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SB-1

SB-1
Switch & Balance Unit

—Instruction Manual—

INSTRUMENTS DIVISION
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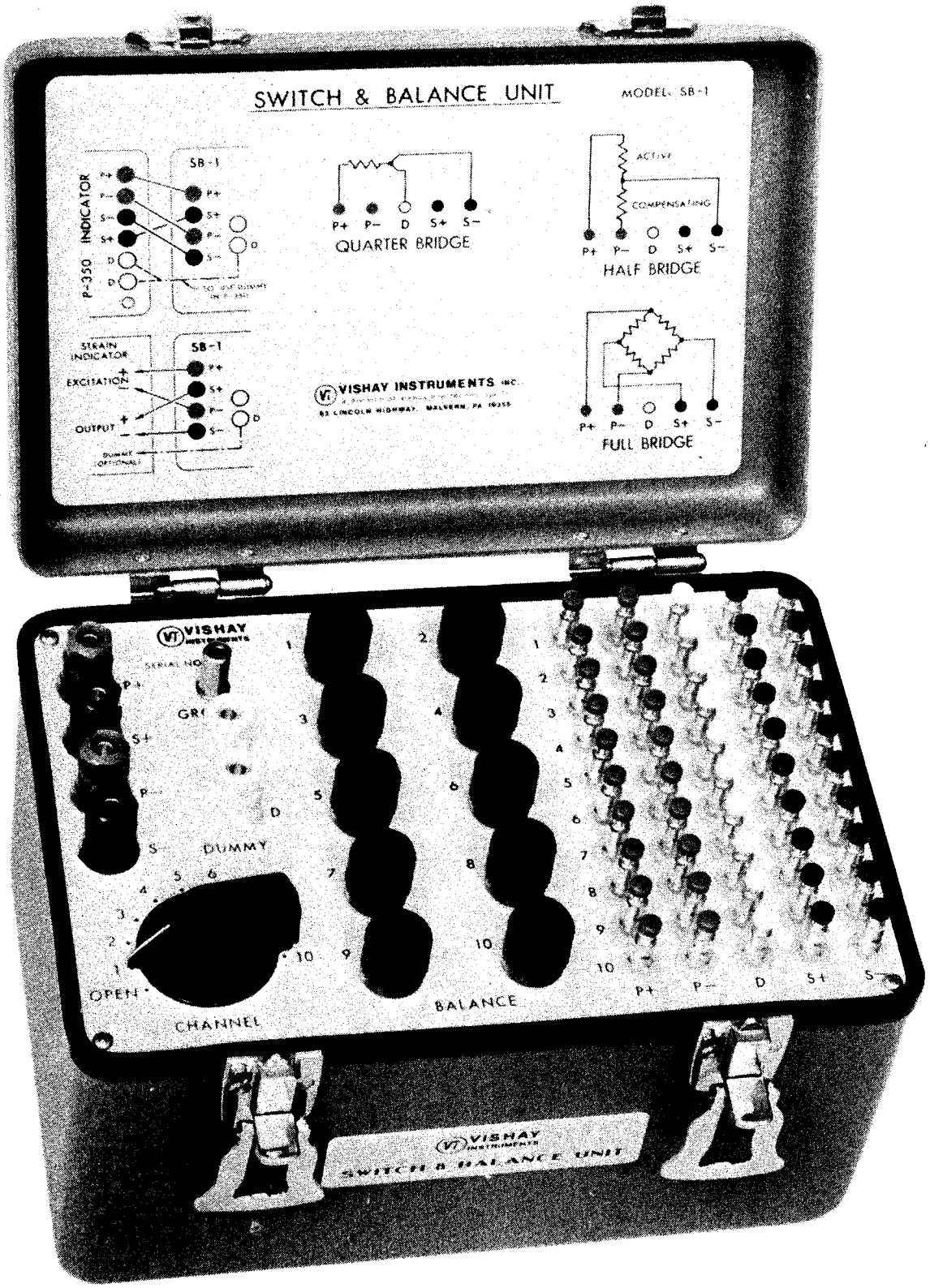
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INSTRUCTION MANUAL

MODEL SB-1 SWITCH AND BALANCE UNIT

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Model SB-1 Switch and Balance Unit

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1.0 GENERAL DESCRIPTION

The SB-1 Switch and Balance Unit is designed primarily to provide a method of sequentially reading the output of ten (10) channels of strain gage information on a single strain indicator. Each channel can be initially balanced to zero output to greatly simplify data interpretation and reduction. In addition, any SB-1 unit will intermix quarter-, half- and full-bridge circuits and offers full isolation for each individual circuit, thus preventing any defect in one input from having any effect on any other input.

