3A NOISE MEASURING SET

CONTENTS PAGE

1. GENERAL

1.01 This section covers the description, calibration, operating principles, and maintenance procedure for the 3A noise measuring set. The set is a portable, visual-indicating device to be used for electrically measuring various types of noise. It is intended that the 3A set will eventually replace the 2B noise measuring set.

1.02 The 3A set is transistorized and is powered by a single 45-volt battery. The set consists essentially of input circuits, an attenuator, two amplifiers, a calibration oscillator, frequency weighting networks, a detector, and a meter. These units are arranged in the set as shown in Fig. 1.

1.03 The evaluation of the disturbing effect of noise on telephone or program circuits must take into account the frequency and duration of the noise voltage as well as its amplitude. The set accounts for the frequency content of the noise by the frequency weighting networks that shape the frequency response of the measuring circuit. The duration of the noise voltage is taken into account by the response time of the detector circuit used in the 3A set. The amplitude which the set indicates is then proportional to the disturbing effect of the noise being measured.

1.04 The set in conjunction with the plug-in networks provides for the measurement of the interfering effect of noise due to metallic or longitudinal (noise-to-ground) voltages in either message or program circuits. The set is equipped to be used with externally connected meters and recorders for special tests.

2. DESIGN FEATURES

A. General

2.01 The 3A set is contained in a covered metal case approximately 7 inches wide, 11 inches long, and 8-1/2 inches deep. The set is portable as it weighs only 15 pounds, including the battery. For convenience, there are two input connections (Fig. 2): one, a set of jacks which take a 289B plug or equivalent; the other input connection is a pair of binding posts which will take banana plugs or any of a number of standard clips. A ground binding post is also provided.

2.02 There are two MON jacks on the face of the set. One is an AC output which is to be used for monitoring or for driving AC measur-

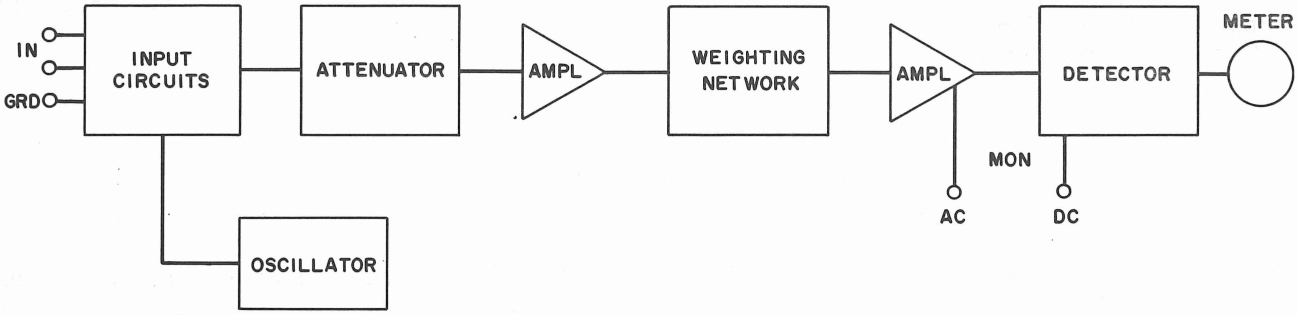
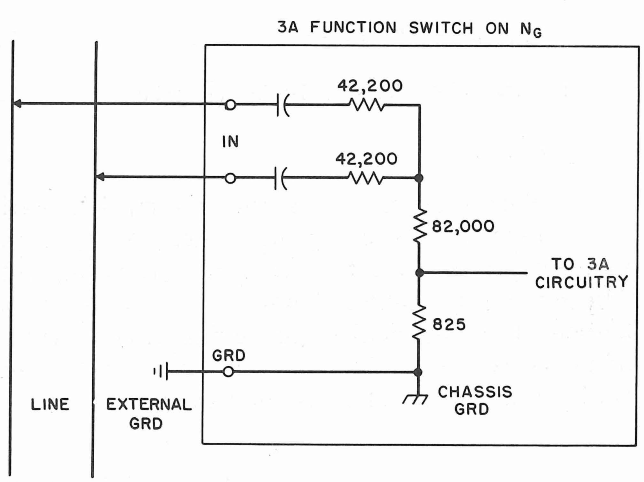


Fig. 1 – Block Diagram of 3A Set

Fig. 2 – Front View of 3A Set

Fig. 3 – Circuit Configuration for Noise-to-ground Measurements



ing equipment. The other is a DC output for driving external recorders or other DC devices. The MON jacks take a 397A or 397B plug or equivalent.

2.03 The frequency weighting networks fit into a receptacle in the face of the set.

2.04 Inside the cover of the 3A set there are compartments for storing an additional network and the monitoring headphone with its cord and plug. The operating instructions are also inside the cover.

B. Explanation of Switches

2.05 Before any attempt is made to describe the use of the set, it may be a good idea to understand what happens at each of the switch positions.

