



HAM TIPS



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NUVISTOR PREAMPLIFIER For Amateur Receivers

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A comment frequently heard on the amateur bands is, "This receiver is fine on 80 up through 20 meters, but on 10 and 15 it seems to lose sensitivity." The problem is a common one, especially with older, general-coverage communications receivers which tune from 0.55 to 35 megacycles in four bands. Because the 10-meter band is near the upper limit of this tuning range, sensitivity often drops off as a result of stray capacitance and a less than optimum LC ratio for this frequency.

One solution to the problem is a ham-band-only receiver optimized for each band. However, on some older models of this type, 10-meter sensitivity still is not satisfactory. All-band preselectors are also available, but these are expensive, elaborate, and bulky; also the extra boost is usually not needed on the lower frequencies. This article describes a preamplifier that adds 25 to 35 db gain ahead of the receiver on the desired band and can be built for less than \$15 from readily available parts.

Design Features

The unit (shown below) is built around a pair of RCA-6CW4 nuvistor triodes. These tiny high-mu triodes, designed for use as



Top view of authors' nuvistor preamplifier designed around two RCA-6CW4's.

TABLE I: PERFORMANCE DATA

Band—meters	Frequency—Mc	Gain—db
15	21.0	30
	21.5	30
10	28.0	27
	29.0	29
	30.0	26
6	50.0	17
	51.5	16

TV-tuner rf amplifiers, work exceptionally well at 30 Mc. The preamplifier provides ample gain ahead of the receiver and improves the signal-to-noise ratio. The resulting overall sensitivity is equal to that of many higher-priced receivers. Gain measurements for the unit are shown in Table I.

As an example of what can be expected from this preamplifier, a 10-meter unit was

TABLE II: COIL DATA

Band—meters	Coil	C ₁	C ₂	Links
15	L ₁ —18 turns #32 enameled wire on ¼-inch slug-tuned form L ₂ —18 turns #32 enameled wire on ¼-inch slug-tuned form	15 μμf	15 μμf	1½ T
10	L ₁ —18 turns #32 enameled wire on ¼-inch slug-tuned form L ₂ —18 turns #32 enameled wire on ¼-inch slug-tuned form	5 μμf	5 μμf	1½ T
6	*L ₁ —10 turns #32 enameled wire on ¼-inch slug-tuned form *L ₂ —10 turns #32 enameled wire on ¼-inch slug-tuned form	5 μμf	6.8 μμf	1½ T

Note: All coils Cambion CTC DL5M 10 Mc.

*Same 10 Mc coil as above with 8 turns removed.

used ahead of a 10-year-old, general-coverage, single-conversion receiver in the \$200 class. At 29 Mc, the receiver alone has a 10-db signal-to-noise ratio at an input of 20 microvolts. With the preamplifier ahead of the receiver, a 10-db signal-to-noise ratio is obtained at a 2.5-microvolt input. This improvement represents a sensitivity increase of 8 times at an equivalent signal-to-noise ratio. The preamplifier output impedance is 75 ohms, while the receiver input impedance may vary from 100 to 300 ohms depending on the design of the input network. If the unit is properly matched to the receiver, sensitivity can be improved even more.

An improvement in signal-to-noise ratio results from the lower noise factor of the nuvistor circuit as compared to that of older pentode amplifier designs. A noise figure of 4.5 db was measured for the nuvistor preamplifier by means of the noise-generator method. With the added gain of the preamplifier, the receiver front-end contributes negligible noise to the system. The noise factor of the preamplifier could be improved an additional 1 db by precise adjustment of the input link and proper tuning. However, the simplicity of alignment would be lost, and the resulting improvement in performance would be difficult to detect in actual use.

