

Heathkit of the Month:
by Bob Eckweiler, AF6C

Heathkit

Heathkit AM-2 Reflected Power Meter and SWR Bridge

Introduction:

In 1957 Heathkit released the AM-2 Reflected Power and SWR Bridge. This device began a line of Heathkit SWR bridges and, later, power meters. Besides stand-alone SWR bridges, the AM-2 circuit and its derivative were occasionally built into other Heathkit ham equipment models. In the fifties SWR became a simple way to monitor in situ one's antenna for changes and to assure a reasonable match exists between the antenna and feedline. SWR meters found their way into almost every ham shack, and many were Heathkit models. Prior to this style of SWR bridge, SWR measuring devices could only be used at low power and not left in-line during normal operation.

The Heathkit AM-2 SWR Bridge:

The AM-2 measures 7-3/8" W x 4-1/8" H x 4-5/8" D and weighs about 1-1/2 lbs. In 1961 it sold for \$15.95. The front panel includes a calibrated 100 μ A meter; a **FUNCTION** switch to the left of the meter that selects **FORWARD** or **REFLECTED** relative power and a 50K linear **SENSITIVITY** potentiometer to the right of the meter that adjusts the sensitivity between **MINIMUM** and **MAXIMUM**. Operation is similar to the typical SWR bridge: Power is sent through the meter and, with the **FUNCTION** set to **FORWARD**, the needle is adjusted with the **SENSITIVITY** control to the **SET** mark at the right edge of the meter scale; then, without moving the **SENSITIVITY** control, the **FUNCTION** switch is changed to **REFLECTED** and the meter scale is read. The meter has two scales, **STANDING WAVE RATIO** and **PERCENT REFLECTED POWER**. Both only go to mid-scale, which represents an SWR of 3.0 : 1



**Figure 1: Heathkit AM-2
Reflected Power and S.W.R. Bridge**

and 25% reflected power. The second half of the meter is marked red to indicate excessive SWR.

The AM-2 is specified for use with power greater than 1 KW. It was originally specified to operate from 160 to 2 meters. On 160 meters a fair amount of power is needed to get full deflection in the forward direction. On 2-meters the meter performance was evidently poor and the later AM-2 SWR meters are only rated to 6-meters. The kit came with two sets of terminating resistors so you could wire the meter for either 50 Ω or 75 Ω coaxial cable. In the early units the load resistors were identical for forward and reverse power, either 150 Ω or 100 Ω for 50 Ω or 75 Ω coaxial line.

The AM-2 remained in production until 1962 when it was replaced by the HM-11.

The Heathkit HM-11 SWR Bridge:

The changes between the AM-2 and HM-11 were purely cosmetic, switching from a silver and dark gray paint scheme of the DX-20/35/40 series to the gray and green motif of the DX-60 / TX-1 families. The circuit was unchanged. The size also remained effectively unchanged, though the specified size changed slightly. The HM-11 is specified for operation from 160 through 6-meters.

The HM-11 was produced until the end of 1965 when it was replaced by the HM-15.

The Heathkit HM-15 SWR Bridge Meter:

The HM-15 SWR meter is another redesign of packaging, this time to match the SB series of ham equipment with its wrinkled gray and green design. This SWR bridge is in a low long cabinet with the meter on the left, the **FUNCTION** switch in the middle and the **SENSITIVITY** control on the right. The circuit was also slightly changed; the terminating resistor values are different and no longer symmetrical.



**Figure 2: Heathkit HM-15
Reflected Power and S.W.R. Bridge**

The HM-15 sold for \$14.95 in 1969. It was in production from 1965 until 1970. At that time Heathkit replaced the SWR bridge as a product with a wattmeter line that provided both forward and reflected power as well as SWR readings. The first of these RF power meters was the HM-102 for HF followed shortly by the HM-2102 for VHF.

Heathkit SWR bridges were also built into some more extensive kits, such as the SB-200/201 1-KW amplifier and the SB-630 station console. These use one of the two circuits used in the SWR bridges mentioned above.

The Monimatch Circuit:

The Heathkit SWR bridges are based on the *Monimatch*¹ and *Monimatch Mark II*² circuits made famous by Lew McCoy - W1ICP. Lew's design came from an article entitled *A Reflector for the H-F Band*³ by O. Norgorden.

The circuit consists of a short length of transmission line with two wires parallel to the center conductor of the transmission line. It is imperative that the lines be only a fraction of a wavelength for proper performance. In the

original Monimatch the pickup wires are in series, with a common terminating resistor. In the later Monimatch Mark II version the pickup wires are in parallel and use separate terminating resistors, allowing the transmission line section to be half the length.