2.06 The positions of the FUNCTION switch are (see Fig. 2):

(a) ***OFF:*** In this position the battery is disconnected and the meter movement is shorted. It is not possible to properly replace the cover unless the FUNCTION switch is turned to OFF.

(b) ***BAT:*** The meter measures the battery voltage under full load and gives an indication of battery usefulness. If the meter indication is below the red line, the battery must be replaced. See 6.02 for replacement procedure.

(c) ***CAL:*** The set contains a 1,000-cycle oscillator that is used to calibrate the set before making noise measurements. With the FUNCTION switch in the CAL position, the meter is made to read on the red line by adjustment of the CAL screw through the hole in the panel. See 3.01 for the primary calibration.

(d) N_G: In this position, the input circuitry is arranged for noise-to-ground measurements. The N_G circuit provides more than 80,000 ohms between the input terminals and more than 100,000 ohms between the input terminals and ground. Fig. 3 shows this schematically.

(e) ***BRDG:*** This position provides an input impedance of about 10,000-ohm resistance in series with 5 microfarads and is used when making bridging measurements on metallic circuits.

(f) ***600:*** This position provides an input impedance of 600-ohm resistance in series with 5 microfarads and is used as a termination when making measurements on nominally 600-ohm metallic circuits.

(g) ***900:*** This position provides an input impedance of 900-ohm resistance in series with 5 microfarads and is used as a termination when making measurements on nominally 900-ohm metallic circuits.

2.07 Each position of the FUNCTION switch except the N_G position provides an input which is balanced to ground. All input positions are equipped with capacitors to block DC currents (150 volts maximum).

2.08 The DBRN switch controls an attenuator with a range of 85 db. All measurements should begin with the DBRN switch set at 85. This provides protection for the meter.

2.09 There is a slide switch immediately above the FUNCTION switch which is called the damping switch. ***Ordinarily, this switch should be in the normal (NORM) position.*** In measuring rapidly varying noise, it may be operated to the damped (DAMP) position in order to smooth the action of the meter. For instructions regarding the use of this switch, see 3.02(10).

C. Weighting Networks

2.10 The interfering effect of a noise voltage depends on its frequency content as well as its amplitude. In other words, equal voltages at different frequencies have different interfering effects. To properly combine the effects of all frequencies into one total for each type of noise measurement, the 3A set weights each frequency in proportion to its interfering effect. This is called frequency weighting.

2.11 Each of the plug-in units contains two weighting networks. When a unit is plugged into the set, the network that is in the circuit is shown by the lettering on the plug-in unit. The other network of the unit may be used by simply removing the plug-in unit, turning it 180 degrees, and reinserting it (Fig. 2).

2.12 The weighting network to be used for specific applications is given in Part 3C. The frequency response of the 3A set using each of the networks is discussed in Part 3C.

D. Reference Voltages; dbrn

2.13 ***Reference Voltages:*** The 1000-cps sensitivity (the input voltage needed to give a reading of 0 dbrn at 1000 cps) varies with the setting of the FUNCTION switch as shown in Table A. For a specific setting of the FUNCTION switch, however, the 1000-cps sensitivity is the same for all the weighting networks.

TABLE A

REFERENCE VOLTAGES

FUNCTION SWITCH POSITION	VOLTAGE AT 1,000 CPS FOR 0 DBRN
N_G	2.45 mv to ground
BRDG	24.5 uv } (10^{-12} watt in 600 ohms)
600	24.5 uv } (10^{-12} watt in 600 ohms)
900	30 uv (10^{-12} watt in 900 ohms)

2.14 ***dbrn:*** The 3A set reads directly in dbrn with no correction factors except as described in 3.12. The term dbrn means "db (above a) reference noise (power)." The power of this reference noise is ***arbitrarily*** set to be 10^{-12} watts at 1000 cps. A noise with frequency components other than 1000 cps will give a reading that depends upon the weighting network being used. It follows, then, that the measurements must be identified with a frequency weighting. For example, measurements made with the C-message network are identified by "dbrn-C message"; and those made with the 3-kc flat network are identified by "dbrn-3 kc flat." The reading given by the 3A set in dbrn-C message will be approximately 4 to 7 db higher than the reading given by the 2B set in dba (F1A) for wide-band noise. The difference between dbrn and dba depends upon the frequency components of the noise and cannot be stated explicitly except for known types of noise. The higher readings with the 3A will be reflected in a re-evaluation of the noise objectives.

E. 3A Detector

2.15 The detector in the 3A set has two characteristics necessary to the measurement of noise on telephone circuits. First, it adds noise voltages on an rss basis. Secondly, the detector circuit in conjunction with the meter has a 200-millisecond response time. These two characteristics correspond approximately to those of the average human ear.

2.16 When the damping switch is operated to DAMP [see 3.02(10)], the response time of the detector is increased to approximately 500 milliseconds.