Although designed primarily as a companion switch and balance unit for the Model P-350A Portable Digital Strain Indicator, the SB-1 can be used with any strain indicator. However, if the strain indicator used does not offer half-bridge operation, the SB-1 can only be used to switch full bridges into the instrument, unless the user supplies his own dummy half-bridge.

The unique gold-plated push clamp binding posts allow fast, convenient, reliable connection of input circuits.

"Common dummy" connections are provided for use with strain indicators which do not incorporate built-in dummies, or to use a common compensating gage.

The SB-1 has an OPEN switch position that permits the use of more than one SB-1 unit with the same indicator.

The balancing controls are ten-turn potentiometers which permit very fine balance adjustments for each input circuit. The SB-1 can also be obtained with locking knobs for the balancing potentiometers (Model SB-1L) or with locking, concentric-dial counting knobs (Model SB-1K) which permit reproducible balance settings.

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2.0 SPECIFICATIONS

2.1 CAPACITY

10 channels plus OPEN position.

2.2 EXTERNAL CIRCUITS

Will accept quarter-, half-, or full-bridge circuits or any combination. Quarter-bridge inputs may be two- or three-wire circuits.

2.3 INPUT BRIDGE RESISTANCE

50 to 2000Ω.

2.4 OUTPUT

Compatible with any strain indicator.

2.5 BALANCE RANGE (GF=2)

Quarter and Half Bridge:
±2000$\mu\epsilon$ with 120Ω half-bridge in indicator.
Full Bridge:
±2000$\mu\epsilon$ for 120Ω bridge. Range proportional to bridge resistance.

2.6 BALANCE RESOLUTION (GF=2)

Better than 1$\mu\epsilon$.

2.7 SWITCHING REPEATABILITY

Better than 1$\mu\epsilon$.

2.8 CASE

Aluminum. Dust and spray-tight with detachable cover.

2.9 SIZE

9 W x 6 H x 6 D in
(230 x 150 x 150 mm)

2.10 WEIGHT

5-1/2 lb *(2.4 kg)*

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3.0 DESCRIPTION OF CONTROLS

3.1 OUTPUT BINDING POSTS

For connection to strain indicator.

3.2 DUMMY BINDING POSTS

For connection of common "dummy" gage in quarter-bridge applications.

3.3 CHANNEL SWITCH

To select desired strain gage input circuit. OPEN position is used when reading inputs from other SB-1's wired in parallel to the same indicator.

3.4 BALANCE KNOBS

10-turn controls used to compensate for the initial unbalance in each input gage circuit, up to ±2000$\mu\epsilon$ (see paragraph 4.5.5).

3.5 INPUT PUSH-POSTS

Five push-posts are provided for each input circuit. All five are never used at once. Various bridge configurations require the use of two, three, or four push-posts. In general, the red push-posts provide full bridge excitation, the black push-posts accept the outputs from a full bridge, and the white push-post is used for quarter-bridge circuits. (See Section 4.4.3.)

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4.0 OPERATING PROCEDURE

It is strongly recommended that the operator read this manual in its entirety before commencing to operate the SB-1 Switch and Balance Unit.

This manual is written primarily for use with strain indicators such as the P-350A, P-3500, V/E-20, V/E-20A, and BAM-1. However, operation with most other strain indicators is possible using essentially the same procedures. If questions arise, our Applications Engineers can give assistance.

NOTE: Many SB-1's and P-350's of earlier manufacture used slightly different designations for the four corners of the bridge than current models. Accordingly, the earlier designations are referenced in parenthesis throughout his manual.

Current Designation	Earlier Designation
P+	P1
P–	P2
S+	S2
S–	S1

4.1 DETACHABLE COVER

The instrument as supplied is equipped with hinges which will allow removal of the cover. To effect removal, bend the open-sided portion of the cover hinge upwards far enough to clear the center section of the body hinge. If you prefer a permanently attached cover, disregard these instructions.

