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# Model 1550A

## Strain
## Indicator Calibrator

*Instruction Manual*

EMEM®

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# INSTRUCTION MANUAL

# MODEL 1550A

# STRAIN INDICATOR CALIBRATOR


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**Model 1550A Strain Indicator Calibrator**

# 1.0 GENERAL DESCRIPTION

The Model 1550A Strain Indicator Calibrator is a passive instrument designed to simulate strain gage circuits for the purpose of statically calibrating the indicator or conditioner to which they will be connected. All bridge circuits can be simulated: quarter, half, or full bridges of both 120Ω and 350Ω.

Output selection is by three decades of push buttons, plus a reversing button, so that any strain up to ±99 900$\mu\epsilon$ can be selected in increments of 100$\mu\epsilon$; no range change or rewiring is necessary over this full range for half- or full-bridge connections. The instrument is direct-reading in microstrain for full or half bridges, calibrated at $GF$=2.00. Strain gage transducers can be simulated to an output of ±49.95 mV/V in increments of 0.05 mV/V.

Many calibrators for strain indicators employ a "star bridge": four resistors are connected at a point with their open ends forming the corners of the "bridge". Strain is simulated by, in essence, placing shunts across adjacent corners of this "bridge". Clearly this arrangement does not represent the Wheatstone bridge for which the indicator was designed: (1) positive strain cannot be properly simulated; (2) it must always be used in the "full-bridge" configuration; and (3) both input and output resistances change in an abnormal manner. All these considerations may affect the validity of the calibration data. By contrast, the Model 1550A Calibrator is a true Wheatstone bridge where two arms change resistance (both increase and decrease) to simulate the theoretical action of a strain gage. It is thus a completely valid calibration, regardless of the indicator circuitry, including quarter- and half-bridge arrangements.

The instrument case is equipped with slip hinges which will allow removal of the cover if desired. This cover will slide off with a firm sidewards force. However, it is highly recommended that the cover be attached, closed and latched when the instrument is not in use, to prevent unnecessary moisture and dirt from getting into the critical components.

# 2.0 SPECIFICATIONS

All specifications are nominal or typical at +23°C unless noted.

**ACCURACY :** ±0.025% of setting ±1$\mu\epsilon$ (±0.0005 mV/V), max. Traceable to N.I.S.T.

**REPEATABILITY:** ±1$\mu\epsilon$ (±0.0005 mV/V), max.

**STABILITY:** (±0.001% of setting ±1$\mu\epsilon$)/°C, max.

**THERMAL EMF:** ±0.5 $\mu$V/V of excitation, max.

**BRIDGE RESISTANCES:** 120Ω and 350Ω.
Input resistance ±0.05%, max, from nominal at all output settings.
Output resistance ±0.05%, max, from nominal at "000"$\mu\epsilon$, –0.25% at ±99 900$\mu\epsilon$.

**CIRCUIT:** True $\pm\Delta R$ in two adjacent arms (opposite sign), plus two fixed arms for bridge completion.

**SIMULATION:** One active arm (quarter bridge). Half bridge, one or two active arms. Full bridge, two active arms.

**RANGE:**

**Two active arms:** 0 to ±99 900$\mu\epsilon$ in steps of 100$\mu\epsilon$ at *GF*=2.00. 0 to ±49.95 mV/V in steps of 0.05 mV/V.