3. OPERATION

A. Primary Calibration

3.01 The purpose of primary calibration is to check the internal calibration of the 3A set and should be made at the installation of a fresh battery or every six months, whichever is the shorter interval of time. Use any 1,000-cycle signal generator to supply the calibrating signal. ***Measure*** the output of the generator and be sure it is 1 milliwatt (0 dbm). Make the measurement with a ***600-ohm measuring set*** (ie, the 7A transmission measuring set, the 22A milliwatt reference meter, or an equivalent set with an accuracy of at least ±0.1 db).

(1) Insert any of the weighting networks (see 2.13) into the 3A noise measuring set. Adjust the DBRN switch to 85.

(2) Set the FUNCTION switch to BAT. If the meter reading is below the red line on the scale, replace the battery.

(3) Set the FUNCTION switch on 600.

(4) Apply the 1,000-cycle signal generator output (that has been ***measured*** to be ***1 milliwatt*** into 600 ohms) to the input terminals of the 3A set. Connect the GRD binding post to a good ground.

(5) Adjust the CAL control for a meter reading of +5. Use a screwdriver through the panel hole for this adjustment.

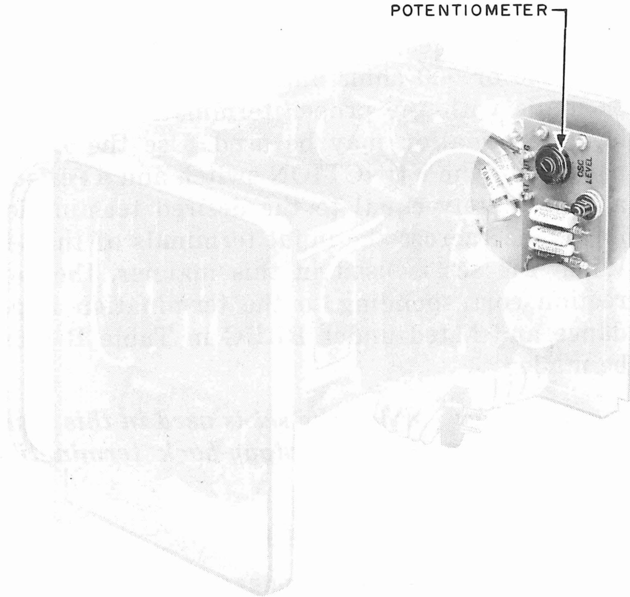


Fig. 4 – Calibration Oscillator Adjustment

(6) Set the FUNCTION switch on OFF.

(7) Remove the 3A set from its case. This is done by simply unscrewing the latches in the four corners on the face of the set. Do not disconnect the battery.

(8) Set the FUNCTION switch on CAL.

(9) Adjust the OSC LEVEL potentiometer (Fig. 4) until the meter reads on the red line of the scale. This completes the primary calibration. One may rely upon the internal calibration until the next battery change (see 3.01).

B. Measuring Procedure

3.02 The measuring procedure is included in the operating instructions found in the cover of the set. They are repeated here in more detail.

(1) Set the FUNCTION switch to OFF and see that the meter zero is properly adjusted. The meter zero adjustment is on the meter case.

(2) Insert the appropriate weighting network. The choice of the network depends upon the measurement to be made. For the discussion of weighting networks, see Part 3C.

(3) Set the DBRN switch to *85*.

(4) Connect the circuit to be measured either to the binding posts marked IN or to the jacks marked IN. These two inputs are electrically identical.

(5) Set the FUNCTION switch on BAT. If the meter fails to read in the scale area marked BAT, then turn the FUNCTION switch to OFF and replace the battery.

(6) Set the FUNCTION switch to CAL. Adjust the CAL control for a meter reading on the red line of the scale. Use a screwdriver through the panel hole for this adjustment.

(7) Set the FUNCTION switch to the position which gives the desired input impedance.

(8) Adjust the DBRN switch in a counterclockwise direction until a convenient meter reading is obtained. The noise reading is then the meter reading plus the DBRN switch setting. The units of the 3A noise measuring set are given in dbrn-weighting. A typical example may be 23 dbrn-C message (see 2.14).

(9) Use the monitoring headphone freely to aid in identifying noise. The quality of the noise heard is not directly comparable to that heard through a subscriber set; it is affected by the frequency weighting in the 3A set (see Fig. 1).

(10) When rapidly fluctuating noise such as atmospheric static or "dial-office noise" is being measured, operate the damping switch to DAMP. This facilitates reading the meter and gives a good estimate of the disturbing effect of this type of noise. Ordinarily, however, the switch should be in the NORM position for greater accuracy.

3.03 Any combination of weighting networks and FUNCTION switch positions may be used as required. There are no correction factors due to any of these combinations.

