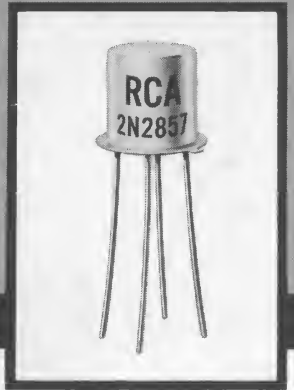




# HAM TIPS



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## A LOW-NOISE UHF TRANSISTOR AMPLIFIER

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RCA Electronic Components and Devices

RCA's recently announced 2N2857 npn silicon transistor opens new possibilities in the construction of extremely low-noise UHF transistor receivers and converters for mobile and fixed-station operation.

The 2N2857 utilizes a new miniature electrode structure which provides a very low noise figure (4.5 db max at 450 megacycles), high power dissipation capability (200 milliwatts at 25° C free air temperature and 300 milliwatts at 25° C case temperature), very low leakage at high temperatures, and very small variation in noise figure with temperature ( $\pm 0.5$  db from  $-40^{\circ}$  to  $+100^{\circ}$  C). Under typical operating conditions in 30- or 60-megacycle intermediate-frequency amplifier applications ( $V_{CC} = 6$  volts,  $I_C = 1$  milliampere, and  $R_G = 400$  ohms), the noise figure of the 2N2857 can be as low as 2db. A 15-db gain and 7.5-db noise figure can be realized in 450-to-30 megacycle converter service.

Designed for UHF, specified for UHF, and 100%-tested for UHF, the RCA-2N2857 can be operated as a common-base oscillator to 1,500 megacycles, and as an amplifier to 1,000 megacycles.

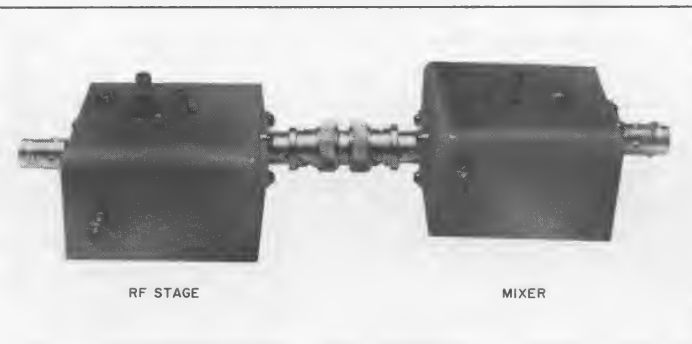


Figure 1: Authors' low-noise UHF transistor amplifier showing two basic chassis (single-stage amplifier, left, and converter, right) as combined unit.

\*Commercial Receiving Tube and Semiconductor Division, Somerville, N. J.

If you were among those who attended the 1962 ARRL Convention in Portland, Ore., you may have seen the demonstration of RCA's new 2N2857, a silicon low-noise VHF/UHF transistor used as an amplifier in a 450-megacycle receiver application.

Among the characteristics of the 2N2857 at 450 megacycles are its unneutralized wide-band (approximately 50-megacycle) power gain of 8 db, its neutralized narrow-band (approximately 8-megacycle) power gain of 15 db, and its low noise figure of 4.0 db.

At the show, a single unneutralized common-emitter rf stage was the main unit of demonstration. In addition, a single-stage self-oscillating converter using the 2N2857 was utilized to facilitate detection by a com-

