FREQUENCY-SHIFT RECEIVING TERMINALS MODELS FSY.1 AND FSY.2

INSTRUCTION MANUAL TL/17/222/1

INSTALLATION
OPERATION
MAINTENANCE.

AUTOMATIC TELEPHONE & ELECTRIC CO., LTD.,
RADIO AND TRANSMISSION DIVISION
STROWGER HOUSE, 8 ARUNDEL STREET, LONDON, W.C.2.
TELEPHONE TEMPLE BAR 9262.

DESIGNED BY THE ASSOCIATED COMPANY
BRITISH TELECOMMUNICATIONS RESEARCH LTD.,
TAPLOW COURT, TAPLOW, BUCKINGHAMSHIRE,
ENGLAND.

CONTENTS

FREQUENCY-SHIFT RECEIVING TERMINALS
MODELS FSY.1 AND FSY.2

INTRODUCTION

Frequency-Shift Receiving Terminals Models FSY.1 and FSY.2 are designed to work in conjunction with one radio receiver or two in diversity for frequency-shift reception. These equipments are suitable for the reception of either hand or automatic radio-telegraph or radio-teleprinter signals. Phase modulation of 200 c/s can be accepted at low keying speeds.

The terminals accept frequency-shift signals at audio frequency and filter, amplify and convert them to D.C. signals by means of a telegraph relay for the operation of teleprinters, tape recorders etc.

Large differences in the shift employed, and appreciable drift of the centre carrier frequency can be accepted.

Model FSY.1 consists of one converter unit and one power unit and is for use with a single receiver, Model FSY.2 consists of two converter units and one power unit and provides for dual, space, polarity, or frequency diversity reception.

All converter and power units have front panels $3\frac{1}{2}$ inches high suitable for mounting on international 19 inch racks or in table cabinets. All controls are mounted on the front panels.

A photograph of Terminal FSY.2 is shown in Figure 1.

FIGURE 1. TERMINAL FSY.2.

FREQUENCY-SHIFT RECEIVING TERMINALS
MODELS FSY.1 AND FSY.2

CIRCUIT PRINCIPLES

GENERAL

A block schematic of Frequency-Shift Converter Unit FSY.1 is shown in Figure 2 and detailed circuit diagrams of the Converter Unit and Power Unit in Figures 12 and 6.

Audio frequency signals from the receiver are fed through an attenuator network, and band-pass filter to a carrier amplifier-limiter and the constant amplitude output of this limiter passes to a linear demodulator which discriminates between mark and space signals. The demodulator output passes to a Keying Amplifier-Limiter which operates a telegraph relay.

When used for dual diversity the telegraph relay is fitted in one Converter Unit only. The diversity connection between the two units causes this relay to follow the stronger signal of the two in a conventional manner.

INPUT

The converter units are designed to operate from the unbalanced, audio-frequency output of radio receivers or lines having an impedance of 600 ohms, with a carrier centre frequency of approximately 2 550 c/s.

The resistive "T" type network consisting of composite resistors, R1, R2, R3, R5 and R6 is inserted to improve the matching of the band-pass filter BPF to the line over a wide range of frequencies.

The input band-pass filter has a pass-band of 1 700 to 3 500 c/s and the attenuation at all frequencies below 1 500 c/s and above 3 800 c/s, is greater than 40 db. The mid-band loss is about 2 db. The loss/frequency characteristic of this filter is presented in Figure 3. A high degree of stability under all climatic conditions is ensured by mounting the filter in a hermetically sealed box.

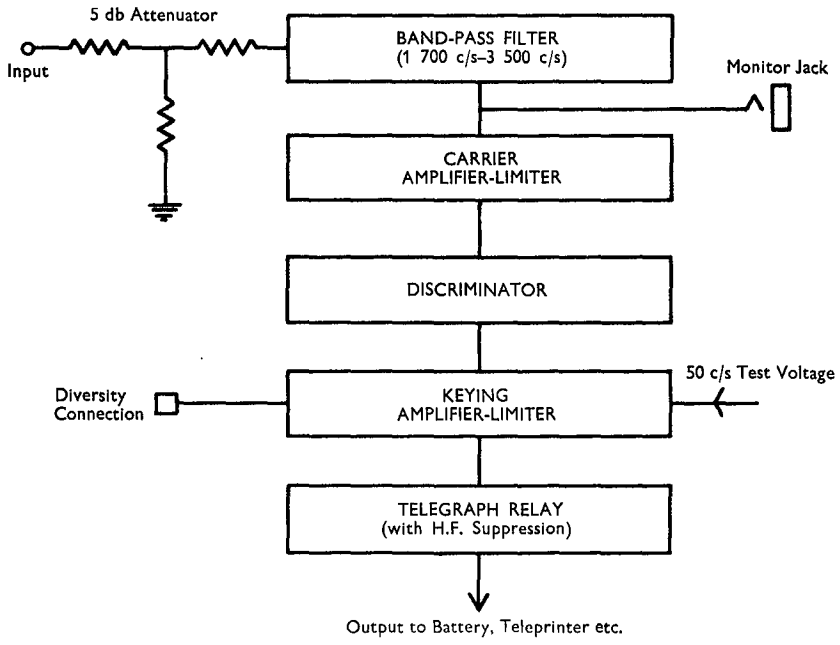


FIGURE 2. BLOCK SCHEMATIC FSY.1.

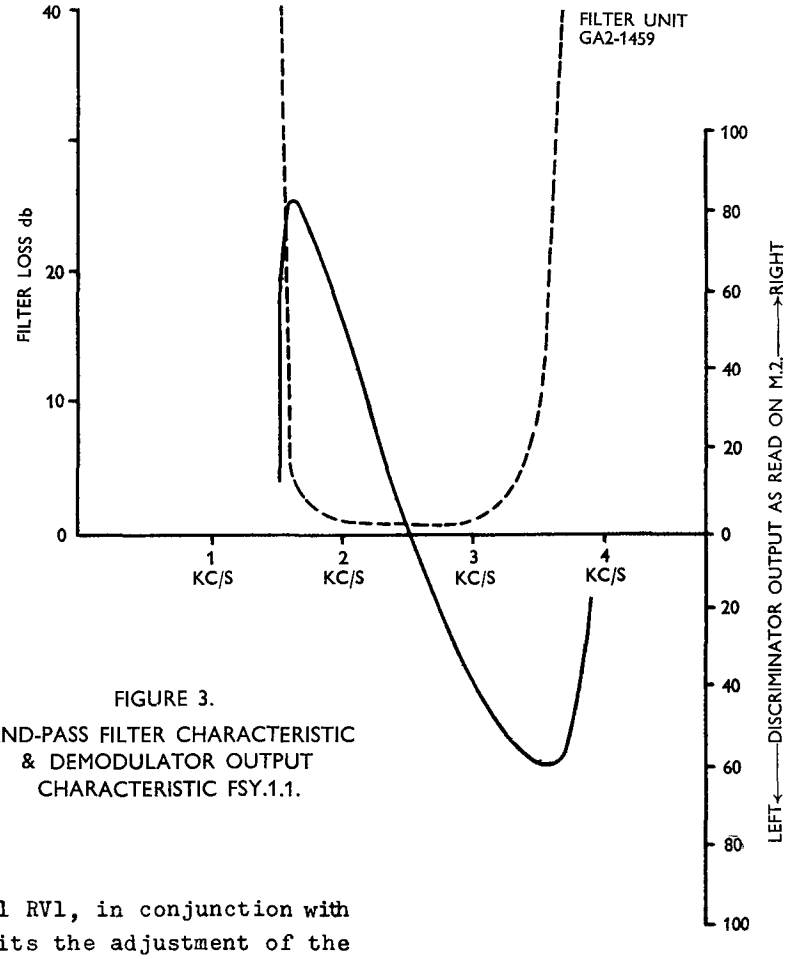


FIGURE 3.
BAND-PASS FILTER CHARACTERISTIC
& DEMODULATOR OUTPUT
CHARACTERISTIC FSY.1.1.

Volume control RV1, in conjunction with Voltmeter M.1 permits the adjustment of the input signal to the required level without disturbing the controls of the receiver. Filtered mark and space signals can be monitored by means of a pair of headphones through the Jack JK. Socket SK1 (green) is provided for connection to a common AFC/BFO unit Model FSR4.1 or Cathode Ray Tuning Indicator Model CRM.1, which can be supplied for use with this equipment.

CARRIER AMPLIFIER-LIMITER.

To make full use of the outstanding advantages of the frequency-shift system in the presence of extreme and rapid variations of input level, the carrier frequency is amplified in a high-gain non-linear amplifier consisting of three valves V1, V2 and V3, type EF 50 (CV1091). This amplifier-limiter has a constant amplitude output with transitions coinciding with the passage of the instantaneous voltage of the input carrier signal through zero. Amplitude variations in the carrier signal are thus removed without producing telegraph distortion or bias. Input variations between -50 db and + 20 db can be accepted.

