DAYTRONIC

MODEL

3178

STRAIN GAGE CONDITIONER

INSTRUCTION MANUAL

3000
Instrument Series

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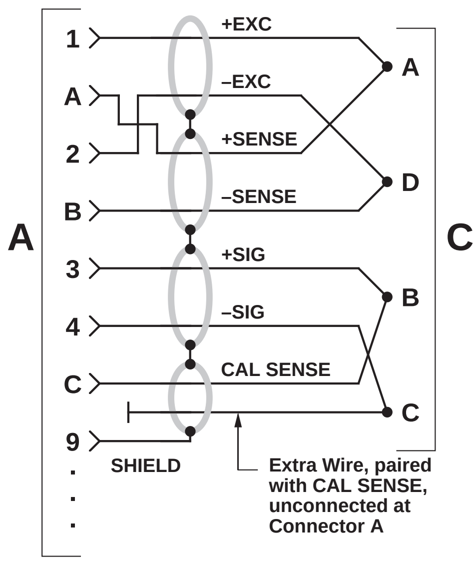
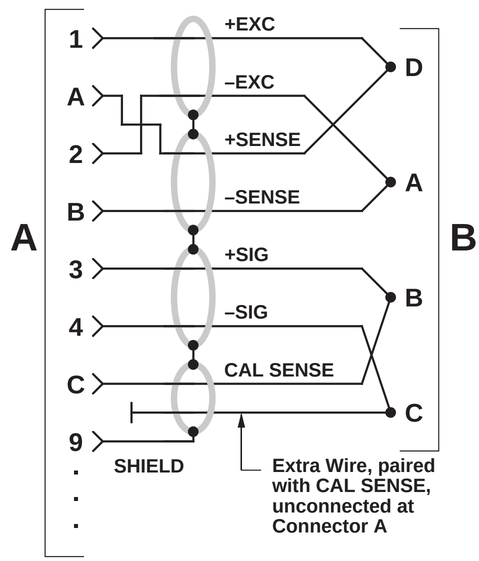
Correction
to Model 3178 Instruction Manual, v. SB.5.1

The *I/O Wiring Data* in Fig. 4 of this manual does not give the correct **shield pairing** of cable wires, which is shown in the revised diagrams below and on the following page:

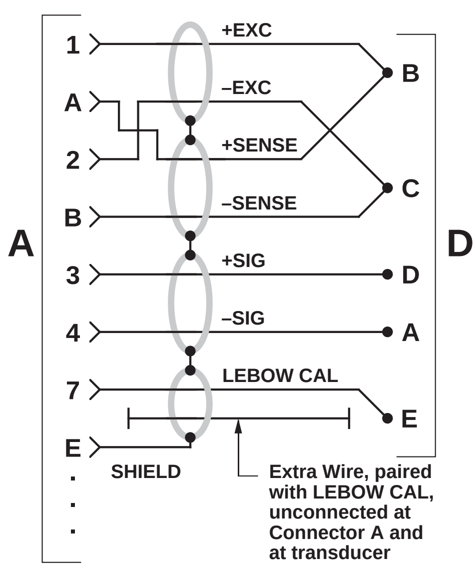
Daytronic 400 Series Transducer Connections



Daytronic 500 Series Transducer Connections



Lebow 1600 Series Rotary Transformer Torque Transducer Connections

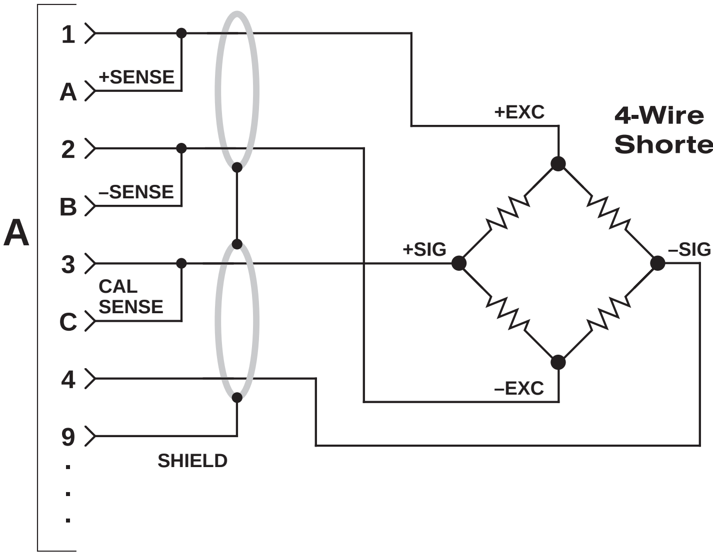


(cont'd)

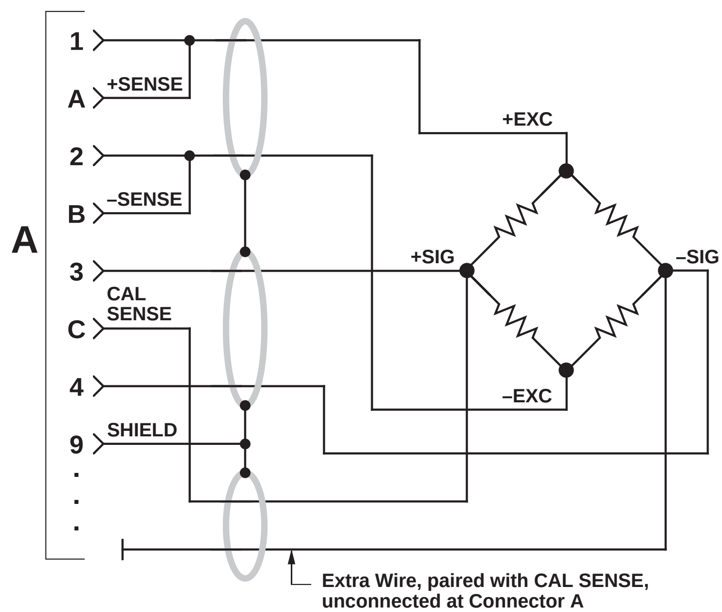
Correction
to Model 3178 Instruction Manual, v. SB.5.1 *(cont'd)*

Daytronic 3X78 Instrument to Generalized Strain Gage Transducer Showing CAL SENSE Connection

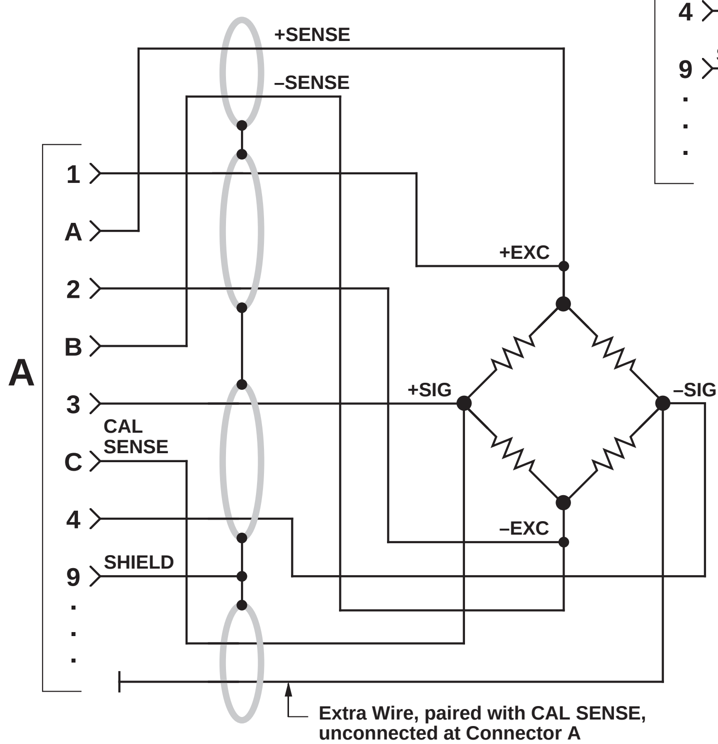
4-Wire Configuration for Cables Shorter Than 20 Feet



6-Wire Configuration for Cables Shorter Than 20 Feet



8-Wire Configuration for Cables Longer Than 20 Feet



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DAYTRONIC

MODEL 3178 STRAIN GAGE CONDITIONER

INSTRUCTION MANUAL

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LIST OF TABLES

PLEASE NOTE: Sections 6 and 7, Figures 8 and 9, and Table 2 have been removed from this manual.

