# 23A AND 23D TRANSMISSION MEASURING SETS
# J94023A AND J94023D
# (RANGE: 300 TO 5000 Hz)
# DESCRIPTION

CONTENTS PAGE



## 1. INTRODUCTION

**1.01** This section covers the description, operation, and maintenance of the J94023A and J94023D transmission measuring sets (23A and 23D TMSs). These sets are small, portable, receiving instruments for measuring transmission levels of –25 to +10 dBm in the frequency range from 300 to 5000 Hz on both 600- and 900-ohm circuits. The 23A set replaces the 12-type transmission measuring set and the 23D set replaces the 23A transmission measuring set. The 23D set is similar to the 23A set except the feature that provides for the measurement of PBX cord circuits has been replaced by a provision for using the dialing, holding, and dc blocking features with other externally connected test sets.

**1.02** This section is reissued to include the information for the 23D transmission measuring set. Since this reissue covers a general revision, the arrows ordinarily used to indicate changes have been omitted.

**1.03** Dialing and holding features are provided by both the 23A and 23D sets for setting up connections over a trunk or line preparatory to making measurements.

**1.04** The circuits of the 23A and 23D sets are passive and, therefore, do not require batteries or an external power source for operation.

## 2. DESIGN FEATURES (GENERAL)

### A. Mechanical

**2.01** The 23A and 23D sets each weigh 6 pounds and measure 6 inches wide, 9-1/2 inches long, and 5-1/4 inches deep (including cover, hinges, feet, and carrying handle). The sets are packaged in an aluminum case of the deep drawn type, which is provided with a retractable handle for carrying. See Fig. 1 and Fig. 2 for views of the 23A and 23D sets, respectively.

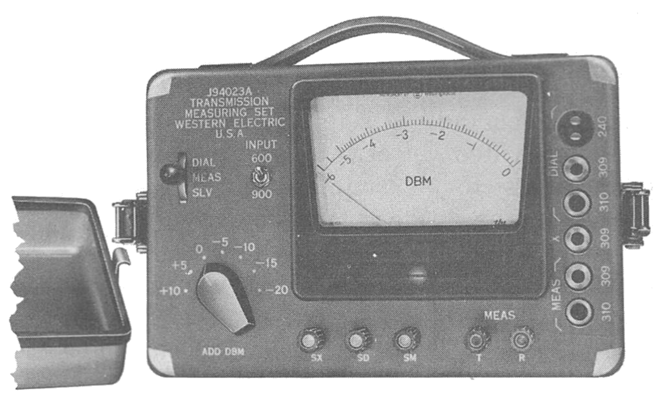


**Fig. 1—The 23A Transmission Measuring Set**

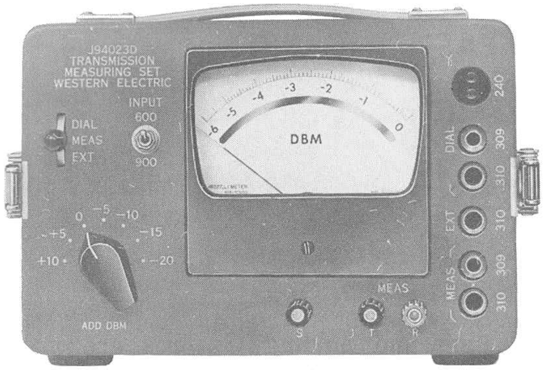


**Fig. 2—The 23D Transmission Measuring Set**

**2.02** The 23A and 23D sets are designed to withstand ordinary handling encountered in transportation and use. The sets employ a rugged high-sensitivity meter with a taut-band suspension.

> ***Note:*** The meter needle may bounce around during transport of the set; but because of the rugged construction of the meter, it does not require damping.

**2.03** The 23A and 23D sets may be used in any position from horizontal (meter face up) to vertical (see 3.20).

**2.04** Multiple jacks and binding posts are provided for making dialing and measuring connections between the 23A or 23D TMS and the circuit under test at a variety of types of switchboards, testboards, test frames, PBXs, and other testing locations.

**2.05** A door on the side of the 23A or 23D TMS provides access to calibration controls. Instructions for a simple calibration procedure appear on the inside of the door.

## B. Electrical

**2.06** Table A shows the electrical characteristics of the 23A and 23D TMSs.

## 3. DESIGN FEATURES (DETAILED)

### General

**3.01** The circuits of the 23A or 23D TMS can be separated into eight consecutive parts as follows: input, holding, blocking, impedance matching, attenuator, filter, detector, and meter. The simplified schematic of the 23A TMS is shown in Fig. 3 and Fig. 4. For the 23D TMS, it is shown in Fig. 5 and 6.

