SB.5.1

DAYTRONIC

MODEL

3170

STRAIN GAGE CONDITIONER

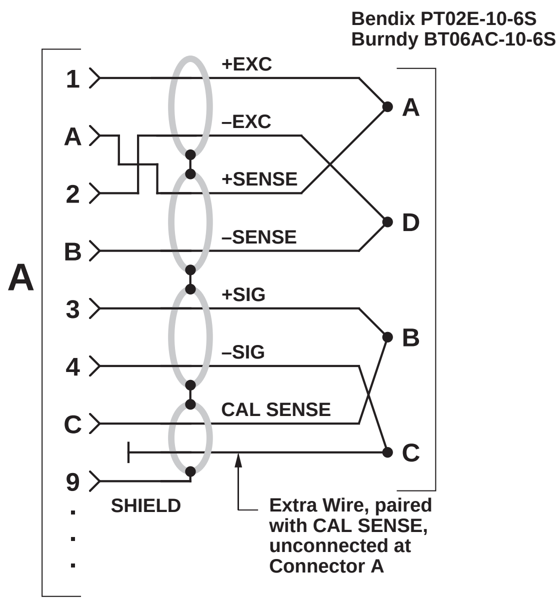
INSTRUCTION MANUAL

3000
Instrument Series

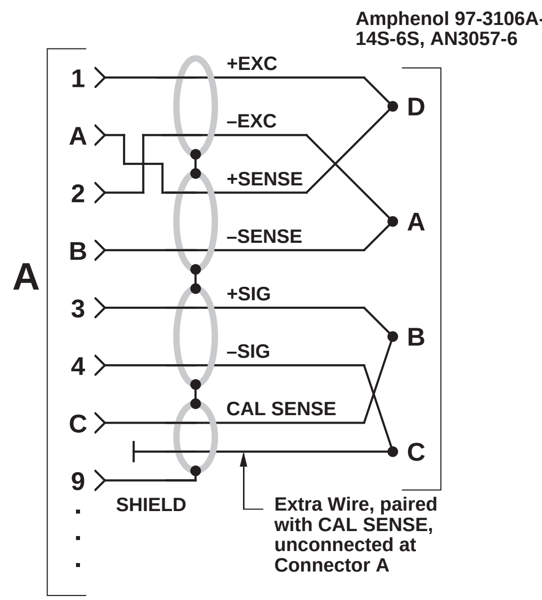
Correction
to Model 3170 Instruction Manual, v. SB.5.1

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



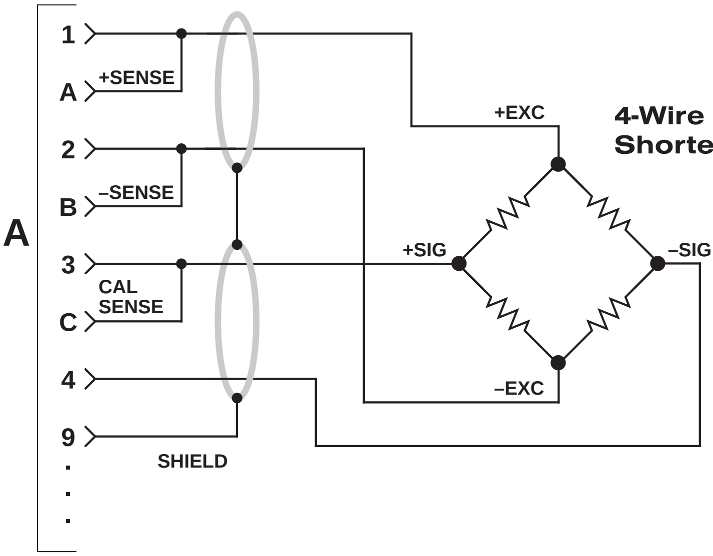
(cont'd)

Correction

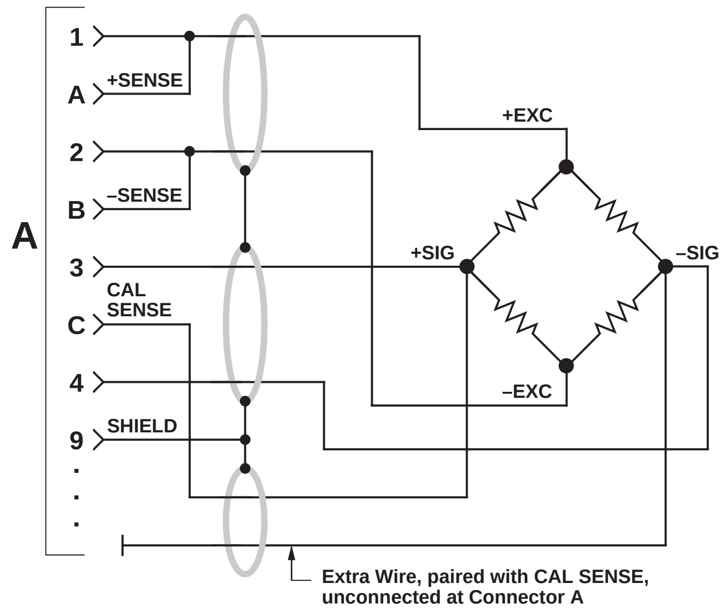
to Model 3170 Instruction Manual, v. SB.5.1 *(cont'd)*

