ACE R/C INC.

DIGITAL COMMANDER

1-8 CMOS DOUBLE DECK RECEIVER

I. RECEIVER SECTION DESIGN

The receiver section is superheterodyne, utilizing a double tuned front end. The use of an IC to perform squaring and pulse stretching in the decoder section permits the receiver to be simplified and the space used to provide good stability. The receiver is quite stable and tuning is easy and solid.

Refer to the block diagram, Figure 1 , and schematic, Figure 2 , for the discussion to follow. The RF tuning, i.e., front end, uses two parallel pass filters (L2, C5) and (L3, C7) which are coupled by C6. This double tuned circuit provides the proper front end selectivity even when an adjacent channel transmitter is close by. The front end components are C5, 6, & 7, L2, 3, & 4.

The output from the secondary winding L4 of L3/L4 is fed directly to the base of the mixer, Q2, which is biased to a given d.c. level via R6. The output from the local oscillator is injected at the emitter of Q2.

The local oscillator usually operates at a frequency 455 KHz below the transmitted frequency. The local oscillator (LO) used is simply a crystal controlled oscillator feeding a tapped inductor. The shorter winding above the tap forms a secondary as well as part of the total inductor. The output of the LO is coupled via C4 to Q2.

Two frequencies appear at the input to Q2; the transmitted frequency and a frequency separated 455 KHz from the transmitted frequency. For example, assume a transmitted frequency of 26.995 MHz. The LO operates at 26.995 MHz minus 0.455 MHz or 26.540 MHz. The function of Q2 is to "mix" these frequencies to produce a 455 KHz intermediate frequency (IF). When two separate frequencies are mixed or "heterodyned", they produce the following frequencies, for our example:

† The sum of the two frequencies or 53.535 MHz,
† The difference between the two frequencies or 455KHz, and
† The two original frequencies.

In order to provide the desired selectivity, we wish to work only with the 455 KHz IF frequency. This is the function of the IF strip to be described a little later. The local oscillator is formed of R1, R3, R4, C3, L1, C1, C2, Q1, and the crystal. C4 is the coupling interface with the mixer formed of C8, L4, Q2, R6, and R7.

The IF strip operates on the 455 KHz signal out of Q2 and excludes all other frequencies. By so doing, it increases the selectivity of the receiver to 5 KHz as desired. The output from T3 is rectified by D1 and the output from Q5 appears as the rectified 455 KHz envelope. This means that the base of Q5 sees only the positive going portion of the IF envelope which occurs when a pulse is received in the RF envelope. Q5 amplifies the pulses to an amplitude which is dependent on the signal input to the receiver; i.e., amplitude increases as signal strength increases. One can visualize that the output amplitude of Q5 would fluctuate continually as range and aspect to the transmitter changes. This is highly undesirable and it results in glitching and/or swamping of the receiver.

The above is prevented by coupling back the detected D C signal out of Q5 to the preceding IF stages to reduce their gain as signal input is increased. Ideally, then, the output from Q5 remains constant from zero range to the maximum anticipated operating range. Within the limits of simple circuitry this is the case. This function is called automatic gain control (AGC). The AGC circuit is formed by C20, C21, R14, R18, and R19. All the remaining circuitry between the output of Q2 and the output of T3 constitutes the IF circuitry (commonly called the IF strip).

The output from Q5 is coupled to a limiter stage consisting of D2, R21, and R22. The function of the limiter is twofold: it tends to limit the amplitude of the detected signal when the transmitter is close to the receiver and thus helps prevent overloading. More importantly, it "clips" noise spikes which could occur under low signal conditions resulting in servo jitter. The net result is that the receiver output remains "clear" to maximum range, then cuts off sharply. This also is important in the rejection of strong adjacent channel signals. The output from the limiter stage is then fed to the decoder board.

For the 1-8 receiver, we feel that the added complexity of a voltage regulator/active filter for the receiver is justified. Actually, no more components are required; but one active component (the transistor) is added. The filter/regulator functions as follows. The transistor (Q6) is forward biased to a specific level via R25 in the static condition. Under these static conditions (which actually occur only when the receiver is on without any incoming signal), capacitor C-24 charges to supply level. However, in the presence of a fluctuating supply voltage (which is almost all the time), the capacitor tends to charge and discharge through the transistor to maintain equilibrium voltage. In so doing, the transistor adds gain such that the apparent value of the capacitor is many times the actual value. The performance observed under test is that the regulator maintains receiver voltage within 10-15 millivolts of the desired level with pulsed fluctuations of up to 150 millivolts in the supply line.

A "keep alive" (R26) maintains operation at low signal levels.

II. DECODER SECTION DESIGN

The decoder section is functional one thru eight channels, and is based on the use of CMOS (Complementary Metal Oxide-Silicon) integrated circuits offering the utmost in stability, noise rejection, and low current drain.

The decoder is also designed to perform the squaring and pulse stretching functions needed to provide clock and synchronization pulses via an IC thus relieving the receiver of this function and, in turn, permitting the receiver to be as simple as practical with a very low parts count but excellent selectivity and sensitivity.

The decoder is shown functionally in the block diagram, Figure 1 and in the schematic, Figure 2. The description which follows is keyed to these two figures. The hexagon inverter 74CO4 consists of six transistors contained in the chip. Digital information operates between two levels; i.e., it is binary. These voltage levels are usually slightly above zero volts and slightly below 4.8 volts for the decoder. An inverter will show the opposite output from the input.

Let us examine the function of inverter No. 1 in the diagrams, as an example. The receiver output is a train of from two (for one channel) to nine (for eight channels) pulses per frame with an upper level of near 4.8V. Each pulse drops to near zero volts. The inverters in the 74C04 will switch at these levels, thus the first stage shown inverts and slightly amplifies the pulse train.

The pulse train now proceeds to two separate stages; the one at the top (Inverters 4 and 5) of both the block diagram and schematic generate the "set" pulse and the lower one (Inverters 2 and 3) simply shapes and squares the pulse train to form clock or "shift" pulses.

The shift pulse shaper accepts the pulse train, squares, and stretches it slightly by feeding back via C27.

The output from Inverter No. 2 is negative but is reinverted by No. 6 to remain positive at the output. The shaped clock pulses then are passed to the eight bit shift register, the 74C164.

