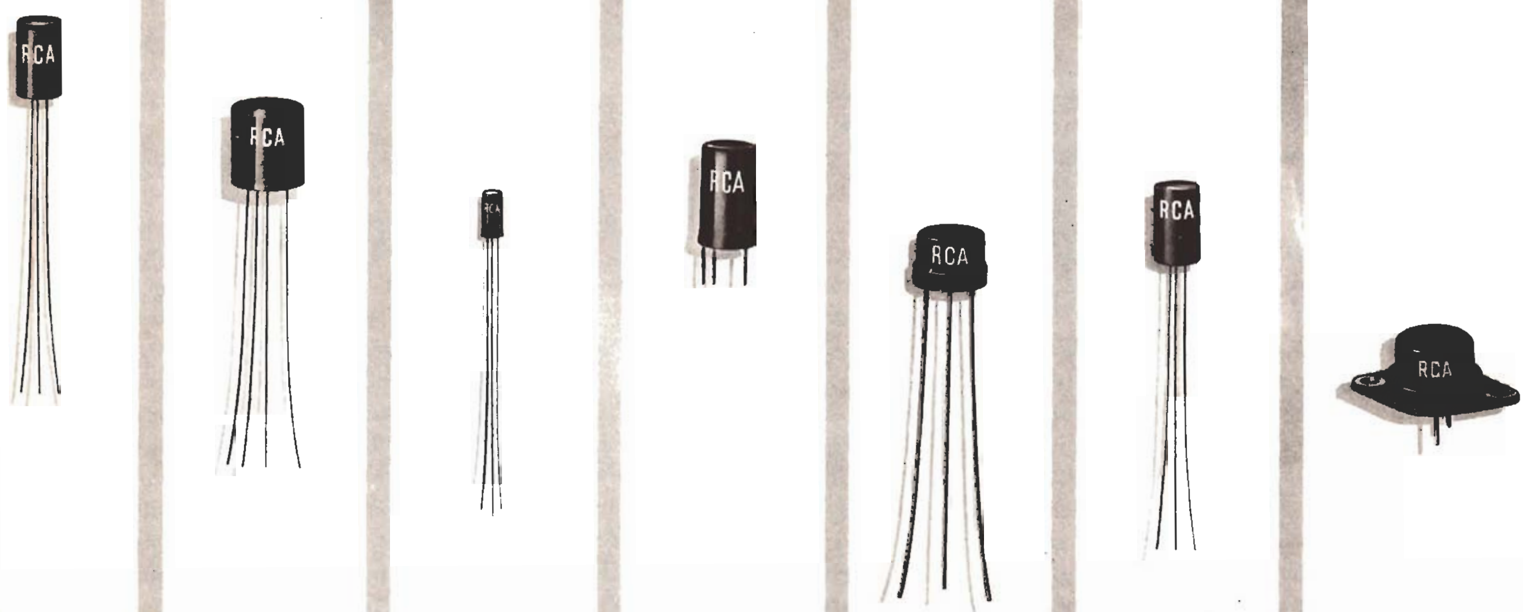
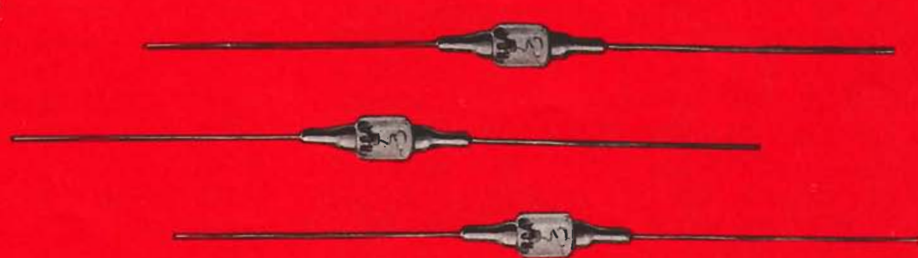
PRICE 25 CENTS



RCA Transistors and Semiconductor Diodes

- CHARACTERISTICS
- CIRCUITS
- THEORY
- INTERCHANGEABILITY DIRECTORY



RADIO CORPORATION OF AMERICA
SEMICONDUCTOR DIVISION SOMERVILLE, N. J.

FORM NO. SCD 106A
PRINTED IN U. S. A.

TRANSISTOR CONSIDERATIONS

INTRODUCTION

Transistors are a new form of electron device. They can perform many of the functions of an electron tube and, in addition, can do some things better and more efficiently than electron tubes. Unlike electron tubes which depend for their functioning on the flow of electrons through a vacuum, a gas, or a vapor, transistors make use of the flow of electric charge carriers in a solid — a semiconductor.

A semiconductor is a material having a conductivity lower than that of metals but higher than that of insulators. The conductivity of a material is determined by the number of charge carriers present. There are many varieties of semiconductors, but the two presently employed in the manufacture of transistors are germanium and silicon. Germanium in its very purest state behaves very much like an insulator because it has very few charge carriers. However, the conductivity of this material can be increased by the addition of almost infinitesimal amounts of certain impurities which cause an increase in the supply of charge carriers. Impurities such as antimony and arsenic increase the number of free electrons, or mobile negative charges while others such as gallium and indium increase the quantity of holes, or mobile positive charges.

The concept of a hole as a mobile positive charge with a definite mass and velocity dates back to 1931. This concept is really an abstraction from the equations of physics which describe the manner in which certain materials conduct electricity. These equations indicate that the material acts as if such a positive particle really existed. The term "hole" in the following discussion will denote a mobile "particle" having a positive charge. The notion of a hole is relatively new, but it is just as useful as the notion of the manner in which electricity is conducted by electrons. The conduction of electricity by electrons is also a very complex matter, though much is taken for granted about it.

A germanium crystal having more holes than free electrons is identified as p-type, because it depends on positive "particles" of electricity, holes, for conduction. On the other hand, a conducting germanium crystal having an excess of free electrons is identified as n-type, because it depends on negative particles of electricity, electrons, for conduction.

As previously implied, holes and mobile electrons are simultaneously present in both p-type and n-type materials. However, one kind of charge carrier predominates and is called the majority carrier. When a hole and a mobile electron meet, they combine with each other and cease to exist as *mobile* charges. This event is often referred to as a recombination. While this event is taking place, other electrons in the structure of the crystal are separated from the atoms they are associated with and result in new mobile electrons and holes to restore the equilibrium condition. There are many recombinations of holes and mobile electrons like these taking place every second in both p-type and n-type materials.

PRINCIPLES OF OPERATION

To gain some facility in the use of these concepts, consider the situation shown in Fig. 1. The applied electric field causes the holes in the p-type material to drift towards its upper end, point "A". At the same time the free electrons in the wire are repelled by the negative terminal of the battery towards the same point. When electrons enter the p-type material, they readily find holes with which to recombine. This recombination depletes the region around point "A" of holes. The equilibrium condition is restored by the arrival of new holes generated by electron-hole pairs within the p-type material. The new free electrons, released by the electron-hole pairs, move towards the positive terminal of the battery, while the holes move towards the end of the p-type material nearest the negative terminal of the battery in order to maintain equilibrium with electrons arriving in this area.

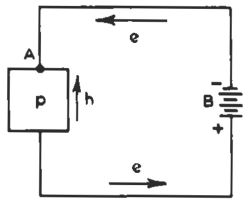


Fig. 1

Consider what happens when an n-type material and a p-type material are joined by suitable means and a voltage is applied as indicated in Fig. 2. The holes in the p-type material are repelled by the battery voltage towards the junction between the n-type and p-type materials, and the electrons in the n-type material are also repelled by the battery voltage towards this junction. In the vicinity of the junction, the holes and electrons meet and combine with each other, and thereupon cease to exist as mobile carriers. In some cases holes will flow a short distance into the n-type material or electrons will flow a short distance into the p-type material before combining. At the opposite end of the n-type material more electrons arrive from the negative terminal of the battery to replenish the electrons that combined with holes at the junction. Similarly, at the end of the p-type material farthest from the junction, electrons leave the crystal, because new holes are created in order to replenish those cancelled at the junction.

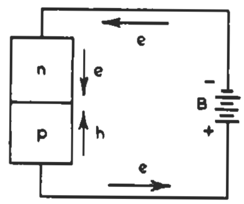


Fig. 2

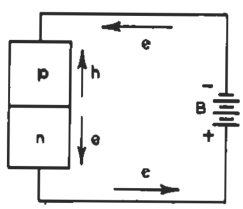


Fig. 3

Consider the case when the positions of the n-type and p-type materials are reversed as in Fig. 3.

There is an initial movement of the holes in the p-type material away from the junction, due to the attraction forces established by the battery voltage. In like manner there is an initial movement of the electrons in the n-type material away from the junction. Thus, there are practically no majority carriers left at the junction and a barrier or depletion region is formed. Conduction across this region practically ceases because it has very few mobile charge carriers. The mobile charges left are minority carriers and are capable of maintaining a current of only a few microamperes.

OPERATION OF JUNCTION TRANSISTORS

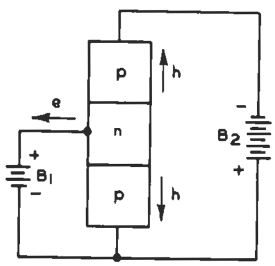


Fig. 4

The next case for consideration is illustrated in Fig. 4. The n-type material shown in Fig. 4 is only about one thousandth of an inch thick. The batteries maintain the voltage of the n-type material positive with respect to both p-type regions. There is, therefore, an initial movement of the mobile electrons in the base away from both junctions, and an initial movement of the holes in both of the p-type materials away from the base. After these initial displacements of charge carriers have taken place there is no further current flow because in the neighborhood of both junctions there are very few mobile charge carriers.

Consider the situation illustrated by Fig. 5. Since the voltage of battery B_2 is several times greater than the voltage of B_1, the voltage of the upper piece of p-type material is more negative than the voltage of the n-type material. Therefore, as in the preceding example, the region around the junction marked "C" is almost devoid of charge carriers. However, in the vicinity of the junction marked "E" there is a relatively high concentration of charge carriers because the lower piece of p-type material has a voltage more positive than that of the n-type material. It might seem at first that no current can flow due to the relative scarcity of charge carriers in the region of "C". However, the n-type material is relatively thin and may be regarded as porous as far as holes are concerned. The thin n-type material appears to be porous because this material has very few mobile negative charges relative to the number of holes diffusing through it, and because only a few of the holes will recombine with the electrons. Holes diffuse from the lower piece of p-type material near junction "E"

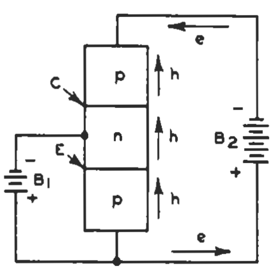


Fig. 5

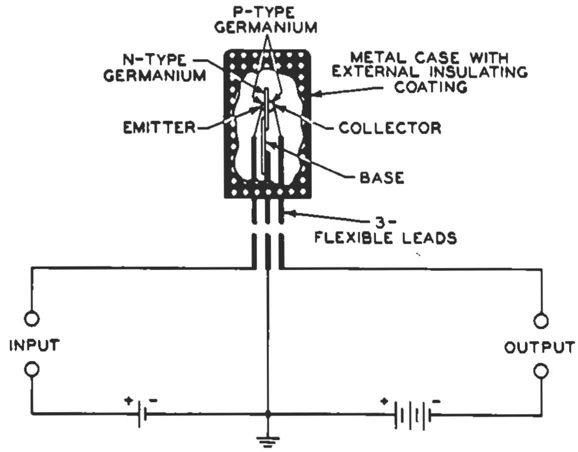


Fig. 6

through the n-type material and arrive at the upper piece of p-type material near junction "C". The lower piece of p-type material is referred to as the *Emitter;* the upper piece is referred to as the *Collector.* These names were adopted because the emitter emits charge carriers and the collector collects them. The junction marked "E" is, therefore, the emitter junction; the junction marked "C", the collector junction. The material between the two junctions is referred to as the *Base.* The complete structure constitutes the basic components of a p-n-p type of junction transistor such as the RCA-2N109, 2N175, 2N270 etc. A diagrammatic sketch showing the structural arrangement of a junction-type transistor with associated simple circuit is shown in Fig. 6.

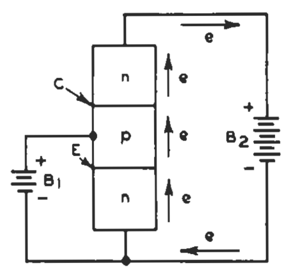


Fig. 7

The discussion of Fig. 4 and Fig. 5 illustrates the fact that the base-to-emitter voltage can, by controlling the density of holes at junction "E", also control the difference in the density of the holes between junctions "C" and "E". This control leads in turn to control of the rate of diffusion of holes through the base. The current in the collector circuit corresponds to this rate of diffusion of holes. In practice, the collector current of a p-n-p type transistor can be varied from a few microamperes up to the maximum current rating without exceeding a base-to-emitter voltage of zero volts. Moreover, the power which the base-to-emitter circuit utilizes in controlling the collector current is very small in comparison with the power available in the collector-to-emitter circuit.

A similar discussion for the n-p-n type of junction transistor will lead up to the circuit shown in Fig. 7, which is similar to Fig. 5.

However, observe the change in the relative positions of the n-type and p-type materials and the change in the battery polarities. In this case electrons are emitted by the n-type emitter. The electrons diffuse through the p-type base and are collected by the n-type collector. This type of transistor is referred to as an n-p-n junction type.

POTENTIAL ENERGY DIAGRAM

Much of the preceding discussion concerning the principles of operation of a transistor can be summarized by a potential-energy diagram. Such a diagram is shown in Fig. 8.

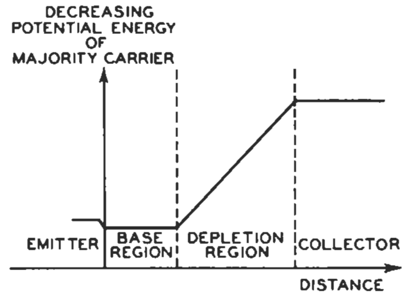


Fig. 8

An electron at the negative terminal of a battery has more potential energy than an electron at the positive terminal. Similarly, if the transistor is a p-n-p type and the collector is, therefore, connected to the negative terminal of the battery, a hole has the least potential energy when it reaches the collector. This diagram also applies to an n-p-n transistor but differs in that an electron has the least potential energy when it reaches the collector. A statement covering both cases is that the majority carriers originating in the emitter region move in the direction of decreasing potential energy. It is important to note that a small amount of energy must be supplied by the base-to-emitter circuit to move a majority carrier out of the emitter into the base. Because of the addition of this small amount of energy, the charge carrier has somewhat more potential energy in the emitter-to-collector circuit than it had before. Once the charge carrier has entered the base, the carrier mingles with the other charges in this region. Those carriers which find their way to the edge of the depletion region in the base are quickly swept across the depletion region by the electric field established by the collector-to-emitter supply voltage.

"DRIFT" TRANSISTORS

As previously noted, the signal current in a conventional transistor is transmitted across the base region by a diffusion process. The transit time of the charge carriers across this region is, therefore, relatively long. RCA has developed a technique for the manufacture of transistors which do not depend upon diffusion for the transmission of the signal across the base region. Transistors manufactured according to this new technique, such as the RCA-2N247, are known as "drift" transistors. Diffusion of charge carriers across the base region is eliminated and the charge carriers are propelled across this region by a "built-in" electric field. The resulting reduction in the transit time of the charge carriers permits "drift" transistors to be used at much higher frequencies than transistors of conventional design.

The "built-in" electric field is in the base region of the "drift" transistor. This field is achieved by utilizing an impurity density which varies from one side of the base to the other. The impurity density is high next to the emitter and low next to the collector. Thus, there are more mobile electrons in the region near the emitter than in the region near the collector and they will try to diffuse evenly throughout the base. However, any displacement of the negative charge leaves a positive charge in the region from which the electrons came, because every atom of the base material was originally electrically neutral. The displacement of the charge creates an electric field that tends to prevent further electron diffusion so that equilibrium condition is reached. The direction of this field is such as to prevent electron diffusion from the high density area near the emitter to the low density area near the collector. Therefore, holes entering the base will be accelerated from the emitter to the collector by the electric field. Thus the diffusion of charge carriers across the base region is augmented by the built-in electric field. A potential energy diagram for a drift transistor appears in Fig. 9.

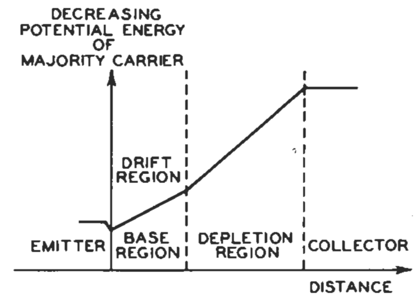


Fig. 9

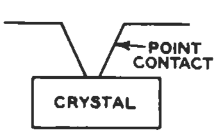


Fig. 10

The transistors discussed so far are known as junction transistors, and they may be made as either p-n-p types or n-p-n types. The essential idea in the manufacture of these transistors is to produce a sandwich-type assembly, i.e., p-type regions and n-type regions in intimate contact with each other. However, it is also possible to manufacture a transistor in which the points of certain kinds of wire touch the surface of an n-type crystal, as illustrated in Fig. 10. The points of the wires must be very close together. After the structure is completed, currents are passed through each of the two contact points in such a way that p-type material is formed in the region of the contact points. Such a transistor is referred to as a point-contact transistor, and has largely been superseded by the junction-type of transistor.

The point-contact type of semiconductor diode is also made by a similar technique, but this type of semiconductor device utilizes only a single point contact. The crystal on which the point contact is made may be either p-type or n-type.

SIGNIFICANCE OF POLARITY

In the preceding discussion, reference was made to the particular kind of charge carriers present. The following discussion will be in terms of conventional current flow, i.e. the flow of positive charge from the positive terminal of the battery to the negative terminal as shown in Fig. 11. The actual flow is a flow of negative charge (electrons) from the negative terminal of the battery to the positive terminal. Because the discussion is based on conventional current flow, the current will flow counterclockwise through the resistor and circuit. Suppose that the magnitude of the current is 10 milliamperes. If the direction of the current is important to the discussion, it can be assumed that the positive direction of the flow of the positive charges is counterclockwise around the circuit and the value of the current is + 10 milliamperes. However, if it had been assumed that the positive charges flowed in a clockwise direction, then the value of the current would be −10 milliamperes, the − sign indicating that the positive charges are actually flowing in a direction opposite to that assumed.

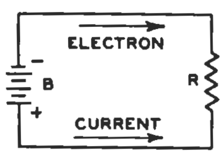


Fig. 11

Fig. 12

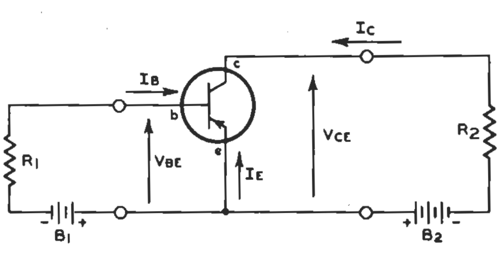


Fig. 13

It has been the custom for many years to assume positive directions of voltage and conventional current flow at the input and output of any device as indicated in Fig. 12. For example, a germanium junction transistor of the p-n-p type would be connected into a common-emitter circuit in the manner indicated in Fig. 13. The assumed positive directions of dc voltage and conventional dc currents are in conformity with the custom indicated in Fig. 12. The emitter current I_E is also assumed to flow into the transistor. Actually, the conventional base current I_B flows out of the transistor; the emitter current, into the transistor; and the collector current I_C, out of the transistor. Thus, the algebraic sign of the numerical value of the base current and of the numerical value of the collector current is negative, while the algebraic sign of the numerical value of the emitter current is positive. Also, as indicated by Fig. 13 the base voltage and collector voltage are negative with respect to the emitter. Therefore, the algebraic sign of the numerical value of V_{BE} and of

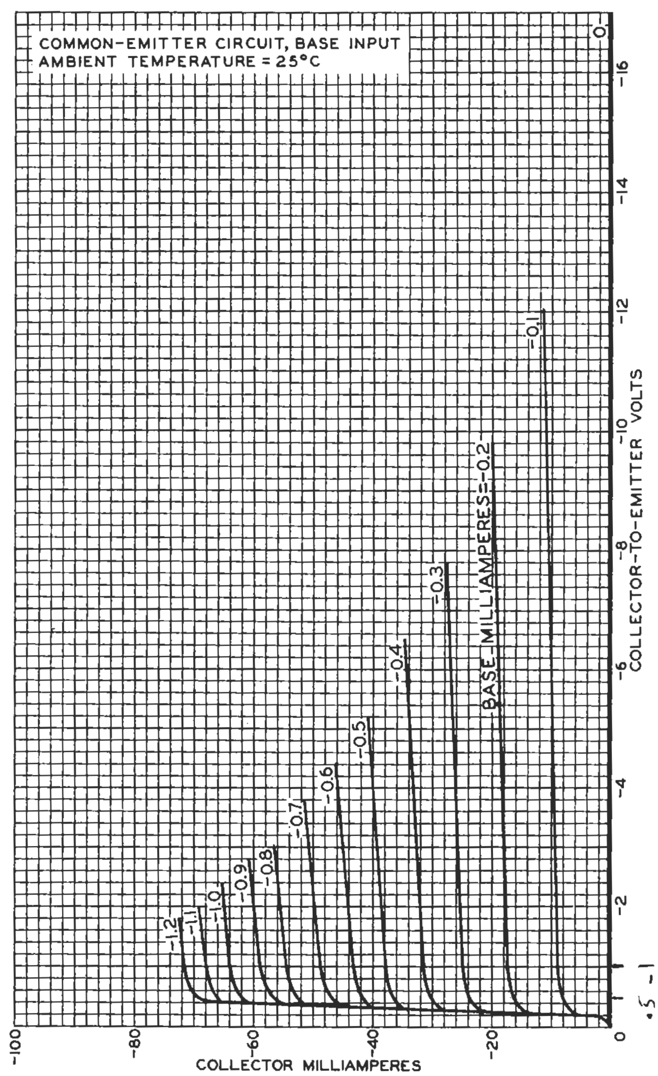


Fig. 14. Average Collector Characteristics.

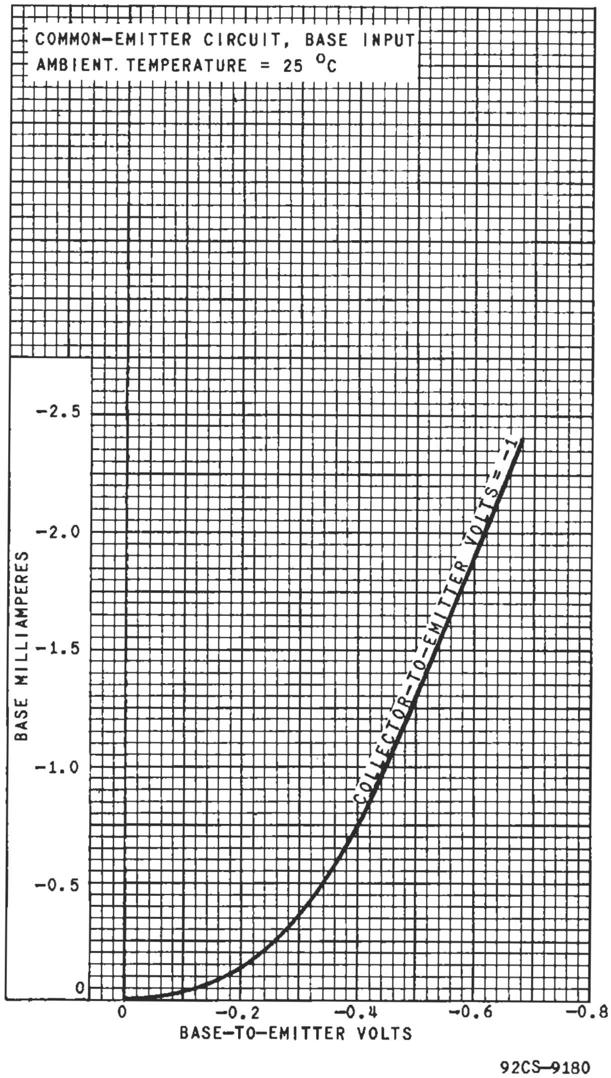


Fig. 15. Average Base Characteristics.

V_{CE} is negative.

These conventions require that the sign of the numerical values shown on the typical characteristics in Fig. 14 and Fig. 15 be negative.

The collector characteristics also show that the collector current is many times greater than the base current. For example, at a collector-to-emitter voltage of —4 volts and a base current of —0.05 milliamperes the collector current is —5 milliamperes. Since it has been assumed that all the currents flow into the transistor, the following equation can be written.

$$I_B + I_E + I_C = 0$$
$$I_E = -I_B - I_C$$

When the numerical values for the base current and collector current are substituted in this equation, the following result is obtained.

$$I_E = -(-0.05) - (-5)$$
$$I_E = 5.05 \text{ milliamperes}$$

There are two facts to be observed from this result. First, the collector current and emitter current are nearly equal, and second, the algebraic sign of the emitter current is positive, which indicates that the emitter current flows into the transistor as assumed.

