



MODEL

3200 / 3300

DIGITAL INDICATOR

INSTRUCTION MANUAL



3000
Instrument Series

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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).

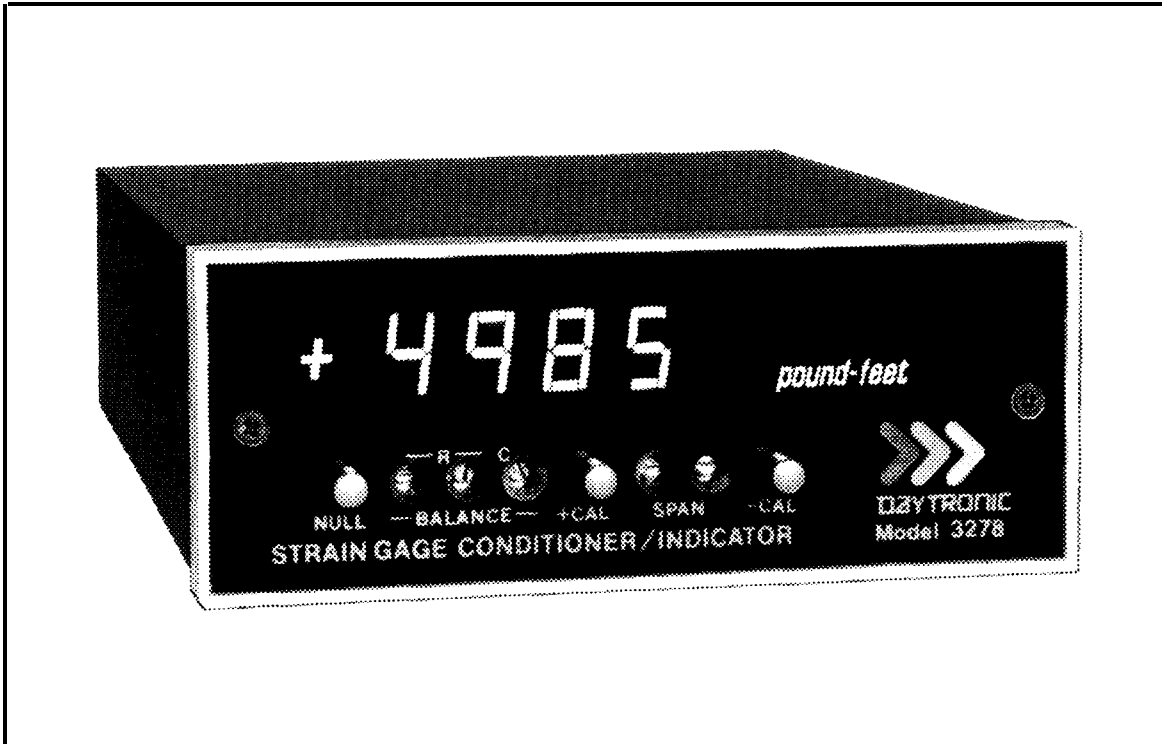
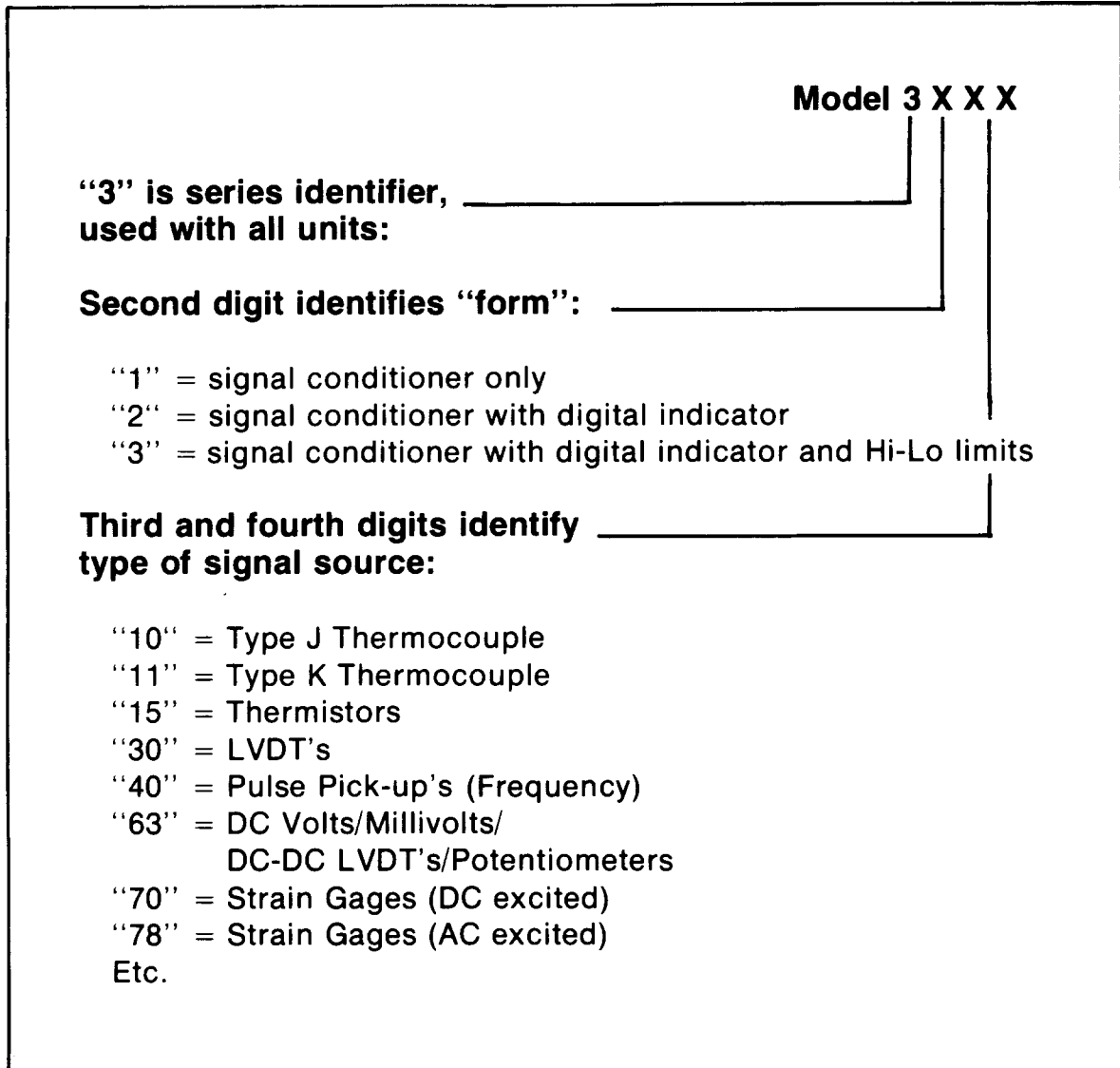


