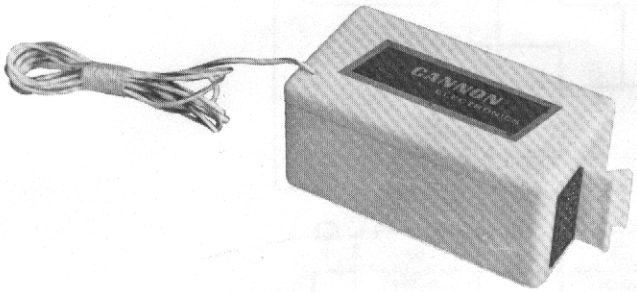
13400-26 Saticoy Street
North Hollywood, Calif. 91605

Assembly and Maintenance Instructions

for the MODEL S540-R Receiver



SPECIFICATIONS

Rx Type	double-tuned superhet
Sensitivity	2 microvolts
Bandwidth	6 DB at 4 KHz
Intermediate Frequency	455 KHz
Available Frequencies	26.995, 27.045, 27.095, 27.145, 27.195, 53.1, 53.2, 53.3, 53.4, 53.5, 72.080, 72.240, 72.400, 72.960, 75.640 MHz
Operating Voltage	4.8 volts
Current Drain	11 ma
AGC	3 stages
Operating Temperature Range	0° to +140°F
Dimensions	1-3/32 by 1-5/32 by 2-1/4 inches long
Weight (including plugs)	1.5 ounces
Plug Type	4-pin Multicon
Case Type	Nylon
Construction	Two-deck
No. of Channels	4, 5 or 6

DESCRIPTION

The Super-Flite Receiver is constructed on two decks and housed in a durable nylon case. Case top is removable to permit tuning of RF coils.

Three basic models of this receiver are available, four, five, or six-channels. Circuitry of all are identical , except for the omission of a few parts on the four and five channel models. Consequently, the four and five channel units can easily be converted to a six-channel receiver to provide increased operational capability.

A Multicon plug block mounted integral with the decoder P.C. board accepts mating four-pin Multicon plugs from the battery and up to six servos. These cables plug directly into the end of the receiver and are held in place by a locking tab molded into the receiver case.

This receiver is compatible with most standard transmitters such as Cannon, Kraft, Heath, PCS, and some models of EK, Orbit and Micro. It is designed for use with a standard Tx encoder transmitting one pulse more than the number of receiver channels (for example, five pulses for four channels).

A newly-developed silicon control rectifier (SCR) permitting turn-off and turn-on through a single gate is employed in the decoder, providing a simple but rugged device much superior to SCS units. Due to decoder design, we recommend use of only Cannon servos with this receiver to reduce loading effects associated with some other servo makes.

MODELS COVERED

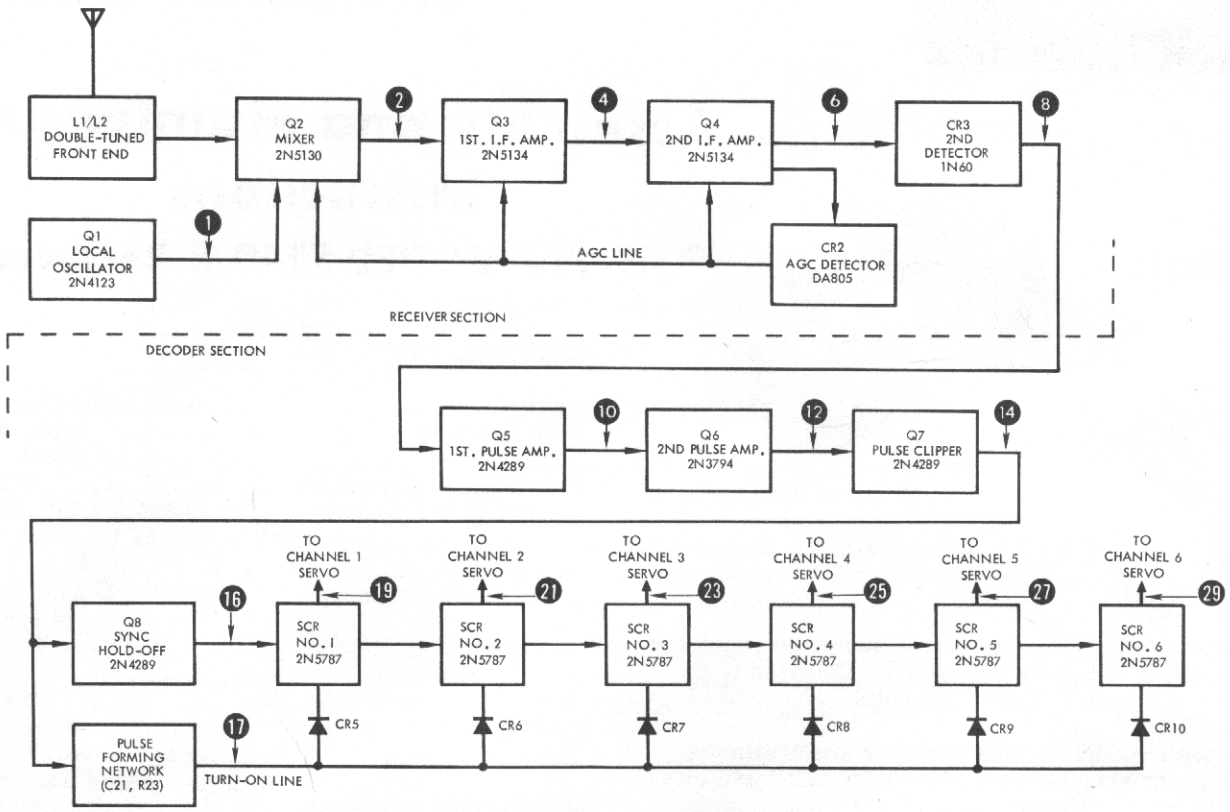
These receivers are available as full-kits or in factory assembled form. All assembly instructions contained herein pertain to the full kit and the builder must perform each step. All other information, except assembly procedures, is applicable to assembled receivers.

FREQUENCIES AVAILABLE

Tx Frequency (MHz)	Rx Crystal (MHz)	Flag (Color)
26.995	26.540	Brown
27.045	26.590	Red
27.095	26.640	Orange
27.145	26.690	Yellow
27.195	26.740	Green
53.1	52.645	Black - Brown
53.2	52.745	Black - Red
53.3	52.845	Black - Orange
53.4	52.945	Black - Yellow
53.5	53.045	Black - Green
72.080	36.2675	White - Brown
72.240	36.3475	White - Red
72.400	36.4275	White - Orange
72.960	36.7075	White - Yellow
75.640	37.5925	White - Green

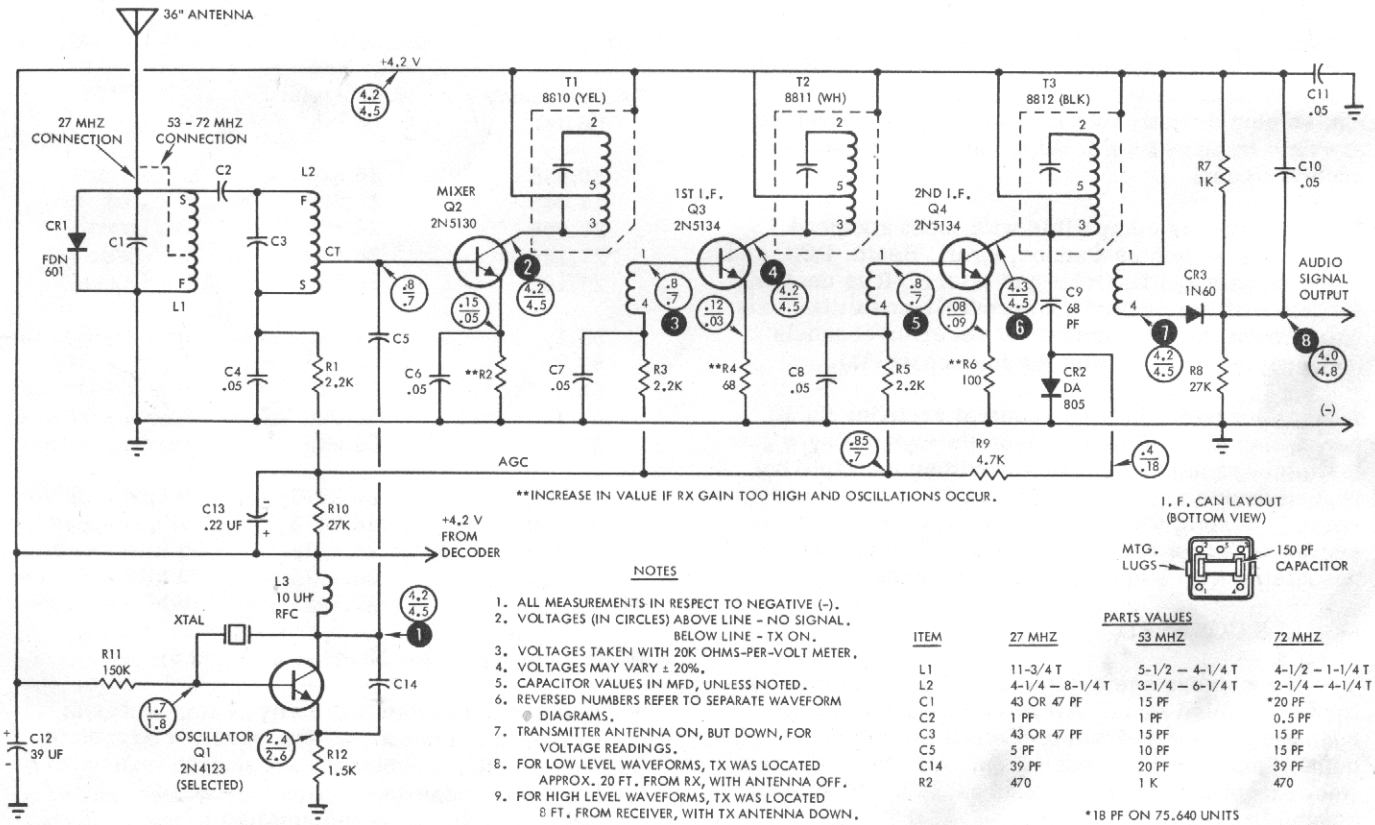
BASIC THEORY (See Figures 2, 3 and 6)

This receiver consists basically of two sections: a receiver and a decoder. The receiver serves to pick up, amplify and detect the radiated transmitter signal; the decoder segregates the detected pulses and transfers the pulse information to each servo.



CIRCLED NUMBERS REFER TO RECEIVER SCHEMATIC TEST POINTS AND WAVEFORM DIAGRAMS

Figure 2. Receiver-Decoder Block Diagram



NOTES

1. ALL MEASUREMENTS IN RESPECT TO NEGATIVE (-).
2. VOLTAGES (IN CIRCLES) ABOVE LINE - NO SIGNAL. BELOW LINE - TX ON.
3. VOLTAGES TAKEN WITH 20K OHMS-PER-VOLT METER.
4. VOLTAGES MAY VARY ± 20%.
5. CAPACITOR VALUES IN MFD, UNLESS NOTED.
6. REVERSED NUMBERS REFER TO SEPARATE WAVEFORM @ DIAGRAMS.
7. TRANSMITTER ANTENNA ON, BUT DOWN, FOR VOLTAGE READINGS.
8. FOR LOW LEVEL WAVEFORMS, TX WAS LOCATED APPROX. 20 FT. FROM RX, WITH ANTENNA OFF.
9. FOR HIGH LEVEL WAVEFORMS, TX WAS LOCATED 8 FT. FROM RECEIVER, WITH TX ANTENNA DOWN.