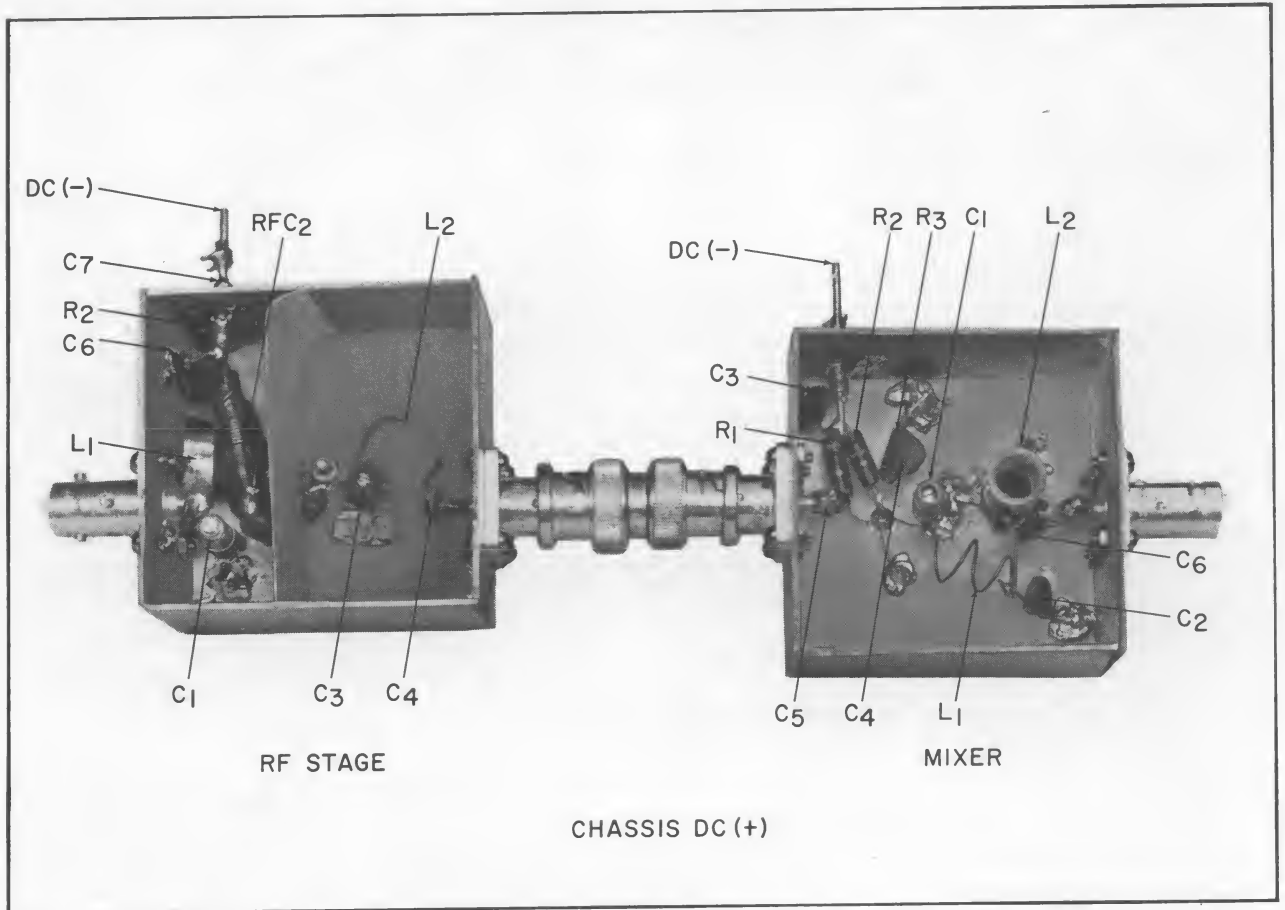
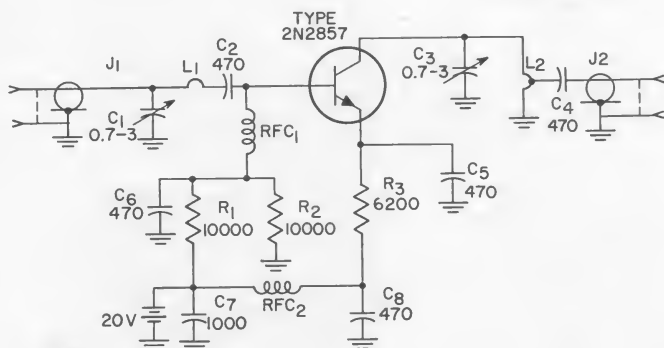


Figure 2: Bottom view of single-stage amplifier chassis, left, and converter chassis, right.

mercial communications receiver at 29 megacycles.

Figure 1 shows the two basic chassis connected. The single-stage amplifier chassis is at the left, and the converter is in the small chassis at the right. A bottom view of these chassis is shown in Figure 2. The tuning inductors in the amplifier stage are lengths of thin copper ribbon curved to approximate a semicircle. These strips, which represent approximately 20 nanohenries of inductance, are relatively high-Q coils. This condition

does not mean that the over-all Q of the circuit is high, but only that there are negligible losses in these elements. In fact, in view of the level of reactance chosen (20 nanohenries), and the low parallel input and output resistance of the device at 450 megacycles, the loaded Q of the input tuning circuit is extremely low and that of the output circuit moderate. Accordingly, the input tuning should be used primarily for matching the device to the antenna or source impedance. The output tuning of the stage sets the selec-



