GenRes

DIAL-A-VOLT

A DIALABLE VOLTAGE REFERENCE

ADDENDUM

Use one volt full scale range for all EMF's below one volt.

INSTRUCTION MANUAL
DIAL-A-VOLT

DIALABLE VOLTAGE REFERENCE

MODEL DAV 4 SERIES

FEBRUARY 1965

Manufactured By

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New York, New York 10455

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ILLUSTRATIONS

1.0 GENERAL DESCRIPTION

The General Resistance Dial-A-Volt is an accurate, stable, dialable voltage reference comprising a Kelvin-Varley divider and an aged, regulated, temperature compensated D.C. voltage source. It is a reliable standard for the calibration of digital voltmeters, standard cells, D.C. potentiometers, voltage dividers and other D.C. measurement equipment. As a replacement for a standard cell, instantly recovering without change from temporary external short circuit, it offers the advantage of a voltage reference which may be set anywhere from zero to ten volts with resolutions to 1 PPM, depending on model. Used in conjunction with a null detector, it becomes a differential voltmeter of high precision. The Dial-A-Volt is also used as a reference for the stability testing of power supplies, Zener reference networks, temperature measurement systems and other D.C. instrumentation, and is ideally suited for calibration of data systems.

Four A.C. powered models are available differing in accuracy, stability and in the number of decade switches used in the Kelvin-Varley divider (resolution). Model DAV-43 has three decade switches, model DAV-44 has four, model DAV-45 has five and model DAV-46 has six. Performance specifications improve, in general, with a greater number of dials. All models are readily adaptable to rack mounting.

Figure 1 is an outline drawing of the Dial-A-Volt showing the dimensions of the unit and the front panel layout. The dials occupying the upper half of the front panel are the decade switches which vary the setting of the Kelvin-Varley divider. They provide both fingertip, dialable control of the output voltage and digital, in-line readout.

Each dial has ten settings corresponding to the digits 0 through 9. The last dial has an additional setting marked 10. With all dials at their maximum settings (99999 [10]), the output terminals deliver a full scale voltage which is either 10 volts or 1 volt depending on the setting of the range switch. The polarity of the output voltage is reversible and depends on the setting of the output switch. The dials are direct reading in volts with the range switch determining the decimal point location.

The two reference terminals on the left side of the panel are connected to the input of the Kelvin-Varley divider. They make the divider available for precisely dividing an external reference voltage or accurately determining a resistance ratio. The division ratio is read from the dials. In this application, the power must be off, the polarity of the reference terminals must be observed, the range switch should be in the 1 volt position, and the full scale output voltage must not exceed ten volts.

A screwdriver adjustment has been included for periodic recalibration of the instrument, thereby maintaining N.B.S. traceability. Nine adjustment steps are provided by a ten position rotary switch. Each step is equivalent to an output change of approximately 10 PPM providing the capability of reference adjustment to ± 5 PPM of a primary standard. Access is through a hole in the right side of the case.
Annual recalibration of the reference voltage is recommended. Where accuracies greater than specified are required, frequent calibration and correction charts produce excellent results.

2.0 OPERATION

2.1 KELVIN-VARLEY DIVIDER

The basic schematic is shown in Figure 2, which is drawn for a six dial unit. The last (least significant) dial switch has a single pole which selects any of the eleven taps on a voltage divider consisting of a series string of ten equal resistors. The eleven switch positions are marked 0 through 10. Each of the other dial switches has two poles which select pairs of taps on a voltage divider consisting of eleven equal resistors. The poles are spaced so as always to include two adjacent resistors between them. The ten switch positions for which this is possible are marked 0 through 9.

FIGURE 2

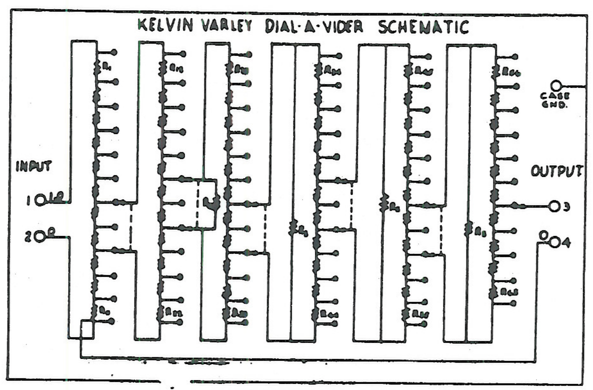


Figure 1
OUTLINE DRAWING

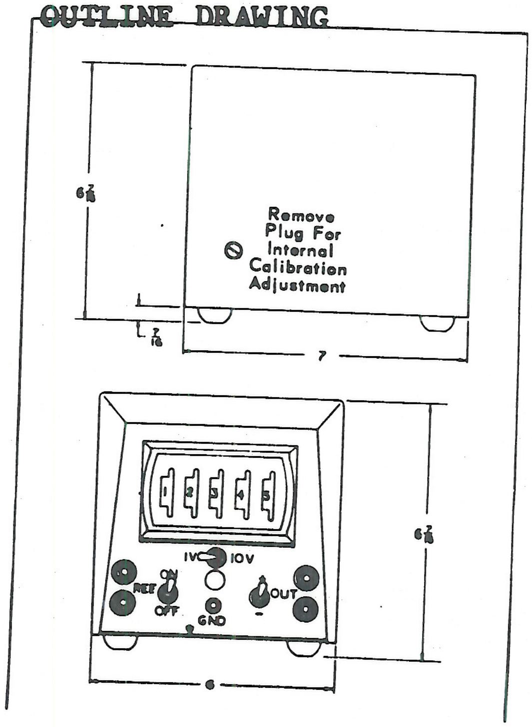
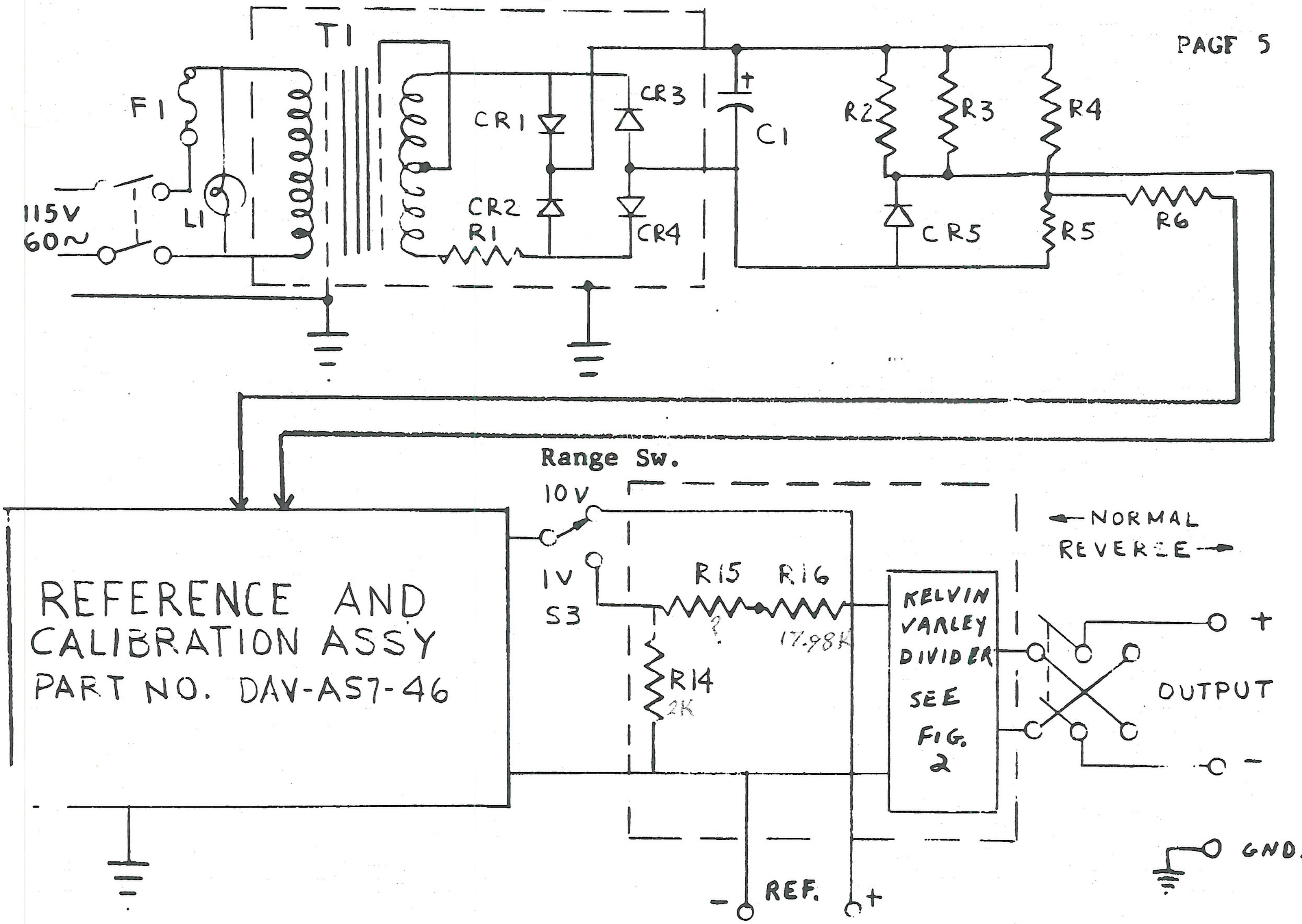


