KRAFT SYSTEMS, INC.®

bicentennial series seventy-seven series seventy-eight series seventy-nine

SERVICE MANUAL

KRAFT SYSTEMS, INC.

SERVICE MANUAL

BICENTENNIAL (1976)
SERIES '77
SERIES '78
SERIES '79

BICENTENNIAL (1976), SERIES '77, SERIES '78, AND SERIES '79 SERVICE MANUAL*

Models: **Transmitters KPT-3C,5C,5CS,7C & 7CS** **Receivers KPR-3C,5C,7C,7L & 7D**
Servos KPS-11,11A,12,14II,15II,15HII, 16 & 18 **Battery Packs KB-4E,4F,4L,4M & 4S**
Chargers KBC-B & KBC-D

All models are the same for 1976 – 1979 except the KPR-3C. It was changed for 1978 and 1979 as described in the appropriate sections.

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***Portions of this manual are also applicable to series '80 radio systems**

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 runnning 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 encoder boards are 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.

★ Many of the resistors on 7ch encoders are 1% precision components. Excess heat can change their value and destroy their stability. Be extremely careful to avoid overheating them.

★ 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 —
3/8″ wide black cloth — for wrapping battery packs; 3/4″ wide, any color — for wrapping motors where necessary.

Mylar Tape —
for wrapping KPS-12 servos, receiver cases.

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, FS-3451, or equivalent — for lubricating servo feedback potentiometers.

Dow Corning R.T.V. — #118 Translucent Silicone Rubber Adhesive Sealant —
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 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.

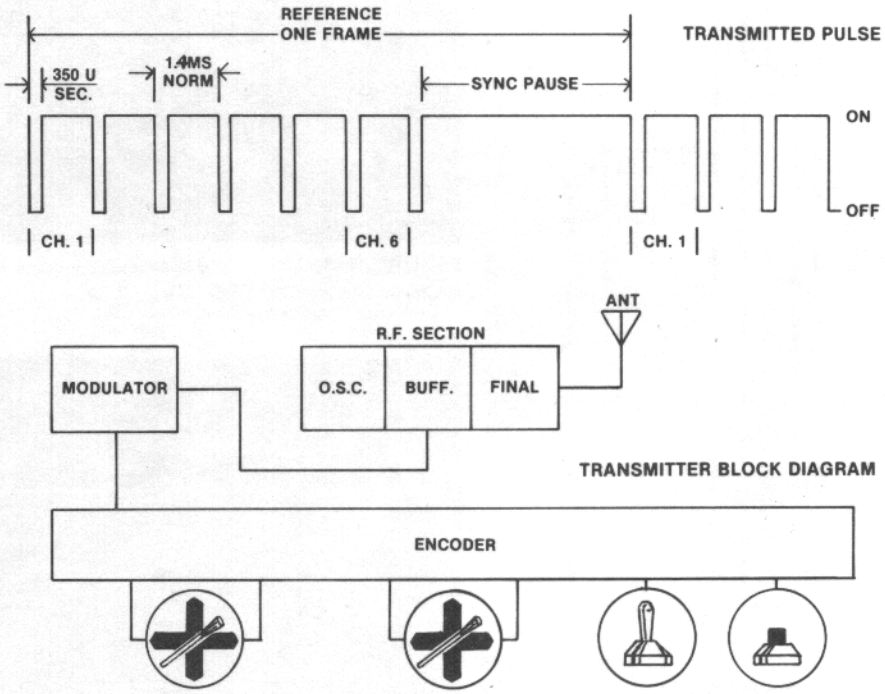


FIGURE 1

Figure 1 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 0.9 ms to a maximum of 1.9 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 module and the off periods result from amplitude modulating the transmitter. The encoder board 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.

ENCODER, 3-5 CHANNEL SCHEMATIC DIAGRAM

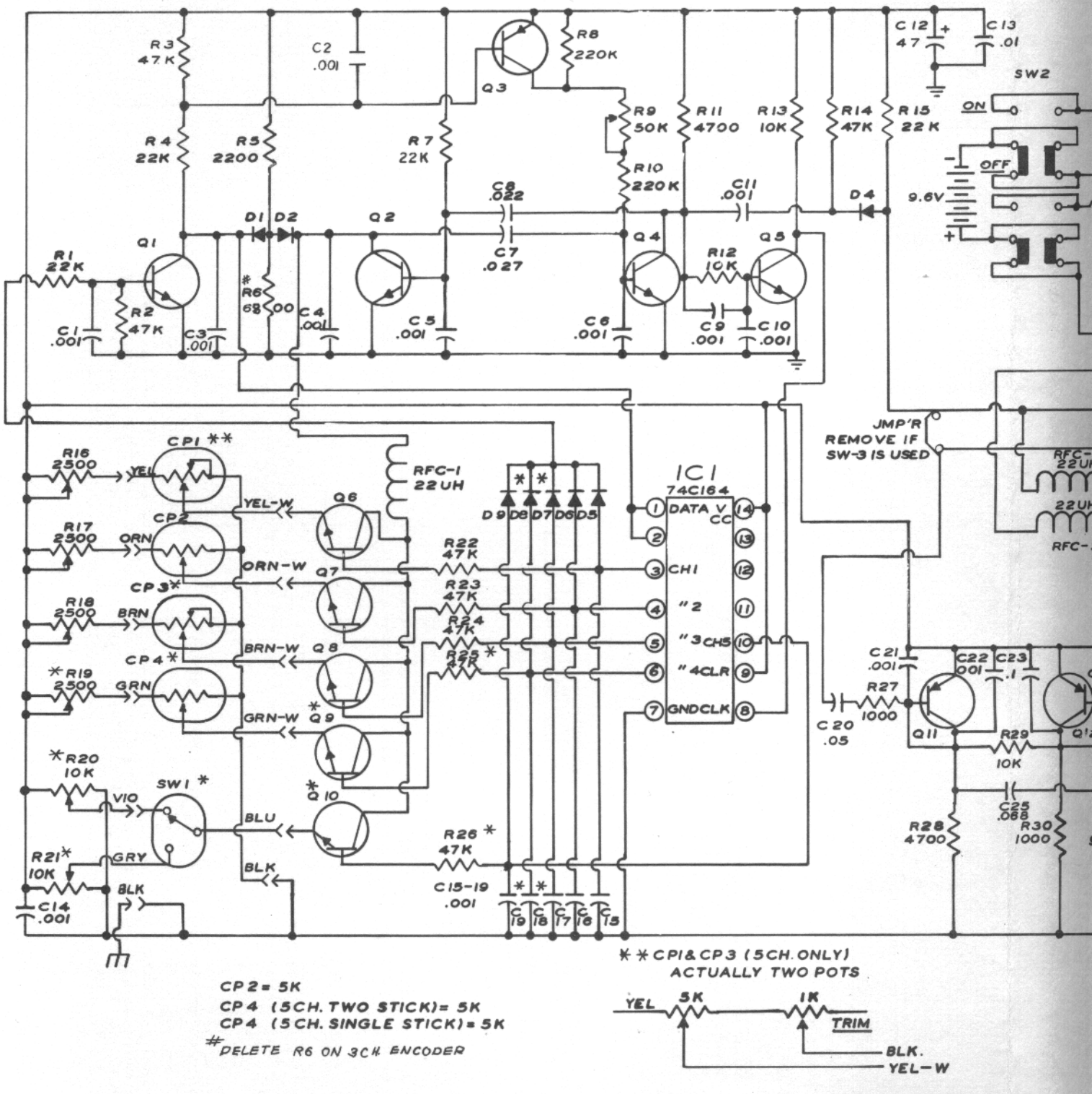
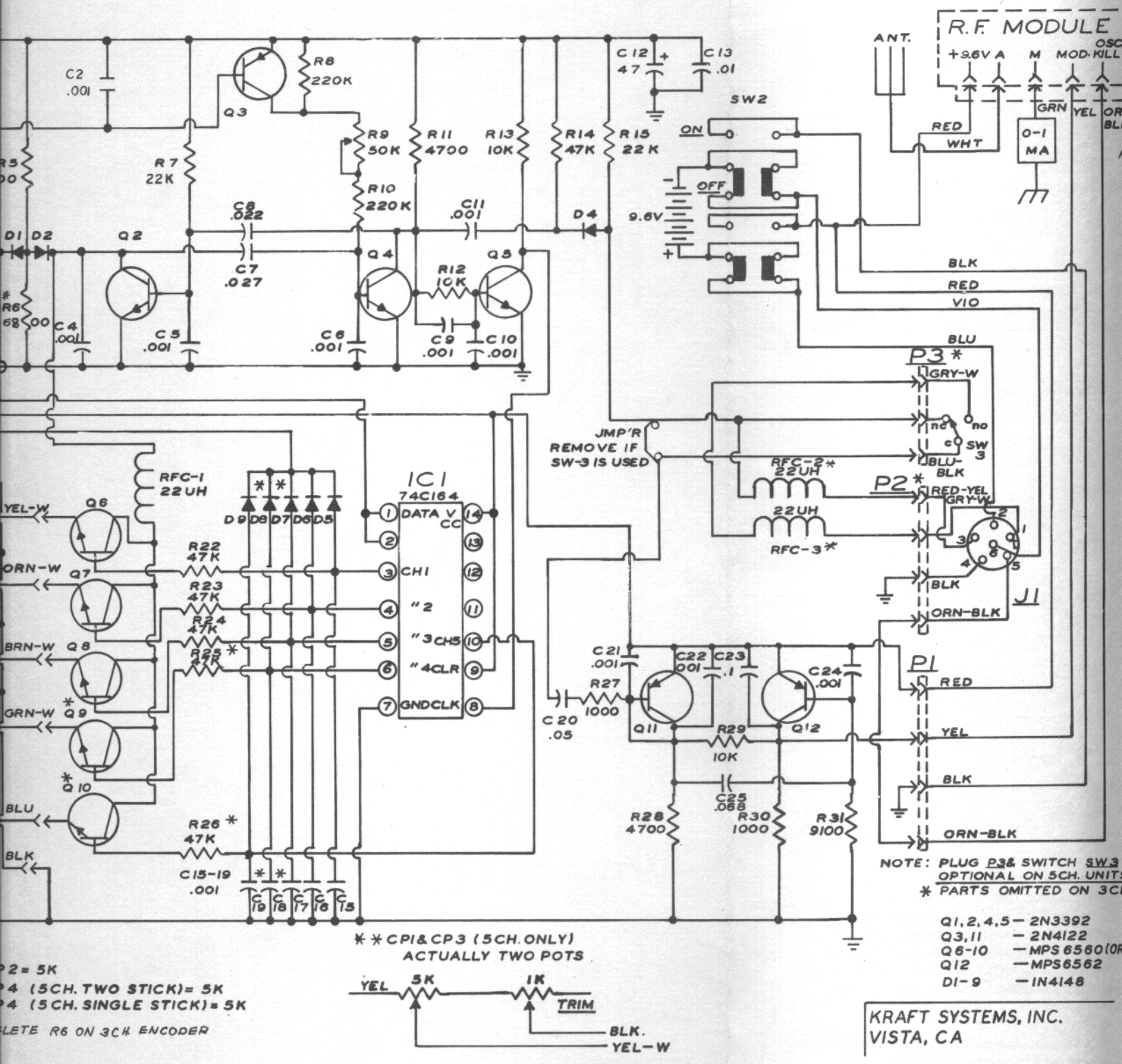


FIGURE 2

ENCODER, 3-5 CHANNEL SCHEMATIC DIAGRAM



NOTE: PLUG P3& SWITCH SW3 OPTIONAL ON 5CH. UNITS

* PARTS OMITTED ON 3CH

Q1, 2, 4, 5 — 2N3392
Q3, 11 — 2N4122
Q6-10 — MPS 6560 (OR
Q12 — MPS6562
D1-9 — IN4148

* * CP1 & CP3 (5CH. ONLY) ACTUALLY TWO POTS

P2 = 5K
P4 (5CH. TWO STICK) = 5K
P4 (5CH. SINGLE STICK) = 5K

LETE R6 ON 3CH ENCODER

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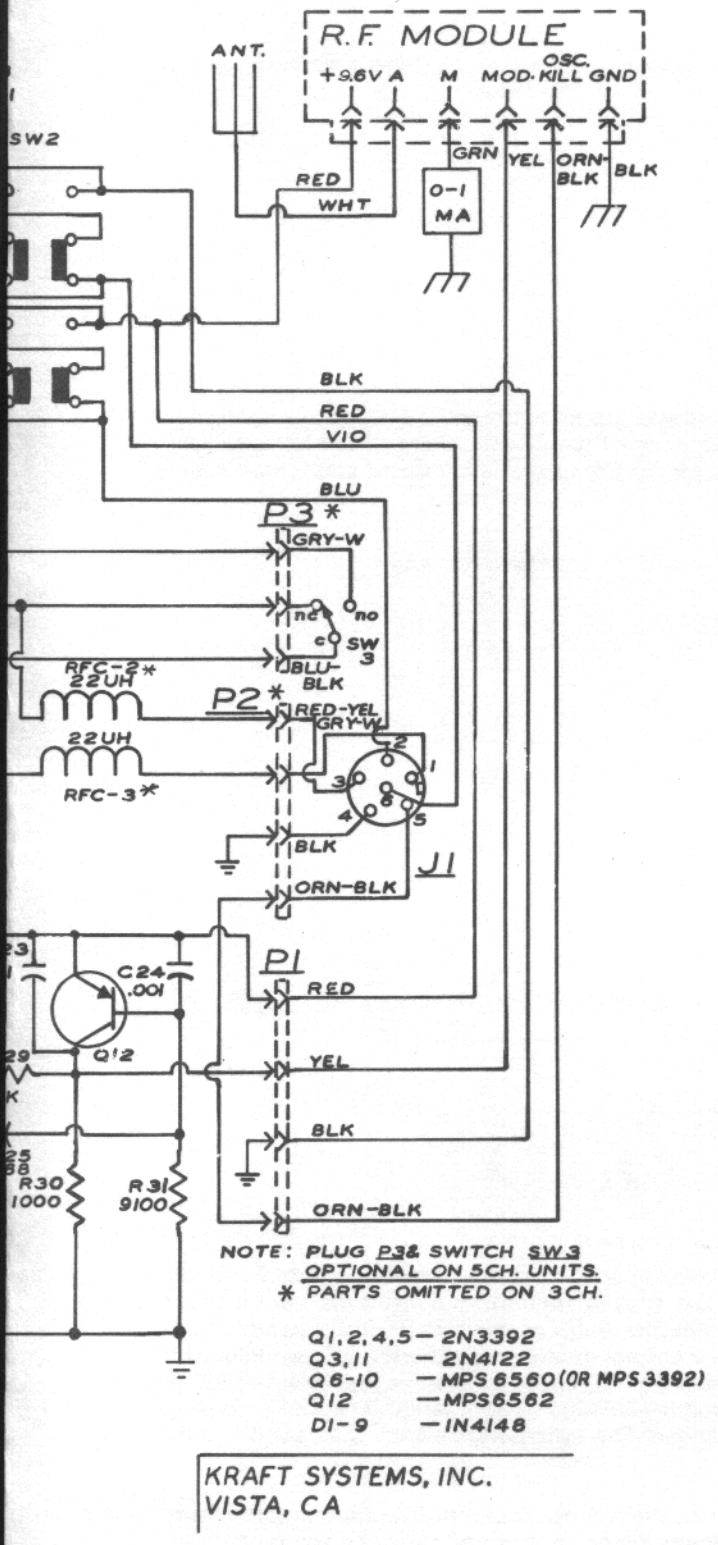


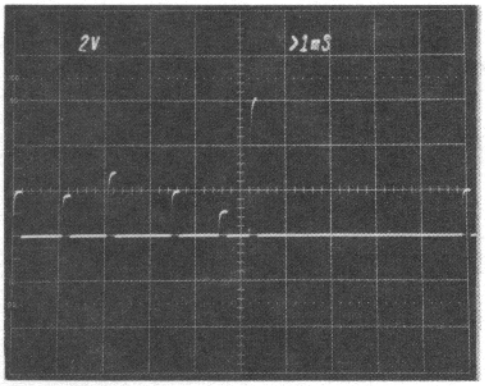


FIGURE 3
5 Channel Encoder, Collector Q2

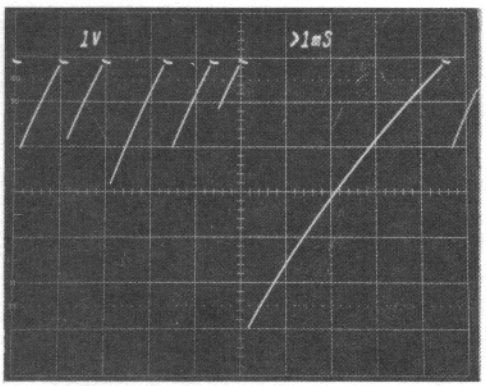


FIGURE 4
5 Channel Encoder, Base Q4

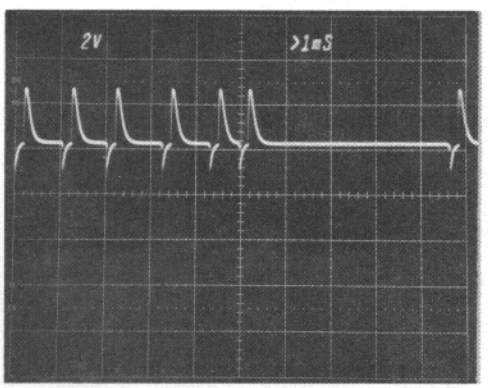


FIGURE 5
5 Channel Encoder, Cathode D4

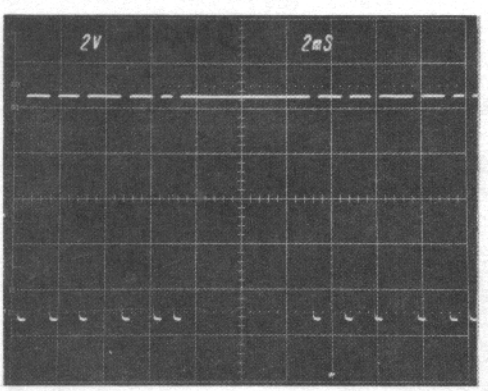
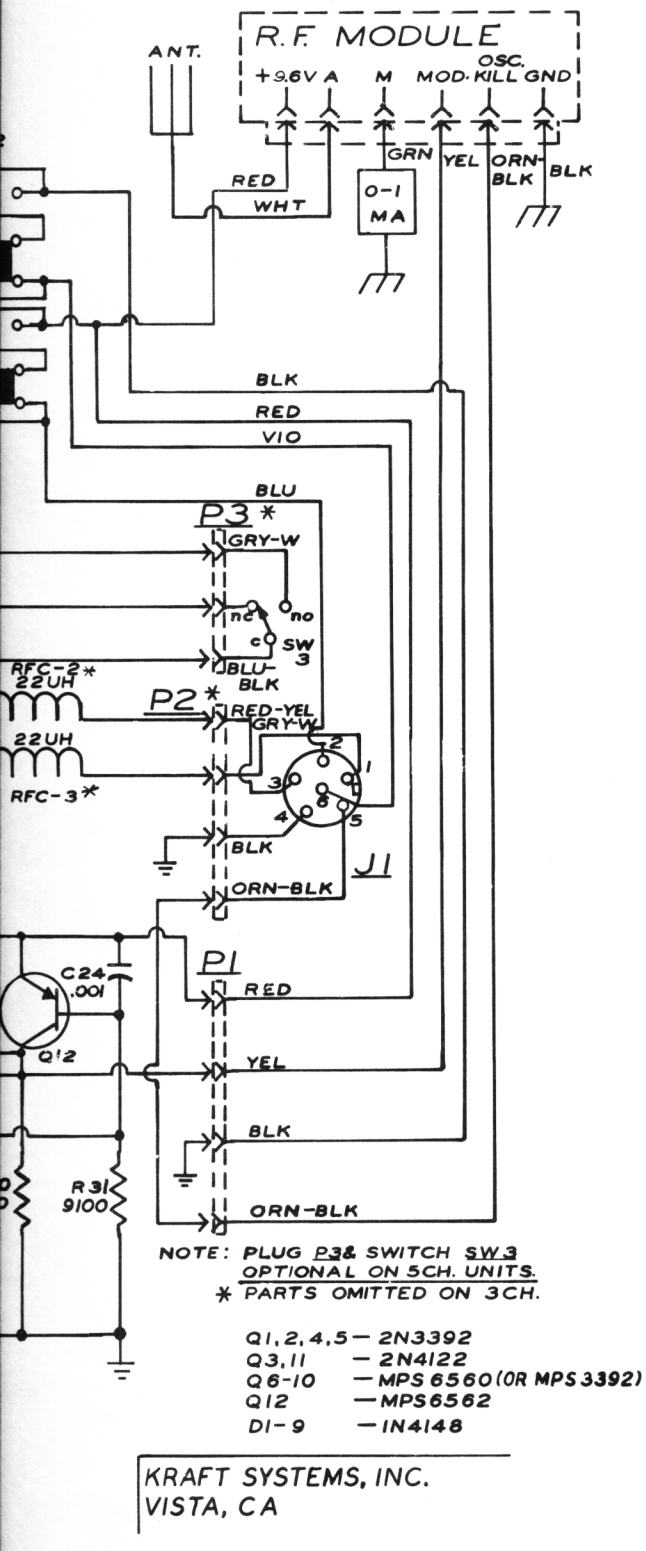


FIGURE 6
5 Channel Encoder, Collector Q12



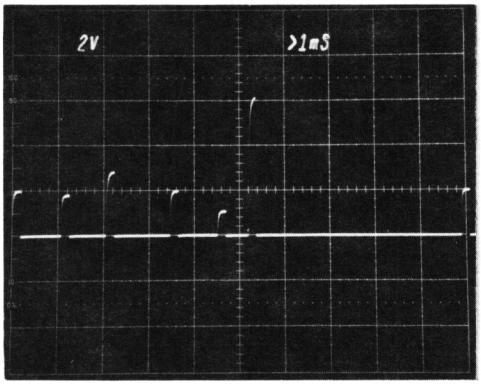


FIGURE 3
5 Channel Encoder, Collector Q2

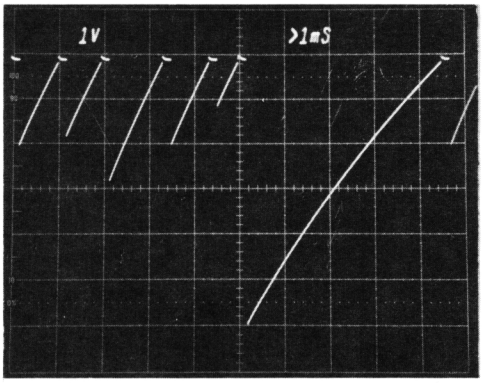


FIGURE 4
5 Channel Encoder, Base Q4

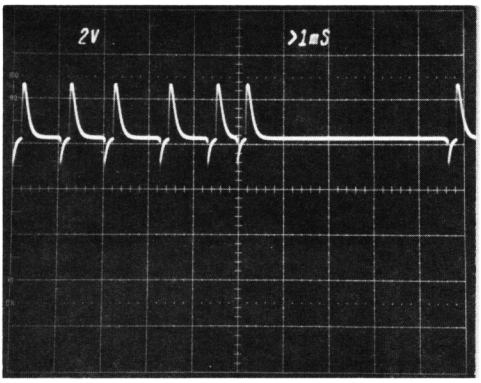


FIGURE 5
5 Channel Encoder, Cathode D4

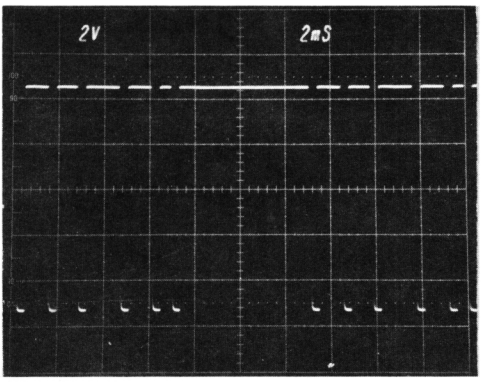


FIGURE 6
5 Channel Encoder, Collector Q12

ENCODER OPERATION, KPT-3C AND KPT-5C
(Figure 2)

Q2 and Q4 form a multivibrator which controls the positive going pulse widths shown in Figure 1. The positive pulse width varies in accordance with the channel control pot position. The variable voltage at the pot arm sets the collector voltage on Q2 (Figure 3) when it is off, which in turn becomes the negative bias on Q4 when Q2 turns on (Figure 4). The amount of this negative bias determines the time it takes C7 to discharge through R10 before Q4 turns back on. The 400us off time of Q2 is determined by C8 and R7 and allows the shift register to connect the next control pot as described below.

The negative going pulse at the collector of Q4 is differentiated by C11 and R14 (Figure 5) and is then applied to the base of Q11 through D4, which blocks the positive spike. When Q11 is turned on by the negative spike on its base, it turns Q12 off through C25 for 400us, removing supply voltage to the transmitter buffer amplifier. Feedback to Q11 through R29 holds Q11 on for the full 400us pulse width, the timing of which is determined by C25 and R31 (Figure 6).

The individual channel control pots are connected in sequence to the collector of Q2 by transistors Q6 to Q10, which, in turn, are controlled by the outputs of shift register IC1 on their bases. When power is first applied, Q1 is off and the positive voltage on its collector puts a "high" on the serial input of IC1. This "high" is then clocked through the shift register appearing, in turn, at each output. Clock pulses for the shift register are supplied from the collector of Q4 through Q5. As soon as the "high" appears at the first output, it is coupled back to the base of Q1 through D5. This turns on Q1, removing the "high" from the shift register input. Q1 continues to remain on while each channel control pot is selected by coupling through D6 to D9. When Q1 is on, it also pulls the junction of R5 and R6 low, which reverse biases D2. When all channels have been sequenced, Q1, again, turns off. This re-applies the "high" to the shift register input, and also allows R5 and R6 to set the collector voltage on Q2. R8 is also added to the timing circuit as a result of Q3 turning off when Q1 turns off.This, in combination with the voltage from R5 and R6, sets the sync period at ~8ms usec.

KPT-3C & 5C ENCODER ADJUSTMENT

Before attempting to adjust the encoder it will be necessary to disable the oscillator by grounding the oscillator-kill line or removing the module. This prevents stray RF from affecting the settings. R9 should also be centered before beginning the other adjustments.

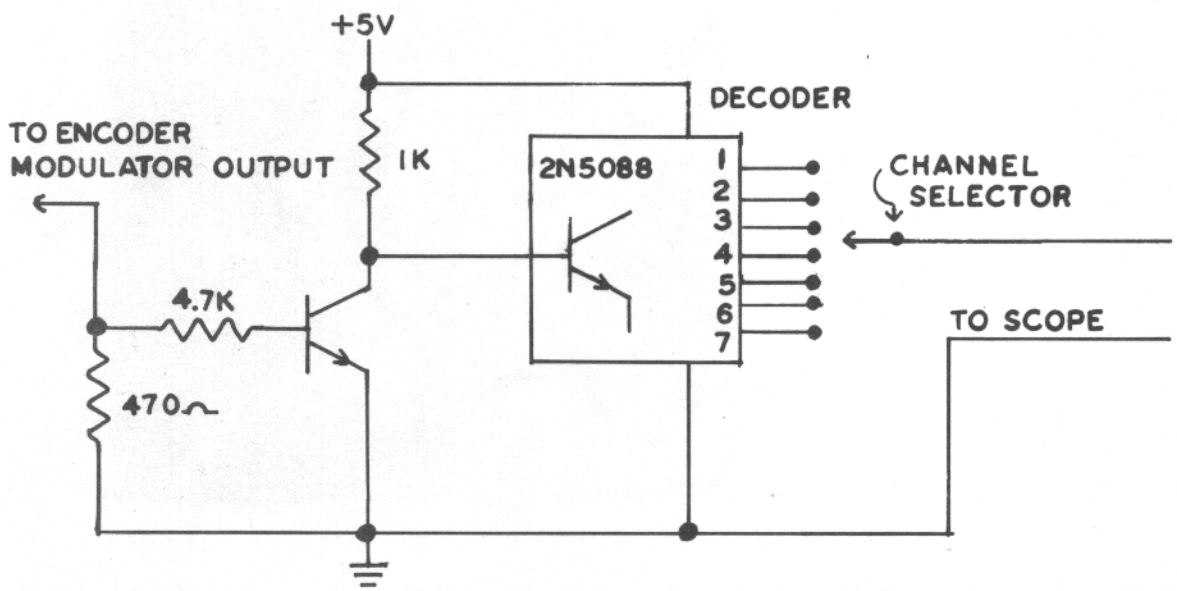


FIGURE 7

ENCODER PULSE WIDTH MEASURING ARRANGEMENT

In order to measure the control pulse widths during adjustments, the circuit in Figure 7 should be used. The channel displayed can be selected by choosing the appropriate decoder output. The verticle sensitivity should be set for 2 volts per division, and the sweep speed should be 200 us per division.

(Instructions are for Mode II units. For Mode I, substitute channel 1 for channel 3 and vice versa.)

Each channel must be adjusted individually. The procedure for channels 1, 2 and 4 is as follows. First the stick trim control must be centered. Then the shaft of the control pot must be positioned within its clamp on the gimbal so that the pot arm is centered when the control lever is centered. After this, the control lever should be moved back and forth between the minimum and maximum pulse width position while the range pot (R16, 17 or 19) is used to adjust the channel pulse width overall (less trim) from 1.0 ms to 1.8 ms. With trim, pulse width should run between 0.9 ms and 1.9 ms. At the same time the shaft should be adjusted in the gimbal clamp to keep the pulse width at 1.4 ms with the control in the neutral position. If it is not possible to obtain the correct maximum or minimum pulse width, it will be necessary to adjust R9 until they can be obtained. It is usually necessary to repeat the adjustments, in turn, several times until the correct readings are all obtained together.

After channels 1, 2 and 4 are set, the remaining channels (3 and 5) should be adjusted. For channel 3, the control lever and trim pot should both be set for minimum pulse width, which should be adjusted to 0.9ms. The control lever and trim pot should then be set for maximum pulse width, which should be 1.9ms. It is not necessary to check the neutral positon pulse width, but the maximum and minimum should be alternately checked until both readings are correct. For channel 5, the maximum and minimum are also set to 1.9 and 0.9ms using R20 and R21.

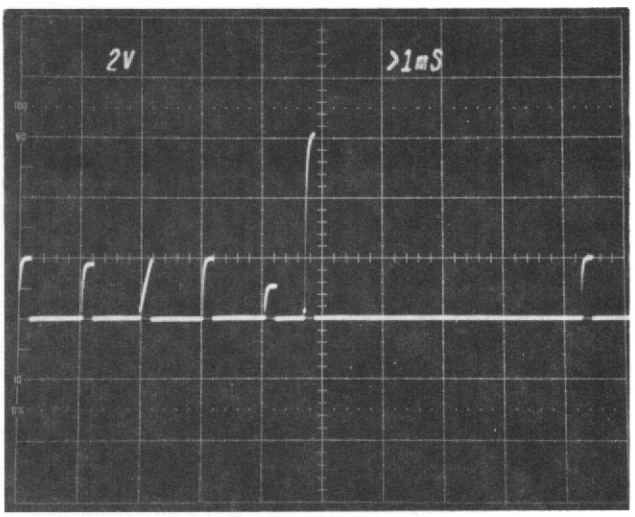
After the adjustments are complete, the pot shaft clamps on the gimbals should be tightened. The encoder should also be checked to make sure that all trim controls are working, that the sync pulse is at least 8ms, and that the modulator off pulse is between 350 and 420ms. Finally, the oscillator kill line should be ungrounded or RF module re-installed.

ENCODER TROUBLE SHOOTING

Failure of the encoder will generally be due to defective transistors, problems with the adjustment pots, or mechanical difficulties. If proper supply voltage is measured at the board and there is no output waveform, or it is incorrect, one channel missing for example, the circuit causing the trouble should be located. Work back through the modulator, variable period multivibrator, control multiplexer, and control pots with the oscilloscope. Once the problem has been located, it can usually be cured by replacing the transistor or potentiometer involved. Figure 8 shows the effect of low β or high saturation resistance in Q8 (Channel 3). Figures 9 and 10 are parts location overlays.

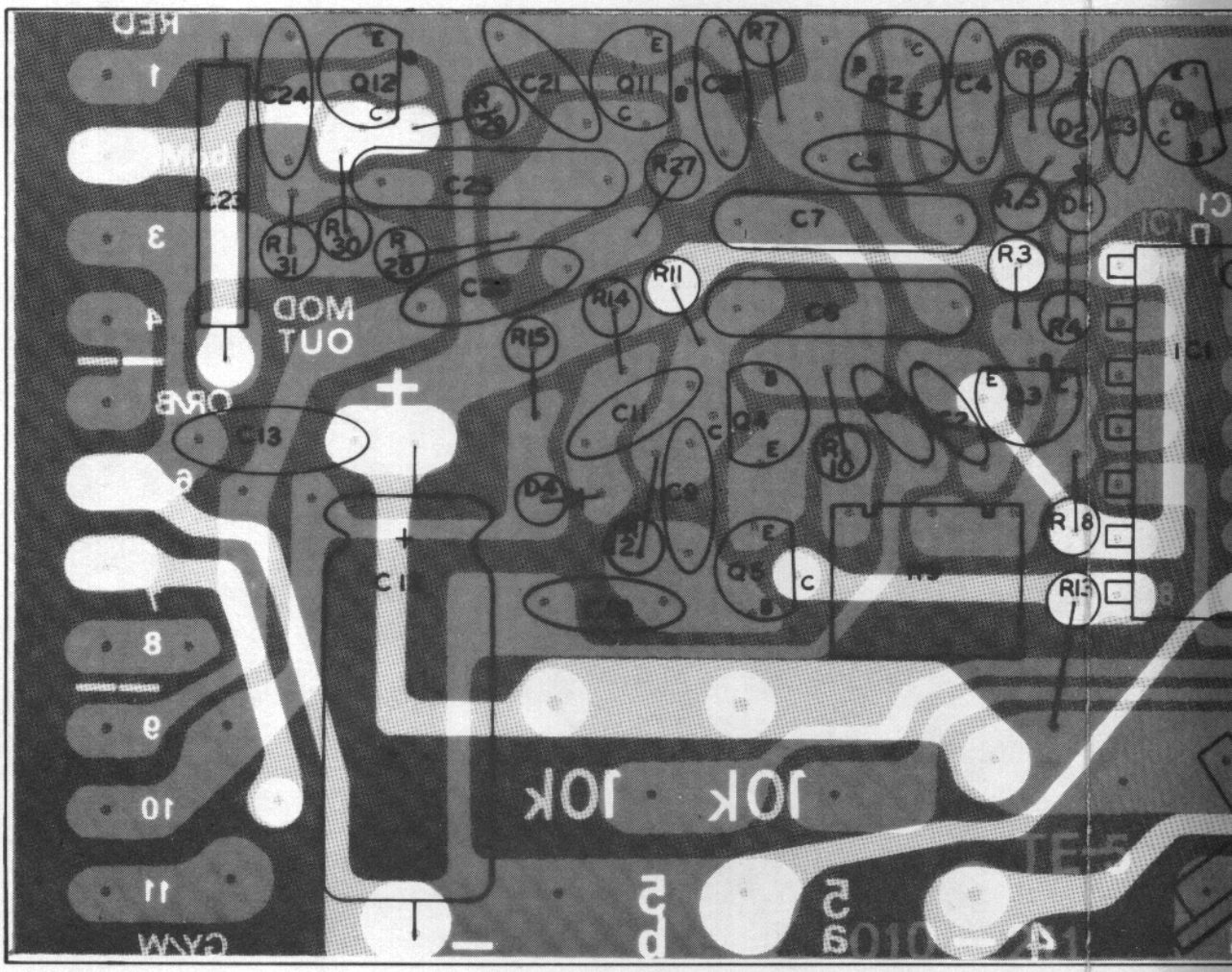
FIGURE 8

5 Channel Encoder, Collector Q2
(Q8 Defective)



With regard to the gimbals, be sure all stick assemblies move freely without rough spots or excessive play. Notice trim action to see if there is any binding or looseness. Checks should be made in such areas as battery mounting, board clearance around gimbals and the case, and proper circuit board insulation from the back of the case.

3C ENCODER



VIEWED FROM FOIL SIDE OF BOARD.

R6 IS NOT PRESENT ON ALL BOARDS.

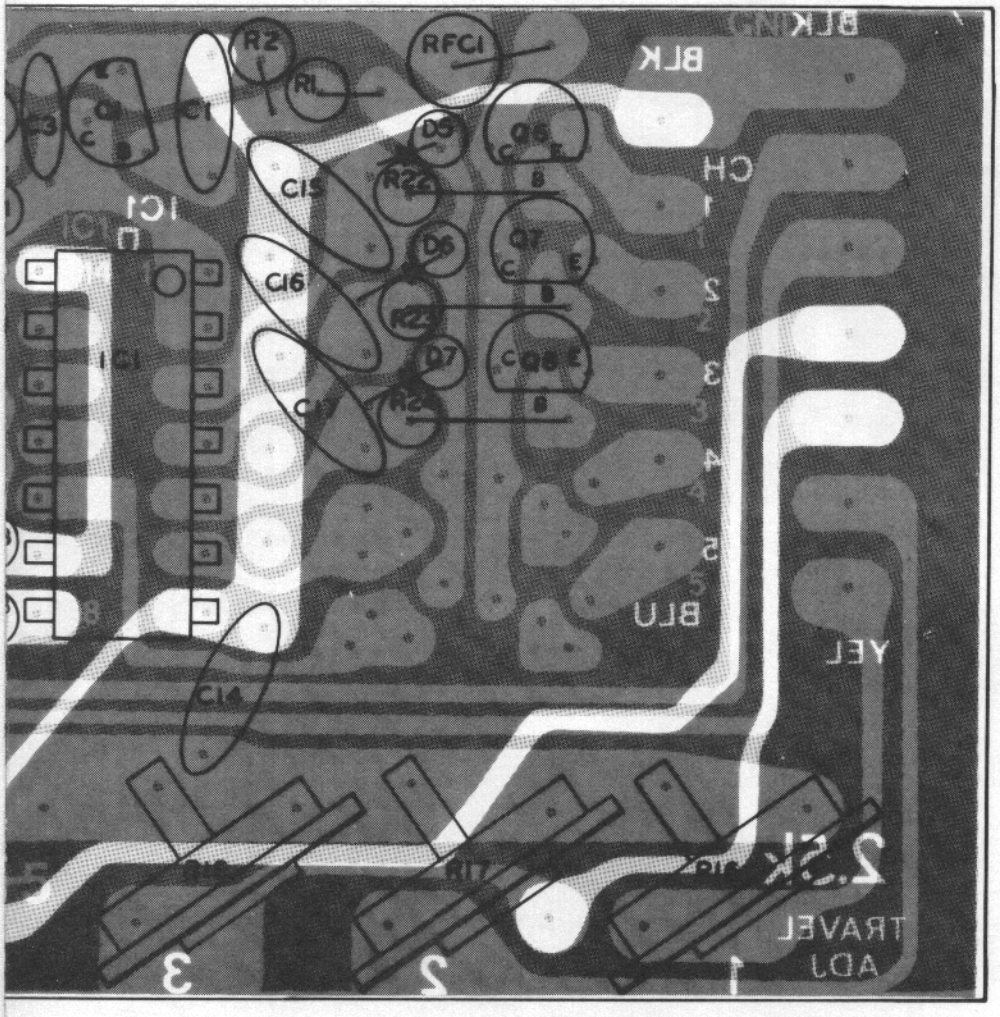
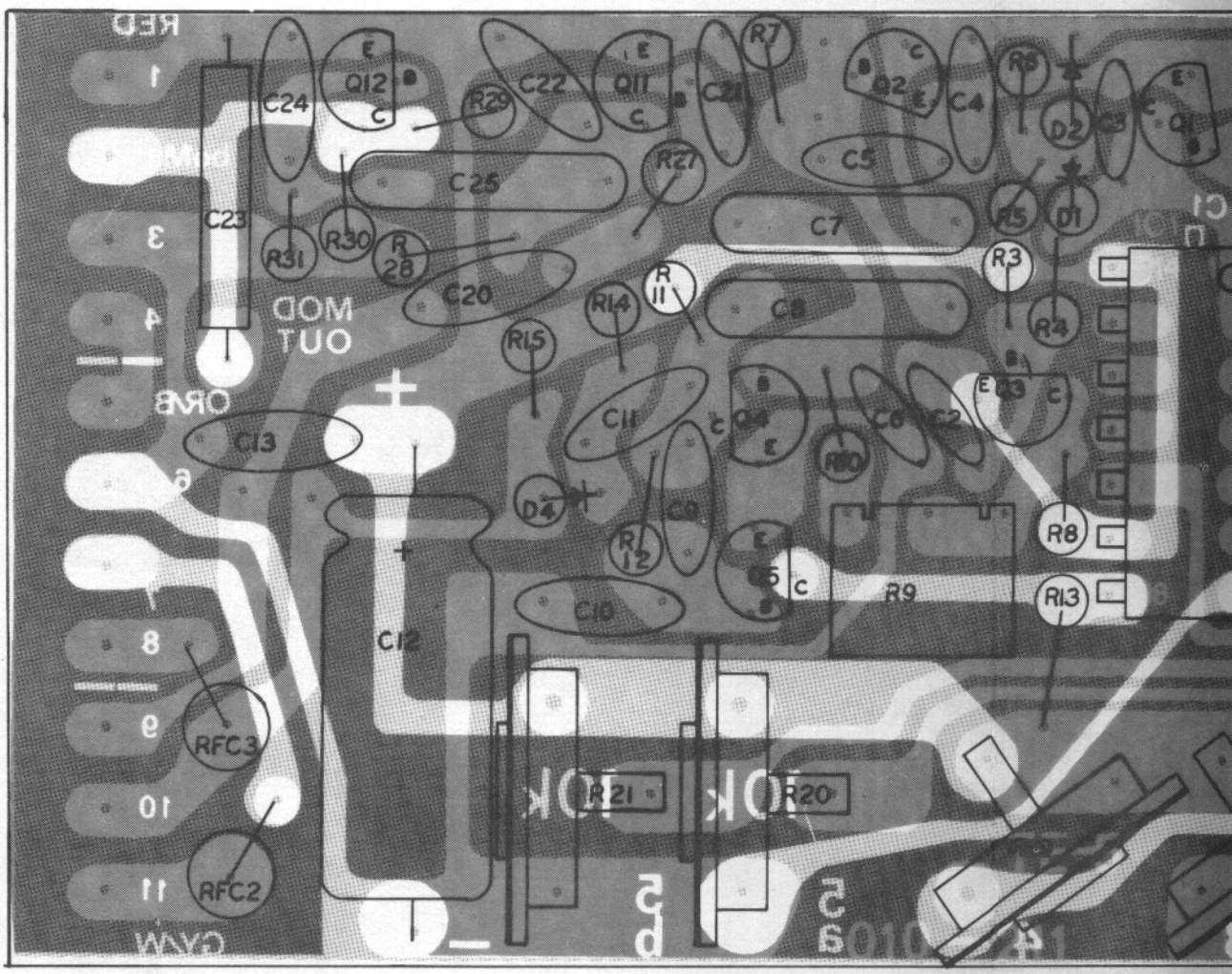

R2
RFC1
R1
C3
Q1
C1
D5
Q6
BLK
CH
C15
R22
IC1
D6
Q7
C16
R23
D7
Q8
C17
R24
BLU
YEL
C14
TRAVEL
ADJ

FIGURE 9

5CS, 5C - ENCODER



COMPONENTS AS SEEN FROM FOIL SIDE OF P.C. BOARD.

ODER

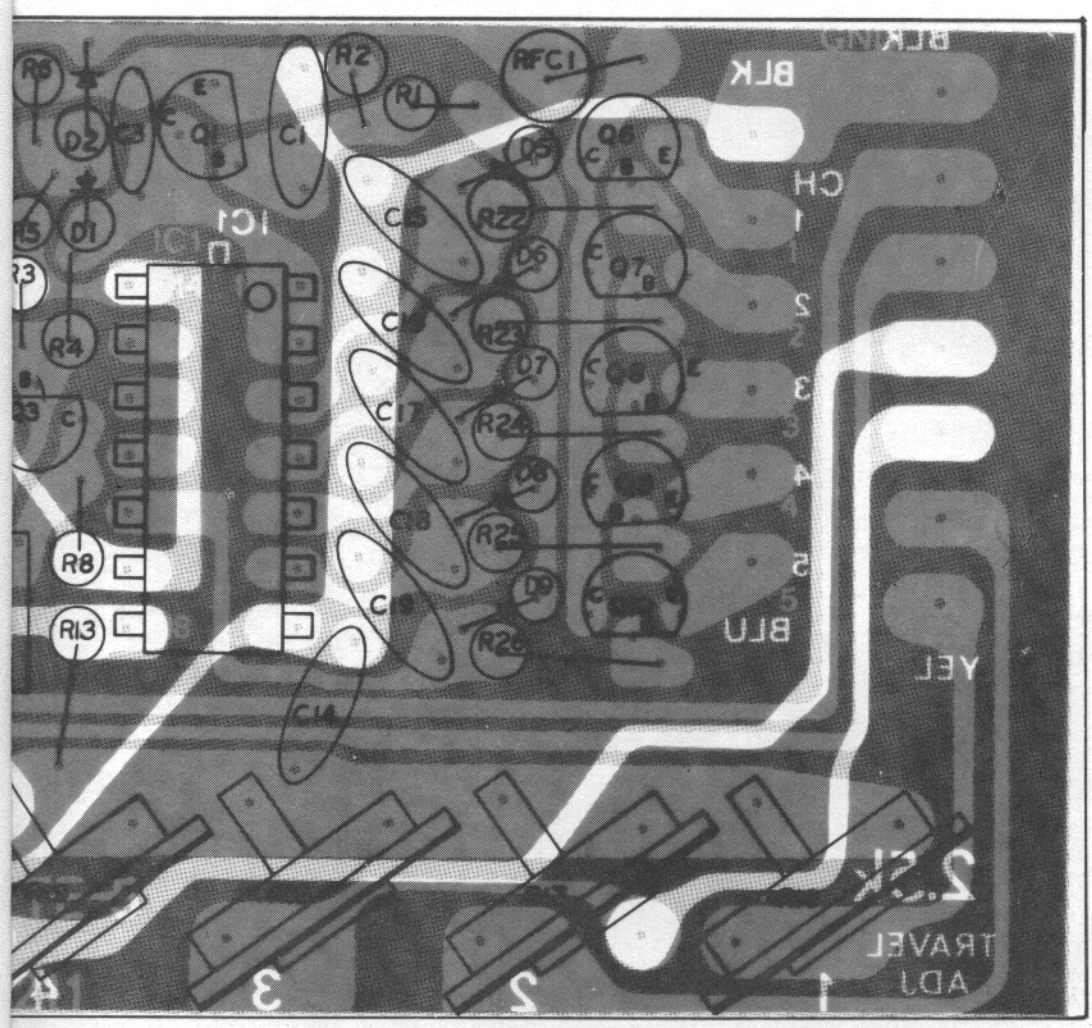


FIGURE 10

ENCODER PARTS LIST
KPT-3C, 5C, & 5CS

RESISTORS

*Parts omitted on 3 channel.

All values in ohms (K = 1000)

R1	22K	¼ W	10%	057-223
R2	47K	¼ W	10%	057-473
R3	47K	¼ W	10%	057-473
R4	22K	¼ W	10%	057-223
R5	2.2K	¼ W	10%	057-222
*R6	6.8K	¼ W	10%	057-682
R7	22K	¼ W	10%	057-223
R8	220K	¼ W	10%	057-224
R9	50K	Bourns Pot		106-039
R10	220K	¼ W	10%	057-224
R11	4.7K	¼ W	10%	057-472
R12	10K	¼ W	10%	057-103
R13	10K	¼ W	10%	057-103
R14	47K	¼ W	10%	057-473
R15	22K	¼ W	10%	057-223
R16	2.5K	CTS Pot		106-055
R17	2.5K	CTS Pot		106-055
R18	2.5K	CTS Pot		106-055
*R19	2.5K	CTS Pot		106-055
*R20	10K	CTS Pot		106-056
*R21	10K	CTS Pot		106-056
R22	47K	¼ W	10%	057-473
R23	47K	¼ W	10%	057-473
R24	47K	¼ W	10%	057-473
*R25	47K	¼ W	10%	057-473
*R26	47K	¼ W	10%	057-473
R27	1K	¼ W	10%	057-102
R28	4.7K	¼ W	10%	057-472
R29	10K	¼ W	10%	057-103
R30	1K	¼ W	10%	057-102
R31	9.1K	¼ W	5%	055-912

Encoder Parts List continued.
Part of Gimbal Assembly

**CP-1	5K	CTS Pot		106-052
	1K	CTS Pot		106-051
CP-2	5K	CTS Pot		106-052
**CP-3	5K	CTS Pot		106-052
	1K	CTS Pot		106-051
*CP-4	5K	CTS Pot		106-052

*Parts omited on 3 channel.

**Five channel only actually two pots.

CAPACITORS

C1	.001uf	500V	Disc	113-012
C2	.001uf	500V	Disc	113-012
C3	.001uf	500V	Disc	113-012
C4	.001uf	500V	Disc	113-012
C5	.001uf	500V	Disc	113-012
C6	.001uf	500V	Disc	113-012
C7	.027uf	100V	Mylar	115-005
C8	.022uf	200V	Mylar	115-029
C9	.001uf	500V	Disc	113-012
C10	.001uf	500V	Disc	113-012
C11	.00luf	500V	Disc	113-012
C12	47uf	16V	Electrolytic	116-008
C13	.01uf	50V	Disc	113-016
C14	.001uf	500V	Disc	113-012
C15	.001uf	500V	Disc	113-012
C16	.001uf	500V	Disc	113-012
C17	.001uf	500V	Disc	113-012
*C18	.001uf	500V	Disc	113-012
*C19	.001uf	500V	Disc	113-012
C20	.05uf	10V	Disc	113-018
C21	.001uf	500V	Disc	113-012
C22	.001uf	500V	Disc	113-012
C23	.1uf	250V	Mylar	115-018
C24	.001uf	500V	Disc	113-012
C25	.068uf	200V	Mylar	115-028

SEMICONDUCTORS

D1, D2, D4, D5, D6, D7, *D8, *D9	1N4148	Diode, Silicon	100-101
D3	Omitted		

Q1, Q2	2N3392	NPN	Transistor, Silicon	101-004
Q3	2N4122	PNP	Transistor, Silicon	101-005
Q4, Q5	2N3392	NPN	Transistor, Silicon	101-004
Q6, Q7, Q8,	MPS-6560	NPN	Transistor, Silicon	101-013
*Q9, *Q10	MPS-6560		Transistor, Silicon	101-013
Q11	2N4122	PNP	Transistor, Silicon	101-005
Q12	MPS-6562	PNP	Transistor, Silicon	101-012
IC-1	74C164			110-117

*Parts omitted on 3 channel.

