

Western Electric

Volume Indicating Equipment

For Radio Telephone Broadcasting and for Speech Input
and Public Address Systems



754A Volume Indicator equipped with KS-8218 Volume Indicator Meter

IN ORDER to meet the requirements of the recently accepted standard reference level for volume measurements in vu, Western Electric has made available Volume Indicating Equipment described in this bulletin. The equipment consists of 754A and 754B Volume Indicators, KS-10065 Meter Cabinet and KS-8218, KS-8208 and KS-8207 Meters. This equipment not only provides means for measuring volume levels in vu but also may be used for transmission measurements in db.

The 754A and 754B Volume Indicators are designed primarily for use in program line transmission systems. They are panel type construction, suitable for mounting on a 19" relay rack or bay cabinet and differ only in that the 754B has provision for an increased sensitivity of 10 db when terminating a line.

The KS-10065 Meter Cabinet is intended primarily for use by a control engineer in riding gain on a program where the instrument is always used in the same circuit at the same level. A range switch for the adjustment of sensitivity is not required under these conditions.

The KS-8218, KS-8208 and KS-8207 Meters are used in the 754 type Volume Indicators and in the Meter Cabinet and differ only in the choice of scales and illumination. The KS-8218 Meter has an emphasized arbitrary voltage or 0 to 100 scale and a subordinated vu scale, indirectly illuminated by lamps mounted inside the front cover of the meter case. The KS-8208 differs from the KS-8218 in that the scales are reversed, the vu scale being emphasized. The KS-8207 Meter is similar to the KS-8208 except that the scales are not illuminated.

754A VOLUME INDICATOR

The Western Electric 754A Volume Indicator is a volume level indicating device which is direct reading when bridged on a 600 ohm circuit. It includes a switch for adjusting the sensitivities over a range from +4 to +26 vu at the 0 vu or 100 mark on the scale (about two-thirds full scale). The 754A Volume Indicator is assembled on a 5¼" x 19" non-magnetic panel arranged for relay rack or cabinet mounting. Finish is aluminum-gray on the front and bright aluminum on the rear. The panel has a photo-etched designation plate finished in black satin with chromium trim.

As there is a choice of meters (KS-8218, KS-8208 or KS-8207) the meter is not supplied as part of the indicator assembly and should be specified separately on the order. A blank plate is available which covers the meter mounting space in installations where the meter is mounted in a control desk or console apart from the 754A Volume Indicator. This plate also should be ordered separately, if desired.

ELECTRICAL CHARACTERISTICS

Input Impedance

The total impedance of the volume indicator is approximately 7500 ohms when the meter is indicating at the 0 vu or 100 mark. The meter itself has an impedance of about 3900 ohms, the approximate 3600 ohms difference consisting of resistances required to obtain the necessary dynamic characteristics and for accuracy in calibration on constant frequency tone.

Bridging Loss

The bridging loss of the Volume Indicator and Meter on circuits of 600 ohms impedance is substantially constant over the frequency range 35 to 10,000 cycles. The loss is approximately 0.3 db.

Harmonic Distortion

The harmonic distortion introduced in a 600 ohm circuit due to bridging the Volume Indicator across it is less than that equivalent to 0.2 per cent r-m-s.

Range of Measurements

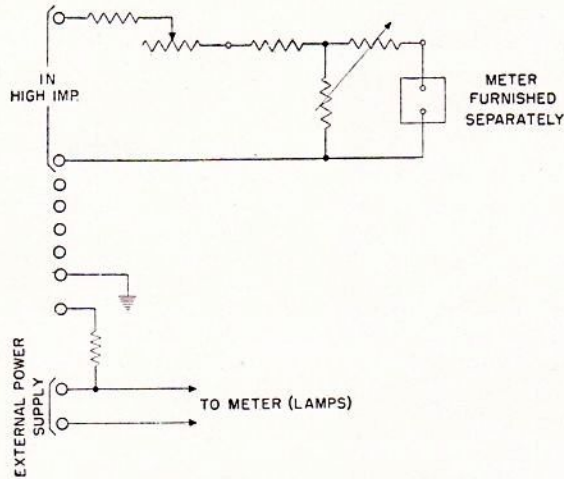
Volume levels from +4 vu to +26 vu in circuits of 600 ohms impedance may be measured. These values are for a deflection to the 0 vu or 100 mark on the meter. Taking into account the whole meter scale, these ranges are extended to volumes which are 20 vu lower than, and 3 vu higher than the values just given.