Figure 2A



C1 Capacitor Electrolytic, 100 MFD 150 WVDC
CR1-CR4 Diode, Rectifier, ER201
CR5 Diode, Zener
F1 Fuse, 1/2 AMA, AGC
L1 Pilot Light
R1 Resistor, Comp., 150Ω 1W 5%
R_2, R3 Resistor, Comp., 2.2K 2W 5%
R4 Resistor, Comp., 18K 1/2W 5%
R5 Resistor, Comp., 100Ω 1/2W 5%
R6 Resistor, WW, Selective
R14 Resistor, WW, 2K 0.1%
R15 Resistor, WW, Selective
R16 Resistor, WW, 17.98K 0.1%
S1, S3, S4 Switch, Toggle, DPDT
T1 Transformer

The poles of each two-pole switch feed the divider associated with the next switch. Thus, each two-pole switch places the entire series resistance of one divider in parallel with two adjacent resistances in the preceding divider. Each divider except the first is designed to produce a total resistance between the switch poles equal to each of the eleven resistances of the preceding divider. In this manner, each divider is fed with one-tenth of the voltage that drives the divider preceding it. Thus the dials indicate the fraction of full scale voltage which appears at the output. Because full scale is normally a power of ten, the fraction can be read directly in volts. The decimal point is before the first digit for 1 volt full scale, and after the first digit for 10 volts full scale. The model DAV-46 achieves a resolution of one micro volt per step on the 1.0 volt scale. A General Resistance plug-in attenuator permits reduction to 10 nanovolts per step.

The stability and accuracy of the output voltage is achieved, in part, by use of General Resistance precision wirewound high stability resistors throughout. These resistors are carefully matched both in value and in temperature coefficient.

2.2 POWER SUPPLY

The input power requirement for C and D series Dial-A-Volt is 115 VAC, 50-400 CPS. The power is completely isolated, rectified, filtered and multi-stage regulated to provide a very stable Zener supplied voltage at the input to the Kelvin-Varley divider. Line voltage variations of ± 10V result in voltage variations at the divider of less than ± 10 PPM.

The stability of the reference is assured by careful selection, power **aging** and long term testing of the final Zener diode. This diode has been chosen for its extremely low temperature coefficient and proven stability. Together with its associated circuitry, it is housed in a steel enclosure which provides both electromagnetic shielding and thermal integration. Temperature compensation included in this circuitry reduces the overall circuitry temperature coefficient to less than ± 5 PPM per degree centigrade in the "D" models. "G" models are furnished to customer specifications as low as ± 1/2 PPM per degree centigrade.

An especially designed transformer provides virtually perfect isolation between the A.C. line and the output.

To keep the output noise level to a minimum well within the specified limits, a combination of extensive shielding and judicious placement of parts has been used.

The Dial-A-Volt is ready for use within moments of turn-on. However, where the very highest degree of accuracy is required, a thirty minute warmup should be allowed to insure operation well within tolerance. To take advantage of the best achievable stability, an hour warmup should be allowed.

3.0 APPLICATIONS

Several of the many applications of the Dial-A-Volt are shown in Figure 3.

3.1 DIFFERENTIAL VOLTMETER

With a null detector placed in series with the output, as in Figure 3A, the Dial-A-Volt becomes a differential voltmeter of high precision. When the Dial-A-Volt in-line decades are adjusted for null, the numerals display the unknown EMF.