### Input Circuit of the 23A TMS

**3.02** The input circuit of the 23A set consists of jacks, binding posts, and the DIAL-MEAS-SLV key (see Fig. 1). The jacks are provided for making the various dialing and measuring connections between the 23A set and a variety of types of switchboards, testboards, test frames, PBXs, etc. The group of jacks designated MEAS provides for connecting the 23A set to the circuit being measured using 309- and 310-type plugs. Dual binding posts for banana-type plugs as well as spade tips or wires are also provided to facilitate making connections to the set when plug-ended cords are not available. One binding post is black and is designated T (tip), and the other is red and is designated R (ring). The group of jacks designated DIAL is for connecting a handset or other equipment, when required, for controlling or establishing connections. The jack designated 240 is provided for making dialing connections for the special 240-type plug on the handset used in the step-by-step offices.

**3.03** The X jack is provided for making measurements at a manual PBX where 1000-Hz testing power is supplied from the central offices. Cord circuits can be measured in both trunk-to-extension and extension-to-extension conditions. In addition, the X jack is associated with circuits which provide for holding the central office trunk supplying the testing power while the cord circuits are being changed. The tip and ring of the X jack are reversed with respect to the DIAL and MEAS jacks. Where the PBX trunk circuit does not require the operation of a relay in the sleeve circuit to cut the trunk through to the central office, the above arrangement supplies ground to the ring side of the trunk for holding the connection to the testing power when the SLV key is operated.

**3.04** The SM and SD binding posts are in the measure and dial sleeve circuits, respectively, and are normally connected together through an auxiliary contact on the X jack. The SX binding post normally is disconnected from the test circuit, but may be connected to the sleeve of the X jack by operating the DIAL-MEAS-SLV key to SLV.

**TABLE A**

**ELECTRICAL CHARACTERISTICS**

| | |
|---|---|
| Measurement Range | —25 to +10 dBm |
| Meter Range | 6 dB |
| Frequency Range | 300 to 5000 Hz |
| Input Impedance | 600 and 900 ohms |
| Input Impedance Accuracy | ±5%, ±3° at 1000 Hz for levels from —20 to +10 dBm (See Part 3 for more detailed information.) |
| Temperature Range | 40 to 100°F |
| Measuring Accuracy | ±0.2 dB at 1000 Hz for levels of —20 to +10 dBm* and ±0.5 dB over frequency range of 400 to 5000 Hz for levels from —25 to +10 dBm (See Part 3 for more detailed information.) |
| Frequency Suppression | >4 dB at 180 Hz; >25 dB at 60 Hz |
| DC Resistance of Holding Circuit | 700 ohms |

* Accuracy of ±0.1 dB can be obtained under conditions specified in 3.20.

**3.05** The DIAL-MEAS-SLV key is provided for setting up dialing and holding conditions. When this key is in the MEAS position, the MEAS jacks are connected to the holding and measuring circuits, and the X jack is connected to the DIAL jacks. In the DIAL position, the MEAS and DIAL jacks are connected together, and the X jack is connected to the holding circuit for holding purposes. The operation of the DIAL-MEAS-SLV key to SLV disconnects the DIAL jack sleeve from the X jack sleeve, connects it to the MEAS jack sleeve, and connects the X jack sleeve to the SX binding post. To this binding post may be connected either battery or ground to secure the proper sleeve condition to hold relays in the trunk operated.

**3.06** The circuit of the 23A set for the three positions of the DIAL-MEAS-SLV key is shown in schematic form in Fig. 3.

#### Input Circuit of the 23D TMS

**3.07** The input circuit of the 23D set consists of jacks, binding posts, and the DIAL-MEAS-EXT key (see Fig. 2). The jacks are provided for making the various dialing and measuring connections between the 23D set and a variety of types of switchboards, testboards, test frames, PBXs, external test sets, etc. The group of jacks designated MEAS provides for connecting the 23D set to the circuit being measured using 309- and 310-type

