Price: $2

R-X NOISE BRIDGE

OPERATOR'S MANUAL

PALOMAR ENGINEERS

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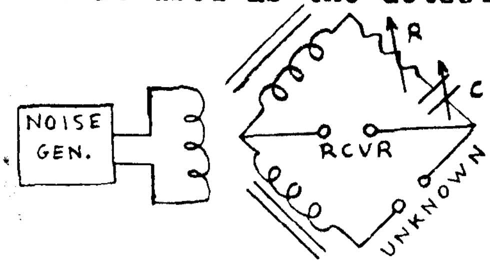
R-X NOISE BRIDGE

General Description. The R-X Noise Bridge contains a wideband noise generator and an r-f impedance bridge. Two arms of the bridge are driven equally by the noise generator through a broadband ferrite transformer. A third leg of the bridge has a calibrated variable resistor R and a calibrated variable capacitor C in series. The antenna or other "Unknown" circuit to be measured is connected as the fourth leg of the bridge. A short-wave receiver is used as the detector.



When R and C are adjusted for a null (minimum noise out of the receiver) their dial settings can be read to find the resistance and reactance of the unknown. A capacitor is in series with the unknown so that, if the unknown is a pure resistance, capacitor C is at half scale for balance. Thus both capacitive and inductive impedances can be measured. By tuning the receiver, the R and X of the unknown can be found at different frequencies.

The useful range of the Noise Bridge is 1-100 MHz. It measures R = 0-250 ohms and C = ±70 pf.

Antenna Resonance. Connect the antenna to the "Unknown" terminal, a receiver to the "Receiver" terminal (through any convenient length of line), and a 9-v transistor battery to the clips provided.

Tune the receiver to the expected resonant frequency of the antenna and turn the Noise Bridge on. A loud noise will be heard. Adjust the R and X controls for null; the controls interact and must be adjusted alternately until a deep null is obtained.

If the reading is on the X_L side of zero, the receiver is tuned to a frequency above resonance. If the X reading is on the X_C side of zero, the receiver is tuned below resonance. Using the X reading as a guide, retune the receiver and readjust the the R and X dials for null. With this procedure it is easy to find the resonant frequency of an antenna.

At the resonant frequency (X=0) the R reading is the antenna resistance at the measurement point. If the measurement is made at a current loop (the center of a dipole antenna, for example) the indicated resistance is effectively the antenna radiation resistance.

Sometimes it is not possible to make the measurements at the antenna. Instead the R-X Noise Bridge can be connected to the antenna's coax feedline. There are two ways to do this:

1. If the feedline is an electrical half wave long, or some multiple of a half wave, then the readings taken at the end of the feedline are exactly the same as though they were taken at the antenna. Of course there is just one frequency where the feedline is a half wave long so all measurements must be taken at this frequency.

2. If the feedline length is known, readings taken at the end of the feedline at any frequency can be converted using the Smith chart to find the antenna resistance and reactance. The procedure is described in detail in the ARRL Antenna Book (13th edition, 1974).

Antennas Off-Resonance. With the antenna connected as the "Unknown" its resistance and reactance off resonance can be found. At frequencies lower than resonance an antenna appears as a capacitor and resistor in series. Above resonsnce it appears as an inductor and resistor in series. The resistance is read directly from the R dial. The reactance is found from the X dial reading and the impedance chart. The chart gives reactance in ohms for a measurement frequency of 1-MHz. To find the reactance at higher frequencies, divide the tabulated values by the frequency in MHz.

Series Tuned Circuits. To find the resonant frequency of a series tuned circuit, connect it across the

"Unknown" terminals. Set the R control to minimum resistance (most tuned circuits used in communications work have very low series resistance). Set the X control to zero. Tune the receiver for a null. The X control can be used as described above to determine whether resonance is above or below the frequency to which the receiver is tuned.

Parallel Tuned Circuits. A coupling link of two turns or so should be connected to the "Unknown" terminal. The link is then brought close to the tuned curcuit and the procedure described above is used to find the resonant frequency.

If the tuned circuit uses a toroid inductor, the link must thread through the toroid core.