Now, suppose that the resistance in the base circuit is reduced. This would cause the base current to increase in magnitude, for example, from —0.05 milliampere to —0.1 milliampere. This increase in base current will cause an increase in the magnitude of the collector current by about 4.5 milliamperes.

Because in practical circuits it is desirable to amplify signals, Fig. 13 has been redrawn in Fig. 16 with slight modifications.

When no signal is applied to the input, the transistor voltages and currents are at their quiescent values, and the top of the resistor in the base circuit is positive with respect to the bottom. Suppose a signal voltage V_{BE} of —0.045 volt is applied at the input. The top of the resistor in the base circuit is now less positive by 0.045 volt than it was before the signal was applied. More of the battery voltage V_{BB} must now appear between the base and emitter. The base current must, therefore, increase in magnitude from 0.05 milliampere to 0.1 milliampere. The collector current increases in magnitude by about 4.5 milliamperes, and the direction of flow is from top to bottom of the resistor in the collector circuit. Thus, V_{CE} becomes more positive in the indicated direction than it was before a V_{BE} of —0.045 volt was applied at the input. The common-emitter type of circuit, with base input, produces a 180° phase reversal, and the change in the output current is much greater than the change in the input current. Moreover, the resistance in the collector circuit is normally much greater than the resistance in the base circuit, resulting not only in a greater change in the collector current than in the base current, but also a greater change in the collector voltage than in the base voltage. Both of these factors contribute to the increase in the signal power output as compared with the signal power input.

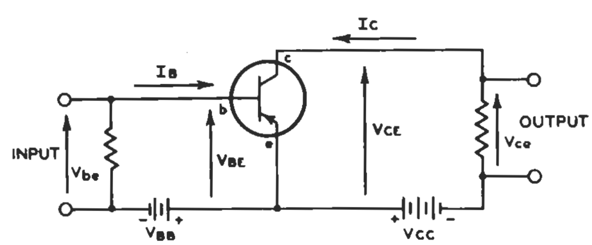


Fig. 16

Fig. 17 shows some typical amplifier circuits for junction transistors of the p-n-p type. These circuits may also be used for junction transistors of the n-p-n type provided the polarities are reversed.

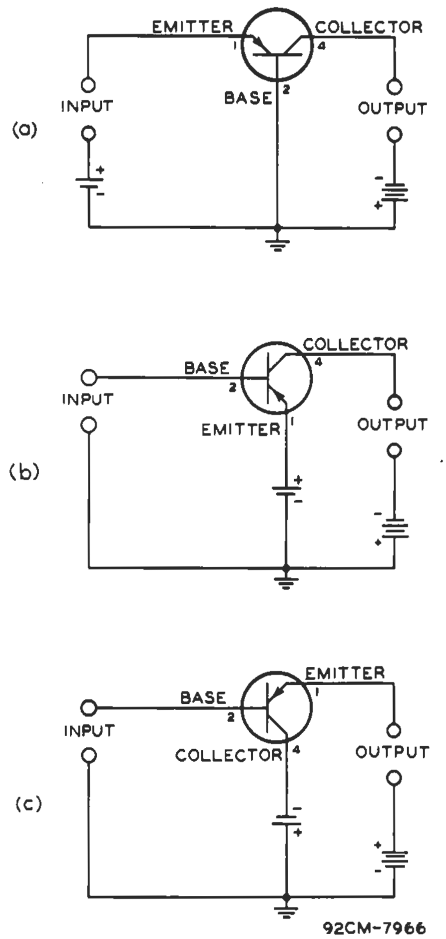


Fig. 17. Typical Amplifier Circuit Connections:
(a) Common-Base, Emitter-Input.
(b) Common-Emitter, Base-Input.
(c) Common-Collector, Base-Input.

DEFINITIONS

Alpha Cutoff Frequency. Frequency at which the forward current transfer ratio drops to 0.707 times its value at 1 kc.

Class A Amplifier. An amplifier in which the bias of the input electrode and the alternating input signal are such that output current flows at all times.

Class B Amplifier. An amplifier in which the bias of the input electrode is such that the output current is approximately zero when no alternating input signal is applied, and such that when an alternating input signal is applied, the output current flows for approximately one-half cycle.

DEFINITIONS (Continued)

Collector Transition Capacitance. The capacitance across the collector-to-base transition region. (A transition region is a region between two homogeneous semiconductor regions, in which the impurity concentration changes).

Large-Signal DC Current Transfer Ratio. The dc output current divided by the dc input current.

Small-Signal Current Transfer Ratio. The change in output current with ac output circuit shorted divided by the change in input current, measured at 1000 cycles per second.

Unilateralization. Unilateralization is a special case of neutralization in that the feedback parameters are completely balanced out. In the case of transistors, these feedback parameters include a resistive component in addition to capacitive component. Unilateralization changes a bilateral network into a unilateral network.

REFERENCES

For an analysis of drift transistors see — A. L. Kestenbaum and N. H. Ditrick, "Design, Construction and High-Frequency Performance of Drift Transistors", RCA Review, March 1957, Vol. 18, No. 1, pp. 12-23.

For a discussion of transistor physics, technology, and circuit applications, including 68-page bibliography, see — "Handbook of Semiconductor Electronics", McGraw-Hill Co., Inc., New York, New York, 1956.

For a selection of papers describing research and development work of RCA as it applies to the theory, fabrication, and application of transistors see—"Transistors I", RCA Laboratories, Princeton, New Jersey, 1956.

For descriptions of transistor manufacturing techniques see — E. W. Herold, "Semiconductors and the Transistor", Journal of the Franklin Institute, February, 1955, Vol. 259, No. 2, pp. 87-106.

For a general discussion of transistors see—A. W. Lo, R. O. Endres, J. Zawels, F. D. Waldhauer, and C. Cheng, "Transistor Electronics", Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1955.

For a discussion of H Parameters see—R. F. Shea, "Transistor Audio Amplifiers", John Wiley and Sons Inc., New York, New York, 1955, Chapter 2.

For a derivation of the hybrid-π equivalent circuit from physical considerations see—L. J. Giacoletto, "Study of p-n-p Alloy Junction Transistors from DC Through Medium Frequencies", RCA Review, December, 1954, Vol. 15, No. 4, pp. 506-562.

For a compilation of linear active four-terminal network equations see—L. J. Giacoletto, "Terminology and Equations for Linear Active Four-Terminal Networks Including Transistors", RCA Review, March 1953, Vol. 14, No. 1, pp. 28-46.

For a discussion of T Parameters see—W. A. Shockley, "Electrons and Holes in Semiconductors", D. Van Nostrand Co., Inc., New York, New York, 1950, pp. 37-41.

For a discussion of transistor physics see—W. A. Shockley, "Electrons and Holes in Semiconductors", D. Van Nostrand Co., Inc., New York, New York, 1950.

TYPE	CLASS OF SERVICE	GENERAL DATA — Electrical♦ — Minimum DC Collector-to-Base volts (for stated DC Collector Current µa)	Maximum DC Collector Current µa (for stated DC Collector-to-Base volts)	Maximum DC Emitter Current µa (for stated DC Emitter-to-Base volts)	Mechanical — Operating Position	Dimensional Outline and Basing or Lead Arrangement see pages 14-16	MAXIMUM RATINGS (Absolute Values) — DC Collector-to-Base volts	DC Emitter-to-Base volts	DC Collector Current ma	DC Emitter Current ma	Collector Dissipation mw at ambient temperature of: 25°C	55°C	71°C	Ambient Storage Temperature● °C	TYPICAL OPERATION Ambient Temperature = 25°C — Circuit	DC Collector-to-Emitter volts	DC Collector Current ma	Current Transfer Ratio at 1 Kc
Germanium, p-n-p, alloy-junction types																		
2N77	Class A AF Amplifier	−30 at $I_C = -20$	−10 at $V_{CB} = -12$	—	Any	H	−25	—	−15	15	—	35	—	−65 to +85	E E C B	−4 −4 −4 −4	−0.7 −0.7 −0.7 −0.7	55 55 — 0.982
2N104	Class A AF Amplifier	−30 at $I_C = -20$	−10 at $V_{CB} = -12$	−10 at $V_{EB} = -12$	Any	B	−30	−12	−50	50	150	80	35	−65 to +85	E E C B B	−4 −6 −3 −3 −6	−0.7 −1 −0.2 −0.2 −1	— 44 — — 0.977
2N105	Class A AF Amplifier	−25 at $I_C = -10$	−7 at $V_{CB} = -12$	—	Any	C	−25	—	−15	15	—	35	—	−65 to +85	E E C B B	−1.3 −4 −1.3 −4 −1.3	−0.3 −0.7 −0.3 −0.7 −0.3	45 55 — 0.982 0.978
2N109	Large-Signal AF Amplifier	—	−14 at $V_{CB} = -25$	−14 at $V_{EB} = -12$	Any	B	−25 peak −12*	−12	−70 peak −35 avg.	70 peak 35 avg.	150	50	20	−65 to +85	E	−1	−50	75■
2N139	Class A 455-Kc Amplifier	−16 at $I_C = -10$	−6 at $V_{CB} = -12$	−12 at $V_{EB} = -0.5$	Any	B	−16	−0.5	−15	15	80	35	10	−65 to +85	E E B B	−9 −9 −9 −9	−0.5 −1 −0.5 −1	45 48 0.978 0.980
2N140	540-1640 Kc Converter	−16 at $I_C = -10$	−6 at $V_{CB} = -12$	−12 at $V_{EB} = -0.5$	Any	B	−16	−0.5	−15	15	80	35	10	−65 to +85	E B	−9 −9	−0.6 −0.6	75 0.987
2N175	Class A Low-Noise AF Amplifier	—	−12 at $V_{CB} = -25$	−12 at $V_{EB} = -12$	Any	B	−10	−10	−2	2	50	20	10	−65 to +85	E B	−4 −4	−0.5 −0.5	65 0.985
2N206	Class A AF Amplifier	—	−10 at $V_{CB} = -30$	−10 at $V_{EB} = -12$	Any	H	−30	−12	−50	50	75	—	—	−65 to +85	E C B B	−5 −3 −3 −5	−1 −0.2 −0.2 −1	47 — 0.974 0.980
2N215	Like RCA—2N104 but has flexible leads.																	
2N217	Like RCA—2N109 but has flexible leads.																	
2N218	Like RCA—2N139 but has flexible leads.																	
2N219	Like RCA—2N140 but has flexible leads.																	
2N220	Like RCA—2N175 but has flexible leads.																	
2N247	Class A RF Amplifier	−40 at $I_C = -50$	−16 at $V_{CB} = -30$	−50 at $V_{EB} = -0.5$	Any	E	−35	−0.5	−10	10	80	50	35	−65 to +85	E E B	−9 −9 −9	−1 −1 −1	60 60 0.984
2N269	Low-Level Switch	−25 at $I_C = -20$	−2.5 at $V_{CB} = -2.5$	−2.5 at $V_{EB} = -2.5$	Any	D	−20	−9	−100	100	120	35	10	−65 to +85	B	−6	−1	—
2N270	Large-Signal AF Amplifier	—	−16 at $V_{CB} = -25$	−12 at $V_{EB} = -12$	Any	J	−25 peak −12*	−12	−150 peak −75 avg.	150 peak 75 avg.	250	150	60	−65 to +85	E E	−1 −6.7	−150 −19	70■ —
2N274	Class A RF Amplifier	−40 at $I_C = -50$	−16 at $V_{CB} = -30$	−50 at $V_{EB} = -0.5$	Any	I	−35	−0.5	−10	10	80	50	35	−65 to +85	E E B	−9 −9 −9	−1 −1 −1	60 60 0.984

♦ Cutoff Data. Collector-to-Base Voltage and Collector Current values obtained with emitter open. Emitter Current values obtained with collector open. Ambient temperature = 25°C.

● Storage or Operating Temperatures above 85°C will affect the serviceability of the transistor.

B = Common-Base, Emitter-Input Circuit.
C = Common-Collector, Base-Input Circuit.
E = Common-Emitter, Base-Input Circuit.
* For inductive load.
■ Large-Signal DC Current Transfer Ratio.

CHARACTERISTICS CHART I

TYPICAL OPERATION (Cont'd) Ambient Temperature = 25°C							CHARACTERISTICS For COMMON-EMITTER CIRCUIT, BASE INPUT at Ambient Temperature = 25°C Small-Signal Hybrid-π Parameters For equivalent circuit, see page 14										TYPE
Power Gain			Noise Factor			Alpha Cutoff Frequency Mc ($f_{\alpha b}$)	DC Collector-to-Emitter volts (V_{CE})	DC Collector Current ma (I_C)	Resistance ohms ($r_{bb'}$)	Conductance μmhos			Capacitance μμf		Intrinsic Trans-conductance μmhos (g_m)	Frequency For Unity Power Amplification‡ Mc	
Input Resistance ohms	Load Resistance ohms	Power Gain db	Generator Resistance ohms	Load Resistance ohms	Noise Factor† db					$g_{b'e}$	g_{ce}	$g_{b'c}$	$C_{b'e}$	$C_{b'c}$			
Small-Signal H Parameters and Small-Signal T Parameters are shown for some types on page 12.							**Germanium, p-n-p, alloy-junction types**										
1980 2670 500000 215	100000 2670 10000 500000	44.1 34.5 17 32.5	1000 — — —	20000 — — —	6.5 — — —	— — — 0.70	−4	−0.7	240	407	6.8	0.13	5000	40	22300	1.7	**2N77**
— 1400 500000 — 170	— 20000 18000 — 500000	— 41 14.3 — 32.4	518 — — — —	20000 — — — —	12 max. — — — —	— — — 0.53 0.70	−3 −6	−0.2 −1	300 290	174 727	1.28 6.62	0.3 0.36	1225 6900	36 40	5540 32000	1.6 1.6	**2N104**
4700 2300 500000 180 —	4700 20000 13000 500000 —	32.5 42 16 33.2 —	1000 — — — —	20000 — — — —	16.5 max. — — — —	— — — 0.75 0.64	−1.3 −4	−0.3 −0.7	260 250	220 380	3.1 4.5	0.20 0.21	2500 4500	27 17	10000 21000	1.9 2.6	**2N105**
—	—	—	—	—	—	—	For typical class B push-pull data, see page 12.										**2N109**
1000 500 — —	70000 30000 — —	38.8□ 37.8□ — —	— — — —	— — — —	4.5 spot□ 4.5 spot□ — —	— — 6.8 6.7	−9 −9	−0.5 −1	85 75	425 800	4.6 8.6	0.22 0.25	540 1100	9.5 9.5	19300 38600	13 14	**2N139**
700 —	75000 —	32 —	(Useful conversion gain) —	 —	 —	— 10	−9	−0.6	85	480	5.4	0.23	650	9.5	22600	16.5	**2N140**
2000 —	70000 —	43 —	1000 —	20000 —	6 max. —	— 0.85	−4	−0.5	190	296	6.6	0.279	3900	36	19200	2.06	**2N175**
1200 560000 — 140	20000 18000 — 500000	46 30 — 35	1000 — — —	20000 — — —	9 — — —	— — 0.62 0.78	−3 −5	−0.2 −1	210 200	225 710	2.3 7.6	0.27 0.4	2380 9400	48 35	7430 33400	— —	**2N206**
Like RCA—2N104 but has flexible leads.																	**2N215**
Like RCA—2N109 but has flexible leads.																	**2N217**
Like RCA—2N139 but has flexible leads.																	**2N218**
Like RCA—2N140 but has flexible leads.																	**2N219**
Like RCA—2N175 but has flexible leads.																	**2N220**
1350 170 —	70000 4500 —	45□ 24□ —	← at 1.5 Mc ← at 10.7 Mc —	 —	8 spot — —	— — 30	−9	−1	40	640	—	—	200	1.7	37000	132	**2N247**
—	—	—	—	—	—	12	For typical data in Low-Level Switching Service, see page 12.										**2N269**
— 400	— 400	— 35	— —	— —	— —	— —	For typical class B push-pull data, see page 12.										**2N270**
1350 170 —	70000 4500 —	45□ 24□ —	← at 1.5 Mc ← at 10.7 Mc —	 —	8 spot — —	— — 30	−9	−1	40	640	—	—	200	1.7	37000	132	**2N274**

† Measured with a noise diode and a thermocouple voltmeter with an equivalent noise bandwidth of 12.3 Kc and geometric mean of 3000 cps.

□ Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power (transformer insertion losses not included).

‡ This frequency (figure of merit) may be calculated from the equation:

$$f = \frac{1}{4\pi}\sqrt{\frac{g_m}{r_{bb'}\,C_{b'e}\,C_{b'c}}}$$

TYPE	CLASS OF SERVICE	GENERAL DATA — Electrical♦: Minimum DC Collector-to-Base volts (for stated DC Collector Current µa)	Maximum DC Collector Current µa (for stated DC Collector-to-Base volts)	Maximum DC Emitter Current µa (for stated DC Emitter-to-Base volts)	Mechanical: Operating Position	Dimensional Outline and Basing or Lead Arrangement see pages 14-16	MAXIMUM RATINGS (Absolute Values): DC Collector-to-Base volts	DC Emitter-to-Base volts	DC Collector Current ma	DC Emitter Current ma	Collector Dissipation mw at ambient temperature of: 25°C	55°C	71°C	Ambient Storage Temperature● °C	TYPICAL OPERATION (Ambient Temperature = 25°C): Circuit	DC Collector-to-Emitter volts	DC Collector Current ma	Current Transfer Ratio at 1 Kc
Germanium, p-n-p, alloy-junction types																		
2N301	Large-Signal AF Power Amplifier	−40 at I_C = −2000	−220 at V_{CB} = −12	−2000 at V_{EB} = −12	Any	F	−40 peak −20*	−12	−2000 peak −1000 avg.	2000 peak 1000 avg.	—	12000	5500	−65 to +85	E E E	−1.5 −1.5 −13.6	−1000 −500 −400	70■ 75 —
2N301-A	Large-Signal AF Power Amplifier	−35 at I_C = −1000	−220 at V_{CB} = −12	−2000 at V_{EB} = −12	Any	F	−60 peak −30*	−12	−2000 peak −1000 avg.	2000 peak 1000 avg.	—	12000	5500	−65 to +85	E E E	−1.5 −1.5 −13.6	−1000 −500 −400	70■ 75 —
2N370	Class A RF Amplifier	—	−20 at V_{CB} = −12	−50 at V_{EB} = −1.5	Any	E	−20	−1.5	−10	10	80	35	10	−65 to +85	E E E	−12 −12 −12	−1 −1 −1	60 60 60
2N371	RF Oscillator	—	−20 at V_{CB} = −12	−50 at V_{EB} = −0.5	Any	E	−20	−0.5	−10	10	80	35	10	−65 to +85	B	−12	−1	0.984
2N372	RF Mixer	—	−20 at V_{CB} = −12	−50 at V_{EB} = −0.5	Any	E	−20	−0.5	−10	10	80	35	10	−65 to +85	E E E	−12 −12 −12	−1 −1 −1	60 60 60
2N384	VHF Amplifier	—	−16 at V_{CB} = −12	−50 at V_{EB} = −0.5	Any	I	−30	−0.5	−10	10	120	70	35	−65 to +85	E B	−12 −12	−1.5 −1.5	60 0.984
2N398	High-Voltage Switch	−105 at I_C = −50	−14 at V_{CB} = −2.5	−50 at V_{EB} = −50	Any	G	−105	−50	−100	100	50	10	—	−65 to +85	E	−0.35	−5	60■
2N404	Low-Level Switch	−25 at I_C = −20	−5 at V_{CB} = −12	−2.5 at V_{EB} = −2.5	Any	G	−25	−12	−100	100	120	35	10	−65 to +85	B	−6	−1	—
2N405	Class A AF Driver	—	−14 at V_{CB} = −12	−14 at V_{EB} = −12	Any	B	−12	−2.5	−70	70	150	50	20	−65 to +85	E	−6	−1	35
2N406	Like RCA−2N405 but has flexible leads.																	
2N407	Large Signal AF Amplifier	—	−14 at V_{CB} = −12	−14 at V_{EB} = −2.5	Any	B	−20	−2.5	−70	70	150	50	20	−65 to +85	E	−1	−50	65■
2N408	Like RCA−2N407 but has flexible leads.																	
2N409	Class A 455-Kc Amplifier	−13 at I_C = −10	−10 at V_{CB} = −12	−12 at V_{EB} = −0.5	Any	B	−12	−0.5	−15	15	80	35	10	−65 to +85	E E B B	−9 −9 −9 −9	−0.5 −1 −0.5 −1	45 48 0.978 0.980
2N410	Like RCA−2N409 but has flexible leads.																	
2N411	540-1640 Kc Converter	−13 at I_C = −10	−10 at V_{CB} = −12	−12 at V_{EB} = −0.5	Any	B	−12	−0.5	−15	15	80	35	10	−65 to +85	E B	−9 −9	−0.6 −0.6	75 0.987
2N412	Like RCA−2N411 but has flexible leads.																	

♦ Cutoff Data. Collector-to-Base Voltage and Collector Current values obtained with emitter open. Emitter Current values obtained with collector open. Ambient temperature = 25°C.

● Storage or Operating Temperatures above 85°C will affect the serviceability of the transistor.

B = Common-Base, Emitter-Input Circuit.
C = Common-Collector, Base-Input Circuit.
E = Common-Emitter, Base-Input Circuit.
* For inductive load.
■ Large-Signal DC Current Transfer Ratio.

TYPICAL OPERATION (Cont'd) Ambient Temperature = 25°C							CHARACTERISTICS For COMMON-EMITTER CIRCUIT, BASE INPUT at Ambient Temperature = 25°C. Small-Signal Hybrid-π Parameters. For equivalent circuit, see page 14										TYPE
Power Gain			Noise Factor							Conductance µmhos			Capacitance µµf				
Input Resistance ohms	Load Resistance ohms	Power Gain db	Generator Resistance ohms	Load Resistance ohms	Noise Factor† db	Alpha Cutoff Frequency Mc ($f_{\alpha b}$)	DC Collector-to-Emitter volts (V_{CE})	DC Collector Current ma (I_C)	Resistance ohms ($r_{bb'}$)	$g_{b'e}$	g_{ce}	$g_{b'c}$	$C_{b'e}$	$C_{b'c}$	Intrinsic Trans-conductance µmhos (g_m)	Frequency For Unity Power Amplification‡ Mc	
◀ Small-Signal H Parameters and Small-Signal T Parameters are shown for some types on page 13.							**Germanium, p-n-p, alloy-junction types**										
75 — —	34 — —	32.5 — —	— — —	— — —	— — —	— — —	For typical class A and class B push-pull data, see page 13.										**2N301**
75 — —	34 — —	32.5 — —	— — —	— — —	— — —	— — —	For typical class A and class B push-pull data, see page 13.										**2N301-A**
1750 200 100	180000 18000 11000	50.5□ (Maximum useful gain = 31 db) ← at 1.5 Mc 26.2□ (Maximum useful gain = 17.6 db) ← at 10 Mc 17.0□ (Maximum useful gain = 12.5 db) ← at 20 Mc													37800 21400 13700	132	**2N370**
For Oscillation applications up to 23 Mc						30	For additional data, see page 14.									132	**2N371**
1750 200 100	180000 18000 11000	50.5□ (Maximum useful gain = 31 db) ← at 1.5 Mc 26.2□ (Maximum useful gain = 17.6 db) ← at 10 Mc 17.0□ (Maximum useful gain = 12.5 db) ← at 20 Mc													37800 21400 13700	132	**2N372**
400 30	28000 5000	34 ← at 10.7 Mc 15 ← at 50 Mc			— —	— 100	−12	−1.5	50	960	—	—	90	1.3	56800	250	**2N384**
For high-voltage "on-off" control applications.						—	For design data for High-Voltage Switching Service, see page 13.										**2N398**
For medium-speed "on-off" control applications.						12	For design data for Low-Level Switching Service, see page 13.										**2N404**
750	85000	43	—	—	—	—	−6	−1	120	1070	6.5	0.295	—	40	37500	—	**2N405**
Like RCA—2N405 but has flexible leads.																	**2N406**
This type is intended for use in class A and class B push-pull power output stages of radio receivers and audio amplifiers operating at power output levels of approximately 150 milliwatts.																	**2N407**
Like RCA—2N407 but has flexible leads.																	**2N408**
1000 500 — —	70000 30000 — —	38.8□ 37.8□ — —	— — — —	— — — —	4.5 spot□ 4.5 spot□ — —	— — 6.8 6.7	−9 −9	−0.5 −1	85 75	425 800	4.6 8.6	0.22 0.25	540 1100	9.5 9.5	19300 38600	13 14	**2N409**
Like RCA—2N409 but has flexible leads.																	**2N410**
700 —	75000 —	32 (Useful conversion gain) —	— —	— —	— —	— 10	−9	−0.6	85	480	5.4	0.23	650	9.5	22600	16.5	**2N411**
Like RCA—2N411 but has flexible leads.																	**2N412**

† Measured with a noise diode and a thermocouple voltmeter with an equivalent noise bandwidth of 12.3 Kc and geometric mean of 3000 cps.

