



**MODEL**  
**3378** Manuals  
3178 + 3200 + 3300  
**STRAIN GAGE CONDITIONER**

**INSTRUCTION MANUAL**



**3000**  
Instrument Series

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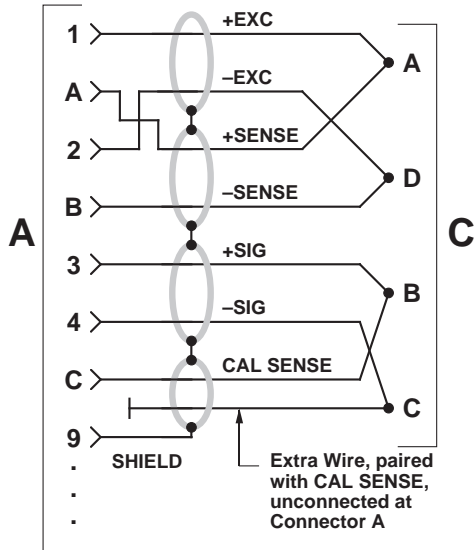
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# Correction

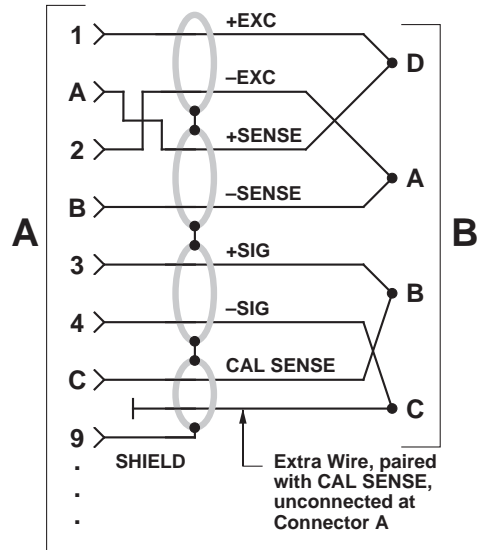
## to Model 3178 Instruction Manual, v. SB.5.1

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:

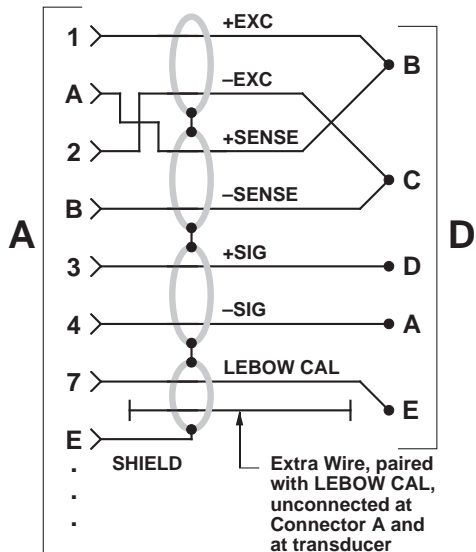
**Daytronic 400 Series  
Transducer Connections**



**Daytronic 500 Series  
Transducer Connections**



**Lebow 1600 Series  
Rotary Transformer Torque  
Transducer Connections**

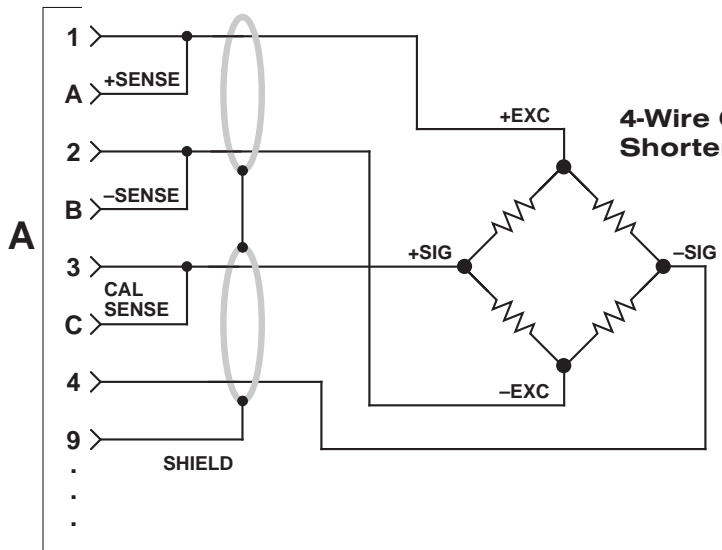


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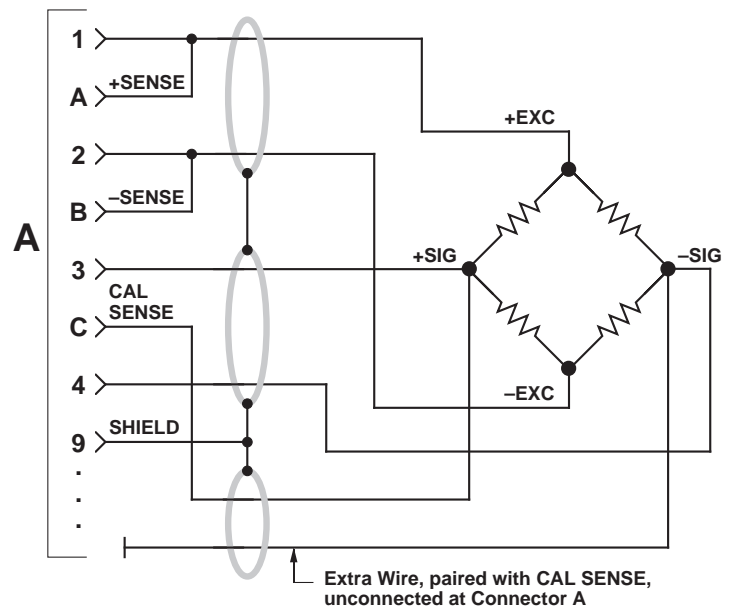
# Correction

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

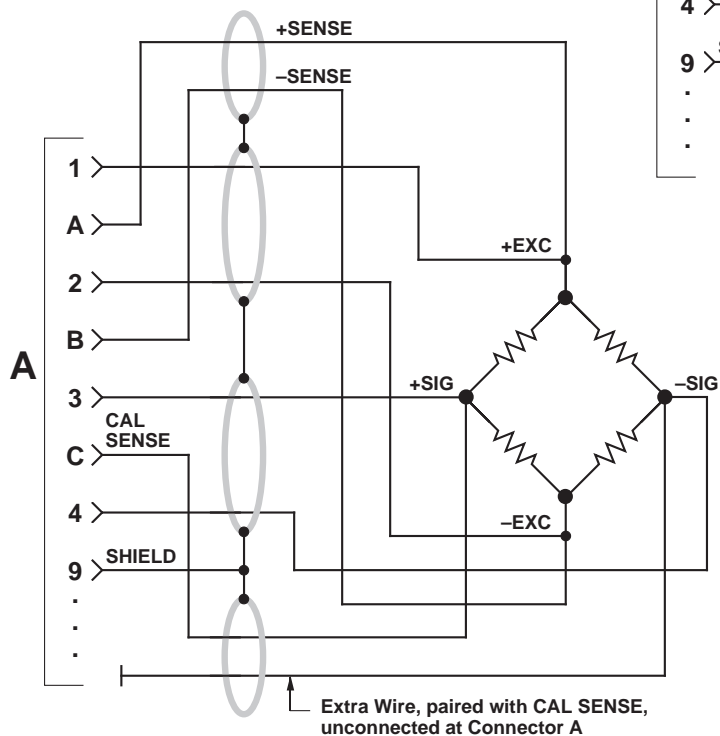
### Daytronic 3X78 Instrument to Generalized Strain Gage Transducer Showing CAL SENSE Connection



### 6-Wire Configuration for Cables Shorter Than 20 Feet



### 8-Wire Configuration for Cables Longer Than 20 Feet





**Model 3178 Instruction Manual, v. SB.5.1**

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**MODEL**  
**3178**  
**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 3178 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.**

## 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*

**Model 3178**

**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  $\pm 5$  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.



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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.

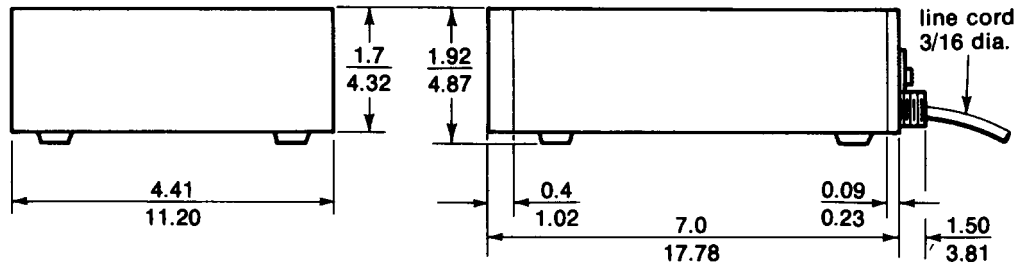
The 3178 Strain Gage Conditioner is also available in two additional forms. The Model 3278 contains a Digital Indicator to view the analog output of the conditioner. The Model 3378 contains a Limit section (in addition to a Digital Indicator) that provides *High/OK/Low* indications and outputs. The Digital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

## 2. INSTALLATION AND CABLING

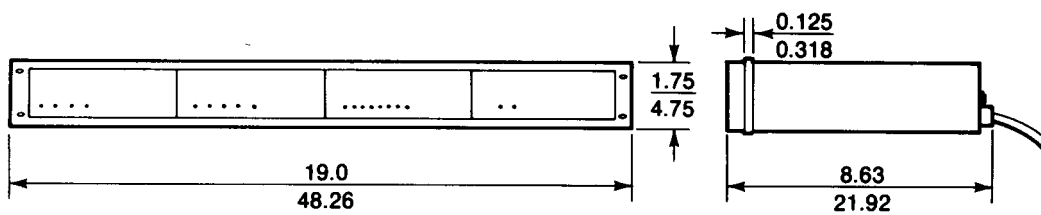
The following paragraphs provide the instructions for instrument installation and cabling.

**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.

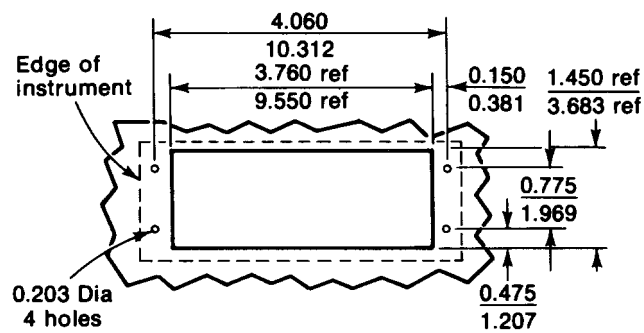
**IMPORTANT:** The unit is shipped with two **spacer washers** on the securing screws of the rear-panel I/O Connector. When **panel-mounting** the unit, you **MUST REMOVE THESE WASHERS**, so that the printed-circuit board may move forward about 1/8" during Step (f).