DEMODULATOR.

The linear demodulator is a two-branch discriminating network consisting of capacitor C12 and inductance L1 which have equal impedances at the carrier centre-frequency, of 2 550 c/s. During the final production testing of the unit, capacitor C12 is adjusted by the addition of some or all of the capacitors C8, C9, C10 and C11, to obtain the correct centre-frequency of the discriminator. At any other frequency in the range of the band-pass filter BPF, the circuit becomes unbalanced and in consequence the output from the differential discriminator V4, 6H6 (CV 1930) will be positive for higher frequencies and negative for lower frequencies. A typical combined frequency/output characteristic of the discriminator and band-pass filter is shown in Figure 3.

The balanced differential connection of this two-branch frequency discriminating network minimises the response to pulse type noise. The voltage/frequency curve of the discriminator is essentially linear centred at about 2 550 c/s. The filtered D.C. components of the received intelligence is indicated on micro-ammeter M2, and may be presented on a Cathode Ray Tuning Indicator Model CRM.1.

KEYING AMPLIFIER-LIMITER

The following three valves V5, V6 and V7 type EF50 (CV1091) comprise a high-gain, non-linear D.C. amplifier operating telegraph relay RL. To improve the signal-to-noise ratio and to remove any residual audio frequency components valve V5 type EF50 (CV1091) employs a negative feedback via capacitors C17 and C18. High-speed keying is received with key S3 in the HIGH position, and at low speed an additional capacitor C17 is connected in parallel with C18 by operating Key S3 to the LOW position. Transition of the square-wave keying output is here determined by the passage of the discriminator output through a very small polar amplitude range.

Bias control for the correction of telegraph distortion is obtained by the adjustment of RV.4.

TELEGRAPH RELAY

The telegraph relay, Carpenter Type 3N1/TR is of the plug-in type. It will operate at high speeds without bounce and is accessible from the front panel for ease of adjustment and maintenance. A removable mumetal cover is fitted. The operating contacts may be used for either single-current or double-current keying as required. H.F. suppression and spark quench circuits are provided.

FUNCTIONAL SWITCH

Switches S1a, S1b, S1c and S1d are all ganged on a single control spindle with six click-stop positions as detailed on the table below.

PLUNGER KEYS

Three locking plunger keys provide the following facilities. Key S2 in the ON position connects the demodulator to the DC amplifier and in the OFF position disconnects the circuit.

SWITCH POSITIONS

SW ARM	TEST	+ Marking current to line Positive		OFF	− Marking current to line Negative.	
		VARIABLE BIAS	NEUTRAL BIAS		VARIABLE BIAS	NEUTRAL BIAS
S1a	Mains frequency test voltage connected to keying amp: limiter.	Discriminator connected to keying amplifier limiter.		Disconnects the input to keying amplifier limiter	Discriminator connected to keying amplifier limiter.	
S1b	Neutral bias.	Bias control (RV4)		Neutral bias		Bias control (RV4)
S1c } S1d }	Relay contacts connected to output line			Steady mark to the output line.	Reverses the relay contact to the output line.	

Key S3 SPEED is set to the HIGH position for high-speed keying and at LOW inserts additional capacitance in the circuit to improve low-speed operation.

Key S4 in the LINE position connects micro-ammeter M2 to the output circuit for line current measurements and in the DISC position connects M2 to the demodulator output circuit.

DIVERSITY OPERATION

When two converter units are operated in diversity the telegraph relay is fitted to one converter only, and the keying amplifier-limiter of the second converter is not in operation. The outputs from both demodulators are applied to the keying amplifier-limiter of the converter fitted with the relay, and thus the telegraph relay is operated by the stronger signal of the two.

POWER SUPPLY

The Power Unit is of conventional design employing a valve type 5Z4G (CV1864) for H.T. rectification. A red lamp indicates that the main switch is closed and a green lamp that the stand-by switch is closed. This stand-by switch breaks the H.T. circuit, enabling the equipment to be held in readiness with current supplied to all valve heaters. Sufficient output current is available to provide for two converter units or one AFC/BFO unit.

Power Unit, Model FSR.1.2 has a mains transformer for use on 210, 230, 250 volts, 50-60 c/s.

Power Unit, Model FSR.1.2A has a transformer for use on 90, 110, 130, 145 volts, 50-60 c/s.

Power Unit Model FSR.1.2B has a mains transformer with the primary winding consisting of two sections which are connected in series for use on 210, 230, 250 volts and connected in parallel for use on 105, 115 and 125 volts, 50-60 c/s.

The circuit diagrams of the power units are shown in Figure 6.

FREQUENCY-SHIFT RECEIVING TERMINALS
MODELS FSY.1 AND FSY.2

INSTALLATION PROCEDURE

Before mounting the units on a rack or in a cabinet, ensure that all valves are pushed firmly in their sockets. Remove the rear cover from the power unit and adjust the mains transformer tapping to correspond to the value of the mains supply available. Replace the cover.

CONNECTIONS

The units are designed to be mounted on an international 19 inch rack or in a cabinet in the order shown in Figure 4. If required, the power unit may be mounted remote from the converter units. Connections between the units are made by the plugs and sockets provided as shown in Figure 4. All interconnections should be made by joining up corresponding numbered contacts at either end, i.e. contact No. 1 to contact No. 1, contact No. 2 to contact No. 2 etc. In the power unit plug PL.5 contacts Numbers 13 and 14 should be connected to the mains and contacts Numbers 15 and 16 to earth.

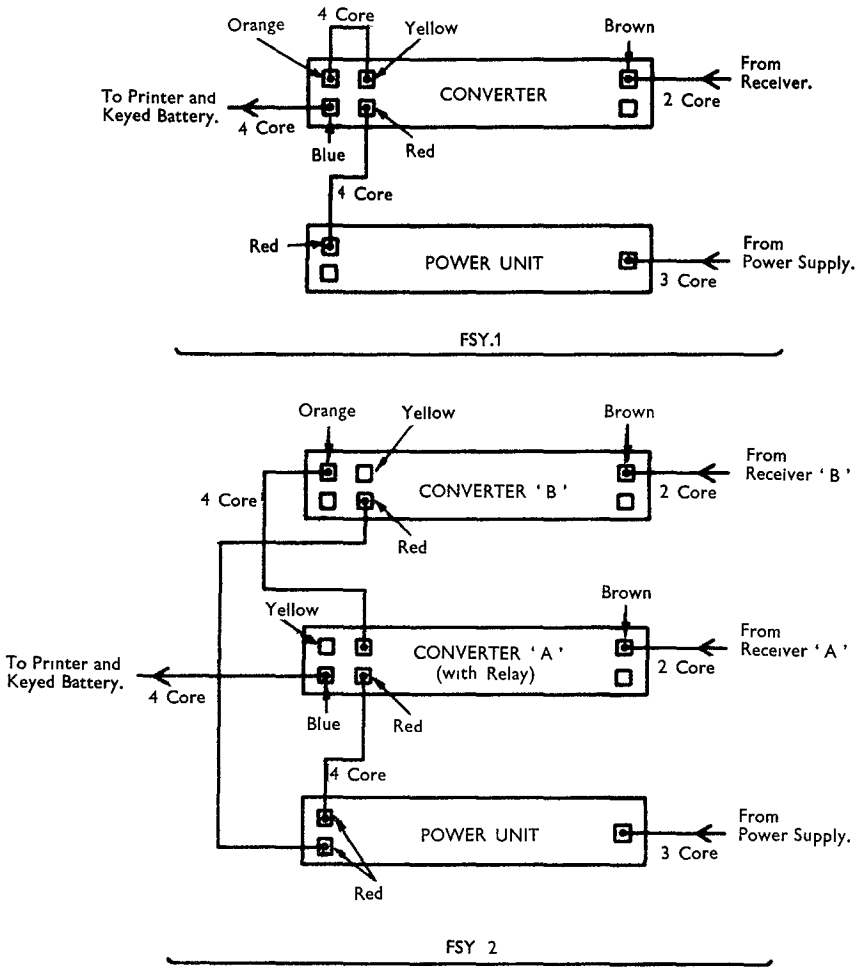


FIGURE 4. INTERCONNECTIONS VIEWED FROM THE REAR.

TELEGRAPH RELAY ADJUSTMENTS

The adjustment of the Carpenter high-speed polarised relay type 3N1/TR is fully described in bulletin No.F.1017 (3rd ED:) supplied by the Telephone Manufacturing Co. Ltd. When used for the reception of high-speed signals the relay should be adjusted by means of the ATM/TDMS/Relay Tester Model 1A or 1B. For low-speed keying the adjustments given below may suffice.

(a) Remove relay from the Converter.

(b) Remove relay cover.

