SERVICE MANUAL

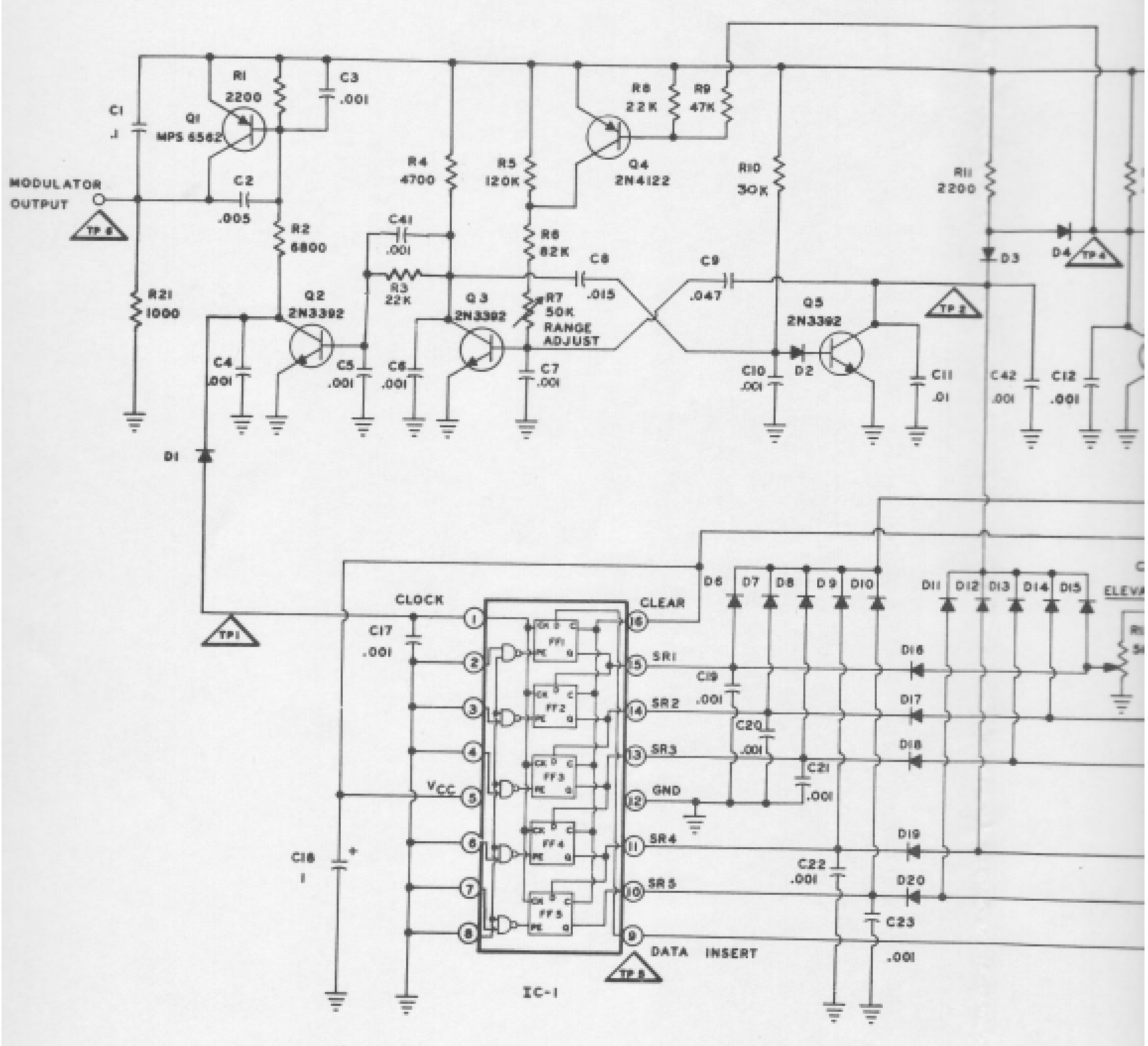
KRAFT
KP-5
Sport series

KRAFT SYSTEMS, INC. ®

450 WEST CALIFORNIA AVENUE
P.O. BOX 1268 · VISTA, CALIFORNIA 92083

World's Largest Manufacturer of Proportional R/C Equipment

5 CHANNEL ENCODER



ENCODER

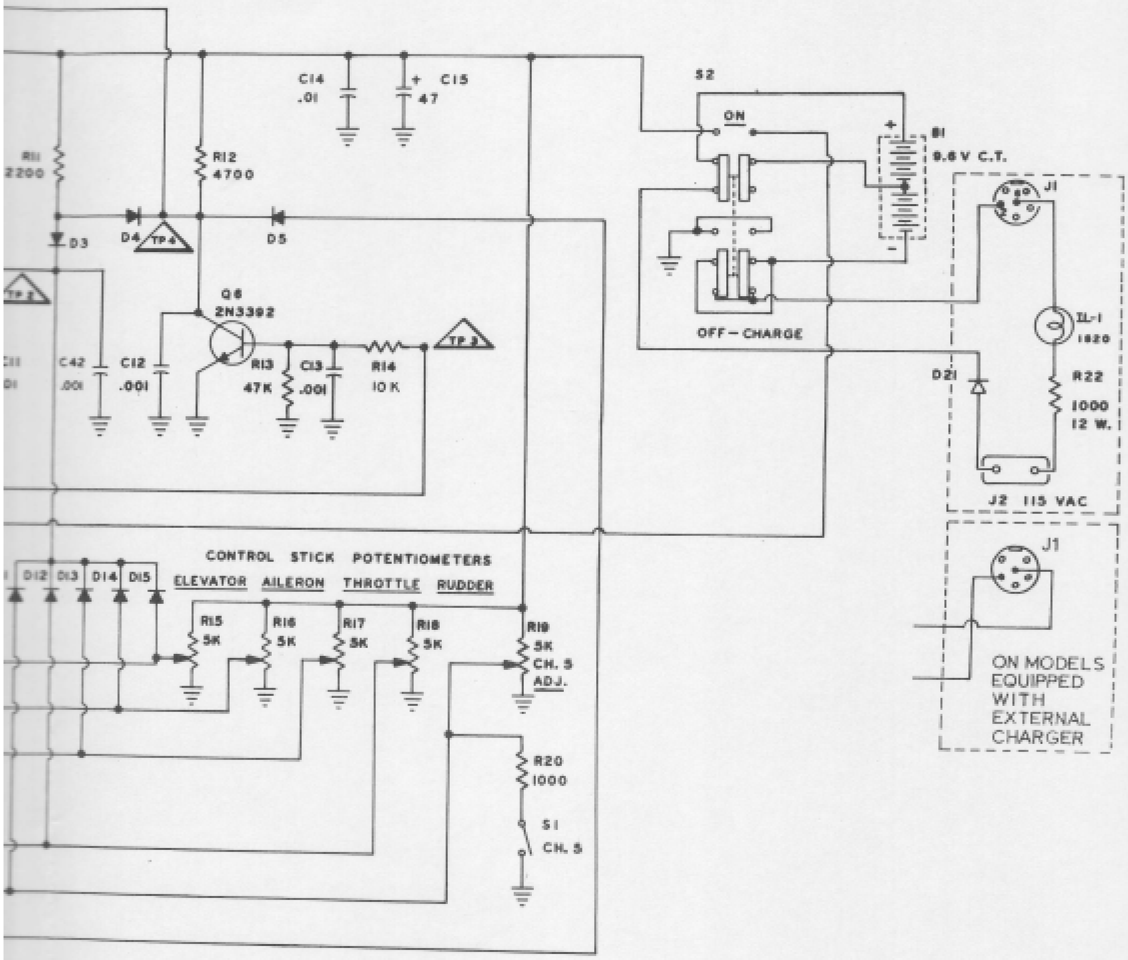


Figure 1

Designed as an economical, basic R/C system, the KP-5 was the first unit in the Kraft Sport Series line. The KP-5 is supplied in only one form, a two-stick Mode II transmitter. It was first supplied with KPS-11A servos (designated KPS-11A-S). In 1974, the KPS-15 servo was made available with the KP-5, and, in 1975, both the KPS-14 and the KPS-15. The KPS-11A-S is no longer supplied with the KP-5.

THEORY OF OPERATION – TRANSMITTER

(see Fig. 1)

Encoder-Modulator

The encoder consists of a clock generator (Q2-Q5), a data insert sync stage (Q6), and a five bit shift register (IC-1). The stages, combined with five control potentiometers generate five channels of control information and a sync period for locking the receiver decoder to the transmitted information.

Clock Generator

Transistor Q3-Q5 form an astable multivibrator providing clock pulses through Q2, which drive shift register IC-1. The "off" time of Q5 is determined mainly by C8 and R10. the "off" time of Q3 is determined mainly by C9, R5, R6, R7, and the state of transistor Q4, and by the D.C. voltage at the collector of Q5 (TP-2). The components determining Q5's "off" time are selected to provide a positive pulse at Q5's collector of 350-400 microseconds. This also appears as a negative going pulse at the collector of Q3. This pulse is inverted by Q2, and serves to drive the shift register, IC-1.

The "off" time of Q3 is determined in part by the voltage at Q5's collector. The voltage at this point is determined by the stage of each shift register output and the setting of the potentiometer wiper connected to it. At one point during each frame of information, this time is also determined by the state of transistors Q6 and Q4. To illustrate the action of the encoder, a typical frame of information will be described in detail below. Since the circuit is free-running, this information frame repeats itself continuously as long as power is applied.

The waveform at the collector of Q2 is shown below:

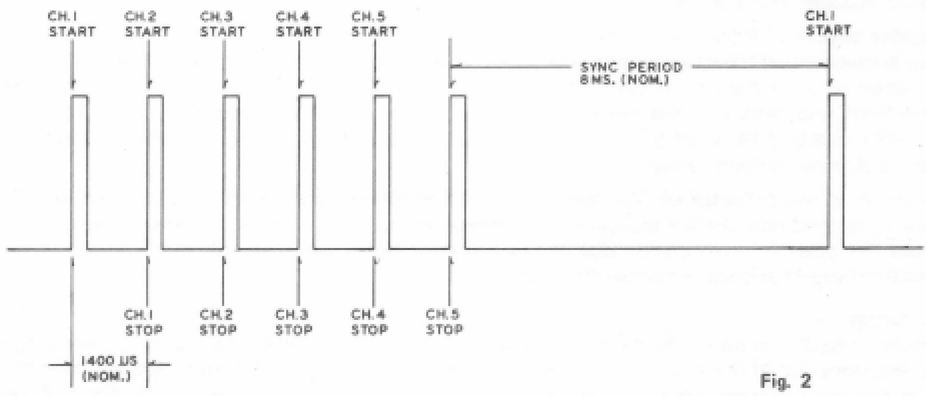


Fig. 2

The operation of the encoder will be described beginning just ahead of the point labeled "CH1 Start".

The state of the free-running multivibrator at this point is Q3 and Q4 off, and Q5 on. Shift register outputs SR1-SR5 are all low causing Q6 to be held off, its collector voltage at nearly supply voltage. The collector of Q6 is connected to pin 9 of IC-1, date input, through diode D5. This positive voltage at Q6 is applied to the data insert terminal, to insert "high" data into the first stage of the shift register as soon as a positive-going clock pulse appears at the clock input. This point is labeled CH1 start in Fig. 2. At this point, Q3 and and Q5 reverse states causing SR1 output of IC-1 to go "high" in response to the high data present at pin 9.

Fig. 1 *(fold-out at left)*

Q5 will be off for approximately 350 microseconds. During this time, the high output at SR1 of the shift register causes Q6 to turn on immediately through diode D6. Q6 will remain on as long as any shift register output remains high due to the diode "OR" gate of diodes D6-D10. The collector of Q6 is then decoupled from Q5's collector by diode D3, and the wiper of potentiometer R15 is now coupled to Q5's collector via diode D15. The data insert terminal of Ic-1 is now low due to the state of Q6, and "low" data will be clocked into the shift register following succeeding clock pulses.

Since the wiper of R15 is now connected to Q5's collector, capacitor C9 will charge to the voltage at the wiper, less the voltage drop due to diode D15.

When C8 has charged sufficiently to turn Q5 on, Q3 turns off for a time determined by the time constant of R6, R7, and C9, and the voltage at the wiper of R15. Since Q4 is now "ON" and saturated, R5 has no effect on the time constant at this point. The time Q3 remains off is nominally 1,400 microseconds, however, depending on the allowable set limits of R15, it may be anywhere between 900 and 1,800 microseconds.

After this half of the timing cycle, Q3 turns on, Q5 turns off and a clock pulse appears at pin 1 of the shift register. This causes the high data present at SR1 output to be transferred or "shifted" to SR2, and low data at pin 9 to be inserted into stage one, simultaneously appearing at output SR1. This effectively grounds the wiper of R15 and disconnects it from the collector of Q5.

The wiper of R16 is now connected to Q5's collector due to the "high" output present at shift register output SR2. Capacitor C9 now charges to this new voltage present at R16's wiper. The duration of the timing cycle with Q3 off is then dependent on the setting of this second potentiometer.

The action described above continues through all five stages of the shift register in the same manner as described above.

After the fifth timing interval, all shift register outputs are once again low. Q6 now turns off connecting R11 to the collector of Q5, and simultaneously turning Q4 off and inserting high data at pin 9 of IC-1 in preparation for the next information frame. C9 now must charge to the supply voltage through R11. Since Q4 has been turned off, R5 is now added to the resistance in the base of Q3, causing a longer "off" time for Q3 than would otherwise be the case. This generates a sync period approximately 8 milliseconds long, to clock the receiver decoder to the transmitter encoder.

The movable wipers of R15-R18 are mechanically linked to control sticks on the front panel of the transmitter to encode desired mechanical movements into pulse spacings, which when decoded in an appropriate receiver, drive servomechanisms to position mechanical elements of the device being controlled. The setting of R19 is fixed internally and this channel is operated by switch S1 located on the top of the transmitter. Resistor R20 shunts R19 when S1 is closed to cause the pulse timing in this channel to change between 900 and 1,800 microseconds when S1 is operated.

The waveform at the collector of Q2 contains the desired information for transmission, but is of the incorrect polarity to modulate the RF section of the transmitter. Q1 performs the necessary invert function, and also slopes the waveform sufficiently due to the action of Miller capacitor C2 enabling the information to be transmitted within allowable bandwidth constraints.

Encoder Setup

A particularly good feature of the KP-5 is the ease with which the encoder is set up. Only one range adjustment is necessary for all five channels. To ensure repeatability, wirewound control pots are used in the gimbals since wirewounds have inherently better linearity than carbon or cermet elements, although resolution is somewhat poorer.

To begin the setup procedure, set the oscilloscope to 1 volt/division vertical, 200 microseconds/division horizontal, positive trigger. Connect the scope "hot" lead to SR1 output (see Fig. 1 and Fig. 3). Turn the transmitter on, and observe the positive-going square wave pulse. The falling edge should be at the seventh horizontal division corresponding to 1,400 microseconds. Check all stick trim controls to see that they are centered. Operate the elevator control over its entire range less trim. The pulse at SR1 should vary from 4-¾ to 9-¼ horizontal divisions.

