TECH SPORT (4201) 6/8 CH. RECEIVER

The Royal Classic R460R superheterodyne receiver has several unique features that place it in a class that has not previously been available to the modeler. It is extremely difficult to design a solid state receiver that will have high sensitivity while maintaining low noise and good stability. These objectives have been accomplished in our design by using an FET mixer, active emitter follower detector, and double sided ground plane PC Board.

The simplicity of the FET mixer, active detector and IC decoder substantially reduces the receiver parts count thus allowing it to be packaged on a single PCB. The low component count and single deck PCB increases the system reliability. This basic receiver design has been flying successfully for over two years.

Refer to block diagram Fig. 1 for the following discussion. The front end of the receiver uses two parallel circuits (L2,C5) and (L3,C7) which are losely coupled by capacitor C6. This double tuned circuit is used to provide better front end selectivity and to better match the antenna to the mixer input.

The first tuned circuit is tapped to better match the antenna inpedance and to provide a voltage step up. Do to the very high input impedance of the FET gate the second tuned circuit does not require a tap as is common in transistor mixers.

The mixer Q2 that is used in this receiver design provides better mixing effeciency, a wider dynamic range, less mixing distortion and a lower noise input than can be obtained by using either a diode or transistor mixer. The secondary of the oscillator coil (L1) supplies the injection voltage to the drain of the FET. The source of the FET is connected to the first IF transformer in the same manner as a conventional transistor stage.

The local oscillator (Q1) is a modified Pierce oscillator which operates at the desired frequency and not at 1/2 the desired frequency as some receivers use. This provides less spurious responses, less distortion in the mixer (for 1/2 frequency operation it is necessary for the mixer to also operate as a frequency doubler) and a higher mixer efficiency resulting in a lower noise lever mixer.

The IF amplifiers will not be discussed in great detail since they are standard and straight forward with the exception of the last IF amplifier. The last IF amplifier transformer is hooked up in such a way to provide a two to one step in voltage at the base of the active emitter follower detector.

The high input impedance of the emitter follower detector, compared to diode or common emitter transistor detector, does not load the last IF transformer which would lower the Q of the stage. The detector impedance thus sharpens the tuning of the last IF transformer which improves selectivity. Resistors R11 and R14 along with capacitors C8 and C11 are used to provide isolation for the superhet portion of the receiver circuit. The above features yield and IF strip that is quite easy to align and will stay in tune.

An active emitter follower detector is formed by transistor Q5 and emitter loas resistor R15. The voltage drop across the previously mentioned 150 ohm isolation resistor (R14) is also used to provide forward bias to the detector stage. This forward bias allows the detector to detect on a very low level IF signal. The detected output is then fed to the filter circuit.

Since the DC voltage at the emitter of the detector Q5 goes negative with increasing signal strength this voltage is fed back to the base of the first IF stage (Q3) to provide AGC. Resistor R12 and capacitor C12 form the AGC filtering and feedback circuit.

The detector output signal is filtered by C13 to remove any IF frequency signa, that may be present on the pulse signal. Additional filtering is also provided by R17 and C14. This filter reduces feedback and aids in eliminating noise.

The filtered detector output is then fed to an audio amplifier (transistor Q6) which is used to amplify and square the signal pulses.

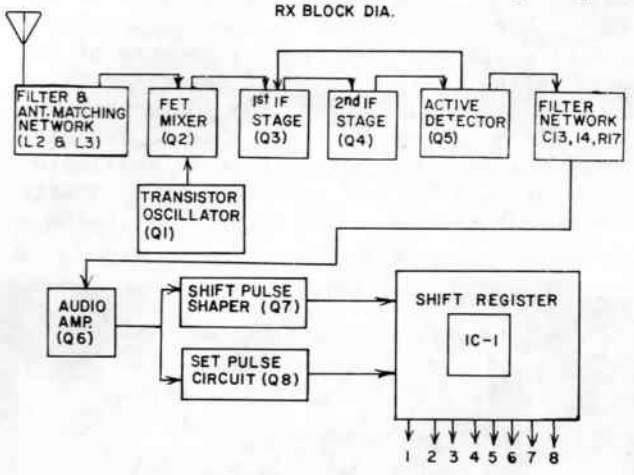


FIG. 1

This amplifier is then used to drive both the shift pulse shaper circuit and the set pulse circuit.

The shift pulse circuit Q7 drives capacitor C16 which provides a negative going differentiated pulse at location "A". This negative shift pulse is then fed to all of the shift register reset inputs simultaneously. If 8 channel system is built 9 of these negative pulses occur during each 18 MS frame time.

Transistor Q8 and associated components form the set pulse circuit. The collector of

6/8 CH. Receiver Parts List

Qty.	Ref. No.	Description	Part No.
3	R1,9,16	27K 1/8W Resistor 10%	000323
4	R2,4,6,10	15K 1/8W Resistor 10%	000320
1	R3	270 Ohm 1/8W Resistor 10%	000299
2	R5,7	100K 1/8W Resistor 10%	000330
4	R8,11,13,14	150 Ohm Resistor 10%	000296
1	R12	10K 1/8W resistor 10%	000318
1	R15	1.5K 1/8W Resistor 10%	000308
1	C1	22PF Capacitor	001013
1	C2	15PF Capacitor	001010
2	C5,7	20PF Capacitor	001012
5	C3,8,9,10, 13	.05 UF Disc Capacitor	001049
1	C12	4.7 UF Tant Capacitor	001150
1	C4	.47UF Tant or Disc Cap	001127
1	C6	1 to 5PF Mica or Disc Cap.	001186
1	C11	33UF Tant A.L. Cap.	001160
2	C8A,C11A	.01UF Disc Capacitor	001044
3	Q1,3,4	MPS3563 Transistor	000464
1	Q2	2N5457 Transistor	000453
1	Q5	2N4126(SPS401K) Transistor	000444
1	L4	IF Transformer Yel.	000489
1	L5	IF Transformer White	000490
1	L6	IF Transformer Black	000491
1		Rubber Grommet	002185
1		PCB 1/16" G-10	000649
1		Royal Decal	000691

RX Coils W/ Cores:

1	L1		000902
1	L2		000478
1	L3		000479

8½"	#26 G. Brown wire	001301
6½"	#26 G. Red/Wht wire	001312
7"	#26 G. Orange wire	001303
7"	#26 G. Yellow wire	001304
9½"	#26 G. Green wire	001305
10"	#26 G. Blue wire	001306
6"	#26 G. Red wire	001302
6½"	#26 G. Black wire	001300
36"	#26 G. White wire	001309
3/4"	1/8" Dia Heat Shrink	002208
3&3/4"	3/64" Dia Heat Shrink	002198
1	Receiver Case w/bottom	000652
1	72 MHZ 5th Overtone Crystal	000514-000517

