

# 3000 INSTRUMENT SERIES

INTRODUCTION

2000 SERIES

3000 SERIES

3500 SERIES

4000 SERIES



*Designed for the toughest real-world requirements, these transducer instruments provide stable, high-level, linear analog output signals for use in servo control, remote recording, or centralized data acquisition.*

Each 3000 Series instrument comes in **three basic forms**. The "form" of a particular instrument is indicated by the second digit of its model number (see Table 3.1).

- [FORM 1: Signal Conditioner](#)
- [FORM 2: Signal Conditioner with Digital Indicator](#)
- [FORM 3: Signal Conditioner with Digital Indicator and HI-LO Limits](#)

See [General Specifications](#).

3000 Series OPTIONS include

- [Analog Peak Capture](#)
- [4-20 mA Current Output](#)
- [0-10 V-DC Dual Galvanic Isolated Outputs](#)
- [Internal Electromechanical Relays](#)
- [Internal Solid-State Relays](#)
- [12 V-DC Battery-Powered Operation or Nominal 230 V-AC Operation](#)

- ✦ ANALOG SIGNAL CONDITIONING WITH MULTIPOLE LOW-PASS ACTIVE FILTERING AND REGULATED, REMOTELY SENSED EXCITATION
- ★ 6-DIGIT LED DIGITAL INDICATION
- ★ SELECTABLE ANALOG FILTERING
- ★ DUAL LIMIT MONITORING WITH FRONT-PANEL ANNUNCIATION AND ISOLATED LOGIC CONTROL OUTPUTS
- ✦ "LIVE" VOLTAGE OUTPUTS
- \* "LIVE" CURRENT OUTPUTS
- \* GALVANIC ISOLATED OUTPUTS
- \* REAL-TIME ANALOG PEAK CAPTURE
- \* INTERNAL CONTROL RELAYS
- ✦ FRONT-PANEL SETUP
- DC-POWERED OPERATION

**Table 3.1**  
**Model-Numbering System for the 3000 Series**

## Model 3 X X X (X)

"3" is the series identifier, used with all units

Second digit identifies "form" (1, 2, or 3):

Third and Fourth digits identify "type" of signal source:

Suffix denotes optional feature(s):

- P = Analog Peak Capture (Forms 2 and 3 only)
- C = 4-20 mA Current Output (Forms 1 and 2 of all instruments, plus Models 3363 and 3370, only)
- G = Galvanic Isolated Outputs (Forms 1 and 2 only)
- R = Internal Electromechanical Relays (Form 3 only)
- S = Internal Solid-State Relays (Form 3 only)
- B = 12 V-DC Battery-Powered Operation (all Forms)
- F = Nominal 230 V-AC Operation (all Forms)

- ✦ = Standard feature for ALL models
- = Optional feature for ALL models
- ★ = Standard feature for SOME models
- \* = Optional feature for SOME models

**NOTE: THE ONLY ALLOWABLE OPTION COMBINATIONS ARE**

P and F   P and B  
 C and F   C and B  
 G and F   G and B  
 R and F   R and B  
 S and F

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## 3000 SERIES GENERAL SPECIFICATIONS

### Physical / Environmental

**Case:** Each unit is housed in a single piece of heavy-gage aluminum (for instrument dimensions, see Fig. 3.1); a simple reassembly procedure allows mounting in the user's precut panel (see Fig. 3.2—maximum panel thickness allowed is 1/8"); the [Model 3004 Rackmount Adaptor](#) permits secure mounting of up to four units in a standard 19-inch rack

**Operating Temperature Range:** 0° F to +130° F (-18° C to +55° C); assumes dry, noncondensing ambient atmosphere

**Weight:** Instrument: approximately 2.0 lb (0.9 kg) maximum; Shipping: approximately 3.5 lb (1.6 kg) maximum

### Power

**Voltage:** 105-135 V-AC; 210-260 V-AC optional (add suffix "F" to model number); any model not employing the solid-state relay ("S") option may be powered by battery (11.5-15 V-DC, 500 mA max.; add suffix "B" to model number)

**Frequency:** 50-400 Hz

**Consumption:** 5 W max. (for [Form 1](#) instruments), 8 W max. (for [Form 2](#) instruments), or 9 W max. (for [Form 3](#) instruments)

### Display ([Form 2](#) and [Form 3](#) instruments only)

**Display:** Orange LED's, six digits with polarity sign, 0.4" (1.0 cm) height; Most Significant Digit of display is either unlit or reads "1," and in either case contains polarity sign; Least Significant Digit is a dummy zero which may be lit or unlit, as desired (see [Fig. 3.8](#))

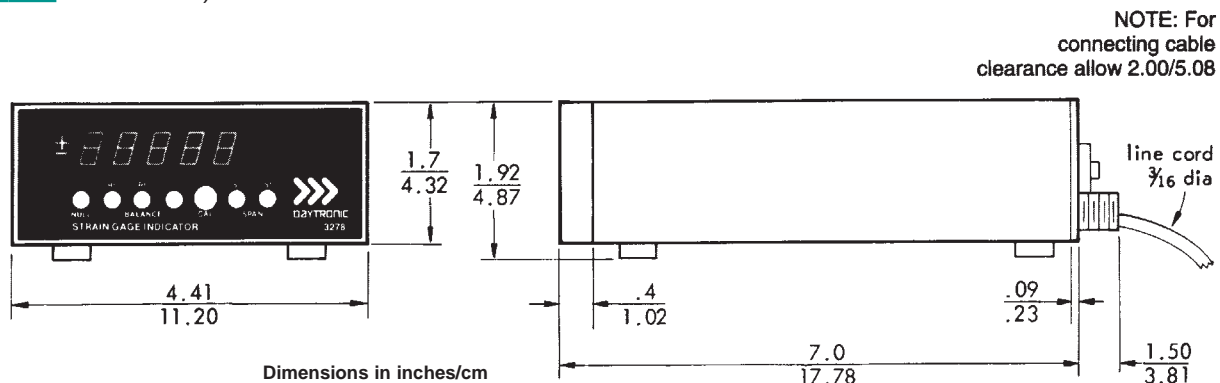
**Scaling:** Selectable at rear panel; full-scale values of  $\pm 5000$  counted by "1's,"  $\pm 10000$  counted by "2's," or  $\pm 20000$  counted by "5's," with selectable decimal-point locations (along with dummy zero) to give decade multiplier factors of 10, 1.0, 0.1, 0.01, 0.001, or 0.0001 (see [Fig. 3.8](#))

**Sampling Rate:** 3 samples per second

### Limit Logic Outputs ([Form 3](#) instruments only)

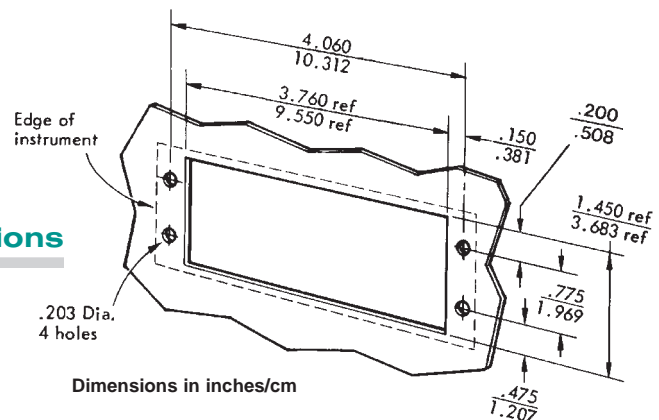
Both true and complement available for each limit condition (LOW, OK, HIGH); TTL-compatible, wire-ORable; 10-mA sink, 0.5-mA source (max.); normally nonlatching, but latching outputs are also available

(cont'd)



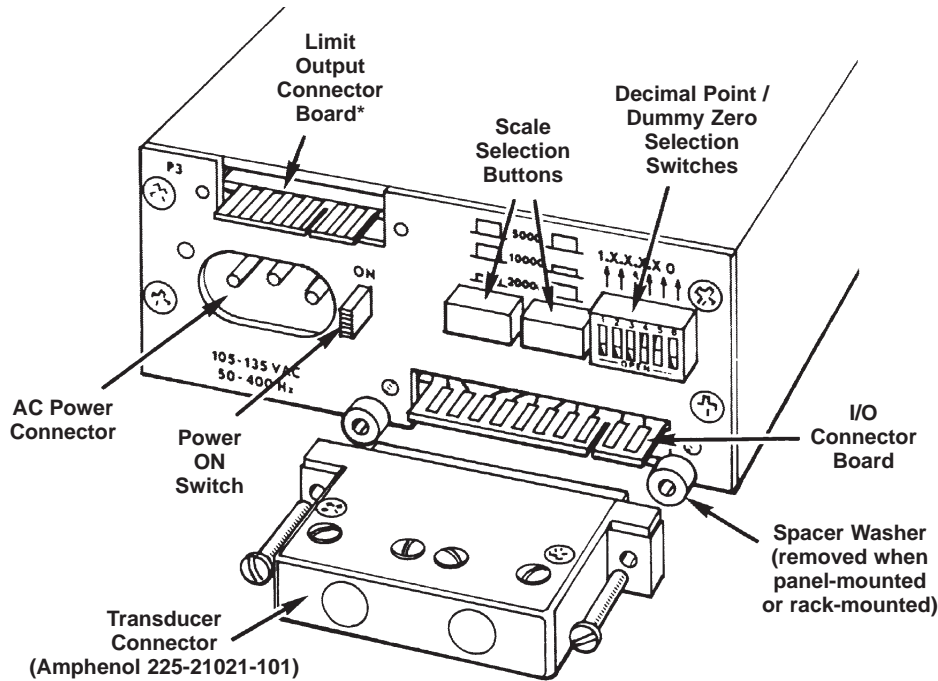
**Fig. 3.1**  
3000 Series Bench-Mount Dimensions

