KRAFT SYSTEMS, INC.®

KP-4A & KP-6A sport series

SERVICE MANUAL

SPORT SERIES RADIO CONTROL
KP-4A AND KP-6A
1977, 1978, 1979
SERVICE MANUAL

GENERAL SERVICING INFORMATION

In most cases, failures are due to defective components and cannot be located visually. Nevertheless it is advisable to give every unit a thorough visual inspection. Even though the cause of the trouble may not be discovered visually, it can reveal future trouble: poor soldering, frayed wires, loose components, etc.

When the cause of the difficulty is located or is obviously in one portion of the system, check the entire system anyway. There may be other defects or weak spots which might cause trouble later.

In cases of crash damage, an even more comprehensive inspection should be undertaken. Check especially for damaged wiring, loose parts, cracked or otherwise damaged circuit board lands, and especially the battery pack and switch harness. The battery case should be unwrapped and each cell closely inspected for damage. Feel the cells under their sleeves for dents which may not be evident on the exterior by running a thumbnail along the sleeve using moderate pressure.

The airborne portion of the system is subject to far more severe use than the transmitter and great care should be exercised when servicing any portion of the receiver, servos, and battery pack. Poor soldering techniques or inadequate care in assembly and testing can be magnified after being subjected to even moderate vibration.

Check component installation, wiring, and plugs carefully to ensure stable performance even under severe environment.

Where soldering on parts of the airborne package is necessary, extraordinary care should be used. Many of the circuit lands in the receiver and servos are quite small and should be worked on carefully. Excess solder should be removed with a bulb type solder sucker or wicking braid, rather than heating the joint and knocking the solder from the joint by rapping the board on a table.

After all soldering has been done, the circuit board should be cleaned using a suitable solvent to remove flux and residue from the soldering operation. The board should now be closely inspected for solder bridges, bits of wire or other debris, and then sprayed using the aerosol listed in the "Materials Necessary" section.

When spraying transmitter boards, use care to keep the lacquer from hitting the padder capacitors, as this will cause detuning later when the spray has completely hardened.

Never perform any tuning procedure while a sprayed board is drying. Tune either before spraying or after the spray has dried for at least one hour or else the wet lacquer will cause inaccuracies in tuning.

When servicing equipment, do not fail to look at mechanical aspects of the system—gimbal action, servo gears, hardware, clearances, and so on. A great deal of trouble can result from poor mechanical operation rather than electronic failure.

SPECIAL PRECAUTIONS

Some boards may be double sided with plated through holes. It is especially important to use wicking braid whenever desoldering components from these boards. Wicking braid is the only thing that will remove enough solder to get the component out without damaging the board.

*Some of the transistors and I.C.s are CMOS devices. They are much more susceptible to damage from static charges and high test voltages than other components. Whenever they are being worked on, the technician should wear a grounded metal bracelet and avoid plastic containers or work surfaces. This is particularly important during periods of low humidity. No attempt should be made to check these devices with an ohmmeter!

REQUIRED MATERIALS AND EQUIPMENT

MATERIALS

Acrylic Spray —
General cement type 8665 only—for spraying printed circuit boards.

Tuner Lubricant —
for cleaning switch contacts and pots. Brands such as Spra-Kleen, Admiral tuner lubricant, are recommended.

Component Cooler —
Such as Propellon "Instant Freez"—for checking temperature sensitive components.

Solder —
Ersin 60/40 5 core, Kester, Alpha, or any type with small diameter and high grade rosin flux.

Cloth and Plastic Tape —
1/2" wide black cloth—for wraping battery packs; 3/4" wide, any color—for wrapping motors where necessary.

Mylar Tape—
for wrapping KPS-12 servos, some receiving motors, etc.

Heat-Shrinkable Sleeving —
1/8" I.D., 3/16" I.D.—for servo harnesses and some receiver components.

Trichlorethylene —
or equivalent solvent—for use in clearing flux from printed circuit boards.

Silicon Lubricant —
Dow Corning type FC-1290, or equivalent—for lubricating servo feedback potentiometers.

R.T.V. — TRANSLUCENT SILICONE RUBBER ADHESIVE SEALANT — USE ONLY DOW CORNING 3148 (P/N 990-003) for bondings, supporting crystals, and strain relieving wiring.

EQUIPMENT

Oscilloscope —
Must have a DC coupled vertical amplifier with calibrated attenuator from .1 V/CM to at least 2 V/CM, and frequency response must be flat to at least 500 KC. The time base must be calibrated.
Suggested Types:
Tektronix — 502, 503, 504, 450 series, or any in the 530's, 540, 550, 560 series with proper plug-in(s), or 5000 or 7000 series.
Telequipment — Model S54A
Hewlett-Packard — 122A, 130, 175, 180, or 1200 series.

Voltmeter —
Any VOM with at least 20,000 OHM/VOLT sensitivity calibrated to within 3%, such as Simpson 260, or any VTVM.

Servo Tester —
Separate source of variable width pulse for operating servos independent of the normal R.F. system.

Servo Neutral Standard —
Supplies a fixed width pulse to a servo in order to check and set servo neutral to factory standards.

Alignment Tools —
General Cement No. 8276 "blade" type tuning wand, and General Cement No. 8606 "hex" alignment tool. For Series '72 and later systems, Ceramic bladed tools are recommended for transmitter R.F. coil slugs.

Heat Gun —
Small hair dryer type is sufficient if air temperature exceeds 150° F.

OPTIONAL EQUIPMENT

Signal Generator —
Must have a calibrated attenuator accurate to 1 uV. instrument comparable to Hewlett-Packard 608B through F is recommended.

Spectrum Analyzer —
Hewlett-Packard 141T/8554L/8552A or equivalent.

SYSTEM THEORY

The output of the transmitter consists of repeated pulse groups. Each pulse group or "frame" contains information on the position of the controls for all channels at the time it is transmitted. As the operator changes the controls from time to time, these changes are reflected in the pulse groups. When no control changes are being made, successive pulse groups remain the same.

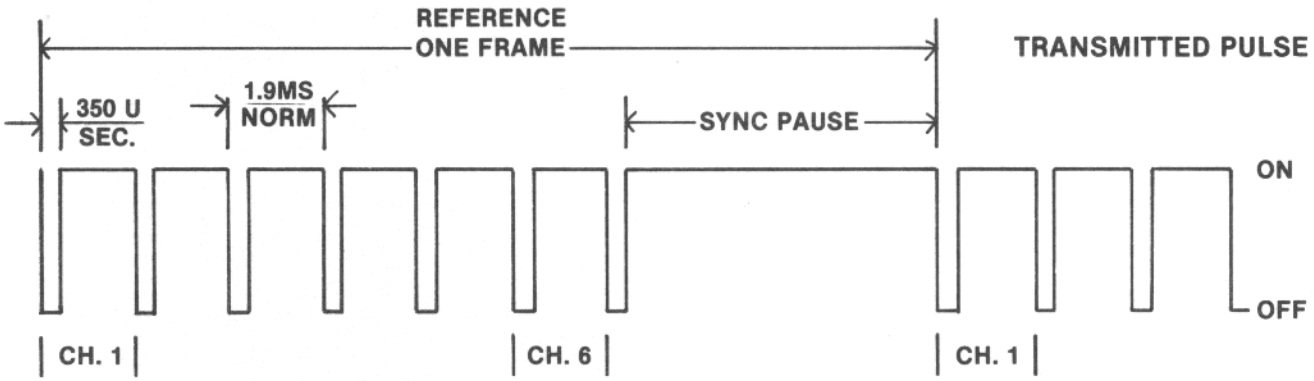
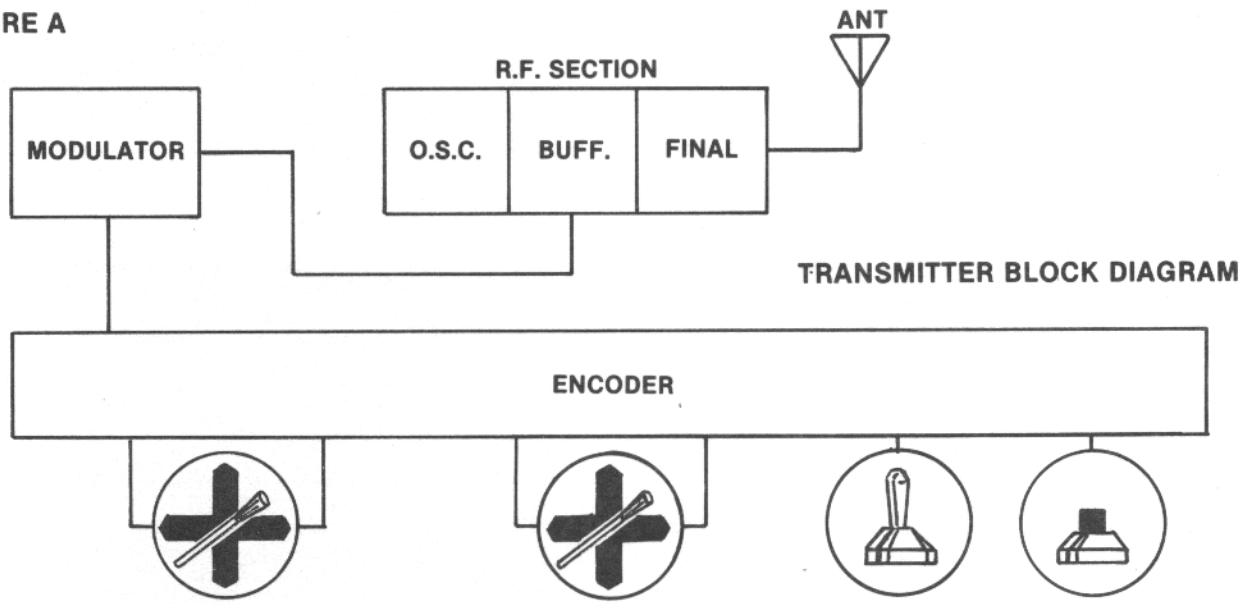


FIGURE A



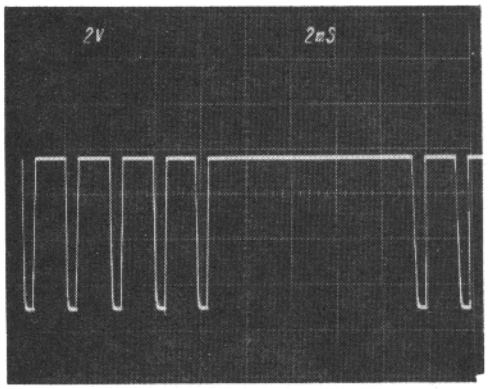
TRANSMITTER BLOCK DIAGRAM

Figure A shows a typical pulse group. It consists of a series of RF pulses separated by 350 us "off" periods. The width of the RF pulses is determined by the positions of the controls. The first off period after the sync period in the preceding group is a reference point. The channel 1 control determines the width of the first RF pulse, which is the time between the first (reference) and second off period. The channel 2 control determines the width of the second RF pulse, and so on for the other channels. The RF pulse width varies from a minimum of 1.4 ms to a maximum of 2.4 ms as the control is moved from one extreme to the other. The sync period RF pulse is fixed in length at about 8 ms. As a result, the length of the pulse group can vary as the controls are changed. The sync period allows the decoder in the receiver to reset in preparation for the next pulse group.

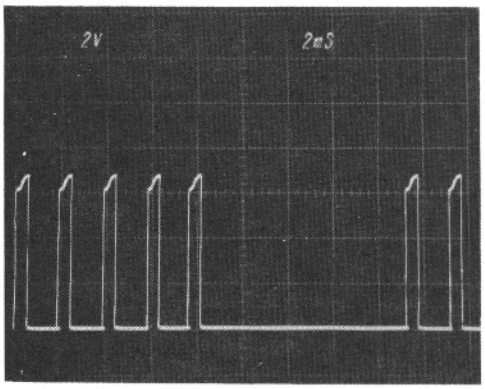
The RF output is generated by the transmitter and the off periods result from amplitude modulating the transmitter. The encoder translates the control positions into properly timed pulses and provides the modulating signal.

The receiver picks up the RF signal, amplifies and detects it, and drives the decoder. The decoder separates the pulse train into individual channels and supplies inputs to each servo, then the servo positions the outputs corresponding to control positions at the transmitter.

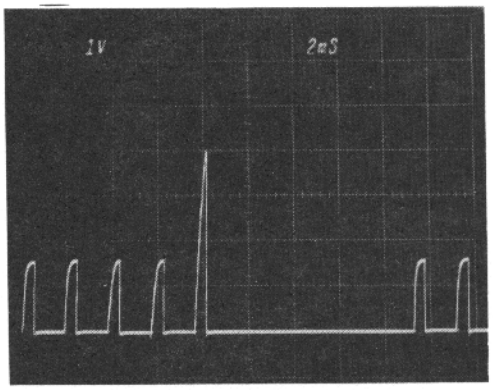
Waveform 1

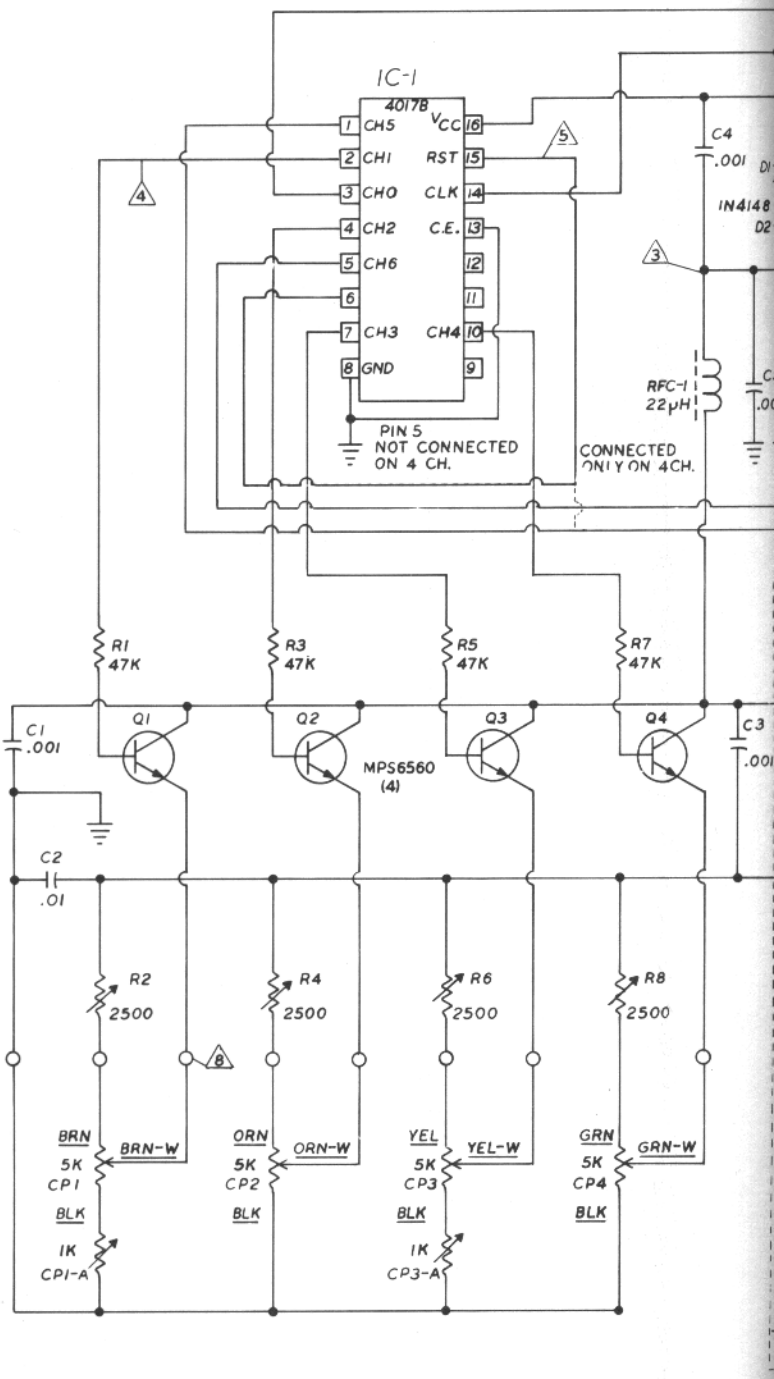


Waveform 2

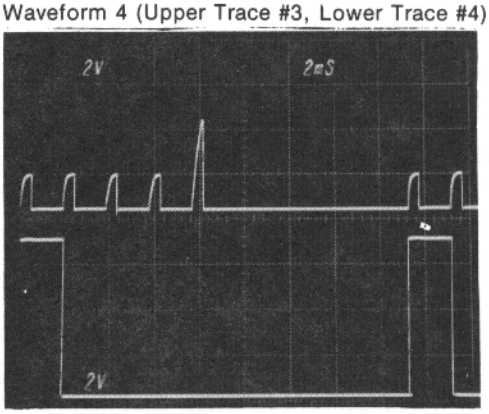


Waveform 3

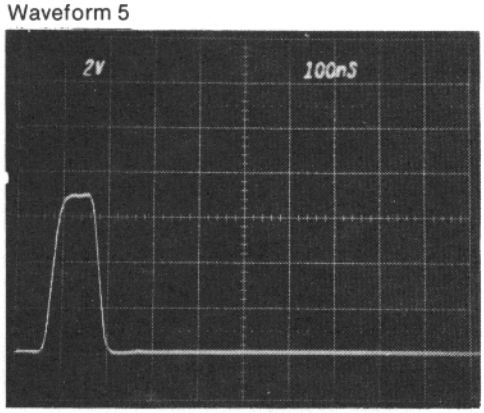




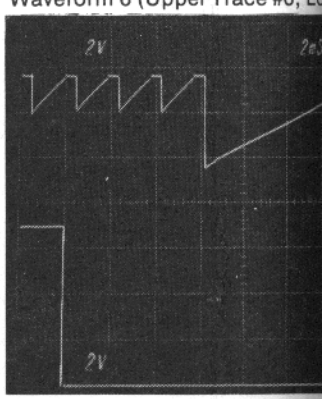
Waveform 4 (Upper Trace #3, Lower Trace #4)

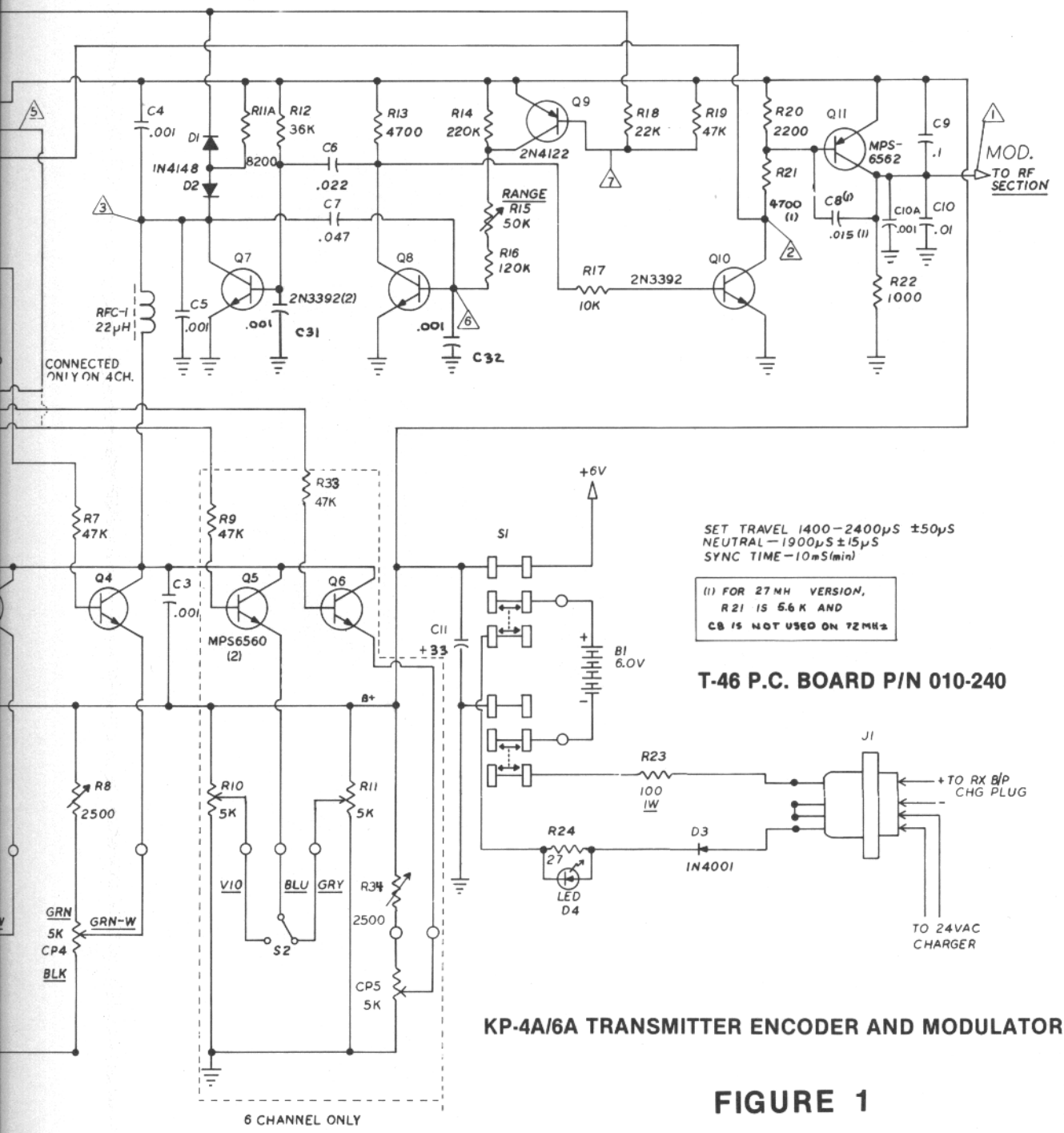


Waveform 5



Waveform 6 (Upper Trace #6, Lo

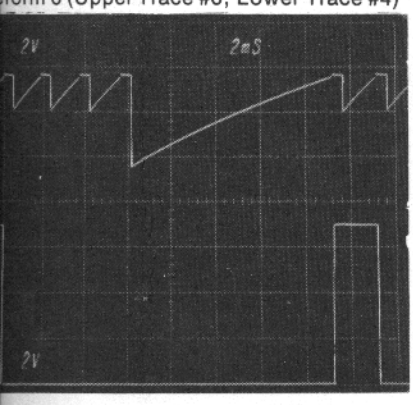




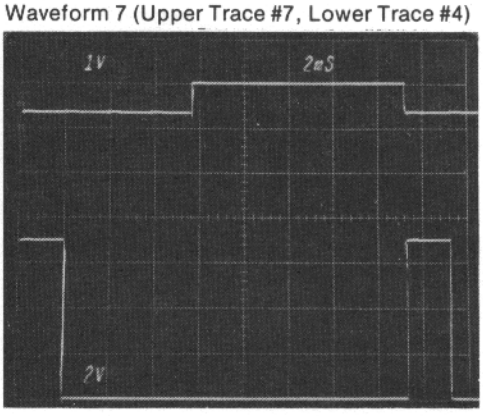
KP-4A/6A TRANSMITTER ENCODER AND MODULATOR

FIGURE 1

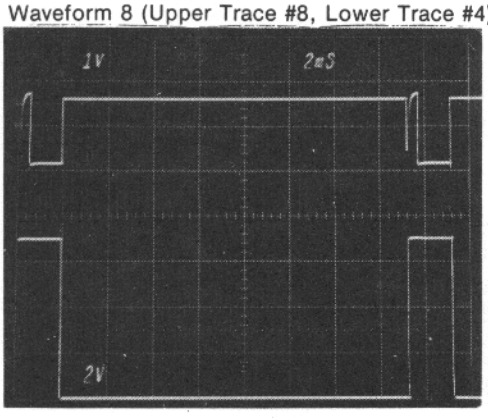
eform 6 (Upper Trace #6, Lower Trace #4)



Waveform 7 (Upper Trace #7, Lower Trace #4)



Waveform 8 (Upper Trace #8, Lower Trace #4)



CIRCUIT DESCRIPTION — ENCODER/MODULATOR

(See Schematic, Figure 1)

This encoder operates similarly to the encoder first used on the KP-5 Sport Series, using a shift register (IC-1), pot-switching transistors (Q1-Q6), and a voltage-controlled astable multivibrator (Q7-Q9). Transistor Q10 is a clock driver and shaper to drive modulator transistor Q11.

Following is a brief explanation of circuit operation:

Assume Q7 and Q10 are on, Q8 and Q9 are off, IC-1 is at "0" count and Q1-Q6 are "off". At this point, capacitor C7 is charging up through R14 + R15 + R16. When the voltage at the base of Q8 reaches ~ + 0.6V, Q8 turns on forcing Q7 off via capacitor C6, and Q10 off. The positive pulse generated at Q10's collector causes shift register IC-1 to advance one count to "CH-1" from "CH-0". This simultaneously turns on Q1, applying the voltage at the wiper of CP-1 to the collector of Q7. C7 will now charge to this voltage while Q7 is off due to the charge time-constant of C6-R12 (~350 microseconds). When Q7 turns on again, Q8 turns off for a time determined by the voltage to which C7 charged (from CP-1) and the time constant of C7 + R15 + R16. (R14 is now shorted out by Q9 as soon as "CH-0" returned low.) When the voltage at the base of Q8 again reaches ~ + 0.6V, Q8 turns on generating another clock pulse, via Q10, advancing the shift register to CH-2. The voltage at the wiper of *CP-2* is now applied to the collector of Q7.

This same action continues through the remaining channels. At the conclusion of the last control channel, the next clock pulse shifts IC-1 to either CH-5 or CH-6, depending upon the number of channels installed (4 or 6). This next channel is connected directly to the reset terminal of IC-1. This causes "CH-0" to go high immediately. Thereupon turning Q9 off and applying supply voltage to the collector of Q7 through R11 and D2. The "Ch-0" interval is thus longer than any control channel owing to the higher voltage applied to Q7's collector and the increased charging time constant due to the addition of R14.

The above constitutes one complete frame of information. The cycle repeats itself as long as power is applied.

Modulator transistor Q11 is driven from the clock driver transistor Q10. It provides the necessary signal inversion and current capability to modulate the RF section.

ENCODER SET-UP AND ADJUSTMENTS

In order to verify proper channel set-up, it is not necessary to remove the circuit board from the case. Each channel pulse may be examined at the appropriate pin of IC-1.

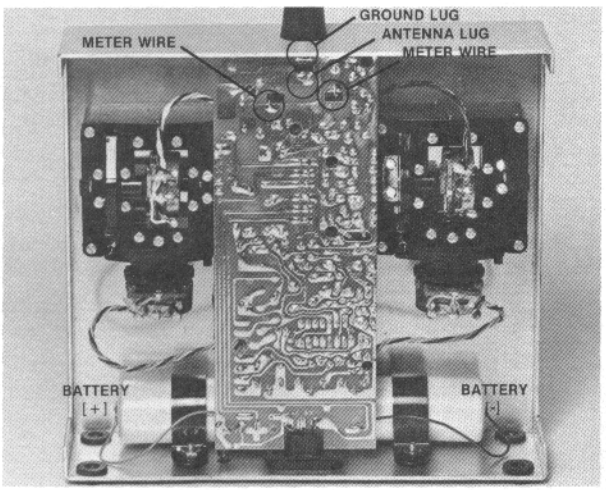
Locate 1C-1 from the rear of the board, Pin 1 is the pad directly below the letters "CA"[1]. Each channel should center at 1900 microseconds (± 15 microseconds) and vary between 1400 and 2400 microseconds (± 50 microseconds) with trim.

If extensive set-up or repairs are necessary, it will be necessary to remove the circuit board. This requires unsoldering four connections and removing four screws. Proceed as follows: (See Figure 2)

CAUTION: Protect the circuit board from contact with bare metal. The battery is connected directly to the circuit board, and can cause fused lands if shorted. If in doubt, remove the + (red) lead from the battery before proceeding.

FIGURE 2

1. Unsolder both meter wires (M + and M-).
2. Unsolder the antenna and ground lugs at the top of the circuit board.
3. Remove the two screws from the charge receptacle on the bottom of the case, if they are present.
4. Remove the two screws from the switch guard on the front of the case.
5. Slide the *top* of the circuit board away from the case first, then lift slightly to clear the charge receptacle and remove the board.



[1] Note: "CA" designation is only found on the T-45 P.C. Board (010-230).

The board is now fully accessible for any adjustments and/or repairs.

Pulse width measurements may be made from the component side of the board using the top of the 47K resistors which are connected to the desired pins of IC-1.

Each channel has an individual range pot to set travel on that channel, as necessary. A "Master Range" adjustment, R15 controls *all* channels simultaneously. If a complete set-up is necessary, adjust CH-1 travel pot (R2) at the mid-point and adjust master range and CP-1 as necessary to obtain proper travel. DO NOT ADJUST MASTER RANGE WHEN SETTING THE REMAINING CHANNELS or it will be necessary to reset every channel again.

Check modulator pulse width for 350-450 microseconds at the collector of Q11, using the 80% amplitude points of the pulse (RF ON).

When all necessary adjustments are completed, replace the circuit board using the reverse order of the removal procedure.

ADDING THE FIFTH CHANNEL SWITCH (KP-4A, T-45 P.C. Board)

NOTE: Addition of the fifth channel should only be undertaken by qualified personnel familiar with printed circuit techniques and possessing the necessary test equipment. Serious component damage could result from poor workmanship or improper operation due to incorrect adjustments on the encoder board.

The following parts are required.

Qty.	P/N	Description
1	109-012	S.P.S.T. Toggle Switch (S2)
1	101-013 101-033	Transistor, MPS-6560 (Fairchild only), or (Q5) Transistor, MPS-3392 (Motorola)
1	057-473	Resistor, 47K, 1/4W 10% (R9)
2	106-056	Potentiometer, 5K (R10, R11)

Miscellaneous

3 lengths hook-up wire (blue, violet, gray); board to switch.

3" piece of hook-up wire (board jumper - see text).

The following procedure should be used for adding the fifth channel to this transmitter: (See Component Layout, Figure 5)

1. Refer to CAUTION note on board removal in the "Set-Up" section above.
2. Cut "channel 5 reset" printed circuit land (immediately to the left of "CA" under IC-1). This land connects pin 1 and pin 15.
3. Install 3" jumper lead from pin 5 to pin 15 of IC-1. Holes are provided for this lead. Install jumper on component side of circuit board.
4. Install Q5, R9, R10, and R11 on circuit board. It will be necessary to remove solder from lands to insert components.
5. Solder the three lengths of wire to the circuit side of the board in the locations shown, and route back through the hole in the circuit board with the green and yellow wires to the control pots.
6. Twist all three wires in the same manner as the control pot wiring.
7. Install toggle switch, S2, in desired location. For Mode II, this is normally the top left (above throttle) of the transmitter.
8. Route new leads neatly to switch, tying these to the wiring on the elevator trim control and running between the meter and the switch actuator. Solder the blue wire to switch S2 common terminal and the violet and gray wires to the other two (outside) terminals of the switch.
9. Assuming the remaining channels have been properly adjusted, set the new fifth channel to extreme travel limits; i.e., 1400 and 2400 microseconds as the switch is operated.
10. If the fifth channel does not operate, check to be sure the land in Step 2 has been cut cleanly. If the channel is still inoperative, set the adjustment pots to center and cycle the on-off switch. If difficulty persists, check for solder bridges, improper component installation, etc.
11. Reinstall the circuit board.

