SUPPLEMENT TO

DSW-II

INSTRUCTIONS

Revision: A

2/07/2004

This document is maintained on-line. Its URL is:
http://smallwonderlabs.com/DSWhelps.pdf

Table of contents:

Description	***Page***
Tools/ Soldering	2
Component Identification	4
Construction Tips	6
Operational Description	7-9
Troubleshooting	10-13

TOOLS:

The following tools are recommended for assembly of the DSW-II kit:

- Soldering iron- 25-40W
- 60/40 solder, .032 (.8 mm) diameter
- Desoldering braid (Radio Shack #64-2090B).
- Diagonal cutters
- Vise-grip pliers, small

The following will be used to align the DSW-II

- Small slot screwdriver
- Jeweler's screwdriver (Radio Shack #tbd)

The following may be useful:

- *Tweezers*
- *Close-up (magnifying) glasses*

STATION BASICS:

- ### *Headphones:*

Stereo (personal CD-player) type
Low impedance, 3-conductor 1/8" (3.5mm) plug

Headphone sensitivities vary. A $10 (US) pair of headphones is a good cost/performance tradeoff. A good benchmark for sensitivity is a perfomance spec of 104dB/mW or better.

- ### *Antenna:*

50-ohm nominal at frequency of interest
(*for instance- a coax-fed dipole*)

The DSW-II has some measure of SWR protection, but if you're planning to use random-wire antennas, a tuner/ SWR bridge would be a good idea

- ### *DC Power:*

The DSW-II operates on a DC voltage source of 7 to 15 Volts. RF Output power is markedly lower at the minimum supply voltage. This wide voltage tolerance means you're still on the air in the field until your batteries are virtually exhausted.

The table below illustrates DC current requirements for Transmit and Receive (by band). The differences in Receive current are due primarily to the choice of system clock for the DDS IC.

Band	Rx Current	Tx Current (mA)
3.5 MHz	34.5 mA	
7 Mhz	41 mA	
10.1 Mhz	41 mA	
14 Mhz	55 mA	

Receive measurements made with no signal input. Transmitter measurements made at 4W out with a 13.8V power supply.

Note : The power supply voltage should be electronically-regulated (if AC-powered) or supplied by battery.

The DC power provided by the widely-used 'wall-wart' supplies is probably not adequate. The output of most of these is 'filtered', which means that an AC signal is rectified and applied to an electrolytic capacitor. These supplies look fine with light current loads but on key-down, will have a large 120 Hz AC 'droop' waveform in the output. Your fellow hams won't appreciate the 'buzz' on your transmitted signal!

You can find electronically-regulated wall-warts, though. Jameco Electronics (800-831-4242 for a catalog) offers a 15V 1 Amp wall-plug supply. It's their part number 169391 and is under $20.

The QRP community usually uses a 12V Sealed Lead - Acid (SLA) battery for field operation. These are available from electronics suppliers such as Mouser Electronics (800-346-6873) and DigiKey Corp. (800-344-4549). They're rechargable, and are rated in Amp-Hours (AH) capacity. At 12V, count on one pound weight per AH.

For portable 'day trips', I use an 8-AA cell holder (Radio Shack) and alkaline batteries. They'll last all day under contest conditions.

The DSW-II board is double-sided and all holes on the board are plated-through. This means that you do __not__ need to solder on the top side of the board unless directed otherwise.

SOLDERING SKILLS

Hopefully this isn't your first experience with a soldering iron. If it is, though, or this is your first solid-state project, here are some tips to ensure your success:

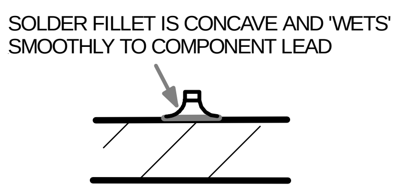
- Soldering Iron:

Use a small iron in the 25-watt class (such as a Radio Shack #64-2070) and keep the tip clean. Use a moistened sponge or paper towel to clean the tip periodically as you work.