TABLE III: ALIGNMENT DATA

Band	Tune L ₁ to	Tune L ₂ to
15 M	21.25 Mc	21.25 Mc
10 M	32.00 Mc	29.50 Mc
6 M	51.00 Mc	50.00 Mc

Construction and Alignment

Similar to the cascode amplifier in the ARRL Amateur Handbook, the circuit, shown in Figure 1, is used in many TV tuners. It has been reduced to its basic form to simplify construction and alignment. As indicated in Table II, a 1½-turn link around the hot end of L₁ matches a 75-ohm coaxial transmission line to the high-impedance input of a conventional grounded-cathode amplifier V₁. The output of V₁ is fed to the cathode of V₂, a grounded-grid amplifier in which the output appears across plate coil L₂. Another link around L₂ couples the output signal to a 75-ohm line to the receiver. Even though this type of amplifier is inherently stable, ample decoupling and bypassing have been included in the design. V₁ and V₂ are operated in a stacked arrangement in series with the B+ supply. Proper bias for V₂ is maintained by tying the grid back to the plate of V₁ through R₃. Because V₂ receives a larger signal than V₁, additional bias for V₂ is obtained across R₂.

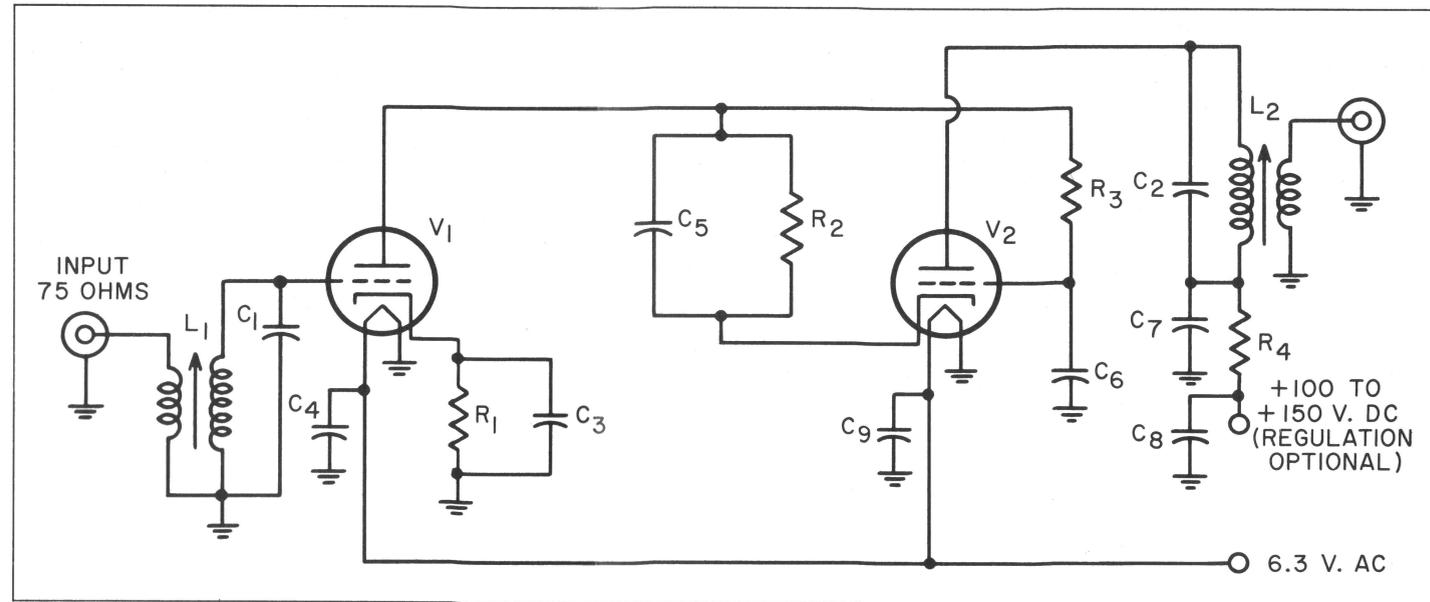
All the parts required are available through local RCA tube distributors, including the 6CW4 nuvistor triodes and sockets. Although lower-cost tube types may be used for V₁ and V₂, only the 6CW4 provides all the advantages of small size, low power drain, and excellent performance. In addition, two separate tubes provide better isolation and a more stable amplifier.

