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RF 'Sample-Box' for 'Scope Monitoring Of Amateur Transmitter Output

By J. F. Sterner, W2GQK*

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Several years ago, W2GQK co-authored an article on adaptation of the RCA WO-33A 3-Inch Oscilloscope for use as "An RF Modulation Monitor" (RCA Ham Tips, Volume 20, No. 3, September, 1960). Since that time, a steadily mounting interest in frequency ranges above 50 MHz has suggested the need for a more simplified and versatile method of RF modulation monitoring that would eliminate "haywire," be more adaptable to higher frequencies, and prove more usable among oscilloscopes in general. The amateur radio operator is now offered such a device in the "sample-box" discussed by W2GQK in the following article. Of simple, straightforward construction, the sample-box requires a minimum of space and is readily affixed to the outer rear section of the oscilloscope case to become a permanent part of the instrument.

General Description

The sample-box is designed as an addition to the outer rear section of the oscilloscope case, as shown in Figure 1, to permit "looping through" of the antenna signal. A small sample of the RF voltage is coupled from the "looping-through" circuit to a capacitor voltage divider. A variable shunt capacitor is used at the bottom of the divider so that the RF signal to be applied to the vertical-deflection ("V") plates of the oscilloscope tube may be adjusted to the desired level.

Addition of the sample-box to the author's 52-ohm antenna transmission-line system has caused no noticeable change in VSWR, even at 144 MHz.

Although the application described in this article makes specific reference to the WO-33A oscilloscope, the sample-box may be attached to any general-purpose 3-inch or 5-inch instrument. Many oscilloscopes (such as the RCA 5-inch WO-91B, for example) even have jacks on the back of their casing for direct connection to the CRT deflection plates. This provision, of course, simplifies the hookup and merely requires that the sample-box be connected to the "V"-plate terminals.

In the author's experience, application of the RF signal to the "V" plates in a "single-ended" manner appears to render best results. If the sample-box is used with 'scopes that have both "V"-plate connections accessible, one of the plates must be grounded for RF as shown at P_2 in Figure 2. In addition, this "V"-plate connection should be isolated for DC by means of a capacitor. If it is not, a 0.001-microfarad, 1,000-volt capacitor should be inserted between P_2 and J_4 to prevent

*Electronic Instruments Operations, Harrison, N. J.

Figure 1: Rear section of WO-33A oscilloscope case with W2GQK's RF sample-box mounted and connected.

shorting of the oscilloscope circuitry.

It should be noted that the normal gain performance of the 'scope's internal "V" amplifier is reduced when the sample-box is connected to the deflection plate. The oscilloscope can be restored to original operating performance for other use by merely unplugging the two phono-type plugs from the sample-box.

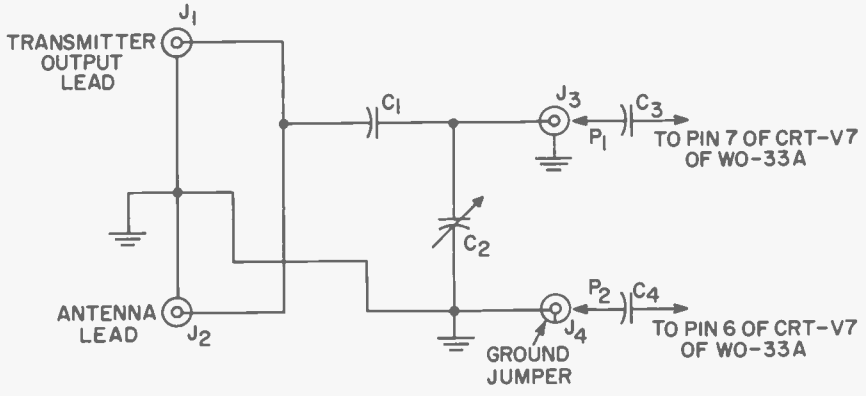
Construction

The builder is advised to follow closely the layout and assembly configurations shown in Figures 3 and 4. Length of the leads from J_3 and J_4 to the "V"-plate connections should not exceed 5 inches. A suggested step-by-step procedure for construction of the sample-box is as follows:

1. Drill all holes designated on the Mini-

Values of C_1 and C_2 to be Selected For Different Transmitter Power Outputs

Transmitter Power Output	C_1	C_2
Up to 5 Watts	15 pF	3-35 pF (Arco #403 or equiv.)
5 to 100 Watts	10 pF	7-100 pF (Arco #423 or equiv.)
100 to 1,000 Watts	10 pF	25-280 pF (Arco #464 or equiv.)



