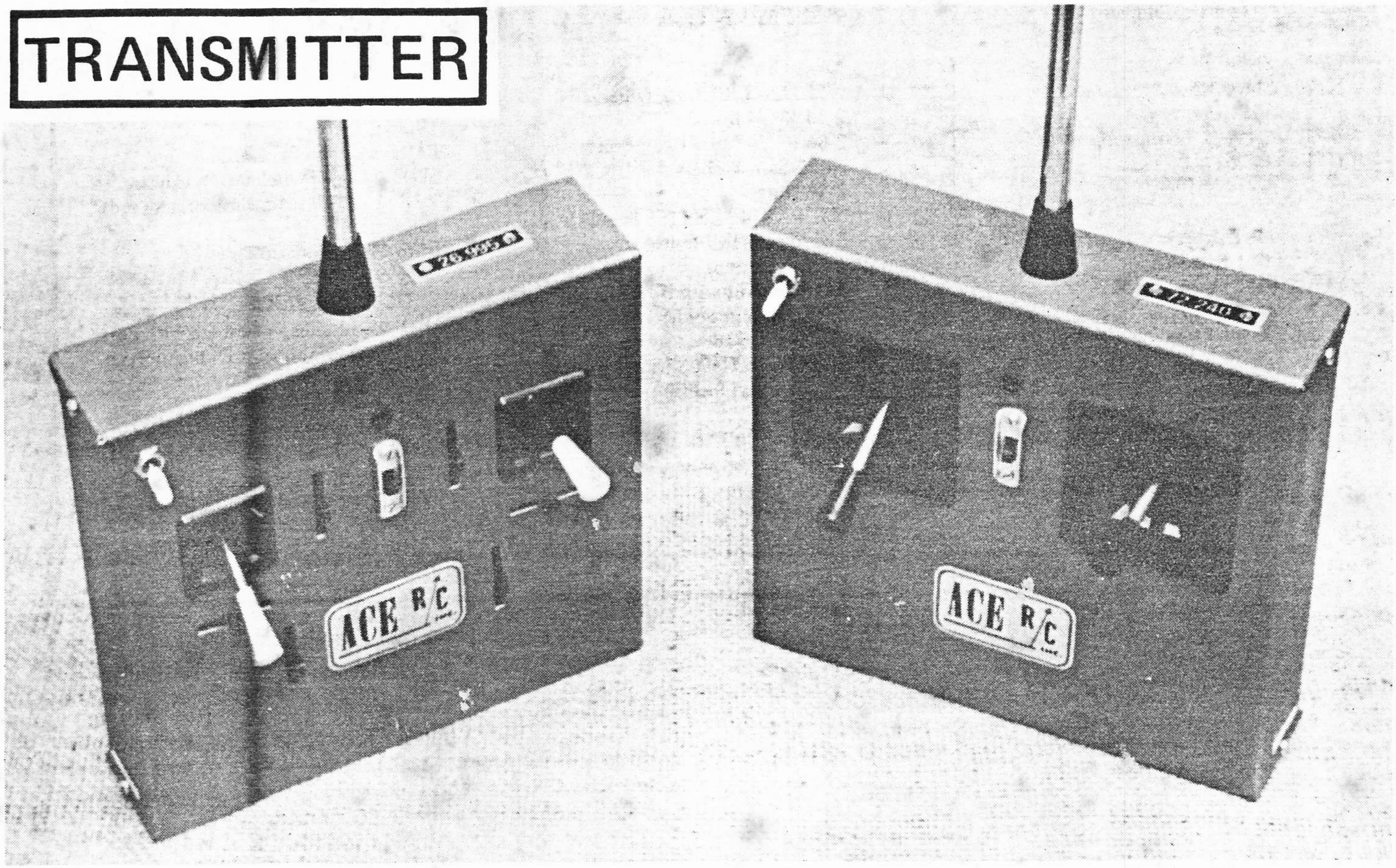
ACE R/C INC. DIGITAL COMMANDER

DESIGNED BY FRED M. MARKS

TRANSMITTER



THE ACE DIGITAL
COMMANDER TRANSMITTER

I. INTRODUCTION

Our Digital Commander transmitter is capable of providing from one to seven channels of completely linear digital control. Although we don't see the need for more channels, the transmitter is capable of providing up to nine channels with a minor modification.

The transmitter features a commutated encoder, i. e., all timing functions are performed by one timing circuit instead of one per channel. Thus, there is just one component in the entire encoder that requires an expensive, temperature stable capacitor instead of eight or so. In addition, we have eliminated all diodes in the encoder--one of the principal points for errors in most kits. This same feature permits us to use a single "bus" wire to each control pot plus one to a second pot terminal. The result--14 solder joints where most sets have 42; 28 fewer points for a failure. This combination of features permits the lowest parts count for any transmitter available for six or seven channels. There are just 25 components that perform the encoding function. This contrasts with the usual discrete component encoder that requires from fifty to seventy-five components. The encoder is voltage regulated and completely stable down to six volts.

A feature that has received universal acclaim from all who have seen it is the use of a flashing red light, rather than a meter, to indicate unsafe transmitter operating voltage. Meter arrangements are highly relative and they can be set to indicate an acceptable output even when it isn't present. Our flasher circuit is accurate to 0.1 volt and is presettable so that there is never any doubt whether it is safe to operate the transmitter.

The RF section delivers a solid 600 milliwatts radiated output (1 watt into the final RF amplifier).

The RF section can be made into a plug-in module that permits changing from one frequency to another or even to another of the three bands used for RC in about 5 minutes.

II. TRANSMITTER DESIGN

A. THE ENCODER

This is a commutated encoder; that is, it employs only one set of timing circuitry for all channels instead of one set per channel as required by conventional encoders. The control input to the timing circuit steps sequentially from one control potentiometer to the next until a complete frame of information is encoded. This function of stepping sequentially is termed commutation.

The reason for the use of a commutated encoder will be evident upon review of the schematic in that the complete encoder, including voltage regulation and power supply filter-

TRANSMITTER PARTS LIST

( ) 1 Assembled and Tuned RF Deck
( ) 1 Encoder PC Board
( ) 1 Punched Case
( ) 1 39 1/2" Antenna
( ) 1 DPDT CW Switch
( ) 1 Switch Guard
( ) 1 Deans Three Pin Female Connector

( ) 1 SN7490 IC
( ) 1 SN74145 IC
( ) 1 555 IC
( ) 3 2N5172 Transistors
( ) 2 1N751A Diodes
( ) 1 1N4446 Diode

( ) 3 .01 Disc Cap
( ) 2 .001 Disc Cap
( ) 1 .047 Mylar Cap
( ) 1 10 mf Tantalum Cap
( ) 2 47 mf Tantalum Cap

RESISTORS ARE 1/4W, 10%
( ) 1 22 ohm (red, red, black)
( ) 1 470 ohm (yellow, violet, brown)
( ) 1 1K (brown, black, red)
( ) 2 2.7K (red, violet, red)
( ) 2 10K (brown, black, orange)
( ) 1 27K (red, violet, orange)
( ) 1 56K (green, blue, orange)
( ) 1 220K (red, red, yellow)
( ) 2 10K Trim Pots

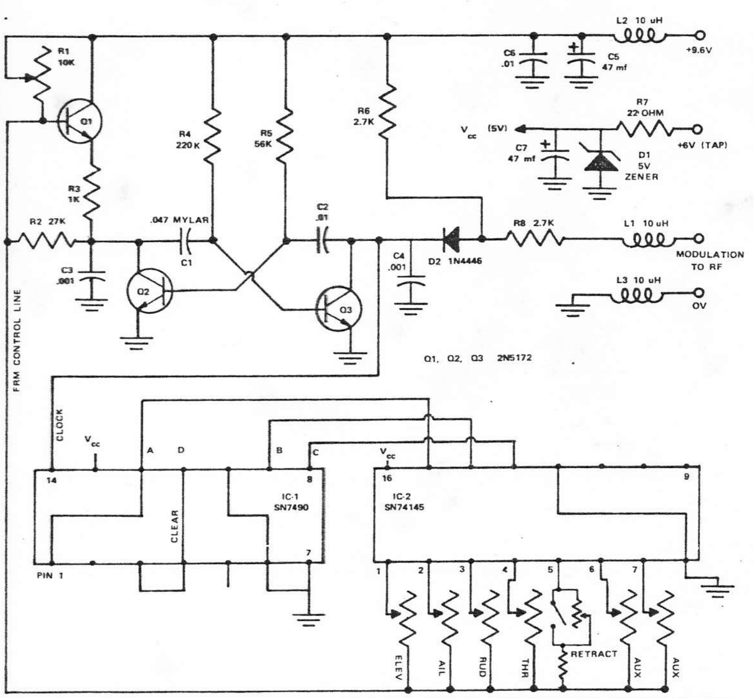
( ) 3 10 uhy Chokes
( ) 1 Small Light Emitting Diode
( ) 8 450 MAH 1.2 Volt Cells
( ) 2 Plastic Battery Cases