COILS & TRANSFORMERS

RFC-1	22uh	R.F. Choke	103-045
*RFC-2	22uh	R.F. Choke	103-045
RFC-3	22uh	R.F. Choke	103-045

MISCELLANEOUS

P1-5	Circuit Board Stake-on Pins	120-057
	P.C. Board	010-211

ELECTRONIC ASSEMBLIES

P.C. Assembly, Encoder, KPT-5C, 5CS	300-279
P.C. Assembly, Encoder, KPT-3C	300-300

NOTES:

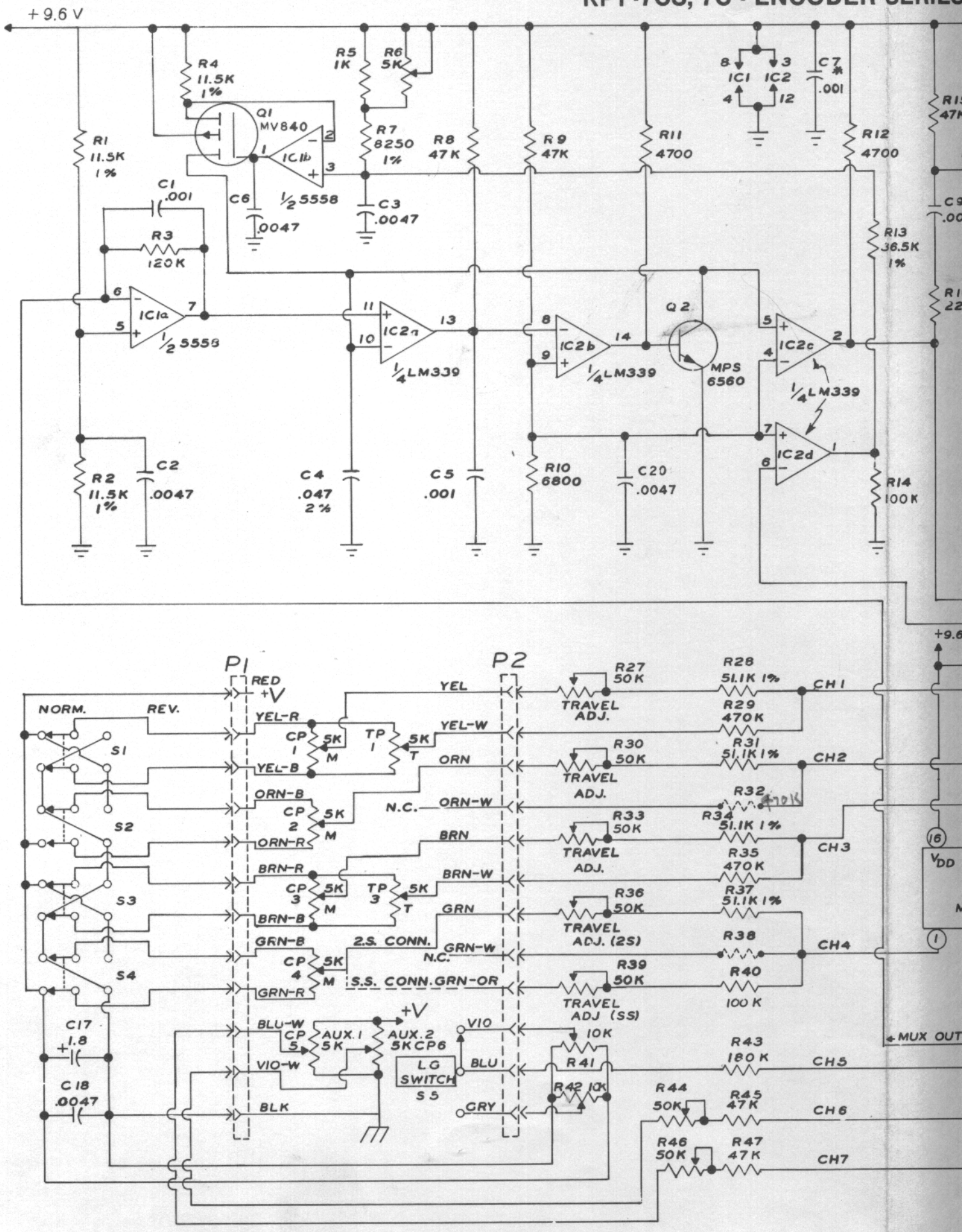
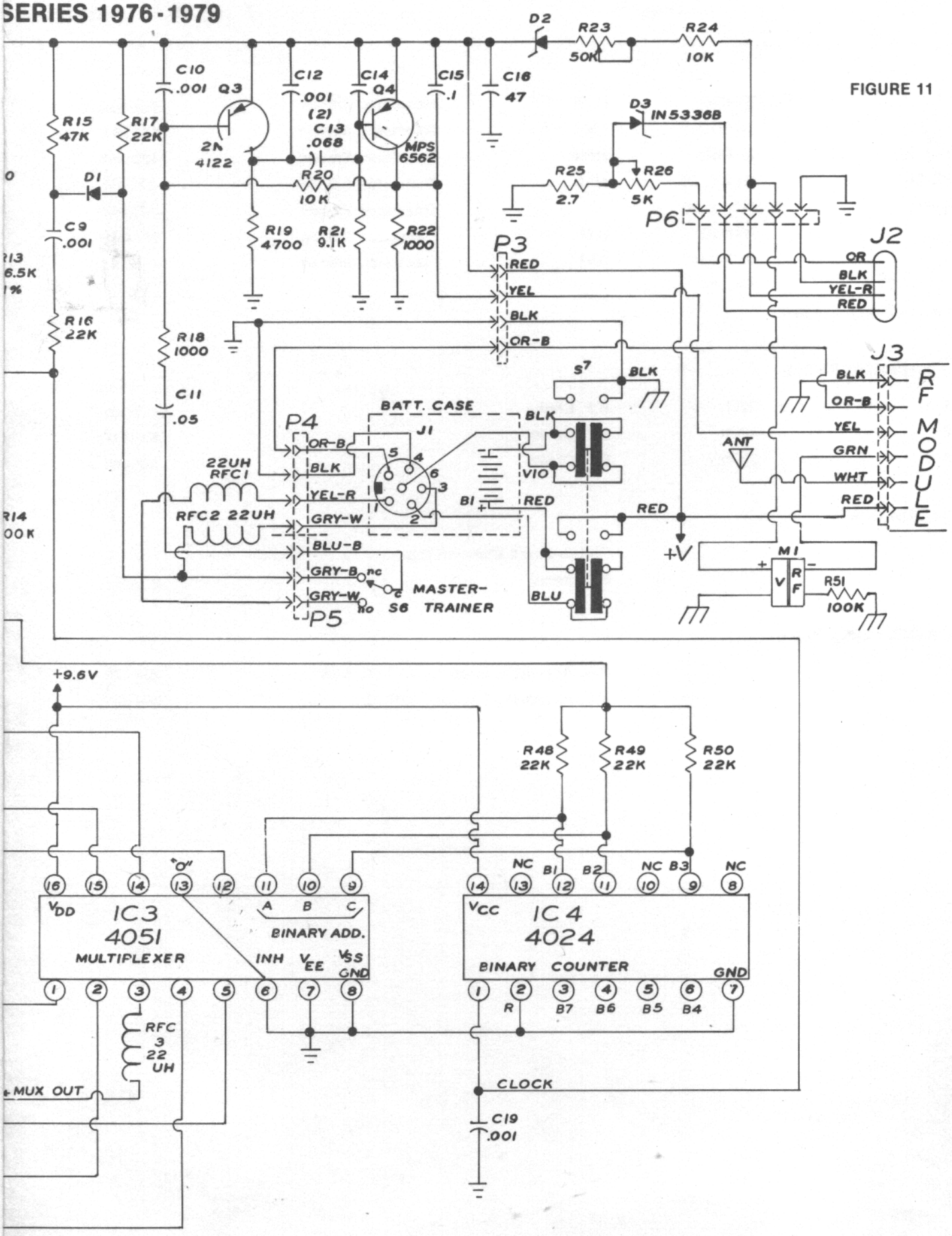

+9.6 V
R1 11.5K 1%
R2 11.5K 1%
R3 120K
R4 11.5K 1%
R5 1K
R6 5K
R7 8250 1%
R8 47K
R9 47K
R10 6800
R11 4700
R12 4700
R13 36.5K 1%
R14 100K
C1 .001
C2 .0047
C3 .0047
C4 .047 2%
C5 .001
C6 .0047
C7 .001
C20 .0047
Q1 MV840
Q2 MPS 6560
IC1a
IC1b
IC2a
IC2b
IC2c
IC2d
1/2 5558
1/4 LM339
P1
P2
RED +V
NORM.
REV.
S1
S2
S3
S4
YEL-R
YEL-B
ORN-B
ORN-R
BRN-R
BRN-B
GRN-B
GRN-R
BLU-W
VIO-W
BLK
YEL
YEL-W
ORN
ORN-W
BRN
BRN-W
GRN
GRN-W
VIO
BLU
GRY
N.C.
2.S. CONN.
S.S. CONN. GRN-OR
CP 1 5K M
CP 2 5K M
CP 3 5K M
CP 4 5K M
CP 5 AUX.1 5K
AUX.2 5K CP6
TP 1 5K T
TP 3 5K T
LG SWITCH S5
C17 1.8
C18 .0047
R27 50K
R28 51.1K 1%
R29 470K
R30 50K
R31 51.1K 1%
R32 470K
R33 50K
R34 51.1K 1%
R35 470K
R36 50K
R37 51.1K 1%
R38
R39 50K
R40 100K
R41 10K
R42 10K
R43 180K
R44 50K
R45 47K
R46 50K
R47 47K
TRAVEL ADJ.
TRAVEL ADJ. (2S)
TRAVEL ADJ (SS)
CH1
CH2
CH3
CH4
CH5
CH6
CH7
MUX OUT
VDD
+9.6

FIGURE 11



S1-S4 DIRECTION SWITCHING OPTIONAL—
JUMPERS INSTALLED IN SWITCH POSITIONS SHOWN

*BOTTOM OF BOARD FOR '76 SERIES (TOP OF BOARD FOR SERIES "7-79).

ENCODER OPERATION, KPT-7C AND KPT-7CS
Figure 11

(See following section for Op Amp theory)

The variation in pulse width which represents the control position is accomplished by letting capacitor C4 charge from a constant current source until its voltage equals a voltage set by the position of the arm of the control pot. The comparison is made by applying the two voltages to the inputs of the differential amp IC2A.

Electrical trim pots, where used, are connected in parallel with the control pots. The voltage at the arm of the control pot, and the trim pot where used, are selected by the multiplexer IC3, and they along with the feedback voltage are summed at the input of voltage follower IC1A through separate summing resistors. Part of the summing resistor in series with the arm of the control pots is variable. This varies the feedback ratio of IC1A, which varies its gain and, therefore, the range of control action. The adjustment of control range does not affect the neutral position of the control, which is set by the voltage at the other input of IC1A.

The multiplexer IC3 connects each control pot in turn to the voltage follower IC1A through its internal analog switches (Figure12) The analog switches are controlled by the decoder in IC3 which receives 3-bit binary numbers from 0 to 7 in sequence from the counter IC4 (Figure 13).

FIGURE 12
7 Channel Encoder
Upper trace pin 7; IC1A

Lower Trace Collector Q4 (x10 probe)

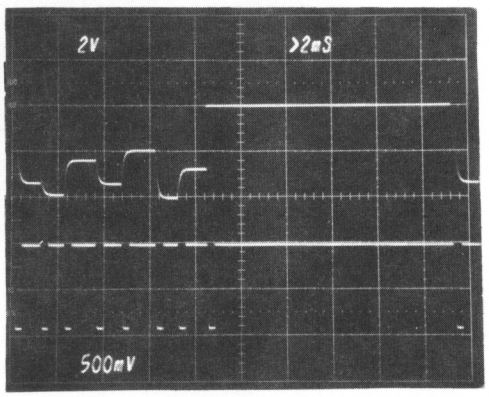
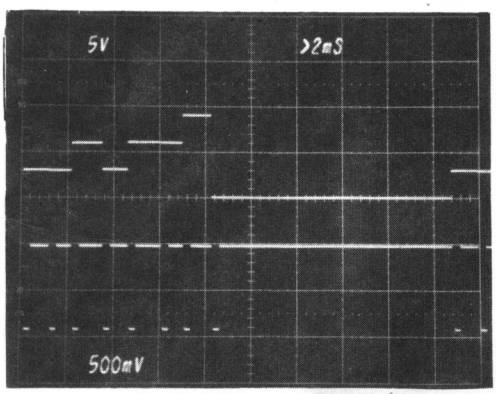


FIGURE 13
7 Channel Encoder
Upper trace IC2D pin 6

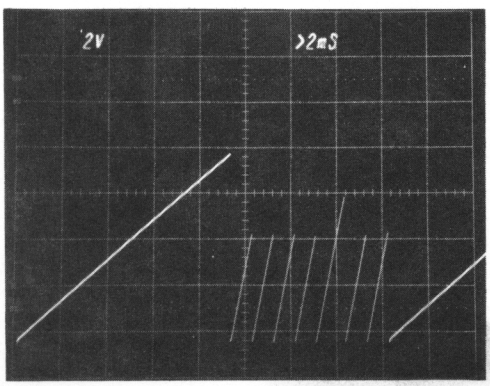
Lower trace Collector Q4 (x10 probe)



The current source for C4 consists of Q1, IC1B, and associated components. During the generation of the variable width pulses, R14 is short-circuited by IC2D. The charging current for C4 flows through R4 so that the voltage across R4 is proportional to the current. By comparing this voltage with a reference voltage at the input of IC1B, and using any difference to adjust the gate voltage of Q1, which is connected to the output of IC1B, the voltage across R4 will be kept close to that of the reference voltage at the junction of R7 and R13. The result is that the current is regulated to a value set by the reference voltage.

When the voltage across C4 reaches the voltage at the other input of IC2A (set by the control pot), the output goes to ground, discharging C5 and driving IC2B so that its output becomes a high impedance (open collector). When the output of IC2B goes high, Q2 turns on, pulling the input and therefore the output of IC2C low. When Q2 turns on it also discharges C4 to prepare it for timing the next channel. Q2 is held on for the time necessary to recharge C5 after the output of IC2A goes high impedance, about 200us, so the counter and multiplexer can select the next channel control pot (Figure14).

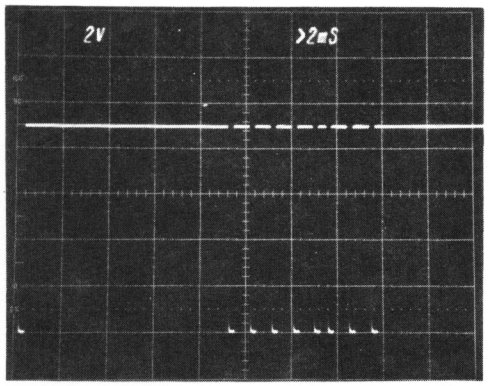
FIGURE 14
7 Channel Encoder, IC2A, pin 10



While the counter is sequencing through the control channels, at least one of its outputs (pins 9, 11, and 12) is always positive. This voltage is coupled to the input of IC2D through R48, R49, and R50 (Figure 13), which keeps its output at ground. When the counter has sequenced all 7 channels, the next clock pulse changes all three outputs of IC4 to ground. This removes the positive voltage from the input of IC2D and allows its output to go "high-impedance" placing R14 actively in the circuit. With R14 in the circuit, the charging current for C4 is reduced to about ½ its previous value. At the same time, the multiplexer has connected the input to IC1A to ground, which forces its output high. The combined effect of these changes is to cause a fixed pulse delay of ~8ms, which is the sync time before the sequence starts over.

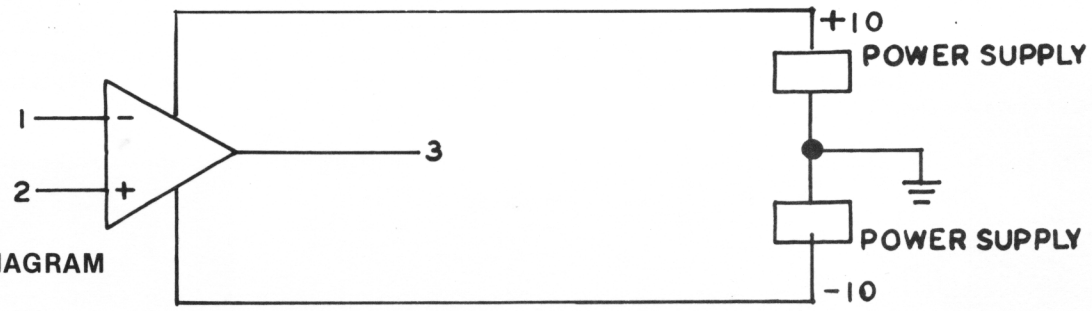
Each time the output of IC2C goes low, it provides a clock pulse to the counter, IC4. It also drives the multivibrator consisting of Q3 and Q4 through differentiator C9, and positive pulse blocking diode D1. The multivibrator generates the modulation pulses for the transmitter. Each time the base of Q3 is driven negative, Q3 turns on and drives Q4 off through C13. Q4 stays off for ~400us as determined by C13 and R21, which removes the supply voltage from the buffer-amplifier in the transmitter. Q3 is held on for the duration of the 400us pulse by feedback through R20 (Figure 15).

FIGURE 15
7 Channel Encoder, Collector Q4



BASIC OPERATIONAL AMPLIFIER (Op Amp) THEORY

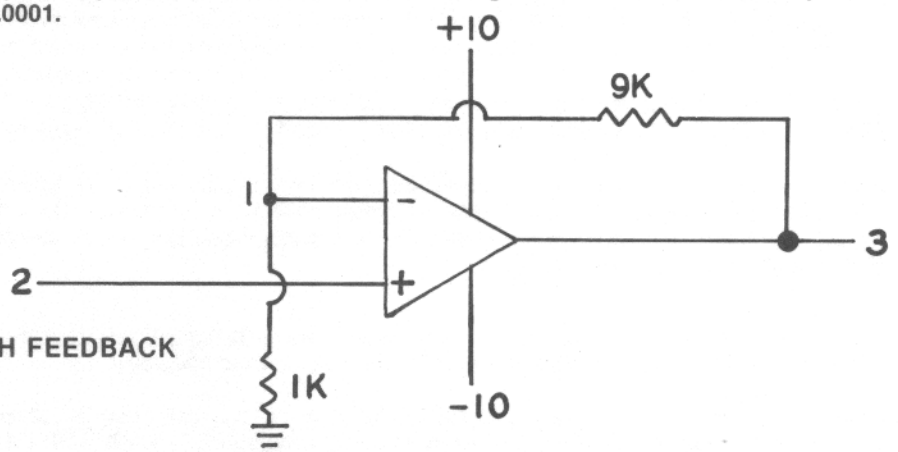
An Op Amp is shown in block diagram form in Fig. 16. It has two inputs (1 & 2) and one output (3). If it were an ideal Op Amp it would operate as follows. When both inputs are grounded the output is also at ground potential. If input 1 is grounded and input 2 is set at a potential of + 10 microvolts, the output will be at a positive potential of 10 microvolts x the gain of the Op Amp (typically 100,000), or + 1 volt. This is called the non-inverting input. If input 2 is grounded and input 1 is set at + 10 microvolts, the output will be at a potential of -1 volt. This is called the inverting input. If both inputs 1 and 2 are connected to + 10 microvolts (or to any other voltage as long as they are both connected to the same voltage) the output will remain at a voltage halfway between the + and - supply voltages (ground in this case). The first condition described above is an example of this.



OP AMP BLOCK DIAGRAM
FIGURE 16

In the case of a real Op Amp there must usually be a small voltage difference between the two inputs for the output to remain halfway between the supply voltages. This voltage may be only a few microvolts and is called the input offset voltage. It is important in some applications but can be ignored when considering the operation of the 7-channel encoder so long as the Op Amp is not defective. A real Op Amp also draws some current at the inputs, but it is usually in the nano amp range and can also be ignored in this application.

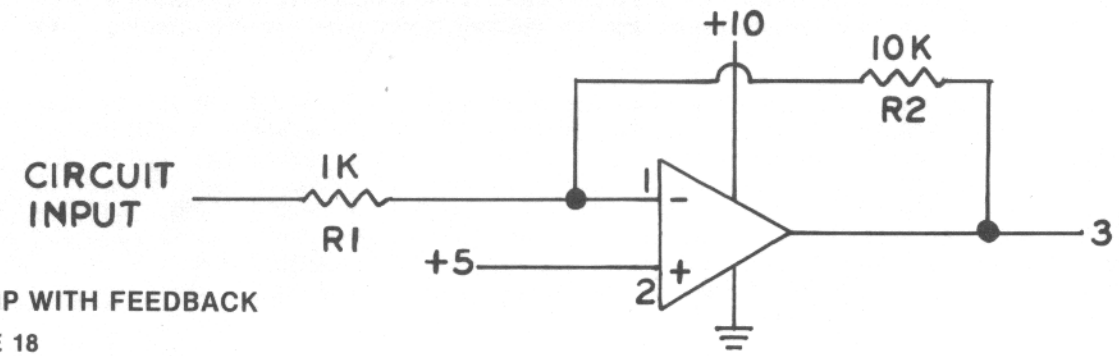
Op Amps are usually used with a feedback network. One example is shown in Fig. 17 . Even though the Op Amp may have a gain of 100,000, the gain of the whole circuit will be about 10. To understand this suppose that the output (3) is at + 10 volts. If the output is at + 10 volts then the voltage at input 2 must be greater than the voltage at input 1 by 100 microvolts (output voltage 10 divided by gain of Op Amp 100,000). But if the output voltage is + 10 volts then input 1 must be at + 1 volt because of the resistor voltage divider. If input 1 is a + 1 volt and input 2 is 100 microvolts more positive than input 1, input 2 must be at 1.0001 volts. The gain of the circuit is the output voltage divided by the input voltage or 10/1.0001.



OP AMP WITH FEEDBACK

FIGURE 17

Another frequently used feedback arrangement is shown in Fig. 18. This is the arrangement used with IC1A in the 7-channel encoder although Fig. 18 is a simplified version. Fig. 18 can be understood as follows. Assume the output (3) is at + 10 volts. Since the output would be at + 5 volts (halfway between the power supply connections) with no input, the output of + 10 represents a + 5 volt change. If this is so then Op Amp input 1 must be at + 4.99995 volts (the 5 volts at input 2 less 50 microvolts) if the gain of the Op Amp is 100,000. Then with the output at + 10 and input 1 at + 4.99995 a voltage divider calculation will show that the circuit input voltage is + 4.499945 which represents a change of -0.500055 (the input change) or about -10.



OP AMP WITH FEEDBACK

FIGURE 18

A comparison between the 7-channel encoder IC1A and the simplified Fig. 18 can be made as follows. If the 7-channel encoder is encoding channel 1 information, then CP1, TP1, R27, R28 and R29 work together as the equivalent of R1 in Fig. 18, R3 in the encoder is the same as R2 in Fig. 18 (C1 is for frequency compensation), and the + 5 volts on input 2 in Fig. 18 is provided by R1 and R2 in the encoder. Calculations relating the 5 equivalent resistors in the encoder to R1 in Fig. 18 can be made based on normal voltage divider theory.

KPT-7C & 7CS ENCODER ADJUSTMENT

Before starting the adjustment the oscillator-kill line should be grounded or the module removed to eliminate any disturbance from stray RF. A scope with the zero reference centered on the screen should then be connected between the junction of R1 and R2, and the arm of each control pot in turn. Center all trim levers prior to starting adjustment. The shaft of each control pot should be adjusted in its gimbal clamp until its arm is at the same potential ± 10mv as the resistor junction when the control lever is centered. The gimbal clamps should then be tightened as there is no interaction with any other adjustment. In order to measure the control pulse widths during adjustments the circuit in Figure 7 should be used. The channel displayed can be selected by choosing the appropriate decoder output. The vertical sensitivity should be set for 2 volts per division and the sweep speed should be 200us per division.

Set R6 for 1400ms pulse widths on any channel, with plugs on encoder board removed. Plug in the connectors with the control and trim levers of channel 1 centered and the scope set to display channel 1, its pulse width should be set at 1.4ms. Channels 2 and 4 should also have pulse widths of 1.4ms with their control and trim levers centered. If they do not, a slight adjustment of their pot shafts may be necessary.

The travel adjustment for channels 1, 2 and 4 should now each be made using R27, R30, and R36 or R39. With trim levers centered, the minimum pulse width should be .950ms and the maximum should be l.85ms.

Channels 3, 5, 6, and 7 should now be set for a minimum pulse width of 0.9ms and a maximum of 1.9ms including the effect of both control and trim levers where applicable. The adjustment for channel 5 is made with R41 and R42. The others are set with the travel pots R33, R44 and R46.

Finally, the encoder should also be checked to make sure all trim controls are working in the correct direction, that the sync pulse is at least 8ms, and that the modulator off pulse is between 350 and 420ms. The oscillator kill line should also be ungrounded or the module replaced.

Calibration of the battery meter is done as follows. First an adjustable power supply with accurate metering of its output voltage should be connected in place of the battery pack to the receiver switch harness. The switch harness should then be connected through the receiver battery check cable to the transmitter. The purpose in doing this is to make the voltage drop between the battery connector and the metering circuit the same during calibration as it will be in actual use.

With the connections complete the voltage at the battery connector should be set at 4.8 volts and the meter adjusted to read 4.8 volts by varying R26. The voltage at the battery connector should then be set at 5.4 volts and the meter adjusted to read 5.4 volts by changing the mechanical zero. These adjustments interact so they must be repeated alternately until both are correct. After the 4.8 and 5.4 volt settings are correct the voltage at the battery connector should be set at 3.6 volts and the meter reading checked. When properly adjusted the meter should read exactly 4.8 when the voltage at the battery connector is 4.8 volts, and should read within 3 needle widths of the correct value for the 5.4 and 3.6 volt settings. The meter needle must also be off its lower stop at the 3.6 volt setting. In other words it must move toward zero when the 3.6 volts is removed. If these adjustments cannot be correctly made it usually indicates a defective zener diode or possibly other components.

After the receiver calibration has been completed the receiver battery check cable should be removed from the transmitter and the accurately metered power supply connected in place of the transmitter battery pack. With the power supply set at 9.6 volts the meter should be adjusted to read 9.6 volts by varying R23.

ENCODER PARTS LIST
KPT-7C & 7CS

RESISTORS

All values in ohms (K = 1000)

R1	11.5K	1/8W	1%	040-033
R2	11.5K	1/8W	1%	040-033
R3	120K	¼W	10%	057-124
R4	11.5K	1/8W	1%	040-033
R5	1K	1/8W	1%	040-038
R6	5K	3386R	Bourns Pot	106-057
R7	8.25K	1/8W	1%	040-020
R8	47K	¼W	10%	057-473
R9	47K	¼W	10%	057-473
R10	6.8K	¼W	10%	057-682
R11	4.7K	¼W	10%	057-472
R12	4.7K	¼W	10%	057-472
R13	36.5K	1/8W	1%	040-031
R14	100K	¼W	10%	057-104
R15	47K	¼W	10%	057-473
R16	22K	¼W	10%	057-223
R17	22K	¼W	10%	057-223
R18	1K	¼W	10%	057-102
R19	4.7K	¼W	10%	057-472
R20	10K	¼W	10%	057-103
R21	9.1K	¼W	5%	055-912
R22	1K	¼W	10%	057-102
R23	50K	339P	Bourns Pot	106-048
R24	10K	¼W	10%	057-103
R25	2.7 ohm	¼W	10%	056-027
R26	5K	3339	Bourns Pot	106-049
R27	50K		Bourns Pot	106-039
R28	51.1K	1/10W	1%	040-036
R29	470K	¼W	10%	057-474
R30	50K		Bourns Pot	106-039
R31	51.1K	1/10W	1%	040-036
R33	50K		Bourns Pot	106-039
R34	51.1K	1/10W	1%	040-036
R35	470K	¼W	10%	057-474
R36	50K		Bourns Pot	106-039
R37	51.1K	1/10W	1%	040-036
R39	50K		Bourns Pot	106-039
R40	100K	¼W	10%	057-104
R41	10K		Bourns Pot	106-038

Encoder Parts List continued.

R42	10K		Bourns Pot	106-038
R43	180K	¼W	10%	057-184
R44	50K		Bourns Pot	106-039
R45	47K	¼W	10%	057-473
R46	50K		Bourns Pot	106-039
R47	47K	¼W	10%	057-473
R48	22K	¼W	10%	057-223
R49	22K	¼W	10%	057-223
R50	22K	¼W	10%	057-223
R51	100K	¼W	10%	057-104

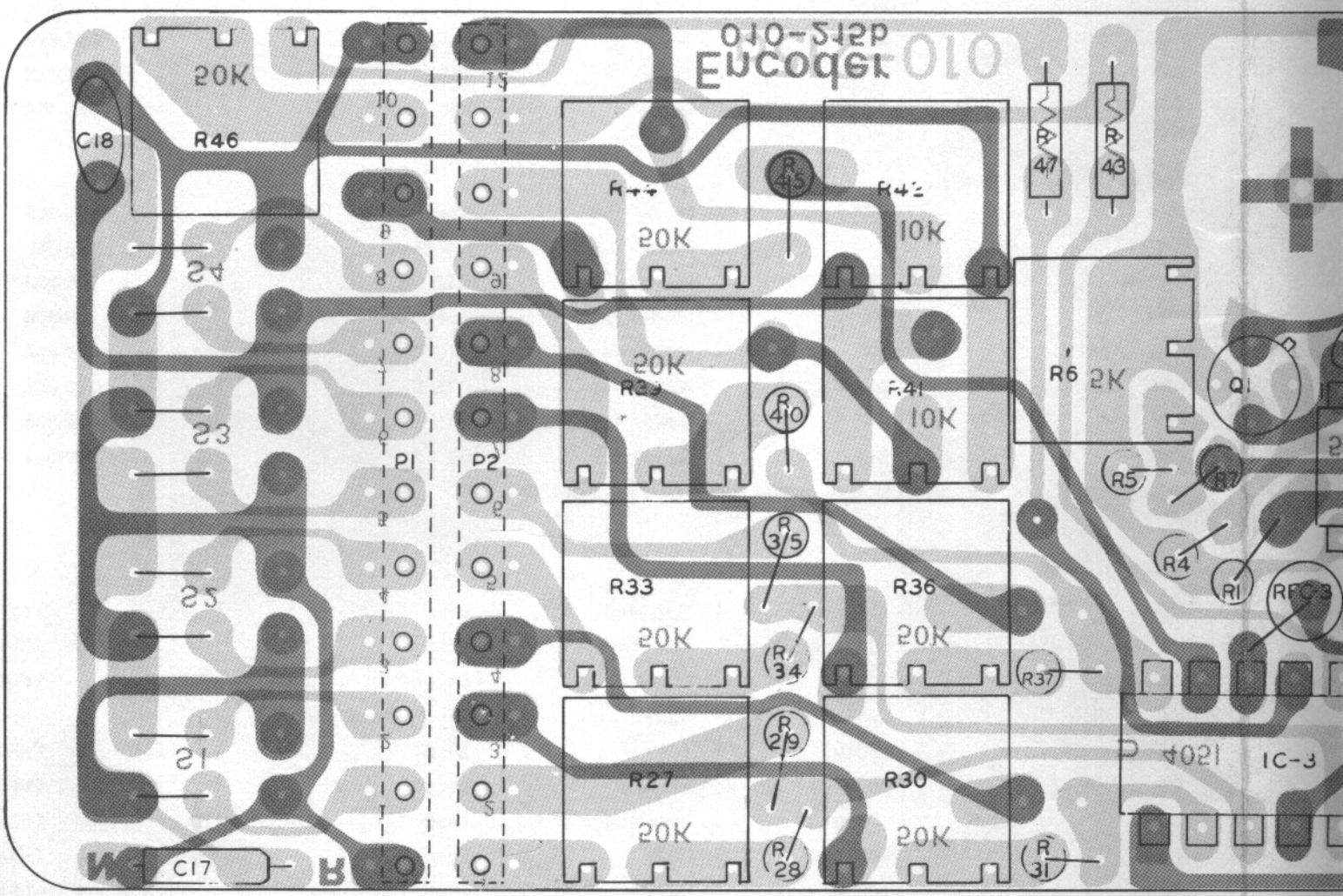
Part of Gimbal Assembly

* CP1	5K	Model 158	Spectrol	106-060
* CP2	5K	Model 158	Spectrol	106-060
CP3	5K	AW Series	CTS Pot	106-052
* CP4	5K	Model 158	Spectrol	106-060
CP5 Aux. 1	5K	AW Series	CTS Pot	106-052
CP6 Aux. 2	5K	AW Series	CTS Pot	106-052
TP1	5K	Series 115	CTS Pot	106-053
TP3	5K	Series 115	CTS Pot	106-053

* In Series 1977 and 1978 Gimbal only, Series 1976 has CTS Pots, P/N 106-052

CAPACITORS

C1	.001uf	Sub-Mini	Disc	113-021
C2	.0047uf	Mepico	Disc	113-038
C3	.0047uf	Mepico	Disc	113-038
C4	.047uf	100V	Disc (Acushnet)	113-042
C5	.001uf	500V	Disc	113-012
C6	.0047uf	Mepico	Disc	113-038
C7	.001uf	Sub-Mini	Disc	113-021
C9	.001uf	500V	Disc	113-012
C10	.001uf	500V	Disc	113-012
C11	.05uf	10V	Disc	113-018
C12	.001uf	500V	Disc	113-012
C13	.068uf	200V	Mylar	115-028
C14	.001uf	500V	Disc	113-012
C15	.1uf	250V	Mylar	115-018
C16	47uf	16V	Electrolytic	116-008
C17	1.8uf	25V	Tantalum	115-010
C18	.0047uf	Mepico	Disc	113-038
C19	.001uf	Sub-Mini	Disc	113-021
C20	.001uf	Sub-Mini	Disc	113-021



VIEWED FROM FOIL SIDE OF BOARD.

ENCODER

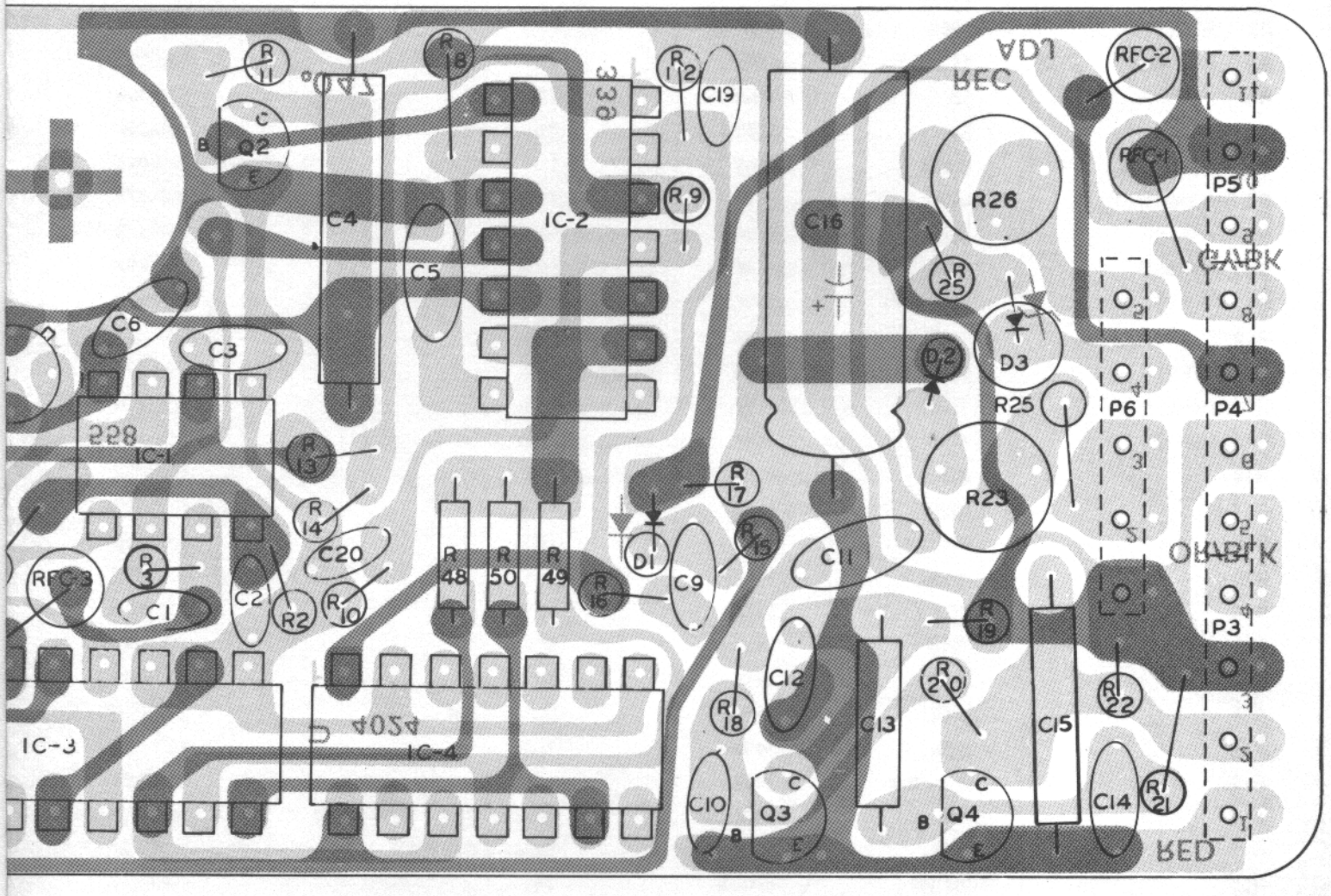


FIGURE 19

SEMICONDUCTORS

D1	1N4148	Diode Silicon		100-101
D2	1N5237B	Diode Zener		100-108
D3	1N5336B	Diode Zener		100-109
Q1	Mv840	FET	Transistor Silicon	101-030
Q2	MPS-6560	NPN	Transistor Silicon	101-013
Q3	2N4122	PNP	Transistor Silicon	101-005
Q4	MPS-6562	PNP	Transistor Silicon	101-012
IC1A & B	NE5558			110-121
IC2A, B, C, D	LM339			110-122
IC3	4051			110-119
IC4	4024			110-120

COILS AND CHOKES

RFC1, 2, 3	22uh	103-045

MISCELLANEOUS

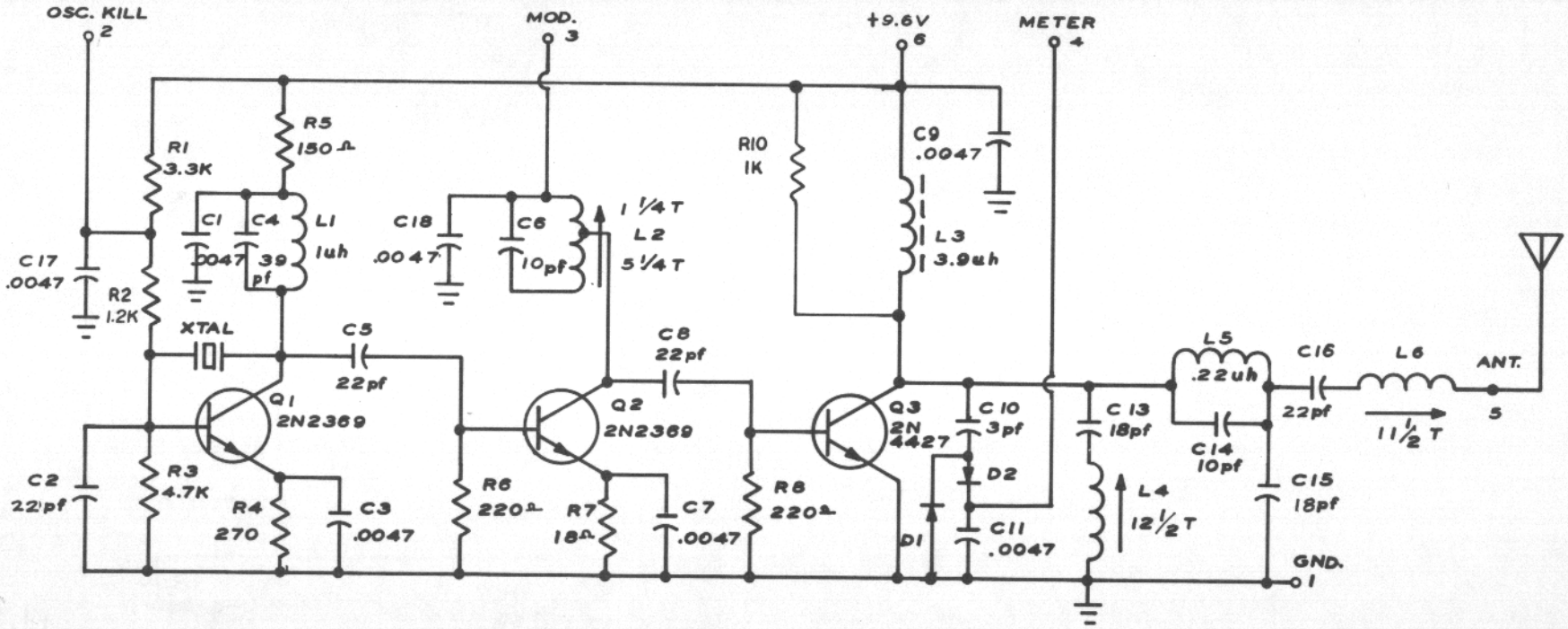
P1, 2, 3, 4, 5, 6	Circuit Board Stake-on Pins	120-057
T-25	P.C. Board	010-215

ELECTRONIC ASSEMBLY

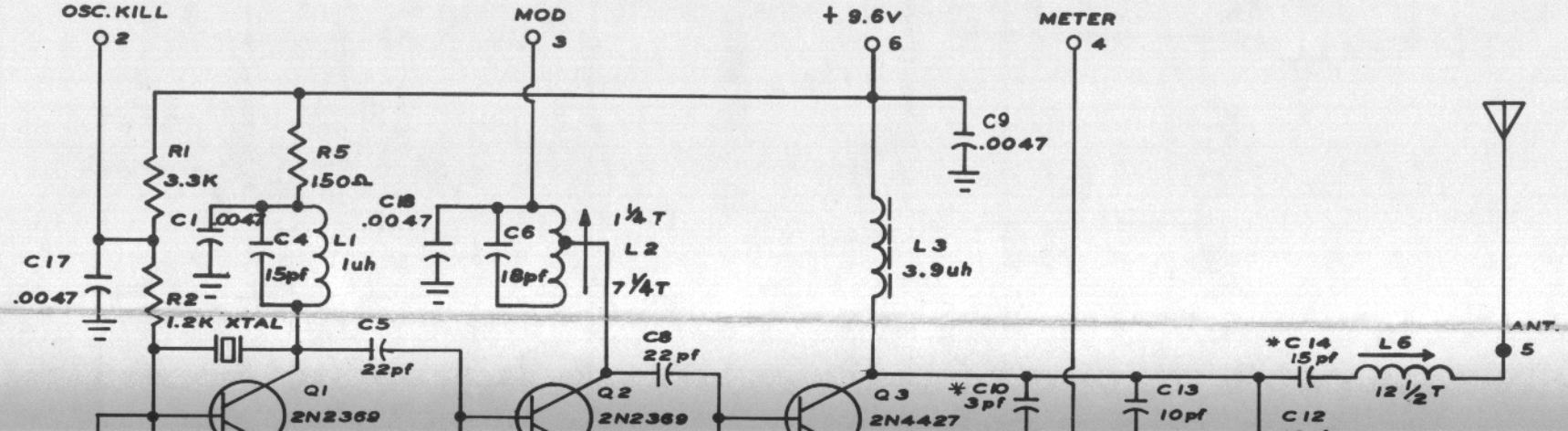
	KPT-7C & 7CS Encoder Assembly	300-287

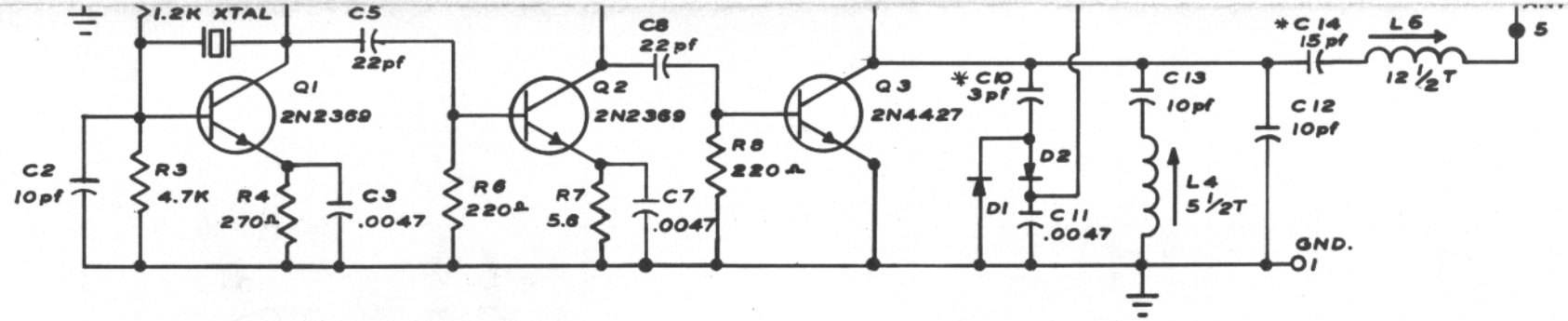
FIGURE 20

72 MHz-TX- -R.F. SECTION (AM)



53 MHz-TX- -R.F. SECTION (AM)





* FOR EUROPEAN TX BLACK MODULES CHANGE C10 AND C14 TO 10PF.

27 MHz-TX- -R.F. SECTION (AM)

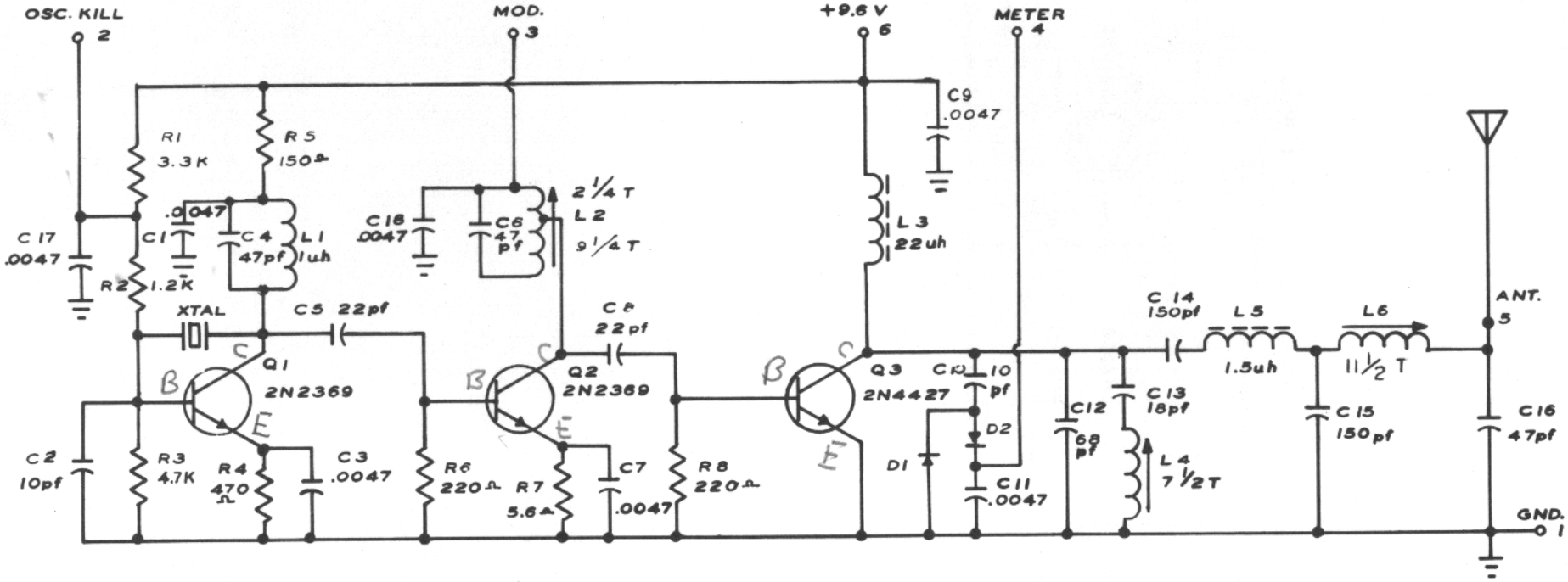
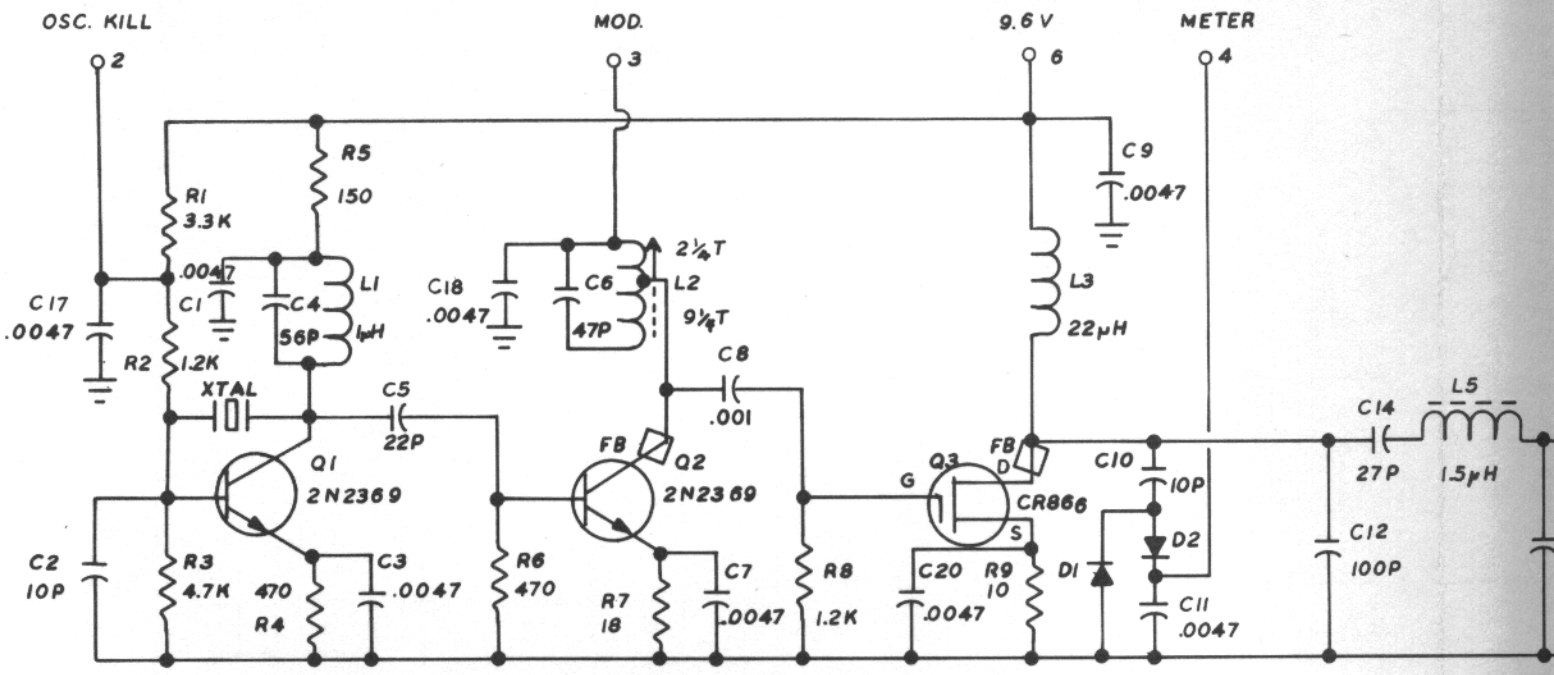


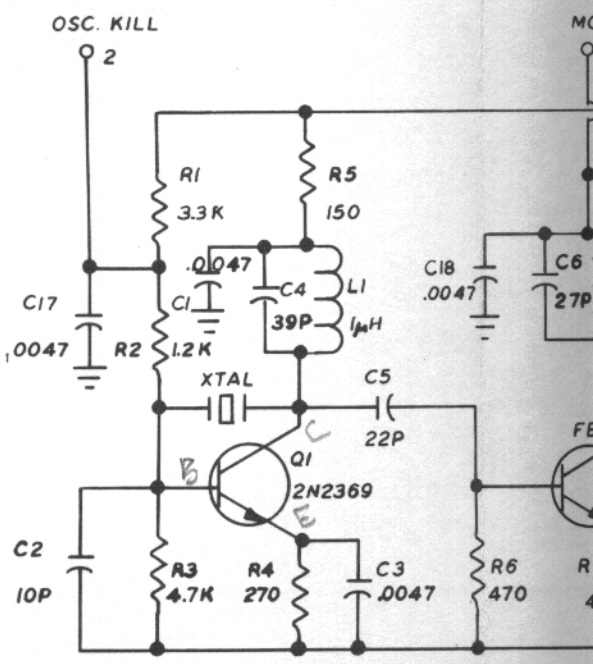
FIGURE 21

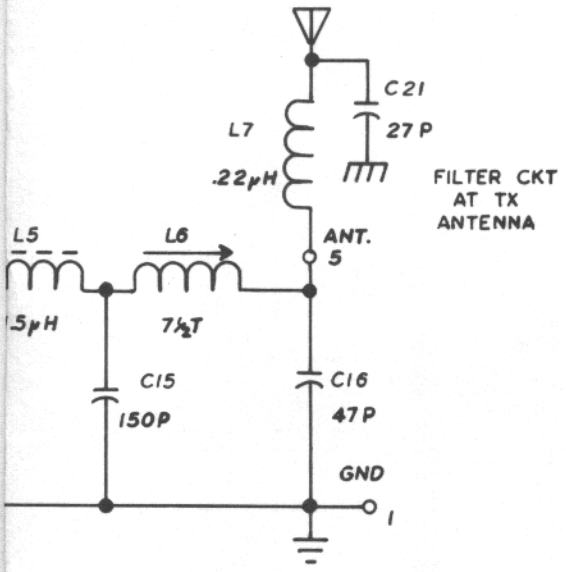
27 MHz TX- R.F. SECTION (EUROPE - AM)



NOTES: 1) L7 AND C21 ARE MOUNTED IN TX C
2) FB IS FERRITE BEAD P/N 990-065
3) REF. DES. C13, C18, C19, L4 NOT

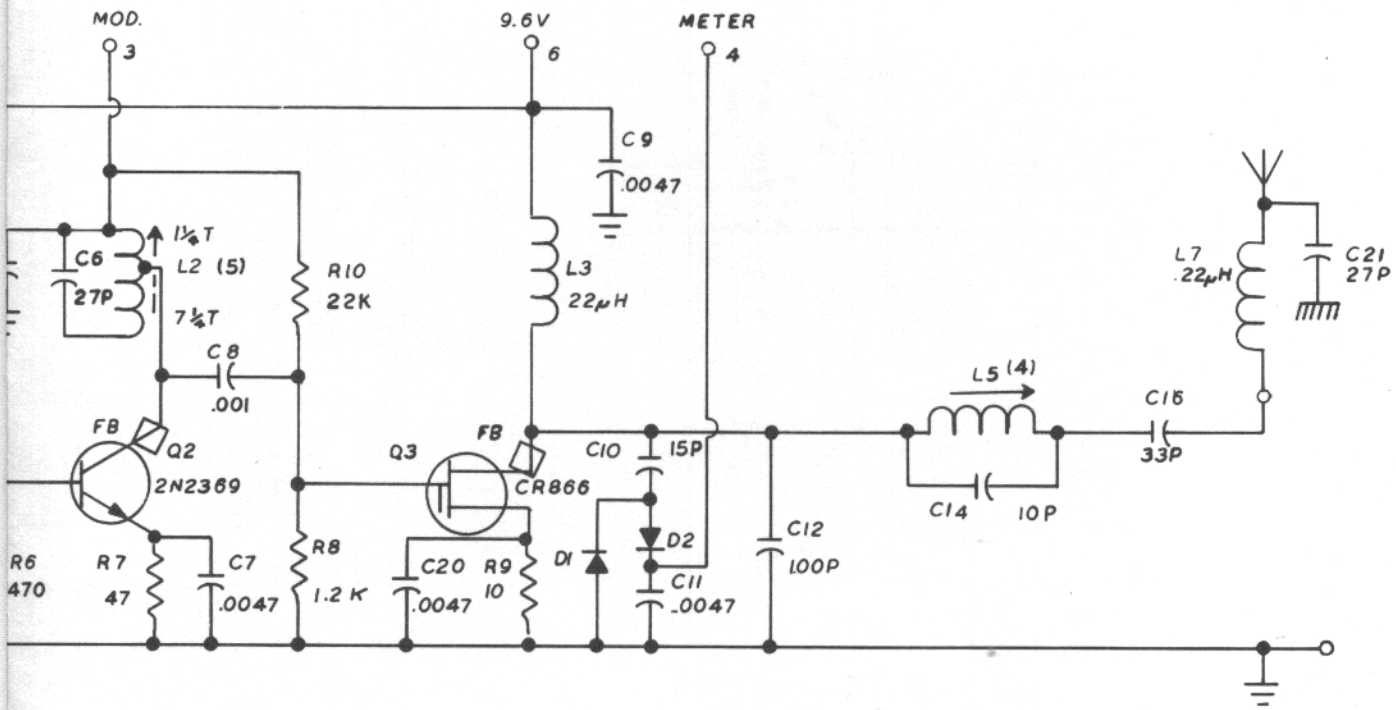
FIGURE 22





D IN TX CASE AT ANT. TERMINALS
990-065
L4 NOT USED

35 & 40 MHz TX- R.F. SECTION (EUROPE - AM)



NOTES:
1) L7 & C21 ARE MOUNTED IN TX CASE AT ANT. TERMINALS
2) FB IS FERRITE BEAD, P/N 990-065
3) L4, L6, C13, C15, C19 NOT USED.
4) L5 - 35 MHZ: 103-082 9½T W/SHORT SLUG
40 MHZ: 103-084 7½T W/SHORT SLUG
5) L2 - 35 MHZ: LONG SLUG - 40 MHZ: SHORT SLUG

TRANSMITTER RF SECTION
Domestic

(Figure 20)

The transmitter R.F. section is a three stage type utilizing an oscillator, buffer, and final amplifier. For 72 MHz, the buffer also serves as a doubler.