C_1 — Mica or ceramic (Select appropriate value for power of your transmitter from accompanying table.)

C_2 — Mica or ceramic (Select appropriate value for power of your transmitter from accompanying table.)

C_3 — 270 pF mica, 600 V ±10%

C_4 — 0.001 μF ceramic disc, 1,000 V ±20%

J_1, J_2 — Type SO-239 coaxial chassis fittings

J_3, J_4 — RCA-type phono jacks

P_1, P_2 — RCA-type phono plugs

Miscellaneous — One Minibox (2¾ by 2⅛ x 1⅝ inches); eight 4-40 by ⅜-inch pan head screws; eight 4-40 nuts; eight #4 T.T. lockwashers; one terminal connector; one Type-52B Cinch terminal strip; two #6 by ¼-inch sheet metal screws; and one socket punch for ⅝-inch holes.

Figure 2: Schematic diagram and parts list of W2GQK's RF sample-box.

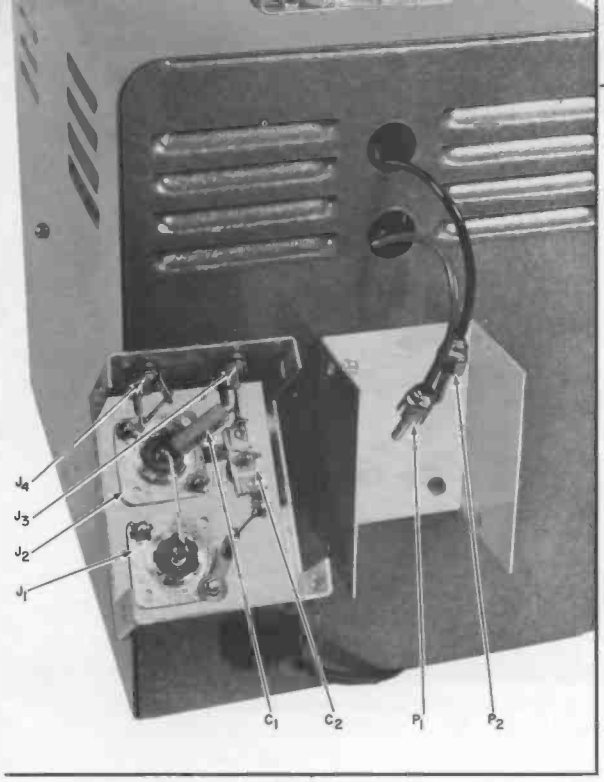


Figure 3: Open halves of RF sample-box showing wiring and mounting detail.

box and assemble the parts. During assembly, make certain that the adjusting screw at C_2 lines up with the "Adj." hole (Figure 4).

2. Remove the side and bottom screws from the case of the oscilloscope and slide out the oscilloscope chassis. (The WO-33A oscilloscope has two S.T. screws on each side and four on the bottom.)

3. Using Figure 3 as a reference, locate the proposed positions on the rear of the oscilloscope case for the two mounting screws (#6 S.T.) of the sample-box. After drilling and punching the 5/8-inch holes, attach the bottom half of the sample-box to the case, making certain that the screws will not short out any components of the chassis. Then attach the "snap-on" top portion.

4. Mount the terminal strip on the oscilloscope chassis to the left of the CRT, as shown in Figure 4. Connect the 270-picofarad and 0.001-microfarad capacitors on the terminal board to CRT socket pins 7 and 6. Then connect the two 5-inch leads to the terminal board.