( ) 1 No. 0 Grommet
( ) 1 1/8" D X 3/8" Brass Tube
( ) 2 2-56 X 1/4 Bolts
( ) 4 2-56 X 1/4" Flat Head Bolts
( ) 2 No. 2 Star Washers
( ) 4 2-56 Nuts
( ) 6 No. 4 X 1/4" Self Tap Screws
( ) 2 Encoder Board Brackets
( ) 1 Antenna Mount
( ) 1 Antenna Bolt with Nut, Star Washer and Solder Lug
( ) 6" 1/8" Foam Tape
( ) 1 1/2" X 1/8" D Heat Shrink Tube
( ) 10 Lengths Vinyl Sleeving
( ) 36" Solder
( ) 30" Red Hookup Wire
( ) 30" Black Hookup Wire
( ) 16" White Hookup Wire
( ) 10" Purple Hookup Wire
( ) 12" Lacing Cord

3 CHANNEL TRANSMITTER
( ) 1 Rand Stick, Assembled with Pots
( ) 1 5K Pot with Hardware
( ) 1 Throttle Pot Bracket
( ) 2 2-56 X 1/4" Flat Head Bolt
( ) 2 2-56 Nuts
( ) 2 No. 2 Star Washers
( ) 4 1.2K 1/4 W Resistors (brown, red, red)
( ) 68" Fifth Color Hookup Wire

5 CHANNEL TRANSMITTER
( ) 2 Stick Assemblies, Assembled with Pots, Rand Closed Gimbal or Dunham Open Gimbal
( ) 1 Retract Switch PC Board
( ) 1 SPDT Toggle Switch with Hardware
( ) 3 1.2K 1/4W Resistor (brown, red, red)
( ) 1 10K Trim Pot
( ) 96" Fifth Color Hookup Wire

7 CHANNEL TRANSMITTER
( ) 2 Stick Assemblies, Assembled with Pots, Rand Closed Gimbal or Dunham Open Gimbal
( ) 1 Retract Switch PC Board
( ) 1 1.2K 1/4 W Resistor (brown, red, red)
( ) 1 SPDT Toggle Switch with Hardware
( ) 1 10K Trim Pot
( ) 2 5K Pots with Hardware
( ) 2 Auxiliary Function Levers
( ) 112" Fifth Color Hookup Wire



TO DELETE ANY CHANNEL, DELETE POTENTIOMETER AND REPLACE WITH 1.2K RESISTOR.

ENCODER SCHEMATIC

FIGURE A-1

ing, consists of just 25 components excluding the control potentiometers. Several current encoders have that many diodes alone!

The encoder (see Figure A-1) consists of a free-running multivibrator (FRM) that performs the timing function, a control input buffer for this multivibrator, and two integrated circuits that commutate control of the miltivibrator time constant from one control input to another.

The free-running multivibrator consists of Q2 and Q3, accompanying resistors R1 through R8, and capacitors C1 thru C4. For purposes of reference, we shall describe the period when the collector of Q2 is "high", i. e., nearly 9.6 volts. This occurs when Q2 is biased "off", i. e., its base is near ground voltage.

The FRM changes state in a clocklike manner, that is, it switches state at a regular interval that is dependent on the value of the related resistors and capacitors. Its period of ON-time may equal OFF-time or they may be varied independently. In our case, we have chosen to fix the OFF-time at 250 microseconds, by selection of the values shown for C2 and R5. This period is the chosen nominal width of the modulation pulse we wish to transmit. The ON-time is variable.

ON-time is set by the value of C1, R4, and the voltage level at the emitter of Q1. For the moment, let us imagine that Q1 has been replaced by a fixed resistor of value RT. The FRM will then run at an OFF-time of 250 microseconds and an ON-time set by RT, R3 and R4 but without any variation.

The goal is to make the ON-time variable about a nominal time of 1.5 milliseconds (ms) by the amount $\pm$ 0.5 ms; i. e., it can be shortened to 1.0 ms or lengthened to 2.0 ms and be continuously variable between these extremes. If we make the imaginary fixed resistor RT mentioned above a variable resistor (potentiometer), then we can control the FRM between these extremes. Q1 then can be viewed as the variable resistor. As Q1 "turns on"; i. e., its emitter is permitted to become more positive, the ON-time period increases and conversely. The variation in the bias level for Q1 is controlled sequentially by each of the ladder of control potentiometers. (Recognize that the retract function is just another form of the control arrangement to permit a switched function that is either 1.0 ms or 2.0 ms for purposes of controlling a two-position function such as retractable landing gear, flaps, and the like.)

Since Q1 is an NPN, it is biased off as the base goes more negative and conversely. Our task now becomes one of providing (1) the bias required to permit a nominal control time period of 1.5 ms $\pm$ 0.5 ms, and (2) the bias required to produce a synchronization pause of around 4.5 ms between each frame of pulses. IC-1 and IC-2 permit this to be done and also are responsible for the extreme simplicity of the encoder.

IC-1 is a decade counter that converts decimal inputs to binary coded outputs. The logic code for IC-1 shows that it takes sequential clock pulses and produces binary coded outputs at A, B, C, and D. This is really no different from counting decimally except that our friend can only count to one! Thus the A output goes high (1) on the first clock pulse, then low (0) on the second. This is just the same as counting to nine then making the last significant place zero while the second becomes a one to form 10. When A goes low, it "carries" to the next significant place just as we did in going from nine to ten and the B output goes high. It cannot go low again until A goes low once more. The same relationship is true for B versus C and for C versus D. Thus, A changes state with every count, B with every other count, C with every fourth count, and D with every eighth count.

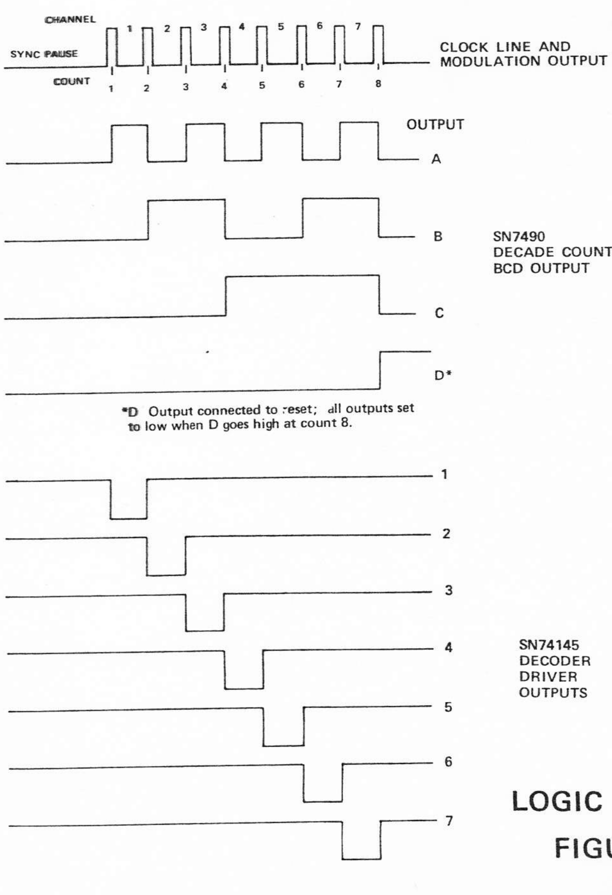
IC-2 is a binary coded decimal (BCD) to decoder driver. Its usual function is to accept the binary coded data characteristic of binary logic computation and convert it to a "one of ten" output. We shall explain the manner in which it does this a bit later. For our purposes, the SN74145 has one outstanding characteristic; it is an open-collector TTL device. That is, the drive transistors are normally used to drive display devices and there is no internal collector load. This is important because it automatically provides the isolation needed to keep the control pots separated from each other when the outputs (1 through 7, and 9 through 11) are high. It is this feature that permits the elimination of blocking diodes needed where other counting devices such as shift registers are used.

As the SN74145 steps through the sequence, the outputs go low as shown in the accompanying logic code. When the inputs A through D are low, then all outputs are high. Thus Q1 is biased strongly ON and the FRM will have the long (4.5 ms) period required for synchronization.

When the FRM reaches the end of the sync pause and goes OFF for 250 microseconds, a frame of information begins, i. e., it issues the sync or start pulse. This sync pulse appears as a 250 microsecond pulse of 9 volts amplitude at the collector of Q3. It then proceeds via D2 and R8 to the modulator in the RF section. However, notice that it is also connected to the "clock" input of IC-1 at pin 14.

Those familiar with IC's will be aware that there are counters that do binary counting along with the decoding function of the SN74145 all on one chip. However, those devices must count all the way to ten before they can start over unless auxiliary "clear" circuitry is used. The SN7490 has the feature of being able to clear itself and we have made use of it. Notice that the D output (pin 11 of IC-1) is connected to the clear input (pin 3-4). As soon as the count reaches eight (remember we need one more pulse than we have channels, i. e., eight pulses for seven channels) and D starts to go "high", IC-1 is cleared, i. e., all outputs go low. Looking at the code for IC-2, we recall that all outputs will be high and we now start a new sync pause and the frame is complete. One could also use the same approach to stop the count at 4 (reset connected to C) to provide three channels or by connecting B to reset to stop the count at two, provide for one channel. However, it is much simpler to delete control pots and install fixed resistors to provide blank output channels that are not used.