**Fig. 3.2**  
Panel Cutout Dimensions



**3000 SERIES GENERAL SPECIFICATIONS (cont'd)**

**Fig. 3.3**  
**3000 Series Rear Panel Elements**

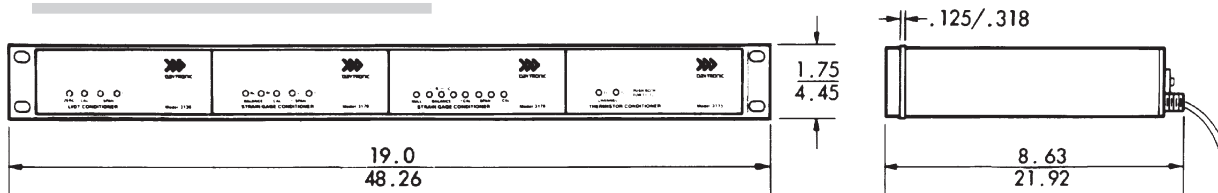


\* "Form 3" instrument only.

**MODEL**  
**3004 RACKMOUNT ADAPTOR**



**Fig. 3.4**  
**Model 3004 Dimensions**



Dimensions in inches/cm

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## "FORM 1" 3000 Series Instruments: SIGNAL CONDITIONERS

A family of premium stand-alone single-channel conditioners accommodates many transducer types—



5-, 6-, or 7-wire AC-excited LVDT's or 3-wire AC-excited variable reluctance transducers



frequency-generating transducers (including magnetic pickups and turbine flowmeters)



miscellaneous analog signal sources (including DC-to-DC LVDT's, potentiometers, Hall-Effect devices, photocells, current shunts, etc.)



DC-excited strain gage transducers (load cells, pressure sensors, etc.)



AC-excited strain gage transducers (rotary transformer torque sensors, etc.)

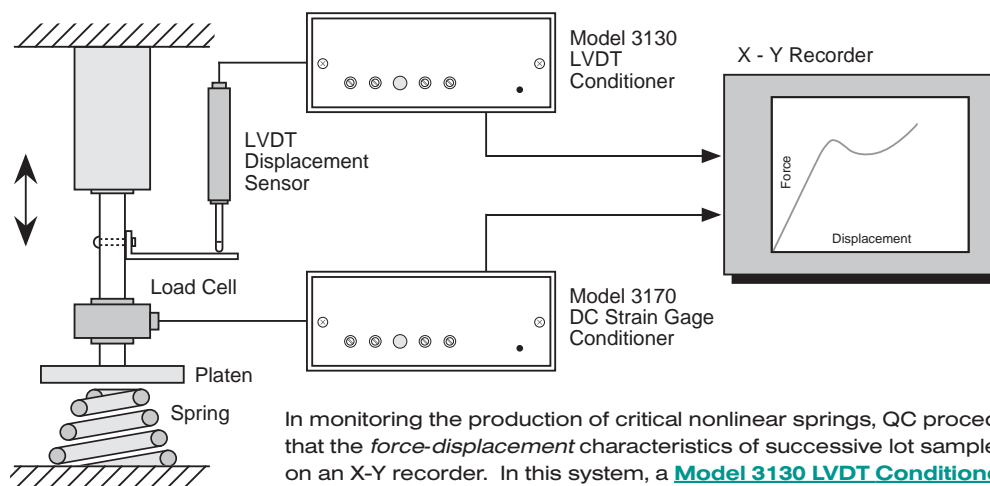
With *built-in regulated excitation, selectable low-pass active filtering, and internal reference calibration standards\**, these instruments produce the most accurate drift-free analog outputs possible.

\* Addressable by front-panel push buttons, or, when used with a centralized data acquisition system, by a common logic command line.



Go to a list of  
[Typical Customer-Specific  
3000 Series Instrument  
Modifications](#)

**Fig. 3.5**  
Using 3000 "Form 1" Conditioners for Spring Testing



In monitoring the production of critical nonlinear springs, QC procedures require that the *force-displacement* characteristics of successive lot samples be plotted on an X-Y recorder. In this system, a [Model 3130 LVDT Conditioner](#) measures spring displacement, while a [Model 3170 DC Strain Gage Conditioner](#) simultaneously measures compression force.

# "FORM 2" 3000 Series Instruments: SIGNAL CONDITIONERS WITH DIGITAL INDICATION

To the basic signal conditioning capability of [Form 1 instruments](#), "Form 2" 3000 units add *three selectable scales* for vivid, rock-solid LED readout of all measured inputs. As shown in Fig. 3.8, the three data-display scales are  $\pm 5000$  by "1's,"  $\pm 10000$  by "2's," and  $\pm 20000$  by "5's." Selectable decimal-point locations along with optional dummy zero give decade multiplier factors from 0.0001 to 10.

Sampling rate of the digital display is three samples per second. All conditioner/indicators are supplied with a large assortment of engineering unit legends on a convenient 4" x 5.5" dry transfer sheet (shown in Fig. 3.7).

For full display specifications, see [General Specifications](#).

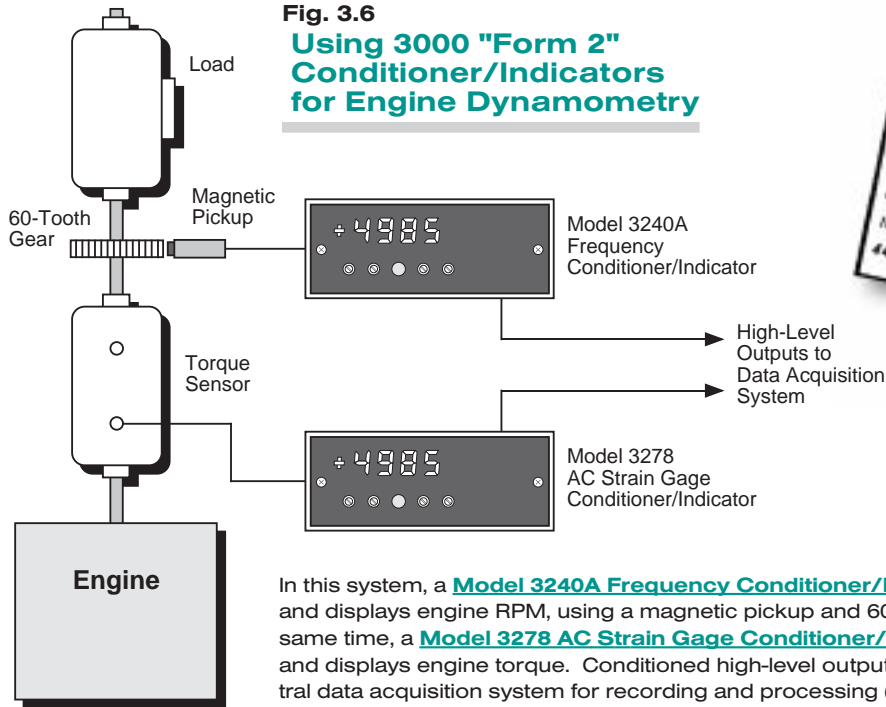


**Fig. 3.7**  
**Legend Sheet**



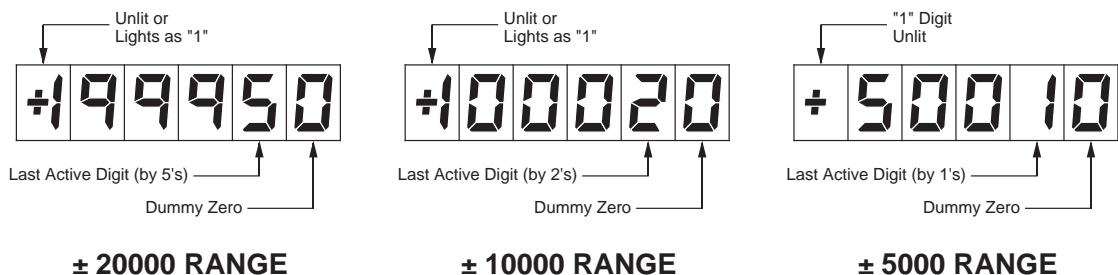
4/10 actual size (approx.)