Measurement of Inductance and Capacitance. The R-X Noise Bridge can be used to find the values of unknown capacitors and inductors. To do this, a standard capacitor (100-pf mica) and a standard inductor (5 microhenry) are used.

To measure the inductance of a coil connect it in series with the standard capacitor and find the resonant frequency. To measure a capacitor, connect it in series with the standard inductor and find the resonant frequency.

$$L = \frac{25{,}330}{f^2 C} \qquad C = \frac{25{,}330}{f^2 L}$$

where: f= resonant frequency in MHz
L= inductance in microhenrys
C= capacitance in picofarads

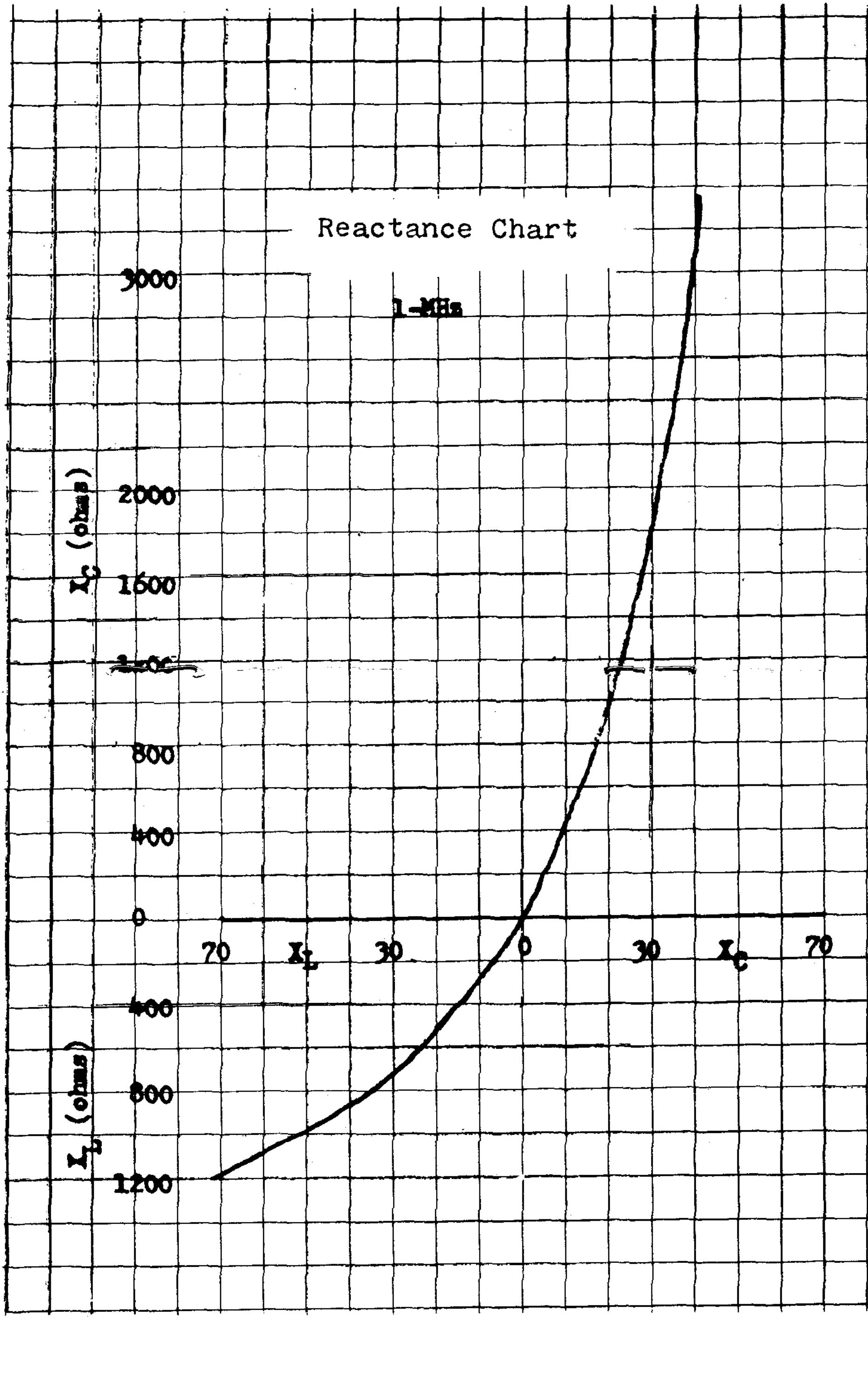
With the resonant frequency known and either the standard capacitor or standard inductor in use an unknown inductor or unknown capacitor value can be calculated.