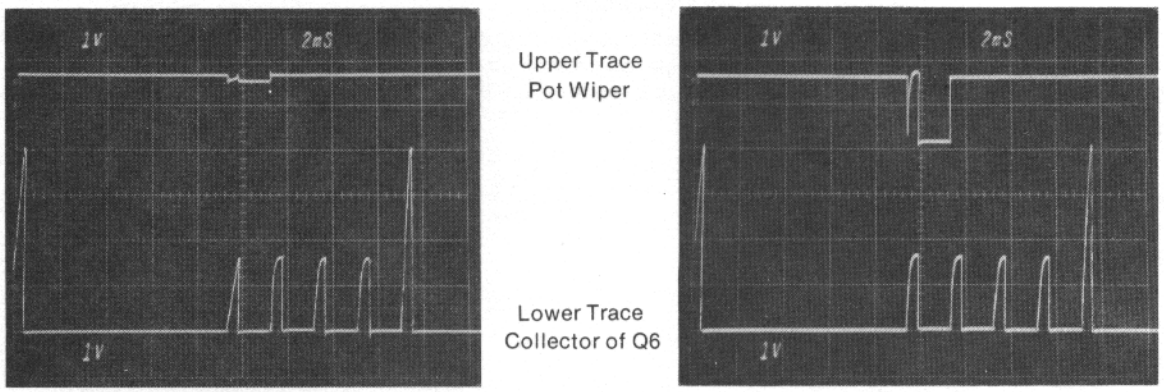
GENERAL TROUBLE SHOOTING ENCODER/MODULATOR

If the encoder is totally inoperative, check for power on the board, and proceed to a visual inspection for clues. Most total encoder failures will be due to a defective part in the main multivibrator, Q7 and Q8. In other cases, at least a portion of the circuit will be operating correctly. Normal trouble-shooting procedures will then identify the source of difficulty.

If the encoder merely puts out a stream of equally spaced pulses, suspect Q9 or IC-1. If clock pulses are present at pin 14 of IC-1, IC-1 is probably defective.

SPECIFIC DIFFICULTIES

Problem	Probable Cause	Remedy
One or more channels inoperative, very narrow pulse width at affected channel pin(s) of IC-1.	1. Associated control transistor (Q1-Q6) defective; base resistor open or broken.	1. Replace transistor or resistor.
	2. Control pot misadjusted.	2. Set CP for 2V at wiper.
	3. Control pot or wiring open or shorted to ground.	3. Check and replace defective pot or wire.
One or more channels inoperative, very long channel pulse at affected channel pin(s) of IC-1.	1. Ground wire to pot(s) open or wiper shorted to positive end of pot.	1. Check and replace wire as necessary.
	2. Control pot misadjusted.	2. Set CP for 2V at wiper.
One or more channels very non-linear, especially in "long" direction. (See Figure 3)	1. Associated control transistor defective.	1. Replace transistor with Fairchild MPS-6560 or Motorola MPS-3392.



INCORRECT CORRECT

FIGURE 3

All channels short, sync O.K.	1. RFC-1 open.	1. Check and replace as necessary.
All channels long, sync period normal.	1. Q9 defective (open) or R18 open or broken.	1. Replace transistor or resistor.
Sync period too short (< 7mS), channels appear normal.	1. Q9 shorted. 2. Drive from IC-1 pin 3 too low (< 4v).	1. Replace Q9. 2. Check pin 3, IC-1. Pulse should be > 4 volts during sync period.
Entire board dead, battery voltage O.K., doesn't charge, however.	1. Fuse land blown due to excessive current or shorting board against bare metal, leads, etc.	1. The land directly above charge receptacle and letters "AC Rx" is a fuse at ~2 amps. If blown, replace with a strand from #26 ga wire soldered between two pads provided.

R.F. SECTION CIRCUIT DESCRIPTION

(See schematics, Figure 4)

The R.F. sections used in the transmitter are fairly conventional three-stage circuits, with the exception of the final R.F. amplifier stage.

Oscillator

Q12 operates as a crystal-controlled Pierce oscillator using the series resonance of the crystal to maintain and stabilize oscillation. On 27-40 MHz units, this crystal is on the operating frequency. On 72 MHz units, the oscillator operates at one-half of the output frequency.

Buffer - Buffer/Doubler

Q13 operates at a Class-C buffer-amplifier on 27-40 MHz units and serves as the modulated RF stage as well. On 72 MHz units, this stage also doubles the crystal oscillator frequency as well.

Final Amplifier

This stage utilizes a relatively new power D-MOS Field Effect transistor. This device is an enhancement-mode (normally off) device which exhibits high gain and relatively high efficiences at low voltages. The circuitry is relatively straight-forward, the main difference being the Class AB bias applied via R32 from the modulator. This ensure device cut-off during modulating pulses.

R.F. ADJUSTMENTS

WARNING: Any adjustments to this unit can be made only be the holder of a Second-Class Radiotelephone or higher FCC license, or under their direct supervision. Unauthorized adjustments are a violation of Federal Law and punishable by fines and/or jail sentences for the violator. Refer all such adjustments to duly licensed personnel only.

27 MHz (Use a spectrum analyzer for all adjustments)

Beginning with oscillator adjustment L1, adjust for maximum output and then bring the slug in slightly (more capacitive) to ensure oscillator starting in all conditions. Cycle on-off switch to verify that the oscillator starts. Next adjust buffer, L2, for maximum output. This coil is fairly sharp tuning-go slowly to find the peak point.

Tune final amplifier coils L4 and L6 for maximum 27 MHz output and minimum harmonics. Alternate between L4 and L6 for minimum 54 and 81 MHz harmonics. When no further adjustments yield an improvement, re-check buffer tuning and then check L4 and L5 for best harmonic suppression.

35-40 MHz (Overseas model only)

Use same tuning procedure as above. Output tuning and buffer tuning should be adjusted for minimum 70 - 80 MHz harmonic output.

72 MHz

These units are tuned much the same as the above, with the exception of the final amplifier stage. This stage incorporates a 36 MHz fundamental trap (C22, L4) in the drain of the FET. This must be adjusted for minimum 36 MHz output. L5 is then tuned for maximum 72 MHz output. As in the other frequency bands, buffer tuning is fairly sharp—adjust slowly for best output.

FREQUENCY CHECK — ALL MODELS

Temporarily short the emitter to collector of Q11, and read output frequency on a suitable counter. Output frequency must be within .003% at 25°C.

TROUBLE SHOOTING R.F. SECTION

In general, trouble in the R.F. section other than mis-tuning will be due to an active device or damaged crystal.

If the final amplifier or buffer stage is inoperative, check for drain or collector voltage. A grid-dip meter is useful for checking low-level stages for operation.

Loss of the modulator transistor (Q11) will result in little or no R.F. output, even though the R.F. portion is functional.

While the oscillator and buffer transistors can be checked in a conventional matter with an ohmmeter, the FET (Q14) CANNOT. Although zener protected, this device can be damaged by static charges and higher voltage ohmmeters. Use extreme care when handling these devices out of the circuit.

The power FET will ordinarily feel warm to the touch when operating. If the output power falls off drastically and the device gets uncomfortably warm to the touch, (be careful—it can burn skin if it is defective) chances are the FET has been damaged. The gate is undoubtedly shorted internally, causing excessive current flow from source to drain.

Before closing the case, recheck all soldered connections removed while the board was out of the case, especially the antenna and ground connection.

ELECTRICAL PARTS LIST

KPT-4A/6A TRANSMITTER ENCODER & R.F. SECTIONS

RESISTORS

All values in ohms (K = 1000)

R1		47K	1/4W	10%	057-473
R2		2.5K		CTS Pot	106-055
R3		47K	1/4W	10%	057-473
R4		2.5K		CTS Pot	106-055
R5		47K	1/4W	10%	057-473
R6		2.5K		CTS Pot	106-055
R7		47K	1/4W	10%	057-473
R8		2.5K		CTS Pot	106-055
* R9		47K	1/4W	10%	057-473
* R10		5K		CTS Pot	106-052
* R11		5K		CTS Pot	106-052
R11A		8.2K	1/4W	10%	057-822
R12		36K	1/4W	5%	055-363
R13		4.7K	1/4W	10%	057-472
R14		220K	1/4W	10%	057-224
R15		50K		Trimpot	106-018
R16		120K	1/4W	10%	057-124
R17		10K	1/4W	10%	057-103
R18		22K	1/4W	10%	057-223
R19		47K	1/4W	10%	057-473
R20		2.2K	1/4W	10%	057-222
R21	27 MHz				
	35 MHz				
	40 MHz	5.6K	1/4W	10%	057-562
R21	72 MHz	4.7K	1/4W	10%	057-472

*Used on 5 and 6 channel versions only.

R22		1K	1/4W	10%	057-102
R23		100 ohm	1W	10%	063-101
R24		27 ohm	1/4W	10%	057-270
R25		4.7K	1/4W	10%	057-472
R26		4.7K	1/4W	10%	057-472
R27	72 MHz	270 ohms	1/4W	10%	057-271
R27	27 MHz 35 MHz 40 MHz	150 ohms	1/4W	10%	057-151
R28	72 MHz	220 ohms	1/4W	10%	057-221
R28	27 MHz 35 MHz 40 MHz	470 ohms	1/4W	10%	057-471
R29	72 MHz 27 MHz	18 ohms	1/4W	10%	057-180
R29	35 MHz 40 MHz	47 ohms	1/4W	10%	057-470
R30	72 MHz	1K	1/4W	10%	057-102
R30	27 MHz 35 MHz 40 MHz	1.2K	1/4W	10%	057-122
R31	72 MHz	1K	1/4W	10%	057-102
R31	27 MHz 35 MHz 40 MHz	1.2K	1/4W	10%	057-122
R32		3.9K	1/4W	10%	057-392
*R34		2.5K		CTS Pot	106-052

* Used on 6 chanel versions only.

CAPACITORS

C1		.001uf	500V	Disc	113-012
C2		.01uf	50V	Disc	113-016
C3		.001uf	500V	Disc	113-012
C4		.001uf	500V	Disc	113-012
C5		.001uf	500V	Disc	113-012
C6		.022uf	200V	Mylar	115-029
C7		.047uf	200V	Mylar	115-009
C8	27 MHz 35 MHz 40 MHz	.022uf *(.015uf)*	200V	Mylar	115-029 *(115-003)*
C8	72 MHz	.01uf *(not used)*	50V	Disc	113-016
C9		.1uf	250V	Mylar	115-018
C10		.01uf	50V	Disc	113-016
C10A		.001uf	500V	Disc	113-012
C11		47uf *(33uf)*	16V *(6V)*	Electrolytic *(Tantalum)*	116-008 *(116-005)*
C12	72 MHz	.01uf	50V	Disc	113-016
C12	27 MHz 35 MHz 40 MHz	.05uf *(.01)*	10V *(50V)*	Disc	113-018

Italicized information applies to the T-46 P.C. Board only.

C13	72 MHz	Delete			
C13	27 MHz	.05uf	10V	Disc	113-018
	35 MHz	*(not used on T-46)*			
	40 MHz				
C14	72 MHz	10pf	40V	Disc	113-004
C14	27MHz	Padding capacitor, may be present in some units			
	35 MHz	Value varies (3-27pf)			
	40 MHz				
C15	72 MHz	.001uf	500V	Disc	113-012
C15	27 MHz	.005uf *(.00luf)*	100V *(500)*	Disc	113-015*(113-012)*
	35 MHz				
	40 MHz				
C16	72 MHz	39pf	Dilectron	Disc	113-041
C16	27 MHz	68pf	100V	Mica	117-010
C16	35 MHz	27pf	100V	Mica	117-006
	40 MHz				
C17	72 MHz	22pf	40V	Disc	113-006
	35 MHz				
	40 MHz				
C17	27 MHz	47pf *(68pf)*	100V *(50V)*	Disc	113-034 *(113-009)*
C18	72 MHz	10pf *(15pf)*	40V	Disc	113-004 *(113-005)*
C18	27 MHz	39pf *(100pf)*	100V *(40V)*	Mica *(Disc)*	117-014 *(113-043)*
C18	35 MHz	27pf	100V	Mica	117-006
C18	40 MHz	15pf	100V	Mica	117-004
C19		.001uf	500V	Disc	113-012
C20		.001uf	500V	Disc	113-012
C21	72 MHz	10pf	40V	Disc	113-004
C21	27 MHz	100pf *(68pf)*	40V *(50V)*	Disc	113-043 *(113-009)*
C21	35 MHz	47pf	100V	Disc	113-034
	40 MHz				
C22	72 MHz	18pf	100V	Disc	113-037
C22	27 MHz	27pf *(150pf)*	40V	Disc	113-007 *(113-010)*
C22	35 MHz	39pf	Dilectron	Disc	113-041
	40 MHz				
C23	72 MHz	.01uf	50V	Disc	113-016
C23	27 MHz	120pf *(.01)*	40V	Disc	113-044 *(113-016)*
C23	35 MHz	68pf	50V	Disc	113-009
	40 MHz				
C24	72 MHz	6.2pf	100V	Disc	113-032
C24	27 MHz	68pf *(10pf)*	50V *(40V)*	Disc	113-009 *(113-004)*
C24	35 MHz	100pf	40V	Disc	113-043
	40 MHz				
C25	72 MHz	22pf	40V	Disc	113-006
C25	27 MHz	82pf *(120 PF)*	40V *(50V)*	Disc	113-045 *(113-044)*
C25	35 MHz	10pf	40V	Disc	113-004
	40 MHz				
C26	72 MHz	3pf	100V	Mica	117-001
C26	27 MHz	22pf *(47pf)*	40V	Disc	113-006 *(113-034)*
C27	27 MHz	3pf	100V	Mica	117-001
	35 MHz				
	40 MHz				

Italicized information applies to the T-46 P.C. Board only.

C28	27 MHz	15pf	40V	Disc	113-005
C28	35 MHz	10pf	40V	Disc	113-004
	40 MHz				
C30	72 MHz	.01uf *(.05uf)*	50V *(10V)*	Disc	113-016 *(113-018)*
C30	27 MHz	.05uf	10V	Disc	113-018
	35 MHz				
	40 MHz				
** C31	27MHz	.001	500V	DISC	113-012
	72MHz				
**C32	27MHz	.001	500V	DISC	113-012
	72MHz				

**Used on T-46 Boards only.

SEMICONDUCTORS

IC-1		4017B		CMOS-Decade	110-124
D1, D2, D5, D6		1N4148		Diode Silicon	100-101
D3		1N4001		Diode Silicon	100-106
D4		FV501		Diode LED	100-110
Q1, Q2, Q3, Q4,Q5,* 06**		MPS-6560 or	NPN	Transistor Silicon	101-013
		MPS-3392	NPN		101-033
Q7, Q8		2N3392	NPN	Transistor Silicon	101-004
Q9		2N4122	PNP	Transistor Silicon	101-005
Q10		2N3392	NPN	Transistor Silicon	101-004
Q11		MPS-6562	PNP	Transistor Silicon	101-012
Q12, Q13,	72 MHz	2N2369A	NPN	Transistor Silicon	101-006
Q12, Q13	27 MHz	2N2369A	Epoxy Version	Transistor Silicon	101-025
	35 MHz				
	40 MHz				
Q14		4025 CR866	FET	Transistor	101-032

*Used on 5 and 6 channel versions.
**Used on 6 channel version only.

COILS AND TRANSFORMERS

RFC-1		22uh	RF Choke	103-045
RFC-2		22uh	Coil-Choke	103-022
RFC-3	72 MHz	4.7uh	R.F. Choke	103-034
RFC-3	27 MHz	22uh	R.F. Choke	103-045
	35 MHz			
	40 MHz			
L1	72 MHz	9-1/2 turns, oscillator coil		103-082
L1	27 MHz	12-1/2 turns, antenna coil *(9-1/2 turns, oscillator coil)*		103-060 *(103-082)*
	35 MHz			
	40 MHz			
L2	72 MHz	4-¼ turns & 1-¼ turns buffer coil		103-103
L2	27 MHz	9-1/4 turns, mixer coil *(4-1/2 turns & 1-1/4 turns buffer coil)*		103-061 *(103-103)*
	35 MHz			
	40 MHz			

Italicized information applies to the T-46 P.C. Board only.

L3	72 MHz	.22uh	Miniature Inductor	103-046
L3	27 MHz	1.5uh *(.22 UH)*	R.F. Choke	103-071 *(103-046)*
L3	35 MHz	1.0uh	R.F. Choke	103-070
	40 MHz			
L4	72 MHz	11-1/2 turns, Trap coil		103-085
L4	27 MHz	10-1/2 turns, load coil *(12-1/2 turns, trap coil)*		103-087 *(103-060)*
	35 MHz			
	40 MHz			
L5	72 MHz	12-1/2 turns, Final coil		103-060
L5	27 MHz	.22uh *(11-1/2 turns, final coil)*	Miniature Inductor	103-046 *(103-085)*
	35 MHz			
	40 MHz			
L6	27 MHz	12-1/2 turns, coil		103-060
	35 MHz			
	40 MHz			

MISCELLANEOUS

X-1	Order by frequency		as required
T-45		PC Board	010-230
T-46		PC Board	010-240
CP1	5K	CTS Pot	106-052
CP1A	1K	CTS Pot	106-051
CP2	5K	CTS Pot	106-052
CP3	5K	CTS Pot	106-052
CP3A	1K	CTS Pot	106-051
CP4	5K	CTS Pot	106-052
S1	Switch, Slide		109-007
* S2	Switch, S.P.S.T.,Toggle		109-012
J1	Plug, Shell		120-041
	Pins, 4 per J1		120-034
F8	Ferrite Bead (4)		990-065

*Used on 5 and 6 channel versions only.

ELECTRONIC ASSEMBLIES

72 MHz	Transmitter, KPT-4A T-46 PC Board	300-363
27 MHz	Transmitter, KPT-4A T-46 PC Board	300-365
35 MHz	Transmitter, KPt-4A (Europe only) T-46 PC Board	300-370
40 MHz	Transmitter, KPT-4A (Europe only) T-46 PC Board	300-390
72 MHz	Transmitter, KPT-6A, T-46 P.C. Board	300-396
27 MHz	Transmitter, KPT-6A, T-46 P.C. Board	300-397
35 MHz	Transmitter, KPT-6A, T-46 P.C. Board	300-398
40 MHz	Transmitter, KPT-6A, T-46 P.C. Board	300-399

Note: T-45 P.C. Assemblies are No Longer Available.

Italicized information applies to the T-46 P.C. Board only.

72 MHZ R.F. SECTION

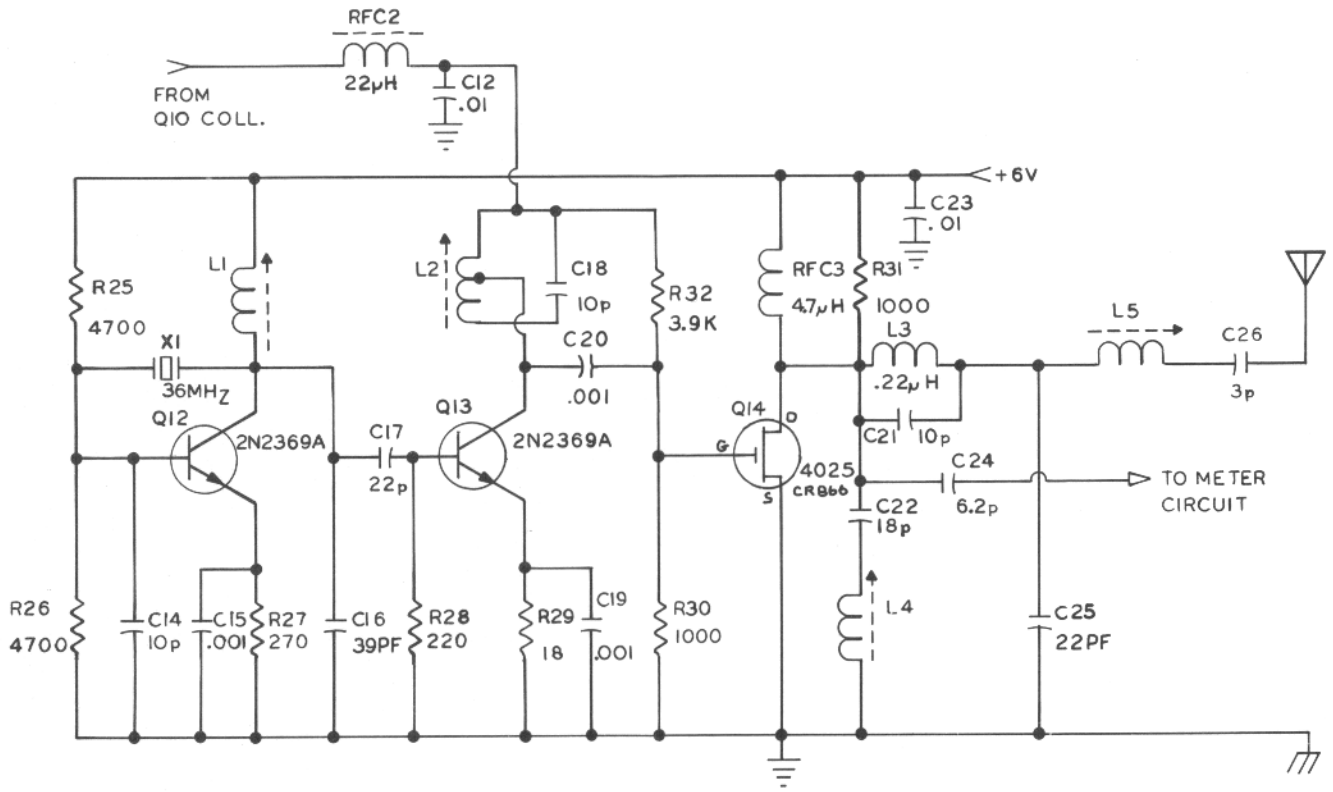
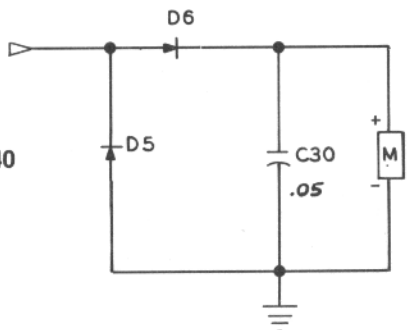


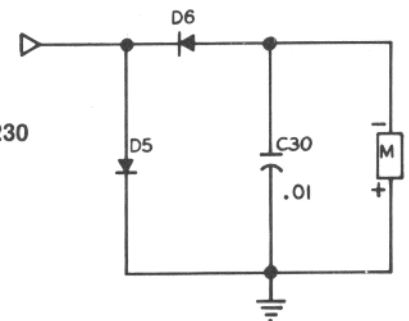
FIGURE 4A

METER CIRCUITS

T-46 Board - P/N 010-240



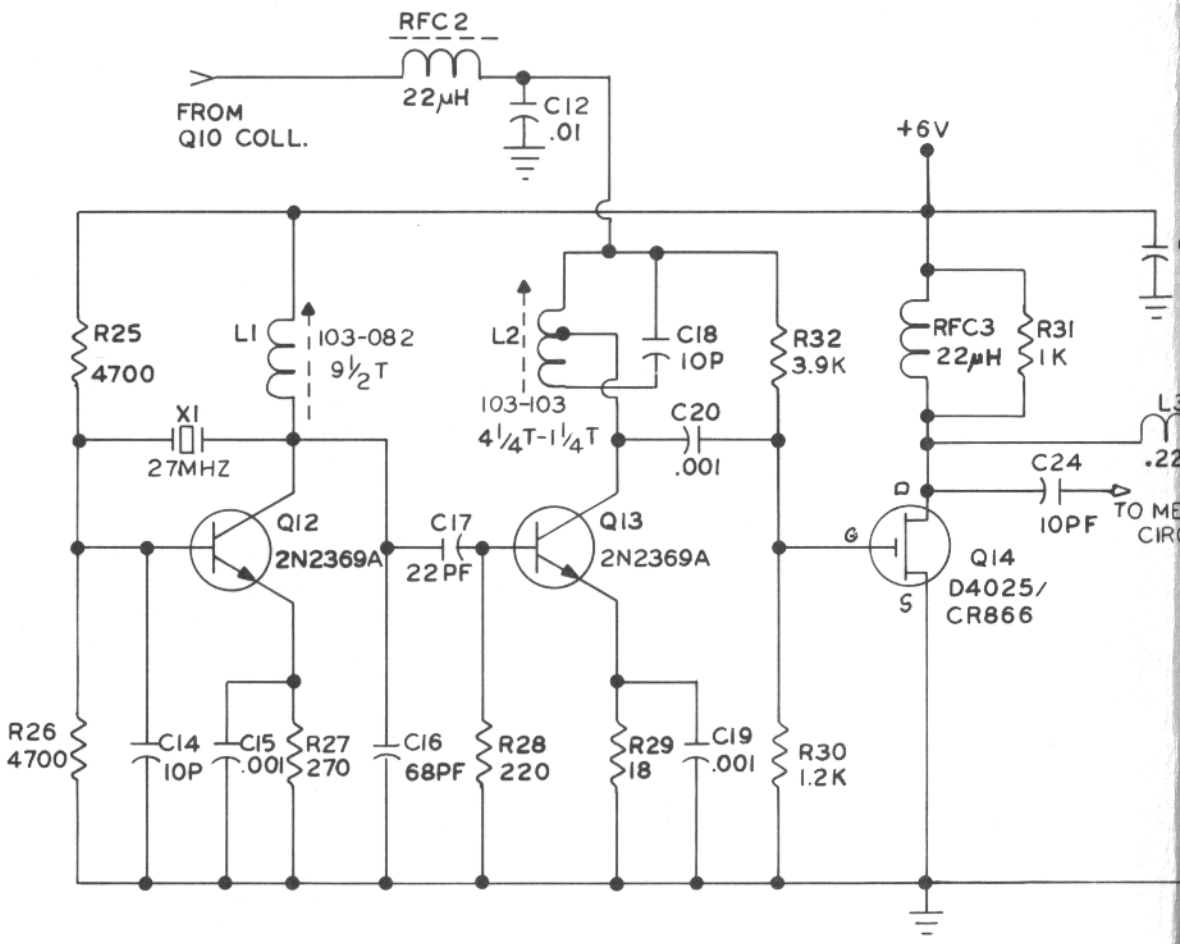
T-45 Board - P/N 010-230



KPT-4A/6A

27 MHz R.F. SECTION

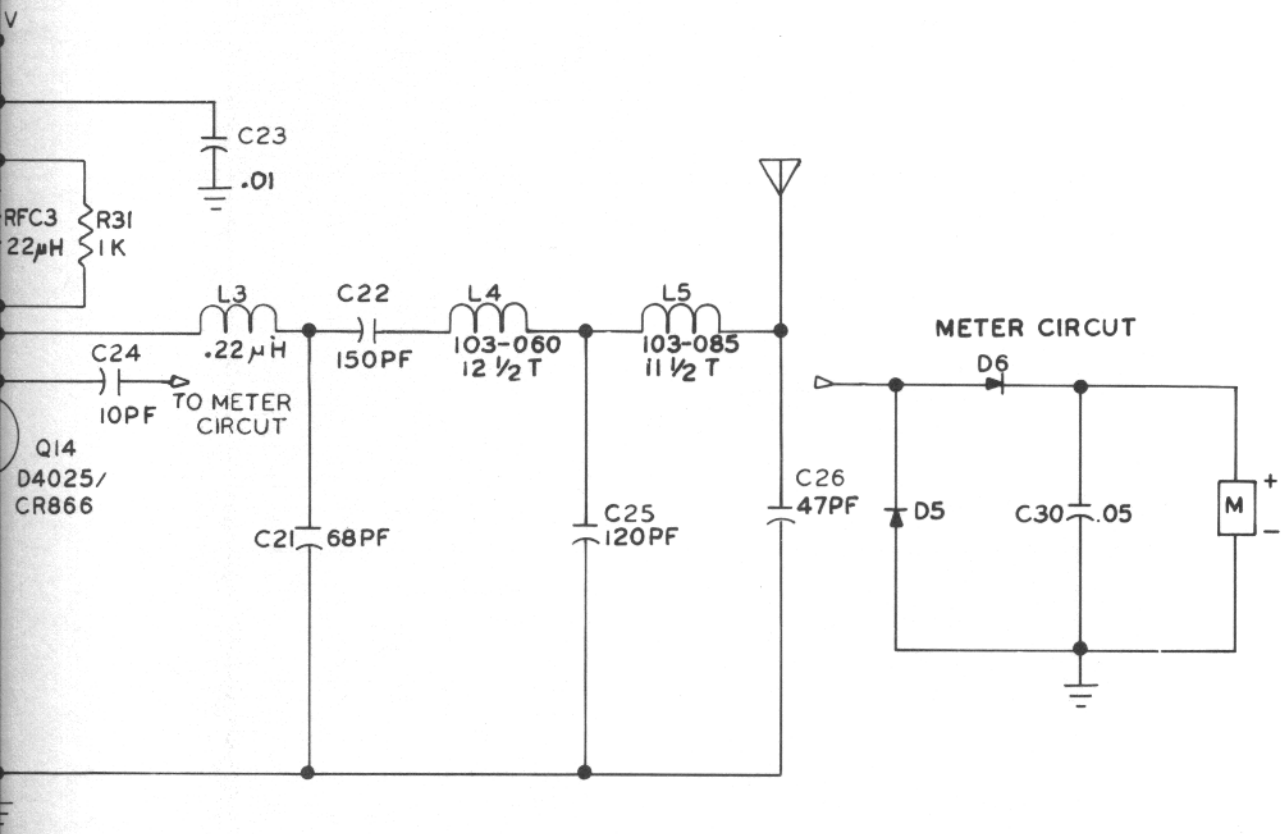
T-46 Board Only — P/N 010-240



NOTES:

1. C27, 28 & 29 ARE NOT USED.
2. FERRITE BEAD IS NO LONGER USED.

FIGURE 4B


C23
.01
RFC3
22μH
R31
1K
L3
.22μH
C22
150PF
L4
103-060
12 ½ T
L5
103-085
11 ½ T
C24
10PF
TO METER
CIRCUT
Q14
D4025/
CR866
C21
68PF
C25
120PF
C26
47PF
METER CIRCUT
D6
D5
C30
.05
M
+
-