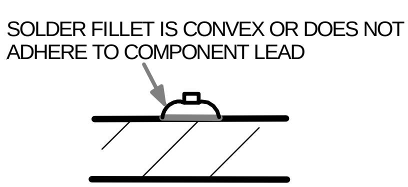
Apply only as much heat as is needed to get a good joint. A small vise to hold the printed-circuit board may make soldering easier.

Touch the soldering iron tip to the PC board trace and the component lead simultaneously. Within a second or so, apply solder and you'll see the solder flow onto the junction. Withdraw the solder and the soldering iron.

Avoid the temptation to load solder onto the joint until no more will fit! This is an invitation for trouble, as solder bridges may form across the closer trace separations. Here's what the correct and incorrect joint treatments look like:



GOOD



BAD

COMPONENT IDENTIFICATION:

'REWORK'-

PLEASE READ THE SECTION BELOW BEFORE REMOVING ANY PARTS FROM THE BOARD

Uh-oh! Sooner or later, you may need to remove a part installed in the wrong location, or perhaps pull a component for troubleshooting purposes.

Using desoldering braid, lay the end of the braid down on the joint to be cleaned and press the soldering iron tip over the braid. Within several seconds you'll see the braid begin to wick up solder from the joint. Remove the braid and reapply a new section as needed until the joint is clean. It may be necessary to pull the component out from the top side of the board while heating the joint. Leave the iron tip on the board only as long as necessary to do the job- the PC-board traces will eventually delaminate (peel off) if overheated.

If that still doesn't do the job, it may be necessary to cut the offending part off on the top side and pull the remaining leads through with pliers. Contact me for replacement parts if necessary.

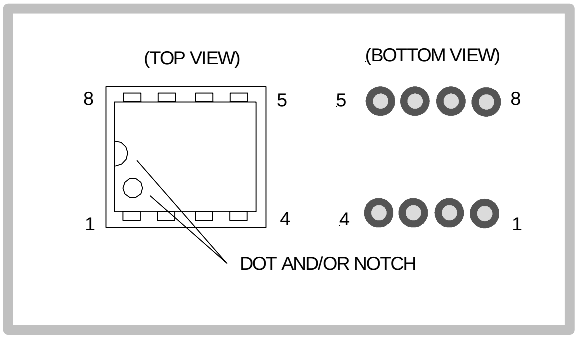
If you need to remove a transistor, I'd highly recommend sacrificing the part by snipping it off on the top side of the board. The leads are best pulled out singly to minimize the risk of lifting pads.

After removing a component from the board, the through-hole will probably still be blocked with solder. Use a dissecting needle or dental probe (explorer), apply heat to the probe and the board trace simultaneously until the tool pushes through. Lacking either of these tools, a round wooden toothpick works well also!

REFERENCE DESIGNATORS:

Each component on the schematic is uniquely identified with a reference designator. Bypass capacitors are identified as C101 and up. Reference designators are shown in blue on the schematic page.

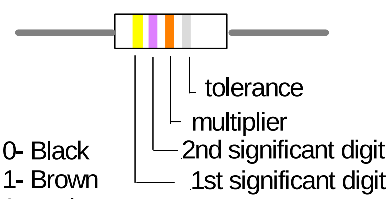
- The figure below illustrates pinout for the DIP ICs. The "pin 1 at lower left" convention applies to all Dual-Inline-Package (DIP) ICs. An 8-pin IC is illustrated below. For U7, pin 18 follows the same progression and is at the upper left corner. **Please note: if you install a socket backwards- leave it that way!** In that case, ignore the socket orientation when installing the IC with its dot or notch to the left as shown.



- ## Resistors and RF chokes

The assembly instructions describe the color coding for all resistors and RF chokes. Only the first three bands are described, the fourth band is a tolerance code, typically gold (=5%) for resistors, and is not listed. All resistors are 1/4W 5% carbon film types, RF chokes are also an 'axial' component (leads out of each end) but can be distinguished by their larger size.

RESISTOR COLOR CODES



0- Black
1- Brown
2- Red
3- Orange
4- Yellow
5- Green
6- Blue
7- Violet
8- Grey
9- White

A 47K ohm resistor is illustrated- the third band (multiplier) is an exponent.

