SOS, SOU THREE-CHANNEL TELEPHONE TERMINAL

1. MANUFACTURER. Standard Telephones and Cables Pty. Ltd.

2. FREQUENCY ALLOCATION.

2.1 The SOS and SOU terminals are similar in appearance and performance, but the carrier frequencies used for the B to A direction of transmission are different in the two systems, as shown below. The SOS B terminal transmits lower sidebands, whereas the SOU B terminal transmits upper sidebands.

2.2 SOS.

Direction	Channel	Carrier Frequency (kc/s)	✱ Sideband Ranges
A to B	1	12.9	13.2 to 15.6
A to B	2	9.4	9.7 to 12.1
A to B	3	6.3	6.6 to 9.0
B to A	1	24.4	24.1 to 21.7
B to A	2	20.7	20.4 to 18.0
B to A	3	28.4	28.1 to 25.7

2.3 SOU.

Direction	Channel	Carrier Frequency (kc/s)	✱ Sideband Ranges
A to B	1	12.9	13.2 to 15.6
A to B	2	9.4	9.7 to 12.1
A to B	3	6.3	6.6 to 9.0
B to A	1	21.4	21.7 to 24.1
B to A	2	17.7	18.0 to 20.4
B to A	3	25.4	25.7 to 28.1

3. STRUCTURAL DETAIL.

3.1 Rack Dimensions. Standard rack 10'6" high, 1'8-1/4" wide and approximately 1'3" deep.

3.2 Racks per Terminal. One.

3.3 Panel Mounting. Double-sided.

3.4 Rack Assembly. See Figs. 1 and 2.

4. PERFORMANCE.

4.1 The system is designed to provide three circuits of zero over-all transmission equivalent over a line having a maximum wet weather attenuation of up to 40 db at 30 kc/s.

4.2 Typical Levels. The normal level of output from the Transmit Amplifier is +18 dbm for an input level of 0 dbm from the switchboard. The typical levels present at various parts of the transmit and receive circuits, under test conditions, are shown in Fig. 3 for a system working over a 40 db line.

4.3 Channel Band-width. The effective band-width of each channel is approximately 300 c/s to 2,700 c/s.

4.4 Frequency Stability. The stability of carrier oscillators is such that the difference of frequency of the transmitted and received audio signals is not greater than 6 c/s.

5. DESIGN FEATURES.

5.1 Transmit and Receive Amplifiers. Identical amplifiers are used for the amplification of sidebands in both transmit and receive circuits. The maximum gain is substantially constant at 52 db over the range 6 to 35 kc/s, and the power output capacity is approximately +30 dbm. Input and output impedances are 600 ohms. The amplifier employs 6SJ7GT tubes in the first and second stages, which consist of voltage amplifier and cathode follower stages respectively. The output stage employs a 6V6GT tube. The effective H.T. is 154 volts, owing to the connection of cathode circuits to the -24 volt terminal. High stability of gain and freedom from distortion and intermodulation between channels are assured by a large degree of negative feedback. The feedback is derived from a bridge arrangement, by which means voltage and current feedback are so proportioned as to produce the correct gain and output impedance.

The gain is adjustable in 5 db steps by means of straps on an input attenuator consisting of one 5 db and two 10 db pads. This attenuator precedes a double-shielded input transformer, with secondary load consisting of a potential divider. The latter provides a further gain adjustment of 20 db in ten steps of 2 db. By means of these controls, the gain may be adjusted in steps of 2 db from 7 db to 11 db, and in steps of 1 db from 11 db to 52 db.

The gain of the Transmit Amplifier is normally set at maximum to give a transmission equivalent of +30 db from Mod. In jacks to the carrier line.

5.2 Carrier Supplies. Stable carrier frequencies are ensured by the use of quartz crystal oscillators. The oscillator circuit consists of a single stage, in which a low-frequency NT-cut crystal is maintained in oscillation and electron-coupled to the modulating or demodulating circuit by a tetrode 6SJ7GT. Each oscillator is mounted on the same panel as its associated modulator or demodulator, the combined unit being termed an Oscillator-Modulator or Oscillator-Demodulator.