27 MHZ R.F. SECTION

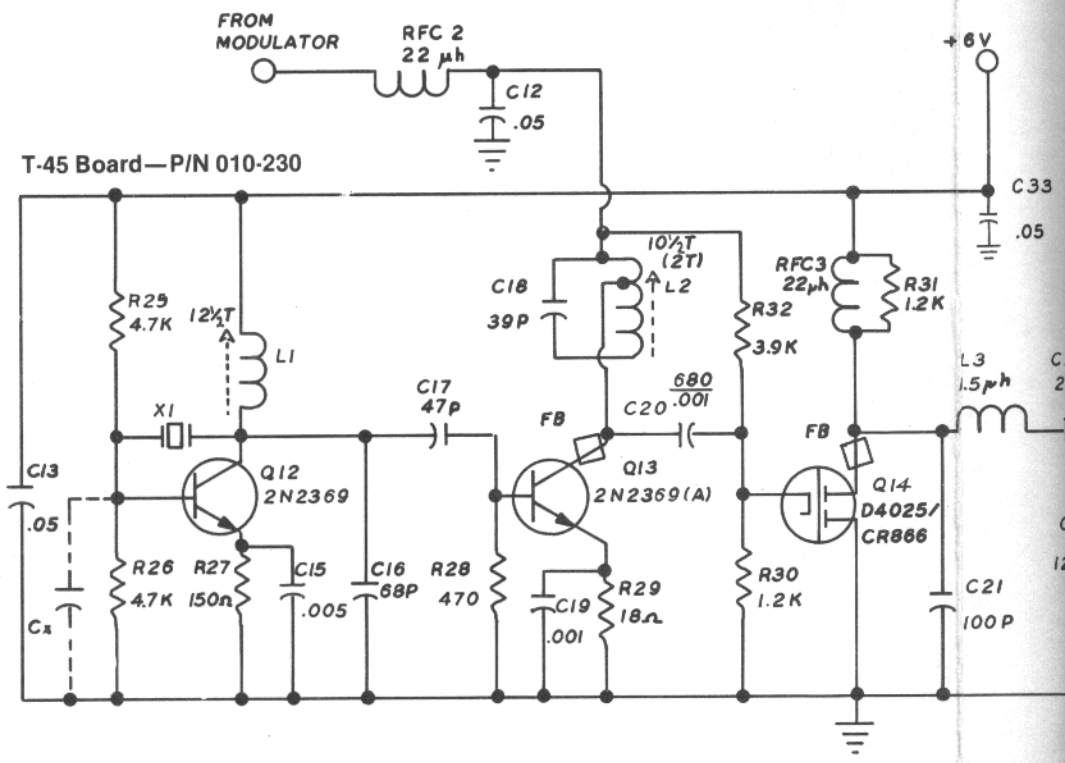
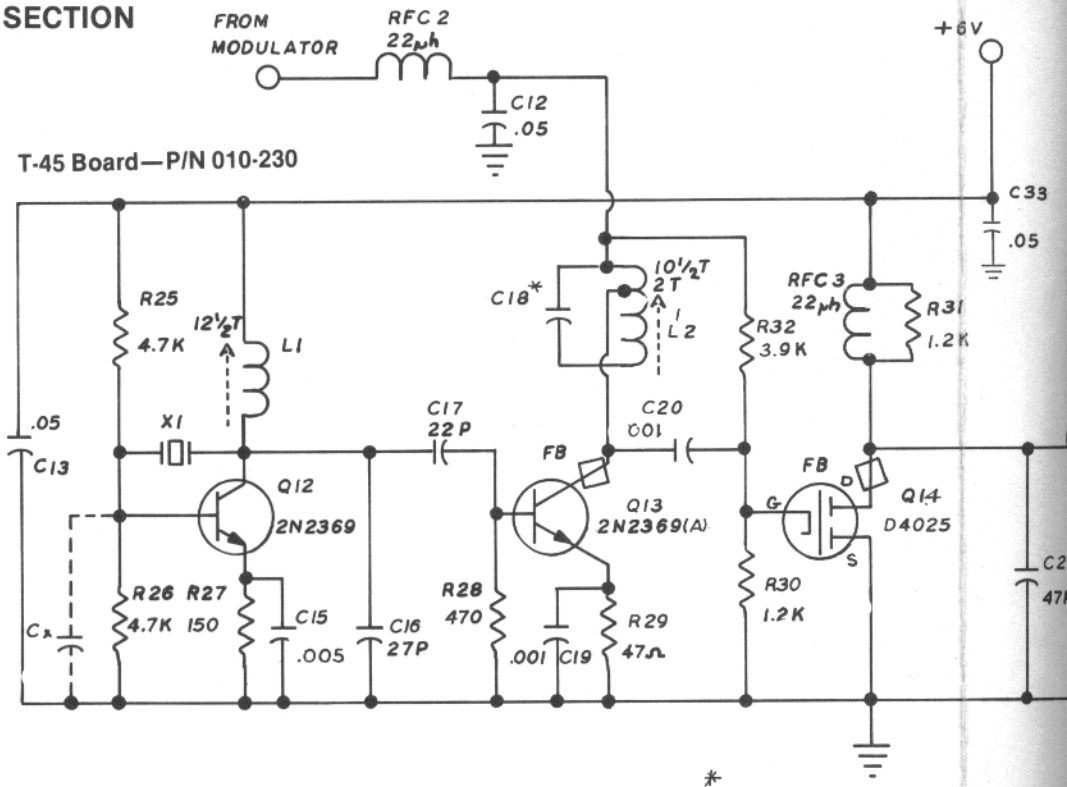


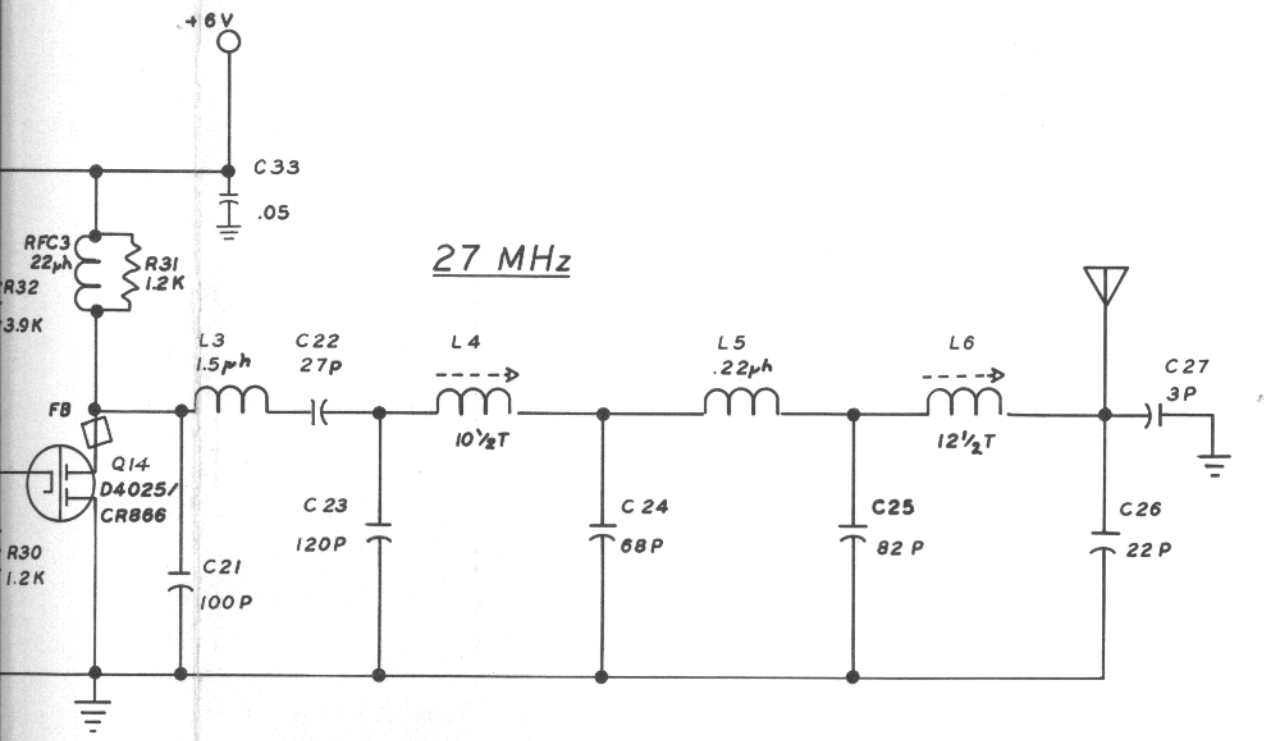
FIGURE 4C

35 MHZ—40 MHZ R.F. SECTION

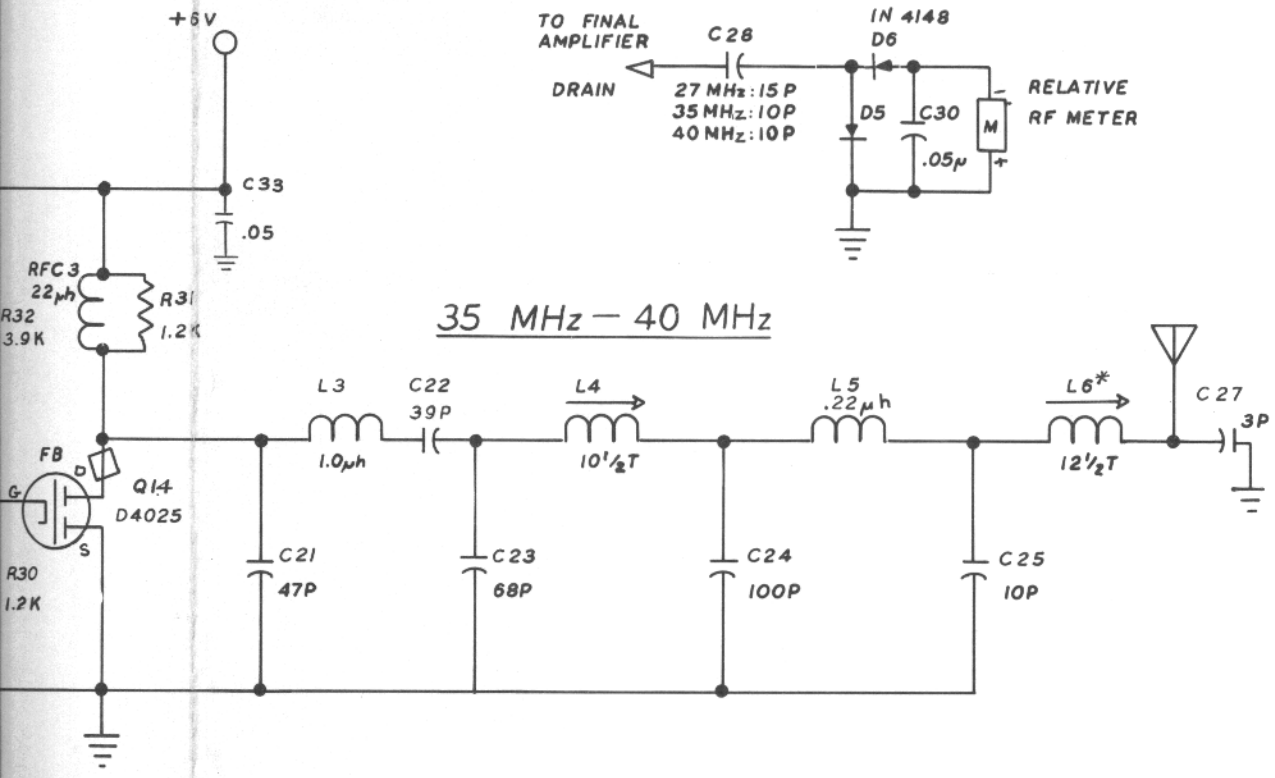


*

	35 MHz	40 MHz
L6	LONG SLUG	SHORT SLUG
C18	27 PF	15 PF

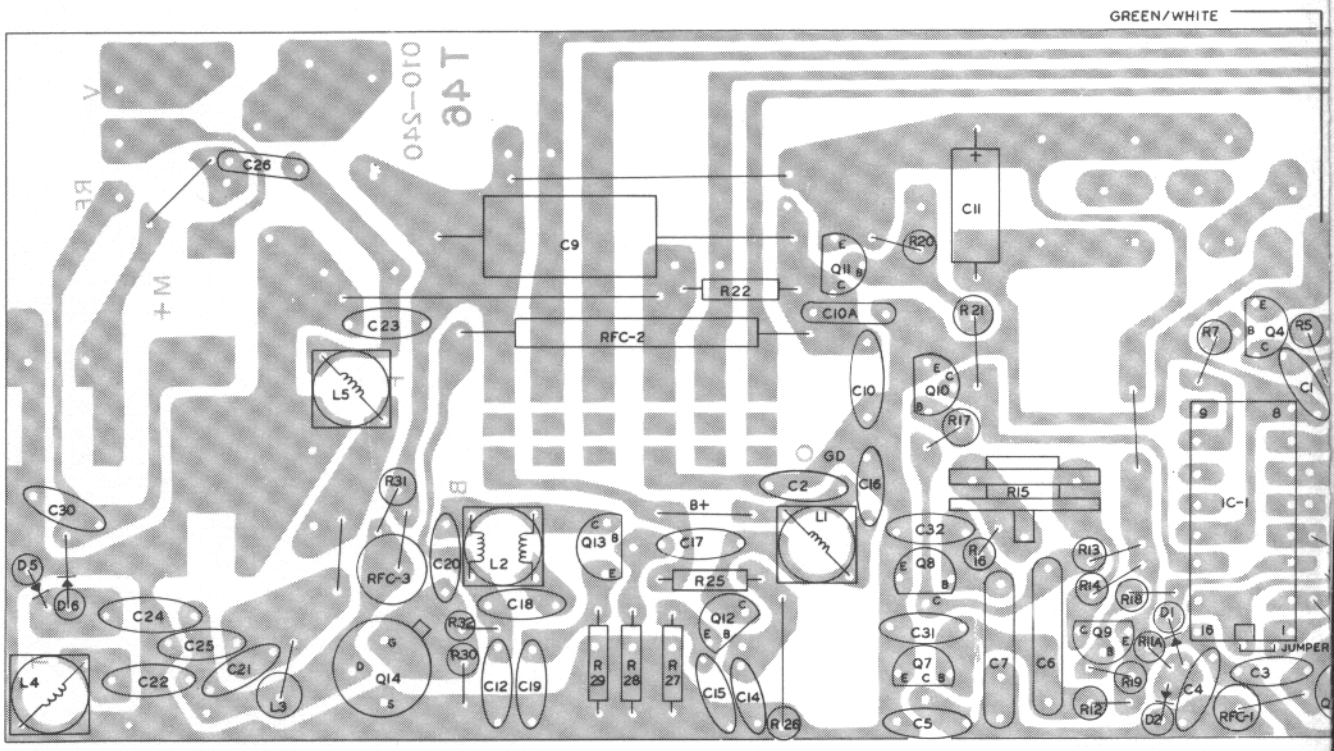


NOTES: 1) Cx IS A PADDING CAPACITOR; IT MAY BE PRESENT IN SOME UNITS
2) FB IS FERRITE BEAD P/N 990-065



	35 MHz	40 MHz
	LONG SLUG	SHORT SLUG
	27PF	15 PF

KPT-4A 72 MHz



KPT-4A/6A TRANSMITTER ENC

KF

T-46 Board—P/N 010-240

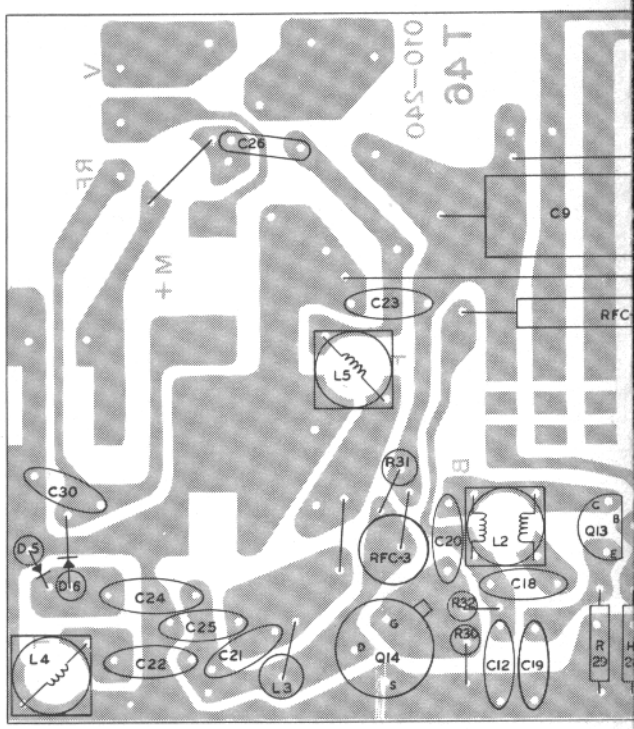
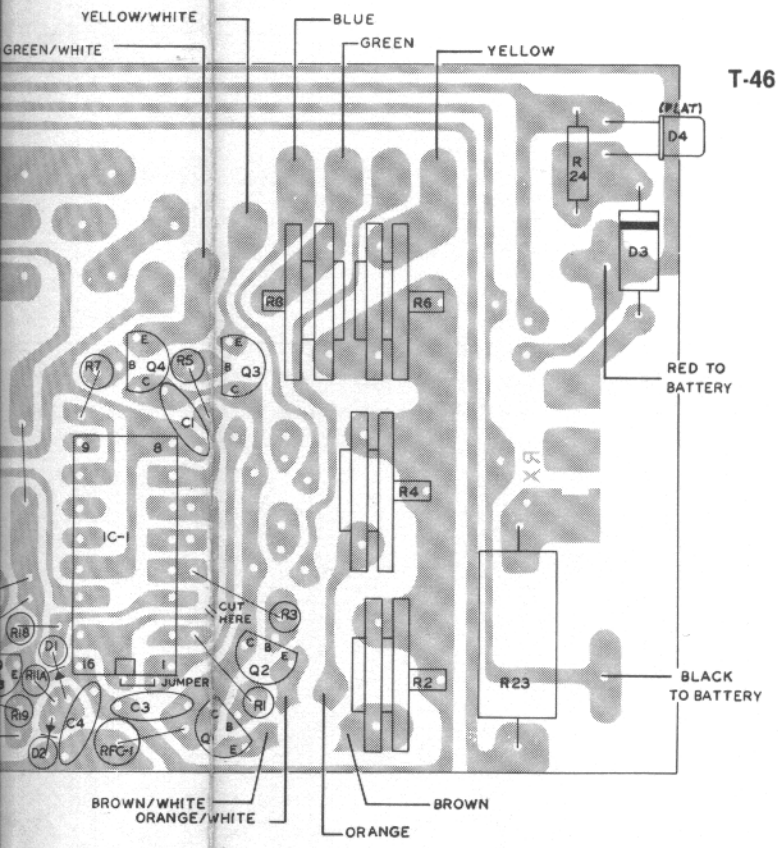