- C<sub>1</sub>, C<sub>3</sub>—0.7-3 pf ceramic disc (Erie 535C or equiv.)
- C<sub>2</sub>, C<sub>4</sub>, C<sub>5</sub>, C<sub>6</sub>, C<sub>8</sub>—470 pf ceramic disc (Erie ED470 or equiv.)
- C<sub>7</sub>—1,000 pf feedthrough (Erie 2404-102 or equiv.)
- J<sub>1</sub>, J<sub>2</sub>—Coaxial chassis connector BNC
- L<sub>1</sub>, L<sub>2</sub>—1/2 turn, 1/4-inch-wide by 1 1/2-inch-long copper foil
- RFC<sub>1</sub>, RFC<sub>2</sub>—0.2 μh
- R<sub>1</sub>, R<sub>2</sub>—10,000 ohms, 1/4 watt
- R<sub>3</sub>—6,200 ohms, 1/4 watt

Figure 3: Schematic diagram and parts list of unneutralized rf stage.

$C_1$ —0.7-3 pf ceramic disc (Erie 535C or equiv.)  
 $C_2$ —33 pf ceramic disc (Erie ED33 or equiv.)  
 $C_3$ —1,000 pf feedthrough (Erie 2404-102 or equiv.)  
 $C_4$ —1,000 pf ceramic disc (Erie ED1000 or equiv.)  
 $C_5$ —470 pf ceramic disc (Erie ED470 or equiv.)  
 $C_6$ —0.01  $\mu$ f ceramic disc (Erie ED 0.01 or equiv.)  
 $L_1$ —2 turns, #22 AWG,  $\frac{1}{4}$  inch by  $\frac{5}{8}$  inch  
 $L_2$ —8 turns, #22 AWG,  $\frac{3}{32}$ -inch form,  $\frac{1}{2}$ -inch long, powdered iron slug  
 $R_1$ —3,000 ohms,  $\frac{1}{2}$  watt

$R_2$ —12,000 ohms,  $\frac{1}{2}$  watt  
 $R_3$ —33,000 ohms,  $\frac{1}{2}$  watt

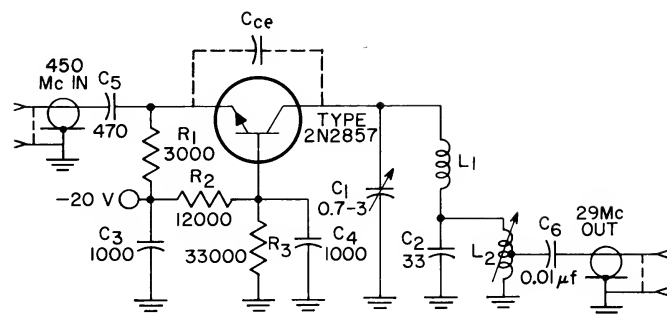


Figure 4: Schematic diagram and parts list of self-oscillating mixer.

$C_1, C_2$ —0.8-8 pf (JFD VC11G or equiv.)  
 $C_3, C_4$ —0.7-3 pf (Erie 535C or equiv.)  
 $C_5, C_6, C_7, C_8$ —500 pf ceramic disc (Erie ED500 or equiv.)  
 $J_1, J_2$ —Coaxial chassis connector BNC  
 $L_1, L_2$ — $\frac{1}{2}$  turn,  $\frac{1}{4}$ -inch-wide by  $1\frac{1}{2}$ -inch-long copper foil  
 $L_3$ — $\frac{1}{2}$ -turn, #12 AWG Bus wire  
 $RFC_1$ —0.2  $\mu$ h phenolic core  
 $R_1$ —6,800 ohms,  $\frac{1}{4}$  watt  
 $R_2$ —2,700 ohms,  $\frac{1}{4}$  watt  
 $R_3$ —1,000 ohms,  $\frac{1}{4}$  watt

#### Neutralization Procedure:

1. Connect a 450-megacycle signal generator (with  $Z_{out}=50$  ohms) to the input terminals of the amplifier.
2. Connect a 50-ohm rf voltmeter across the output terminals of the amplifier.
3. Apply the supply voltage (-8 volts) and, with the signal generator adjusted for 10-millivolt output, tune  $C_1, C_2$  and  $C_3$  for maximum output.

4. Interchange the connections to the signal generator and the output indicator.

5. With sufficient signal applied to the output terminals of the amplifier, adjust  $C_4$  for a minimum indication at the input.