(c) Slacken the top locking screws.

(d) Unscrew the side contact screws until the contact gaps are sufficiently wide to permit the use of a burnisher.

(e) Make a careful examination of the armature pole pieces and bias magnet. Any magnetic particles should be removed, e.g. by a piece of black adhesive tape fixed to the end of a sliver of wood.

(f) Smooth and clean the contacts with a burnisher.

(g) Wipe the contacts, pole pieces and armatures with a piece of cloth moistened with pure sulphur-free carbon-tetrachloride.

(Commercial grade does more harm than good)

(h) Set bias magnet vertically.

(i) Move the armature to the right and advance the right contact, (on which the armature is resting) very slowly, until the armature falls over on to the other contact. Then advance the left contact until the armature touches the right contact again.

(j) Separate contacts by unscrewing them one division each on the capstan head.

(k) Tighten the top locking screws.

(l) Replace the cover.

The relay may now be plugged into the socket provided on Converter A.

SETTING-UP

Set the standby switch marked HT on the power unit to OFF and the main switch to ON. The red lamp should glow. Allow sufficient time for the valve heaters to warm up and close the standby switch. The green lamp should glow.

For the purposes of description, the units are referred to as Converter A, Converter B and Power Unit, as marked in Figure 4, and the associated receivers as Receiver A and Receiver B. (If using Terminal FSY.1 ignore all references to Converter B and Receiver B in the following instructions).

KEYING AMPLIFIER-LIMITER ADJUSTMENT

Converter A.

Set the functional switch of Converter A to TEST, and if using double-diversity, of Converter B to OFF. Remove the masking covers of preset potentiometers RV2 and RV3. Using a screw driver, turn RV2 clockwise to the point where the telegraph relay operates in response to the test voltage of the mains frequency, i.e. 50-60 c/s. The operation of the relay can easily be detected aurally or by using a tape recorder. About one-third of a revolution of RV2 is usually sufficient to make the relay operate. Adjust RV3 and it will be found that for a large portion of the travel the relay operates and at either side of this position the relay ceases to operate as shown in Figure 5.

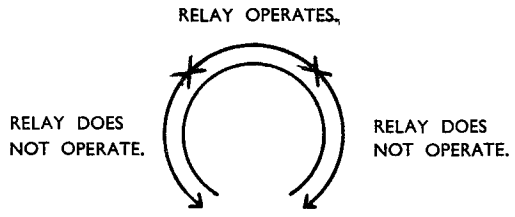


FIGURE 5

ADJUSTMENT OF RV2 AND RV3

Set RV3 approximately in the mid-position of the arc over which the relay operates. Turn RV2 slightly anti-clockwise and again readjust RV3 to the mid-position of the arc. It will be found that this arc is now reduced in length. Repeat this process until the arc through which RV3 can be turned without stopping the operation of the relay is as short as possible. The Keying Amplifier-Limiter of Converter A is now set in the most sensitive position. Replace the masking covers of the preset potentiometers RV2 and RV3.

OPERATION

TERMINAL FSY.1

Close the mains switch on the power unit and allow 2-3 minutes for the valve heaters to warm up. Set the Functional Switch of the converter unit to OFF. Close the standby switch on the power unit and setting key S4 to DISC tune the Receiver to the required signal, thus obtaining a reading on meter M1 of the Converter. Carefully adjust the B.F.O. of the Receiver to give equal deflections to the right and left on Meter M2 of the Converter for slow test transmission of mark and space signals. Adjust the input level by means of RV1 to give a reading on meter M1 of about 0.75 volts. On deep flat or selective fading of the received signal the reading on meter M1 will drop towards zero, and it may be beneficial in these conditions to increase the input. With selective fading, i.e. a fading of either mark or space frequency only, meter M1 will show different levels for mark and space.

This can also be noted by monitoring the signal with a pair of headphones via jack JK and simultaneously observing the variations of reading on meter M1. Such variations are common on HF circuits and the converter is designed to accommodate them. Operate S2 to ON position to connect the discriminator to the Keying Amplifier-Limiter.

Meter M2 is slightly damped and with fast continuous reversals reads zero. On a test signal of "RY" from a teleprinter, this meter will also read zero intermittently. If on a steady mark M2 deflects to the right, set the Functional Switch to the right and if a steady mark deflects meter M2 to the left, set the Functional Switch to the left.

If it is necessary to remove any telegraph bias in the incoming signal set the Functional Switch to the appropriate VARiable bias and adjust RV4 as required.

If the incoming signal is in excess of 100 bauds set S3 to HIGH and if the signal speed is less than 100 bauds set S3 to LOW.

TERMINAL FSY.2

Converter A (fitted with the telegraph relay) should be set up as previously described for FSY.1.

On Converter B set S2 to OFF, S4 to DISC and the Functional Switch to "-". Tune Receiver B until meters M2 in both converters move in sympathy, then operate S2 in Converter B to ON. In converter B, S3-SPEED, RV4-BIAS have no effect on the operation of the equipment.

To disconnect either or both Converters operate keys S2 as appropriate to OFF.

FREQUENCY-SHIFT RECEIVING TERMINALS
MODELS FSY.1 AND FSY.2

BENCH PERFORMANCE TESTS

TEST INSTRUMENTS

The following apparatus is required for making bench adjustments and performance tests.

1. Beat Frequency Oscillator covering the range 1 000 - 4 000 c/s.
2. Calibrated Variable attenuator with 600-ohm output impedance.

   N.B. One such attenuator is required for testing single converters, and two attenuators for making a test on dual diversity equipment.
3. Multi-range AC/DC Voltmeter (1 000 ohms per volt).
4. A Telegraph Relay, Carpenter type 3N1/TR adjusted on relay tester.
5. A pair of headphones for monitoring.
6. Sufficient tested valves for the equipment under test. Particular attention should be paid to obtaining the double-diode valve V4, of the Converter with balanced emission, since an unbalanced emission can produce a false indication of the discriminator centre-frequency.
7. Cabling for interconnecting the units.

KEYING TEST OPTIONAL

8. Frequency-Shift Keying Unit ATM type FSK.2 or equivalent with provision for keying at speeds of 25 and 100 c/s.
9. Double-beam Oscilloscope.
10. Line-voltage supply 80 + 80 volts.
11. Undulator (optional).
12. Line loading resistor 2 000 ohm ± 20% 10 watt.
13. Communications receiver.

TEST INSTALLATION AND SETTING-UP

Follow the procedure detailed on Page 7 for setting-up the equipment for operation but connect the units as shown in Figure 7 and substitute "BFO and attenuator" for the word "Receiver" in this description.

FREQUENCY-SHIFT RECEIVING TERMINALS
MODELS FSY.1 AND FSY.2

PERFORMANCE SPECIFICATION

When checking the performance of FSY 2 the tests described below for a single converter unit should be made on both converter units in turn.

INPUT CIRCUIT INSERTION LOSS

These losses consist of 5 db in resistive T network R1, R2, R3, R5, R6 and 1-2 db in the Band-pass Filter Unit type GA2-1459. The loss is given by the ratio between the volts on pin 1 of plug PL.1 and pin 3 of socket SK1 with control RV1 set at its maximum. The voltage on pin 1 of plug PL1 should be read by means of an AC voltmeter (range 0-10 volts). The voltage on pin 3 of socket SK1 is indicated on meter M1.

DISCRIMINATOR CENTRE FREQUENCY

With the equipment switched off adjust the centre-zero of meter M2 mechanically.

The centre frequency is indicated on micro-ammeter M2, the centre zero corresponding to 2 550 c/s ± 25 c/s with an input of 0.775 volts shown on meter M1.

In the case of failure of one half of the double-diode valve V4, meter M2 will give a permanent full-scale deflection to one side of the other.

Adjustment of the centre-frequency can be made by varying the capacity of the circuit by the addition of some or all of capacitors C8, C9, C10 and C11. If the combined capacity is too small meter M2 deflects to the right and if too large, the deflection will be to the left.

CARRIER AMPLIFIER-LIMITER

The sensitivity of this circuit can be determined by the level of the input signal required for a given discriminator output with potentiometer RV1 adjusted to give a reading of 0.775 volts on meter M1. For an input signal reduced by 40 db from that level the discriminator meter M2 should read a minimum of 20 microamps at input frequencies of 2 125 c/s and 2 975 c/s.

KEYING AMPLIFIER-LIMITER

The sensitivity and balance of the keying amplifier-limiter can be determined by the amount of driving voltage required for satisfactory operation of the relay at mains frequency.

The setting of pre-set control RV2 to give satisfactory operation of the relay should not exceed a rotation of 90° clockwise from its minimum position. If the required setting exceeds 90° the driving valve V5 is unsatisfactory and should be replaced.

