

Instruction Manual

for

**FREQUENCY SHIFT
CONVERTER**

MODEL FSC-250

Electrocom[®] INDUSTRIES

1105 NORTH IRONWOOD DRIVE

SOUTH BEND 15, INDIANA



FIGURE 1 - ELECTROCOM FSC-250 FREQUENCY SHIFT CONVERTER

SECTION 1 DESCRIPTION

1.1 GENERAL

The Electrocom Model FSC-250 is a completely self-contained frequency shift terminal unit designed to convert audio tones to keyed direct current suitable for the operation of teleprinters and/or associated equipment.

With the ever increasing activity both on amateur and commercial high frequency bands, it becomes necessary to use stable, selective equipment capable of rejecting unwanted interference. Fading and noise are also ever existing problems in the reliable reception of radio teleprinter signals. Distorted signals together with insufficient converter response frequently limit the "range" of signals the teleprinter is able to copy. For ease of operation an accurate and fast method of tuning and monitoring incoming signals is a necessity. Frequently radio interference and keying problems occur when keying

relays are used in a radio receiving system. Taking all of these factors into mind, the FSC-250 has been designed to effectively combat these problems. It provides a complete terminal unit that is highly versatile, reliable and easy to operate; while incorporating many deluxe operating features which will be described in following paragraphs.

1.2 SPECIFICATIONS

Input: 600 ohm, unbalanced to ground
Sensitivity: .1 v rms provides full limiting

Shift: 850 cps nominal \pm 350 cps

Filters: 600 ohm hermetically sealed plug in units providing 3 db. band-pass of 250 cps. Mark-space channel attenuation greater than 40 db. Center frequency of Mark filter is 2125 cps; center frequency of Space filter is 2975 cps.

Tuning indicator and monitor: 2 inch CRT

Output: D C continuously variable from
20 to 60 ma. into a 500 ohm load
Maximum keying speed: 200 WPM
Case: Aluminum with clear iridite finish
Dimensions behind front panel: 3 1/2 by
17 by 11 inches deep
Front panel: Grey hammertone, white
figures, 19 by 3 1/2 inches high, 1/8
inch thick, standard rack mounting
Weight: 14 pounds
Power: 110 - 125 v., 60 cps, 75 watts
maximum

1.3 ACCESSORIES

1.3.1 The filters normally supplied with the FSC-250 are for 850 cps shift as described above. Other filters are available on special order for optimum performance on other shifts (170 cps, 425 cps, etc.). Filter bandwidths and attenuation characteristics will be de-

termined by system requirements and keying speeds. These optional filters are interchangeable with the plug in filters supplied.

1.3.2 Provisions have been incorporated for the use of an optional input filter. The most desirable characteristics of such a filter depend upon the communications receiver with which the FSC-250 will be used. This input filter is not required for operation of the converter but will provide improved performance if the communications receiver is not capable of rejecting strong adjacent channel interference. For receivers with good selectivity a notch filter is useful for preventing strong signals between the mark and space channels from "capturing" the limiter. Hence, various input filters are available if the ultimate is desired in a particular receiving system.

SECTION 2 INSTALLATION

2.1 UNPACKING

Carefully remove the equipment from the packing carton and examine for any possible damage which may have occurred during transit. Remove the packing from the filters. The 2125 cps filter (BPF 2125A) should normally be installed in the MARK socket and the 2975 cps filter (BPF 2975A) in the SPACE socket.

Inspect for any loose parts. Check to see that knobs and switches turn properly. Should any damage be apparent, file a claim immediately with the transportation company.

2.2 LOCATION

The FSC-250 is designed for rack mounting; however, it may also be located on top of other equipment. Adequate space for air circulation must be provided in either case. The unit should not

be placed directly over sources of high heat, and space must be allowed for proper air circulation. If it is desired to locate the FSC-250 on top of another cabinet, rubber mounting feet should be installed on the underside cover so as to raise the case a sufficient amount for air to circulate.

2.3 EXTERNAL CONNECTIONS

All external connections are made as follows to terminals on the rear of the case:

2.3.1 Input

The audio input to the converter should be connected to a 500/600 ohm output of a communications receiver. The signal side of the receiver output connects to terminal 11, and the ground side to terminal 12. If a 500/600 ohm source is not available, other imped-

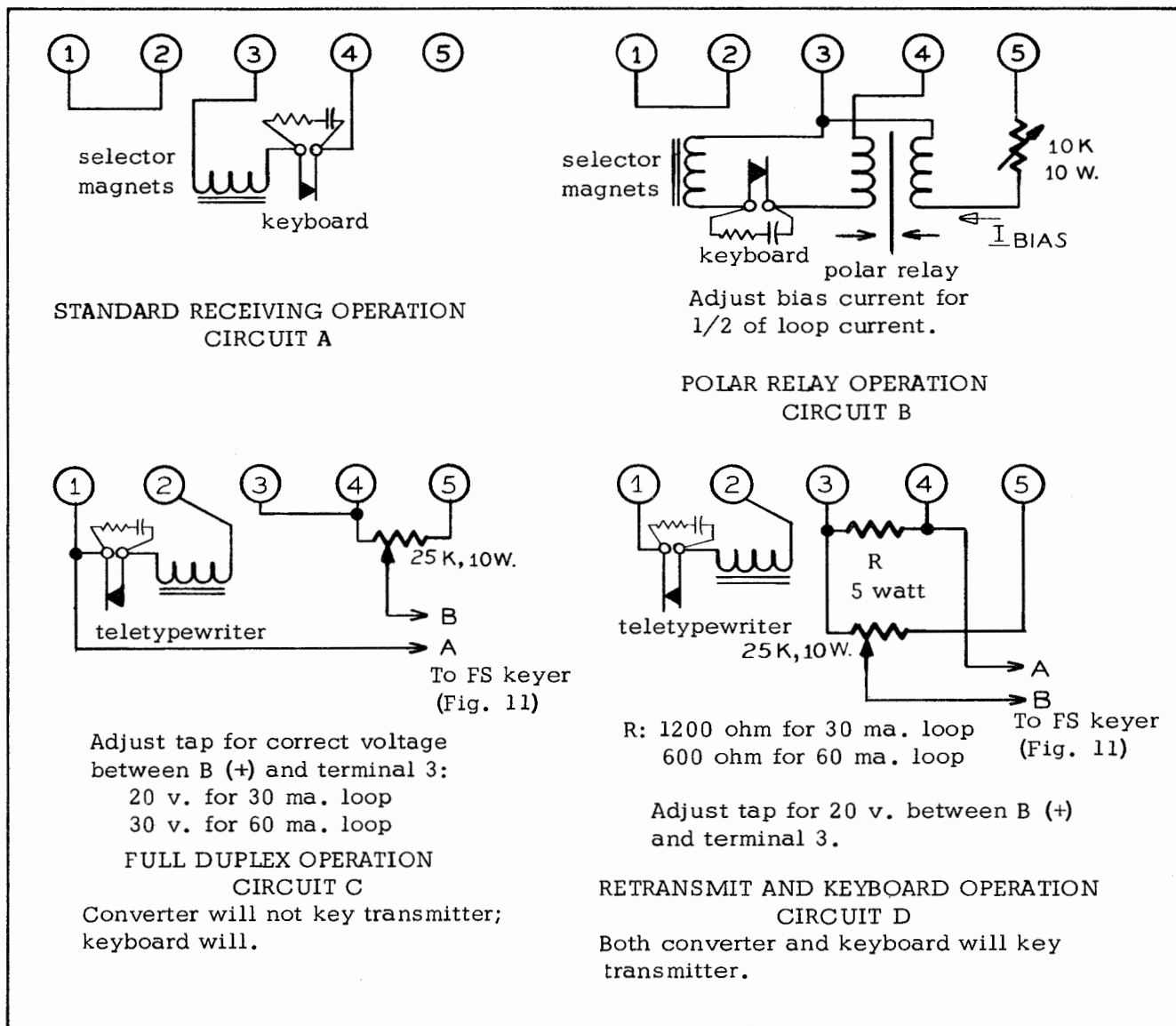


FIGURE 2 - TELETYPEWRITER CONNECTIONS

ances may be used with a suitable matching transformer.

2.3.2 Teleprinter connections

Terminals 1, 2, 3, 4, and 5 provide connections to the loop power supply and vacuum tube keyer circuits. For printer operation only, terminals 1 and 2 are connected together and the printer selector magnet is connected between terminals 3 and 4.

The above terminals may be wired in

several ways in order to provide voltages to electronically operate a frequency shift transmitter keyer, such as appears in figure 11. They may be wired for duplex, retransmission, and keyboard operation. In the event the transmitter requires a polar relay for keying, current for the bias winding of the relay is also available. Figure 2 shows external connections required for various types of operation.

NOTE: The loop power supply current

rating is 60 ma. maximum. If this supply is used for polar relay bias, total current (bias + loop current) shall not exceed this rating.

2.3.3 Remote keyers & transmit lockout

Frequently it is desirable to operate several isolated DC loops from a common converter. In this manner one loop may be used for local perforation of tape while another loop is receiving off of the air. By switching this loop onto the converter, incoming signals may be re-perforated. This flexibility of operation has been incorporated into the FSC-250. The grid circuit of external keyers may be connected to terminal 6 without affecting the normal operation of the converter. The ground return on the external keyer may be connected to terminal 4. An external keyer circuit is shown in figure 10. Terminals 1 thru 5 may be connected as described in paragraph 2.3.2.

