



MODEL

3270

Manuals 3170 + 3200

STRAIN GAGE CONDITIONER

INSTRUCTION MANUAL



3000
Instrument Series

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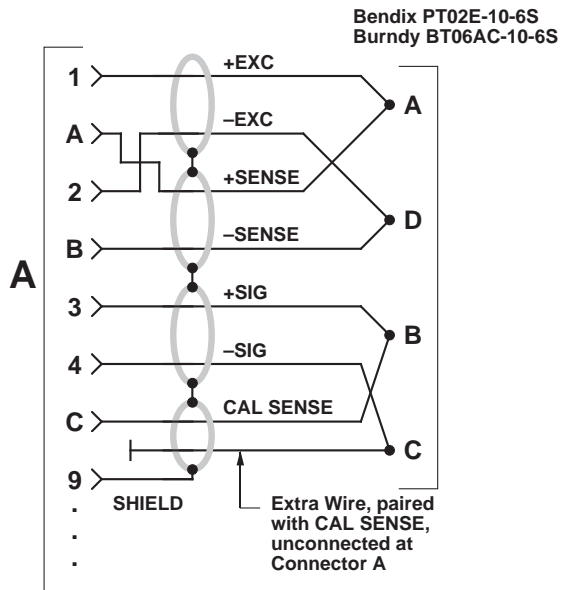
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Correction

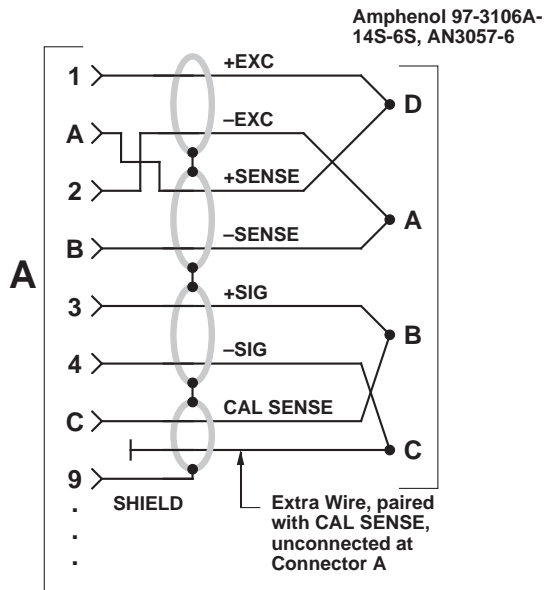
to Model 3170 Instruction Manual, v. SB.5.1

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

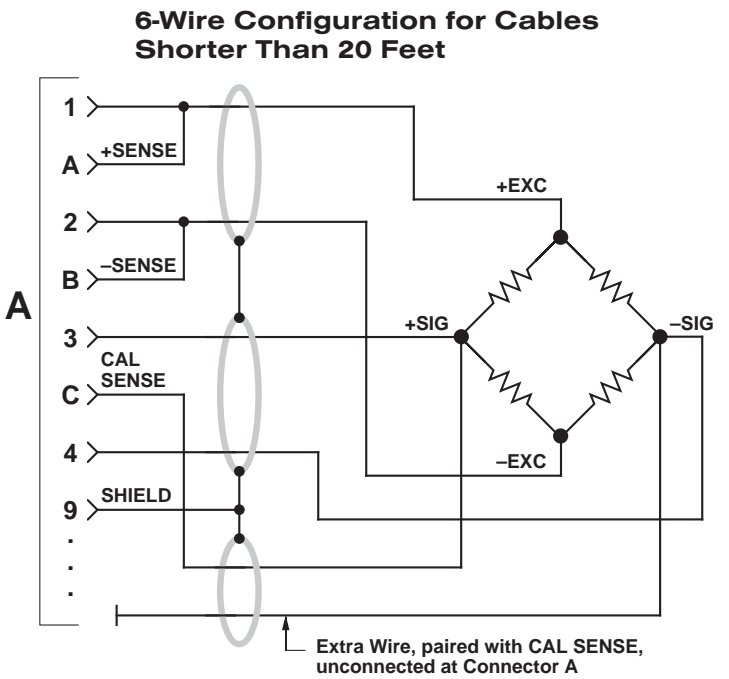
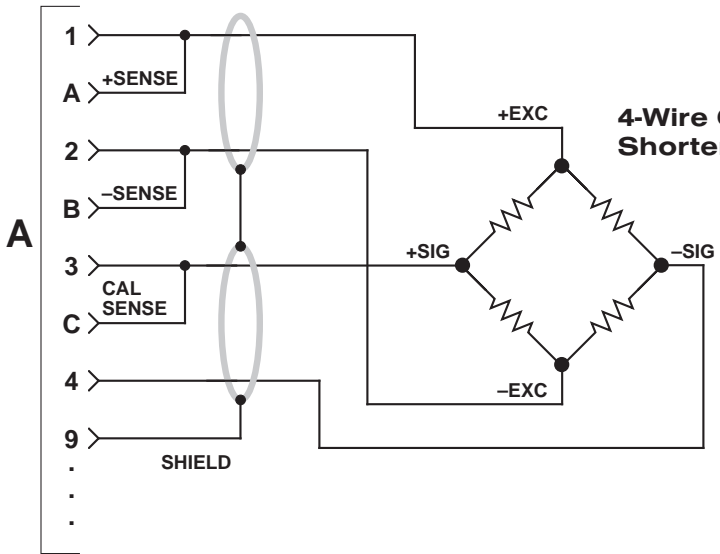


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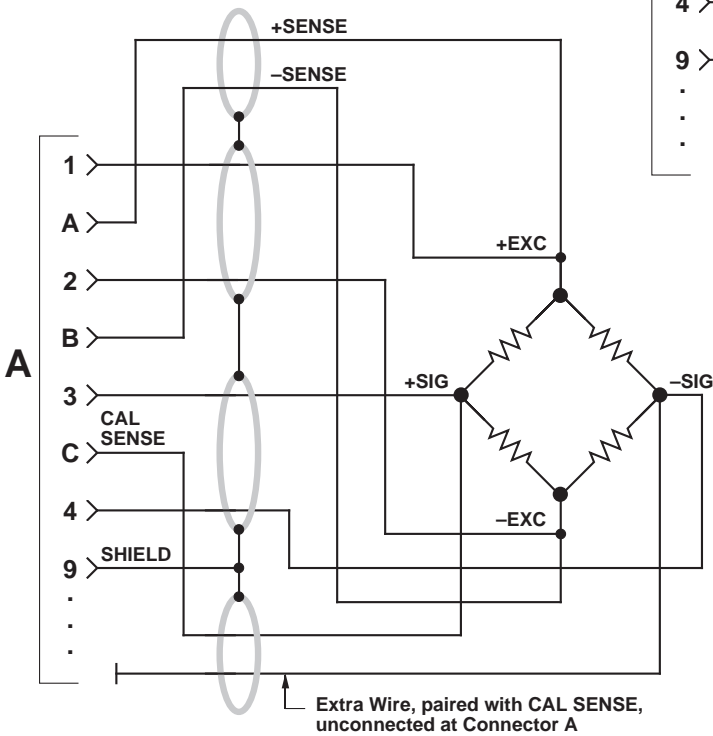
Correction

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

Daytronic 3X70 Instrument to Generalized Strain Gage Transducer



8-Wire Configuration for Cables Longer Than 20 Feet





Model 3170 Instruction Manual, v. SB.5.1

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MODEL
3170
STRAIN GAGE CONDITIONER

INSTRUCTION MANUAL

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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

Model 3170

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% overrange, 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.

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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.