**Fig. 3.6**  
**Using 3000 "Form 2" Conditioner/Indicators for Engine Dynamometry**



In this system, a [Model 3240A Frequency Conditioner/Indicator](#) measures and displays engine RPM, using a magnetic pickup and 60-tooth gear. At the same time, a [Model 3278 AC Strain Gage Conditioner/Indicator](#) measures and displays engine torque. Conditioned high-level outputs are sent to a central data acquisition system for recording and processing (computation of horsepower, efficiency, etc.)

**Fig. 3.8**  
**Full-Scale Displays for Digital Indicator Ranges**



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## "FORM 3" 3000 Series Instruments: SIGNAL CONDITIONERS WITH DIGITAL INDICATION AND HI-LO LIMITS



To the basic signal conditioning capability of [Form 1 instruments](#) and the data display capability of [Form 2 instruments](#), each "Form 3" instrument adds *two control setpoints*. These are independently adjustable over the full  $\pm$  range, via front-panel Coarse and Fine controls.

Each setpoint may be designated as either a HIGH or a LOW limit value. Thus, three limit modes are available. Units are normally shipped with LOW/OK/HIGH mode activated, but you can easily rewire for either BOTH LIMITS HIGH or BOTH LIMITS LOW. A front-panel "Push-to-Set" button for each limit

lets you display the respective setting in proper engineering units.

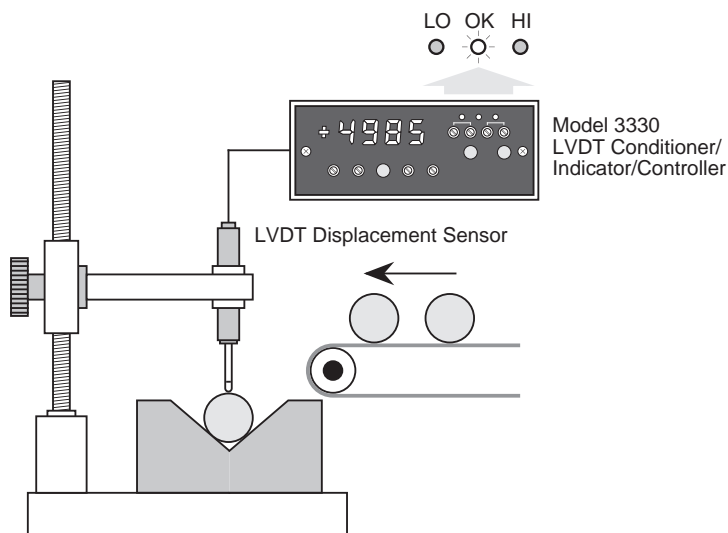
Individual red front-panel LED's indicate HIGH or LOW LIMIT VIOLATION (see Fig. 3.9, below). Such indication is normally nonlatching, but latching mode is also available. A single green LED indicates NO VIOLATION ("OK").

Both true and complement TTL-compatible *logic outputs* are available for each limit condition (LOW, OK, HIGH)—see [General Specifications](#). These outputs are normally disabled as soon as the violation condition ceases to occur, but latching mode is also available.

Optional internal electromechanical or solid-state relays are available for all "Form 3" instruments, to allow the switching of power for annunciation and process control on the basis of existing limit conditions (see ["R" or "S" Option](#)).

**Fig. 3.9**  
Using a 3000 "Form 3" Conditioner/Indicator/Controller for "GO NO-GO" Dimensional Gaging of Parts

A [Model 3330 LVDT Conditioner/Indicator/Controller](#) checks individual parts for conformance to a prespecified "OK" limit range, with front-panel indication of limit status. Limit violations can be made to trigger TTL-level outputs from the 3330's rear panel for purposes of external annunciation and process control. Optional internal relays allow direct switching of power on occurrence of specific limit violations (e.g., to stop the belt that brings parts to the measurement jig). See also [Fig. 3.13](#).



# ANALOG PEAK CAPTURE OPTION ("P" OPTION)

With the installation of an optional circuit board, *real-time analog peak capture* is possible for a [Form 2](#) or [Form 3](#) instrument, in addition to its normal "tracking" function.

Controlled either by front-panel push buttons or by a remote user-installed switch, a "P" unit can "freeze" and display the last positive input-signal "peak" value to have been perceived. The analog output is held at this value until a RESET command is applied.\* A subsequent higher signal excursion disables the "hold," permitting the capture of subsequent higher peaks. Because it is digitally held, a displayed peak value will not decay. The maximum decay rate for a held analog output is only 0.1% of full scale per minute.

For capture of negative "peaks" (signal minima), the input lines may be inverted.

\* To prevent low-level signal noise from triggering a "peak hold," the peak capture function is automatically disabled when the input is less than 8% of full scale. If you require peak capture within the 0-8% range, contact the factory.

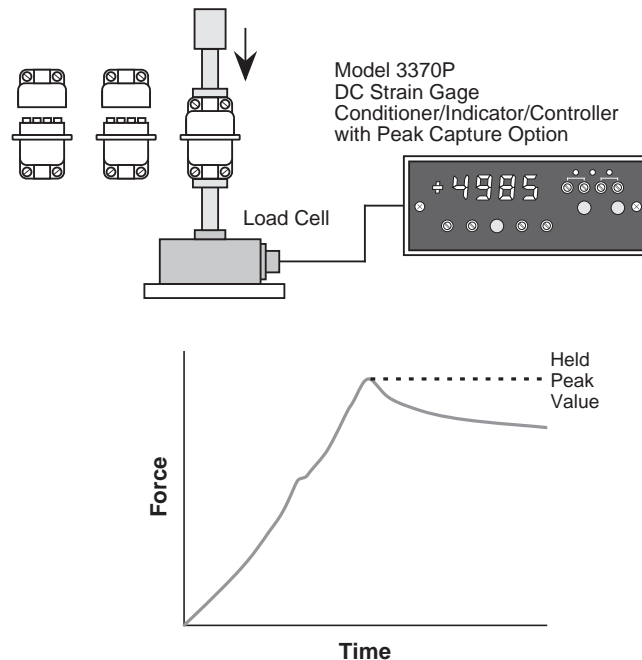


**Model 3378P**

With all [Form 3](#) instruments, limits are automatically latched upon peak capture, and are automatically reset on return to normal "track" mode.

For a special "P" version dedicated to the capture and hold of *peak torque values*, see the [Model TM3 Torque Monitor](#).

**Fig. 3.10**  
**Monitoring Peak Connector Insertion Force**



# 4-20 mA CURRENT OUTPUT OPTION ("C" OPTION)

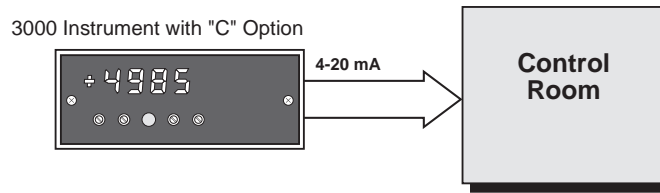
Operating in this mode, any **Form 1** or **Form 2** 3000 Series instrument—or a **Model 3363** or **Model 3370**—can transmit high-accuracy measurement data as *process signals for supervisory monitoring and control*. Each "C" unit produces two kinds of analog output simultaneously: (1) its normal voltage output and (2) a current output continuously proportional to the voltage signal to within  $\pm 0.05\%$ .

As normally shipped, this option generates a current output within

the ISA standard signal range of 4 to 20 mA, corresponding to a range of 0 to +5 V. Bipolar ranges of  $\pm 16$  mA and 4 to 12 to 20 mA are also

available, each corresponding to -5 to +5 V. Voltage compliance is +5 V relative to Signal Common.

**Fig. 3.11**  
**3000 Instrument as 4-20 mA Transmitter**



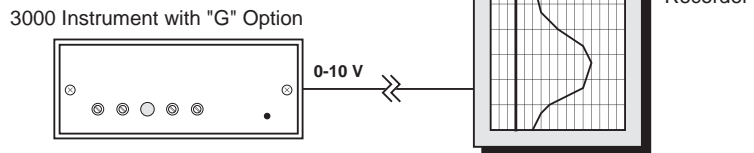
# DUAL GALVANIC ISOLATED OUTPUTS OPTION ("G" OPTION)

With this option, a **Form 1** or **Form 2** instrument can furnish two independent galvanic outputs, each 0-10 V-DC (2 mA max), full scale. These outputs are completely isolated not only from each other but also from the 3000 instrument's "common."

The use of galvanically isolated outputs prevents ground-loop effects in interconnections with remote data-acquisition systems or controllers. The presence of two independent outputs lets you send collected data to two different systems or devices, each with its own ground.

Load limit for each output exceeds 10 k $\Omega$ . Output bandwidth is normally 40 Hz; the "G" option can be easily modified, however, for other bandwidths up to 500 Hz.