When the DC loop of the FSC-250 is used for transmitter keying the converter keying circuits must be disabled during the transmit period to prevent an incom-

ing signal from opening this loop. In this manner the receiver may be left on and the "off the air" signal monitored on the built in scope monitor, without affecting the transmitter keying circuit. To provide this feature a relay may be used to connect terminals 6 and 4 together when the transmitter is on. (If the converter is used for retransmission, this relay will have to be disabled.)

2.3.4 Autostart control

Terminals 7 & 8 provide normally open relay contacts for motor control of automatically started printers. Contact rating is 5 amperes at 125 v. These terminals may be connected in parallel with the motor control switch on the teleprinter for turning the machine on when the "autostart" signal is received.

2.3.5 Power

The power cord may now be plugged into a source of 117 volts, 60 cps. The unit is protected with a 1 ampere delay type fuse.

SECTION 3 OPERATION

3.1 CONTROLS - FRONT PANEL

3.1.1 Bias

This control adjusts the converter for the most reliable copy of an incoming signal. Normally the control is positioned on the vertical line. This position is for use on incoming signals which contain no bias distortion. If the incoming signal is biased in a marking direction the BIAS control is turned towards SPACING (CW) to insert spacing bias into the keying circuits, thereby correcting the distortion. If the incoming signal is biased in a spacing direc-

tion the control is turned towards MARKING (CCW). This adjustment is not critical for good quality signals. For poor quality signals the control should be adjusted for the best printed copy.

3.1.2 Channel

This control allows the converter to copy the MARK channel only, BOTH channels in polar operation, or the SPACE channel only. In event of interference on either the mark or space channel, the receiver is used to reject the interference and the CHANNEL selector is set to receive from the clear

channel. The BIAS control must be adjusted for best printed copy. Since the converter is operating from make-break signals when copying off of one channel only, it is desirable to reduce the receiver audio gain so as to prevent noise from keying the converter during "key up" conditions. One channel operation may also be used for receiving cw signals for keying recorders, or for receiving fsk shifts that are not within the passband of the filters. If both mark and space channels are clear, the best performance is obtained with the CHANNEL selector in the BOTH position.

3.1.3 Keying

This control selects the keying mode of the DC loop supply. Each position functions as follows:

3.1.3.1 Local position prevents the converter from keying the DC loop, disables the monitor scope, and allows the loop power supply to be used for local keyboard operation of the teleprinter. The keyboard must be wired in series with the printer for this type of operation. This position is also useful for holding the machine in standby condition while tuning the receiver.

3.1.3.2 Reverse position permits a signal that is shifted in reverse to be copied without retuning the receiver or reversing the filters. If the tuning indicator shows proper converter adjustment yet the signals fail to print properly in the NORMAL position, this REVERSE position should be selected.

3.1.3.3 Normal position is used for standard operation. With the filters supplied the mark signal is to be 2125 cps and the space signal is 2975 cps.

3.1.3.4 Mark position allows the machine to be "locked" in a marking condition during no signal or cw identification periods. The converter is keyed in a normal manner after receiving approximately one second of mark signal. It continues to function normally until approximately one second of con-

tinuous space signal is received, at which time the machine "locks" in a marking condition. CW identification may then be transmitted on the space frequency without causing the machine to print. In the event of signal loss, the machine will also lock on mark after one second duration. For MARK or AUTO operation of the KEYING selector the CHANNEL selector must be in either the BOTH or MARK position.

3.1.3.5 Auto position allows automatic starting of the teleprinter. Operation is similar to the MARK position. However, in AUTO the loop supply is disabled so that no current flows through the machine, and the scope monitor is blanked to prevent burning a spot on the center of the tube for long periods with no signal input. Upon reception of one second of mark signal the autostart relay closes turning on the printer motor, current is supplied to the machine, and the printer is ready to receive. The machine may be shut off again by the reception of a one second space signal. Automatic motor control may be used in either the MARK or AUTO positions.

3.1.4 Power

This switch turns all power to the converter and DC loop on or off.

3.2 CONTROLS - REAR PANEL

3.2.1 Loop Current Adjust

This control adjusts the current into the teleprinter. Upon installation a DC milliammeter should be inserted in series with the teleprinter and the current adjusted to the recommended value for the machine. This adjustment is made with the keying selector in the LOCAL position. The meter may then be removed from the circuit.

3.2.2 Channel Balance

This is a factory locked control and should not require any further adjustment unless the filters are changed or the

channel gains change appreciably. The balance may be adjusted by connecting a 50 microampere meter between terminals 9 and 10 (+), alternately feeding a mark and space signal into the converter and adjusting the balance control for equal current on both mark and space. After adjustment the meter should be removed and terminals 9 & 10 connected together with a jumper.

3.2.3 Hor., Vert., Focus, & Int.

These controls adjust the horizontal position, the vertical position, the focus and the intensity of the monitor.

3.3 SCOPE TUNING INDICATOR AND MONITOR

The monitor scope on the front panel provides an accurate and rapid means of adjusting the communications receiver for proper reception of radio-teletype-writer signals. It also will indicate conditions of severe fading, receiver or transmitter drift, and improper transmitter shift adjustment.

When the receiver is properly tuned a vertical line will appear on the scope during a mark signal and a horizontal line will appear during a space signal. The speed at which the signal is being shifted during transmission will cause these two lines to appear as a crossmark on the face of the monitor. Proper tuning will give maximum amplitude to both lines simultaneously.

During periods of extreme fade or "dropout" the vertical or horizontal lines will disappear for an instant and then return. If transmitter or receiver drift occurs the size of the crossmark will be reduced. The receiver should then be retuned for maximum "crossmark" amplitude. Should the shift adjustment of a transmitter drift, one indicator line will remain at maximum amplitude while the other one will be reduced.

Incorrect shifts for the filters being used may be noted by failure of both vertical and horizontal lines to reach

maximum amplitude at the same receiver setting. If the shift is within a few hundred cycles of being correct, the receiver should be tuned for equal amplitude of mark and space lines, and performance will be satisfactory. If the shift is in error, the following simple procedure will enable the operator to determine whether the shift is too narrow or too wide. The tuning procedure described in paragraph 3.4.1 is used to tune the mark signal for maximum vertical indication on the monitor scope. The receiver tuning dial is then readjusted for maximum horizontal deflection of the space signal on the scope. If during this operation it is necessary to tune the dial higher in frequency then the shift is narrow; if lower frequency tuning is required then the shift is wide. For optimum performance on narrow shift the appropriate narrow shift filters should be installed.

The precision tuned filters used in the FSC-250 allow the converter to be used for adjusting transmitter shift. It is simply a matter of tuning in the transmitter on the receiver, keying the transmitter between mark and space, and adjusting the transmitter shift control for the maximum crossmark on the monitor.

Figure 3 shows MONITOR patterns for various conditions.

3.4 RECEIVER TUNING

3.4.1 The procedure for tuning a FSK signal on a communications receiver is as follows:

3.4.1.1 Adjust receiver tuning dial for equal signal sensitivity for both mark and space frequencies. If variable selectivity is available the bandwidth should be reduced to approximately 1500 cps for receiving 850 cps shift. Be sure that both frequencies are within the bandwidth setting of the receiver. The "S" meter and AVC circuits of the receiver may be left on. When the tuning dial is properly adjusted the "S" meter will