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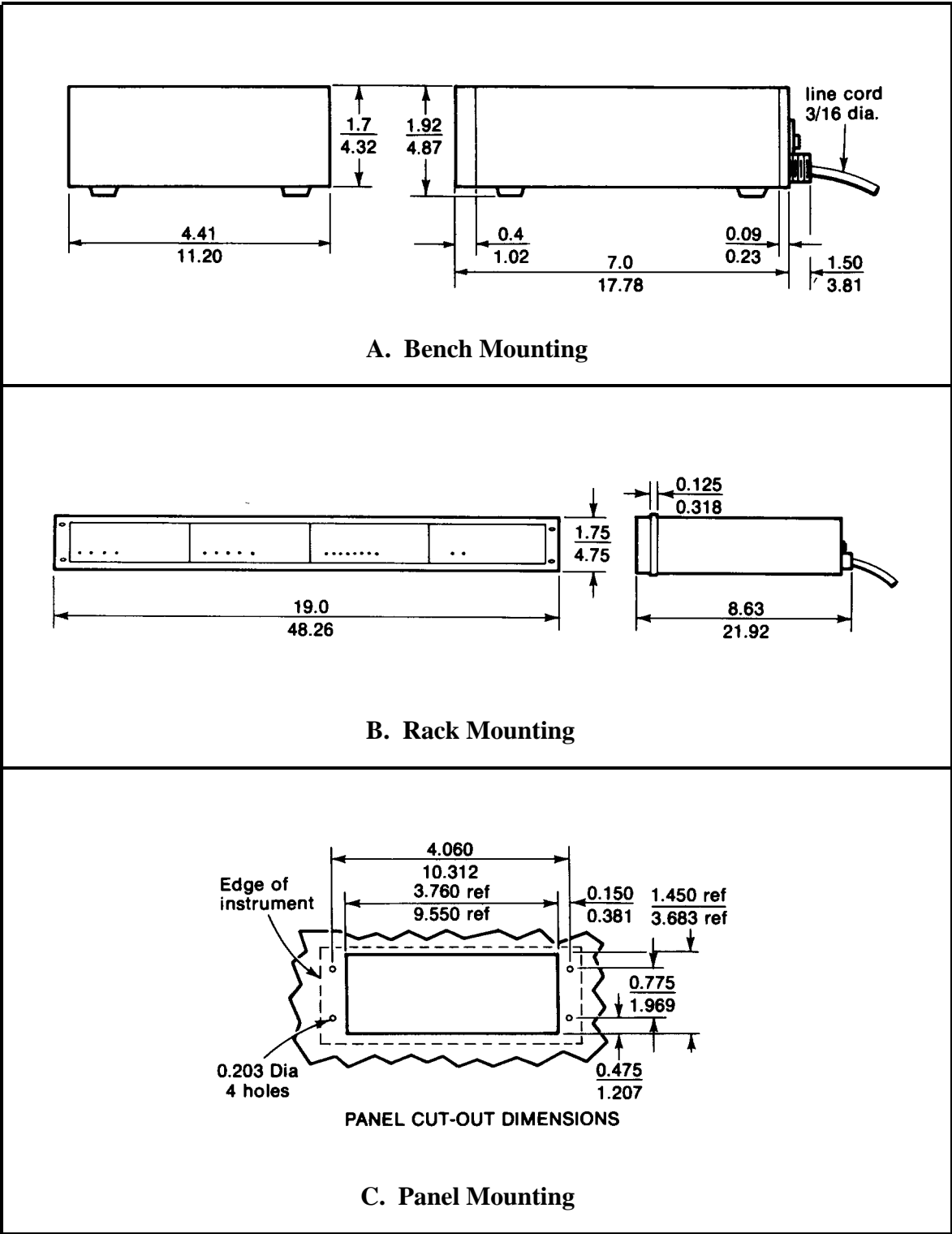


Figure 2. Instrument Mounting Dimensions

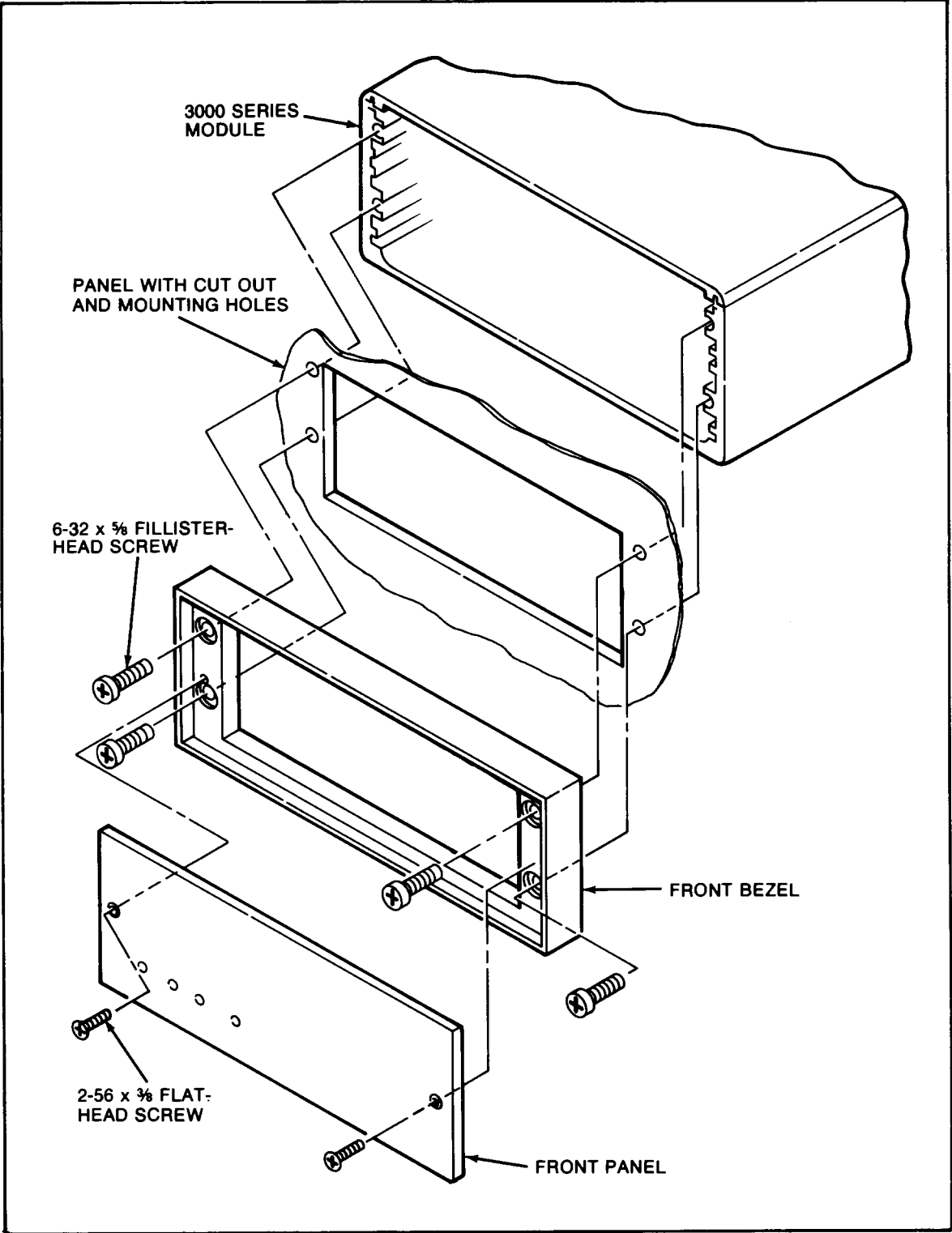


Figure 3. Instrument Panel Mounting

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- (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:

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- (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.

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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 rolloff a decade from the cutoff frequency. The filter characteristics are given by the following equations.

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

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

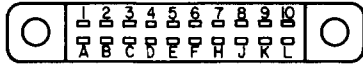
This section contains the instructions for calibrating the 3170. Included is a functional description of the module front panel (see Figure 5). To perform calibration, proceed as follows.

- (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

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)**

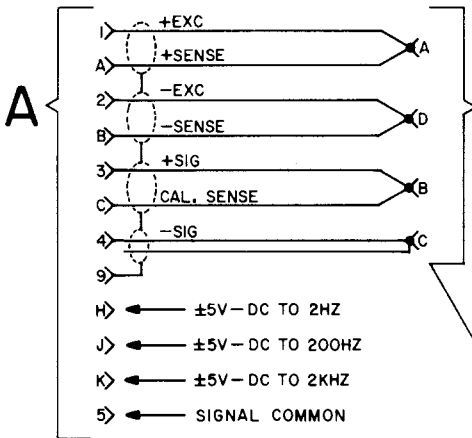
A



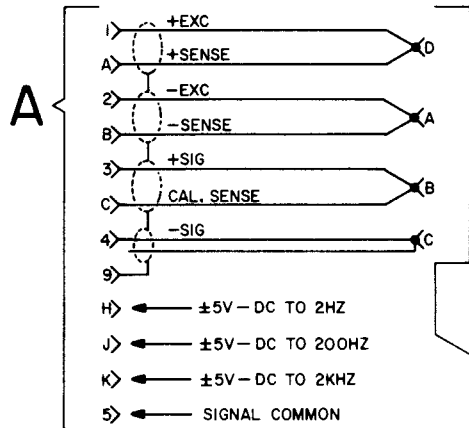
AMPHENOL 225-21021-103 REARVIEW

PIN		PIN	
1	+EXCITATION	A	+SENSE
2	-EXCITATION	B	-SENSE
3	+SIGNAL INPUT	C	CALIBRATION SENSE
4	-SIGNAL INPUT	D	CONNECT FOR
5	SIGNAL COMMON	E	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