Decoder:

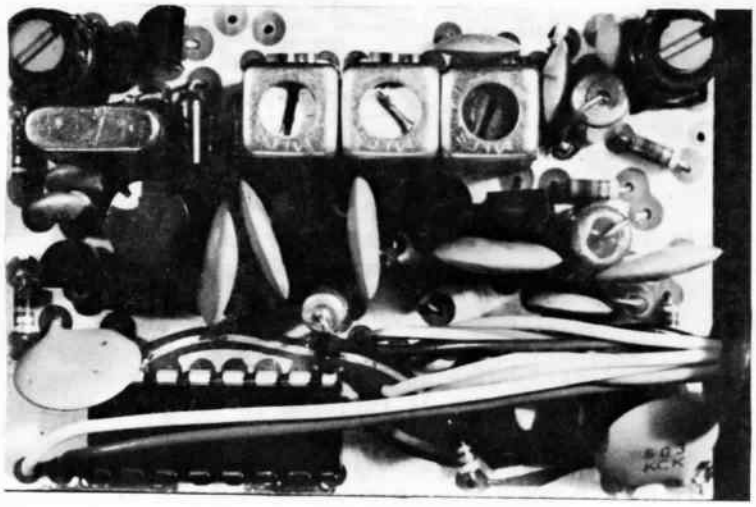
1	R 17	4.7K 1/8W resisror	000314
1	R17A	100K 1/8W Resistor 10%	000330
2	R18,19	47K 1/8W Resisror 10%	000326
1	R20	3.3K 1/8W Resistor 10%	000312
1	R21	56K 1/8W Resistor 10%	000327
1	R22	27K 1/8W Resistor 10%	000323
1	C15	1.0 UF Tant Capacitor	001135
2	C14,16	.01UF Disc Capacitor	001044
1	C17	.22Uf Tant Capacitor	001126
2	C19,20	.05UF Disc Capacitor	001049
1	C21	33UF Tant Capacitor	001160
3	Q6,7,8	2N4124(M400) Transistor	000443
1	IC-1	4015	000460

Order Seperatly:

1	Multicon Connector	
	6 CH Rx Bl. or	003218
	8 CH Rx Bl. Con.	003220

Q8 drives to ground each time a shift is present. The collector of Q8 goes only slightly positive between shift pulses because of the integrating time constant of capacitor C17 and resistor R22. During the longer reset time which corresponds time wise to several shift pulses. Sufficient time is available to allow capacitor C7 to charge up to nearly the supply voltage. The first shift pulse will then cause transistor Q8 to conduct which will pull the collector negative. This large negative going pulse will provide a negative going set pulse. This negative set pulse is then fed into the set side of the shift resistor.

One integrated circuit containing four pairs of cross coupled micro logic gates are used to form the shift register. The negative



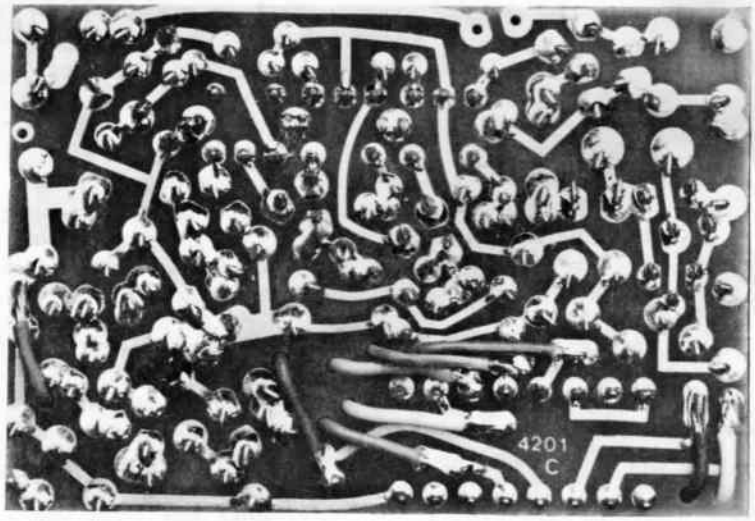


Fig. 1A

set and shift pulses are input into the set and shift side of the first stage simultaneously. Therefore the first stage outputs (Q and Q) both go positive. Since the set pulse (because capacitor C17 is larger than C18) Q goes back down leaving the "1" or high output at Q. When the next shift pulse occurs it drives Q high (in the first stage) causing Q to go low. When Q goes low it causes a differentiated negative pulse at S for the second stage.

The operation of the second stage is then the same as when the "1" was set in the first stage except that Q side of the second stage stays high and the Q side of the first and all other stages are low. This process continues shifting the pulse down the shift register one stage each time a shift pulse occurs. The eight outputs of the shift register are then connected to the servo plugs so they can be used by the servo amplifiers.

Soldering Suggestions:

A: Keep your soldering iron clean by frequently rubbing over the tip with a wet sponge.

B: Heat the PC Board pad and component lead simultaneously unless experience shows that one or the other takes more heat, then heat that part first.

C: Feed a small of solder to the joint immediately, wail until the solder flows then add enough solder to complete the joint.

D: Wipe the soldering iron tip up the component lead when the joint is complete.

E: Clip the component lead.

F: Use only #22 gage solder, joints should not exceed 1/32" in height.

1. ( ) Check the parts supplied against the parts list.
2. ( ) Check for correction sheet inserted in this book. If none is found build per this book.
3. ( ) Check the fit of the PCB (Printed Circuit Board) in the receiver case. If board does not fit return it to the factory for replacement.

Winding Data

4A.( ) Wind coil L1 per fig. 2 and chart with #28 magnet wire. Smaller dia. of two types supplied. The winding data in the chart of fig. 2 means to wind in reference to viewing L1 from the top.

4B.( ) If coil comes pre-wound, the two short wire leads out of the bottom of the coil are the primary coils and the two long leads are the secondary coil leads.

