ceiver a complete operational checkout. Make several contacts with the base station. If vehicle noise degrades the transceiver's performance, read the section on noise suppression and take appropriate action to correct any noise suppression deficiences.

3.2 NOISE SUPPRESSION

3.2.1 NEED FOR NOISE SUPPRESSION

Any radio installed in an automobile or truck has to contend with electrical noise generated by the engine's ignition system and generator system when the engine is running. Of course, when the engine is not running, the noise is not present. However, if the radio is to be really useful and versatile, it must be abe to receive the weaker radio signals while the vehicle is traveling at reasonably high rates of speed. Unfortunately, the electrical noise from the engine increases as the engine speed increases. This noise takes the form of whining, popping, crackling, etc. and can make it difficult to understand a voice through the interference. It can completely "cover up" weak signals when the vehicle is operating at extended distances from the base station or other mobile stations (in "fringe areas"). Therefore, the electrical noise from the engine will materially determine the amount of "range" that the mobile station has while it is in motion and how fast the vehicle can travel at any given range and still satisfactorily receive the base station.

3.2.2 CAUSES OF IGNITION NOISE

The engine of any vehicle contains at least a dozen or more tiny "spark" radio transmitters such as spark plugs, regulator points, distributor points, generator brushes etc. The ignition wiring of the engine acts as an antenna to radiate the radio noise from these arcs into the radio. Additional noise may be generated by unnecessary arcs which are caused by poor connections. Loose connections between the spark plugs and the connectors on the spark plug wires or between the wires and the distributor cap cause unnecessary arcs. Another noise source is the build-up of static electricity on moving parts of the engine and its accessories, such as the armature of the generator. When these charges of static electricity "discharge", the effect is much the same as a bolt of lightning only on a much smaller scale. Due to the fact that the car body is usually used as part of the electrical circuit (ground return) for lights, accessories and ignition system, small arcs may occur between various parts of the car body that are not properly bonded together electrically. These small arcs also generate noise.

Spark plug noise is identified by a regular popping noise which increases with engine speed. Generator noise is characterized by a whining sound which also increases with engine speed. Regulator noise creates an uneven, rasping sound only when the generator is charging.

3.2.3 METHODS OF SUPPRESSING IGNITION

One of the first methods of reducing ignition noise is to insure that the ignition system of the engine is in good condition and working properly. This means that the distributor points and condenser should be in good condition and the points properly adjusted. The regulator points should be free from pitting and should be properly adjusted. The spark plugs should be clean and properly adjusted. The generator brushes and commutator should be in good condition and the brushes properly seated. The generator cover should be free of paint and grease that might prevent good electrical connection to the generator frame. All connections in the high voltage wires between the spark plugs and the distributor should be making good contact. Soldering the wires to the connectors on the ends of the wires will insure this. All other connections in the ignition system should be free of corrosion and thoroughly tightened. All the wires in the distributor cap should be pushed as far into the cap as they will go. The high voltage wire to the coil should also be pushed into its socket as far as it will go. The inside of the distributor cap should be free of any dirt or carbon deposits since they can cause arcing between the distributor terminals.

When the entire ignition system is in good condition, the next step toward suppressing ignition noise is to install noise suppressing devices in the ignition wiring of the engine. The noise suppressing devices to be installed consist mainly of distributor and spark plug suppressors, coaxial capacitors and shielded wires. The distributor and spark plug suppressors are small devices similar to radio resistors, which are inserted in the distributor and spark plug wires. They suppress the electrical noise caused by the spark plugs and distributor. The coaxial capacitors are highly efficient electrical devices which "filter out" or "bypass" directly to ground (ground is the car frame, body or engine) the electrical noise caused by the generator and regulator. The shielded wires provided are to prevent the escape of any remaining noise from the generator and regulator wires.

3.2.4 RESISTOR-TYPE SPARK PLUGS

Resistor-type spark plugs may be installed in place of the regular spark plugs. Resistor-type spark plugs are normally "quieter" than standard plugs with suppressors. Since resistor-type spark plugs are standard equipment on some of the later model cars, they should be checked before resistor-type plugs are purchased. Spark plug suppressors should not be used with resistor spark plugs.