If you need information regarding specific 3178 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.

Daytronic Corporation

INSTRUCTION MANUAL
MODEL 3178 STRAIN GAGE CONDITIONER

1. DESCRIPTION

The Model 3178 is a conditioner-amplifier for use with resistance strain gage transducers in applications which require an ac excitation voltage. It supplies a 3.28 kHz precision amplitude-regulated excitation, remotely sensed, to the transducer. The instrument uses a phase-sensitive carrier amplifier-demodulator design so that both direction and magnitude of the applied force are determined. The 3178 contains the necessary balancing and calibration controls and conditions/amplifies the applied input to a standard Five-Volt Data Signal Level which is the output analog signal level of *3000 Series* Instruments. Two analog outputs, having low-pass cutoff frequencies of 2 Hz and 400 Hz, are provided. The filtered outputs provide for averaging or smoothing of signals containing noise or other unwanted dynamic components which are periodic in nature. Filtering removes these dynamic components so that stable digital indication and precise *jitter-free* control action can be obtained. The Model 3178 is shown in Figure 1 and the specifications are given in Table 1.

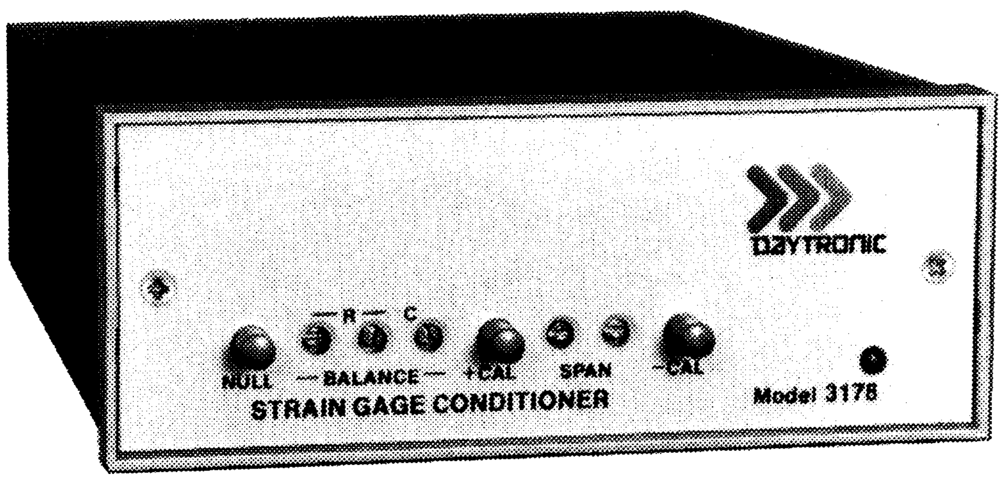


Figure 1. Model 3178 Strain Gage Conditioner

Table 1. Specifications

Transducers: 4-arm bridges, 90 to 1000 ohms. nominally 0.5 mv/v to 5 mv/v, full scale.

Cables: 4-, 5-, or 7-wire, depending on application; 1000 feet maximum length.

Bridge Excitation: Regulated 3.28 kHz ac; nominally 2 vac.

Balance Adjustments: 10-turn coarse and fine; will balance 1.5 mv/v initial unbalance.

Span Adjustments: 10-turn coarse and fine; 0.5 to 5 mv/volt, full scale.

Analog Outputs: Two analog outputs available; 0 to ±5 volts with 50% overrange, 5 milliamperes maximum. Bandpass is dc to 2 Hz or dc to 400 Hz. Active low-pass filters provide for rolloff of 60 dB per decade above cutoff frequency. Full-scale slew time is 1.4/f seconds, where f is the cutoff frequency.

Output Ripple and Noise: 0.15% of full scale (rms) maximum for 400-Hz output; 0.02% of full scale (rms) on 2-Hz output.

Accuracy: 0.05% of full scale.

Dimensions: 1.7 x 4.41 x 8.5 (HWD inches).

Operating Temperature Range: 0 to +130 degrees F.

Power Requirements: 105 to 135 volts ac, 50 to 400 Hz at 5 watts maximum.

The Model 3178 is useful in applications involving transformer coupling to the strain gage bridge (for example, rotary transformer torque sensors) and in certain applications that require high sensitivity with optimum *signal-to-noise* characteristics. Carrier amplifiers offer higher sensitivity than dc amplifiers and, since they respond only to the modulated carrier frequency, they reject certain extraneous voltages that can cause error in dc systems. These error sources include *thermocouple* or *galvanic* voltages in the cable-connector system, *homopolar* voltages from rotating machinery, *low-frequency* pickup, and *1/f* noises of various origin. Consequently, the Model 3178 is an excellent instrument choice when special noise environment conditions and the need for amplification of low-level signals exist.

Calibration of the 3178 is accomplished by the conventional shunt technique, using an internally installed calibration resistor. Front-panel CAL buttons provide for shunt calibration in both the positive and negative realms. An internal symmetry control provides independent adjustment of negative realm sensitivity for transducers that do not have symmetrical slope characteristics. Positive-realm calibration can be remotely checked by means of *Remote Cal* terminals on the instrument I/O connector.

The 3178 Strain Gage Conditioner is also available in two additional forms. The Model 3278 contains a Digital Indicator to view the analog output of the conditioner. The Model 3378 contains a Limit section (in addition to a Digital Indicator) that provides *High/OK/Low* indications and outputs. The Digital Indicator and Limit features are standard to all *3000* Instruments and are covered in separate instruction manuals.

2. INSTALLATION AND CABLING

The following paragraphs provide the instructions for instrument installation and cabling.

Mounting. The *3000 Series* Instruments can be operated as bench-top units or they can be rack- or panel-mounted. Clearance dimensions for a bench-mounted instrument are given in Figure 2. Panel cut-out dimensions for panel mounting are also shown in Figure 2. Up to four *3000 Series* Instruments can be mounted in a 19-inch rack using the 1.75-inch high Model 3004 Rack Adaptor. Rack-mounting dimensions are also given in Figure 2. To panel mount an instrument, proceed as follows. Refer to Figure 3.

IMPORTANT: The unit is shipped with two **spacer washers** on the securing screws of the rear-panel I/O Connector. When **panel-mounting** the unit, you MUST REMOVE THESE WASHERS, so that the printed-circuit board may move forward about 1/8" during Step (f).