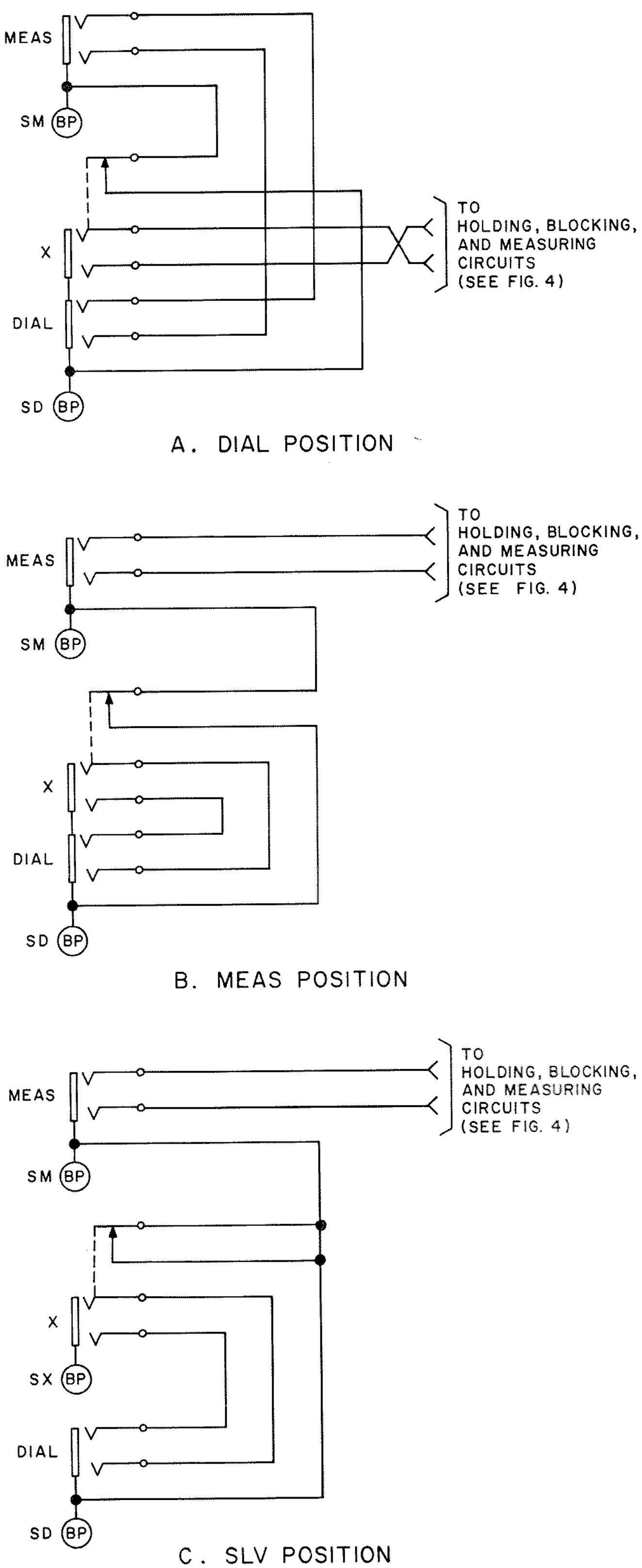


**Fig. 3—Simplified Schematic of DIAL-MEAS-SLV Key of 23A TMS**

plugs. Dual binding posts for banana-type plugs as well as spade tips or wires are also provided to facilitate making connections to the set when plug-ended cords are not available. One binding post is black and is designated T (tip), the other is red and is designated R (ring). The group of jacks designated DIAL is for connecting a handset or other equipment, when required, for controlling or establishing connections. The jack designated 240 is provided for making dial connections to the special 240-type plug on the handset used in step-by-step offices.

**3.08** The EXT jack is provided for connecting a test set or other equipment to use the dialing, holding, and dc blocking features of the 23D set. This jack accepts a 310-type plug. The sleeves of all the jacks are connected together and brought out to a binding post designated S.

**3.09** The DIAL-MEAS-EXT key is provided for setting up dialing and holding conditions. When this key is in the MEAS position, the MEAS jacks are connected to the holding and measuring circuits. In the DIAL position, the MEAS and DIAL jacks are connected together. The operation of the DIAL-MEAS-EXT key to the EXT position connects the EXT jack through the holding and blocking circuits to the MEAS jacks.

**3.10** The circuit of the 23D set for the three positions of the DIAL-MEAS-EXT key is shown in schematic form in Fig. 5.

## Holding and DC Blocking Circuits

**3.11** The input connections at the jacks are carried through the contacts of the DIAL-MEAS-SLV key of the 23A set or the DIAL-MEAS-EXT key of the 23D set to the holding circuit. This circuit has a resistance of 700 ohms and acts as a bridge to provide a dc path for holding the connection established to the test line when required. It has a sufficiently large inductance so that it presents a high impedance and consequently little shunting effect to the ac signal being measured. The blocking circuit blocks direct voltages from circuits following the holding circuit. The total insertion loss of the holding and blocking circuits is less than 0.1 dB over the frequency range of 300 to 5000 Hz.