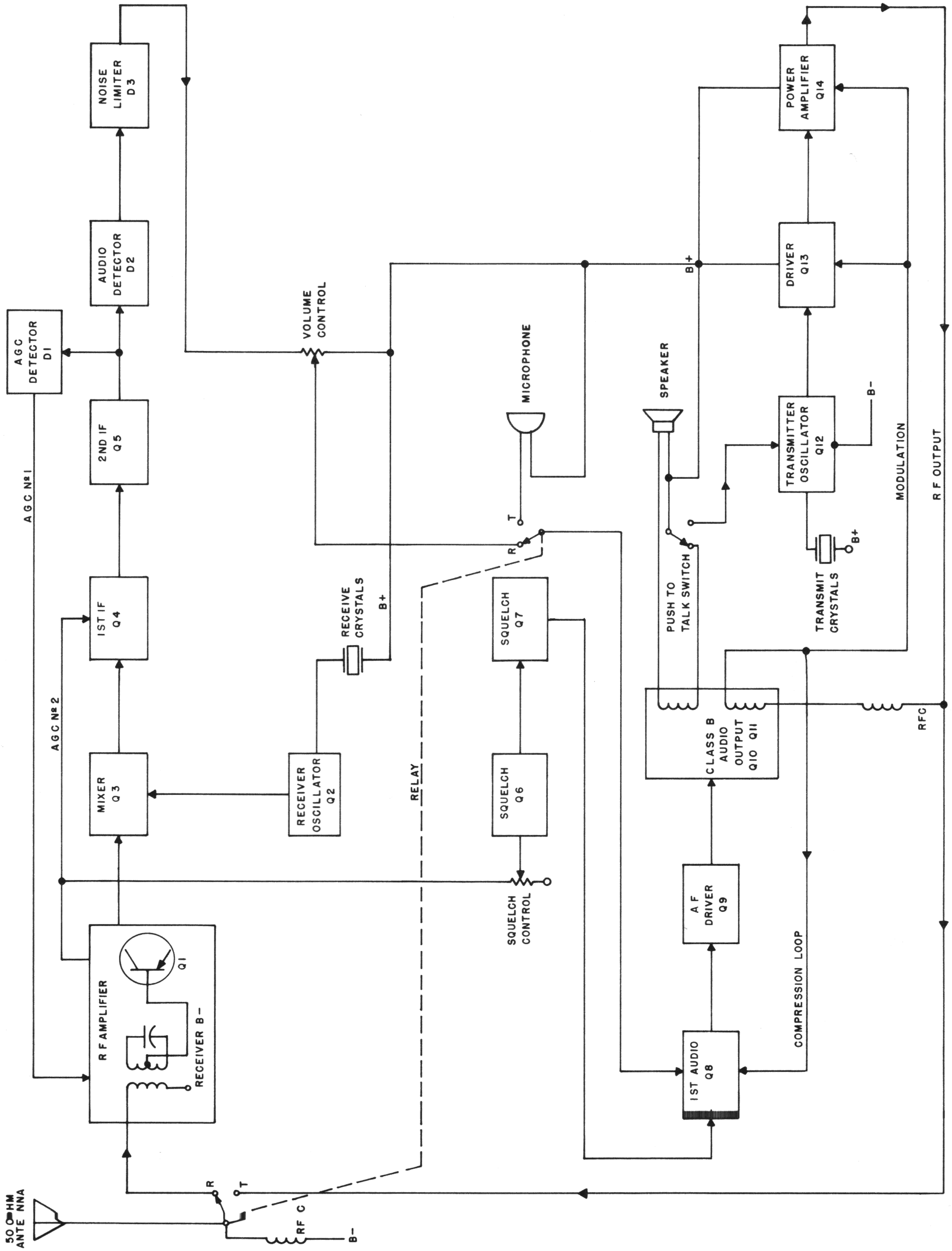
Radio resistor ignition wire is standard equipment on most late model vehicles. If the vehicle does not have radio resistor ignition wire, then it should be installed.