A. Bench Mounting



B. Rack Mounting



PANEL CUT-OUT DIMENSIONS

C. Panel Mounting

Figure 2. Instrument Mounting Dimensions

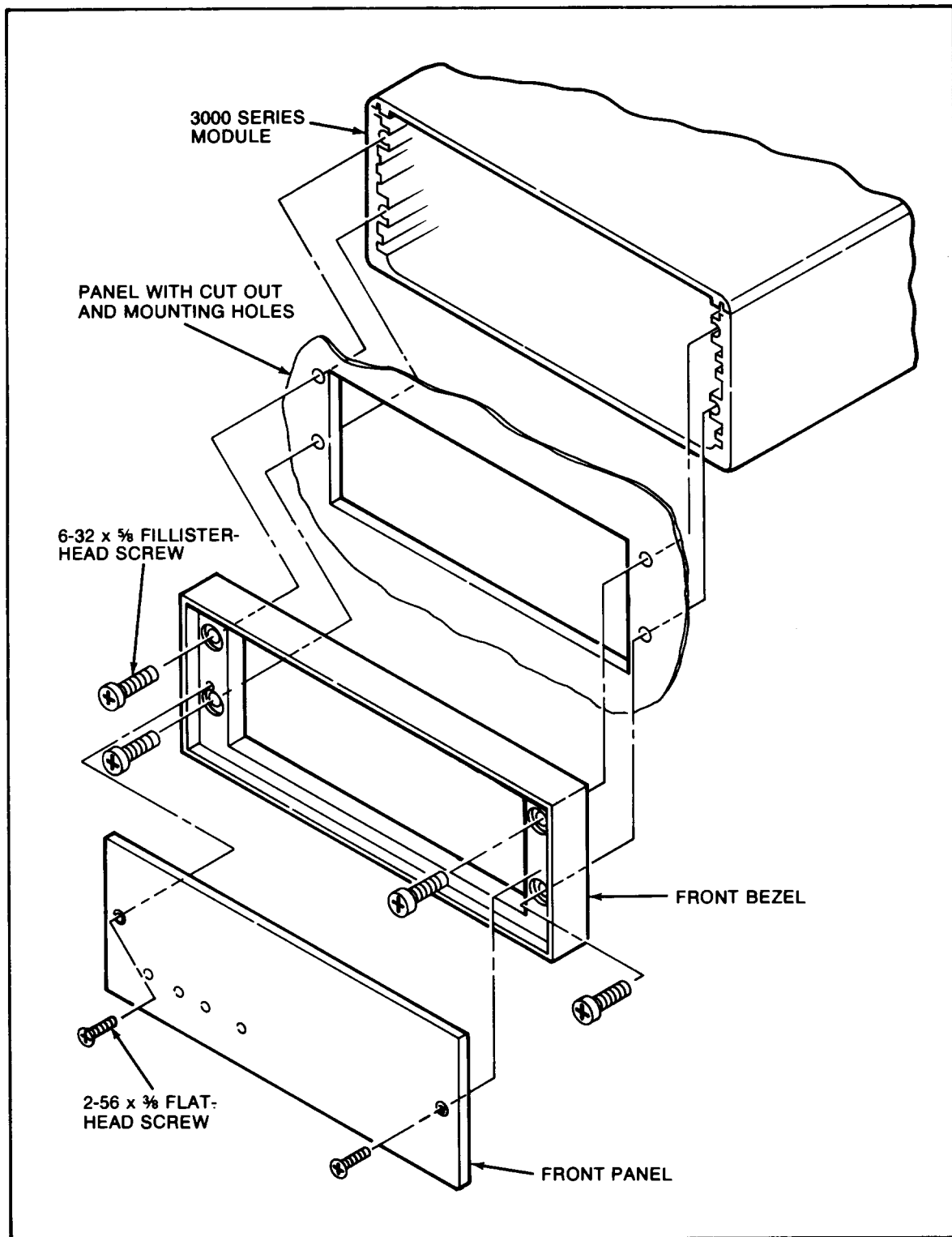


Figure 3. Instrument Panel Mounting

- (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.

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**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.

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



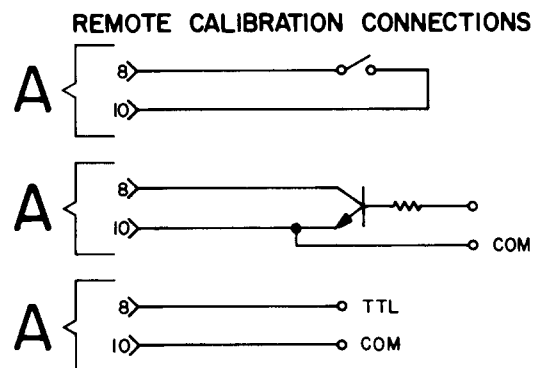
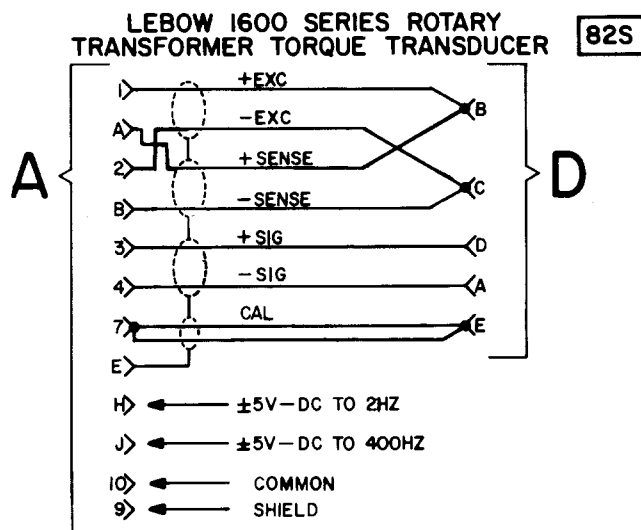
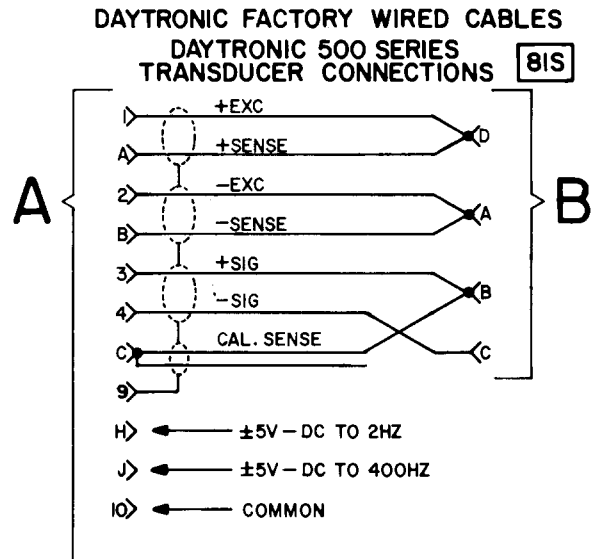
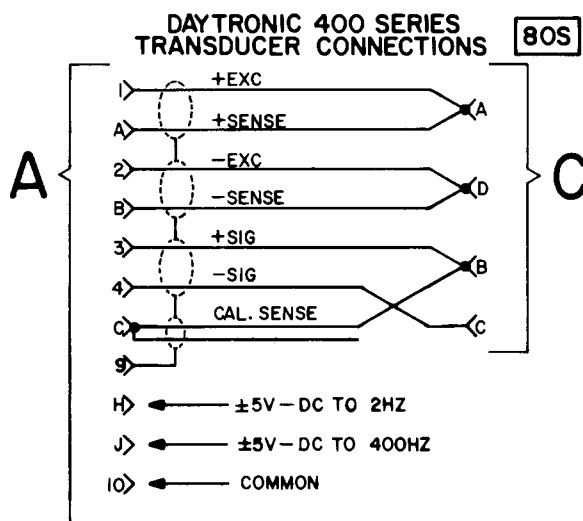
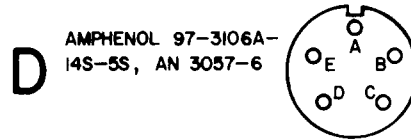
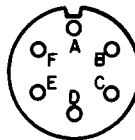
Fig. 4 I/O Wiring Data

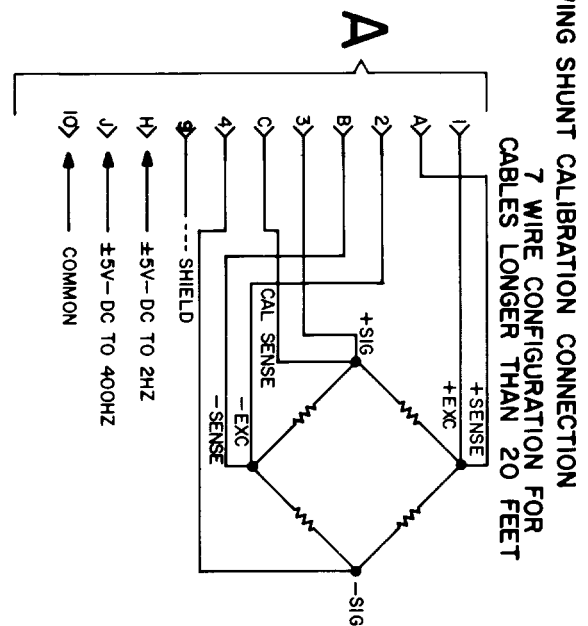
**A**

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 OSC. DISABLE
5 SIGNAL COMMON	E TRANSDUCER CABLE SHIELD { LEBOW 1600
6 OSC. INPUT	F OSC. OUTPUT { SERIES ONLY
7 LEBOW 1600 CAL.	H ANALOG OUTPUT, $\pm 5V$ -DC TO 2HZ
8 REMOTE CALIBRATION	J ANALOG OUTPUT, $\pm 5V$ -DC TO 400HZ
9 OUTPUT SHIELD	K NC
10 OUTPUT SIGNAL COMMON	L NC

**B**  
**C**

AN 3057-6  
AMPHENOL 97-3106A-14S-6S  
BENDIX PTO2E-10-6S  
BURNDY BT06AC-10-6S





**MASTER 3X78**

# MASTER/SLAVE CONNECTION FOR 3X78 INSTRUMENTS

**SLAVE 3X78**

TO  
OTHER  
SLAVES



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

where  $A_{\text{out}}$  = output amplitude

$A_{\text{in}}$  = input amplitude

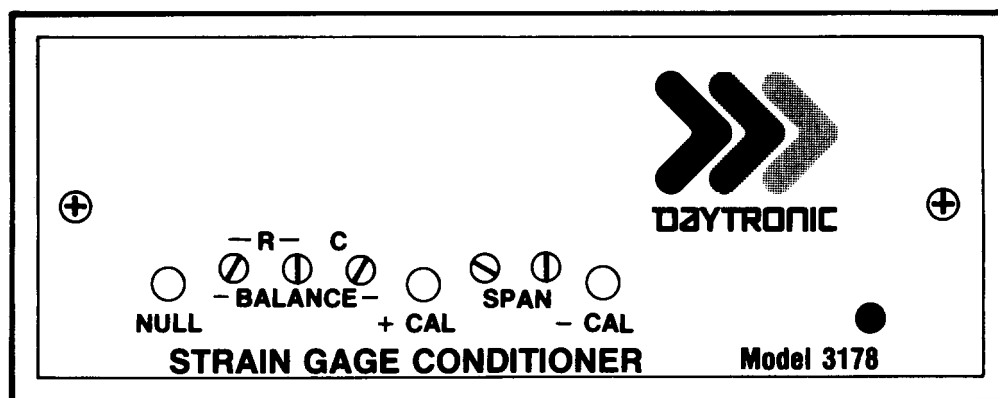
$f_0$  = selected cutoff frequency

$T$  = 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

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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  $\pm 9$  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.

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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.