If the best operating point of the keying amplifier-limiter lies outside the range of potentiometer RV3, it indicates faulty relay or considerable discrepancies in the characteristics of valves V6 and V7, this fault can be rectified by interchanging these two valvesor replacing the faulty items.

BAND-PASS FILTER

To check the performance of this filter set the BFO to 2 550 c/s and adjust the input level to give a reading of 2 volts on meter M1. Then vary the frequency of the BFO noting the corresponding readings of meter M1. The following results should be obtained.

Input	Frequency c/s	Reading on Meter M1.
	1 600	0.55
	1 650	1.25
	1 700	1.55
	1 800	1.75
	1 900	1.9
	2 000	2.0
	2 800	2.0
	3 000	1.9
	3 200	1.55
	3 400	1.25
	3 500	0.70

Failures in the resistive networks on either side of the filter will cause mis-matching and considerable discrepancies in these readings.

OUTPUT CIRCUIT

With the Functional Switch in position OFF, Key S4 to LINE and link LK2 in position, there should be resistance of 22 ohms between Pins 1 and 4 of plug PL4.

With the relay inserted in the converter and the diversity interconnection cable removed, set the Functional Switch to "-". With an input signal of 2 000 c/s there should be a resistance of about 27 ohms between pins 1 and 4 of output plug PL4 and with an input signal of 3 000 c/s there should be a resistance of about 27 ohms between pins 1 and 2 of plug PL4.

With the Functional Switch set to "+", and with an input signal of 2 000 c/s, there should be a resistance of about 27 ohms between pins 1 and 2 of output plug PL4 and with an input signal of 3 000 c/s, there should be a resistance of about 27 ohms between pins 1 and 4 of Plug PL4.

MONITOR JACK

Certain types of telephone plugs produce a momentary short circuit between the contacts of monitor Jack JK. The reading on meter M1 should not drop more than 25% when these contacts are short circuited.

DIVERSITY TEST

Insert the telegraph relay in Converter A and connect the diversity cable between socket SK2 on Converter A and plug PL3 on Converter B. Reduce the input to Converter B to zero. Vary the frequency of the BFO A between 2 000 and 3 000 c/s and check that the relay operates satisfactorily.

Repeat this test with the input to Converter A reduced to zero. The input to Converter B should now operate the relay when the frequency of BFO B is varied between 2 000 and 3 000 c/s.

Insert the relay in Converter B and connect the diversity cable between socket SK2 on Converter B and plug PL3 on Converter A. Repeat the tests with the input to the Converters reduced in turn. Failure of any of the above tests indicates incorrect wiring.

POWER UNIT

The H.T. voltage with two Converters connected should, under average conditions be 300 ± 10 volts. However, the total H.T. current and hence the voltage varies with the setting of RV3 and RV4 on the Converters and also the mark and space signals. An average value is 40 milliamps for two Converters. The value of the H.T. current for a particular installation should be noted, as any subsequent drop in this value will indicate failure of one or more valves.

VOLTAGE ANALYSIS

Check that the tapping on the main transformer corresponds to the voltage of the supply. With the relay in position and the equipment adjusted as above set S1 to OFF, S2 to ON, S3 to LOW, S4 to DISC. and use the multirange meter to check the voltages as shown in the table on Page 13. The figures quoted are nominal only. Variations in valve characteristics may cause wide discrepancies from these figures. The values should be noted for each particular installation so that variations can be observed and indicate possible sources of failure.

KEYING TEST (OPTIONAL)

Connect the equipment as shown in Figure 7 but replace the BFO and attenuator(s) by the F-S Keyer and receiver. Connect the output plug PL4 to a symmetrical line supply 80 + 80 volts and connect the 2 000-ohm load resistor between pin 1 of plug PL4 and earth. Set switch S3 to LOW, switch S1 to either "+NEUTRAL BIAS" or "-NEUTRAL BIAS" and switch S2 to ON. Adjust the keying unit to operate with 850 c/s shift and tune the receiver to give an audio output of 2 125 and 2 975 c/s. Key slowly and check that meter M2 gives symmetrical deflections about the centre zero of approximately 20 μA with switch S4 set to LINE. Increase the keying speed to 25 c/s and check that meter M2 reads centre zero with switch S4 set to either LINE or DIScriminator. Set switch S4 to LINE and check that varying the bias control RV4 has no effect on the reading of meter M2. Set switch S1 to "+VARIABLE BIAS" and "-VARIABLE BIAS" in turn and check that turning RV4 from

TEST POINT

Valve	Electrode	Pin No.	Meter Scale	Volts	Remarks
V1	Anode	3	400	80	
V1	Screen	2	400	52	
V1	Cathode and Suppressor	6 & 4	10	0.85	
V2	Anode	3	400	15	
V2	Screen	2	400	11	
V2	Cathode and Suppressor	6 & 4	10	0.1	
V3	Anode, screen & Suppressor	3,2 & 4	400	232	
V3	Cathode	6	10	2.6	
V5	Anode, screen & Suppressor	3,2 & 4	400	83	
V5	Cathode	6	10	1.6	
V6	Anode, screen & Suppressor	3,2 & 4	400	270	
V6	Cathode	6	400	82	
V7	Anode, screen & Suppressor	3, 2 & 4	400	270	
V7	Cathode	6	400	86	
Junction of R36 and R37			400	68	
Pin 2 of Plug PL2 H.T. current.			400	310	25mA read on milliameter on the power unit.
Pin 4 of Plug PL2			10 A.C.	6.1	

the centre zero causes meter M2 to indicate at least 5 μA in each direction.

Set switch S3 to HIGH and increase the keying speed to 100 c/s. Again check that turning RV4 gives at least 5 μA readings to right and left of the centre zero according as switch S1 is set to "+VARIABLE BIAS" or "-VARIABLE" . When switch S1 is set to "-VARIABLE BIAS" and the bias control is turned clockwise with switch S4 set to LINE check that the deflection of meter M2 is to the right.

Discrepancy in the mark/space ratio of the input to the converter unit will cause difficulty in obtaining the above results. The mark/space ratio should be unity and may be checked by means of the double-beam oscilloscope. The output wave form of the converter may be displayed on an undulator connected in place of the line loading resistor or on the oscilloscope connected across the line loading resistor.

LIST OF COMPONENTS
FSY.1.1

RESISTORS

R1	68	ohms 1/2 watt ± 10% R.M.A.8
R2	100	ohms 1/2 watt ± 10% R.M.A.8
R3	1 200	ohms 1/2 watt ± 10% R.M.A.8
R4	1 200	ohms 1/2 watt ± 10% R.M.A.8
R5	100	ohms 1/2 watt ± 10% R.M.A.8
R6	68	ohms 1/2 watt ± 10% R.M.A.8
R7	1 200	ohms 1/2 watt ± 10% R.M.A.8
R8	120 000	ohms 1/2 watt ± 10% R.M.A.8
R9	470	ohms 1/2 watt ± 10% R.M.A.8
R10	56 000	ohms 1/2 watt ± 10% R.M.A.8
R11	120 000	ohms 1/2 watt ± 10% R.M.A.8
R12	470 000	ohms 1/2 watt ± 10% R.M.A.8
R13	120 000	ohms 1/2 watt ± 10% R.M.A.8
R14	1 500	ohms 1/2 watt ± 10% R.M.A.8
R15	220 000	ohms 1/2 watt ± 10% R.M.A.8
R16	470 000	ohms 1/2 watt ± 10% R.M.A.8
R17	120 000	ohms 1/2 watt ± 10% R.M.A.8
R18	22 000	ohms 1/2 watt ± 10% R.M.A.8
R19	470 000	ohms 1/2 watt ± 10% R.M.A.8
R20	470	ohms 1/2 watt ± 10% R.M.A.8
R21	2 200	ohms 1/2 watt ± 10% R.M.A.8
R22	2 200	ohms 1/2 watt ± 10% R.M.A.8
R23	10 000	ohms 1/2 watt ± 10% R.M.A.8
R24	120 000	ohms 1/2 watt ± 10% R.M.A.8
R25	120 000	ohms 1/2 watt ± 10% R.M.A.8
R26	56 000	ohms 1/2 watt ± 10% R.M.A.8
R27	220 000	ohms 1/2 watt ± 10% R.M.A.8
R28	220 000	ohms 1/2 watt ± 10% R.M.A.8
R29	47	ohms 1/2 watt ± 10% R.M.A.8
R30	220 000	ohms 1/2 watt ± 10% R.M.A.8
R31	470 000	ohms 1/2 watt ± 10% R.M.A.8
R32	5 600	ohms 1/2 watt ± 10% R.M.A.8
R33	Not required	
R34	22 000	ohms 1/2 watt ± 10% R.M.A.8
R35	22 000	ohms 1/2 watt ± 10% R.M.A.8
R36	56 000	ohms 1/2 watt ± 10% R.M.A.8
R37	56 000	ohms 1/2 watt ± 10% R.M.A.8
R38	220 000	ohms 1/2 watt ± 10% R.M.A.8
R39	220 000	ohms 1/2 watt ± 10% R.M.A.8
R40	10 000	ohms 1/2 watt ± 10% R.M.A.8
R41	10 000	ohms 1/2 watt ± 10% R.M.A.8
R42	470	ohms 1/2 watt ± 10% R.M.A.8
R43	470	ohms 1/2 watt ± 10% R.M.A.8
R44	22	ohms 1/2 watt ± 10% R.M.A.8
R45	22 000	ohms 1/2 watt ± 10% R.M.A.8
R46	22 000	ohms 1/2 watt ± 10% R.M.A.8