Upon receipt of the first, or "synchronization" pulse, the diode D3 and C26 act as a "sample and hold" or pulse stretcher. C26 discharges through Inverter No. 4 and places it in an inverted, positive-going state. At this point, the pulse is stretched across the entire pulse train. The output from Inverter No. 4 is still slightly rounded and is of the wrong level, i.e., positive going for "set" so further stretching is provided by C28. The output from Inverter No. 5 is quite square and is negative-going during the period when the pulse train is present. The shift register is "set" by having the output of Inverter No. 5 be one at the instant the first clock pulse is received. The "set" is immediately driven to ground at the first clock pulse and remains so until after the last pulse is received. In doing so, the first stage of the register, which is a flip-flop, is inhibited from shifting back to Q until the next frame of information is received.

The eight bit shift register consists of eight R-S (as opposed to J-K) flip-flops. Requirements for the decoding function are as follows:

a) No flip flop will respond to a clock pulse, i.e., Q becomes a one (positive) unless S is a one at the time the clock pulse is received (CP).
b) If the "clear" line is a zero (negative), none of the registers will shift and any that is a one will be "cleared", i.e., becomes zero.
c) Making SA or SB a one (positive) permits the first flip flop to clock (i.e., Q1 becomes a one) upon receipt of the first clock pulse.

The simplest flip-flop works as follows: It shifts its binary one (high voltage out) back and forth between Q and $\overline{Q}$ each time a clock pulse is received. Whenever Q is positive (one), $\overline{Q}$ is negative (zero) and vice versa. By adding a bit more sophistication, additional control may be added to inhibit the shift or to arbitrarily "clear" the flip-flop by setting it on $\overline{Q}$. The two functions we use for control are entered at the "set" input of FF-1 (the S input) and at the clock inputs.

When there is no information present, during the synchronization pause or "set" period, Q for FF-1 through FF-8 is zero. As soon as the first clock pulse is received, FF-1 shifts to Q, i.e., Q becomes positive and, as stated earlier, $\overline{Q}$ becomes negative. FF-1 can not shift to Q unless it "sees" a one, or positive level, at SA/SB (pins 1 and 2) which it does at the instant the first clock pulse is received. Q for FF-1 remains positive until the second clock pulse is received at which time it reverts to zero.

If S for FF-1 were to remain at the one level at all times, FF-1 would simply shift back and forth between Q and $\overline{Q}$ every time a clock pulse was received and there would be no decoding. Thus, the "set" pulse was driven to zero an instant after the first pulse was received as mentioned earlier. Now, FF-1 can not shift again as long as the output from Inverter No. 5 is negative, i.e., not until after all pulses have been received and the output of Inverter No. 5 returns to the one level. This, of course, is why the pause between frames is called the synchronization or "set" pause since FF-1 is "set" to accept the first pulse during this pause.

Go back and reread the preceding two paragraphs and remember that FF-2 can not shift to Q unless its S sees a one. It sees a one only when Q for FF-1 is a one, i.e., during the first control pulse. So, as soon as Q for FF-1 is a one, FF-2 is set and is free to shift to Q when the second pulse, which also returns FF-1 to $\overline{Q}$, is received. FF-1 shifts to Q until the third pulse is received to return it to $\overline{Q}$, and so on for the number of channels chosen up to eight. As soon as C26 and C28 have discharged after the last pulse, the output of Inverter No. 5 returns to a one and FF-1 is reset to be ready for the next frame.

The lengths of the control pulses are determined by the length of time (1.5 milliseconds $\pm$ 0.5 milliseconds for control motion) between the clock pulses. The synchronization pause is nominally 4 milliseconds, thus the entire frame is 4 plus 1.5 ms per channel. This makes the frame rate about 65 per second for an eight channel set.

The decoder has been tested with just about every servo available that requires a positive control pulse, and has been found compatible with all of them. Negative going servos operating from $\overline{Q}$ such as the Controlaire S-4a and S4d and the EK MM3 can be used by making the modification indicated to access $\overline{Q}$. Reread the text on the decoding function of the dual R-S flip-flop and it will be noted that, once FF-2 has completed its cycle with the receipt of pulses two and three, neither flip-flop can be shifted again until a synchronization pause. This has the beauty that the decoder can be used with any transmitter whether it is one channel or eight. The decoder simply decodes the first functions from one or eight that arrive. It is held off for extraneous pulses. In general, then, the decoder could be used for any glider, car, boat, or plane as a second multi channel system operating from an existing transmitter.

The Digital Commander system will not work with Bonner Digimite, Jerobee, or Kraft KP2B (early two channel). Digital Commander servos will not work with Hobby Lobby 5 (amps are in decoder). A pulse inverter is available for using the Digital Commander servos with negative pulse systems: 14G19—Servo Pulse Inverter $1.00.