4C.( ) Wind coils L2 and L3 per fig. 3. Note: L2 and L3 are wound by winding all the #26 wire supplied on a 3/16" dia. dowel. Drill a small hole in the dowel to accept the #26 wire. Stretch magnet wire a slight amount, insert wire in the hole and wind 1/2 the wire supplied. Cut off the coil and wind

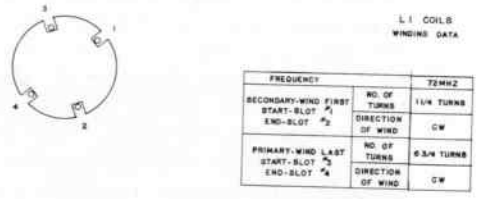


FIG. 2

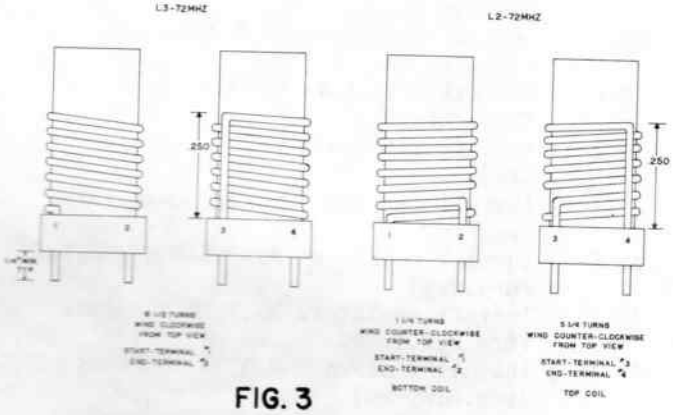


FIG. 3

remaining wire in the opposite direction. Count off the correct number of turns plus enough length to form the legs. Scrape leads and tin lightly with solder.

5. ( ) Note that the PCB is clad on both sides. All components go on the ground plane side. The ground plane clad is cut away for the IF transformers and the crystal case. Inspect both sides of the PCB to make sure the ground plane clad will not touch the component leads that should not be grounded. If any look questionable releive the clad a slight amount more with a 3/32" dia. bit.

For steps 6 through 8 ref. to Figs. 4 & 5.

6. ( ) On the following scrape one lead of each resistor and capacitor and put the scraped lead through the hole on the overlay that is marked with a "T". All resistors lay down. Install resistors R2-15K (Brn,Grn,Org.), R3-270 Ohm (Red,Purp,Brn), R8-150 Ohm (Brn,Grn,Brn), R21-56K (Grn,Blue, Org), R22 27K (Red,Purp,Org). Install Capacitors C17-.22UF Red end down. C11-33UF Red end down. Scrape the ground lead of the crystal and install in hole "T3". Solder both leads on the bottom of the PCB first, then solder pads marked with a "T" on the top side of the PCB. Bend the lead marked "T" (clad side) on R21 away from the end of the PCB before soldering.

7. ( ) Install a resistor lead remnant in hole F1 and a resistor lead remnant

in hold F2. Bend over and solder lead remnants top and bottom. Clip off excess. These connectors serve as jumpers from the top of the PCB to the bottom.

8. ( ) Clean the PCB throughly on the top side, remove all soldering resins. Inspect all solder joints on the top side and rework if necessary, Make sure no resistor leads are touching the ground plane clad.

For steps 9-37 Refer to Figs. 6 & 7.

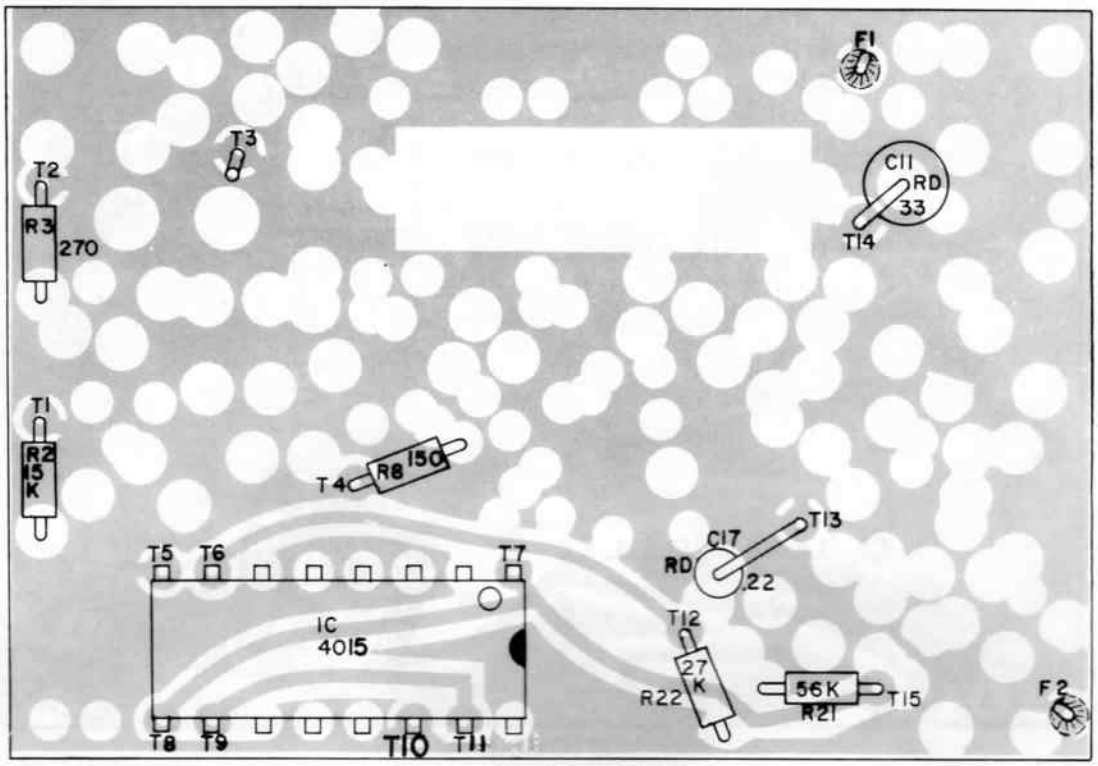
9. ( ) Install Q6, 7 & 8 2N4124.
10. ( ) Install R17-4.7K (Yel,Purp,Red).
11. ( ) Install C15 1.0UF Tant A.L. Cap. Red end up.
12. ( ) Install resistors R4,6 & 10-15K (Brn,Grn,Org).
13. ( ) Install resistors R1,9,16 (Brn,Blk,Org) 27K (Red,Purp,Org).
14. ( ) Install resistor R12-10K (Brn,Blk. Org).
15. ( ) Install resistor R13-150 Ohms (Brn, Grn,Brn).
16. ( ) Install resistors R18,19-47K (Yellow, Purp,Org).
17. ( ) Install resistors R5,7, & 17A-100K (Brn,Blk,Yel).
18. ( ) Install resistors R11,14-150 Ohms (Brn,Grn,Brn).
19. ( ) Install resistor R15-1.5K (Brn,Grn, Red).
20. ( ) Install resistor R20 3.3K (Org,Grn, red).
21. ( ) Install IC-1. The IC should go down parallel to the PCB and make sure that all the leads stick through the PCB far enough to solder securly. Solder the IC seven places on the top side of the PCB marked T5 through T11. Clean the PCB throughly in the area of the IC.
22. ( ) Install the three IF Transformers. Note the yellow, white and black color code.