Figure 1. 3000 Series Instrument with Digital Indicator

"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.

"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 ± 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.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: ± 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

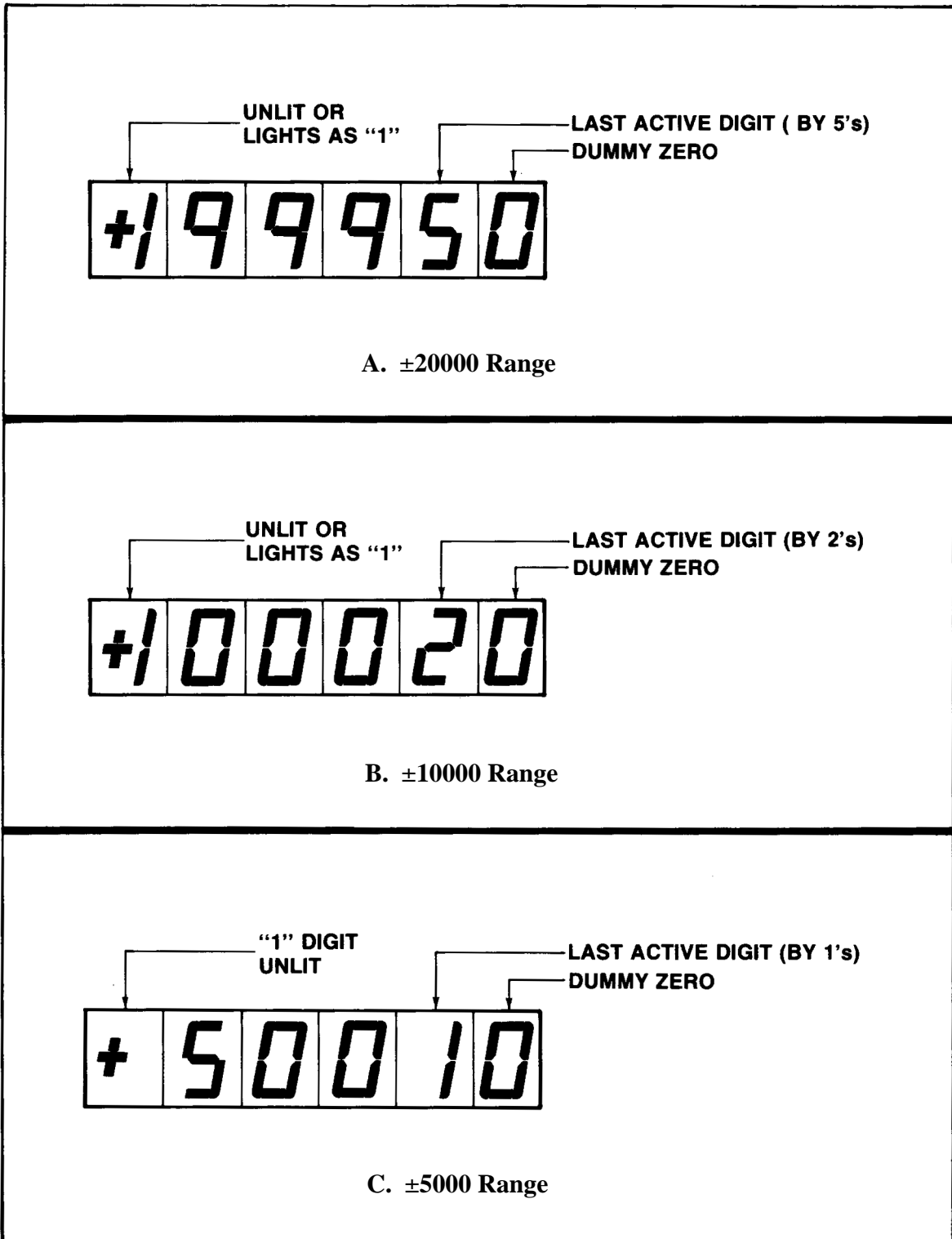


Figure 2. Full-Scale Displays for Three Ranges

