MODEL

GD-19 5-Channel Digital Proportional Radio Control System

HEATHKIT®

ASSEMBLY MANUAL

HEATHKIT

Price $2.00

595-1060-09

Dear Customer:

The Heathkit electronic product you have purchased is one of the best performing electronic products in the world.

Here's how we aim to keep it that way:

Your Heathkit Warranty

During your first 90 days of ownership, any parts which we find are defective, either in materials or workmanship, will be replaced or repaired free of charge. And we'll pay shipping charges to get those parts to you – anywhere in the world.

If we determine a defective part has caused your Heathkit electronic product to need other repair, through no fault of yours, we will service it free – at the factory, at any retail Heathkit Electronic Center, or through any of our authorized overseas distributors.

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What happens after warranty? We won't let you down. If your Heathkit electronic product needs repairs or you need a part, just write or call the factory, your nearest retail Heathkit Electronic Center, or any Heath authorized overseas distributor. We maintain an inventory of replacement parts for each Heathkit model at most locations – even for many models that no longer appear in our current product line-up. Repair service and technical consultation are available through all locations.

We hope you'll never need our repair or replacement services, but it's nice to know you're protected anyway – and that cheerful help is nearby.

Sincerely,

HEATH COMPANY
Benton Harbor, Michigan 49022

Prices and specifications subject to change without notice.

Assembly

and

Operation

of the

HEATHKIT

5-CHANNEL DIGITAL PROPORTIONAL RADIO CONTROL SYSTEM

MODEL GD-19

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

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INTRODUCTION

The Heathkit 5-Channel Digital Proportional Radio Control System, Model GD-19, consists of a Transmitter, a Receiver, four Servos, and the Receiver Battery Pack. This all solid-state system uses digital techniques to provide five channels (fifth servo optional) of simultaneous proportional control.

TRANSMITTER

The Digital Transmitter, Model GDA-19-1, can be purchased to operate on any one of the fifteen frequencies which make up the following three bands.

27 MHz Band	53 MHz Band	72 MHz Band
26.995 MHz	53.100 MHz	72.080 MHz
27.045 MHz	53.200 MHz	72.240 MHz
27.095 MHz	53.300 MHz	72.400 MHz
27.145 MHz	53.400 MHz	72.960 MHz
27.195 MHz	53.500 MHz	75.640 MHz

The completed Transmitter is housed in an attractive, light blue, wrinkle finish aluminum case that has rounded corners to provide a comfortable grip. A 54" antenna collapses into the case when it is not in use. A relative power output meter is provided for visual monitoring of the radiated signal. Sealed plastic molded control sticks and trim tabs allow complete control of the servo positions. (The trim tabs are designed to rotate the control potentiometer for trim adjustment without changing the position of the control sticks.)

A total of twelve silicon transistors are used in the Transmitter; or thirteen transistors if the unit operates on the 72 MHz band. All parts except the battery charging circuit are mounted on two glass epoxy circuit boards: the transmitter circuit board and the encoder circuit board. The transmitter circuit board is preassembled and prealigned to one of the above frequencies.

Supply voltage for the Transmitter is from an internal 9.6 volt nickel-cadmium rechargeable battery. A charging circuit is provided inside the Transmitter case for charging the transmitter and receiver batteries. Charging current for the batteries is obtained from the 120 volt power line. A pilot lamp on the Transmitter indicates when the batteries are being charged.

NOTE: It is necessary to have a CLASS C operator's license from the FCC (Federal Communication Commission) before the GDA-19-1 Transmitter can be operated on the 27 and 72 MHz bands. A technician class or higher amateur radio operator's license is required to operate on the 53 MHz band. (A pushbutton is provided, for keying purposes, on the top of the 53 MHz transmitter. The amateur radio operator uses this pushbutton to comply with FCC regulations for this band by transmitting his amateur radio station call letters at regular intervals.)

A delay of at least a few weeks will occur between the time you apply for your license and the time you receive it from the FCC. Therefore, you will save time if you apply for your license immediately. The necessary forms are included with this kit. All applications for this license must be accompanied by the FCC license fee.

RECEIVER

A total of nine silicon transistors, five silicon-controlled switches (SCS), and three ceramic IF filters are used in the GDA-19-2 Receiver. All parts are mounted on two glass epoxy circuit boards: the receiver circuit board and the decoder circuit board. The outputs for the five radio controlled channels are supplied to the individual servos by a space-saving connector block and inline connectors.

Supply voltage for the Receiver and Servos is from a compact rectangular 4.8 volt nickel-cadmium rechargeable battery, Heathkit Model GDA-19-3. The supply voltage is controlled by an ON-OFF switch. The completed Receiver is housed in an attractive, compact, molded nylon case.

SERVOS

The Heathkit Model GDA-19-4 Digital Proportional Servo is a compact, 9 transistor, electromechanical unit that is used to accurately move the control elements in model airplanes, boats, and cars. Both linear-motion and circular-motion outputs are available. The two linear-motion outputs travel in opposite directions from each other, providing a more universal servo.

The servo has been designed for long life and trouble-free operation. One outstanding feature is the use of a variable capacitor as a feedback element instead of the usual potentiometer. The variable capacitor uses intermeshing aluminum plates which are insulated from each other with a polyethylene film. The Servo is housed in a compact molded nylon case.

ASSEMBLY NOTES

UNPACKING

To avoid intermixing the parts, do not open a pack until you are instructed to do so.

The GD-19 Radio Control System is divided into the following major packs: The transmitter pack, marked with the first seven numbers 171-1983; the receiver pack, marked with the first seven numbers 171-2038; the receiver battery pack, marked with the first six numbers 191-361 and the four servo packs, each marked with the first seven numbers 171-2126. If you ordered a complete Radio Control System you will also receive pack #8. This pack contains all the parts that were variable, depending on which crystal you ordered. A paragraph at the beginning of each Parts List (Transmitter, Receiver, and Servo) will tell you which pack or packs to open.

Also included in this kit is the manual pack, consisting of one Assembly Manual (see front cover for part number), one Parts Order Form, one Kit Builders Guide, and six blue and white labels.

NOTE: To order replacement parts, refer to the Replacement Parts Price List and use the Parts Order Form furnished with this kit.

Refer to the "Kit Builders Guide" for complete information on unpacking, parts identification, tools, wiring, soldering, and step-by-step assembly procedures.

STEP-BY-STEP PROCEDURE

The following assembly instructions for the Radio Control System are divided into three sections: Transmitter, Receiver, and Servos. Refer to the Identification Photographs of these units (Pages 118, 124 and 127) from time to time during assembly to see the actual position of wires and components.

TRANSMITTER PARTS LIST

Open the Transmitter pack marked with the first seven numbers 171-1983 and check the parts against the following Parts List. If you ordered a complete Radio Control System, you will also need two or more parts from Pack #8. The numbers in parentheses are keyed to the numbers on the Transmitter Parts Pictorial (fold-out from Page 9). NOTE: Do not open the two control stick packs marked 171-2010 until instructed to do so.

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
1/4 Watt		
(1) 1-2-12	1	1000 Ω (brown-black-red)
1-4-12	1	2200 Ω (red-red-red)
1-8-12	3	4700 Ω (yellow-violet-red)
1-46-12	1	27 kΩ (red-violet-orange)
1-11-12	7	47 kΩ (yellow-violet-orange)
1-47-12	5	150 kΩ (brown-green-yellow)
Other Resistors		
(2) 1-10	1	1200 Ω 1/2 watt (brown-red-red)
1-21	1	15 kΩ 1/2 watt (brown-green-orange).
1-102	1	82 kΩ 1/2 watt (gray-red-orange)
(3) 2-208	2	111 kΩ 1/2 watt 1%
(4) 3-15-7	1	1000 Ω 7 watt
CAPACITORS		
(5) 20-102	1	100 pF mica
(6) 21-140	16	.001 μF disc
21-46	6	.005 μF disc
(7) 27-74	1	.01 μF Mylar*
27-63	1	.022 μF Mylar (small)
(8) 27-88	5	.022 μF Mylar (large)
27-77	3	.1 μF Mylar
(9) 25-116	1	50 μF electrolytic

*DuPont Registered Trademark

PART No.	PARTS Per Kit	DESCRIPTION
DIODES-TRANSISTORS		
NOTE: Transistors will be marked with either the part number, the transistor type number, or both the part number and the type number.		
(10) 56-27	8	Silicon diode (GES160)
(11) 57-27	1	Silicon rectifier (1N2079)
(12) 417-91	5	2N5232A/2N3391A transistor
417-118	2	2N3393 transistor
417-201	3	X29A829
SWITCH-SOCKETS-CONNECTORS		
(13) 60-35	1	Slide switch
(14) 434-88	1	Pilot lamp socket
(15) 432-101	1	4-terminal socket
(16) 432-106	1	4-pin plug with cap
(17) 432-104	1	4-pin flat connector
LINE CORD-WIRE		
89-38	1	Line cord
134-189	1	Wire harness
344-50	1	Black solid wire
344-52	1	Red solid wire
344-90	1	Black stranded wire
344-92	1	Red stranded wire
346-35	1	Small black sleeving
346-20	1	Medium-size black sleeving
346-3	1	Large black sleeving

PART No.	PARTS Per Kit	DESCRIPTION
METAL PARTS		
(18)90-427	1	Cabinet back
(19)90-428	1	Cabinet front
(20)100-801	2	Side bracket
(21)204-102	2	Support bracket
(22)204-920	1	Control mounting bracket
(23)204-922	1	Meter mounting bracket
(24)205-729	1	Cabinet bottom plate

***TRANSMITTER RF CIRCUIT BOARD ASSEMBLY**

NOTE: Only one of the following transmitter RF circuit board assemblies is supplied with this kit. CAUTION: The transmitter circuit board assembly has been pretested and prealigned. Do not change the setting of any coil on this circuit board, as this will decrease performance and void the Warranty.

Assembly Part No.	Transmitted Frequency (MHz)	Transmitter Crystal (MHz)	Matching Receiver Crystal (MHz)
181-26	26.995	26.995	26.542
181-27	27.045	27.045	26.592
181-28	27.095	27.095	26.642
181-29	27.145	27.145	26.692
181-30	27.195	27.195	26.742
181-430	53.100	53.100	26.3235
181-431	53.200	53.200	26.3735
181-432	53.300	53.300	26.4235
181-433	53.400	53.400	26.4735
181-434	53.500	53.500	26.5235
181-435	72.080	36.040	36.2665
181-436	72.240	36.120	36.3465
181-437	72.400	36.200	36.4265
181-438	72.960	36.480	36.7065
181-439	75.640	37.820	37.5935

*These parts will be packed in Pack #8 if you ordered a complete Radio Control System.

PART No.	PARTS Per Kit	DESCRIPTION
GENERAL		
10-222	5	50 kΩ control
10-273	1	5000 Ω control
(25) 75-93	1	Fiber insulator
85-187-3	1	Encoder circuit board
142-113	1	Antenna
(26) 260-16	2	Alligator clip
(27) 407-116	1	Meter
(28) 412-47	1	Pilot lamp (#1820)
(29) 413-15	1	Pilot lamp jewel
100-960	1	Battery assembly (9.6 volt nickel-cadmium)
(30) 462-299	1	Thumb knob
(31) 266-145	1	Switch stop
(32) 490-5	1	Nut starter
(33) 490-110	1	Wrench
597-405	1	FCC License form and regulation packet
		Solder

The following parts are supplied with the transmitters indicated.

***27 MHz Band Transmitter**		
(34) 205-649	1	Cabinet top plate
***53 MHz Band Transmitter**		
(35) 64-39	1	Pushbutton switch assembly
(36) 205-711	1	Cabinet top plate
(37) 254-5	1	Control lockwasher
344-91	1	Brown stranded wire
27-64	1	.033 μF Mylar capacitor
***72 MHz Band Transmitter**		
205-726	1	Cabinet top plate

NOTE: All transmitters contain the following parts.

HARDWARE		
#3 Hardware		
(38) 250-49	2	3-48 x 1/4" screw
#4 Hardware		
(39) 250-163	14	4-40 x 5/16" self-tapping screw
(40) 250-285	4	4-40 x 1/4" screw
(41) 250-312	2	4-40 x 3/4" screw
(42) 252-2	6	4-40 nut
(43) 254-9	11	#4 lockwasher
250-477	2	4-24 x 3/4" self-tapping screws

PART No.	PARTS Per Kit	DESCRIPTION
#6 Hardware		
(44)250-276	9	6-32 x 3/8" black screw
(45)252-3	5	6-32 nut
(46)254-1	5	#6 lockwasher
(47)259-1	1	#6 solder lug
Other Hardware		
(48)252-7	1	Control nut
(49)253-100	1	Antenna fiber flat washer
(50)253-101	1	Antenna fiber shoulder washer
(51)253-103	1	1/4" fiber washer
(52)254-4	1	Control lockwasher
(53)255-29	2	3/16" spacer

CONTROL STICK PARTS

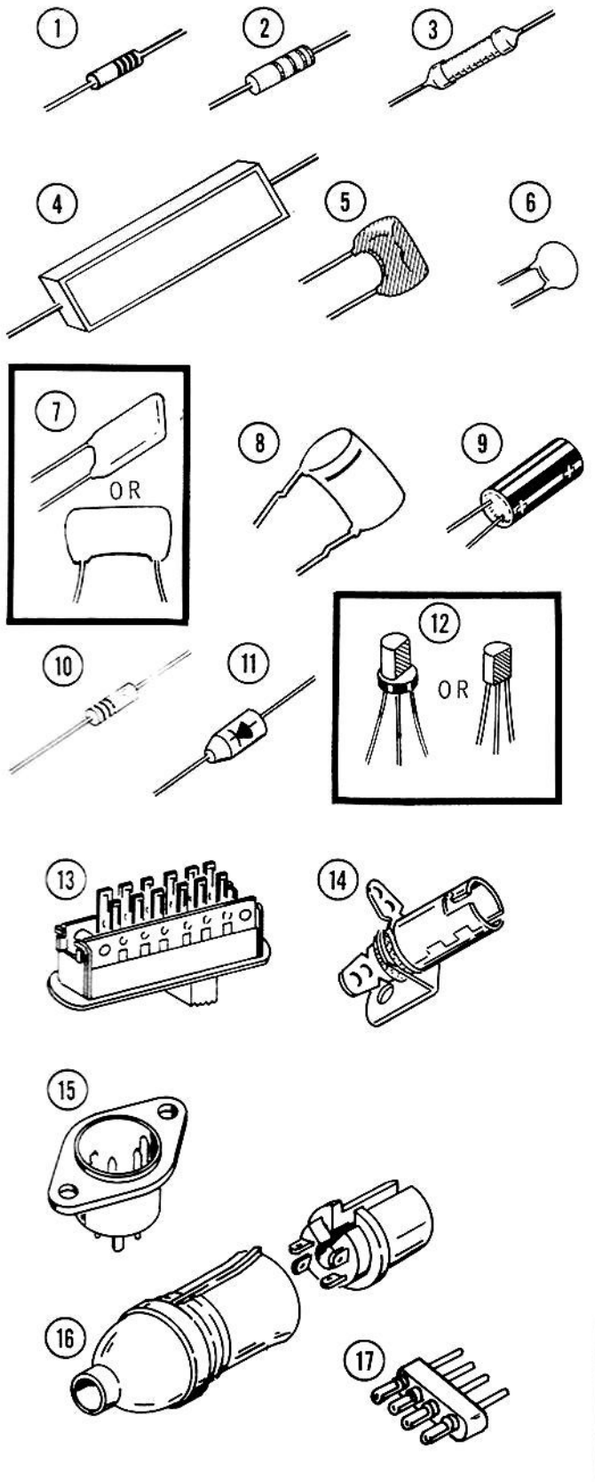
NOTE: The control stick parts are in two containers. Each container holds a complete set of parts that has a group part number of 171-2010. The quantities listed below are the total Parts Per Kit for both containers.

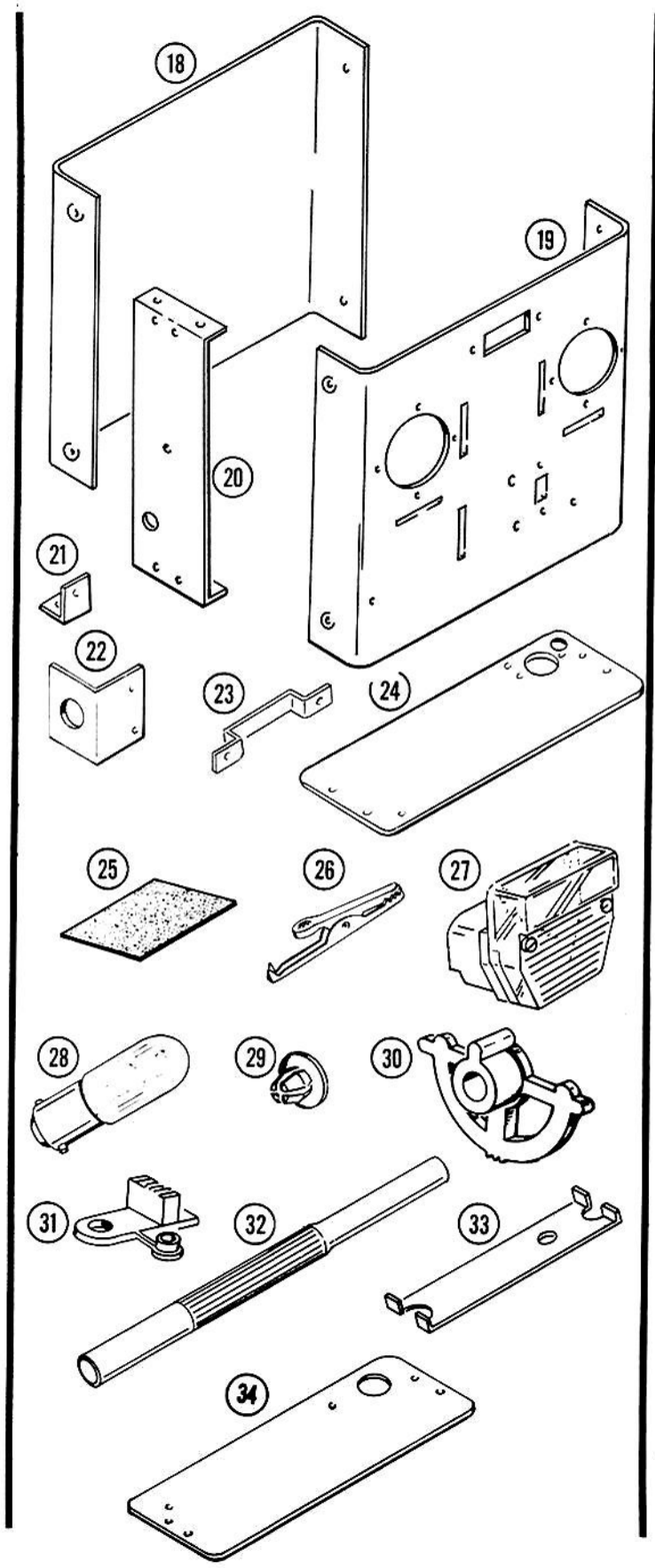
CAUTION: Do not mix together the parts from the container now or during assembly. Also, please note that numbers stamped on certain parts may be printed backwards.

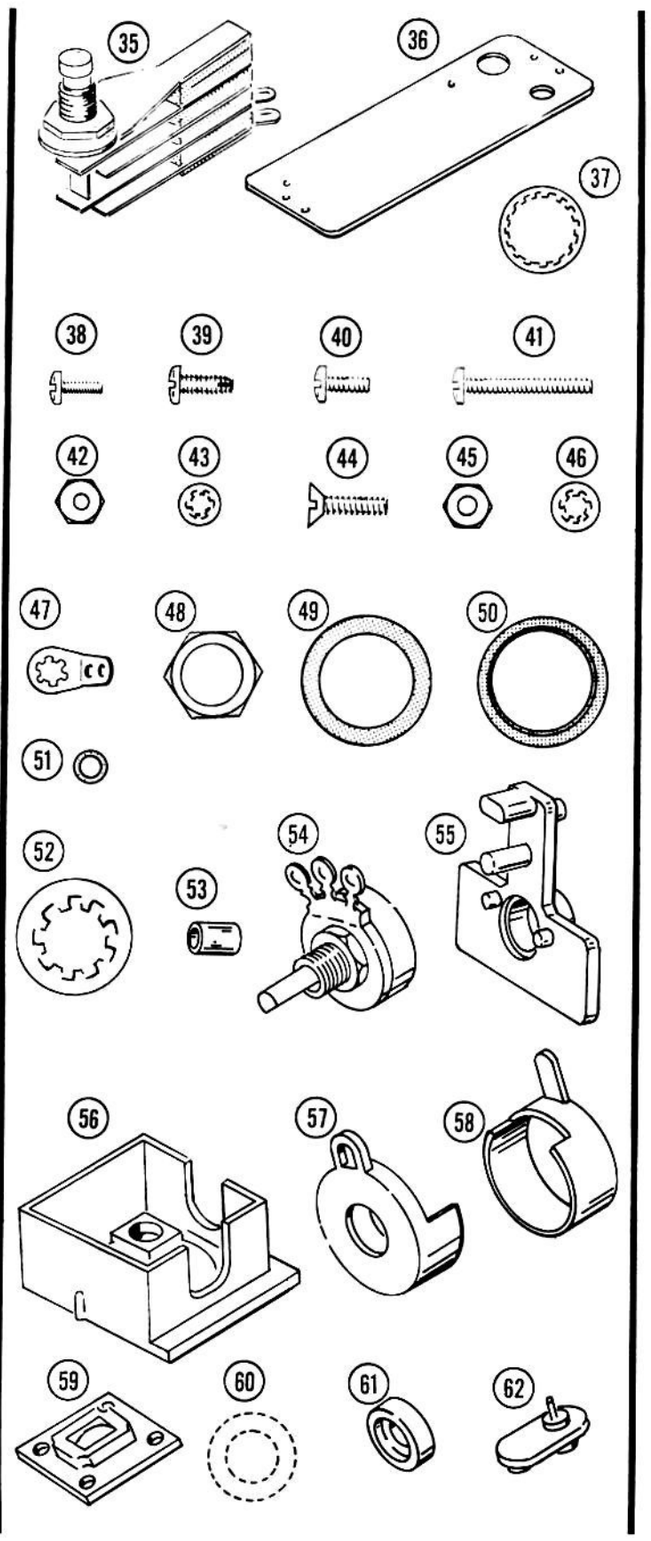
(54)11-114	4	5000 Ω control
(55)205-682	2	Control mounting plate (#1 stamped on part)

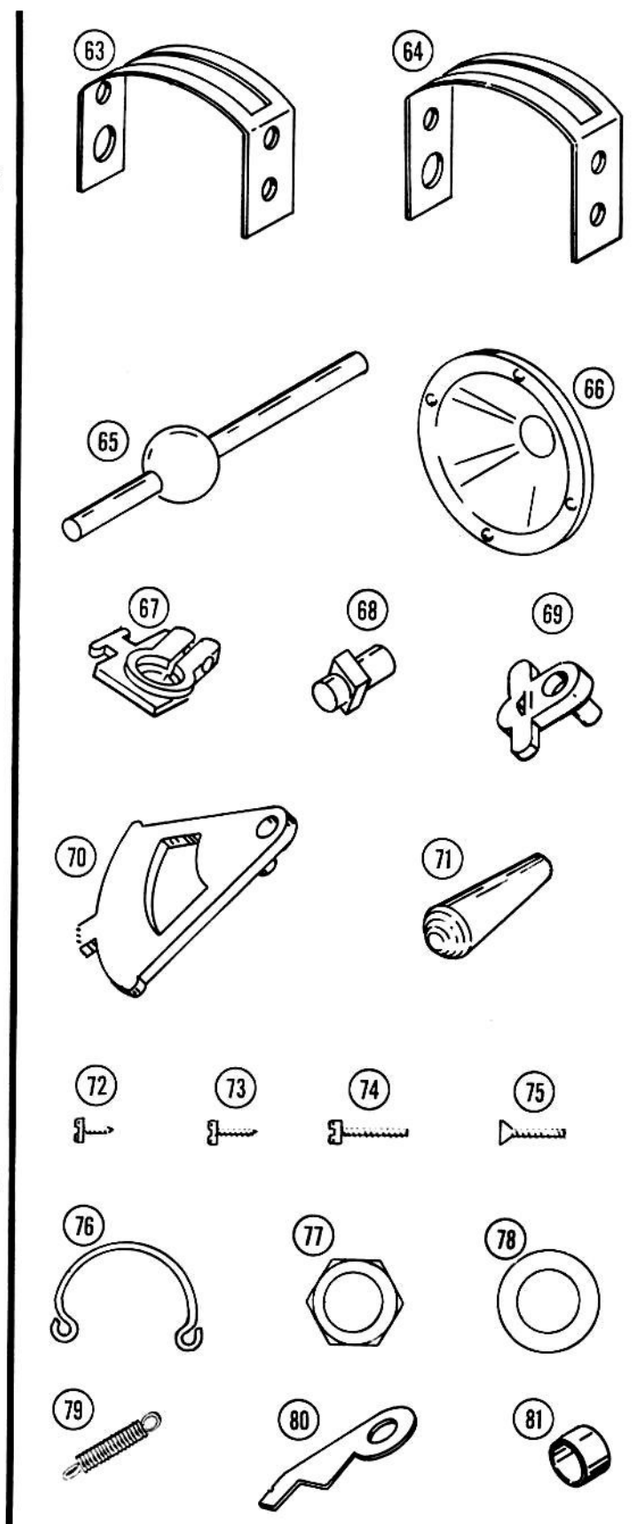
PART No.	PARTS Per Kit	DESCRIPTION
Control Stick Parts (cont'd.)		
205-683	2	Control mounting plate (#2 stamped on part)
(56)238-58	2	Control stick housing
(57)214-82	4	Control front cover
(58)214-83	4	Control back cover
(59)214-84	2	Ball housing
(60)253-124	4	Teflon washer
(61)255-100	2	Nylon spacer
(62)265-16	4	Hinge pin
(63)266-121	2	Gimbal #1
(64)266-122	2	Gimbal #2
(65)266-123	2	Control stick
(66)266-125	2	Chrome cup
(67)455-77	2	Adjustable bearing
(68)456-24	2	Control stick coupler
(69)456-25	4	Gimbal coupler
(70)462-300	4	Trim plate
(71)462-301	2	Control stick knob
Control Stick Hardware		
(72)250-355	8	2-32 x 3/16" sheet metal screw
(73)250-420	8	2-32 x 1/4" sheet metal screw
(74)250-421	2	2-56 x 3/8" screw
(75)250-422	8	2-56 x 5/16" screw
(76)208-17	4	Spring clip
(77)252-7	4	Control nut
(78)253-119	8	Control washer
(79)258-103	4	Centering spring
(80)266-124	8	Dog stop
(81)455-78	4	Brass bushing

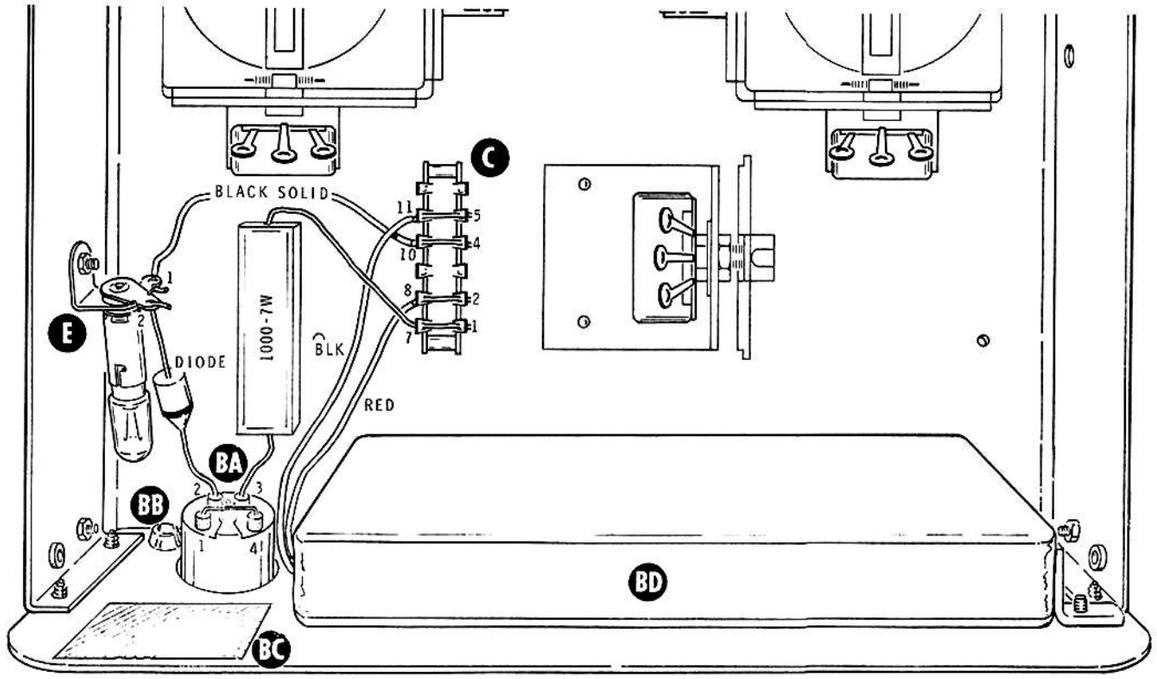
TRANSMITTER PARTS PICTORIAL



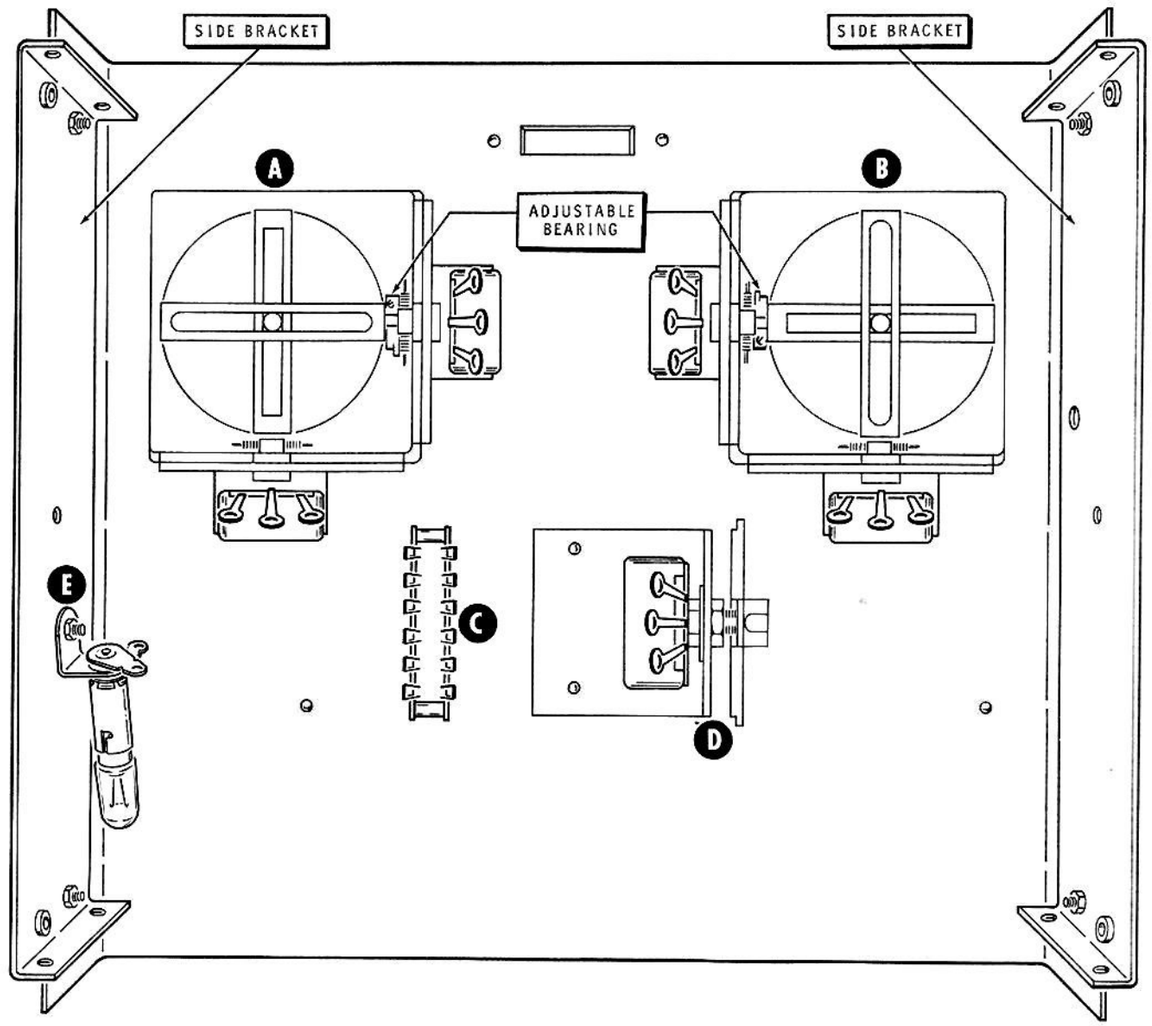








PICTORIAL 1-8



PICTORIAL 1-7

TRANSMITTER STEP-BY-STEP ASSEMBLY

ENCODER CIRCUIT BOARD ASSEMBLY

Before starting to assemble this kit, be sure you have read the wiring, soldering, and step-by-step assembly information in the Kit Builders Guide.

Since the circuit board and the components to be installed on it are quite small, it is suggested that you take your time while assembling the circuit board. Each component should be positioned carefully over its outline on the circuit board, as it is shown in the Pictorial.

Resistors will be called out by their resistance value (in Ω, or kΩ) and color code. Resistors are 1/4 watt unless specified otherwise in a step. Capacitors will be called out by their capacitance value and type.

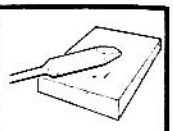
You may find it helpful to place the circuit board on a soft cloth to prevent it from sliding around when it is being soldered. Also, be very careful not to cover unused holes with solder.

NOTE: It is recommended that you use a soldering iron that is rated at 15 to 25 watts. Its tip should be no wider than 1/8" at its widest dimension; pyramid or chisel-shaped tip is best. This type of soldering iron will make the kit easier to assemble, with less chance of solder bridges occurring between foils on the circuit board.

Complete the steps on Pictorial 1-1 through 1-4.

START

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN...



WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

( ) Locate the encoder circuit board (#85-187-3) and position it lettered side up as shown.

( ) 1000 Ω (brown-black-red).

( ) 2200 Ω (red-red-red).

( ) 47 kΩ (yellow-violet-orange).

( ) 150 kΩ (brown-green-yellow).

( ) 4700 Ω (yellow-violet-red).

( ) 47 kΩ (yellow-violet-orange).

( ) 150 kΩ (brown-green-yellow).

( ) Solder all connections and cut off the excess lead lengths.

( ) 47 kΩ (yellow-violet-orange).

( ) 150 kΩ (brown-green-yellow).

( ) 47 kΩ (yellow-violet-orange).

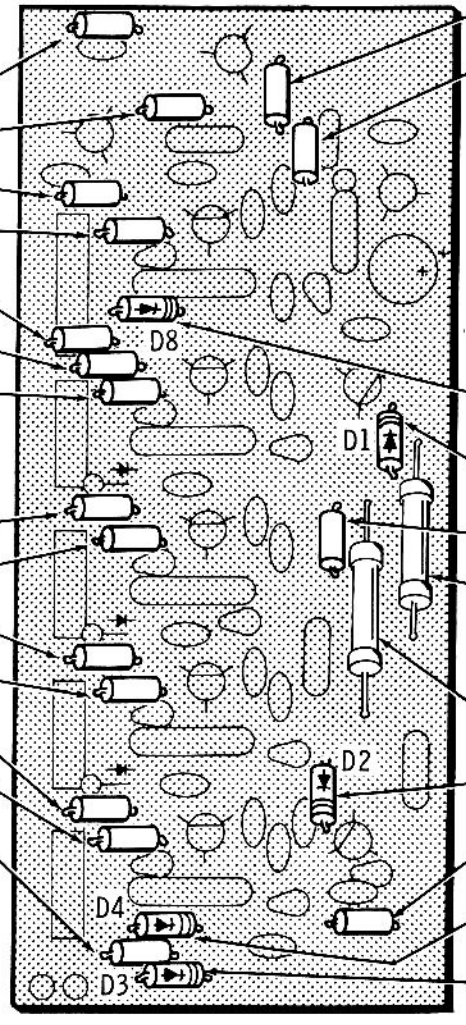
( ) 150 kΩ (brown-green-yellow).

( ) 47 kΩ (yellow-violet-orange).

( ) 150 kΩ (brown-green-yellow).

( ) 47 kΩ (yellow-violet-orange).

( ) Solder all connections and cut off the excess lead lengths.



CONTINUE

( ) 4700 (yellow-violet-red).

( ) 27 kΩ (red-violet-orange).

NOTE: When installing silicon diodes, be sure to position the (banded) end as shown.

( ) Silicon diode D8 (S160). Note position of banded end.

( ) Silicon diode D1 (S160). Note position of banded end.

( ) 4700 Ω (yellow-violet-red).

( ) 111 kΩ 1%, 1/2 watt.

( ) Solder all connections and cut off the excess lead lengths.

( ) 111 kΩ 1%, 1/2 watt.

( ) Silicon diode D2 (S160). Note position of banded end.

( ) 47 kΩ (yellow-violet-orange).

( ) Silicon diode D4 (S160). Note position of banded end.

( ) Silicon diode D3 (S160). Note position of banded end.

( ) Solder all connections and cut off the excess lead lengths.

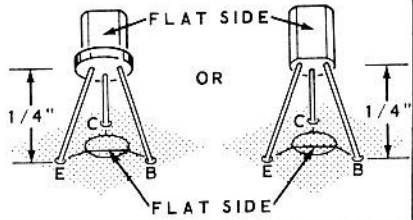
PROCEED TO PICTORIAL 1-2.

PICTORIAL 1-1

START

NOTE: When installing transistors, place the E, B, and C leads of the transistor in the corresponding holes of the circuit board. Position the transistor 1/4" above the circuit board. Solder all three connections of each transistor as it is installed. Cut off the excess lead lengths.

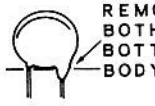
( ) X29A829 transistor (#417-201) at Q8.



( ) X29A829 transistor (#417-201) at Q9.

( ) X29A829 transistor (#417-201) at Q10.

NOTE: When installing all capacitors onto this circuit board, remove any excess coating from the leads. Use long-nose pliers to remove this coating.

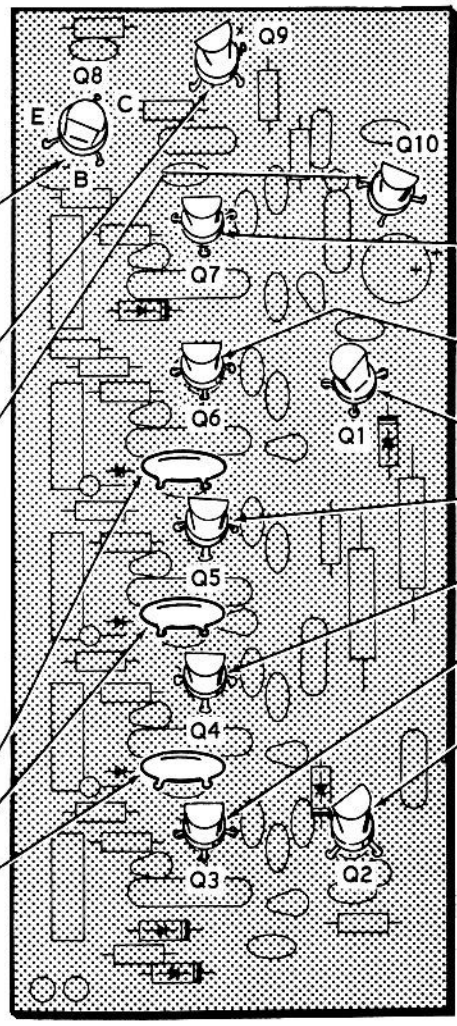


( ) .005 μF disc.

( ) .005 μF disc.

( ) .005 μF disc.

( ) Solder all connections and cut off the excess lead lengths.



CONTINUE

( ) 2N5232A/2N3391A transistor (#417-91) at Q7.

( ) 2N5232A/2N3391A transistor (#417-91) at Q6.

( ) 2N3393 transistor (#417-118) at Q1.

( ) 2N5232A/2N3391A transistor (#417-91) at Q5.

( ) 2N5232A/2N3391A transistor (#417-91) at Q4.

( ) 2N5232A/2N3391A transistor (#417-91) at Q3.

( ) 2N3393 transistor (#417-118) at Q2.

( ) Check to see that all connections are soldered and the excess lead lengths are cut off.

PROCEED TO PICTORIAL 1-3.

PICTORIAL 1-2

START

( ) .022 μF Mylar. (small).

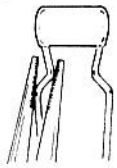
( ) .001 μF disc.

( ) .001 μF disc.

( ) .001 μF disc.

( ) .001 μF disc.

NOTE: When installing .022 μF Mylar (large) capacitors, use long-nose pliers and straighten the leads if necessary after removing the excess coating from the leads.

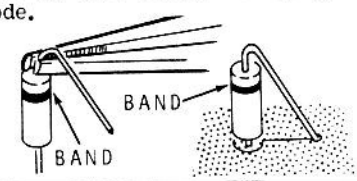


( ) .022 μF Mylar, (large).

( ) .022 μF Mylar, (large).

( ) Solder all connections and cut off the excess lead lengths.

NOTE: When installing silicon diodes vertically, position the lead opposite the cathode (banded end) in the hole with the outline. Hold the diode lead with pliers so the diode is not broken when bending the lead. Bend the lead before installing the diode.



( ) Silicon diode D7 (S160). Position banded end up.

( ) Silicon diode D6 (S160). Position banded end up.

( ) .022 μF Mylar (large).

( ) Silicon diode D5 (S160). Position banded end up.

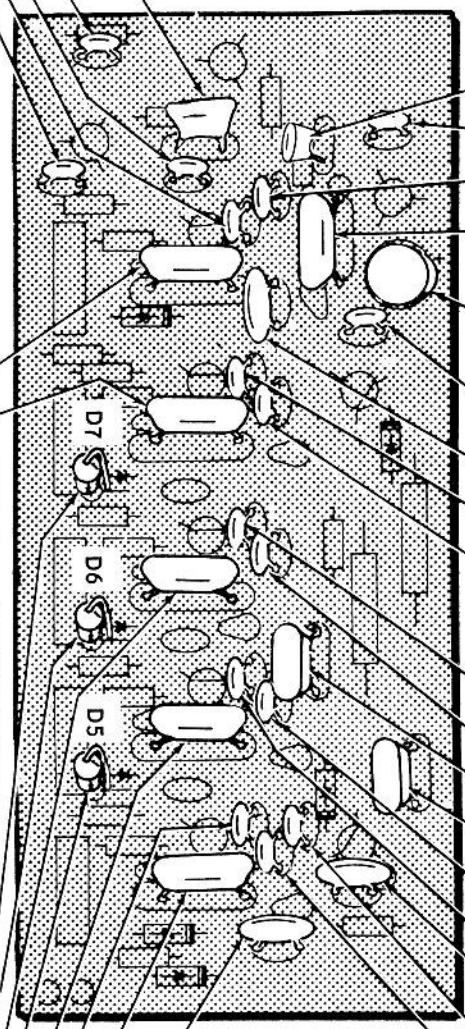
( ) .022 μF Mylar (large).

( ) .001 μF disc.

( ) .022 μF Mylar (large).

( ) .005 μF disc.

( ) Solder all connections and cut off the excess lead lengths.



PICTORIAL 1-3

CONTINUE

( ) .01 μF Mylar.

( ) .001 μF disc.

( ) .001 μF disc.

( ) .1 μF Mylar.

( ) 50 μF electrolytic. Position the positive (+) lead in the positive (+) marked hole in the circuit board.

( ) .001 μF disc.

( ) .005 μF disc.

( ) .001 μF disc.

( ) .001 μF disc.

( ) Solder all connections and cut off the excess lead lengths.

( ) .001 μF disc.

( ) .001 μF disc.

( ) .1 μF Mylar.

( ) .1 μF Mylar.

( ) .001 μF disc.

( ) .001 μF disc.

( ) .005 μF disc.

( ) .001 μF disc.

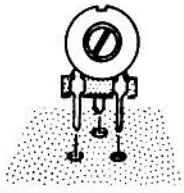
( ) .001 μF disc.

( ) Solder all connections and cut off the excess lead lengths.

PROCEED TO PICTORIAL 1-4.

START

( ) Install 50 kΩ controls (#10-222) at the CHAN. 5, CHAN. 4, CHAN. 3, CHAN. 2, and CHAN. 1 locations. Solder all three connections of each control as it is installed.



NOTE: The cable assembly will be installed in the next step. Look at the end of each wire in the assembly before you install it. If the small strands have separated, twist them together again. Then apply a small amount of solder to the end of the wire to hold the strands together.

( ) Position the cable assembly over the circuit board with the breakouts as shown. (The term "breakout" refers to a place where a group of wires come from the cable assembly.) Solder each wire as it is installed. NOTE: Do not shorten any of the wires even though they may seem too long.

( ) White-blue to 10.

( ) White-green to 8.

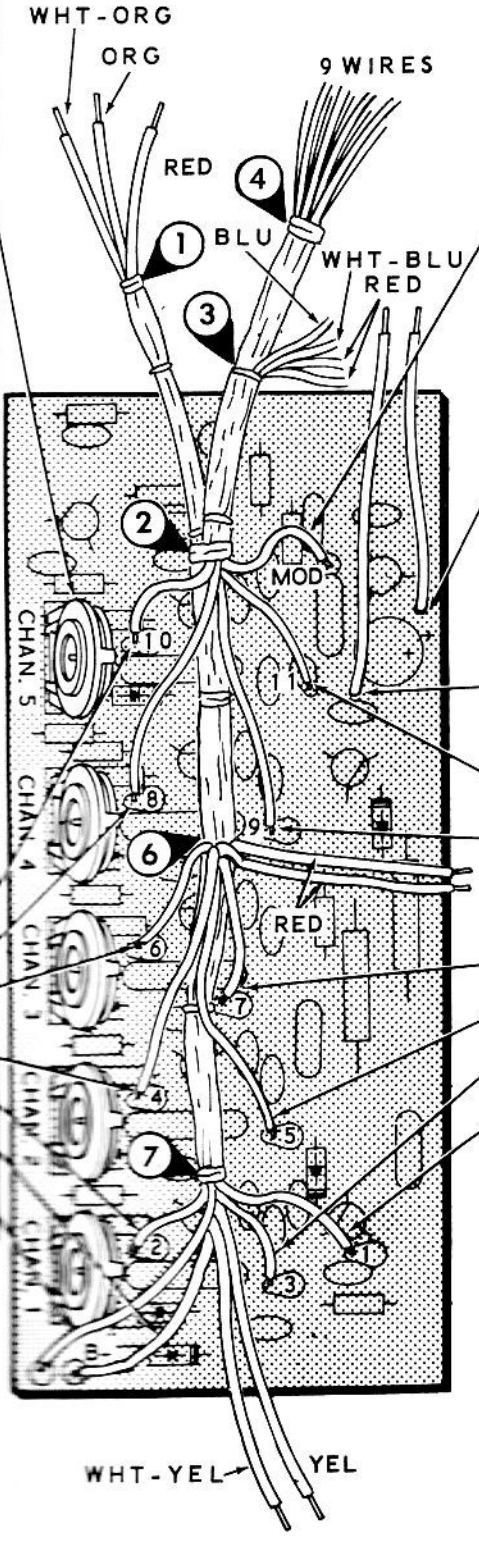
( ) White-yellow to 6.

( ) White-orange to 4.

( ) White-brown to 2.

( ) Red to indicated B-.

( ) White-red to other B-.



CONTINUE

( ) Violet to MOD.

NOTE: Be sure to use solid wire in all steps unless stranded wire is specified.

( ) Cut off a 2" length of red solid wire, remove 1/4" of insulation from each end, and solder one end in the indicated position. The other end will be connected later. NOTE: The hole is not marked.

( ) Cut off a 2-1/2" length of black solid wire, remove 1/4" of insulation from each end, and solder one end in the indicated position. The other end will be connected later. NOTE: The hole is not marked.

( ) Black to 11.

( ) Blue to 9.

NOTE: These two red wires will be connected later.

( ) Green to 7.

( ) Yellow to 5.

( ) Orange to 3.

( ) Brown to 1.

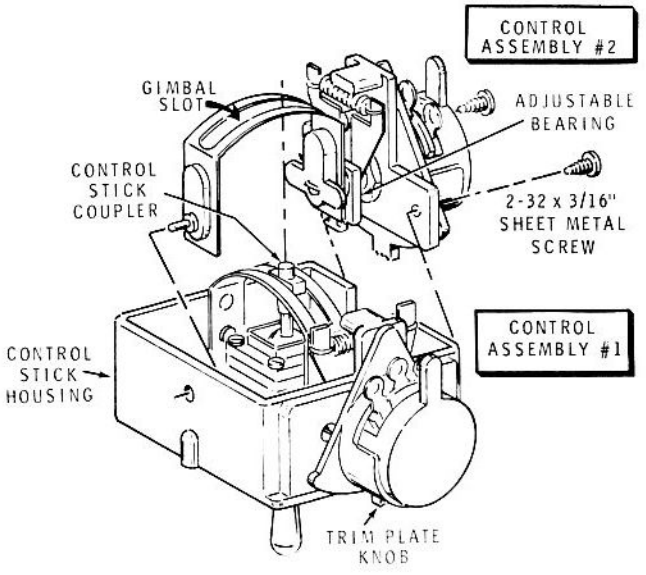
( ) Check all connections to see that they are soldered and cut off any excess lead lengths. Be sure there are no solder bridges between the foils. The remaining cable assembly wires will be connected later.

( ) Set the completed circuit board aside temporarily.

FINISH

PICTORIAL 1-4

CONTROL STICKS ASSEMBLY

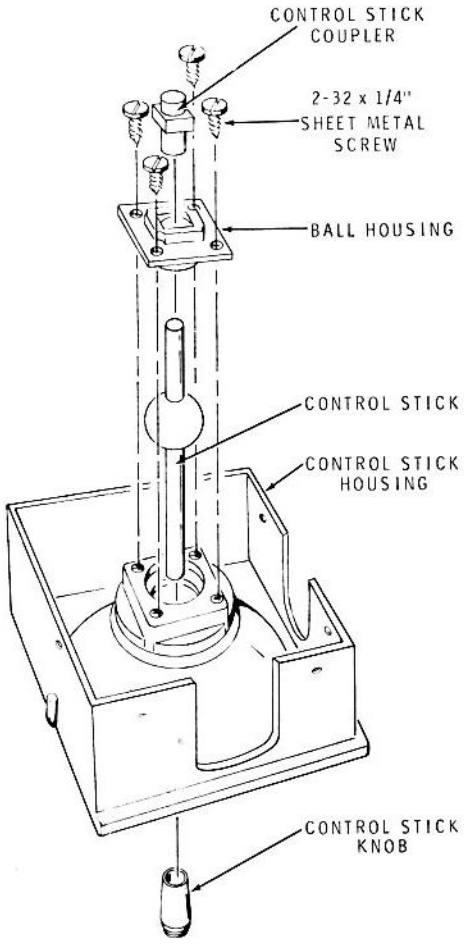


PICTORIAL 1-5

Refer to Pictorial 1-5 for an overall view of the control stick assemblies as you perform the following steps.

In the following steps you will put together both control stick assemblies. Carefully assemble the parts as shown in each of the Details; be sure each part is in its proper place, and that nuts and screws are properly tightened. Before you perform each step, locate the necessary parts for that step. NOTE: The nylon parts are precision molded and, in some cases, may require a force fit.

NOTE: Both control sticks will be assembled with all centering springs attached. Then, the proper spring will be removed later to establish the correct mode of operation for the throttle control. Please perform all of the steps as directed to obtain the correct results.



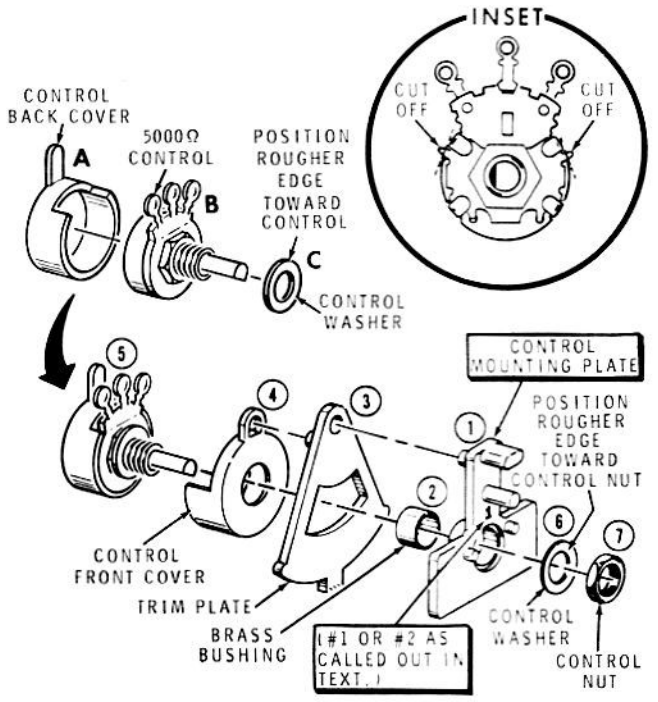
Detail 1-5A

( ) Assemble a control stick housing as shown in Detail 1-5A.

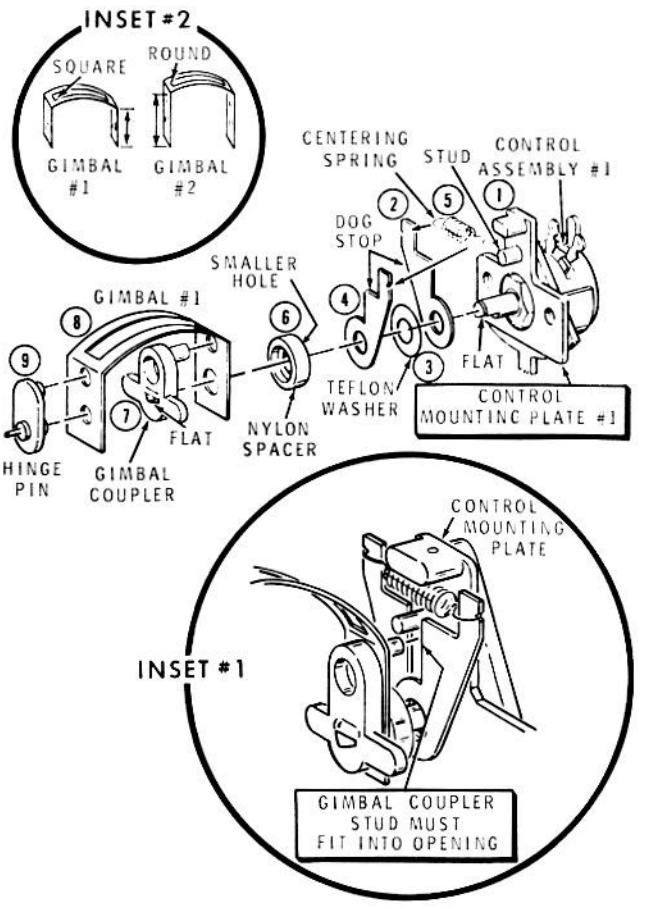
( ) Assemble the remaining control stick housing as shown.

NOTE: To operate properly, the control sticks must move freely. Move the control stick knobs in a circular motion and loosen the ball housing screws if necessary.

( ) Set the two units aside until they are called for later.



Detail 1-5B



Detail 1-5C

CONTROLS

( ) Refer to the inset drawing on Detail 1-5B and examine the four 5000 Ω controls. If small ears protrude past the control body, cut them off.

( ) Refer to Detail 1-5B and carefully examine each of the control mounting plates to be used in the next step. Note a small #1 on two plates and a #2 on the other two plates (the numbers may be printed backwards). The #1 or #2 determines the number of the assembly. NOTE: Other parts may also have numbers on them, but these may be disregarded.

Refer to Detail 1-5B as you perform the following steps. Be sure to assemble the parts following the lettered sequence, A through C, and then the numbered sequence, 1 through 7, in the Detail. CAUTION: Do NOT over tighten the control nut; if the control nut is too tight, it can prevent the trim plate from adjusting the control.

( ) Assemble a #1 control assembly.

( ) Assemble the remaining #1 control assembly.

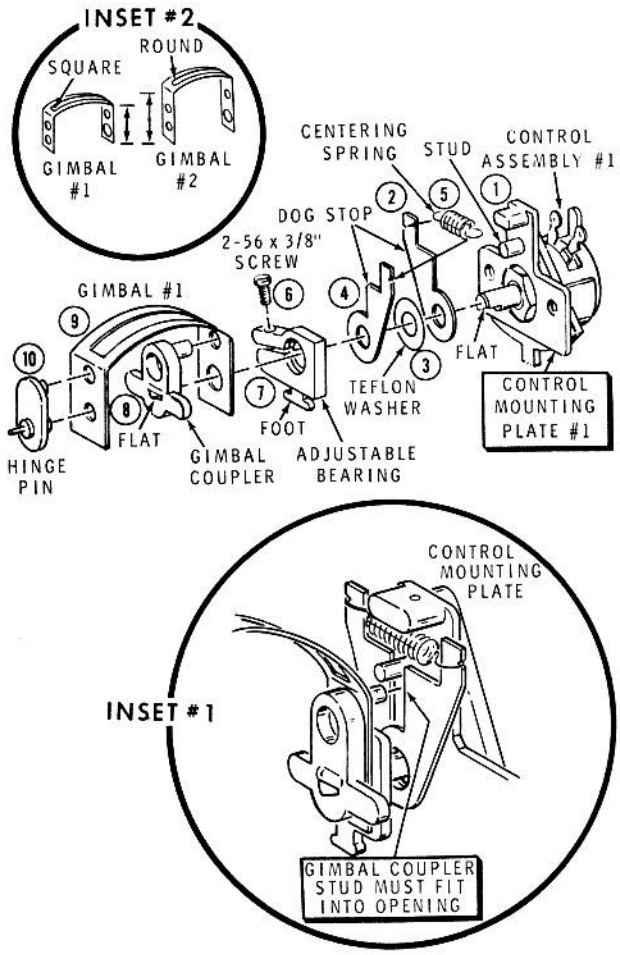
( ) Assemble a #2 control assembly.

( ) Assemble the remaining #2 control assembly.

Refer to inset drawing #2 on Detail 1-5C and notice the difference between gimbals #1 and #2.

Locate all parts before you start each of the next four steps. Note that some different parts are used in each assembly.

( ) Assemble a gimbal assembly #1 as shown in Detail 1-5C. It may be necessary to use some force to assemble the hinge pins and gimbal couplers to the gimbals in steps 7, 8, and 9.

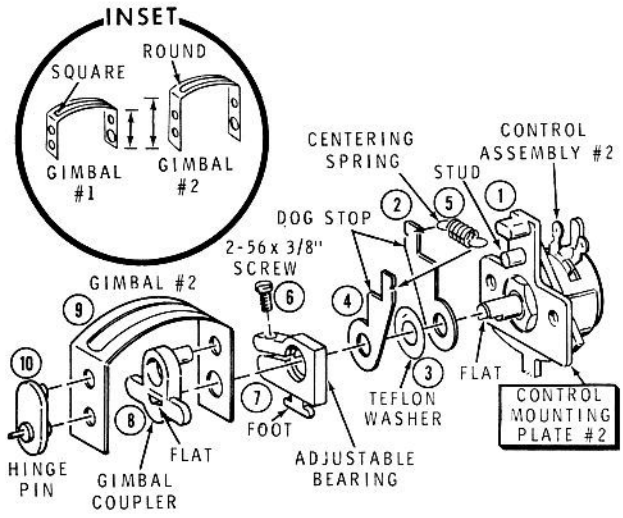


Detail 1-5D

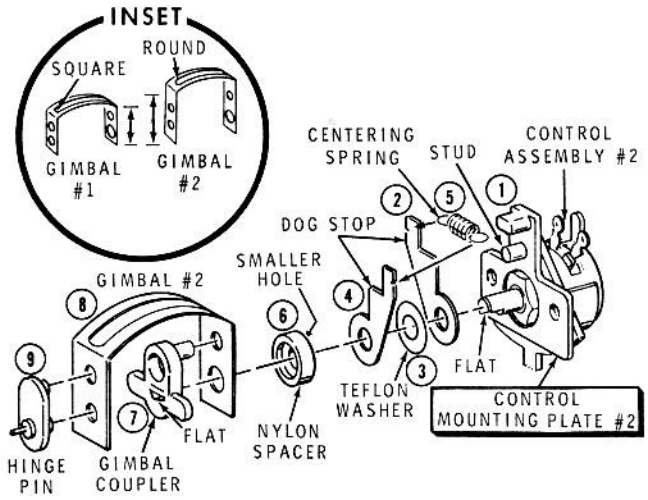
( ) Assemble a gimbal assembly #1 as shown in Detail 1-5D.

( ) Assemble a gimbal assembly #2 as shown in Detail 1-5E.

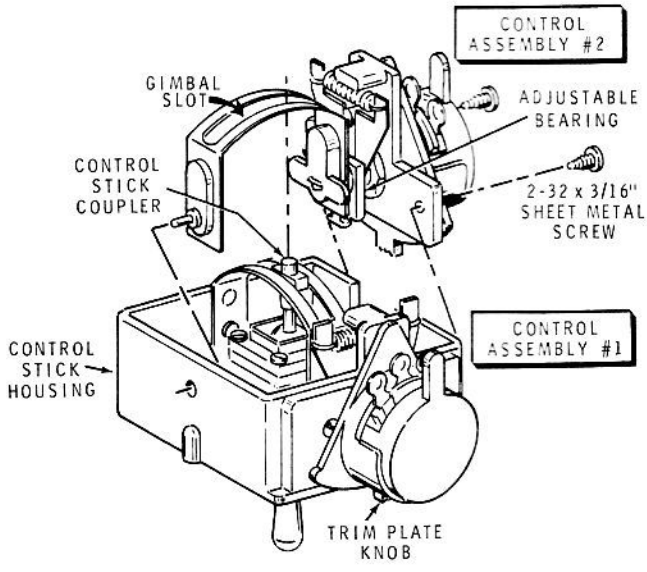
( ) Assemble a gimbal assembly #2 as shown in Detail 1-5F.



Detail 1-5E

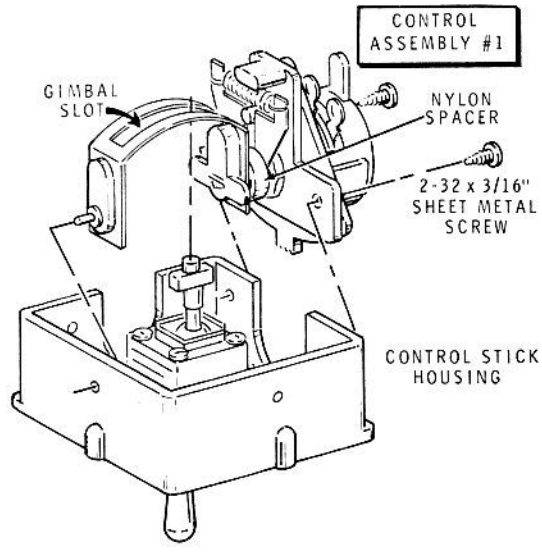


Detail 1-5F



PICTORIAL 1-5
(Repeat)

( ) Refer to Detail 1-5G and mount the completed control assembly #1 with the nylon spacer (assembled in Detail 1-5C) in the following manner: Hook the hinge pin into its hole, position the rectangular portion of the control stick coupler into the gimbal slot, and fasten the control assembly with two 2-32 x 3/16" screws. The control mounting plate screw holes are made accessible by moving the trim plate knob one way or the other.

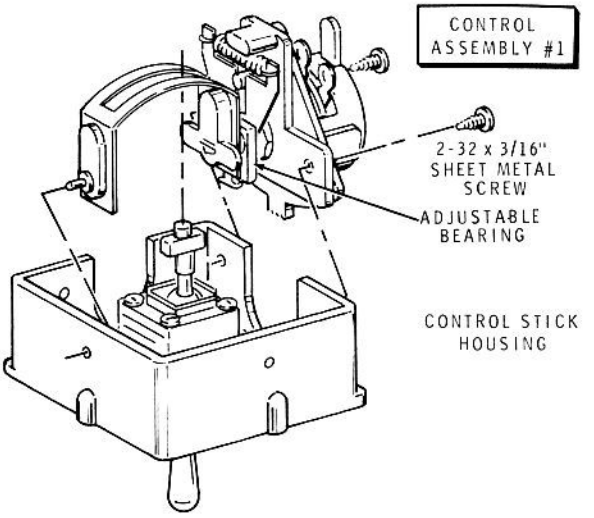


Detail 1-5G

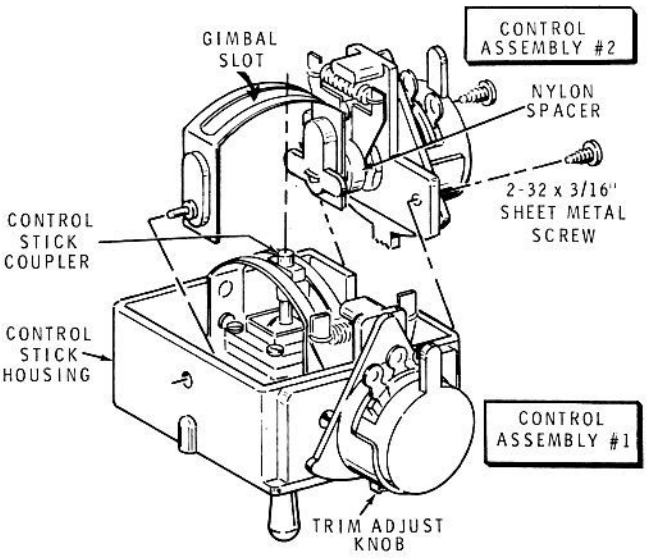
( ) Refer to Pictorial 1-5 and locate the control assembly #2 with an adjustable bearing (assembled in Detail 1-5E). Position the adjustable bearing so its foot is pointing straight down, as shown, and tighten the adjustable bearing screw. The gimbal must now point straight up when the adjustable bearing foot points down as shown.

( ) Mount the control assembly #2 from the previous step into the remaining control stick housing position (#2). Position the remaining portion of the control stick coupler into the gimbal slot, and fasten the control assembly with two 2-32 x 3/16" screws.

( ) Loosen the adjustable bearing screw three complete turns.



Detail 1-6A



PICTORIAL 1-6

Refer to Pictorial 1-6 for an overall view of the control stick assemblies as you perform the following steps.

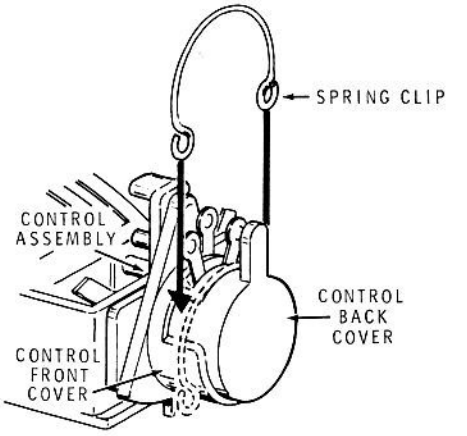
( ) Refer to Detail 1-6A and locate the control assembly #1 with an adjustable bearing (assembled in Detail 1-5D). Position the adjustable bearing so its foot is pointing straight down, as shown, and tighten the adjustable bearing screw. The gimbal must now point straight up when the adjustable bearing foot points down as shown.

( ) Mount the control assembly #1 from the previous step as shown. Position the rectangular portion of the control stick coupler into the gimbal slot and fasten the assembly with two 2-32 x 3/16" screws.

( ) Loosen the adjustable bearing screw three complete turns.

( ) Refer to Pictorial 1-6 and mount the remaining control assembly (assembly #2 with a nylon spacer, assembled in Detail 1-5F) into the remaining control stick housing position (#2). Position the remaining portion of the control stick coupler into the gimbal slot and fasten the assembly with two 2-32 x 3/16" screws.

( ) Refer to Detail 1-6B and push a spring clip onto each of the control assemblies. The three control lugs may have to be bent out of the way to do this.



Detail 1-6B

This completes the assembly of the control sticks. When the control stick is moved to any position other than center and released, it should freely return to center. However, if the control stick binds or does not return to center, try loosening the four ball-housing screws shown in Detail 1-5A. If this does not remedy the situation, make sure that #1 or #2 parts were used when they were called for. Also be sure the control stick coupler fits into the gimbal track properly as shown in Pictorials 1-5 and 1-6.

CHASSIS ASSEMBLY

CABINET PARTS MOUNTING

Refer to Pictorial 1-7 (fold-out from Page 10) for the following steps.

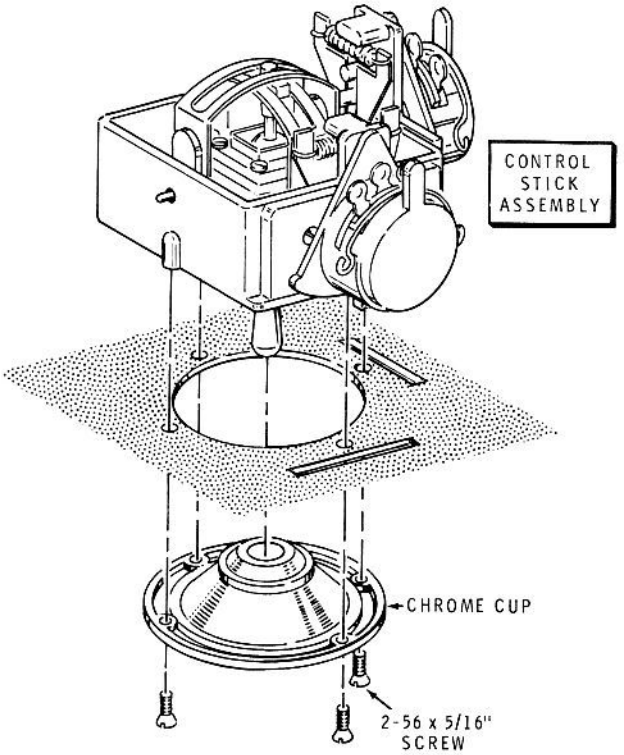
( ) Place a soft cloth on your work area to prevent the cabinet from being scratched.

( ) Locate the cabinet front and position it on your work area as shown.

NOTE: Use the plastic nut starter to hold and start 6-32 and 4-40 nuts on screws. Refer to Page 3 of the Kit Builders Guide.

( ) Locate the control stick assemblies, chrome cups, and eight 2-56 x 5/16" screws.

( ) Mount the control stick assemblies as shown in Detail 1-7A with the adjustable bearings positioned as shown in Pictorial 1-7.

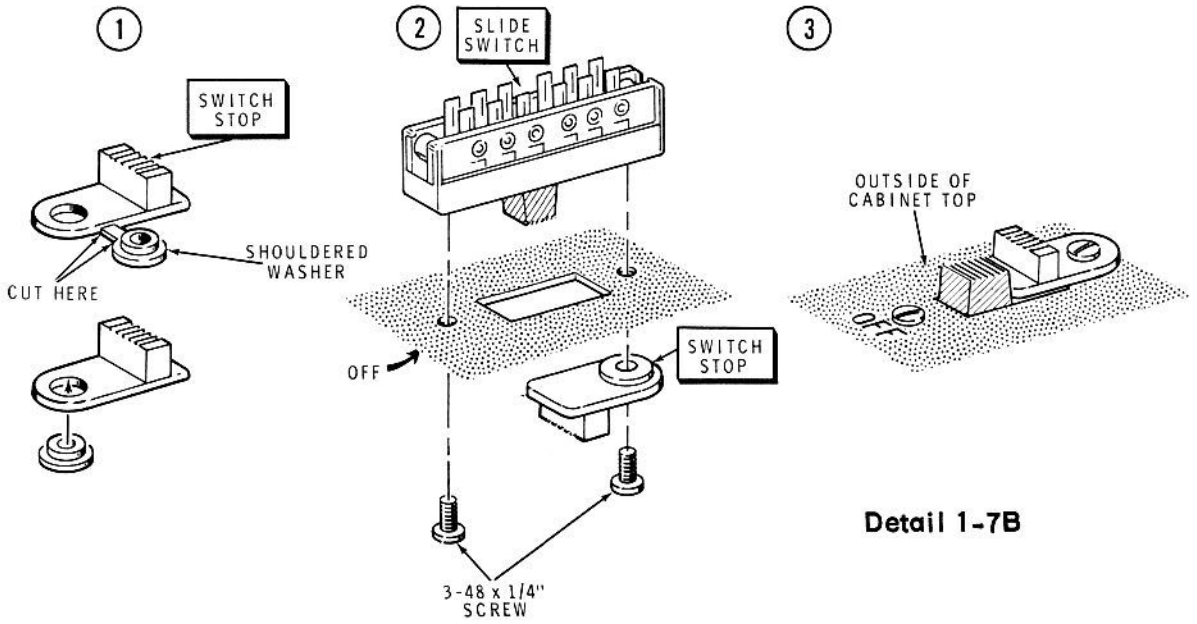


Detail 1-7A

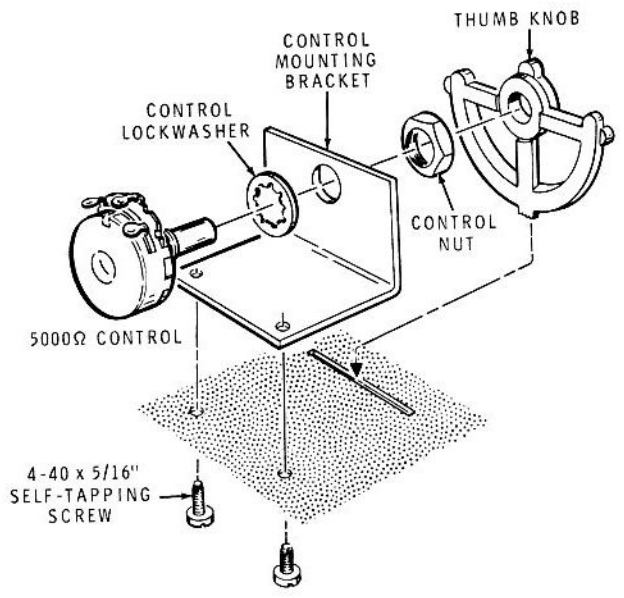
Refer to Detail 1-7B for the following steps.

( ) Locate the switch stop and cut off the shouldered washer as shown in part 1 of the Detail. Then push the shouldered portion of the washer into the hole of the switch stop.

( ) Mount the slide switch and switch stop at C with two 3-48 x 1/4" screws as shown in parts 2 and 3 of the Detail. The switch is symmetrical and can be positioned either way.



Detail 1-7B



Detail 1-7C

Refer to Detail 1-7C for the following steps.

( ) Install the 5000 Ω control (#10-273) on the control mounting bracket as shown with a control lockwasher and a control nut.

( ) Rotate the control shaft back one-quarter turn from the full clockwise position.

( ) Push the thumb knob onto the control shaft so the thumb knob points down with the control at its preset position.

( ) Mount the control mounting bracket at D with two 4-40 x 5/16" self-tapping screws.

( ) Rotate the knob to make sure it moves freely. If it does not, reposition the control mounting bracket or knob.

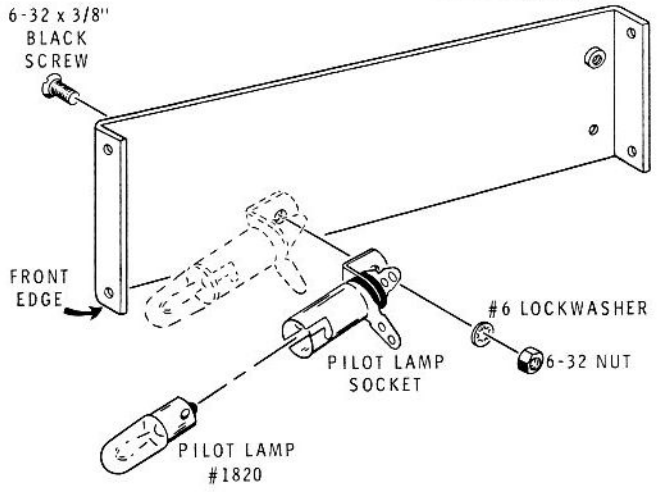
Refer to Detail 1-7D for the following steps.

( ) Insert the pilot lamp into the pilot lamp socket.

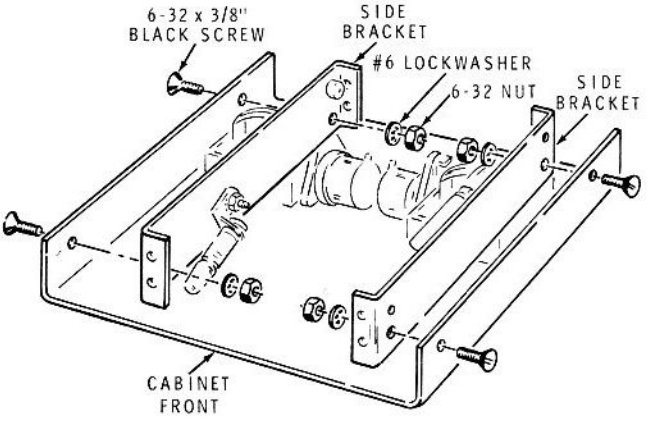
( ) Mount the pilot lamp socket to either side bracket at E with a 6-32 x 3/8" black screw, #6 lockwasher, and 6-32 nut. Position the pilot lamp socket so the lamp is near the bottom of the front edge as shown.

Refer to Detail 1-7E for the following steps.

( ) Mount the side bracket, with the pilot lamp, to the cabinet front as shown. Use two 6-32 x 3/8" black screws, #6 lockwashers, and 6-32 nuts.



Detail 1-7D



Detail 1-7E

( ) Mount the remaining side bracket with two 6-32 x 3/8" black screws, #6 lockwashers, and 6-32 nuts.

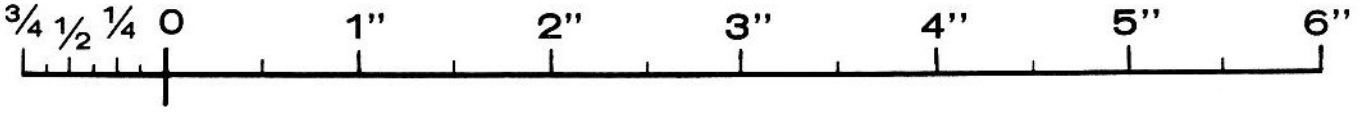
Refer to Pictorial 1-8 (fold-out from Page 10) and Detail 1-8A for the following steps.

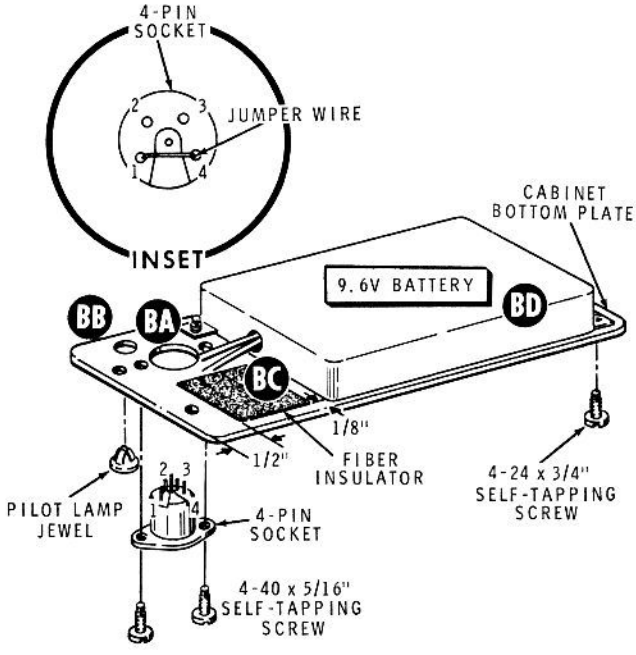
( ) Position the cabinet bottom plate as shown in Detail 1-8A.

( ) Mount the 4-pin socket at BA with two 4-40 x 5/16" self-tapping screws. Position the socket as shown.

( ) Locate a length of excess resistor lead or solid wire with its insulation removed and cut it to a length of 1/2".

( ) Refer to the inset drawing and connect this wire from lug 1 (S-1) to lug 4 (S-1) of the socket BA. NOTE: Do not allow the wire to touch any other metal parts on the socket.





Detail 1-8A

( ) Install the pilot lamp jewel at BB. Push on the jewel until it snaps into place.

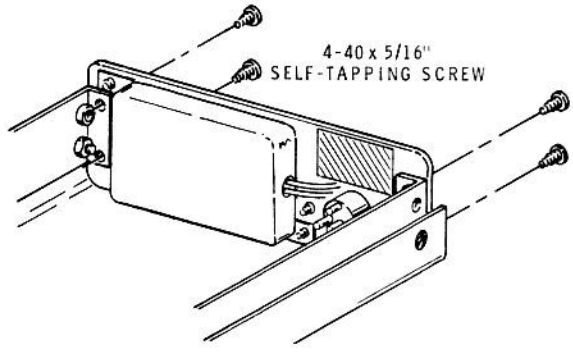
( ) Clean the area on the bottom plate at BC of any grease where the fiber insulator is to be installed.

NOTE: In the following steps, note the dimensions on Detail 1-8A for correct positioning of the fiber insulator.

( ) Peel off the protective backing and press the fiber insulator in place at BC.

( ) Mount the battery at BD with two 4-24 x 3/4" self-tapping screws. CAUTION: Do not overtighten these screws.

( ) Refer to Detail 1-8B and mount the cabinet bottom plate with four 4-40 x 5/16" self-tapping screws.



Detail 1-8B

( ) Make sure switch C, the ON-OFF switch, is in the OFF position.

CAUTION: Do not turn the Transmitter on until instructed to do so. This could damage the battery.

( ) Cut each battery lead to a length of 3". NOTE: Cut only ONE lead at a time.

CAUTION: In the following steps do not let the bare battery lead ends touch each other. Where a wire passes through a connection and then goes to another point as in the following steps, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection.

NOTE: If your transmitter is on the 53 MHz band, do not perform the next two steps only. (The battery will be connected later for the 53 MHz band).

FOR 27 AND 72 MHz BAND TRANSMITTERS ONLY

( ) Remove 1/4" of insulation from the black battery lead. Then connect this lead through lug 11 (S-2) to lug 5 (S-1) of switch C.

( ) Remove 1/4" of insulation from the red battery lead. Then connect this lead through lug 8 (S-2) to lug 2 (S-1) of switch C.

NOTE: When wiring this kit, you will be instructed to prepare lengths of hookup wire. To prepare wire, cut it to the indicated length and remove 1/4" of insulation from each end. Scales are provided on a number of pages throughout the Manual for measuring wires.

Always use solid wire unless stranded is specified in a step. When stranded wire is called for, twist the strands together and melt a small amount of solder on the bare wire ends to hold the separate strands together.

( ) Prepare a 2-1/2" length of black wire.

( ) Connect one end of this wire through lug 10 (S-2) to lug 4 (S-1) of switch C. Connect the other end of the wire to lug 1 of socket E as shown (S-1).

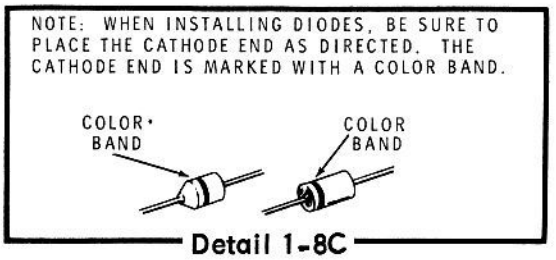
( ) Cut one lead of the 1000 Ω 7 watt resistor to a length of 1".

( ) Connect the long lead of the 1000 Ω 7 watt resistor through lug 7 (S-2) to lug 1 (S-1) of switch C.

( ) Connect the other lead of the 1000 Ω 7 watt resistor to lug 3 of socket BA (S-1). Push the resistor down against the cabinet as shown.

( ) Locate the 1N2079 (#57-27) silicon diode and cut each lead to a length of 3/4".

( ) Refer to Detail 1-8C and connect the cathode end of this silicon diode to lug 2 of socket BA (S-1).



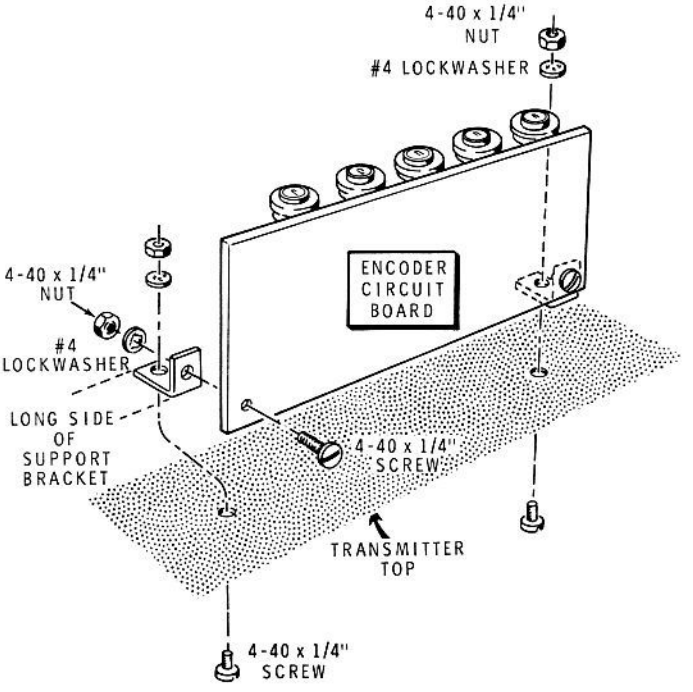
Detail 1-8C

( ) Connect the other lead of the silicon diode to lug 2 of socket E (S-1).

Refer to Pictorial 1-9 (fold-out from Page 25) for the following steps.

( ) Refer to Detail 1-9A and mount the two support brackets to the component side of the encoder circuit board. Use two 4-40 x 1/4" screws, #4 lockwashers, and 4-40 nuts. Position the brackets with the long side as shown.

( ) Place the encoder circuit board into the cabinet and secure it with two 4-40 x 1/4" screws, #4 lockwashers, and 4-40 nuts. Make sure no wires are pinched between the circuit board and the front panel.



Detail 1-9A

PRELIMINARY WIRING

Refer to Pictorial 1-9 for the following steps.

( ) Connect the solid red wire coming from the encoder circuit board through lug 3 (S-2) to lug 9 (S-1) of switch C.

( ) Connect the solid black wire coming from the encoder circuit board through lug 6 (S-2) to lug 12 (S-1) of switch C.

NOTE TO EXPERIENCED MODELERS: Do not change any of the following steps. It is not necessary for you to choose a particular mode of operation at this time, since the Transmitter controls will be wired to operate in any mode. (Modes of operation are explained in detail during the Receiver wiring, on Page 49, where you must choose the mode you intend to use.)

The wires from the wire harness will be connected to the controls and RF circuit board in the following steps. The term "breakout", and its abbreviation - BO, refers to a place where a group of wires come out of the harness.

NOTE: Do not cut any of the harness leads, even though they may appear to be too long.

WARNING: Be careful not to melt any of the nylon on the control sticks while soldering.

( ) Connect the two red wires from BO#6 (breakout #6) to lug 1 of the channel 3 control (S-2).

( ) Connect the white-yellow wire from BO#7 to lug 2 of the channel 3 control (S-1).

NOTE: If your transmitter will operate in the 27 MHz or 72 MHz bands, solder the connections in the next two steps. The connections on the 53 MHz band transmitter will be soldered later.

( ) Connect the yellow wire from BO#7 to lug 3 of the channel 3 control (S-1). (NS) on 53 MHz band transmitters.

( ) Connect the white-brown wire from BO#4 to lug 2 of the channel 1 control (S-1). (NS) on 53 MHz band transmitters.

( ) Connect the two red wires from BO#4 to lug 1 of the channel 1 control (NS).

( ) Connect the brown wire from BO#4 to lug 3 of the channel 1 control (S-1).

( ) Connect the two red wires from BO#3 to lug 1 of the channel 5 control (S-2).

( ) Connect the white-blue wire from BO#3 to lug 2 of the channel 5 control (S-1).

( ) Connect the blue wire from BO#3 to lug 3 of the channel 5 control (S-1).

( ) Connect the red wire from BO#1 to lug 1 of the channel 2 control (S-1).

( ) Connect the white-orange wire from BO#1 to lug 2 of the channel 2 control (S-1).

( ) Connect the orange wire from BO#1 to lug 3 of the channel 2 control (S-1).

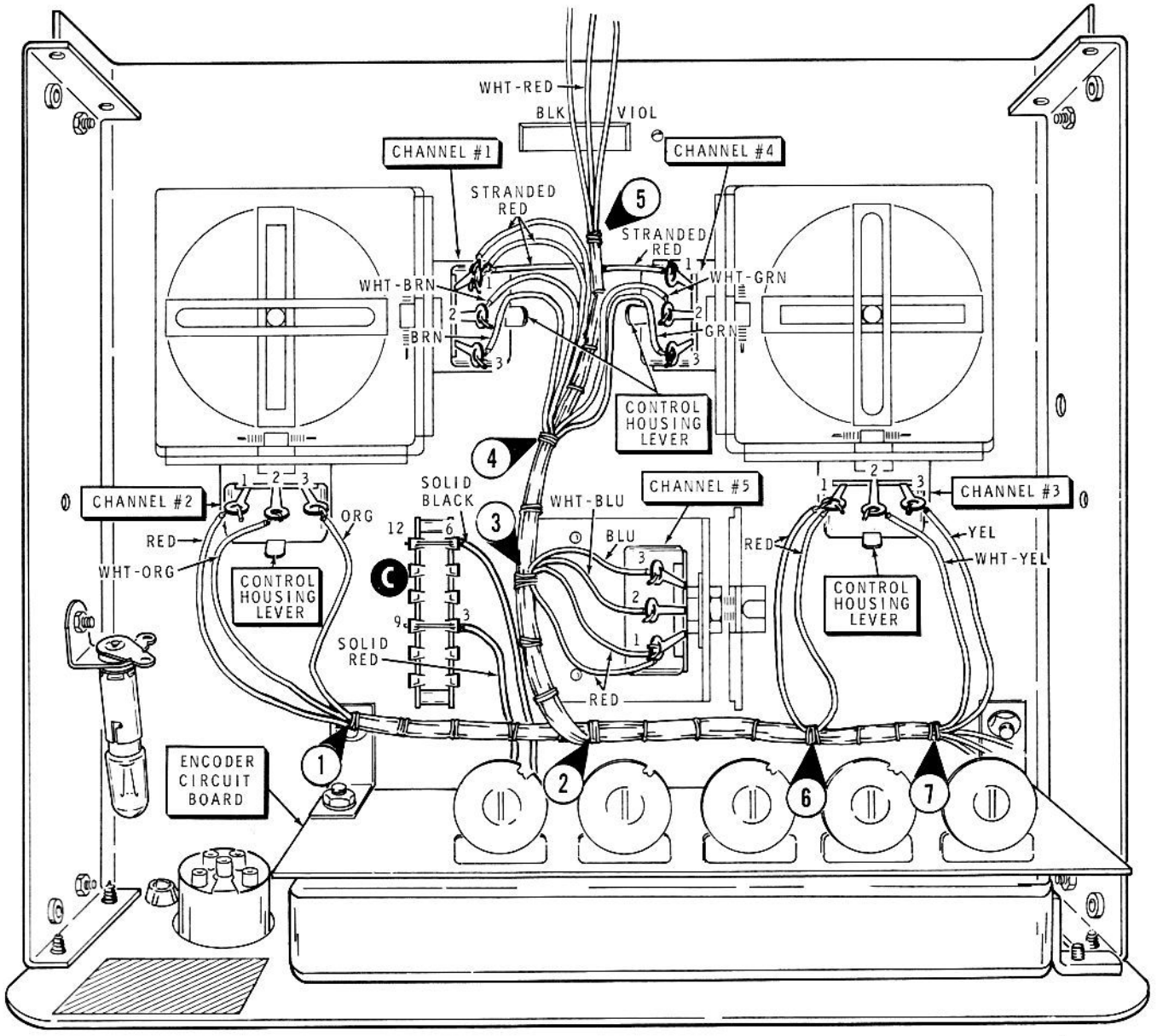
( ) Connect the green wire from BO#4 to lug 3 of the channel 4 control (S-1).