[80S] DAYTRONIC FACTORY WIRED CABLES [81S]
**DAYTRONIC 400 SERIES
TRANSDUCER CONNECTIONS**



**DAYTRONIC 500 SERIES
TRANSDUCER CONNECTIONS**



DAYTRONIC P/N 25040 AND 25025
AMPHENOL 97-3106A-14S-6S, AN3057-6
BENDIX PT02E-10-6S
BURNDY BT06AC-10-6S

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

DAYTRONIC 3X70 INSTRUMENT TO GENERALIZED TRANSDUCER

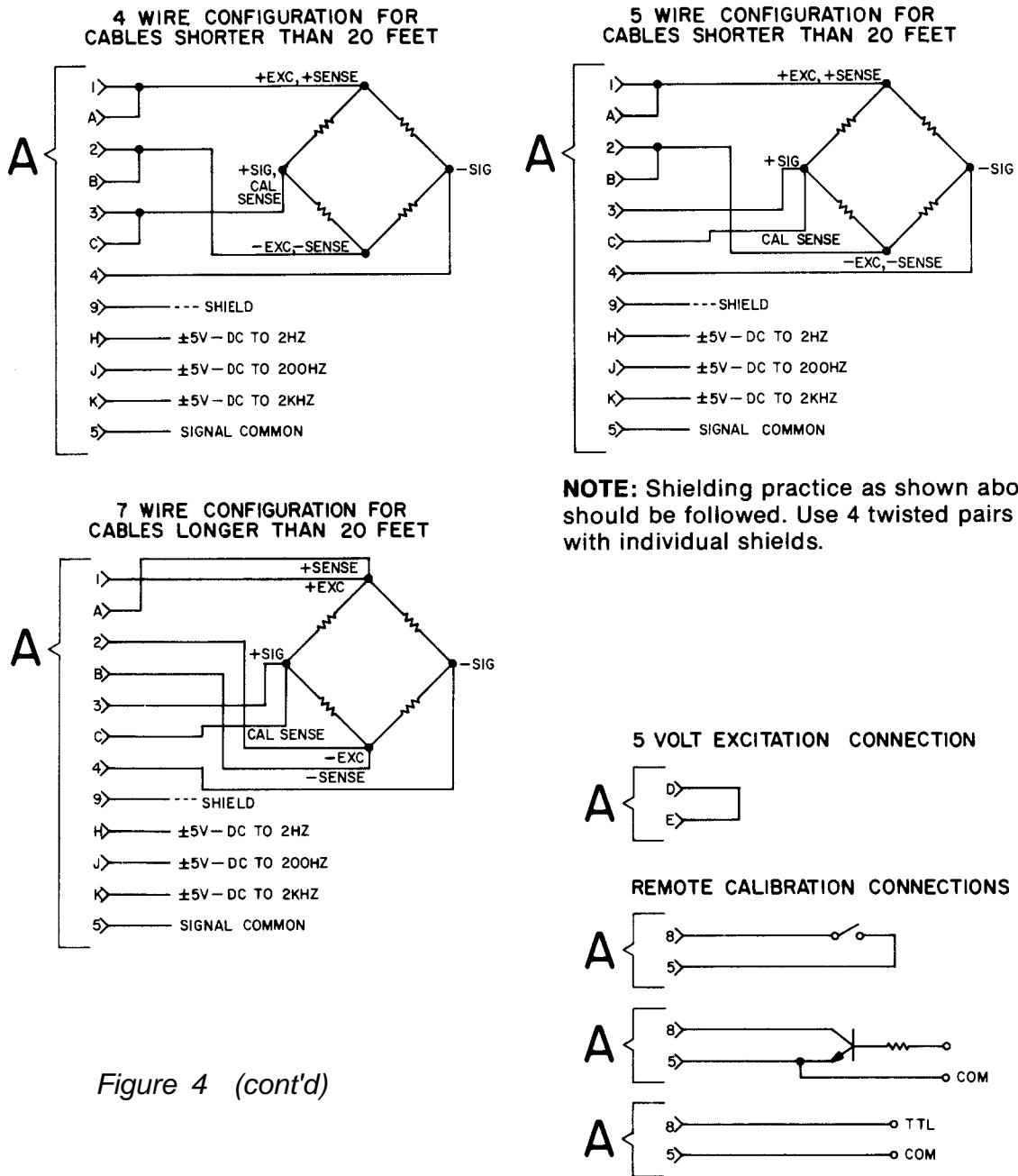


Figure 4 (cont'd)

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

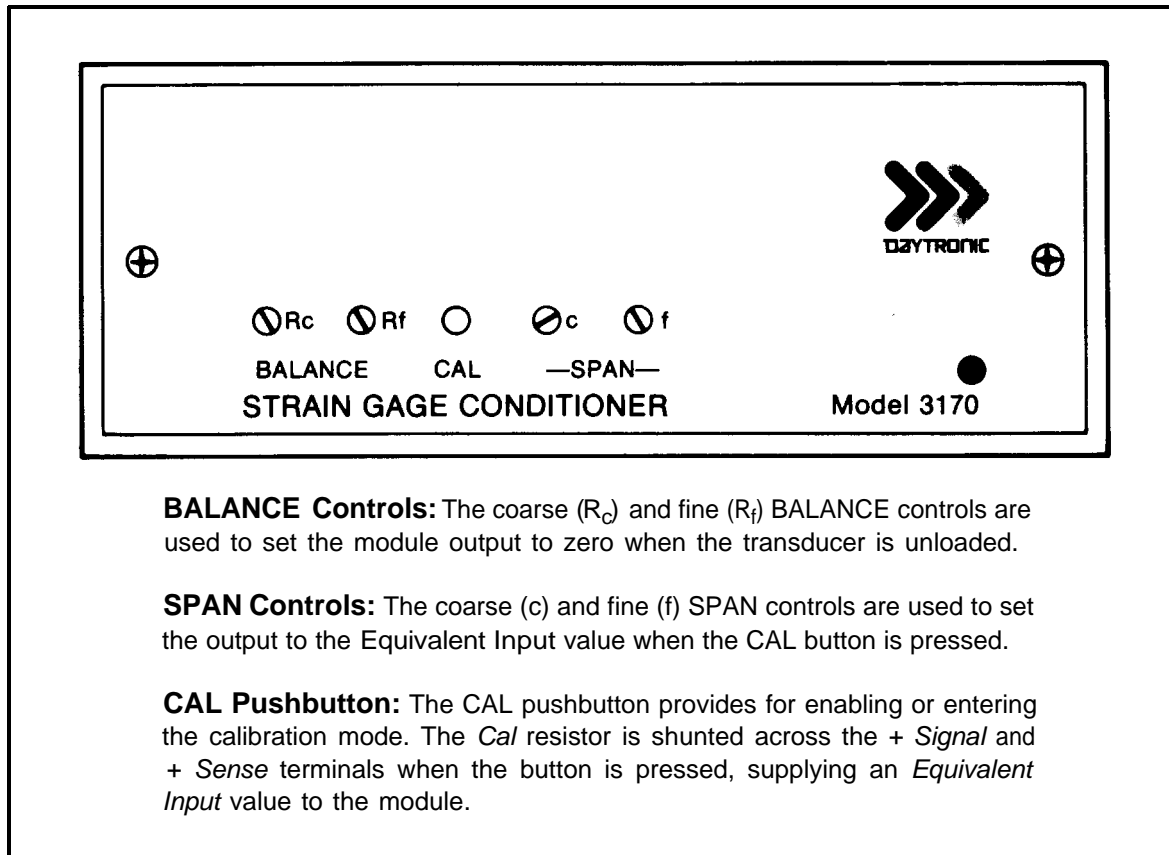


Figure 5. Front-Panel Description

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*

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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

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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 stabilized 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.

