The HW-9: Heathkit's last QRP Classic

Ian Liston-Smith G4JQT describes the HW-9, its features and its flaws.

Ian Liston-Smith G4JQT
ian.ls@hotmail.co.uk

Many readers will know of the Heathkit Company, Benton Harbor, Michigan, USA. From the late 1940s to the early 1990s, the company produced a wide range of electronic kits.

In the 1970s, Heathkit introduced the first in a series of solid-state HF QRP CW transceivers, the HW-7, supplied between 1972 and 1975. Then came the HW-8 available from 1976 to 1983, which is widely said to be Heathkit's most popular amateur radio kit and is described with some of the popular basic modifications in my *PW* article published in November 2015.

Heathkit's final CW QRP kit was the HW-9, offered between 1984 and 1991. It had a superhet receiver rather than the direct-conversion receiver of its two predecessors and gave about twice the RF output power. With the optional WARC band components, it covered the CW portions of all the HF amateur bands from 80m to 10m.

Although exactly the same size as the Heathkit's two previous QRP CW kits, the HW-9 was a complete redesign with generally improved performance, which removed most of the HW-7 and HW-8 shortcomings, but also introduced a few of its own!

Like most of Heathkit's products, an extra month or two in the design lab might have ironed out some of the problems that subsequently came to light, particularly as some of the fixes are quite trivial. These include PA instability at some power settings, poor matching for the IF filter causing passband ripple, transmit frequency varying as CW power is adjusted, birdies on receive, binding or slipping dial, barely adequate receiver dynamic range, etc. Heathkit recognised a few of these and addressed them in their *Service Bulletin HW-9-1* [1]. All these issues and more are addressed in the many comprehensive sources for modifications listed below, some of which I will describe briefly later.

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Main Features

The transceiver covers the lower 250kHz of 80, 40, 30, 20, 17, 15, 12 and 10m. However, the 30, 17, 12m WARC bands and 10m aren't included as standard, they come with the HWA-9 accessory pack. You can only tell if the components for these bands are present by looking inside at the oscillator circuit board.

The VFO covers 5.7493 to 5.9993MHz and is mixed with diode-switched crystal oscillators for each band. The HW-9 has an RIT with a range of about ±1kHz and a variable power-output control.

Heathkit used the same 8.83MHz IF crystal filter as in some of their SSB transceivers, and with a bandwidth of over 2.5kHz it isn't ideal for a CW rig. Strong signals inside the IF filter bandwidth, but outside the WIDE-NARROW audio filter bandwidth cause blocking and the S-meter responds to the stronger signal, not necessarily to the one you're listening to. This is a known 'feature' of the HW-9.

I built mine in 1990 and have done a few of the many published modifications. I've had three other HW-9s to compare so have a fair idea how they should perform. The rig's main specifications are summarised in the sidebar and these should be fairly easy to obtain in a fully working set.

Accessories

Heathkit provided the following matching accessories for the HW-9, although they could of course be used with other equipment.

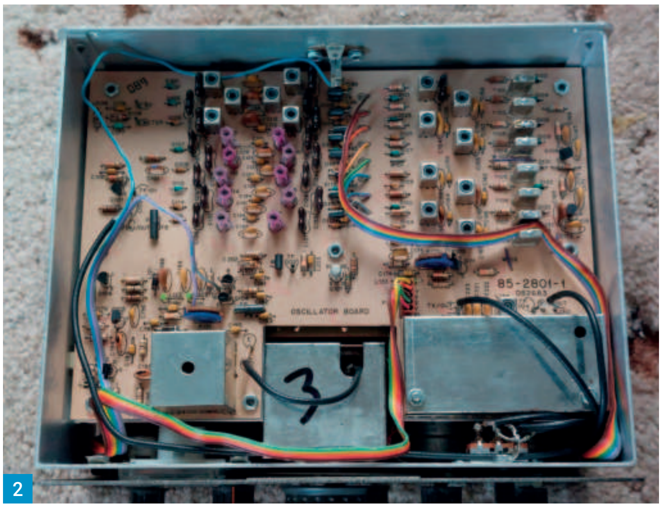
HM-9 wattmeter
HFT-9 antenna tuner
SP-99 speaker
PSA-9 power supply. As with the HWA-7-1 matching power supply for the HW-7 and HW-8, Heathkit didn't add any RF decoupling to the circuit. Liberal use of 47nF capacitors across the 12V output, rectifier diodes and the transformer secondary will reduce noise and the possibility of common-mode hum, particularly when used with direct-conversion receivers.