Daytronic 3X70 Instrument to Generalized Strain Gage Transducer

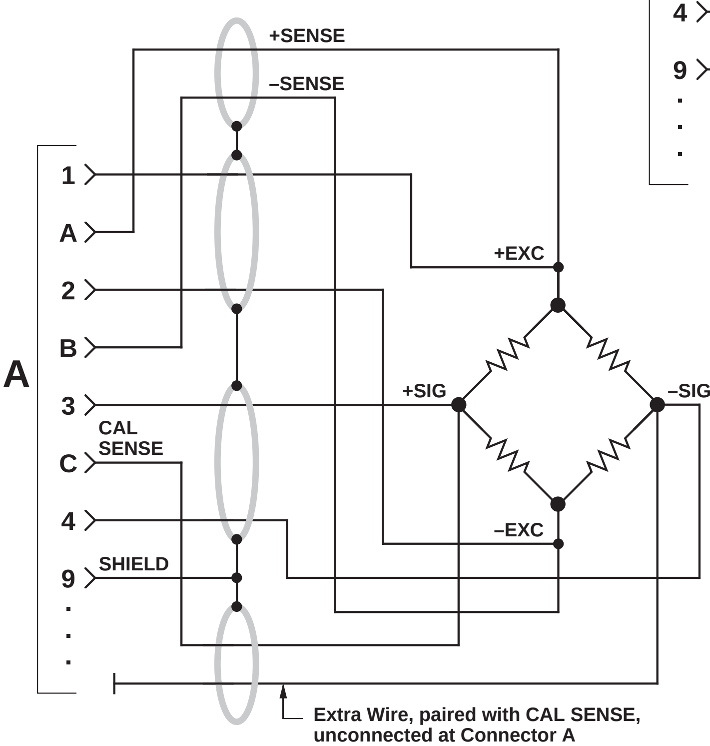
4-Wire Configuration for Cables Shorter Than 20 Feet



6-Wire Configuration for Cables Shorter Than 20 Feet



8-Wire Configuration for Cables Longer Than 20 Feet



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DAYTRONIC

MODEL
3170
STRAIN GAGE CONDITIONER

INSTRUCTION MANUAL

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

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 3170 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.

INSTRUCTION MANUAL
MODEL 3170 STRAIN GAGE CONDITIONER

1. DESCRIPTION

The Model 3170 conditioner-amplifier module for use with resistance strain gage transducers. It supplies a regulated dc excitation voltage to the transducer bridge, provides the necessary balancing and calibration controls, and amplifies the resulting signal to a standard Five-Volt Data Signal Level which is the output analog signal level of *3000 Series* Modules. The 3170 has three separate analog outputs, each having a different bandpass: (1) dc to 2 kHz, (2) dc to 200 Hz, and (3) dc to 2 Hz. Active low-pass filters are used to achieve the 200 Hz and 2 Hz cutoff frequencies. The filtered outputs provide for averaging or smoothing 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 3170 is shown in Figure 1 and the specifications are given in Table 1.

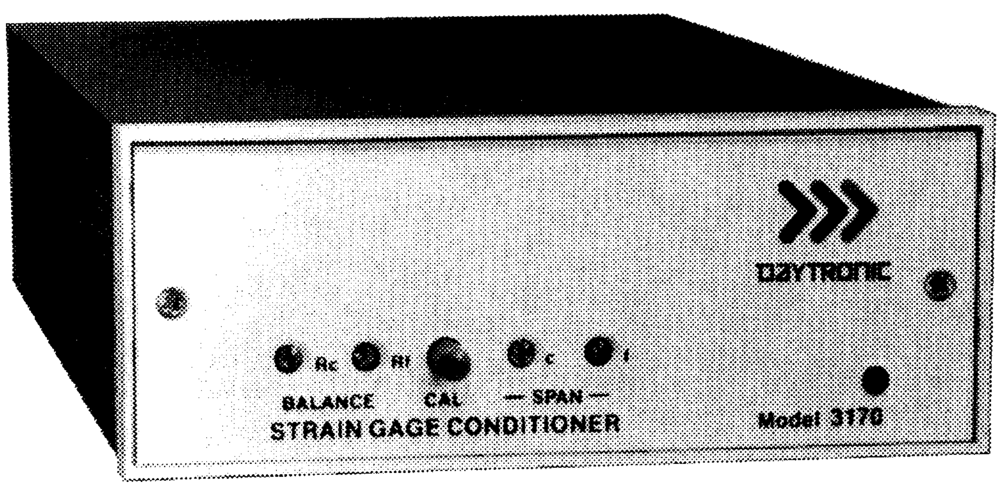


Figure 1. Model 3170 Strain Gage Conditioner

Table 1. Specifications

Transducers: 4-arm bridges, 90 to 2000 ohms, nominally 1 to 8 mv/v, full scale (120 ohms or less requires use of 5-volt excitation).

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

Bridge Excitation: Regulated 5 volts or 10 volts dc, selected with I/O connector wiring. Transducers with sensitivity from 4 to 8 mv/v full scale must use 5-volt excitation.

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

Span Adjustments: 10-turn coarse and fine; 1 to 8 mv/v, full scale.

Analog Outputs: Three analog outputs available; 0 to ±5 volts with 50% overange, 5 milliamperes maximum. Bandpass is dc to 2 kHz, dc to 200 Hz, or dc to 2 Hz, depending on output used. 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.

Common Mode Rejection: Greater than 80 dB.