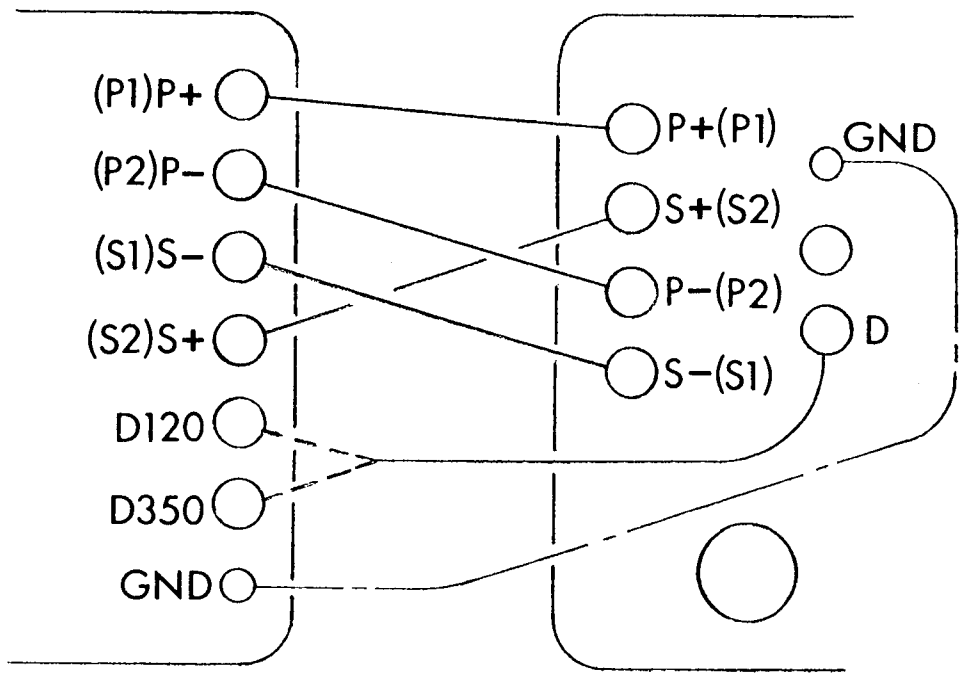
4.2 INDICATOR CONNECTIONS

4.2.1 While the Model SB-1 Switch and Balance Unit is designed primarily for use with the Model P-350A and P-3500 Portable Strain Indicator, it can be used with any similar self-contained indicator designed for use with a single strain gage circuit.

AWG 18, 20, or 22 gauge stranded wire is recommended for interconnections.

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4.2.2 Connections to the Model P-350A or P-3500 Strain Indicators.



P-350A, P-3500
Strain Indicator

SB-1
Switch & Balance Unit

Figure 1

Leads P+, P–, S+, and S– (P1, P2, S2 and S1) must always be connected. Good engineering practice dictates that the two GND terminals be connected together and grounded, but it is not mandatory.

If one or more channels on the SB-1 are to be used for measuring 120Ω or 350Ω quarter-bridges, the white "D" binding post on the SB-1 must be connected to one of the "D" terminals on the P-350A and P-3500 (D120 for 120Ω gages, D350 for 350Ω gages). Alternately, this wire may be omitted and a "dummy" gage or highly stable resistor of appropriate resistance must then be attached between the two white DUMMY binding posts on the SB-1.

If one or more channels on the SB-1 are to be used for measuring quarter-bridges with a resistance other than 120Ω or 350Ω, the alternate procedure above must be used.

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4.2.3 Connection to V/E-20, V/E-20A, and BAM-1 Strain Indicators.

SB-1 Binding Posts	V/E-20A Binding Posts	V/E-20 Binding Posts	V/E-20 or V/E-20A INPUT Connector	BAM-1 Binding Posts
P+ (P1)	S+	+ Signal	C	C
P– (P2)	S–	– Signal	D	D
S+ (S2)	P+	Power +	A	A
S– (S1)	P–	Power –	B	B
D	D_{120} or D_{350}	BCR_{120} or BCR_{350}	F or G	D_{120} (if present)
Ground	GND	GRD	E	GRD

Leads P+, P–, S+ and S–(P1, P2, S2, and S1) must always be connected. Good engineering practice dictates that the GND terminals be connected together, but for static measurements it is not required; for dynamic use with the BAM-1, these **must** be connected.

If one or more channels on the SB-1 are to be used for measuring 120Ω or 350Ω quarter-bridges, the white "D" binding post on the SB-1 must be connected to the appropriate Dummy binding post (or connector pin) on the indicator (older BAM-1's do not provide this feature, so the following procedure must be used). Alternately, this wire may be omitted and a "dummy" gage or highly stable resistor of the appropriate resistance must be attached between the two white DUMMY binding posts on the SB-1.

If one or more channels on the SB-1 are to be used for measuring quarter-bridges with a resistance other than 120Ω or 350Ω, the alternate procedure above must be used.

