An RIT for the SW+Transceivers

Small Wonder Labs revised the original NExx40/SW series QRP transceivers in early 1998. All Dave's improvements were implemented in the same compact board size (7.1 x 10.1 cm, or 2.8 x 4.0 in.).

Dave's previously-designed receiver incremental tuning (RIT) for the NExx40 series used a CMOS analog switch to add extra resistors in the "ground" leg of the transceiver's tuning potentiometer to allow tuning the receive frequency slightly above and below the transmit frequency. This feature is useful for dodging interference and adjusting the receive frequency to the exact center of the IF passband.

This revised RIT has been designed on a compact board to facilitate easy installation into an existing SWxx+, SWxx, NExx or other varactor-tuned transceiver. The new board mounts onto the front panel using the board-mounted RIT potentiometer and switch. It's small 2.5 x 3.6 cm (1.0 x 1.4 in.) size fits easily into the smallest rigs. The interface is compatible with the Molex™ connectors used with the SW+ series and it can be wired easily into older SW, NExx40 and other varactor-tuned transceivers.

CIRCUIT OPERATION

Referring to the schematic diagram, the RIT circuit adds three resistors to the VFO tuning potentiometer: one (R101) between the transceiver's regulated 8 volt line and the "top" of the VFO tuning pot and two (R102 or R103) between the "bottom" of the tuning pot and ground. Either R102 or R103 is connected to the "bottom" leg, depending on whether the RIT is on or off and whether the transceiver is receiving or transmitting.

The '4066 analog switch (U101) contains four switch sections - only three are used. Any switch section turns on when its corresponding control pin (in our case pins 5, 10 or 13) is a logic '1,' or high voltage, state. Switching S101 "open" enables the RIT by setting control pin 13 'high' via the voltage through a 100K resistor (R105) from +Vr. The corresponding switch section (pins 1 and 2) closes thus connecting R103 to the bottom leg of Rtune (VFO tuning pot). Tuning R103 varies the varactor's bias voltage slightly and shifts the VFO frequency.

When the key is depressed to transmit, control pin 13 goes 'low' (i.e., ground or 0 volts) and pins 1 and 2 open to disconnect R103. Sequentially, control pin 12 goes 'low' opening switch 10-11 which raises control pin 5 to 'high' (via R104 from +Vr), closes switch 3 and 4 and connects R102 to the tuning potentiometer's bottom leg. Since R102 is a fixed resistor (called the *"centering"* resistor) it sets a *fixed* voltage on the bottom leg of Rtune. Thus the transmit frequency is controlled only by the Rtune setting - R103 has no effect. Note that the 10-11-12 switch simply reverses the logic state for the 3-4-5 switch; it is called a *logic inverter*.

Switching S101 "off" (grounding control pins 12 and 13) has the same effect as depressing the key. R102 is inserted into Rtune's bottom leg and the radio receives at the same *VFO frequency* as when it transmits.

Why is R101 there? Without R101, the tuning voltage on Rtune varies from about 8 volts (Vr) to a bit above 0 volts (set by R102). Since the varactor's capacitance variation with voltage is *nonlinear*, installing the RIT circuit without R101 gives a plus or minus 1.5 kHz RIT offset at the low end of the VFO range and much less (measured as *only* plus or minus 0.2 kHz) at the upper end. That is, varactor diode nonlinearity causes the RIT range to be greater at the lower end than at the top end of the tuning range. Introducing R101 reduces the tuning voltage change to less than the original 8 volts and the RIT range differences at the upper and lower frequencies become less. Installing, for example, a 47K resistor (about one half the value of R1) at R101 reduced the tuning voltage change to 5 volts and the RIT offset became plus or minus 1.5 kHz at the lower frequency and plus or minus 1.0 kHz at the upper frequency - a big improvement.

