Kenwood SWC-2 Replacement Coupler Construction Project

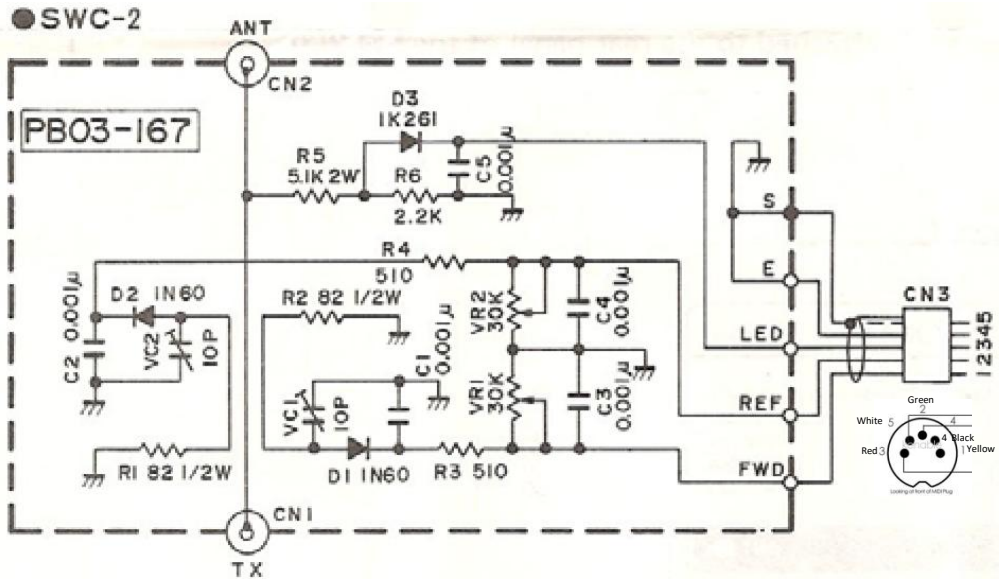
Building a reproduction SWC-2 coupler for the popular but discontinued Kenwood SW-2000 SWR-Wattmeter

Kevin C. Hastings
VE9XYZ
January 7 2018

Introduction

- This project builds a near-exact replacement for the discontinued Kenwood SWC-2 UHF/VHF Coupler for the popular SW-2000 Watt-meter / SWR meter
- The SW-2000 meter itself is often available at flea markets but its optional SWC-2 VHF/UHF couplers are very hard to find
- The SW-2000 can select between 3 couplers (i.e. HF, VHF, UHF rigs)
- This coupler is used for measuring power and VSWR for 140-450 MHz at 100 W (200W PEP) with the SW-2000
- At the 2m and 440 MHz amateur frequencies the VSWR contribution was $\leq$ 1.1.
- Displayed power closely tracked with the reference power meter when finished with a simple calibration
- Kenwood Support helped provide some information, and two Yahoo Group (Amateur-repairs, and ham-antennas) participants provided scale photos of their SWC-2 devices
- The SWC-2 uses strip-line SWR/Power detection incorporating patterns on both sides of a pcb. The circuit uses pcb traces, resistors, diodes and capacitors to determine RF presence (for the coupler LED), and measurement points for Forward Power, and Reverse Power/SWR feeds to the SW-2000 meter display unit