$4\ 7 \times 10^3$ = 47K ohms

tolerance: silver=10%, gold=5%

For what it's worth, roughly 8% of the male population is red/green color blind. If you're one of these folks, you should be verifying resistances with a multimeter before installing them.

- ## Capacitors:

These are disk capacitors:

These are electrolytic capacitors:

These are monolithic caps:

This is a poly cap:

Here's the general rule for capacitor nomenclature:

If 3 digits are printed on the capacitor, the first two are significant figures and the third is a multiplier.

Examples:

'470' = 47 x 10^0 = 47 pF
'471' = 47 x 10^1 = 470 pF
'103' = 10 x 10^3 = 10,000 pF = .01 uF
Letter suffixes: J=5%, K=10%, M=20%

Do not substitute small-value caps from your 'junkbox' unless they have that black bar. NPO disk caps have a black bar at the top of the disk. All disk caps of less than 100 pF provided with your kit are NPO types.

Do not substitute 'junkbox' caps for the small (<.01 uF) monolithic caps provided in the kit. They are also an NPO (C0G) type. Silver Mica caps are an acceptable substitute, but tend to be physically larger.

- Capacitor Voltage Ratings

Capacitors are rated by working voltage. If a part is listed as '16V 47 uF' and we supply you with a 25V 47 uF cap (for instance), it's not an error. It's an equal-or-better part!

Please- If you're looking for a particular value of capacitor, be sure to inspect both sides of the caps before concluding we gave you the wrong value!

Diodes:

These are generally provided in a poly bag-strip Since the lettering on some of these very small, diodes in each section may be equated by quantity to corresponding entries in the parts list. They're arranged in the strip in order of appearance in the parts list.

• Extra information on components

There's often extraneous information marked on components. In the case of ICs, there's usually a date code marking. *If I've specified a capacitor '104' and you find the correct number of a suspect capacitor, but marked "104M', for instance, those are them! These components vary slightly in marking by vendor. Although we strive to make the manual as accurate as possible, it's very difficult when capacitor markings. differ by supplier or voltage rating. "Use the Force, Luke".*

Construction Tips:

All parts installed on the PC board should be fully seated unless otherwise noted in the assembly text.

All components are installed on the side with the silkscreen printing- this is the 'top' side of the board.

Static-sensitive Components:

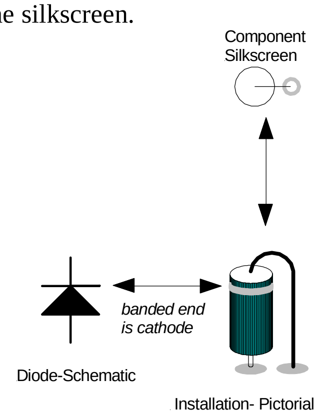
The 2N7000 transistors and the 16C622A IC (U7) are static-sensitive.

- Keep these parts in their antistatic bag until you're ready to install them and handle them no more than necessary.

If possible, touch ground before handling them. 'Ground' can be the retaining screws on an AC outlet cover or even a sink faucet (assuming your plumbing is metallic). When I'm away from my antistatic station, I touch the 4-pin microphone connector shell on my 'big-rig'. *Background: You build up a static electric charge during normal activities. Its intensity depends on relative humidity (worse in dry weather) and the materials you come in contact with- primarily clothing and furniture. This precaution ensures that you don't transfer a large charge to these parts when picking them up.*

- Diode Installation:

Some of the diodes are bent for "upright" installation on the board. Installation polarity is as shown below. Be sure to note the orientation of the silkscreened circle on the board and install the diode body over this hole. The cathode (banded) end of the diode is oriented at the top. For diodes which are installed 'lying down', match the banded end to that shown on the silkscreen.



- Resistor installation:

Most resistors are likewise installed in 'hairpin' fashion. As with the diodes, try to match the mounting orientation shown on the drawing. (This has nothing to do with performance- if mounted as shown, you've got better troubleshooting access to circuit points from the top side of the board.) Orientation of color bands on resistors and other non-polar devices is not critical.

- Installing IC sockets:

The "notch" or dot at one end should be oriented as shown in the pictorial drawings. Doublecheck orientation before soldering. *A suggestion-* solder down two opposite corners of each socket, and then go back and press a fingertip on the socket from underneath while reheating both connections in turn. You may then solder the remaining pads. This precaution ensures that the socket is well-seated on the PC board.