4.2.4 Connections to Strain Indicators other than the P-350A, P-3500, V/E-20, V/E-20A, or BAM-1:

a. Connect terminals P+ and P– (P1 and P2) to the bridge excitation terminals on the indicator; terminal P+ (P1) should be connected to the indicator terminal normally adjacent to a single "active" gage.

b. Connect terminals S+ and S– (S2 and S1) to the "bridge output" terminals on the indicator; terminal S– (S1) should be connected to the indicator terminal normally used at the center-tap of a fully active half-bridge (that is, the binding post or posts electrically common to the "active" and "compensating" gages); terminal S+ (S2) should be connected to the indicator terminal normally used only for full-bridge inputs.

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c. The "D" terminal on the SB-1 frequently has no counterpart on the indicator.

d. Good engineering practice dictates that the GND terminal on the SB-1 be connected to a ground terminal on the indicator, and that this terminal be physically grounded.

4.3 MULTIPLE SB-1's:

Two or more SB-1's (and/or SB-2's) can be simultaneously connected to the same indicator to read more than 10 input circuits, which may be mixed quarter-, half- and full-bridges. It is also possible to use two or more SB-1's (or SB-2's) to group quarter-bridge inputs of different resistance – for example, 10 (ten) 120Ω inputs and 10 (ten) 350Ω inputs.

The four power and signal leads (P+, P–, S+, and S– or P1, P2, S2 and S1) must be connected in parallel to all SB-1's. The D or DUMMY binding post (s) are each wired in accordance with the gages connected to each individual SB-1; thus all D terminals are usually wired in parallel, but not necessarily so.

4.4 GAGE CONNECTIONS

4.4.1 The existing environment may determine the type of wire used. The following characteristics must be carefully considered:

a. The insulation must be compatible with temperatures involved.

b. To avoid an excessive loss of sensitivity (decreased effective gage factor) with long lead lengths, leads should have low resistance (at the operating temperature).

c. Copper wire is recommended over Constantan.

d. The conductor material must be readily solderable for most installations.

e. In quarter- and half-bridge circuits all conductors (for a given input) should be of the same gage and length.

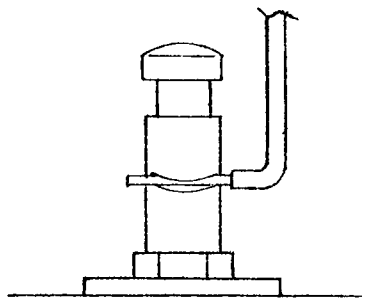
4.4.2 Wire Gage and Stranding

The input push-posts will accept wire from AWG 18 to AWG 30 gage *(0.25 to 1.0 mm)*. Especially at the heavier gages, stranded wire is more satisfactory. Unless other circumstances dictate a choice, AWG 24 or 26 gage *(0.4 or 0.5 mm)* stranded wire will give best performance. At the SB-1 ends, the insulation should be stripped about 3/8 in *(10 mm)* and the strands twisted and tinned with solder.

When leads longer than 10 ft *(3 m)* are used, careful consideration should be given to the apparent reduction in gage factor of the strain gages, especially with the finer gages of wire.

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To attach a wire to the push-posts, bend a right-angle hook about 1/2 in *(13 mm)* from the end of the wire, press the push-post with one hand and hook the wire in the notch with the other; release the push-post.



4.4.3 Input Gage Circuits

QUARTER BRIDGE – Independent circuits (Figure 2A)

"Quarter-bridge" operation indicates that only one gage is active with strain. A single dummy gage is used for all 10 inputs – this gage or ultra-stable resistor (same resistance as the active gage) is either attached between the two white DUMMY binding posts on the SB-1 (using short leads), or – if the indicator has built-in dummy gages as in the P-350A and P-3500 – the large white D binding post is tied directly to the D_{120} or D_{350} binding posts on the indicator.

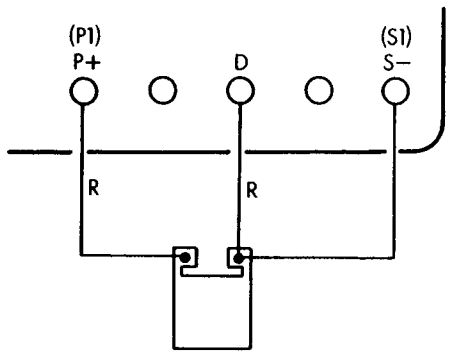
In either arrangement above good strain gage practice dictates the use of the three-wire circuit as shown in Figure 2A.

However, the SB-1 can be used with two-wire circuits: short together the S– (S1) and D push-posts. If all inputs to the indicator are to be quarter-bridges wired this way, the short can be placed at the large S– (S1) and D binding posts and then the D push-posts are not used.