RESISTORS (continued)

R47	220 000	ohms 1/2 watt ± 10% R.M.A.8
R48	220 000	ohms 1/2 watt ± 10% R.M.A.8
R49	120 000	ohms 1/2 watt ± 10% R.M.A.8
R50	47	ohms 1/2 watt ± 10% R.M.A.8
R51	56 000	ohms 1/2 watt ± 10% R.M.A.8
R52	33 000	ohms 1/2 watt ± 10% R.M.A.8
R53	390 000	ohms 1/2 watt ± 10% R.M.A.8
R54	470	ohms 1/2 watt ± 10% R.M.A.8
R55	330 000	ohms 1/2 watt ± 10% R.M.A.8
R56	390 000	ohms 1/2 watt ± 10% R.M.A.8

VARIABLE RESISTORS

RV1	1 000 ohms	Colvern CLR.4239/11
RV2	50 000 ohms	Morganite LHNAR 50350
RV3	100 ohms	Colvern CLR. 1206/75
RV4	100 000 ohms	Morganite LHNAR 10450

CHOKES

L1	Choke B.T.R. Drg. A5-45
L2	Choke Air Cored B.T.R. Drg. A5-41
L3	Choke Air Cored B.T.R. Drg. A5-41
L4	Choke Air Cored B.T.R. Drg. A5-41

VALVES

V1	EF50	(CV1091)
V2	EF50	(CV1091)
V3	EF50	(CV1091)
V4	6H6	(CV1930)
V5	EF50	(CV1091)
V6	EF50	(CV1091)
V7	EF50	(CV1091)

PLUGS AND SOCKETS

PL1	4 conductors Painton 500464
PL2	4 conductors Painton 500464
PL3	4 conductors Painton 500464
PL4	4 conductors Painton 500464
SK1	4 conductors Painton 500467
SK2	4 conductors Painton 500467

CAPACITORS

C1	5 000	pF		550v DC	TCC	CP 329 Metalmite.
C2	0.05	µF		500v DC	TCC	CP 45S Metal Pack
C3	1 000	pF		500v DC	TCC	CP 30S Metalmite
C4	0.05	µF		500v DC	TCC	CP 45S Metal Pack
C5	1 000	pF		500v DC	TCC	CP 30S Metalmite
C6	200	pF	± 2%	350v DC	UIC	SMP 101
C7	4	µF		400v DC	TCC	82 (Tropical)
C8	700	pF	± 2%	350v DC	UIC	SMP 101
C9	100	pF	± 2%	350v DC	UIC	SMP 101
C10	200	pF	± 2%	350v DC	UIC	SMP 101
C11	400	pF	± 2%	350v DC	UIC	SMP 101
C12	1 000	pF + 2 300 pF	± 2%	350 v DC	UIC	SMP 701
C13	0.05	µF		150v DC	Dubilier 418	
C14	0.05	µF		500v DC	TCC	CP 45S Metal Pack
C15	5 000	pF		500v DC	TCC	CP 329 Metalmite
C16	5 000	pF		500 DC	TCC	CP 329 Metalmite
C17	2 000	pF		500v DC	TCC	CP 30S Metalmite
C18	200	pF	± 2%	350v DC	UIC	SMP 101
C19	4	µF		400v DC	TCC	82 (Tropical)
C20	0.5	µF		350v DC	TCC	CP47N
C21	0.5	µF		350v DC	TCC	CP47N
C22	0.05	µF		500v DC	TCC	CP45S Metal Pack
C23	0.05	µF		500v DC	TCC	CP45S Metal Pack
C24	0.05	µF		500v DC	TCC	CP45S Metal Pack
C25	0.001	µF		500v DC	TCC	SP30S Metalmite
C26	47	pF	± 2%	350v DC	UIC	SMP 101

RELAY

RL Carpenter Type 3N1/TR

METERS

M1 0 - 3v Weston S.34
M2 50 - 0 - 50µA Weston S.33.

JACK

JK Jack A.T. & E. Co. Ltd. 300B/6/N.H46/1

FILTERS

B.P.F. Band Pass Filter B.T.R. Drg. GA2-1459

SWITCHES

S1 4 pole 6 way B.T.R. Drg. K5-4240
S2 Key Plunger Locking A.T. & E. Co. Ltd. type T3423 (Tropical)
S3 Key Plunger Locking A.T. & E. Co. Ltd. type T3423 (Tropical)
S4 Key Plunger Locking A.T. & E. Co. Ltd. type T3423 (Tropical)

LIST OF COMPONENTS
FOR
POWER UNIT MODELS FSR.1.2 ETC.

Ref. Symbol	Description
R.1	Resistor 100 000 ohm 10 watt TC.1 ERG 18
C.1	Capacitor 6 μF 400v TCC 82
C.2	Capacitor 6 μF 400v TCC 82
C.3	Capacitor 6 μF 400v TCC 82
C.4	Capacitor 0.01μF 1 000v TCC CP45W
C.5	Capacitor 0.01μF 1 000v TCC CP45W
L.1	Choke 10H Type GR. 9901
L.2	Choke 10H Type GR. 9901
T.1	Mains Transformer Model FSR.1.2 Type GR.9900
	Mains Transformer Model FSR.1.2A Type GR.10209
	Mains Transformer Model FSR.1.2B Type GR.9958
V.1	Valve Type 5Z4G (CV1864)
S.6	Switch double pole on/off 100 002 - PM
S.7	Switch double pole on/off 100 002 - PM
SK3, SK4	Socket 4 conductors Painton 500467
PL5	Plug 4 conductors F. & E. JP-AB
M.1	Milliammeter 0-15 mA Weston S33
M.2	Voltmeter 0.500v Weston S33
LP1 and LP2	Lamp 6.3v Hivac No. 2
F1 and F2	Fuse 250 mA Standard Cartridge
F3 and F4	Fuse A2 Standard Cartridge