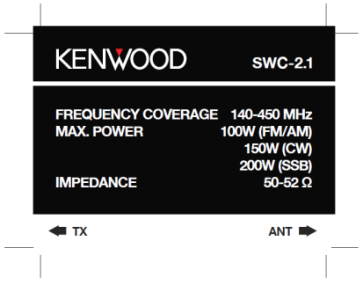
The Original SWC-2

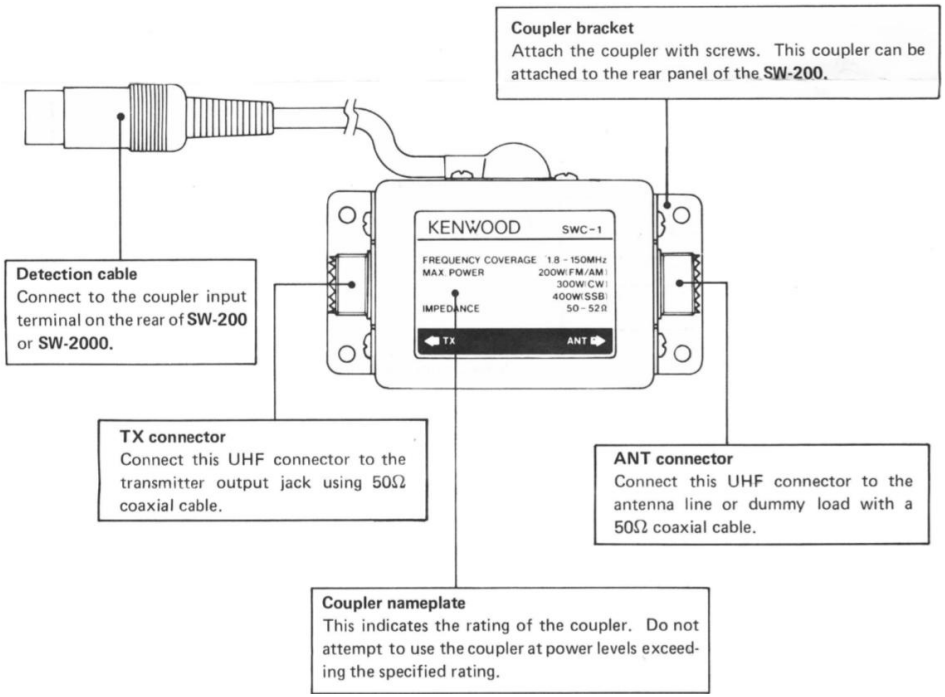


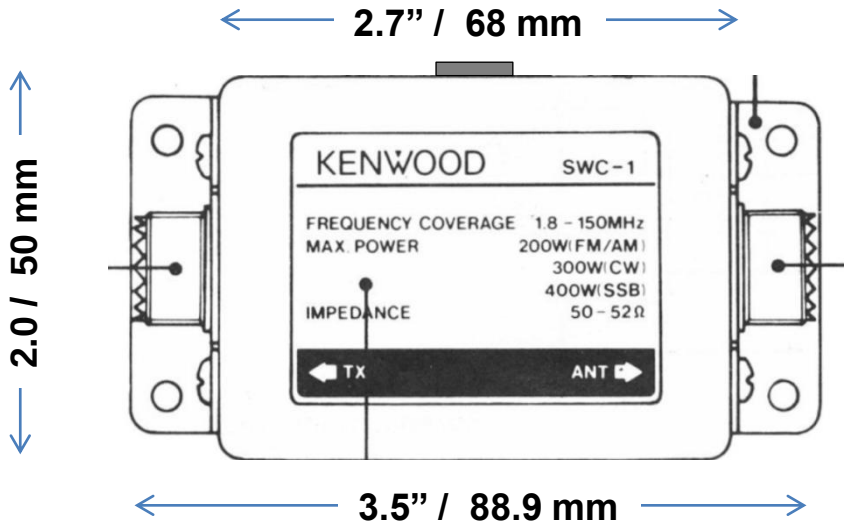
Kenwood SWC-2 Schematic

■ Specifications

Item	SWC-3 (attached to SW-2000)	SWC-2 (option)
(1) Coupler section		
Impedance	50 – 52Ω	50 – 52Ω
Frequency range	1.8 – 54 MHz	140 – 450 MHz
Feed through power overload	HF / VHF	
	1000W / 300W	100W (AM/FM)
	1500W / 450W	150W (CW)
	2000W / 600W	200W (PEP)
Insertion loss	Less than 0.3 dB	Less than 0.5 dB
Residual SWR	Within 1.2	Within 1.2
Connector	M type (SO-239)	M type (SO-239)
Detector cable length	Approx. 1.5m	Approx. 1.5m
Dimensions	68(W) x 32(H) x 50(D) (93) (33) (62)	parts
Weight	260g.	260g.