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

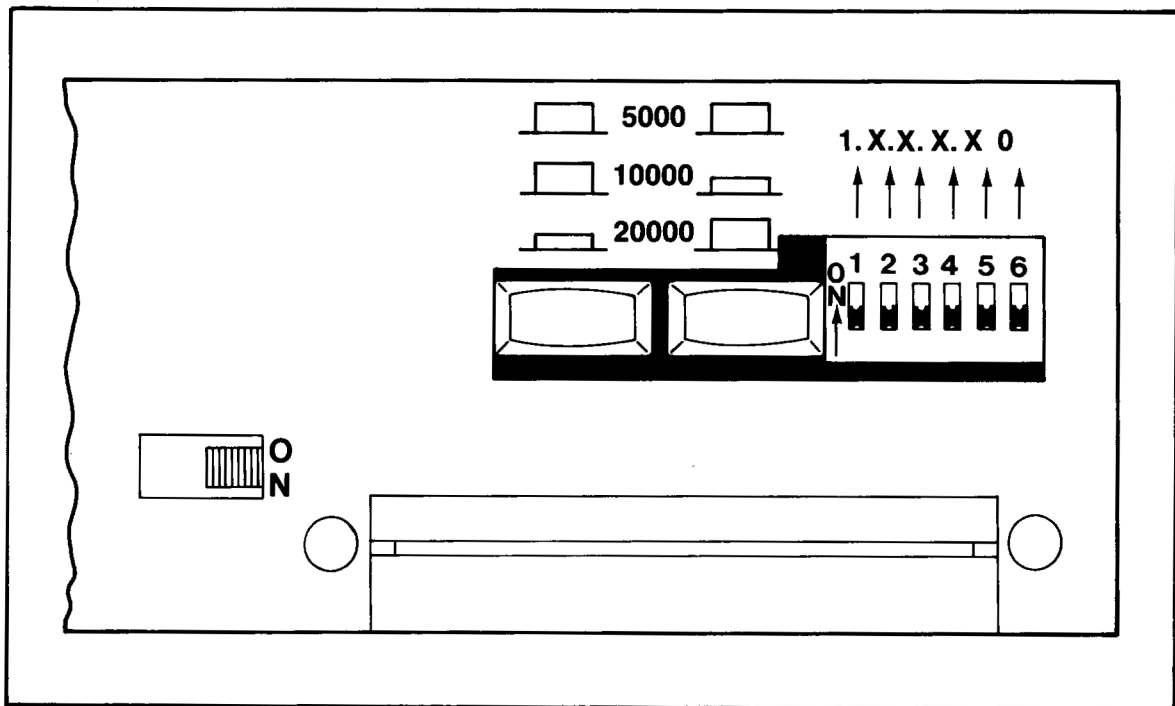


Figure 3. Scale, Decimal Point, Dummy Zero Switches

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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 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

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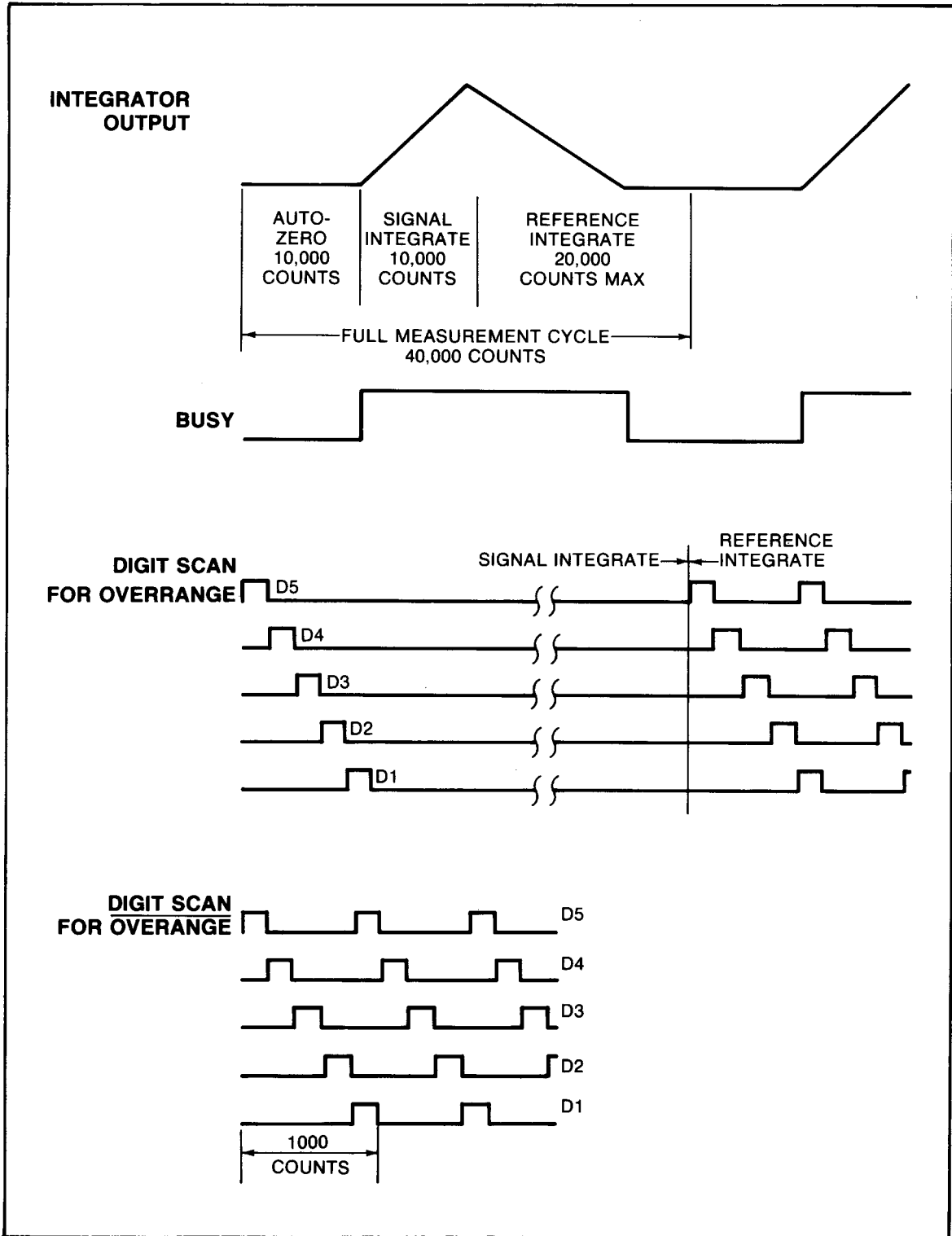