A 1½- by 2- by 4-inch aluminum minibox, shown in Figure 2, provides more than enough room for construction. As in any circuit at this frequency, leads should be kept short and the input isolated from the output.

Although the circuit is not especially critical, a shield has been placed between the two triodes for maximum isolation. Oscillation, which should not occur if the input and output are connected to the proper impedances, may be encountered if the antenna is not connected.

The original 10-meter unit was designed to use high-Q tuned circuits to obtain a flat-topped response over the band, and required careful tuning with the aid of a sweep generator and 'scope to obtain the desired response. The unit described in this article uses lower-Q tuned circuits which have a broader response. This arrangement is not only easier to align initially, but is also less sensitive to changes in supply voltage and loading. Alignment data for three bands are listed in Table III. The difference in gain over the band is not sufficient to degrade performance.

A grid-dip oscillator may be used to pre-set the coils at the correct frequency. For 15 meters, adjust L_1 and L_2 to a maximum indicated signal on the S-meter of the receiver with the preamplifier connected and a 21.25



- C_1, C_2 —see coil data, Table II
- $C_3, C_4, C_5, C_6, C_7, C_8, C_9$ —0.001 μf , ceramic, 500 v
- L_1, L_2 —see coil data, Table II (Link: $1\frac{1}{2}$ turns #32 enameled wire on form over other turns)
- R_1, R_2 —100 ohms, $\frac{1}{2}$ w, carbon
- R_3 —470,000 ohms, $\frac{1}{2}$ w, carbon
- R_4 —1,000 ohms, $\frac{1}{2}$ w, carbon
- V_1, V_2 —6CW4

Figure 1: Schematic diagram and parts list.

Mc input signal. For 10 and 6 meters, adjust L_1 and L_2 with a grid-dip oscillator to the frequencies indicated in Table III, with no power connected to the preamplifier. The grid-dipper frequency should be checked against a reliable standard to insure correct align-

ment. The preamplifier cannot be tuned for 10 and 6 meters with a grid-dip oscillator if the heaters are on because grid current in V_1 , due to the signal from the dip oscillator, will result in a false indication or no dip at all. If a sweep generator and 'scope are available, alignment is no problem. Simply tune the coils so that the edges of the band fall at the -3 db points on the response curve. The links should not have to be adjusted during alignment.

The preamplifier may be mounted inside the receiver cabinet, but should be more convenient to disconnect if mounted on the back near the antenna terminal. The maximum length of coaxial cable between the receiver and the preamplifier should not exceed 12 inches. The small power requirements (5 milliamperes at 150 volts and 0.26 amperes at 6.3 volts) may be obtained from the receiver through the accessory plug. The unit described uses 75-ohm coaxial connectors for easy changeover to bands where the preamplifier is not needed. If a balanced antenna system is used, terminal strips for the twin-lead may be used instead of coaxial connectors. In this case, the input link around L_1 would not be grounded. If 300-ohm twin-line is used for the input, one extra turn should be added to the input link to match the line.