( ) Connect the white-green wire from BO#4 to lug 2 of the channel 4 control (S-1).

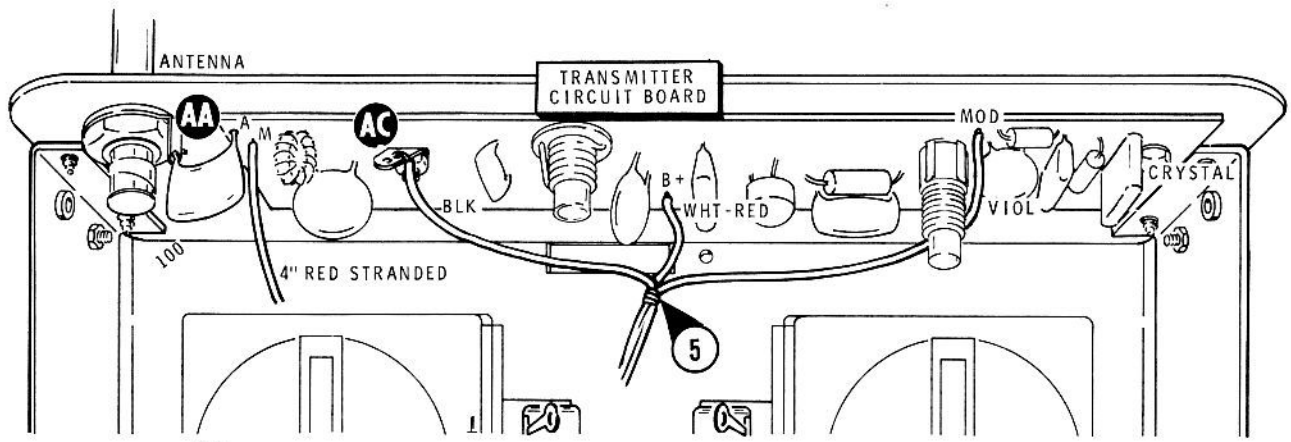
( ) Prepare a 2-1/2" length of red stranded wire.

( ) Connect this wire from lug 1 of the channel 4 control (S-1) to lug 1 of the channel 1 control (S-3).

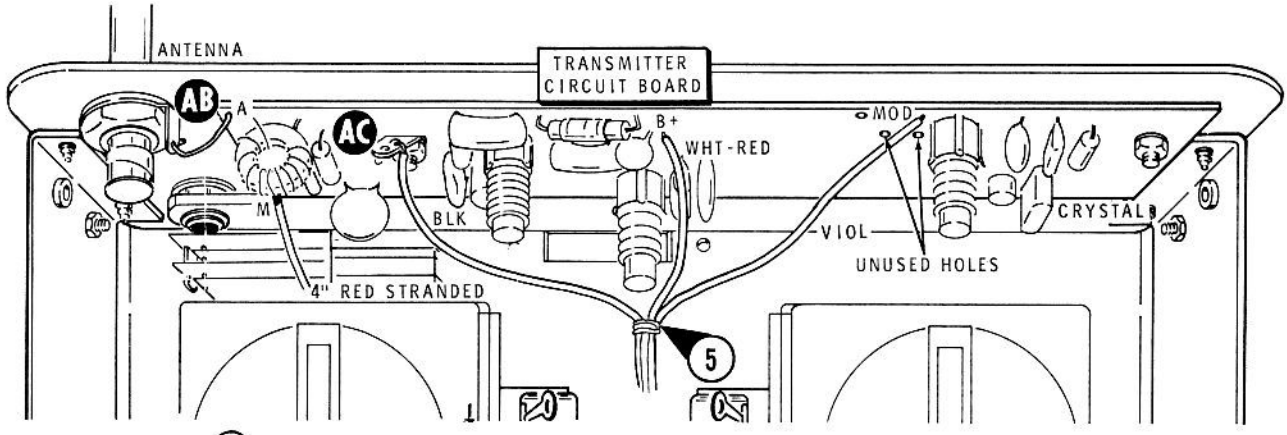
( ) Position the harness wires around the control housing levers as shown in the Pictorial.



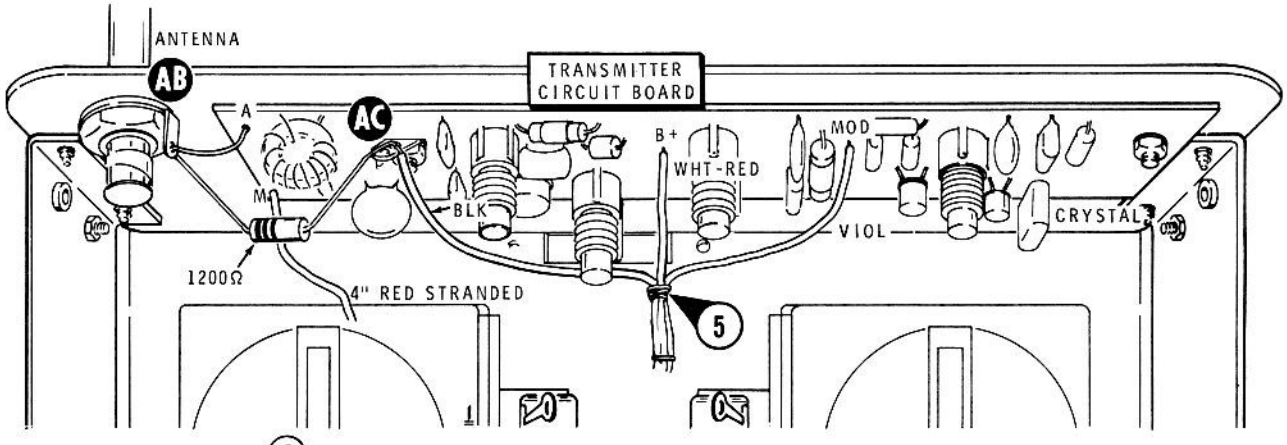
PICTORIAL 1-9



(A) WIRING FOR 27MHz TRANSMITTER CIRCUIT BOARD



(B) WIRING FOR 53MHz TRANSMITTER CIRCUIT BOARD



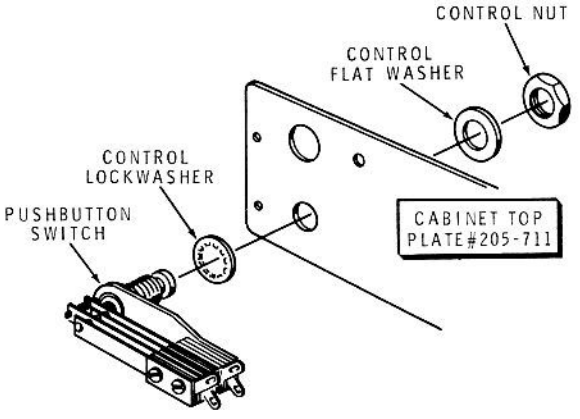
(C) WIRING FOR 72MHz TRANSMITTER CIRCUIT BOARD

PICTORIAL 1-11

NOTE: The following steps are for 53 MHz band transmitters only. For 27 MHz and 72 MHz band transmitters, proceed to ALL BANDS on Page 28.

Refer to Pictorial 1-10 for the following steps.

Refer to Detail 1-10A and remove the control nut and control flat washer from the pushbutton switch assembly. Using a control lockwasher and the hardware just removed, mount the pushbutton switch assembly on the cabinet top plate as shown.



Detail 1-10A

( ) Prepare the following lengths of stranded wire:

LENGTH	COLOR
3"	brown
9"	brown

( ) Connect one end of the 3" brown stranded wire to lug 3 of the pushbutton switch (S-1). See the inset drawing in Pictorial 1-10.

( ) Connect the other end of this wire to lug 2 of the channel 1 control (S-2).

( ) Connect a .033 μF Mylar capacitor from lug 2 (NS) to lug 4 (S-1) of the pushbutton switch (S-2). See the inset drawing in Pictorial 1-10.

( ) Connect one end of the 9" brown stranded wire to lug 2 of the pushbutton switch (S-2). See the inset drawing in Pictorial 1-10.

( ) Connect the other end of this wire to lug 3 of the channel 3 control (S-2).

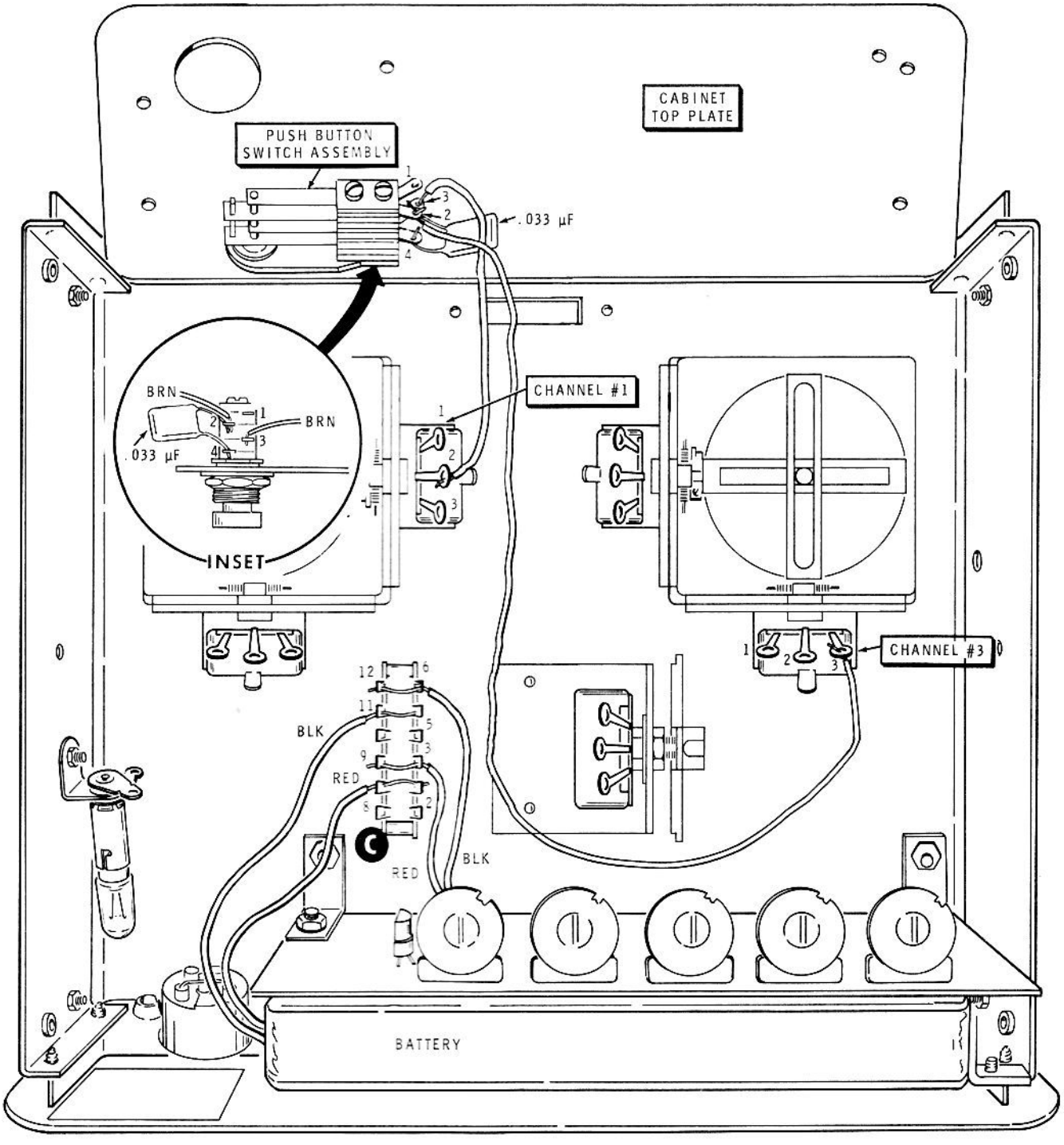
CAUTION: In the following steps, do NOT let the bare battery lead ends touch each other.

( ) Make sure switch C, the ON-OFF switch, is in the OFF position.

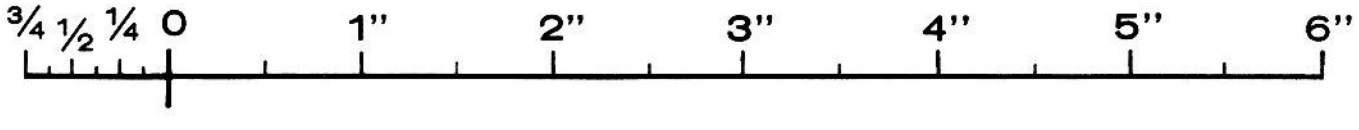
( ) Remove 1/4" of insulation from the black battery lead. Then connect this lead through lug 11 (S-2) to lug 5 (S-1) of switch C.

( ) Remove 1/4" of insulation from the red battery lead. Then connect this lead through lug 8 (S-2) to lug 2 (S-1) of switch C.

NOTE: For the following steps, you will be referred to details that do not show the pushbutton switch assembly. Do not be alarmed by this and perform each step as instructed.



PICTORIAL 1-10



ALL BANDS

NOTE: Since there are three transmitting bands for this kit and each band's transmitter is different, your transmitter circuit board may or may not look like the one in Detail 1-11B. Nevertheless, even though the board may look different, it will be mounted with the crystal (X-tal) on the right-hand end of the circuit board.

Refer to Pictorial 1-11 (fold-out from Page 26) for the following steps. For 27 MHz band Transmitters refer to part A, for 53 MHz band Transmitters refer to part B, and for 72 MHz band Transmitters refer to part C.

CAUTION: The transmitter circuit board assembly has been prealigned at the factory; therefore, do not change the setting of any coil or slug.

( ) Position the transmitter circuit board above the control stick assemblies.

Connect the wires from BO#5 of the wiring harness to the transmitter circuit board as follows.

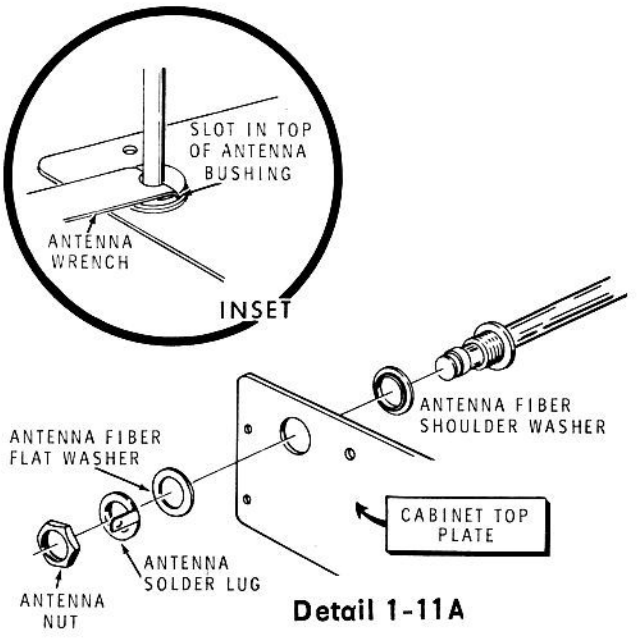
( ) Violet to the hole marked MOD (S-1).

( ) White-red to the hole marked B+ (S-1).

( ) Prepare a 4" length of red stranded wire.

( ) Connect one end of this wire into the hole marked M on the transmitter RF circuit board. The other end will be connected later.

( ) Refer to Detail 1-11A and mount the antenna on the cabinet top plate. Use the nut and solder lug furnished with the antenna, the antenna fiber flat washer, and the antenna fiber shoulder washer. Position the lug as shown in Pictorial 1-11, parts A, B, and C. Use the small end of the antenna wrench as shown in the inset drawing. Hold the antenna nut with a pair of pliers to keep it from turning.

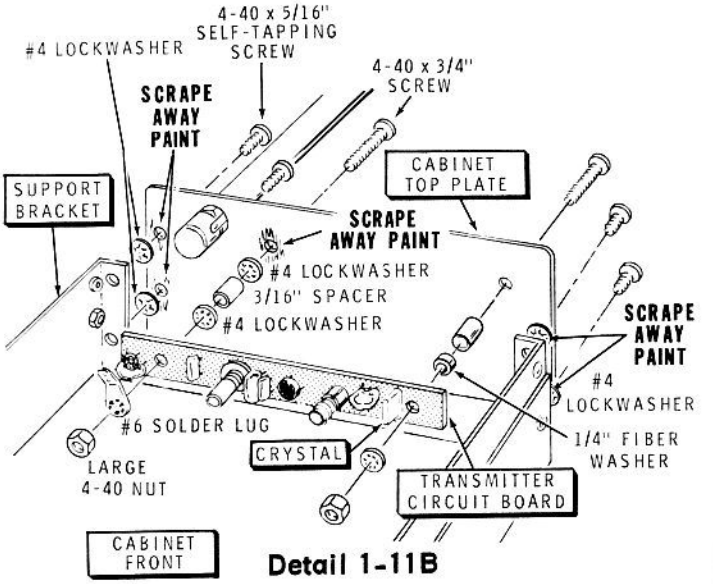


Detail 1-11A

Refer to Detail 1-11B for the following steps.

( ) On the inside of the cabinet top plate scrape away all paint around the five holes indicated. These bare spots, which should be about the size of a #4 lockwasher, are critical because they will be the "ground contact" points, without which the transmitter circuit board will not function.

( ) Mount the cabinet top plate into place with four #4 lockwashers and 4-40 x 5/16" self-tapping screws. Be sure to position the lockwashers between the cabinet top plate and the support brackets.



Detail 1-11B

( ) Mount the transmitter circuit board on the cabinet top plate with two 4-40 x 3/4" screws, three #4 lockwashers, two 3/16" spacers, one 1/4" fiber washer, and two 4-40 nuts, with a #6 solder lug at AC. Position the solder lug as shown.

RF WIRING

Complete only the following steps that refer to the transmitter RF circuit board you have purchased.

For 27 MHz Band RF Circuit Boards

Refer to part A of Pictorial 1-11 for the following steps.

( ) Cut one lead of a 100 pF mica capacitor to 1/4". Connect this lead to hole A in the transmitter circuit board (S-1).

( ) Connect the other capacitor lead to antenna lug AA (S-1), and remove the excess lead. Position the capacitor leads so they do not touch the cabinet or any other leads on the circuit board.

Proceed to Final Wiring.

For 53 MHz Band RF Circuit Boards

Refer to part B of Pictorial 1-11 for the following steps.

NOTE: Use a discarded length of resistor lead or a piece of solid wire with its insulation removed for the jumper wire in the next step.

( ) Connect a 3/4" jumper wire from antenna lug AB (S-1) to hole A on the transmitter circuit board (S-1). Position the wire so it does not touch the cabinet or any other leads on the circuit board.

Proceed to Final Wiring.

For 72 MHz Band RF Circuit Boards

Refer to part C of Pictorial 1-11 for the following steps.

( ) Cut one lead of the 1200 Ω resistor (brown-red-red) to a length of 3/4". Connect this lead to solder lug AC (NS). Use the hole that is nearest the circuit board.

( ) Insert the other lead of the 1200 Ω resistor through antenna lug AB (S-2) to hole A (S-1) on the transmitter circuit board and cut off any excess resistor lead. Position the resistor as shown, making sure that the resistor leads do not touch the donut-shaped coil.

FINAL WIRING

( ) Refer to Pictorial 1-11 and connect the black wire from BO#5 to solder lug AC (S-1 for 27 MHz band; S-1 for 53 MHz band; S-2 for 72 MHz band). NOTE: Use the hole in the solder lug that is nearest the circuit board. Do not allow solder to run into the other hole of the solder lug, as a connection will be made here later.

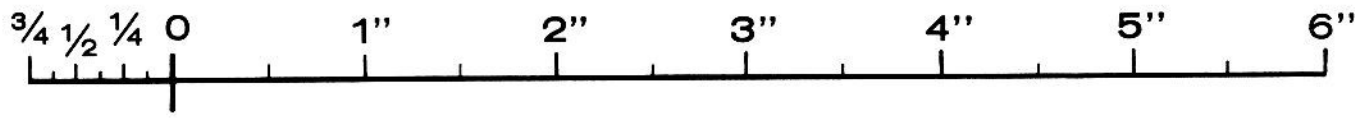
This completes the wiring of the Transmitter, except for the meter which will be connected to the Transmitter later. Check to see that all connections are soldered and shake out any wire clippings or solder splashes. The free end of the red wire coming from the transmitter circuit board will be connected later.

( ) Set the Transmitter aside temporarily.

Prepare the meter as follows:

( ) Prepare the following lengths of stranded wire:

LENGTH	COLOR
7"	black
7"	red



Refer to Pictorial 1-12 for the following steps.

( ) Remove the shorting wire or strap from between the meter lugs.

( ) Connect one end of the 7" black stranded wire to the negative (-) lug of the meter (S-1). Solder the wire flat on the lug. Do not use the hole in the lug of the meter.

( ) Connect the other end of this wire to an alligator clip. Bend the tabs over the wire and solder (S-1).

( ) Connect one end of the 7" red stranded wire to the positive (+) lug of the meter (S-1). Solder the wire flat on the lug.

( ) Connect the other end of this wire to an alligator clip. Bend the tabs over the wire and solder the connection (S-1).

( ) Set the meter aside temporarily.

CHARGING CABLE ASSEMBLY

Refer to Detail 1-13A for the following steps.

( ) Locate the line cord and cut off the bare wires at the exposed end.

( ) Locate the 4-pin plug with cap. Remove the cap from the plug if this is not already done. If a metal bushing is supplied with your cap and plug, it may be discarded.

NOTE: The line cord has a silver wire (with ribbed insulation) and a copper wire (with smooth insulation). The proper positioning of the line cord will be important in the following steps.

Refer to Detail 1-13A for the following steps.

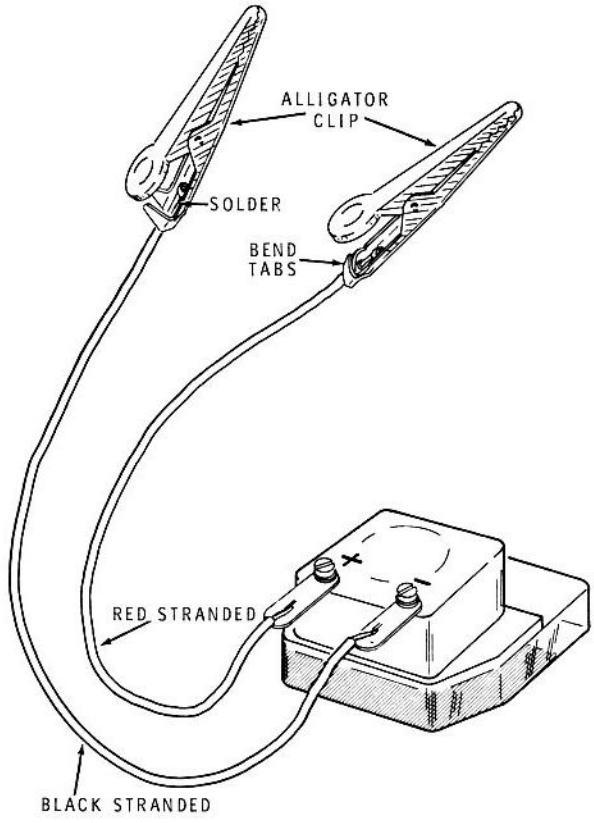
( ) Position the line cord 2-prong plug to your left-hand side as shown.

( ) With the ribbed insulation UP, fold the line cord five feet from the 2-prong plug. Then push the folded end through the hole in the small end of the 4-pin plug cap for a length of several inches.

Refer to Pictorial 1-13 (fold-out from Page 31) for the following steps.

( ) Cut the line cord at the fold.

( ) Split these two cord ends 1" and remove 1/4" of insulation from each of the four wires.



PICTORIAL 1-12

( ) Place a 1/2" length of small black sleeving over each of the four wire ends.

CAUTION: Be sure to push the sleeving as far back as possible on the leads before soldering.

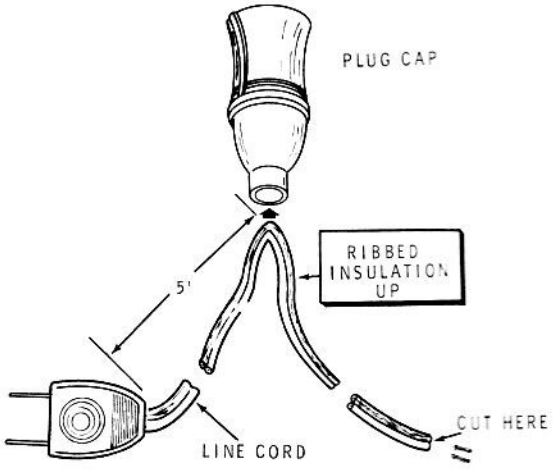
NOTE: In the following steps, you will be instructed to connect the silver (ribbed) and copper (smooth) wires of one line cord and then the silver (ribbed) and copper (smooth) wires of the other line cord to the 4-pin plug. Twist the small wire strands together at the end of each lead before inserting the leads into the connector pins.

( ) Connect the silver (ribbed) wire of the longer line cord to pin 1 (S-1).

( ) Connect the copper (smooth) wire of the longer line cord to pin 2 (S-1).

( ) Connect the copper (smooth) wire of the shorter line cord to pin 3 (S-1).

( ) Connect the silver (ribbed) wire of the shorter line cord to pin 4 (S-1).

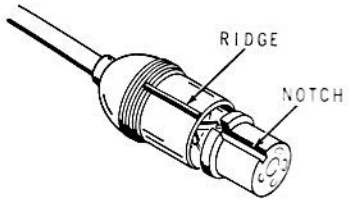


Detail 1-13A

( ) Push the sleeving over each of the four connections.

( ) Hold each section of sleeving near a hot 100 watt light bulb so the sleeving will shrink around the connection. NOTE: A match may be used if extreme care is taken.

( ) Push the plug cap over the plug. Be sure to align the ridge of the cap with the notch in the plug. See Detail 1-13B.



Detail 1-13B

The remaining end of the shorter line cord will now be connected.

( ) Slip the medium-size and large lengths of black sleeving over the unconnected line cord end. Position them several inches from the cord end.

( ) Split the line cord end 1-1/4", and remove 1/4" of insulation from each of the two wires.

( ) Slip a 3/4" length of small black sleeving over each wire.

( ) Position the 4-pin flat connector as shown, taking note of the larger space between pins 1 and 2.

( ) Connect the silver (ribbed) wire of the line cord to pin 1 of the 4-pin flat connector (S-1).

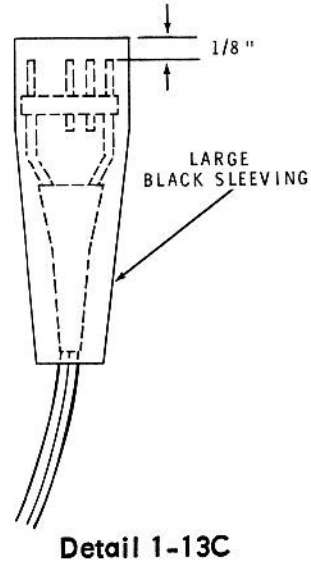
( ) Connect the copper wire to pin 4 of the connector (S-1).

( ) Slide the small lengths of sleeving over each of these connections. Then hold each section of sleeving close to a hot 100 watt light bulb so the sleeving will shrink around the connection.

( ) Refer to Pictorial 1-13 and slide the medium-size black sleeving over a portion of the two smaller sleevings as shown.

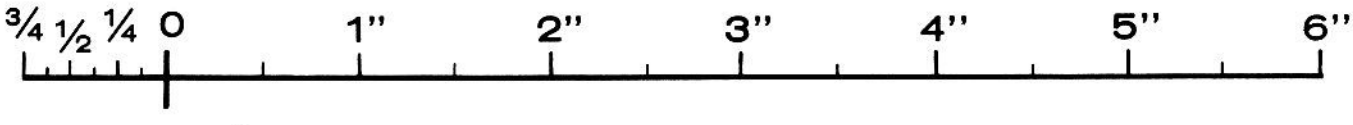
( ) Apply heat, as before, to the medium-size black sleeving until it shrinks around the line cord and two other sections of sleeving.

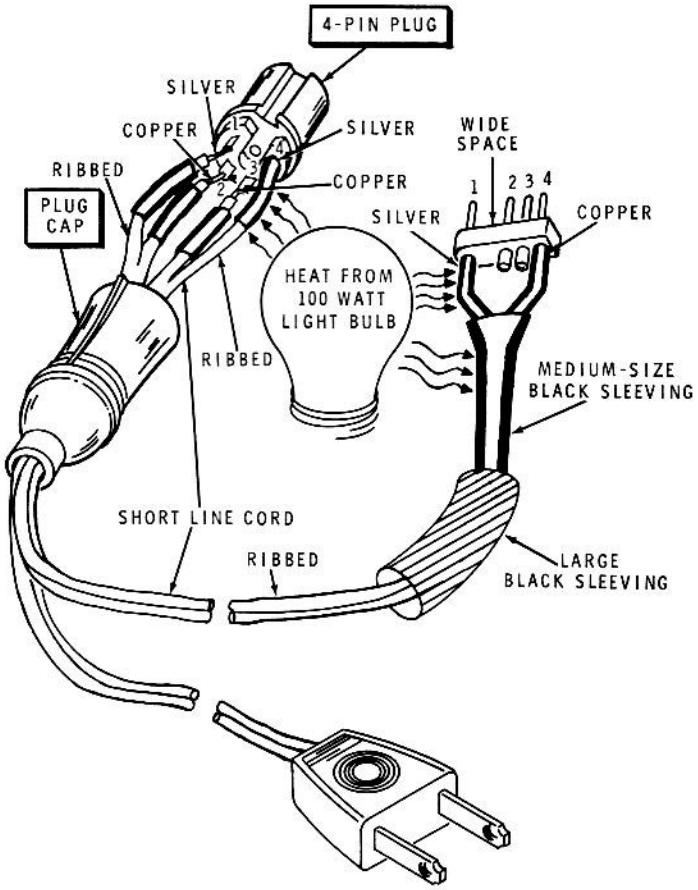
( ) Refer to Detail 1-13C and slide the large black sleeving over the plug assembly until the plug pins are recessed approximately 1/8" into the large sleeving.



Detail 1-13C

Temporarily set the transmitter charging cable aside and proceed to the Receiver portion of the Manual. NOTE: You should have some components and hardware left over. They will be used later.





PICTORIAL 1-13

( ) Mount the transmitter circuit board on the cabinet top plate with two 4-40 x 3/4" screws, three #4 lockwashers, two 3/16" spacers, one 1/4" fiber washer, and two 4-40 nuts, with a #6 solder lug at AC. Position the solder lug as shown.

RF WIRING

Complete only the following steps that refer to the transmitter RF circuit board you have purchased.

For 27 MHz Band RF Circuit Boards

Refer to part A of Pictorial 1-11 for the following steps.

( ) Cut one lead of a 100 pF mica capacitor to 1/4". Connect this lead to hole A in the transmitter circuit board (S-1).

( ) Connect the other capacitor lead to antenna lug AA (S-1), and remove the excess lead. Position the capacitor leads so they do not touch the cabinet or any other leads on the circuit board.

Proceed to Final Wiring.

For 53 MHz Band RF Circuit Boards

Refer to part B of Pictorial 1-11 for the following steps.

NOTE: Use a discarded length of resistor lead or a piece of solid wire with its insulation removed for the jumper wire in the next step.

( ) Connect a 3/4" jumper wire from antenna lug AB (S-1) to hole A on the transmitter circuit board (S-1). Position the wire so it does not touch the cabinet or any other leads on the circuit board.

Proceed to Final Wiring.

For 72 MHz Band RF Circuit Boards

Refer to part C of Pictorial 1-11 for the following steps.

( ) Cut one lead of the 1200 Ω resistor (brown-red-red) to a length of 3/4". Connect this lead to solder lug AC (NS). Use the hole that is nearest the circuit board.

( ) Insert the other lead of the 1200 Ω resistor through antenna lug AB (S-2) to hole A (S-1) on the transmitter circuit board and cut off any excess resistor lead. Position the resistor as shown, making sure that the resistor leads do not touch the donut-shaped coil.

FINAL WIRING

( ) Refer to Pictorial 1-11 and connect the black wire from BO#5 to solder lug AC (S-1 for 27 MHz band; S-1 for 53 MHz band; S-2 for 72 MHz band). NOTE: Use the hole in the solder lug that is nearest the circuit board. Do not allow solder to run into the other hole of the solder lug, as a connection will be made here later.

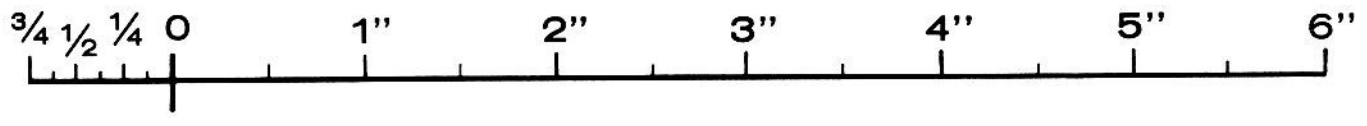
This completes the wiring of the Transmitter, except for the meter which will be connected to the Transmitter later. Check to see that all connections are soldered and shake out any wire clippings or solder splashes. The free end of the red wire coming from the transmitter circuit board will be connected later.

( ) Set the Transmitter aside temporarily.

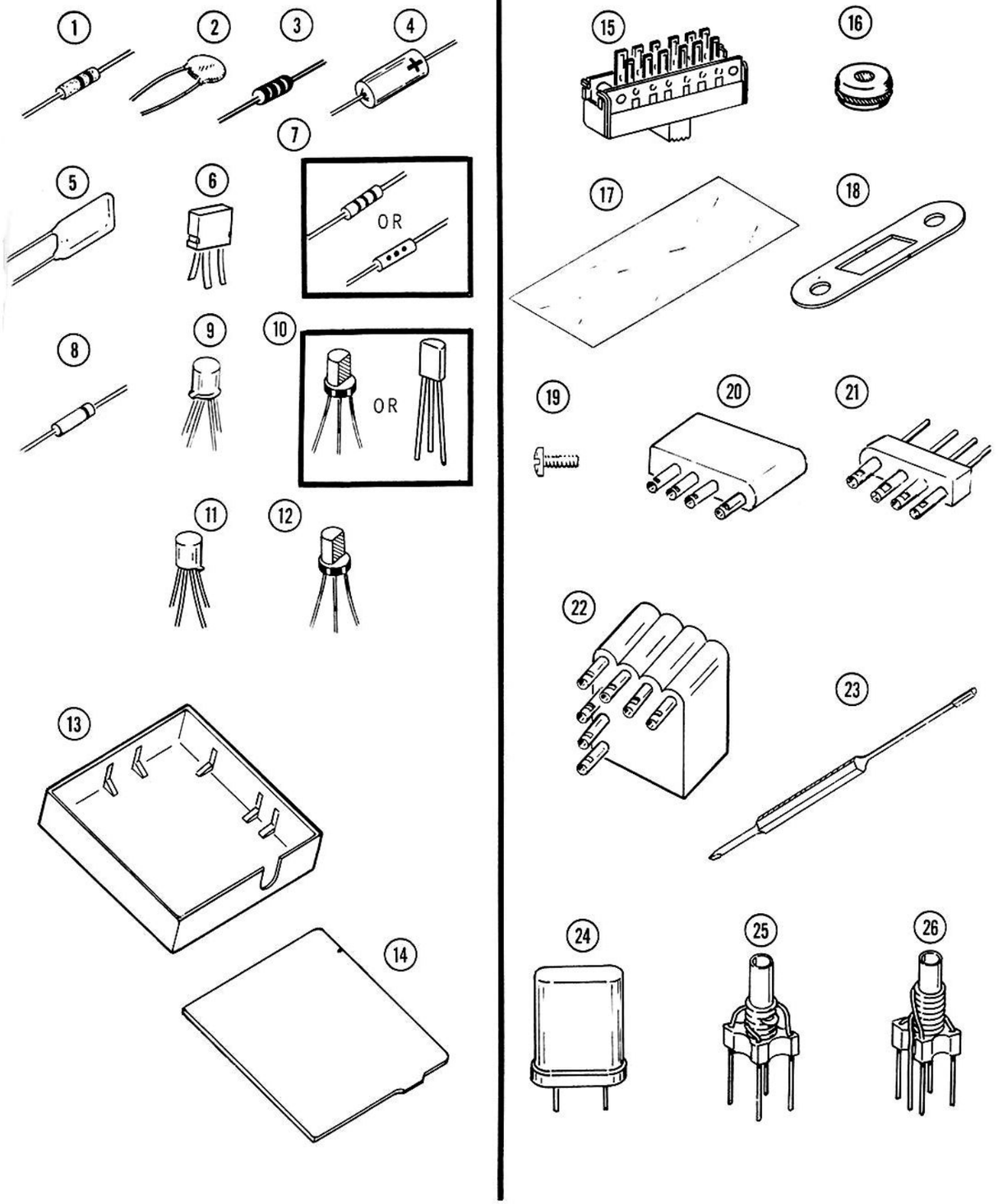
Prepare the meter as follows:

( ) Prepare the following lengths of stranded wire:

LENGTH	COLOR
7"	black
7"	red



RECEIVER PARTS PICTORIAL



RECEIVER PARTS LIST

Unpack the Receiver pack marked with the first seven numbers, 171-2038 and Receiver Battery Pack marked with the first six numbers, 191-361. If you ordered a complete Radio Control System, you will also need two or more parts from Pack #8. The numbers in parentheses are keyed to the numbers on the Parts Pictorial.

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS		
1/4 Watt		
(1) 1-1-12	2	100 Ω (brown-black-brown)
1-35-12	1	470 Ω (yellow-violet-brown)
1-24-12	1	820 Ω (gray-red-brown)
1-2-12	8	1000 Ω (brown-black-red)
1-36-12	1	1500 Ω (brown-green-red)
1-4-12	4	2200 Ω (red-red-red)
1-5-12	1	2700 Ω (red-violet-red)
1-8-12	5	4700 Ω (yellow-violet-red)
1-26-12	2	5600 Ω (green-blue-red)
1-27-12	1	6800 Ω (blue-gray-red)
1-9-12	5	10 kΩ (brown-black-orange)
1-10-12	9	15 kΩ (brown-green-orange)
1-52-12	1	18 kΩ (brown-gray-orange)
1-45-12	2	22 kΩ (red-red-orange)
1-46-12	1	27 kΩ (red-violet-orange)
1-11-12	1	47 kΩ (yellow-violet-orange)
1-32-12	5	100 kΩ (brown-black-yellow)
1-41-12	1	33 kΩ (orange-orange-orange)
CAPACITORS		
Disc		
(2) 21-6	*	27 pF
21-147	*	47 pF
21-148	1	75 pF
Disc (cont'd.)		
21-140	3	.001 μF
21-141	1	.0033 μF
21-27	6	.005 μF
Tubular Ceramics		
(3) 21-174	1	180 pF (brown-gray-brown-white)
21-175	1	.001 μF (brown-black-red-yellow)

*The quantity of these capacitors that you receive depends on the transmitting band you selected to have your Receiver (and Transmitter) operate on: the 27 MHz band, the 53 MHz band, or the 72 MHz band. Refer to the following chart. These parts will be in Pack #8 if you ordered a complete Radio Control System.

QUANTITY

	27 MHz	53 MHz	72 MHz
21-6	0	2	2
21-147	3	1	1

PART No.	PARTS Per Kit	DESCRIPTION
Tantalum		
(4)25-209	4	.047 μF
25-210	1	.22 μF
25-197	1	1.0 μF
25-195	1	2.2 μF
25-211	2	33.0 μF
Mylar*		
(5)27-74	2	.01 μF
27-64	1	.033 μF
FILTERS-RF CHOKE		
(6)404-399	3	Ceramic filter
(7)45-73	1	2.2 μH RF choke (red-red-gold)
45-80	1	1000 μH RF choke (brown-black-red)
DIODES-TRANSISTORS		
NOTE: Transistors will be marked with either the part number, the transistor type number, or both the part number and the type number.		
(8)56-27	1	Crystal diode
56-56	7	1N4149 silicon diode
(9)57-47	5	Silicon-controlled switch (SCS) (GE X13B615)
(10)417-91	1	2N5232A/2N3391A transistor
417-118	3	2N3393 transistor
417-164	1	16G2349 transistor
(11)417-228	1	SE5055 transistor
(12)417-200	3	X29A826 transistor
WIRE-SLEEVING		
344-50	1	Black solid wire
344-125	1	Black stranded wire
344-126	1	Brown wire
344-127	1	Red wire
344-128	1	Orange wire
344-129	1	Yellow wire
344-130	1	Green wire
344-131	1	Blue wire
344-134	1	White wire
346-1	1	Black sleeving
346-21	1	White sleeving

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PART No.	PARTS Per Kit	DESCRIPTION
GENERAL		
(13)95-33	1	Case
(14)95-34	1	Case bottom
(15)60-35	1	Slide switch
73-39	1	Foam tape
(16)73-73	1	Rubber grommet
(17)75-126	1	Mylar insulator
85-412	1	Receiver circuit board (larger circuit board)
85-413	1	Decoder circuit board (smaller circuit board)
(18)205-559	1	Switch plate
(19)250-49	2	3-48 x 1/4" screw
390-244	1	Heathkit decorative label
390-348	1	FCC label
(20)432-103	3	4-lug socket
(21)432-104	2	4-pin plug
(22)432-105	1	Large block connector
(23)490-109	1	Alignment tool
		Solder

***CRYSTAL**

Only one of the following crystals is supplied with this kit.

			Receiver Crystal	Transmitted Frequency
(24)404-384	1		26.542 MHz	26.995 MHz
404-385	1		26.592 MHz	27.045 MHz
404-386	1		26.642 MHz	27.095 MHz
404-387	1		26.692 MHz	27.145 MHz
404-388	1		26.742 MHz	27.195 MHz
404-389	1		26.3235 MHz	53.100 MHz
404-390	1		26.3735 MHz	53.200 MHz
404-391	1		26.4235 MHz	53.300 MHz
404-392	1		26.4735 MHz	53.400 MHz
404-393	1		26.5235 MHz	53.500 MHz
404-394	1		36.2665 MHz	72.080 MHz
404-395	1		36.3465 MHz	72.240 MHz
404-396	1		36.4265 MHz	72.400 MHz
404-397	1		36.7065 MHz	72.960 MHz
404-398	1		37.5935 MHz	75.640 MHz

*Your crystal will be in Pack #8 if you ordered a complete Radio Control System.

*TRANSFORMERS

NOTE: The antenna and RF transformers you receive with this kit depend on the transmitting band you selected for your Receiver (27 MHz, 53 MHz, or 72 MHz).

For 27 MHz Band Receivers (26.995, 27.045, 27.095, 27.145, and 27.195 MHz)

PART No.	PARTS Per Kit	DESCRIPTION
(25)40-913	1	4-lead variable transformer
(26)40-914	1	5-lead variable transformer

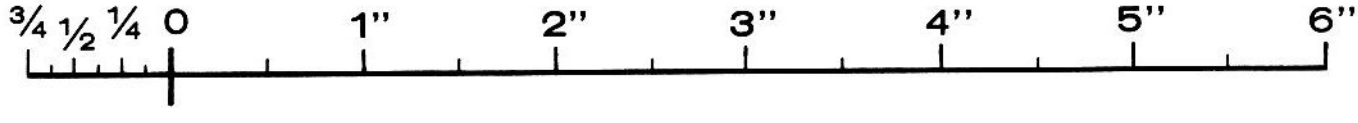
For 53 MHz Band Receivers (53.100, 53.200, 53.300, 53.400, and 53.500 MHz)

(25)40-915	1	4-lead variable transformer
(26)40-916	1	5-lead variable transformer

For 72 MHz Band Receivers (72.080, 72.240, 72.400, 72.960, and 75.640 MHz)

(25)40-917	1	4-lead variable transformer
(26)40-918	1	5-lead variable transformer

*These parts will be in Pack #8 if you ordered a complete Radio Control System.



PART No.	PARTS Per Kit	DESCRIPTION
Tantalum		
(4)25-209	4	.047 μF
25-210	1	.22 μF
25-197	1	1.0 μF
25-195	1	2.2 μF
25-211	2	33.0 μF
Mylar*		
(5)27-74	2	.01 μF
27-64	1	.033 μF
FILTERS-RF CHOKE		
(6)404-399	3	Ceramic filter
(7)45-73	1	2.2 μH RF choke (red-red-gold)
45-80	1	1000 μH RF choke (brown-black-red)
DIODES-TRANSISTORS		
NOTE: Transistors will be marked with either the part number, the transistor type number, or both the part number and the type number.		
(8)56-27	1	Crystal diode
56-56	7	1N4149 silicon diode
(9)57-47	5	Silicon-controlled switch (SCS) (GE X13B615)
(10)417-91	1	2N5232A/2N3391A transistor
417-118	3	2N3393 transistor
417-164	1	16G2349 transistor
(11)417-228	1	SE5055 transistor
(12)417-200	3	X29A826 transistor
WIRE-SLEEVING		
344-50	1	Black solid wire
344-125	1	Black stranded wire
344-126	1	Brown wire
344-127	1	Red wire
344-128	1	Orange wire
344-129	1	Yellow wire
344-130	1	Green wire
344-131	1	Blue wire
344-134	1	White wire
346-1	1	Black sleeving
346-21	1	White sleeving

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PART No.	PARTS Per Kit	DESCRIPTION
GENERAL		
(13)95-33	1	Case
(14)95-34	1	Case bottom
(15)60-35	1	Slide switch
73-39	1	Foam tape
(16)73-73	1	Rubber grommet
(17)75-126	1	Mylar insulator
85-412	1	Receiver circuit board (larger circuit board)
85-413	1	Decoder circuit board (smaller circuit board)
(18)205-559	1	Switch plate
(19)250-49	2	3-48 x 1/4" screw
390-244	1	Heathkit decorative label
390-348	1	FCC label
(20)432-103	3	4-lug socket
(21)432-104	2	4-pin plug
(22)432-105	1	Large block connector
(23)490-109	1	Alignment tool
		Solder

***CRYSTAL**

Only one of the following crystals is supplied with this kit.

			Receiver Crystal	Transmitted Frequency
(24)404-384	1		26.542 MHz	26.995 MHz
404-385	1		26.592 MHz	27.045 MHz
404-386	1		26.642 MHz	27.095 MHz
404-387	1		26.692 MHz	27.145 MHz
404-388	1		26.742 MHz	27.195 MHz
404-389	1		26.3235 MHz	53.100 MHz
404-390	1		26.3735 MHz	53.200 MHz
404-391	1		26.4235 MHz	53.300 MHz
404-392	1		26.4735 MHz	53.400 MHz
404-393	1		26.5235 MHz	53.500 MHz
404-394	1		36.2665 MHz	72.080 MHz
404-395	1		36.3465 MHz	72.240 MHz
404-396	1		36.4265 MHz	72.400 MHz
404-397	1		36.7065 MHz	72.960 MHz
404-398	1		37.5935 MHz	75.640 MHz

*Your crystal will be in Pack #8 if you ordered a complete Radio Control System.

*TRANSFORMERS

NOTE: The antenna and RF transformers you receive with this kit depend on the transmitting band you selected for your Receiver (27 MHz, 53 MHz, or 72 MHz).

For 27 MHz Band Receivers (26.995, 27.045, 27.095, 27.145, and 27.195 MHz)

PART No.	PARTS Per Kit	DESCRIPTION
(25)40-913	1	4-lead variable transformer
(26)40-914	1	5-lead variable transformer

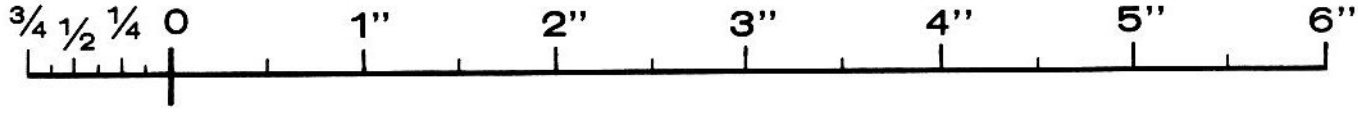
For 53 MHz Band Receivers (53.100, 53.200, 53.300, 53.400, and 53.500 MHz)

(25)40-915	1	4-lead variable transformer
(26)40-916	1	5-lead variable transformer

For 72 MHz Band Receivers (72.080, 72.240, 72.400, 72.960, and 75.640 MHz)

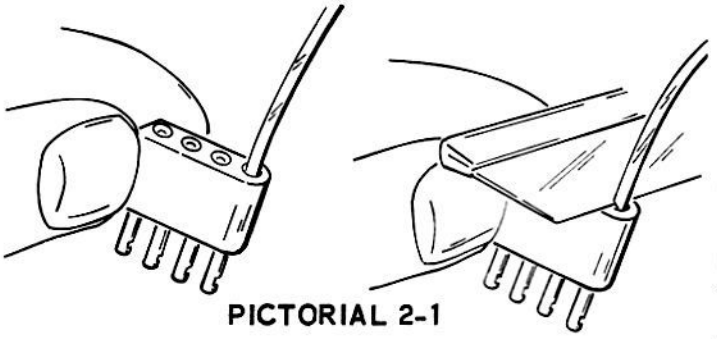
(25)40-917	1	4-lead variable transformer
(26)40-918	1	5-lead variable transformer

*These parts will be in Pack #8 if you ordered a complete Radio Control System.



RECEIVER STEP-BY-STEP ASSEMBLY

BATTERY WIRING AND CHARGING



PICTORIAL 2-1

BATTERY WIRING

Refer to Pictorial 2-1 for the following steps.

( ) Push one end of the white sleeving into a 4-lug socket opening as shown. Be sure the sleeving is pushed all the way into the opening (approximately 3/16") and is around the connector pin.

( ) Cut the sleeving flush with the surface of the socket with a razor blade or sharp knife.

( ) In the same manner, install sleeving in the three remaining openings of the same socket.

( ) Install white sleeving in all pin openings in the remaining 4-lug sockets and cut each piece flush with the socket surface.

( ) Similarly, install and cut the sleeving in each opening in the large block connector.

NOTE: Only one of the 4-lug sockets will be used in the following steps. Lay the large block connector and the remaining 4-lug sockets aside. They will be used later.

Refer to Detail 2-1A for the following steps.

CAUTION: Be careful that the bare wires of the battery leads do not touch each other and do not short circuit between the lugs of the socket or the battery may be damaged.

( ) Locate the Receiver Battery, Model GDA-19-3 and twist the three leads together as shown.

( ) Cut the ends of the three battery leads, one at a time, so that they are all the same length as the shortest lead. Then place a 1/2" length of sleeving over each lead.

NOTE: Prepare only one battery lead at a time when performing the following steps. To prepare a lead, remove 1/8" of insulation, and then melt a small amount of solder on the exposed lead end to hold the small wire strands together.

( ) Position a 4-lug socket as shown, taking note of the wide space between lugs 1 and 2.

Connect the leads of the battery to the 4-lug socket as follows:

( ) Prepare the end of the black lead.

( ) Connect the black lead to lug 4 (S-1). Then push the sleeving over the connection.

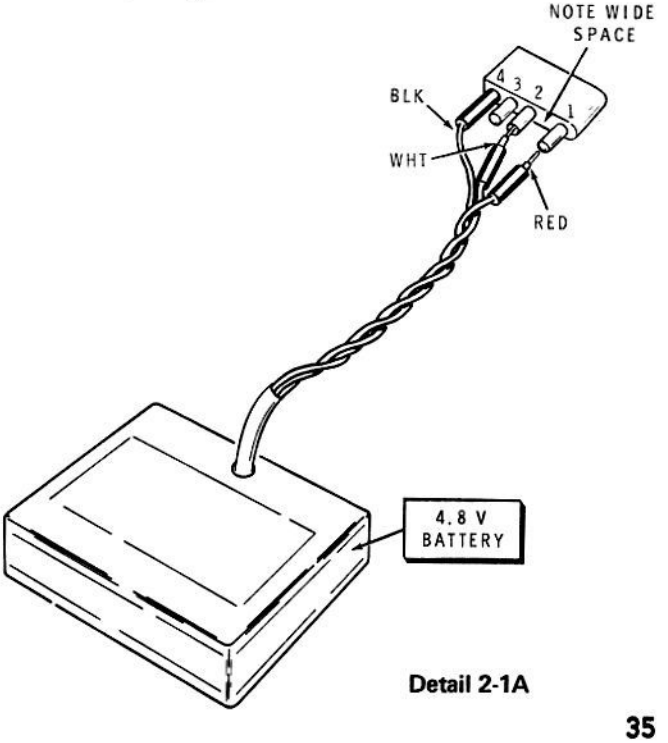
( ) Prepare the end of the white lead.

( ) Connect the white lead to lug 2 (S-1). Then push the sleeving over the connection.

( ) Prepare the end of the red lead.

( ) Connect the red lead to lug 1 (S-1). Then push the sleeving over the connection.

( ) Rotate the 4-lug socket to twist the battery leads up to the sleeving.



Detail 2-1A

BATTERY CHARGING

The manufacturer recommends that you do not place the battery in operation until after it has first been charged. The battery should be charged for a period of at least twenty-four hours, but not more than thirty-six hours.

The recommended way to charge this Receiver battery is by using the charging circuit in the Transmitter. Both the Transmitter and Receiver batteries should be charged at this time so they can be placed in operation when you complete the assembly of the Receiver and Servo. If the Receiver battery is charged on a separate charger, charge it at a rate of 50 mA for 14 hours.

Refer to Figure 1-1 for the following steps. Both batteries should be charged as follows:

( ) Observing the polarity of the connectors, connect the charging cable to the battery.

( ) Be sure the transmitter switch is turned off.

( ) Connect the charging cable to the Transmitter.

NOTE: The batteries will only charge when the ON-OFF switch of the Transmitter is in the OFF position.

If the pilot lamp does not light when the transmitter is plugged into an AC outlet in the following step, unplug the line cord right away. This would indicate that some part in this circuit is faulty or improperly wired. For example, if the pilot lamp did not light, it might be due to a fault in the wiring of the ON-OFF switch, or 4-pin connector. There might also be a fault in the diode, resistor, or pilot lamp that is connected to the ON-OFF switch. Be sure to locate and repair the difficulty before proceeding. Refer to the In Case Of Difficulty section of the Manual on Page 97.

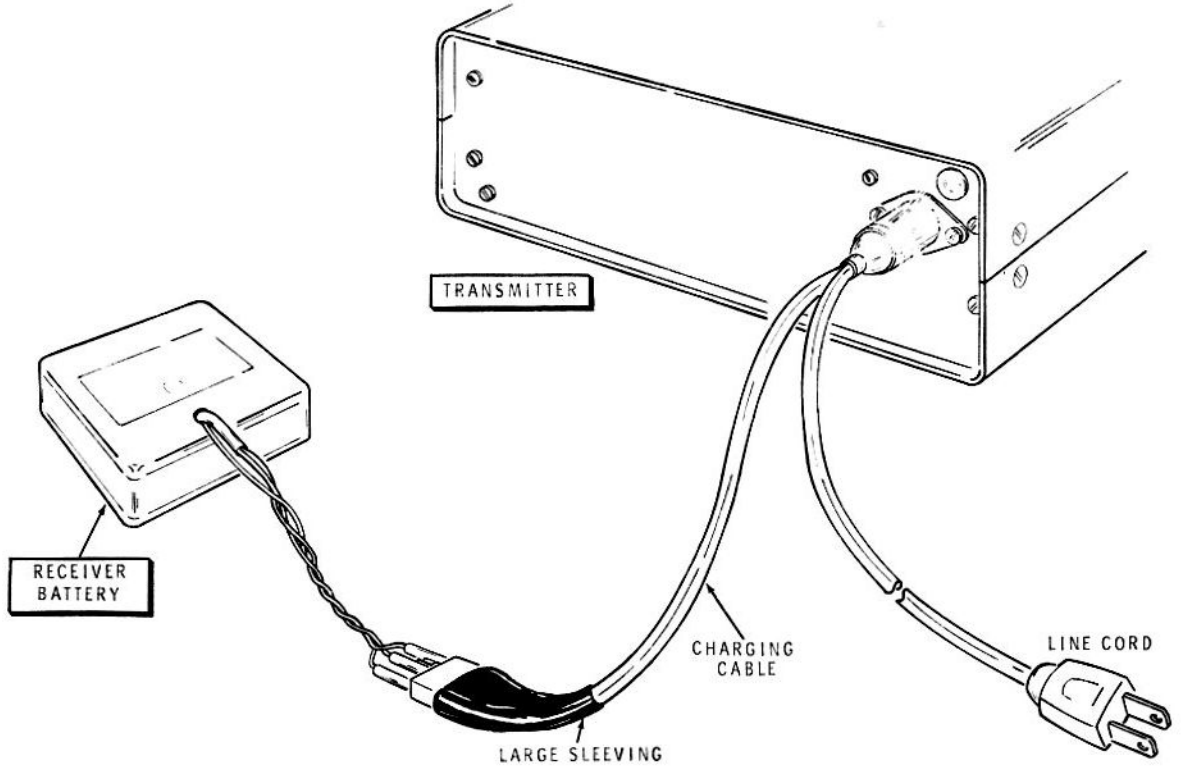


Figure 1-1

( ) Plug the other end of the line cord into a 105-125 volt 60 Hz AC outlet. The pilot lamp in the Transmitter should light indicating that both batteries are charging.

( ) At the end of the charging period, remove the line cord from the AC outlet. Then remove the charging cable from the Transmitter, and remove the charging cable from the Receiver battery. Set the units aside until called for later. Do not turn the transmitter On until instructed to do so.

CIRCUIT BOARD ASSEMBLY

ASSEMBLY NOTES

The two circuit boards in the Receiver, when put together, measure approximately two inches square and contain 21 different wires and 106 circuit components. Therefore, it is suggested that you take your time while assembling this kit.

Because the circuit boards are so small, there is not sufficient room on them to letter the value of each component. Therefore, all component locations except for resistors are shown on the boards with only an outline of the component. The locations where resistors are to be installed are filled in. Holes with triangles are used for wires. See Figure 1-2. Use extreme care when installing components so that they fit directly over their outline on the circuit board.

Due to the small foil area around the circuit board holes and the small areas between foils, it will be necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use only a minimum amount of solder and do not heat components excessively with the soldering iron. Diodes, transistors, etc., can be damaged if subjected to excessive amounts of heat. Use no larger than a 25 watt soldering iron, allow it to reach operating temperature, and then apply it only long enough to make a good solder connection.

When installing each component, bend its leads flat against the same foil from which they extend, as shown in Figure 1-2. Then cut the leads off approximately 1/16" from the hole on the foil side of the circuit board. This will hold the components in place until they are soldered, and will provide a larger solder area. This larger solder area is important because of the great amount of vibration that the Receiver must withstand.

Resistors will be called out by resistance value (in Ω, kΩ, or MΩ) and color code. Capacitors will be called out by capacitance value and type.

The variable transformers, crystal, and ceramic filters must be seated down onto the circuit board, and no component should be allowed to protrude above the top of the tallest of these items. This will ensure that the unit will fit into its case.

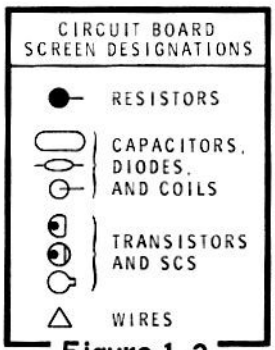
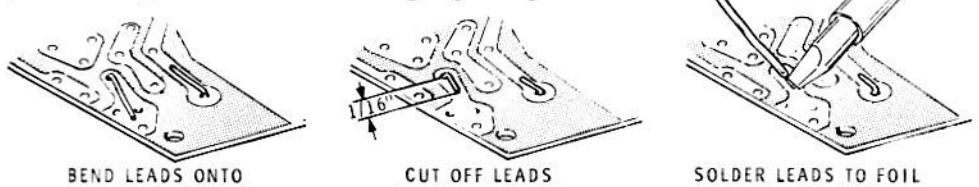


Figure 1-2

IMPORTANT SOLDER NOTE

When you install each component, bend its leads flat against the same foil from which they extend, as shown below. It is important that each lead is bent toward the center of a foil pad, or in the same direction as the foil lead to prevent solder bridging between foils. Cut the leads 1/16" from the hole on the foil side of the circuit board. This will hold the components in place until they are soldered, and will provide a larger solder area. This larger solder area is important because of the great amount of vibration that the receiver and servos must withstand. This note applies to the leads of all components being installed in the following steps and pictorials.



BEND LEADS ONTO FOIL FROM WHICH THEY EXTEND

CUT OFF LEADS 1/16" FROM HOLE

SOLDER LEADS TO FOIL WHEN ALL THE HOLES IN A FOIL PAD ARE USED

Parts mounted on the edges of the circuit board should be tilted toward the center of the board before they are soldered. This is to insure that the parts will clear the ribs of the receiver case.

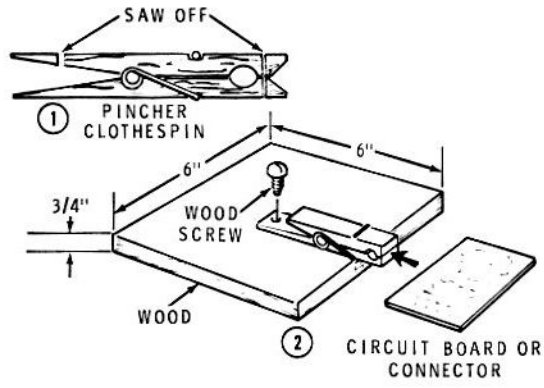
CIRCUIT BOARD ASSEMBLY

NOTE: Because the circuit boards and connectors are small, and have a tendency to move when being soldered, it is a good idea to hold them in some manner. A simple jig made up of a small board and a pincher clothespin as shown in Detail 2-2A works very well for this purpose. A small vise can also be used.

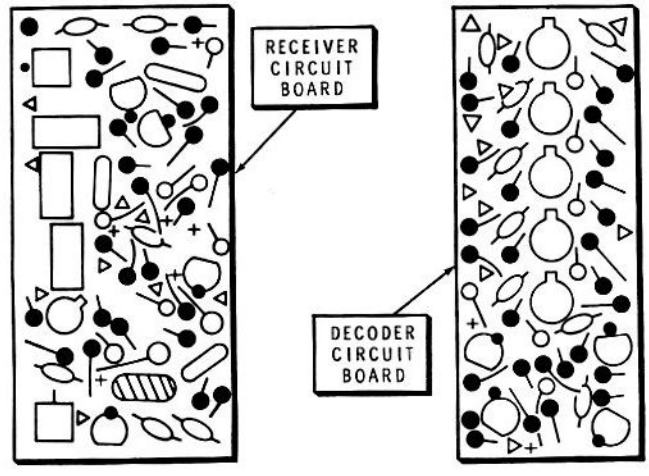
There are no specific steps for soldering the component leads to the foil of the circuit boards. When all the holes in a foil pad have been used, the component leads should be soldered to the foil. This will eliminate the possibility of excessive solder buildup and of covering unused holes. Also, be very careful not to make any solder bridges between adjacent foils.

( ) Refer to Detail 2-2B and locate the receiver circuit board, (the larger circuit board #85-412) and position it foil side down.

Complete each step on Pictorials 2-2 through 2-5.



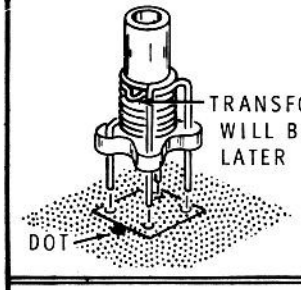
Detail 2-2A



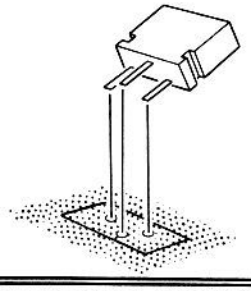
Detail 2-2B

START

( ) T1, the four lead variable transformer. Position the transformer tap over the dot on the circuit board as shown.



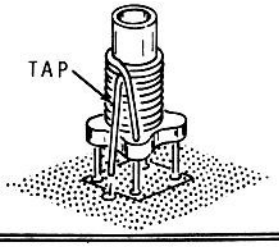
( ) Ceramic filter (#404-399). Line up the pins of the filter with the correct holes in the circuit board. Then push the filter in place and solder the pins to the foil.



( ) Ceramic filter (#404-399).

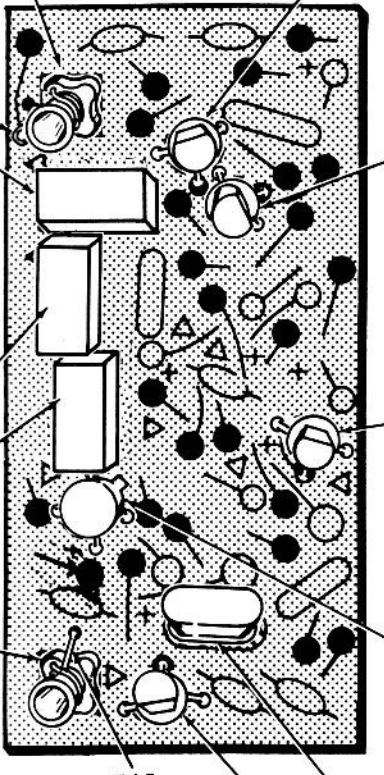
( ) Ceramic filter (#404-399).

( ) T2, five lead variable transformer.



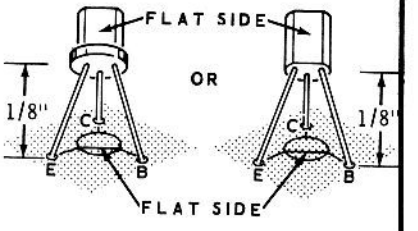
CAUTION: The transistors mounted on this circuit board are not all the same type. Be sure to select each transistor properly by either its part or type number which is stamped on it.

NOTE: Install the transistors in the following manner as shown: First line up the flat of the transistor with the outline of the flat on the circuit board. Then insert the transistor leads into their correct holes.



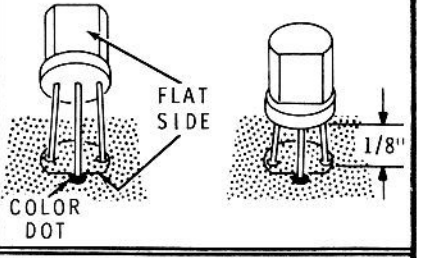
CONTINUE

The position of the collector (center) lead is indicated by the dot on the circuit board. Position the transistors 1/8" away from the circuit board. Then solder each lead to the foil and cut off the excess lead lengths.



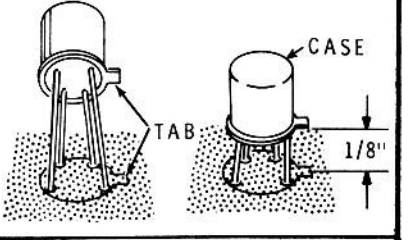
( ) Transistor 2N3393 (#417-118).

( ) Transistor X29A826 (#417-200). NOTE: Position the center lead toward the flat when installing this transistor only.



( ) Transistor 2N5232A/2N3391A (#417-91).

( ) Transistor SE5055 (#417-228). NOTE: Position the transistor tab over the tab printed on the circuit board. Do not let this transistor's case touch any other component leads.



( ) Crystal.

( ) Transistor 16G2349 (#417-164). Position it away from the edge of the circuit board.

PROCEED TO PICTORIAL 2-3.

PICTORIAL 2-2

START

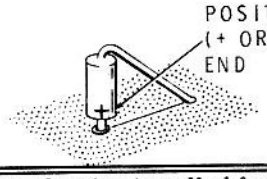
( ) 33 kΩ (orange-orange-orange).

( ) 1000 Ω (brown-black-red).

( ) 2200 Ω (red-red-red).

( ) 15 kΩ (brown-green-orange).

( ) 1 μF Tantalum. Position the positive (+ or red) end on the circuit board.



When sleeving is called for, remove and use the indicated length from the solid black wire supplied in this kit.

( ) 5600 Ω (green-blue-red). Use 1/4" of sleeving.

NOTE: In the next step, if you chose 27 MHz operation for your transmitter, install the 470 Ω (yellow-violet-brown) resistor. If you chose 53 MHz or 72 MHz operation install the 1000 Ω (brown-black-red) resistor.

( ) 470 Ω (yellow-violet-brown).
1000 Ω (brown-black-red).

Tilt the resistor toward the center of the circuit board before soldering.

( ) 15 kΩ (brown-green-orange). Use 1/4" of sleeving.

( ) 100 Ω (brown-black-brown). Use 1/4" of sleeving.

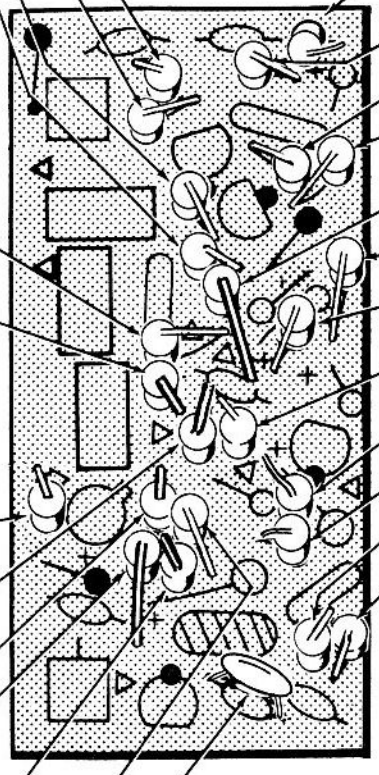
( ) 2700 Ω (red-violet-red). Use 3/8" of sleeving.

( ) 2.2 μH RF choke, #45-73, (red-red-gold). Use 3/8" of sleeving.

NOTE: The RF choke resembles a resistor and may have either color bands or color dots.

( ) 5600 Ω (green-blue-red).

( ) 47 pF disc. Tilt it toward center of the circuit board.



PICTORIAL 2-3

CONTINUE

( ) 18 kΩ (brown-gray-orange). Tilt toward center of circuit board before soldering.

( ) 22 kΩ (red-red-orange).

( ) 2200 Ω (red-red-red).

( ) 2200 Ω (red-red-red).

( ) 22 kΩ (red-red-orange). Use 3/8" of sleeving.

( ) 10 kΩ (brown-black-orange).

( ) 1000 μH RF choke (brown-black-red).

( ) 100 Ω (brown-black-brown).

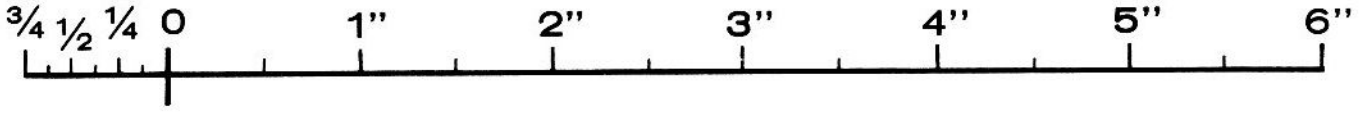
( ) 1000 Ω (brown-black-red).

( ) 27 kΩ (red-violet-orange).

( ) 820 Ω (gray-red-brown).

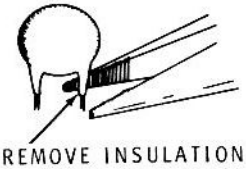
( ) 6800 Ω (blue-gray-red).

PROCEED TO PICTORIAL 2-4.

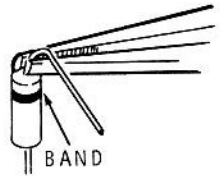


START

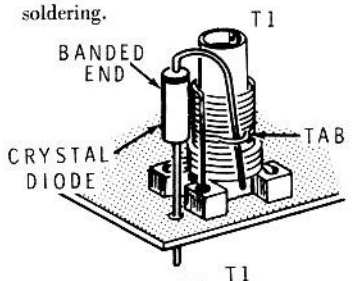
( ) NOTE: 27 MHz band Receivers use 47 pF disc. 53 and 72 MHz band Receivers use 27 pF disc. Tilt toward center of circuit board.

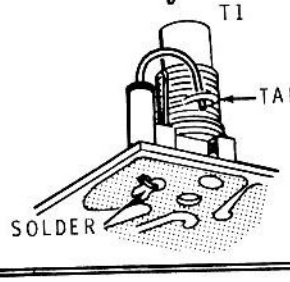


NOTE: When installing diodes vertically, hold the diode lead with pliers so the diode is not broken when bending the lead. Bend the lead before installing the diode. Then, position the diode on the circuit board as directed in each step.



( ) Crystal diode (#56-27). Connect the banded end to the tap on T1. Tilt toward center of circuit board before soldering.

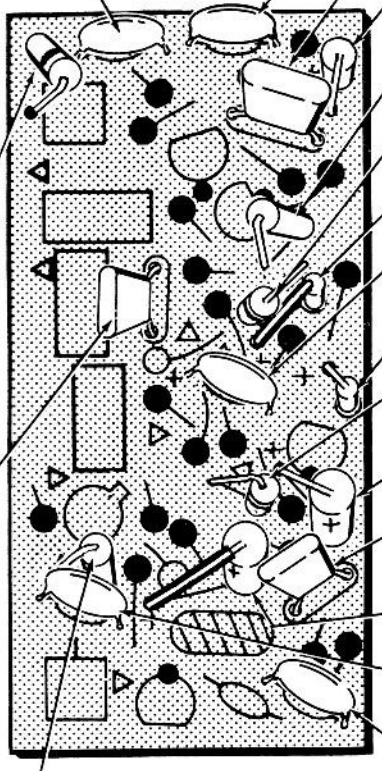




( ) .01 μF Mylar.

( ) .047 μF tantalum. Position the positive (+ or red) end down. Tilt toward center of circuit board before soldering.

SOLDERING IRON TIP



CONTINUE

( ) .001 μF disc. Tilt toward center of circuit board before soldering.

( ) .033 μF Mylar.

( ) 2.2 μF tantalum. Position the positive (+ or red) end on the circuit board. (Do not confuse with .22 μF).

( ) 180 pF tubular ceramic (brown-gray-brown-white).

( ) Diode 1N4149 (#56-56). Position the banded end up.

( ) .047 μF tantalum. Position the positive (+ or red) end up. Use 1/4" of sleeving.

( ) .0033 μF disc.

( ) .047 μF tantalum. Position the positive (+ or red) end up.

( ) Diode 1N4149 (#56-56). Position the banded end up.

( ) 33 μF tantalum. Position the positive (+ or red) end up.

( ) .01 μF Mylar.

( ) 33 μF tantalum. Position positive (+ or red) end up. Use 1/2" of sleeving.

( ) 27 MHz band Receivers use 47 pF disc. 53 and 72 MHz band Receivers use 27 pF disc.

( ) 75 pF disc. Tilt toward center of circuit board.

PROCEED TO PICTORIAL 2-5

PICTORIAL 2-4

START

( ) Locate a length of cut off resistor lead and cut it to a length of 3/4".

( ) Insert the 3/4" wire in the indicated holes.

NOTE: When preparing the following wires, cut them to the indicated length and remove the proper amounts of insulation from the wire ends. Then twist the wire strands together and melt a minimum amount of solder on the strands to hold them together. Solder each lead as it is inserted into its indicated hole (△).

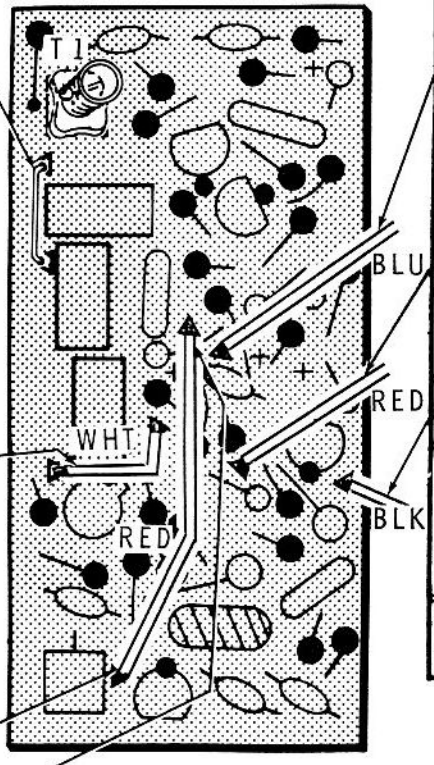
( ) 2-1/2" white wire; remove 3/4" of insulation from each end.

( ) Insert the white wire ends into their holes using the exposed wire ends like needles. Pull the wire ends through from the copper foil side of the circuit board until the wire's insulation is close to the circuit board. Do not try to lay this wire down against the circuit board.

( ) 2-1/2" red wire; remove 1/8" of insulation from one end and 3/4" of insulation from the other end.

( ) Insert the 1/8" exposed end of the red wire into its indicated hole (△).

( ) Insert the remaining end of the red wire like a needle as before.



CONTINUE

( ) 2-1/2" blue wire; remove 1/2" of insulation from one end only.

( ) Insert the blue wire like a needle. The other end will be connected later.

( ) 2-1/2" red wire; remove 1/2" of insulation from one end only.

( ) Insert the red wire like a needle. The other end will be connected later.

( ) 1" black stranded wire; remove 1/8" of insulation from both ends.

( ) Insert the black wire. The other end will be connected later.

( ) Carefully inspect the circuit board and trim all excess lead lengths close to the foil of the circuit board and make sure all connections are soldered.

( ) Set the circuit board aside temporarily.

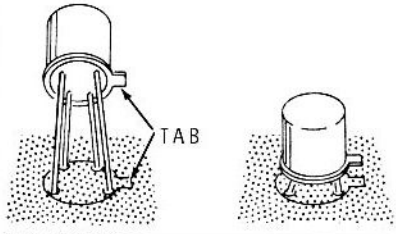
PROCEED TO PICTORIAL 2-6

PICTORIAL 2-5

START

( ) Locate the decoder circuit board (#85-413) and position it foil side down. Complete each step on Pictorials 2-6 through 2-9.

NOTE: In the following steps, install silicon-controlled switches in the following manner, as shown. Align the tab of the switch with the tab outline on the circuit board. Position the body of the switch as close to the circuit board as possible without letting the leads touch the case. Do not crisscross any of the leads.



( ) Silicon-controlled switch X13B615 (#57-47).

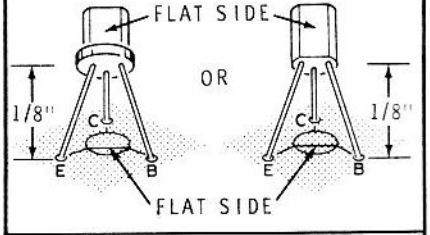
( ) Silicon-controlled switch X13B615 (#57-47).

( ) Silicon-controlled switch X13B615 (#57-47).

( ) Silicon-controlled switch X13B615 (#57-47).

( ) Silicon-controlled switch X13B615 (#57-47).

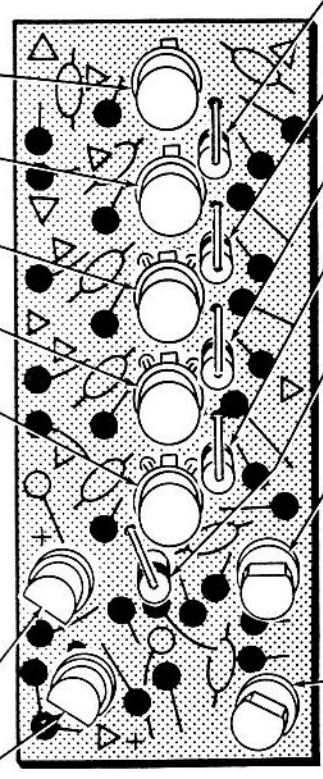
NOTE: Install the next two transistors in the following manner as shown:



( ) Transistor 2N3393 (#417-118).

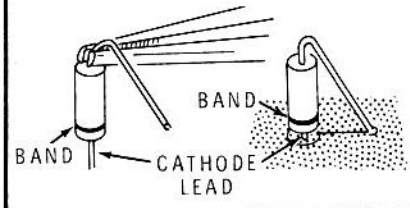
( ) Transistor 2N3393 (#417-118).

SOLDERING IRON TIP



CONTINUE

NOTE: When installing diodes vertically, hold the diode lead with pliers so the diode is not broken when bending the lead. Bend the lead before installing the diode. Then, position the diode on the circuit board as directed in each step. In each installation, the diode lead may touch the silicon controlled switch case. This will not change the operation of the decoder.



( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

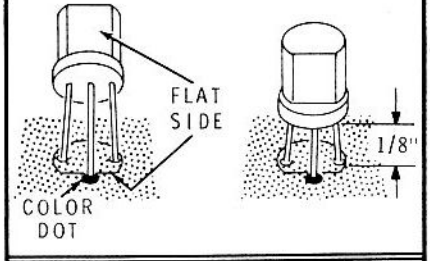
( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

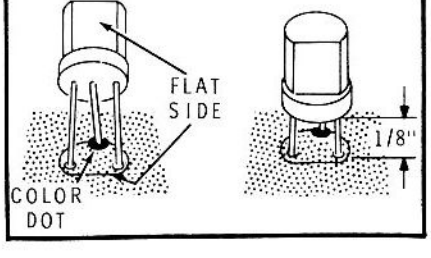
( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

( ) Diode 1N4149 (#56-56). NOTE: Position with cathode (banded) end up.

( ) Transistor X29A826 (#417-200). NOTE: Position the center lead toward the flat when installing this transistor only.



( ) Transistor X29A826 (#417-200).



PROCEED TO PICTORIAL 2-7

PICTORIAL 2-6

START

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 4700 Ω (yellow-violet-red). Use 1/4" of sleeving.

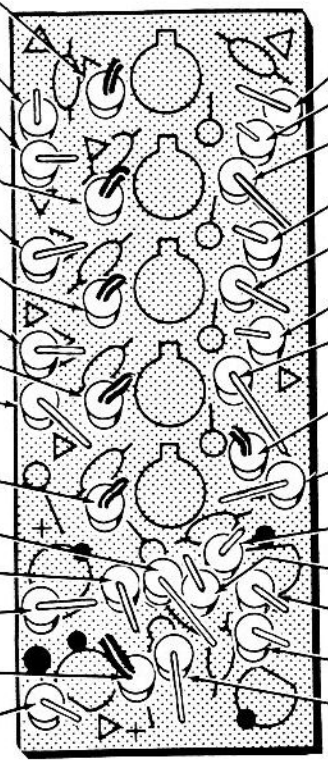
( ) 4700 Ω (yellow-violet-red).

( ) 4700 Ω (yellow-violet-red).

( ) 15 kΩ (brown-green-orange).

( ) 2200 Ω (red-red-red). Use 1/4" of sleeving.

( ) 100 kΩ (brown-black-yellow).



CONTINUE

( ) 15 kΩ (brown-green-orange). Tilt toward center of board before soldering.

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow). Use 1/4" of sleeving.

( ) 15 kΩ (brown-green-orange). Tilt toward center of circuit board before soldering.

( ) 4700 Ω (yellow-violet-red).

( ) 47 kΩ (yellow-violet-orange).

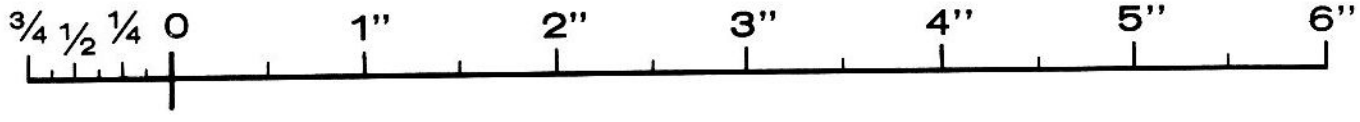
( ) 15 kΩ (brown-green-orange).

( ) 4700 Ω (yellow-violet-red).

( ) 1500 Ω (brown-green-red).

PROCEED TO PICTORIAL 2-8

PICTORIAL 2-7



START

NOTE: When a wire is called for, cut it to length, remove 1/4" of insulation from one end, and position the prepared end in the indicated hole (△). Solder the wire to the foil. The other end will be connected later.

( ) 7" blue wire.

NOTE: When installing three wires in the same hole, twist the ends of the three wires together and melt a minimum amount of solder on the strands.

( ) Three 7" white wires. Insert the three wires into the same hole.

NOTE: When installing disc capacitors, remove any excess coating from the leads. Use long-nose pliers to remove this coating.

( ) .001 μF disc.

( ) Three 7-1/2" black stranded wires. Insert the three wires into the same hole.

( ) 7-1/2" green wire.

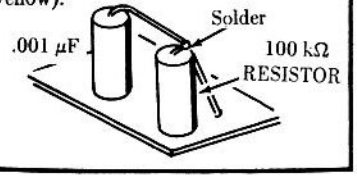
( ) .005 μF disc.

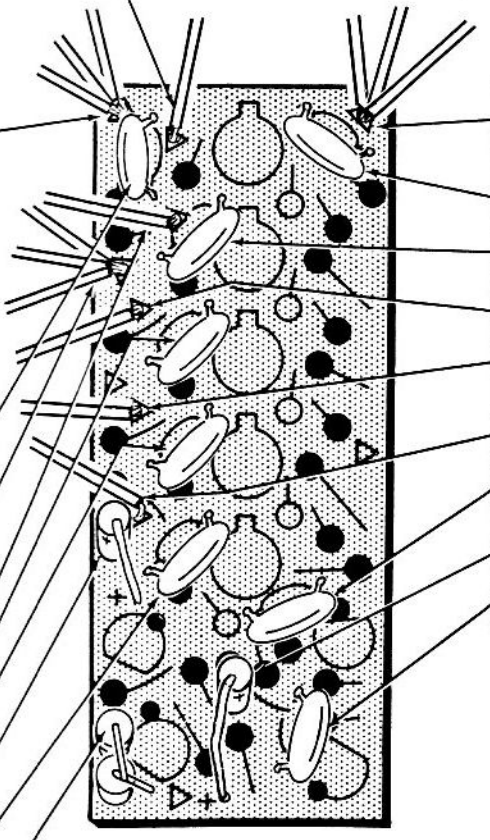
( ) .005 μF disc.

( ) .22 μF tantalum. Position with positive (+) or red end up.

( ) .005 μF disc.

( ) .001 μF (brown-black-red-yellow) tubular ceramic. Connect to the top lead of the 100 kΩ resistor (brown-black-yellow).





CONTINUE

( ) Three 7-1/2" red wires. Insert the three wires into the same hole.

( ) .001 μF disc.

( ) .005 μF disc.

( ) 7-1/2" yellow wire.

( ) 7-1/2" orange wire. Make sure you use the proper hole.

( ) 8" brown wire.

( ) .005 μF disc.

( ) .047 μF tantalum. Position with the positive (+) or red end up.

( ) .005 μF disc.

PROCEED TO PICTORIAL 2-9

PICTORIAL 2-8

START

( ) Position the receiver and decoder circuit boards as shown (foil side down) for final wiring.

( ) Remove 1/8" of insulation from the free end of the red and blue wires coming from the receiver circuit board. Then twist the wire strands of each lead together and melt a minimum amount of solder on the strands to hold them together.

( ) Insert the black wire.

( ) Insert the red wire.

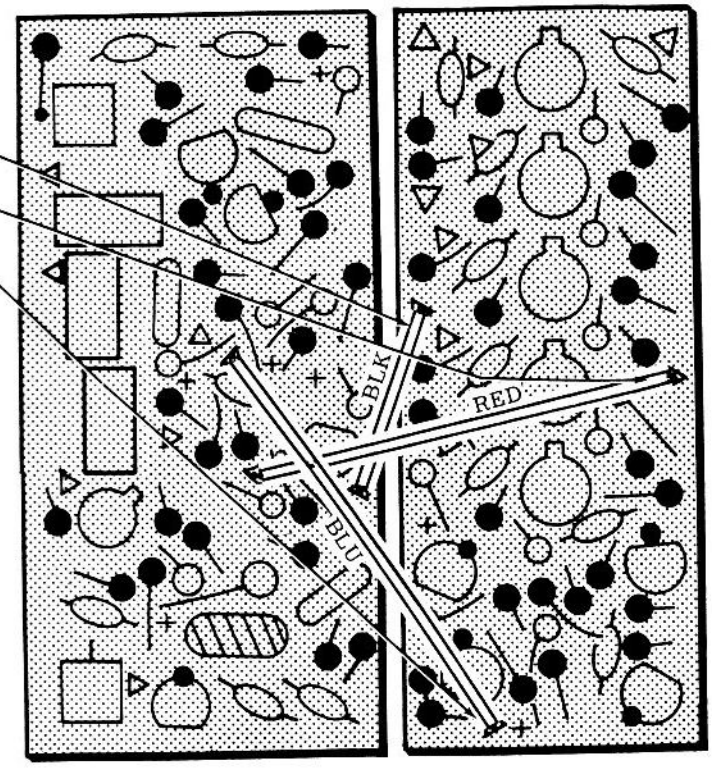
( ) Insert the blue wire.

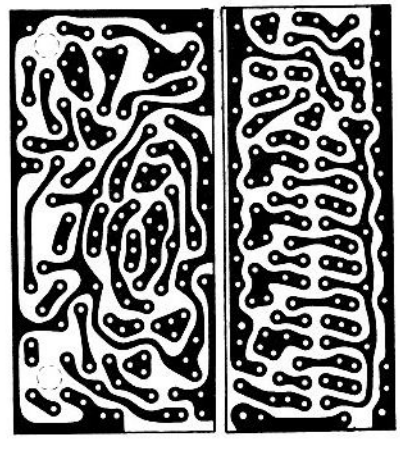
( ) Solder all three connections to the foil and cut off the excess lead lengths.

( ) Compare your foil pattern against those shown to make sure there are no solder bridges. To make it easier to locate solder bridges, it is suggested that you clean the foil side of the circuit board and remove the rosin. This can be done by using a small stiff brush (tooth brush) and lacquer thinner or dope thinner. Only a very small amount of these chemicals are required. Do not get them on the component side of the circuit board or in the coils.

NOTE: This completes the assembly of the circuit boards. Check the component side to make sure that a lead from any one component is not touching the lead of any other component.

FINISH





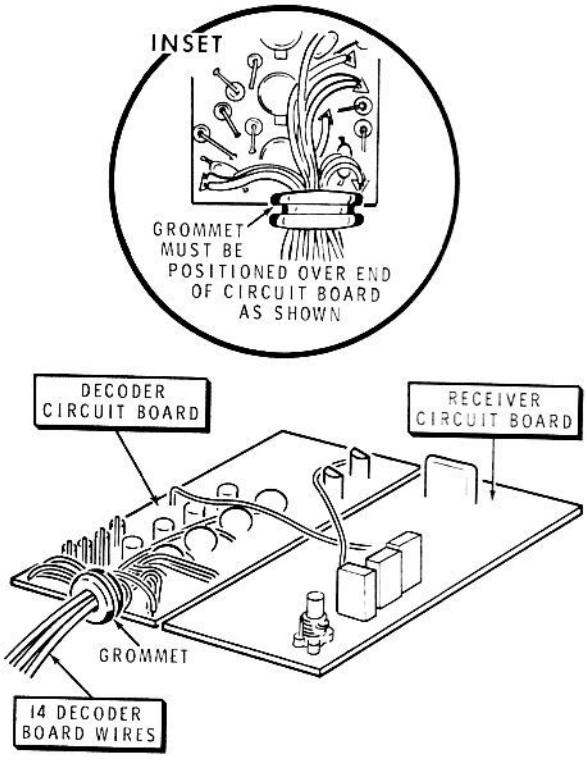
PICTORIAL 2-9

WIRING

Refer to Detail 2-10A for the following steps.

( ) Position the fourteen decoder circuit board wires around the decoder components as shown.

( ) Slip a rubber grommet over the fourteen decoder circuit board wires. Position the wires and grommet as shown in the inset drawing.