Output Ripple and Noise: 0.15% of full scale (rms) maximum for 2-kHz and 100-Hz outputs; 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.

Remote sensing techniques are used to regulate the excitation voltage at the transducer. Either a 10-volt or a 5-volt excitation voltage can be selected by appropriate wiring at the module I/O connector. The excitation voltage is protected against overloads and accidental short circuits.

The 3170 uses a CMOS chopper-stabilized differential signal amplifier which has over 100-megohms input impedance per input line. This circuit guarantees negligible drift with temperature variations or component aging.

Calibration of the 3170 is accomplished by the conventional shunt technique, using an internally installed calibration resistor. A front-panel CAL button or *Remote Cal* terminals on the module I/O connector can be used to initiate the calibration procedure.

The 3170 Strain Gage Conditioner is also available in two additional forms. The Model 3270 includes the addition of a digital indicator to view the analog output of the conditioner. The Model 3370 includes a *Limit* section (in addition to a digital indicator) which provides high, low, and ok indications and outputs. The digital indicator and limit options are standard to all *3000* Modules and are covered in separate instruction manuals.

2. INSTALLATION AND CABLING

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

Module Mounting. The *3000 Series* Modules can be operated as bench-top instruments 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).

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

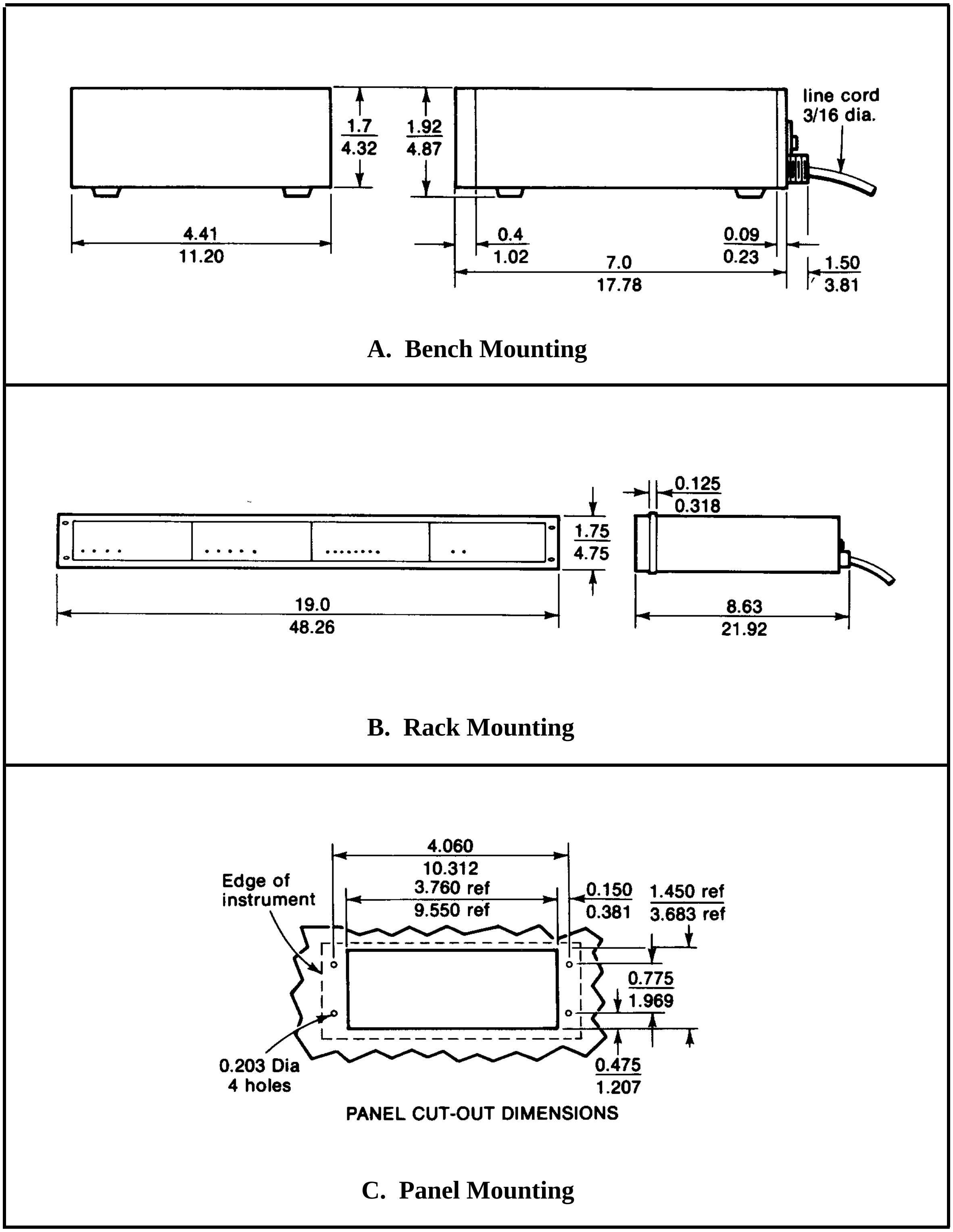


Figure 2. Instrument Mounting Dimensions

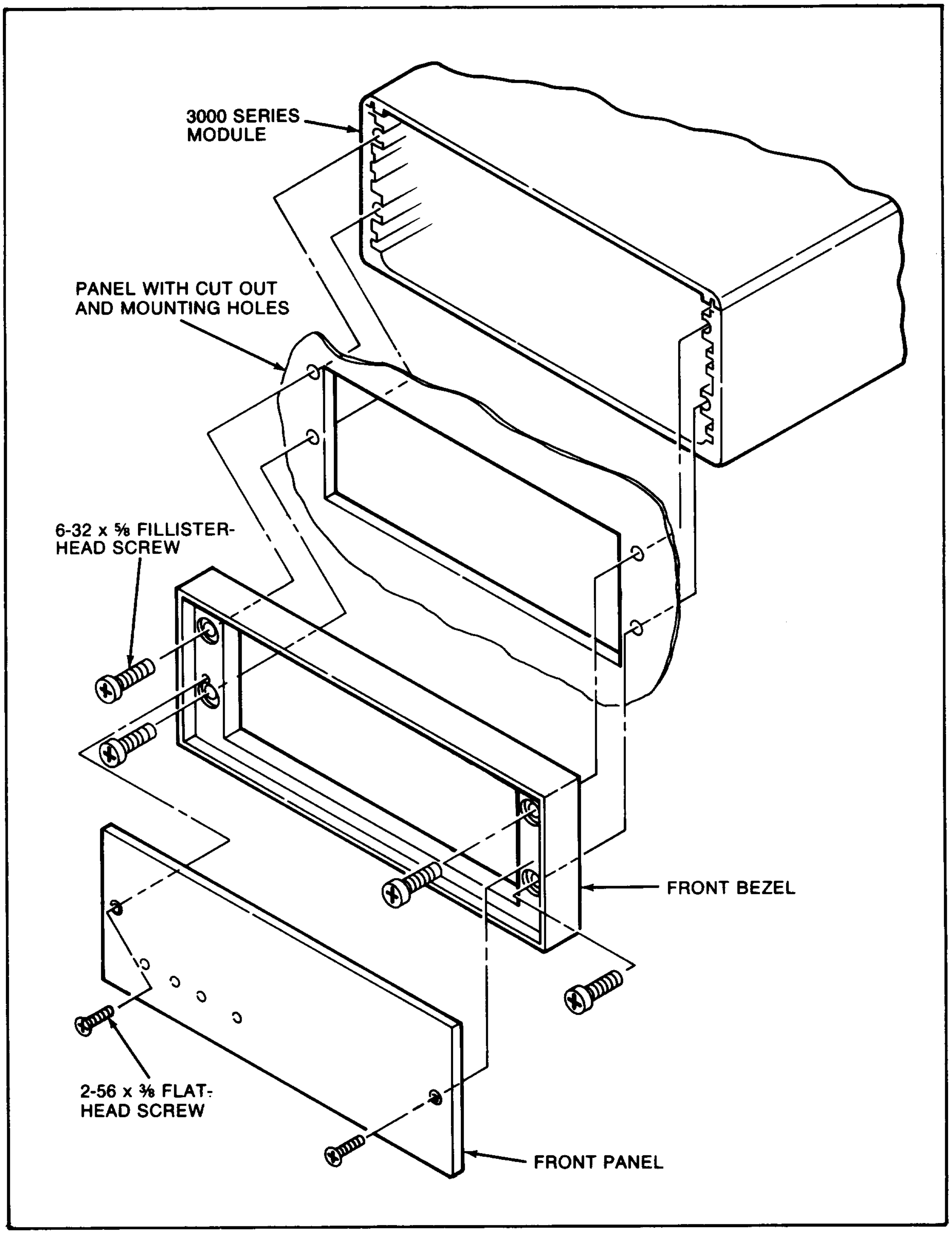


Figure 3. Instrument Panel Mounting

(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 module enclosure behind the panel and reattach the front bezel to the enclosure from the front of the panel with the four mounting screws.

(e) Reinstall the front panel.