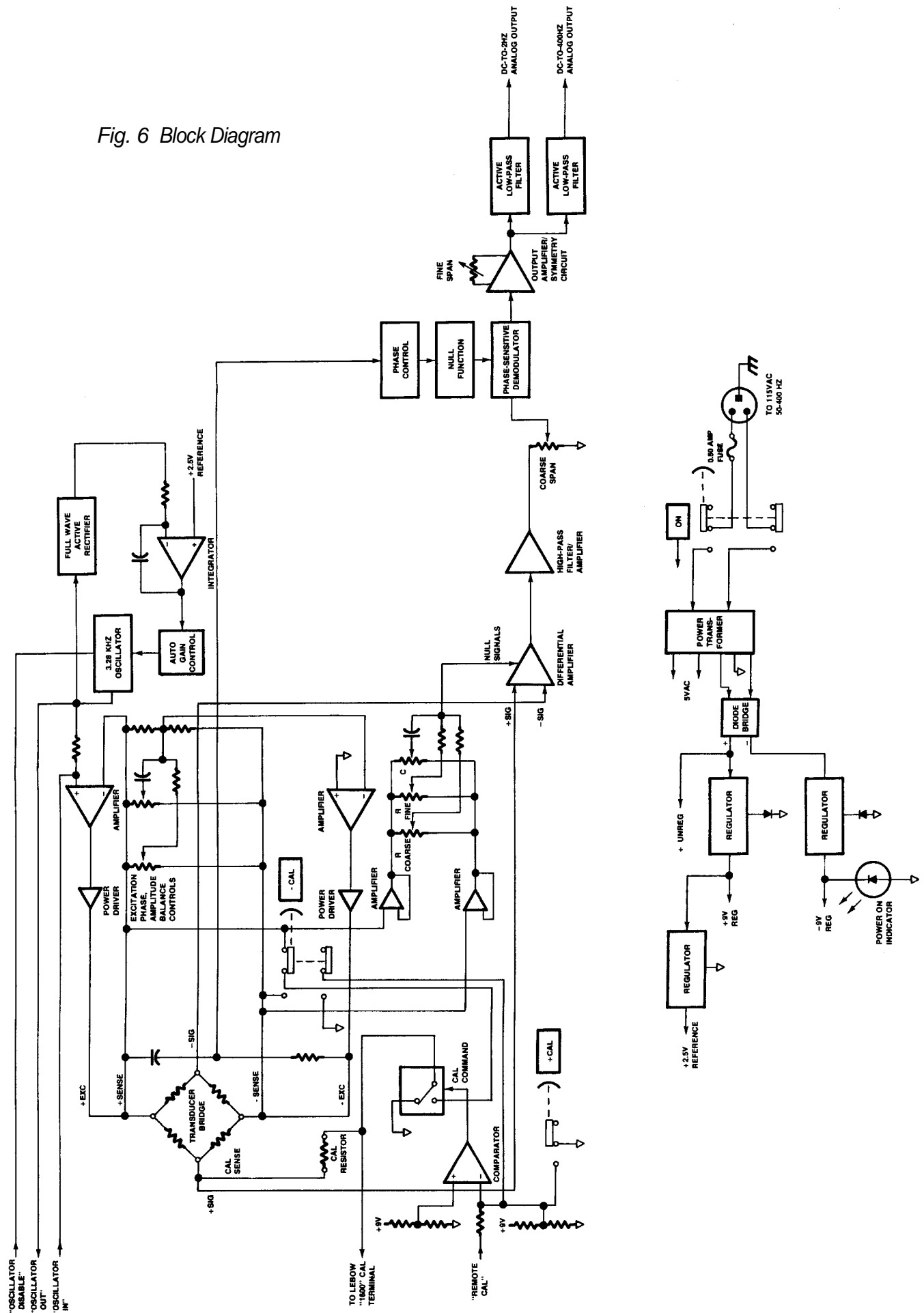
Calibration in the positive realm can also be remotely checked. When the *Remote Cal* input at the 3178 I/O connector is brought to a zero-volt (ground) level through the action of an external switch, transistor driver, etc., the same action occurs as when the +CAL button is pressed.

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.

Fig. 6 Block Diagram



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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 (F1) 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

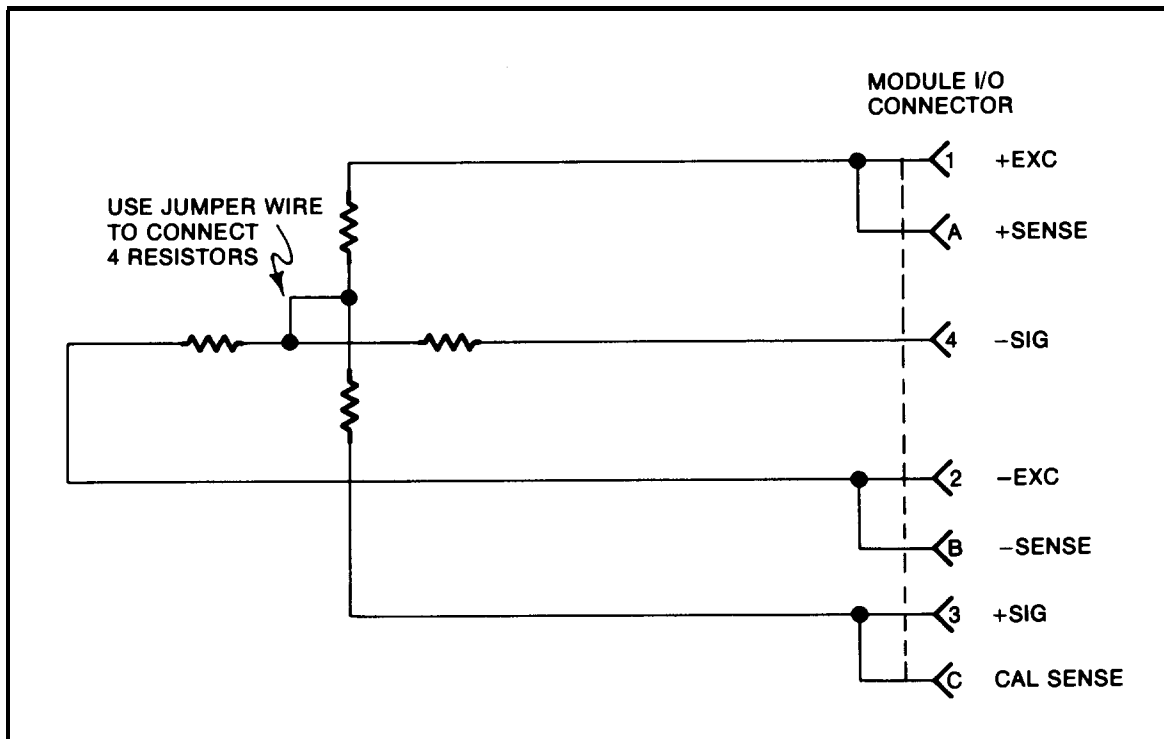


Figure 7. Star Bridge Construction

## **Daytronic Corporation**

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.



**MODEL**

**3200 / 3300**

**DIGITAL INDICATOR**

# **INSTRUCTION MANUAL**



**3000**  
Instrument Series



**Model 3200/3300 Instruction Manual, v. SB.5**

Pub. No. 3200/3300M.5, Issued 10/96

Part No. 91130

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**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

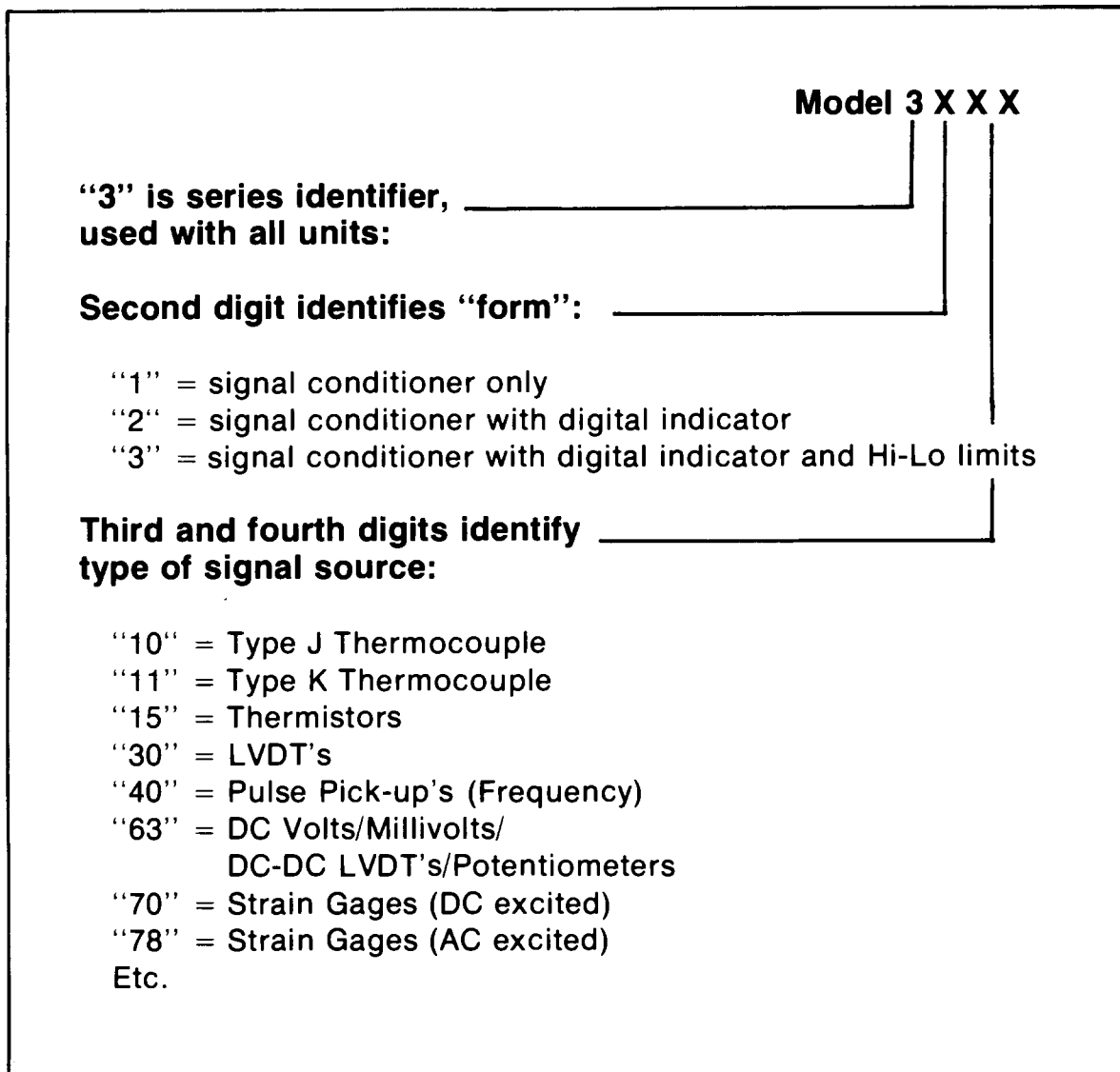
The *3000 Instrument Series* is a family of premium signal conditioning instruments that includes models to accommodate virtually all types of transducers and signal sources commonly encountered in electro-mechanical testing and control operations. The *3000 Instruments* are available in three forms: *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  $\pm 5000$  counted by 1's,  $\pm 10000$  counted by 2's, or  $\pm 20000$  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.



## "3000" Digital Indicator

*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  $\pm 5000$  counted by 1's,  $\pm 10000$  counted by 2's, or  $\pm 20000$  counted by 5's.

**Decimal Point:** Decimal-point location can be selected with rear-panel switches as follows: 1.XXXX, 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

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.