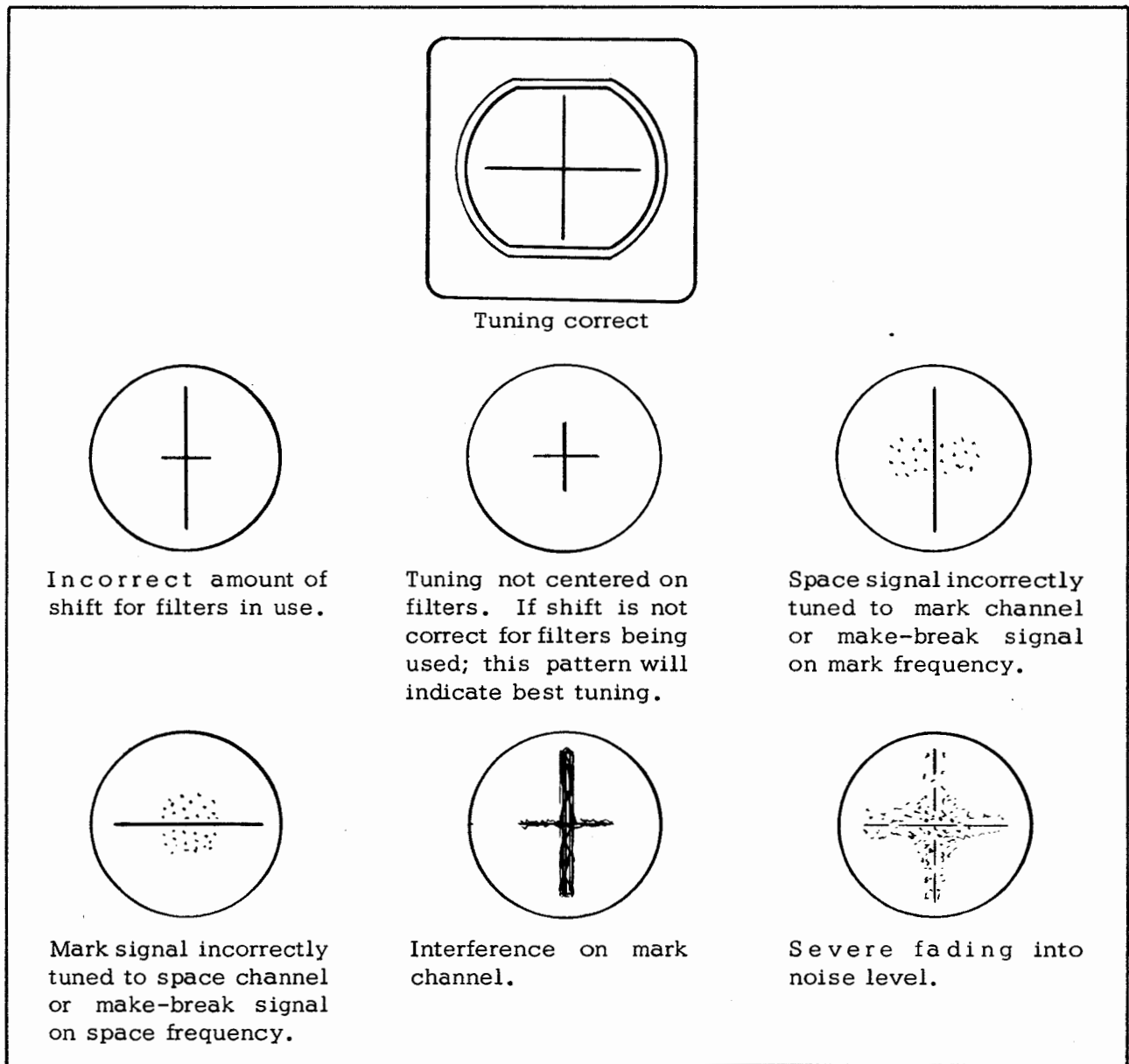


FIGURE 3 - MONITOR PATTERNS

show no variation as the signal is shifted from mark to space.

3.4.1.2 Turn b f o on.

3.4.1.3 Adjust b f o pitch control until a crossmark appears on the face of the MONITOR. The pitch control is normally adjusted so as to place the b f o on the high frequency side of the received signal. This will cause the mark signal to produce a 2125 cps tone and the space signal to produce a 2975 cps tone.

NOTE: Selectable sideband receivers

should be operated in the lower sideband position. If they incorporate "passband tuning" the passband control should be centered at 2550 cps and the receiver tuning dial adjusted until the crossmark appears on the face of the monitor. If a choice of AVC action is available, fast AVC should be used.

3.4.1.4 Once the receiver is tuned the audio gain control is adjusted so that any further variation of this control will not effect the size of the crossmark on the MONITOR.

SECTION 4

THEORY OF OPERATION

The basic operation of the FSC-250 is most easily understood by referring to the block diagram, figure 4. The operation of these blocks is described in the following paragraphs.

4.1 INPUT FILTER (OPTIONAL)

The receiver audio is fed into this filter for the purpose of removing any signals the harmonics of which may cause interference to the mark or space channels after limiting takes place. It also serves to attenuate signals near the mark and space frequencies so that they will not feed into the limiter and desensitize it towards the radio-teletype signals. The effectiveness of this filter depends upon the amount of interference present and upon the communications receiver with which it is used. If sufficient selectivity can be built into the receiver, then the usefulness of an input filter is reduced. The input and output impedance of this filter is 600 ohms so that it may be installed directly in the 600 ohm line feeding the converter.

4.2 AMPLIFIER

The incoming tone signals are amplified by V1-a (1/2 12AU7) which serves to increase these signals sufficiently to saturate the limiter which follows.

4.3 LIMITER

Both sections of V2 (12AX7) are used in a cathode coupled limiter circuit. This limiter in conjunction with V1-a provides a constant output voltage amplitude over a wide range of input variations. Therefore, the output variation of the limiter is one of frequency only. The limiter also serves to reduce the effect of noise on incoming signals. In this manner

the advantages of a frequency modulated system may be maintained.

4.4 DRIVER

A cathode follower V1-b (1/2 12AU7) serves as an impedance matching device suitable for driving the mark and space filters which follow. A balance control is provided in the output of this circuit in order to adjust for equal mark and space signal currents.

4.5 MARK AND SPACE FILTERS

These filters allow only the mark and space frequencies to pass into their respective channels. Frequencies outside of the passband of these filters are attenuated thereby preventing them from operating the keying circuits which follow. Precision tuned, 600 ohm, hermetically sealed, plug in filters were chosen so as to produce excellent long term stability. This type of filter is less susceptible to "feed around," noise pickup, and detuning by capacitive loads than high impedance filters which are frequently used. Typical response curves for filters BPF 2125A & BPF 2975A are shown in figure 5.

4.6 MARK AND SPACE AMPLIFIERS

V3-a (1/2 12AX7) amplifies the output of the space filter and feeds to the horizontal plates of the scope monitor and to the detector circuit. V3-b (1/2 12AX7) amplifies the output of the mark filter and feeds to the vertical plates of the scope monitor and to the detector circuit.

4.7 MARK AND SPACE DETECTOR

V4-a and V4-b (6AL5) respectively are space and mark channel diode detectors. The rectified tone voltages out of these