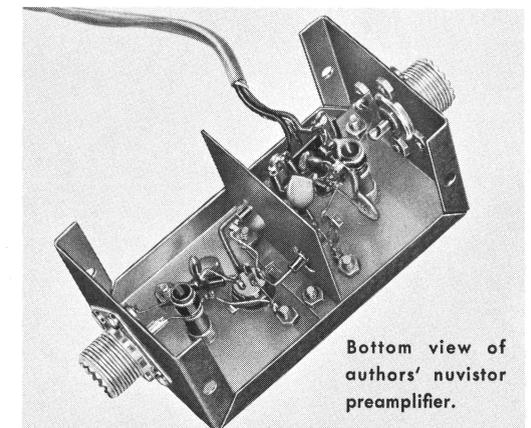
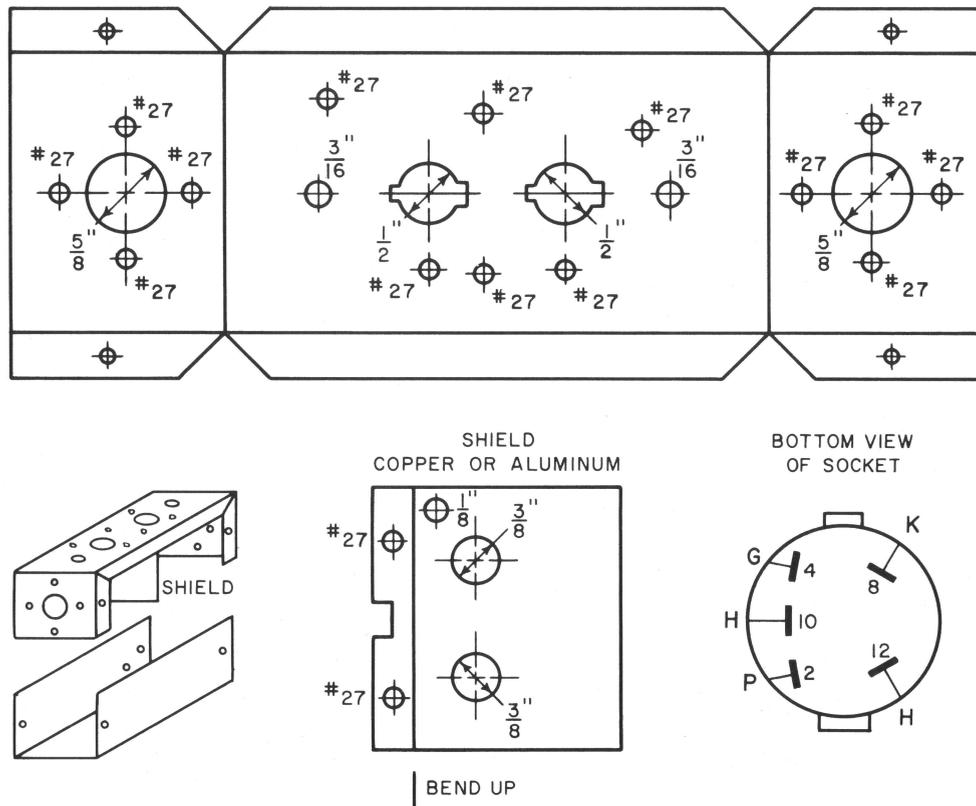
When to Use

The nuvistor preamplifier is not intended to improve the image rejection of a single conversion receiver. Because response is intentionally made broad to eliminate tuning during operation, images will be present whether the unit is used or not. The increased sensitivity of the receiver due to the nuvistor

unit will be apparent from the rise in background noise level. In addition, signals that were previously about equal to the background noise in strength will be 3 or 4 S-units above the noise with the preamplifier connected, due to the improvement in signal-to-noise ratio in the front-end. The greatest improvement will be noticed in receivers having poor sensitivity initially. Little advantage is gained in receivers which have 1.5 to 3 microvolt sensitivity and a good signal-to-noise ratio. If it is desired to use this circuit on 6 meters, the design can be incorporated in a crystal-controlled or tunable-type converter. This arrangement would eliminate tracking problems because the rf section would not have to be tuned after initial alignment.

The nuvistor preamplifier has been designed for best performance consistent with simplicity and ease of construction and alignment. If you have not been hearing those signals on ten, here is the opportunity to obtain top performance from your receiver with a minimum investment.

Figure 2: As stated in the text, a 1½-by 2-by 4-inch minibox provides more than enough room for construction.



Bottom view of authors' nuvistor preamplifier.

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*For low noise-level applications. †Same as RCA-872A, but has long-pin base.



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