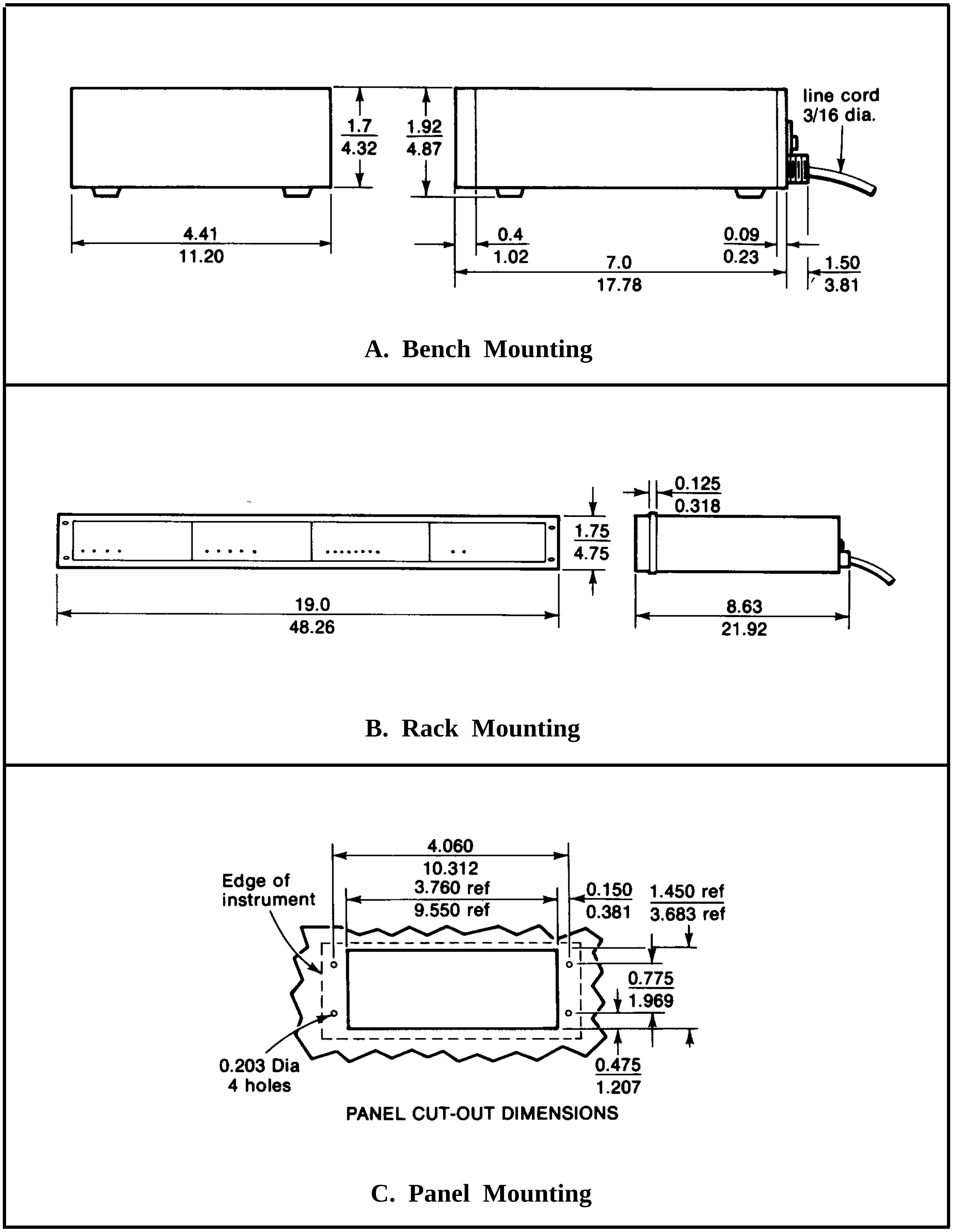


Figure 2. Instrument Mounting Dimensions

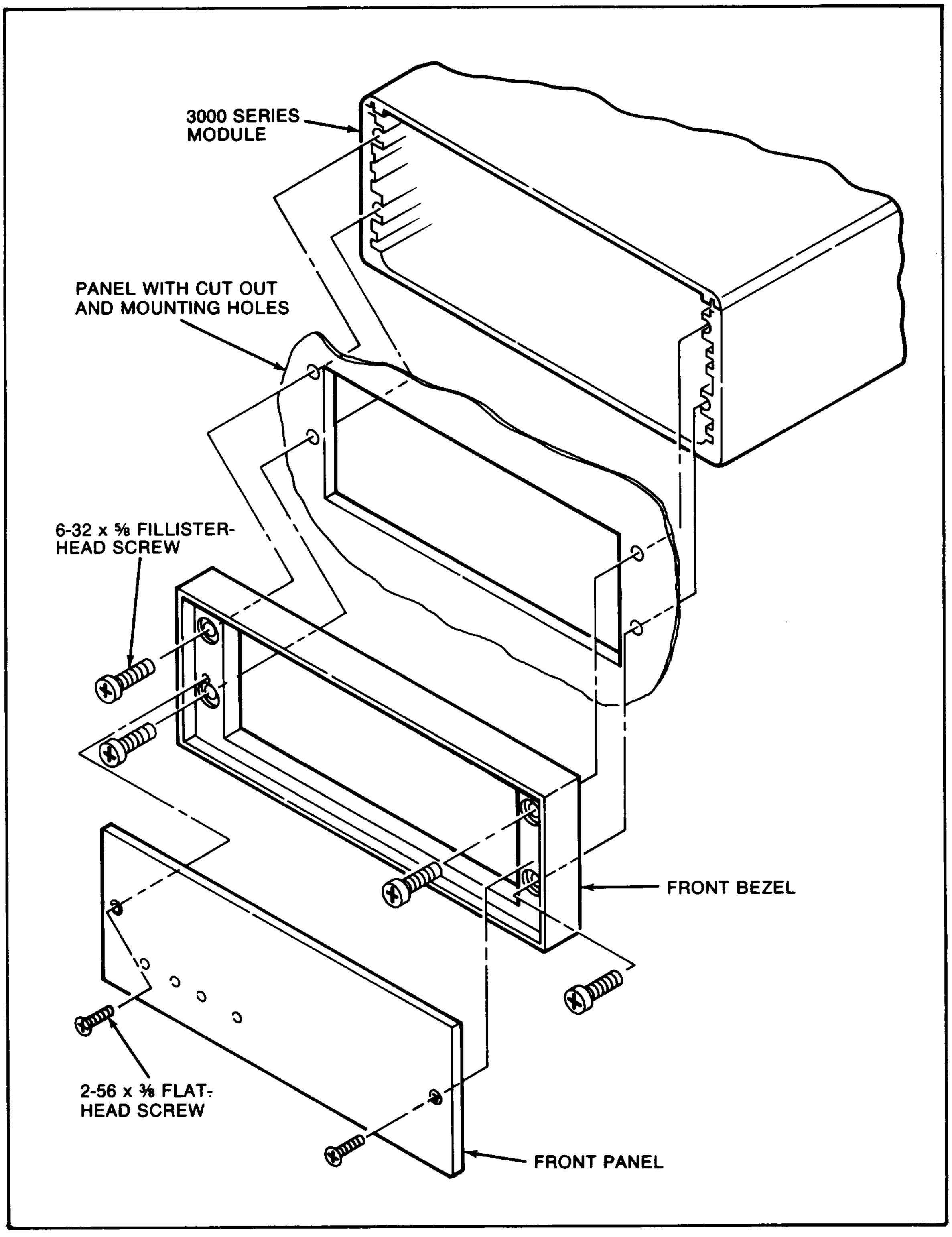


Figure 3. Instrument Panel Mounting

(a) Remove the front panel by removing the two 2-56 x 3/8 flat-head screws.

(b) Remove the front bezel by removing the four 6-32 x 5/8 fillister-head screws.

(c) Make the panel cutout and drill the screw clearance holes indicated in Figure 2. The front bezel can be used as a template to define the rectangular cutout and locate the clearance holes.

(d) Hold the instrument enclosure behind the panel and reattach the front bezel to the enclosure from the front of the panel with the four remaining screws.