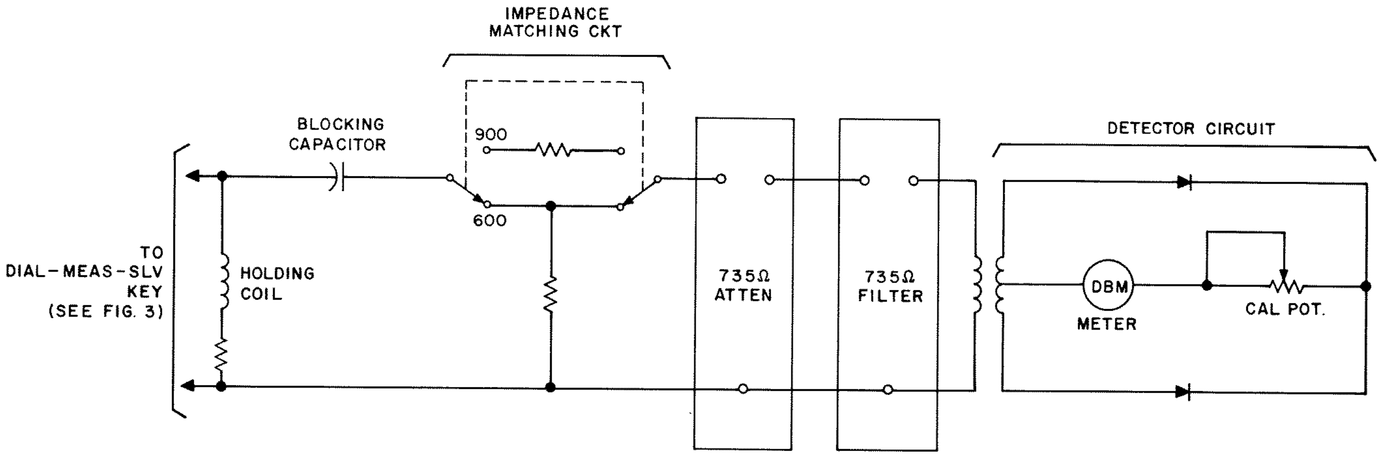


**Fig. 4—Simplified Schematic of the Holding, Blocking, and Measuring Circuits of the 23A TMS**

### Impedance Matching Circuit

**3.12** The impedance matching circuit matches either a 600- or 900-ohm circuit under test to the common 735-ohm measuring circuit. This is done with the use of resistance pads having equal insertion loss. The insertion loss of each pad is within 0.01 dB of the other so that the set can be calibrated with either a 600- or 900-ohm outlet, and essentially the same measurement accuracy is obtained when measuring on either a 600- or 900-ohm circuit. A 2-position toggle switch, designated INPUT, selects either pad to provide the proper impedance match.

### Attenuator

**3.13** The attenuator has an impedance of 735 ohms and provides attenuation from 0 to 30 dB, in 5-dB steps. Each step is accurate to within 0.04 dB. The ADD DBM switch controls the setting of the attenuator. Positions are designated +10, +5, 0, -5, -10, -15, and -20. These designations correspond to attenuation in the attenuator of 30, 25, 20, 15, 10, 5, and 0 dB, respectively.

### Filter

**3.14** The filter is a 735-ohm high-pass network. Its purpose is to attenuate low-frequency noise and hum pickup which might result from exposure of the circuit under test to low-frequency induction. This will minimize possible measurement error at low levels. The response of the filter is essentially flat over the frequency range of 300 to 5000 Hz, and below 300 Hz its insertion loss increases. Most low-frequency noise power is expected to be at 60 and 180 Hz, and the suppression provided by the filter, as referred to 1000 Hz, is greater than 4 dB at 180 Hz and greater than 25 dB at 60 Hz.

### Detector

**3.15** The detector is of the full-wave average type. Silicon backward-type diodes, which have the properties of a low forward impedance and a low temperature coefficient, provide the full-wave rectification. The meter provides the load for the rectifiers. With some compensation, detector variations are held to within ±0.1 dB over the ambient temperature range of 40 to 100°F.