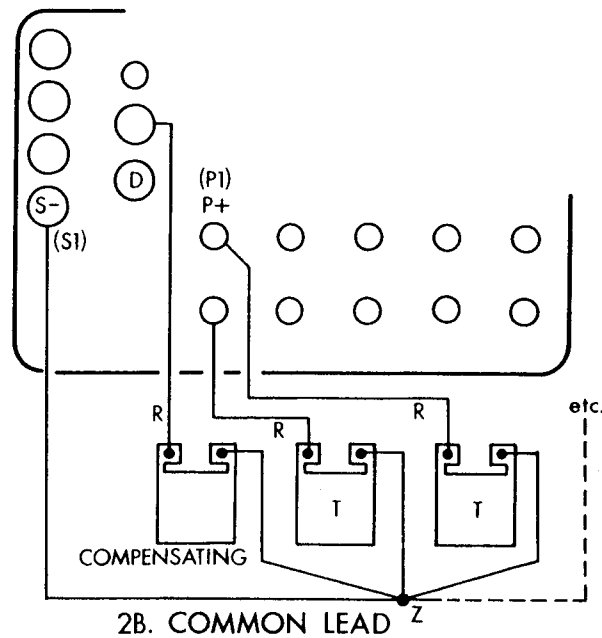
Due to the high temperature coefficient of resistance of copper wire, ambient temperature changes on the lead wires can give a large false indication of strain when only two lead wires are used [Using 30 ft *(9 m)* of twisted-pair AWG No. 26 wire *(0.5 mm)* to a 120Ω gage, the apparent zero will shift more than 200$\mu\epsilon$ for a 10°F *(5.6°C)* change. Even using AWG No. 20 wire in this situation, the shift would be over 50$\mu\epsilon$.] The recommended three-wire system puts half of the temperature-induced lead wire resistance change in series with the dummy gage while the other half remains in series with the active gage. Equal changes in lead resistances in these adjacent arms then do not effect the strain measurement.

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NOTE: Leads marked "R" must be same length and size for best balance and stability.

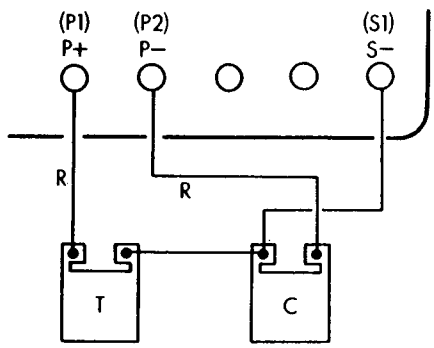


2A. INDEPENDENT CIRCUITS

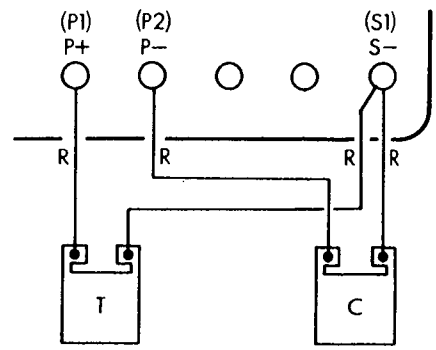


2B. COMMON LEAD

QUARTER BRIDGE

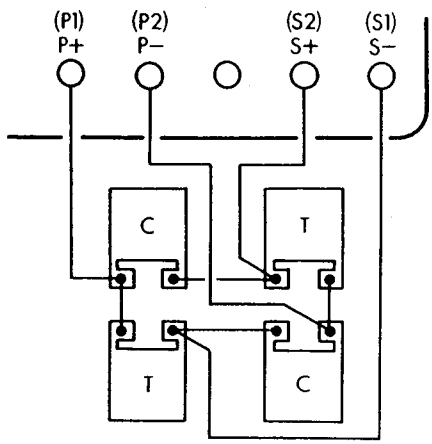


2C. GAGES ADJACENT

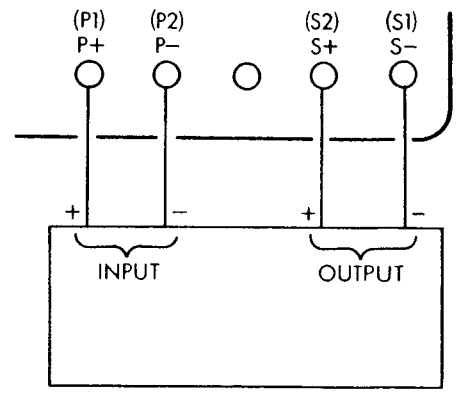


2D. GAGES APART

HALF BRIDGE



2E. GAGES



2F. TRANSDUCER

FULL BRIDGE

FIGURE 2: INPUT CONNECTIONS

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The best approach is to get in the habit of ALWAYS using three leads – don't guess it doesn't matter in a particular test and then get erratic data.

