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05/25/00

Microsense™ II

Model 5300
Gaging System

with 5130 and 5210 Modules

User Manual

- Revision B -

Part Number 028653-R01

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Revision History of this Manual

Revision	Date	Description of change
Preliminary	07/31/98	First version
A	08/28/98	Illustrations added I/O connector "-ANALOG OUT" incorrectly specified as Pin 24 - changed to Pin 26.
B	04/20/00	*Released per ECO 624* Manual rewritten to include sections on **Model 5300 Console** and **Model 5210 Velocity and Acceleration Module**. Topics from the **Model 3401 Gaging System** operation manual also included. Formatting and font style of manual changed as well.

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Microsense™ II Model 5300 Gaging System

Functional Overview

The Model 5300 is a modular, configurable, benchtop gaging system that accepts up to four Model 5130 noncontact capacitive displacement-gaging modules, a single Model 5210 velocity and acceleration module and a single display module. Rear-panel connectors provide differential analog outputs for all channels, access to a simple serial digital interface for remote calibration of the 5130 modules and a power-entry module configurable for all international power standards.

Each Model 5130 module connects to a single capacitive probe and offers high-bandwidth and superior signal-to-noise ratio. The modules are especially suitable for dynamic measurements such as vibration and high-speed spindle analysis.

The Model 5210 module connects to channels A & B and provides velocity, acceleration and displacement of A, B, A+B, and A-B as selected by the operator.

Please refer to the individual sections on the Model 5130 and Model 5210 modules for details on their operation.

Applications

The Model 5300 gaging system provides noncontact, one- to four-channel measurements suited to a wide variety of applications. The system can be used to measure values including thickness, step height, dynamic diameter variation, concentricity, surface velocity and surface acceleration.

The gage is intended for general purpose industrial applications such as:

- Inspection/Evaluation of High-Speed Ball, Hydrodynamic or Air Bearings
- Machine Tool Spindle Performance Evaluation/Monitoring
- High-Speed PCB Drilling Spindle Evaluation/Monitoring
- Precision Optics Processing Equipment Evaluation/Monitoring
- Run-Out/NRRO Motor or Disk Analysis
- Vibration Analysis
- Velocity, Acceleration, Flutter and Warp Analysis
- Non-Contact, Non-Destructive Measurement Applications
- Computer disk Edge Runout Applications

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Model 5300 Gaging System Specifications

Performance:

Ranges:	±25 microns to ±500 microns full scale, depending on probe selection.
Frequency Response:	Jumper selectable filtering: 1 kHz, 5 kHz, 20 kHz, 100 kHz
Linearity:	Typically 0.1% of full-scale (see note 1)
Resolution:	1 nanometer rms @ 100 kHz bandwidth (see note 1)

Functions: (Standard Unit)

Meter: Zero meter reading indicates probe is at nominal standoff from measured target.

Option for differential measurements

A+B: Sum of the A probe and the B probe displacement signals
A-B: Difference of the A probe and the B probe displacement signals

EMC Certification:

The Model 5300 Capacitance Gage has been tested and is in compliance with the requirements set forth in EMC Directives EN 55022, EN 50082-1, 89/336/EC, IEC 801-2, IEC 801-3, and IEC 801-4.
Test Report Number: CE101195

Model 5120 Velocity/Acceleration Option:

A plug-in VA option is available for the Model 5300 system. When configured with this VA option, Velocity and Acceleration measurements are derived for the probe selected on the channel switch. Filtering is provided by three-pole Bessel or Butterworth low-pass plug-in filters. The user selects the upper roll-off frequency (as defined by ANSI standards) over a range from 1-20 kHz.

Mechanical Parameters:

Dimensions:	Width: 16.5 inches (42.31 cm)
	Height: 5.75 inches (14.74 cm)
	Depth: 13.0 inches (33.33 cm)
Shipping Weight:	23 pounds (10.35 kg)

Power Requirements:

The 5300 System utilizes a power supply that will accept virtually any standard input voltage in the world. Please specify the proper IEC320 power cord for your region.