3.2.5 ADDITIONAL NOISE SUPPRESSION MEASURES

1. Installing short lengths of heavy shield braid or metal straps between various parts of the automobile and engine to improve the electrical bonding will usually reduce interference in the more stubborn cases. These straps should be installed between the firewall and the engine, the engine and the frame, the generator and the frame (or the engine or both), the exhaust pipe and the frame (in one or more places) and in some cases the hood to the frame or firewall. Be sure the cases of the coil and the regulator are well grounded also.

2. In stubborn cases of generator whine, a carbon brush (mounted on a short spring-loaded bracket) which rides on the end of the generator shaft will usually reduce this interference. Be sure the brush and bracket are well grounded to the generator or car frame with a short connection .

3. Some interference may be caused by the dash instruments, accessories (such as electric windshield wipers, heater blowers and fans, etc.) and the lighting system. In cases where this interference is objectionable, it may be reduced by installing bypass capacitors from the terminals of the troublesome instruments or accessories directly to ground (car frame or dash, etc.). The wire leads of the capacitors should be kept as short as possible. These capacitors should be of the mica or ceramic disc variety and should be from 0.001 μF to 0.01 μF.



MESSENGER 100 & 110
BLOCK DIAGRAM
FIGURE 5

SECTION 4
CIRCUIT DESCRIPTION

4.1 RECEIVER

The Messenger receiver is a completely solid state single-conversion superheterodyne unit. The intermediate frequency is 455 kHz.

You should become familiar with the tranceiver by studying the schematic diagram found at the back of the manual, and the block diagram, Figure 5, while following the receiver circuit description.

4.1.1 RF AMPLIFIER

The incoming signal is coupled to the base of the RF amplifier, Q1, through C39, a set of contacts on the relay and the input transformer L1. The signal is amplified by Q1 and applied to the base of mixer stage, Q3, through L2.

4.1.2 MIXER

The output of the crystal oscillator, operating 455 kHz below the signal from the RF amplifier, from the secondary of L3 is directly injected to the emitter of the mixer stage, Q3. The mixer output transformer, L4, is tuned to the difference frequency or to 455 kHz.

4.1.3 OSCILLATOR

The crystal oscillator, Q2, is a grounded base type using a third overtone crystal. The oscillator operates at 455 kHz below the incoming received signal.

4.1.4 IF

The receiver IF section consists of IF amplifiers Q4, Q5 and double tuned transformers, L5 and L6.

The IF output is taken off the collector of Q5 and coupled to the detector diode D2 by transformer L6. A small portion of the output of the second IF amplifier is coupled by C15 to a rectifier filter network consisting of D1, R8, C14 and C13. The DC output of the network is the AGC voltage which controls the gain of the RF amplifier and, indirectly, the first IF amplifier.

4.1.5 AGC

An increase in the gain of the second IF amplifier, the ultimate result of a stronger received signal from the antenna, causes more output from the second IF amplifier to be coupled to the AGC rectifier. This in turn causes the output of the AGC rectifier to go more positive. This positive going output is coupled to the base of the RF amplifier through a voltage divider network in Z1 and the secondary of L1. A positive going voltage appearing at the base of Q1 tends to reduce the gain of that stage. The emitter voltage of Q1 follows the base and also goes in a positive direction. The emitter of Q1 is connected to the base of the first IF amplifier, Q4. Therefore, any change in the emitter voltage of Q1 will be felt on the base of Q4. This results in a gain reduction of the first IF amplifier, Q4.

4.1.6 AUDIO

The audio from the detector diode, D2, is applied through a noise limiting network, Z5, and the volume control to a set of contacts on the relay. During receive condition, the audio is coupled through the relay contacts to the base of the audio pre-amplifier, Q8. The amplified signal is then coupled to the audio driver stage, Q9, for further amplification. Q9 furnishes power to drive the

Class B output stage, Q10 and Q11. The driver transformer, T1, provides the proper impedance match between the collector of Q9 and the bases of the Class B stage. The output of the Class B amplifier is transformed by T2 and applied to the speaker. Transformer, T2, is a combination audio and modulation transformer. The green and black leads are the 3.2 ohm speaker windings during receive. During transmit, the orange and yellow leads provide audio for modulation. One side of the speaker is connected to B+. The other side of the speaker is connected to T2 and from T2 to ground through the push-to-talk switch on the microphone. The push-to-talk switch contacts are used to open the receiver audio during transmit and apply audio from the microphone to the pre-amp, Q8.