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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 (F1) 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-

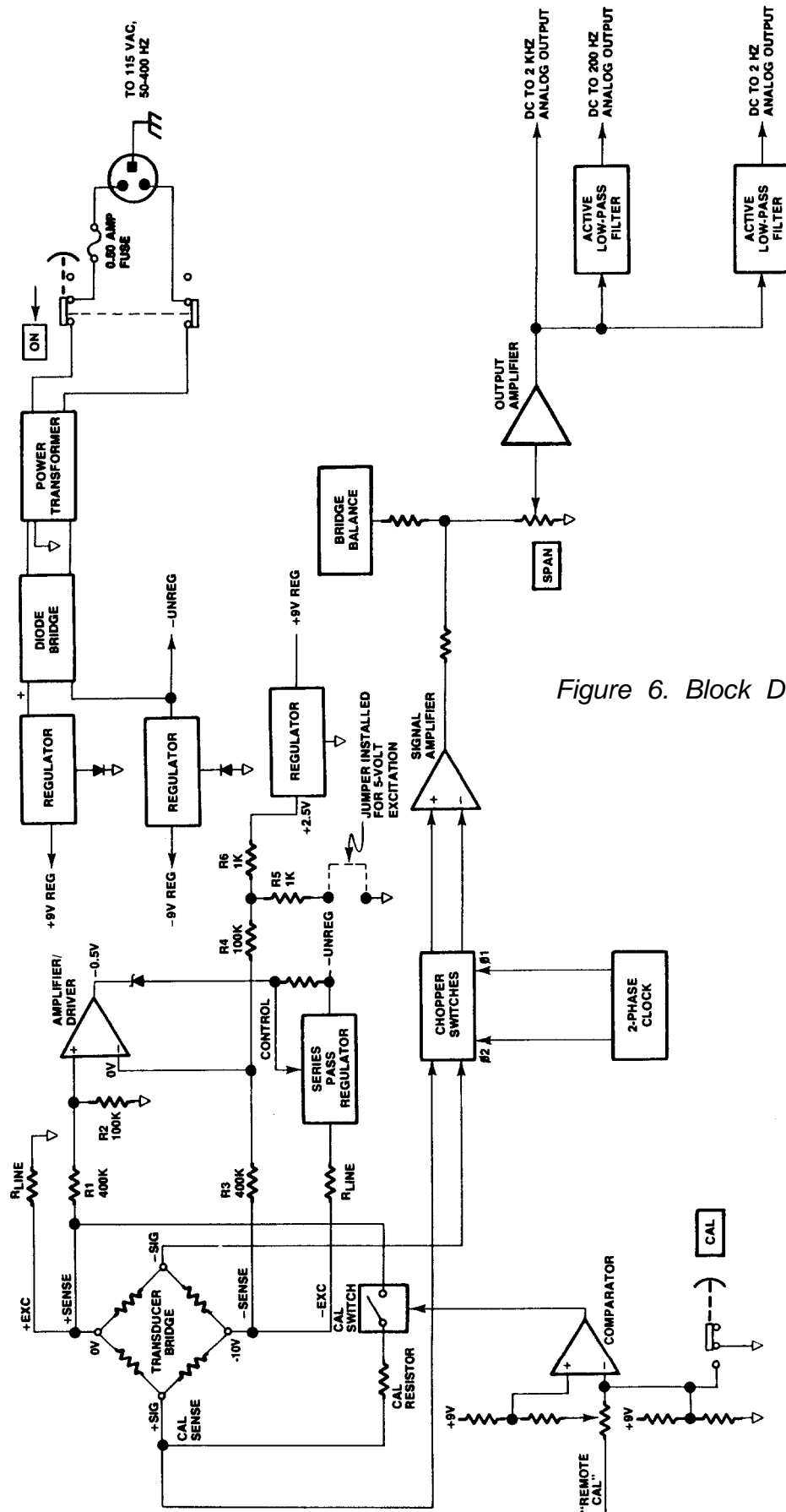


Figure 6. Block Diagram

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.

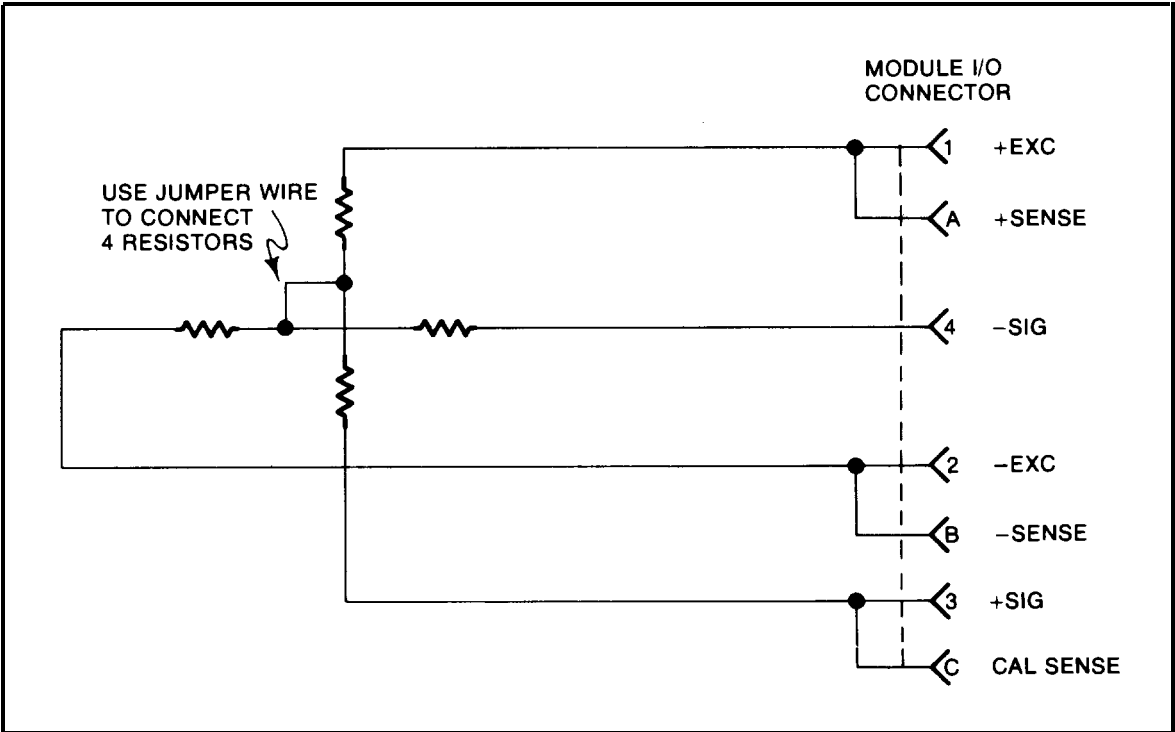


Figure 7. Star-Bridge Construction



MODEL

3200 / 3300

DIGITAL INDICATOR

INSTRUCTION MANUAL



3000
Instrument Series



MODEL
3200 / 3300

DIGITAL INDICATOR

INSTRUCTION MANUAL

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PLEASE NOTE: Sections 6 and 7, Figures 6 and 7, and Table 3 have been removed from this manual.

If you need information regarding specific 3200/3300 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.

