RCA
Plain Talk
and Technical Tips

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Multiband Radios—Frequency Band Coverage

Many of us who have serviced multiband radios have wondered, or have been asked by customers, what radio services can be received on the various shortwave bands of RCA 6-band receivers. These instruments feature three shortwave bands, in addition to AM broadcast, FM broadcast, and the longwave (LW) aircraft and marine weather band. The above mentioned shortwave bands provide frequency coverage from 1.6 to 30 MHz. The frequency coverage, type of radio service, as well as best time of day and time of year for optimum reception of each band described in the following text. These bands are designated on the radio as:

SW-1, 1.6 to 4.8 MHz; SW-2, 4.8 to 13.2 MHz; SW-3, 13.2 to 30.0 MHz.

Included within this frequency coverage are the following services that would be of interest to the shortwave listener:

A. **Shortwave Commercial Broadcast Bands**
1. 3.95—4.00 MHz (80 Meters)
2. 4.75—4.85 MHZ (61 Meters)
3. 4.85—4.995; 5.005—5.06 MHz (59 Meters)
4. 5.95—6.2 MHz (49 Meters)
5. 7.1—7.3 MHz (41 Meters)
6. 9.5—9.775 MHz (31 Meters)
7. 11.5—11.975 MHz (25 Meters)
8. 15.1—15.45 MHz (19 Meters)
9. 17.7—17.9 MHz (16 Meters)
10. 21.45—21.75 MHz (13 Meters)
11. 25.6—26.1 MHz (11 Meters)

B. **Amateur Frequency Allocations**
1. 1.8—2.0 MHz (160 Meters)
2. 3.5—4.0 MHz (80 Meters)
3. 7.0—7.3 MHz (40 Meters)
4. 14.0—14.35 MHz (20 Meters)
5. 21.0—21.45 MHz (15 Meters)
6. 28.0—29.7 MHz (10 Meters)

C. **Citizens Band Radio**
1. 26.965—27.275 MHz (11 Meters)

D. **Marine and Aircraft, Weather, etc.**
Coverage of these services is explained in the instruction book packed with each instrument.

Generally, best reception of the shortwave frequencies follows seasonal and time variations outlined in the chart below:

Frequency	Reception Time
3.5—9 MHz	Winter—night
9—11 MHz	Winter—all day & night
11—13 MHz	Summer—afternoon & evening
13—16 MHz	Summer—evening, early morning
16—19 MHz	Summer—evening, early morning
19—22 MHz	All year—day & night

The following information will be of particular interest to persons interested in Commercial Shortwave Broadcasts:

The shortwave bands make it possible to receive stations throughout the world. Reception conditions will vary depending on frequencies, the time of day, and season of year. Another factor also influences shortwave reception; an 11-year cycle caused by sunspot activity. Thus, due to the above considerations, it is not possible to receive all the stations indicated in the customer instruction book at any one time. However, the large frequency coverage usually enables the reception of desired programs on one band or another, depending on the time of day.

Figure 1—Six Band Portable Radio (RZM 195)

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3.95—4.0 MHz (80-meter band)
The radio propagation characteristics of the 80-meter band allow only limited long-distance reception during winter months. In countries with their own transmitting stations, reception is possible on the 80-meter band. The 80-meter band is essentially for amateurs. Here, the shortwave listener will find amateurs exchanging messages by voice and code. There are a few broadcasting stations on this band.

4.75—5.06 MHz (61 and 59-meter bands)
These bands are mainly used in tropical regions where they serve the same purpose as the medium and long wave frequencies used in Europe and the USA. In the tropics, satisfactory broadcasting is possible on the 61 and 59-meter bands even when atmospheric disturbances make the medium and long-wave bands useless. Thus, the broadcasting stations of equatorial countries prefer to use the 59 and 61 meter bands, which can be received only in certain parts of Europe.

5.95—6.2 MHz (49-meter band)
Reception of broadcasting stations within a radius of about 550 miles is possible on this band. At dusk, the number of stations which can be received increases and the reception is best during the night, decreasing again at dawn.