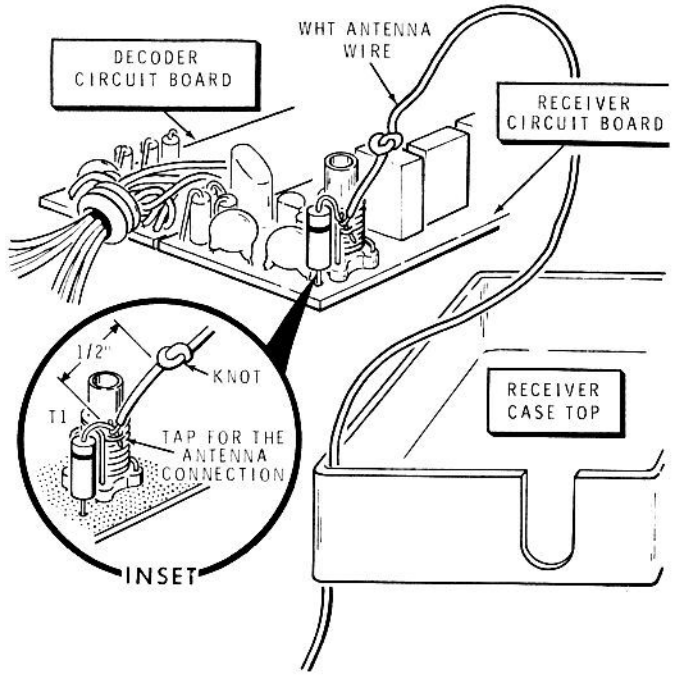
Detail 2-10A

Refer to Detail 2-10B for the following steps.

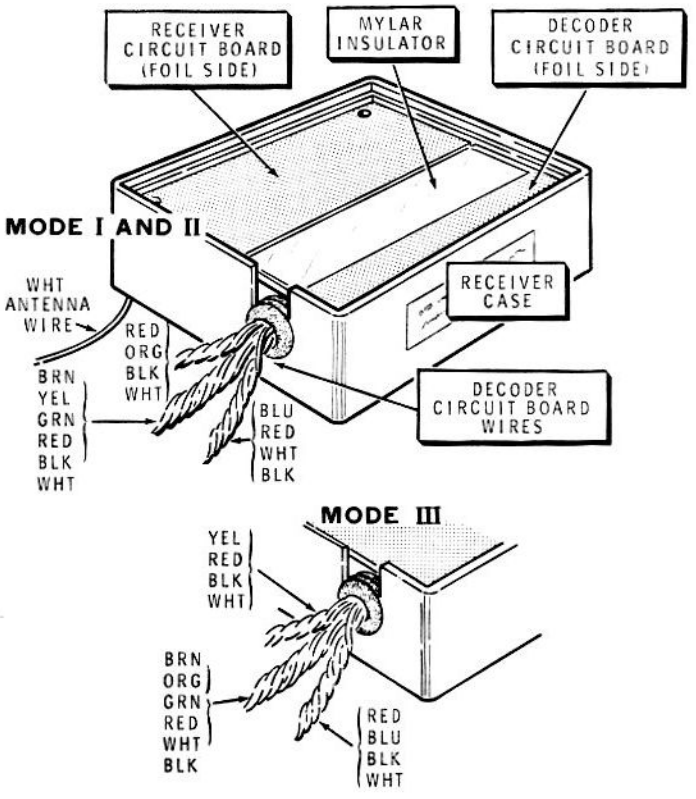
( ) Remove 1/8" of insulation from one end of the 36" white wire. Tie a small knot in this wire 1/2" from the end of the wire.

( ) Refer to the inset drawing and form a hook in the wire. Connect the hook to the top lead of the diode (S-1).

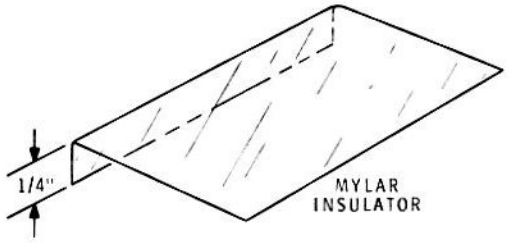
( ) Locate the receiver case and insert the 36" antenna wire through the small hole in the case top. NOTE: This hole may have to be enlarged in some of the cases.



Detail 2-10B



PICTORIAL 2-10

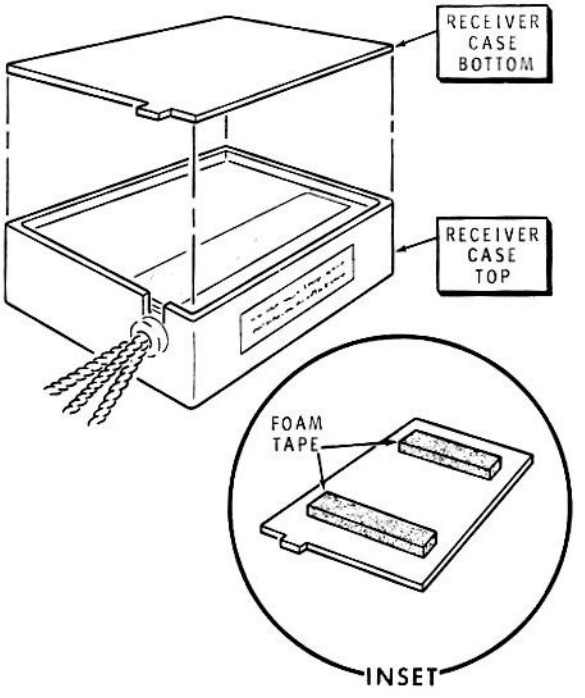


Detail 2-10C

( ) Refer to Detail 2-10C and bend the Mylar insulator to the shape shown.

Refer to Pictorial 2-10 for the following steps.

( ) Insert the 1/4" section of the Mylar insulator between the circuit boards as shown and position the circuit boards into the case. Be sure the fourteen decoder wires, rubber grommet, and 36" antenna wire are positioned so the circuit boards fit properly into the case.



Detail 2-10D

( ) Cut the foam tape into two equal lengths.

( ) Refer to the inset drawing on Detail 2-10D. Remove the paper backing from the two lengths of foam tape and install the tape on the inside of the case bottom.

( ) Place the case bottom into position.

( ) Remove the paper backing from the FCC label and press the label into place on the side of the receiver case as shown.

At this point in the construction of your GD-19 system, you must decide which mode of operation you will be using. The three modes of operation in popular use today are:

	Left Control Stick	Right Control Stick
Mode I	Rudder-Elevator	Aileron-Throttle
Mode II	Rudder-Throttle	Aileron-Elevator
Mode III	Aileron-Throttle	Rudder-Elevator

Select the mode you prefer and follow the receiver wiring instructions under that particular heading. If you are unfamiliar with model control, we suggest that you follow Mode II instructions, or consult a local modeler for advice on which Mode to use. The mode of operation is one of personal preference and all work equally well.

The decoder circuit board wires will now be twisted into three groups. Refer to the heading of the Mode you have selected and perform the given operations.

MODES I AND II

( ) Group an orange, red, black, and white wire together and twist the leads together.

( ) Twist together a red, blue, black, and white wire to form a second group.

( ) Twist together the remaining six decoder wires (green, brown, yellow, red, black, and white).

Proceed to Connector Wiring.

MODE III

( ) Group a yellow, red, black, and white wire together and twist the leads together.

( ) Group a blue, red, black, and white together and twist the wires into a second group.

( ) Twist together the remaining six decoder wires (brown, orange, green, red, black, and white).

CONNECTOR WIRING

( ) Cut the wire ends in each group so they are even with the end of the shortest wire of that group.

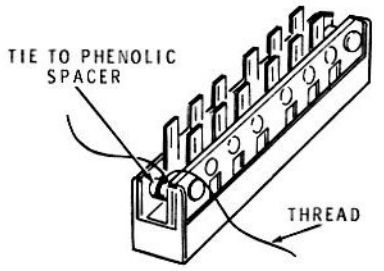
( ) Remove 1/8" of insulation from the end of each of the fourteen wires. Then twist the small strands together, and melt a small amount of solder on the exposed end of each wire.

( ) Cut fourteen 1/2" lengths of sleeving.

( ) Place a 1/2" of sleeving over each of the fourteen wires.

For Mode I or II operation, refer to Pictorial 2-11A (fold-out from Page 51) and connect these twisted wires to the large block connector and two 4-lug sockets.

For Mode III operation, refer to Pictorial 2-11B (fold-out from Page 51) and connect these twisted wires to the large block connector and two 4-lug sockets.



Detail 2-12A

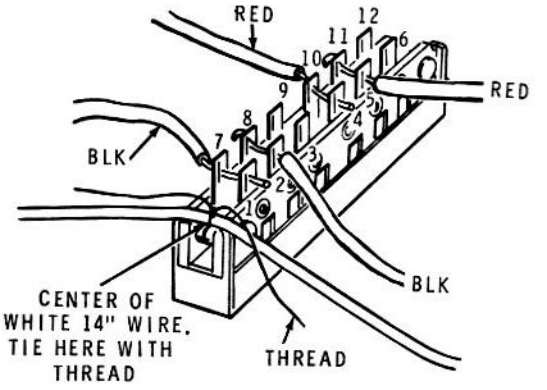
RECEIVER BATTERY SWITCH WIRING

Refer to Detail 2-12A for the following step.

NOTE: The slide switch is symmetrical and may be positioned either way.

( ) Tie a length of thread, about 5" long to the phenolic spacer as shown.

Refer to Detail 2-12B for the following steps.



Detail 2-12B

Prepare the following lengths of wire by removing 1/4" of insulation from only <u>one</u> end of each wire. Twist together the small wire strands of each lead. Then melt a small amount of solder on the exposed end of each wire to hold the separate strands together. The other ends of the wires will be prepared later.

COLOR	LENGTH
( ) Black	8"
( ) Black	8"
( ) Red	8"
( ) Red	8"

NOTE: Where a wire passes through a connection and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection.

Connect the prepared ends of the red and black wires to the slide switch as follows. The other ends of these wires will be connected later. NOTE: The pincher clothespin can be used to hold the switch while soldering.

( ) 8" black through lug 7 (S-2) to lug 1 (S-1).

( ) 8" black through lug 2 (S-2) to lug 8 (S-1).

( ) 8" red through lug 10 (S-2) to lug 4 (S-1).

( ) 8" red through lug 5 (S-2) to lug 11 (S-1).

( ) Cut a 14" length of white wire (but do not prepare the ends). Position the center of this wire as shown in Detail 2-12B and tie it in place with the thread. Do not cut the ends of the thread off yet.

Refer to Pictorial 2-12 for the following steps.

( ) Fold the red, black, and white wires together and tie them as shown. The thread ends may now be trimmed off.

The six wires from the receiver switch will now be separated into two groups. Complete the following steps for each wire group. Two check off spaces are provided in front of each step for this purpose.

( ) ( ) Select a red, white, and black wire and twist them into a group.

( ) ( ) Cut the ends of the three wires so they are even with the end of the shortest wire in the group.

( ) ( ) Remove 1/8" of insulation from the end of each of these wires. Melt a small amount of solder on the exposed end of each wire.

( ) ( ) Place 1/2" of sleeving over each wire.

Refer to Pictorial 2-12 and connect the wires to the two 4-pin plugs as shown. Note the wide space between pins 1 and 2.

Connect the wires to a four pin plug as follows:

( ) Red to pin 4 (S-1).

( ) White to pin 3 (S-1).

( ) Black to pin 2 (S-1).

( ) Temporarily mount the switch mounting plate onto the switch with two screws.

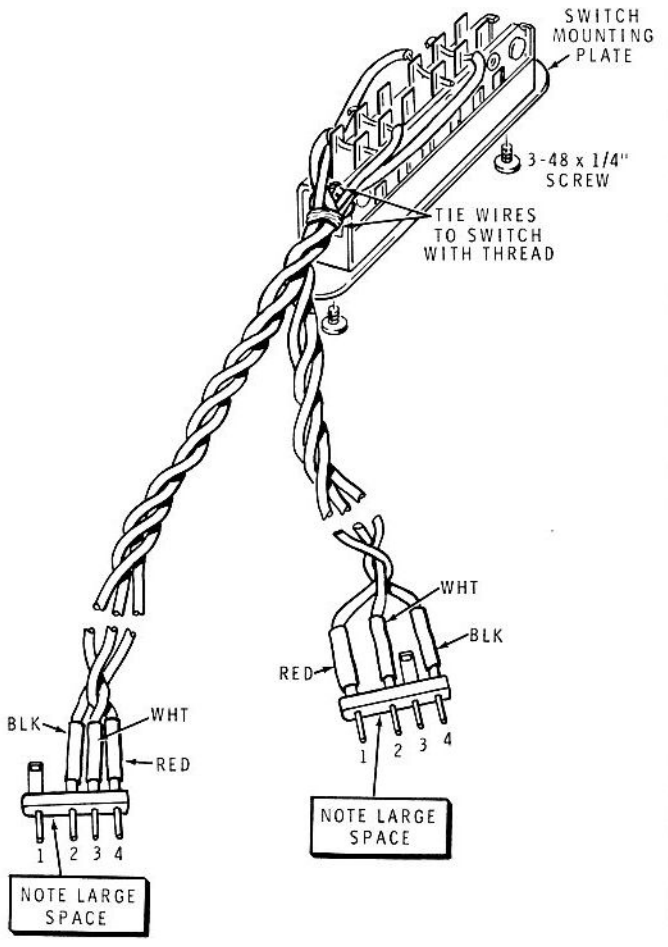
Connect the wires to a four pin plug as follows:

( ) Black to pin 4 (S-1).

( ) White to pin 2 (S-1).

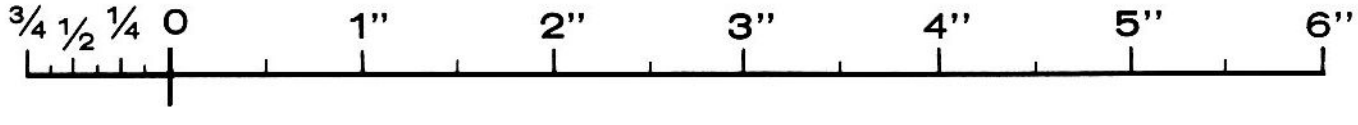
( ) Red to pin 1 (S-1).

( ) Push the six lengths of sleeving over the lugs and twist the wires up tight to the ends of the sleeving. Temporarily set the switch aside.



PICTORIAL 2-12

Proceed to the Servo section of the Manual.



WIRING FOR MODES I AND II OPERATION

LARGE BLOCK CONNECTOR

Connect the wires to the large block connector as follows:

( ) Brown to pin 1 (S-1).

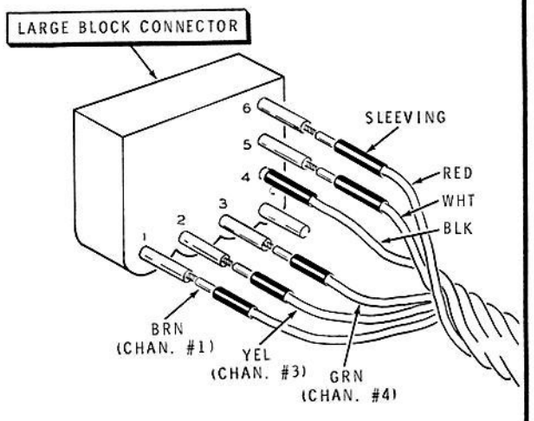
( ) Yellow to pin 2 (S-1).

( ) Green to pin 3 (S-1).

( ) Black to pin 4 (S-1).

( ) White to pin 5 (S-1).

( ) Red to pin 6 (S-1).



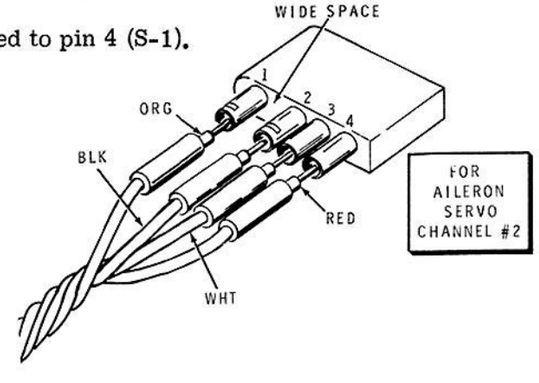
Connect the wires to a 4-lug socket as follows:

( ) Orange to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).



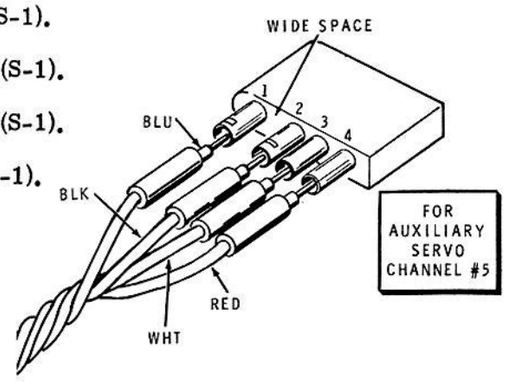
Connect the wires to a 4-lug socket as follows:

( ) Blue to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).



( ) Push the 14 lengths of sleeving over the lugs and twist the wires up to the ends of the sleeving.

Set the Receiver aside temporarily and proceed to Receiver Battery Switch Wiring.

PICTORIAL 2-11A

WIRING FOR MODE III OPERATION

LARGE BLOCK CONNECTOR

Connect the wires to the large block connector as follows:

( ) Brown to pin 1 (S-1).

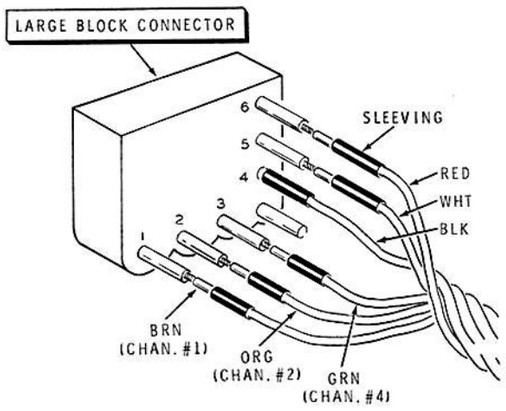
( ) Orange to pin 2 (S-1).

( ) Green to pin 3 (S-1).

( ) Black to pin 4 (S-1).

( ) White to pin 5 (S-1).

( ) Red to pin 6 (S-1).



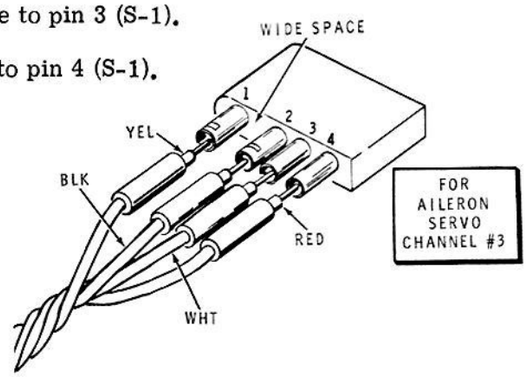
Connect the wires to a 4-lug socket as follows:

( ) Yellow to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).



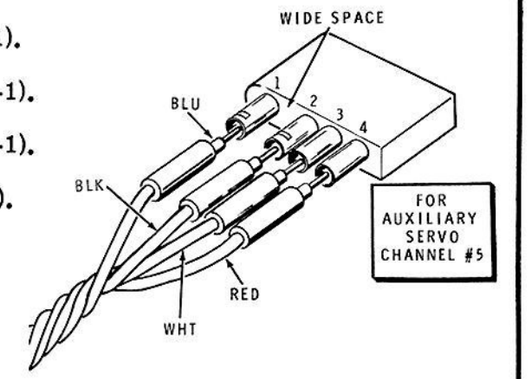
Connect the wires to a 4-lug socket as follows:

( ) Blue to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).



( ) Push the 14 lengths of sleeving over the lugs and twist the wires up to the ends of the sleeving.

Set the Receiver aside temporarily and proceed to Receiver Battery Switch Wiring.

PICTORIAL 2-11B

BATTERY CHARGING

The manufacturer recommends that you do not place the battery in operation until after it has first been charged. The battery should be charged for a period of at least twenty-four hours, but not more than thirty-six hours.

The recommended way to charge this Receiver battery is by using the charging circuit in the Transmitter. Both the Transmitter and Receiver batteries should be charged at this time so they can be placed in operation when you complete the assembly of the Receiver and Servo. If the Receiver battery is charged on a separate charger, charge it at a rate of 50 mA for 14 hours.

Refer to Figure 1-1 for the following steps. Both batteries should be charged as follows:

( ) Observing the polarity of the connectors, connect the charging cable to the battery.

( ) Be sure the transmitter switch is turned off.

( ) Connect the charging cable to the Transmitter.

NOTE: The batteries will only charge when the ON-OFF switch of the Transmitter is in the OFF position.

If the pilot lamp does not light when the transmitter is plugged into an AC outlet in the following step, unplug the line cord right away. This would indicate that some part in this circuit is faulty or improperly wired. For example, if the pilot lamp did not light, it might be due to a fault in the wiring of the ON-OFF switch, or 4-pin connector. There might also be a fault in the diode, resistor, or pilot lamp that is connected to the ON-OFF switch. Be sure to locate and repair the difficulty before proceeding. Refer to the In Case Of Difficulty section of the Manual on Page 97.

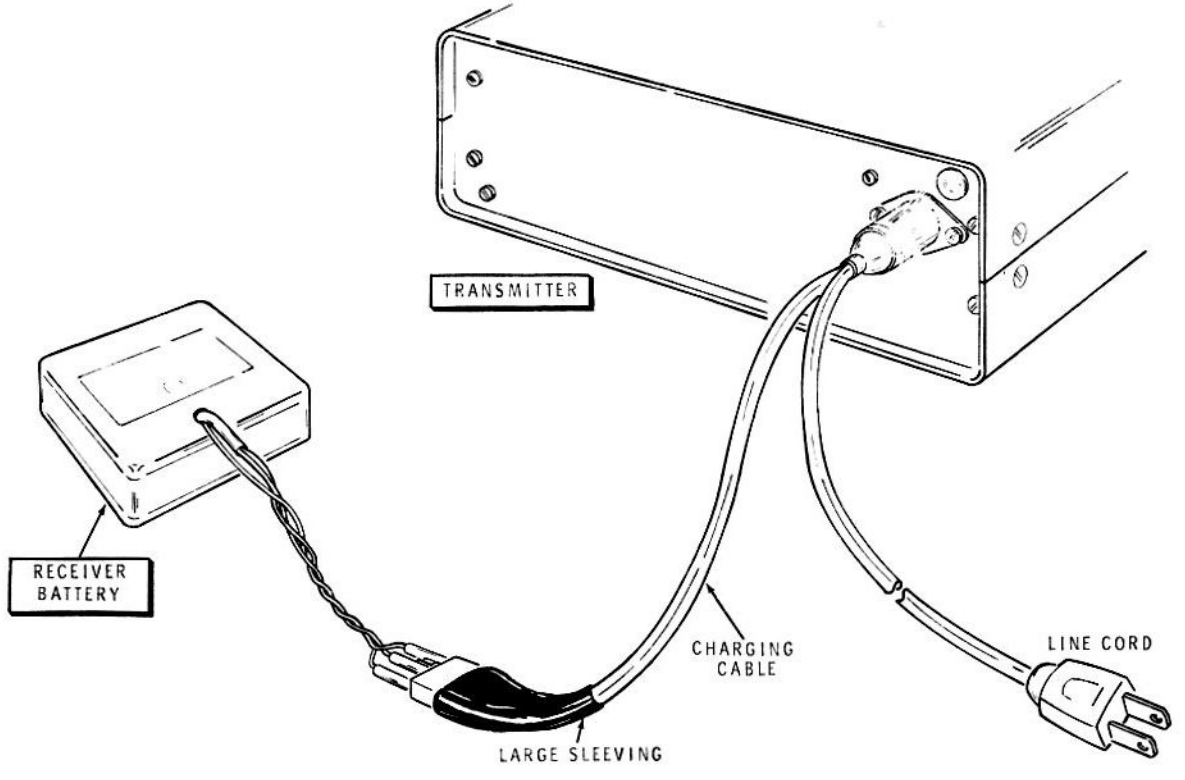


Figure 1-1

( ) Plug the other end of the line cord into a 105-125 volt 60 Hz AC outlet. The pilot lamp in the Transmitter should light indicating that both batteries are charging.

( ) At the end of the charging period, remove the line cord from the AC outlet. Then remove the charging cable from the Transmitter, and remove the charging cable from the Receiver battery. Set the units aside until called for later. Do not turn the transmitter On until instructed to do so.

CIRCUIT BOARD ASSEMBLY

ASSEMBLY NOTES

The two circuit boards in the Receiver, when put together, measure approximately two inches square and contain 21 different wires and 106 circuit components. Therefore, it is suggested that you take your time while assembling this kit.

Because the circuit boards are so small, there is not sufficient room on them to letter the value of each component. Therefore, all component locations except for resistors are shown on the boards with only an outline of the component. The locations where resistors are to be installed are filled in. Holes with triangles are used for wires. See Figure 1-2. Use extreme care when installing components so that they fit directly over their outline on the circuit board.

Due to the small foil area around the circuit board holes and the small areas between foils, it will be necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use only a minimum amount of solder and do not heat components excessively with the soldering iron. Diodes, transistors, etc., can be damaged if subjected to excessive amounts of heat. Use no larger than a 25 watt soldering iron, allow it to reach operating temperature, and then apply it only long enough to make a good solder connection.

When installing each component, bend its leads flat against the same foil from which they extend, as shown in Figure 1-2. Then cut the leads off approximately 1/16" from the hole on the foil side of the circuit board. This will hold the components in place until they are soldered, and will provide a larger solder area. This larger solder area is important because of the great amount of vibration that the Receiver must withstand.

Resistors will be called out by resistance value (in Ω, kΩ, or MΩ) and color code. Capacitors will be called out by capacitance value and type.

The variable transformers, crystal, and ceramic filters must be seated down onto the circuit board, and no component should be allowed to protrude above the top of the tallest of these items. This will ensure that the unit will fit into its case.

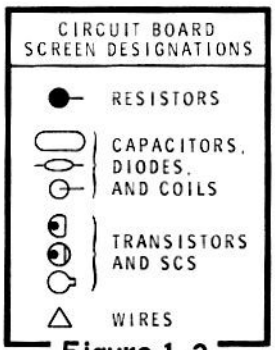
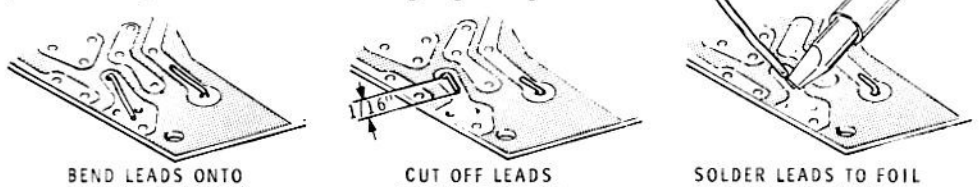


Figure 1-2

IMPORTANT SOLDER NOTE

When you install each component, bend its leads flat against the same foil from which they extend, as shown below. It is important that each lead is bent toward the center of a foil pad, or in the same direction as the foil lead to prevent solder bridging between foils. Cut the leads 1/16" from the hole on the foil side of the circuit board. This will hold the components in place until they are soldered, and will provide a larger solder area. This larger solder area is important because of the great amount of vibration that the receiver and servos must withstand. This note applies to the leads of all components being installed in the following steps and pictorials.



BEND LEADS ONTO FOIL FROM WHICH THEY EXTEND

CUT OFF LEADS 1/16" FROM HOLE

SOLDER LEADS TO FOIL WHEN ALL THE HOLES IN A FOIL PAD ARE USED

Parts mounted on the edges of the circuit board should be tilted toward the center of the board before they are soldered. This is to insure that the parts will clear the ribs of the receiver case.

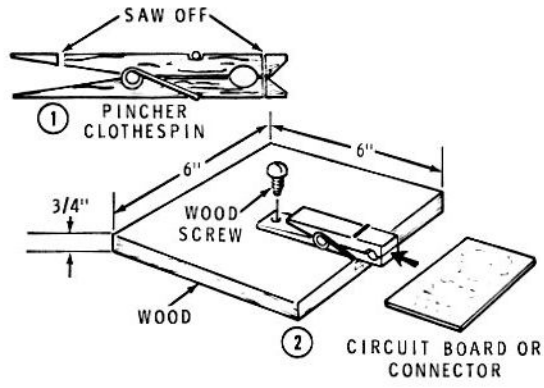
CIRCUIT BOARD ASSEMBLY

NOTE: Because the circuit boards and connectors are small, and have a tendency to move when being soldered, it is a good idea to hold them in some manner. A simple jig made up of a small board and a pincher clothespin as shown in Detail 2-2A works very well for this purpose. A small vise can also be used.

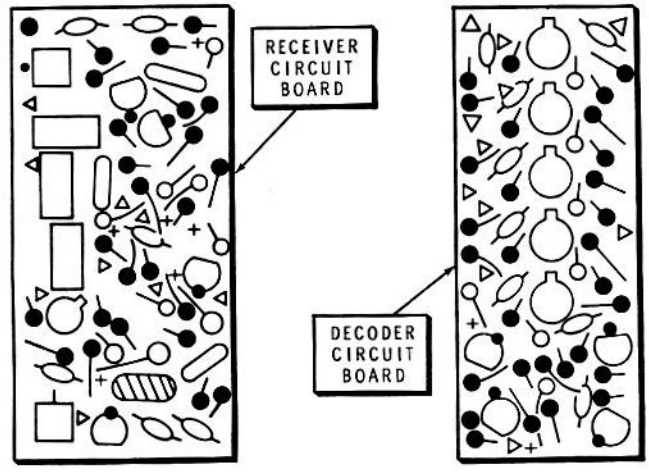
There are no specific steps for soldering the component leads to the foil of the circuit boards. When all the holes in a foil pad have been used, the component leads should be soldered to the foil. This will eliminate the possibility of excessive solder buildup and of covering unused holes. Also, be very careful not to make any solder bridges between adjacent foils.

( ) Refer to Detail 2-2B and locate the receiver circuit board, (the larger circuit board #85-412) and position it foil side down.

Complete each step on Pictorials 2-2 through 2-5.



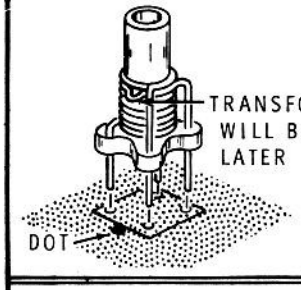
Detail 2-2A



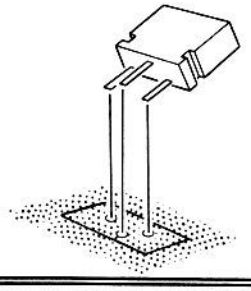
Detail 2-2B

START

( ) T1, the four lead variable transformer. Position the transformer tap over the dot on the circuit board as shown.



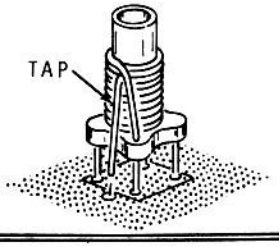
( ) Ceramic filter (#404-399). Line up the pins of the filter with the correct holes in the circuit board. Then push the filter in place and solder the pins to the foil.



( ) Ceramic filter (#404-399).

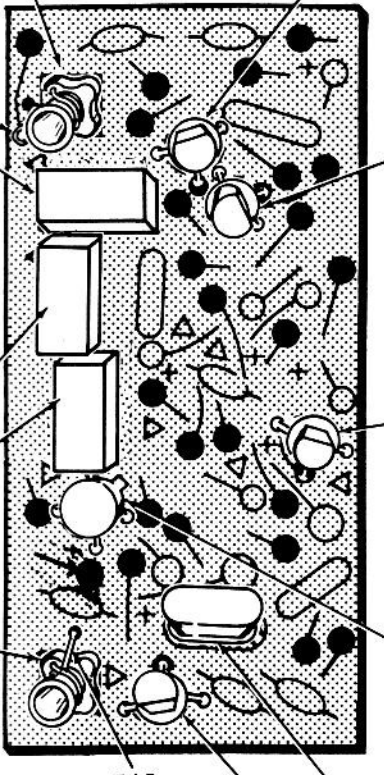
( ) Ceramic filter (#404-399).

( ) T2, five lead variable transformer.



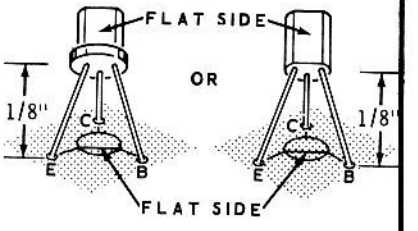
CAUTION: The transistors mounted on this circuit board are not all the same type. Be sure to select each transistor properly by either its part or type number which is stamped on it.

NOTE: Install the transistors in the following manner as shown: First line up the flat of the transistor with the outline of the flat on the circuit board. Then insert the transistor leads into their correct holes.



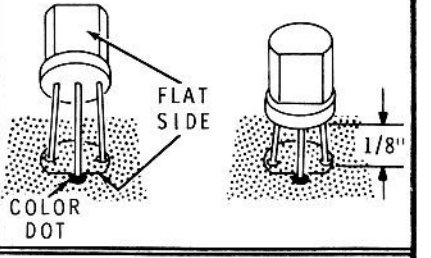
CONTINUE

The position of the collector (center) lead is indicated by the dot on the circuit board. Position the transistors 1/8" away from the circuit board. Then solder each lead to the foil and cut off the excess lead lengths.



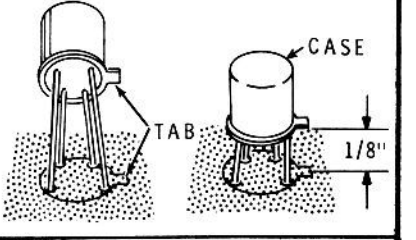
( ) Transistor 2N3393 (#417-118).

( ) Transistor X29A826 (#417-200). NOTE: Position the center lead toward the flat when installing this transistor only.



( ) Transistor 2N5232A/2N3391A (#417-91).

( ) Transistor SE5055 (#417-228). NOTE: Position the transistor tab over the tab printed on the circuit board. Do not let this transistor's case touch any other component leads.



( ) Crystal.

( ) Transistor 16G2349 (#417-164). Position it away from the edge of the circuit board.

PROCEED TO PICTORIAL 2-3.

PICTORIAL 2-2

START

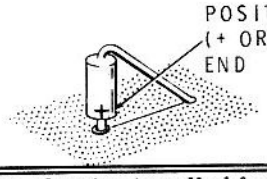
( ) 33 kΩ (orange-orange-orange).

( ) 1000 Ω (brown-black-red).

( ) 2200 Ω (red-red-red).

( ) 15 kΩ (brown-green-orange).

( ) 1 μF Tantalum. Position the positive (+ or red) end on the circuit board.



When sleeving is called for, remove and use the indicated length from the solid black wire supplied in this kit.

( ) 5600 Ω (green-blue-red). Use 1/4" of sleeving.

NOTE: In the next step, if you chose 27 MHz operation for your transmitter, install the 470 Ω (yellow-violet-brown) resistor. If you chose 53 MHz or 72 MHz operation install the 1000 Ω (brown-black-red) resistor.

( ) 470 Ω (yellow-violet-brown).
1000 Ω (brown-black-red).

Tilt the resistor toward the center of the circuit board before soldering.

( ) 15 kΩ (brown-green-orange). Use 1/4" of sleeving.

( ) 100 Ω (brown-black-brown). Use 1/4" of sleeving.

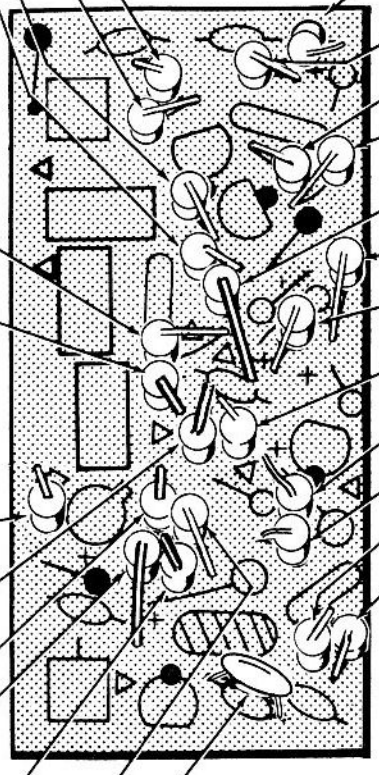
( ) 2700 Ω (red-violet-red). Use 3/8" of sleeving.

( ) 2.2 μH RF choke, #45-73, (red-red-gold). Use 3/8" of sleeving.

NOTE: The RF choke resembles a resistor and may have either color bands or color dots.

( ) 5600 Ω (green-blue-red).

( ) 47 pF disc. Tilt it toward center of the circuit board.



PICTORIAL 2-3

CONTINUE

( ) 18 kΩ (brown-gray-orange). Tilt toward center of circuit board before soldering.

( ) 22 kΩ (red-red-orange).

( ) 2200 Ω (red-red-red).

( ) 2200 Ω (red-red-red).

( ) 22 kΩ (red-red-orange). Use 3/8" of sleeving.

( ) 10 kΩ (brown-black-orange).

( ) 1000 μH RF choke (brown-black-red).

( ) 100 Ω (brown-black-brown).

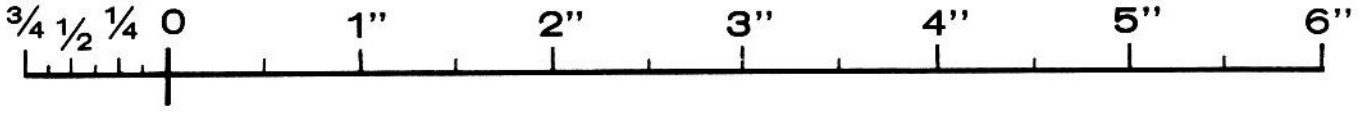
( ) 1000 Ω (brown-black-red).

( ) 27 kΩ (red-violet-orange).

( ) 820 Ω (gray-red-brown).

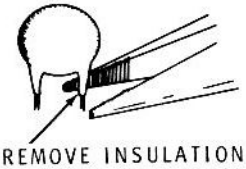
( ) 6800 Ω (blue-gray-red).

PROCEED TO PICTORIAL 2-4.

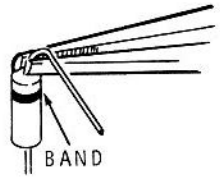


START

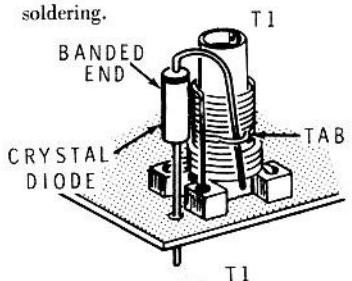
( ) NOTE: 27 MHz band Receivers use 47 pF disc. 53 and 72 MHz band Receivers use 27 pF disc. Tilt toward center of circuit board.

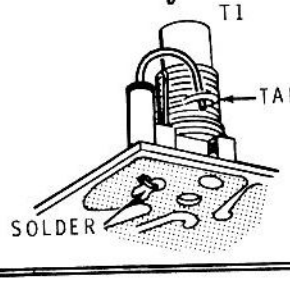


NOTE: When installing diodes vertically, hold the diode lead with pliers so the diode is not broken when bending the lead. Bend the lead before installing the diode. Then, position the diode on the circuit board as directed in each step.



( ) Crystal diode (#56-27). Connect the banded end to the tap on T1. Tilt toward center of circuit board before soldering.

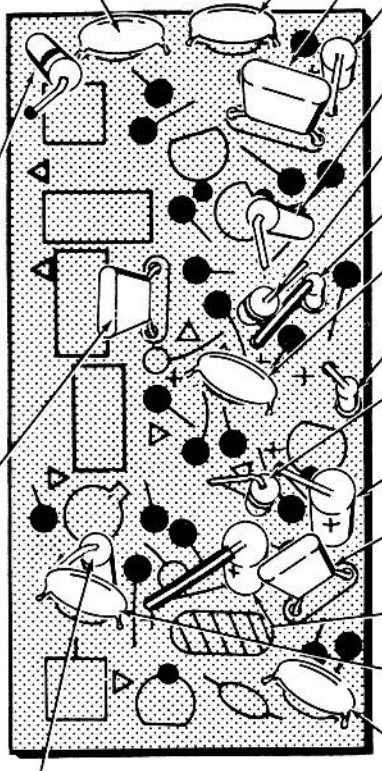




( ) .01 μF Mylar.

( ) .047 μF tantalum. Position the positive (+ or red) end down. Tilt toward center of circuit board before soldering.

SOLDERING IRON TIP



CONTINUE

( ) .001 μF disc. Tilt toward center of circuit board before soldering.

( ) .033 μF Mylar.

( ) 2.2 μF tantalum. Position the positive (+ or red) end on the circuit board. (Do not confuse with .22 μF).

( ) 180 pF tubular ceramic (brown-gray-brown-white).

( ) Diode 1N4149 (#56-56). Position the banded end up.

( ) .047 μF tantalum. Position the positive (+ or red) end up. Use 1/4" of sleeving.

( ) .0033 μF disc.

( ) .047 μF tantalum. Position the positive (+ or red) end up.

( ) Diode 1N4149 (#56-56). Position the banded end up.

( ) 33 μF tantalum. Position the positive (+ or red) end up.

( ) .01 μF Mylar.

( ) 33 μF tantalum. Position positive (+ or red) end up. Use 1/2" of sleeving.

( ) 27 MHz band Receivers use 47 pF disc. 53 and 72 MHz band Receivers use 27 pF disc.

( ) 75 pF disc. Tilt toward center of circuit board.

PROCEED TO PICTORIAL 2-5

PICTORIAL 2-4

START

( ) Locate a length of cut off resistor lead and cut it to a length of 3/4".

( ) Insert the 3/4" wire in the indicated holes.

NOTE: When preparing the following wires, cut them to the indicated length and remove the proper amounts of insulation from the wire ends. Then twist the wire strands together and melt a minimum amount of solder on the strands to hold them together. Solder each lead as it is inserted into its indicated hole (△).

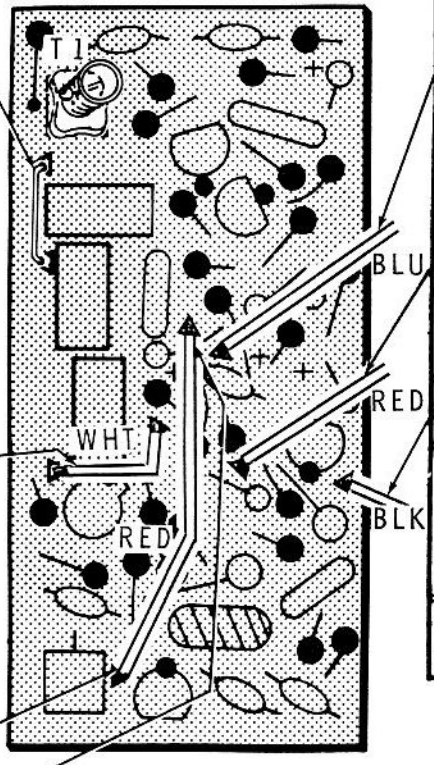
( ) 2-1/2" white wire; remove 3/4" of insulation from each end.

( ) Insert the white wire ends into their holes using the exposed wire ends like needles. Pull the wire ends through from the copper foil side of the circuit board until the wire's insulation is close to the circuit board. Do not try to lay this wire down against the circuit board.

( ) 2-1/2" red wire; remove 1/8" of insulation from one end and 3/4" of insulation from the other end.

( ) Insert the 1/8" exposed end of the red wire into its indicated hole (△).

( ) Insert the remaining end of the red wire like a needle as before.



CONTINUE

( ) 2-1/2" blue wire; remove 1/2" of insulation from one end only.

( ) Insert the blue wire like a needle. The other end will be connected later.

( ) 2-1/2" red wire; remove 1/2" of insulation from one end only.

( ) Insert the red wire like a needle. The other end will be connected later.

( ) 1" black stranded wire; remove 1/8" of insulation from both ends.

( ) Insert the black wire. The other end will be connected later.

( ) Carefully inspect the circuit board and trim all excess lead lengths close to the foil of the circuit board and make sure all connections are soldered.

( ) Set the circuit board aside temporarily.

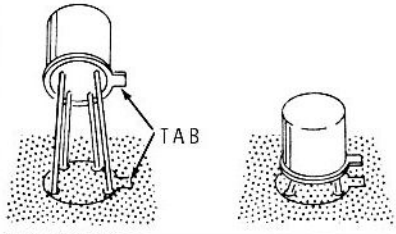
PROCEED TO PICTORIAL 2-6

PICTORIAL 2-5

START

( ) Locate the decoder circuit board (#85-413) and position it foil side down. Complete each step on Pictorials 2-6 through 2-9.

NOTE: In the following steps, install silicon-controlled switches in the following manner, as shown. Align the tab of the switch with the tab outline on the circuit board. Position the body of the switch as close to the circuit board as possible without letting the leads touch the case. Do not crisscross any of the leads.



( ) Silicon-controlled switch X13B615 (#57-47).

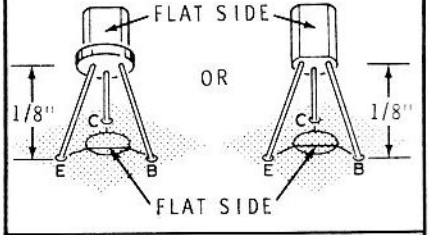
( ) Silicon-controlled switch X13B615 (#57-47).

( ) Silicon-controlled switch X13B615 (#57-47).

( ) Silicon-controlled switch X13B615 (#57-47).

( ) Silicon-controlled switch X13B615 (#57-47).

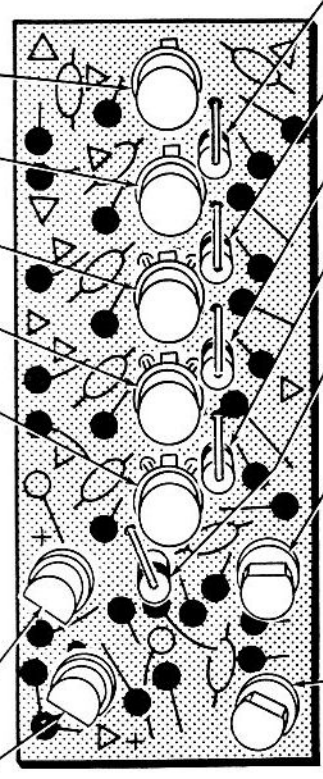
NOTE: Install the next two transistors in the following manner as shown:



( ) Transistor 2N3393 (#417-118).

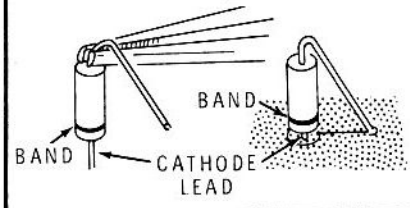
( ) Transistor 2N3393 (#417-118).

SOLDERING IRON TIP



CONTINUE

NOTE: When installing diodes vertically, hold the diode lead with pliers so the diode is not broken when bending the lead. Bend the lead before installing the diode. Then, position the diode on the circuit board as directed in each step. In each installation, the diode lead may touch the silicon controlled switch case. This will not change the operation of the decoder.



( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

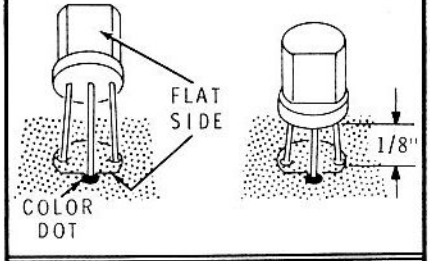
( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

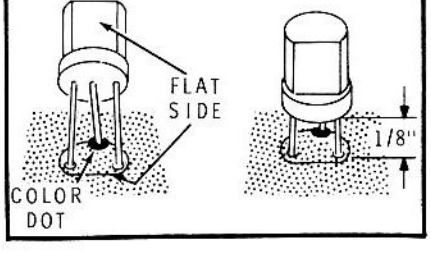
( ) Diode 1N4149 (#56-56). Position with cathode (banded) end down.

( ) Diode 1N4149 (#56-56). NOTE: Position with cathode (banded) end up.

( ) Transistor X29A826 (#417-200). NOTE: Position the center lead toward the flat when installing this transistor only.



( ) Transistor X29A826 (#417-200).



PROCEED TO PICTORIAL 2-7

PICTORIAL 2-6

START

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 10 kΩ (brown-black-orange). Use 1/4" of sleeving.

( ) 1000 Ω (brown-black-red).

( ) 4700 Ω (yellow-violet-red). Use 1/4" of sleeving.

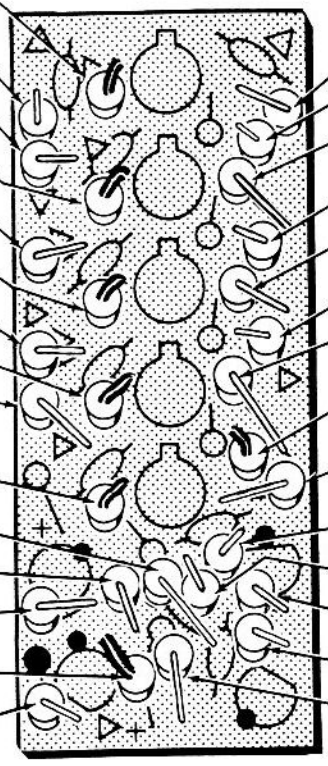
( ) 4700 Ω (yellow-violet-red).

( ) 4700 Ω (yellow-violet-red).

( ) 15 kΩ (brown-green-orange).

( ) 2200 Ω (red-red-red). Use 1/4" of sleeving.

( ) 100 kΩ (brown-black-yellow).



CONTINUE

( ) 15 kΩ (brown-green-orange). Tilt toward center of board before soldering.

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow).

( ) 15 kΩ (brown-green-orange).

( ) 100 kΩ (brown-black-yellow). Use 1/4" of sleeving.

( ) 15 kΩ (brown-green-orange). Tilt toward center of circuit board before soldering.

( ) 4700 Ω (yellow-violet-red).

( ) 47 kΩ (yellow-violet-orange).

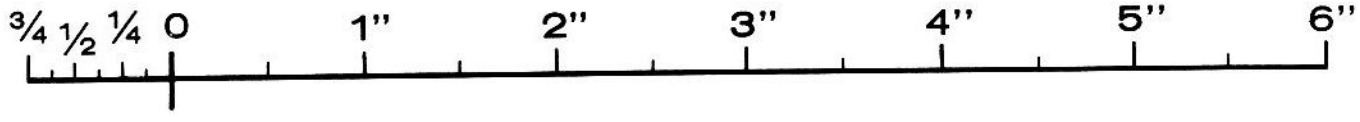
( ) 15 kΩ (brown-green-orange).

( ) 4700 Ω (yellow-violet-red).

( ) 1500 Ω (brown-green-red).

PROCEED TO PICTORIAL 2-8

PICTORIAL 2-7



START

NOTE: When a wire is called for, cut it to length, remove 1/4" of insulation from one end, and position the prepared end in the indicated hole (△). Solder the wire to the foil. The other end will be connected later.

( ) 7" blue wire.

NOTE: When installing three wires in the same hole, twist the ends of the three wires together and melt a minimum amount of solder on the strands.

( ) Three 7" white wires. Insert the three wires into the same hole.

NOTE: When installing disc capacitors, remove any excess coating from the leads. Use long-nose pliers to remove this coating.

( ) .001 μF disc.

( ) Three 7-1/2" black stranded wires. Insert the three wires into the same hole.

( ) 7-1/2" green wire.

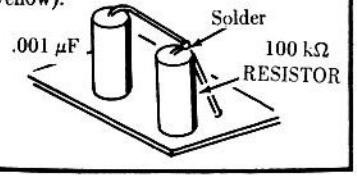
( ) .005 μF disc.

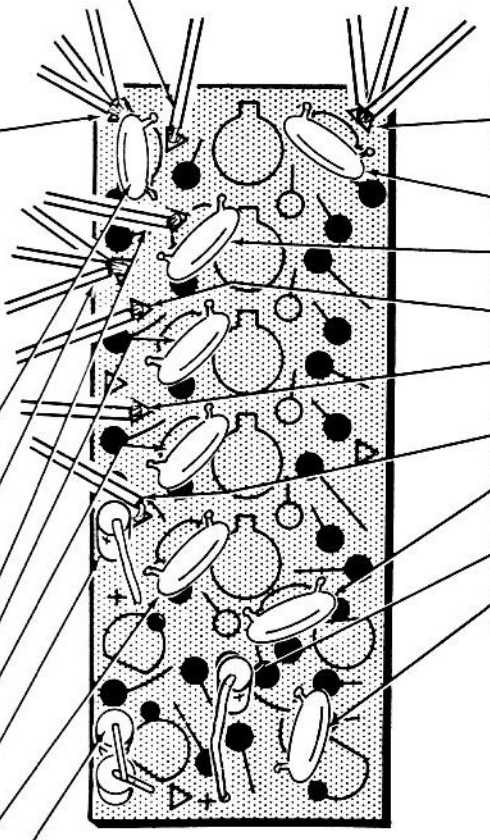
( ) .005 μF disc.

( ) .22 μF tantalum. Position with positive (+) or red end up.

( ) .005 μF disc.

( ) .001 μF (brown-black-red-yellow) tubular ceramic. Connect to the top lead of the 100 kΩ resistor (brown-black-yellow).





CONTINUE

( ) Three 7-1/2" red wires. Insert the three wires into the same hole.

( ) .001 μF disc.

( ) .005 μF disc.

( ) 7-1/2" yellow wire.

( ) 7-1/2" orange wire. Make sure you use the proper hole.

( ) 8" brown wire.

( ) .005 μF disc.

( ) .047 μF tantalum. Position with the positive (+) or red end up.

( ) .005 μF disc.

PROCEED TO PICTORIAL 2-9

PICTORIAL 2-8

START

( ) Position the receiver and decoder circuit boards as shown (foil side down) for final wiring.

( ) Remove 1/8" of insulation from the free end of the red and blue wires coming from the receiver circuit board. Then twist the wire strands of each lead together and melt a minimum amount of solder on the strands to hold them together.

( ) Insert the black wire.

( ) Insert the red wire.

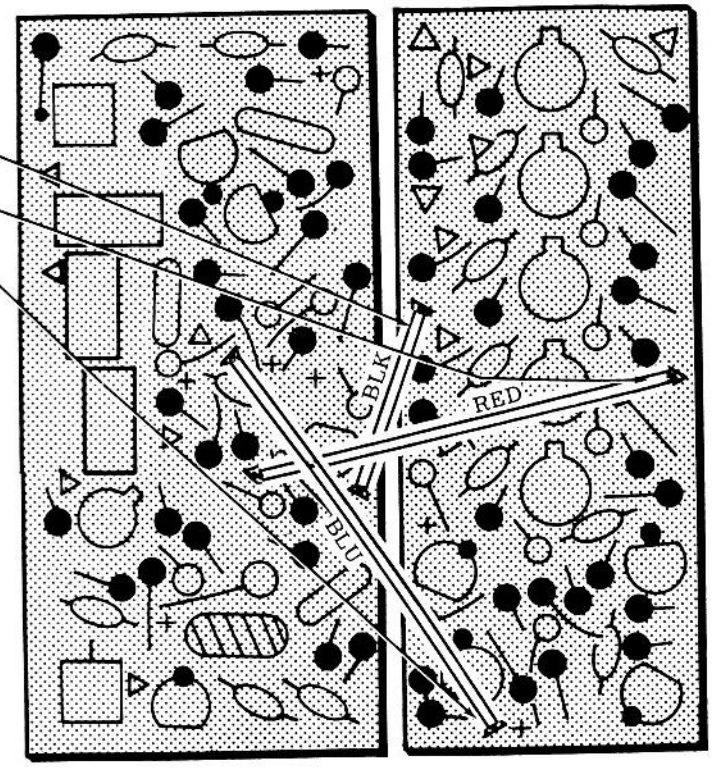
( ) Insert the blue wire.

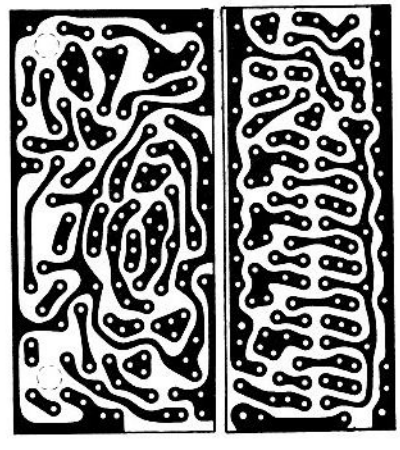
( ) Solder all three connections to the foil and cut off the excess lead lengths.

( ) Compare your foil pattern against those shown to make sure there are no solder bridges. To make it easier to locate solder bridges, it is suggested that you clean the foil side of the circuit board and remove the rosin. This can be done by using a small stiff brush (tooth brush) and lacquer thinner or dope thinner. Only a very small amount of these chemicals are required. Do not get them on the component side of the circuit board or in the coils.

NOTE: This completes the assembly of the circuit boards. Check the component side to make sure that a lead from any one component is not touching the lead of any other component.

FINISH





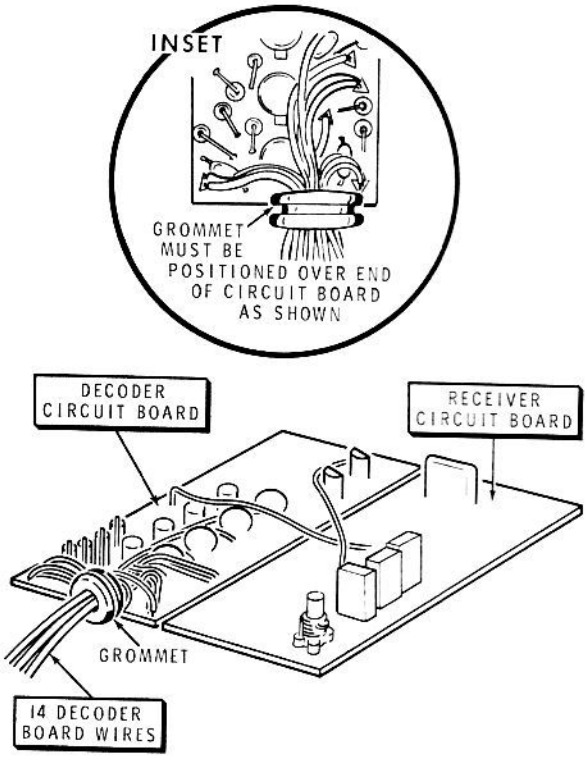
PICTORIAL 2-9

WIRING

Refer to Detail 2-10A for the following steps.

( ) Position the fourteen decoder circuit board wires around the decoder components as shown.

( ) Slip a rubber grommet over the fourteen decoder circuit board wires. Position the wires and grommet as shown in the inset drawing.



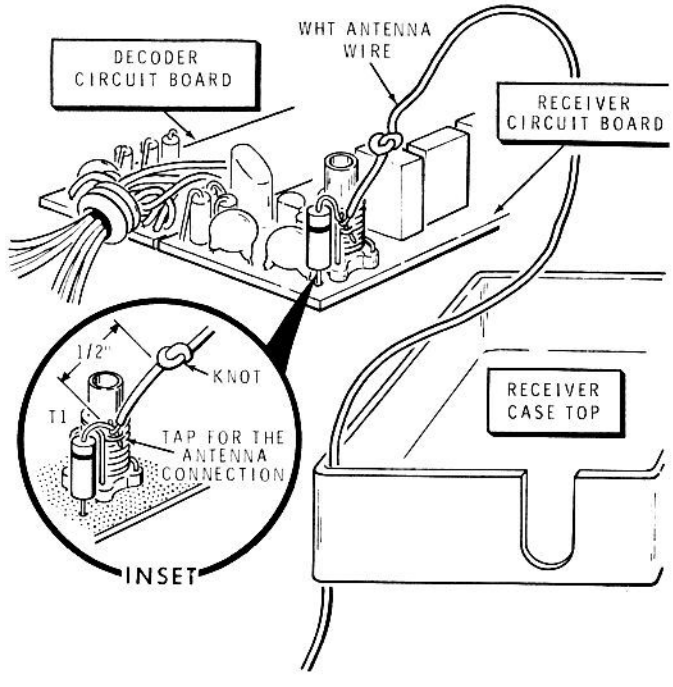
Detail 2-10A

Refer to Detail 2-10B for the following steps.

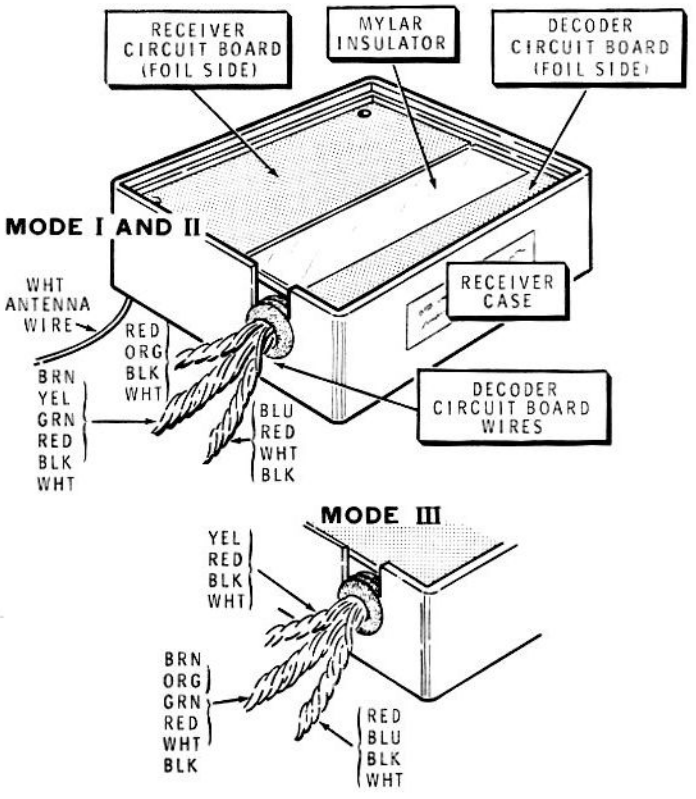
( ) Remove 1/8" of insulation from one end of the 36" white wire. Tie a small knot in this wire 1/2" from the end of the wire.

( ) Refer to the inset drawing and form a hook in the wire. Connect the hook to the top lead of the diode (S-1).

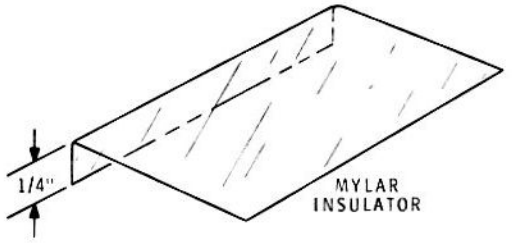
( ) Locate the receiver case and insert the 36" antenna wire through the small hole in the case top. NOTE: This hole may have to be enlarged in some of the cases.



Detail 2-10B



PICTORIAL 2-10

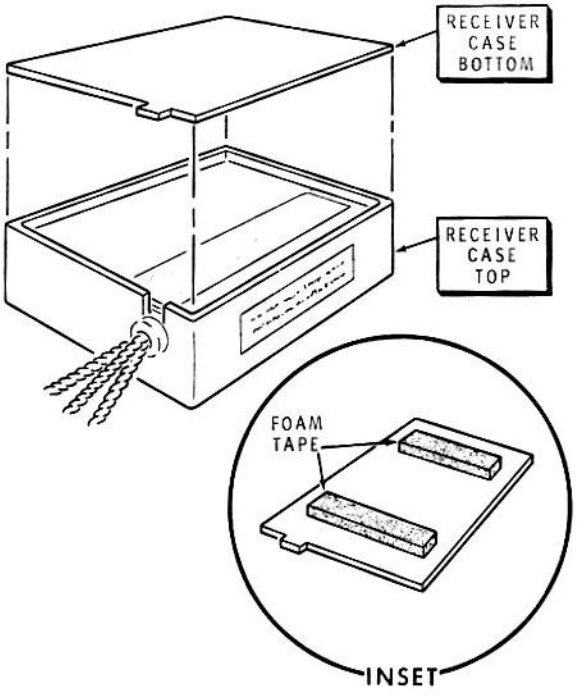


Detail 2-10C

( ) Refer to Detail 2-10C and bend the Mylar insulator to the shape shown.

Refer to Pictorial 2-10 for the following steps.

( ) Insert the 1/4" section of the Mylar insulator between the circuit boards as shown and position the circuit boards into the case. Be sure the fourteen decoder wires, rubber grommet, and 36" antenna wire are positioned so the circuit boards fit properly into the case.



Detail 2-10D

( ) Cut the foam tape into two equal lengths.

( ) Refer to the inset drawing on Detail 2-10D. Remove the paper backing from the two lengths of foam tape and install the tape on the inside of the case bottom.

( ) Place the case bottom into position.

( ) Remove the paper backing from the FCC label and press the label into place on the side of the receiver case as shown.

At this point in the construction of your GD-19 system, you must decide which mode of operation you will be using. The three modes of operation in popular use today are:

	Left Control Stick	Right Control Stick
Mode I	Rudder-Elevator	Aileron-Throttle
Mode II	Rudder-Throttle	Aileron-Elevator
Mode III	Aileron-Throttle	Rudder-Elevator

Select the mode you prefer and follow the receiver wiring instructions under that particular heading. If you are unfamiliar with model control, we suggest that you follow Mode II instructions, or consult a local modeler for advice on which Mode to use. The mode of operation is one of personal preference and all work equally well.

The decoder circuit board wires will now be twisted into three groups. Refer to the heading of the Mode you have selected and perform the given operations.

MODES I AND II

( ) Group an orange, red, black, and white wire together and twist the leads together.

( ) Twist together a red, blue, black, and white wire to form a second group.

( ) Twist together the remaining six decoder wires (green, brown, yellow, red, black, and white).

Proceed to Connector Wiring.

MODE III

( ) Group a yellow, red, black, and white wire together and twist the leads together.

( ) Group a blue, red, black, and white together and twist the wires into a second group.

( ) Twist together the remaining six decoder wires (brown, orange, green, red, black, and white).

CONNECTOR WIRING

( ) Cut the wire ends in each group so they are even with the end of the shortest wire of that group.

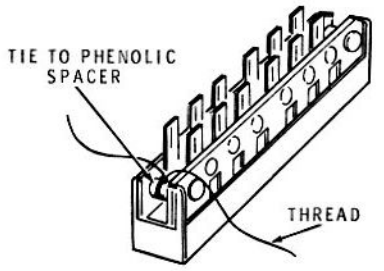
( ) Remove 1/8" of insulation from the end of each of the fourteen wires. Then twist the small strands together, and melt a small amount of solder on the exposed end of each wire.

( ) Cut fourteen 1/2" lengths of sleeving.

( ) Place a 1/2" of sleeving over each of the fourteen wires.

For Mode I or II operation, refer to Pictorial 2-11A (fold-out from Page 51) and connect these twisted wires to the large block connector and two 4-lug sockets.

For Mode III operation, refer to Pictorial 2-11B (fold-out from Page 51) and connect these twisted wires to the large block connector and two 4-lug sockets.



Detail 2-12A

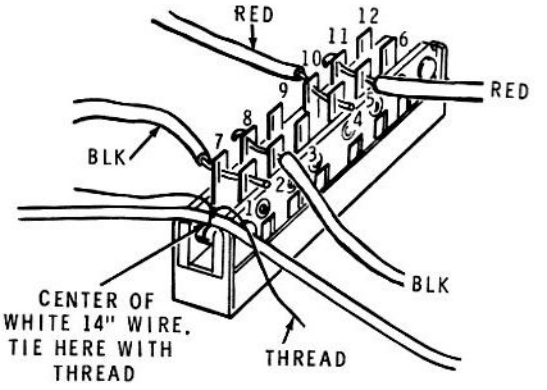
RECEIVER BATTERY SWITCH WIRING

Refer to Detail 2-12A for the following step.

NOTE: The slide switch is symmetrical and may be positioned either way.

( ) Tie a length of thread, about 5" long to the phenolic spacer as shown.

Refer to Detail 2-12B for the following steps.



Detail 2-12B

Prepare the following lengths of wire by removing 1/4" of insulation from only <u>one</u> end of each wire. Twist together the small wire strands of each lead. Then melt a small amount of solder on the exposed end of each wire to hold the separate strands together. The other ends of the wires will be prepared later.

COLOR	LENGTH
( ) Black	8"
( ) Black	8"
( ) Red	8"
( ) Red	8"

NOTE: Where a wire passes through a connection and then goes to another point, as in the next step, it will count as two wires in the solder instructions (S-2), one entering and one leaving the connection.

Connect the prepared ends of the red and black wires to the slide switch as follows. The other ends of these wires will be connected later. NOTE: The pincher clothespin can be used to hold the switch while soldering.

( ) 8" black through lug 7 (S-2) to lug 1 (S-1).

( ) 8" black through lug 2 (S-2) to lug 8 (S-1).

( ) 8" red through lug 10 (S-2) to lug 4 (S-1).

( ) 8" red through lug 5 (S-2) to lug 11 (S-1).

( ) Cut a 14" length of white wire (but do not prepare the ends). Position the center of this wire as shown in Detail 2-12B and tie it in place with the thread. Do not cut the ends of the thread off yet.

Refer to Pictorial 2-12 for the following steps.

( ) Fold the red, black, and white wires together and tie them as shown. The thread ends may now be trimmed off.

The six wires from the receiver switch will now be separated into two groups. Complete the following steps for each wire group. Two check off spaces are provided in front of each step for this purpose.

( ) ( ) Select a red, white, and black wire and twist them into a group.

( ) ( ) Cut the ends of the three wires so they are even with the end of the shortest wire in the group.

( ) ( ) Remove 1/8" of insulation from the end of each of these wires. Melt a small amount of solder on the exposed end of each wire.

( ) ( ) Place 1/2" of sleeving over each wire.

Refer to Pictorial 2-12 and connect the wires to the two 4-pin plugs as shown. Note the wide space between pins 1 and 2.

Connect the wires to a four pin plug as follows:

( ) Red to pin 4 (S-1).

( ) White to pin 3 (S-1).

( ) Black to pin 2 (S-1).

( ) Temporarily mount the switch mounting plate onto the switch with two screws.

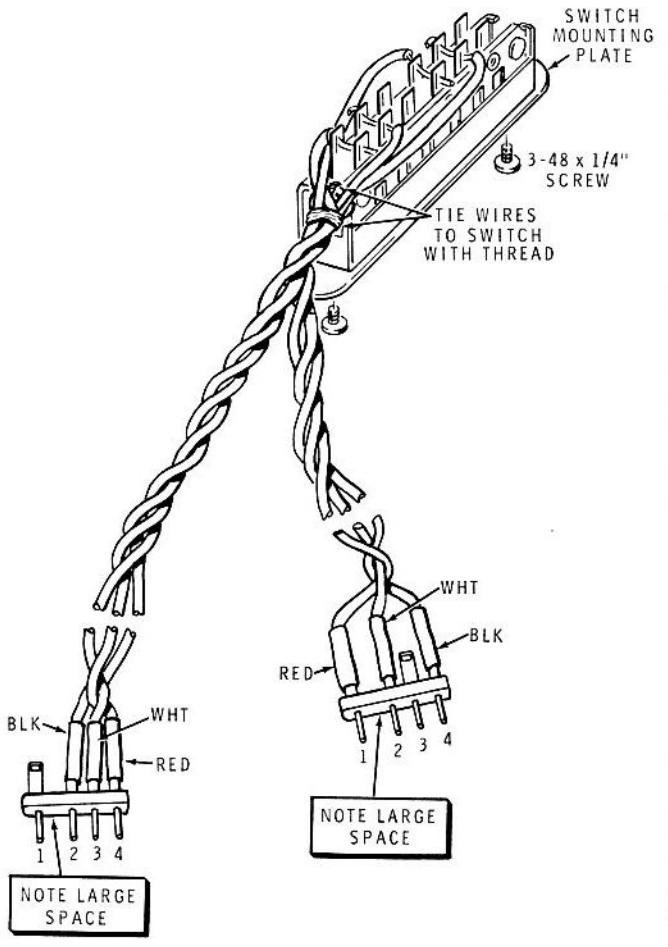
Connect the wires to a four pin plug as follows:

( ) Black to pin 4 (S-1).

( ) White to pin 2 (S-1).

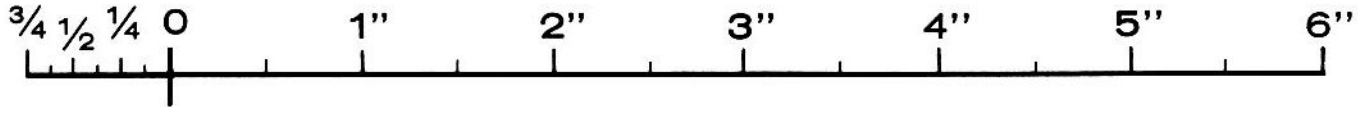
( ) Red to pin 1 (S-1).

( ) Push the six lengths of sleeving over the lugs and twist the wires up tight to the ends of the sleeving. Temporarily set the switch aside.



PICTORIAL 2-12

Proceed to the Servo section of the Manual.



WIRING FOR MODES I AND II OPERATION

LARGE BLOCK CONNECTOR

Connect the wires to the large block connector as follows:

( ) Brown to pin 1 (S-1).

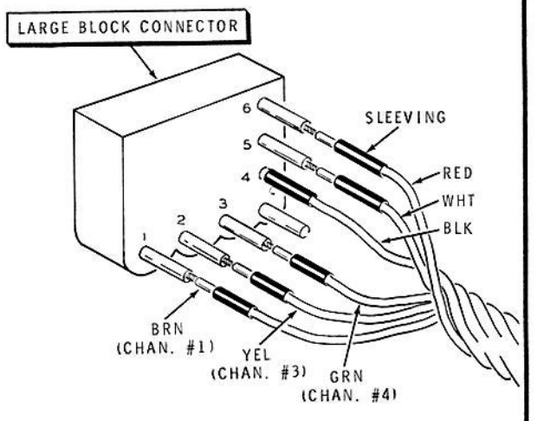
( ) Yellow to pin 2 (S-1).

( ) Green to pin 3 (S-1).

( ) Black to pin 4 (S-1).

( ) White to pin 5 (S-1).

( ) Red to pin 6 (S-1).



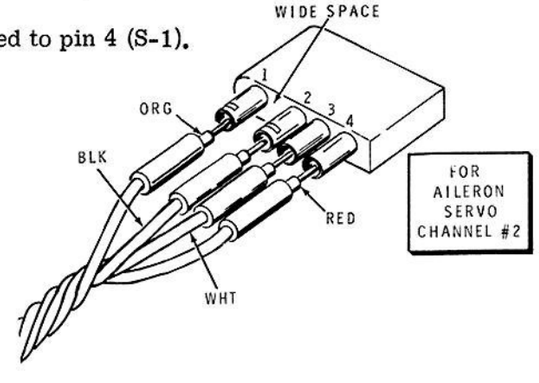
Connect the wires to a 4-lug socket as follows:

( ) Orange to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).



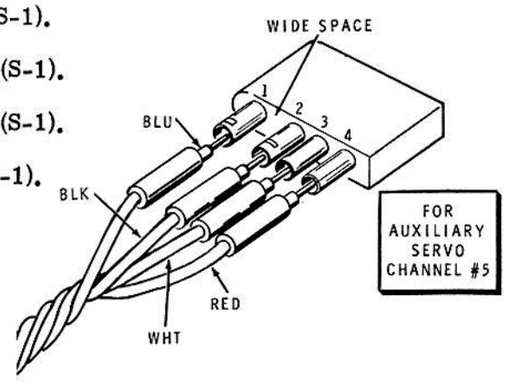
Connect the wires to a 4-lug socket as follows:

( ) Blue to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).



( ) Push the 14 lengths of sleeving over the lugs and twist the wires up to the ends of the sleeving.

Set the Receiver aside temporarily and proceed to Receiver Battery Switch Wiring.

PICTORIAL 2-11A

WIRING FOR MODE III OPERATION

LARGE BLOCK CONNECTOR

Connect the wires to the large block connector as follows:

( ) Brown to pin 1 (S-1).

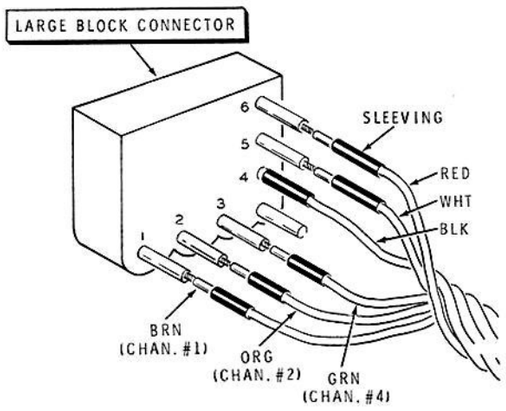
( ) Orange to pin 2 (S-1).

( ) Green to pin 3 (S-1).

( ) Black to pin 4 (S-1).

( ) White to pin 5 (S-1).

( ) Red to pin 6 (S-1).



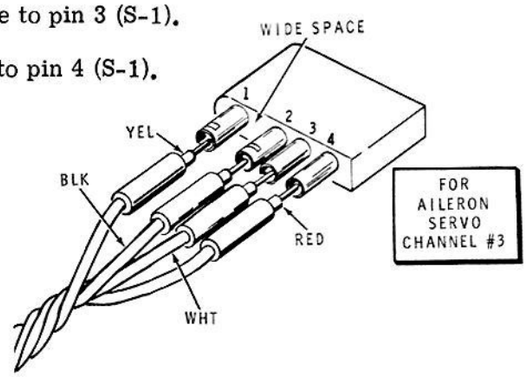
Connect the wires to a 4-lug socket as follows:

( ) Yellow to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).



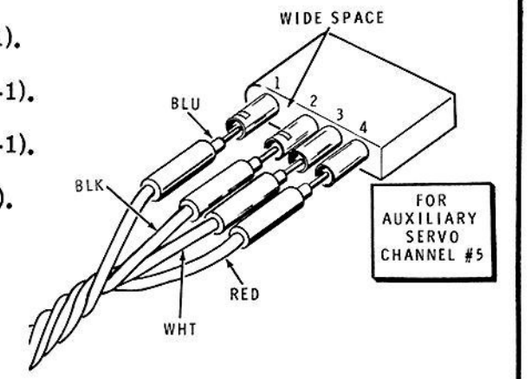
Connect the wires to a 4-lug socket as follows:

( ) Blue to pin 1 (S-1).

( ) Black to pin 2 (S-1).

( ) White to pin 3 (S-1).

( ) Red to pin 4 (S-1).

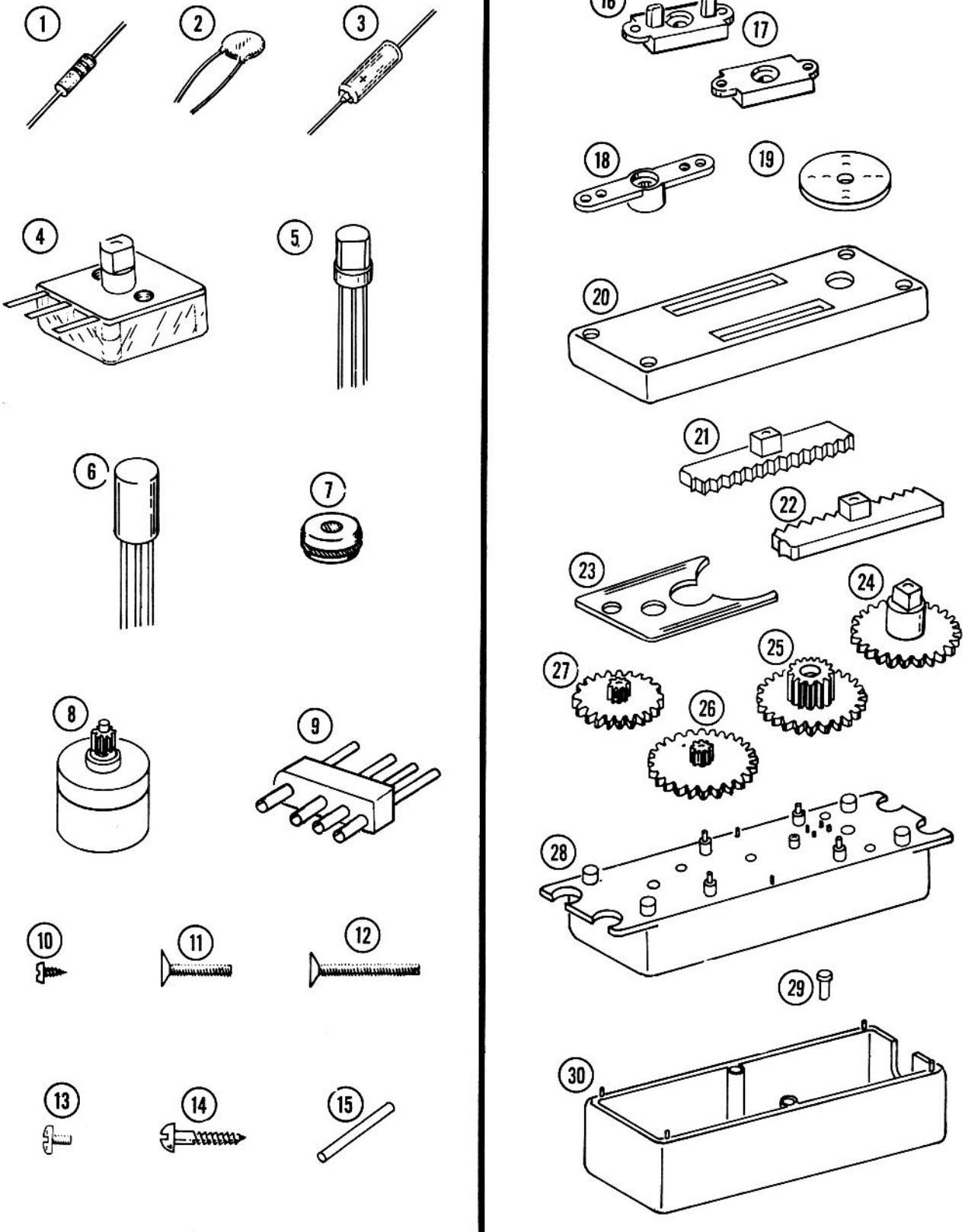


( ) Push the 14 lengths of sleeving over the lugs and twist the wires up to the ends of the sleeving.

Set the Receiver aside temporarily and proceed to Receiver Battery Switch Wiring.

PICTORIAL 2-11B

SERVO PARTS PICTORIAL



SERVO PARTS LIST

NOTE: If you have purchased either a GD-19M or a GD-19S Radio Control System, disregard the "Servo" section of this Manual and use the manual packed with the servo. If you have purchased a GD-19 system or a GD-19-4 servo, proceed with the "Servo" section in this Manual.

Unpack the Servo packs marked with the first seven numbers, 171-2126. Keep the four sets of parts separated from each other. Each Servo should contain the parts listed below. The numbers in parentheses are keyed to the numbers on the Parts Pictorial.

PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS 1/4 Watt		
(1) 1-20-12	1	33 Ω (orange-orange-black)
1-51-12	2	47 Ω (yellow-violet-black)
1-17-12	1	220 Ω (red-red-brown)
1-24-12	1	820 Ω (gray-red-brown)
1-3-12	1	1200 Ω (brown-red-red)
1-4-12	3	2200 Ω (red-red-red)
1-6-12	1	3300 Ω (orange-orange-red)
1-8-12	3	4700 Ω (yellow-violet-red)
1-28-12	1	8200 Ω (gray-red-red)
1-9-12	1	10 kΩ (brown-black-orange)
1-45-12	2	22 kΩ (red-red-orange)
1-11-12	2	47 kΩ (yellow-violet-orange)
1-50-12	1	11 MΩ (brown-brown-blue)

PART No.	PARTS Per Kit	DESCRIPTION
CAPACITORS		
(2) 21-6	1	27 pF disc
21-140	1	.001 μF disc
21-141	1	.0033 μF disc
21-94	3	.05 μF disc
(3) 25-197	3	1.0 μF electrolytic
(4) 26-121	1	2-section variable
TRANSISTORS		
NOTE: Transistors will be marked with either the part number or transistor type number.		
(5) 417-91	2	2N5232A/2N3391A
417-200	5	X29A826
117-6	1	Transistor pair
Consisting of:		
	1	2N2430
	1	2N2431

PART No.	PARTS Per Kit	DESCRIPTION
WIRE-SLEEVING		
344-90	1	Black wire
344-92	1	Red wire
344-95	1	Green wire
344-99	1	White wire
344-110	1	Special flex wire (gray)
346-1	1	Small sleeving
346-20	1	Large sleeving
GENERAL		
(7) 73-59	4	Large rubber grommet
73-53	1	Small rubber grommet
85-305	1	Circuit board
(8) 420-56	1	Motor
(9) 432-104	1	4-pin male connector
		Solder

PART No.	PARTS Per Kit	DESCRIPTION
HARDWARE		
(10) 250-355	3	2-32 x 3/16" sheet metal screw
(11) 250-353	4	2-56 x 7/16" screw
(12) 250-352	2	2-56 x 11/16" screw
(13) 250-354	2	3-56 x 1/8" screw
(14) 250-82	4	#4 x 1/2" wood screw
(15) 452-19	3	Gear pin
MOLDED NYLON PARTS		
(16) 266-111	1	Linear output arm (with tabs)
(17) 266-100	1	Linear output arm (without tabs)
(18) 266-102	1	Rotary output arm
(19) 266-101	1	Rotary output wheel
(20) 92-41	1	Case top section
(21) 451-59	1	Right rack gear
(22) 451-54	1	Left rack gear
(23) 266-99	1	Rack gear guide
(24) 451-53	1	Capacitor drive gear
(25) 451-52	1	Rack drive gear
(26) 451-51	1	Idler gear
(27) 451-50	1	Motor coupling gear
(28) 92-42	1	Case center section
(29) 262-14	1	Pin
(30) 92-43	1	Case bottom section

SERVO PARTS LIST

NOTE: If you have purchased either a GD-19M or a GD-19S Radio Control System, disregard the "Servo" section of this Manual and use the manual packed with the servo. If you have purchased a GD-19 system or a GD-19-4 servo, proceed with the "Servo" section in this Manual.

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RESISTORS 1/4 Watt		
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1-17-12	1	220 Ω (red-red-brown)
1-24-12	1	820 Ω (gray-red-brown)
1-3-12	1	1200 Ω (brown-red-red)
1-4-12	3	2200 Ω (red-red-red)
1-6-12	1	3300 Ω (orange-orange-red)
1-8-12	3	4700 Ω (yellow-violet-red)
1-28-12	1	8200 Ω (gray-red-red)
1-9-12	1	10 kΩ (brown-black-orange)
1-45-12	2	22 kΩ (red-red-orange)
1-11-12	2	47 kΩ (yellow-violet-orange)
1-50-12	1	11 MΩ (brown-brown-blue)

PART No.	PARTS Per Kit	DESCRIPTION
CAPACITORS		
(2) 21-6	1	27 pF disc
21-140	1	.001 μF disc
21-141	1	.0033 μF disc
21-94	3	.05 μF disc
(3) 25-197	3	1.0 μF electrolytic
(4) 26-121	1	2-section variable
TRANSISTORS		
NOTE: Transistors will be marked with either the part number or transistor type number.		
(5) 417-91	2	2N5232A/2N3391A
417-200	5	X29A826
117-6	1	Transistor pair
Consisting of:		
	1	2N2430
	1	2N2431

PART No.	PARTS Per Kit	DESCRIPTION
WIRE-SLEEVING		
344-90	1	Black wire
344-92	1	Red wire
344-95	1	Green wire
344-99	1	White wire
344-110	1	Special flex wire (gray)
346-1	1	Small sleeving
346-20	1	Large sleeving
GENERAL		
(7) 73-59	4	Large rubber grommet
73-53	1	Small rubber grommet
85-305	1	Circuit board
(8) 420-56	1	Motor
(9) 432-104	1	4-pin male connector
		Solder

PART No.	PARTS Per Kit	DESCRIPTION
HARDWARE		
(10) 250-355	3	2-32 x 3/16" sheet metal screw
(11) 250-353	4	2-56 x 7/16" screw
(12) 250-352	2	2-56 x 11/16" screw
(13) 250-354	2	3-56 x 1/8" screw
(14) 250-82	4	#4 x 1/2" wood screw
(15) 452-19	3	Gear pin
MOLDED NYLON PARTS		
(16) 266-111	1	Linear output arm (with tabs)
(17) 266-100	1	Linear output arm (without tabs)
(18) 266-102	1	Rotary output arm
(19) 266-101	1	Rotary output wheel
(20) 92-41	1	Case top section
(21) 451-59	1	Right rack gear
(22) 451-54	1	Left rack gear
(23) 266-99	1	Rack gear guide
(24) 451-53	1	Capacitor drive gear
(25) 451-52	1	Rack drive gear
(26) 451-51	1	Idler gear
(27) 451-50	1	Motor coupling gear
(28) 92-42	1	Case center section
(29) 262-14	1	Pin
(30) 92-43	1	Case bottom section

SERVO
STEP-BY-STEP ASSEMBLY

NOTE: All four Servos must be completed according to the Step-By-Step Assembly instructions. They can be assembled one at a time or all four Servos can be assembled simultaneously.

CIRCUIT BOARD ASSEMBLY NOTES

The circuit board and the components to be installed on it are quite small. Therefore, we suggest that you take your time while assembling it.

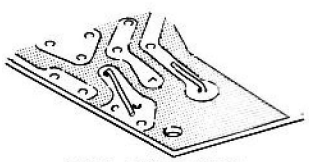
Because the circuit board is so small, there is not sufficient room on it to letter the value of each component. Therefore, all component locations except for resistors are shown on the board with only an outline of the component. See Figure 1-2 on Page 37. The locations where resistors are to be installed are blanked in. Holes outlined with a triangle are used for wires.

Use extreme care when installing components so that they fit directly over their outline on the circuit board. Position all components down tight against the circuit board unless directed otherwise. Be sure none of the components (except the two large transistors) are more than 5/16" above the circuit board at their maximum height. This is necessary to provide clearance when the case is installed.

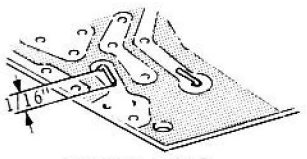
Complete each step on Pictorials 3-1 through 3-4.

IMPORTANT SOLDER NOTE

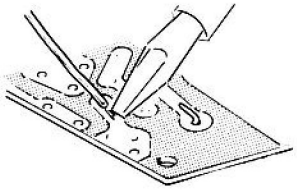
When you install each component, bend its leads flat against the same foil from which they extend, as shown below. It is important that each lead is bent toward the center of a foil pad, or in the same direction as the foil lead to prevent solder bridging between foils. Cut the leads 1/16" from the hole on the foil side of the circuit board. This will hold the components in place until they are soldered, and will provide a larger solder area. This larger solder area in important because of the great amount of vibration that the receiver and servos must withstand. This note applies to the leads of all components being installed in the following steps and pictorials.



BEND LEADS ONTO FOIL FROM WHICH THEY EXTEND



CUT OFF LEADS 1/16" FROM HOLE



SOLDER LEADS TO FOIL WHEN ALL THE HOLES IN A FOIL PAD ARE USED

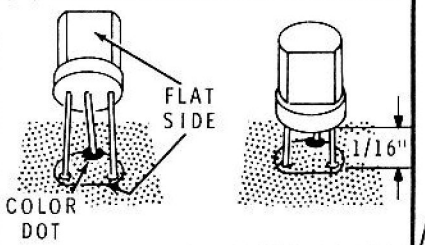
START

NOTE: There are no specific steps for soldering the component leads to the foil of the circuit board. When all the holes in a foil pad have been used, the component leads should be soldered to that foil. This will eliminate the possibility of covering unused holes. Also, be very careful not to make any solder bridges between adjacent foils.

( ) Locate the Servo circuit board and position it as shown.

NOTE: When installing transistors in the following steps, be sure to align the flat of the transistor with the flat of the outline on the circuit board. Also, place the collector lead of each transistor in the hole that is marked with a white dot. Position each transistor 1/16" above the circuit board.

( ) X29A826 transistor (#417-200).

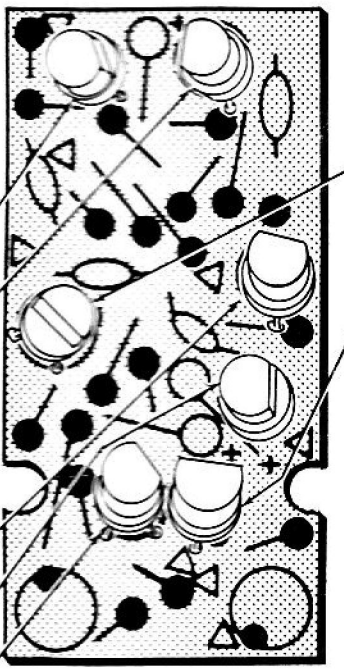


( ) X29A826 transistor (#417-200).