INSTRUCTION MANUAL 3200/3300 SERIES DIGITAL INDICATOR

1. DESCRIPTION

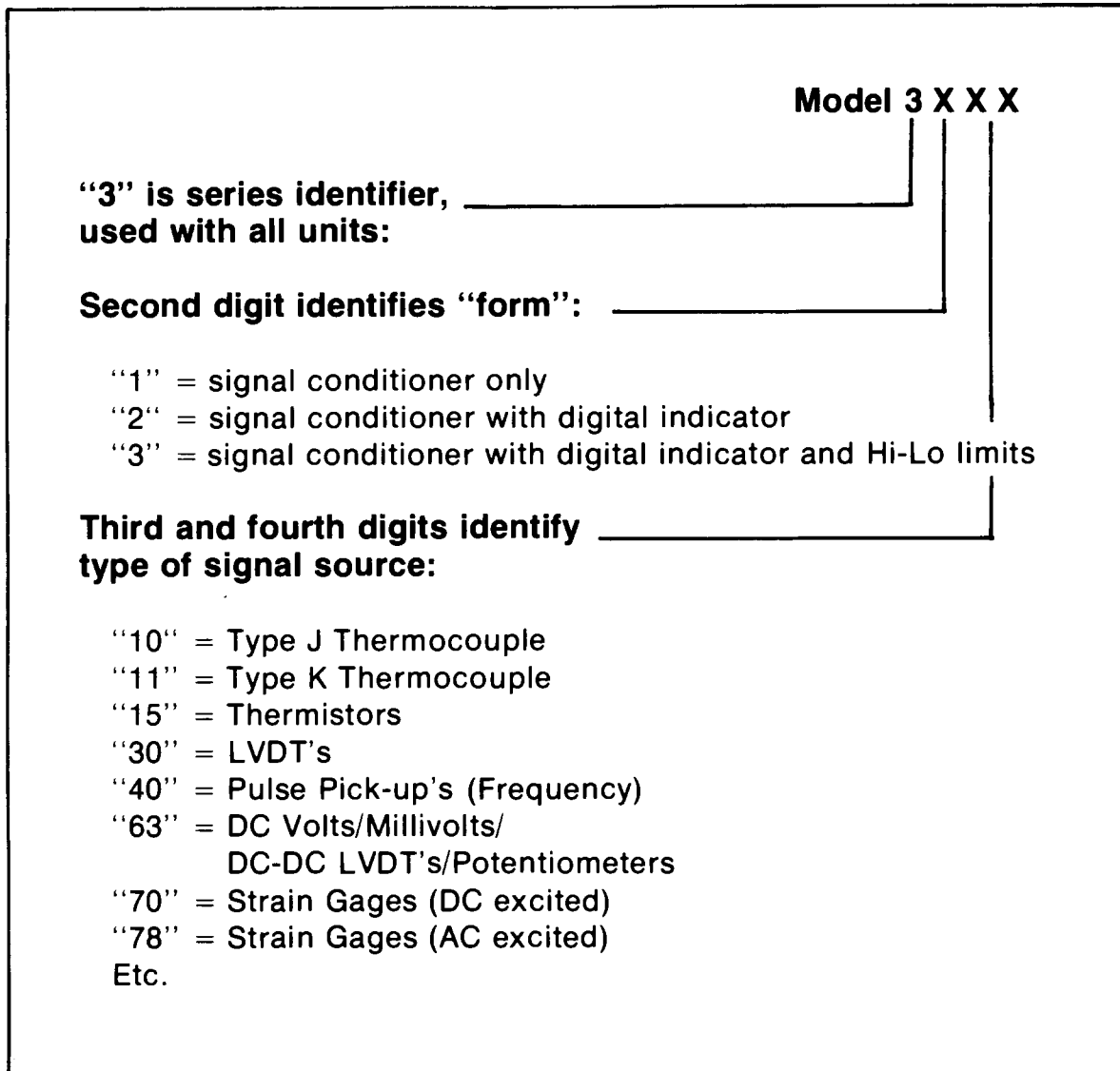
The *3000 Instrument Series* is a family of premium signal conditioning instruments that includes models to accommodate virtually all types of transducers and signal sources commonly encountered in electro-mechanical testing and control operations. The *3000 Instruments* are available in three forms: *Form 1* contains the Signal Conditioner only; *Form 2* is the Signal Conditioner with Digital Indicator; *Form 3* is the Signal Conditioner with Digital Indicator and Hi-Lo Limits. The Model numbering system used with the *3000 Series* identifies the form and the type of signal source. This numbering system is further explained in Table 1. From Table 1, it can be seen that all models having a Digital Indicator are identified by a 32XX or 33XX number, with the last two digits identifying the type of signal source (thermocouple, LVDT, etc).



Figure 1. 3000 Series Instrument with Digital Indicator

"3000" Digital Indicator

Table 1. 3000 Series Model Numbering



The *3000 Series* instruction manual system is designed to provide the user with the following documentation: (1) a separate instruction manual for each type of Signal Conditioner purchased; (2) an instruction manual covering only the Digital Indicator section of a *3000 Series* instrument, but applicable to any *Form 2* or *Form 3* instruments; and (3) an instruction manual covering only the Hi-Lo Limit section

of a *3000 Series* instrument, but applicable to any *Form 3* instrument. It is the purpose of this manual to cover the Digital Indicator section of all *Form 2* and *Form 3* instruments.

The Digital Indicator section of any *Form 2* or *Form 3* instrument consists of a printed-circuit board on which are mounted the required circuit components for digitizing the analog output of the Signal Conditioner and the light-emitting-diode (LED) display. This board is mounted above the circuit board which contains the components for the Signal Conditioner. The digits which comprise the display are mounted on a small board which is affixed to the digitizer board with a right-angle printed-circuit board header. The *Form 3* instruments contain an additional printed-circuit board for the Hi-Lo Limit circuitry.

The LED display is comprised of six orange digits with polarity sign. The 0.4 inch height of the digits, combined with the inherent brilliance of an LED type of display, make the display easily discernible in normal room lighting. The display is viewed through the red plastic front panel of the instrument to provide filtering of external light and enhance the display brilliance. The front panel is opaque except for that portion through which the display is viewed. A typical *3000 Instrument* with Digital Indicator is shown in Figure 1.

The Digital Indicator scaling is selected with rear-panel pushbutton switches. Full-scale values of ± 5000 counted by *1's*, ± 10000 counted by *2's*, or ± 20000 counted by *5's* can be selected. The most significant digit (MSD) of the display contains the polarity sign and is either unlit or lights as a *1* for displays of 10000 or greater. The least significant digit (LSD) is a dummy zero which can be turned ON or left unlit as desired. In addition, decimal-point position can be selected to give display readings as follows: 1.XXXX, 1X.XXX, 1XX.XX, 1XXX.X, or 1XXXX (no decimal point). Decimal-point location and dummy zero selection are also accomplished with rear-panel switches (miniature slide-switch bank). When the 20000 scale is selected, the display is digitally limited to read a maximum number of 19995 since the MSD is either unlit or reads a "1" for displays of 10000 or greater. The 5000 and 10000 scales are analog limited to an overrange of approximately 5600 and 11200, respectively. An overrange condition on any range is indicated by a flashing display. The sampling rate of the display is 3 samples per second. The Digital Indicator specifications are summarized in Table 2.

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Table 2. Specifications

Display: Orange LED's, six digits with polarity sign, 0.4 inch height. MDS is either unlit or reads a 1 and contains the polarity sign. LSD is a dummy zero which can be programmed to be lit or unlit (rear-panel switch).

Scaling: Selectable at rear panel; full-scale values of ± 5000 counted by 1's, ± 10000 counted by 2's, or ± 20000 counted by 5's.

Decimal Point: Decimal-point location can be selected with rear-panel switches as follows: 1.XXXXX, 1X.XXX, 1XX.XX, 1XXX.X, or 1XXXX (no decimal point).

Sampling Rate: 3 samples per second.

Legends: Each instrument supplied with an appropriate assortment of user-installable rub-on engineering unit legends.

2. INSTALLATION

The *3000 Series* Instruments can be operated as bench-top instruments or they can be rack- or panel-mounted. Dimensions for all three types of mounting and corresponding mounting instructions are given in the accompanying Signal Conditioner *Instruction Manual*. The following paragraphs provide the instructions for legend installation, scale selection, decimal point/dummy zero selection, and ac power connection.

Legend Installation. A sheet of dry-transfer lettering is supplied with each instrument to provide the user with a means of affixing an engineering-unit legend to the front panel. The sheet contains the common engineering units encountered in making electro-mechanical measurements and additional alpha-numeric characters. Space is supplied on the front panel to affix the desired legend to the right of the display. To affix the legend to the front panel, press the dry-transfer sheet firmly

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against the panel with the desired legend or character situated in place. Rubbing the legend or character with a ball-point pen will cause the legend to be transferred onto the panel. The legend can be protected from scratches which may occur during calibration/operation of the instrument by lightly spraying it with Krylon #1306 Workable Fixative.

If it is desired to change a legend, remove the legend to be replaced by pressing masking tape against the legend, then pulling off the gummed tape.

Scale Selection. Figure 2 shows the full-scale display for the three selectable scales: ± 5000 counted by 1's, ± 10000 counted by 2's, and ± 20000 counted by 5's. The figure also indicates the last active digit and the dummy zero which can be lit for any scale selection. The first digit of the display contains the polarity sign and lights as 1 on the 10000 and 20000 scales for values equal to or greater than 10000. On the 20000 range, because the most significant digit is either unlit or a 1 and the count is by 5's, the greatest number which can be displayed is 19995. Of course, this would be displayed as 199950 if the dummy zero were lit.

Scale selection is accomplished with the two pushbutton switches located at the rear panel. The panel is marked to indicate which switches are pushed IN or left OUT for the corresponding scale selection. The switches have a push-push action and are illustrated, with the scale selection coding, in Figure 3. With both switches OUT, the ± 5000 range is selected. With the left switch OUT and the right switch IN, the ± 10000 range is selected. With the left switch IN and the right switch OUT, the ± 20000 range is selected.