(f) Tighten the two securing screws of the rear-panel module I/O connector to insure that the connector is seated and that the module 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 width 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* Modules 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 module 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 module 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 shunt 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 3170 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, the 59-kilohm resistor should be replaced at this time by one that is appropriate for the transducer and measurement range to be used. The calibration resistor is mounted on terminals located at the front edge of the strain gage conditioner printed-circuit board. It can be accessed by removing the module front panel.

Transducer Cabling. Cabling to the transducer is accomplished via the supplied module 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. 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 *dead weight* 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 (or resistance value) 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.

Transducer Excitation. Either 5-volt or 10-volt bridge excitation can be selected. In general, 5-volt excitation is used with 120-ohm transducers, and the 10-volt excitation is used with 350-ohm devices. However, for any transducer which has a 4 mv/v or higher sensitivity, 5-volt excitation must be used to maintain proper operation without saturating the conditioner amplifiers. Five-volt excitation is selected by shorting pins D and E of the module I/O connector (see Figure 4). Ten-volt excitation is achieved when pins D and E are not connected together.

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

Analog Outputs. Three different analog outputs are available at the module I/O connector. Each output has a different passband: dc to 2 kHz, dc to 200 Hz, and dc to 2 Hz. The 200 and 7 Hz cutoff frequencies are achieved with active low-pass filters. As the cutoff frequency is lowered, a trade off is made between noise elimination and increased time-to-answer or slew time. Each output has a 60-dB rnlloff a decade from the cutoff frequency. The filter characteristics are given by the following equations.

$$A_{out} \text{ @ } f_0 = 0.7\ A_{in}$$
$$A_{out} \text{ @ } 10f_0 = 0.001\ A_{in}$$
$$T = 1.4/f_0$$

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

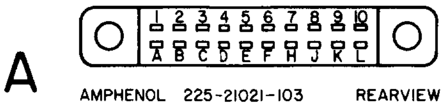
This section contains the instructions for calibrating the 3170 Included is a functional description of the module front panel (see Figure 5). To perform calibration, proceed as follows.