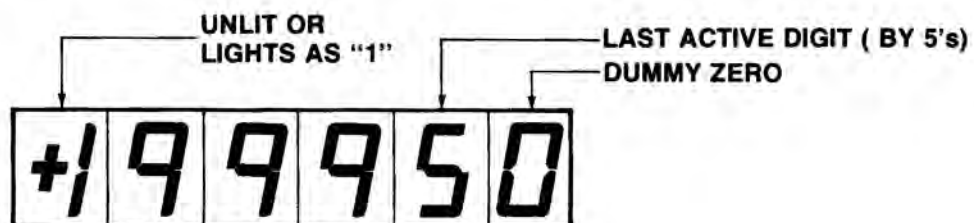
**Scale Selection.** Figure 2 shows the full-scale display for the three selectable scales:  $\pm 5000$  counted by 1's,  $\pm 10000$  counted by 2's, and  $\pm 20000$  counted by 5's. The figure also indicates the last active digit and the dummy zero which can be lit for any scale selection. The first 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  $\pm 5000$  range is selected. With the left switch OUT and the right switch IN, the  $\pm 10000$  range is selected. With the left switch IN and the right switch OUT, the  $\pm 20000$  range is selected.

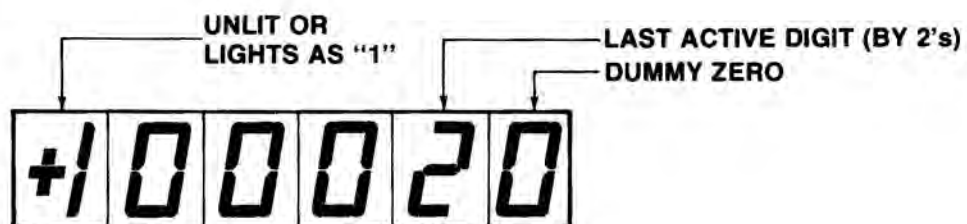
**Decimal Point/Dummy Zero Selection.** Decimal-point location and dummy-zero activation are selected with a rear-panel miniature slide switch bank. The switch bank is marked on the rear panel as shown in Figure 3. The decimal-point position can be fixed at any one of the display locations indicated 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

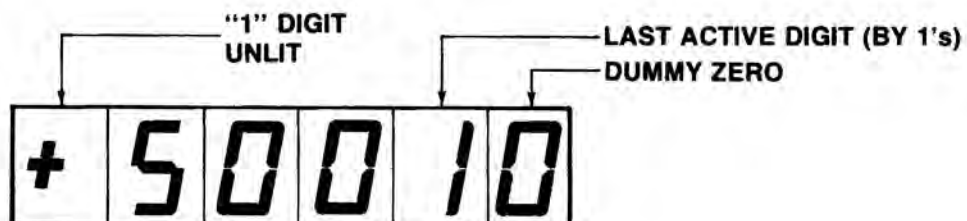
## "3000" Digital Indicator



A.  $\pm 20000$  Range



B.  $\pm 10000$  Range



C.  $\pm 5000$  Range

Figure 2. Full-Scale Displays for Three Ranges

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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

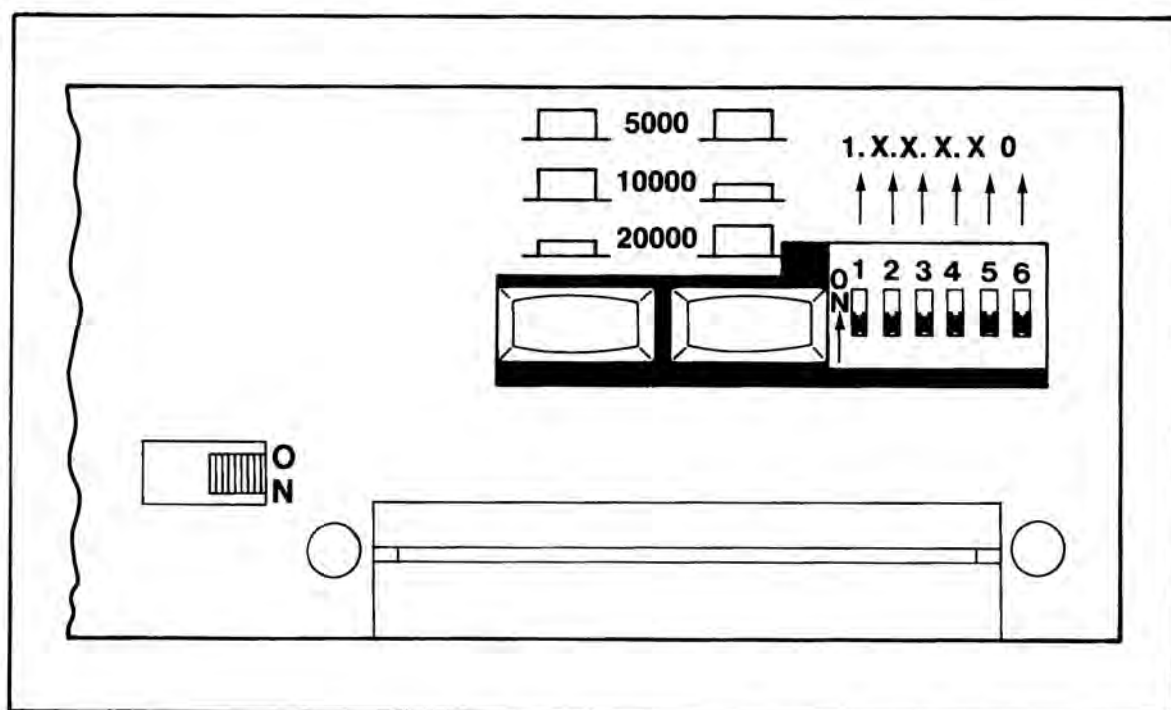


Figure 3. Scale, Decimal Point, Dummy Zero Switches

## "3000" Digital Indicator

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  $\pm 9$  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 VREF 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