### Meter

**3.16** The meter is of the taut-band suspension type. Its scale is calibrated in dB and has a range of -6 to 0 dB. The zero current position is off scale to the left. The meter current is approximately 10 $\mu$A for a -6 dB scale indication and 25 $\mu$A for a 0-dB scale indication. Calibrated markings are provided at -6.0, -5.5, and -5.0 dB, and at 0.1-dB intervals from -5 to 0 dB. A zero-adjust knob with a lever attached is provided on the rear of the meter for calibration purposes. The zero-adjust on the front of the meter has been disabled to prevent attempts to "zero" the meter, since it is of the suppressed-zero type.

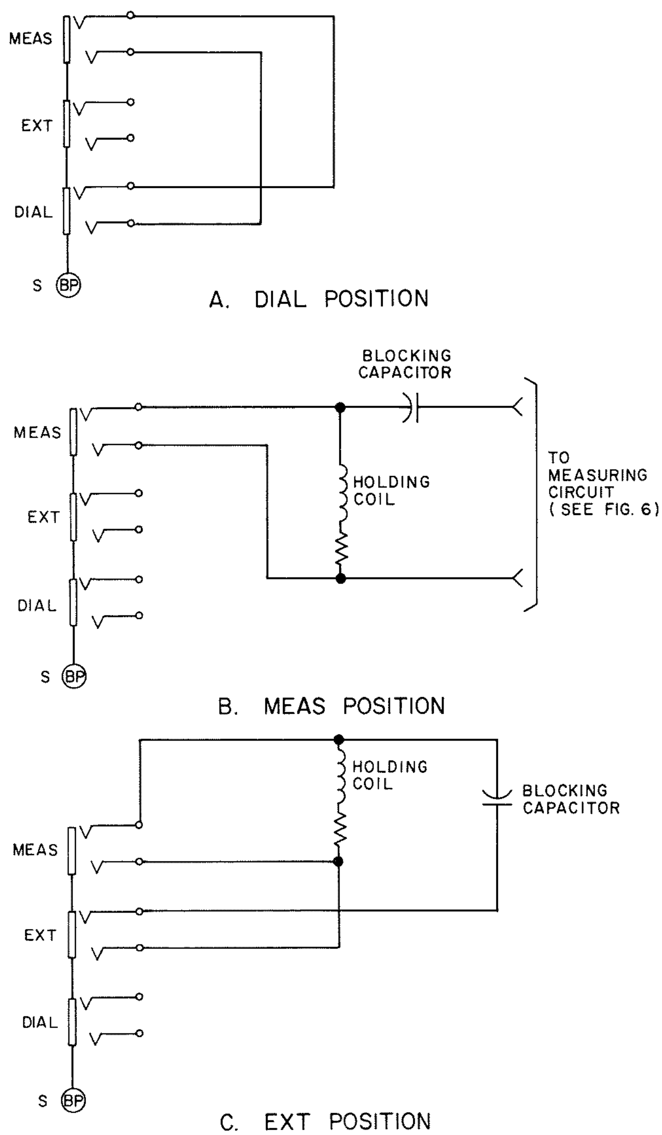


**Fig. 5—Simplified Schematic of the DIAL-MEAS-EXT Key, Holding and Blocking Circuits of the 23D TMS**

**Frequency Characteristic**

**3.17** Figure 7 shows the frequency characteristic of the 23A and 23D TMSs. The dashed lines show the frequency characteristic limits which might be expected because of component tolerances. The solid line represents the typical performance. In the frequency range of 400 to 5000 Hz, the frequency characteristic is practically flat, the maximum meter deviation being about 0.2 dB. In the range below 400 Hz, because of the effect of the low-frequency filter, the characteristic falls off—the meter deviation at 300 Hz being about 0.4 dB below the 1000-Hz reading. At 180 Hz, the overall response is down about 4.5 dB and at 60 Hz, about 30 dB.

**Input Impedance Accuracy**

**3.18** The input impedance of the 23A and 23D TMSs is dependent on the level and frequency of the signal being measured. Most impedance variations are due to the filter and detector circuits. The attenuator, which precedes these circuits, reduces the impedance variations whenever it has attenuation in it. When the ADD DBM switch is in the −20 position, the attenuator has 0 dB of loss. In this case, the input impedance variations will be at a maximum. In the other extreme, when the ADD DBM switch is in the +10 position, the attenuator provides 30 dB of loss, and the impedance variations will be at a minimum. The input impedance of the set has been held as close to nominal as possible to provide the highest measurement accuracy. The accuracy of the input impedance for either 600- or 900-ohm measurements is as follows:

| FREQUENCY (Hz) | LEVEL (dBm) | IMPEDANCE ACCURACY* |
|---|---|---|
| 1000 | −20 to +10 | ±5%, ±3° |
| 1000 | −25 to −20 | ±10%, ±6° |
| 300 to 5000 | −20 to +10 | ±10%, ±6° |
| 300 to 5000 | −25 to −20 | ±15%, ±9° |

* The input impedance is within the stated range of being purely resistive.