Decimal Point/Dummy Zero Selection. Decimal-point location and dummy-zero activation are selected with a rear-panel miniature slide switch bank. The switch bank is marked on the rear panel as shown in Figure 3. The decimal-point position can be fixed at any one of the display locations indicated on Figure 3. Place any one of slide switches 1 through 4 ON to light the decimal point at the desired location. Place slide switch 5 ON if no decimal point is to be lit. To activate the dummy zero (digit to the right of last active digit will continuously light as a zero), place slide switch 6 ON.

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

"3000" Digital Indicator

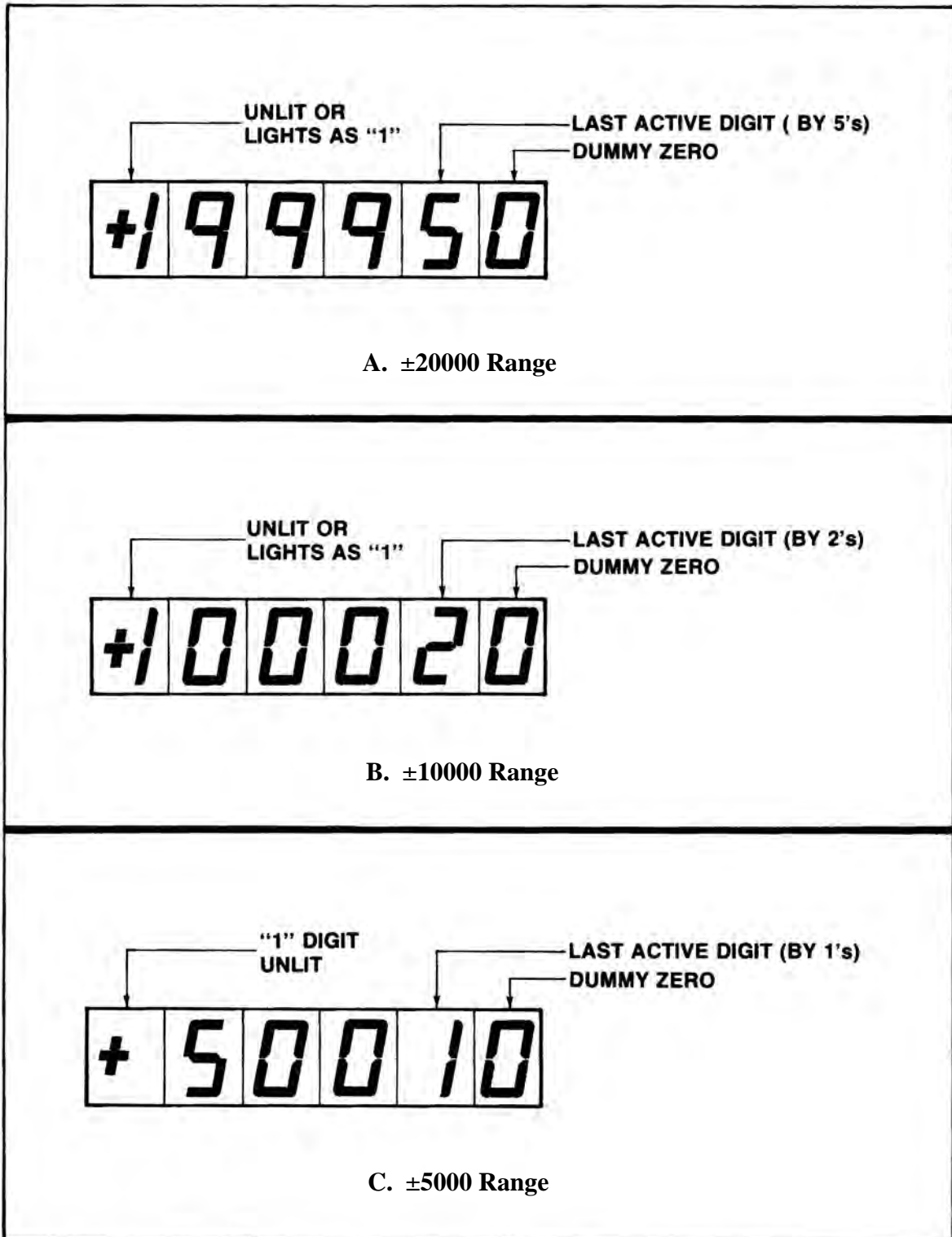


Figure 2. Full-Scale Displays for Three Ranges

power cord is ground. To maintain the safety ground when operating the instrument 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.

3. OPERATION

The only operation required is turning ON/OFF ac power to the instrument. This is accomplished with the rear-panel slide switch (see Figure 3). The display lights immediately when ac power is ON.

NOTE

In all instances, a flashing display indicates that an overrange condition has occurred, and it is likely that the Signal Conditioner amplifiers are being overdriven. The 5000 and 10000 ranges are analog limited at approximately 5600 and 11200, and while a number may be displayed, if

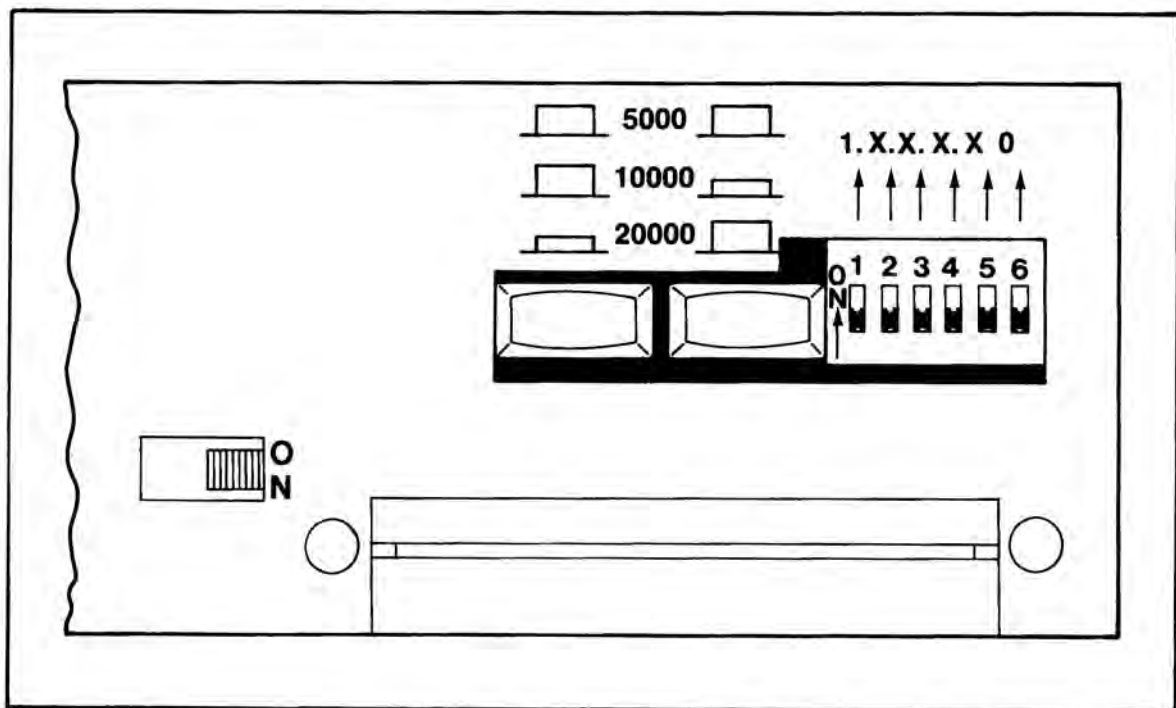


Figure 3. Scale, Decimal Point, Dummy Zero Switches

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the display is flashing an overrange condition has occurred. Consequently, the displayed value may be invalid. The 20000 range is digitally limited to 19995. When an overrange occurs on this range, the display will flash all zeros.

4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the Digital Indicator 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 5.

Power Supplies. The integrated-circuit chips which comprise the *A/D Converter* and the *Overrange Comparator* are CMOS circuits which require ± 9 volts regulated. These voltages are supplied from power supplies contained on the Signal Conditioner circuit board and are discussed in the *Signal Conditioner Instruction Manual*.

The digital part of the *A/D Converter*, the *Bit Selector*, and the various logic gates and inverters are operated from +5 volts regulated (TTL logic). The +5 volt supply consists of a three-terminal *Regulator*. The unregulated input to the Regulator is obtained from Signal Conditioner circuit board (unregulated side of +9 volt supply).

