TRANSMISSION AND NOISE MEASURING SYSTEM
1U AMPLIFIER-RECTIFIER
(RANGE 35 TO 15,000 CYCLES)
DESCRIPTION

CONTENTS PAGE

1. GENERAL

1.01 This section describes the 1U amplifier-rectifier panel (J64001U). The panel is part of the combined transmission and noise measuring system per SD-95900-01 provided at testboards, switching maintenance centers, and other locations. It is also part of the transmission measuring system per SD-59432-01 provided at voice-frequency patch bays, repeater bays, and packaged N carrier terminals, and part of the transmission measuring system per SD-1G073-01 provided for private service systems at air-ground, A1 digital data, and private line testboards.

1.02 The 1U amplifier-rectifier consists of a feedback amplifier and copper oxide varistor whose input and output are associated with the receiving portion of a transmission measuring system. The input of the amplifier is associated with the receiving jacks or keys of the measuring system and the output of the rectifier is connected by the measuring system to a suitable db meter. During calibration and measurement, the relays mounted on the panel change the sensitivity and impedance of the amplifier-rectifier as directed by the control leads of the associated measuring circuit.

1.03 All transmission measurements made with the 1U amplifier-rectifier are direct readings in db referred to 1 MW (0 dbm). Sensitivity control arrangements in the associated measuring circuits provide a measuring range from −35 to +15 dbm at any frequency from 35 to 15,000 cycles. The amplifier-rectifier is capable of a range from −35 to +25 dbm but the upper range (+10 to +25 dbm) is not presently used by the associated measuring circuits. The measurements can be made on a 600-ohm terminated, 900-ohm terminated, or high-impedance bridging basis. The bridging impedance is about 60,000 ohms.

2. AMPLIFIER-RECTIFIER EQUIPMENT

2.01 The 1U amplifier-rectifier panel is usually located in a bay in or near the testing area. The principal equipment features of the panel are shown in Fig. 1.

2.02 The CAL resistor is accessible on the front of the panel and is used for adjusting the overall gain of the unit. It is adjusted by means of a screwdriver. The S adjustable resistor is located on the rear of the panel and is used for adjustment of readings above 0 dbm after the CAL resistor has been adjusted. It is adjusted by means of a slidewire which is locked in place by a screw.

2.03 The FIL jack provides a means of measuring the filament current of the electron tubes. Adjustable resistors A and B are used in regulated 24-volt battery offices to adjust the filament current at specified battery voltages.

2.04 Two electron tubes are used in the amplifier-rectifier. Each is encased in a shield which is grounded to the panel by means of contact clips. The flexible grid wires are connected to the grids of the tubes on the front of the panel by means of grid caps.

2.05 Three electrolytic bypass capacitors are used in the circuit and each is insulated from the panel.

2.06 Four relays are provided on the panel. Each is controlled by the associated measuring system. Relay A is a two-winding relay which can be operated, by application of either battery or ground, to provide a 600-ohm termination. Relays B, C and D control the effective amplification and measuring range of the system.

2.07 Early versions of the 1U amplifier-rectifier were provided with a high-pass filter which could be wired in by exercise of option Y of SD-64098-01. This filter has no use in any present application of the amplifier-rectifier since a key controlled high-pass filter is included in the associated measuring system, where required. It is desirable to verify that this filter (option Y) has been disconnected in all 1U amplifier-rectifiers in service. Failure to remove this filter will result in errors during frequency response measurements.

3. AMPLIFIER-RECTIFIER CIRCUIT

3.01 The principal circuit features of the 1U amplifier-rectifier circuit are shown in Fig. 2.

3.02 The input circuit is used for transmission measurements on a 600-ohm terminated, 900-ohm terminated, or high-impedance bridging basis. When the measurement is on a 600-ohm terminated basis, the A relay in the amplifier-rectifier may be operated to provide the 600-ohm termination for the circuit being measured. For some applications, a 600-ohm or 900-ohm termination is provided externally in the associated transmission measuring circuit. In such cases, the amplifier-rectifier is operated on a bridging basis and the A relay is not operated. For 900-ohm measurements, the termination consists of a voltage divider so designed that the results of the measurements are read directly in dbm without the need for corrections. A single adjustment is adequate when the measuring system is arranged to test both 600- and 900-ohm circuits.

3.03 The input transformer is balanced and shielded against longitudinal effects. The secondary winding is tapped and in combination with the adjustable resistor S and relay D provides a means of changing the overall gain by 25 db. Relay D in the released position closes a path to the full secondary winding to provide gain for measurements below 1 MW. The gain adjustment is made with the CAL resistor. Relay D in the operated position closes a path to the tap of the secondary winding to provide reduced gain for measurements above 1 MW. The S resistor is used to adjust the gain under this condition, after the CAL resistor has been adjusted.

