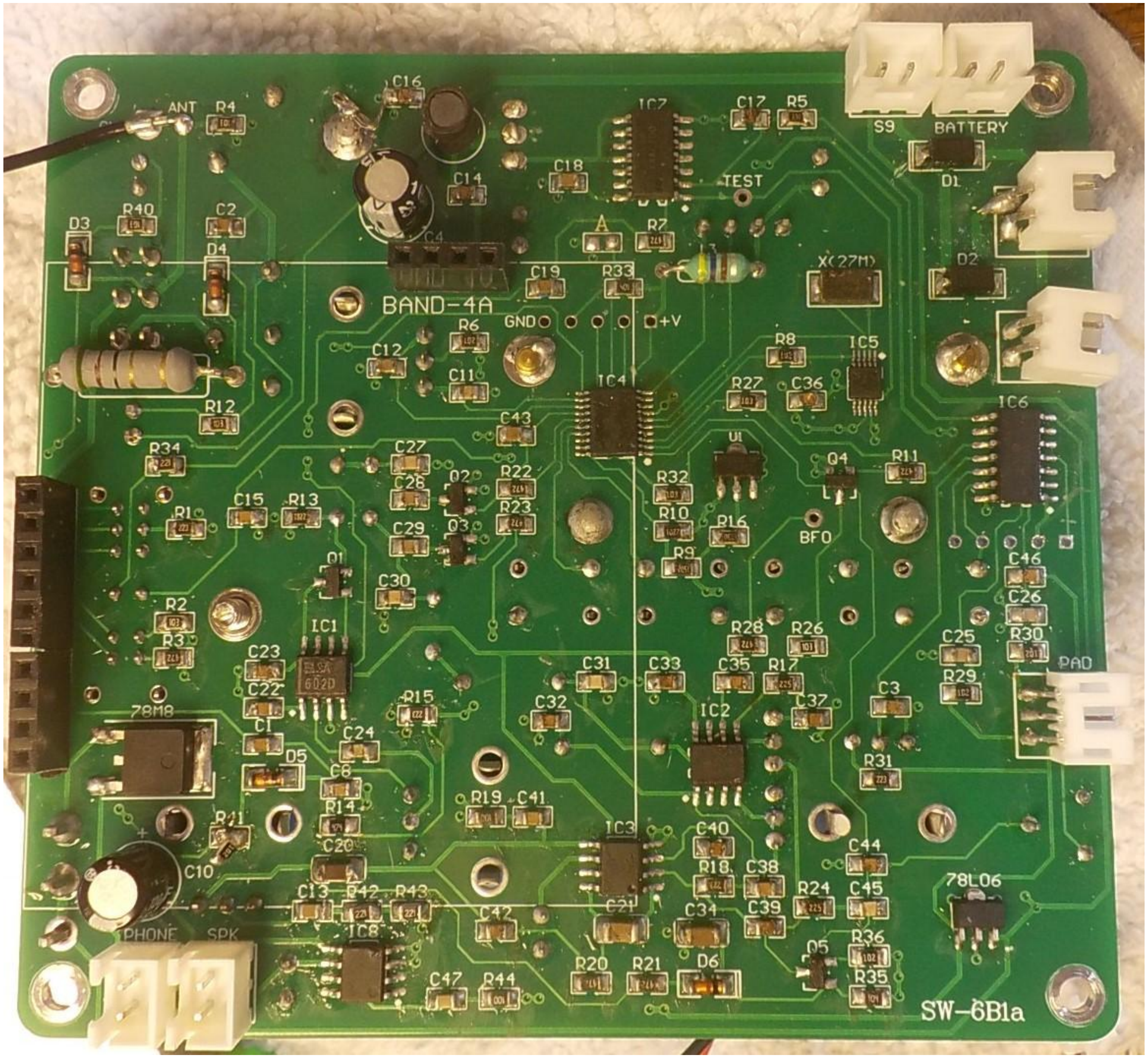


AF Gain potentiometer pinout

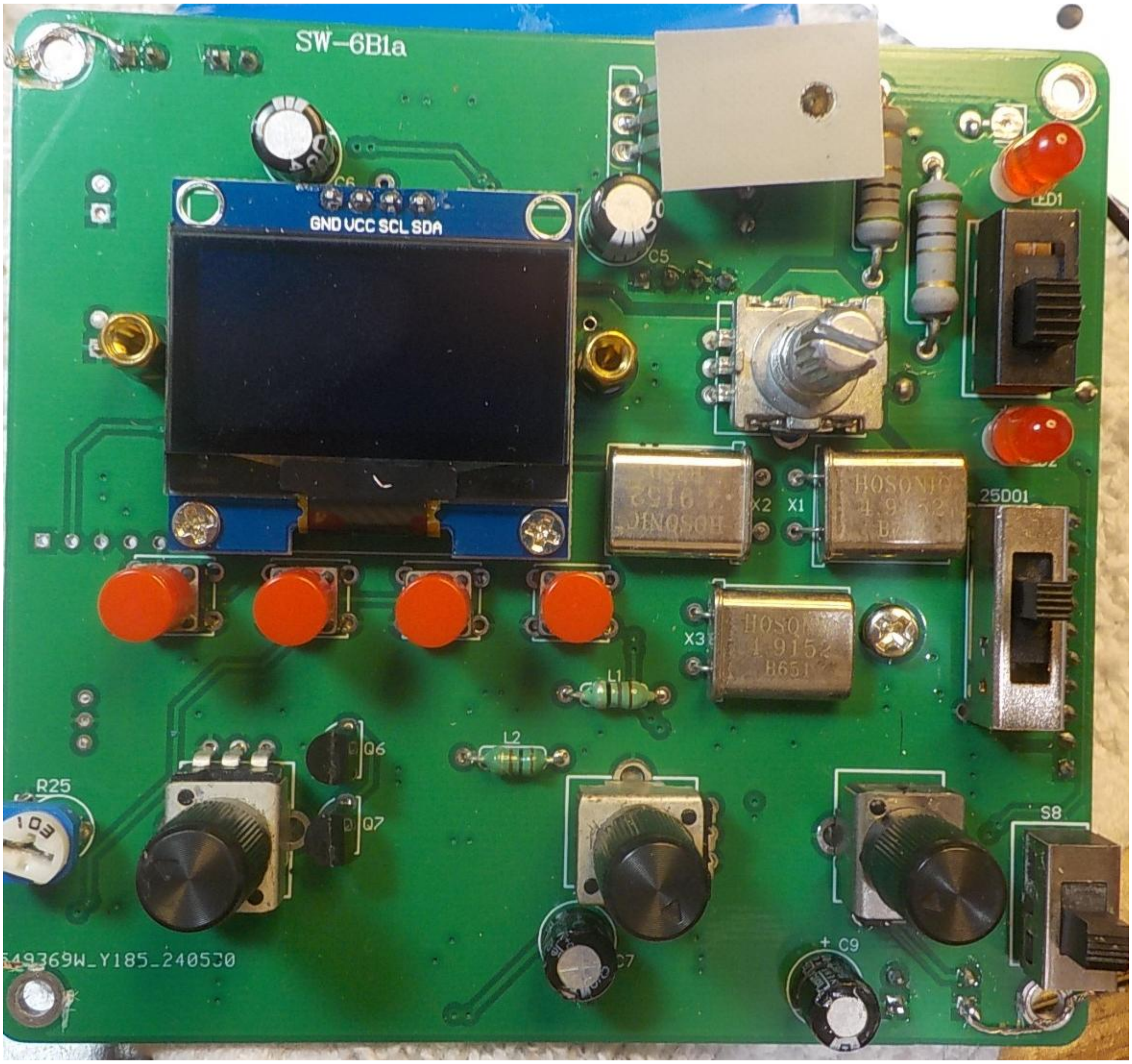


Keying system




ANT
S9
BATTERY
TEST
X(27M)
BAND-4A
GND
+V
BFO
PAD
78M8
78L06
PHONE
SPK
SW-6B1a

Front of circuit board



Hints, Tips, Kinks

Recommended items not supplied with radio set.