This represents 950 to 1850 microseconds. If the pulse is not at 1400 microseconds with the elevator at neu-

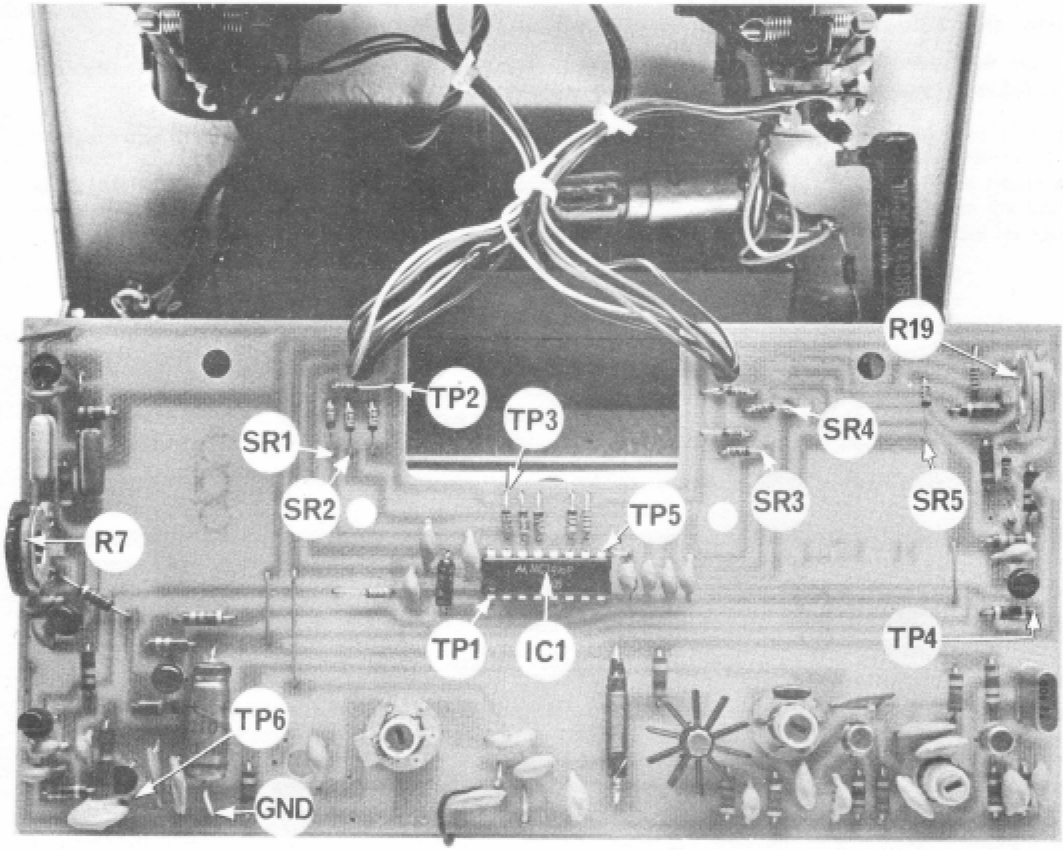


Fig. 3

tral, adjust the control pot housing tab on the elevator to obtain the correct pulse width. Check the range (less trim). It should be 950 to 1850 microseconds (±10 microseconds). If it is not within this range, adjust range pot R7. If total throw was too short, adjust R7 to make the pulse wider, readjust the control pot for correct neutral, and check range. If throw was too long, adjust R7 for a slightly shorter pulse, re-center the control pot, and check range. Go back and forth between centering and range adjustments until proper throw is obtained. **ONCE THE ELEVATOR CHANNEL IS SET, DO NOT MAKE FURTHER ADJUST- MENTS TO R7.**

Connect the oscilloscope to SR2 output. The pulse at this output with aileron stick at neutral should be 1400 microseconds. If it is not, adjust only the control pot housing tab on the stick. Check total throw to see that there is no severe nonlinearity, but do not adjust R7.

Connect the oscilloscope to SR3 output. Since the throttle channel is non-centering, simply check pulse width at the extremes of stick travel. Adjust the control pot tab if necessary to obtain proper pulse width (950 to 1850 microseconds).

Connect the oscilloscope to SR4 output. Set up exactly as SR2 above.

Connect the oscilloscope to SR5 output. Since this channel is switched, throw is set up at the extremes only. Adjust R19 to give proper travel as the switch is operated in both positions.

Set up is now complete. Check the sync period by connecting the oscilloscope to TP4. The positive portion of the waveform should be a minimum of 7 milliseconds. Check modulator pulse width at TP6. The negative pulses should measure between 350 and 425 microseconds. If either sync period or modulator pulse period are not within the above ranges, change the value of R5 to R10 respectively. Increase the resistor values to increase the pulse width or decrease the resistance to decrease pulse width.

NOTE: If the transmitter has been changed to a Mode I configuration, begin set up of the encoder with channel No. 2 (aileron) as you would channel No. 1. Then set up the first channel as described for throttle above.

Encoder Trouble-Shooting

The encoder circuitry is such that difficulties in one portion of the encoder usually cause failure of the entire encoder. Because of this, trouble-shooting can be difficult without a thorough understanding of the circuit operation. It is important to read and thoroughly understand the Theory of Operation section above.

Most field problems will consist of semiconductor failures. Other components, however, should not be overlooked.

The inter-dependent nature of the entire circuit makes a dual-trace oscilloscope very helpful in determining the nature and location of a fault. If your oscilloscope is not equipped with dual trace, an inexpensive accessory chopping dual-trace adapter such as the Heathkit ID-101 is a worthwhile addition.

Most of the waveforms in this section were photographed in dual-trace to provide a clearer reference for analysis of the specific problems covered.

Perhaps the most telling test point for trouble-shooting is the programming line-TP2 on the schematic. See Fig. 4 below for the normal waveform at this point. Notice there are four pulses of equal height (all controls at neutral) followed by two pulses which are higher in amplitude. The fifth pulse represents the landing gear channel. Depending upon the switch position, this pulse will be higher or lower in amplitude than the first four pulses. The sixth pulse is the sync channel and is of fixed amplitude. Below are several normal waveforms at various points in the circuit. All show the program line on the upper trace as a reference.

Fig. 5 shows channel 1 (SR1) below the program line. This pulse runs from the leading edge of the first program pulse to the leading edge of the second. All other "SR" outputs are alike but occur in sequence down the line.

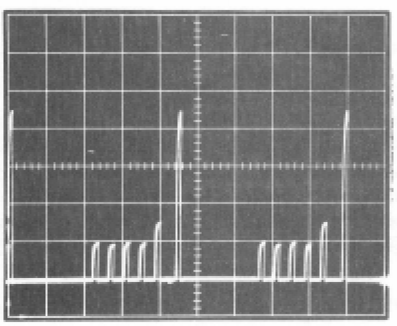


Fig. 4

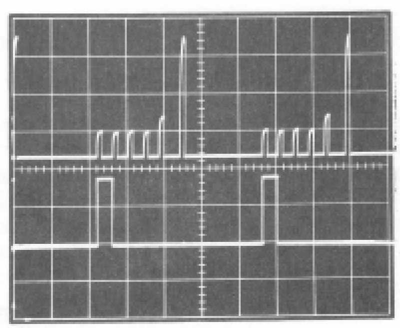


Fig. 5

Fig. 6 shows the collector waveform of Q6-TP4 in relation to the program line. The data insert for IC-1 is also derived from this point.

Fig. 7 shows the waveform at the base of Q3 above the waveform at TP4. Notice the large change in the slope of the recharge during the sync interval compared to the slope during channel information. This is due to the turn-off of transistor Q4 during sync, adding 120K to the timing resistance.

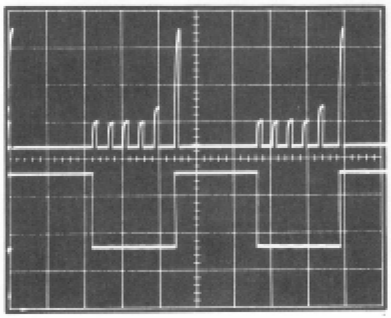


Fig. 6

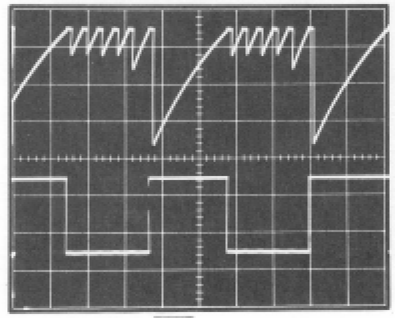


Fig. 7

Fig. 8 shows the clock waveform at the collector of Q2 below the program line.

Fig. 9 shows the waveform at the wiper of R18 (Rudder pot) below the program line. The height of the pulse varies with the position of the control stick. A simultaneous variation occurs on the fourth pulse in the program line waveform.

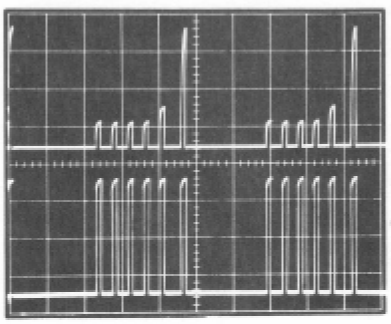


Fig. 8

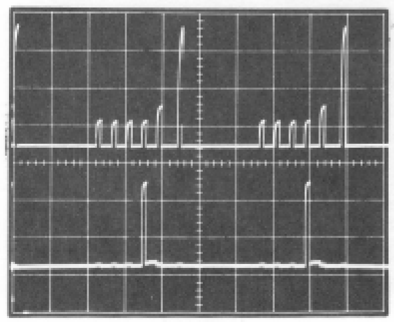


Fig. 9

Fig. 10 shows the waveform at the modulator output-TP6-below the program line. This waveform was taken with the RF Section operating. With the RF section disabled, the negative tips of the pulses will be much more rounded.

Below are a series of waveforms in which various diodes were open or reversed. Although this type of difficulty will rarely be found in the field, it can occur, and locating the defective part can be difficult. Waveforms when a diode is shorted are not included, since it is fairly easy to find the defective diode because the same waveform appears at both ends of the diode. All waveforms below show the program line on the upper trace.

Fig. 11 was the result of a reversed select diode (D19) in the rudder channel. The lower waveform appeared at the same place as the waveform in Fig. 9. By noting the one pulse which appears to be different, in this case the fourth, a clue can be found to the location of the fault.

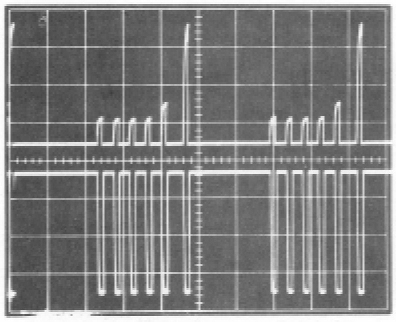


Fig. 10

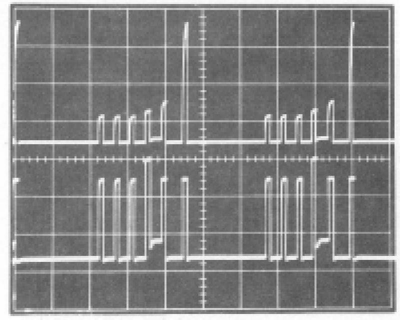


Fig. 11

Fig. 12 shows the result of D19 being open. In this case, the first three channels will not work normally, the fourth controls all channels and the fifth channel usually operates abnormally.

Fig. 13 was the result of program diode D12 being reversed. The severe pulse clipping on the program line is the result of the rudder channel holding all other outputs lower than normal. Here again, the channel location of the fault is obvious since the fourth pulse is different from all the others.

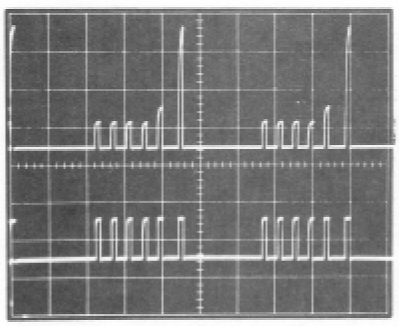


Fig. 12

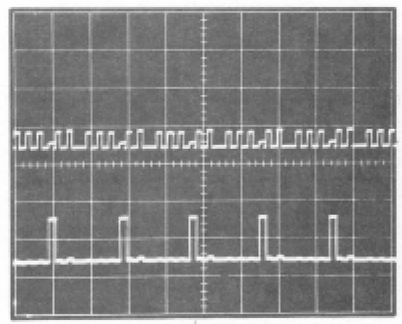


Fig. 13

Fig. 14 shows the effects of D12 being open. In this case, the rudder channel simply doesn't operate. All other channels work normally.

Fig. 15 shows the result when data insert diode D9 is open. The last two channels are inoperative. Although the sync period is unchanged, the frame rate has shortened by two channels. The lower waveform appears at TP3.

Fig. 16 shows the result of a reversed data insert diode D16. The lower trace is TP3, the common cathodes of the data insert diodes. The clue to the defective diode is to observe the register outputs SR1 through SR5. Only one output will have a rectangular pulse similar to the lower trace in this photograph. All other register outputs will have very large steps on their output signals. The one which appears almost as a simple rectangular pulse without large steps indicates the location of the reversed diode.

Other failure conditions in the encoder will generally be confined to IC failure, or the free-running multivibrator. IC defects are usually confined to failure to clock data into the register. In this case, the signal at TP6 (Modulator Output) will be a continuous stream of pulses. This is due to the free-running nature of the astable multivibrator which runs regardless of the state of the shift register IC. If no pulses are present at the collector of Q3, it should first be assumed that the problem lies in the free-running multivibrator.

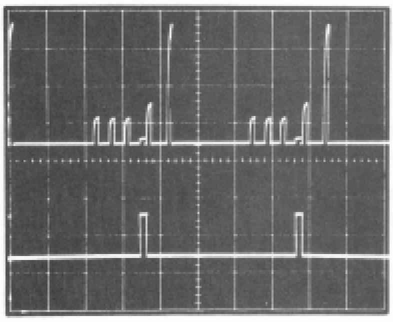


Fig. 14

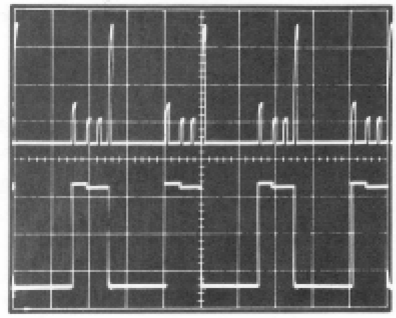


Fig. 15

RF Sections — Tuning and Adjustment

WARNING: It is unlawful for any person to tune or make any other adjustments to any 27 or 72 MHz transmitter which affects RF output unless that person is the holder of a valid 2nd class or higher radio telephone license issued by the Federal Communications Commission, and possesses the necessary equipment to ensure operation within frequency and bandwidth limits as specified in Part 95 of the Rules.

27 MHz (See Fig. 17)

The 27 MHz RF Section is a three stage type utilizing a 27 MHz oscillator, a buffer, and a final power amplifier. All tuning adjustments are slug-tuned coils, accessible from the rear of the P.C. Board. A ceramic bladed tuning tool is recommended to minimize inductance changes caused by metal in the adjustment tool. The use of a tuned diode wavetrap and oscilloscope are recommended as a tuning indicator, although a meter type wavetrap may be used.

Oscillator

With power switch off, rotate the slug in oscillator coil L1 clockwise several turns. Apply power and rotate the slug counterclockwise slowly until the oscillator starts. Continue CCW until the output **just begins** to fall off.

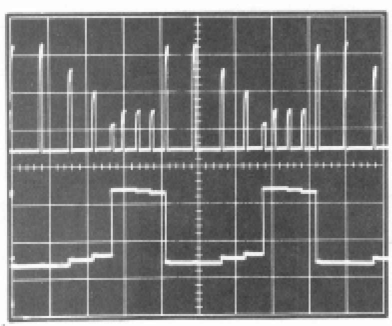


Fig. 16

Buffer

Adjust buffer tuning coil L2 for maximum output then adjust the tuning **very slightly** capacitive (CW) for optimum stability.