3.04 The amplifier circuit employs two heater-type electron tubes of the multigrid type, operating from the regular 24 or 48V office battery supply. The tubes are impedance coupled with grid bias voltages obtained from the filament and plate battery supplies. The output of the amplifier is supplied to the rectifier through a blocking capacitor to prevent the flow of dc from the plate supply to the rectifier unit.

3.05 The rectifier circuit includes a return lead connected with its phase reversed. The lead is connected through relay contacts to the grid bias resistors in the amplifier input circuit. With this arrangement, the effective overall gain of the feedback amplifier is materially reduced and a large amount of gain stability is obtained. By operation of relay B or C, the amount of negative feedback is reduced and the overall gain increased by 10 or 20 db. These relays, in combination with relay D as discussed in 3.03, provide means for changing the measuring range of the amplifier-rectifier in fixed 10 db steps.

3.06 The output of the rectifier is connected by the associated transmission measuring system to the output meter. With the output meter current adjusted to full scale zero reading on the B scale by means of the CAL calibrating resistor, the dc voltage obtained from

the rectifier is at a proper value for the feedback circuit to maintain the stated accuracy (see Par. 6) over the entire range of the meter scale. Subsequent to this adjustment, gain variations resulting from electron tube deterioration, battery voltage changes, etc, are minimized by the stabilizing action of the feedback circuit.

3.07 The measuring range relays B, C and D are controlled by sensitivity keys, dial switches or jack contacts located at the test positions where measurements are made. When the B, C and D relays are operated, either singly or in combination, the changes in the feedback path and transformer tap connection alter the amplifier gain and measuring range as shown in Table I.

TABLE I

RELAY(S) OPERATED	CHANGE IN AMP. GAIN (DB)	MEASURING RANGE (DBM)
C	+20	−35 to − 20 (loss)
B	+10	−25 to −10
None	0	−15 to 0
B and D	−15	0 to +15 (gain)
D	−25	+10 to +25 (not used. See Par. 1.03)

4. OUTPUT METER

4.01 The output meter is connected to the rectifier output by the associated measuring system. A projection-, bracket-, or panel-mounted type meter can be used. The meters are electrically equivalent. The meter resistance is about 180 ohms and the full scale current is approximately 1.5 milliamperes.

4.02 The meter has two 15 db scales, each with approximately uniform db divisions and 0.2 db subdivisions. The A scale (usually red) is marked 0 to 15. It is used with the 1U panel for transmission measurements of gains or levels above a milliwatt and with the 1W noise amplifier-rectifier panel for noise measurements above reference noise. The B scale (black) is marked 15 to 0 and is used for transmission measurements of losses or levels below a milliwatt. The total measurement, in db above or below 0 dbm, is the arithmetic sum of the meter reading plus the designation on the jack or on the operated sensitivity key or dial switch.

5. OPERATION

5.01 Access to the input of the 1U amplifier-rectifier and control of its sensitivity and input impedance is provided by the connecting transmission measuring circuits SD-95900-01, SD-1G073-01 or SD-59432-01. The connecting circuits also switch the output of the rectifier to the db meter where the results of measurements can be read. Table II shows the various sensitivity control designations, the output meter sensitivity, and the sensitivity relay operation.

TABLE II

SENSITIVITY DIAL SETTING OR KEY OPERATED	OUTPUT METER SENSITIVITY IN DBM	RELAY(S) OPERATED ON 1U PANEL
B + 20	−35 to −20	C
B + 10	−25 to −10	B
None, B, or B + 0	−15 to 0	None
A, Scale A, or A + 0	0 to +15	B & D

(− less than 0 dbm) (+ more than 0 dbm)

5.02 The 1U amplifier-rectifier is calibrated with its input terminated in 600 ohms when all measurements, with a particular amplifier-rectifier, are made at 600 ohms impedance or at both 600 and 900 ohms. When all measurements, with a particular amplifier-rectifier, are made at 900 ohms impedance, it is calibrated with its input terminated in a voltage divider whose impedance facing the circuit being tested is 900 ohms. The calibration adjustment of the CAL resistor is made with all sensitivity relays (B, C and D) released to provide a meter reading of 0 on the B scale when the input power is 0 dbm at 1000 cycles. After the B scale calibration has been made, the A scale range is calibrated, using the same input power (0 dbm), by means of the adjustable resistor S with the B and D relays operated. The S resistor is adjusted to provide a meter reading of 0 on the A scale. With the amplifier-rectifier used solely at voice-frequency patch bays, the B scale adjustment (CAL) is made to a reading of 6 (−16 dbm) when the input power is −16 dbm, the B relay operated, and the C and D relays released. The A scale adjustment(s) is made to a reading of 7 when the input power is +7 dbm with the B and D relays operated and the C relay released.