7.1—7.3 MHz (41-meter band)
The 41-meter band serves both broadcasting stations and the 40-meter amateur band. Amateur radio activity is found in the frequency range between 7.0 and 7.3 MHz. Just as in the 49-meter band, reception in the 41-meter band is subject to wide variations depending upon time and place.

9.5—9.775 MHz (31-meter band)
The 31-meter band is the first of a number of definite long-range bands. The shorter the wavelength, the larger the area covered, although reception is subject to greater variations. The time of day, the season of year, and sunspot activity are increasingly important factors. Intercontinental reception is possible on the 31-meter band. A blind spot occurs in the immediate vicinity of a station within which reception is practically impossible.

11.5—11.975 MHz (25-meter band)
The same conditions apply as for the 31-meter band. Overseas reception is possible. The best reception times occur during daylight hours. Reception conditions are very good in the direction of the rising or setting sun. In America, for instance, European stations are best received before or during sunrise, and Asian stations before and during sunset.

15.1—15.45 MHz (19-meter band)
The qualities of long-distance reception are even more marked on the 19-meter band than in the 25-meter band.

17.7—17.9 MHz (16-meter band)
The 16-meter band is normally used for overseas reception. Here again good transmission depends on good atmospheric conditions, which may vary from one hour to another, and even from one minute to another. The blind spot around the station may cover several hundred miles, i.e. short-distance reception may be completely impossible at times. In certain circumstances, this may be an advantage, since many neighboring stations are eliminated, and better undistorted reception is obtained of overseas transmissions. Local times are different in overseas countries, so it may be possible to receive their night programs during the day and vice-versa.

21.45—21.75 MHz (13-meter band)
The 13-meter band includes the 15-meter amateur band, ranging between 21.00 and 21.45 MHz. The 13-meter and 11-meter bands contain a smaller number of stations since sunspot activity is a dominating factor of good reception. During the years of minimum sunspot activity (about 1964), the long-distance reception qualities in shortwave bands will not be particularly good. At times intercontinental reception will be impossible. During the years of maximum sunspot activity (probably in 1970) excellent reception quality is to be expected—just as in previous periods of high solar activity. The reception of overseas stations will then be as good as that of local stations. Long-distance reception in the 13-meter band is best about noon.

25.6—26.1 MHz (11-meter band)
The specific reception qualities of the 13-meter band are even more marked in the 11-meter band. Therefore this band serves only a few broadcasting stations.

TV Output Components Protection

Over the years we all develop habits—some good and some bad. Many of these habits are the techniques we use for servicing, again some good and some bad. One area of laxity with many service technicians is in the protection of the audio and video output components while other circuitry is being serviced. It is standard practice with most service technicians when servicing mono and stereo amplifiers to either load the audio output with speakers or resistors, or to set the volume control at minimum in order to protect the output stage components. This same precaution should also be applied when servicing television chassis, and should be extended to the video output stage as well. The practice of loading the audio and video output stages is particularly important if transistors are used for the audio or video output stages, since solid-state devices are somewhat more susceptible to damage from voltage transients than are vacuum tubes. Another practice of some service technicians is to remove the plate cap from the horizontal output tube, rather than removing the tube from its socket. This practice of disconnecting the plate cap is bad because

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Darlington Transistors

Unlike vacuum tubes, which are voltage operated devices showing extremely high input resistance at the grid, transistors are current operated devices. Hence they require a definite base current. The ratio between collector current and base current is known as "beta", and it is expressed as follows:

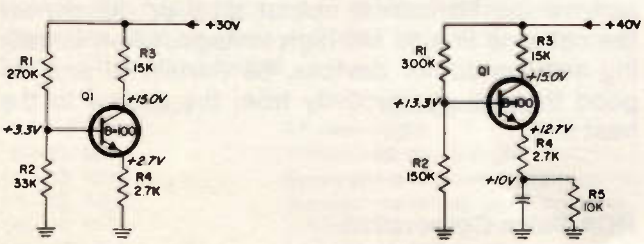
$$\frac{\text{Collector-Current } (I_C)}{\text{Base-Current } (I_B)} = (\beta) \text{ beta}$$

