CANNON ELECTRONICS

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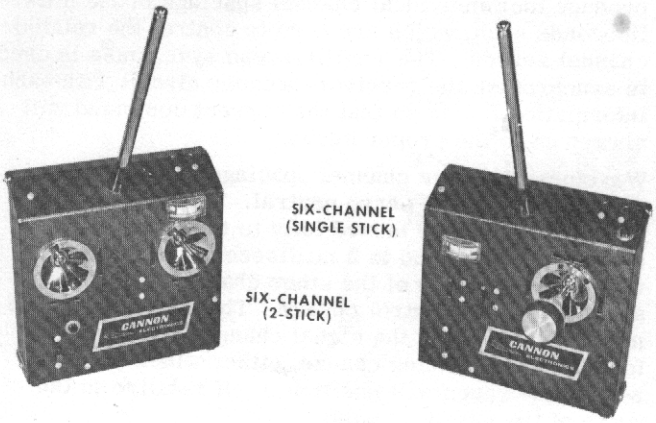
Assembly and Maintenance Instructions for the MODEL S540-T SUPER-FLITE Transmitter



DESCRIPTION

The Super-Flite Digital Transmitter is housed in a durable vinyl-clad aluminum case with operating controls on the front or top. Charging connections are accessible on the bottom of the case; a charge indicator lamp is visible through a red jewel on the case front. A 54" collapsible antenna screws into a plastic retainer on top of the transmitter case. An external meter indicates both RF output and battery condition.

Kraft-Hayes control sticks are standard in both 2-axis and 3-axis (single stick) models. Trims are provided for all channels except auxiliary (on 5 and 6-channel models). On the two-stick models Mode I or Mode II operation is obtained by selected installation of centering springs and adjustment of friction clutch.

The 4-channel transmitter employs a total of 13 transistors; 6-channel models have 15. All parts, except charging resistor, are mounted on two glass epoxy boards: the Logic (encoder) board and the RF board. The RF assembly is furnished completely built and pretuned; the encoder must be aligned after assembly. Alignment instructions are included herein.

A 9.6 volt nickel-cadmium rechargeable battery supplies transmitter power. A built-in charging circuit, with indicator lamp, permits charging of both transmitter and receiver batteries simultaneously. Charging current is obtained from the 120 volt AC line. Charging cords are supplied with the complete system, not with individual units.

MODELS COVERED

These instructions cover construction of 4, 5 and 6-channel transmitters with 2-axis sticks, as well as equivalent single stick models. Units are available as full kits, half-kits and in factory assembled form.

All assembly instructions contained herein pertain to the full kit and the builder must perform each step. The half-kit contains assembled and soldered printed circuit boards, so assembly steps 1 through 115 can be omitted. All other information, except assembly procedures, is applicable to assembled transmitters.

FREQUENCIES AVAILABLE

Tx Frequency (MHz)	Tx Crystal (MHz)	Flag (Color)
26.995	26.995	Brown
27.045	27.045	Red
27.095	27.095	Orange
27.145	27.145	Yellow
27.195	27.195	Green
53.1	53.1	Black - Brown
53.2	53.2	Black - Red
53.3	53.3	Black - Orange
53.4	53.4	Black - Yellow
53.5	53.5	Black - Green
72.080	36.040	White - Brown
72.240	36.120	White - Red
72.400	36.200	White - Orange
72.960	36.480	White - Yellow
75.640	37.820	White - Green

NOTE

A class "C" operators license from the FCC (Federal Communications Commission) is required before this transmitter can be operated on the 27 and 72 MHz bands. A technician class (or higher) Amateur License is required to operate on the 53 MHz band. License application forms can be obtained from your local FCC office.

SPECIFICATIONS

Operating Voltage	9.6 volts
Batteries	8 series-connected 500 mah 1.2 volt nickel-cadmium cells
Power Input	1000 milliwatts (27 or 53 MHz) 450 milliwatts (72 MHz)
Power Output	750 milliwatts (27 or 53 MHz) 350 milliwatts (72 MHz)
Total Current Consumption	80 milliamps
Pulse Train Duration	(4 channel) 13 ms nominal (6 channel) 16 ms nominal
Frame Rate	(4 channel) 75 cps (6 channel) 60 cps
Pulse Width	Variable 1 to 2 milliseconds (1.5 milliseconds neutral)
Frame Type	Variable
Off Time Pulse	300 microseconds
Frequency Tolerance	.005%
Operating Temperature Range	0° to +140°F
Dimensions	2 inches deep, 7 inches wide, 7 inches high
Antenna	54 inch collapsible whip
Total Weight (with antenna and battery)	2-1/8 pounds

BUDDY BOX PROVISIONS

A push button switch on the transmitter permits flight trainer operation of any two Super-Flite systems (or modified Econo-Flite transmitters). An external cable plugs between the receiver charging plugs of two transmitters so that one operates as an instructor unit and the other as a student control box.

SYSTEM THEORY (Figure 2)

A continuous train of pulses is generated in the Super-Flite transmitter encoder and is used to pulse-modulate the RF carrier. Waveform A shows one complete pulse frame, which is transmitted approximately 75 times per second. Note that the five pulses produce four individual channel spacings of 1.5 milliseconds each, which are used to control the related channel servos. The 7 millisecond sync pause is used to synchronize the receiver-decoder circuit with each information frame so that the correct command will always go to the proper servo.

Waveform A shows channel spacings of 1.5 milliseconds, equivalent to servo neutral. When Channel 1 (aileron) control is moved fully to the right, pulse spacing is increased to 2 milliseconds as shown in waveform B. None of the other channel spacings are affected by this control change. The Channel 1 servo moves full right as the signal changes. Therefore, for any pulse spacing change, either wider or narrower, the servo will position itself relative to the width of the resultant pulse.

The modulated RF carrier waveform is shown at C. Carrier pulse spacing is controlled directly by spacing between the modulating pulses.

With a "variable frame rate" encoder, total length of each frame varies with control changes, but length of the sync pause is not affected. A comparison of waveforms A and B shows this effect. Consequently, this system permits a higher frame rate with increased servo speed and resolution.

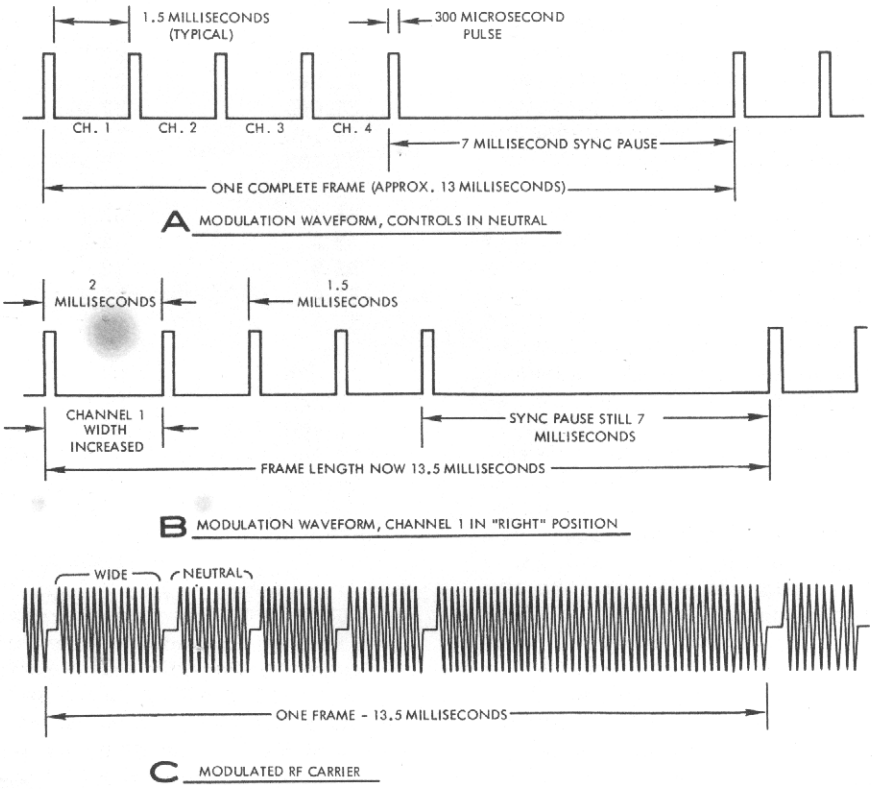


Figure 2. Modulation and Carrier Waveforms (4-Channel)

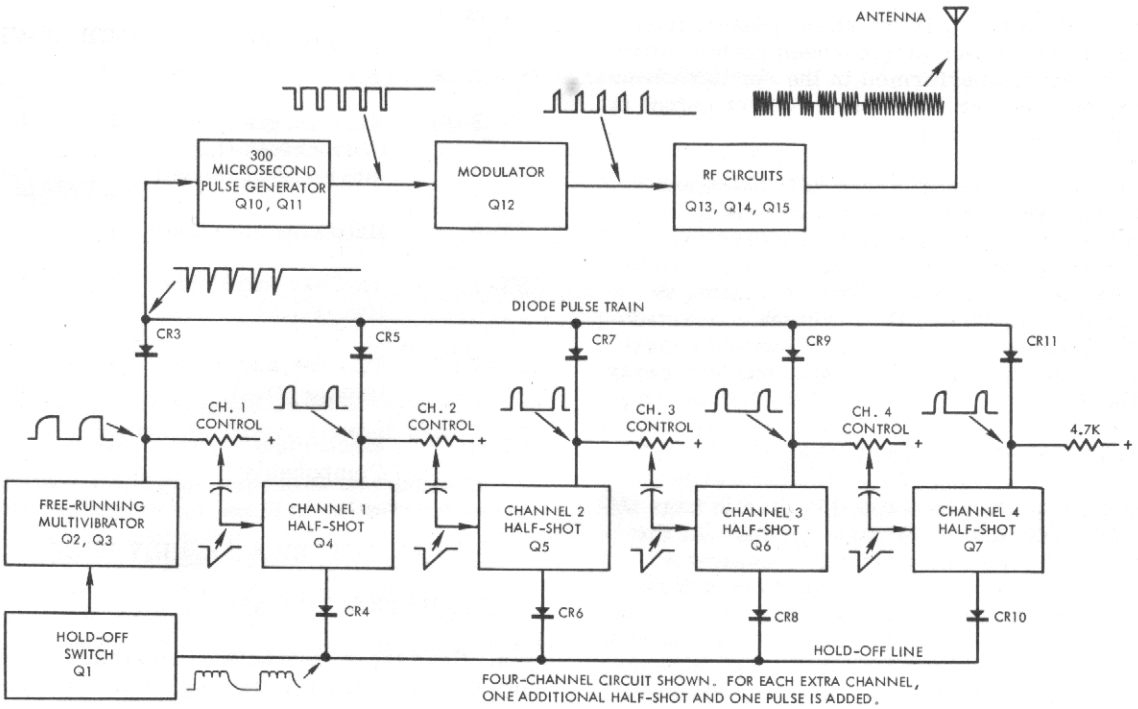


Figure 3. Transmitter Block Diagram (4-Channel)

The pulse-modulated RF signal from the transmitter is picked up by the receiver and demodulated to obtain the pulse spacing information generated in the transmitter logic section. In the Rx decoder these pulses are segregated by channel, and fed to the individual channel servos.

In each servo the pulse width 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.

TRANSMITTER THEORY (Figure 3)

A free-running multivibrator (Q2, Q3) produces a consecutive series of pulses which establish the frame rate in the transmitter at 75 cycles per second. The resulting starting pulse is passed through diode CR3 and becomes the first pulse in the diode pulse train. The same pulse passes through Channel 1 control pot and is used to trigger Channel 1 Half-Shot Q4, which is basically a monostable timing circuit.

Output of Q4 is a positive square wave whose width is variable from 1 to 2 milliseconds by means of Channel 1 control pot settings. Neutral position is 1.5 milliseconds. This pulse is fed through diode CR5 to form the second pulse in the diode pulse train, and provides pulse spacing equivalent to the pulse width of Q4 output.

Through Channel 2 control pot, the output of Q4 triggers Half-Shot Q5 and provides the third pulse in the pulse train. Channels 3 and 4 operate in a similar manner to complete the five pulses required for the four-channel pulse train. Note that the spacing between each of these pulses is exactly the same as that of each related channel waveform.

Monostable Multivibrator Q10, Q11 is a timing circuit with time constants selected to provide a 300 microsecond square wave output pulse for each trigger pulse from the incoming diode pulse train.

Modulator Q12 acts as a switch connected in the emitter circuit of oscillator transistor Q13 (27 and 53 MHz) or the frequency doubler transistor Q14 (72 MHz) of the RF section. Negative pulses from pulse generator Q10, Q11 turn modulator Q12 OFF, which in turn shuts off the transmitter RF output for the 300 microsecond period of each pulse. The resultant RF envelope follows exactly the pulse modulation waveform, with OFF periods corresponding in time and duration with the 300 microsecond pulses.

A portion of each channel output is fed through diodes CR4, CR6, CR8 and CR10 to the base circuit of switch Q1. These positive pulses hold Q1 in OFF condition until the last channel output in the chain is completed. Q1 then turns ON, permitting multivibrator Q2, Q3 to trigger the half-shots for the next frame. Sync pause is thus held to a minimum, providing a higher frame rate per second.

An oscillator and two parallel power output transistors are used in the 27 and 53 MHz RF sections. Control pulses are used to modulate crystal-controlled oscillator Q13. Dual power transistors provide approximately 750 milliwatts of power output. The meter circuit indicates RF power output as well as battery condition.

The 72 MHz RF section utilizes an oscillator, frequency doubler stage, and single-ended power output stage. Modulation is performed in the emitter circuit of the frequency doubler transistor. Power output is approximately 350 milliwatts.

A half-wave diode charging circuit for the nickel-cadmium batteries utilizes a No. 40 bulb as a charging indicator and to absorb voltage surges. A 1000 ohm dropping resistor insures correct charging current (50 milliamperes). Charging is performed with both Tx and Rx batteries connected in series. Transmitter and receiver switches must be OFF when charging if the external charge receptacle is utilized.

TRANSMITTER PARTS PACKAGING

Kit and Half-Kit parts are shipped in plastic bags to permit rapid identification of parts groups. At the beginning of each phase of transmitter 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 system model.

Package No.	Contents	4-CH	5-CH	6-CH
ST-1 (Full Kit)	Logic Board & Components (4-ch)	1	1	1
or				
ST-1A (Half-Kit)	Assembled Logic Board	1	1	1
ST-2	Extra Channel Logic Parts (omitted from Half-Kits)	0	1	2
ST-3	Logic Board Wiring	1	1	1
ST-3A	Extra Channel Wiring and Mechanics	0 (2 stick)	1	2
		1 (single stick)	2	3
ST-4	Assembled RF Section	1	1	1
ST-5 (RH)	Kraft Std RH Stick Components (for two-stick model)	1	1	1
ST-5 (LH)	Kraft Std LH Stick Components (for two-stick model)	1	1	1
	or			
ST-5 (S)	Kraft Single Stick Components (for single-stick model)	1	1	1
ST-6	Batteries and Case	1	1	1
ST-7	Tx Case and Parts (two-stick)	1	1	1
ST-7 (S)	Tx Case and Parts (single stick)	1	1	1
ST-8	Mechanical Components	1	1	1

TRANSMITTER ASSEMBLY PROCEDURES

PREPARATION FOR ASSEMBLY

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

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 and chisel tips for soldering iron
6. Damp cellulose sponge for cleaning soldering iron
7. Rosin-core solder, 60-40 type, .062" diameter (supplied in kit)
8. Small screwdriver, 1/8" flat metal blade
9. Small Phillips screwdriver
10. Allen wrenches, 3/64" and 1/16" (for single stick)
11. Fine tooth metal files, assorted sizes
12. Small, stiff bristle brush
13. Lacquer thinner
14. X-acto knife
15. Eye loupe, 2-1/2" to 3" focal length

Logic Board Electronics

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

QTY	ITEM	PRICE (ea)
1	P.C. board	$ 4.50
7	.001 UF disc capacitor	.20
7	.005 UF disc capacitor	.20
1	.015 UF mylar capacitor	.35
1	.01 UF disc capacitor	.20
4	.02 UF disc capacitor	.20
4	.056 UF mylar capacitor	.35
1	.1 UF disc capacitor	.30
2	.1 UF mylar capacitor	.40
1	50 UF electrolytic capacitor	.55
1 ea	1/4 watt resistors, values 3.9K, 6.8K and 27K ohms, ±10%	.15
2 ea	1/4 watt resistors, values 4.7K, 10K, 68K, 100K ohms, ±10%	.15
8	1/4 watt resistors, 47K ±10%	.15
2	47K (or 50K) trim potentiometer	.50
2	100K trim potentiometer	.50
11	FDN601 silicon diode	.50
1	TS-2 charging diode	1.00
1	2N4123 transistor	1.25
1	2N4916 transistor	1.00
8	2N5134 transistor	1.00
1	Solder, .062 diameter, 36" lg	.10 ft

LOGIC BOARD ASSEMBLY

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

b. Open package(s) ST-1 and ST-2 containing P.C. board and electronic components.

c. Check parts against the parts lists and figures 4 thru 9 for parts identification. If this is a Half-Kit, proceed directly to step 116.

d. Position printed circuit board S540T, metal side down, so that hole arrangement corresponds with layout in figure 4. Proceed with assembly steps in figure 4, then continue with steps in figures 5 thru 9. Omit steps 1 thru 115 on Half-Kits.

Extra Channel Logic Parts

Package No. ST-2 Parts List (5 and 6-Channel Models)

1	.001 UF disc capacitor	.20
1	.005 UF disc capacitor	.20
1	.02 UF disc capacitor	.20
1	.056 UF mylar capacitor	.35
2 ea	1/4 watt resistors, value 47K ±10%	.15
1	100K trim potentiometer	.50
2	FDN601 silicon diode	.50
1	2N5134 transistor	1.00

1	P.C. logic board assembly, 4-channel, with all parts assembled and soldered in place	$17.00
1	P.C. logic board assembly, 5-channel, with all parts assembled and soldered in place	$19.00
1	P.C. logic board assembly, 6-channel, with all parts assembled and soldered in place	$21.00

These P.C. assemblies are supplied as Package ST-1A in Half-Kits in place of above separate components.