**Fig. 3.12**  
**Isolated Voltage Output to Strip Chart Recorder**



## ADDITIONAL "G" OPTION SPECIFICATIONS

**Output Range:**  $\pm 10$  V-DC full scale (2 mA max.), normal; internal controls give approximately  $\pm 5\%$  of adjustment authority on both SPAN and ZERO

**Common-Mode Range:**  $\pm 500$  V, max.

**Common-Mode Rejection Ratio:** -120 dB at DC; -60 dB at 60 Hz

**Gain:** Factory set to 2.00; user-adjustable within  $\pm 5\%$

**Linearity:**  $\pm 0.1\%$  of full scale

**Maximum Zero or Span Drift (after warmup of 1/2 hour):**  $\pm 0.2\%$  of full scale\*

\* Applies to the "G" Option only, and does not include possible drift contributed by the signal conditioner board of the base 3000 instrument.



# INTERNAL RELAYS OPTION ("R" OR "S" OPTION)

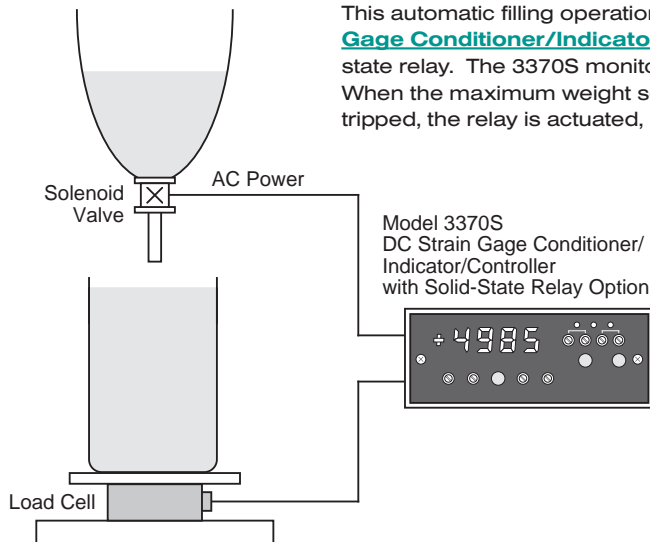
With this option, a [Form 3](#) instrument can switch power for control action in all types of open-loop or ON-OFF closed-loop operations. It may be used, for example, to actuate alarms or sorting devices, or to start up or shut down external processes. Both relay types are controlled directly by the unit's LIMIT VIOLATION outputs.

The **Electromechanical Relay ("R" Option)** is ideal for DC or low-level switching. Two normally open and two normally closed contacts are rated at 8 amps, 250 V-AC at full

resistive load. Switch lifetime at 1 amp resistive load exceeds 100,000 operations.

The **Solid-State Relay ("S" Option)** is suitable for controlling medium-power AC loads, or for highly repetitive operations (since its lifetime at full resistive load exceeds 10,000,000 operations). Its contacts (similar to those of the Electromechanical Relay) are rated at 3 amps, 250 V-AC at full load. Zero-crossing circuitry ensures low EMI.

**Fig. 3.13**  
**Relay-Controlled Filling Operation**



This automatic filling operation uses a [Model 3370S DC Strain Gage Conditioner/Indicator/Controller](#) with internal solid-state relay. The 3370S monitors the container's weight as it fills. When the maximum weight setpoint is reached, the HI limit is tripped, the relay is actuated, and the bin's solenoid valve closes.


**MODELS**

# 3130, 3230, 3330

## AC LVDT INSTRUMENTS



The **Model 3130 LVDT Conditioner** is the basic [Form 1 instrument](#).

The **Model 3230 LVDT Conditioner/Indicator** is the [Form 2 instrument](#), providing vivid front-panel digital indication of measured

values. The available scales allow ready calibration over virtually any measurement range, with a wide choice of engineering units. Instrument sensitivity and resolution allow precision to a fraction of a microinch, if required.

The **Model 3330 LVDT Conditioner/Indicator/Controller** is the [Form 3 instrument](#), and includes HI/LO limit detection. This feature is useful in wide variety of "GO NO-GO" dimensional gaging applications, like the one shown in [Fig. 3.9](#).

Working on the synchronous carrier-demodulator principle, all three instruments supply amplitude-regulated 3-kHz AC excitation to the transducer. Two standard 5-V outputs are produced (see Specifications). Each output is precisely proportional to LVDT core displacement over the full  $\pm$  range of the

(cont'd)

The **Models 3130, 3230, and 3330 LVDT Instruments** may be used with any series-opposed 5-, 6-, or 7-wire LVDT sensors or 3-wire variable reluctance transducers that can be operated with a 3-kHz frequency. Optional remote sensing is available for long cables.

### LVDT INSTRUMENT SPECIFICATIONS

**Input Type:** Series-opposed 5-, 6-, or 7-wire LVDT sensor or 3-wire variable reluctance transducer capable of 3-kHz operation and having primary impedance greater than 80  $\Omega$

**Input Range (full-scale):**  $\pm 0.001$  to  $\pm 4.000$  inches ( $\pm 0.0254$  to  $\pm 101.6$  mm)

**Excitation Supplied:** 3 kHz, amplitude regulated

**Analog Outputs:** Two outputs, each  $\pm 5$  V full-scale with 50% overrange, 5 mA max.; low-pass corner frequencies of 2 Hz and 400 Hz, respectively

**Analog Filtering:** Active low-pass filters provide -60 dB per decade above cutoff frequency ("f"); full-scale slew time is  $1.4/f$  sec

**Output Ripple and Noise:** 0.15% of full scale (rms) max. for

400-Hz output; 0.02% for 2-Hz output

**Accuracy (typical, following calibration):** Varies from 0.1% to 1.0% of calibrated range\*

**Display Resolution (Models 3230 and 3330):** 0.02% of full scale

\* Depending on the *linearity characteristics of the LVDT element itself*. The resolution and accuracy of these instruments are considerably in excess of what is generally useful in practical applications. In high-sensitivity LVDT measurement, the ultimate limits of accuracy are not imposed by the instrumentation, but by considerations of dimensional stability that pertain to the transducer, the fixture, and/or the measured object itself. In general, accuracy to 0.0001 inch or better can be achieved only with carefully designed fixtures and under conditions of precise temperature control.

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**Go To GENERAL 3000 SERIES  
DESCRIPTION & SPECS**



**MODELS**

**3130, 3230, 3330**

**AC LVDT INSTRUMENTS**

*(cont'd)*

sensor. Sensitivity is widely adjustable, allowing full-scale output for input displacements as small as  $\pm 0.001$  inch ( $\pm 0.0254$  mm).

A unique phase-control circuit automatically and continuously adapts the instrument to any signal phase shift occurring in the transducer or cable. This simplifies setup procedures, and ensures optimum sensitivity and linearity for each type of LVDT sensor employed.

Span adjustment is accomplished through 12-turn Coarse and Fine front-panel controls plus 5 internal range multiplier switches. Nominal maximum sensitivity is 10 mV (in-phase component) for full-scale input.

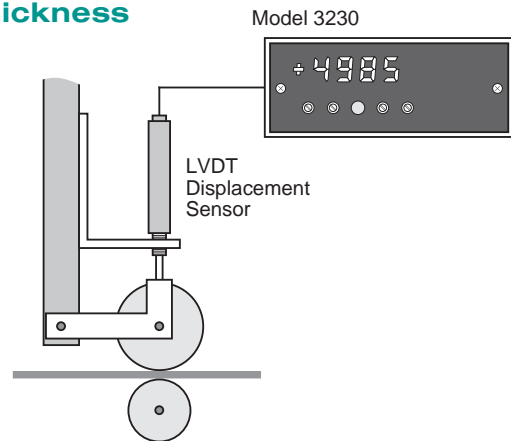
See [General Specifications](#).