Note: Form all transistors leads before installing so that the transistor is exactly positioned on the PCB as in Figs. 6 & 7.

23. ( ) Install L1 in the PCB with the white dot positioned as in Figs. 6 & 7.
24. ( ) Install the crystal. The receiver crystal will be .455KHZ above or below the transmitter frequency.
25. ( ) Install C1 22PF.
26. ( ) Install Q1,3,4, MPS 3563.
27. ( ) Install C2 15PF.
28. ( ) Install Q2 2N5457.
29. ( ) Install Q5-2N4126.
30. ( ) Install C3,8,9,10,13,19,20-.05UF Disc. Capacitor.
31. ( ) Install C4 .47UF Tant Cap. Red end goes next to Q2. Lay the tantalum cap down. A .47 disc cap maybe substituted. It has no polarity.
32. ( ) Install C21, 33UF Tant A.L. Red end up.
33. ( ) Install C5 and C7. 72MHZ 20PF Disc or Mica.
34. ( ) Install C8A,11A,14 & 16 .01 Disc.
35. ( ) Install C17-.22UF Red End Down.
36. ( ) Install C12-15UF Red End Down. 417
37. ( ) Install L2 and L3. Use a small amount of contact cement on the bottom of the coil form four places.

For steps 38-46 Refer Figs 1A & 8

38. ( ) Clean the PCB board to remove all solder flux.
39. ( ) Inspect all solder joints, rework if necessary and reclean the PCB.
40. ( ) Strip all hookup wires 1/8" and tin.
41. ( ) Solder the specified wire to the correct pad and then run through the specified hole.
    - 6¼" Brown wire to Ch. 1 Pad.
    - 6¼" Wht/Red wire to Ch.2 Pad.
    - 5½" Black wire.
    - 5½" Red wire.
    - 6¼" Orange wire to Ch. 3 Pad.
    - 7¼" Yellow wire to Ch. 4 Pad.
    - 6" Green wire to Ch. 5 Pad.
    - 6" Blue wire to Ch. 6 Pad.
    - 7¼" Purple wire to Ch. 7 Pad. (8 Ch only).
    - 6½" White wire to Ch. 8 Pad (8CH only).
42. ( ) Slide one 5/16" dia grommet and one 1/4" dia. x 1/4" Hear shrink over all 8 wires.
43. ( ) Install the receiver PCB into the case, twist the first 4" of the 8 wires into a cable. Ref. to Fig. 1A
44. ( ) Cut the Red, Blk, Wht/Red, org, yellow wires 4" from the case, strip 1/8" and tin.
45. ( ) Tin all pins on the servo connector blocks and cut all pins per Fig. 10.
46. ( ) Slide a peice of 3/64" dia x 3/8" long heat shrink over all eight or ten wires. Solder wires to connector block. Slide the heat shrink in place and shrink
47. ( ) Measure the resistance from red to black power leads. Resistance should be approximately 4K when checked with a 20,000 ohms/volt multimeter such as a Simpson 270. Some import meters will not read correctly on this test. If the reading is very low, look for shorts such as solder bridges. Correct before applying power.
48. ( ) Apply 4.8 volts, current reading should be approximately 30 ma.
49. ( ) Tune-up Procedure, Scope Method
    - A: Solder a 68K resistor to the base of Q5 (clad side of PCB).
    - B: Hook a scope probe (X10) to the other end of the 68K resistor and ground the scope as close to the 68K as possible.
    - C: Set the scope to .05V/cm. Back the transmitter off till the signal displayed is 2cm (1.0V) output.
    - D: Peak all IF transformers keeping the 2cm signal by backing off the transmitter when necessary.



TOP SIDE (GROUND)