**One active arm:** 0 to ±49 950$\mu\epsilon$ in steps of 50$\mu\epsilon$ at *GF*=2.00

**OUTPUT AT 000:** ±50$\mu\epsilon$ (±0.025 mV/V), max in full-bridge mode.

**EXCITATION:**

**To meet accuracy and repeatability specifications:** *120Ω:* up to 10Vdc. *350Ω:* up to 15Vdc.

**Maximum permissible:** *120Ω:* 25V ac or dc. *350Ω:* 30V ac or dc.

**ENVIRONMENT:**

**Temperature:** 50° to 100°F *(10° to 38°C).*

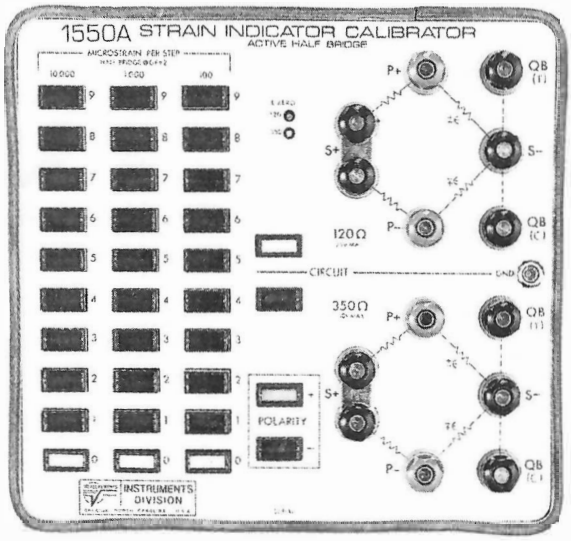
**Humidity:** Up to 70% RH, noncondensing.

**SIZE:** 8-1/4 W x 5-3/4 H x 7-3/4 D in *(210 x 145 x 195 mm).*

**WEIGHT:** 4.8 lb *(2.2 kg).*

## 3.0 FUNCTIONAL DESCRIPTION

### 3.1 Binding Posts




Two groups are provided, one for 120Ω and one for 350Ω simulation. The active half bridge is between P+, S– and P–. A fixed resistor is between each P post and each S+ post; these form a half bridge if the shorting link at S+ is closed. The GND post provides a convenient chassis ground connection.

### 3.2 CIRCUIT Push Buttons

These buttons connect the $\Delta R$ network to the selected binding post group thus simulating strain in the P+/S–/P– half bridge. (Without the proper circuit button selected, the bridge will be unbalanced some 48 000$\mu\epsilon$.)

### 3.3 POLARITY Push Buttons

These buttons select the polarity of the unbalance ( $\Delta R$) selected by the MICR O-STRAIN push buttons.

### 3.4 ±ZERO Adjustments

These trimpots (one each for 120 Ω and 350 Ω) trim the netw ork to eliminate zero-crossing errors (that is, so that the output at "+000" and "–000" are identical).

### 3.5 MICROSTRAIN Push Buttons

Three rows of ten buttons select the desired output to be simulated, the output being the total of the three b uttons selected; it is direct-reading in microstrain (assuming both active arms are in use).

## 4.0 INDICATOR CALIBRATION

While the following instructions explain proper use of this instrument in detail, the brief instructions inside the lid will normally be adequate for subsequent use.

### 4.1 Connections

Choose the circuit arrangement desired, with re gard to resistance per arm (120 Ω or 350Ω) and bridge configuration (see Fig. 1). The GND post should be connected to the system ground (normally the strain indicator chassis) to minimize the effects of electrical noise pickup. Place the S+ shorting link as shown and connect the leads to the indicator. For use with the V/E-20A, it is normally recommended that the P and S connections be transposed in the interconnection (i.e., S– of the Model 1550A be connected to P– of the V/E-20A, P– to S–, etc.).

