Heathkit of the Month #42:
by Bob Eckweiler, AF6C

Heathkit®

Heathkit HD-1422-A
Antenna Noise Bridge

Introduction:
If you work with antennas, an antenna noise bridge can be a very handy tool. Table 1 lists some of the uses of an antenna noise bridge as described in the Heathkit manual:

- Finding Antenna Resonant Frequency.
- Finding Non-resonant Characteristics.
- Making Tuned Circuit Measurements.
- Making Component Measurements.
- Finding Transmission Line Resonant Frequency.
- Tuning Transmission Line Length 1/4λ or 1/2λ.
- Antenna Tuner Adjustments.

Table 1: Bridge Uses (from Heathkit Manual)

An antenna noise bridge measures an unknown impedance connected to the bridge. Two controls are on the front panel; these controls are adjusted until the noise nulls in an external detector. The front panel resistance control then shows the resistive component of the impedance. The front panel center zero reactance control reads the reactance, usually in ±pF. To find the true reactance you must convert capacitance into reactance using the well known formula:

$$X = 1/(2\pi fC)$$

where f is the frequency of the detector and C is the capacitor front panel reading. Negative C values represent inductive reactance.

An antenna bridge, sometimes called an **R-X** bridge, is made up of three sections: a wideband noise generator, sometimes keyed at an audio frequency, a bridge circuit, and a detector. The best detector (and the one most commonly used) is the station receiver; it is sensitive, selective, stable and accurately reads the frequency.

Figure 1: Heathkit Antenna Noise Bridge Model HD-1422-A - Front View

The Heathkit HD-1422 Noise Bridge:
Heathkit first released the HD-1422 in late 1985. In 1989 it was upgraded to the HD-1422-A, changing the paint scheme to a small degree, as well as making a small improvement to the circuit. The HD-1422-A was priced at $49.95 in 1989.

The HD-1422 has a range of 0 to 200 ohms resistive component and ±60 pF of reactance. This 60 pF calculates from 1.5KΩ at 1.8 MHz to 90Ω at 29.7 MHz.

The front panel of the HD-1422 (Figure 1) contains three controls and an LED pilot light. On the left is the **OFF-ON** slide switch with a red LED above it; the other two controls, left to right, are a potentiometer scaled **0 – 200** that represents the resistive (**R**) component in ohms. A 120 pF variable capacitor that is scaled **60 X_L – 0 – 60 X_C** that represents the reactive (**X**) component in pF . Negative pF converts to inductive reactance.

On the rear panel of the HD-1422 (Figure 2) are, left to right, **RECEIVER** (SO-239 UHF connector), **UNKNOWN** (SO-239 UHF connector), External **+9VDC** power jack (1/8" mini phone jack) and a #8 **GROUND** stud. The unit

is normally powered by in internal standard NEDA #1604 9-volt battery. The external power jack presents an interesting problem; the external power connector is a male 1/8 plug and is prone to shorting when lying on the table unplugged, or while plugging into the HD-1422 with the power on. This requires a rather high impedance or current-limited external supply to prevent sparks when the plug shorts. The optional PS-2350 wall wart power supply provides a nominal 9V at 100 ma max. that can power the antenna noise bridge. The HD-1422 requires 45 ma at 9 to 11 VDC.

Figure 2: Heathkit Antenna Noise Bridge Model HD-1422-A - Rear View

The Heathkit HD-1422-A Noise Bridge:
Externally the "A" model of the HD-1422 appears identical to the original except for the paint scheme. The cabinet color has changed from a two-tone dark brown to a two-tone dark gray. The nomenclature remains in white except for the Heathkit logo in the upper left that is red on the original and is pale yellow on the "A" model.