The L/C/F calculator (available from the American Radio Relay League) finds the answers without the need for arithmetic calculations.

<u>Transmission Lines</u>. The length of a quarter wave line is:

$$L_{(feet)} = \frac{246}{f} V$$

where: f = frequency in MHz
V = velocity factor of the line


Reactance Chart
1-MHz
X_C (ohms)
3000
2000
1600
800
400
0
400
800
1200
X_L (ohms)
70
X_L
30
0
30
X_C
70

V is approximately 0.66 for coaxial cables, 0.8 for foam dielectric coaxial cables, 0.82 for twin-lead cables.

To find the frequency at which a given line is an electrical quarter wave first set the noise bridge by shorting the "Unknown" terminal and adjusting the R and X knobs for null. The null will be at R=0 and X=0 but, by using this procedure you will be able to set the knobs more accurately than by reading the printed scales.

Now connect your quarter-wave line to the "Unknown" terminal Leave the other end of the line open. Tune the receiver to the expected frequency. If the line is an exact electrical quarter wave, the null will be at X=0. If the receiver is tuned too low in frequency the null will be on the X_C side. If the receiver is tuned too high, the null will be on the X_L side of zero. If the null is not sharp, adjust the R knob slightly (Losses in the line show up as increased R readings).

If it is desired to prune the line to resonance at a given frequency the line should be disconnected from the R-X Bridge. Short the "Unknown" terminal and adjust the X and R controls for a null with the receiver at the desired frequency. Reconnect the line and do not readjust the X control. Find the quarter wave frequency by tuning the receiver to null and adjusting the R knob for a sharp null. Prune the line slightly, retune the receiver, and repeat the procedure until the desired frequency is reached.

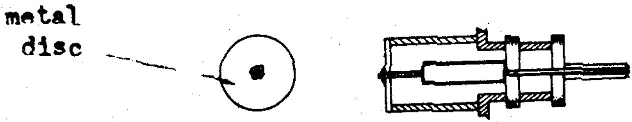
The length of a halfwave line is:

$$L_{(feet)} = \frac{492}{f} V$$

To find the frequency for a halfwave line, the far end of the line should be short-circuited (instead of open-circuited as for a quarter wave line). Then follow the same procedure as described for quarter wave lines.

Calibration. The R-X Noise Bridge has wide range controls (0-250 ohms and ±70-pf) to take care of the many uses to which it may be put. Because of this, and because of variations in bridge components, the dials cannot be read as precisely as desired for some measurements. To find the precise setting for a given antenna resistance and to check the calibration of the bridge, resistors of known values can be connected to the "Unknown" terminal. ¼ watt or ½ watt carbon resistors are suitable for this purpose. They should be mounted in a PL-259 coaxial plug as shown below. The plug is then mated with the "Unknown" receptacle of the Noise Bridge.

Resistors connected to the "Unknown" terminal by banana plugs or other open wiring methods invariably will give *incorrect* X readings because of lead inductance.