(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

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

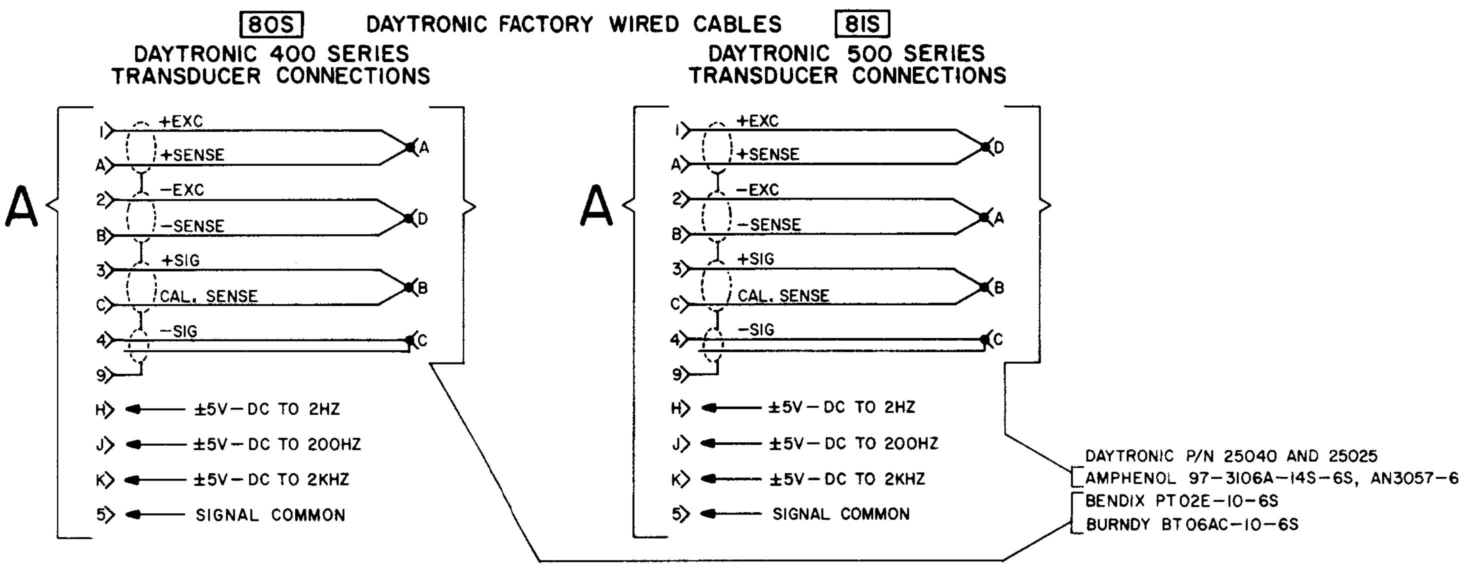
Figure 4 I/O Wiring Data

DAYTRONIC 3X70 INSTRUMENT I/O CONNECTOR W/PIN DESIGNATIONS (X = 1, 2, or 3, e.g. 3170, 3270, or 3370)



AMPHENOL 225-21021-103 REARVIEW

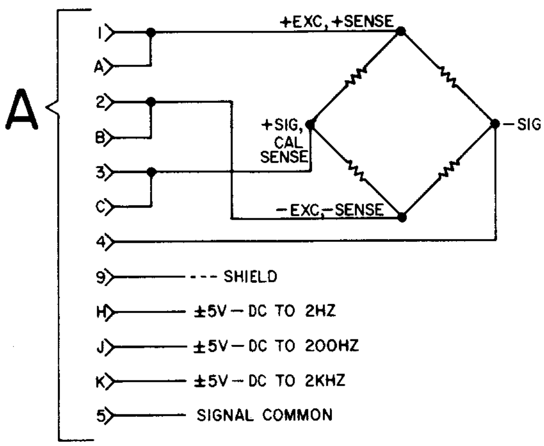
PIN		PIN	
1	+EXCITATION	A	+SENSE
2	−EXCITATION	B	−SENSE
3	+SIGNAL INPUT	C	CALIBRATION SENSE
4	−SIGNAL INPUT	D	CONNECT FOR 5V EXCITATION
5	SIGNAL COMMON	E	(CONNECT FOR 5V EXCITATION)
6	NC	F	NC
7	NC	H	ANALOG OUTPUT, ±5V−DC TO 2HZ
8	REMOTE CALIBRATION	J	ANALOG OUTPUT, ±5V−DC TO 200HZ
9	SHIELD	K	ANALOG OUTPUT, ±5V−DC TO 2KHZ
10	OUTPUT SIGNAL COMMON	L	NC



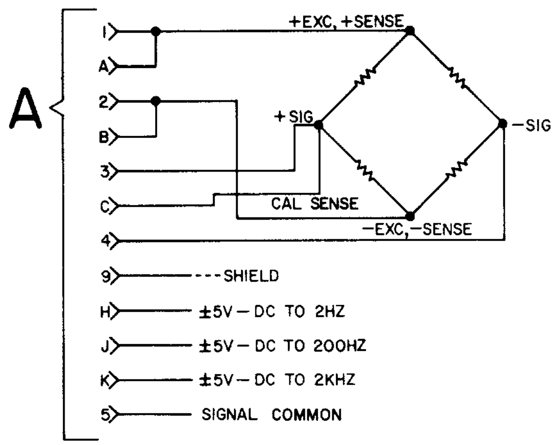
See the CORRECTION to Fig. 4 in the front of this manual.