Common faults

Earlier HW-9s had a reputation for the dial slipping and binding. Of the ones I've used this wasn't a problem, but the *Heathkit Service Bulletin* listed below describes the cure. [1]

If you find low power output and low sensitivity, check the position of L118 as during alignment it will peak in two positions. The correct peak is when the core is near the middle of the coil not at the top. [1]

Low or no power output might be due to D405 and/or D407 going short-circuit.



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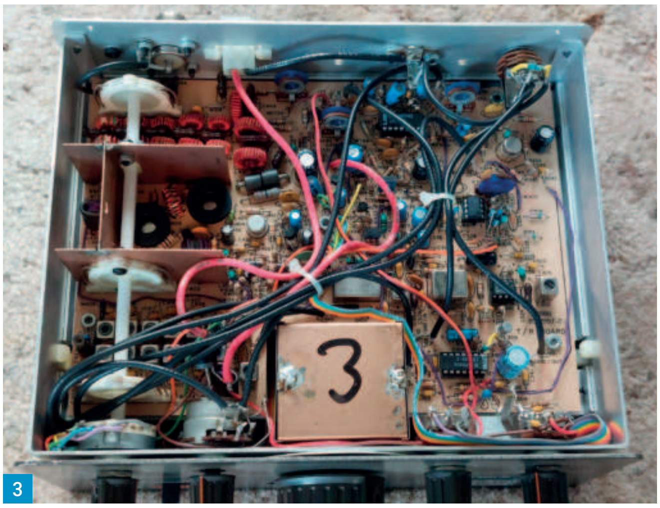

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Photo 1: The HW-9 with matching wattmeter and antenna tuner. Photo 2: Top view inside.
Photo 3: Bottom view inside.
Photo 4: Circuit diagram of output stage.

Also check the output transistors, Q405, Q406, which are both MRF237. But a word of warning; not all MRF237 transistors are the same. Those used in the HW-9 were manufactured by Motorola, and have the collector/emitter swapped compared with conventional TO39 transistors, with the tab indicating the collector, not the emitter. This is confirmed on page 103 of the manual and is not an error!

The original Motorola types are getting hard to find. I've not had to use substitutes yet, but if original types are unobtainable, it might be possible to cut and swap the tracks for Q405 and Q406 or maybe raise the transistors off the board and swap the E and C leads over. If this causes instability, then ferrite beads on each base may cure this. Substitutes might be also problematic as I believe the Motorola included emitter ballasting resistors in their versions, which help stabilise the PA stage. I don't know if this is the case with other makes of MRF237s. [2]

A Few Modifications

As with most Heathkit products, a quick internet search will reveal many modifications for the HW-9. However, before carrying out any of them, and assuming there are no obvious faults on any band, a careful alignment as described in the instruction manual will probably improve performance. It must be remembered the kit might have been last aligned well over 30 years ago by someone inexperienced and using nothing more than a multimeter. Leave the transceiver switched on for at least 15 minutes before alignment is attempted.

The first and most obvious modification is to add reverse-polarity protection. Goodness knows how many of these Heathkits have been destroyed by a moment's inattentiveness! There are a number of ways of doing this but the simplest is to add a diode in series with the positive lead before the ON/OFF switch, and using a 1N5819 Schottky diode will only drop about 0.3V rather than 0.6 to 0.7V of an ordinary silicon diode.

Please note that some of the ferrite cores are quite fragile and easily break if the wrong tool or too much force in used. But if any are broken and/or jammed in the former, all is not lost. The cores (except those in what look like metal IF transformers) can be unsoldered, and the cores turned around as they are slotted at both ends.

Four small white LEDs sandwiched along the top of the inner front chassis and the front panel with an appropriate limiting resistor will illuminate both the dial and meter.