However adding R101 reduces the VFO tuning range because the available voltage change is now only 5 volts instead of the original 8 volts. To regain the original tuning range simply increase C8 (on the SW+ board) by about 20-50%. A precise value for the new C8 cannot be given because

component tolerances affect the VFO range. Simply try different C8 capacitances to recover the tuning range - or simply pad (parallel) C8 with a 15 to 47 pF NP0 capacitor soldered on the bottom of the board. You also may have to readjust either L1 or C7 to return the VFO frequency back to where it was before the RIT was added.

RESISTOR SCALING

Resistors R101, R102 and R103 must be scaled according to the Rtune value used. R101 is about one half of Rtune. R103 controls the amount of frequency shift available; a value about one tenth Rtune will produce a shift of 5 to 10% of the VFO's frequency coverage. R102 is the "centering" resistor; it is one half the resistance of R103. These values are not precise and may require some adjustment to get the RIT coverage you desire, since individual radios have different frequency coverages. Typical values are:

Rtune	R101	R102	R103
100K	47K	5.1K	10K
10K	4.7K	510R	1 K

If the RIT range is less than you desire, increase the resistance of R103 to the next larger value and use an R102 half the value of the new R103. If the range is too much, reduce R103 and rescale R102.

INSTALLATION INSTRUCTIONS

Read all the instructions before beginning assembly. It is important to follow the specified installation sequence.

DO NOT DEVIATE FROM THE INSTALLATION SEQUENCE.

___ 1. First, orient the board with the "K3ASW" legend facing you and reading left-to-right. This is the *component* side of the board - **all components mount on this side.** All *component* soldering is done on the opposite (*trace*) side. Refer to COMPONENT LAYOUT (page 4) for component locations.

___ 2. Install S101. It must be seated flush with the board *and* it must be installed *perpendicular* to the board. The best way to mount S101 is to insert it onto the component side of the board and then solder ONLY ONE pad. Check that it is seated fully and is perpendicular. If not, apply the iron to remelt the solder and adjust S101's position. When it is seated fully and is perpendicular, then solder the other two terminals.

___ 3. Next install the IC socket on the component side. It is oriented so the notched end is opposite the K3ASW legend and is adjacent the small square pad. The socket also must be seated flush with the board. Install it and solder only two pins at opposite corners. Check that it is fully seated; if not, reheat the solder at each of the two pins and press the socket onto the board while the solder is molten. Once the socket is fully seated, solder the remaining twelve pins.

___ 4. Install resistors R101 (nominal 47K), R102 (nominal 5K1), and R104 and R105 (100K) onto the component side of the board and solder.

___ 5. Install D101 on the component side of the board. The diode is oriented with its band (cathode) towards the square (interconnect) pads on the board's left edge. Solder the diode leads.

___ 6. Install C101 on the component side of the board and solder it.

___ 7. R103, the RIT potentiometer, now can be installed. It must be aligned and mounted perpendicular to the board.

The best way to assure alignment is to solder the board onto the potentiometer which has been installed onto the radio's front panel. See **Drilling Instructions**, on page 5, to drill the two mounting holes in the front panel. After the holes have been drilled and their alignment checked, install the potentiometer onto the front panel (from the rear) and FINGER TIGHTEN its nut to the outside panel. Carefully mount the board-switch assembly by placing the switch bushing through its mounting hole; R103's mounting pins should go through the holes on the board. Finger tighten the

switch nut. Now the board should be parallel to the front panel. (See instruction #2, above.) Once you are satisfied with the alignment of the board and the potentiometer, solder the potentiometer pins to the board. The potentiometer will be spaced above the plane of the board, "sitting" on its three pins.

___ 8. Now remove the RIT assembly from the rear of the front panel.

___ 9. Complete assembly of the RIT accessory.

Refer to the Interface Connection Diagram, page 5.