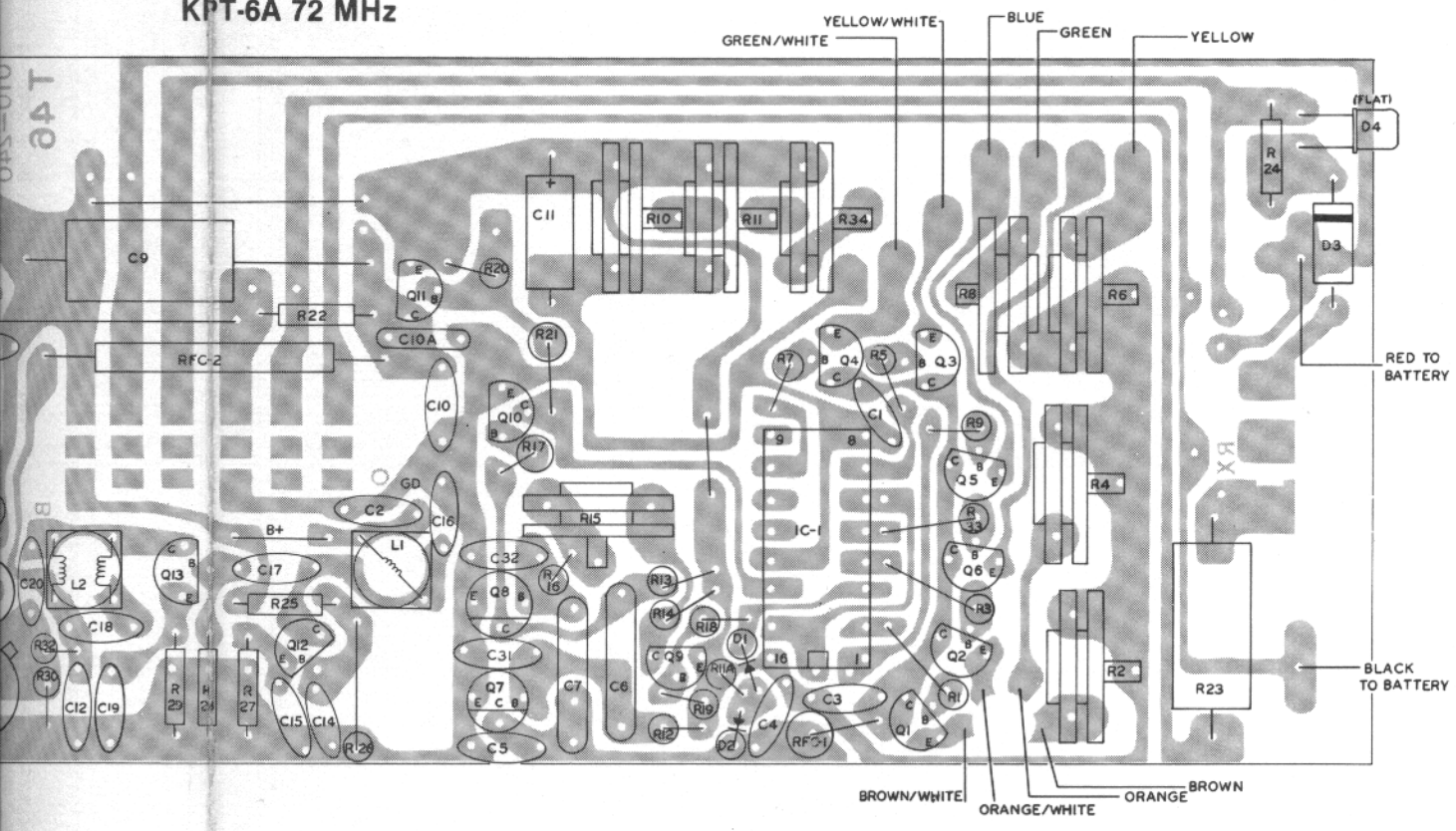
FIGURE 5

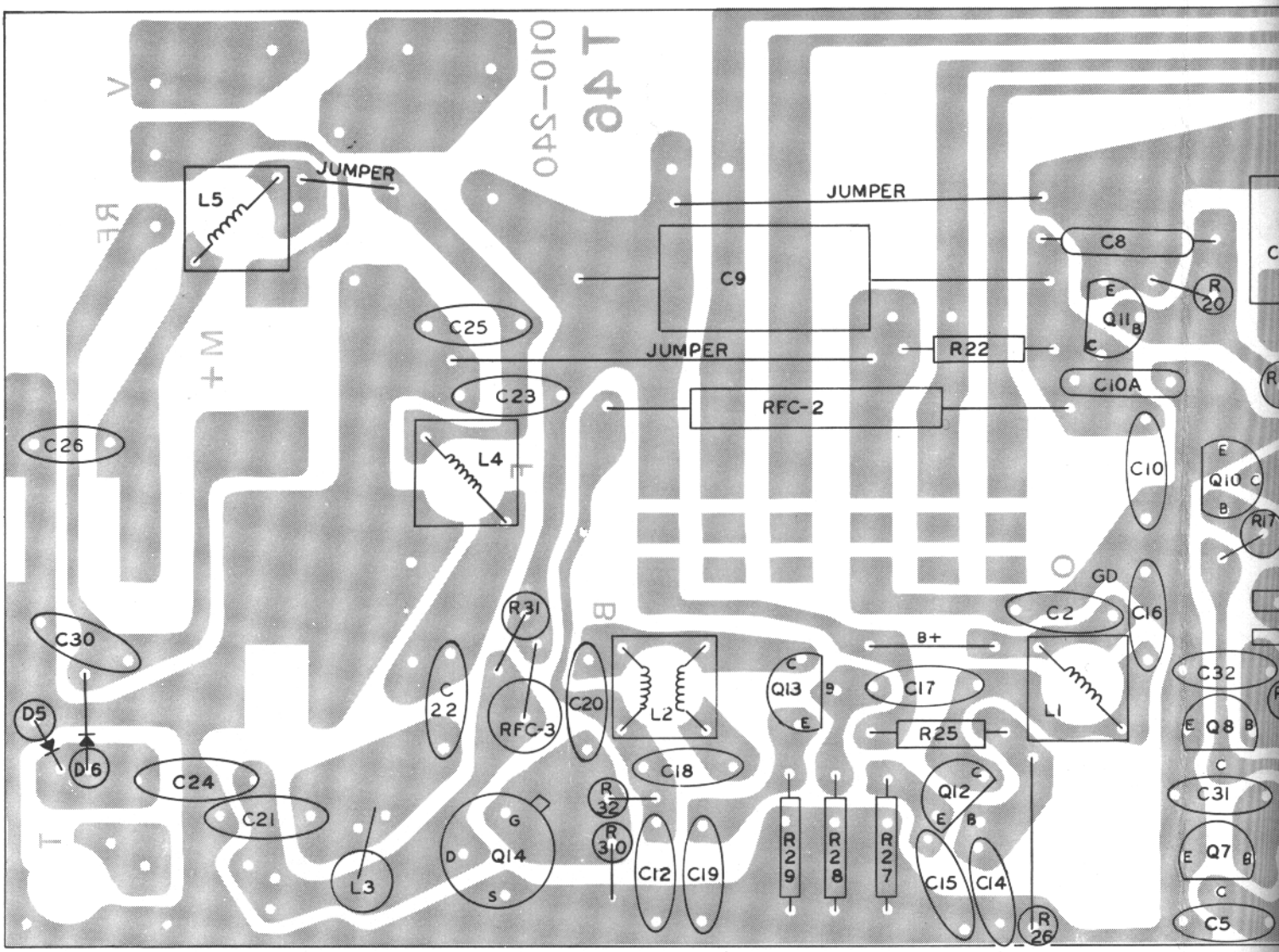


T-46 Board—P/N 010-240

NSMITTER ENCODER & R.F. SECTIONS

KPT-6A 72 MHz

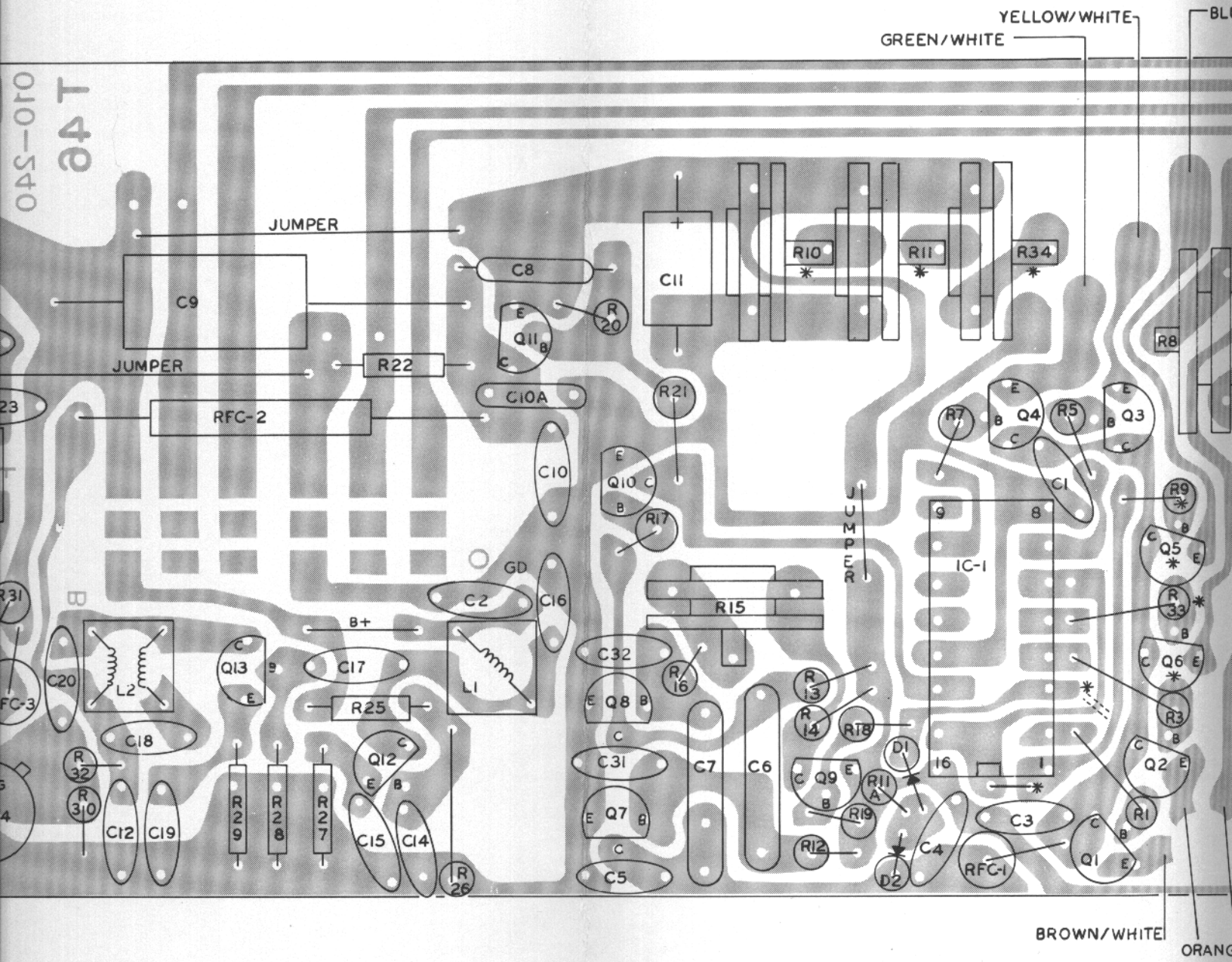




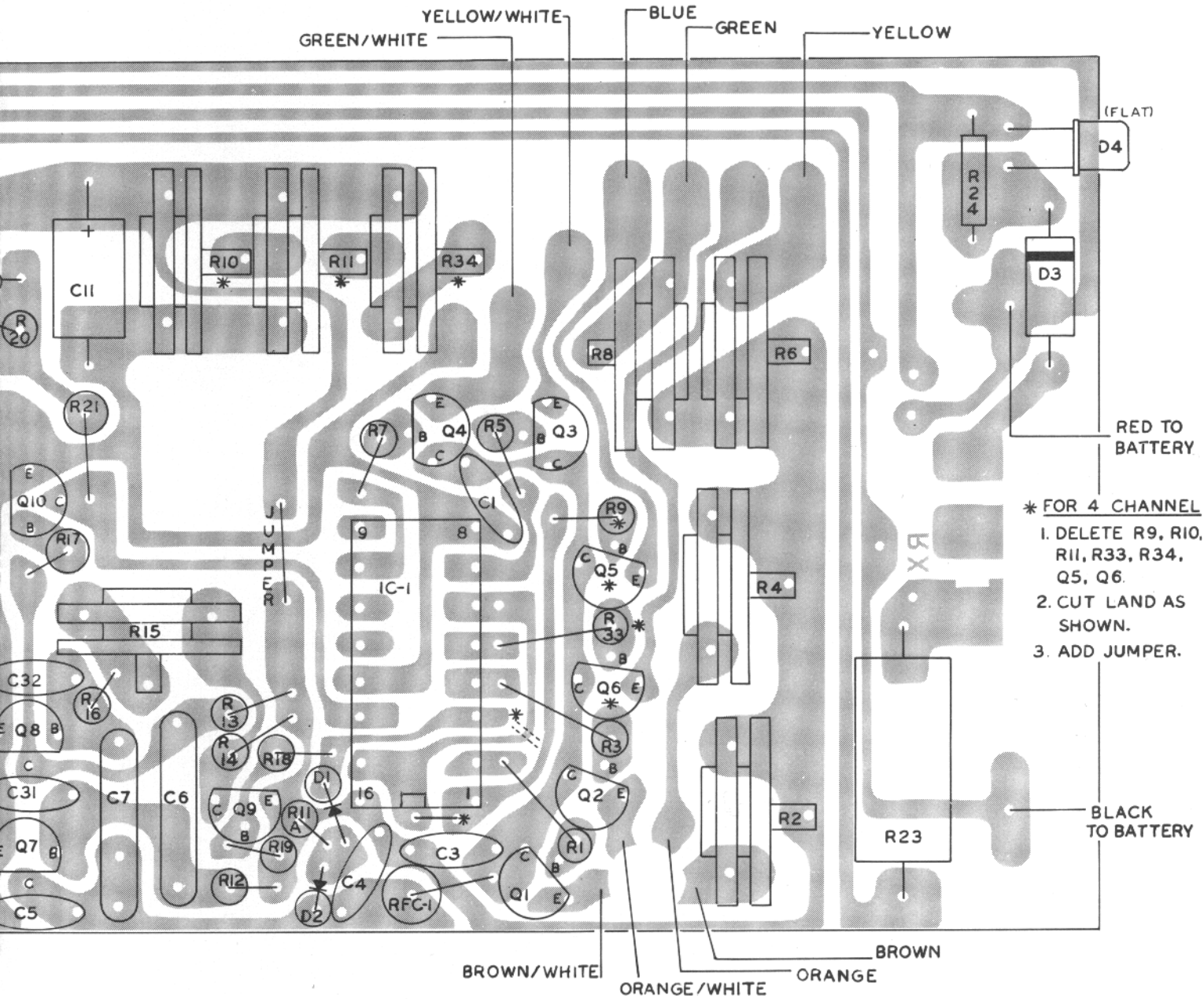
T-46 Board—P/N 010-240

FIGURE 6

KPT-4A/6A 27 MHz 1978 & 1979



27 MHz 1978 & 1979



ENCODER-MODULATOR and 27 MHZ R.F. SECTION

T-45 Board—P/N 010-230

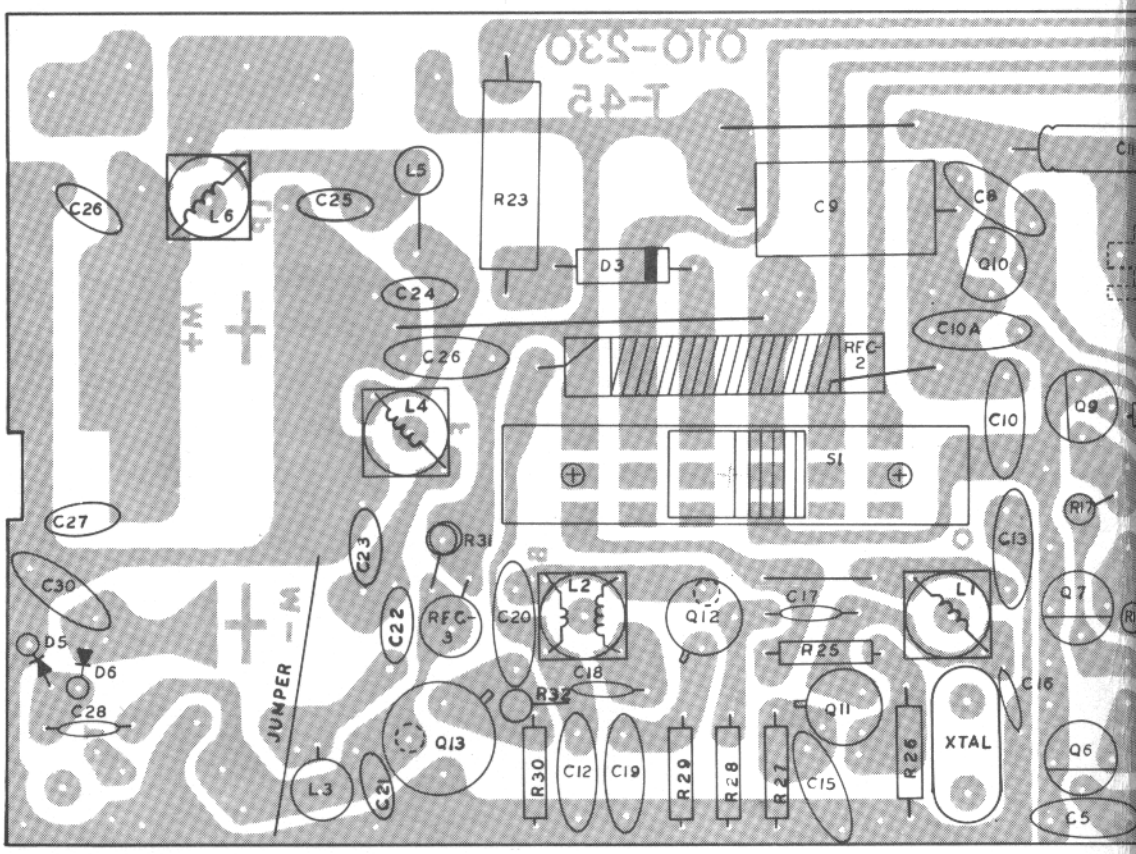


FIGURE 7

ENCODER-MODULATOR and 35 MHZ—40 MHZ R.F. SECTION

T-45 Board—P/N 010-230

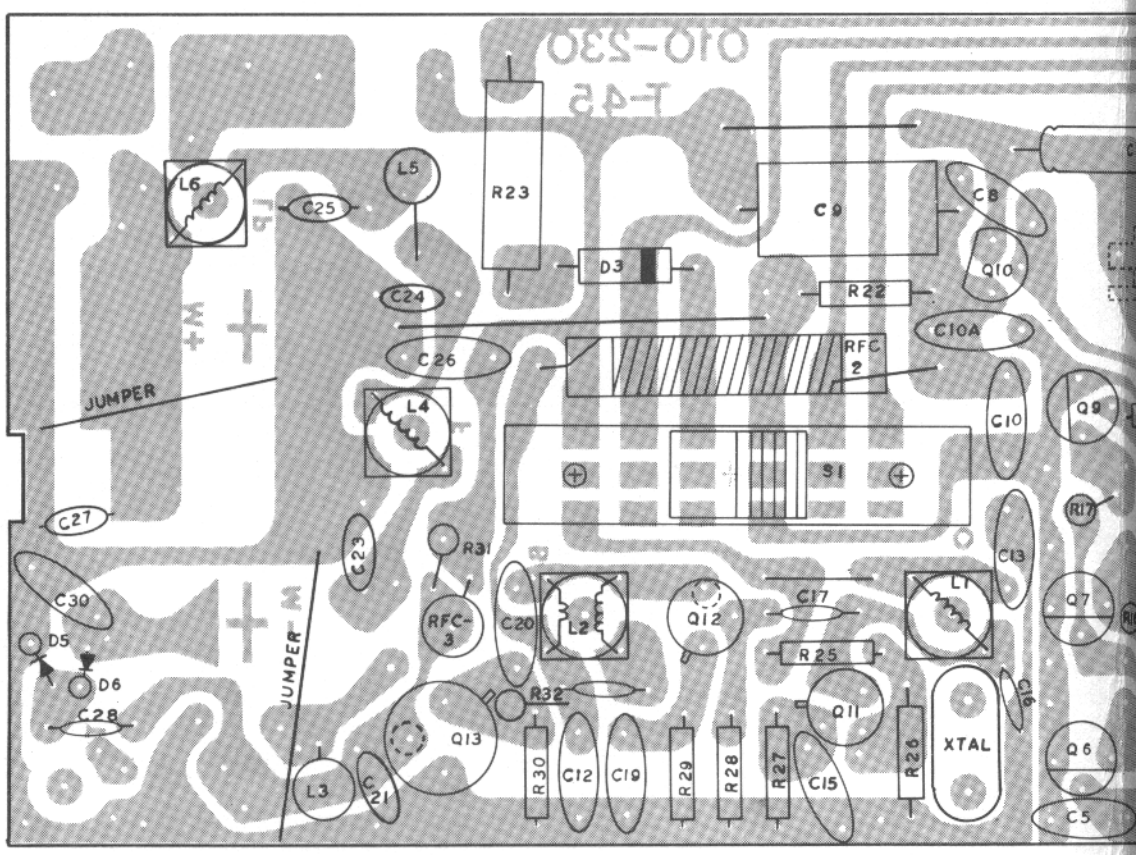
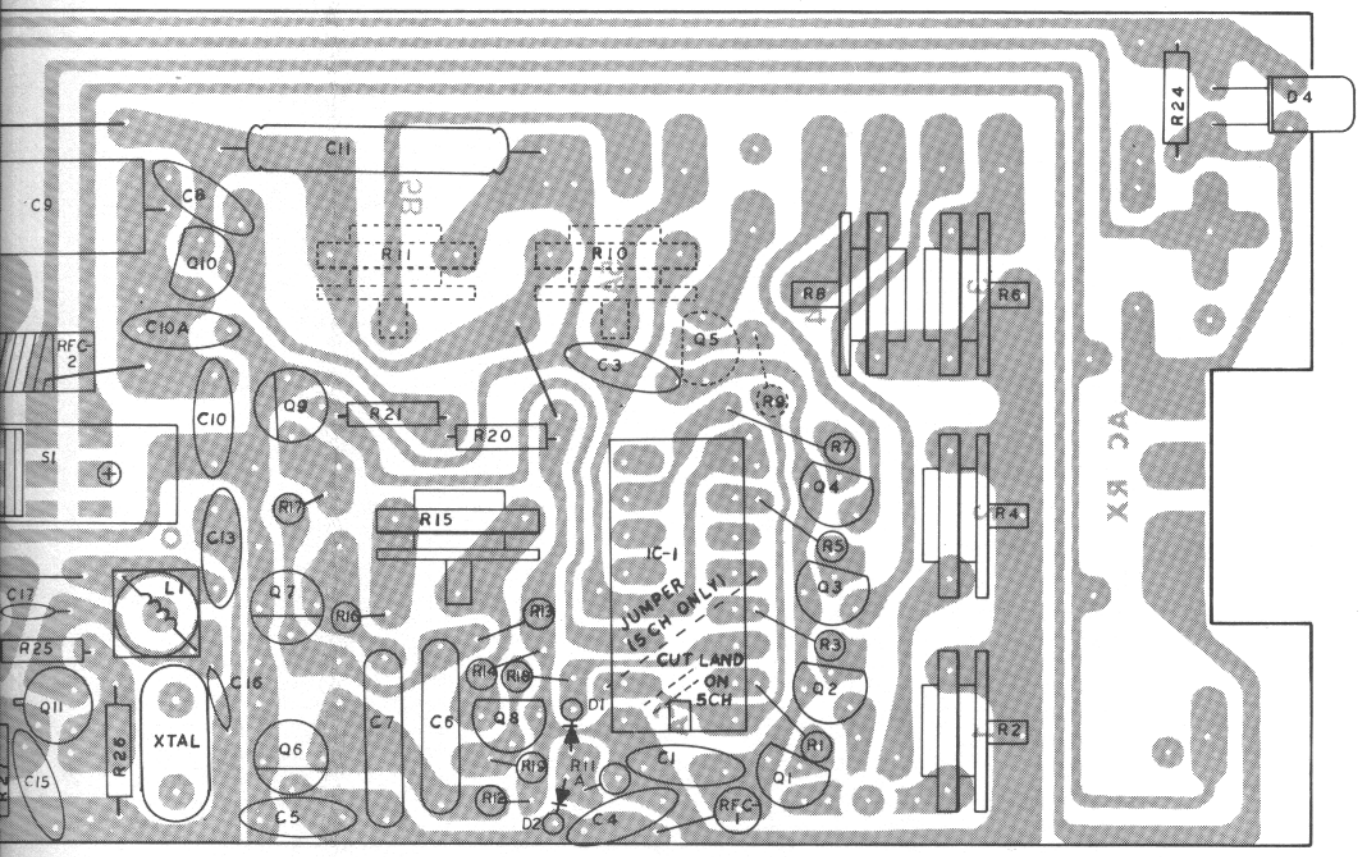
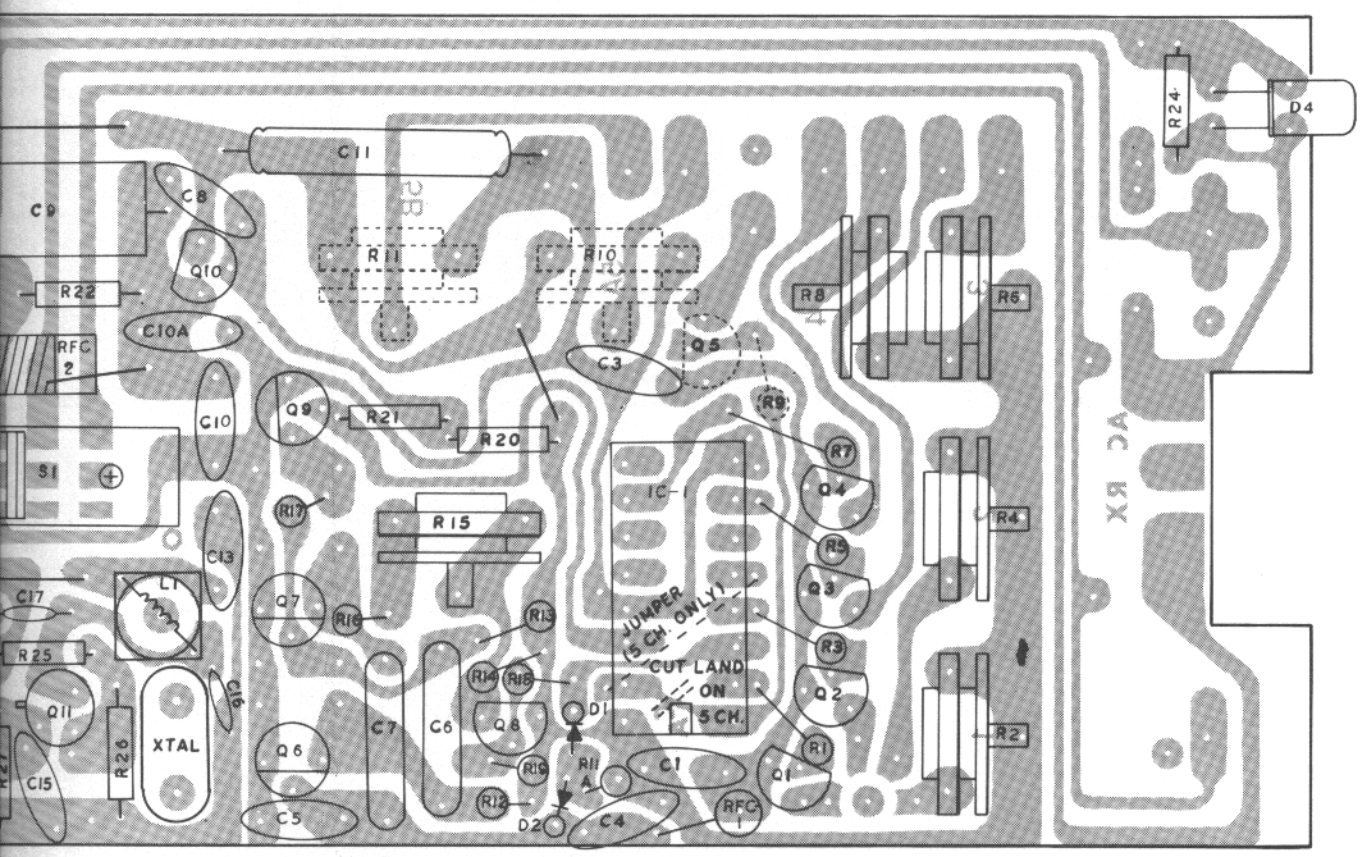


FIGURE 8


C11
C9
C8
Q10
C10A
RFC 2
C10
S1
C13
C17
L1
R25
Q11
C16
R26
XTAL
C15
R11
R10
R21
R20
R15
R17
Q7
R16
R13
R14
R18
Q8
D1
R19
R11 A
R12
D2
C7
C6
Q6
C5
C4
C3
Q5
R9
R8
R6
R7
Q4
R5
Q3
R3
Q2
R1
Q1
C1
RFC 1
IC-1
JUMPER (5 CH. ONLY)
CUT LAND ON 5CH
R24
D4
R4
R2
AC RX


C11
C9
C8
Q10
R22
C10A
RFC 2
C10
S1
C13
C17
L1
R25
Q11
C16
R26
XTAL
C15
R11
R10
R21
R20
R15
R17
Q7
R16
R13
R14
R18
Q8
D1
R19
R11 A
R12
D2
C7
C6
Q6
C5
C4
C3
Q5
R9
R8
R6
R7
Q4
R5
Q3
R3
Q2
R1
Q1
C1
RFC
IC-
JUMPER (5 CH. ONLY)
CUT LAND ON 5CH.
R24
D4
R4
R2
AC RX

ENCODER-MODULATOR and 72 MHZ R.F. SECTION

T-45 Board—P/N 010-230

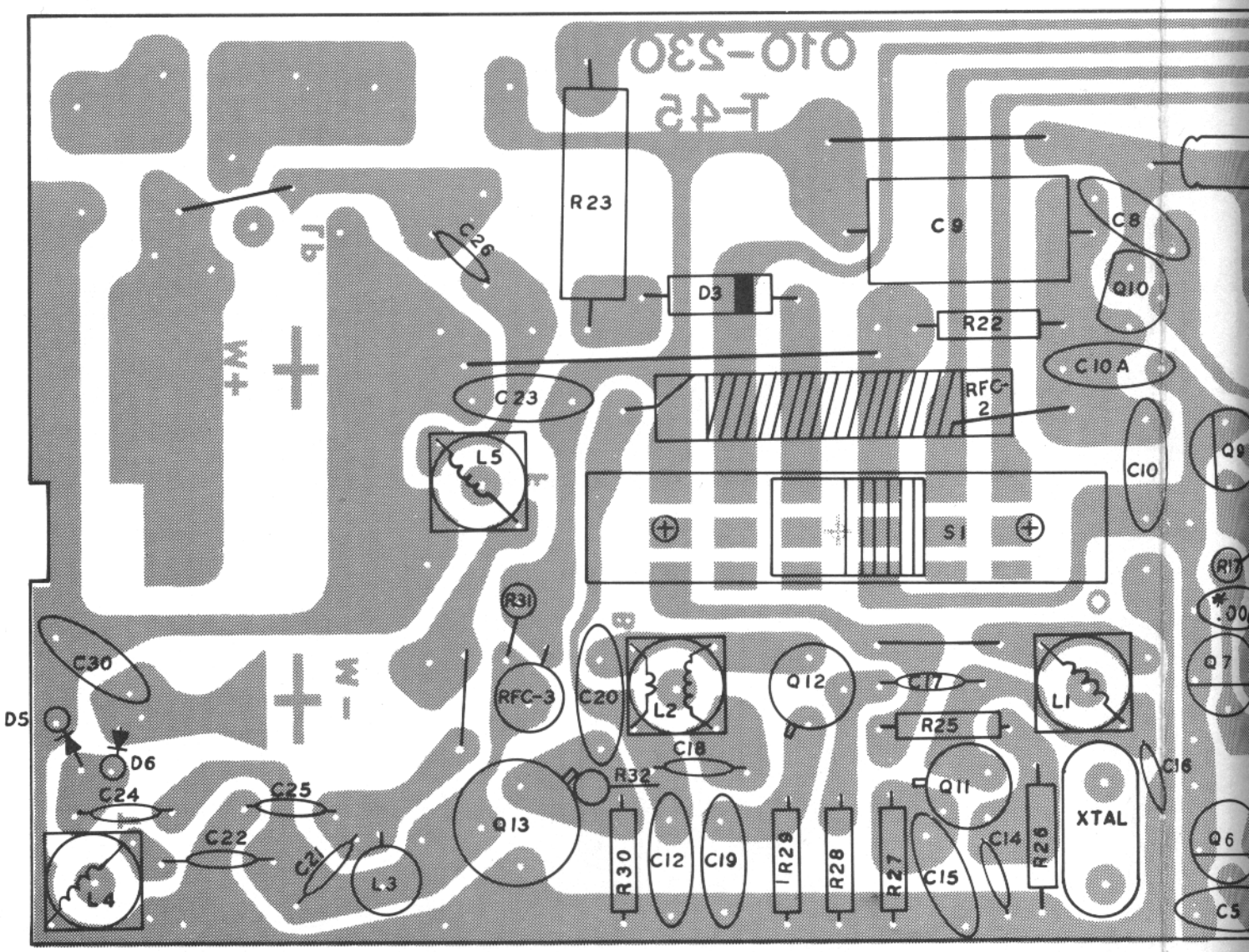
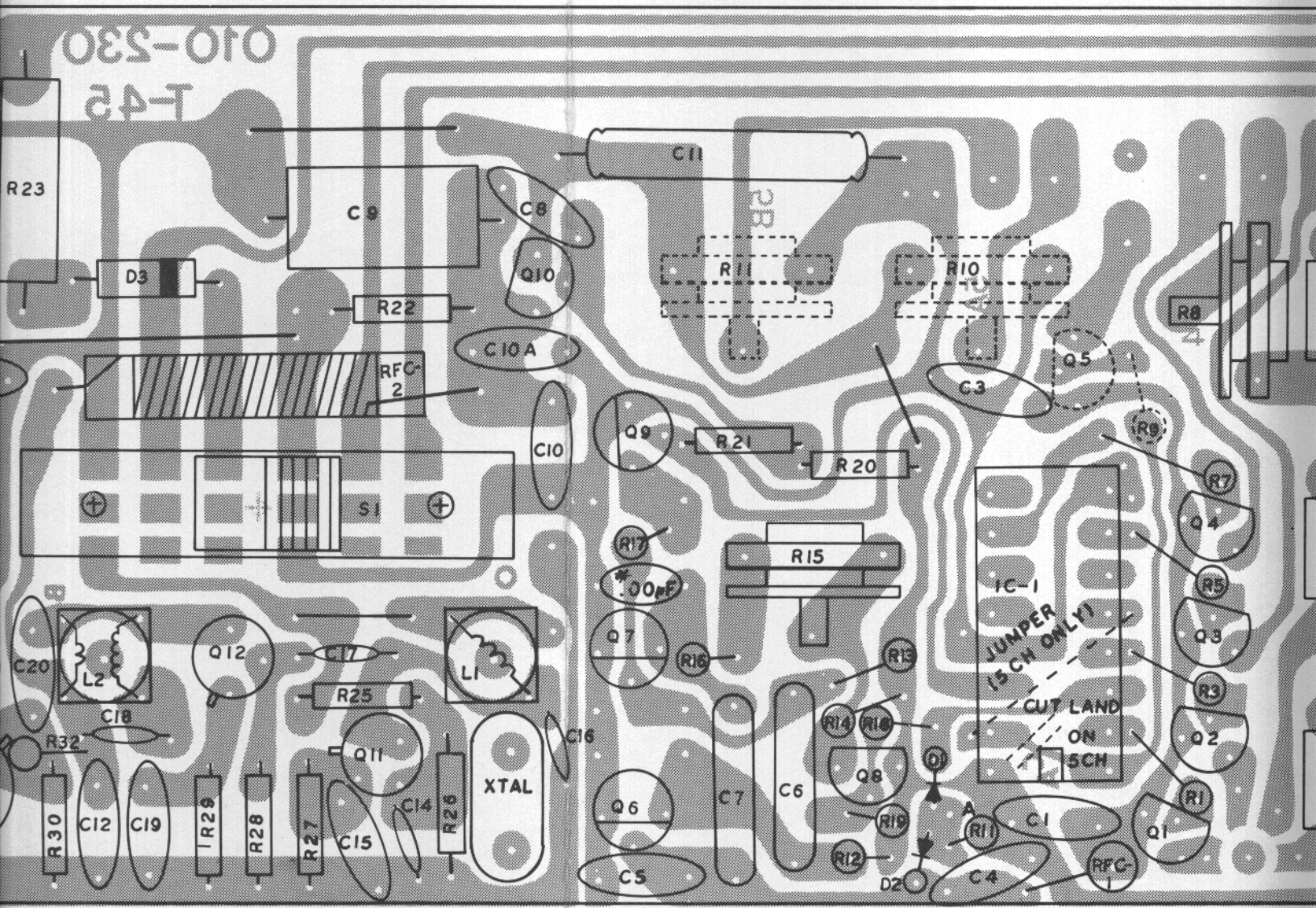
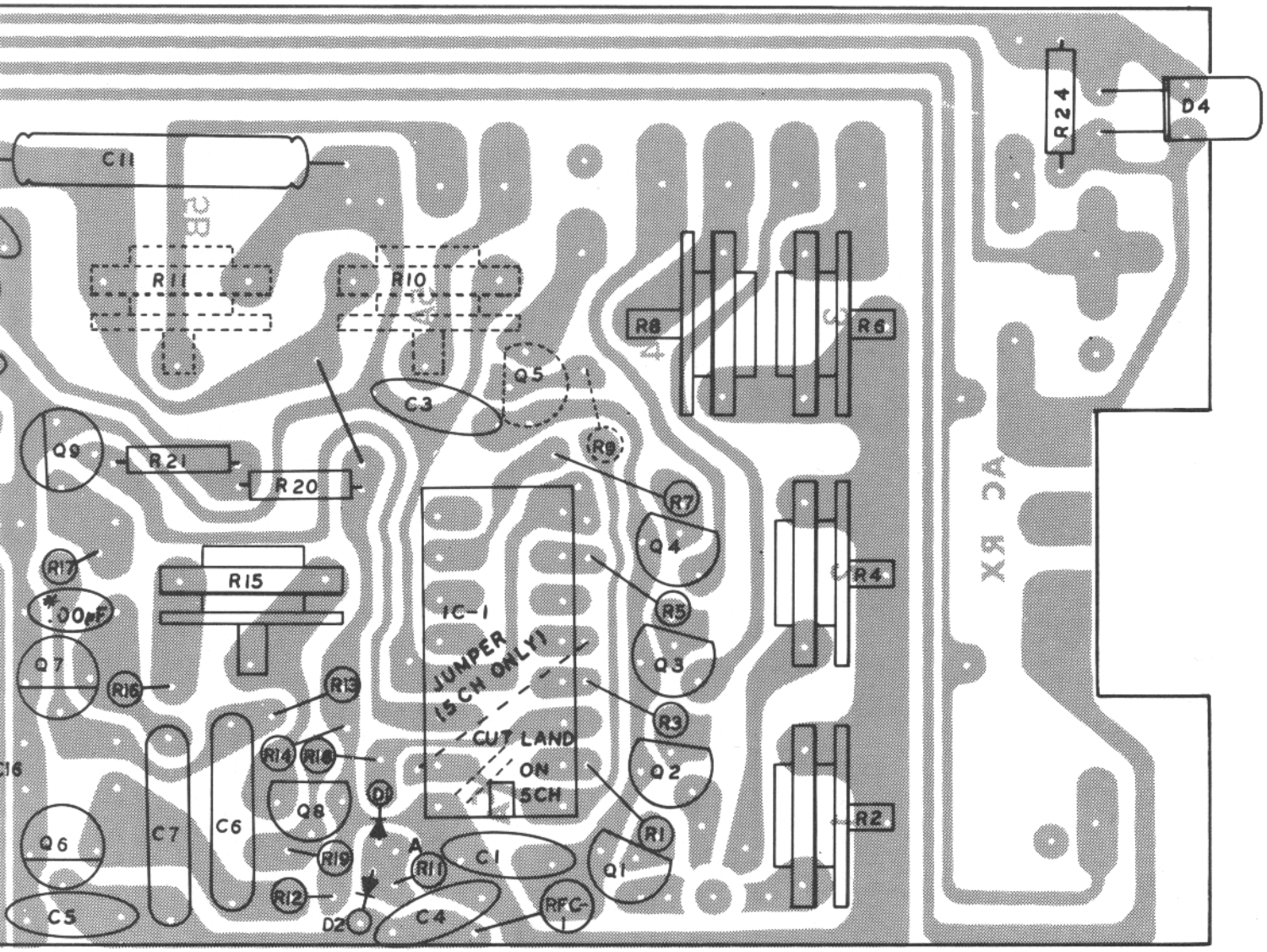


FIGURE 9

ECTION


010-230
T-45
R23
C9
C8
C11
D3
Q10
R11
R10
R22
C10A
RFC-2
C3
Q5
R8
C10
Q9
R21
R20
S1
R9
R7
Q4
R17
R15
.00pF
IC-1
JUMPER (5 CH ONLY)
CUT LAND ON 5CH
R5
Q3
C20
L2
Q12
C17
L1
R16
R13
Q7
R25
C18
R14
R18
R3
Q2
R32
Q11
C16
Q8
D1
XTAL
Q6
C7
C6
R19
A
C1
R1
Q1
R30
C12
C19
R29
R28
R27
C15
C14
R26
R11
R12
D2
C4
RFC-1
C5


C11
R24
D4
R11
R10
R8
R6
Q5
C3
Q9
R21
R20
R9
R7
Q4
R17
R15
R4
.00mF
IC-1
R5
Q7
R16
R13
JUMPER
(5 CH ONLY)
Q3
R3
CUT LAND
ON
5CH
R14
R18
Q2
Q8
D1
R2
Q6
C7
C6
R19
A
C1
R1
Q1
R12
R11
C5
D2
C4
RFC-1
RX
VC