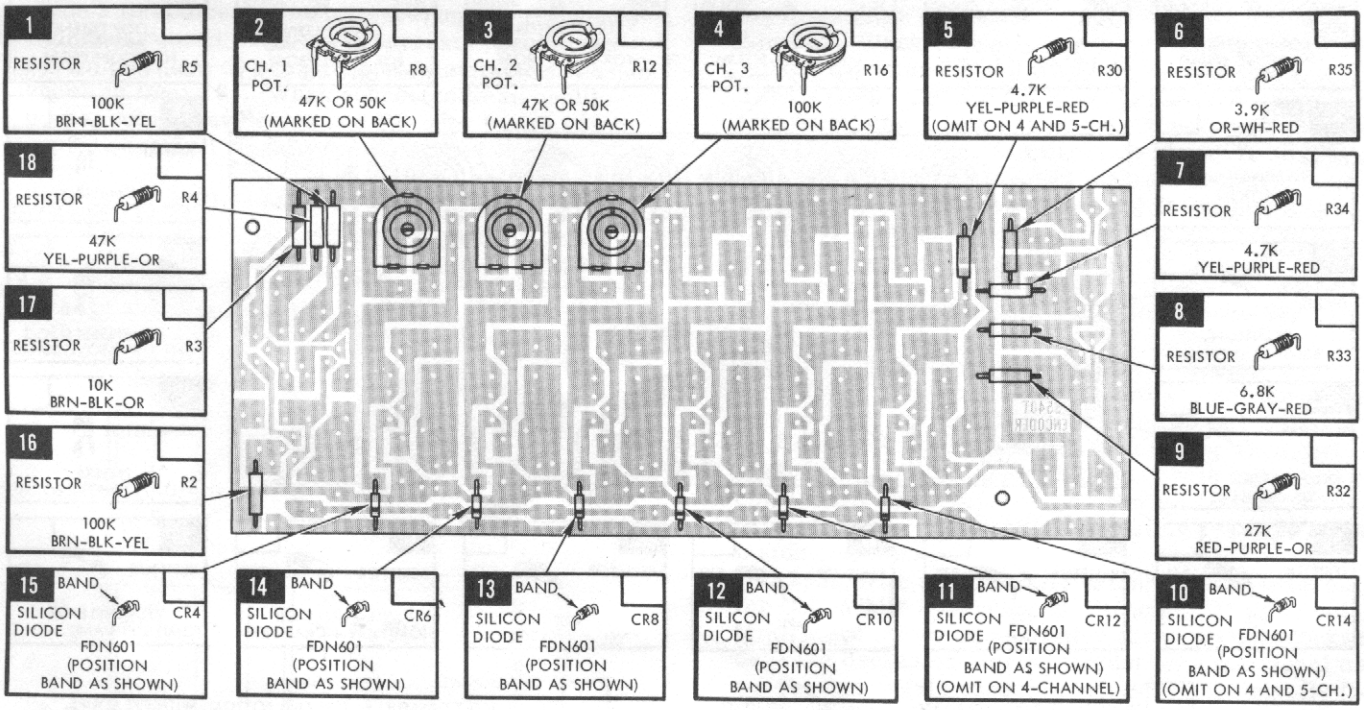


Figure 4. Logic Board Assembly (Sheet 1 of 6)

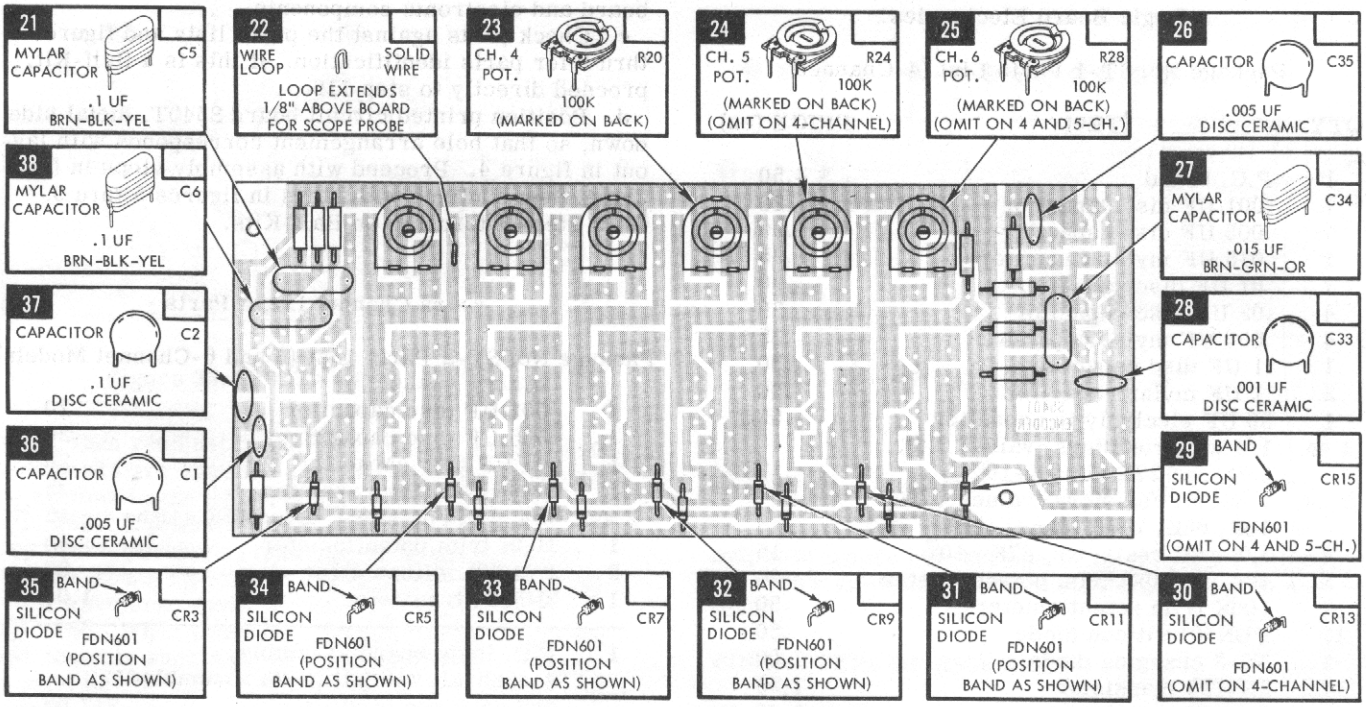


Figure 5. Logic Board Assembly (Sheet 2 of 6)

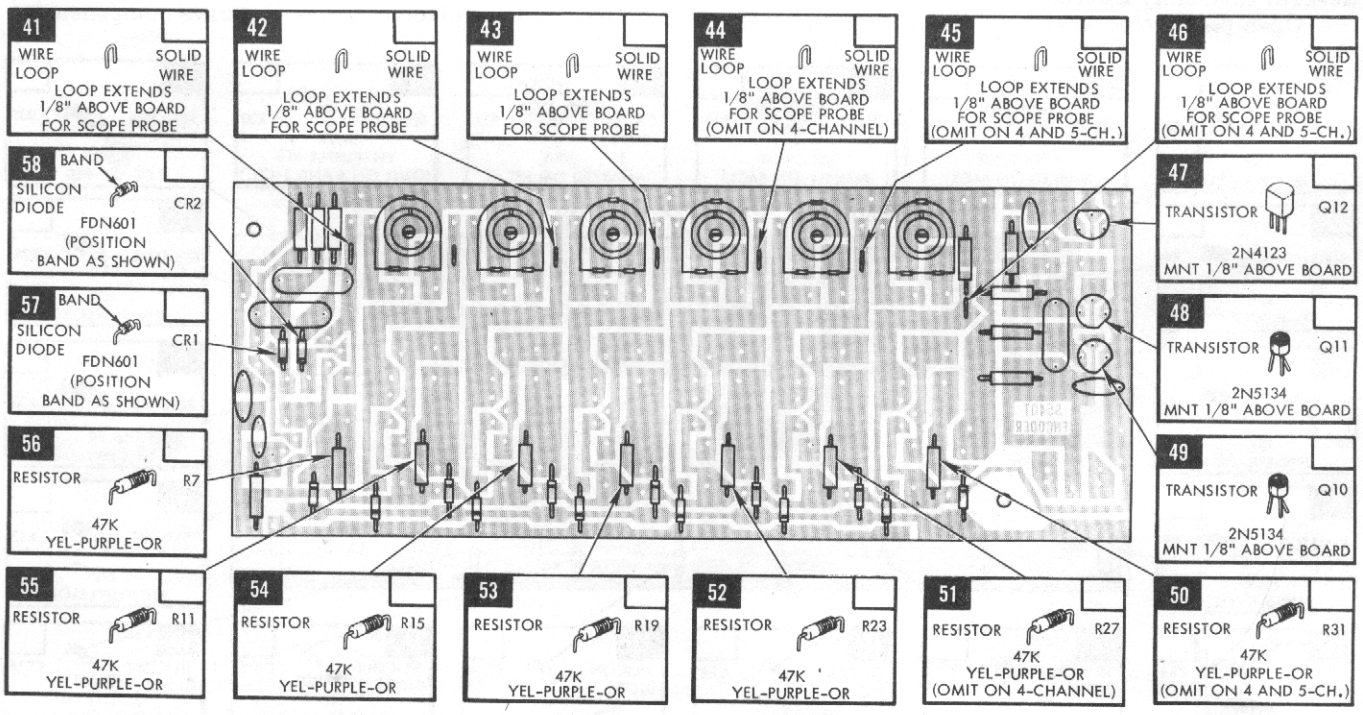


Figure 6. Logic Board Assembly (Sheet 3 of 6)

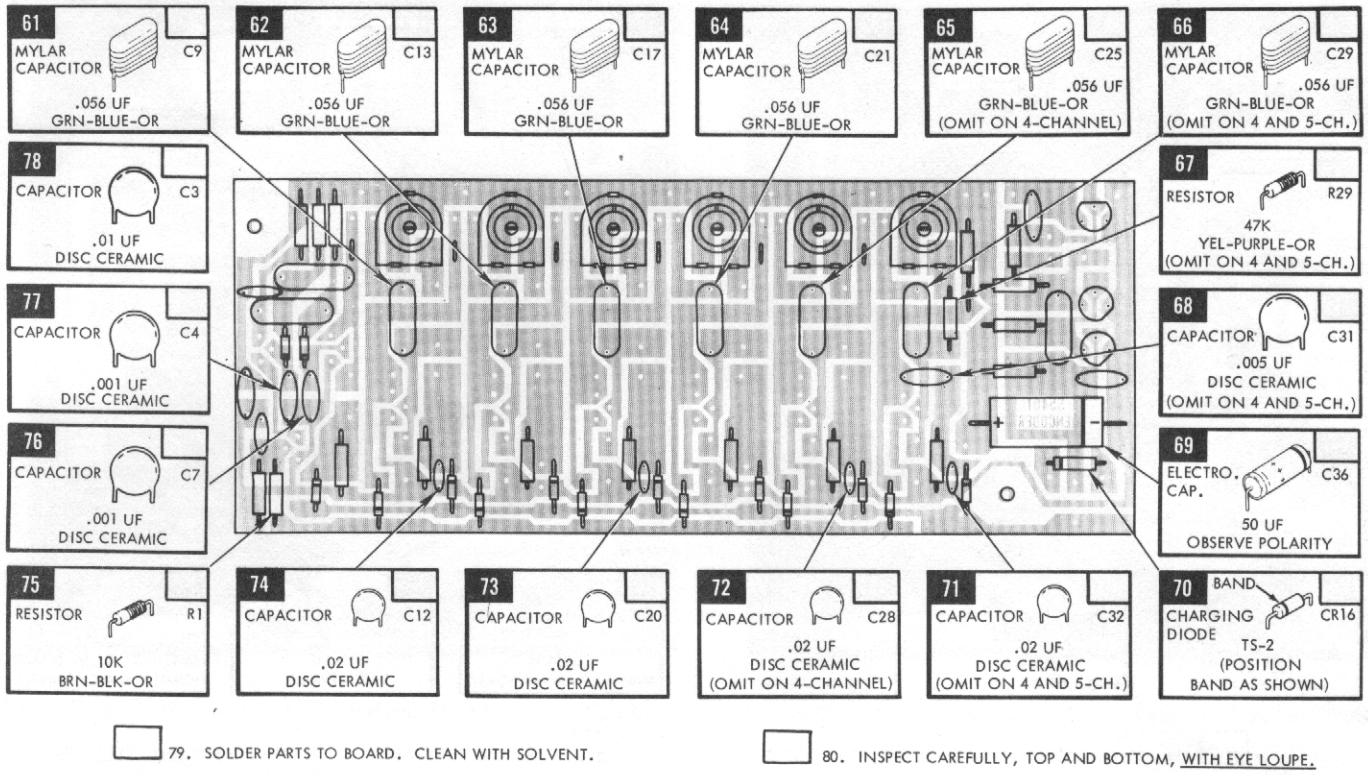


Figure 7. Logic Board Assembly (Sheet 4 of 6)

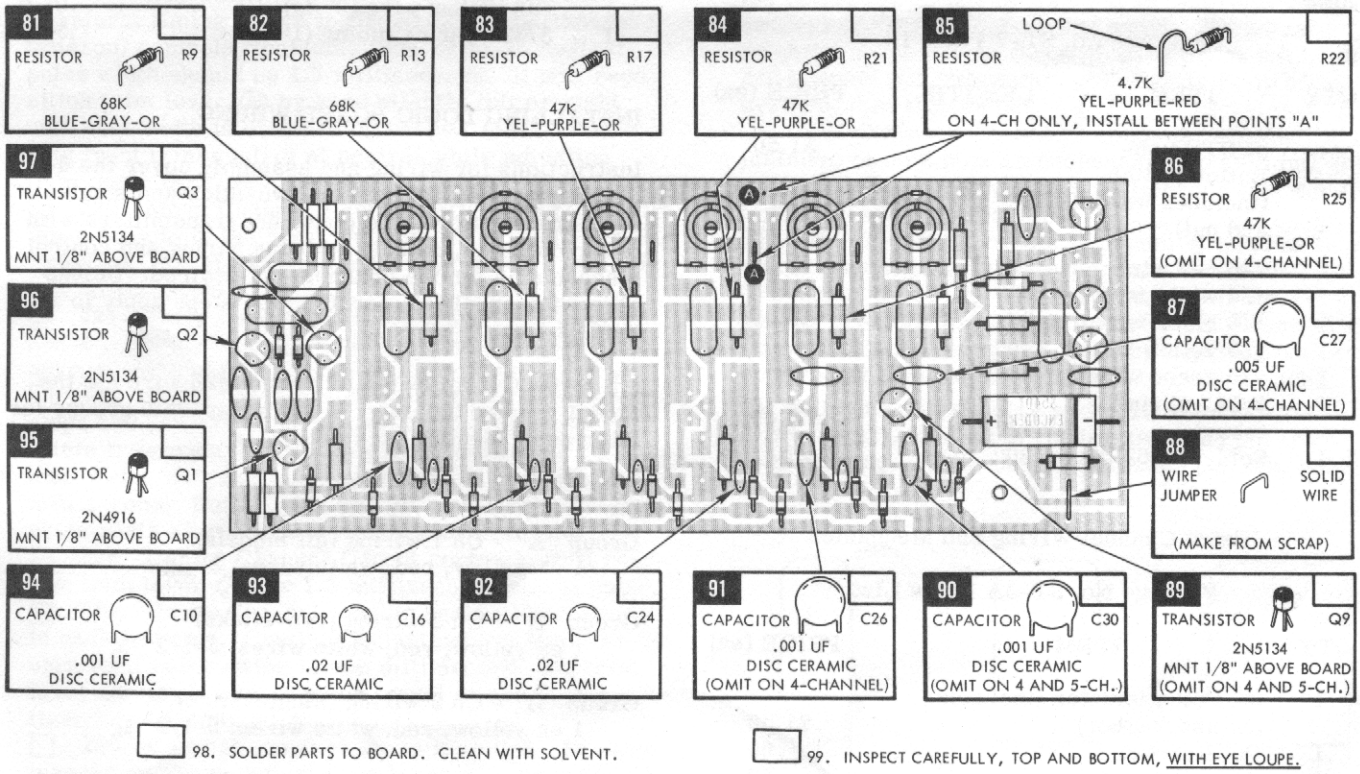


Figure 8. Logic Board Assembly (Sheet 5 of 6)