With the K3ASW legend up and facing you, insert a three-wire interface to the lower three, left edge square pads *from the trace side* and *solder it on the component side*. [For those installing the RIT in an existing SW+, unsolder the three-wire Molex interface (going to J2) *at the tuning potentiometer* and insert the wires through the three, lower square pads from the *trace side* and *solder them on the component side.*]

Install a three-wire jumper from the upper, left-edge square pads to the VFO potentiometer (Rtune), per the **Interface Connection Diagram**. [This three-wire jumper is supplied with the kit to replace the J2 connection to Rtune, used above.] Again, insert the wires *into the trace side* and *solder on the component side.*

Install a single-wire jumper to the larger, round, upper left pad (near D101) from the trace side and solder it on the component side. The other end of this wire is soldered to J3 pin 3 (SW+ series) or to the key line on other radios.

Finally, install the IC into its socket - pin 1 is adjacent the notch. (This IC is CMOS and is sensitive to ESD - take proper precautions when installing it, especially in dry environments.)

___10. Install the assembled RIT unit into the transceiver and connect the three sets of interface connections (J2, Rtune and J3/key line).

___ 12. Connect a dummy load to the transceiver and turn it on. Turn the RIT OFF (switch towards pot). Key the transmitter and measure the VFO frequency at C3 (U1 side). It should not change between key up and key down.

Next tune in a signal with the RIT OFF. Turn it ON, then tune R103 until you hear the same tone as with RIT OFF. This "centers" R103. If the knob is not aligned with a reference (center) mark, loosen its set screws and align it so it points to the center mark.

The RIT now will tune slightly up and down from the transmit frequency during receive when it is switched on.

TROUBLE SHOOTING:

1. VFO tuning pot (Rtune) does not tune in proper sense (CW or CCW):

   Reverse grey and black wires at Rtune.

2. RIT does not tune in proper sense relative to VFO tuning pot:

   On trace side of board, cut trace between U101 pin 2 (round pad adjacent to square pad) and R103 "inner" pad (in line with U101 pin 5 pad). Install a jumper between U101 pin 2 and previously-unconnected R103 pad (adjacent to U101 pad 3). [This reverses sense of R103.]

3. RIT tuning range is not centered when it is turned on (by S101):

   Incorrect R102 value - it should be one half the value of R103.

4. RIT range at one end of VFO tuning range is very small compared to other end:

   Incorrect R101 value installed.

5. DC voltage checks:

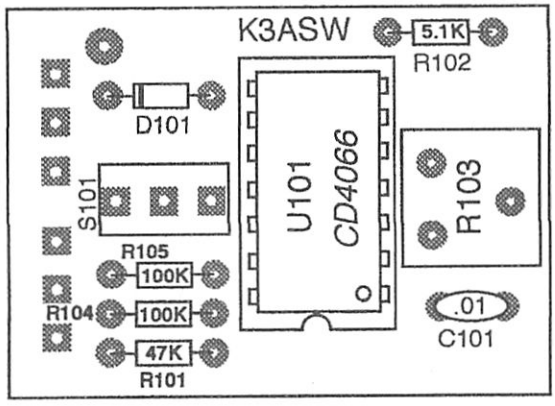
U101 (14)	Vr
U101 (6,7,11)	0
U101 (12,13)	0 - RIT ON or KEY DOWN
U101 (1,4)	= U101 (2) - RIT OFF