The effects of impedance variations have been included in the measurement accuracy statement in 3.19.

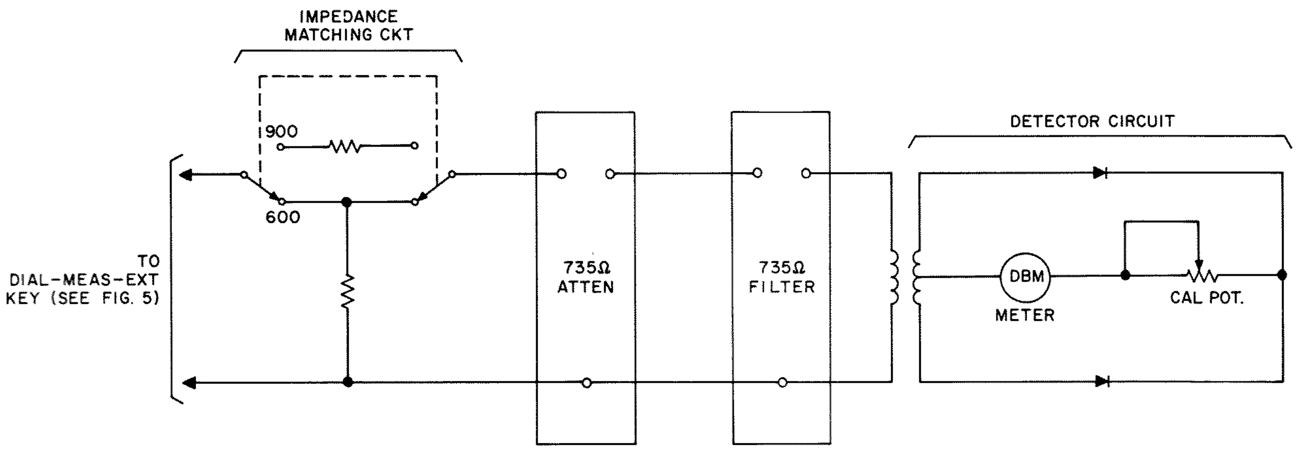


**Fig. 6—Simplified Schematic of the Measuring Circuit of the 23D TMS**

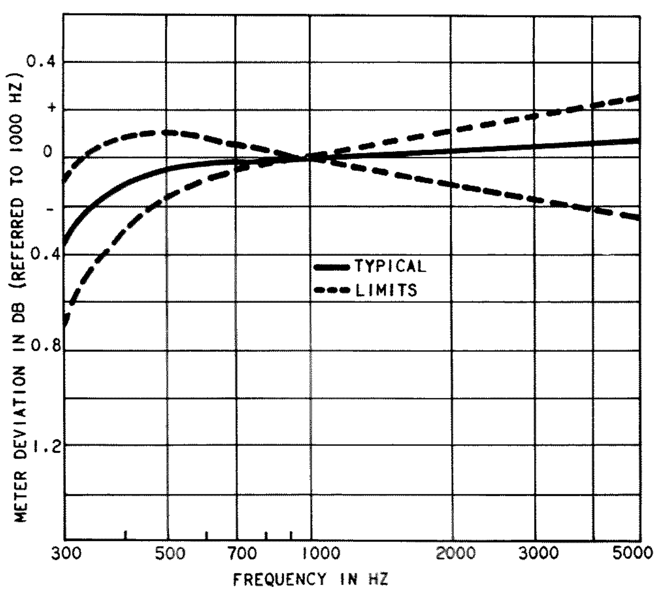


**Fig. 7—Frequency Characteristic of the 23A and 23D Transmission Measuring Sets**

### Measurement Accuracy

**3.19** The measurement accuracy of the 23A and 23D TMS is a function of the level and the frequency of the signal being measured. When the set is properly calibrated at room temperature (70 to 85°F), its accuracy is as follows:

| FREQUENCY (Hz) | LEVEL (dBm) | ACCURACY (dB) |
|---|---|---|
| 1000 | —15 to +10 | (See 3.20) |
| 1000 | —20 to +10 | ±0.2 |
| 1000 | —25 to —20 | ±0.3 |
| 400 to 5000 | —25 to +10 | ±0.5 |
| 300 to 400 | —20 to +10 | —0.3 ±0.5 |
| 300 to 400 | —25 to —20 | —0.3 ±0.6 |

*Note:* The above accuracies apply with the 23A and 23D TMS in any position from horizontal (meter face up) to vertical, when measuring on either 600- or 900-ohm circuits, and over an ambient temperature range of 40 to 100°F.