( ) X29A826 transistor (#417-200).

( ) X29A826 transistor (#417-200).

( ) X29A826 transistor (#417-200). Position this transistor 1/8" above the circuit board.



CONTINUE

( ) 2N5232A/2N3391A transistor (#417-91).

( ) 2N5232A/2N3391A transistor (#417-91). Position this transistor 1/8" above the circuit board.

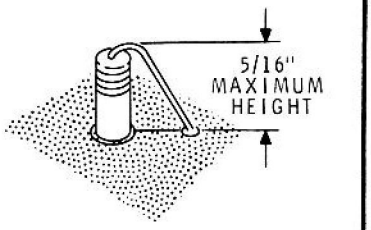
PROCEED TO PICTORIAL 3-2.

PICTORIAL 3-1

START

NOTE: Position all vertically mounted components as perpendicular to the circuit board as possible.

( ) 11 MΩ (brown-brown-blue).



( ) 47 Ω (yellow-violet-black).

( ) 1200 Ω (brown-red-red).

( ) 8200 Ω (gray-red-red).

( ) 4700 Ω (yellow-violet-red).

( ) 10 kΩ (brown-black-orange).

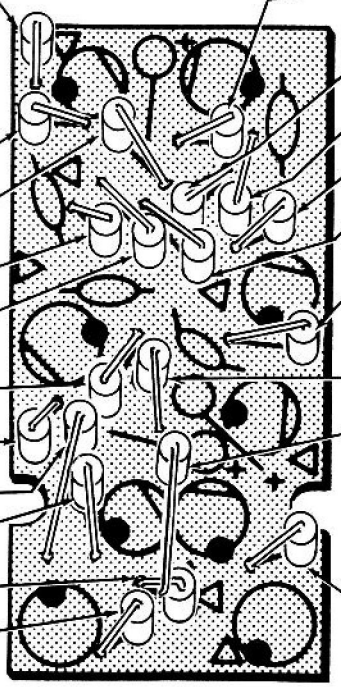
( ) 47 kΩ (yellow-violet-orange).

( ) 2200 Ω (red-red-red).

( ) 220 Ω (red-red-brown).

( ) 33 Ω (orange-orange-black).

( ) 47 Ω (yellow-violet-black).



CONTINUE

( ) 3300 Ω (orange-orange-red).

( ) 4700 Ω (yellow-violet-red).

( ) 22 kΩ (red-red-orange).

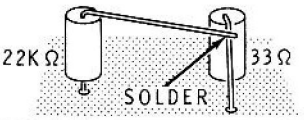
( ) 4700 Ω (yellow-violet-red).

( ) 2200 Ω (red-red-red).

( ) 47 kΩ (yellow-violet-orange).

( ) 2200 Ω (red-red-red).

( ) 22 kΩ (red-red-orange). Lay the end of the free lead against the 33 Ω (orange-orange-black) resistor lead as shown and solder the connection. Do not wrap the connection. Due to other components, this resistor may not sit down against the circuit board.



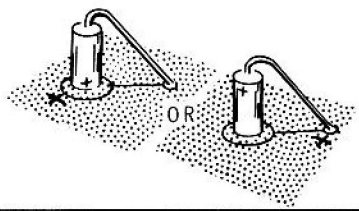
( ) 820 Ω (gray-red-brown).

PROCEED TO PICTORIAL 3-3.

PICTORIAL 3-2

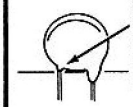
START

NOTE: When installing electrolytic capacitors, be sure to position the positive (+) lead (red end of capacitor) in the positive (+) marked hole in the circuit board.



( ) 1.0 μF electrolytic. Position (+) end down.

NOTE: When installing disc capacitors, remove any excess coating from the leads. Use long-nose pliers to remove this coating.



( ) .0033 μF disc.

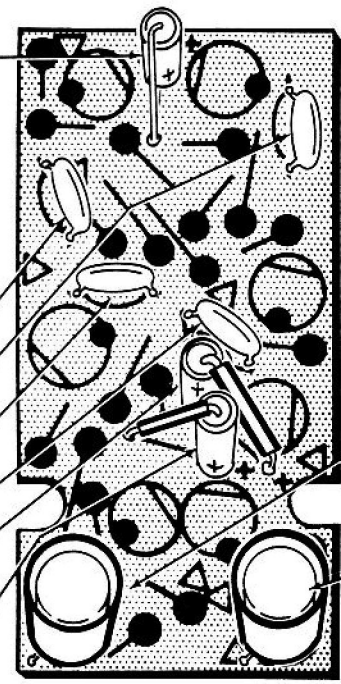
( ) .001 μF disc.

( ) .05 μF disc.

( ) .05 μF disc.

( ) 1.0 μF electrolytic. Use a 5/16" length of small sleeving on the indicated lead. Position (+) end up.

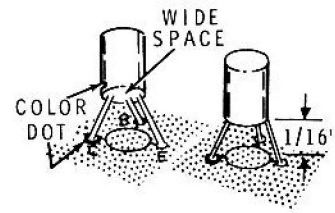
( ) 1.0 μF electrolytic. Use a 5/16" length of small sleeving on the indicated lead. Position (+) end down.



CONTINUE

NOTE: When installing the transistors in the following steps, align the color dot of the transistor with the dot on the circuit board. Position each lead in its proper hole and position the transistor 1/16" above the circuit board.

( ) 2N2430 transistor.



( ) 2N2431 transistor.

( ) Place a 1/2" length of large sleeving over each of these two transistors. Press the sleeving down tight against the circuit board.

PROCEED TO PICTORIAL 3-4

PICTORIAL 3-3

START

NOTE: When a wire is called for in a step, remove 1/8" of insulation from only one end of a wire of the specified length and color. Twist the small strands of each lead together and melt a small amount of solder on the exposed wire to hold the small strands together. Position the prepared end of the wire in the indicated hole (△). Bend the end over and solder it in place. The free end of each wire will be connected later.

( ) 2-1/2" green wire.

( ) 7-1/2" green wire.

( ) 7-1/2" black wire.

( ) 2" red wire.

( ) 7-1/2" red wire.

( ) 2-1/2" white wire.

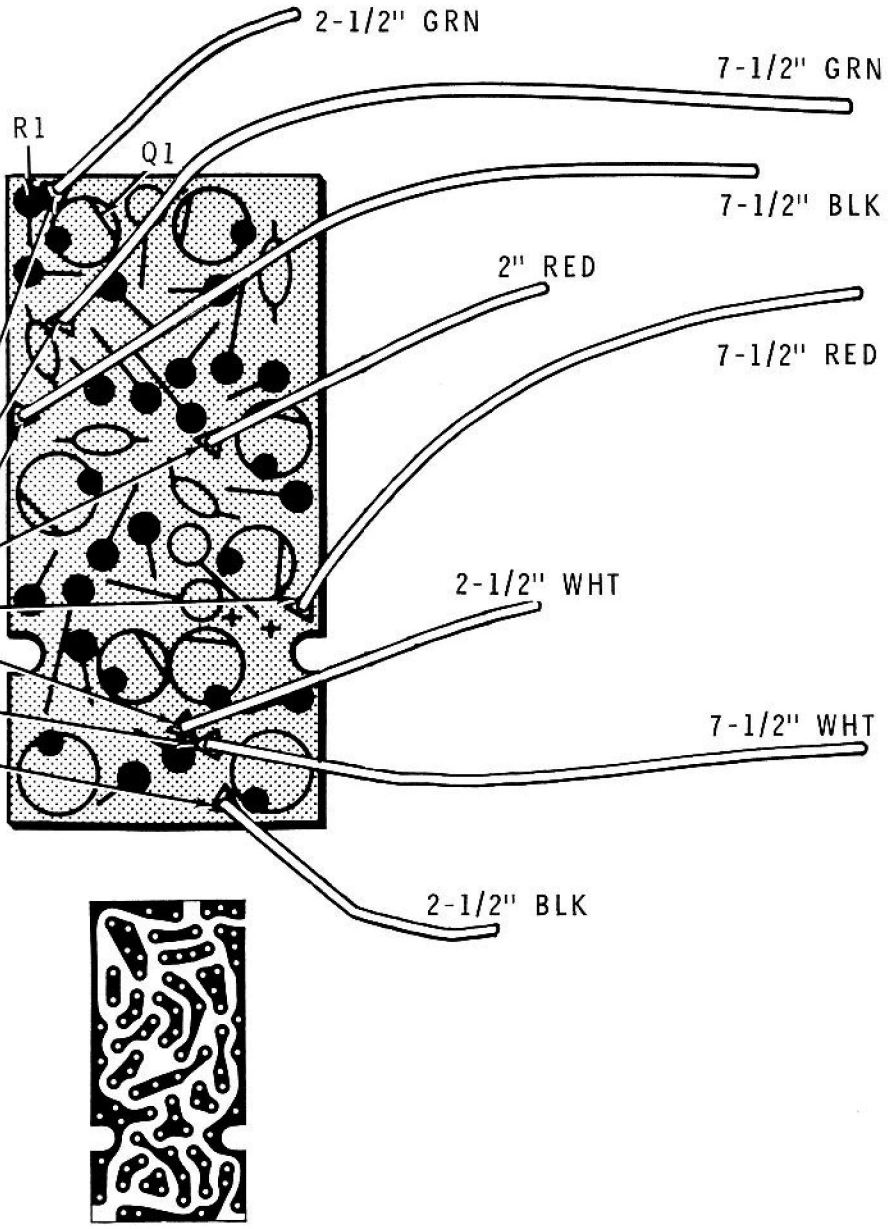
( ) 7-1/2" white wire.

( ) 2-1/2" black wire.

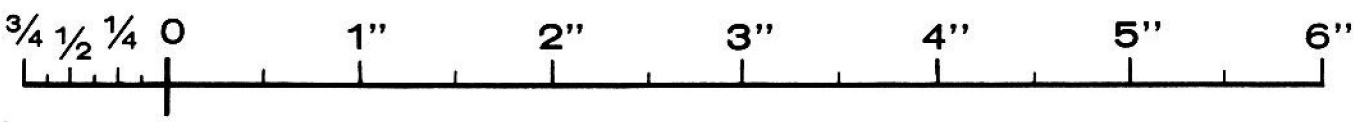
Reheat the connections to straighten any components that may have tipped over during assembly. Be careful not to break any components as you straighten them.

NOTE: This completes the assembly of the circuit board. Check to see that all connections are soldered and that all excess lead lengths have been cut off. To make it easier to locate any possible solder bridges between adjacent foil pads, it is suggested that you compare the foil side of the circuit board with the foil view shown.

FINISH



PICTORIAL 3-4



WIRING

CONNECTOR WIRING

Refer to Pictorial 3-5 for the following steps.

( ) Pass the small rubber grommet over the long black, red, green, and white wires coming from the servo circuit board.

( ) Twist these wires together as shown.

( ) Cut the ends of these wires even with the end of the shortest wire. Be sure the wires are positioned as shown in Pictorial 3-5 before cutting.

( ) Prepare the ends of these four wires by removing 1/8" of insulation and melting a small amount of solder on the exposed wire ends.

( ) Cut and place a 1/2" length of small sleeving on each of these four wires.

Refer to Pictorial 3-5 and connect these four wires to the 4-pin connector as shown.

Connect the wires to a four pin plug as follows:

( ) Green to lug 1 (S-1).

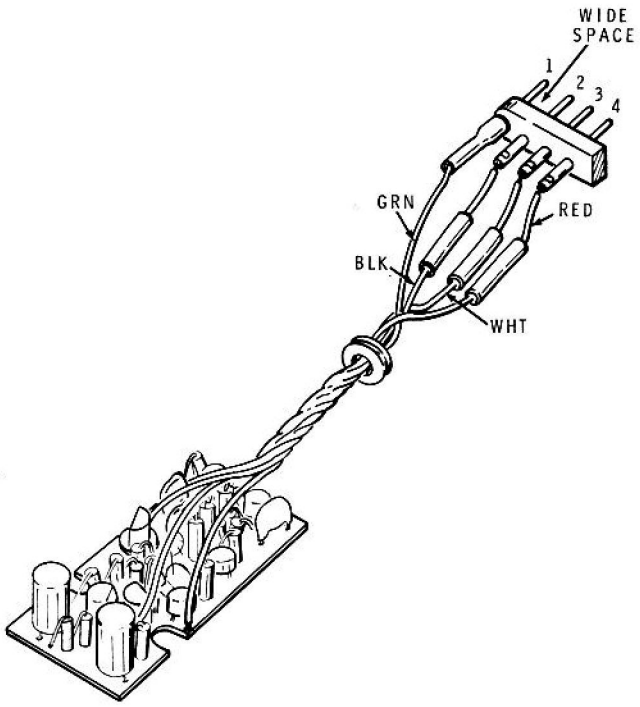
( ) Black to lug 2 (S-1).

( ) White to lug 3 (S-1).

( ) Red to lug 4 (S-1).

( ) Push the lengths of sleeving over the lugs of the connector.

( ) Twist the wires up to the ends of the sleeving.



PICTORIAL 3-5

Proceed to Variable Capacitor Wiring.

VARIABLE CAPACITOR WIRING

Refer to Detail 3-6A for the following steps.

( ) Locate the variable capacitor (#26-121) and bend the lugs as shown.

CAUTION: When soldering to the variable capacitor, do not touch its plastic case with the soldering iron, as the case will melt.

( ) Cut one lead of a 27 pF disc capacitor to 1/4". Connect this lead to lug 2 of the variable capacitor (S-1). Position the body of the disc capacitor against the variable capacitor as shown.

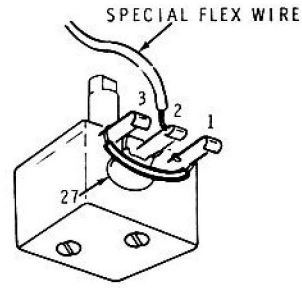
( ) Wrap the other lead of the disc capacitor around lug 3 of the variable capacitor as shown (S-2). Then place a 1/2" length of small sleeving on this lead, connect the lead to lug 1 of the variable capacitor (S-1), and cut off the excess lead length.

( ) Carefully remove 1/4" of insulation from one end of the length of special flex (gray) wire. Melt solder only on this end of the wire.

( ) Connect this end of the special flex wire to lug 2 of the capacitor (S-1). The disc capacitor has already been soldered. The other end of this wire will be connected later.

Refer to Pictorial 3-6 for the following steps.

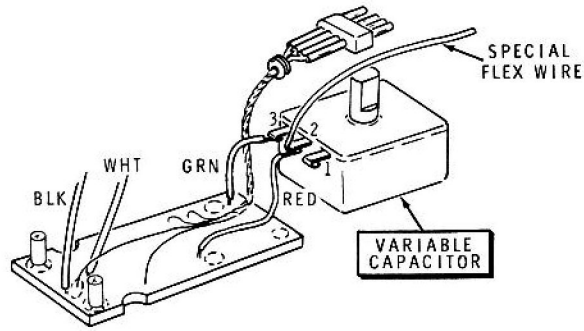
( ) Prepare the free ends of the red and green wires that come from the circuit board. Remove 1/4" of insulation from the end of each lead, twist the small strands of each lead together, and melt a small amount of solder on each lead.



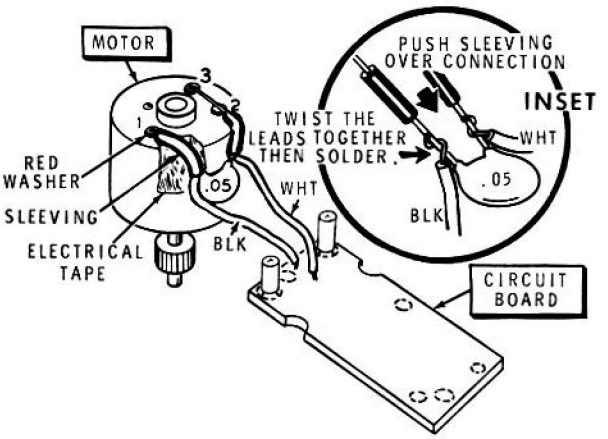
Detail 3-6A

( ) Remove 1/4" of insulation from the remaining black and white wires. Do not apply solder to these leads.

( ) Connect the red wire to lug 2 (S-1) and the green wire to lug 3 (S-1) of the variable capacitor. The disc capacitor leads and the special flex wire have already been soldered. Position the connector cable under the green wire as shown.



PICTORIAL 3-6



PICTORIAL 3-7

MOTOR WIRING

Refer to Pictorial 3-7 for the following steps.

( ) Cut one lead of a .05 μF disc capacitor to 3/4" and the other lead to 1". Remove any excess coating from the capacitor leads.

NOTE: In the following two steps, make the connections to the capacitor by twisting the leads as shown in the inset drawing on Pictorial 3-7.

( ) Connect the white wire from the circuit board to the long lead of the capacitor (S-1).

( ) Connect the black wire from the circuit board to the short lead of the capacitor (S-1).

( ) Place 5/8" lengths of small sleeving on each lead of the capacitor. Push the sleeving tight against the capacitor so that the bare leads are not exposed.

NOTE: In the following steps, be sure the capacitor is positioned as shown, and bend the motor lugs over the leads.

( ) Solder the short lead of the capacitor to lug 1 (indicated by the red washer) on the motor (S-1). Be sure the solder does not touch the case of the motor.

( ) Position the long lead of the capacitor next to lug 2 (NS) and to lug 3 (S-1) of the motor.

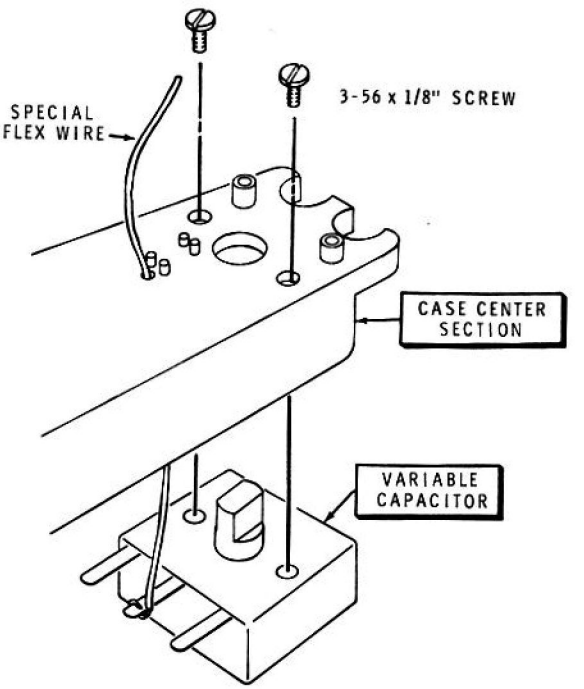
( ) Now solder the capacitor lead to lug 2. More heat is required for this connection, as the motor frame conducts the heat away from the lug.

( ) If electrical tape is available, place a length of it on the motor housing under the capacitor lead connected to lug 1 of the motor. This is further protection against a short circuit.

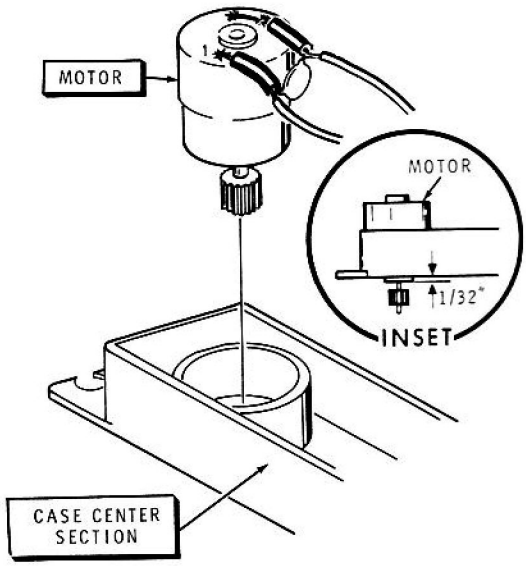
( ) Bend the capacitor flat against the side of the motor.

This completes the wiring of the Servo with the exception of the special flex wire which will be connected later. Check all connections to see that they are soldered.

( ) Refer to Detail 3-7A and mount the variable capacitor in the case center section with two 3-56 x 1/8" screws. Do not overtighten the screws. Be sure to pull the special flex (gray) wire all the way through the indicated hole in the case. The free end of this wire will be connected later. Be sure the shaft of the variable capacitor turns freely.



Detail 3-7A



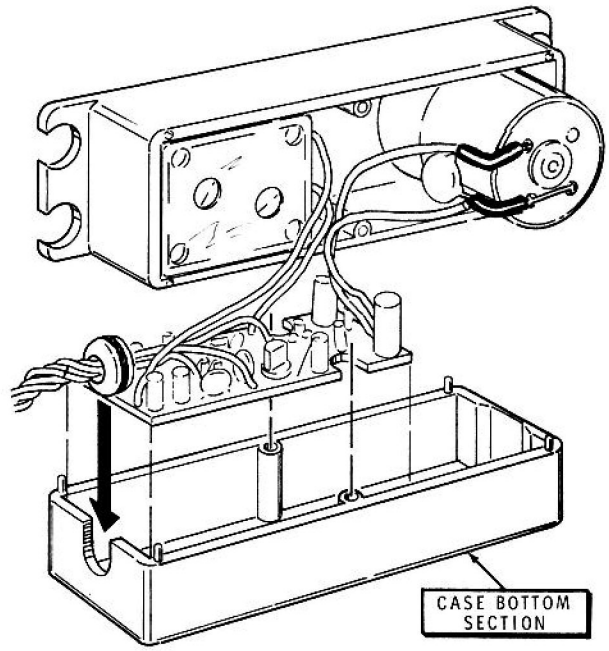
Detail 3-7B

( ) Refer to Detail 3-7B and install the motor in the case center section. Position the motor as shown in Detail 3-7C and push it as far as possible into the case; see inset drawing. NOTE: This is a force fit, so some pressure must be applied to do this.

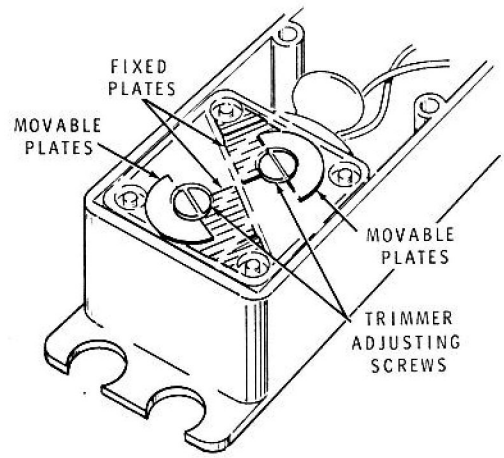
CAUTION: Be sure the capacitor lead connected to lug 1 of the motor does not touch the motor housing.

( ) Refer to Detail 3-7C and install the circuit board into the case bottom section. Be sure to position the rubber grommet in the notch as shown. Push the circuit board all the way down into the case.

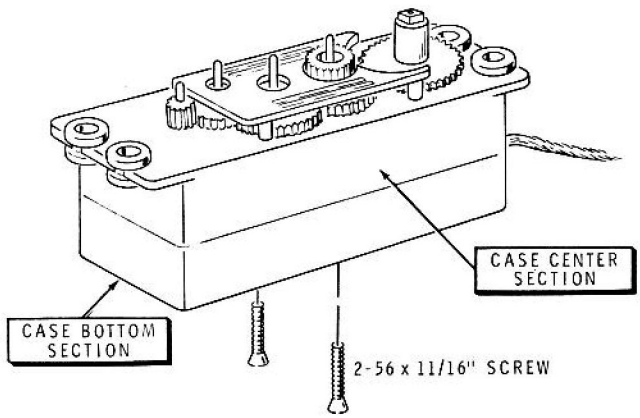
( ) Refer to Detail 3-7D and set both trimmer sections of the variable capacitor so that one-half the movable plates cover one-half the fixed plates.



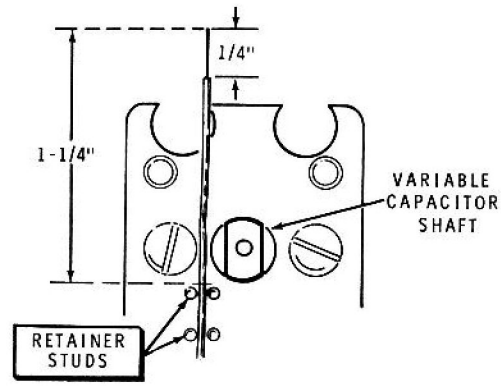
Detail 3-7C



Detail 3-7D



PICTORIAL 3-8



Detail 3-8A

GEAR INSTALLATION

Refer to Pictorial 3-8 for the following steps.

NOTE: When performing the following step, position the wires so they are not pinched between the circuit board components and the variable capacitor.

( ) Position the case bottom section and case center section of the Servo together. Align the pins of the bottom section with the holes in the center section. Temporarily install two 2-56 x 11/16" screws.

Refer to Detail 3-8A for the following steps.

( ) Position the shaft of the variable capacitor to the center of its rotation.

( ) Push the special flex (gray) wire down between the two sets of retainer studs as shown.

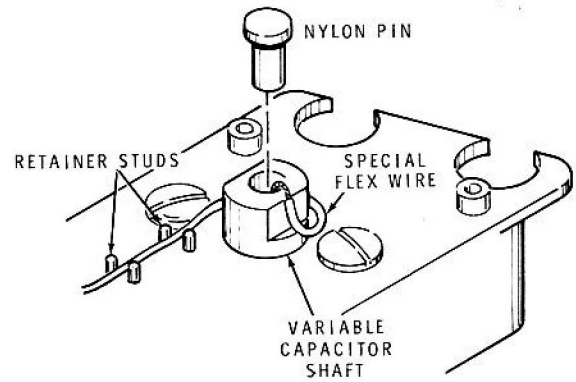
( ) Cut the special flex (gray) wire to a length of 1-1/4". Measure from the indicated retaner stud.

( ) Remove 1/4" of insulation from the free end of this wire. DO NOT apply solder to the wire end.

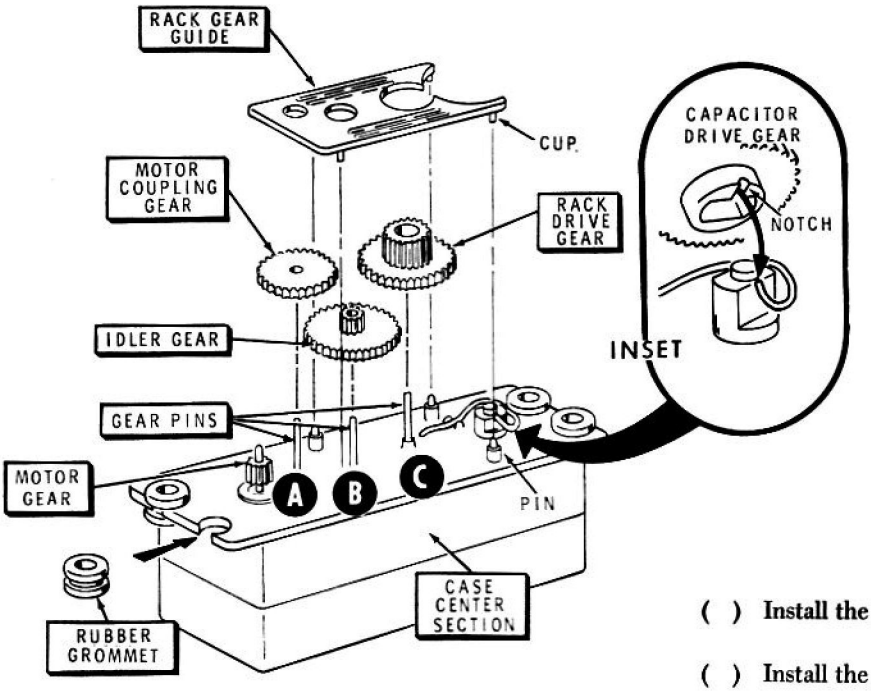
Refer to Detail 3-8B for the following steps.

( ) Install the free end of this wire into the hole in the end of the variable capacitor shaft. Be sure only the bare end of the wire is in the hole and position the wire as shown.

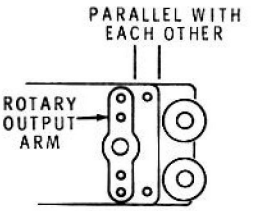
( ) Secure the wire with the nylon pin. Push it in tightly with the handle of a screwdriver. NOTE: This wire is a back-up circuit providing an extra measure of safety. It parallels a mechanical contact in the capacitor shaft, thus providing two connections instead of one.



Detail 3-8B



Detail 3-8C



Detail 3-8D

Refer to Detail 3-8C for the following steps.

( ) Install rubber grommets in the notches at the ends of the case center section.

CAUTION: Do not grip the gear pins with pliers or scratch them in any way. They must be perfectly smooth to provide proper operation of the Servo.

( ) Install the three gear pins in holes at locations A, B, and C. Use the handle of a screwdriver to push the pins all the way in place.

NOTE: In the following steps, be sure to position each gear as shown. You may find it necessary to rotate a gear back-and-forth slightly to get its teeth to engage with another gear.

( ) Install the idler gear at B.

( ) Install the motor coupling gear at A.

( ) Install the rack driver gear at C.

( ) Install the rack gear guide on the case center section. Align the four pins of the case center section with the four pin cups in the rack gear guide. Push the rack gear guide down as far as possible.

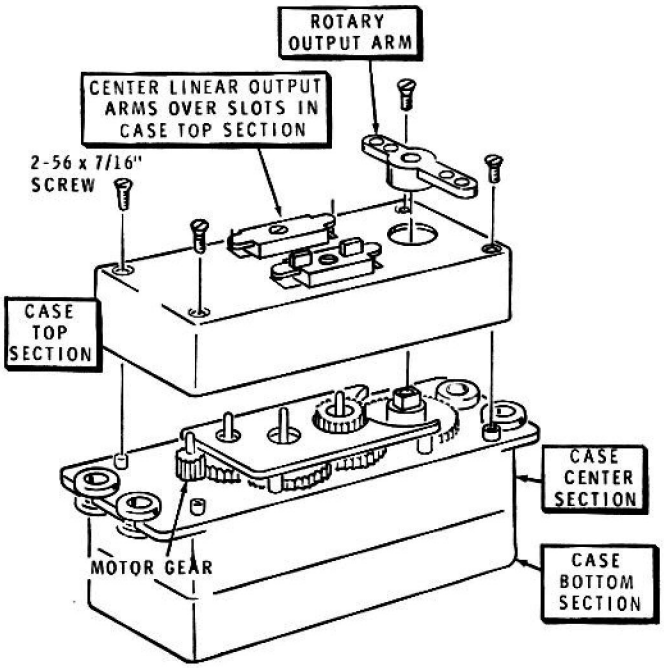
( ) Be sure the shaft of the variable capacitor is set to the center of its rotation.

( ) Install the capacitor drive gear on the shaft of the variable capacitor of the Servo. Be sure the notch in the gear fits over the wire connected to the capacitor shaft. See the inset drawing on Detail 3-8C.

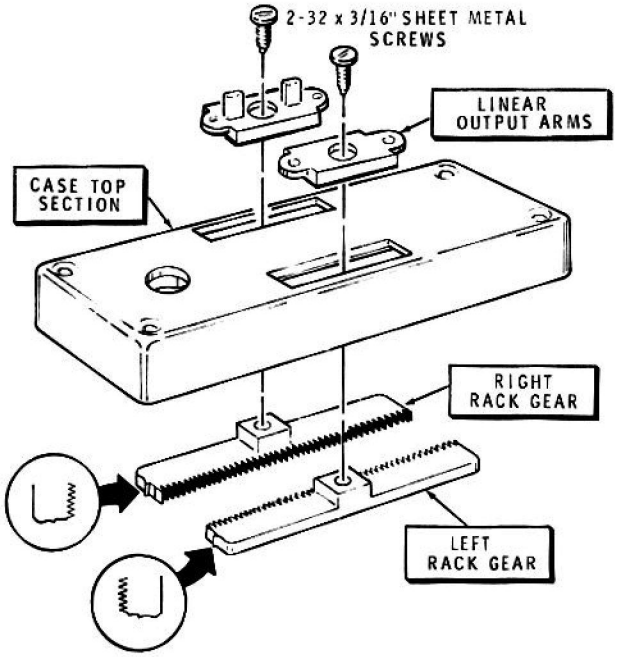
( ) Temporarily install the rotary output arm on the capacitor drive gear as shown. Do not install a screw at this time.

( ) Turn the motor gear by hand to the point where the rotary output arm is perfectly parallel to the end of the Servo case, as shown in Detail 3-8D.

( ) Remove the rotary output arm; be careful that you do not change the gear position.



PICTORIAL 3-9



Detail 3-9A

( ) Set the Servo assembly aside until it is called for later.

Refer to Pictorial 3-9 for the following steps.

NOTE: It is very important that the left rack gear and right rack gear be installed properly in the next step. One end of each gear has a step in it. Position this end of each gear as shown in Detail 3-9A.

( ) Refer to Detail 3-9A and install the left rack gear, right rack gear, and linear output arms on the case top section. Use 2-32 x 3/16" sheet metal screws. Be sure to position the rack gears and output arms as shown. Do not overtighten the screws as the rack gears can be damaged. Be sure both rack gears slide easily.

( ) Center the linear output arms over the slots in the case top section.

( ) Place the case top section on the case center section. It may be necessary to move the linear output arms slightly so the teeth of the rack gears line up with the teeth of the rack drive gear. Be sure the linear output arms are still centered over the slots of the case top section.

( ) Fasten the case top section to the case center section with four 2-56 x 7/16" screws. Do not overtighten the screws as this can strip out the holes in the case center section.

( ) Install the rotary output arm on the capacitor drive gear with a 2-32 x 3/16" sheet metal screw. Be sure to position the rotary arm parallel with the end of the servo case.

This completes the "Step-By-Step Assembly," proceed to the "Test And Adjustments" section.

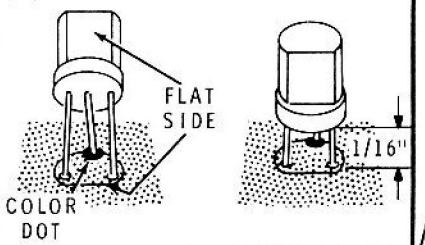
START

NOTE: There are no specific steps for soldering the component leads to the foil of the circuit board. When all the holes in a foil pad have been used, the component leads should be soldered to that foil. This will eliminate the possibility of covering unused holes. Also, be very careful not to make any solder bridges between adjacent foils.

( ) Locate the Servo circuit board and position it as shown.

NOTE: When installing transistors in the following steps, be sure to align the flat of the transistor with the flat of the outline on the circuit board. Also, place the collector lead of each transistor in the hole that is marked with a white dot. Position each transistor 1/16" above the circuit board.

( ) X29A826 transistor (#417-200).

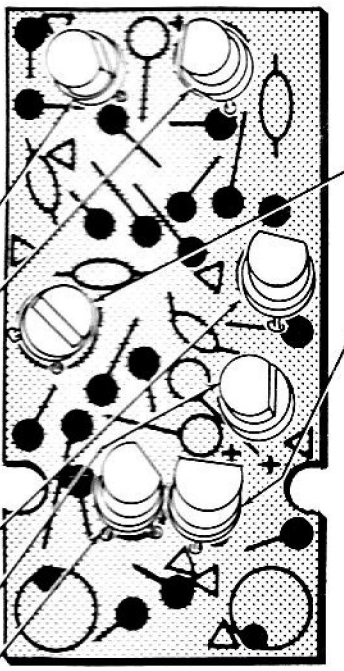


( ) X29A826 transistor (#417-200).

( ) X29A826 transistor (#417-200).

( ) X29A826 transistor (#417-200).

( ) X29A826 transistor (#417-200). Position this transistor 1/8" above the circuit board.



CONTINUE

( ) 2N5232A/2N3391A transistor (#417-91).

( ) 2N5232A/2N3391A transistor (#417-91). Position this transistor 1/8" above the circuit board.

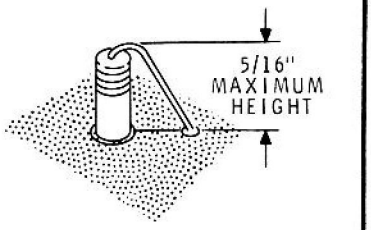
PROCEED TO PICTORIAL 3-2.

PICTORIAL 3-1

START

NOTE: Position all vertically mounted components as perpendicular to the circuit board as possible.

( ) 11 MΩ (brown-brown-blue).



( ) 47 Ω (yellow-violet-black).

( ) 1200 Ω (brown-red-red).

( ) 8200 Ω (gray-red-red).

( ) 4700 Ω (yellow-violet-red).

( ) 10 kΩ (brown-black-orange).

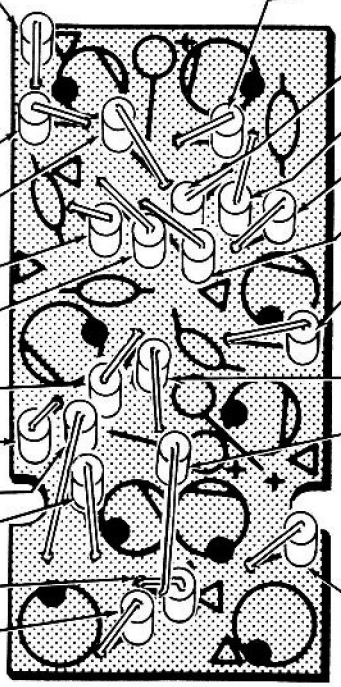
( ) 47 kΩ (yellow-violet-orange).

( ) 2200 Ω (red-red-red).

( ) 220 Ω (red-red-brown).

( ) 33 Ω (orange-orange-black).

( ) 47 Ω (yellow-violet-black).



CONTINUE

( ) 3300 Ω (orange-orange-red).

( ) 4700 Ω (yellow-violet-red).

( ) 22 kΩ (red-red-orange).

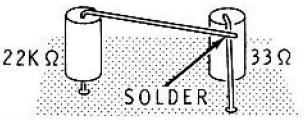
( ) 4700 Ω (yellow-violet-red).

( ) 2200 Ω (red-red-red).

( ) 47 kΩ (yellow-violet-orange).

( ) 2200 Ω (red-red-red).

( ) 22 kΩ (red-red-orange). Lay the end of the free lead against the 33 Ω (orange-orange-black) resistor lead as shown and solder the connection. Do not wrap the connection. Due to other components, this resistor may not sit down against the circuit board.



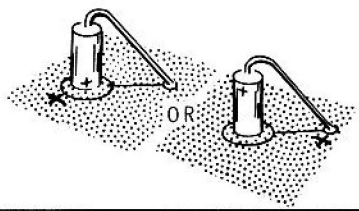
( ) 820 Ω (gray-red-brown).

PROCEED TO PICTORIAL 3-3.

PICTORIAL 3-2

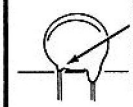
START

NOTE: When installing electrolytic capacitors, be sure to position the positive (+) lead (red end of capacitor) in the positive (+) marked hole in the circuit board.



( ) 1.0 μF electrolytic. Position (+) end down.

NOTE: When installing disc capacitors, remove any excess coating from the leads. Use long-nose pliers to remove this coating.



( ) .0033 μF disc.

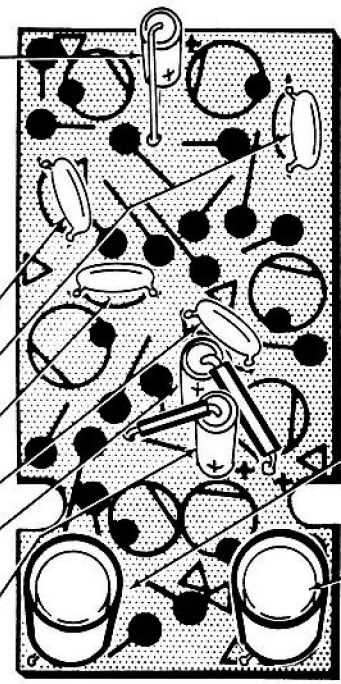
( ) .001 μF disc.

( ) .05 μF disc.

( ) .05 μF disc.

( ) 1.0 μF electrolytic. Use a 5/16" length of small sleeving on the indicated lead. Position (+) end up.

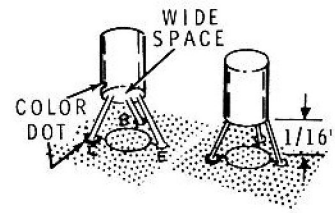
( ) 1.0 μF electrolytic. Use a 5/16" length of small sleeving on the indicated lead. Position (+) end down.



CONTINUE

NOTE: When installing the transistors in the following steps, align the color dot of the transistor with the dot on the circuit board. Position each lead in its proper hole and position the transistor 1/16" above the circuit board.

( ) 2N2430 transistor.



( ) 2N2431 transistor.

( ) Place a 1/2" length of large sleeving over each of these two transistors. Press the sleeving down tight against the circuit board.

PROCEED TO PICTORIAL 3-4

PICTORIAL 3-3

START

NOTE: When a wire is called for in a step, remove 1/8" of insulation from only one end of a wire of the specified length and color. Twist the small strands of each lead together and melt a small amount of solder on the exposed wire to hold the small strands together. Position the prepared end of the wire in the indicated hole (△). Bend the end over and solder it in place. The free end of each wire will be connected later.

( ) 2-1/2" green wire.

( ) 7-1/2" green wire.

( ) 7-1/2" black wire.

( ) 2" red wire.

( ) 7-1/2" red wire.

( ) 2-1/2" white wire.

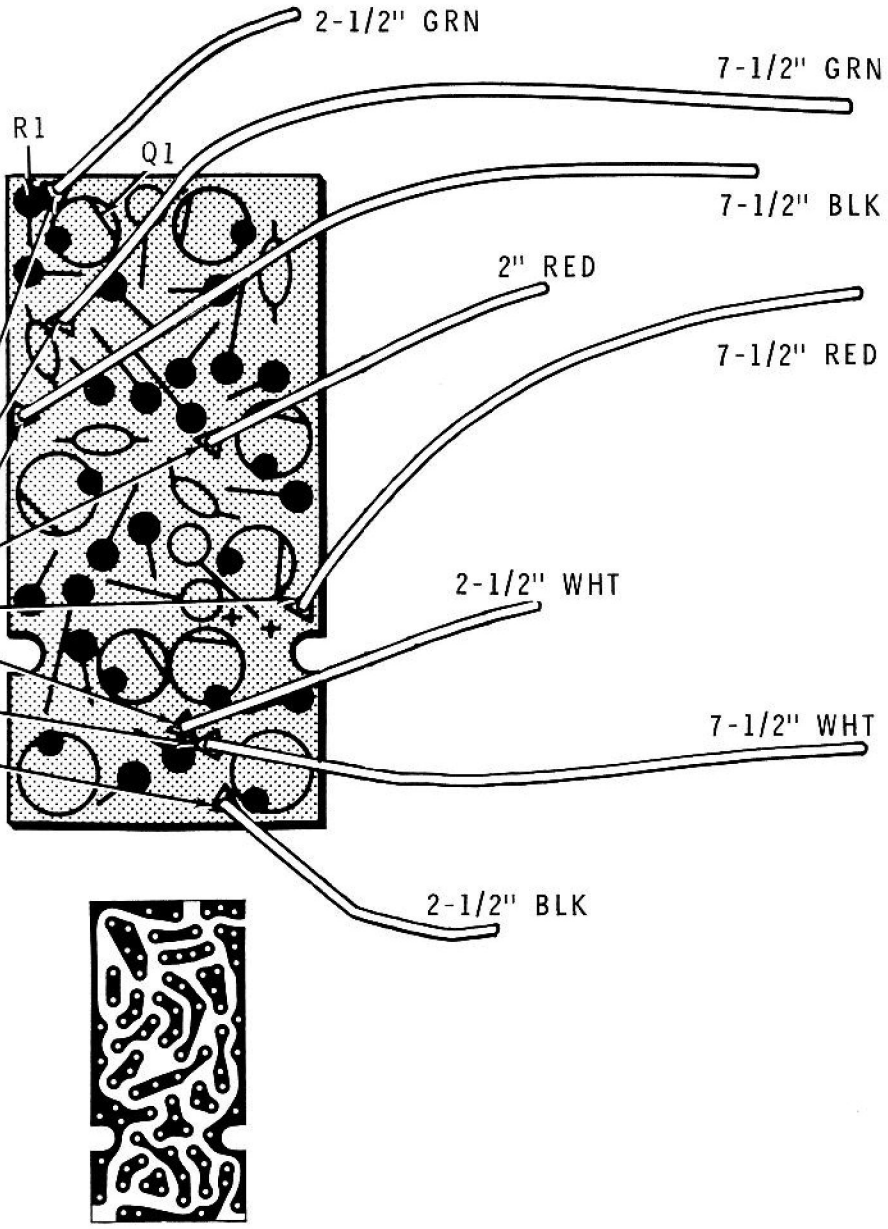
( ) 7-1/2" white wire.

( ) 2-1/2" black wire.

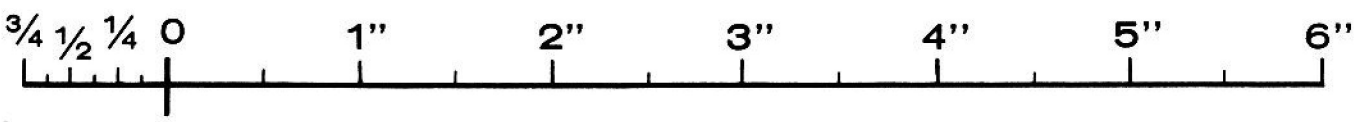
Reheat the connections to straighten any components that may have tipped over during assembly. Be careful not to break any components as you straighten them.

NOTE: This completes the assembly of the circuit board. Check to see that all connections are soldered and that all excess lead lengths have been cut off. To make it easier to locate any possible solder bridges between adjacent foil pads, it is suggested that you compare the foil side of the circuit board with the foil view shown.

FINISH



PICTORIAL 3-4



WIRING

CONNECTOR WIRING

Refer to Pictorial 3-5 for the following steps.

( ) Pass the small rubber grommet over the long black, red, green, and white wires coming from the servo circuit board.

( ) Twist these wires together as shown.

( ) Cut the ends of these wires even with the end of the shortest wire. Be sure the wires are positioned as shown in Pictorial 3-5 before cutting.

( ) Prepare the ends of these four wires by removing 1/8" of insulation and melting a small amount of solder on the exposed wire ends.

( ) Cut and place a 1/2" length of small sleeving on each of these four wires.

Refer to Pictorial 3-5 and connect these four wires to the 4-pin connector as shown.

Connect the wires to a four pin plug as follows:

( ) Green to lug 1 (S-1).

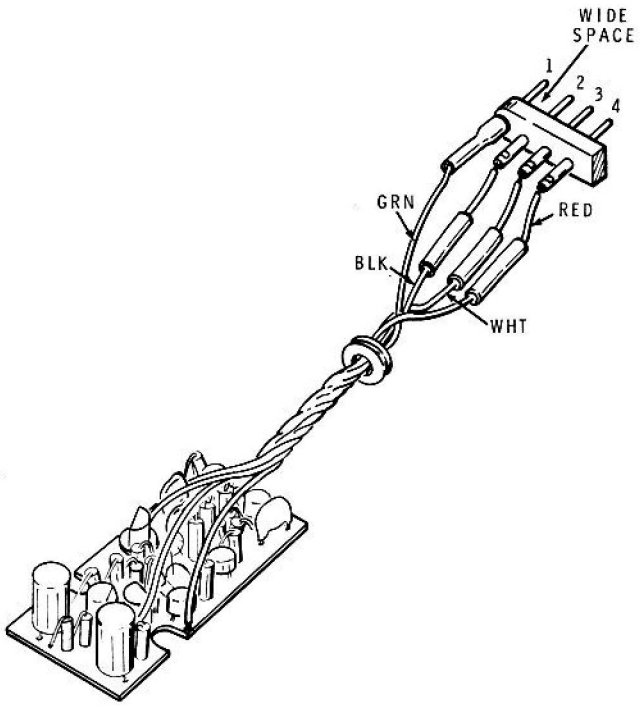
( ) Black to lug 2 (S-1).

( ) White to lug 3 (S-1).

( ) Red to lug 4 (S-1).

( ) Push the lengths of sleeving over the lugs of the connector.

( ) Twist the wires up to the ends of the sleeving.



PICTORIAL 3-5

Proceed to Variable Capacitor Wiring.

VARIABLE CAPACITOR WIRING

Refer to Detail 3-6A for the following steps.

( ) Locate the variable capacitor (#26-121) and bend the lugs as shown.

CAUTION: When soldering to the variable capacitor, do not touch its plastic case with the soldering iron, as the case will melt.

( ) Cut one lead of a 27 pF disc capacitor to 1/4". Connect this lead to lug 2 of the variable capacitor (S-1). Position the body of the disc capacitor against the variable capacitor as shown.

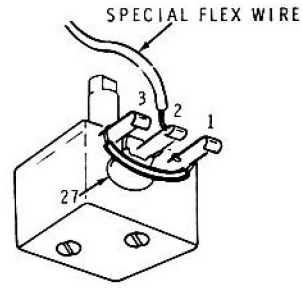
( ) Wrap the other lead of the disc capacitor around lug 3 of the variable capacitor as shown (S-2). Then place a 1/2" length of small sleeving on this lead, connect the lead to lug 1 of the variable capacitor (S-1), and cut off the excess lead length.

( ) Carefully remove 1/4" of insulation from one end of the length of special flex (gray) wire. Melt solder only on this end of the wire.

( ) Connect this end of the special flex wire to lug 2 of the capacitor (S-1). The disc capacitor has already been soldered. The other end of this wire will be connected later.

Refer to Pictorial 3-6 for the following steps.

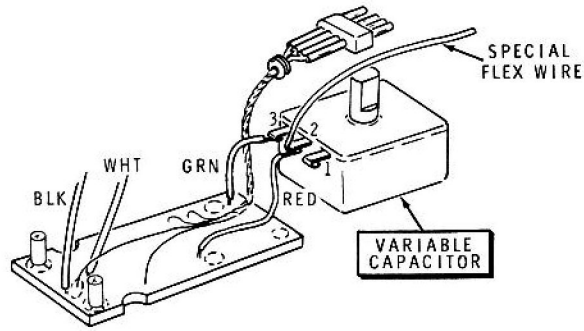
( ) Prepare the free ends of the red and green wires that come from the circuit board. Remove 1/4" of insulation from the end of each lead, twist the small strands of each lead together, and melt a small amount of solder on each lead.



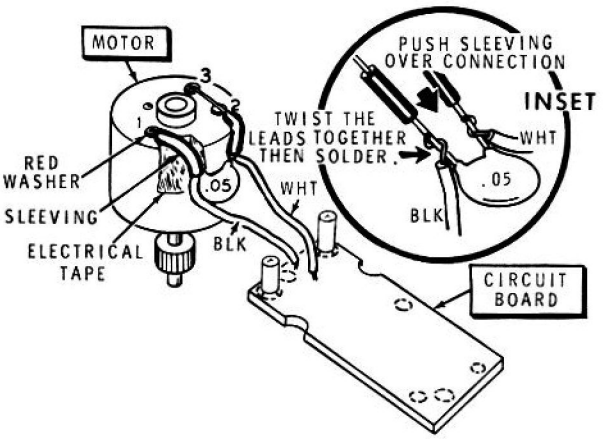
Detail 3-6A

( ) Remove 1/4" of insulation from the remaining black and white wires. Do not apply solder to these leads.

( ) Connect the red wire to lug 2 (S-1) and the green wire to lug 3 (S-1) of the variable capacitor. The disc capacitor leads and the special flex wire have already been soldered. Position the connector cable under the green wire as shown.



PICTORIAL 3-6



PICTORIAL 3-7

MOTOR WIRING

Refer to Pictorial 3-7 for the following steps.

( ) Cut one lead of a .05 μF disc capacitor to 3/4" and the other lead to 1". Remove any excess coating from the capacitor leads.

NOTE: In the following two steps, make the connections to the capacitor by twisting the leads as shown in the inset drawing on Pictorial 3-7.

( ) Connect the white wire from the circuit board to the long lead of the capacitor (S-1).

( ) Connect the black wire from the circuit board to the short lead of the capacitor (S-1).

( ) Place 5/8" lengths of small sleeving on each lead of the capacitor. Push the sleeving tight against the capacitor so that the bare leads are not exposed.

NOTE: In the following steps, be sure the capacitor is positioned as shown, and bend the motor lugs over the leads.

( ) Solder the short lead of the capacitor to lug 1 (indicated by the red washer) on the motor (S-1). Be sure the solder does not touch the case of the motor.

( ) Position the long lead of the capacitor next to lug 2 (NS) and to lug 3 (S-1) of the motor.

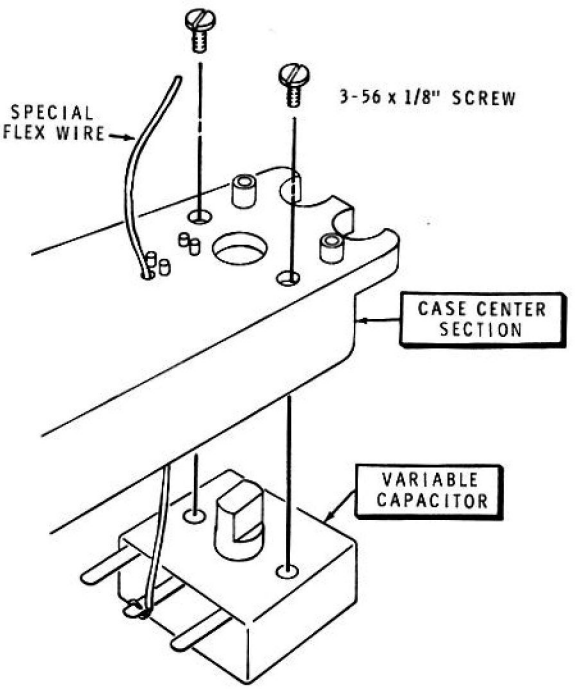
( ) Now solder the capacitor lead to lug 2. More heat is required for this connection, as the motor frame conducts the heat away from the lug.

( ) If electrical tape is available, place a length of it on the motor housing under the capacitor lead connected to lug 1 of the motor. This is further protection against a short circuit.

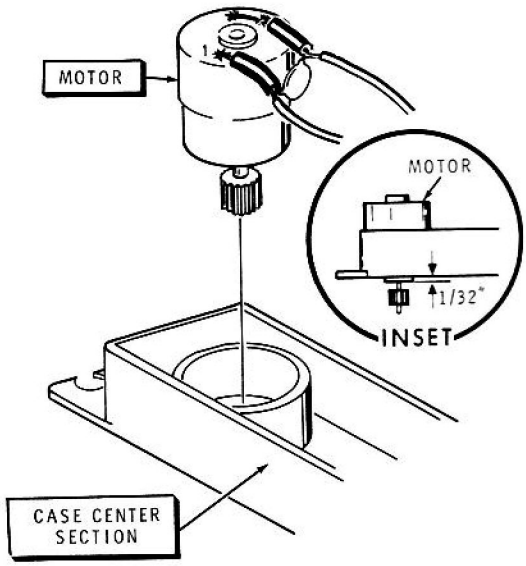
( ) Bend the capacitor flat against the side of the motor.

This completes the wiring of the Servo with the exception of the special flex wire which will be connected later. Check all connections to see that they are soldered.

( ) Refer to Detail 3-7A and mount the variable capacitor in the case center section with two 3-56 x 1/8" screws. Do not overtighten the screws. Be sure to pull the special flex (gray) wire all the way through the indicated hole in the case. The free end of this wire will be connected later. Be sure the shaft of the variable capacitor turns freely.



Detail 3-7A



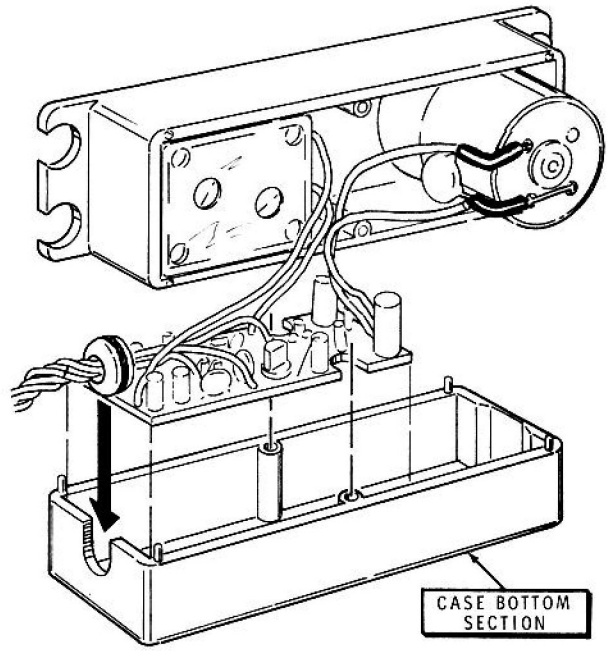
Detail 3-7B

( ) Refer to Detail 3-7B and install the motor in the case center section. Position the motor as shown in Detail 3-7C and push it as far as possible into the case; see inset drawing. NOTE: This is a force fit, so some pressure must be applied to do this.

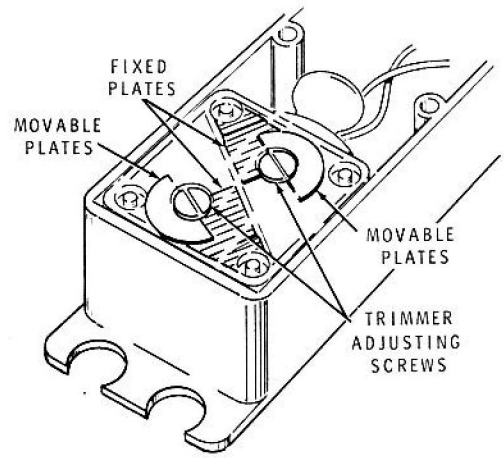
CAUTION: Be sure the capacitor lead connected to lug 1 of the motor does not touch the motor housing.

( ) Refer to Detail 3-7C and install the circuit board into the case bottom section. Be sure to position the rubber grommet in the notch as shown. Push the circuit board all the way down into the case.

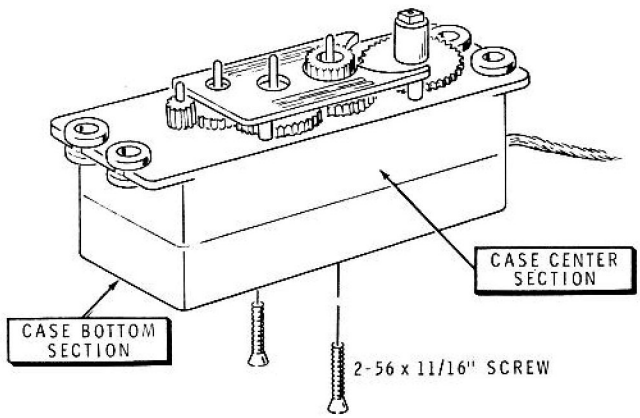
( ) Refer to Detail 3-7D and set both trimmer sections of the variable capacitor so that one-half the movable plates cover one-half the fixed plates.



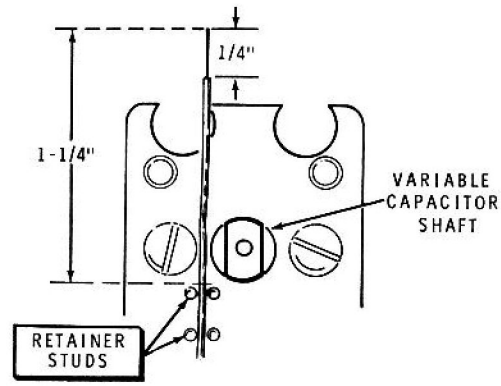
Detail 3-7C



Detail 3-7D



PICTORIAL 3-8



Detail 3-8A

GEAR INSTALLATION

Refer to Pictorial 3-8 for the following steps.

NOTE: When performing the following step, position the wires so they are not pinched between the circuit board components and the variable capacitor.

( ) Position the case bottom section and case center section of the Servo together. Align the pins of the bottom section with the holes in the center section. Temporarily install two 2-56 x 11/16" screws.

Refer to Detail 3-8A for the following steps.

( ) Position the shaft of the variable capacitor to the center of its rotation.

( ) Push the special flex (gray) wire down between the two sets of retainer studs as shown.

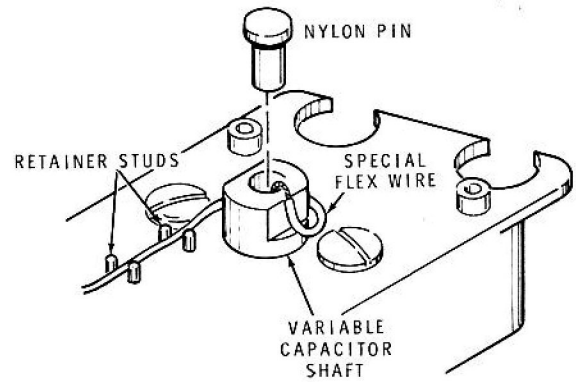
( ) Cut the special flex (gray) wire to a length of 1-1/4". Measure from the indicated retaner stud.

( ) Remove 1/4" of insulation from the free end of this wire. DO NOT apply solder to the wire end.

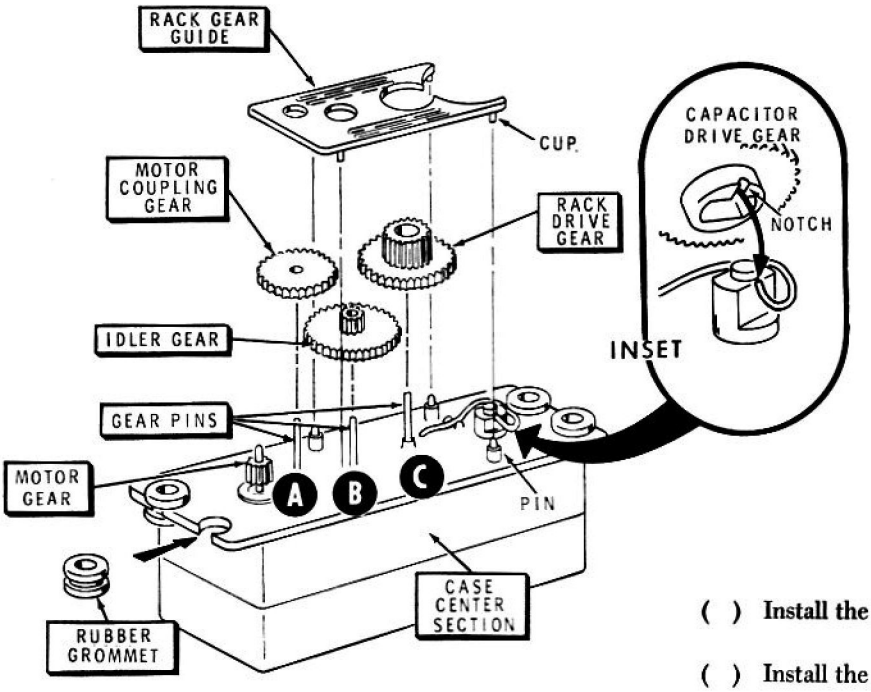
Refer to Detail 3-8B for the following steps.

( ) Install the free end of this wire into the hole in the end of the variable capacitor shaft. Be sure only the bare end of the wire is in the hole and position the wire as shown.

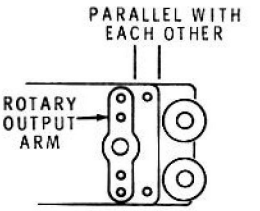
( ) Secure the wire with the nylon pin. Push it in tightly with the handle of a screwdriver. NOTE: This wire is a back-up circuit providing an extra measure of safety. It parallels a mechanical contact in the capacitor shaft, thus providing two connections instead of one.



Detail 3-8B



Detail 3-8C



Detail 3-8D

Refer to Detail 3-8C for the following steps.

( ) Install rubber grommets in the notches at the ends of the case center section.

CAUTION: Do not grip the gear pins with pliers or scratch them in any way. They must be perfectly smooth to provide proper operation of the Servo.

( ) Install the three gear pins in holes at locations A, B, and C. Use the handle of a screwdriver to push the pins all the way in place.

NOTE: In the following steps, be sure to position each gear as shown. You may find it necessary to rotate a gear back-and-forth slightly to get its teeth to engage with another gear.

( ) Install the idler gear at B.

( ) Install the motor coupling gear at A.

( ) Install the rack driver gear at C.

( ) Install the rack gear guide on the case center section. Align the four pins of the case center section with the four pin cups in the rack gear guide. Push the rack gear guide down as far as possible.

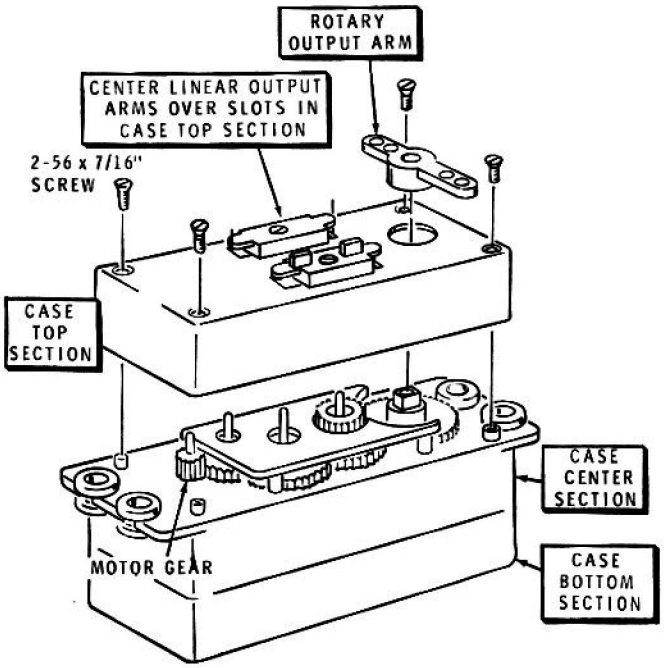
( ) Be sure the shaft of the variable capacitor is set to the center of its rotation.

( ) Install the capacitor drive gear on the shaft of the variable capacitor of the Servo. Be sure the notch in the gear fits over the wire connected to the capacitor shaft. See the inset drawing on Detail 3-8C.

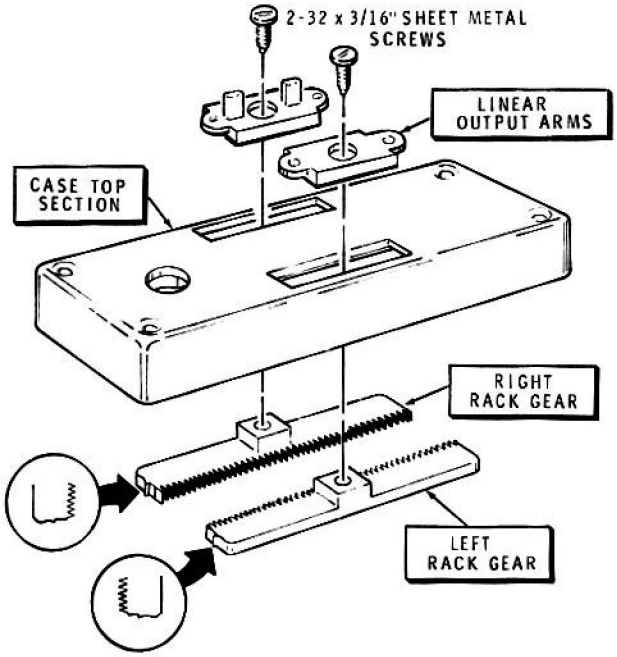
( ) Temporarily install the rotary output arm on the capacitor drive gear as shown. Do not install a screw at this time.

( ) Turn the motor gear by hand to the point where the rotary output arm is perfectly parallel to the end of the Servo case, as shown in Detail 3-8D.

( ) Remove the rotary output arm; be careful that you do not change the gear position.



PICTORIAL 3-9



Detail 3-9A

( ) Set the Servo assembly aside until it is called for later.

Refer to Pictorial 3-9 for the following steps.

NOTE: It is very important that the left rack gear and right rack gear be installed properly in the next step. One end of each gear has a step in it. Position this end of each gear as shown in Detail 3-9A.

( ) Refer to Detail 3-9A and install the left rack gear, right rack gear, and linear output arms on the case top section. Use 2-32 x 3/16" sheet metal screws. Be sure to position the rack gears and output arms as shown. Do not overtighten the screws as the rack gears can be damaged. Be sure both rack gears slide easily.

( ) Center the linear output arms over the slots in the case top section.

( ) Place the case top section on the case center section. It may be necessary to move the linear output arms slightly so the teeth of the rack gears line up with the teeth of the rack drive gear. Be sure the linear output arms are still centered over the slots of the case top section.

( ) Fasten the case top section to the case center section with four 2-56 x 7/16" screws. Do not overtighten the screws as this can strip out the holes in the case center section.

( ) Install the rotary output arm on the capacitor drive gear with a 2-32 x 3/16" sheet metal screw. Be sure to position the rotary arm parallel with the end of the servo case.

This completes the "Step-By-Step Assembly," proceed to the "Test And Adjustments" section.

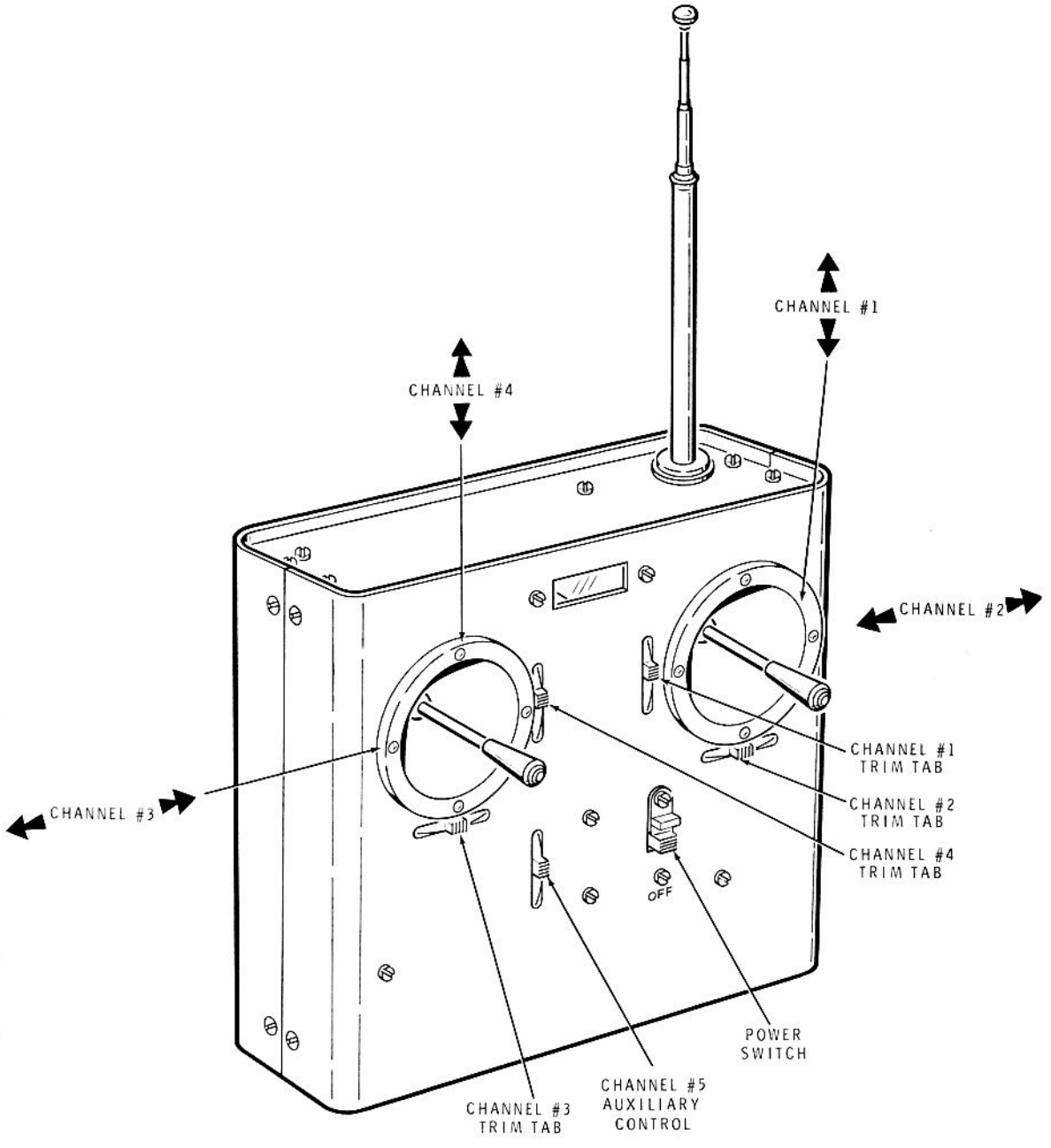

CHANNEL #1
CHANNEL #4
CHANNEL #2
CHANNEL #3
CHANNEL #1
TRIM TAB
CHANNEL #2
TRIM TAB
CHANNEL #4
TRIM TAB
OFF
POWER
SWITCH
CHANNEL #3
TRIM TAB
CHANNEL #5
AUXILIARY
CONTROL

FIGURE 3-1

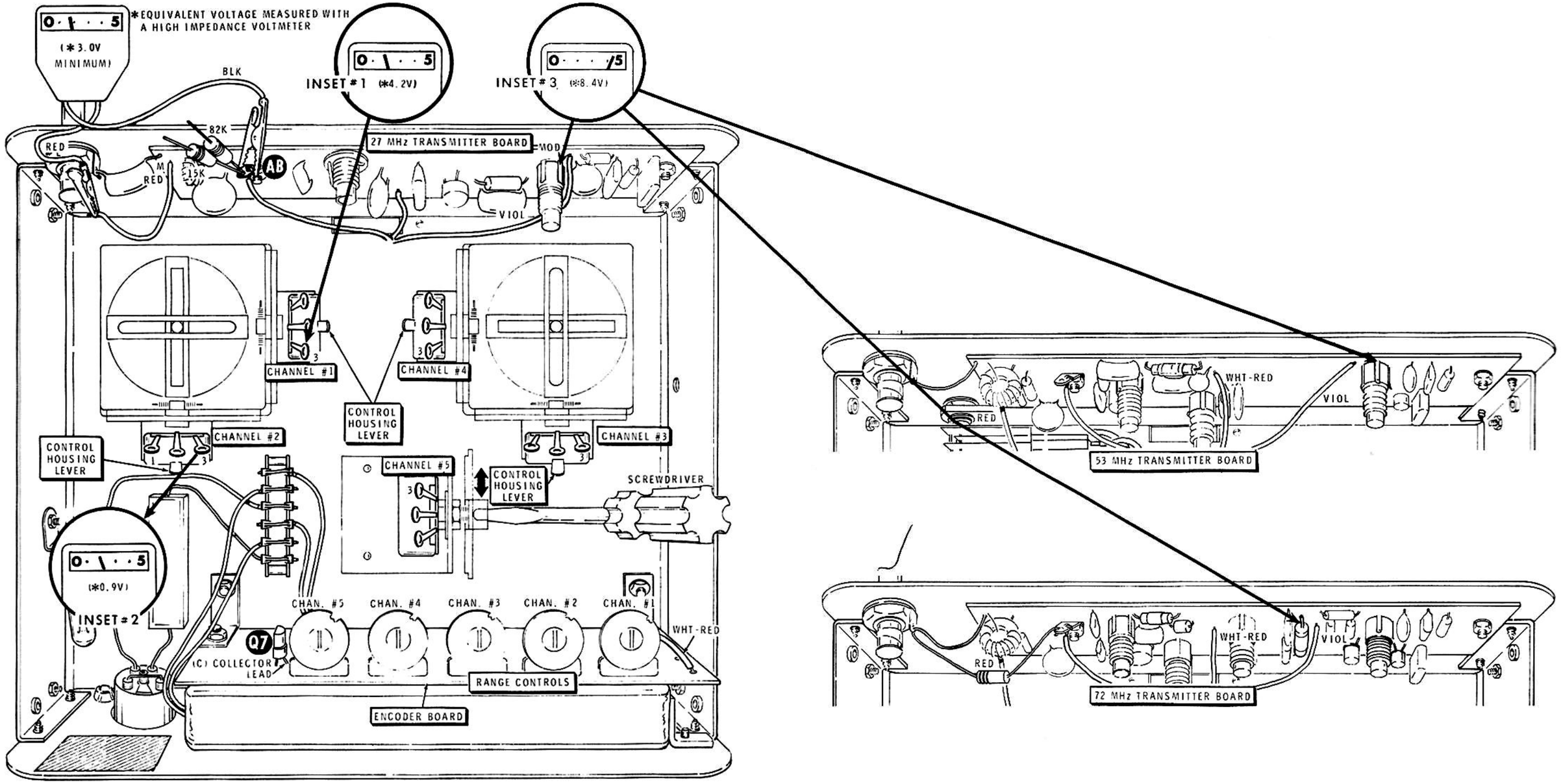

*EQUIVALENT VOLTAGE MEASURED WITH A HIGH IMPEDANCE VOLTMETER
(*3.0V MINIMUM)
INSET #1 (*4.2V)
INSET #3 (*8.4V)
INSET #2 (*0.9V)
BLK
82K
RED
M. RED
15K
AB
27 MHz TRANSMITTER BOARD
MOD
VIOL
CHANNEL #1
CHANNEL #2
CHANNEL #3
CHANNEL #4
CHANNEL #5
CONTROL HOUSING LEVER
SCREWDRIVER
CHAN. #5
CHAN. #4
CHAN. #3
CHAN. #2
CHAN. #1
WHT-RED
Q7
(C) COLLECTOR LEAD
RANGE CONTROLS
ENCODER BOARD
53 MHz TRANSMITTER BOARD
72 MHz TRANSMITTER BOARD
RED

FIGURE 3-2

TEST AND ADJUSTMENTS

NOTE: The meter furnished with the Transmitter is used as an indicating device throughout the Test And Adjustments section of the Manual. If you have a high impedance voltmeter, it can be used in place of the Transmitter meter. Above each of the meter drawings you will find the equivalent voltmeter reading in parentheses.

If you do not obtain the proper results when making a test or an adjustment, turn off the equipment and refer to the chart following the step. These charts list the Condition of the malfunction, and the Possible Cause. Review the items listed in the Possible Cause column and correct the condition before proceeding to the next step. If a particular part or parts are mentioned (transistor Q2 for example, or resistor R6) as Possible Causes, check these parts to see if they were incorrectly installed, or were wired incorrectly, or to see if the improper part was installed at that location. It is also possible, on rare occasions, for a part to be faulty.

The information in the In Case Of Difficulty section (Page 97) of the Manual may also be helpful in locating trouble in the kit. Refer to the X-Ray Views and Chassis Photo (Pages 119 through 127) for the location of parts.

TRANSMITTER

Refer to Figure 3-1 (fold-out from Page 66) for the following steps.

WARNING: The transmitter circuit board has been prealigned and pretested. Under no conditions should its circuit or adjustments be changed. To do so will void the warranty of the unit, and also cause decreased overall performance. Only persons holding a second class or higher FCC radiotelephone license are qualified to adjust the transmitter circuit board.

( ) Disconnect the charging cable from the AC line, Transmitter, and Receiver Battery Pack if it is still connected.

( ) Extend the largest diameter section of the antenna until it hits the stop. Do not extend any of the remaining smaller diameter sections of the antenna.

( ) Set all Trim Tabs and the Auxiliary control to their center positions.

NOTE: Be sure you do not change the settings of the Auxiliary control and all Trim Tabs unless you are instructed to do so in a step.

TRANSMITTER RF CHECKOUT

Refer to Figure 3-2 (fold-out from Page 66) for the following steps.

NOTE: If a high impedance voltmeter is used to make the following tests, the next two steps may be disregarded. The common test lead of the voltmeter should be connected to solder lug AB for all tests in the Transmitter. The 15 kΩ and 82 kΩ resistors are only required when using the meter furnished with the Transmitter.

( ) Cut both leads of the 15 kΩ (brown-green-orange) resistor and the 82 kΩ (gray-red-orange) resistor to 1/2". Save one of these cut off leads for use later.

NOTE: Do not proceed to the steps below until you complete the steps in the right-hand column.

( ) Temporarily solder one lead of the 15 kΩ resistor and one lead of the 82 kΩ resistor to solder lug AB (S-2).

( ) Clip the black meter lead to solder lug AB and the red meter lead to the end of the red wire coming from hole M on the transmitter circuit board.

( ) While observing the meter, turn the ON-OFF switch of the Transmitter to its ON position. The meter should deflect to approximately the second dot or higher.

( ) Turn the Transmitter OFF and disconnect the meter leads.

CONDITION	POSSIBLE CAUSE
Low or no meter indication.	1. Weak battery. This should not be the case at this time, since the battery was just charged, unless the charging circuit is not operating properly. See Battery Charging on Page 36. 2. ON-OFF switch wired incorrectly. 3. Meter wired incorrectly. 4. White-red and violet wires incorrectly connected to the transmitter circuit board.

ENCODER CHECKOUT

( ) Disconnect the white-red harness wire from the B+ location at the right-hand corner of the encoder circuit board. Be sure this wire does not touch any other leads.

( ) Preset the five Range controls (channels 1-5) on the encoder circuit board to the center of their rotation.

( ) Connect the black meter wire to the free end of the 82 kΩ (gray-red-orange) resistor at solder lug AB.

( ) Clip the red meter wire to lug 3 of Channel #1 Stick Control and turn the Transmitter ON. The meter should deflect to a little less than 1/2 scale. See inset drawing #1 on Figure 3-2.

CONDITION	POSSIBLE CAUSE
Multivibrator not operating properly (improper indication).	1. Transistors Q1 or Q2 and associated components. 2. Diode D1 or D2 faulty or installed backwards.

NOTE: Always turn the Transmitter OFF before changing the meter connection.

In the following tests, clip the red meter wire to the indicated connection and observe the meter indication. If the meter indication is not correct, you will be instructed to adjust one of the Control Housing Levers. Be sure the Trim Tabs remain in the center position. See Figure 3-3.

( ) Move the black meter wire to the free end of the 15 kΩ (brown-green-orange) resistor at solder lug AB. Leave the black meter lead connected to this point until instructed to move it to another point in a step.

( ) Now connect the red meter wire to lug 3 of Channel #2 Stick Control. The meter needle should move to the second red dot. See inset drawing #2 on Figure 3-2. If it does not move to this area, adjust the Channel #1 (NOT Channel #2) Control Housing Lever to obtain the proper meter indication.

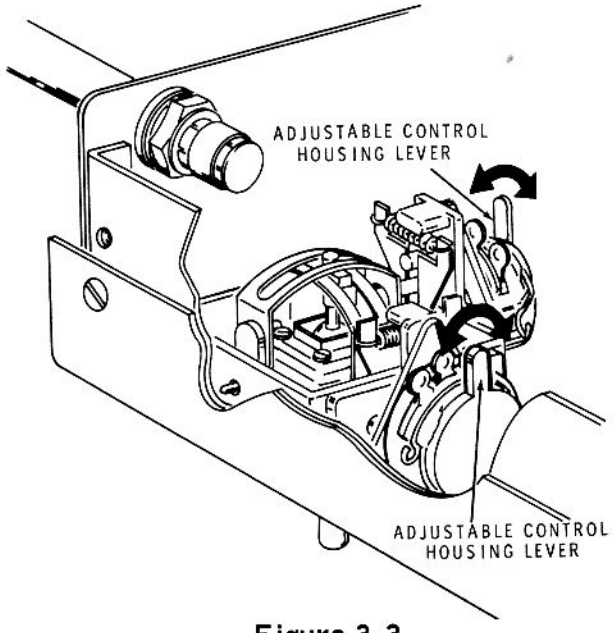


Figure 3-3

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q3. 2. Control R202 or R203. 3. Control R5. 4. Capacitor C6 through C9. Resistor R6 or R7.

( ) Move the red meter lead to lug 3 of Channel #3 Stick Control. The meter should deflect the same amount as it did in the last step. If it does not, adjust the Channel #2 Control Housing Lever until the proper meter reading is obtained.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q4. 2. Control R203 or R204. 3. Control R8. 4. Capacitor C11 through C14. Resistor R9 or R11.

( ) Move the red meter wire to lug 3 of Channel #4 Stick Control and note the meter reading. If it is not the same as in the previous two steps, adjust the Channel #3 Control Housing Lever for the proper meter indication.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q5. 2. Control R204 or R205. 3. Control R12. 4. Capacitor C15 through C18. Resistor R13 and R14.

( ) Move the red meter wire to lug 3 of Channel #5 Control. The meter reading should be the same as in the previous three steps. If it is not, adjust the Channel #4 Control Housing Lever for the proper meter indication.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q6. 2. Control R205 or R206. 3. Control R15. 4. Capacitor C19, C21, C22, and C23. Resistor R16 or R17.

( ) Move the red meter wire to the collector (c) lead of transistor Q7 on the encoder circuit board. The meter reading should be the same as in the previous four steps. If it is not, adjust the Auxiliary (Channel #5) Control for the proper meter indication. Then place a screwdriver into the control shaft slot, hold the shaft stationary with the screwdriver, and move the thumb knob back to its center position by slipping it on the control shaft. These steps may have to be performed more than once to obtain a desirable meter indication.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q7. 2. Control R206. 3. Control R18. 4. Capacitor C24 through C27. Resistor R19, R21, or R22.

( ) Turn the Transmitter OFF.

( ) Resolder the white-red harness wire to the B+ location on the encoder circuit board.

( ) Move the black meter wire to the free end of the 82 kΩ (gray-red-orange) resistor at solder lug AB.

( ) Turn the Transmitter ON.

( ) Touch the red meter wire to lug #1 of Channel #2 Stick Control and note the meter indication. The meter should indicate approximately 5 (approximately 9.6 volts on high impedance voltmeter) or slightly higher.

( ) Connect the red meter wire to the indicated coil lug next to the MOD connection on the transmitter circuit board. The meter should indicate slightly less (approximately 1 volt) than the battery voltage in the previous step. See inset drawing #3 on Figure 3-2.

CONDITION	POSSIBLE CAUSE
Too high or too low a meter indication.	1. Transistors Q8, Q9, or Q10. 2. Capacitors C28, C29, and C31 through C35. Resistors R23 through R27.

( ) Turn the Transmitter OFF.

( ) Disconnect the meter and set it aside temporarily.

( ) Unsolder the 82 kΩ (gray-red-orange) resistor and the 15 kΩ (brown-green-orange) resistor connected to solder lug AB. Save the 15 kΩ resistor for use later.

This completes the Transmitter checkout. Do not change any of the Trim Tabs or the Auxiliary control from their center positions. Also leave the antenna in its present position.

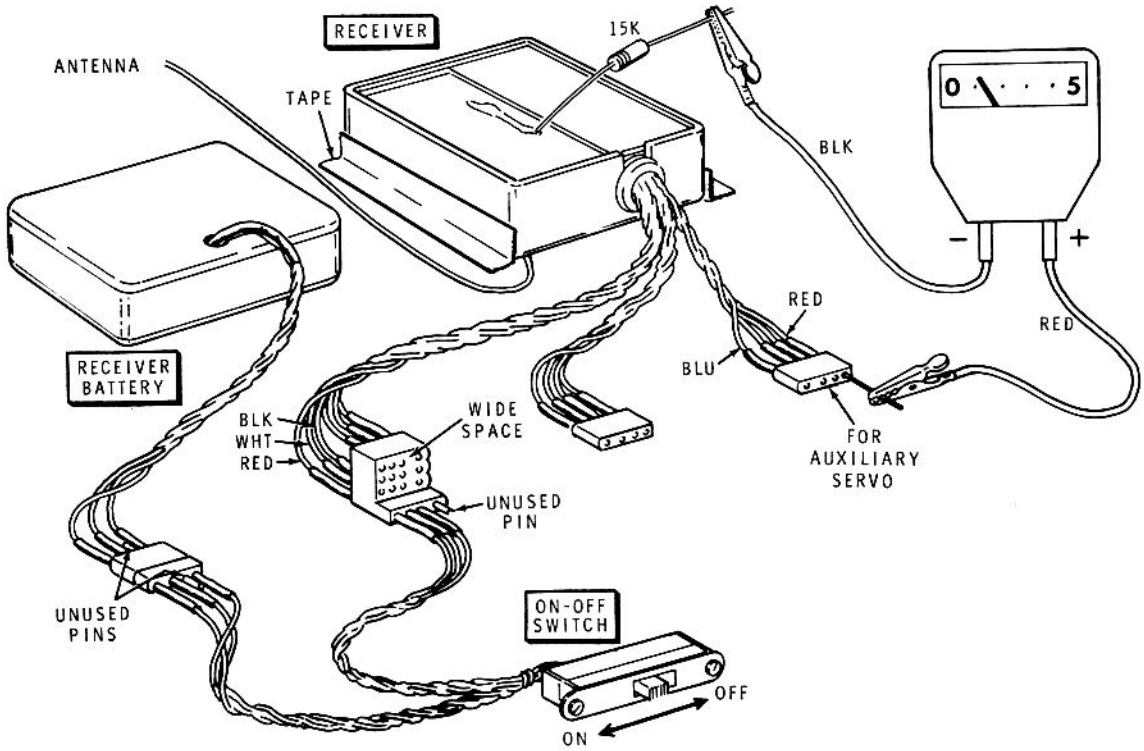


Figure 3-4

RECEIVER

In the following steps, the Receiver will be aligned for maximum sensitivity using the Transmitter as the signal source with the meter as a peaking indicator.

Refer to Figure 3-4 for the following steps.

( ) Remove the receiver case bottom.

( ) Carefully solder one end of a 15 kΩ (brown-green-orange) resistor to the test point on the foil side of the receiver circuit board (S-1). See Figure 3-5 for this test point.

NOTE: A high impedance voltmeter, if available, may be used for the following steps in place of the meter furnished with the Transmitter.

( ) Clip the black meter wire to the free end of this 15 kΩ resistor.

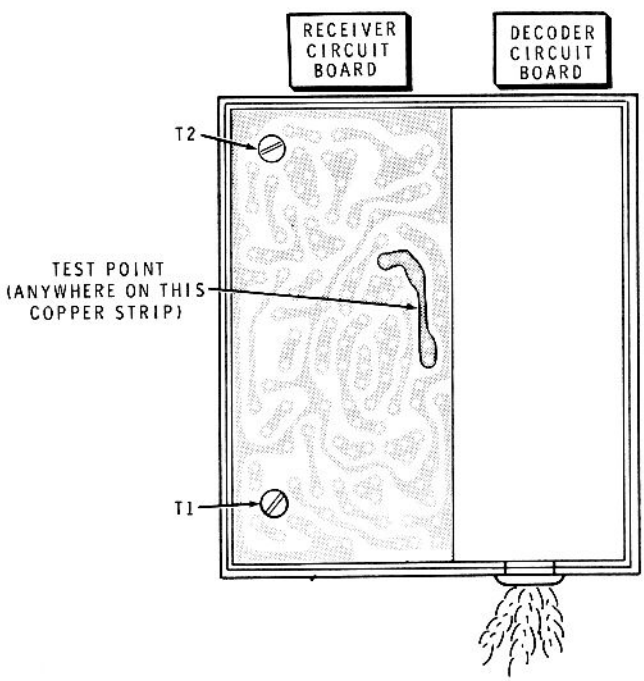


Figure 3-5

NOTE: In the next step (and in similar steps later), the meter will be connected to one of the five output connections of the Receiver. Each of the five channels has an identifying colored wire.

If you use a high impedance voltmeter for the following measurements, use a 1000 Ω or larger resistor in place of the cut-off resistor lead in the following steps.

( ) Locate the output connector with the blue wire connected to it.

( ) Push the previously saved resistor lead into the connector terminal with the red wire connected to it.

( ) Clip the red meter wire to this lead.

( ) Stretch the antenna (white wire of the Receiver out straight, keeping it away from any metal objects.

( ) Be sure the receiver battery switch is in the OFF position.

NOTE: There is only <u>one</u> correct way to connect the receiver switch to the large receiver black connector. Refer to Figure 3-4 for proper installation.

( ) Plug the receiver switch assembly into the Receiver and receiver battery.

( ) Turn the Receiver on. The meter should deflect only a slight amount. See the meter drawing on Figure 3-4.

CONDITION	POSSIBLE CAUSE
Incorrect or no meter indication.	1. Weak battery. This should not be the case at this time, as the battery was just charged, unless the charging circuit in the Transmitter is not operating properly. See Battery Charging on Page 36. 2. Battery switch. 3. Transistors Q1 through Q5. 4. Diode D2. 5. Transformer T1 or T2. 6. Components associated with stages Q1 through Q5.