FIG. 4

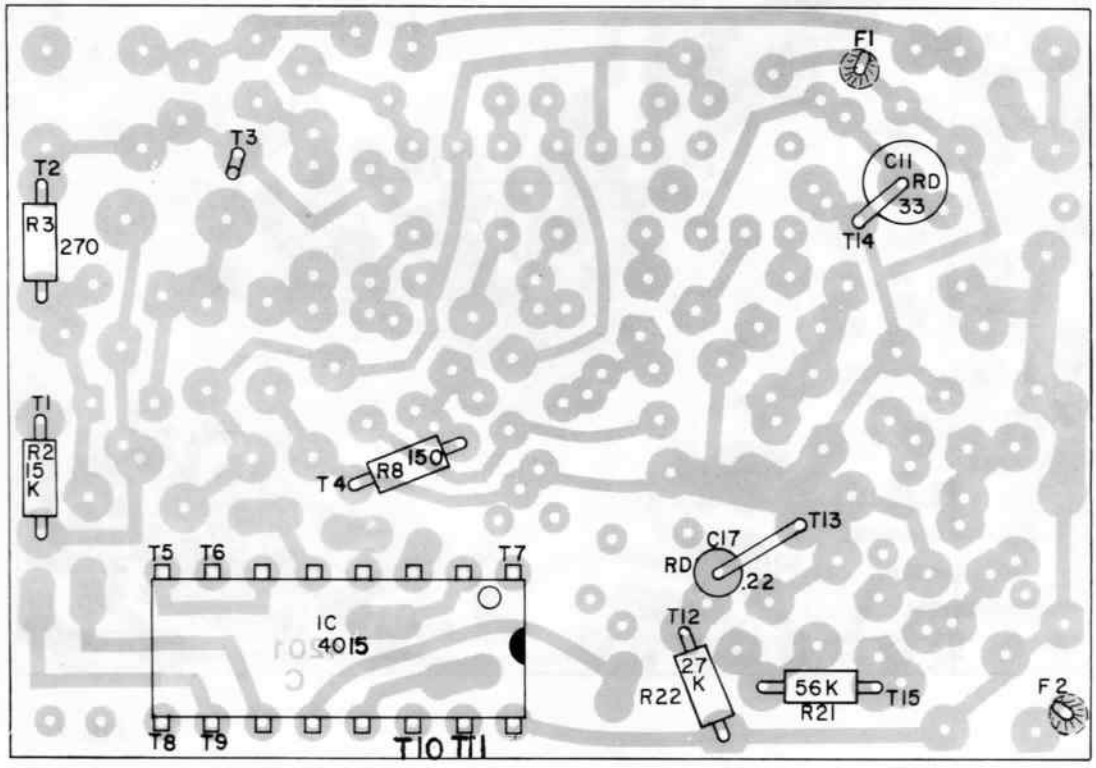
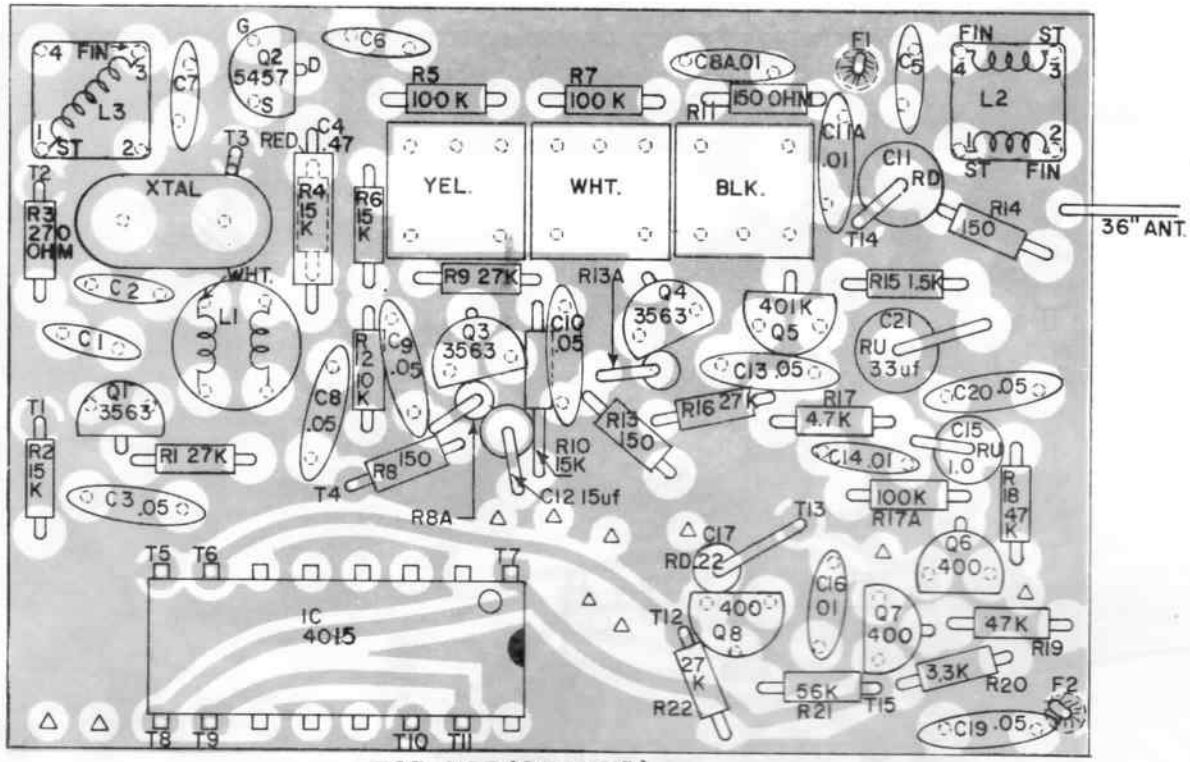


FIG. 5



TOP SIDE (GROUND)