4.1.7 SQUELCH

In the squelched condition, Q7, the second squelch amplifier is turned off. Its collector voltage is several volts more negative than the emitter of the audio amplifier, Q8. In this condition diode D5 is forward biased. With D5 forward biased the emitter of Q8 is at the same potential as the collector of Q7 minus the drop across D5. The base emitter junction of Q8 is reverse biased and turns off, disabling the receiver audio.

When an RF signal is present the AGC line goes in an increasingly positive direction. This causes the base and emitter voltages of Q1 to go in a positive direction. The positive going emitter of Q1 causes the base bias of Q6 to go more positive. As the base bias of Q6 goes positive, the stage is conducting less and its collector voltage is increasing. The collector of Q6 and the base of Q7 are direct coupled and therefore at the same electrical potential. The rising collector voltage of Q6 tends to turn Q7 on. The harder Q7 conducts the more the collector voltage drops. When the collector voltage of Q7 becomes less than the emitter voltage of Q8, diode D5 becomes reverse biased. With D5 reverse biased, Q8 becomes forward biased and the audio is enabled.

Squelch temperature compensation is provided by thermistor RT14.

4.2 TRANSMITTER

Refer to the schematic and block diagram, Figure 5, while following the transmitter circuit description.

4.2.1 AUDIO

The audio signal from the microphone during transmit condition is coupled through the relay contacts to the base of the audio pre-amp, Q8. The signal is amplified by Q8 and Q9 and coupled through the driver transformer, T1, to the bases of the Class B audio output stage, Q10 and Q11. The amplified audio signal from Q10 and Q11 is coupled through the orange and yellow leads on T2 to provide modulation of the driver, Q13, and power amplifier, Q14.

Audio compression is also provided in this unit by rectifying part of the signal appearing at the secondary of T2. This signal is applied to the emitter of the 1st audio stage, Q8. A large signal from the microphone (caused when an operator shouts into the microphone) will in turn provide a larger signal at the secondary of T2. This in turn places a higher voltage at the emitter of Q8 and reduces its gain, thus maintaining a relatively constant audio level for a given input signal.

4.2.2 OSCILLATOR

The transmitter oscillator, Q12, is a modified Colpitts type. The oscillator utilizes a third overtone crystal to produce low level RF signals in the 26.965 to 27.255 MHz range. There is no frequency multiplication. The crystal oscillates at the carrier frequency. Temperature compensation is provided by capacitors C42 and C43. Transformer L10 provides frequency tuning.

4.2.3 DRIVER

The driver raises the power of the RF signal from the oscillator to a level sufficient to drive the power amplifier, Q14.

4.2.4 POWER AMPLIFIER

The power amplifier, Q14, is operated Class C and designed to operate at 5 watts DC power input. Q14 is in emitter follower configuration and drives the antenna through a pi network and a set of contacts on the relay. The pi network serves as an impedance matching device and as a low pass filter for harmonic attenuation.

SECTION 5
MAINTENANCE

5.1 CRYSTAL INSTALLATION

a. Remove the Messenger from its mount and disconnect the power lead and antenna cable at the rear of the cabinet.

b. Remove the two screws at the side of the cabinet.

c. With the cabinet on a flat surface, grasp the front panel and carefully withdraw the panel and chassis assembly from the cabinet. The chassis will slide out easily, do not force.

d. Note that the crystal sockets are marked by letters corresponding to positions on the channel switch. The marking REC indicates the location of receiver crystals and TRANS indicates the location of transmitter crystals. Each crystal is marked by channel number and by function. For example, a crystal marked R5 is a receiver crystal for channel 5 and should be used with a transmitter crystal marked T5. Receiver and transmitter crystals must have the same channel number and be placed in the crystal sockets bearing the same letter designation to provide operation on that channel.

Carefully re-install the chassis in the cabinet. Be sure that the protective rubber grommet on the microphone cable is seated in the notch in the cabinet and the cabinet is seated in the panel groove. Insert and tighten the two cabinet screws at the side of the cabinet. Connect the antenna and power lead. The unit is now ready for operation.