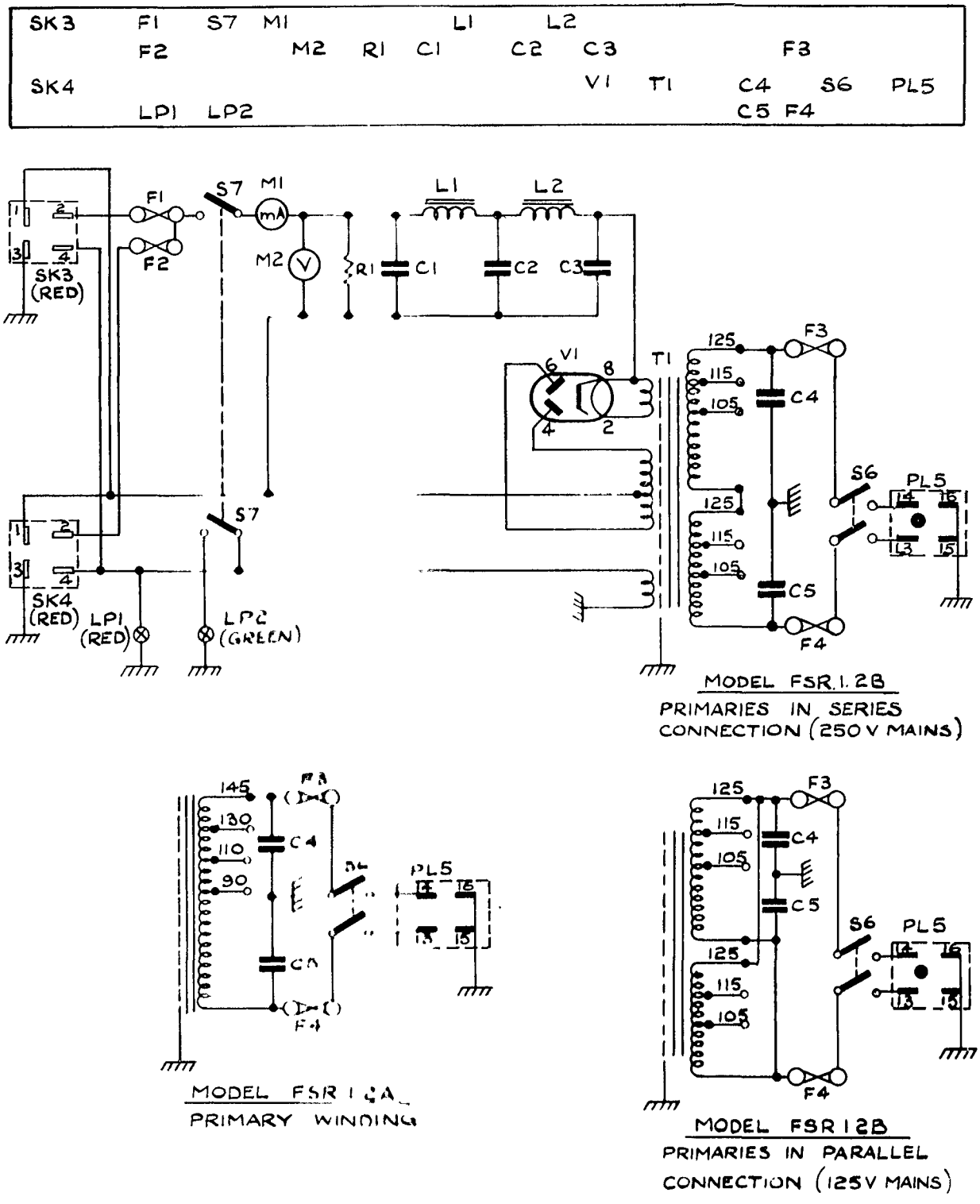


FIGURE 6 CIRCUIT DIAGRAM POWER UNIT MODEL FSR 1.2A & MODEL FSR.1.2B.

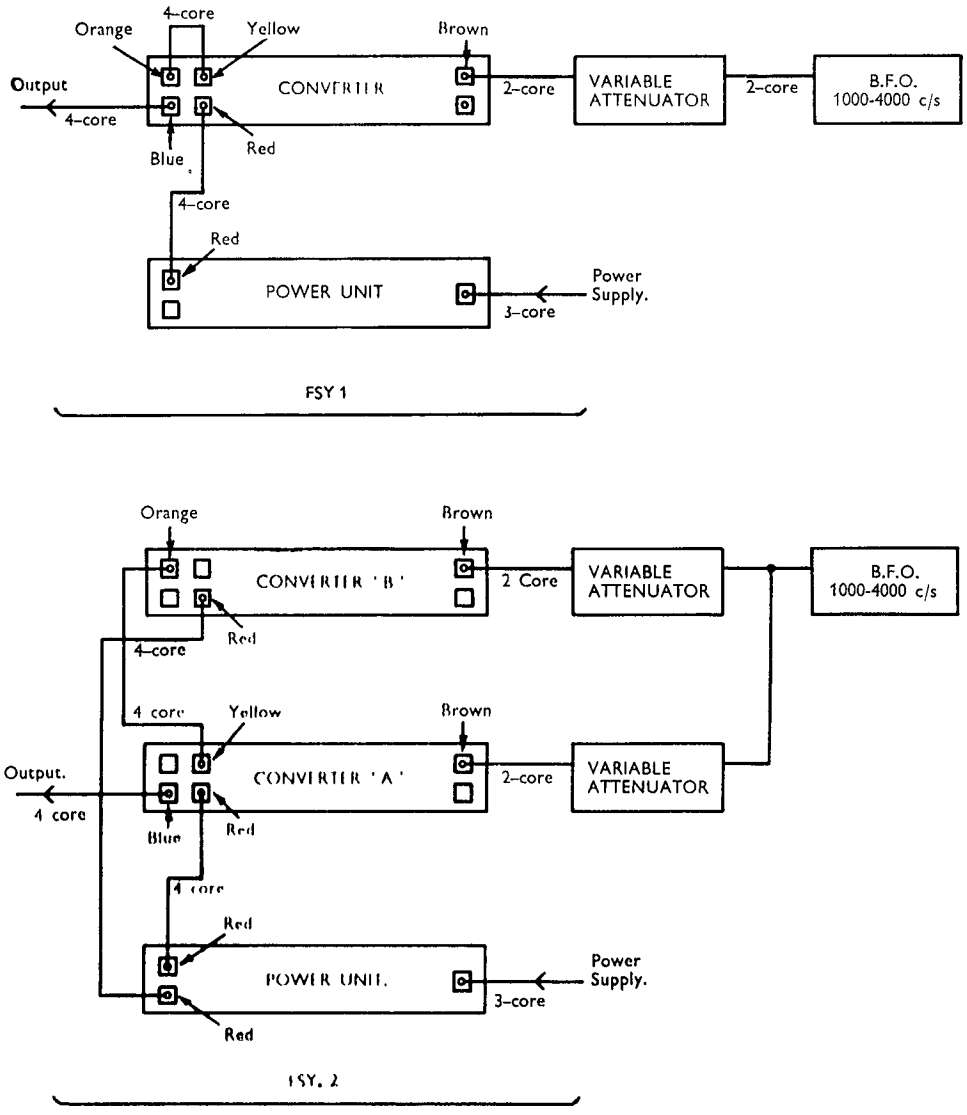


FIGURE 7. TEST INTERCONNECTIONS.

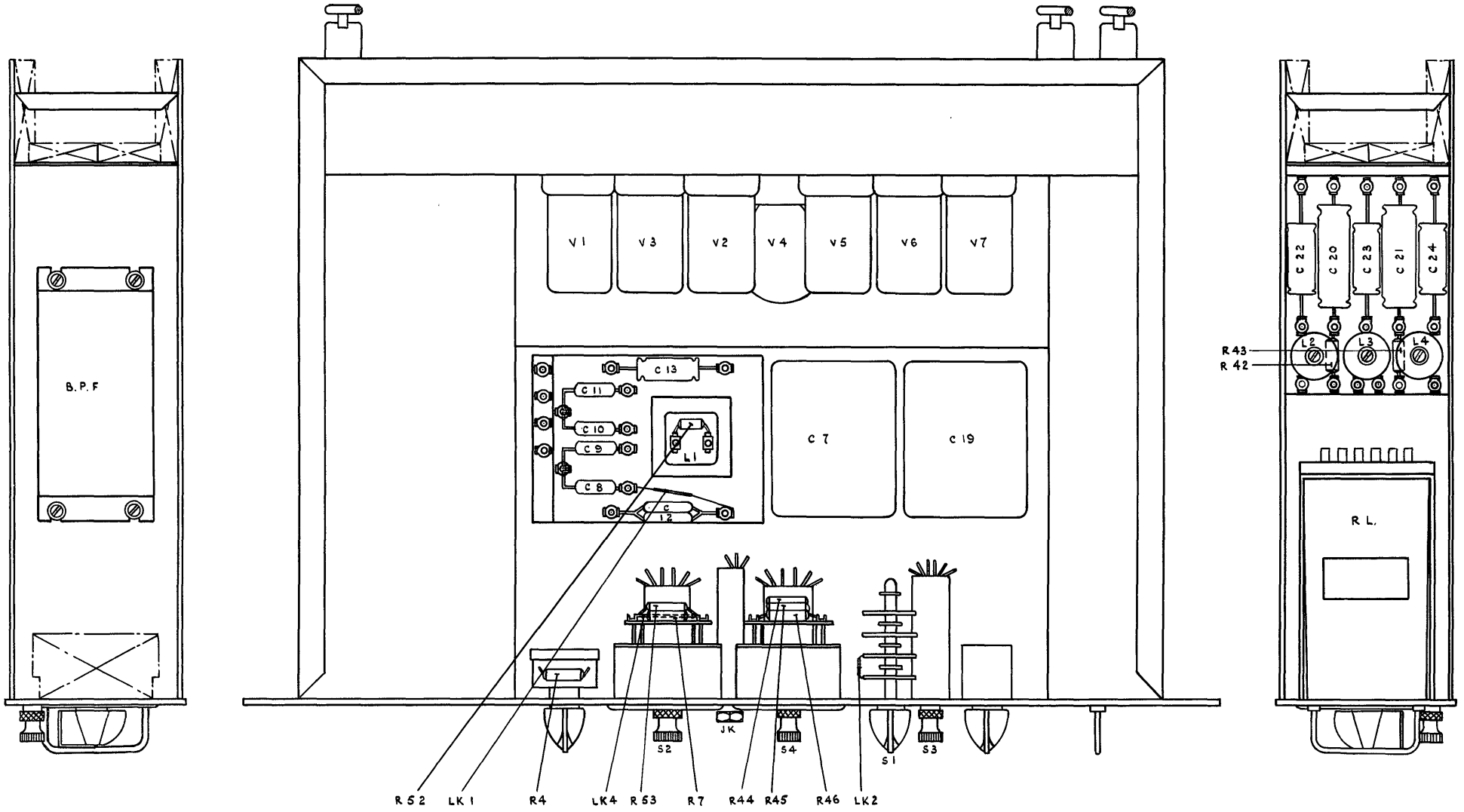


FIGURE 8. TOP AND END VIEWS. (COVERS REMOVED) FREQUENCY – SHIFT SIGNAL CONVERTER MODEL FSY.1.1.