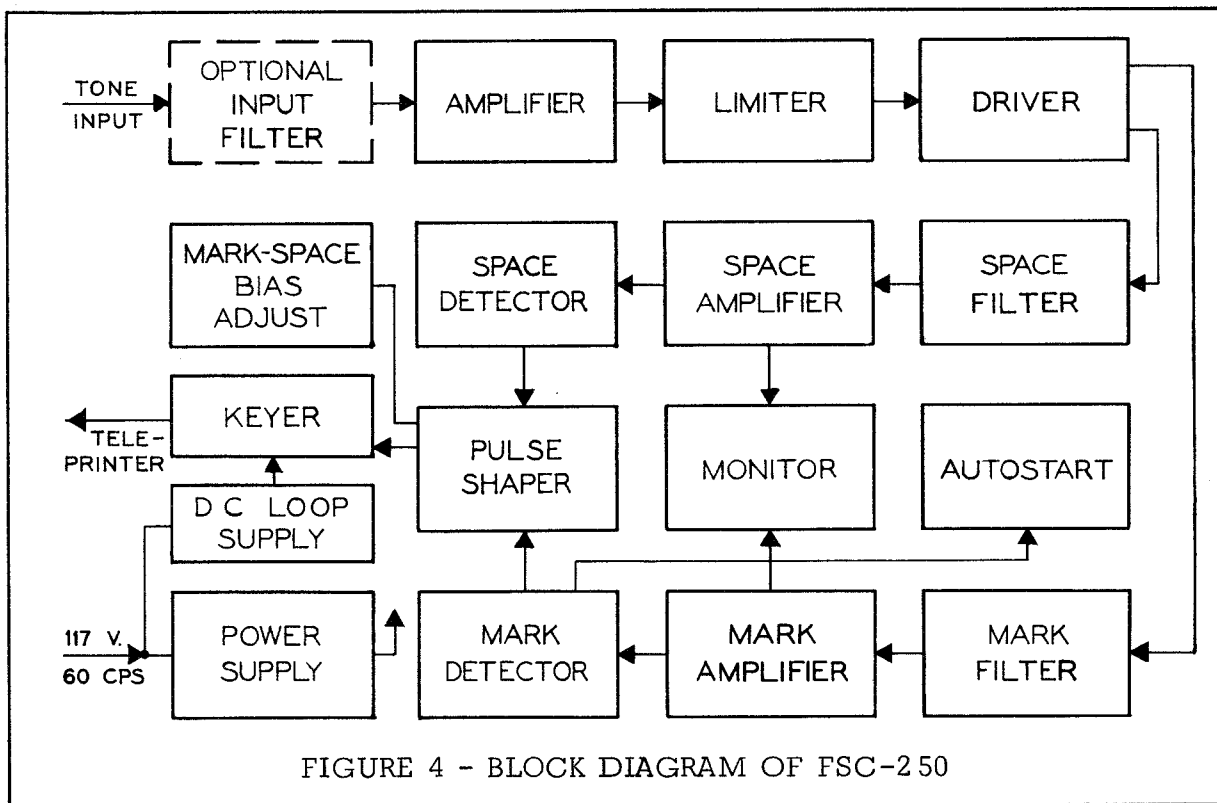


FIGURE 4 - BLOCK DIAGRAM OF FSC-250

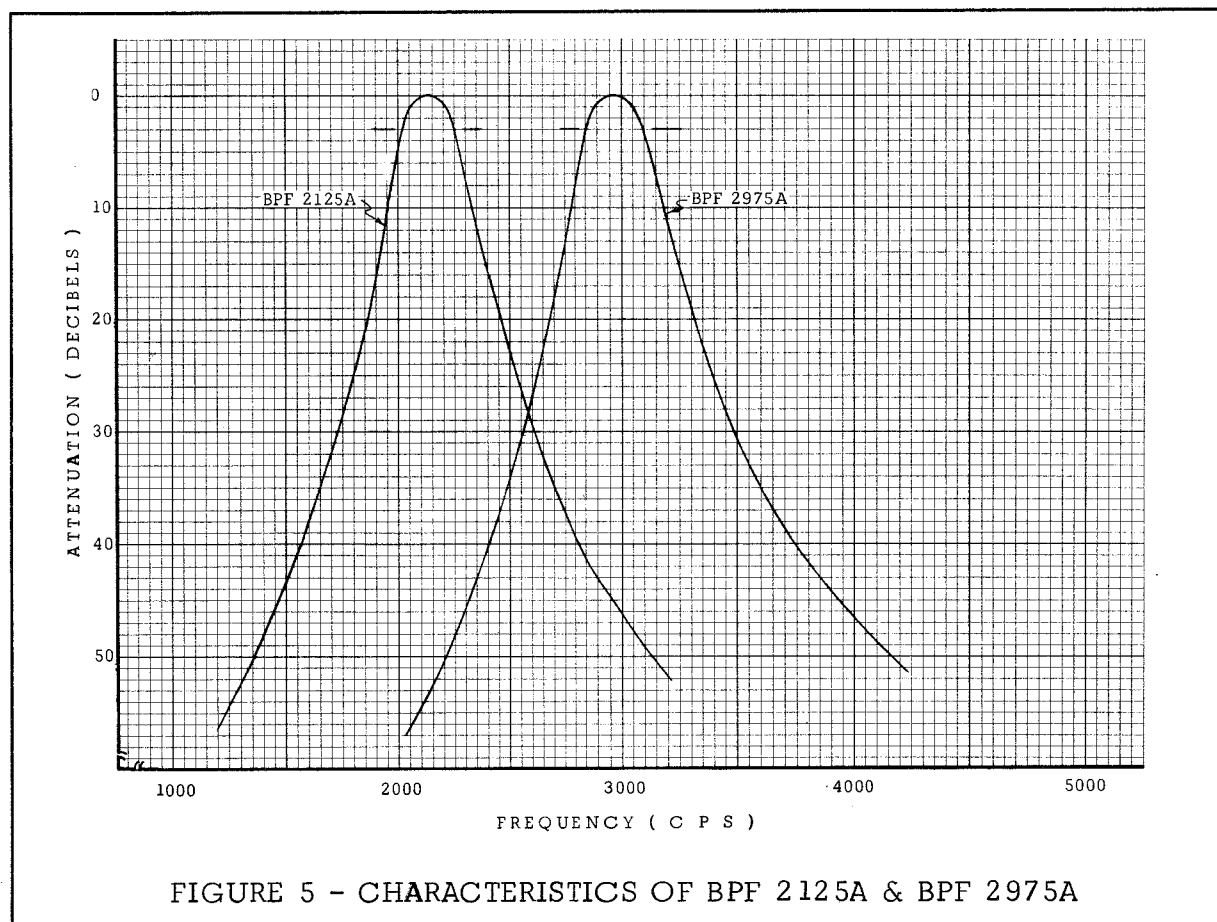


FIGURE 5 - CHARACTERISTICS OF BPF 2125A & BPF 2975A

detectors feed the pulse shaper circuit. The current through these detectors is controlled by the associated RC circuits for optimum triggering voltage for the pulse shaper which follows.

4.8 PULSE SHAPER

The detected mark and space signals are fed to opposite sides of a basic Eccles-Jordan flip-flop circuit. This circuit acts in much the same manner as a polar relay. The incoming mark signal will cause V5-b (1/2 12AX7) to conduct and remain conducting until a space signal feeding into V5-a (1/2 12AX7) reverses the action by causing V5-a to conduct and biasing V5-b to cutoff. The triggering point of each tube may be adjusted with the BIAS control. For no bias operation the stage operates in a balanced manner. For mark or space only operation this stage is biased to return to the opposite condition from that of the operating channel, thereby accepting make and break signals. Since the on-off transition of this stage is an abrupt one, the output to the keyer approaches a square wave. Glow tubes N1 thru N4 are used as DC coupling devices between the pulse shaper and the vacuum tube keyer.

4.9 KEYER

The output of the converter is a separate DC power supply which is keyed by V9 (6W6). This tube is operated either at zero grid voltage or at cutoff. In this manner the keyer tube either opens the loop for a space condition or

closes it for a mark condition. The loop current is adjusted by R-34 which is in series with the keyer and the loop power supply. An RC combination is placed in the grid circuit of V9 so as to limit the positive excursion of grid voltage, improve keyer stability, and provide a filter to any rf which might be present.

4.10 POWER SUPPLY

Three power supplies are contained in the FSC-250. A loop power supply to supply current to the teleprinter uses a silicon rectifier, a positive voltage power supply using a 6X4 rectifier (V6) and an 0A2 regulator (V8) furnishes all positive voltages to the converter circuits, and another 6X4 rectifier (V7) supplies all negative voltages.

4.11 AUTOSTART CONTROL

V11-a (1/2 12AT7) is used as a detector and cathode follower and derives a voltage from the mark rectifier. This voltage feeds relay control tube V11-b (1/2 12AT7) causing sufficient increase in plate current to operate RY-1. Time constants in this circuit are chosen for a pull in and release time of approximately one second each.

4.12 MONITOR

The scope tube V10 (2AP1) derives tone voltages from the output of the mark and space channel amplifiers. These voltages give a visual indication of the placement of the incoming signals with respect to the passband of the mark and space filters.

NOTE:

If difficulty in obtaining correct performance upon replacing tube V5 is encountered (see paragraph 5.4, page 12), we suggest trying "Raytheon" or "Tung-Sol" brand 12AX7 tubes. (In general these brands have been found to exhibit good balance between sections.) The proper selection of this tube will allow correct performance for MARK only and SPACE only operation, as well as giving proper voltages as indicated on page 12, figure ~~10~~, for BOTH operation.

SECTION 5

MAINTENANCE

The model FSC-250 converter has been designed to provide long term trouble free operation with a minimum of maintenance. Normal failures such as burned out tubes or worn controls are easily noted and repaired. Should a more serious failure occur, only a competent technician familiar with frequency shift techniques should be allowed to service this equipment.

Figures 6, 7, and 8 show the location of components within the FSC-250.

5.1 TUBES

5.1.1 All tubes are easily accessible through the top of the unit by removing the sheet metal screws holding the top cover in place. The cathode ray tube may be removed by prying the MONITOR bezel off, releasing the tube clamp, and gently pushing the base of the tube forward, removing it from its socket.

5.1.2 The neon coupling tubes N1 through N4 should remain lighted at all times when the power is on and the keying circuits are operable.

5.2 COMPONENTS

The remaining converter components are accessible by removing the sheet metal screws holding the bottom cover in place. For easy maintenance most resistors and capacitors are mounted on terminal boards and are clearly identified.

5.3 POWER SUPPLY

The underside of the power supply may be serviced by removing both the bottom cover and the four screws holding this subassembly to the side of the case. The power supply may then be pulled away from the case, tilted, and the bottom exposed for servicing.

5.4 MARK - SPACE BIAS ADJUSTMENT

Proper adjustment of this control is made at the factory. However, with tube ageing or replacement it may be necessary to reset this control for optimum performance. Correct procedure for making this adjustment is as follows:

(a) With the converter operating feed a variable frequency tone source to the input (terminals 11 & 12). (If an audio oscillator is not available a communications receiver may be used by beating the b f o against a crystal calibration oscillator.)

(b) Remove the jumper and connect a 50 microampere DC meter between terminals 9 and 10 (+) on the rear panel.

(c) Connect a 100 ma. DC meter in series with the DC loop.

(d) Place CHANNEL selector in BOTH position and KEYING selector in NORMAL position.

(e) Slowly adjust tone oscillator alternately between the mark and space frequencies and note diode current required for output current to change from marking (current) to spacing (no current) and vice versa. Adjust the bias control until the diode current required to trigger from space to mark is the same as that required to trigger from mark to space. This is the point of balance or zero bias.

(f) Loosen the set screw and position the knob on the BIAS control to the vertical indicator line, being careful not to disturb the setting of the control during this operation. Tighten set screw, remove meters, and reconnect jumper between terminals 9 and 10. This adjustment is now complete. The zero bias position will normally occur within 60 degrees of the center of rotation of the BIAS control.

If any readjustment is required on this control it is well to check the balance of the pulse shaper and associated components. This may be done by connecting a VTVM from terminal 6 on rear to ground (terminal 4) and observing voltage limits resulting from a mark and space tone for both NORMAL and REVERSE positions of the KEYING selector. These limits should be within five volts of each other when the BIAS control is set for zero bias. If this condition is not satisfied, tube V5 should be replaced. If a satisfactory tube V5 cannot be obtained, it may be necessary to replace R-21 with another value as indicated on the parts list. Other possible faults are unsatisfactory lamps N1 through N4 or components R-21 through R-30.

NOTE: The resistors used in conjunction with V5 are mostly of 5 percent tolerance. In order not to effect their values during any soldering operation, it is well to use a long nose pliers on the resistor lead to act as a heat sink to prevent heat from reaching the resis-

tor proper.

5.5 BALANCE & GAIN ADJUSTMENT

Channel balance adjustment is described in paragraph 3.2.2. After channels are balanced, the diode current as measured between terminals 9 and 10 (with signal input) should be adjusted with R8 to approximately 30 microamperes. Failure to obtain correct balance may be due to a faulty channel filter, highly unbalanced tube V3, faulty capacitors C5 or C6, or a shorted C R tube (V 10).