5.03 Descriptions of the controls and sensitivity keys or switches are also contained in the sections of practices on the associated transmission measuring systems SD-95900-01, SD-1G073-01 and SD-59432-01.

6. ACCURACY

6.01 The measuring accuracy of the 1U amplifier-rectifier and its output meter(s) is a function of the level and frequency of the signal being measured. When the amplifier-rectifier and meter are properly calibrated, the combined accuracy is as shown in Table III.

7. MAINTENANCE

7.01 Maintenance of the 1U amplifier-rectifier requires periodic calibration with an accurate milliwatt supply and periodic checks for gain without feedback, scale matching, and sensitivity control requirements. It is necessary to check for these requirements whenever components are replaced or major repairs made. The test and adjustment procedures are covered in the sections on the associated transmission measuring circuits.

A. Trouble Testing

7.02 When the requirements cannot be met, or if the system exhibits instability or difficulty in adjustment, the circuit should be investigated for trouble. Circuit details are given on the drawings listed in Par. 8. It is particularly important to check the electron tubes and electrolytic capacitors whenever trouble is experienced.

B. Test of Gain Without Feedback

7.03 A test of the amplifier gain without feedback can be made to find troubles which might otherwise be masked by the stabilizing

TABLE III

FREQUENCY CPS	LEVEL DBM	ACCURACY IN DB METER	1U PANEL	COMBINED	SEE NOTE
1000	+1 to +15	±0.15	*	±0.15	(a)
1000 (Calibration)	0	±0.05	*	±0.05	
1000	−1 to −10	±0.15	*	±0.15	(b)
1000	−11 to −20	±0.15	*	±0.15	(a,c)
1000	−21 to −35	±0.15	*	±0.15	
400 to 1000 & 1000 to 4000	−35 to +15	±0.15	*	±0.15	(d,e)
50 to 400 & 4000 to 8000	−35 to +15	±0.15	±0.2	±0.35	(e)
35 to 50 & 8000 to 15000	−35 to +15	±0.15	±0.5	±0.65	(e)

* Negligible when compared to values in "meter" column.

Note (a) When measuring circuit serves only voice-frequency patch bays and calibrations are at +7 (or +4) and −16 (or −13) levels, the accuracy at these levels is increased to ±0.05 db.

(b) When B + 10 position is used and meter reads between 0 and 10 on B scale, the accuracy increases to ±0.10 db.

(c) When B + 10 position is used and meter reads between 10 and 15 on B scale, the accuracy decreases to ±0.20 db.

(d) At the 1000-cycle point, the accuracies listed for 1000 cycles in Table III apply.

(e) These accuracies assume that the external high-pass filter is not in the measuring path. At frequencies 8000, 360, and 180 cps when filter is in measuring path, the respective loss is 0.5, 0.2 and 12; and the accuracy is ±0.5, ±0.2 and ±2 db.

TABLE IV

RESISTOR(S)	MEAS. FROM + APP.	TERM.	MEAS. TO − APP.	TERM.	DC VOLTS MIN.	MAX.
T (D)	ET 2	4	TS B	4	7.0	9.0
U (E)	TS B	2	ET 2	3	45.0	75.0
*K, L & M (B)	ET 1	5	Rel. C	1 Top	3.5	5.5

( ) — Capacitor under test.

* Operate B +20 key or switch for this test (operates C relay).

action of the feedback circuit. This can be done by using a 5A attenuator or its equivalent to determine the loss that must be inserted between a milliwatt source and the input of the measuring system to obtain a full scale meter reading of 0 on the B scale. For the test the meter shunt should be opened by disconnecting one of the leads to the W resistor (59 ohms), the J resistor (41.9 ohms) should be short-circuited, the attenuator should be connected between the receiving jack of the system (600Ω TST, RCV or TST MEAS with TST-101 key operated to TST and SEND-RCV key operated to RCV) and a source of test power which provides 1 MW (0 dbm) at 1000 cycles. The B + 20 sensitivity key should be held operated, or the sensitivity switch operated to B + 20 and the attenuator keys or dials adjusted until the meter reads 0 on the B scale. The total attenuation (5A attenuator plus test pads, if associated with TST MEAS jack), should be 56 ±2 db. If this limit is not met defective electron tubes, electrolytic capacitors, or feedback resistors should be suspected. The feedback resistors (J, K and L) can be checked on a Wheatstone bridge against the limits shown on Drawing SD-64098-01. The electrolytic capacitors (D, E and B) can be checked by measuring with a volt-ohm-milliammeter (20,000 ohms per volt), the dc voltage across the resistors (T; U; K, L and M) shown in Table IV.