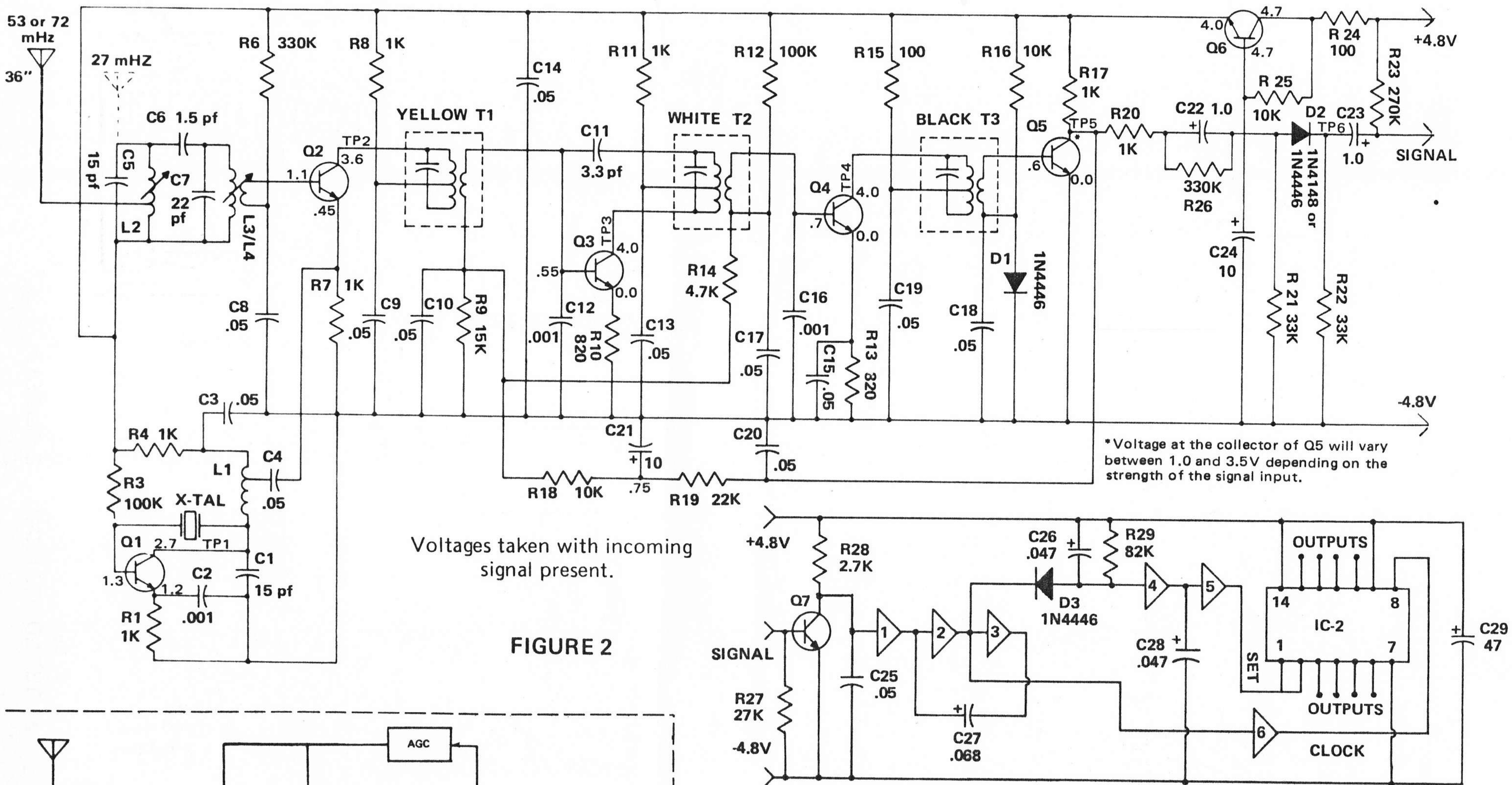


FIGURE 2

INVERTERS 1-6 = IC-1, 74C04 SHIFT REGISTER = IC-2, 74C164

NOTES:

1. ALL CAPACITORS MF UNLESS OTHERWISE NOTED
2. Q1 2N/PN3646
3. Q2, Q3, Q4 2N/PN3563
4. Q5-2N2925; Q6-2N5088; Q7-2N4124 or 2N4400
5. L1 TAPPED RF CHOKE
6. SCHEMATIC INDICATES VALUES FOR 72 MHZ. CHECK LEGEND FOR 27 AND 53 MHZ CHANGES.

VALUES REQUIRED FOR FREQUENCY BANDS:

FREQ.	C1	R1	R3
53/72 MHz	15 pf	1K	100K
27 MHz	47 pf	470 OHM	47K

Coils L2 and L3/4 are wound differently for each frequency band. These coils, plus the crystal, plus the components indicated to the left must be changed if the frequency band is changed.

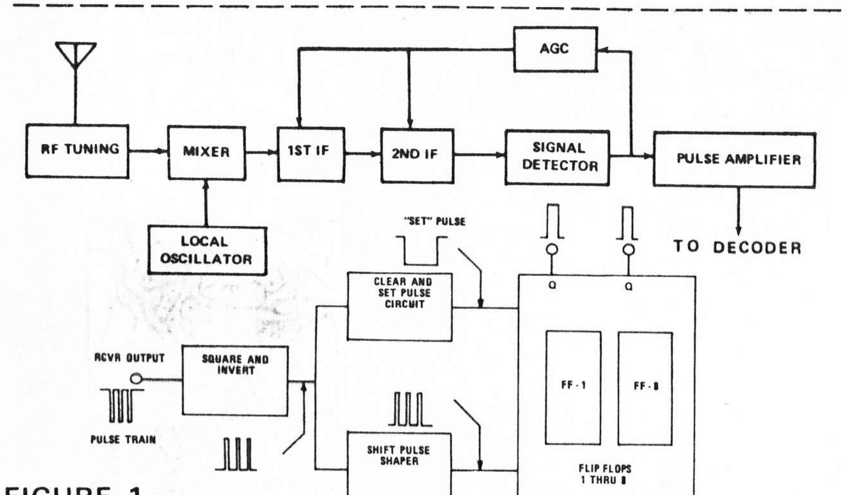
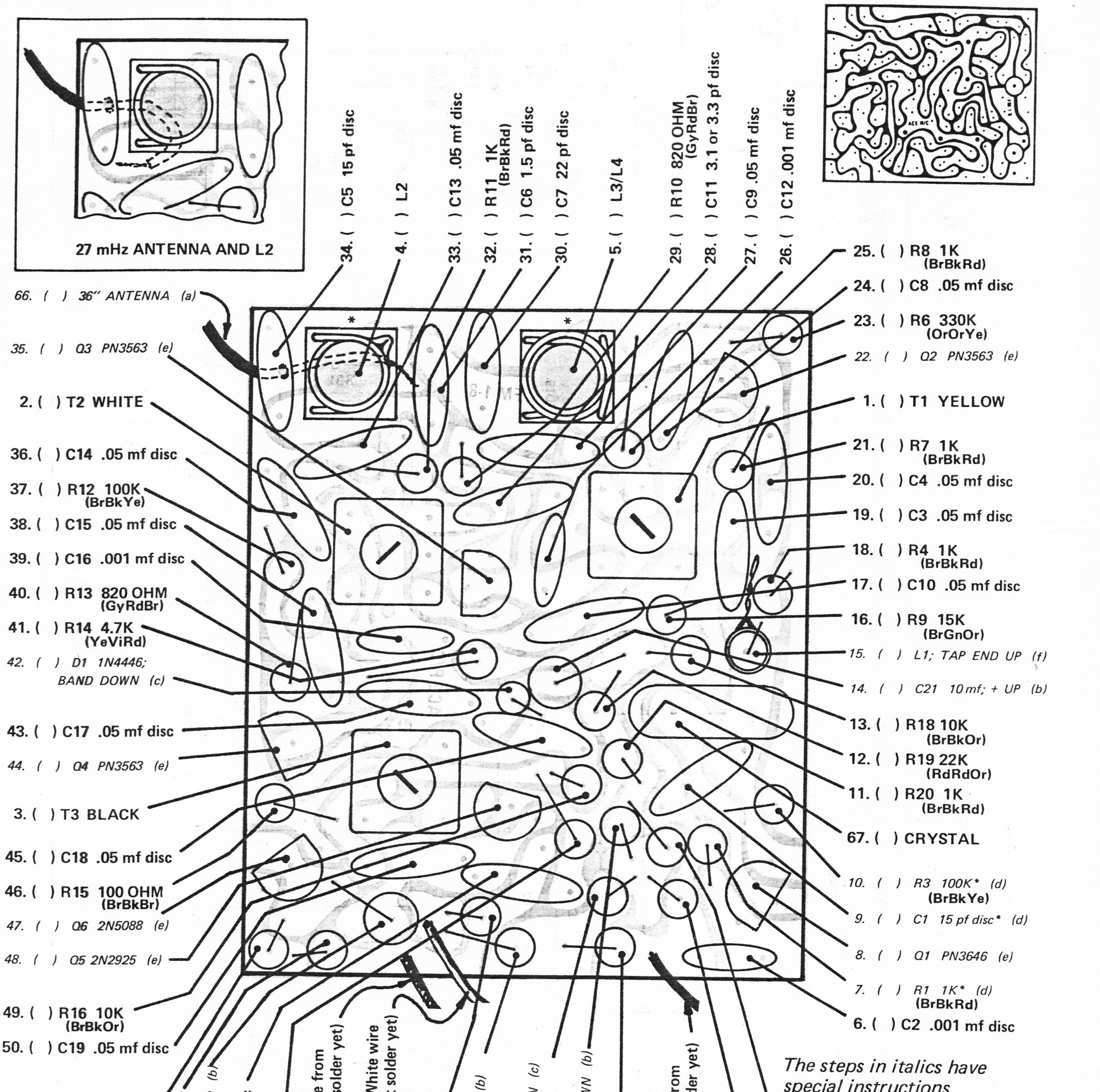