PARTS VALUES

ITEM	27 MHZ	53 MHZ	72 MHZ
L1	11-3/4 T	5-1/2 – 4-1/4 T	4-1/2 – 1-1/4 T
L2	4-1/4 – 8-1/4 T	3-1/4 – 6-1/4 T	2-1/4 – 4-1/4 T
C1	43 OR 47 PF	15 PF	*20 PF
C2	1 PF	1 PF	0.5 PF
C3	43 OR 47 PF	15 PF	15 PF
C5	5 PF	10 PF	15 PF
C14	39 PF	20 PF	39 PF
R2	470	1 K	470

*18 PF ON 75.640 UNITS

Figure 3. Receiver Schematic

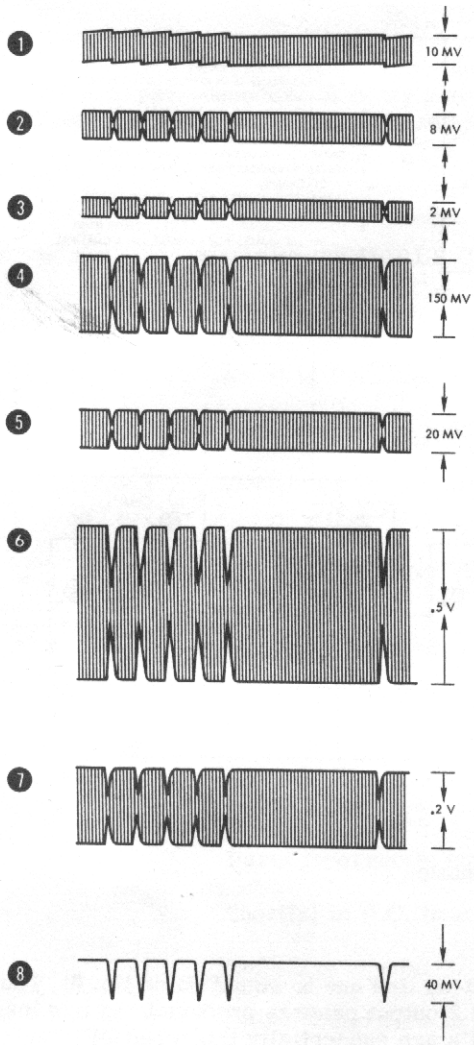


Figure 4. Receiver Waveforms (Low Level)

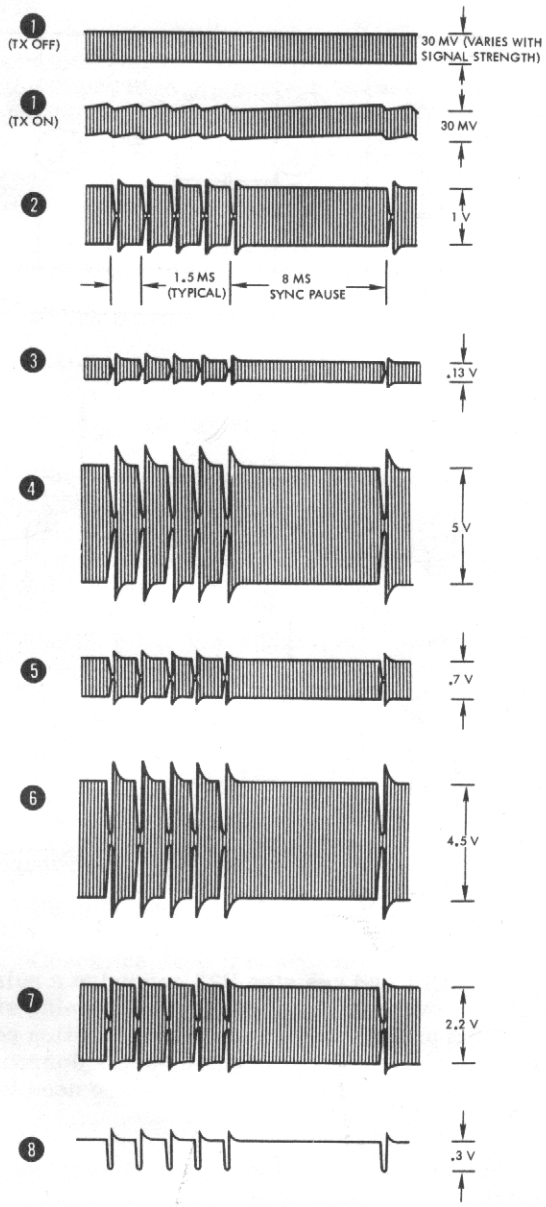


Figure 5. Receiver Waveforms (High Level)

The receiver section is a conventional superheterodyne, consisting of transistor circuits Q1 through Q4, and second detector CR3. Intermediate frequency is 455 KHz.

Tunable antenna and RF coils L1 and L2 provide excellent selectivity and rejection of undesired signals. Local oscillator Q1 operates at 455 KHz below the incoming RF signal (except on 72 MHz). In Q2 the incoming RF and local oscillator signals are mixed to provide the 455 KHz I.F. signal. This is amplified in Q3 and Q4, and detected by diode CR3, then fed to the pulse amplifier circuits.

A portion of the I.F. signal is rectified by diode CR2 to provide the AGC (automatic gain control) feedback voltage applied to the base circuits of stages Q2, Q3 and Q4. This AGC voltage varies inversely in amplitude with the power of the RF signal received. Gain of these stages is reduced at higher input power levels, and assures proper receiver selectivity and freedom from signal swamping.

Transistors Q5 and Q6 serve as pulse amplifiers, while Q7 provides clipping action to reduce effects of electrical interference and random noise. As a result, only the upper portion of the detected and amplified pulses is passed to the logic stages, and threshold noise is suppressed. Positive pulses from Q7 are fed to both Q8, the sync hold-off stage, and to the Pulse Forming Network (C21, R23).

The first incoming pulse to the base of Q8 turns that stage OFF, and applies the resultant negative pulse through capacitor C23 to the gate circuit of SCR No. 1. Time constants of C22 and R24 in the base circuit of Q8 continue to hold this stage in OFF condition until after the pulse train is completed. C22 resumes its normal charge state during the sync pause, turning Q8 ON again. The decoder is then ready to process the next pulse information frame that arrives.

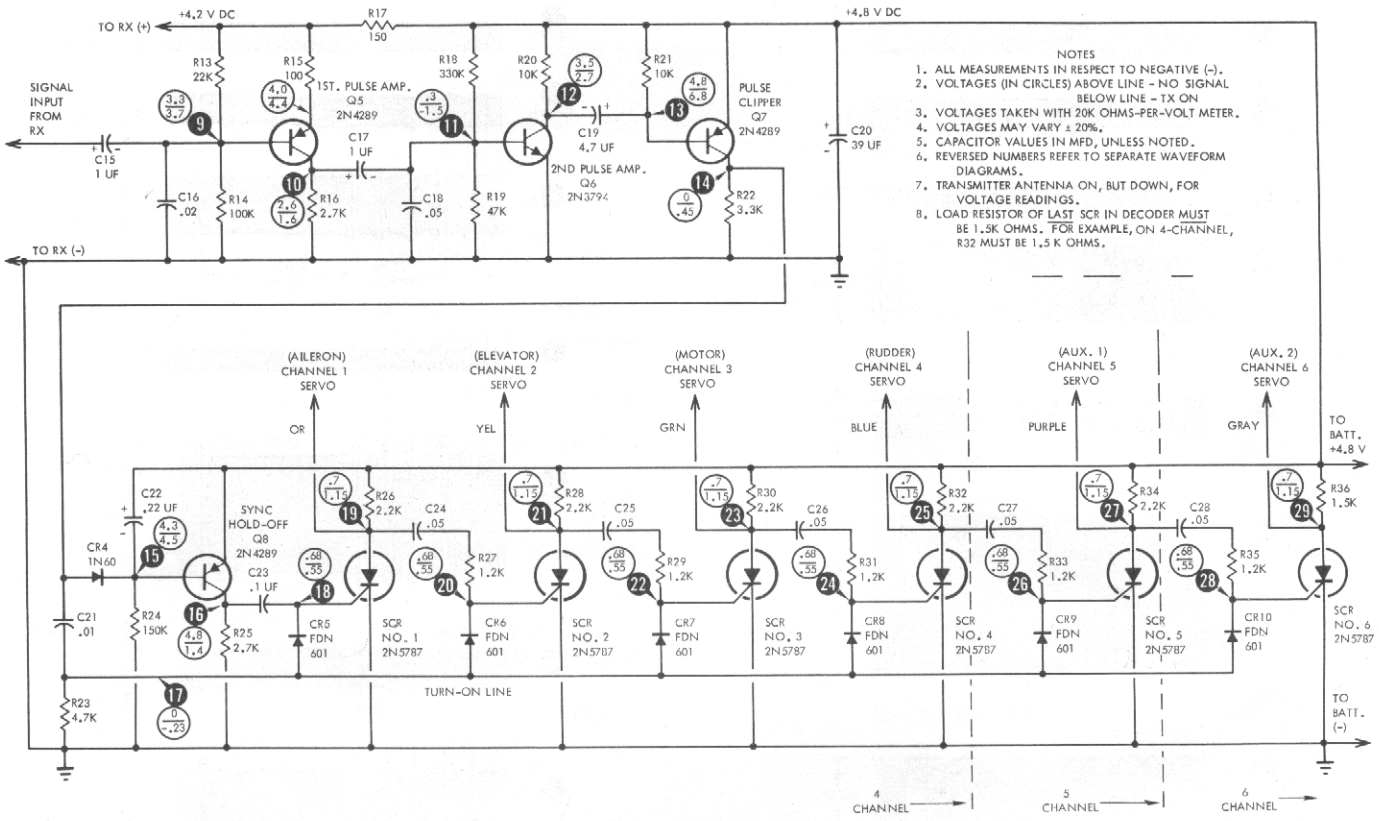


Figure 6. Decoder Schematic

Capacitor C21 and resistor R23 comprise a pulse forming network to differentiate the incoming signal pulses and produce a series of short duration positive trigger pulses. These pulses applied through the turn-on line and isolation diodes are used to turn ON the SCR's.

Note that pulse No. 1 of the pulse train applies both a positive and a negative pulse simultaneously to the gate of SCR No. 1, which is normally conducting. The longer duration incoming negative pulse at the gate causes SCR No. 1 to turn OFF. Signal pulse No. 2 has no effect on Q8 which is now OFF, but does apply a positive pulse through diode CR5 to the gate of SCR No. 1, turning it back ON and producing the channel 1 output pulse (waveform (19)) shown on the waveform chart.

Conduction of SCR No. 1 causes a negative pulse to be applied through C24 and R27 to the gate of SCR No. 2, shutting it OFF. Turn-on of SCR No. 2 occurs when the gate is triggered by the positive pulse from the turn-on line due to signal pulse No. 3. Thus the channel 2 output pulse is produced. In like manner, all SCR's are sequentially triggered OFF and ON to obtain the desired number of output pulses (servo input signals). Note that the time duration of each SCR output pulse is determined by the position of the related control stick on the transmitter.