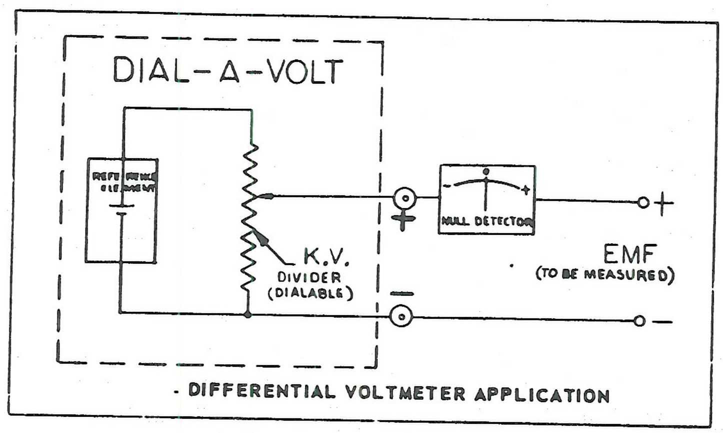


FIGURE 3A

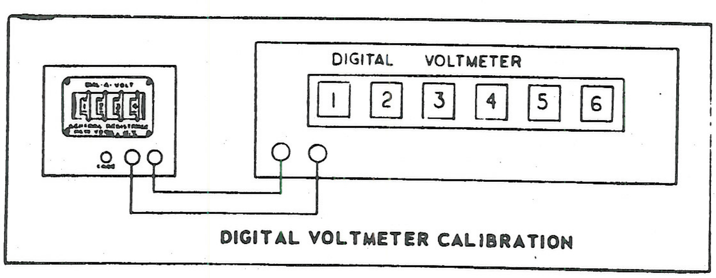
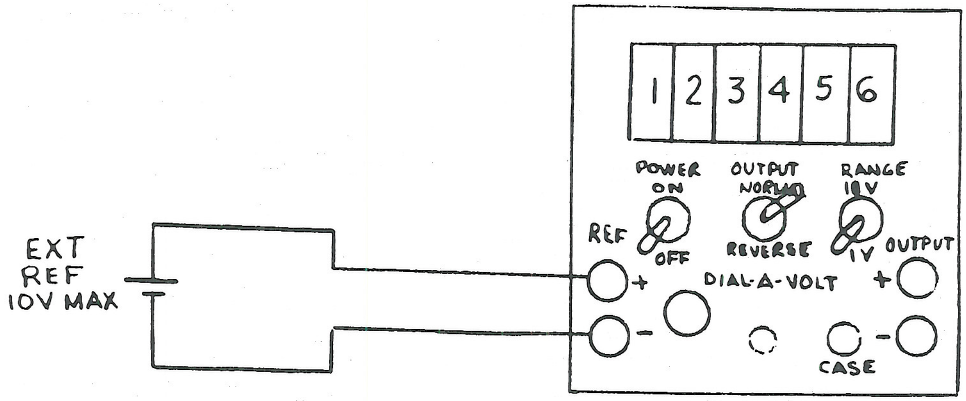
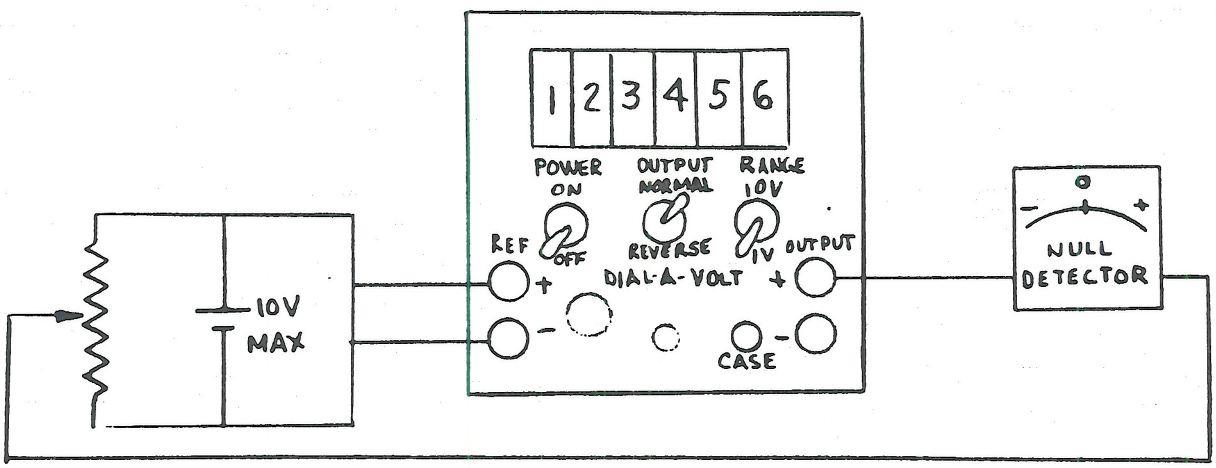


FIGURE 3B



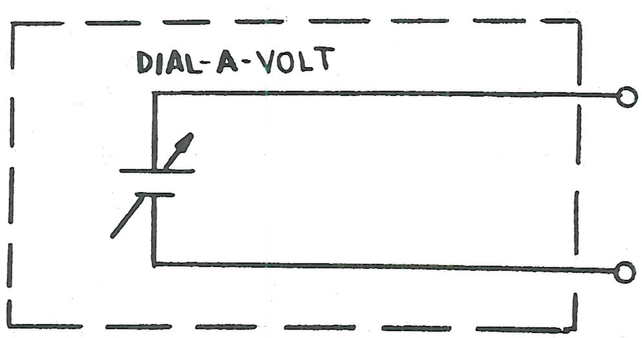
USING EXTERNAL REFERENCE VOLTAGE

FIGURE 3C



VOLTAGE DIVIDER CALIBRATION

FIGURE 3D



A BASIC HIGH PRECISION D.C. VOLTAGE REFERENCE

FIGURE 3E

3.2. VOLTMETER CALIBRATION

The Dial-A-Volt output voltage may be fed directly into the voltmeter to be calibrated as in Figure 3B. Most digital voltmeters and all differential voltmeters have input impedance sufficiently high so that no loading correction is necessary. Careless loading of the output of the Dial-A-Volt produces predictable errors requiring algebraic correction until the load is removed. These errors depend on both the output impedance Rd of the Dial-A-Volt and the input impedance Rv of the voltmeter. The Dial-A-Volt output will be lower than the voltage indicated by an amount given in PPM as:

$$\text{PPM error} = \frac{-10^6}{1 + \frac{Rv}{Rd}}$$

Figure 4 shows the error as a function of load impedance for both setting of the range switch. Because the output impedance of the Dial-A-Volt varies widely with settings of the Kelvin-Varley divider and of the range switch, it is not practical to give the error as a function of load impedance for all cases. When required a simple measurement can be made to determine the output impedance for the actual settings used. This is done by making a resistance measurement at the output terminals with the power off. When measuring output resistance with the range switch in the 10V position, the reference terminals must be shunted with 210 ohms.

Actual output voltages under load for the various settings can be tabulated for each voltmeter.

An alternate method of voltmeter calibration is to measure an adjustable voltage both with the voltmeter to be calibrated and simultaneously, with the Dial-A-Volt differential voltmeter of Figure 3A. This method precludes any possible error due to loading of the Dial-A-Volt.

3.3 DIVIDER, EXTERNAL REFERENCE VOLTAGE

The Dial-A-Volt may be turned off and the Kelvin-Varley divider driven by an external reference voltage introduced at the reference terminals as in Figure 3C. The dials indicate the fraction of the reference voltage which appears at the output. To protect the internal power supply, only the polarity shown should be used, and the voltage should not exceed 10.2 volts. The range switch should be thrown to the 1 volt position.

When using an external reference, the full-scale voltage available at the output terminals is to the order of PPM less than the voltage applied to the reference terminals. The difference is due to voltage drops in leads and switch contacts in the Kelvin-Varley divider. (This error is compensated for in the normal operating mode). If desired, this small error can be taken into account by measuring the microvoltage drop from the positive reference terminal to the positive output terminal in the full scale position, and from the positive output terminal to the negative reference terminal in the zero position. The sum of these two microvoltage drops is the amount by which the full scale output voltage differs from the voltage applied to the reference terminals.

3.4 PRECISE DIVIDER CALIBRATION

Figure 3D shows how the Kelvin-Varley divider in the Dial-A-Volt may be used as a comparison standard to determine the division ratio of an unknown divider, or to set the unknown divider to a desired ratio. The unknown divider is connected across the reference terminals so that it and the Kelvin-Varley divider may be operated from the same source. The two dividers are set to the same ratio by nulling, and the ratio is read from the dials.

The two dividers may be operated from an external source as shown, or the Kelvin-Varley divider input voltage normally available at the reference terminals may be used to drive the unknown divider also. If an external source is used, it must be limited to 10 volts of the indicated polarity. **Also the Dial-A-Volt power switch must be off**, and the range switch should be in the 1 volt position.