MECHANICAL PARTS LIST
KPT-4A/6A

No. Required	Description	Part No.
* 1	Case, KPT-6A Front & Back	904-204
1	Case, KPT-4A Front & Back	904-181
1	Switch Guard	901-194
1	Spacer	901-354
1	Spacer, Switch	901-399
1	Lever, Switch	901-401
1	Antenna Assembly - less antenna	901-402
1	Gimbal Assembly - Throttle - open	900-062
1	Gimbal Assembly - Spring Return - open	900-063
1	Connector, Charge receptacle	120-069
1	Meter, 0-1 MA Edgewise	126-001
1	Battery, 6V, 550 MAH - 5 cell	130-011
1	Antenna	200-057
4	Rubber Foot	500-005
2	Nut 4-40 Large	500-137
2	Plastic Clamp 7/8" (for batteries)	500-174
1	Logo, Tx, Sport Series	600-067
1	Plate, FCC, Tx 4A Sport	600-175
* 1	Plate, FCC, Tx 6A Sport	600-175
* 1	Switch Landing Gear S.P.D.T.	109-012
* 1	Bracket, Pot (Aux)	904-205
	Label Frequency	as required

HARDWARE

(All supplied in minimum quantities of 20 each)

2	Screw, 2-56 x 3/8" P.H.M.S.	500-049
2	Screw, 4-40 x 3/8" P.H.M.S.	500-138
2	Screw, 3-48 x 1-1/8" R.H.P.M.S. (Black)	500-173
2	Screw, 2-56 x 1/4" P.H.M.S.	500-052
4	Screw, #2 x 3/16" P.H.P.S.M.S. (Black)	500-158

* Applies to KPT-6A only

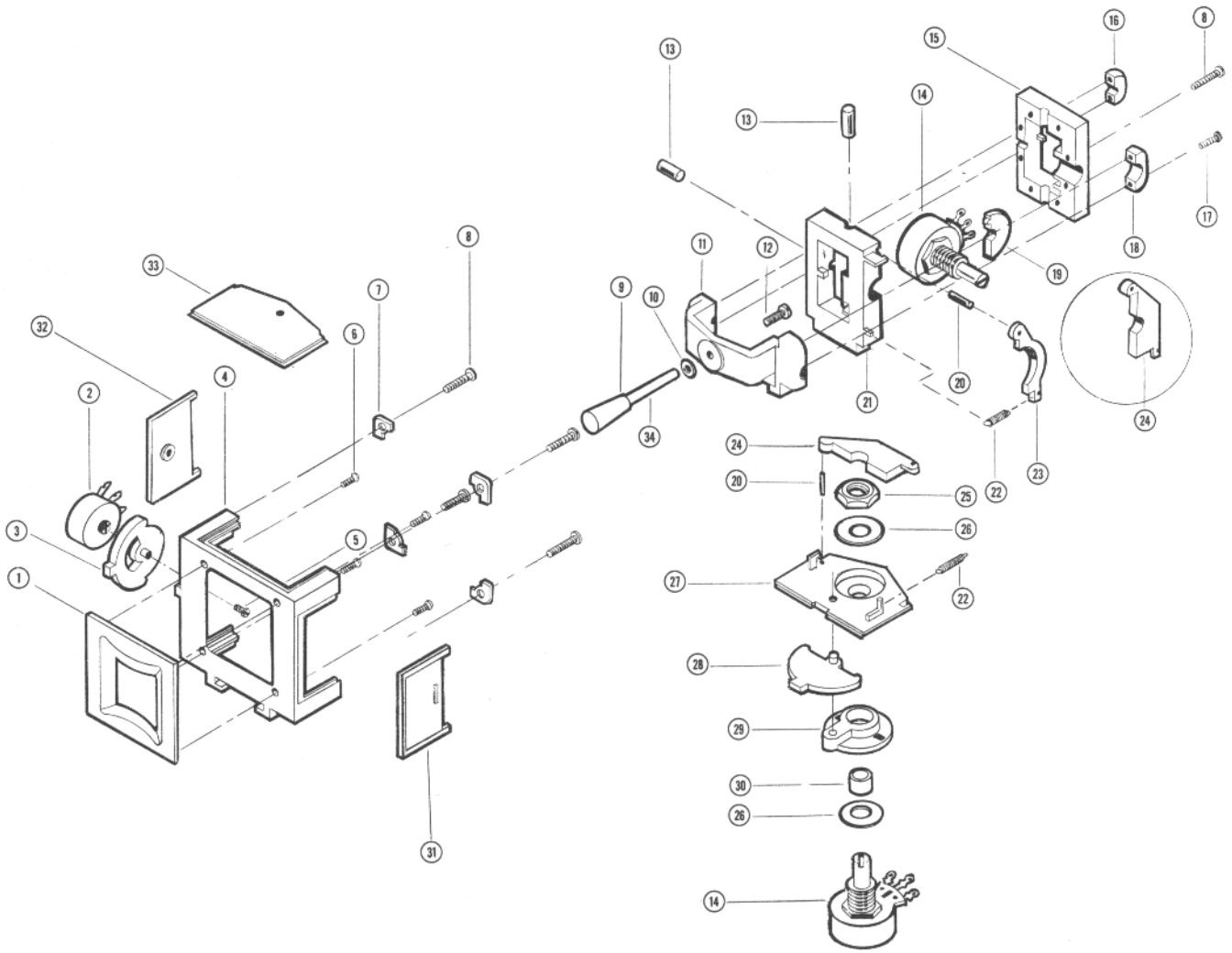
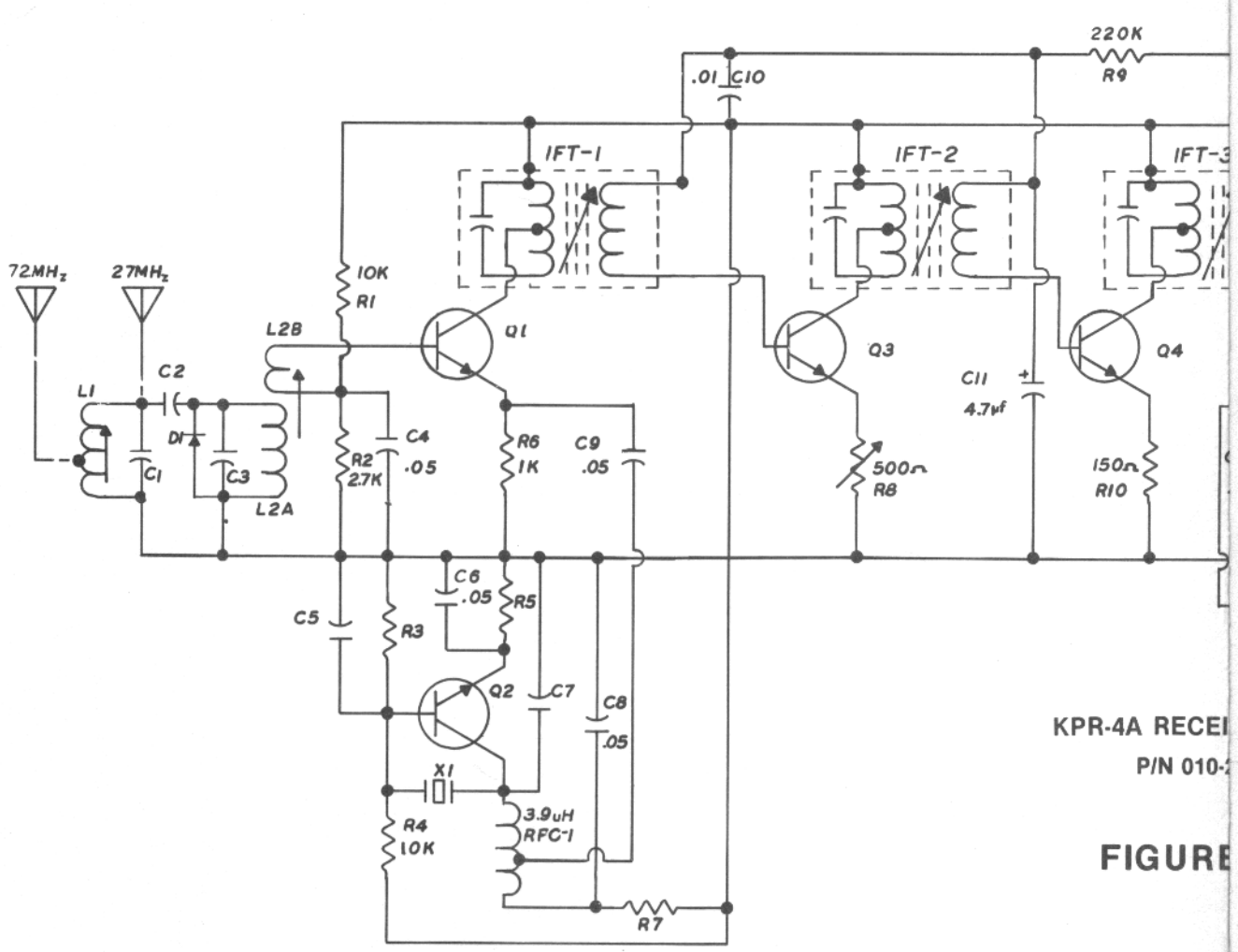


FIGURE 10

MECHANICAL ASSEMBLY
OPEN GIMBAL

Key No.	No. Required Per Assembly	Description	Part Number
2	1	Potentiometer, 1K	106-051
14	2	Potentiometer, 5K	106-052
9	1	Tip, Stick	200-050
25	1	Nut, Hex 3/8 - 32	500-016
6	4	Screw, 1-72 x 1/4" Rd. Hd. M.S.	500-024
17	5	Screw, 2-56 x 3/8" P.H.M.S.	500-049
26	2	Washer, 5/8 O.D. x 3/8 I.D. x .025	500-054
5	1	Screw, 1-72 x 3/16 M.S.	500-059
8	12	Screw, 2-56 x 1/2 P.H.M.S.	500-112
22	2	Spring	500-135
20	2	Dowel Pin, 1/16 x 3/8	500-146
13	2	Dowel Pin 1/8 x 3/8	500-147
12	1	Screw, 4-40 x 5/16 Hex Head M.S.	500-148
10	1	Washer, .21 O.D. x .12 I.D. x .032	500-160
30	1	Bushing, Brass	850-008
24	2	Arm, Centering, Spring Return	850-106
21	1	Frame, Top	850-107
15	1	Frame, Bottom	850-108
11	1	Bail	850-109
16	1	Cap, Bail 1/8 Side	850-110
18	1	Cap, Bail, Pot Side	850-111
19	1	Sector, Throttle Ratchet (Throttle Only)	850-104
23	1	Arm, Throttle Ratchet (Throttle Only)	850-105
27	1	Plate, Pot Side	850-113
29	1	Coupler, Pot to Trim Lever	850-114
28	1	Lever, Trim (Pot Coupler)	850-115
33	1	Plate, Side (Frame Bearing)	850-116
32	1	Plate, Side (Electrical Trim)	850-117
31	1	Plate, Side Plate	850-118
4	1	Housing	850-119
7	4	Clips, Corner Post	850-120
3	1	Lever, Trim (Pot Cplr-Elec Trim)	850-121
34	1	Stick, Gimbal	850-122
1	1	Window, Open Gimbal	901-343



KPR-4A RECEI

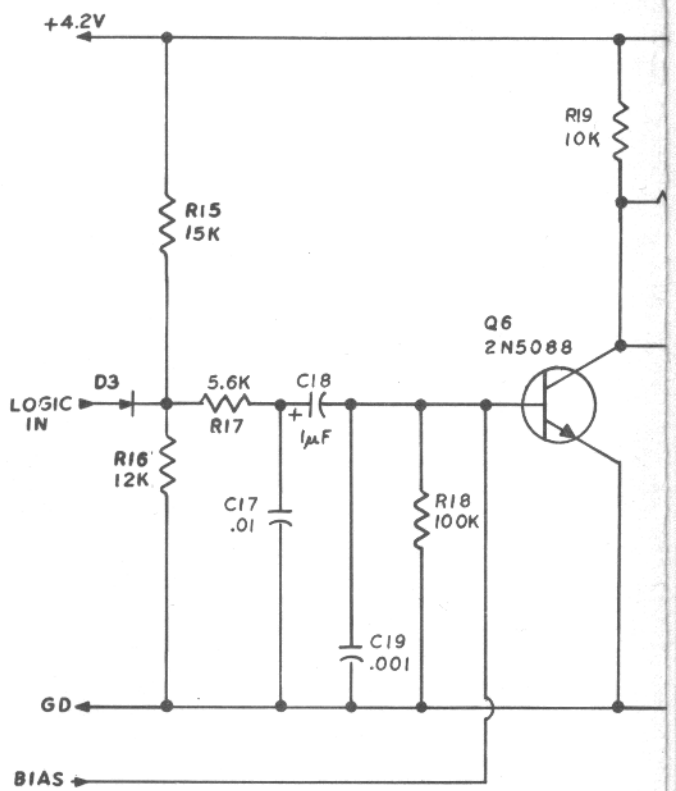
P/N 010-

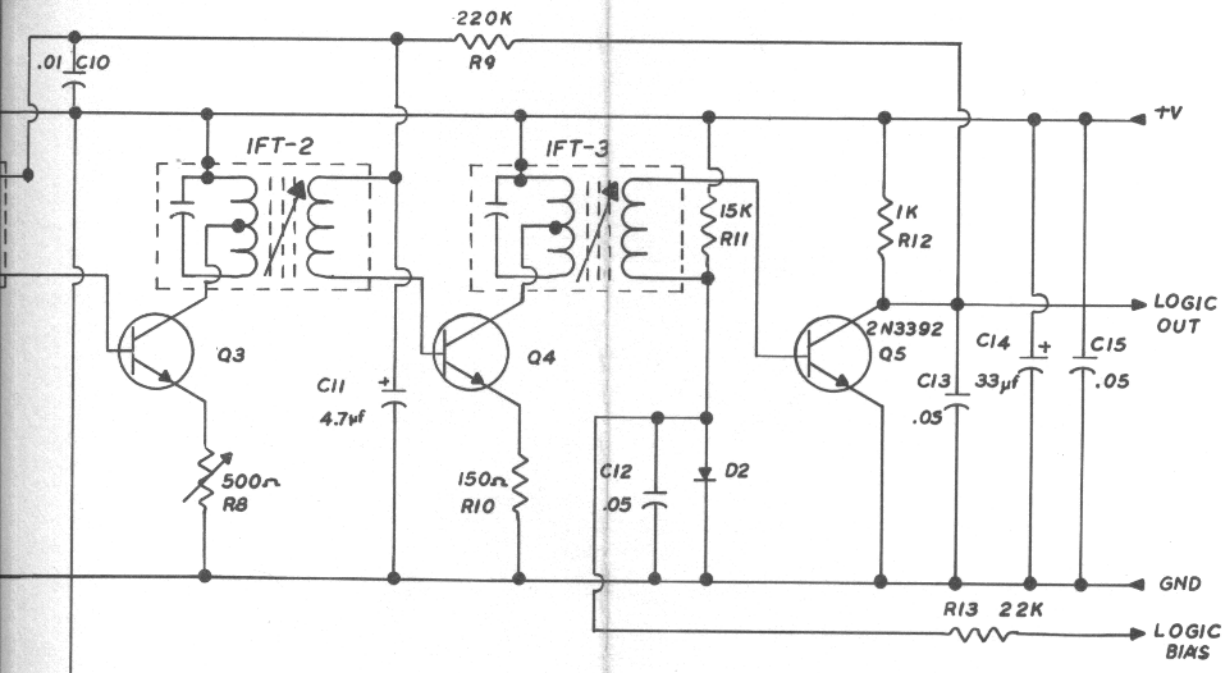
FIGURE

COMP.	27MHz	72MHz	35MHz	40MHz
C1	27 PF	27PF	18PF	39PF
C2	1 PF	.5PF	1PF	.5PF
C3	56 PF	18PF	39PF	39 PF
C7	27PF	18PF	18PF	10 PF
R3	4.7K	2.7K	4.7K	4.7 K
R5	470Ω	270Ω	470Ω	470Ω
L1	11½T	4½T TAP ¾ T FROM GND.	11½T	7½ T
L2A	9¼T	5¼T	9¼T	7¼T
L2B	2¼T	1¼T	2¼T	1¼T
C5	DELETE	10 PF	DELETE	DELETE
R7	1.5K	1K	1.5K	1.5 K

D1–D4 IN4148

Q1–Q4 MAY BE D16G6 OR 2N3663



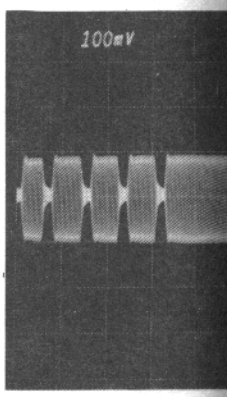


KPR-4A RECEIVER R-23

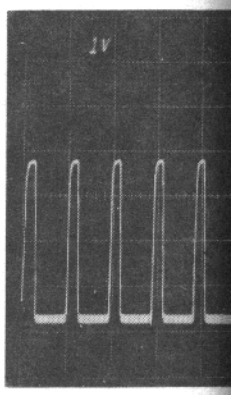
P/N 010-229

FIGURE 11

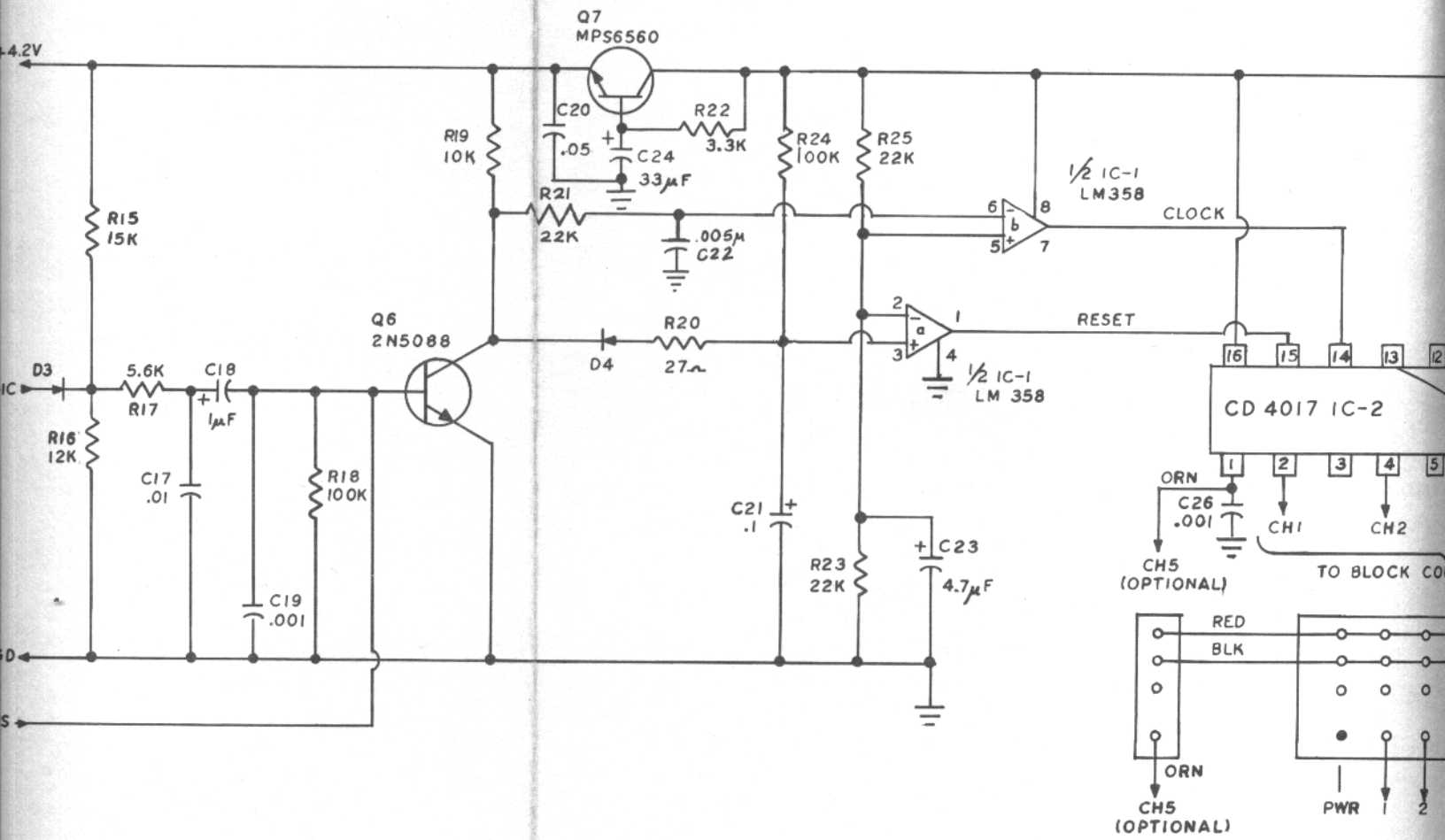
Q1 Collector

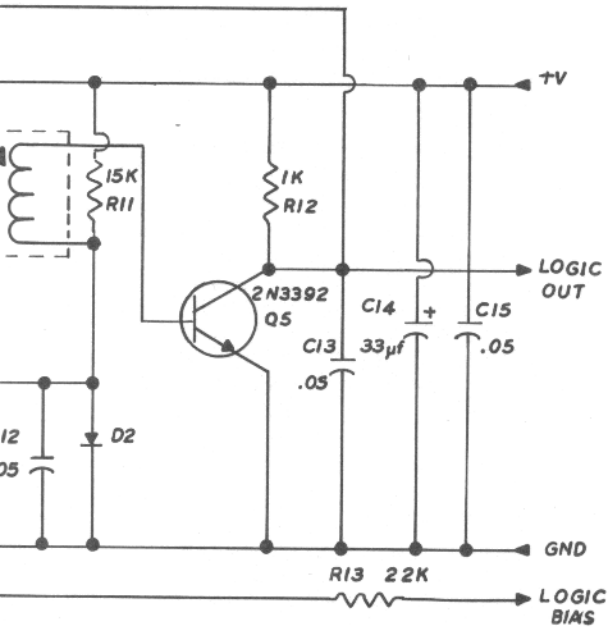


Receiver detector 4V P

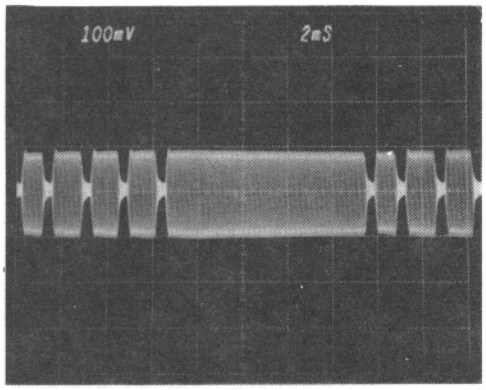


FIGU





Q1 Collector



Receiver detector 4V P-P

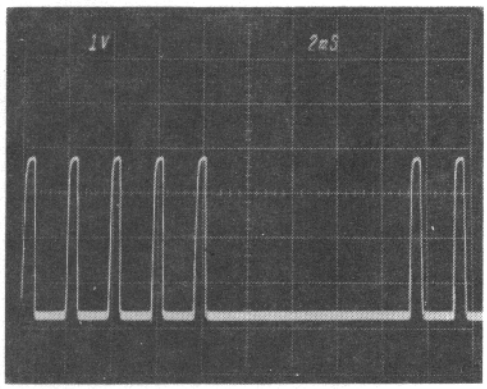
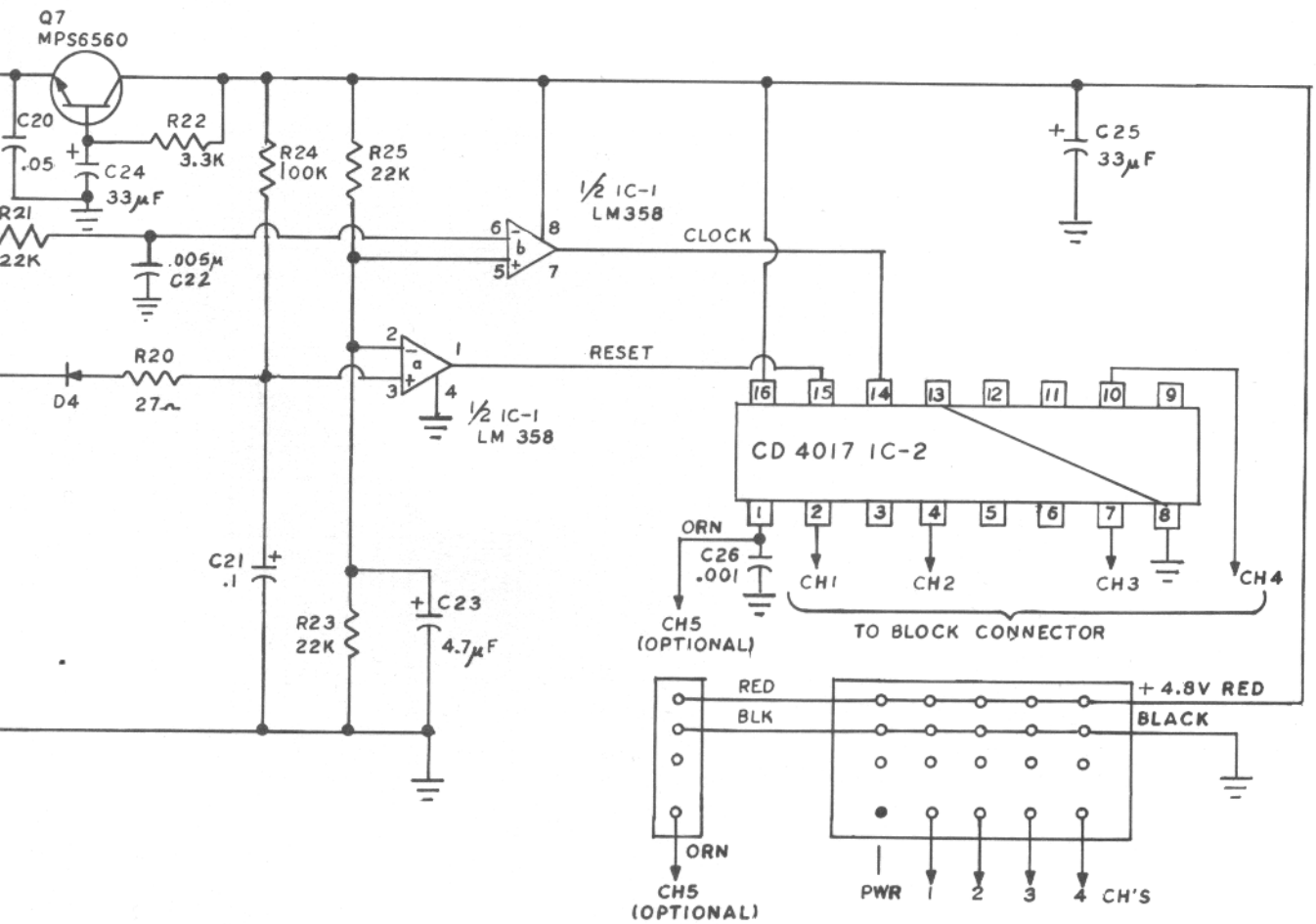
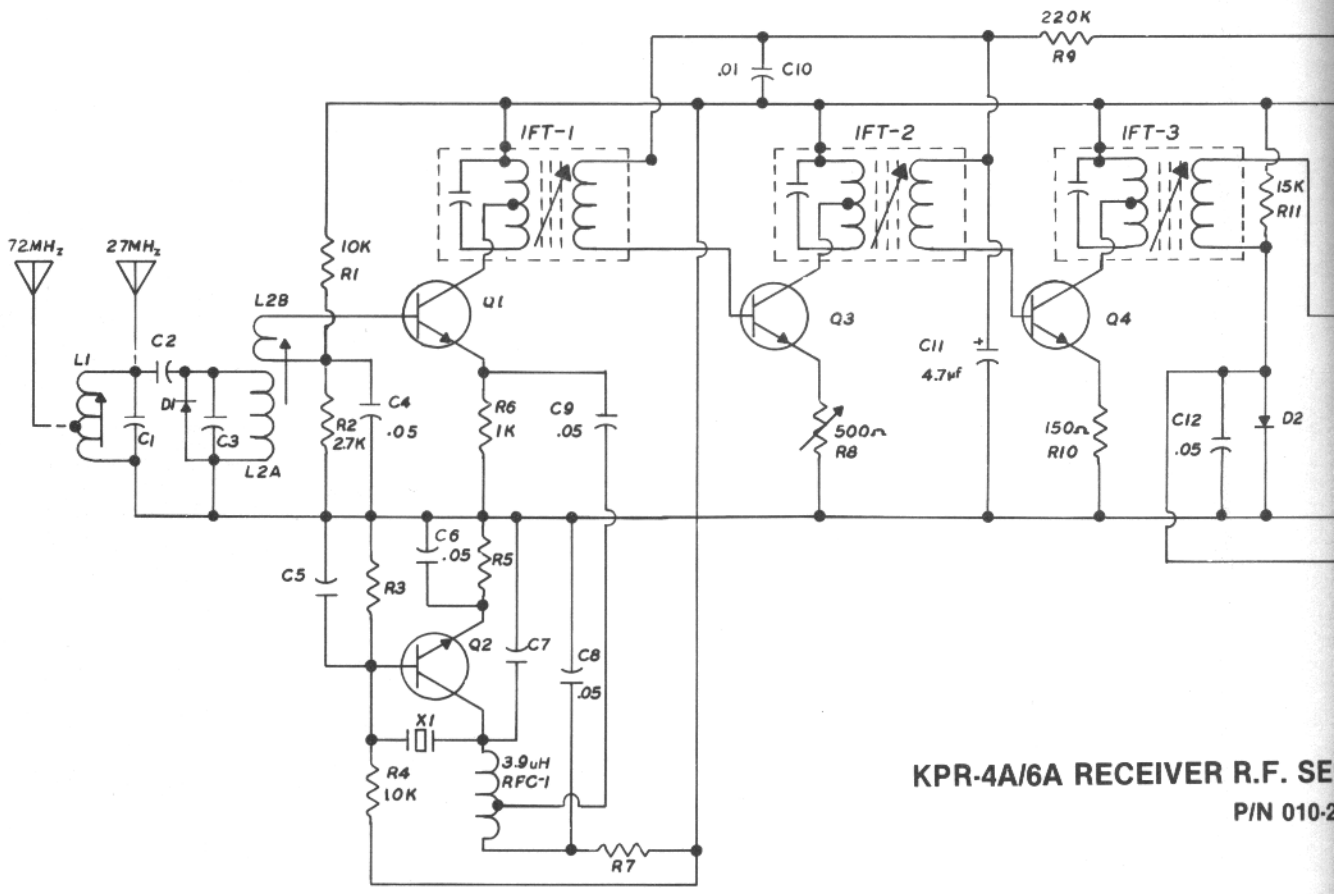