Input Voltages:	100-240 VAC, externally switched
Input Frequency:	50-60 Hz

Notes:

1. Parameters listed are typical when using a 2mm active sensor area and a range of ±50 microns. Specifications will vary depending upon range, standoff distance, and probe active sensor area. Resolution improves with larger sensor areas, reduced bandwidth and smaller ranges. Ideal Operating Temperature is 60-90°F (16-35°C). For specific resolution for your application, talk to your ADE Technologies' sales representative.

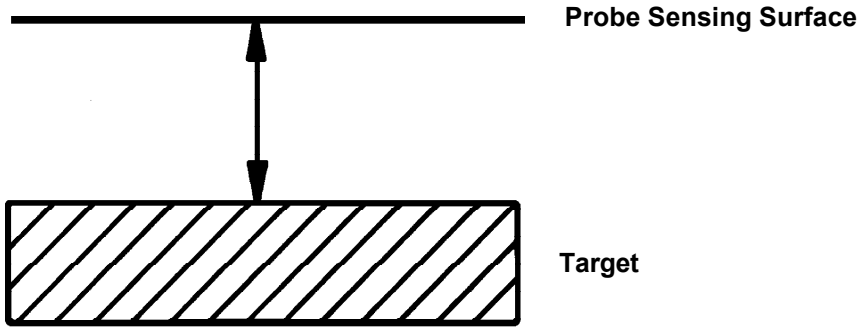
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Selected Measurement Concepts

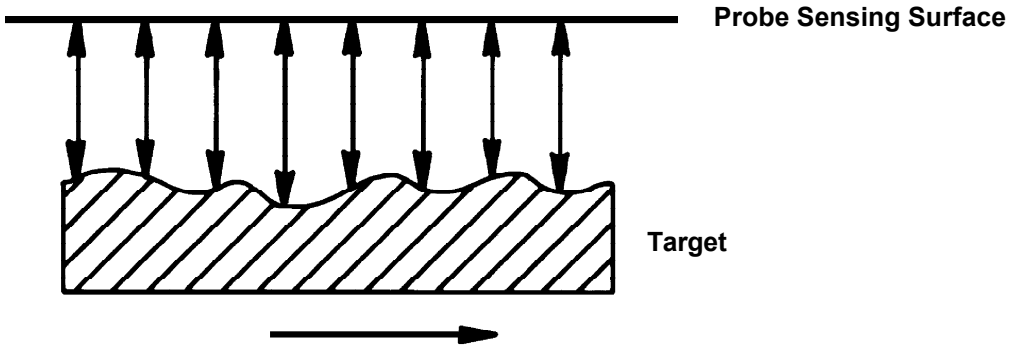
Microsense probes measure displacement. Measurements which may be derived using the Model 5300 gaging system are described briefly in the pages which follow.

Displacement

"Displacement" is the distance change between the probe and a target surface.



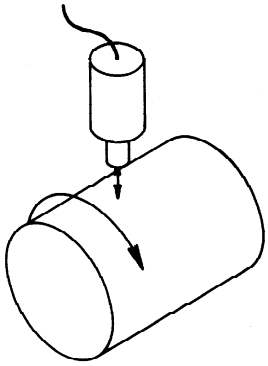
Surface variations can be examined by measuring displacement values over the entire surface of a moving object.



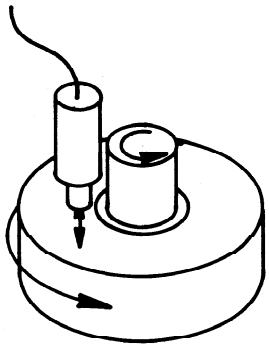
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Runout

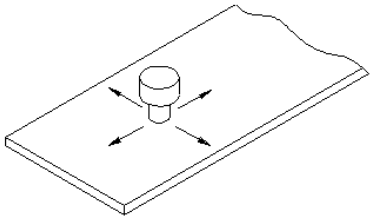
"Runout" measurements examine the variation in displacement between the probe and a surface, typically as it rotates around an axis.



Radial Runout



Axial Runout



Flatness Runout

"Radial runout" examines variations in the radius from the axis of rotation to all points on the rotating surface examined by the probe.