Frequency Response

The frequency response of the 754A Volume Indicator is substantially the same as that of the meter alone. For all frequencies between 35 and 10,000 cycles per second, the response is uniform to within 0.2 db (0.2 vu as read on the vu scale).

Meter Adjustment Control

By means of an adjustable calibrating resistance, the deflection of the meter to the 0 vu or 100 mark can be made exact.

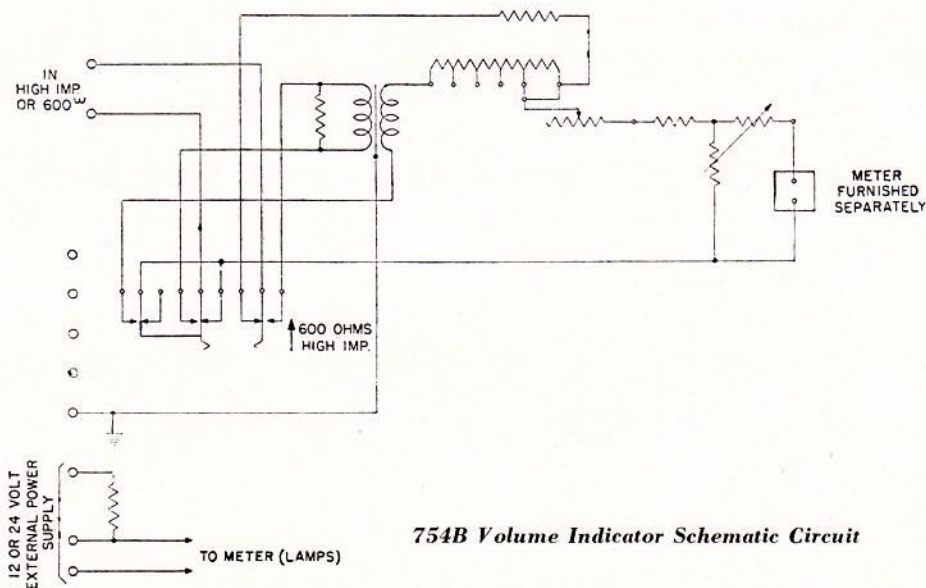


754A Volume Indicator Schematic Circuit

754B VOLUME INDICATOR

The 754B Volume Indicator has the same circuit and utility as the 754A. In addition it has a key by means of which the volume indicator circuit is changed to terminate a circuit in 600 ohms and give an increased sensitivity of 10 db. With this key operated to give increased sensitivity the volume indicator should not, of course, be bridged across a line.

The mechanical design and finish of the 754B are similar to that of the 754A. The electrical characteristics, other than sensitivity, and the choice of meters also are the same.



754B Volume Indicator Schematic Circuit

The readings of these new instruments are based on the recently adopted standard reference level. A detailed explanation of this new standard is given in the article reprinted from "Electronics" of February, 1939 on pages 4 and 5 of this bulletin.

† A New "VI" and

H. A. AFFEL
Bell Telephone Laboratories

HOWARD
Columbia Broad



Type B scale, preferred by NBC and CBS, is intended for program production and transmission applications. Meter case is $4\frac{1}{4}$ in. wide and 4 in. high

On December 16, 1938, an announcement was made by the Bell Telephone Laboratories, the Columbia Broadcasting System and the National Broadcasting Company that agreement had been reached upon a new standard volume indicator instrument and a new standard reference level. The design of the new volume indicator meter was fixed upon after much consideration and many tests. It is a simple, comparatively inexpensive, copper-oxide rectifier type of meter, having carefully determined dynamic, electrical and other characteristics so chosen as to make the instrument readable over long periods with a minimum of eyestrain or fatigue. It is designed to have a response to the rapidly varying program waves which is a satisfactory compromise between the ideals for each of the purposes for which a volume indicator is used.