The accuracy to which a divider ratio can be measured by this method depends on the Kelvin-Varley divider accuracy for the model used. However, small voltage drops in leads and switch contacts give rise to an additional ratio error that can be eliminated by lead resistance compensation or by computation. This additional error is virtually zero for ratios between 0.4 and 0.5, and is less than 10 PPM for larger ratios. Eliminating mention of larger errors at lower ratios eliminates the best reason for using a lead compensator. As is the case with any ratiometric measurement or instrument, lead compensation is required to obtain the highest degree of accuracy at zero and full scale.

Section 4.2 explains how the lead resistance compensation technique is used to eliminate this type of error when calibrating the Dial-A-Volt divider against a more precise divider standard (General Resistance model DV-4107). The compensation procedure is exactly the same when calibrating an unknown divider against the Dial-A-Volt divider. The compensation is accomplished by using a General Resistance model LRC-201 lead resistance compensator, a device which has been designed especially for this purpose.

If a lead resistance compensator is not available, the ratio can be corrected by using the formula:

$$r = r_m + \frac{R_m (e_o - e_f) - e_o}{E} \times 10^{-6}$$

where

$\underline{r}$ is the corrected ratio;
$\underline{rm}$ is the uncorrected ratio measured as in Figure 3D;
$\underline{eo}$ is the microvoltage (+ or -) from the unknown divider tap to positive output terminal with both dividers at zero;
$\underline{ef}$ is the microvoltage (+ or -) from the unknown divider tap to the positive output terminal with both dividers at full scale;
$\underline{E}$ is the voltage developed at the reference terminals. It need not be accurately measured.

If the unknown divider is not adjustable, e_o and e_f are measured, respectively, at the negative and positive ends of the divider.

4.0 MAINTENANCE AND CALIBRATION

The Dial-A-Volt will provide years of trouble free service without the need for routine maintenance other than periodic recalibration of the reference voltage. General Resistance offers complete calibration service at a nominal charge. Annual documentation of Dial-A-Volt accuracy provides an invaluable record of performance and stability.

4.1 REFERENCE VOLTAGE CALIBRATION

Calibration should be performed annually. More frequent calibration corrects for minor drift. Calibration requires a standard cell and a high impedance null detector.

PROCEDURE

1. Connect the Dial-A-Volt and null detector in the differential voltmeter configuration of Figure 3A. Set the output switch to normal, the range switch to 10 volts and the dials as close to the voltage of the standard cell (corrected for temperature) as the number of dials will permit. Allow the Dial-A-Volt a warmup period of an hour or more.

2. Connect the differential voltmeter "set up" to the standard cell, observing the proper polarity. The null detector should read within 50 microvolts of the voltage difference between the Dial-A-Volt setting and the standard cell voltage. If it does not, ~~read just~~ re-adjust the calibration adjustment.

4.2 KELVIN-VARLEY DIVIDER CALIBRATION

It is recommended that the Kelvin-Varley divider in the Dial-A-Volt be calibrated biannually. Calibration requires the use of a more precise Kelvin-Varley divider to serve as a reference. General Resistance model DV-4107 is such a divider featuring terminal linearity well within ± 1 PPM. It is also necessary to compensate for the lead and contact resistance of both dividers by using a lead resistance compensator such as the General Resistance model LRC-201. The LRC-201 contains two identical, low resistance, adjustable networks, each having a fine, an intermediate and a coarse control and a resolution better than 0.1 milliohm. The positive ends of both dividers are powered through one of these networks, and the negative ends through the other.

Figure 5 is a simplified schematic which illustrates the principle of lead compensation. Both Kelvin-Varley dividers and both networks in the LRC-201 have been shown as simple potentiometers. Clearly, the two LRC=201 networks can be adjusted so that the two dividers are fed at both ends through lead resistances which are proportional to their own resistances. Under these conditions, there will be no potential difference between the positive ends of the two dividers, and no potential difference between their negative ends. Because of multiple switch contact drops in both dividers, adjustments differing somewhat from the proportionality condition are generally required to equalize the divider output potentials at their zero settings and at their full scale settings.

In addition to the DV-4107 and the LRC-201, a null detector and an external power supply are required for calibration. A power reversing switch is also useful to eliminate zero errors due to thermal emf's. Figure 6 shows the circuit connectors.

PROCEDURE

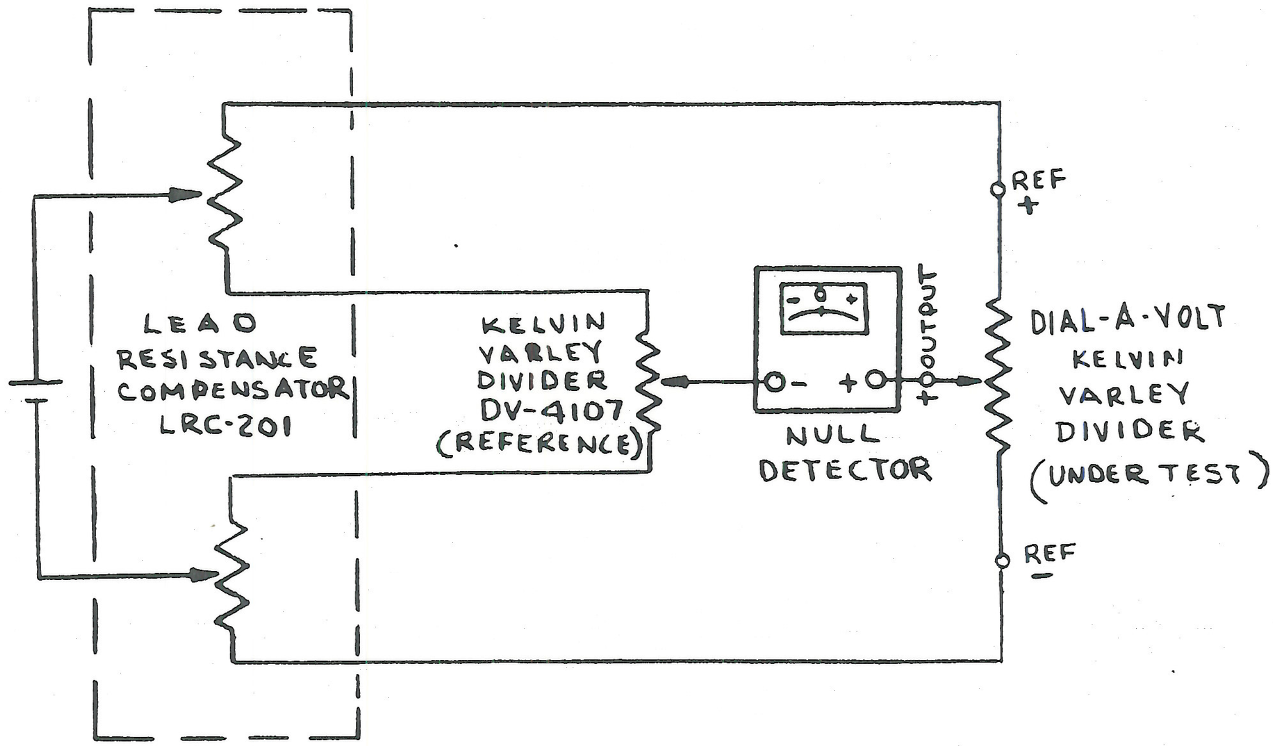
1. Turn the Dial-A-Volt power off, turn the output switch to normal and the range switch to 1V. Connect the Dial-A-Volt and test equipment as in Figure 6. (When one divider has a higher input resistance than the other, it is always connected to Divider Input B. The input resistances of the DV-4107 and the Dial-A-Volt dividers are, respectively, 100K and 1.8K).