While we chose to stop the encoder at 7 channels, it is capable of producing 9 channels for special applications. To do this, pins 3 and 4 of IC-1 must be tied to ground, and the D output from IC-1 connected to pin 12 of IC-2. Pin 12 is no longer tied to ground. Control pots are added as for 1-7 at pins 9 and 10.



LOGIC DIAGRAMS

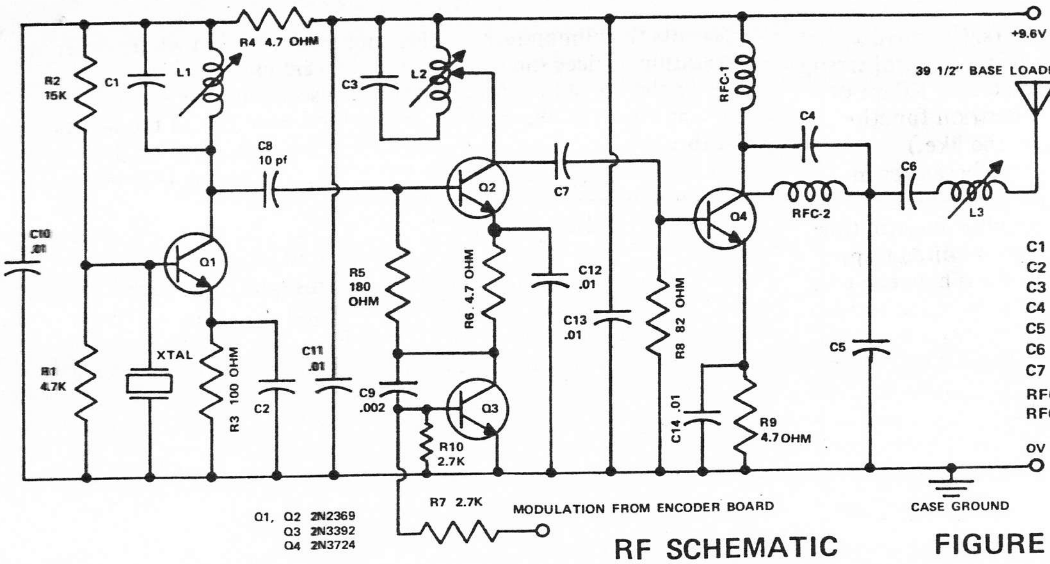
FIGURE A-2

COUNT	OUTPUT D	OUTPUT C	OUTPUT B	OUTPUT A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

TRUTH TABLE--SN7490 DECADE COUNTER
H=HIGH LEVEL L=LOW LEVEL

INPUT D	INPUT C	INPUT B	INPUT A	OUTPUT LOW
L	L	L	L	0
L	L	L	H	1
L	L	H	L	2
L	L	H	H	3
L	H	L	L	4
L	H	L	H	5
L	H	H	L	6
L	H	H	H	7
H	L	L	L	8
H	L	L	H	9

TRUTH TABLE--SN74145 BCD TO DECODER DRIVER
H=HIGH LEVEL L=LOW LEVEL

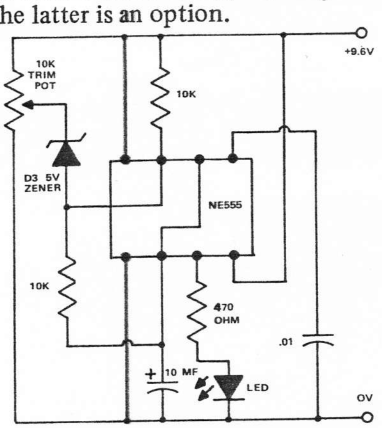


	27 MHZ	53 MHZ	72 MHZ
C1	33 pf	15 pf	3.9 pf
C2	62 pf	33 pf	33 pf
C3	33 pf	20 pf	25 pf
C4	47 pf	10 pf	6.8 pf
C5	33 pf	20 pf	15 pf
C6	10 pf	10 pf	3 pf
C7	62 pf	62 pf	25 pf
RFC-1	22 uH	4.7 uH	4.7 uH
RFC-2	.15 uH	.22 uH	.22 uH

RF SCHEMATIC FIGURE B

B. LOW VOLTAGE WARNING DEVICE

Located on the encoder board is the low voltage warning system. Over the years we have observed a bad habit among the many RC modelers that we know. They do not range check a system or even check an RF output meter until a problem is encountered--usually resulting in a crash. Because of this, we have adopted the use of a low voltage detector (LVD) system that can provide either a visual, flashing red light or an audio warning. The latter is an option.



LOW VOLTAGE WARNING DEVICE (LVD) SCHEMATIC

FIGURE A-3

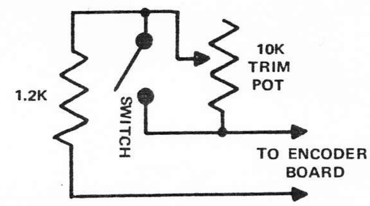
The heart of the LVD (Figure A-3) is an IC timer, the popular 555, used in the free-running multivibrator mode. From the schematic, it will be seen that the timer is held in a cut-off state by the zener diode which sets a reference of 5.1 volts. The potentiometer is used to set this reference at just above the zener voltage. So long as the zener is conducting, the internal comparators of the 555 are biased to make the output at pin 3 "high" and keep the LED lit. However, should power supply voltage decrease below the desired preset level (8.8 volts), determined by the potentiometer setting, the LED will begin to flash at about four pulses per second.

C. THE RF SECTION

The RF section (Figure B) is quite simple. A crystal oscillator operating at the desired frequency (no doubling or tripling, etc.) produces the unmodulated, unamplified RF. The oscillator is formed of R1, R2, R3, C1, C2, L1, Q1 and the crystal. R4 drops the supply voltage to the oscillator. The RF is coupled to an intermediate stage amplifier and modulator formed by Q2, Q3, L2, C3 and related loading resistors and shaping capacitors. From the modulator-amplifier, C7 couples the RF to the final amplifier, Q4. RFC-2, C4, C5, C6, and L3 form the final RF filter and loading for a 39½ inch whip antenna.

D. TWO POSITION FUNCTION BOARD

In the fifth channel, a two position function (Figure C) is provided that gives a control pulse length of either 1.0 ms or 2.0 ms for use with retract gears, flaps, etc. Actually, this arrangement can be used on any channel or as many as the user desires. The two wires are treated the same as any pair of wires from a control pot.



RETRACT SWITCH SCHEMATIC

FIGURE C

When SW-1 is closed, the trim pot is shorted to give a control element resistance of 1.2K for a 1.0 ms pulse width. With SW-1 open, the trim pot is adjusted to give a pulse width of 2.0 ms.

III. BEGINNING CONSTRUCTION

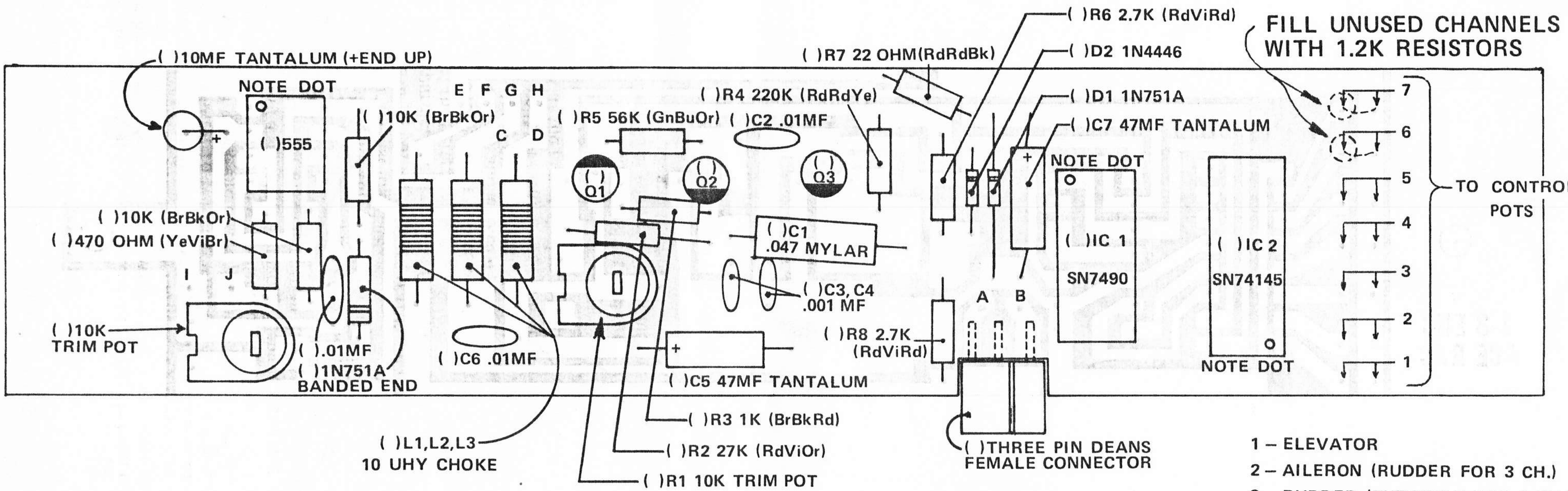
A. CONSTRUCTION OF THE ENCODER--LVD BOARD

( )Follow the general construction techniques described earlier. Mount and solder the encoder--LVD components on the board (Figure D) being careful to observe registry for the ICs. Pin one is identified by the indentation in the case. Observe the basing for Q1 through Q3, the polarity for the tantalum capacitors and the cathode (banded) ends of the diodes.