Figure 4. A/D Converter Timing Diagram

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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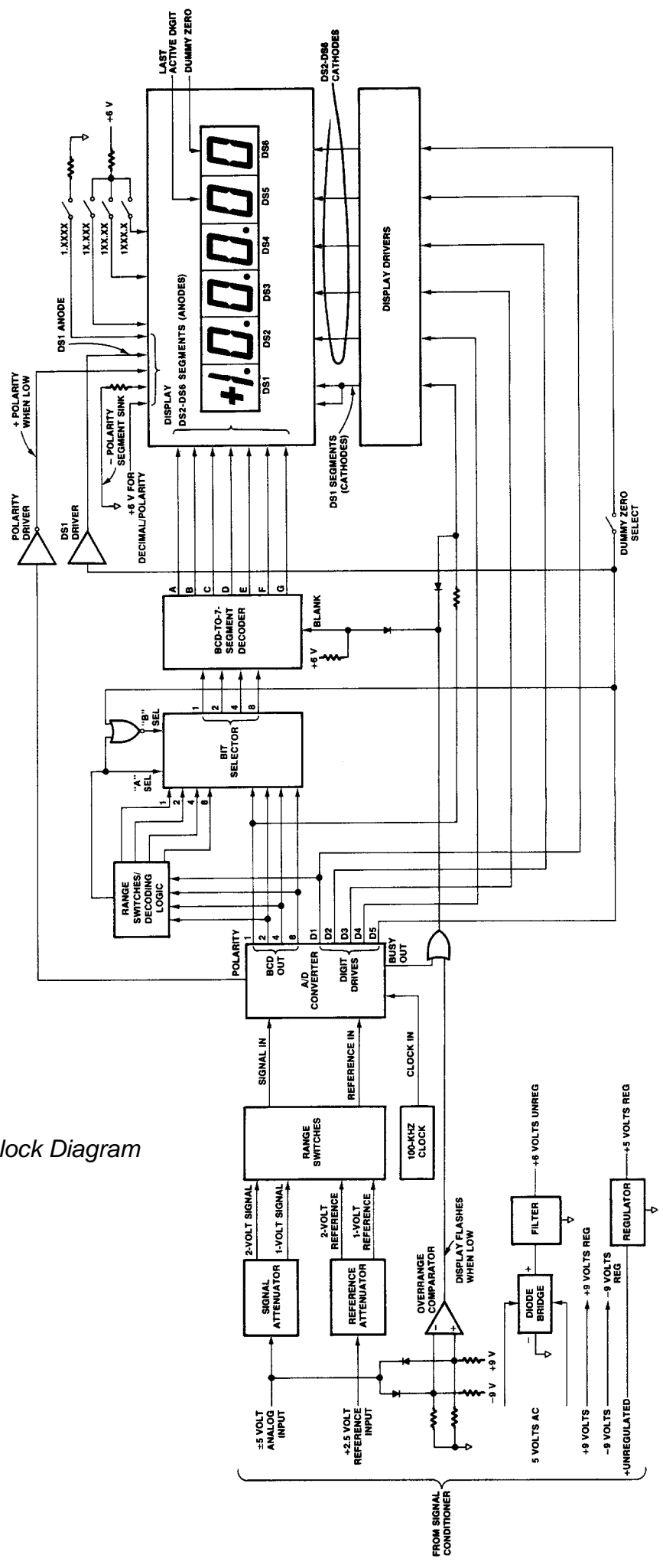
high, the B SELECT input to the *Bit Selector* is pulled low through the NOR gate connected to the port. The A SELECT input is also low since it is either held hard low through the *Range* switches on the 5000 range or it is connected to D1 through the *Range* switches on the 10000 and 20000 ranges (when 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 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 ± 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



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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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