C. Choice of Weighting Network

3.04 *C Message:* The C-message network has a frequency response that is a compromise for the measurement of noise based on the modern telephones. It includes the estimated response of the average human ear. This network, then, makes the 3A set reading correspond to the disturbing effect on the listener of noise in an ordinary telephone connection.

3.05 ***3-kc Flat:*** This weighting may be used when extra sensitivity is needed to indicate the presence of low-frequency noise (see Fig. 7). For example, one may find 25, 60, or 180 cps from power induction or 20 cps from ringing induction.

3.06 ***Program:*** The program weighting is used for noise measurements on program supply circuits. A specific example would be an intercity program circuit.

3.07 ***15-kc Flat:*** The 15-kc flat network should be used on certain studio-to-transmitter program channels and on wired-music circuits. It may also be used in special applications as given in 4.04.

3.08 The nominal frequency response of the 3A set using each of these networks is given in Fig. 5 through 7.

D. Precautions

3.09 ***General:*** Always set the DBRN switch on 85 before connecting the set to an external circuit or when changing from circuit to circuit. This is to avoid possible damage to the meter movement.

3.10 ***Batteries:*** Do ***not*** attempt to use central office battery to power the set. Generally, there is too much noise on the central office battery to be used as a supply for the 3A set. See 6.02 for list of batteries that may be used.

3.11 ***Storage:*** When the set is not being used, turn the FUNCTION switch to OFF; this will help conserve the battery supply. When the set is being stored, always replace the cover.

3.12 ***Circuit Impedances:*** If the set is used (either bridging or terminating) on circuits which are not normally terminated with 600 ohms or 900 ohms, a correction will have to be made in the dbrn reading. These corrections are listed in Table B.

3.13 ***Piggy-back Terminations:*** If the circuit under test is not normally terminated with 600 or 900 ohms and a measurement must be made with the proper termination, a piggy-back termination may be used. Use the BRDG position of the FUNCTION switch and a resistor approximately equal to the desired termination impedance across the input terminals of the set. When the set is used in this manner, the correction corresponding to the termination impedance and listed under BRDG in Table B must be made.

Caution: When the set is used in this manner, note that the piggy-back termination has no DC blocking.

TABLE B

IMPEDANCE CORRECTIONS

(Add to 3A Noise Measuring Set Readings)

CIRCUIT TERMINATION IMPEDANCE	FUNCTION SWITCH		
	BRDG	600	900
200	+5	+1	+2
250	+4	+1	+2
300	+3	+1	+1
400	+2	0	+1
500	+1	0	0
600	0	0	0
800	−1	0	0
1000	−2	0	0
1200	−3	+1	0
2000	−4	+2	+1

3.14 ***External Fields:*** Pickup can occur from intense external fields. An indication of such a condition is a meter deflection with no input to the set. To make a measurement, move the set out of the field or position it in such a way that the effect of the field is negligible.

3.15 ***N_G Measurements:*** When N_G (noise-to-ground) measurements are being taken, the ground (GRD) post of the set ***must*** be connected to a good ground to avoid error. Note that the N_G reading is 40 db below the actual noise-to-ground.

3.16 ***Flat Weightings:*** If the set is being used with one of the flat weightings, the low-frequency response depends upon the FUNCTION switch setting. When the 3A set is being