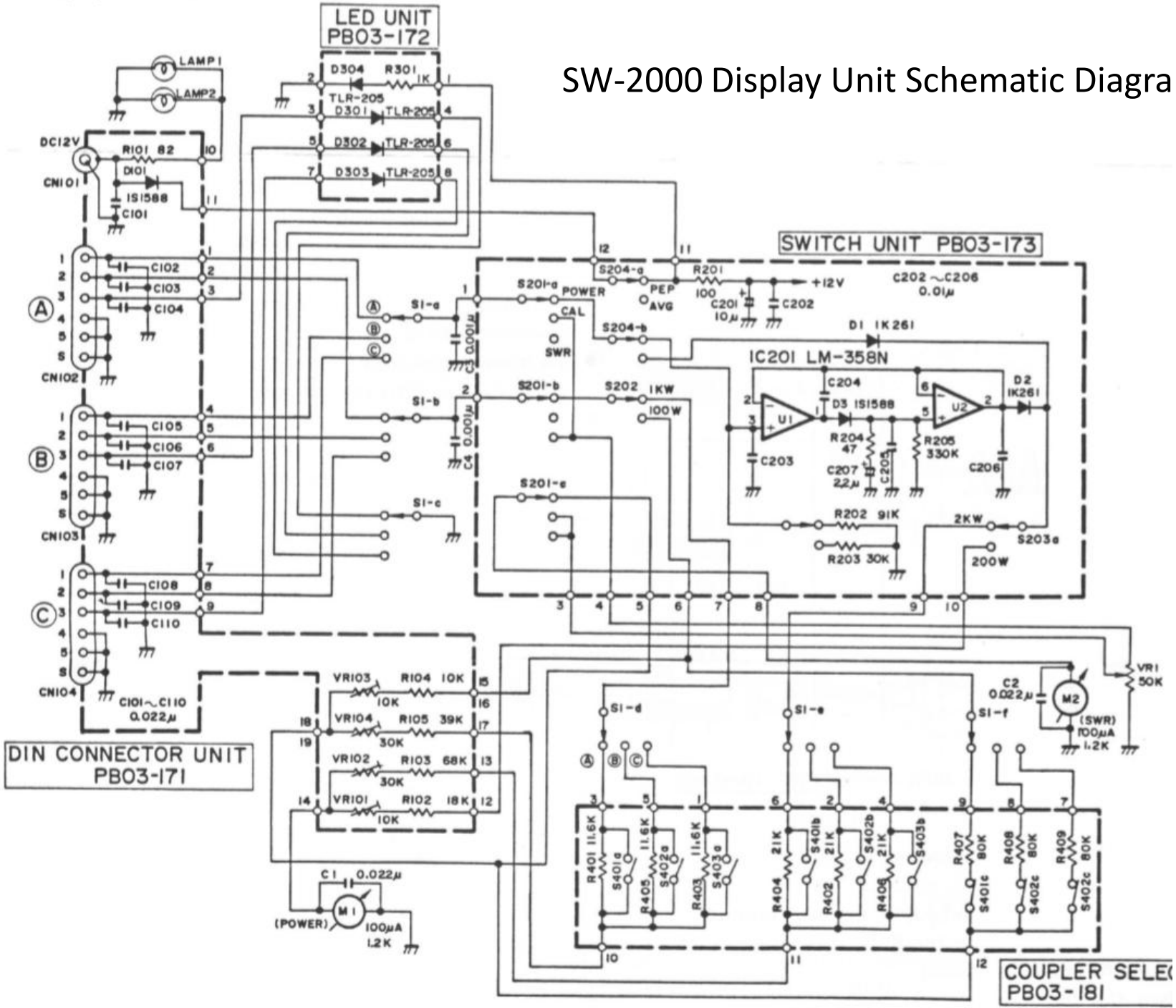






Original Kenwood SWC-2

SW-2000 Display Unit Schematic Diagram

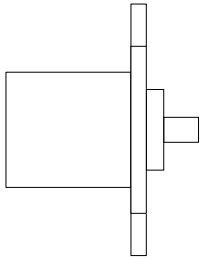


Construction Notes

- The original steel cabinet is not available, but a near exact aluminum enclosure that was 0.6” wider than the SWC-2 was used. The enclosure selected was a product from Youngu-enclosure.com and purchased from Aliexpress along with all other components. It was cut to length to match the original SWC-2.
- Total cost for enclosure and new parts was approximately $25, with only a few on-hand components and pcb stock from our junk box. Get your parts before developing your pcb in case component sizes differ slightly or your enclosure is different.
- The pcb layout follows the original SWC-2 layout closely, and is slightly wider to accommodate the new enclosure exactly
- Two coupler units were developed simultaneously – one with N-Connectors, and one with SO-239 connectors for comparison; performance was very consistent between both units produced
- The pcbs were made by photocopying the suggested board layout (at full scale), pressing onto stock pcb material, heating under a hot clothes iron for 2 minutes, soaking away the paper in warm water, and bathing the resulting pcb in ferric-chloride etching solution. Final boards were drilled & trimmed with a file and disc sander to make them fit the enclosure exactly. Make sure centre strips are aligned exactly over top of one another on both sides.
- My pcb layout was actually a reverse image of the Kenwood pcb (i.e. flipped about the axis of the SO-239-SO-239 strip-line but is symmetrical in any case and is otherwise the same. See the Kenwood schematic for suggested component values.
- R3 and R4 – a more common resistor value of 470 ohm was used
- Measure the resistors that you plan to use for R1 and R2 – and try to pick 2 that closely match
- D3 used an 1N34 diode instead of the 1K261 diode specified
- Use a DVM to measure the diode voltage drops for D1 and D2 and try to select ones that match closely
- In my unit 3 pF of additional capacitance was used across VC1 and VC2 to get exact calibrating results from both units; a 15 pF trimmer (instead of the specified 10 pF trimmer) would have alleviated that
- C1 and C2 are shown in the Kenwood schematic but are not used in their product nor this reproduction. Add it if you like
- 50 K trimmers were used for VR1 and VR2 since their size is more commonly available. They may be made to function as 28K trimmers by adding a 68K fixed resistor across their outer terminals if that is desired to more exactly replicate the Kenwood parts but in practice this may not be necessary. 30-turn trimmers were found to be more precise in the calibration procedure and eventually replaced the single-turn pots shown in the photos.
- I used 3 aluminum stand-offs to provide additional cabinet grounding points - a good idea but probably not required
- Use a well-shielded 5 pin DIN cable, and use a ferrite core on the cable
- If you want to calibrate the unit while assembled, drill small holes in the cabinet to access the 2 trimmer caps and variable resistors. I found I could calibrate my units satisfactorily while disassembled.