3000 Series options applying to the LVDT instruments include

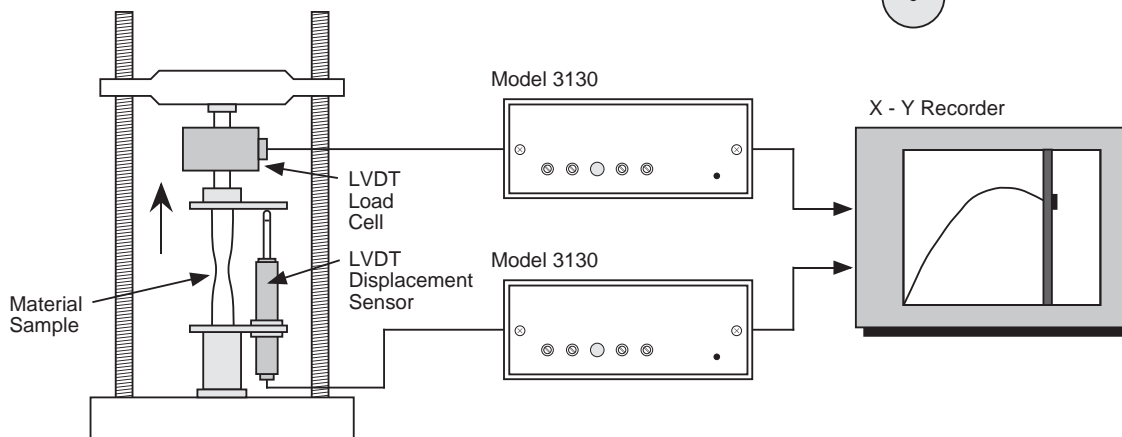
- [Analog Peak Capture](#) (Models 3230 and 3330)
- [4-20 mA Current Output](#) (Models 3130 and 3230)
- [0-10 V-DC Dual Galvanic Isolated Outputs](#) (Models 3130 and 3230)

- [Internal Electromechanical Relays](#) (Model 3330)
- [Internal Solid-State Relays](#) (Model 3330)
- [12 V-DC Battery-Powered Operation or Nominal 230 V-AC Operation](#) (Models 3130, 3230, and 3330)

**Fig. 3.14(b)**  
**Continuous Thickness Measurement**



**Fig. 3.14(a)**  
**Stress-Strain Recording**



*(cont'd)*

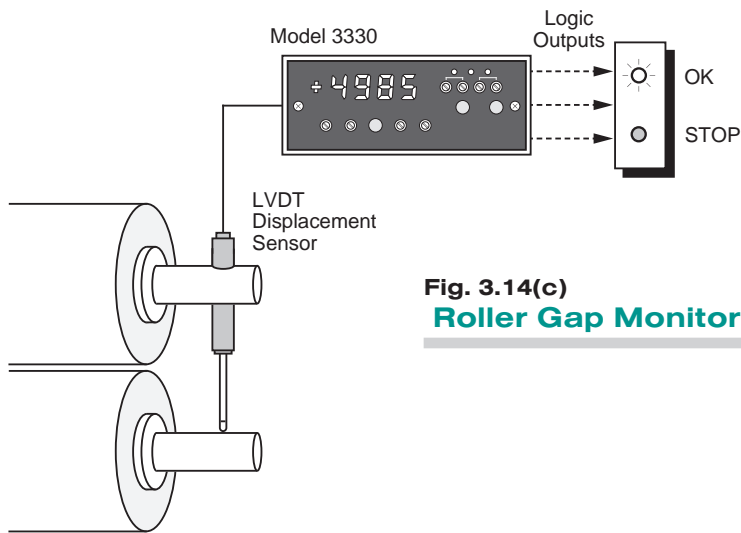


**MODELS**

**3130, 3230, 3330**

**AC LVDT INSTRUMENTS**

*(cont'd)*



**Fig. 3.14(c)**  
**Roller Gap Monitoring**

INTRODUCTION

2000 SERIES

3000 SERIES

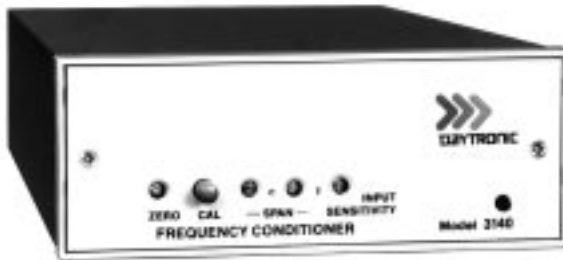
3500 SERIES

4000 SERIES


**MODELS**

# 3140A, 3240A, 3340A

## FREQUENCY MEASURING INSTRUMENTS



The **Models 3140A, 3240A, and 3340A Frequency Measuring Instruments** accept any type of AC or pulse input signal, single-ended or differential, irrespective of waveform. Each instrument produces one standard 5-V output (see Specifications), each precisely propor-

tional to the frequency of the source. These conditioners are useful for measuring *rpm*, *flow*, and other phenomena that can be sensed by frequency-generating devices like magnetic pickups or turbine flowmeters—

see [Fig. 3.15\(a\)](#) and [Fig. 3.15\(b\)](#).

The **Model 3140A Frequency Conditioner** is the basic [Form 1 instrument](#).

The **Model 3240A Frequency Conditioner/Indicator** is the [Form 2 instrument](#), providing vivid front-

The **Models 3140A, 3240A, and 3340A** are similar in appearance to the instruments shown.

panel digital indication of measured values, scalable in desired engineering units.

The **Model 3340A Frequency Conditioner/Indicator/Controller** is the [Form 3 instrument](#), and includes HI/LO limit detection. This feature is useful in various control and safety alarm functions (e.g., shaft overspeed, low oil flow, etc.).

A wide selection of frequency ranges accommodates virtually any mechanical measurement require-

(cont'd)

### FREQUENCY INSTRUMENT SPECIFICATIONS

**Input Type:** Any AC or unipolar pulse signal, floating or grounded, irrespective of waveform

**Input Threshold Level:** Automatic triggering at 75% and 25% of the input amplitude

**Input Ranges (full-scale):** Switch-selectable 0 to 100, 200, 500, 1000, 2000, 5000, 10000, 20000, or 50000 Hz

**Sensitivity (full-scale):** Continuously adjustable from 0.1 to 200 V\*

**Excitation Supplied:** -9 V-DC auxiliary supply available on rear connector

**Analog Output:** One output,  $\pm 5$  V full-scale with 50% over-range, 5 mA max.; low-pass corner frequency of 2 Hz for 100, 200, and 500 Hz ranges; 10 Hz for all other ranges

**Output Ripple and Noise:** Less than 0.1% of full scale from 20 to 100% of the selected range

**Step-Function Response Time (to 99% of final full-scale value):** 1.8 sec for 100-, 200-, and 500-Hz ranges; 350 msec for all other ranges

**Accuracy (typical, following calibration):** 0.05% of full scale

**Display Resolution (Models 3240A and 3340A):** 0.02% of full scale

\* Input sensitivity decreases above 10 kHz by 0.01 V/kHz (to 0.5 V at 50 kHz).

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DESCRIPTION & SPECS




**MODELS**

# 3140A, 3240A, 3340A

## FREQUENCY MEASURING INSTRUMENTS (*cont'd*)

ment. Input sensitivity level is continuously adjustable via front-panel control.

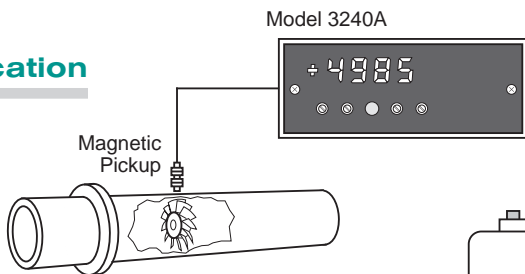
A simple procedure, using an internal crystal reference oscillator and adjustable span controls, allows precise calibration in terms of frequency, rpm, gallons per hour, or any other appropriate unit. An auxiliary excitation supply of -9 V-DC is available on the rear connector.

See [General Specifications](#).

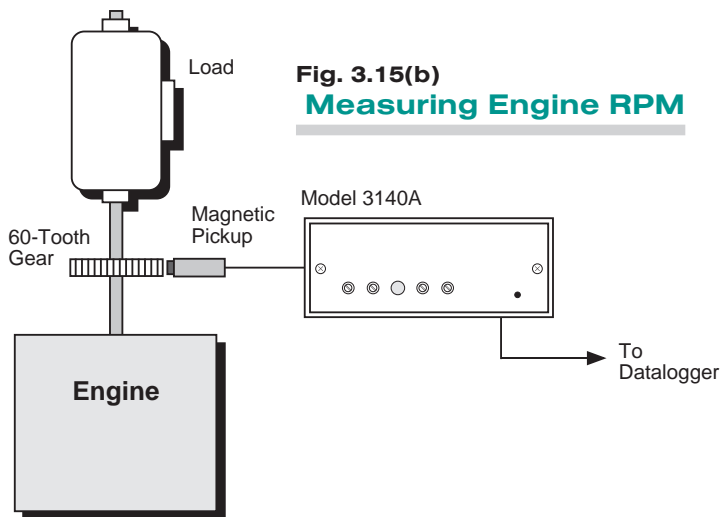
3000 Series options applying to the frequency instruments include

- [Analog Peak Capture](#) (Models 3240A and 3340A)
- [4-20 mA Current Output](#) (Models 3140A and 3240A)
- [0-10 V-DC Dual Galvanic Isolated Outputs](#) (Models 3140A and 3240A)
- [Internal Electromechanical Relays](#) (Model 3340A)
- [Internal Solid-State Relays](#) (Model 3340A)
- [12 V-DC Battery-Powered Operation or Nominal 230 V-AC Operation](#) (Models 3140A, 3240A, and 3340A)

**Fig. 3.15(a)**  
**Flow Indication**



**Fig. 3.15(b)**  
**Measuring Engine RPM**





# MODELS 3163, 3263, 3363 ANALOG INPUT INSTRUMENTS



The **Models 3163, 3263, and 3363 Analog Input Instruments** accept inputs from various analog voltage sources, including *DC-to-DC LVDT's, potentiometer-type sensors, Hall-Effect devices, photocells, current shunts,* and the outputs of other instrument systems with vari-

ous grounding configurations and voltage/impedance levels.