There is no provision for adjustment of the carrier frequency, the initial accuracy and stability of the crystal being such that the frequency remains within 3 c/s of the nominal value over a wide range of ambient temperature.

Means are provided for the readjustment of output level, should this be found necessary after replacement of the tube or crystal. The output level may be measured at a jack designated Osc. Test, and can be increased by altering straps to raise the effective value of a group of resistors in the screen feed to the tube (screen functions as an anode). A potential divider with three tappings provides an additional 6 db range of output adjustment by alteration of A.V.C. voltage fed back to the grid. The nominal output level at Osc. Test jacks produces a reading of -3 ± 3 dbm on a high-impedance measuring set scaled for a 600 ohm circuit.

5.3 Oscillator-Modulator. The Mod. In jacks are connected to the input transformer of the modulating circuit via a fixed pad, which is 3 db for the lower group of carrier frequencies and 2 db for the higher group. The modulating circuit is of the usual balanced type, with copper-oxide rectifiers and a potentiometer for the adjustment of carrier leakage. A 5 db pad is included in the output circuit to present a proper impedance to the subsequent band filters.

The over-all loss, from Mod. In jacks to Mod. Out jacks, is approximately 14 db with respect to the wanted sideband.

5.4 Oscillator-Demodulator. The input circuit of the demodulator includes a fixed pad which ensures a correct input impedance. The loss thus introduced is 9 db or 10 db, according to the carrier frequency. The demodulating circuit employs the usual balanced arrangement of copper-oxide rectifiers with no provision for adjustment of carrier leakage. A low-pass filter, which follows the demodulator, serves to suppress the residual carrier leakage and the various unwanted products of demodulation.

A demodulator amplifier precedes the Demod. Out jacks, introducing a maximum gain of 29 db. The gain may be reduced by approximately 10 db by means of a cathode rheostat, which introduces negative current feedback and increases the grid bias. A tapping on the secondary winding of the grid transformer provides for a further 5 db reduction of gain. The normal gain setting for +4 dbm from Demod. Out jacks is approximately 23 db.

5.5 Voltage Limiter. A voltage limiter is included in each channel to prevent overloading of the Oscillator-Modulator and Transmit Amplifier. The limiter consists of a special neon lamp and transformer, which are mounted on the Terminating Panel, with the primary winding of the transformer connected to the four-wire transmit terminals of the hybrid. The neon lamp is connected across the secondary of the transformer, which has a high step-up ratio and causes the neon lamp to strike when the level at the hybrid terminals exceeds a certain predetermined value.

Normally, the limiter is adjusted to its maximum sensitivity and operates with a voltage on the primary winding corresponding to +3 dbm into 600 ohms. Since the limiter is connected to the circuit at a point where the level is 4 db below the input to Hybrid Line jacks, operation of the limiter occurs when the level at the latter point exceeds +7 dbm.

The discharge current in the neon causes a large shunt loss in the 600 ohm circuit, and, since the striking of the neon is dependent on the instantaneous applied voltage, the neon is struck and then extinguished at each half-cycle of a large input, with the result that the peaks are cut and an excessive sinusoidal input becomes approximately a square wave.

The transmitted power increases as the input exceeds the operating point of the limiter, due to the fact that the power in a wave with the peaks clipped is greater than a sinusoidal wave of the same amplitude; the increase is 3 db for the extreme condition of a square wave. But the cutting of the peaks prevents overloading of the Transmit Amplifier and Repeater Amplifiers, whose power-handling capacities depend on the maximum potentials involved. Overloading could possibly occur if the various frequencies present in a high-level speech input were subjected to considerable phase distortion after the limiter, but such distortion occurs only at the extreme upper and lower frequencies of the range and such components are sufficiently attenuated by the band filter to prevent any appreciable increase of the amplitude of the composite wave.