NOTE: As you perform the following steps, increase the distance between the Transmitter and Receiver to keep the meter reading between the second and fourth red dots. <u>Do not touch the Receiver or any of its leads when making the following adjustments.</u> Tape the Receiver to a nonmetallic surface to hold it securely in place as shown. <u>Do not use any metallic tape.</u> Use the plastic alignment tool to make all adjustments.

( ) Push the transmitter antenna completely into the case. Then turn the Transmitter ON and move it to a location where the meter gives an indication at about the third red dot.

NOTE: Use the screwdriver end of the alignment tool for the following steps. Do not turn any slug more than <u>one</u> turn in either direction. If the end of the alignment tool will not fit into the slot, taper the end of the blade with a file.

( ) 1. Adjust transformer T1 for a maximum indication on the meter.

( ) 2. Adjust transformer T2 for a maximum indication on the meter.

( ) Repeat the previous two steps until no further improvement can be made.

( ) Turn both the Receiver and Transmitter OFF.

( ) Unclip both meter leads from the Receiver.

( ) Unsolder the 15 kΩ resistor from the receiver circuit board. Save the resistor for use later.

( ) Reinstall the case bottom on the Receiver.

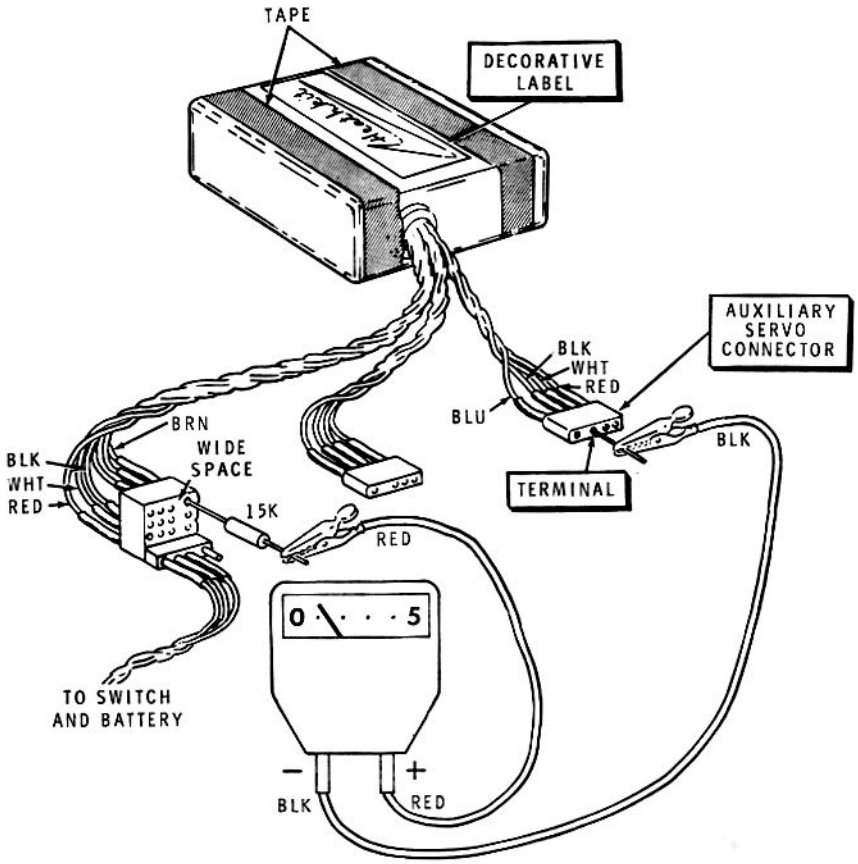


Figure 3-6

DECODER CHECKOUT

Refer to Figure 3-6 for the following steps.

NOTE: In the following steps the black meter wire will be connected to the auxiliary servo connector terminal with the black wire. The red meter wire and 15 kΩ resistor will connect to each of the different colored wire terminals (brown, orange, yellow, green, and blue).

( ) Cut both leads of the 15 kΩ resistor to 1/4" and connect one end to the red meter wire.

( ) Insert the other end of this resistor into the terminal with the brown (channel #1) wire connected to it.

( ) Move the cut off resistor lead from the red wire terminal to the black wire terminal of the auxiliary connector.

( ) Clip the black meter wire to this lead.

NOTE: The servo-controlling signal which is present at these connectors is produced by the Transmitter and picked up by the Receiver in the following channel sequence: channel #1, 2, 3, 4, and 5. If any one of the channels operates erratically (in the Transmitter or Receiver), usually all the remaining channels in the sequence will also be affected. For example, if channel #2 fails to operate properly, it is quite likely that channels #3, 4, and 5 will also be erratic in operation. Therefore, when checking the Receiver and Transmitter channels, you must correct any malfunction in the first channel affected in the sequence before the remaining channels can be expected to work properly. This can be an important observation if proper operation is not obtained.

( ) Turn the Receiver ON.

( ) Turn the Transmitter ON. The meter should deflect to approximately the first red dot.

( ) Now operate the Channel #1 Stick on the Transmitter. See Figure 3-1 (fold-out from Page 66). The meter should move slightly above and below the first meter indication as the stick is moved through its entire range. Moving the stick up should cause a decrease and moving the stick down should cause an increase in the meter indication. The meter should return to the first meter setting when the stick is returned to its center position.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #1 control stick.	1. Transistors Q101, Q102, Q104, or SCS101. 2. Diode D101. 3. Components associated with the above stages.

Now repeat the preceding steps and check each output channel in the same manner as channel #1. The channels should be checked in the following sequence:

( ) Move the 15 KΩ resistor to channel #2 (terminal with orange wire). Moving the stick to the left should cause an increase and moving it to the right should cause a decrease in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #2 control stick.	1. SCS102. 2. Diode D102. 3. Components associated with stage SCS102.

( ) Move the 15 KΩ resistor to channel #3 (terminal with yellow wire). Moving the stick to the left should cause an increase, and moving it to the right should cause a decrease in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #3 control stick.	1. SCS103. 2. Diode D103. 3. Components associated with stage SCS103.

( ) Move the 15 kΩ resistor to channel #4 (terminal with green wire). Moving the stick up should cause a decrease, and moving it down should cause an increase in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #4 control stick.	1. SCS104. 2. Diode D104. 3. Components associated with stage SCS104.

NOTE: In the following step, be careful not to short the two meter leads together.

( ) Move the 15 KΩ resistor to channel #5 (terminal with blue wire). Moving the AUX control up should cause an increase, and moving it down should cause a decrease in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when the AUX (channel #5) control is moved.	1. SCS105. 2. Diode D105. 3. Components associated with stage SCS105.

( ) Turn the Transmitter and Receiver OFF.

( ) Disconnect the meter wires and remove the 15 kΩ resistor and the cut off resistor lead.

This completes the Receiver adjustments.

NOTE: The blue and white label shows the Production Series number of your kit. Refer to this number in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

Do not put this label on your receiver case or the tuning of your Receiver may be affected.

( ) Remove the backing from a blue and white label. Then press this label onto the top of Page 97 of this Manual or you may prefer to place it on the inside back cover of the Transmitter.

Refer to Figure 3-6 (on Page 74) for the following steps.

( ) Carefully peel away the backing paper from the Heathkit decorative label. Then press the label onto the outside of the Receiver case top.

( ) Tape the receiver case closed. This will increase the ruggedness of the Receiver.

TRANSMITTER TO SERVO

In the following steps, the stick controls will be adjusted for proper centering and travel by using the Receiver and Servo.

( ) Mark one of the Servos with a piece of tape. This Servo will be used as a reference for adjusting purposes.

( ) Refer to Figure 3-7 (fold-out from Page 85) and plug the connector of the marked Servo into channel #1 of the Receiver (the terminal with the brown wire). Note that the connectors are polarized and will fit correctly only one way.

Refer to Figures 3-1 and 3-2 (fold-out from Page 66) for the following steps.

( ) Be sure the AUX control and the trim tabs of the Transmitter are in their centered positions.

( ) Turn on the Transmitter and Receiver. NOTE: The Servo may start to run then stop. This is normal.

( ) Move the stick of Channel #1 through its entire range. The linear output arms should turn in one direction with the stick to one end limit. Then as the stick is moved toward the other end limit, the arms should stop and begin turning in the opposite direction for the rest of the stick movement to the other end limit. NOTE: If the Servo did not operate as described, refer to the chart below.

( ) Turn off the Transmitter and Receiver. Unplug the Servo.

( ) Temporarily remove both linear output arms.

CONDITION	POSSIBLE CAUSE
Servo completely dead. Motor will not turn in either direction.	1. Faulty connection between Receiver and Servo. 2. Receiver battery run down. 3. Servo transistors Q8 and Q9 interchanged. 4. Servo transistors Q4 through Q9. 5. Faulty component in one of the above stages.
Servo motor runs when the Transmitter is turned off.	1. Faulty positive (red wire) connection between Receiver and Servo. 2. Capacitor C5. 3. Transistors Q1 through Q9.
Output rotary arm turns only in a clockwise direction, when viewed from shaft end.	1. Servo transistor Q5, Q7, or Q9. 2. Control Housing Lever misadjusted in Transmitter.
Output rotary arm turns only in a counterclockwise direction, when viewed from shaft end.	1. Servo transistor Q4, Q6, or Q8. 2. Control Housing Lever misadjusted in Transmitter.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the Service and Warranty section of the "Kit Builders Guide," and to the "Factory Repair Service" information on Page 134 of this Manual.

TRAVEL AND CENTERING

In the following steps, each of the five Transmitter channels will be checked and adjusted to make sure its servo will center properly and travel the proper distance in each direction. Use the following seven-step Procedure to adjust each channel. Refer to Figure 3-2 (fold-out from Page 66) and Figure 3-7 (fold-out from Page 85).

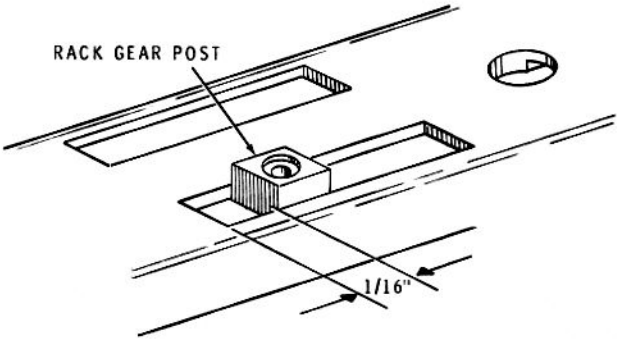


Figure 3-8

ADJUSTMENT PROCEDURE

1. Connect the marked servo to the output connector of the channel referred to in the step. Then turn on the Transmitter and Receiver.

2. Adjust the proper channel Control Housing Lever to center the rack gear posts in the center of the case top-section slots.

3. Operate the proper stick slowly through its entire range. Be sure the Trim Tab is in the center position. The rack gear posts on the servo should move in each direction. They should move each way until approximately 1/16" exists between the leading edge of the rack gear post and the end of the slot in the case top section. See Figure 3-8.

4. If the posts travel the correct distance in each direction, proceed to step #7.

5. If the posts do not travel far enough, turn the Range control (on the encoder circuit board in the Transmitter) for that channel clockwise a small amount. Then readjust the Control Housing Lever to bring the posts back to their center position. Repeat steps 3 and 5 until the posts travel the correct distance.

6. If the posts travel too far, turn the Range control for that channel counterclockwise a small amount. Then readjust the Control Housing Lever to bring the posts back to their center position. Repeat steps 3 and 6 until the posts travel the correct distance.

7. Move the Trim Tab to one end and then the other while operating its stick through its entire range. Check to be sure that the rack gear posts do not touch the ends of the slots of the servo case as this will cause excessive drain on the receiver battery. If they do touch, repeat step 6 and then step 3.

NOTE: The Servo may chatter if picked up. This is due to hum picked up from your hand. This will not interfere with proper operation when the Servo is mounted in a model.

ADJUSTMENTS

Check and adjust each of the following channels in order, using the Procedure just described.

( ) Channel #1 (brown wire).

( ) Channel #2 (orange wire).

( ) Channel #3 (yellow wire).

( ) Channel #4 (green wire).

( ) Channel #5 (blue wire).

( ) Turn off the Transmitter and Receiver.

After all five channels have been checked and any necessary adjustments made, no further adjustments are required in the Transmitter or the Servo used in making these adjustments.

SERVO TO TRANSMITTER

CENTERING

The following adjustments are only for the remaining unmarked (no tape) Servos. Do not attempt these adjustments unless the Transmitter has been completely adjusted with one of the Servos according to the instructions in the Travel and Centering Section. Do not make any of these adjustments on the marked Servo (marked with the piece of tape).

Refer to Figure 3-7 (fold-out from Page 85) for the following steps. Repeat these steps for each Servo.

( ) Connect the Servo to be adjusted to channel #1 (brown wire) of the Receiver.

( ) Turn the Receiver Battery switch on.

( ) Turn the Transmitter ON. Be sure the channel #1 Trim Tab is in its center position.

Move the Channel #1 stick in one direction and then the other direction. The output arms should move, stop, and then move in the reverse direction along with the control stick.

If the Servo does not operate as described, refer to the "In Case Of Difficulty" section on Page 97.

NOTE: If the rotary output arm is now parallel to the end of the Servo case, turn the Transmitter and Receiver Off and disregard the next three steps.

( ) 1. Remove the case bottom section by removing the two 2-56 x 11/16" screws.

NOTE: Picking up the Servo to make the following adjustment can cause the Servo motor to chatter. This is normal due to hum pickup from your hand. After an adjustment, the Servo should be set down on the work surface to be sure the correct amount of adjustment has been made. Make all adjustments with a screwdriver or alignment tool.

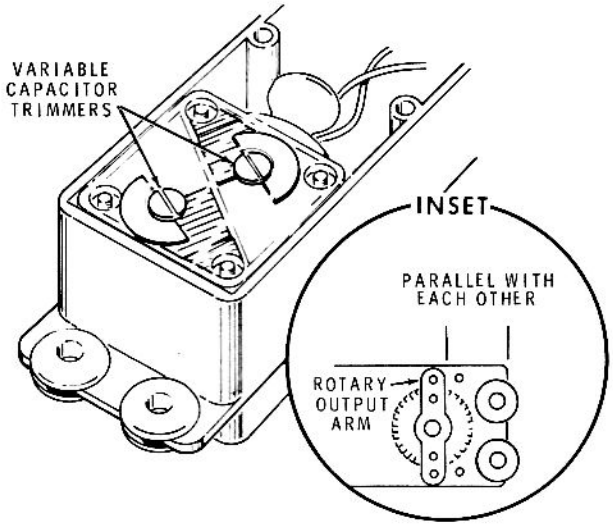


Figure 3-9

( ) 2. Adjust (one or both) the trimmer(s) on the rear of the variable capacitor until the rotary output arm is perfectly parallel to the end of the Servo case. See Figure 3-9.

( ) 3. Mount the case bottom section on the case center section of each Servo with 2-56 x 11/16" screws. Be sure that no wires are pinched between the two sections of the case and that the rubber grommet is positioned properly.

from Page 85

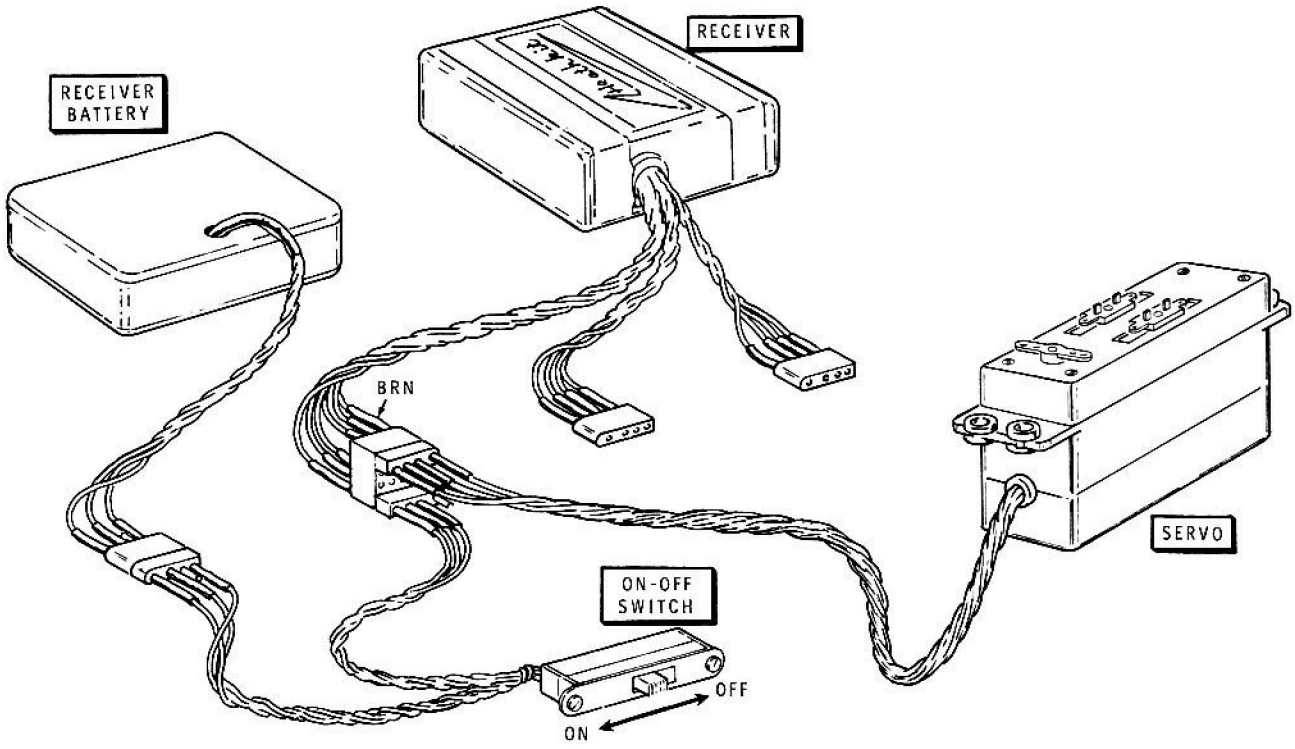


FIGURE 3-7

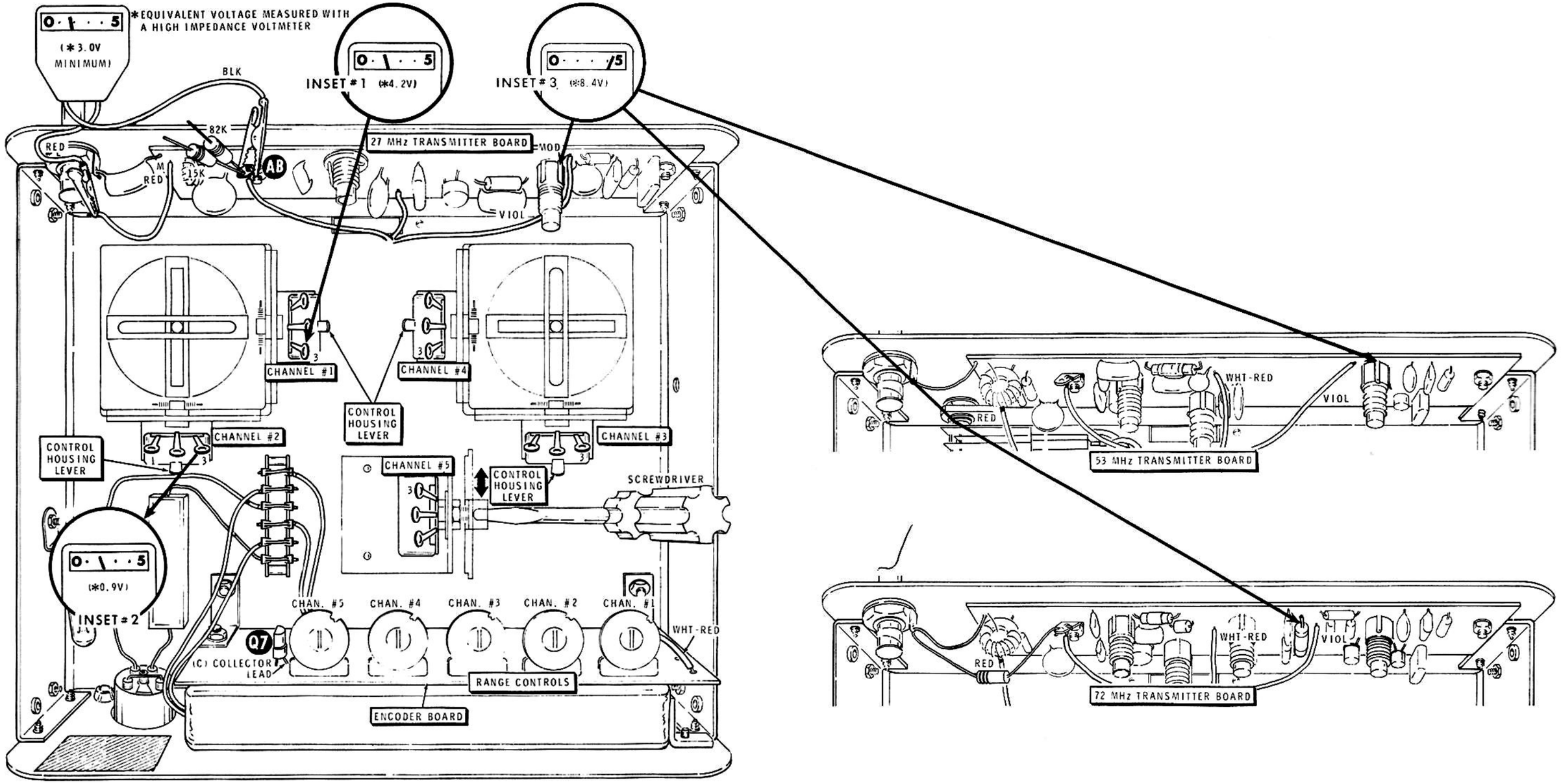

*EQUIVALENT VOLTAGE MEASURED WITH A HIGH IMPEDANCE VOLTMETER
(*3.0V MINIMUM)
INSET #1 (*4.2V)
INSET #3 (*8.4V)
INSET #2 (*0.9V)
BLK
82K
RED
M. RED
15K
AB
27 MHz TRANSMITTER BOARD
MOD
VIOL
CHANNEL #1
CHANNEL #2
CHANNEL #3
CHANNEL #4
CHANNEL #5
CONTROL HOUSING LEVER
SCREWDRIVER
CHAN. #5
CHAN. #4
CHAN. #3
CHAN. #2
CHAN. #1
WHT-RED
Q7
(C) COLLECTOR LEAD
RANGE CONTROLS
ENCODER BOARD
53 MHz TRANSMITTER BOARD
72 MHz TRANSMITTER BOARD
RED

FIGURE 3-2

TEST AND ADJUSTMENTS

NOTE: The meter furnished with the Transmitter is used as an indicating device throughout the Test And Adjustments section of the Manual. If you have a high impedance voltmeter, it can be used in place of the Transmitter meter. Above each of the meter drawings you will find the equivalent voltmeter reading in parentheses.

If you do not obtain the proper results when making a test or an adjustment, turn off the equipment and refer to the chart following the step. These charts list the Condition of the malfunction, and the Possible Cause. Review the items listed in the Possible Cause column and correct the condition before proceeding to the next step. If a particular part or parts are mentioned (transistor Q2 for example, or resistor R6) as Possible Causes, check these parts to see if they were incorrectly installed, or were wired incorrectly, or to see if the improper part was installed at that location. It is also possible, on rare occasions, for a part to be faulty.

The information in the In Case Of Difficulty section (Page 97) of the Manual may also be helpful in locating trouble in the kit. Refer to the X-Ray Views and Chassis Photo (Pages 119 through 127) for the location of parts.

TRANSMITTER

Refer to Figure 3-1 (fold-out from Page 66) for the following steps.

WARNING: The transmitter circuit board has been prealigned and pretested. Under no conditions should its circuit or adjustments be changed. To do so will void the warranty of the unit, and also cause decreased overall performance. Only persons holding a second class or higher FCC radiotelephone license are qualified to adjust the transmitter circuit board.

( ) Disconnect the charging cable from the AC line, Transmitter, and Receiver Battery Pack if it is still connected.

( ) Extend the largest diameter section of the antenna until it hits the stop. Do not extend any of the remaining smaller diameter sections of the antenna.

( ) Set all Trim Tabs and the Auxiliary control to their center positions.

NOTE: Be sure you do not change the settings of the Auxiliary control and all Trim Tabs unless you are instructed to do so in a step.

TRANSMITTER RF CHECKOUT

Refer to Figure 3-2 (fold-out from Page 66) for the following steps.

NOTE: If a high impedance voltmeter is used to make the following tests, the next two steps may be disregarded. The common test lead of the voltmeter should be connected to solder lug AB for all tests in the Transmitter. The 15 kΩ and 82 kΩ resistors are only required when using the meter furnished with the Transmitter.

( ) Cut both leads of the 15 kΩ (brown-green-orange) resistor and the 82 kΩ (gray-red-orange) resistor to 1/2". Save one of these cut off leads for use later.

NOTE: Do not proceed to the steps below until you complete the steps in the right-hand column.

( ) Temporarily solder one lead of the 15 kΩ resistor and one lead of the 82 kΩ resistor to solder lug AB (S-2).

( ) Clip the black meter lead to solder lug AB and the red meter lead to the end of the red wire coming from hole M on the transmitter circuit board.

( ) While observing the meter, turn the ON-OFF switch of the Transmitter to its ON position. The meter should deflect to approximately the second dot or higher.

( ) Turn the Transmitter OFF and disconnect the meter leads.

CONDITION	POSSIBLE CAUSE
Low or no meter indication.	1. Weak battery. This should not be the case at this time, since the battery was just charged, unless the charging circuit is not operating properly. See Battery Charging on Page 36. 2. ON-OFF switch wired incorrectly. 3. Meter wired incorrectly. 4. White-red and violet wires incorrectly connected to the transmitter circuit board.

ENCODER CHECKOUT

( ) Disconnect the white-red harness wire from the B+ location at the right-hand corner of the encoder circuit board. Be sure this wire does not touch any other leads.

( ) Preset the five Range controls (channels 1-5) on the encoder circuit board to the center of their rotation.

( ) Connect the black meter wire to the free end of the 82 kΩ (gray-red-orange) resistor at solder lug AB.

( ) Clip the red meter wire to lug 3 of Channel #1 Stick Control and turn the Transmitter ON. The meter should deflect to a little less than 1/2 scale. See inset drawing #1 on Figure 3-2.

CONDITION	POSSIBLE CAUSE
Multivibrator not operating properly (improper indication).	1. Transistors Q1 or Q2 and associated components. 2. Diode D1 or D2 faulty or installed backwards.

NOTE: Always turn the Transmitter OFF before changing the meter connection.

In the following tests, clip the red meter wire to the indicated connection and observe the meter indication. If the meter indication is not correct, you will be instructed to adjust one of the Control Housing Levers. Be sure the Trim Tabs remain in the center position. See Figure 3-3.

( ) Move the black meter wire to the free end of the 15 kΩ (brown-green-orange) resistor at solder lug AB. Leave the black meter lead connected to this point until instructed to move it to another point in a step.

( ) Now connect the red meter wire to lug 3 of Channel #2 Stick Control. The meter needle should move to the second red dot. See inset drawing #2 on Figure 3-2. If it does not move to this area, adjust the Channel #1 (NOT Channel #2) Control Housing Lever to obtain the proper meter indication.

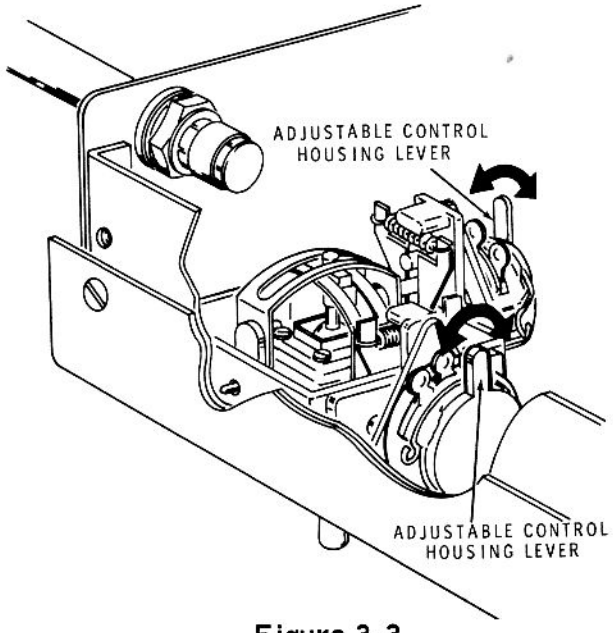


Figure 3-3

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q3. 2. Control R202 or R203. 3. Control R5. 4. Capacitor C6 through C9. Resistor R6 or R7.

( ) Move the red meter lead to lug 3 of Channel #3 Stick Control. The meter should deflect the same amount as it did in the last step. If it does not, adjust the Channel #2 Control Housing Lever until the proper meter reading is obtained.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q4. 2. Control R203 or R204. 3. Control R8. 4. Capacitor C11 through C14. Resistor R9 or R11.

( ) Move the red meter wire to lug 3 of Channel #4 Stick Control and note the meter reading. If it is not the same as in the previous two steps, adjust the Channel #3 Control Housing Lever for the proper meter indication.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q5. 2. Control R204 or R205. 3. Control R12. 4. Capacitor C15 through C18. Resistor R13 and R14.

( ) Move the red meter wire to lug 3 of Channel #5 Control. The meter reading should be the same as in the previous three steps. If it is not, adjust the Channel #4 Control Housing Lever for the proper meter indication.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q6. 2. Control R205 or R206. 3. Control R15. 4. Capacitor C19, C21, C22, and C23. Resistor R16 or R17.

( ) Move the red meter wire to the collector (c) lead of transistor Q7 on the encoder circuit board. The meter reading should be the same as in the previous four steps. If it is not, adjust the Auxiliary (Channel #5) Control for the proper meter indication. Then place a screwdriver into the control shaft slot, hold the shaft stationary with the screwdriver, and move the thumb knob back to its center position by slipping it on the control shaft. These steps may have to be performed more than once to obtain a desirable meter indication.

CONDITION	POSSIBLE CAUSE
Improper or no meter indication.	1. Transistor Q7. 2. Control R206. 3. Control R18. 4. Capacitor C24 through C27. Resistor R19, R21, or R22.

( ) Turn the Transmitter OFF.

( ) Resolder the white-red harness wire to the B+ location on the encoder circuit board.

( ) Move the black meter wire to the free end of the 82 kΩ (gray-red-orange) resistor at solder lug AB.

( ) Turn the Transmitter ON.

( ) Touch the red meter wire to lug #1 of Channel #2 Stick Control and note the meter indication. The meter should indicate approximately 5 (approximately 9.6 volts on high impedance voltmeter) or slightly higher.

( ) Connect the red meter wire to the indicated coil lug next to the MOD connection on the transmitter circuit board. The meter should indicate slightly less (approximately 1 volt) than the battery voltage in the previous step. See inset drawing #3 on Figure 3-2.

CONDITION	POSSIBLE CAUSE
Too high or too low a meter indication.	1. Transistors Q8, Q9, or Q10. 2. Capacitors C28, C29, and C31 through C35. Resistors R23 through R27.

( ) Turn the Transmitter OFF.

( ) Disconnect the meter and set it aside temporarily.

( ) Unsolder the 82 kΩ (gray-red-orange) resistor and the 15 kΩ (brown-green-orange) resistor connected to solder lug AB. Save the 15 kΩ resistor for use later.

This completes the Transmitter checkout. Do not change any of the Trim Tabs or the Auxiliary control from their center positions. Also leave the antenna in its present position.

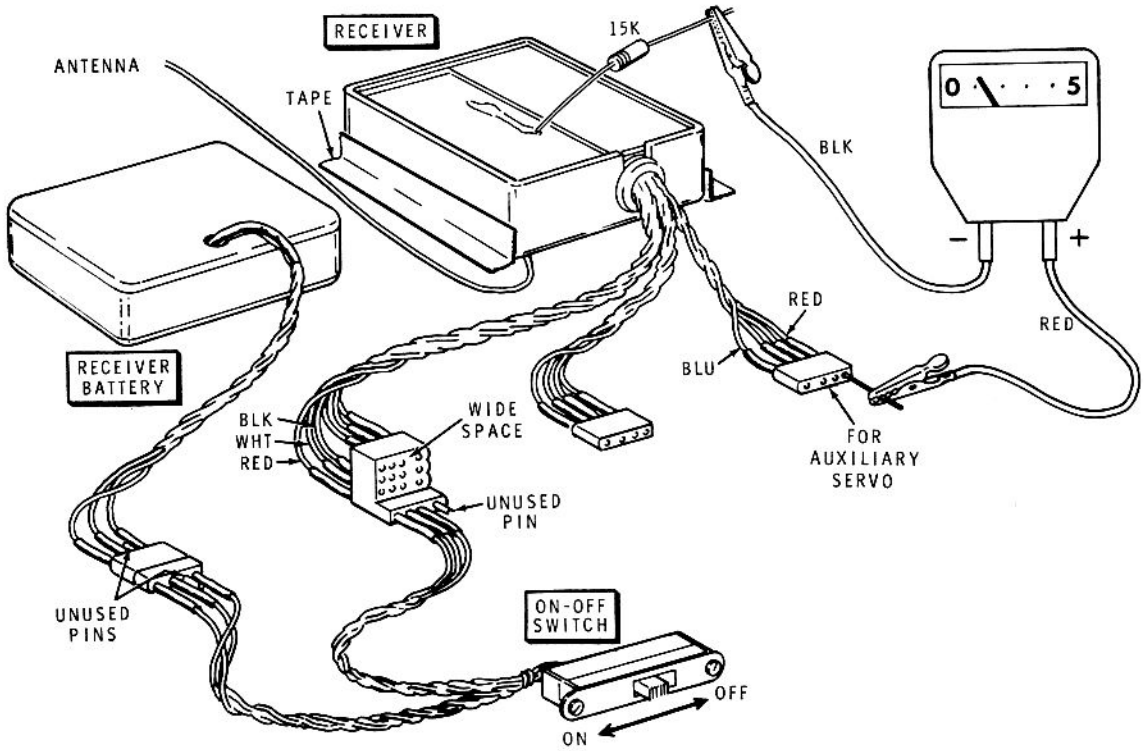


Figure 3-4

RECEIVER

In the following steps, the Receiver will be aligned for maximum sensitivity using the Transmitter as the signal source with the meter as a peaking indicator.

Refer to Figure 3-4 for the following steps.

( ) Remove the receiver case bottom.

( ) Carefully solder one end of a 15 kΩ (brown-green-orange) resistor to the test point on the foil side of the receiver circuit board (S-1). See Figure 3-5 for this test point.

NOTE: A high impedance voltmeter, if available, may be used for the following steps in place of the meter furnished with the Transmitter.

( ) Clip the black meter wire to the free end of this 15 kΩ resistor.

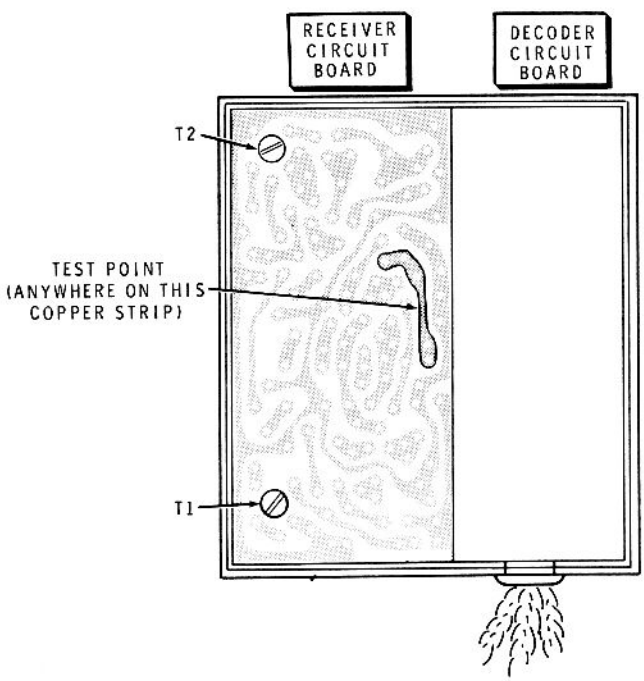


Figure 3-5

NOTE: In the next step (and in similar steps later), the meter will be connected to one of the five output connections of the Receiver. Each of the five channels has an identifying colored wire.

If you use a high impedance voltmeter for the following measurements, use a 1000 Ω or larger resistor in place of the cut-off resistor lead in the following steps.

( ) Locate the output connector with the blue wire connected to it.

( ) Push the previously saved resistor lead into the connector terminal with the red wire connected to it.

( ) Clip the red meter wire to this lead.

( ) Stretch the antenna (white wire of the Receiver out straight, keeping it away from any metal objects.

( ) Be sure the receiver battery switch is in the OFF position.

NOTE: There is only <u>one</u> correct way to connect the receiver switch to the large receiver black connector. Refer to Figure 3-4 for proper installation.

( ) Plug the receiver switch assembly into the Receiver and receiver battery.

( ) Turn the Receiver on. The meter should deflect only a slight amount. See the meter drawing on Figure 3-4.

CONDITION	POSSIBLE CAUSE
Incorrect or no meter indication.	1. Weak battery. This should not be the case at this time, as the battery was just charged, unless the charging circuit in the Transmitter is not operating properly. See Battery Charging on Page 36. 2. Battery switch. 3. Transistors Q1 through Q5. 4. Diode D2. 5. Transformer T1 or T2. 6. Components associated with stages Q1 through Q5.

NOTE: As you perform the following steps, increase the distance between the Transmitter and Receiver to keep the meter reading between the second and fourth red dots. <u>Do not touch the Receiver or any of its leads when making the following adjustments.</u> Tape the Receiver to a nonmetallic surface to hold it securely in place as shown. <u>Do not use any metallic tape.</u> Use the plastic alignment tool to make all adjustments.

( ) Push the transmitter antenna completely into the case. Then turn the Transmitter ON and move it to a location where the meter gives an indication at about the third red dot.

NOTE: Use the screwdriver end of the alignment tool for the following steps. Do not turn any slug more than <u>one</u> turn in either direction. If the end of the alignment tool will not fit into the slot, taper the end of the blade with a file.

( ) 1. Adjust transformer T1 for a maximum indication on the meter.

( ) 2. Adjust transformer T2 for a maximum indication on the meter.

( ) Repeat the previous two steps until no further improvement can be made.

( ) Turn both the Receiver and Transmitter OFF.

( ) Unclip both meter leads from the Receiver.

( ) Unsolder the 15 kΩ resistor from the receiver circuit board. Save the resistor for use later.

( ) Reinstall the case bottom on the Receiver.

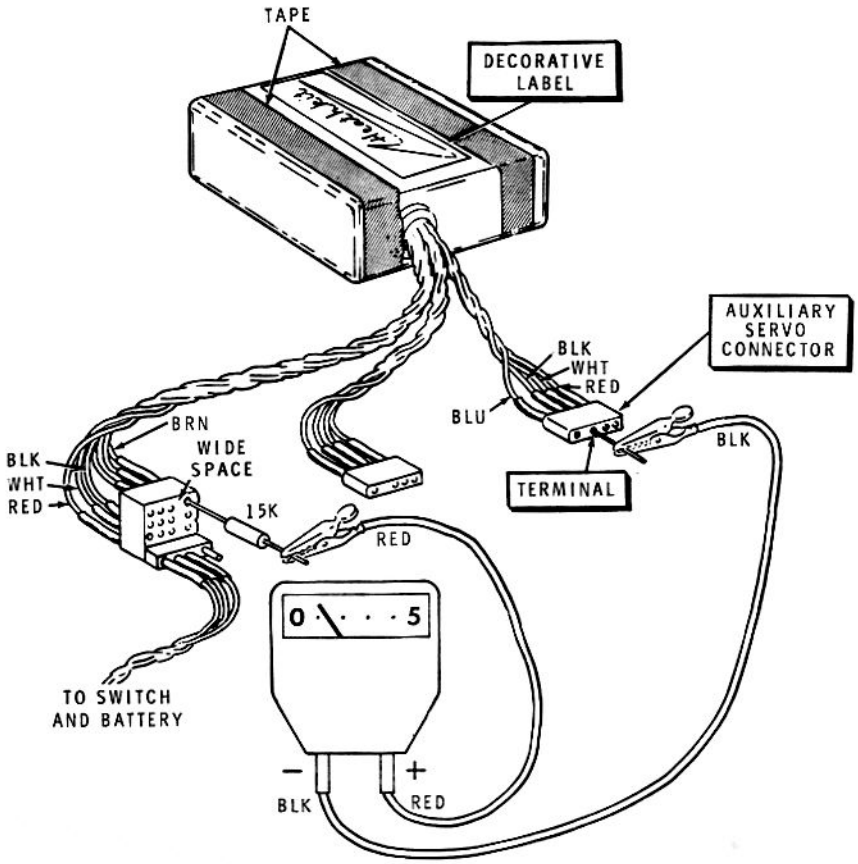


Figure 3-6

DECODER CHECKOUT

Refer to Figure 3-6 for the following steps.

NOTE: In the following steps the black meter wire will be connected to the auxiliary servo connector terminal with the black wire. The red meter wire and 15 kΩ resistor will connect to each of the different colored wire terminals (brown, orange, yellow, green, and blue).

( ) Cut both leads of the 15 kΩ resistor to 1/4" and connect one end to the red meter wire.

( ) Insert the other end of this resistor into the terminal with the brown (channel #1) wire connected to it.

( ) Move the cut off resistor lead from the red wire terminal to the black wire terminal of the auxiliary connector.

( ) Clip the black meter wire to this lead.

NOTE: The servo-controlling signal which is present at these connectors is produced by the Transmitter and picked up by the Receiver in the following channel sequence: channel #1, 2, 3, 4, and 5. If any one of the channels operates erratically (in the Transmitter or Receiver), usually all the remaining channels in the sequence will also be affected. For example, if channel #2 fails to operate properly, it is quite likely that channels #3, 4, and 5 will also be erratic in operation. Therefore, when checking the Receiver and Transmitter channels, you must correct any malfunction in the first channel affected in the sequence before the remaining channels can be expected to work properly. This can be an important observation if proper operation is not obtained.

( ) Turn the Receiver ON.

( ) Turn the Transmitter ON. The meter should deflect to approximately the first red dot.

( ) Now operate the Channel #1 Stick on the Transmitter. See Figure 3-1 (fold-out from Page 66). The meter should move slightly above and below the first meter indication as the stick is moved through its entire range. Moving the stick up should cause a decrease and moving the stick down should cause an increase in the meter indication. The meter should return to the first meter setting when the stick is returned to its center position.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #1 control stick.	1. Transistors Q101, Q102, Q104, or SCS101. 2. Diode D101. 3. Components associated with the above stages.

Now repeat the preceding steps and check each output channel in the same manner as channel #1. The channels should be checked in the following sequence:

( ) Move the 15 KΩ resistor to channel #2 (terminal with orange wire). Moving the stick to the left should cause an increase and moving it to the right should cause a decrease in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #2 control stick.	1. SCS102. 2. Diode D102. 3. Components associated with stage SCS102.

( ) Move the 15 KΩ resistor to channel #3 (terminal with yellow wire). Moving the stick to the left should cause an increase, and moving it to the right should cause a decrease in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #3 control stick.	1. SCS103. 2. Diode D103. 3. Components associated with stage SCS103.

( ) Move the 15 kΩ resistor to channel #4 (terminal with green wire). Moving the stick up should cause a decrease, and moving it down should cause an increase in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when moving the channel #4 control stick.	1. SCS104. 2. Diode D104. 3. Components associated with stage SCS104.

NOTE: In the following step, be careful not to short the two meter leads together.

( ) Move the 15 KΩ resistor to channel #5 (terminal with blue wire). Moving the AUX control up should cause an increase, and moving it down should cause a decrease in the meter indication.

CONDITION	POSSIBLE CAUSE
No meter indication, or meter indication does not change when the AUX (channel #5) control is moved.	1. SCS105. 2. Diode D105. 3. Components associated with stage SCS105.

( ) Turn the Transmitter and Receiver OFF.

( ) Disconnect the meter wires and remove the 15 kΩ resistor and the cut off resistor lead.

This completes the Receiver adjustments.

NOTE: The blue and white label shows the Production Series number of your kit. Refer to this number in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

Do not put this label on your receiver case or the tuning of your Receiver may be affected.

( ) Remove the backing from a blue and white label. Then press this label onto the top of Page 97 of this Manual or you may prefer to place it on the inside back cover of the Transmitter.

Refer to Figure 3-6 (on Page 74) for the following steps.

( ) Carefully peel away the backing paper from the Heathkit decorative label. Then press the label onto the outside of the Receiver case top.

( ) Tape the receiver case closed. This will increase the ruggedness of the Receiver.

TRANSMITTER TO SERVO

In the following steps, the stick controls will be adjusted for proper centering and travel by using the Receiver and Servo.

( ) Mark one of the Servos with a piece of tape. This Servo will be used as a reference for adjusting purposes.

( ) Refer to Figure 3-7 (fold-out from Page 85) and plug the connector of the marked Servo into channel #1 of the Receiver (the terminal with the brown wire). Note that the connectors are polarized and will fit correctly only one way.

Refer to Figures 3-1 and 3-2 (fold-out from Page 66) for the following steps.

( ) Be sure the AUX control and the trim tabs of the Transmitter are in their centered positions.

( ) Turn on the Transmitter and Receiver. NOTE: The Servo may start to run then stop. This is normal.

( ) Move the stick of Channel #1 through its entire range. The linear output arms should turn in one direction with the stick to one end limit. Then as the stick is moved toward the other end limit, the arms should stop and begin turning in the opposite direction for the rest of the stick movement to the other end limit. NOTE: If the Servo did not operate as described, refer to the chart below.

( ) Turn off the Transmitter and Receiver. Unplug the Servo.

( ) Temporarily remove both linear output arms.

CONDITION	POSSIBLE CAUSE
Servo completely dead. Motor will not turn in either direction.	1. Faulty connection between Receiver and Servo. 2. Receiver battery run down. 3. Servo transistors Q8 and Q9 interchanged. 4. Servo transistors Q4 through Q9. 5. Faulty component in one of the above stages.
Servo motor runs when the Transmitter is turned off.	1. Faulty positive (red wire) connection between Receiver and Servo. 2. Capacitor C5. 3. Transistors Q1 through Q9.
Output rotary arm turns only in a clockwise direction, when viewed from shaft end.	1. Servo transistor Q5, Q7, or Q9. 2. Control Housing Lever misadjusted in Transmitter.
Output rotary arm turns only in a counterclockwise direction, when viewed from shaft end.	1. Servo transistor Q4, Q6, or Q8. 2. Control Housing Lever misadjusted in Transmitter.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the Service and Warranty section of the "Kit Builders Guide," and to the "Factory Repair Service" information on Page 134 of this Manual.

TRAVEL AND CENTERING

In the following steps, each of the five Transmitter channels will be checked and adjusted to make sure its servo will center properly and travel the proper distance in each direction. Use the following seven-step Procedure to adjust each channel. Refer to Figure 3-2 (fold-out from Page 66) and Figure 3-7 (fold-out from Page 85).

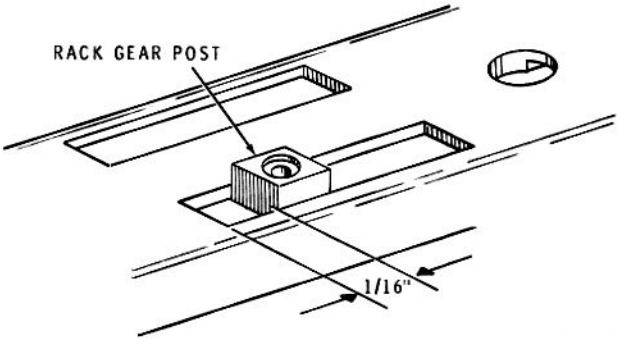


Figure 3-8

ADJUSTMENT PROCEDURE

1. Connect the marked servo to the output connector of the channel referred to in the step. Then turn on the Transmitter and Receiver.

2. Adjust the proper channel Control Housing Lever to center the rack gear posts in the center of the case top-section slots.

3. Operate the proper stick slowly through its entire range. Be sure the Trim Tab is in the center position. The rack gear posts on the servo should move in each direction. They should move each way until approximately 1/16" exists between the leading edge of the rack gear post and the end of the slot in the case top section. See Figure 3-8.

4. If the posts travel the correct distance in each direction, proceed to step #7.

5. If the posts do not travel far enough, turn the Range control (on the encoder circuit board in the Transmitter) for that channel clockwise a small amount. Then readjust the Control Housing Lever to bring the posts back to their center position. Repeat steps 3 and 5 until the posts travel the correct distance.

6. If the posts travel too far, turn the Range control for that channel counterclockwise a small amount. Then readjust the Control Housing Lever to bring the posts back to their center position. Repeat steps 3 and 6 until the posts travel the correct distance.

7. Move the Trim Tab to one end and then the other while operating its stick through its entire range. Check to be sure that the rack gear posts do not touch the ends of the slots of the servo case as this will cause excessive drain on the receiver battery. If they do touch, repeat step 6 and then step 3.

NOTE: The Servo may chatter if picked up. This is due to hum picked up from your hand. This will not interfere with proper operation when the Servo is mounted in a model.

ADJUSTMENTS

Check and adjust each of the following channels in order, using the Procedure just described.

( ) Channel #1 (brown wire).

( ) Channel #2 (orange wire).

( ) Channel #3 (yellow wire).

( ) Channel #4 (green wire).

( ) Channel #5 (blue wire).

( ) Turn off the Transmitter and Receiver.

After all five channels have been checked and any necessary adjustments made, no further adjustments are required in the Transmitter or the Servo used in making these adjustments.

SERVO TO TRANSMITTER

CENTERING

The following adjustments are only for the remaining unmarked (no tape) Servos. Do not attempt these adjustments unless the Transmitter has been completely adjusted with one of the Servos according to the instructions in the Travel and Centering Section. Do not make any of these adjustments on the marked Servo (marked with the piece of tape).

Refer to Figure 3-7 (fold-out from Page 85) for the following steps. Repeat these steps for each Servo.

( ) Connect the Servo to be adjusted to channel #1 (brown wire) of the Receiver.

( ) Turn the Receiver Battery switch on.

( ) Turn the Transmitter ON. Be sure the channel #1 Trim Tab is in its center position.

Move the Channel #1 stick in one direction and then the other direction. The output arms should move, stop, and then move in the reverse direction along with the control stick.

If the Servo does not operate as described, refer to the "In Case Of Difficulty" section on Page 97.

NOTE: If the rotary output arm is now parallel to the end of the Servo case, turn the Transmitter and Receiver Off and disregard the next three steps.

( ) 1. Remove the case bottom section by removing the two 2-56 x 11/16" screws.

NOTE: Picking up the Servo to make the following adjustment can cause the Servo motor to chatter. This is normal due to hum pickup from your hand. After an adjustment, the Servo should be set down on the work surface to be sure the correct amount of adjustment has been made. Make all adjustments with a screwdriver or alignment tool.

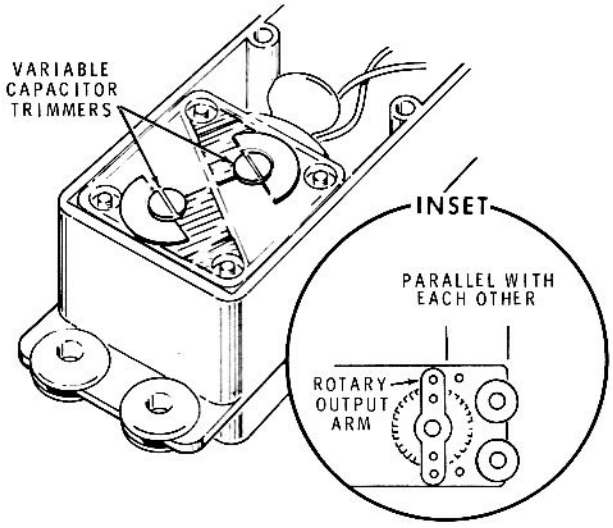


Figure 3-9

( ) 2. Adjust (one or both) the trimmer(s) on the rear of the variable capacitor until the rotary output arm is perfectly parallel to the end of the Servo case. See Figure 3-9.

( ) 3. Mount the case bottom section on the case center section of each Servo with 2-56 x 11/16" screws. Be sure that no wires are pinched between the two sections of the case and that the rubber grommet is positioned properly.

from Page 85

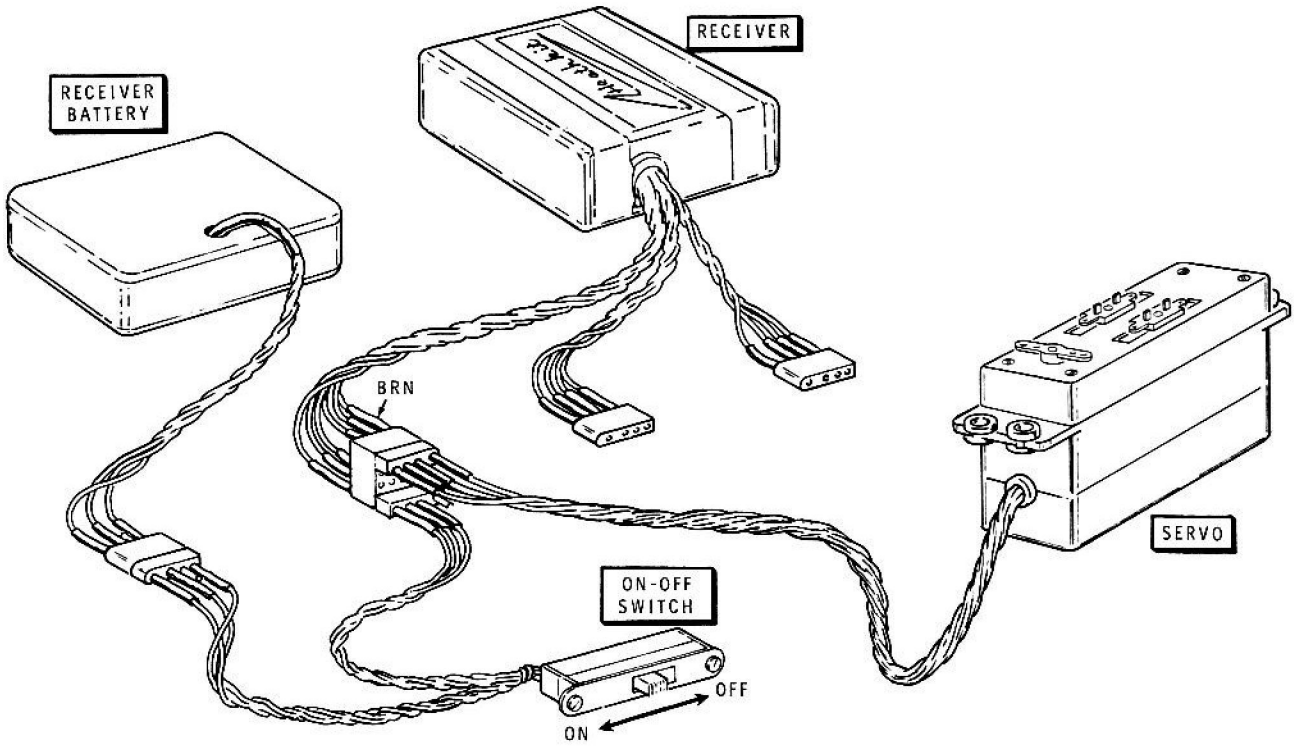


FIGURE 3-7

FINAL ASSEMBLY

NOTE: If optimum range is desired, the Receiver alignment (Page 72) should be repeated with all servos connected and installed in the model.

TRANSMITTER

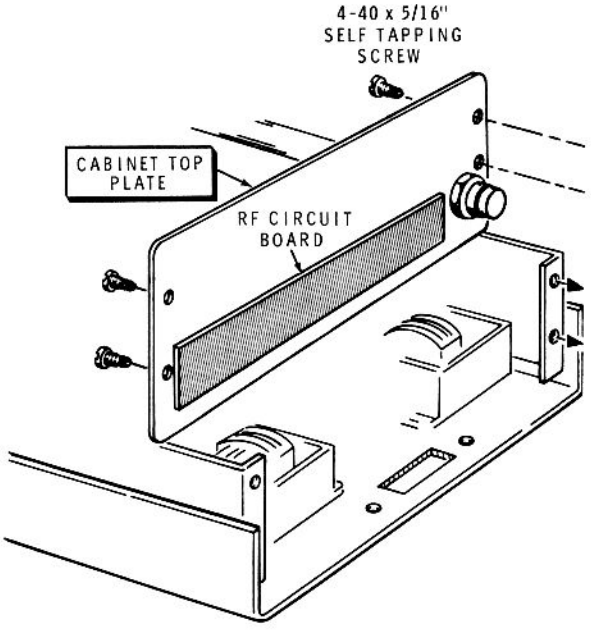
( ) Unsolder the red wire from the meter.

( ) Cut the black wire connected to the meter to 4" as measured from the meter lug. Then remove 1/4" of insulation from the free end of this wire and melt a small amount of solder on the exposed wire end.

( ) Extend the largest diameter section of the antenna until it hits the stop. Do not extend any of the remaining smaller diameter sections of the antenna.

( ) Refer to Detail 4-1A, and remove the four 4-40 x 5/16" self-tapping screws that hold the cabinet top plate to the support brackets.

( ) Carefully move the cabinet top plate out of the way.



Detail 4-1A

Refer to Detail 4-1B for the following steps.

( ) Carefully bend the lugs of the meter as shown.

( ) Connect the free end of the red wire coming from hole M on the transmitter circuit board, to the positive (+) lug of the meter (S-1).

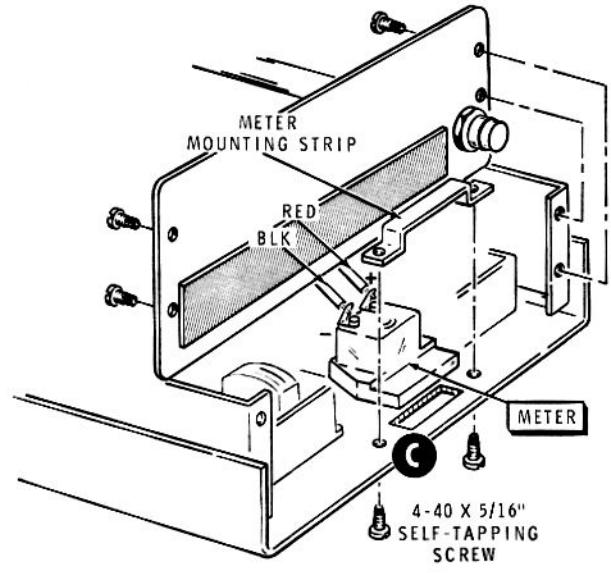
( ) Mount the meter at C as shown with the meter mounting bracket and two 4-40 x 5/16" self-tapping screws.

( ) Remount the cabinet top plate on the cabinet with the 4-40 x 5/16" self-tapping screws.

( ) Connect the free end of the black meter wire to solder lug AB and solder the connection. See Detail 4-1C. Note that there is already a black wire soldered to AB. The 72 MHz band also has a 1200 Ω resistor soldered to AB.

( ) Position the red and black meter wires down towards the front panel. See Detail 4-1C.

( ) If you have decided to operate in Mode I, remove the centering spring from the dog stops on Channel #1 stick control. If Mode II or III has been selected, remove the centering spring from the dog stops on Channel #4 stick control. See Detail 4-1C.

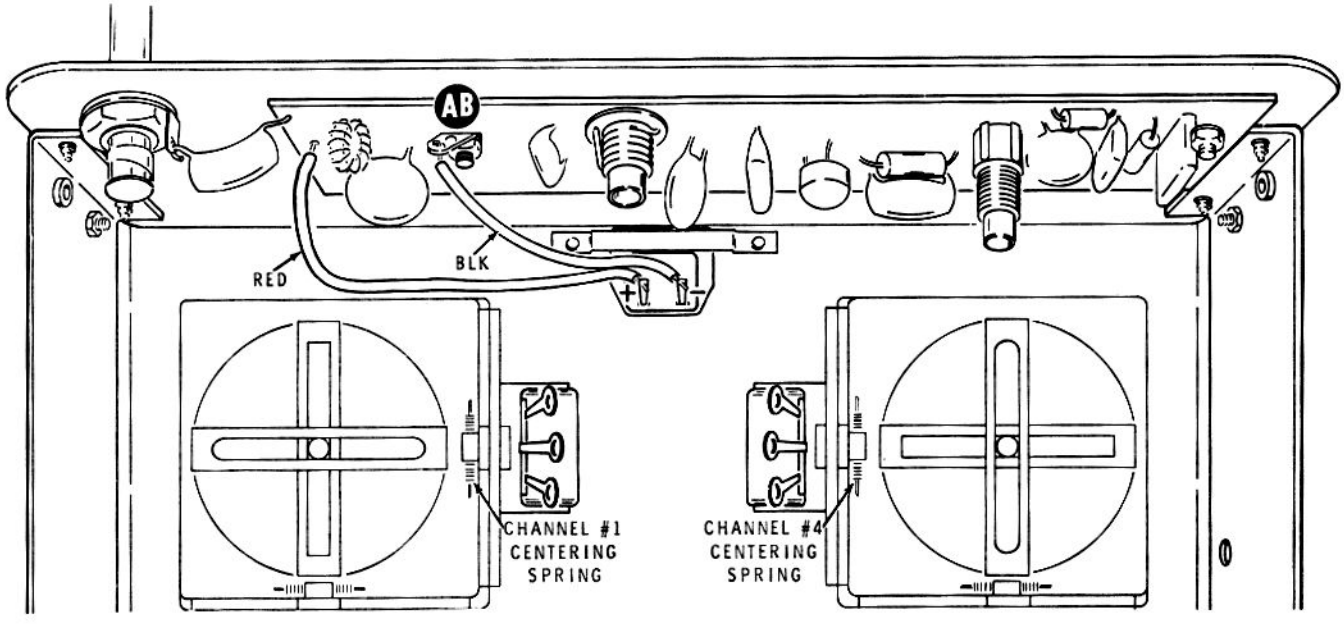


Detail 4-1B

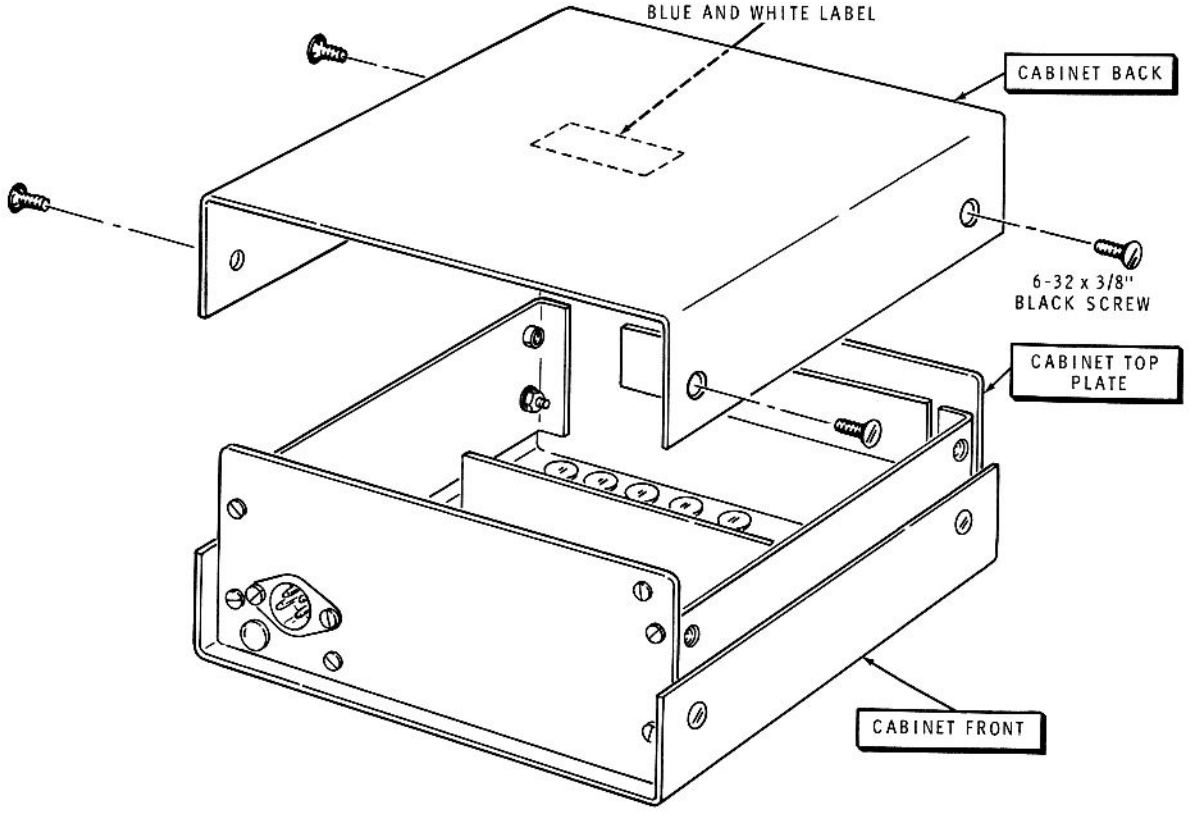
( ) Move the control stick (selected in the preceding step by the removal of its centering spring) back and forth and tighten the adjustable bearing screw (see Figure 5-1, Page 93) to the desired tension.

TRANSMITTER-SERVO

NOTE: The blue and white labels that are installed in the following steps show the Production Series number of your kit. Refer to this number in any communications with the Heath Company.



Detail 4-1C



PICTORIAL 4-1

Refer to Pictorials 4-1 and 4-2 for the following steps.

( ) Carefully peel away the backing from a blue and white label. Then press the label onto the inside surface of the cabinet back as shown.

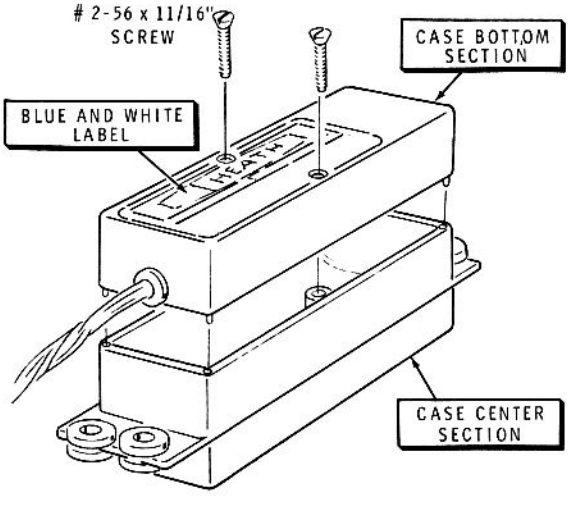
( ) Carefully peel away the paper backing from the remaining blue and white labels. Then press one of these labels onto the case bottom section of each Servo (or if you prefer, onto the inside surface of the transmitter cabinet back).

( ) Mount the Transmitter cabinet back with four 6-32 x 3/8" black screws.

This completes the final assembly of the Transmitter and Servos.

NOTE: 53 MHz and 72 MHz Transmitters should have a 100 pF mica capacitor left over. 53 MHz and 27 MHz Transmitters should have a 1200 Ω 1/2 watt resistor left over. You may wish to save the 15 KΩ resistor, 82 KΩ resistor, and the alligator clips.

There should be three #2 x 3/16" self-tapping screws, a rotary output arm, a rotary output wheel, two linear output arms, and four #4 x 1/2" wood screws left for each Servo. Information for their use is located in the Installation section of the Manual.



PICTORIAL 4-2

Refer to Detail 4-1B for the following steps.

( ) Carefully bend the lugs of the meter as shown.

( ) Connect the free end of the red wire coming from hole M on the transmitter circuit board, to the positive (+) lug of the meter (S-1).

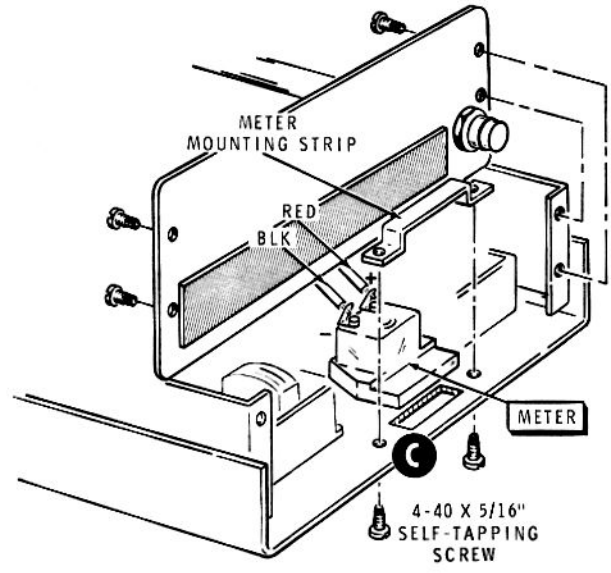
( ) Mount the meter at C as shown with the meter mounting bracket and two 4-40 x 5/16" self-tapping screws.

( ) Remount the cabinet top plate on the cabinet with the 4-40 x 5/16" self-tapping screws.

( ) Connect the free end of the black meter wire to solder lug AB and solder the connection. See Detail 4-1C. Note that there is already a black wire soldered to AB. The 72 MHz band also has a 1200 Ω resistor soldered to AB.

( ) Position the red and black meter wires down towards the front panel. See Detail 4-1C.

( ) If you have decided to operate in Mode I, remove the centering spring from the dog stops on Channel #1 stick control. If Mode II or III has been selected, remove the centering spring from the dog stops on Channel #4 stick control. See Detail 4-1C.

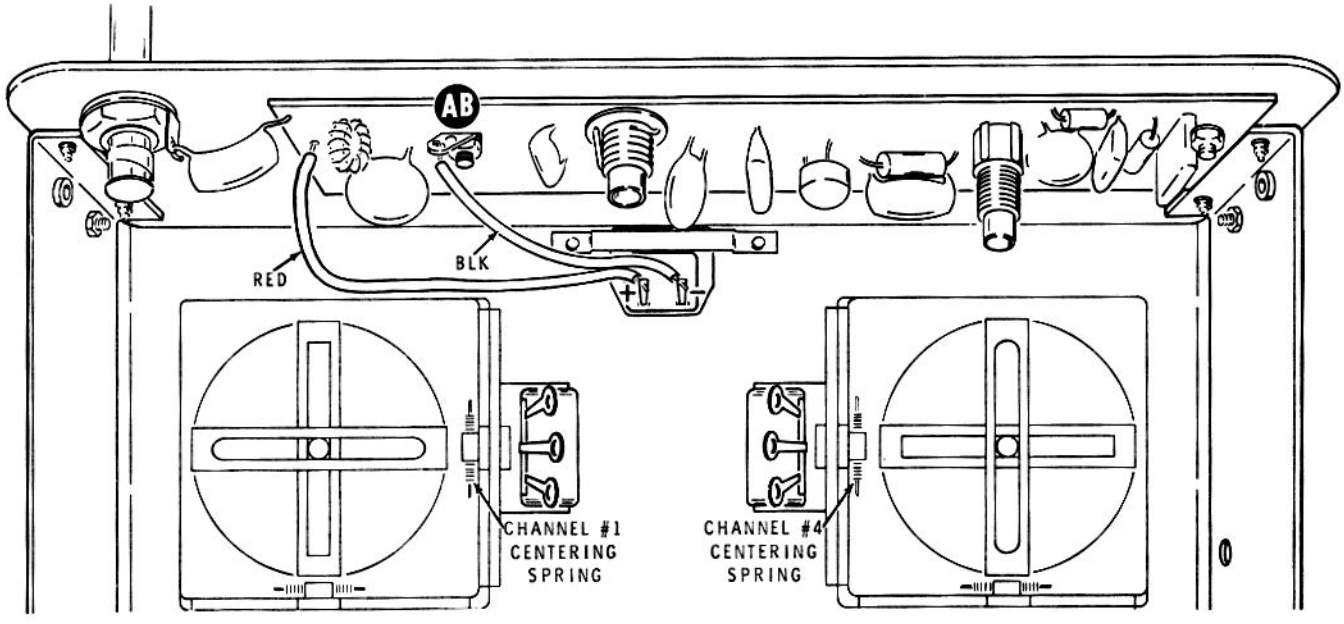


Detail 4-1B

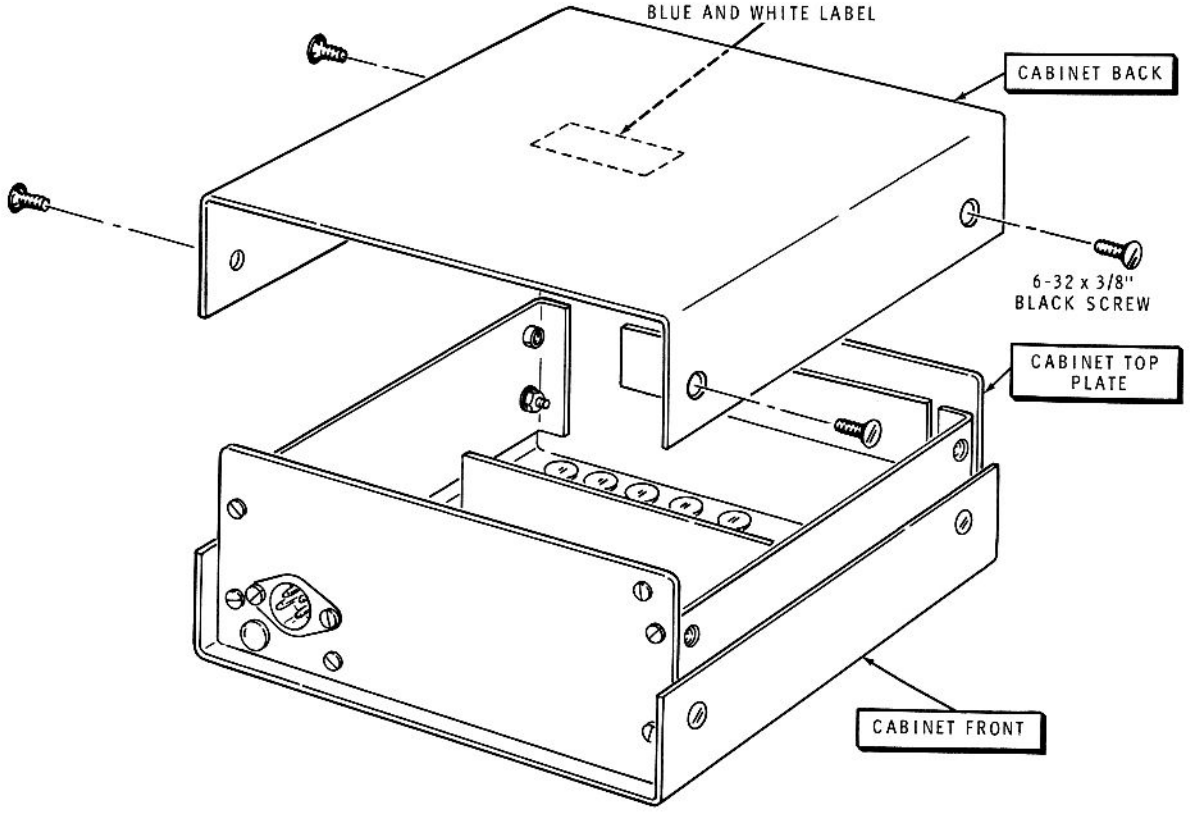
( ) Move the control stick (selected in the preceding step by the removal of its centering spring) back and forth and tighten the adjustable bearing screw (see Figure 5-1, Page 93) to the desired tension.

TRANSMITTER-SERVO

NOTE: The blue and white labels that are installed in the following steps show the Production Series number of your kit. Refer to this number in any communications with the Heath Company.



Detail 4-1C



PICTORIAL 4-1

Refer to Pictorials 4-1 and 4-2 for the following steps.

( ) Carefully peel away the backing from a blue and white label. Then press the label onto the inside surface of the cabinet back as shown.

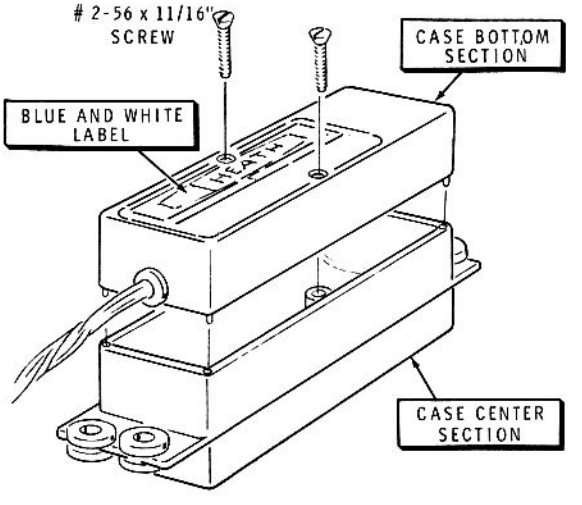
( ) Carefully peel away the paper backing from the remaining blue and white labels. Then press one of these labels onto the case bottom section of each Servo (or if you prefer, onto the inside surface of the transmitter cabinet back).

( ) Mount the Transmitter cabinet back with four 6-32 x 3/8" black screws.

This completes the final assembly of the Transmitter and Servos.

NOTE: 53 MHz and 72 MHz Transmitters should have a 100 pF mica capacitor left over. 53 MHz and 27 MHz Transmitters should have a 1200 Ω 1/2 watt resistor left over. You may wish to save the 15 KΩ resistor, 82 KΩ resistor, and the alligator clips.

There should be three #2 x 3/16" self-tapping screws, a rotary output arm, a rotary output wheel, two linear output arms, and four #4 x 1/2" wood screws left for each Servo. Information for their use is located in the Installation section of the Manual.



PICTORIAL 4-2

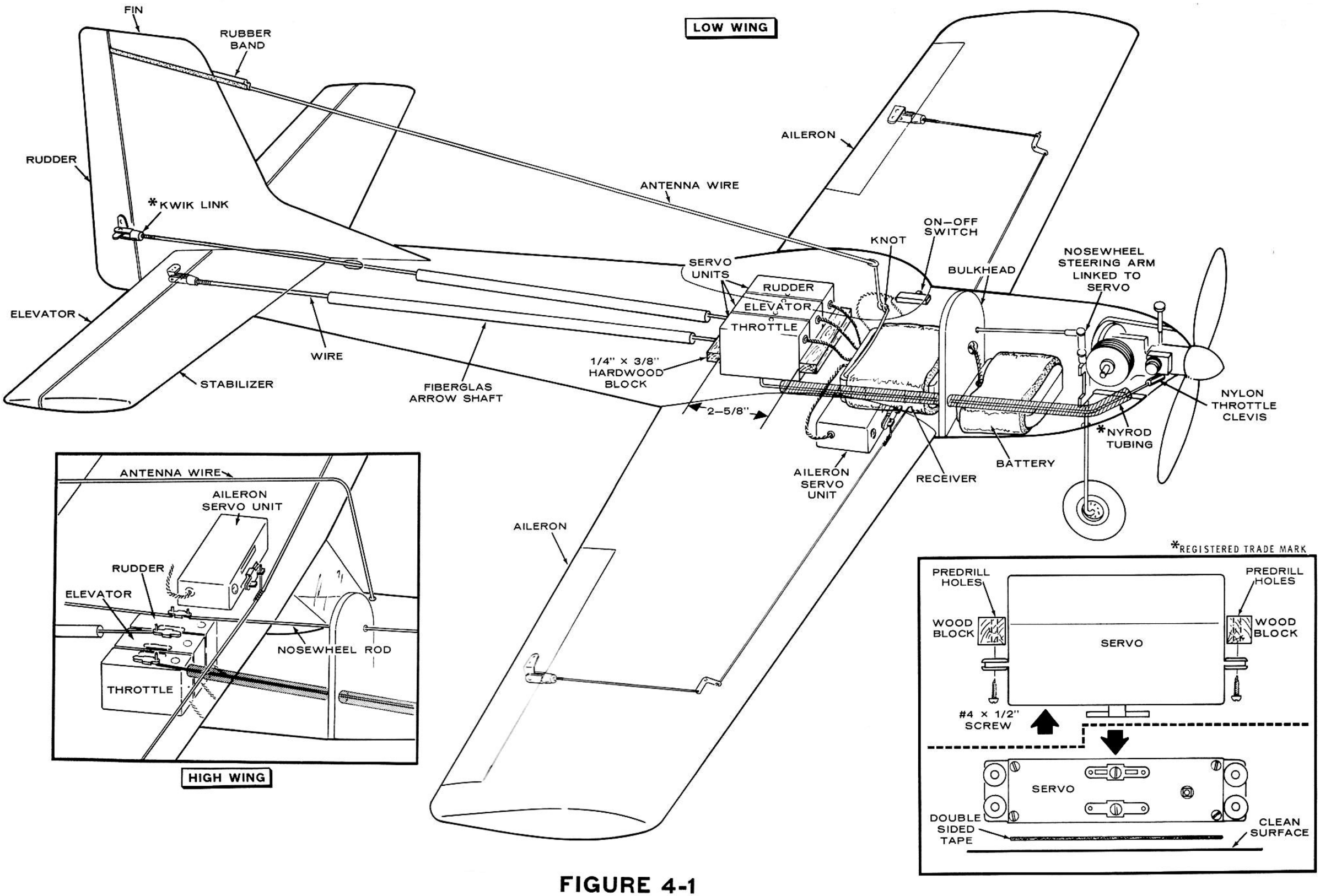

LOW WING
FIN
RUBBER BAND
RUDDER
*KWIK LINK
ANTENNA WIRE
AILERON
ON–OFF SWITCH
KNOT
SERVO UNITS
RUDDER
ELEVATOR
THROTTLE
BULKHEAD
NOSEWHEEL STEERING ARM LINKED TO SERVO
ELEVATOR
WIRE
1/4" x 3/8" HARDWOOD BLOCK
FIBERGLAS ARROW SHAFT
STABILIZER
2–5/8"
NYLON THROTTLE CLEVIS
*NYROD TUBING
AILERON SERVO UNIT
BATTERY
RECEIVER
AILERON
ANTENNA WIRE
AILERON SERVO UNIT
RUDDER
ELEVATOR
NOSEWHEEL ROD
THROTTLE
HIGH WING
*REGISTERED TRADE MARK
PREDRILL HOLES
PREDRILL HOLES
WOOD BLOCK
WOOD BLOCK
SERVO
#4 x 1/2" SCREW
SERVO
DOUBLE SIDED TAPE
CLEAN SURFACE

FIGURE 4-1

INSTALLATION

The Model GDA-19-2 Receiver and Model GDA-19-4 Servo units can be used in model cars and boats as well as in model airplanes. But since the five channels of this system are ideal for use in model planes, only this type of installation will be described. These same installation principles can also be applied to other types of models.

The main points for you to consider in your installation are: weight distribution, directness of action from the Servos (through the pushrods) to the devices they control, and protection from mechanical shock, vibration, dirt, and oil. Many model manufacturers furnish complete data for mounting and connecting radio control equipment in their planes.

Figure 4-1 (on Page 85) shows a typical model airplane installation. Compare this Figure with your plane very carefully to determine the best location for the Receiver, Servo units, and Battery. Temporarily set the components in the chosen places to be sure they will fit. Allow enough space for foam rubber packing around the Receiver and Battery. After you have decided on the most suitable locations for all components, remove them from the plane and then install them one at a time.

The following instructions cover the most important considerations for the installation of each component.

BATTERY

The Battery should be wrapped in foam rubber and installed forward of a strong bulkhead, ahead of the Receiver. A battery compartment can be made by installing another bulkhead in front of the Battery. Be sure the Battery cannot shift, and that it does not interfere with any pushrod movement. A loose battery can shift due to vibration and break off the battery leads.

BATTERY SWITCH

Select a location for mounting the switch in the side of the fuselage that is away from the engine exhaust. This will keep exhaust oil and fumes from fouling the switch contacts. Cut a 1/4" x 3/8" opening in the fuselage to clear the switch slide; then mount the switch and switch plate with the two 3-48 x 1/4" screws that are supplied.

NOTE: When you connect the battery switch to the Receiver and Battery, note the polarization of the plugs and also that the switch plugs are not wired alike.

RECEIVER-ANTENNA

Although the Receiver is very rugged, it should be well protected in case the plane should crash. Wrap the Receiver and Receiver Battery in thick foam rubber. Then install the Receiver behind a strong bulkhead. Be sure the Receiver and Battery do not interfere with any pushrod movement. POSITION THE ANTENNA WIRE AWAY FROM METAL PUSHRODS, SERVOS, AND SERVO WIRES, OR THE OPERATING RANGE CAN BE SEVERELY REDUCED.

Tie a single knot in the antenna wire at a point that will permit a looseness between the Receiver and the antenna hole in the fuselage. Then pass

the antenna wire through the hole and pull it toward the tail of the plane. Tie a rubber band to the end of the antenna wire; then fasten the rubber band to the tail fin. Use a rubber band that is just heavy enough to support the antenna without placing strain on the fin. CAUTION: Do not shorten the length of the antenna wire. Any change in antenna length would detune the Receiver and reduce its operating range. Keep the antenna wire away from the receiver case and metal parts.

NOTE: If your plane was sprayed with a metallic paint, be sure to keep the antenna away from the plane's surface or the operating range may be severely reduced.

SERVO UNITS

NOTE: If you desire to have less travel on a particular channel (Throttle, for example) the Range control can be readjusted to reduce it. See Travel and Centering (Page 78).

Each Servo unit should be placed for the most direct action on the pushrod it operates. NOTE: In some installations it may be desirable to reverse Servo travel. This can be done easily by reversing the connections between lugs 1 and 3 of the associated stick control in the transmitter. It may be necessary to readjust the Control Housing Lever to obtain proper centering as called out in the Travel and Centering adjustments. Depending on the fuselage width of your plane, two or more Servo units may be installed side-by-side between two hardwood blocks. Secure each Servo to the blocks with the four #4 x 1/2" screws that are supplied. Predrill holes for these screws with a 5/64" drill.

NOTE: For some positions of Servo units, it may be difficult to use screws for mounting. In this case, a double-coated pressure sensitive foam tape, such as Scotch-Mount* vinyl or polyurethane, may be used to secure the Servo to a clean flat surface. Position the Servo carefully, as the pressure sensitive tape sticks fast and can be removed only by cutting the tape. This type of installation is adequate for all types of radio control aircraft.

Each Servo makes available many mechanical output combinations. Each has a rotary output wheel, a rotary output arm, and two different linear output arms. Use the output hookup that fits your particular installation. Figure 4-2 shows only three of the many output combinations. It is not a good idea to combine both rotary and linear output combinations on the same Servo, as these will interfere with each other and may cause the Servo to bind and draw excessive current. This could shorten the battery life per charge. Binding could also cause the plane to crash.

Note that two servos may be operated simultaneously from one control stick by connecting them in parallel.

NOTE: When using the linear output arm with tabs, it will be necessary to drill a hole in the tab that is large enough to accept the linkage rod used. See Figure 4-2.

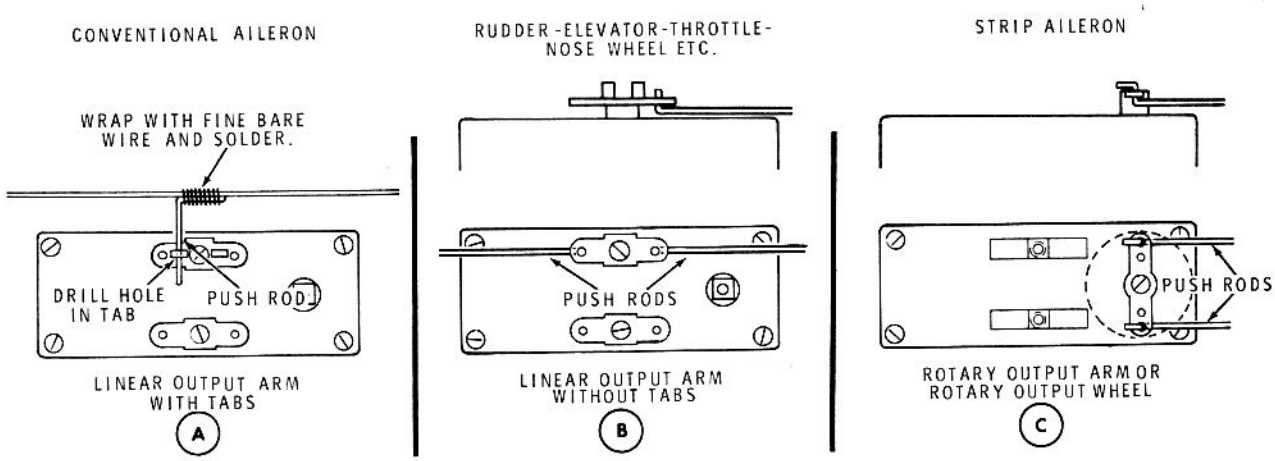


Figure 4-2

* Registered Trademark, 3-M Company.

Use the #2 x 3/16" screws to mount the rotary and linear arms or rotary wheel on the Servos.

The servo connectors from the Receiver have a different color wire that identifies the Servo function. The different colored wires and the Servo functions are as follows:

CHANNEL	WIRE COLOR	MODE I	MODE II	MODE III
1	Brown	THROTTLE (T)	ELEVATOR (E)	ELEVATOR (E)
2	Orange	AILERON (A)	AILERON (A)	RUDDER (R)
3	Yellow	RUDDER (R)	RUDDER (R)	AILERON (A)
4	Green	ELEVATOR (E)	THROTTLE (T)	THROTTLE (T)
5	Blue	AUX (X)	AUX (X)	AUX (X)

The letters in parentheses can be scratched into the Receiver and Servo connectors to insure proper hookup between the two units.

Before you close the plane's fuselage, check to see that all components are snugly mounted so they cannot shift positions when the plane is in flight. Also be sure that all pushrods are properly coupled between their Servo units and the devices they operate. Pushrods must not touch any of the components or bind on any foam rubber wrapping. Finally, be sure the battery connections are made, and that the Servos are properly connected; then test the Receiver and Servo units as directed in the Operation section of the Manual.

When you have completely tested the Receiver and Servo installation, you may close the fuselage and prepare the plane for operation.

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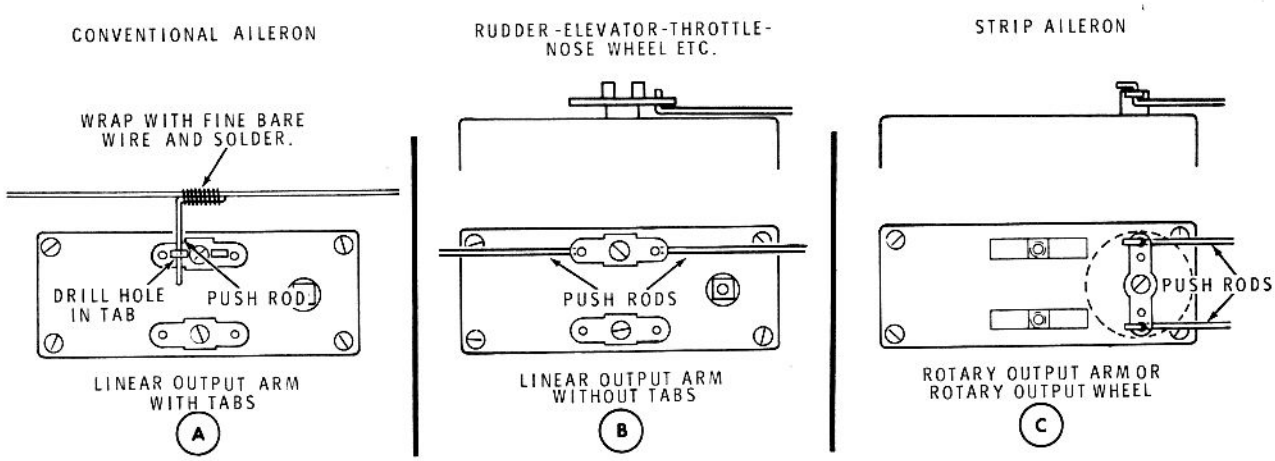
Note that two servos may be operated simultaneously from one control stick by connecting them in parallel.

NOTE: When using the linear output arm with tabs, it will be necessary to drill a hole in the tab that is large enough to accept the linkage rod used. See Figure 4-2.



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* Registered Trademark, 3-M Company.