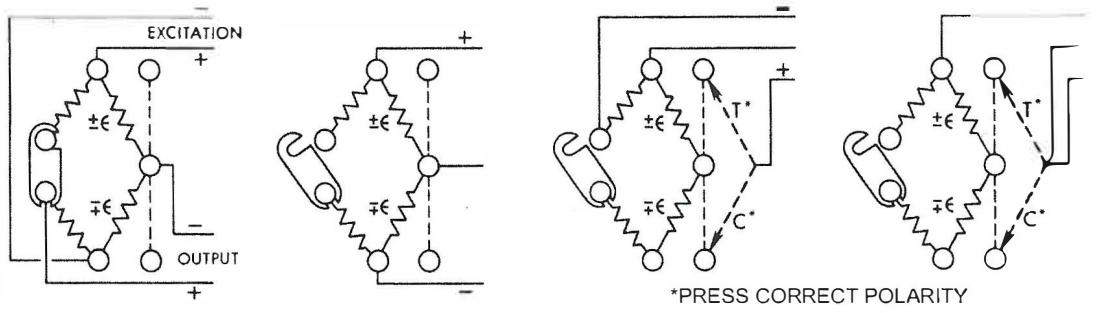



*Fig. 1*

**4.1a Full Bridge:** With the indicator connected as shown in Fig. 1a (note that S+ shorting link must be closed), the output at S– will be exactly linear regardless of type excitation. Linearity is achieved since the total resistance from P+ to P– is constant as strain is simulated. It is the conventional arrangement, but note that the entire output is at S–; S+ is inactive with simulated strain.

An alternate use is to interchange the excitation and output leads to the indicator (i.e., positive excitation at S+, etc.). Now the output appears at *both* signal leads (binding posts marked P+ and P–) with opposite signs. This arrangement is precisely linear with constant current excitation; under constant voltage excitation, the theoretical nonlinearity cannot even be detected over most ranges of use (0.25$\mu\epsilon$ at 10 000$\mu\epsilon$, or 0.00012 mV/V at 5 mV/V). This arrangement is thus recommended when calibrating transducer indicators.

**4.1b Half Bridge:** The full bridge must be "opened" by opening the link at the S+ binding posts. In the normal arrangement (Fig. 1b) both arms are active in opposite directions; since the resistance between the excitation binding posts is constant, output will be linear. Occasionally it may be desirable to check the indicator with only one active arm; in this case use the arrangement shown in Fig. 1c, but note that a somewhat nonlinear display would be expected in most indicators since the bridge resistance changes somewhat as strain is simulated.

**4.1c Quarter Bridge:** This arrangement (Fig. 1d) simulates a single active strain gage where the balance of the bridge exists within the indicator. To essentially eliminate zero shift due to temperature effects on the leadwire, the three-wire circuit shown should be used; for connections to the indicator refer to the instructions for that indicator. When changing polarity, the appropriate binding post must be utilized in addition to pressing the desired polarity button. To simulate tension or a positive output, the QB (T) post would be used with the +POLARITY button pressed. To simulate compression or a negative output, the QB (C) post would be used with the –POLARITY button pressed.

### 4.2 Leadwire Resistance

The resistance of the leadwires between the calibrator and indicator is somewhat critical and can produce several effects:

a. Reduced calibrator output (usually called leadwire desensitization).

b. Unstable zero due to changes in lead resistance with ambient temperature.

c. Span errors when the indicator is "calibrated" by shunt calibration of arms external to the indicator.

All of the above effects are proportional to the ratio of the lead resistance to the gage (or bridge arm) resistance. Using relatively heavy leads, such as AWG 18 [0.0403 in *(1.024 mm)* diameter] will minimize errors; this is especially important when using the 120Ω circuit. However, if the purpose is to simulate an actual gage or transducer installation, use leadwires of the same size and length as would be used in the actual installation.

Good zero stability with temperature requires complete symmetry in the total bridge. To achieve this with the quarter or half bridge, use nearly identical wires for all leads (size and length) and keep them grouped together to minimize temperature differentials.

Leadwire desensitization should be considered in almost all bridge circuits; since the effect varies somewhat among indicators, it is usually discussed in the companion instruction manual, which should be consulted. Generally the error would be below

0.02% using a 3 ft *(1 m)* length AWG 18, although the error may be several times greater where shunt calibration is employed.

### 4.3 Calibrator Setup

Press the CIRCUIT button corresponding to the binding post group in use (120 Ω or 350Ω).