Fig. 17 *(folds out from next page)* ⟶

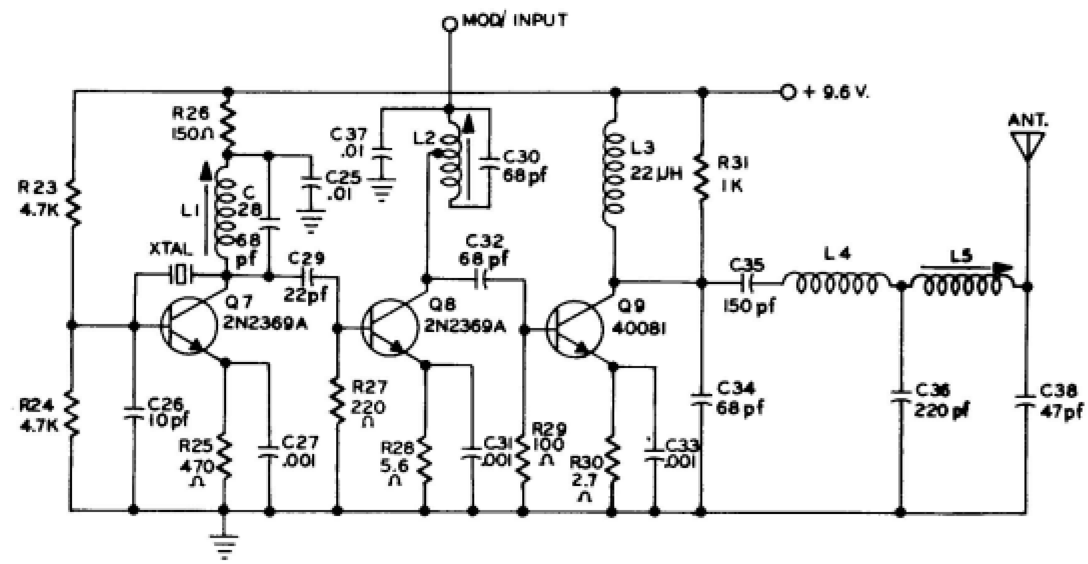
Final
Adjust final tuning coil L5 for maximum output indication.

Re-check tuning of all adjustments beginning with the oscillator to make certain all tuning coils are in correct alignment as outlined above. Check output frequency with modulation removed to be sure frequency is within .005% of nominal.

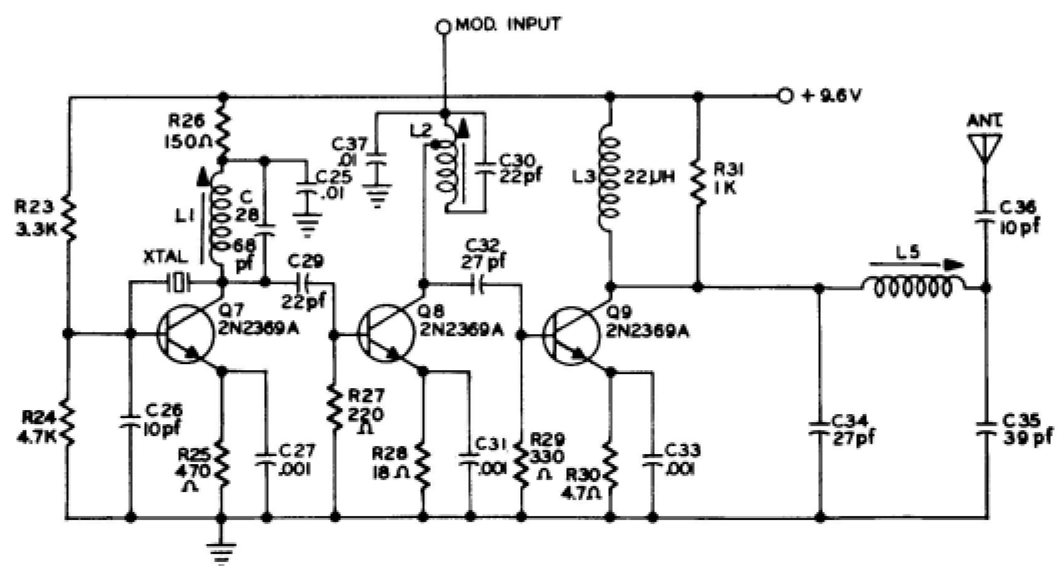
72 MHz
The 72 MHz RF section is a three stage circuit using a 36 MHz oscillator, buffer-doubler, and final power amplifier. A tuned wavetrap and oscilloscope should be used to indicate output.

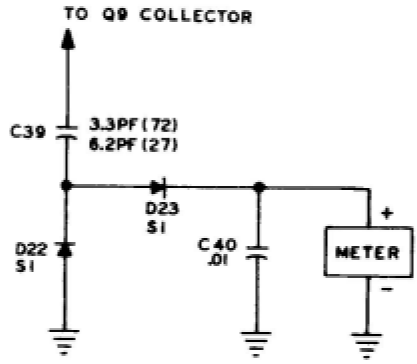
Tuning procedure is identical to the 27 MHz unit with the exception of the buffer tuning. The buffer tuning should be set at the peak point to minimize 36 MHz output.

27 MHZ.— TX— R.F. SECTION



72 MHZ.— TX— R.F. SECTION





METER CIRCUIT

Figure 17

PARTS LIST – ENCODER MODULATOR

RESISTORS – all values in ohms (K=1,000)

					Part No.
R1	2.2K	1/4W	10%		057-222
R2	6.8K	1/4W	10%		057-682
R3	22K	1/4W	10%		057-223
R4	4.7K	1/4W	10%		057-472
R5	120K	1/4W	10%		057-124
R6	82K	1/4W	10%		057-823
R7	50K	1/2W	10%	variable trimpot	106-018
R8	22K	1/4W	10%		057-223
R9	47K	1/4W	10%		057-473
R10	47K (May be 30K)	1/4W	10% (5%)		057-473 (055-303)
R11	2.2K	1/4W	10%		057-222
R12	4.7K	1/4W	10%		057-472
R13	47K	1/4W	10%		057-473
R14	22K (May be 10K)	1/4W	10%		057-223 (057-103)
R15*	5K	1/2W	10%	W. W. Variable	106-006
R16*	5K	1/2W	10%	W. W. Variable	106-006
R17**	5K	1/2W	10%	W. W. Variable	106-006
R18**	5K	1/2W	10%	W. W. Variable	106-006
R19	5K	1/2W	10%	variable trimpot	106-020
R20	1K	1/4W	10%		057-102
R21	1K	1/4W	10%		057-102
R22***	1K	12W	5%		073-102

* Part of Gimbal Assembly No. 900-012 (see mechanical parts list)
Part of Gimbal Assembly No. 900-013 (see mechanical parts list)
*** Units with internal charger only

PARTS LIST – ENCODER MODULATOR – continued

CAPACITORS – all values in uf.

				Part No.
C1	.1	200v	Mylar	115-018
C2	.005	100v	Disc Ceramic	113-015
C3	.001	100v	Disc Ceramic	113-012
C4	.001	100v	Disc Ceramic	113-012
C5	.001	100v	Disc Ceramic	113-012
C6	.001	100v	Disc Ceramic	113-012
C7	.001	100v	Disc. Ceramic	113-012
C8	.015	100v	Mylar	115-003
C9	.047	100v	Mylar	115-009
C10	.001	100v	Disc Ceramic	113-012
C11	.01	50v	Disc Ceramic	113-016
C12	.001	100v	Disc Ceramic	113-012
C13	.001	100v	Disc Ceramic	113-012
C14	.01	100v	Disc Ceramic	113-016
C15	47	16v	Electrolytic	116-008
C16*	.001	100v	Disc Ceramic	113-012
C17	.001	100v	Disc. Ceramic	113-012
C18	1.0	35v	Tantalum	116-002
C19	.001	100v	Disc Ceramic	113-012
C20	.001	100v	Disc Ceramic	113-012
C21	.001	100v	Disc Ceramic	113-012
C22	.001	100v	Disc Ceramic	113-012
C23	.001	100v	Disc Ceramic	113-012
C24	NOT USED			
C25-C40 – see RF Section PARTS LIST				
C41	.001	100v	Disc Ceramic	113-012
C42	.001	100v	Disc Ceramic	113-012

SEMICONDUCTORS

D1-D20	Diode, Silicon	IN4148 or equiv.	100-101
D21**	Diode, Silicon Rectifier	IN4004 or equiv.	100-100

* Deleted after July '74 **Units with internal charger only

PARTS LIST – ENCODER MODULATOR – continued

IC1	Integrated Circuit		110-103
Q1	Transistor, PNP	MPS-6562	101-012
Q2	Transistor, NPN	2N3392	101-004
Q3	Transistor, NPN	2N3392	101-004
Q4	Transistor, PNP	2N4122	101-005
Q5	Transistor, NPN	2N3392	101-004
Q6	Transistor, NPN	2N3392	101-004
MISCELLANEOUS			
B1	Battery, 8-cell 550 MAH 9.6v c.t.		KB8-5
IL1*	Lamp, Indicator No. 1820		400-003
J1	Receptacle, 6 pin chassis		120-004
J2 *	Receptacle, 2 pin interlock		120-007
S1	Switch, S. P. D. T. Toggle		109-012
S2	Switch, 4P. D. T. Slide		109-007
METER	Milliammeter, O-1 MA		126-001
– –*	Charge Cord, 117 VAC to Transmitter		200-000
– –*	Umbilical Cord, Transmitter to Receiver Battery		200-031
– –*	Set of Charge Cords – one each of above		200-032

ELECTRONIC SUB–ASSEMBLIES

27 MHz	P. C. Assembly Complete	300-204
72 MHz	P. C. Assembly Complete	300-205

*Units with internal charger only

MECHANICAL PARTS		No. Required	
Antenna, 6-1/2"		1	200-057
Case, Transmitter KPT-5		1	904-117
Gimbal, 2-Axis R. H.		1	900-012
Gimbal, 2-Axis L. H.		1	900-013
Antenna Post		1	901-193
Switch Guard, on-off switch		1	901-194
Jewel, Red indicator *		1	901-156
Rubber Foot		8	500-005-1
Socket, Bayonet Lamp *		1	500-050
Solder Lug No. 4 *		1	500-014-1
Logo, Transmitter "Sport Series"		1	600-049
HARDWARE — All supplied in packages of 20 each			
No. 4 x 1/4"	Sheet Metal Screw	1	500-013
4-40 x 1"	P.H. Slotted Machine Screw (Battery Box Mounting)	2	500-043
4-40 x 1/4"	P.H. Slotted Machine Screw (J1-J2 Mounting	4	500-044
4-40	Hex Nut, for above	4	500-045
3-48 x 1/4"	F.H. Phillips Machine Screw (S2 Mounting)	2	500-048
2-56 x 5/16"	F.H. Phillips Machine Screw (Gimbal Mounting)	8	500-053
No. 2 x 1/4"	P.H. Slotted Sheet Metal Screw (P.C. Mounting Board)	4	500-055
.250" x .100"	Fiber Washer (P.C.Board Mounting)	4	500-041
No.2 x 1/4"	P.H. Slotted Sheet Metal Screw (Tx Case back to front)	4	500-007

*Units with internal charger only

PARTS LIST RF SECTIONS

RESISTORS – all values in ohms (K=1,000)

		27 MHz		Part No.
R23	4.7K	1/4W	10%	057-472
R24	4.7K	1/4W	10%	057-472
R25	470	1/4W	10%	057-471
R26	150	1/4W	10%	057-151
R27	220	1/4W	10%	057-221
R28	5.6	1/4W	10%	056-056
R29	100	1/4W	10%	057-101
R30	2.7	1/4W	10%	056-027
R31	1K	1/4W	10%	057-102
		72 MHz		
R23	3.3K	1/4W	10%	057-332
R24	4.7K	1/4W	10%	057-472
R25	470	1/4W	10%	057-471
R26	150	1/4W	10%	057-151
R27	220	1/4W	10%	057-221
R28	18	1/4W	10%	057-180
R29	330	1/4W	10%	057-331
R30	4.7	1/4W	10%	056-047
R31	1K	1/4W	10%	057-102

CAPACITORS – all disc ceramic unless noted.

		27 MHz		Part No.
C25	.Oluf	50v		113-016
C26	10pf	100v	NPO	113-004
C27	.001uf	100v		113-012
C28	68pf	100v	N470	113-009
C29	22pf	100v	NPO	113-006
C30	68pf	100v	N470	113-009
C31	.001uf	100v		113-012
C32	68pf	100v	N470	113-009

CAPACITORS — continued

C33	.001uf	100v		113-012
C34	68pf	100v	N470	113-009
C35	150pf	100v	N750	113-010
C36	220pf	100v	N750	113-036
C37	.01uf	50v		113-016
C38	47pf	100v	N470	113-034
C39	6.2pf	100v	NPO	113-032
C40	.01uf	50v		113-016

72MHz

C25	.01uf	50v		113-016
C26	10pf	100v	NPO	113-004
C27	.001uf	100v		113-012
C28	68pf	100v	N470	113-009
C29	22pf	100v	Silver Mica	117-005
C30	22pf	100v	Silver Mica	117-005
C31	.001uf	100v		113-012
C32	27pf	100v	N470	113-007
C33	.001uf	100v		113-012
C34	27pf	100v	N470	113-012
C35	39pf	100v	N470	113-007
C36	10pf	100v	NPO	113-004
C37	.01uf	50v		113-016
C38	NOT USED			
C39	3.3pf	100v	NPO	113-003
C40	.01uf	50v		113-016

SEMICONDUCTORS

D22-23	Diode, Silicon	IN4148	100-101
Q7 & Q8	Transistor, 2N2369A		101-006
Q9	Transistor, 2N2369A (72 MHz)		101-006
	RCA 40081 (27 MHz)		101-015

COILS & CHOKES

	27 MHz	Part No.
L1	Coil, Oscillator Tuning	103-047
L2	Coil, Buffer Tuning	103-048
L3	Choke, 22uh	103-022
L4	Coil, Final Tuning	103-049
L5	Coil, Loading	103-047
	72 MHz	
L1	Coil, Oscillator Tuning	103-050
L2	Coil, Buffer Tuning	103-052
L3	Choke, 22uh	103-022
L4	NOT USED	
L5	Coil, Final Tuning	103-050

MISCELLANEOUS

XTAL	Order by Frequency Desired	
Heat Sink	To-18 for 2N2369A	904-050
	To-5 for RCA40081	904-087

RECEIVER

The Sport Series receiver can be either of two types: the KPR-5 which is built on a single PC board, or the KPR-5B which is built on two boards. One contains the receiver portion and the other contains the decoder portion.

The section that follows immediately, RECEIVER ALIGNMENT and TESTING, applies to both receiver models. Their logic circuits, however, are different. Each is explained separately below.

RECEIVER ALIGNMENT and TESTING

FRONT END SECTION (Figs. 18 and 37)

Transistors Q1 through Q5 form a conventional superhetrodyne receiver. Q1 is used as a mixer in conjunction with Q2, the local oscillator. The IF output frequency of 455 KHz is tuned by IFT-501. Q3 and Q4 operate as tuned IF amplifiers at 455 KHz.

Transistor Q5 operates as a class B detector and also supplies AGC to the IF amplifiers. Diode D2 in conjunction with bias resistors R12 and R13 acts as a high level clipper to pass only the upper .7 volt of the detected waveform and feed it to the logic stage.

Under most conditions an interfering signal must reach 60-80% of the command signal in order for it to interfere with reception. Consequently, this network is highly effective in eliminating interference from noise or other transmitted signals. However, if the clipping level is less than 0.7v, the receiver will be very sensitive to slight phase shifts.

ALIGNMENT and TESTING

With the proper crystal installed in the receiver board and secured with RTV silicon rubber, alignment can be performed. A DC oscilloscope is necessary for best results.

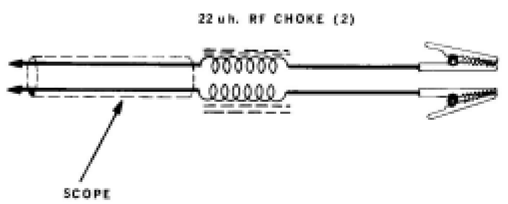


Fig. 20

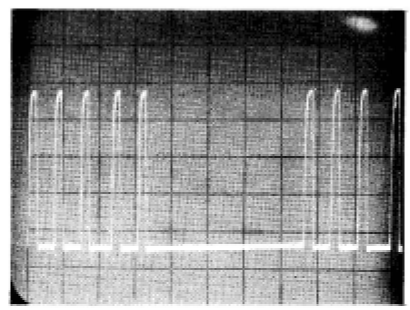


Fig. 21

Attach the scope signal lead (isolated by RF chokes Fig. 20) to the top of R16, the class B detector. With a strong signal from the transmitter, observe the waveform on the oscilloscope. If the receiver IF stages and oscillator are operating, either the waveform shown in Fig. 21 or Fig. 22 should be seen.