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3	Yellow	RUDDER (R)	RUDDER (R)	AILERON (A)
4	Green	ELEVATOR (E)	THROTTLE (T)	THROTTLE (T)
5	Blue	AUX (X)	AUX (X)	AUX (X)

The letters in parentheses can be scratched into the Receiver and Servo connectors to insure proper hookup between the two units.

Before you close the plane's fuselage, check to see that all components are snugly mounted so they cannot shift positions when the plane is in flight. Also be sure that all pushrods are properly coupled between their Servo units and the devices they operate. Pushrods must not touch any of the components or bind on any foam rubber wrapping. Finally, be sure the battery connections are made, and that the Servos are properly connected; then test the Receiver and Servo units as directed in the Operation section of the Manual.

When you have completely tested the Receiver and Servo installation, you may close the fuselage and prepare the plane for operation.

OPERATION

PREFLIGHT CHECKS

BINDING

After the Receiver and Servos have been installed, operate all the controls to see that the Servos function properly and without binding. This will keep Servo overload and battery drain to a minimum.

VIBRATION

To be sure your mechanical connections and construction do not fail during flight, you should have someone hold your model so it will not fly, and then start the engine. Run a couple tanks of fuel through the engine. At the same time, operate all the controls to see that they perform faultlessly at all engine speeds.

RANGE CHECK

If the range shown in the following chart cannot be achieved, recheck the antenna to be sure it is placed as directed in the Receiver-Antenna section on Page 87. The Receiver antenna should fully extended as shown in Figure 4-1 (fold-out from Page 86). The indoor range may be greatly increased or reduced from this figure due to reflections from metal objects.

BAND	ANTENNA POSITION	MINIMUM RANGE
27 MHz	Fully collapsed into the case.	50 feet.
53 MHz	Fully collapsed into the case.	50 feet.
72 MHz	*Base section extended.	100 feet.

*Extend the largest diameter section of the antenna until it hits its stop. Do not extend any of the remaining sections of the antenna.

CONTROL FAMILIARIZATION

A thorough understanding of the Transmitter's controls and operation will help you obtain the most satisfactory use of your complete radio control system.

Figure 5-1 shows the Transmitter Controls and their functions for Mode II operation. Each Control stick serves two functions. An Auxiliary control is provided for an additional function, such as brakes, flaps, retractable landing gear, or fuel mixture control.

Be sure to extend the antenna to its full length. This assures proper loading to the Transmitter and provides maximum power transmission.

Place the Power switch in the On position and observe the Meter. With a fully charged battery, the meter should register near the "5" at the right-hand end of the scale. If the meter indicates less than "3" when the power is turned on, recharge the battery before you operate the Transmitter. See Battery Charging on Page 36.

TRIM TABS

Set the Trim Tabs to their center position. THE TRIM TABS SHOULD ONLY BE USED AFTER THE MODEL IS AIRBORNE.

ELEVATOR

Move the Elevator control stick in either direction. The elevator on the model should follow the movement of this control stick. Release the stick and note whether the model's elevator is in a straight line (neutral trim) with its stabilizer. If not, adjust the pushrod connecting the Servo to the elevator until neutral trim is achieved.

AILERON

Move the Aileron control stick from side to side. One of the plane's ailerons should move upward as the other moves downward. With the Aileron stick in the neutral position, adjust the ailerons to neutral trim with the adjustable pushrods.

RUDDER

Move the Rudder control stick from side to side. The plane's rudder should follow the movement of the control stick. With the Rudder control stick in its neutral position, adjust the trim as before.

THROTTLE

The operation of the Throttle control may be checked by observing the air intake port of the engine while moving the Throttle control stick vertically in either direction. The carburetor should open and close as the stick is moved.

NOTE: When installing the throttle Servo, be sure the Servo has a slight amount of slack at each end of its travel with the Stick and Trim Tab in their extreme positions. If the Servo runs the throttle up against its stop, the Servo will stall and cause heavy battery drain, resulting in severely reduced battery life or shorted battery cells. Never allow a Servo to stall in any position, as a crash could result.

If the Throttle stick operates too freely or too tightly, you can adjust the throttle adjustable bearing screw on the back of the control assembly. See the inset drawing on Figure 5-1.

AUXILIARY

If you have a Servo unit connected to the Auxiliary cable of your Receiver, you can check the Auxiliary control in the same manner as the other controls. There is no trim tab on the Auxiliary control.

IDENTIFICATION KEY

All Transmitters on the 53 MHz band have an identification key (pushbutton switch) located on the cabinet top plate of the Transmitter. This switch should be used to identify your station at the beginning and end of each flight, and at ten minute intervals, to comply with FCC regulations. To use the key, place the transmitter power switch in the ON position and operate the pushbutton switch as a key.

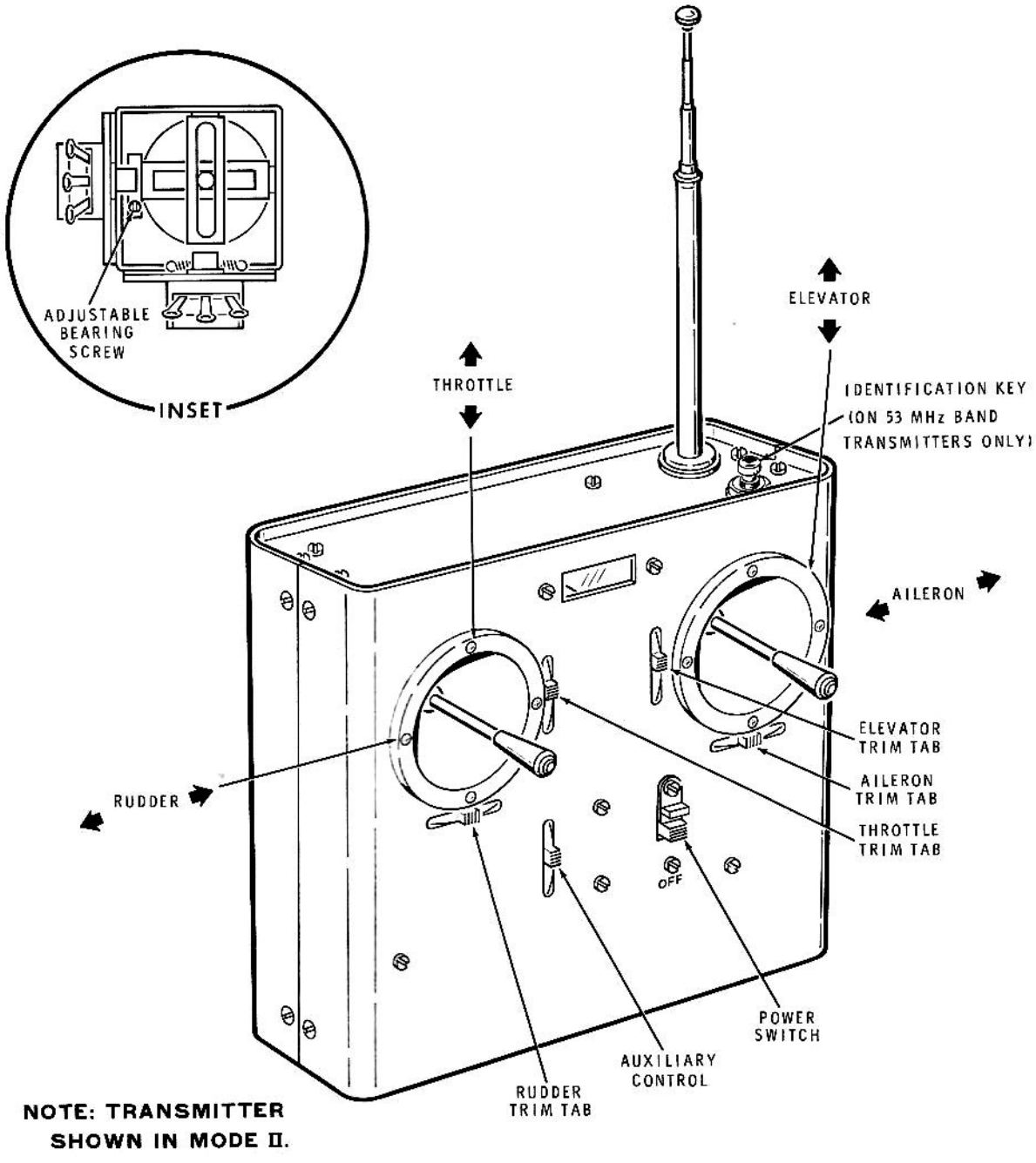
ADJUSTABLE BEARING SCREW
INSET
ELEVATOR
THROTTLE
IDENTIFICATION KEY
(ON 53 MHz BAND TRANSMITTERS ONLY)
AILERON
ELEVATOR TRIM TAB
AILERON TRIM TAB
THROTTLE TRIM TAB
RUDDER
OFF
POWER SWITCH
AUXILIARY CONTROL
RUDDER TRIM TAB
NOTE: TRANSMITTER SHOWN IN MODE II.

Figure 5-1

FLYING THE FIRST TIME

If you have never flown proportional equipment, it is suggested that you have an experienced flier assist you and "check you out" when making your first flights. If no one is available, it is suggested that you go through the operation of each control several times, to get the "feel", before you start the plane's engine or attempt to fly it. A few imaginary flights will also be helpful, along with extensive taxiing on the ground.

When you are ready to start the engine, use the Throttle control to govern the engine's speed. After the engine is warmed up and running properly, move the Throttle control slowly downward until the engine idles smoothly. Set the Throttle Trim Tab to provide proper engine idle with the Throttle stick fully downward. Hold the plane firmly on the ground while you advance the Throttle and speed up the engine. Then return the Throttle to idle. NOTE: The engine throttle stop can be adjusted to kill the engine when the Throttle Trim Tab is in its full down position. Do not stall the Servo when making these checks.

Practice taxiing the plane around a large flat area several times before you attempt to fly it. Be sure the plane taxis straight; this helps assure you of a successful takeoff. Get a real good "feel" for the controls and the plane's response. An extra hour or two of practice with the plane on the ground may save you many hours and dollars spent repairing the plane later.

Refer to the transmitter radiation pattern of Figure 5-2. Notice that a minimum of radiated signal will reach the aircraft if the transmitter

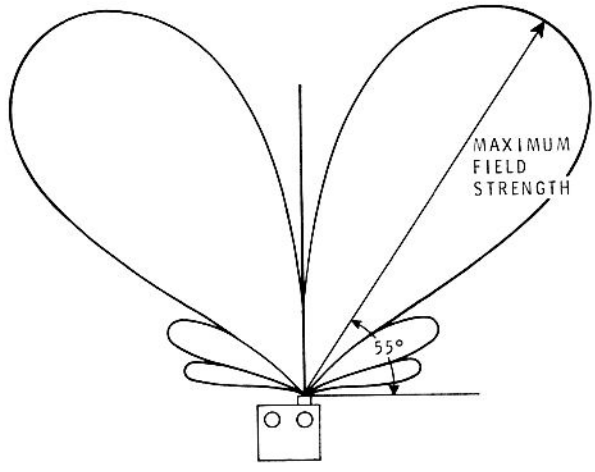

Figure 5-2

antenna is pointed directly at the aircraft. The maximum signal will be picked up by the aircraft if it is approximately 55 degrees up from an imaginary line across the top of the Transmitter. The signal appears in Figure 5-2 to radiate from the left and right side of the antenna, but it actually radiates all around (360 degrees) the antenna, with its maximum field strength as shown.

FLAGS

The operating frequency of any GDA-19-1 Transmitter corresponds to a particular color or colors. By making a flag of the color(s) that correspond(s) to your transmitter's operating frequency and tying the flag to the extended end of your antenna, other model operators in the area can quickly identify your transmitting frequency.

27 MHz Band		53 MHz Band		72 MHz Band	
Frequency MHz	Color	Frequency MHz	Color	Frequency MHz	Color
26.995	Brown	53.100	Black-brown	72.080	White-brown
27.045	Red	53.200	Black-red	72.240	White-red
27.095	Orange	53.300	Black-orange	72.400	White-orange
27.145	Yellow	53.400	Black-yellow	72.960	White-yellow
27.195	Green	53.500	Black-green	75.640	White-green

BATTERY RECHARGING

To assure maximum performance from your Transmitter, Receiver, and Servo system, be sure both the Transmitter and Receiver batteries are fully charged before you begin operating. The surest way of knowing that the batteries are charged is to recharge them before each use.

The Transmitter and Receiver batteries are charged simultaneously when they are connected as shown in the Battery Charging instructions on Page 36.

Connect the charging cable to a 120 volt AC line, the Transmitter, and the Receiver battery. Place the Transmitter Power switch in the OFF position. The indicator lamp will glow when the charging circuit is operating.

The batteries should be charged for at least 24 hours the first time and at least 14 hours per charge thereafter. It is not necessary to remove the batteries from the plane for recharging.

SELF-DISCHARGE

Self-discharging characteristics of nickel-cadmium cells during storage are shown in Figure 5-3. The characteristics are shown as a decline in percent of rated capacity from a full charge. Note that after the first thirty days the capacity has decreased to approximately 70% when stored at 68 degrees F. However, these batteries are not harmed even if not used for long periods of time.

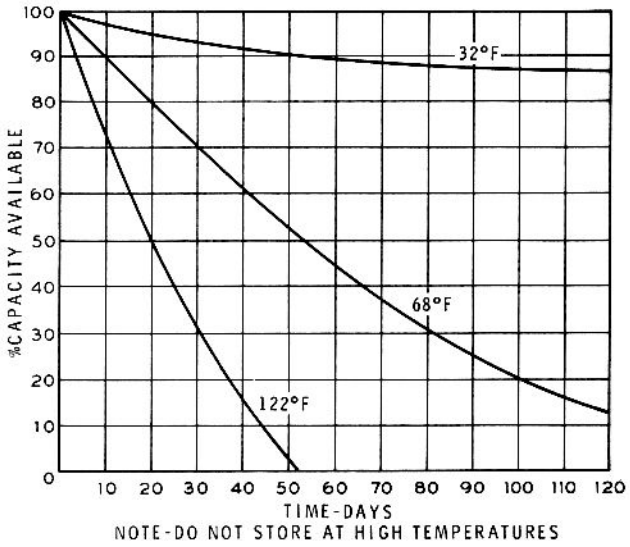

Figure 5-3

CONTROL FAMILIARIZATION

A thorough understanding of the Transmitter's controls and operation will help you obtain the most satisfactory use of your complete radio control system.

Figure 5-1 shows the Transmitter Controls and their functions for Mode II operation. Each Control stick serves two functions. An Auxiliary control is provided for an additional function, such as brakes, flaps, retractable landing gear, or fuel mixture control.

Be sure to extend the antenna to its full length. This assures proper loading to the Transmitter and provides maximum power transmission.

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The operation of the Throttle control may be checked by observing the air intake port of the engine while moving the Throttle control stick vertically in either direction. The carburetor should open and close as the stick is moved.

NOTE: When installing the throttle Servo, be sure the Servo has a slight amount of slack at each end of its travel with the Stick and Trim Tab in their extreme positions. If the Servo runs the throttle up against its stop, the Servo will stall and cause heavy battery drain, resulting in severely reduced battery life or shorted battery cells. Never allow a Servo to stall in any position, as a crash could result.

If the Throttle stick operates too freely or too tightly, you can adjust the throttle adjustable bearing screw on the back of the control assembly. See the inset drawing on Figure 5-1.

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If you have a Servo unit connected to the Auxiliary cable of your Receiver, you can check the Auxiliary control in the same manner as the other controls. There is no trim tab on the Auxiliary control.

IDENTIFICATION KEY

All Transmitters on the 53 MHz band have an identification key (pushbutton switch) located on the cabinet top plate of the Transmitter. This switch should be used to identify your station at the beginning and end of each flight, and at ten minute intervals, to comply with FCC regulations. To use the key, place the transmitter power switch in the ON position and operate the pushbutton switch as a key.

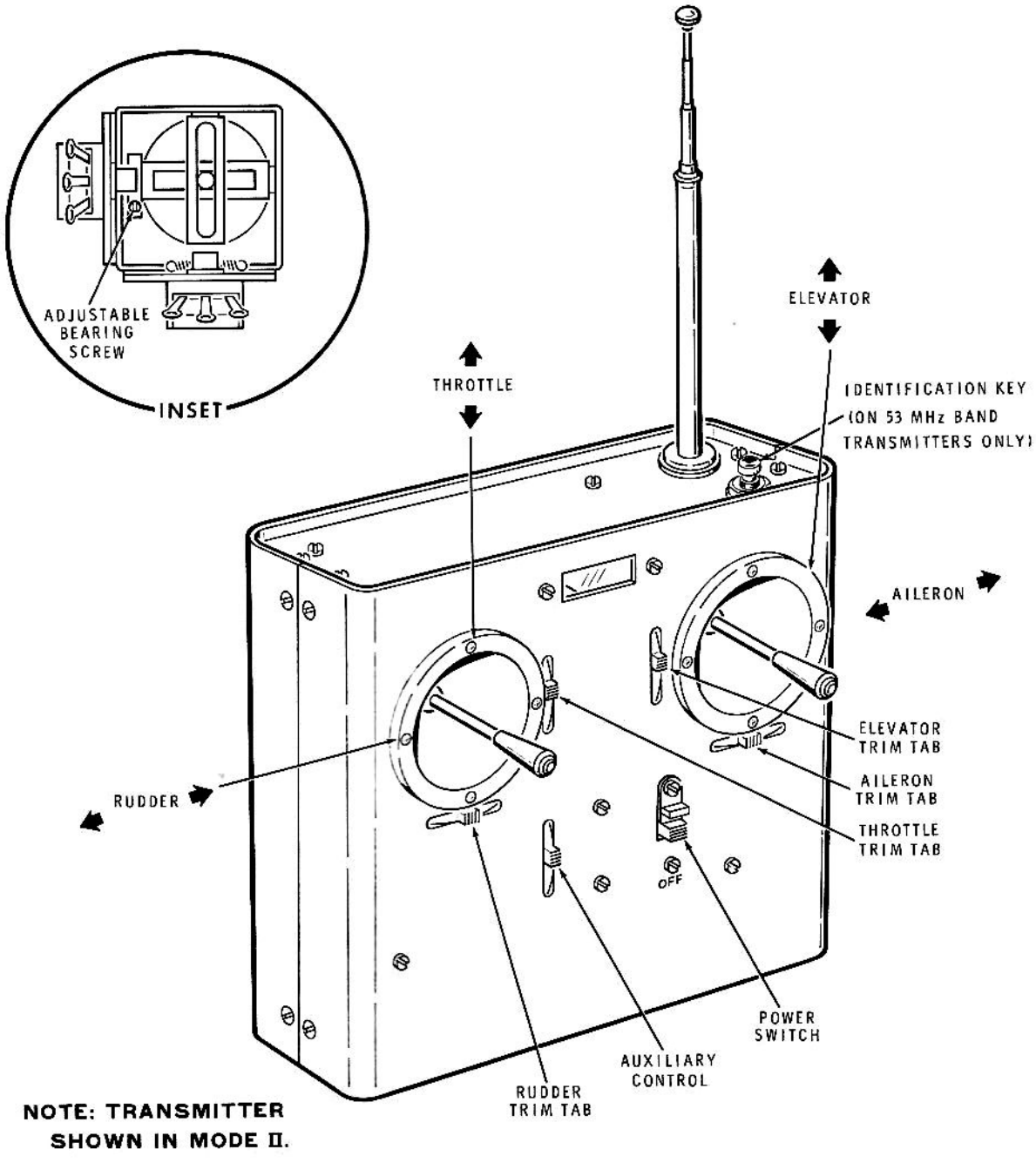

ADJUSTABLE BEARING SCREW
INSET
ELEVATOR
THROTTLE
IDENTIFICATION KEY
(ON 53 MHz BAND TRANSMITTERS ONLY)
AILERON
ELEVATOR TRIM TAB
AILERON TRIM TAB
THROTTLE TRIM TAB
RUDDER
OFF
POWER SWITCH
AUXILIARY CONTROL
RUDDER TRIM TAB
NOTE: TRANSMITTER SHOWN IN MODE II.

Figure 5-1

FLYING THE FIRST TIME

If you have never flown proportional equipment, it is suggested that you have an experienced flier assist you and "check you out" when making your first flights. If no one is available, it is suggested that you go through the operation of each control several times, to get the "feel", before you start the plane's engine or attempt to fly it. A few imaginary flights will also be helpful, along with extensive taxiing on the ground.

When you are ready to start the engine, use the Throttle control to govern the engine's speed. After the engine is warmed up and running properly, move the Throttle control slowly downward until the engine idles smoothly. Set the Throttle Trim Tab to provide proper engine idle with the Throttle stick fully downward. Hold the plane firmly on the ground while you advance the Throttle and speed up the engine. Then return the Throttle to idle. NOTE: The engine throttle stop can be adjusted to kill the engine when the Throttle Trim Tab is in its full down position. Do not stall the Servo when making these checks.

Practice taxiing the plane around a large flat area several times before you attempt to fly it. Be sure the plane taxis straight; this helps assure you of a successful takeoff. Get a real good "feel" for the controls and the plane's response. An extra hour or two of practice with the plane on the ground may save you many hours and dollars spent repairing the plane later.

Refer to the transmitter radiation pattern of Figure 5-2. Notice that a minimum of radiated signal will reach the aircraft if the transmitter

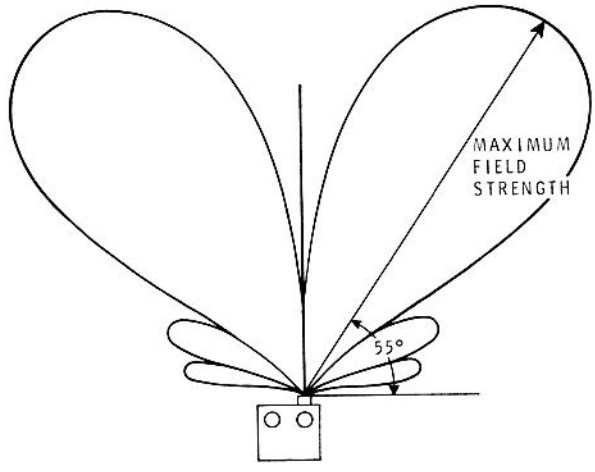


Figure 5-2

antenna is pointed directly at the aircraft. The maximum signal will be picked up by the aircraft if it is approximately 55 degrees up from an imaginary line across the top of the Transmitter. The signal appears in Figure 5-2 to radiate from the left and right side of the antenna, but it actually radiates all around (360 degrees) the antenna, with its maximum field strength as shown.

FLAGS

The operating frequency of any GDA-19-1 Transmitter corresponds to a particular color or colors. By making a flag of the color(s) that correspond(s) to your transmitter's operating frequency and tying the flag to the extended end of your antenna, other model operators in the area can quickly identify your transmitting frequency.

27 MHz Band		53 MHz Band		72 MHz Band	
Frequency MHz	Color	Frequency MHz	Color	Frequency MHz	Color
26.995	Brown	53.100	Black-brown	72.080	White-brown
27.045	Red	53.200	Black-red	72.240	White-red
27.095	Orange	53.300	Black-orange	72.400	White-orange
27.145	Yellow	53.400	Black-yellow	72.960	White-yellow
27.195	Green	53.500	Black-green	75.640	White-green

BATTERY RECHARGING

To assure maximum performance from your Transmitter, Receiver, and Servo system, be sure both the Transmitter and Receiver batteries are fully charged before you begin operating. The surest way of knowing that the batteries are charged is to recharge them before each use.

The Transmitter and Receiver batteries are charged simultaneously when they are connected as shown in the Battery Charging instructions on Page 36.

Connect the charging cable to a 120 volt AC line, the Transmitter, and the Receiver battery. Place the Transmitter Power switch in the OFF position. The indicator lamp will glow when the charging circuit is operating.

The batteries should be charged for at least 24 hours the first time and at least 14 hours per charge thereafter. It is not necessary to remove the batteries from the plane for recharging.

SELF-DISCHARGE

Self-discharging characteristics of nickel-cadmium cells during storage are shown in Figure 5-3. The characteristics are shown as a decline in percent of rated capacity from a full charge. Note that after the first thirty days the capacity has decreased to approximately 70% when stored at 68 degrees F. However, these batteries are not harmed even if not used for long periods of time.

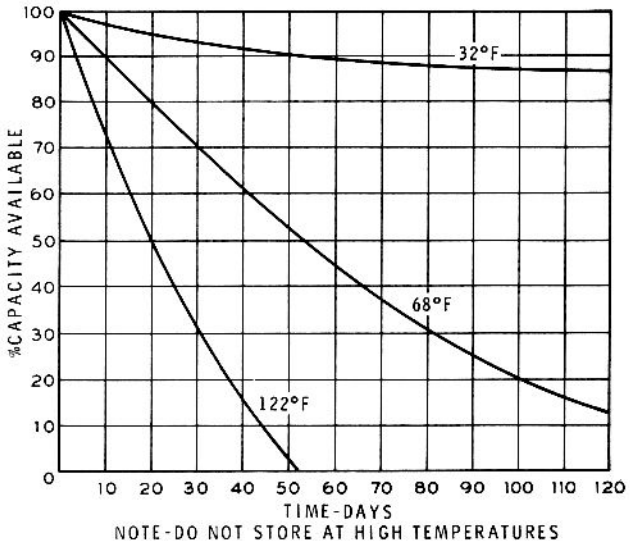


Figure 5-3

IN CASE OF DIFFICULTY

This part of the Manual is divided into two sections: Finding The Area Of Trouble, and General Tests. When necessary, refer to other parts of the Manual. For example, you may wish to refer to the Block Diagram, Identification Photos, Circuit Board X-Ray Views, and parts of the Step-By-Step Assembly section for help in locating parts and wires. Refer to the Table Of Contents on Page 2 to quickly locate a particular part of the Manual. If you have a knowledge of electronics, you will also find additional valuable information in the Circuit Description and Schematic Diagram. All voltages were taken with a high impedance voltmeter.

FINDING THE AREA OF TROUBLE

When trouble develops, the first indication usually is that one or more of the Servos do not respond to the movement of the Transmitter controls.

BATTERY

Before you suspect a faulty piece of equipment, you must first be sure that the batteries have a sufficient charge to provide proper operation. When the Transmitter is turned on and the meter indication is below 3, the transmitter battery is weak and should be recharged.

The batteries can also be checked with a voltmeter. To get an accurate check however, the batteries must be checked under load. That is, with the battery connected and the equipment turned on.

NOTE: The servo-controlling signal is produced by the Transmitter and picked up by the Receiver in the following channel sequence: channel #1, 2, 3, 4 and 5. If any one of the channels begins to operate erratically (in the Transmitter or Receiver) usually all the remaining channels in the sequence will also be affected. For example, if channel #3 fails to operate properly, it is quite likely that channels #4 and 5 will also be erratic in operation.

Therefore, when checking the Receiver and Transmitter for channel failure, you must correct any malfunction in the first channel affected in the sequence before the remaining channels can be expected to work properly. This can be an important observation when trying to locate trouble.

SERVO

If a Servo stops operating, first check the receiver battery. Then unplug the faulty Servo from the Receiver and plug another Servo known to be operating properly into the same connector. If this Servo also fails to operate, you can assume that the first Servo is all right and that the trouble is in the Receiver or Transmitter. In a condition where all of the Servos failed at the same time, you should suspect the Receiver Battery, the Receiver, or the Transmitter.

If the Servo was faulty, refer to the General Tests section of this Manual and the Servo difficulty chart in the Transmitter Servo section on Page 77.

If a Servo runs much slower than the others, check its gear train. Remove the gears and check for roughness on the surface of the gear pins. Each gear must slide freely over the gear pin.

RECEIVER

If a substitute Servo also failed to operate when plugged into the nonoperating channel of the Receiver, the Receiver or Transmitter should be suspected.

If all Receiver channels are faulty, it is more than likely that the trouble is in the receiver circuit board. Repeat the Receiver Test and Adjustments on Page 72.

If there are four or less channels at fault, the trouble is probably on the decoder circuit board of the Receiver. Refer to the Decoder Checkout on Page 74, and the General Tests.

TRANSMITTER

The quickest way to find the difficulty in the Transmitter is to go through the Transmitter Test And Adjustments on Page 67, and the General Tests section.

If the trouble is in the preassembled transmitter circuit board, remove the circuit board and return it to the Heath Company.

GENERAL TESTS

1. Recheck the wiring. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Soldering section of the Kit Builders Guide. However, be careful not to create any solder bridges.

3. Check the values of all the parts. Be sure that the proper part has been installed at each location on the circuit board. Pay special attention to resistor values, since there are many resistors of similar value that are easily interchanged. Example: 4700 Ω (yellow-violet-red) and 47 kΩ (yellow-violet-orange).

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

5. Check very carefully to be sure there are no solder bridges between different circuit board foils.

6. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings in the circuits of the unit that you are having trouble with against those shown on the Voltage Chart, X-Ray Views, and Schematic. All voltage readings were taken with a high impedance voltmeter. Voltages may vary as much as 20%.

7. A review of the Circuit Description and Schematic for each unit may also help you to locate any difficulties in the kit. NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is inside the front cover.

If the Servo was faulty, refer to the General Tests section of this Manual and the Servo difficulty chart in the Transmitter Servo section on Page 77.

If a Servo runs much slower than the others, check its gear train. Remove the gears and check for roughness on the surface of the gear pins. Each gear must slide freely over the gear pin.

RECEIVER

If a substitute Servo also failed to operate when plugged into the nonoperating channel of the Receiver, the Receiver or Transmitter should be suspected.

If all Receiver channels are faulty, it is more than likely that the trouble is in the receiver circuit board. Repeat the Receiver Test and Adjustments on Page 72.

If there are four or less channels at fault, the trouble is probably on the decoder circuit board of the Receiver. Refer to the Decoder Checkout on Page 74, and the General Tests.

TRANSMITTER

The quickest way to find the difficulty in the Transmitter is to go through the Transmitter Test And Adjustments on Page 67, and the General Tests section.

If the trouble is in the preassembled transmitter circuit board, remove the circuit board and return it to the Heath Company.

GENERAL TESTS

1. Recheck the wiring. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the builder.

2. About 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the Soldering section of the Kit Builders Guide. However, be careful not to create any solder bridges.

3. Check the values of all the parts. Be sure that the proper part has been installed at each location on the circuit board. Pay special attention to resistor values, since there are many resistors of similar value that are easily interchanged. Example: 4700 Ω (yellow-violet-red) and 47 kΩ (yellow-violet-orange).

4. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

5. Check very carefully to be sure there are no solder bridges between different circuit board foils.

6. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings in the circuits of the unit that you are having trouble with against those shown on the Voltage Chart, X-Ray Views, and Schematic. All voltage readings were taken with a high impedance voltmeter. Voltages may vary as much as 20%.

7. A review of the Circuit Description and Schematic for each unit may also help you to locate any difficulties in the kit. NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of the Manual. Your Warranty is inside the front cover.

SPECIFICATIONS

TRANSMITTER
Model GDA-19-1

RF Carrier Frequency. . . . . . One of the following, crystal-controlled:

27 MHz Band	53 MHz Band	72 MHz Band
26.995 MHz	53.100 MHz	72.080 MHz
27.045 MHz	53.200 MHz	72.240 MHz
27.095 MHz	53.300 MHz	72.400 MHz
27.145 MHz	53.400 MHz	72.960 MHz
27.195 MHz	53.500 MHz	75.640 MHz

Frequency Stability. . . . . . Within ±.005% on 27 MHz band.
Within ±.002% on 53 and 72 MHz bands.

Temperature. . . . . . 0 degrees to + 160 degrees F.

RF Output Circuit. . . . . . Pi network.

RF Input Power. . . . . . 500 mW.

Modulation. . . . . . ON-OFF carrier keying.

Approximate Current Drain. . . . . . 100 mA on all bands.

Controls . . . . . Five channels; four with trim.

ON-OFF switch.

Power Supply. . . . . . Internal 9.6 volt nickel-cadmium battery. Rechargeable simultaneously with receiver battery at 35 to 40 mA from 120 volt power line.

Dimensions. . . . . . 6-3/8" high x 6-3/4" wide x 2-7/16" deep.

Net Weight, with battery. . . . . . 2-3/4 lbs.

RECEIVER
Model GDA-19-2

RF Carrier Frequency.	One of the following, crystal-controlled:

27 MHz Bands	53 MHz Bands	72 Mhz Bands
26.995 MHz	53.100 MHz	72.080 MHz
27.045 MHz	53.200 MHz	72.240 MHz
27.095 MHz	53.300 MHz	72.400 MHz
27.145 MHz	53.400 MHz	72.960 MHz
27.195 MHz	53.500 MHz	75.640 MHz

Frequency Stability.	.003% on 27 MHz band. .002% on 53 and 72 MHz bands.
Temperature Range.	0 degrees to +160 degrees F.
Sensitivity.	5 μV.
Selectivity.	6 dB down at ±4.0 kHz. 30 dB down at ±9.0 kHz.
Approximate Current Drain.	6 mA.
Intermediate Frequency.	453 kHz.
Power Supply.	Heath GDA-19-3 Battery Pack.
Controls.	ON-OFF switch.
Dimensions.	25/32" high x 2" wide x 2-7/32" deep.
Net Receiver Weight.	2.3 oz.

RECEIVER BATTERY
Model GDA-19-3

Type.	Nickel-cadmium. Rechargeable simultaneous with the transmitter batteries at 35 to 40 mA from the 120 volt power line.
Voltage.	+2.4 V and +4.8 V outputs.
Current Rating.	500 mA hours.
Dimensions.	5/8" high x 2-1/8" wide x 2-3/8" deep.
Net Weight.	3.9 oz.

SERVO
Model GDA-19-4

Input Signal.	Pulse: 1 to 2 milliseconds wide; 4 volts peak-to-peak.
Thrust.	3.25 lbs. minimum.
Transit Time for 5/8" Travel.	0.7 seconds.
Linear Output Travel.	5/8" end-to-end.
Rotary Output Travel.	Over 100 degrees rotation (end-to-end).
Temperature Range.	0 degrees to +160 degrees F.
Power (Battery) Requirements.	Idling Current: 2 mA. Stall Current: 350 mA. No Load Running Current: 80 mA typical.
Total Gear Train Backlash.	Less than .002".
Mechanical Output.	1 - rotary arm. 1 - rotary wheel. 2 - linear arms.
Position Accuracy.	±0.5%.
Dimensions.	1-3/4" high x 15/16" wide x 3-1/16" long. (Length includes mounting ears. Height includes linear arms.)
Net Weight.	2.5 oz.

GENERAL

Complete Airborne System Weight.	16.6 oz. (1 Receiver, 1 Receiver Battery, 1 Switch, and 4 Servos).
Total Flying Time.	Four hours minimum (with batteries fully charged).

RECEIVER
Model GDA-19-2

RF Carrier Frequency.	One of the following, crystal-controlled:

27 MHz Bands	53 MHz Bands	72 Mhz Bands
26.995 MHz	53.100 MHz	72.080 MHz
27.045 MHz	53.200 MHz	72.240 MHz
27.095 MHz	53.300 MHz	72.400 MHz
27.145 MHz	53.400 MHz	72.960 MHz
27.195 MHz	53.500 MHz	75.640 MHz

Frequency Stability.	.003% on 27 MHz band. .002% on 53 and 72 MHz bands.
Temperature Range.	0 degrees to +160 degrees F.
Sensitivity.	5 μV.
Selectivity.	6 dB down at ±4.0 kHz. 30 dB down at ±9.0 kHz.
Approximate Current Drain.	6 mA.
Intermediate Frequency.	453 kHz.
Power Supply.	Heath GDA-19-3 Battery Pack.
Controls.	ON-OFF switch.
Dimensions.	25/32" high x 2" wide x 2-7/32" deep.
Net Receiver Weight.	2.3 oz.

RECEIVER BATTERY
Model GDA-19-3

Type.	Nickel-cadmium. Rechargeable simultaneous with the transmitter batteries at 35 to 40 mA from the 120 volt power line.
Voltage.	+2.4 V and +4.8 V outputs.
Current Rating.	500 mA hours.
Dimensions.	5/8" high x 2-1/8" wide x 2-3/8" deep.
Net Weight.	3.9 oz.

SERVO
Model GDA-19-4

Input Signal.	Pulse: 1 to 2 milliseconds wide; 4 volts peak-to-peak.
Thrust.	3.25 lbs. minimum.
Transit Time for 5/8" Travel.	0.7 seconds.
Linear Output Travel.	5/8" end-to-end.
Rotary Output Travel.	Over 100 degrees rotation (end-to-end).
Temperature Range.	0 degrees to +160 degrees F.
Power (Battery) Requirements.	Idling Current: 2 mA. Stall Current: 350 mA. No Load Running Current: 80 mA typical.
Total Gear Train Backlash.	Less than .002".
Mechanical Output.	1 - rotary arm. 1 - rotary wheel. 2 - linear arms.
Position Accuracy.	±0.5%.
Dimensions.	1-3/4" high x 15/16" wide x 3-1/16" long. (Length includes mounting ears. Height includes linear arms.)
Net Weight.	2.5 oz.

GENERAL

Complete Airborne System Weight.	16.6 oz. (1 Receiver, 1 Receiver Battery, 1 Switch, and 4 Servos).
Total Flying Time.	Four hours minimum (with batteries fully charged).

THEORY OF OPERATION

The Heathkit Model GDA-19-1 Digital Transmitter produces a pulse modulated, crystal-controlled, RF carrier. The unique method of modulation permits remote control of five separate devices when the Transmitter is used with a Digital Receiver and Servo Units. An understanding of the modulation principles used in this Transmitter will help you to understand the Operation and Circuit Description. You may find it helpful to refer to the Block Diagram in Figure 6-2 as you read the following paragraphs.

Waveform A in Figure 6-1 shows a frame of six pulses that is repeated every 16,000 microseconds in a continuous train. Each pulse in the frame is 350 microseconds wide, and all pulses in a frame except the first one normally start 1500 microseconds after the start of the previous pulse.

The time interval between the first pulse in one frame and the first pulse in the next frame is always 16,000 microseconds and cannot be changed. This is called "fixed frame rate". The time interval between any two successive pulses within a frame can be increased or decreased as much as 500 microseconds. It is this variable width between individual pulses that is used to position the servo motors. One of these variable width segments is used to control each servo.

The long space between the last pulse in a frame and the first pulse in the next frame is called the sync pause. This locks the receiver's decoder circuit in synchronization with the transmitted signal. When one of the control

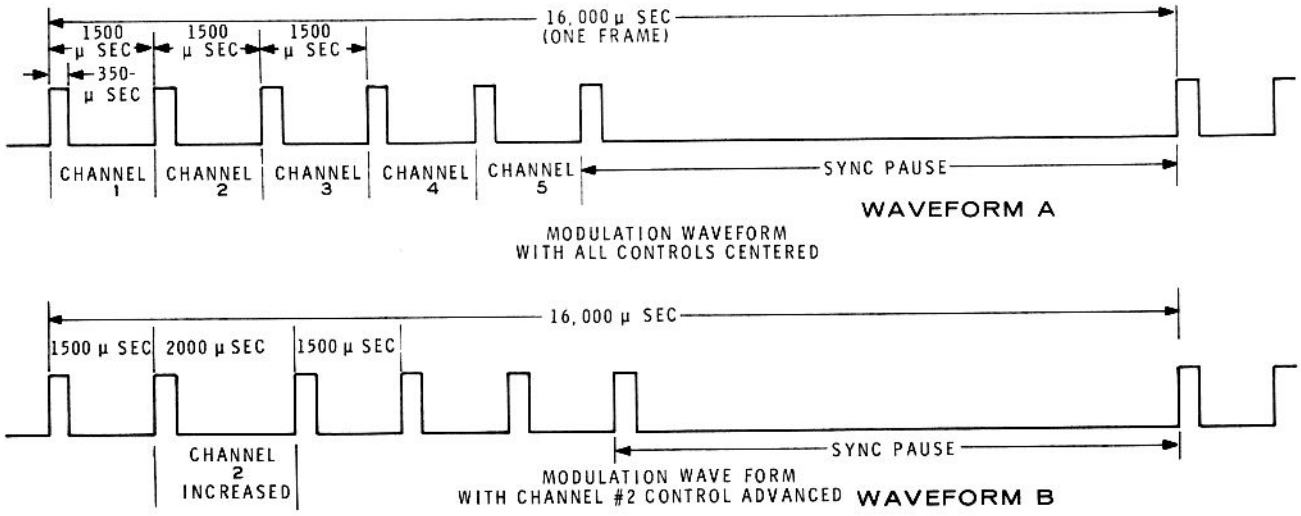


Figure 6-1

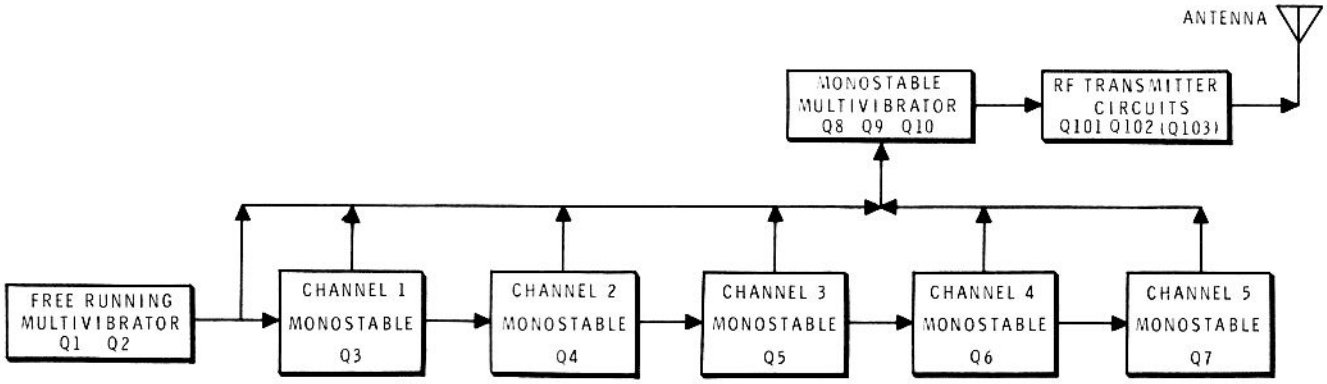


Figure 6-2

sticks is moved, that channel's time interval is changed. Waveform B of Figure 6-1 shows the relative position of the pulses when the Channel #2 control stick is moved to increase its time interval. The other channels are not affected, although the sync pause time is shortened by the amount of channel 2 increase.

The frame waveform modulates the RF carrier as shown in Figure 6-3. That is, the carrier is turned off during the 350 microsecond pulses, but is on at all other times. This form of modulation reduces the possibility of the Receiver circuits being triggered by interference, which would cause the servo units to operate erratically.

The Receiver circuits receive, amplify, and detect this RF carrier to reproduce the pulse modulation waveform. The pulses are then shaped for proper triggering of the decoder circuits that control the servo units. The decoder circuits are reset in synchronism with the transmitter signal by the long sync pause. The first pulse then starts a new pulse frame and begins passing a pulse to the channel #1 servo unit.

The time interval between the start of the first and the start of the second trigger pulse determines the length of the pulse that is sent to the channel #1 servo unit for positioning.

The decoder passes the second pulse to the channel #2 servo unit, and the next pulse to the channel #3 servo unit, etc. Therefore, each servo unit receives one pulse from each frame, or one pulse every 16,000 microseconds, and the length of the pulse determines the position of the Servo.

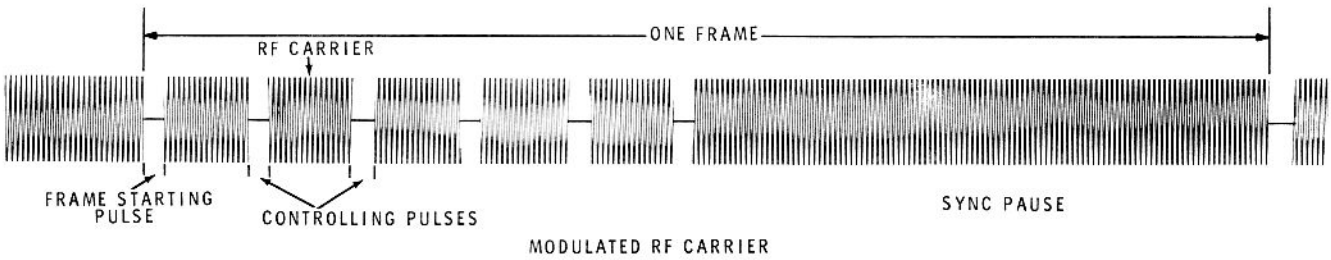


Figure 6-3

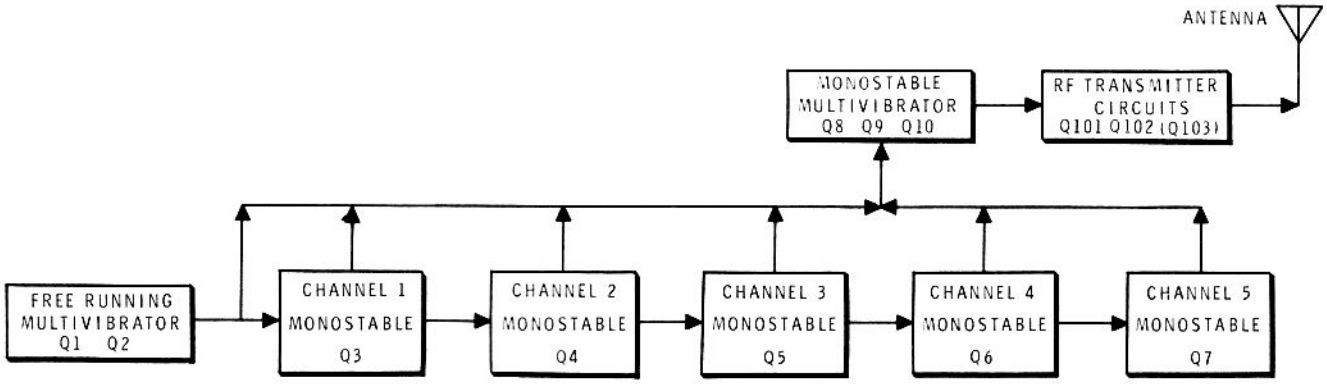


Figure 6-2

sticks is moved, that channel's time interval is changed. Waveform B of Figure 6-1 shows the relative position of the pulses when the Channel #2 control stick is moved to increase its time interval. The other channels are not affected, although the sync pause time is shortened by the amount of channel 2 increase.

The frame waveform modulates the RF carrier as shown in Figure 6-3. That is, the carrier is turned off during the 350 microsecond pulses, but is on at all other times. This form of modulation reduces the possibility of the Receiver circuits being triggered by interference, which would cause the servo units to operate erratically.

The Receiver circuits receive, amplify, and detect this RF carrier to reproduce the pulse modulation waveform. The pulses are then shaped for proper triggering of the decoder circuits that control the servo units. The decoder circuits are reset in synchronism with the transmitter signal by the long sync pause. The first pulse then starts a new pulse frame and begins passing a pulse to the channel #1 servo unit.

The time interval between the start of the first and the start of the second trigger pulse determines the length of the pulse that is sent to the channel #1 servo unit for positioning.

The decoder passes the second pulse to the channel #2 servo unit, and the next pulse to the channel #3 servo unit, etc. Therefore, each servo unit receives one pulse from each frame, or one pulse every 16,000 microseconds, and the length of the pulse determines the position of the Servo.

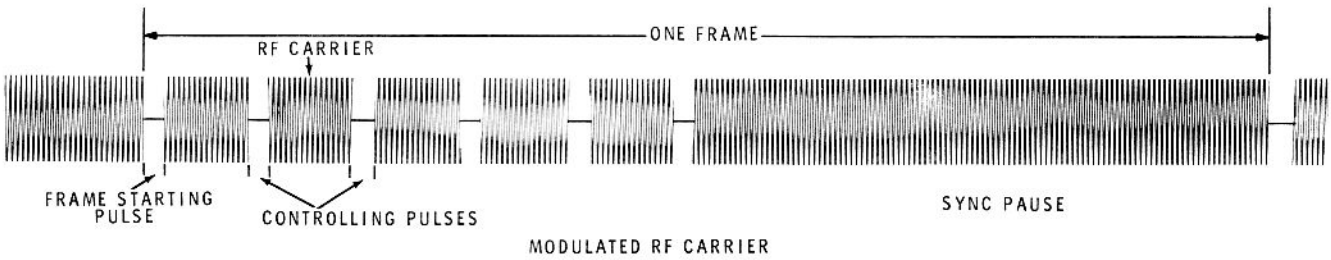
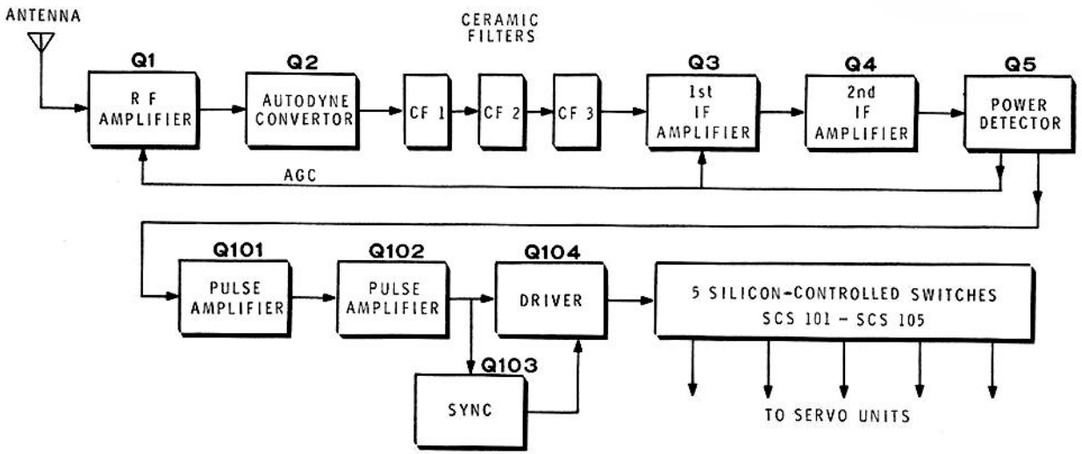
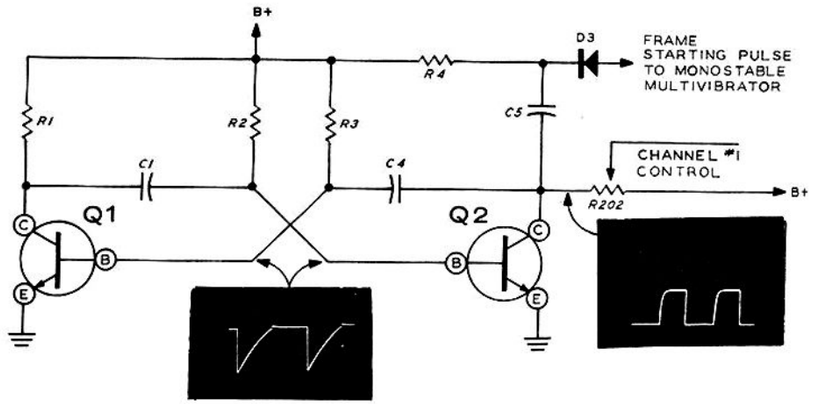


Figure 6-3

RECEIVER BLOCK DIAGRAM





FREE-RUNNING MULTIVIBRATOR

Figure 6-4

CIRCUIT DESCRIPTION

TRANSMITTER

A number series has been assigned to each of the two circuit boards and to the cabinet in the Transmitter. These number series are used on the Schematic Diagram and in this Circuit Description to help you identify and locate circuits and parts. The part numbers are grouped as follows:

1- 99 Parts mounted on the encoder circuit board.
101-199 Parts mounted on the RF transmitter circuit board.
201-299 Parts mounted on the cabinet.

Pulses that are used to modulate the RF carrier of the Transmitter originate in the circuits of the encoder circuit board. These circuits include a free-running multivibrator, five monostable timers, and a monostable multivibrator. The RF circuit board contains a crystal-controlled oscillator and an RF output on the 27 and 53 MHz bands. The 72 MHz RF circuit board contains a crystal-controlled oscillator, doubler, and RF output stage. Each circuit of the Transmitter will be described separately in the following paragraphs.

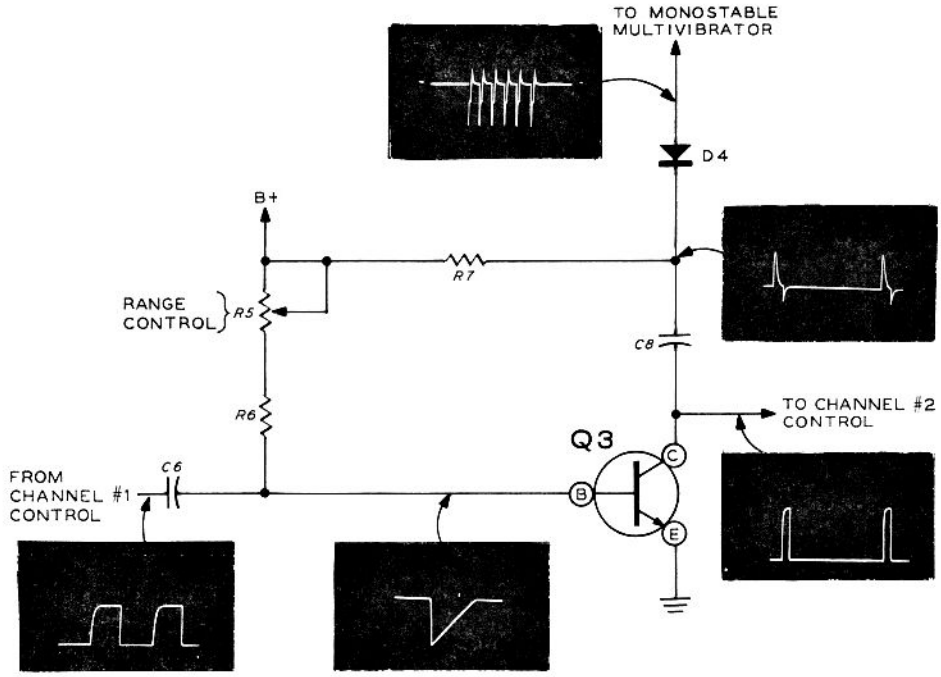
Refer to the Block Diagram on Page 103 and to the Schematic Diagram (fold-out from Page 109), while you read this Circuit Description. Several partial schematics are included with the text to help describe individual circuits.

FREE-RUNNING MULTIVIBRATOR

Transistors Q1 and Q2 are connected in a circuit that operates as a free-running multivibrator. See Figure 6-4. Alternately, one of these transistors conducts while the other is cut off.

Assume that transistor Q1 conducts first when power is applied to the circuit. The voltage at the collector of Q1 is reduced, causing capacitor C1 to start charging through resistor R2 from the power supply. During the charging of C1, the voltage to the base of Q2 increases sufficiently to cause Q2 to conduct, reducing its collector voltage to near zero. This applies a negative voltage through C4 to the base of Q1 and stops Q1 from conducting. Now C4 begins to charge through R3. During the charging of C4, the voltage to the base of Q1 rises in a positive direction and Q1 again conducts.

The time required to charge C1 through R2, and C4 through R3, determines the period of the multivibrator. The values of these resistors and capacitors are chosen to turn each transistor on and off every 16,000 microseconds. This multivibrator period of 16,000 microseconds produces the starting pulse for each frame, and this frame starting pulse is coupled through capacitor C5 and diode D3 to transistor Q8 of the monostable multivibrator circuit. The pulse also passes through Channel #1 Stick Control R202 to a series of monostable timers which produces the other five pulses for channel information and will be described next.



MONOSTABLE TIMER

Figure 6-5

MONOSTABLE TIMERS

Transistors Q3 through Q7 are connected in five identical monostable timer circuits. Each frame-starting pulse from the free-running multivibrator begins a chain reaction through the monostable timers. Since these circuits are identical, only the operation of Q3 will be described. See Figure 6-5.

Transistor Q3 is biased through Channel #1 Range control R5 and resistor R6 so that it is normally conducting and its collector voltage is near zero. The negative frame-starting pulse from transistor Q2 is coupled from the arm of stick control R202, through capacitor C6, to the base of Q3. This pulse drives the base of Q3 negative by an amount that depends on the setting of R202, cutting off the transistor.

As soon as the negative frame-starting pulse is fed to the base of Q3, the voltage at this base begins to rise again due to the positive voltage through R5 and R6. When the base reaches +.6 volts, Q3 again conducts. The time required for the base to reach +.6 volts is affected by the time constant of R5, R6, and C6, as well as by the amplitude of the pulse that is passed through control R202. Thus, control R202 provides manual control of the pulse amplitude, which controls the length of time that transistor Q3 is cut off.

Control R5 adjusts the effective range of control R202 by altering the charging time of capacitor C6. (NOTE: The charge curve of C6 is the trailing edge of the pulse at the base of Q3.) As C6 charges up to +.6 volts more slowly, for example, due to a larger resistance value of R5, a wider range of pulse widths is available from the collector of Q3. When the resistance of R5 is decreased, a smaller range of pulse widths is available from Q3.

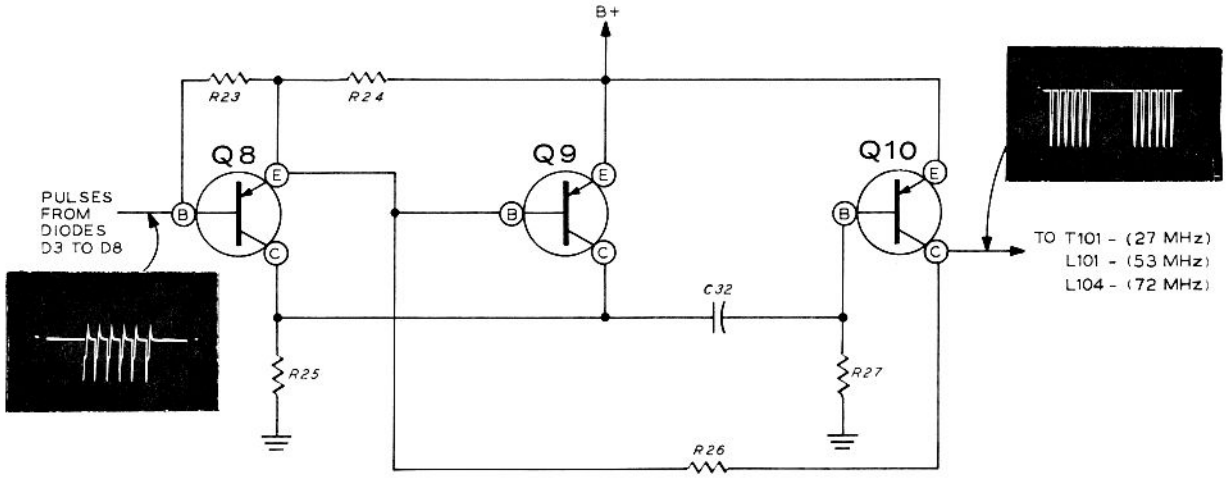


Figure 6-6

When transistor Q3 again conducts, a negative-going pulse appears at its collector. This pulse is passed through Channel #2 Control R203 to the next monostable timer circuit, which operates in the same manner as the circuit of Q3. Note that only the negative-going portion of the pulse will trigger this stage.

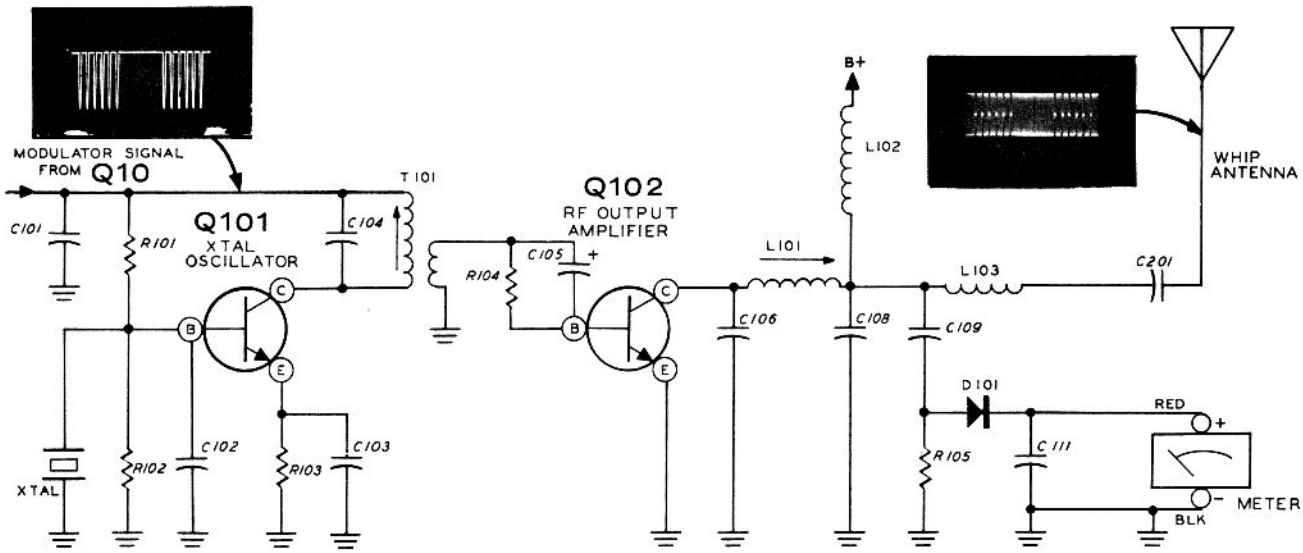
The channel #1 controlling pulse from Q3 is coupled through C8 and D4 to the monostable multivibrator circuit Q8, Q9, and Q10. Diodes D5, D6, D7, and D8 couple the other controlling pulses to the monostable multivibrator.

MONOSTABLE MULTIVIBRATOR

Transistors Q8, Q9, and Q10 are connected to operate as a monostable, 350 microsecond multivibrator (see Figure 6-6). Its purpose is to cause each frame-starting pulse and controlling pulse to modulate the transmitter's RF carrier for only 350 microseconds during each pulse.

Diodes D3 through D8 allow only the negative-going portion of the pulse from the monostable timers and the multivibrator to be applied to the base of transistor Q8. Since the emitter of Q8 is direct coupled to the base of Q9, this negative-going pulse causes Q8 and Q9 to conduct and produce a positive pulse at the collector of Q9. This positive pulse is coupled through capacitor C32 to the base of Q10, causing Q10 to cut off. The time constant of C32 and R27 holds transistor Q10 cut off for a period of 350 microseconds after each pulse is applied to its base. Resistor R26 provides positive DC feedback from the collector of Q10 to the base of Q9. This feedback insures that Q9 continues to conduct during the 350 microsecond cutoff period of the monostable multivibrator.

From the collector of transistor Q10, power is supplied to the crystal oscillator circuit on the 27 and 53 MHz bands, and to the doubler circuit on the 72 MHz band. Since Q10 normally conducts, and is cut off during the presence of pulses, this transistor turns the crystal oscillator (on 27 and 53 MHz) or frequency doubler (on 72 MHz) off and on like a switch and thereby modulates the RF signal.



OSCILLATOR AND RF OUTPUT AMPLIFIER CIRCUITS 27 MHz BAND

Figure 6-7

27 MHz BAND RF TRANSMITTER CIRCUITS

The crystal-controlled oscillator and RF output amplifier circuits are contained on the small RF Transmitter circuit board. These circuits generate and amplify the radio frequency carrier signal that is modulated by the controlling pulses from the multivibrator. See Figure 6-7.

Crystal oscillator transistor Q101 operates as a grounded-base Colpitts oscillator. The primary winding of transformer T101, which is in parallel with capacitor C104, tunes the circuit to the frequency of the crystal.

During the intervals between pulses from the monostable multivibrator circuit, while transistor Q10 conducts, power is applied through the primary winding of T101 to the collector of Q101, causing the oscillator to operate. Since the oscillator stops when the power is cut off during a pulse, the oscillator's output signal is negative-modulated by the pulse signals.

The secondary winding of transformer T101 couples the modulated oscillator signal to the base of final RF amplifier transistor Q102 through capacitor C105. Q102 conducts on the positive peaks of the RF carrier which charges C105 to the polarity shown. R104 provides a return path for the negative voltage on the base of Q102 and provides proper bias. This bias is determined by the time constant of R104 and C105.

Transistor Q102 operates as a tuned collector amplifier. The pi network of C106, C108, and L101 tunes the amplifier output to the crystal frequency and provides a proper impedance match between Q102 and the antenna. Coil L103 is the antenna loading coil, and capacitor C201 prevents the DC supply voltage from reaching the antenna. B+ voltage is supplied through choke L102.

A portion of the RF signal is taken from the pi network through C109 and rectified by diode D101 to operate the meter, which indicates relative carrier strength. Resistor R105 provides a DC return path for the diode while capacitor C111 filters the diode's rectified output.

The pulse-modulated RF signal is radiated from the collapsible whip antenna to be received and detected by the Receiver.

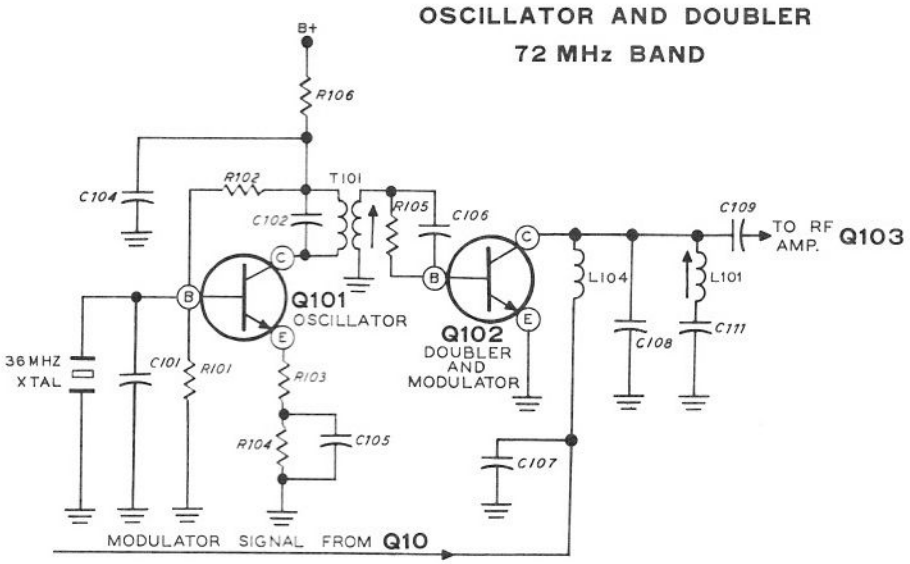


Figure 6-8

53 MHz BAND RF TRANSMITTER CIRCUITS

The 53 MHz band RF transmitter circuits are similar in operation to the 27 MHz band circuits. The circuits differ the most by the addition of the tuned circuit, C105 and L102, which is tuned to the oscillator frequency and used to drive RF amplifier Q102. The tap on L102 is for impedance matching. See the Schematic Diagram (fold-out from this Page.)

72 MHz BAND RF TRANSMITTER CIRCUITS

The 72 MHz band oscillator operates just like the oscillators for the other bands, except that it oscillates at a frequency that is one-half of the final transmitted frequency. The secondary winding of transformer T101 couples the oscillator signal through C106 to the base of Q102. Q102 conducts on the positive peaks of the oscillator signals. See Figure 6-8.

The output of Q102 (C108, C111, and L101) is tuned to the second harmonic of the oscillator frequency. This appears as a low impedance to ground for the fundamental oscillator frequency and, at the same time, resonates at a high impedance for the second harmonic.

Coil L104 couples DC to the collector of Q102 from multivibrator Q10 and, at the same time, isolates Q10 from the RF at Q102. The DC from Q10 causes Q102 to operate normally until a negative pulse arrives at the collector of Q102. Then Q102 cuts off for the duration of the pulse, modulating the RF.

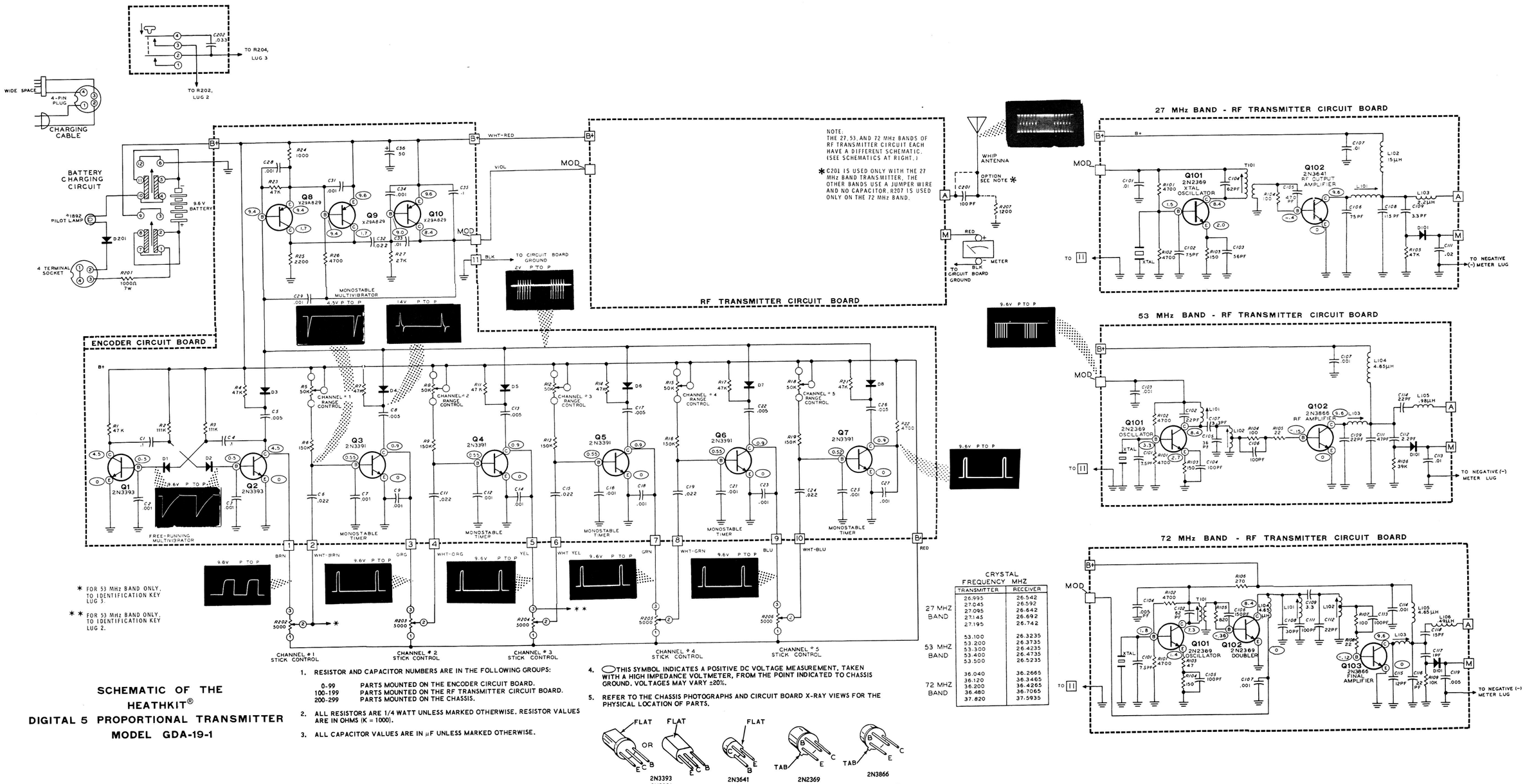
The doubled and modulated signal is then coupled from Q102 to RF amplifier Q103, amplified, and coupled to the antenna in the same manner as the signals of the other two bands.

POWER SUPPLY

Power for the Transmitter circuits is supplied by a self-contained, rechargeable 9.6 volt nickel-cadmium battery. When the Power switch is in the Off position, the Battery is connected to a charging circuit which operates in the following manner.

The Receiver's battery is connected, by means of the charging cable, in series with D201 and the pilot lamp, through the ON-OFF switch, to the negative (-) lead of the Transmitter Battery. R201 connects to the positive (+) lead of the Transmitter Battery through the ON-OFF switch. When the charging cable is connected between the 4-pin connector and a 120 volt AC outlet, the series circuit charges both the Receiver Battery and the Transmitter Battery at the same time.

Diode D201 rectifies the AC line voltage and resistor R201 limits the charging current to a safe value. The pilot lamp indicates when the batteries are being charged. Since the Off position of the power switch removes all connections between the Battery and the Transmitter circuits, the danger of shock from the charging circuit is eliminated.



SCHEMATIC OF THE HEATHKIT® DIGITAL 5 PROPORTIONAL TRANSMITTER MODEL GDA-19-1

CRYSTAL FREQUENCY MHZ

	TRANSMITTER	RECEIVER
27 MHZ BAND	26.995	26.542
	27.045	26.592
	27.095	26.642
	27.145	26.692
	27.195	26.742
53 MHZ BAND	53.100	26.3235
	53.200	26.3735
	53.300	26.4235
	53.400	26.4735
	53.500	26.5235
72 MHZ BAND	36.040	36.2665
	36.120	36.3465
	36.200	36.4265
	36.480	36.7065
	37.820	37.5935

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS:

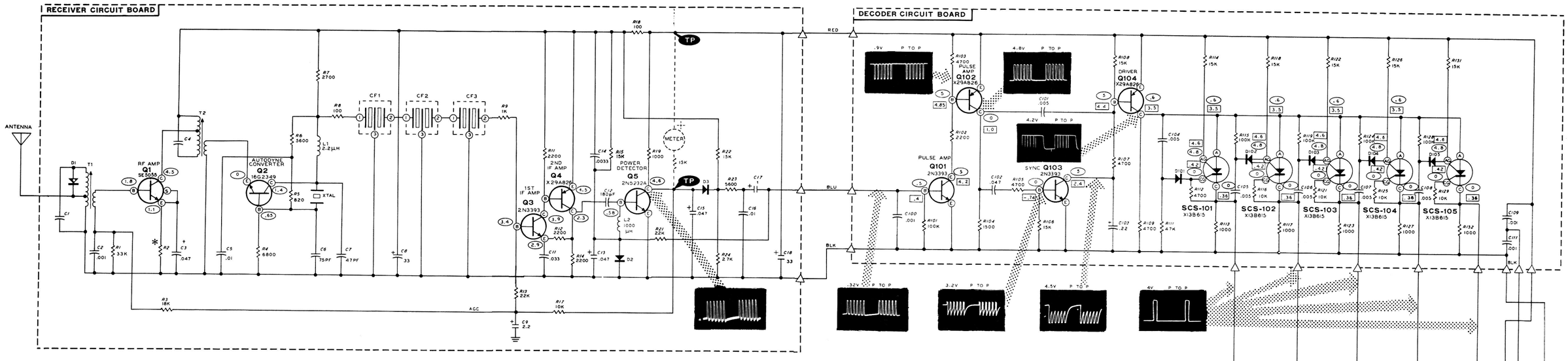
0-99	PARTS MOUNTED ON THE ENCODER CIRCUIT BOARD.
100-199	PARTS MOUNTED ON THE RF TRANSMITTER CIRCUIT BOARD.
200-299	PARTS MOUNTED ON THE CHASSIS.

2. ALL RESISTORS ARE 1/4 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K = 1000).

3. ALL CAPACITOR VALUES ARE IN μF UNLESS MARKED OTHERWISE.

4. ⊖ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT, TAKEN WITH A HIGH IMPEDANCE VOLTMETER, FROM THE POINT INDICATED TO CHASSIS GROUND. VOLTAGES MAY VARY ±20%.

5. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.



	C1	C4
27 MHZ	47PF	47PF
53 - 72 MHZ	27PF	27PF

SCHEMATIC OF THE HEATHKIT© DIGITAL 5 PROPORTIONAL RECEIVER MODEL GDA-19-2

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS:

   0-99 PARTS MOUNTED ON THE RECEIVER CIRCUIT BOARD.
   100-199 PARTS MOUNTED ON THE DECODER CIRCUIT BOARD.

2. ALL RESISTORS ARE 1/4 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1,000).

3. ALL CAPACITOR VALUES ARE IN µF UNLESS MARKED OTHERWISE.

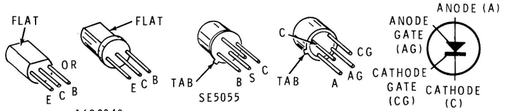
4. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT WITH NOTSIGNAL BEING RECEIVED.

5. ▭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT WITH SIGNAL BEING RECEIVED.

6. ALL VOLTAGES ARE MEASURED WITH A HIGH IMPEDANCE VOLTMETER. FROM THE POINT INDICATED TO COMMON GROUND. VOLTAGES MAY VARY ±20%.

7. REFER TO THE CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.

8. * 470Ω RESISTOR FOR 27 MHz OPERATION. 1000Ω RESISTOR FOR 53 MHz OR 72 MHz OPERATION.

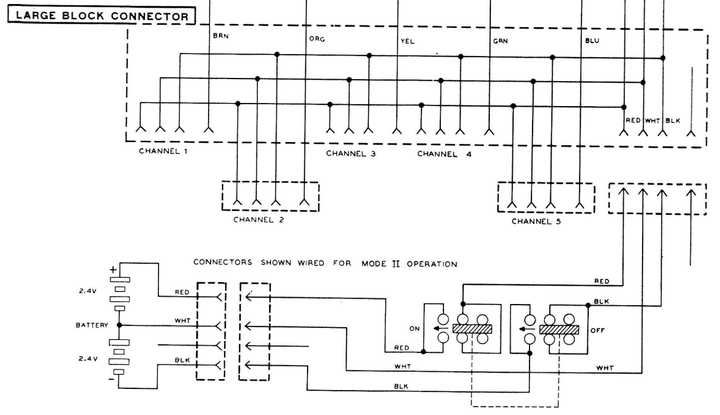


16G2349
2N3393
X29A826
2N5232A

X13B615

CRYSTAL FREQUENCY MHZ

	TRANSMITTER	RECEIVER
27 MHZ BAND	26.995	26.542
	27.045	26.592
	27.095	26.642
	27.145	26.692
	27.195	26.742
53 MHZ BAND	53.100	26.3235
	53.200	26.3735
	53.300	26.4235
	53.400	26.4735
	53.500	26.5235
72 MHZ BAND	36.040	36.2665
	36.120	36.3465
	36.200	36.4265
	36.480	36.7065
	37.820	37.5935



RECEIVER

GENERAL

A number series has been assigned to each of the two circuit boards used in this Receiver. This number series is used on the Schematic Diagram and in this Circuit Description to help you identify and locate circuits and parts. The part numbers are grouped as follows:

1- 99 Parts mounted on the receiver circuit board.
101-199 Parts mounted on the decoder circuit board.

The Receiver circuit board contains a conventional crystal-controlled superheterodyne receiver with a power detector and an integrator circuit. The decoder circuit board contains a pulse amplifier, sync and driver circuits, and five silicon-controlled switch circuits.

Refer to the Schematic Diagram (fold-out from this page) and to the Block Diagram (fold-out from Page 104) while you read this Circuit Description.

RECEIVER CIRCUIT BOARD

The transmitted RF signal is picked up by the antenna and fed to the tuned circuit of T1 and C1. T1 and C1 are tuned to the transmitted signal frequency, and their values are selected for each band of frequencies.

From the secondary of T1, the signal is coupled to the base of RF amplifier Q1. The amplified signal from Q1 is applied to the tuned circuit of C4 and T2, which are also tuned to the transmitted signal frequency. T2 is tapped to provide an impedance match to the collector of Q1. From the secondary of T2, the signal is coupled to the emitter of autodyne converter Q2.

Regenerative feedback through the receiver crystal causes the autodyne converter circuit to oscillate at a frequency that is 453 kHz from the incoming frequency. This will be at the crystal's fundamental frequency on the 27 MHz band, or at its second harmonic on the 53 and 72 MHz bands. The input signal and oscillator signal beat together in transistor Q2 to produce a 453 kHz difference signal that is passed through coil L1 and resistor R8 to the first ceramic (IF) filter, CF1. Capacitor C7 tunes with L1 near the crystal oscillator frequency.

The ceramic filters are made up of one ceramic disc in each filter. As the IF signal is applied to the disc, it vibrates at that frequency. The ceramic filters will vibrate at and pass only the frequency to which they are tuned; in this case the 453 kHz IF frequency.

The IF signal is coupled through CF1, CF2, CF3, and resistor R9 to the base of the first IF amplifier, Q3. The amplified IF signal from Q3 is further amplified by second IF transistor Q4 and coupled through capacitor C12 to the base of the power detector, Q5. Diode D2 is forward biased by resistor R15 so that about .5 volt is applied to the base of Q5 through L2, which will hold Q5 at cutoff. Since Q5 requires about .6 volt at its base to conduct, the additional .1 volt is supplied by the positive portion of the IF signal. Thus, transistor Q5 conducts only on the positive peaks of the IF signal.

When receiving an IF signal, Q5 is conducting. Then when a transmitted pulse is received, which temporarily stops the RF carrier, there is no IF signal to make Q5 conduct. Therefore, Q5 stops conducting and its collector voltage rises. This then produces a positive pulse from Q5 that is equivalent to the pulses in the Transmitter.

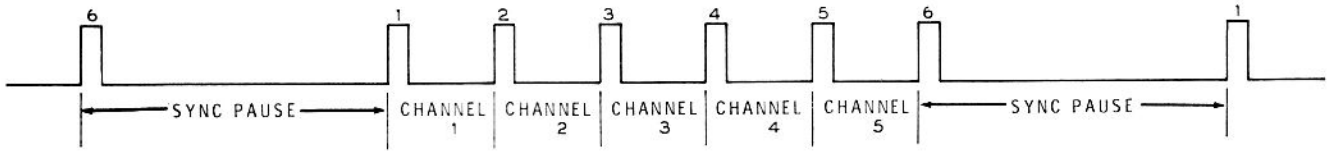


Figure 6-9

Capacitor C15 bypasses the IF frequency to ground and leaves a train of audio frequency pulses that are coupled through D3, R23, and C17 to the base of the pulse amplifier Q101 on the decoder circuit board. Diode D3 and resistors R22 and R24 eliminate noise pulses under strong signal conditions, and integrator network resistor R23 and capacitor C16 prevent noise from interfering under weak signal conditions.

An automatic gain control (AGC) circuit that consists of resistors R17, R13, R3, and R1 with capacitor C9, feeds back part of the Q5 collector voltage to the base circuits of transistors Q1 and Q3. The stronger the received signal, the more transistor Q5 conducts, lowering the voltage at its collector. This voltage is applied through R17, R13, and R3 to reduce the gain of Q1 and Q3. This AGC action prevents the IF amplifier and detector circuits from overloading and producing improper pulses when strong signals are received.

The output signal from the Receiver is a series of positive pulses that are spaced like the modulation pulses of the Transmitter. See the waveform in Figure 6-9. These signal pulses are coupled to the decoder circuit, which will be described next.

DECODER CIRCUIT BOARD

Pulse amplifier transistors Q101 and Q102 further increases the amplitude of the pulses from Q5 on the receiver circuit board. Q101 and Q102 are normally cut off until the pulses reach a high enough amplitude to turn them on, thus providing further noise immunity and producing clear sharp pulses at the collector of Q102.

The signal pulses from the collector of Q102 are coupled through C102 and R105 to the base of sync transistor Q103, and through C101 to the base of driver transistor Q104. Transistor Q104 is used to supply anode voltage to the five SCS's (silicon-controlled switches: SCS-101 through SCS-105). Q104 is normally cut off, removing the anode voltage from these five SCS's. Q103 is also normally cut off, but it conducts during each signal pulse from Q102. This controls the charge and discharge of capacitor C103 which, in turn controls Q104 during the sync pause time.

When Q103 is cut off during the sync pause time, capacitor C103 begins to charge through resistors R108 and R107, and the base emitter junction of Q104. The resulting voltage drop across R107 holds Q104 on until the charging current decreases and C103 becomes charged. Then Q104 returns to its normally cutoff condition.

Transistor Q103 conducts during each positive pulse it receives from Q102 and discharges capacitor C103 (see the waveform at the collector of Q103 on Figure 6-10). The six pulses of each train occur in such rapid succession that C103 cannot obtain a charge sufficient enough to turn Q104 off. However, during the sync pause time, Q103 is cut off long enough to permit C103 to charge up to the voltage which stops Q104 from conducting.

The first pulse following the sync pause turns on Q103, discharging capacitor C103 and allowing Q104 to conduct again. During the time that Q103 holds Q104 on, pulses are coupled from Q102 to the base of Q104 through C101. These positive pulses momentarily turn Q104 off, interrupting the anode voltage from the SCS's for a short instant. This is necessary for proper operation of the SCS's.

Each SCS acts like a transistor with an additional "latching" junction. With the correct biasing conditions, the SCS can be made to conduct from anode to cathode by applying a positive pulse to its cathode gate, or a negative pulse to its anode gate. The SCS continues to conduct until its anode voltage is interrupted. After the anode voltage is restored, another pulse is required at one of its gates before the SCS will turn on again. The SCS circuits operate in the following manner. See Figure 6-11.

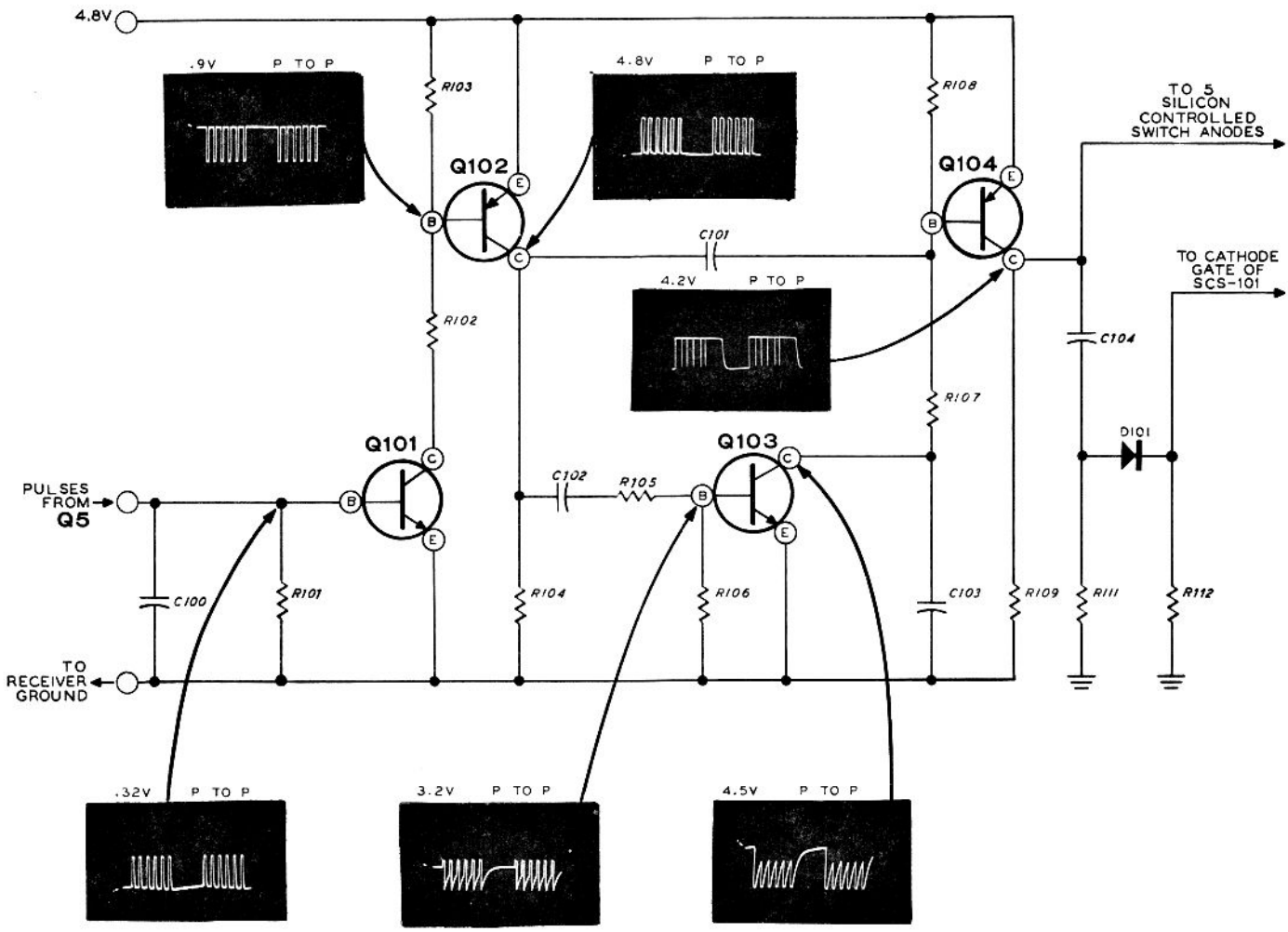


Figure 6-10

The sync pause time of the voltage waveform at the collector of Q104 stops all five SCS circuits from conducting. The positive-going portion of the first pulse, which is applied to all SCS anodes, prepares them to conduct. At the same time, this first positive pulse is applied through the differentiating network of C104 and R111, and through diode D101, to the cathode gate of SCS-101. This turns on SCS-101, passing current to the first (channel #1) Servo unit.

The second pulse momentarily cuts off the SCS anode voltage and turns off SCS-101. When SCS-101 turns off, its cathode presents a negative-going trailing edge which is coupled through C105 and D102 as a negative pulse to the anode gate of SCS-102, turning on this SCS. Now SCS-101 is turned off, removing current from the first Servo, while SCS-102 conducts and passes current to the second Servo.

Each SCS conducts only during the interval between two pulses. The first pulse in each train starts SCS-101 conducting and the second pulse stops it. As SCS-101 stops conducting, it starts SCS-102. The third pulse stops SCS-102, and SCS-102 in turn starts SCS-103, etc. Each SCS passes current to its own servo unit only during the interval that was initially determined by a control position at the Transmitter.

Each Servo unit translates the pulse-time interval into motor revolutions. The operation of the Servo unit is described next.