**3.20** With certain restrictions and care in reading the meter, the measurement accuracy at a frequency of 1000 Hz, and over a level range of -15 to +10 dBm, will be better than ±0.1 dB. The restrictions are:

(a) If the ambient temperature is within ±10°F of the calibrating temperature

(b) If the set is used in only the horizontal position

(c) If the calibration of the set is checked regularly and adjusted as close to the calibration markers as possible.

## 4. OPERATION

### General

**4.01** The 23A and 23D TMSs are rugged and stable, and it is expected that the calibration will be quite stable under normal conditions of use and handling. However, the calibration should be checked frequently to guard against possible malfunction of the set due to misuse or component failure. The calibration procedure appears on the inside of a door which opens on the front side of the case. Two calibration controls are accessible through this door. A lever-type control (on the left side) is used to calibrate the meter at the -5 dB point, and a potentiometer with a knob control (on the right side) is used to calibrate the meter at the 0-dB point. Figure 8 shows a view of the calibration controls and the door.

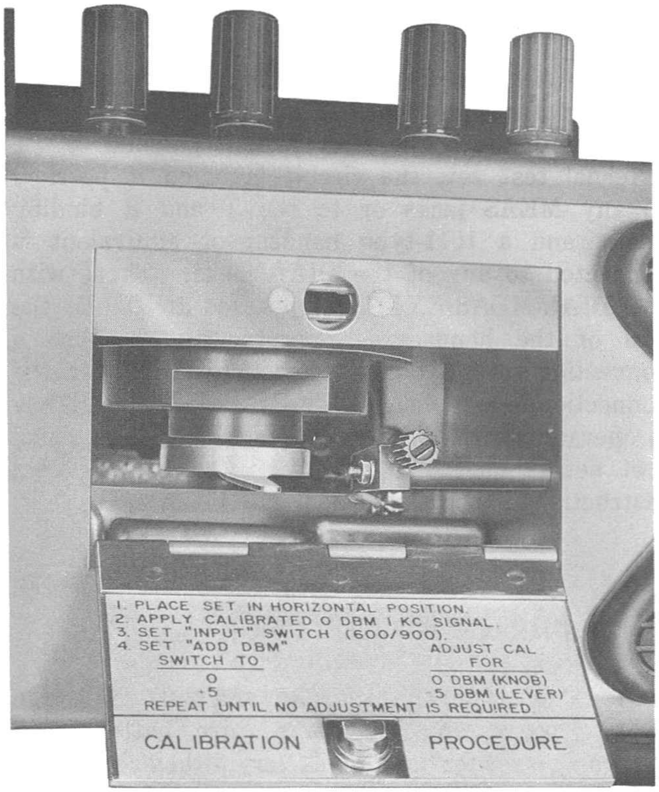


**Fig. 8—Calibration Controls of the 23A and 23D Transmission Measuring Sets**

**4.02** If the 23A or 23D TMS is used in the temperature range of 40 to 100°F, it should be calibrated at room temperatures (70 to 85°F). At temperatures outside this range the accuracy of the set becomes proportionally poorer. The set should, therefore, be calibrated at the temperature to which it is exposed during measurement to ensure that the accuracies of Part 3 are attained. After exposure to very high or low temperatures, such as during transport or storage, the set should be allowed to return to approximately room temperature before use, or calibration, for highest accuracy. The set has a long thermal time constant, and the time allowed should depend on temperature differences involved. In extreme cases, about an hour must be allowed.

**Calibration**

**4.03** The calibration procedure is as follows:

(1) Place the set on a bench with the meter face in a horizontal position.

(2) Connect a 1000-Hz signal from an accurately calibrated 600- or 900-ohm 0-dBm outlet to the T and R binding posts or to any MEAS jack.

(3) Set the INPUT switch to 600 or 900 to match the impedance of the outlet.

(4) Set the DIAL-MEAS-SLV key of the 23A set or the DIAL-MEAS-EXT key of the 23D set to MEAS.

(5) Open the door on the front side of the case.

(6) Set the ADD DBM switch to 0 and adjust the potentiometer knob on the right for a reading of 0 on the meter.

(7) Set the ADD DBM switch to +5 and adjust the meter lever on the left for a reading of -5 on the meter.

(8) Repeat Steps (6) and (7) until both the 0 and -5 readings are obtained without changing either adjustment.