FIGURE 1

FIGURE 2 RECEIVER OVERLAY



The steps in italics have special instructions.

*VALUES FOR 72 mHz . SEE SCHEMATIC LEGEND FOR 27 and 53 mHz.

1-8 RECEIVER PARTS LIST

( ) 1 Printed Circuit Board
( ) 1 Receiver Crystal
( ) 1 L2 Tuning Coil
( ) 1 L3/L4 Tuning Coil
( ) 1 L1 Tapped RF Choke
( ) 2 10 uhy Chokes

( ) 1 Yellow IF Transformer
( ) 1 White IF Transformer
( ) 1 Black IF Transformer

SEMICONDUCTORS

( ) 2 1N4446 Diodes
( ) 3 PN3563
( ) 1 PN3646
( ) 1 2N2925
( ) 1 2N5088

RESISTORS

ALL RESISTORS ARE 1/4W

( ) 2 100 ohm (brown, black, brown)
( ) 1 470 ohm (yellow, violet, brown)
( ) 2 820 ohm (grey, red, brown)
( ) 7 1K (brown, black,red)
( ) 1 4.7K (yellow, violet, red)
( ) 3 10K (brown, black, orange)
( ) 1 15K (brown, green, orange)
( ) 1 22K (red, red, orange)
( ) 2 33K (orange, orange, orange)
( ) 1 47K (yellow, violet, orange)
( ) 2 100K (brown, black, yellow)
( ) 1 270K (red, violet, yellow)
( ) 2 330K (orange, orange, yellow)
( ) 36" Antenna Wire
( ) 36" Micro Solder

CAPACITORS

( ) 1 1.5 pf disc
( ) 1 3.1 or 3.3 pf disc
( ) 2 15 pf disc
( ) 1 22 pf disc
( ) 1 47 pf disc
( ) 12 .05 mf disc
( ) 3 .001 mf disc
( ) 2 1 mf Components, Inc.
( ) 2 10 mf Components, Inc.

( ) Receiver Case Package
( ) Plug and Switch Package
(Included in Flite Paks and Systems only)

III. RECEIVER ASSEMBLY

A. PC BOARD CONSTRUCTION

( ) Re-read the introduction concerning general info and soldering techniques.

( ) Using fine steel wool or a rubber eraser, clean the foil side of the receiver board until it is shiny.

( ) If tuning slugs are present in the two tuning coils (L2 and L3/4), remove them with a small screwdriver and set them in a safe place until later. Note that L2 has a single coil of wire and may or may not have a tap exiting out a third hole in the coil form, depending on the frequency band. L3/4 has two overlapping coils.

( ) Using an Exacto knife, scrape the ends of the wire for L2 and L3/4 that will protrude through the PC board absolutely free of enamel.

( ) Install L2 and L3/4 in the locations indicated on the parts overlay page with the red dot on the coil form toward the top of the board, indicated by asterisks (*). Glue the coil forms to the board by sparingly using 5 Minute Epoxy or "Hot Stuff" Solder to the PC board making sure of a good joint.

( ) Solder in the IF cans next, following the color code (yellow, white, and black). Make sure the leads and lugs line up with the holes before inserting, and that the IF can is flat on the board when soldering. DO NOT install the crystal yet.

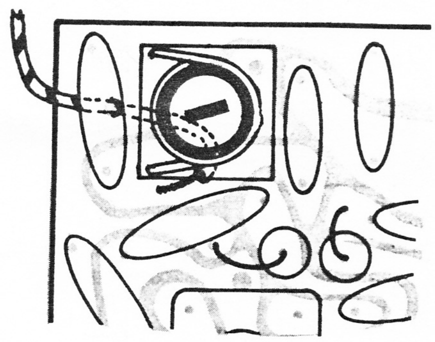
( ) Install the remainder of the components in the order indicated by the parts overlay.

For the steps in italics, refer to the following special instructions. The letter in parenthesis indicates which instruction to refer to.

a. The antenna is soldered to the land indicated and then threaded through the hole in the PC board for strain relief. The solder connection as indicated on the parts overlay page is for the 53 and 72 MHz version only. If you're building a 27 MHz receiver, solder the antenna as indicated in Figure 4.

b. The tantalum capacitors must be installed with the proper polarity. The plus end is either colored red or "shouldered". The proper position of the plus ends is identified as "up" or "down".

c. The banded end on the diodes identifies the cathode. Be sure to install them as indicated.



WIRE ANTENNA AS SHOWN FOR 27 MHZ.