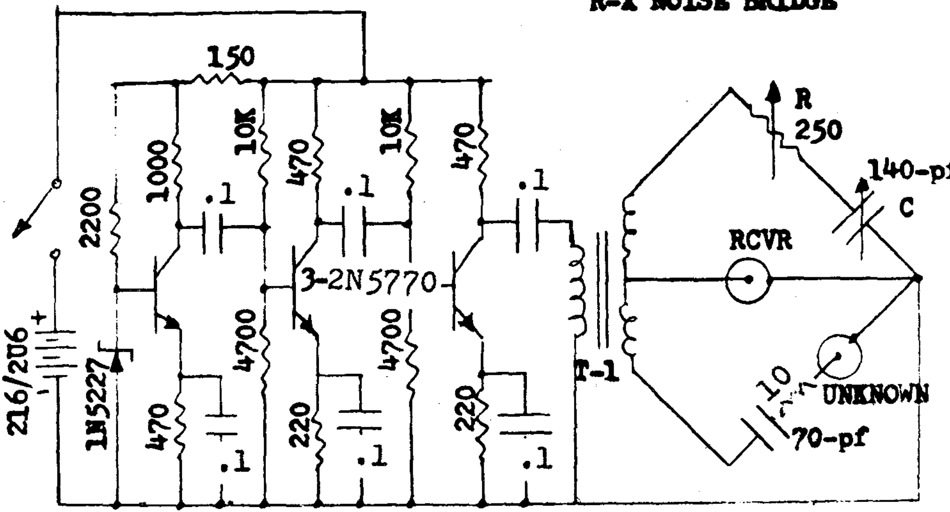


Reactance Chart. Refer to the schematic diagram on page 7. R and C are the panel controls labeled R and X. C = 70 pf at a dial reading of X = 0. There is a 70-pf capacitor in series with the unknown. If the unknown series resistance and reactance are R_U and X_U then at null.

$$R = R_U \text{ and } X_C = X_U + X_{(70\text{-pf})}$$

Schematic

R-X NOISE BRIDGE



The reactance chart shows this last relationship with reactance values given for f=1-MHz. To find the reactance at higher frequencies divide the tabulated values by the frequency in MHz.

Trap Diploles. The noise bridge will give a null on each band that the trap dipole resonates. Start with the highest requency band and measure the resistance and reactance as described for a dipole. Adjust the center (or lower) section if necessary to resonate. Then repeat the procedure on the next lower band. The method works with either horizontal or vertical trap antennas.

Beams. Connect the noise bridge to the driven element. Tune your receiver to the operating frequency and read the resistance and reactance. Adjust the element to resonance if needed.

Test a Balun. How do you tell if a balun is good? Not with an ohmmeter, because most baluns have all input and output terminals connected together at DC; you read a direct short whether the balun is good or not.

Instead, connect your noise bridge to the coax fitting of the balun. Then, if it is a 1:1 balun, put a 50-ohm resistor across the output terminals. A ¼ or ½ watt carbon resistor will do.

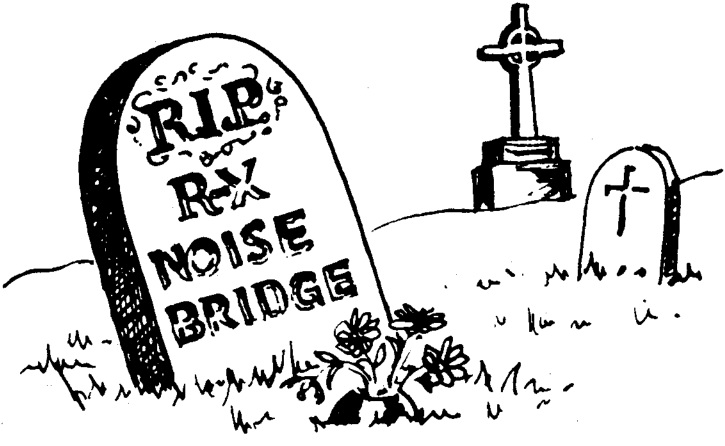
Now turn on the noise bridge and adjust it for null. You should read X = 0 and R=50 ohms.

<u>Save that Final</u>. If you use an antenna tuner, you can use the noise bridge to set its controls without turning on your transmitter. Just connect the noise bridge to the transmitter side of the tuner.

Set the noise bridge controls to X=0 and R=50 ohms. Adjust tuner for null. Now the tuner input is 50 ohms resistive, just what your transmitter wants to see.

CAUTION: Remove the noise bridge from the line before transmitting.

CAUTION!



Do not turn on transmitter or let VOX turn it on when R-X Noise Bridge is connected to antenna.