The **Model 3163 Analog Input Conditioner** is the basic [Form 1 instrument](#).

The **Model 3263 Analog Input Conditioner/Indicator** is the [Form 2](#)

[instrument](#), providing vivid front-panel digital indication of measured values, scalable in desired engineering units.

The **Model 3363 Analog Input Conditioner/Indicator/Controller**

is the [Form 3 instrument](#), and includes HI/LO limit detection with control output.

The signal source can be grounded or floating, and may use 2-, 3-, or 4-wire cabling (see [Fig. 16\(a\)](#)). A regulated 10-V supply is provided for excitation of potentiometers, DC-to-DC sensors, and similar devices. Full-scale sensitivity is continuously adjustable in four jumper-selectable ranges. Three standard 5-V outputs are produced (see Specifications).

With a sensitive, high-impedance, floating differential input, wide com-  
*(cont'd)*

## ANALOG INPUT INSTRUMENT SPECIFICATIONS

**Input Type:** 2-, 3-, or 4-wire DC voltage source, floating or grounded

**Input Ranges (full-scale):** Full-scale sensitivity continuously adjustable in jumper-selectable ranges of 50 to 500 mV, 500 mV to 5 V, 5 to 50 V, and 50 to 250 V

**Excitation Supplied:** Regulated 10V  $\pm 0.02\%$ , 20 mA max., for excitation of potentiometers, DC-to-DC sensors, and similar devices

**Analog Outputs ( $\pm 5$  V Full-Scale):** Three outputs, each  $\pm 5$  V full-scale with 50% overrange, 5 mA max.; low-pass corner frequencies of 2 Hz, 200 Hz, and 2 kHz, respectively

**Common-Mode Range:**  $\pm 100$  V-DC

**Common-Mode Rejection Ratio:** -70 dB, DC to 60 Hz

**Input Impedance:** 1 M $\Omega$  (all ranges)

**Analog Filtering:** Active low-pass filters provide -60 dB per decade above cutoff frequency ("f"); full-scale slew time is 1.4/f sec

**Output Ripple and Noise:** 0.15% of full scale (rms) max. for 200-Hz and 2-kHz outputs; 0.02% of full scale (rms) max. for 2-Hz output

**Accuracy (typical, following calibration):** 0.1% of full scale for 60 days ("hands off") following initial calibration

**Display Resolution (Models 3263 and 3363):** 0.02% of full scale



# MODELS **3163, 3263, 3363** ANALOG INPUT INSTRUMENTS *(cont'd)*

mon-mode range, and exceptional common-mode rejection, these models can be used to obtain difficult low-level signals from highly off-ground sources, without common-mode AC or DC offset problems.

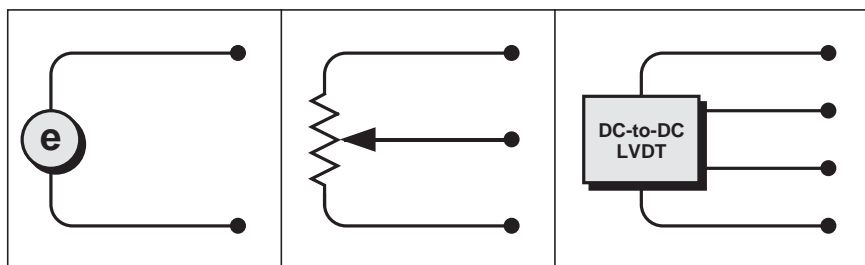
Selectable low-pass active filtering allows the smoothing of unwanted normal-mode dynamic components that might prevent stable digital conversion or control action.

See [General Specifications](#).

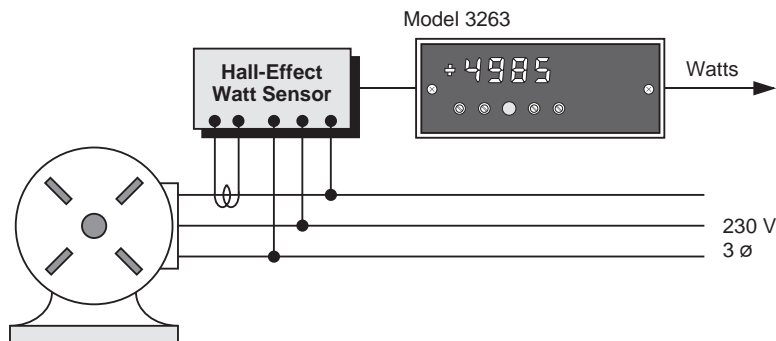
3000 Series options applying to the analog input instruments include

- [Analog Peak Capture](#) (Models 3263 and 3363)
- [4-20 mA Current Output](#) (Models 3163, 3263, and 3363)
- [0-10 V-DC Dual Galvanic Isolated Outputs](#) (Models 3163 and 3263)
- [Internal Electromechanical Relays](#) (Model 3363)
- [Internal Solid-State Relays](#) (Model 3363)
- [12 V-DC Battery-Powered Operation or Nominal 230 V-AC Operation](#) (Models 3163, 3263, and 3363)

**Fig. 3.16(a)**  
**Signal Source Configurations for the Models 3163, 3263, 3363**



**Fig. 3.16(b)**  
**3-Phase AC Power Measurement**





# MODELS 3170, 3270, 3370

## DC STRAIN GAGE INSTRUMENTS



The **Models 3170, 3270, and 3370 DC Strain Gage Conditioners** are highly accurate DC instruments for use with load cells, pressure sensors, and other strain gage transducers employing a 4-arm bridge.

The **Model 3170 Strain Gage Conditioner** is the basic **Form 1 instrument**.

The **Model 3270 Strain Gage Conditioner/Indicator** is the **Form 2 instrument**, providing vivid front-panel digital indication

of measured values, scalable in desired engineering units.

The **Model 3370 Strain Gage Conditioner/Indicator/Controller** is the **Form 3 instrument**, and

includes HI/LO limit detection with control output (see [Fig. 3.13](#) and [Fig. 3.17\(c\)](#)).

Advanced circuit design overcomes many of the errors traditionally afflicting the strain gage measurement process, resulting in three high-level, drift-free, noise-free analog outputs (see Specifications). Nearly all mechanical measurement and control requirements are covered by these three simultaneously available outputs.

*(cont'd)*

### DC STRAIN GAGE INSTRUMENT SPECIFICATIONS

**Input Type:** Conventional 4-arm strain gage bridge, nominal 90 to 2000  $\Omega$

**Input Range (full-scale):** Nominal sensitivity 1 to 8 mV/V, full scale\*

**Excitation Supplied:** Regulated 5 or 10 V-DC, user selectable\*\*

**Analog Outputs:** Three outputs, each  $\pm 5$  V full-scale with 50% overrange, 5 mA max.; low-pass corner frequencies of 2 Hz, 200 Hz, and 2 kHz, respectively

**Common-Mode Rejection:** Greater than 80 dB

**Input Impedance:** Greater than 100 M $\Omega$

**Analog Filtering:** Active low-pass filters provide -60 dB per decade above cutoff frequency ("f"); full-scale slew time is 1.4/f sec

**Output Ripple and Noise:** 0.15% of full scale (rms) max. for 200-Hz and 2-kHz outputs; 0.02% of full scale (rms) max. for 2-Hz output

**Accuracy (typical, following Calibration):** 0.05% of full scale

**Display Resolution (Models 3270 and 3370):** 0.02% of full scale\*\*\*

\* Ten-turn coarse and fine front-panel controls will balance 1.5 mV/V initial unbalance and allow span adjustment over the stated full-scale sensitivity.

\*\* Transducers with sensitivity from 4 to 8 mV/V, full scale, or with bridge resistance of 120  $\Omega$  or less, must use 5-V excitation.

\*\*\* Includes the combined effects of nonlinearity, random noise, line-voltage variation between 105 and 130 volts, ambient temperature variation of  $\pm 20^\circ$  F about starting value, and six-months drift of zero and span. Errors attributable to the transducer are not included.

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DESCRIPTION & SPECS**



# MODELS 3170, 3270, 3370

## DC STRAIN GAGE INSTRUMENTS (cont'd)

Other important features include

- **remote sensing and regulation of bridge excitation**—eliminates errors from temperature effects on cable resistance
- **seven-wire calibration circuitry**—applies the internal shunt calibration resistor at the transducer terminals, thereby eliminating significant calibration transfer error in long-cable installations
- **true differential input**, with better than 80 dB of common-mode rejection—eliminates errors from common-mode pickup and possible “ground-loop” coupling
- **input impedance in excess of 100 megohms** preserves the validity of factory calibration, pre-

vents conversion of common-mode to normal-mode signals, and eliminates remaining errors attributable to cable resistance. Allowable cable length has virtually no practical limits.