□ Measured in a single-tuned unilateralized circuit matched to the generator and load impedances for maximum transfer of power (transformer insertion losses not included).

‡ This frequency (figure of merit) may be calculated from the equation:

$$f = \frac{1}{4\pi}\sqrt{\frac{g_m}{r_{bb'}\,C_{b'e}\,C_{b'c}}}$$

RCA TRANSISTOR CHARACTERISTICS CHART II

RCA TYPE	CHARACTERISTICS For COMMON-EMITTER CIRCUIT, BASE INPUT at Ambient Temperature = 25°C											
	Small-Signal H Parameters						Small-Signal T Parameters					
	DC Collector-to-Emitter volts (V_{CE})	DC Collector Current ma (I_C)	Input Resistance, Output Circuit Shorted ohms (h_i)	Reverse Voltage Transfer Ratio, Input Circuit Open (h_r)	Forward Current Transfer Ratio, Output Circuit Shorted (h_f)	Output Conductance, Input Circuit Open µmhos (h_o)	DC Collector-to-Emitter volts (V_{CE})	DC Collector Current ma (I_C)	Collector Resistance megohms (r_c)	Emitter Resistance ohms (r_e)	Base Resistance ohms (r_b)	Mutual Resistance megohms (r_m)

Germanium, p-n-p, alloy-junction types

For equivalent circuits, see page 14

TYPE	V_{CE}	I_C	h_i	h_r	h_f	h_o	V_{CE}	I_C	r_c	r_e	r_b	r_m
2N77	−4	−0.7	2720	3.23×10^{-4}	55	14	−4	−0.7	3.93	23	1430	3.86
2N104	−3 −6	−0.2 −1	6040 1667	17.2×10^{-4} 4.95×10^{-4}	32 44	11.1 22.8	−3 −6	−0.2 −1	2.95 1.974	155 21.7	960 690	2.86 1.93
2N105	−1.3 −4	−0.3 −0.7	4800 2880	9.1×10^{-4} 5.5×10^{-4}	45 55	12.4 16.3	−1.3 −4	−0.3 −0.7	3.74 3.45	73 34	1400 976	3.66 3.39

2N109

Typical Operation in Class B Push-Pull Service for Common-Emitter, Base-Input Circuit ●

DC Supply Voltage	−4.5	−9 volts	Signal-Source Impedance (base-to-base)	1500	1500	ohms
Zero-Signal DC Base-to-Emitter Voltage	−0.15	−0.15 volt	Load Impedance (collector-to-collector)	400	800	ohms
Peak Collector Current (per transistor)	−35	−40 ma	Signal Frequency	1000	1000	cps
Zero-Signal DC Collector Current (per transistor)	−2	−2 ma	Circuit Efficiency	60	69	%
			Power Gain♦	30	33	db
Max.-Signal DC Collector Current (per transistor)	−11.5	−13 ma	Total Harmonic Distortion	7	7	%
			Max.-Signal Power Output	75	160	mw

TYPE	V_{CE}	I_C	h_i	h_r	h_f	h_o	V_{CE}	I_C	r_c	r_e	r_b	r_m
2N139	This type is intended for use in 455-Kc intermediate-frequency amplifier service.											
2N140	This type is intended for 540-1640 Kc converter service.											
2N175	−4	−0.5	3570	9.44×10^{-4}	65	25	−4	−0.5	2.86	37.7	1085	2.82
2N206	Derived from a Common-Base, Emitter-Input Equivalent Circuit											
	−3 −5	−0.2 −1	137 33	3.8×10^{-4} 3.2×10^{-4}	−0.974 −0.980	0.3 0.55	−3 −5	−0.2 −1	3.34 1.82	104 21	1270 580	3.25 1.78
2N215	Like RCA—2N104 but has flexible leads.											
2N217	Like RCA—2N109 but has flexible leads.											
2N218	Like RCA—2N139 but has flexible leads.											
2N219	Like RCA—2N140 but has flexible leads.											
2N220	Like RCA—2N175 but has flexible leads.											
2N247	Interlead Capacitance between base lead and collector lead is .003 µµf with leads cut to 5/16" and interlead shield grounded.											

2N269

Maximum DC Collector Current, at 80°C (for stated DC Collector-to-Base volts), and with emitter open:
at V_{CB} = −2.5 .... −50 µa
at V_{CB} = −12 .... −60 µa

Minimum Change in Temperature of Transistor Junctions such that the collector current will double for a dc collector-to-base voltage equal to or greater than −2.5 volts (but not more than −25 volts) and with emitter open .... 10°C

Maximum temperature rise of transistor junctions (transistor in free air) .... 0.35°C/mw

Typical Operation in Low-Level Switching Service for Common-Emitter, Base-Input Circuit

DC Collector Current	−12	−24 ma	Max. DC Collector-to-Emitter Voltage	−0.15	−0.2 volt
DC Base Current	−0.4	−1 ma	Max. DC Base-to-Emitter Voltage	−0.35	−0.4 volt

2N270

Typical Operation in Class B Push-Pull Service for Common-Emitter, Base-Input Circuit ●

DC Supply Voltage	12 volts	Load Impedance (per collector)	150	ohms
Zero-Signal DC Base-to-Emitter Voltage	−0.11 volt	Signal Frequency	1000	cps
Peak Collector Current (per transistor)	−110 ma	Circuit Efficiency	75	%
Zero-Signal DC Collector Current (per transistor)	−2 ma	Power Gain♦	32	db
Max.-Signal DC Collector Current (per transistor)	−35 ma	Total Harmonic Distortion: at 500 mw	10	% max.
		at 10 mw	5	% max.
Signal-Source Impedance (per base)	1000 ohms	Max.-Signal Power Output	500	mw

TYPE	
2N274	Interlead Capacitance between base lead and collector lead is .094 µµf with leads cut to 5/16" and interlead shield grounded.

♦ Measured at the primary of the output transformer.   ● Unless otherwise specified, values are for 2 transistors.

RCA TRANSISTOR CHARACTERISTICS CHART II (Cont'd)

CHARACTERISTICS
For COMMON-EMITTER CIRCUIT, BASE INPUT at Ambient Temperature = 25°C

TYPE	Small-Signal H Parameters						Small-Signal T Parameters					
	DC Collector-to-Emitter volts (V_{CE})	DC Collector Current ma (I_C)	Input Resistance, Output Circuit Shorted ohms (h_i)	Reverse Voltage Transfer Ratio, Input Circuit Open (h_r)	Forward Current Transfer Ratio, Output Circuit Shorted (h_f)	Output Conductance, Input Circuit Open µmhos (h_o)	DC Collector-to-Emitter volts (V_{CE})	DC Collector Current ma (I_C)	Collector Resistance megohms (r_c)	Emitter Resistance ohms (r_e)	Base Resistance ohms (r_b)	Mutual Resistance megohms (r_m)

Germanium, p-n-p, alloy-junction types

For equivalent circuits, see page 14

2N301, 2N301-A

Typical Operation for Common-Emitter, Base-Input Circuit

	Service Class A	Service Class B Push-Pull	
DC Supply Voltage	−14.4	−14.4●	volts
Zero-Signal DC Base-to-Emitter Voltage	−0.24	−0.13	volt
Peak Collector Current	−0.8	−2	amp
Zero-Signal DC Collector Current	−0.4	−0.05	amp
Max.-Signal DC Collector Current	—	−0.64	amp
DC Collector-to-Emitter Voltage	−13.6	—	volts
Signal-Source Impedance	75	15	ohms
Load Impedance	34	6	ohms

	Service Class A	Service Class B Push-Pull	
Signal Frequency	400	400	cps
Circuit Efficiency	47	67●	%
Power Gain♦	32.5	30●	db
Total Harmonic Distortion:			
at 2.7 watts	10	—	% max.
at 12 watts	—	10●	% max.
Max.-Signal Power Output	2.7	12●	watts
Emitter Resistor (unbypassed)	1	—	ohm

2N370

This type is intended for use in radio-frequency amplifier service in short-wave receivers.
Interlead Capacitance between base lead and collector lead is .003 µµf with leads cut to 5/16" and interlead shield grounded.

2N371

The 2N371, in rf oscillator service up to 23 Mc, can provide the required oscillator-injection voltage to the rf mixer stage for optimum mixing operation. In an oscillator stage utilizing the 2N371 and operating at 22 Mc, if the collector supply voltage drops from —12 to —8 volts, the frequency provided by this stage will deviate from 22 Mc by less than 7 Kc.
Interlead Capacitance between base lead and collector lead is .003 µµf with leads cut to 5/16" and interlead shield grounded.

2N372

This type is intended for use in radio-frequency mixer service in short-wave receivers.
Interlead Capacitance between base lead and collector lead is .003 µµf with leads cut to 5/16" and interlead shield grounded.

2N384

This type is intended for VHF amplifier and oscillator service.
Interlead Capacitance between base lead and collector lead is .094 µµf with leads cut to 5/16" and interlead shield grounded.

2N398

DC Collector Breakdown Voltage
with dc collector current = −50 µa,
dc emitter current = 0
typical.................... −150 volts
minimum.................. −105 volts

DC Emitter Breakdown Voltage
with dc emitter current = −50 µa,
dc collector current = 0
typical...................... −75 volts
minimum.................... −50 volts

2N404

DC Collector Breakdown Voltage
with dc collector current = −20 µa,
dc emitter current = 0
typical...................... −40 volts
minimum.................... −25 volts

DC Emitter Breakdown Voltage
with dc emitter current = −20 µa,
dc collector current = 0
typical...................... −35 volts
minimum.................... −12 volts

TYPE	V_{CE}	I_C	h_i	h_r	h_f	h_o	V_{CE}	I_C	r_c	r_e	r_b	r_m
2N405, 2N406	−6	−1	1115	2.93 x 10^{-4}	35	17.2	−6	−1	2.1	17	500	2.04

2N407, 2N408

These types are intended for use in class A and class B push-pull service.

2N409, 2N410

These types are intended for use in 455-Kc intermediate-frequency amplifier service.

2N411, 2N412

These types are intended for 540-1640 Kc converter service.

● Value is for 2 transistors. ♦ Measured at the primary of the output transformer.

RCA SEMICONDUCTOR DIODES

TYPE	RECTIFIER SERVICE (For Frequencies of 25 cps and above)											
	MAXIMUM RATINGS (Absolute Values)					CHARACTERISTICS (Ambient Temperature = 25°C)						
	Peak Inverse volts	Forward Current		Fault Current▲ ma	Ambient Temperature Range °C	Minimum Forward Current ma At DC volts = 1	Max. Average Inverse Current µa				Minimum Peak Inverse Voltage for Zero Dynamic Resistance volts	Capacitance Between Stud Tips (Approx.) µµf
		Peak ma	Average● ma				At DC volts = −3	At DC volts = −10	At DC volts = −50	At DC volts = −100		
1N34-A	60	150	50	500	−50 to +75	5	—	30	500	—	75	1
1N38-A	100	150	50	500	−50 to +75	4	5	—	—	·500	120	1
1N54-A	50	150	50	500	−50 to +75	5	—	7	100	—	75	1
1N58-A	100	150	50	500	−50 to +75	4	—	—	—	600	120	1

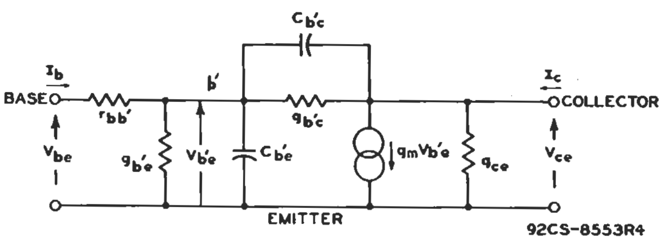
● Averaged over one conduction cycle.

▲ Maximum Fault Current is the highest value of current that should be permitted to flow through the diode under a fault condition such as load short circuit. Values are for time durations up to one second.

EQUIVALENT CIRCUITS

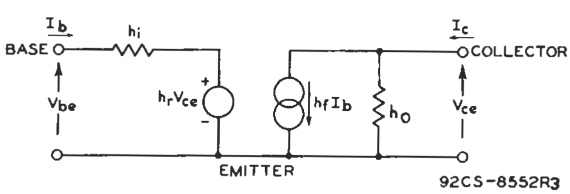
SMALL-SIGNAL HYBRID-π PARAMETERS:

Derived from the accompanying one-generator equivalent circuit and applicable over the useful frequency range of the transistor.



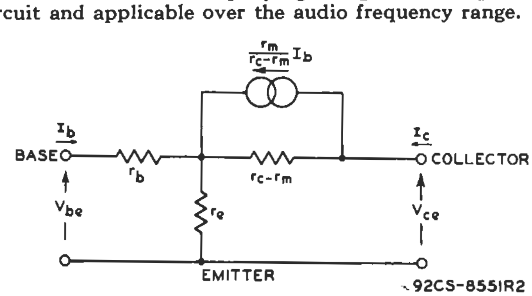
SMALL-SIGNAL H PARAMETERS:

Derived from the accompanying two-generator equivalent circuit and applicable over the audio frequency range.



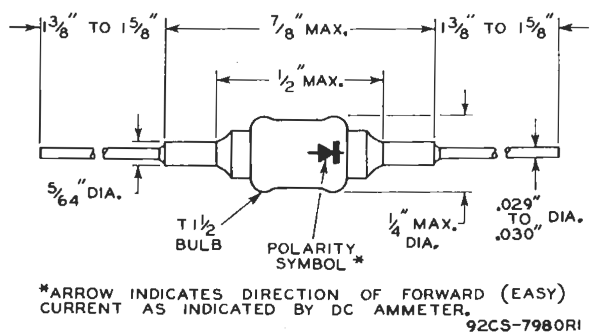
SMALL-SIGNAL T PARAMETERS:

Derived from the accompanying one-generator equivalent circuit and applicable over the audio frequency range.



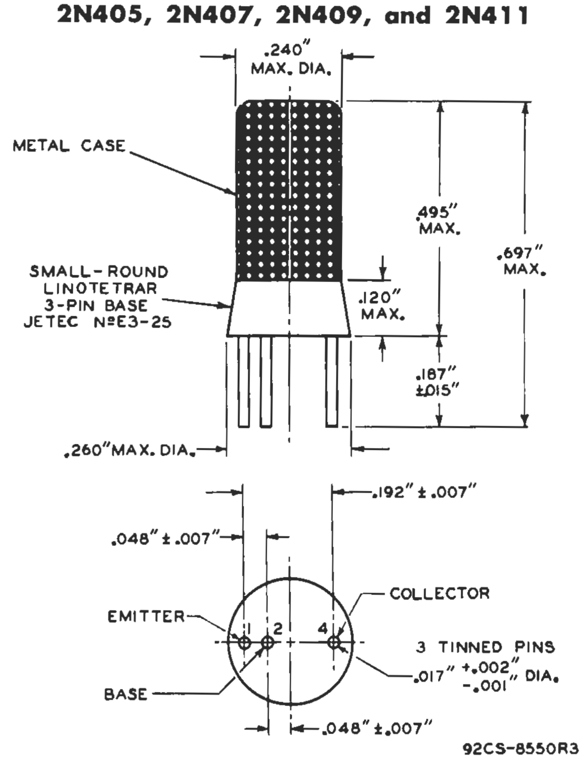
DIMENSIONAL OUTLINES

1N34-A, 1N38-A, 1N54-A, and 1N58-A



A

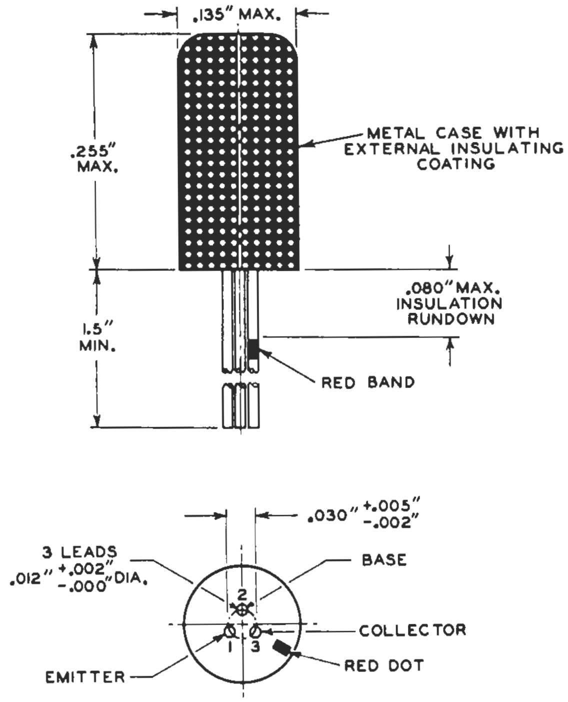
2N104, 2N109, 2N139, 2N140, 2N175, 2N405, 2N407, 2N409, and 2N411



PIN-SPACING TOLERANCES ARE NOT CUMULATIVE

B

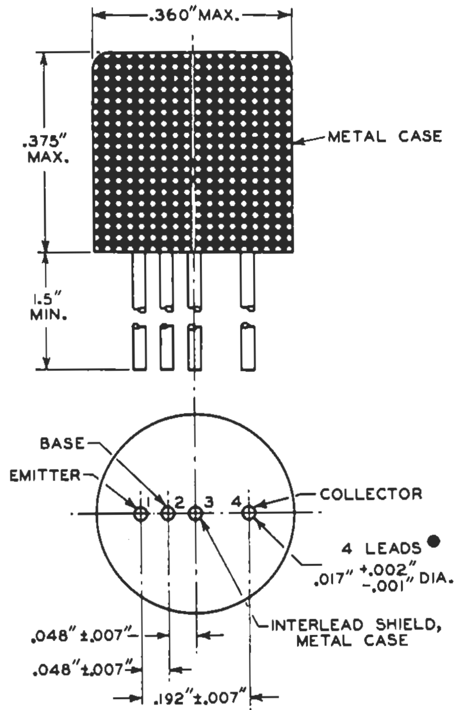
2N105



92CS-8577R2

C

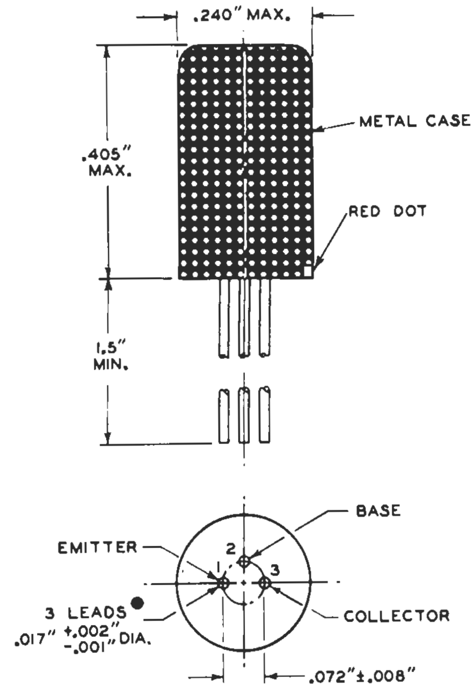
2N247, 2N370, 2N371, and 2N372



92CS-9122R2

E

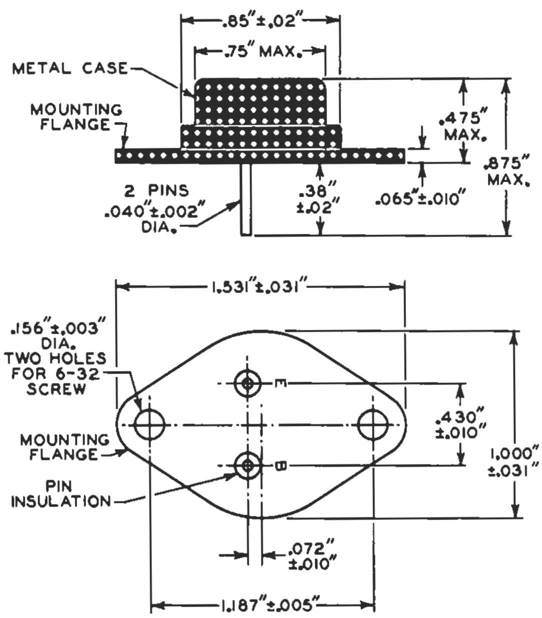
2N215, 2N217, 2N218, 2N219, 2N220, 2N269, 2N406, 2N408, 2N410, and 2N412



92CS-9148R1

D

2N301 and 2N301A



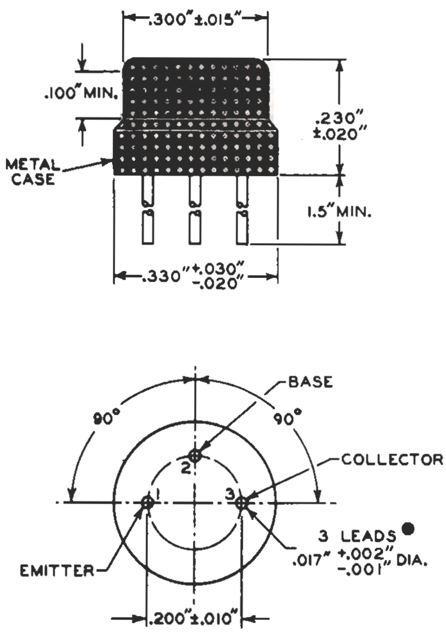
E=EMITTER
B=BASE
MOUNTING FLANGE=COLLECTOR

92CS-9238R2

F

● The specified lead diameter applies in the zone between 0.050" and 0.250" from the base seat. Between 0.250" and 1.50" a maximum of 0.021" diameter is held. Outside of these zones, the lead diameter is not controlled.

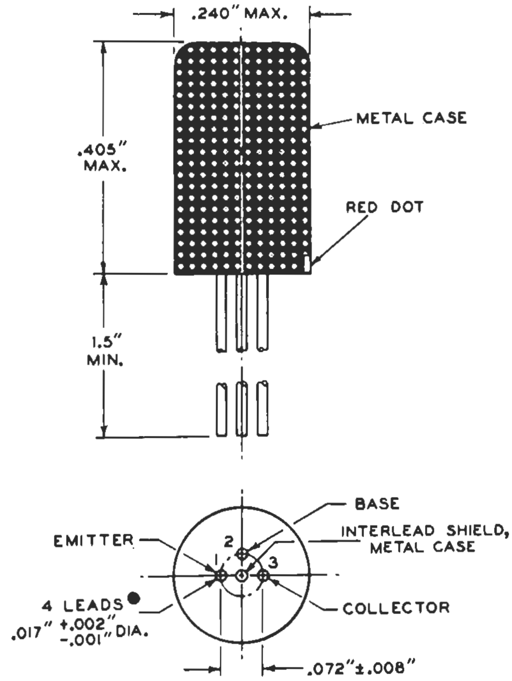
2N398 and 2N404



92CS-9371R1

G

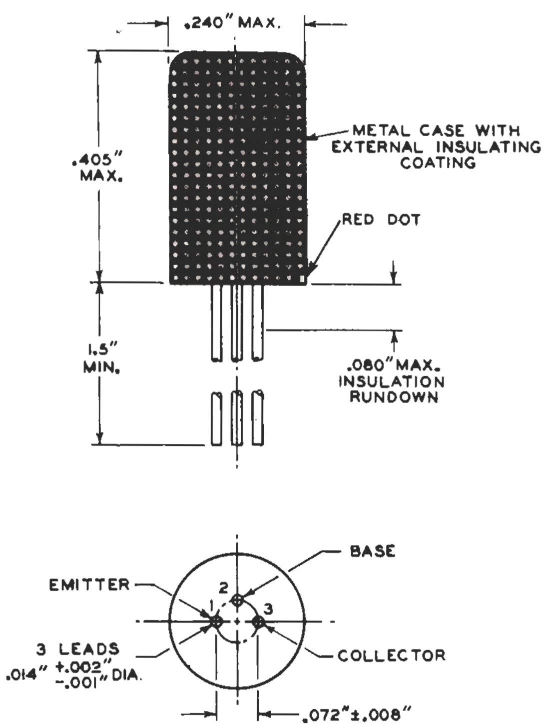
2N274 and 2N384



92CS-9266R1

I

2N77 and 2N206 ■

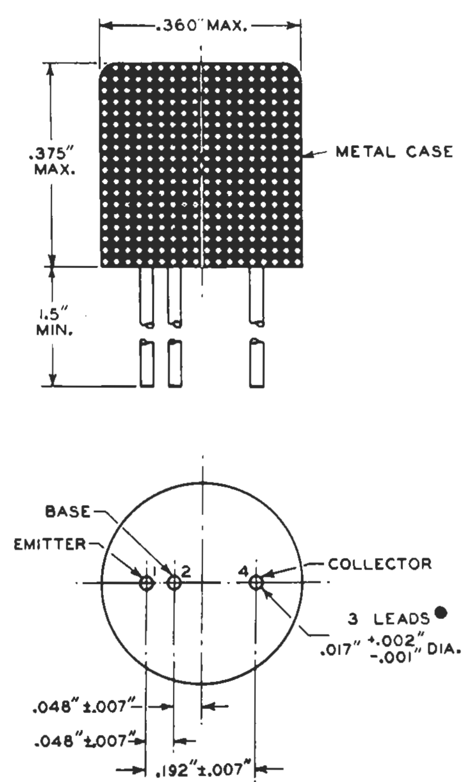


■ Lead Diameter is .017" + .002" or —.001"

92CS-8563R2

H

2N270



92CS-9176R2

J

● The specified lead diameter applies in the zone between 0.050" and 0.250" from the base seat. Between 0.250" and 1.50" a maximum of 0.021" diameter is held. Outside of these zones, the lead diameter is not controlled.