5.6 VOLTAGE MEASUREMENTS

Figure 9 is a table of voltage measurements which will help in locating difficulties in the FSC-250. Voltages should be checked on all converter tubes first. If power supply voltages are incorrect, the power supply subassembly may then be removed for checking. All DC voltage measurements should be obtained with a VTVM having an input impedance of 10 megohms or greater.

FIGURE 9 - TABLE OF VOLTAGE MEASUREMENTS

Voltage measurements to ground except as noted. Controls set for zero BIAS, BOTH channels, and MARK keying. Input: 2125 cps tone of approximately 100 mv. rms amplitude. (Increase amplitude until limiting starts. See paragraph 3.4.1.4.) Line voltage = 117 volts, 60 cps.

	1	2	3	4	5	6	7	8	9	10	11
V1	18	0	.4	0	0	150	0	6.5	6.3 ac		
V2	150	0	5	0	0	136	0	5	6.3 ac		
V3	130	0	1.2	0	0	130	0	1.2	6.3 ac		
V4	7	0	0	6.3 ac	.8	0	-2.6				
V5	77	13.5	13.5	0	0	122	10	13.5	6.3 ac		
V6	265 ac	NC	6.3 ac	0	NC	265 ac	275				
V7	-330	NC	**1	**1	NC	-330	265 ac				
V8	NC	NC	NC	NC	150	NC	0				
V9	0	**2	**3	**3	0	NC	**2	0			
V10, **4		-180/-230	25/200	-100/-180	NC	25/200	136	136	136	-230/-250	
V11, **5	110	3.5/12.5	6.5/12	0	0	150	-2.2	3.5/12.5	6.3 ac		

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Note 1: 6.3 v ac measured between pins 3 & 4 of V7.

Note 2: 6.3 v ac measured between pins 2 & 7 of V9.

Note 3: For loop current of 30 ma. voltage is 38 v.;
for loop current of 60 ma. voltage is 60 v.
This voltage may be checked at terminal 1
on rear panel.

Note 4: Maximum and minimum voltages are given.
Voltages will vary with position of rear
panel scope controls. 6.3 v. ac between
pins 1 and 11.

Note 5: Minimum voltages are with no signal input.
Maximum voltages are with mark signal input.

With the keying selector on NORMAL the following measurements should be obtained:

The voltage from J1-6 to Gnd. = 5 volts ($\pm 5v$) for mark tone input, -40 volts ($\pm 5v$) for space tone input.
The total voltage across lamps N1 & N2 and across lamps N3 & N4 should be 115 ± 5 volts.

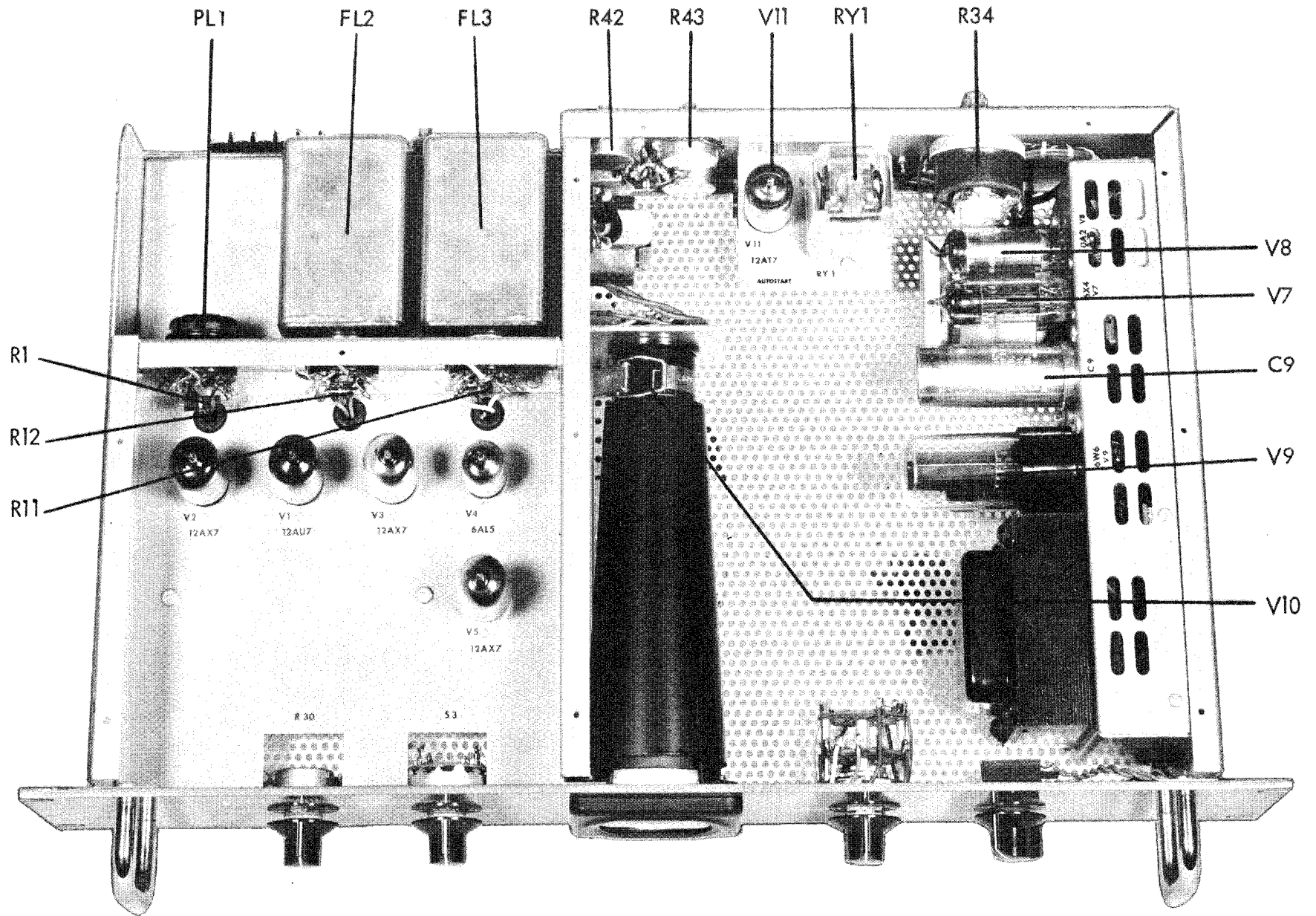


FIGURE 6 - TOP VIEW OF ELECTROCOM FSC-250 (Cover removed)

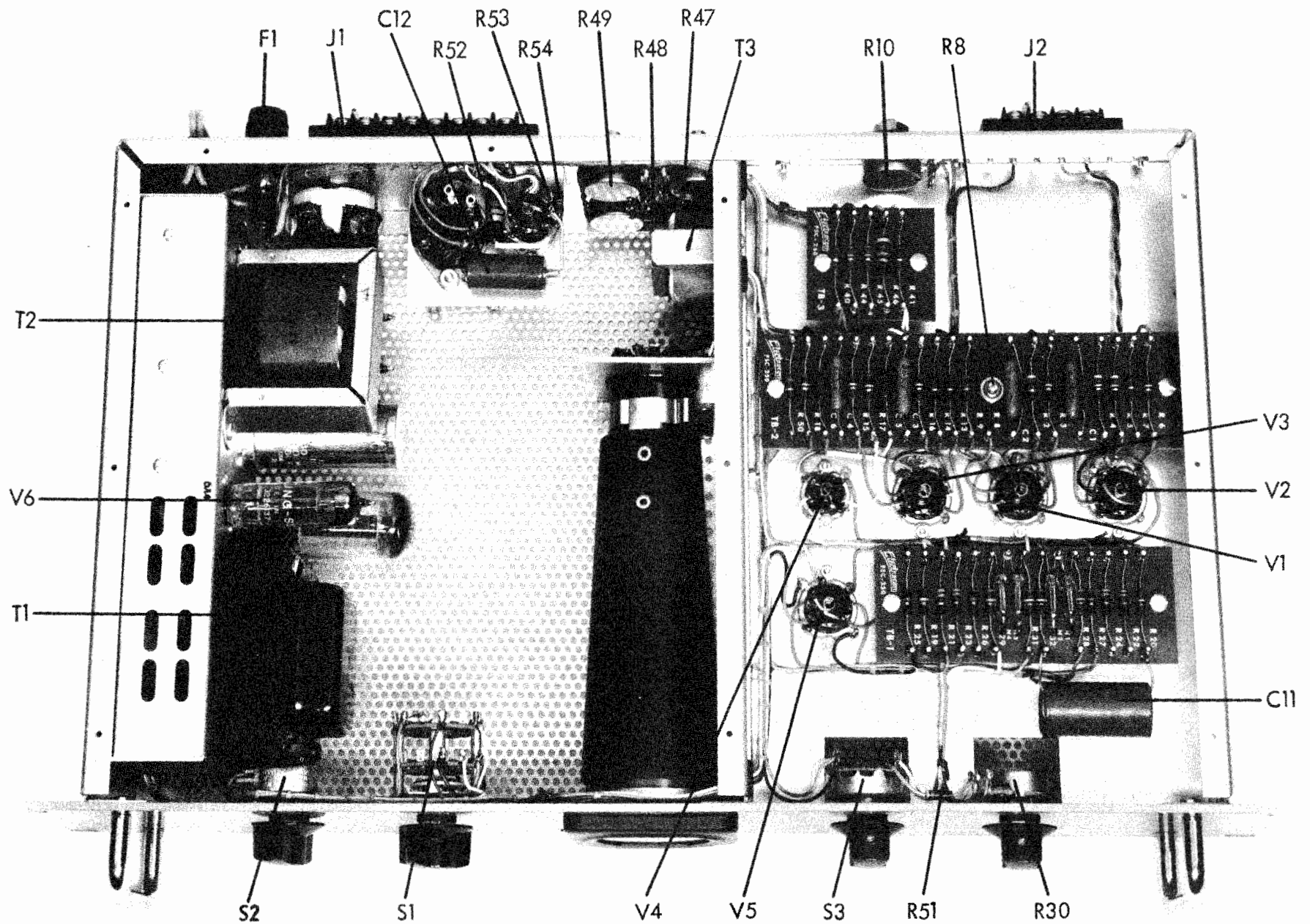


FIGURE 7 - BOTTOM VIEW OF ELECTROCOM FSC-250 (Cover removed)