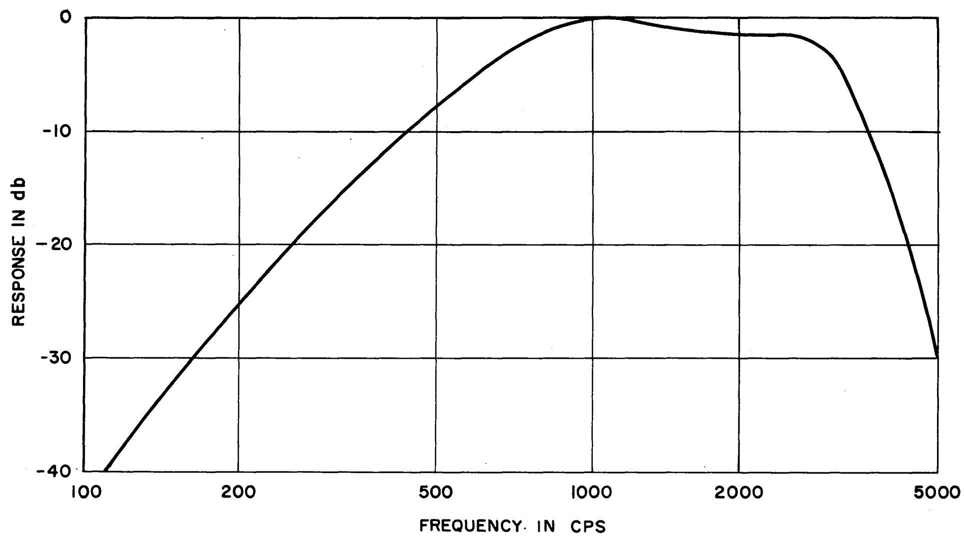


Fig. 5 – C-Message Weighting

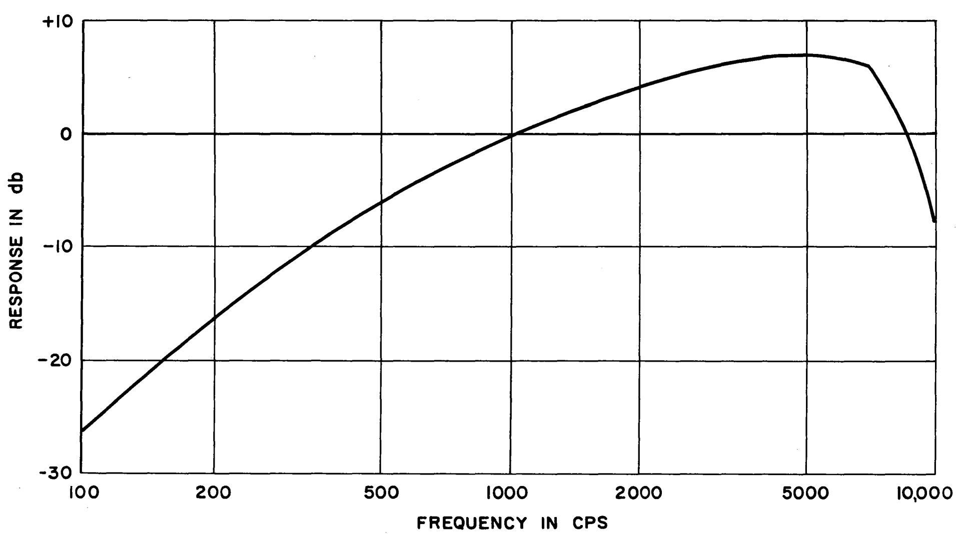


Fig. 6 – Program Weighting

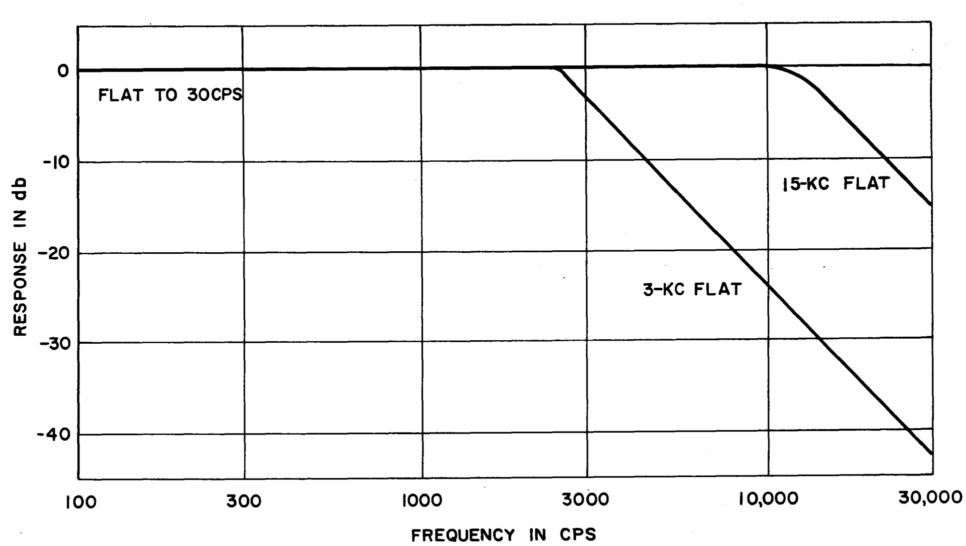


Fig. 7 – Flat Weightings

used on BRDG, the frequency response is nearly flat down to 30 cps. When the set is being used on 600 or 900, the flat response begins to roll off at about 60 cps. To avoid this roll-off, use the technique described in 3.13.

4. USE FOR SPECIAL TESTS

4.01 *Level Measurements:* The 3A set may be used as a transmission measuring set in emergencies. To do this, set the FUNCTION switch to give the proper input impedance and use the 3- or 15-kc flat weighting (if other than 1,000 cps is to be measured). One milliwatt (0 dbm) into the set will give a reading of 90 dbrn. To convert dbrn readings to dbm (db relative to 1 milliwatt), subtract 90 from the set reading. The range of the set is:

From 0 to 97 dbrn
or -90 to $+7$ dbm.

The range may be extended in the upward direction by connecting an attenuator ahead of the set.

Caution:* *Always keep in mind that the accuracy of the 3A set is only about ±0.5 db. Precise level measurements should not be attempted with the set.

