

HobbyPCB Hardrock-50

160 – 6 Meter 50 W Amplifier Kit

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In the August 2010 issue of *QST*, Jim Veatch, WA2EJ, detailed a 40 – 15 meter amplifier designed for QRP transceivers. Jim has since evolved that design into the Hardrock-50 now offered by HobbyPCB. The HR-50 provides 50 W output power with a drive level of 5 W or less on 160 – 10 meters, and 35 W on 6 meters. It is supplied only in kit form and is housed in a rugged aluminum enclosure. Available options include a PIN-diode QSK switch, a low-level preamplifier that permits full output from 0.5 W drive, and an internal automatic antenna tuner (not yet available during the review period). However, you cannot include both the automatic antenna tuner and the low-level preamplifier. The QSK option (available for SN1200 and above) fits with either option. The Hardrock-50 reviewed here is the standard relay-switched version with no options installed.

Putting It Together

The HR-50 arrived in a small box containing the main chassis/heat-sink, and a smaller box with the amplifier parts. This includes front and rear panels, three printed circuit (PC) boards with pre-installed surface-mounted (SMD) components, and the connectors, wire, ferrites, toroids, and hardware. See Figure 3.

No documentation is included in the box, so you must download the assembly manual from www.hobbypcb.com. You can print out the assembly manual, though I found it convenient to display the pages on a laptop computer adjacent to my assembly area. A printed manual would be convenient for checking off each assembly step. However it is difficult to miss a step because all SMD components are pre-mounted and so assembly consists of adding large connectors, relays, inductors, and transformers.

I built the HR-50 over 3 days and I'd estimate that the full assembly took me about 8 – 10 hours. I was missing two ferrites and a connector. I emailed HobbyPCB and

received an answer within minutes — and this was on a Saturday afternoon. It seems they had identified a run of amplifiers where these parts had not been included. The replacement parts were quickly received and I continued with the assembly.

Small PC boards with display and control circuitry attach to the front and rear panels. All that was required was soldering connectors to the PC boards and then mounting the boards to the panels.

For me, the most time-consuming part was soldering in the 15 relays, followed by winding and installing the inductors and transformers. While the inductor/transformer winding process is not difficult due to the clear instructions and color illustrations, you can purchase them pre-wound from toroidguy@earthlink.net for \$35. The as-delivered amplifier PC board with



SMD parts mounted is shown in Figure 4, along with the finished inductors and transformers.

Figure 5 shows the completed amplifier just before attaching the cover. There was excess ribbon cable length, so I folded it and tie-wrapped it to the dc power cable just to keep things neat. When the amplifier is complete, only five adjustments are needed. A single-turn potentiometer sets the display contrast, and four multiturn potentiometers set the four FET gate bias voltages (for this adjustment you'll need a digital multimeter). If you cannot get your Hardrock-50 to work properly, HobbyPCB provides excellent technical support via e-mail as well as through a user forum on their website. And if all else fails, you can ship your HR-50 to HobbyPCB and they will fix it. HobbyPCB guarantees everyone will have a working amp at the end of the build.

Technical Details

The HR-50 dc input is an Anderson Powerpole connector. You will need a 13.8 V dc power supply capable of at least 12 A continuous current. As the amplifier is not fused, a fused (15 A) dc input cable is recommended. The large heatsink provides

Bottom Line

The Hardrock-50 is a compact 50 W amplifier designed to work with any QRP transceiver. Silent QSK operation may be added as an option.



Figure 3 — The Hardrock-50 arrives!