In each servo the width of the pulse from the related SCR is compared with that of a reference pulse generated within the servo. If the two pulses are of different widths, the servo moves until the internal reference generator variable pulse matches the width of the incoming pulse, at which point it stops. Thus, movement of a control stick changes the related output pulse spacing from the transmitter and positions the servo as desired.

The total number of SCR's employed in the decoders determines the number of channels which the receiver-decoder is capable of operating.

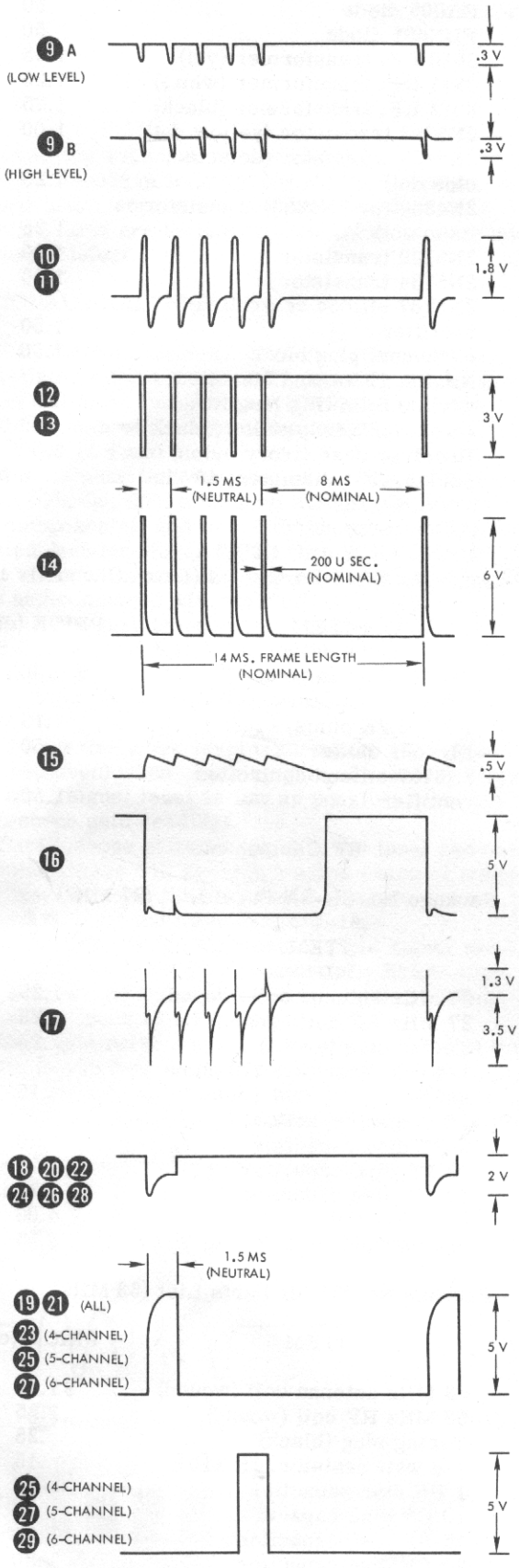


Figure 7. Decoder Waveforms

RECEIVER PARTS PACKAGING

Kit parts are shipped in plastic bags to permit rapid identification of parts groups. At the beginning of each phase of receiver assembly, open only the bag (or bags) pertaining to that phase. In the event a part is left over, save it for future use in a succeeding step.

Listed below are the various packages supplied with your kit, together with quantities required for each receiver model.

Package No.	Contents	4-CH	5-CH	6-CH
SR-1	Receiver Boards & 4-CH Components	1	1	1
SR-2	Extra Channel Components	0	1	2
SR-3A or SR-3B or SR-3C	RF Package "A" (27 MHz) RF Package "B" (53 MHz) RF Package "C" (72 MHz)	1	1	1
SR-4	Assembly and Maintenance Instructions	1	1	1

Package SR-1 contains the P.C. boards and all electronic components required to build a basic 4-channel decoder and receiver without the RF elements. Package(s) SR-2 contains parts to convert the receiver logic section to 5 or 6 channels.

Your kit contains one of the following packages, depending upon frequency: SR-3A (27 MHz), SR-3B (53 MHz) or SR-3C (72 MHz). Installation of these parts is shown in figures 14, 15 and 16. Select the illustration applicable to your receiver and install these frequency determining components as shown.

RECEIVER ASSEMBLY PROCEDURES

PREPARATION FOR ASSEMBLY

a. Read these instructions and the General Assembly Instructions over thoroughly before starting receiver assembly.

b. Kits are packaged to provide several component groups. At the beginning of each assembly phase a parts list is provided to cover the specific parts required during that operation. Packages are easily identified as to contents. Open only the package(s) needed for that assembly procedure. Check package parts against the parts list.

NOTE: In event of parts shortages, contact the factory for replacements. Kits are warranted only for completeness of parts. No parts

exchange will be made after the part has been installed or soldered on. In no case will exchange be made unless original parts are returned.

c. Choose a smooth, clean work area so parts are not easily lost.

d. The following tools are required:

1. Needle nose pliers, 4" long.
2. Diagonal cutters, 4" long, flush-cutting type preferred.
3. Wire strippers for no. 26 wire.
4. Soldering iron, 30 to 47-1/2 watts.
5. Pencil tip for soldering iron.
6. Damp cellulose sponge for cleaning soldering iron.
7. Rosin core solder, 60-40 type, .031 diameter (supplied in kit).
8. Fine tooth metal file, flat sided.
9. Small, stiff bristle brush.
10. Lacquer thinner.
11. X-acto knife.
12. Eye loupe, 2-1/2" to 3" focal length.

e. Check that outer trim edges of P.C. boards extend no more than 1/64" beyond outer edges of copper lands. If necessary, dress edges slightly with a file. Check fit of boards into receiver case.

f. When soldering board, use no more solder than necessary to obtain a good connection. Too much solder is undesirable, as it will cause the boards to fit too tightly in the case slots.

g. Use caution in handling subminiature 2N3794 and 2N4288 (or 2N4289) transistors. Their construction is delicate, and placing undue stress on the wire legs by spreading too far may fracture them internally.

NOTE: Your kit may contain either 2N4288 or 2N4289 transistors. These units are identical in all respects in so far as your equipment is concerned.

Receiver Board Electronics

Package No. SR-1 Parts List (4-Channel)

QTY	ITEM	PRICE (ea)
1	P.C. board (S540-D) Sold in pairs only	$4.00
1	P.C. board (S540-R) Sold in pairs only	$4.00
1	68 PF disc capacitor	.20
1	.01 UF disc capacitor	.20
1	.02 UF disc capacitor	.20
10	.05 UF disc capacitor	.30
1	.1 UF disc capacitor	.30
2	.22 UF tantalum capacitor	.75
2	1 UF tantalum capacitor	.75
1	4.7 UF tantalum capacitor	.75
2	39 UF tantalum capacitor	.75
1 ea	1/4 watt resistors, values 68, 150, 1K, 3.3K, 22K, 47K, 100K, 330K ohms, ±10%	.15
2 ea	1/4 watt resistors, values 100, 1.5K, 2.7K, 4.7K, 10K, 27K, 150K ohms ±10%	.15
3	1/4 watt resistor, 1.2K ±10%	.15
6	1/4 watt resistor, 2.2K ±10%	.15
1	10 UH RF choke	.60
2	1N60 diode	.50
1	DA805 diode	.50
5	FDN601 diode	.50
1	8810 I.F. transformer (yel)	1.25
1	8811 I.F. transformer (white)	1.25
1	8812 I.F. transformer (black)	1.25
1	2N3794 transistor (yellow dot)	1.00
1	2N4123 transistor (selected, blue dot)	1.25
3	2N4288 (or 2N4289) transistor (blue dot)	1.25
1	2N5130 transistor	1.00
2	2N5134 transistor	1.00
4	2N5787 silicon controlled rectifier	1.50
1	6-channel plug block	7.50
1 ea	No. 26, 19-strand insulated wire in following length and colors: 2" red, yellow, black	.05 ft
1	Receiver case (ivory nylon)	2.50
1	Solder, .031 diameter, 48" lg	.10 ft

Package No. SR-2 Parts List (Extra Channel)

QTY	ITEM	PRICE (ea)
1	.05 UF disc capacitor	$ .30
1 ea	1/4 watt resistors, values 1.2K, 2.2K ohms, ±10%	.15
1	FDN601 diode	.50
1	2N5787 silicon controlled rectifier	1.50

RF Components

Package No. SR-3A Parts List (27 MHz)

QTY	ITEM	PRICE (ea)
1	27 MHz antenna coil (wound)	$1.25
1	27 MHz RF coil (wound)	1.25
2	Tuning slug (green)	.25
1	1/4 watt resistor, 470 ohms ±10%	.15
1	1 PF disc capacitor	.20
1	5 PF disc capacitor	.20
1	39 PF disc capacitor	.20
2	47 PF disc capacitor	.20
1	27 MHz crystal	4.00
1	#26 antenna wire, 36" lg (gray)	.15

Package No. SR-3B Parts List (53 MHz)

QTY	ITEM	PRICE (ea)
1	53 MHz antenna coil (wound)	$1.25
1	53 MHz RF coil (wound)	1.25
2	Tuning slug (black)	.25
1	1/4 watt resistor, 1K ±10%	.15
1	1 PF disc capacitor	.20
1	10 PF disc capacitor	.20
2	15 PF disc capacitor	.20
1	20 PF disc capacitor	.20
1	53 MHz crystal	6.00
1	#26 antenna wire, 36" lg (black)	.15

RECEIVER BOARD ASSEMBLY

a. Check printed circuit boards as outlined in General Assembly Instructions.

b. Open package SR-1 (4-channel) and package(s) SR-2 (extra channel) containing P.C. boards and electronic components to build the decoder and basic receiver. Assembly procedures for these items are covered in steps 1 through 99.

c. Check parts against the parts lists and figures 8 through 16 for parts identification.

NOTE: Diodes are hardest to identify. FDN601 diodes are the smallest, the DA805 is intermediate size with the number printed on the side, and the 1N60's are the large glass units. Handle all with extreme care to avoid breaking.

d. To begin assembly, position decoder printed circuit board S540-D, metal side down, so that hole arrangement corresponds with layout in figure 8. Proceed with assembly steps in figure 8, then continue with steps in figures 9 through 11.

e. Next, position receiver printed circuit board S540-R, metal side down, to correspond with layout in figure 12. Assemble basic receiver as instructed in figures 12 and 13.

f. After basic receiver is done, open package SR-3A, SR-3B, or SR-3C, depending on frequency band of your receiver. Check parts against proper parts list, then proceed with assembly steps 100 through 110 to complete the receiver electronic assembly.

Package No. SR-3C Parts List (72 MHz)

QTY	ITEM	PRICE (ea)
1	72 MHz antenna coil (wound)	$1.25
1	72 MHz RF coil (wound)	1.25
2	Tuning slugs (black)	.25
1	1/4 watt resistor, 470 ohms ±10%	.15
1	0.5 PF disc capacitor	.20
2	15 PF disc capacitor	.20
1	20 PF disc capacitor	.20
1	39 PF disc capacitor	.20
1	36 MHz crystal (doubler for 72 MHz)	5.00
1	#26 antenna wire, 36" lg (white)	.15
*1	18 PF disc capacitor	.20
1	Certification label	.25

*Included with 75.640 receivers only.