Before the "Smoke Test":

Inspect your work to ensure there are no solder bridges or unsoldered joints. Check to see that the ICs are mounted in their proper orientations, or install them if you haven't already done so

You may want to hook up the DSW-II and test it out on the bench before putting it into an enclosure. *"Do you feel lucky today, punk?"* You'll save yourself a bunch of disassembly work if you need to get at the board for troubleshooting. I typically perform the alignment steps in the instructions and then operate the rig for a while with the top cover and rear panel off.

Before closing up the unit, take a few moments to remove excess solder resin from the bottom side of the board. *I use cotton swabs and acetone (or isopropyl alcohol) to remove the worst of this material.*

The DSW-II may be operated without the top cover installed. The DSW-II is not prone to hand-capacity effects (as with an analog VFO rig.). The cover provides mechanical protection for the interior of the rig. The top cover is steel and will accept magnetic-mount keyers such as the "Palm Paddle".

Operational Description:

This monoband transceiver is a single printed-circuit board design measuring approximately 3.9" (W) by 3.5" (D) and integrally-mounted in an enclosure measuring approximately 4.23" square by 1.5" in height.

Unlike its ancestor, the SW+ series, the DSW-II makes use of a Direct Digital Synthesis (DDS) approach to generating the local oscillator (LO) signal. The heart of this transceiver design is a PIC 16C622A. This is a 2K x 14 CMOS microcontroller which performs the following functions::

- Shaft encoder interface
- DDS Frequency management
- RIT management
- 'Freq-Mite' Morse audio readout
- Iambic keyer

Note that the familiar transmit mixer and tuned bandpass filter seen in the SW+ series are absent. The DDS IC generates the transmit frequency directly during key-down.

Upon power-up, the DDS IC (U6) is loaded with both the receiver local oscillator (LO) frequency and the Transmitter output frequency. The DDS IC contains two sets of frequency registers, the one currently being used to generate the DDS output is select by the logic state on its pin 10 ('FSEL'). This pin normally rests at logic '0' (0V) and during receive, the DDS outputs the frequency frequency shown below. Value in parentheses are for the alternate power-up frequency

Band (MHz)	IF (MHz)	DDS Clock Freq. (MHz)	LO tuning range* (in Receive)	LO frequency on initialization
3.5	5.185	25.00	8.685- 8.910 Mhz	8745.5 (8885.5) KHz
7.0	4.00	32.00	11.00-11.15 MHz	11040.2 (11110.2) KHz
10.1	4.00	32.00	6.100-6.15 MHz	6109.7 (5999.7) KHz
14.0	5.185	50.00	8.815-8.915 Mhz	8874.5 (9814.5) KHz

* nominal- the DSW-II may be tuned indefinitely

Each time the frequency is initialized or changed, the DDS IC receives a Sync signal and a burst of 40 Clock pulses and corresponding serial Data. This data is in the form of an 8-bit control word and a 32-bit frequency control word. The IC generates a sinusoidal waveform with 10 bits of D/AC resolution. [This is an accuracy of 1 part in 1024 (2^{10})- maximum error is 1 part in 2048, which corresponds to roughly 66 dB below the desired output.] Much of this unwanted energy is at the DDS clock frequency and will be filtered out (discussion below). Other components ('spurs') of this waveform are present at low levels and their presence establishes the Spurious-Free Dynamic Range (SFDR).

The output of the DDS is applied to a low-pass filter to removed unwanted high-frequency energy. This consists of both the system clock energy and an 'alias' signal. The alias signal is at the difference of the system clock and desired outputs. [e.g., for 14 Mhz operation, the alias is at (50-14) or 36 Mhz. The second stage of the filter contains a parallel-resonant trap to provide added rejection of the alias signal. The resulting spectrum at the output of this filter is quite clean. This eliminates the need for the usual tuned bandpass filter in the transmitter chain and hence greats simplifies the DSW alignment process.