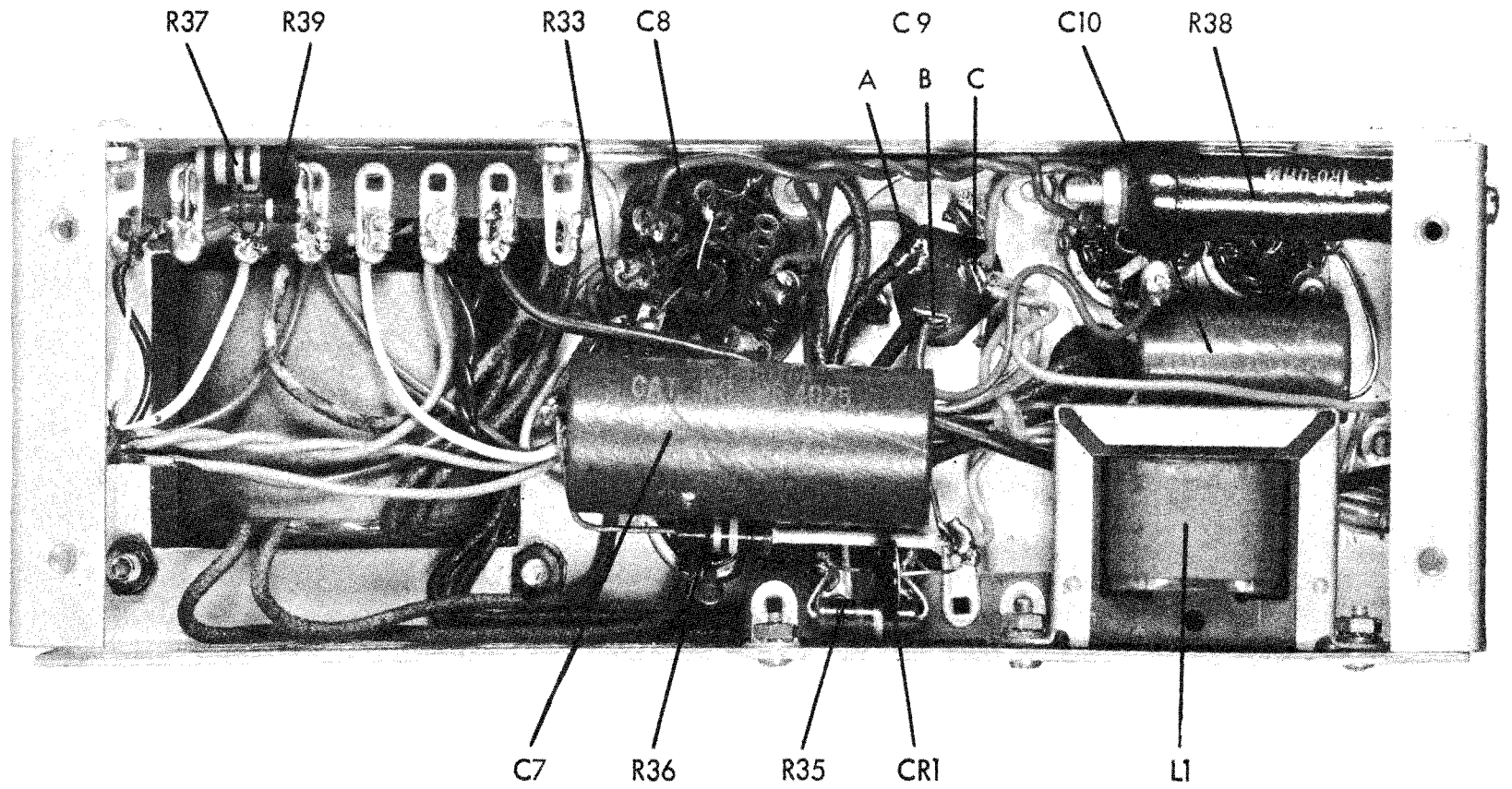
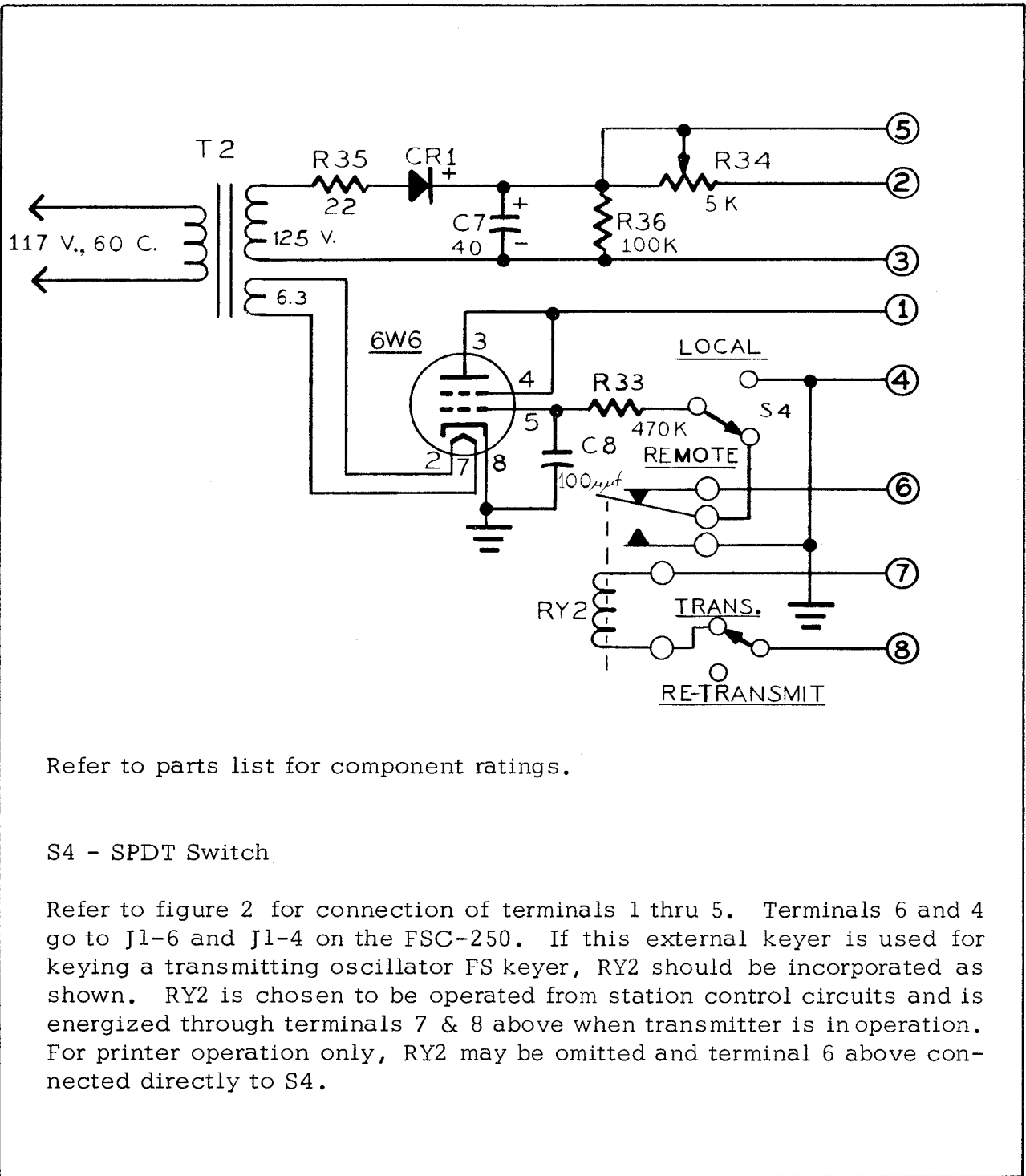