INTERCHANGEABILITY DIRECTORY

The following directory has been prepared to guide designers, experimenters, and servicemen in selecting the proper RCA transistor type as a replacement and to help identify and describe many of the transistor types which have been introduced on the market by different manufacturers. More than 500 type designations are listed including junction types, point-contact types and phototransistors.

In using the **Transistor Directory,** note that the basic type designations of different manufacturers may have been assigned according to different systems. Some basic designations consist only of a number such as 210, 355, 1032, etc.; others consist of a combination of letters and digits such as 2N77, X78, SB100, etc. In either case the basic designation may or may not have a prefix composed of one or more letters, such as CK, GT, H, OC, ZJ, etc., which indicates the particular manufacturer. For certain transistors, this prefix becomes an essential part of the type designation when as sometimes happens, two or more manufacturers utilize the same designation for different transistor types.

Identifying information about the **Type To Be Replaced** including the following: (1) manufacturer's prefix, if any, (2) the basic type designation in bold face, (3) symbol to designate the manufacturer, (4) symbol to indicate the description, for example, GPA=Germanium, p-n-p, Alloy-Junction Type (denotes the structural arrangement and kind of semiconductor materials used in the device), and (5) class of service is charted in the first five columns. The next two columns show the **RCA Direct Replacement Type,** or the RCA Similar Type, respectively, when one or the other is available.

Basic designations shown in Column 2 of the tabulation are listed in numerical — alphabetical sequence. Those starting with a digit are given first; those starting with a letter appear at the end of the tabulation.

Types listed in the Similar RCA Type column (Column 6) are **not directly interchangeable** with the types listed in the Basic Designation column **because of mechanical and/or electrical differences.** For more information as to degree of similarity refer to respective transistor data.

How to Use

1. Look in Column 2 for basic designation of type to be replaced.

2. If type to be replaced has a prefix, look for that prefix in Column 1.

For example: If type CK-762 is to be replaced, find the basic designation 762 in Column 2 and the prefix CK in Column 1.

3. Consult Column 6 for corresponding **RCA Direct Replacement Type.**

4. If no **Direct RCA Replacement Type** is shown consult Column 7 for RCA Similar Type and obtain respective transistor data to determine degree of similarity.

KEY TO SYMBOLS IN COLUMN 3

A = Amperex
B = Bendix
BOG = Bogue (Germanium Products)
CBS = CBS-Hytron
CC = Clevite Corporation
DEL = Delco
GE = General Electric
GT = General Transistor
HA = Hughes Aircraft
M = Motorola
MAL = Mallory
MH = Minneapolis-Honeywell
N = Nucleonics
NA = National Aircraft
NU = National Union
P = Philco
RCA = Radio Corporation of America
RK = Raytheon
RR = Radio Recepter
S = Sylvania
SPR = Sprague
SS = Scientific Specialities
TEC = Transitron
TI = Texas Instruments
TS = Tung-Sol
WE = Western Electric
WL = Westinghouse

KEY TO SYMBOLS IN COLUMN 4

GC = Germanium, Point-Contact Type
GNA = Germanium, n-p-n, Alloy-Junction Type
GNG = Germanium, n-p-n, Grown-Junction Type
GPA = Germanium, p-n-p, Alloy-Junction Type
GPD = Germanium, p-n-p, "Drift" Type
GPG = Germanium, p-n-p, Grown-Junction Type
GPS = Germanium, p-n-p, Surface-Barrier Type
SNA = Silicon, n-p-n, Alloy-Junction Type
SNG = Silicon, n-p-n, Grown-Junction Type
SPA = Silicon, p-n-p, Alloy-Junction Type
SPG = Silicon, p-n-p, Grown-Junction Type
SD = Semiconductor Diode

* RCA types shown in this column are direct replacements under all circumstances for corresponding types to be replaced.

† RCA types shown in this column are not directly interchangeable with the types to be replaced because of mechanical and/or electrical differences. For more information as to degree of interchangeability, refer to respective type data or write to Commercial Engineering, RCA, Somerville, New Jersey.

Information contained herein has been carefully checked and is believed to be reliable but no responsibility is assumed for inaccuracies. The reporting of errors to Commercial Engineering, RCA, Somerville, N. J., will be appreciated.

INTERCHANGEABILITY DIRECTORY

1	2	3	4	5	6	7
Type To Be Replaced				Class of Service	Replace by RCA Type*	Similar RCA Type‡
Mfr. Prefix	Basic Designation	Mfr.	Description			
H	1	MH	GPA	AF Power Ampl		
H	2	MH	GPA	AF Power Ampl		
	2A	CC	GC	AF Amplifier		
	2B	CC	GC	Switching		
	2C	CC	GC	Switching		
	2D	CC	GC	Switching		
	2E	CC	GC	AF Amplifier		
	2G	CC	GC	Switching		
	2H	CC	GC	AF Amplifier		
	2L	CC	GC	Switching		
	2N21	WE	GC	Switching		
	2N21A	WE	GC	AF Amplifier		
	2N22	WE	GC	Switching		
	2N23	WE	GC	Switching		
	2N24	WE	GC	AF Amplifier		
	2N25	WE	GC	AF Amplifier		
	2N26	WE	GC	Switching		
	2N27	WE	GNG	AF Amplifier		2N104
	2N28	WE	GNG	AF Amplifier		2N104
	2N29	WE	GNG	Switching		
	2N30	GE	GC	AF Amplifier		
	2N31	GE●	GC	Oscillator		
	2N32	RCA●	GC	Switching		
	2N32A	RCA●	GC	Switching		
	2N33	RCA●	GC	Oscillator		
	2N34	GT	GPA	AF Amplifier		2N109
	2N34	RCA●	GPA	AF Amplifier		2N109
	2N34	S	GPA	AF Amplifier		2N109
	2N34	TEC	GPA	AF Amplifier		2N109
	2N34A	RCA●	GPA	AF Amplifier		2N109
	2N35	RCA●	GNA	AF Amplifier		
	2N35	S	GNA	AF Amplifier		
	2N36	CBS	GPA	General Use		2N217
	2N36	GT	GPA	General Use		2N109
	2N37	CBS	GPA	General Use		2N109
	2N37	GT	GPA	General Use		2N109
	2N37	TEC	GPA	General Use		2N109
	2N38	CBS	GPA	AF Amplifier		2N109
	2N38	GT	GPA	AF Amplifier		2N109
	2N38	TEC	GPA	AF Amplifier		2N109
	2N38A	CBS	GPA	AF Amplifier		2N109
	2N38A	GT	GPA	AF Amplifier		2N109
	2N39	GT	GPA	General Use		
	2N39	NU	GPA	General Use		
	2N39	TEC	GPA	General Use		
	2N40	GT	GPA	General Use		
	2N40	NU	GPA	General Use		
	2N40	TEC	GPA	General Use		
	2N41	RCA●	GPA	AF Amplifier		2N105
	2N42	GT	GPA	General Use		
	2N42	NU	GPA	General Use		
	2N42	TEC	GPA	General Use		
	2N43	GE	GPA	AF Amplifier		2N109
	2N43	GT	GPA	AF Amplifier		2N109
	2N43	TEC	GPA	AF Amplifier		2N109
	2N43A	GE	GPA	AF Amplifier		2N206
	2N43A	TEC	GPA	AF Amplifier		2N206
	2N44	GE	GPA	AF Amplifier		2N109
	2N44	GT	GPA	AF Amplifier		2N109
	2N44	TEC	GPA	AF Amplifier		2N109
	2N44A	GE	GPA	AF Amplifier		2N109
	2N45	GE	GPA	AF Amplifier		2N109
	2N45	GT	GPA	AF Amplifier		2N109
	2N45	TEC	GPF	AF Amplifier		2N109
	2N46	RCA●	GPA	AF Amplifier		2N105
	2N47	P	GPA	AF Amplifier		2N105
	2N48	P	GPA	AF Amplifier		2N105
	2N49	P	GPA	AF Amplifier		2N105
	2N50	CC	GC	Switching		
	2N51	CC	GC	Switching		
	2N52	CC	GC	Oscillator		
	2N53	CC	GC	Switching		
	2N54	WL	GPA	AF Amplifier		2N109
	2N55	WL	GPA	AF Amplifier		2N109
	2N56	WL	GPA	AF Amplifier		2N109
	2N57	MH	GPA	AF Power Ampl		
	2N62	P	GPA	General Use		2N109
	2N63	GTC	GPA	AF Amplifier		2N217
	2N63	RK	GPA	AF Amplifier		2N217
	2N63	TEC	GPA	AF Amplifier		2N217
	2N64	GT	GPA	AF Amplifier		2N217
	2N64	RK	GPA	AF Amplifier		2N217
	2N64	TEC	GPA	AF Amplifier		2N217
	2N65	GT	GPA	AF Amplifier		2N217
	2N66	WE	GPA	AF Power Ampl		
	2N67	WE	GC	Switching		
	2N68	S	GPA	AF Power Ampl		
	2N69	WE	GPA	AF Amplifier		
	2N71	WL	GPA	AF Amplifier		
	2N72	RCA●	GC	Switching		
	2N73	WL	GPA	Switching		
	2N74	WL	GPA	Switching		
	2N75	WL	GPA	Switching		
	2N76	GE	GPA	AF Amplifier		2N104
	2N76	TEC	GPA	AF Amplifier		2N104
	2N77	RCA	GPA	AF Amplifier	2N77	
	2N78	GE	GNG	IF-RF Amplifier		2N139
	2N79	RCA●	GPA	AF Amplifier		2N206
	2N80	CBS	GPA	AF Amplifier		
	2N81	GE	GPA	AF Amplifier		
	2N82	CBS	GPA	AF Amplifier		
	2N83	TEC	GPA	AF Power Ampl		
	2N83A	TEC	GPA	AF Power Ampl		
	2N84	TEC	GPA	AF Power Ampl		
	2N84A	TEC	GPA	AF Power Ampl		
	2N85	TEC	GPA	AF Amplifier		2N109
	2N86	TEC	GPA	AF Amplifier		2N109
	2N87	TEC	GPA	AF Amplifier		2N109
	2N88	TEC	GPA	AF Amplifier		2N105
	2N89	TEC	GPA	AF Amplifier		2N105
	2N90	TEC	GPA	AF Amplifier		2N105
	2N91	TEC	GPA	Switching		
	2N92	TEC	GPA	Switching		
	2N94	S	GNA	Switching		2N139
	2N94A	S	GNA	Switching		2N139
	2N95	S	GNA	AF Power Ampl		
	2N96	RCA●	GPA	AF Amplifier		2N206
	2N97	BOG	GNG	AF Amplifier		
	2N97A	BOG	GNG	Switching		
	2N98	BOG	GNG	AF Amplifier		
	2N98A	BOG	GNG	Switching		
	2N99	BOG	GNG	Switching		
	2N100	BOG	GNG	AF Amplifier		
	2N101	S	GPA	AF Amplifier		
	2N102	S	GNA	AF Amplifier		
	2N103	BOG	GNG	AF Amplifier		
	2N104	RCA	GPA	AF Amplifier	2N104	
	2N105	RCA	GPA	AF Amplifier	2N105	
	2N106	RK	GPA	AF Amplifier		2N104
	2N107	GE	GPA	General Use		2N218
	2N108	CBS	GPA	AF Amplifier		
	2N109	A	GPA	AF Amplifier	2N109	
	2N109	GT	GPA	AF Amplifier	2N109	
	2N109	RCA	GPA	AF Amplifier	2N109	
	2N110	WE	GC	Switching		
	2N111	CC	GPA	IF Amplifier		2N218
	2N111	GT	GPA	IF Amplifier		2N218
	2N111	RK	GPA	IF Amplifier		2N218
	2N111A	RK	GPA	IF Amplifier		2N218
	2N112	CC	GPA	IF Amplifier		2N218
	2N112	GT	GPA	IF Amplifier		2N218
	2N112	RK	GPA	IF Amplifier		2N218
	2N112A	RK	GPA	IF Amplifier		2N218
	2N113	CC	GPA	IF Amplifier	2N139	
	2N113	GT	GPA	IF Amplifier	2N139	
	2N113	RK	GPA	IF Amplifier	2N139	
	2N114	GT	GPA	Converter	2N140	
	2N114	RK	GPA	Converter	2N140	
	2N115	A	GPA	AF Power Ampl		
	2N116	CBS	GPA	AF Amplifier		2N175
	2N117	TI	SNG	AF Amplifier		
	2N118	TI	SNG	AF Amplifier		
	2N119	TI	SNG	AF Amplifier		
	2N123	GE	GPA	Switching		2N404
	2N124	TI	GNA	Switching		
	2N125	TI	GNG	Switching		
	2N126	TI	GNG	Switching		
	2N127	TI	GNG	Switching		
	2N128	P	GPS	4 Mc Amplifier		2N247
	2N129	P	GPS	455 Kc Ampl		2N247
	2N130	GT	GPA	AF Amplifier		2N105
	2N130	RK	GPA	AF Amplifier		2N105
	2N131	GTC	GPA	AF Amplifier		2N105
	2N131	RK	GPA	AF Amplifier		2N105
	2N132	GT	GPA	AF Amplifier		2N105
	2N132	RK	GPA	AF Amplifier		2N105
	2N133	GT	GPA	AF Amplifier		2N175
	2N133	RK	GPA	AF Amplifier		2N175
	2N135	GE	GPA	IF-RF Amplifier		2N139
	2N136	GE	GPA	IF-RF Amplifier	2N139	
	2N137	GE	GPA	IF-RF Amplifier	2N140	
	2N138	RK	GPA	AF Amplifier		2N406
	2N138A	RK	GPA	AF Amplifier		2N406
	2N139	RCA	GPA	IF Amplifier	2N139	
	2N140	RCA	GPA	Converter	2N140	
	2N141	S	GPA	AF Power Ampl		
	2N142	S	GNA	AF Power Ampl		
	2N143	S	GPA	AF Power Ampl		
	2N144	S	GNA	AF Power Ampl		
	2N145	TI	GNG	455 Kc Ampl		2N218
	2N146	TI	GNG	455 Kc Ampl		2N218
	2N147	TI	GNG	455 Kc Ampl		2N218
	2N148	TI	GNG	262 Kc Ampl		
	2N148A	TI	GNG	262 Kc Ampl		
	2N149	TI	GNG	262 Kc Ampl		
	2N149A	TI	GNG	262 Kc Ampl		
	2N150	TI	GNG	262 Kc Ampl		
	2N150A	TI	GNG	262 Kc Ampl		
	2N151	MAL	GPA	AF Amplifier		
	2N152	MAL	GPA	AF Power Ampl		
	2N153	MAL	GPA	AF Power Ampl		
	2N154	MAL	GPA	AF Power Ampl		
	2N155	CBS	GPA	AF Amplifier		2N301
	2N156	CBS	GPA	AF Power Ampl		2N301
	2N158	CBS	GPA	AF Power Ampl		2N301
	2N159	SPR	GC	Switching		
	2N160	BOG	SNG	RF Amplifier		
	2N160A	BOG	SNG	RF Amplifier		
	2N161	BOG	SNG	RF Amplifier		
	2N161A	BOG	SNG	RF Amplifier		
	2N162	BOG	SNG	RF Amplifier		
	2N162A	BOG	SNG	RF Amplifier		
	2N163	BOG	SNG	RF Amplifier		
	2N163A	BOG	SNG	RF Amplifier		
	2N166	GE	GNG	IF Amplifier		2N218
	2N167	GE	GNG	Switching		2N269
	2N168	GE	GNG	IF Amplifier		2N139
	2N168A	GE	GNG	Converter		2N140
	2N169	GE	GNG	IF Amplifier		2N139
	2N169A	GE	GNG	IF Amplifier		2N139
	2N170	GE	GNG	RF Amplifier		2N139
	2N172	TI	GNG	Converter		2N140
	2N173	DEL	GPA	AF Power Ampl		2N301
	2N174	DEL	GPA	AF Power Ampl		
	2N175	RCA	GPA	AF Amplifier	2N175	
	2N176	M	GPA	AF Power Ampl		2N301
	2N178	M	GPA	AF Power Ampl		
	2N179	M	GPA	AF Power Ampl		
	2N180	CBS	GPA	General Use		2N109
	2N181	CBS	GPA	General Use		2N270
	2N182	CBS	GNA	Switching		2N269
	2N183	CBS	GNA	Switching		2N269
	2N184	CBS	GNA	Switching		2N269
	2N185	TI	GPA	AF Amplifier		2N109
	2N186	GE	GPA	AF Amplifier		2N109
	2N186A	GE	GPA	AF Amplifier		2N270
	2N187	GE	GPA	AF Amplifier		2N109
	2N187A	GE	GPA	AF Amplifier		2N270
	2N188	GE	GPA	AF Amplifier		2N109
	2N188A	GE	GPA	AF Amplifier		2N270
	2N189	GE	GPA	AF Amplifier		2N109
	2N190	GE	GPA	AF Amplifier		2N109
	2N191	GE	GPA	AF Amplifier		2N109
	2N192	GE	GPA	AF Amplifier		2N109
	2N193	S	GNA	Oscillator		
	2N194	S	GNA	Converter		2N219
	2N195	TEC	GPA	AF Amplifier		2N217
	2N196	TEC	GPA	AF Amplifier		2N217
	2N197	TEC	GPA	AF Amplifier		2N217
	2N198	TEC	GPA	AF Amplifier		2N217
	2N199	TEC	GPA	AF Amplifier		2N109
	2N200	TEC	GPA	AF Amplifier		2N206
	2N204	TEC	GPA	General Use		2N206
	2N205	TEC	GPA	General Use		2N206
	2N206	RCA	GPA	AF Amplifier	2N206	
	2N207	P	GPA	AF Amplifier		2N105
	2N207A	P	GPA	AF Amplifier		2N105
	2N207B	P	GPA	AF Amplifier		2N105
	2N211	S	GNA	Oscillator		
	2N212	S	GNA	Converter		
	2N213	S	GNA	AF Amplifier		
	2N214	S	GNA	AF Amplifier		
	2N215	RCA	GPA	AF Amplifier	2N215	
	2N216	S	GNA	IF Amplifier		
	2N217	A	GPA	AF Amplifier	2N217	
	2N217	RCA	GPA	AF Amplifier	2N217	
	2N218	RCA	GPA	IF Amplifier	2N218	
	2N219	RCA	GPA	Converter	2N219	
	2N220	RCA	GPA	AF Amplifier	2N220	
	2N222	GT	GPA	General Use		
	2N223	P	GPA	AF Amplifier		2N270
	2N224	P	GPA	AF Amplifier		2N270
	2N225	P	GPA	AF Amplifier		2N270
	2N226	P	GPA	AF Amplifier		2N270
	2N227	P	GPA	AF Amplifier		2N270
	2N228	S	GNA	AF Amplifier		
	2N229	S	GNA	General Use		
	2N230	MAL	GPA	AF Power Ampl		
	2N231	P	GPS	455 Kc Ampl		2N218
	2N232	P	GPS	455 Kc Ampl		2N218
	2N233	S	GNA	RF Amplifier		2N218
	2N233A	S	GNA	RF Amplifier		2N218
	2N234	B	GPA	AF Power Ampl		2N301
	2N234A	B	GPA	AF Power Ampl		2N301
	2N235	B	GPA	AF Power Ampl		2N301
	2N235A	B	GPA	AF Power Ampl		2N301
	2N236A	B	GPA	AF Power Ampl		2N301
	2N237	NA	GPA	AF Amplifier		2N220
	2N238	TI	GPA	AF Amplifier		2N217
	2N240	P	GPS	Switching		
	2N241	GE	GPA	AF Amplifier		2N217
	2N241A	GE	GNA	AF Amplifier		2N217
	2N242	S	GPA	AF Amplifier		2N301
	2N243	TI	SNG	AF Amplifier		
	2N244	TI	SNG	AF Amplifier		
	2N245	TI	SNG	AF Amplifier		
	2N246	TI	SNG	AF Amplifier		
	2N247	RCA	GPD	RF Amplifier	2N247	
	2N248	TI	GPG	RF Amplifier		2N247
	2N249	TI	GPA	AF Amplifier		2N270
	2N250	TI	GPA	AF Power Ampl		
	2N251	TI	GPA	AF Power Ampl		
	2N252	TI	GPA	Converter		2N140
	2N253	TI	GNG	455 Kc Ampl		2N139
	2N254	TI	GNG	455 Kc Ampl		2N139
	2N255	CBS	GPA	AF Power Ampl		
	2N256	CBS	GPA	AF Amplifier		
	2N257	CC	GPA	AF Power Ampl		
	2N260	CC	SPA	General Use		
	2N260A	CC	SPA	General Use		
	2N261	CC	SPA	General Use		
	2N262	CC	SPA	General Use		
	2N262A	CC	SPA	General Use		
	2N263	TI	SNG	Switching		
	2N265	GE	GPA	AF Amplifier		2N406
	2N266	GE	GPA	AF Amplifier		
	2N267	RCA●	GPD	RF Amplifier		2N247
	2N268	CC	GPA	Switching		2N301A
	2N269	RCA	GPA	Switching	2N269	
	2N270	RCA	GPA	AF Amplifier	2N270	
	2N272	CC	GPA	Switching		
	2N274	RCA	GPD	RF Amplifier	2N274	
	2N277	DEL	GPA	AF Power Ampl		
	2N278	DEL	GPA	AF Power Ampl		
	2N279	A	GPA	AF Amplifier		2N215

For key to symbols in columns 3 and 4, see page 17.

