

Heathkit of the Month:
by Bob Eckweiler, AF6C



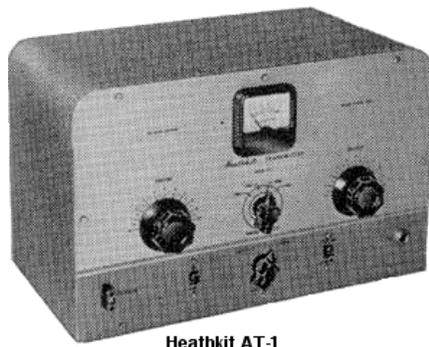
**Heath DX-40
Amateur HF Transmitter**

Introduction:

This month I chose the Heathkit DX-40 since a ham always remembers his first transmitter, especially if it is homebrew or a kit. The DX-40 is only one of a large line of kit transmitters built for use by new hams who received their Novice Class license. The FCC designed the Novice Class license specifically to let new hams build up their code speed and learn operating practices prior to taking their General Class test before an FCC examiner. A novice could operate only CW on HF* and only on small segments of the 80, 40, and 15 meter CW bands. Power input was limited to 75 watts and the transmitter had to be crystal controlled. The DX-40 met all these requirements and also had built-in AM capability so a Novice Class could continue to use the radio after upgrading to General just by adding a VFO. Conveniently, Heathkit also made the VF-1 VFO that would work with the DX-40 and many other transmitters. Prior to the DX-40 Heathkit made other Novice transmitters including the AT-1, DX-20 and DX-35. Let's look at them briefly:

The AT-1 Transmitter:

The AT-1 was the first Heathkit amateur transmitter. It was built from 1951 through 1956 and utilized three tubes, a 5U4 rectifier, a 6AG7 oscillator - multiplier and a 6L6 amplifier - doubler. The



Heathkit AT-1

radio ran 25 - 30 watts input and covered 80, 40, 20, 15, 11 and 10 meters. Frequency was determined by a crystal that plugged into a socket on the front panel. The 6L6 used link coupling to match a 50 - 75 ohm antenna. The transmitter had connections on the back for an external plate modulator and for power to run an external VFO. Heathkit also built a pair of companion receivers, the AR-2, and later the AR-3. The AT-1 was advertised in 1956 at \$29.50.

The DX-20 Transmitter:

The DX-20 Transmitter replaced the AT-1 in 1957 and continued in production until 1960. It also used three tubes, a 5U4 rectifier, 6CL6 oscillator - multiplier and a 6DQ6A final amplifier. The



Heathkit DX-20

The 6CL6 is a miniature version of the 6AG7 and the 6DQ6A was a tube designed for TV Horizontal sweep. Heathkit was one of the first to use this type tube for RF amplification. Sweep tube finals became very popular in the later years. The DX-20 also covered the same 80 - 10 meter bands as the AT-1. It had ran 50 watts input. The final stage ran straight through (not as a doubler) on all bands. The output circuit of the amplifier was a true pi-network circuit. The crystal socket was no longer on the front panel, but instead housed inside the left side of the case. A hole-plug attached to a knob allowed the plug to be removed to change the crystal. This modification as well as the new pi-network were to reduce TVI that was becoming a problem for radio amateurs. The DX-20 was replaced by the Heathkit HX-11 in 1961, that was almost identical in circuitry except for a built-in low-pass filter and a new cabinet. The DX-20 was listed at \$35.95 in a 1957 Heathkit Catalog.

The DX-35 Transmitter:

The DX-35 was the forerunner of the DX40 and was in production only two years, from 1957 through 1958. It had six tubes including a buffer stage between the oscillator and final amplifier assuring better grid drive on the higher bands. The tube line up was a 5U4B rectifier, two 12BY7s, one the oscillator and one the buffer, a 6146 final amplifier tube, and since the transmitter had AM capability, a 12AX7 speech amplifier and a 12AU7 carrier control and modulator. The 6146, being a true transmitting tube ran 65 watts input on CW and 50 watts on AM phone. The pi-network output could match loads up to 1000Ω. Frequency was still by crystal controlled though the radio was designed to also work with the VF-1 VFO. A plate in the back of the radio could be removed to allow installation of up to three crystals and the VFO plugged right into an RCA jack on the back. the back also had a switch that let you select one of the three crystals or the VFO. The DX-35 kit sold for \$56.95 .

All of these transmitters had a meter on the front. The meter was one of the older style black metal cased meters with a pointer without much damping. The meter needle would swing wildly when transmitting CW.

The DX-40 Transmitter:

The DX-40 was an upgraded replacement of the DX-35 and was manufactured from 1958 until 1960. Cosmetically, the DX-35 and DX-40 were very similar with one exception. The DX-40 sported a new modern style, well damped meter. Internally there were other changes too. The 12BY7 oscillator - multiplier and buffer tubes of the DX-35 gave way to 6CL6 tubes and the 12AU7 controlled current - modulator tube was replaced with a 6DE7. These modifications, along with a slightly beefier power supply. resulted in the DX-40 being able to run 75 watts, which was the maximum Novice power level. The DX-40 used the same crystal switching scheme as the DX-35.