QUARTER BRIDGE – Common lead (Figure 2B)

While this approach may economize in wiring, it may be unreliable because, if any gage shorts to ground, **all** inputs connected to the indicator may give erroneous data. Thus, the approach is generally not recommended; however, there may be situations in which wire economy is essential. Properly done, net temperature effects on the lead wires can be minimal.

To use a common compensating gage in the test environment, wire as in Figure 2B: the total lead length between tie-point "Z" and the SB-1 should be the same for all gages including the compensating or dummy gage; a portion of this length will usually be between the gage and point "Z", with balance between the gage and the SB-1.

To use the dummy gage in the indicator (rather than a compensating gage), delete the COMP gage – in its place connect a wire (length as above) directly from "Z" to the D_{120} or D_{350} binding post on the indicator.

If the indicator doesn't have a dummy, connect a dummy gage or resistor between the SB-1 DUMMY binding posts and run the above lead to the D binding post on the SB-1.

HALF BRIDGE

"Half Bridge" operation indicates that two gages are bonded to the specimen; both may be active with strain or one may be in an unstressed area adjacent to the active gage and thus becomes a compensating gage. (The latter would rarely be done except tests involving high temperature gradients; with a uniform temperature over the test specimen a common compensating gage is more economical – see Quarter Bridge, above.)

Figure 2C is the customary circuit. Figure 2D is more susceptible to temperature gradients on the lead wires and therefore may be less stable.

FULL BRIDGE

See Figures 2E and 2F, which should be self-explanatory.

4.5 OBTAINING READINGS

4.5.1 Strain Indicator BRIDGE Selector

Note: Where more than one bridge type is used in the same SB-1, follow the specific instruction for the Bridge Type corresponding to each position of the CHANNEL Selector Switch.

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Full Bridge:

Set the BRIDGE Selector Switch on the Indicator to FULL ("4" on BAM-1).

Half or Quarter Bridge:

Set the BRIDGE Selector Switch on the Indicator to HALF ("2" on BAM-1).

4.5.2 Strain Indicator BALANCE Control

a. **P-350** – Turn BALANCE control about five turns from ccw stop and lock it (if there is a counting knob on this control, set it to 500).

b. **P-350A** – Set the BALANCE toggle switch at OFF (down).

c. **V/E-20 or V/E-20A** – Set BALANCE – COARSE at "0" and BALANCE – FINE at 500, and lock it.

d. **BAM-1** – Set BRIDGE Balance control at 500.

4.5.3 Setting BALANCE Controls on SB-1 (under "no load")

a. **P-350 or P-350A** – Set digital counter on P-350 to −0000. Set SB-1 to CHANNEL 1; turn corresponding BALANCE control on SB-1 until Null Meter on P-350A is exactly centered. Repeat for remaining nine channels.

b. **V/E-20 or V/E-20A** – Set BRIDGE selector on X1 range. Set SB-1 to CHANNEL 1; turn corresponding BALANCE control on SB-1 until the digital Display indicates 000. Check SPAN within CALIB position and reset SB-1 BALANCE (and V/E-20 SPAN) as required in the normal manner. Repeat BALANCE procedure for remaining channels (the SPAN setting will be the same for all channels).

c. **BAM-1** – Turn GAIN fully clockwise. Check Amplifier BALANCE as usual, then turn BDG PWR to ON. Set SB-1 to CHANNEL 1; turn corresponding BALANCE control on SB-1 to center BAM-1 Meter. Repeat for remaining channels.

d. **P-3500** – Set P-3500 coarse BALANCE switch to 0 and fine BALANCE control to 5.00 (mid-point). Set SB-1 to CHANNEL 1 and adjust SB-1 BALANCE to achieve a +0000 reading on the P-3500 LCD display. Repeat for remaining SB-1 channels.