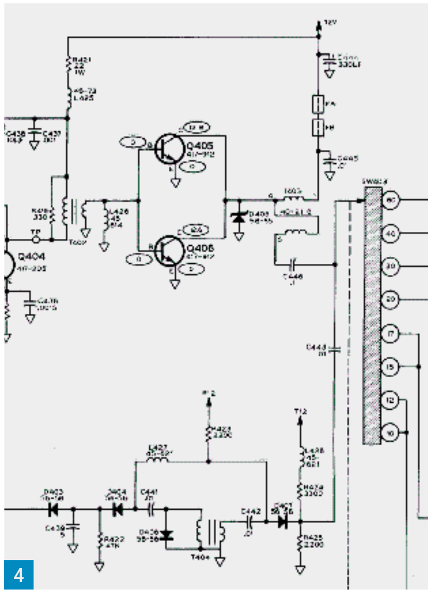
I found the simple cure for the poor dynamic range of the receiver reported by some users – particularly on 40m at night in Europe. It appears to be caused by insufficient forward bias through D403 and D404. I added a 100µH choke across R423 (2.2kΩ). This significantly increases the current through these switching diodes, while R401 (3.3kΩ) still limits the current to a safe level. Keeping R423 in place removes any possible resonances in the choke. These diodes originally only had about 2mA to forward bias them causing intermodulation from the strong broadcast signals on the 41m band.

The transmitted frequency tends to vary as the CW LEVEL control is adjusted. A 1N4148 diode added between Q103 base and R132 with its cathode connected to the base of Q103 prevents this. [3]

There isn't much RF decoupling on the PA voltage supply. I soldered a 470nF capacitor across C445 (10nF), which stopped occasional PA parasitic oscillations under some load conditions. [2]

Heathkit overlooked the decoupling capacitor on the Vcc supply to the AGC amplifier U302. Add 47nF from pin 7 to ground. A 100pF cap between U302 pins 1 and 8 will also stop any spurious oscillation in the AGC amplifier. [2]

The VFO low pass filter isn't very well designed, which, among other things,



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Current consumption with 12.6V supply:
- Receiving approximately 190mA; transmitting on full power 1 to 1.5A depending on band
- Typical RF output into 50Ω:
- 4W on all bands, 3W on 10m
- Typical receiver sensitivity:
- Less than 0.5µV for 10dB S+N/N and 0.2µV for a readable signal

creates a number of 'birdies' while tuning through each band. The analysis of the problem by ND3P and the changes he suggests are a bit too long to describe here, but can be found in the sources info below. I found it a very worthwhile modification. [2]

It's worth carefully juggling the controls R329 and R333 to get the AGC and S-meter working nicely, otherwise the receiver will be a bit 'deaf' and the S-meter will hardly move. Also, if the S-meter tends to creep up at one end of a band, even when no signals are audible, then a bit of tweaking of the appropriate coils on the Oscillator Circuit Board might be required.

On a properly aligned HW-9 receiver sensitivity is very good, and I've managed to get mine to give a minimum detectable signal of about 0.05μV. In practice that's academic because noise on most bands will be much higher than that. Although the receiver is quite sensitive, as previously mentioned, selectivity and blocking leave something to be desired.

I've only included a few of the many HW-9 mods – the ones that are easy and really do make a significant difference. A Google search of 'Heatkit HW-9 modifications' will bring up plenty of others. The collections compiled by WD8RIF, AB7MY and ND3P are particularly useful. The *HW-8 Handbook* also covers the HW-9 and is downloadable free if you do a Google search, as are the circuit diagram and manual. There are also Heathkit HW-9 Facebook and HW-9 email groups, both with a very useful files section.

I have an Elecraft K2, KX3 and a **Hans Summers** QCX40. Although they completely outperform my HW-8 and HW-9 in every respect, I still find my two Heathkits much more fun to use. Each control does just one thing without all the wings and wheels of my modern equipment.

Heathkit's HW-9 never was an outstanding transceiver, but if you find one in reasonably good condition and give it a bit of TLC, it will be a perfectly capable little rig. Perhaps someone will update its circuitry for those of us who just want a really simple-to-use but high-performance multi-band CW QRP kit.