Transistor Q1 forms a crystal-controlled oscillator in Pierce configuration. Resistors R1, R3, R4, and R5 serve as biasing components. Capacitor C2 serves to help start the oscillator reliably. The resonant collector tank, L1-C4, tunes the oscillator and assures a clean 36 MHz output signal. R1, R2 and C17 provide a DC control line to disable the oscillator when using the mastertrainer system.

Transistor Q2 operates as a Class C buffer to bring the oscillator frequency up to the desired power level to drive final amplifier Q3. Drive for this stage is capacitively coupled from the oscillator collector via C5. The resonant collector tank, L2-C6, is tapped to provide high "Q" for low harmonic output from this stage. This stage also serves as the modulated stage, driven by the encoder-modulator circuit.

Transistor Q3 is operated as a Class C amplifier and brings the signal from the buffer up to usable transmission level, as well as further reducing the harmonic output. Drive for this stage is taken from the buffer collector via C8. L3 in the collector circuit delivers battery power to the final amplifier and serves as an RF load.

The type of output tuning network used depends on the operating frequency and they are shown on the respective schematics. In each case, there is a series tuned resonant circuit between the collector and ground to provide a low impedance bypass for undesired harmonics. The balance of the components serve to match the output impedance of the final amplifier to the antenna impedance at the operating frequency and to offer a high impedance to harmonics.

D1, D2 and C11 provide a DC drive signal for the relative RF meter on the transmitter.

TRANSMITTER RF SECTION
Europe

(Figures 21, 22)

(72 MHz European transmitter is same as domestic.)

These Rf sections are the same as the domestic units except for the final amplifier and output network. The final amplifier uses a D-MOS FET, which provides high efficiency at low voltages and good linearity to minimize harmonic generation. Ferrite beads are also used on the output leads of the buffer and final transistor to minimize parasitics. The 35 and 40 MHz circuits use some turn on bias on the final transistor provided by R10. This ensures full utilization of the drive from the buffer. Since the bias comes from the modulator output, it is not present when the drive is removed, so the final is not prone to parasitic oscillation.

The series trap in the output network is not used in order to minimize the presence of high order harmonics in the output.

RF SECTIONS — TUNING AND ADJUSTMENT

Adjusting the RF modules is normally a factory operation. It can be done in the field, however, if the following conditions are met:

1. A valid Second Class (or higher) Radio-Telephone Operator's License, issued by the Federal Communications Commission, is needed to tune the 27 or 72 MHz transmitters.
2. A valid Amateur Operator's License is necessary to tune transmitters on the 53 MHz band.
3. A spectrum analyzer or tuned detector with enough sensitivity to determine the level of harmonic output, along with an attenuator to permit reading the carrier output must be used. Sufficient and accurate equipment must also be available to ensure compliance with Part 97 of FCC Rules and Regulations.
4. Tuning sequence must be repeated several times until no change occurs.

27 and 53 MHz (Domestic)

A. Adjust buffer coil L2 for maximum carrier output.
B. Adjust antenna coil L5 or L6 for maximum carrier output.
C. Adjust trap coil L5 for minimum second harmonic output.

72 MHz (Domestic and European)

A. Adjust buffer coil L2 for maximum carrier output.
B. Adjust antenna coil L6 for maximum carrier output.
C. Adjust trap coil L4 for minimum 36 MHz output.

27, 35 and 40 MHz (European)

A. Adjust buffer coil L2 for maximum carrier output.
B. Adjust antenna coil L5 and L6 for maximum carrier output.
C. Check second harmonic and readjust antenna coil to minimize.

All European transmitter modules must be adjusted with the shield in place and the back on the transmitter. (A spare back with tuning holes is suggested.)

After tuning is complete, all units should be checked to be sure output frequency is within 0.005% of nominal.

All units should be turned on and off several times to see that the oscillator starts properly. This check should be with a battery voltage of 8.4v while using first a hair dryer and then the component cooler. This will ensure operation under the range of conditions which may be found in use.

KPT-7C METER

The dual meter mounted in the transmitter case gives an indication of relative RF output and also reads battery voltage in the transmitter and receiver voltage through a connecting cable to the receiver.

The relative RF meter is directly connected to the rectifier circuit in the RF transmitter board.

The battery voltage meter is connected to the transmitter battery whenever the transmitter is turned on. The circuit includes a zener diode which serves to expand the meter scale in order to read small changes accurately. The meter is, in effect, a 1.4 volt meter which is protected from the rest of the battery voltage by the zener diode. The series resistance serves to set and adjust the meter sensitivity.

If the cable to the receiver is connected, the meter reads the receiver battery in the same way, except that a load resistor is added so that the receiver does not have to be on to get a meaningful reading. As long as the transmitter is off when reading the receiver battery, the transmitter will not effect the reading.

TRANSMITTER TROUBLE SHOOTING

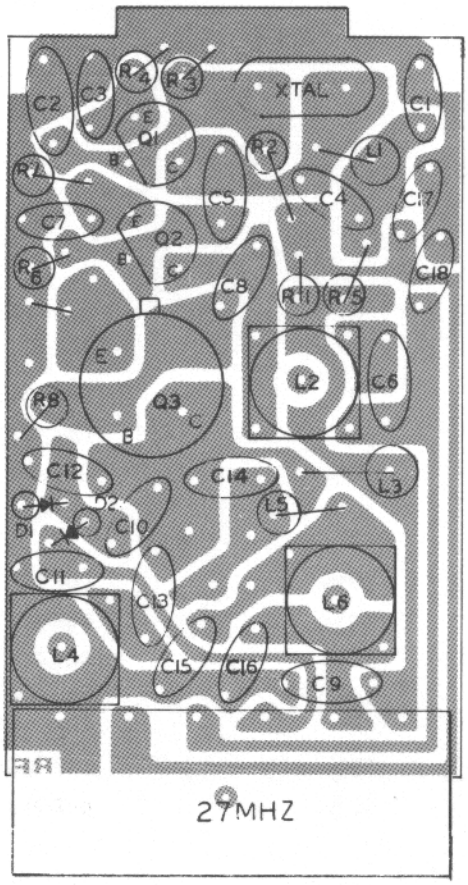
In general, a trouble in the RF section will be the result of mistuning, a bad transistor, or a defective crystal.

If there is little or no output, check the oscillator for proper operation (a grid dip meter is handy). If necessary, replace the transistor or crystal. If the oscillator is alright, check the buffer and final amplifier for correct tuning and proper drain and/or collector voltage. Also check the modulator for proper output.

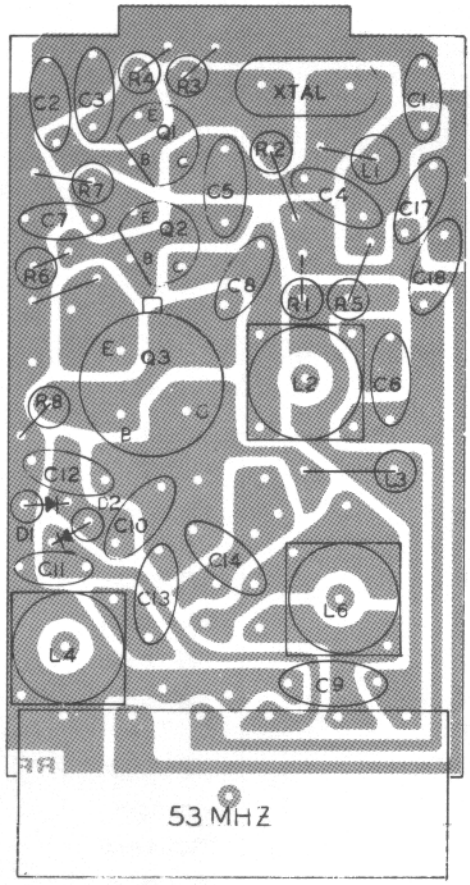
If there is RF output but it is low, check tuning, batteries, crystal, and transistors, in turn.

The final amplifier will ordinarily feel warm to the touch. If the output falls off drastically and the device gets uncomfortably hot (be careful - it can burn), chances are it is shorted.

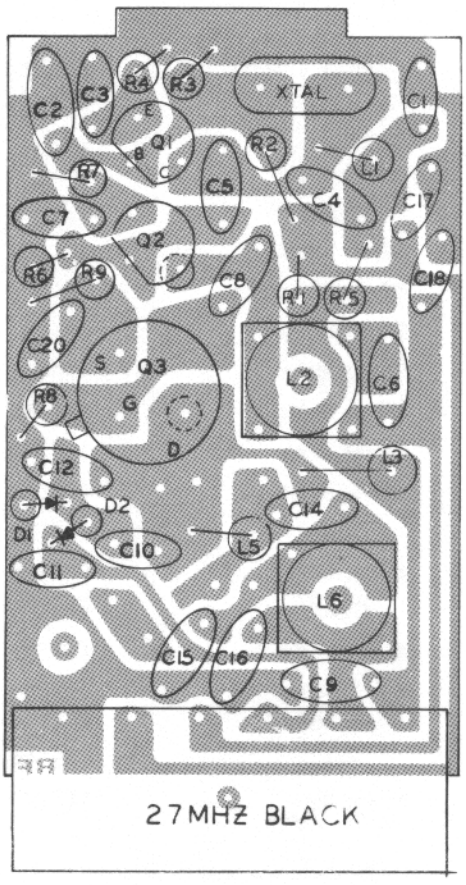
Recheck all connection when reinstalling the transmitter board, particularly the antenna and ground. Also check the antenna fittings mounted to the case.



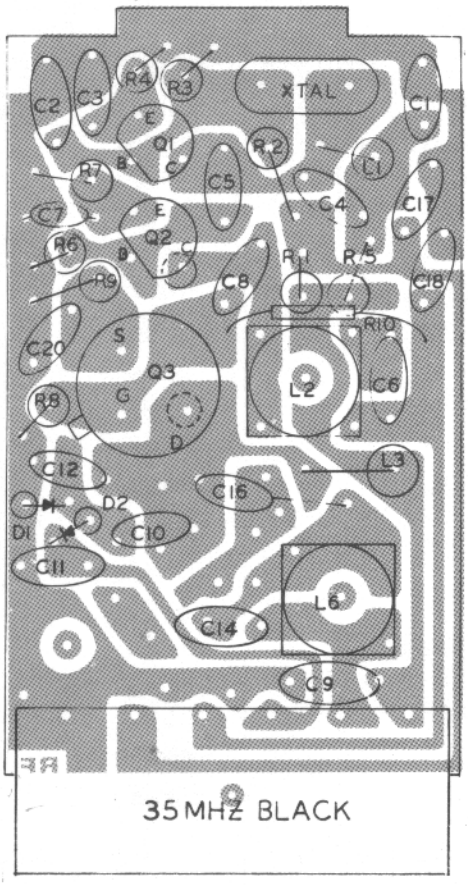
27MHZ



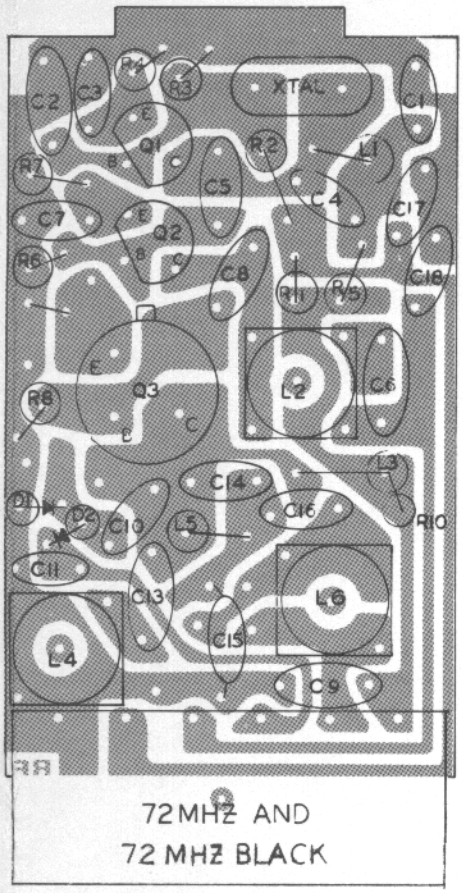
53 MHZ



27MHZ BLACK

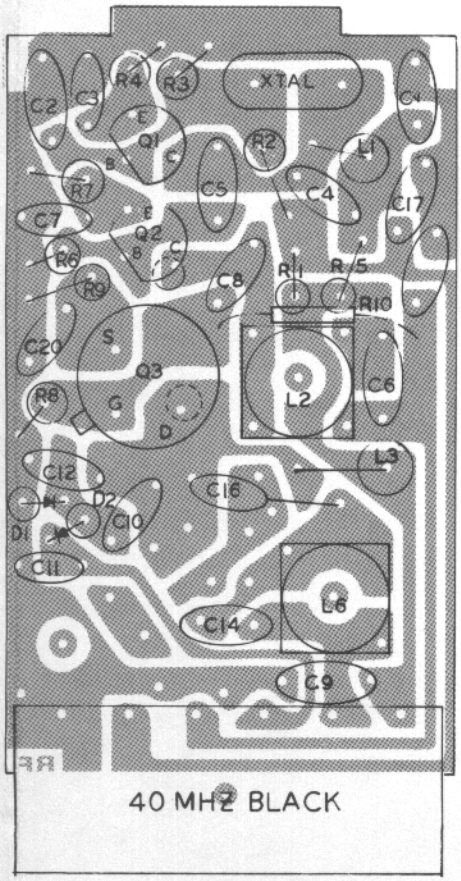


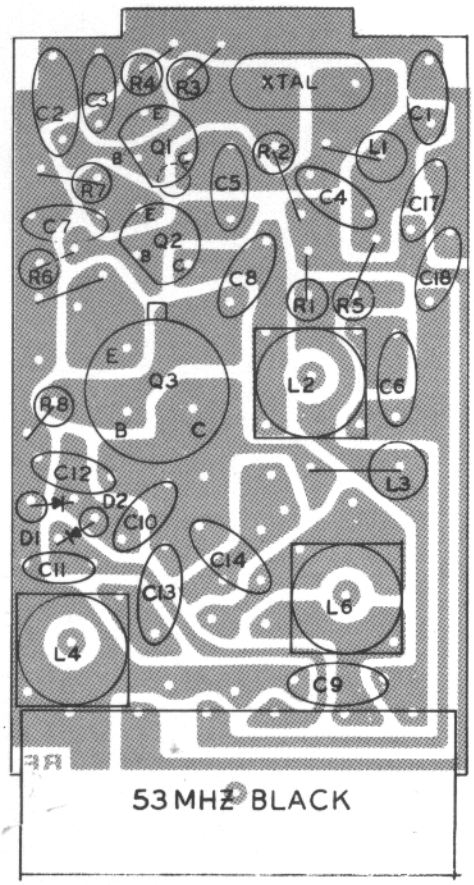
35MHZ BLACK



TRANSMITTER MODULES P.C. ASSEMBLIES

FIGURE 23





TRANSMITTER MODULES (DOMESTIC)
AM R.F. SECTION

RESISTORS

All values in ohms (K = 1000)

R1		3.3K	¼ W	10%	057-332
R2		1.2K	¼ W	10%	057-122
R3		4.7K	¼ W	10%	057-472
R4	72 MHz	270 ohms	¼ W	10%	057-271
	53 MHz	"	"	"	"
R4	27 MHz	470 ohms	¼ W	10%	057-471
R5		150 ohms	¼ W	10%	057-151
R6		220 ohms	¼ W	10%	057-221
R7	27 MHz	5.6 ohms	¼ W	10%	056-056
	53 MHz	"	"	"	"
R7	72 MHz	18 ohms	¼ W	10%	057-180
R8		220 ohms	¼ W	10%	057-221
R9		Not used			
R10	27 MHz	Not used			
	53 MHz	"			
R10	72 MHz	1K	¼ W	10%	057-102

CAPACITORS

C 1		.0047uf	Mepico	Disc	113-038
C2	27 MHz	10pf	100V	Silver Mica	117-003
C2	72 MHz	22pf	100V	Silver Mica	117-005
	53 MHz	10pf	100V	Silver Mica	117-003
C3		.0047uf	Mepico	Disc	113-038
C4	27 MHz	56pf	100V	Silver Mica	117-009
C4	53 MHz	15pf	100V	Silver Mica	117-004
C4	72 MHz *	39pf	100V	Silver Mica	117-014
C5		22pf	100V	Silver Mica	117-005
C6	27 MHz	47pf	100V	Silver Mica	117-008
C6	53 MHz	18pf	100V	Silver Mica	117-013
C6	72 MHz	10pf	100V	Silver Mica	117-003
C7		.0047uf	Mepico	Disc	113-038
C8		22pf	100V	Silver Mica	117-005
C9		.0047uf	Mepico	Disc	113-038
C10	27 MHz	6.2pf	100V	Silver Mica	113-032
C10	53 Mhz	6.2pf	100V	Silver Mica	113-032
	72 MHz	3pf	100V	Silver Mica	117-001
C11		.0047uf	Mepico	Disc	113-038
C12	27 MHz	68pf	100V	Silver Mica	117-010

* For 75 MHz Modules C4 is 27pf 100V Silver Mica 117-006

Transmitter Modules (Domestic) Parts List continued.

C12	53 MHz	10pf	100V	Silver Mica	117-003
C12	72 MHz	Not used			
C13	27 MHz	18pf	100V	Silver Mica	117-013
	72 MHz	"	"	"	"
C13	53 MHz	10pf	100V	Silver Mica	117-003
C14	27 MHz	150pf	100V	Silver Mica	117-011
C14	53 MHz	15pf	100V	Silver Mica	117-004
C14	72 MHz	10pf	100V	Silver Mica	117-003
C15	27 MHz	150pf	100V	Silver Mica	117-011
C15	53 MHz	Not used			
C15	72 MHz	22pf	100V	Silver Mica	117-005
C16	27 MHz	47pf	100V	Silver Mica	117-008
C16	53 MHz	Not used			
C16	72 MHz	3pf	100V	Silver Mica	117-001
C17		.0047uf	Mepico	Disc	113-038
C18		.0047uf	Mepico	Disc	113-038

SEMICONDUCTORS

D1, D2	1N4148		Diode Silicon	100-101
Q1, Q2	2N2369	NPN	Transistor, Plastic	101-025
Q3	2N4427	NPN	Transistor Silicon	101-021

COILS & CHOKES

L1		1uh	R.F. Choke	103-070
L2	27 MHz	Coil, 9¼ turns, tapped at 2¼		103-061
L2	53 MHz	Coil, 7¼ turns, tapped at 1¼		103-065
L2	72 MHz	Coil, 5¼ turns, tapped at 1¼		103-063
L3	27 MHz	22uh	R.F. Choke	103-045
L3	53 MHz	3.9uh	R.F. Choke	103-068
	72 MHz	"	"	"
L4	27 MHz	Coil, 7½ turns		103-084
L4	53 MHz	Coil, 5½ turns		103-086
L4	72 MHz	Coil, 12½ turns		103-060
L5	27 MHz	1.5uh	R.F. Choke	103-071
L5	53 MHz	Not used		
L5	72 MHz	.22uh	R.F. Choke	103-046
L6	27 MHz	Coil, 12 turns		103-060
L6	53 MHz	Coil, 12½ turns		103-060
L6	72 MHz	Coil, 11½ turns		103-085

MISCELLANEOUS

Crystal, Order by frequency	as required
Label, Frequency, Order by frequency	as required
P.C. Board, R.F. Section	010-212
Connector, RF Plug-In	120-050
Shield, PCB	010-218
Screw, 0-80 x3/8"	500-093
Case, Tx Plug-In (Gold)	901-329
Cap, for case (Gold)	901-330

BLACK TRANSMITTER MODULE (EUROPE)
AM R.F. SECTION

RESISTORS

All values in ohms (K = 1000)

R1		3.3K	¼ W	10%	057-332
R2		1.2K	¼ W	10%	057-122
R3		4.7K	¼ W	10%	057-472
R4	27 MHz	470 ohms	¼ W	10%	057-471
R4	53 MHz	270 ohms	¼ W	10%	057-271
	72 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R5		150 ohms	¼ W	10%	057-151
R6	27 MHz	470 ohms	¼ W	10%	057-471
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R6	53 MHz	220 ohms	¼ W	10%	057-221
	72 MHz	"	"	"	"
R7	27 MHz	18 ohms	¼ W	10%	057-180
	72 MHz	"	"	"	"
R7	53 MHz	5.6 ohms	¼ W	10%	056-056
R7	35 MHz	47 ohms	¼ W	10%	057-470
	40 MHz	"	"	"	"
R8	27 MHz	1.2K	¼ W	10%	057-122
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R8	53 MHz	220 ohms	¼ W	10%	057-221
	72 MHz	"	"	"	"
R9	27 MHz	10 ohms	¼ W	10%	057-100
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"

Black Transmitter Module (Europe) Parts List continued.

R9	53 MHz	Not used			
R9	72 MHz	Not used			
R10	27 MHz 53 MHz	Not used "			
R10	72 MHz	1K	¼W	10%	057-102
R10	35 MHz 40 MHz	22K "	¼W "	10% "	057-223 "

CAPACITORS

C1		.0047uf	Mepico	Disc	113-038
C2		10pf	100V	Silver Mica	117-003
C3		.0047uf	Mepico	Disc	113-038
C4	27 MHz	56pf	100V	Silver Mica	117-009
C4	53 MHz	15pf	100V	Silver Mica	117-004
C4	72 MHz 35 MHz 40 MHz	39pf " "	100V " "	Silver Mica " "	117-014 " "
C5		22pf	100V	Silver Mica	117-005
C6	27 MHz	47pf	100V	Silver Mica	117-008
C6	53 MHz	18pf	100V	Silver Mica	117-013
C6	72 MHz	10pf	100V	Silver Mica	117-003
C6	35 MHz 40 MHz	27pf "	100V "	Silver Mica "	117-006 "
C7		.0047uf	Mepico	Disc	113-038
C8	27 MHz 35 MHz 40 MHz	.001uf " "	Sub Mini " "	Disc " "	113-021 " "
C8	72 MHz 53 MHz	22pf "	100V "	Silver Mica "	117-005 "
C9		.0047uf	Mepico	Disc	113-038
C10	27 MHz 53 MHz	10pf "	100V "	Silver Mica "	117-003 "
C10	72 MHz	3pf	100V	Silver Mica	117-001
C10	35 MHz 40 MHz	15pf "	100V "	Silver Mica "	117-004 "
C11		.0047uf	Mepico	Disc	113-038
C12	27 MHz 35 MHz 40 MHz	100pf " "	40V " "	Disc " "	113-043 " "
C12	53 MHz	10pf	100V	Silver Mica	117-003
C12	72 MHz	Not used			
C13	27 MHz 35 MHz 40 MHz	Not used " "			
C13	53 MHz	10pf	100V	Silver Mica	117-003
C13	72 MHz	18pf	100V	Silver Mica	117-013

C14	27 MHz	27pf	100V	Silver Mica	117-006
C14	53 MHz	10pf	100V	Silver Mica	117-003
	72 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
C15	27 MHz	150pf	100V	Silver Mica	117-011
C15	53 MHz	Not used			
	35 MHz	"			
	40 MHz	"			
C15	72 MHz	15pf	100V	Silver Mica	117-004
C16	27 MHz	47pf	100V	Silver Mica	117-008
C16	53 MHz	Not used			
C16	72 MHz	3pf	100V	Silver Mica	117-001
C16	35 MHz	33pf	100V	Silver Mica	117-007
	40 MHz	"	"	"	"
C17		.0047uf	Mepico	Disc	113-038
C18		.0047uf	Mepico	Disc	113-038
C19		Not used			
C20	27 MHz	.0047uf	Mepico	Disc	113-038
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
C20	72 MHz	Not used			
	53 MHz	"			
* C21		27pf	40V	Disc	113-007

SEMICONDUCTORS

D1, D2		1N4148		Diode Silicon	100-101
Q1, Q2		2N2369	NPN	Transistor, Silicon	101-025
Q3	27 MHz	CR866	DMP4025DE	Transistor	101-032
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
Q3	53 MHz	2N4427	NPN	Transistor Silicon	101-021
	72 MHz	"	"	"	"

COILS & CHOKES

L1		1uh	R.F. Choke	103-070
L2	27 MHz	Coil, 9-¼ turns tapped at 2¼		103-061
L2	35 MHz	Coil, 7¼ turns tapped at 1¼ long slug		103-065
L2	40 MHz	Coil, 7¼ turns tapped at 1¼ short slug		103-065
L2	53 MHz	Coil, 7¼ turns tapped at 1¼		103-065
L2	72 MHz	Coil, 5¼ turns tapped at 1¼		103-063
L3	27 MHz	22uh	R.F. Choke	103-045
	35 MHz	"	"	"
	40 MHz	"	"	"

*Located in transmitter at base of antenna.

Black Transmitter Modules Parts List continued.

L3	72 MHz	3.9uh	R.F. Choke	103-068
	53 MHz	"	"	"
L4	27 MHz		Not used	
L4	53 MHz		Coil, 5½ turns	103-086
	35 MHz		Not used	
	40 MHz		Not used	
L4	72 MHz		Coil, 12½ turns	103-060
L5	27 MHz	1.5uf	R.F. Choke	103-071
L5	53 MHz		Not used	
L5	72 MHz	.22uh	R.F. Choke	103-046
L5	35 MHz		Not used	
L5	40 MHz		Not used	103-084
L6	27 MHz		Coil, 7½ turns	103-080
L6	35 MHz		Coil, 9½ turns with short slug	103-082
	40 MHz		Coil, 7½ turns with short slug	103-084
	53 MHz		Coil, 12½ turns	103-060
L6	72 MHz		Coil, 11½ turns	103-085
*L7		.22uh	R.F. Choke Wee-Wee Ductor	103-043

*Located in transmitter at base of antenna.

MISCELLANEOUS

FB	Ferrite Bead	990-065
	Crystal, Order by frequency	as required
	Label, Frequency, Order by frequency	as required
	P.C. Board, R.F. Section Tx Plug-In	010-212
	Connector, Tx R.F. Plug-In	120-050
	Shield, PCB	010-218
	Screw, 0-80 x 3/8"	500-093
	Case, Tx Plug-In (Black)	901-329
	Cap, for case (Black)	901-330

MECHANICAL PARTS LIST
KPT-3C 1976, 1977, 1978, 1979

No. Required		
1	KB-8-5 Battery Pack, KPT-5C, 3C, 5CS	001-069
1	Plug, #2, 3 Channel Encoder	120-064
1	Plug, #3, 3 Channel Encoder	120-065
1	Milliammeter, 0-1 MA Edgewise	126-001
1	Antenna Assembly W/ Antenna	200-144
8	Foot-Rubber 1/16" GRV for Tx	500-005
2	Screw, 1-72 x 1/8" BH SLT MS	500-032

2	Screw, 3-48 x 1/4" FHPS	500-048
2	Screw, 4-40 x 3/8" P.H.M.S.	500-138
10	Screw, #2 x 3/16" PHPSMS (A) Blk	500-158
1	Logo Tx Kraft Series '76	600-113
1	Series '77	600-117
1	Series '78	600-190
1	Series '79	600-226
1	Frequency Plate Tx FCC Series '79	600-227
1	Label, Freq. Any, Inventory Only	600-999
1	Ctrl-Stk, Sgl-Ax, WW Pot	900-022
1	Gimbal, Spring Return 5 Channel '76	900-063
1	'77	900-076
1	'78	
1	'79	
1	Switch Guard, Tx ('70 & Later)	901-194
1	Plate, Freq. ID Front & Back	901-363
1	Bracket, Tx RF Plug In	904-159
1	Case, Tx KPT-3C Front & Back	904-169

KB-8-5 Tx Pack for KPT-3C

1	Switch, Slide 4 PDT	109-007
1	Recep. 6-Pin RD/Female Chassis	120-004
1	Plug, #2, 5 Channel Encoder	120-060
1	Cable Assembly, RF Encoder KPT-5C	123-029
2	Battery, Ni-Cad, 4.8V, 550 MAH Tx	130-007
2	Washer, Ant Mt. .500 x .167 x .048	500-095
2	Screw, 4-40 x 5/8" P.H.M.S.	500-154
1	Case, Battery, Tx	901-212
2	Slide, Tx PC Board	901-335

MECHANICAL PARTS LIST

KPT-5C 1976, 1977, 1978, 1979

No. Required		
1	KB-8-5 Battery Pack KPT-5C, 3C, 5CS	001-069
1	Switch, Landing Gear S.P.D.P.	109-012
1	Plug, ¼" Chrome BS 48151	120-058
1	Plug, #4, 5 Channel Encoder	120-062
1	Plug, #5, 5 Channel Encoder	120-063
1	Milliammeter, 0-1 MA Edgewise	126-001
1	Antenna Assembly W/Antenna	200-144
8	Foot-Rubber 1/16" GRV For Tx	500-005
2	Screw, 1-72 x 1/8" BH SLT MS	500-032

2	Screw, 3-48 x ¼" P.H.P.M.S.	500-048
1	Dress Nut, LG Switch, 1/4-32	500-075
2	Screw, 4-40 x 3/8" P.H.M.S.	500-138
6	Screw, #2 x 3/16" P.H.P.S.M.S. (A) Blk	500-158
1	Logo Tx Kraft Series '76	600-113
1	Series '77	600-117
1	Series '78	600-190
1	Series '79	600-226
1	Frequency Plate Tx FCC Series '79	600-227
1	Label, Freq. Any, Inventory Only	600-999
1	Gimbal, Throttle 5 Channel, '76	900-062
1	'77	900-075
1	Gimbal, Spring Return 5 Channel, '76	900-063
1	'77	*900-076
1	Switch Guard, Tx ('70 & Later)	901-194
1	Plate, Freq. ID Front & Back	901-363
1	Case, Tx KPT-5C	904-157
1	Bracket, Tx RF Plug in	904-159

KB-8-5 TX Pack for KPT-5C

1	Switch, Slide 4 PDT	109-007
1	Recep. 6-Pin RD/Female Chassis	120-004
1	Plug, #2 5 Channel Encoder	120-060
1	Cbl-Assy, RF Encoder KPT-5C	123-029
2	Battery, Ni-Cad, 4.8V, 550 MAH Tx	130-007
2	Washer, Ant Mt .500 x .167 x .048	500-095
2	Screw, 4-40 x 5/8" P.H.M.S.	500-154
1	Case, Batter, Tx	901-212
2	Slide, Tx PC Board	901-335

MECHANICAL PARTS LIST
KPT-5CS 1976-1979

No. Required		
1	KB-8-5 Battery Pack KPT-5C, 3C, 5CS	001-069
1	Potentiometer, WW, 5K CTS	106-052
1	Switch, Landing Gear S.P.D.T.	109-012
1	Plug, 1/4" Chrome BS 48151	120-058
1	Plug, #4, 5 Channel Encoder	120-062
1	Plug, #5, 5 Channel Encoder	120-063
1	Milliammeter, 0-1 MA Edgewise	126-001
1	Antenna Assembly W/Antenna	200-144
8	Foot-Rubber 1/16" GRV for Tx	500-005
2	Screw, 1-72 x 1/8" BH SLT MS	500-032

2	Screw, 3-48 x 1/4" FHPMS	500-048
1	Dress Nut, LG Switch, 1/4-32	500-075
2	Screw, 4-40 x 5/8" P.H.M.S.	500-154
8	Screw, #2 x 3/16" PHPSMS (A) Blk	500-158
1	Logo Tx Kraft Series '76	600-113
1	Series '77	600-171
1	Series '78	600-190
1	Series '79	600-226
1	Frequency Plate Tx FCC Series '79	600-227
1	Label, Freq. Any, Inventory Only	600-999
1	Gimbal, Single Stick KP-5CS	900-073
1	Switch Guard, Tx ('70 & Later)	901-194
1	Plate, Freq. ID Front & Back	901-363
1	Lever, Circular Press Fit, Long	901-394
1	Bracket, Tx RF Plug In	904-159
1	Case, Tx KPT-5CS	904-178
1	Plate, Side KPT-5CS	904-179

KB-8-5 Tx Pack for KPT-5CS

1	Switch, Slide 4 PDT	109-007
1	Receptacle, 6-Pin RD/Female Chassis	120-004
1	Plug, #2, 5 Channel Encoder	120-060
1	Cbl-Assy, RF Encoder KPT-5C	123-029
2	Battery, Ni-Cad, 4.8V, 550 MAH Tx	130-007
2	Washer, Ant Mt .500 x .167 x .048	500-095
2	Screw, 4-40 x 5/8" P.H.M.S.	500-154
1	Case, Battery, Tx	901-212
2	Slide, Tx PC Board	901-335

MECHANICAL PARTS LIST

KPT-7C 1976, 1977, 1978, 1979

No. Required		
1	KB-8-7 Battery Pack Tx KPT-7C	001-068
1	Res. Cbn. 47K OHM, 1/4W, 10%	057-473
2	Potentiometer, WW, 5K CTS	106-052
1	Switch, Landing Gear S.P.D.T.	109-012
1	Conn. Master Trainer	120-061
1	Cbl-Assy, Encoder to AB Test	123-032
1	Cbl-Assy, Encoder Plug-Pot PWR	123-033
1	Cbl-Assy, Encoder Plug-Pot WIP	123-034
1	Cbl-Assy, Encoder Plug-LG	123-035
2	Meter, Mura Single	126-006
1	Antenna Post Assy. W/Ant.	200-072
8	Foot-Rubber 1/16" GRV for Tx	500-005

2	Screw, #2 x 1/4" S.M.S.	500-007
2	Nut, Hex. Pot 3/8"-32	500-016
2	Screw, 3-48 x 1/4" FHPMS	500-048
2	Screw, 2-56 x 1/4" PHMS	500-052
4	Washer, Pot 5/8" O.D. x 3/8" I.D. x .025	500-054
2	Dress Nut, LG Switch, 1/4-32	500-075
2	Screw, 0-80 x 3/8" (Trays-Wheels)	500-093
2	Screw, 4-40 x 3/8" P.H.M.S.	500-138
1	Lug. Solder, Small F/200-072	500-145
2	Screw, #2 x 1/2" S.M.S. (A)	500-157
6	Screw, #2 x 3/16" PHPSMS (A) Blk	500-158
1	Label, Meter RF 7CH 76-1/2	600-172
1	Label, Meter Battery 7CH 76-1/2	600-173
1	Bezel, Meter, Tx, Hot Stamped	600-182
1	Logo Tx Kraft Series '76	600-113
1	Series '77	600-171
1	Series '78	600-190
1	Series '79	600-226
1	Frequency Plate Tx FCC Series '79	600-227
1	Gimbal, Throttle 7 Channel '76	900-069
1	'77	900-077
1	Gimbal, Spring Return 7 Channel '76	900-070
1	'77	900-078
2	Lever, Ctr. Press Fit Black	901-148
1	Switch Guard, Tx ('70 & Later)	901-194
1	Antenna Cone & Plug-in Receptacle	901-342
1	Spacer, KPT-7C A/B Bat Ck Receptacle	901-354
1	Case, Tx KPT-7C	904-158
1	Bracket, Pot KPT-7C	904-164

KB-8-7 Tx Pack for KPT-7C

1	Switch, Slide 4 PDT	109-007
1	Receptacle, 6-Pin RD/Female Chassis	120-004
1	Plug, #2, 5 Channel Encoder	120-060
1	Cbl-Assy, RF Encoder KPT-7C	123-030
4	Battery, Ni-Cad 2.4V 550 MAH	130-006
2	Washer, Ant Mt. .500 x .167 x .048	500-095
2	Screw, 4-40 x 5/8" P.H.M.S.	500-154
2	Slide, Tx PC Board	901-335
1	Case, Battery KPT-7C, 7CS	901-362

MECHANICAL PARTS LIST

KPT-7CS 1976, 1977, 1978, 1979

No. Required		
1	KB-8-7B Battery Pack, Tx KPT-7CS	001-145
1	Res. Cbn. OHM, 1/4W, 10%	057-473

1	Potentiometer, Dual 5K	106-032
1	Potentiometer, WW, 5K CTS	106-052
1	Switch, Landing Gear S.P.D.T.	109-012
1	Conn. Master Trainer	120-061
1	Cbl-Assy, Encoder to AB Test	123-032
1	Cbl-Assy, Encoder Plug-Pot PWR	123-033
1	Cbl-Assy, Encoder Plug-Pot WIP	123-036
2	Cbl-Assy, Encoder Plug-Pot WIP	123-037
2	Meter, Mura Single	126-006
1	Antenna Post Assembly, W/Ant.	200-072
8	Foot-Rubber 1/16" GRV for Tx	500-005
2	Screw, #2 x 1/4" S.M.S.	500-007
1	Nut, Hex. Pot 3/8"-32	500-016
2	Screw, 3-48 x 1/4" FHPMS	500-048
2	Washer, Pot 5/8" O.D. x 3/8" I.D. x .025	500-054
2	Dress Nut, LG Switch, 1/4-32	500-075
2	Screw, 0-80 x 3/8" (Trays-Wheels)	500-093
2	Screw, 4-40 x 3/8" P.H.M.S.	500-138
1	Lug, Solder, Small F/200-072	500-145
2	Screw, #2 x 1/2" S.M.S. (A)	500-157
8	Screw, #2 x 3/16" PHPSMS (A) Bld	500-158
1	Label, Meter RF 7 Channel 76-1/2	600-172
1	Label, Meter Battery, 7 Channel 76-1/2	600-173
1	Bezel, Meter, Tx, Hot Stamped	600-182
1	Logo Tx Kraft Series '76	600-113
1	Series '77	600-171
1	Series '78	600-190
1	Series '79	600-226
1	Frequency Plate Tx FCC Series '79	600-227
1	Gimbal, Single Stick KPT-7CS '76	90-068
1	'77	900-079
1	Switch Guard, Tx ('70 & Later)	901-194
1	Lever, Aux. Control, Open Gimbal	901-224
1	Lever, Aux. Control, SS '73 (Top)	901-226
1	Antenna Cone & Plug-In Receptacle	901-342
1	Spacer, KPT-7C A/B Bat Ck Receptacle	901-354
1	Lever, Circular Press Fit, Long	901-394
1	Case, Tx KPT-7CS	904-166
1	Plate, Side KPT-7CS	904-167
1	Bracket, Pot KPT-7CS	904-168
1	Stop, Antenna KPT-7CS	904-170

KP-8-7B Tx Pack for KPT-7CS Tx

1	Switch, Slide 4 PDT	109-007

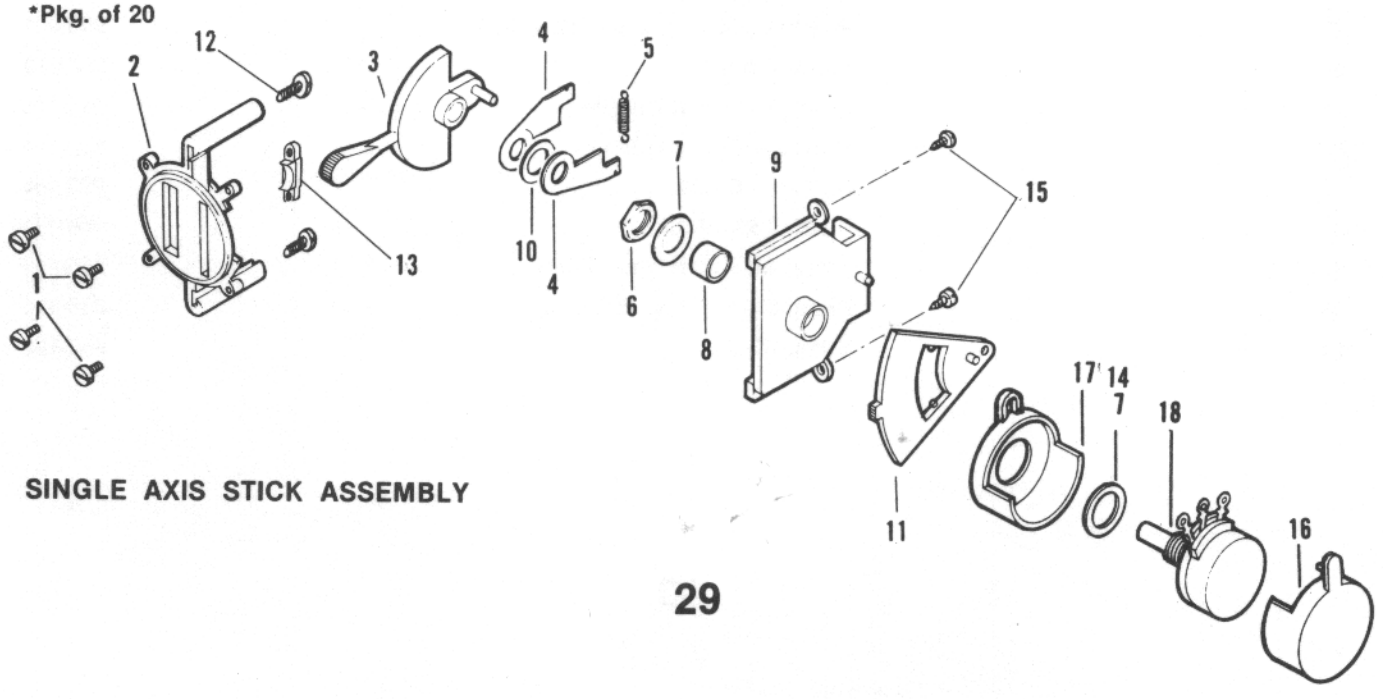
1	Receptacle 6-Pin RD/Female Chassis	120-004
1	Plug, #2, 5 Channel Encoder	120-060
1	Cbl-Assy, RF Encoder KPT-7CS	123-031
4	Battery, Ni-Cad 2.4V 550 MAH	130-006
2	Washer, Ant Mt .500 x .167 x .048	500-095
2	Screw, 4-40 x 5/8" P.H.M.S.	500-1[illegible]4
2	Slide, Tx PC Board	901-335
1	Case, Battery KPT-7C, 7CS	901-362

SINGLE AXIS STICK (900-022)

(See exploded parts view)

Key Number	Number Required	Description	Part Number
2	1	Control Stick Housing	850-001
3	1	Control Stick, Keyed	850-002
9	1	Control Pot Mounting Plate	850-003
11	1	Trim Lever	850-004
17	1	Control Pot Front Housing (for pot 18)	850-005
16	1	Control Pot Rear Housing (for pot 18)	850-006
4	2	Dog Stops	850-007
8	1	Brass Bushing	850-008
10	1*	Teflon Washer ½" O.D. x ¼" I.D. x .005"	850-010
13	1	Clamp, Control Stick Pivot	850-158
12	2	Screw, 2-56 x ¼" P.H.M.S.	500-052
15	2	Screw, #2 x ¼" S.M.S.	500-007
5	1	Spring Extension	500-027
7	2*	Washer 5/8" O.D. x 3/8" I.D. x .025"	500-054
1	4*	Screw, #2 x 3/16" P.H.P.S.M.S. (A) Blk.	500-158
6	1*	3/8"-32 x ½" A.F. x 3/32" Hex Nut	500-016
14	1*	Washer 5/8" O.D. x 3/8" I.D. x .052" for P/N 106-027 Pot "Bourns"	500-073
18	1	Potentiometer	106-006

*Pkg. of 20

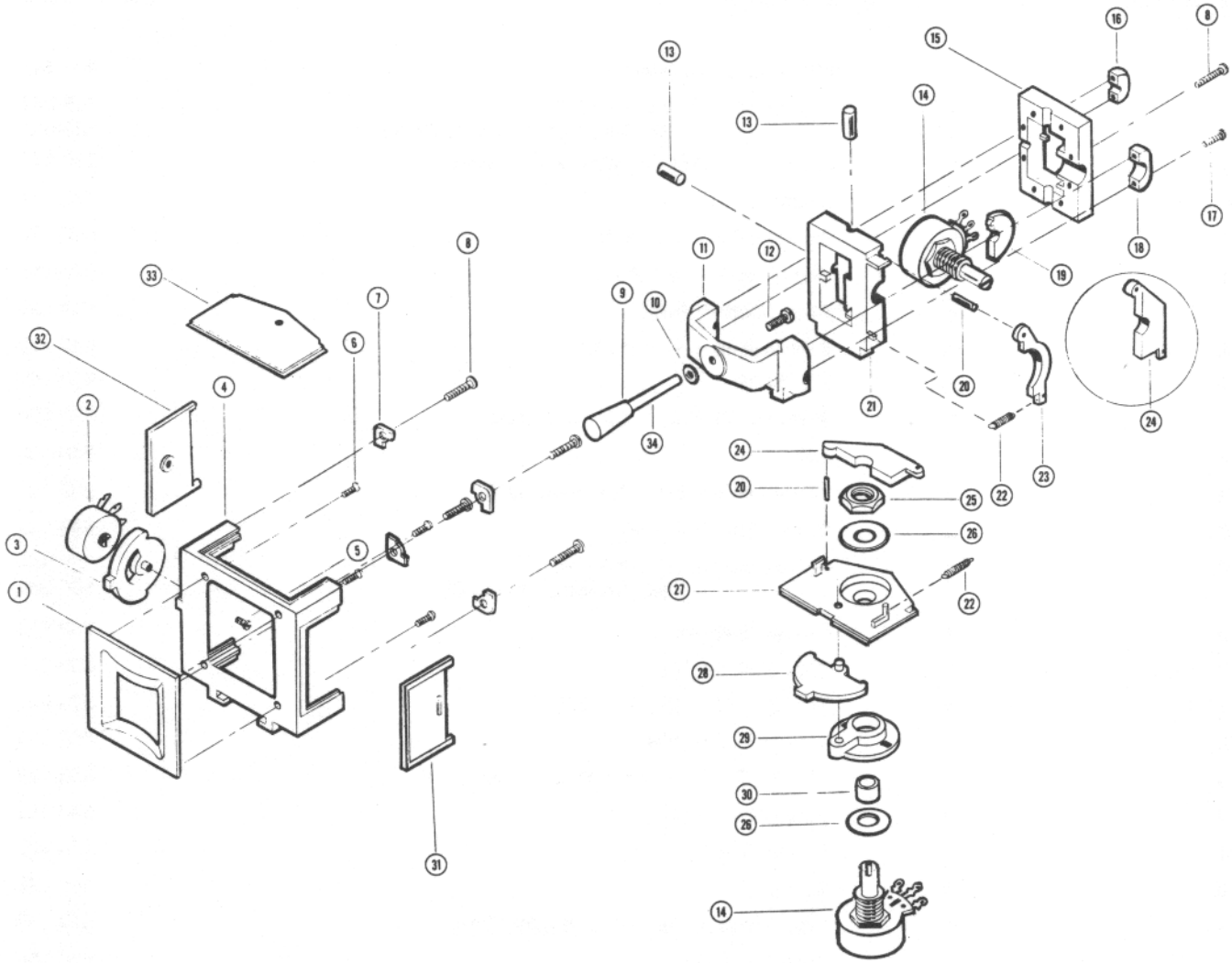


SINGLE AXIS STICK ASSEMBLY

OPEN GIMBAL 900-062) &(900-063

(See exploded parts view)