Transistors of the type used in radio and television receivers display betas ranging from somewhere around 30 to perhaps as high as 400. Thus the base current of the highest beta transistor described will be about 1/400th of the collector current or more. The base voltage of a transistor is determined by the base-emitter junction barrier voltage. In the case of silicon transistors the junction voltage will be about .6 to .7 volts unless external circuitry is used to raise the base voltage above ground. Ohm's Law reveals that the low base voltage equated with a typical value of base current yields a rather low input resistance, making it necessary in many cases for the circuit designer to provide some external means of matching the low input resistance of the transistor to the signal source. In the early days of transistor technology this was often done with interstage or coupling transformers. These transformers contributed to the size, weight, and expense of transistor equipment of that day.

One way to raise the input resistance of the transistor circuit is to use an unbypassed emitter resistor, which is often done at the expense of stage gain. When an unbypassed emitter resistor is used, the base resistance of the transistor is approximately beta times the value of the emitter resistor. Unfortunately the increased input resistance afforded by the unbypassed emitter resistor is not realized because the actual input resistance of the stage is mainly determined by the parallel combination of the base bias resistors (R1 and R2 in Figure-2A for example) which must be substantially lower than base resistance of the transistor in order to satisfy stability requirements. In other words, the input resistance is somewhat less than the 33K value of R_2, rather than the 270K calculated by multiplying R_4 (2.7K) times β (100). Obviously a higher beta transistor would be of little advantage in raising the input resistance of this circuit.

Where higher supply voltages are available, the circuit of Figure-2B may be used to furnish increased input resistance. This stage incorporates the same value of unbypassed emitter resistance; but, an additional bypassed emitter resistor is used to elevate the DC voltage of the base higher above ground, thereby increasing the resistance of R1 and R2 so that the paralleling effect of these resistors is reduced.

Another way of achieving higher input resistance is to drive the transistor stage with an emitter-follower, as illustrated in Figure-3. The circuitry of transistor Q2 is identical to that used in the simple circuit of Figure-2A in-so-far as the collector and emitter resistances, and supply voltages are concerned. Hence, the stage furnishes the same collector output signal characteristics as that of the simple circuit. Transistor Q1, the emitter follower, needs only to provide signal and DC bias to the base of Q2. Consequently it operates at a relatively low collector current and so requires a lower base bias current. This permits the base bias resistors (R1 and R2) to be correspondingly larger. Analyzing the circuit of Q1 and Q2, it is evident that Q2 requires the same base voltage and current drive as it did in the simple circuit; however, this is now provided by emitter follower Q1. The DC operating point of Q1 is determined by the emitter current necessary to develop the required base bias for transistor Q2 across resistor R3. The value of resistor R3 has been determined to establish an emitter current equal to approximately ten-



A.—Unbypassed Emitter

B.—Elevated Emitter

Figure 2—Common Emitter Stages

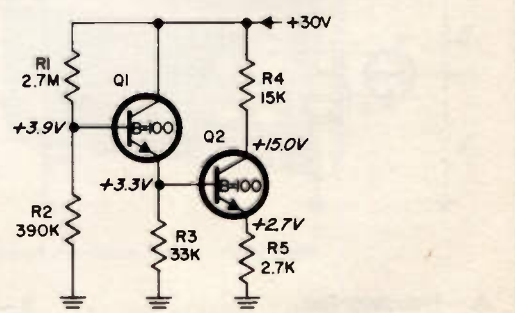
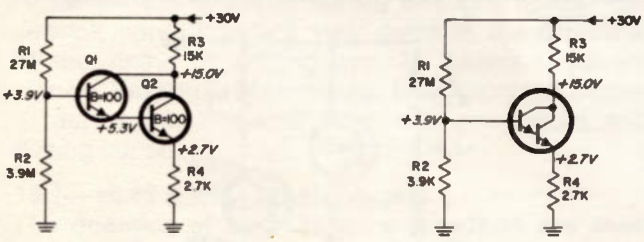