4.02 *Volume Measurements:* For speech volume, use the C-message network and adjust the DBRN switch to a high setting. Gradually reduce the setting until the meter deflections are around +5 on the scale. Note the point on the meter scale reached by the majority of the maximum deflections, and neglect the occasional overswings above this point. The approximate speech volume in vu is then the set reading in dbrn minus 90, or

$$\text{vu} \backsimeq \text{dbrn} - 90.$$

Note: The 3A set is ***not*** to be used for regular volume measurements such as those required for the Volume Rating Plan.

4.03 *Crosstalk Measurements:* For crosstalk volume, read as for speech volume (see 4.02). In some cases, part of the reading is caused by noise. In order to obtain the crosstalk volume, monitor the circuit and measure when only noise is present. Next, measure the circuit when both crosstalk and noise are present. From this reading, subtract the value found in Table C to give the crosstalk volume.

TABLE C

CORRECTIONS TO BE MADE TO FIND CROSSTALK FROM CROSSTALK AND NOISE

DB DIFFERENCE BETWEEN CROSSTALK AND NOISE AND NOISE ALONE	DB CORRECTION, SUBTRACT FROM CROSSTALK AND NOISE TO GIVE CROSSTALK VOLUME
1	5
2	4
3	3
4 to 5	2
6 to 8	1
Over 8	0

4.04 *Use as a Flat Amplifier:* The 3A set may be used as a flat amplifier having about 85-db voltage gain. The input impedance may be set with the FUNCTION switch. The output is taken from the AC monitoring jack, and the output impedance is about 600 ohms. The maximum undistorted open-circuit voltage is about 9 volts rms; but into a 600-ohm load, the maximum undistorted output voltage is about 0.75 volt. At these voltages the meter is off scale, but the set is not overloaded. This does not harm the meter. The 3- or 15-kc flat networks are used.

5. USE WITH EXTERNAL METERS AND RECORDERS

5.01 *External AC Meters:* Any reliable AC-type instrument should prove satisfactory so long as its range will cover values expected to be encountered, and no impairment results from the unbalanced output impedance at the AC MON jack (about 600 ohms) of the 3A set. Specific application here is the measurement of a total noise voltage or harmonic voltage directly rather than on a db scale.

5.02 For instructions regarding the use of the 3A set with the General Radio type 1556-A impact-noise analyzer, see the section appropriate to the nature of the measurement to be made.

USE WITH DC RECORDERS

5.03 The 3A set may be used to drive many different DC recorders, and no attempt will be made to list them. The limitation of the

DC output of the set will be discussed since this will govern what recorders may be used.

A. General

5.04 Fig. 8 is divided into three areas. For any given recorder, a point may be determined on Fig. 8 which will fall within one of the areas. For instance, suppose the recorder that is available has an input impedance of 3,000 ohms and a full-scale current of 500 microamperes. The point determined by these two numbers falls in region 2. This recorder may be used with the 3A set (as Fig. 8 indicates). If the point had fallen in region 1, the set would not be able to drive that recorder to full scale, and erroneous results may be recorded. If the point had fallen in region 3, the set may be used to drive the recorder as discussed in 5.06.

5.05 The division line between region 1 and region 2 is determined by the characteristics of the rectifier in the 3A set. The division line between region 2 and region 3 is determined by the internal noise of the set.