Record the channel number opposite the channel switch position letter, so that you will know precisely which channels you have set up and the corresponding channel switch position.

Merely select the desired channel of operation by use of the Channel Selector switch. Operation is instantaneous and channels may be changed as often or as rapidly as desired. Avoid operating the Messenger on channel positions which have no crystals inserted.

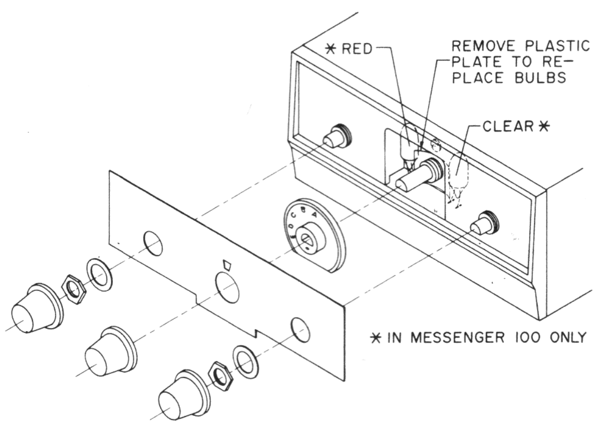
5.2 CHANNEL SELECTOR DIAL REPLACEMENT

You may find it desirable to have your Messenger channel indicator dial read in numbers. The following procedure is recommended to facilitate making this change.

To prevent errors, we suggest that you first make a list relating the channel positions to channel numbers. For example:

A = Channel 1
B = Channel 7
C = Channel 9
D = Channel 11
E = Channel 13

Use this list to set up the channel numbers on the dial. The channel numbers, supplied with the Messenger, are die cut to fit the channel selector dial, and are adhesive backed for easy mounting. A pair of tweezers will be found useful for removing the numbers from the card and attaching them to the dial. Fold the card on the perforated line--tear the card on this line to expose one edge of that row of numbers. Replace this portion of the card to protect the adhesive backing on the remaining numbers in that row. Use Figure 6 as a guide for the following channel selector dial conversion.



FRONT PANEL EXPLODED VIEW
FIGURE 6

a. Loosen the set screws and remove the three front panel knobs.

b. Remove the two nuts and washers on the two outside controls.

c. The front panel overlay can now be removed.

d. Remove the channel dial by carefully sliding it from the channel selector switch shaft.

e. Peel off the lettered mask on the dial face.

f. TURN THE DIAL AROUND and place the channel numbers in the spaces corresponding to the letters you previously listed (letters are molded into dial).

g. Slide the dial onto the channel selector shaft with the numbered side forward.

h. Replace the front panel overlay and the washers and nuts on the two outside controls.

i. Replace the three knobs and tighten the set screws.

5.3 CONVERSION FOR USE IN POSITIVE GROUND SYSTEMS

The Messenger may be used in positive ground systems by modifying the unit in accordance with the following outline: (See Figure 7)