Press the "0" button in each MICROSTRAIN decade.

Apply the bridge excitation. Excellent stability will be achieved with normal excitations (up to 10V on 120Ω, or 15V on 350Ω). Maximum permissible excitation (25V and 30V, respectively) may produce some warm-up drift; readings should not be recorded until stable, which may take several minutes at each selected output under extreme conditions.

If it is anticipated that readings will be taken through zero (that is, both POLARITY buttons will be used), check that "+000" and "–000" both yield the same reading. If not, adjust ±ZERO slightly to achieve this.

### 4.4 Indicator Setup

Where an initial zero or bridge balance control is provided on the indicator, it would be normal practice to set this to achieve a zero reading so that data need not be corrected for initial offset.

**NOTE:** An unbalance of up to ±50 $\mu\epsilon$ (±0.025 mV/V) can be encountered with the Model 1550A Calibrator where no indicator balance control is used.

Set the indicator scale factor as desired.

(a) A strain indicator would usually be set for a gage factor of exactly 2.000 to achieve direct-reading calibration. If it is set for any other gage factor, data reduction will be necessary (see ***paragraph 4.5a***). Assume *one* active gage.

(b) A transducer indicator may read directly in mV/V, percent input for a fixed or settable span, or it may read directly in engineering units (pounds, newtons, etc.) for a selected transducer. Any indicator above can be accurately calibrated with the Model 1550A, although some simple data reduction is generally necessary (see ***paragraph 4.5b***). Some special cases exist such as a percent instrument set for 0.5 or 5 mV/V span, where "data reduction" is simply decimal point placement; while this makes calibration simple, it may not represent the parameters over which the instrument is normally used and thus may not be an entirely valid check of the instrument.

### 4.5 Data Reduction

#### 4.5a Strain Indicator:

(a) If set for $GF$=2.000 and using two active arms in the calibrator, no data reduction is necessary; the indicator reading and calibrator can be directly compared.

(b) If set for $GF$=2.000 but using only one active arm in the calibrator, the indicator should read *half* the calibrator setting. Nonlinearity in the indicator would be expected at the higher readings; this effect is predictable and can be confirmed by referring to Vishay Micro-Measurements Tech Note TN-507, "Errors Due to Wheatstone Bridge Nonlinearity".

(c) If set for any gage factor other than 2.000, the following relationship applies:

$$\text{Ideal indicator reading} = \text{calibrator setting} \times \frac{N}{GF}$$

where $GF$ = indicator gage factor setting

$N$ = number of active arms used in calibrator

again, where $N = 1$, some nonlinearity is normal and predictable.

**4.5b Transducer Indicator (full-bridge input, two active arms):**

In all expressions below, "calibrator setting" is the setting of the decade buttons in microstrain. For example, if buttons 0-2-5 are selected, the "calibrator setting" would be 2500.

(a) mV/V Readout:

$$\text{Ideal mV/V reading} = \text{calibrator setting} \times \frac{1}{2000}$$

(b) Percent Readout:

$$\text{Ideal percent reading} = \text{calibrator setting} \times \frac{1}{20 \times k}$$

where $k$ = full-scale output of transducer in mV/V.

(c) Direct-reading in engineering units:

$$\text{Ideal reading} = \text{calibrator setting} \times \frac{T_R}{2000 \times k}$$

where $T_R$ = rated input to transducer in engineering units (pounds, newtons, etc.)

$k$ = transducer output in mV/V at rated input.

**4.6 Model 1550A As Precision Attenuator**

The Model 1550A Strain Indicator Calibrator is simply a passive network in a Wheatstone bridge configuration with an output/input ratio from 0 to 0.05 in 1000 linear steps. It therefore has application where large but precise attenuations are required.

For example, it can be used to check the linearity of low-input instruments. If the Model 1550A is excited (at P+ and P–) with a stable and accurate 2V source, outputs of 0 to 99.9 mV can be generated between S+ and S– in increments of 0.1 mV The step resolution will always be one part in 20 000 of the excitation.