# "3000" Digital Indicator

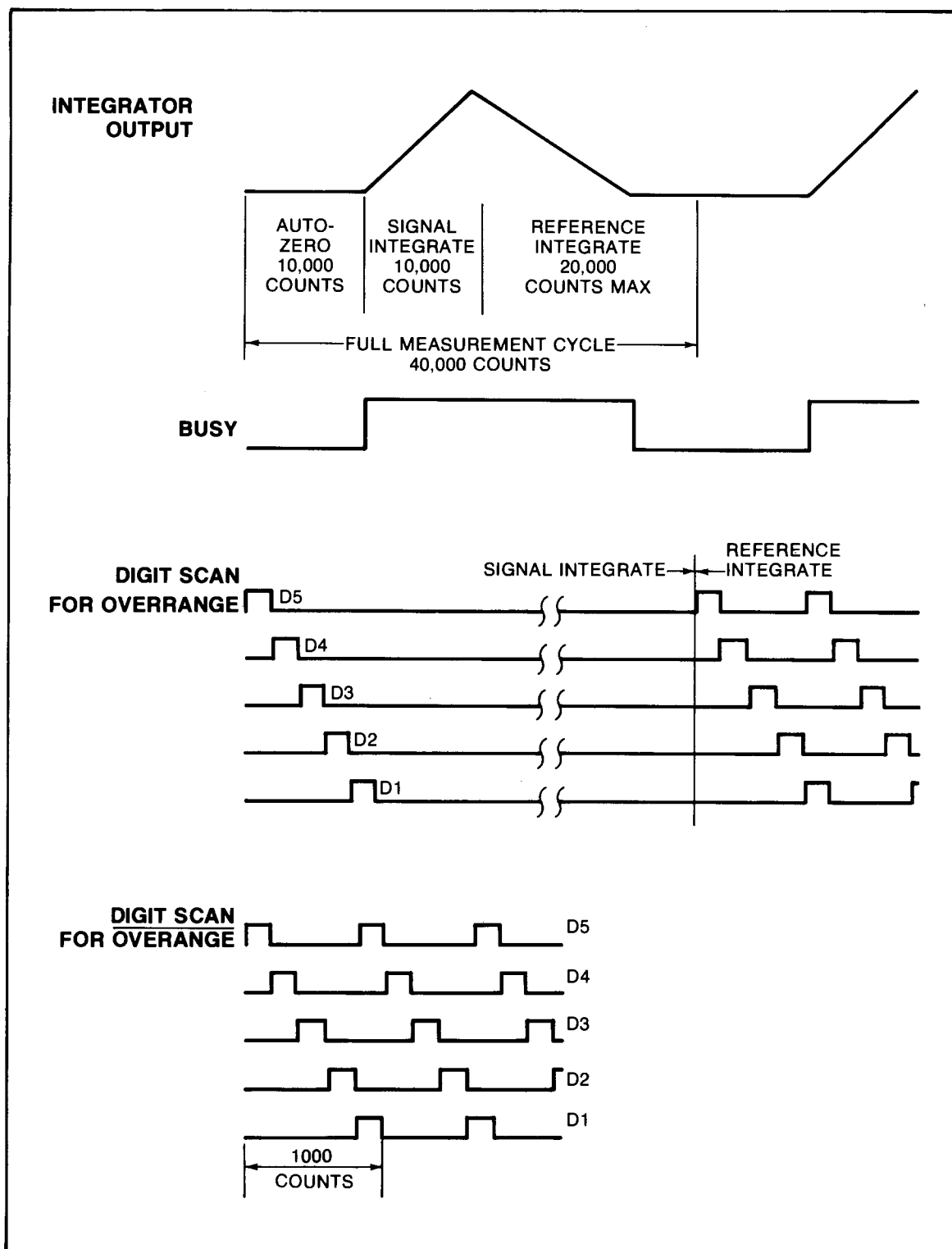


Figure 4. A/D Converter Timing Diagram

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



## "3000" Digital Indicator

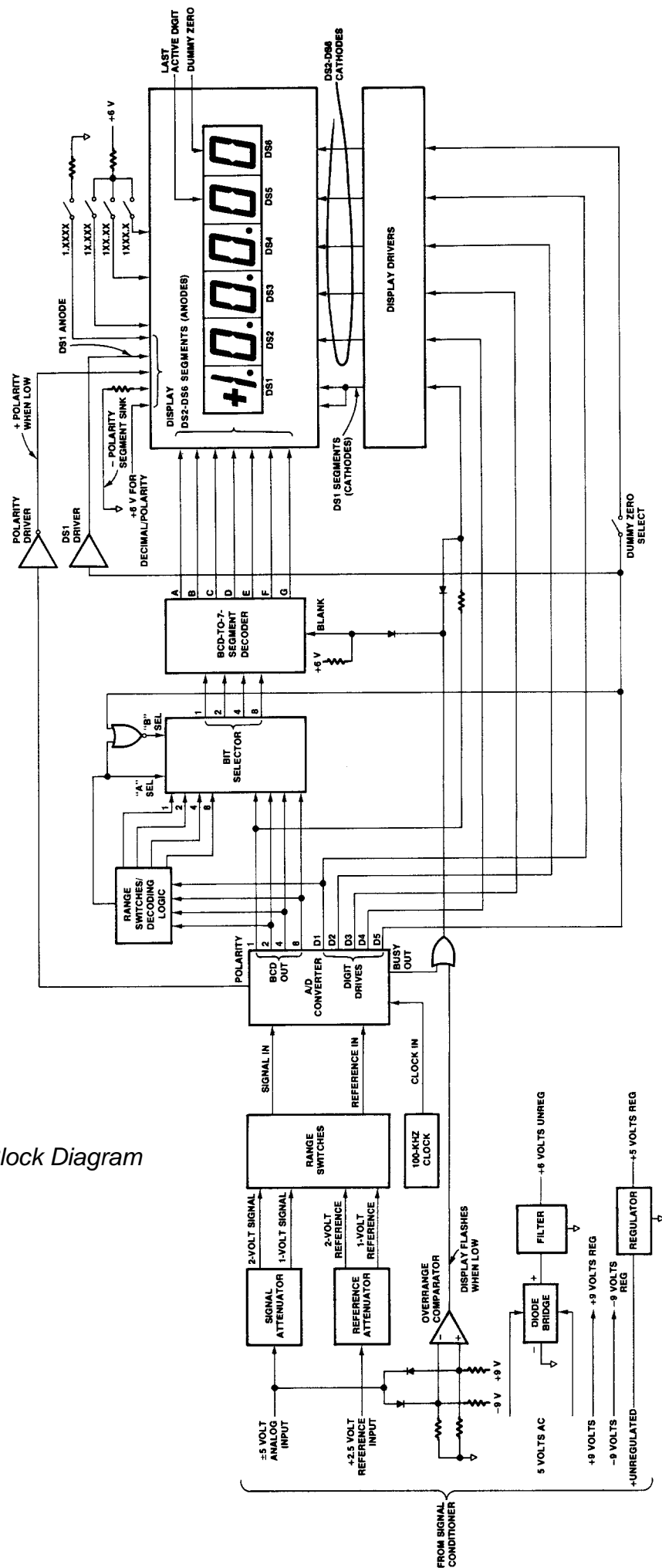
high, the B SELECT input to the *Bit Selector* is pulled low through the NOR gate connected to the port. The A SELECT input is also low since it is either held hard low through the *Range* switches on the 5000 range or it is connected to D1 through the *Range* switches on the 10000 and 20000 ranges (when 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 sunk 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 Overrange.** 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 *Overrange Comparator* is dc biased with equal resistors returned to the  $\pm 9$  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 *Overrange 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.



**MODEL**

**3300**

**HI-LO LIMITS**

# INSTRUCTION MANUAL



**3000**  
Instrument Series



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**MODEL**  
**3300**  
**HI-LO LIMITS**

**INSTRUCTION MANUAL**

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**PLEASE NOTE:**

**Units manufactured after Y2001 (as noted by serial number starting with the letter W, then X, Y .....). The "Output Disable" feature on the Limit Output connector was eliminated.**

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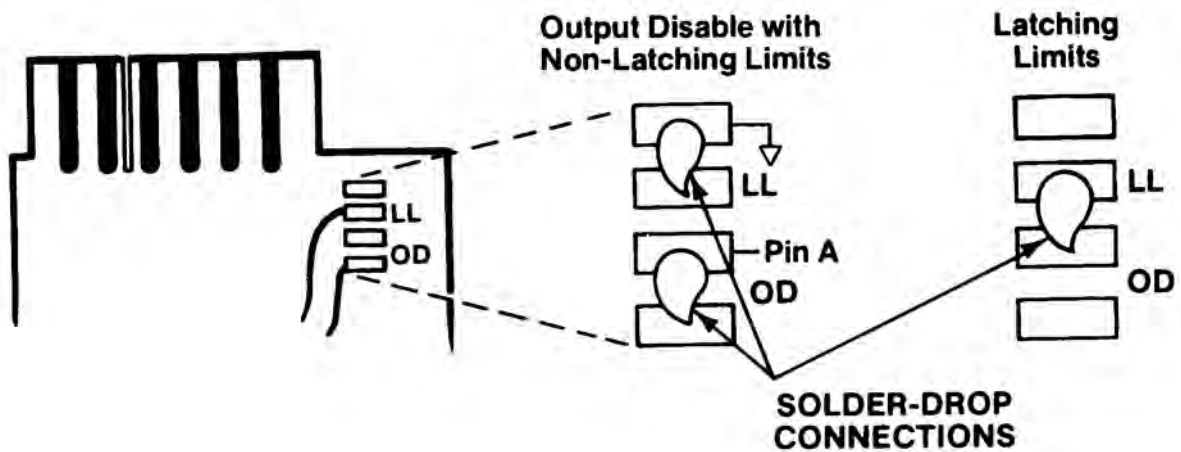
**PLEASE NOTE:** Sections 6 and 7, Figures 8 and 9, and Table 4 have been removed from this manual.

**If you need information regarding specific 3330 components and circuitry, please contact the Daytronic Service Department at (937) 293-2566.**

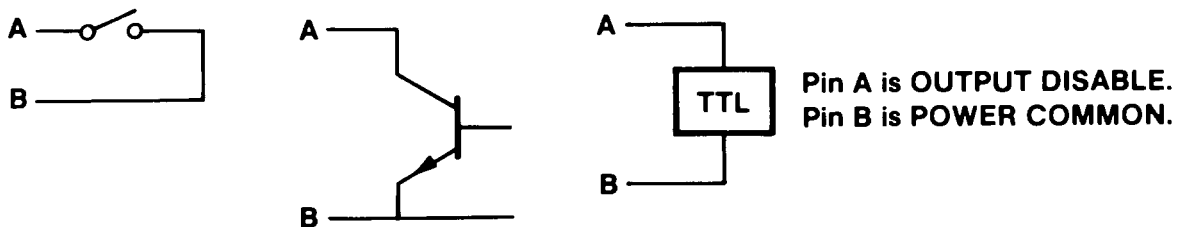
## NOTE

The Model 3300 may operate in either of two modes: *Latching Limits* (LL), where limit logic outputs are held until application of an external *Reset* action, or *Output Disable* (OD), where limit logic outputs are *non-latching* being automatically disabled as soon as the *Violation* condition ceases.

Unless you have specified otherwise, your Model 3300 will have been preset *at the factory* for *non-latching* operation, through solder-drop terminals on the underside (“Side 1”) of the printed-circuit board, as shown below. You may at any time, however, resolder the terminal connections as shown to produce *latching* limit outputs.



For *latching* operation, you must also provide an external means of resetting the limit outputs as soon as the condition(s) giving rise to the violation have ceased to exist, thus resetting the 3300 to continue normal limit monitoring. To reset *latched* limit outputs, Pins A and B of the *Limit Output Connector* (see Table 3, p. 8) must be connected by one of the three methods shown below:



In all discussions of limit logic outputs in this manual, “normal”—i.e., *Output Disable*—operation of the Model 3300 is presumed.

## INSTRUCTION MANUAL 3300 SERIES HI-LO LIMITS

### 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 Hi-Lo Limits are identified by a 33XX number, with the last two digits identifying the type of signal source (thermocouple, LVDT, etc).

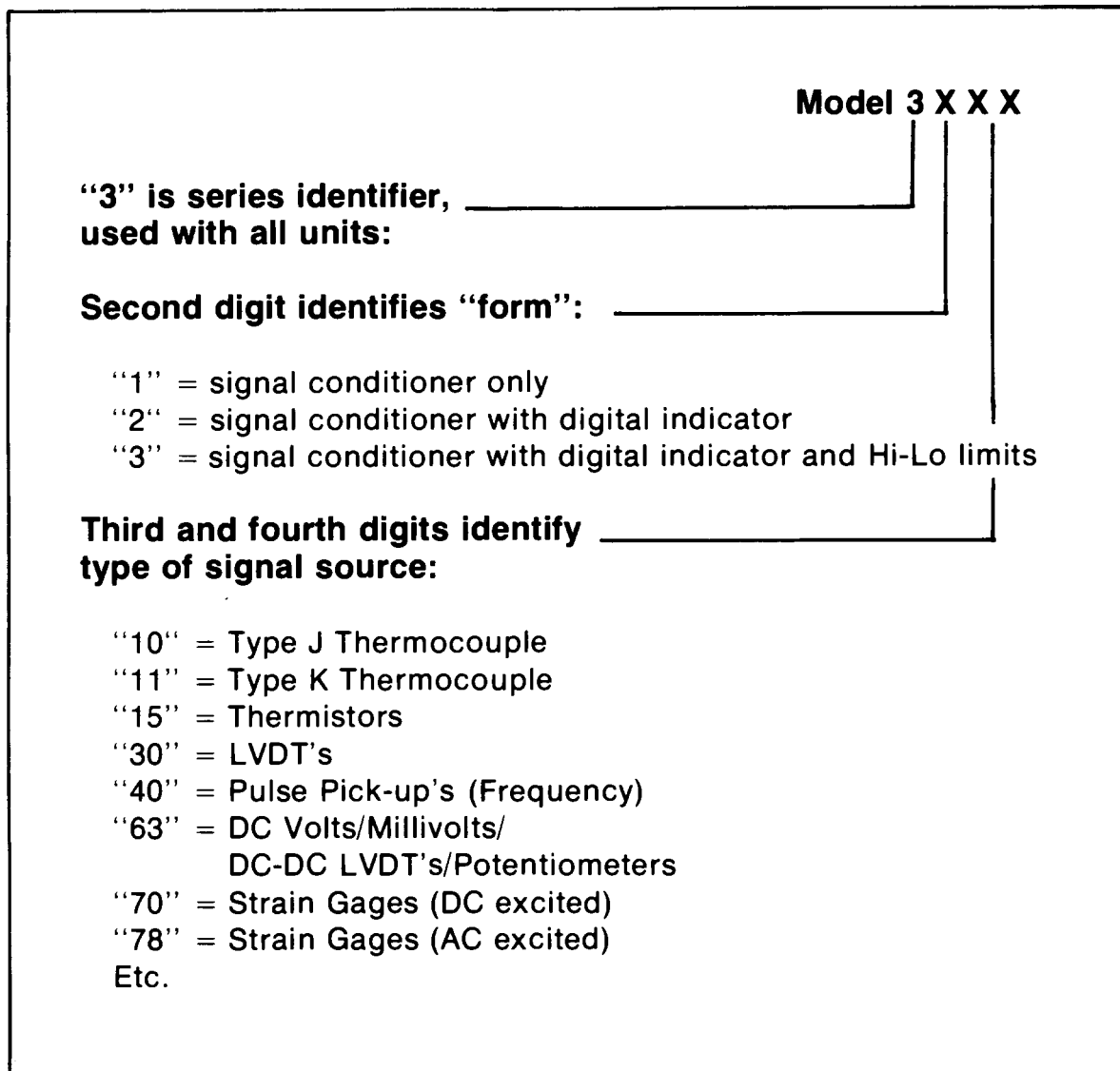


Figure 1. 3000 Series Instrument with Hi-Lo Limits



## "3000" Hi-Lo Limits

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 3* instrument. It is the purpose of this manual to cover the Hi-Lo Limit section of all *Form 3* instruments.

The Hi-Lo Limit section of any *Form 3* instrument consists of the following: ( 1) an additional printed-circuit board on which are mounted the required circuit components for Hi-Lo Limit operation, (2) associated front-panel controls and indicators, and (3) a rear-panel connector where the *Limit* mode is selected and where *Limit* logic outputs can be obtained.

The *3300 Series* instruments can be used in any of three *Limit* modes. The *Low/OK/High* is the most common mode of operation and is used to detect when the analog signal drops below a *Low* limit or exceeds a *High* limit. The range in between limits is designated as OK. The second mode which can be used is the *Both Limits High* mode where both limits are above the OK range. The third mode is the opposite function, or the *Both Limits Low* mode, where both limits are below the OK range. In all three modes of operation, the limits can be set across the entire  $\pm$  signal range ( $\pm 5$  volts). The instrument is shipped for operation in the *Low/OK/High* mode, but either of the other two modes can be easily selected by wiring of the rear-panel *Limit* output connector (see Section 2, Installation).