(e) Reinstall the front panel.

(f) Tighten the two securing screws of the rear-panel I/O connector to ensure that the connector is seated and that the conditioner printed-circuit board is pushed fully forward so that the front-panel screwdriver adjustments and buttons are accessible. These screws give approximately 1/8-inch of adjustment; consequently, this is the maximum panel thickness which should be used.

CAUTION

Do not overtighten the connector securing screws or resultant damage may occur to the printed-circuit board.

AC Power Connection. To protect operating personnel, the *3000 Series* Instruments are equipped with a three-conductor power cord. When the cord is plugged into the appropriate receptacle, the instrument is grounded. The offset pin on the power cord is ground. To maintain the safety ground when operating the unit from a two-contact outlet, use a three-prong to two-prong adaptor and connect the green pigtail on the adaptor to ground.

To prepare the instrument for operation, connect the power cable to a 105-135 volt ac, 50-400 Hz power source. The instrument can use up to 5 watts of power.

Calibration Resistor. If a fixed resistor is shunted across one arm of a strain gage bridge, it produces an unbalance equivalent to that of a particular value of mechanical input. If this *Equivalent Input* value is accurately known, it can be used as a reference point for shunt calibration of the system. Upon completion of installation of the transducer and its associated cabling, the user can:

(1) Perform an overall *dead weight* calibration using a precisely known value of mechanical input. The calibration can then be transferred to the installed calibration resistor for convenience in subsequent checking.

(2) Replace the installed calibration resistor with one (or an equivalent resistance value) supplied by the transducer manufacturer to achieve a precisely known *Equivalent Input* allowing the instrument sensitivity to be adjusted correctly.

(3) Determine the *Equivalent Input* value for the installed calibration resistor, knowing the transducer sensitivity, and adjust the instrument sensitivity accordingly.

A precision 59-kilohm calibration resistor is installed in the 3178 at the factory. The installed resistor can usually be used even though the transducer calibration data mentions some other resistance value. In Section 3 of this manual, the techniques described above are demonstrated. If, however, the installed value of calibration resistor is not appropriate for the transducer and measurement range to be used, the 59-kilohm resistor should be replaced at this time. The calibration resistor is mounted on terminals located at the front edge of the conditioner printed-circuit board. It can be accessed by removing the instrument front panel. **Note:** Lebow *1600 Series* Rotary Transformer Torque Transducers are supplied with the appropriate calibration resistor integral to the transducer. When this type of transducer is used with the 3178, it is not necessary to remove the 59-kilohm resistor internal to the instrument. The Lebow calibration resistor can be appropriately connected to the 3178 calibration circuit via the transducer cabling. Refer to Figure 4 and the following section.

Transducer Cabling. Cabling to the transducer is accomplished via the supplied instrument I/O connector. The I/O connector pin numbers and functions are given in Figure 4. When Daytronic 400 or 500 Series Transducers are used, factory-wired cables are available as shown in Figure 4. The Daytronic 82S Cable is for use with Lebow *1600 Series* Rotary Transformer Torque Transducers. This cable provides connection from the 3178 calibration circuit to the calibration resistor which is integral to the *1600 Series* transducers, without requiring the removal of the 3178 calibration resistor.

When user-fabricated transducer cabling is used, it should take the form of either the 4-, 5-, or 7-wire cable configuration shown in Figure 4. The 4-wire configuration should be used when overall *deadweight* calibration is the method used and the required cable length is less than 20 feet. The 5-wire configuration should be used when the instrument is to be calibrated by achieving a precisely known *Equivalent Input* value through the use of a shunt calibration resistor supplied by the transducer manufacturer and when the required cable length is less than 20 feet. The 7-wire configuration should be used with cable lengths longer than 20 feet since the excitation voltage is sensed and regulated at the transducer and optimum shunt calibration can be achieved.

Remote Calibration Check. The instrument can be placed in the calibration mode (positive realm only) by shorting pins 5 (Signal Common) and 8 (Remote Cal) of the rear-panel I/O connector. Figure 4 indicates three methods of remotely entering the calibration mode (external switch, transistor, or TTL source). The *Remote Cal* function provides a convenient method of periodically monitoring calibration of the instrument in the positive realm.

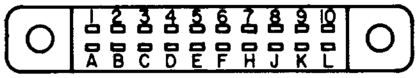
Master/Slave Connections. When more than one 3178 (or a combination of 3178 or 3130 LVDT Conditioners) is being used in a measurement setup (instruments are continuously mounted or the transducer cabling is in a common conduit or raceway), beat frequencies may be produced from the 3-kHz oscillators used in the instruments to develop the excitation. To prevent beat frequencies from occurring, one unit can be designated the *master,* and the remaining units can be driven from the oscillator contained in the *master* unit. The remaining units are designated as slave instruments. To perform *master/slave* wiring, refer to Figure 4.

Analog Outputs. Two analog outputs are available at the instrument I/O connector, with each output having a different passband: dc to 2 Hz and dc to 400 Hz. The cutoff frequencies are achieved with active low-pass filters. When the dc-to-2 Hz output is used, a trade off is made between noise elimination and increased time-to-answer or slew time. Each output has a 60-dB rolloff a decade from the cutoff frequency. The filter characteristics are given by the following equations.

See the CORRECTION to Fig. 4 in the front of this manual.

Fig. 4 I/O Wiring Data

DAYTRONIC 3X78 INSTRUMENT I/O CONNECTOR W/PIN DESIGNATIONS
(X=1,2, or 3, e.g. 3178,3278,3378)

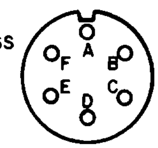


AMPHENOL 225–21021–103 REARVIEW

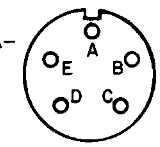
A

PIN		PIN	
1	+EXCITATION	A	+SENSE
2	–EXCITATION	B	–SENSE
3	+SIGNAL INPUT	C	CALIBRATION SENSE
4	–SIGNAL INPUT	D	OSC. DISABLE
5	SIGNAL COMMON	E	TRANSDUCER CABLE SHIELD (LEBOW 1600 SERIES ONLY)
6	OSC. INPUT	F	OSC. OUTPUT (LEBOW 1600 SERIES ONLY)
7	LEBOW 1600 CAL.	H	ANALOG OUTPUT, ±5V–DC TO 2HZ
8	REMOTE CALIBRATION	J	ANALOG OUTPUT, ±5V–DC TO 400HZ
9	OUTPUT SHIELD	K	NC
10	OUTPUT SIGNAL COMMON	L	NC