Upon rotation of the shaft encode, the PIC controller calculates and reloads new values for the Transmit and Receive DDS Registers. If RIT is ON, only the receive frequency is changed upon shaft rotation. Complete operating characteristics are found in the main Instructions document.

Frequency readout is initiated by a brief depression of the 'FREQ' control switch. A longer-duration closure is used to select the tuning step size. These operating characteristics are also found in the main Instructions document. Operation of this audio (Morse) frequency readout is quite similar to that of the Freq-Mite. The PIC controller is in direct control of the DDS (and thus, operating) frequencies and as a result, there's no need for a 'counting' process. The PIC controller recalculates and stores readout frequency with each step of the shaft encoder. Readout speed is equal to the keyer speed.

Other interesting facts:

> The PIC and DDS use their own local vocal regulator (U4). The primary contributor to 'digital noise' in the receiver proved to be those ICs- this separation was necessary to keep the receive quiet.
>
> The regulators both run at 5V. Their dropout overhead voltage (~2V) establishes the minimum operating voltage for the DSW at about 7V.
>
> The 5V logic level present at the PIC outputs necessitated some level translation between pin 1 of the PIC (TX key) and the 12V bias supply switching at PNP transistor Q4. Q3 performs this function- it's used as a switch. This device is 'open' (non-conducting) with 0V at its gate and 'closed' (conducting) with >3V at its gate. An NPN transistor would have accomplished the same function but would have needed a resistor in series with the base input lead. Q2 is also used as a switch, and when closed, mutes the receiver audio by biasing muting FET Q1 into 'cutoff' (non-conduction).

Receiver operation:

The receiver RF input is applied to mixer U1 through transformer T1, which provides a bandpass filter tuned to the band of interest. There's about 10 dB of voltage gain prior to U1's input, a tradeoff between sensitivity and overload (IMD) problems. U1 provides about 13 dB of conversion gain and converts the RF input signal to the Intermediate Frequency (IF). Components C5 and L3 comprise an L-network used to step the mixer output impedance down to the crystal filter's design impedance. Note that C6 and L3 appear to be 'transposed'- this simply reflects their physical positions on the printed-circuit board. [C6 is a portion of the crystal filter- interchanging it physically with L3 has no electrical consequence.]

The crystal filter itself uses three crystals. This works fairly well because of the low IF. Loss through the filter is less than 2 dB and the -6 dB bandwidth is about 500 Hz (it varies somewhat from band to band). Despite the filters' simplicity, performance is adequate when combined with the AF amplifier section's selectivity. The unwanted sideband image is down about 50 dB at the audio chain's 800 Hz peak response frequency.

The filter output is terminated in a 470 ohm resistor at the input to U2, the product detector stage. U2 converts the IF signal to audio and provides additional gain. A trimmer cap at BFO crystal Y4 provides a means of adjusting the BFO frequency for correct Transmit/Receive frequency offset. [The adjustment process is described in the main Instructions document under 'Alignment'.] The .033 uF capacitor across pins 4 and 5 of U2 provides the first measure of audio lowpass filtering.

U3 is a CMOS rail-to-rail dual op-amp. The two sections of this IC each provide roughly 30 dB of gain. The first section is configured as a differential amplifier to make use of U2's differential output and also rolls off the audio response above 1.5 Khz. Diodes D1 and D2 limit the audio swing during key-down to reasonable levels. Without these diodes, this stage saturates and upsets the operation of the following FET switch section.

The AF mute function is the familiar series FET switch popularized by W7EL. Despite its relative simplicity, it's hard to beat this circuit for click-free audio switching. In the 'key-up' condition the FET (Q1) is zero-biased and acts like a resistance of a few tens of ohms. In the 'key-down' condition the FET is in cutoff because the gate is now approximately 5 volts below the source. It then acts like an open circuit, preventing audio from getting to U3B- the second audio amplifier stage. This second stage is configured as an active bandpass filter with a peak response frequency of 800 Hz and a 'Q' of 2. The high gain of the AF stages allows a design without an IF amplifier stage. The audio output level is adequate for headphone use, but it's not intended for loudspeaker use. See the main Instructions document, p. 2, 'Station Basics' for suggestions about headphones.