When power travels along the transmission line to the antenna it travels in the forward direction, however power reflected at the antenna travels in the reverse direction. The two pickup wires are oriented 180° to each other. One end is terminated with a fixed resistor while the other end is terminated with a crystal detector circuit. Power is coupled between the transmission line and the pickup rod both capacitively and inductively. If the termination is correct a balance is created and the voltage from the crystal detector will respond only to the current flowing in one direction. Since the two circuits are in opposite directions, one responds to forward power and the other to reflected power. A switch selects which signal is sent to the meter. The meter readings are frequency sensitive so the potentiometer allows the user to keep the forward reading on the set mark as frequency is changed.

The schematic of the HM 15 is shown in Figure 3. The only change between it and the circuits in the older AM-2 and HM-11 is the values of the two terminating resistors. In the original AM-2 and the HM-11 the terminating resistors R1 and R2 are 150Ω for 52Ω cable and 100Ω for 75Ω cable. In the later HM-15 new diodes are used and the terminating resistor values are changed to 56Ω for R1, the forward terminator, and 100Ω for R2, the reflected terminator, when wiring the SWR bridge for 52Ω coaxial cable. when wiring the bridge for 75 Ω coaxial cable the values are changed to 33Ω for R1, the forward terminator, and 75Ω for R2, the reflected terminator.

It is interesting to note that the manuals for the earlier kits (AM-2 and HM-11) have the input and output connectors mismatched on their

schematics. This was corrected in the HM-15 manual.

The Heathkit AM-1 Antenna Impedance Meter:

You may wonder about the AM-1 that preceded the AM-2. It is an Antenna Impedance Meter. (Figure 4) This device, which sold for \$14.50 in 1956, measures antenna impedance and SWR by a bridge circuit that is usually excited by a grid dip meter such as the Heathkit GD-1. Measurements take patience and need to be done near the antenna feedpoint, making the AM-2 SWR bridge a much more convenient instrument than its predecessor.

Comments:

I built an AM-2 back in 1959 to monitor SWR and help me prune my 40 meter dipole that ran from the house to a pole in the back yard; it