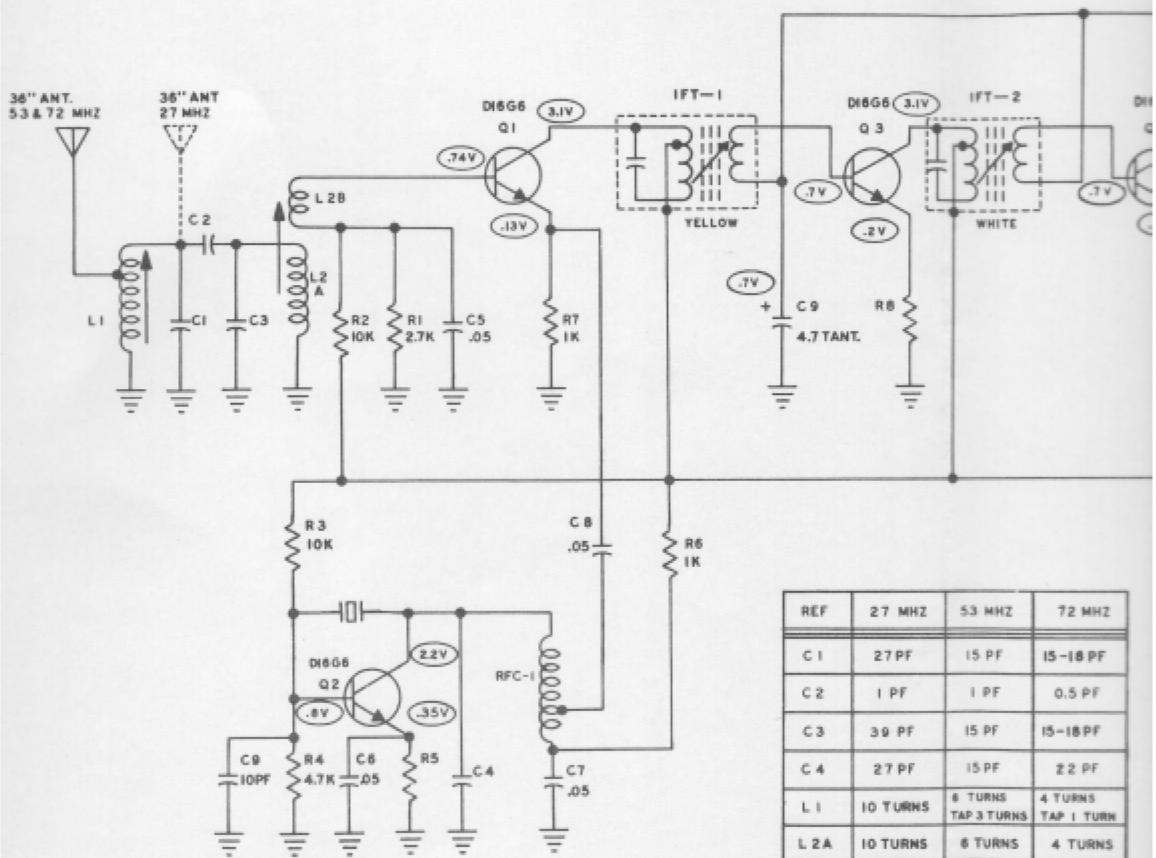
If the waveform is similar to Fig. 21, reduce signal strength and begin aligning IF transformer IFT501 through IFT503. Rotate the tuning slug in each IF transformer to maximum detected signal.

Fig. 22 shows the signal at the detector when the IF transformers are not properly aligned.

Should no signal be obtained at the detector, check the collector of transistor Q4 with a strong signal for a waveform similar to Fig. 23. If it cannot be obtained, trace toward the mixer until the collector of Q1 is reached. If no signal can be obtained here, suspect either a defective crystal or mixer transistor.

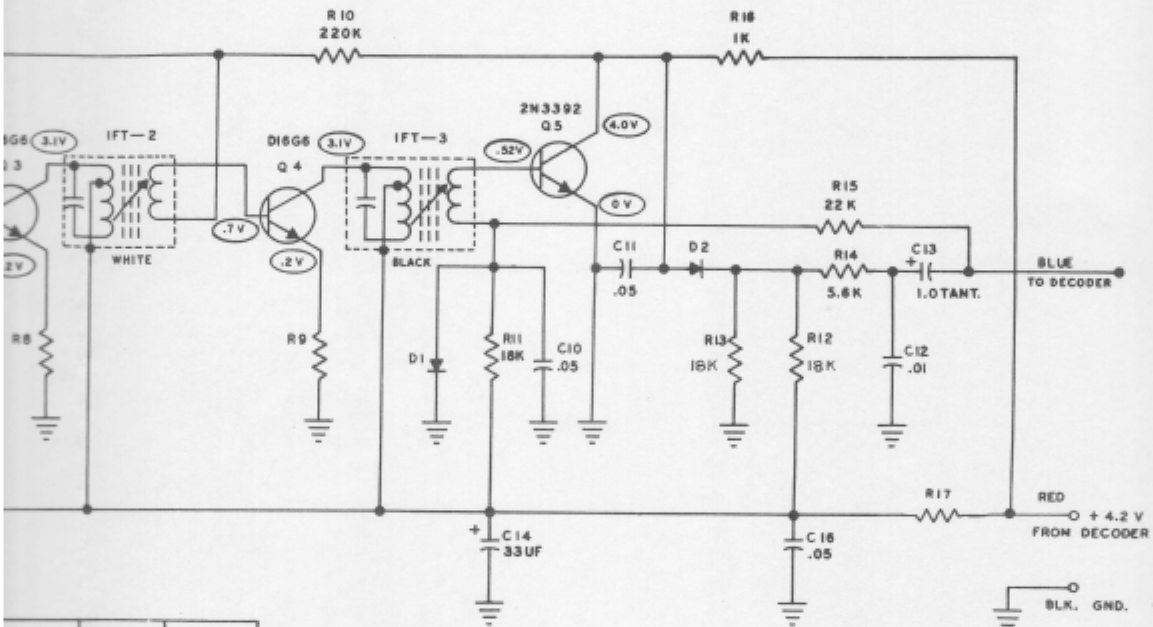
If neither component restores operation, check voltages in the mixer and oscillator circuits to locate the faulty stage.

RECEIVER — FRONT— END



REF	27 MHZ	53 MHZ	72 MHZ
C 1	27 PF	15 PF	15-18 PF
C 2	1 PF	1 PF	0.5 PF
C 3	39 PF	15 PF	15-18 PF
C 4	27 PF	15 PF	22 PF
L 1	10 TURNS	6 TURNS TAP 3 TURNS	4 TURNS TAP 1 TURN
L 2A	10 TURNS	6 TURNS	4 TURNS
L 2B	2 TURNS	1 TURN	1 TURN
R 8,9	270 OHMS	270 OHMS	220 OHMS
R 5	470 OHMS	470 OHMS	270 OHMS

ER — FRONT — END

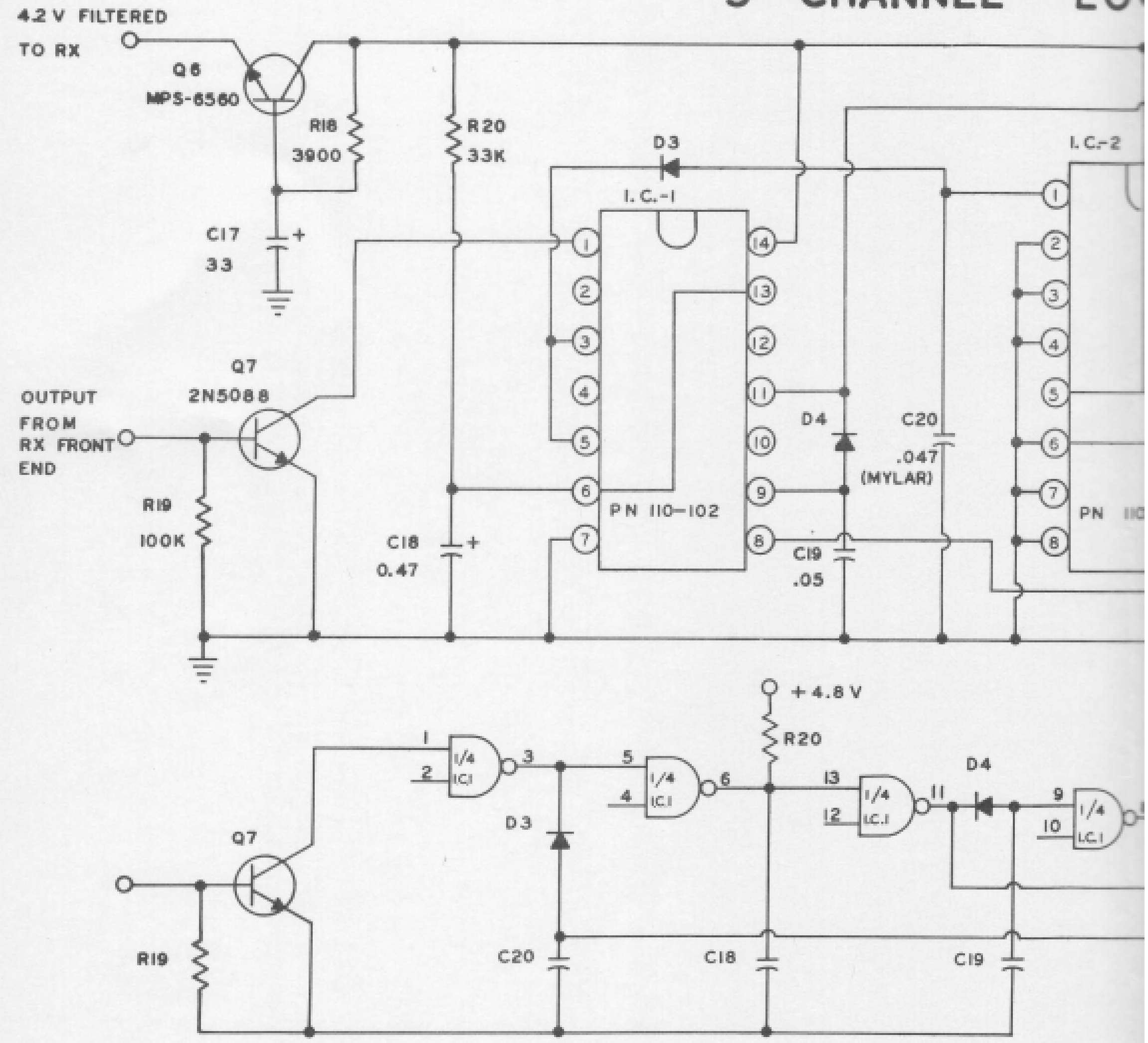


27 MHZ	53 MHZ	72 MHZ
27PF	15 PF	15-18 PF
1 PF	1 PF	0.5 PF
39 PF	15 PF	15-18 PF
27 PF	15 PF	22 PF
0 TURNS	6 TURNS TAP 3 TURNS	4 TURNS TAP 1 TURN
0 TURNS	6 TURNS	4 TURNS
TURNS	1 TURN	1 TURN
70 OHMS	270 OHMS	220 OHMS
70 OHMS	470 OHMS	270 OHMS

NOTES
1. ALL RESISTORS 1/4W. 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.
5. C15 IS LOCATED ON DECODER ON 2 CHANNEL UNITS.

Figure 18 (KPR-5B)

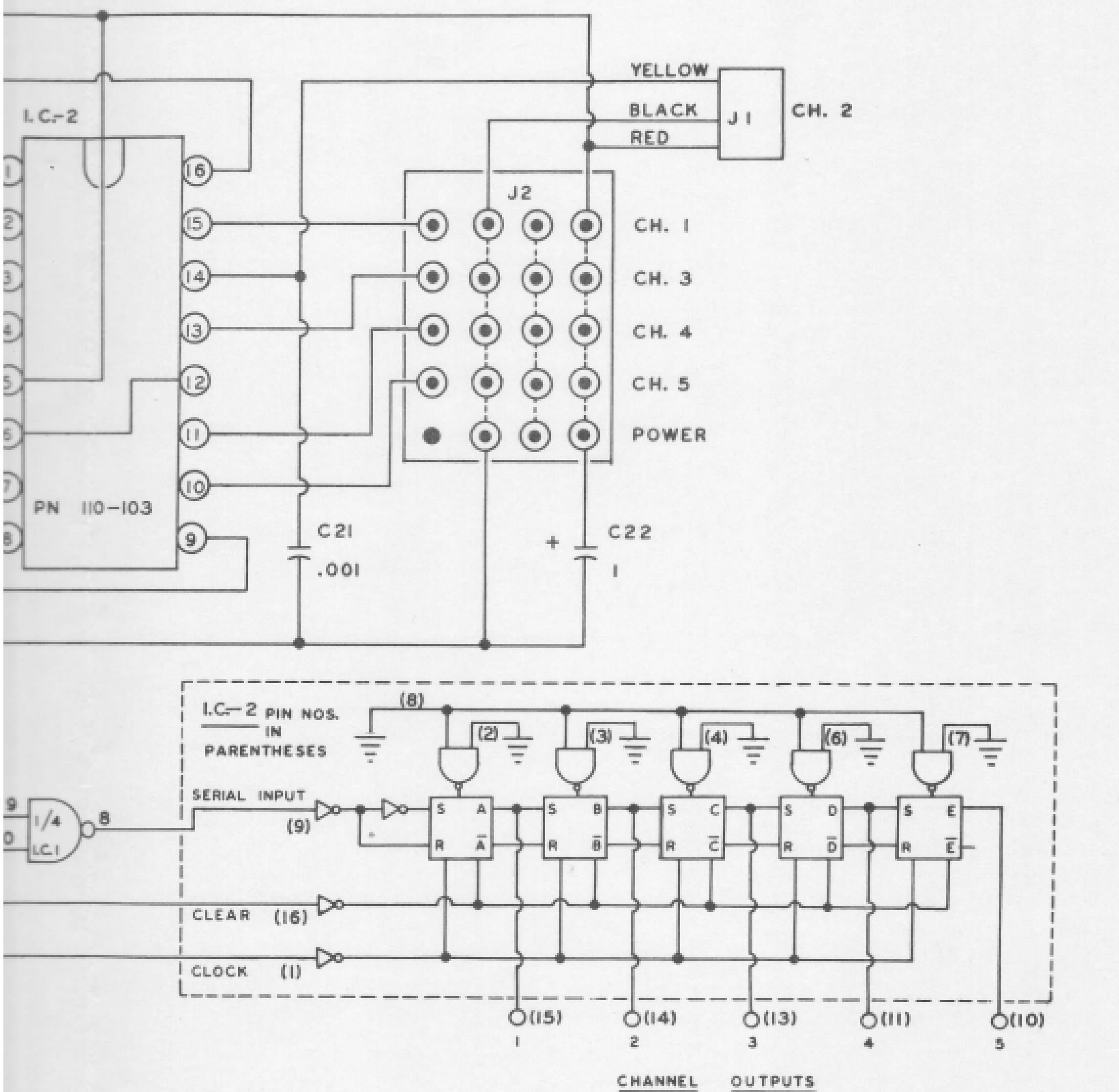
5 CHANNEL LO



Flow Diagram

Figure 19

LOGIC - KPR-5



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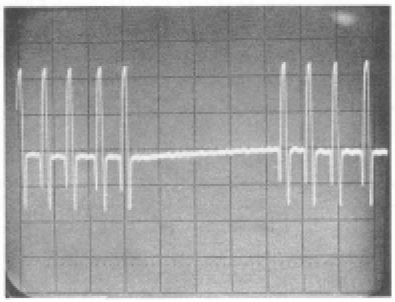


Fig. 22

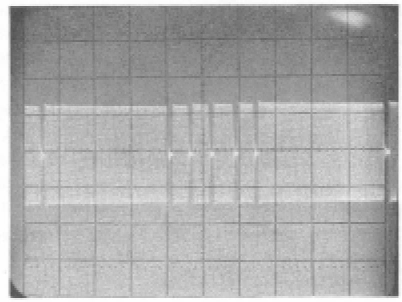


Fig. 23

With the IF transformers aligned, the mixer and antenna coils can be tuned. Insert a hex alignment tool in one slug and tune for maximum detected signal. Then move to the other slug and tune it for maximum also. Be sure the antenna wire is fully extended and trailing from the bench. When tuning is complete, seal RF coil cores with wax.