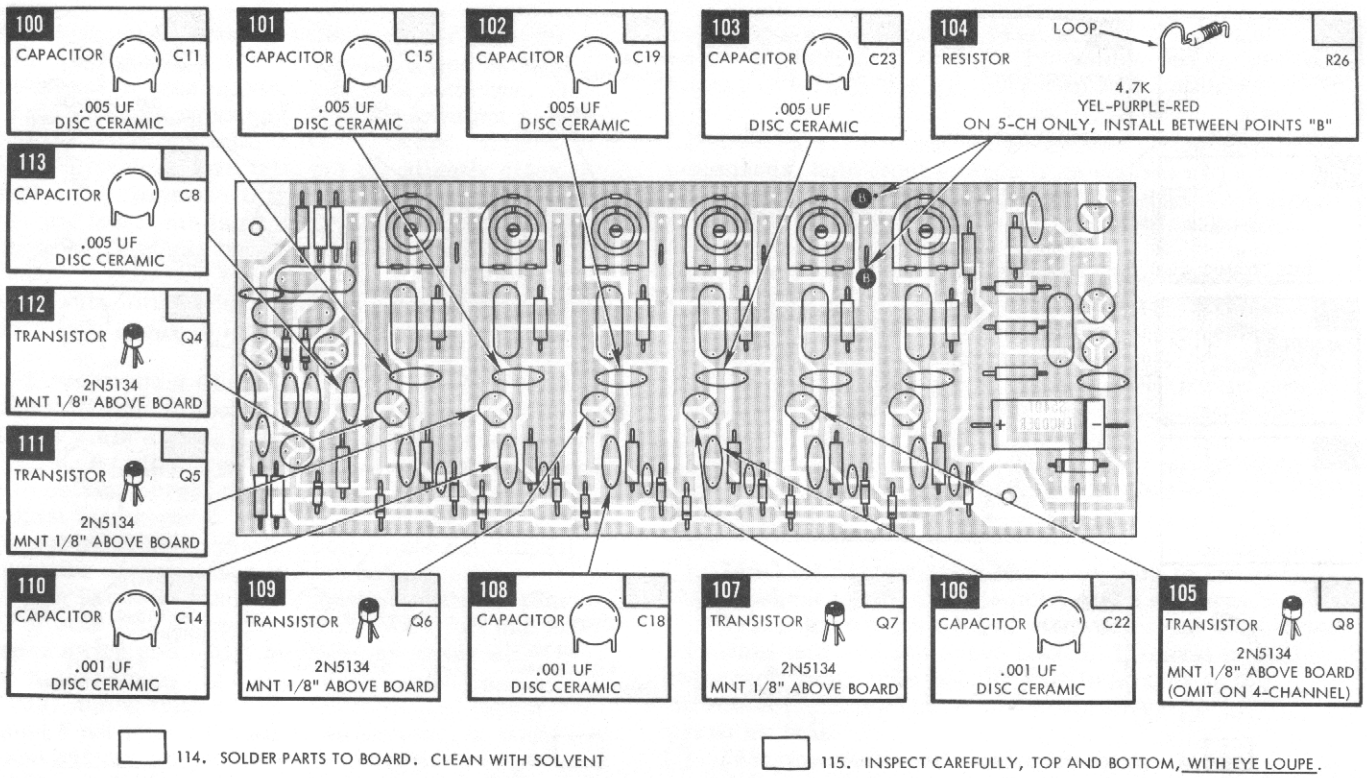


Figure 9. Logic Board Assembly (Sheet 6 of 6)

Logic Board Wiring

Package No. ST-3 Parts List

QTY	ITEM	LENGTH	PRICE (ea)
1	SPDT Push-Button Switch (includes washer and nut)		$1.50
1	#26 red wire	38"	.05 ft
1	#26 white wire	32"	
1	#26 black wire	24"	
1	#26 yellow wire	40"	
1	#26 green wire	4"	
1	3/32" shrink tubing	12"	.50 ft
1	Solder, .062 dia	30"	.10 ft

Extra Channel Wiring and Mechanics

Package No. ST-3A Parts List

QTY	ITEM	PRICE (ea)
1	5K Potentiometer (includes nut and washer)	$1.50
1	Pot Bracket	.60
1	Control Lever	.50
1	1/4" Rubber Grommet	.05
2	No. 4 x 1/4" S.M. screws	.05
1	#26 red wire (8" lg)	.05 ft
1	#26 white wire (8" lg)	.05 ft
1	#26 yellow wire (8" lg)	.05 ft
1	3/32" shrink tubing (1" lg)	.50 ft

INSTALLING LOGIC BOARD WIRING

Instructions for wiring and assembly cover the 6-channel versions of both the two-stick and single-stick transmitters. To construct transmitters with fewer channels, merely omit the wiring and control mechanisms for the channels not desired. Unless otherwise specified, construction steps apply to all models.

☐ 116. Cut following lengths of #26 wire for the model you are building. Keep in separate groups for later use. Identify each group.

Group "A" - Ch 1 wiring (all models)
1 ea yellow, red, white wires; 3" lg

Group "B" - Ch 2 wiring (two-sticks)
1 ea yellow, red, white wires; 5-1/2" lg

Group "B" - Ch 2 wiring (single-stick)
1 ea yellow, red, white wires; 6-1/2" lg

Group "C" - Ch 3 wiring (two-stick)
1 ea yellow, red, white wires; 5-1/2" lg

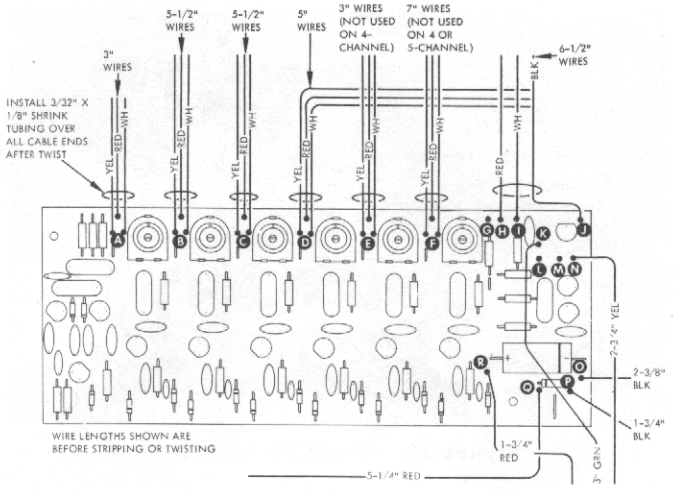


Figure 10. Logic Board Wiring (Two-Stick)

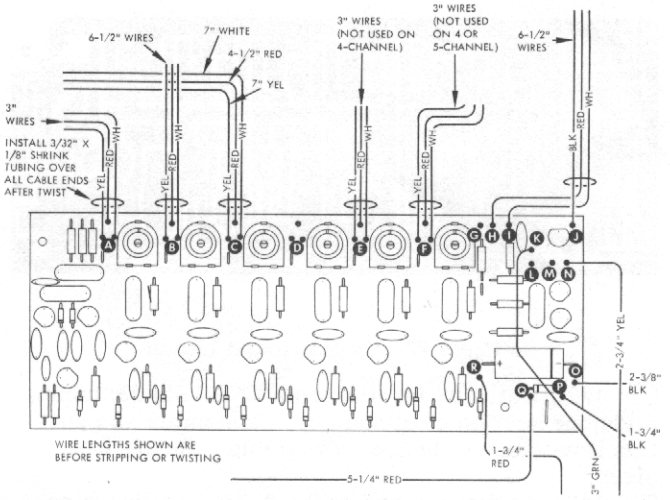


Figure 11. Logic Board Wiring (Single-Stick)

Group "C" - Ch 3 wiring (single-stick)
1 ea yellow and white wires; 7" lg
1 red wire; 4-1/2" lg
1 red wire; 3" lg

Group "D" - Ch 4 wiring (two-stick)
1 ea yellow, red, white wires; 5" lg

Group "D" - Ch 4 wiring (single-stick)
1 yellow wire; 8" lg

Group "E" - Ch 5 wiring (all models)
1 ea yellow, red, white wires; 3" lg

Group "F" - Ch 6 wiring (two-stick)
1 ea yellow, red, white wires; 7" lg

Group "F" - Ch 6 wiring (single-stick)
1 ea yellow, red, white wires; 3" lg

Group "H", "I", "J" - RF wiring (all models)
1 ea red, white, black wires; 6-1/2" lg

Buddy Box Switch Wires (two-stick)

1 ea red and yellow wires; 3" lg
1 white wire; 5" lg

Buddy Box Switch Wires (single-stick)

1 ea red and yellow wires; 10" lg
1 white wire; 12" lg

Meter Wires (two-stick)

1	black wire	3-1/2" lg
1	yellow wire	3" lg

Meter Wires (single-stick)

1	black wire	3-3/4" lg
1	yellow wire	4-3/4" lg

Miscellaneous Wires (all models)

Ⓚ	1	green wire	3" lg
Ⓝ	1	yellow wire	2-3/4" lg
Ⓞ	1	black wire	2-3/8" lg
Ⓟ	1	black wire	1-3/4" lg
Ⓠ	1	red wire	5-1/4" lg
Ⓡ	1	red wire	1-3/4" lg
Ⓤ	1	black wire	1-3/4" lg
Ⓥ	1	black wire	3" lg

☐ 117. Using wire strippers, remove 1/8" insulation from both ends of each wire above, except remove 1/2" from one end of 2-3/8" black wire Ⓞ.

☐ 118. Twist strands of exposed wire ends tightly, then tin both ends of all wires cut. Use as little solder as possible to avoid solder lumps on wires.

☐ 119. Insert one end of yellow, red and white wires from Group "A" into proper holes on logic board at position Ⓐ, and solder in place. (See figures 10 and 11.)

☐ 120. Solder Group "B" yellow, red and white wires into position Ⓑ holes.

☐ 121. Solder proper length Group "C" wires into position Ⓒ holes. (See figures 10 and 11 for positive wire length identification.)

☐ 122. On 2-stick model only, solder Group "D" wires into holes at position Ⓓ. (Wires from single stick rudder pot will be connected here later.)

☐ 123. On 5 and 6-channel models, solder proper length Group "E" wires into position Ⓔ holes (figures 10 and 11).

☐ 124. On six-channel models, solder correct length Group "F" wires into position Ⓕ holes (figures 10 and 11).

☐ 125. Solder 6-1/2" red, white and black wires to board at positions Ⓗ, Ⓘ and Ⓙ.

☐ 126. Twist the three wires of each of these wire groups tightly together to form a neat wire cable.

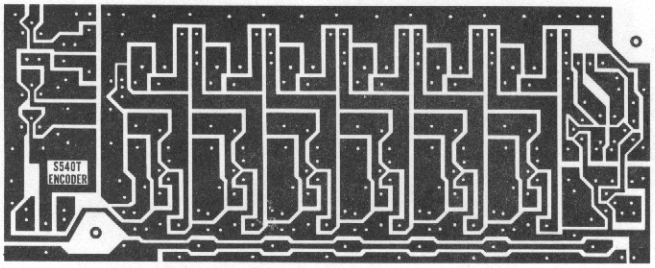


Figure 12. Logic Board Lands

☐ 127. Cut 1/8" lengths from 3/32" shrink tubing. Slide one section of tubing over each cable and position it as close to board as possible. Shrink into place.

☐ 128. Solder one end of the 2-3/4" yellow wire into hole at position Ⓝ on logic board.

☐ 129. Likewise, solder the 1/8" stripped end of the 2-3/8" black wire at position Ⓞ, the 1-3/4" black wire at position Ⓟ, the 5-1/4" red wire at position Ⓠ, and the 1-3/4" red wire at position Ⓡ on board.

☐ 130. Clip protruding leads from bottom of board then use lacquer thinner to remove solder rosin. Inspect carefully, under magnification, for possible shorts between board lands. Compare with figure 12. Put logic board aside until final installation.

☐ 131. Solder yellow and black meter wires to RF board assembly (Package No. ST-4) at position Ⓦ. Clip excess leads below board. See figures 13, 24 and 25 for correct connections and wire lengths. Twist these wires, then shrink a 1/8" length of 3/32" shrink tubing over wires as close to board as possible.

☐ 132. Clean and inspect bottom of RF board, then put aside until later.

RF Section

Package No. ST-4 Parts List

QTY	ITEM	PRICE (ea)
1	Assembled RF Section	
	27 MHz	$14.00
	53 or 72 MHz	16.00
1	Type Acceptance Label (72 MHz only)	1.00

☐ 133. Solder proper lengths of white, yellow and red wires to terminals on buddy box push-button switch. Refer to figure 14 for wire lengths and details of cable fabrication.

☐ 134. Slide a 1/2" section of 3/32" shrink tubing over each switch wire. Position tubing to cover terminals, then shrink into place.

☐ 135. Twist the three wires together to form a neat wire cable.

☐ 136. Slide a piece of 3/32" x 1/8" shrink tubing over cable and position as close to switch as possible. Shrink into place.

☐ 137. Install a second piece of 3/32" x 1/8" shrink tubing over cable, positioned 1/2" from end of wire insulation (see figure 14). Shrink into place. Put switch cable aside until final installation.

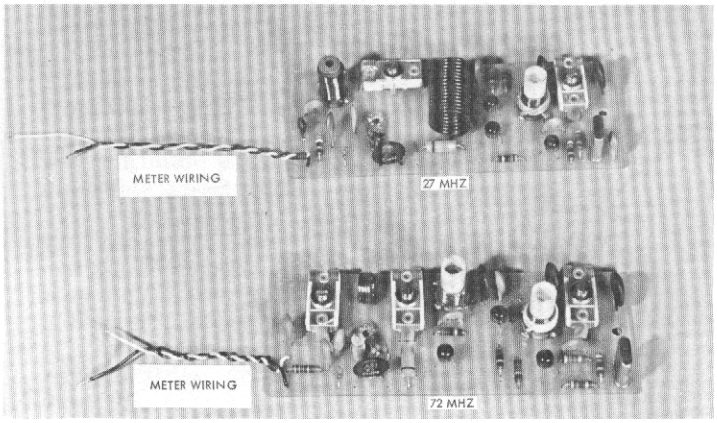


Figure 13. Wired RF Boards

KRAFT CONTROL STICKS

Two-stick transmitters employ two slightly different stick assemblies, one right-hand, the other left-hand. These are supplied in Package Nos. ST-5 (RH) and ST-5 (LH), one each being required. Package No. ST-5 (S) contains the single stick components. Check contents of each bag against Parts List before proceeding with transmitter assembly.

Stick Assemblies

Package No. ST-5 (RH or LH) Parts List

QTY	ITEM	PRICE (ea)
1	Stand. two-axis stick (RH or LH)	$18.95
1	Centering Spring (with RH stick only)	.35
1	Chrome Face Plate	1.00
4	2-56 x 5/16" fl hd mach screws	.10

Package No. ST-5(S) Parts List

1	Single-Stick Assembly	per set	39.95
1	Rudder Knob Assembly		
1	Chrome Face Plate		1.00
4	2-56 x 5/16" fl hd mach screws		.10

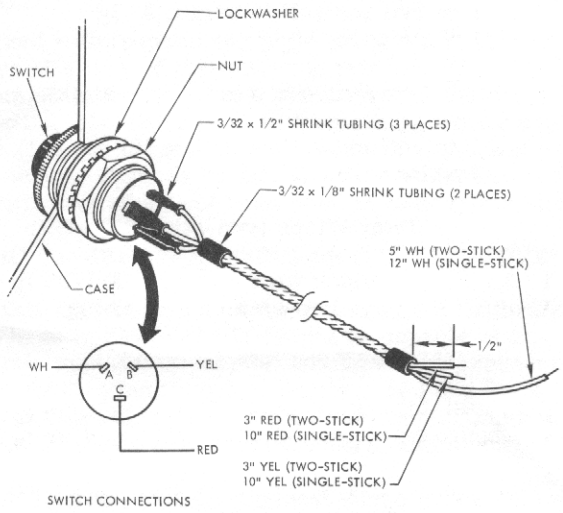


Figure 14. Buddy Box Switch Wiring

BATTERY ASSEMBLY

Battery Components

Package No. ST-6 Parts List

QTY	ITEM	PRICE (ea)
1	Battery case	$ 2.00
8	500 ma nicad cells	2.50 (per cell)
		5.00 (per pair)
		10.00 (per four)
2	4-40 x 1-1/8" mach screws	.10
2	No. 4-40 hex nuts	.05
1	No. 26 red teflon wire, 5" lg	.10 ft
1	No. 26 black teflon wire, 12" lg	.10 ft

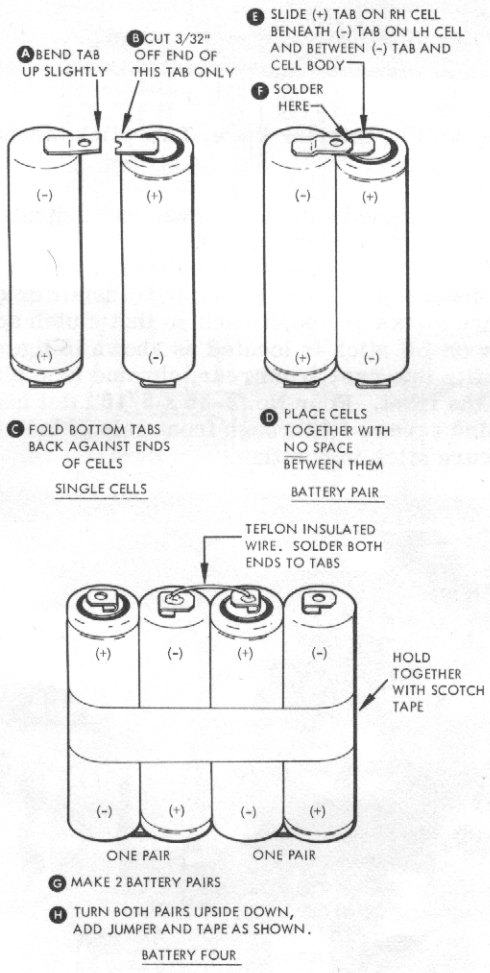


Figure 15. Making Battery Four-Cell Pack

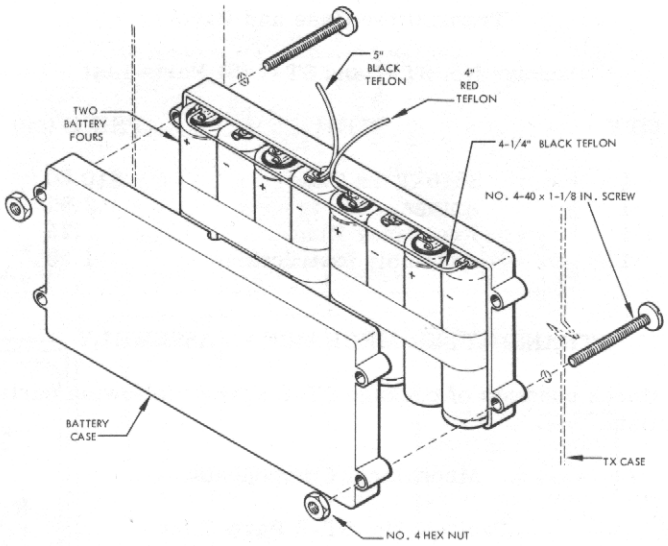


Figure 16. Assembling Transmitter Battery Pack

☐ 138. Nickel-cadmium batteries supplied with your kit may consist either of single cells, a welded pair of cells, or a welded pack of four cells. Two packs of four cells each are required for transmitter power. Figure 15 shows construction of four-cell packs starting with single cells. Using batteries supplied, fabricate two 4-cell packs as shown. If your kit contains welded four-packs, no fabrication will be necessary.