- **elimination of both short-term and long-term drift** through an advanced solid-state chopper stabilization technique, while preserving the full frequency pass-band, free of chopper noise; the rated accuracy is obtained without “warm-up” period or periodic “tweaking” of controls
- **active low-pass filtering** smooths unwanted dynamic signal components arising from vibration, power impulses, etc., that might prevent stable digital conversion or control action

For a special “P” version of the Model 3370 dedicated to the capture and hold of *peak torque values*, see the [Model TM3 Torque Monitor](#). For conditioning inputs from *AC-excited* strain gage transducers, see the [Models 3178, 3278, and 3378](#).

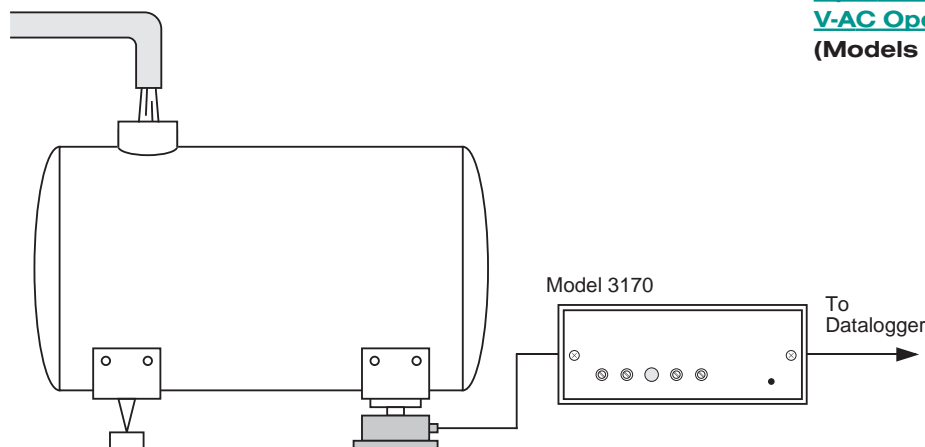
See [General Specifications](#).

3000 Series options applying to the DC Strain Gage instruments include

- [Analog Peak Capture](#) (Models 3270 and 3370)
- [4-20 mA Current Output](#) (Models 3170, 3270, and 3370)
- [0-10 V-DC Dual Galvanic Isolated Outputs](#) (Models 3170 and 3270)
- [Internal Electromechanical Relays](#) (Model 3370)
- [Internal Solid-State Relays](#) (Model 3370)
- [12 V-DC Battery-Powered Operation or Nominal 230 V-AC Operation](#) (Models 3170, 3270, and 3370)

(cont'd)

**Fig. 3.17(a)**  
**Tank Level Measurement Using a Single Load Cell**

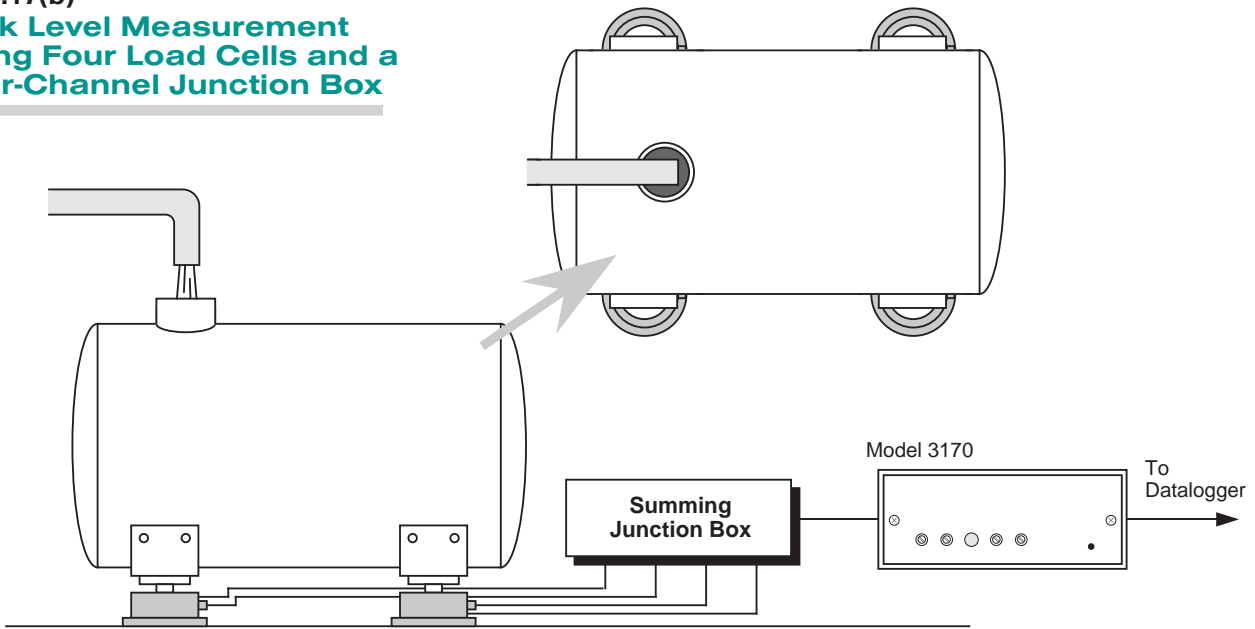




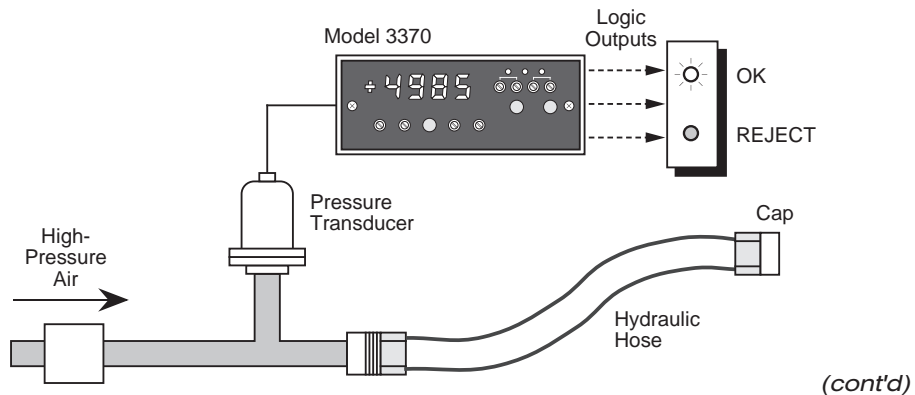


**MODELS**  
**3170, 3270, 3370**  
**DC STRAIN GAGE**  
**INSTRUMENTS (cont'd)**

**Fig. 3.17(b)**  
**Tank Level Measurement**  
**Using Four Load Cells and a**  
**Four-Channel Junction Box**



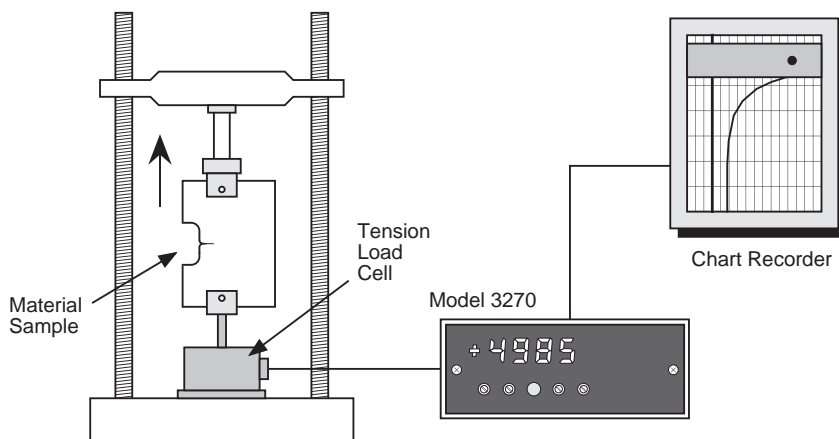
**Fig. 3.17(c)**  
**Leak-Testing of Hydraulic Hoses**