Heathkit DX-40

The designers at Heathkit did a few unusual things in the design. First, the 5U4GB, which is a heavier version of the 5U4 was actually run above it's maximum plate-to-plate voltage rating by about 350 volts. Heath tested this extensively and even mentioned it in the kit's manual. Evidently this never led to any significant problems so their testing was valid. The second thing they did was to run the power to the oscillator and buffer circuits in series. This allowed the two tubes to run directly from the 600 volt high voltage supply and cut down the need for a lower voltage power supply. Those two circuits draw a fair amount of power, so otherwise Heath would have had to add a low voltage supply or use heavy dropping resistors for those stages. Since the modulator stage runs at full voltage in AM mode, the only other stages requiring lower voltage are the three audio stages which draw very little current and can use half-watt dropping resistors. Heathkit did pay a small penalty for this design. Since the cathode of the 6CL6 buffer stage is at nearly 300 volts, way above the 90 volts maximum specified for the tube, the buffer stage had to have its own (isolated from ground) filament winding on the power transformer.

The mode switch on the DX-40 had five positions, **Off**, **Tune**, **Standby**, **Phone** and **CW**. The **Tune** position allowed the oscillator and buffer to run allowing the operator to tune the

buffer stage without going on the air. One usually adjusted the **Grid** capacitor for 2 to 3 ma of grid current. The **Tune** position also allowed you to spot your transmitter frequency on the receiver. Receiver dials had much less accuracy in those days! The **Standby** position was used when receiving. The **Phone** position connected voltage to the screen grid of the amplifier through the 6DE7 modulator tube. Audio at the mic jack was amplified by the two stages of the 12AX7 and fed to the first stage of the 6DE7. The result was controlled carrier (AKA screen modulation.) The **CW** position connected the final amplifier's screen grid directly to the center tap of the bleeder resistors in the power supply. An auxiliary connector on the back had a 120 VAC output to operate an external antenna relay. Power for the relay was present only when in the Phone or CW position. The auxiliary connector also had contacts to power an external VFO, namely the VF-1.

The oscillator stage was a Colpitts oscillator with its output tuned to 7 MHz. Either 3.5 or 7 MHz crystals could be used. On 80 meters the oscillator ran with an untuned plate. A switch on the back of the radio that selected one of three crystals also had a fourth position for the VFO. When in this position, the choke in the cathode of the oscillator was bypassed. The cathode of the oscillator and final were grounded through shorting contacts on the key jack. When a key was inserted this short was removed and the key would key the cathodes. When the VFO was in use, it was keyed too. One consequence was that the key needed to either be removed or closed to work phone.



Heathkit VF-1 Accessory VFO

The buffer stage provided all the multiplication needed. The buffer output circuitry was changed significantly from the DX-35. It used a pi-network with a variable tuning capacitor marked Grid. The load was provided by a fixed capacitor and the final tube. The pi-network improvement lowered harmonics reaching the final amplifier, another improvement that helped reduce TVI.

The final amplifier used the very popular 6146 transmitting tube. This tube was capable of 90 watts input. In its day it sold for \$5.00. Heathkit designed the amplifier stage to run with 600 volts on the plate and a key down plate current of 125 milliamperes. (75 watts). The output circuit was another pi-network. It didn't have the matching range of the earlier Heathkit transmitters, but still provided a good matching range of 50Ω to 1000Ω. Two big knobs on the front panel adjusted the **Plate** tuning and **Load**. Once the buffer was tuned for 2 to 3 ma of final amplifier grid current the Load was set to maximum capacitance and the DX-40 was switched to CW. The transmitter was then momentarily keyed and the **Tune** control was adjusted for minimum plate current. The load capacitance was then reduced and the process repeated until the minimum current at the dip was 125 milliamperes. You were now tuned up and running 75 watts input on CW. To operate phone you would then switch the function to **Phone** and you were on the air on AM running about 60 watts.

Heathkit also made a British version of the DX-40 called the DX-40U.

73, from AF6C



Even though these transmitters were not in production for long many were sold and a lot of today's old timers made their first QSOs on these rigs.

DX-60, 60A and 60B Transmitters:

In 1962 the DX-40 was replaced by the restyled DX-60 (1962 - 1964), the DX-60A (1965 - 1967) and the DX-60B (1967 - 1976). In 1962 the DX-60 was listed at \$82.95. The DX-60B ranged in price from \$79.95 to \$109.95 just before it was discontinued. The DX-60 was based on the DX-40 except that it now came in a more modern low-style case and featured the new Heathkit green styling. Electrically, the power supply was changed from a fullwave tube rectifier with choke input filter to a voltage doubler circuit utilizing silicon diodes with a capacitor input filter. In the DX-60B the power transformer had dual primaries so the radio could be wired for 240 volts. The keying was changed from cathode keying to grid-blocked keying. A low-pass filter was built into a shielded box at the back of the rig. A new neon pilot light adorned the front panel. The meter was mounted behind a metal bezel on the original DX-60, but was later moved back directly to the front panel. Two new controls adorned the front panel, a drive level for adjusting the grid current, and the crystal VFO switch that was on the back panel on the DX-40. The DX-60 series had provisions for four internal crystals instead of three. The DX-60 series had an accessory socket, similar to the DX-40 with added connections for keying the VFO and for removing plate voltage when using a crystal. Heathkit sold a matching VFO, the HG-10, and later the 10A and 10B. With the new power supply the DX-60 was rated at 90 watts CW and AM.

Remember if you come across any old Heathkit Manuals or Catalogs that you do not need, please pass them along to me.

Thanks - AF6C

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** Novices did have voice privileges on a segment of two-meters. However, since the novice license was for one year and not renewable, most hams preferred to build up their code speed rather than operate voice immediately.*