The new standard reference level was announced in the following words:

Zero or reference volume level shall be defined by specifying (a) the characteristics and method of use of the volume indicator instrument, and (b) a steady state reference of 1 milliwatt. The impedance of the circuit across which the instrument is calibrated shall be 600 ohms. The characteristics of the instrument as well as the value of the calibrating power are important features of the definition.

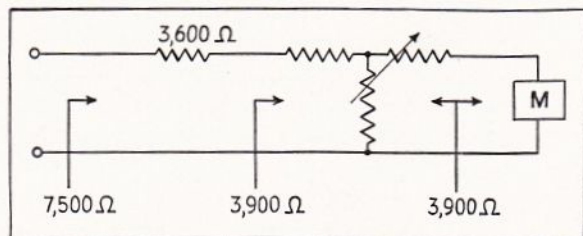
In order to avoid the more cumbersome term "db above zero volume level" and confusion with several existing standards, it is proposed to designate the readings of the new instrument as so many "vu", numerically equal to the number of db above the reference volume level.

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At the present time, there are a wide variety of volume level indicators* in use throughout the communications industry. These differ in such characteristics as: Whether the instrument is r-m-s or peak reading; slow, medium or high speed; half or full-wave rectifying; critically or lightly damped; or whether the reference level used for calibration is 1, 6, 10, $12\frac{1}{2}$ or 50 milliwatts in 500 or 600 ohms. These conditions have led to widespread confusion and misunderstanding in the communications industry, particularly when an attempt is made to correlate the measurements and results of one group with those of another.

To avoid this confusion, the above organizations have proposed for standardization the new instrument and the new standard reference level. It is hoped that the new instrument and the advantages of standardization will be sufficiently attractive for general acceptance. During the course of the investigation of the new volume indicator and its reference level, a number of informal meetings were held for the purpose of demonstrating the improved instrument to other organizations. One of these conferences was held on June 2, 1938, and another on June 17, 1938, at the IRE annual convention in New York. A total of 27 organizations concerned with the broadcasting industry in the United States and Canada were represented at the two meetings.

At these conferences, approval of the new meter was expressed, and it was agreed that the originating group should determine on a generally acceptable reference level for volume measurement. The Bell System companies, the National Broadcasting Company and the Columbia Broadcasting System are looking forward to the adoption of the new instruments in their plants,



Schematic wiring diagram of the new volume indicator meter. Meter impedance is 3900 ohms and must be used with an external resistance of 3600 ohms to obtain desired ballistic characteristics. The impedance of the complete instrument is 7500 ohms

together with the new reference volume level on May 1, 1939.

The scope of the present article does not permit a detailed account of the fundamental considerations and the tests which led to the design of the new volume indicator. It is planned, however, to publish this information at a later date.

Reference Level

CHINN
ing System

ROBERT M. MORRIS
National Broadcasting Co.

1. The instrument employs a full-wave, copper-oxide rectifier contained within the meter case.

2. The ballistic characteristic is such that the sudden application of a single frequency voltage of such value as to give a steady state reading at 0 vu or 100 mark will cause the pointer to overshoot by 1 to 1½ per cent (0.1 to 0.15 vu). The pointer speed is such that under the same conditions, a deflection of 99 per cent of the steady state value is reached 0.3 second after the sudden application of the single frequency voltage. This characteristic is in agreement with the C.C.I.F. recommendations.

3. The scale card is a cream yellow and has markings in black and red. Two scale types are available as indicated in the illustrations.