Sources

https://tinyurl.com/3ub54hd8 [1]
Modifications and improvements to the HW-9 ND3P (*QEX* Oct 1990) [2]
www.zerobeat.net/g3ycc/ab7my.htm [3]
https://tinyurl.com/bd3a3cvb
www.qsl.net/kk4kf/hw9-mods.html
https://tinyurl.com/52pxn4ps
https://tinyurl.com/2p8z4h4b
https://tinyurl.com/3umf5wcw

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much less tolerant of SWR. While I paid £1200 for mine, I have recently seen one advertised for £1000, and it is very good value indeed at this price point.

Another quite common used find are amplifiers from Ameritron. These are owned by MFJ in the US and the AL-811, **Fig. 8**, is a reasonably common amplifier found in the UK. You can actually buy these new for around £1,600 and they appear moderately frequently on the used market for £800 - £1000.

The now venerable Yaesu FL2100B valve amplifier comes on the used market from time to time. While not equipped for the WARC bands, they do cover 80, 40, 20, 15 and 10 metres. Rarer is the Z suffix version, which covers 160 and the WARC bands too. When new they were claimed to deliver 800W on CW and up to 1200W PEP on SSB. You can pick these up used from time to time for around £200 - £300, which could be a very good purchase, but be sure to satisfy yourself of the power output on each band before purchase.

Kenwood produced the TL-922 which covers topband (160m) to 10m (with no WARC coverage) and is capable of 1kW. Expect to pay less than £1,000 used. *(see the article in this month's issue – **ed.**)*

Finally, Linear Amp UK are a highly respected amplifier manufacturer and it is not often you see used models for sale. However, some of their older models do come up from time to time and are well worth a close look. As an example, one of their older Ranger 811, 800W amplifiers was recently sold on an auction site for £720.

You will note that all the amplifiers I have listed in this category are valve based, at least in the final stage. Do not think of valves as old technology – they still have many enthusiasts for their rugged and clean signals at high power, and many amplifiers being built new today employ valves in the final stages. One thing you should be aware of though is the very high voltages present inside. Please do **not** open one up unless you are absolutely confident of your ability to know what you are doing and stay safe!

I hope you have found this article informative and it has given you some ideas for increasing your power as cost effectively as possible but, as I said at the beginning, if you can, put your budget and effort into more effective antennas first.

Next time we will take a look at the shack receiver and how we can achieve good receive capability at reasonable cost. Until then, happy operating!

Radio News

BANDPLAN CHART GENERATOR: Graham M7GRW says, *"I recently published a set of scripts/code on github that generate a graphical bandplan layout from datasets. The initial datasets are derived from the RSGB bandplans. I wrote the scripts as I wanted to generate myself a bandplan that while focussed on CW and QRP, did extend out to the band edges, as I've not got them all committed to memory, yet"*.
You can see the code along with generated images at:
https://tinyurl.com/2p8uvxzu
The code is open source. It should be fairly easy to add new datasets for other regions etc. Details are on the github site.

EIGHT-SATELLITE TEVEL MISSION: The TEVEL mission, which consists of eight satellites carrying amateur radio FM transponders, launched on 13 January on the SpaceX Falcon 9 Transporter-3 mission, which also carried AMSAT-Spain's (AMSAT-EA) EASAT-2 and HADES satellites. The TEVEL satellites were developed by the Herzliya Science Center in Israel.
All eight satellites will use the same frequencies, as long as their footprints overlap, and only one FM transponder will be activated at a time. Beacon transmissions will be on 436.400MHz (9,600 bps BPSK). The uplink frequency of the FM transponders is 145.970MHz, and the downlink frequency is 436.400MHz. The satellites were built by eight schools in different parts of Israel. The TEVEL programme – tevel means universe in Hebrew and also is an acronym for 'Students Build Satellites' – was run in partnership with the Israel Space Agency and the Science and Technology Ministry.

ARISS HIGHLIGHTED AMONG NASA'S BEST SPACE STATION SCIENCE PICTURES OF 2021: NASA has recognised Amateur Radio on the International Space Station (ARISS) as a science education and research program. Two images of ARISS activity are among those singled out by the space agency as some of the Best Space Station Science Pictures of 2021.
ARISS team member Armand Budzianowski SP3QFE wrote, *"It is phenomenal that we were honoured as creating science. It is a proud moment that ARISS and amateur radio were honoured for the field of science and research by NASA!"*
NASA also shared the photos on its website.
https://tinyurl.com/msaf8rkm

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