B
AN 3057–6
AMPHENOL 97–3106A–14S–6S
C
BENDIX PT02E–10–6S
BURNDY BT06AC–10–6S

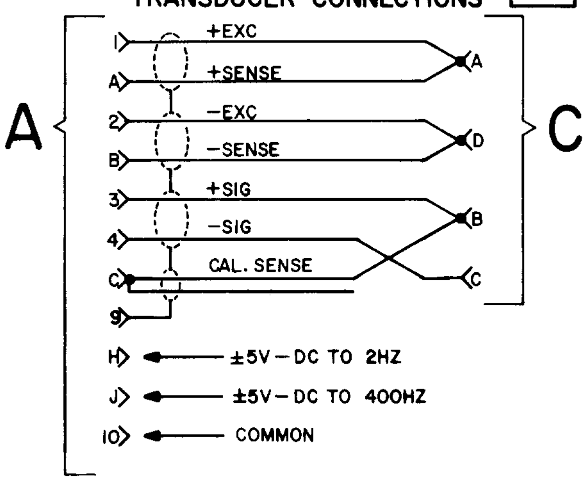


D
AMPHENOL 97–3106A–14S–5S, AN 3057–6

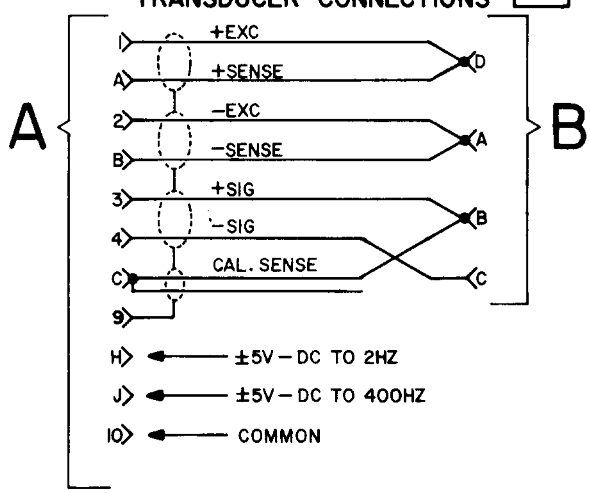


DAYTRONIC FACTORY WIRED CABLES

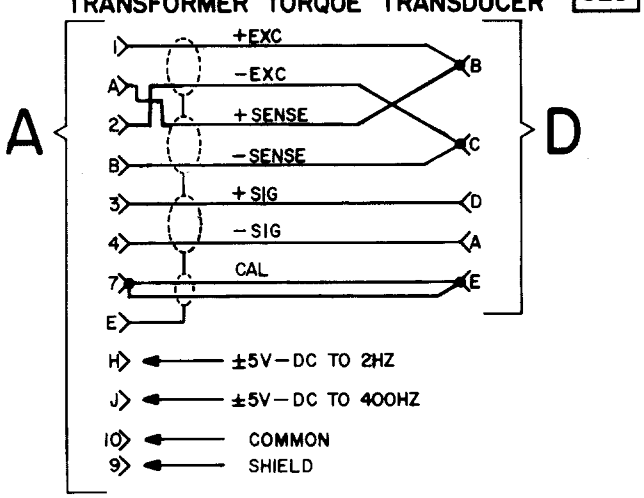
DAYTRONIC 400 SERIES TRANSDUCER CONNECTIONS **80S**



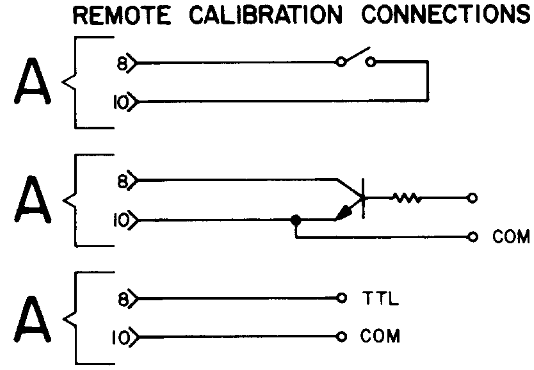
DAYTRONIC 500 SERIES TRANSDUCER CONNECTIONS **81S**



LEBOW 1600 SERIES ROTARY TRANSFORMER TORQUE TRANSDUCER **82S**

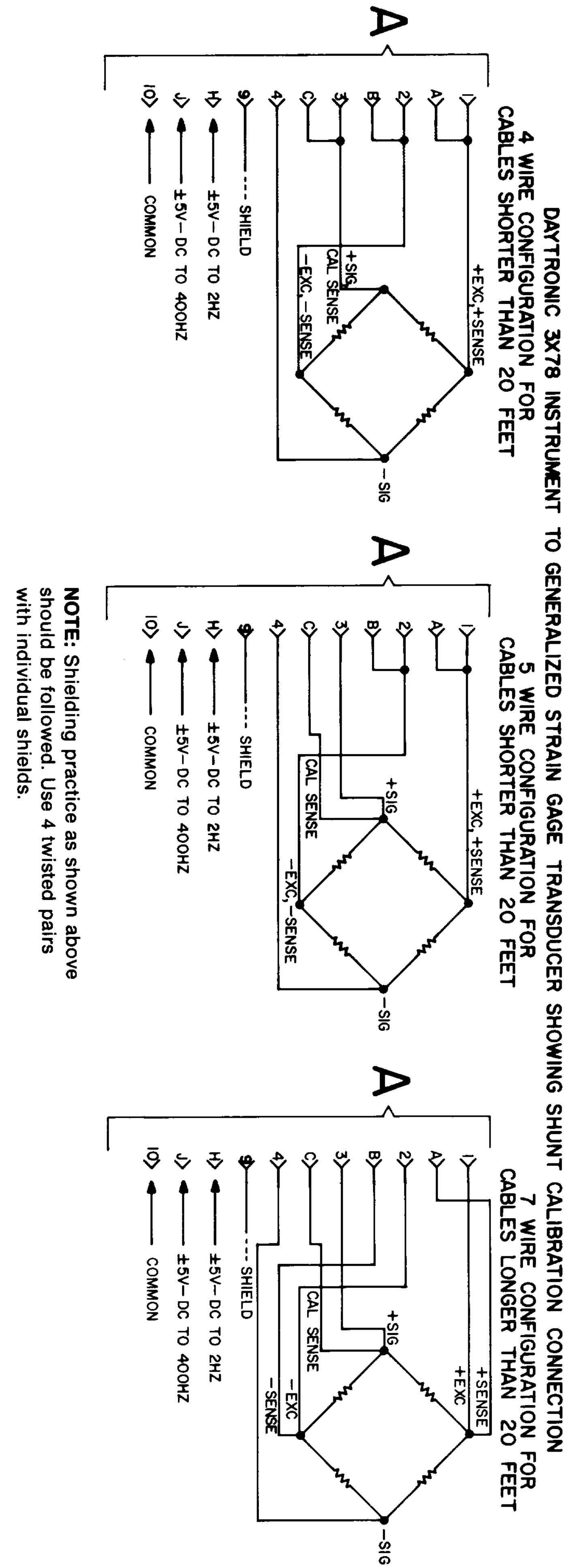


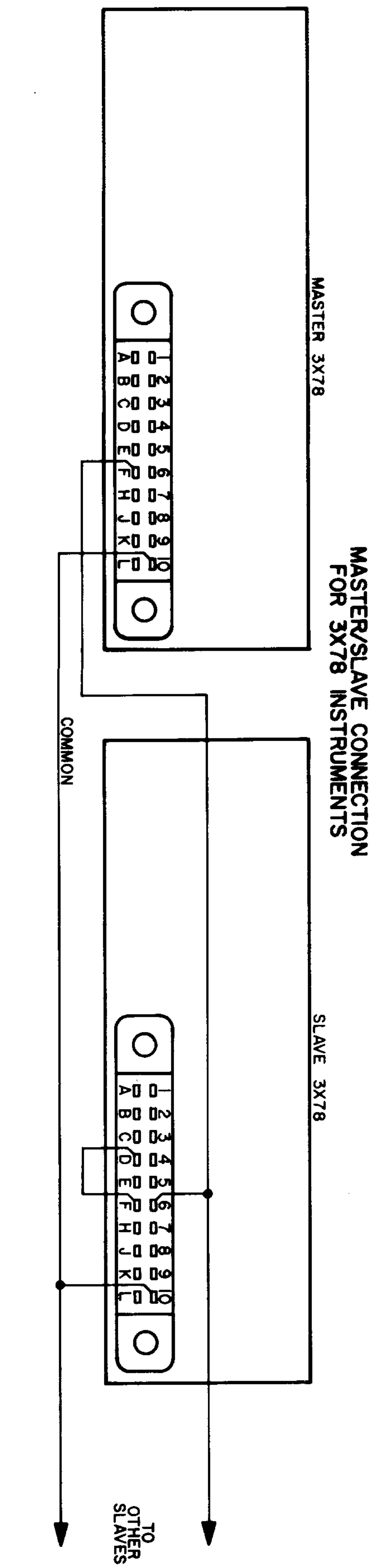
REMOTE CALIBRATION CONNECTIONS



See the CORRECTION to Fig. 4 in the front of this manual.