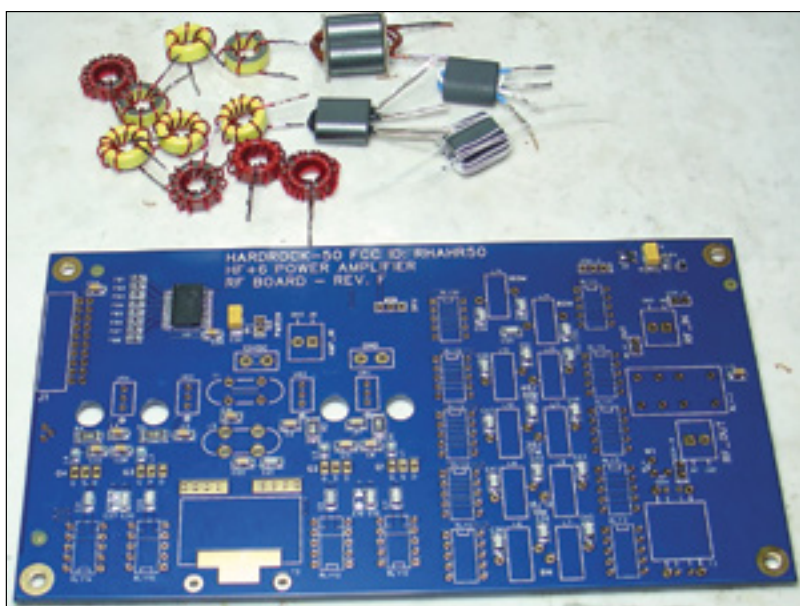


Figure 4 — As delivered, SMD parts are already mounted on the amplifier pc board. The author wound the inductors and transformers shown at the top.

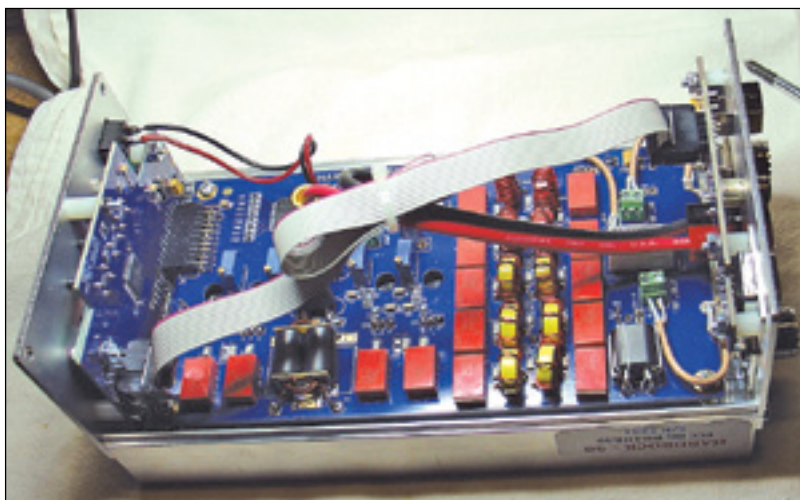


Figure 5 — Completed Hardrock-50 amplifier.

the necessary thermal dissipation — no fan is needed.

Power output is 50 W from 160 – 10 meters with 5 W maximum drive (typically 3 – 4 W is enough) using four RH16HHF1 MOSFETs. Power on 6 meters is specified at 35 W, though most amplifiers will exceed 40 W on this band. TR switching is handled by a relay or an optional PIN-diode switch. The relay 6 ms/4 ms maximum specified operate/release time is fast enough to prevent hot switching when used with most transceiver amplifier keying outputs. The optional PIN-diode QSK switch assembly switches in less than 140 μ s, but there is a trade-off. The QSK switch has 0.25 dB loss in both the transmit and receive path on 160 – 10 meters (typically 3 W transmit loss). The loss increases to about 0.5 dB on 6 meters (typically 5 W transmit loss).

No automatic fault protection is included — nor is it needed! The RH16HHF1 MOSFETs are rated to operate at 16 V dc into a 20:1 SWR at any phase angle. An open or short on the output (so only the low pass filters are inline) results in a worst case SWR of 18:1 to the FETs. About the only way the FETs can be damaged is by overheating due to insufficient contact with the heatsink. The FET mounting instructions are well written and should preclude this from occurring.

Finally, the HR-50 supports automatic band tracking with the Elecraft KX3, the Flex-1500 and any of the low power software defined radios (SDRs) that use *PowerSDR* software (for example, Softrock, Peaberry, or G10 SDRs). As the HR-50 supports the Kenwood CAT command set, other SDR programs may support automatic band tracking as well. Firmware updates are easy (a USB A/B cable is required) — just follow the detailed instructions given in the assembly manual.

Display and Control

When the unit is powered on, there is a 5 – 10 second boot process during which the amplifier firmware revision is shown. The amplifier then displays mode, band, temperature and voltage. When the HR-50 is keyed, the display changes to TX mode where a top bar graph shows average forward power, and the bottom display shows calculated SWR and peak power.