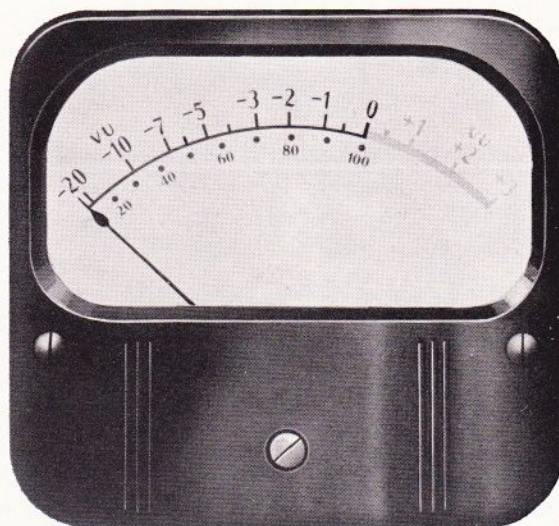
4. The meter sensitivity is uniform to within 0.2 db of the 1000 cps value over the frequency range from 35 to 10,000 cps and within 0.5 db over the range from 25 to 16,000 cps.

5. The instrument is capable of withstanding, for at least 0.5 second without injury or effect on calibration, voltage peaks of ten times the value equivalent to a reading of 100 per cent or zero vu. It is capable of withstanding a continuous overload of five times the 100 per cent or zero vu voltage.

As now available, the instrument itself has an impedance of 3900 ohms and *must* be used in series with an external resistance of 3600 ohms in order to have the required ballistic characteristics. The instrument with the series resistance has a sensitivity such that the pointer is deflected to the 0 vu or 100 mark on either program material or single frequency power having a volume level of +4 vu. For reading high levels, a variable 3900-ohm attenuator may be inserted between the meter and the external resistance to decrease the meter sensitivity. The meter must not be placed in close proximity to magnetic materials and must therefore not be mounted on magnetic panels.

The adoption of 1 milliwatt as the calibration of the new reference volume was decided upon because (a) it is a simple decimal number of convenient magnitude, (b) it is related to 1 watt by the "preferred" factor of 10^{-3} , (c) it corresponds to the value of testing power used for transmission measurements on program circuits, and (d) it was found to be the one value to which general agreement is possible. A survey indicated that adoption of a 600-ohm standard impedance would meet with the most ready acceptance throughout the communications field. It also appeared to be most favorable for international adoption.

The adoption of the new terminology for expressing volume readings made with the new in-



Type A scale, preferred by the Bell System, is intended for use in program transmission. The illustration is approximately three-fourths full size. Scales are from Weston type 30 volume indicator

strument is considered an important part of the standardization. It should be borne in mind that volume expressed in "vu" implies a measurement of absolute volume level. It indicates that the measurement was made with the new standard instrument. Most previous types of volume indicators, even though recalibrated to a 1 milliwatt basis, will not give indications on program material corresponding to those of the new instrument.

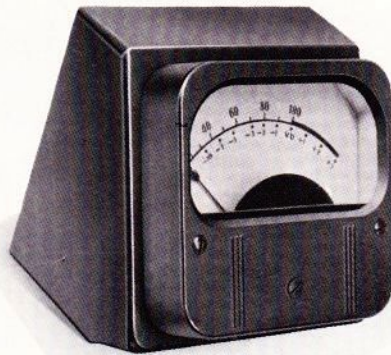
There has in the past been considerable controversy over whether a volume indicator should be of the r-m-s or peak reading type. As a result of the tests which were made, it was found that there was only a minor difference between the peak type and the r-m-s instrument of the design finally determined upon. The significance of this difference disappears when volume limiting amplifiers are employed. On the other hand, the change in wave shape which occurs in transmission over lines of any length, even after phase correction has been applied, may make it impossible to check readings with peak reading types of instruments, whereas the r-m-s instrument is not affected. These facts, together with other considerations, led to the adoption of the r-m-s type of instrument.

It is to be hoped that the new volume level indicator with the new standards of calibration and terminology will be adopted generally by the communications industry in this country, and that they may receive international recognition.

*Volume level indicators are not to be confused with power-level indicators since the former are intended for the measurement of program material involving speech, music, etc., whereas the latter should be limited to the measurement of steady-state "sine-wave" power. This latter measurement is not, obviously, influenced by the ballistic characteristics of the instrument employed. Since sine-wave power is considered a form of program material, it is evident that a volume level indicator is also capable of power-level measurements but not vice versa.