These are items I've added to my 'kit' to carry with the radio all the time. When operating outside of the shack, I make notes in my log about items I wished I brought along or needed. Here are some of those noted items:

- Adapter BNC male to BNC male. I use this with my home-made dummy load.
- Adapter BNC Female to SO239. May allow use of existing antennas.
- Cable, jumper, BNC to BNC. To connect to an external antenna tuner. You may need an adapter BNC Female to PL-259, depending on the tuner.
- Jameco P/N GSE 231015: Cable ASM RG58/U 15 Foot BNC to BNC 50 Ohm M-M.
- Adaptor, BNC To Dual binding posts. Allows you put up a makeshift antenna.

KK6FVP uses these cleverly modified adapters for an antenna feed. Hook up your wire to the post for a dipole and hoist into a tree. The split rings carry the weight of the wire, saving wear on the binding post. Use a BNC to BNC cable and the adapter isn't required.

Thoughts on building a portable DC power system

An easy place to start is with the supplied power cable allows you enough cable to park your battery pack someplace convenient. Like, inside your parka to keep the batteries warm in inclement weather.

ALWAYS put in-line fuses on any power cable. Use at least a 1.5 ampere fuse for this cable.

Add a "Holder, battery, "AA", for either 8 or 10 cells. I use a 10 cell unit and carry a pair of dummy cells. This allows use of NiMH or regular alkaline cells. The SW-6B is happy with anything over 9 volts, so a 9VDC battery is also an option, with reduced power out and shorter operations time..

The cell holders are just a couple of dollars. A rubber band on the outside to keep the cells in place and you're ready to travel.

For extreme cold weather, *Lithium* 1.7 volt "AA" cells are now available at reasonable prices. There are also Lithium primary cells at 3.6 VDC @ 2.4 aH that will work in a 3 or 4 cell holder – price is a major consideration here as the cells cost up to 3+ dollars - *per cell*. If *weight* is your primary consideration, these are worth a look. These are also TSA safe for travel where Li-ion cells are banned on many carriers.

I bought my cell holders on line because the output of the pack is a polarized connector – one that looks just like the top of a 9 volt battery. That was by design. *I cannot stress enough to USE A POLARIZED battery connector.*

A single 9 volt battery will power the SW-6B long enough for a few contacts or some extended listening to shortwave stations. I see this as maximum flexibility.

A connector for the power cable is easily had. Take a dead 9V battery and peel off the foil on the outside. You discover a set of very small 1.5 volt batteries and a ready-made for your cell holder connector. Solder this connector to your power cable, put some insulating tape over the soldered connections and you're in business.

With this setup I can run primary cells, rechargeable cells or to save weight on a hike, just carry a couple of 9 volt batteries for a few quick QSO's. All with the same, polarized, power cable.

Finally, a thought about LiPO batteries. The AA sized 14500 series are 3.7 VDC at almost 2.4 aH capacity – that's no typo. 2.4 amp hours. So, a 3 cell (11.1 VDC) or a 4 cell (14.8VDC) battery pack with that amount of power density has some appeal. Keep in mind LiPO cells require *exquisite care* in charging and use. These cells should *always* be monitored while under charge. Read more about these cells and related hazards elsewhere or on line.

I've been asked why I seem to be such a fan of AA batteries for powering this rig. Simple, AA batteries are just about universally available *world-wide*.

For example, I was working an oil spill clean-up project in the Komi Republic, part of the old Soviet Union. This was in 1995, just after the old Soviet fell apart. Despite being in an isolated town, quite literally at the end of the railroad line on the Arctic Circle, I never had any issues finding fresh AA batteries for my shortwave set. I've been a fan ever since.

The antenna used must be resonant – so unless you plan to sting up a dipole on each outing, a tuner is indicated. I use the QRPGUYs end fed tuner. I have built and use the Pacific Antenna tuner kit, which comes with a nice metal case. The QRPGUYS is less expensive, and weighs less, which is why I use it. Both are based on identical components.

I carry 50 feet of 550 cord/shroud line/paracord (same thing, different name) for stringing up my End Fed Half Wave antenna. I also use the Coleman camping 'clothesline reel' to hold my wire. Makes for easy setup and a clean carry.

Best of luck with your new rig!

73

Don//KL7KN

SW-6B1.pdf

BAND-5A.pdf