DAYTRONIC 3X70 INSTRUMENT TO GENERALIZED TRANSDUCER

4 WIRE CONFIGURATION FOR
CABLES SHORTER THAN 20 FEET

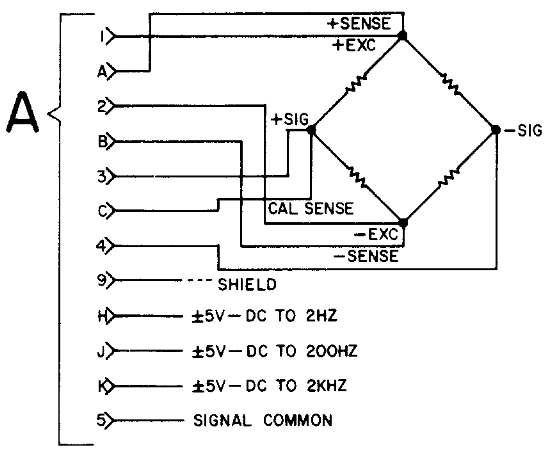


5 WIRE CONFIGURATION FOR
CABLES SHORTER THAN 20 FEET

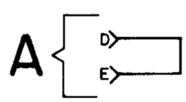


NOTE: Shielding practice as shown above should be followed. Use 4 twisted pairs with individual shields.

7 WIRE CONFIGURATION FOR
CABLES LONGER THAN 20 FEET



5 VOLT EXCITATION CONNECTION



REMOTE CALIBRATION CONNECTIONS

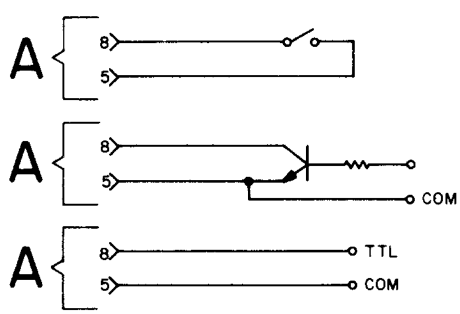
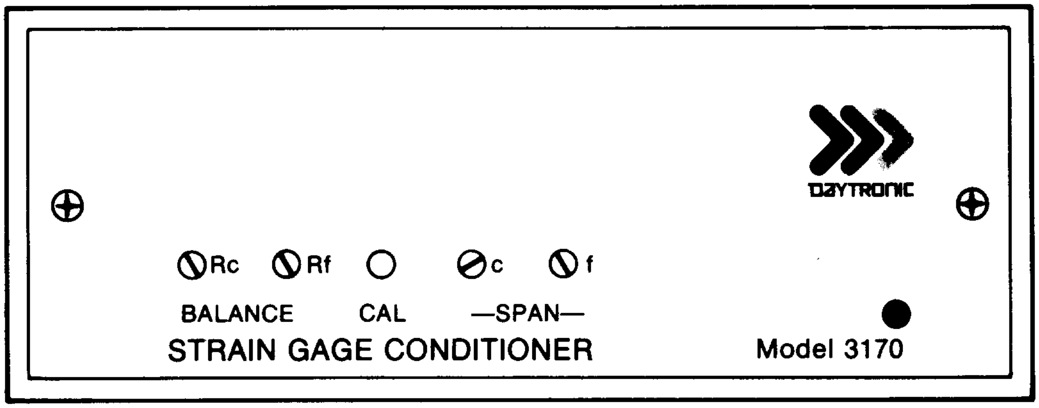


Figure 4 (cont'd)



BALANCE Controls: The coarse (R_c) and fine (R_f) BALANCE controls are used to set the module output to zero when the transducer is unloaded.

SPAN Controls: The coarse (c) and fine (f) SPAN controls are used to set the output to the Equivalent Input value when the CAL button is pressed.

CAL Pushbutton: The CAL pushbutton provides for enabling or entering the calibration mode. The ***Cal*** resistor is shunted across the + ***Signal*** and + ***Sense*** terminals when the button is pressed, supplying an ***Equivalent Input*** value to the module.

Figure 5. Front-Panel Description

ac power. Allow 5 minutes of warm-up for stabilization of transducer characteristics.

(b) With the transducer unloaded, set the module output to zero using the coarse (R_c) and fine (R_f) BALANCE controls. In some instances, an integral digital indicator will be used to display the conditioner output (Model 3270 or 3370). When only the conditioner is supplied (3170), an external indicator must be used to monitor the conditioner output.

(c) Load the transducer to a convenient up-scale value which is greater than one half of full scale. Adjust the coarse (c) and fine (f) SPAN controls until the output signal causes a reading equal to the *dead weight* value. Remove the *dead weight,* then press the CAL button and note the indicator reading obtained. This reading can now be used in future calibrations since it is related to a value obtained thru *dead weight* calibration. To calibrate the instrument in the future, simply press the CAL button and adjust the SPAN controls to obtain the reading previously recorded after *dead weight* calibration.