Key Number	Number Required	Description	Part Number
1	1	Window, Open Gimbal	901-343
2	1	Potentiometer, 1K	106-051
3	1	Lever, Trim (Pot Cpir-Elec Trim)	850-121
4	1	Housing	850-119
5	1	Screw, 1-72 x 3/16 M.S.	500-059
6	4	Screw, 1-72 x ¼" Rd. Hd. M.S.	500-213
7	4	Clips, Corner Post	850-120
8	12	Screw, 2-56 x ½ P.H.M.S.	500-112
9	1	Tip, Stick Plastic	200-050
10	1	Washer, .21 O.D. x .12 I.D. x .032	500-160
11	1	Bail	850-109
12	1	Screw, 4-40 x 5/16 Hex Head M.S.	500-148
13	2	Dowel Pin, 1/8 x 3/8	500-147
14	2	Potentiometer, 5K	106-052
15	1	Frame, Bottom	850-108
16	1	Cap, Ball 1/8" Side	850-110
17	5	Screw, 2-56 x 3/8" P.H.M.S.	500-049
18	1	Cap, Bail, Pot Side	850-111
19	1	Sector, Throttle Ratchet (Throttle Only)	850-104
20	2	Dowel Pin, 1/16 x 3/8	500-146
21	1	Frame, Top	850-107
22	2	Spring	500-135
23	1	Arm, Throttle Ratchet (Throttle Only)	850-105
24	2	Arm, Centering	850-106
25	1	Nut, Hex 3/8 - 32	500-016
26	2	Washer, 5/8 O.D. x 3/8 I.D. x .025	500-054
27	1	Plate, Pot Side	850-113
28	1	Lever, Trim (Pot Coupler)	850-115
29	1	Coupler, Pot to Trim Lever	850-114
30	1	Bushing, Brass	850-008
31	1	Plate, Side Plate	850-118
32	1	Plate, Side (Electrical Trim)	850-117
33	1	Plate, Side (Frame Bearing)	850-116
34	1	Stick, Gimbal	850-122



OPEN GIMBAL STICK ASSEMBLY
(P/N 900-062 & 900-063)

OPEN GIMBAL, 2-Axis

KPT-7C and KPT-5C

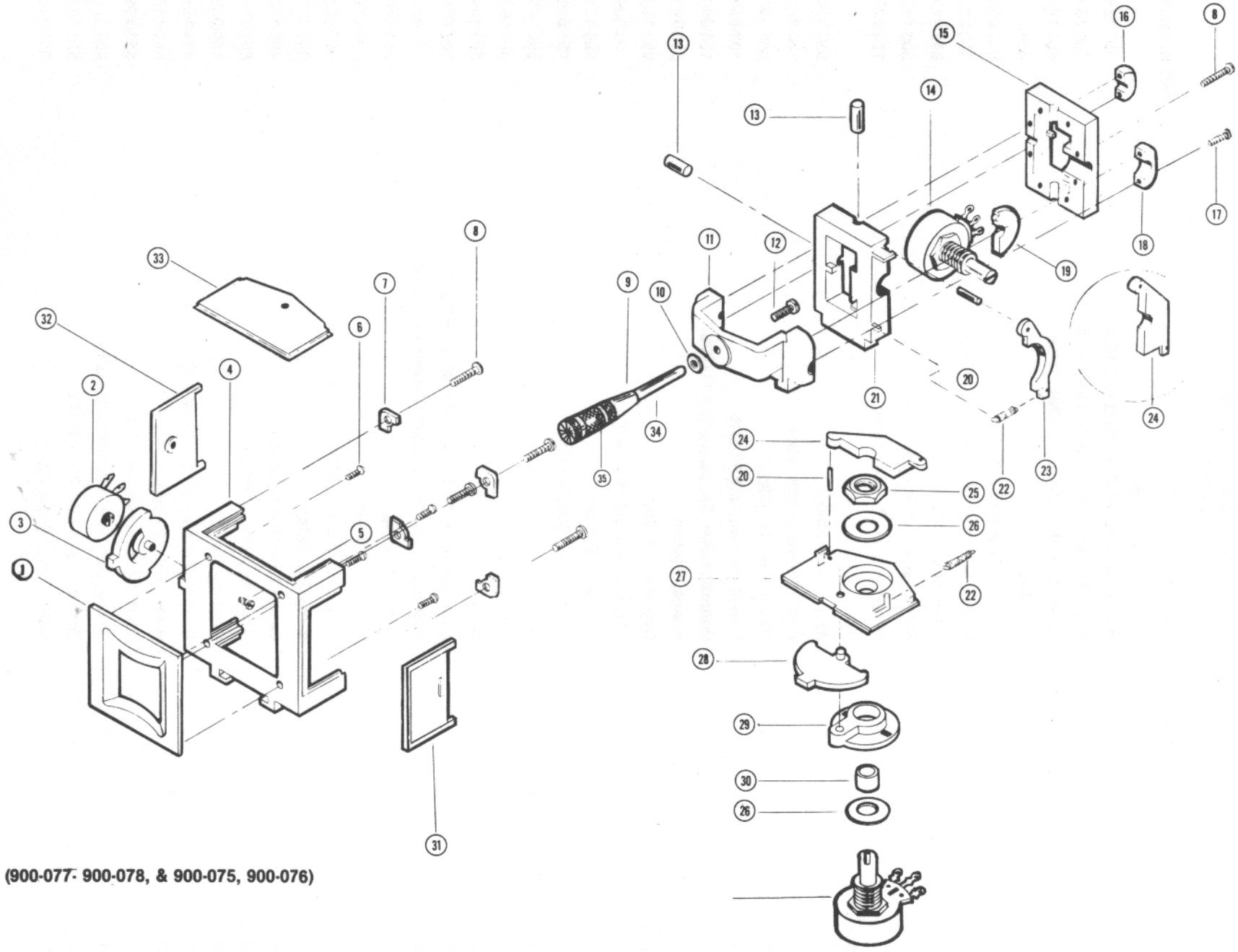
900-077,-078 & 900-075,-076

Key Number	Number Required	Description	Part Number
1	1	Window, Open Gimbal	901-343
2	1	Potentiometer, 1K (KPT-5C) 5K (KPT-7C) (Throttle Only)	106-051 106-052
3	1	Lever, Trim (Pot Coupler, Elec. Trim)	850-121
4	1	Housing	850-119
5	1	Screw, 1-72 x 3/16 M.S.	500-059
6	4	Screw, 1-72 x ¼" P.H.P.	500-213
7	4	Clips, Corner Post	850-120
8	12	Screw, 2-56 x ½ P.H.M.S.	500-112
9	1	Tip, Stick	850-101
10	1	Washer, .21 O.D. x .12 I.D. x .032	500-160
11	1	Bail	850-109
12	1	Screw, 4-40 x 5/16 Hex Head M.S.	500-148
13	2	Dowel Pin, 1/8"x 3/8"	500-147
14	2	Potentiometer, 5K (KPT-5C) 5K, Spectrol (KPT-7C)	106-052 106-060
15	1	Frame, Bottom	850-108
16	1	Cap, Bail 1/8"Side	850-110
17	5	Screw, 2-56 x 3/8" P.H.M.S.	500-049
18	1	Cap, Bail, Pot Side	850-111
19	1	Sector, Throttle Ratchet (Throttle Only)	850-104
20	2	Dowel Pin, 1/16"x 3/8"	500-146
21	1	Frame, Top	850-107
22	2	Spring	500-135
23	1	Arm, Throttle Ratchet (Throttle Only)	850-105
24	2	Arm, Centering	850-106
25	1	Nut, Hex 3/8 - 32	500-016
26	2	Washer, 5/8 O.D. x 3/8 I.D. x .025	500-054
27	1	Plate, Pot Side	850-113
28	1	Lever, Trim (Pot Coupler)	850-115
29	1	Coupler, Pot to Trim Lever	850-114
30	1	Bushing, Brass	850-008
31	1	Plate, Side Plate	850-118
32	1	Plate, Side (Electrical Trim)	850-117
33	1	Plate, Side (Frame Bearing)	850-116
34	1	Stick, Gimbal	850-102
35	1	Screw, Set, Black Oxide, 4-40 x 3/32	500-110

GIMBAL, SINGLE STICK

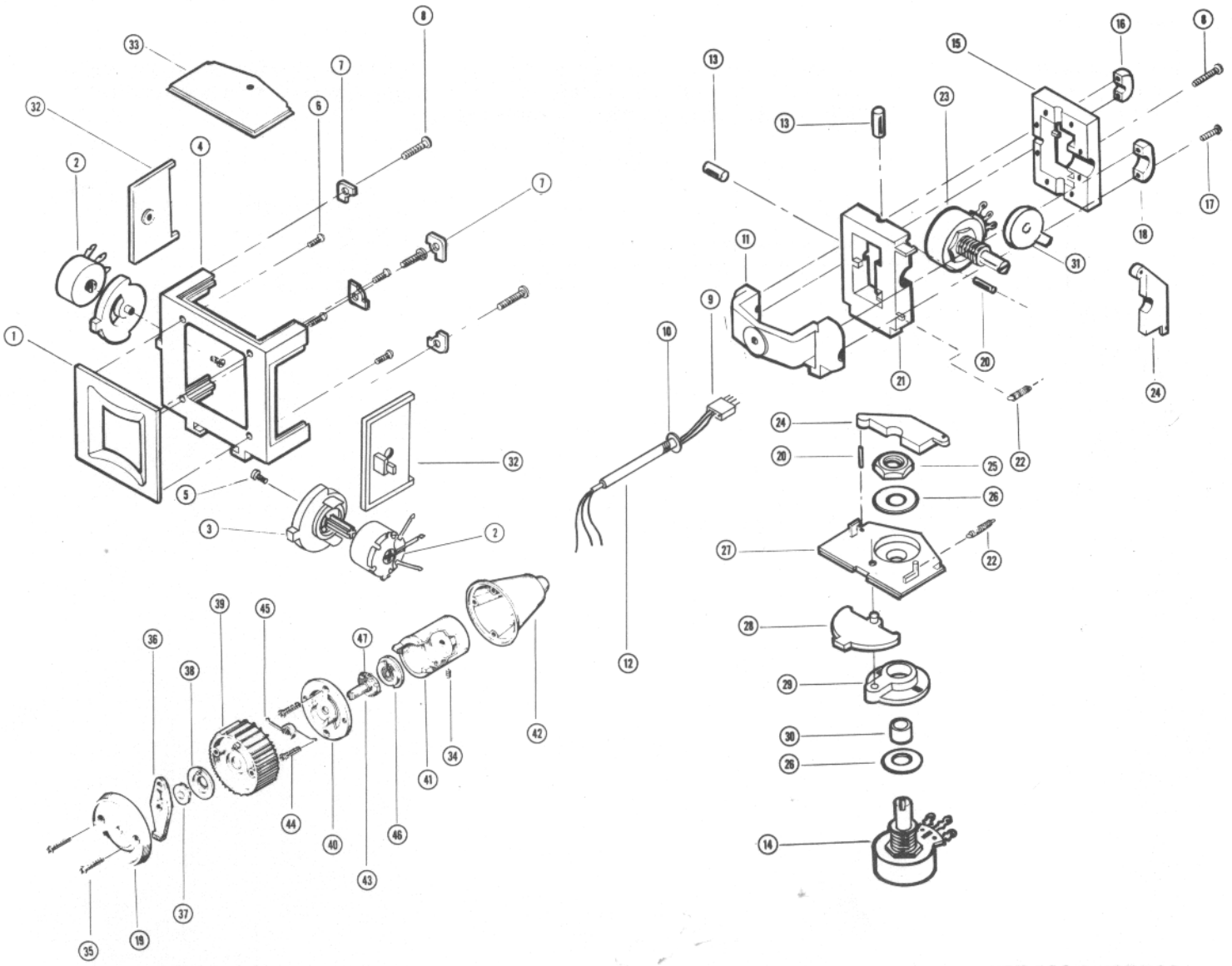
KPT-5CS and KPT-7CS
900-073 & 900-079

Item	Quantity	Description	Part Number
1	1	Window, Open Gimbal	
2	2	Potentiometer, 1K (Trim Pot) KPT-5CS	106-051
2	2	Potentiometer, 5K (Trim Pot) KPT-7CS	106-053
3	2	Lever, Trim (Pot Coupler - Elec. Trim)	850-121
4	1	Housing	850-
5	2	Screw, 1-72 x 3/16 M.S.	500-059
6	4	Screw, 1-72 x ¼" P. H.P.	500-213
7	4	Clips, Corner Post	840-120
8	12	Screw, 2-56 x ½ P.H.M.S.	500-112
9	1	Wire Harness, Rudder Knob,	123-039
10	1	Dress Nut, ¼" x 32	
11	1	Bail, Single Stick	850-124
12	1	Post, Hollow, Single Stick	500-163
13	2	Dowel Pin, 1/8" x 3/8"	500-147
14	1	Potentiometer, 1K KPT-5CS	106-052
14	1	Potentiometer, 5K, Spectrol KPT-7CS	106-060
15	1	Frame, Bottom	850-108
16	1	Cap, Ball 1/8 Side	850-110
17	5	Screw, 2-56 x 3/8" P.H.M.S.	500-049
18	1	Cap, Ball, Pot Side	850-111
19	1	Knob Cover, Single Stick	901-345
20	2	Dowel Pin, 1/16 x 3/8	500-146
21	1	Frame, Top	850-107
22	2	Spring	500-135
23	1	Potentiometer, 5K Bourns, Elevator KPT-5CS	106-027
23	1	Potentiometer, 5K Spectrol, Elevator KPT-7CS	106-060
24	2	Arm, Centering	850-106
25	1	Nut, Hex 3/8 - 32	500-016
26	2	Washer, 5/8 O.D. x 3/8 I.D. x .025	500-054
27	1	Plate, Pot Side	850-113
28	1	Lever, Trim (Pot Coupler)	850-115
29	1	Coupler, Pot to Trim Lever	850-114
30	1	Bushing, Brass	850-008
31	1	Gimbal, Pot Key (KPT-5CS ONLY)	805-155
32	2	Plate, Side (Electrical Trim)	850-117
33	1	Plate, Side (Frame Bearing)	850-116
34	1	Screw, Socket Head, set 6-32 x 3/16"	500-071
35	2	Screw, 2-56 x 5/8" F.H.P.S.M.S.	500-104
36	1	Lever, Trim Single Stick	901-346



(900-077- 900-078, & 900-075, 900-076)

37	1	Centering Coupler	901-347
38	1	Trim Coupler	901-348
39	1	Knob, Single Stick	901-349
40	1	Cover, Single Stick	901-350
41	1	Pot Housing	901-351
42	1	Stick Housing	901-352
43	1	Pot Shaft	901-353
44	2	Screw, 2-56 x 3/16″	500-060
45	1	Spring, Centering, Single Stick	500-151
46	1	Pot, Conductive Plastic 1.5K KPT-5CS	106-025
46	1	Pot, Carbon, 5K KPT-7CS	106-019
47	1	Wiper, Pot	106-045



KPT-5CS & KPT-7CS

MASTER-TRAINER SYSTEM

For trainer operation, transmitters need not be on the same frequency, and may have 5 or 7 channels. Mode I is compatible only with another Mode I transmitter. Mode II is compatible with Mode II and also with single stick transmitters.

The receiver in the aircraft to be flown must be matched to the master or instructor's transmitter.

The transmitter interconnect cable determines which transmitter is to be used as the master. The end of the interconnect cable marked with the black ring is plugged into the slave or student transmitter. Remove or retract the antenna on the slave transmitter. Both transmitters must be switched "ON." When the master transmitter transfer control switch is operated, it transfers control to the slave transmitter. Releasing the switch instantly transfers control back to the master transmitter.

Since the R.F. oscillator in the slave unit must be disabled, it is necessary to shunt power away from the oscillator by returning base power through a low value of resistance to ground through a shorting wire in the slave end of the connecting cable. Because the modulator in the slave unit is not disconnected from the logic output line, capacitive triggering was used on the modulator to prevent locking out the master transmitter modulator if the battery voltage in the slave unit is substantially higher than the battery voltage in the master transmitter.

OPERATIONAL CHECKS

Check the oscillator disabling to be sure the oscillator is indeed "off" in the slave mode, i.e., when the slave end of the cable is plugged into the student transmitter, the R.F. output meter should indicate zero output. Modulator operation may be checked by using a second transmitter and the interconnecting cable.

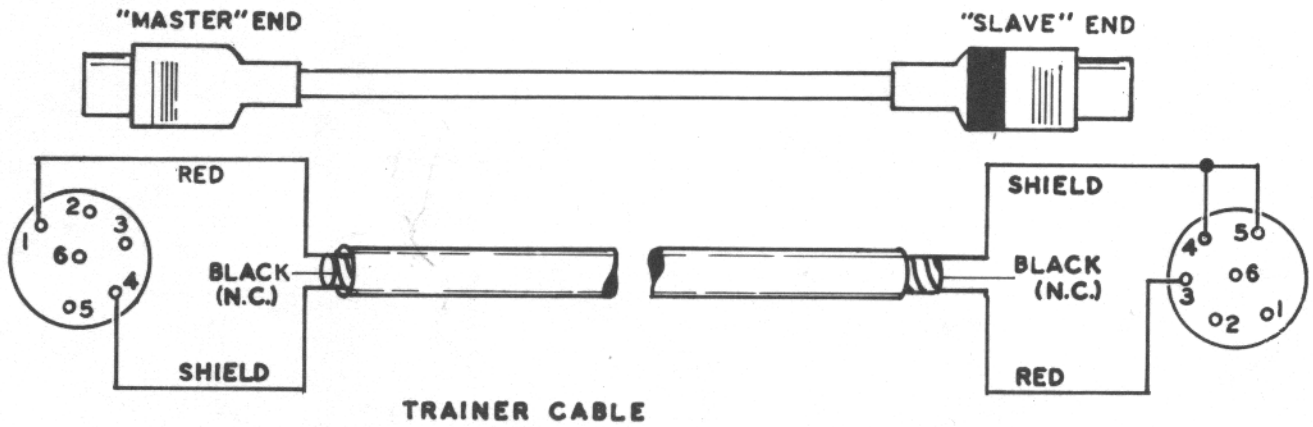


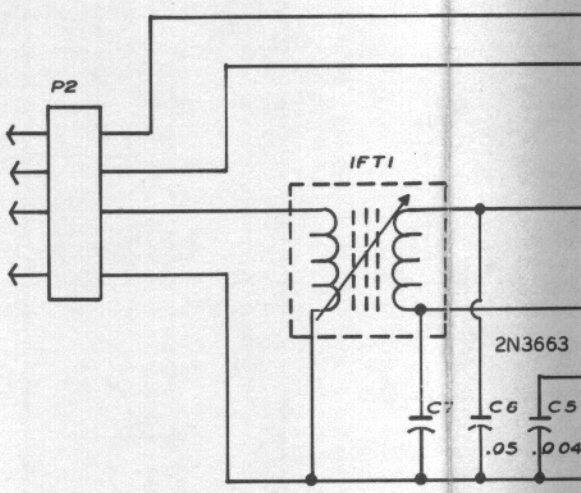
FIGURE 24

FIGURE 25

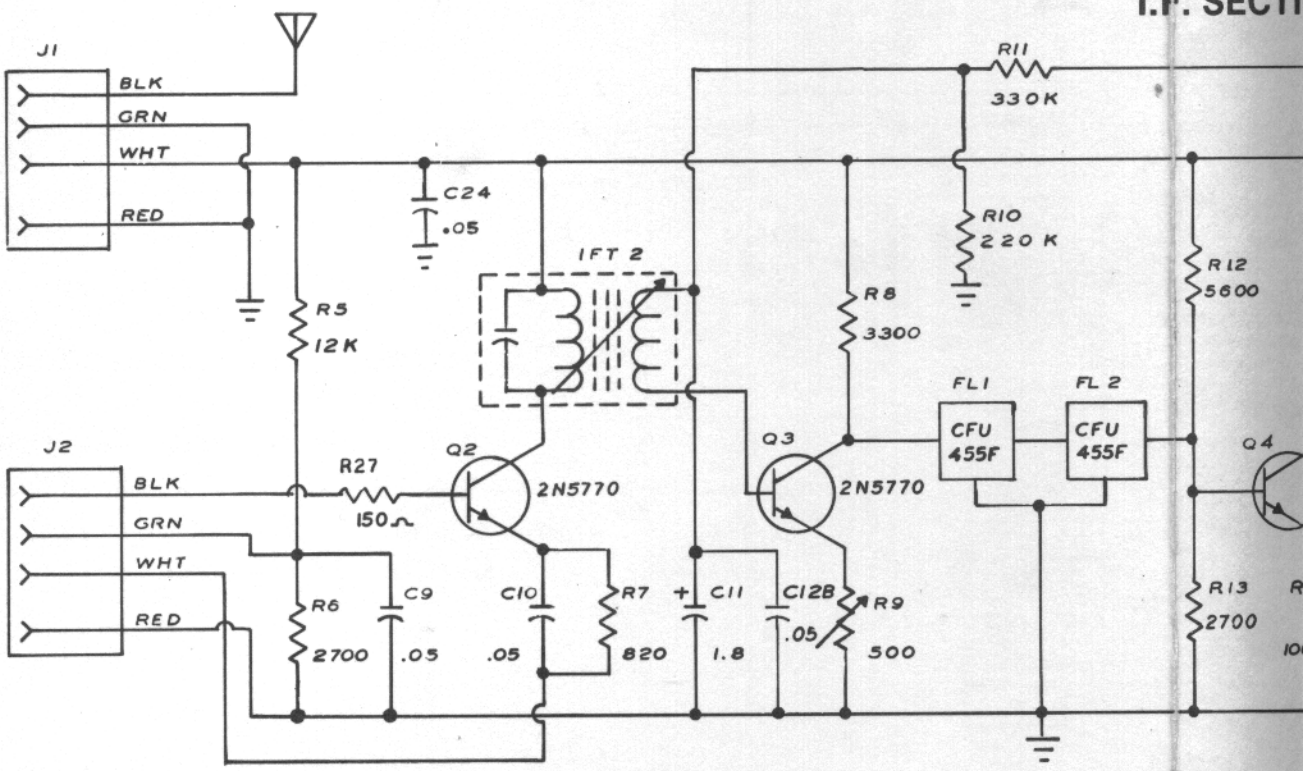
KPR-7C RECEIVE

FRONT-END (PLUG-

	27	53	72	35-40
C1-	22pf	18pf	18pf	47pf
C2-	1.0	0.5	0.5	3 pf
C3-	47	27	15	47pf
C4-	18pf	18pf	27pf	18pf
C7-	22	10	15	18pf
R1-	4700	4700	2700	4700
R3-	1.5K	1.5K	330	1500

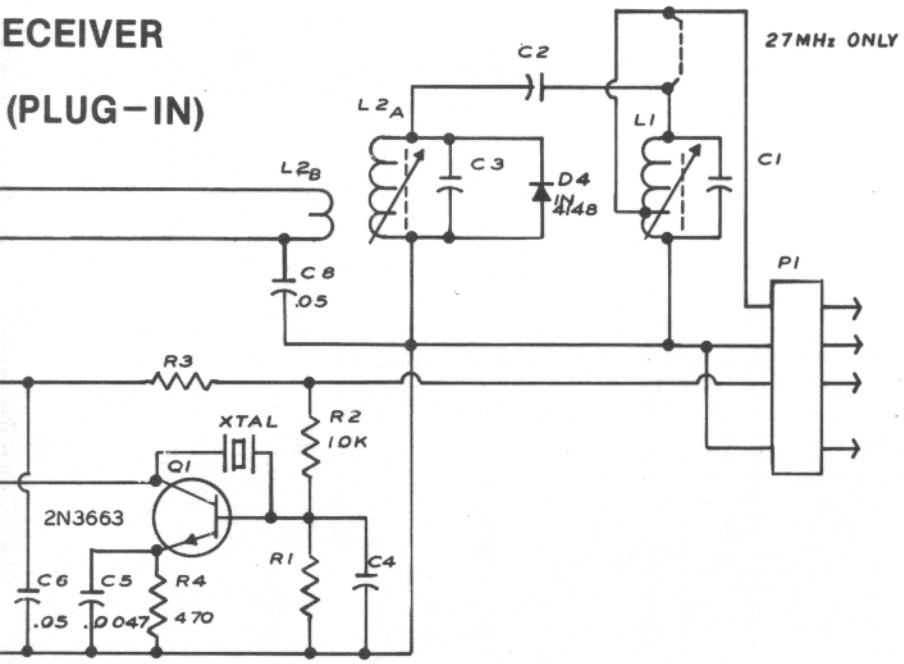


I.F. SECTI



ECEIVER

(PLUG–IN)



. SECTION

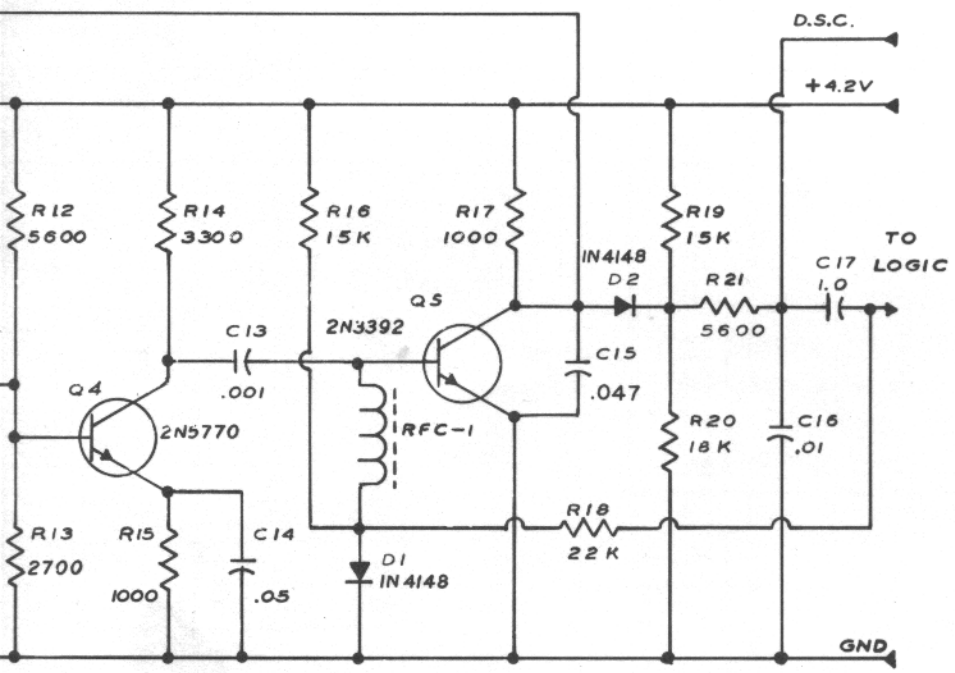
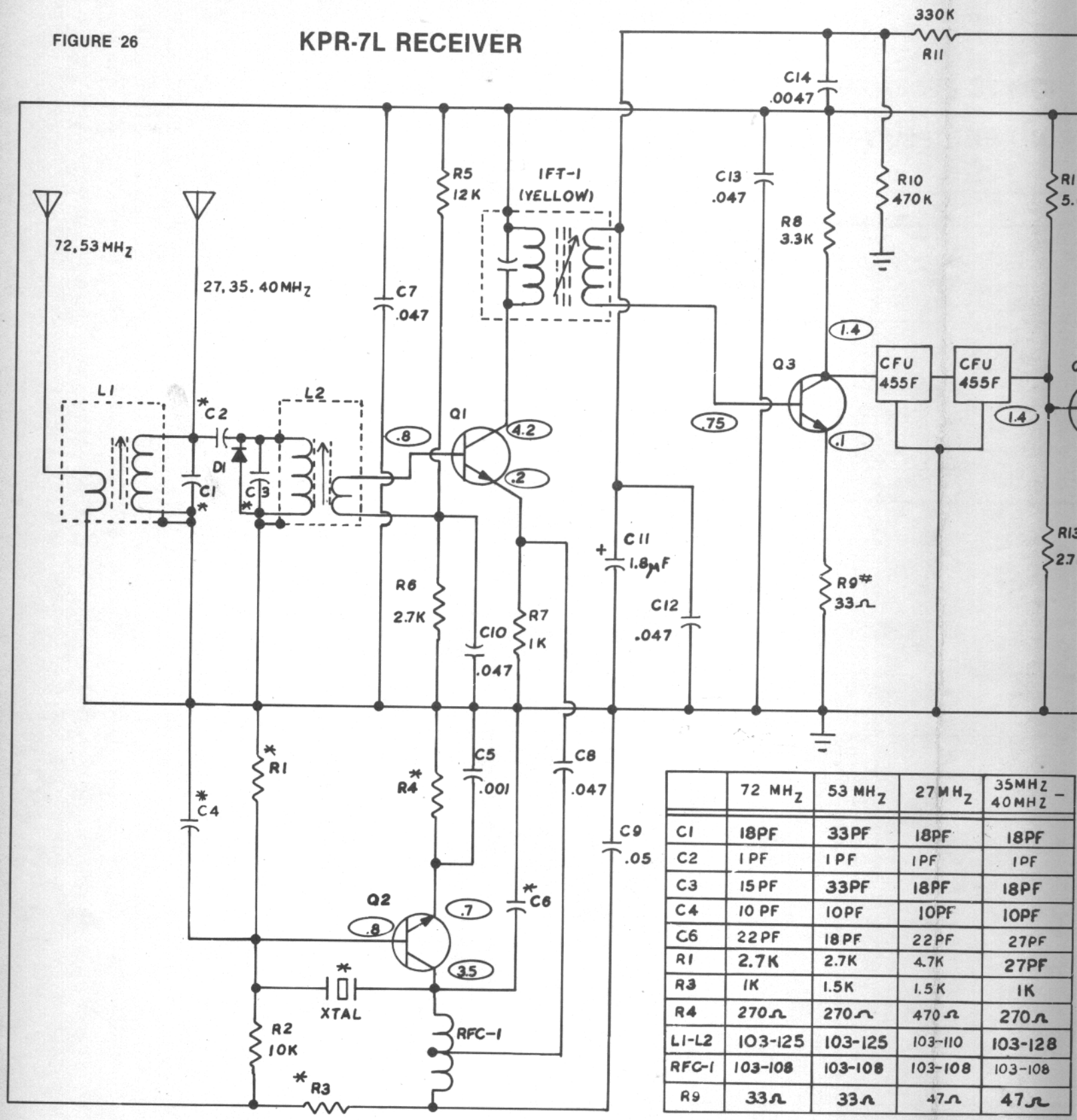
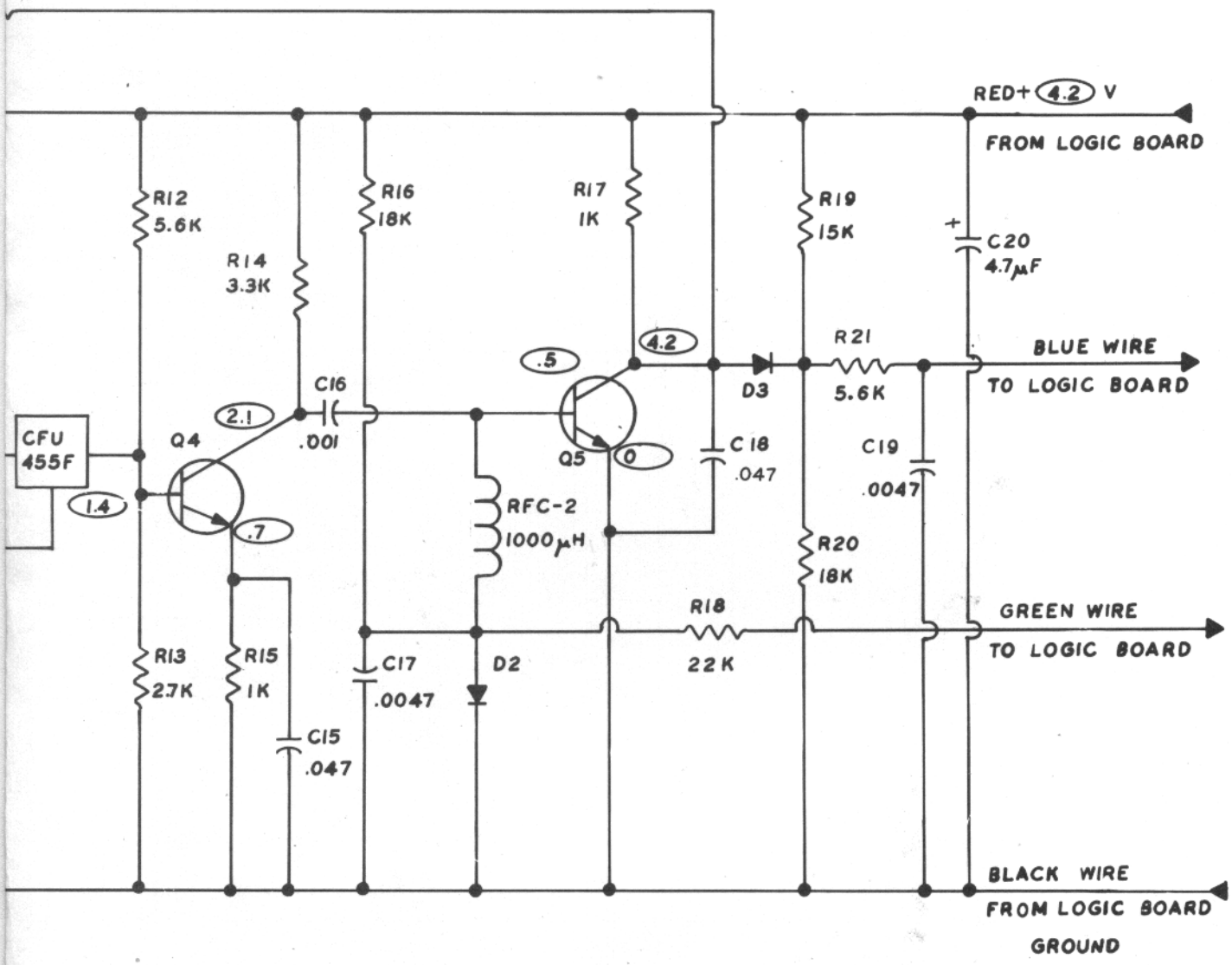


FIGURE 26

KPR-7L RECEIVER



	72 MHz	53 MHz	27 MHz	35MHz 40MHz
C1	18PF	33PF	18PF	18PF
C2	1 PF	1 PF	1PF	1PF
C3	15 PF	33PF	18PF	18PF
C4	10 PF	10PF	10PF	10PF
C6	22 PF	18 PF	22 PF	27PF
R1	2.7K	2.7K	4.7K	27PF
R3	1K	1.5K	1.5K	1K
R4	270Ω	270Ω	470Ω	270Ω
L1-L2	103-125	103-125	103-110	103-128
RFC-1	103-108	103-108	103-108	103-108
R9	33Ω	33Ω	47Ω	47Ω



MHz	35MHZ 40MHZ
F	18PF
	1PF
F	18PF
PF	10PF
PF	27PF
K	27PF
K	1K
Ω	270Ω
-110	103-128
-108	103-108
7Ω	47Ω

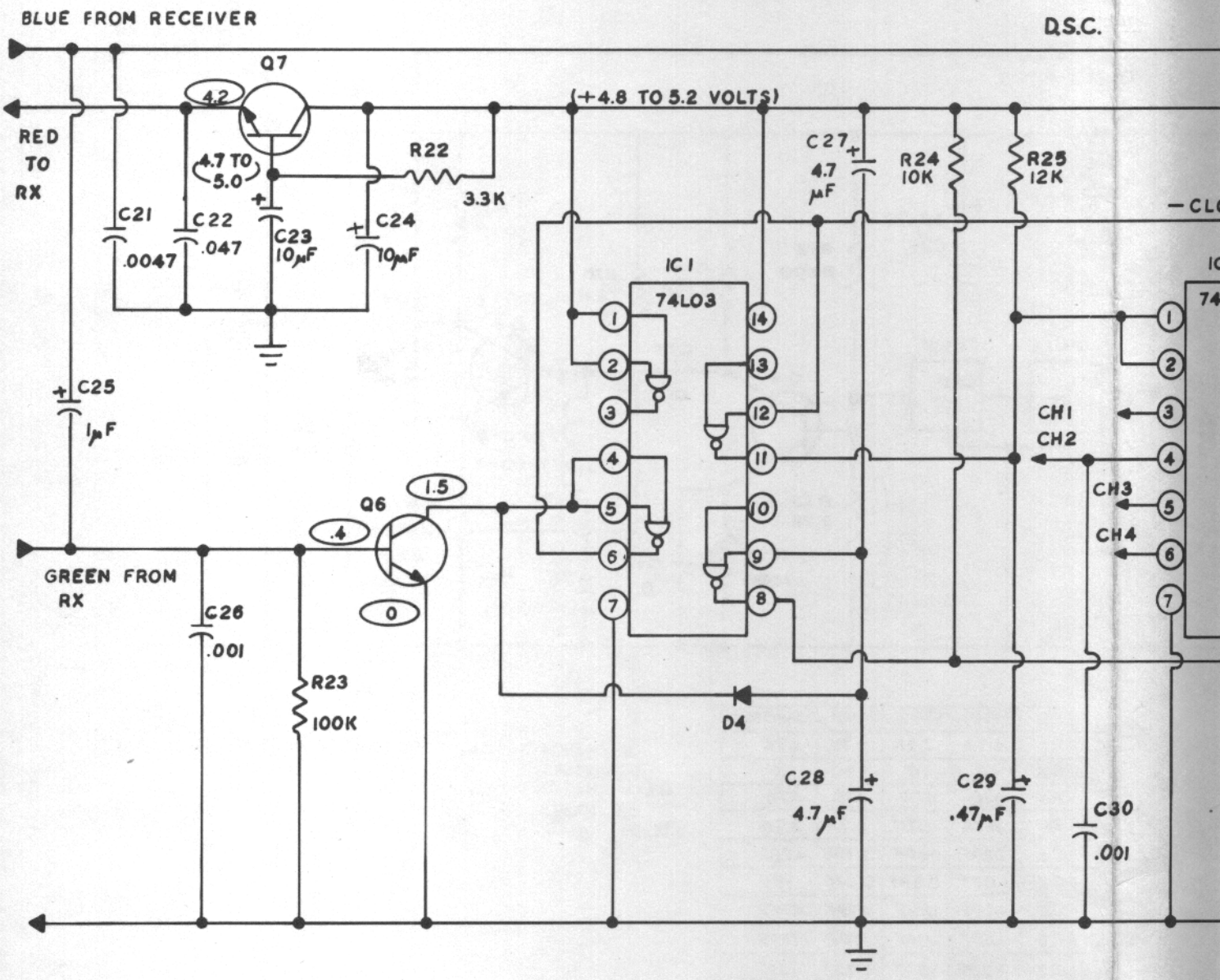
Q1 2N3904
Q2-Q4 FS42875
Q5 2N5088
D1-D3 1N4148

(4.2) THIS SYMBOL INDICATES A POSITIVE D.C. VOLTAGE REFERENCED TO GROUND MEASURED WITH A D.C. 1 MEG OHM INPUT OSCILLOSCOPE, NO SIGNAL CONDITION. MAY VARY ±10% FROM INDICATED.

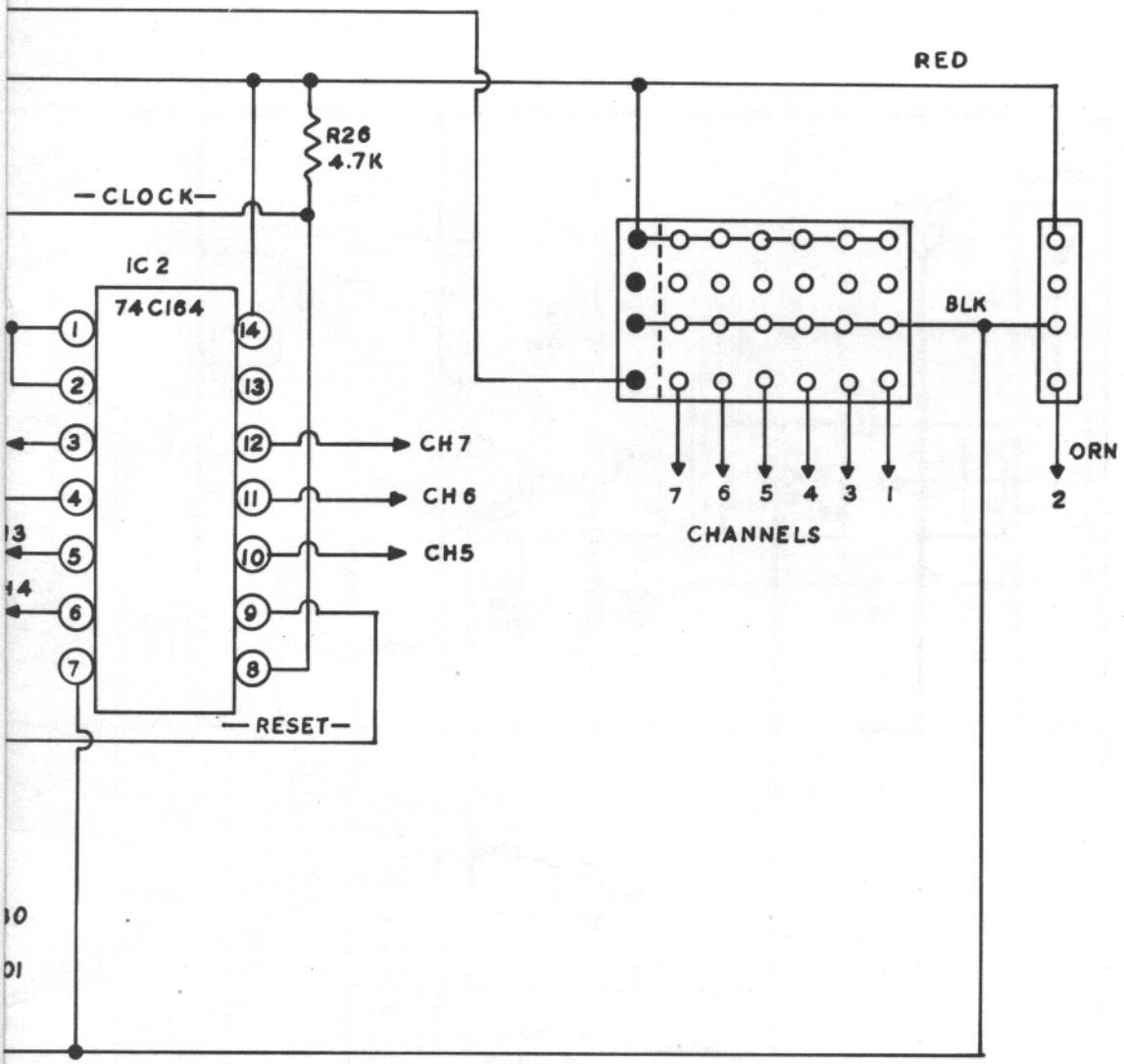
* NOMINAL VALUE— MAY VARY FROM 33 OHMS TO 150 OHMS.

* SELECTED BY FREQUENCY

KPR-7L LOGIC



THIS SYMBOL INDICATES A POSITIVE D.C. VOLTAGE REFERENCED TO GROUND ME
WITH A D.C. 1 MEG OHM INPUT OSCILLOSCOPE, NO SIGNAL CONDITION.
MAY VARY ± 10% FROM INDICATED.



OUND MEASURED

Q6 2N5088

Q7 MPS6560

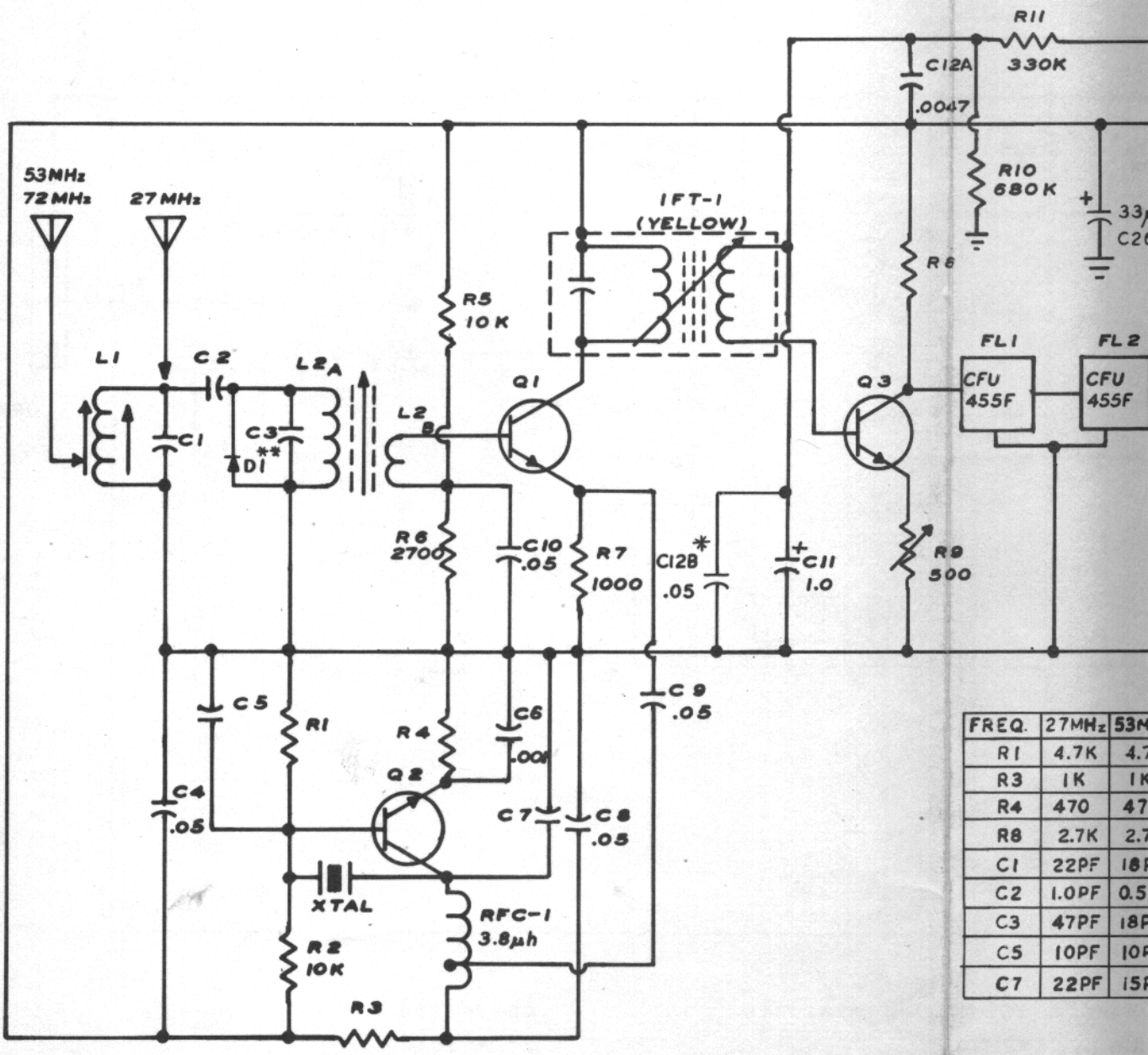
D4 IN4148

FIGURE 27

72.535
.455
080

KPR-5C RECEIVER FRONT-END

R-20



FREQ.	27MHz	53M
R1	4.7K	4.7
R3	1K	1K
R4	470	47
R8	2.7K	2.7
C1	22PF	18P
C2	1.0PF	0.5
C3	47PF	18P
C5	10PF	10P
C7	22PF	15P

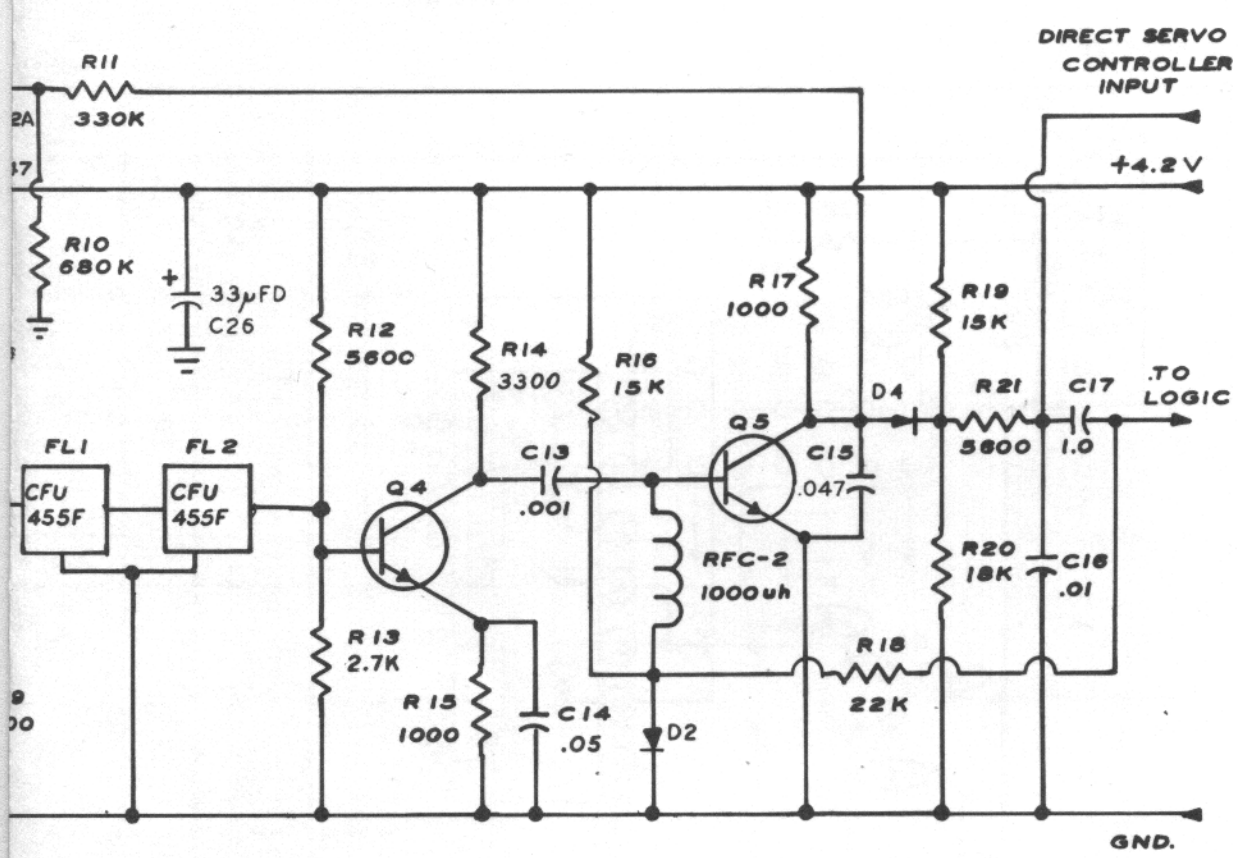
* C12B ON 5 CHANNEL RECEIVERS USING R20A P.C. BOARD ONLY

** D1 PRESENT ON LATE 1977,78,79 SERIES PRODUCTION 5 CHANNEL RECEIVERS.

72080
10.700
82.780

10.700
.455
11.155

RONT-END



FREQ.	27MHz	53MHz	72MHz	35-40MHz
R1	4.7K	4.7K	2.7K	4.7K
R3	1K	1K	390	1K
R4	470	470	270	470
R8	2.7K	2.7K	2.7K	3.3K
C1	22PF	18PF	27PF	47PF
C2	1.0PF	0.5PF	0.5PF	1PF
C3	47PF	18PF	27PF	47PF
C5	10PF	10PF	10PF	18PF
C7	22PF	15PF	22PF	18PF

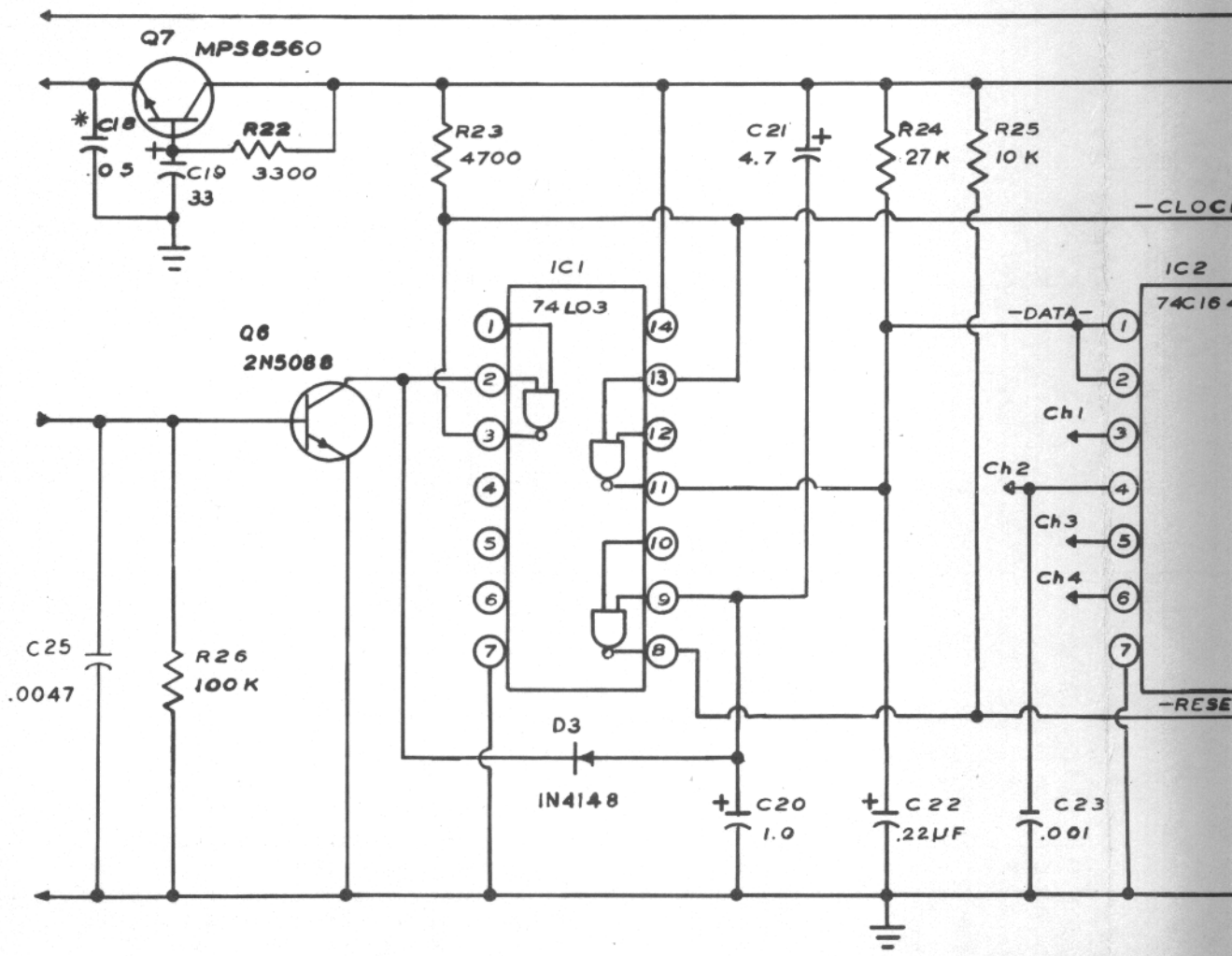
Q1 2N3904 ON 72&27MHZ, 2N3663 ON 53MHZ
Q2 2N3663
Q3, Q4 2N5770
Q5 2N3392
D1-D3 IN4148

IVERS.