2. Set both dividers to zero and adjust the Balance 2 dials of the LRC-201 for detector null. The outside dial is for coarse adjustment, the middle dial is for intermediate adjustment, and the inside dial is for fine adjustment. Reverse the input power to verify the null.

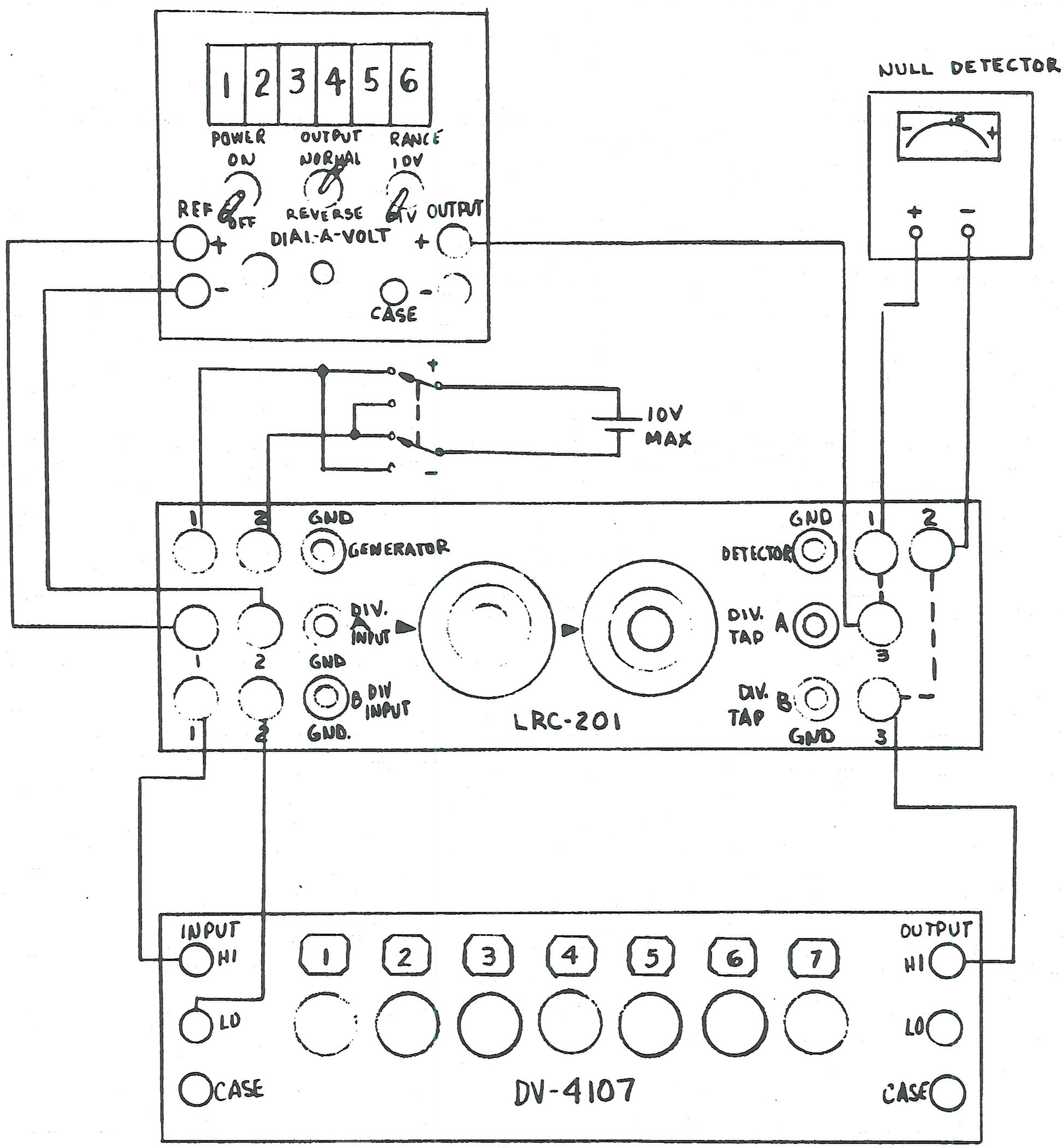
3. Set both dividers to full scale and adjust balance 1 dials for null.

4. Set the Dial-A-Volt divider to a desired check setting and adjust the DV-4107 for null. The difference between the DV-4107 setting and the Dial-A-Volt setting, expressed in PPM, is the error for this Dial-A-Volt setting.

5. Repeat step 4 for each desired check setting.



LEAD RESISTANCE COMPENSATION
FIGURE 5



TEST CIRCUIT, KELVIN VARLEY DIVIDER CALIBRATION

FIGURE 6

PARTS LIST

DAV-HO-46	Housing and Base Plate
DAV-HA-46	Handle
DAV-LC-46	Line Cord
DAV-RB-46	Rubber Bumper
DAV-AS4-46	Transformer & Rectifier Assembly
DAV-AS6-46	Bridge Rectifier #1 Assembly
DAV-AS7-46	Bridge Rectifier #2 Assembly
DAV-AS9-46	Front Panel Assembly
DAV-PA-46	Front Panel
DAV-TW-46	Toggle Switch, DPDT
DAV-LP-46	Pilot Light
DAV-BP1-46	Ground Post
DAV-BP2-46	Binding Post
DAV-FH-46	Fuse Holder
DAV-FU-46	Fuse
DAV-BZ-46	Bezel
DAV-KV-44	Range & Kelvin-Varley Divider Assembly (Model DAV-44C)
DAV-KV-45	Range & Kelvin-Varley Divider Assembly (Model DAV-45D)
DAV-KV-46	Range & Kelvin-Harley Divider Assembly (Model DAV-46D)

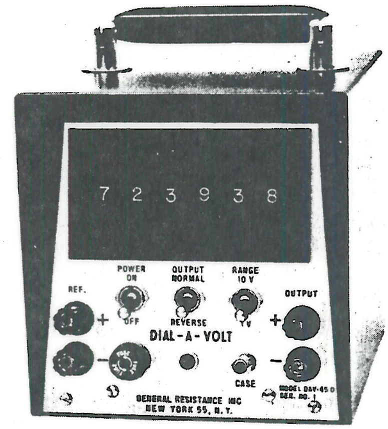
GenRes

DIAL-A-VOLT

A DIALABLE VOLTAGE REFERENCE

BULLETIN
NO. 407-1

±.0035% $^{+5\mu v}$ ACCURACY*
of ACTUAL SETTING



FEATURES:

- D.C. Reference 0.1 Nano Volts to 10 Volts
- Digital in line read out
- Fingertip Dialable Control
- 4 Compact Models and auxillary Attenuator
- 4, 5, or 6 Dial Precision Voltage Divider

NEW!