( )When all components are soldered in place, clip the excess leads from the bottom of the board, scrub off the resin and check for solder bridges and missed solder joints. Set the board aside until final assembly.

B. RETRACT GEAR SWITCH BOARD

( )Assemble the retract switch board according to the overlay drawing, Figure E.



FILL UNUSED CHANNELS WITH 1.2K RESISTORS

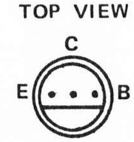
1 – ELEVATOR
2 – AILERON (RUDDER FOR 3 CH.)
3 – RUDDER (THROTTLE FOR 3 CH.)
4 – THROTTLE
5 – RETRACT
6 – AUXILIARY I
7 – AUXILIARY II

WIRE LOCATIONS

A – CHARGING NEGATIVE (BLACK)
B – CHARGING POSITIVE (RED)
C – NEGATIVE FROM SWITCH (BLACK)
D – POSITIVE FROM SWITCH (RED)
E – +6V FROM BATTERY PACK (WHITE)
F – MODULATION OUTPUT TO RF DECK (5TH COLOR)
G – NEGATIVE TO RF DECK (BLACK)
H – POSITIVE TO RF DECK (RED)
I – TO LED CATHODE (WHITE)
J – TO LED ANODE (PURPLE)

Q1, Q2, Q3 = 2N5172

TOP VIEW



GE
2N5172
transistor basing

FIGURE D

ENCODER OVERLAY

NOTE: INSTALL IC 1 AND IC 2 FIRST AND CONTINUE INSTALLING THE COMPONENTS WORKING FROM RIGHT TO LEFT. NOTICE THE ORIENTATIONS OF THE BANDED ENDS OF THE DIODES, THE POSITIVE (RED) ENDS OF THE TANTALUM CAPACITORS, AND THE FLAT SIDES ON THE TRANSISTORS.

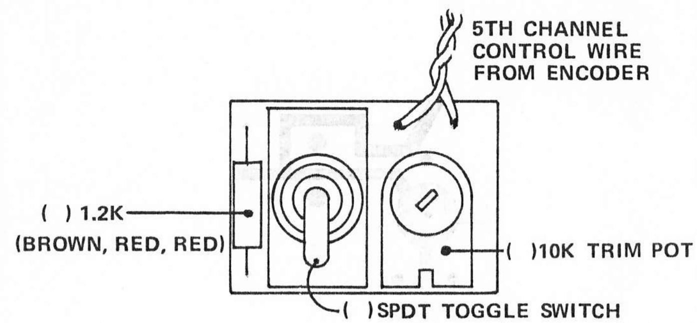


FIGURE E

RETRACT SWITCH BOARD OVERLAY

IV. FINAL ASSEMBLY AND WIRING

A. WIRE TWISTING TECHNIQUE

Primarily for appearance sake and for easier harness makeup, we have chosen to use tightly twisted wire pairs rather than to bundle and lace an entire wiring harness. A job neatly done here will lend a professional look to your system and make for greater reliability. To twist the wire, the easiest and quickest way is to clamp one end of the pair or triplet of wire in a vise and chuck the other end in an electric drill. Turn on the drill and twist until a smooth, tight wound length is attained. Clip off the sections that were clamped in the vise and drill and the twisted wire is ready to use.

( ) The wire may be twisted now. You've been furnished 30" of red and black hookup wire. Cut off 22" each of red and black wire and twist together.

( ) You have 16" of white. Cut off 10" and twist with the 10" length of purple. The remaining 6" is to be used for the +6V lead out of the battery pack.

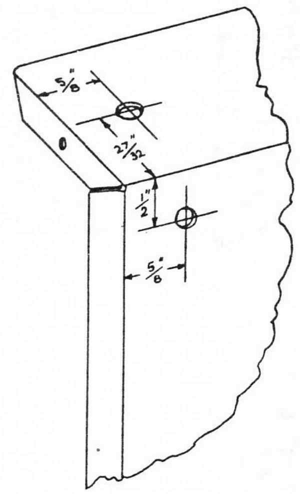
( ) Take the long length of wire which is a fifth color and cut off a piece 8" long and a piece 4" long. Twist the 8" length together with the 8" of red and 8" of black you have remaining. Save the 4" length for the battery pack interconnect wire. Cut the rest of the long length in half and twist the two pieces together. This will be used for control wiring.

A word about routing the wires and determining the proper lengths. Never cut the wire too short so there is strain on the connection. That encourages trouble. We prefer to run the control pot wires and the power wires from the encoder board to the middle of the case and then up or over to the proper connection point. After wiring is complete, lacing cord can be tied at various points to consolidate the wire pairs. Remember, be neat. Neatness will lend a professional appearance to your handiwork.

When the proper length for a given twisted set has been established, back off a few of the turns from each end and strip off 1/8" insulation from each wire, twist the strands tight and smooth between the finger and thumb. Then melt a bit of solder on the stripped wire to "tin" it.

B. RETRACT SWITCH LOCATION

( ) You have an option whether to mount the retract switch on the front or on the top of the case, depending on your personal preference. All that is required is to drill a 1/4" hole in the case according to the dimensions furnished.



RETRACT SWITCH HOLE LOCATION FOR EITHER FRONT OR TOP MOUNTING

C. MOUNTING THE HARDWARE REFER TO FIGURE F

( ) Mount the power switch and switch guard, encoder board brackets, and antenna mount using the hardware indicated in the illustration. You may need to wedge a small screwdriver between the antenna nut and the antenna mount indentation to keep it from turning while tightening. Do not mount the stick assemblies or the retract switch board yet.