If a calibrated signal generator is available, the receiver sensitivity should be checked prior to final tuning. Couple into the receiver antenna coil through a two-turn loop on the generator output cable. (Fig. 24)

Coil up the receiver antenna and adjust the generator for 400 Hz modulation. Reduce the output sufficiently to see the peak of the modulating waveform clearly.

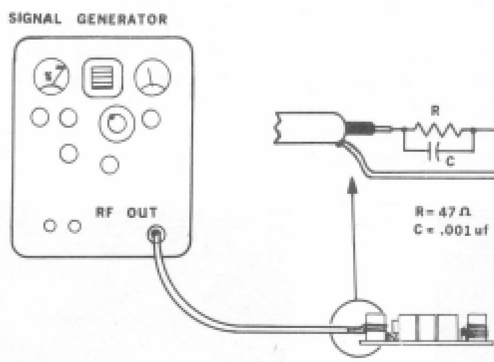


Fig. 24

Peak L1 and L2 for maximum if necessary. Reduce the generator output until the detected signal is 0.5v in amplitude. The signal generator should read a maximum of 3.5uV. A reading under 2.0uV may show possible receiver instability. Under no circumstances should receiver sensitivity measure less than 1.0uV on any frequency. If it was necessary to change the setting of L1 or L2, retune as above with antenna extended before sealing.

If adjustment of receiver sensitivity is necessary to bring the receiver within tolerance, it is best to raise or lower IF emitter resistors R8 or R9. Lowering the value will increase sensitivity and vice-versa. These resistors should be no lower than 82 ohms nor no greater than 330 ohms. If it is necessary to exceed these limits, investigate further in that most likely the receiver has a defective or low gain mixer or IF amplifier transistor.

If sensitivity checks are satisfactory, check clipper level. The upper 0.7V 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. 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 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 R11 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 stages are correct and the clipped signal observed at the cathode of diode D502 is still less than 0.7V, check to be sure that resistor R12 is 15K. Then, if necessary, reduce R13 from 22K to 18K. If the clipped signal is still not within tolerance, replace diode D2.

RECEIVER-DECODER (KPR-5)

The logic circuitry consists of a transistor amplifier Q7, IC pulse shaper IC1, and IC shift register-decoder IC2. The amplifier receives the output of the clipper, amplifies and inverts the signal, suitable for driving IC1. Refer to the flow diagram in Fig. 19. The first stage of IC1 squares and inverts its input signal to make the pulse train suitable for driving the clock input of IC2 (Fig. 25). Capacitor C20 slows the rate of clock pulse rise to permit proper register operation. Diode D3 couples the clock line of IC2 (see Fig. 26) to ground through IC1 when pin 3 is low. When pin 3 is high, D3 decouples IC2's clock line to prevent loadingof the following stage (pin 5) by IC1. This stage inverts the clock signal and serves as the first stage of a pulse omission detector to provide reset and data insert for IC2 (see Fig. 27). The third stage of IC1 provides a reset or "clear" signal to IC2 prior to the first clock pulse. Fig. 28 shows the input to the third stage of IC1 on the upper trace, while the lower trace shows the output of this stage. To operate IC2 correctly, the clear input must be high at the leading edge of the first clock pulse. Capacitor C20 slows the clock pulse rise to permit the clear line to return high prior to clocking. Fig. 29 shows this more explicitly. Here a mixed speed sweep shows the time relationship between clock and clear. The upper trace is the clock line, lower trace is reset.The last four clock pulses in one frame are visible on the left at approximately 4 milliseconds per CM sweep speed. Just past the fourth horizontal division, the horizontal sweep speed is increased to approximately 50 microseconds per division. The reset signal on the lower trace was low (clearing) during most of the sync period. At 5.6 horizontal divisions on the photograph, it switches high. IC2 does not clock until the top of the clock pulses approximately 6 horizontal divisions. Therefore, it is apparent that the clock pulse does not clock IC2 until 20 microseconds beyond the point where clear goes "high".

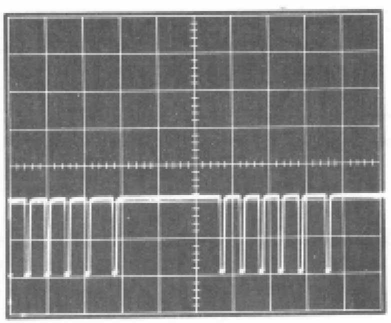


Fig. 25

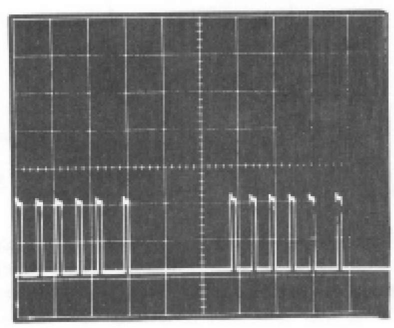


Fig. 26

The last stage of IC1 provides "data insert" for IC2. This enters "high" data into register one at the first clock pulse in a new frame. Since "data insert" is derived from the "clear" signal, and "data insert" must be present after the clock has gone "high", it is necessary to delay data insert beyond the leading edge of the clock pulse. Fig. 30 shows the clock waveform (upper trace) and the data insert signal to IC1 (lower trace).

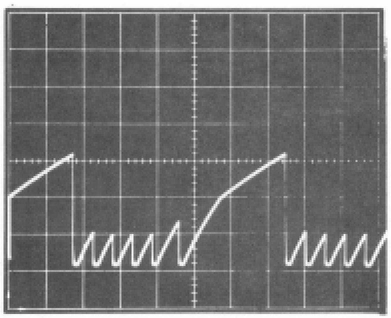


Fig. 27

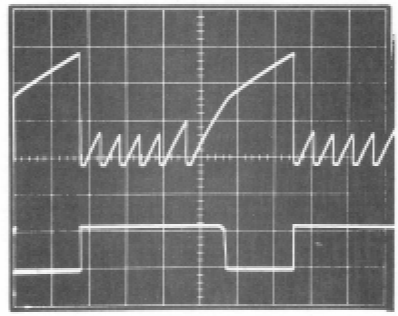


Fig. 28

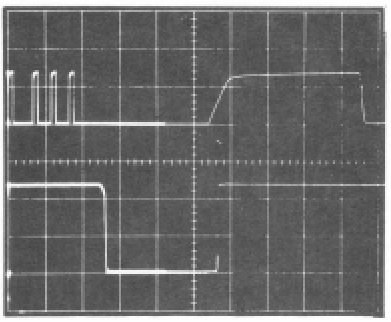


Fig. 29

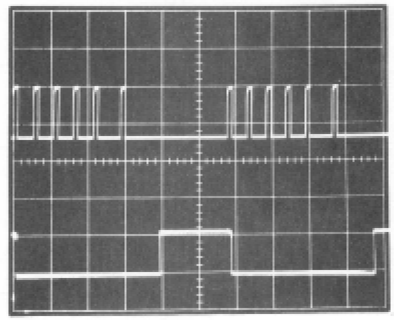


Fig. 30

The diode and capacitor, D4 and C19, provide the necessary delay. Fig. 31 again makes use of mixed sweep to show the time relationship between clock and data insert. The small pulse on the upper level of data insert shows where the clocking occurs. Data insert returns low about two-thirds into clock high period.

The above relationship must occur in proper sequence in order for IC2 to function properly. Figures 32 and 33 show the outputs of channels one and four, respectively, in relation to the clock pulses (upper trace).

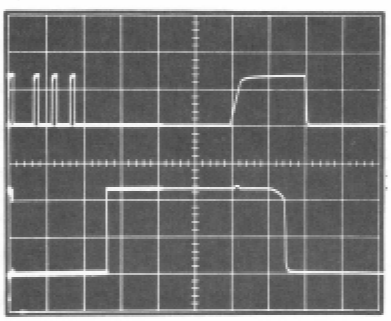


Fig. 31

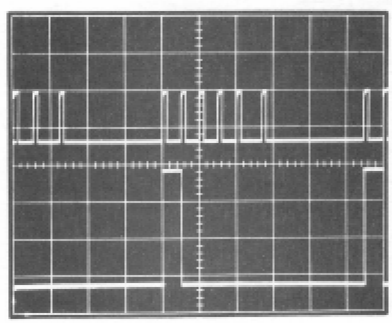


Fig. 32

PARTS LIST – RECEIVER FRONT END (KPR-5; KPR-5B)

				Part No.
R1	2.7K	1/4W	10%	057-272
R2	10K	1/4W	10%	057-103
R3	10K	1/4W	10%	057-103
R4	4.7K	1/4W	10%	057-472
R5	470 (27 MHz)	1/4W	10%	057-471
	270 (72 MHz)	1/4W	10%	057-271
R6	1K	1/4W	10%	057-102
R7	1K	1/4W	10%	057-102
R8	100-220	1/4W	10%	
R9	100-220	1/4W	10%	
R10	220K	1/4W	10%	057-224
R11	18K	1/4W	10%	057-183
R12	15K (May be 18K)	1/4W	10%	057-153 (057-183)
R13	22K (May be 18K)	1/4W	10%	057-223 (057-183)
R14	5.6K	1/4W	10%	057-562
R15	22K	1/4W	10%	057-223
R16	1K	1/4W	10%	057-102
R17	47 ohm (72 MHz)	1/4W	10%	057-470
R17	NOT USED ON 27 MHz UNITS			

CAPACITORS

C1	27pf	(27 MHz)	100v	Disc Ceramic	113-007
	15pf	(72 MHz)	100v	Disc Ceramic	113-005
C2	1.0pf	(27 MHz)	100v	Tubular Ceramic	114-002
	0.5pf	(72 MHz)	100v	Tubular Ceramic	114-001
C3	39pf	(27 MHz)	100v	Disc Ceramic	113-041
	15pf	(72 MHz)	100v	Disc Ceramic	113-005
C4	27pf	(27 MHz)	100v	Disc Ceramic	113-007
	22pf	(72 MHz)	100v	Disc Ceramic	113-006
C5	.05uf		10v	Disc Ceramic	113-018

C6	.001uf	100v	Disc Ceramic	113-012
C7	.05uf	10v	Disc Ceramic	113-018
C8	.05uf	10v	Disc Ceramic	113-018
C9	4.7uf	6v	Tantalum	116-004
C10	.05uf	10v	Disc Ceramic	113-018
C11	.05uf	10v	Disc Ceramic	113-018
C12	.01uf	50v	Disc Ceramic	113-016
C13	1.0uf	35v	Tantalum	116-002
C14	33uf	6v	Tantalum	116-005
C15	NOT USED			
C16	.05	10v	Disc Ceramic	113-015

COILS AND TRANSFORMERS

L1	Antenna Coil, 27 MHz		103-016
	Antenna Coil, 72 MHz		103-020
L2	Mixer Coil, 27 MHz		103-017
	Mixer Coil, 72 MHz		103-021
IFT1	Transformer, Input I. F.		103-013
IFT2	Transformer, Intermediate I. F.		103-014
IFT3	Transformer, Output		103-015
RFC1	Choke, Oscillator-tapped		103-023

SEMICONDUCTORS

D1, D2	Diode, Silicon	IN4148	100-101
Q1	Transistor, Silicon	D16G6	101-008
Q2	Transistor, Silicon	D16G6	101-008
Q3	Transistor, Silicon	D16G6	101-008
Q4	Transistor, Silicon	D16G6	101-008
Q5	Transistor, Silicon	2N3392	101-004

PARTS LIST – 5 CHANNEL LOGIC (KPR-5)

RESISTORS – all values in ohms (K=1,000)

R18	3.9K	1/4W	10%	057-392
R19	100K	1/4W	10%	057-104
R20	33K	1/4W	10%	057-333

CAPACITORS

C17	33uf	6v	Tantalum	116-005
C18	0.47uf	35v	Tantalum	116-011
C19	.05uf	10v	Disc Ceramic	113-018
C20	.047uf	100v	Mylar	115-009
C21	.001uf	100v	Disc Ceramic	113-012
C22	1.0uf	35v	Tantalum	116-002

SEMICONDUCTORS

D3, D4	Diode, Silicon	1N4148	100-101
IC1	Integrated Circuit, Gate		110-102
IC2	Integrated Circuit, Register		110-103
Q6	Transistor, Silicon NPN MPS-6560		101-013
Q7	Transistor, Silicon NPN 2N5088		101-014

MISCELLANEOUS

J1	Connector Assembly, Wired MCP-4	123-004
J2	Block Plug, 4 Channel	120-021
– –	Case, 5 Channel Receiver	901-214
– –	0-80 x 1/4" P. H. S. Machine Screw (pkg of 20)	500-022
– –	Label, Receiver – Battery Pack Kraft Sport Series	600-062

ELECTRONIC ASSEMBLIES – P. C. Board with components

Receiver, 5 Channel – 27 MHz	300-206
Receiver, 5 Channel – 72 MHz	300-207

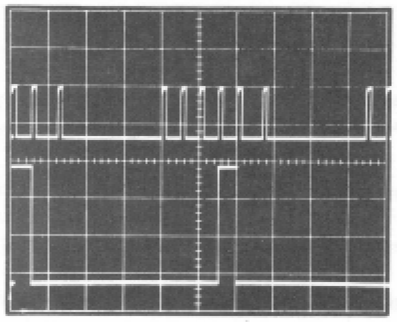


Fig. 33

FUNCTION

RECEIVER-DECODER
(KPR-5B)

R14 forward biases D3 to a voltage which is just below the forward conduction voltage of the base emitter junction of the detector transistor Q5, and the pulse amplifier Q6. This enables very small voltages to cause these transistors to turn on.

R15 and R16 form a voltage divider which biases D4 to the point where only the top .6 to .7 volt of the spike tops are transmitter through to the pulse amplifier. R17 acts to unload the detector collector. C17 AC decouples the signal from the base of Q6 (Fig. 34a). C18 further filters any remaining 455 KHz. R18 in conjection R19 sets the bias level of Q6.

Refer to Fig. 35a the signal at the collector of Q6 under low signal conditions. Notice that the signal at pin 5 of I.C. 1 (Fig. 35b) is high. Therefore, pin 6 is low and thereby clears the register so that all outputs will be low. Fig. 36a shows the clock time (pin 3, I.C. 1). You will notice that the clock pulses and serial input (pin 1, 2, of I.C. 2) (Fig. 36b) waveforms are fully developed but since register clear is low, no output pulses appear.

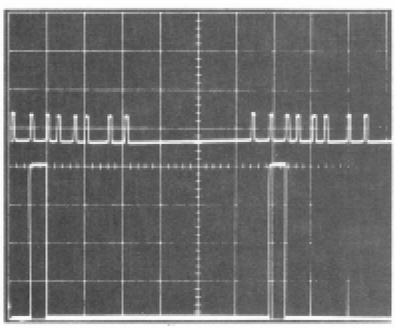


Fig. 34a Base Q6 (V= .5V Div.
H = 2ms Div. Uncalibrated)
Fig. 34b Ch. 2 Output pulse
(V = 1V. Div. H = 2ms Div. Uncal.)