FIGURE 12





KPR-4A/6A RECEIVER R.F. SE

P/N 010-2

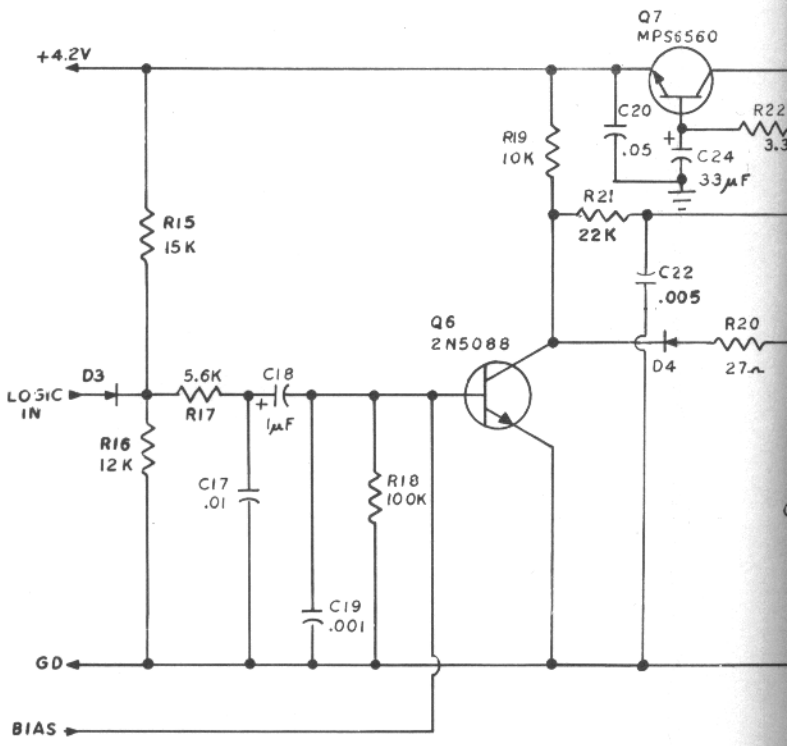
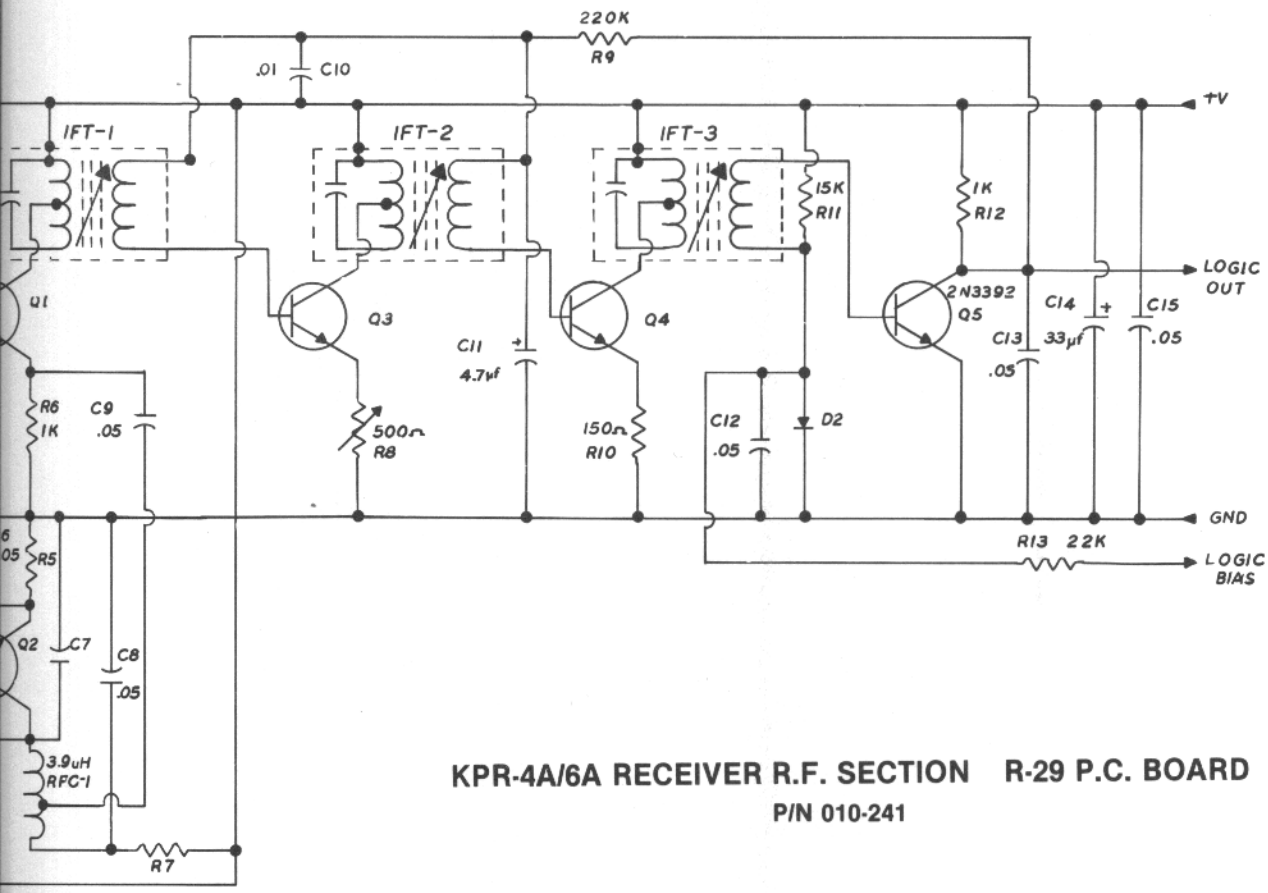


FIGURE 13



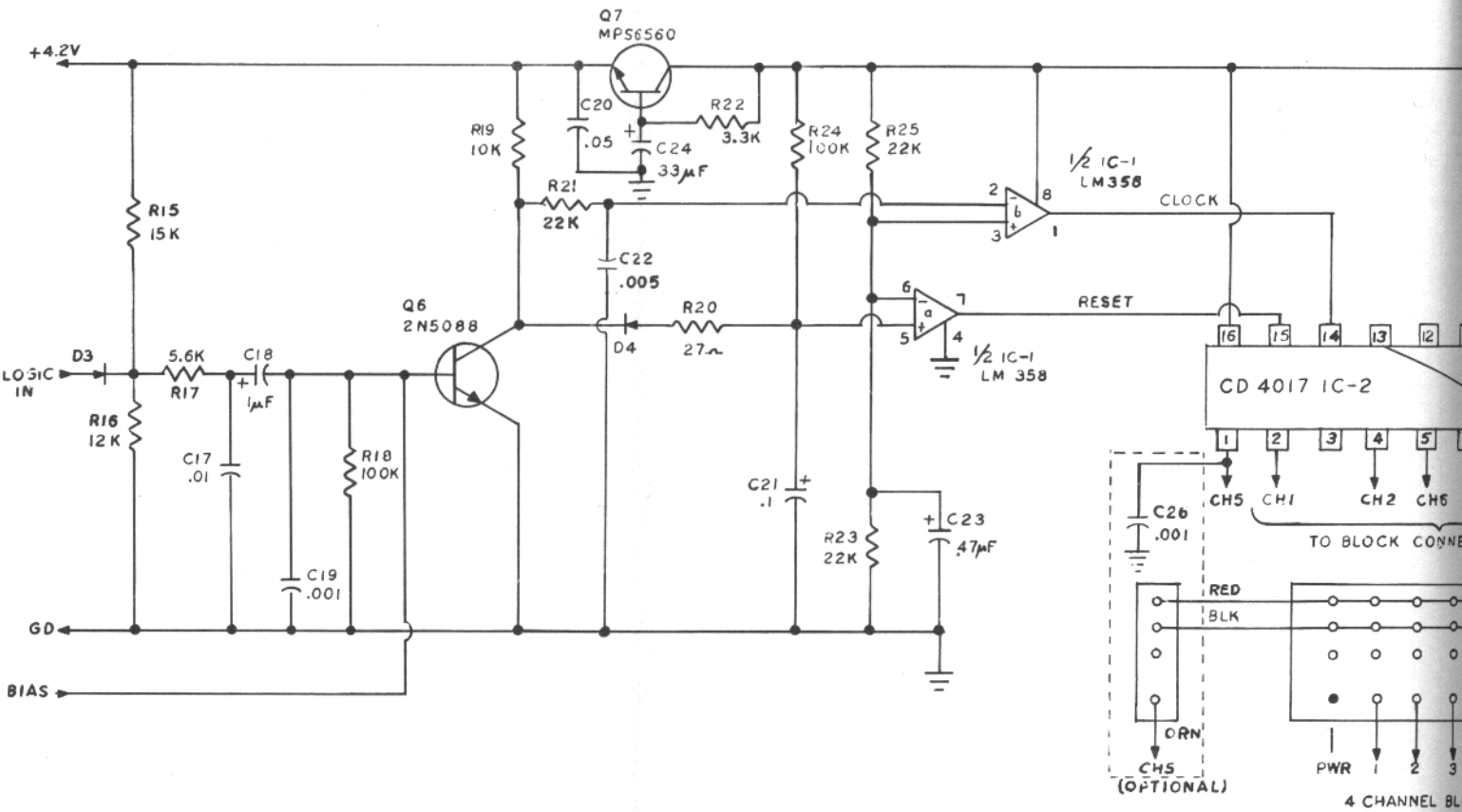
KPR-4A/6A RECEIVER R.F. SECTION R-29 P.C. BOARD

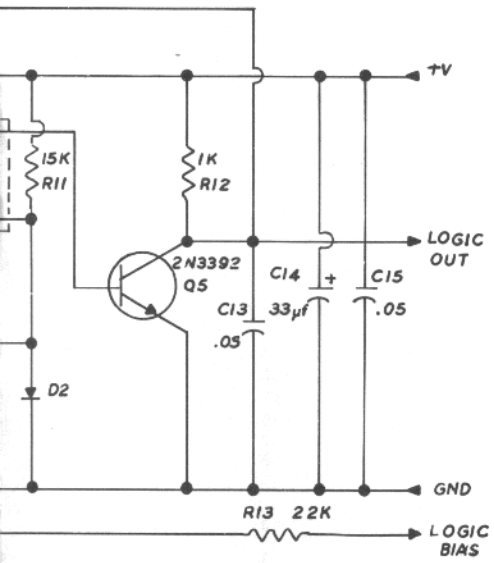
P/N 010-241

COMP.	27MHz	72
C1	27 PF	27
C2	1 PF	1P
C3	56 PF	18
C7	22PF	18
R3	4.7K	2
R5	470Ω	27
L1	11½T	4½
L2A	9¼T	5½
L2B	2¼ T	1¼
C5	DELETE	10
R7	1.5K	1K

D1–D4 IN4148

Q1–Q4 MAY BE DI





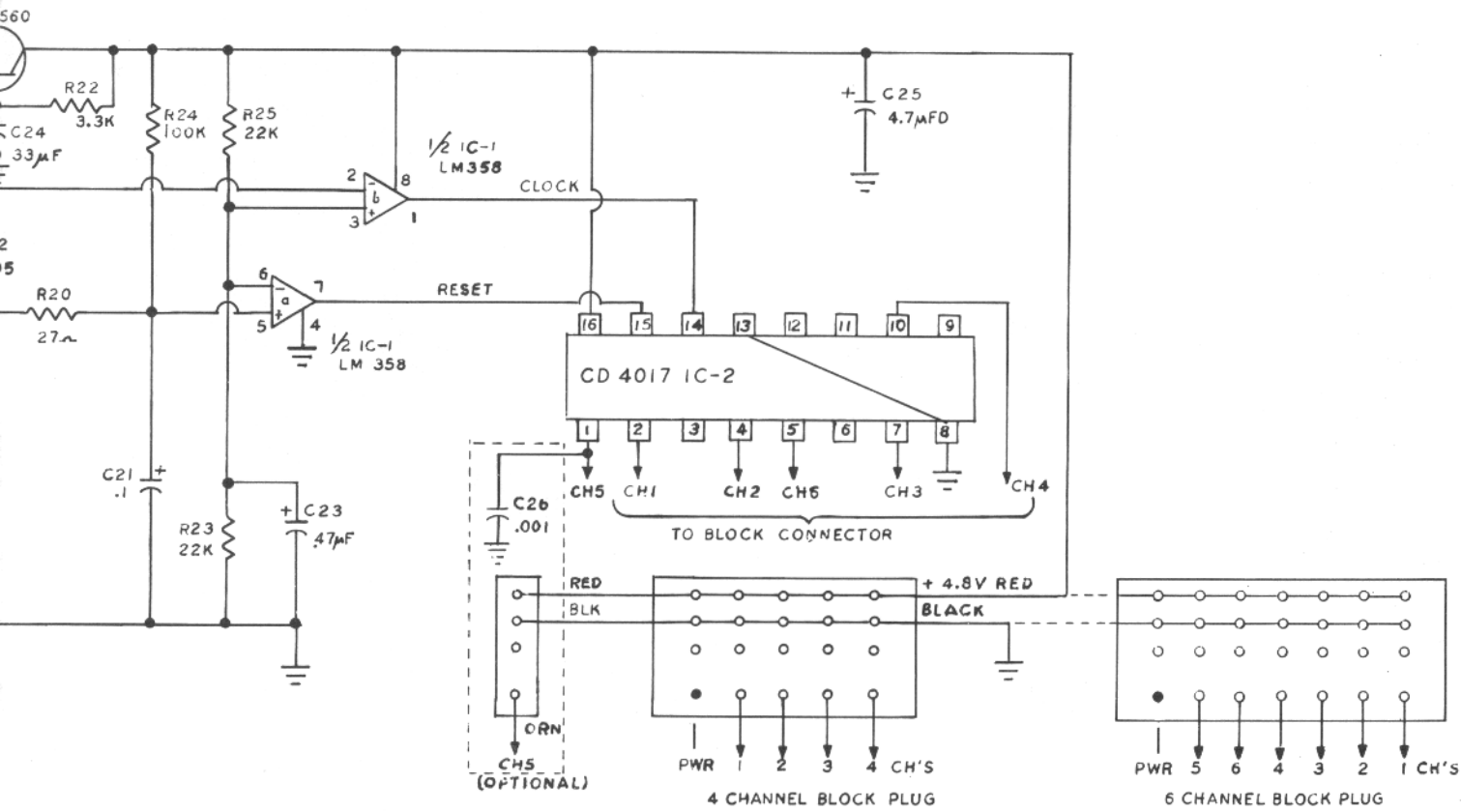
COMP.	27MHz	72MHz	35MHz	40MHz
C1	27 PF	27PF	18PF	39PF
C2	1 PF	1PF	1PF	1PF
C3	56 PF	18PF	39PF	39 PF
C7	22PF	18PF	18PF	10 PF
R3	4.7K	2.7K	47K	4.7 K
R5	470Ω	270Ω	470Ω	470Ω
L1	11½T	4½T TAP ¾ T FROM GND.	11½T	7½ T
L2A	9¼T	5¼ T	9¼T	7¼ T
L2B	2¼ T	1¼ T	2¼ T	1¼ T
C5	DELETE	10 PF	DELETE	DELETE
R7	1.5K	1K	1.5K	1.5 K

D1–D4 IN4148

Q1–Q4 MAY BE D16G6 OR 2N3663

R.F. SECTION R-29 P.C. BOARD

P/N 010-241



RECEIVER CIRCUIT DESCRIPTION

(See schematics, Figure 11 and Figure 13)

The receiver front end portion of this unit is a conventional super heterodyne single conversion type with a 455 KHz I.F. Transistor Q1 is the first mixer, converting the incoming signal frequency to a 455 KHz reproduction for amplification by Q3 and Q4. Q2 operates as a Pierce oscillator 455 KHz removed from the desired signal frequency.

The amplified 455 KHz signal is converted to audio pulses by Class B detector transistor Q5 which also provides gain control to the I.F. amplifiers via R9 and C11 to prevent overloading on strong signals.

After detection, the signal is fed to a clipper circuit formed by D3, R15, and R16, which passes only the upper 30% of the detected signal to the integrator (R17, C17) to further filter noise from the detected signal. The remaining signal is fed to amplifier transistor Q6, biased at cut-off via R13 to the detector bias network.

The amplified pulses are then fed to two operational amplifiers (IC-1). One section (pins 1, 2, & 3) generates a well-defined clock signal for shift register IC-2. The other section (pins 5, 6, & 7) is used to generate sync reset for IC-2 during the long on-time in each frame of information. This assures proper synchronization of the received—decoded pulse train with the transmitted information. Note: Pin numbers are reversed on R-23 receiver board.

Shift register IC-2 then converts the serial pulse train into each individual channel pulse at its output.

Active filter network Q7, R22, C24 smooths variations in supply voltage caused by servo drain. The circuit functions in a capacitor multiplier mode, making the effective filter capacitance the value of C24 times the gain of the transistor (typically 100) or 3,300uf.

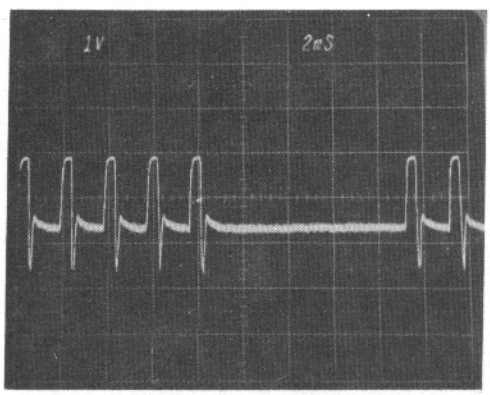
RECEIVER TUNING

In order to properly tune up this receiver, an oscilloscope and decoupled test leads are required. To fabricate the test leads, insert 22uh RF chokes in series with each lead as close to the probe tips as possible. The remaining lead to the oscilloscope should be shielded.

With the receiver removed from its case, apply power to the receiver from a suitable battery supply (4.8v nominal). Never tune up a receiver using line operated power supplies for other than test purposes. It will greatly affect RF tuning.

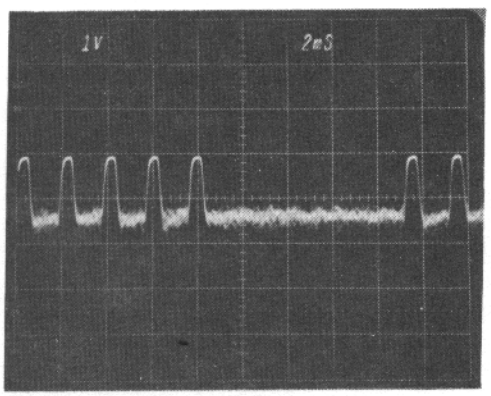
Clip the ground lead of the oscilloscope to a convenient ground point in the receiver. NOTE: The I.F. cans are NOT ground. These are connected to the decoupled positive supply. Clip the "hot" scope lead to the top of R12. This resistor has a longer top lead for this purpose.

Turn on a transmitter on the same frequency. You should see the display in Figure 15. Reduce the received signal strength by either moving the transmitter some distance away or placing it in a partly open metal enclosure. Reduce the signal sufficiently to produce 1-2 volts peak-to-peak on the oscilloscope. You should now see a display similar to either Figure 14 (mistuned), or Figure 15 (tuned). Tune IFT-1, IFT-2 and IFT-3 for maximum amplitude, reducing signal as necessary to maintain 1-2 volts p-p amplitude.



Receiver detector 1.5V P-P (Mistuned)

FIGURE 14

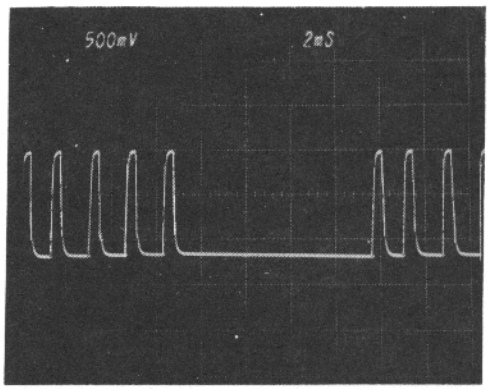


Receiver detector 1.5V P-P (Tuned)

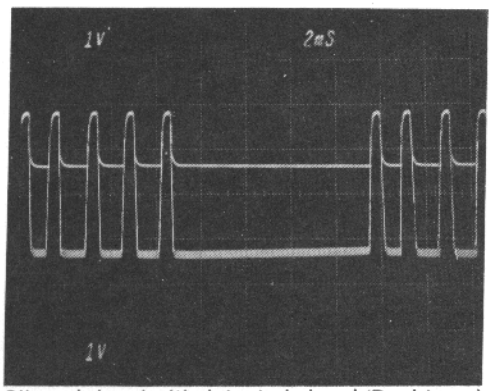
FIGURE 15

Extend the antenna wire fully as clear as possible from any other objects. Trailing the wire over the edge of the bench is quite suitable.

Now adjust L1 and L2 for maximum displayed amplitude. Reduce signal strength until the displayed amplitude is between 1/2 to 1 volt. Peak all the foregoing adjustments at this level for maximum displayed amplitude. Receiver adjustments are now complete. Do not adjust IF gain control R8, unless setting sensitivity as described later.



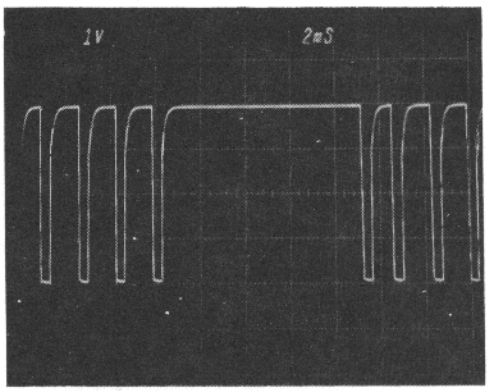
Clipped signal



Clipped signal with detected signal (Dual trace)

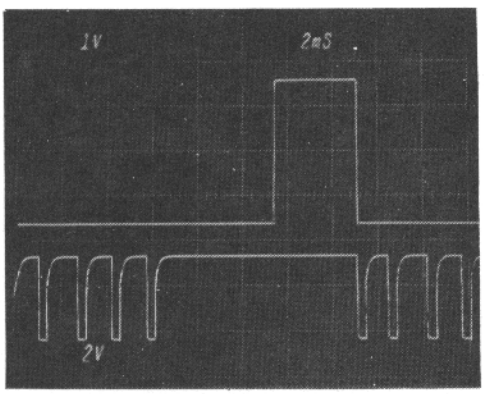
FIGURE 16

Increase signal strength as necessary to provide a full 4v p-p display. Check amplitude of signal at the output of the clipper stage (cathode of D3). The pulse train should be between 1 and 1.5v p-p amplitude (Figure16). Next check the pulses at the collector of Q6. They should appear as in Figure 17. Then check pulses at pin 14 of IC-2. These will be the inverse of the pulses at Q6 collector. This is the "clock" signal for the shift register and must be clean and free of extraneous noise spikes for proper operation.



Q6 Collector

FIGURE 17



Reset signal and Q6 collector (dual trace)

FIGURE 18

The reset signal is derived from one-half of the dual op-amp, IC-1. The signal from the collector of Q6 is used to drive a pulse omission detector formed by 1/2 of IC-1, C21 and R24. The op-amp is used in a non-inverting comparator mode with the trigger point set at 1/2 supply voltage via R23 and R25. The time constant of C21 and R24 will cause the voltage at pin 5 of IC-1 to reach the comparator threshold after 4-6 milliseconds without a channel pulse. The resulting output pulse from IC-1 is then used to reset the shift register, IC-2. Figure 18 shows the relationship of the reset pulse at pin 15 of IC-2 to the total information frame shown at Q6 collector. Note: Pin numbers of IC-1 are reversed for R-23 P.C. Board.

In order to verify proper operation without a dual-trace scope, measure total sync period time and subtract the width of the channel O pulse at pin 3 of IC-2. This output gives the time spent in reset after the pulse omission detector has initiated reset. This result should be at least 3 milliseconds. This assures proper operation over any expected range of voltage and temperature.

Next, check all channel outputs for decoded channel pulses. These must correspond to the proper channels in the transmitter, and be at least 4v peak-to-peak (no load).

If all the foregoing tests were acceptable, the receiver should be temperature tested over a range of at least 0-140°F (-18 to +60°C). Check to be sure the oscillator starts at either extreme by cycling the power switch. Also check for channel outputs at each extreme.

If a variable voltage supply is available, check for proper operation over a range of 4 to 6 volts. Receiver sensitivity will vary some with supply voltage; all you are looking for is correct functioning of the receiver. As in the temperature tests, cycle the power switch at each extreme to ensure the oscillator starts reliably.

CHECKING AND SETTING RECEIVER SENSITIVITY

In order to properly adjust receiver sensitivity, it is necessary to have an accurately calibrated signal generator with internal modulation such as the Hewlett Packard 608C or later, or 8654A/B Series VHF signal generators.

In addition, a special injection loop is necessary to duplicate factory procedures and correlate your measurements with those of the factory. (See Figure 19).

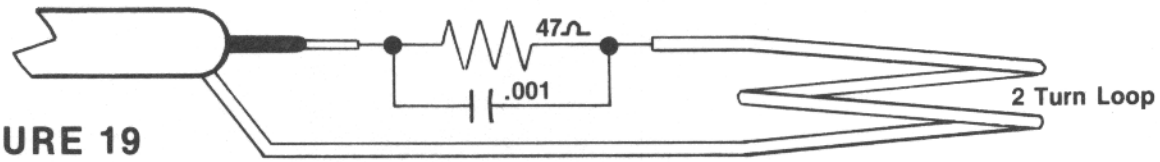
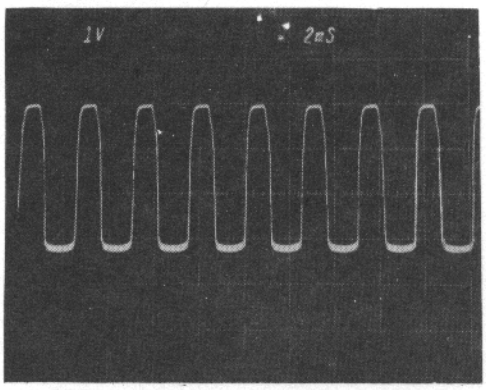


FIGURE 19

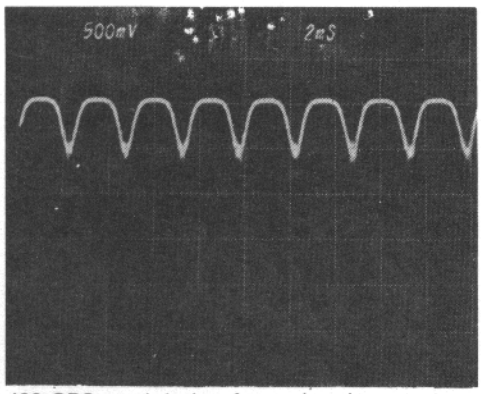
With the receiver already tuned to a suitable transmitter, coil up the antenna lead tightly. Place the injection loop over the antenna coil. Hook the choke decoupled scope leads to the detector collector (Q6). The receiver must be operated on a suitable battery pack—do not use a line operated supply for this test.

Adjust the signal generator to the desired RF frequency with 400 cycle modulation set at 95-100%. You should see the signal shown in Figure 20 at RF levels over 100 microvolts. Reduce generator level to 10 microvolts and fine tune the generator for maximum signal on the oscilloscope. Now peak the antenna and mixer coils only for maximum signal. Reduce generator output until only 1/2 volt p-p signal is displayed (Figure 21). Read sensitivity on generator level controls. This should be between 2 and 3 microvolts, if the receiver is properly adjusted and the generator is accurately calibrated.



400 CPS modulation from signal generator 100uV

FIGURE 20



400 CPS modulation from signal generator 2.5uV

FIGURE 21

If the receiver falls outside these limits, and you are certain the equipment you are using is calibrated, adjust sensitivity control, R8, for 1/2v p-p at 2.5 microvolts generator output.

Be sure to retune the antenna and mixer coils with the antenna wire extended as described in the section on receiver tuning.

RECEIVER TROUBLE SHOOTING

In general, trouble shooting will be confined to locating inoperative devices or replacing broken or damaged components. If the receiver has been subjected to crash damage, particular attention should be paid to checking for any physical damage not immediately apparent, such as cracked resistor, loose IF cans, etc. Pay special attention to the crystal, particularly by temperature cycling as described above in receiver adjustment.

Lack of range (low sensitivity) will generally be due to mis-tuning; however, the mixer or IF amplifiers can be the cause. In general, the IF transistors will be the culprit if the receiver is, indeed, low on sensitivity.

A defective crystal or crystal oscillator will be obvious without actually checking the RF output of the oscillator. Using a strong signal from a suitable transmitter, the scope display shown in Figure 22 will appear at the detector if the oscillator is inoperative. This is also the display which will be seen if the transmitter is not on the same frequency as the receiver.

As with the any printed circuit board of this density, all soldering should be done with a low-voltage ($\leq$35 watt) soldering iron. Be sure to inspect the printed circuit traces for solder bridges after soldering and before applying power! The reliability of the entire system can be compromised by poor workmanship especially on the airborne portion of the system.