Both true and complement limit logic outputs are available at the *Limit* output connector for the *Low/OK/High* functions. The outputs are wire-ORable, TTL compatible (10 milliamperes sink, 0.5 milliamperes source). For *latching* limits, see NOTE, inside front cover.

Front-panel status indicators light to indicate when a limit is exceeded or when the analog signal is within the OK range. A red LED is used for each of the limits and a green LED is used as the OK indicator.

*Coarse* and *Fine* setting potentiometers are provided for each limit. Individual *Push-to-Set* buttons cause the limit value to be displayed by the Digital Indicator in the proper engineering units. A typical *3300 Instrument* is shown in Figure 1. The specifications for the *Limit* section are given in Table 2.

## 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 instructions for limit mode selection, input filtering, logic output connections, and ac power connection.

## "3000" Hi-Lo Limits

Table 2. Specifications

**Limit Status Display:** Individual red LED's indicate if limits are violated. Single green LED indicates no violations (analog signal within *OK* range).

**Limit Setting:** *Coarse* and *Fine* setting potentiometers provided for each limit. Individual *Push-to-Set* buttons also provided. When button is pushed, limit is displayed in proper engineering units on Digital Indicator.

**Limit Logic Outputs:** Both true and complement outputs provide for *Low/OK/High* functions. Outputs are TTL compatible, wire Orable; 10 ma sink, 0.5 ma source (max). Logic outputs are normally disabled when violation ceases to occur, but *latching* mode is also available (see NOTE, inside front cover).

**Limit Modes:** Three modes are available thru rear-panel *Limit* output connector wiring. Units shipped with *Low/OK/High* mode activated. *Both Limits High* or *Both Limits Low* mode can be user selected.

**Output Disable:** An *Output Disable* line provided which, if tied low, will cause all *limit* logic outputs to go high (both true and complement for each function).

**Limit Mode Selection.** Figure 2 illustrates the three modes in which 3300 Instruments can be operated. The unit is shipped from the factory with the *Low/OK/High* mode activated. In this mode, the *Low* limit is set some increment below the *High* limit. The increment between limits is the *OK* range. Either limit can be set positive or negative, as long as the *Low* limit is more negative than the *High* limit. When the *High* limit is exceeded, the front-panel LED status indicator (red) marked HIGH will light. When the analog signal drops below the *Low* limit, the front-panel LED status indicator (red) marked LOW will light. When the signal is between the two limits, the front-panel status indicator (green) marked OK will light. In this mode, only one of the three status indicators will light at any one time.

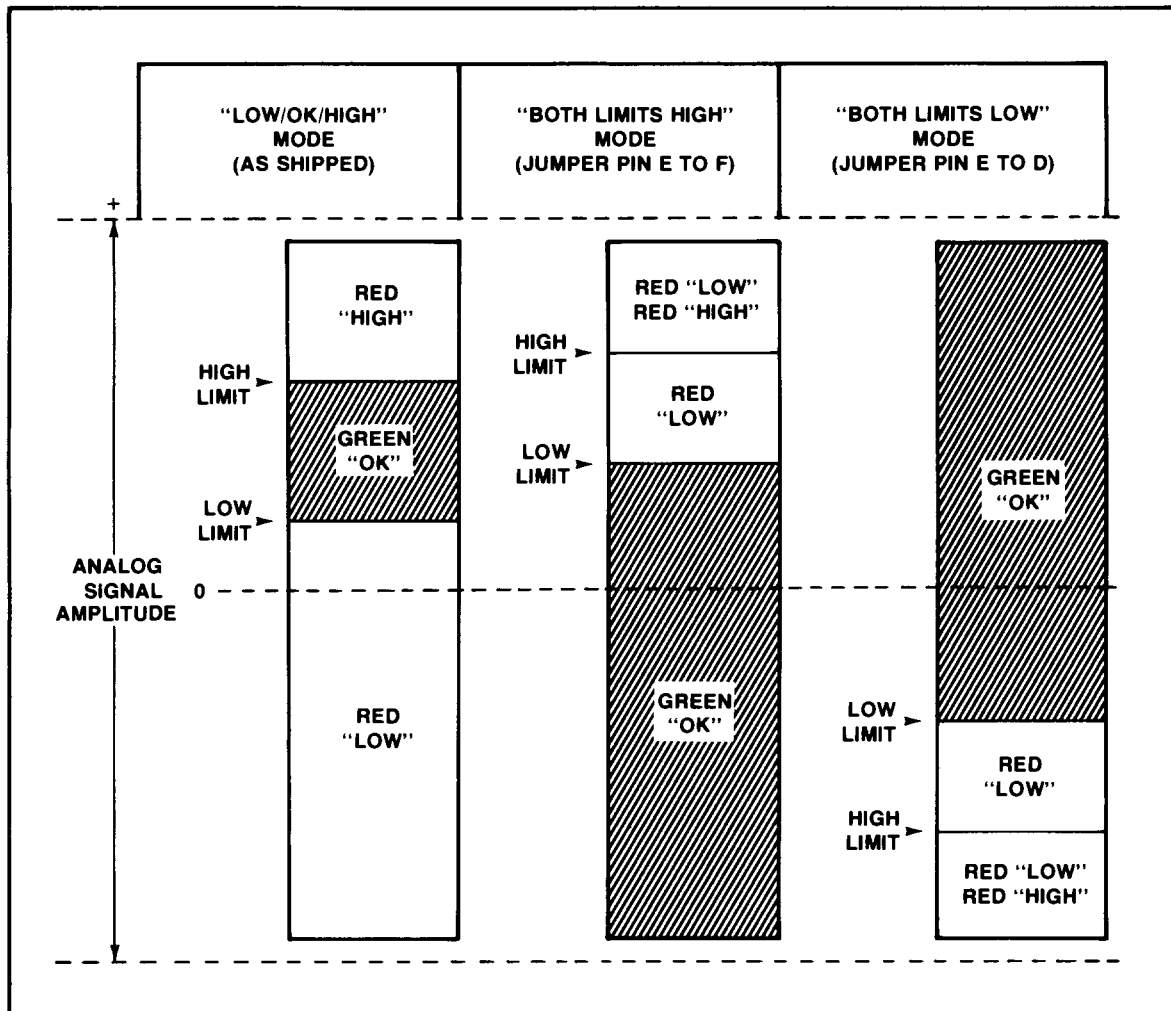


Figure 2. Limit Modes

To activate the *Both Limits High* mode, jumper pin E to pin F at the supplied rear-panel *Limit* output connector. In this mode, the limits can also be set positive or negative, as long as the *High* limit is set some increment more positive than the *Low* limit. When the analog signal is below or more negative than the *Low* limit, the green OK indicator will light. When the *Low* limit is exceeded, the red LOW indicator will light (green OK will extinguish). When the *High* limit is exceeded, the red HIGH indicator will light and the red LOW indicator will remain lit to indicate that now both limits are exceeded. When the signal drops below the *High* limit (but not the *Low* limit), the LOW indicator will remain lit. When the signal drops below the *Low* limit, the LOW indicator will extinguish and the OK indicator will again light to indicate no violations.

## "3000" Hi-Lo Limits

To activate the *Both Limits Low* mode, jumper pin E to pin D at the *Limit* output connector. In this mode, the limits can also be set positive or negative, as long as the *High* limit is set some increment more negative than the *Low* limit. This mode works exactly opposite to that described in the preceding paragraph. When the analog signal is above or more positive than the *Low* limit, the green OK indicator will light. When the signal drops below the *Low* limit, the red LOW indicator will light (green OK will extinguish). When the signal drops below the *High* limit, the red HIGH indicator will light and the red LOW indicator will remain lit to indicate that now both limits are violated. When the signal rises above the *High* limit (but not the *Low* limit), only the LOW indicator will remain lit. When the signal rises above the *Low* limit, the LOW indicator will extinguish and the OK indicator will again light to indicate no violations.

**Input Filtering.** Two filtered outputs are brought from the Signal Conditioner printed-circuit board to the Limit printed-circuit board. Both are low-pass filter outputs with one having a cutoff frequency of 200 Hz (*fast* signal) and the other having a cutoff frequency of 2 Hz (*slow* signal). The fast signal is normally connected to the Limit board circuitry via a solder-drop terminal labelled *F* on the underside (*Side 1*) of the Limit board (all 3300 units are shipped with this connection made). Instrument operation should be attempted without removing this connection. However, if excessive limit *chattering* is encountered (transducer is subject to excessive vibration etc.), this connection should be removed and the *slow* signal terminals should be connected via a solder drop. The *fast* and *slow* signal solder-drop terminals are illustrated in Figure 3.

**Logic Output Connections.** Logic outputs are provided at the *Limit* output connector for the *Low/OK/High* functions. Both true and complement outputs are provided that are TTL compatible (10 millamperes sink, 0.5 millamperes source maximum). These outputs may be used to trigger alarms or sort/reject devices etc. Typical wiring to these outputs to obtain a contact closure is shown in Figures 4 and 5. In Figure 4, wiring to a Daytronic 9399 Triac Controller is illustrated. Notice that while a variety of logic configurations can cause a contact closure, that current is always sunk by the 3300 instrument. If a device other than the 9399 is used, a resistor must be placed in series with the +5 volt line from the 3300 to limit the sink current to 10 milliamperes maximum.

Figure 5 shows the wiring and external circuitry when it is desired to close an external relay contact using source current. Only a Q output is used in this configuration and the source current drawn must be limited to 0.5 milliamperes maximum.

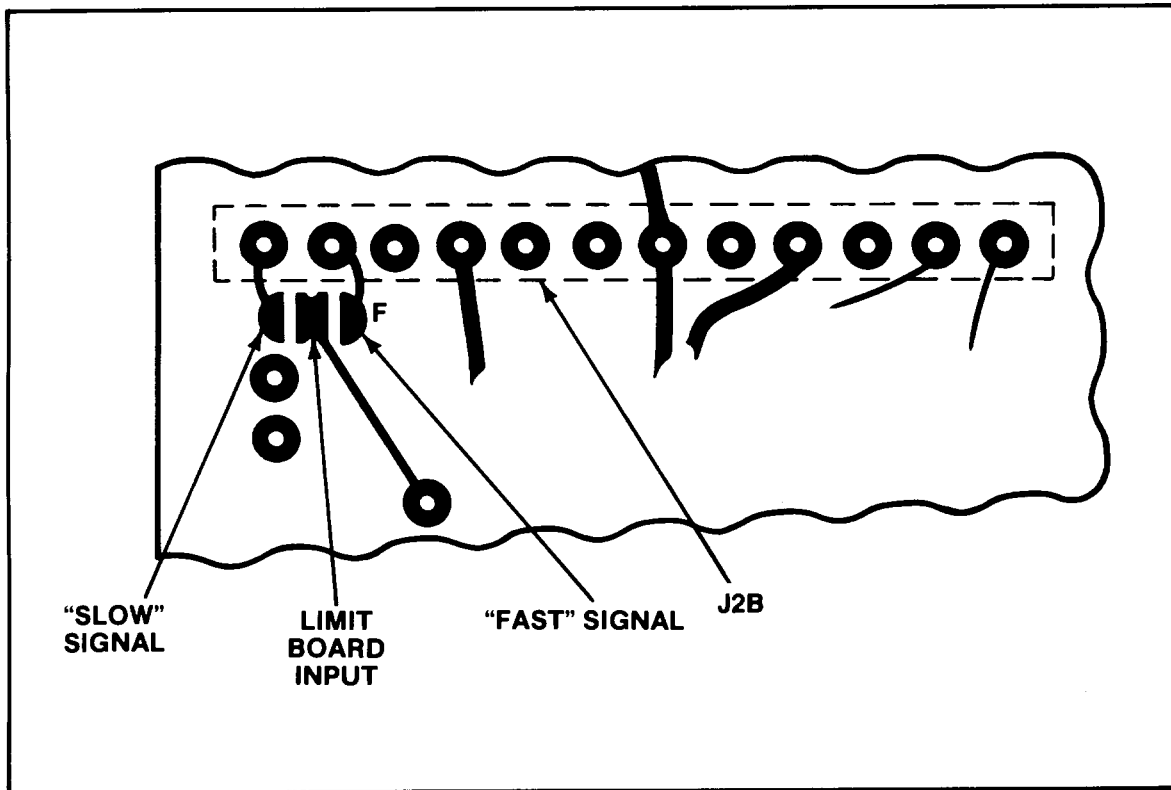


Figure 3. Fast/Slow Signal Solder-Drop Terminals

An *Output Disable* is also provided at the *Limit* output connector (pin A). When pin A is jumpered to pin B (common), all logic outputs (true and complement) are held high (+5 volts). Table 3 gives a listing of the functions available at the *Limit* output connector and the corresponding pin numbers.