The input level to the channel may increase some 20 db above the operating point of the limiter without causing any increase of the peak amplitude applied to the modulator circuit. The operation of the limiter is not noticeable by the distant subscriber, the distortion introduced being usually accompanied by some distortion in the overloaded sub-set transmitter.

5.6 Regulating Equipment. Either manual or automatic regulation may be employed. Equipment for automatic regulation is supplied when specified.

5.7 Manual Regulation. Adjustment of the receive terminal gain to compensate for line variations can be effected by means of gain controls on the receive amplifier and individual demodulator amplifiers, as described in Paragraphs 5.1 and 5.4.

5.8 Automatic Regulation. Equipment at each terminal for automatic regulation is provided when specified, and consists of a pilot oscillator connected to the output of the modulator band filters and an Automatic Gain Control (A.G.C) panel inserted in the receive path between equaliser output and receive amplifier input.

The pilot oscillator incorporates a quartz crystal and is similar to the carrier oscillators, except that an output stage is provided including a controlling circuit which stabilises the output level to the degree necessary for a pilot oscillator. The output level of the pilot oscillator is adjustable between the limits of -59 dbm and -32 dbm and is normally set to give a pilot output of 0 dbm from the transmit amplifier, with the latter adjusted for channel sideband outputs of +18 db, relative to the input from switchboard. Higher pilot levels may be required in order to work over noisy lines. The pilot frequencies are as follows -

System	Direction	Pilot Frequency (kc/s).
SOS	A to B	9.45
	B to A	24.35
SOU	A to B	9.45
	B to A	21.45

The A.G.C. panel introduces into the receive path an auxiliary amplifier, whose input circuit contains a variable potential-divider network. The potential-divider is formed by two fixed capacitors in conjunction with a variable capacitor and terminating resistors; its setting is controlled by a drive magnet which actuates the variable capacitor.

Pilot current present in the output of the receive amplifier is picked off at the input terminals of the demodulator band-pass filters by a pilot-amplifier circuit, consisting of an input transformer, a very narrow band-pass filter and a single-stage amplifier feeding two contact-type level meters. The gain of the pilot-amplifier circuit is adjustable, to suit the normal level of the received pilot, by means of a cathode rheostat R13 and secondary tappings on the input transformer, which has a high step-down turns ratio so that the bridging loss caused by its connection to the receive path is negligible. Deviations of approximately 0.5 db from the normal level of the received pilot cause operation of the "high" or "low" contacts of one of the level meters, designated MA.

The operation of MA causes one of a pair of gas-filled relay tubes to operate, followed by a telephone-type relay which closes the circuit of the drive magnet controlling the setting of the auxiliary amplifier. The setting of the latter is thus altered in the necessary direction by steps of approximately 0.15 db, until the level at the receive amplifier output is normal. The time taken for correction is quite appreciable, as the 0.15 db steps are separated by intervals of two seconds.

The second contact-type level meter MB is provided in order to give an alarm and disable the automatic gain control in the event of an abnormal condition of the line, due to a fault. The "high" and "low" contacts of MB are connected to a common circuit, which energises a third gas-filled relay when the pilot level at receive amplifier output is 3 db above, or 5 db below, the normal level. Such a deviation can only be caused by a sudden change of attenuation, more rapid than the correcting action of the A.G.C., and is indicative of a line fault. Operation of the gas-filled relay gives rise to a visual alarm and a delayed aural alarm, and disconnects the 24 volt supply to the drive magnet of the automatic gain control. The aural alarm is delayed by 30 seconds to prevent operation by momentary interruptions of pilot supply.

A multi-position switch enables the A.G.C. panel to be switched for manual operation of the auxiliary amplifier control, either with or without alarm bell, or for A.G.C. with or without alarm bell.

The transmission equivalent of the A.G.C. panel, from the equaliser output jacks to the receive amplifier input jacks, is 0 db at the maximum gain setting of the auxiliary amplifier. This condition normally coincides with the condition of maximum line attenuation, any reduction of the latter causing a corresponding increase of attenuation in the A.G.C. panel. The total range of automatic regulation is 16 db.