FIGURE 8 - BOTTOM VIEW OF POWER SUPPLY SUBASSEMBLY, FSC-250

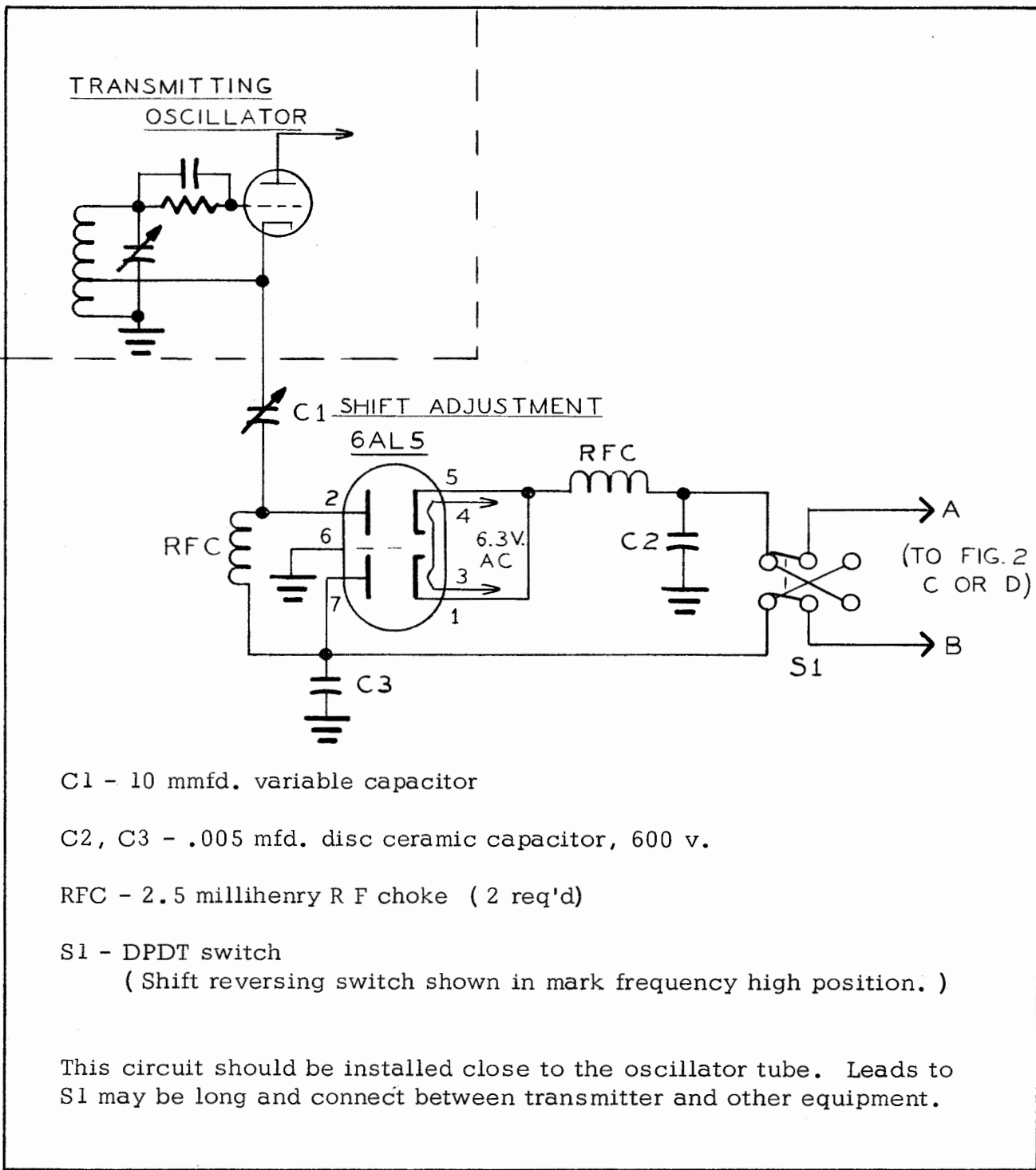


Refer to parts list for component ratings.

S4 - SPDT Switch

Refer to figure 2 for connection of terminals 1 thru 5. Terminals 6 and 4 go to J1-6 and J1-4 on the FSC-250. If this external keyer is used for keying a transmitting oscillator FS keyer, RY2 should be incorporated as shown. RY2 is chosen to be operated from station control circuits and is energized through terminals 7 & 8 above when transmitter is in operation. For printer operation only, RY2 may be omitted and terminal 6 above connected directly to S4.

EXTERNAL KEYSER CIRCUIT
FIGURE 10



C1 - 10 mmfd. variable capacitor

C2, C3 - .005 mfd. disc ceramic capacitor, 600 v.

RFC - 2.5 millihenry R F choke (2 req'd)

S1 - DPDT switch

(Shift reversing switch shown in mark frequency high position.)

This circuit should be installed close to the oscillator tube. Leads to S1 may be long and connect between transmitter and other equipment.

FREQUENCY SHIFT KEYER
(for transmitting oscillator)
FIGURE 11

SERVICE PARTS LIST

ITEM	DESCRIPTION	ELECTROCOM PART NUMBER
C1, C2 C3, C4	Capacitor, tubular ceramic, .005 mfd., GMV, 600 v.	10D6-502
C5, C6	Capacitor, dipped mica, .00043 mfd., ± 5%, 500 v.	20DM15-431J
C7	Capacitor, tubular electrolytic, 40 mfd., 250 v.	11BR-4025
C8	Capacitor, disc ceramic, .0001 mfd., 600 v.	11L-10T1
C9	Capacitor, electrolytic, 10, 10, 10 mfd., 450 v.	11CO-240
C10	Capacitor, tubular electrolytic, 2 mfd., 450 v.	11BR-245
C11	Capacitor, tubular electrolytic, 8 mfd., 450 v.	11BR-845
C12	Capacitor, tubular electrolytic, 50 mfd., 25 v.	11BBR-5025
C13	Capacitor, disc ceramic, .001 mfd., 600 v.	11L-10D1
CR1	Rectifier, Silicon, 200 ma., 400 piv	250-030
F1	Fuse, 1 ampere Slow Blow, 125 v., 3AG	313-010
FL2	Filter, bandpass, 250 cps bandwidth, 2125 cps.	BPF 2125A
FL3	Filter, bandpass, 250 cps bandwidth, 2975 cps.	BPF 2975A
J1	Connector, strip, bakelite, 8 screw terminals	250-031
J2	Connector, strip, bakelite, 4 screw terminals	250-032
L1	Inductor, 7 hy., .05 a., 550 ohm dc	18C1-707
N1, N2	Lamps, 2 NE2 neon lamps matched for 110 to 120 volt drop at .3 ma.	250-034
N3, N4	Same as N1, N2.	250-034
PL1	Plug, octal, jumper pins 1 & 2, 4 & 7.	250-036
PL2	Plug, cord set, 6 feet, plastic	1917-106
R1	Resistor, fixed comp., 560 ohm, 5%, 1 w.	RC10A561
R2	Resistor, fixed comp., 470 ohm, 10%, 1/2 w.	RC05B471

R3	Resistor, fixed comp., 150K ohm, 10%, 1/2 w.	RC05B154
R4, R5	Resistor, fixed comp., 470K ohm, 10%, 1/2 w.	RC05B474
R6	Resistor, fixed comp., 220K ohm, 10%, 1/2 w.	RC05B224
R7	Resistor, fixed comp., 5,600 ohm, 10%, 1/2 w.	RC05B562
R8	Resistor, variable comp., slotted shaft, 500K ohm, 30%, 1/4 w., linear taper	JX 3553
R9	Resistor, fixed comp., 820 ohm, 10%, 1/2 w.	RC05B821
R10	Resistor, variable comp., locking bushing, 500 ohm, 15%, 1/2 w., linear taper	HQ 3568
R11, R12	Resistor, fixed comp., 560 ohm, 5%, 1/2 w.	RC05A561
R13, R14	Resistor, fixed comp., 2,200 ohm, 10%, 1/2 w.	RC05B222
R15, R16	Resistor, fixed comp., 220K ohm, 10%, 1/2 w.	RC05B224
R17, R18	Resistor, fixed comp., 100K ohm, 10%, 1/2 w.	RC05B104
R19, R20	Resistor, fixed comp., 220K ohm, 5%, 1/2 w.	RC05A224
R21	Resistor, fixed comp., 3.3 Megohm, 5%, 1/2 w. This value is nominal. Actual value is selected during test and may vary between 3.0 Megohms and 3.9 Megohms.	RC05A335
R22, R23 R24	Resistor, fixed comp., 3.3 Megohm, 5%, 1/2 w.	RC05A335
R25	Resistor, fixed comp., 20K ohm, 5%, 1/2 w.	RC05A203
R26, R27	Resistor, fixed comp., 10 Megohm, 5%, 1/2 w.	RC05A106
R28, R29	Resistor, fixed comp., 75K ohm, 5%, 1/2 w.	RC05A753
R30	Resistor, variable comp., rd. shaft, 25K ohm, 15%, 1/2 w., linear taper	HQ 3571
R31, R32	Resistor, fixed comp., 820K ohm, 5%, 1/2 w.	RC05A824
R33	Resistor, fixed comp., 470K ohm, 10%, 1/2 w.	RC05B474
R34	Resistor, variable wirewound, 5K ohm, .07 a.	HO-162
R35	Resistor, fixed comp., 22 ohm, 10%, 1 w.	RC10B220