**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 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.

## "3000" Hi-Lo Limits

Table 3. Limit Output Connector Functions/Pin Nos.

Function	Pin Number
+5 volts	C
Common	B
Limit Select	E
Both Lo	D
Both Hi	F
Output Disable	A *
$Q_{Lo}$	5
$\overline{Q}_{Lo}$	6
$Q_{Hi}$	1
$\overline{Q}_{Hi}$	2
$Q_{OK}$	3
$\overline{Q}_{OK}$	4

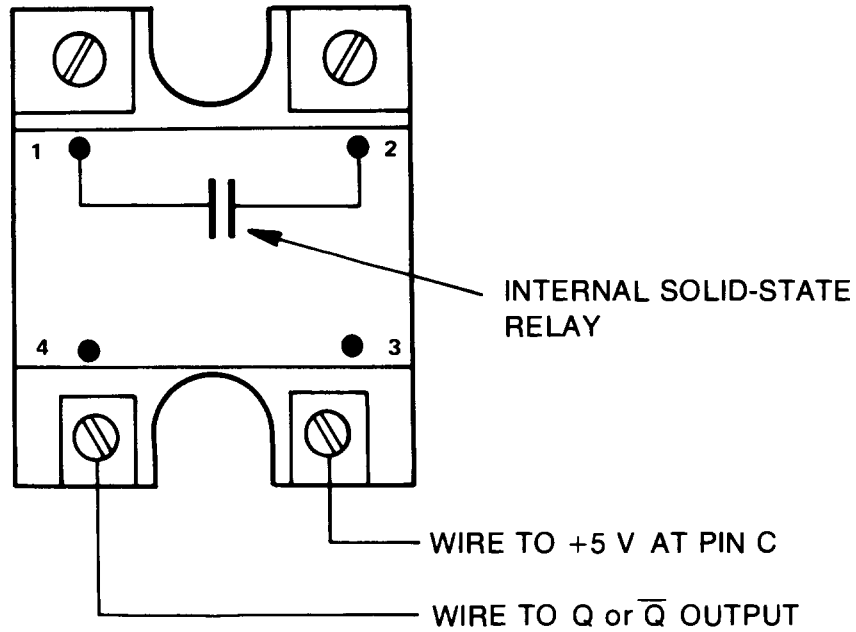
\* Note feature disable  
on units built after Y2001

**Note:** Jumper E to F to enable *Both Limits High* mode.  
Jumper E to D to enable *Both Limits Low* mode. No  
connection to E enables *Low/OK/High* mode.

### 3. OPERATION

The only operation required is turning ON/OFF ac power and setting the desired limits. These operations are described in the following paragraphs. Figure 6 provides a functional description of the front-panel.

**Power On/Off.** AC power is turned ON/OFF the instrument by means of a rear-panel slide switch. The digital display lights immediately when ac power is ON.



1. Wire pin 4 of 9399 to  $\bar{Q}_{Hi}$  or  $\bar{Q}_{Lo}$  output for contact closure at violation of limit.
2. Wire pin 4 of 9399 to  $Q_{Hi}$  or  $Q_{Lo}$  output for contact closure with no violation.
3. Wire pin 4 of 9399 to  $\bar{Q}_{OK}$  output for contact closure with no violation.
4. Wire pin 4 of 9399 to  $Q_{OK}$  output for contact closure at violation.
5. If Triac Controller other than 9399 is used, make certain sink current does not exceed 10 ma for TTL outputs.

Figure 4. Model 9399 Triac Controller Wiring



## "3000" Hi-Lo Limits

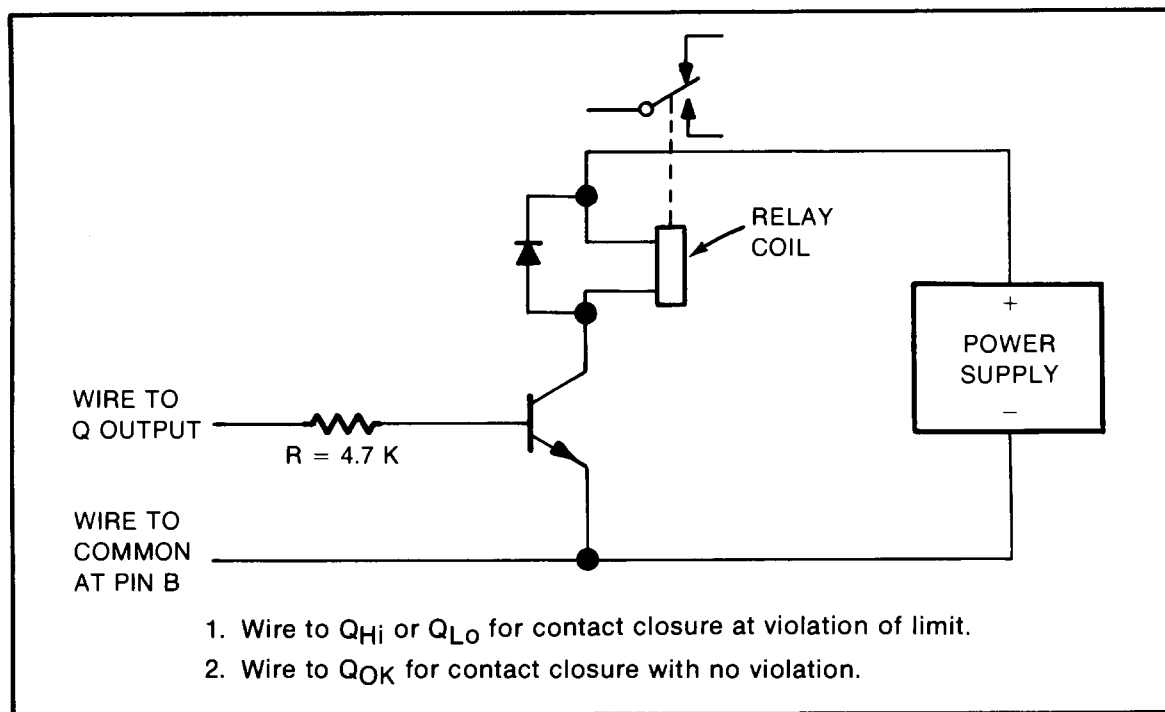


Figure 5. External Relay Driver Wiring

**Limit Setting.** Before setting the *Low* and *High* limits, the user should refer to Section 2 of this manual and become familiar with the limit mode in which the instrument is to be operated. Figure 2 illustrates the three operating modes by giving a graphic representation of typical limit settings. The *Limit* logic outputs wiring should also be reviewed before attempting to operate the instrument. This information is also contained in Section 2. To prevent inadvertent triggering of external circuits while setting the limits, remove the rear-panel *Limit* output connector. The connector can then be replaced after the proper limits have been set. To set the limits, proceed as follows:

- (a) Press the *Set Low Limit* button and adjust the *Coarse* and *Fine Low* limit controls until the desired *Low* limit value is displayed on the Digital Indicator.
- (b) Press the *Set High Limit* button and adjust the *Coarse* and *Fine High* limit controls until the desired *High* limit value is displayed on the Digital Indicator.

- (c) The limits are now set and the appropriate LOW and HIGH status indicators will light when a violation of the limit occurs. The OK indicator will be lit when there is no violation. **NOTE:** For the front-panel status indicators to have meaning as marked, the *Low* limit must be set more negative than the *High* limit in the *Low/OK/High* and *Both Limits High* modes. In the *Both Limits Low* mode, the *Low* limit must be set more positive than the *High* limit for the terminology to have meaning.

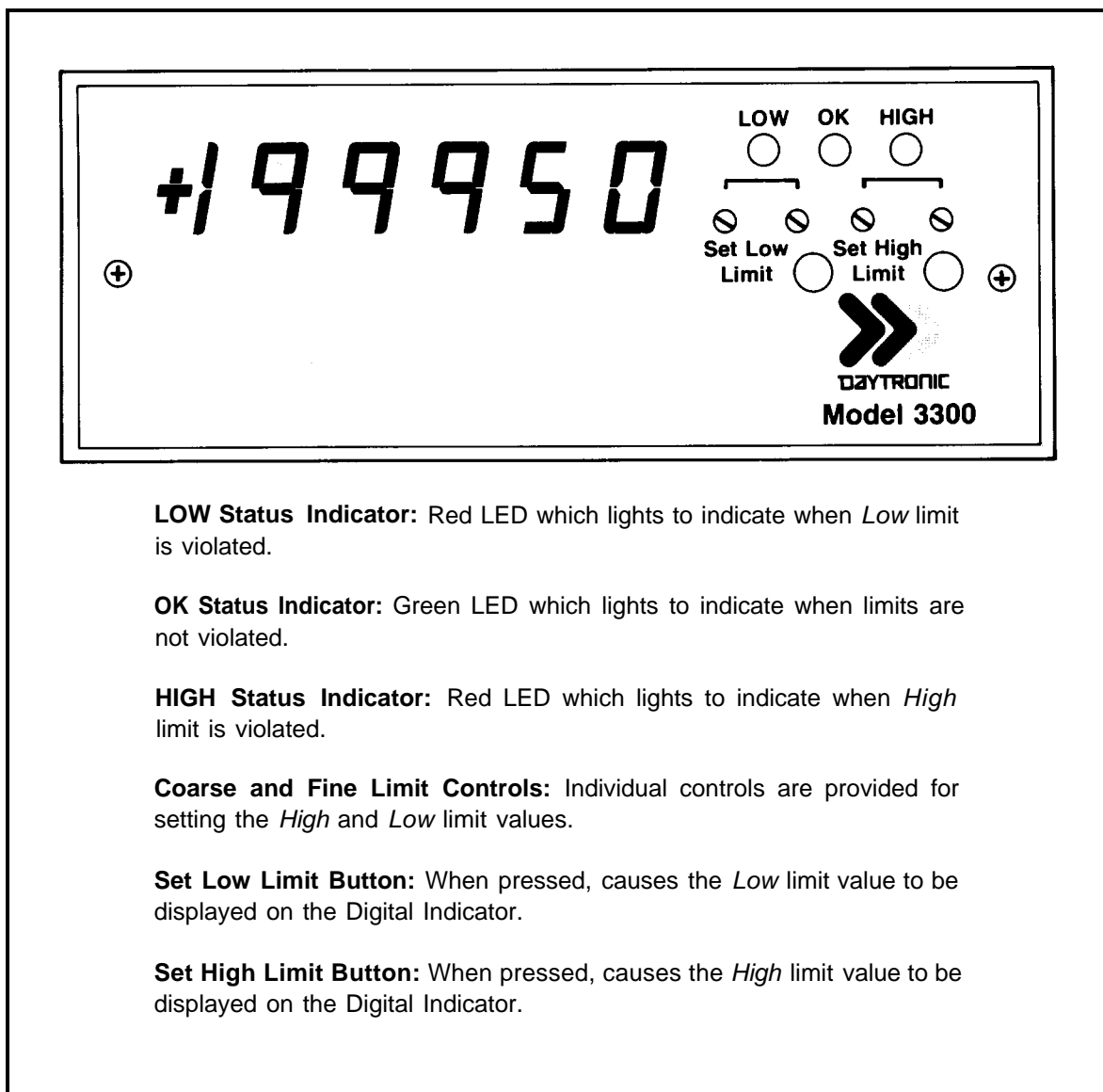


Figure 6. Front-Panel Description

## "3000" Hi-Lo Limits

### 4. BLOCK DIAGRAM DESCRIPTION

The purpose of this section is to explain how the Limit circuits work 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 7.