There are only three control buttons — up/

Table 2
Hardrock-50, serial number 1251

Manufacturer's Specifications	Measured Performance
Frequency range: All ham bands from 1.8 – 54 MHz except 60 meters.	As specified. The optional antenna tuner includes additional filtering to allow 60 meter operation.
Power requirements: 11 – 16 V dc (13.8 V nominal), 10 A typical, 12 A peak.	See Table 3.
Input SWR: Not specified	See Table 3.
Drive power: 2.5 – 3 W typ, 5 W maximum.*	See Table 3.
Output power: 50 W typical at 13.8 V dc, 1.8-30 MHz; 35 W at 50 MHz.**	See Table 3.
Internal power meter accuracy ± 5 W @ 50 Ω	As specified.
Harmonic and spurious suppression: Not specified.	HF, 48 dB (worst case, 1.8 MHz band), typically 64 dB; 50 MHz, 60 dB. Complies with FCC requirements.
Intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order IMD products: 14 MHz: 38/33/38/46 dB below PEP. 50 MHz: 33/32/42/60 dB below PEP.
Key in: Receive, +5 V dc open circuit, ground to transmit, 10 mA maximum.†	As specified.
Amplifier TR relay transition time: Not specified.	PTT mode: Amplifier key to RF output, 3.2 ms; amplifier un-key to RF power off: 3.8 ms. Carrier operated mode, 12 ms for 0.4 W to max drive power.
Size (height, width, depth): 3.5 × 4.25 × 7.5 inches; weight: 3 lb.	
Price: Hardrock-50 \$299; QSK option, \$49; 0.5 – 5 W preamp, \$35; internal ATU, \$179.	
*The HR-50 will tolerate 10 W of drive for a short time without damage.	
**Exceeding rated output may result in signal distortion. If the PIN-diode QSK option is installed, output power should be reduced 3 W on HF and 5 W on 6 meters.	
†The PTT line is diode protected for externally applied voltages from –24 to +24 V.	

down BAND SELECT buttons and a KEY MODE button. The BAND SELECT buttons only operate during receive, and the band setting is retained when the HR-50 is powered off.

Tapping the KEY MODE button toggles between OFF (standby), PTT (push-to-talk where grounding the PTT line keys the amplifier), COR (RF carrier detect keys the amplifier), and QRP (to follow the optional antenna tuner to be used with the exciter only). The COR mode is provided as many QRP radios don't have an amp-key output. However, you *will* hot switch your driving transmitter's output as you can't sense RF and switch instantly. When added to the relay operation time, the RF sense circuitry time constant will result in RF being present for 10 – 12 ms before switching completes. Even when the QSK option is used, RF will be present for 5 – 7 ms before PIN-diode switching occurs. So if possible, use the PTT input for amplifier keying. The PTT interface is compatible with all trans-

ceivers that have an amp-key output, including the +8 V dc/0 V dc HSEND output of the Icom IC-703 transceiver.

A 3-second push of the KEY MODE button also provides access to some internal menus for other custom settings. The up/down buttons provide scrolling through the menus and changing the settings. Currently the menus include: Accessory Baud Rate, USB Baud Rate, KX3 Serial On/Off, Temperature Display ($^{\circ}\text{F}/^{\circ}\text{C}$), Watt Meter Adjust, COR Hang Time, Key-up Delay and FT-817 Mode.

Performance Measurements

I have a KX3, so I built an interface cable (shown in Figure 6), which plugs into the ACC jack on the rear panel (Figure 7). The automatic band tracking worked great. It simplified testing as my KX3 was used as the signal source for much of my work.

Table 2 summarizes the measured amplifier performance. Spurious and harmonic distortion and IMD products, and the TR

Table 3
Hardrock-50 Operating Conditions

13.8 V dc key-down voltage; standby 0.1 A; operate, no drive, 0.3 A.				
Band (m)	Drive (W)	Input SWR*	Power Output** (W)	DC Current (A)
160	4.0	1.29:1	50	9.8
80	2.4	1.21:1	50	7.8
40	3.6	1.20:1	50	8.3
30	5.0	1.23:1	49	9.9
20	4.0	1.25:1	50	9.8
17	2.7	1.30:1	50	7.3
15	2.8	1.41:1	50	7.2
12	3.0	1.48:1	50	8.0
10	2.9	1.52:1	50	9.0
6†	3.0	1.41:1	40	6.3

*Bypass SWR was 1.1:1 or less except 6 meters which was 1.4:1
 **Measured with Mini-Circuits PWR-6GHS+ power sensor and calibrated attenuators.
 †The 6 meter output power specification is 35 W for best IMD.

relay timing were measured in the ARRL Lab.

During my initial tests I measured a high input SWR on 6 meters (about 4:1). This has been a known problem with the HR-50, but I was able to determine the cause and came up with a simple fix. The rework has been incorporated into amplifier boards above serial number 1399. For those with Rev F amplifier boards below this serial number, simply insert 33 pF/100 V capacitors into the RF-IN and AMP-IN connectors. Contact HobbyPCB for the rework necessary on earlier amplifier boards.