DIALABLE VOLTAGE REFERENCE and INDEPENDENT 4, 5 or 6 DIAL VOLTAGE DIVIDER

.001% STABILITY

1PPM RESOLUTION

The General Resistance Dial-A-Volt produces extremely accurate D.C. voltages for calibration and reference. Voltages from .1 nano v to 10v are literally at your fingertips. Temperature compensated zener supplies with proven stability in all models are designed to facilitate periodic calibration against primary voltage standards. Dial-A-Volts are available in 4, 5, and 6 dial models with accuracies from .0035% to .01% (of actual output voltage).

*Engineers; Check our NO Nonsense SPECS. Accuracy ±.005% of actual reading plus 5μv.

GENERAL RESISTANCE, INC.
430 SOUTHERN BOULEVARD, NEW YORK, N.Y. 10455
OXpress 2-[illegible] Area Code 212 TWX [illegible]

DIAL-A-VOLT
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GenRes

PRINCIPLE OF OPERATION

General Resistance Dial-A-Volt may be accurately desc''ed as a precision Kelvin Varley divider driven by a s: accurate D.C. reference. The reference element, dependent on model, consists of either a temperature compensated zener diode in an ambient temperature correcting circuit or a unique zener stabilized mercury reference cell. Dial-A-Volt is designed to permit periodic restandardization of the reference through an accessible adjustment potentiometer. 12 models provide a range of accuracies and resolutions filling a multitude of requirements.

Figure 1 illustrates the equivalent circuit for all models of Dial-A-Volt. The Thevenin Theorem simplification is illustrated in Figure 2. The schematic (Figure 6) on page 3 further details the circuit of a six dial unit having a resolution of 1 part in a million. A range switch permits selection of 10 volts or 1 volt, as a full scale reference in A.C. powered models.

Reference voltages traceable to primary standards from 1 micro volt to ten volts can be quickly and accurately set by in line digital dialing of the General Resistance Dial-A-Vider incorporated in each Dial-A-Volt unit. Reference voltages as low as 0.1 nano volts may be set by utilizing a Model NAV-453 attenuator.

Effects of line voltage variation, temperature and time have been minimized to assure maximum accuracy in the measurement or calibration function.

CALIBRATION

Periodic calibration is facilitated by incorporation of a reference voltage adjustment switch. This internal trim switch is accessible through an access hole on the right side of the unit.

APPLICATIONS

I. AS A REFERENCE

The Dial-A-Volt is ideally suited as a readily dialable D.C. reference source traceable to primary standards (NBS etc.) wherever load impedances are high. Use in potentiometric, Differential Volt Meter and reference applications assures specified performance free of loading effects or corrections. Figure 4 depicts the circuit employing the Dial-A-Volt and a Null Director as a precision Differential Volt Meter.

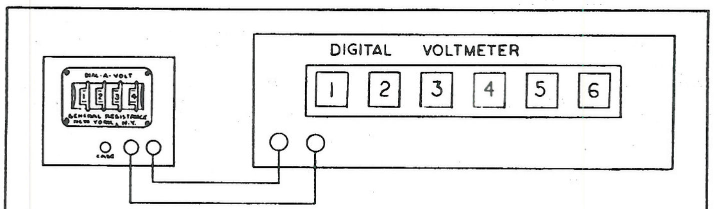


FIG. 3 - DIGITAL VOLTMETER CALIBRATION

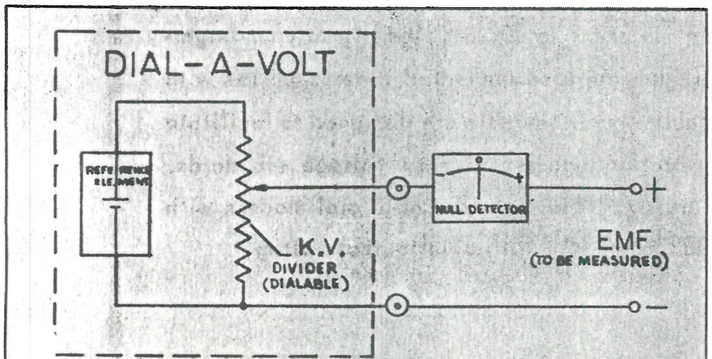


FIG. 4 - DIFFERENTIAL VOLTMETER APPLICATION

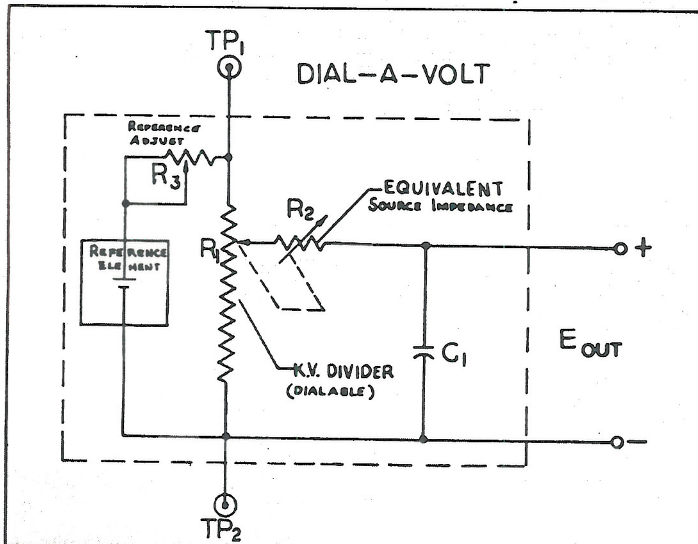


FIG. 1 - EQUIVALENT CIRCUIT

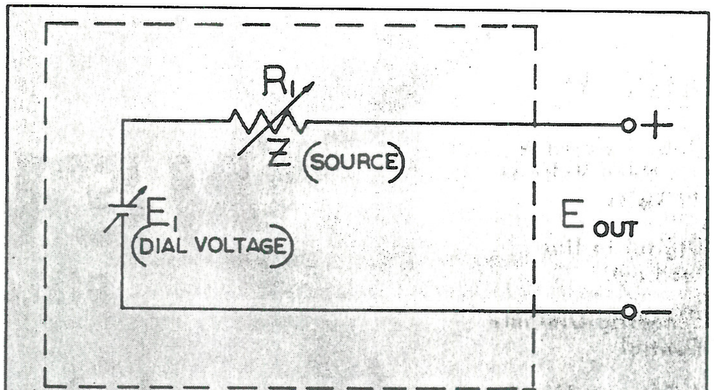


FIG. 2 - DIAL-A-VOLT THEVENIN EQUIVALENT

Dial-A-Volt permits rapid calibration of digital volt meters as shown in Figure 3. Since the majority of digital volt meters have extremely high input impedances the loading effects generally fall within tolerance limits of the Dial-A-Volt and can be neglected. Other applications include: linearity testing of operational amplifiers; as a Voltage Transfer Standard; a Milli-Microvolt reference source; as a programmable voltage source in computers, and others limited only by the ingenuity and versatility of the designer. Output polarity is reversable by means of a front panel mounted toggle switch.