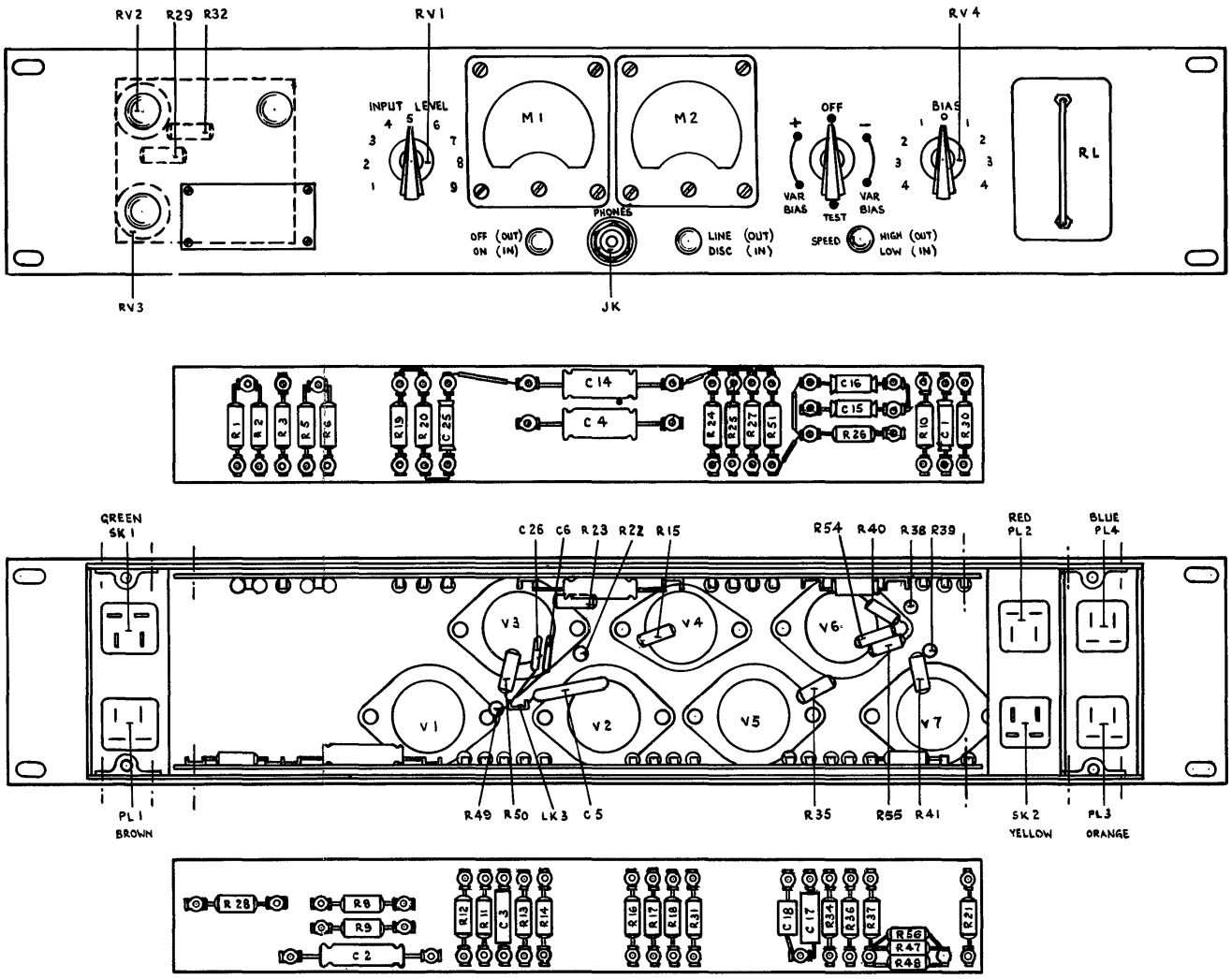


FIGURE 9. FRONT AND REAR VIEWS. (COVER REMOVED) FREQUENCY-SHIFT SIGNAL CONVERTER MODEL FSY.1.1.

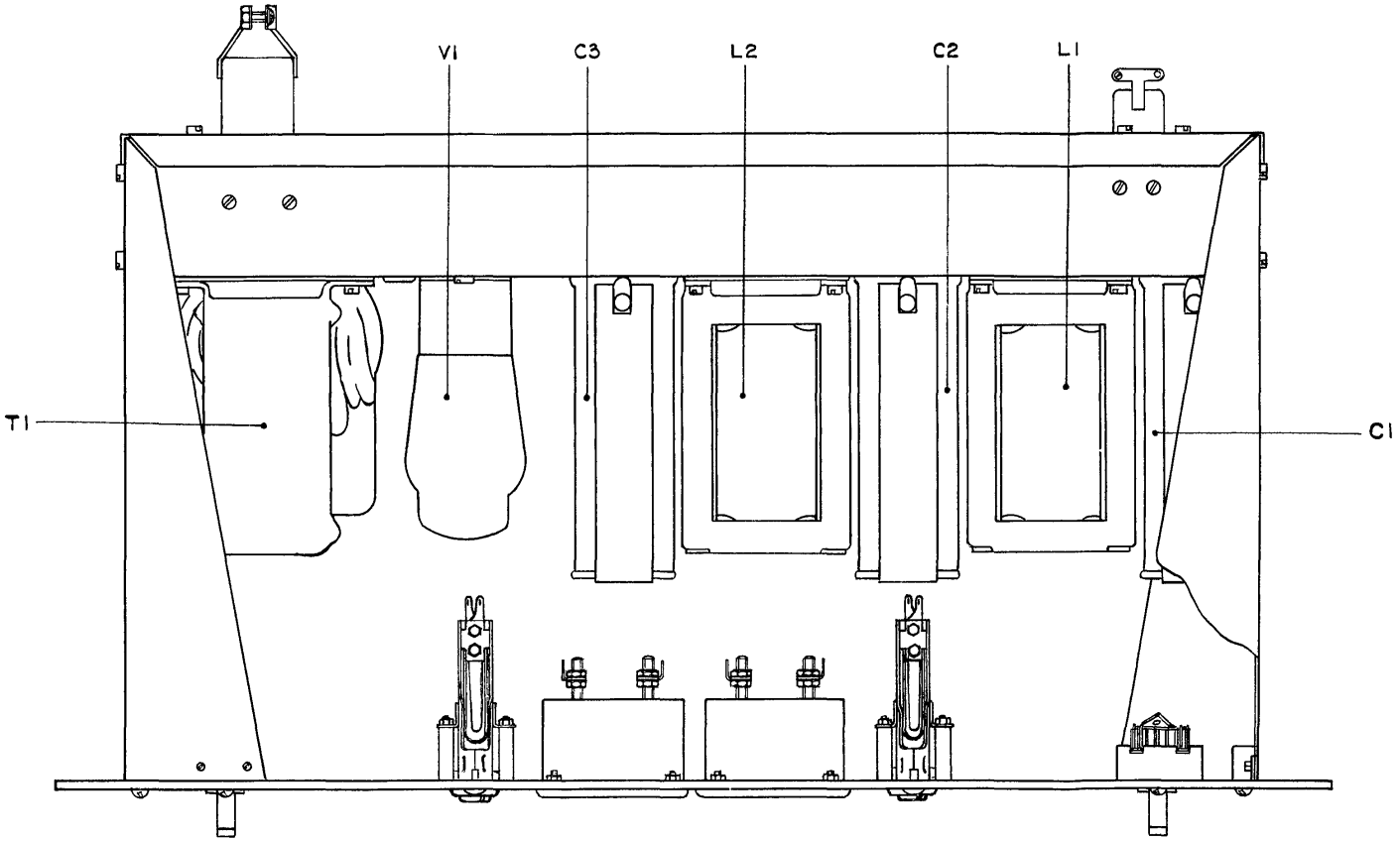


FIGURE 10. TOP VIEW. POWER UNIT MODEL FSR.1.2A. AND MODEL FSR.1.2B.