A +2.5 volt precision *Reference* is supplied from a precision power supply located on the Signal Conditioner circuit board. This *Reference* is supplied as an input to a non-inverting amplifier from which the voltages are developed which are used for limit setting. A +5.6 volt level is obtained at the output of the *Reference Amplifier* and a -5.6 volt level is generated through the use of a *Unity Gain Inverter*. The  $\pm 5.6$  volt levels are then applied across the *Fine* and *Coarse* limit potentiometers. The potentiometer wipers are summed together, then applied as non-inverting inputs to *Buffer Amplifiers* (one for the *Low Limit* channel and one for the *High Limit* Channel). Each *Buffer Amplifier* output is wired to a normally-open contact of a *Set Limit* pushbutton. When either pushbutton (*Set Low Limit* or *Set High Limit*) is pressed, the limit value is connected as an input to the Digital Indicator (analog output from the Signal Conditioner is disconnected from the Digital Indicator input). While the limit value is displayed on the Digital Indicator, the appropriate value can be set with the *Fine* and *Coarse* limit potentiometers. The *Buffer Amplifier* outputs are applied as inputs to a pair of voltage *Comparators*. The analog output from the Signal Conditioner is applied to each of the remaining *Comparator* inputs. When the signal is less than the limit set point, a *Comparator* output will be at a *logic 1* level (+9 volts). When the signal is greater than the limit set point, a *Comparator* output will be at a *logic 0* level (-9 volts).

Filtered outputs from the Signal Conditioner are applied to the Limit printed-circuit board. Both dc-to-200 Hz and dc-to-2 Hz analog outputs are provided. The 200-Hz signal is referred to as the fast signal and is normally connected to the limit circuits via a solder-drop connection. The 2-Hz signal, or *slow* signal, can be connected as an input to the limit circuits by unsoldering the *fast* signal solder terminal and soldering the *slow* terminal to the limit circuit input terminal. This is usually accomplished if limit *chattering* is encountered during operation. The *fast* signal is always connected to the limit input at factory fabrication.

Limit mode selection is accomplished by connecting the *Both Limits High* line or the *Both Limits Low* line to the *Limit Select* line (-9 volts) at the *Limit* output connector. The unit is shipped with neither of these connections made, automatically enabling the *Low/OK/High* mode. Exclusive OR logic is used to detect a violation. Two exclusive OR gates are used with a *60-Hz Filter* inserted between gates (diode-capacitor peak detector) to eliminate any ripple which might cause false triggering of the logic.

The first gate in the *Low Limit* channel has an input held low (thru an inverter whose input is tied high with a pull-up resistor) when the *Low/OK/High* mode is operational. When the analog signal is less than the set point, the remaining input to the gate is high. The gate output is consequently high. The second gate has one input tied low, thus its output is also high when the signal is less than the set point. Since this is the condition for a violation of the *Low* limit in the *Low/OK/High* mode, the LOW lamp (red LED) is lit through an inverter.

The first gate in the *High Limit* channel has an input held high (thru a pull-up resistor) when the *Low/OK/High* mode is operational.. When the analog signal is greater than the set point, the remaining input to the gate is low. The gate output is consequently high. The second gate has one input tied low, thus its output is also high when the signal is greater than the set point. Since this is the condition for a violation of the *High* limit in the *Low/OK/High* mode, the HIGH lamp (red LED) is lit through an inverter.

The gated outputs of the *Low* and *High Limit* channels are ORed together to light the OK lamp (green LED). Both outputs must be low (no violation) to take the OR gate output high. With this output high, the OK lamp is lit through an inverter.

When the *Both Limits High* line is tied to the *Limit Select* line (-9 volts), the input to the first gate in the *Low Limit* channel is held high through the inverter. This reverses the logic and causes the *Low Limit* channel to be violated by an increasing analog signal. Operation of the *High Limit* channel remains as before, and the OK lamp lights when the signal is below both of the set points.

When the *Both Limits Low* line is tied to the *Limit Select* line, the input to the first gate in the *High Limit* channel is held low. This reverses the logic and causes

## "3000" Hi-Lo Limits

the *High Limit* channel to be violated by a decreasing signal. Operation of the *Low Limit* channel remains as in the *Low/OK/High* mode, and the OK lamp lights when the signal is above both of the set points.

Both true and complement outputs are provided for the *Low/OK/High* functions. These outputs are provided via a hex inverter chip with open-collector outputs. The open collectors are tied to +5 volts via pull-up resistors to provide TTL compatible outputs. An *Output Disable* line is provided which takes all outputs to +5 volts when tied to circuit common. This removes the +9 volts operating voltage from the hex inverter chip so that the outputs go to the pull-up resistor voltage of +5 volts. **(This feature is disabled on units built after 2001)**

The  $\pm 9$  Volts *Regulated* is supplied from power supplies contained on the Signal Conditioner circuit board. The +5 Volts *Regulated* is developed by a three-terminal *Regulator*. The *Unregulated* input to the *Regulator* is obtained from the Signal Conditioner circuit board (unregulated side of +9 volt supply). The +9 volt supplies are discussed in the Signal Conditioner *Instruction Manual*.

## 5. VERIFICATION OF NORMAL OPERATION

It is the purpose of this section to aid the user in rapidly determining whether the limit circuits are functioning normally or whether they are the source of the observed trouble. In the event a repair to the limit circuits 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.

- (a) Make certain that the desired limit mode has been properly selected and that the limits have been set according to the front-panel terminology. The *Low* limit should be set more negative than the *High* limit in the *Low/OK/High* and *Both Limits High* modes. The *Low* Limit should be set more positive than the *High* limit when the *Both Limits Low* mode is used.
- (b) Make certain that some input is provided to the Signal Conditioner so that the Digital Indicator is reading a value off zero in the direction of the *Low* limit.

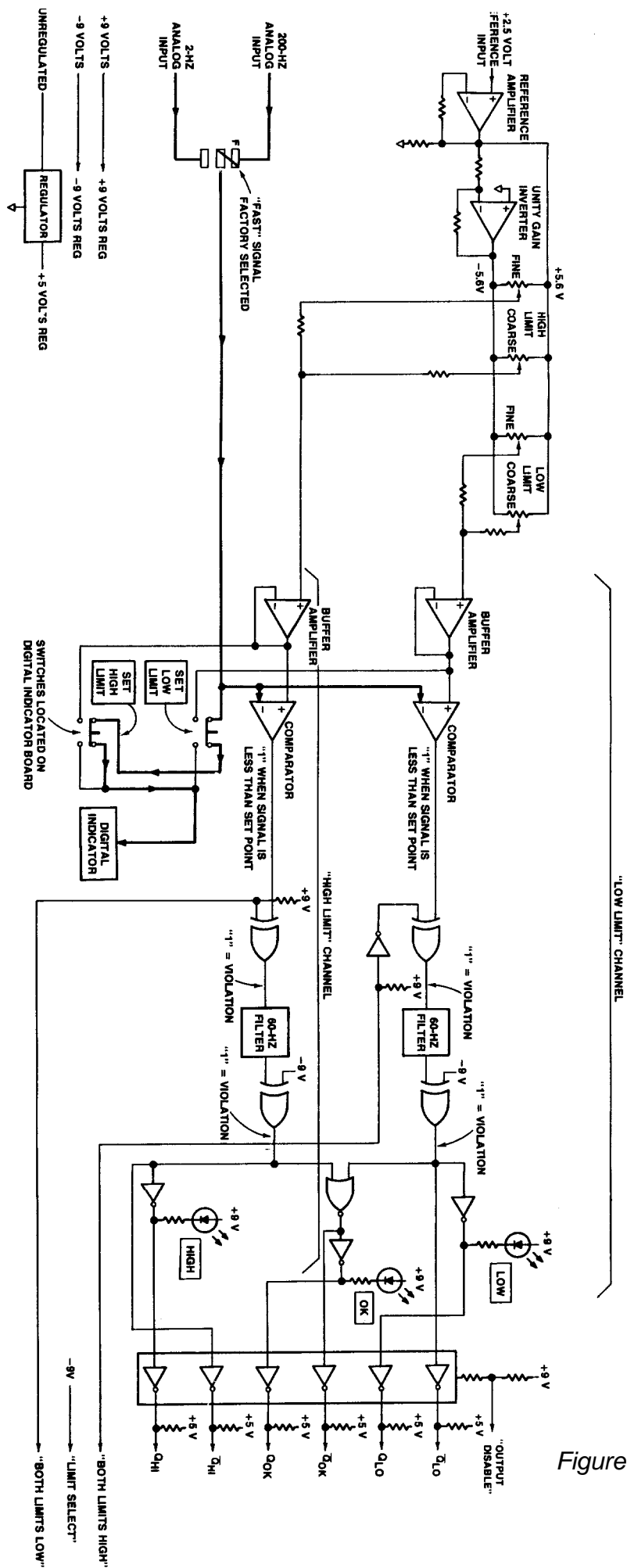


Figure 7. Block Diagram

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- (c) Adjust the *Coarse* and *Fine Low Limit* controls until the LOW indicator lights. Using the *Fine* control, backoff the limit until the LOW indicator extinguishes; then, readjust the *Fine* control until the indicator lights again.
- (d) Press the *Set Low Limit* button. The Digital Indicator should have the same reading that was previously displayed for the Signal Conditioner output. This indicates that it is possible to set a limit value equal to the Signal Conditioner Output and that the violation is being sensed.
- (e) Increase the Signal Conditioner output toward the value of the *High* limit and repeat the procedure of steps (c) and (d) using the *High Limit* controls to check the *High* limit operation. If the *Low/OK/High* mode is being used, only one front-panel status indicator will be lit at any one time. The green OK indicator will light in the range between limits. If either of the remaining two modes are in use, when the HIGH indicator is lit, the LOW indicator will also be lit. When both the LOW and HIGH indicators are extinguished, the OK indicator will be lit.
- (f) If the front-panel indications show that the limits are properly functioning, but external circuits are not being properly triggered, check the wiring to the *Limit* output connector. If a wiring error cannot be found, remove the external circuit connections and check the logic output levels while repeating steps (c) thru (e). Refer to table 3 for output functions and pin numbers of the *Limit* output connector. The Q outputs should be true (+5 volts) when the corresponding status indicator is lit.



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