Circuit-wise the HD-1422-A is very similar to the older model. A bypass capacitor, C108, has been added across the emitter resistor of Q102, the second stage of the noise amplifier. Also, the schematic has been corrected to agree with the actual circuit. In the original schematic R107 and R108 are shown connected between the 9-volt line and the base of Q101 and Q102 respectively. However the circuit board x-ray view shows the resistors correctly connected between the base and respective collector. See figure X; this figure also shows the added C108. On the later model R109 is mounted directly to the leads of added C108, and C108 is inserted into the circuit board holes negating the need for an updated circuit board. There is another minor schematic error that was not fixed in the later schematic. The "A" and "B" circuit board connections are mislabeled; "B" should be the ground lead with the BLK wire and "A" should be the connection from R101 with the RED lead.

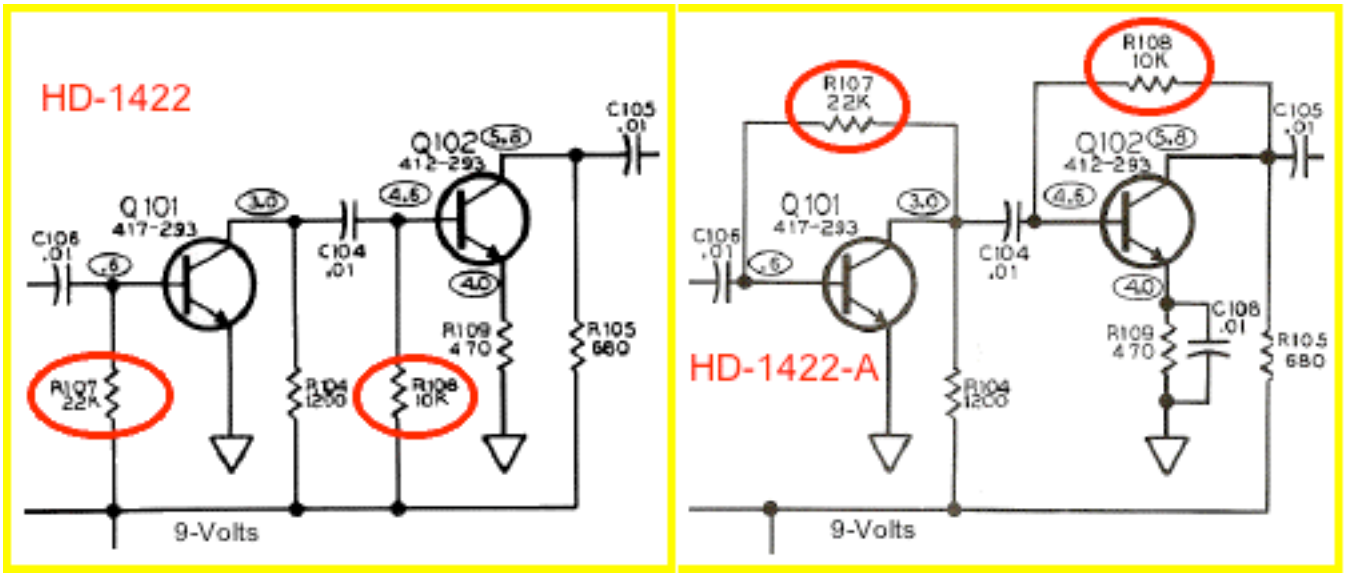


Figure 3: R107 & R108 are misplaced on the HD-1422 schematic (left) but corrected on the HD-1422-A schematic (right). Both units are wired identically except for added C-108.

The Heathkit HD-1422A Circuit Description:
The Heathkit HD-1422A circuit can be broken into 4 parts: A tone oscillator, a noise generator, a noise amplifier and a bridge circuit. The schematic is shown in figure 5.

The tone oscillator uses an NE-555 timer integrated circuit (U101) to produce a nominal 1,000 Hz square wave that drives the noise generator. This effectively puts a 1000 Hz tone on the noise signal making it easy to distinguish. It is a feature not found in many antenna noise bridges.

The square wave output at pin 3 of the U101 passes current through zener diode D103 to ground. Zener diodes are notorious for generating noise. This noise is wide-band and in use where the noise is not desirable is immediately bypassed to ground with a capacitor. Here the noise is wanted and is coupled to a two stage noise amplifier by C106.