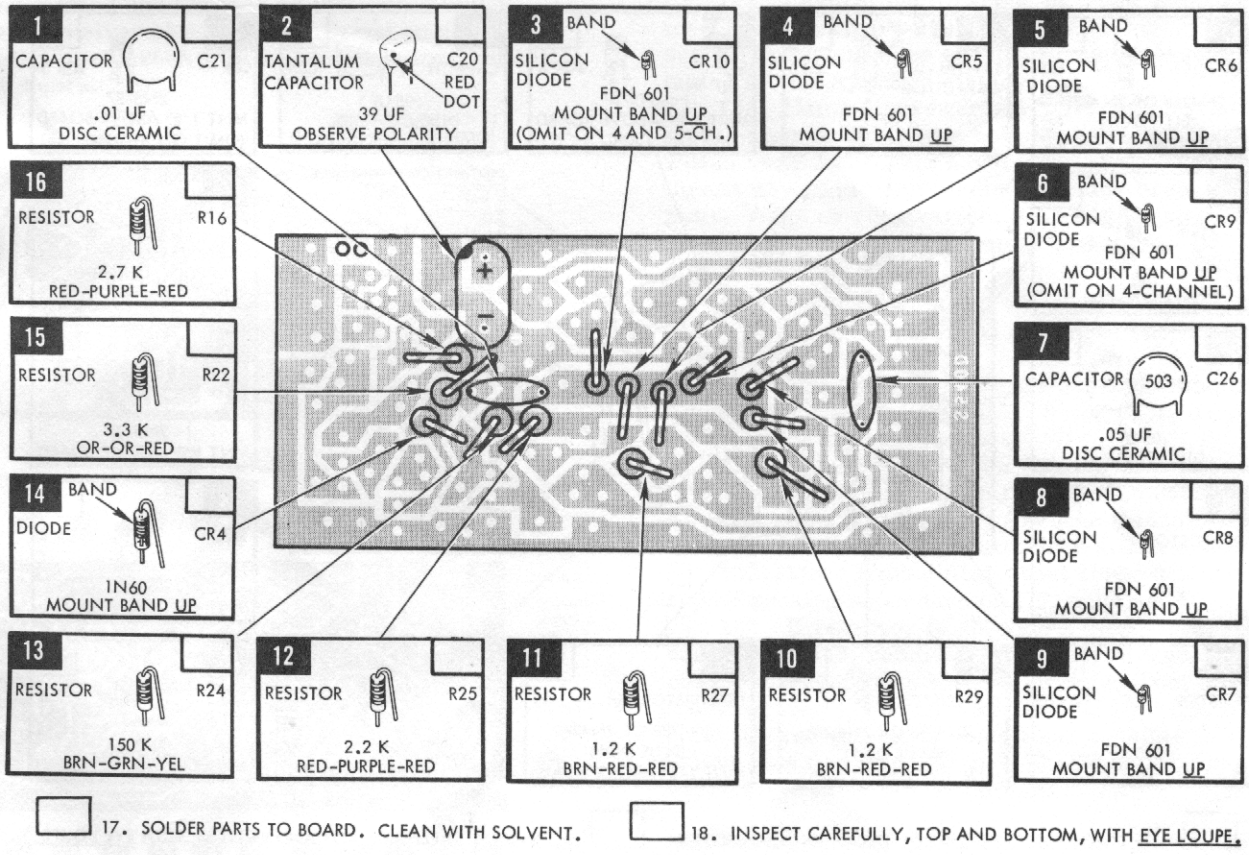


Figure 8. Decoder Assembly (Sheet 1 of 4)

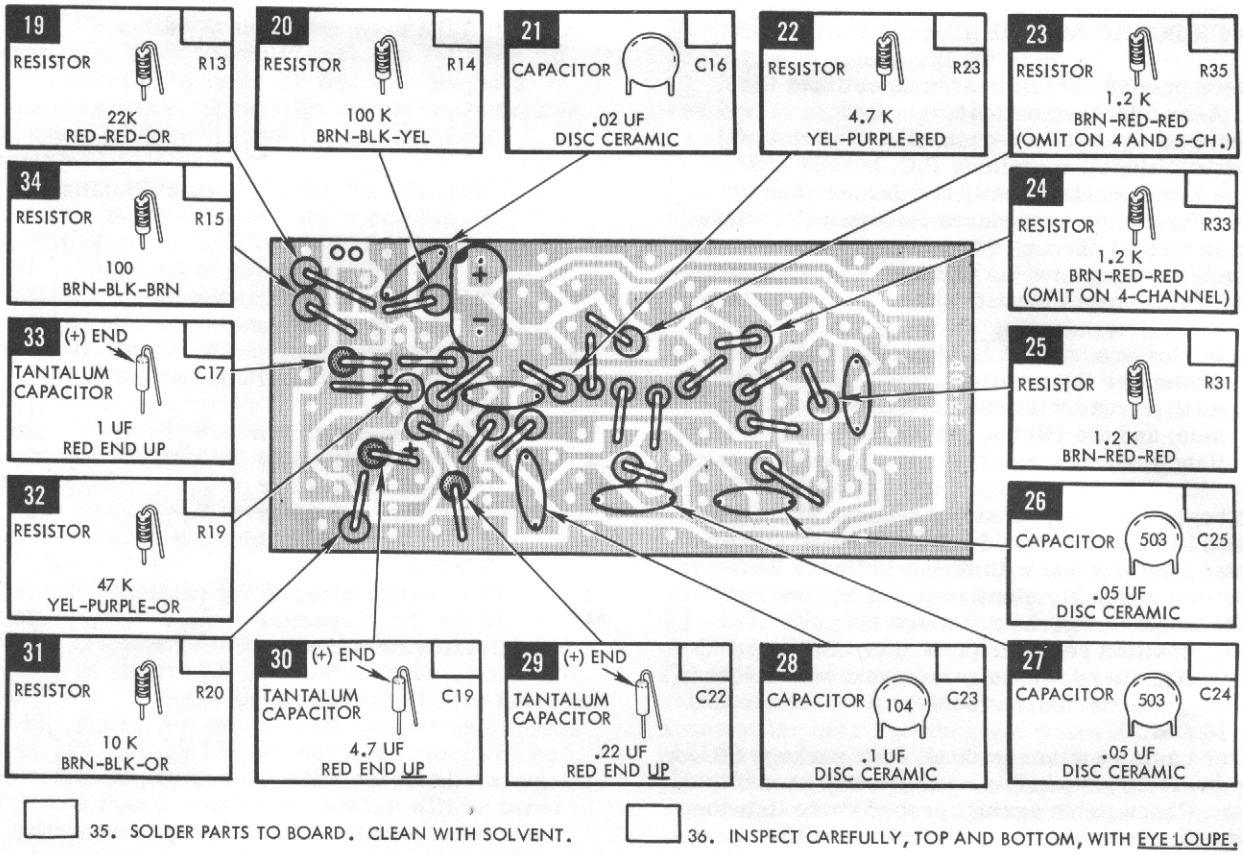


Figure 9. Decoder Assembly (Sheet 2 of 4)

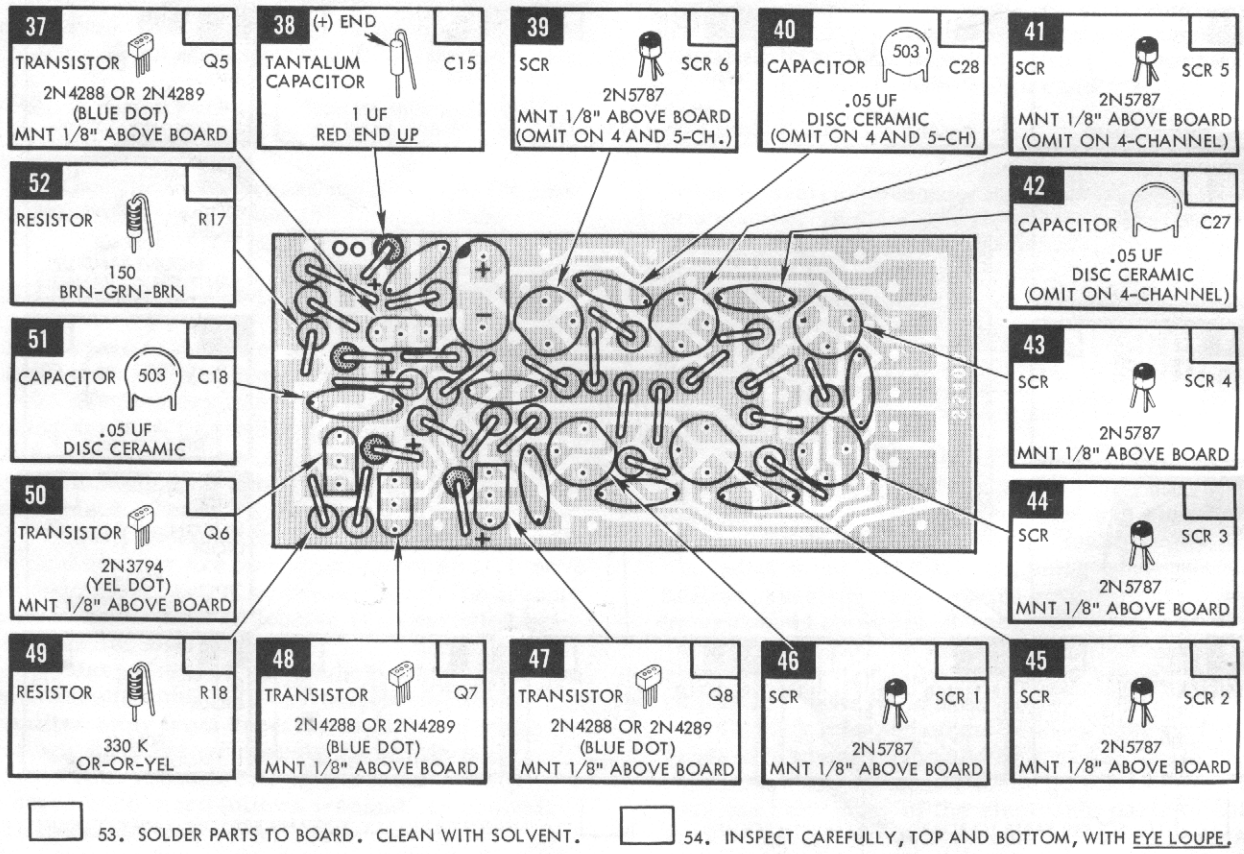


Figure 10. Decoder Assembly (Sheet 3 of 4)