The user is cautioned on two limitations:

(a) The output at "000" may be up to half the value of the smallest step (0.0025% of excitation) unless some external means are provided to balance the Model 1550A.

This could be a 10k potentiometer across P+ and P– with the wiper connected to S+ via a resistor of approximately 500 k Ω; the potentiometer would be set as required to achieve zero output.

(b) Either the power supply output must be floating (not grounded) or the instrument must be able to accept a differential input, since the level at the output will be half the excitation voltage, measured from the P– binding post.

## 5.0 SERVICING

The Model 1550A Strain Indicator Calibrator is a completely passive device consisting of only switches and precision resistors. Routine or preventive maintenance is not required.

In view of the intended purpose of this instrument as a "standard", it should be accorded more than the normal care in handling. If required, the cover will slide off the slip hinges with a firm sideways force. However, when the instrument is not in use, it is recommended that the cover be attached, closed and latched. Avoid storing in extreme temperatures, high humidity, or areas which may contain corrosive atmospheres.

### 5.1 Resistor Replacement

Should it be necessary to replace any resistors in the networks, it is strongly suggested that such replacements be obtained from Vishay Micro-Measurements to maintain the superior quality of these resistors with special regard to stability with time and temperature. All resistors have a tolerance of 0.01 or 0.02%.

A complete schematic is available for those who wish to gain a more detailed understanding of circuit operations and for organizations that choose to do their own repairs and adjustments. We recommend that all units be returned to the Vishay Micro-Measurements for repair and calibration. Our Applications Engineering Department can provide the diagram, upon request, in paper and/or electronic formats.

# WARRANTY

Micro-Measurements, warrants all instruments it manufactures to be free from defect in materials and factory workmanship, and agrees to repair or replace any instrument that fails to perform as specified within three years after date of shipment. Coverage of computers, cameras, rechargeable batteries, and similar items, sold in conjunction with equipment manufactured by Micro-Measurements and bearing the identifying name of another company, is limited under this warranty to one year after the date of shipment. The warranty on nonrechargeable batteries and similar consumable items is limited to the delivery of goods free from defects in materials and factory workmanship. This warranty shall not apply to any instrument that has been:

i) repaired, worked on or altered by persons unauthorized by the Micro-Measurements in such a manner as to injure, in our sole judgment, the performance, stability, or reliability of the instrument;
ii) subjected to misuse, negligence, or accident; or
iii) connected, installed, adjusted, or used otherwise than in accordance with the instructions furnished by us.

At no charge, we will repair, at our plant, or an authorized repair station, or at our option, replace any of our products found to be defective under this warranty.

**This warranty is in lieu of any other warranties, expressed or implied, including any implied warranties of merchantability or fitness for a particular purpose. There are no warranties which extend beyond the description on the face hereof. Purchaser acknowledges that all goods purchased from Micro-Measurements are purchased as is, and buyer states that no salesman, agent, employee or other person has made any such representations or warranties or otherwise assumed for Micro-Measurements any liability in connection with the sale of any goods to the purchaser. Buyer hereby waives all rights buyer may have arising out of any breach of contract or breach of warranty on the part of Micro-Measurements, to any incidental or consequential damages, including but not limited to damages to property, damages for injury to the person, damages for loss of use, loss of time, loss of profits or income, or loss resulting from personal injury.**

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Return transportation charges of repaired or replacement instruments under warranty will be prepaid by Micro-Measurements.

Micro-Measurements is solely a manufacturer and assumes no responsibility of any form for the accuracy or adequacy of any test results, data, or conclusions which may result from the use of its equipment.

The manner in which the equipment is employed and the use to which the data and test results may be put are completely in the hands of the Purchaser. Micro-Measurements shall in no way be liable for damages consequential or incidental to defects in any of its products.

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