FIGURE 28

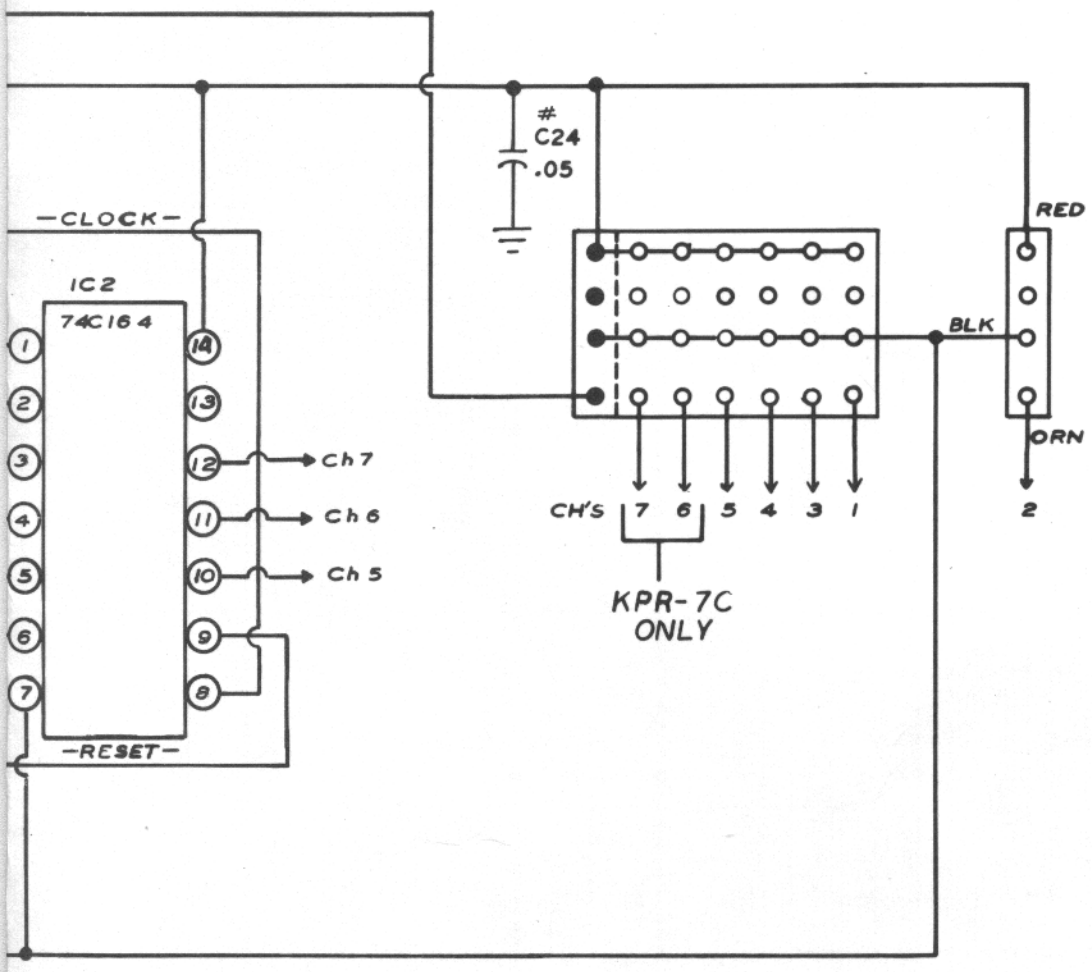
FIGURE 29

LOGIC — KPR-5 & 7C

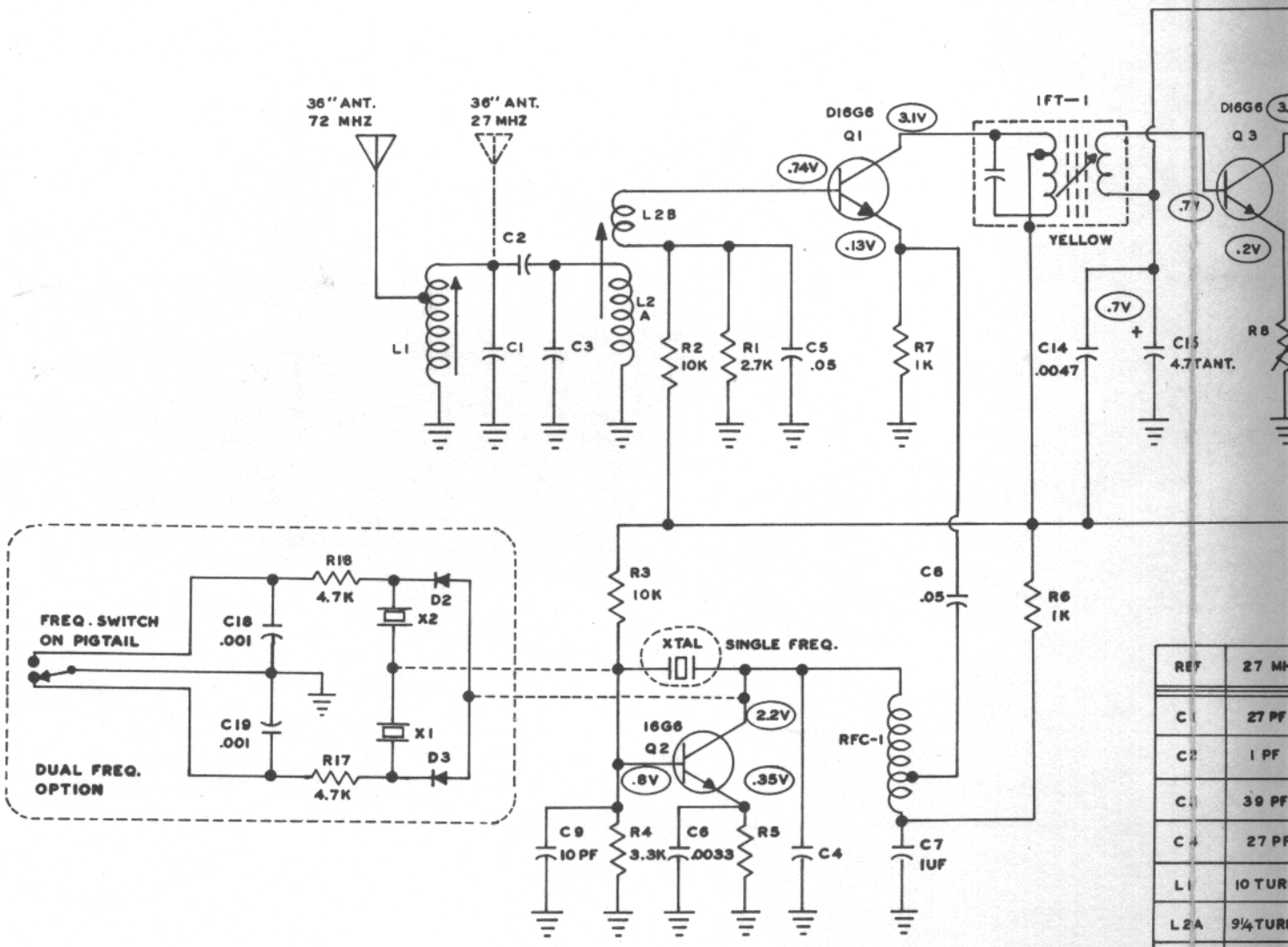


C24 ONLY PRESENT ON 5 CHANNEL RECEIVERS.

*C18 ON 7 CHANNEL, AND 5 CHANNEL RECEIVERS WITH R20 P.C. BOARD ONLY.

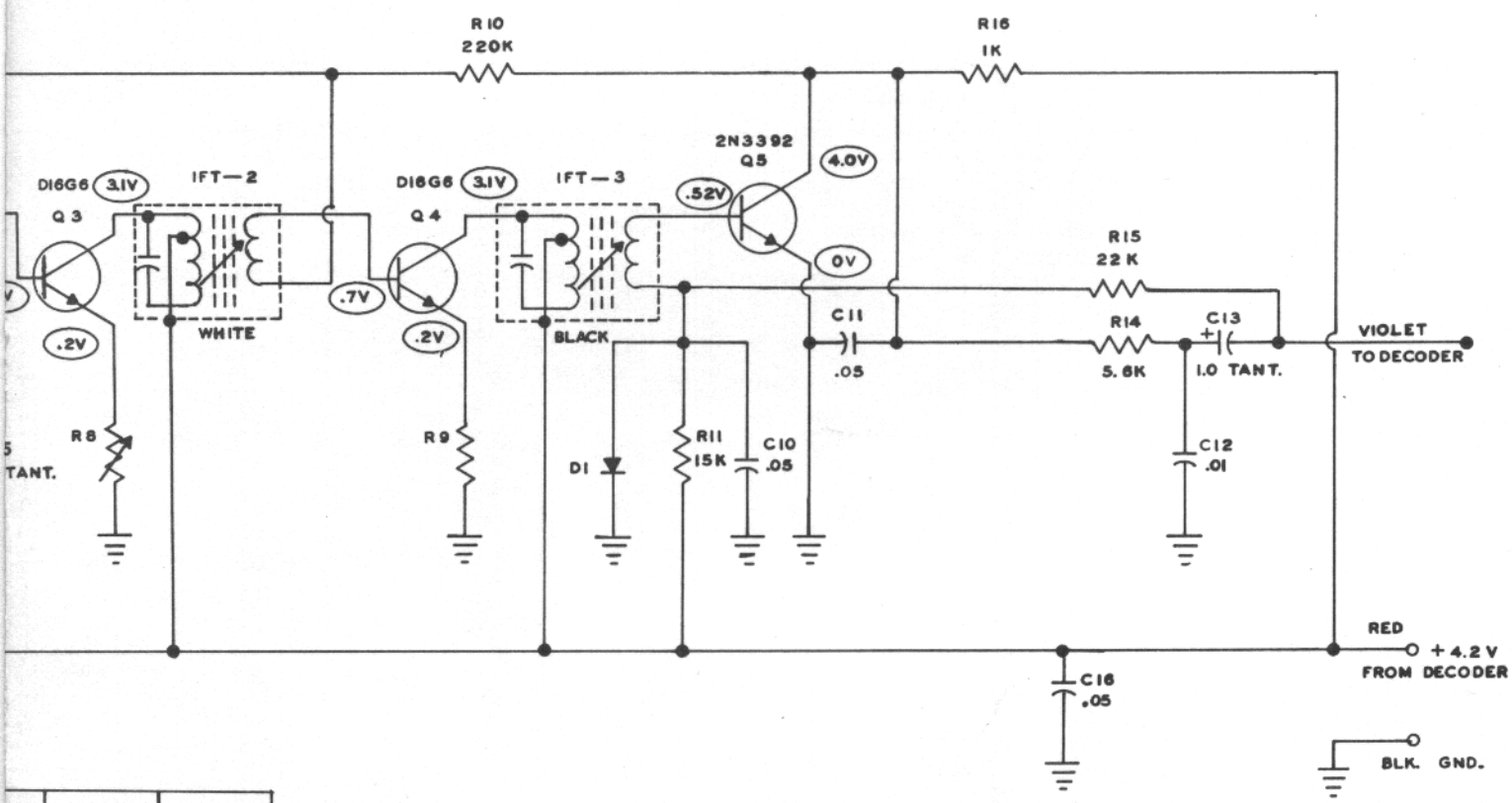

#
C24
.05
-CLOCK-
IC2
74C164
1
2
3
4
5
6
7
14
13
12
11
10
9
8
Ch 7
Ch 6
Ch 5
-RESET-
RED
BLK
ORN
2
CH'S
7
6
5
4
3
1
KPR-7C
ONLY

KPR-3C BRICK RECEIV



REF	27 MH
C1	27 PF
C2	1 PF
C3	39 PF
C4	27 PF
L1	10 TUR
L2A	9¼TURI
L2B	2½TURN
R6	500 OH
R5	470 OH
R1	100 OH

RECEIVER — FRONT END SERIES 1976-1977



F	27 MHZ	72 MHZ
	27 PF	15-18PF
	1 PF	0.5PF
	39 PF	15-18 PF
	27 PF	22 PF
	10 TURNS	4 TURNS TAP 1 TURN
A	9¼ TURNS	5¼ TURNS
B	2½ TURNS	1¼ TURNS
	500 OHMS	500 OHMS
	470 OHMS	270 OHMS
	100 OHMS	100 OHMS

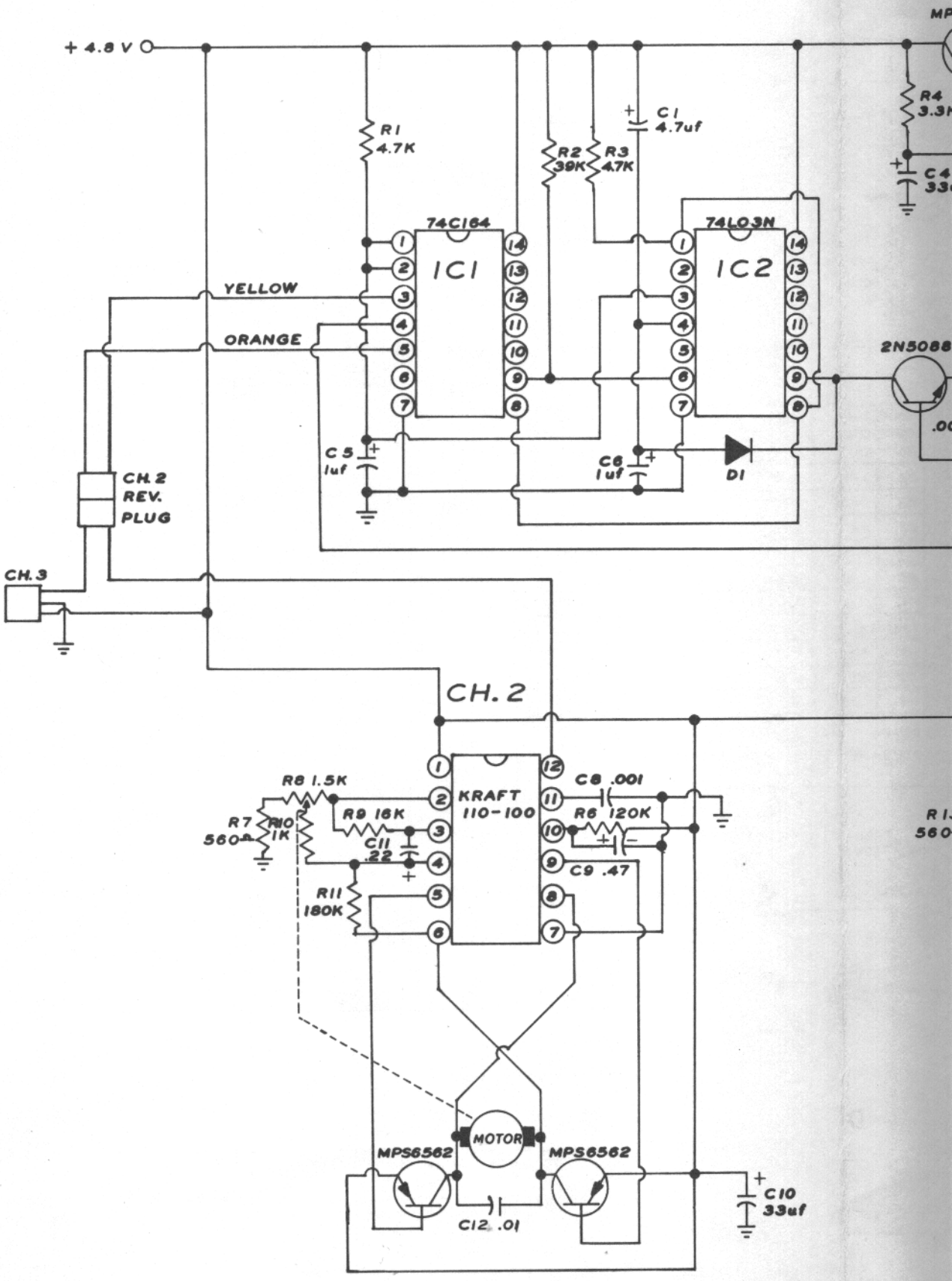
NOTES
1. ALL RESISTORS 1/4 W. 10% — VALUES IN OHMS (K=1000).
2. ALL CAPACITORS DISC CERAMIC UNLESS NOTED. VALUES IN UFD UNLESS NOTED.
3. (◯) THIS SYMBOL INDICATES A POSITIVE DC VOLTAGE REFERENCED TO GROUND TAKEN WITH A 20,000 OHM PER VOLT V.O.M. AND NO INCOMING SIGNAL.
4. PART VALUES NOT INDICATED ON SCHEMATIC ARE SHOWN IN TABLE AT LEFT.

KRAFT SYSTEMS, INC.
VISTA, CA

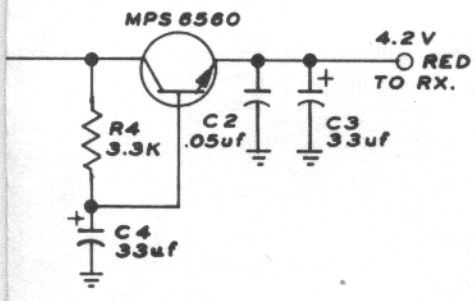
FIGURE 30

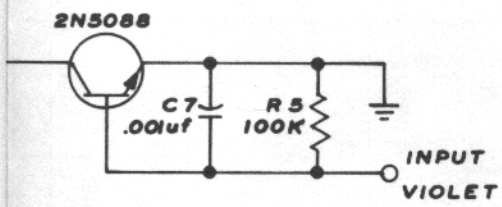
FIGURE 31

KPR-3C DECODER — SERVO AMPLIFIERS



FIERS


MPS 6560
4.2 V
RED
TO RX.
R4
3.3K
C2
.05uf
C3
33uf
C4
33uf


2N5088
C7
.001uf
R5
100K
INPUT
VIOLET

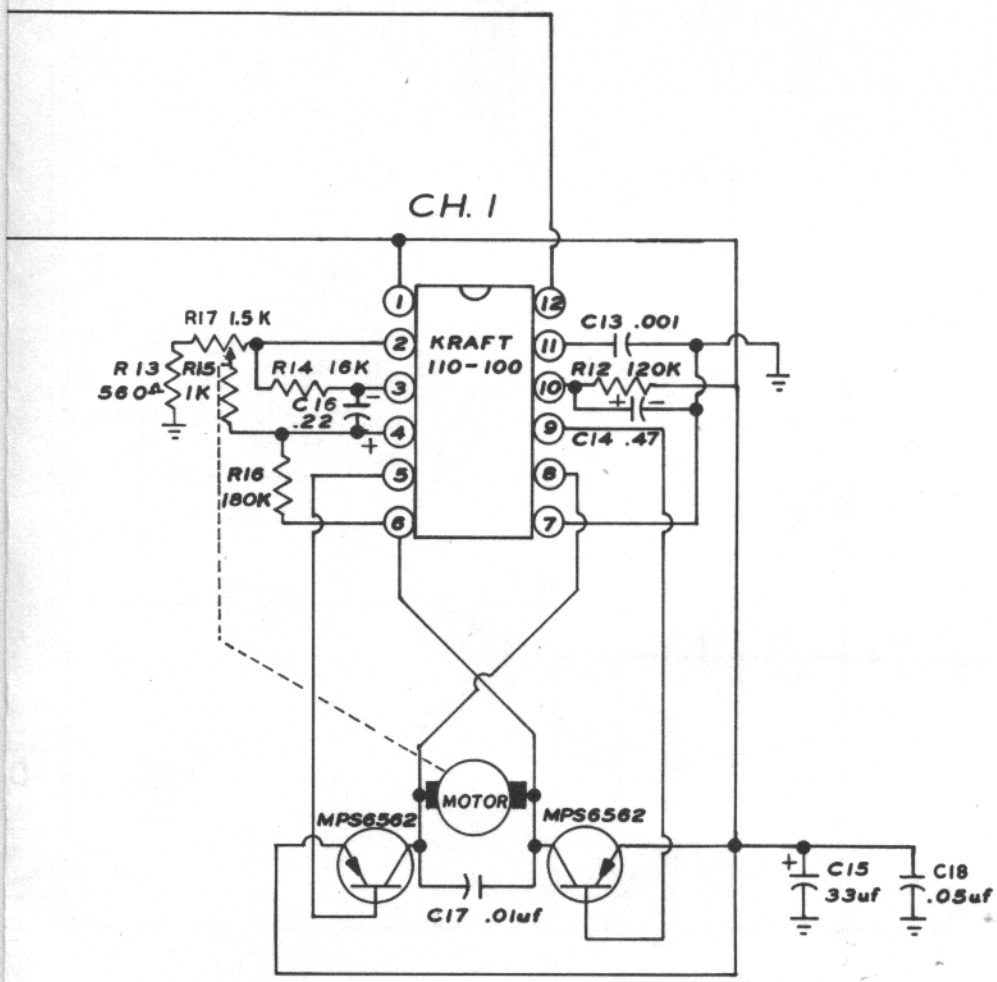
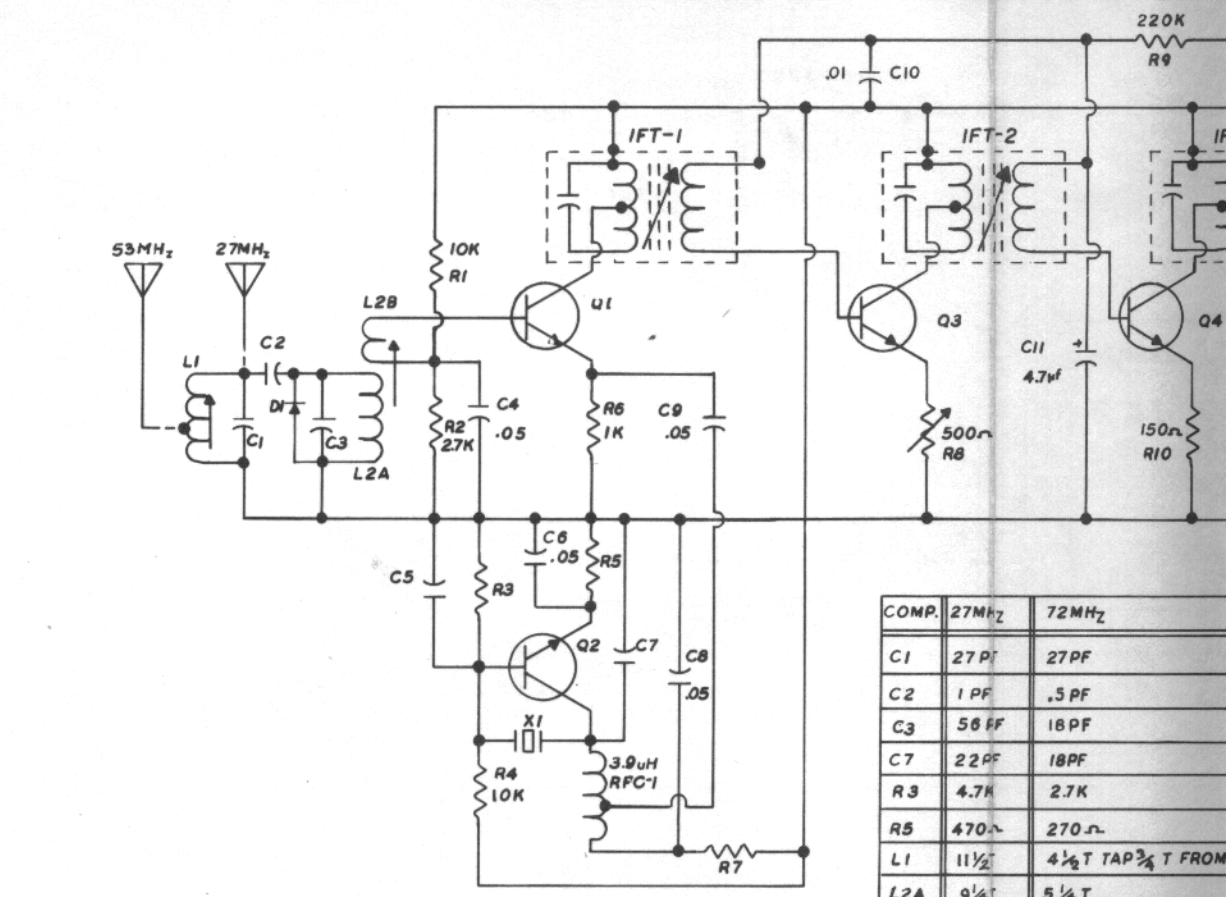

CH. 1
R17 1.5 K
R13
560
R15
1K
R14 16K
C16
.22
R16
180K
KRAFT
110-100
C13 .001
R12 120K
C14 .47
MOTOR
MPS6562
MPS6562
C17 .01uf
C15
33uf
C18
.05uf

FIGURE 32

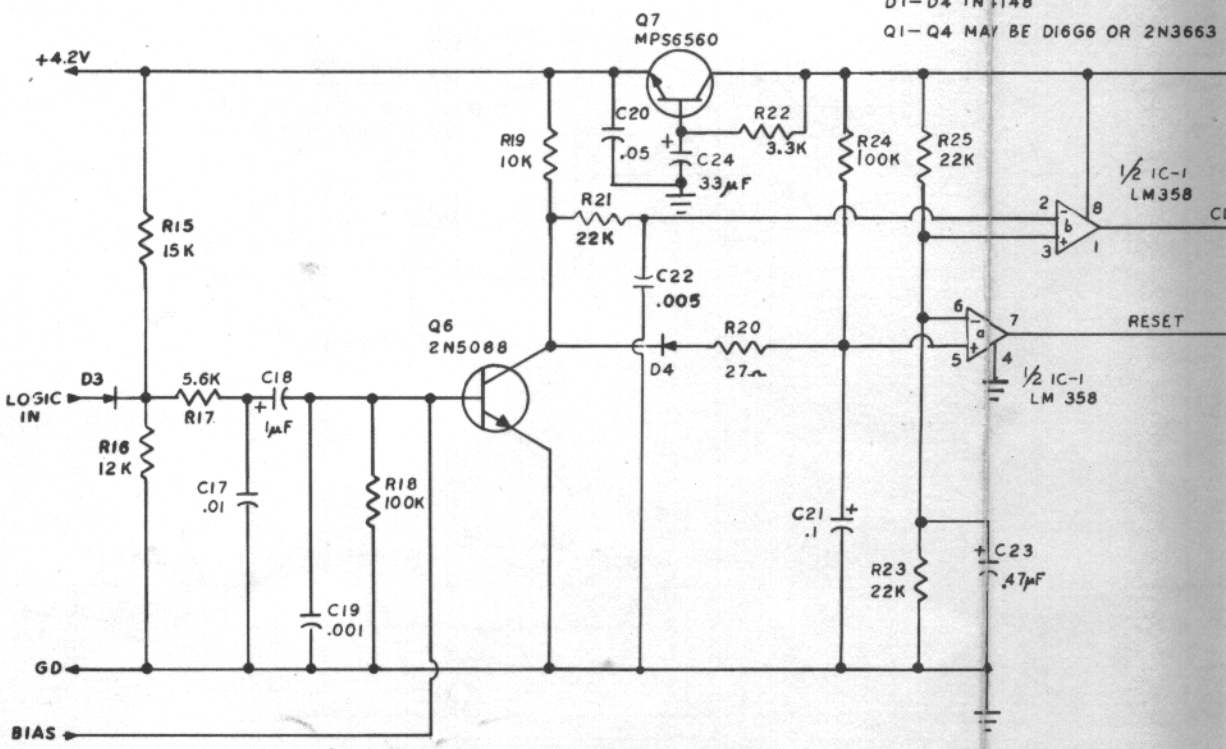
KPR-3C RECEIVER AND DECODER SER



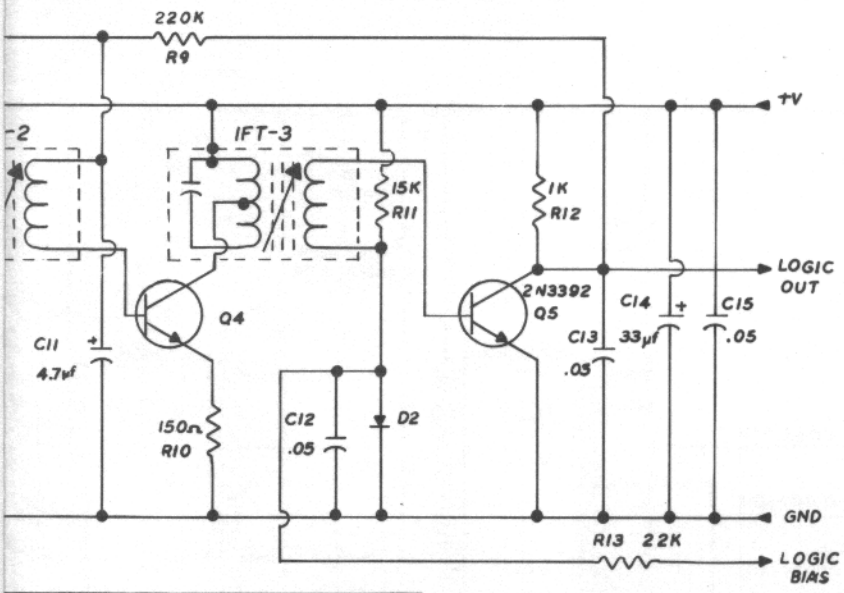
COMP.	27MHz	72MHz
C1	27 PF	27PF
C2	1 PF	.5 PF
C3	56 PF	18 PF
C7	22 PF	18PF
R3	4.7K	2.7K
R5	470Ω	270Ω
L1	11½T	4½T TAP ¾T FROM
L2A	9¼T	5¼T
L2B	2¼T	1¼T
C5	DELETE	10 PF
R7	1.5K	1K

D1–D4 IN 5148

Q1–Q4 MAY BE D16G6 OR 2N3663



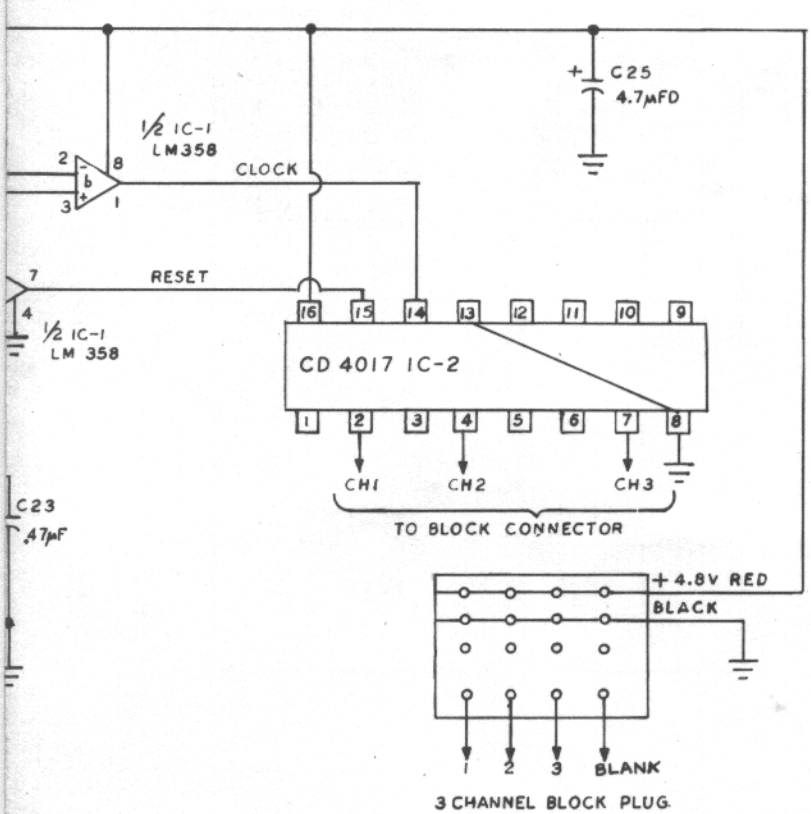
ECODER SERIES 1978-1979 R29



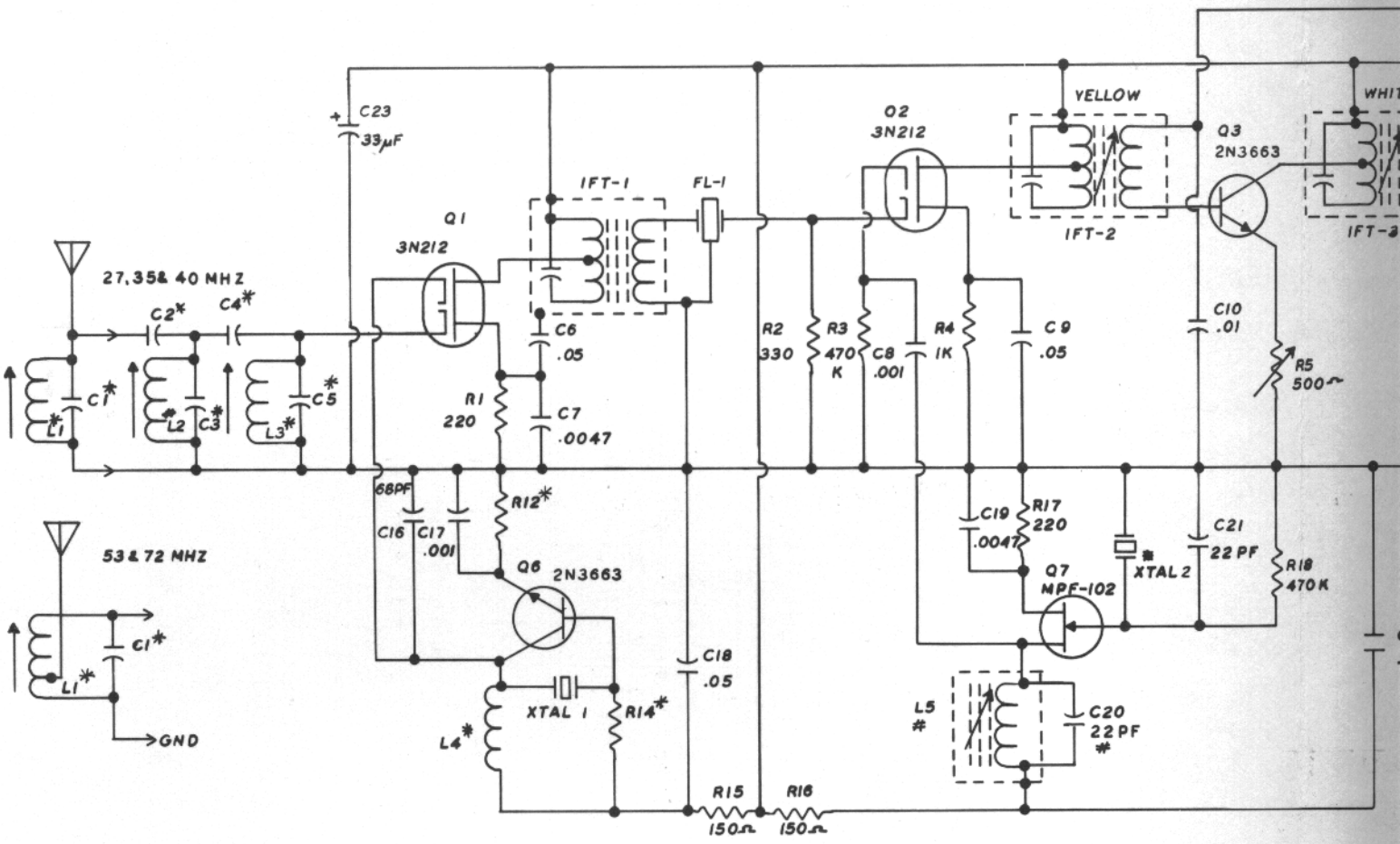
Z	72MHz	53MHz
F	27PF	18PF
	.5PF	.5PF
F	18PF	27PF
F	18PF	10 PF
	2.7K	4.7K
	270Ω	470Ω
	4½ T TAP ¾ T FROM GND.	7½ T TAP AT 3¾ T
T	5¼ T	7¼ T
T	1¾ T	1¼ T
TE	10 PF	10PF
	1K	1.5K

4148

Y BE D16G6 OR 2N3663



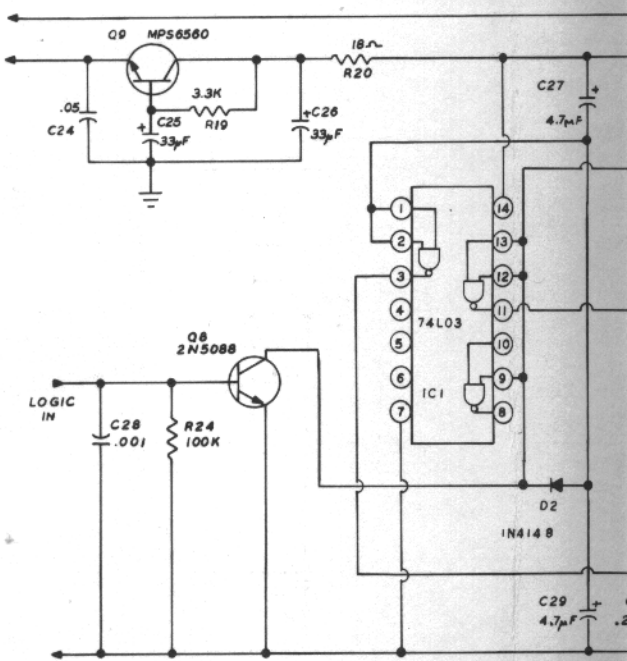
KPR-7D RECEIVER FRONT END

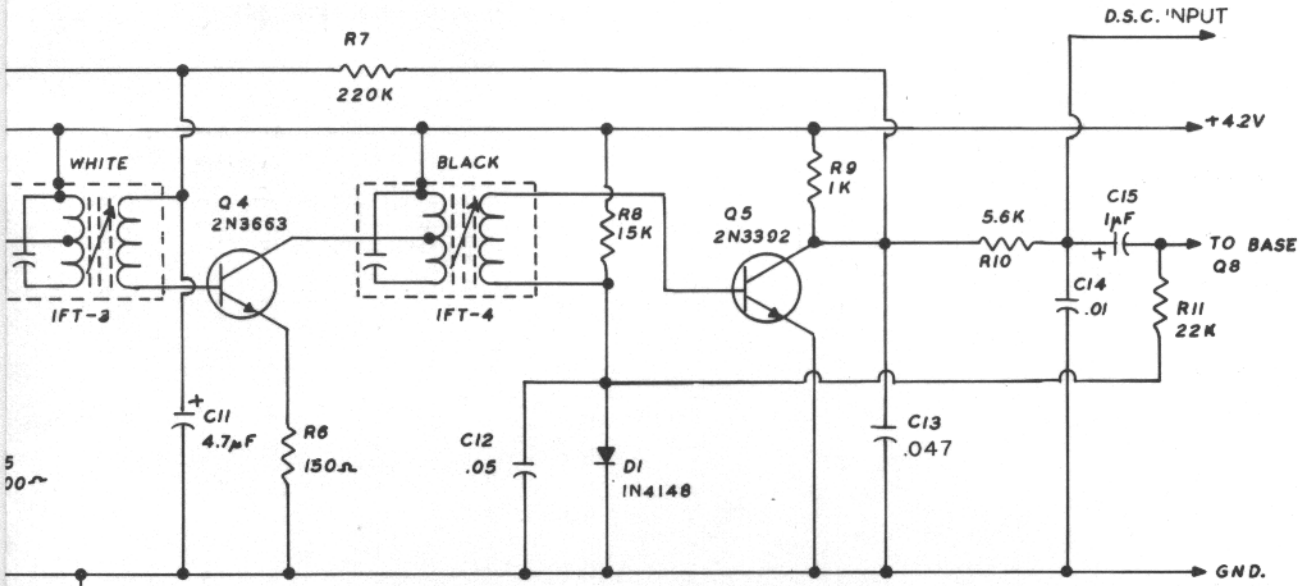


*SELECTED BY FREQUENCY

REVISIONS
7-11-77 ADDED 35 & 40 MHz COMPONENTS TO CHART; C20 CHANGED FROM 18 PF
29-11-78 - L5 REPLACED WITH TORDID COIL 103-130, & C20 CHANGED TO 47PF, SEE ECN 78-79 CHANGE APPLICABLE IF OLD COIL IS DAMAGED.

LOGIC — KP





BAND	53 MHZ	72MHZ	27MHZ	35MHZ	40MHZ
L1	103-104	103-093	103-085	103-085	103-085
L2	103-080	103-105	103-060	103-060	103-060
L3	103-084	103-105	103-072	103-072	103-072
L4	103-043	103-043	103-044	103-044	103-043
# L5	103-035	103-035	103-035	103-035	103-035
IFT-1	103-088	103-088	103-088	103-088	103-088
C1	22PF	33PF	39PF	22PF	18 PF
C2	.5PF	.5PF	3PF	1PF	1 PF
C3	22PF	18PF	33PF	22PF	18PF
C4	1PF	1PF	3PF	1PF	1PF
C5	10PF	18PF	27PF	15PF	10PF
R12	150Ω	560Ω	220Ω	220Ω	220Ω
R14	15K	4.7K	15K	15K	15K
XTAL 1	FO + 10.7MHZ	FO − 10.7 MHZ	FO + 10.7 MHZ	FO + 10.7 MHZ	FO + 10.7 MHZ
XTAL 2	11.155MHZ	11.155MHZ	11.155MHZ	10.245MHZ	11.155 MHZ

NOTE: Q3, Q4, AND Q6 MAY ALSO BE D16G6

— KPR-7D

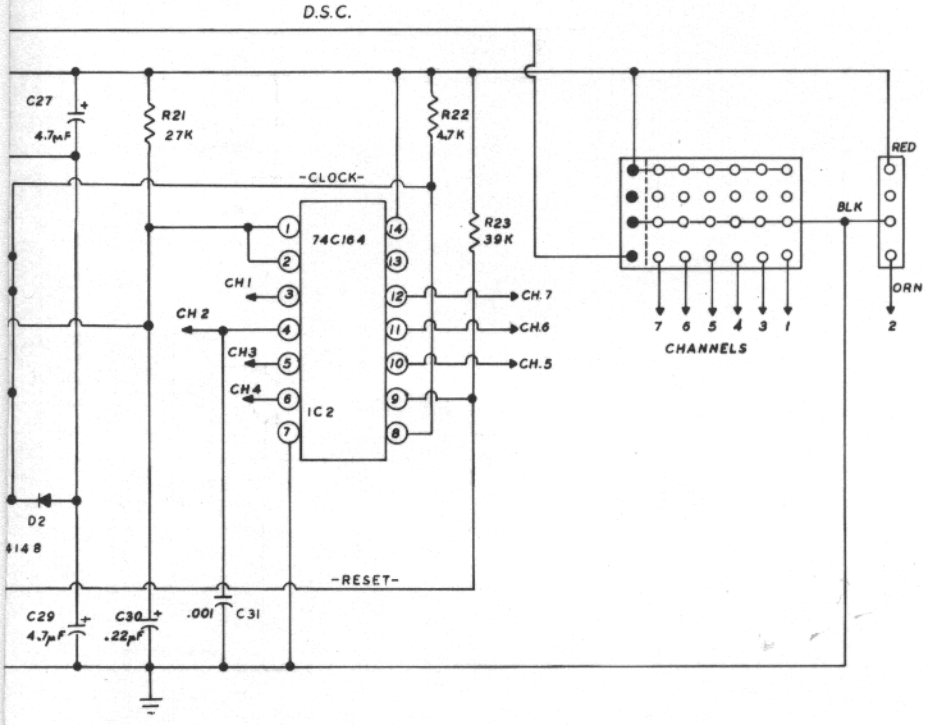


FIGURE 33

FIGURE 36
Q5 Collector Waveform, IF detuned

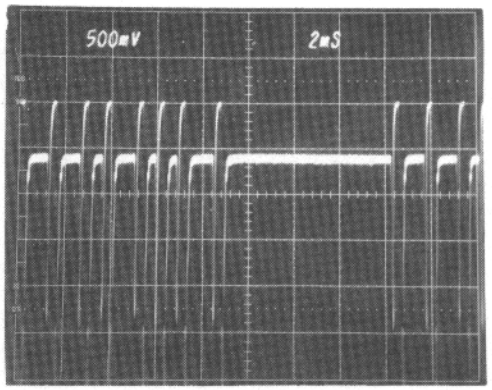
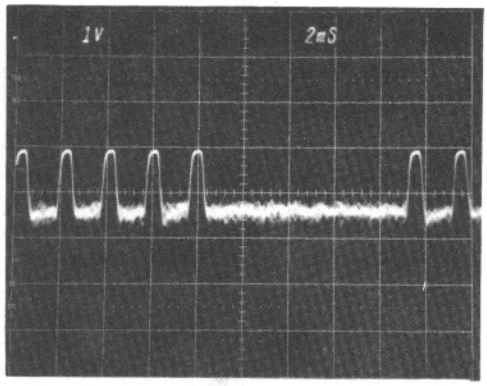


FIGURE 37
Q5 Collector Waveform, IF properly tuned



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 the RF and mixer coils for maximum displayed amplitude. Reduce signal strength until the displayed amplitude is between ½ to 1 volt. Peak all the foregoing adjustments at this level for maximum displayed amplitude. Do not adjust IF gain control R3, unless setting sensitivity as described later.

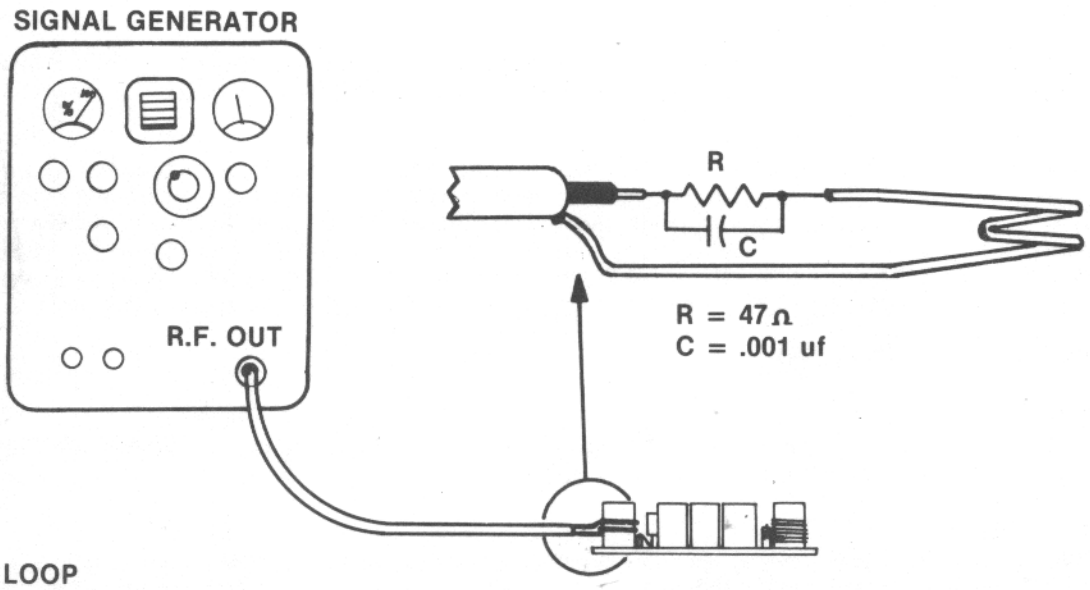
If all the foregoing tests were acceptable, the receiver should be temperature tested over a range of at least 0-140°F (– 18 to + 60°C). Check to be sure the oscillator starts at either extreme by cycling the power switch. Also check for channel outputs at each extreme.

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 procedures and correlate your measurements with those of the factory. (See Figure 38)



INJECTION LOOP
FIGURE 38

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 (Q5). 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 17 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 ½ volt p-p signal is displayed. 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.