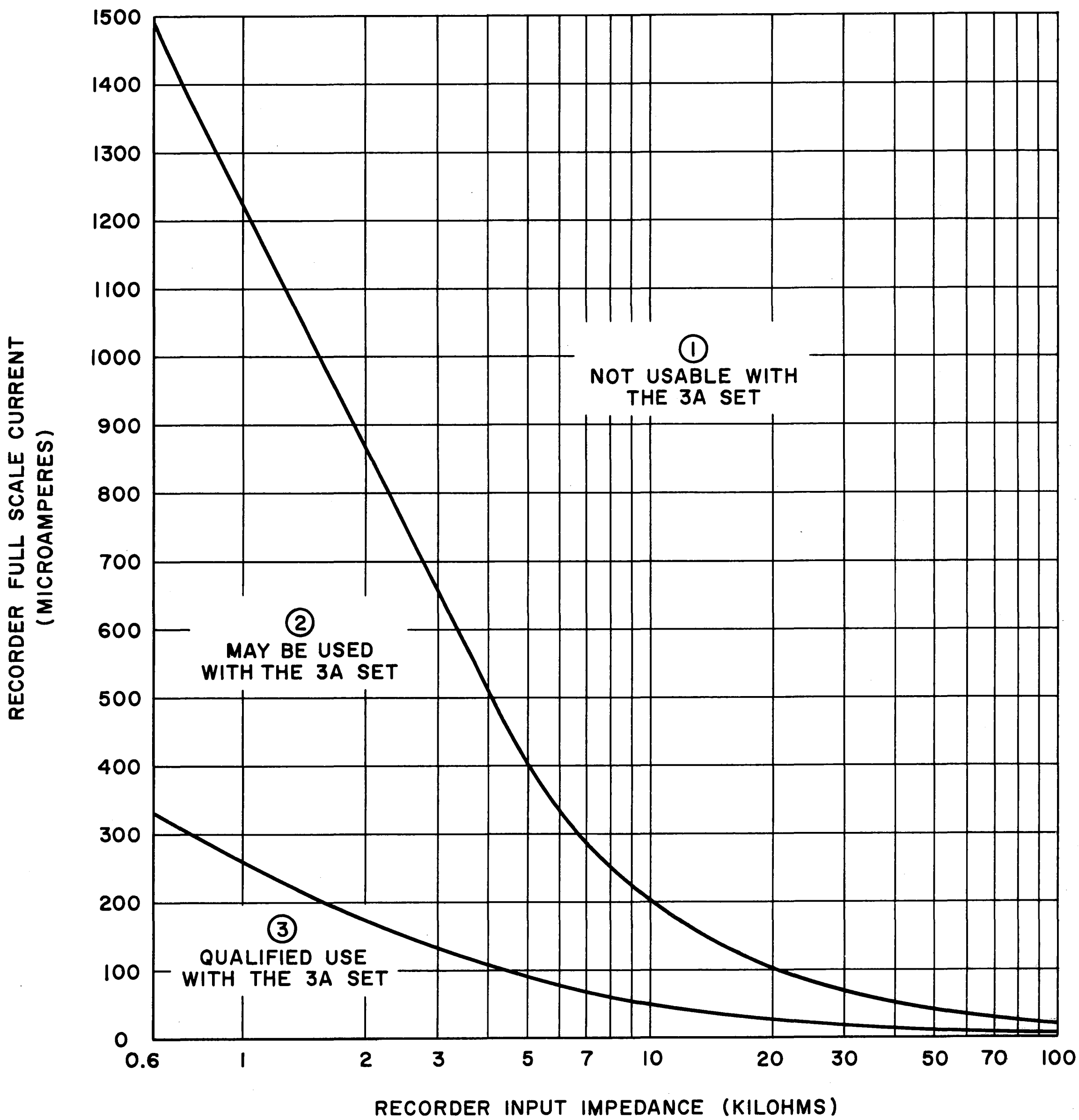


Fig. 8 — Use of DC Recorder with 3A Set

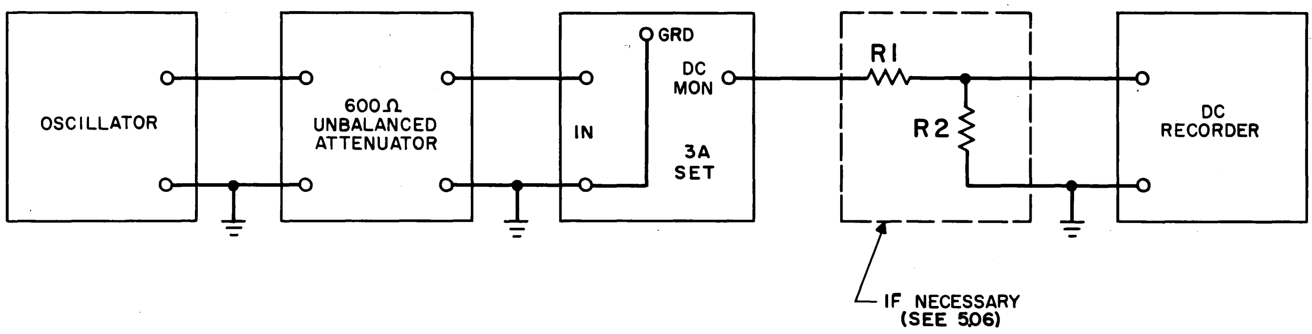


Fig. 9 — Calibration of DC Recorder

5.06 If the coordinates of a particular recorder fall within region 3, the recorder may be used as shown in Fig. 9. As an example, suppose the recorder has an input impedance of 10,000 ohms and a full-scale sensitivity of 20 microamperes. R_2 may be chosen to be 500 ohms. This makes the apparent input impedance essentially 500 ohms and the full-scale sensitivity to be 10,000/500 = 20 times as large or 400 microamperes. Then choose R_1 to be, say, 3,500 ohms; this makes the combination look like a recorder with 4,000-ohm input impedance and 400-microampere sensitivity. This now falls in region 2 of Fig. 8.

B. Calibration of Recorder

5.07 Without disturbing any resistor arrangement which may have been necessary (as in 5.06), set up the equipment shown in Fig. 9, but do ***not*** connect the recorder.

(1) Set the FUNCTION switch on the 3A set to 600 (follow instruction card), the DBRN switch to 50, and the attenuator loss to 40 db. Adjust the oscillator level at 1,000 cps so that the meter on the 3A set reads +9 (oscillator voltage output should be about 2.2 volts).

(2) Connect the DC recorder to the DC MON output on the 3A set, and decrease the attenuator loss until the recorder reads near full scale. Note the attenuator setting and subtract that number from 49. Mark this number (49 minus the attenuator setting) on the recorder paper at the recorder indication.