The *BCD-to-7-Segment, Decoder, Display Drivers*, and *Display LED's* operate from +6 volts unregulated. Five volts ac is supplied from the Signal Conditioner circuit board (secondary of power transformer located on board). Plus 6 volts unregulated is developed with a *Diode Bridge* and *Filter* located on the Digital Indicator board.

A +2.5 volts precision reference is supplied from a precision power supply located on the Signal Conditioner circuit board. This reference is used in the *A/D Converter* for digitizing the analog input signal.

A/D Converter. The *A/D Converter* is a dual-slope converter which digitizes the analog input signal using a ratiometric integrating technique. The analog signal input, a reference input, and a clock input are applied to the converter. The measurement cycle is divided into an *Auto-Zero* cycle, a *Signal Integrate* cycle, and

a *Reference Integrate* cycle. Each cycle has a time base in which a certain amount of clock pulses occur. The clock used is a 100-kHz crystal oscillator. The *Auto-Zero* cycle is used to bring the output of the integrator to zero and lasts 10,000 counts. The next cycle is the *Signal Integrate* cycle which also lasts 10,000 counts. If the analog input is zero at the start of the *Signal Integrate* cycle, the integrator will see the same voltage that existed in the previous state. Thus, the integrator output will not change but will remain stationary during the entire *Signal Integrate* cycle. If the analog input is not equal to zero, an unbalanced condition exists compared to the *Auto-Zero* cycle and the integrator will generate a ramp whose slope is proportional to the analog input. At the end of this cycle, the sign of the ramp is determined. If the input signal was positive, a voltage which is V_{REF} more negative than during *Auto-Zero* is applied to the integrator input. The *A/D Converter* chip generates the equivalent of a *+Reference* or *-Reference* from the single *+Reference* applied. The reference voltage returns the output of the integrator to zero. The time, or number of counts, required to do this is proportional to the input voltage. The *Reference Integrate* cycle can be a maximum of 20,000 counts. The full measurement cycle is then a maximum of 40,000 counts, with the answer to the measurement being achieved when the reference voltage returns the integrator output to zero. The full measurement cycle is shown in Figure 4.

The DIGIT DRIVES are positive-going signals that last for 200 clock pulses (see Figure 4). The scan sequence is D5 (MSD), D4, D3, D2, and D1 (last active digit). The scan is continuous unless an overrange occurs. Then all DIGIT DRIVES are blanked from the end of the first scan until the beginning of the *Reference Integrate* cycle when D5 will start the scan again. This gives a blinking or flashing display as a visual indication of overrange. Because the Digital Indicator has 5000 and 10000 ranges as well as a 20000 range, an analog *Overrange Comparator* is used as well as the inherent overrange capability of the *A/D Converter*. The *Overrange Comparator* is described in a following paragraph.

The binary-coded-decimal (BCD) outputs of the *A/D Converter* are positive logic signals that go on simultaneously with the DIGIT DRIVE. Since the DIGIT DRIVES are blanked for an overrange on the 20000 scale, the display will flash all zeros when this condition occurs on this scale.

Input Attenuators/Range Switches. The 5-volt analog signal input (full scale) and the 2.5 volt reference from the Signal Conditioner are applied to attenuator networks where 2-volt and 1-volt signal and reference inputs are developed for the *A/D Converter*. Since, on the 20000 range, the *Reference Integrate* cycle can be

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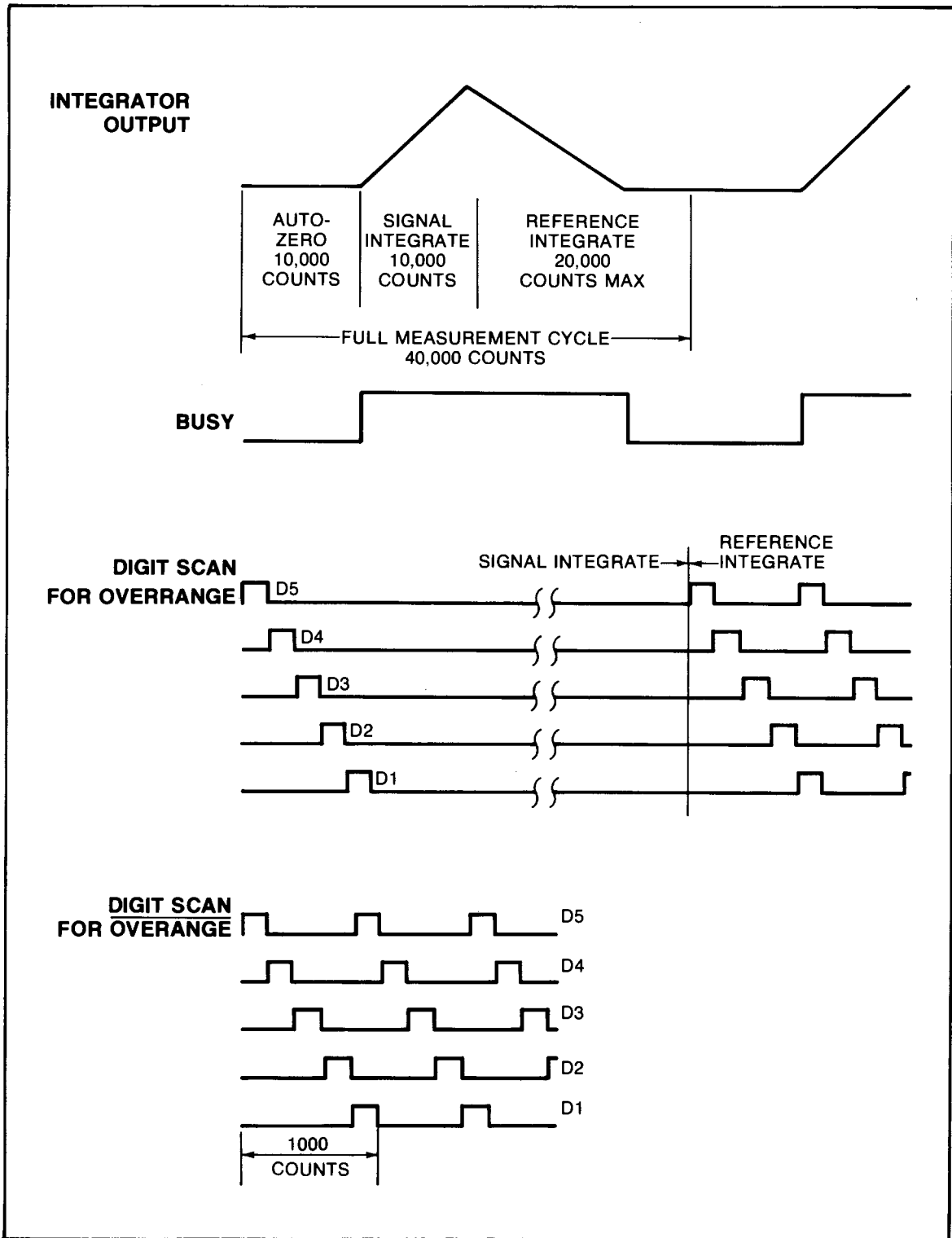


Figure 4. A/D Converter Timing Diagram

twice as long as the *Signal Integrate* cycle, the analog input voltage required to give a full-scale reading is exactly equal to $2 V_{REF}$. Consequently, on the 20000 range, the V_{REF} is 1 volt and the V_{SIG} is 2 volts for full scale. On the 10000 range, the two cycles can be equal; thus, $V_{SIG} = V_{REF} = 2$ volts. On the 5000 range, the analog voltage for a full-scale reading is then equal to $1/2 V_{REF}$; thus, V_{REF} must be 2 volts and V_{SIG} 1 volt. The appropriate levels are switched to the *A/D Converter* through the rear-panel *Range* switches.

Bit Selector/Decoding Logic. The Bit Selector transfers one of two sets of 4-line BCD data applied at input ports to output ports upon receiving a command at the A SELECT or B SELECT port. When the A SELECT port is high, the X input data is transferred to the Z output ports. Conversely, when the B SELECT input is high, the Y input data is transferred to the Z output ports. The Y data is obtained directly from the BCD output ports of the *A/D Converter*. The X data is comprised of specially coded bits used to count by 2's or 5's when the 10000 or 20000 ranges are selected, respectively. On the 5000 range, the A SELECT input is held low through the *Range* switches and the B SELECT input is high. The Y data is transferred to the output of the *Bit Selector* and the display count is by 1's. On the 10000 range, the A SELECT input is held low except when the D1 DIGIT DRIVE is high. When D1 is high, the A SELECT is high and the B SELECT is low, transferring the X data to the Z ports of the *Bit Selector* and allowing the display to count by 2's. Operation on the 20000 range is identical except that the bit coding is arranged to give a count by 5's with the X data.