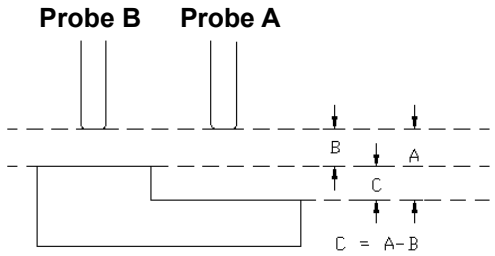
"Axial runout" examines variations in displacement from the probe to a flat surface as it spins around an axis.

"Flatness runout" examines variations in displacement from the probe to a flat surface as it moves parallel to the probe sensing surface.

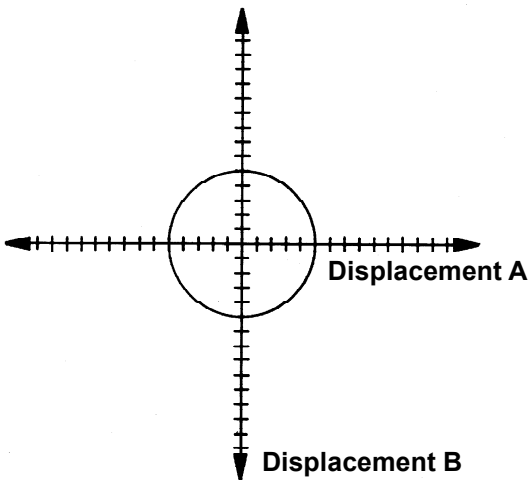
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Step Height

"Step height" is an example of a two-channel measurement, where one displacement value is subtracted from another.



Two probes can be used independently (without adding or subtracting displacement values) to analyze displacement in one direction with respect to displacement in another direction. This relationship may be displayed on an oscilloscope.



Velocity

The "surface velocity" of a measured object describes the rate at which the displacement measurement is changing. This value is equal to the first derivative of displacement with respect to time.

Acceleration

The "surface acceleration" of a measured object describes the rate at which the surface velocity is changing. This value is equal to the second derivative of displacement with respect to time.

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Physical Description

The Model 5300 Gaging System consists of two major components, the main console (which includes the analog display module) and the probes.

The Console

The Model 5300 console provides indicators, controls and connectors for the gaging system and includes a large analog meter which monitors the output of each gaging channel. At the console's front panel, the operator can select the type of measurement to be made and view the measurement results.

The rear panel connectors supply output signals to user-supplied equipment.

Hard, durable casing and modular electronic components make the Model 5300 a rugged instrument which is well-suited for production environments.

The Display Module Selector Switch

The knob located on the bottom left of the display module is referred to as the "Display Module Selector Switch". This switch controls what channel or channels will be connected to the analog meter and the Model 5210 module, if this module is installed in your system.

Channels "A", "B", "A+B" or "A-B" are available as inputs to the Model 5210 module; channels "C" and "D" are not available for connection to the 5210. (For purposes of this discussion, channel "A" refers to the module that is plugged into the left-most slot of the Model 5300 console. Channel "B" is the next module to the right of channel "A", and so on.)