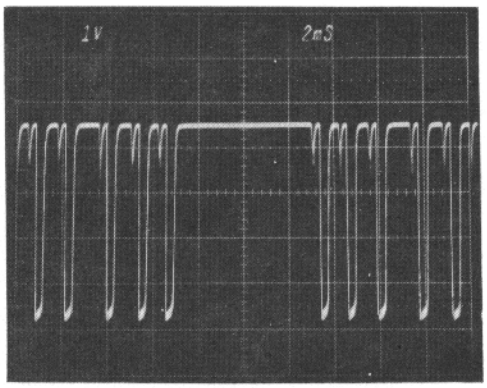
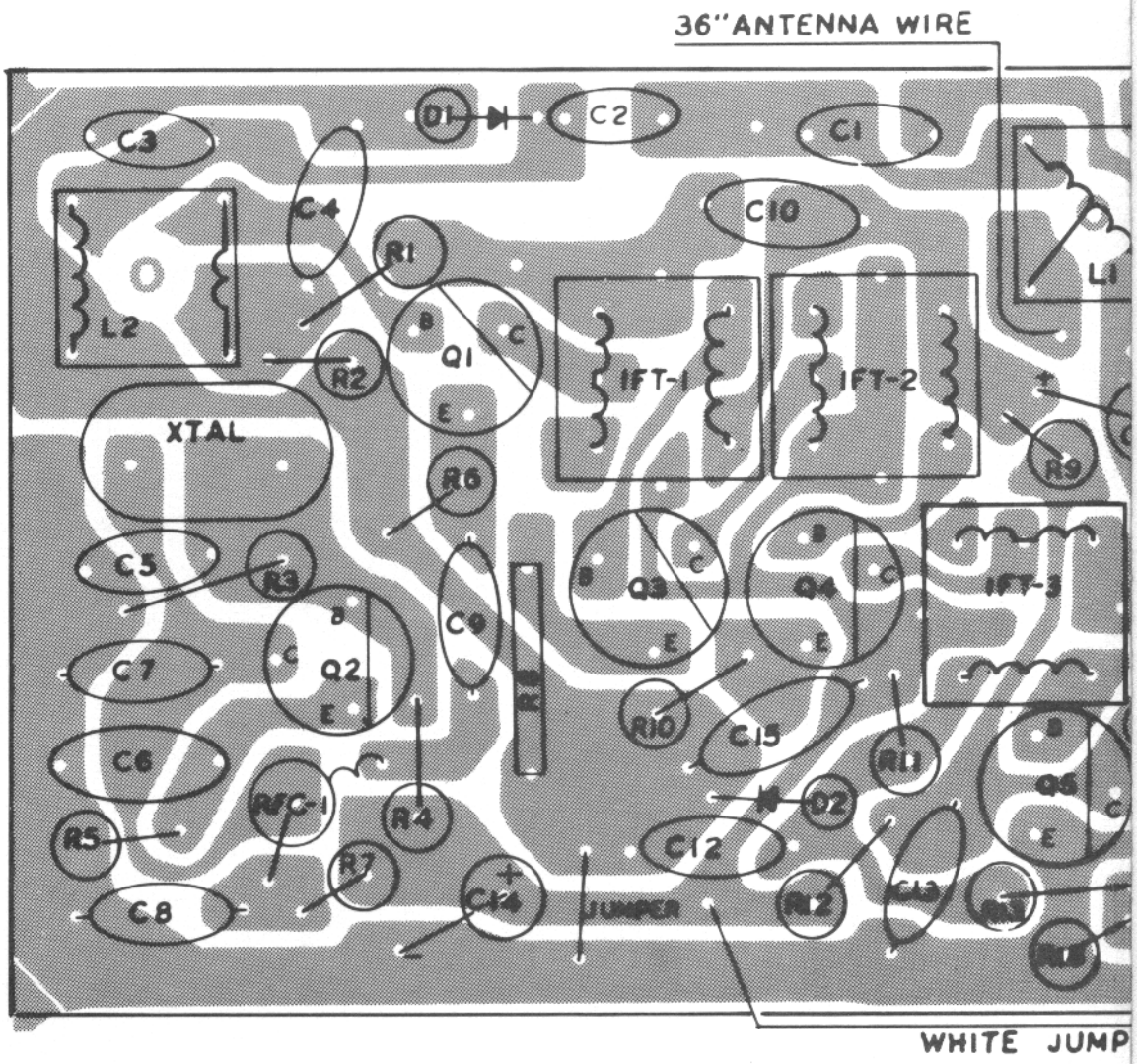


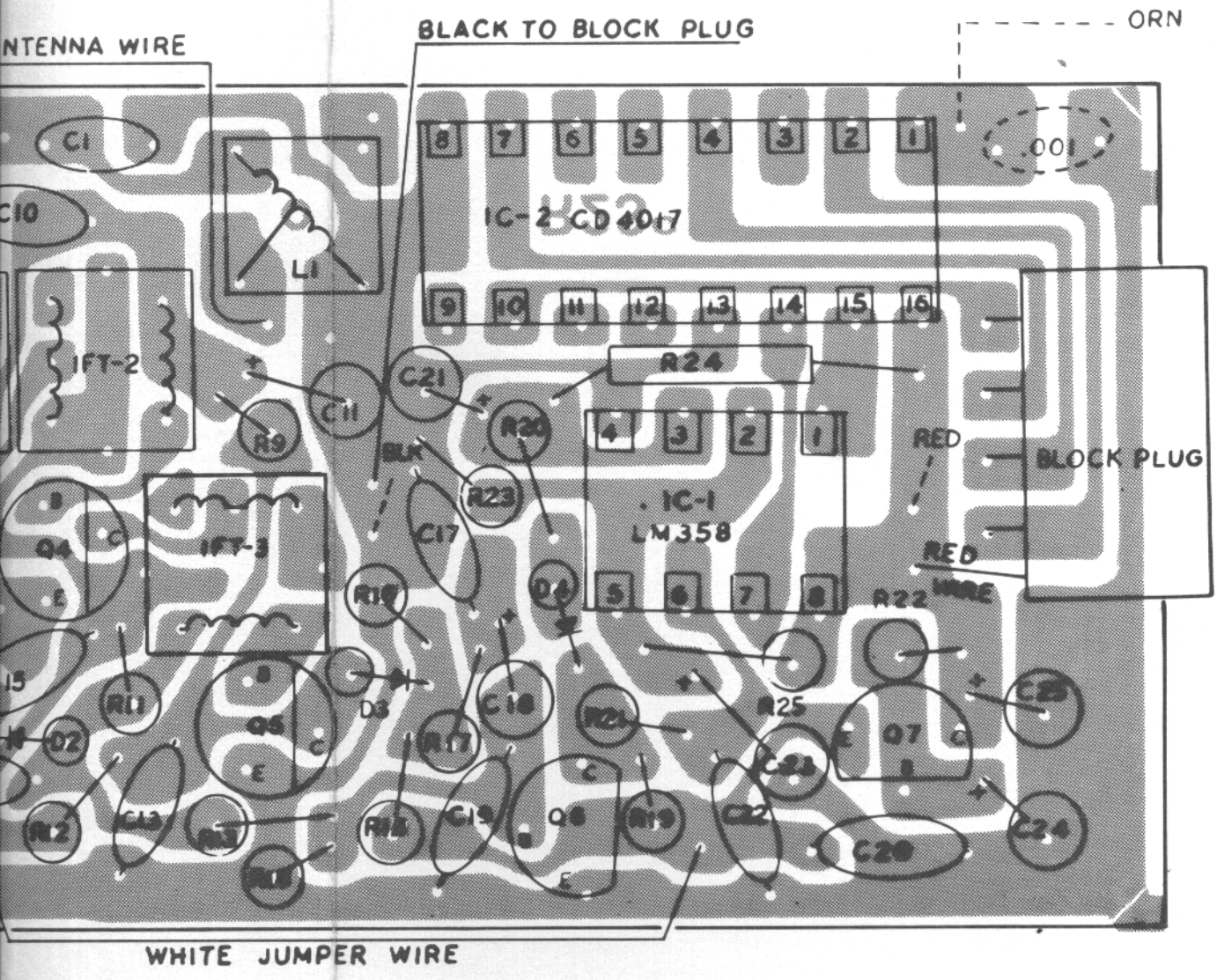
FIGURE 22

KPR-4A R-23 RECEIVER



- - - - INDICATES ADDITION OF FIFTH CHANNEL

FIGURE 23


NTENNA WIRE
BLACK TO BLOCK PLUG
ORN
C1
C10
L1
IFT-2
IFT-3
IC-2 CD 4017
IC-1 LM358
R24
R23
R22
R25
C21
C11
C17
C18
C19
C20
C22
C23
C24
R9
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
D2
D3
Q4
Q5
Q6
Q7
BLK
RED
RED WIRE
BLOCK PLUG
WHITE JUMPER WIRE

KPR-6A

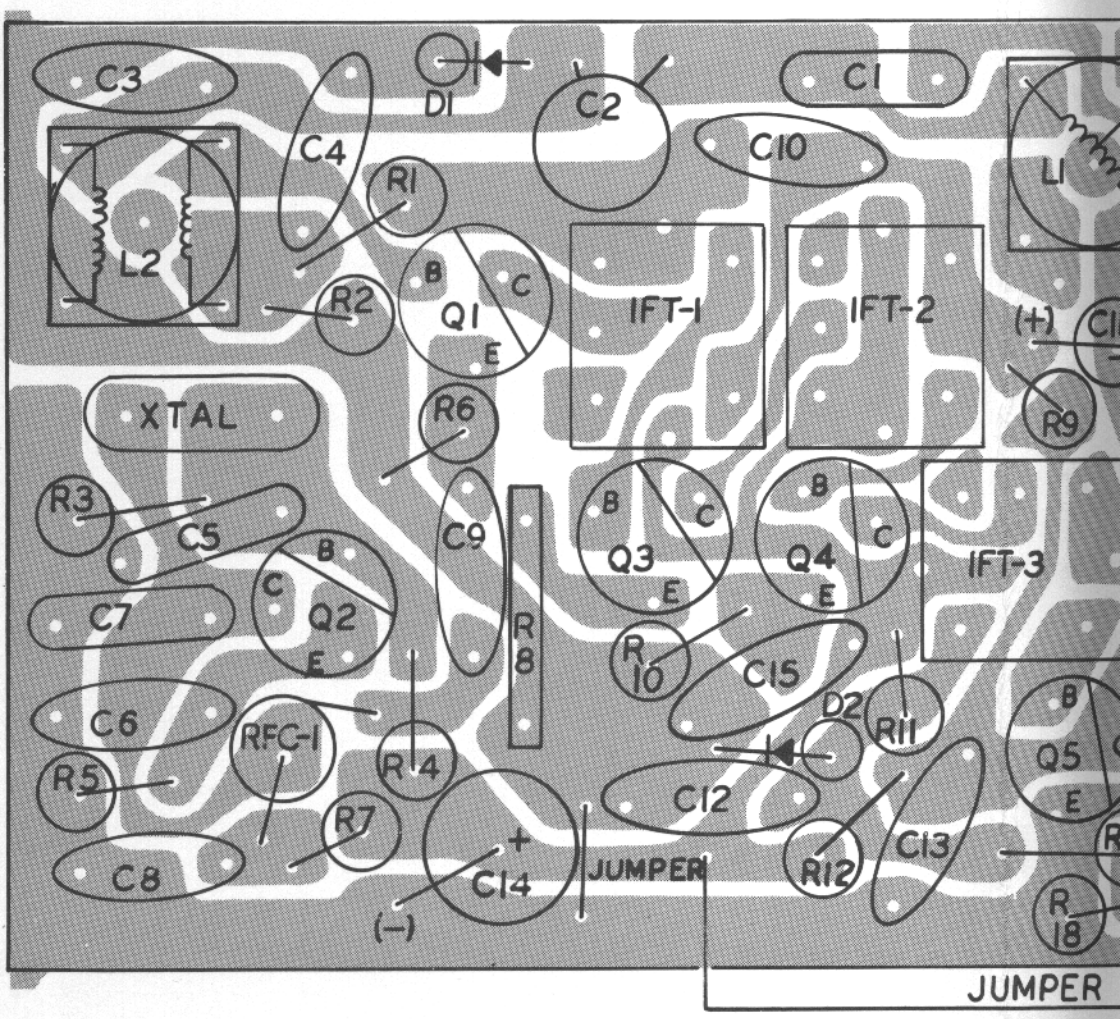
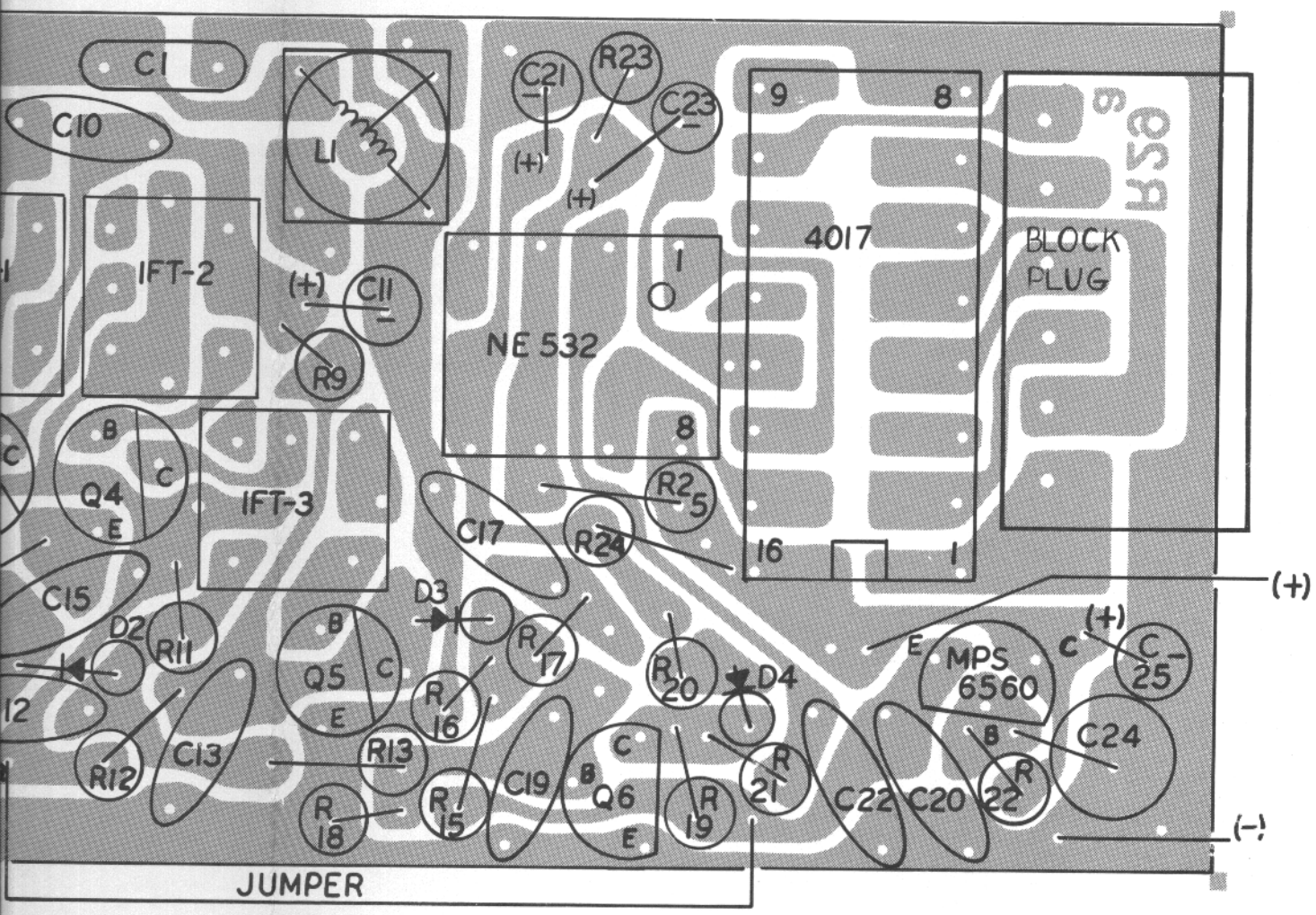


FIGURE 24

KPR-6A


C1
C10
L1
C21
R23
C23
(+)
(+)
9
8
4017
BLOCK
PLUG
IFT-2
(+)
C11
R9
NE 532
1
8
B
C
Q4
E
IFT-3
R25
C17
R24
16
1
(+)
C15
D2
R11
D3
R17
B
Q5
C
E
R16
R20
D4
E
MPS
6560
C
(+)
C
25
12
R12
C13
R13
C19
C
B
Q6
E
R21
C22
C20
B
22
R
C24
R18
R15
R19
(-)
JUMPER

ELECTRICAL PARTS LIST

KPR-4A/6A— R23 & R29 RECEIVER

RESISTORS

All Values in ohms (K = 1000)

R1		10K	1/4W	10%	057-103
R2		2.7K	1/4W	10%	057-272
R3	27 MHz				
	35 MHz				
	40 MHz	4.7K	1/4W	10%	057-472
R3	72 MHz	2.7K	1/4W	10%	057-272
R4		10K	1/4W	10%	057-103
R5	27 MHz				
	35 MHz				
	40 MHz	470 ohm	1/4W	10%	057-471
R5	72 MHz	270 ohm	1/4W	10%	057-271
R6		1K	1/4W	10%	057-102
R7	27 MHz				
	35 MHz				
	40 MHz	1.5K	1/4W	10%	057-152
R7	72 MHz	1K	1/4W	10%	057-102
R8		500 ohm	Trimpot	Centralab	106-029
R9		220K	1/4W	10%	057-224
R10		150 ohm	1/4W	10%	057-151
R11		15K	1/4W	10%	057-153
R12		1K	1/4W	10%	057-102
R13		22K	1/4W	10%	057-223
R15		15K	1/4W	10%	057-153
R16		12K	1/4W	10%	057-123
R17		5.6K	1/4W	10%	057-562
R18		100K	1/4W	10%	057-104
R19		10K	1/4W	10%	057-103
R20		27 ohm	1/4W	10%	057-270
R21		22K	1/4W	10%	057-223
R22		3.3K	1/4W	10%	057-332
R23		22K	1/4W	10%	057-223
R24		100K	1/4W	10%	057-104
R25		22K	1/4W	10%	057-223

CAPACITORS

C1	27 MHz				
	72 MHz	27pf	100V	Silver Mica	117-006
C1	35 MHz	18pf	100V	Silver Mica	117-013
C1	40 MHz	39pf	100V	Silver Mica	117-014

C2	27 MHz				
	35 MHz	1pf	500V	Tubular	114-002
C2	72 MHz				
	40 MHz	.5pf	500V	Tubular	114-001
C3	27 MHz	56pf	100V	Silver Mica	117-009
C3	72 MHz	18pf	100V	Silver Mica	117-013
C3	35 MHz				
	40 MHz	39pf	100V	Silver Mica	117-014
C4		.05uf	10V	Disc	113-018
C5	27 MHz				
	35 MHz				
	40 MHz	Delete			
C5	72 MHz	10pf	100V	Silver Mica	117-003
C6		.05uf	10V	Disc	113-018
C7	27 MHz	27pf	100V	Silver Mica	117-006
C7	35 MHz				
	72 MHz	18pf	100V	Silver Mica	117-013
C7	40 MHz	10pf	100V	Silver Mica	117-003
C8		.05uf	10V	Disc	113-018
C9		.05uf	10V	Disc	113-018
C10		.01uf	50V	Disc	113-016
C11		4.7uf	6V	Tantalum	116-004
C12		.05uf	10V	Disc	113-018
C13		.05uf	10V	Disc	113-018
C14		33uf	6V	Tantalum	116-005
C15		.05uf	10V	Disc	113-018
C17		.01uf	50V	Disc	113-016
C18		1uf	35V	Tubular	116-002
C19		.001uf	500V	Disc	113-012
C20		.05uf	10V	Disc	113-018
C21		.1uf	35V	Tubular	116-016
C22		.005uf	100V	Disc	113-015
C23		4.7uf (.47uf, R-29)	6V	Tantalum	116-004
C24	33uf	6V	Tantalum	116-005	
C25		33uf (4.7uf, R-29)	6V	Tantalum	116-005
*C26		.001uf	500V	Disc	113-012

*Used on 5 channel R-23 version only.

SEMI-CONDUCTORS

D1, D2, D3, D4	1N4148		Diode Silicon	100-101
Q1, Q2, Q3, Q4	D16G6 or	NPN	Transistor Silicon	101-008
	2N3663	NPN	Transistor Silicon	101-034
Q5	2N3392	NPN	Transistor Silicon	101-004
Q6	2N5088	NPN	Transistor Silicon	101-014
Q7	MPS-6560	NPN	Transistor Silicon	101-013
IC-1	LM358 or NE532		Dual Op-Amp	110-125
IC-2	CD4017 (Fairchild)		Shift Register	110-124

COILS & TRANSFORMERS

IFT-1		IF Transformer	Yellow 455KC	103-013
IFT-2		IF Transformer	White 455KC	103-014
IFT-3		IF Transformer	Black 455KC	103-015
RFC-1		3.9uh	Oscillator Tapped	103-023
L-1	72 MHz	4½ turns — tapped ¾ turn from ground, — antenna coil		103-093
L-1	27 MHz			
	35 MHz	11-1/2 turns - antenna coil		103-085
L-1	40 MHz	7-1/2 turns - antenna coil		103-064
L-2A & B	72 MHz	P = 5-1/4 turns; S = 1-1/4turns - mixer coil		103-063
L-2A & B	27 MHz			
	35 MHz	P = 9-1/4 turns; S = 2-1/4 turns - mixer coil		103-061
L-2A & B	40 MHz	P = 7-1/4 turns; S = 1-1/4 turns - mixer coil		103-065

MISCELLANEOUS

X-1	Order by Frequency	as required
R-23	P.C. Board	010-229
R-29	P.C. Board	010-241
	Logo, Sport Series	600-062
	Label, Rx Radiation Pt. 15 FCC	600-181
	Label, Frequency	as required
R-23	Case, 4A Receiver, Ivory	901-398
R-29	Case, 4A Receiver, Ivory	901-432
R-29	Case, 6A Receiver, Ivory	901-428
	Latch, Connector, Block	901-404
	Screws, 0-80 x 3/8" P.H.M.S.	500-093
	Tubing, Teflon,1/4"	990-016
	Wire, AWG #26 Stranded 36" Antenna	990-019
P-1 R-23, R-29	Block Plug, 4 Channel	120-078
P-1 R-29	Block Plug, 6 Channel	120-079
*P-2	Connector, 5thChannel	123-053

*Used on 5 channel R-23 versions.

ELECTRONIC ASSEMBLIES

R-23 P.C. Board	72 MHz Receiver, KPR-4A	NLA
	27 MHz Receiver, KPR-4A	NLA
	35 MHz Receiver, KPR-4A (Europe Only)	NLA
	40 MHz Receiver, KPR-4A (Europe Only)	NLA
R-29 P.C. Board	72 MHz Receiver, KPR-4A	300-359
	27 MHz Receiver, KPR-4A	300-361
	72 MHz Receiver, KPR-6A	300-400
	27 MHz Receiver, KPR-6A	300-401

SERVO AMPLIFIER

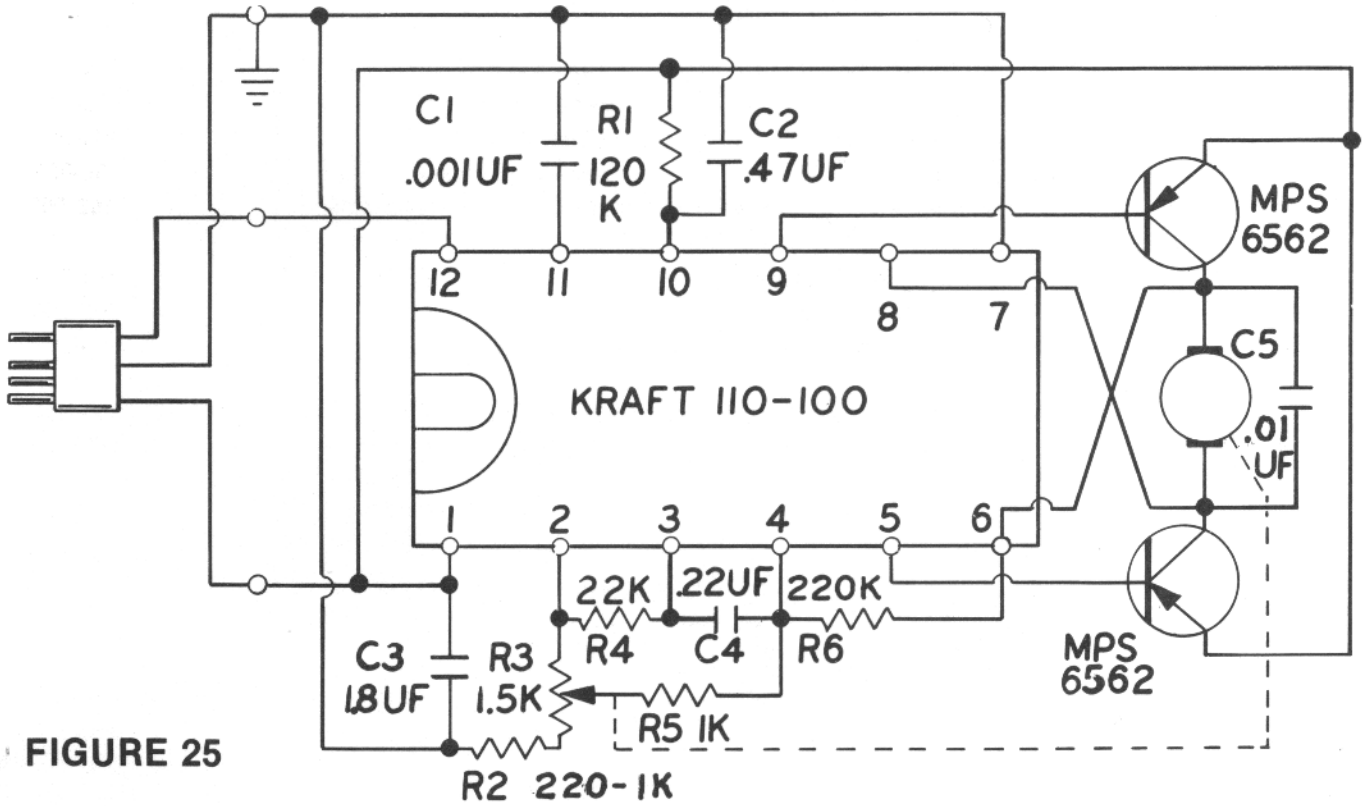
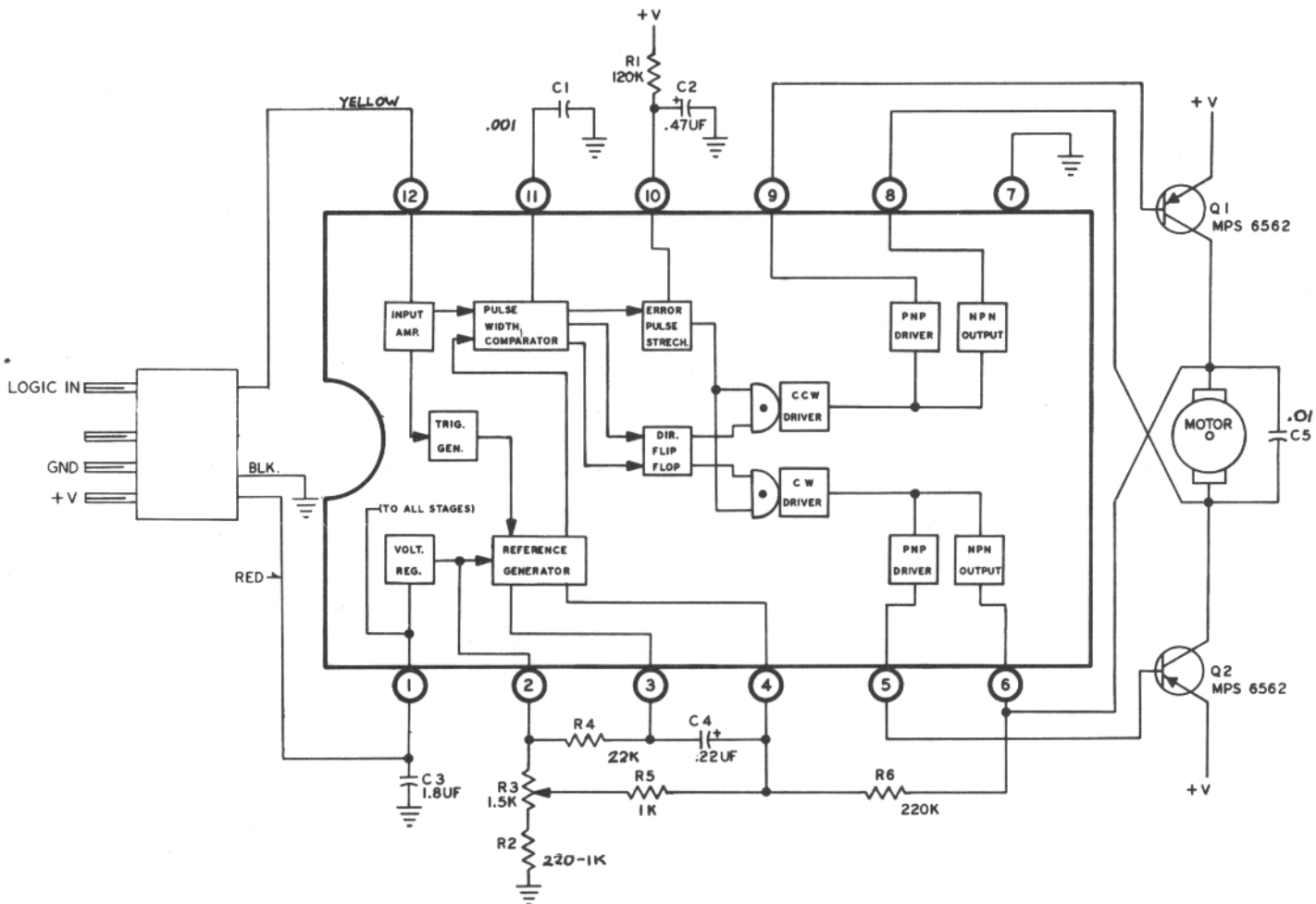
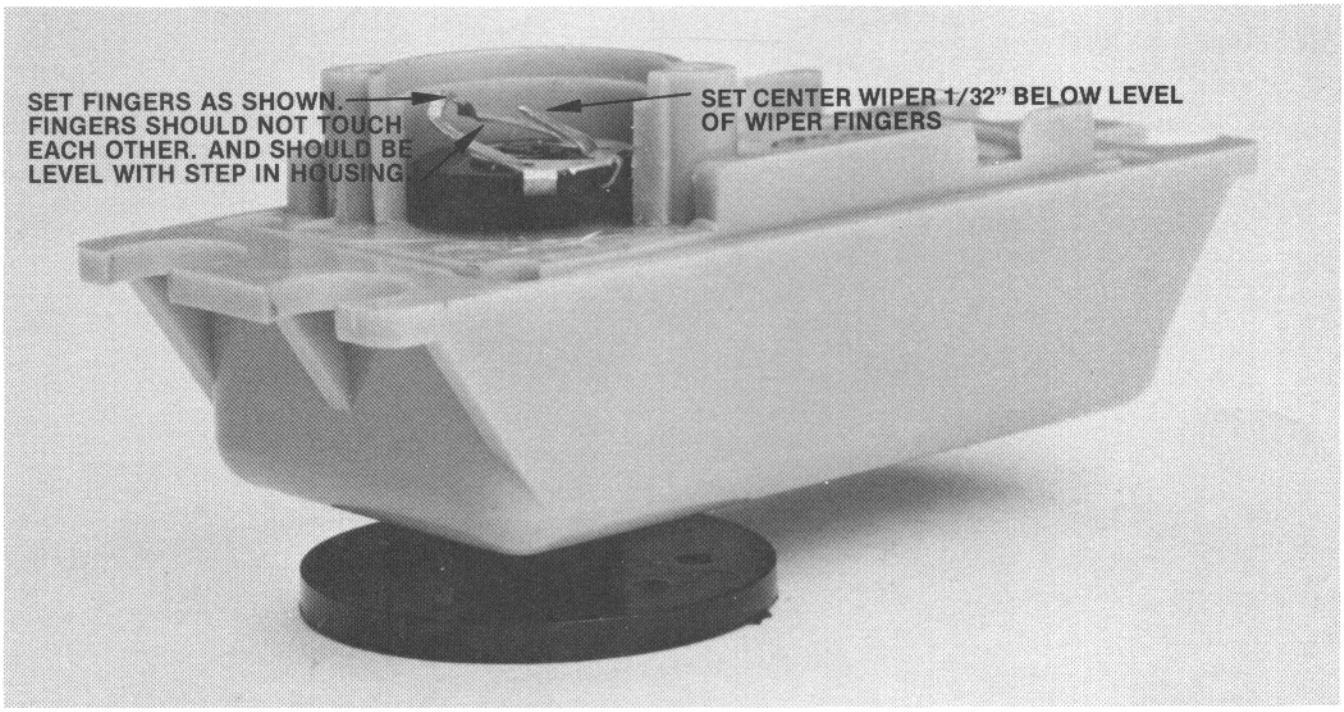