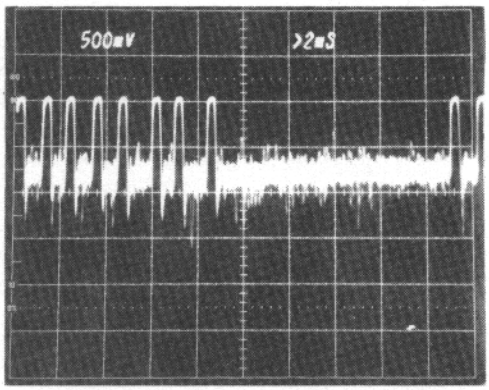
If the receiver falls outside these limits, and you are certain the equipment you are using is calibrated, adjust an IF emitter resistor for ½V p-p at 2.5 microvolts generator output. In no case should these resistors be less than 100 ohms or greater than 330 ohms. The KPR-7L is the only exception.

The KPR-7L receiver uses shilded antenna and mixer coils. To check receiver sensitivity, a special injection cable consisting of a 22 pf silver mica capacitor in series with the hot lead of the RG-58 A/U coaxial cable is connected to the output of the generator. The ground side of the coax is connected to a small clip lead. The hot side at the 22 pf capacitor connects to a 2½" length of wire with plug which is cut from a plug-in antenna (Part No. 200-183). The antenna plug is inserted directly into the receiver antenna jack. The ground lead is attached to the receiver ground as close as possible to the signal input. Injection of the signal is made directly into the antenna coil of the receiver. Follow the normal procedures for alignment and gain adjustment.

Be sure to retune the antenna and mixer coils with the antenna wire extended as described in the section on receiver tuning. Figure 39 shows the receiver output with very low RF input.

FIGURE 39

Q5 Collector Waveform, Weak signal condition



RECEIVER TROUBLE SHOOTING

Due to its environment, the receiver may be subject not only to component failures, but can exhibit trouble under vibration or temperature extremes. Temperature variations can be checked on the bench with hot air blower and freeze type spray.

Vibration failures are much more difficult to track down on the bench. Some vibration problems are due to cracked components or loose wires in plugs and can be located on the bench. Gently rocking parts while monitoring the output on an oscilloscope will most often reveal the location of loose or cracked parts. If the source of vibration trouble cannot be located and has been definitely narrowed down to one part of the system, try a replacement and see if the problem ceases. If so, it might be advantageous to simply replace that portion of the system and scrap the defective part. In dealing with vibration problems, don't neglect to examine the switch harness as a possible source of trouble.

Some other causes of difficulty are:

Poor Range—

Generally due to lack of sufficient sensitivity, assuming model installation is correct. Check AGC voltage and part value in receiver. Often retuning is all that is necessary.

Receiver Unstable—

Oscillation or instability in a receiver is often the result of defective I.F. transformers. Most often the input I.F. is the one at fault. Check also for proper AGC action to be sure that gain is being adjusted to suit signal conditions. On rarer occasions, a bypass capacitor may open in either the mixer or detector stages.

Interference —

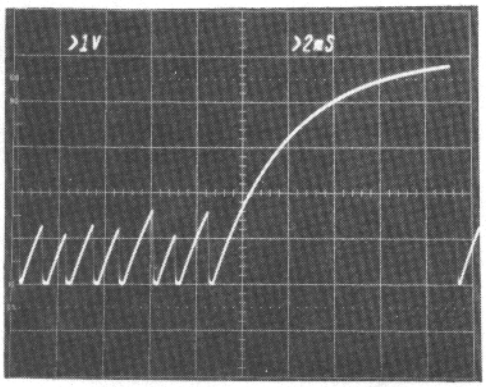
If sensitivity checks are satisfactory, check clipper lever (Figure 34) The upper O.7V of the detected waveform should appear at this point.

The clipping diode is forward biased by approximately 0.7V to 0.8V. This bias is obtained by the voltage difference between the collector of detector transistor Q5 and the cathode end of diode D2 on the KPR-7C. To insure proper operation, first check the voltage at Q5's collector. This should be very close to the supply voltage (within 0.2V with no input signal). If it is not, check the voltage drop across diode D1 which should be approximately 0.54V. Since transistor Q5 requires 0.6V to conduct, if the voltage is correct at this point, Q5's collector should be approximately at the supply voltage. If the voltage is too high at diode D1 (the base of Q5), suspect a defective diode first; and second, check the value of resistor R20 which should be 18K. If this voltage is correct and the collector voltage of Q5 is still low, it will be necessary to replace transistor Q5. If the preceding conditions are correct and the clipped signal observed at the cathode of diode D2 is still less than 0.7V, check to be sure that resistor R19 is 15K. Then, if necessary, reduce R18 from 22K to 18K. If the clipped signal is still not within tolerance, replace diode D2.

KPR-7C AND 5C RECEIVER DECODER (Figure 29)

The operation of the decoder is based on loading a "high" into a shift register IC-2, during the sync period in the transmitted pulse group. This "high" is then clocked through the shift register by the control pulses so that the "high" advances once location in the shift register each time a control pulse is received. Since the time the "high" appears at any specified output of the shift register is equal to the spacing between the corresponding two control pulses, the result is a pulse at each shift register output whose width represents the control position for that channel.

FIGURE 40
IC2, pin 1, Waveform



When the collector of Q6 goes low at the start of the sync period, the signal is coupled through two of the gate elements that are used in IC-1 and then to the data input of IC-2 to provide the "high" which will be clocked through the shift register. The data input of the shift register responds only to the sync period and not the control pulses because of the time constant provided by R24 and C22 (Figure 40). The clock pulse is derived from pin 2 of IC-1 and all control pulses are seen at the clock input of IC-2 pin 8 because there is no RC network at this pin. There is no need to clear the shift register during normal operation since any erroneous "ones" will be clocked out within one pulse group.

In order to ensure that no servos will operate if the received signal is lost or when the transmitter is turned off, the shift register is cleared by the output of a third gate in IC-1. When a normal signal is present, the negative pulses on the collector at Q6 are coupled through D3 to the gate input, which then disables the shift register clear. The time constant provided by C20 and C21 is chosen to provide a clean drop out when signal is lost.

Q7 and associated components form an active filter capacitor for the receiver supply voltage. The effective capacitance is approximately β x C19 or $\approx$3,300µf.

KPR-3C DECODER AND SERVO AMPLIFIERS ('76 and '77) (Figure 31)

The circuits and operation of the 3 channel decoder and servos are the same as the five channel. The only difference is that the 3 channel unit incorporates 2 servo amplifiers on the same PC board assembly as the decoder. A third servo, if desired, can be mounted separately and connected to the decoder output.

KPR-3C DECODER ('78-'79)
(Figure 32)

This decoder is somewhat different from the one used in 1976 and 1977, and does not include servo amplifiers. The servos used are the same as those for the KPR-5C and 7C described in a following section. Operation and trouble shooting are as follows.

Amplified pulses from Q6 are 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.

Shift register IC-1 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.

To verify proper decoder operation increase signal strength as necessary to provide a full 4V p-p display at the collector of Q5. 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 (Figure 34). Next check the pulses at the collector of Q6. 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.

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 ½ of IC-1, C21 and R24. The op-amp is used in a non-inverting comparator mode with the trigger point set at ½ 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.

In order to verify proper operation, measure total sync period time and subtract the width of the channel 0 pulse at pin 3 of IC-2. 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).

DECODER TROUBLE SHOOTING

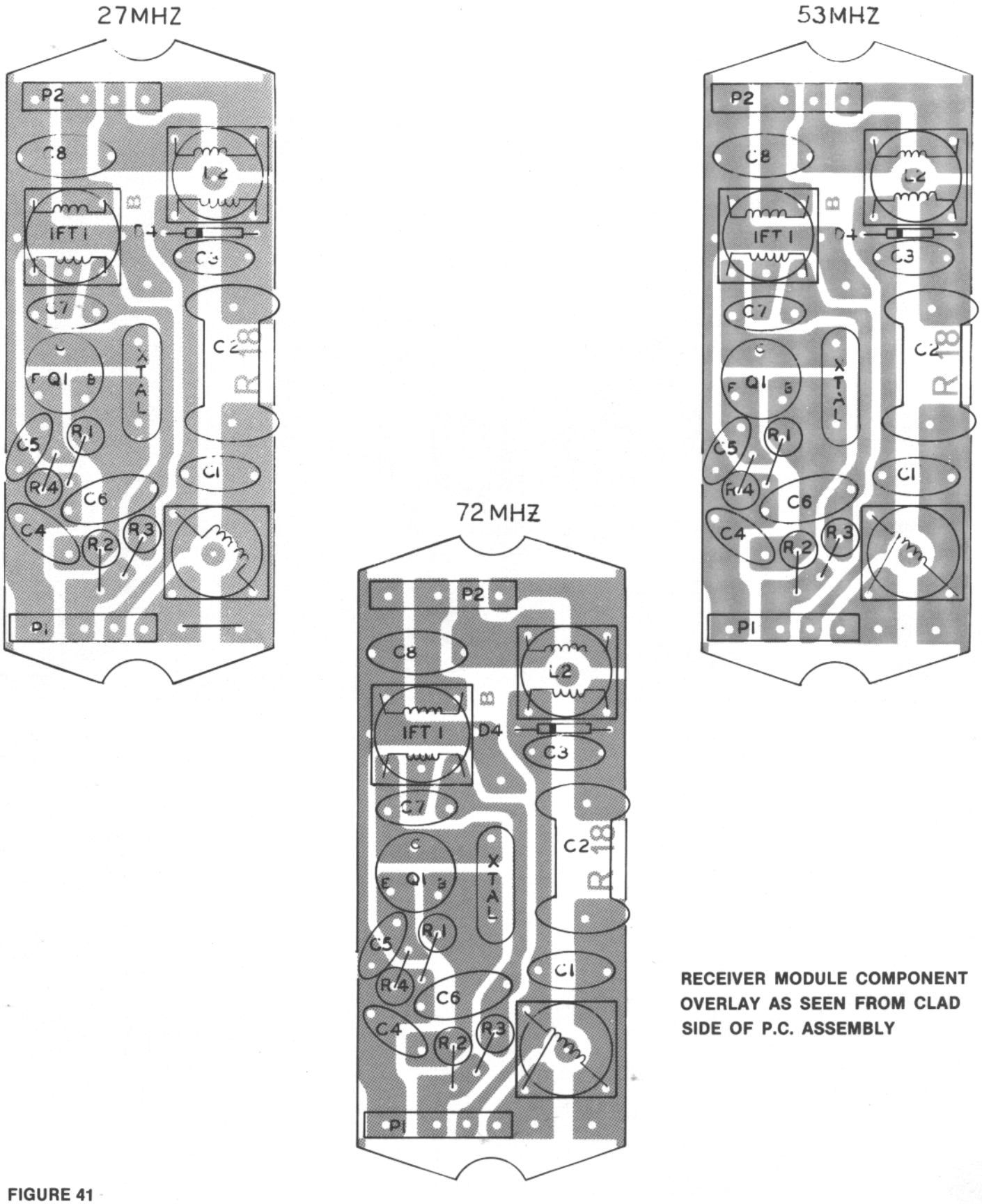
Any difficulty will generally be caused by a defective transistor of IC. If there is no signal at the base of Q6, try lifting its base lead from the board. If signal appears, replace Q6. If there is still no signal, check the connections back to the receiver.

If the correct signal is at the base of Q6, check the supply voltage to all active devices and if these are correct, trace the various signal paths with an oscilloscope until the problem is located. Also check the connector block for any loose connections.

KPR-7L SENSITIVITY CHECK

The KPR-7L receiver uses shielded antenna and mixer coils. To check receiver sensitivity a special injection cable is necessary which consists of a 22pf silver mica capacitor in series with the hot lead of the RG-58 A/U coaxial cable which is connected to the output of the generator. The ground side of the coax is connected to a small clip lead. The hot side at the 22pf capacitor connects to a 2½" length of wire with plug which is cut from a 200-183 plug-in antenna. The antenna plug-in is inserted directly into the receiver antenna jack. The ground lead is attached to receiver ground as close as possible to the signal input. Injection of the signal is made directly into the antenna coil of the receiver. Follow the normal procedures for alignment and gain adjustment.

RECEIVER MODULE P.C. ASSEMBLIES



RECEIVER MODULE COMPONENT OVERLAY AS SEEN FROM CLAD SIDE OF P.C. ASSEMBLY

FIGURE 41

7 CHANNEL RECEIVER IF / LOGIC

VIEWED FROM FOIL SIDE OF BOARD

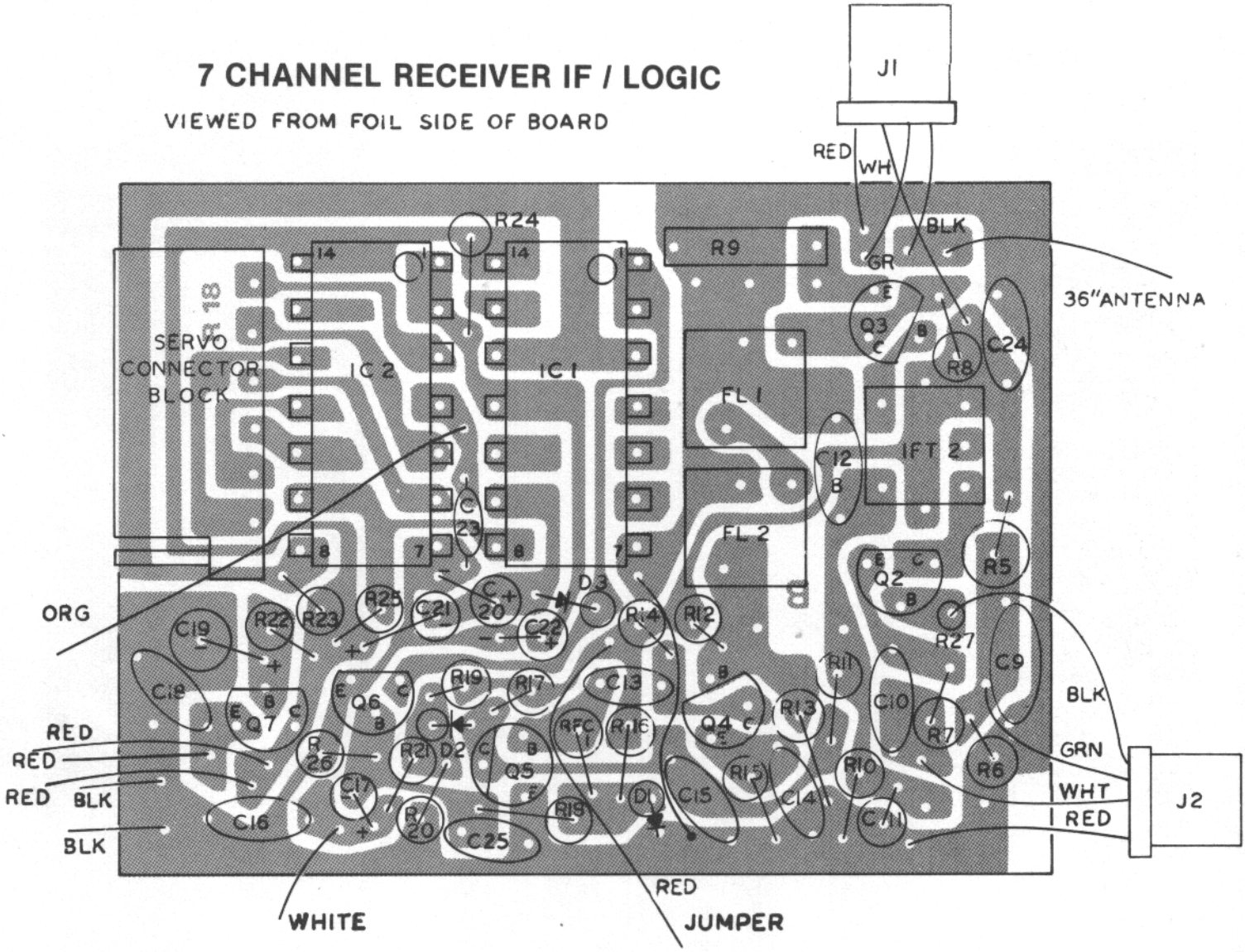


FIGURE 42

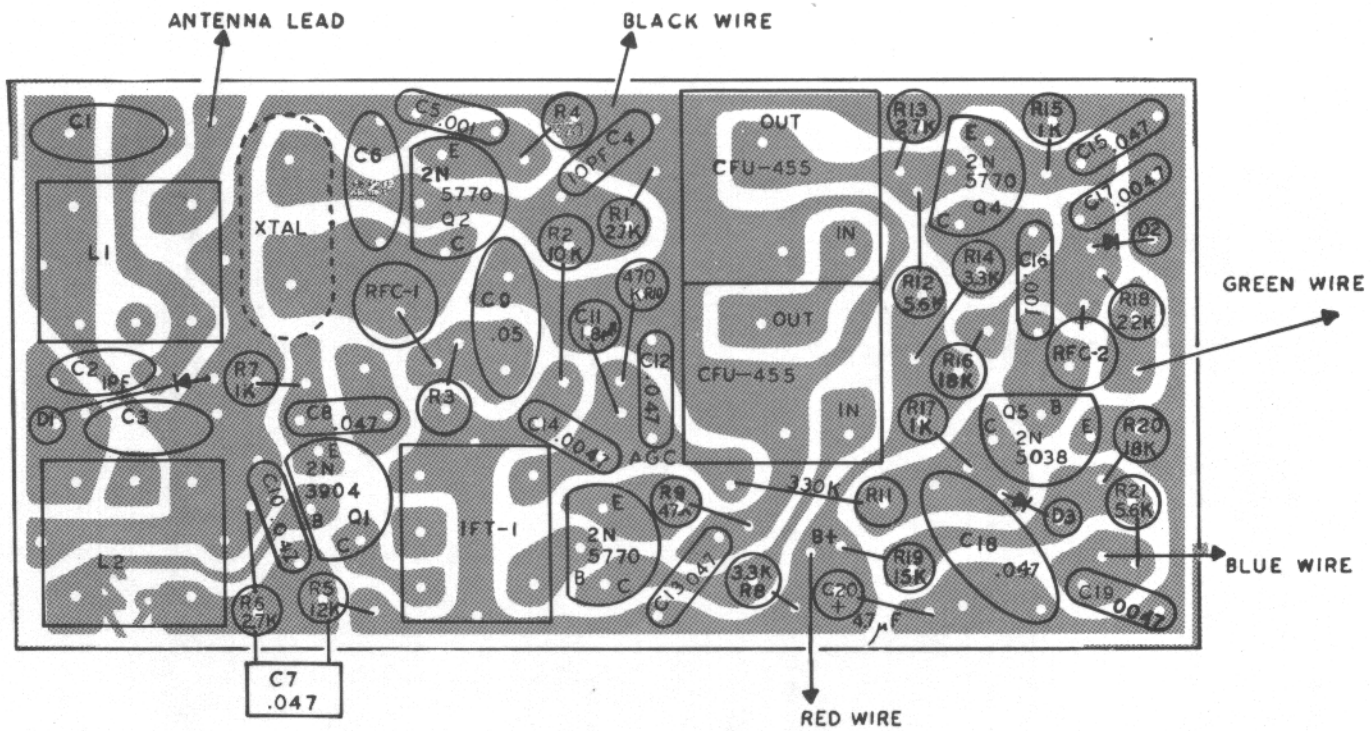
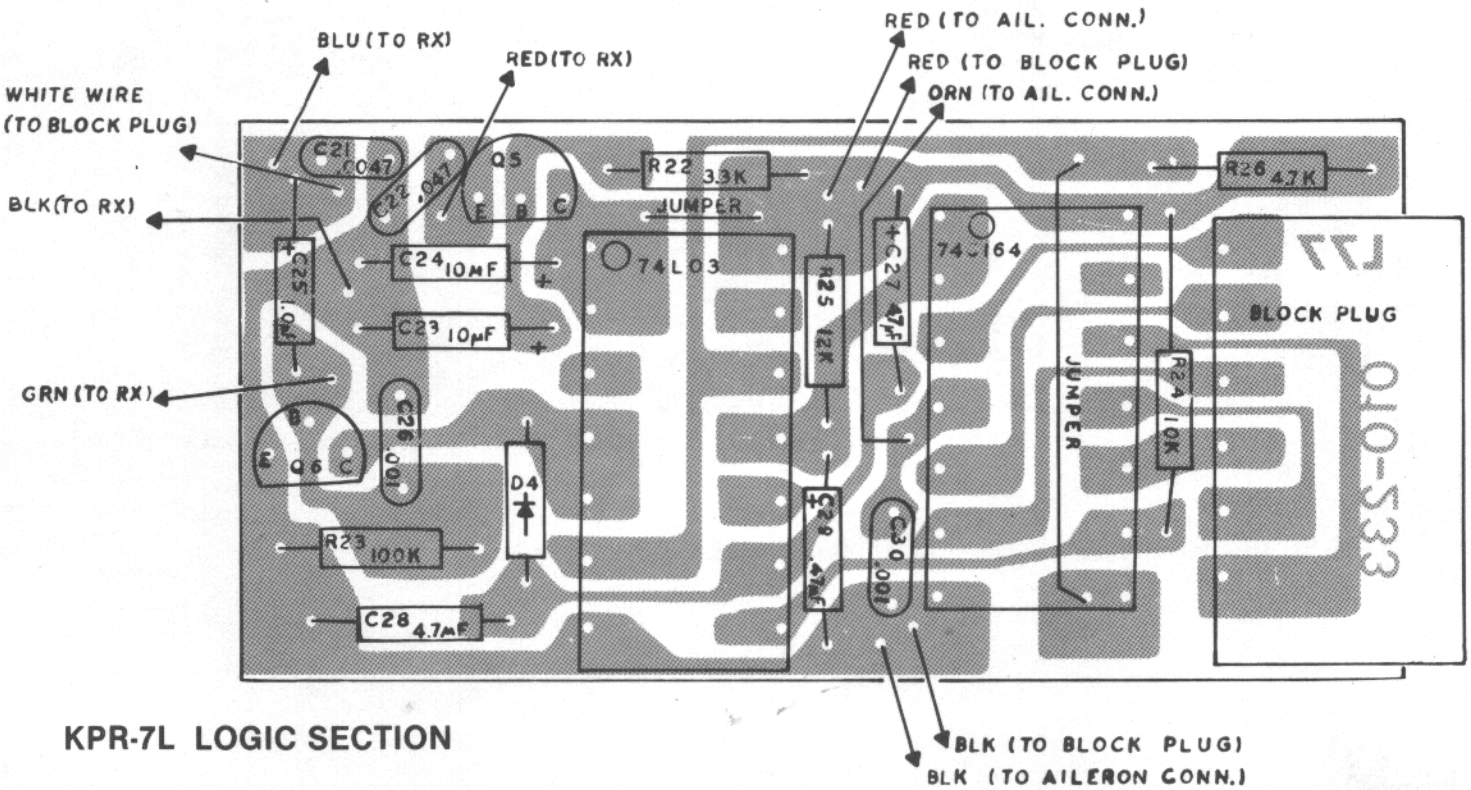


FIGURE 43

KPR-7L R.F. SECTION

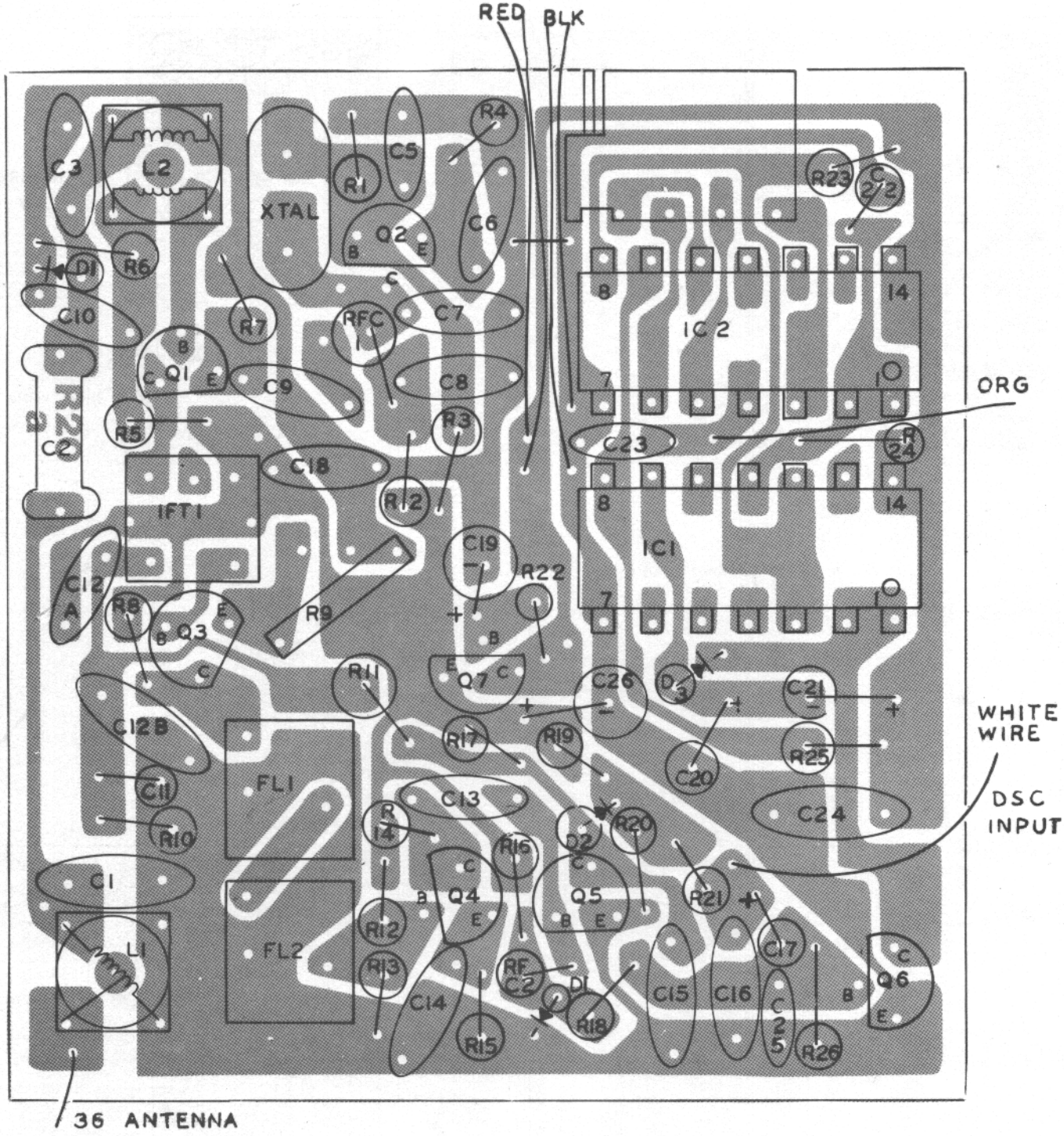


KPR-7L LOGIC SECTION

NOTE: INSTALL BOTH JUMPERS BEFORE INSTALLING I.C.s.

FIGURE 44

5-CHANNEL RECEIVER R.F. SECTION



KPR-5C RECEIVER AS SEEN FROM FOIL SIDE OF P.C. BOARD.

FIGURE 45

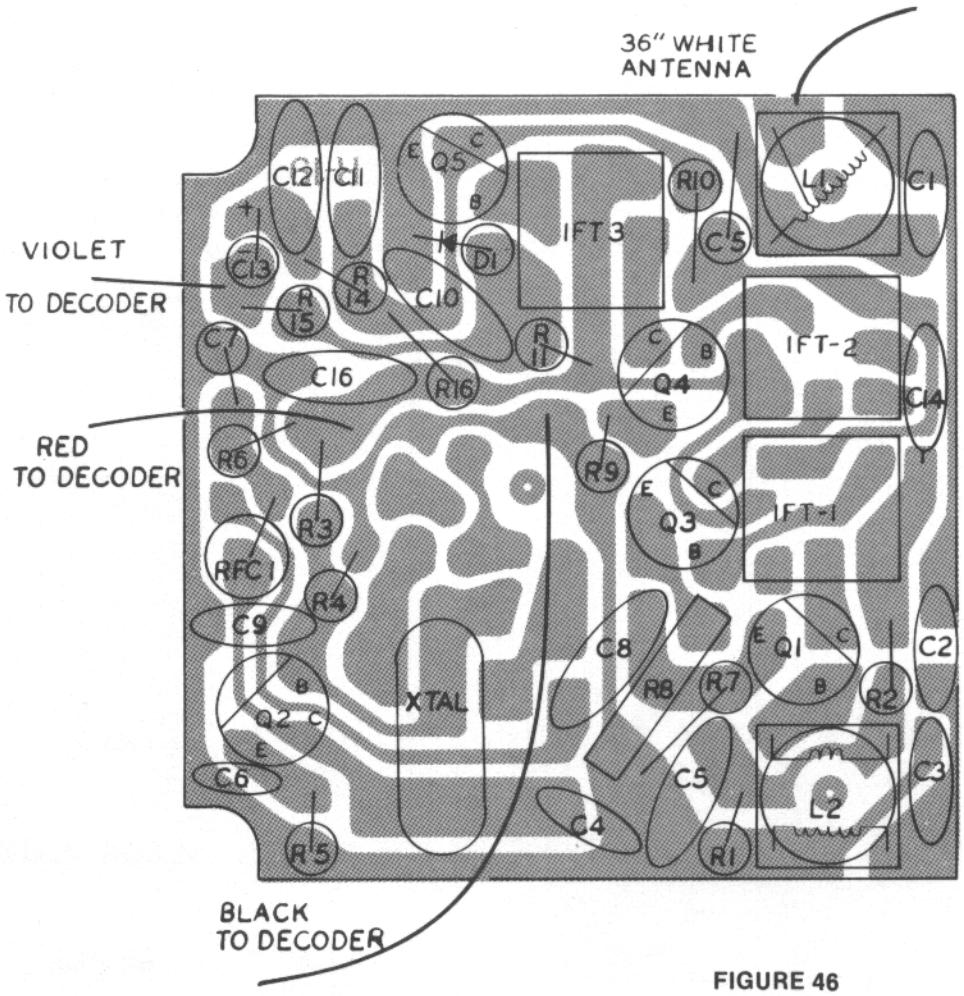


FIGURE 46

3 CHANNEL BRICK R.F. SECTION

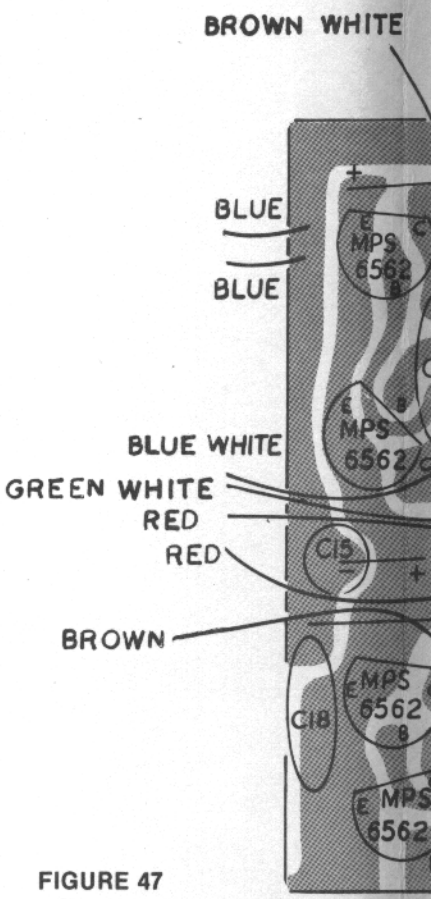
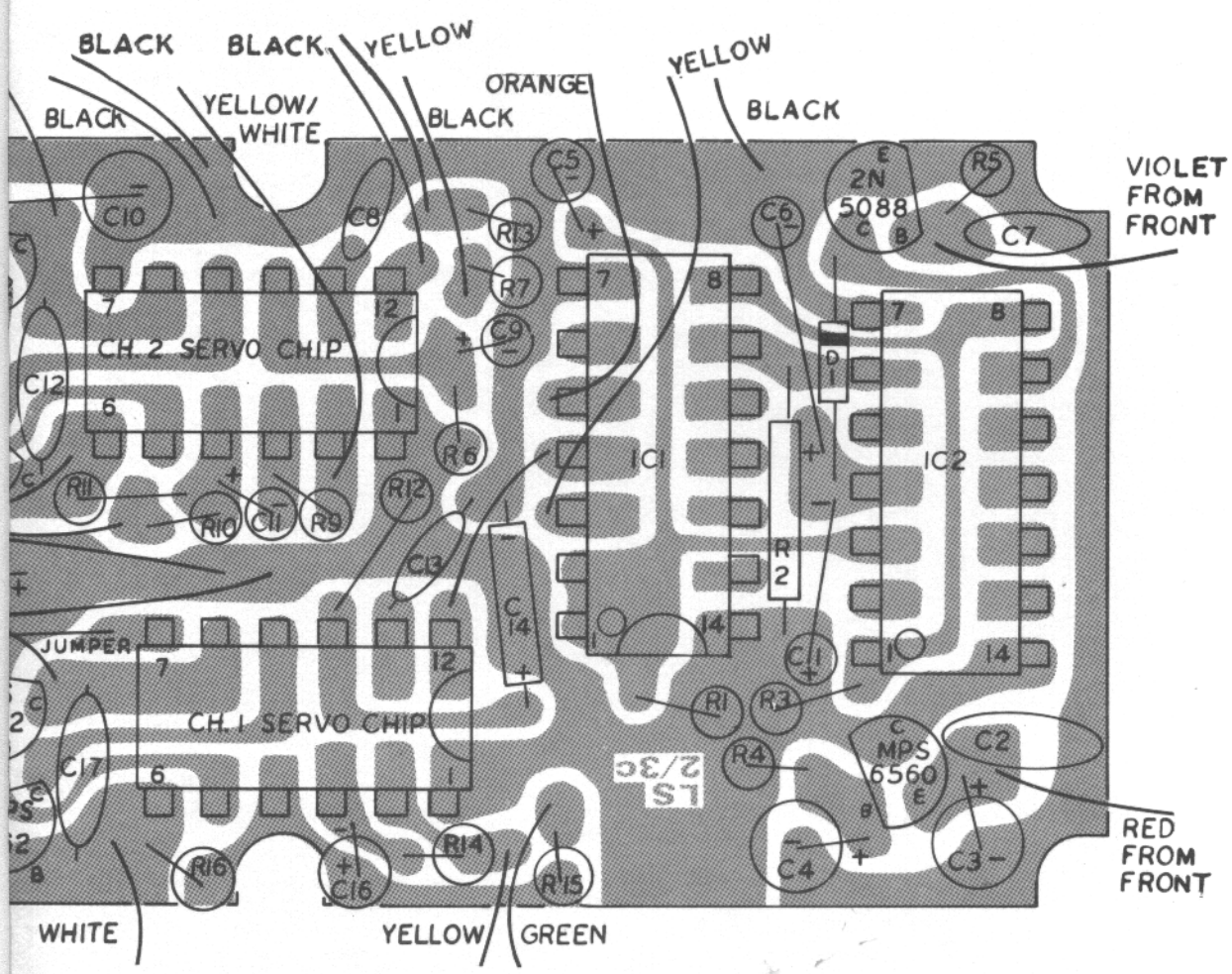


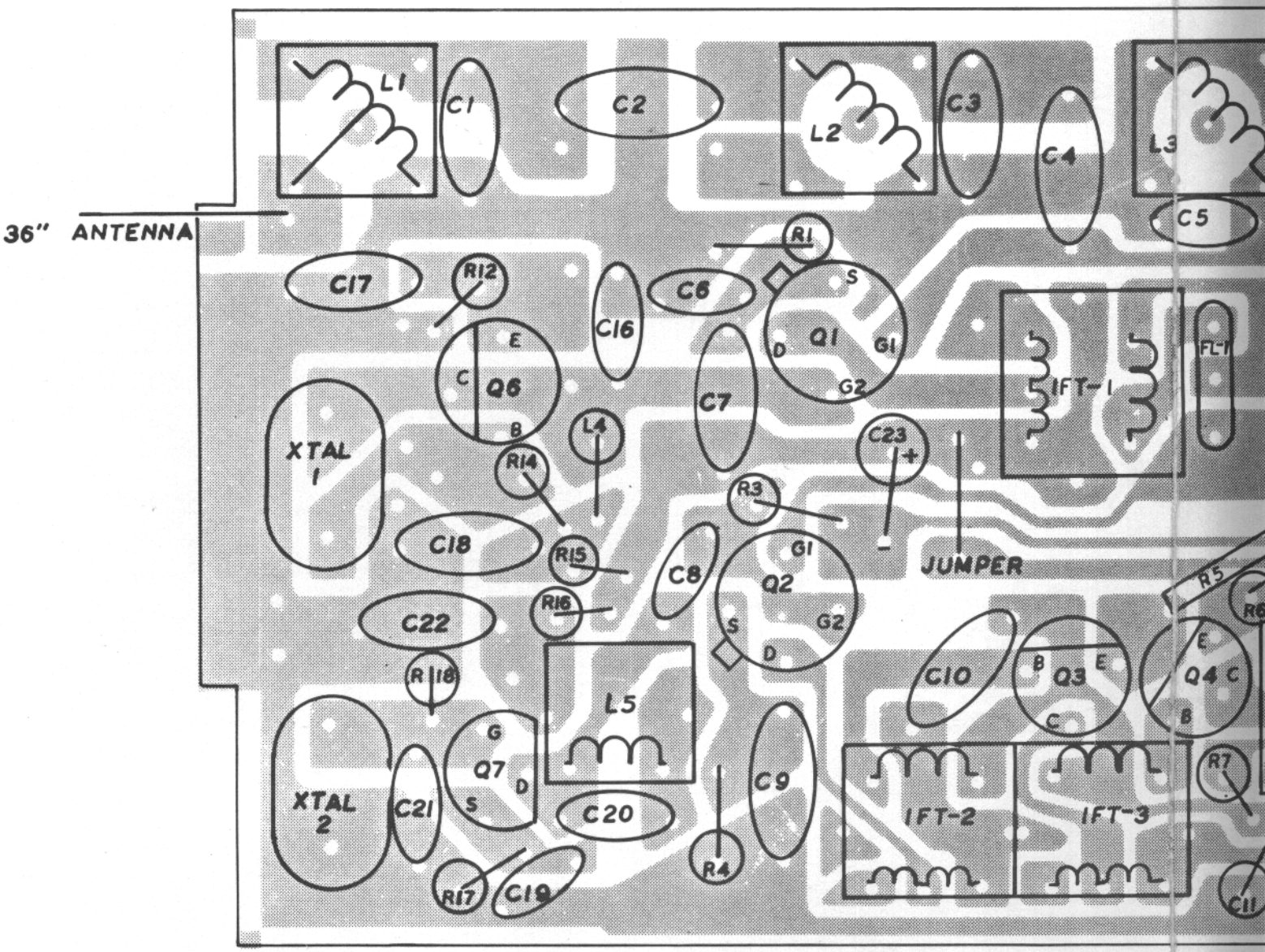
FIGURE 47

1976-1977 BRICK RX Decoder/Servo Amplifier



KPR-3C AS SEEN FROM FOIL SIDE OF BOARD

KPR-7D RECEIVER P.C. ASSEMBLY



Viewed from foil side.

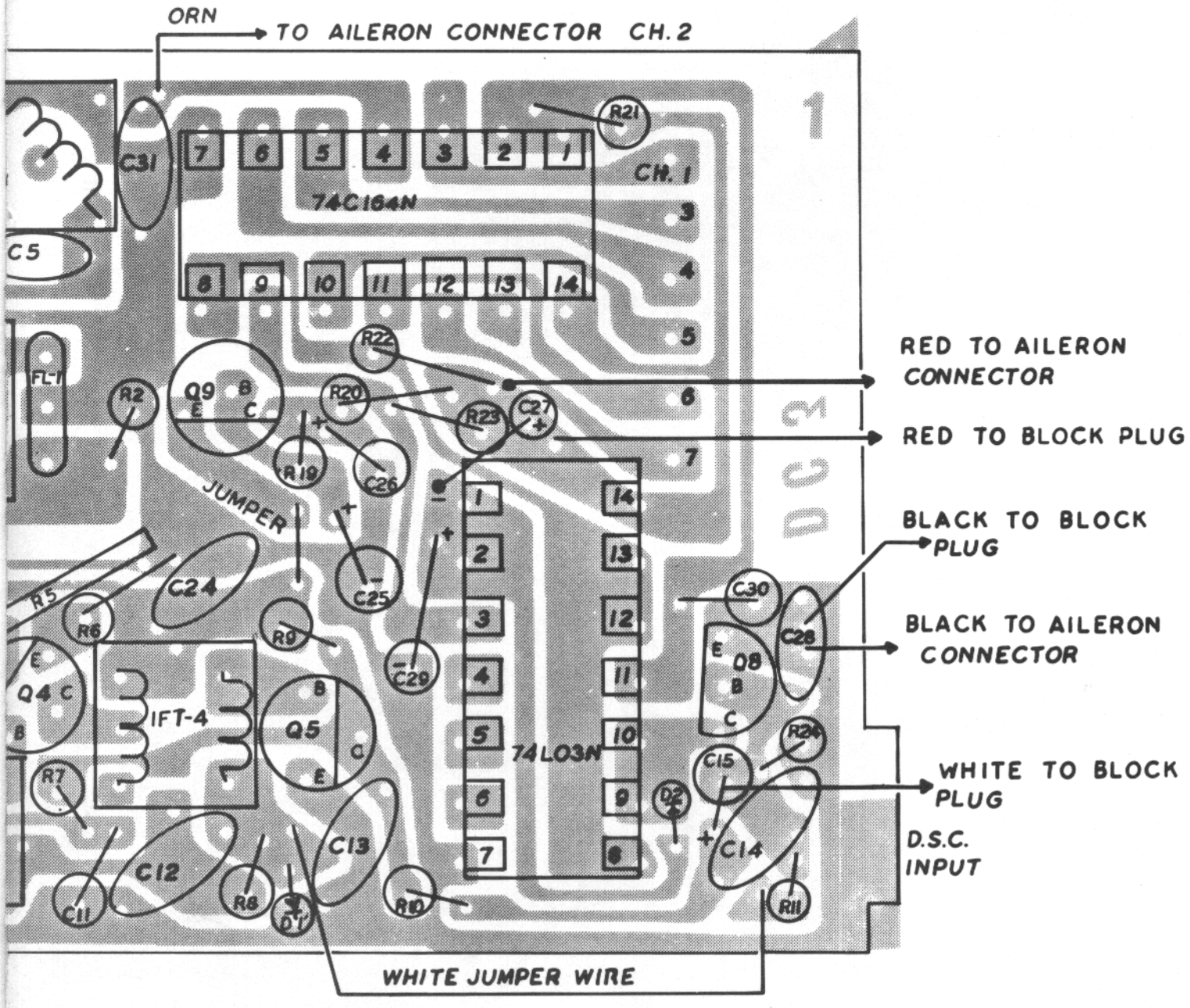

ORN
TO AILERON CONNECTOR CH. 2
C31
R21
CH. 1
74C164N
C5
FL-1
R2
Q9
R22
R20
R23
C27
RED TO AILERON CONNECTOR
RED TO BLOCK PLUG
R19
C26
JUMPER
BLACK TO BLOCK PLUG
R5
C24
C25
C30
C28
BLACK TO AILERON CONNECTOR
R6
R9
C29
Q4
IFT-4
Q5
D8
74LO3N
R24
C15
WHITE TO BLOCK PLUG
R7
D2
C13
C14
D.S.C. INPUT
C12
R8
D7
R10
R11
C11
WHITE JUMPER WIRE

FIGURE 49

KPR-7C
RECEIVER MODULE

RESISTORS

All values in ohms (K = 1000)

R1	27 MHz	4.7K	¼ W	10%	057-472
	53 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R1	72 MHz	2.7K	¼ W	10%	057-272
R2		10K	¼ W	10%	057-103
R3	27 MHz	1.5K	¼ W	10%	057-152
	53 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R3	72 MHz	330 ohms	¼ W	10%	057-331
R4		470 ohms	¼ W	10%	057-471

CAPACITORS

C1	72 MHz	18pf	100V	Silver Mica	117-013
	53 MHz	22pf	"	"	117-005
	27 MHz	22pf	100V	Silver Mica	117-005
C1	35 MHz	47pf	100V	Silver Mica	117-008
	40 MHz	"	"	"	"
C2	35 MHz	3pf	100V	Silver Mica	117-001
	40 MHz	"	"	"	"
C2	27 MHz	1pf	500V	Tubular	114-002
C2	53 MHz	.5pf	500V	Tubular	114-001
	72 MHz	"	"	"	"
C3	27 MHz	47pf	100V	Silver Mica	117-008
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
C3	53 MHz	27pf	100V	Silver Mica	117-006
C3	72 MHz	15pf	100V	Silver Mica	117-004
C4	27 MHz	18pf	100V	Silver Mica	117-013
	53 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
C4	72 MHz	27pf	100V	Silver Mica	117-006
C5		.0047uf	Mepico	Disc	113-038
C6		.05uf	10V	Disc	113-018
C7	27 MHz	18pf	100V	Silver Mica	117-013
C7	53 MHz	10pf	100V	Silver Mica	117-003
C7	72 MHz	18pf	100V	Silver Mica	117-013
	35 MHz	"	"	"	"
	40 MHz				
C8		.05uf	10V	Silver Mica	113-018

COILS & TRANSFORMERS

L1	27 MHz	Coil, 12½ turns, tapped, antenna	103-060
L1	35 MHz	Coil, 7½ turns, tapped, antenna	103-064
	40 MHz	"	"
	53 MHz	"	"
L1	72 MHz	Coil, 5½ turns, tapped, antenna	103-099
L2A & B	27 MHz	Coil, 9¼ + 2¼ turns, mixer	103-061
L2A & B	35 MHz	Coil, 7¼ + 1¼ turns, mixer	103-065
	40 MHz		"
	53 MHz	"	"
L2A & B	72 MHz	Coil, 5¼ + 1¼ turns, mixer	103-063
IFT-1		XFMR, Oscillator, Orange	103-069

SEMICONDUCTORS

D4	1N4148	Diode Silicon		100-101
Q1	2N3663	NPN	Transistor Silicon	101-034

MISCELLANEOUS

P1 & 2	Connector, Solder Type	123-011
	Crystal, Order by frequency	as required
	Label, Order by frequency	as required
	P.C. Board, Rx Plug-In, R18	010-213
	Screw, 0-80 x3/8"	500-093
	Case, Rx Plug-In	901-364
	Lid, Rx Plug-In	901-365

KPR-7C
IF/LOGIC SECTION

RESISTORS

All values in ohms (K = 1000)

R5	12K	¼W	10%	057-123
R6	2.7K	¼W	10%	057-272
R7	820 ohms	¼W	10%	057-821
R8	3.3K	¼W	10%	057-332
R9	500 ohms	Pot	Centralab	106-029
R10	220K	¼W	10%	057-224
R11	330K	¼W	10%	057-334

KPR-7C IF/Logic Section Parts List continued.

R12	5.6K	¼W	10%	057-562
R13	2.7K	¼W	10%	057-272
R14	3.3K	¼W	10%	057-332
R15	1K	¼W	10%	057-102
R16	15K	¼W	10%	057-153
R17	1K	¼W	10%	057-102
R18	22K	¼W	10%	057-223
R19	15K	¼W	10%	057-153
R20	18K	¼W	10%	057-183
R21	5.6K	¼W	10%	057-562
R22	3.3K	¼W	10%	057-332
R23	4.7K	¼W	10%	057-472
R24	27K	¼W	10%	057-273
R25	10K	¼W	10%	057-103
R26	100K	¼W	10%	057-104
R27	150 ohms	¼W	10%	057-151

CAPACITORS

C9	.05uf	10V	Disc	113-018
C10	.05uf	10V	Disc	113-018
C11	1.8uf	25V	Tantalum	116-010
C12B	.05uf	10V	Disc	113-018
C13	.001uf	Sub-Mini	Disc	113-021
C14	.05uf	Sub-Mini	Disc	113-018
C15	.047uf	10V	Disc	113-046
C16	.01uf	50V	Disc	113-016
C17	1.0uf	35V	Tantalum	116-002
C18	.05uf	10V	Disc	113-018
C19	33uf	6V	Tantalum	116-005
C20	4.7uf	35V	Tantalum	116-004
C21	4.7uf	6V	Tantalum	116-004
C22	.22uf	35V	Tantalum	116-001
C23	.001uf	Sub-Mini	Disc	113-021
C24	.05uf	10V	Disc	113-018
C25	.0047uf	Mepico	Disc	113-038

SEMICONDUCTORS

D1, D2, D3	1N4148		Diode Silicon	100-101
Q2, Q3, Q4	2N5770	NPN	Transistor Silicon	101-027
Q5	2N3392	NPN	Transistor Silicon	101-004
Q6	2N5088	NPN	Transistor Silicon	101-014

Q7	MPS-6560	NPN Transistor Silicon	101-013
IC-1	74L03	Quad 2 Nand Open Collector	110-102
IC-2	74C164	I.C.	110-117

COILS & TRANSFORMERS

IFT-2	455HKz	I.F. Yellow	103-013
RFC-1	1000uh	R.F. Choke	103-039

MISCELLANEOUS

	P.C. Board, Rx, R18	010-214
FL-1,2	CFU 455 F Filter	400-009
	Block Plug. 7 channel	120-036
	Connector, Flange	120-051
	Connector, 3 Wire, Aileron Ext.	123-018
	Screw, 0-80 x 3/8	500-093
	Label, Kraft Systems, Inc	600-115
	Case, Rx Logic Section KPR-7C	901-366
	Latch, Connector	901-367
	Lid, Rx Logic Section KPR-7C	901-368
	Label, FCC Radiation Series '76 KPR-7C	600-120
	Label, FCC Radiation Series '77 KPR-7C	600-178
	Label, FCC Radiation Series '78 KPR-7C	600-196
	Antenna Connector, Inside	123-065

ELECTRONIC ASSEMBLY

	IF/Logic Section KPR-7C	300-280

KPR-7L
RF Section

RESISTORS
All values in ohms (K = 1000)

R1	72 MHz 53 MHz 40 MHz	2.7K 2.7K	1/4W	10%	057-272
R1	27 MHz	4.7K	1/4W	10%	057-472
R2		10K	1/4W	10%	057-103
R3	72 MHz 40 MHz	1K 1K	1/4W	10%	057-102
R3	53 MHz 27 MHz	1.5K 1.5K	1/4W	10%	057-152
R4	72 MHz 53 MHz 40 MHz	270 ohm 270 ohm	1/4W	10%	057-271
R4	27 MHz	470 ohm	1/4W	10%	057-471
R5		12K	1/4W	10%	057-123
R6		2.7K	1/4W	10%	057-272
R7		1K	1/4W	10%	057-102
R8		3.3K	1/4W	10%	057-332
R9		47 ohm	1/4W	10%	057-470
R10		470K	1/4W	10%	057-474
R11		330K	1/4W	10%	057-334
R12		5.6K	1/4W	10%	057-562
R13		2.7K	1/4W	10%	057-272
R14		3.3K	1/4W	10%	057-332
R15		1K	1/4W	10%	057-102
R16		18K	1/4W	10%	057-183
R17		1K	1/4W	10%	057-102
R18		22K	1/4W	10%	057-223
R19		15K	1/4W	10%	057-153
R20		18K	1/4W	10%	057-183
R21		5.6K	1/4W	10%	057-562

CAPACITORS

CI	72 MHz	18pf	100V	Silver Mica	117-013
C1	53 MHz	33pf	100V	Silver Mica	117-007
C1	27 MHz	33pf.	100V	Silver Mica	117-007
C1	35-40 MHz	33pf			
C2		1pf	100V	Silver Mica	117-015
C3	72 MHz	15pf	100V	Silver Mica	117-004
C3	53 MHz	33pf	100V	Silver Mica	117-007
C3	27 MHz	18pf	100V	Silver Mica	117-013
C3	35-40 MHz	18pf			

Nominal value — may vary from 33 ohms to 150 ohms.