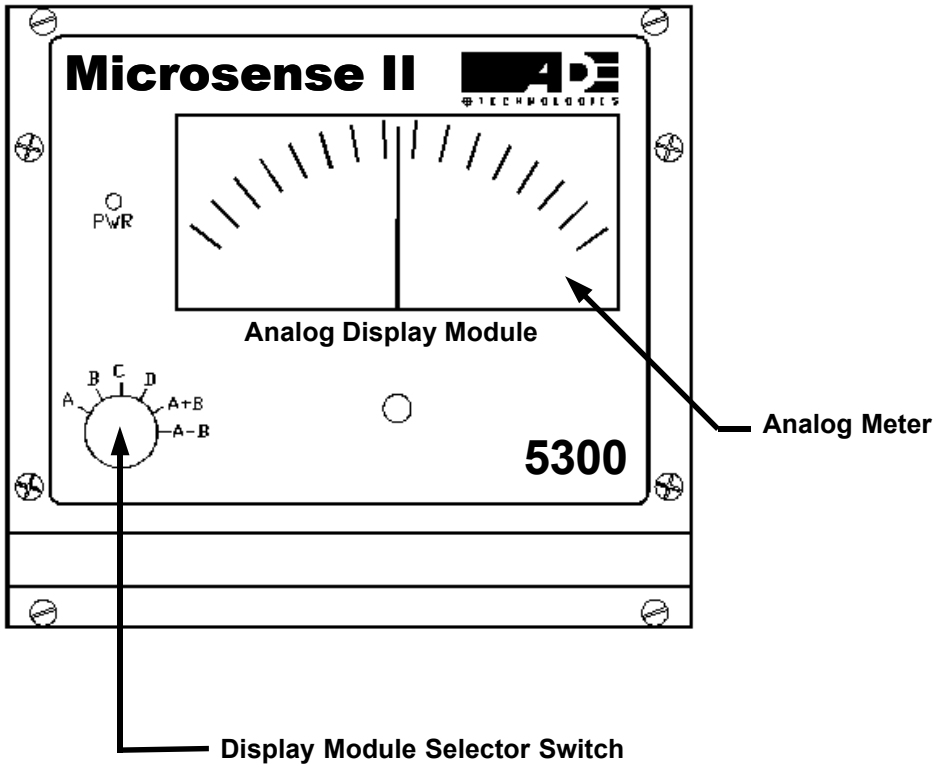
When using the Model 5210 module, after all probes have been set up, turn the Display Module Selector Switch to the desired input channel. For example, if the switch is positioned on "A", channel A is connected to the Model 5210 module and the displacement, velocity and acceleration signals for channel A will appear on the front-panel connectors on the Model 5210.

Even if the velocity and acceleration signals of the Model 5210 are not used, its ability to provide "A+B" and "A-B" signals will frequently be of interest. A+B is often used for making differential thickness measurements. A-B is often used for making differential position or step-height measurements.

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The Analog Display

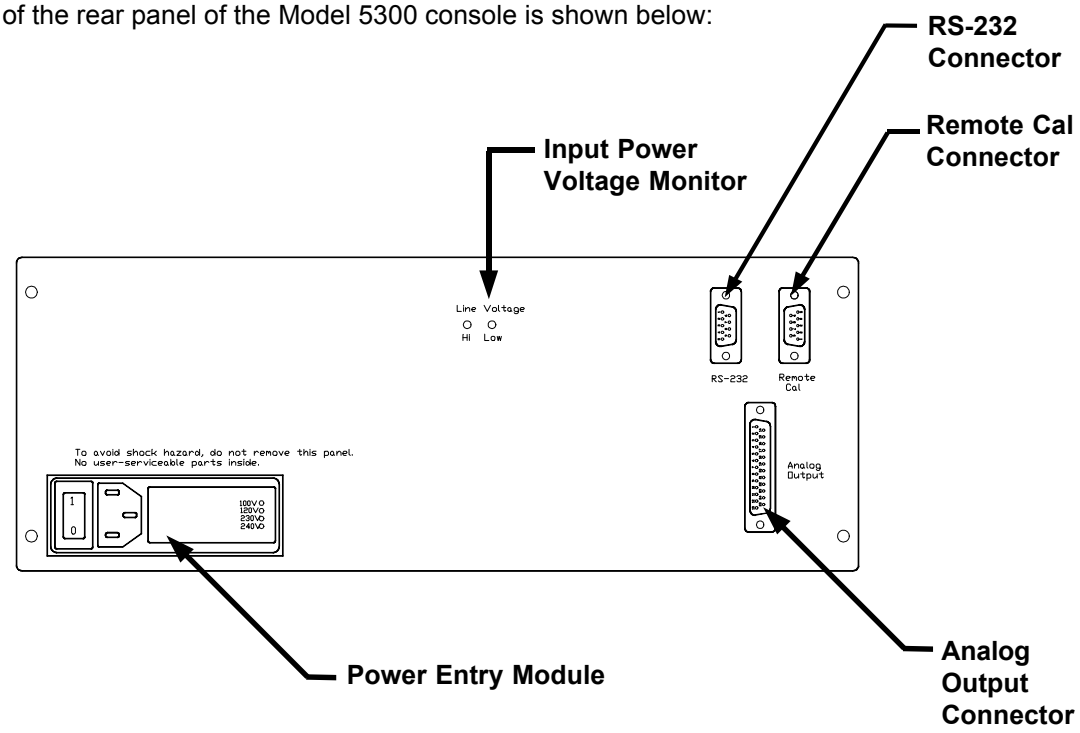
The analog display allows you to view the output of each gaging channel. The analog meter is most useful for setting the probe-to-target distance. For example, to adjust the channel A probe in its fixture, set the Display Module Selector Switch to "A" and carefully adjust the position of the probe. As the probe is pulled away from its target, the meter will swing toward the "Far" position. As the probe is pushed toward its target, the meter will swing toward the "Near" position. When the meter is centered, the probe is also centered in its range, allowing symmetrical deviation of the target from its current position.