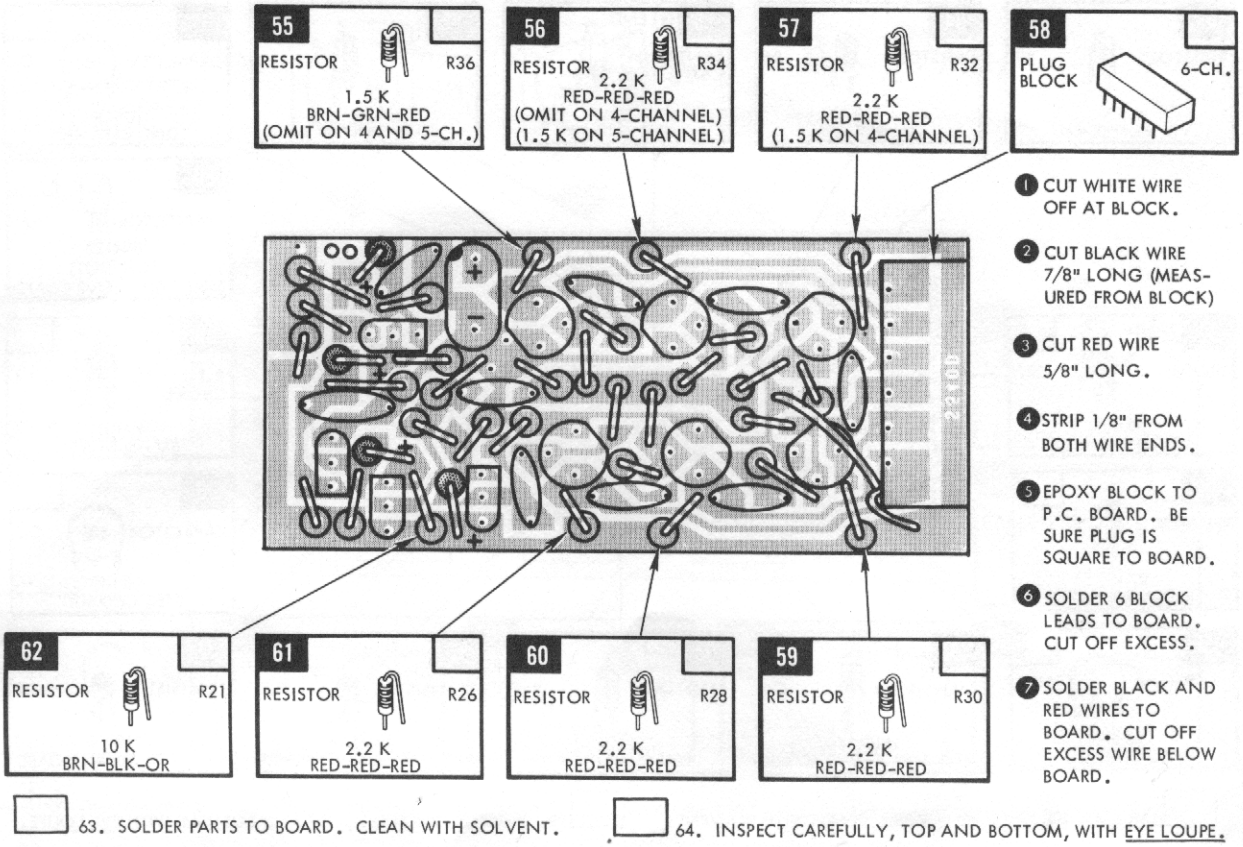


Figure 11. Decoder Assembly (Sheet 4 of 4)

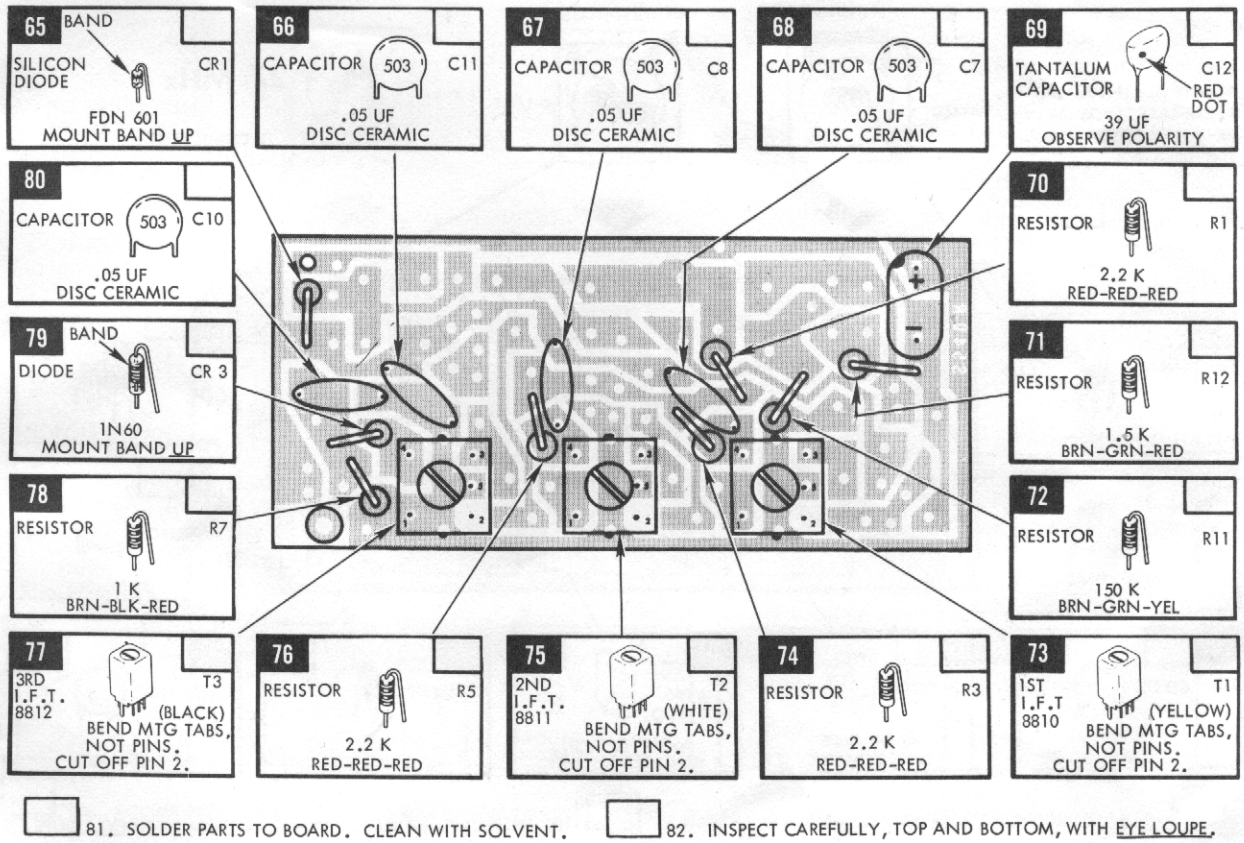


Figure 12. Basic Receiver Assembly (Sheet 1 of 2)

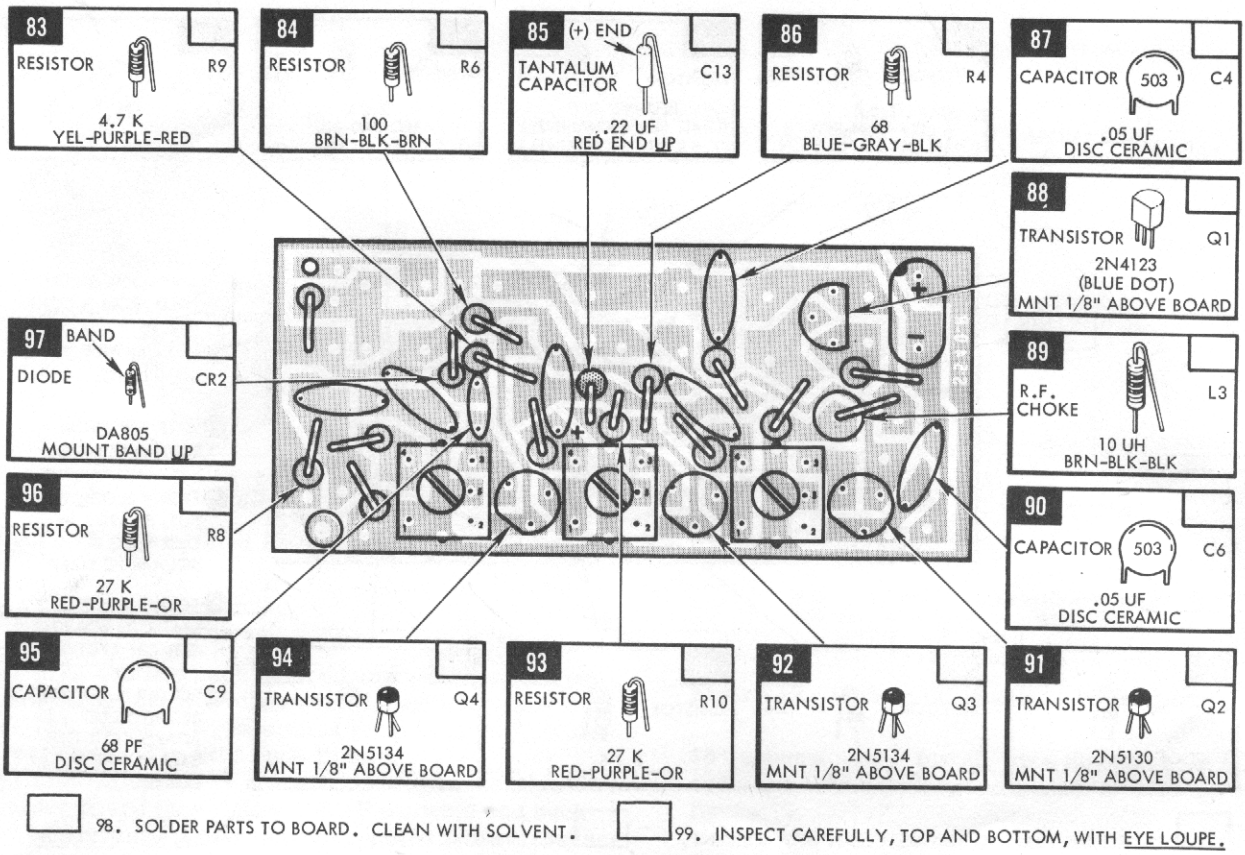


Figure 13. Basic Receiver Assembly (Sheet 2 of 2)

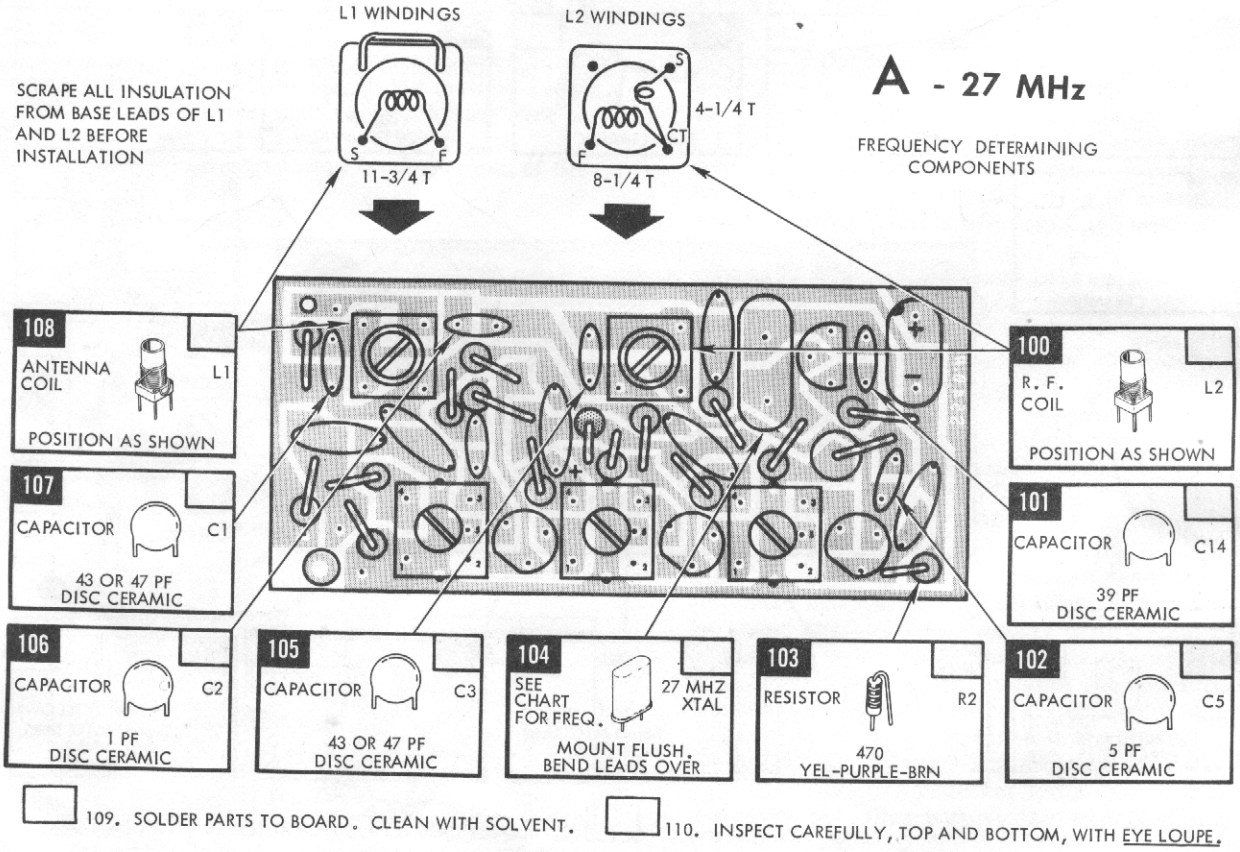


Figure 14. RF Section Assembly (27 MHz)