T-R Switching

The DSW T-R switching, like that of its predecessors, uses no relays, so the transitions between Transmit and Receive are essentially instantaneous. The key-up recovery times allow the operator to hear between characters up to about 25 WPM, and at higher code speeds, during character or word spaces. The receiver input is connected through the transceiver low-pass filter (point 'A') and through C1/L1. C1 and L1 are a series-resonant circuit tuned to the band of interest. D1-D4 'clip' the rather sizable (up to 40V p-p) signal at point 'A' to about 3V p-p during key down. This level provides protection for mixer U1. During receive, signal levels are not normally high enough to cause the diodes to conduct. *So… why the series diode pairs? The voltage at the junction of C1 and L1 is larger than you might think. Signal levels there are higher by a factor of that tuned circuit's loaded 'Q'. I'd watched diode-limiting occur on winter nights here in the Northeastern US and opted for 'better safe than sorry'. Although not a cure-all for IMD problems, I did see situations where the extra compenents made a difference. It raises the IMD intercept of that network by a factor of 2 (6 dB).*

Transmitter Operation:

The output of the DDS has been scaled to a characteristic impedance of 240 ohms- an increase over the original DSW's 150-ohm value. This was done simply to yield higher signal levels out of the DDS/filter section. The output of the filter (point 'H') goes the to receiver first mixer and for transmit operation, is further amplified by the following stage, U8.

U8 is a high-speed video amplifier/driver IC featuring high a gain-bandwidth product of 300 Mhz and intended to drive fairly low-impedance (high-current) loads. In this application, gain is set by the combination of R23 and R22, i.e., a voltage gain of 10 (20 dB). This stage is powered via bias switch Q4 only during key-down intervals, with waveform shaping accomplished by the charging and discharging of C117. Rise/fall times are on the order of 2 mSec.

C30 and D8 at the PA base are a clamp circuit intended to make Q5 easier to drive. Power amplifier device Q5 is rated for 6W output at VHF- a bit heftier than its predecessor! Zener diode D9 begins conducting at 30V and provides a measure of protection for the final when run without a load. The collector impedance of Q5 is designed for 25 ohms (3W at 12V supply). The impedance step-up to the final value of 50 ohms is provided by the combination of L8 and a portion of C33. (The remainder of C33's capacitance forms a portion of the 50 ohm in/out low pass filter in concert with L9/10 and C34/C35.)

The maximum output of the DSW-II is 3.5 to 4 Watts for 14 MHz and 5 Watts for the other bands. The DSW-II complies with current FCC requirements for spectral purity, measurements were made at 5 Watts (3 Watts on 20M) out. Maximum harmonic/spur content at that level are as shown below.

Band	Harmonic/spur content
3.5 MHz	< -43 dBc
7 MHz	
10.1 MHz	
14 MHz	< -42 dBc

Troubleshooting the DSW-II:

The "bugs" you're most likely to encounter often turn out to be caused by simple problems. If your DSW-II doesn't play, here are some general troubleshooting guidelines.

General guidelines:

Check once more for solder bridges and missing solder joints. Probing a suspect section of the circuitry with a fingertip or insulated tool will sometimes bring a stubborn circuit to life- if so, check again for a bad connection!

Of the problems I see, about 85% of the problems are caused by cold solder joints, 5% by solder bridges and 5% due to incorrect resistor installation. That leaves only 5% for all the other problems put together. *Enough said!*

- Ensure that the ICs, transistors and diodes are installed in the correct location and with the right orientations.

BASIC PROBLEM :

Symptom: Nothing works!

Probable cause: No DC voltage to board

Look for:

1) Incorrectly wired DC power plug
2) D7 installed backwards
3) Missing solder joint
4) Pwr/ground short on board

BASIC PROBLEM :

Symptom: Sidetone and controls OK, but no received signals or RF output.

Probable cause: cold solder joint/ inadequate lead prep at L8, L9, L10

Look for: DC continuity from C31- right side (top of board) to BNC (J3) center conductor.