The noise amplifier is two stages of simple amplification. The first stage (Q101) is a simple amplifier coupled via C104 to the second stage. The gain of the second stage (Q102) was increased in the later model by bypassing the emitter with C108. The output of the second stage excites the primary lead of T101, the bridge transformer.

T101 is part of the bridge circuit; the heart of the HD- 1422-A Noise Bridge. The circuitry up to this point just produces white noise over the HF frequency at a level of 50 to 100 µV. Heathkit added U101 to give the noise a nice 1,000Hz tone and make it distinguishable, but the 50µV noise should register at least S9 on most receivers. The secondary of the bridge circuit has four legs. Two of the legs are identical windings in a RF toroid transformer. The third leg is coupled through a 68 pF capacitor to the **UNKNOWN** UHF connector on the back. The fourth leg is made up of a 7 - 120 pF variable capacitor in series with a 250Ω potentiometer. The center tap of the secondary windings is connected to the detector connector on the back, which is your station receiver. The bridge is pretty simple. When the R of the unknown impedance is identical to the R of the potentiometer AND the reactance of the unknown impedance is also identical to the reactance of the reactance capacitor then the bridge balances and the noise in the receiver nulls. In order to measure inductive reactance as well as capacitive reactance a 68 pF capacitor (C107) is place in series with the unknown leg of the bridge. This skews the reactance part of the adjustment leg so that zero reactance occurs in the known leg when the variable capacitor is at 68 pF which is about mid-scale.

HD-1422-A Assembly & Test:
Heathkit classed this kit as a “one evening project”. Most of the components mount on a small printed circuit board. The internal 9V battery is held to the board by a clip; one lead of the battery connector connects to the board; the other lead is connected to the external power jack so that when external power is plugged in, the battery is disconnected.

Transformer T101 must be wound by the builder. Three 9” color-coded wires are grouped and wound next to each other on the small green color-coded toroid core. A total of seven turns per winding are made. I could not find the core model in an old Amidon catalog.

Only the front and rear panel controls and connectors are not mounted on the circuit board. These are mounted and wired up after the board is completed. Finally the board is installed by #6 hardware to the chassis and leads from the board are attached where necessary.

Checkout is done by first making some simple ohmmeter readings and then installing the battery (or plugging in the external power supply) and making one voltage measurement.

Calibration requires only your receiver, a short piece of wire and a 51Ω resistor (supplied with the kit). First the unknown connector is shorted internally with the piece of wire and

the receiver is connected with a short piece of coax to the **RECEIVER** connector. Then the Noise Bridge controls are adjusted for a null. This should happen with the two controls near zero. If necessary the knobs can be loosened and set right on. Then the short is replaced with the 51Ω resistor. Again the Noise Bridge controls are adjusted for a null. This time the pot should indicate 50Ω and the reactance should remain at zero. Again the knobs can be realigned. This should be repeated if necessary until the calibration is as close as possible.