FIG. 6

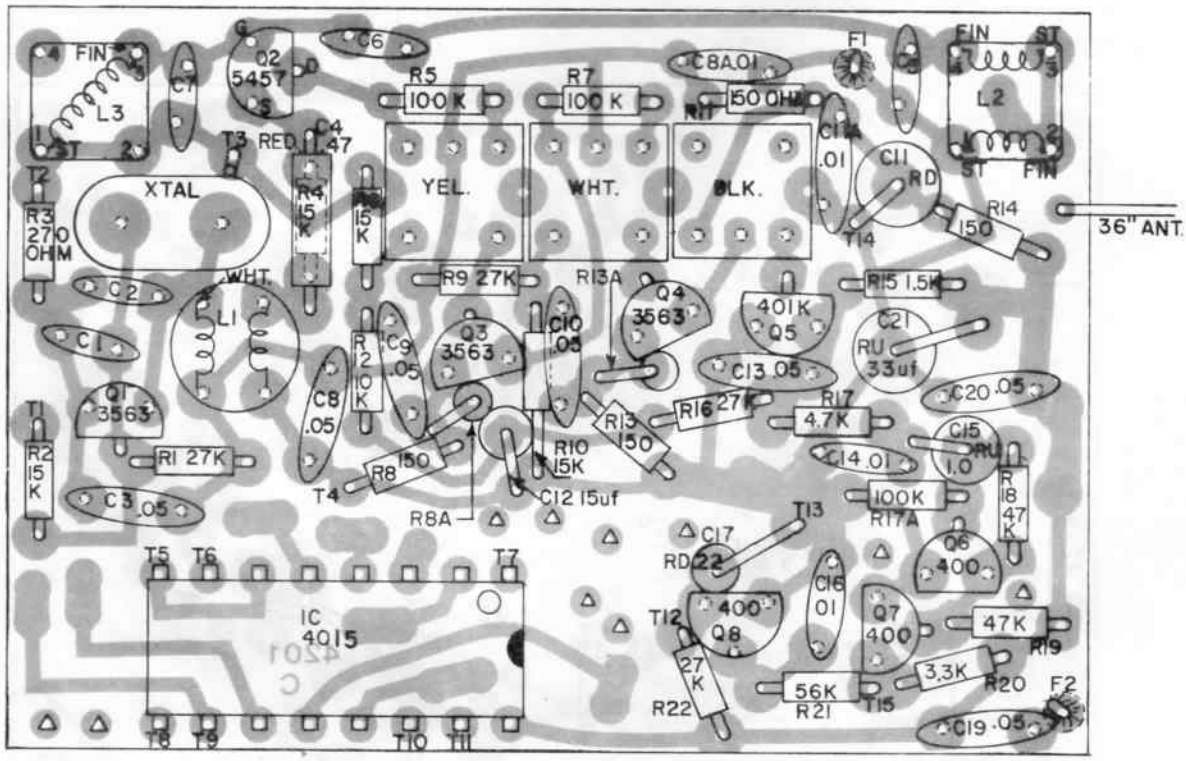


FIG. 7

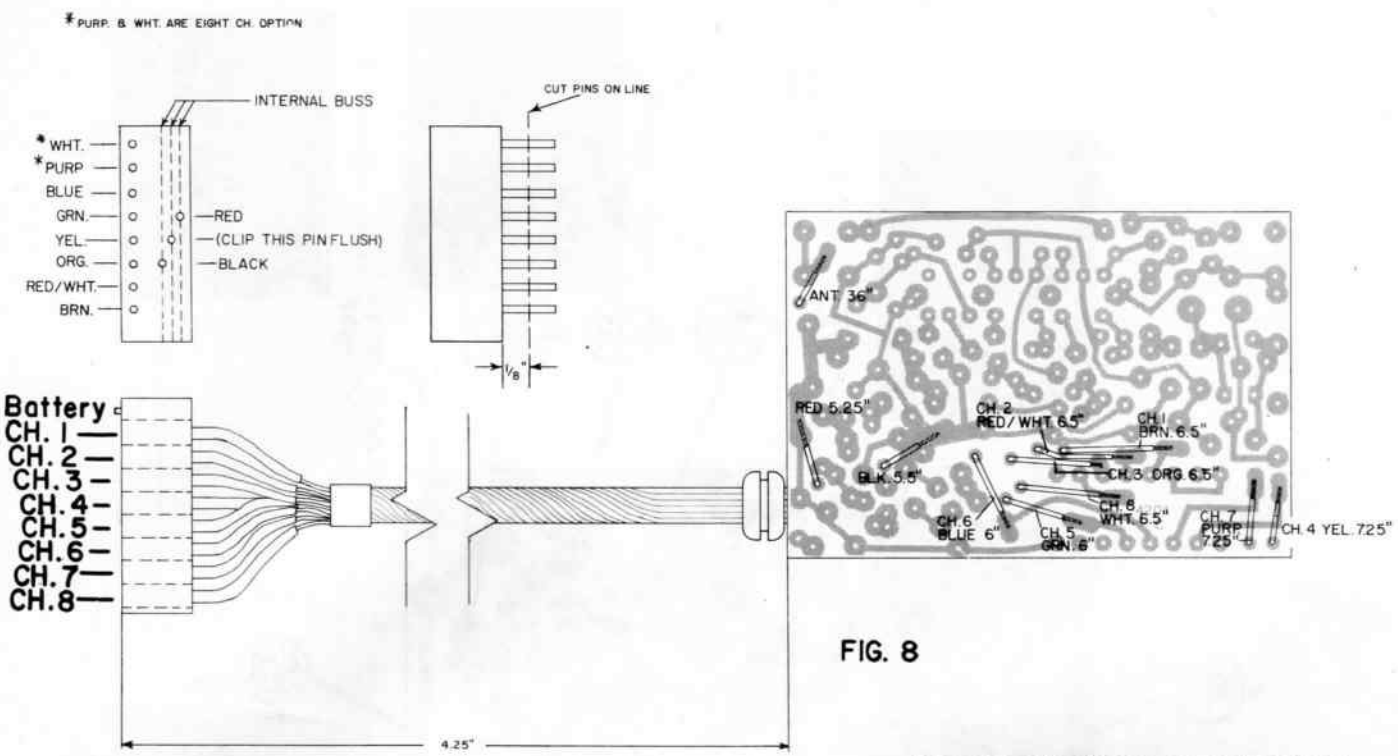


FIG. 8

E: Peak L3 with the same signal level.

F: Install C6 and the .34" antenna wire. Peak L2. Do not retune L3.

G: Kill the oscillator operation several times by touching the crystal leads with your finger (clad side). Look for immediate return of the signal when your finger is removed.

H: No signal test. Turn Transmitter off scope trace should return to a clean trace with no indication of oscillation.
If oscillation is noted add a small value resistor 10 Ohm or less at R8A & R13A. Use as small value as possible to stop oscillation. A large value resistor at R8A and R13A will reduce receiver sensitivity.

I: Seal the L2 and L3 coil with wax.

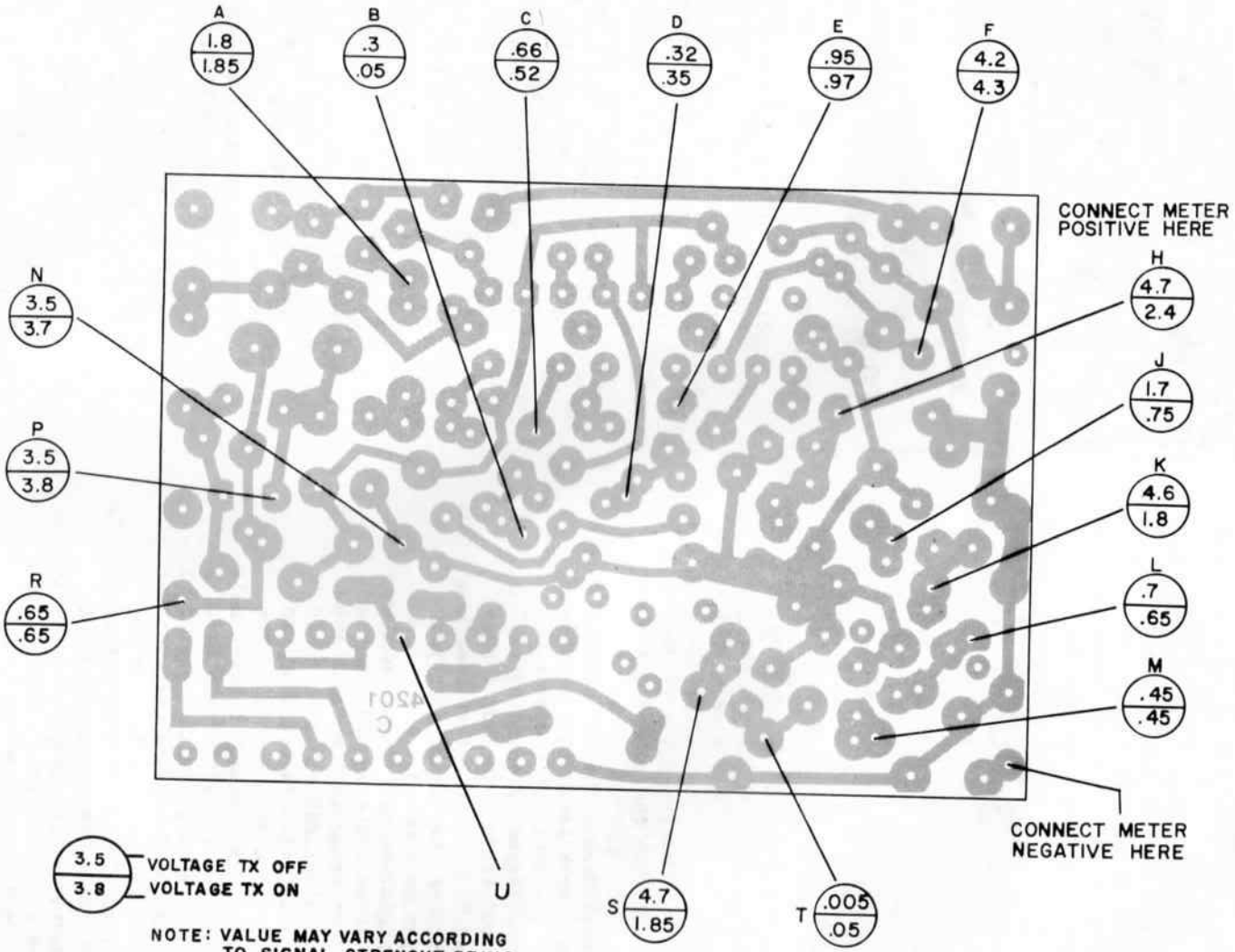
J: Alternate tune-up point; a 68K resistor can be temporarily soldered to the emitter of Q5. This eliminates the need for a D.C. scope. You may then continue with the normal tuning procedure.