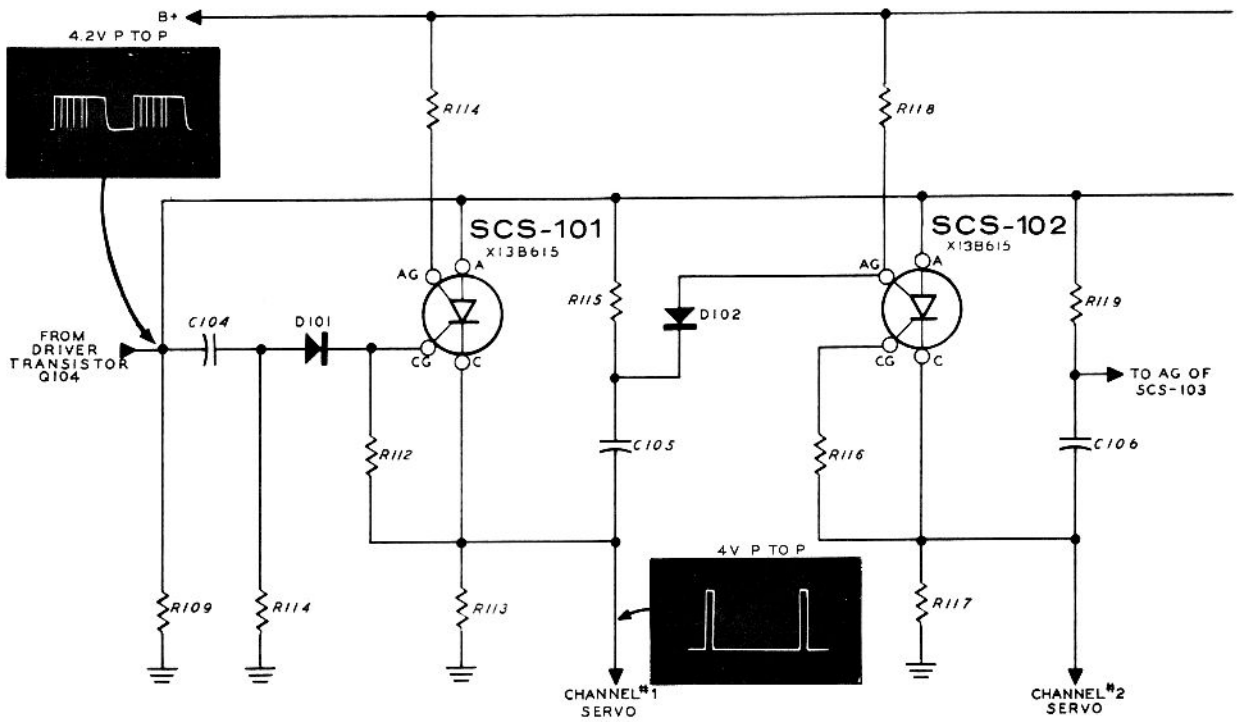
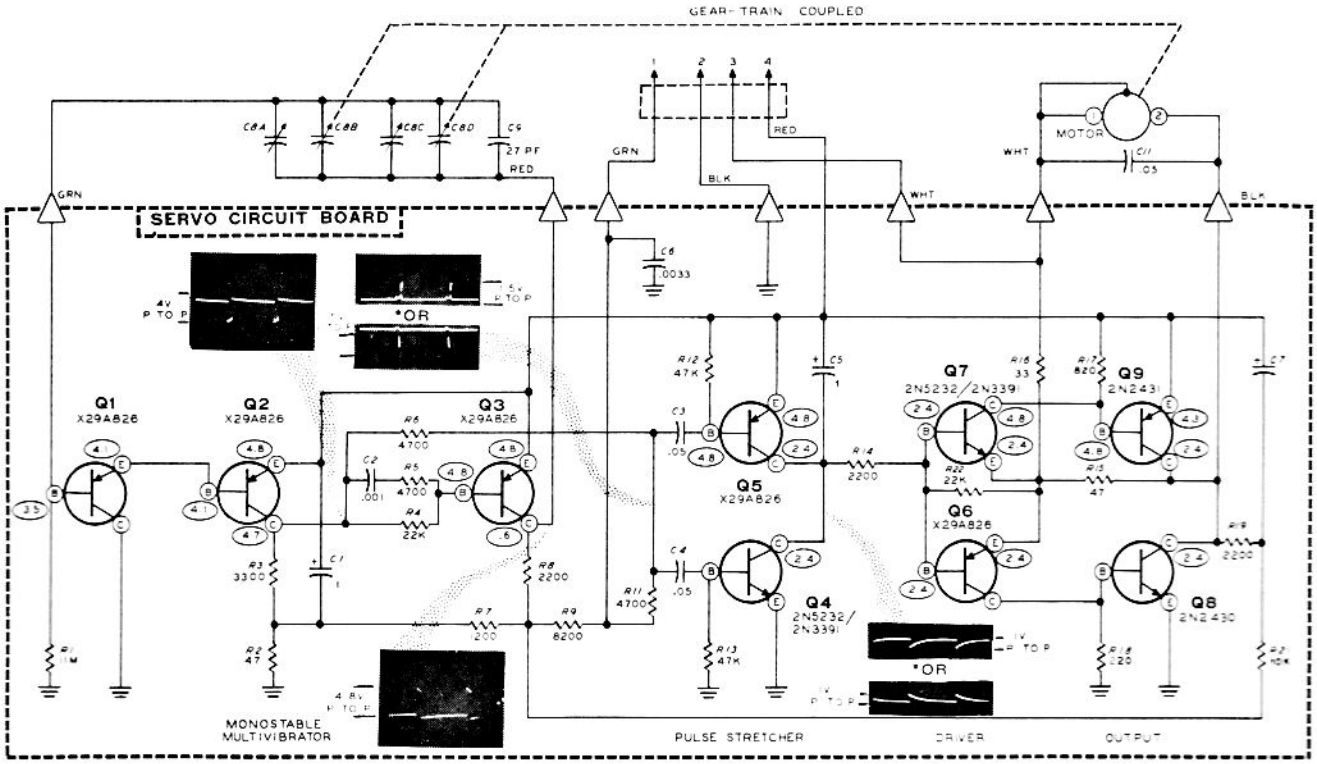
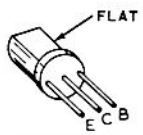


Figure 6-11

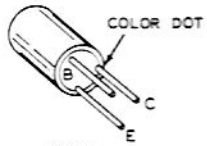


SCHEMATIC OF THE HEATHKIT® DIGITAL PROPORTIONAL SERVO MODEL GDA-19-4

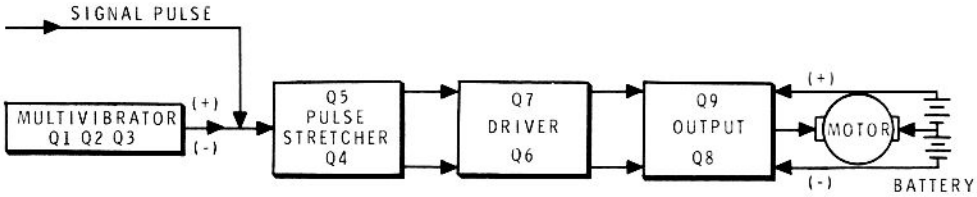
1. ALL RESISTORS ARE 1/4 WATT.
   RESISTOR VALUES ARE IN OHMS (K = 1,000, MEG = 1,000,000).
2. ALL CAPACITOR VALUES ARE IN μF UNLESS MARKED OTHERWISE.
3. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT WITH NO SIGNAL BEING RECEIVED.
4. ALL VOLTAGES ARE MEASURED WITH A HIGH IMPEDANCE VOLTMETER, FROM THE POINT INDICATED TO COMMON GROUND. VOLTAGES MAY VARY ±20%.
5. REFER TO THE SERVO PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEW FOR THE PHYSICAL LOCATION OF PARTS.
6. ✻ THESE WAVEFORMS SHOW THE DRIVE SIGNALS FOR BOTH DIRECTIONS.



2N5232/2N3391
X29A826



2N2430
2N2431



SERVO BLOCK DIAGRAM

SERVO

The Servo unit translates the pulses that come from the Receiver into positive or negative voltages, and these voltages operate a motor that moves a control surface of a model. The signal pulses and the battery voltages are coupled from the Receiver to the Servo through a multi-pin connector. The miniature circuit board in the Servo contains a monostable multivibrator circuit, a pulse stretcher circuit, a driver circuit, and an output circuit. Each of these circuits will be described separately in the following paragraphs. Refer to the Block Diagram and to the Schematic Diagram (fold-out from this Page) while you read this Circuit Description.

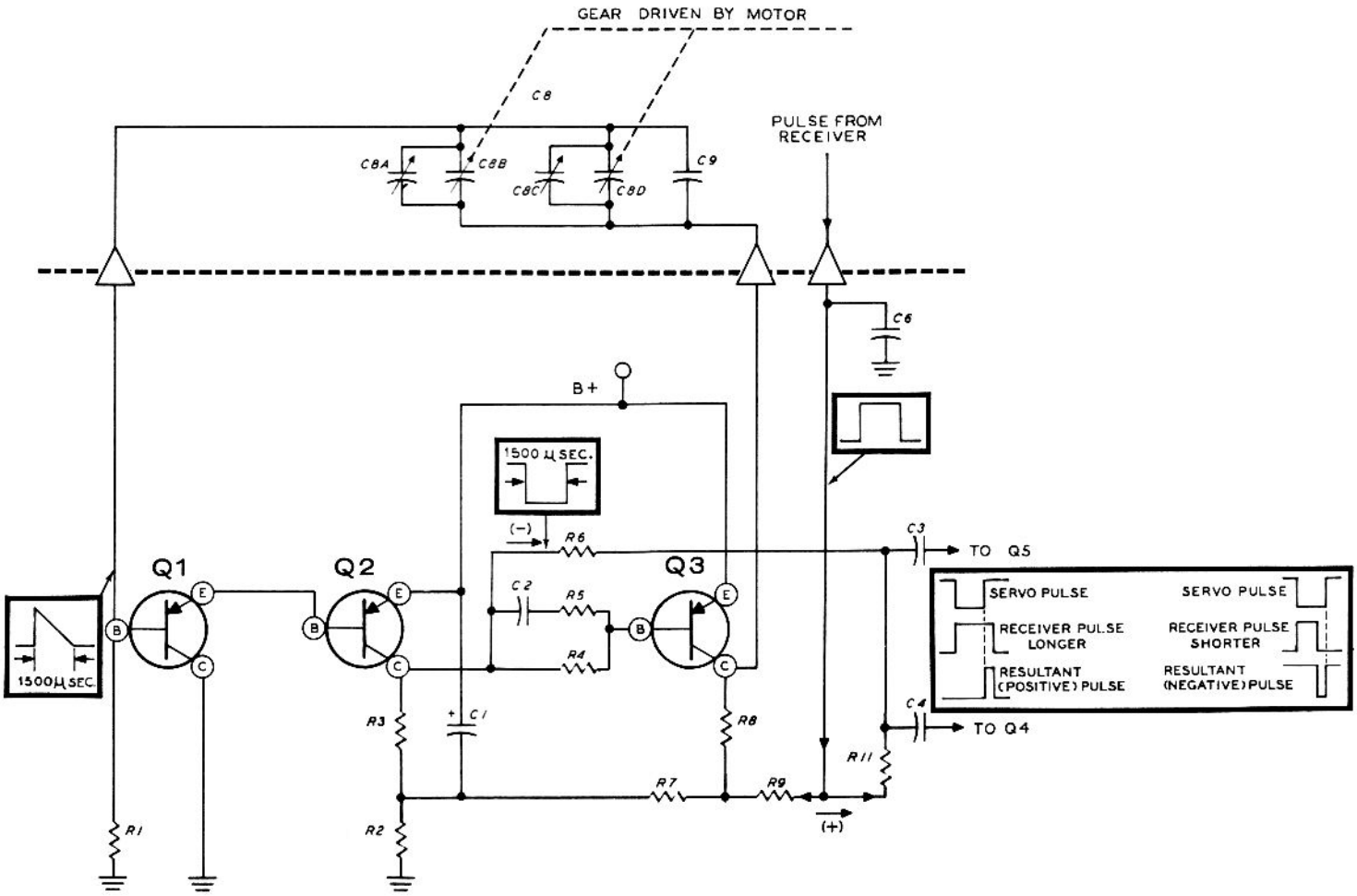
MULTIVIBRATOR CIRCUIT

Transistors Q1, Q2 and Q3 form a monostable (one-shot) multivibrator. See Figure 6-12. In this multivibrator circuit, transistors Q1 and Q2 normally conduct while Q3 is normally cut off. When a positive signal pulse from the Receiver is applied through R8 and R9 to the collector circuit of Q3, the conditions are reversed and Q3 conducts while Q1 and Q2 are cut off. The circuit remains in the reversed condition for a definite period of time and then returns to the normal condition.

The length of time that the multivibrator will remain reversed (normally 1500 microseconds) depends on the RC (resistor-capacitor) time constant set by resistor R1 and capacitors C8 and C9. Capacitor C8 consists of two variable sections, B and D, and two trimmer capacitors, A and C. These parallel capacitors are connected between the base of Q1 and the collector of Q3.

Each positive signal pulse from the Receiver passes through the green wire of the Servo and resistors R9 and R8 to the collector of Q3. This positive signal voltage also passes through capacitors C8 and C9 to the base of Q1, causing Q1 to cut off. Since the emitter of Q1 is direct-coupled to the base of Q2, Q2 also cuts off producing a negative pulse at its collector. This negative pulse, which is coupled through R4 to the base of Q3, causes Q3 to conduct. The circuit remains in this condition until capacitors C8 and C9 charge sufficiently through R1 to raise the base voltage of Q1 and cause it to conduct. Then the circuit reverts to its normal condition.

The variable sections of capacitor C8 are gear-driven by the servo motor. With the capacitor in its midposition, the period of the multivibrator is approximately 1500 microseconds. Thus, the negative pulse from the collector of Q2 lasts for 1500 microseconds, and is coupled through resistor R6 to the junction of capacitors C3 and C4. The positive signal pulse from the Receiver is passed through R11 to the same junction of C3 and C4. If the duration of the positive signal pulse equals the duration of the negative multivibrator pulse, the pulses cancel and the voltage at the junction of C3 and C4 is zero. A signal pulse that is longer than the multivibrator pulse results in a proportionately positive voltage pulse at the junction of C3 and C4, while a shorter signal pulse leaves a proportionately negative voltage pulse at this junction.



MONOSTABLE MULTIVIBRATOR

Figure 6-12

PULSE STRETCHER CIRCUIT

Capacitors C3 and C4 couple any difference pulses to transistors Q4 and Q5. See Figure 6-13. These transistors are connected in series between the supply voltage and ground. Without a difference pulse at the base of Q4 or Q5, neither transistor conducts. The voltage at their common collectors is then approximately half of the voltage between the supply and ground. Capacitor C5 is then charged to this voltage at the collectors.

When a positive difference pulse results from comparing the signal pulse with the multivibrator pulse, transistor Q4 conducts and reduces its collector voltage to zero, causing C5 to charge to the battery voltage. Since this collector is coupled through R14 to the common bases of Q6 and Q7, these bases become more negative. If the difference pulse at the junction of C3 and C4 is negative, transistor Q5 conducts discharging C5, making its collector and the bases of Q6 and Q7 more positive.

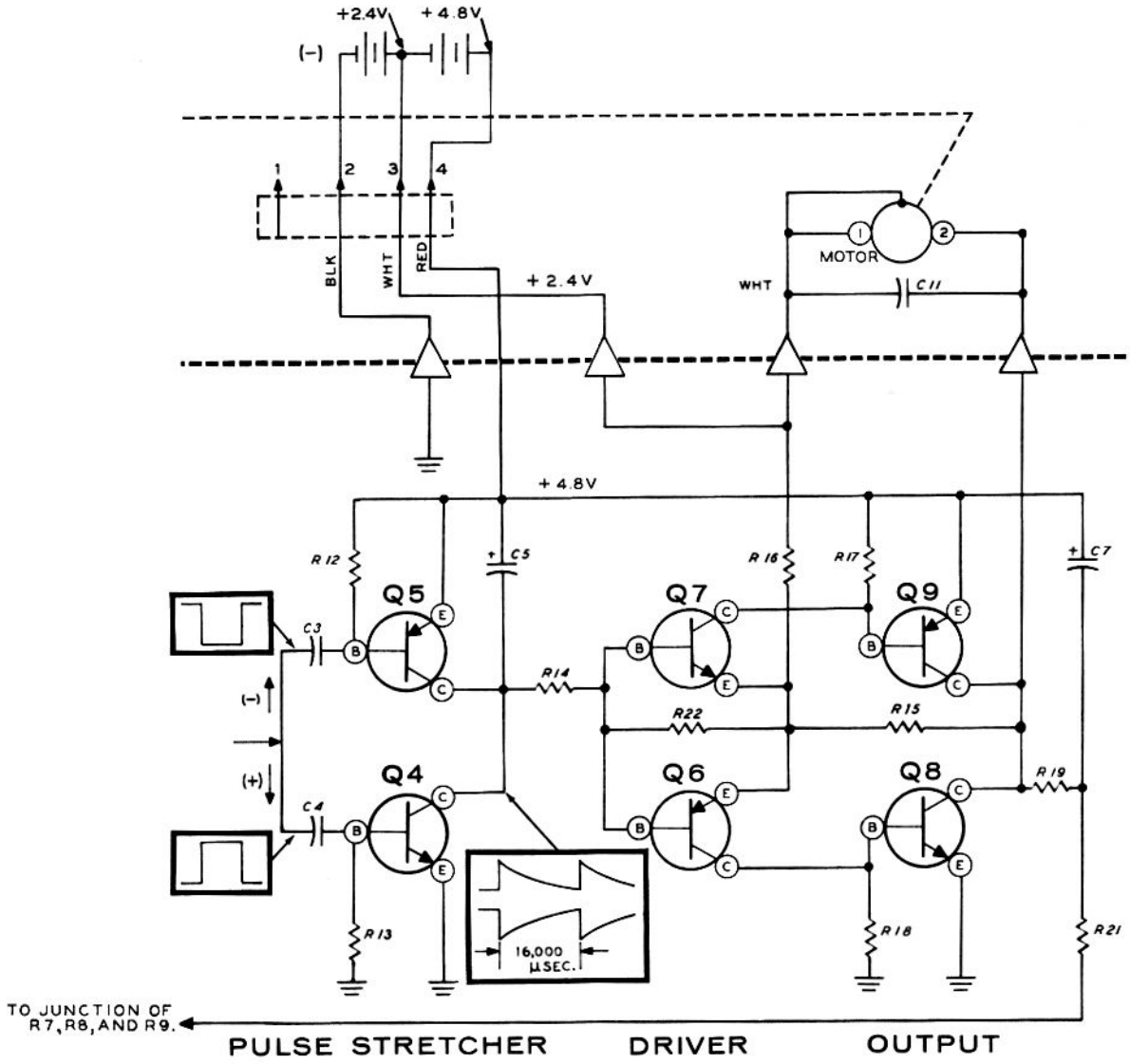


Figure 6-13

As the difference pulse may be very narrow due to only slight differences in the receiver pulse and the multivibrator pulse, and since it is only repeated once every 16,000 microseconds, very little average current would be fed to the motor. Therefore, C5 is used to stretch out this pulse at the collectors of Q4 and Q5 to hold this voltage there for a much longer period of time. This will give the motor greatly increased average current and power.

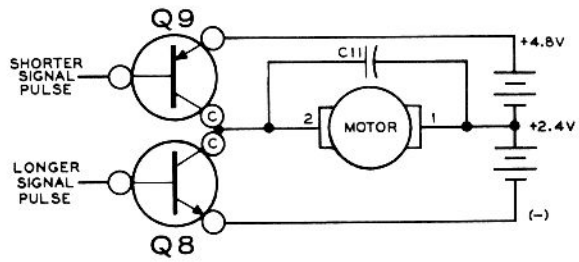


Figure 6-14

DRIVER AND OUTPUT CIRCUITS

The collector of Q6 is direct coupled to the base of Q8, and the collector of Q7 is direct coupled to the base of Q9. The common emitters of Q6 and Q7 are supplied through R16 from the center tap of the battery. When transistor Q6 is made to conduct as the result of a longer signal (positive difference) pulse from the Receiver, Q8 also conducts and shorts its collector to ground. A shorter signal (negative difference) pulse, on the other hand, causes Q9 to conduct and shunts its collector to the 4.8 volt supply. Resistor R15 feeds back a portion of the output to increase the stability of the amplifier, and resistors R19 and R21, along with capacitor C7, form a feedback network to prevent overshoot.

Number 1 pole of the reversible motor is connected to the center tap of the battery as shown in the simplified schematic of Figure 6-14. The motor runs in one direction when number 2 pole is connected to the positive end of the battery, and reverses when this pole is connected to the negative (ground) end of the battery. Transistors Q6 and Q7 are the drivers that operate Q8 and Q9 to perform the battery switching that drives the motor.

The collectors of Q8 and Q9 are common to the number 2 pole of the motor. With a signal pulse from the Receiver that is longer than the multivibrator pulse, transistors Q4, Q6, and Q8 conduct, making the number 2 pole of the motor negative, and driving the motor in one direction. When the signal pulse from the Receiver is shorter than the multivibrator pulse, transistors Q5, Q7, and Q9 conduct. This places the number 2 pole of the motor at the positive end of the battery supply, and the motor runs in the opposite direction. Capacitor C11 is used to filter out motor brush noise.

The length of the multivibrator period is determined by the RC time constant of resistor R1 and variable capacitors C8 and C9. The rotor plates of C8B and C8D are gear-driven by rotation of the servo motor. When a signal pulse length differs from the multivibrator pulse length, the motor turns in one direction and rotates the variable capacitor plates. When the capacity of C8B and C8D change enough to make the multivibrator pulse length equal to the signal pulse length, these pulses cancel and no longer produce the difference pulse that is required to turn on either Q4 and Q5. This absence of a pulse length difference keeps the driver and output transistors turned off and the motor remains stopped. In this way, each different pulse length input to the Servo is represented by a different portion of the variable capacitor and the output wheel and coupling tabs.

The motor gear train turns the variable capacitor rotor plates while it drives a pair of rack gears. The rack gears can be driven approximately 5/8 inch. These rack gears are mechanically connected to one of the control devices in the model so that the Servo unit operates the device.

PULSE STRETCHER CIRCUIT

Capacitors C3 and C4 couple any difference pulses to transistors Q4 and Q5. See Figure 6-13. These transistors are connected in series between the supply voltage and ground. Without a difference pulse at the base of Q4 or Q5, neither transistor conducts. The voltage at their common collectors is then approximately half of the voltage between the supply and ground. Capacitor C5 is then charged to this voltage at the collectors.

When a positive difference pulse results from comparing the signal pulse with the multivibrator pulse, transistor Q4 conducts and reduces its collector voltage to zero, causing C5 to charge to the battery voltage. Since this collector is coupled through R14 to the common bases of Q6 and Q7, these bases become more negative. If the difference pulse at the junction of C3 and C4 is negative, transistor Q5 conducts discharging C5, making its collector and the bases of Q6 and Q7 more positive.

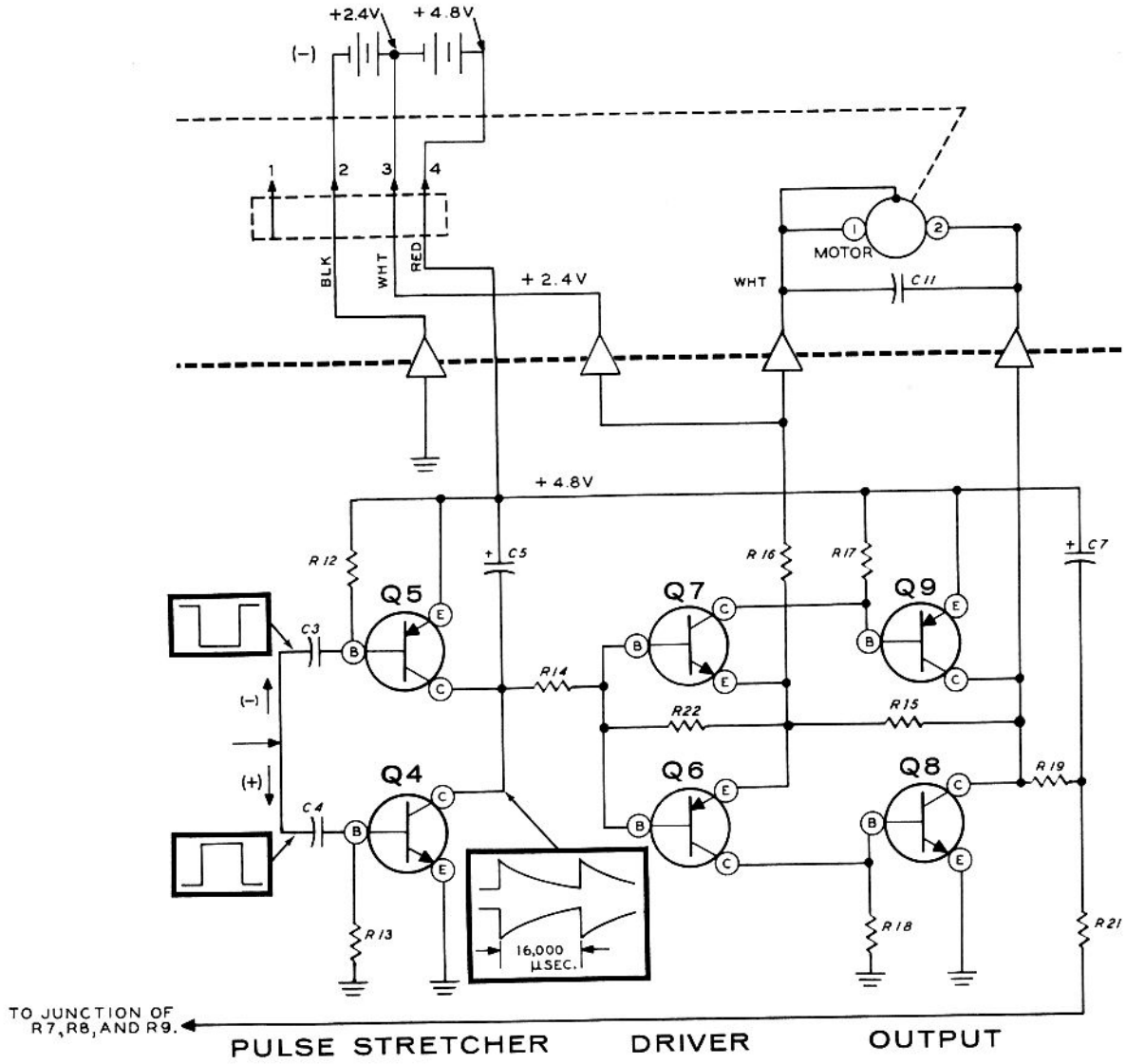


Figure 6-13

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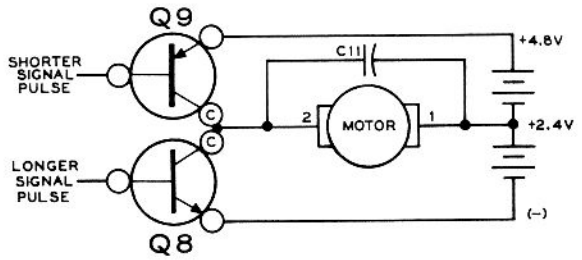

Figure 6-14

DRIVER AND OUTPUT CIRCUITS

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The motor gear train turns the variable capacitor rotor plates while it drives a pair of rack gears. The rack gears can be driven approximately 5/8 inch. These rack gears are mechanically connected to one of the control devices in the model so that the Servo unit operates the device.

CIRCUIT DESCRIPTION

TRANSMITTER

A number series has been assigned to each of the two circuit boards and to the cabinet in the Transmitter. These number series are used on the Schematic Diagram and in this Circuit Description to help you identify and locate circuits and parts. The part numbers are grouped as follows:

1- 99 Parts mounted on the encoder circuit board.
101-199 Parts mounted on the RF transmitter circuit board.
201-299 Parts mounted on the cabinet.

Pulses that are used to modulate the RF carrier of the Transmitter originate in the circuits of the encoder circuit board. These circuits include a free-running multivibrator, five monostable timers, and a monostable multivibrator. The RF circuit board contains a crystal-controlled oscillator and an RF output on the 27 and 53 MHz bands. The 72 MHz RF circuit board contains a crystal-controlled oscillator, doubler, and RF output stage. Each circuit of the Transmitter will be described separately in the following paragraphs.

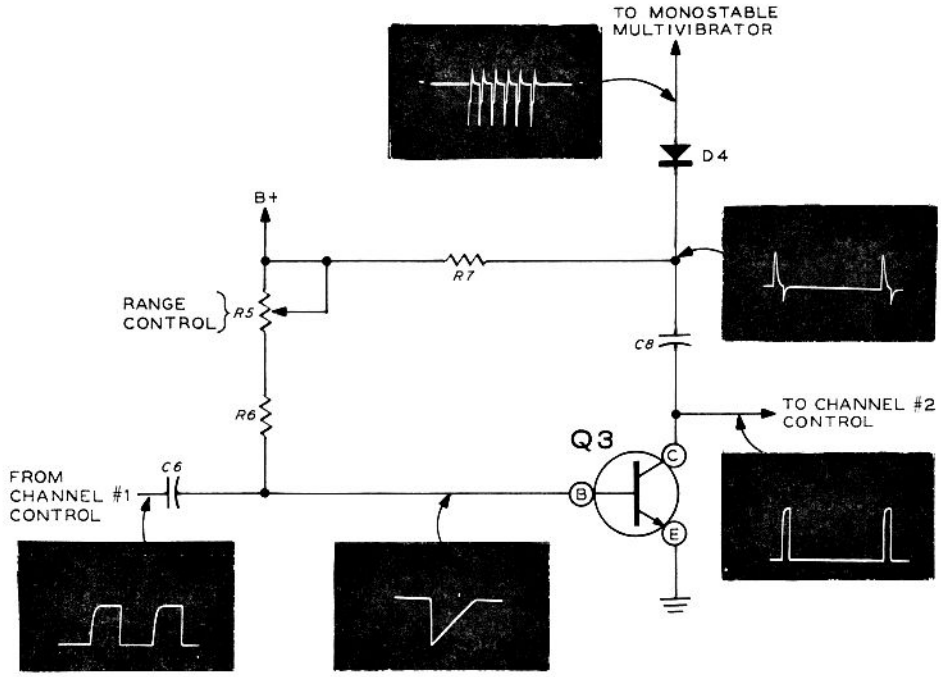
Refer to the Block Diagram on Page 103 and to the Schematic Diagram (fold-out from Page 109), while you read this Circuit Description. Several partial schematics are included with the text to help describe individual circuits.

FREE-RUNNING MULTIVIBRATOR

Transistors Q1 and Q2 are connected in a circuit that operates as a free-running multivibrator. See Figure 6-4. Alternately, one of these transistors conducts while the other is cut off.

Assume that transistor Q1 conducts first when power is applied to the circuit. The voltage at the collector of Q1 is reduced, causing capacitor C1 to start charging through resistor R2 from the power supply. During the charging of C1, the voltage to the base of Q2 increases sufficiently to cause Q2 to conduct, reducing its collector voltage to near zero. This applies a negative voltage through C4 to the base of Q1 and stops Q1 from conducting. Now C4 begins to charge through R3. During the charging of C4, the voltage to the base of Q1 rises in a positive direction and Q1 again conducts.

The time required to charge C1 through R2, and C4 through R3, determines the period of the multivibrator. The values of these resistors and capacitors are chosen to turn each transistor on and off every 16,000 microseconds. This multivibrator period of 16,000 microseconds produces the starting pulse for each frame, and this frame starting pulse is coupled through capacitor C5 and diode D3 to transistor Q8 of the monostable multivibrator circuit. The pulse also passes through Channel #1 Stick Control R202 to a series of monostable timers which produces the other five pulses for channel information and will be described next.



MONOSTABLE TIMER

Figure 6-5

MONOSTABLE TIMERS

Transistors Q3 through Q7 are connected in five identical monostable timer circuits. Each frame-starting pulse from the free-running multivibrator begins a chain reaction through the monostable timers. Since these circuits are identical, only the operation of Q3 will be described. See Figure 6-5.

Transistor Q3 is biased through Channel #1 Range control R5 and resistor R6 so that it is normally conducting and its collector voltage is near zero. The negative frame-starting pulse from transistor Q2 is coupled from the arm of stick control R202, through capacitor C6, to the base of Q3. This pulse drives the base of Q3 negative by an amount that depends on the setting of R202, cutting off the transistor.

As soon as the negative frame-starting pulse is fed to the base of Q3, the voltage at this base begins to rise again due to the positive voltage through R5 and R6. When the base reaches +.6 volts, Q3 again conducts. The time required for the base to reach +.6 volts is affected by the time constant of R5, R6, and C6, as well as by the amplitude of the pulse that is passed through control R202. Thus, control R202 provides manual control of the pulse amplitude, which controls the length of time that transistor Q3 is cut off.

Control R5 adjusts the effective range of control R202 by altering the charging time of capacitor C6. (NOTE: The charge curve of C6 is the trailing edge of the pulse at the base of Q3.) As C6 charges up to +.6 volts more slowly, for example, due to a larger resistance value of R5, a wider range of pulse widths is available from the collector of Q3. When the resistance of R5 is decreased, a smaller range of pulse widths is available from Q3.

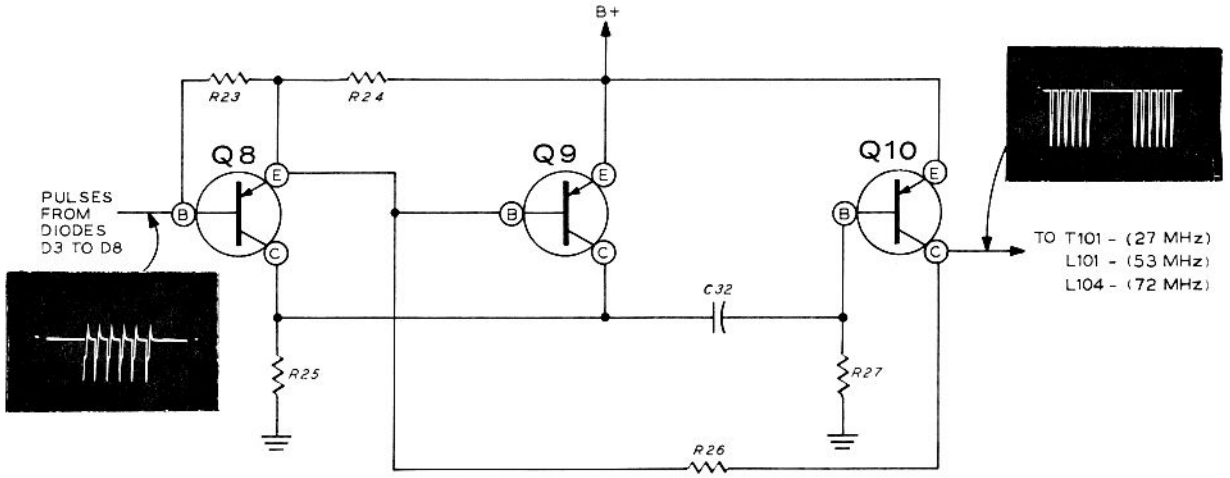


Figure 6-6

When transistor Q3 again conducts, a negative-going pulse appears at its collector. This pulse is passed through Channel #2 Control R203 to the next monostable timer circuit, which operates in the same manner as the circuit of Q3. Note that only the negative-going portion of the pulse will trigger this stage.

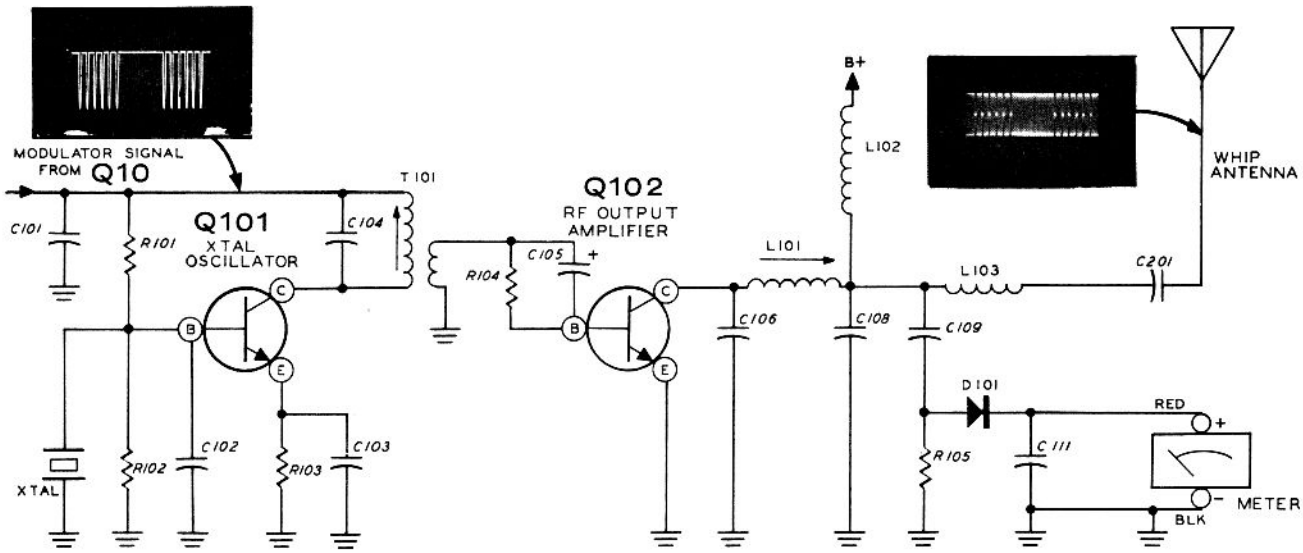
The channel #1 controlling pulse from Q3 is coupled through C8 and D4 to the monostable multivibrator circuit Q8, Q9, and Q10. Diodes D5, D6, D7, and D8 couple the other controlling pulses to the monostable multivibrator.

MONOSTABLE MULTIVIBRATOR

Transistors Q8, Q9, and Q10 are connected to operate as a monostable, 350 microsecond multivibrator (see Figure 6-6). Its purpose is to cause each frame-starting pulse and controlling pulse to modulate the transmitter's RF carrier for only 350 microseconds during each pulse.

Diodes D3 through D8 allow only the negative-going portion of the pulse from the monostable timers and the multivibrator to be applied to the base of transistor Q8. Since the emitter of Q8 is direct coupled to the base of Q9, this negative-going pulse causes Q8 and Q9 to conduct and produce a positive pulse at the collector of Q9. This positive pulse is coupled through capacitor C32 to the base of Q10, causing Q10 to cut off. The time constant of C32 and R27 holds transistor Q10 cut off for a period of 350 microseconds after each pulse is applied to its base. Resistor R26 provides positive DC feedback from the collector of Q10 to the base of Q9. This feedback insures that Q9 continues to conduct during the 350 microsecond cutoff period of the monostable multivibrator.

From the collector of transistor Q10, power is supplied to the crystal oscillator circuit on the 27 and 53 MHz bands, and to the doubler circuit on the 72 MHz band. Since Q10 normally conducts, and is cut off during the presence of pulses, this transistor turns the crystal oscillator (on 27 and 53 MHz) or frequency doubler (on 72 MHz) off and on like a switch and thereby modulates the RF signal.



OSCILLATOR AND RF OUTPUT AMPLIFIER CIRCUITS 27 MHz BAND

Figure 6-7

27 MHz BAND RF TRANSMITTER CIRCUITS

The crystal-controlled oscillator and RF output amplifier circuits are contained on the small RF Transmitter circuit board. These circuits generate and amplify the radio frequency carrier signal that is modulated by the controlling pulses from the multivibrator. See Figure 6-7.

Crystal oscillator transistor Q101 operates as a grounded-base Colpitts oscillator. The primary winding of transformer T101, which is in parallel with capacitor C104, tunes the circuit to the frequency of the crystal.

During the intervals between pulses from the monostable multivibrator circuit, while transistor Q10 conducts, power is applied through the primary winding of T101 to the collector of Q101, causing the oscillator to operate. Since the oscillator stops when the power is cut off during a pulse, the oscillator's output signal is negative-modulated by the pulse signals.

The secondary winding of transformer T101 couples the modulated oscillator signal to the base of final RF amplifier transistor Q102 through capacitor C105. Q102 conducts on the positive peaks of the RF carrier which charges C105 to the polarity shown. R104 provides a return path for the negative voltage on the base of Q102 and provides proper bias. This bias is determined by the time constant of R104 and C105.

Transistor Q102 operates as a tuned collector amplifier. The pi network of C106, C108, and L101 tunes the amplifier output to the crystal frequency and provides a proper impedance match between Q102 and the antenna. Coil L103 is the antenna loading coil, and capacitor C201 prevents the DC supply voltage from reaching the antenna. B+ voltage is supplied through choke L102.

A portion of the RF signal is taken from the pi network through C109 and rectified by diode D101 to operate the meter, which indicates relative carrier strength. Resistor R105 provides a DC return path for the diode while capacitor C111 filters the diode's rectified output.

The pulse-modulated RF signal is radiated from the collapsible whip antenna to be received and detected by the Receiver.

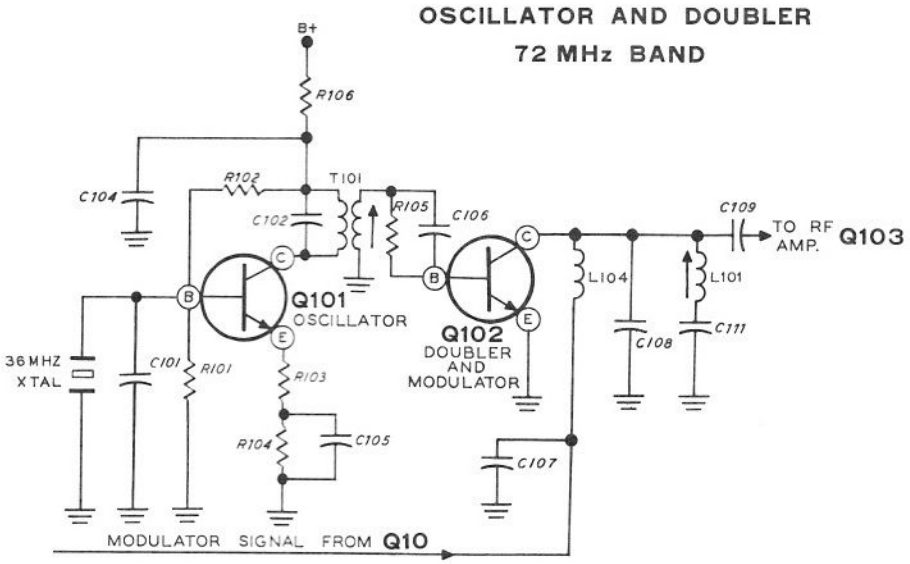


Figure 6-8

53 MHz BAND RF TRANSMITTER CIRCUITS

The 53 MHz band RF transmitter circuits are similar in operation to the 27 MHz band circuits. The circuits differ the most by the addition of the tuned circuit, C105 and L102, which is tuned to the oscillator frequency and used to drive RF amplifier Q102. The tap on L102 is for impedance matching. See the Schematic Diagram (fold-out from this Page.)

72 MHz BAND RF TRANSMITTER CIRCUITS

The 72 MHz band oscillator operates just like the oscillators for the other bands, except that it oscillates at a frequency that is one-half of the final transmitted frequency. The secondary winding of transformer T101 couples the oscillator signal through C106 to the base of Q102. Q102 conducts on the positive peaks of the oscillator signals. See Figure 6-8.

The output of Q102 (C108, C111, and L101) is tuned to the second harmonic of the oscillator frequency. This appears as a low impedance to ground for the fundamental oscillator frequency and, at the same time, resonates at a high impedance for the second harmonic.

Coil L104 couples DC to the collector of Q102 from multivibrator Q10 and, at the same time, isolates Q10 from the RF at Q102. The DC from Q10 causes Q102 to operate normally until a negative pulse arrives at the collector of Q102. Then Q102 cuts off for the duration of the pulse, modulating the RF.

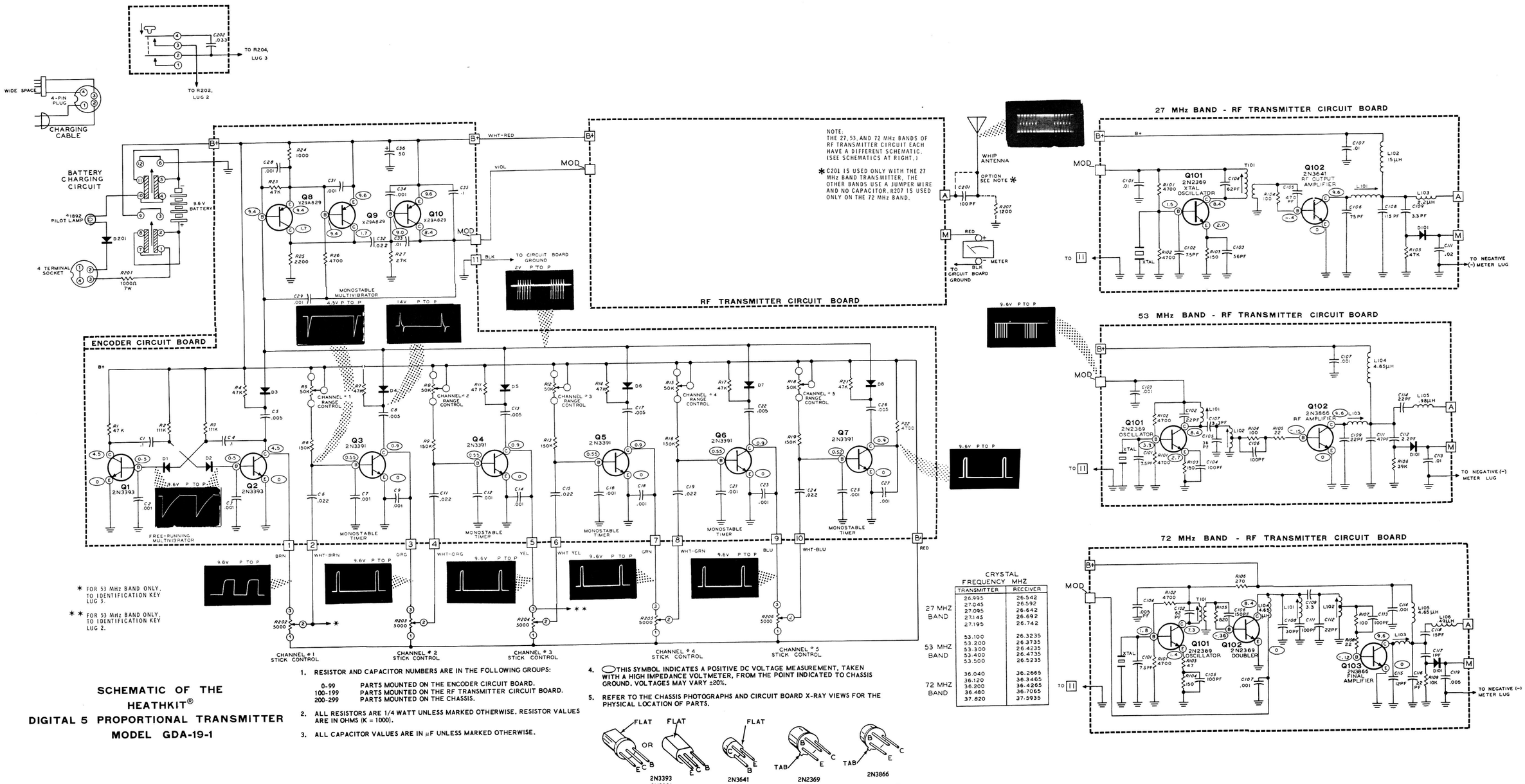
The doubled and modulated signal is then coupled from Q102 to RF amplifier Q103, amplified, and coupled to the antenna in the same manner as the signals of the other two bands.

POWER SUPPLY

Power for the Transmitter circuits is supplied by a self-contained, rechargeable 9.6 volt nickel-cadmium battery. When the Power switch is in the Off position, the Battery is connected to a charging circuit which operates in the following manner.

The Receiver's battery is connected, by means of the charging cable, in series with D201 and the pilot lamp, through the ON-OFF switch, to the negative (-) lead of the Transmitter Battery. R201 connects to the positive (+) lead of the Transmitter Battery through the ON-OFF switch. When the charging cable is connected between the 4-pin connector and a 120 volt AC outlet, the series circuit charges both the Receiver Battery and the Transmitter Battery at the same time.

Diode D201 rectifies the AC line voltage and resistor R201 limits the charging current to a safe value. The pilot lamp indicates when the batteries are being charged. Since the Off position of the power switch removes all connections between the Battery and the Transmitter circuits, the danger of shock from the charging circuit is eliminated.



SCHEMATIC OF THE HEATHKIT® DIGITAL 5 PROPORTIONAL TRANSMITTER MODEL GDA-19-1

CRYSTAL FREQUENCY MHZ

	TRANSMITTER	RECEIVER
27 MHZ BAND	26.995	26.542
	27.045	26.592
	27.095	26.642
	27.145	26.692
	27.195	26.742
53 MHZ BAND	53.100	26.3235
	53.200	26.3735
	53.300	26.4235
	53.400	26.4735
	53.500	26.5235
72 MHZ BAND	36.040	36.2665
	36.120	36.3465
	36.200	36.4265
	36.480	36.7065
	37.820	37.5935

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS:

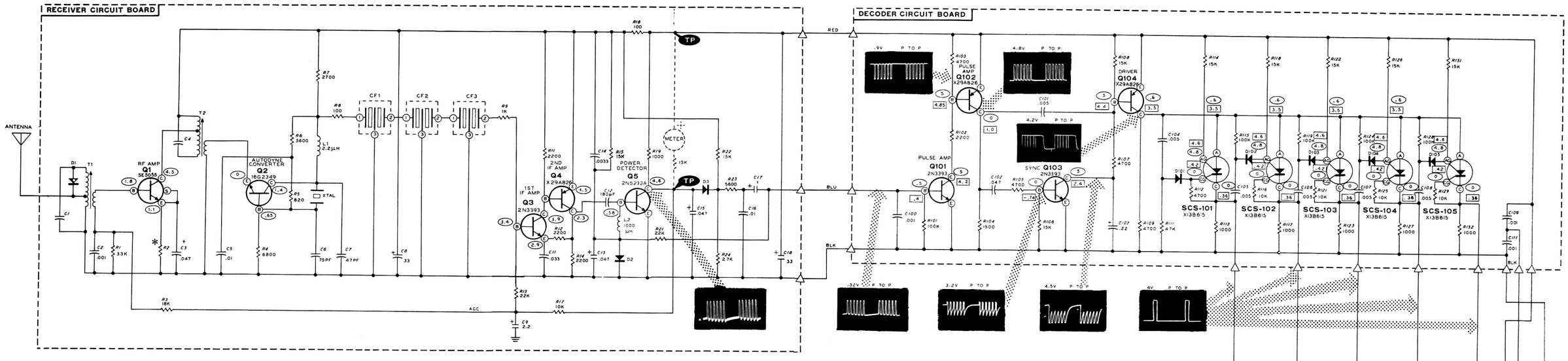
0-99	PARTS MOUNTED ON THE ENCODER CIRCUIT BOARD.
100-199	PARTS MOUNTED ON THE RF TRANSMITTER CIRCUIT BOARD.
200-299	PARTS MOUNTED ON THE CHASSIS.

2. ALL RESISTORS ARE 1/4 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K = 1000).

3. ALL CAPACITOR VALUES ARE IN μF UNLESS MARKED OTHERWISE.

4. ⊖ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT, TAKEN WITH A HIGH IMPEDANCE VOLTMETER, FROM THE POINT INDICATED TO CHASSIS GROUND. VOLTAGES MAY VARY ±20%.

5. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.



	C1	C4
27 MHZ	47PF	47PF
53 - 72 MHZ	27PF	27PF

SCHEMATIC OF THE HEATHKIT© DIGITAL 5 PROPORTIONAL RECEIVER MODEL GDA-19-2

1. RESISTOR AND CAPACITOR NUMBERS ARE IN THE FOLLOWING GROUPS:

   0-99 PARTS MOUNTED ON THE RECEIVER CIRCUIT BOARD.
   100-199 PARTS MOUNTED ON THE DECODER CIRCUIT BOARD.

2. ALL RESISTORS ARE 1/4 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1,000).

3. ALL CAPACITOR VALUES ARE IN µF UNLESS MARKED OTHERWISE.

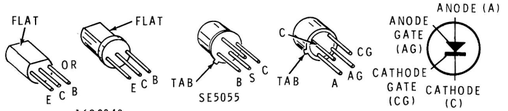
4. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT WITH NOTSIGNAL BEING RECEIVED.

5. ▭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT WITH SIGNAL BEING RECEIVED.

6. ALL VOLTAGES ARE MEASURED WITH A HIGH IMPEDANCE VOLTMETER. FROM THE POINT INDICATED TO COMMON GROUND. VOLTAGES MAY VARY ±20%.

7. REFER TO THE CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.

8. * 470Ω RESISTOR FOR 27 MHz OPERATION. 1000Ω RESISTOR FOR 53 MHz OR 72 MHz OPERATION.

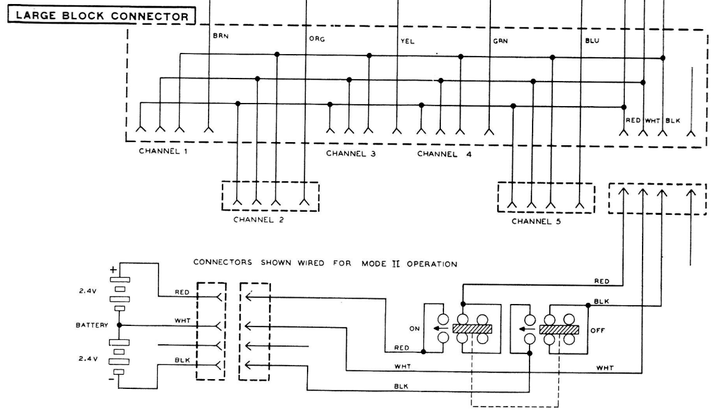


16G2349
2N3393
X29A826
2N5232A

X13B615

CRYSTAL FREQUENCY MHZ

	TRANSMITTER	RECEIVER
27 MHZ BAND	26.995	26.542
	27.045	26.592
	27.095	26.642
	27.145	26.692
	27.195	26.742
53 MHZ BAND	53.100	26.3235
	53.200	26.3735
	53.300	26.4235
	53.400	26.4735
	53.500	26.5235
72 MHZ BAND	36.040	36.2665
	36.120	36.3465
	36.200	36.4265
	36.480	36.7065
	37.820	37.5935



RECEIVER

GENERAL

A number series has been assigned to each of the two circuit boards used in this Receiver. This number series is used on the Schematic Diagram and in this Circuit Description to help you identify and locate circuits and parts. The part numbers are grouped as follows:

1- 99 Parts mounted on the receiver circuit board.
101-199 Parts mounted on the decoder circuit board.

The Receiver circuit board contains a conventional crystal-controlled superheterodyne receiver with a power detector and an integrator circuit. The decoder circuit board contains a pulse amplifier, sync and driver circuits, and five silicon-controlled switch circuits.

Refer to the Schematic Diagram (fold-out from this page) and to the Block Diagram (fold-out from Page 104) while you read this Circuit Description.

RECEIVER CIRCUIT BOARD

The transmitted RF signal is picked up by the antenna and fed to the tuned circuit of T1 and C1. T1 and C1 are tuned to the transmitted signal frequency, and their values are selected for each band of frequencies.

From the secondary of T1, the signal is coupled to the base of RF amplifier Q1. The amplified signal from Q1 is applied to the tuned circuit of C4 and T2, which are also tuned to the transmitted signal frequency. T2 is tapped to provide an impedance match to the collector of Q1. From the secondary of T2, the signal is coupled to the emitter of autodyne converter Q2.

Regenerative feedback through the receiver crystal causes the autodyne converter circuit to oscillate at a frequency that is 453 kHz from the incoming frequency. This will be at the crystal's fundamental frequency on the 27 MHz band, or at its second harmonic on the 53 and 72 MHz bands. The input signal and oscillator signal beat together in transistor Q2 to produce a 453 kHz difference signal that is passed through coil L1 and resistor R8 to the first ceramic (IF) filter, CF1. Capacitor C7 tunes with L1 near the crystal oscillator frequency.

The ceramic filters are made up of one ceramic disc in each filter. As the IF signal is applied to the disc, it vibrates at that frequency. The ceramic filters will vibrate at and pass only the frequency to which they are tuned; in this case the 453 kHz IF frequency.

The IF signal is coupled through CF1, CF2, CF3, and resistor R9 to the base of the first IF amplifier, Q3. The amplified IF signal from Q3 is further amplified by second IF transistor Q4 and coupled through capacitor C12 to the base of the power detector, Q5. Diode D2 is forward biased by resistor R15 so that about .5 volt is applied to the base of Q5 through L2, which will hold Q5 at cutoff. Since Q5 requires about .6 volt at its base to conduct, the additional .1 volt is supplied by the positive portion of the IF signal. Thus, transistor Q5 conducts only on the positive peaks of the IF signal.

When receiving an IF signal, Q5 is conducting. Then when a transmitted pulse is received, which temporarily stops the RF carrier, there is no IF signal to make Q5 conduct. Therefore, Q5 stops conducting and its collector voltage rises. This then produces a positive pulse from Q5 that is equivalent to the pulses in the Transmitter.

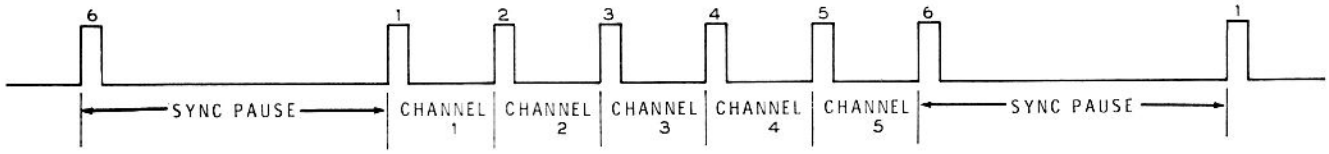


Figure 6-9

Capacitor C15 bypasses the IF frequency to ground and leaves a train of audio frequency pulses that are coupled through D3, R23, and C17 to the base of the pulse amplifier Q101 on the decoder circuit board. Diode D3 and resistors R22 and R24 eliminate noise pulses under strong signal conditions, and integrator network resistor R23 and capacitor C16 prevent noise from interfering under weak signal conditions.

An automatic gain control (AGC) circuit that consists of resistors R17, R13, R3, and R1 with capacitor C9, feeds back part of the Q5 collector voltage to the base circuits of transistors Q1 and Q3. The stronger the received signal, the more transistor Q5 conducts, lowering the voltage at its collector. This voltage is applied through R17, R13, and R3 to reduce the gain of Q1 and Q3. This AGC action prevents the IF amplifier and detector circuits from overloading and producing improper pulses when strong signals are received.

The output signal from the Receiver is a series of positive pulses that are spaced like the modulation pulses of the Transmitter. See the waveform in Figure 6-9. These signal pulses are coupled to the decoder circuit, which will be described next.

DECODER CIRCUIT BOARD

Pulse amplifier transistors Q101 and Q102 further increases the amplitude of the pulses from Q5 on the receiver circuit board. Q101 and Q102 are normally cut off until the pulses reach a high enough amplitude to turn them on, thus providing further noise immunity and producing clear sharp pulses at the collector of Q102.

The signal pulses from the collector of Q102 are coupled through C102 and R105 to the base of sync transistor Q103, and through C101 to the base of driver transistor Q104. Transistor Q104 is used to supply anode voltage to the five SCS's (silicon-controlled switches: SCS-101 through SCS-105). Q104 is normally cut off, removing the anode voltage from these five SCS's. Q103 is also normally cut off, but it conducts during each signal pulse from Q102. This controls the charge and discharge of capacitor C103 which, in turn controls Q104 during the sync pause time.

When Q103 is cut off during the sync pause time, capacitor C103 begins to charge through resistors R108 and R107, and the base emitter junction of Q104. The resulting voltage drop across R107 holds Q104 on until the charging current decreases and C103 becomes charged. Then Q104 returns to its normally cutoff condition.

Transistor Q103 conducts during each positive pulse it receives from Q102 and discharges capacitor C103 (see the waveform at the collector of Q103 on Figure 6-10). The six pulses of each train occur in such rapid succession that C103 cannot obtain a charge sufficient enough to turn Q104 off. However, during the sync pause time, Q103 is cut off long enough to permit C103 to charge up to the voltage which stops Q104 from conducting.

The first pulse following the sync pause turns on Q103, discharging capacitor C103 and allowing Q104 to conduct again. During the time that Q103 holds Q104 on, pulses are coupled from Q102 to the base of Q104 through C101. These positive pulses momentarily turn Q104 off, interrupting the anode voltage from the SCS's for a short instant. This is necessary for proper operation of the SCS's.

Each SCS acts like a transistor with an additional "latching" junction. With the correct biasing conditions, the SCS can be made to conduct from anode to cathode by applying a positive pulse to its cathode gate, or a negative pulse to its anode gate. The SCS continues to conduct until its anode voltage is interrupted. After the anode voltage is restored, another pulse is required at one of its gates before the SCS will turn on again. The SCS circuits operate in the following manner. See Figure 6-11.

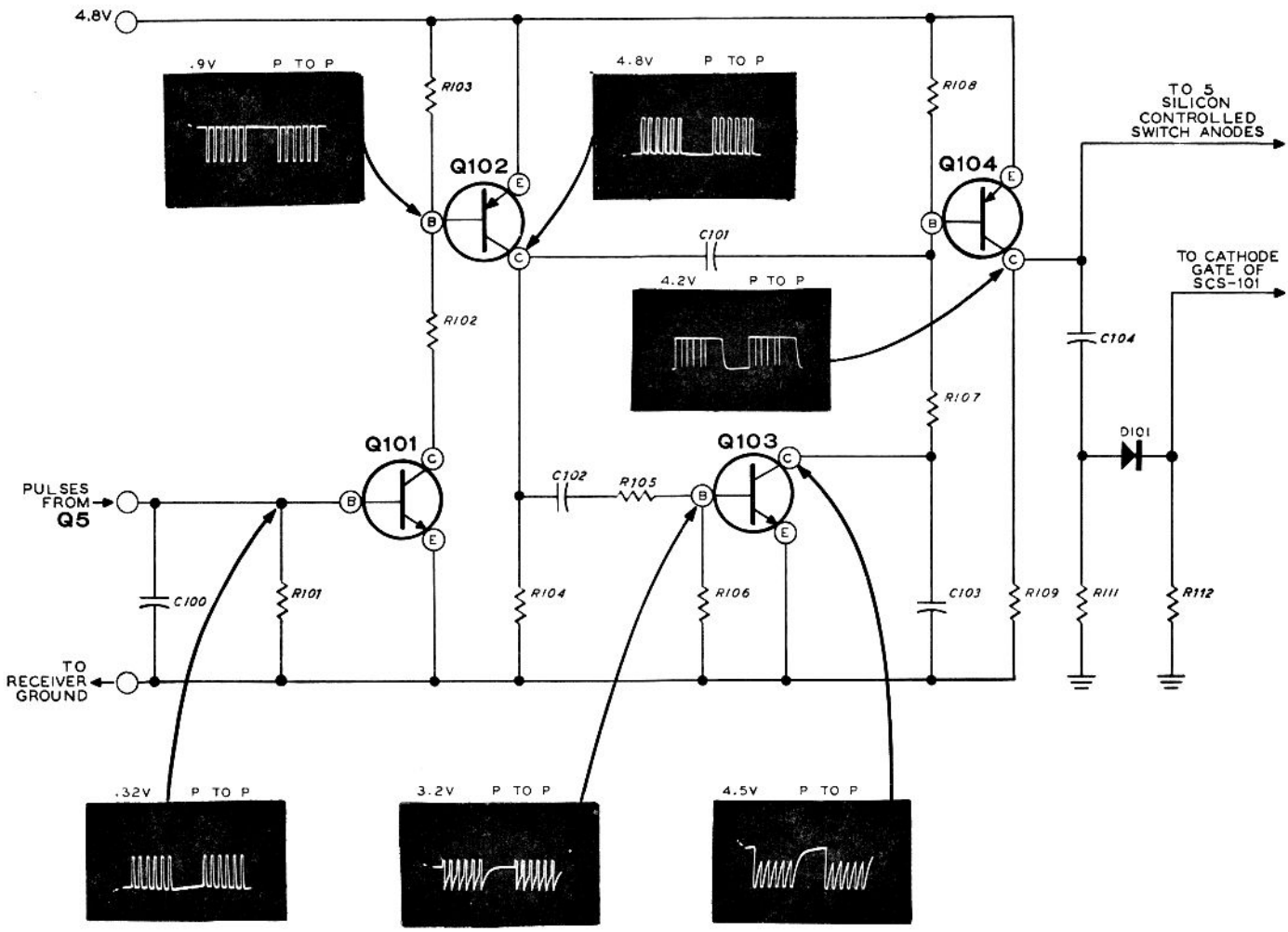


Figure 6-10

The sync pause time of the voltage waveform at the collector of Q104 stops all five SCS circuits from conducting. The positive-going portion of the first pulse, which is applied to all SCS anodes, prepares them to conduct. At the same time, this first positive pulse is applied through the differentiating network of C104 and R111, and through diode D101, to the cathode gate of SCS-101. This turns on SCS-101, passing current to the first (channel #1) Servo unit.

The second pulse momentarily cuts off the SCS anode voltage and turns off SCS-101. When SCS-101 turns off, its cathode presents a negative-going trailing edge which is coupled through C105 and D102 as a negative pulse to the anode gate of SCS-102, turning on this SCS. Now SCS-101 is turned off, removing current from the first Servo, while SCS-102 conducts and passes current to the second Servo.

Each SCS conducts only during the interval between two pulses. The first pulse in each train starts SCS-101 conducting and the second pulse stops it. As SCS-101 stops conducting, it starts SCS-102. The third pulse stops SCS-102, and SCS-102 in turn starts SCS-103, etc. Each SCS passes current to its own servo unit only during the interval that was initially determined by a control position at the Transmitter.

Each Servo unit translates the pulse-time interval into motor revolutions. The operation of the Servo unit is described next.

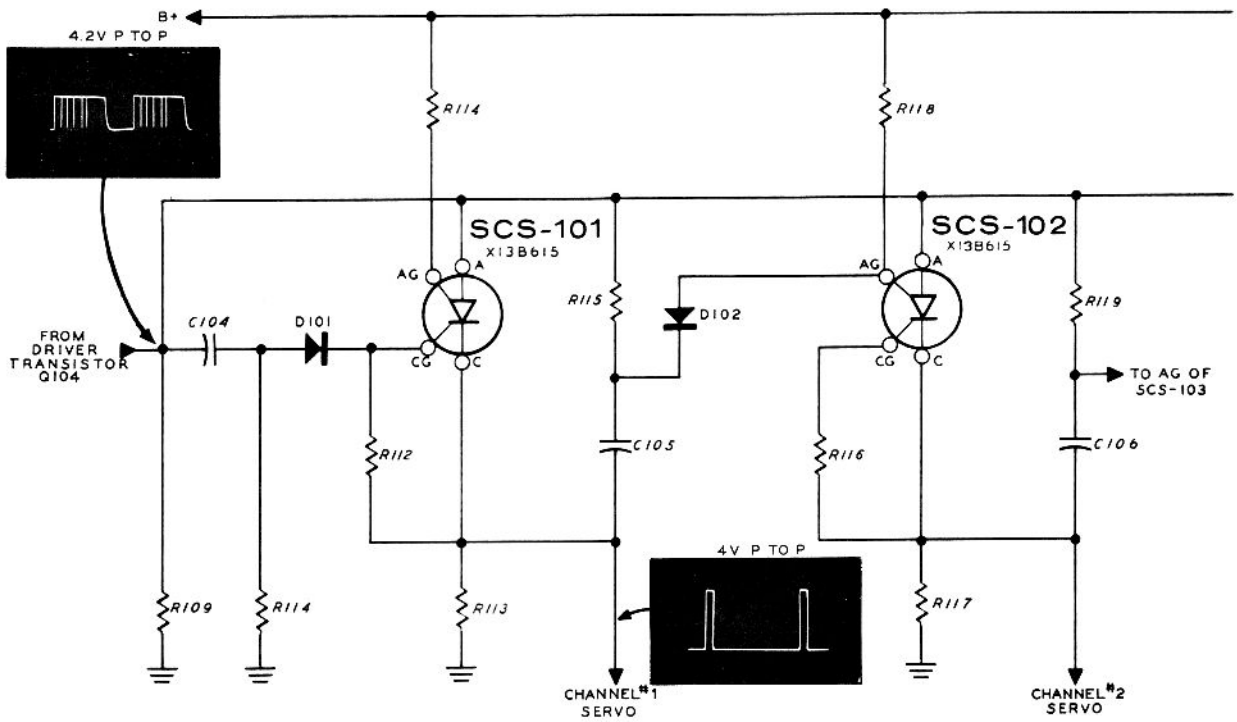
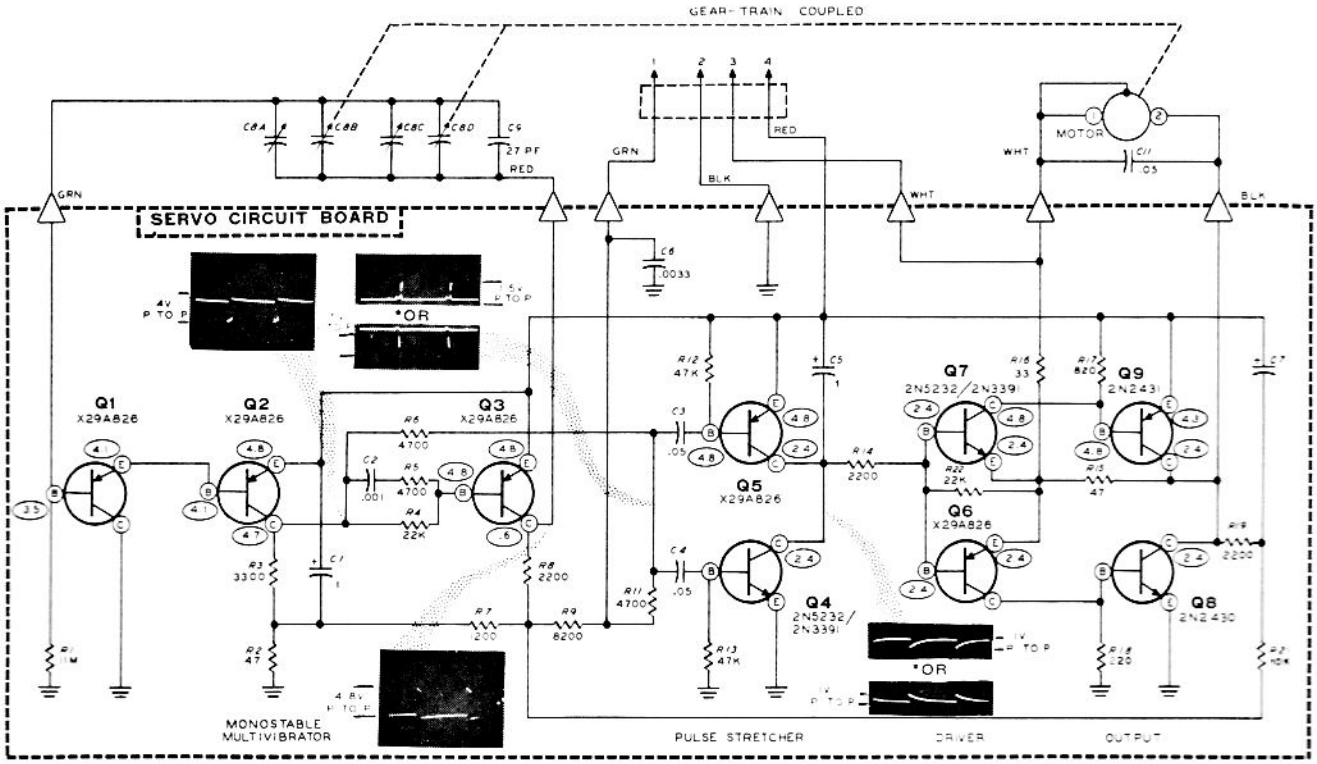
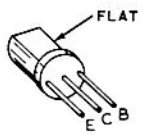


Figure 6-11

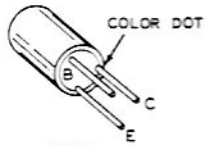


SCHEMATIC OF THE HEATHKIT® DIGITAL PROPORTIONAL SERVO MODEL GDA-19-4

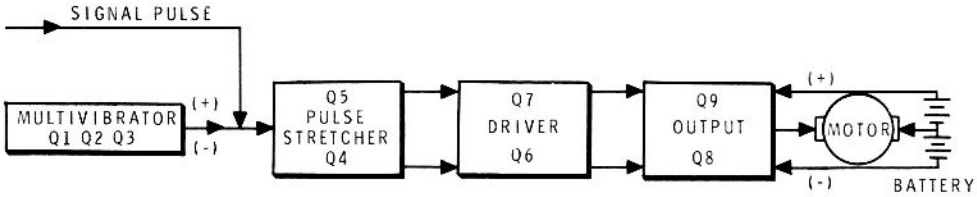
1. ALL RESISTORS ARE 1/4 WATT.
   RESISTOR VALUES ARE IN OHMS (K = 1,000, MEG = 1,000,000).
2. ALL CAPACITOR VALUES ARE IN μF UNLESS MARKED OTHERWISE.
3. ⬭ THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE MEASUREMENT WITH NO SIGNAL BEING RECEIVED.
4. ALL VOLTAGES ARE MEASURED WITH A HIGH IMPEDANCE VOLTMETER, FROM THE POINT INDICATED TO COMMON GROUND. VOLTAGES MAY VARY ±20%.
5. REFER TO THE SERVO PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEW FOR THE PHYSICAL LOCATION OF PARTS.
6. ✻ THESE WAVEFORMS SHOW THE DRIVE SIGNALS FOR BOTH DIRECTIONS.



2N5232/2N3391
X29A826



2N2430
2N2431



SERVO BLOCK DIAGRAM

SERVO

The Servo unit translates the pulses that come from the Receiver into positive or negative voltages, and these voltages operate a motor that moves a control surface of a model. The signal pulses and the battery voltages are coupled from the Receiver to the Servo through a multi-pin connector. The miniature circuit board in the Servo contains a monostable multivibrator circuit, a pulse stretcher circuit, a driver circuit, and an output circuit. Each of these circuits will be described separately in the following paragraphs. Refer to the Block Diagram and to the Schematic Diagram (fold-out from this Page) while you read this Circuit Description.

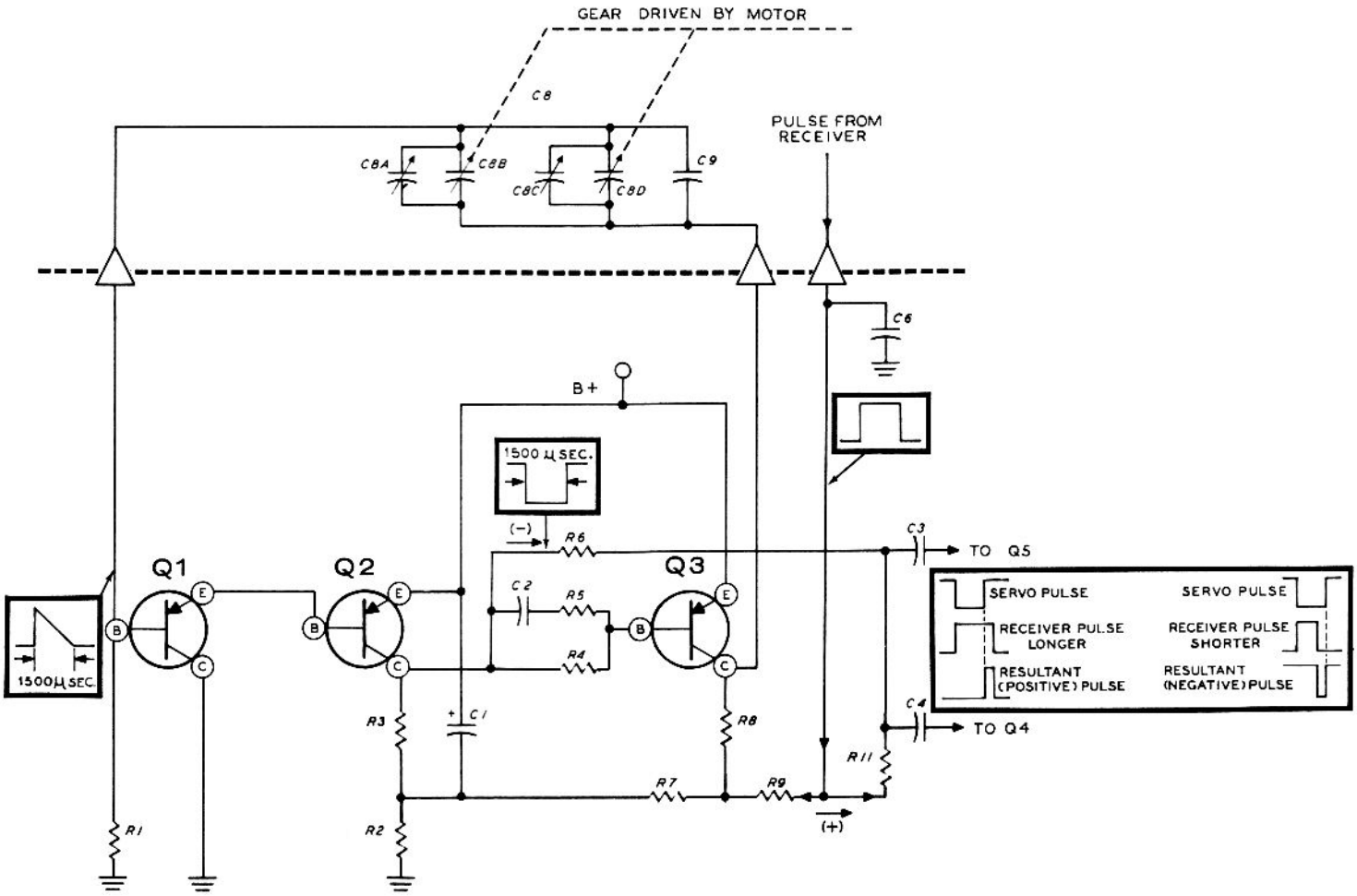
MULTIVIBRATOR CIRCUIT

Transistors Q1, Q2 and Q3 form a monostable (one-shot) multivibrator. See Figure 6-12. In this multivibrator circuit, transistors Q1 and Q2 normally conduct while Q3 is normally cut off. When a positive signal pulse from the Receiver is applied through R8 and R9 to the collector circuit of Q3, the conditions are reversed and Q3 conducts while Q1 and Q2 are cut off. The circuit remains in the reversed condition for a definite period of time and then returns to the normal condition.

The length of time that the multivibrator will remain reversed (normally 1500 microseconds) depends on the RC (resistor-capacitor) time constant set by resistor R1 and capacitors C8 and C9. Capacitor C8 consists of two variable sections, B and D, and two trimmer capacitors, A and C. These parallel capacitors are connected between the base of Q1 and the collector of Q3.

Each positive signal pulse from the Receiver passes through the green wire of the Servo and resistors R9 and R8 to the collector of Q3. This positive signal voltage also passes through capacitors C8 and C9 to the base of Q1, causing Q1 to cut off. Since the emitter of Q1 is direct-coupled to the base of Q2, Q2 also cuts off producing a negative pulse at its collector. This negative pulse, which is coupled through R4 to the base of Q3, causes Q3 to conduct. The circuit remains in this condition until capacitors C8 and C9 charge sufficiently through R1 to raise the base voltage of Q1 and cause it to conduct. Then the circuit reverts to its normal condition.

The variable sections of capacitor C8 are gear-driven by the servo motor. With the capacitor in its midposition, the period of the multivibrator is approximately 1500 microseconds. Thus, the negative pulse from the collector of Q2 lasts for 1500 microseconds, and is coupled through resistor R6 to the junction of capacitors C3 and C4. The positive signal pulse from the Receiver is passed through R11 to the same junction of C3 and C4. If the duration of the positive signal pulse equals the duration of the negative multivibrator pulse, the pulses cancel and the voltage at the junction of C3 and C4 is zero. A signal pulse that is longer than the multivibrator pulse results in a proportionately positive voltage pulse at the junction of C3 and C4, while a shorter signal pulse leaves a proportionately negative voltage pulse at this junction.



MONOSTABLE MULTIVIBRATOR

Figure 6-12

PULSE STRETCHER CIRCUIT

Capacitors C3 and C4 couple any difference pulses to transistors Q4 and Q5. See Figure 6-13. These transistors are connected in series between the supply voltage and ground. Without a difference pulse at the base of Q4 or Q5, neither transistor conducts. The voltage at their common collectors is then approximately half of the voltage between the supply and ground. Capacitor C5 is then charged to this voltage at the collectors.

When a positive difference pulse results from comparing the signal pulse with the multivibrator pulse, transistor Q4 conducts and reduces its collector voltage to zero, causing C5 to charge to the battery voltage. Since this collector is coupled through R14 to the common bases of Q6 and Q7, these bases become more negative. If the difference pulse at the junction of C3 and C4 is negative, transistor Q5 conducts discharging C5, making its collector and the bases of Q6 and Q7 more positive.

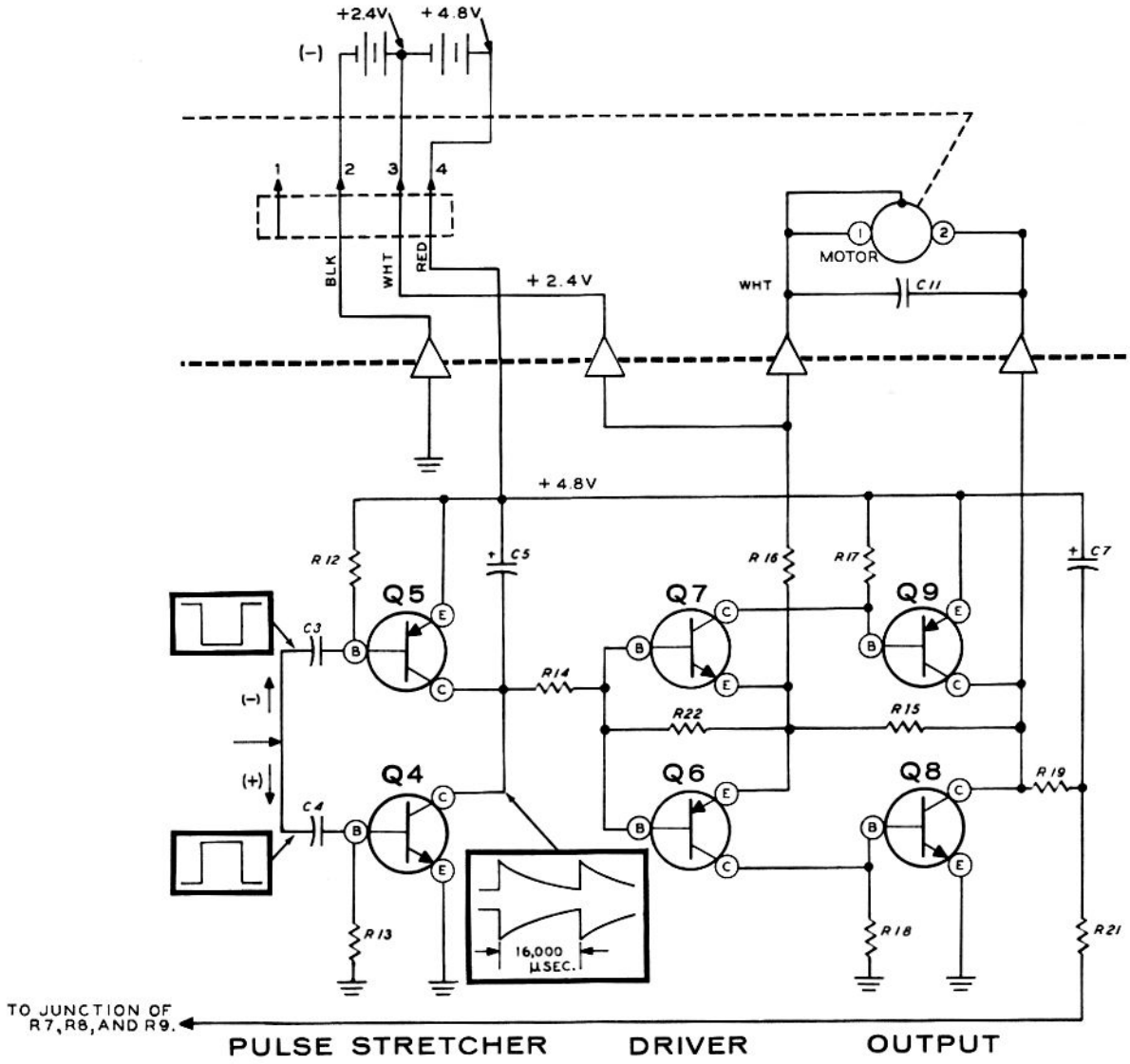


Figure 6-13

As the difference pulse may be very narrow due to only slight differences in the receiver pulse and the multivibrator pulse, and since it is only repeated once every 16,000 microseconds, very little average current would be fed to the motor. Therefore, C5 is used to stretch out this pulse at the collectors of Q4 and Q5 to hold this voltage there for a much longer period of time. This will give the motor greatly increased average current and power.

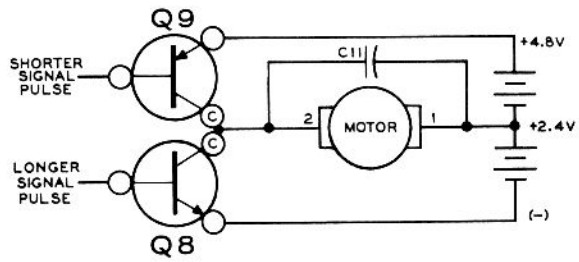


Figure 6-14

DRIVER AND OUTPUT CIRCUITS

The collector of Q6 is direct coupled to the base of Q8, and the collector of Q7 is direct coupled to the base of Q9. The common emitters of Q6 and Q7 are supplied through R16 from the center tap of the battery. When transistor Q6 is made to conduct as the result of a longer signal (positive difference) pulse from the Receiver, Q8 also conducts and shorts its collector to ground. A shorter signal (negative difference) pulse, on the other hand, causes Q9 to conduct and shunts its collector to the 4.8 volt supply. Resistor R15 feeds back a portion of the output to increase the stability of the amplifier, and resistors R19 and R21, along with capacitor C7, form a feedback network to prevent overshoot.

Number 1 pole of the reversible motor is connected to the center tap of the battery as shown in the simplified schematic of Figure 6-14. The motor runs in one direction when number 2 pole is connected to the positive end of the battery, and reverses when this pole is connected to the negative (ground) end of the battery. Transistors Q6 and Q7 are the drivers that operate Q8 and Q9 to perform the battery switching that drives the motor.

The collectors of Q8 and Q9 are common to the number 2 pole of the motor. With a signal pulse from the Receiver that is longer than the multivibrator pulse, transistors Q4, Q6, and Q8 conduct, making the number 2 pole of the motor negative, and driving the motor in one direction. When the signal pulse from the Receiver is shorter than the multivibrator pulse, transistors Q5, Q7, and Q9 conduct. This places the number 2 pole of the motor at the positive end of the battery supply, and the motor runs in the opposite direction. Capacitor C11 is used to filter out motor brush noise.

The length of the multivibrator period is determined by the RC time constant of resistor R1 and variable capacitors C8 and C9. The rotor plates of C8B and C8D are gear-driven by rotation of the servo motor. When a signal pulse length differs from the multivibrator pulse length, the motor turns in one direction and rotates the variable capacitor plates. When the capacity of C8B and C8D change enough to make the multivibrator pulse length equal to the signal pulse length, these pulses cancel and no longer produce the difference pulse that is required to turn on either Q4 and Q5. This absence of a pulse length difference keeps the driver and output transistors turned off and the motor remains stopped. In this way, each different pulse length input to the Servo is represented by a different portion of the variable capacitor and the output wheel and coupling tabs.

The motor gear train turns the variable capacitor rotor plates while it drives a pair of rack gears. The rack gears can be driven approximately 5/8 inch. These rack gears are mechanically connected to one of the control devices in the model so that the Servo unit operates the device.

PULSE STRETCHER CIRCUIT

Capacitors C3 and C4 couple any difference pulses to transistors Q4 and Q5. See Figure 6-13. These transistors are connected in series between the supply voltage and ground. Without a difference pulse at the base of Q4 or Q5, neither transistor conducts. The voltage at their common collectors is then approximately half of the voltage between the supply and ground. Capacitor C5 is then charged to this voltage at the collectors.

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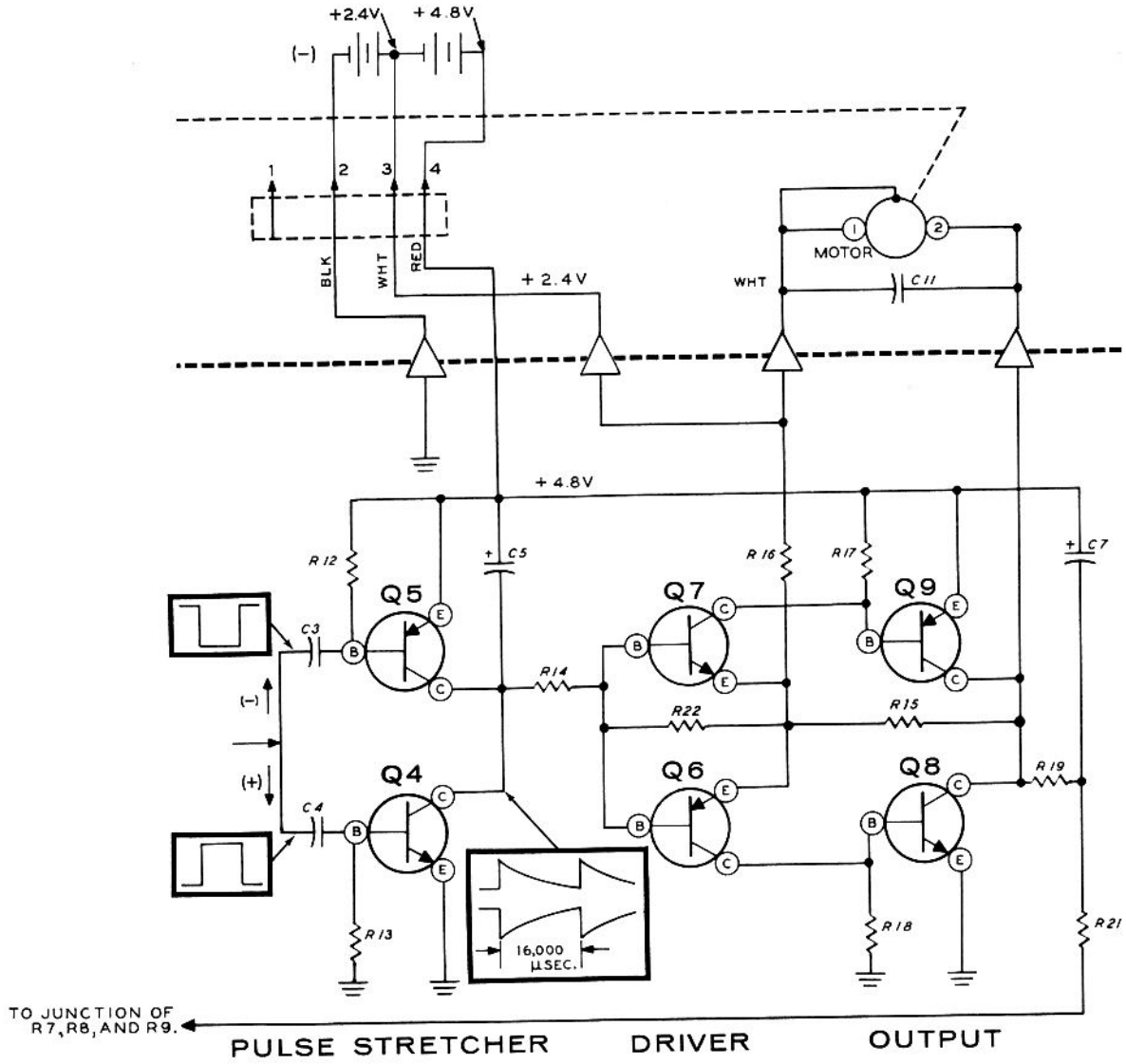

Figure 6-13

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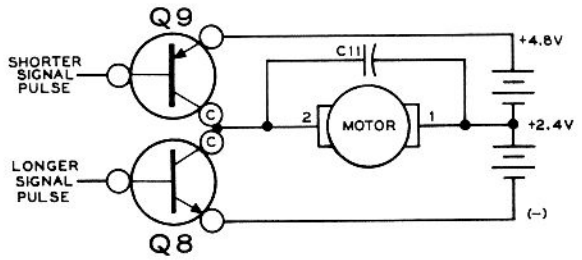

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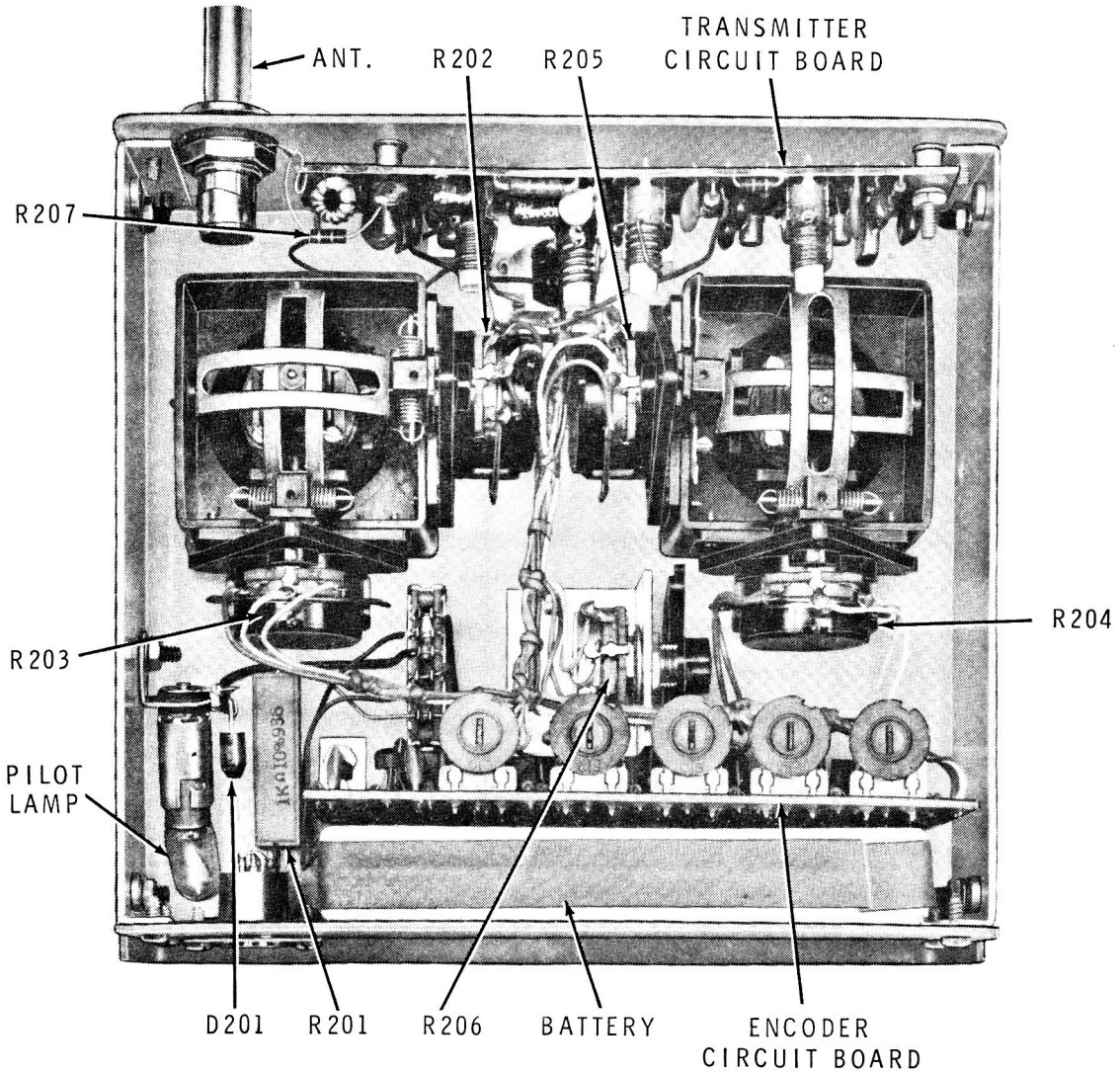
The motor gear train turns the variable capacitor rotor plates while it drives a pair of rack gears. The rack gears can be driven approximately 5/8 inch. These rack gears are mechanically connected to one of the control devices in the model so that the Servo unit operates the device.