KPR-7L RF Section Parts List continued.

C4		10pf	100V	Silver Mica	117-003
C5		.001uf	100V	Mepico Disc	113-021
C6	72 MHz	22pf	100V	Silver Mica	117-005
	27 MHz	27pf	100V	Silver Mica	117-006
C6	53 MHz	18pf	100V	Silver Mica	117-013
	40 MHz	22pf			
C7		.047uf	Sub-Mini	Disc	113-046
C8		.047uf	Sub-Mini	Disc	113-046
C9		.05uf	10V	Disc	113-018
C10		.047uf	Sub-Mini	Disc	113-046
C11		1.8uf	25V	Tantalum	116-010
C12		.047uf	Sub-Mini	Disc	113-046
C13		.047uf	Sub-Mini	Disc	113-046
C14		.0047uf		Mepico Disc	113-038
C15		.047uf	Sub-Mini	Disc	113-046
C16		.001uf	100V	Disc	113-021
C17		.0047uf		Mepico Disc	113-038
C18		.047uf	Sub-Mini	Disc	113-046
C19		.0047uf		Mepico Disc	113-038
C20		4.7uf	6V	Tantalum	116-004

COILS AND TRANSFORMERS

L-1 & 2	53 MHz		
	72 MHz	Coil, Mixer and Antenna	103-125
L-1	27 MHz	Coil, Mixer and Antenna	103-241
L2	27 MHz	Coil, Mixer and Antenna	103-127
L-1 & 2	40 MHz	Coil, Mixer and Antenna	103-128
RFC-1		Coil, Oscillator	103-108
RFC-2		RF Choke, 1000uh	103-039
IFT-1		Transformer, Yellow	103-013

SEMICONDUCTORS

Q1	2N3904	NPN	Transistor, Silicon	101-023
Q2 - Q4	2N5770	NPN	Transistor, Silicon	101-027
Q5	2N5088	NPN	Transistor, Silicon	101-014
D1 - D3	1N4148		Diode Silicon	100-101

MISCELLANEOUS

P.C. Board, Rx, R-27	010-232
Filters, CFU-455F	400-009
P.C.B. Shield	010-218
Antenna Connector, Inside	123-065

KPR-7L
Logic Section

RESISTORS

All values in ohms (K = 1000)

R22	3.3K	1/4W	10%	057-332
R23	100K	1/4W	10%	057-104
R24	10K	1/4W	10%	057-103
R25	12K	1/4W	10%	057-123
R26	4.7K	1/4W	10%	057-472

CAPACITORS

C21	.0047uf		Mepico Disc	113-038
C22	.047uf		Sub-Mini Disc	113-046
C23	10uf	6V	Tantalum	116-012
C24	10uf	6V	Tantalum	116-012
C25	1uf	35V	Tantalum	116-002
C26	.001uf	100V	Disc	113-021
C27	4.7uf	6V	Tantalum	116-004
C28	4.7uf	6V	Tantalum	116-004
C29	.47uf	35V	Tantalum	116-011
C30	.001uf	100V	Disc	113-021

SEMICONDUCTORS

D4	1N4148		Diode Silicon	100-101
Q6	2N5088	NPN	Transistor Silicon	101-014
Q7	MPS-6560	NPN	Transistor Silicon	101-013
IC-1	74L03 Quad Nand Open Collectors Low Power			110-102
IC-2	74C164			110-117

CONNECTORS

Seven Channel Block Plug	120-036
Cable Assembly - Aileron - 3 Wire	123-018

MISCELLANEOUS

P.C. Board L-77	010-233
Label, Part 15 FCC	600-179
Label, Frequency	As required

Parts List continued on next page

KPR-7L MISCELLANEOUS Parts List continued.

Latch, Connector	901-367
Case, Rx Mini 7L	901-405
Tape, Clear, 6″	990-013

ELECTRONIC ASSEMBLIES

Decoder/Logic Receiver Assy - KPR-7L	300-375
RF Section, KPR-7L 72 MHz	300-376
RF Section, KPR-7L 53 MHz	300-377
RF Section, KPR-7L 27 MHz	300-378
RF Section, KPR-7L 35 - 40 MHz	300-410
PC Assembly Complete 72 MHz (300-375 & 300-376)	300-379
PC Assembly Complete 53 MHz (300-375 & 300-377)	300-380
PC Assembly Complete 27 MHz (300-375 & 300-378)	300-381
PC Assembly Complete 35 - 40 MHz (300-375 & 300-410)	300-408

KPR-7D Receiver

RESISTORS

All values in ohms (K = 1000)

R1		220 ohms	1/4W	10%	057-221
R2		330 ohms	1/4W	10%	057-331
R3		470K	1/4W	10%	057-474
R4		1K	1/4W	10%	057-102
R5		500 ohms		Centralab Pot	106-029
R6		150 ohms	1/4W	10%	057-151
R7		220K	1/4W	10%	057-224
R8		15K	1/4W	10%	057-153
R9		1K	1/4W	10%	057-102
R10		5.6K	1/4W	10%	057-562
R11		22K	1/8W	10%	053-223
R12	27 MHz 35 MHz 40 MHz	220 ohms	1/4W	10%	057-221

KPR-7D Parts List continued.

R12	53 MHz	150 ohms	1/4W	10%	057-151
R12	72 MHz	560	1/4W	10%	057-561
R14	53 MHz 27 MHz 35 MHz 40 MHz	15K	1/4W	10%	057-153
R14	72 MHz	4.7K	1/4W	10%	057-472
R15		150 ohms	1/4W	10%	057-151
R16		150 ohms	1/4W	10%	057-151
R17		220 ohms	1/4W	10%	057-221
R18		470K	1/4W	10%	057-474

CAPACITORS

C1	72 MHz 53 MHz	33pf	100V	Silver Mica	117-007
C1	35 MHz	22pf	100V	Silver Mica	117-005
C1	27 MHz	39pf	100V	Silver Mica	117-014
C1	40 MHz	18pf	100V	Silver Mica	117-013
C2	53 MHz 72 MHz	.5pf	500V	Tubular	114-001
C2	27 MHz	3pf	100V	Silver Mica	117-001
C2	35 MHz 40 MHz	1pf	500V	Tubular	114-002
C3	53 MHz 35 MHz	22pf	100V	Silver Mica	117-005
C3	72 MHz 40 MHz	18pf	100V	Silver Mica	117-013
C3	27 MHz	33pf	100V	Silver Mica	117-007
C4	53 MHz 72 MHz 35 MHz 40 MHz	1pf	500V	Tubular	114-002
C4	27 MHz	3pf	100V	Silver Mica	117-001
C5	53 MHz 40 MHz	10pf	100V	Silver Mica	117-003
C5	72 MHz	18pf	100V	Silver Mica	117-013
C5	27 MHz	27pf	100V	Silver Mica	117-006
C5	35 MHz	15pf	100V	Silver Mica	117-004
C6		.05uf	10V	Disc Ceramic	113-018
C7		.0047uf		Disc Ceramic	113-038
C8		.001uf	100V	Mepico Disc	113-021
C9		.05uf	10V	Disc Ceramic	113-018
C10		.01uf	50V	Disc Ceramic	113-016
C11		4.7uf	6V	Tantalum	116-004
C12		.05uf	10V	Disc Ceramic	113-018
C13		.047uf	Sub-Mini	Disc	113-046

KPR-7D Parts List continued.

C14	.01uf	50V	Disc Ceramic	113-016
C15	1uf	35V	Tantalum	116-002
C16	68pf	100V	Silver Mica	117-010
C17	.001uf	500V	Disc Ceramic	113-012
C18	.05uf	10V	Disc Ceramic	113-018
C19	.0047uf		Disc	113-038
# C20	22pf	100V	Silver Mica	117-005
C21	22pf	100V	Silver Mica	117-005
C22	.05uf	10V	Disc Ceramic	113-018
C23	33uf	6V	Tantalum	116-005

SEMICONDUCTORS

Q1, Q2	3N212	IGMOSFET	Transistor	101-018
Q3, Q4, Q6	D16G6 or	NPN	Transistor, Silicon	101-008
	2N3663	NPN	Transistor, Sislicon	101-034
Q5	2N3392	NPN	Transistor, Silicon	101-004
Q7	MPF-102	JFET	Transistor	101-019
D1	1N4148		Diode Silicon	100-101

COILS AND TRANSFORMERS

IFT-1	IF Transformer	Orange	103-088
IFT-2	IF Transformer	Yellow 455KC	103-013
IFT-3	IF Transformer	White 455KC	103-014
IFT-4	IF Transformer	Black 455KC	103-015
L-1	53 MHz 7½ turn - tapped antenna coil		103-104
L-1	72 MHz 4½ turn — tapped antenna coil		103-093
L-1	27, 35, 40 MHz 11½ turn - antenna coil		103-085
L-2	53 MHz 7½ turn - R.F. coil		103-080
L-2	72 MHz 5½ turn - R.F. coil		103-105
L-2	27, 35, 40 MHz 12½ turn - mixer coil		103-060
L-3	53 MHz 7½ turn - mixer coil		103-084
L-3	72 MHz 5½ turn - mixer coil		103-105
L-3	27, 35, 40 MHz 11½ turn - R.F. coil		103-072
L-4	53, 72, 40 MHz, RFC .22uh Wee Wee Ductor		103-043
L-4	27, 35 MHz, RFC .39uh Wee Wee Ductor		103-044
# L-5	IF Transformer 10.7 MHz Violet		103-035

 # OSC Coil P/N 103-035 is no longer available, therefore, L5 is replaced by Toroid Coil P/N 103-130 and C20 (22pf) is replaced by a 47pf mica capacitor. See ENC 78-78, Nov. 25, 1978.

KPR-7D Parts List continued.

MISCELLANEOUS

DC-3	P.C. Board	010-228
FL-1	Filter 10.7 MHz	400-007
XTAL-1	Order by Frequency	as required
XTAL-2	35 MHz 10.245	008-034
XTAL-2	53, 72, 27, 40 MHz 11.155	008-001
	Frequency Label	as required
	Antenna Connector, Inside	123-065

ELECTRONIC ASSEMBLY

	53 MHz Dual Conversion Receiver	300-362
	72 MHz Dual Conversion Receiver	300-366
	27 MHz Dual Conversion Receiver	300-367
	35 MHz Dual Conversion Receiver	300-387
	40 MHz Dual Conversion Receiver	300-388

KPR-7D
Logic Section

RESISTORS

All Values in ohms (K-1000)

R19	3.3K	1/4W	10%	057-332
R20	18 ohm	1/4W	10%	057-180
R21	27K	1/4W	10%	057-273
R22	4.7K	1/4W	10%	057-472
R23	39K	1/4W	10%	057-393
R24	100K	1/8W	10%	053-104

CAPACITORS

C24	.05uf	10V	Disc Ceramic	113-018
C25	33uf	6V	Tantalum	116-005
C26	33uf	6V	Tantalum	116-005
C27	4.7uf	6V	Tantalum	116-004
C28	.001uf	Mepico Disc	113-021	
C29	4.7uf	6V	Tantalum	116-004
C30	.22uf	35V	Tantalum	116-009
C31	.001uf	100V	Disc Ceramic	113-012

SEMICONDUCTORS

Q8	2N5088	NPN	Transistor Silicon	101-014
Q9	MPS-6560	NPN	Transistor Silicon	101-013

KPR-7D SEMICONDUCTORS Parts List continued.

D2	1N4148	Diode Silicon	100-101
IC-1	74L03 Quad 2 Nand Open Collectors Low Power		110-102
IC-2	74C164		110-117

CONNECTORS

	Seven Channel Block Plug	120-036
	Cable Assembly - 3 Wire	123-018

MISCELLANEOUS

	Label, Phil Kraft Signature Series	600-114
	Label, Rx Radiation Pt. 15 FCC	600-180
	Pivot, Bail Coupling	850-038
	Latch, Connector	901-367
	Case, KPR-7D, Top and Bottom	904-183

KPR-5C
RECEIVER SECTION

RESISTORS

All values in ohms (K = 1000)

R1	27 MHz	4.7K	¼ W	10%	057-472
	53 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R1	72 MHz	2.7K	¼ W	10%	057-272
R2		10K	¼ W	10%	057-103
R3	27 MHz	1K	¼ W	10%	057-102
	53 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R3	72 MHz	390 ohm	¼ W	10%	057-391
R4	27 MHz	470 ohm	¼ W	10%	057-471
	53 MHz	"	"	"	"
	35 MHz	"	"	"	"
	40 MHz	"	"	"	"
R4	72 MHz	270 ohm	¼ W	10%	057-271
R5		10K	¼ W	10%	057-103
R6		2.7K	¼ W	10%	057-272
R7		1K	¼ W	10%	057-102
R8	27 MHz	2.7K	¼ W	10%	057-272
	53 MHz	"	"	"	"
	72 MHz	"	"	"	"
R8	35 MHz	3.3K	¼ W	10%	057-372
	40 MHz	"	"	"	"
R9		500 ohm	Centralab Trimpot		106-029
R10		680K	¼ W	10%	057-684
R11		330K	¼ W	10%	057-334
R12		5.6K	¼ W	10%	057-562
R13		2.7K	¼ W	10%	057-272
R14		3.3K	¼ W	10%	057-372
R15		1K	¼ W	10%	057-102
R16		15K	¼ W	10%	057-153
R17		1K	¼ W	10%	057-102
R18		22K	¼ W	10%	057-223
R19		15K	¼ W	10%	057-153
R20		18K	¼ W	10%	057-183
R21		5.6K	¼ W	10%	057-562

CAPACITORS

C1	27 MHz	22pf	100V	Silver Mica	117-005
C1	53 MHz	18pf	100V	Silver Mica	117-013

C1	72 MHz	27pf	100V	Silver Mica	117-006
C1	35 MHz 40 MHz	47pf "	100V "	Silver Mica "	117-008 "
C2	27 MHz 35 MHz 40 MHz	1.0pf " "	500V " "	Tubular " "	114-002 " "
C2	53 MHz 72 MHz	.5pf "	500V "	Tubular "	114-001 "
C3	27 MHz 35 MHz 40 MHz	47pf " "	100V " "	Silver Mica " "	117-008 " "
C3	53 MHz	18pf	100V	Silver Mica	117-013
C3	72 MHz	27pf	100V	Silver Mica	117-006
C4		.05uf	10V	Disc	113-018
C5	27 MHz 53 MHz 72 MHz	10pf " "	100V " "	Silver Mica " "	117-003 " "
C5	35 MHz 40 MHz	18pf "	100V "	Silver Mica "	117-013 "
C6		.001uf	500V	Disc	113-012
C7	27 MHz 72 MHz	22pf "	100V "	Silver Mica "	117-005 "
C7	53 MHz	15pf	100V	Silver Mica	117-004
C7	35 MHz 40 MHz	18pf "	100V "	Silver Mica "	117-013 "
C8		.05uf	10V	Disc	113-018
C9		.05uf	10V	Disc	113-018
C10		.05uf	10V	Disc	113-018
C11		1.0uf	35V	Tantalum	116-002
C12A		.0047uf		Mepico Disc	113-038
* C12B		.05uf	10V	Disc	113-018
C13		.001uf	500V	Disc	113-012
C14		.05uf	10V	Disc	113-018
C15		.047uf	Sub Mini	Disc	113-046
C16		.01uf	50V	Disc	113-016
C17		1.0uf	35V	Tantalum	116-002
C26		33uf	6V	Tantalum	116-005

* Used on R20A board only.

SEMICONDUCTORS

D1** , D2, D4		1N4148	Diode Silicon	100-101
Q1	53MHz	2N3663	Transistor Silicon	101-034
Q1	27MHz 72MHz	2N3904 NPN	Transistor Silicon	101-023
Q2		2N3663	Transistor Silicon	101-034
Q3, Q4		2N5770 NPN	Transistor Silicon	101-027
Q5		2N3392 NPN	Transistor Silicon	101-004

**Present on late 1977, 1978, and 1979 production receivers.

KPR-5C (76-77) Receiver Section Parts List continued.

COILS & TRANSFORMERS

L-1	27 MHz	12½ turns, tapped antenna coil			103-060
L-1	72 MHz	4½ turns, tapped antenna coil			103-062
L-1	53 MHz	7½ turns, tapped antenna coil			103-102
	35 MHz	"			"
	40 MHz	"			"
L-2A & 2B	27 MHz	9¼ turns, mixer coil			103-061
L-2A & 2B	72 MHz	4¼ turns, mixer coil			103-103
L-2A & 2B	35 MHz	7¼ turns, mixer coil			103-065
	40 MHz	"			"
IFT-1		455 KHz	Yellow	Transformer	103-013
RFC-1		3.8uh	Coil, Osc. - tapped		103-023
RFC-2		1000uh	R.F. Choke		103-039
FL-1		CFU 455F	Filter		400-009
FL-2		CFU 455F	Filter		400-009

MISCELLANEOUS

X-1	Crystal	Order by frequency	as required
	P.C. Board R-20 or R20A P.C. Board (Specify)		010-219
	Block Plug, 5 Channel		120-054
	Connector, Cable — 3 Wire, Aileron Ext.		123-018
	Screw, 0-80 x ¼ P. H. M. S.		500-022
	Label, FCC Radiation Series '76 KPR-5C		600-119
	Label, FCC Radiation Series '77 KPR-5C		600-177
	Label, FCC Radiation Series '78 KPR-5C		600-195
	Label, FCC Radiation Series '79 KPR-5C		600-228
	Label, Frequency		as required
	Case, Receiver 5 channel		901-217

ELECTRONICS ASSEMBLIES

27 MHz	Receiver, KPR-5C	300-295
72 MHz	Receiver, KPR-5C	300-296
53 MHz	Receiver, KPR-5C	300-297
35 MHz	Receiver, KPR-5C	300-391
40 MHz	"	

KPR-5C
LOGIC SECTION

RESISTORS

All values in ohms (K = 1000)

R22	3.3K	¼ W	10%	057-332
R23	4.7K	¼ W	10%	057-472
R24	27K	¼ W	10%	057-273
R25	10K	¼ W	10%	057-103
R26	100K	¼ W	10%	057-104

CAPACITORS

C18	.05uf	10V	Disc	113-018
C19	33uf	6V	Tantalum	116-005
C20	1.0uf	35V	Tantalum	116-002
C21	4.7uf	6V	Tantalum	116-004
C22	.22uf	35V	Tantalum	116-009
C23	.001uf	500V	Disc	113-012
C24	.05uf	10V	Disc	113-018
C25	.0047uf		Mepico Disc	113-038

SEMICONDUCTORS

Q6	2N5088	NPN	Transistor Silicon	101-014
Q7	MPS-6560	NPN	Transistor Silicon	101-013
D3	1N4148		Diode Silicon	100-101
IC-1	74L03 Quad 2 Nand Open Collectors Low Power			110-102
IC-2	74C164			110-117
*C18	.05uf	10V	Disc	113-018

*Used on R20 P.C. Board only for 5 channel.

KPR-3C BRICK (76-77)
RECEIVER SECTION

RESISTORS

All values in ohms (K = 1000)

R1	2.7K	¼ W	10%	057-272
R2	10K	¼ W	10%	057-103
R3	10K	¼ W	10%	057-103
R4	3.3K	¼ W	10%	057-332

KPR-3C Brick Receiver Section Parts List continued.

R5	27 MHz	470 ohms	¼ W	10%	057-471
R5	72 MHz	270 ohms	¼ W	10%	057-271
R6		1K	¼ W	10%	057-102
R7		1K	¼ W	10%	057-102
R8		500 ohms	Potentiomenter, Centralab		106-029
R9		100 ohms	¼ W	10%	057-101
R10		220K	¼ W	10%	057-224
R11		15K	¼ W	10%	057-153
R12		Not used			
R13		Not used			
R14		5.6K	¼ W	10%	057-562
R15		22K	¼ W	10%	057-223
R16		1K	¼ W	10%	057-102
*R17		4.7K	¼ W	10%	057-472
*R18		4.7K	¼ W	10%	057-472

CAPACITORS

C1	27 MHz	27pf	100V	Silver Mica	117-006
C1	72 MHz	15-18pf	100V	Silver Mica	117-004 or 117-013
C2	27 MHz	1pf	100V	Silver Mica	117-015
C2	72 MHz	0.5pf	500V	Tubular	114-001
C3	27 MHz	39pf	100V	Silver Mica	117-014
C3	72 MHz	15-18pf	100V	Silver Mica	117-004 or 117-013
C4	27 MHz	27pf	100V	Silver Mica	117-006
C4	72 MHz	22pf	100V	Silver Mica	117-005
C5		.05uf	10V	Disc	113-018
C6		.0033uf	Sub Mini	Disc	113-022
C7		1.0uf	35V	Tantalum	116-002
C8		.05uf	10V	Disc	113-018
C9		10pf	100V	Silver Mica	117-003
C10		.05uf	10V	Disc	113-018
C11		.05uf	10V	Disc	113-018
C12		.01uf	50V	Disc	113-016
C13		1.0uf	35V	Tantalum	116-002
C14		.0047uf	Mepico	Disc	113-038
C15		4.7uf	6V	Tantalum	116-004
C16		.05uf	10V	Disc	113-018
C17		Not used			
*C18		.001uf	500V	Disc	113-012
*C19		.001uf	500V	Disc	113-012

* Dual Frequency Option

COILS & TRANSFORMERS

L1	27 MHz	Coil, 10 turns, Antenna	103-060
L1	72 MHz	Coil, 4 turns, Antenna, tapped at 1 turn	103-062
L2A & B	27 MHz	Coil, 9¼ turns, Mixer, + 2¼ turns	103-061
L2A & B	72 MHz	Coil, 5¼ turns, Mixer, + 1¼ turns	103-063
IFT-1		455 KHz I.F. Yellow	103-013
IFT-2		455 KHz I.F. White	103-014
IFT-3		455 KHz I.F. Black	103-015
RFC-1		3.8uh Tapped R.F. Choke	103-023

SEMICONDUCTORS

D1, *D2, *D3	1N4148		Diode Silicon	100-101
Q1, Q2, Q3, Q4	D16G6 or		Transistor Silicon	101-008 or
	2N3663		Transistor Silicon	101-034
Q5	2N3392	NPN	Transistor Silicon	101-004

MISCELLANEOUS

	P.C. Board, Rx, R-1 9, KPR-3C	101-216

ELECTRONIC ASSEMBLY

	27 MHz P.C. Assembly, Receiver R-19	KPR-3C	300-293
	72 MHz P.C. Assembly, Receiver R-19	KPR-3C	300-294

*Dual Frequency Option

KPR-3C BRICK (76-77)
DECODER — SERVO AMP

RESISTORS

All values in ohms (K = 1000)

R1	4.7K	¼ W	10%	057-472
R2	39K	¼ W	10%	057-393
R3	4.7K	¼ W	10%	057-472
R4	3.3K	¼ W	10%	057-332
R5	100K	¼ W	10%	057-104
R6	120K	¼ W	10%	057-124
R7	560 ohms	¼ W	10%	057-561
*R8				

KPR-3C Decoder - Servo Amp Parts List continued.

R9	16K	¼W	5%	055-163
R10	1K	¼W	10%	057-102
R11	180K	¼W	10%	057-184
R12	120K	¼W	10%	057-124
R13	560 ohms	¼W	10%	057-561
R14	16K	¼W	5%	055-163
R15	1K	¼W	10%	057-102
R16	180K	¼W	10%	057-184
*R17				

*SEE MECHANICS PARTS LIST

CAPACITORS

C1	4.7uf	6V	Tantalum	116-004
C2	.05uf	10V	Disc	113-018
C3	33uf	6V	Tantalum	116-005
C4	33uf	6V	Tantalum	116-005
C5	1uf	35V	Tantalum	116-002
C6	1uf	35V	Tantalum	116-002
C7	.001uf	Sub Mini	Disc	113-021
C8	.001uf	Sub Mini	Disc	113-021
C9	.47uf	35V	Tantalum	116-011
C10	33uf	6V	Tantalum	116-005
C11	.22uf	35V	Tantalum	116-009
C12	.01uf	50V	Disc	113-016
C13	.001uf	500V	Disc	113-012
C14	.47uf	35V	Tantalum	116-011
C15	33uf	6V	Tantalum	116-005
C16	.22uf	35V	Tantalum	116-009
C17	.01uf	50V	Disc	113-016
C18	.05uf	10V	Disc	113-018

SEMICONDUCTORS

D1	1N4148		Diode Silicon	100-101
Q1	MPS-6560	NPN	Transistor Silicon	101-013
Q2	2N5088	NPN	Transistor Silicon	101-014
Q3, Q4, Q5, Q6	MPS-6562	PNP	Transistor Silicon	101-012
IC-1	74C164		I.C.	110-117
IC-2	74L03N	Quad 2 Nand Open Collector		110-102
CH-1, CH-2	SN218992		I.C.	110-100

No. Required	Description	Part No.
2	Wiper Pot	106-023
1	Grommet, 3/32″ Groove	500-002
4	Grommet, 1/4″-1/16″ Groove	500-003
6	Screw, 2-56 x 1¼″ M.S.	500-012
2	Screw, 1-72 x 1/8″ BH SLT MS	500-032
7	Screw, 1-72 x 3/16″ M.S.	500-059
2	Centering Shaft (K-14II, 15II)	500-062
2	Gear Pin, (KPS-14II, 15II)	500-066
4	Washer	500-108
2	Motor, 12 Ohm	800-007
2	Gear, 1st Intermed, KPS-14 II	981-273
2	Gear, 2nd Intermed., KPS-14 II	901-274
2	Gear, Drive, KPS-14 II	981-275
2	Gear Pot KPS-14II	901-276
2	Output Wheel, KPS-14II	901-277
2	Output Arm, KPS-14II	901-278
2	Disc, Wiper Support, KPS-14II	901-286
1	Case, Bottom, KPR-3C Brick	901-338
1	Case, Top	901-339
1	Case, Center	901-340
2	Potentiometer Carbon Element, 1.5K (R8 & R17)	106-012
		010-217
		123-038
		123-027

MISCELLANEOUS

	Crystal, Order by frequency	as required
	P.C. Board L/S-23, KPR-3C	010-217
	Switch Harness	123-027
	Wiring Harness	123-038

ELECTRICAL ASSEMBLY

	P.C. Assembly, Logic Section LS-23	300-292

SERVO AMP–I.C.

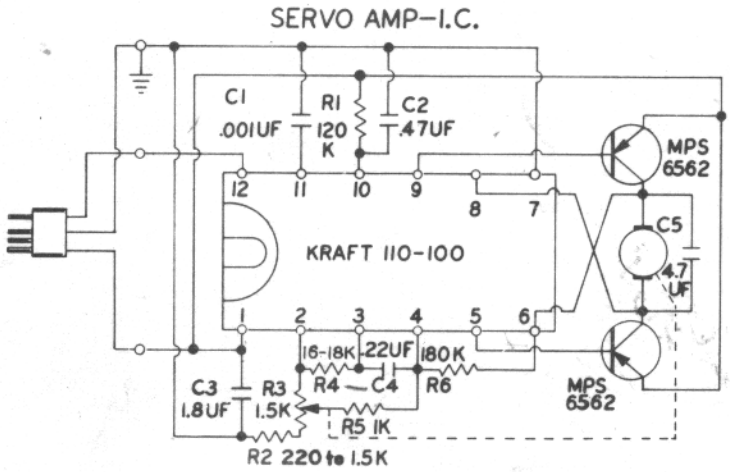
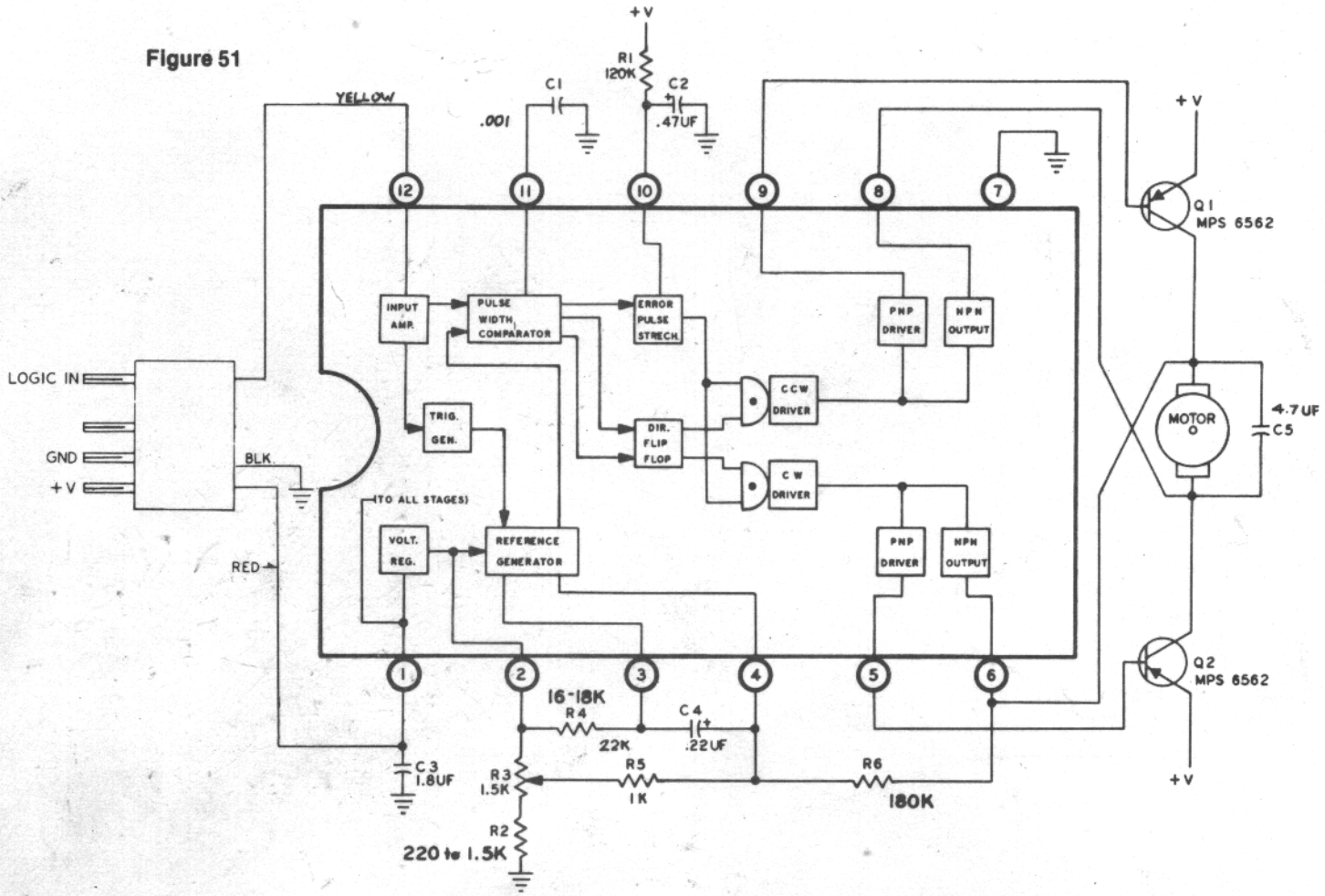


Figure 50

Figure 51



I.C. SERVO AMPLIFIERS
(Figure 50)

The integrated circuit servo amplifier is a Schmitt trigger type amplifier, completely integrated except for the timing components and PNP output transistors.

The integrated circuit features a temperature-compensated voltage regulator to power the reference generator and provide stable operation from -25°C to +75°C and 2.8v to 6.0v supply voltage. A special feature is the use of a single pulse stretcher capacitor to provide equal minimum pulse width drive in both error directions.

Discrete external PNP output transistors are used to minimize voltage drop across the output transistors and keep I.C. package dissipation low.

The block diagram, figure 51, shows the relationship of the enternal components to the I.C. itself.

The input signal at pin 12 is amplified and applied to one side of the pulse width comparator. The trigger generator provides a pulse suitable for initiating the one-shot reference generator from the loading edge of the input pulse. The reference generator is powered by an internal voltage regulator which makes the one-shot nearly immune to supply transients and is temperature compensated to maintain virtually zero drift over the operating temperature range. The resistors and capacitors connected to pins 2, 3, and 4 control the reference generator pulse width. R6 is the damping resistor to minimize servo overshoot with large changes in command pulse width. Potentiometer R3 is mechanically linked to the motor so that the reference pulse width approaches the input pulse width as the servo approaches the desired position.

The output of the reference generator is connected to one side of the comparator, and the comparator supplies an output pulse to both the error pulse stretcher and the proper side of the direction flip-flop whenever there is any difference between input and reference generator pulse widths.

Capacitor C1 slows comparator speed to permit proper adjustment of servo dead band. Increasing the capacitance at this pin will widen dead band.

The error pulse stretcher lengthens the error pulse width to make it long enough to drive the motor whenever dead band is exceeded. The minimum output pulse width is nominally 3 milliseconds.

The pulse stretcher's pulse polarity remains the same for either direction of error signal.

The direction flip-flop changes states only when the direction of error changes. The outputs are fed to two "AND" gates which turn on the appropriate driver transistors. The other input of each "AND" gate is the output of the error pulse stretcher. The two direction drivers supply necessary current for the NPN output transistors located in the I.C., and for the PNP driver stage which supplies base current to the external PNP output transistors.

ADJUSTING DEAD BAND, MINIMUM IMPULSE, DAMPING

Occasionally it will be necessary to alter the operation of the amplifier for certain applications. The most often changed constant will be dead band. Capacitor C1 controls the dead band, which should be between 4 and 8 microseconds total on all systems except Sport Series systems. If dead band is too little (< 4uS), increase the value of C1. Early Series Seventy-Two production used a 330pf capacitor which sometimes led to a jittery neutral.

Minimum impulse should be adjusted only if absolutely necessary. If minimum impulse is too short, the servo will tend to stay on at neutral. However, if the motor is defective, the symptoms will be much the same. Be sure to eliminate either of these possibilities before altering minimum impulse. Increasing R1 will widen the minimum impulse and conversely decreasing R1, will narrow the minimum impulse width.

With KPS-12, KPS-14II, KPS-15II, KPS-15HII, and KPS-16 servos, minimum pulse width should be 3-3.5 milliseconds. KPS-11/11A servo is designed to operate with 2.5-3.0 milliseconds minimum impulse. If these values are correct in the servo under test, the trouble most likely lies in the damping resistor or the motor.

Damping resistor R6 controls overshoot in the servo. If the value of R6 is too high, the servo will have a tendency to overshoot netural or in severe cases, oscillate at extremes of travel. If it is too low, the servo will approach null slowly or in severe cases, will never quite reach neutral and stay on, severly reducing battery life.

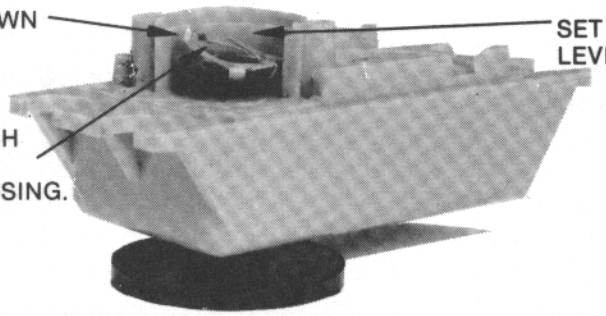


FIGURE 52

PARTS LIST
I.C. SERVO AMP.

RESISTORS

All values in ohms (K = 1000)

R1	KPS-11, -11A	100K	¼ W	10%	057-104
	KPS-12 - 16	120K	¼ W	10%	057-124
R2		560 ohm nominal	¼ W	10%	057-561
R3		1.5K	½ W	10% Feedback pot	106-012
R4		16K nominal	¼ W	5%	055-163
R5		1K	¼ W	10%	057-102
R6	KPS-11, -11A	180K	¼ W	10§	057-184
	KPS-12 - 16	220K	¼ W	10%	057-224

CAPACITORS

C1	.001uf	100V	Disc Ceramic	113-021
C2	.47uF	35V	Tantalum	116-011
C3	1.8uF	35V	Tantalum	116-010
C4	.22uF	35V	Tantalum	116-009
C5	4.7uF	35V	Tantalum	116-013

SEMICONDUCTORS

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

ELECTRONIC ASSEMBLY

— — KPS-11, -11A	Servo Amplifier	300-152
— — KPS-12 - 16	Servo Amplifier	300-153

CONNECTOR ASSEMBLY

— —	Servo Connector 4 Pin 3 Wire	123-010

NEUTRAL ADJUSTMENT FOR KPS-11 AND KPS-12 SERVOS

The pot wiper shaft used on these servos is designed to permit centering the servo while it is completely assembled. A molded wiper contact assembly holds one knurled end of the shaft, and the output gear fits over the opposite end. The screwdriver slot in the gear end of the shaft may be turned to center the servo while the servo is plugged into a neutral standard or receiver. It is not necessary, therefore, to rotate the pot element once it is installed in the mechanics and wired to the amplifier.

When using only the racks on the KPS-11, the cap provided for the output wheel shaft should be used to keep the pot shaft from slipping inside the fourth gear.

It has come to our attention that some customers are using screws other than those supplied to attach the output wheel to the wiper shaft. Please check to see if any damage has been caused by improper use of screws on this shaft. If you note any damage, replace the shaft and inform the customer of the damage caused by sheet metal screws to the wiper shaft. A 1-72 x 1/8" binder head screw is the only proper screw to use on this servo.

180° I.C. SERVOS

180° servos require a change of three components to modify the throw. The values given are nominal and should be used as a starting point only. R2 becomes 1.5K, R4 becomes 13K (series two resistors 6.2K and 6.8K), and R6 becomes 220K. In some types of servos, R6 is 220K and will not need to be changed. R4 will have the greatest effect on throw, and should be adjusted for the required amount. R2 should be adjusted to keep the pot wiper from running off one end of the pot element. Some care should be used when making the adjustment. Make sure the wiper does not travel to the very end into the nonlinear portion of the element.

One of the simplest methods for finding the correct values for R2 and R4 is to substitute a 2K pot for R2 and a 15K or 20K pot for R4. Keep the leads as short as possible, and adjust the pots for the required throw. Now remove the pots from the amplifier and check their values with an ohmmeter. Then replace them with fixed resistors of corresponding values. Check Damping and adjust R6 if necessary.

TROUBLE SHOOTING AND SERVICING SERVOS

Servos are subjected to much of the aircraft's vibration level, and care should be used to ensure successful operation under all expected conditions.

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 slew 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 the 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 severly reduce element life. See Figure 52 for correct wiper settings if the wiper is damaged or replaced.

Electronic parts replacement will generally involve replacement of either the integrated circuit or a 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 0.6v 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 involves replacement of the integrated circuit. Neutral adjustment is accomplished by loosing the two screws that hold the feedback pot in the servo and turning the pot, with the servo energized, to neutralize the servo arm. A sharp pair of tweezers can be used to align the pot.

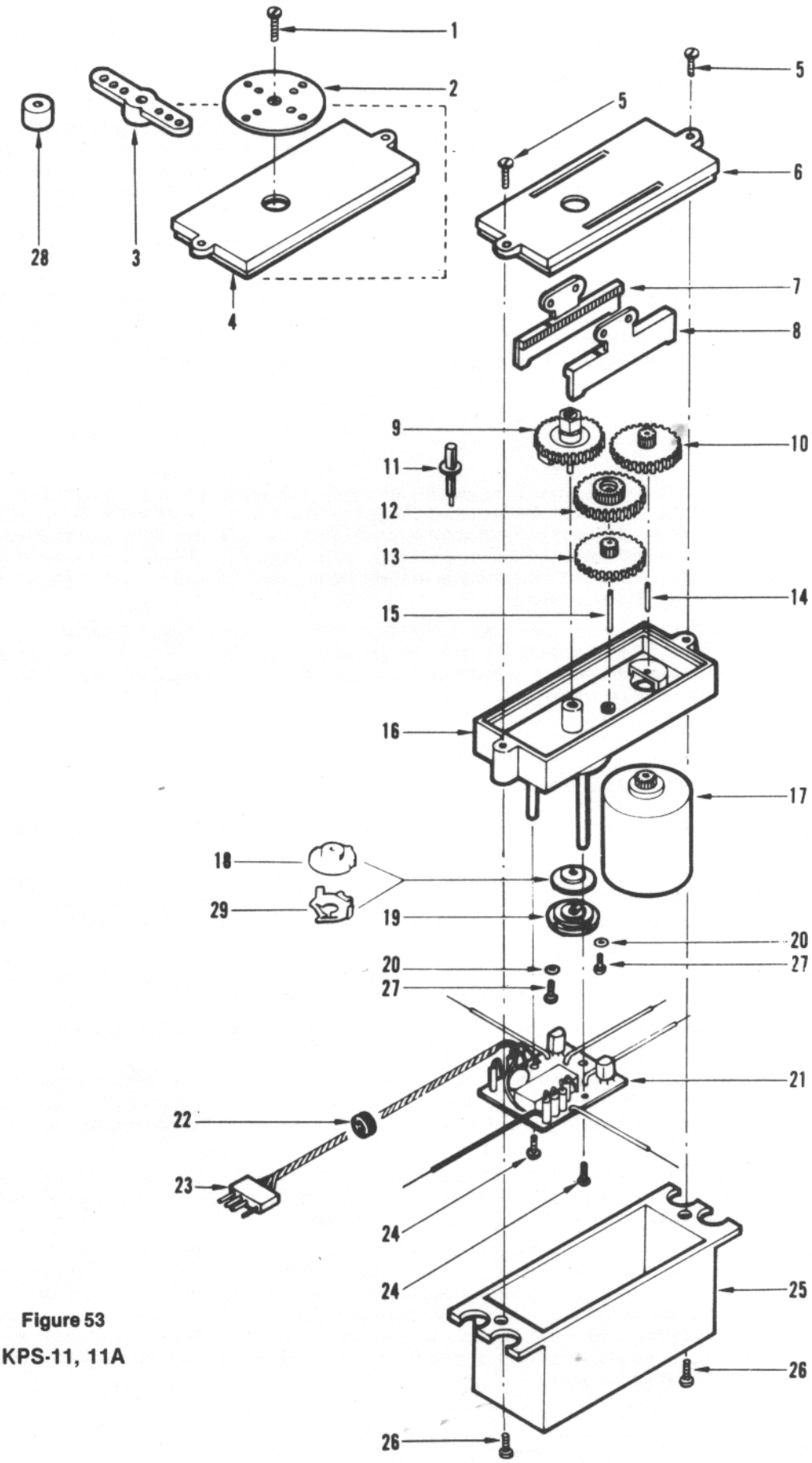


Figure 53

KPS-11, 11A

KPS-11 AND KPS-11A PARTS LIST
(Figure 53)

Key No.		
17	Motor, KPS-10, KPS-11, KPS-11A 10 ohm	800-006
6	Case, Top KPS-11	901-161
4	Case, Top KPS-11A	901-162
16	Case, Center	901-163
25	Case, Bottom	901-164
—	Case, Complete KPS-11	901-189
—	Case, Complete KPS-11A	901-190
13	Gear, First Intermediate	901-165
10	Gear, Second Intermediate	901-166
12	Gear, Drive	901-167
9	Gear, Pot	901-168
—	Gear Set	901-172
7	Right Rack Gear KPS-11	901-169
8	Left Rack Gear KPS-11	901-170
—	Rack Gear Set KPS-11	901-171
28	Output Shaft Cap KPS-11	901-201
2	Output Wheel	901-173
3	Output Arm	901-174
—	Output Wheel & Arm Set	901-175
18	Pot Wiper Support Disc	901-176
11	Pot Shaft	500-033
29	Pot Wiper Contact	106-023
19	Pot Element 1.5K	106-012
15	Gear Pin .050″ x .375″	500-029
14	Gear Pin .050″ x .250″	500-030
24	0-80 x ¼ Machine Screw (pkg. of 20)	500-022
5	2-56 x 3/16 Pan Head M.S. (pkg. of 20)	500-037
26	2-56 x 7/32″ Flat Head Phillips (pkg. of 20)	500-031
27	1-72 x ¼″ Binding Head M.S. (pkg. of 20)	500-039
1	1-72 x 1/8″ Binding Head M.S. (pkg. of 20)	500-032
22	¼ O.D. Grommets (pkg. of 20)	500-003
20	Fiber Washer (pkg. of 20)	500-025
21	See Electronic Assembly	300-153
23	See Connector Assembly	123-012

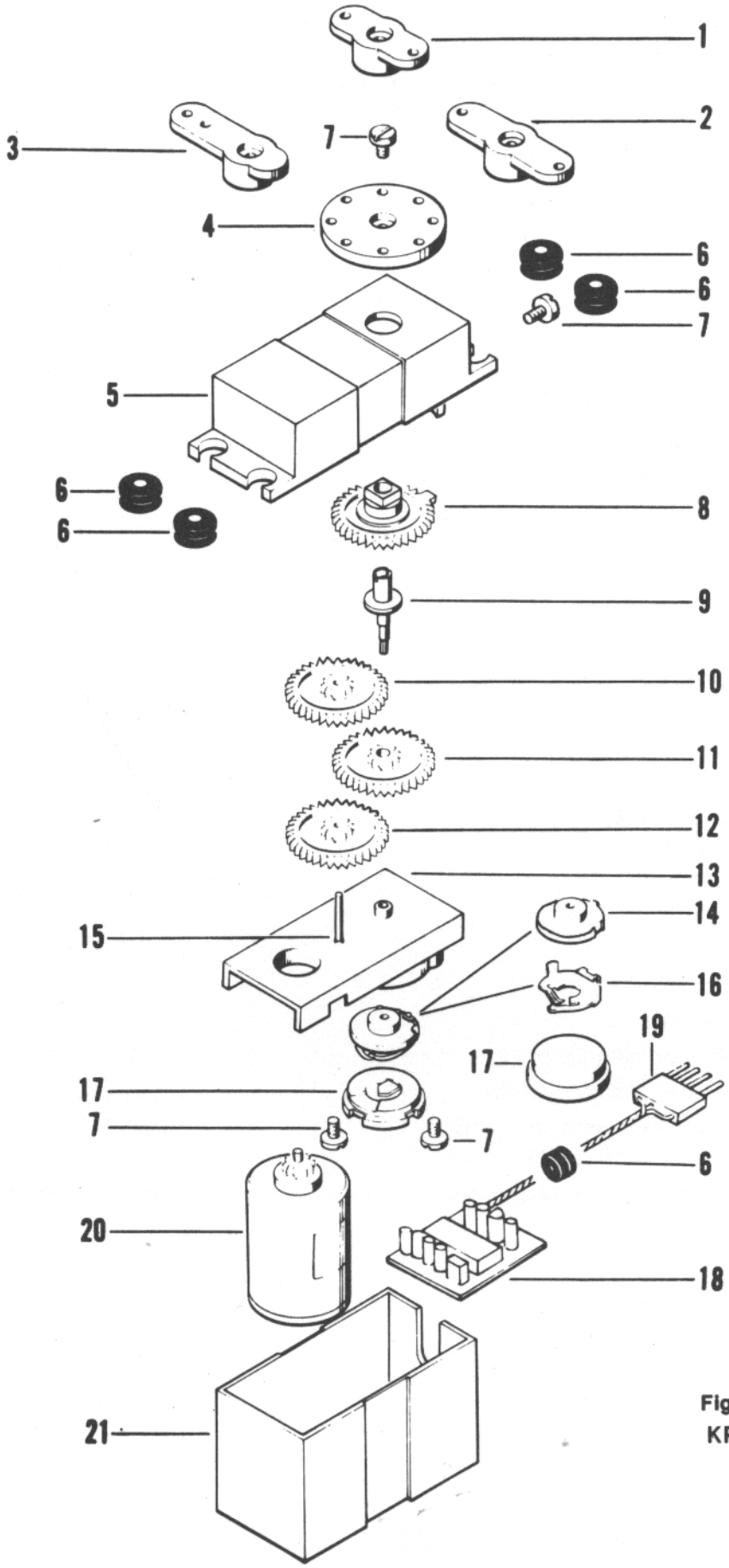


Figure 54
KPS-12

KPS-12 PARTS LIST
(Figure 54)

Key No.		
20	*Motor, KPS-12 12 ohm	800-007/*800-011
5	Case, Top	901-177
13	**Case, Center	**901-178/901-489
21	Case, Bottom	901-179
—	Case, Complete	901-191
12	Gear, First Intermediate	901-180
11	Gear, Second Intermediate	901-181
10	Gear, Drive	901-182
8	Gear, Pot Output	901-183
—	Gear, Set	901-187
4	Output Wheel	901-184
1	Output Arm Short - two holes	901-185
3	Output Arm Long	901-186
2	Output Arm Short - one hole	901-198
—	Output Wheel & Arm Set	901-188
14	Pot Wiper Support Disc	901-192
9	Pot Shaft	500-034
16	Pot Wiper Contact	106-023
17	Pot Element 1.5K	106-012
15	Gear Pin .050″ x .400″	500-061
7	1-72 x 1/8″ Binding Head M.S. (pkg. of 20)	500-032
6	3/16″ O.D. Grommets (pkg. of 20)	500-040
18	See Electronic Assembly	300-153
19	See Connector Assembly	123-012

*** This motor replaces the previous motor, P/N800-700 which is no longer available. P/N901-493, is required for motor installation when center case P/N901-178 is used.**

**** Center case has changed from P/N901-178 to 901-489.**

Dimensions of the new motor P/N800-011 have been reduced therefore it requires a motor collar P/N901-493, to be able to use it in the old center case.

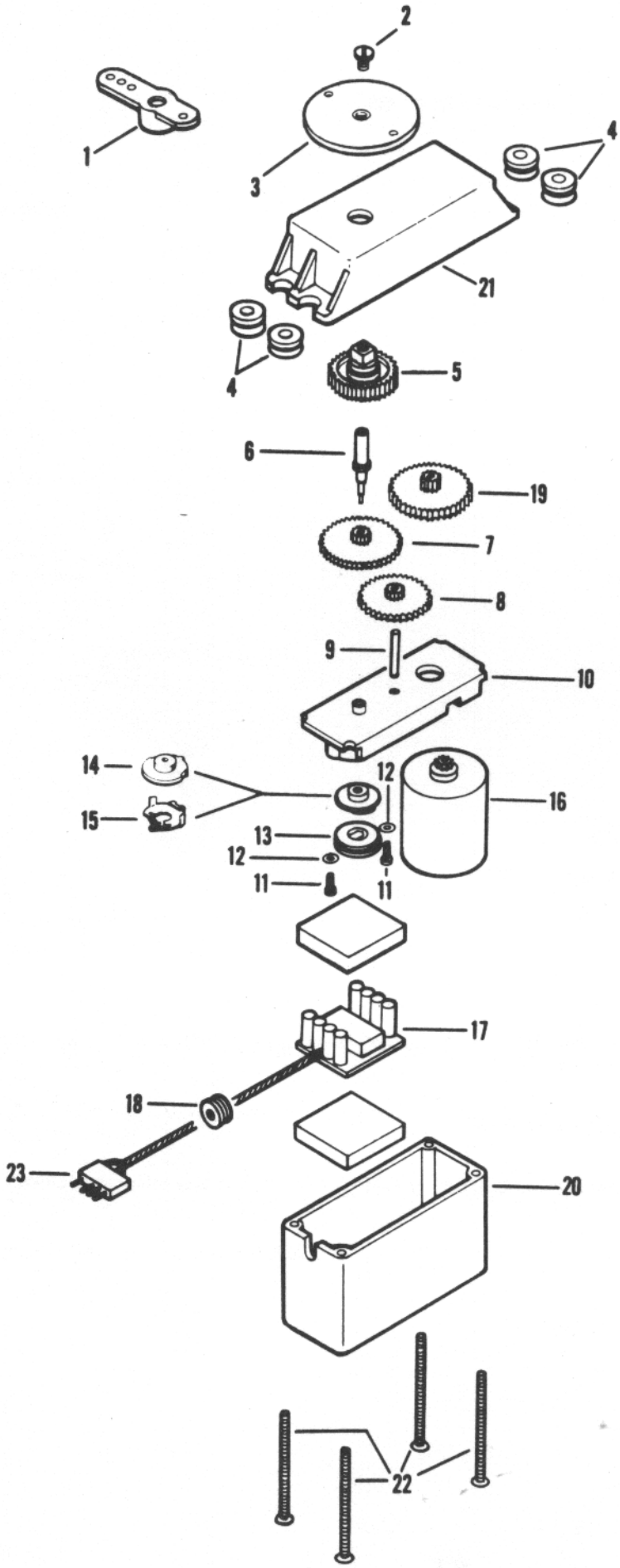


Figure 55
KPS-14II

KPS-14II PARTS LIST
(Figure 55)

KEY NO.		
16	*Motor with pinion gear — 12 ohm	800-007/*800-011
21	Case, Top	901-272
10	**Case, Center	**901-311-/901-490
20	Case, Bottom	901-230
—	Case, Complete	901-296
8	Gear, First Intermediate	901-273
7	Gear, Second Intermediate	901-274
19	Gear, Drive	901-275
5	Gear, Pot Output	901-276
—	Gear Set	901-293
1	Output Arm	901-278
3	Output Wheel	901-277
—	Output Arm Set	901-292
14	Pot Wiper Support Disc	901-286
15	Pot Wiper Contact	106-023
13	Potentiometer Element, 1.5K	106-012
9	Gear Pin .050″ x .550″	500-066
6	Gear/Wiper Shaft	500-062
22	2-56 x 1-1/4″ F.H. Phillips M.S. (Pkg. of 20)	500-012
2	1-72 x 1/8″ B.H.M.S. (Pkg. of 20)	500-032
11	1-72 x 3/16″ B.H.M.S. (Pkg. of 20)	500-059
12	Fiber Washer (Pkg. of 20)	500-108
4	Grommet, 3/16″ O.D. (Pkg. of 20)	500-040
18	Grommet, 5/32″ O.D. (Pkg. of 20)	500-002
17	See Electronic Assembly	300-153
23	See Connector Assembly	123-012

*** This motor replaces the previous motor, P/N800-700 which is no longer available. A motor collar, P/N901-493, is required for motor installation when center case P/N901-311 is used.**

**** Center case has changed from P/N901-311 to 901-490.**

Dimensions of the new motor P/N800-011 have been reduced therefore it requires a motor collar P/N901-493, to be able to use it in the old center case.