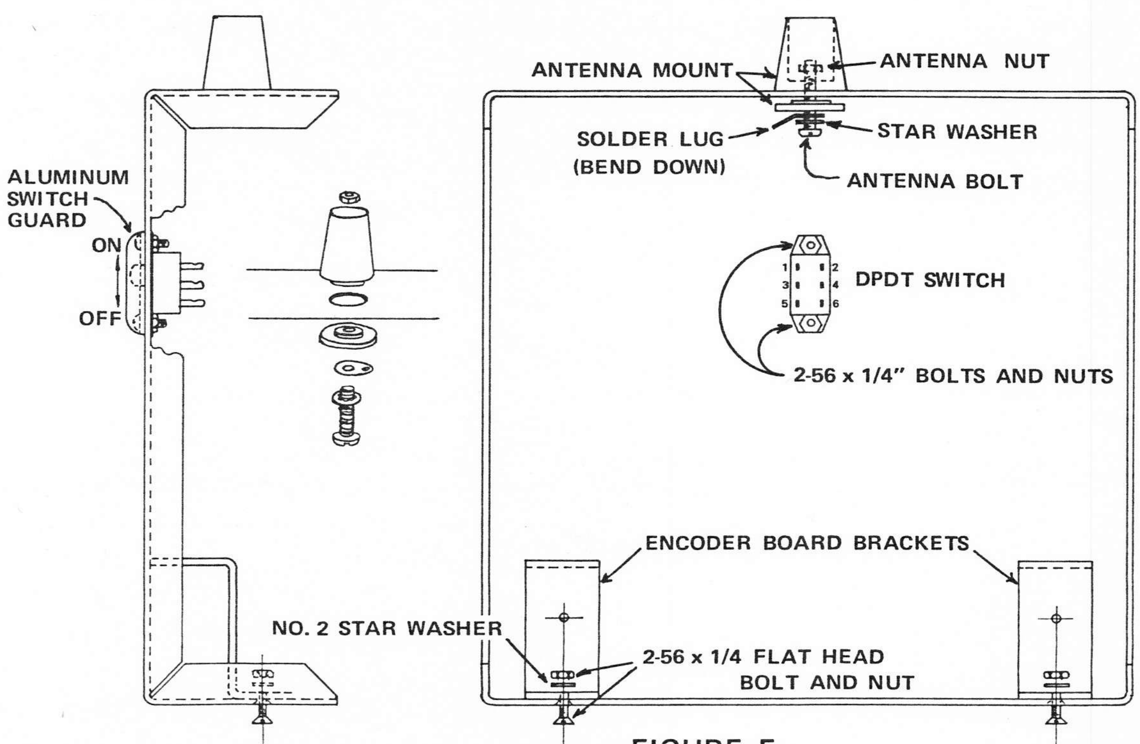


FIGURE F
HARDWARE MOUNTING

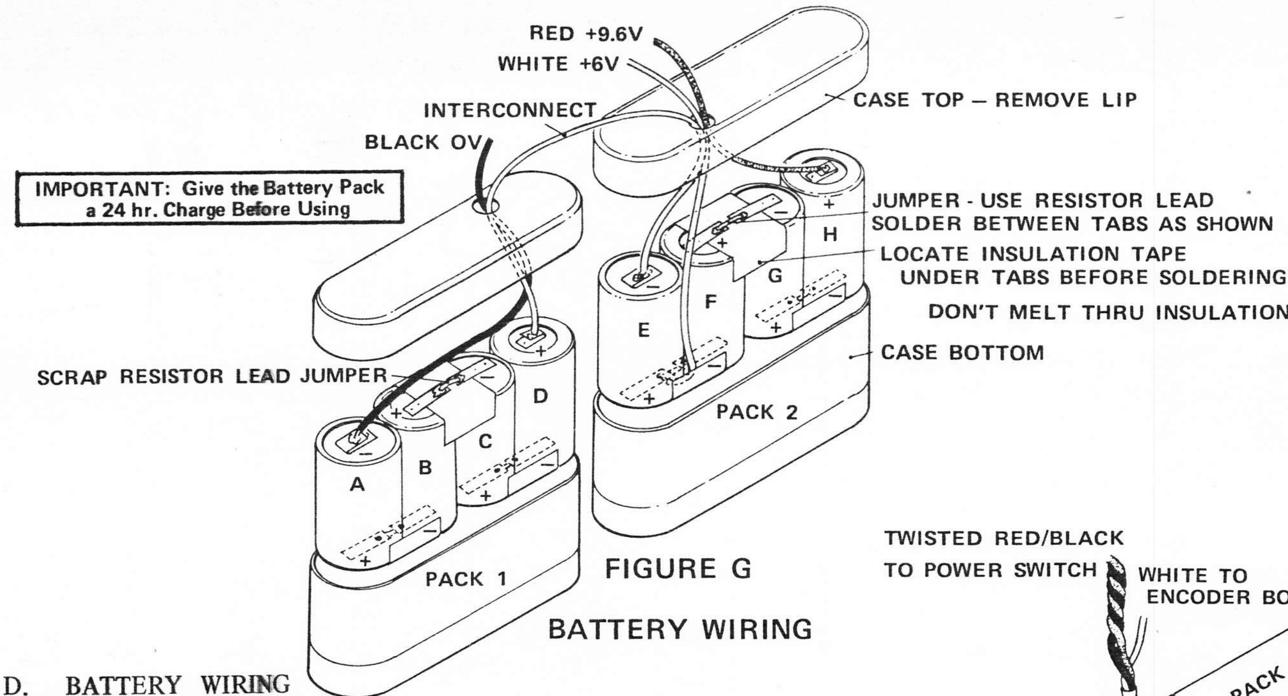


FIGURE G

BATTERY WIRING

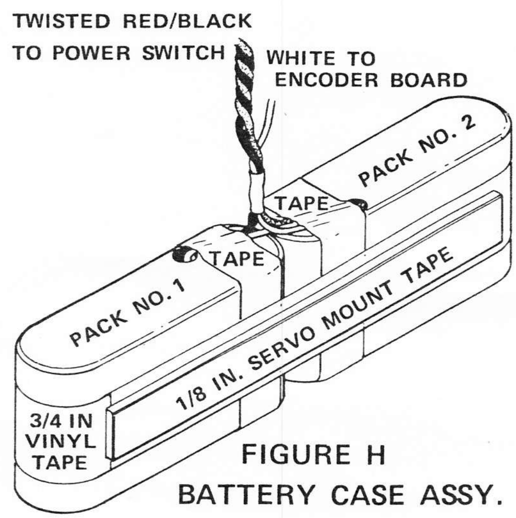


FIGURE H

BATTERY CASE ASSY.

D. BATTERY WIRING

1. Care must be exercised when wiring the battery packs. To prevent shorts, don't work on a metal surface or have extraneous wire lying around. Always maintain proper polarity--the shouldered end of the battery is positive (+) and the flat end is negative (–). When wiring the cells together use scrap resistor leads to jumper the solder tabs and a piece of plastic tape under the tabs to prevent shorting and to hold the cells together while soldering. A drop of "Hot Stuff" is also handy to hold the batteries together while soldering. To prevent melting through the insulation, don't use excessive heat. Always "tin" the tabs and jumpers before soldering together.

When the battery pack is wired, remember that you are working with a "hot" pack and a short can melt all your wiring and possibly ruin the batteries, and void the battery warranty.

( )2. Begin by trimming the lips off the tops of the two plastic battery cases with scissors. This allows the case to butt together when assembled rather than have an overlapping joint.

( )3. Solder the cells together in two packs as shown in Figure G.

( )4. Untwist about 3" from the end of the 22" long twisted set of red and black wire and use it for the red and black wire indicated in Figure G. Make sure the other end of the twisted pair is not shorting together.

Note that the solder tabs on the battery are bent over on the terminals where the wires go. Remember to maintain proper polarity!

( )5. Assemble the packs together using plastic or vinyl tape to secure the top and bottom together. Also run a strip of tape over the leads after they exit the hole for strain relief. Refer to Figure H.

( )6. Slip a short piece of 1/8" heat shrink tube over the red, black and white leads and using the soldering iron shrink it down close to the packs.

( )7. Slip the two packs under the encoder board brackets in the transmitter case and run the piece of 1/8" foam tape across the two packs to hold them together and to provide a non-slip surface for the encoder board to restrain the battery packs.

( )8. Cut the red/black twisted wire coming from the battery pack at such a length that it runs neatly to the middle two lugs on the power switch (3 and 4). Be careful not to short them together. After tinning the leads, slide pieces of vinyl sleeving on the wires and solder the red to the middle left lug (3) and the black to the middle right lug (4). Slip the sleeving down over the connection.

E. ENCODER BOARD WIRING

For the following steps when you need to determine the proper length for the wire, temporarily place the encoder in its proper location in the transmitter case. Don't secure it into position with screws until all wiring is complete.

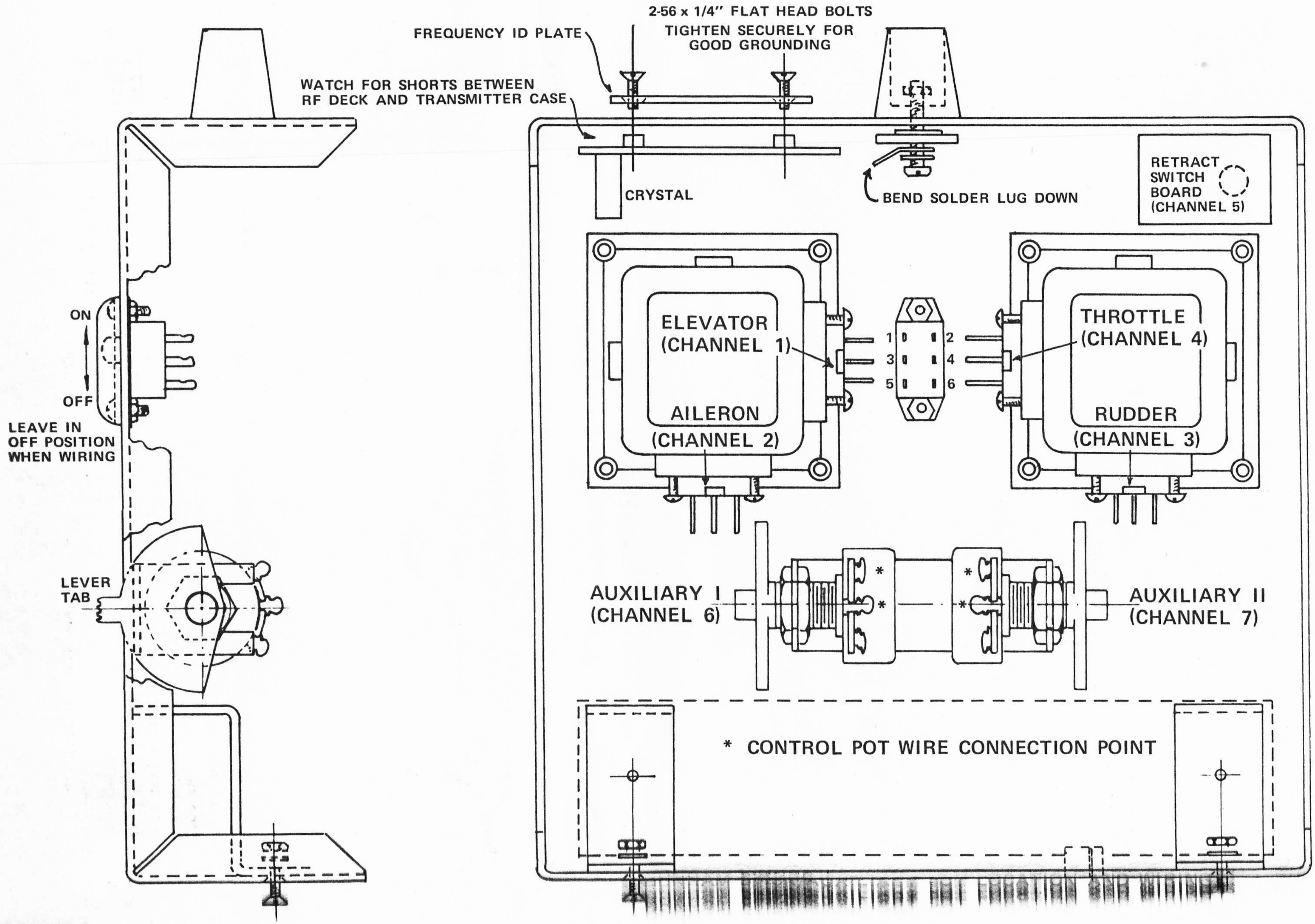
( )1. Use the remaining piece of red/black and strip, tin, and solder the black into hole A and the red into hole B on the encoder board. (Figure D) With the encoder in position, cut the red/black from holes A and B to length at the bottom lugs on the power switch (5 and 6). With the switch in the "on" position (slide in the uppermost position), strip, tin, and solder the red to the lower left lug (5) and black to the lower right lug (6) using insulation sleeving.