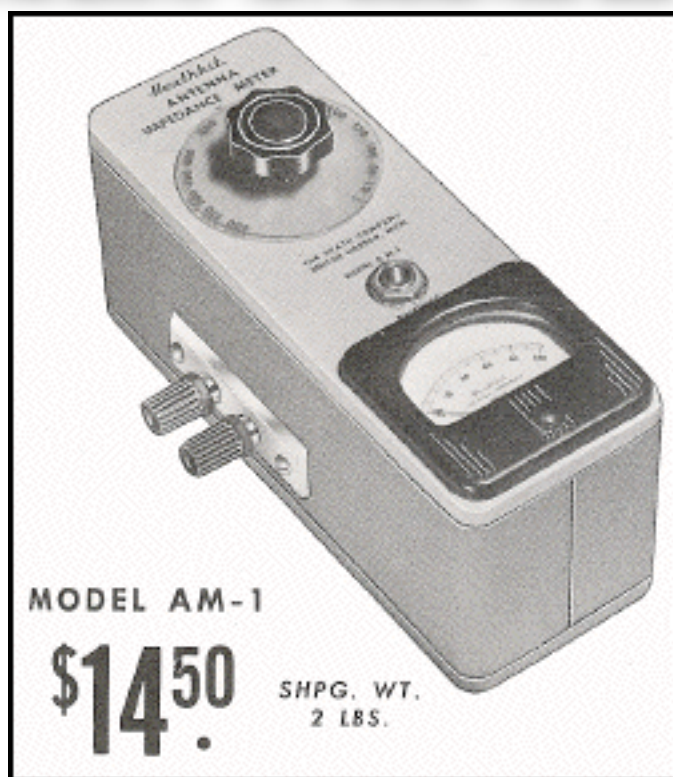


Fig 4: AM-1 from a 1956 Heathkit Catalog

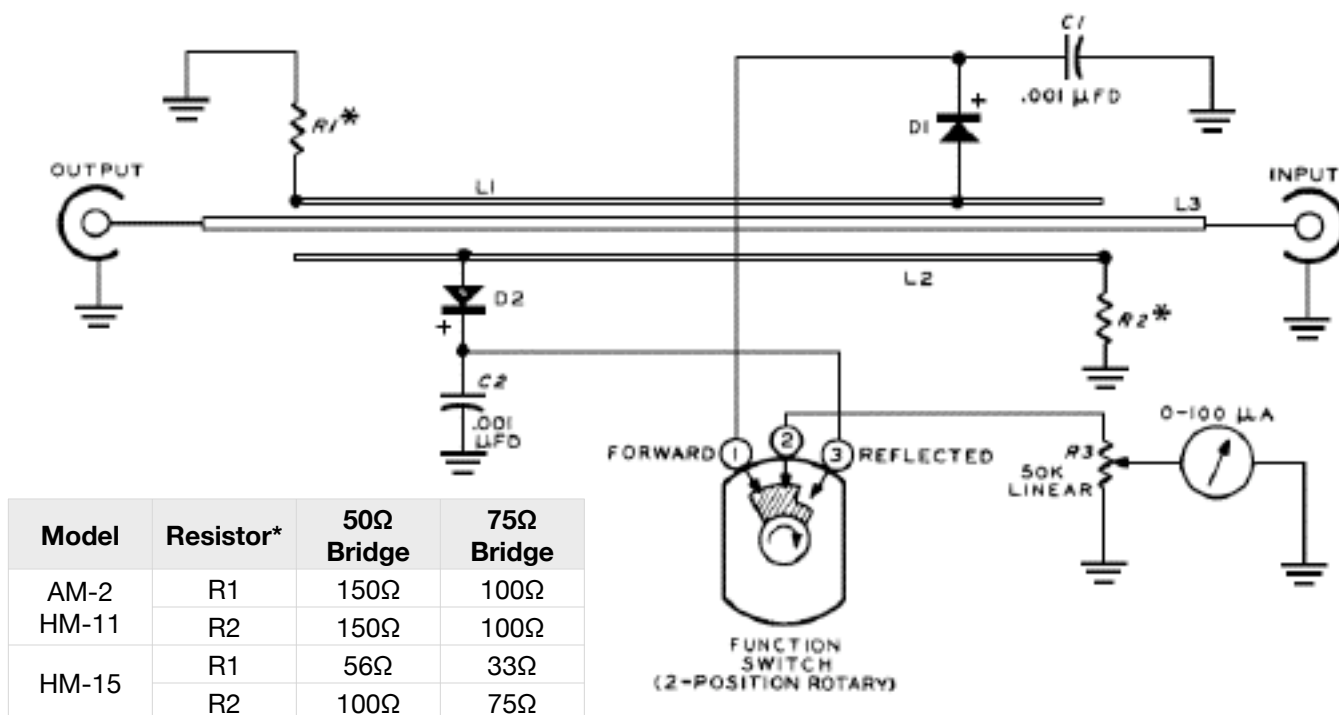


Figure 3:

SCHEMATIC OF THE HEATHKIT®
REFLECTED POWER METER
AND SWR BRIDGE
MODEL HM-15

Check your antenna system . . .
REFLECTED POWER METER

- ✦ Meter indicates percent reflected power and SWR
- ✦ May be used on amateur bands from 160 through 6 meters



AM-2 **\$15⁹⁵**

This handy Reflected Power Meter checks the match of your antenna's transmission system by measuring the percentage of reflected power and indicating the SWR (standing wave ratio). Handles a peak power of well over 1 kilowatt of energy and may be left in the antenna system feed line at all times. Matches 50 or 75 ohm coaxial lines. Band coverage is 160 through 6 meters. The built-in panel meter indicates voltage-standing-wave-ratio from 1:1 to 3:1. A sensitivity control permits adjustment to full-scale forward power reading without reducing transmitter output. The AM-2 is also handy for use in matching impedances between exciters or RF sources and linear amplifiers. Negligible insertion loss is introduced since the AM-2 is a portion of coaxial line in series with the feeder system. Measures 7 1/8" x 4 1/8" x 4 3/8". 2 lbs.

Kit AM-2 **\$15.95**

Advertisement for the AM-2 from a 1961 Heathkit Catalog

was up only 15 feet or so! The AM-2 did a good and reliable job for many years. I finally sold it in the late seventies at our radio club auction after obtaining a newer, non-Heathkit, SWR meter that was later replaced with a Bird wattmeter.

Notes:

1. Lew. McCoy, "The Monimatch", QST October 1956, pp 11-14.
2. Lew. McCoy, "The Monimatch Mark II", QST February 1957, pp 39, 39.
3. O Norgorden, "Reflectometer for H-F Band", September 1949, NTIS Report #NRL-3538.

73, from AF6C



Due to the workload as the new club treasurer and assistant webmaster, as well as family concerns, I will not be able to turn out a Heathkit of the month every month. However, I am planning to cover at least two of the larger ham kits this year. I do hope to continue with an article every other month or so for the next few months.

73, Bob

Remember, if you are getting rid of any old Heathkit Manuals or Catalogs, please pass them along to me for my research.

Thanks - AF6C

This article originally appeared in the January 2012 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.