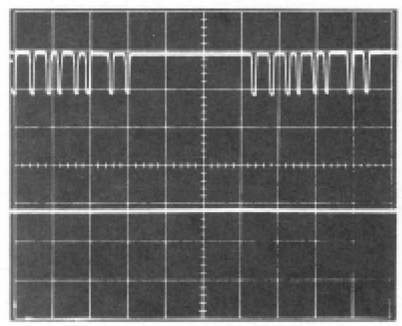


Fig. 35a Collector Q6
(V = .5V. Div. H = 2ms Div. Uncal.)
35b Pin 5 IC-1
(V = .5V Div. H = 2ms Div. Uncal.)

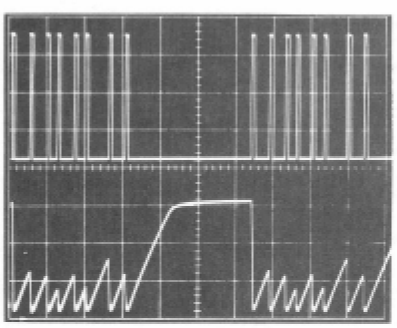


Fig. 36a Pin 3 IC-1
(V = .5V Div. H = 2ms Div. Uncal.)
36b Pin 1 & 2 IC-2
(V = .5V Div. H = 2ms Div. Uncal.)

As the signal input increases, D5 conducts discharging C20 and causing the clear line to go high, enabling the register. This action insures that the register will function only when the input is strong enough to insure solid operation.

This results in an extremely clean drop-out characteristic. C20 remains discharged below the conduction voltage at pin 5 of I.C. 1 for a period equal to several frames. If no information is received, C20 charges up (through the internal resistance in I.C. 1) to the point where the clear line goes low, clearing the register.

This insures that all outputs are low when the transmitter is off, preventing any servo from running hard over due to an output being in a steady state high condition. C21 performs the function of sync detector. It is kept discharged by the train of pulses. During the absence of pulses (sync pause), C21 charges up through the internal gate resistance in I.C. 2. When the voltage across C21 reaches approximately 1.2 volts, the register is armed and the first pulse will cause the number one output to go high, the second pulse will cause number two output to go high, and number to return to its low state, and so forth. C22 supplies instantaneous current necessary when the switching action occurs in the register. C23 is a bypass to keep the aileron pigtail from radiating back to the receiver.

Dynamic Decoupler: Transistor Q7, R20, and C19 make up the dynamic decoupler. Q7 is used as a pass transistor while R20 and C19 make up the time constant at which the decoupler filters. C19, being in the base of Q7, takes advantage of the gain characteristics of the transistor and multiplies the capacitance at the emitter.

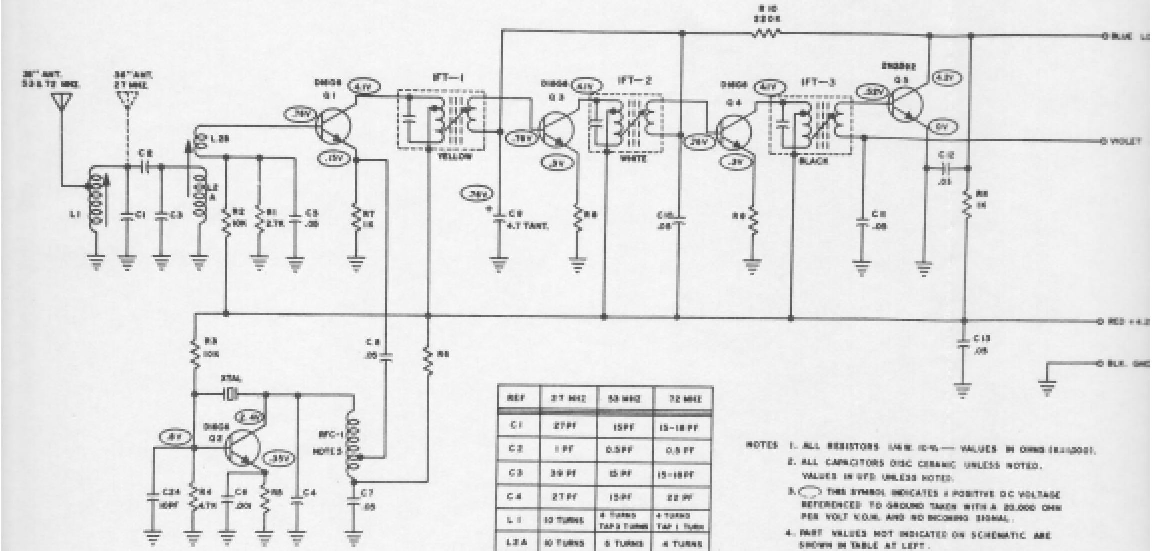
Operational Check: This check is performed by checking the voltage drop from collector to emitter on Q7. It should be between .6 and .8 volts.

DECODER PARTS LIST — KPR-5B

RESISTORS				
R14	18K	1/4W	10%	057-183
R15	15K	1/4W	10%	057-153
R16	22K	1/4W	10%	057-223
R17	5.6K	1/4W	10%	057-562
R18	100K	1/4W	10%	057-104
R19	22K	1/4W	10%	057-223
R20	3.9K	1/4W	10%	057-392
CAPACITORS				
C16	33uF	6V	Tantalum	116-005
C17	1.0uF	35V	Tantalum	116-002
C18	.001	500V	Disc Ceramic	113-012
C19	33uF	6V	Tantalum	116-005
C20	4.7uF	6V	Tantalum	116-004
C21	1.0uF	35V	Tantalum	116-002
C22	1.0uF	35V	Tantalum	116-002
C23	.001uF	500V	Disc Ceramic	113-012

RECEIVER — FRONT — END (KPR-5B)

R — 14

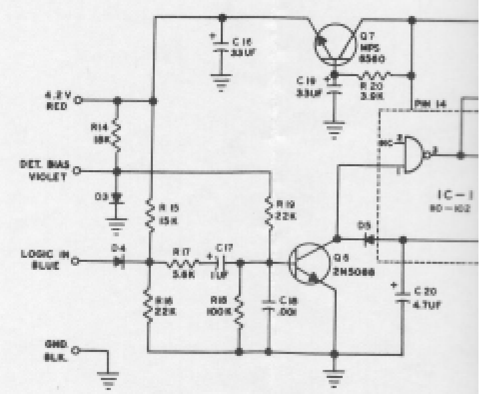


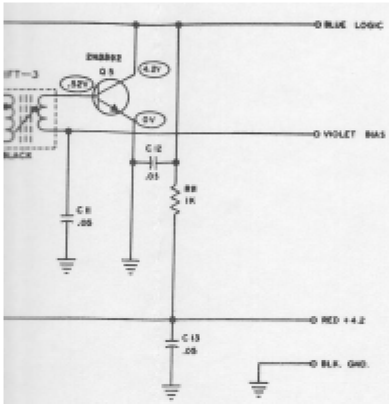
REF	27 MHZ	53 MHZ	72 MHZ
C1	27 PF	15 PF	15-18 PF
C2	1 PF	0.5 PF	0.5 PF
C3	39 PF	15 PF	15-18 PF
C4	27 PF	15 PF	22 PF
L1	10 TURNS	6 TURNS TAP 3 TURNS	4 TURNS TAP 1 TURN
L2A	10 TURNS	6 TURNS	4 TURNS
L2B	2 TURNS	1 TURN	1 TURN
R6,9	100—220Ω	100—220Ω	100—220Ω
R5	470 OHMS	470 OHMS	270 OHMS
R6	1 K	2.2 K	1 K

NOTES

1. ALL RESISTORS 1/4 W. 10% — VALUES IN OHMS (K=1,000).
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.
5. RFC-1 ON SINGLE FREQ. UNITS ARE PART NO. 103-023 RFC-1 ON DUAL FREQ. UNITS ARE PART NO. 103-038

RECE





ALL RESISTORS 1/4 W. 10% — VALUES IN OHMS (K=1,000).
ALL CAPACITORS DISC CERAMIC UNLESS NOTED.
VALUES IN UFD UNLESS NOTED.
THIS SYMBOL INDICATES A POSITIVE D-C VOLTAGE REFERENCED TO GROUND TAKEN WITH A 20,000 OHM PER VOLT V.O.M. AND NO INCOMING SIGNAL.
PART VALUES NOT INDICATED ON SCHEMATIC ARE SHOWN IN TABLE AT LEFT.
RFC-1 ON SINGLE FREQ. UNITS ARE PART NO. 103-023
RFC-1 ON DUAL FREQ. UNITS ARE PART NO. 103-039

RECEIVER DECODER CKT. L19 & L20 (KPR-5B)

NOTES — 1. CIRCUIT L19 USES 6 CHAN. BLOCK CONNECTOR.
CIRCUIT L20 USES 4 CHAN. BLOCK CONNECTOR.

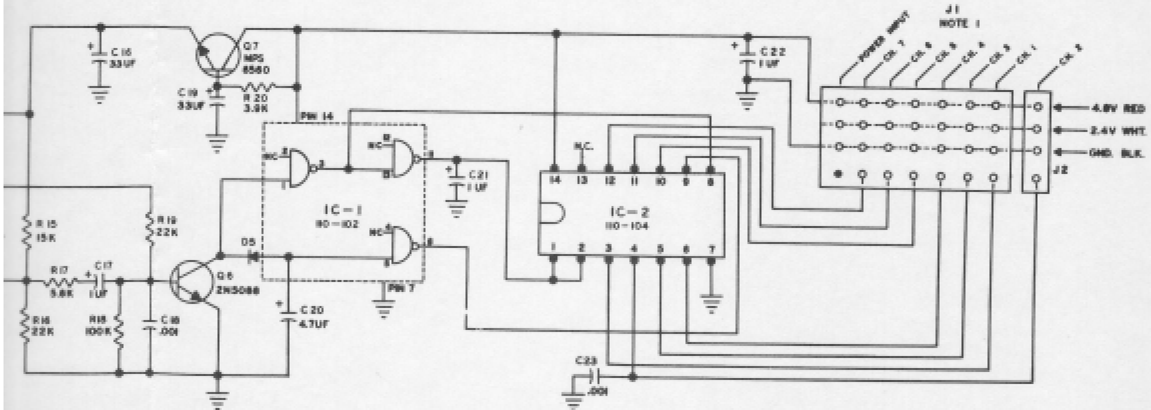


Figure 37

SEMICONDUCTORS

Q6	2N5088	NPN	Transistor Silicon	101-014
Q7	MPS6560	NPN	Transistor Silicon	101-013
D3	1N4148		Diode Silicon	100-101
D4	1N4148		Diode Silicon	100-101
D5	1N4148		Diode Silicon	100-101
IC-1	Quad – 2 Nand Open Collectors Low Power			110-102
IC-2	Shift Register 8 Bit Low Power			110-104

CONNECTORS

J1	Circuit Board L-19 uses 6 ch. block plug		120-022
J1	Circuit Board L-20 uses 4 ch. block plug		120-021
J2	Aileron plug		123-004

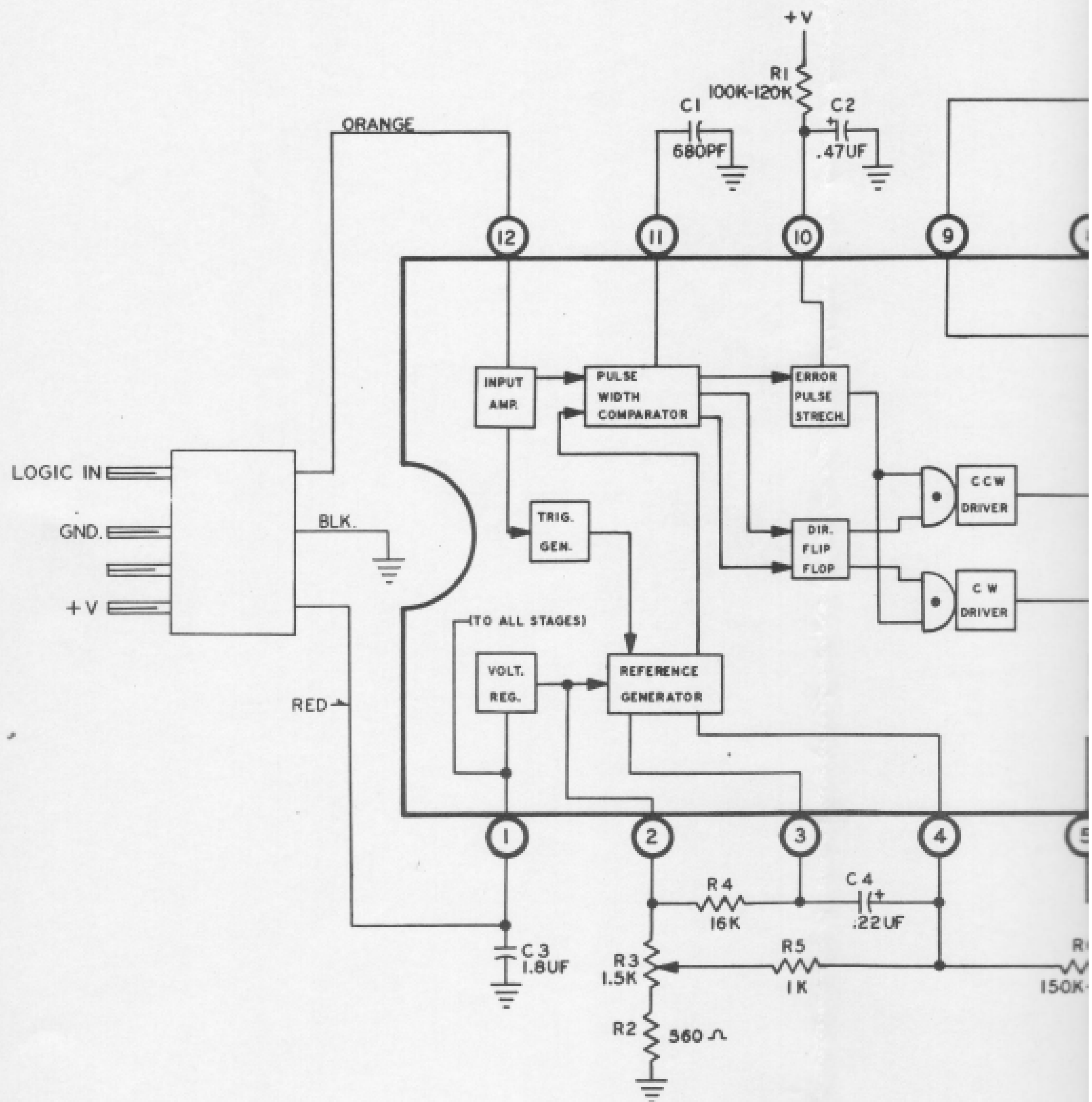
MISCELLANEOUS

– – –	2 and 5 channel receiver case		901-218
– – –	7 channel receiver case		901-219
– – –	3 and 5 channel receiver case – dual frequency		901-220
– – –	7 channel receiver case – dual frequency		901-221
– – –	Label Rx/Battery Pack – Series Seventy-Three		600-064
– – –	Label Rx Radiation Pt.	FCC Label	600-023