☐ 139. Cut one piece #26 black teflon wire 5" long, another piece 4-1/4" long.

☐ 140. Cut one piece #26 red teflon wire 4" long.

☐ 141. Using wire strippers, remove 1/8" insulation from both ends of 4-1/4" black wire, and from only one end of each of the other two wires. Twist and tin exposed wire ends.

☐ 142. Position two battery four-packs, with polarities as shown in figure 16, in front half of battery case.

☐ 143. Solder 4-1/4" black teflon wire to plus (+) and minus (-) tabs on batteries on extreme outer ends.

☐ 144. Solder 4" red teflon wire to + terminal tab of center cell. Solder 5" black wire to negative tab on adjacent cell.

☐ 145. Dress wires so that the two single-ended wires fit through hole in battery case, and long jumper wire tucks away along inside of case.

☐ 146. Install case cover, place battery assembly inside transmitter case front, and attach battery assembly with two 4-40 x 1-1/8" machine screws through case front. Tighten hex nuts securely.

Transmitter Case and Parts

Package No. ST-7 and ST-7 (S) Parts List

QTY	ITEM	PRICE (ea)
1	S540-T Tx Case	$10.00
1	Antenna, 54" lg	2.95
1	Frequency Flag	.25
1	Assembly Instructions	1.50

TRANSMITTER MECHANICAL ASSEMBLY

Check contents of package ST-8 against following parts lists.

Mechanical Components

Package No. ST-8 Parts List

QTY	ITEM	PRICE (ea)
1	Antenna fitting (2 parts)	$1.25
1	AC socket	.35
1	Rx socket, 6 pins	.80
1	1000 ohm, 10W resistor	.35
1	Meter (1 ma) and mtg. clip	3.50
1	Lamp socket, screw type	.35
1	#40 lamp	.25
1	Red indicator lens	.25
1	DPST switch	.50
1	Switch lock	.25
8	Rubber mounting feet	.10
1	Cannon label	.25
4	No. 4 x 1/4" S.M. screws	.05
7	4-40 x 5/16" screws	.05
1	4-40 x 1/2" screw	.05
1	4-40 x 1-1/8" screw	.05
6	#4 internal tooth lockwasher	.05
9	No. 4-40 hex nut	.05
1	Brass spacer, 1/8 x 1/4" lg	.10
1	Plastic tie, 5" lg	.15

☐ 147. Install the 8 rubber feet in 1/4" holes in bottom and back of transmitter case.

☐ 148. Check fit of meter into meter slot in transmitter case front. If necessary, file slot for correct fit.

☐ 149. Install meter, with spring clip on back side as shown in figure 19. Press serrated flanges down with a screwdriver until meter is locked in.

☐ 150. Very carefully bend solder tabs on meter parallel with meter face. (See figure 18.)

☐ 151. Position ON-OFF switch in Tx case, solder lugs up. Secure with two No. 4-40 x 5/16" machine screws through front of case. Note that upper screw also holds switch lock in place. (Figure 20)

☐ 152. Screw No. 40 lamp securely into charging lamp socket. (Figure 21) Secure bulb to socket with a dab of fingernail polish or RTV.

☐ 153. Using pliers, bend charging socket bracket at such an angle that, when socket is correctly positioned over mounting hole in Tx base, end of lamp aligns perfectly with viewing hole in front of case.

☐ 154. Attach socket to case with No. 4-40 x 5/16" screw, lockwasher and hex nut. Make certain bulb is correctly aligned with hole. Snap red indicator lens into front side of viewing hole.

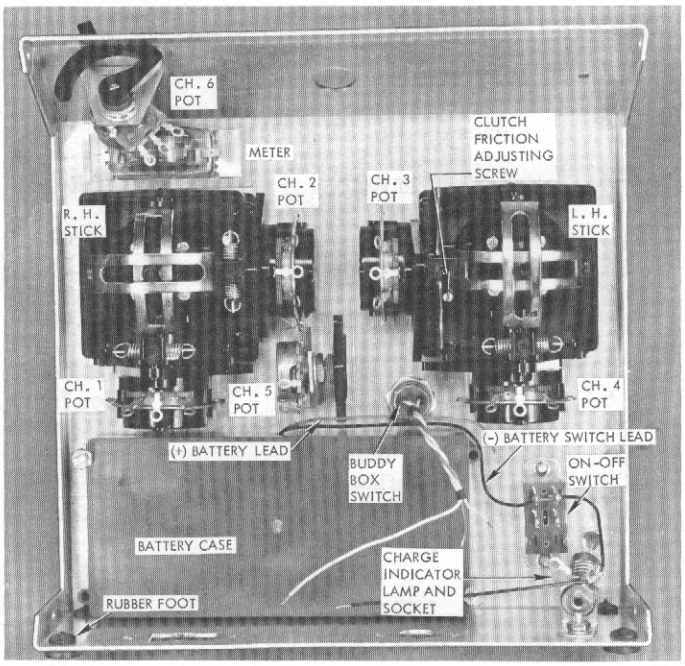


Figure 17. Interior View, Two-Stick Mechanics

☐ 155. On two-stick transmitters, install one each right-hand and left-hand stick in transmitter case. Be sure sticks are positioned so that clutch adjusting screw on LH stick is located as shown in figure 17. Stick fits into case from rear, chrome face plate from the front. Four No. 2-56 x 5/16" flat head machine screws fit through front side of face plate to secure stick in position.

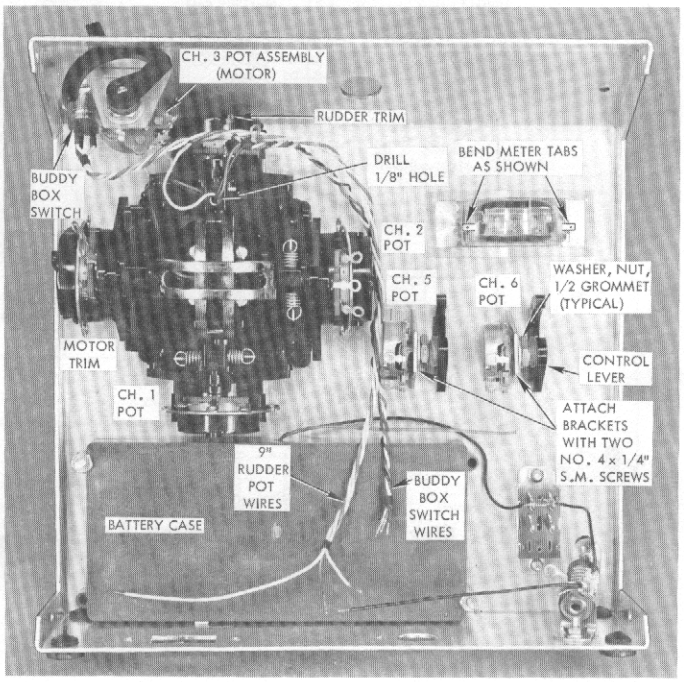


Figure 18. Interior View, Single-Stick Mechanics

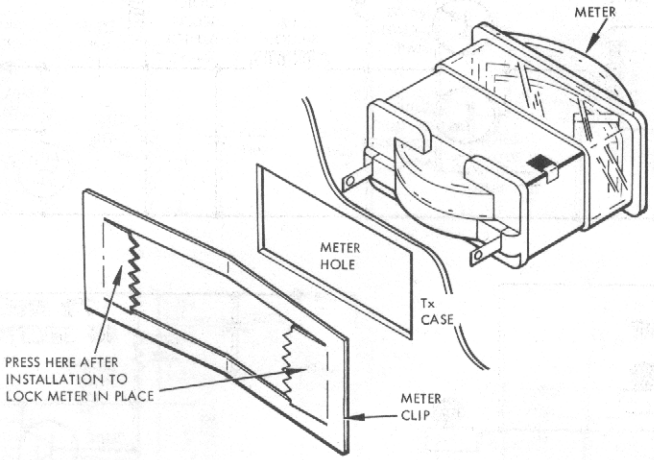


Figure 19. Meter Installation

☐ 156. On single-stick model, install stick assembly in same manner. Be sure centering springs on stick are located in positions shown (figure 18).
☐ 157. Before tightening face plate screws fully, be sure sticks are correctly aligned so that trim levers work freely in lever slots.
☐ 158. On two-stick model, decide whether Mode I or Mode II operation is desired. In Mode I, motor and aileron are on RH stick, and elevator and rudder on LH stick. Mode II (most popular) has aileron and elevator on RH stick, with motor and rudder on LH.
☐ 159. For Mode II, install centering spring on rear side of RH stick so that stick centers in both axes. Be sure clutch screw is not placing drag on vertical movement of stick.
☐ 160. Tighten clutch adjusting screw on LH stick (figure 17) until motor control stick has desired amount of friction in the vertical plane.

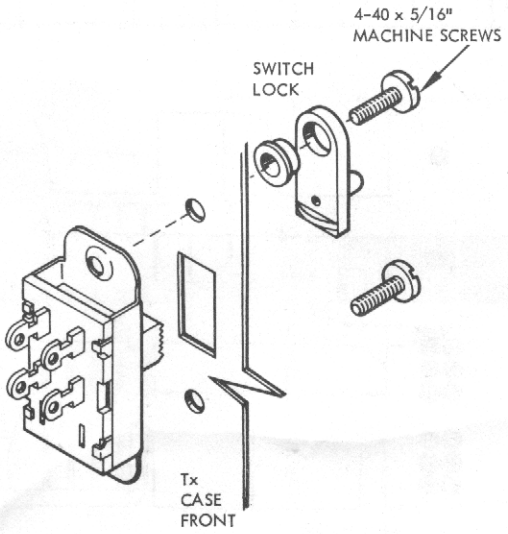


Figure 20. Switch Installation

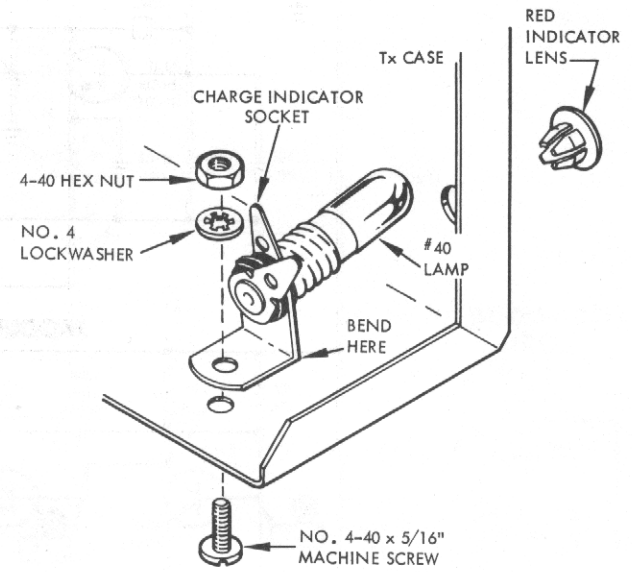


Figure 21. Charge Indicator Lamp Installation

☐ 161. For Mode I operation, install centering spring on LH stick, and tighten clutch screw on RH stick.
☐ 162. On single-stick models, next step is to install the rudder knob assembly on the stick shaft. To do this, first loosen set screw "A" with a 1/16" Allen wrench, then separate cone housing from rudder knob assembly. (See figure 22.)
☐ 163. Feed the three rudder wires through rear opening in cone housing, and slide housing down over stick shaft until end of shaft comes flush with end of internal bevel in housing. Tighten set screw "B", making sure centering pin is UP (towards top of case).
☐ 164. Rotate rudder control pot until it is positioned relative to rudder knob as shown in figure 22.
☐ 165. Strip 1/8" insulation from ends of all three wires protruding from cone housing. Tin wire ends.

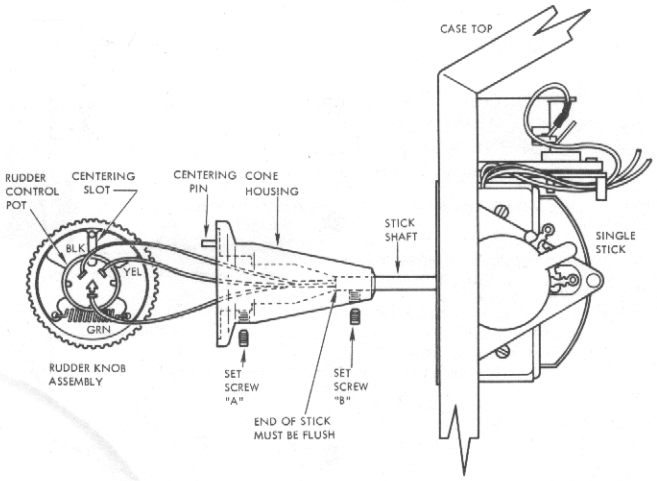


Figure 22. Installing Rudder Knob Mechanism

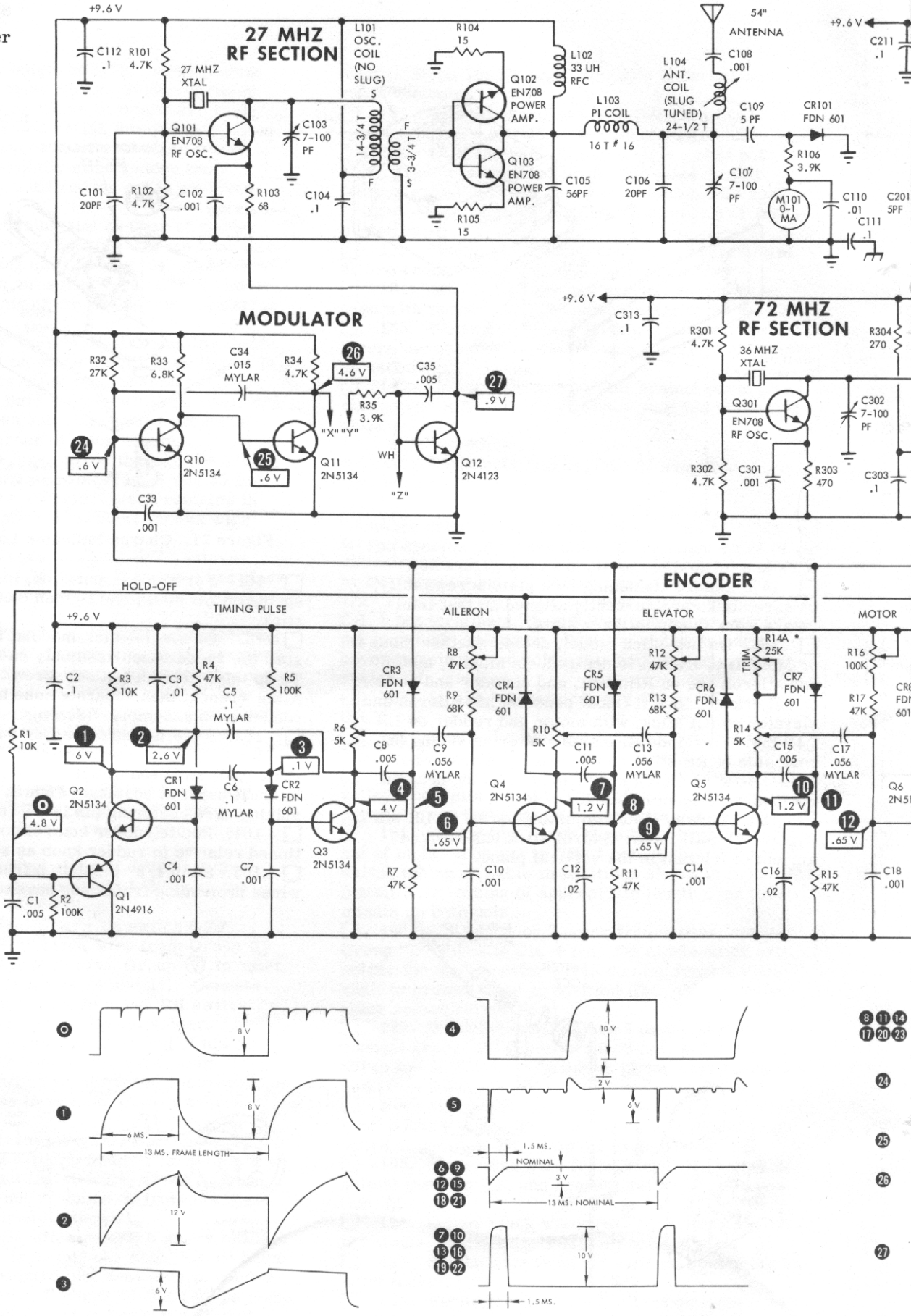
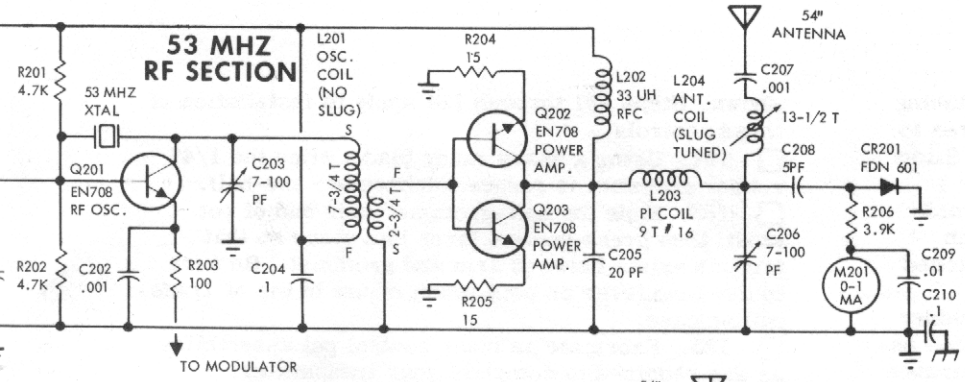
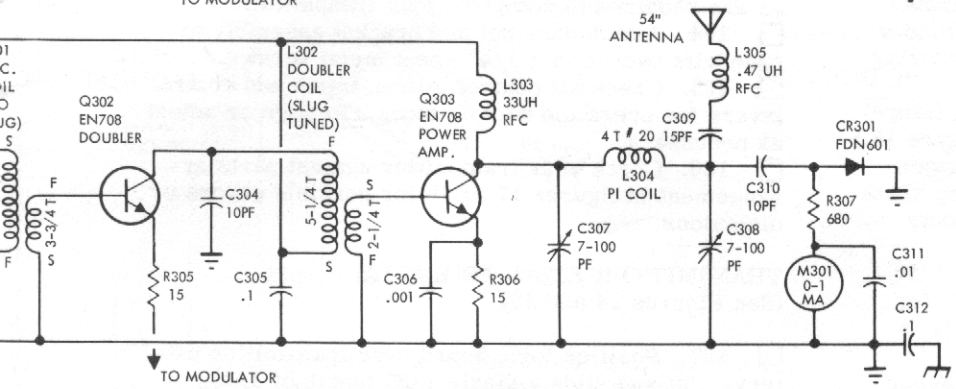
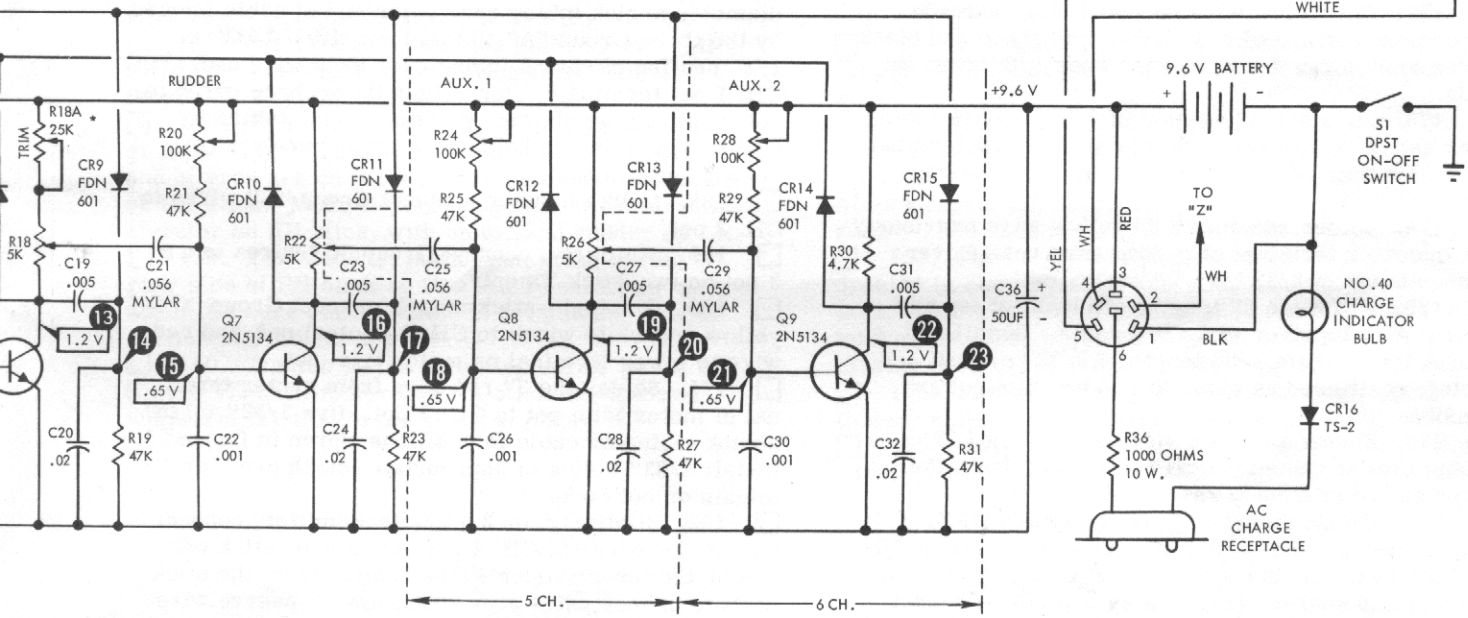