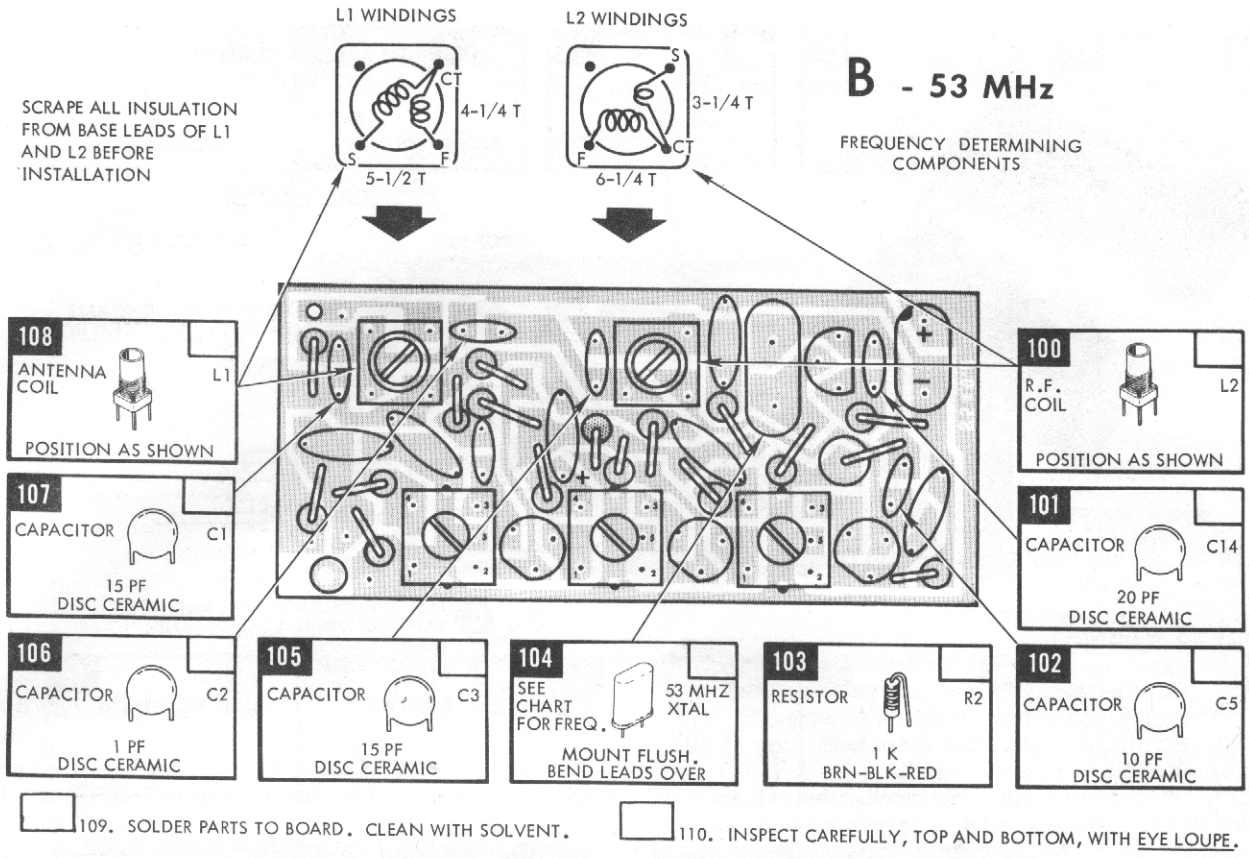


Figure 15. RF Section Assembly (53 MHz)

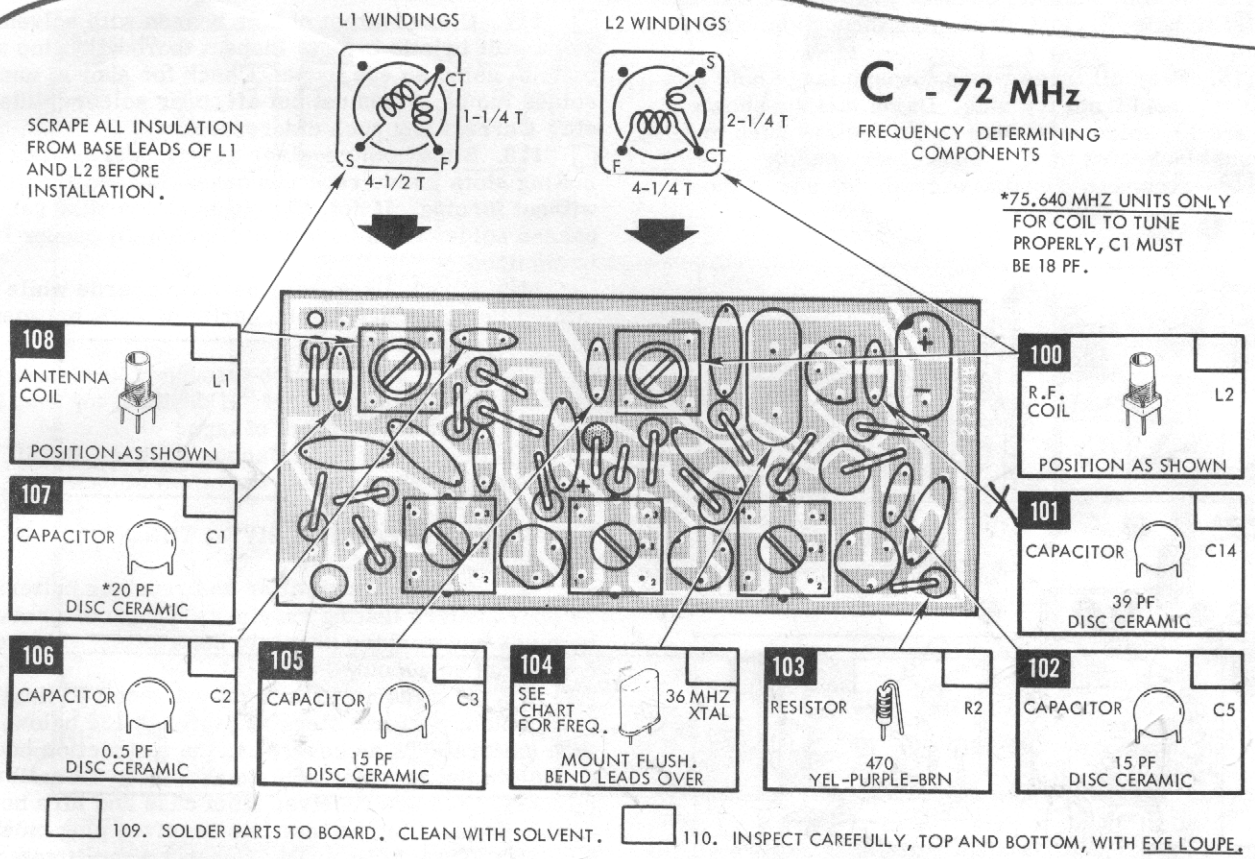


Figure 16. RF Section Assembly (72 MHz)

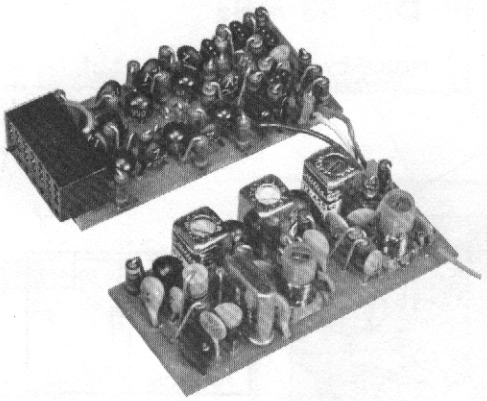


Figure 17. Completed Receiver and Decoder Boards

RECEIVER WIRING

☐ 111. Cut one each #26 red and yellow wires to 1-5/8" long; cut one black wire 1-3/4" long.
☐ 112. Strip 1/8" insulation from both ends of all three wires. Tin wire ends lightly.
☐ 113. Slide end of red wire through hole ① in decoder board (see figure 18). Pass wire end back through hole Ⓐ , seat wire fully, then solder in place as shown in figure 19.
☐ 114. In like manner, connect yellow wire through hole ② to hole Ⓑ, and black wire through hole ③ to hole Ⓒ.
☐ 115. Pass all three wires through large hole in receiver board from top side. Using method shown in figure 19, solder red wire to Ⓐ, yellow wire to Ⓑ, and black wire to Ⓒ on receiver board.
☐ 116. Strip 1/8" insulation from one end of the

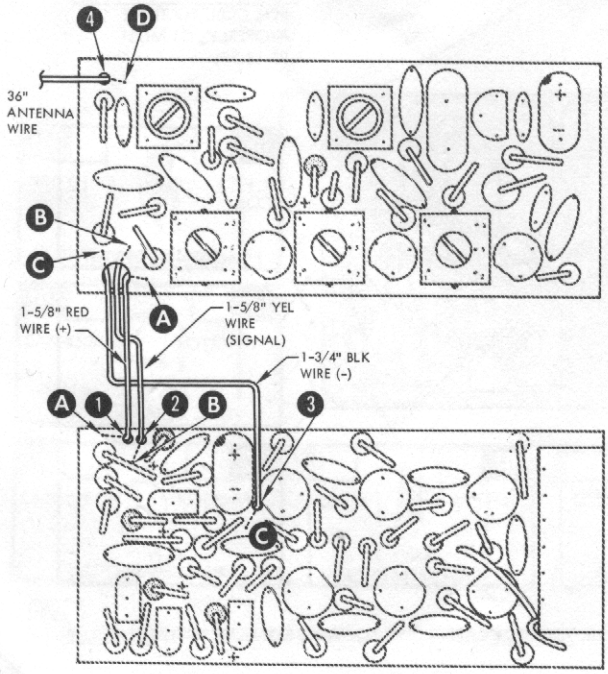


Figure 18. Wiring Boards

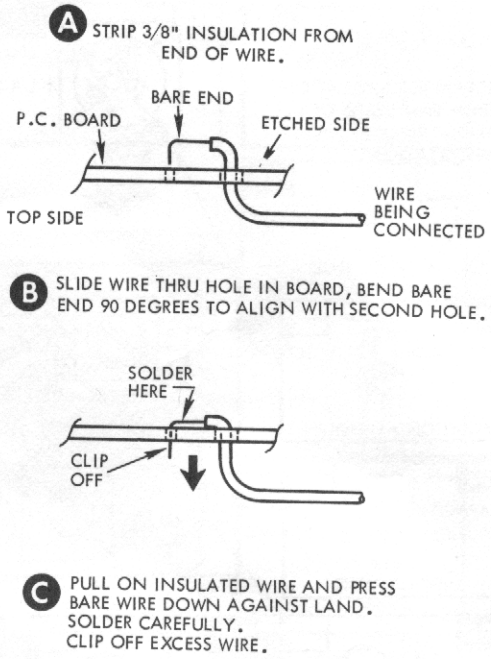


Figure 19. Method of Attaching Wires through Board

36" antenna wire. Install wire through hole ④ on end of receiver board, and solder to hole Ⓓ as in figure 19.