FIGURE 4

d. If you are building a receiver on 27 MHz, the values of the components indicated by an asterisk (*) are different than shown. See the legend on the schematic page to obtain the proper value. Since you have been supplied the values for all frequency bands there will be a few parts left over.

e. Make sure the transistors are installed with the flat part as shown on the overlay.

f. Notice that the tap coming off of the tapped choke is nearer to one end. Install this end up. Thread the tap over to the hole indicated and solder.

( ) Install the crystal where indicated. It must match the frequency of the transmitter you're going to use. It may have the transmitted frequency (e.g. 26.995) and/or the actual crystal frequency which is 455 KHz above or below the transmitted frequency (e.g. 26.540 or 27.450). Check below for the 72 MHz doubler crystal designation.

72 MHZ DOUBLER CRYSTAL DESIGNATIONS

72.08	(brown/white)	– .455	=	71.625/2	=	35.8125
72.16	(light blue/white)	– .455	=	71.705/2	=	35.8525
72.24	(red/white)	– .455	=	71.785/2	=	35.8925
72.32	(violet/white)	– .455	=	71.865/2	=	35.9325
72.40	(orange/white)	– .455	=	71.945/2	=	35.9725
72.96	(yellow/white)	– .455	=	72.505/2	=	36.2525
75.64	(green/white)	– .455	=	75.185/2	=	37.5925

( ) Ground the crystal case by soldering a scrap resistor lead between the middle of the top of the crystal case to the top of the yellow IF can. Make sure you don't solder to the corner of the crystal case that already has solder on it; if you do so, you may unsolder the internal connection.

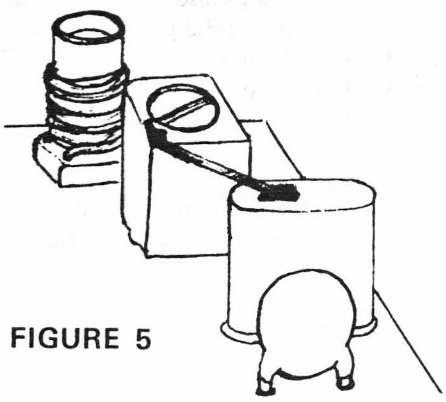


FIGURE 5

( ) When construction is complete, inspect the completed receiver carefully for placement of components.

( ) Scrub the bottom of the PC board with alcohol using an old toothbrush to remove the solder resin.

( ) Compare the bottom of the board with the PC positive shown in Figure 9 to be sure there are no solder bridges.

( ) Assemble and wire the decoder. Make the interconnect between the receiver and decoder.

CMOS DECODER PARTS LIST

SEMICONDUCTORS

( ) 1 1N4446
( ) 1 2N4400
( ) 1 74C04 IC
( ) 1 74C164 IC

CAPACITORS

( ) 1 .05 mf Disc
( ) 2 .047 mf Tantalum
( ) 1 .068 mf Tantalum
( ) 1 47 mf Tantalum

RESISTORS

( ) 1 2.7K (red, violet, red)
( ) 1 27K (red, violet, orange)
( ) 1 82K (grey, red, orange)

( ) 1 Printed Circuit Board
( ) 18" Solder
( ) Wire: 30" Red
30" Black
6" Blue
6" Orange
6" Yellow
6" Green
3" White

IV. DECODER ASSEMBLY

( ) Check the parts obtained against the parts list.
( ) Clean the copper side of the PC board with fine steel wool or a rubber eraser.
( ) Construct the PC board referring to the following notes.

A. Install and solder all parts except the IC's working around the board in a clockwise manner.
B. Prepare the 2N4400 as shown in the drawing before installing.
C. Use a scrap resistor lead for the jumper wire.
D. Make sure the capacitors are installed with the positive ends as indicated and the 1N4446 is installed with the banded end as indicated.
E. Leave the IC's out until after the wires are installed.