4.5.4 Taking Strain Readings

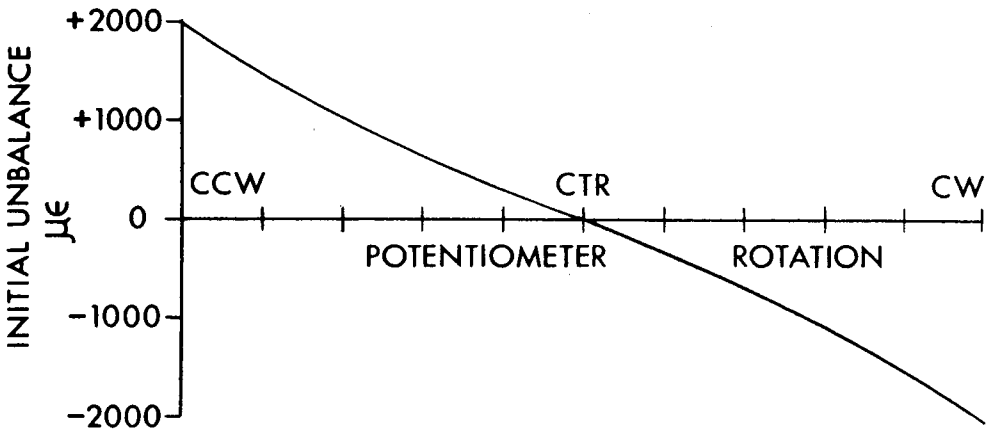
Readings can now be taken under various load conditions in the normal manner for the indicator in use, selecting the desired strain gage circuit with the CHANNEL Selector Switch.

If more than one SB-1 is used (they are all connected in parallel to the indicator – see paragraph 4.3), all CHANNEL switches should be set at OPEN except the one containing the circuit to be measured.

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4.5.5 Range of the Balance Potentiometers

It is noted that the range of the BALANCE potentiometers is dependent on both (1) the effective resistance in series with the potentiometer wipers and (2) the value of the bridge resistors attached between terminals P+, S+ and P– (P1, S2 and P2).



In the SB-1, the resistor in series with the potentiometer wipers is a single 30 000Ω resistor for all circuits; at the center of travel, one quarter of the potentiometer resistance (50 000Ω) must be added for a total of 42 500Ω. Thus, the resolution of the balance controls is best near center of travel where it is generally used. The following curve shows the approximate performance of these controls (for a 120Ω reference bridge, as in P-350 and P-350A).

Should it be desired to increase the ±2000$\mu\epsilon$ range, the 30 000Ω resistor can be replaced with a somewhat smaller one (it should be a Vishay resistor or a wire-wound type); half the value will double the range, etc.

The balance range is also directly proportional to the bridge resistance. Obviously, then, in full-bridge operation the balance range will be approximately ±2000$\mu\epsilon$ for a 120Ω bridge, ±6000 for a 350Ω bridge, etc. On half- or quarter-bridge operation, the range is dependent on the value of the "dummy half-bridge" between P–, S+ and P+ (P1, S2 and P2). For the P-350A Strain Indicator this is 120Ω, yielding a balance range of ±2000$\mu\epsilon$. For the V/E-20A and BAM-1 the "dummy" half-bridge is 400Ω, yielding a range of ±6600$\mu\epsilon$. For the P-3500 Strain Indicator this is 350Ω, yielding a balance range of ±6000$\mu\epsilon$.

4.6 If the unit does not operate according to the description outlined in this section, please contact the manufacturer for assistance.

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5.0 MAINTENANCE

Within the warranty period, you should not attempt any repairs or maintenance to the SB-1 unit. In the event of a possible malfunction during this period, contact our local sales representative or the plant. Since the SB-1 is a passive device, no regular maintenance should be necessary.

5.1 CONTACTS

Should the repeatability of readings deteriorate, and provided you are assured there is no change in the input to the instrument (two-wire quarter-bridge circuits are extremely sensitive to temperature changes and often give effects similar to a defective switch), the most likely cause would be excessive corrosion on the silver contacts of the channel selector switch. In this event, the unit should be disassembled by removing the instrument from its case (four Phillips screws at the corners of the front panel). Clean the contacts with Stoddard solvent (or carbon tetrachloride, followed by alcohol) using a "Q-tip". Relubricate contact surfaces with a light film of white unmedicated Vaseline (Blue Seal).

5.2 SCHEMATIC

The electrical schematic of the SB-1 unit is included as page 15 of this manual.

5.3 OPTIONS

5.3.1 Counting Balance Knobs, Model SB-1K

Concentric-dial counting knobs are available at time of purchase for the balance controls on the SB-1, replacing standard knobs. This option facilitates the repeat settings of these controls for measurements taken at different times on the same strain gage installation.

5.3.2 Locking Balance Knobs, Model SB-1L

Locking Balance knobs are also available at the time of purchase for the balance controls. This option enables the balance knobs to be set and then locked in order to prevent unintentional rotation and erroneous data.