Scaled Component Images

Scale-Size Components



N-Connector Chassis

2 W 82 Ω, 5.1 kΩ Res

1N34A

½ Watt 82 Ω Resistor

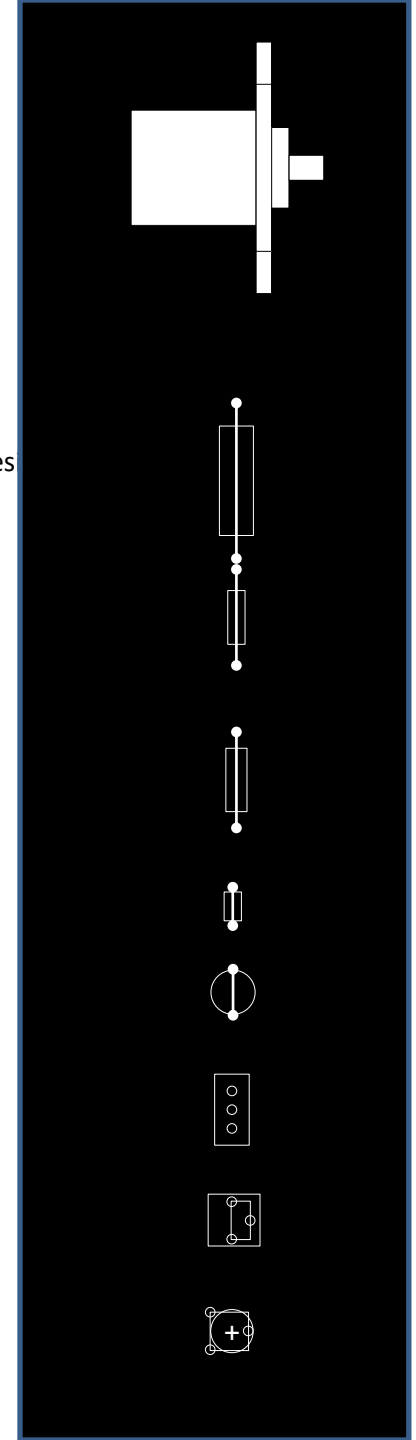
Ceramic Caps

2pF Variable Cap

Trim-pot Resistor

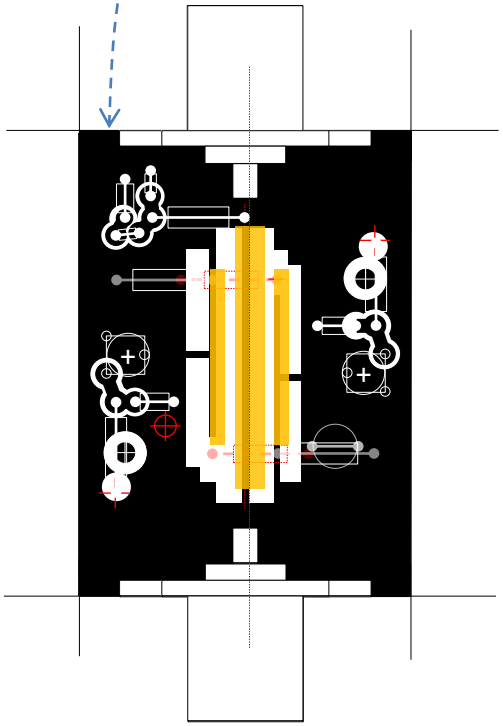
50 kΩ Adj Resistor

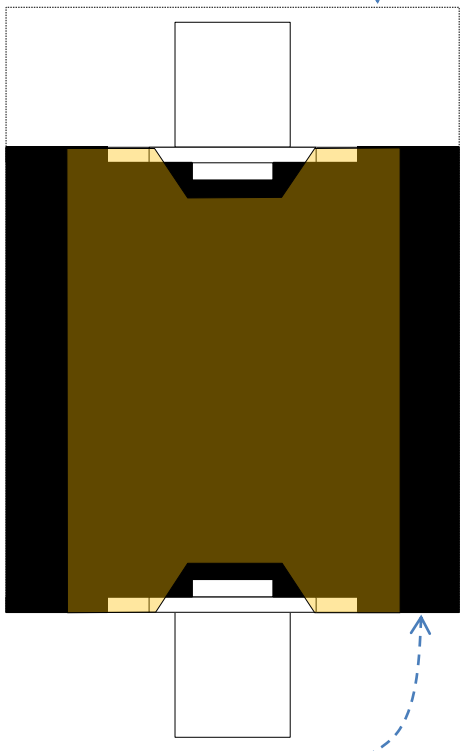
50 kΩ Adj Resistor



Original Kenwood pcb

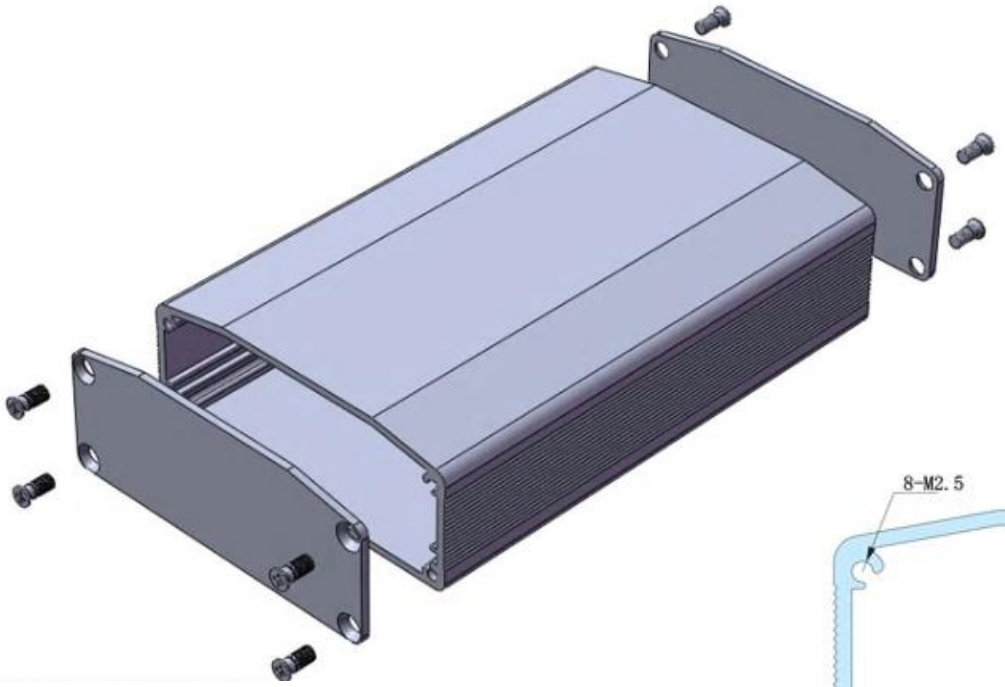