C. Electron Tubes

7.04 Replacement of electron tubes in the 1U amplifier-rectifier is made in accordance with the SD-drawing or as given in Table V.

TABLE V

ELECTRON TUBE SOCKET	24V REGULATED FILAMENT BATTERY OFFICES	24V NONREGULATED FILAMENT & 48V BATTERY OFFICES
1	310A	328A
2	311B	329A

8. LIST OF DRAWINGS (Not attached)

SD-64098-01	1U Amplifier-Rectifier Circuit
SD-1G073-01	Transmission Measuring Circuit
SD-59432-01	Transmission Measuring Circuit
SD-95900-01	Transmission and Noise Measuring Circuit

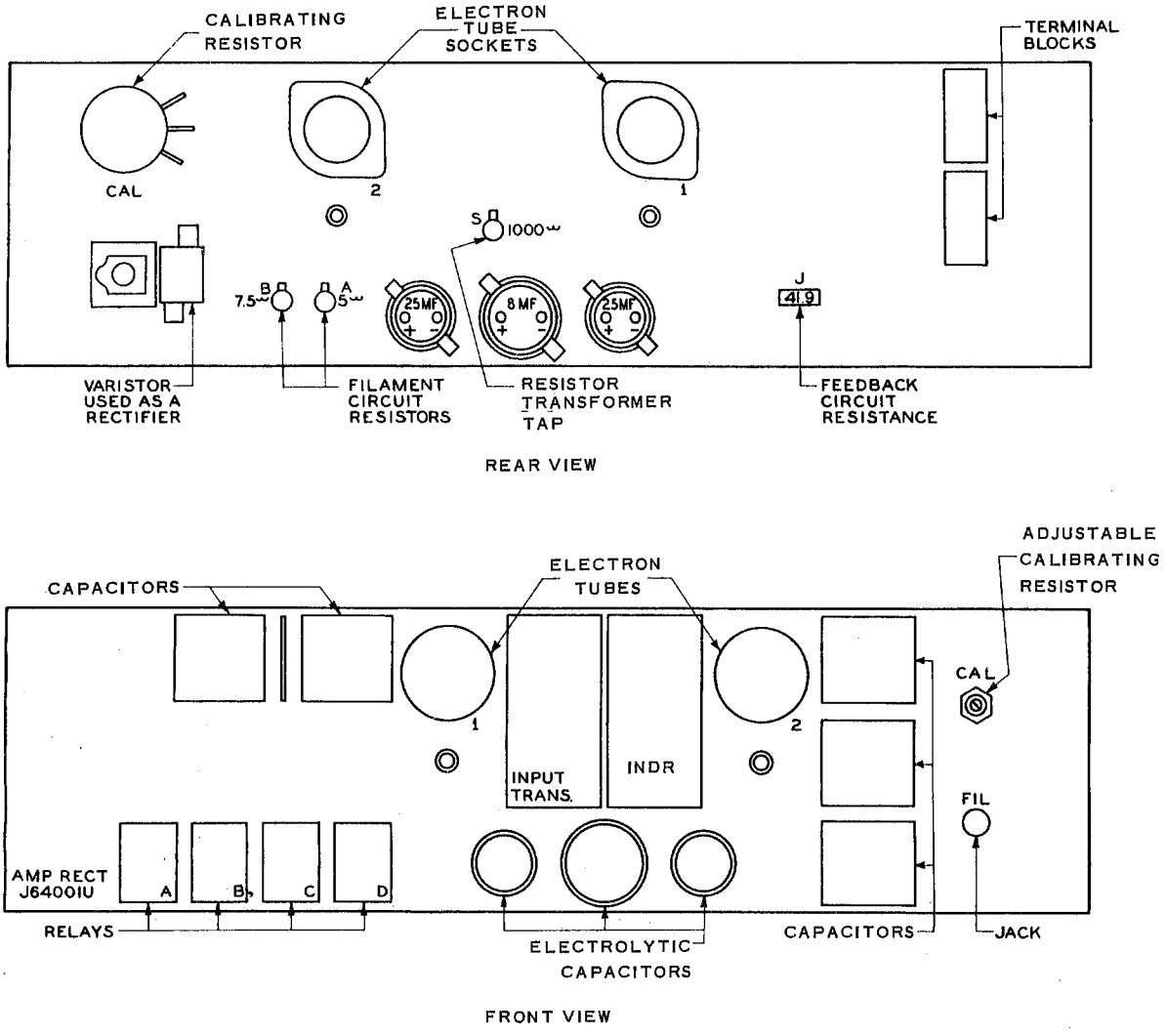

Fig. 1 – Principal Equipment Features

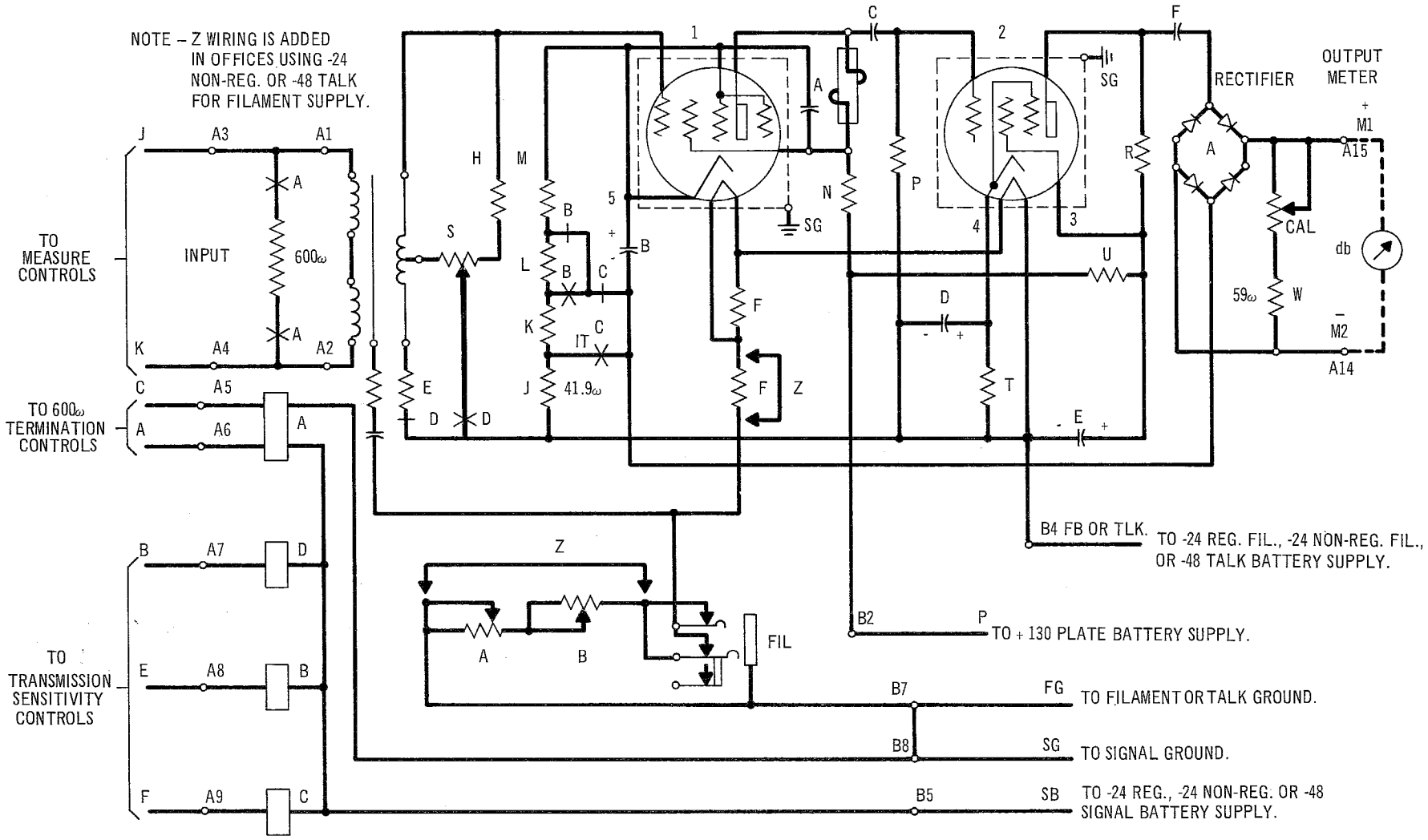

Fig. 2 – Principal Circuit Features