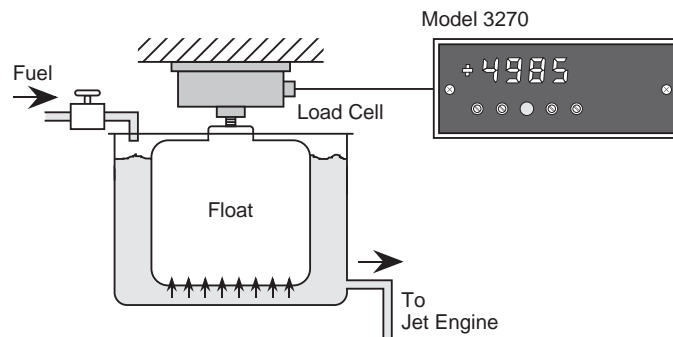


# MODELS 3170, 3270, 3370 DC STRAIN GAGE INSTRUMENTS *(cont'd)*

**Fig. 3.17(d)**  
**Measuring Material Rupture Strength**



**Fig. 3.17(e)**  
**Measuring Mass Flow of Fuel Consumed**



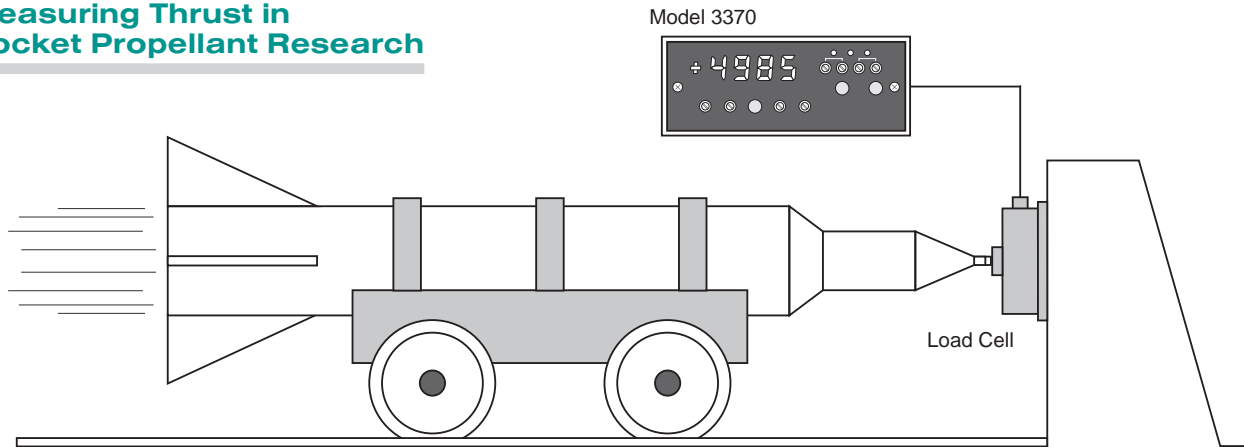
Additional applications of the **DC Strain Gage Instruments** are illustrated in:

- **Fig. 3.5** (Spring Testing)
- **Fig. 3.10** (Monitoring Peak Connector Insertion Force)
- **Fig. 3.13** (Relay-Controlled Filling Operation)



**MODELS**  
**3170, 3270, 3370**  
**DC STRAIN GAGE**  
**INSTRUMENTS (cont'd)**

**Fig. 3.17(f)**  
**Measuring Thrust in**  
**Rocket Propellant Research**




**MODELS**

# 3178, 3278, 3378

## AC STRAIN GAGE INSTRUMENTS



Being *phase-sensitive carrier-demodulator instruments* (rather than *fully DC*), the **Models 3178, 3278, and 3378 AC Strain Gage Conditioners** are intended for applications involving transformer

coupling to the transducer bridge (as with *rotary-transformer torque sensors*) and for applications requiring *high sensitivity with optimum signal-to-noise characteristics*—as, for example, where the electrical environ-

ment is especially noisy and there is a need for high amplification of low signal levels.

The **Model 3178 Strain Gage Conditioner** is the basic [Form 1 instrument](#).

The **Model 3278 Strain Gage Conditioner/Indicator** is the [Form 2 instrument](#), providing vivid front-panel digital indication of measured values, scalable in desired engineering units. See [Fig. 3.6](#) for use of the 3278 in a typical engine dynamometry application.

The **Model 3378 Strain Gage Conditioner/Indicator/Controller** is the [Form 3 instrument](#), and includes HI/LO limit detection with control output.

(cont'd)

### AC STRAIN GAGE INSTRUMENT SPECIFICATIONS

**Input Type:** Conventional 4-arm strain gage bridge, nominal 90 to 1000  $\Omega$

**Input Range (full-scale):** Nominal sensitivity 0.5 to 5 mV/V, full scale\*

**Excitation Supplied:** 2 V-AC (rms) at 3.28 kHz

**Analog Outputs:** Two outputs, each  $\pm 5$  V full-scale with 50% overrange, 5 mA max.; low-pass corner frequencies of 2 Hz and 400 Hz, respectively

**Common-Mode Rejection:** Greater than 80 dB

**Input Impedance:** Greater than 100 M $\Omega$

**Analog Filtering:** Active low-pass filters provide -60 dB per decade above cutoff frequency ("f"); full-scale slew time is 1.4/f sec

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

**Accuracy (typical, following Calibration):** 0.05% of full scale

**Display Resolution (Models 3278 and 3378):** 0.02% of full scale\*\*

\* Ten-turn coarse and fine front-panel controls will balance 1.5 mV/V initial unbalance and allow span adjustment over the stated full-scale sensitivity.

\*\* Includes the combined effects of nonlinearity, random noise, line-voltage variation between 105 and 130 volts, ambient temperature variation of  $\pm 20^\circ$  F about starting value, and six-months drift of zero and span. Errors attributable to the transducer are not included.

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**MODELS**

# 3178, 3278, 3378

## AC STRAIN GAGE

### INSTRUMENTS (*cont'd*)

Other important features include

- **remote sensing and regulation of bridge excitation**—eliminates errors from temperature effects on cable resistance
- **seven-wire calibration circuitry**—applies the internal shunt calibration resistor at the transducer terminals, thereby eliminating significant calibration transfer error in long-cable installations
- **true differential input**, with better than 80 dB of common-mode rejection—eliminates errors from common-mode pickup and possible “ground-loop” coupling
- **input impedance in excess of 100 megohms** preserves the validity of factory calibration, pre-

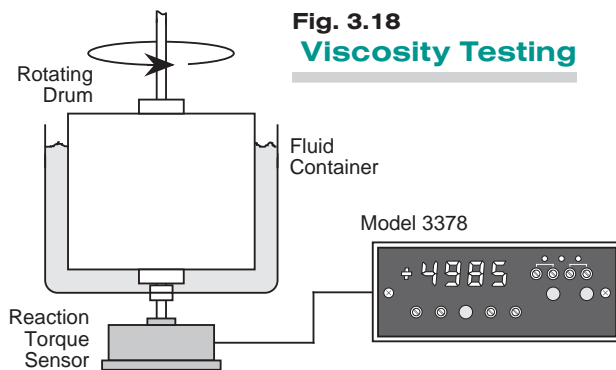
vents conversion of common-mode to normal-mode signals, and eliminates remaining errors attributable to cable resistance. Allowable cable length has virtually no practical limits.

- **elimination of both short-term and long-term drift** through an advanced solid-state chopper stabilization technique, while preserving the full frequency pass-band, free of chopper noise; the rated accuracy is obtained without “warm-up” period or periodic “tweaking” of controls
- **active low-pass filtering** smooths unwanted dynamic signal components arising from vibration, power impulses, etc., that might prevent stable digital conversion or control action

See [General Specifications](#).

3000 Series options applying to the AC Strain Gage instruments include

- [Analog Peak Capture \(Models 3278 and 3378\)](#)
- [4-20 mA Current Output \(Models 3178 and 3278\)](#)
- [0-10 V-DC Dual Galvanic Isolated Outputs \(Models 3178 and 3278\)](#)
- [Internal Electromechanical Relays \(Model 3378\)](#)
- [Internal Solid-State Relays \(Model 3378\)](#)
- [12 V-DC Battery-Powered Operation or Nominal 230 V-AC Operation \(Models 3178, 3278, and 3378\)](#)



**Fig. 3.18**  
**Viscosity Testing**



# MODEL TM3 TORQUE MONITOR

Peak *air-tool torque* is a critical parameter in many quality control operations. A special "P" version of the [Model 3370 DC Strain Gage Conditioner/Indicator/Controller](#), the Model TM3 is a simple, economical benchtop unit for automatic capture, display, and evaluation of the true "real-time" maximum value experienced by a single analog torque signal. It can be used with all kinds of transducerized air-operated strain gage torque tools—and, as shown in Fig. 3.19, below, can even be used to test performance of such tools themselves.

Peak-capture mode and reset control are fully automatic. Thus, after each peak is captured and displayed, the operator need only place the air tool on the next fastener to be tested, and the unit will instantly "auto-reset" for the next measurement. A factory-set threshold of approximately 15% of full-scale output prevents triggering of the peak-capture function by induced low-level signal noise,

when the tool socket is seated on the bolt to be tightened (if you require peak capture within the 15% range, contact the factory).

TM3 specifications are identical to those of the Model 3370 with reference to basic signal-conditioning, digital-indication, and limit-monitoring capabilities. In addition, a "HELD PEAK" analog output is momentarily available after every peak capture (for about one second) at the TM3's rear I/O connector, for recording by an external

instrument or system. Front-panel limit status indicators (HIGH, LOW, and OK) are latched until auto-reset, as are rear-connector logic outputs, which are available in both true and complement for each limit condition.

For optional battery power (11.5-15 V-DC, 500 mA max.), specify the **Model TM3B**. Special versions for high-sensitivity semiconductor bridges (up to 100 mV/V) can also be ordered.



**Fig. 3.19**  
**Testing Torque Wrenches for Proper Slip Point**