BASIC PROBLEM :

Symptom: same as previous

Alternate cause: no Local Oscillator signal

Look for: Presence of 0.3V pk-pk waveform at R18 (if scope available) or - tune a general-coverage receiver to the frequency in the rightmost column in the table on p.7. Remove and reapply DSW DC power to ensure that the DSW is at its startup frequency. If the oscillator is working, you'll hear the beat-note.

If no joy, contact Small Wonder Labs for additional assistance. The DDS IC is not a user-serviceable part.

The table below shows voltages present on U7 during transmit and receive.You probably don't need to check these voltages unless you encounter an operational problem, e.g, RIT doesn't work. Most such problems are likely traced to cold solder joints on the daughterboard.

U7 (Microcontroller) Voltages

Pin	Voltage (Receive)	Voltage (Transmit)
1	0V	0V/ 5V at dot/dash duty cycle. 5V → TX ON
2	5V - ***Note 1***	***Note 1***
3	5V (0V when RIT switch closed)	n/a
4	5V DC	5V DC
5	0V (ground)	0V (ground)
6	5V (0V when keyer switch closed)	n/a
7	5V - ***note 2***	n/a
8	0V 5V when sidetone on	0V 5V when sidetone on
9	5V - ***note 2***	n/a
10	5V	5V (0V when keyer paddle closed)
11	5V	5V (0V when keyer paddle closed)
12	5V (0V when FREQ switch closed)	n/a
13	5V - ***note 2***	n/a
14	5V DC	5V DC
15	4V p-p @ 4.096 MHz	4V p-p @ 4.096 MHz
16	2V nominal - ***note 3***	2V nominal - ***note 3***
17	5V- RIT ON 0V- RIT OFF ***note 2***	5V- RIT ON 0V- RIT OFF ***note 2***
18	0V - ***note 2***	0V- ***note 2***

(cont'd)

Note 1: This pin rests at 5V and is an 800Hz square wave (0V/5V) during dots and dashes in Transmit and
during frequency-annunciation.

Note 2: Values shown above are 'resting' values. This pin shows bursts of activity when using the tuning control and upon turning RIT off.

Note 3: this is a high-impedance point- applying a test probe here usually stops U7's 4 Mhz clock.

'n/a': Voltages match those for the receive mode, *but why would you be doing this?*

Receiver troubleshooting: (*power applied*)

Receiver troubleshooting may be tricky without test equipment, since the signal levels tend to be quite small. There are several types of tests you can make without special equipment, though:

1) DC voltage measurement
2) 'Probing'

Troubleshooting starts at the output of the receiver and works back upstream one stage at a time. By probing circuit points with a small screwdriver blade or similar metallic tool, a properly-working receiver will yield some sort of sound in the headphones at each stage. As you move back upstream and the response disappears, the components between the previous probing point and the current one are very likely the problem!

DC voltage measurement are made with a multimeter set to 'DC volts'. The black meter lead goes to ground and the red lead is touched to the circuit point of interest. *(You knew that- right?)*

When that happens, look for :

1) Cold solder joints in that area.
3) Missing or incorrect value components installed.

General guidelines:

- Expect up to 20% variation in your results- we're looking for things that are broken, and they'll clearly deviate from the given values.

Test 1) Probe pin 6 of U3 (TS922).

Expected result: AC hum in headphones

Look for: -C21, R14, J4 not soldered
-Solder joints around U3

If OK, measure DC voltages at U3:

Pin	DC voltage (Volts)
1	5.0
2	5.0
3	4.5*
4	0V
5	4.5*
6	5.0
7	5.0
8	13

Your mileage may vary- these points are loaded down by the multimeter.

If the voltages vary widely from these readings, check to make sure that U9 (78L05) is delivering 5V.

Test 2) Probe pins 4 and 5 of U2 (SA602)

Expected result: Loud AC hum in headphones (pin 5 test will be louder)

Look for: - misplaced component around U3-A

- incorrect voltage at Q1 gate (should be 4-5V. If ~ 0V, suspect failed Q2.)

Test 3) Probe pin 2 of U2 (SA602)

Expected result:: Shortwave broadcast sounds in headphones.