Fig. 4 (cont'd)





A_{out} @ f_0 = 0.7 A_{in}
A_{out} @ $10f_0$ = 0.001 A_{in}
T = $1.4/f_0$
where A_{out} = output amplitude
A_{in} = input amplitude
f_0 = selected cutoff frequency
T = time-to-answer in seconds (output of filter within 0.1% of final value after step function is applied).

3. CALIBRATION

This section contains the instructions for calibrating the 3178. Included is a functional description of the instrument front-panel (see Figure 5). To perform calibration, proceed as follows.

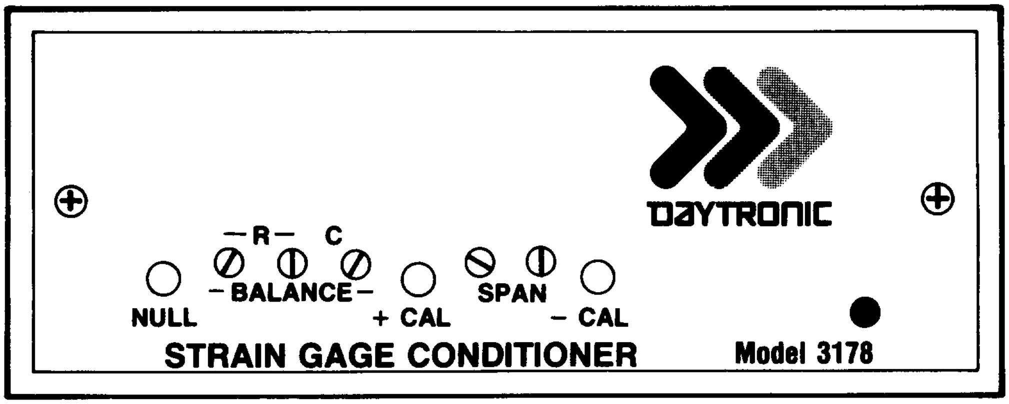
(a) Turn power ON by placing the rear-panel slide switch in the ON position. The front-panel indicator should light to indicate the application of ac power. Allow 5 minutes of warmup for stabilization of transducer characteristics.

(b) Set the *Fine* and *Coarse* SPAN controls fully clockwise.

(c) With the transducer unloaded, press the NULL button and adjust the C BALANCE control to obtain the minimum (least positive or most negative) output reading. In some instances, an integral digital indicator will be used to display the conditioner output (Model 3278 or 3378). When only the conditioner is supplied (3178), an external indicator must be used to monitor the conditioner output.

(d) Release the NULL button and bring the output reading to zero with the *Fine* and *Coarse* R balance controls.

(e) Load the transducer in the positive direction with a convenient *dead weight* value which is greater than one half of full scale. Then remove the 3178's front panel (one small flat-head screw near each edge) to access both the SYMMETRY and PHASE adjustments. Adjust the PHASE control (the one on the *extreme right),* until a *maximum output* value is obtained. Then replace the front panel. (Once set for your transducer, this PHASE ADJUSTMENT step need not be repeated unless a great change in cable length–or capacitance–is required). Adjust the *Coarse* and *Fine* SPAN controls until



R and C BALANCE Controls: These controls are used to set the output to zero when the transducer is unloaded.

NULL Pushbutton: This pushbutton is pressed when nulling the transducer bridge with the R and C BALANCE controls. It provides for non-synchronous demodulation of the carrier for balancing purposes. After a minimum reading is obtained on the display device by adjusting the C control, the pushbutton is released and the output is zeroed using the R controls.

SPAN Controls: The *Coarse* and *Fine* SPAN controls are used to set the output to the *dead weight* value when *dead weight* calibration is used. They can also be used to set the output to the *Equivalent Input* value when the CAL (+ or –) button is pressed.

CAL Pushbuttons: The + and – CAL pushbuttons provide for shunt calibration in the positive and negative realms, respectively. They are used in conjunction with the SPAN controls to calibrate the instrument. When both positive and negative realm calibration is required, the +CAL button is used in conjunction with the SPAN controls and the –CAL button is used with the internal *Symmetry* adjustment.

Figure 5. Front-Panel Description

the output value equals the *dead weight* value. Remove the *dead weight*, and then press the +CAL button, noting the indicator reading obtained. In future calibrations, you need only press the +CAL button and adjust the SPAN controls until you obtain the previously recorded *dead weight* reading.

(f) If the transducer is to be also used in the negative realm, load the transducer in the negative direction with the same *dead weight* value as used in step (e) and confirm that the *dead weight* reading obtained is the same as that of step (e). If not, see steps (g) thru (i).

(g) An internal *Symmetry* adjustment is provided to compensate for transducers that do not have symmetrical sensitivity characteristics. This adjustment is factory set assuming symmetrical characteristics. If step (f) indicates that a field adjustment is necessary, proceed as follows.

(h) Remove the front panel by removing the two 2-56 flat-head screws to obtain access to the *Symmetry* adjustment.

(i) With the transducer loaded as in step (f), adjust the *Symmetry* control (just to the right of the –CAL button) to obtain a *dead weight* reading equal to that obtained in step (e).

(j) If *dead weight* calibration is not practical and the transducer manufacturer has supplied a calibration resistor (or resistor value), install the recommended calibration resistor.

(k) Repeat steps (b) thru (d). Now press the +CAL button and adjust the SPAN controls until the instrument output is equal to the *Equivalent Input* value simulated by the installed resistor.

(l) If a negative *Equivalent Input* value is also provided (as in the case of Lebow *1600 Series* transducers), press the –CAL pushbutton and confirm that the negative value can also be obtained with the same setting of the *Coarse* and *Fine* SPAN controls. If not, adjust the *Symmetry* control to obtain the negative *Equivalent Input* value.

(m) If *dead weight* calibration is not practical and the transducer calibration data is unknown, the *Equivalent Input* value for the factory-installed calibration resistor can be approximated as follows, assuming that the mv/v sensitivity rating of the transducer and the bridge resistance are known.

$$X = \frac{25000\ R_b}{K\ R_c}$$

where X = Equivalent Input, % of full scale
R_b = bridge resistance, ohms
K = transducer sensitivity, mv/v full scale
R_c = calibration resistance, ohms (59 K installed)

Sample Calculation: Assume that K = 3.000 mv/v for a 5000-pound load cell (fullscale) with a bridge resistance of 350 ohms.

$$X = \frac{25000 \times 350}{59000 \times 3} = 49.4\% \text{ of full scale} = 2472 \text{ pounds}$$

4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the Model 3178 works by using a simplified block diagram. This section is not intended to provide a detailed explanation of electronic circuits for personnel untrained in electronic technology. However, it provides an adequate overview of operation for those familiar with basic electronic circuit operation. Throughout the following, refer to Figure 6.