II. AS A PRECISION VOLTAGE DIVIDER

The Kelvin Varley divider may be used to precisely divide resistance or an external reference voltage in a ratio indicated by the dial settings, just as it is normally used to divide the stable internal voltage. A pair of reference terminals on the front panel are used to connect the external voltage to the input of the Kelvin Varley divider. If the driving voltage is a power of ten, as in normal use, the output voltage is read directly from the dials. When using the Kelvin Varley divider with an external voltage, turn the power switch to the off position. Measurement and correction of other Kelvin Varley or conventional resistive dividers can be accomplished using the Dial-A-Volt K.V. Divider as a secondary standard ratio reference.

LOAD RESISTANCE CORRECTIONS

In applications where loading produces shifts in excess of allowable tolerances, exact corrections can be made as well as determination of the error contributed by specific loading at any particular dial setting. These effects are dependent on source impedances related to load resistance and vary with dial setting. Dial-A-Volt source impedances vary from zero to a maximum of 1000 ohms dependent on model and dial setting. The greatest source impedance occurs at a dial setting of about 555---.

To determine the output error for a given dial setting and load condition:

1) Turn Dial-A-Volt off and disconnect from circuit.
2) Shunt the reference terminals with 200 ohms for the 10V position of the range switch, or with 18,180 ohms for the 1V position.
3) Measure the resistance at the output terminals (Z out in formula).
4) Measure the loading resistance. (Z load in formula)
5) Substitute measured values in formula and calculate output change.

$$\text{PPM Output Change} = \frac{-10^6}{1 + \frac{Z\ \text{load}}{Z\ \text{out}}}$$

6) Calculated output changes may be used as corrections by adding to the dial setting.

Experience has shown that as a rule of thumb, where Dial-A-Volt applications require accuracies of .01% or less, load resistances above 10 megs may be neglected.

General Resistance representatives and application engineering department will gladly assist with information and data for your specific requirements.

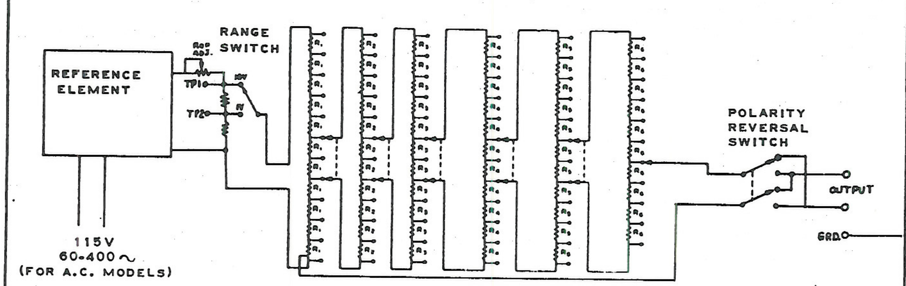


FIG. 6 - BASIC SCHEMATIC

COMPONENT STABILITY

The resistive elements employed in the DIAL-A-VOLT are of the High Stability type* manufactured and qualified to Mil R9444. Each element is tested and aged over an extended period prior to assembly in the DIAL-A-VOLT.

**For documentation of long term stability send for report SR 101.*

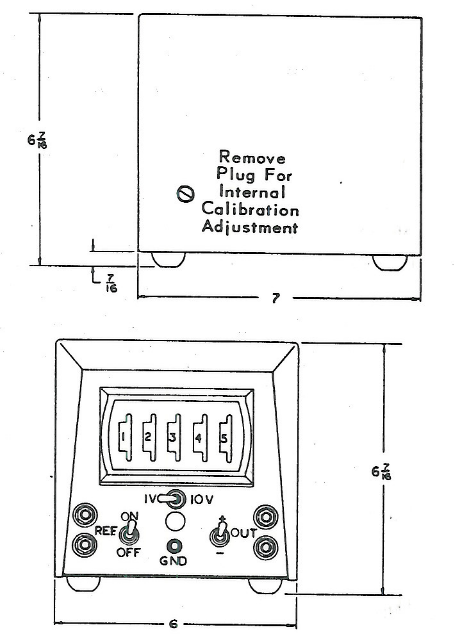
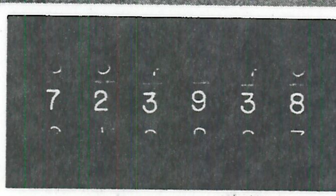


FIG. 5 - CASE OUTLINE



"HUMAN ENGINEERED" DIAL & DISPLAY

Dial-A-Volt the latest in General Resistance's fingertip dialable instruments featuring in-line numeric display. These compact instruments permit rapid selection and clear visual readout of Voltage, Resistance and Ratio eliminating interpolation of digits. Positive detent action at each numeral eliminates setting errors and prevents accidental movement of dials. Other General Resistance Instruments which include these features are:

Dial-A-Viders *(Military and Commercial Kelvin Varley dividers)*

Dial-A-Stats *(Military and Commercial resistance decade units)*

DIAL-A-VOLT SPECIFICATIONS

MODEL	DAV44C	DAV45D	DAV46D	DAV46E
[illegible]er of Decades	4	5	6	6
Full Scale EMF (maximum output volts)	1 and 10	1 and 10	1 and 10	1 and 10
Minimum Volts per Step	100μv	10 μv	1μv	1μv
Min. Volts Per Step with NAV-25 Attenuator	10. Nano Volts	1.0 Nano Volts	0.1 Nano Volts	0.1 Nano Volts
Kelvin Varley Divider Accuracy* (Terminal linearity)	±.005%	±.001%	±.001%	±.0005%
▲Accuracy (+5μv) of Actual Setting	±.01%	±.005%	±.005%	±.0035%
Input Power	115VRMS	115VRMS	115VRMS	115VRMS
Output Regulation for line variation 105 - 125 volts	±.001%	±.001%	±.001%	±.001%
Short Term Stability - 8 hours at Room Temperature in PPM**	±15	±10	±10	±10
Long Term Stability** PPM per year	±35	±25	±25	±20
Output EMF Temperature Coefficient in PPM/°C.	±10	±5	±5	±2.5
Price	$335	$375	$439	$539

*Dial A Volt can be used at K.V. Divider accuracy when calibrated and referred to an external voltage reference.
▲Accuracy at 25°C of voltage dialed.
**After 30 minute warm up.

PLUG IN — NANO VOLT ATTENUATOR
Model NAV-453

Attenuation: 10,000:1 (Ratio = 10^{-4})
Ratio accuracy: ±.01% of Output at 25°C.
Input Impedance: 8 meg. ohms
Output Impedance: 800 ohms.
Size: 1¾" x 1" x 1½"
Input Terminals: Banana Plugs.
Output Terminals: 5 Way Binding Posts

Dial-A-Volt Setting	Attenuator Output
10 Volts	1 MV
1 Volt	100 νμ
1 MV	10 Nano Volts
100 μν	1 Nano Volts
10 μν	.1 Nano Volts

PRICE: $50

GENERAL CHARACTERISTICS

Output Voltage: Temperature compensated, accurately selected by rapid digital dialing insures reliable references over expanded ambient conditions.

Short Circuit Protection: Continuous output short will not damage unit or effect accuracy after removal of short.

Connectors: Reference test and output are 5 way binding posts. AC models have 3 conductor power connectors.

Long Term Stability: Although annual restandardization for all reference and calibration devices is recommended the duration of use between calibration is dependent upon the model and accuracy required. Zener models typically have shown a yearly stability of better than 25PPM, however, for short periods they provide a useable stability as high as one part per million. Recalibration should be performed at intervals ranging from 2 years to monthly dependent on accuracy requirements. Short term drifts are generally non cumulative.