FIGURE 25





Servo wiper (cut-away view)

FIGURE 26

KPS-14IIA, KPS-15IIA SERVO AMPLIFIER S20

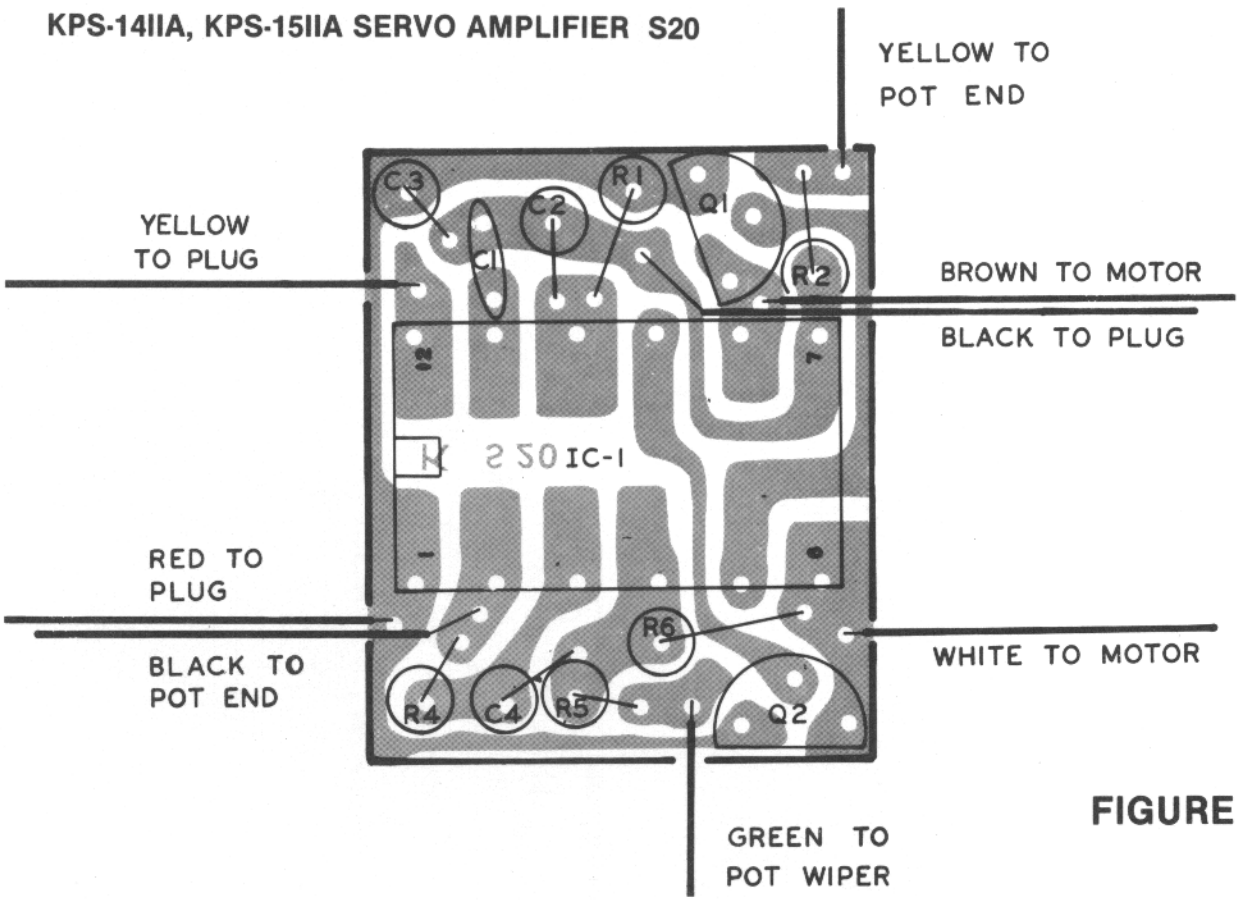
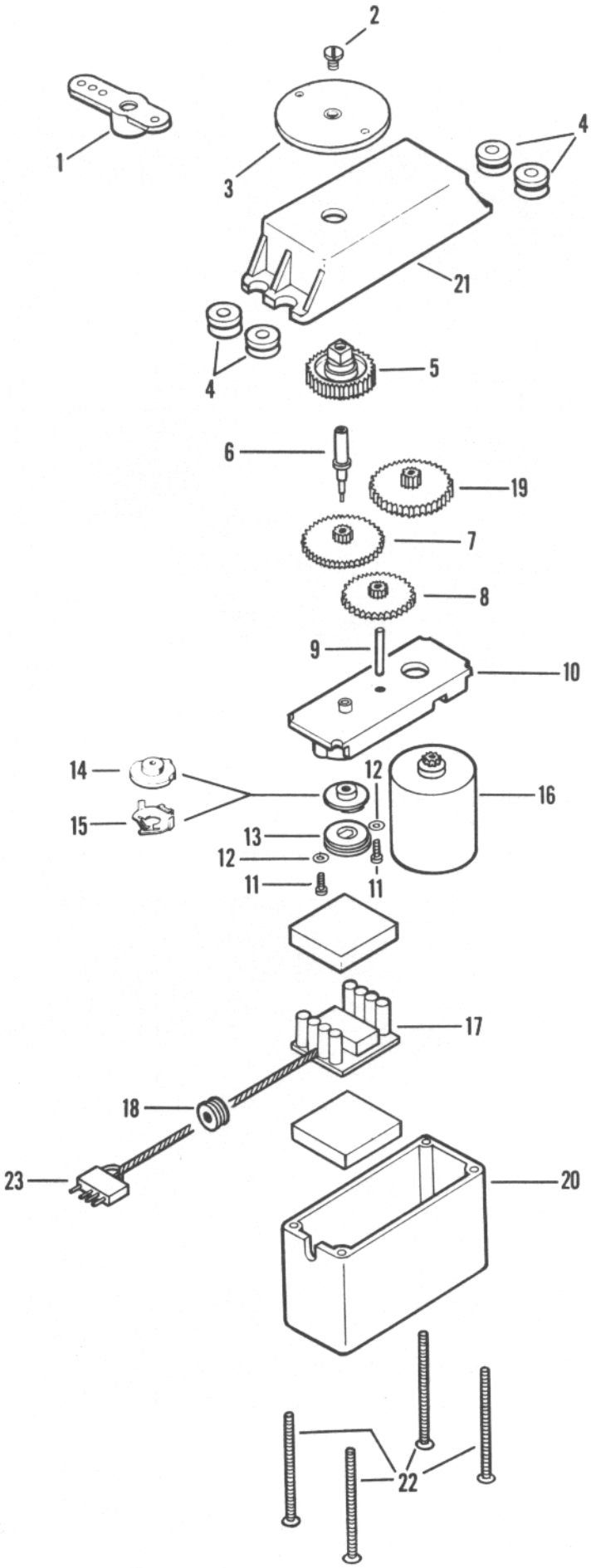


FIGURE 27

KPS-14 II A SERVO



SERVOS

Two types of servos are supplied with KP-4A Systems—the KPS-14A and the KPS-15A. These are identified by the white cases to differentiate them from other Kraft Servos in gold cases. Mechanically, the KPS-14A and KPS-15A differ only in physical size and output torque. Electronically the servos are identical.

SERVO AMPLIFIER

(See schematic Figure 25)

Most of the components are contained in a single, custom integrated circuit. The timing components and PNP output driver transistors comprise the remaining components. The block diagram below the servo amplifier schematic shows the major functional portions of the system which are contained in the I.C.

The input pulse from the receiver is shaped internally and delivers a trigger pulse to the one-shot which is controlled by the position of the output shaft and hence the potentiometer wiper. When the output shaft is in the center of its rotation, the one-shot will produce a 1900uS pulse each time it is triggered by the receiver pulse. The receiver pulse and one-shot pulse are compared for equality in the comparator portion of the I.C. If the input pulse differs from the one-shot pulse by more than 10 microseconds, error signals are produced which tell the remainder of the circuitry how much the error is, in which direction the motor must be driven to remove the error and how fast the motor must be driven. In this manner, the servo output shaft will follow corresponding commands from the transmitter controls.

TROUBLE SHOOTING AND SERVICING SERVOS

Most servicing will be confined to the moving portions of the servo—motor, gears, and feedback potentiometer. Routine inspection should include opening the upper case to expose the gear train and inspecting for worn or damaged gears. The feedback pot need not be checked unless servo operation warrants it or the servo has been crash damaged.

The motor has two main failure modes—dead spots and high current drain due to defective magnet or armatures. While running the servo, observe speed in each direction. It should be very close to the same in either direction. Running the servo at very slow, slow speed will often reveal any dead spots (open armature pole).

Gear train damage, if not readily visible, is generally quite audible. In most cases, it is good practice to replace all plastic gears in the servo even though only one may be obviously damaged.

The feedback pot is subject to excessive wear if the model has had vibration problems or control surface flutter. Most often, feedback pot wear will be evidenced by one particular spot where there is jitter or "hunting" usually near neutral. Cleaning the element will sometimes cure the problem for a time; however, it is best to cure the source of vibration or flutter to prolong pot life.

If the feedback pot is removed, be very careful not to distort the wiper contact shape. Tension is important to proper pot performance. Too little or too much wiper pressure can cause erratic operation or severely reduce element life. See Figure 26 for correct wiper settings if the wiper is damaged or replaced.

Electronic parts replacement will generally involve replacement of either the integrated circuit or PNP output transistor, other than crash damaged components. The PNP transistors generally will fail in the base-emitter junction. Check each base with an oscilloscope. The pulse amplitude should be o.6v when that side is being driven. Full voltage pulses indicate an open base junction.

Other difficulties not associated with the PNP transistors or mechanical portion involve replacement of the integrated circuit.

180° SERVOS

In some cases, it may be required to modify a servo for 180° operation. Change R2 to 2.2K. The timing resistor R4 will have to be selected between 15K and 18K. Note the timing resistor on pins 2 and 3 is trimmed. This is to insure that the wiper of the feedback pot is as close to the center of the element as possible. A decade box is almost a necessity to select the appropriate resistor. It may be necessary to series two resistors to obtain the required value.

ELECTRICAL PARTS LIST

I.C. Servo Amp

RESISTORS

All values in ohms (K = 1000)

R1		120K	1/4W	10%	057-124
R2		220 to 1K	1/4W	10%	057-099
R4	KPS-14IIA-15IIA	22K	1/4W	5%	055-223
R4	KPS-15IIA 180°	2.2K	1/4W	10%	057-222
R5		1K	1/4W	10%	057-102
R6		220K	1/4W	10%	057-224

CAPACITORS

C1	.001uf	Sub-Mini	Disc Ceramic	113-022
C2	.47uf	35V	Tantalum	116-011
C3	1.8uf	25V	Tantalum	116-010
C4	.22uf	35V	Tantalum	116-009
C5	.01uf	50V	Disc Ceramic	113-016

SEMICONDUCTORS

IC1	Servo Amplifier Integrated Circuit	110-100
Q1, Q2	Transistor, PNP Silicon MPS-6562	101-012

ELECTRONIC ASSEMBLY

KPS-14II-A & KPS-15II-A, 15H-II-A	Servo Amplifier	300-368
KPS-15II-A & KPS-15H-II-A 180°	Servo Amplifier	300-372

CONNECTOR ASSEMBLY

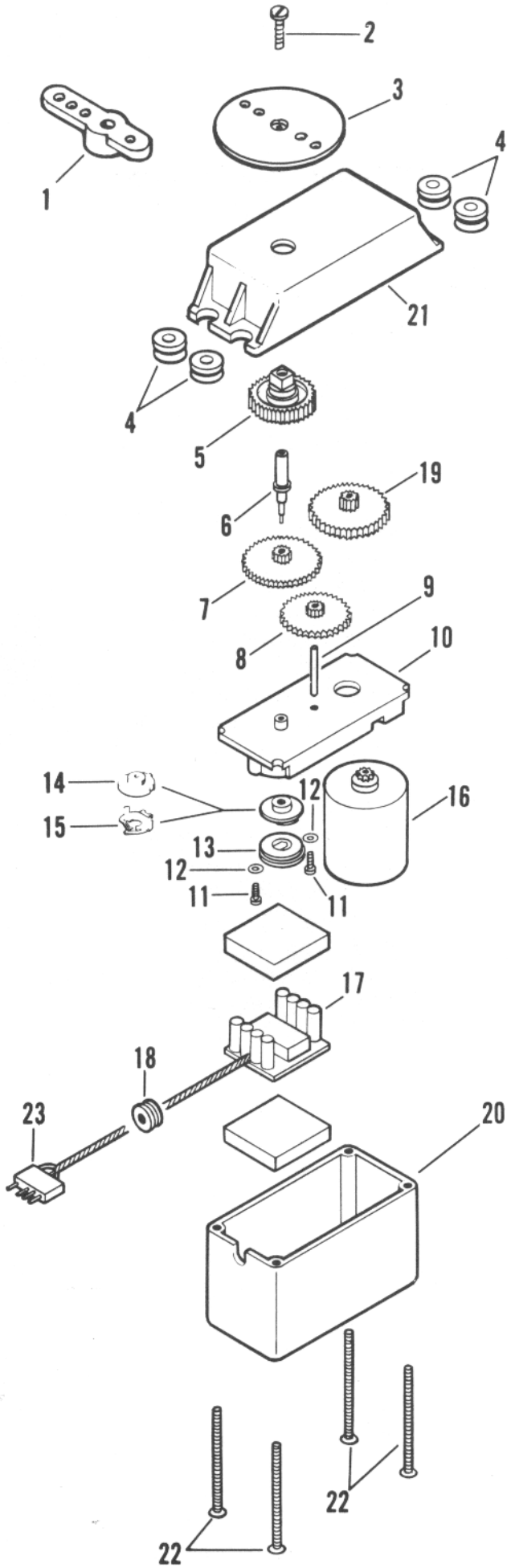
Servo Connector	4 Pin	3 Wire	123-050

MECHANICAL PARTS LIST

KPS-14II-A

Key No.	No. Required Per Assembly	Description	Part Number
21	1	Top Housing	901-272
10	1	Center Section	901-311
20	1	Bottom Housing	901-230
8	1	First Intermediate Gear	901-273
7	1	Second Intermediate Gear	901-274
19	1	Drive Gear	901-275
5	1	Pot Gear	901-276
3	1	Output Wheel	901-277
1	1	Output Arm	901-278
14	1	Wiper Support Disc	901-286
16	1	Motor (With pinion gear)	800-007
15	1	Wiper Contact Element	106-023
13	1	Potentiometer Element, 1.5K	106-012
6	1	Wiper Gear Shaft	500-062
9	1	Gear Pin .050" x .550"	500-066
2	1	1-72 x 1/8" Binding Head M.S.	500-032
11	2	1-72 x 3/16" Binding Head M.S.	500-059
22	4	2-56 x 1-1/4" Flat Head Phillips M.S.	500-012
4	4	1/4" O.D. Grommets	500-040
18	1	5/32" O.D. Grommet	500-002
12	2	Fiber Washer	500-108
17	1	Electronic Assembly	300-368
23	1	Connector Assembly	123-050

KPS-15 II A SERVO



MECHANICAL PARTS LIST
KPS-15II-A & KPS-15H-II-A

Key No.	No. Required Per Assembly	Description	Part Number
21	1	Top Housing	901-279
10	1	Center Section	901-312
20	1	Bottom Housing	901-243
8	1	First Intermediate Gear	901-280
7	1	Second Intermediate Gear	901-281
19	1	Drive Gear	901-282
5	1	Pot Gear	901-283
3	1	Output Wheel	901-284
1	1	Output Arm	901-285
14	1	Wiper Support Disc	901-287
16	1	Motor (with pinion gear) 10 ohm, 15	800-006
16	1	Motor (with pinion gear) 6 ohm, 15H	800-002
15	1	Wiper Contact Element	106-023
13	1	Potentiometer Element, 1.5K	106-012
6	1	Wiper Gear Shaft	500-062
9	1	Gear Pin .0625" x .550"	500-068
2	1	1-72 x 1/8" Binding Head M.S.	500-032
11	2	1-72 x 3/16" Binding Head M.S.	500-059
22	4	2-56 x 1-1/4" Flat Head Phillips M.S.	500-012
4	4	1/4" O.D. Grommets	500-003
18	1	5/32" O.D. Grommet	500-002
12	2	Fiber Washer	500-108
17	1	Electronic Assembly	300-368
23	1	Connector Assembly	123-050

KPS-18A SERVO

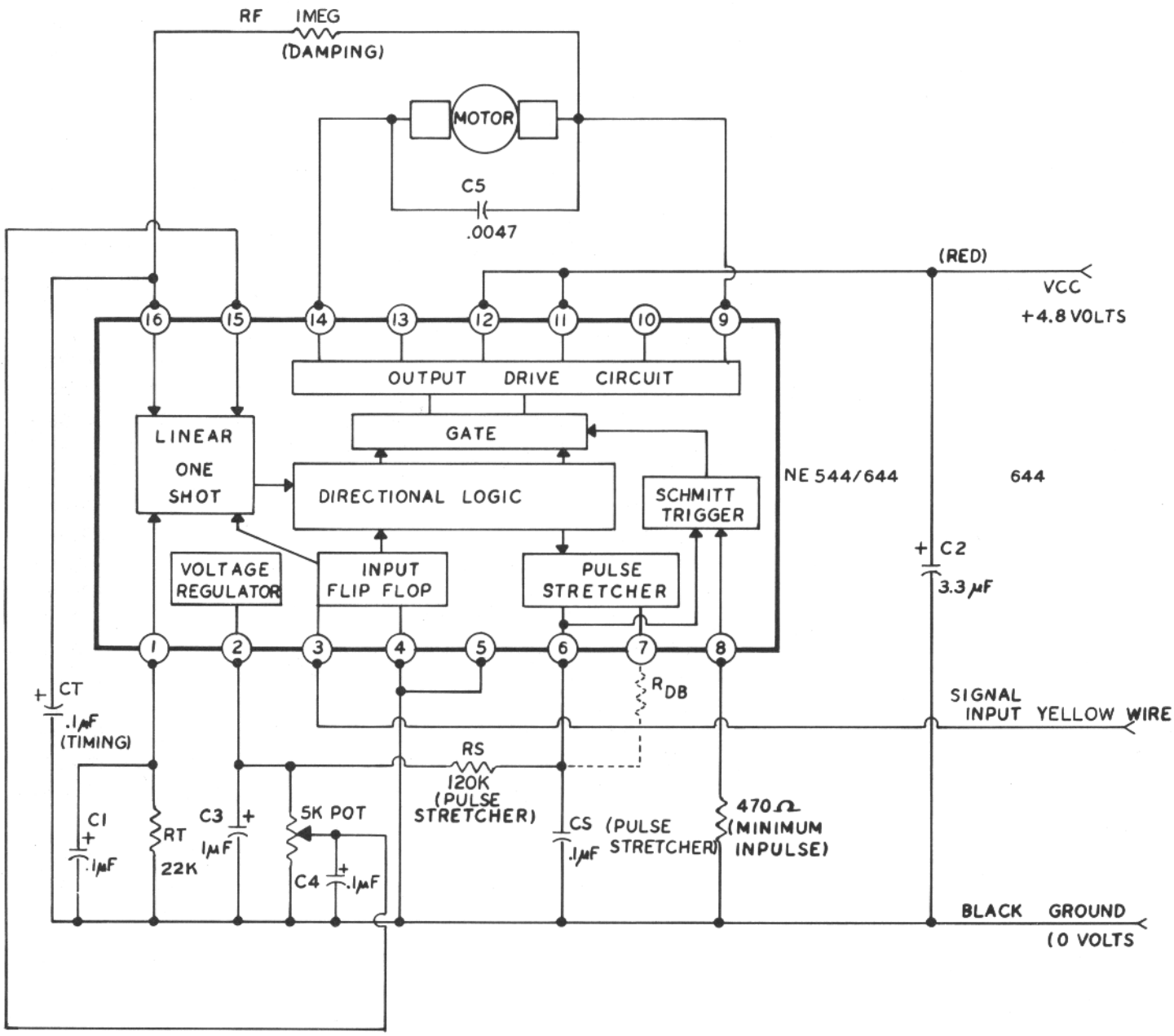


FIGURE 28

KPS-18A SERVO

The KPS-18A is the world's smallest and lightest proportional radio control servo. It features exceptional efficiency and performance comparable to the standard Kraft servos and can be purchased separately to use with the KP-4A or KP-6A system. It is identified by the white case to differentiate it from the other Kraft servos in gold cases.

SERVO AMPLIFIER (See schematic Figure 28)

Most of the components are contained in a single signatics NE-544 integrated circuit. The timing, pulse stretcher and other components are mounted on the two P.C. boards that make up the complete servo amplifier. The servo functions identically to the KPS-14A and KPS-15A described on a previous page.

TROUBLE SHOOTING AND SERVICING

Due to the small size of the servo amplifier, and since it is composed of two P.C. boards back-to-back, it may prove difficult for some service centers to service. However, the failure modes experienced are similar to that described for the KPS-14A and KPS-15A servos. Excessive vibration can cause early failure of the motor, pot, and associated wiper. The KPS-18A is not recommended for installation in any aircraft using an engine size of .10 or larger. It is best to mount it using the grommets supplied and screwing it to servo mounting rails to reduce vibration transmitted to the servo.

ELECTRICAL PARTS LIST
KPS-18A IC SERVO AMP

RESISTORS

All values in ohms (K = 1000)

RF	1 MEG	1/8 W	10%	053-105
RT	22 K	1/8 W	10%	o53-223
RS	120 K	1/8 W	10%	053-124
RM_I	470	1/8 W	10%	053-471

CAPACITORS

C1	.1uF	20V	10%	116-018
C2	3.3uF	6V	10%	116-020
C3	1uF	10V	10%	116-019
C4	.1uF	20V	10%	116-018
C5	.0047	Sub Mini	Disc Mono	113-047
CS	.1uF	Sub Mini	Disc Mono	113-048
CT	.1uF	20V	5%	116-017

SEMI CONDUCTORS

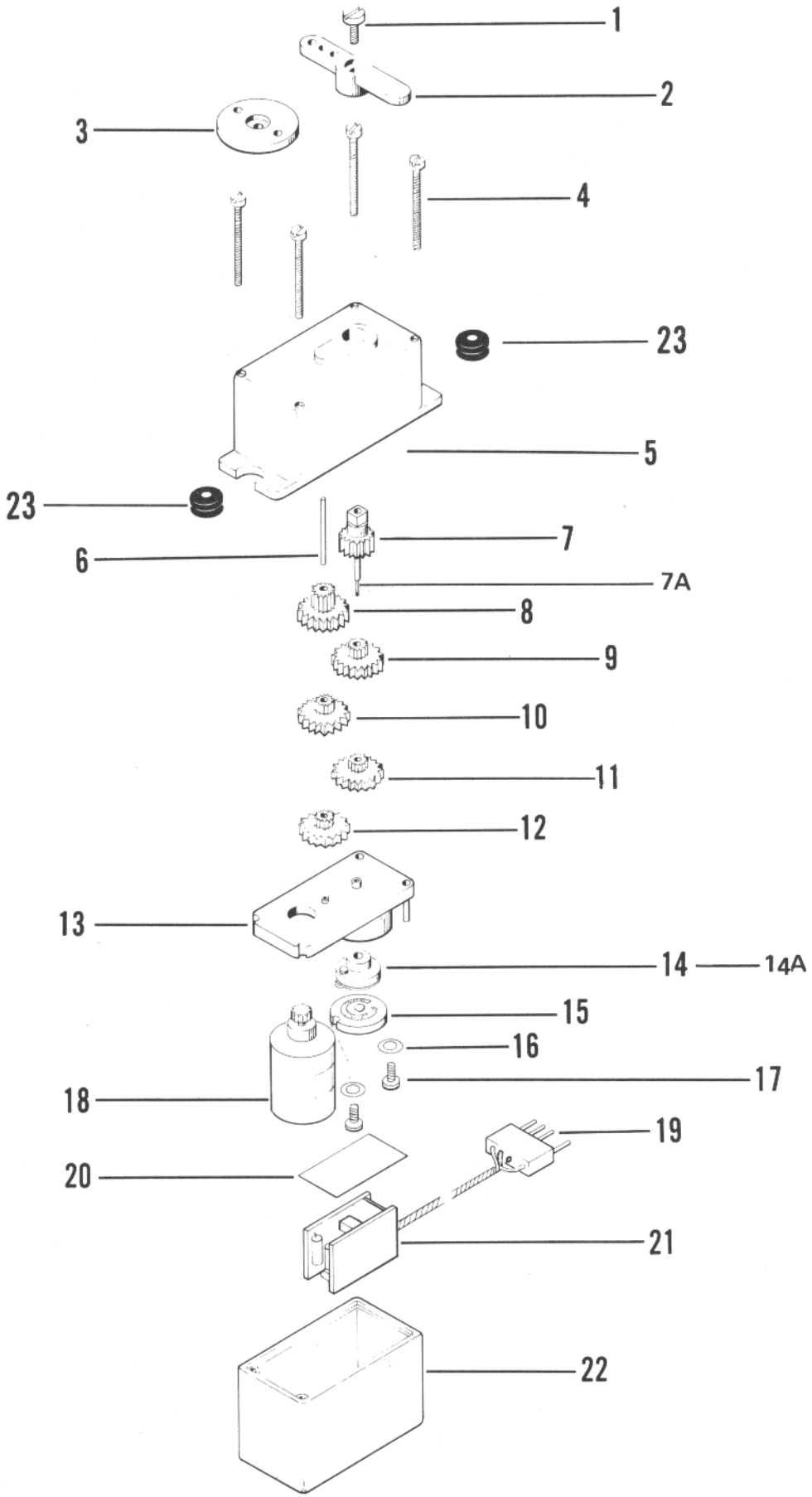
IC_1	Servo Amplifier Integrated Circuit NE-644 (selected)	110-126

ELECTRONIC ASSEMBLY

KPS-18A W/Connnector & Case Bottom	300-418

CONNECTOR ASSEMBLY

Servo Connector	4 pin	3 wire	123-050



KPS-18A

MECHANICAL PARTS LIST
KPS-18A

Key No.	Number Required per Assembly	Description	Part Number
15	1	Element, 5K CTS KPS-18A	106-061
14A	1	Wiper, CTS KP-18A	106-062
1	1	Screw, 1-72x1/4"	500-039
6	1	Gear Pin (KPS-14II)	500-066
17	2	Screw, 0-80x1/8" PH SLT M.S.	500-159
4	4	Screw, 0-80x5/8" Fillister	500-179
7A	1	Centering Shaft	500-180
16	2	Washer, FBR .125x.072x.016	500-194
18	1	Motor 17 ohm Miniature KPS-18A	800-010
20	1	Fish Paper, 5/8"x1/2"	
5	1	Case, Top KPS-18A, Ivory	901-410
13	1	Case, Center KPS-18A, Ivory	901-411
22	1	Case, Bottom KPS-18A, Ivory	901-412
12	1	Gear #1, KPS-18A 901-417	901-423
11	1	Gear #2, " 901-418	
10	1	Gear #3, " 901-419	
9	1	Gear #4, " 901-420	
8	1	Gear #5, " 901-421	
7	1	Gear #6, " 901-422	
2	1	Out Put Arm KPS-18A	901-424
3	1	Out Put Wheel KPS-18A	901-425
14	1	Disc, Wiper Support KPS-18A	901-429
23	2	5/32"x1/32" Grommets	500-002

NOTE: Gears are sold only in sets.

BATTERY PACKS

The standard battery pack furnished with the KP-4A and KP-6A systems is the KB-4EA. This battery is physically identical to the Kraft KB-4E battery except for pin connections and fast charge capability. The battery is rated at 550 MAH minimum at 100 ma. discharge rate.

Optionally available are two 450 MAH battery packs, the KB-4MA and KB-4SA, and a 225 MAH battery pack, the KB-4LA. These are physically similar to the Kraft KB-4M, KB-4S, and KB-4L except for plug wiring, of course.

All the above packs can be charged with the KP-4A charging system which has a design charge rate of 45-55 mA continuously.

When using the KP-4A internal charger, these batteries should be charged for at least 16 hours for a full charge. Fast charging of these batteries is not recommended.

KB-4EA PARTS LIST

No. Per Assembly	Description	Part Number
1	Connector, Battery Cable, wired	123-051
2	Cells, 2.4V 550 MAH	130-006
1	Grommet, 5/32" O.D.	500-002
1	Label, Sport Series	600-062
1	Case, Battery (Ivory)	901-211
6"	Tape, Black Cloth	990-014

KB-4MA PARTS LIST

No. Per Assembly	Description	Part Number
1	Connector, Battery Cable, wired	123-051
1	Cells, 4.8V 450 MAH	130-009
1	Grommet, 5/32" O.D.	500-002
1	Label, Sport Series	600-062
1	Case, Battery (Ivory)	901-270
6"	Tape, Black Cloth	990-014

KB-4SA PARTS LIST

No. Per Assembly	Description	Part Number
1	Connector, Battery Cable, wired	123-051
1	Cells, 4.8V 450 MAH	130-009
1	Grommet, 5/32" O.D.	500-002
1	Label, Sport Series	600-062
1	Case, Battery (Ivory)	901-271
6"	Tape, Black Cloth	990-014

KB-4LA PARTS LIST

No. per Assembly	Description	Part Number
1	Connector, Battery	123-051
2	Battery, 2.4V 225 MAH 2 cell	130-012
1	Grommet, 5/32" O.D.	500-002
1	Label, Sport Series	600-062
1	Case, Battery Pack KB-4LA, Ivory	901-406
4"	Tape, Black Cloth	990-014

KP-4A AND KP-6A CHARGING SYSTEM

The charger system used on this unit is a series type with most of the charger contained on the transmitter board. The power is supplied by a 24V stepdown transformer in a wall-mounted unit. The charge rate is determined primarily by a dropping resistor, R23. The indicator is a general purpose LED also mounted on the transmitter board.

If the charge rate is too low in one area due to abnormally low line voltage, shunt R23 until charge current with fully charged batteries is at least 45 mA.

TRANSFORMER PARTS LIST

No. Per Assembly	Description	Part Number
1	Transformer, Wall, without plug	001-206
6	Socket, Crimp Type	120-025
1	Plug, Shell, 2 Pin Charge Cord	120-027
1	Plug, Shell	120-039
2	Cap, For Plug Shell	120-071
1	Strain Relief	120-092
1	Label, Sport Series	600-062
72"	Speaker Cable, 24 ga. Gray	990-036

SWITCH HARNESS

The switch harness (200-149) furnished with this system is a two-wire type, including a charge receptacle for more convenient airborne battery charging. Note that each end is wired differently. The end with all four contacts plugs into the battery pack. Although the charge receptacle does match other Kraft plugs, do not use high rate chargers with the KB-4EA, KB-4MA, KB-4SA, or KB-4LA battery packs. These are not designed for fast charging.