5.9 Equalising Equipment. An Equaliser Panel is included in the receive path, following the receive directional filters. The input section of this panel contains a transformer, which couples the balanced circuits of the directional filter to the unbalanced equaliser circuits. The first equaliser section is a fixed section, which compensates for attenuation distortion introduced by directional and line filters at the distant terminal and in the local line filters and receive directional filters.

The fixed equaliser section is followed by a four-section line equaliser, whose attenuation characteristic may be varied in steps of -0.1 db per 1 kc/s up to a maximum of -1.1 db per 1 kc/s, which is adequate to compensate for the attenuation distortion of a 40 db line.

5.10 Terminating Circuit. The terminal is arranged for normal two-wire termination, with a hybrid transformer mounted on the Terminating Panel. Included on this panel are two groups of pads, each of 15 db maximum attenuation, for the adjustment of levels in the four-wire transmit and receive circuits.

5.11 Pad Switching. Switching pads of 3 db (mounted on the Terminating Panel, with a controlling relay for remote operation from the switchboard) are included in the two-wire line connection and balance-network circuit.

5.12 Tail-Chasing Connection. To eliminate hybrid losses, a second relay provides remote switching of the hybrid network terminals to establish a tail-chasing connection to the hybrid transformer of another circuit.

5.13 Four-Wire Tandem Connection. Straps on the terminal panel at the top of the rack may be rearranged to provide for four-wire tandem connection via 3 db pads.

6. SIGNALLING EQUIPMENT.

6.1 Signalling equipment is not provided with the terminal.

7. TESTING EQUIPMENT.

7.1 Transmission testing equipment and meters are not included with the terminal. For the checking of anode currents at the various jacks provided, a special 1,000 ohm voltmeter is required having full-scale deflection of one volt and percentage calibration either side of mid-scale deflection.

7.2 Monitoring. A Monitoring Panel is provided giving facilities for listening and/or speaking in either direction of transmission or both simultaneously, and for signalling on the two-wire circuit in either direction or on a local service line.

8. POWER SUPPLY.

8.1 The terminal is designed for operation from the usual 24-volt and 130-volt battery supplies, or from a 220 ± 20 volt 50 c/s supply by means of a mains unit provided at the top rear of the rack, when specified. When the terminal is operated from the mains unit, the tube heater circuits are supplied with 24 volts A.C.

The approximate total load currents on the 24-volt and 130-volt supplies are 2.2 amperes and 0.11 ampere, respectively.

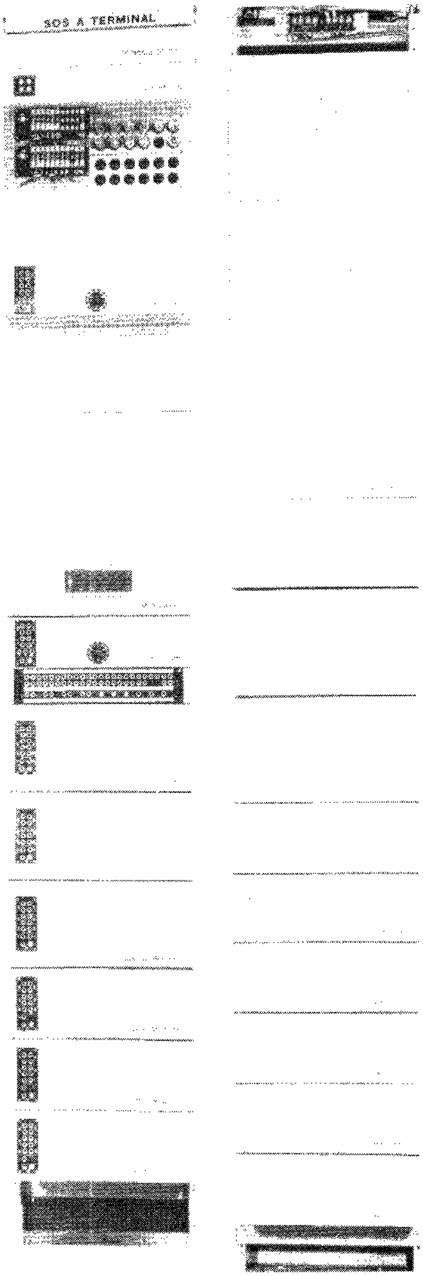
9. VACUUM TUBES.