Uncut Enclosure 2.36” W x 3.15” L



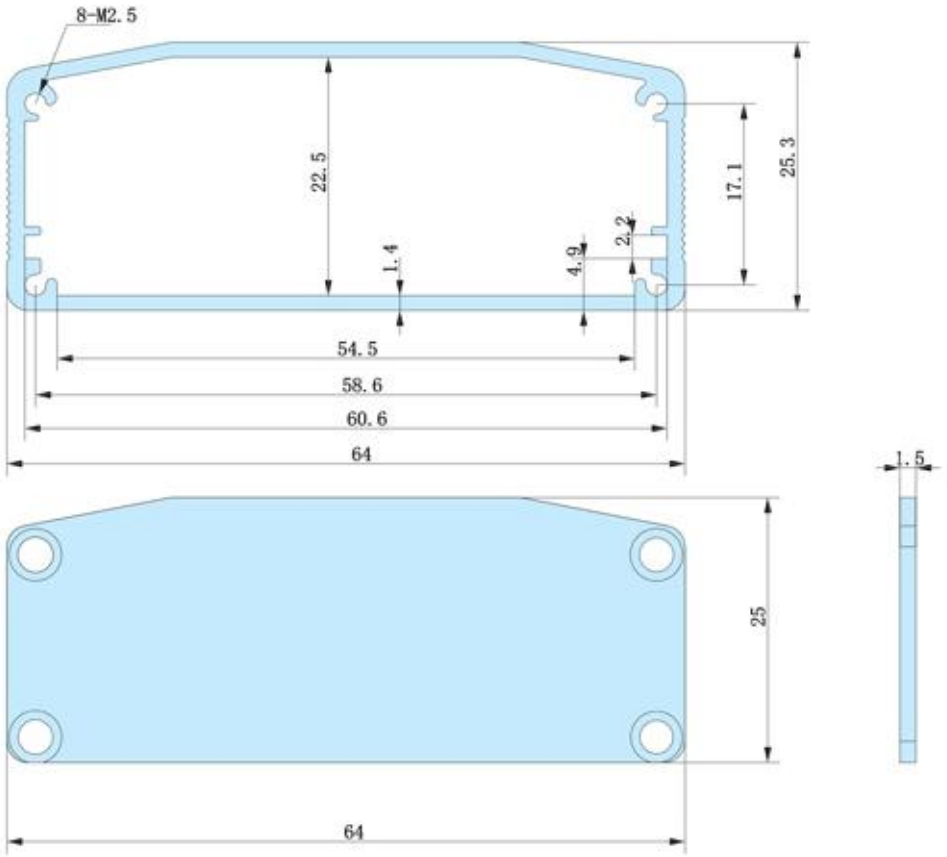


Finished pcb Enclosure 2.36” W x 2.42” L

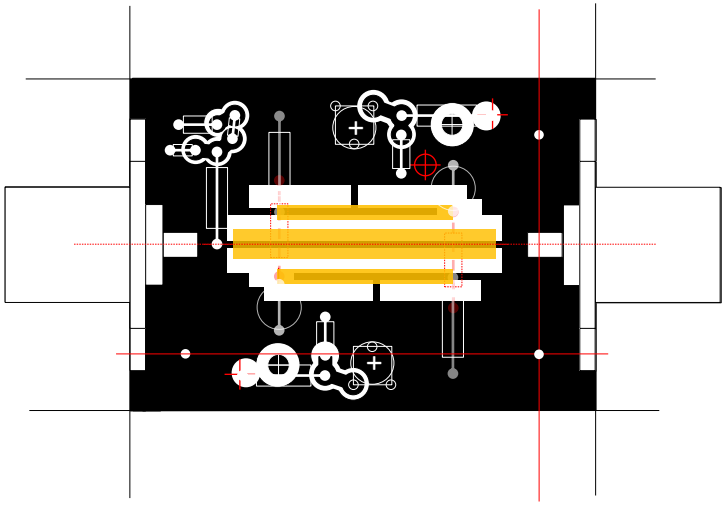
Note: PCB material thickness (including copper) = 0.06” or 1.5 mm



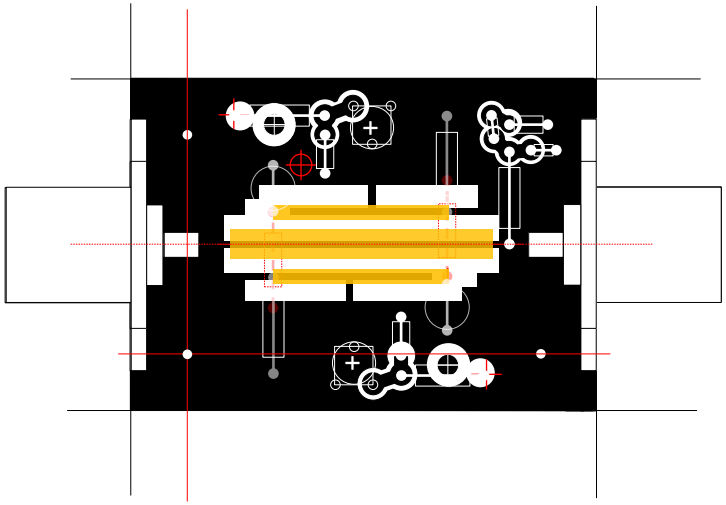
Enclosure Product Used:
YGK-008 64*25.5-80 mm (WxH-L) aluminum electronic pcb enclosures case junction box