( )2. Strip, tin, and solder one end of the left-over piece of twisted red/black in the encoder board with the black in hole C and the red in hole D. Cut this pair to length at the top lugs of the power switch (1 and 2). With the switch in the "off" position (down), strip, tin, and solder the red on the upper left lug (1) and the black on the upper right (2) using insulation sleeving. Leave the switch in the down position (off) until it is time to apply power.

( )3. Cut to length, strip, tin, and solder the white wire from the battery pack to hole E in the encoder.

( )4. Strip and tin the three wires on one end of the red, black, and fifth color twisted triplet. Solder the fifth color wire in hole F, the black in hole G and the red in hole H. The other end of this triplet will be hooked to the RF deck later.

( )5. Strip, tin, and solder the white wire of the white/purple pair in hole I and the purple in hole J. The other end will go to the LED later.



2-56 x 1/4" FLAT HEAD BOLTS
TIGHTEN SECURELY FOR GOOD GROUNDING
FREQUENCY ID PLATE
WATCH FOR SHORTS BETWEEN RF DECK AND TRANSMITTER CASE
CRYSTAL
BEND SOLDER LUG DOWN
RETRACT SWITCH BOARD (CHANNEL 5)
ON
OFF
LEAVE IN OFF POSITION WHEN WIRING
LEVER TAB
ELEVATOR (CHANNEL 1)
AILERON (CHANNEL 2)
THROTTLE (CHANNEL 4)
RUDDER (CHANNEL 3)
1
2
3
4
5
6
AUXILIARY I (CHANNEL 6)
AUXILIARY II (CHANNEL 7)
* CONTROL POT WIRE CONNECTION POINT

F. AUXILIARY POT MOUNTING
REFER TO FIGURE I

If you have a three or a five channel transmitter disregard this step.

( )Slip the two auxiliary function levers on the 5K auxiliary pots. Slide the pots onto the pot bracket with a pot nut on either side of the bracket and the lever tab passing through the slot in the case. (The pot bracket is already mounted in the case.) Adjust the location of the pot so the action of the lever is smooth and doesn't bind against the sides of the slot and the tab protrudes thru the slot far enough for proper operation when the lever is moved to the extremes but not too far which would cause the lever to bind on the top and bottom of the slot. Tighten the nuts with the pot lugs facing you. Double check for smooth operation. The pots may be physically smaller than illustrated.

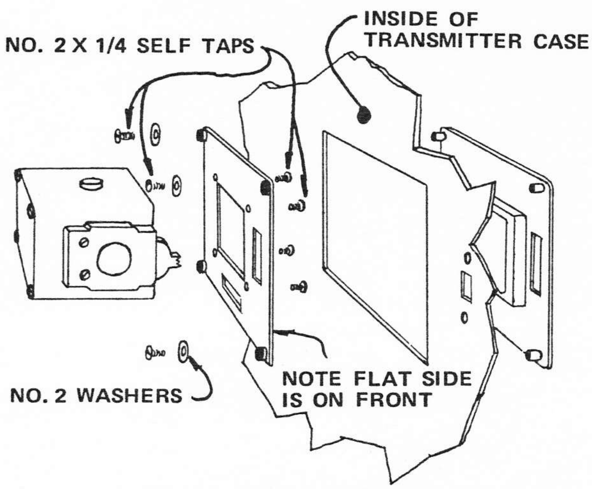
G. CONTROL POT INSTALLATION AND WIRING

DUNHAM SEVEN CHANNEL

The following instructions are for wiring a seven channel transmitter with Dunham open gimbal sticks. If you have one of the other versions (three or five channel; Rand or Dunham sticks), go ahead and read through this section and following it will be instructions that apply to your particular transmitter.

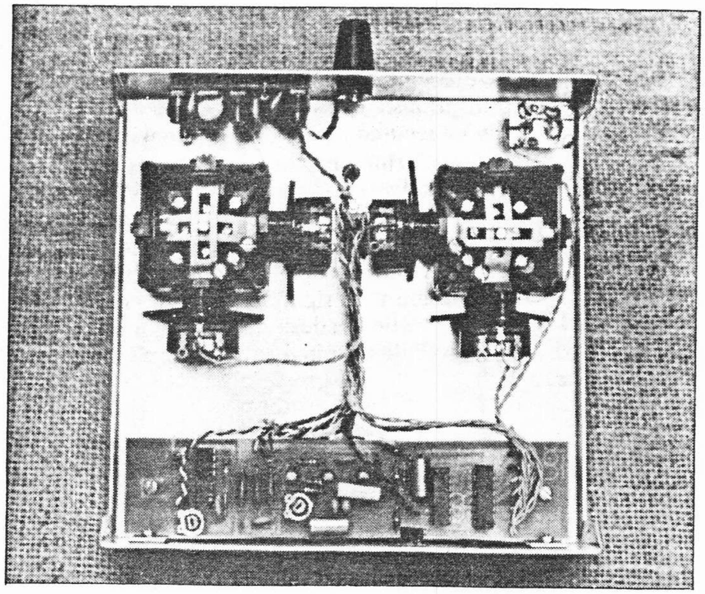
A note for Mode I fliers. (Aileron/throttle right stick, rudder/elevator left stick). The Dunham stick assemblies as furnished are set up for Mode II. To change them over for Mode I, remove the four screws from the back cover and lift it off. With thumb and forefinger grasp the yoke assembly and slide the whole unit out of the body; rotate it 180° and put it back in, making sure the stick engages in the yoke. Put the back cover back on. Now the trim lever/pot assembly will be in the proper location for the Mode I configuration. Also, the wiring illustrations and instructions are for the Mode II setup. You'll have to adjust as necessary if you desire Mode I.

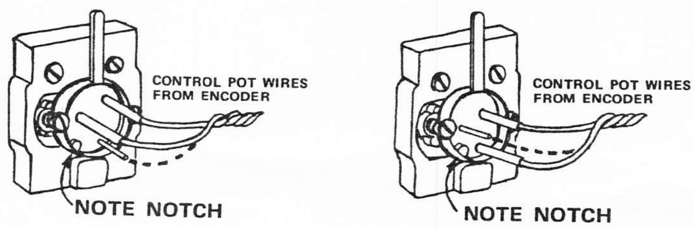
( )1. With four No. 2 X 1/4" self tap screws secure the mounting plates to the stick assemblies with the flat side on the front.



DUNHAM STICK MOUNTING

( )2. Place the sticks into position in the case with the pots oriented as shown in Figure I. The horizontal function trim lever should be on the bottom and the vertical function trim lever should be toward the middle of the case. The ratcheted function (throttle) should be the vertical function on the left stick as you face the front of the case. Don't secure the sticks in place yet because it's easier to solder to the pot terminals with the stick away from the case.





Wiring in this manner will give clockwise servo rotation when the stick is moved to the right and downward. If opposite rotation is desired, wire as indicated by the dotted line.

FIGURE J
DUNHAM STICK POT WIRING

( )3. Strip, tin, and solder the two wires on one end of the long twisted pair of wires into the two holes indicated for channel one on the parts overlay for the encoder, Figure D. Place the encoder in position and determine the proper length for the wire to run to the elevator control pot. Remember, route the wire neatly with no strain. Cut to length, strip, tin, and solder to the two control pot terminals indicated in Figure J. Use sleeving over the connection for insulation and strain relief.

( )4. Repeat the same procedure, wiring channel 2 to the aileron function, channel 3 to rudder, and channel 4 to throttle. The sticks can now be secured in the case using the face plate and four No. 2 X 1/4" self tap screws and washers.

( )5. Determine the length of the wire needed to run from the 5th channel on the encoder board to the retract switch board when it is in position in the case. Connect the 5th channel to the retract switch board referring to the overlay drawing, Figure E. Using the nuts on the switch, secure the retract switch assembly in the case.

( )6. Wire the 6th and 7th channels to the auxiliary function pot terminals indicated in Figure I. Insulation sleeving is not necessary on these pots.

( )This completes the encoder board wiring. Trim up any leads that might protrude too long from the bottom of the board and clean the solder rosin off the foil side of the board with alcohol and a toothbrush. Mount the board to the brackets using two No. 4 X 1/4" self taps. Note that the 3 pin female Deans charging connector goes thru the square hole in the bottom of the case and is flush with the very bottom. Make sure the No. 4 self taps don't go into the battery cases.

RAND SEVEN CHANNEL

Follow the same procedure as spelled out for the Dunham sticks with a few exceptions.

1. The sticks can be secured into place before wiring begins. Make sure the non-neutralizing function (throttle) is the vertical function on the left stick as you face the front of the transmitter.
2. No insulation sleeving is necessary on the Rand stick pots.
3. Refer to Figure K for the proper pot terminals to wire to for clockwise servo rotation with right and downward stick movement. If opposite rotation is desired for any or all of the functions, wire to the middle terminal and the terminal opposite the one indicated.