> ***Note:*** If the calibration controls do not have sufficient range or the calibration is drifting, refer to Part 5.

**Connection to External Circuits**

**4.04** As stated in Part 3, connections to external circuits are made by means of the jacks and binding posts on the transmission measuring set. In general, a patching cord such as the 3P12H, which consists of a P3F cord equipped with a 310 plug on one end and a 309 plug on the other end, may be kept with the 23A or 23D TMS. This provides a universal patching cord, adapting the set to all applications except where the X jack (23A only) is used at PBXs equipped with 309 plugs. For these cases, the 3P3A patching cord which consists of a P3D cord equipped with 309 plugs (or equivalent) is desirable. (Refer to 4.07.)

**Transmission Measurements**

**4.05** In general, transmission measurements can be made by connecting the circuit involved to any MEAS jack or to the T and R binding posts of the 23A or 23D set and to a source of testing power in accordance with the measurement procedure given in numerous sections of Bell System Practices.

If handsets or other testing facilities are required to establish a connection to the testing power, they are connected to any DIAL jack, and the DIAL-MEAS-SLV key of the 23A set or the DIAL-MEAS-EXT key of the 23D set is operated to DIAL. After the connection is established and the test tone is heard, the DIAL-MEAS-SLV key of the 23A set or the DIAL-MEAS-EXT key of the 23D set should be operated to MEAS, thereby connecting the testing power to the meter circuit. The ADD DBM switch should then be positioned for an on-scale meter reading. For best accuracy, the upper end of the meter (near 0) should be used whenever possible (–6 to –5 dB is an overlap region). The measured value in dBm is then the algebraic sum of the ADD DBM switch setting and the meter reading.

### Sleeve Supervision

**4.06** If the test procedure calls for battery or ground on the sleeve of the jack to which the set is connected, this can be done by connecting battery or ground to the SM binding post (23A set) or the S binding post (23D set).

### PBX Cord Circuit Measurements (23A Only)

**4.07** When testing a PBX circuit using testing power supplied over a trunk from the central office, the X jack is patched to the trunk jack, the cord circuit is patched to the DIAL and MEAS jacks, and ground is supplied at the SM binding post in accordance with the procedure given in other sections of the Bell System Practices. Then, with the DIAL-MEAS-SLV key operated to DIAL, the measured loss is that of the PBX trunk. With this key operated to MEAS, the measured loss is that of the trunk plus that of the PBX cord circuit in trunk-to-extension transmission condition. With the DIAL-MEAS-SLV key operated to SLV, the measured loss is that of the trunk plus that of the extension-to-extension transmission condition of the cord circuit. With the key operated to DIAL, the trunk connection to the testing power is held while changing cords. Where PBXs are involved which require that sleeve relays of the trunks be held operated, use is made of the SX binding post. This binding post is connected to the sleeve of an idle front cord. For this purpose, a 1W13B cord (893 cord with 360A tools on each end) together with one 364 tool (spade tip) and one 365 tool (alligator clip) or equivalent may be used.

### Use of the 23D TMS with Other External Test Sets

**4.08** When the dialing, holding, and dc blocking features of the 23D set are used with an external test set, the EXT jack is patched to the external test set, the circuit involved is patched to any MEAS jacks or to the T and R binding posts, and a 1011-type handset or equivalent is connected to any of the DIAL jacks. Then, with the DIAL-MEAS-EXT key operated to DIAL, the dial of the handset is operated to establish a connection to the far-end termination. After the connection is established, the DIAL-MEAS-EXT key is operated to the EXT postion. Then the external test set is operated in accordance with its own instruction to complete the test.

## 5. MAINTENANCE

**5.01** The circuits of the 23A and 23D TMSs are passive and do not require batteries or external power for operation. Very little maintenance should be required, to keep the sets in working condition. If it is suspected that any item of the set is malfunctioning or defective, the set should be sent to a Western Electric repair center for repair.

**5.02** Most trouble conditions, such as a defective meter, will become apparent in the process of calibration. Calibration of the set should, therefore, be checked frequently to detect possible failure. It is recommended that the set be sent to a Western Electric repair center for complete calibration at 2-year intervals.

**5.03** The set can be removed from its case by first releasing both of the quarter-turn fasteners at the rear of the set and then lifting the set from its case.

## 6. LIST OF DRAWINGS FOR REFERENCE

### Drawings (Not Attached)

| | |
|---|---|
| SD-99700-01 | Circuit (23A) |
| SD-99700-04 | Circuit (23D) |