Dual PCB Overlay Layout

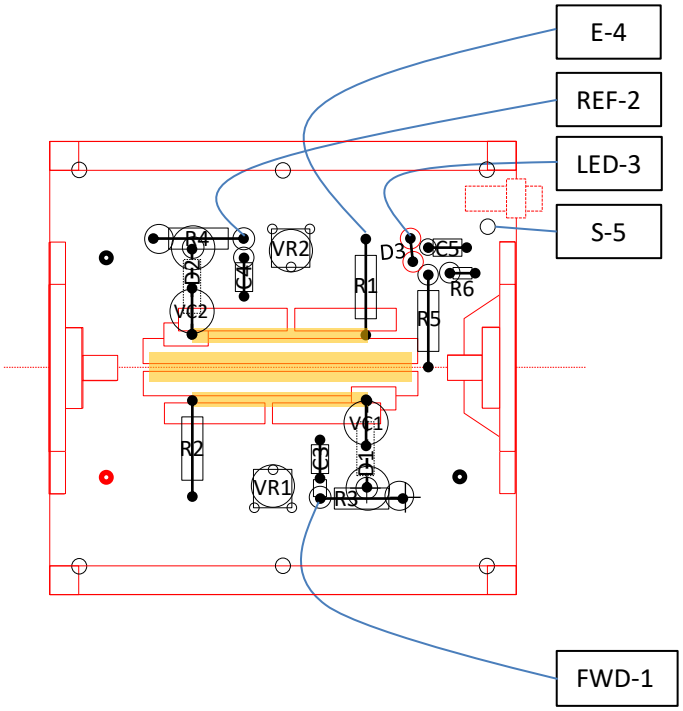


Actual PCB

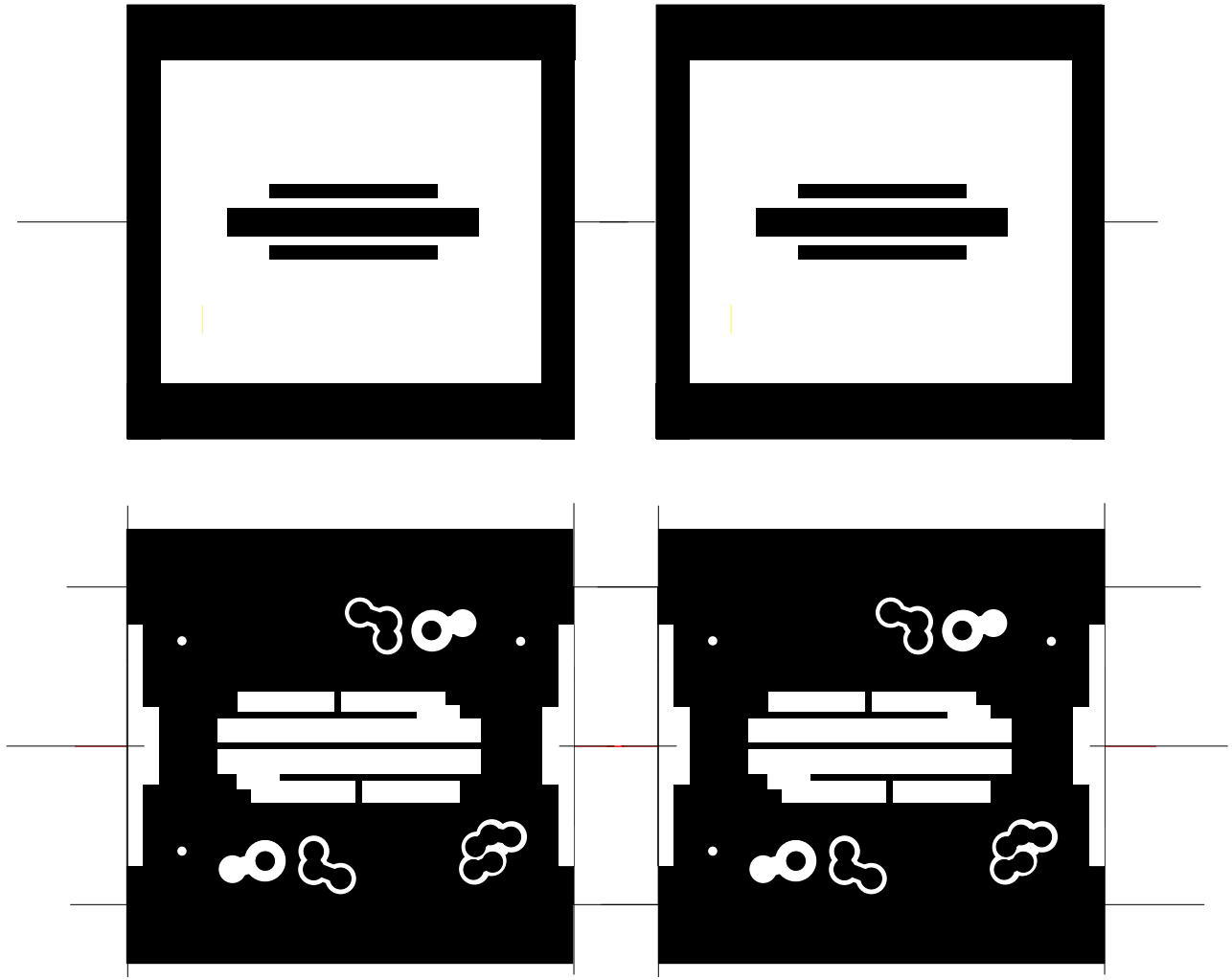


Reverse PCB

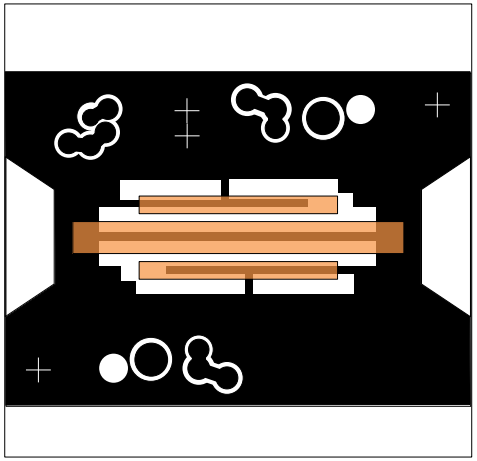
PROPOSED PARTS PLACEMENT
(can reverse depending on printing or preference)