Tune-up Procedure-Meter Method

Use a meter with 20K ohms per volt sensitivity. Simpson 260 or equal. Place receiver in a area clear of large metal objects. Connect meter + and - leads as shown.
Set meter to 10V scale. Turn Receiver on, meter should read about 4.8 volts.
Place transmitter near Receiver and Turn on. Meter reading should drop. Rough tune the RF coil L3 and the yellow, white and black IF coils for a minimum meter reading. Each coil should show a well defined dip. Move the transmitter away from the receiver until the minimum reading starts to rise toward 4.8V. A reading of approximately 2.0V will produce a good point for fine tuning. Change meter to the 2.5V scale and fine tune L3 and yellow, white and black IF coils for maximum reading. Turn Receiver off. Install C6 5PF and the 36" antenna lead per Figs 6 & 8.
Turn Receiver on place 36" antenna lead in a clear area of metal objects.
Remove Transmitter antenna if necessary to keep voltmeter reading about 2.0V. Adjust L2 for minimum reading. Do not adjust L3. Your receiver is now tuned. Remove test meter and range check your receiver. Range with Transmitter antenna off should be at least 50 feet.

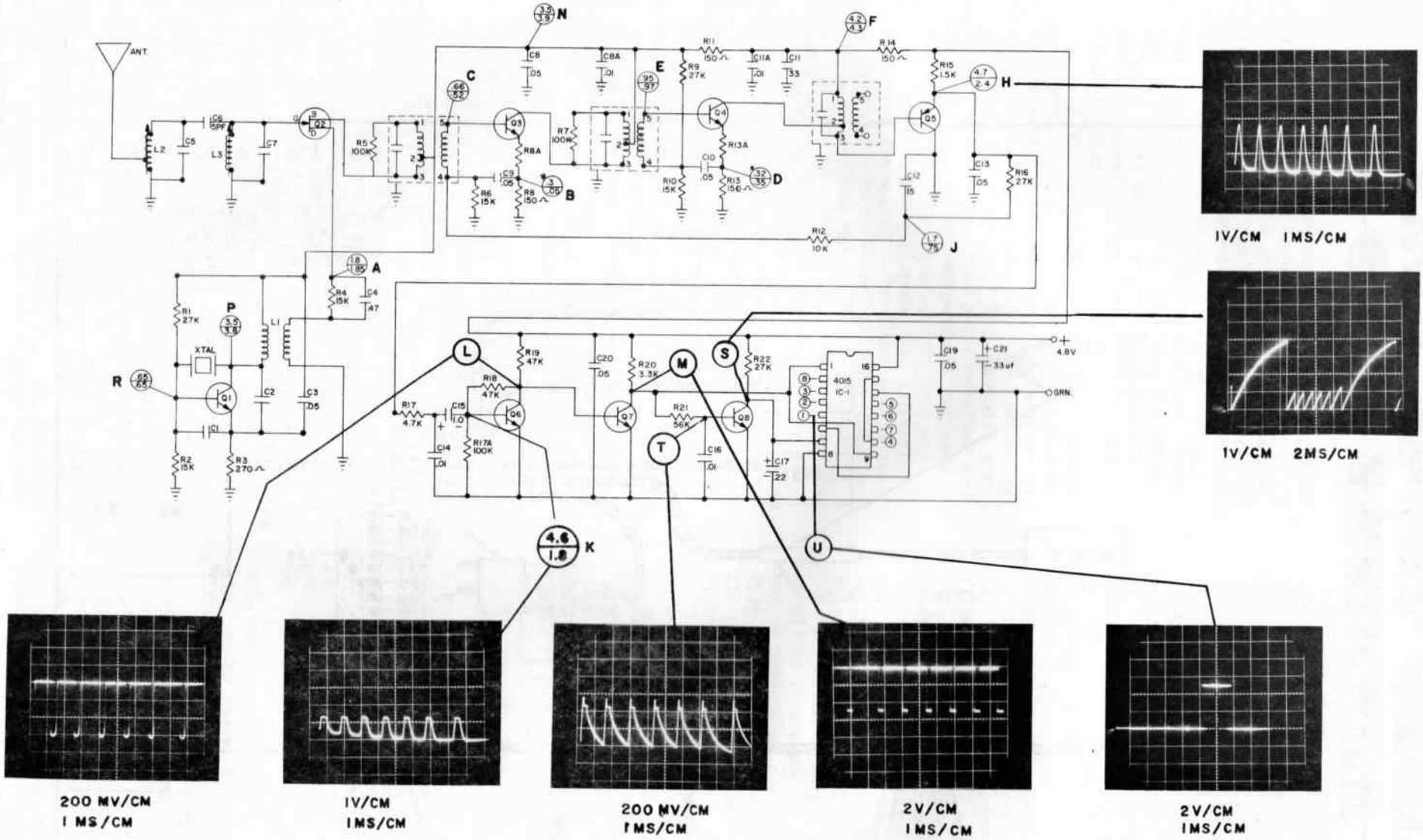
50.( ) Coat the clad side of the PCB with Krylon 1302 or G3 8665, make sure all wires are correctly routed before the coating dries. Allow coating to dry for 1 hour minimum, then install the receiver PCB in the case. Secure the case lid with tape or a small drop of acetone in the corners of the case.

51.( ) Range check. 72MHZ-Antenna collapsed 200 feet minimum.