FINAL ASSEMBLY

☐ 117. Clean bottom of both boards with solvent and a stiff bristle brush. Inspect thoroughly, top and bottom, using an eye loupe. Check for shorts, uneven solder lumps, wires not cut off, poor solder joints, etc. Correct any such discrepancies.
☐ 118. Slide both receiver and decoder boards into mating slots inside receiver case. Boards should fit without forcing. If not, file edges of board or remove excess solder from bottom of board until proper fit is obtained.
☐ 119. Check clearances between boards while installed in case. Be sure no parts or leads between boards are touching.
☐ 120. Slide antenna wire through hole in case top. Install top over case bottom. If desired, top may be secured with a small piece of tape.
☐ 121. Peel back from Cannon sticker. Install sticker in center of recess in bottom of case.

PREPARATION FOR RECEIVER TUNING

☐ 122. Charge transmitter and receiver batteries 24 hours before testing receiver. Transmitter must be tuned and working properly before final receiver tuning can be accomplished.
☐ 123. If transmitter has not yet received final calibration, perform steps 127 through 132 below, then calibrate Tx as covered in the instruction book. Complete the receiver adjustments after Tx calibration.
☐ 124. Remove receiver from case and turn boards upside down. Plug battery into receiver plug block.
☐ 125. Turn battery ON. Connect a multimeter between the minus land and the two positive lands and measure incoming battery voltage (+4.8 - 5.0V) and

receiver front end voltage (+4.2 - 4.3V). (See figure 20 for proper test points.) If voltage is not correct, locate and remove cause of trouble.

☐ 126. Turn battery OFF.

TUNING METHODS

Three methods are offered here for tuning your receiver: use of an oscilloscope (most accurate); a voltmeter (reasonably accurate); or without any test equipment except your calibrated transmitter and a servo.

Figure 21 shows connection points for oscilloscope and/or voltmeter, both for tuning and for check of decoder outputs. Circled numbers on figure 21 refer to test points on schematics and to related waveforms.

Oscilloscope used must be capable of reproducing waveforms shown in figures 4, 5 and 7, especially if used for troubleshooting and signal tracing. A calibrated time base is not essential, but vertical voltage scale calibrations are helpful.

A vacuum tube voltmeter or multimeter of 20K ohms-per-volt is recommended for accurate voltage measurements, and as an alignment tool.

For all tests, a properly calibrated and operating transmitter is required.

Depending upon equipment available, select your tuning method and proceed as instructed below. Note - Receiver should be positioned on non-metallic work bench with antenna hanging vertically off of bench.

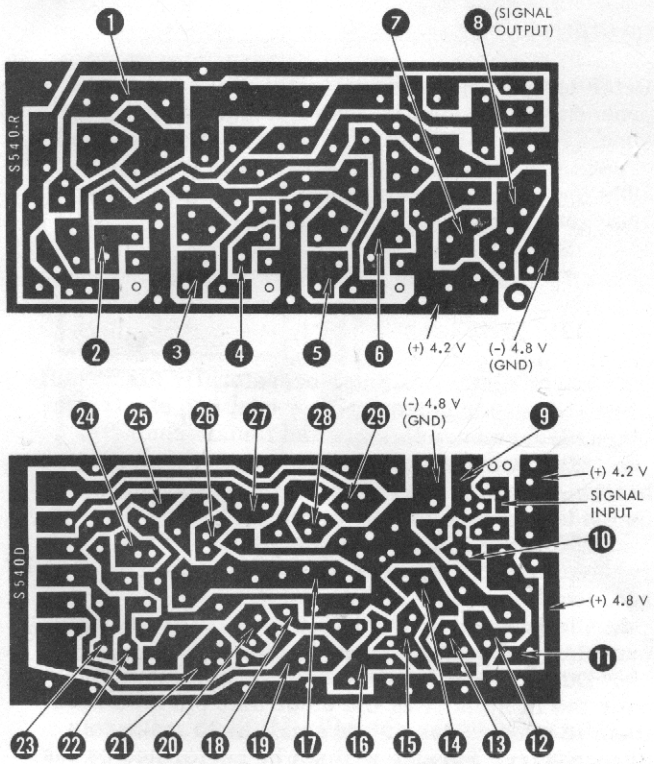


Figure 20. Receiver Test Points (Bottom Side)

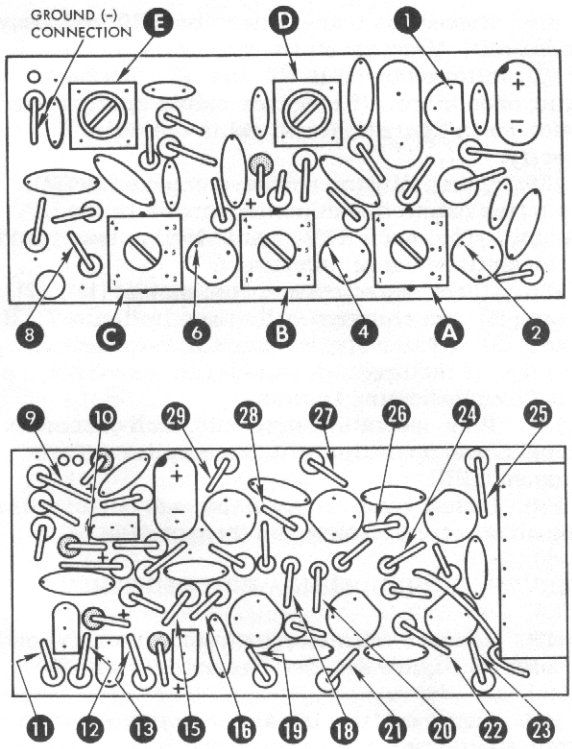


Figure 21. Tuning and Check Points (Top Side)

RECEIVER TUNING USING AN OSCILLOSCOPE

☐ 127. Connect oscilloscope between ground (-) and test point ⑧, figure 21. Set scope on high sensitivity scale. Readjust scope sensitivity as necessary during tuning for most usable display.

☐ 128. Using a screwdriver which exactly fits the slots in tuning slugs, run both slugs up and down within their coil forms several times to loosen the thread fit and prevent binding and slug breakage. Set tuning slugs on receiver coils L1 and L2 approximately 1/16" down below top of coil form. Do not adjust I.F. cans.

☐ 129. Place transmitter on work bench 2 to 3 feet from receiver, with antenna on, but down. Turn transmitter ON.

☐ 130. Turn receiver ON and observe oscilloscope. Adjust scope for best display. Refer to figure 5 for correct waveform at test point ⑧.

☐ 131. Adjust 1st I.F. can Ⓐ (figure 21) for maximum scope amplitude. Do the same on cans Ⓑ and Ⓒ, then coils Ⓓ and Ⓔ. Amplitude should show some increase or change with each adjustment.

☐ 132. Move transmitter about 10-15 feet away and repeat peaking procedure on I.F. cans and front coils.

☐ 133. If receiver is showing a strong proper signal at this time, remove transmitter antenna completely and place transmitter on floor about 5 feet from receiver. Repeak cans Ⓐ, Ⓑ and Ⓒ, then coils Ⓓ and Ⓔ. It is sometimes possible to get two tuning peaks on cans Ⓐ and Ⓑ. Tune for the peak which gives greatest signal amplitude.

NOTE: If receiver operation is questionable, or if oscillations occur, refer to troubleshooting section.

☐ 134. Reposition transmitter about 20 feet away (antenna off). Very carefully peak can Ⓐ, then Ⓑ, then Ⓒ, followed by coils Ⓓ and Ⓔ. Recheck peaking once more. If receiver output approximates waveforms in figure 4, front end is operating correctly.
☐ 135. Using silicone rubber compound (RTV), apply a tiny dab to the adjusting screws in the I.F. cans only. Too much RTV, while drying, may tend to pull the settings out of adjustment.
☐ 136. Check waveforms at test points (19), (21), (23) and (25) and compare with those in figure 7. If correct, all decoder stages and SCR's are operating correctly. If pictures are missing or incorrect, refer to Troubleshooting section.
☐ 137. Plug operating servo into each channel in turn and check operation with transmitter. Turn equipment OFF.
☐ 138. Install receiver case top and perform final tuning as covered in steps 156 through 160.

RECEIVER TUNING USING A VOLTMETER

☐ 139. Connect voltmeter between ground (-) and test point Ⓖ, figure 21. Set meter to 6V or 10V scale.
☐ 140. Tune receiver in same manner as outlined in steps 128 through 135, except that tuning will be for a maximum reading on voltmeter in all cases. Please note than antenna-off readings will be lower than antenna-on readings. Careful observation of meter is necessary to obtain optimum peak tuning of all coils.
☐ 141. Plug operating servo into first channel on receiver plug. Check operation by moving transmitter control. If not operating, refer to Troubleshooting section.
☐ 142. If servo works in Channel 1, check operation of remaining channels in same manner. Turn equipment OFF.
☐ 143. Install receiver case top and perform final tuning as instructed in steps 156 through 160.

RECEIVER TUNING WITHOUT TEST EQUIPMENT

☐ 144. Place transmitter on work bench about one foot from receiver antenna, with antenna on, but down.
☐ 145. Plug battery into receiver. Connect an operating servo to Channel 1 receiver output.
☐ 146. Set tuning slugs on receiver coils L1 and L2 approximately 1/16" down below top of coil form. Do not adjust I.F. cans.
☐ 147. Turn transmitter and receiver ON. If receiver and decoder are operating, servo should move to approximately neutral position. If not, the trouble in your receiver must be located and corrected before proceeding with tune-up.
☐ 148. Have a second person hold transmitter and move Channel 1 control to operate servo. Move transmitter away from receiver until servo stops operating. Have helper operate Tx at this point.
☐ 149. Tune antenna coil Ⓔ, then RF coil Ⓓ until servo once more follows transmitter control.
☐ 150. Rotate slug on coil Ⓔ to find both adjustment extremes where unit stops operating. Set slug on coil Ⓔ midway between these extremes.
☐ 151. Move transmitter further away and repeat procedure to adjust coil Ⓓ slug.
☐ 152. Move transmitter away until unit fails to respond to control signals. Adjust I.F. can Ⓐ, then can Ⓑ, then Ⓒ until all are tuned to mid-point settings.
☐ 153. Remove transmitter antenna. Move Tx close to receiver antenna until servo operates. Move away slowly until control is lost. At this Tx position, carefully tune I.F. cans Ⓐ, Ⓑ and Ⓒ in turn until operation is regained.
☐ 154. Continue moving transmitter further away and tuning until all I.F. cans are peaked and no more range can be obtained.
☐ 155. Apply a tiny dab of RTV (silicone rubber) to the three I.F. adjusting screws.