Power Supplies. Primary power (115 volts ac, 50-400 Hz) is applied to the instrument by means of a rear-panel ac connection point and the supplied 3-conductor power cord. A rear-panel slide switch is used to turn ON primary power. Overload protection is provided by a 0.25 ampere fuse mounted near the ac connection point. When the slide switch is ON, primary power is applied to the power transformer which provides the necessary power-line isolation and the low ac voltages required to develop the regulated dc voltages used in the 3178. The secondary of the power transformer has a grounded center tap, and a Diode Bridge functions as two full-wave rectifiers to produce ±9 volts regulated dc. Two three-terminal integrated-circuit *Regulators* are used to develop these regulated voltages. The reference terminal of each *Regulator* is biased with one or two diodes to make certain that a minimum regulated voltage of 9 volts is achieved. The proper diode biasing is accomplished at factory check out.

A dc reference voltage of +2.5 volts dc is further developed from regulated +9 volts by the use of a third three-terminal *Regulator.* This precision dc reference is used to control the amplitude of the ac excitation signal and is further discussed in a following paragraph.

The -9 volts regulated is used to light the front panel indicator (LED) which indicates the application of ac power to the instrument.

The + unregulated voltage from the diode bridge is routed to the Digital Indicator and HI/LO Limits circuit boards when these items are supplied (Models 3278 and 3378). It is used to develop +5 volts regulated for the TTL logic employed in these circuits. Refer to the Digital Indicator and HI/LO Limits *Instruction Manuals.*

The secondary of the power transformer also supplies 5 volts ac to the Digital Indicator circuit board when the Model 3278/3378 is supplied. This ac voltage is used to develop unregulated +6 volts. Refer to the Digital Indicator *Instruction Manual.*

AC Excitation. The 3.28 kHz ac excitation is produced with a *Wein Bridge Oscillator.* The oscillator output is applied to a full-wave rectifier to obtain a dc voltage proportional to the ac amplitude of the oscillator output. The rectifier output is applied to the inverting input of an *Integrating Amplifier.* The non-inverting input of the amplifier is connected to the precision *Reference* voltage (+2.5 volts dc). If the amplitude of the oscillator varies, the output of *the Integrating Amplifier* changes the resistance of an *Automatic Gain Control* element (FET) to return the oscillator amplitude to its nominal value of 2 volts ac. The *Integrating Amplifier* thus serves as an error amplifier, and the integrating element (capacitor) deletes 60-Hz ripple.

A pair of operational amplifiers is used as a phase splitter to eliminate the ground reference of the oscillator signal so that the transducer bridge is floating. This reduces signal-carrier common-mode voltages to a negligible value. Both plus and minus *Sense* wires are returned from the transducer bridge to the instrument to sense and regulate the excitation voltage at the transducer (Figure 6 shows the 3178 connected to the transducer via a 7-wire cable. Refer to Figure 4). Excitation *Phase* and *Amplitude* balance controls are connected across the *Sense* lines. A pair of *Power Drivers* is used to provide the 80 milliamperes of drive current required by the transducer bridge.

When more than one 3178 (or a combination of 3178 or 3130 LVDT Conditioners) is being used in a measurement setup, beat frequencies may be produced from the 3-kHz oscillators contained in each instrument. To prevent beat frequencies from occurring, one unit can be designated the *master,* and the remaining units can be driven from the oscillator contained in the *master* unit. The remaining units are designated as *slave* instruments. The *Oscillator In* terminal of each *slave* unit (at the instrument I/O connector) provides a connection point to the *Oscillator Out* terminal of the *master* unit. The *Oscillator Out* and *Oscillator Disable* terminals of the *slave* units are jumpered to disable the oscillator internal to these units.

Calibration Circuit. A *Cal Sense* line is returned from the +*Signal* connection at the transducer to provide for shunting the *Cal Resistor* across a bridge leg to simulate an *Equivalent Input*. When the +CAL button is pressed, the *Cal Resistor* is shunted across the +*Signal* and +*Sense* connections. This action occurs by grounding the negative input of a *Comparator* through the +CAL switch. The *Comparator* output then closes an analog switch to which the *Cal Resistor* is connected. The connection to the +*Sense* line is then made through normally-closed contacts of the –CAL switch. Similarly, when the –CAL button is pressed, the *Cal Resistor* is shunted across the +*Signal* and –*Sense* connections. The *Comparator* is exercised as when the +CAL button is pressed, and the *Cal Resistor* is switched to the –*Sense* line through the normally-open contacts of the –CAL switch.

Calibration in the positive realm can also be remotely checked. When the *Remote Cal* input at the 3178 I/O connector is brought to a zero-volt (ground) level through the action of an external switch, transistor driver, etc., the same action occurs as when the +CAL button is pressed.

A line from the *Cal Resistor* is also provided for use with Lebow *1600 Series* rotary transformer torque transducers. This type of transducer has an integral *Cal Resistor* installed by the manufacturer. The line provided from the Daytronic *Cal Resistor* enables the use of the Lebow *Cal Resistor* without removing the resistor integral to the 3178.

Signal Conditioner. The +*Signal* and –*Signal* inputs from the transducer are applied to a differential ac signal amplifier with excellent common-mode rejection. Summed into the amplifier are the appropriate resistive and capacitive nulling voltages from the R and C BALANCE controls. These enable the operator to set the 3178 output to zero under transducer *no load* conditions.

A high-pass filter/amplifier follows the input differential amplifier to provide the required gain and eliminate 60-Hz ripple or noise related to the rotational frequency of the device when a rotating transformer torque transducer is used. The *Coarse* SPAN control is situated at the output of the amplifier to provide a gain control.

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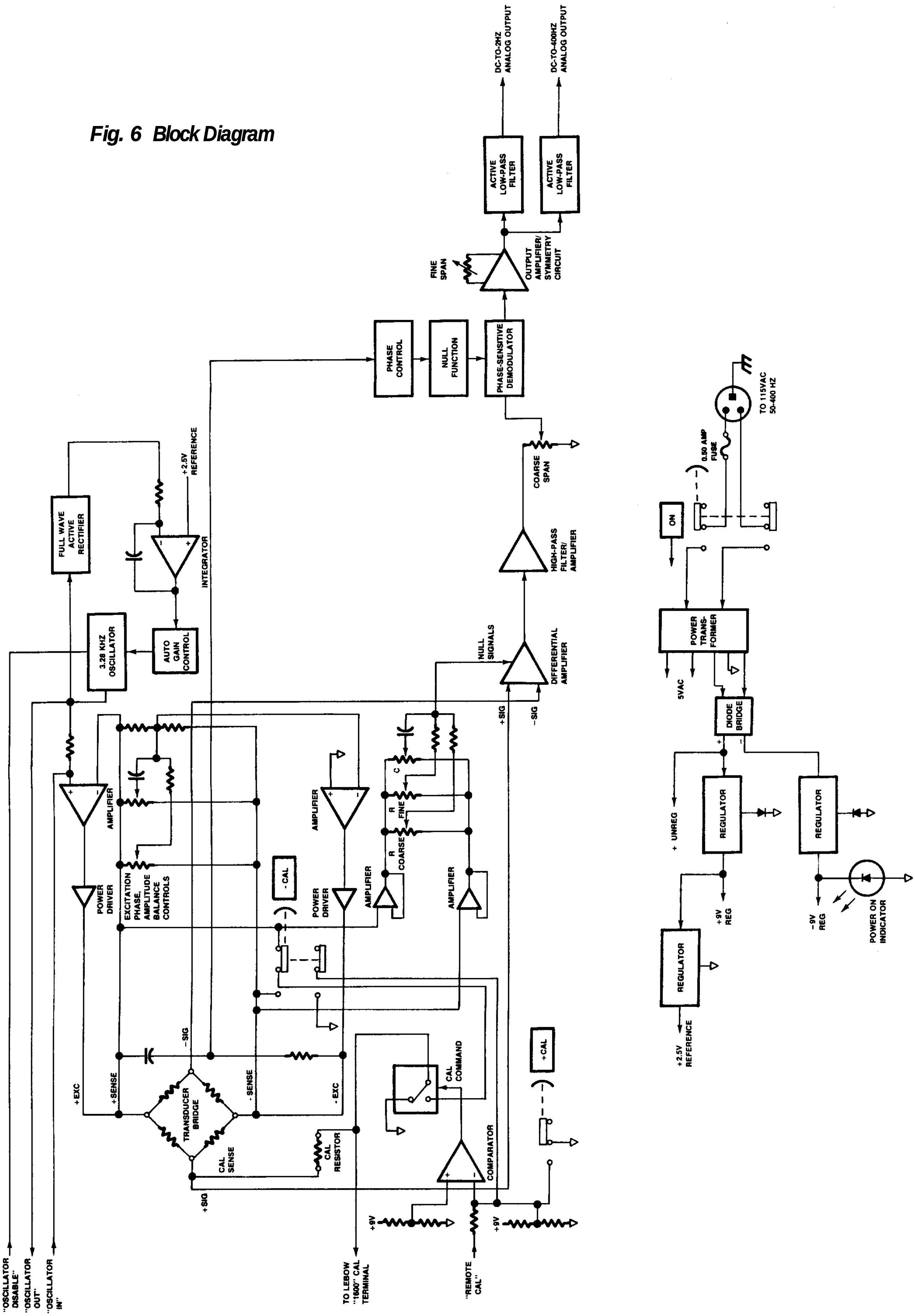
Fig. 6 Block Diagram