6. Repeat steps 1, 2, and 3 to determine whether re-tuning is necessary.

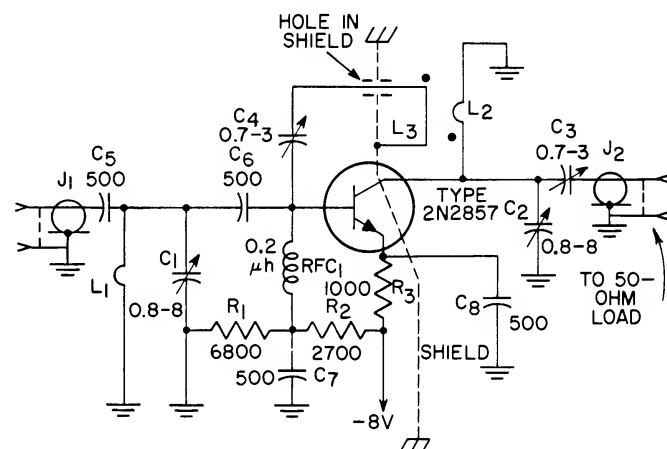


Figure 5: Schematic diagram and parts list of neutralized rf stage.

#### RCA-2N2857 NPN Silicon Transistor Electrical Specifications

$BV_{CBO}$	at $I_C=1\mu a$	30 volts min.
$BV_{CEO}$	at $I_C=3ma$	15 volts min.
$BV_{EBO}$	at $I_E=10\mu a$	2.5 volts min.
$I_{CBO}$	at $V_{CB}=15$ volts	0.01 $\mu a$ max.
$h_{FE}$	at $V_{CE}=1$ volt $I_C=3$ ma	30—150
$h_{fe}$	at $V_{CE}=6$ volts, $I_C=5$ ma, $f=100$ Mc	10—19
$G_{pe}$ (neut. power gain)	at $V_{CE}=6$ volts, $I_C=1.5$ ma, $f=450$ Mc	12.5—19 db
N.F. (Noise Figure)	at $V_{CE}=6$ volts, $I_C=1.5$ ma $f=450$ Mc	4.5 db max.

tivity by choice of appropriate reactance level, i.e., the reactance of the parallel tuning capacitance or inductance at resonance.

Figure 3 shows the single-stage amplifier, which uses a pi-matching network at the input consisting of the parallel tuning capacitor, the series inductance copper strip,  $L_1$ , and the parallel input capacitance of the transistor. The output is simply a tuned tank circuit having the inductance tapped to match the parallel input resistance of the following stage. An alternate method of matching to the next stage is to place a small variable capacitor (0.8—8 picofarads) in series from the collector side of the tank to the next stage. It should be realized that this approach, in effect, places additional capacitance in parallel with the tank inductance and, consequently, may re-

quire a smaller value of inductance,  $L_2$ , to resonate at the desired frequency. The parallel input capacitance of the converter is tuned out as part of the over-all tank capacitance of the previous stage.

Figure 4 shows the self-oscillating mixer employing the 2N2857. This circuit oscillates because of the capacitance feedback within the transistor, and is frequency-dependent on the  $L_1$ - $C_1$  tank circuit.  $C_2$  has small reactance compared to  $L_1$  at the radio frequency, but resonates with  $L_2$  at the intermediate frequency.

UHF gain up to 19 db can be obtained from the 2N2857 in the 450-megacycle neutralized circuit shown in Figure 5—if the neutralizing capacitance,  $C_4$ , is carefully adjusted. The feedback coupling loop,  $L_3$ , is a piece of No. 12 AWG copper wire running parallel to and approximately  $\frac{1}{4}$  inch from  $L_2$ . One end of  $L_3$  is connected to the grounded shield; the other end passes through a hole in the shield to the neutralizing capacitor. It is important that the ground end of  $L_3$  be placed adjacent to the signal end of  $L_2$  to achieve the phase reversal necessary for neutralization.

All of the circuits described have standard mica-filled phenolic transistor sockets designed to accommodate leads arranged in 0.1-inch pin circle. A suitable socket is the Elco 3307 or equivalent. The transistor leads should

be cut to about  $\frac{1}{4}$  inch for best operation. All components connected to the transistor should be mounted as close as possible to the socket to reduce the effects of stray reactances.

## ! ATTENTION HAMS !

Interested in a handy guide of metric-system terminology? You may find the following table a useful addition to your literature reference file.

### Metric System Unit Prefixes

Prefix	Abbreviation	Meaning
pico-	p	$10^{-12}$
nano-	n	$10^{-9}$
micro-	$\mu$	$10^{-6}$
milli-	m	$10^{-3}$
centi-	c	$10^{-2}$
deci-	d	$10^{-1}$
deca-	da	10
hecto-	h	$10^2$
kilo-	k	$10^3$
mega-	M	$10^6$
giga-	G	$10^9$
tera-	T	$10^{12}$

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