Look for - misplaced component around U2.
- Check the DC voltages at U2:

Pin	DC voltage (Volts)
1	1.4
2	1.4
3	0.0
4	3.6
5	3.6
6	4.7*
7	4.2*
8	4.8

(*If you have oscilloscope available:*)
pins 6,7:   ~ 0.4V p-p at IF

Test 4) Probe pin 5 of U1 (SA602)

(This step isolates problems in the crystal filter section)

Expected result: Scratching sound in headphones.

Look for:

Occasionally, a filter crystal will be 'open', generally due to overheating during soldering. The probing response should normally get quieter as you probe back upstream one crystal at a time. If it disappears abruptly at one crystal, though, one of two possibilities exists:

1) Short-to-ground at crystal. Look for solder bridges or lack of clearance between crystal can and top side of board.

2) Open crystal. Bridging the suspect crystal's 2 pins with a short jumper wire will make a dramatic difference in volume. *Contact me (last page) for assistance if this occurs.*

Crystals Y1-Y4 are a matched set and must be replaced as a group rather than individually.

Test 5) Probe pin 1 of U1 (SA602)

Expected result:: Short-wave sounds and/or CW in headphones.

Look for -

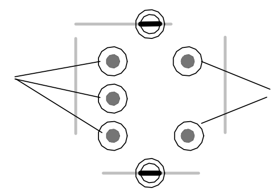
misplaced component around U1.
- Check the DC voltages at U1:

Pin	DC voltage (Volts)
1	1.4
2	1.4
3	0.0
4	3.6
5	3.6
6	4.7*
7	4.2*
8	4.8

(*If you have oscilloscope available:*)
pin 6,7:   0.8-1V p-p at LO frequency.

If the Voltages on U1 are OK, remove DC power from the DSW and test the following components for DC continuity. (Multimeter on 'ohms' scale) [*These are 'in-circuit' tests, i.e., the components are* not *removed from the board. The meter leads are applied to both ends of the component being tested.*]

L1, L2, L3 and **T1**



If all of the above tests is OK, check DC continuity between the wire lead on D3 (in the T-R switch) and ground. A low resistance value (tens of ohms or lower) suggests an earlier probing 'mishap' which has put high current to ground through D3/D4 and damaged them.

Transmitter troubleshooting-

Add a key/keyer paddles and make measurements in the key-down state. *If you have just a multimeter, put the DSW into 'Tune' mode (see Instructions document) so that the measurements are steady rather than changing with each dot or dash.*

Caution: Be sure to use a dummy load when doing transmitter troubleshooting.

Driver (U8) DC voltages:
These measurements are made with the drive pot set for minimum output:

Pin	DC voltage (Volts)
1	- -
2	6.5
3	6.5
4	0.0
5	- -
6	6.5
7	13
8	- -

Look for: -L6 cold solder joint
-Q4 failed open
-Component values, R24,R25
-Q3 failed open

If the above readings are OK and you have an oscilloscope: Driver (U8) AC voltages:

Pin	AC voltage (V p-p)
1	- -
2	0.3
3	0.3
4	- -
5	- -
6	- -
7	3V, distorted
8	- -

Look for -

Component values- R23,R22,C29

PA (Q5) DC voltages

Q5's leads are not readily accessible on the top side of the board- the following points may be used:

Q5 collector : C31 (left)
Q5 base: R28 or D8 (left)

Collector: 13V *note- always powered*
Base: 0.5V (keydown)

Look for - open connection at L7

If the above readings are OK and you have an oscilloscope: PA (Q5) AC voltages

Base: 2.5V p-p, distorted
Collector 25V p-p, distorted
C31- both sides: 25V p-p

Look for - C31 cold solder
- PA (Q5) failed

C33-C35 (high side): ~40V p-p

Look for:

- *wrong turns counts L8,L9,L10*
- *component values C33-C35*

- You may contact me for parts replacement or with questions::

Dave Benson, K1SWL
e-mail: dave@smallwonderlabs.com
tel: 860-537-8031

Factory troubleshooting is available for the DSW-II. *It's a flat $40 fee, including return shipping ($45 overseas). Please contact us by e-mail for shipping instructions- this work is done off-site.*

We'd prefer to receive just the main board and the daughterboard (if appropriate)- the enclosure is just more 'stuff' to keep track of.