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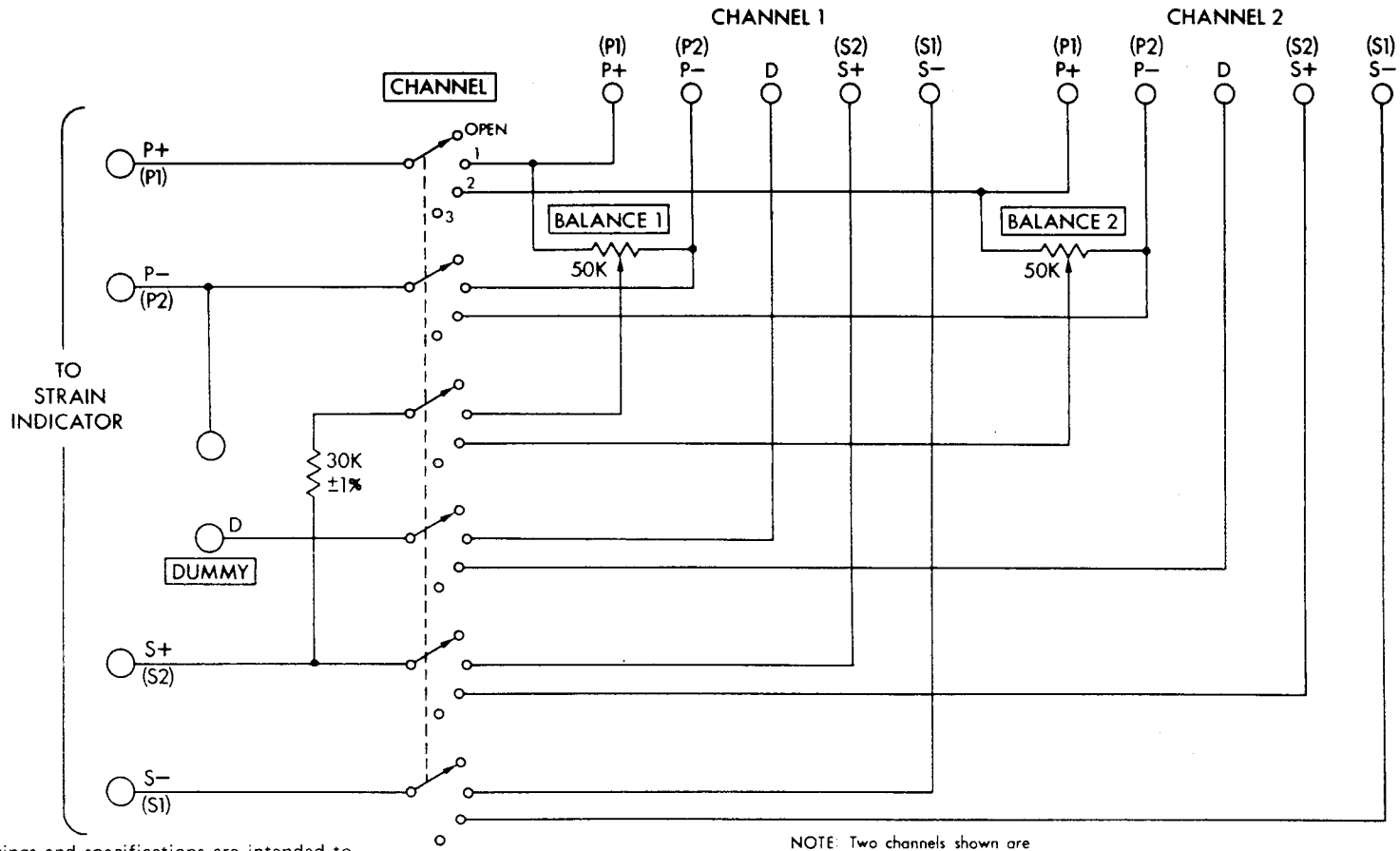
5.4 PARTS LISTS

The following maintenance and repair parts are available:

DESCRIPTION	PART NO.
Output and Dummy Binding Posts:	
Red (01-1001-0-0312) Concord	13X200150
Black (01-1001-0-0310) Concord	13X200151
White (01-1001-0-0319) Concord	13X200152
Input Push-Posts:	
Red	12X700072
Black	12X700070
White	12X700079
Balance Potentiometers (50 K)	152-012732
Balance Resistor (30 K)	15X200059
Channel Selector Switch (after Serial No. 8335)	10X500132
Knob for Balance Potentiometers (Raytheon 70-2-2)	13X400026
Knob for Channel Selector Switch	13X400088

5.5 For repairs or replacements involving other than the above, please write or contact the factory for instructions.

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NOTE: Two channels shown are typical of ten channels.

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MEASUREMENTS GROUP, INC.

SCHEMATIC
SWITCH & BALANCE UNIT
SB-1

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