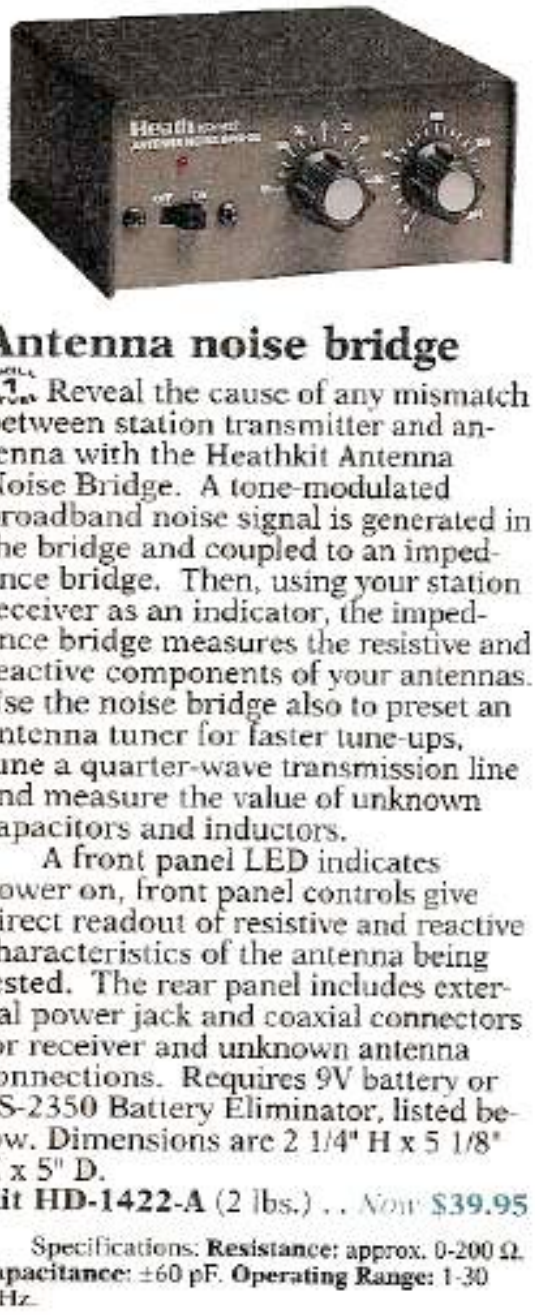
Summary:
The Heathkit HD-1422, while a basic Antenna Noise Bridge, provides numerous features that make antenna measurements easier.

In the late seventies I built a noise bridge from an article in the February 1977 issue of Ham Radio Magazine. The authors W6BXI & W6NKU gave a presentation at our club, providing a lot of additional information. I still have a copy of their presentation if anyone would like to see it. Their bridge is designed to operate over a larger reactance span then the Heathkit bridge - 0-250Ω and ±180 pF and they designed adapters to further increase coverage on the lower ham bands. A computer program I wrote for the old Apple][and later in "C" for the Apple IIgs made this a versatile piece of test equipment. Unfortunately porting it to a more modern computer is still on my to-do list.

After building the HR featured noise bridge, I picked up a Palomar Engineers "R-X Noise Bridge" which has an R-X range of 0-250Ω and ±70 pF. And some years back I was given the Heathkit by Elmer - WA6PFA during a shack cleaning he was conducting.

For Next month I hope to present another component of the Heathkit SB Amateur Line.

73, from AF6C



Antenna noise bridge

Reveal the cause of any mismatch between station transmitter and antenna with the Heathkit Antenna Noise Bridge. A tone-modulated broadband noise signal is generated in the bridge and coupled to an impedance bridge. Then, using your station receiver as an indicator, the impedance bridge measures the resistive and reactive components of your antennas. Use the noise bridge also to preset an antenna tuner for faster tune-ups, tune a quarter-wave transmission line and measure the value of unknown capacitors and inductors.

A front panel LED indicates power on, front panel controls give direct readout of resistive and reactive characteristics of the antenna being tested. The rear panel includes external power jack and coaxial connectors for receiver and unknown antenna connections. Requires 9V battery or PS-2350 Battery Eliminator, listed below. Dimensions are 2 1/4" H x 5 1/8" H x 5" D.

Kit HD-1422-A (2 lbs.) . . Now $39.95

Specifications: **Resistance:** approx. 0-200 Ω. **Capacitance:** ±60 pF. **Operating Range:** 1-30 MHz.

Figure 4: HD-1422-A From the Winter 1991 Catalog. Note closeout price of $39.95

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 August 2012 issue of RF, the newsletter of the Orange County Amateur Radio Club - W6ZE.