Hole Drill Reference



PCB LAYOUT FOR PRINTING – Actual Print View for 2 Units

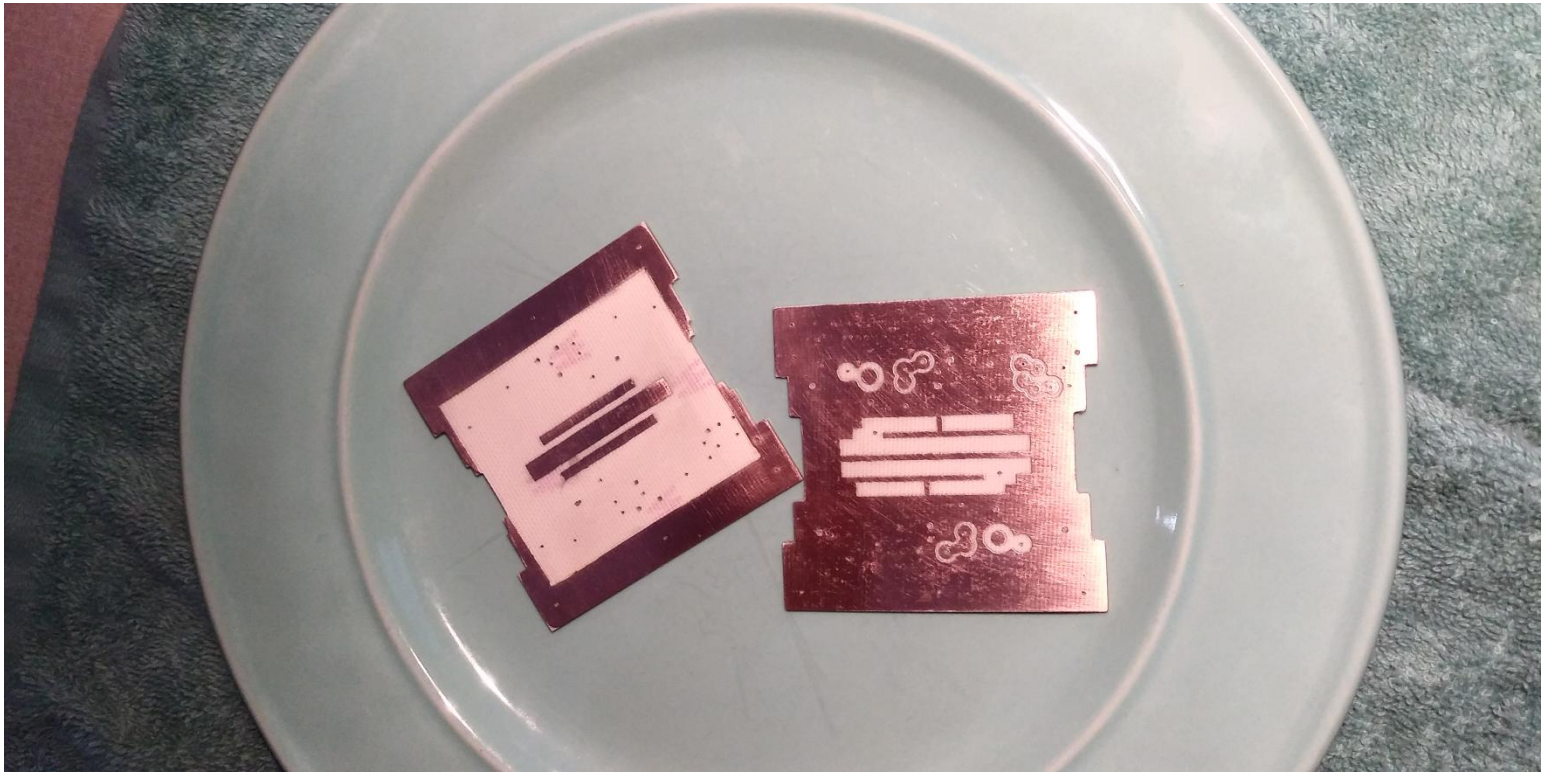


New PCB Foilside

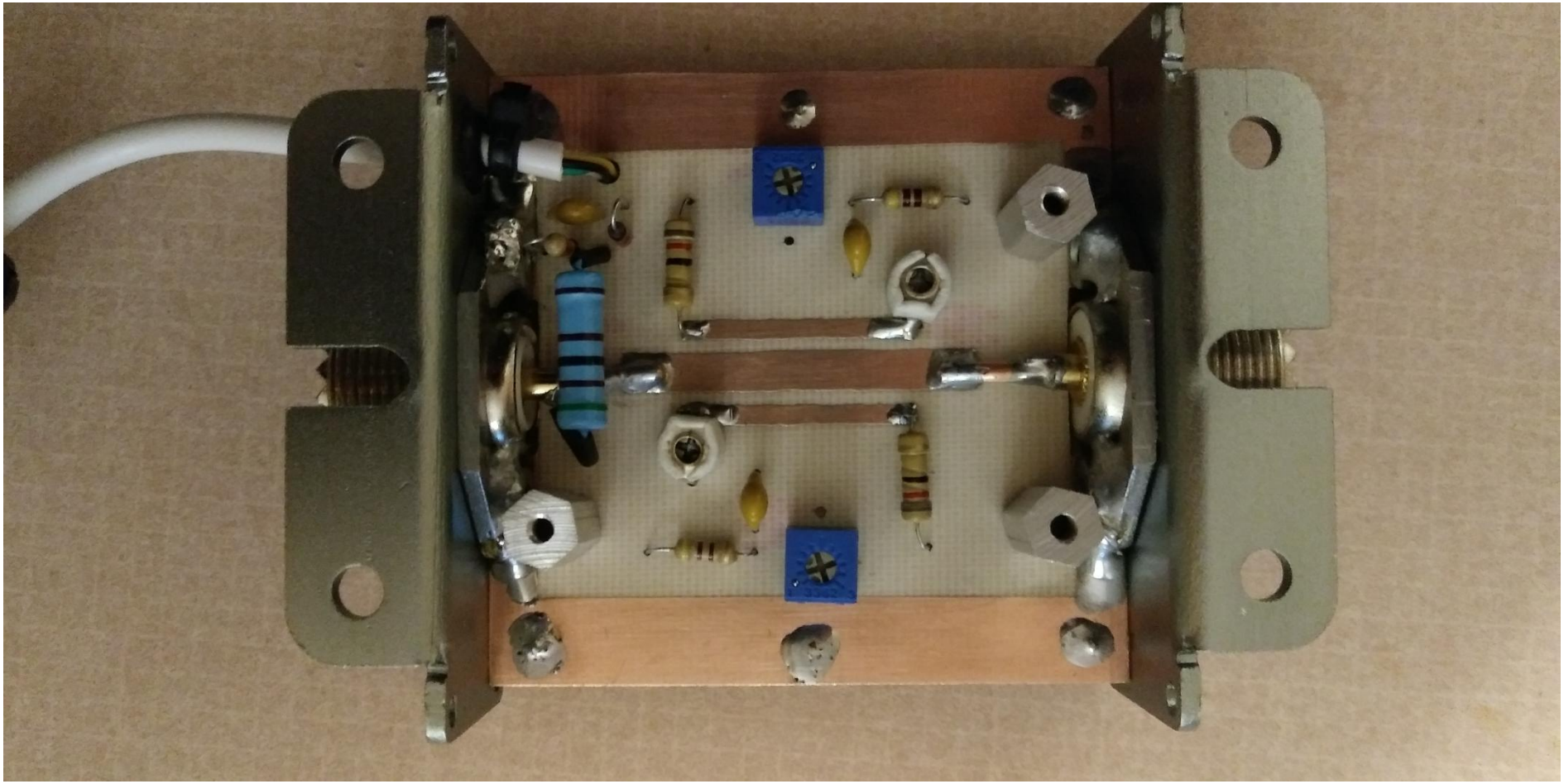
PCB Topside

PCB LAYOUT – Overlay View of Both Sides

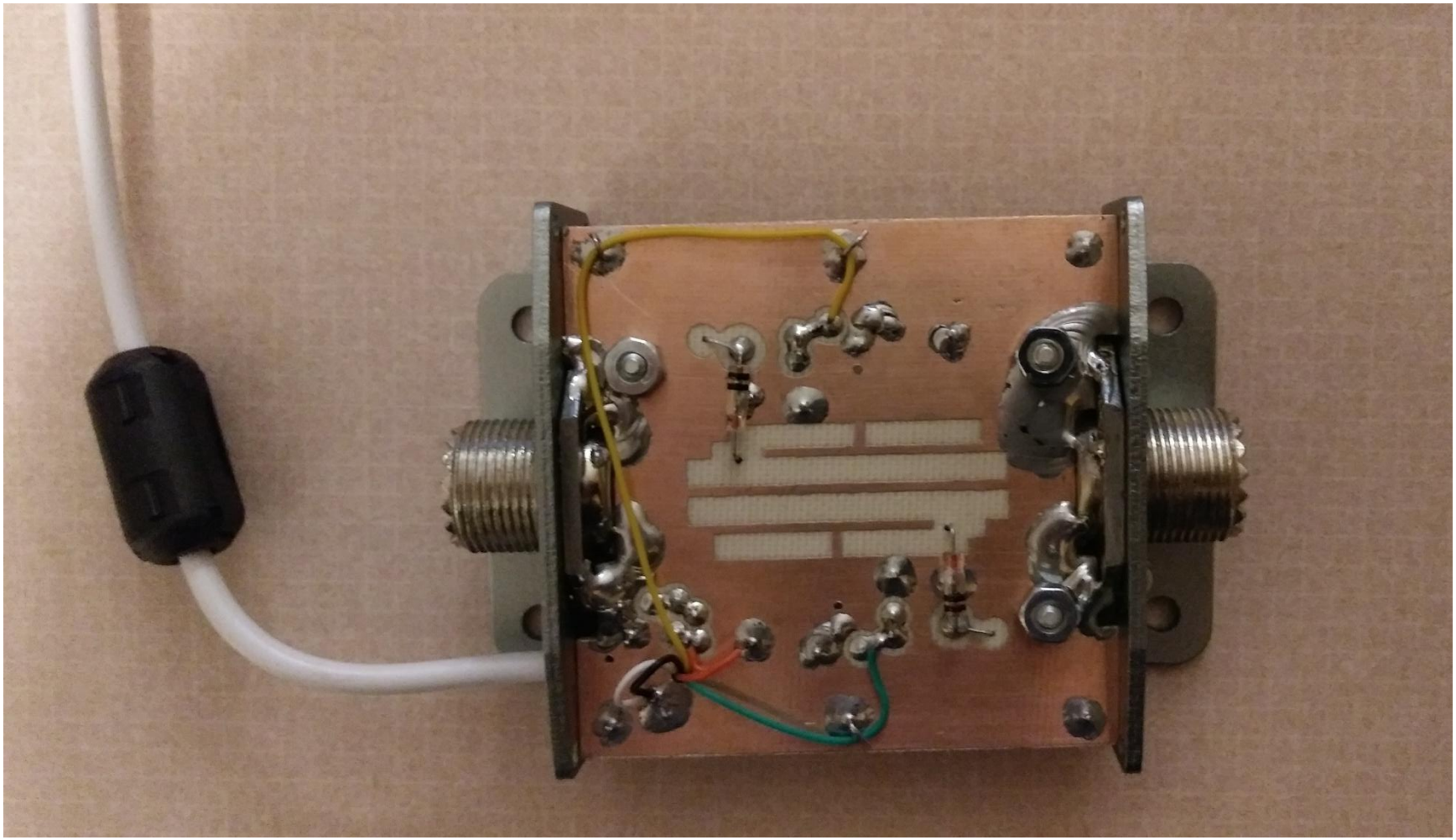
Project Photos



2 Etched, Drilled PCB Boards Before Cleaning & Polishing



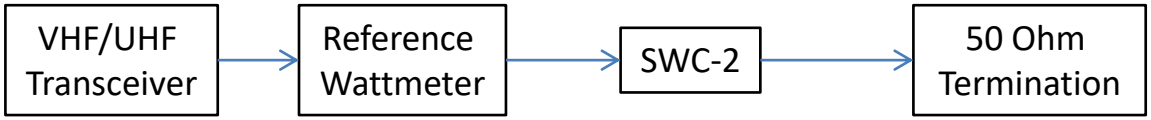
Finished Project – Top View



Finished Project – Bottom View

2 finished couplers, one with N-Connectors, one with SO-239 connectors in completed enclosures

Alignment and Calibration



1. At VHF high power, adjust VR1^{FWD} for correct meter reading that matches the reference wattmeter. Since VC-1 has little effect on VHF, its setting at this point does not matter much
2. At UHF high power, adjust VC-1 to lower the meter reading to match the UHF power on the reference wattmeter. If your trimmer capacitor does not permit reducing the reading down enough, add 3 pF across the 10 pF trimmer, or use a slightly greater trimmer. More capacitance makes the meter less sensitive at UHF, and more sensitive at VHF.
3. Re-check steps 1 & 2 and readjust to refine the meter reading if required for VHF measurement. Repeat steps 1 & 2 and re-check until readings are correct on both bands. Try different power levels and scales on the SW-2000 to ensure that all is correct. My units tracked almost exactly on all ranges and power levels.
4. Reverse the connections to the SWC-2 so that you are then feeding power into the ANT terminal and terminating the TX port. This will allow you to properly calibrate the reverse power in the same way as you have calibrated the forward power adjustments.