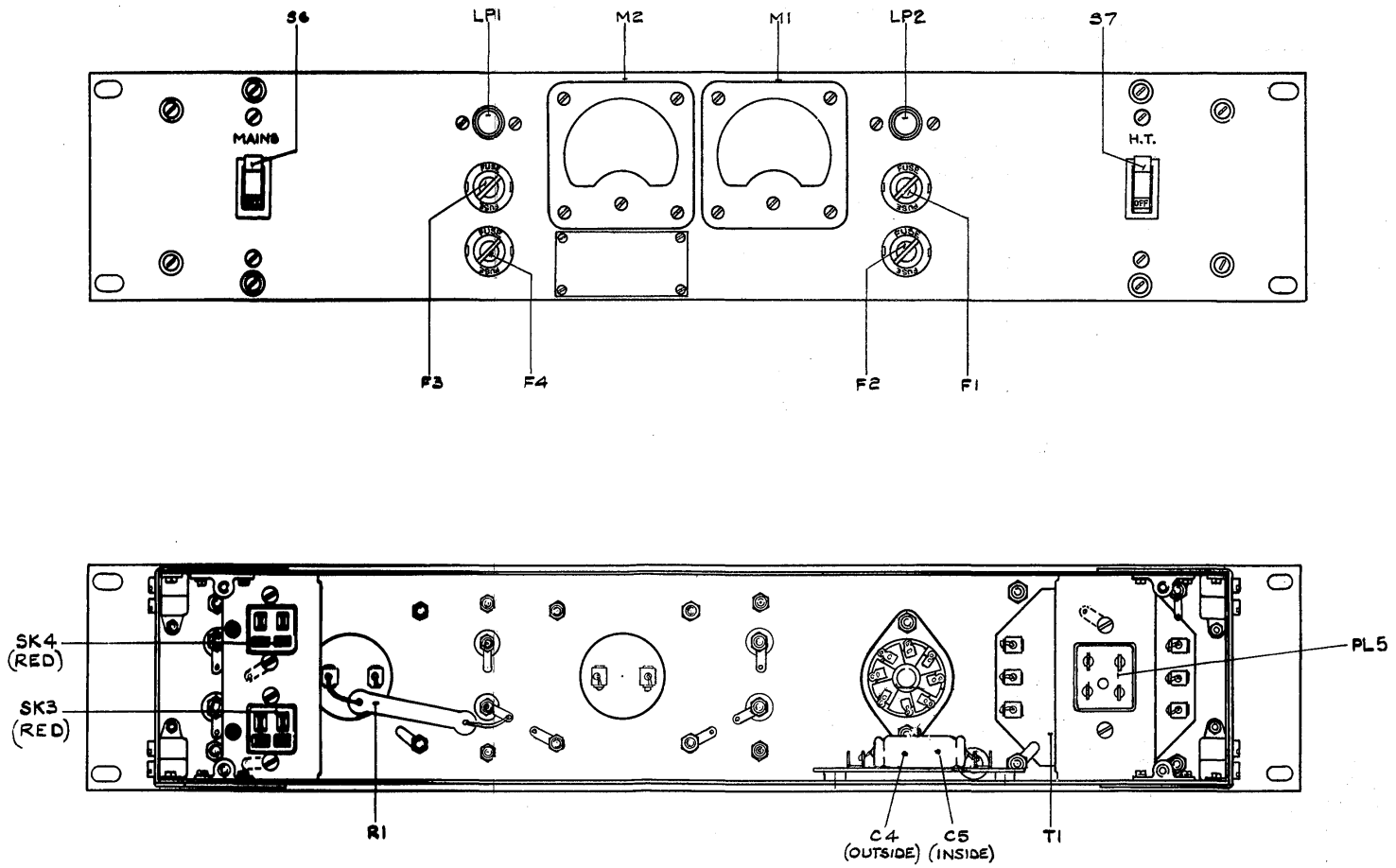
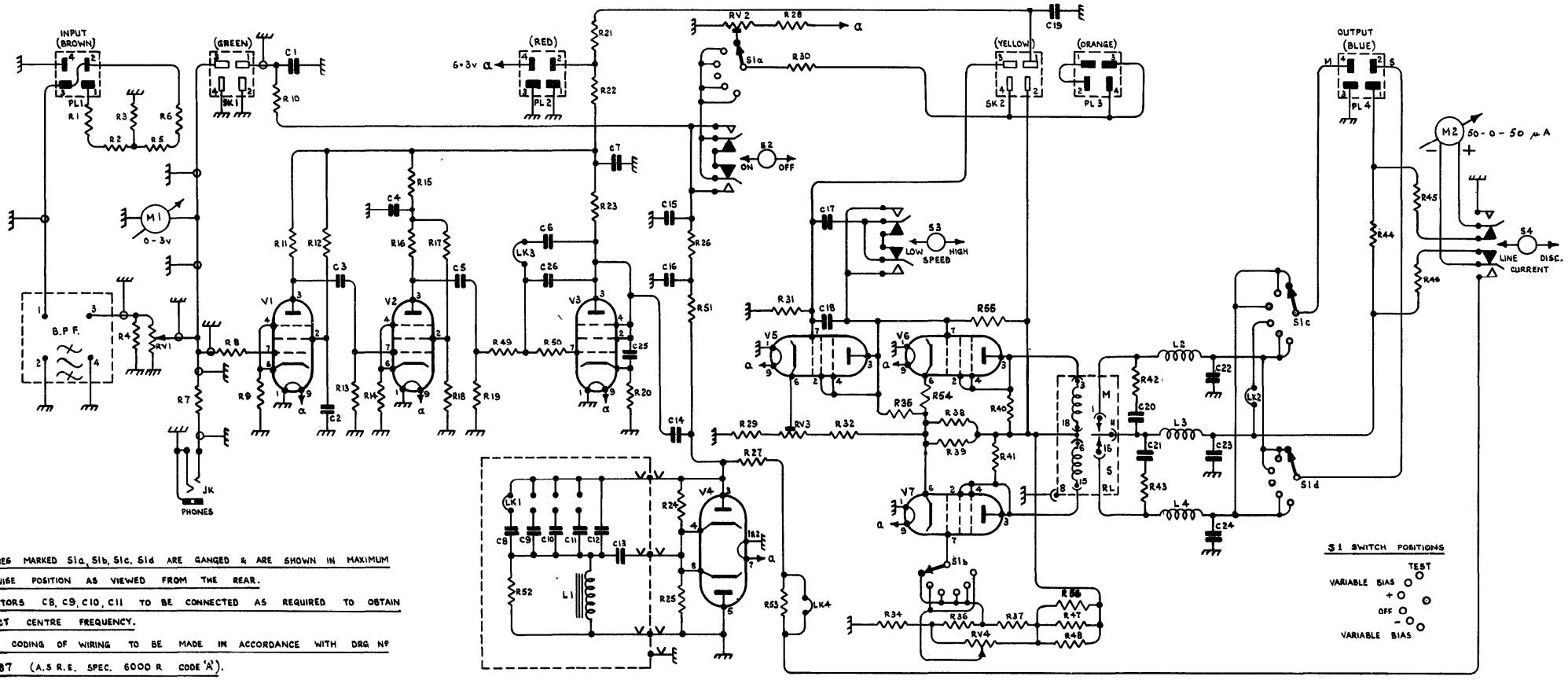


FIGURE 11. FRONT AND REAR VIEW (COVER REMOVED) POWER UNIT MODEL FSR.1.2A AND MODEL FSR.1.2B.

CAPACITORS	C1 C2 C3 C4 C5 C8 C9 C10 C6 C26 C11 C12 C7 C13 C25 C15 C16 C14 C17 C18 C19 C20 C21 C22 C23 C24
RESISTORS	R1 R2 R3 R4 R5 RV1 R6 R7 R8 R9 R10 R11 R12 R13 R14 R15 R16 R17 R18 R19 R49 R52 R50 R21 R22 R23 R24 R26 R25 R51 RV2 R27 R29 RV3 R28 R30 R31 R32 R34 R35 R54 R38 R39 R35 R55 RV4 R40 R41 R37 R56 R47 R48 R42 R43 R44 R45 R46
MISC.	PL1 B.P.F. M1 SK1 V1 V2 LK1 LK3 PL2 L1 V3 V4 S1a S2 LK4 V5 S3 V6 V7 S1b SK2 RL PL3 L2 L3 L4 LK2 S1c S1d PL4 M2 S4



NOTES

1. SWITCHES MARKED S1a, S1b, S1c, S1d ARE GANGED & ARE SHOWN IN MAXIMUM CLOCKWISE POSITION AS VIEWED FROM THE REAR.
2. CAPACITORS C8, C9, C10, C11 TO BE CONNECTED AS REQUIRED TO OBTAIN CORRECT CENTRE FREQUENCY.
3. COLOUR CODING OF WIRING TO BE MADE IN ACCORDANCE WITH DRG Nº D8 - 87 (A.S.R.E. SPEC. 6000 R CODE 'A').
4. REAR VIEW OF PLUGS & SOCKETS SHOWN.
5. PIN Nºs 5, 8, & SPIGOT OF VALVES V1, V2, V3, V5, V6, V7 TO BE CONNECTED TO CHASSIS.

FIGURE 12. CIRCUIT DIAGRAM. FREQUENCY SHIFT SIGNAL CONVERTER MODEL FSY.1.1.