FINAL RECEIVER TUNING

☐ 156. Set receiver on a large cardboard box in an open area away from buildings, wires, autos, etc, with antenna hanging vertically.
☐ 157. Plug battery into receiver. Connect servo to Channel 1 receiver output only.
☐ 158. Remove transmitter antenna. Turn transmitter and receiver ON. Have another person hold transmitter near receiver and operate Channel 1 control. Servo should follow control action.
☐ 159. As transmitter operator moves away from receiver, tune both front end coils alternately until maximum range is obtained. Use a small plastic wand for tuning. Do not attempt to adjust I.F. cans.
☐ 160. Once tuned, use a small dab of silicone rubber to lock tuning slugs in position. Apply compound to each side of crystal to prevent possible vibration effects.
☐ 161. Reinstall receiver in case.

RANGE TEST

Refer to system operating instructions for range test procedures. Basically, average antenna-down range should be 400-500 feet with equipment 3 feet above ground level. Antenna-up ground range should be 2000 feet or more. Air range will be 3 to 5 times your ground range.

MAINTENANCE

a. Check electrical plugs occasionally for cleanliness and proper contact. To clean, use electronic tuner cleaner on both male and female contacts.
b. After a period of use and being subjected to vibration, receiver may require retuning. This would be evidenced as a loss of range or "glitches" in flight.
c. After a crash or extremely hard landing, inspect receiver very carefully with an eye loupe. This will help locate loose or broken parts.
d. Check wires periodically for breaks or fraying, especially where connected to board.
e. Do not use silicone rubber or similar material over the remainder of the electronic parts to hold them in place. Mass is so small as to make this unnecessary. Service will not be performed by the factory on equipment so treated.

TROUBLESHOOTING AND REPAIR

GENERAL

Following are a number of tips and techniques describing methods of locating circuit faults, isolating troubles, basic repair procedures, etc. Troubleshooting charts are included as an aid in locating and isolating a defect.

SECTIONAL ANALYSIS

a. For service, consider your receiver section as an oscillator (Q1), a mixer (Q2), two I.F. amplifiers (Q3 and Q4) and a 2nd detector (CR3), all with measurable outputs which can be displayed on an oscilloscope (figures 4 and 5).

b. The decoder is comprised of a pulse amplifier section (Q5, Q6, Q7), a hold-off circuit (Q8 and related components), and four individual sequentially-operated decoder stages (SCR1 thru SCR4). Input and output waveforms of each stage can be checked with a scope and compared with figure 7.

c. Receiver and decoder test points on figures 20 and 21 correspond with those on the schematic diagrams, figures 3 and 6. By using an oscilloscope for signal tracing it is very easy to locate a non-operative circuit.

d. Always use a low level transmitter signal (antenna removed) when checking gain of receiver stages. Keep input signal level as low as possible when taking oscilloscope gain readings.

e. Oscilloscope patterns taken at the input and output of each stage will provide a quick check of stage gain. Normal expected gain for each stage can be determined from the waveform charts.

f. If any given stage has normal input signal level, but output level is zero or substantially below standard, suspect the transistor and/or related circuit components (such as I.F. cans).

g. High gain pulse amplifier stages are used in the decoder to increase overall receiver sensitivity. Receiver gain is intentionally kept low to increase selectivity and stability. Therefore, it is imperative that decoder amplifier stages Q5, Q6 and Q7 provide full design amplification.

h. Major problems in kit-built receivers are parts installed incorrectly or in wrong place, solder shorts on board, and oscillations in receiver section. Cure for the first two problems is obvious. Oscillations are primarily due to excessive gain in the mixer and/or I.F. stages.

i. Oscillations in the I.F. stages and at CR3 will appear as waveforms different from those shown in figures 4 and 5. Typical examples of oscillations which might appear at test point ⑧ are illustrated in figure 22.

j. To reduce receiver gain (if excessive) and eliminate oscillations, it is necessary to decrease gain in the I.F. stages (Q3, Q4) and possibly the mixer (Q2). If oscillations are slight, increasing R4 to 100 ohms may suffice. If not, raise R4 to 150 ohms. If oscillations persist, change R6 to 150 ohms. Changing R2 to 680 ohms will reduce mixer gain, if necessary.

k. Be careful not to reduce receiver gain to a point where range is sacrificed. Ordinarily an oscillating receiver has far more gain than necessary and can be brought to normal sensitivity with changes described above without affecting range.

l. Sometimes a receiver may not exhibit oscillating tendencies when connected to a scope, but will go into oscillation when antenna-off range test is made. This is usually evidenced as low range and "nervous" servos.

m. In the decoder, absence of a signal at any transistor output indicates that transistor is defective (assuming normal input to transistor).

n. SCR's are normally very reliable devices, but occasionally one may become defective or damaged during installation. Replace any SCR which fails to trigger or shows a double-width pulse (especially noticeable under servo load).

o. Remember that the SCR's are triggered in "chain". Should SCR No. 2 go out, Channels 3, 4, 5 and 6 would also fail to operate. Therefore, in event of decoder breakdown, usually the first inoperative SCR is to blame.

p. Remember an oversensitive receiver may also cause glitches by receiving undesired signals. Do

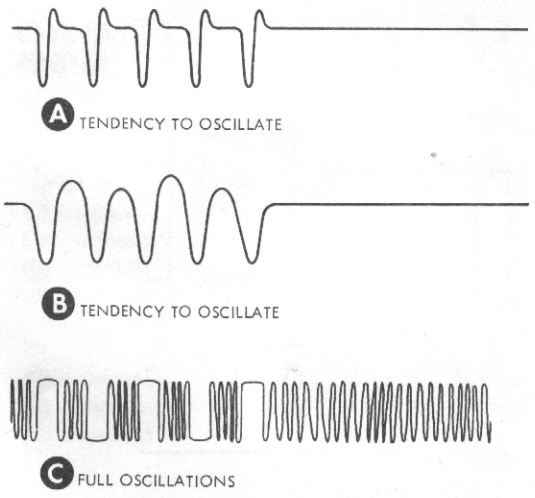


Figure 22. Typical Oscillation Waveforms

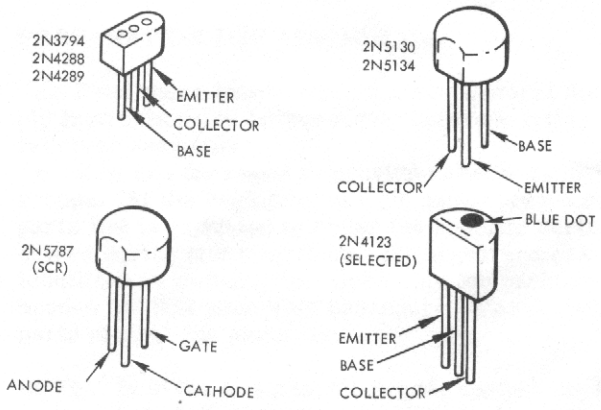


Figure 23. Transmitter Identification

not attempt to obtain too much sensitivity. To decrease sensitivity, increase value of R2 or R4.

q. Even though this is a receiver book, please remember that batteries are our major problem. Always check these first if equipment malfunctions.

CIRCUIT BOARD REPAIR

a. After bent over and soldered in place, parts are difficult to remove without damage to circuit board lands.

b. When a part must be removed, if possible use a solder "sucker" to remove excess solder from joint. Otherwise, heat the joint until solder melts, then "flip" the board to throw solder off.

c. Using diagonal cutters, clip off part leads below board. With application of a small amount of heat, parts should be easily taken out. We recommend use of small size surgical clamps to assist in removing parts.

d. Open holes with soldering iron or small drill (no. 60) before installing new parts.

TROUBLESHOOTING CHARTS

Two charts are provided as a troubleshooting aid; one covers the receiver RF section, the other covers the decoder. For any repair, first verify correct operation of receiver section and make necessary replacements and adjustments before proceeding with decoder repair.

Receiver Troubleshooting Chart

TROUBLE	POSSIBLE CAUSE	REMEDY
No receiver output at CR3	No Rx voltage	Check batteries, wiring, etc.
	Short in P.C. board	Inspect carefully, remove shorts
	Component(s) installed incorrectly	Recheck all parts, replace as required
	Oscillator Q1 or Xtal defective	Check waveform at ①. Replace part(s) if no signal
	Q2, Q3 or Q4 defective	Check input vs output. Replace if no gain
	T1, T2 or T3 open	Replace I.F. can showing no voltage at pin 3
	CR3 defective	Check and replace
Receiver sensitivity low (output at CR3 substandard)	Low voltage (should be 4.8V at rear end, 4.2V at front end)	Short in front or rear end; locate and repair
	Parts incorrectly installed	Check, replace
	Short(s) in P.C. board	Remove short(s)
	Defective crystal	Check, replace if necessary
	Antenna coil does not peak	C1 value too large, replace part
		Defective coil; replace
	RF coil defective	Replace coil
	Defective I.F. can	Locate and replace defective part
	Yellow or white I.F. can tuned to wrong peak	Retune I.F.
	Receiver out of alignment	Retune Rx
	CR3 defective	Check, replace if necessary
Receiver gain excessive (Rx oscillates)	Short in P.C. board	Remove short(s)
	Wrong parts installed in front end	Install correct parts
	Defective crystal	Replace
	Q1 defective	Check waveform, replace if incorrect
	2N5134 gain too high	In turn, increase R4 to 150 ohms, R6 to 150 ohms, then R2 to 680 ohms
	I.F. can defective	Replace T2, then T1, if necessary

Decoder Troubleshooting Chart

TROUBLE	POSSIBLE CAUSE	REMEDY
All decoder outputs inoperative	Q5, Q6, Q7 or Q8 defective	Check input, output waveforms, replace bad part
	SCR No. 1 defective	Check and replace
	Short in P.C. board	Inspect, remove short
	Wrong parts installed (possibly transistor backwards)	Check and replace
	Bad solder connection	Resolder
Decoder works, but overall receiver range low	Q5, Q6 or Q7 weak	Check for proper stage gain
	Wrong parts installed	Install correct parts
Some decoder outputs inoperative	Defective SCR (kills all following stages)	Locate and replace
	One diode (CR5 thru CR10) defective or incorrectly installed	Check carefully, replace part
	SCR double-pulsing	Replace SCR

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ORDERING INFORMATION

On all receiver parts orders under $10.00, include .50 for cost of shipping and handling. Minimum order $1.00 (+50). No C.O.D.'s.

REPAIR SERVICE

In event of trouble send unit direct to the factory, NOT to the dealer. Repairs are not priced for dealer discounts. Equipment will be serviced and returned within a few days. Be sure and include detailed information on the problem. After repair is completed, you will be notified regarding cost and shipping.

KITS ARE WARRANTED ONLY FOR COMPLETENESS OF PARTS. NO PARTS EXCHANGE WILL BE MADE AFTER THE PART HAS BEEN INSTALLED OR SOLDERED ON.

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