● RCA has discontinued this type

INTERCHANGEABILITY DIRECTORY

1	2	3	4	5	6	7
Type To Be Replaced				Class of Service	Replace by RCA Type*	Similar RCA Type‡
Mfr. Prefix	Basic Designation	Mfr.	Description			
	2N280	A	GPA	AF Amplifier		2N215
	2N281	A	GPA	AF Amplifier		
	2N282	A	GPA	AF Amplifier		
	2N283	A	GPA	AF Amplifier		2N215
	2N284	A	GPA	AF Amplifier		
	2N284A	A	GPA	AF Amplifier		
	2N285A	B	GPA	AF Power Ampl		
	2N290	DEL	GPA	AF Power Ampl		
	2N291	TI	GPA	AF Amplifier		2N270
	2N292	GE	GNA	AF Amplifier		2N410
	2N293	GE	GNA	AF Amplifier		2N410
	2N296	S	GPA	AF Power Ampl		2N301A
	2N297	CC	GPA	AF Power Ampl		2N301A
	2N299	P	GPS	RF Amplifier		
	2N300	P	GPS	RF Amplifier		
	2N302	RK	GPA	Switching		2N269
	2N303	RK	GPA	Switching		2N269
	2N306	S	GNA	General Use		
	2N307	S	GPA	AF Power Ampl		2N301
	2N307	TS	GPA	AF Power Ampl		2N301
	2N308	TI	GPA	RF Amplifier		2N247
	2N309	TI	GPA	RF Amplifier		2N247
	2N310	TI	GPA	AF Amplifier		2N247
	2N311	GT	GPA	Switching		2N404
	2N311	M	GPA	Switching		2N404
	2N312	GT	GNA	Switching		
	2N313	GE	GNA	AF Amplifier		
	2N314	GE	GNA	AF Amplifier		
	2N315	GT	GPA	Switching		2N404
	2N316	GT	GPA	Switching		2N404
	2N317	GT	GPA	Switching		2N404
	2N318	GT	GPA	⊕		
	2N319	GE	GPA	AF Amplifier		2N270
	2N320	GE	GPA	AF Amplifier		2N270
	2N321	GE	GPA	AF Amplifier		2N270
	2N322	GE	GPA	AF Amplifier		2N406
	2N323	GE	GPA	AF Amplifier		2N270
	2N324	GE	GPA	AF Amplifier		
	2N325	S	GPA	AF Power Ampl		2N301
	2N326	S	GNA	AF Power Ampl		2N301
	2N327	RK	SPA	Switching		
	2N328	RK	SPA	Switching		
	2N329	RK	SPA	Switching		
	2N330	RK	SPA	Switching		
	2N331	RCA	GPA	AF Amplifier	2N331	
	2N332	BOG	SNA	General Use		
	2N332	TI	SNA	General Use		
	2N332	TEC	SNA	General Use		
	2N333	BOG	SNA	General Use		
	2N333	TI	SNA	General Use		
	2N333	TEC	SNA	General Use		
	2N334	BOG	SNA	General Use		
	2N334	TI	SNA	General Use		
	2N334	TEC	SNA	General Use		
	2N335	BOG	SNA	General Use		
	2N335	TI	SNA	General Use		
	2N335	TEC	SNA	General Use		
	2N336	BOG	SNA	General Use		
	2N336	TI	SNA	General Use		
	2N337	TI	SNA	Switching		
	2N338	TI	SNA	Switching		
	2N339	TI	SNA	AF Power Ampl		
	2N340	TI	SNA	AF Power Ampl		
	2N341	TI	SNA	AF Power Ampl		
	2N342	TI	SNA	AF Power Ampl		
	2N343	TI	SNA	AF Power Ampl		
	2N344	P	GPS	IF-RF Ampl		2N274
	2N345	P	GPS	IF-RF Ampl		2N274
	2N346	P	GPS	IF-RF Ampl		2N384
	2N347	BOG	SNA	AF Power Ampl		
	2N348	BOG	SNA	AF Power Ampl		
	2N349	BOG	SNA	AF Power Ampl		
	2N352	P	GPA	AF Power Ampl		2N301
	2N353	P	GPA	AF Power Ampl		2N301
	2N354	P	SPA	General Use		
	2N355	P	SPA	Switching		
	2N356	GT	GNA	Switching		
	2N357	GT	GNA	Switching		
	2N358	GT	GNA	Switching		
	2N359	RK	GPA	AF Amplifier		
	2N360	RK	GPA	AF Amplifier		
	2N361	RK	GPA	AF Amplifier		
	2N362	RK	GPA	AF Amplifier		
	2N363	RK	GPA	AF Amplifier		
	2N370	RCA	GPA	RF Amplifier	2N370	
	2N371	RCA	GPA	Oscillator	2N371	
	2N372	RCA	GPA	RF Mixer	2N372	
	2N377	S	GNA	Switching		
	2N378	TS	GPA	Switching		2N301
	2N379	TS	GPA	Switching		
	2N380	TS	GPA	Switching		2N301A
	2N381	TS	GPA	AF Amplifier		2N270
	2N382	TS	GPA	AF Amplifier		2N270
	2N383	TS	GPA	AF Amplifier		
	2N384	RCA	GPA	VHF Amplifier	2N384	
	2N385	S	GNA	Switching		
	2N386	P	GPA	AF Power Ampl		2N301A
	2N387	P	GPA	AF Power Ampl		
	2N388	S	GNA	Switching		
	2N389	TI	SNG	AF Power Ampl		
	2N393	P	GPA	RF Amplifier		
	2N394	GE	GPA	Switching		2N404
	2N395	GE	GPA	Switching		2N404
	2N396	GE	GPA	Switching		2N404
	2N397	GE	GPA	Switching		2N404
	2N398	RCA	GPA	Switching	2N398	
	2N399	B	GPA	AF Power Ampl		
	2N400	B	GPA	AF Power Ampl		
	2N401	B	GPA	AF Power Ampl		
	2N402	WL	GPA	AF Amplifier		2N104
	2N403	WL	GPA	AF Amplifier		2N139
	2N404	RCA	GPA	Switching	2N404	
	2N405	RCA	GPA	AF Driver	2N405	
	2N406	RCA	GPA	AF Driver	2N406	
	2N407	RCA	GPA	AF Amplifier	2N407	
	2N408	RCA	GPA	AF Amplifier	2N408	
	2N409	RCA	GPA	IF Amplifier	2N409	
	2N410	RCA	GPA	IF Amplifier	2N410	
	2N411	RCA	GPA	Converter	2N411	
	2N412	RCA	GPA	Converter	2N412	
	2N413	RK	GPA	IF Amplifier		2N218
	2N413A	RK	GPA	IF Amplifier		2N218
	2N414	RK	GPA	IF Amplifier		2N218
	2N414A	RK	GPA	IF Amplifier		2N218
	2N415	RK	GPA	RF Amplifier		2N247
	2N415A	RK	GPA	RF Amplifier		2N247
	2N416	RK	GPA	RF Amplifier		2N247
	2N417	RK	GPA	RF Amplifier		
	2N419	B	GPA	Power Switch		
	2N420	B	GPA	Power Switch		
	2N421	B	GPA	Power Switch		
	2N422	RK	GPA	AF Amplifier		
	2N424	TI	SNA	AF Power Ampl		
	2N425	RK	GPA	Switching		2N404
	2N426	RK	GPA	Switching		2N404
	2N427	RK	GPA	Switching		2N404
	2N428	RK	GPA	Switching		2N404
	2N430	GE	SNA	Switching		
	2N431	GE	SNA	RF Amplifier		
	2N432	GE	SNA	RF Amplifier		
	2N433	GE	SNA	RF Amplifier		
	2N434	GE	SNA	RF Amplifier		
	2N438	CBS	GNA	IF Amplifier		
	2N439	CBS	GNA	IF Amplifier		
	2N440	CBS	GNA	RF Amplifier		
	2N441	DEL	GPA	AF Power Ampl		
	2N442	DEL	GPA	AF Power Ampl		
	2N443	DEL	GPA	AF Power Ampl		
	2N448	GE	GPA	RF Amplifier		
	2N449	GE	GNA	RF Amplifier		
	2N450	GE	GNA	RF Amplifier		
	2N451	GE	GNA	AF Power Ampl		
H	3	MH	GPA	AF Power Ampl		
H	3A	MH	GPA	AF Power Ampl		
	3N22	WE	GNG	RF Amplifier		
	3N23	BOG	GNG	RF Amplifier		
	3N23A	BOG	GNG	RF Amplifier		
	3N23B	BOG	GNG	RF Amplifier		
	3N23C	BOG	GNG	RF Amplifier		
	3N25	TI	GPG	VHF Amp		
	3N26	TI	SNG	RF Amplifier		
	3N27	TI	SNG	RF Amplifier		
	3N29	GE	GNA	RF Amplifier		
	3N30	GE	GNA	RF Amplifier		
	3N31	GE	GNA	RF Amplifier		
	3N32	TI	SNG	RF Amplifier		
	3N33	TI	SNG	Video Amplifier		
	3N34	TI	SNG	Video Amplifier		
H	4A	MH	GPA	AF Power Ampl		
	4JD1B2	GE	GPA	Switching		
	4JD1B3	GE	GPA	Switching		
	4JD1B4	GE	GPA	Switching		
	4JD4A2	GE	GNG	RF Amplifier		
	4JD4A3	GE	GNG	Switching		
	4JD4A4	GE	GNG	RF Amplifier		
	4JD4A5	GE	GNG	RF Amplifier		
H	5	MH	GPA	AF Power Ampl		
	5A	SPR	GC	Switching		
	5B	CC	SD	⊕		
	5C	CC	SD	⊕		
H	6	MH	GPA	AF Power Ampl		
SS	6	SS	SD	⊕		
H	7	MH	GPA	AF Power Ampl		
	8D	SPR	GPA	AF Amplifier		2N218
	8E	SPR	GPA	AF Amplifier		2N218
	8F	SPR	GPA	AF Amplifier		2N218
H	10	MH	GPA	AF Power Ampl		
	10A	CC	SD	⊕		
	10A	SPR	GPA	AF Amplifier		2N270
	10B	CC	SD	⊕		
	10B	SPR	GPA	AF Amplifier		2N270
	10C	SPR	GPA	AF Amplifier		2N270
	11A	CC	SD	⊕		
	11B	CC	SD	⊕		
ZJ	12	GE	SNG	AF Amplifier		
MN	13A	M	GPA	AF Amplifier		
MN	13B	M	GPA	AF Amplifier		
MN	13C	M	GPA	AF Amplifier		
ZJ	13	GE	GNG	AF Amplifier		2N109
GT	14	GT	GPA	AF Amplifier		2N109
RR	14	RR	GPA	AF Amplifier		
ZJ	14	GE	SD	Switching		
GT	14H	GT	GPA	AF Amplifier		2N105
OC	16	A	GPA	AF Power Ampl		2N301
ZJ	16	GE	SPA	AF Power Ampl		
	17A	CC	SD	⊕		
MN	19	M	GPA	Switching		
GT	20	GT	GPA	AF Amplifier		2N109
RR	20	RR	GPA	AF Amplifier		
GT	20H	GT	GPA	AF Amplifier		2N105
MN	21	M	GPA	AF Power Ampl		
RR	21	RR	GPA	AF Amplifier		
GT	24	GT	GPA	AF Amplifier		
MN	24	M	GPA	AF Power Ampl		2N301
MN	25	M	GPA	AF Power Ampl		2N301
MN	26	M	GPA	AF Power Ampl		2N301
MN	28	M	GPA	AF Power Ampl		
MN	29	M	GPA	AF Power Ampl		
GT	34	GT	GPA	AF Amplifier		
RR	34	RR	GPA	AF Amplifier		
T	34A	NU	GPA	AF Amplifier		2N105
T	34B	NU	GPA	AF Amplifier		2N105
T	34C	NU	GPA	AF Amplifier		2N105
T	34D	NU	GPA	AF Amplifier		2N109
T	34E	NU	GPA	AF Amplifier		2N109
T	34F	NU	GPA	AF Amplifier		2N109
GT	34HV	GT	GPA	Switching		
GT	34S	GT	GPA	Detector		
GT	38	GT	GPA	AF Amplifier		2N77
RR	38	RR	GPA	AF Amplifier		
OC	44	A	GPA	RF Amplifier		2N247
OC	45	A	GPA	RF Amplifier		2N247
OC	50	A	GC	Oscillator		
OC	51	A	GC	Switching		
OC	65	A	GPA	AF Amplifier		2N105
GT	66	GT	GPA	⊕		
OC	66	A	GPA	AF Amplifier		2N105
RR	66	RR	SD	⊕		
OC	70	A	GPA	AF Amplifier		2N77
OC	71	A	GPA	AF Amplifier		2N77
ZJ	71	GE	GNG	RF Amplifier		2N247
OC	72	A	GPA	AF Amplifier		2N109
ZJ	72	GE	GNG	VHF Amplifier		2N247
OC	73	A	GPA	AF Amplifier		
ZJ	73	GE	GNG	RF Amplifier		2N247
GT	74	GT	GPA	AF Amplifier		
GT	75	GT	GPA	AF Amplifier		
OC	76	A	GPA	Switching		
GT	81	GT	GPA	AF Amplifier		2N109
GT	81H	GT	GPA	AF Amplifier		2N105
GT	81HS	GT	GPA	AF Amplifier		
GT	82	GT	GPA	Switching		
GT	83	GT	GPA	Switching		
GT	87	GT	GPA	Switching		
GT	88	GT	GPA	Switching		
DR	100	TS	GPA	AF Amplifier		
DR	101	TS	GPA	AF Amplifier		
DR	102	TS	GPA	AF Amplifier		
GT	109	GT	GPA	AF Amplifier	2N109	
GT	122	GT	GPA	Switching		2N269
GT	123	GT	GPA	Switching		
RR	125	RR	GPA	AF Amplifier		
DR	126	TS	GPA	AF Amplifier		2N105
DR	128	TS	GPA	AF Amplifier		2N105
DR	129	TS	GPA	General Use		
DR	130	TS	GPA	General Use		
DR	131	TS	GPA	General Use		
DR	132	TS	GPA	General Use		
DR	149	TS	GPA	General Use		
DR	150	TS	GPA	AF Power Ampl		
GT	153	GT	GPA	Switching		
DR	154	TS	GPA	General Use		
DR	155	TS	GPA	General Use		
TS	161	TS	GPA	AF Amp		2N109
TS	162	TS	GPA	General Use		2N104
TS	163	TS	GPA	AF Amplifier		2N104
TS	164	TS	GPA	AF Amplifier		2N104
TS	165	TS	GPA	AF Amplifier		2N109
TS	166	TS	GPA	AF Amplifier		2N175
GT	167	GT	GPA	Switching		
TS	176	TS	GPA	AF Power Ampl		
	200	TI	GNG	General Use		
	201	TI	GNG	General Use		
	202	TI	GNG	General Use		
	206	TI	GNG	AF Amplifier		2N77
	207	TI	GNG	AF Amplifier		2N77
	208	TI	GNG	AF Amplifier		2N77
GT	210	GT	GPA	Switching		
	210	TI	GNG	AF Amplifier		
	220	TI	GNG	IF Amplifier		
	221	TI	GNG	IF Amplifier		
	222	TI	GNG	IF Amplifier		2N139
GT	222	GT	GPA	General Use		2N104
	223	TI	GNG	Converter		2N140
	224	TI	GNG	IF Amplifier		
	225	TI	GNG	IF Amplifier		2N139
	227	TI	GNG	IF Amplifier		
	228	TI	GNG	Converter		2N140
	229	TI	GNG	Detector		
	234	TI	GPA	IF Amplifier		
	235	TI	GPA	Converter		
	300	TI	GPA	AF Amplifier		2N109
	301	TI	GPA	AF Amplifier		2N109
	302	TI	GPA	AF Amplifier		2N109
	310	TI	GPA	AF Amplifier		2N109
RD	317	GPC	SNG	RF Amplifier		
RD	317A	GPC	SNG	RF Amplifier		
	320	N	SPA	AF Amplifier		
RD	320	GPC	SNG	RF Amplifier		
RD	321A	GPC	SNG	RF Amplifier		
RD	322	GPC	SNG	RF Amplifier		
RD	324	GPC	SNG	RF Amplifier		
RD	324A	GPC	SNG	RF Amplifier		
	330	N	GPA	AF Amplifier		
	340	N	GPA	AF Amplifier		

For key to symbols in columns 3 and 4, see page 17.

⊕ Phototransistor

Continued on page 20

INTERCHANGEABILITY DIRECTORY

1	2	3	4	5	6	7
Type To Be Replaced					Replace by RCA Type*	Similar RCA Type‡
Mfr. Prefix	Basic Designation	Mfr.	Description	Class of Service		
	350	TI	GPA	AF Amplifier		2N109
	352	TI	GPA	AF Amplifier		2N109
	353	TI	GPA	AF Amplifier		2N109
	355	TI	GPA	AF Power Ampl		
	501	TI	GPG	VHF Amplifier		
TS	612	TS	GPA	AF Power Ampl		
TS	613	TS	GPA	AF Amplifier		
TS	615	TS	GPA	AF Amplifier		
TS	616	TS	GPA	AF Amplifier		
TS	617	TS	GPA	AF Amplifier		
TS	618	TS	GPA	AF Amplifier		
TS	619	TS	GPA	AF Amplifier		
TS	620	TS	GPA	AF Amplifier		2N139
TS	621	TS	GPA	AF Amplifier		2N140
TS	630	TS	GPA	AF Amplifier		
	700	TI	GNG	AF Amplifier		
CK	721	RK	GPA	AF Amplifier		2N104
CK	722	RK	GPA	AF Amplifier		2N104
CK	725	RK	GPA	AF Amplifier		2N104
CK	727	RK	GPA	AF Amplifier		2N104
CK	751	RK	GPA	AF Amplifier		2N109
CK	754	RK	GPA	AF Amplifier		
CK	758	RK	GPA	AF Amplifier		
CK	759	RK	GPA	RF Amplifier		2N139
GT	759	GT	GPA	Switching		2N139
CK	760	RK	GPA	RF Amplifier		2N139
GT	760	GT	GPA	455 Kc Ampl		2N139
CK	761	RK	GPA	RF Amplifier	2N139	
GT	761	GT	GPA	455 Kc Ampl	2N139	
CK	762	RK	GPA	Converter	2N140	
GT	762	GT	GPA	Converter	2N140	
GT	763	GT	GPA	RF Amplifier		
GT	764	GT	GPA	Switching		
CK	766	RK	GPA	RF Amplifier		2N140
CK	766A	RK	GPA	RF Amplifier		2N140
CK	768	RK	GPA	Converter		
CK	790	RK	SPA	AF Amplifier		
CK	791	RK	SPA	AF Amplifier		
CK	793	RK	SPA	AF Amplifier		
	800	TI	GNG	⊕		
	830	TI	GNG	Converter		2N140
CK	870	RK	GPA	AF Amplifier		
CK	871	RK	GPA	AF Amplifier		
GT	903	GT	GNA	Switching		
	903	TI	SNG	AF Amplifier		
	904	TI	SNG	AF Amplifier		
GT	904	GT	GNA	Switching		
	904A	TI	SNG	AF Amplifier		
GT	905	GT	GNA	Switching		
	905	TI	SNG	AF Amplifier		
	910	TI	SNA	General		
	925	TI	SNG	IF-RF Ampl		
	926	TI	SNG	IF-RF Ampl		
GT	947	GT	GNA	Switching		
GT	948	GT	GNA	Switching		
GT	949	GT	GNA	Switching		
	951	TI	SNG	AF Power Ampl		
	952	TI	SNG	AF Power Ampl		
	953	TI	SNG	AF Power Ampl		
	970	TI	SNG	AF Power Ampl		
CTP	1002	CC	GPA	AF Power Ampl		
CTP	1003	CC	GPA	AF Power Ampl		
CTP	1004	CC	GPA	AF Power Ampl		
CTP	1005	CC	GPA	AF Power Ampl		
CTP	1006	CC	GPA	AF Power Ampl		
	1032	CC	GPA	AF Amplifier		2N109
	1033	CC	GPA	AF Amplifier		2N109
	1034	CC	GPA	AF Amplifier		2N109
	1035	CC	GPA	AF Amplifier		2N109
	1036	CC	GPA	AF Amplifier		2N109
CTP	1102	CC	GPA	AF Power Ampl		
CTP	1103	CC	GPA	AF Power Ampl		
CTP	1104	CC	GPA	AF Power Ampl		
CTP	1108	CC	GPA	AF Power Ampl		
CTP	1109	CC	GPA	AF Power Ampl		
CTP	1111	CC	GPA	AF Power Ampl		
CTP	1112	CC	GPA	AF Power Ampl		
CTP	1117	CC	GPA	AF Power Ampl		
	1320	CC	GPA	AF Amplifier		2N109
	1330	CC	GPA	AF Amplifier		2N109
	1340	CC	GPA	AF Amplifier		2N109
	1350	CC	GPA	AF Amplifier		2N109
	1360	CC	GPA	AF Amplifier		2N109
	1390	CC	GPA	IF-RF Ampl		2N139
	1400	CC	GPA	IF-RF Ampl		2N139
	1410	CC	GPA	IF-RF Ampl		2N139
RD	2517A	BOG	GNG	General Use		
RD	2518A	BOG	GNG	Switching		
RD	2520A	BOG	GNG	RF Amplifier		
RD	2521A	BOG	GNG	Switching		
RD	2523A	BOG	GNG	Switching		
RD	2525A	BOG	GNG	AF Amplifier		
HA	5001	HA	GNA	AF Amplifier		
HA	5002	HA	GNA	AF Amplifier		
HA	5003	HA	GNA	AF Amplifier		
HA	5005	HA	GNA	General Use		
HA	5009	HA	GNA	General Use		
HA	5011	HA	GNA	AF Amplifier		
HA	5012	HA	GNA	AF Amplifier		
HA	5014	HA	GNA	AF Amplifier		
HA	5016	HA	GNA	Switching		
HA	5020	HA	GNA	Switching		
HA	5021	HA	GNA	Switching		
HA	7501	HA	SPA	AF Amplifier		
	9052	TI	SNG	AF Amplifier		

1	2	3	4	5	6	7
Type To Be Replaced					Replace by RCA Type*	Similar RCA Type‡
Mfr. Prefix	Basic Designation	Mfr.	Description	Class of Service		
	10101	WL	GPA	Switching		
	10123	WL	GPA	Switching		
	A0	NA	GC	AF Amplifier		
	A1	NA	GC	AF Amplifier		
	A2	NA	GC	AF Amplifier		2N274
	AO1	P	GPS	AF Amplifier		2N218
	CQ1	NA	GPA	AF Amplifier		
	FS2500	BOG	GNG	General Use		
	G11	GE	GC	Oscillator		
	G11A	GE	GC	Oscillator		
	GA52609	WE	GNG	AF Amplifier		
	GA52829	WE	GPA	AF Amplifier		
	GA52830	WE	GPA	Switching		
	GA52837	WE	GC	Switching		
	GA52996	WE	GC	Switching		
	GFT20	N	GPA	AF Amplifier		2N109
	GFT21	N	GPA	AF Amplifier		
	GFT26	N	GPA	AF Power Ampl		2N301
	GFT32	N	GPA	AF Amplifier		2N270
	GFT44	N	GPA	RF Amplifier		2N218
	GFT45	N	GPA	RF Amplifier		
	GFT26	N	GPA	AF Power Ampl		
	GT547A	S	GNA	IF-RF Ampl		
	GT547B	S	GNA	Switching		
	HA1	CBS	GPA	AF Amplifier		2N77
	HA1	NA	GPA	AF Amplifier		2N77
	HA2	CBS	GPA	AF Amplifier		2N77
	HA3	CBS	GPA	AF Amplifier		2N77
	HA8	CBS	GPA	AF Amplifier		2N105
	HA9	CBS	GPA	AF Amplifier		2N105
	HA10	CBS	GPA	AF Amplifier		2N105
	HC1	CBS	GPA	Switching		
	HD197	CBS	GPA	AF Power Ampl		
	HF1	NA	GPA	RF Amplifier		
	HS1	NA	GPA	Switching		
	HS2	NA	GPA	Switching		
	HS3	NA	GPA	Switching		2N269
	HS4	NA	GPA	Switching		2N269
	IF1	NA	GPA	IF Amplifier		
	IF3	NA	GPA	IF Amplifier		
	J1	NA	GPA	AF Amplifier		2N109
	J2	NA	GPA	AF Amplifier		2N109
	J3	NA	GPA	AF Amplifier		2N109
	JP1	NA	GPA	AF Amplifier		2N109
	L5108	P	GPS	RF Amplifier		2N247
	L5121	P	GPS	Switching		2N247
	L5122	P	GPS	Switching		2N247
	N119	TI	SNG	AF Amplifier		
	NPN3	GPC	GNG	AF Amplifier		
	OC32	N	GPA	AF Amplifier		2N109
	OC33	N	GPA	AF Amplifier		2N109
	OC34	N	GPA	AF Amplifier		2N109
	OC360	N	GPA	AF Amplifier		
	S0	NA	GC	Switching		
	S1	NA	GC	Switching		
	S2	NA	GC	Switching		
	SB100	P	GPS	IF Amplifier		2N247
	SB100	SPR	GPS	IF Amplifier		2N247
	SB101	P	GPS	RF Amp		
	SB101	SPR	GPS	RF Amp		
	SB102	SPR	GPS	RF Amplifier		
	SB102	SPR	GPS	RF Amplifier		
	SB103	P	GPS	IF-RF Ampl		
	SB103	SPR	GPS	IF-RF Ampl		
	SB5122	SPR	GPS	Switching		
	ST10	TEC	SNA	AF Amplifier		
	ST11	TEC	SNA	AF Amplifier		
	ST12	TEC	SNA	AF Amplifier		
	ST13	TEC	SNA	AF Amplifier		
	ST30	TEC	SNA	AF Amplifier		
	ST31	TEC	SNA	AF Amplifier		
	ST32	TEC	SNA	AF Amplifier		
	ST33	TEC	SNA	AF Amplifier		
	ST40	TEC	SNA	AF Amplifier		
	ST41	TEC	SNA	AF Amplifier		
	ST42	TEC	SNG	RF Amplifier		
	T1000	P	GPA	RF Amplifier		
	T1001	P	GPA	AF Power Ampl		
	T1040	P	GPA	AF Power Ampl		2N301
	T1041	P	GPA	AF Power Ampl		2N301
	T1050	P	GS	AF Amplifier		
	T1164	P	GPA	Switching		2N384
	T1166	P	GPA	Switching		2N384
	X2	TI	GNG	AF Power Ampl		
	X15	TI	SNG	AF Amplifier		
	X30A	GPC	SNA	General Use		
	X31A	GPC	SNA	General Use		
	X32A	GPC	SNA	General Use		
	X78	CC	GPA	AF Power Ampl		
	X107	CC	GPA	AF Power Ampl		
	X113	B	GPA	Switching		
	X114	B	GPA	AF Power Ampl		
	X120	CC	GPA	AF Power Ampl		
	X133	B	GPA	Switching		
	X134	B	GPA	Switching		
	X137	B	GPA	Switching		
	X140	B	GPA	AF Power Ampl		
	X145	B	GPA	AF Power Ampl		
RD	X300	GPC	GNG	RF Amplifier		
RD	X300A	GPC	GNG	RF Amplifier		
RD	X301	GPC	GNG	RF Amplifier		
RD	X302	GPC	GNG	RF Amplifier		
	XD5081	WL	GPA	AF Amplifier		
	XD5082	WL	GPA	AF Amplifier		
	XH10	MH	GPA	AF Power Ampl		

1	2	3	4	5	6	7
Type To Be Replaced					Replace by RCA Type*	Similar RCA Type‡
Mfr. Prefix	Basic Designation	Mfr.	Description	Class of Service		

For key to symbols in columns 3 and 4, see page 17.