1. Remove the Messenger from the cabinet by removing the screws at the sides of the cabinet.

2. Remove the screws at the rear of the chassis which secure the filter choke, L7, and ground lug.

3. Lay the filter choke back toward the front of the chassis to expose the circuit board area shown in Figure 7.

4. Unsolder one end of the black lead, W12, at hole "B".

5. Unsolder the red lead at hole "A" as shown in Figure 3 and resolder in hole "B".

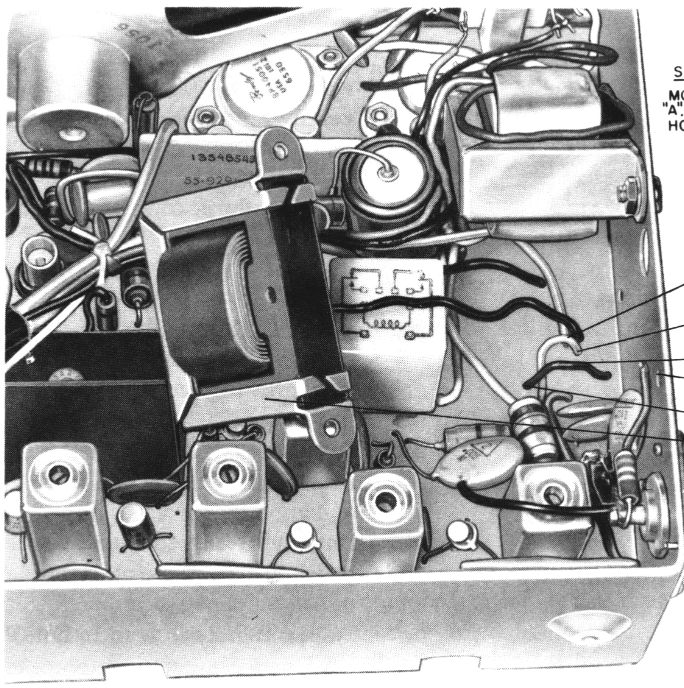
6. Solder the black lead in hole "A".

7. Replace the filter choke and ground lug using the screws previously removed.

8. Install the Messenger in the cabinet and secure with the screws at the sides.

This completes the conversion for positive ground operation. We recommend that the rear of the chassis be marked or tagged in some manner to indicate that the unit has been re-wired for positive ground operation.

NOTE: The Messenger accessory AC Power Supply, Model 250-848-1, is for operation with NEGATIVE GROUND units only. DO NOT ATTEMPT TO USE THE POWER SUPPLY WITH POSITIVE GROUND MESSENGERS.



CONVERSION FOR USE IN POSITIVE
GROUND SYSTEMS
FIGURE 7

SECTION 6
SERVICING

6.1 TRANSISTOR TROUBLE SHOOTING

6.1.1 GENERAL

The following information is intended to aid trouble shooting and isolation of transistor circuit malfunctions.

6.1.2 TRANSISTOR OPERATING CHARACTERISTICS

For all practical purposes the transistor base-emitter junction and the transistor base-collector junction can be considered to be diodes. For the transistor to conduct collector to emitter, its base-emitter junction must be forward biased in the same manner as a conventional diode. In a germanium transistor the typical forward biased junction voltage is 0.2 to 0.4 volts. A typical silicon transistor will have forward biased junction voltage of 0.5 to 0.7 volts. When collector current is high the base-emitter voltage of both germanium and silicon transistors increases from 0.1 to 0.2 volts. The base-emitter bias voltage in the forward biased condition is then 0.4 to 0.5 volts for a germanium transistor and 0.7 to 0.9 volts for a silicon transistor. High current silicon transistors may go up to 2 volts under load.

A high impedance DC voltmeter is usually the only measuring instrument required for determining the operational status of an in-circuit transistor. The meter is used to measure the transistor bias voltages. See Figure 8 for the correct voltmeter connections for measuring in-circuit transistor bias.

6.1.3 IN-CIRCUIT TRANSISTOR TESTING

a. Refer to Figure 8 for test connections.

b. Measure the emitter voltage. Compare your measurement to the voltage listed on the schematic diagram. A correct emitter voltage reading generally indicates that the transistor is working properly. If you are in doubt as to the condition of the transistor after measuring the emitter voltage, proceed to the following tests.

c. Measure the base-emitter junction bias. The voltage measured across a forward biased junction should be approximately 0.3 volts for a germanium transistor and 0.6 volts for a small signal silicon transistor.

d. Check for amplifier action by shorting the base to the emitter while monitoring the collector voltage.* The transistor should cut off (not conducting emitter to collector) because the base-emitter bias is removed. The collector voltage should rise to near the supply level. Any difference is the result of leakage current through the transistor. Generally, the smaller the leakage current the better the transistor. If no change occurs in the collector voltage when the base-emitter junction is shorted the transistor should be removed from the circuit and checked with an ohmmeter or a transistor tester. The following section describes the technique for testing transistors out of the circuit with an ohmmeter.