9.1 The vacuum tube requirements per terminal are as follows -

Location	Type	Quantity
Transmit Amplifier	6SJ7GT 6V6GT	2 1
Receive Amplifier	6SJ7GT 6V6GT	2 1
Oscillator-Modulator	6SJ7GT	3
Oscillator-Demodulator	6SJ7GT	6
Pilot Oscillator	6SJ7GT 4313C	2 1
A.G.C. Panel	6SJ7GT 4313C	2 3

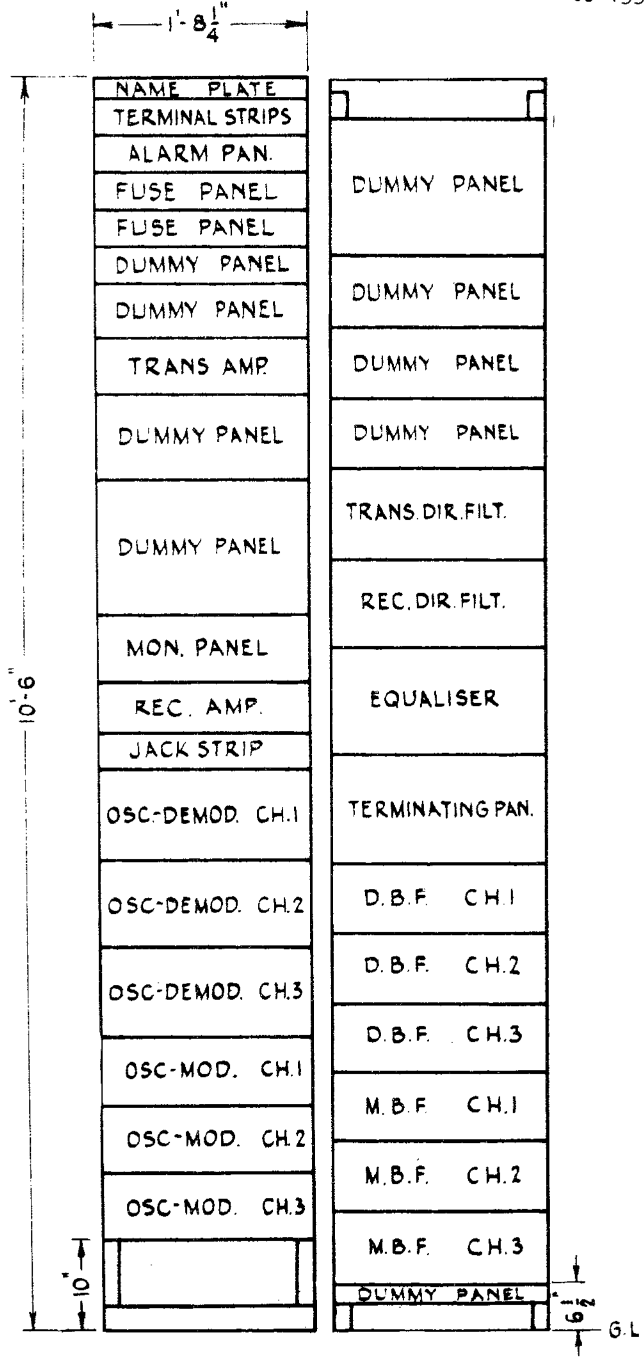
10. REFERENCE HANDBOOK.

S.T.C. Handbook No. 1057 - Volume 1 (Issue 2) and Volume 2.