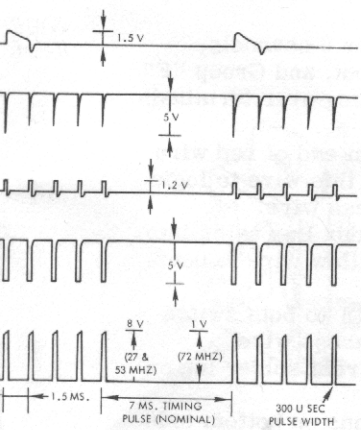
Figure 23. Transmi





BUDDY BOX CIRCUIT





FOUR-CHANNEL LOGIC SHOWN. ADD ONE PULSE WIDTH FOR EACH CHANNEL ADDED.

NOTES

1. ALL MEASUREMENTS IN RESPECT TO NEGATIVE (-).
2. DC VOLTAGES SHOWN IN BOXES.
3. VOLTAGE READINGS TAKEN WITH 20K OHMS-PER-VOLT MULTIMETER.
4. VOLTAGES MAY VARY ±20%.
5. VOLTAGES AND WAVEFORMS TAKEN WITH ALL CONTROLS IN NEUTRAL, AND FULL BATTERY CHARGE.
6. WAVEFORMS TAKEN WITH TEKTRONIX 503 OSCILLOSCOPE WITH CALIBRATED AMPLITUDE AND TIME BASE.
7. CAPACITOR VALUES IN MICROFARADS UNLESS NOTED.
8. DOTTED LINES INDICATE PARTS USED IN VARIOUS MODELS.
9. PARTS WITH ASTERISK (*) USED ONLY WITH SINGLE STICK (3-AXIS) MODEL.
10. WAVEFORMS TAKEN WITH ANTENNA REMOVED.
11. FOUR-CHANNEL LOGIC SHOWN. FRAME LENGTH WILL BE 1.5 MILLISECONDS LONGER FOR EACH EXTRA CHANNEL.

ter Schematic Diagram

☐ 166. Slip a 1/4" length of 3/32" shrink tubing over ends of each of these wires. Solder wires to rudder pot terminals as shown in figure 22. Slide tubing over terminals and shrink into place.
☐ 167. While pulling on the three wires from back side of stick, carefully slide rudder knob towards cone housing until rudder pot is enclosed in housing.
☐ 168. Engage centering slot on rear of rudder knob with centering pin on housing. Press knob assembly against housing until about 1/64" clearance remains, then tighten set screw "A". Check rudder knob for freedom of operation and correct centering action.
☐ 169. Drill a 1/8" hole in small mounting flange near rudder trim pot on single stick. (See figure 18.)
☐ 170. Move single-stick control knob to upper right hand position. Hold it there while pulling slack from the yellow, green and black wires extending through upper left corner of stick housing.
☐ 171. Feed these three wires through the 1/8" hole drilled in step 169. See figures 18 and 25 for wire routing. Be sure sufficient slack remains in wires to permit full stick movement without wire strain.
☐ 172. Cut yellow wire so that 1-1/2" extends beyond top surface of 1/8" hole. Cut green and black wires to 8" long. Strip all wire ends 1/8", then tin ends.
☐ 173. Slide a 1/2" section of 3/32" shrink tubing over end of yellow wire. Solder wire to LH terminal of rudder trim pot. Shrink the tubing over wire and terminal.
☐ 174. Solder one end of 8" yellow wire previously cut to center terminal of rudder trim pot. Cover connection with 3/32" x 1/2" shrink tubing.
☐ 175. Twist the 8" lengths of black, green and yellow wire together to form a cable. Install and shrink into place a 1/8" length of 3/32" shrink tubing, positioned as close to rudder trim pot as possible.
☐ 176. Shrink a second piece of 3/32" x 1/8" tubing around cable approximately 1/2" from the outer end to prevent unravelling.
☐ 177. On all models: Turn Tx switch OFF. Solder one end of 1-3/4" black wire from Group Ⓤ and one end of 3" black wire from Group Ⓥ to outer lug on lamp socket. (Figures 24 and 25) Connect other end of short black wire to upper RH switch terminal (viewed from rear). Do not solder.
☐ 178. Strip 1/2" insulation from end of black teflon wire from battery box. Tin wire, slide it through both upper switch terminals at position Ⓢ, then solder both wires to switch. Cut off excess wire.
☐ 179. From the front side, insert push button switch harness wires through Buddy Box switch hole in case (figures 17 and 18). Secure switch to case with lockwasher and nut threaded on from the rear (figure 14). Route wires as shown.
☐ 180. On the single-stick model, a motor channel control pot assembly is required. Also, for all 5 and 6-channel models, a control pot assembly is needed for each extra channel. (Figures 17 and 18) To make these, assemble small 5K pot to bracket with lockwasher and nut. (Figures 24 and 25) Be sure pot is mounted to bracket in the same relative position shown. Steps 181 through 184 apply to installation of these controls.
☐ 181. Using a sharp razor blade, slice the 1/4" rubber grommet to reduce thickness to one-half.
☐ 182. Slide the half-grommet over end of pot shaft, then press control lever into place so that friction exists between arm and grommet. Be sure to use long lever on pots which mount in top of transmitter case.
☐ 183. Fabricate as many control pot assemblies as are required to complete your transmitter.
☐ 184. Attach each pot and bracket assembly to case with two No. 4 x 1/4" sheet metal screws.
☐ 185. Check all control sticks, trims and control levers for operation without binds. Realign or adjust as necessary.
☐ 186. Check your transmitter against parts arrangement in figures 17 or 18 for possible errors or omissions.

TRANSMITTER FINAL ASSEMBLY
(See Figures 24 and 25)

☐ 187. Position logic board over transmitter battery. Cut and slide a single 1/8" length of 3/32" diameter shrink tubing over outer end of cable formed by the three Group "A" wires, then slip a 3/32" x 1/2" section of shrink tubing over each wire end. Tin CH. 1 pot terminals, then solder these three wires to pot terminals as shown. Position shrink tubing to cover terminals and hold cable end securely, then shrink into position.
☐ 188. In like manner, connect Group "B" wires to CH. 2 pot.
☐ 189. Similarly, connect Group "C" wires to CH. 3 pot on two-stick Tx only.
☐ 190. On single-stick model, connect Group "C" yellow and white wires to CH. 3 (motor) pot, and red wire to lower terminal on motor trim pot.
☐ 191. Solder the 3" red wire from center terminal of motor trim pot to CH. 3 pot. Use 3/32" x 1/8" shrink tubing on cable in positions shown in figure 25. Install 3/32" tubing of appropriate length over terminals on both pots.
☐ 192. Similarly, on 2-stick transmitter, connect Group "D" wires to CH. 4 pot. On single-stick unit, solder the three rudder wires coming from the stick shaft to proper holes at position Ⓓ. Observe wire color coding carefully.
☐ 193. When transmitter has 5 or 6 channels, connect group "E" wires to CH. 5 pot, and Group "F" wires to CH. 6 pot. Use shrink tubing over terminals and cable ends.
☐ 194. Strip 1/8" insulation from end of red wire from battery pack. Tin and solder this wire to logic board at position Ⓖ. Clip off excess wire.
☐ 195. Solder red wire from Buddy Box cable into hole at position Ⓛ, and connect yellow wire to position Ⓜ.
☐ 196. Solder black wire from Ⓞ to both switch terminals, position Ⓣ. Clip off excess wire.
☐ 197. Solder wire from Ⓟ to front solder lug on lamp socket.
☐ 198. Recheck solder connections on bottom side of logic board, then position board over mounting screws on rear of battery box. Secure with two No. 4 lockwashers and hex nuts.

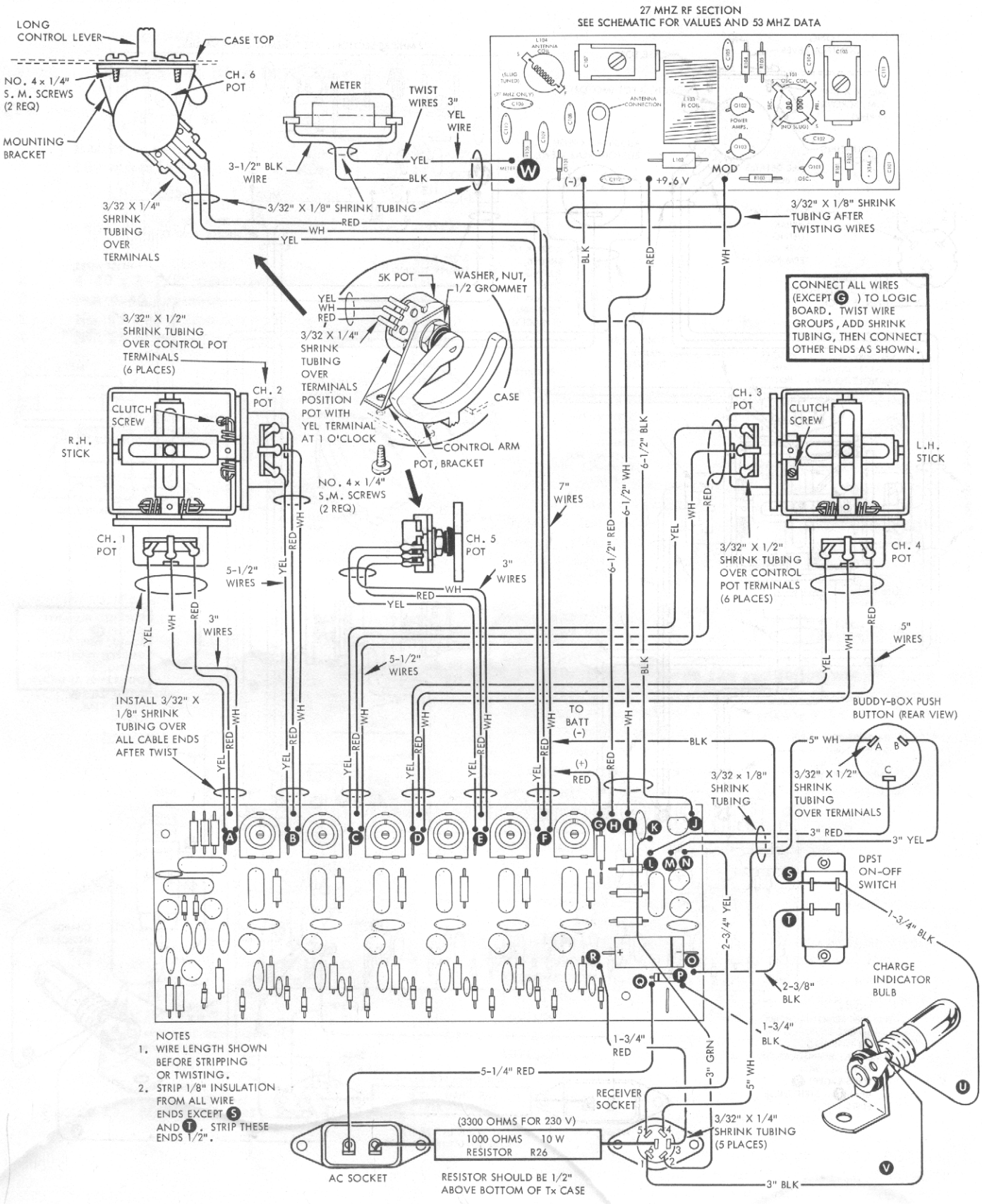


Figure 24. Transmitter Wiring (Two-Stick)

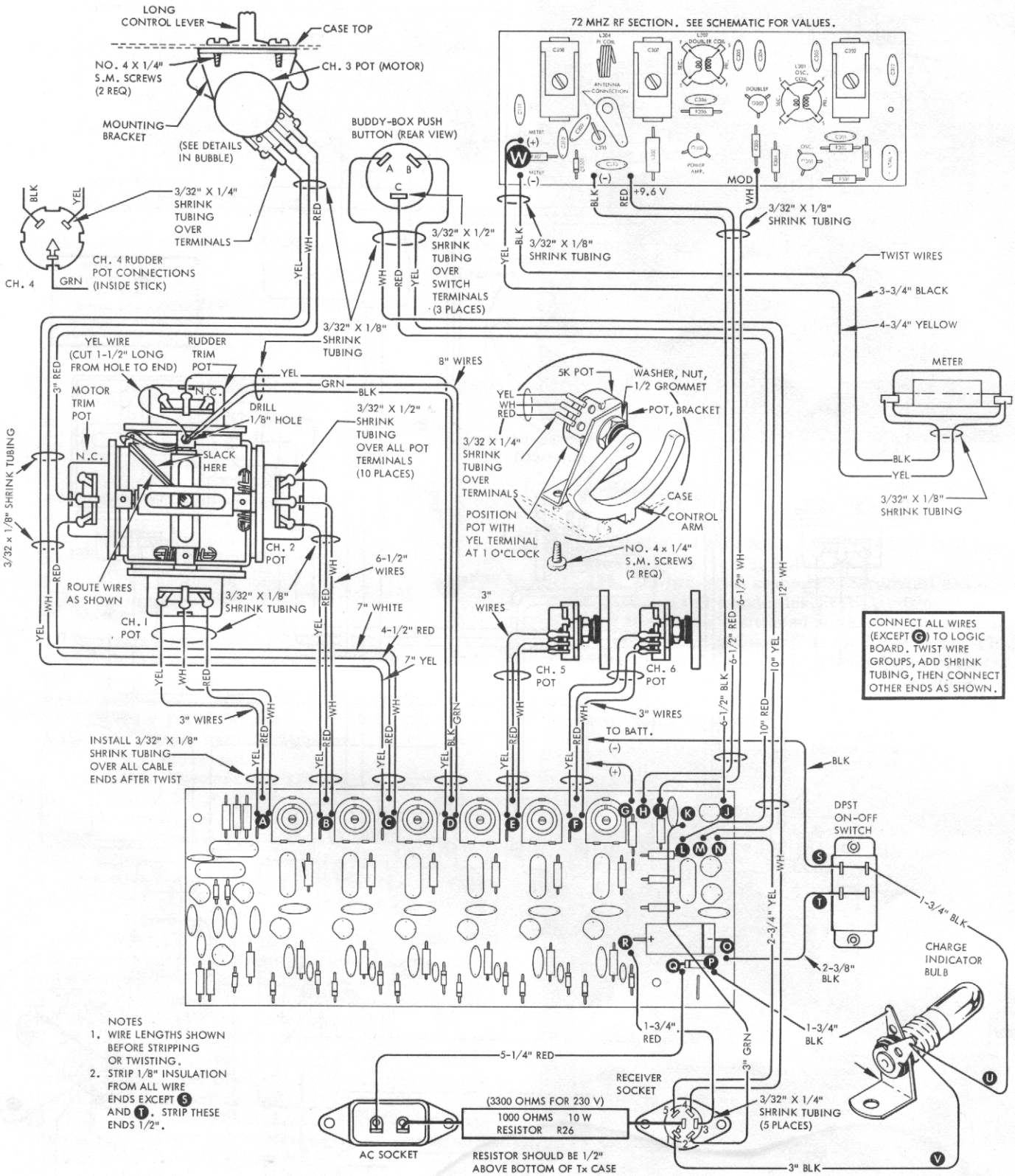


Figure 25. Transmitter Wiring (Single-Stick)