The signal is next applied to a phase-sensitive demodulator (active full-wave rectifier). The amplified ac signal is synchronously demodulated to restore the information content of the signal; that is, the amplitude and direction of the applied force. The NULL pushbutton and associated circuit provide nonsynchronous demodulation for balancing of the transducer bridge under *no load* conditions.

The dc output of the demodulator is buffered by an output amplifier which contains the *Fine* SPAN adjustment and a *Symmetry* circuit. The *Symmetry* circuit and its associated adjustment provide for compensating transducers with non-symmetrical positive and negative characteristics.

The amplified analog signal is applied to two active low-pass filters, each of which provide an output at the instrument I/O connector. The two outputs provide passbands of dc to 2 Hz and dc to 400 Hz. Output selection is a trade off between eliminating unwanted signals caused by vibration, etc., or increasing the time-to-answer (slew rate) of the conditioner. The rolloff of each output is 60 dB within a decade of the cutoff frequency.

5. VERIFICATION OF NORMAL OPERATION

It is the purpose of this section to aid the user in determining, in the event of a malfunction to which the Model 3178 is suspected of contributing, whether the instrument is functioning normally or whether it is the source of the observed trouble. In the event the unit requires repair, a complete parts list, schematic diagram, and component location drawing are included in this manual. The user may also contact the factory Service Department or the local Daytronic Representative for assistance.

If the instrument is suspected of faulty operation, observe the following steps.

(a) If the unit is totally inoperational (front-panel power indicator does not light), check the primary power fuse (Fl) located on the standup board which forms the power cord connection point. If the fuse is blown, replace it with a 0.50 ampere fuse (see Table 2 for part number). Before reapplying power, visually inspect the power cord and the input power connections for any discrepancy which could have caused the overload.

(b) If the transducer has some preloading, the BALANCE controls may not allow successful zeroing of the instrument output. This condition can be remedied by connecting a resistor (50 K-200 K range, metal-film type) from the +*Signal* terminal of the transducer to the + or –*Excitation* terminals. The *Excitation* terminal to which the connection is made is determined by the direction of the loading or off-zero reading.

(c) The inability to balance correctly where the instrument output reads totally off scale and the BALANCE controls have no authority can very likely be the result of a damaged or defective transducer or cable. This possibility can be confirmed (or eliminated) by substituting a transducer and cable known to be in good condition or by simulating a balanced transducer, using either a commercially available transducer simulator or the simple *star bridge* arrangement shown in Figure 7. The *star bridge* simulates a conventional four-arm bridge in an exact condition of balance. To construct a *star bridge* connect four 10% carbon resistors as shown in Figure 7. Use 180-ohm resistors to simulate a 350-ohm bridge and use 56-ohm resistors to simulate a 120-ohm bridge. Neither the resistor values nor temperature characteristics are critical since the balance condition of a *star bridge* is not determined by the resistance

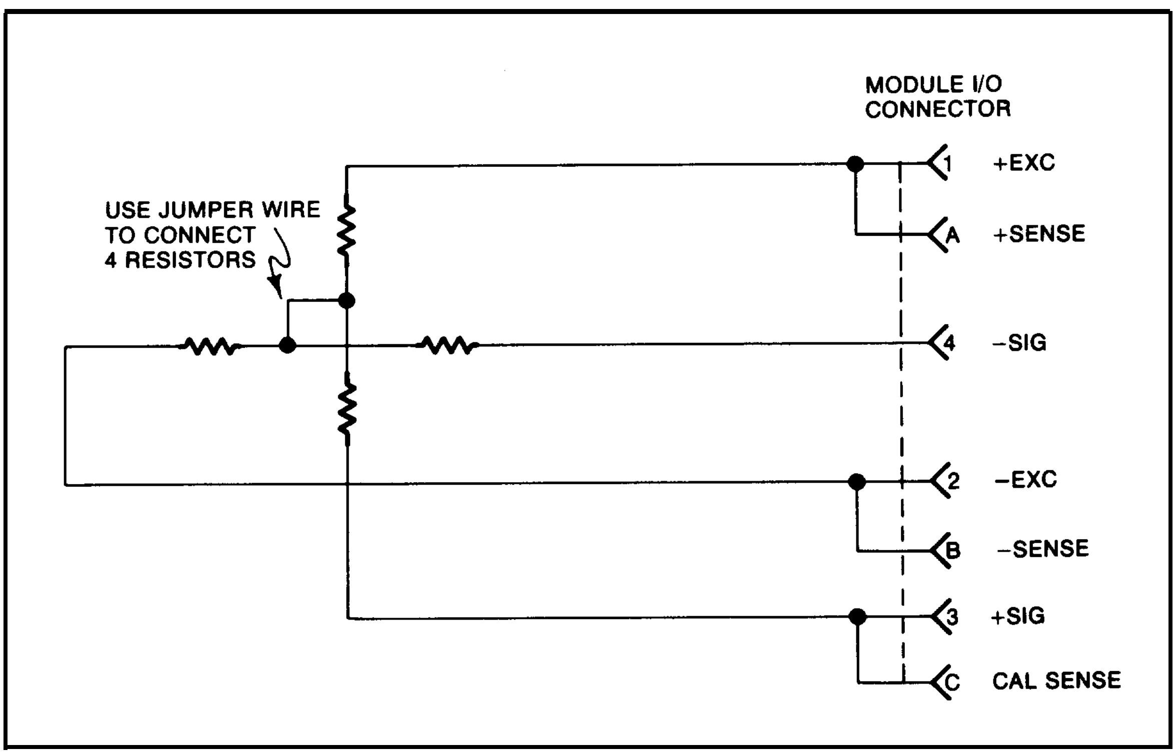


Figure 7. Star Bridge Construction

values. Solder two resistors together, then solder the remaining two resistors together. Next, connect the two junctions together using a separate wire as shown. There is a good reason for this method of construction, and it should be followed. Connect the substitute or simulated transducer to the instrument I/O connector using a short 4-wire cable configuration as shown in Figure 4. Attempt to balance the substitute or simulated transducer. If conditions now appear to be normal, the transducer or cable is at fault. If the previous difficulties persist, the 3178 is faulty.

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