5. Replace the oscilloscope chassis in its

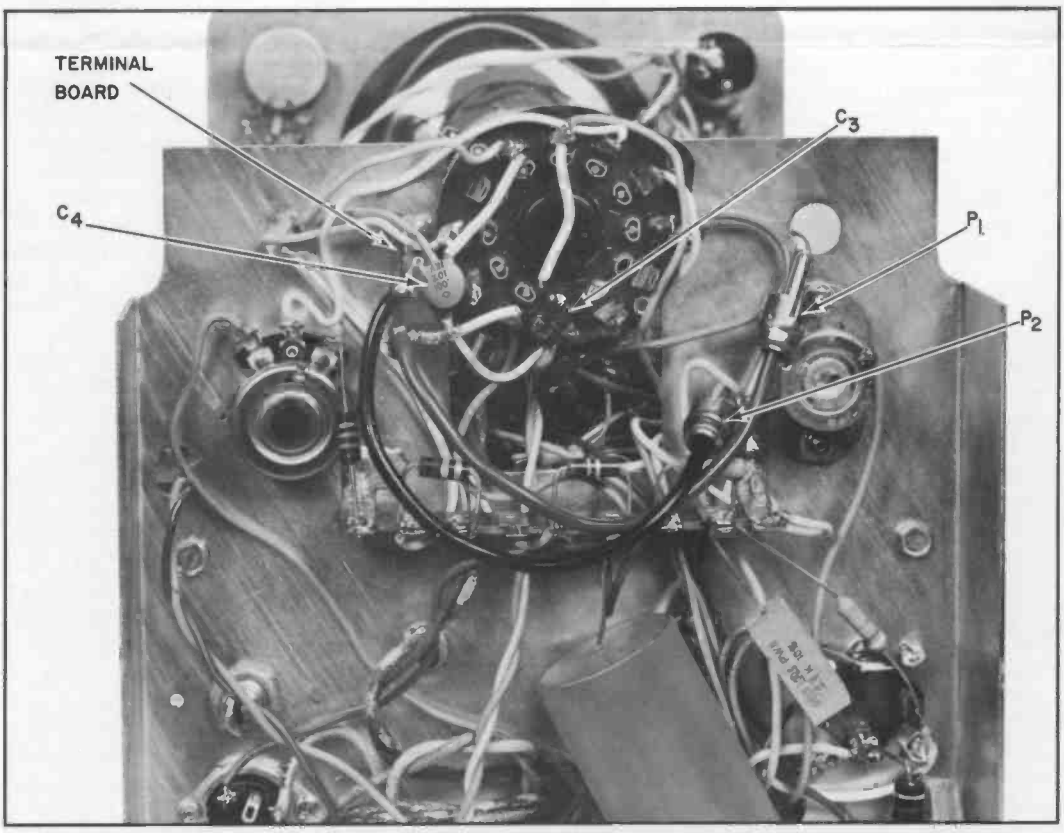


Figure 4: Rear section of chassis at CRT socket showing wiring and connections.

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case and bring the two 5-inch leads out through the rear holes. Solder a phono plug to each lead and insert the plugs into J_3 and J_4.

Connections and Operation On 50- or 75-Ohm Coaxial Antenna Feed System

• **Modulation Envelope Display Connections (AM).** Connect a length of coaxial cable between the transmitter output and J_1. This cable should have the same impedance as the antenna lead. Next, connect the antenna lead to J_2. Turn on the 'scope and set the "H/Sweep Selector" control to the LINE position. Adjust the horizontal line trace to a width of approximately 2 inches at the center of the CRT screen. Tune up the set for normal transmitting-load conditions. Adjust C_1 for a bar-type trace about 1 inch in height (no modulation). During modulation, the peaks should increase to a height of approximately 2 inches. (For further details and explanation of this type of pattern, the reader is referred to the ARRL Handbook and other similar publications.)

• **Trapezoidal Pattern Display Connections (AM).** In addition to sampling the RF output of the transmitter, the user must sample some of the audio signal from the modulator. The audio is used to provide horizontal deflection of the CRT beam and is applied between the "Ext Sync/H input" terminals of the 'scope. Because of the high gain of the 'scope "H" amplifier, however, shielded wire should be used for these connections. In addition, the "H/Sweep Sel" switch must be turned to the "H" input position. A typical adjustment procedure might be as follows:

1. Set the "H-Gain" control to minimum.
2. Turn on the transmitter and adjust the trace for a vertical line measuring 1 inch.
3. Modulate the transmitter while slowly advancing the "H-Gain" control, noting the formation of the trapezoidal pattern. (For additional information and analyses of trapezoidal patterns, the reader is referred to the ARRL Handbook and corresponding publications.)

Conclusion

Although connections for monitoring an SSB transmitter may vary widely from unit to unit, the basic principle of monitoring the RF power output remains the same in practically all cases.

The RF sample-box, it should be emphasized, offers a reliable and efficient means for connecting the RF signal of the transmitter to the "V" plates of an oscilloscope without encountering "haywire."

It follows, therefore, that in the various systems detailed in amateur radio handbooks, the sample-box can replace pickup loops and the like. This added benefit should greatly enhance the appeal and value of this device for most hams.