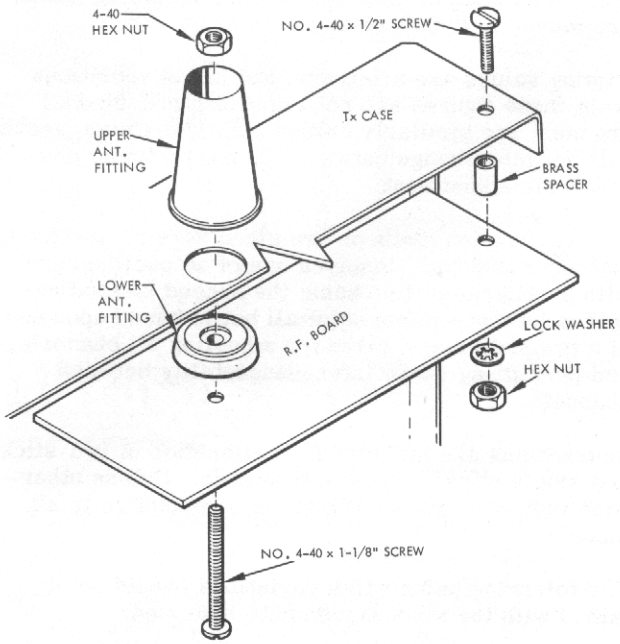


Figure 26. Installation of RF Board

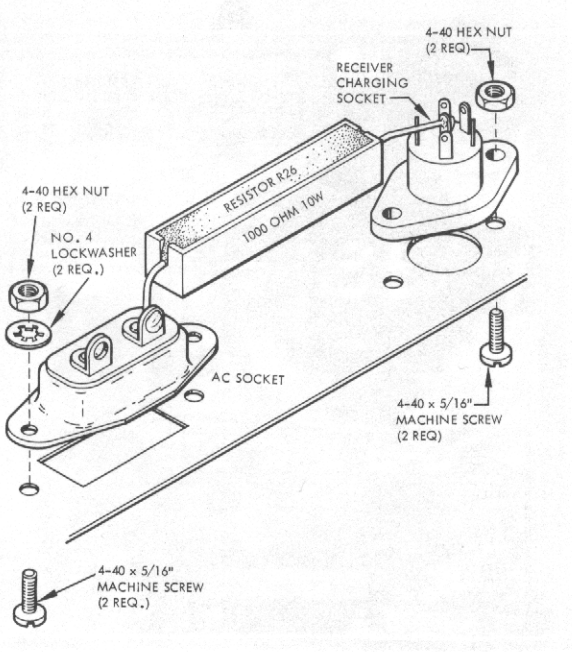


Figure 27. Installation of Charging Resistor

☐ 199. Route cable made of wires Ⓗ, Ⓘ and Ⓙ towards top of case as shown in appropriate illustration (28 or 29). Slide 1/8" length of shrink tubing over wires, then solder red, white and black wires to RF board assembly. Clip off excess wire. Shrink the tubing over wires as close to board as possible.

☐ 200. Attach RF board to inside top of transmitter case as shown in figure 26. Tighten hardware securely with screwdriver.

NOTE

A hex nut insert within the upper antenna fitting will hold nut in place while threading fitting on by hand.

☐ 201. Add 1/8" length of 3/32" shrink tubing, then solder black and yellow wires from RF board to meter lugs. Use as little heat as possible to avoid melting plastic meter case. Shrink the tubing over wires as close to meter as possible.

☐ 202. Install AC socket on inside bottom of Tx case. Position terminal as shown. Attach with two 4-40 x 5/16" screws, lockwashers and nuts. (Figure 27)

☐ 203. Fasten receiver charging socket to case bottom with two 4-40 x 5/16" screws and nuts.

☐ 204. Mount large 10 watt charging resistor between pin 6 (center pin) of Rx charging socket and closest pin of AC socket. Loop and bend resistor wire leads through these contacts until mechanically secure. Solder in place; cut off extra lead length. When installed, resistor should be in free air for heat dissipation, approximately 1/2" from back and bottom of Tx case.

☐ 205. Solder 5-1/4" red wire from Ⓠ on logic board to end terminal on AC socket.

☐ 206. Solder 1-3/4" red wire from Ⓡ on logic board to pin 3 of Rx charge socket. Use 3/32" x 1/4" shrink tubing over this connection.

☐ 207. Solder 2-3/4" yellow wire from Ⓝ on logic board to pin 5 of Rx charge socket. Use 3/32" x 1/4" shrink tubing over terminal.

☐ 208. Solder white wire from Buddy Box cable to pin 4 of charge socket. Use shrink tubing.

☐ 209. Connect 3" green wire from Ⓚ on logic board to pin 2 of charge socket, with shrink tubing over pin connection.

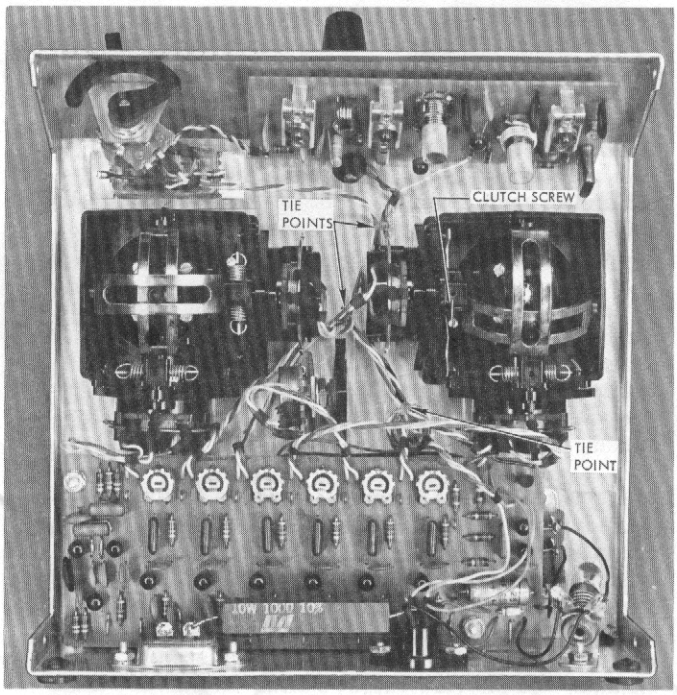


Figure 28. Complete Two-Stick Transmitter (Interior)

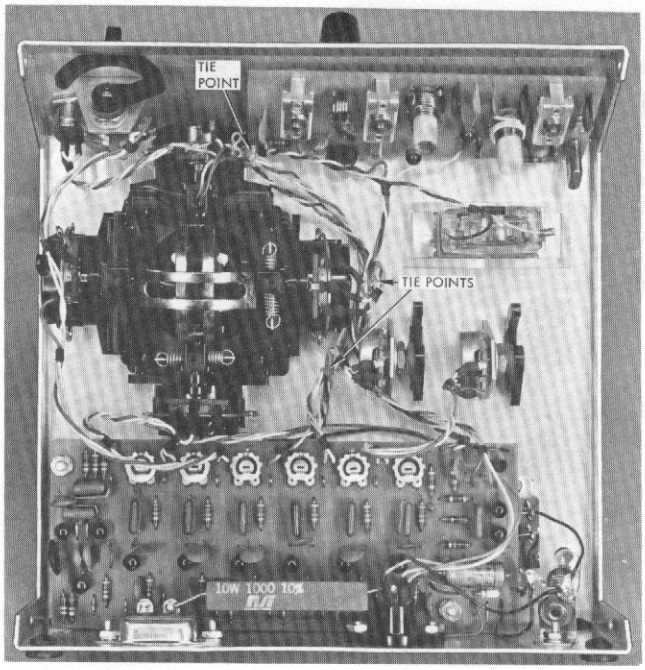


Figure 29. Complete Single-Stick Transmitter (Interior)

☐ 210. Slide 1/4" section of 3/32" shrink tubing over end of 3" black wire from lamp socket. Solder wire to pin 1 of Rx charge socket, and shrink the tubing into position.

☐ 211. Dress wires as shown. We recommend at least two or more wiring tie points for neatest appearance. Use linen cord or plastic tie for this purpose.

☐ 212. Check your completed transmitter against the appropriate illustration (figure 28 or 29). See that all parts agree with the photo and that all wiring appears correct.

TRANSMITTER LOGIC CALIBRATION
(Figures 30 and 31)

Calibration of transmitter logic is necessary to provide proper output pulse spacing and control stick action for each channel. This calibration basically consists of adjustment of two controls (not control stick positions) within each channel.

A small trim lever on the outer edge of each stick control potentiometer inside the transmitter is used to position that pot to obtain correct total width of the related channel pulse. Total swing width variation of the pulse is set by a variable trim pot on the logic board.

For example, trim lever Ⓐ is set to obtain neutral pulse width of 1.5 milliseconds, and trim pot Ⓑ is adjusted for a variation of exactly .5 millisecond each way when the control stick is moved to its extremes. Lever and pot settings are interrelated, making alternate adjustments necessary until correct settings of both are obtained. Final correct adjustment of each channel will provide output pulses which vary from one to two milliseconds, with 1.5 milliseconds neutral, when control sticks or levers (including trims) are moved to their extremes.

Timing values are arbitrary, and slight variations from these figures are not important provided all channels are similarly calibrated. Otherwise, servos will not interchange between channels without considerable adjustment.

Two calibration methods are given herein: the first, and most accurate, involves use of an oscilloscope with a calibrated time base; the second method requires no test equipment at all but is based upon use of a pre-calibrated servo for adjusting all channels, and permitting servo interchangeability between channels.

Instructions are included for calibration of two-stick and single stick (three-axis) models. Unless otherwise indicated, each calibration step applies to all models.

The following pulse width variations should be obtained with the stick movements indicated.

Channel	Function	Command	Pulse Variation
1	Aileron	Right	Wide
2	Elevator	Up	Wide
3	Motor	High throttle	Wide
4	Rudder	Right	Wide

PREPARATION FOR CALIBRATION

☐ 213. Charge transmitter and receiver batteries for 24 hours before use.

☐ 214. Use a multimeter to check battery voltage with Tx ON. It should read approximately 10 volts DC.

☐ 215. Set front transmitter controls, including trims, to neutral. Place trim levers Ⓐ, Ⓒ, Ⓔ and Ⓖ in straight up position, and set trim pots Ⓑ, Ⓓ, Ⓕ, Ⓗ, Ⓙ and Ⓛ to 12 o'clock positions. (See figures 30 and 31.)

☐ 216. Omit antenna for oscilloscope calibration. Install antenna (down position) if calibrating with servo.

Proceed with transmitter logic calibration, using your choice of either of the following two methods. Basic alignment instructions are primarily for the standard two-stick, six-channel unit. Variations for the single-stick (3-axis) transmitter are specifically noted as they occur. Figures 30 and 31 provide location and identification of all controls used in logic calibration.

LOGIC CALIBRATION USING AN OSCILLOSCOPE

For this operation, an oscilloscope with a calibrated time base is required. It should be capable of accurately measuring units as low as 100 microseconds. Basic calibrations require readings of 1 - 1.5 - 2 milliseconds. If scope accuracy is doubtful, use the calibrated servo procedure for logic alignment.

☐ 217. Turn Tx ON. Connect scope probe between battery minus (on switch) and loop ④ on logic board.

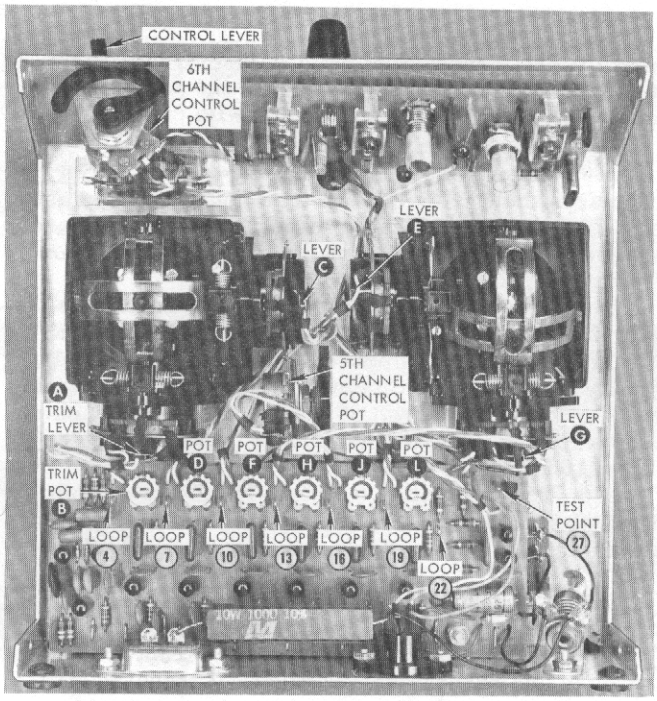


Figure 30. Logic Calibration Points (Two-Stick)

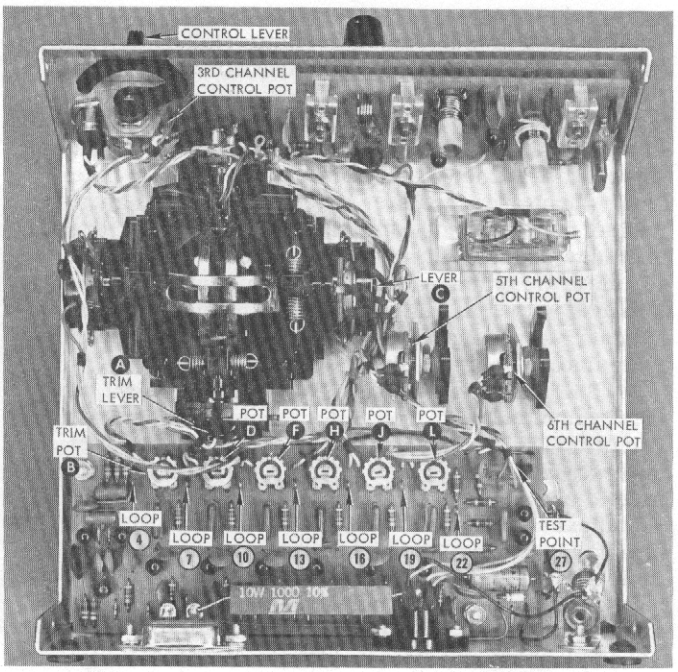


Figure 31. Logic Calibration Points (Single-Stick)

Waveform should appear as ④ on schematic diagram, to denote correct operation of multivibrator Q2, Q3.

☐ 218. Connect scope probe to loop ⑦. Set sweep time to 0.5 msec/cm. Adjust scope controls for stable picture. Compare result with waveforms shown on schematic, figure 23, and those on figure 32.

☐ 219. Adjustments will now be made to obtain waveform timing shown in figure 32. With Channel 1 (aileron) controls, including front trim, in neutral, pulse width should be 1.5 milliseconds. If not, reposition trim lever Ⓐ by hand slightly left or right until this width is obtained on scope. Make sure to hold front trim control at neutral while adjusting trim lever Ⓐ.

☐ 220. Move Channel 1 control stick and front trim lever fully to to the right and note pulse width reading on scope. We are looking for a wide pulse of exactly two milliseconds.

☐ 221. Move front control stick and trim fully to the left. Observe scope reading. Our objective is a narrow pulse of exactly one millisecond.

☐ 222. If the difference in pulse width between steps 220 and 221 exceeds one millisecond total, rotate trim pot Ⓑ clockwise a few degrees until total swing with full control movement is about one millisecond. Rotate trim pot Ⓑ counterclockwise if pulse width swing is less than one millisecond.

☐ 224. Center Channel 1 front controls, then readjust trim lever Ⓐ for 1.5 millisecond neutral pulse.

☐ 225. Check Channel 1 pulse again with controls in each extreme. Continue adjustment of trim pot Ⓑ until total pulse swing is one millisecond, and trim lever Ⓐ until correct pulse travel of one to two milliseconds is obtained.

☐ 226. Connect scope probe to loop ⑩. In same manner as above, adjust trim lever Ⓒ and trim pot Ⓓ until Channel 2 calibration is obtained.