⊕ Phototransistor

CIRCUITS

The circuits shown in the following pages are included in this Booklet to illustrate some of the more important applications of RCA transistors and semiconductor diodes. These circuits are not necessarily examples of commercial practice. They have been conservatively designed and are capable of excellent performance. Electrical specifications are given for circuit components to assist those interested in home construction. Layouts and mechanical details are omitted because they vary widely with the requirements of individual set builders and with the sizes and shapes of the components employed.

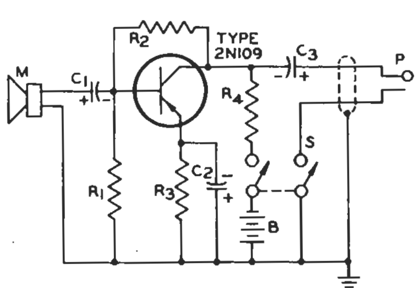
Performance of these circuits depends as much on the quality of the components selected and the care employed in layout and construction as on the circuits themselves. Good signal reproduction from receivers and amplifiers requires the use of good-quality speakers, transformers, inductors, and input sources (microphones, phonograph pickups, etc.).

Information on the characteristics of each RCA transistor and semiconductor diode will be found on pages 8, 9, 10, 11 and 12. This information will prove of assistance in understanding and utilizing the circuits.

The following circuits will be found in the subsequent pages:

INDEX

MICROPHONE PREAMPLIFIER

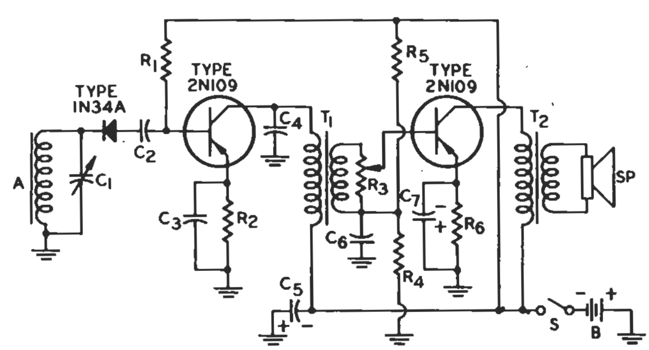


B = 9 volts, VS300 or VS301
C1 = 52 µf, electrolytic, 12 v.
C2 = 50 µf, electrolytic, 12 v.
C3 = 2.5 µf, electrolytic, 25 v.
M = RCA-239S1 2⅛" Speaker
P = Plug to make connection to audio amplifier
R1 = 10000 ohms, 0.5 watt
R2 = 68000 ohms, 0.5 watt
R3 = 1200 ohms, 0.5 watt
R4 = 8200 ohms, 0.5 watt
S = Switch, push-button, double-pole single throw, non-locking

NOTE:

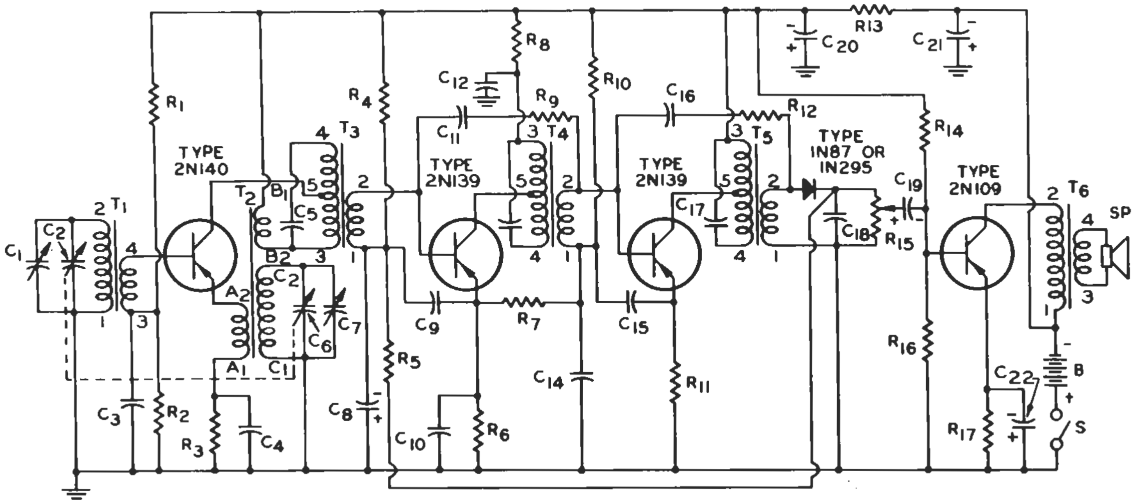
The low-frequency characteristics of the RCA-239S1 2⅛" speaker can be improved for operation as a microphone by gluing a small disk of felt over each of the holes, except one, on the back of the speaker. The last hole should be covered with a piece of fibre or cardboard having a ½" hole. A baffle such as a case should be provided for the speaker. If an enclosed case is used, a ⅛" hole should be drilled in the case.

TWO-TRANSISTOR RECEIVER
Standard AM Broadcast Band



A = Ferrite loop antenna, 540-1600 Kc
B = 9 volts, VS300 or VS301
C1 = Variable capacitor, 540-1600 Kc
C2 = 0.01 µf, paper, 150 v.
C3 = 0.05 µf, paper 150 v.
C4 = 0.001 µf, paper, 150 v.
C5 = 10 µf, paper, 150 v.
C6 = 0.1 µf, electrolytic, 3 v.
C7 = 100 µf, electrolytic, 6 v.
R1 = 0.1 megohm, 0.5 watt
R2 = 50 ohms, 0.5 watt
R3 = Volume-control potentiometer, 5000 ohms, 0.5 watt
R4 = 5600 ohms, 0.5 watt
R5 = 10000 ohms, 0.5 watt
R6 = 220 ohms, 0.5 watt
SP = Speaker, high-sensitivity
T1 = Interstage audio transformer to provide a 30000-ohm load at the primary terminals with a 1000-ohm load between the secondary terminals. DC primary current = 0.5 ma. DC primary resistance = 1000 ohms.
T2 = Output transformer to provide a 500-ohm load at the primary terminals with the desired speaker connected to the secondary terminals.

FOUR-TRANSISTOR RECEIVER
Standard AM Broadcast Band



B = 9 volts, VS300 or VS301
C1 = Trimmer capacitor, 0-20 μμf
C2 = Variable capacitor, 12-230 μμf
C3 = 0.05 uf, paper, 150 v.
C4 = 0.04 μf, mica, 150 v.
C5 = 220 μμf, mica, 150 v.
C6 = Variable capacitor, 10-105 μμf
C7 = Trimmer capacitor, 0-20 μμf
C8 = 10 μf, electrolytic, 15 v.
C9 = 0.05 μf, paper, 150 v.
C10 = 0.05 μf, paper, 150 v.
C11 = 75 μμf, mica, 150 v.
C12 = 0.05 μf, paper, 150 v.
C13 = 220 μμf, mica, 150 v.
C14 = 0.05 μf, paper, 150 v.
C15 = 0.05 μf, paper, 150 v.
C16 = 33 μμf, mica, 150 v.
C17 = 220 μμf, mica, 150 v.
C18 = 0.05 μf, paper, 150 v.
C19 = 2 μf, electrolytic, 15 v.
C20 = 50 μf, electrolytic, 15 v.
C21 = 50 μf, electrolytic, 15 v.
C22 = 100 μf, electrolytic, 15 v.
R1 = 33,000 ohms, 1/8 watt
R2 = 24,000 ohms, 1/8 watt
R3 = 820 ohms, 1/4 watt
R4 = 120,000 ohms, 1/8 watt
R5 = 18,000 ohms, 1/8 watt
R6 = 1200 ohms, 1/4 watt
R7 = 75,000 ohms, 1/8 watt
R8 = 560 ohms, 1/4 watt
R9 = 560 ohms, 1/4 watt
R10 = 150,000 ohms, 1/8 watt
R11 = 1200 ohms, 1/4 watt
R12 = 2000 ohms, 1/8 watt
R13 = 100 ohms, 1/4 watt
R14 = 10,000 ohms, 1/8 watt
R15 = Volume control, 2500 ohms, 1/4 watt
R16 = 5600 ohms, 1/8 watt
R17 = 220 ohms, 1/4 watt
SP = Speaker

T1 = Antenna transformer wound on the largest feasible ferrite core to provide the following characteristics:

Primary Inductance (With secondary open)	353 μh
Primary Q at 1 Mc, mounted on chassis with secondary open	200
Equivalent output resistance across secondary terminals, at 1 Mc with primary tuned	600 ohms

The primary should be wound on one end of the ferrite rod with spacing between turns equal to the thickness of the wire.

The secondary should be wound on the opposite end of the ferrite rod with no spacing between turns (close wound). The end of the primary winding nearest the secondary is the ground end. Use #7/41 Litz wire. A ferrite rod about 8″ long and 3/8″ in diameter will provide excellent results.

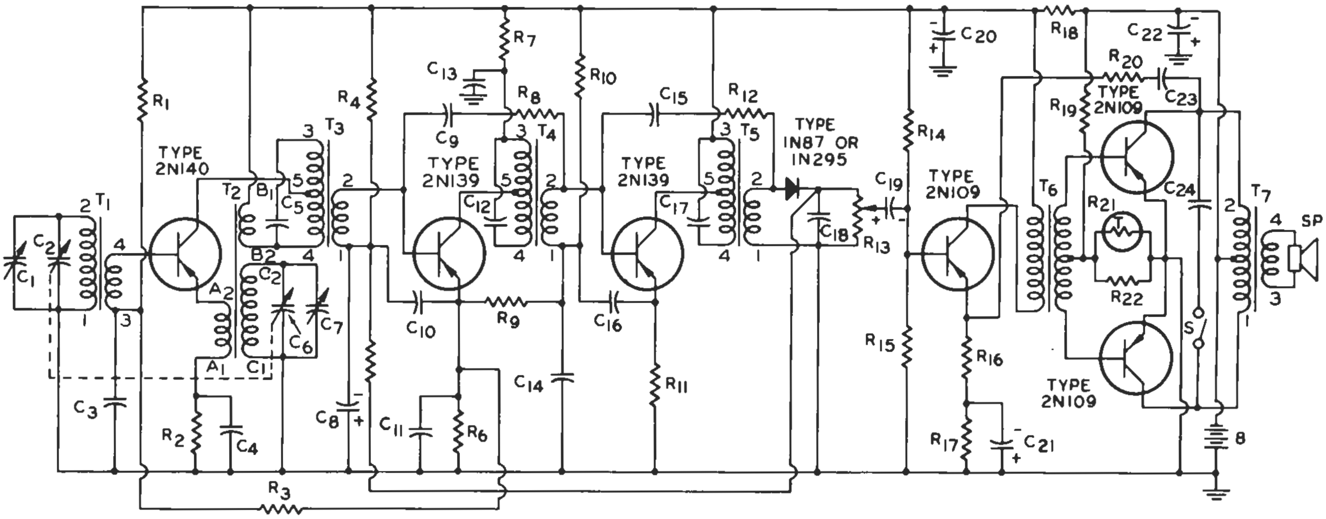
T2 = Oscillator transformer. Wind as follows:
Using a threaded resinite coil form about 1″ long with internal threads to match a 1/4″-diameter ferrite core about 3/4″ in length, wind 4 turns near the center of the coil form. This winding is located between the terminals marked A1 and A2 on the circuit diagram. The winding between terminals B1 and B2 consists of a 10-turn winding and is wound on top of the 4-turn winding. The winding between terminals C1 and C2 is wound on top of the other two windings and is a multilayer 115-turn winding. This winding should extend over a length of about 3/8″. All the windings are universally wound with #5/44 Litz wire. A resinite collar with 6-terminals may be fitted over one end of the coil form to provide secure anchorage for the ends of the windings and convenient terminals for making connnections to the windings. When the transformer is completed, connect a 120-μμf capacitor across the 115-turn winding and tune the ferrite core to obtain resonance at 1.455 Mc with the other two windings open circuited. The Q of this winding under the same conditions should be 100 or greater.

T3, T4, T5 = Intermediate-frequency transformers. Using materials like those described for the oscillator transformer T2, wind T3, T4, and T5 to meet the following requirements:

	T3	T4	T5
Tuned resistance at primary tap	118,000	15,300	17,200 ohms
Primary (terminals 3 and 5): Reflected resistance with secondary terminated	206,000	29,000	10,900 ohms
Secondary (terminals 1 and 2): Reflected resistance with primary terminated	1,000	500	1,000 ohms
Turns Ratios: Terminals 4 and 3 to terminals 5 and 3	1.17	2.48	3.16
Terminals 5 and 3 to terminals 2 and 1	14.35	7.62	3.3
Core (Ferrite): Unloaded Q (mounted in chassis)	110	61	110
Loaded Q (mounted in chassis)	35	35	35

T6 = Class A output transformer, primary impedance = 500 ohms, secondary impedance = 12 ohms.

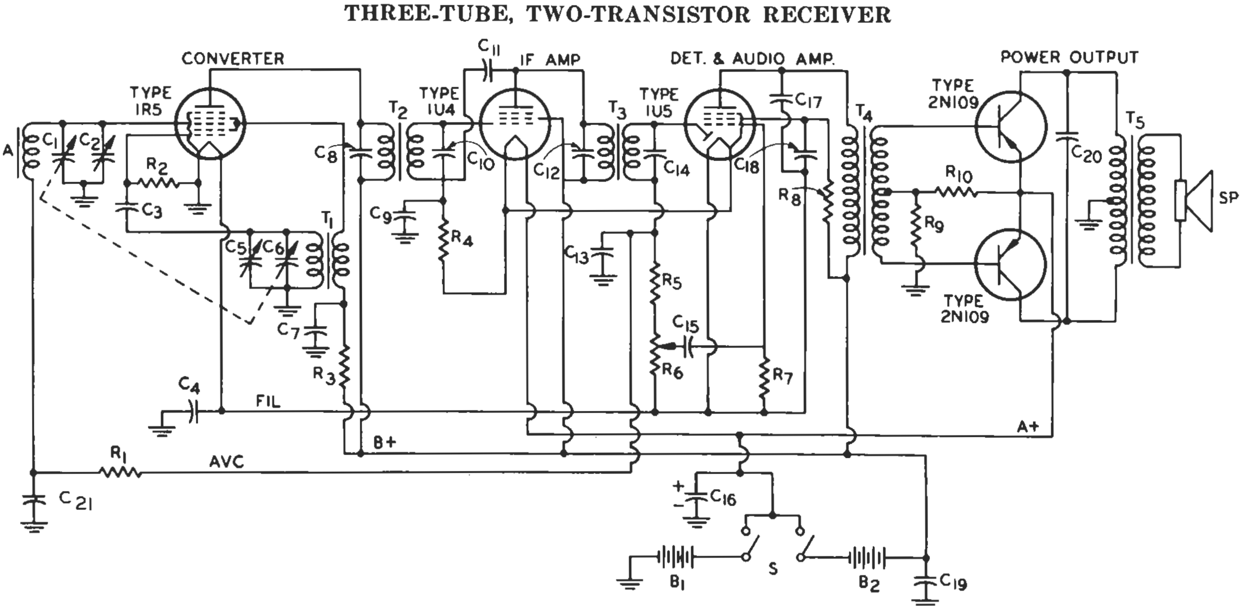
SIX-TRANSISTOR RECEIVER
Standard AM Broadcast Band



B = 9 volts, VS300 or VS301
C1 = Trimmer capacitor, 2-20 μμf
C2 = Variable capacitor, 12-230 μμf
C3 = 0.01 μf, paper, 150 v.
C4 = 0.04 μf, paper, 150 v.
C5 = 220 μμf, mica
C6 = Variable capacitor, 10-105 μμf
C7 = Trimmer capacitor, 0-20 μμf
C8 = 10 μf, electrolytic, 3 v.
C9 = 75 μμf, mica
C10 = 0.05 μf, paper, 150 v.
C11 = 0.05 μf, paper, 150 v.
C12 = 220 μμf, mica
C13 = 0.05 μf, paper, 150 v.
C14 = 0.05 μf, paper, 150 v.
C15 = 33 μμf, mica
C16 = 0.05 μf, paper, 150 v.
C17 = 220 μμf, mica
C18 = 0.05 μf, paper, 150 v.
C19 = 2 μf, electrolytic, 12 v.
C20 = 50 μf, electrolytic, 12 v.
C21 = 100 μf, electrolytic, 12 v.
C22 = 50 μf, electrolytic, 12 v.
C23 = 0.01 μf, paper, 150 v.
C24 = 0.03 μf, paper, 150 v.
R1 = 33000 ohms, 0.5 watt
R2 = 820 ohms, 0.5 watt
R3 = 100 ohms, 0.5 watt
R4 = 100000 ohms, 0.5 watt
R5 = 8200 ohms, 0.5 watt
R6 = 560 ohms, 0.5 watt
R7 = 560 ohms, 0.5 watt
R8 = 560 ohms, 0.5 watt
R9 = 1800 ohms, 0.5 watt
R10 = 47000 ohms, 0.5 watt
R11 = 560 ohms, 0.5 watt
R12 = 2000 ohms, 0.5 watt
R13 = Potentiometer, 2500 ohms, 0.5 watt, volume-control
R14 = 39000 ohms, 0.5 watt
R15 = 51000 ohms, 0.5 watt
R16 = 220 ohms, 0.5 watt
R17 = 5100 ohms, 0.5 watt
R18 = 100 ohms, 0.5 watt
R19 = 10000 ohms, 0.5 watt
R20 = 220000 ohms, 0.5 watt
R21 = Thermistor, 300 ohms at 25°C, 108 ohms at 50°C
R22 = 270 ohms, 0.5 watt
T1 = Antenna transformer
T2 = Oscillator transformer
T3, T4, T5 = Intermediate-frequency transformers
T6 = Driver transformer with primary to secondary impedance (base-to-base, center tapped) of 20,000 ohms to 2,000 ohms.
T7 = Class B output transformer with primary to secondary impedance (collector-to-collector, center tapped) of 750 to 3.2 ohms.

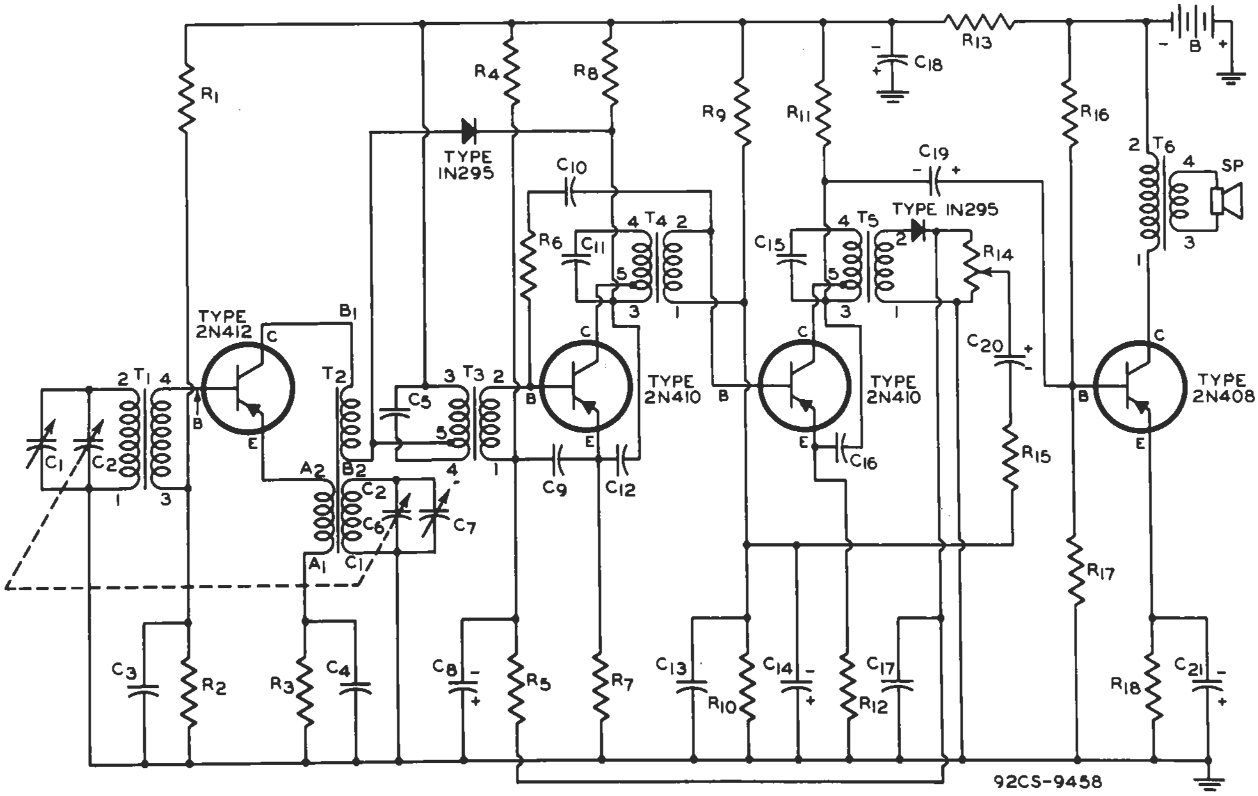
NOTE: Transformers T1, T2, T3, T4, and T5 are the same as those described for the 4-transistor receiver.

THREE-TUBE, TWO-TRANSISTOR RECEIVER



A = Loop antenna, 540-1600 Kc
B1 = 4.5 volts
B2 = 67.5 volts
C1 = Ganged tuning capacitor, 10-274 μμf
C2 = Trimmer capacitor, 2-15 μμf
C3 = 56 μμf, ceramic
C4 = 0.1 μf 100 v.
C5 = Ganged tuning capacitor, 7.5-122.5 μμf
C6 = Trimmer capacitor, 2-15 μμf
C7 = 0.02 μf paper 100 v.
C8 = Trimmer capacitor
C9 = 0.05 μf, paper, 100 v.
C10 = Trimmer capacitor
C11 = 5 μμf, silver mica
C12 = Trimmer capacitor
C13 = 82 μμf, ceramic
C14 = Trimmer capacitor
C15 = 0.002 μf, paper, 150 v.
C16 = 50 μf, electrolytic, 6 v.
C17 = 0.005 μf, paper 200 v.
C18 = 0.04 μf, paper, 100 v.
C19 = 20 μf, electrolytic, 150 v.
C20 = 0.04 μf, paper, 100 v.
C21 = 0.02 μf, paper, 100 v.
R1 = 3.3 megohms, 0.25 watt
R2 = 100,000 ohms, 0.25 watt
R3 = 4700 ohms, 0.25 w.
R4 = 10 megohms, ¼ w.
R5 = 1000 ohms, ¼ w.
R6 = 1 meg. ½ w. pot. vol. control.
R7 = 10 megohms ¼ w.
R8 = 360,000 ohms ¼ w.
R9 = 3000 ohms ¼ w.
R10 = 100 ohms ¼ w.
T1 = Oscillator coil for use with tuning capacitor of 7.5-122.5 μμf, and 455 Kc IF transformer
T2, T3 = 455 Kc IF transformers
T4 = Driver transformer, primary impedance = 100,000 ohms, primary resistance = 2900 ohms, secondary impedance (base-to-base) = 1500 ohms, secondary resistance = 30 ohms.
T5 = Output transformer, primary impedance (collector-to-collector) = 400 ohms, primary resistance = 20 ohms, secondary impedance = 11 ohms, secondary resistance = 1 ohm.