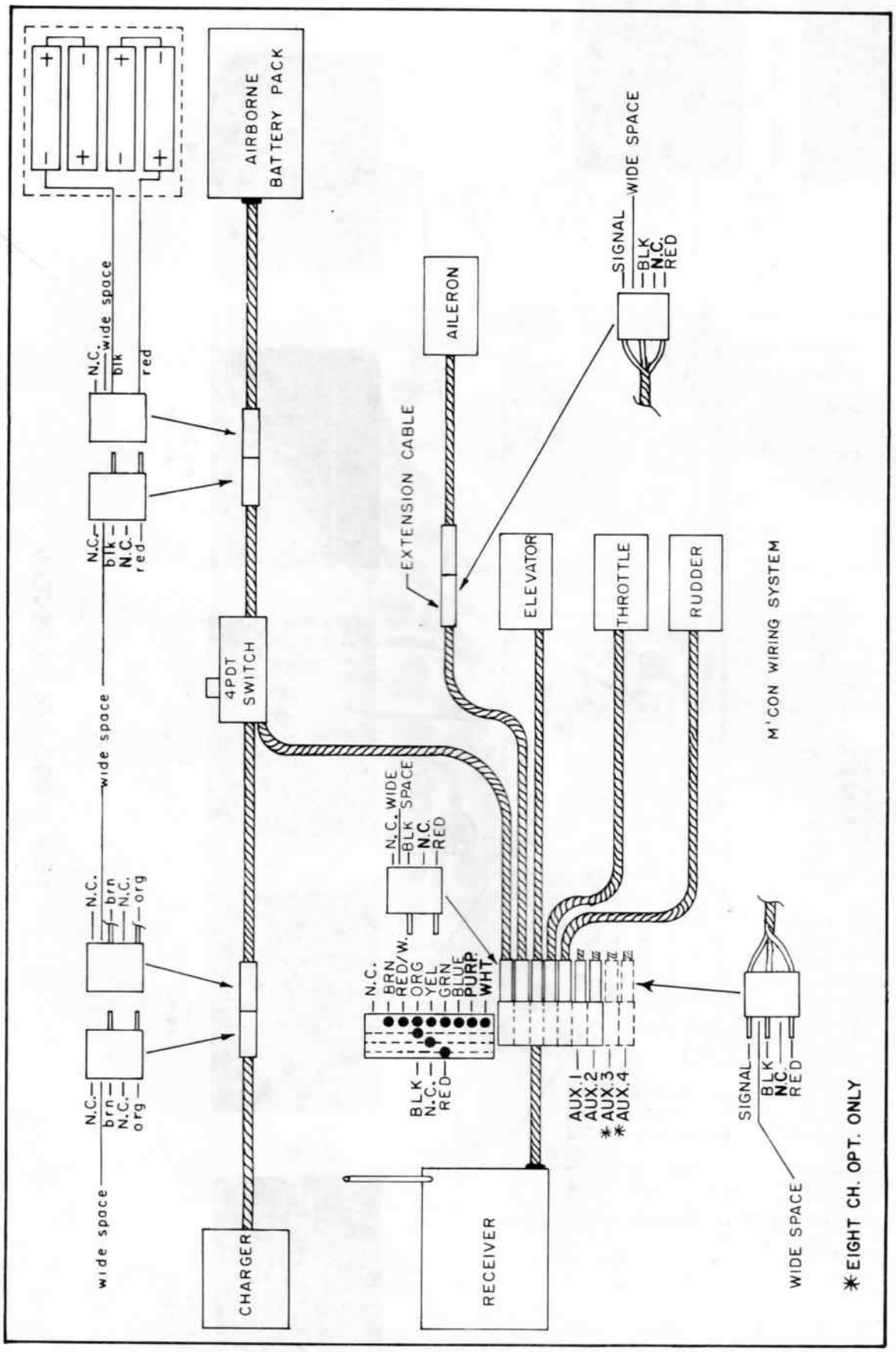


VOLTAGE TEST POINTS

ALL VOLTAGES TAKEN WITH 20K PER VOLT METER WITH RESPECT TO GROUND.



TECH SPORT 6/8 CH. RECEIVR


AIRBORNE BATTERY PACK
N.C.
wide space
blk
red
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blk
N.C.
red
wide space
4PDT SWITCH
EXTENSION CABLE
AILERON
SIGNAL
WIDE SPACE
BLK
N.C.
RED
ELEVATOR
THROTTLE
RUDDER
M'CON WIRING SYSTEM
N.C.
brn
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wide space
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N.C. WIDE SPACE
BLK
N.C.
RED
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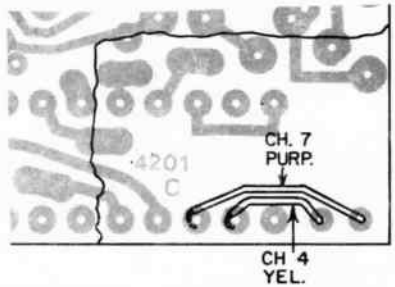
RED/W.
ORG
YEL
GRN
BLUE
PURP.
WHT.
BLK
N.C.
RED
AUX.1
AUX.2
**AUX.3
**AUX.4
SIGNAL
BLK
N.C.
RED
WIDE SPACE
CHARGER
RECEIVER
*EIGHT CH. OPT. ONLY

TECH SPORT(4201) RX CORRECTIONS SHEET



Parts List:
C12 should be 4.7uf.

BEFORE ASSEMBLY:
R8A and R13A are shown on the overlay drawings, figure 6&7. These resistors are not normally needed and are not supplied. The only time they are used is when the transistor gain in Q3 and Q4 is abnormally high and the receiver tends to oscilate. Oscilation shows up as occasional kicking of a servo when the Tx is off and Receiver/Servo turned on. Servo "kicking" can also be caused by external interference such as another transmitter or florescent lights.
Note:
Your PC Board has been modified in area shown on Figure 1. Some receivers exhibited a poor range on channel four and channel seven. The closeness ot the wire pads to the oscilator circuit (R2) caused the problem. Install the channel 4 yellow wire and the channel 7 purple wire per the drawing. The best way to do this is to bend the wires around the IC pins. This is much easier to do if these two IC pins are not soldered until you begin installing the channel 4 and 7 wires.

Assembly:
Step (6) A resistor lead can be used as a ground lead. This lead will be soldered to the crystal when the crystal is installed.
Step (20) Color code wrong, should be orange, orange, red.
Step (35) Delete.
Step (36) C12, 4.7uf.
Step (49) Tune-up Procedure-Meter Method: L3 and the yellow, white, and black if cans should be tuned for MINIMUM readings, not maximum. Scope Method: (G) You may have to ground the oscilator to kill it.