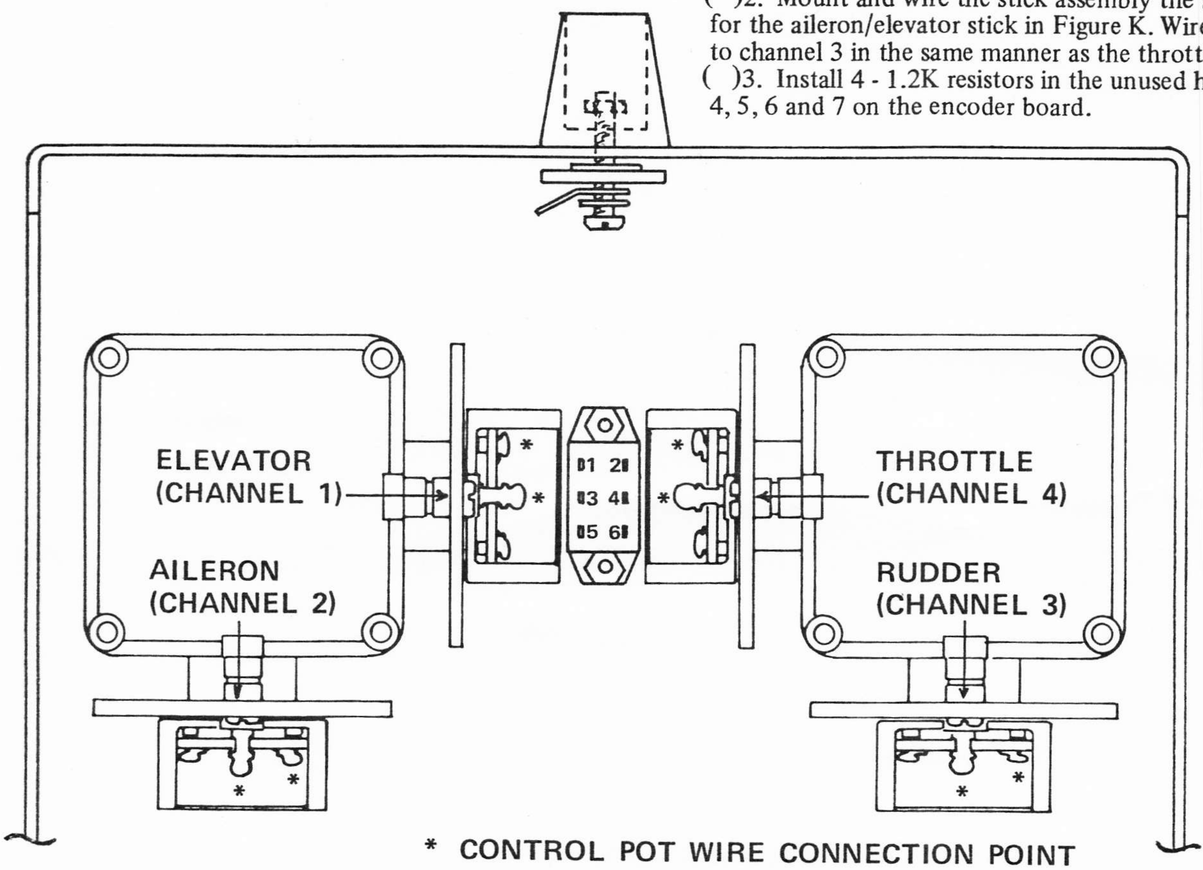
DUNHAM AND RAND FIVE CHANNEL

Follow the same procedure as for the seven channel versions except disregard the portion concerning the auxiliary functions.

Install 2 - 1.2K resistors in the 6 and 7 channel output holes in the encoder board.

RAND THREE CHANNEL

( )1. Install the throttle pot bracket in the case using two 2-56 X 1/4" flat head bolts, nuts and lock washers. Mount the throttle control pot and function lever the same as indicated for the auxiliary function pots in the preceding instructions.
( )2. Mount and wire the stick assembly the same as indicated for the aileron/elevator stick in Figure K. Wire the throttle pot to channel 3 in the same manner as the throttle pot in Figure K.
( )3. Install 4 - 1.2K resistors in the unused holes for channels 4, 5, 6 and 7 on the encoder board.



* CONTROL POT WIRE CONNECTION POINT

FIGURE K

RAND STICK POT WIRING

H. LED MOUNTING AND WIRING
REFER TO FIGURE L

( )1. Install a No. 0 grommet in the hole above the switch.
( )2. Take the 3/8" long piece of 1/8" ID brass tube and slightly squeeze one end so the LED will be a tight fit in the tube. Push the LED in the tube up to the shoulder where the leads exit.
( )3. Using insulation sleeving, strip, tin and solder the white lead of the white/purple pair coming from the encoder board to the cathode of the LED. The cathode is identified by the flat spot on the shoulder of the LED. Solder the purple to the anode. It will be necessary to shorten the leads on the LED so the insulation sleeving will cover the whole joint.
( )4. Slip the LED/brass tube assembly into the grommet in the case. Don't allow the tubing to protrude past the front of the grommet. The tubing provides a "tunnel" so the LED remains visible even in direct sunlight. A drop of "Hot Stuff" or silicone cement will secure the tunnel into place.

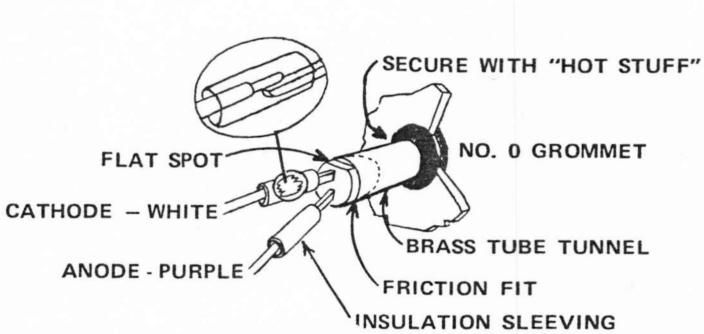


FIGURE L

LED WIRING

I. RF DECK WIRING

( )1. Strip, tin, and solder the wires in the remaining three wire bundle coming from the encoder board in the proper holes indicated on the RF deck overlay drawing, Figure B-2.
( )2. Take two 1½" pieces of scrap wire and strip, tin, and solder them both to the solder lug on the antenna mount. Cover this connection with heat shrink tube. Strip, tin, and solder the other ends of these wires in the two holes indicated on the RF overlay drawing. Clip the wire leads short to prevent them from shorting on the transmitter case.
( )3. Mount the RF deck and the frequency I.D. plate on the transmitter case using two 2-56 X 1/4" flat head bolts as shown in Figure I. The crystal should be on the left as you look inside the back of the case. Tighten securely to insure good ground. Make sure the antenna lug is not shorting to the RF deck and that no leads on the RF deck are touching the transmitter case.

OPTIONAL CONNECTOR WIRING

If desired, you may wire the RF deck up with Deans plugs to permit easy removal for quick frequency change. This is an option and the plugs are not furnished.

Obtain one pair each of the Deans two pin & three pin connectors. Drill out the wire holes in the RF deck to accept the connector and solder the male half of each connector onto the RF deck and the female halves to the wires coming from the encoder board and the antenna--use insulation sleeving on the females. Make sure that the proper wires make the correct connection to the RF board when the connectors are plugged together. Also make sure the legs on the connectors don't short out on the transmitter case when the RF deck is installed.

Your transmitter is now ready for set-up and integration with the rest of the system.