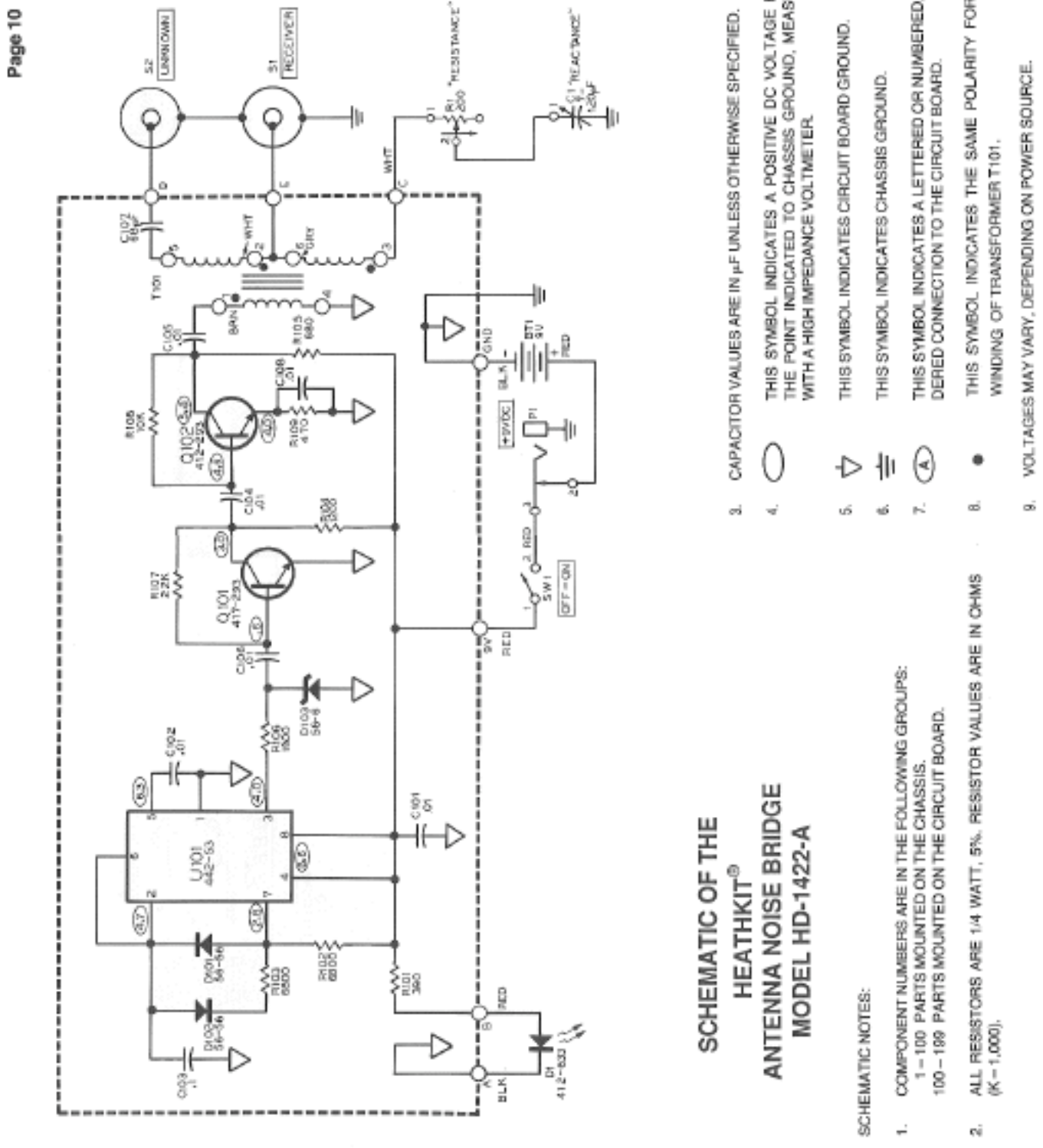


Figure 5: Heathkit HD-1422-A Schematic

D101-102: 1N4149 Signal Diode
D103: VR6.8 Zener Diode
Q101-102: 2N5770 Si NPN Transistor
T101: 7 turns trifilar wound
U101: 555 Timer IC