FOUR-TRANSISTOR REFLEX RECEIVER
Standard AM Broadcast Band



B = 9 volts, VS300 or VS306
C1 = Trimmer capacitor, 0-20 $\mu\mu$f
C2 = Variable capacitor, 12-230 $\mu\mu$f
C3 = 0.04 μf, paper, 150 v.
C4 = 0.04 μf, paper, 150 v.
C5 = Fixed tuner capacitor, 220 $\mu\mu$f
C6 = Variable capacitor, 10-105 $\mu\mu$f
C7 = Trimmer capacitor, 0-20 $\mu\mu$f
C8 = 10 μf, electrolytic, 15 v.
C9 = 0.04 μf, paper, 150 v.
C10 = 75 $\mu\mu$f, mica, 150 v.
C11 = Fixed tuner capacitor, 220 $\mu\mu$f
C12 = 0.04 μf, paper, 150 v.
C13 = 0.02 μf, paper, 150 v.
C14 = 10 μf, electrolytic, 15 v.
C15 = Fixed tuner capacitor, 220 $\mu\mu$f
C16 = 0.05 μf, paper, 150 v.
C17 = 0.04 μf, paper, 150 v.
C18 = 50 μf, electrolytic, 15 v.
C19 = 10 μf, electrolytic, 15 v.
C20 = 10 μf, electrolytic, 15 v.
C21 = 50 μf, electrolytic, 15 v.
R1 = 33,000 ohms, 0.5 watt
R2 = 2,400 ohms, 0.5 watt
R3 = 820 ohms, 0.5 watt
R4 = 120,000 ohms, 0.5 watt
R5 = 18,000 ohms, 0.5 watt
R6 = 510 ohms, 0.5 watt
R7 = 1,200 ohms, 0.5 watt
R8 = 1,200 ohms, 0.5 watt
R9 = 68,000 ohms, 0.5 watt
R10 = 3,900 ohms, 0.5 watt
R11 = 1,000 ohms, 0.5 watt
R12 = 680 ohms, 0.5 watt
R13 = 100 ohms, 0.5 watt
R14 = Volume-control potentiometer, 2500 ohms, 0.5 watt
R15 = 1200 ohms, 0.5 watt
R16 = 4700 ohms, 0.5 watt
R17 = 1500 ohms, 0.5 watt

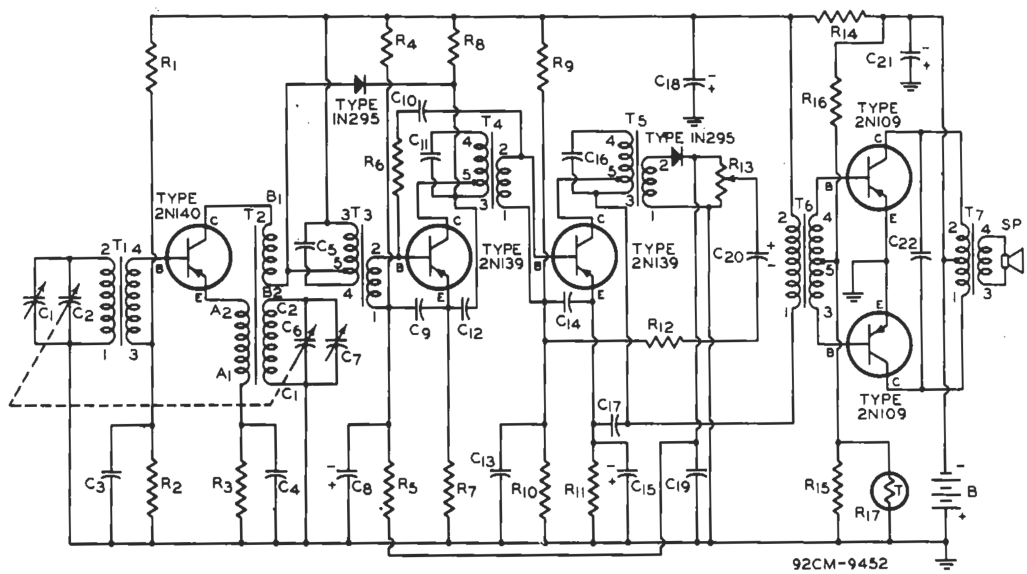
T1 = Antenna transformer wound on the largest feasible ferrite core to provide the following characteristics:
Primary Inductance (With secondary open) 353 μh
Primary Q at 1 Mc, mounted on chassis with secondary open 200
Equivalent output resistance across secondary terminals, at 1 Mc with primary tuned 600 ohms
The primary should be wound on one end of the ferrite rod with spacing between turns equal to the thickness of the wire.
The secondary should be wound on the opposite end of the ferrite rod with no spacing between turns (close wound). The end of the primary winding nearest the secondary is the ground end. Use #7/41 Litz wire. A ferrite rod about 8" long and 3/8" in diameter will provide excellent results.
T2 = Oscillator transformer. Wind as follows:
Using a threaded resinite coil form about 1" long with internal threads to match a 1/4"-diameter ferrite core about 3/8" in length, wind 4 turns near the center of the coil form. This winding is located between the terminals marked A1 and A2 on the circuit diagram. The winding between terminals B1 and B2 consists of a 10-turn winding and is wound on top of the 4-turn winding. The winding between terminals C1 and C2 is wound on top of the other two windings and is a multilayer 115-turn winding. This winding should extend over a length of about 3/8". All the windings are universally wound with #5/44 Litz wire. A resinite collar with 6-terminals may be fitted over one end of the coil form to provide secure anchorage for the ends of the windings and convenient terminals for making connnections to the windings. When the transformer is completed, connect a 120-$\mu\mu$f capacitor across the 115-turn winding and tune the ferrite core to obtain resonance at 1.455 Mc with the other two windings open circuited. The Q of this winding under the same conditions should be 100 or greater.

T3, T4, T5 = Intermediate-frequency transformers. Using materials like those described for the oscillator transformer T2, wind T3, T4, and T5 to meet the following requirements:

	T3	T4	T5
Tuned resistance at primary tap	118,000	15,300	2,260 ohms
Primary (terminals 3 and 5): Reflected resistance with secondary terminated	206,000	29,000	1,000 ohms
Secondary (terminals 1 and 2): Reflected resistance with secondary terminated	1,000	500	1,000 ohms
Turns Ratios: Terminals 4 and 3 to terminals 5 and 3	1.17	2.48	8.4
Terminals 5 and 3 to terminals 2 and 1	14.35	7.62	1
Core (Ferrite): Unloaded Q (mounted in chassis)	110	61	100
Loaded Q (mounted in chassis)	35	35	30

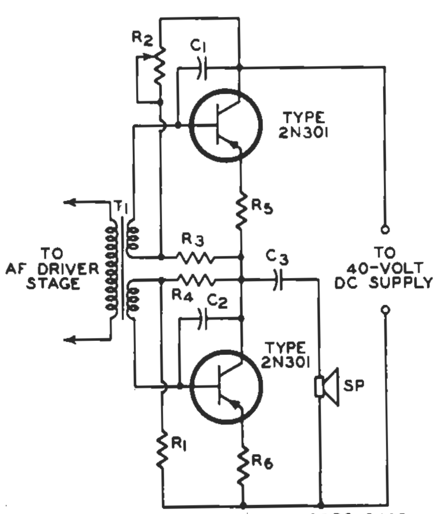
T6 = Class A output transformer, primary impedance = 400 ohms, secondary impedance = 12 ohms.

FIVE-TRANSISTOR REFLEX RECEIVER
Standard AM Broadcast Band



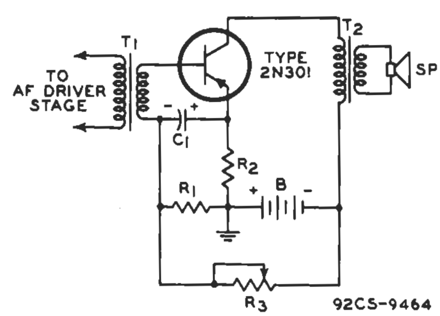
B = 9 volts, VS300 or VS306
C1 = Trimmer capacitor, 0-20 μμf
C2 = Variable capacitor, 12-230 μμf
C3 = 0.04 μf, paper, 150 v.
C4 = 0.04 μf, paper, 150 v.
C5 = Fixed tuner capacitor, 220 μμf
C6 = Variable capacitor, 10-105 μμf
C7 = Trimmer capacitor, 0-20 μμf
C8 = 10 μf, electrolytic, 15 v.
C9 = 0.04 μf, paper, 150 v.
C10 = 75 μμf, mica, 150 v.
C11 = Fixed tuner capacitor, 220 μμf
C12 = 0.04 μf, paper, 150 v.
C13 = 0.04 μf, paper, 150 v.
C14 = 0.04 μf, paper, 150 v.
C15 = 50 μf, electrolytic 15 v.
C16 = Fixed tuner capacitor, 220 μμf
C17 = 0.02 μf, paper, 150 v.
C18 = 50 μf, electrolytic, 15v.
C19 = 0.04 μf, paper, 150 v.
C20 = 10 μf, electrolytic, 15 v.
C21 = 50 μf, electrolytic, 15 v.
C22 = 0.03, paper, 150 v.
R1 = 33,000 ohms, 0.5 watt
R2 = 2,400 ohms, 0.5 watt
R3 = 820 ohms, 0.5 watt
R4 = 120,000 ohms, 0.5 watt
R5 = 18,000 ohms, 0.5 watt
R6 = 510 ohms, 0.5 watt
R7 = 1,200 ohms, 0.5 watt
R8 = 1,200 ohms, 0.5 watt
R9 = 68,000 ohms, 0.5 watt
R10 = 10,000 ohms, 0.5 watt
R11 = 680 ohms, 0.5 watt
R12 = 820 ohms, 0.5 watt
R13 = Volume-control potentiometer, 2500 ohms, 0.5 watt
R14 = 100 ohms, 0.5 watt
R15 = 180 ohms, 0.5 watt
R16 = 6,200 ohms, 0.5 watt
R17 = Thermistor, 495 ohms at 0°C., 150 ohms at 25°C., and 54 ohms at 50°C.
SP = Speaker
T1 = Antenna transformer (same as T1 of the four-transistor receiver)
T2 = Oscillator transformer (same as T2 of the four-transistor receiver)
T3, T4, T5 = Intermediate-frequency transformers (same as T3, T4, and T5 of the four-transistor reflex receiver).
T6 = Driver transformer, primary impedance = 5000 ohms, secondary impedance (base-to-base, center tapped) = 2000 ohms.
T7 = Class B output transformer, primary impedance (collector-to-collector, center tapped) = 800 ohms, secondary impedance = 12 ohms.

AUDIO POWER AMPLIFIER
Class B; Output, 15 Watts



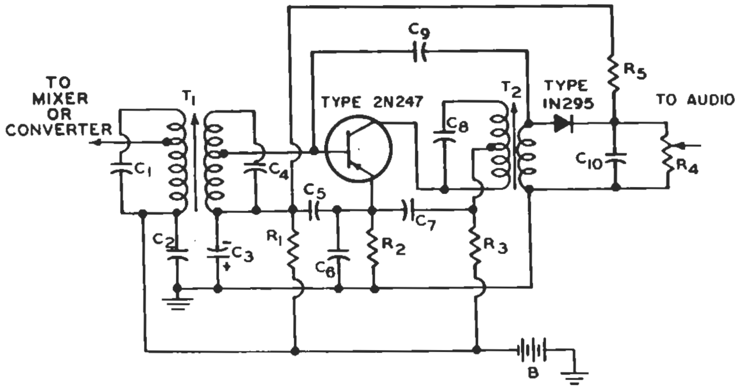
C1 = 0.01 μf, paper, 150 v.
C2 = 0.01 μf paper, 150 v.
C3 = 1000 μf, electrolytic, 25 v.
R1 = 2.7 ohms, 1 watt
R2 = Bias-control potentiometer, 250 ohms, 1 watt
R3 = 2.7 ohms, 1 watt
R4 = 220 ohms, 1 watt
R5 = 1 ohm, 1 watt
R6 = 1 ohm, 1 watt
SP = 15-watt, 8-ohm speaker
T1 = Driver transformer

AUTOMOBILE RECEIVER AUDIO AMPLIFIER
Class A; Output, 4 Watts



B = 14.4 volts (12-volt automobile battery source)
C1 = 500 μf, electrolytic, 15 v.
R1 = 27 ohms, 1 watt
R2 = 1 ohm, 1 watt
R3 = Bias-control potentiometer, 500 ohms, 1 watt
T1 = Driver transformer
T2 = Class A output transformer, primary impedance = 15 ohms secondary impedance = 3.2 ohms

ONE-STAGE NEUTRALIZED 455-KC IF AMPLIFIER

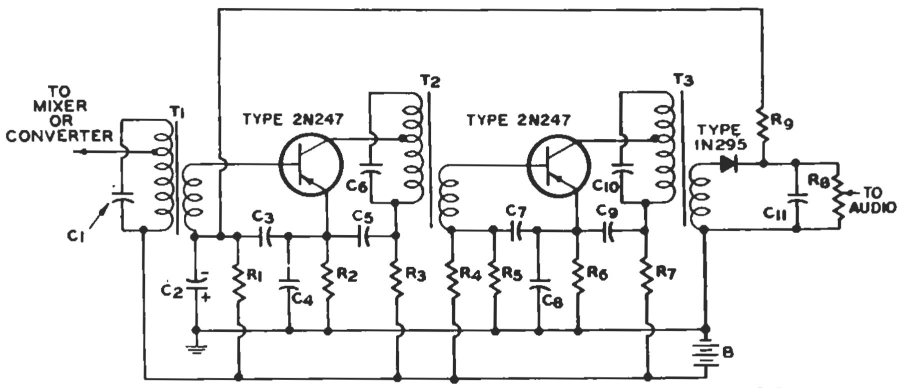


B = 9 volts, VS300 or VS301
C1 = 220 $\mu\mu$f, mica, 150 v.
C2 = 0.05 paper, 150 v.
C3 = 10 μf, electrolytic, 15 v.
C4 = 220 $\mu\mu$f, mica, 150 v.
C5 = 0.05 μf, paper, 150 v.
C6 = 0.05 μf, paper, 150 v.
C7 = 0.05 μf, paper, 150 v.
C8 = 220 $\mu\mu$f, mica, 150 v.
C9 = 7 $\mu\mu$f, mica, 150 v.
C10 = 0.05 μf, paper, 150 v.
R1 = 33000 ohms, 0.5 watt
R2 = 1000 ohms, 0.5 watt
R3 = 560 ohms, 0.5 watt
R4 = 5000 ohms, volume control, 1 watt
R5 = 10000 ohms, 0.5 watt

T1 = Doubled-tuned IF transformer, unloaded Q of primary and secondary = 120, loaded Q of primary = 41, tuned resistance of primary = 190,000 ohms, loaded Q of secondary = 50, tuned resistance of secondary = 190,000 ohms, reflected impedance of secondary = 138,000 ohms, impedance of secondary = 1700 ohms, coefficient of coupling = 82%.

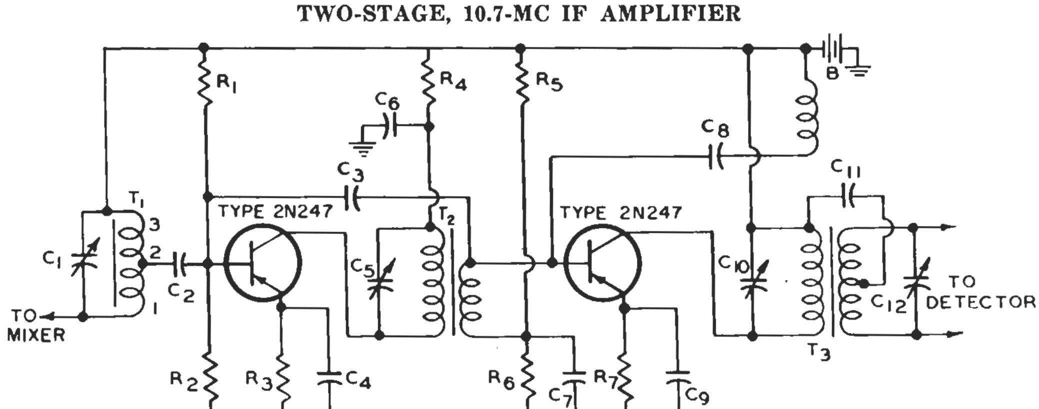
T2 = Single-tuned IF transformer, unloaded Q = 120, loaded Q = 45.5, primary impedance = 17,000 ohms, secondary impedance = 1000 ohms, tuned resistance = 1000 ohms.

TWO-STAGE UNNEUTRALIZED 455-KC IF AMPLIFIER



B = 9 volts, VS300 or VS301
C1 = 220 $\mu\mu$f, mica, 150 v.
C2 = 10 μf, electrolytic, 15 v.
C3 = 0.05 μf, paper, 150 v.
C4 = 0.05 μf, paper, 150 v.
C5 = 0.05 μf, paper, 150 v.
C6 = 220 $\mu\mu$f, mica, 150 v.
C7 = 0.05 μf, paper, 150 v.
C8 = 0.05 μf, paper, 150 v.
C9 = 0.05 μf, paper, 150 v.
C10 = 220 $\mu\mu$f, mica, 150 v.
C11 = 0.05 μf, paper, 150 v.
R1 = 33000 ohms, 0.5 watt
R2 = 1000 ohms, 0.5 watt
R3 = 560 ohms, 0.5 watt
R4 = 39000 ohms, 0.5 watt
R5 = 5600 ohms, 0.5 watt
R6 = 1000 ohms, 0.5 watt
R7 = 560 ohms, 0.5 watt
R8 = 5000 ohms, volume control, 1 watt
R9 = 10000 ohms, 0.5 watt
T1 = IF transformer, primary impedance = 105000 ohms, secondary impedance = 1700 ohms, unloaded Q = 100, loaded Q = 35.
T2 = IF transformer, primary impedance = 4600 ohms, secondary impedance = 1700 ohms, unloaded Q = 39, loaded Q = 35
T3 = IF transformer, primary impedance = 30,000, secondary impedance = 1000 ohms, unloaded Q = 100, loaded Q = 35

TWO-STAGE, 10.7-MC IF AMPLIFIER



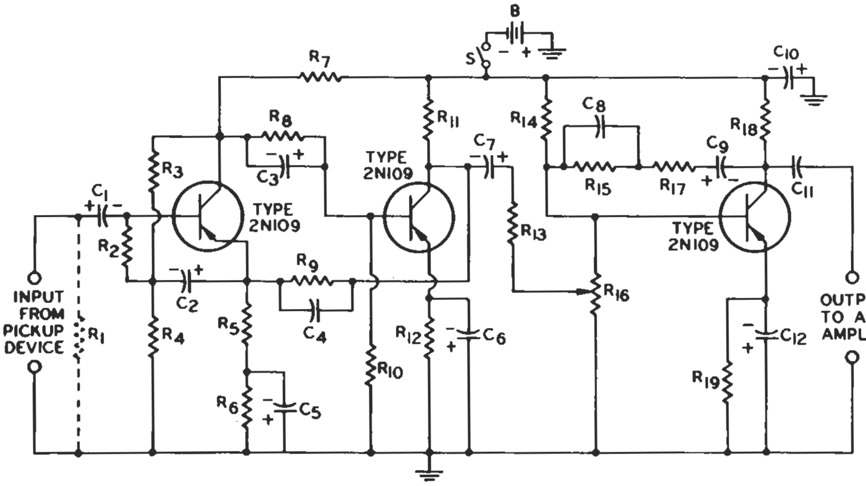
B = 9 volts, VS300 or VS301
C1 = 30 $\mu\mu$f, mica, 500 v.
C2 = 1000 $\mu\mu$f, mica, 500 v.
C3 = 8.5 $\mu\mu$f, mica, 500 v.
C4 = 0.05 μf, paper, 0.5 watt
C5 = Variable capacitor, 2-30 $\mu\mu$f
C6 = 0.05 μf, paper, 150 v.
C7 = 0.05 μf, paper, 150 v.
C8 = 0.05 μf, paper, 150 v.
C9 = 0.05 μf, paper, 150 v.
C10 = Variable capacitor, 2-30 $\mu\mu$f
C11 = 0.05 μf, paper, 150 v.
C12 = 30 $\mu\mu$f, mica, 500 v.
R1 = 39000 ohms, 0.5 watt
R2 = 5600 ohms, 0.5 watt
R3 = 1000 ohms, 0.5 watt
R4 = 680 ohms, 0.5 watt
R5 = 39000 ohms, 0.5 watt
R6 = 5600 ohms, 0.5 watt
R7 = 1000 ohms, 0.5 watt

T1 = Tap transformer, primary impedance (terminal 1 to terminal 3) = 4250 ohms, tap impedance (terminal 1 to terminal 2) = 170 ohms, unloaded Q = 150, loaded Q = 27.3, Turns Ratio = 5:1

T2 = IF air-core transformer, inductance to tune with 30 $\mu\mu$f, unloaded Q = 150, loaded Q = 27.3, Turns Ratio = 5:1

T3 = IF air-core transformer, unloaded Q = 150, loaded Q = 27.3, Turns Ratio = 5:1

PHONOGRAPH PREAMPLIFIER



B = 12 volts, 9 cells from VS087 battery assembly or 8 VS035 batteries connected in series
C1 = 15 μf, electrolytic, 6 v.
C2 = 5μf, electrolytic, 12 v.
C3 = 1 μf, electrolytic, 12 v.
C4 = Equalization component. Refer to chart below.
C5 = 10 μf, electrolytic, 3 v.
C6 = 100 μf, electrolytic, 3 v.
C7 = 5 μf, electrolytic, 12 v.
C8 = Equalization component. Refer to chart below.
C9 = 1 μf, electrolytic, 12 v.
C10 = 100 μf, electrolytic, 25 v.
C11 = 0.02 μf, paper, 150 v.
C12 = 100 μf, electrolytic, 3 v.
R1 = Refer to note below
R2 = 0.01 megohm, 0.5 watt
R3 = 3900 ohms, 0.5 watt
R4 = 0.01 megohm, 0.5 watt
R5 = Refer to note below
R6 = 3300 ohms, 0.5 watt
R7 = 22000 ohms, 0.5 watt
R8 = 0.1 megohm, 0.5 watt
R9 = 30000 ohms, 0.5 watt
R10 = 0.01 megohm, 0.5 watt
R11 = 15000 ohms, 0.5 watt
R12 = 1000 ohms, 0.5 watt
R13 = 3900 ohms, 0.5 watt
R14 = 0.12 megohm, 0.5 watt
R15 = Equalization component. Refer to chart below
R16 = Potentiometer, 5000 ohms, 0.5 watt, volume-control
R17 = 15000 ohms, 0.5 watt
R18 = 0.01 megohm, 0.5 watt
R19 = 510 ohms, 0.5 watt

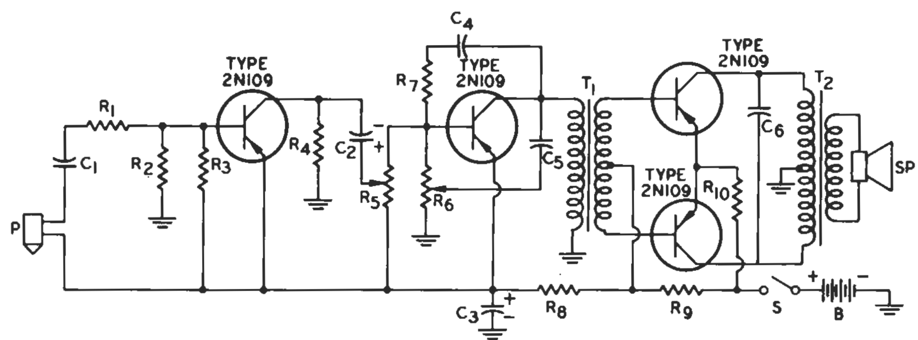
EQUALIZATION COMPONENTS

Curve	C4 μf	C8 μf	R15 ohms
R1AA	0.0045	0.02	300,000
AES	0.0033	0.038	omit
LP	0.0065	0.026	75000
NAB	0.0065	0.025	omit
Flat	omit	omit	short

NOTE: With low-inductance pickup, R1 = 2000 ohms, R5 = 200 ohms. With high-inductance pickup, omit R1, R5 = 1000 ohms. With piezoelectric-crystal pickup, R1 = 47000 ohms, R5 = 500 ohms, also insert a paper capacitor of 100 μμf in series with the pickup.