ELECTRONIC ASSEMBLY

L-19	7 channel decoder	300-221
L-20	3 and 5 channel decoder	300-222

I.C. SERVO AMPLIFIER – KPS



I.C. SERVO AMPLIFIER – KPS-14 / KPS-15

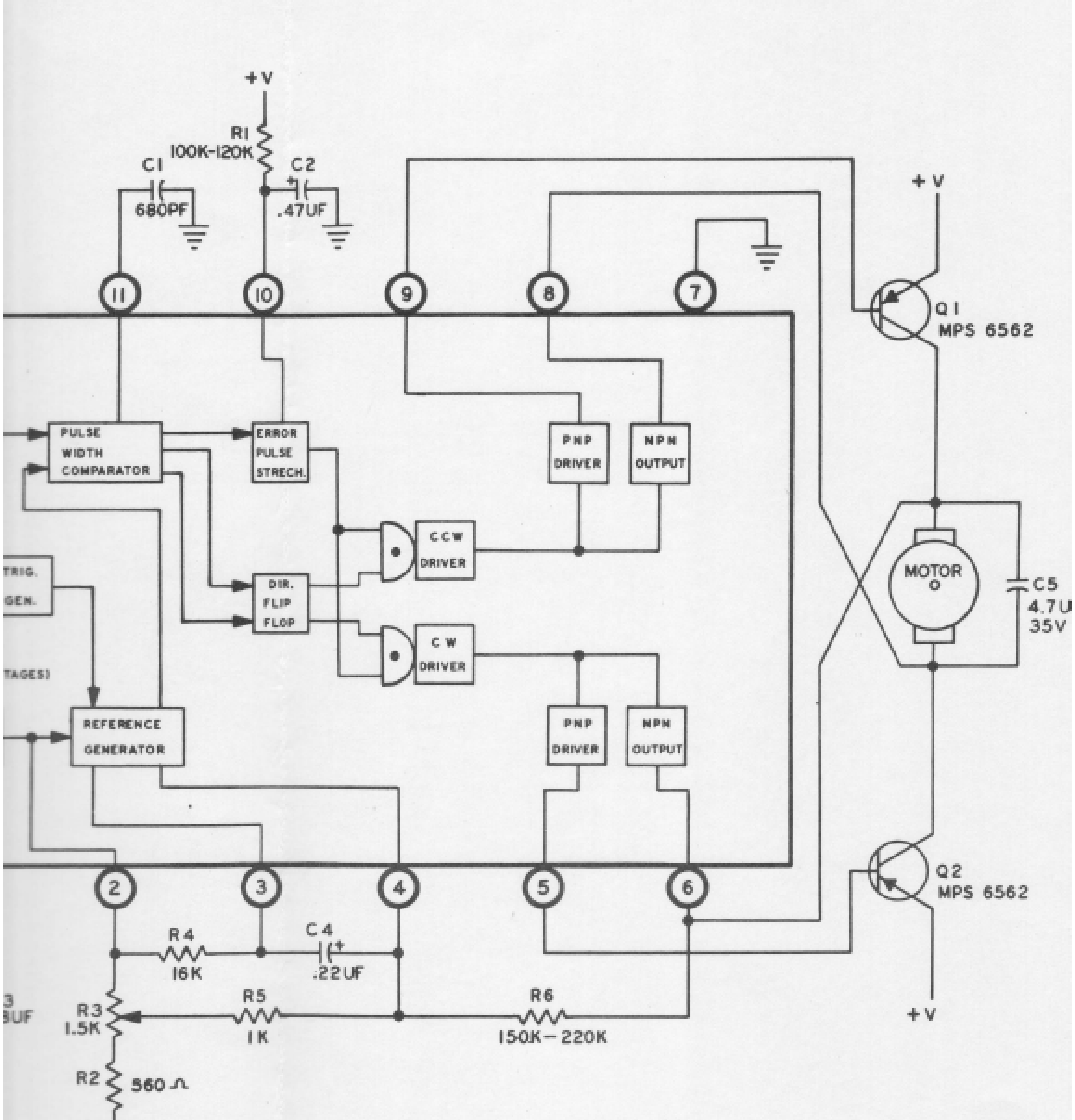


Figure 39

The integrated circuit servo amplifier used in the KPS-14 and 15 units is a Schmitt trigger type amplifier, completely integrated except for the timing components and PNP output transistors. (Fig. 39)

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 2.8_v to 6.0_v 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 of the servo shows the functions located within the chip and the relationship of the external components to the I. C. itself.

THEORY OF OPERATION

The input signal at pin 12 is amplified and applied to one side of the pulse width comparator. The trigger generator drives 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.

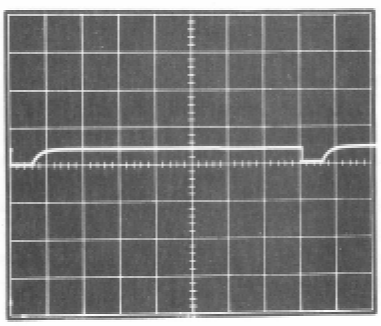


Fig. 40

Pin-4 Pot Wiper
(V= .5v/Div. H=2ms/Div.)

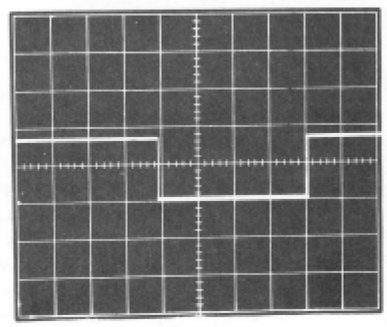


Fig. 41

Pin-10 Pulse Stretcher
(LARGE ERROR)
Same polarity for both directions
(V= .5v/Div. H=2ms/Div.)

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 apply 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.

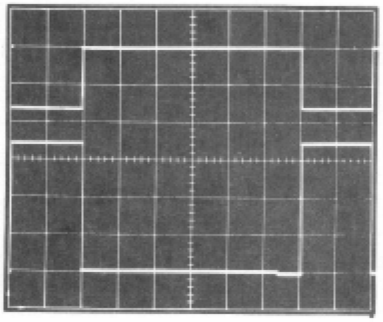


Fig. 42

Q1 Driver Transistor
Dual Trace (SMALL ERROR)
Motor disconnected
Base (V= .5v/Div. H=2ms/Div.)
Collector (V=1v/Div. H=2ms/Div.)

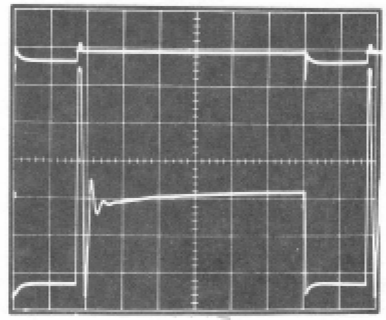


Fig. 43

Same as Previous Illustration
But with Motor Connected

I. C. SERVO AMPLIFIERS TROUBLE-SHOOTING INFORMATION

Servo amplifier failure will generally be the result of a defective I. C. or one or both PNP output transistors. If the servo drives in one direction only, the most likely cause will be an open PNP output transistor. If this is suspected, remove the motor from the mechanics or disconnect one motor lead. Neutralize the servo output shaft. Connect an oscilloscope to pin 5 of the I. C. and examine the waveform at the base of the PNP connected to it. Move the control stick on the servo tester or transmitter to one side and note the amplitude of the negative going pulse at this point. If no pulse is seen, move the control lever to the opposite side. The amplitude of the resulting pulse should be less than 1v below the base line. If it is nearly the full supply (+5V.), the associated PNP is defective.

Connect the oscilloscope to pin 9 of the I. C. and check the pulse here in the same manner. If both checks show correct operation, the defect is likely in the I. C. itself.

Operational difficulties other than semiconductor failure may be the result of a defective potentiometer or motor. Hunting, erratic spots in the rotation, or jumpiness are generally due to a defective potentiometer. Dead spots, slow drive in one or both directions, or electrical noise, especially in one direction, are typical of defective motors.

Capacitor C3 is very important for proper operation of the system, since it supplies the high instantaneous current required when the servo motor is being driven. If this capacitor is defective or too low in value, it will cause erratic operation around neutral due to the large voltage drop in the wiring. If difficulties of this nature are noted and a good capacitor is installed, increase the value of C3 to 1.8-2.2uf from 1.0uf.

Two versions of this amplifier are currently in use. The S20 P.C. assembly is used in the KPS-12, KPS-14, KPS-15, KPS-15H, KPS-16 servos. The S21 is used in the KPS-11/11A servo.

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. Later production uses a 680pf capacitor.

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 possiblities 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-14, KPS-15, KPS-15H 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 any overshoot in the servo. If the value of R6 is too high, the servo will have a tendency to overshoot neutral 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, severely reducing battery life.

NEUTRAL ADJUSTMENT FOR KPS-11 through KPS-16 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.

PARTS LIST
I.C. SERVO AMP.

RESISTORS – All values in ohms (K=1000)

R1	KPS-11, -11A	100K	1/4W	10%	057-104
	KPS-12 – 16	120K	1/4W	10%	057-124
R2		560 ohm	1/4W	10%	057-561
R3		1.5K	1/2W	10% Feedback pot	106-012
R4		16K	1/4W	5%	055-163
R5		1K	1/4W	10%	057-102
R6	KPS-11, -11A	180K	1/4W	10%	057-184
	KPS-12 –16	220K	1/4W	10%	057-224

CAPACITORS

C1	680pF	100V	Disc Ceramic	113-039
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

PARTS LIST – KPS-11A

RESISTORS – all values in ohms (K=1,000)

R1	120K	1/4W	10%	057-124
R2	560	1/4W	10%	057-561
R3	1.5K	1/2W	10% FEEDBACK POT	106-012
R4	16K	1/4W	5%	055-163
R5	1K	1/4W	10%	057-102
R6	180K	1/4W	10%	057-184

CAPACITORS

C1	.003uf	100v	Disc Ceramic	113-014
C2	.47uf	35v	Tantalum	116-011
C3	1.0uf	35v	Tantalum	116-002
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-11A Sport Series Servo Amplifier	300-028

CONNECTOR ASSEMBLY

– – –	4 pin Multicon Servo Plug Sport Series	123-002

MECHANICAL ASSEMBLY – see exploded parts view Fig. 35

KEY NO.		
17	MOTOR KPS-10, KPS-11 – 10 ohm	800-006
6	Case, Top – KPS-11A	901-162
16	Case, Center	901-163
25	Case, Bottom	901-164
– –	Case, Complete	901-190
13	Gear, First Intermediate	901-165
10	Gear, Second Intermediate	901-166

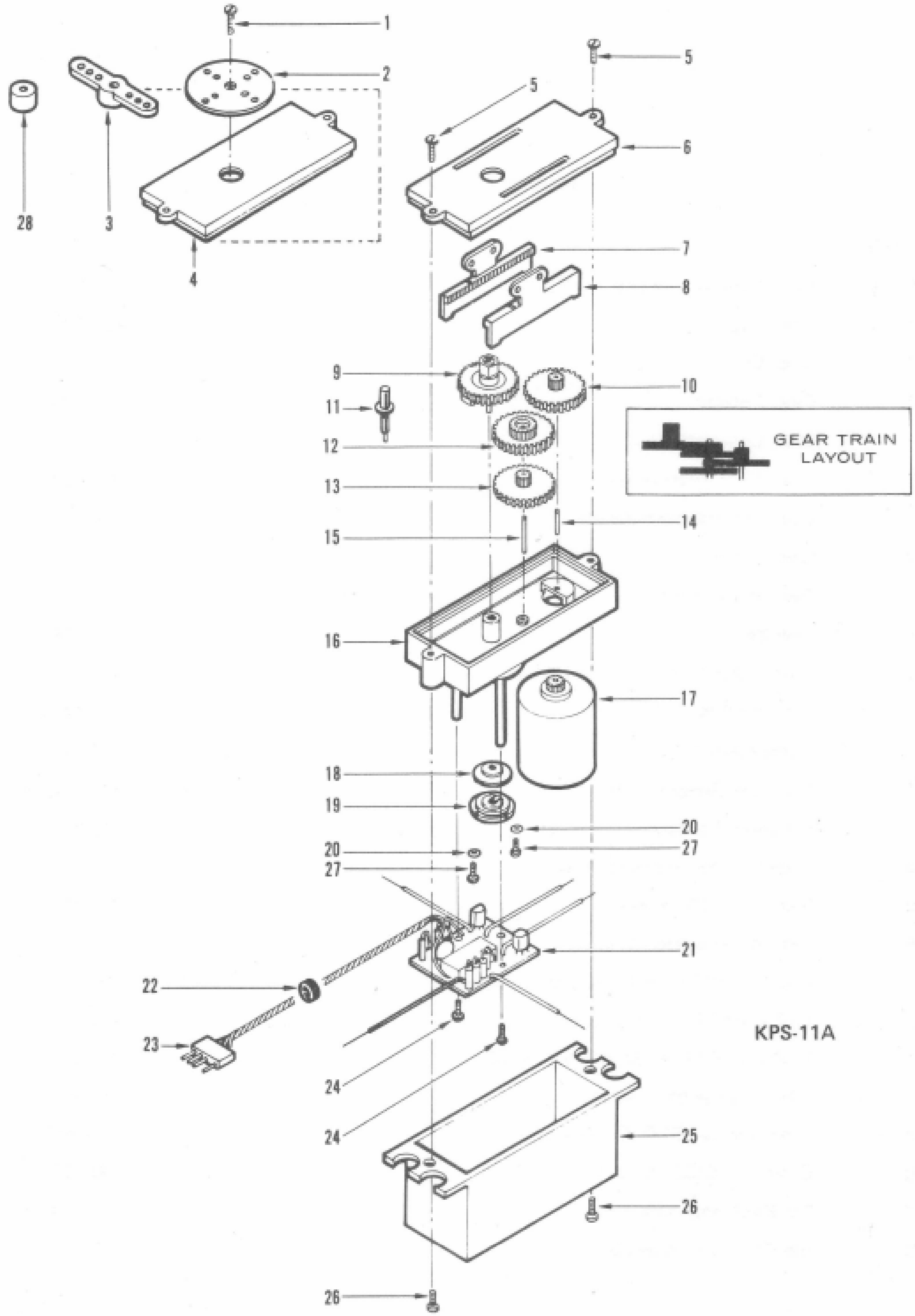
PARTS LIST — KPS-11A — continued

12	Gear, Drive Intermediate	901-167
9	Gear, Pot, Intermediate	901-168
– –	Gear Set	901-172
2	Output Wheel	901-173
3	Output Arm	901-174
– –	Output Arm & Wheel Set	901-175
18	Pot Wiper Support Disc	901-176
18	Pot Wiper, KPS-11A	106-023
11	Pot Shaft	500-033
1	1-72 x 1/8" B. H. Machine Screw (Output Arms) pkg. of 20	500-032
26	2-56 x 7/32" F. H. Machine Screw (Case bottom) pkg. of 20	500-031
5	1-72 x 1/4" B. H. Machine Screw (Case Top) pkg. of 20	500-037

KEY NO.		
14	Gear Pin, short	500-030
15	Gear Pin, long	500-029
27	1-72 x 1/4" B. H. Machine Screw (Pot Hold-down) pkg. of 20)	500-039
22	1/4" Grommet – pkg. of 20	500-003