R36	Resistor, fixed comp., 100K ohm, 10%, 1 w.	RC10B104
R37	Resistor, fixed comp., 33K ohm, 10%, 1 w.	RC10B333
R38	Resistor, fixed w.w., 2,750 ohm, 10%, 20 w.	RW200B2751
R39, R40 R41	Resistor, fixed comp., 2.2 Megohm, 10%, 1/2 w.	RC05B225
R42, R43	Resistor, variable comp., slotted shaft 500K ohm, 15%, 1/2 w., linear taper	HQ 3572
R44, R45	Resistor, fixed comp., 68K ohm, 10%, 1/2 w.	RC05B683
R46	Resistor, fixed comp., 47K ohm, 10%, 1 w.	RC10B473
R47	Resistor, variable comp., slotted shaft 25K ohm, 15%, 1/2 w., linear taper	HQ 3569
R48	Resistor, fixed comp., 15K ohm, 10%, 1/2 w.	RC05B153
R49	Same as R47	HQ 3569
R50	Resistor, fixed comp., 2.2 Megohm, 10%, 1/2 w. This value is nominal. Actual value is selected during test and may vary between 1.5 Megohms and 3.3 Megohms.	RC05B225
R51	Resistor, fixed comp., ^{5.6} 4.7 Megohm, 5%, 1/2 w.	RC05A 475 565
R52	Resistor, fixed comp., 18K ohm, 10%, 2 w.	RC20B183
R53	Resistor, fixed comp., 820 ohm, 10%, 1/2 w.	RC05B821
R54	Resistor, fixed comp., 10K ohm, 10%, 1/2 w.	RC05B103
RY1	Relay, 5000 ohm, 7 ma., DPDT, octal base	250-033
S1	Switch, rotary, phenolic, 4P5Position, shorting	PA022-2142
S2	Switch, rotary, SPST, 3a., 125 v.	151-561B
S3	Switch, rotary, 3P3Position	143-233J
T1	Transformer, Power, Primary - 117 v., 60 cps Secondaries - 480 vct, .07 a.; 6.3 v., 3.0 a.	18PM8-419

T2	Transformer, Power, Primary - 117 v., 60 cps Secondaries - 125 v., .06 a.; 6.3 v., 1.8 a.	18PA8-421
T3	Transformer, Filament, Primary - 117 v., 60cps Secondary - 6.3 v., .6 a.	18P6-465
V1	Electron tube, type 12AU7	12AU7
V2, V3	Electron tube, type 12AX7	12AX7
V4	Electron tube, type 6AL5	6AL5
V5	Electron tube, type 12AX7	12AX7-B
V6, V7	Electron tube, type 6X4	6X4
V8	Electron tube, type 0A2	0A2
V9	Electron tube, type 6W6GT	6W6GT
V10	Cathode ray tube, type 2AP1/2AP1A	2AP1
V11	Electron tube, type 12AT7	12AT7
XF1	Receptacle, fuse holder, 3AG	13-HKP
XFL1, XFL2 XFL3, XRY1 XV9	Receptacle, octal, bakelite; 1 1/2" mtg. ctrs.	167-7MIP8
XV1, XV2 XV3, XV5 XV11	Receptacle, 9 pin miniature tube socket, black phenolic, bottom mtg., 1 1/8 mtg. ctrs.	17370
XV4, XV6 XV7, XV8	Receptacle, 7 pin miniature tube socket, black phenolic, bottom mtg., 7/8" mtg. ctrs.	17300
XV10	Receptacle, magnal	250-035

Electrocom[®] INDUSTRIES

Communications Products and Systems

1105 NORTH IRONWOOD DRIVE, SOUTH BEND, INDIANA 46615

USE OF FILTERS BPF 2125P-110 AND BPF 2295P-110 WITH ELECTROCOM[®] FSC-250 F. S. CONVERTER

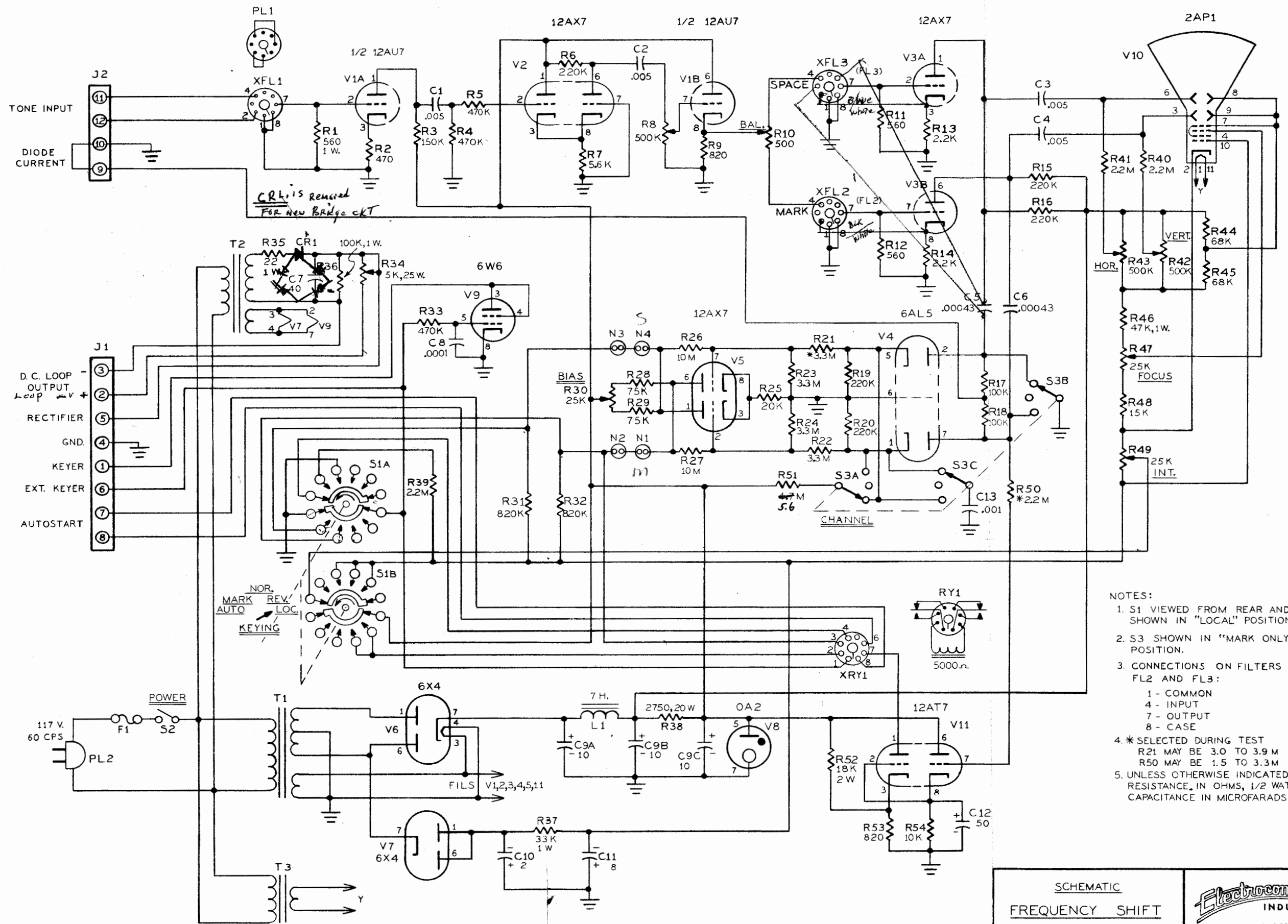
Filters BPF2125P-110 & BPF 2295P-110 are designed for use with the FSC-250 frequency shift converter for receiving frequency shifts of 170 ± 120 cps, using tone frequencies of 2125 and 2295 cps.

The FSC-250 must be modified as follows for use with these filters:

1. Connect a wire (red-white, 4-1/2 inches long) from space filter socket (XFL3) pin 3, to one end of capacitor C5 on terminal board TB-2. Connect another wire (red-white, 4-1/2 inches long) from space filter socket (XFL3) pin 6 to the other end of C5 on TB-2.
2. Connect a wire (Blue-white, 5 inches long) from space filter socket (XFL3) pin 2 to R13 (2.2K) on TB-2. Connect to end of resistor adjacent to component identification marking.
3. Connect wire (black-white, 4 inches long) from mark filter socket (XFL2) pin 2 to R14 (2.2K) on TB-2. Connect to end of resistor adjacent to component identification marking.
4. Install filter BPF 2125P-110 in "Mark" filter socket and BPF 2295P-110 in "Space" filter socket.
5. When using a selectable sideband receiver, operate the receiver in lower sideband position to obtain normal sensing of frequency shift.

Correct tuning for 170 cps shift is indicated by a vertical oval for mark and a horizontal oval for space. As the input tone is varied between the mark and space frequencies, the vertical oval will appear to turn towards the left until the space frequency is obtained. For shifts less than 170 cps, the tone frequencies should be adjusted to produce two ovals equally spaced from an imaginary line drawn approximately 30 degrees to the left from vertical.

(All of the above modifications have been factory installed for converters supplied with these filters.)



*C.R.L. is removed
For new Bridge ckt*

- NOTES:
1. S1 VIEWED FROM REAR AND SHOWN IN "LOCAL" POSITION.
 2. S3 SHOWN IN "MARK ONLY" POSITION.
 3. CONNECTIONS ON FILTERS FL2 AND FL3:
1 - COMMON
4 - INPUT
7 - OUTPUT
8 - CASE
 4. * SELECTED DURING TEST
R21 MAY BE 3.0 TO 3.9M
R50 MAY BE 1.5 TO 3.3M
 5. UNLESS OTHERWISE INDICATED, RESISTANCE, IN OHMS, 1/2 WATT CAPACITANCE IN MICROFARADS

SCHEMATIC FREQUENCY SHIFT CONVERTER MODEL FSC-250		 1105 N. IRONWOOD DRIVE SOUTH BEND, INDIANA
250001-V	REV E DATE 2-12-62	