(3) Add attenuator loss in 1-db steps. Mark the recorder scale value for each step. The value of each step is simply one less than the preceding step. Do this until the scale range has been covered.

Caution: In this calibration procedure, do not set the attenuator loss at more than 49 db. The internal noise of the 3A set may begin to affect the reading if this is done.

5.08 ***Measuring Procedure:*** After calibration as in 5.07, use the measuring procedure given in 3.02 through Step 5. Then connect the DC recorder and use the following procedure:

(1) Set the FUNCTION switch to CAL. Adjust the CAL control for a ***recorder reading of +9.*** Use a screwdriver through the panel hole for this adjustment.

(2) Set the FUNCTION switch to the position which gives the desired input impedance.

(3) Adjust the DBRN switch in a counterclockwise direction until a convenient recorder deflection is obtained. The noise reading in dbrn is then the recorder reading plus the DBRN switch setting.

5.09 In 5.08(3), a convenient recorder deflection should be one that anticipates any expected change in the noise. For example, if increases are expected, set the DBRN switch so that the chart reading starts at or near the low end of the scale.

5.10 Mark the recorder paper to show the type of measurement, weighting, DBRN switch setting, and the date and hour of the start. Keep a log of any altered settings and mark the record accordingly when it is removed.

C. Precautions

5.11 The voltage at the DC MON output is ***negative*** with respect to the 3A set case.

5.12 Continuous operation of the set will subject the battery to a constant drain. At continuous operation, the battery may be expected to last about 48 hours. Therefore, frequent checks on the battery are advisable.

6. MAINTENANCE

A. General

6.01 The 3A set needs very little maintenance except for the replacement of the battery or worn mechanical parts such as knobs, banana plugs, rubber feet, etc.

6.02 The battery is replaced very simply. Remove the 3A set from the case by unscrewing the latches in the four corners on the face of the set. The battery is connected with a cord and plug and is held in the case by a metal bracket. Removal of this bracket frees the battery for replacement. Any of the following batteries may be used:

Air Castle 1520	Montgomery Ward 49
Bright Star 30-03	Philco P305
Burgess B30	Ray-O-Vac 207
Crosley CR71	RCA VS012
Eveready 484*	Sears Roebuck 6462
Gamble Z243-301	Usalite 624
General 111	Western Auto 3B6239
Mallory M207	Willard V30B
Marathon 3050	Zenith Z550

*Recommended.

6.03 Select a dry location for storage of the 3A set, and keep the cover on the set.

B. Electrical Performance

6.04 A good check on the general condition of the active portion of the 3A set is to make a frequency response test annually. To do this, the following procedure should be used:

(1) Select an oscillator that will reliably supply about 1 volt into 600 ohms over a frequency range of 30 to 1,000 cps.

(2) Set up the testing arrangement shown in Fig. 9 (without the recorder). Set the FUNCTION switch to BRDG, the DBRN switch to 80, and use either the 3- or 15-kc flat network. Connect a 600-ohm resistor across the IN terminals of the 3A set.

(3) Adjust the oscillator output so that the 3A set reads 90 dbrn (80 on DBRN switch and +10 on meter) at 1,000 cps.

(4) Adjust the frequency of the oscillator to the values in Table D. If the 3A set does not deviate more than the listed tolerances, it should perform satisfactorily.

TABLE D

FREQUENCY RESPONSE

FREQUENCY CPS	3A METER INDICATION
1,000	10 ±0
800	10 ±0.5
500	10 ±0.5
200	10 ±0.5
100	10 ±0.5
80	10 ±0.7
50	10 ±1.0
40	10 ±1.0
30	10 +1.0 −2.5

6.05 At frequencies above 1,000 cps, the response of the set is determined by the network. Because of this, tests on the set above 1,000 cps do not reveal trouble conditions.

6.06 Another good check on the performance of the 3A set is an overload test. This is no less important than frequency response for proper operation. To test for overload, set the FUNCTION switch on CAL, and use the headphone provided with the 3A set to monitor the calibrating tone. Then decrease the DBRN switch setting to 70. The tone should be louder with no change in quality. When the DBRN switch is set to 65, there will be a change in the calibrating tone quality. If this change in tone quality occurs at a DBRN switch setting higher than 65, the 3A set is in need of corrective maintenance.

6.07 If the set does not meet the requirements of the tests outlined in 6.04 or 6.05, it should be sent to the nearest Western Electric Distribution House. This is suggested since the printed circuit boards, transistors, and diodes, along with the associated circuitry, are incompatible with the ordinary techniques of repair.

7. LIST OF DRAWINGS FOR REFERENCE

A. Drawings (not attached)

7.01 ***Schematic Drawings:*** SD-95276-011, SD-95276-012.

7.02 ***Equipment Information:*** J94003A.