Accessory Plastic Parts

6	Case top (for racks) – KPS-11	901-161
7, 8	Output Rack Set	901-171
28	Output Shaft Cap – KPS-11	901-201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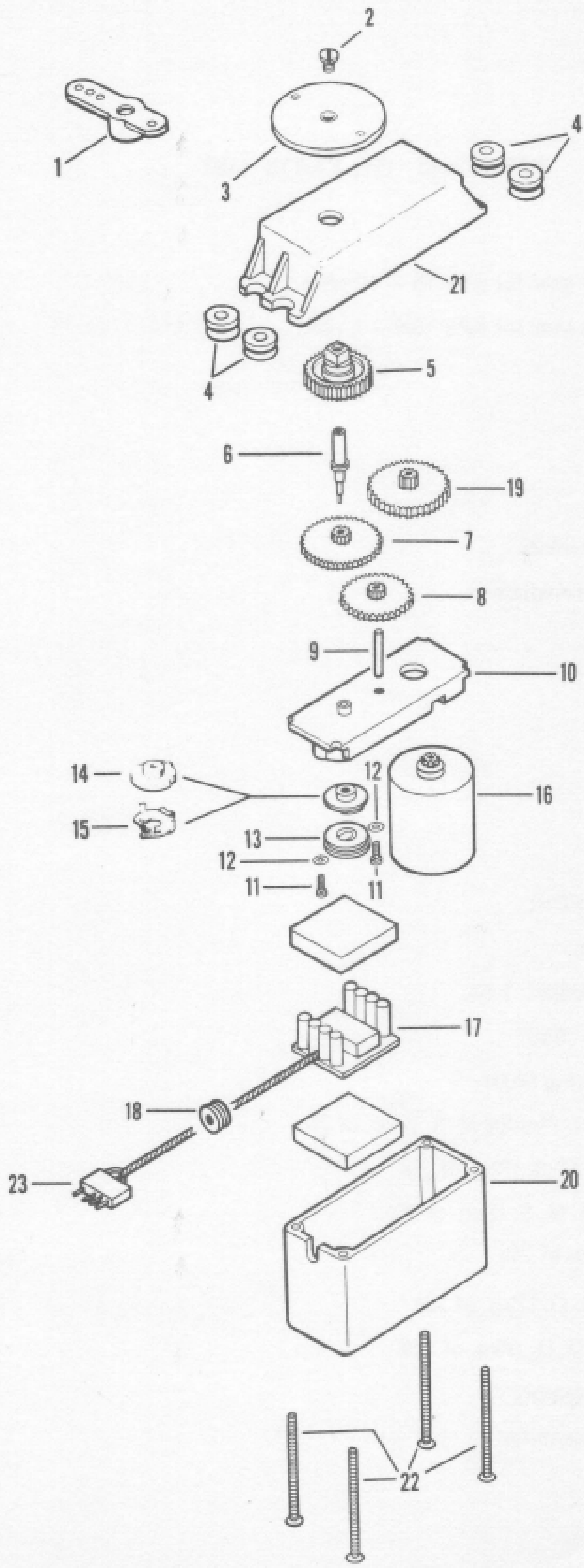
KPS-11A

Fig. 35

PARTS LIST KPS-14

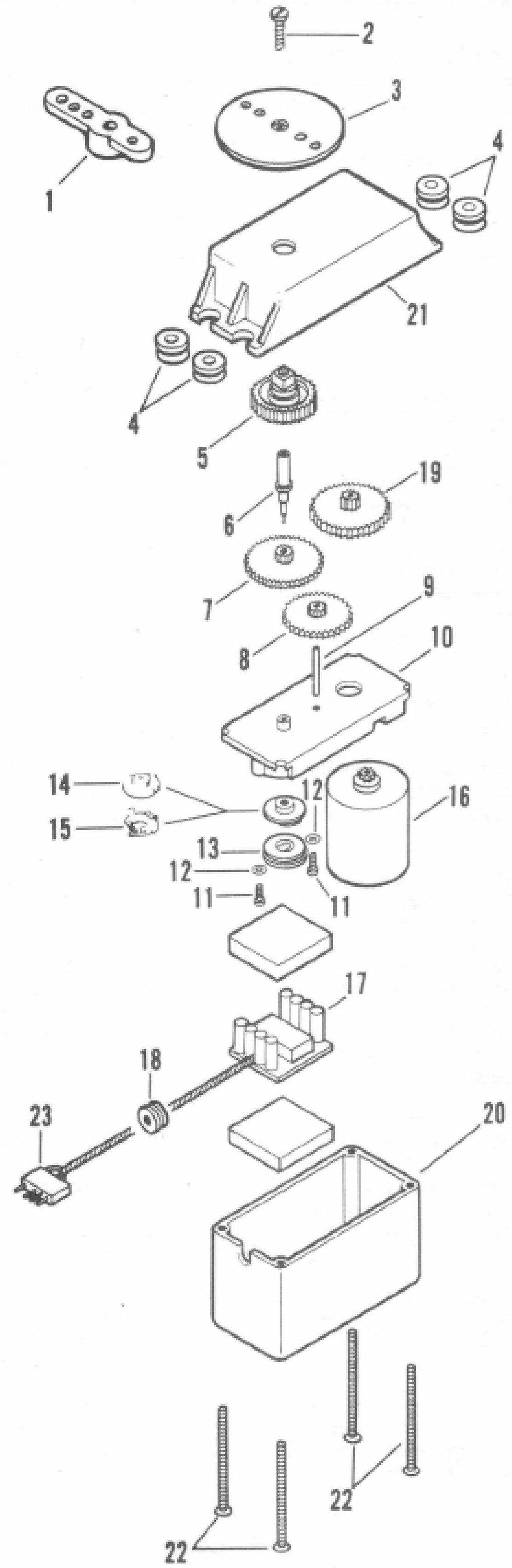
KEY NO.		
16	Motor with pinion gear — 12 ohm	800-007
21	Case, Top	901-228
10	Case, Center	901-229
20	Case, Bottom	901-230
——	Case, Complete	901-231
8	Gear, First Intermediate	901-232
7	Gear, Second Intermediate	901-233
19	Gear, Drive	901-234
5	Gear, Pot Output	901-235
——	Gear Set	901-236
1	Output Arm	901-237
3	Output Wheel	901-238
——	Output Arm Set	901-239
14	Pot Wiper Support Disc	901-240
15	Pot Wiper Contact	106-023
13	Potentiometer Element, 1.5K	106-012
9	Gear Pin .050" x .550"	500-066
6	Gear/Wiper Centering 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)	500-025
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	123-010



KPS-14

KPS-15 and -15H PARTS LIST

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	901-240
10	Case, Center	901-242
20	Case, Bottom	901-243
––	Case, Complete	901-244
8	Gear, First Intermediate	901-246
7	Gear, Second Intermediate	901-247
19	Gear, Drive	901-248
5	Gear, Output	901-249
––	Gear Set	901-250
1	Output Arm	901-251
3	Output Wheel	901-252
––	Output Arm Set	901-253
14	Pot Wiper Support Disc	901-192
15	Pot Wiper Contact	106-023
13	Potentiometer Element 1.5K	106-012
9	Gear Pin .062" x .550"	500-068
6	Gear/Wiper Centering 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)	500-025
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	123-010



KPS-15 & 15H

Centering Shaft Modification

The centering shaft on the KPS-14 and KPS-15 has been known to slip under heavy loading conditions. The following modification will improve the operation of the servos. The factory will provide the new shaft at no charge. Order part number 500-062. NOTE: Many servos have already been modified in the field. The new shaft can be identified by the straight knurl where it presses into the number 4 gear, and by the absence of the screwdriver slot at the top of the shaft.

The centering shaft on the KPS-14 and KPS-15 servo-mechanisms has been improved. The new shaft has been made available at no charge, and may be installed by the modeler himself. The following instructions must be followed EXACTLY to prevent damage to the servo.

IMPORTANT NOTE: Read each step COMPLETELY before starting that phase of the work.

1. Turn on the transmitter and receiver to center the servo. With the stick and trim lever in the neutral position, the holes of the wheel, or arm, will be square with the servo case. See Figure 5.

2. Turn the equipment off, disconnect the servo, and remove it from the model.

3. Remove the wheel and the four screws from the servo case. (Refer to Figure 1 for all steps, unless otherwise indicated.)

4. Hold the servo upside down and carefully separate the top and bottom halves of the case, removing both from the body of the servo. As you pull the case apart, look for the small square piece of padding (1) that insulates the potentiometer (2)--hereafter called the "pot"--from the circuit board (3). Note that the green side is towards the pot. Remove the padding.

IMPORTANT NOTE: If at any point during disassembly, a gear--or gears--should fall loose, or if the idler shaft (4) should pull out of the body of the servo (generally sticking in the case), do not be concerned. Proper reassembly of the gear train is given later on.

5. Pull the circuit board away from the pot and to one side. DO NOT PUT ANY PRESSURE ON THE WIRES OR COMPONENTS OF THE CIRCUIT BOARD.

6. Make a pencil mark on the rim of the pot housing next to the green wire. This will enable you to return the pot element to the same place when reassembling the unit. Remove the two screws (5) that hold the pot assembly together, and remove the pot element.

7. The wiper (6) is now visible. Make a pencil mark on the side of the pot housing that the wiper "arrow" points to. See Figure 2.

8. Carefully pull out on the number 4 gear--the top one that is mounted on the centering shaft (7). See Figure 3 for identification. When the shaft comes free, the wiper--which is mounted on the other end--will be free to drop out of the housing. If the gear should pull loose before the shaft is worked out, finish removing the shaft by pulling straight out with a pair of pliers. Discard the shaft. The number 2 gear, which is mounted on the inner portion of the centering shaft, will also fall free.

9. If the shaft and the number 4 gear were pulled out together, remove the shaft from the gear and discard the shaft.

10. Insert the new centering shaft into the number 4 gear. Using the FLAT side of the pliers, push against the flange of the shaft while resting the gear on the bench. Make sure that the shaft is inserted into the underside of the number 4 gear. Figure 3 identifies the top side of the gear. TAKE CARE NOT TO BURR THE SHAFT.

11. Make sure that gears 1 and 3 are on the idler shaft in the correct position. See Figures 1 and 3. The shaft must be seated in the small bearing, or cup.

12. Slide the number 2 gear on the centering shaft and insert the shaft into the mounting hole that feeds through to the pot housing. Carefully work the four gears together until they are all meshed properly. Make sure that the stop on the number 4 gear faces away from the number 3 gear. See Figure 3.

CENTERING SHAFT MODIFICATION FOR KPS-14 AND KPS-15 SERVOS

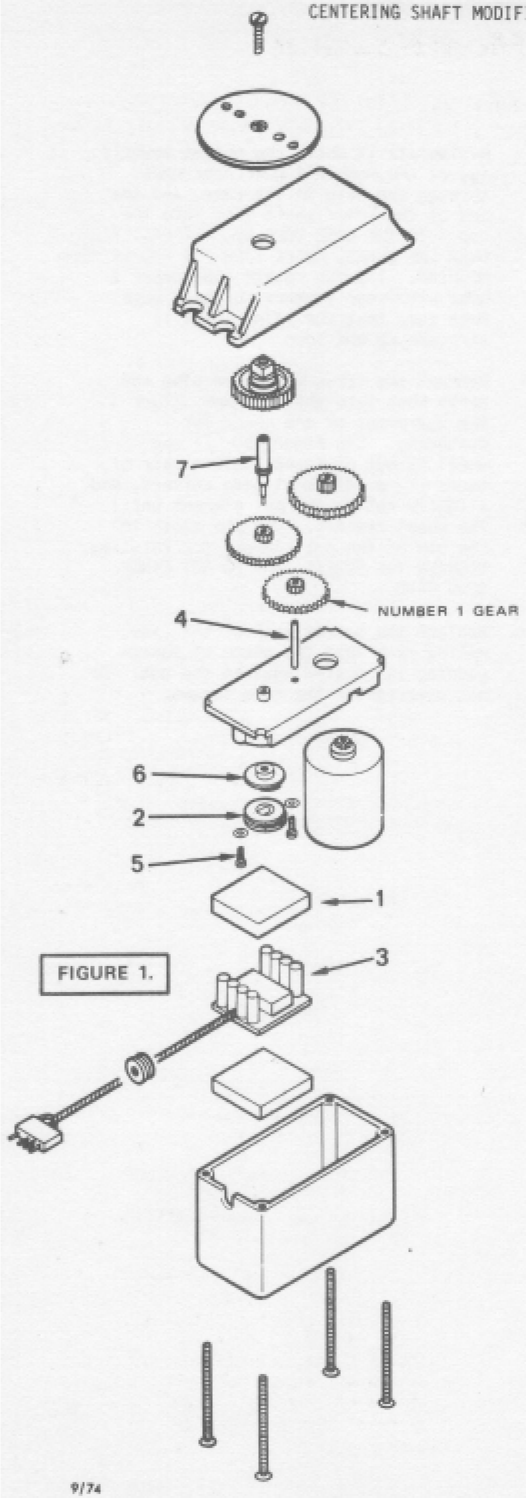


FIGURE 1.

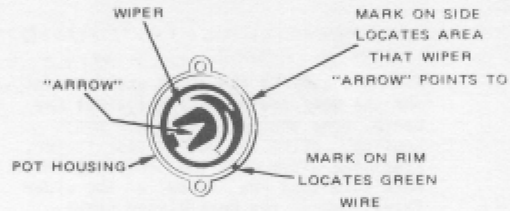


FIGURE 2.

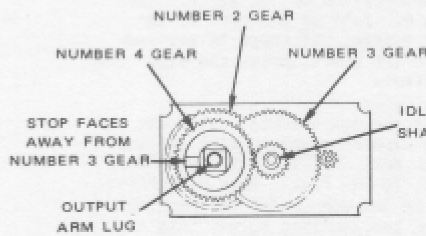


FIGURE 3.

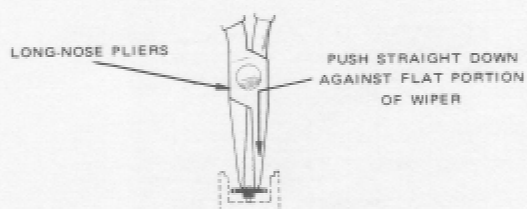


FIGURE 4.

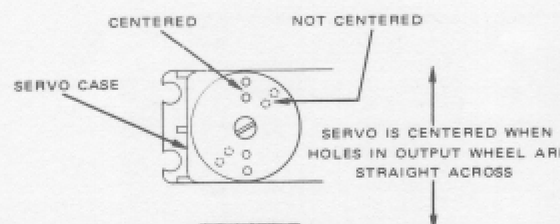


FIGURE 5.

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13. With the body of the servo upside down, and the gear train resting against the bench, drop the wiper into the pot housing. Using the end of your finger, start the wiper onto the centering shaft. Make sure that the "arrow" of the wiper faces towards the mark placed previously on the side of the pot housing. Using long-nose pliers, push the wiper down on the shaft firmly. PUSH AGAINST THE FLAT PORTION OF THE WIPER. See Figure 4. Pull up and down on the number 4 gear. If there is any end-play in the shaft, press the wiper down more firmly.

14. Replace the pot element, using the larger washers supplied with the new shaft. MAKE SURE THAT THE GREEN WIRE IS NEXT TO THE PENCIL MARK MADE PREVIOUSLY ON THE RIM OF THE POT HOUSING. Run the two mounting screws into the pot housing until the washers are snug against the pot element. DO NOT TIGHTEN.

15. Replace the top case. You will have to manipulate it until the output mounting lug of the number 4 gear protrudes through the hole in the case, and the end of the idler shaft fits into the cup. IF THE CASE DOES NOT FIT EASILY OVER THE GEARS, CHECK THEM FOR PROPER MESHING. You can rotate the number 2 gear with your fingers to check mesh. Make sure that the idler shaft is straight up and down.

16. Remount the servo wheel and plug the servo back into the receiver. Turn the equipment on and check for centering. See Figure 5. If the wheel is not centered, take a pair of tweezers, or diagonal side cutters, and slightly rotate the pot element until the wheel centers. Use the slots in the rim of the pot element for rotating. TIGHTEN THE SCREWS--BUT DO NOT CINCH DOWN HARD.

17. Replace the bottom half of the case, making sure that the piece of square padding is located against the pot. Do not overtighten the case screws.

BATTERY PACKS

The battery used with the KP-5 is the Kraft type KB-4E. As supplied with the 1972-74 sets, it has the switch harness wired permanently to it, and was designated the KB-4E-S.

For 1975, the regular KB-4E was supplied with a separate switch harness.

PARTS LIST

DESCRIPTION	QUANTITY REQUIRED	PART NUMBER
Case, Battery – KB-4E	1	901-211
Cells, 550 MAH – Stack of two	2	130-006
Wired Switch Assembly (1972-74; for KB-4E-S)	1	123-015
Wired Switch Assembly (1975; separate assembly)	1	200-029
Battery Connector (For KB-4E)	1	123-001
Grommet – 1/8"	1	500-002-1
Tape – 3/8" black (sold in 60 yd. rolls only)		990-014
Label – Sports Series, Battery Pack	1	600-062