FRONT. REAR.

FIG. 1.



FRONT VIEW. REAR VIEW.

FIG. 2.

SOS, SOU THREE-CHANNEL CARRIER TELEPHONE TERMINAL.

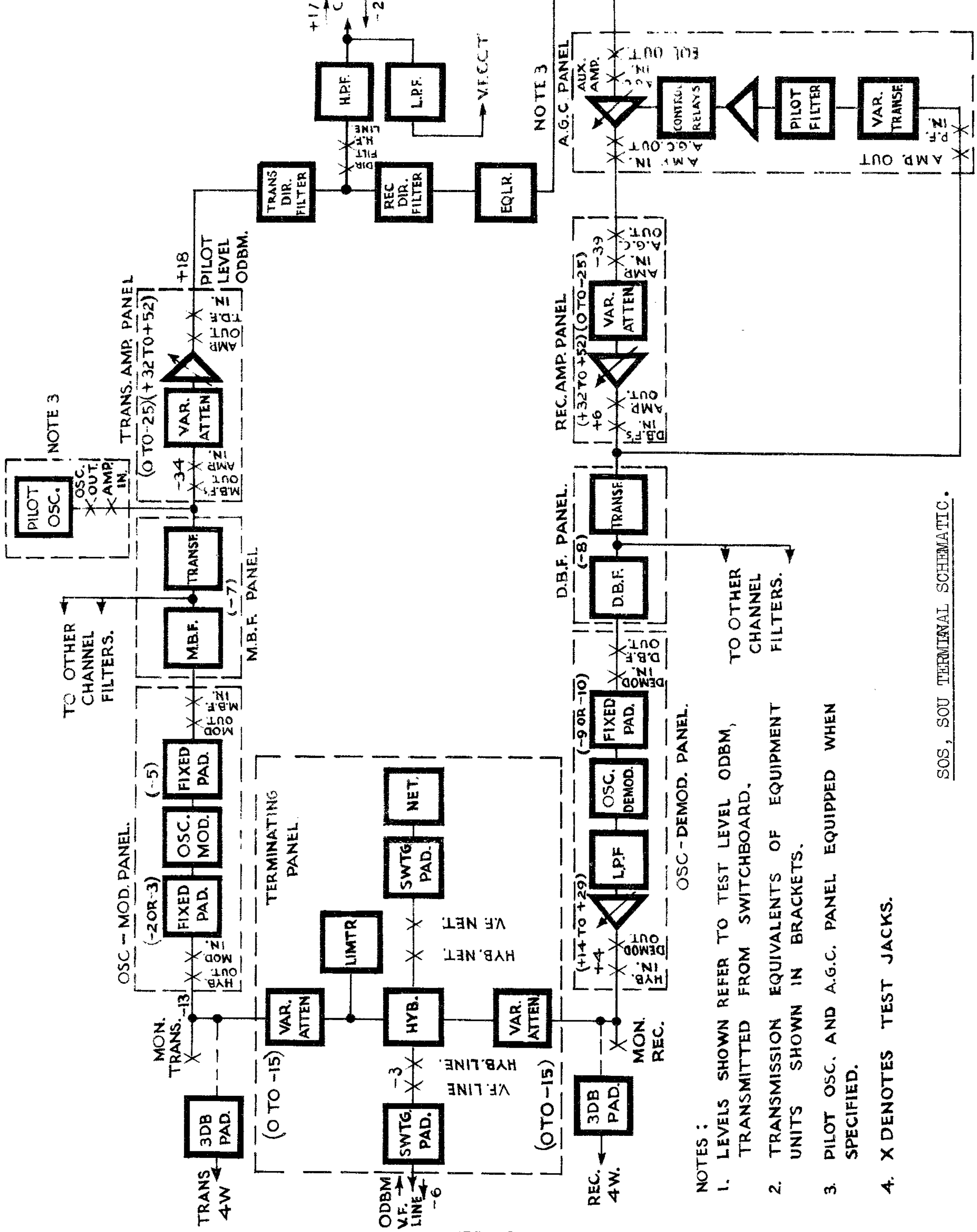
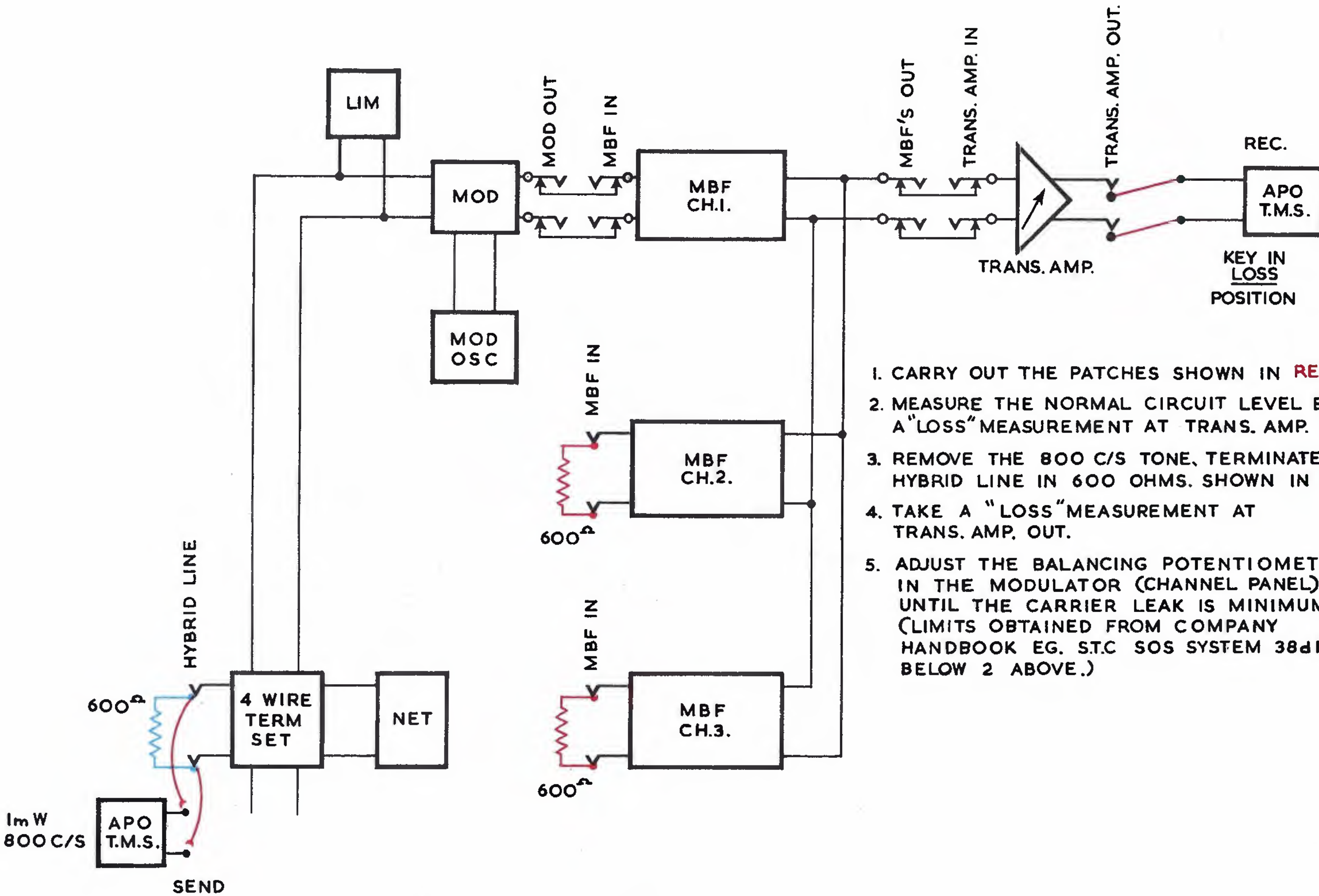