5. At VHF high power, adjust VR2^{REV} for correct meter reading that matches the reference wattmeter. Since VC-2 has little effect on VHF, its setting at this point does not matter much
6. At UHF high power, adjust VC-2 to lower the meter reading to match the UHF power on the reference wattmeter
7. Re-check steps 5 & 6 and readjust to refine the meter reading if required for VHF reading. Repeat step 2 and recheck until readings are correct on both bands.
8. Note that once in the sealed aluminum housing, the power readings on the SW-2000 may be reduced slightly (mine was). If so, re-calibrate slightly to counter this effect, or drill holes in the enclosure so that all 4 adjustments are exactly correct while the unit is fully assembled.
9. Use an MFJ-269 or similar antenna analyser to sweep through the newly-constructed terminated SWC-2 at all VHF and UHF frequencies to see the net effect the unit will have on your transmission line. On my unit, the SWC-2 with N-Connectors showed VSWR at 1.0 up to 174 MHz, and 1.1-1.2 over 415-469 MHz. Similarly, the PL-259 connector unit showed VSWR at 1.1 up to 174 MHz, and 1.1 or less from 415-469 MHz. At the 2m and 440 MHz amateur frequencies the VSWR contribution was insignificant ($\leq$ 1.1).

Acknowledgements

- Thanks to Kenwood Support for providing some technical details of the discontinued, unsupported SW-2000 product and its original couplers
- Thanks to members of the two Yahoo Groups (Amateur-repairs, and ham-antennas) who provided scale photos of their SWC-2 devices, including Joe WB7UQU, Donald KJ3I, Dick W1KSZ, Dave NR1DX