PHONOGRAPH AMPLIFIER

Class B, Output 200 mw

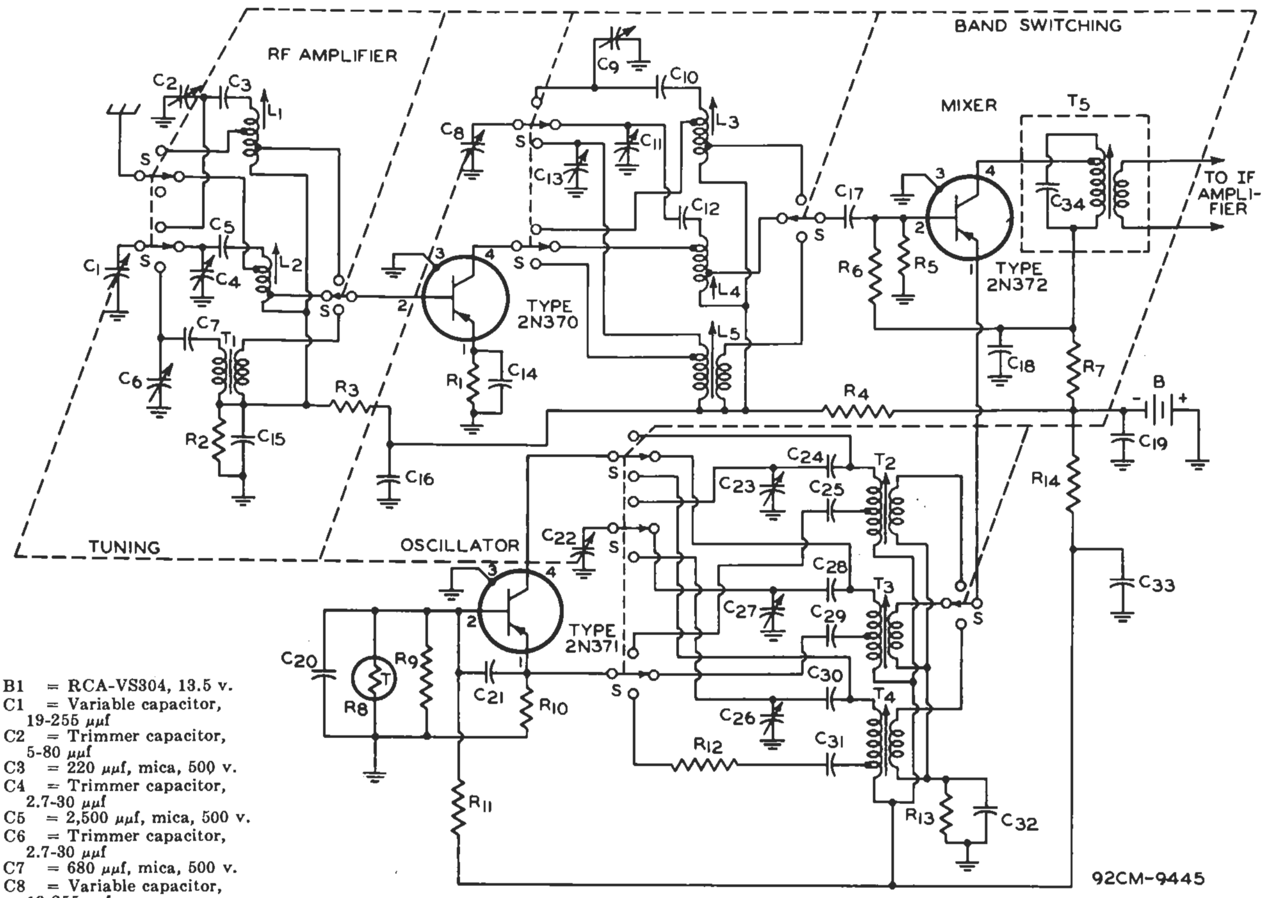


B = 9 volts, VS300 or VS301
C1 = 0.01 μf, paper, 150 v.
C2 = 1 μf, electrolytic, 12 v.
C3 = 50 μf, electrolytic, 12 v.
C4 = 0.003 μf, paper, 150 v.
C5 = 0.002 μf, paper, 150 v.
C6 = 0.04 μf, paper, 150 v.
P = Phonograph cartridge, ceramic
R1 = 1 megohm, 0.5 watt
R2 = 0.22 megohm, 0.5 watt
R3 = 4700 ohms, 0.5 watt
R4 = 1500 ohms, 0.5 watt
R5 = Potentiometer, 5000 ohms, 0.5 watt, volume-control
R6 = Potentiometer, 0.1 megohm, 0.5 watt, bass-boost
R7 = 0.22 megohm, 0.5 watt
R8 = 680 ohms, 0.5 watt
R9 = 27 ohms, 0.5 watt
R10 = 33 ohms, 0.5 watt
SP = Speaker
T1 = Interstage audio transformer with center-tapped secondary to provide a 3000-ohm load at the primary terminals with a 5000-ohm load between the outer secondary terminals. DC primary current = 1.5 ma. DC primary resistance = 300 ohms.
T2 = Output transformer with center-tapped primary to provide a 550-ohm load between the outer primary terminals with the desired speaker connected to the secondary terminals. DC current unbalance between halves of primary = 1 ma. DC primary resistance = 15 ohms per section.

Battery Current:
- No-signal current = 6 ma
- Average current = 26 ma
- Peak current = 42 ma

RF and MIXER-OSCILLATOR STAGES for 3-BAND RECEIVER

Utilizing Types 2N370, 2N371, and 2N372.



B1 = RCA-VS304, 13.5 v.
C1 = Variable capacitor, 19-255 μμf
C2 = Trimmer capacitor, 5-80 μμf
C3 = 220 μμf, mica, 500 v.
C4 = Trimmer capacitor, 2.7-30 μμf
C5 = 2,500 μμf, mica, 500 v.
C6 = Trimmer capacitor, 2.7-30 μμf
C7 = 680 μμf, mica, 500 v.
C8 = Variable capacitor, 19-255 μμf
C9 = Trimmer capacitor, 5-80 μμf
C10 = 39 μμf, mica, 500 v.
C11 = Trimmer capacitor, 2.7-30 μμf
C12 = 2,700 μμf, mica, 500 v.
C13 = Trimmer capacitor, 2.7-30 μμf
C14 = 0.05 μf, paper, 150 v.
C15 = 0.05 μf, paper, 150 v.
C16 = 0.05 μf, paper, 150 v.
C17 = 2200 μμf, mica, 500 v.
C18 = 0.05 μf, paper, 150 v.
C19 = .1 μf, paper, 150 v.
C20 = .05 μf, paper, 150 v.

C21 = 120 μμf, mica, 500 v.
C22 = Variable capacitor, 19-255 μμf
C23 = Trimmer capacitor, 5-80 μμf
C24 = 0.0068 μf, ceramic disc, 500 v.
C25 = 56 μμf, mica, 500 v.
C26 = Trimmer capacitor, 2.7-30 μμf
C27 = Trimmer capacitor, 5-80 μμf
C28 = 0.0033 μf, ceramic disc, 500 v.
C29 = 180 μμf, mica, 500 v.

C30 = 1,500 μμf, mica, 500 v.
C31 = 430 μμf, mica, 500 v.
C32 = 0.05 μf, paper, 150 v.
C33 = 0.05 μf, paper, 150 v.
C34 = Fixed tuner capacitor for T-5 Transformer
R1 = 1,000 ohms, 0.5 watt
R2 = 5,100 ohms, 0.5 watt
R3 = 39,000 ohms, 0.5 watt
R4 = 1,000 ohms, 0.5 watt
R5 = 4,700 ohms, 0.5 watt
R6 = 82,000 ohms, 0.5 watt
R7 = 470 ohms, 0.5 watt
R8 = Thermistor 20,000 ohms at 25° C, 78,600 ohms at 0° C, 6,520 ohms at 50° C

R9 = 20,000 ohms, 0.5 watt
R10 = 560 ohms, 0.5 watt
R11 = 100,000 ohms, 0.5 watt
R12 = 5,600 ohms, 0.5 watt
R13 = 1,000 ohms, 0.5 watt
R14 = 470 ohms, 0.5 watt
T-5 = 455-Kc I.F. Transformer

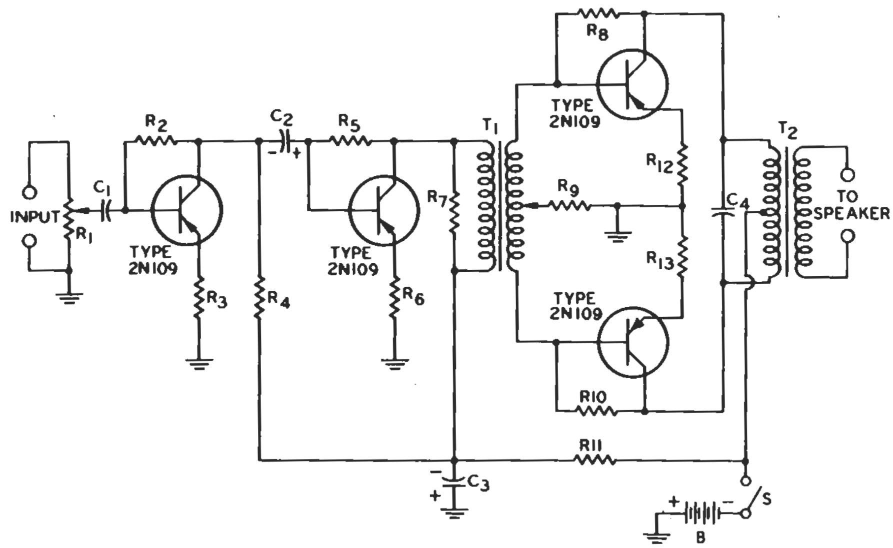
NOTE: Standard Broadcast Band Antenna Coil (T1) should be wound on an 8" X .33" ferrite rod.

Radio-Frequency Tuner Circuit Coil Data

COIL	ANTENNA			INTERSTAGE			OSCILLATOR		
	T1 (Standard Broadcast Band)	L2 (4.5 to 11.5 Mc)	L1 (10.5 to 23 Mc)	L5 (Standard Broadcast Band)	L4 (4.5 to 11.5 Mc)	L3 (10.5 to 23 Mc)	T4 (Standard Broadcast Band)	T3 (4.5 to 11.5 Mc)	T2 (10.5 to 23 Mc)
Total primary turns	127	21	13	225	21	12	120	18	10
1st primary tap-turns from bottom	–	2	1	13	2	1	12	2	1
2nd primary tap-turns from bottom	–	7	4	–	6	6	–	–	–
Secondary turns	7	–	–	12	–	–	2	1	1
Wire size	10/38 Litz	#22	#24	7/41 Litz	#22	#24	7/41 Litz	#28	#28
Coil diameter (inside) – inches	.33	⅝	⅜	¼	⅝	⅜	¼	¼	¼
Turns per inch	24	24	24	Universal	24	24	Universal	60	11

HIGH-GAIN, LOW-DISTORTION, LOW-DRAIN AUDIO AMPLIFIER

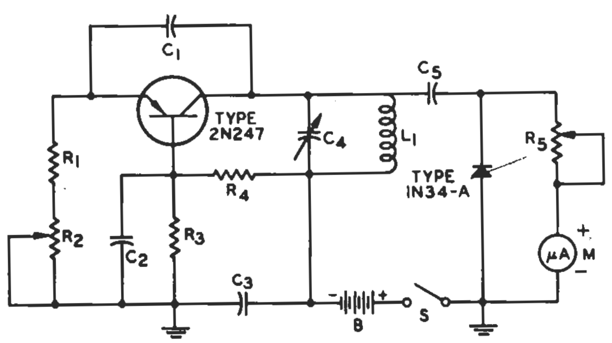
Class B; Output, 250 mw; Power Gain, approx. 90 db
Input Impedance, approx. 7500 ohms



B = 12 volts, 9 cells from VS087 battery assembly or 8 VS035 batteries connected in series
C1 = 1 μf, paper, 150 v.
C2 = 2 μf, electrolytic, 12 v.
C3 = 100 μf, electrolytic, 12 v.
C4 = 0.05 μf, paper, 150 v.
R1 = Volume-control potentiometer 10000 ohms, 0.5 watt
R2 = 0.15 megohm, 0.5 watt
R3 = 10 ohms, 0.5 watt
R4 = 10000 ohms, 0.5 watt
R5 = 0.27 megohm, 0.5 watt
R6 = 10 ohms, 0.5 watt
R7 = 10000 ohms, 0.5 watt
R8 = 15000 ohms, 0.5 watt
R9 = 60 ohms, 0.5 watt
R10 = 15000 ohms, 0.5 watt
R11 = 1000 ohms, 0.5 watt
R12, R13 = 4.7 ohms, 0.5 watt
T1 = Interstage audio transformer with center-tapped secondary to provide a 25000-ohm load at the primary terminals with a 3000-ohm load between the outer secondary terminals. DC primary current = 1 ma. DC primary resistance = 300 ohms.
T2 = Output transformer with center-tapped primary to provide a 300-ohm load between the outer primary terminals with the desired speaker connected to the secondary terminals. DC current unbalance between halves of primary = 5 ma. DC primary resistance = 20 ohms per section.
Battery Current:
No-signal current = 3.8 ma
Average current = 18 ma
Peak current = 50 ma

GRID-DIP METER

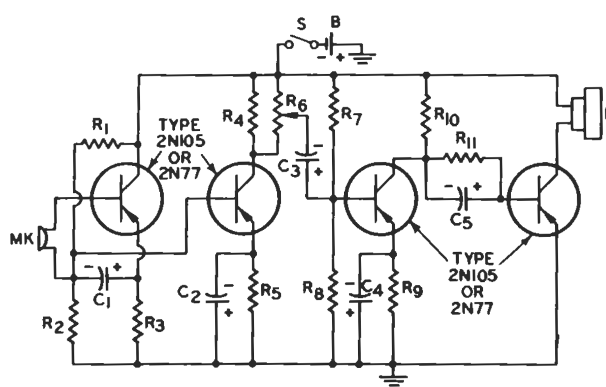
For Measuring Rensonant Frequencies from 2 to 50 Mc (approx.)



B = 9 volts, VS300
C1 = 10 μμf, mica, 500 v.
C2 = 0.05 μf, paper, 150 v.
C3 = 0.05 μf, paper, 150 v.
C4 = Variable capacitor, 10-100 μμf
C5 = 5 μμf, mica, 500 v.
L1 = Air-core plug-in coil to resonate with C4
M = DC Microammeter, range: 0 to 50 μa
R1 = 220 ohms, 0.5 watt
R2 = Potentiometer, 3000 ohms, 0.5 watt
R3 = 3900 ohms, 0.5 watt
R4 = 39000 ohms, 0.5 watt
R5 = Potentiometer, 0.25 megohms, 0.5 watt

NOTE: R_1 and R_2 may be replaced with a single 1000-ohm resistor, but there will be a small decrease in output at the lower and higher frequencies.

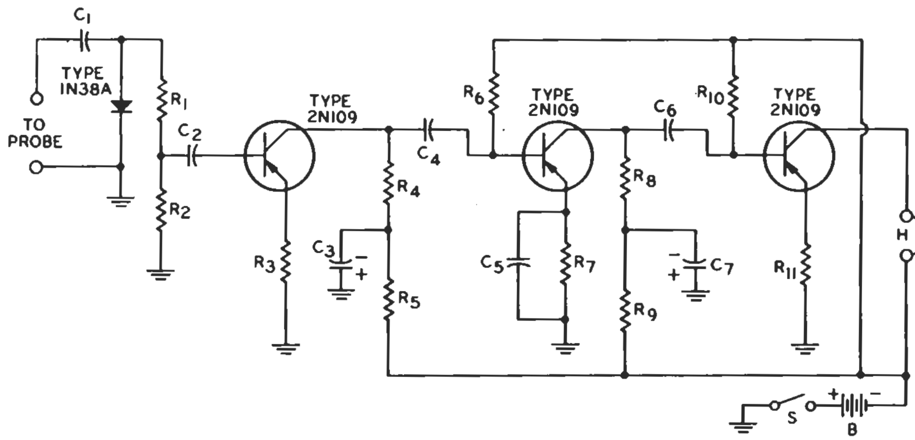
HEARING AID



B = 1.5 volts, VS034
C1 = 4 μf, electrolytic, 3 v.
C2 = 10 μf, electrolytic, 3 v.
C3 = 4 μf, electrolytic, 3 v.
C4 = 10 μf, electrolytic, 3 v.
C5 = 1 μf, electrolytic, 3 v.
E = Earphone, 2000-ohm
MK = Microphone, 1000-ohm, magnetic
R1 = 12000 ohms, 1/8 watt
R2 = 6800 ohms, 1/8 watt
R3, R4, R5 = 1500 ohms, 1/8 watt
R6 = Potentiometer, 0.1 megohm, 1/8 watt, volume-control
R7 = 15000 ohms, 1/8 watt
R8 = 6800 ohms, 1/8 watt
R9 = 1200 ohms, 1/8 watt
R10 = 1500 ohms, 1/8 watt
R11 = 56000 ohms, 1/8 watt

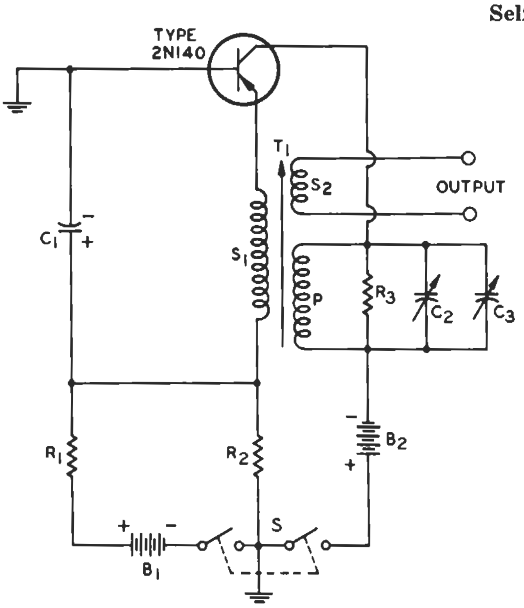
CIRCUITS

HIGH-GAIN TRANSFORMERLESS SIGNAL-TRACING PROBE



B = 6 volts, 4 VS035 batteries connected in series
C1 = 0.001 μf, mica, voltage rating as required
C2 = 0.5 μf, paper
C3 = 25 μf, electrolytic, 6 v.
C4, C5, C6 = 0.5 μf, paper
C7 = 25 μf, electrolytic, 6 v.
H = Headphones, 2000-ohm
R1 = 51000 ohms, 0.5 watt
R2 = 0.5 megohm, 0.5 watt
R3 = 5100 ohms, 0.5 watt
R4 = 0.01 megohm, 0.5 watt
R5 = 1000 ohms, 0.5 watt
R6 = 1 megohm, 0.5 watt
R7 = 1000 ohms, 0.5 watt
R8 = 0.01 megohm, 0.5 watt
R9 = 1000 ohms, 0.5 watt
R10 = 0.7 megohm, 0.5 watt
R11 = 47 ohms, 0.5 watt

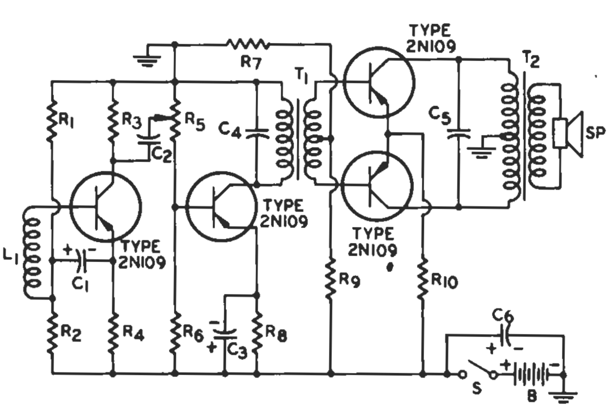
IF AND BROADCAST-BAND SIGNAL TRACER (0.4-Mc to 1.7-Mc)
Self-Quenching Oscillator



B1 = 4.5 volts, 3 VS034 batteries connected in series
B2 = 4.5 volts, 3 VS034 batteries connected in series
C1 = 0.25 μf, electrolytic, 6 v.
C2 = Variable capacitor, 10-335 μμf
C3 = Trimmer capacitor, 2-20 μμf
R1 = 47000 ohms, ⅛ watt
R2 = 56000 ohms, ⅛ watt
R3 = 33000 ohms, ⅛ watt
P = Primary winding of T1
S = Switch
S1, S2 = secondary windings of T1
T1 = Transformer wound as follows: Using a threaded resinite coil form and a ½" ferrite core with matching threads, wind 180 turns of #7/41 Litz wire over a length of about ½". This winding will have more than one layer and is the primary winding P. The secondary windings, S1 and S2, are wound on top of the primary winding with #34 SSE wire. Winding S1 has 10 turns, and winding S2, 3 turns. A resinite collar with terminals may be fitted over one end of the coil form to provide connections to all the windings.

NOTE: The fundamental frequency of oscillation is about 0.4 to 0.85 megacycles per second. The second harmonic frequencies from 0.8 to 1.7 megacycles per second may be used but will provide a smaller output. The modulation frequency is about 500 cycles per second.

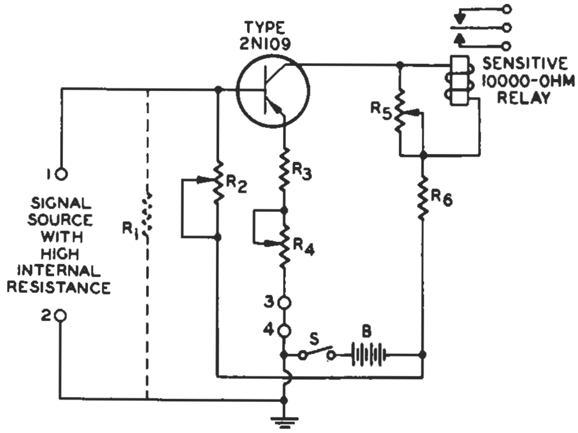
TELEPHONE PICKUP AMPLIFIER



B = 12 volts, 9 cells from VS087 battery assembly or 8 VS035 batteries connected in series
C1 = 10 μf, electrolytic, 6 v.
C2 = 1 μf, paper, 150 v.
C3 = 10 μf, electrolytic, 6 v.
C4 = 0.01 μf, paper, 150 v.
C5 = 0.04 μf, paper, 150 v.
C6 = 50 μf, electrolytic, 12 v.
L1 = Telephone pickup coil
R1 = 0.1 megohms, 0.5 watt
R2, R3 = 10000 ohms, 0.5 watt
R4 = 1500 ohms, 0.5 watt
R5 = Potentiometer, 0.1 megohm, 0.5 watt, volume-control
R6 = 10000 ohms, 0.5 watt
R7 = 5100 ohms, 0.5 watt
R8 = 680 ohms, 0.5 watt
R9 = 75 ohms, 0.5 watt
R10 = 10 ohms, 0.5 watt
SP = Speaker
T1 = Interstage audio transformer with a center-tapped secondary to provide a 9000-ohm load at the primary terminals with a 9000-ohm load between the outer secondary terminals.
T2 = Output transformer with a center-tapped primary to provide a 750-ohm load at the outer primary terminals with the desired speaker connected to the secondary terminals.

Battery Current:
No-signal current = 6 ma
Average current = 10.3 ma
Peak current = 23 ma

SENSITIVE RELAY



B = 22.5 volts, VS084

R1 = 1000 ohms, 0.5 watt

R2 = Bias-control potentiometer, 0.1 megohm, 0.5 watt

R3 = 10 ohms, 0.5 watt

R4 = Input-impedance-control potentiometer, 1000 ohms, 0.5 watt

R5 = Sensitivity-control potentiometer, 0.1 megohm, 0.5 watt

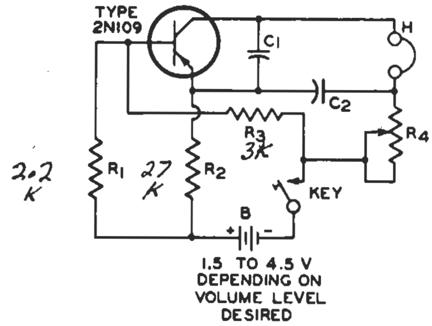
R6 = 1000 ohms, 0.5 watt

NOTES: (1) If a signal source with internal resistance is used, omit R1 and connect a jumper between terminals 3 and 4 as shown. Adjust R4 for best performance.

(2) If a signal source with a low internal resistance is used, connect the source between terminals 3 and 4, omitting the jumper. Connect R1 as shown. Adjust R4 to provide a direct connection from R3 to terminal 3.

(3) Relays having a dc coil resistance of less than 10000 ohms may be used, provided the battery voltage is proportionately reduced. In such event, circuit sensitivity will be reduced.

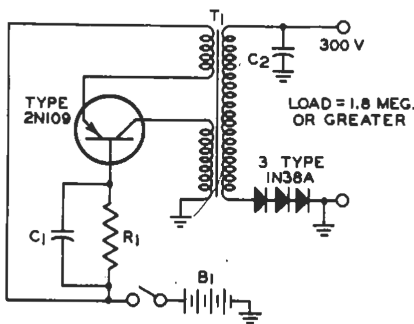
CODE-PRACTICE OSCILLATOR



B = VS036 (see note)
C1, C2 = 0.01 μf, paper, 150 v.
H = Headphones, 2000-ohm, magnetic
R1 = 2200 ohms, 0.5 watt
R2 = 27000 ohms, 0.5 watt
R3 = 3000 ohms, 0.5 watt
R4 = Volume control potentiometer, 50000 ohms, 0.5 watt

NOTE: One to three series-connected RCA-VS036 dry cells may be used, depending upon the volume level desired.

PORTABLE LOW-DRAIN HIGH-VOLTAGE POWER SUPPLY



B = 12 volts, 9 cells from VS087 battery assembly or 8 VS035 batteries connected in series
C1 = 0.01 μf, paper, 150 v.
C2 = 0.1 μf, paper, 600 v.
R1 = 22000 ohms, 0.5 watt
T1 = Transformer with 15-turn primary, 5-turn tickler and 530-turn secondary

RCA