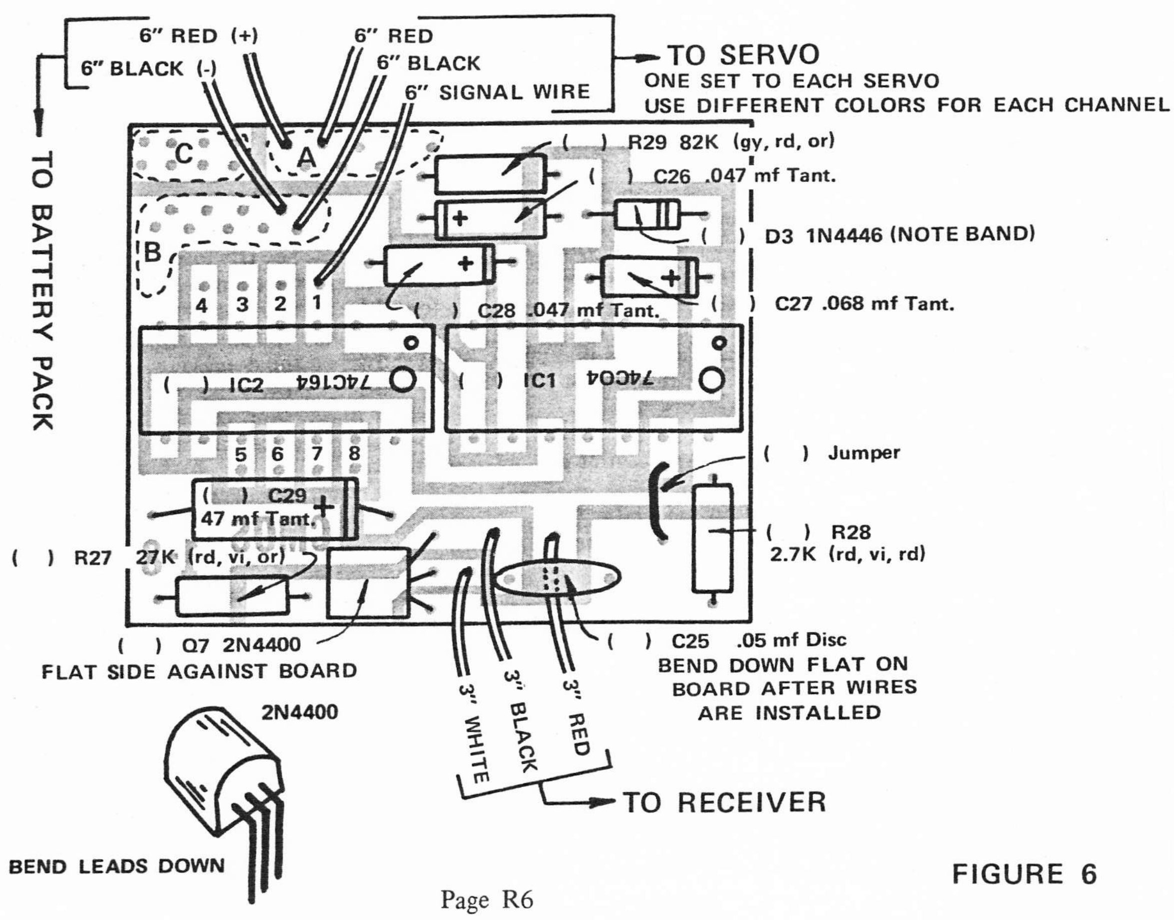


FIGURE 6

V. DECODER WIRING

( ) Refer to the "Kit Builder's Hints" section for proper wire preparation.

A. INTERCONNECT WIRING

( ) Cut a 3" piece of red and black wire; install them and the 3" piece of white wire in the PC board as indicated for: "TO RECEIVER". Bend C25, .05 disc cap, over so it's almost flat on the board and not protruding any higher than the rest of the components.

B. POWER WIRING

( ) Install a 6" red wire in land A and a 6" black wire in land B. Twist them together. Slip a No. 0 grommet over the pair of wires and solder them to either the power switch or connector, depending on the switch harness configuration you are using. Make sure that the red wire hooks up to +4.8V (positive) and the black wire hooks up to OV (negative) of the battery pack. If you are using Deans connectors as furnished in Flite Packs and Systems refer to the "Kit Builder's Hints" and the Plug Wiring illustration for proper hookup.

C. SERVO OUTPUT WIRING
(Three Channel Systems and Two Channel Flite Packs)

( ) You have been furnished female three pin Deans connectors for servo connectors. For each servo you need a 6" piece of red wire from land A, a 6" piece of black wire from land B and a 6" piece of color coded signal wire from the output of IC2. For two servos, use outputs 1 and 2 of IC2; for three servos use outputs 1, 2, and 3 of IC2.

( ) Twist the three wires for each servo together to form cables. If you are wiring for two servos, thread the two cables thru a No. 0 grommet and solder a three pin female Deans connector to each of them, referring to the "Kit Builder's Hints" and the Plug Wiring illustration for proper hookup. If you are wiring up three servos, thread two of the cables thru a No. 0 grommet and the third thru the same grommet that the power cable goes thru. Solder each to a female Deans connector.

D. SERVO OUTPUT WIRING
(Five and Seven Channel Systems and Four Channel Flite Packs)

( ) You have been furnished a female Deans Three Servo Block connector for elevator, rudder, and throttle outputs and a female three pin Deans connector for aileron output. Wire as follows:

( ) Begin with the aileron servo cable. Prepare 6" of red, black, and orange; solder the red into a hole in land "A", black in a hole in "B", and the orange into the hole marked "2" (the signal output for the second channel.) Twist these three wires together and thread them thru the No. 0 grommet with the power cable. Trim the end of the cable even and solder to a 3 pin female Deans plug as illustrated.

( ) The block connector is next. Prepare a cable with 6" of red from land "A", 6" of black from land "B", 6" of blue from hole "1", 6" of yellow from hole "3", and 6" of green from hole "4". Twist these together, run them thru the grommet, and solder to the block connector as shown. green from hole "4". Twist these together, run them thru the other No. 0 grommet, and solder to the block connector as shown.

( ) If additional functions are desired (5th, 6th, 7th, and 8th channels), wire them as the aileron servo cable with the signal wires in hole 5, 6, 7, and 8 using additional 3 pin female Deans connectors (not furnished.)

Any or all of the outputs can be used. An unoccupied output won't hurt a thing.

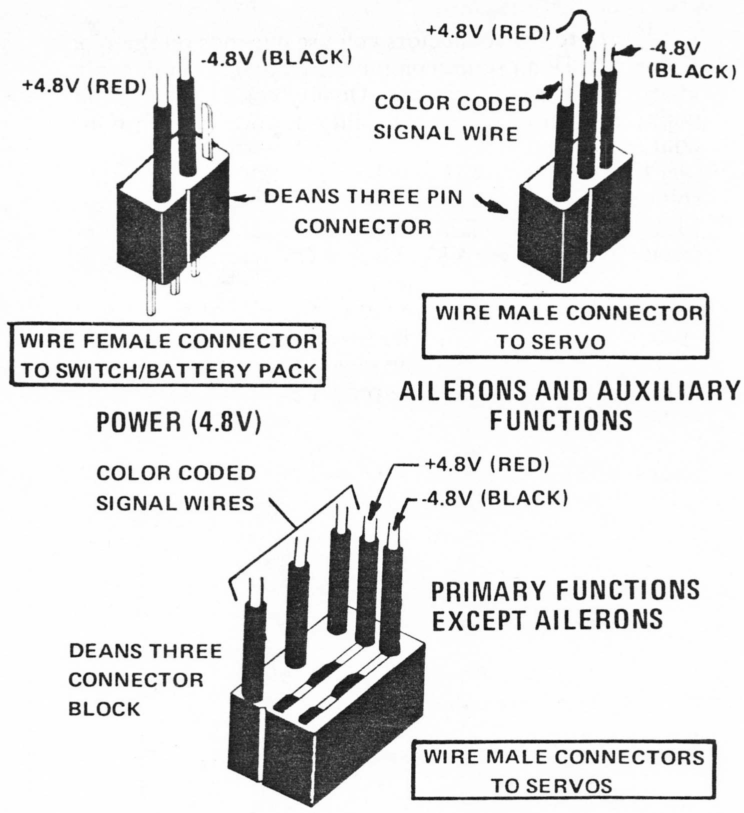


FIGURE 7
PLUG WIRING

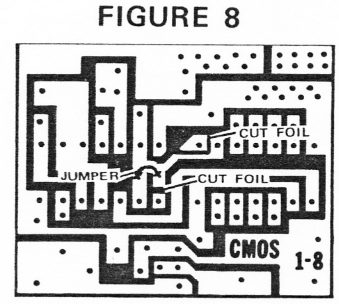
F. SERVO CABLE WIRING (Using other servos and connectors).