☐ 227. On 2-stick transmitter, similarly align Channel 3 by using loop ⑬, lever Ⓔ and trim pot Ⓕ. Use loop ⑯, lever Ⓖ and trim pot Ⓗ to calibrate Channel 4.

☐ 228. To adjust Channel 3 control on single-stick transmitter, connect scope probe to loop ⑬. Observe pulse width variation while moving Channel 3 control lever and trim control from one extreme to the other. Trim pot Ⓕ is used as before to obtain correct one millisecond pulse swing. To adjust for proper 1 - 1.5 - 2 ms throw, loosen brass nut holding 3rd channel pot, reposition pot slightly in direction desired, then tighten nut.

☐ 229. Recheck Channel 3 controls; continue adjustment of both pots as necessary to obtain full one millisecond swing and 1 to 2 millisecond throw with lever and trim in extremes.

☐ 230. To adjust rudder (Channel 4) on single-stick transmitter, follow procedure as outlined for Channel 1, observing waveform at loop ⑯. Trim pot Ⓗ provides for adjustment of 1 ms pulse swing. Pulse width adjustment is made by adjusting rudder control pot position with respect to rudder knob.

☐ 231. To adjust pulse width, first loosen set screw A (figure 22), then slide rudder knob and pot from cone housing. While observing scope pattern, hold

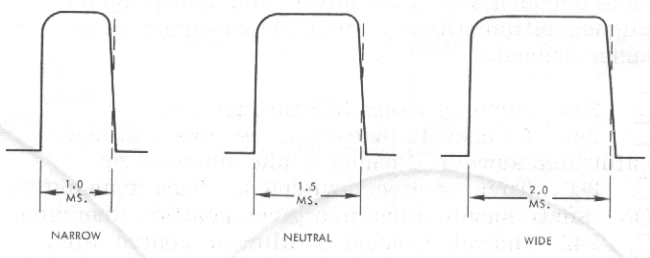


Figure 32. Channel Waveform Adjustments

rudder knob in one hand and rotate rudder pot with the other to provide a 1.5 ms neutral scope pattern. Reinstall pot in housing, and lock with setscrew.

☐ 232. Operate rudder control and trim pot in both directions and check total travel on scope. If greater than 1 millisecond, turn trim pot Ⓗ slightly clockwise (counterclockwise if travel is not enough), reset rudder pot to 1.5 ms (step 231), then recheck throw. Continue adjustments between rudder pot and trim pot Ⓗ until the standard 1 - 1.5 - 2 millisecond travel is obtained with full rudder knob and rudder trim travel. (Rudder trim lever is located directly above chrome face plate.)

☐ 233. To adjust Channel 5 pot (all models), connect scope probe to loop ⑲. Observe pulse width variation while moving Channel 5 control lever from one extreme to the other. Trim pot Ⓙ is used as before to obtain correct one millisecond pulse swing. To adjust for proper 1 - 1.5 - 2 ms throw, loosen brass nut holding 5th channel pot, rotate pot slightly in direction desired, then tighten nut.

☐ 234. Recheck Channel 5 control; continue adjustment of both pots as necessary to obtain full one millisecond swing and 1 to 2 millisecond throw with lever in extremes.

☐ 235. Using trim pot Ⓛ and loop ㉒, adjust Channel 6 pot in same manner as outlined in steps 233 and 234 above.

☐ 236. Connect scope probe to test point ㉗ (collector of Q12). Adjust scope controls to show at least one full information frame. Check against waveforms on schematic diagram, figure 23. For a four-channel transmitter, a total of five pulses should be observed at this point, followed by a long timing pulse (seven pulses for six channels).

☐ 237. Expand the scope controls and measure the width of one of these individual pulses. It should approximate 300 microseconds at the widest point.

☐ 238. Using the oscilloscope on each channel in turn, recheck accuracy of your calibration. Readjust as required for perfect alignment. When complete, carefully tighten rudder knob set screws. Completed servos must be centered to each transmitter channel.

LOGIC ALIGNMENT USING CALIBRATED SERVO

Included with your kit is one preassembled and calibrated servo for use in aligning your transmitter. Do not make any adjustments to this servo, or system calibration will be incorrect.

In addition to the assembled servo, an operating receiver and Rx battery pack are needed for this transmitter alignment procedure. Receiver must be on same frequency as transmitter, and operating and aligned sufficiently to provide outputs from all decoder channels.

☐ 239. Perform steps 213 through 216.

☐ 240. Connect Rx battery to receiver. Connect calibrated servo to Channel 1 plug on receiver.

☐ 241. Turn receiver switch ON. Turn transmitter ON. Servo should move to a given position, then stop.

☐ 242. Operate Channel 1 (aileron) control stick on transmitter and verify that servo follows stick movement. If not, a fault must exist in your transmitter, receiver, battery or wiring. Determine and correct source of trouble before continuing with calibration.

☐ 243. If servo responds properly to transmitter commands, hold front aileron trim control and adjust position of trim lever Ⓐ until servo output arms are centered. See figures 30 and 31 for logic calibration adjustment points.

☐ 244. Move aileron control stick and front trim lever fully to the right and then to the left extremes. Note travel distance of servo output arms (or wheel). For correct adjustment, arms on linear servos should move to within 1/16-inch of ends of slots; rotary output wheels should have a maximum travel of ±50 degrees (100 degrees total).

☐ 245. If servo travel is excessive in one or both directions, rotate trim pot Ⓑ clockwise a few degrees. If travel is too little, rotate pot counterclockwise.

☐ 246. Set control stick and front trim to neutral, then readjust trim lever Ⓐ until servo centers.

☐ 247. Again move control stick and front trim to extremes and recheck servo travel. If travel is still incorrect rotate trim pot Ⓑ a little further in the direction indicated above, and reset lever Ⓐ for servo neutral.

☐ 248. Check servo travel once more. If total travel is correct, but servo moves slightly farther one way than the other, adjust trim lever Ⓐ until servo travel each way is equal. Trim neutral should now also be correct.

☐ 249. If necessary, continue with minor adjustments until servo travel and centering are perfect.

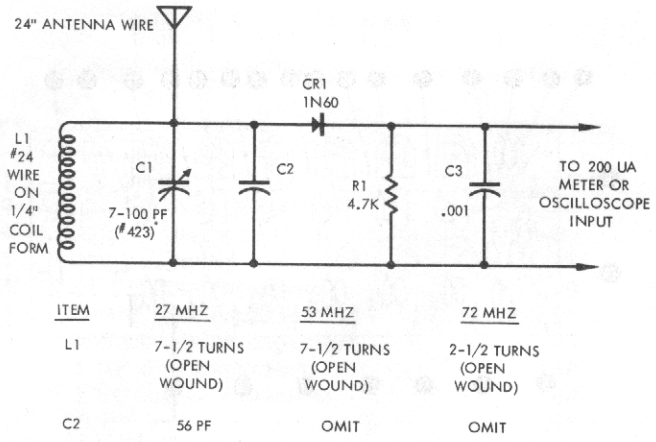
☐ 250. With same servo plugged into the proper receiver channel outputs, repeat steps 243 through 249 for the remaining three channels, using the matching trim lever and trim pot for the channel being calibrated. If adjustments are properly made, the servo should work equally well in all channels. This completes the logic calibration of the 2-stick, four-channel transmitter.

NOTE

Three other system servos, when complete, must be centered to match the transmitter.

☐ 251. To adjust the rudder pot (Channel 4) on single-stick transmitter, remove rudder pot from cone housing as instructed in steps 231 above. Rotate pot to obtain desired servo neutral position, then reinstall pot in cone housing. Adjust trim pot Ⓗ for total throw, and rudder pot for correct centering, until desired servo travel is obtained, with servo neutral position corresponding to stick neutral. Be sure to include travel of rudder trim lever in checking servo operation.

☐ 252. Channels 5 and 6 (all models) do not have an adjustable trim lever, either front or rear. Correct adjustment of these channels is obtained by loosening the control pot mounting nut and rotating the entire pot body slightly until proper servo movement is achieved. Trim pot Ⓙ (or Ⓛ) must be adjusted as described above to provide correct travel.



ITEM	27 MHZ	53 MHZ	72 MHZ
L1	7-1/2 TURNS (OPEN WOUND)	7-1/2 TURNS (OPEN WOUND)	2-1/2 TURNS (OPEN WOUND)
C2	56 PF	OMIT	OMIT

Figure 33. Demodulator Circuit Diagram

TRANSMITTER RF ALIGNMENT

GENERAL INFORMATION

The transmitter RF section is factory-assembled and tuned and should normally not require adjustment. However, for those occasions where it may be needed, RF tuning procedures are given below.

NOTE

FCC regulations require that transmitter RF tuning be performed by a licensed first or second class commercial radio operator.

Minimum equipment requirements for RF tuning include a field strength meter covering the frequency band being tuned. For more accurate results, we recommend use of a tuned demodulator circuit as shown in figure 33. When connected to an oscilloscope, output waveforms and RF peak tuning points can be observed visually on the scope.

TUNING 27 AND 53 MHZ RF SECTION (See Figure 35)

☐ 253. Turn adjusting screws on variable capacitors ① and ② clockwise until seated, then rotate both screws counterclockwise two full turns.

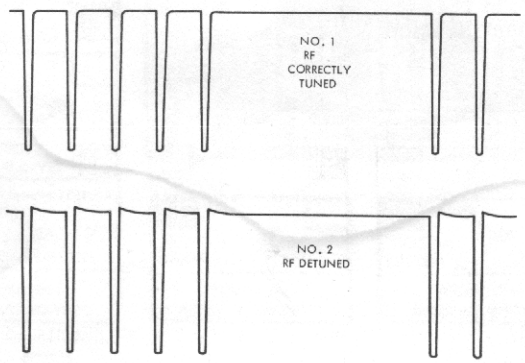


Figure 34. Demodulated RF Output Pattern

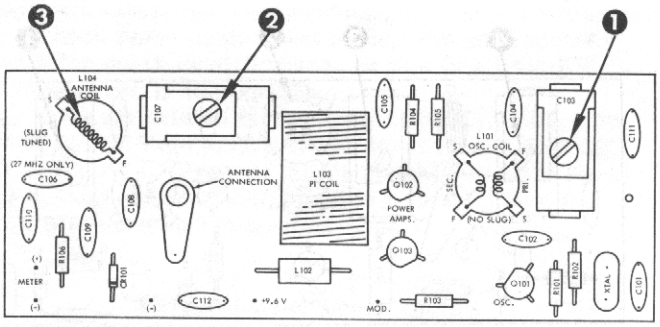


Figure 35. 27 and 53 MHz RF Tuning Points

☐ 254. Using a plastic hexagon tuning wand, set tuning slug on antenna coil ③ flush with outer end of coil.

☐ 255. With antenna fully extended, turn transmitter ON. While observing oscilloscope for wave patterns, turn screw on oscillator capacitor ① clockwise until the oscillator starts. Adjust for peak signal on scope, and turn screw approximately fifteen degrees more clockwise beyond peak to "lock" oscillator in (until power output begins to fall off).

☐ 256. Adjust tuning capacitor ② clockwise until waveform peaks and approximates the output of figure 34.

☐ 257. Alternately adjust tuning slug ③ and capacitor ② until definite peaks are obtained and the observed waveform is similar to the illustration.

☐ 258. If positive peaks or slopes appear on the top of the waveform, transmitter is not properly tuned. Touch up all adjustments (including oscillator) until waveform shows a clean flat top and bottom. When properly tuned, output meter reading should be approximately full scale.

☐ 259. When tuning is complete, hold transmitter in both hands and press it tightly against the body. Turn switch OFF and ON several times to make certain oscillator starts each time. If not, turn capacitor ① clockwise slightly more to "lock" in oscillator.

☐ 260. Using a frequency meter, check transmitter output to insure correct operating frequency within the .005% tolerance permitted. Transmitter is now tuned.

TUNING 72 MHZ RF SECTION (See Figure 36)

☐ 261. Turn adjusting screws on variable capacitors ①, ③ and ④ clockwise until seated, then rotate all three screws counterclockwise two full turns.

☐ 262. Using a plastic hexagon tuning wand, set tuning slug on doubler coil ② flush with outer end of coil. Then rotate coil slug clockwise six full turns until slug is positioned approximately 1/4-inch down inside coil form.

☐ 263. With antenna fully extended, turn transmitter ON. While observing oscilloscope for wave patterns, turn screw on oscillator capacitor ① clockwise until the oscillator starts. Adjust for peak signal on scope, then rotate capacitor screw approximately five degrees more clockwise beyond peak to "lock" oscillator in (until power output begins to fall off).

☐ 264. Alternately adjust capacitors ③ and ④ very carefully for peak output. Adjust slug ② for

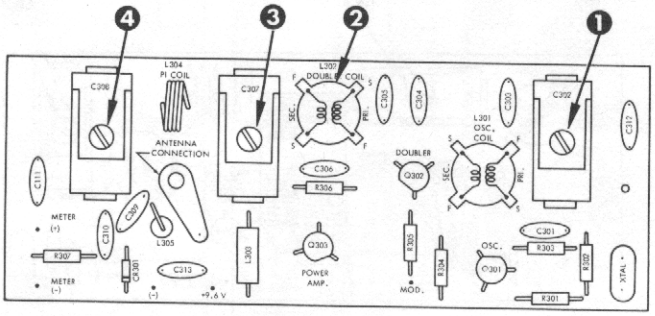


Figure 36. 72 MHz RF Tuning Points

peak, then readjust capacitors ③ and 4 until definite peaks are obtained and the observed waveform is similar to the illustration.

☐ 265. If positive peaks or slopes appear on the top of the waveform, transmitter is not properly tuned. Touch up coil ② and capacitors ③ and ④ until waveform shows a clean, flat top.

☐ 266. When properly adjusted, tuning peaks for all controls should be very definite and waveform should be clean. Maximum transmitter output meter reading (approximately full-scale) should coincide with optimum scope picture.

☐ 267. When tuning is complete, hold transmitter in both hands and press it tightly against the body. Turn switch OFF and ON several times to make certain oscillator starts each time. If not, turn oscillator capacitor ① clockwise slightly more.

☐ 268. Using a frequency meter, check transmitter

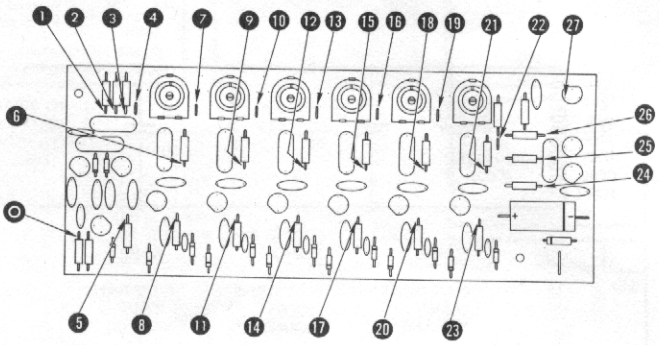


Figure 37. Transmitter Test and Calibration Points

output to insure correct operating frequency within the .005% tolerance permitted. Transmitter is now tuned.

FINAL STEPS OF ASSEMBLY

☐ 269. Peel backing from CANNON label and apply self-adhesive sticker to lower right front of transmitter case.

☐ 270. On 72 MHz model, apply type acceptance sticker to rear side of case.

☐ 271. Slide case back into position and attach to case front with four No. 4 x 1/4" sheet metal screws. Transmitter is now complete.

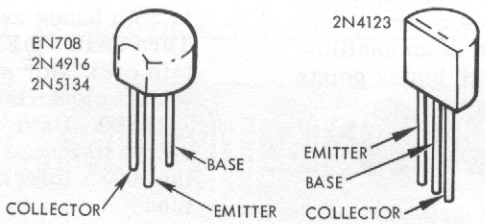


Figure 38. Transistor Identification

MAINTENANCE AND ADJUSTMENT

GENERAL MAINTENANCE TIPS

a. Should transmitter case become dirty, clean exterior with mild soap and water.

b. After a period of use, control sticks may become "sticky". If mechanically tight, loosen and adjust as required. If dirty, use silicone cleaner lubricant on ball joint to loosen it.

c. Trim pots on logic board may be erratic when adjusting. If so, clean with silicon cleaner and lubricant.

d. After a period of time, vibration and use may cause minor changes in transmitter calibration and alignment. We recommend that logic calibration and RF alignment be rechecked every 6 months of use.

e. Keep an eye on battery condition. Occasionally check battery voltage after charge. If low, open battery box and check each individual cell. Replace those defective.

f. After a period of use, it is possible for the stick pot wiper on rudder to lose its tension and fail to make solid contact. In such a case, disassemble stick, clean pot element and wiper, and restore spring tension to wiper contacts. Recalibrate logic.

g. In the event transmitter fails to show a charge indication, check tightness of indicator bulb in socket. Occasionally this bulb may need replacement.