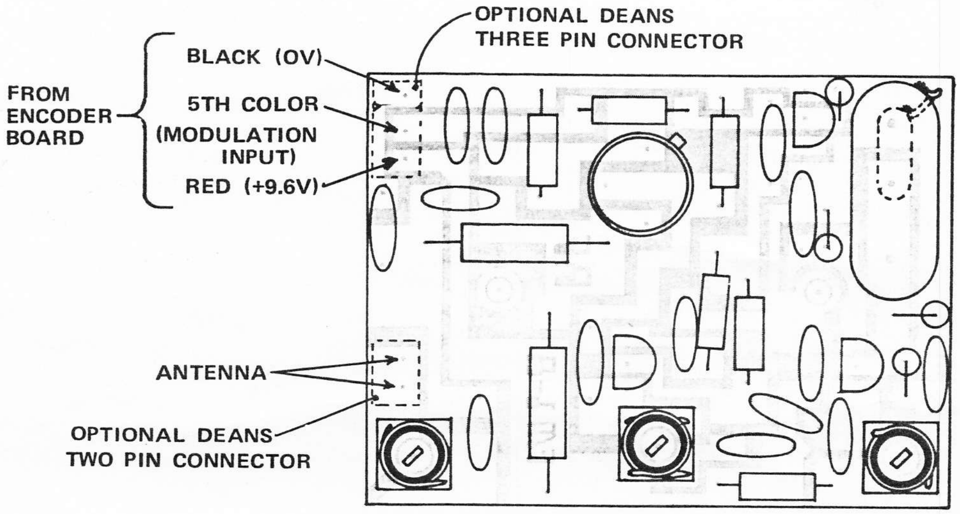
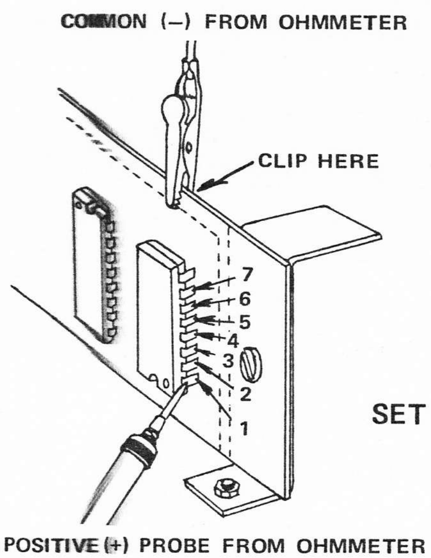
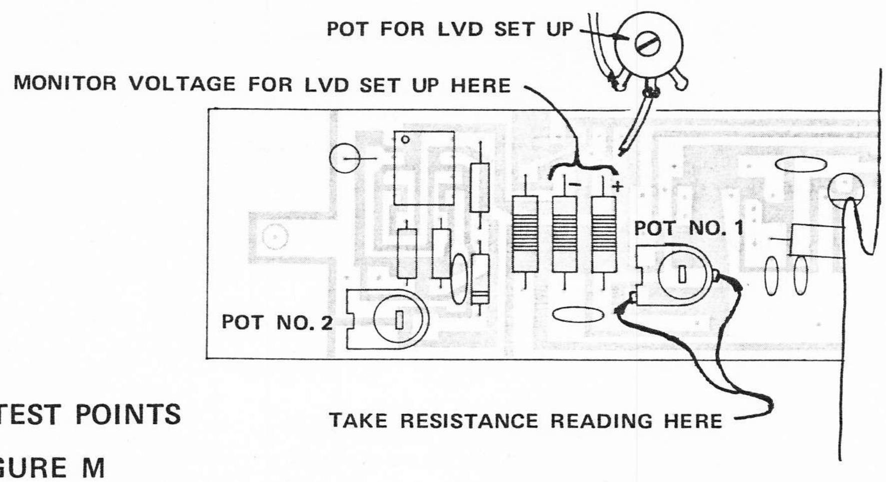


FIGURE B-2
RF DECK OVERLAY





SET UP TEST POINTS

FIGURE M

V. TRANSMITTER SETUP

A. INITIAL POT SETTINGS

Using a VTVM or a solid state VOM of at least 20,000 ohms per volt, set the following pot resistances to the following levels. Make sure power remains off.

1. Control Pots

The instructions are written for the seven channel version. If you have a three or a five channel, disregard reference to the unused channels.
( )Clip the common (-) lead of the ohmmeter to the encoder PC board so it makes contact with the land indicated in Figure M.
( )Using a probe on the positive (+) lead of the ohmmeter, make connection with the appropriate exposed leg of IC-2 for channel 1 (pin one). Adjust the elevator function control pot on the

control stick until the ohmmeter reads 1.8K. Make sure the stick and trim are in neutral. Repeat this procedure for channels 2, 3, and 4, taking the resistance reading off of pins 2, 3, and 4, and adjusting the aileron, rudder, and throttle pots. Make sure all trims are in neutral and center the throttle stick.

To adjust the Rand stick pots, loosen the appropriate yoke screw and rotate the pot adjust wheel until the proper reading is attained. When retightening the yoke screws, don't over-tighten--it's possible to strip out the yoke. Also double check the adjustment because it might slip as you're retightening.

To adjust the Dunham stick pots, simply move the pot adjust lever on the stick assembly until the proper setting is attained. It will stay in position.

( )Connect the probe to the fifth channel leg of IC-2 (pin 5) and adjust the pot on the retract board until 2.5K is achieved when the switch is either toward the top of the case or the rear of the case, depending on whether you mounted the retract assembly on the front or the top. When the switch is in the other position the ohmeter will read 1.2K.

( )Adjust the 6th and 7th channel auxiliary function pots to indicate 1.8K taking the readings off of pins 6 and 7 on IC-2. Hold the auxiliary function lever in the center of its travel and turn the pot shaft with a needle nose pliers until the proper setting is achieved.

2. Encoder Pot

( )Taking the resistance reading off of the two test points indicated for pot No. 1 on the encoder board, set the pot to read 2.9K. Refer to Figure M.

VI. FINAL ALIGNMENT

( )Charge the batteries. Make sure proper polarity is observed when the charger is plugged into the transmitter. It would be a good idea to put a dot on the bottom of the transmitter case at one end or the other of the charging plug hole and put a corresponding dot on the male half of the connector from the charger to indicate when the plug is inserted properly. The charger plug can be forced in backwards and this will ruin the batteries and void any guarantee if they're charged backwards.

IMPORTANT: Give the Battery Pack a 24 hr. Charge Before Using

( )The transmitter can now be turned on and should be operational. Don't operate the transmitter for extended periods (over five or ten minutes) with the antenna off or in the collapsed state. This puts undue strain on the output transistor in the RF deck.

( )Assemble the receiver/decoder now and tune it to the transmitter according to the instructions.

To set up the time base of the transmitter, you have been furnished one assembled servo which has been neutralized at 1.5 ms and rotates thru 90° with 1 ms pulse width variation. Do NOT change this neutral setting on this servo. If you are building the transmitter separately, you will have to use your existing flight system or an oscilloscope to set up the time base.

( )Plug the assembled master servo into output 1 of the decoder. With the system on, the servo should operate when the elevator function on the transmitter is moved. If the servo is not centered when the stick and trim are neutralized, adjust pot No. 1 on the encoder board until the servo centers. Move the stick and trim to the extremes--the servo should move through approximately 45° on both sides of neutral.

( )Plug the master servo into the remaining channels and adjust the TRANSMITTER CONTROL POTS to achieve center on the servo. Do not change the centering of the master servo.

( )Assemble the remaining servos and plug each one into channel 1 and center it by adjusting it through the output shaft. Each should move approximately 45° on either side of neutral.

( )Plug the servos into the appropriate channels and operate the sticks. If more servo throw is desired on all channels, lower all stick pot neutral resistances by 200 ohms. In other words, if you aren't getting enough throw with a 1.8K neutral resistance, lower all stick pots to 1.6K neutral resistance. Pot No. 1 will have to be readjusted to recenter the master servo on channel 1 and then all other control pots will have to be readjusted to center the master servo on all channels. Remember not to change the feedback pot setting on the master servo. Repeat if still more throw is desired.

If less servo throw is desired, raise the neutral resistance by 200 ohms and repeat the centering procedure.

( ) If you have a Seven Channel transmitter, carefully tighten the set screw on the auxiliary function levers to keep them from losing adjustment.

( ) If you have a Rand stick version, make sure the yoke screws are retightened.

Note: Subject to linearity and tolerance of the control pots, the pulse width variation from channel to channel and from neutral to one extreme or the other may vary ± 5%.

VII. SETTING THE LVD

The LVD should be set to begin flashing whenever the transmitter battery voltage goes below 9 volts. 8.8 volts is the danger point when the batteries will start to decrease in voltage rapidly. You even may want to set the blink point at a higher voltage to give more of a safety margin, say around 9.3 or 9.4 volts.

( )Check the battery voltage for a full 9.6 volts or more. Temporarily desolder the red power lead from hole D on the encoder board and connect a 500 ohm to 1K pot in series. (This pot is not furnished) Refer to Figure M.

( )Turn the transmitter on and with a voltmeter measure the voltage from minus to plus taking the readings off of the chokes indicated in Figure M. Set the potentiometer to give 9.0 volts.

( )With the supply at 9.0 volts, adjust pot No. 2 on the encoder board so that the LVD just barely begins to flash. Now increase supply voltage to 9.3 volts and the flashing should stop. Reducing the voltage to 9.0 volts should start it flashing again. Repeat this test several times and make pot adjustments in very small increments until the process is clearly repeatable. The pot is very sensitive so it will take some trial and error until proper operation is achieved. Remember, 9.6 volts is normal operating voltage and 8.8 volts is the danger point.

At any time the light flashes one should land the airplane immediately and stop operation of the system.

The system is now ready for installation. If a glider or power plane is to be flown, a full range check with transmitter antenna extended should be made. Have a helper walk out with the transmitter with the antenna held upright while slowly and steadily moving one control back and forth. Caution him not to move the other controls as it is desirable to use their steadiness as an indication of solid operation. Hold the model at head level and check operation to a range of around 500 feet. Solid operation to this point is an indication of solid operation to an air distance several times greater.

It's always a good idea to test a new system in an old "test bed" airplane in case there is a problem which doesn't show up on the bench. Also it's good practice to cycle (charge and discharge) the batteries a few times to check them out. Don't discharge the transmitter pack below 8.5 volts or the flite pack below 4.3 volts because a deep discharge may cause damage to the batteries causing them either not to accept a charge or to go negative.

Good luck with your Digital Commander. We at Ace R/C are proud of the quality of components and of the design from both an electrical and a mechanical standpoint. We hope you enjoyed building the Digital Commander and hope you have years of dependable, satisfactory operation from your system. We would appreciate any comments you might have on the building or operation of your system.