If the servos you plan to use are four or five wire servos, you need to run a third wire from the battery pack to land "C" on the PC board (drill out the holes). This third wire (usually white) is center tap (+2.4V) from the battery pack. Each servo cable will then need a fourth wire from land "C" in addition to the red from "A", black from "B" and the color coded signal wire from holes 1 thru 8.

Determine whether your servos require a positive pulse or negative pulse. If the brand you are using isn't on the list provided, check with the manufacturer. If your servos require negative pulse make the modification illustrated.

POSITIVE PULSE SYSTEMS:	NEGATIVE PULSE SYSTEMS:
Ace Digital Commander	Controlaire
Blue Max	EK (Super Pro to '73–white/black non-polarized plugs)
EK ('73 and Later--red/black polarized connectors)	EK Logictrol II
Heath	EK MM3 servos
Kraft	F & M
Micro Avionics	M.A.N.
MRC	O.S.
Orbit	Pro-Line
Royal	
W. E. Midget	
Sanwa	
Futaba	

FIGURE 8



To modify the 1-8 Decoder for operation with servos that require a negative-going pulse, cut the PC foil as indicated. Also install a jumper wire between the two lands as shown. The decoder will now emit a negative pulse to all channels.

Wiring to the connectors you use depends on the type you've got. Don't scrimp on buying connectors and don't use something that's marginal. Quality connectors play an important part in the dependability of your system; if in doubt, replace.

Three wire servos should have a red, black, and a third colored wire (plus white if it is a four wire servo and plus white and green if it is a MRC five wire servo.) In most all instances, the red is +4.8V, black is OV (ground), white is +2.4V (if used) and the other colored wire is signal input. The only exception we know of to this rule of thumb is RS System's servo. If there is any doubt, check the wires coming from the receiver that the servo was originally used with using a voltmeter to establish proper polarity and wiring sequence.

( ) Wire the servos to the receiver so red goes to +4.8V, black to OV (ground), and the signal output wires from holes 1 thru 8 go to signal input on the servo.
Also wire in the battery center tap (+2.4V) if applicable. If you are using a MRC five wire servo, wire both the green and the red from the servo to red coming from the receiver.

Be careful here because most servos can be damaged if reverse polarity is applied.

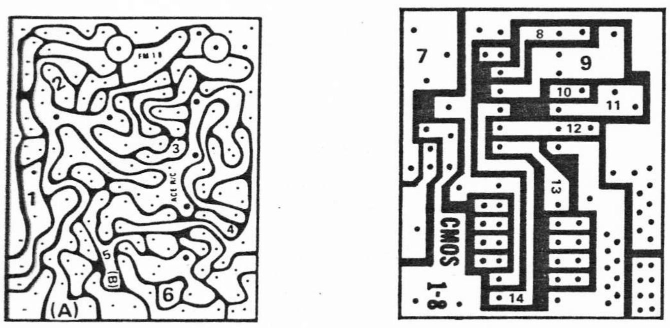
V. IC INSTALLATION

A. CMOS HANDLING

Because the IC is a CMOS device it is susceptible to damage from spurious static electricity while it is not installed in a circuit. To prevent damage, handle the IC as little as possible . . . that's why they're the last component to go in. Use common sense. Don't handle the IC after shuffling across a carpet and don't drop the IC on the floor or on your lap. Just keep it on the workbench and leave it in the foil package until ready.

( ) Take IC-1, 74C04 out of the foil. The leads of the IC are spread somewhat. Press the entire row on one side against a flat surface to bend them in simultaneously. Install and solder in the PC board with the dot indicating pin 1 in the location indicated in the overlay. Repeat for IC-2, 74C164 making sure the dot is where indicated. Let the red wires go over the top of IC-2.

( ) Double check the overlay for proper parts placement. Make sure all leads are clipped short. Scrub the bottom of the board with alcohol or dope thinner and an old toothbrush to remove the solder rosin. Use a magnifying glass to inspect the bottom of the board for bad solder joints and solder bridges, comparing it to the PC board positive shown in Figure 9. Take your time! Double check now to avoid disappointment later.



"A" TO SCOPE OR METER GROUND (-)

"B" TO SCOPE OR METER PROBE (+)

FIGURE 9

VI. TUNING

A. PREPARATION

( ) Prepare the receiver for tuning by running the tuning slugs up and down the tuning coils (L2 and L3/4) a few times with a small screwdriver. This establishes threads in the coil forms and makes for easier tuning.

( ) Clip one lead on each of the two 10 uHy chokes to 1/4". Solder them to the lands on the PC board as indicated in Figure 9 and the photo, Figure 10. Put a piece of tape between the body of the choke and the PC board as shown to prevent shorts while tuning.

( ) If you don't have a suitable non-metallic tuning wand, fabricate one out of dowel or plastic rod. Use it for tuning both the IF cans (T1, T2, and T3) and the tuning coils (L2 and L3/4).

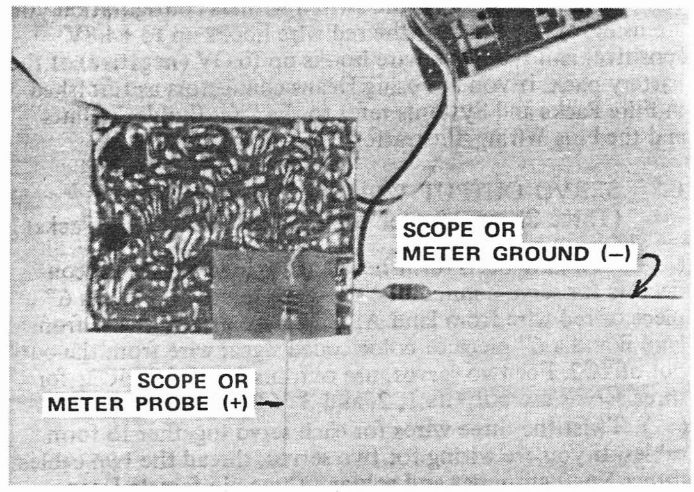


FIGURE 10

B. TUNING WITH A SCOPE

( ) Connect the scope as indicated in Fig. 9. Set the scope to 0.1V/cm or the lowest setting available.

( ) Position the receiver with the antenna dangling over the edge of a non-metallic workbench away from metal objects. Be sure your soldering iron is not plugged in and lying near the receiver.

( ) If your transmitter has a top-mounted antenna, remove it. If the antenna is mounted internally, collapse it as far as possible. Turn the transmitter on.