During the ARRL Lab testing, a spurious out-of-spec half-frequency signal was found when driving the amplifier on 6 meters. HobbyPCB determined that this was due to a change in the manufacturer of four SMD inductors (L1 – L4) and only affects Revision F amplifier boards from serial number 1200 to 1399. If your HR-50 falls into the affected serial number range and you operate 6 meters, you can either replace the inductors yourself (HobbyPCB will send you replacement inductors), or you can return your amplifier for the update. While these are SMD parts, I easily removed them by placing a soldering iron across each inductor and picking them off with tweezers. Next I added a small blob of solder to one pad end for each inductor, and used a piece of copper braid to wick

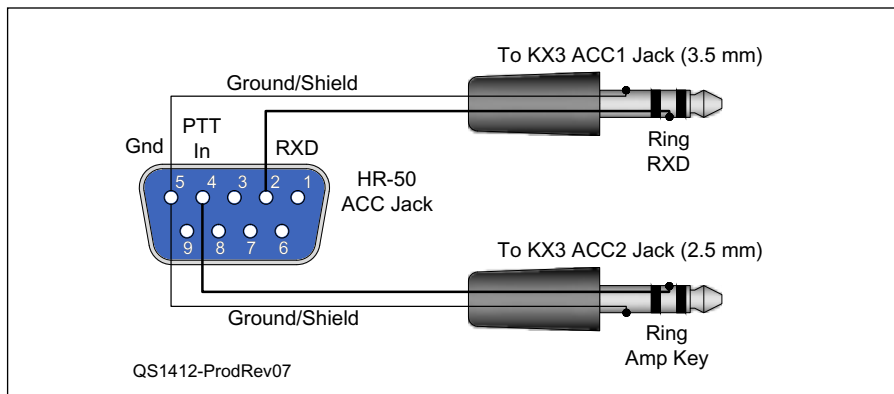


Figure 6 — The author made this cable for interfacing the HR-50 with an Elecraft KX3. The DB-9P connections are shown from the solder-cup side of the connector. I purchased the connectors from www.mouser.com. The 3.5 mm and 2.5 mm right-angle plugs are part numbers 171-3308-EX and 171-3325-EX, respectively. The DB-9P and hood are part numbers 156-1209T-E and 156-2009-EX, respectively. A 3-foot section of dual shielded cable connects the DB-9P and the two KX3 accessory plugs.



Figure 7 — Hardrock-50 rear panel. The USB port is used for firmware updates and the ACC jack may be used for automatic band switching from a compatible transceiver.

off excess solder on the other pad end. Then I held each inductor in place with tweezers and heated the solder blob end of the pad. This soldered one end of each inductor, and permitted the inductor to lie flat on the PC board. Then I soldered the other end of each inductor to the opposite pad.

Table 3 documents bypass and amplifier input SWR, required drive for 50 W output (or 5 W maximum drive), and +13.8 V dc

current at rated output. Power was measured with a NIST-traceable Mini-Circuits PWR-6GHS+ sensor and calibrated attenuators ($\pm 3\%$ accuracy). Input SWR was measured with an Array Solutions PowerMaster, and input dc current was measured with an AEMC 514 Hall-effect clamp-on DMM.

The HR-50 power detector has a very flat frequency response. The power read about 12% high when first tested (better a high reading than a low reading to ensure no signal distortion). Some inaccuracy is expected due to variations in the power coupler's ferrite tolerance, and primary/secondary winding symmetry and positioning. However, a menu selection permits adjusting the power reading. I put in -13% (the factory default was -1%) and achieved readings within 1 W of my PWR-6GHS+ test setup. If you have access to an accurate wattmeter, you can achieve excellent HR-50 displayed-power accuracy. Finally, don't forget to back down the output power by 3 W on HF and 5 W on 6 meters if you have the PIN-diode QSK option installed.

Conclusion

The Hardrock-50 is a compact, rugged amplifier that integrates perfectly with any QRP transceiver. It is reasonably priced and the kit is easy to build for those hams with some prior soldering experience. If you occasionally need to boost your QRP signal by an S unit or two, the Hardrock-50 is certainly worth considering.

Manufacturer: HobbyPCB, tel 646-580-4722; www.hobbypcb.com.



See the Digital Edition of QST for a video overview of the HobbyPCB Hardrock-50 160 – 6 meter 50 W amplifier kit.