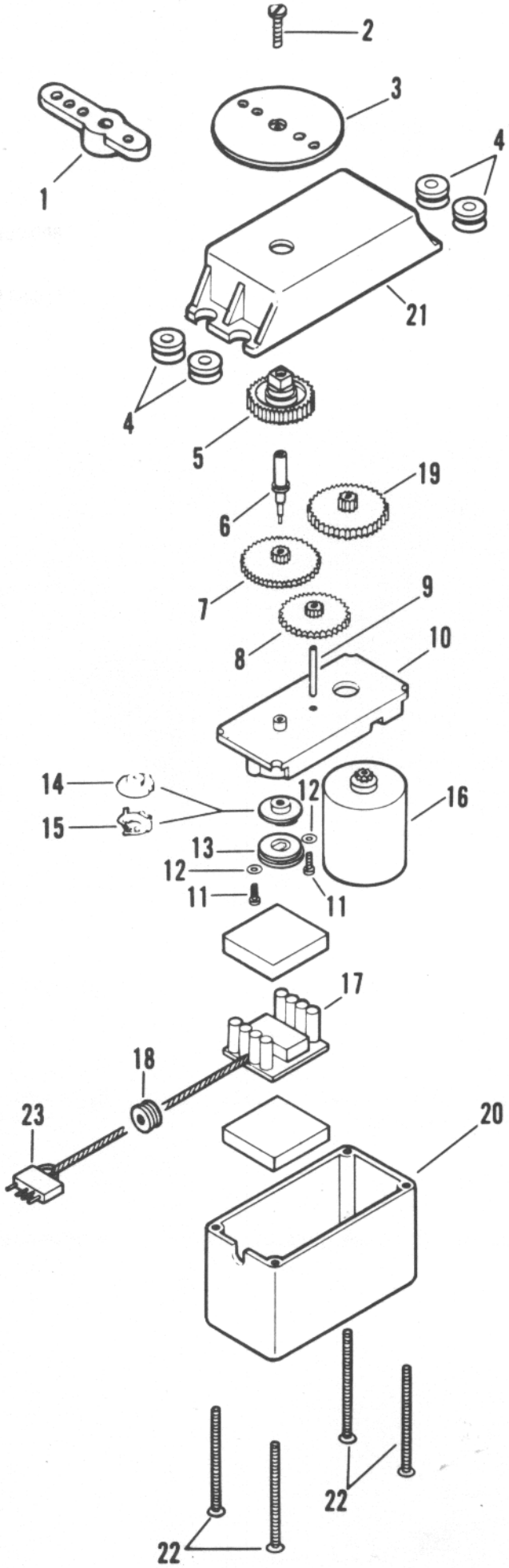


Figure 56
KPS-15II and KPS-15HII

KPS-15II and — 15HII PARTS LIST
(Figure 56)

KEY NO.		
16	Motor with pinion gear for KPS-15 — 10 ohm	800-006
16	Motor with pinion gear for KPS-15H — 6 ohm	800-002
21	Case, Top	**901-279**
10	Case, Center	**901-312**
20	Case, Bottom	901-243
—	Case, Complete	**901-297**
8	Gear, First Intermediate	**901-280**
7	Gear, Second Intermediate	**901-281**
19	Gear, Drive	901-282
5	Gear, Output	**901-283**
—	Gear Set	**901-295**
1	Output Arm	**901-285**
3	Output Wheel	**901-284**
—	Output Arm Set	**901-294**
14	Pot Wiper Support Disc	**901-287**
15	Pot Wiper Contact	106-023
13	Potentiometer Element 1.5K	106-012
9	Gear Pin .062″ x .55o″	500-068
6	Gear/Wiper Shaft	500-062
22	2-56 x 1-1/4″ F.H. Phillips M.S. (Pkg. of 20)	500-012
2	1-72 x 1/8″ B.H.M.S. (Pkg. of 20)	500-032
11	1-72 x 3/16″ B.H.M.S. (Pkg. of 20)	500-059
12	Fiber Washer (Pkg. of 20)	**500-108**
4	Grommet, 1/4″ O.D. (Pkg. of 20)	500-003
18	Grommet, 5/32″ O.D. (Pkg. of 20)	500-002
17	See Electronic Assembly	300-153
23	See Connector Assembly	**123-012**

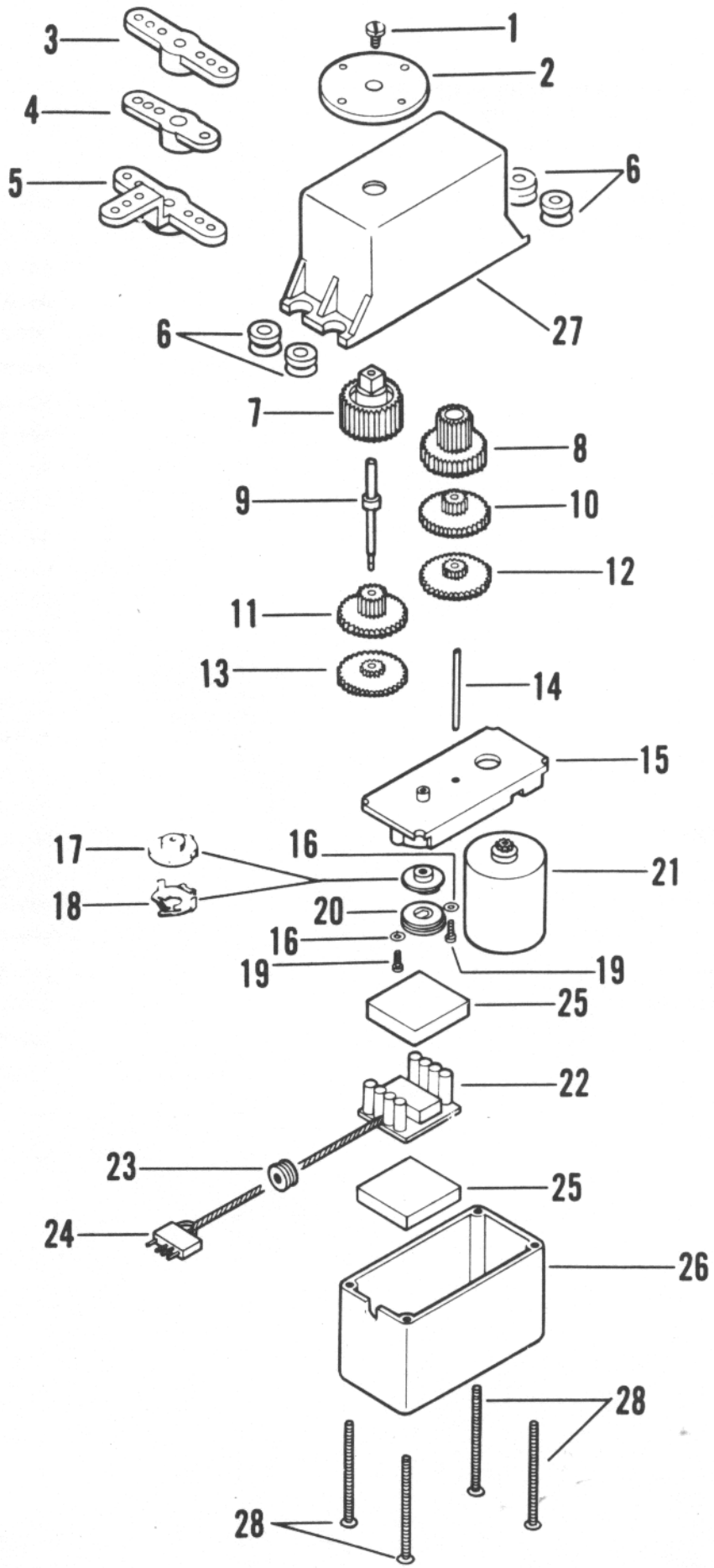


Figure 57
KPS-16

KPS-16 PARTS LIST
(Figure 57)

KEY NO.		
21	Motor, with pinion gear — 10 ohm	800-006
27	Case, Top	901-241
15	Case, Center	901-266
26	Case, Bottom	901-243
—	Case Complete	901-245
12	Gear, First Intermediate	901-254
13	Gear, Second Intermediate	901-255
10	Gear, Third Intermediate	901-256
11	Gear, Fourth Intermediate	901-257
8	Gear, Drive	901-258
7	Gear, Output	901-259
—	Gear Set	901-260
3	Output Arm	901-261
4	Output Arm Offset	901-264
5	Output Arm Triangular Offset	901-265
2	Output Wheel	901-262
—	Output Arm Set	901-263
17	Pot Wiper Support Disc	901-192
18	Pot Wiper Contact	106-023
20	Potentiometer Element, 1.5K	106-012
14	Gear Pin .062″ x 1.00″	500-067
9	Gear/Wiper Centering Shaft	500-046
28	2-56 x 1-1/4″ F.H. Phillips M.S. (Pkg. of 20)	500-012
1	1-72 x 1/8″ B.H.M.S. (Pkg. of 20)	500-032
19	1-72 x 3/16″ B.H.M.S. (Pkg. of 20)	500-059
16	Fiber Washer (Pkg. of 20)	500-025
6	Grommet, 1/4″ O.D. (Pkg. of 20)	500-003
23	Grommet, 5/32″ O.D. (Pkg. of 20)	500-002
22	See Electronic Assembly	300-153
24	See Connector Assembly	123-012

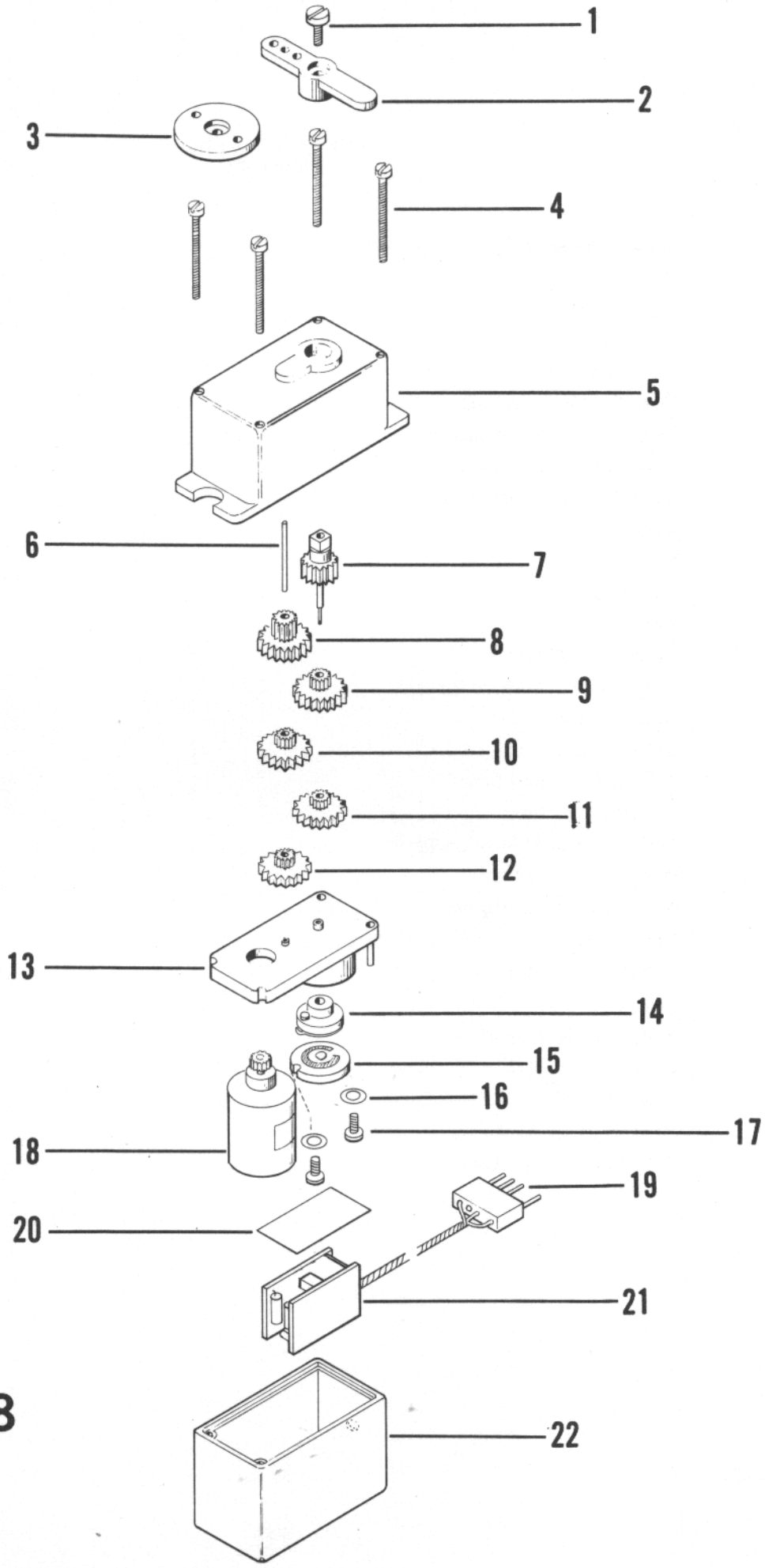


Figure 58

KPS–18

KPS-18 PARTS LIST
(Figure 58)

Key No.		
1	Screw Package (20 pcs) - 1-72 x 1/4" B.H.M.S. (KPS-11, -11A Pot hold down) KPS-18 Output Arm	500-039
2	Output Arm KPS-18	901-424
3	Output Wheel KPS-18	901-425
4	0-80 x 5/8" Fillister Hd. C.P. Slotted (10)	500-179
5	Case, Tap KPS-18	901-410
6	KPS-14, -14II Gear Pin	500-066
7	Gear #6 KPS-18	901-422
7A	Centering Shaft KPS-18	500-180
8	Gear #5 KPS-18	901-421
9	Gear #4 KPS-18	901-420
10	Gear #3 KPS-18	901-419
11	Gear #2 KPS-18	901-418
12	Gear #1 KPS-18	901-417
13	Case, Center KPS-18	901-411
14	Disc, Wiper Support, KPS-18	901-429
14	Wiper ets# 175-N3 for KPS-18	106-062
15	Element, 5K CTS #9P1017 KPS-18	106-061
16	Washer, Fiber .125 OD x .072ID x .016, KPS-18	500-194
17	0-80 x 1/8 P.H.M.S. Slotted CP #1 (20)	500-159
18	Motor, 17 ohm Mini for KPS-18	800-010
19	Servo Connector-Multicon Series 72 - 75 short/long	123-012
21	Servo Amp, KPS-18 Miniature	300-382
22	Case, Bottom KPS-18	901-412

KPS-18 SERVO

Figure 59

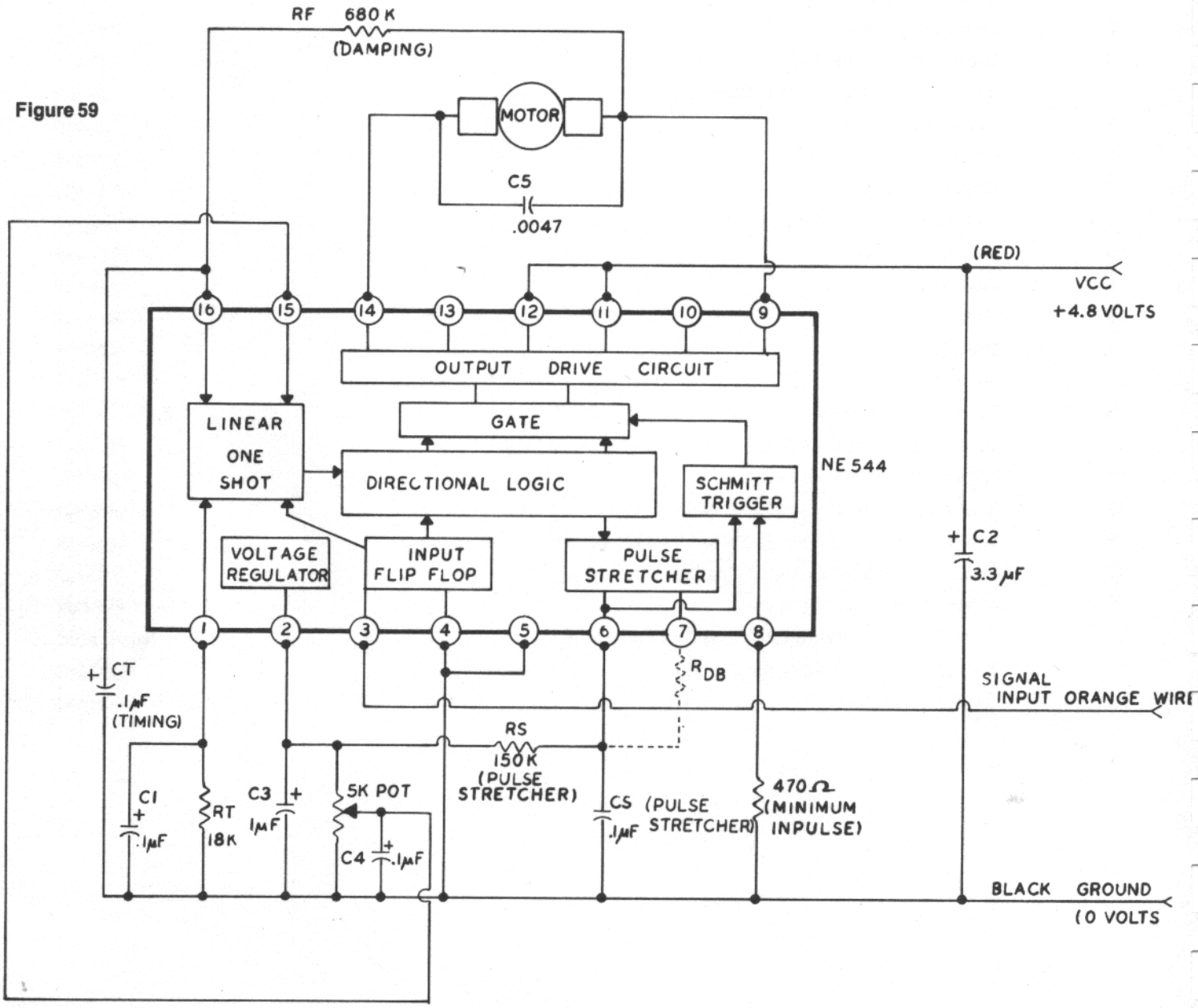
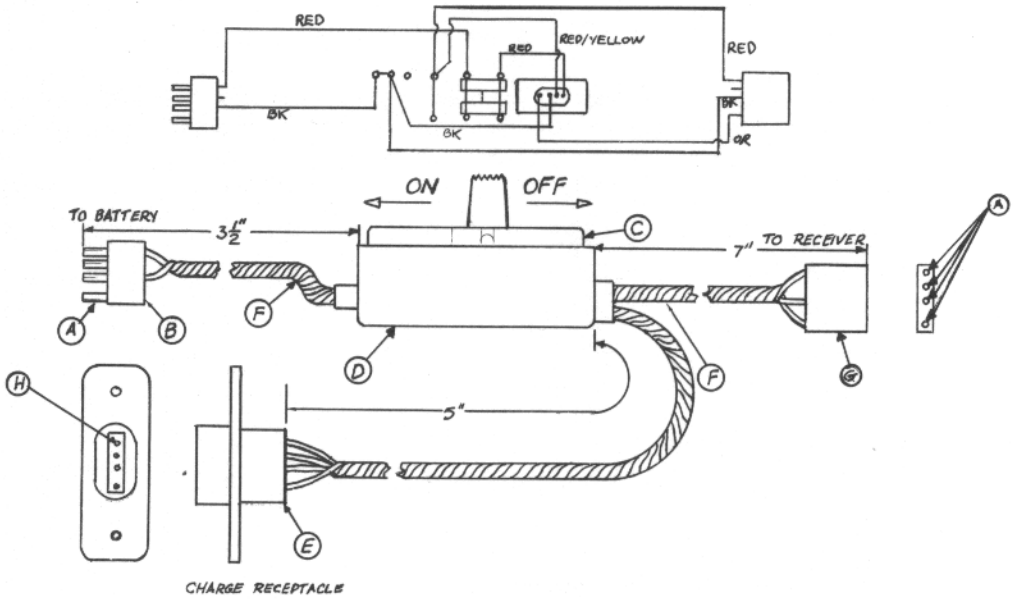


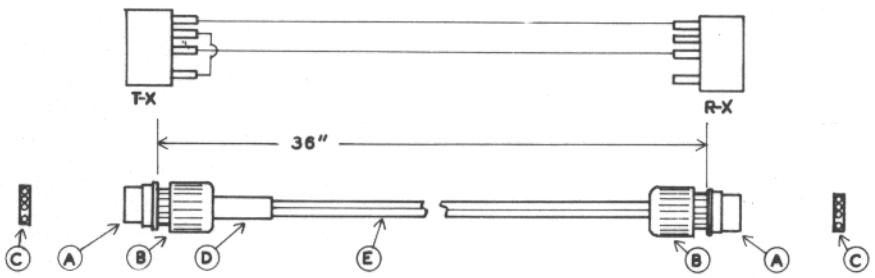
Figure 60



SWITCH HARNESS SERIES '75 (P/N 200-121)

Key Number	Quantity Required	Description	Part Number
I	2	Heat Shrink Tubing 1/8 x 1/2	990-034
H	4	Pin Contact	120-026
G	1	Molded Shell 75 Rx Power	120-040
F	3	#26 AWG 26 strand	990-019
E	1	Charge Receptacle 75	120-041
D	1	Switch Cover — Rx Harness	901-200
C	1	Slide Switch 4 P.O.T.	109-007
B	1	Molded Shell for 120-025	120-023
A	8	Socket Contact	120-025

Figure 61



CABLE ASSEMBLY R-X BATTERY TEST (P/N 200-134)

Key Number	Quantity Required	Description	Part Number
E	1	Wire	990-036
D	1	Heat Shrink Tube 1/8 x 1/2	990-008
C	8	Socket Contact	120-025
B	2	Cap Charge Plug	120-038
A	2	Plug Charger Series 75	120-039

BATTERY PACKS

All battery packs are designed to withstand extreme vibration and high charge rates. They will accept charge rates up to C/3 (full charge in 3 hours) for 6-8 hrs. without damage. The capacity rating is based on a one-hour discharge period.

MODEL	CAPACITY	CHARGER	ADAPTER	CHARGE TIME
KB-4E	550 MAH	KBC-B	No	6 hours
KB-4F	1000 MAH	KBC-B	No	8 hours
KB-4L	225 MAH	KBC-B	Yes	4 hours
KB-4M	450 MAH	KBC-B	No	3 hours
KB-4S*	450 MAH	KBC-B	No	3 hours

*Same as KB-4M except for physical configuration

KBC-B BATTERY CHARGER

The KBC-B battery charger is a sealed unit and is not serviceable.

KBC-D BATTERY CHARGER

The KBC-D charger is a dual rate, switch selectable charger which replaces the KBC-B and KBC chargers. The KBC-D uses a removable P.C. assembly which can be serviced if trouble occurs.

RESISTORS
All values in ohms (K = 1000)

R1	1K	¼ W	10%	057-102
R2	1 ohm	½ W	10%	060-010
R3	1 ohm	½ W	10%	060-016
R4	1K	¼ W	10%	057-102
R5	10 ohm	¼ W	10%	057-100
R6	18 ohm	¼ W	10%	057-180

DIODES SEMICONDUCTORS

D1, D2, D3, D4, D5, D6,	1N4001	Diode Silicon	100-106
D7, D8	FV501	L.E.D.	100-110

MISCELLANEOUS

SW1	Switch DPDT	109-022

KBC-D CHARGER
MECHANICS PARTS LIST

No. Required	Description	Part No.
1	Case, Complete	901-452
2	Terminal Blades	120-085
1	Cable with 6 Pin Plug	120-006
1	Cable with 4 Pin Plug	123-042
4	Screw	500-204

Figure 62

KBC-D CHARGER

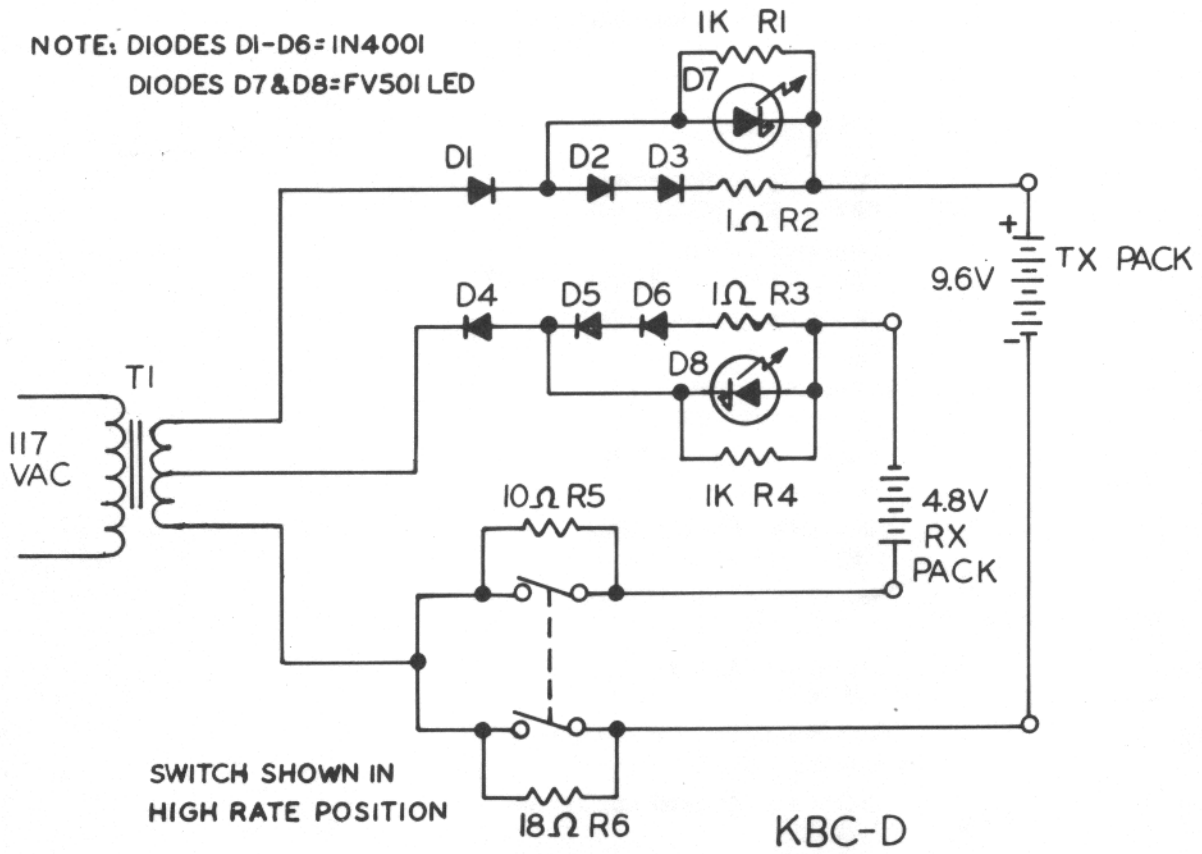
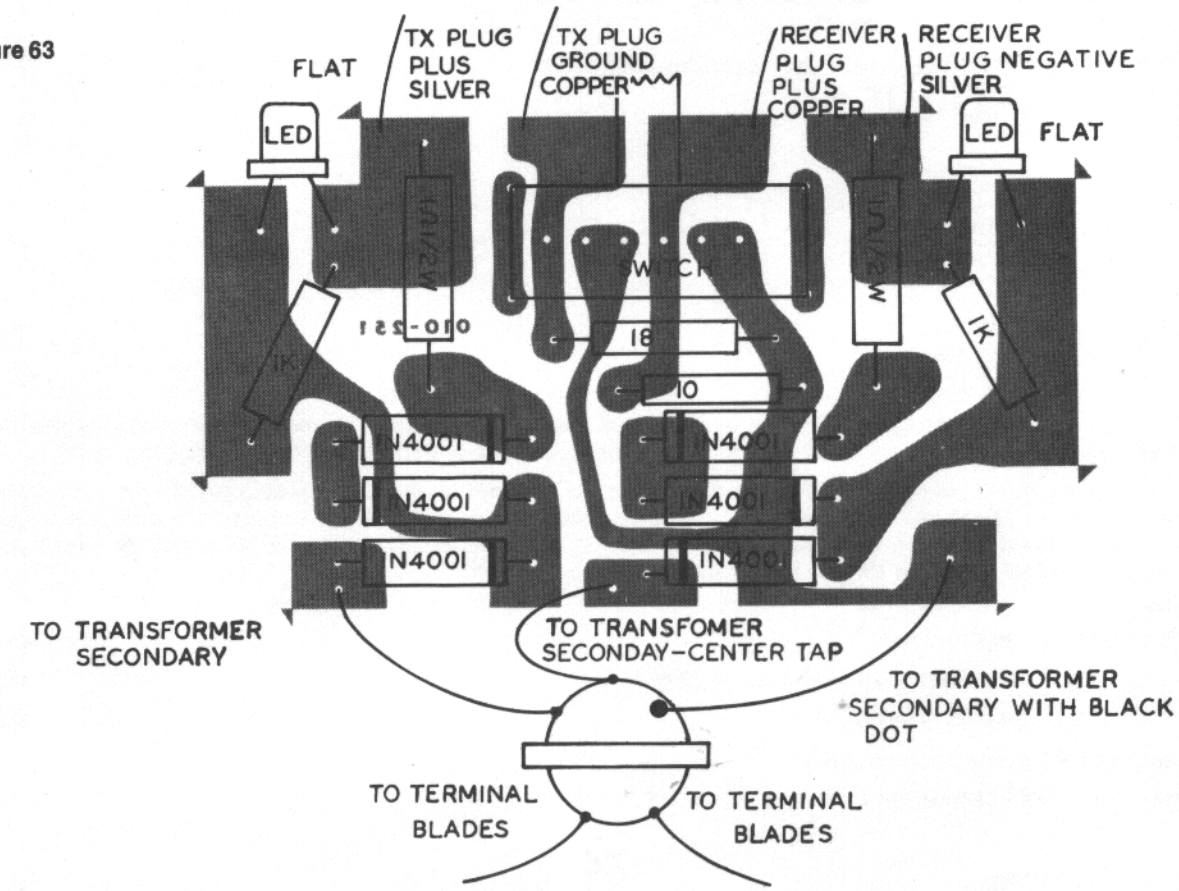


Figure 63



*CONVERSION KITS
(Full instructions with kit)

Part Number	Description
350-005	Dual Rate - Elevator Only KPT-3C, KPT-5C, KPT-5CS
350-006	Slow Roll Button KPT-3C, KPT-5C, KPT-5CS, KPT-7Z
350-007	Dual Rate - Aileron Only KPT-7C
350-008	Slow Roll Button KPT-7C, KPT-7CS
350-009	Dual Rate - Aileron Only KPT-7CS
350-011	Dual Rate - Elevator Only KPT-7C, KPT-7CS
350-012	Dual Rate - Aileron Only KPT-7C, KPT-5C
350-013	Dual Rate - Aileron Only KPT-5CS
350-016	Dual Rate - Elevator and Aileron KPT-3C, KPT-5C
350-017	Dual Rate - Elevator and Aileron KPT-5CS
350-018	Dual Rate - Elevator and Aileron KPT-7Z
350-019	Dual Rate - Elevator or Aileron KPT-7Z

ADJUSTMENT

PART NUMBER 350-005
DUAL RATE — ELEVATOR ONLY
KPT-3C, KPT-5C, AND KPT-5CS

Prior to the start of adjustment, energize the system and place elevator trim at neutral and check to see that a calibrated servo on elevator channel is at neutral. Leave the trim lever at neutral and de-energize the system.

Position the elevator dual rate switch to the open position; i.e., normal travel. Using a calibrated servo, readjust the elevator control pot shaft and the throw pot (R16) for neutral and proper servo throw. Position the dual rate switch to the "ON", reduced travel, position and adjust the 2K pot on the Dual Rate P.C. Assembly to center the servo. Adjust the 10K rate pot for desired servo throw. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly	**300-386
1	Switch, Landing Gear	109-012

*Sole to Authorized Service Stations only

** P.C. Board parts lists and wiring diagrams

Part Number 350-005
PARTS LIST continued.

1	Dress Nut, ¼-32	500-075
2	2-56 x ½" PanHead Machine Screw	500-112
2	Nut, Hex 2-56	500-169
2	Washer, Fiber .250" OD	500-041
4	Spacers, 11/32" OD x .125" thick	850-045

PART NUMBER 350-006
SLOW ROLL/SPIN BUTTON
KPT-3C, KPT-5C, KPT-5CS, AND KPT-7Z

Adjust the 4-turn, 5K ohm pot for desired servo throw when the pushbutton switch is activated. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Slow Roll Button P.C. Assembly	*300-298
1	Dress Nut, ¼-32	500-075

PART NUMBER 350-007
DUAL RATE — AILERON ONLY
KPT-7C

Position the dual rate switch to the open position; i.e., normal travel. Center the aileron trim lever on the face of the transmitter, adjust the Bourns aileron trim pot shaft until the servo is centered at neutral. Tighten the set screw on the trim pot. Remove the wire from center terminal on the Bourns aileron trim pot and go through the same sequence to center the servo by adjusting the shaft of the aileron control pot. Tighten the set screw on the control pot and clamp screws, and resolder the wire to the center terminal on the trim pot. Insure that the trim lever moves the servo in the same direction as the control stick. If not, reverse the two outside trim pot wires and recheck servo neutral. This completes the alignment of the electrical trim and the control pot.

Energize the system and check aileron servo action when the dual rate switch is activated. Adjust the 4-turn, 100K rate pot mounted on the dual rate P.C. board assembly to obtain the desired servo travel.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly	*300-302
1	Potentiometer, 10K Bourns w/nut, washer and locknut	106-044
2	#2 x ¼" Sheet Metal Screw	500-007
1	#1-72 x ¼" Machine Screw	500-024
1	Dress Nut, ¼-32	500-075
2	#0-80 x 1/8" Machine Screw	500-159
1	Crank, Mechanical Aileron Trim	850-125
1	Bracket, Mechanical Trim	850-126
1	Arm, Mechanical Trim	850-127
1	Lever, Mechanical Trim	850-128
1	Bushing, Gimbal - Dual Rate	**850-132

* P.C. Board parts lists and wiring diagrams
**Replaces 850-008 bushing on gimbal when using this kit.

PART NUMBER 350-008
SLOW ROLL PUSH BUTTON
KPT-7C AND KPT-7CS

Adjust the 4-turn, 5K ohm pot for desired servo throw when the pushbutton switch is activated. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Slow Roll Buttn P.C. Assembly	*300-301
1	Dress Nut, ¼-32500-075	

PART NUMBER 350-009
DUAL RATE — AILERON ONLY
KPT-7CS

Remove the center orange wire from pin 2 of the aileron control pot. Center the aileron trim lever on the face of the transmitter and turn the system on. Using the aileron servo as a reference, adjust the Bourns aileron trim pot shaft until the aileron servo is centered at neutral. Tighten the set screw on the trim pot. Remove the wire from the center terminal on the Bourns aileron trim pot and use the same sequence to center the servo by adjusting the shaft of the aileron control pot. Tighten the set screw on the control pot and resolder the wire to the center terminal of the trim pot. Insure that the trim lever moves the servo in the same direction as the control stick. If not, reverse the two outside trim pot wires and recheck servo neutral. This completes the alignment of electrical trim and the control pot.

Energize the system and check aileron action when the dual rate switch is activated to the reduced travel position. Adjust the 4-turn, 100K rate pot mounted on the dual rate P.C. Assembly to obtain the desired servo travel.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly	*300-302
1	Potentiometer, 10K Bourns, w/nut, washer and locknut	106-044
1	#1-72 x ¼" Machine Screw	500-024
1	Dress Nut, ¼-32	500-075
2	#0-80 x 1/8" Machine Screw	500-159
1	Crank, Mechanical Aileron Trim	850-125
1	Arm, Mechanical Trim	850-127
1	Lever, Mechanical Trim	850-128
1	Bushing, Gimbal - Dual Rate	**850-132
1	Bracket, Pot and Electrical Trim	904-180

PART NUMBER 350-011
DUAL RATE — ELEVATOR ONLY
KPT-7C AND KPT-7CS

Energize the system and check elevator servo action when the dual rate switch is positioned to the reduced travel position. Adjust the 4-turn, 100K rate pot mounted on the dual rate P.C. board assembly to obtain desired servo travel. With both the elevator stick and trim at neutral, activation of the dual rate switch should not cause any displacement of the elevator servo. If the servo does move off of neutral, then neutral alignment of the elevator control pot and trim pot should be checked. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly	*300-302
1	Dress Nut, ¼-2	500-075

*** P.C. Board parts lists and wiring diagrams**
**** Replaces 850-008 bushing on gimbal when using this kit.**

PART NUMBER 350-012
DUAL RATE — AILERON ONLY
KPT-3C AND KPT-5C

Position the aileron dual rate switch to the open position; i.e., normal travel. Check that the trim lever is at neutral. Move the black wires from the aileron control pot to the center terminal of the aileron trim pot. Solder a white jumper wire from one of the other terminals of the trim pot to the aileron control pot terminal vacated by the black wires. Energize the system and adjust the aileron control pot and encoder aileron channel throw pot (R17) for proper centering and servo throw. Tighten the set screw on the control pot and clamp screws. Insure that the aileron trim lever moves the servo in the same direction as the control stick. If not, reverse the white wire to the other outside terminal of the trim pot and recheck servo neutral. If it is not correct. readjust the aileron control pot and servo throw pot as done previously.

Position the aileron dual rate switch to the "ON"reduced travel position and adjust the 2K pot on the dual rate P.C. Assembly to center the servo. Adjust the 10K rate pot for desired servo throw. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly	*300-386
1	Switch, Landing Gear	109-012
1	Dress, Nut, ¼-32	500-075
1	Potentiometer, 1.5K Bourns	106-041
2	#2 x ¼" Sheet Metal Screw	500-007
1	#1-72 x ¼" Machine Screw	500-024
2	#0-80 x 1/8" Machine Screw	500-159
1	Crank, Mechanical Aileron Trim	850-125
1	Bracket, Mechanical Trim	850-126
1	Arm, Mechanical Trim	850-127
1	Lever, Mechanical Trim	850-128
1	Bushing, Gimbal - Dual Rate	**850-132
2	2-56 x ½" PanHead Machine Screw	500-112
2	Nut, Hex, 2-56	500-169
2	Washer, Fiber .250" OD	500-041
4	Spacers, 11/32" OD x .125" thick	850-045

PART NUMBER 350-013
AILERON ONLY
KPT-5CS ONLY

Position the aileron dual rate switch to the open position; i.e., normal travel. Insure that the trim lever is at neutral, then tighten the set screw on the aileron trim pot. Remove the black wires from the aileron control pot and solder to the center terminal of the aileron trim pot. Solder a white jumper wire from one of the other terminals of the trim pot to the aileron control pot terminal vacated by the black wires. Energize the system and adjust the aileron control pot and encoder aileron channel throw pot (R17) for proper centering and servo throw. Tighten the set screw on the control pot and clamp screws. Insure that the trim lever moves the servo in the same direction as the control stick. If not, reverse the white wire to the other outside terminal, and recheck servo neutral.

Position the aileron dual rate switch to the "ON" reduced travel position and adjust the 2K pot on the dual rate P.C. Assembly to center the servo. Adjust the 10K rate pot for desired servo throw. This completes the alignment.

* P.C. Board parts lists and wiring diagrams
** Replaces 850-008 bushing on gimbal when using this kit.

Part Number 350-013
PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly	*300-386
1	Switch, Landing Gear	109-012
1	Dress Nut, ¼-32	500-075
1	Potentiometer, 1.5K Bourns	106-041
1	#1-72 x ¼" Machine Screw	500-024
2	#0-80 x 1/8" Machine Screw	500-159
1	Crank, Mechanical Aileron Trim	850-125
1	Arm, Mechanical Trim	850-127
1	Lever, Mechanical Trim	850-128
1	Bushing, Gimbal - Dual Rate	**850-132
1	Bracket, Pot and Electrical Trim	904-180
2	2-56 x ½" PanHead Machine Screw	500-112
2	Nut, Hex, 2-56	500-169
2	Washer, Fiber .250 OD	500-041
4	Spacer, 11/32" OD x .125 thick	850-045

PART NUMBER 350-016
DUAL RATE — ELEVATOR AND AILERON
KPT-3C AND KPT-5C

Energize the system and place the elevator trim at neutral. Check to see that a calibrated servo on the elevator channel is at neutral. Leave the trim lever in that position and de-energize the system.

Position the elevator dual rate switch to the open position; i.e., normal travel. Using a calibrated servo, readjust the elevator control pot shaft and the throw pot (R16) for neutral and proper throw. Position the elevator dual rate switch to the "ON" reduced travel position and adjust the 2K pot on the dual rate P.C. Assembly to center the servo. Adjust the 10K rate pot for desired throw. This completes alignment of the elevator channel.

Position the aileron dual rate switch to the open position; i.e., normal travel. Insure that the trim lever is at neutral, then tighten the set screw on the aileron trim pot. Move the black wires from the aileron control pot to the center terminal of the aileron trim pot. Solder a white jumper wire from one of the other terminals of the trim pot to the aileron control pot terminal vacated by the black wires. Energize the system and adjust the aileron control pot and encoder aileron channel throw pot (R17) for proper centering and servo throw. Tighten the set screw on the control pot and clamp screws. Insure that the trim lever moves the servo in the same direction as the control stick. If not, reverse the white wire to the other outside terminal and recheck servo neutral.

Position the aileron dual rate switch to the "ON" reduced travel position and adjust the 2K pot on the dual rate P.C. Assembly to center the servo. Adjust the 10K rate pot for desired servo throw. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate P.C. Assembly, Aileron & Elevator	*300-299
2	Switch, Landing Gear	109-012
2	Dress Nut, ¼-32	500-075
1	Potentiometer, 1.5K Bourns	106-041
2	#2 x ¼" Sheet Metal Screw	500-007
1	#1-72 x ¼" Machine Screw	500-024

* P.C. Board parts lists and wiring diagrams
** Replaces 850-008 bushing on gimbal when using this kit.

Part Number 350-016
PARTS LIST continued.

2	#0-80 x 1/8" Machine Screw	500-159
1	Crank, Mechanical Aileron Trim	850-125
1	Bracket, Mechanical Trim	850-126
1	Arm, Mechanical Trim	850-127
1	Lever, Mechanical Trim	850-128
1	Bushing, Gimbal - Dual Rate	**850-132
2	2-56 x ½" Pan Head Machine Screw	500-112
2	Nut, Hex 2-56	500-169
2	Washer, Fiber .250 OD	500-041
4	Spacer, 11/32" OD x .125 thick	850-045

PART NUMBER 350-017
DUAL RATE — ELEVATOR AND AILERON
KPT-5CS ONLY

Energize the system and place the elevator trim at neutral, check to see that a calibrated servo on the elevator channel is at neutral. Leave trim lever in that position and de-energize the system.

Position the elevator dual rate switch to the open position; i.e., normal travel. Using a calibrated servo, readjust the elevator control pot shaft and the throw pot (R16) for neutral and proper servo throw. Position the elevator dual rate switch to the "ON" reduced travel position and adjust the 2K pot on the dual rate P.C. Assembly to center the servo. Adjust the rate pot for desired throw. This completes alignment of the elevator channel.

Position the aileron dual rate switch to the open position; i.e., normal travel. Check that the trim lever is at neutral. Move black wires from the aileron control pot to the center terminal of the aileron trim pot. Solder a white jumper wire from one of the other terminals of the trim pot to the aileron control pot terminal vacated by the black wires. Energize the system and adjust the aileron control pot and encoder aileron channel throw pot (R17) for proper centering and throw. Tighten the set screw on the control pot and clamp screws. Insure that the aileron trim lever moves the servo in the same direction as the control stick. If not, reverse the white wire to the other outside terminal of the trim pot and recheck servo neutral.

Position the aileron dual rate switch to the "ON" reduced travel position and adjust the appropriate 2K pot on the dual rate P.C. Assembly to center the servo. Adjust the 10K rate pot for desired servo throw. This completes alignment.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly, Aileron & Elevator	*300-299
2	Switch, Landing Gear	109-012
2	Dress Nut, ¼-32	500-075
1	Potentiometer, 1.5K Bourns	106-041
1	#1-72 x ¼" Machine Screw	500-024
2	#0-80 x 1/8" Machine Screw	500-159
1	Crank, Mechanical Aileron Trim	850-125
1	Arm, Mechanical Trim	850-127
1	Lever, Mechanical Trim	850-128
1	Bushing, Gimbal - Dual Rate	**850-132
1	Bracket, Pot and Electrical Trim	904-180

* P.C. Board parts lists and wiring diagrams
** Replaces 850-008 bushing on gimbal when using this kit.

Part Number 350-017
PARTS LIST continued.

2	2-56 x ½" PanHead Machine Screw	500-112
2	Nut, Hex 2-56	500-169
2	Washer, Fiber .250 OD	500-041
4	Spacer, 11/32" x .125 thick	850-045

PART NUMBER 350-018
DUAL RATE — AILERON AND ELEVATOR
KPT-7Z

Energize the system and place the elevator trim at neutral. Check to see that a calibrated servo on the elevator channel is at neutral. Leave the trim lever in that position and de-energize the system.

Position the elevator dual rate switch to the open position; i.e., normal travel. This is normally towards the top of the transmitter. Using a calibrated servo, readjust the elevator control pot shaft and the throw pot, (R7 on Mode II transmitter, R15 on Mode I transmitter), on the encoder for elevator neutral and proper throw. Position the elevator dual rate switch to the "ON" reduced travel position; i.e., down, and adjust the 2K pot on the dual rate P.C. Assembly to center the servo. Adjust the 19K rate pot for desired servo throw. This completes alignment of the elevator channel.

Align the aileron channel using the same procedure as in Step 4. R11 is the aileron throw pot on the encoder. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate P.C. Assembly, Aileron & Elevator	*300-299
2	Switch, Landing Gear	109-012
2	Dress Nut, ¼-32	500-075
2	2-56 x ½" Pan Head Machine Screw	500-112
2	Nut, Hex 2-56	500-169
2	Washer, Fiber .250 O.D.	500-041
4	Spacer, 11/32" OD x .125 thick	850-045

PART NUMBER 350-019
DUAL RATE — AILERON OR ELEVATOR
KPT-7Z

Energize the system and place the elevator or aileron trim as appropriate at neutral. Check to see that a calibrated servo on the appropriate channel as at neutral. Leave the trim lever in that position and de-energize the system.

Position the dual rate switch to the open position; i.e., normal travel. The switch is installed so that this is normally towards the top of the transmitter. Using a calibrated servo, readjust the appropriate control pot and the throw pot, (R7 elevator or R11 aileron), on the encoder for neutral and proper throw. Position the dual rate switch to the "ON" position: i.e., down and adjust the 2K pot on the dual rate P.C. Assembly to center the appropriate servo. Adjust the 10K ohm rate pot on the P.C. Assembly from the front of the transmitter for desired servo throw. This completes the alignment.

PARTS LIST

Number Required	Description	Part Number
1	Dual Rate Switch P.C. Assembly	*300-386
1	Switch, Landing Gear	109-012
1	Dress Nut, ¼-32	500-075

Parts List continued on next page.

* P.C. Board parts lists and wiring diagrams

Part Number 350-019
PARTS LIST continued.

2	2-56 x ½" Pan Head Machine Screw	500-112
2	Nut, Hex, 2-56	500-169
2	Washer, Fiber .250" OD	500-041
4	Spacer, 11/32" OD x .125 thick	850-045

Part Number 300-298
SLOW ROLL BUTTON P.C. ASSEMBLY

Number Required	Description	Part Number
1	P.C. Board	010-222
1	Resistor, 1.5K ¼W 10%	057-152
1	Resistor, 2.2K ¼W 10%	057-272
1	Potentiometer, 5K Bourns 3339P-1-502	106-049
1	Switch, Master Trainer	109-013
36"	#26 AWG Strand Wire	990-019

Part Number 300-299
DUAL RATE SWITCH P.C. ASSEMBLY

Number Required	Description	Part Number
1	P.C. Board	010-221
2	Resistor, 1K ¼W 10%	057-102
2	Resistor, 3.3K ¼W 10%	057-332
2	Resistor, 560 ohm ¼W 10%	057-561
2	Potentiometer, 2K Bourns	016-037
2	Potentiometer, 10K Bourns	106-038
105"	#26 AWG Strand Wire	990-019

Part Number 300-301
SLOW ROLL BUTTON P.C. ASSEMBLY

Number Required	Description	Part Number
1	P.C. Board	010-222
1	Resistor, 4.7K ¼W 10%	057-472
1	Potentiometer, 5K Bourns 3339-1-502	106-049
1	Switch, Master Trainer	109-013
30"	#26 AWG Strand Wire	990-019

Part Number 300-386
DUAL RATE SWITCH P.C. ASSEMBLY

Number Required	Description	Part Number
1	P.C. Board	010-221
1	Resistor, 1K ¼W 10%	057-102
1	Resistor, 3.3K ¼W 10%	057-332
1	Resistor, 560 ohm ¼W 10%	057-561
1	Potentiometer, 2K Bourns	106-037
1	Potentiometer, 10K Bourns	106-038
60″	#26 AWG Strand Wire	990-019

Part Number 300-302
DUAL RATE SWITCH P.C. ASSEMBLY

Number Required	Description	Part Number
1	P.C. Board	010-222
1	Potentiometer, 100K Bourns 3339-1-104	106-047
1	Switch, Landing Gear	109-012
30″	#26 AWG Strand Wire	990-019