KS-10065 METER CABINET

The Western Electric KS-10065 Meter Cabinet illustrated here is intended primarily for control console mounting to enable the control engineer to ride gain at the location where programs originate. The cabinet is stream-lined and in suitable size to sit on the top of the control console, within the engineer's line of vision without appreciably obstructing his view.

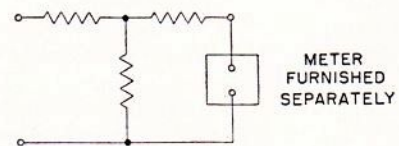


*KS-10065
Meter Cabinet*

The KS-10065 Meter Cabinet illustrated contains a complete volume indicator circuit which is essentially the same as that of the 754A volume indicator except that it is without a range switch and adjustable calibrating resistance and is designed for permanent bridging across a 600 ohm circuit of suitable level in a speech input channel. When shipped, the input circuit of this cabinet is arranged to give a meter deflection to the 0 vu or 100 mark (about two-thirds full scale) with an input level of +18 vu which is the proper level when used with the Western Electric 704A Speech Input Bay and 721A Control Cabinet.

Instructions which accompany the KS-10065 cabinet give suitable values of fixed resistances which may be substituted in the input circuit to adjust its sensitivity over a range of from +4 to +38 vu. These values are for a deflection to the 0 vu or 100 mark on the meter. Taking into account the whole meter scale, these ranges are extended to volumes which are 20 vu lower than, and 3 vu higher than the values just given.

The KS-10065 Meter Cabinet is aluminum cast and measures $4\frac{3}{4}$ " long by $4\frac{5}{16}$ " high. It is finished in aluminum gray lacquer. This cabinet is arranged to mount the KS-8218, KS-8208 or KS-8207 meter. Meters are not furnished as part of the cabinet and should be specified separately on the order.



*KS-10065 Meter Cabinet
Schematic Circuit*

KS-8218 METER

The KS-8218 Meter is of the copper-oxide, rectifier type similar to the one illustrated on page 4. As a result of refinements in design of the new meter and of associated rectifier elements, an accuracy of approximately 3% of the voltage required for a deflection to the 0 vu or 100 mark is obtainable at any point of the scale at a room temperature of 75° F. Among the features of this instrument are:



KS-8218 Meter

Frequency and Temperature Stability

The response is uniform for all frequencies between 35 and 10,000 cycles per second to within 0.2 db (0.2 vu as read on the vu scale). The effect of temperature on the readings is less than 0.2 vu between 50° and 110° F.

Dynamic Characteristics

The dynamic characteristics of the meter are such that the sudden application of a single frequency voltage which would cause a steady state reading at the 0 vu or 100 mark results in an overswing of between 1 and 1½% (0.1 and 0.15 vu on the scale). Under the same conditions the pointer speed is such that a deflection of 99% of the steady state value is reached within 0.3 second.

Scale Reading

The KS-8218 Meter is provided with a type B scale in which the 0 to 100 scale is emphasized and the vu scale subordinated. The meter scale is long (arc length 3.3 inches) and the reference point so located that about two-thirds of the total scale length is utilized. This, together with the cream yellow scale and bold figures, reduces eye-strain and fatigue. The scale is indirectly illuminated by lamps mounted within the meter case which are accessible by removing the front of the meter.

The sensitivity of the meter in series with 3600 ohms external resistance is such that a deflection is obtained when a voltage of 1.228 volts AC is impressed across the combination. This corresponds to a volume level of +4 vu in a 600 ohm circuit.

KS-8208 METER

The KS-8208 Meter is essentially the same as the KS-8218 except that it is provided with a type A scale in which the vu scale is emphasized and the 0 to 100 scale subordinated.

KS-8207 METER

The KS-8207 Meter is essentially the same as the KS-8208 Meter except that no provision is made for illuminating the scale.

FOR FURTHER INFORMATION

If additional information is required regarding the Volume Indicating Equipment described in this Bulletin or other Western Electric Radio Broadcasting, Speech Input or Public Address Equipment, inquiries should be directed to the nearest distributor listed on this page.

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