( ) Apply power to the receiver. (4.8V)

( ) As you perform the following steps, increase the distance between the transmitter and receiver to maintain the displayed signal at about 1.5 cm peak-to-peak. Do not touch the receiver or any of its leads while making the adjustments to follow. Use a tuning wand or piece of dowel to hold the receiver down.

( ) Using a non-metallic tuning wand, adjust T1, T2, and T3 for peak displayed output. Then adjust L2 and L3/4 for peak. Keep moving the transmitter away to maintain 1.5 cm peak-to-peak. Run through the adjustments at least three times to insure that the receiver is peaked. The signal displayed must not be permitted to distort and should have the appearance shown in Trace 5 of the Troubleshooting instruction. Final tuning should be done while someone is holding the transmitter.

( ) After the receiver has been tuned, turn the transmitter off and observe the receiver waveform. It should appear as a horizontal line on the scope with small negative spikes. If the waveform has large negative spikes, tune the yellow IF can counterclockwise until these large spikes are no longer displayed. This will be up to 1/4 turn. Turn the trans-

mitter back on and repeak the white and black IF cans. This completes the tuning of the receiver.
( ) Remove the chokes.

C. TUNING WITH A VOLTMETER

If a scope is not available but a VTVM or a solid state VOM of at least 20,000 ohms/V is available, perform the following procedure using the lowest DC setting.
( ) Hook the meter up, position the receiver, prepare the transmitter, apply power and tune just as spelled out for the scope except adjust the IF cans and tuning coils for the LOWEST voltage reading. Keep moving the transmitter away and retuning until maximum range is obtained. Final tuning should be done while someone is holding the transmitter.
( ) After the receiver has been tuned, turn the transmitter off and observe the voltmeter. The voltage without an incoming signal should be higher than when the transmitter was on, and must be stable. If the voltmeter needle gives an erratic reading, tune the yellow IF can counterclockwise up to 1/4 turn until the meter needle is stable. Turn the transmitter back on and repeak the white and black IF cans. This completes the tuning of the receiver.
( ) Remove the chokes.

D. SERVO INTEGRATION

( ) Plug the servos in and check operation with the transmitter. If you wish to change the sequence of the servos, it's easiest to change them around at the PC board. Example; if you get elevator function on the aileron servo cable, unsolder and switch the blue and orange wires going to holes "1" and "2" on the PC board rather than change the cabling.

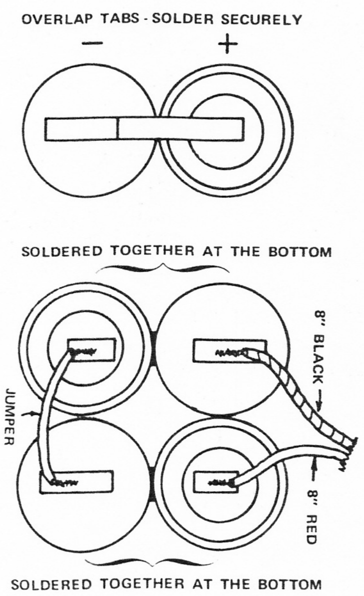
( ) Install the receiver in the case as shown in the illustration included with the case. If room is critical, you may want to not use the case and simply wrap the receiver in foam–make sure the decoder board and the receiver board are adequately insulated so they don't touch one another.

VII. BATTERY WIRING

(Micro Flite Packs and Complete Systems Only)

A. 100 MAH BATTERY PACK ASSEMBLY

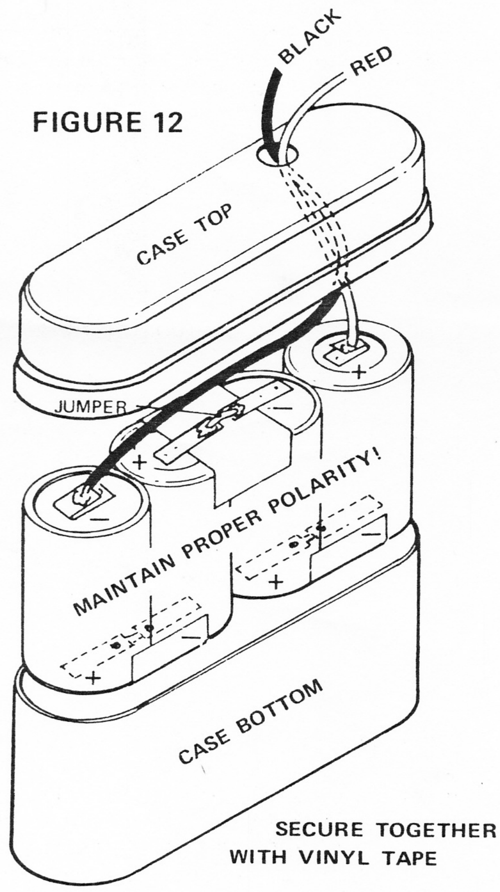
FIGURE 11



( ) Solder a pair of cells together by overlapping the tabs and soldering securely. A piece of tape can be used to hold the batteries together while soldering. Maintain proper polarity--the shouldered end of the cell is positive (+) and the flat end is negative (-). Repeat for the other two cells.
( ) Turn the two pairs of cells over and bend the tabs over upon themselves to prevent shorting.
( ) Install a jumper wire between the two pairs of cells as shown.
( ) Solder an 8" length of red wire to the positive terminal of one pair and an 8" length of black wire to the negative terminal of the other pair.
( ) Twist these wires together and tie a knot in them about 1/2" from the battery terminals--this knot will serve as strain relief.
( ) Assemble the battery pack by threading the wires through the hole in the case top and securing the case top and bottom together with vinyl or "Scotch" tape.

B. 450 MAH BATTERY PACK ASSEMBLY

FIGURE 12



( ) Following the illustration, wire the batteries together using scrap resistor leads as jumper wires--be sure to maintain proper polarity. The shouldered end of the cell is positive and the flat end is negative.

Use a piece of tape between the solder lugs and the cells when soldering together. This helps hold the cells together and helps insulate. Don't apply too much heat so you keep from melting through the tape and plastic insulator.
( ) For strain relief, tie a knot in the red/black leads before they exit the hole in the case top; or put a gob of silastic or epoxy on the leads where they exit thru the hole; or tape the leads down to the case after assembly.
( ) Secure the case together using vinyl tape and twist the leads together.

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