(d) If *dead weight* calibration is not practical and the transducer manufacturer has supplied a calibration resistor (or resistor value), install the recommended calibration resistor. Now press the CAL button and adjust the SPAN controls until the module output is equal to the *Equivalent Input* value simulated by the installed calibration resistor.

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 is 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 (full scale) with a bridge resistance of 350 ohms.

$$X = \frac{25000 \times 350}{59000 \times 3} = 49.44\% \text{ of full scale} = 2472 \text{ pounds}$$

4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the 3170 works by using a simplified block diagram of the conditioner. This is not intended to be used as a detailed theory of operation discussion for personnel untrained in electronic technology, but as a simplified explanation of the detailed schematic diagram provided with this manual.

Refer to Figure 6. Primary power (115 volts ac, 50-400 Hz) is applied to the module by means of the attached power cable. A rear-panel slide switch is used to turn ON primary power. Overload protection is provided by a 0.25 ampere fuse mounted on the conditioner printed-circuit board. 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 module. 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 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 bias an amplifier/driver which works in conjunction with a series-pass regulator to regulate the excitation voltage at the transducer bridge. The excitation voltage is normally 10 volts dc, but a jumper can be installed at the module I/O connector to select a 5-volt excitation voltage. The excitation voltage is developed from the minus unregulated side of the diode bridge to more equally balance the current drain on the power transformer secondary. The series-pass regulator has short-circuit protection in the event that the excitation voltage is accidentally shorted at the transducer or module I/O connector.

Figure 6 shows the connections between the transducer bridge and the module made via a 7-wire cable. Optimum accuracy is obtained with the 7-wire configuration since the excitation voltage is regulated at the transducer bridge and a *Cal Sense* line is returned to the module for accurately setting the *Equivalent Input* value when the *Cal* resistor is shunted across one leg of the transducer bridge. The *Calibration* mode is entered (*Cal* resistor is shunted across the + *Signal* and + *Sense* lines) when the front-panel CAL button is pressed or the *Remote Cal* input at the module I/O connector is brought to a zero-volt level through the action of an external switch, transistor driver, etc. Either of these actions fires a comparator which, in turn. closes an analog switch in series with the *Cal* resistor.

The + and – *Signal* inputs from the transducer bridge are applied to a differential signal amplifier. Each leg of the signal amplifier inputs has approximately 100-megohms input impedance so that no loading is seen by the bridge. The signal amplifier is chopper stablized to prevent drift which might result from temperature or component aging. A two-phase clock signal synchronized with power line frequency is used as the chopper signal. The differential signal amplifier also provides excellent common-mode rejection.

The bridge balance circuit immediately follows the signal amplifier. The BALANCE and SPAN controls act upon the output of the signal amplifier, not the bridge, to achieve the proper impedance isolation.

Three analog outputs of the conditioned strain gage signal are available at the module I/O connector. The three outputs provide three different passbands of dc to 2 kHz, dc to 200 Hz, and dc to 2 Hz. Output selection is a trade off between eliminating unwanted signals caused by vibration or increasing the time-to-answer (slew rate) of the conditioner. The 200-Hz and 2-Hz cutoff frequencies are achieved with the use of active low-pass filters. 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 3170 is suspected of contributing, whether the module is functioning normally or whether it is a source of the observed trouble. In the event the module 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 module is suspected of faulty operation, observe the following steps.

(a) If the module is totally inoperational (front panel power indicator does not light), check the primary power fuse (Fl) located on the conditioner printed-circuit board (see Figure 8). If the fuse is blown, replace it with a 0.50 ampere fuse. Before reapplying power, visually inspect the power cord wiring and the printed-circuit board 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 module 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 module 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 possibil-