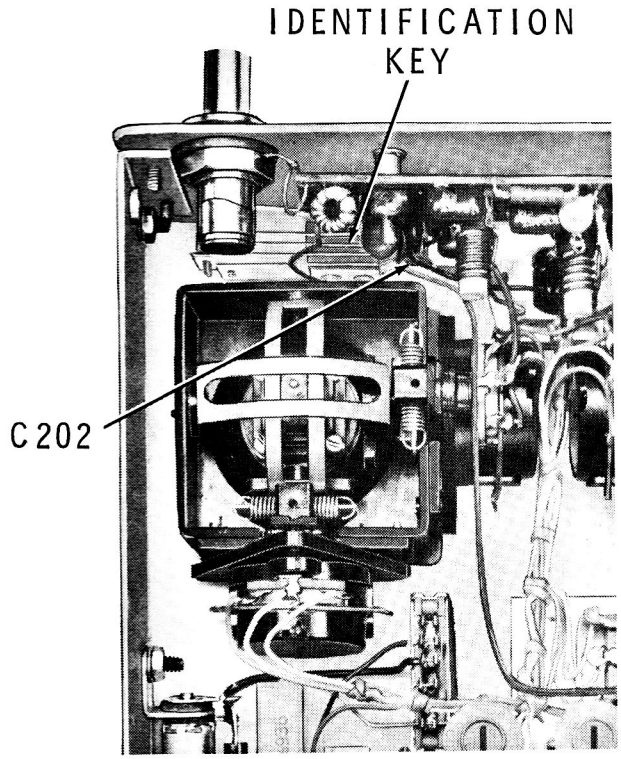
IDENTIFICATION

NOTE: This chassis photograph shows the 72 MHz band Transmitter. The 27 MHz band Transmitter is similar except for a different transmitter circuit board, R207 is not used, and a 100 pF capacitor is connected between the transmitter circuit board and antenna lug.

TRANSMITTER CHASSIS PHOTOGRAPHS

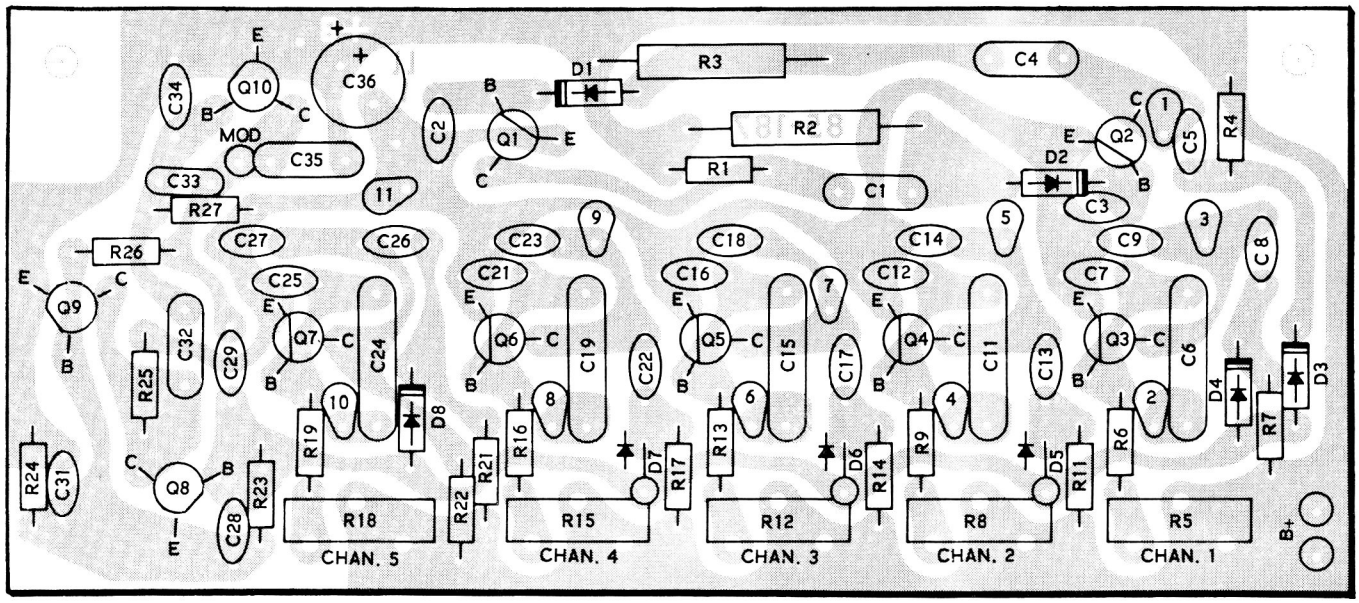


72 MHz BAND TRANSMITTER



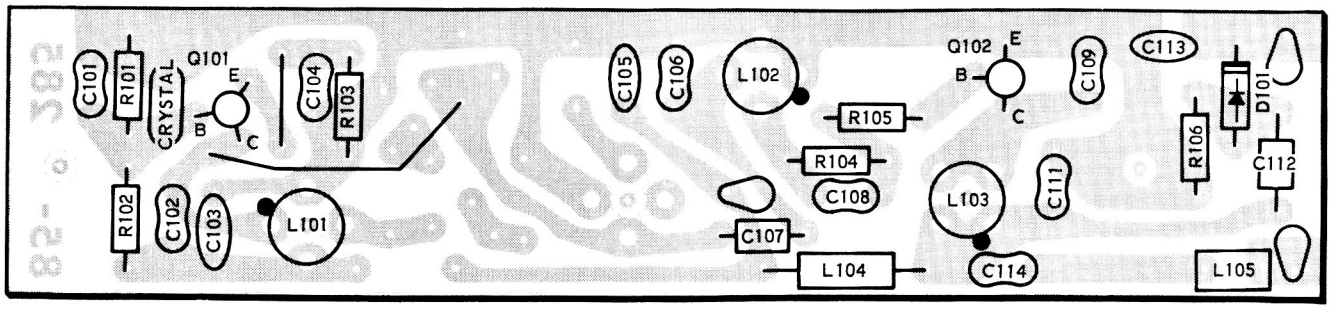
53 MHz BAND TRANSMITTER

TRANSMITTER CIRCUIT BOARD X-RAY VIEWS



ENCODER CIRCUIT BOARD

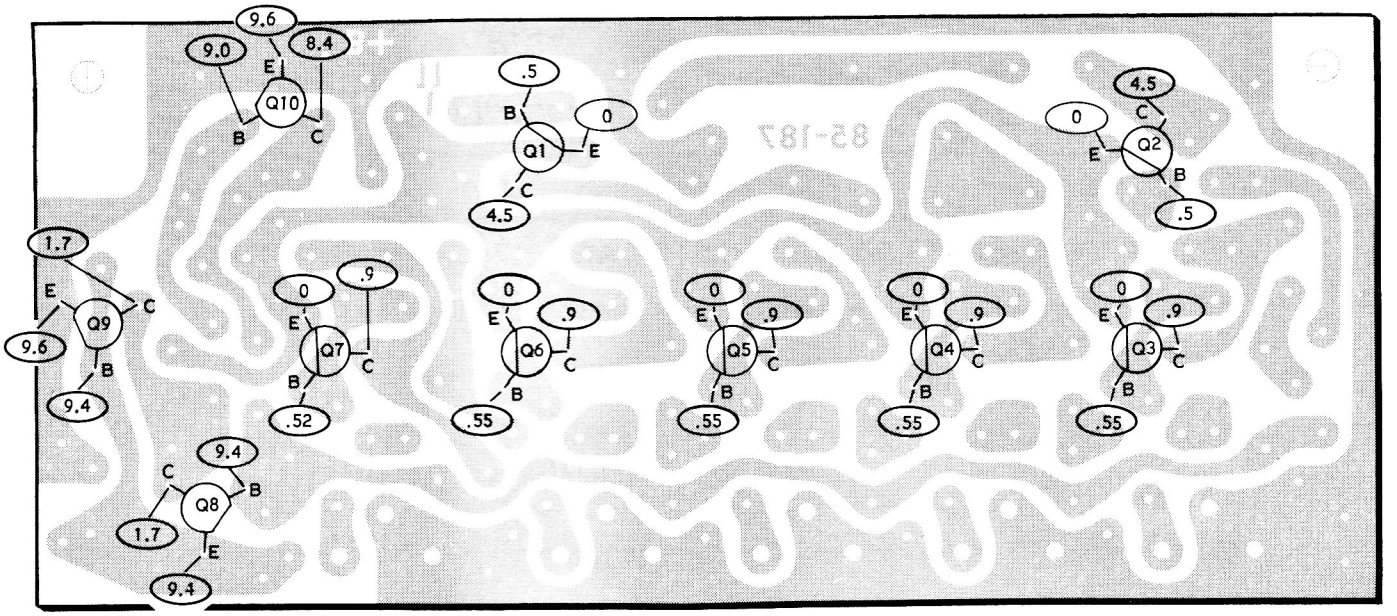
(SHOWN FROM COMPONENT SIDE)



RF TRANSMITTER CIRCUIT BOARD
(53 MHz BAND)

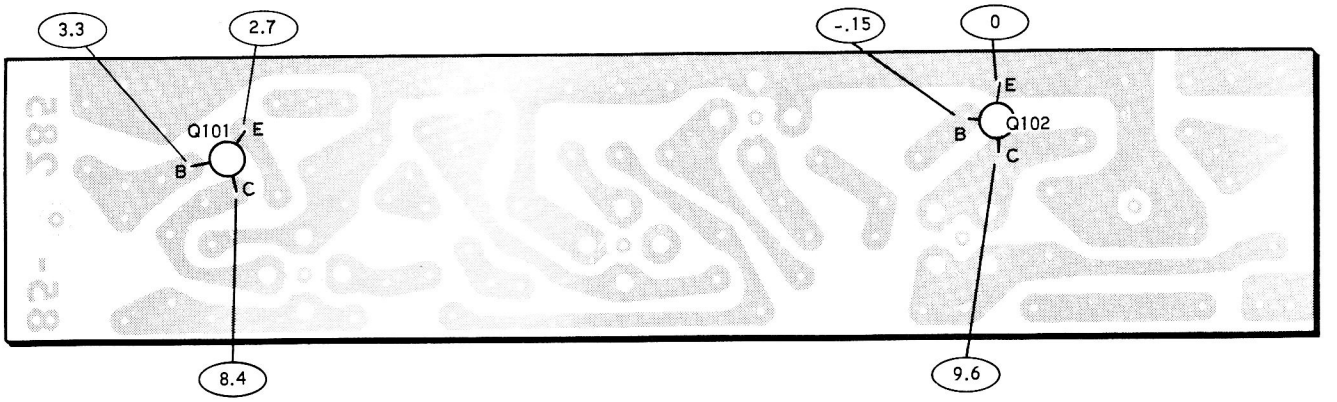
(SHOWN FROM COMPONENT SIDE)

TRANSMITTER VOLTAGE CHARTS



ENCODER CIRCUIT BOARD

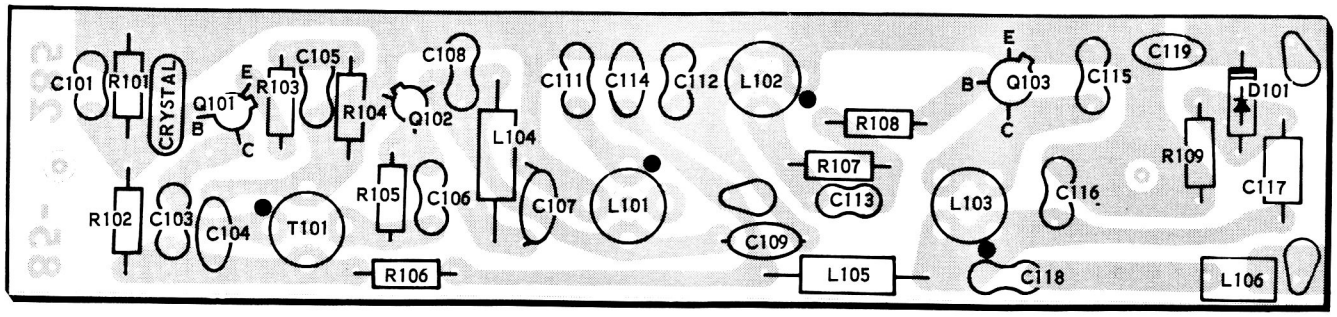
(SHOWN FROM COMPONENT SIDE)



+DC VOLTAGE

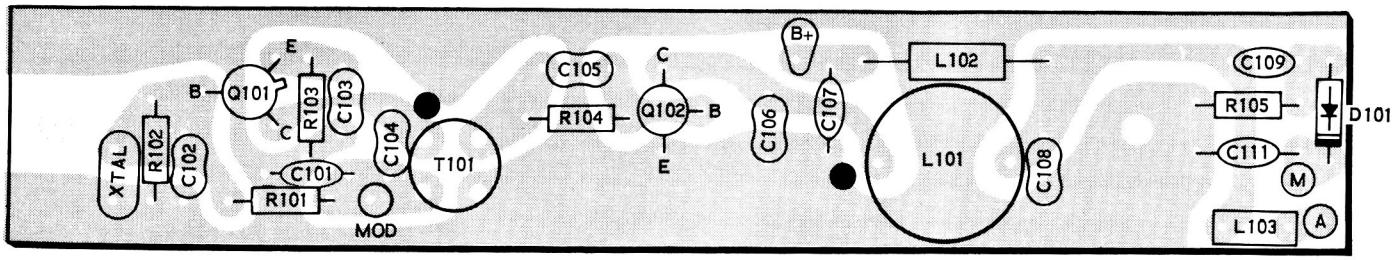
RF TRANSMITTER CIRCUIT BOARD
(53 MHz BAND)

(SHOWN FROM COMPONENT SIDE)



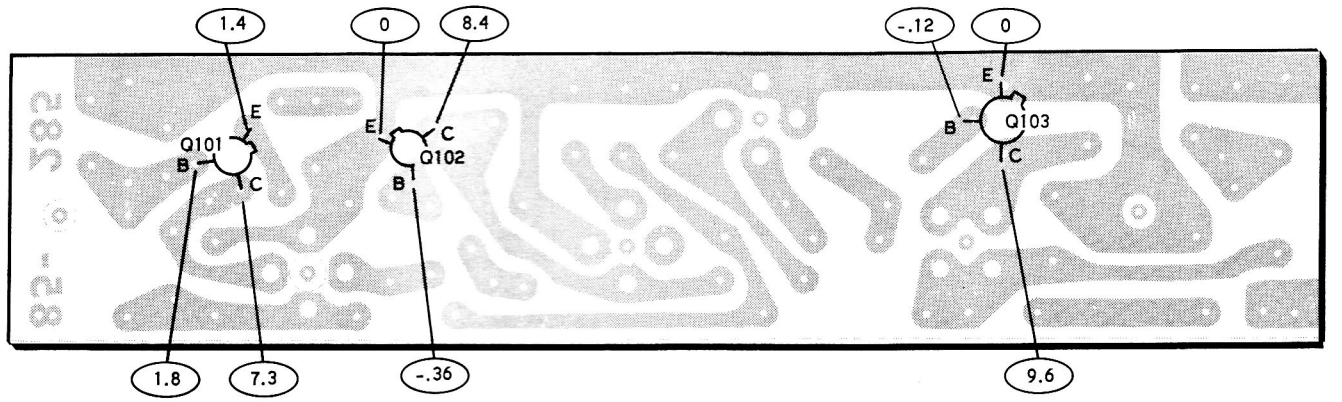
RF TRANSMITTER CIRCUIT BOARD (72 MHz BAND)

(SHOWN FROM COMPONENT SIDE)



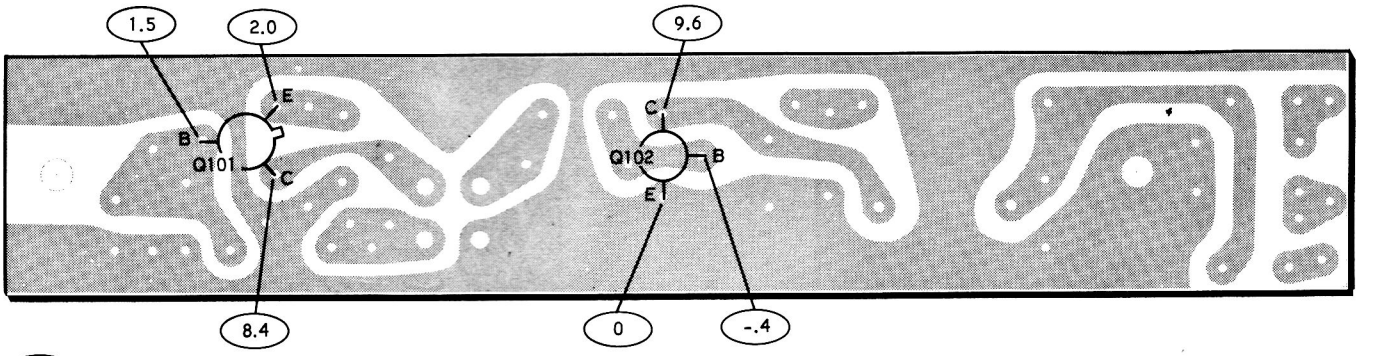
RF TRANSMITTER CIRCUIT BOARD (27 MHz BAND)

(SHOWN FROM COMPONENT SIDE)



RF TRANSMITTER CIRCUIT BOARD (72 MHz BAND)

(SHOWN FROM COMPONENT SIDE)

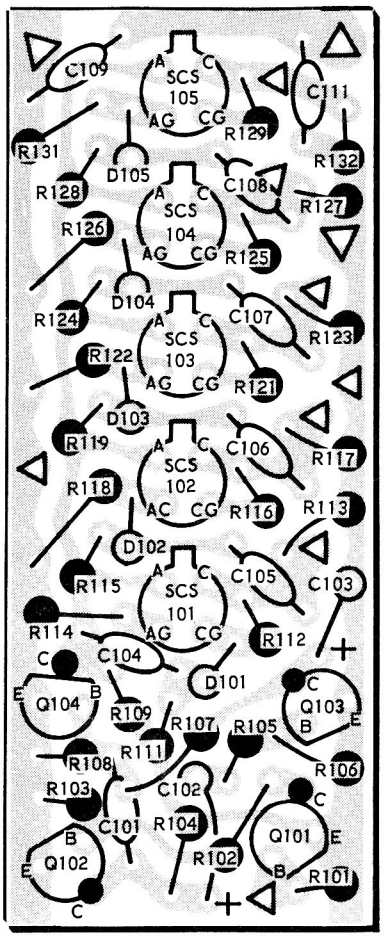


+ DC VOLTAGE

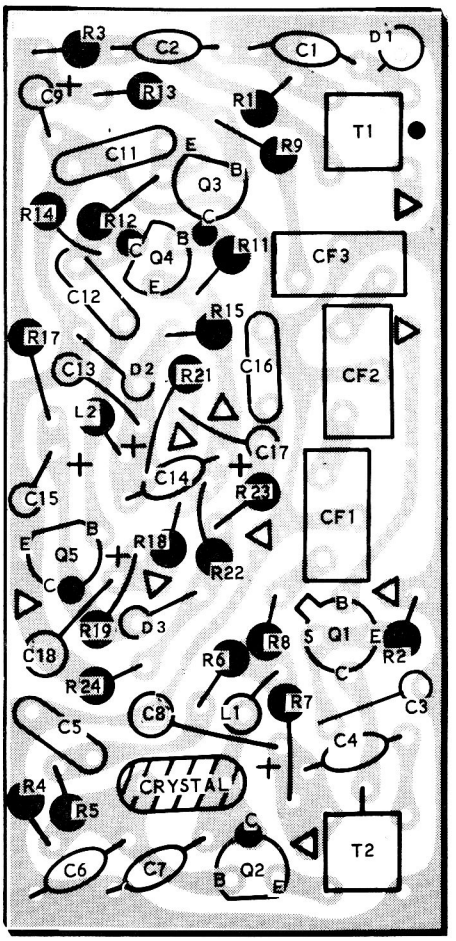
RF TRANSMITTER CIRCUIT BOARD (27 MHz BAND)

(SHOWN FROM COMPONENT SIDE)

RECEIVER CIRCUIT BOARD X-RAY VIEWS

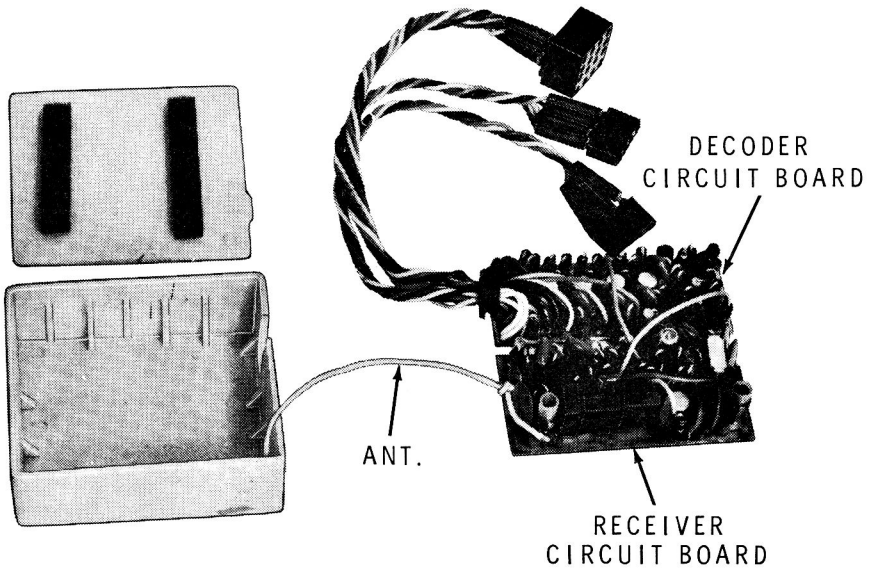


DECODER CIRCUIT BOARD
(SHOWN FROM FOIL SIDE)

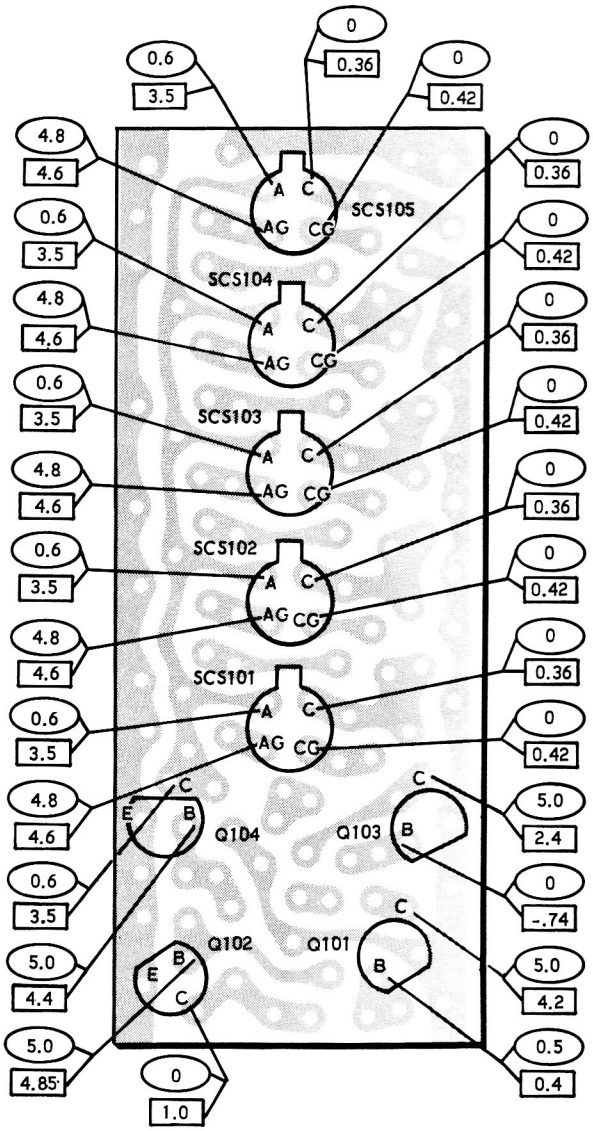


RECEIVER CIRCUIT BOARD
(SHOWN FROM FOIL SIDE)

RECEIVER CHASSIS PHOTOGRAPH



RECEIVER VOLTAGE CHARTS

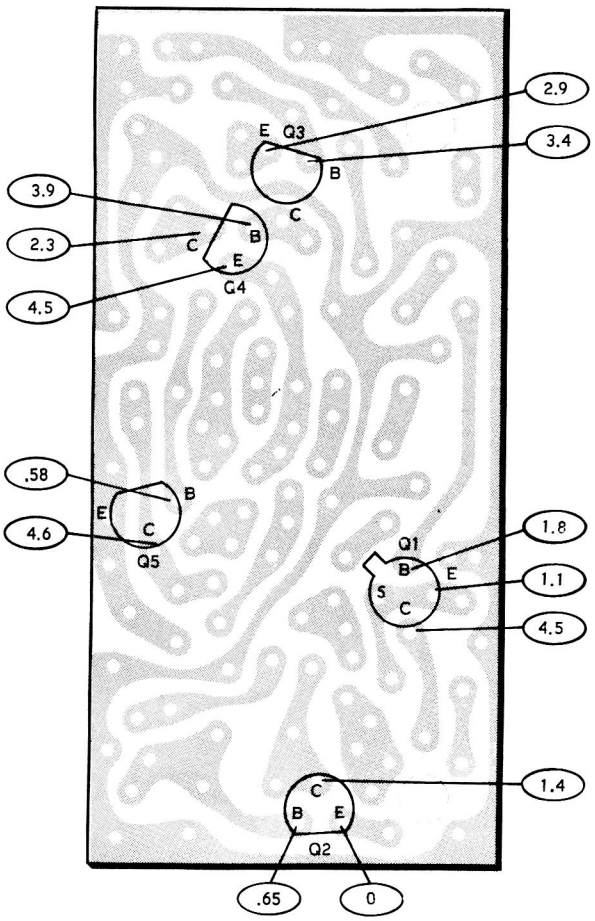


+DC VOLTAGE, NO SIGNAL CONDITIONS.

+DC VOLTAGE, SIGNAL CONDITIONS.

DECODER CIRCUIT BOARD

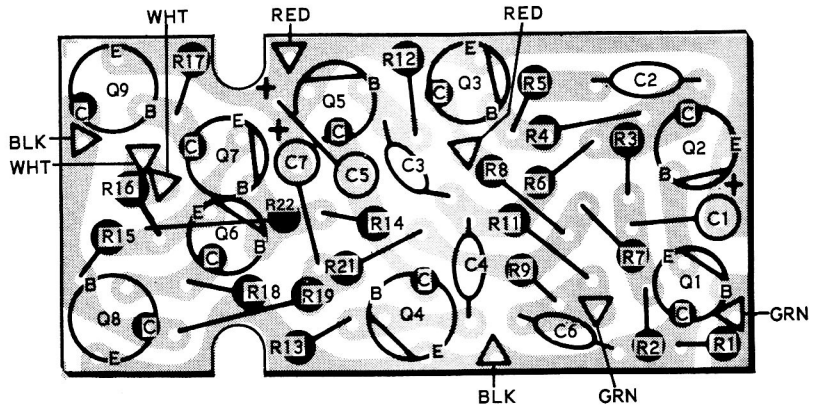
(SHOWN FROM FOIL SIDE)



RECEIVER CIRCUIT BOARD

(SHOWN FROM FOIL SIDE)

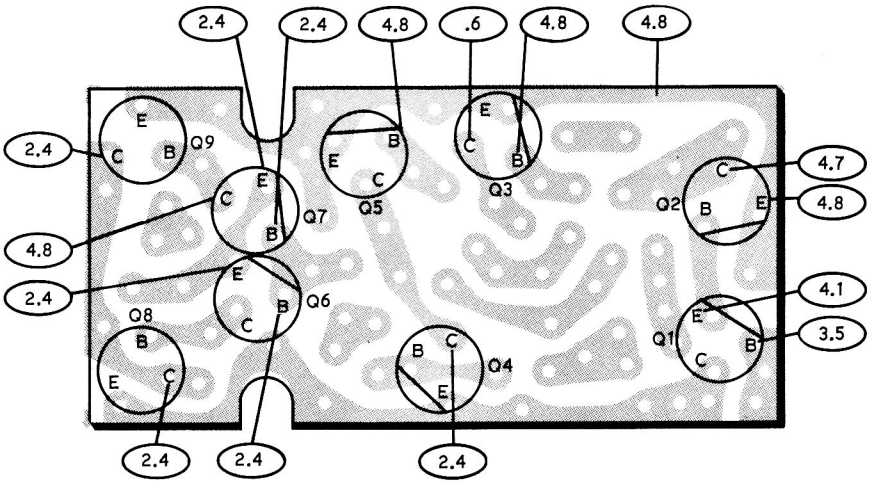
SERVO CIRCUIT BOARD X-RAY VIEW



SERVO CIRCUIT BOARD

(SHOWN FROM FOIL SIDE)

SERVO VOLTAGE CHART

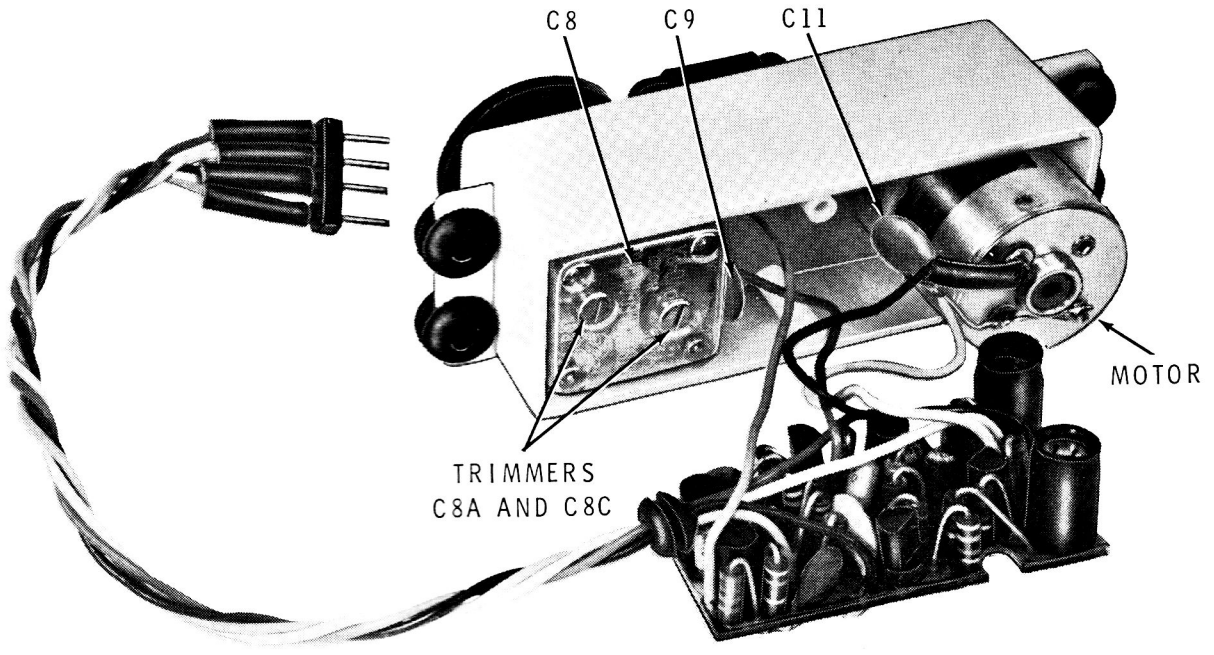


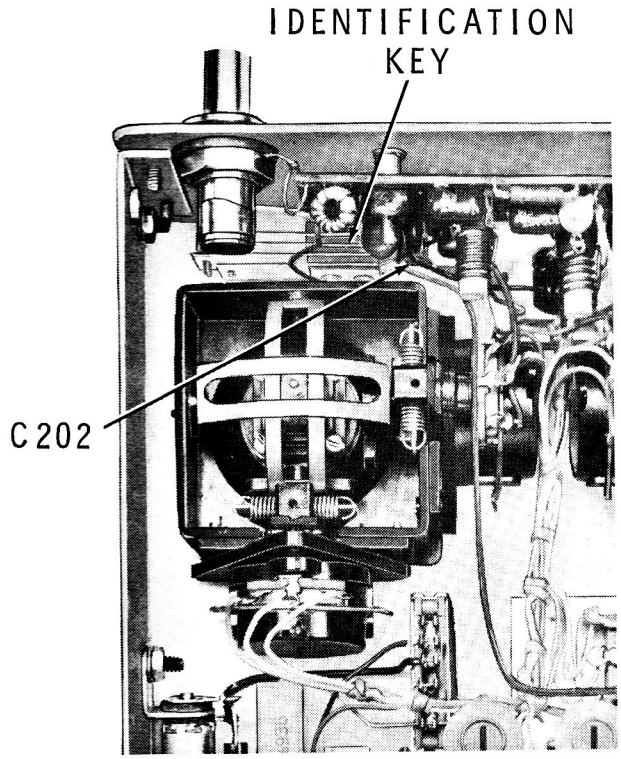
SERVO CIRCUIT BOARD

(SHOWN FROM FOIL SIDE)

⬭ +DC VOLTAGE

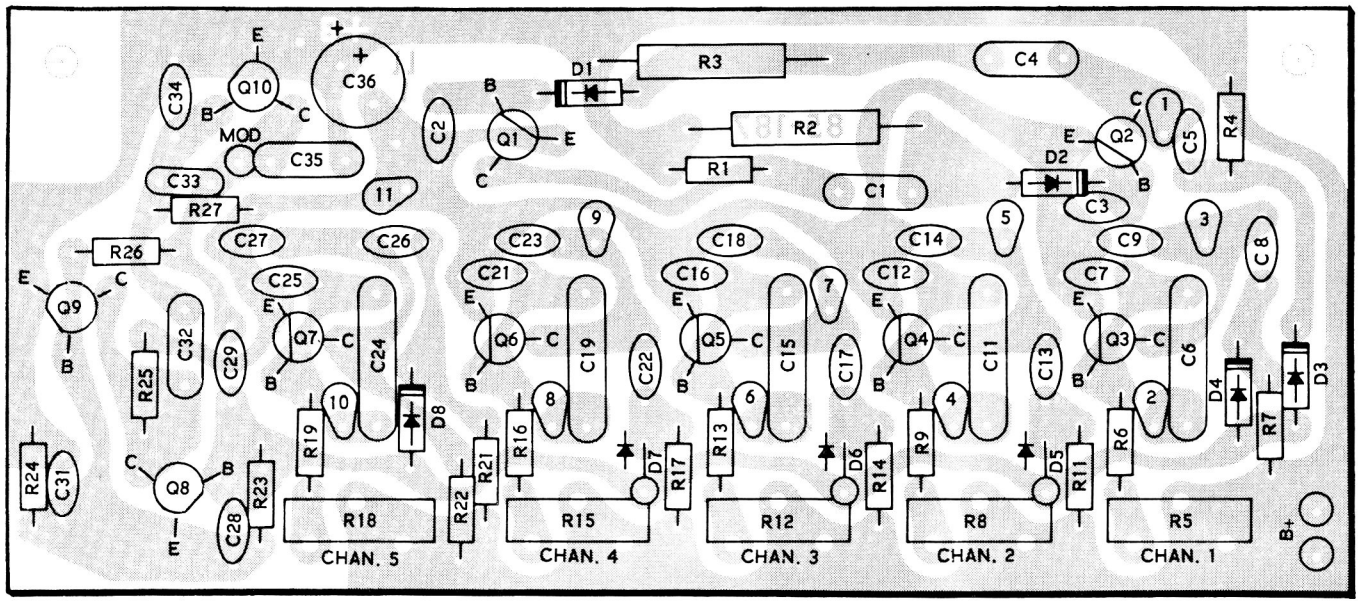
SERVO CHASSIS PHOTOGRAPH





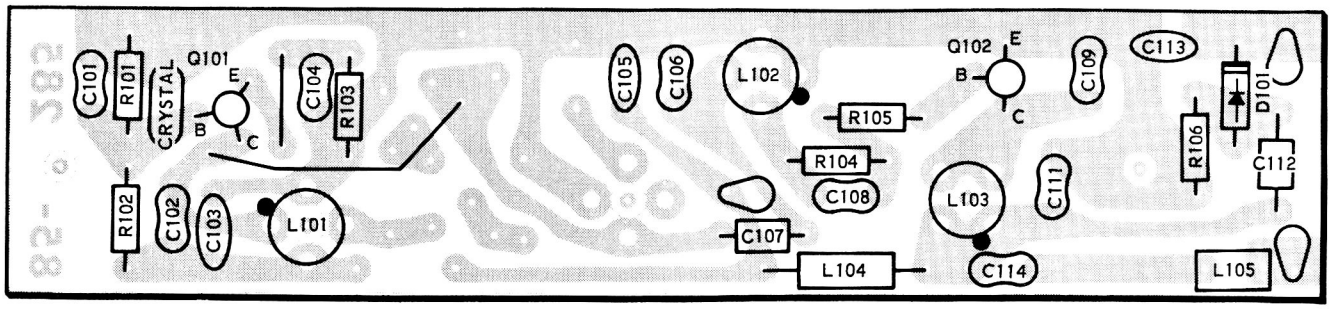
53 MHz BAND TRANSMITTER

TRANSMITTER CIRCUIT BOARD X-RAY VIEWS



ENCODER CIRCUIT BOARD

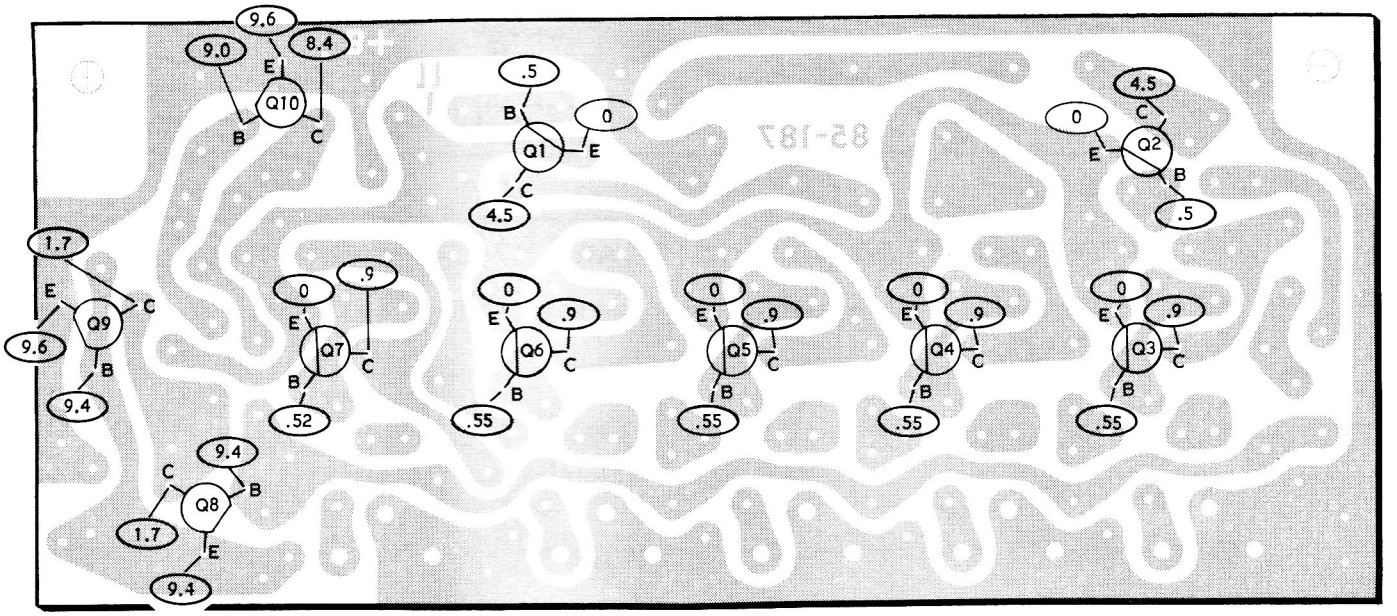
(SHOWN FROM COMPONENT SIDE)



RF TRANSMITTER CIRCUIT BOARD
(53 MHz BAND)

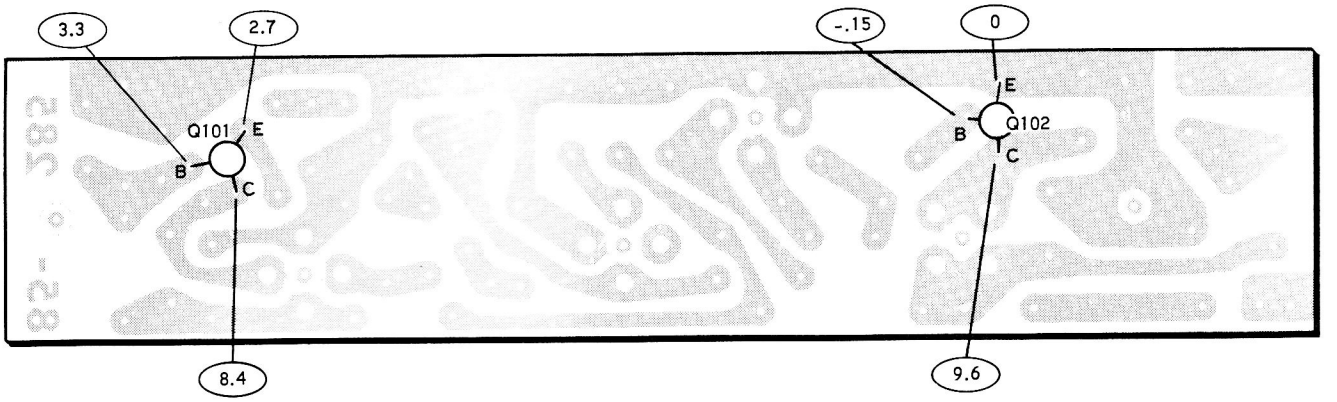
(SHOWN FROM COMPONENT SIDE)

TRANSMITTER VOLTAGE CHARTS



ENCODER CIRCUIT BOARD

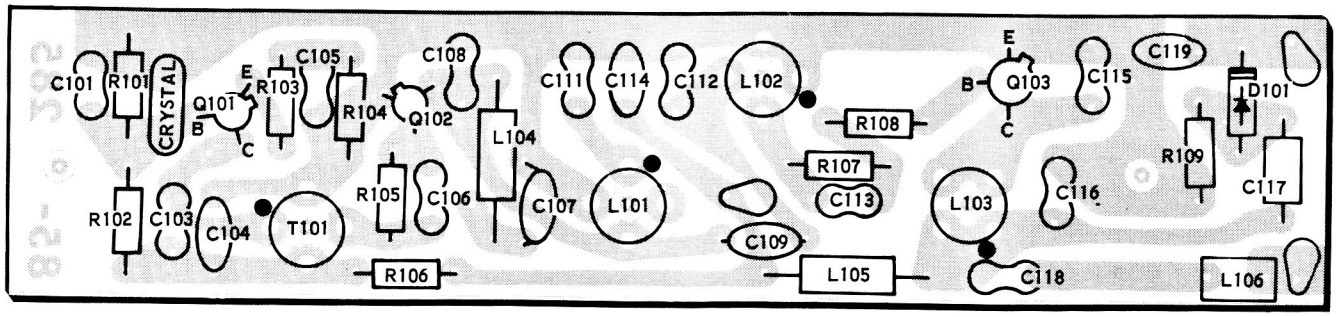
(SHOWN FROM COMPONENT SIDE)



+DC VOLTAGE

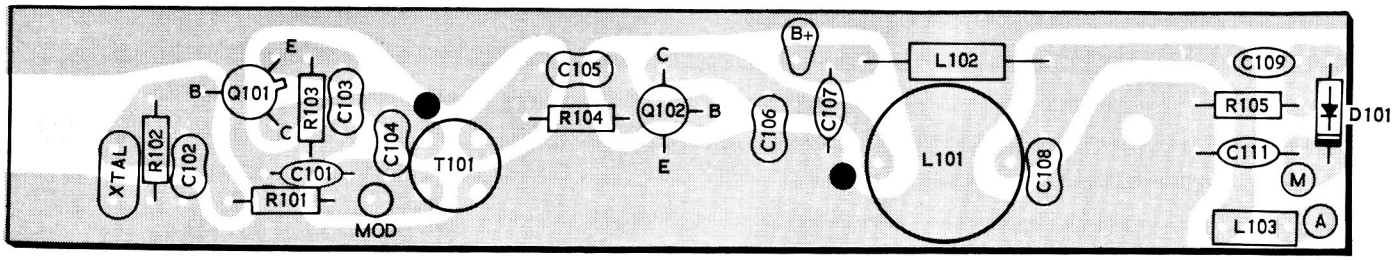
RF TRANSMITTER CIRCUIT BOARD
(53 MHz BAND)

(SHOWN FROM COMPONENT SIDE)



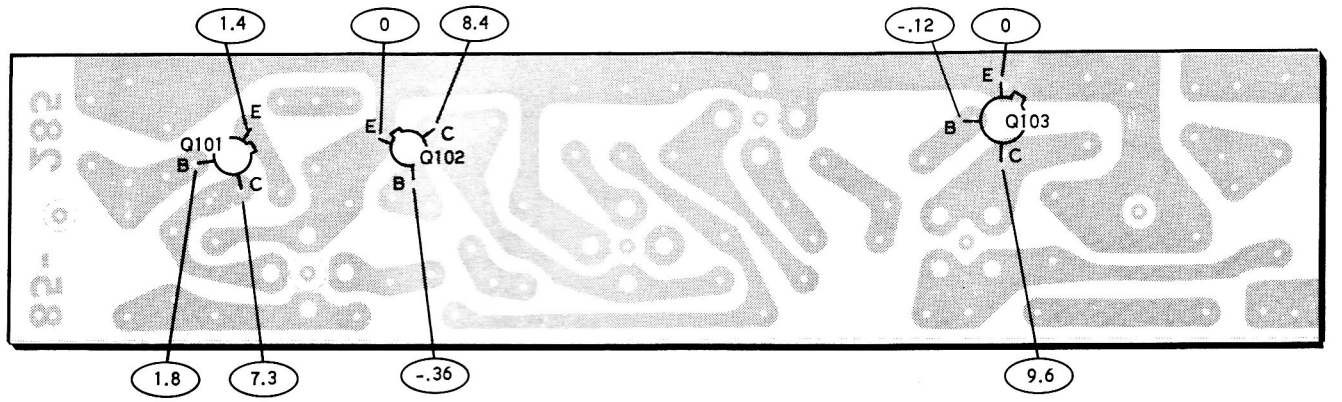
RF TRANSMITTER CIRCUIT BOARD (72 MHz BAND)

(SHOWN FROM COMPONENT SIDE)



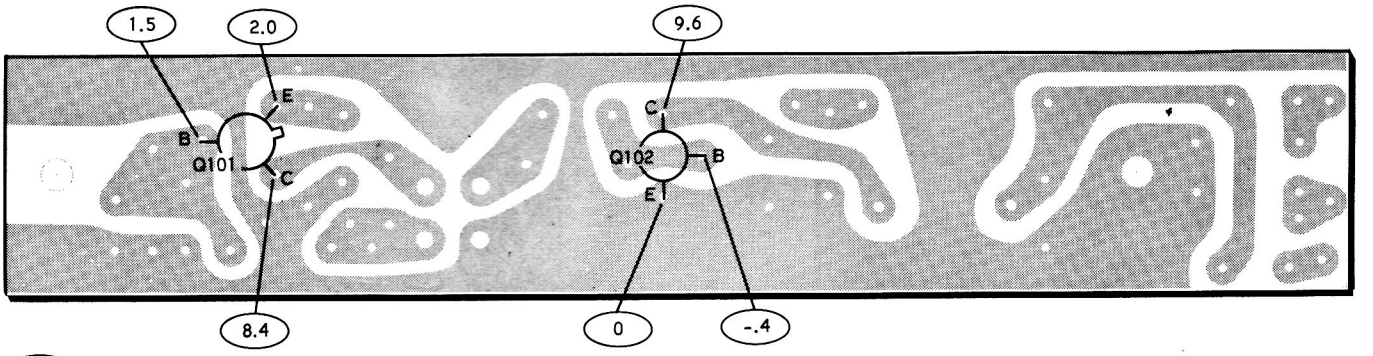
RF TRANSMITTER CIRCUIT BOARD (27 MHz BAND)

(SHOWN FROM COMPONENT SIDE)



RF TRANSMITTER CIRCUIT BOARD (72 MHz BAND)

(SHOWN FROM COMPONENT SIDE)

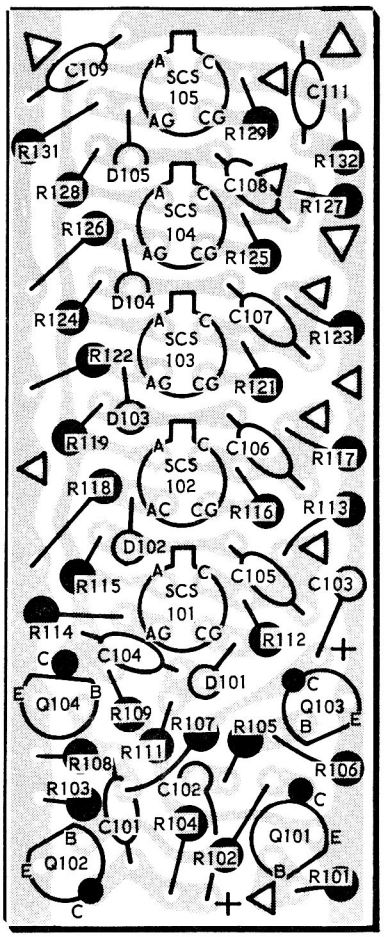


+ DC VOLTAGE

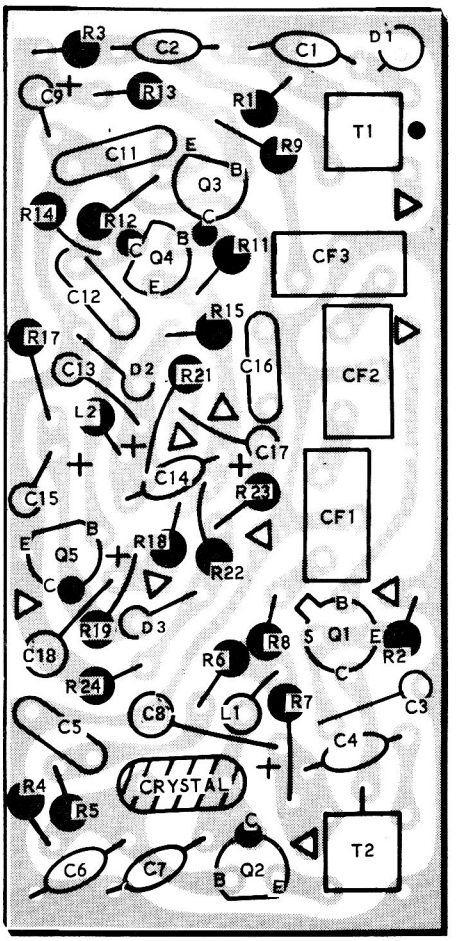
RF TRANSMITTER CIRCUIT BOARD (27 MHz BAND)

(SHOWN FROM COMPONENT SIDE)

RECEIVER CIRCUIT BOARD X-RAY VIEWS

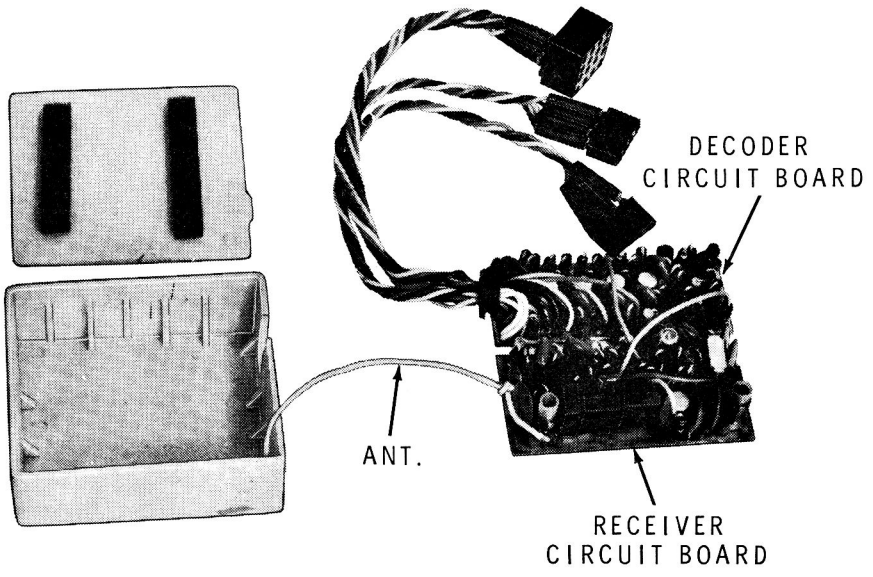


DECODER CIRCUIT BOARD
(SHOWN FROM FOIL SIDE)

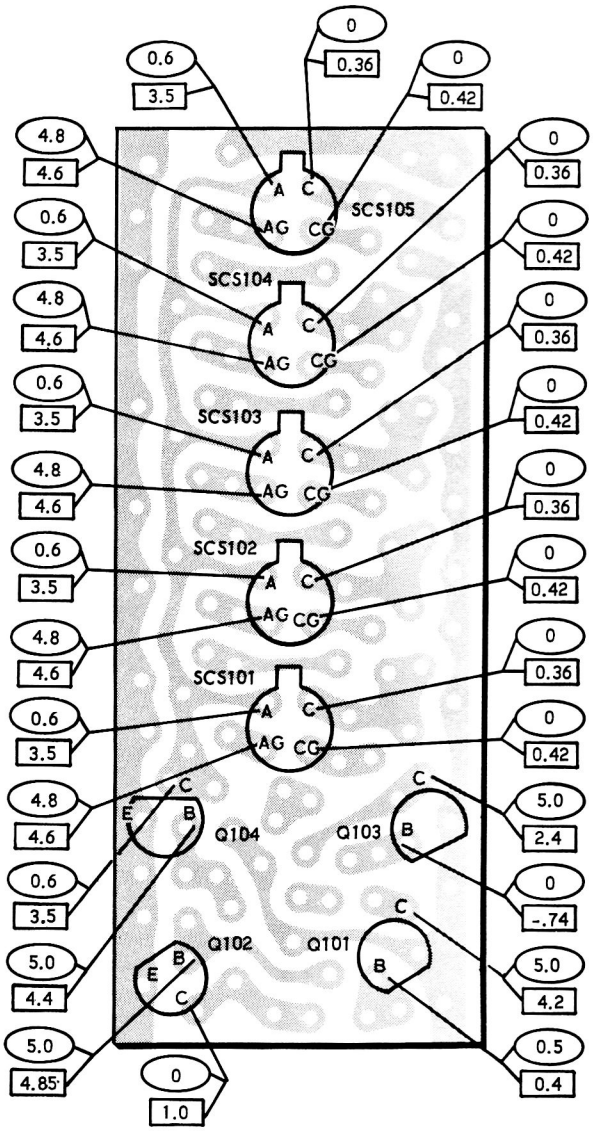


RECEIVER CIRCUIT BOARD
(SHOWN FROM FOIL SIDE)

RECEIVER CHASSIS PHOTOGRAPH



RECEIVER VOLTAGE CHARTS

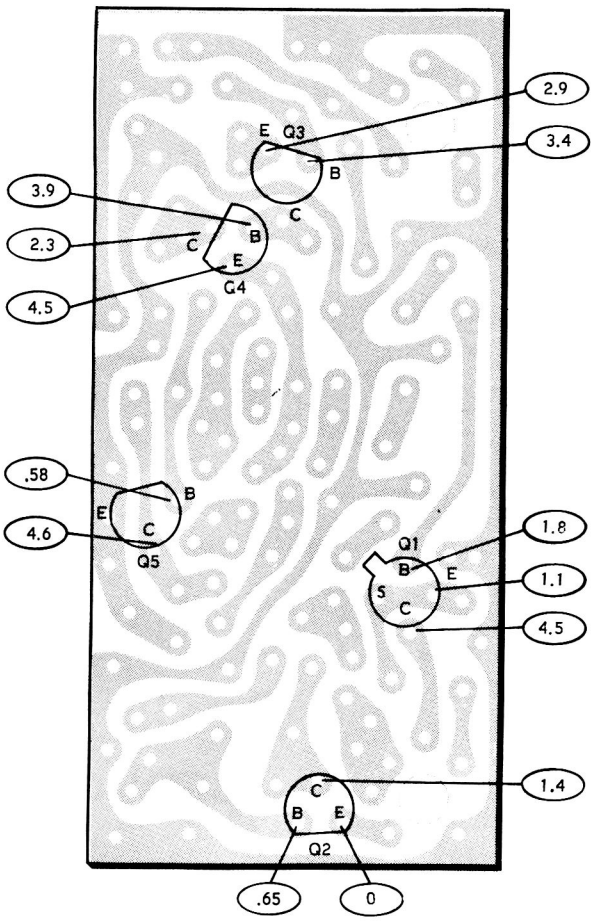


+DC VOLTAGE, NO SIGNAL CONDITIONS.

+DC VOLTAGE, SIGNAL CONDITIONS.

DECODER CIRCUIT BOARD

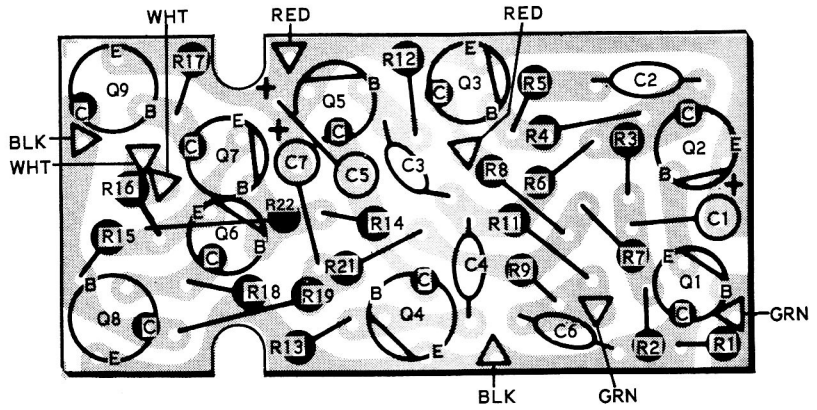
(SHOWN FROM FOIL SIDE)



RECEIVER CIRCUIT BOARD

(SHOWN FROM FOIL SIDE)

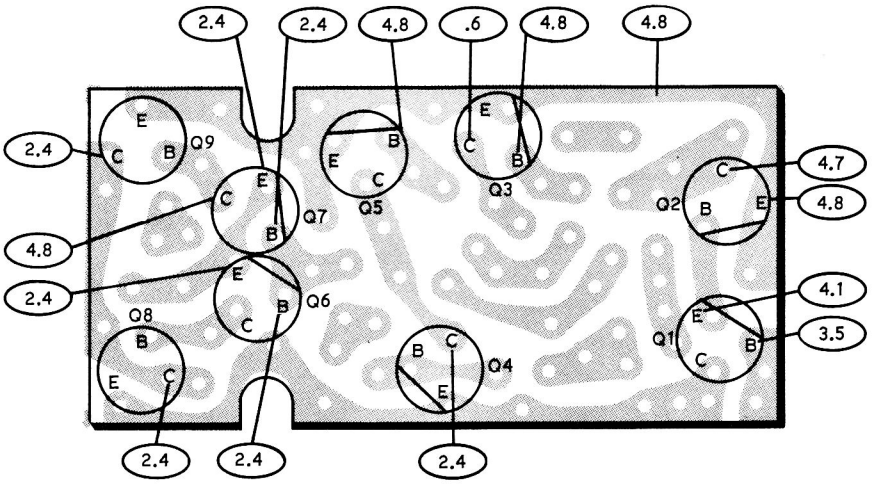
SERVO CIRCUIT BOARD X-RAY VIEW



SERVO CIRCUIT BOARD

(SHOWN FROM FOIL SIDE)

SERVO VOLTAGE CHART

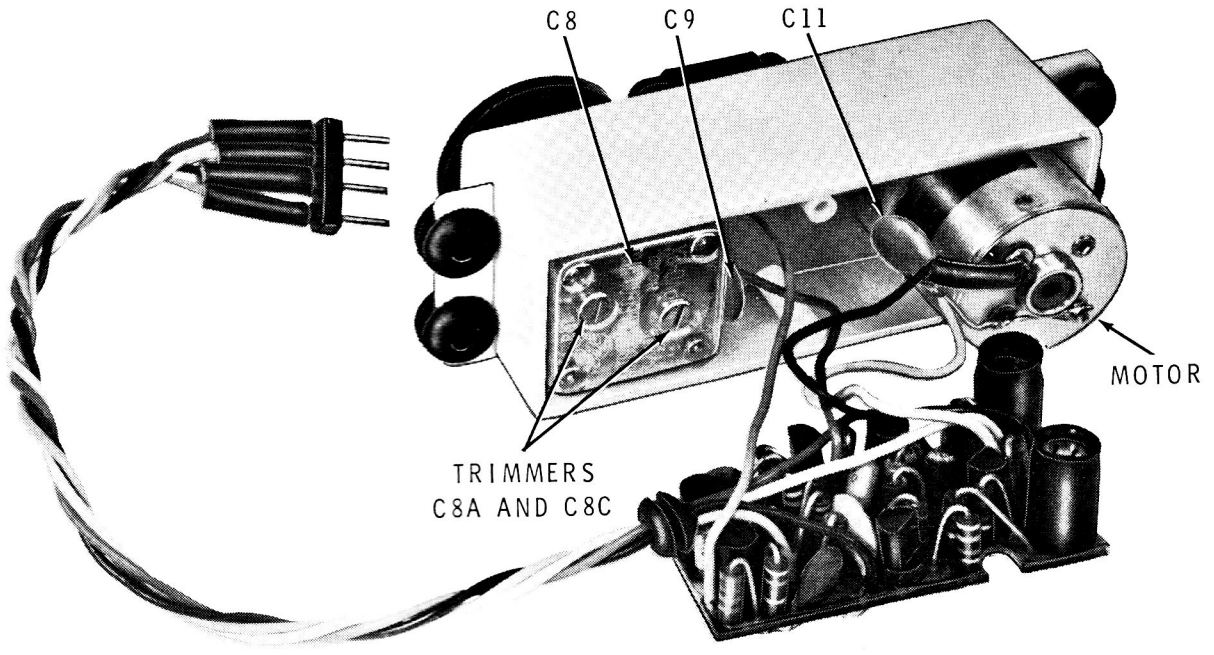


SERVO CIRCUIT BOARD

(SHOWN FROM FOIL SIDE)

⬭ +DC VOLTAGE

SERVO CHASSIS PHOTOGRAPH



REPLACEMENT PARTS PRICE LIST

To order parts, use the Parts Order Form furnished with this kit. If a Parts Order Form is not available, refer to Replacement Parts in the Kit Builders Guide.

The following prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from an authorized Service Center or Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation taxes, duties and rates of exchange.

MANUAL PACK

The Manual Pack for this Radio Control System, Model GD-19, includes the following parts:

PART No.	PRICE Each	DESCRIPTION
597-260 597-308	2.00	Assembly Manual (See front cover for part number.) Parts Order Form Kit Builders Guide

TRANSMITTER

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/4 Watt		
1-2-12	.10	1000 Ω
1-4-12	.10	2200 Ω
1-8-12	.10	4700 Ω
1-46-12	.10	27 kΩ
1-11-12	.10	47 kΩ
1-47-12	.10	150 kΩ
Other Resistors		
1-10	.10	1200 Ω 1/2 watt
1-21	.10	15 kΩ 1/2 watt
1-102	.10	82 kΩ 1/2 watt
2-208	.25	111 kΩ 1/2 watt 1%
3-15-7	.15	1000 Ω 7 watt
CAPACITORS		
20-102	.15	100 pF mica
21-140	.10	.001 μF disc
21-46	.10	.005 μF disc
27-74	.10	.01 μF Mylar
27-63	.10	.022 μF Mylar (small)
27-88	.15	.022 μF Mylar (large)
27-77	.10	.1 μF Mylar
25-116	.50	50 μF electrolytic
DIODES-TRANSISTORS		
56-27	.25	Silicon diode (GES160)
57-27	.50	Silicon rectifier (1N2079)
417-118	.40	2N3393 transistor
417-201	.50	X29A829 transistor
417-91	.85	2N5232A/2N3391A transistor
SWITCH-SOCKETS-CONNECTORS		
60-35	1.15	Slide switch
434-88	.15	Pilot lamp socket
432-101	.70	4-terminal socket
432-106	1.00	4-pin plug with cap
432-104	.70	4-pin flat connector

PART No.	PRICE Each	DESCRIPTION
LINE CORD-WIRE		
89-38	.40	Line cord
134-189	1.60	Wire harness
344-50	.05/ft	Black solid wire
344-52	.05/ft	Red solid wire
344-90	.05/ft	Black stranded wire
344-92	.05/ft	Red stranded wire
346-35	.05/ft	Small black sleeving
346-20	.15/ft	Medium-size black sleeving
346-3	.05/ft	Large black sleeving
METAL PARTS		
90-427	.90	Cabinet back
90-428	1.35	Cabinet front
100-801	.40	Side bracket
204-102	.10	Support bracket
204-920	.10	Control mounting bracket
204-922	.10	Meter mounting bracket
205-729	.40	Cabinet bottom plate
TRANSMITTER RF CIRCUIT BOARD ASSEMBLY		
181-26	9.60	26.995
181-27	9.60	27.045
181-28	9.60	27.095
181-29	9.60	27.145
181-30	9.60	27.195
181-430	12.00	53.100
181-431	12.00	53.200
181-432	12.00	53.300
181-433	12.00	53.400
181-434	12.00	53.500
181-435	12.00	72.080
181-436	12.00	72.240
181-437	12.00	72.400
181-438	12.00	72.960
181-439	12.00	75.640

PART No.	PRICE Each	DESCRIPTION
GENERAL		
10-222	.45	50 kΩ control
10-273	.55	5000 Ω control
75-93	.10	Fiber insulator
85-187-3	1.50	Encoder circuit board
142-113	2.55	Antenna
260-16	.10	Alligator clip
407-116	3.00	Meter
412-47	.35	Pilot lamp (#1820)
413-15	.30	Pilot lamp jewel
100-960	16.95	Battery assembly (9.6 volt nickel-cadmium)
462-299	.60	Thumb knob
266-145	.15	Switch stop
490-5	.10	Nut starter
490-110	.25	Wrench
331-6	.15	Solder

The following parts are supplied with the transmitters indicated.

27 MHz Band Transmitter

205-649	.35	Cabinet top plate

53 MHz Band Transmitter (The group has a part number of 171-2410).

64-39	1.60	Pushbutton switch assembly
205-711	.30	Cabinet top plate
254-5	.05	Control lockwasher
344-91	.05/ft	Brown stranded wire
27-64	.15	.033 μF Mylar capacitor

72 MHz Band Transmitter

205-726	.35	Cabinet top plate

All transmitters contain the following parts.

HARDWARE

#3 Hardware

250-49	.05	3-48 x 1/4" screw

#4 Hardware

250-163	.05	4-40 x 5/16" self-tapping screw
250-285	.05	4-40 x 1/4" screw
250-312	.05	4-40 x 3/4" screw
252-2	.05	4-40 nut
254-9	.05	#4 lockwasher
250-477	.05	4-24 x 3/4" self-tapping screw

#6 Hardware

250-276	.05	6-32 x 3/8" black screw
252-3	.05	6-32 nut
254-1	.05	#6 lockwasher
259-1	.05	#6 solder lug

PART No.	PRICE Each	DESCRIPTION
Other Hardware		
252-7	.05	Control nut
253-100	.05	Antenna fiber flat washer
253-101	.05	Antenna fiber shoulder washer
254-4	.05	Control lockwasher
255-29	.05	3/16" spacer
253-103	.05	1/4" fiber washer

CONTROL STICK PARTS

11-114	1.75	5000 Ω control
205-682	1.50	Control mounting plate (marked #1)
205-683	1.50	Control mounting plate (marked #2)
238-58	4.95	Control stick housing
214-82	.30	Control front cover
214-83	.30	Control back cover
214-84	.45	Ball housing
253-124	.25	Teflon washer
255-100	.15	Nylon spacer
265-16	.10	Hinge pin
266-121	1.30	Gimbal #1
266-122	1.30	Gimbal #2
266-123	3.00	Control stick
266-125	3.00	Chrome cup
455-77	1.05	Adjustable bearing
456-24	.15	Control stick coupler
456-25	.30	Gimbal coupler
462-300	.45	Trim plate
462-301	.45	Control stick knob

Control Stick Hardware

250-355	.05	2-32 x 3/16" screw
250-420	.05	2-32 x 1/4" screw
250-421	.05	2-56 x 3/8" screw
250-422	.05	2-56 x 5/16" screw
208-17	.15	Spring clip
252-7	.05	Control nut
253-119	.05	Control washer
258-103	.25	Centering spring
266-124	.25	Dog stop
455-78	.15	Brass bushing

RECEIVER

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/4 Watt		
1-1-12	.10	100 Ω
1-35-12	.10	470 Ω
1-24-12	.10	820 Ω
1-2-12	.10	1000 Ω
1-36-12	.10	1500 Ω
1-4-12	.10	2200 Ω
1-5-12	.10	2700 Ω
1-8-12	.10	4700 Ω
1-26-12	.10	5600 Ω
1-27-12	.10	6800 Ω
1-9-12	.10	10 kΩ
1-10-12	.10	15 kΩ
1-52-12	.10	18 kΩ
1-45-12	.10	22 kΩ
1-46-12	.10	27 kΩ
1-11-12	.10	47 kΩ
1-32-12	.10	100 kΩ
1-41-12	.10	33 kΩ
CAPACITORS		
Disc		
21-6	.10	27 pF
21-147	.10	47 pF
21-148	.10	75 pF
21-140	.10	.001 μF
21-141	.10	.0033 μF
21-27	.10	.005 μF
Tubular Ceramics		
21-174	.50	180 pF
21-175	.50	1000 pF
Tantalum		
25-209	.75	.047 μF
25-210	.75	.22 μF
25-197	.70	1.0 μF
25-195	.60	2.2 μF
25-211	.85	33.0 μF
Mylar		
27-74	.10	.01 μF
27-64	.15	.033 μF

PART No.	PRICE Each	DESCRIPTION
FILTERS-RF CHOKE		
404-399	.85	Ceramic filter
45-73	.70	2.2 μH RF choke
45-80	1.40	1000 μH RF choke
DIODES-TRANSISTORS		
56-27	.25	Crystal diode
56-56	.20	1N4149 silicon diode
57-47	2.05	Silicon-controlled switch (SCS) (GE X13B615)
417-91	.85	2N5232A/2N3391A transistor
417-118	.40	2N3393 transistor
417-164	1.05	16G2349 transistor
417-228	.90	SE5055 transistor
417-200	.60	X29A826 transistor
WIRE-SLEEVING		
344-50	.05/ft	Black solid wire
344-125	.05/ft	Black stranded wire
344-126	.05/ft	Brown wire
344-127	.05/ft	Red wire
344-128	.05/ft	Orange wire
344-129	.05/ft	Yellow wire
344-130	.05/ft	Green wire
344-131	.05/ft	Blue wire
344-134	.05/ft	White wire
346-1	.05/ft	Black sleeving
346-21	.30/ft	White sleeving
GENERAL		
95-33	1.20	Case
95-34	.60	Case bottom
60-35	1.15	Slide switch
73-39	.10	Foam tape
73-73	.10	Rubber grommet
75-126	.10	Mylar insulator
85-412	.40	Receiver circuit board (large circuit board)
85-413	.40	Decoder circuit board (smaller circuit board)
205-559	.45	Switch plate
250-49	.05	Screw
390-244	.15	Heathkit decorative label
390-348	.15	FCC label
432-103	.70	4-lug socket
432-104	.70	4-pin plug
432-105	5.00	Large block connector
490-109	.10	Alignment tool
331-6	.15	Solder

CRYSTAL

PART No.	PRICE Each	Crystal Frequency In MHz	Transmitted Frequency In MHz
404-384	4.00	26.542	26.995
404-385	4.00	26.592	27.045
404-386	4.00	26.642	27.095
404-387	4.00	26.692	27.145
404-388	4.00	26.742	27.195
404-389	4.00	26.3235	53.100
404-390	4.00	26.3735	53.200
404-391	4.00	26.4235	53.300
404-392	4.00	26.4735	53.400
404-393	4.00	26.5235	53.500
404-394	4.00	36.2665	72.080
404-395	4.00	36.3465	72.240
404-396	4.00	36.4265	72.400
404-397	4.00	36.7065	72.960
404-398	4.00	37.5935	75.640

TRANSFORMERS

PART No.	PRICE Each	DESCRIPTION
For 27 MHz Band Receivers (26.995, 27.045, 27.095, 27.145, and 27.195 MHz)		
40-913	1.15	4-lead variable transformer
40-914	1.15	5-lead variable transformer
For 53 MHz Band Receivers (53.100, 53.200, 53.300, 53.400, and 53.500 MHz)		
40-915	1.25	4-lead variable transformer
40-916	1.25	5-lead variable transformer
For 72 MHz Band Receivers (72.080, 72.240, 72.400, 72.960, and 75.640 MHz)		
40-917	1.25	4-lead variable transformer
40-918	1.25	5-lead variable transformer

SERVO

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/4 Watt		
1-20-12	.10	33 Ω
1-51-12	.10	47 Ω
1-17-12	.10	220 Ω
1-24-12	.10	820 Ω
1-3-12	.10	1200 Ω
1-4-12	.10	2200 Ω
1-6-12	.10	3300 Ω
1-8-12	.10	4700 Ω
1-28-12	.10	8200 Ω
1-9-12	.10	10 kΩ
1-45-12	.10	22 kΩ
1-11-12	.10	47 kΩ
1-50-12	.10	11 MΩ
CAPACITORS		
21-6	.10	27 pF disc
21-140	.10	.001 μF disc
21-141	.10	.0033 μF disc
21-94	.15	.05 μF disc
25-197	.70	1.0 μF electrolytic
26-121	1.65	2-section variable
TRANSISTORS		
417-91	.85	2N5232A/2N3391A
417-200	.60	X29A826
117-6	2.05	Transistor pair
Consisting of:		
1		2N2430
1		2N2431
WIRE-SLEEVING		
344-90	.05/ft	Black wire
344-92	.05/ft	Red wire
344-95	.05/ft	Green wire
344-99	.05/ft	White wire
344-110	.25/ft	Special flex wire (gray)
346-1	.05/ft	Small sleeving
346-20	.15/ft	Large sleeving

PART No.	PRICE Each	DESCRIPTION
GENERAL		
73-59	.10	Large rubber grommet
73-53	.10	Small rubber grommet
85-305	.40	Circuit board
420-56	5.00	Motor
432-104	.70	4-pin male connector
331-6	.15	Solder
HARDWARE		
250-355	.05	2-32 x 3/16" sheet metal screw
250-353	.05	2-56 x 7/16" screw
250-352	.05	2-56 x 11/16" screw
250-354	.05	3-56 x 1/8" screw
250-82	.05	#4 x 1/2" wood screw
452-19	.20	Gear pin
MOLDED NYLON PARTS		
266-111	.60	Linear output arm (with tabs)
266-100	.75	Linear output arm (without tabs)
266-102	.75	Rotary output arm
266-101	.75	Rotary output wheel
92-41	1.50	Case top section
451-59	.60	Right rack gear
451-54	.75	Left rack gear
266-99	1.50	Rack gear guide
451-53	.75	Capacitor drive gear
451-52	.75	Rack drive gear
451-51	.75	Idler gear
451-50	.75	Motor coupling gear
92-42	1.50	Case center section
262-14	.25	Pin
92-43	1.50	Case bottom section

CUSTOMER SERVICE

REPLACEMENT PARTS

If you need a replacement part, please fill in the Parts Order Form that is furnished and mail it to the Heath Company. Or, if you write a letter, include the:

- **Part number** and **description** as shown in the **Parts List.**
- Model number and Series number from the blue and white label.
- Date of purchase.
- Nature of the defect.

Please do not return parts to the factory unless they are requested. Parts that are damaged through carelessness or misuse by the kit builder will not be replaced without cost, and will not be considered in warranty.

Parts are also available at the Heathkit Electronic Centers listed in your catalog. Be sure to provide the Heath part number. Bring in the original part when you request a warranty replacement from a Heathkit Electronic Center.

NOTE: Replacement parts are maintained specifically to repair Heathkit products. Parts sales for other reasons will be declined.

TECHNICAL CONSULTATION

Need help with your kit? . . . . Self-Service? . . . . Construction? . . . . Operation? . . . . Call or write for assistance. You'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek. . .please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit C.O.D. for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.

TRANSMITTER

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/4 Watt		
1-2-12	.10	1000 Ω
1-4-12	.10	2200 Ω
1-8-12	.10	4700 Ω
1-46-12	.10	27 kΩ
1-11-12	.10	47 kΩ
1-47-12	.10	150 kΩ
Other Resistors		
1-10	.10	1200 Ω 1/2 watt
1-21	.10	15 kΩ 1/2 watt
1-102	.10	82 kΩ 1/2 watt
2-208	.25	111 kΩ 1/2 watt 1%
3-15-7	.15	1000 Ω 7 watt
CAPACITORS		
20-102	.15	100 pF mica
21-140	.10	.001 μF disc
21-46	.10	.005 μF disc
27-74	.10	.01 μF Mylar
27-63	.10	.022 μF Mylar (small)
27-88	.15	.022 μF Mylar (large)
27-77	.10	.1 μF Mylar
25-116	.50	50 μF electrolytic
DIODES-TRANSISTORS		
56-27	.25	Silicon diode (GES160)
57-27	.50	Silicon rectifier (1N2079)
417-118	.40	2N3393 transistor
417-201	.50	X29A829 transistor
417-91	.85	2N5232A/2N3391A transistor
SWITCH-SOCKETS-CONNECTORS		
60-35	1.15	Slide switch
434-88	.15	Pilot lamp socket
432-101	.70	4-terminal socket
432-106	1.00	4-pin plug with cap
432-104	.70	4-pin flat connector

PART No.	PRICE Each	DESCRIPTION
LINE CORD-WIRE		
89-38	.40	Line cord
134-189	1.60	Wire harness
344-50	.05/ft	Black solid wire
344-52	.05/ft	Red solid wire
344-90	.05/ft	Black stranded wire
344-92	.05/ft	Red stranded wire
346-35	.05/ft	Small black sleeving
346-20	.15/ft	Medium-size black sleeving
346-3	.05/ft	Large black sleeving
METAL PARTS		
90-427	.90	Cabinet back
90-428	1.35	Cabinet front
100-801	.40	Side bracket
204-102	.10	Support bracket
204-920	.10	Control mounting bracket
204-922	.10	Meter mounting bracket
205-729	.40	Cabinet bottom plate
TRANSMITTER RF CIRCUIT BOARD ASSEMBLY		
181-26	9.60	26.995
181-27	9.60	27.045
181-28	9.60	27.095
181-29	9.60	27.145
181-30	9.60	27.195
181-430	12.00	53.100
181-431	12.00	53.200
181-432	12.00	53.300
181-433	12.00	53.400
181-434	12.00	53.500
181-435	12.00	72.080
181-436	12.00	72.240
181-437	12.00	72.400
181-438	12.00	72.960
181-439	12.00	75.640

PART No.	PRICE Each	DESCRIPTION
GENERAL		
10-222	.45	50 kΩ control
10-273	.55	5000 Ω control
75-93	.10	Fiber insulator
85-187-3	1.50	Encoder circuit board
142-113	2.55	Antenna
260-16	.10	Alligator clip
407-116	3.00	Meter
412-47	.35	Pilot lamp (#1820)
413-15	.30	Pilot lamp jewel
100-960	16.95	Battery assembly (9.6 volt nickel-cadmium)
462-299	.60	Thumb knob
266-145	.15	Switch stop
490-5	.10	Nut starter
490-110	.25	Wrench
331-6	.15	Solder

The following parts are supplied with the transmitters indicated.

27 MHz Band Transmitter

205-649	.35	Cabinet top plate

53 MHz Band Transmitter (The group has a part number of 171-2410).

64-39	1.60	Pushbutton switch assembly
205-711	.30	Cabinet top plate
254-5	.05	Control lockwasher
344-91	.05/ft	Brown stranded wire
27-64	.15	.033 μF Mylar capacitor

72 MHz Band Transmitter

205-726	.35	Cabinet top plate

All transmitters contain the following parts.

HARDWARE

#3 Hardware

250-49	.05	3-48 x 1/4" screw

#4 Hardware

250-163	.05	4-40 x 5/16" self-tapping screw
250-285	.05	4-40 x 1/4" screw
250-312	.05	4-40 x 3/4" screw
252-2	.05	4-40 nut
254-9	.05	#4 lockwasher
250-477	.05	4-24 x 3/4" self-tapping screw

#6 Hardware

250-276	.05	6-32 x 3/8" black screw
252-3	.05	6-32 nut
254-1	.05	#6 lockwasher
259-1	.05	#6 solder lug

PART No.	PRICE Each	DESCRIPTION
Other Hardware		
252-7	.05	Control nut
253-100	.05	Antenna fiber flat washer
253-101	.05	Antenna fiber shoulder washer
254-4	.05	Control lockwasher
255-29	.05	3/16" spacer
253-103	.05	1/4" fiber washer

CONTROL STICK PARTS

11-114	1.75	5000 Ω control
205-682	1.50	Control mounting plate (marked #1)
205-683	1.50	Control mounting plate (marked #2)
238-58	4.95	Control stick housing
214-82	.30	Control front cover
214-83	.30	Control back cover
214-84	.45	Ball housing
253-124	.25	Teflon washer
255-100	.15	Nylon spacer
265-16	.10	Hinge pin
266-121	1.30	Gimbal #1
266-122	1.30	Gimbal #2
266-123	3.00	Control stick
266-125	3.00	Chrome cup
455-77	1.05	Adjustable bearing
456-24	.15	Control stick coupler
456-25	.30	Gimbal coupler
462-300	.45	Trim plate
462-301	.45	Control stick knob

Control Stick Hardware

250-355	.05	2-32 x 3/16" screw
250-420	.05	2-32 x 1/4" screw
250-421	.05	2-56 x 3/8" screw
250-422	.05	2-56 x 5/16" screw
208-17	.15	Spring clip
252-7	.05	Control nut
253-119	.05	Control washer
258-103	.25	Centering spring
266-124	.25	Dog stop
455-78	.15	Brass bushing

RECEIVER

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/4 Watt		
1-1-12	.10	100 Ω
1-35-12	.10	470 Ω
1-24-12	.10	820 Ω
1-2-12	.10	1000 Ω
1-36-12	.10	1500 Ω
1-4-12	.10	2200 Ω
1-5-12	.10	2700 Ω
1-8-12	.10	4700 Ω
1-26-12	.10	5600 Ω
1-27-12	.10	6800 Ω
1-9-12	.10	10 kΩ
1-10-12	.10	15 kΩ
1-52-12	.10	18 kΩ
1-45-12	.10	22 kΩ
1-46-12	.10	27 kΩ
1-11-12	.10	47 kΩ
1-32-12	.10	100 kΩ
1-41-12	.10	33 kΩ
CAPACITORS		
Disc		
21-6	.10	27 pF
21-147	.10	47 pF
21-148	.10	75 pF
21-140	.10	.001 μF
21-141	.10	.0033 μF
21-27	.10	.005 μF
Tubular Ceramics		
21-174	.50	180 pF
21-175	.50	1000 pF
Tantalum		
25-209	.75	.047 μF
25-210	.75	.22 μF
25-197	.70	1.0 μF
25-195	.60	2.2 μF
25-211	.85	33.0 μF
Mylar		
27-74	.10	.01 μF
27-64	.15	.033 μF

PART No.	PRICE Each	DESCRIPTION
FILTERS-RF CHOKE		
404-399	.85	Ceramic filter
45-73	.70	2.2 μH RF choke
45-80	1.40	1000 μH RF choke
DIODES-TRANSISTORS		
56-27	.25	Crystal diode
56-56	.20	1N4149 silicon diode
57-47	2.05	Silicon-controlled switch (SCS) (GE X13B615)
417-91	.85	2N5232A/2N3391A transistor
417-118	.40	2N3393 transistor
417-164	1.05	16G2349 transistor
417-228	.90	SE5055 transistor
417-200	.60	X29A826 transistor
WIRE-SLEEVING		
344-50	.05/ft	Black solid wire
344-125	.05/ft	Black stranded wire
344-126	.05/ft	Brown wire
344-127	.05/ft	Red wire
344-128	.05/ft	Orange wire
344-129	.05/ft	Yellow wire
344-130	.05/ft	Green wire
344-131	.05/ft	Blue wire
344-134	.05/ft	White wire
346-1	.05/ft	Black sleeving
346-21	.30/ft	White sleeving
GENERAL		
95-33	1.20	Case
95-34	.60	Case bottom
60-35	1.15	Slide switch
73-39	.10	Foam tape
73-73	.10	Rubber grommet
75-126	.10	Mylar insulator
85-412	.40	Receiver circuit board (large circuit board)
85-413	.40	Decoder circuit board (smaller circuit board)
205-559	.45	Switch plate
250-49	.05	Screw
390-244	.15	Heathkit decorative label
390-348	.15	FCC label
432-103	.70	4-lug socket
432-104	.70	4-pin plug
432-105	5.00	Large block connector
490-109	.10	Alignment tool
331-6	.15	Solder

CRYSTAL

PART No.	PRICE Each	Crystal Frequency In MHz	Transmitted Frequency In MHz
404-384	4.00	26.542	26.995
404-385	4.00	26.592	27.045
404-386	4.00	26.642	27.095
404-387	4.00	26.692	27.145
404-388	4.00	26.742	27.195
404-389	4.00	26.3235	53.100
404-390	4.00	26.3735	53.200
404-391	4.00	26.4235	53.300
404-392	4.00	26.4735	53.400
404-393	4.00	26.5235	53.500
404-394	4.00	36.2665	72.080
404-395	4.00	36.3465	72.240
404-396	4.00	36.4265	72.400
404-397	4.00	36.7065	72.960
404-398	4.00	37.5935	75.640

TRANSFORMERS

PART No.	PRICE Each	DESCRIPTION
For 27 MHz Band Receivers (26.995, 27.045, 27.095, 27.145, and 27.195 MHz)		
40-913	1.15	4-lead variable transformer
40-914	1.15	5-lead variable transformer
For 53 MHz Band Receivers (53.100, 53.200, 53.300, 53.400, and 53.500 MHz)		
40-915	1.25	4-lead variable transformer
40-916	1.25	5-lead variable transformer
For 72 MHz Band Receivers (72.080, 72.240, 72.400, 72.960, and 75.640 MHz)		
40-917	1.25	4-lead variable transformer
40-918	1.25	5-lead variable transformer

SERVO

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/4 Watt		
1-20-12	.10	33 Ω
1-51-12	.10	47 Ω
1-17-12	.10	220 Ω
1-24-12	.10	820 Ω
1-3-12	.10	1200 Ω
1-4-12	.10	2200 Ω
1-6-12	.10	3300 Ω
1-8-12	.10	4700 Ω
1-28-12	.10	8200 Ω
1-9-12	.10	10 kΩ
1-45-12	.10	22 kΩ
1-11-12	.10	47 kΩ
1-50-12	.10	11 MΩ
CAPACITORS		
21-6	.10	27 pF disc
21-140	.10	.001 μF disc
21-141	.10	.0033 μF disc
21-94	.15	.05 μF disc
25-197	.70	1.0 μF electrolytic
26-121	1.65	2-section variable
TRANSISTORS		
417-91	.85	2N5232A/2N3391A
417-200	.60	X29A826
117-6	2.05	Transistor pair
Consisting of:		
1		2N2430
1		2N2431
WIRE-SLEEVING		
344-90	.05/ft	Black wire
344-92	.05/ft	Red wire
344-95	.05/ft	Green wire
344-99	.05/ft	White wire
344-110	.25/ft	Special flex wire (gray)
346-1	.05/ft	Small sleeving
346-20	.15/ft	Large sleeving

PART No.	PRICE Each	DESCRIPTION
GENERAL		
73-59	.10	Large rubber grommet
73-53	.10	Small rubber grommet
85-305	.40	Circuit board
420-56	5.00	Motor
432-104	.70	4-pin male connector
331-6	.15	Solder
HARDWARE		
250-355	.05	2-32 x 3/16" sheet metal screw
250-353	.05	2-56 x 7/16" screw
250-352	.05	2-56 x 11/16" screw
250-354	.05	3-56 x 1/8" screw
250-82	.05	#4 x 1/2" wood screw
452-19	.20	Gear pin
MOLDED NYLON PARTS		
266-111	.60	Linear output arm (with tabs)
266-100	.75	Linear output arm (without tabs)
266-102	.75	Rotary output arm
266-101	.75	Rotary output wheel
92-41	1.50	Case top section
451-59	.60	Right rack gear
451-54	.75	Left rack gear
266-99	1.50	Rack gear guide
451-53	.75	Capacitor drive gear
451-52	.75	Rack drive gear
451-51	.75	Idler gear
451-50	.75	Motor coupling gear
92-42	1.50	Case center section
262-14	.25	Pin
92-43	1.50	Case bottom section

CUSTOMER SERVICE

REPLACEMENT PARTS

If you need a replacement part, please fill in the Parts Order Form that is furnished and mail it to the Heath Company. Or, if you write a letter, include the:

- **Part number** and **description** as shown in the **Parts List.**
- Model number and Series number from the blue and white label.
- Date of purchase.
- Nature of the defect.

Please do not return parts to the factory unless they are requested. Parts that are damaged through carelessness or misuse by the kit builder will not be replaced without cost, and will not be considered in warranty.

Parts are also available at the Heathkit Electronic Centers listed in your catalog. Be sure to provide the Heath part number. Bring in the original part when you request a warranty replacement from a Heathkit Electronic Center.

NOTE: Replacement parts are maintained specifically to repair Heathkit products. Parts sales for other reasons will be declined.

TECHNICAL CONSULTATION

Need help with your kit? . . . . Self-Service? . . . . Construction? . . . . Operation? . . . . Call or write for assistance. You'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek. . .please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

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- A brief description of the difficulty.
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