Calibration Certificate: General Resistance furnishes a calibration certificate establishing traceability to NBS and containing output voltage curves for each unit.

Input Voltage Requirements: 105 to 125VRMS, 50 to 400 cycles.

Isolation From Line: Floating Output; either terminal may be grounded or may be guarded up to 500 volts with respect to ground. Leakage is approximately 1000 megohms and less than one (1) picofarad.

Output Impedance: Zero to 1000 ohms max. dependent on model & dial setting. Less than 250 ohms at full scale setting of 10 volts.

Polarity: Reversible via toggle switch on front panel.

Warm Up Time: Instantaneous operation, (absolute stability requires 30 minute warm up).

Noise & Ripple: Less than .0015% of output voltage setting or 15 microvolts Peak (whichever is greater). Exclusive of random transients.

Delivery: Stock or 30 days.

General Resistance instruments can be modified to meet your specific requirements.

GENERAL RESISTANCE, INC.
430 SOUTHERN BOULEVARD, NEW YORK, N.Y. [illegible]
CYpress 2-1500 Area Code 212 TWX [illegible]

NEW from General Resistance

.0025% ACCURACY DIAL-A-VOLT

MODEL	DAV44C	DAV45D	DAV46D	DAV46E	DAV46F
Number of Decades	4	5	6	6	6
Full Scale EMF (maximum output volts)	1 and 10	1 and 10	1 and 10	1 and 10	1 and 10
Minimum Volts per Step	100$\mu\nu$	10$\mu\nu$	1$\mu\nu$	1$\mu\nu$	1$\mu\nu$
Min. Volts Per Step with NAV-25 Attenuator	10. Nano Volts	1.0 Nano Volts	0.1 Nano Volts	0.1 Nano Volts	0.1 Nano Volts
Kelvin Varley Divider Accuracy (Terminal linearity)	±.005%	±.001%	±.001%	±.0005%	±.0005%
▲Accuracy (+5$\mu\nu$) of Actual Setting	±.01%	±.005%	±.005%	±.0035%	±.0025%
Input Power	115VRMS	115VRMS	115VRMS	115VRMS	115VRMS
Output Regulation for line variation 105 – 125 volts	±.001%	±.001%	±.001%	±.001%	±.0005%
Short Term Stability – 8 hours at Room Temperature in PPM**	±15	±10	±10	±10	±10
Long Term Stability** PPM per year	±35	±25	±25	±20	±20
Output EMF Temperature Coefficient in PPM/°C	±10	±5	±5	±2.5	±2
Price	$335	$375	$439	$539	$645

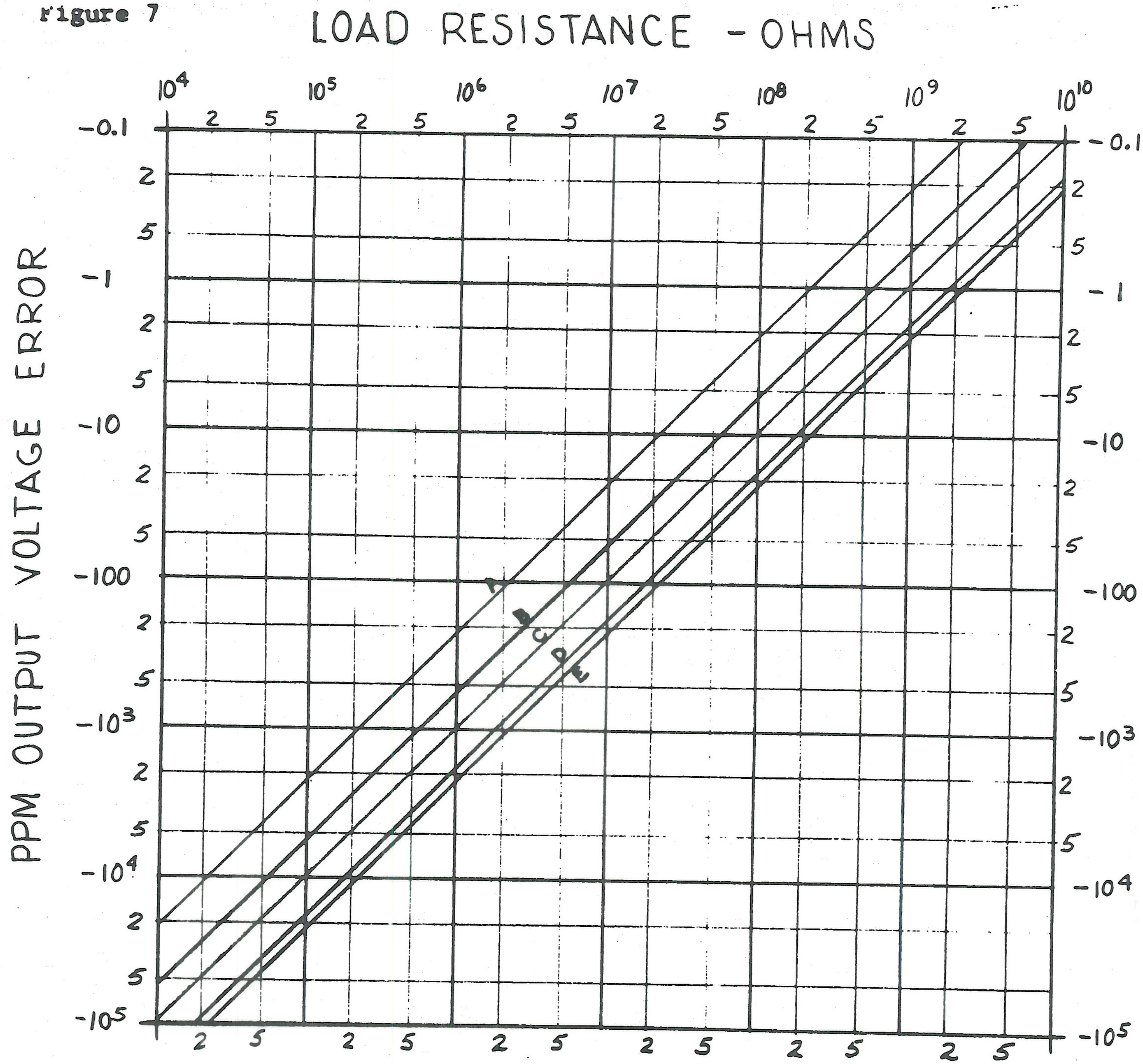
▲Accuracy at 25°C of voltage dialed.
**After 30 minute warm up.

OTHER NEW FEATURES FOR DIAL-A-VOLTS

- Rack Mountable in 7" x 19" panel. ($30.00 additional).
- 220 Volt. 50 Cycle units available.
- Temperature coefficient ±2PPM per °C.
- Line regulation .0005%.

see bulletin 407-4.

Figure 7



RANGE	ERROR	DIAL SETTING	CURVE
10V	Maximum	555555	C
10V	Full Scale	99999(10)	A
10V	Mean	--------	B
1V	Maximum	955555	E
1V	Full Scale	99999(10)	D
1V	Mean	--------	C

NOTE: Curves drawn for a Six Dial Unit.