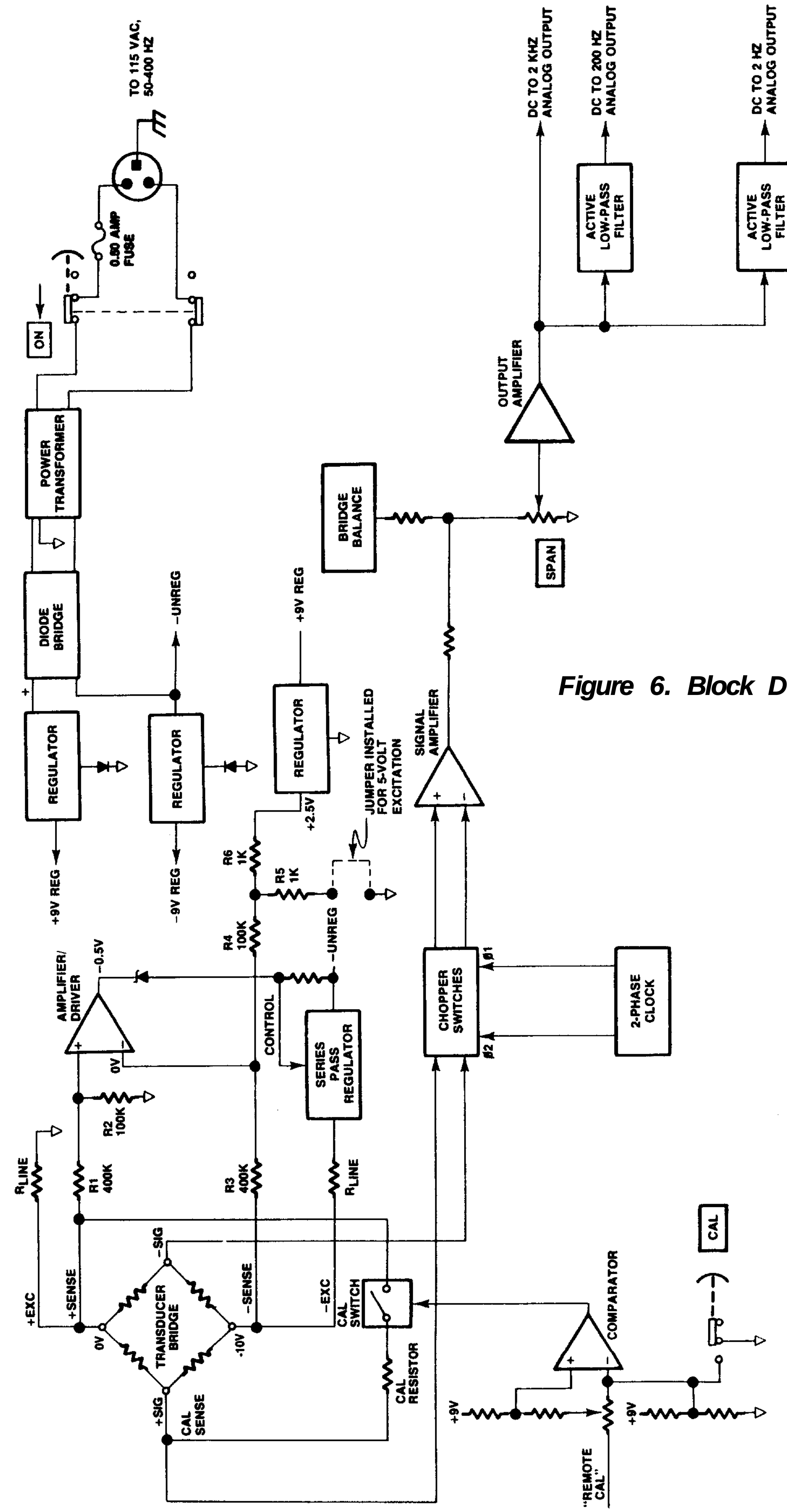


Figure 6. Block Diagram

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ity 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 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 module 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 module is faulty.

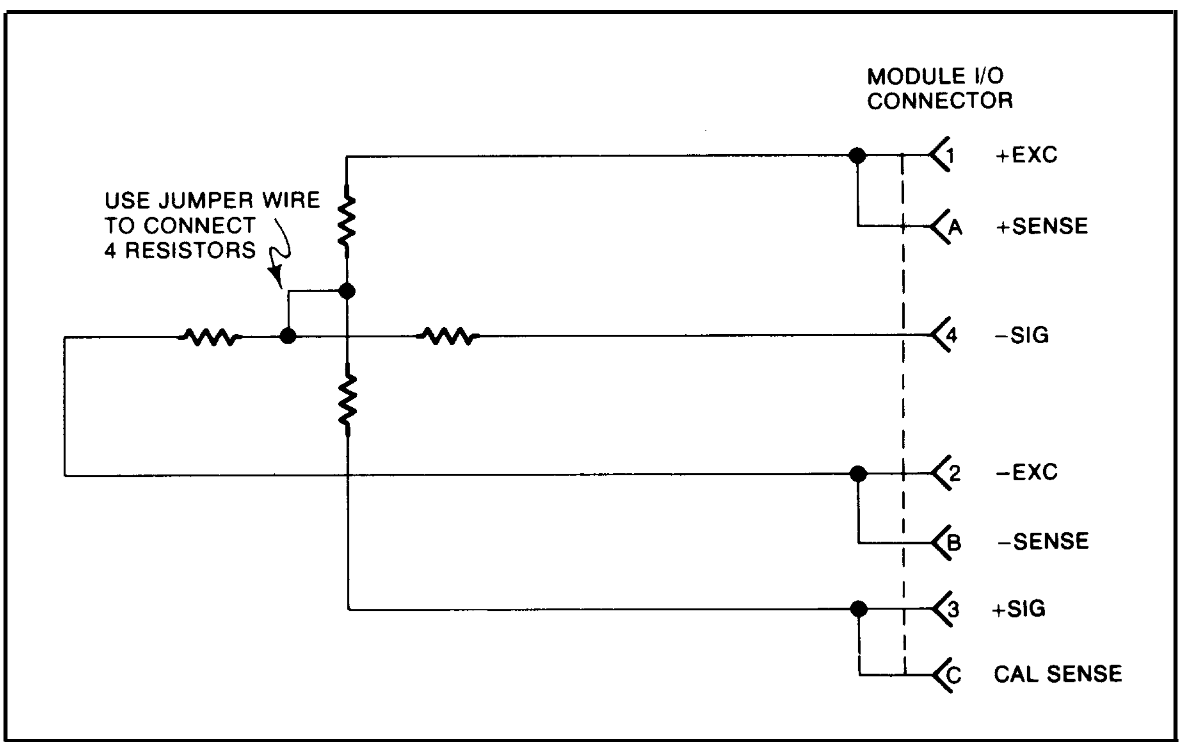

Figure 7. Star-Bridge Construction

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