SOS, SOU TERMINAL SCHEMATIC.
NOTES :
1. LEVELS SHOWN REFER TO TEST LEVEL ODBM, TRANSMITTED FROM SWITCHBOARD.
2. TRANSMISSION EQUIVALENTS OF EQUIPMENT UNITS SHOWN IN BRACKETS.
3. PILOT OSC. AND A.G.C. PANEL EQUIPPED WHEN SPECIFIED.
4. X DENOTES TEST JACKS.
CARRIER LINE
+17
-23
H.P.F.
L.P.F.
V.F.C.C.T
TRANS DIR. FILTER
REC DIR. FILTER
EQLR.
NOTE 3
A.G.C. PANEL
AUX. AMP.
CONTROL RELAYS
PILOT FILTER
VAR. TRANSF.
TRANS. AMP. PANEL
(0 TO -25)(+32 TO +52)
VAR. ATTEN
+18
PILOT LEVEL ODBM.
-34
PILOT OSC.
M.B.F. PANEL
(-7)
TRANSF.
M.B.F.
TO OTHER CHANNEL FILTERS.
OSC - MOD. PANEL.
(-20R-3)
FIXED PAD.
OSC. MOD.
(-5)
FIXED PAD.
-13
MON. TRANS.
3DB PAD.
TRANS 4W
TERMINATING PANEL
VAR. ATTEN
LIMTR
HYB.
SWTG. PAD.
NET.
(0 TO -15)
(0TO -15)
-3
-6
ODBM
V.F. LINE
REC. AMP. PANEL
(+32 TO +52) (0TO -25)
-39
+6
D.B.F. PANEL.
(-8)
D.B.F.
OSC - DEMOD. PANEL.
(-9 OR -10)
(+14 TO +29)
+4
L.P.F
OSC. DEMOD.
MON. REC.
REC. 4W.

FIG. 3.

END.

CARRIER LEAK TEST SOS AND SOT SYSTEMS.



1. CARRY OUT THE PATCHES SHOWN IN RED
2. MEASURE THE NORMAL CIRCUIT LEVEL BY TAKING A "LOSS" MEASUREMENT AT TRANS. AMP. OUT.
3. REMOVE THE 800 C/S TONE, TERMINATE HYBRID LINE IN 600 OHMS. SHOWN IN BLUE.
4. TAKE A "LOSS" MEASUREMENT AT TRANS. AMP. OUT.
5. ADJUST THE BALANCING POTENTIOMETER IN THE MODULATOR (CHANNEL PANEL) UNTIL THE CARRIER LEAK IS MINIMUM. (LIMITS OBTAINED FROM COMPANY HANDBOOK EG. S.T.C SOS SYSTEM 38db BELOW 2 ABOVE.)

SYNCHRONISATION TEST SOS AND SOT SYSTEMS.

1. CHANNEL 2 TO BE SYNCHRONISED USING DOUBLE SIDE BAND METHOD A→B AND LOOP BACK METHOD B→A. CHANNELS 1 AND 3 SYNCHRONISED USING DOUBLE SIDEBAND METHOD B→A AND LOOP BACK METHOD A→B.
2. CARRY OUT PATCHES IN RED TO USE DOUBLE SIDEBAND METHOD.
3. ADJUST DEMOD. OSC TRIMMER CAPACITOR UNTIL BEAT NOTE HEARD IN HANDSET AT RECEIVE TERMINAL IS ONE BEAT PER SECOND OR LESS.
4. TO SYNCHRONISE IN REVERSE DIRECTION USING LOOP BACK METHOD REMOVE PATCHES SHOWN IN RED AND CARRY OUT PATCHES SHOWN IN BLUE
5. ADJUST DEMOD OSC TRIMMER CAPACITOR AT SENDING END UNTIL BEAT NOTE HEARD IN HANDSET IS ONE BEAT PER SECOND OR LESS.