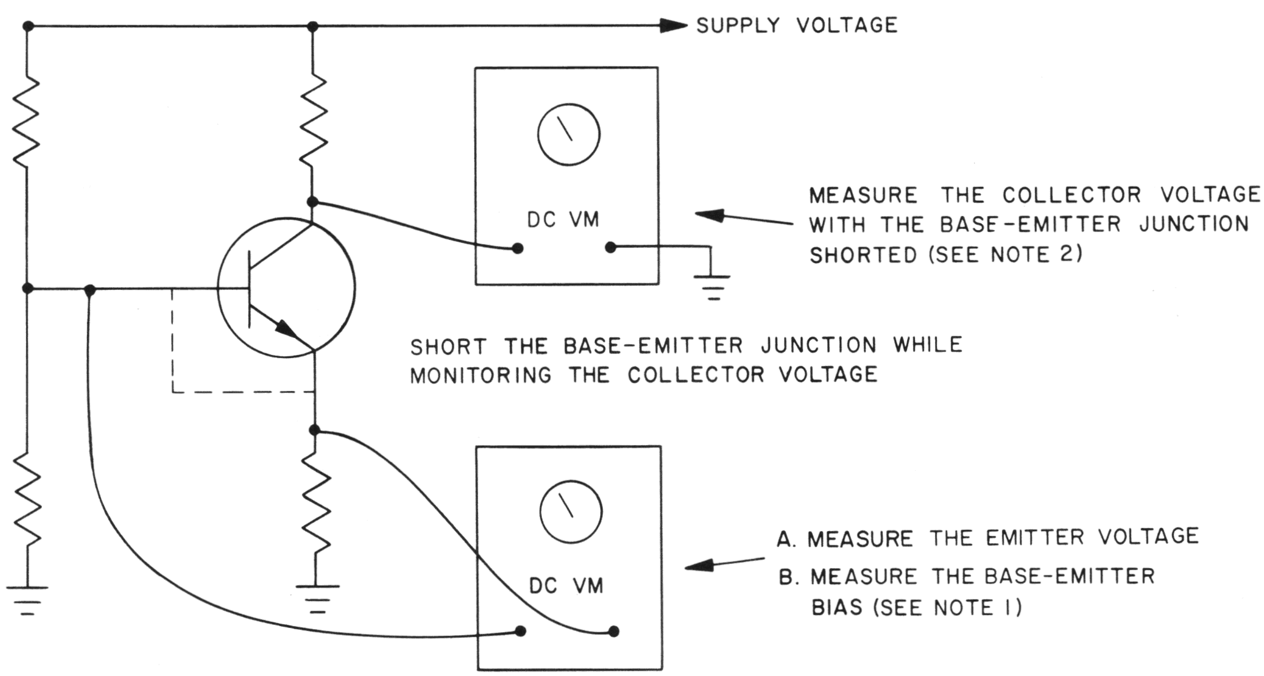
* Not recommended for high level stages under driving conditions.

6.1.4 OUT OF CIRCUIT TRANSISTOR TESTING

Only high quality ohmmeters should be used to measure the resistance of transistors. Many ohmmeters of both VOM and electronic types have short circuit current capabilities in their lower ranges that can be damaging to semiconductor devices. A good "rule of thumb" is to never measure the resistance of a semiconductor on any ohmmeter range that produces more than 3 milliamperes of short circuit current. Also, it is not advisable to use an ohmmeter that has an open circuit voltage of more than 1.5 volts. A current limiting resistor may be used in series with ohmmeter probes to make the lower ranges safe for measuring semiconductor resistances. If a current limiting resistor is used its value must be subtracted from the ohmmeter reading. The following section describes a method for determining the short circuit current capabilities of ohmmeters.

6.1.5 HOW TO DETERMINE OHMMETER CURENT

When the ohmmeter test probes are shorted together (measuring the forward resistance of a diode or the emitter - base junction of a transistor amounts to the same thing) the meter deflects full scale and the entire battery voltage appears across a resistance that we will designate as R1. The current through the probes is the battery voltage



TEST CONNECTIONS FOR
IN-CIRCUIT TRANSISTOR TESTING
FIGURE 8

NOTE 1:

Enough loop current is present in the leads of some electronic voltmeters to destroy transistors if measurements are made directly across transistor junctions. If an electronic voltmeter is used, perform the above measurements with respect to the circuit voltage common.

NOTE 2:

If the collector voltage is measured with a VOM the meter leads may be connected directly across the collector resistor. The difference between the supply voltage and the collector voltage will then be indicated directly on the VOM.