Display Coding/Driving. The display is a 4.5-digit LED display with polarity and a dummy zero. DS2 through DS6 are 7-segment displays with common cathodes. The *Bit Selector* output ports are connected as inputs to a *BCD-to-7-Segment Decoder*. The 7 outputs of the decoder are connected as inputs to the segments (anodes) of DS2 through DS6. The DIGIT DRIVES of the *A/D Converter* are used to sequentially turn on DS2 through DS6 through *Display Drivers* which sink current. DS1 is either unlit or lights as a 1 for displays of 10000 or greater. Unlike DS2 through DS6, DS1 is a common anode device. The DS1 segments (cathodes) are sunk via a display driver from the 1 bit of the *A/D Converter*. The DS1 anode is then brought high by D5 through a driver comprised of an inverter and a transistor which applies +6 volts unregulated to the anode when D5 is high.

The last digit of the Display (DS6) is the dummy zero digit. When the *Dummy Zero Select* switch is ON, the DS6 cathode is sunk when D5 is high. The outputs of the *BCD-to-7-Segment Decoder* are tied to the DS6 segments. Also, when D5 is

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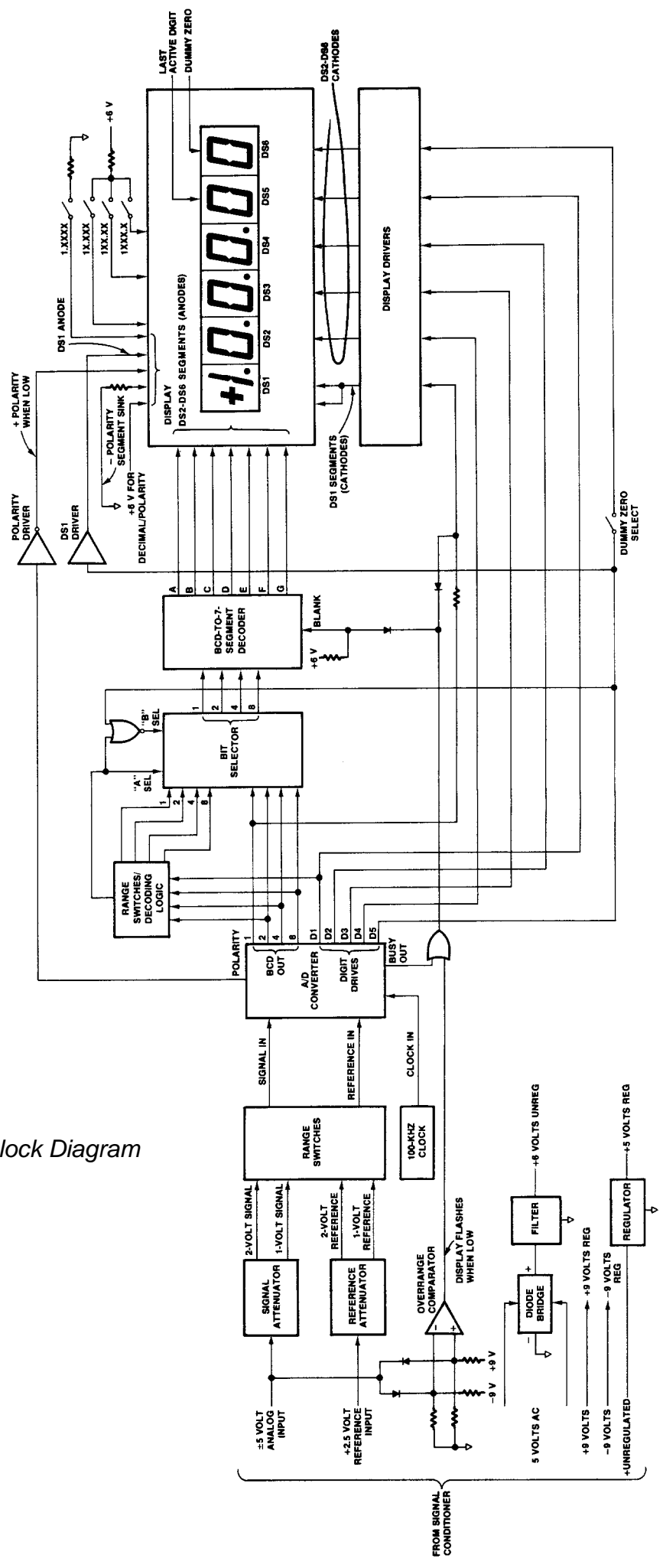
high, the B SELECT input to the *Bit Selector* is pulled low through the NOR gate connected to the port. The A SELECT input is also low since it is either held hard low through the *Range* switches on the 5000 range or it is connected to D1 through the *Range* switches on the 10000 and 20000 ranges (when D5 is high D1 must be low). With the A SELECT and B SELECT inputs both low, the Z ports of the *Bit Selector* assume the low state no matter what the X and Y input data reads. Consequently, each time D5 is high, DS6 displays a zero.

The polarity sign is also part of DS1. The minus (-) segment is always lit through 6 volts and an external resistor tied to circuit common. When the *A/D Converter* senses a positive polarity, the POLARITY port goes high. This action drives an inverter low to light the vertical portion of the polarity sign.

Decimal point position is selected with rear-panel slide switches (as is dummy zero selection). Only one of the *Decimal* slide switches is turned ON at any one time. The decimal-point LED for DS1 is hard wired to +6 volts. Turning ON the associated *Decimal* switch connects an external resistor and circuit common to the other side of the decimal-point LED. Since the remaining digits with decimal-point LED's (DS2 through DS4) are common cathodes devices, each LED is sunked when the corresponding DIGIT DRIVE is high and associated *Decimal* switch is ON, applying +6 volts to the other side of the LED through an external resistor.

Analog Overage. Digital overrange for the 20000 range is inherent in the A/D Converter chip and has been previously described. However, for the 5000 and 10000 ranges, an analog overrange circuit is required. The *Overage Comparator* is dc biased with equal resistors returned to the ± 9 volt supplies so that its output is at approximately 4.5 volts. Both of the comparator inputs are connected through diodes to the analog input from the Signal Conditioner. When the analog input is one diode drop above or below the comparator biasing, an overrange condition exists since approximately 5.2 volts is present at the analog input (5 volts = full-scale value). The output of the *Overage Comparator* goes low when either of the input diodes is forward biased. The comparator output and the BUSY output of the A/D Converter are gated through an OR gate. The BUSY signal is high during the Signal and Reference Integrate cycles of the A/D Converter, then it goes low. This causes the output of the OR gate to go low. The BLANK port of the BCD-to-7-Segment Decoder is normally held high through an external resistor. When the OR gate output goes low, the BLANK port is pulled low through a diode, causing DS2 through DS6 to flash. Since DS1 is not driven from the decoder, a second diode and resistor are used to pull the *A/D Converter 1-bit* output low when the overrange OR gate is low. This action causes DS1 to flash.

Figure 5. Block Diagram



5. VERIFICATION OF NORMAL OPERATION

It is the purpose of this section to aid the user in rapidly determining whether the Digital Indicator is functioning normally or whether it is the source of the observed trouble. In the event a repair to the Digital Indicator is required, 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.

One of the two techniques can be used to rapidly determine whether the Digital Indicator is malfunctioning or whether the problem is in the Signal Conditioner, transducer, or transducer cabling. If the unit is a *Form 2* instrument (no Hi-Lo Limits), attempt to zero and calibrate the Signal Conditioner while observing the Signal Conditioner analog output (use the dc-to-2Hz output) on a dc coupled oscilloscope. If the Digital Indicator is unstable or reads erratically, but the oscilloscope indicates a stable analog output from the Signal Conditioner, the problem is likely in the Digital Indicator. In the event the Signal Conditioner output is unstable or noisy, consult the Signal Conditioner *Instruction Manual* for the proper action to be taken.

If the instrument is a *Form 3* type, push one of the Limit pushbuttons and observe how the limit value is displayed on the Digital Indicator. If the display is stable with the Limit button pressed, but is unstable when the button is released, the problem is in the Signal Conditioner, transducer, or transducer cabling. If the display is unstable or erratic whether the button is pressed or released, the problem is in the Digital Indicator.



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