TROUBLESHOOTING AND REPAIR

GENERAL

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

SECTIONAL ANALYSIS

a. For service, consider your transmitter logic as being a multivibrator (Q2, Q3) followed by a number of sequentially triggered half-shots (see figure 3). A diode is used to couple each of their outputs to a pulse generator (Q10, Q11) which feeds a modulator circuit. This in turn controls output from the RF section.

b. Test points on figure 37 correspond with those on the schematic diagram, figure 23. By using an oscilloscope for signal tracing it is very easy to locate a non-operative circuit.

c. When checking your transmitter, a correct waveform appearing at test point ④ will indicate that the multivibrator section is working normally.

d. An incorrect waveform (or absence thereof) at point ⑥ would indicate a possible defect in R6 (the control pot), C9, R8, R9, C10 or a shorted Q4. Similarly, incorrect signals in the base circuits of any of following half-shot transistors can be analyzed in the same manner.

e. Should waveform at ⑥ be normal, but incorrect or missing at ⑦, things to check would be transistor Q4, control R10, capacitor C11 and associated circuit wiring. Likewise, on all following stages, signal correlations of input to output can be used to analyze and locate the defective part.

f. Please note that, because of sequential triggering, should one half-shot become non-operative, all following half-shots will also perform incorrectly. Therefore, in such a case, the basic problem will usually be with the first inoperative stage.

g. As long as the multivibrator and all half-shots are operative, diodes CR3, CR5, CR7, CR9, CR11, CR13 and CR15 will each couple one pulse to the input of pulse generator Q10, Q11. Absence of one of these pulses is usually indicative of a defective diode or diode coupling capacitor.

h. If circuit operation is unstable, it may be caused by Q1 or components in the associated hold-off circuit. In such case, install a wire jumper from emitter to collector of Q1. If circuit operation becomes stable, replace Q1 or the faulty diode or capacitor in the Q1 base circuit.

i. With correct input to Q10, no signal at ㉖ usually indicates Q10 or Q11 defective. Presence of a pulse at this point appreciably shorter than 300 microseconds would be due to a defective C34 or transistor Q10 or Q11.

j. Absence of positive modulator output (with correct input) indicates a defective Q12 or related transistor in the RF section.

k. Once built and tuned, problems in RF sections are usually limited to transistor replacement or misalignment because of rough treatment. Low RF output can be due to weak or defective oscillator or output transistor.

l. Meter circuit problems are usually limited to a defective meter or meter diode.

m. Major problems are batteries. If trouble is suspected, open battery box and check voltage of each cell with transmitter ON. Replace cells if 1 volt or below. Recharge fully after cell replacement.

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 CHART

TROUBLE	POSSIBLE CAUSE	REMEDY
No RF output	RF oscillator improperly tuned	Tune RF section
	Defective oscillator or output transistor	Locate and replace transistor
	Batteries dead	Charge or replace as necessary
	Broken wires to RF board	Check, repair wires
	Defective modulator transistor Q12	Check, replace transistor
Weak RF output	Batteries low	Check, charge, replace as necessary
	RF not aligned properly	Retune RF
	Weak oscillator or output transistor	Check, replace as necessary
Logic inoperative	Parts installed incorrectly	Check each part carefully
	Short in P.C. board	Inspect carefully, remove shorts
	Q1, Q2 or Q3 defective	Check, replace
	Battery voltage low or dead	Check, charge batteries
Some logic channels inoperative	Trim adjustment pot dirty	Clean pot, calibrate
	Half-shot transistor bad	Check, replace transistor
	Short in half-shot P.C. section	Inspect, remove short
	Defective control pot or pot wiring	Check, repair or replace part
	Control pot wiper not making contact	Open pot, increase wiper tension
	Defective coupling diode	Replace defective diode
All channels operate, but centering varies	RF logic alignment off	Recalibrate logic
	Loose trim adjustments on stick, causing alignment shift	Tighten trim levers, recalibrate logic
	Batteries weak	Check, replace
Transmitter will not charge	Charge indicator lamp loose or defective	Tighten or replace lamp
	Battery cell(s) defective	Check and replace if necessary

ORDERING INFORMATION

On all transmitter 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.

Litho in U.S.A.

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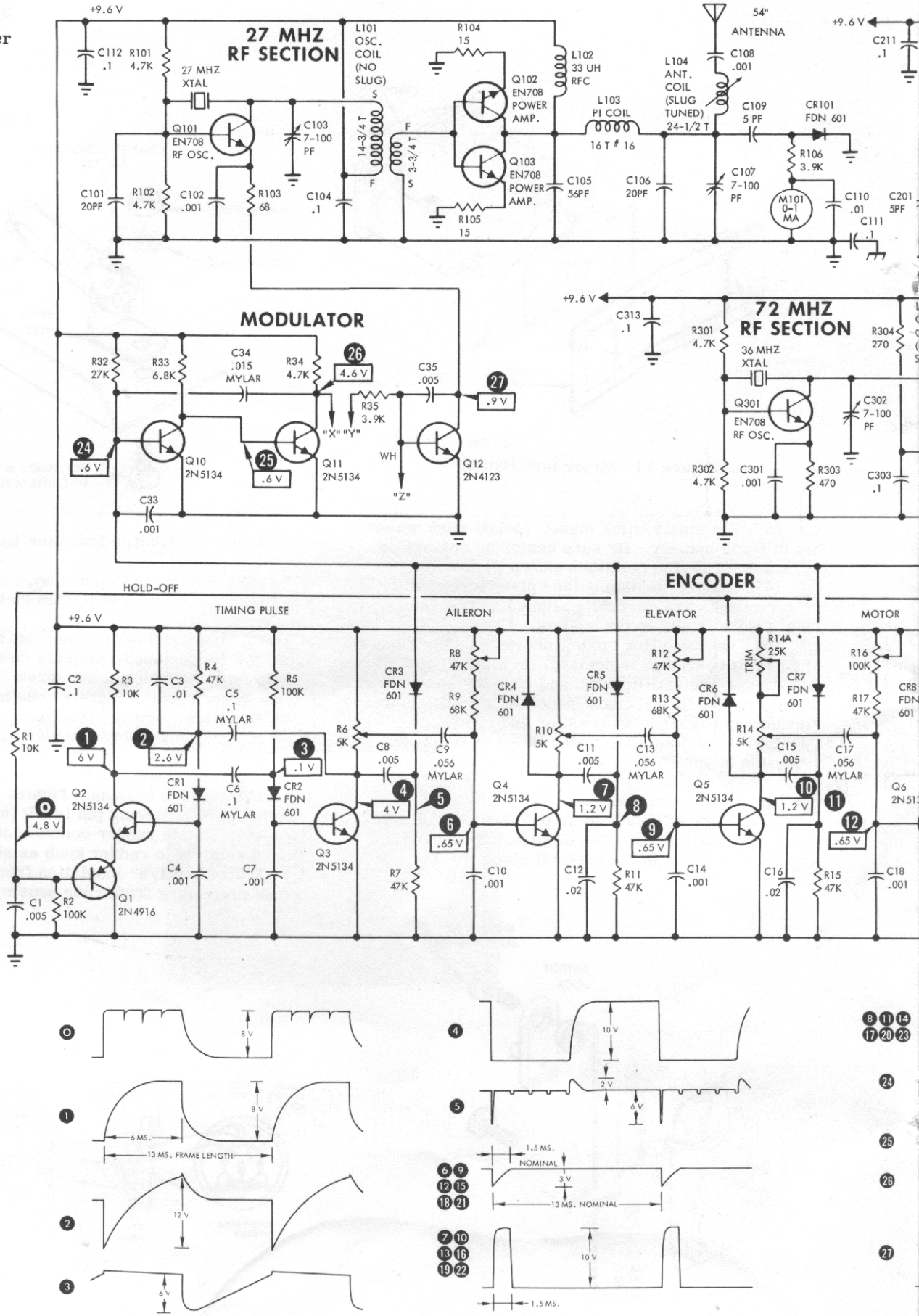


Figure 23. Transmi

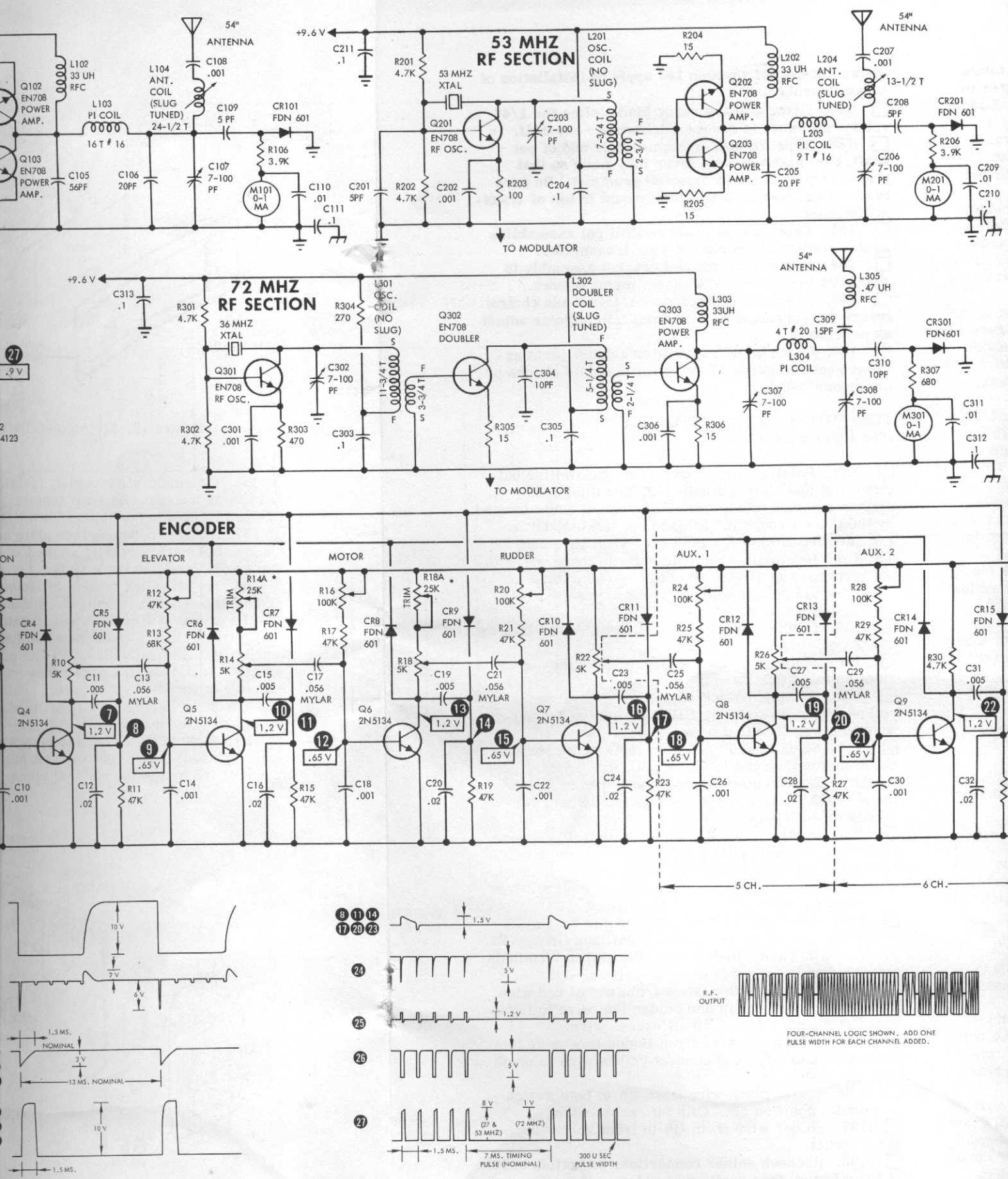
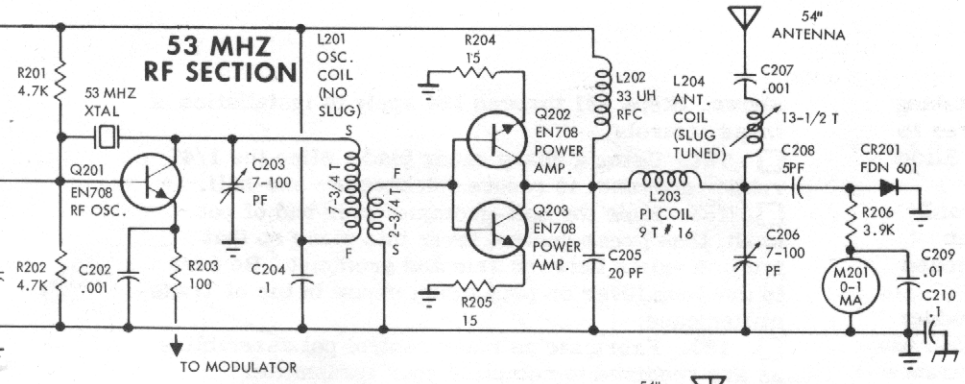
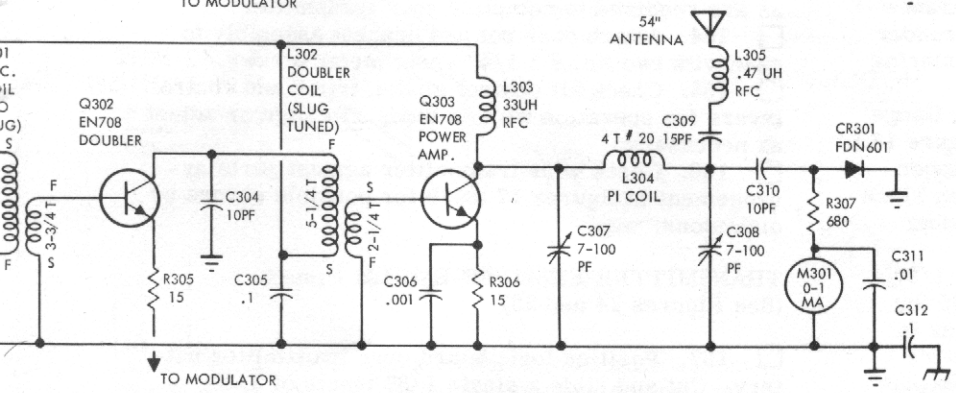
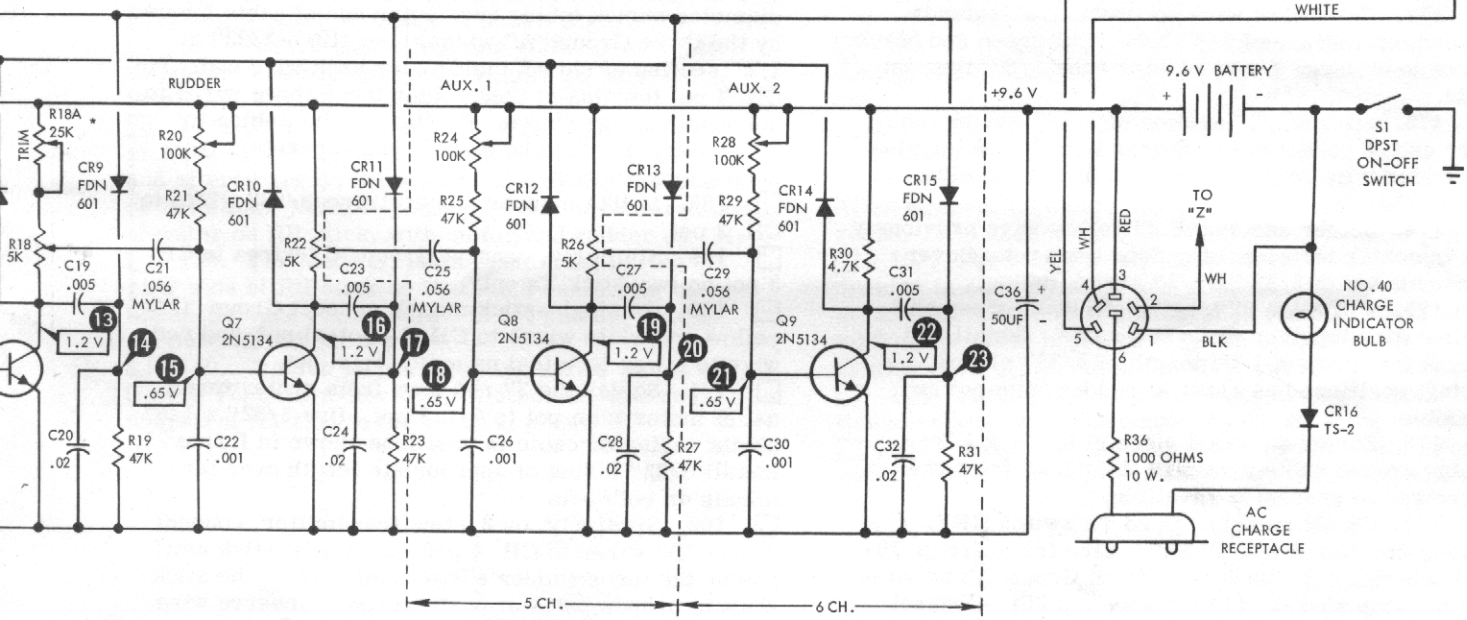


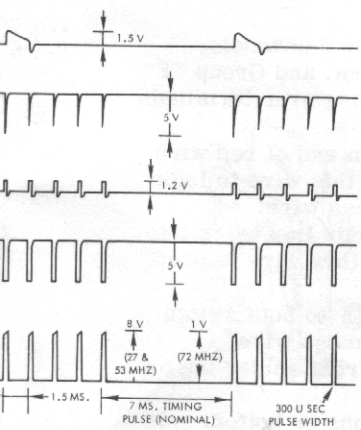
Figure 23. Transmitter Schematic Diagram





BUDDY BOX CIRCUIT





FOUR-CHANNEL LOGIC SHOWN. ADD ONE PULSE WIDTH FOR EACH CHANNEL ADDED.

NOTES

1. ALL MEASUREMENTS IN RESPECT TO NEGATIVE (-).
2. DC VOLTAGES SHOWN IN BOXES.
3. VOLTAGE READINGS TAKEN WITH 20K OHMS-PER-VOLT MULTIMETER.
4. VOLTAGES MAY VARY ±20%.
5. VOLTAGES AND WAVEFORMS TAKEN WITH ALL CONTROLS IN NEUTRAL, AND FULL BATTERY CHARGE.
6. WAVEFORMS TAKEN WITH TEKTRONIX 503 OSCILLOSCOPE WITH CALIBRATED AMPLITUDE AND TIME BASE.
7. CAPACITOR VALUES IN MICROFARADS UNLESS NOTED.
8. DOTTED LINES INDICATE PARTS USED IN VARIOUS MODELS.
9. PARTS WITH ASTERISK (*) USED ONLY WITH SINGLE STICK (3-AXIS) MODEL.
10. WAVEFORMS TAKEN WITH ANTENNA REMOVED.
11. FOUR-CHANNEL LOGIC SHOWN. FRAME LENGTH WILL BE 1.5 MILLISECONDS LONGER FOR EACH EXTRA CHANNEL.

er Schematic Diagram