Figure 3—Emitter Follower Driving Common Emitter Stage

times the base current required by transistor Q2—in this example R3 is 33K. This value is chosen, as it was in the previous examples, to provide sufficient bias stability when the stage is subjected to extremes of operating conditions. Thus, this value of R3 will prevent an excessive change in collector current when transistors of different betas, or when higher temperatures, are encountered. With these factors in mind, the designer develops the required circuitry for Q1 to satisfy the voltage/current conditions of R3. Once the base bias requirements for Q2 are known, the operating point (collector current of Q1) is chosen to establish the correct bias at R3. This is done by setting the base voltage of Q2 with voltage divider resistors R1 and R2. As illustrated in Figure-3, the value of resistor R3 is substantially higher than the emitter resistor of the simple circuit, and the resistance values of R1 and R2 are also considerably higher. Summarizing, it is evident that the two stages combined act as one with the added advantage of much higher input resistance.

With the advent of silicon transistors, which have lower leakage currents than the germanium transistors, even higher input resistances may be realized by using a configuration known as a Darlington circuit. Examination of Figure-4A illustrates that resistor R3 has been eliminated, so that Q1 need only supply base current for transistor Q2. Also, the collector of Q2 is connected to the collector of Q1 to furnish a negative feedback path which provides the required bias stability at higher temperatures. Considering now that transistor Q1 needs only supply base bias for Q2, the conditions are such that the actual input resistance is determined by the compounded beta of the two transistors. For example, beta times resistance R4 yields a base input resistance of 270K. Using this value of 270K as the emitter resistance for transistor Q1; this, when multiplied by the beta of transistor Q1, results in a base input resistance for transistor Q1 of 27 megohms. However, this high resistance is still subject to the shunting effects of the paralleled resistors R1 and R2. These resistances can in practice be quite high because of the inherent stability of the silicon devices and the extremely low base bias current of Q1. Thus, the input resistance of this Darlington circuit is about 3.1 megohms.



A.—Transistor Darlington Connected

B.—The Darlington Transistor

Figure 4—Darlington Common Emitter Stages

With the advent of integrated circuit technology it became practical to put two transistors on a single silicon wafer, making fabrication of the Darlington circuit rather simple. This single package Darlington (Figure-4B) is thought of as a single transistor having a beta equal to the product of the individual betas of the compounded transistors. The beta of a typical Darlington transistor may range upwards to the neighborhood of 16,000.

Darlington transistors are being used today in many circuit areas of RCA Consumer Electronics Products. One use of the Darlington transistor was the integrated circuit impedance matching device which was part of the cartridge in some RCA RP 228 record changers. In this application, the Darlington matched the output of a high-compliance, low-capacitance, ceramic pickup to the relatively low input impedance of a solid-state stereophonic amplifier. More recently Darlington transistors have been used for function keyer circuits in RCA color television remote control systems. It is evident from these two applications that the Darlington transistor is a versatile device. For this reason, Darlington transistors will find increasing use in the products of the future.

TV Output Components Protection

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many times the tube will draw excessive screen current which will ultimately damage the tube.

Recent RCA chassis are equipped with a slip-on cathode link that provides a quick, convenient way to disable the horizontal output circuit. Another area of laxity on the part of some service technicians is the failure to use thermal conductive grease when installing new output devices such as transistors and SCR's. When these components are installed "dry", heat is not conducted from the device into the heat sink, resulting in the device operating at excessively high temperature—a cause of early failure. Replacing the replacement component is expensive to you and disturbing to your customer. Enough said!

These bad servicing habits are easily corrected by remembering to load the audio output or set volume to minimum when the speaker is disconnected; turn brightness and contrast controls to minimum when the picture tube is disconnected; remove the horizontal output tube or disconnect the cathode link to kill high-voltage; when installing semiconductor devices, be certain to provide good thermal conductivity from the device to the heat sink.

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Product Performance—Technical Training

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