SW RIT ACCESSORY PARTS LIST

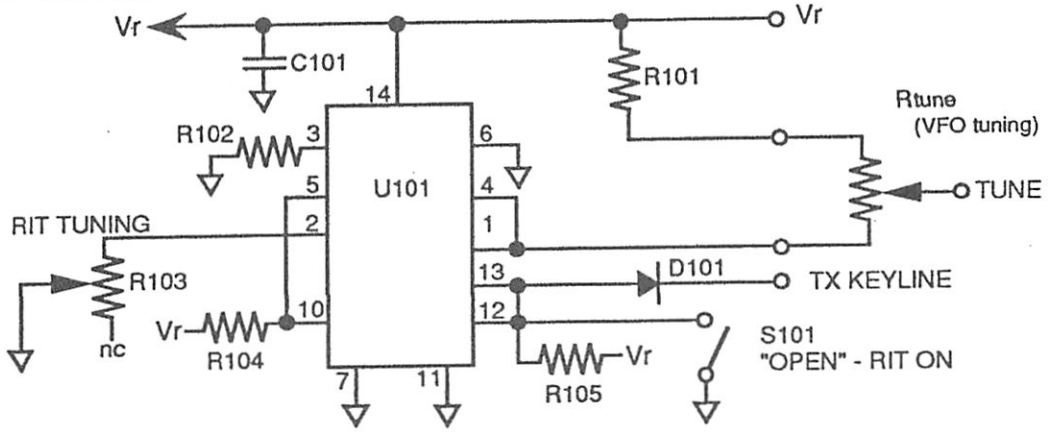
Designator	Qty	Description	Info
C101	1	0.01 uF disc ceramic	
R101	1	Nominal 47K	Note 1.
R102	1	Nominal 5.1K	Note 1.
R103	1	10K pot, PC-board mt.	*Bourns 3310Y(Digikey)*
R104,105	2	100K resistor	
S101	1	RIT Switch, SPDT	*(Mouser 612-200-A1121)*
D101	1	1N914, 1N4148 or equiv.	
U101	1	CD4066, MC14066, 14-pin DIP	
Misc:	1	14-pin low-profile IC socket	
	1	Knob, anodized, 0.125" shaft	*Kilo*
	1	3-wire jumper	blk/white/grey
	1	Printed-circuit board	

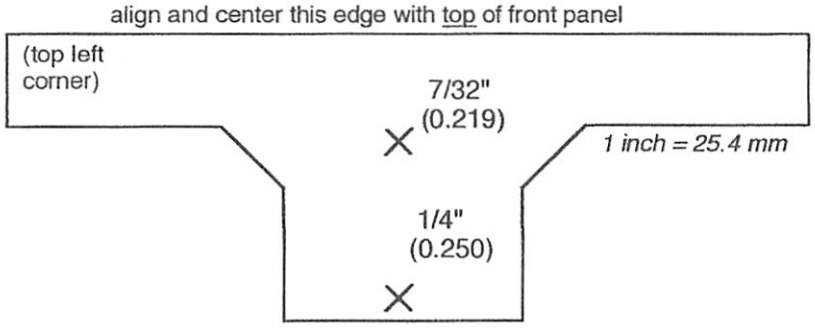
Note 1: If your transceiver tuning pot is not 100K, see resistor scaling on page 2 to substitute appropriate resistors for R101 and R102; R103 (RIT tuning potentiometer may also need to be substituted.

COMPONENT LAYOUT (Component side of board)



SW RIT ACCESSORY SCHEMATIC





[Distance between centers is 0.820 inches (20.83 mm).]

RIT ACCESSORY - DRILLING TEMPLATE FOR *SWL* ENCLOSURES

Cut template and tape to panel to mark drill centers

Drilling Instructions

When drilling your panel, it is important to center punch the hole centers. For the *SWL* - supplied enclosures, cut off and tape the above template to the front panel. Mark the hole centers using a center punch or sharp nail. For non-SWL-supplied panels, the center-to-center distance is 0.82 inch or 20.83 mm. The RIT potentiometer hole diameter is 0.250 in. (6.35 mm) and the switch hole is 0.219 in. (5.56 mm).

When drilling the panel, protect the front painted area where you will be drilling with masking tape. It is best to use a drill press, if available, to securely hold the panel piece and the drill. If you do not have access to a drill press, clamp the panel flat to the edge of a work bench with "C" clamps, using a piece of wood to protect the panel face.

Some formed enclosures are made of "soft" aluminum and a drill will tend to "wander" when using a hand-held drill. If you suspect that your drill might wander and cause a misalignment, an alternative is to drill the two holes undersized and enlarge them to fit the RIT assembly using a small round file. Take out an misalignment on the potentiometer holes as the knob will hide the enlarged hole.

Interface Connection Diagram