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The Rear Panel

An illustration of the rear panel of the Model 5300 console is shown below:



Setting Power Line Voltage

Although the Model 5300 system is configured by ADE Technologies before shipment, you should verify that the power entry module is set for the correct line voltage before turning the unit on. Locate the power entry module on the Model 5300 rear panel and note what voltage designation the white pin is near. If the voltage is not set correctly for your facility's input power, you may easily change the setting. First, remove the power entry module cover (by prying it off with a small screwdriver). Rotate the small circuit card inside to the correct position for the available power line voltage and replace the cover.

Note that the 5300 can be set to accept four international voltages:

- 100 VAC, 50 to 60 Hz
- 120 VAC, 50 to 60 Hz
- 220 VAC, 50 to 60 Hz
- 240 VAC, 50 to 60 Hz

The Model 5300 has a built-in safety mechanism to protect the electronics against improper line voltages. For example, if the power entry module was set for 100 or 120 VAC and plugged into 220 or 240 VAC, a crowbar circuit would instantaneously cause the fuses to blow, thereby protecting the electronics. Constant fuse outage, therefore, is normally a sign of an improperly-set power entry module.

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Changing Fuses

The Model 5300 uses two 5mm by 20mm metric fuses that meet all IEC standards. They are rated at 0.5 amp, 250 volt, slow-blow. Replace only with similar types, such as "Littelfuse" part 218.500. To change the fuses, pry the cover off the power entry module and remove the plastic fuse holder. The fuses can then be easily withdrawn from the holder and replaced with new ones.

Input-power Voltage Monitor

The rear panel has two yellow LEDs labeled “Line Voltage, High, Low.” When the unit is on, both lights should be out. If the “Low” light is on, the power line voltage supplied to the Model 5300 is too low. This may indicate that the power entry module has been set incorrectly, or that the line voltage is not to specification. Analogously, when the “High” light is on, the power entry module is either not set correctly or the line voltage is not to specification.

RS-232 Connector

This connector is provided for future enhancements and carries no signals at present.

Remote Calibration Connector

This connector provides access to a serial digital communications bus that can be used to control calibration of the Model 5130 module by means of an external computer. This function is intended for special circumstances. Contact ADE Technologies for instructions on using this feature.

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Analog Output Connector

The analog output 25-pin "D" subminiature connector provides differential output signals from all channels. Its pinout is as follows:

Pin	Cable Wire Position	Signal
1	1	gnd
14	2	ch1+
2	3	ch1-
15	4	ch1 com
3	5	ch2+
16	6	ch2-
4	7	ch2 com
17	8	ch3+
5	9	ch3-
18	10	ch3 com
6	11	ch4+
19	12	ch4-
7	13	ch4 com
20	14	velacc/ch5+
8	15	velacc/ch5-
21	16	velacc/ch5 com
9	17	display module+
22	18	display module-
10	19	display module com
23	20	display module com
11	21	display module com
24	22	O/R com
12	23	O/R com
25	24	velacc O/R
13	25	display module O/R

NOTE:

Signals are listed by order of their cable position and not by order of their pin number.

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Microsense Probes

Microsense noncontact probes allow precise positional measurement of stationary or moving surfaces. Signals provided by the probe are processed by circuitry housed within the console to calculate surface position and related parameters. Because the measurement is made without physical contact, probes are prevented from damaging the examined surface or altering the parameter being measured.

Each probe consists of three distinct parts:

1) a tip which houses the sensor and associated circuitry

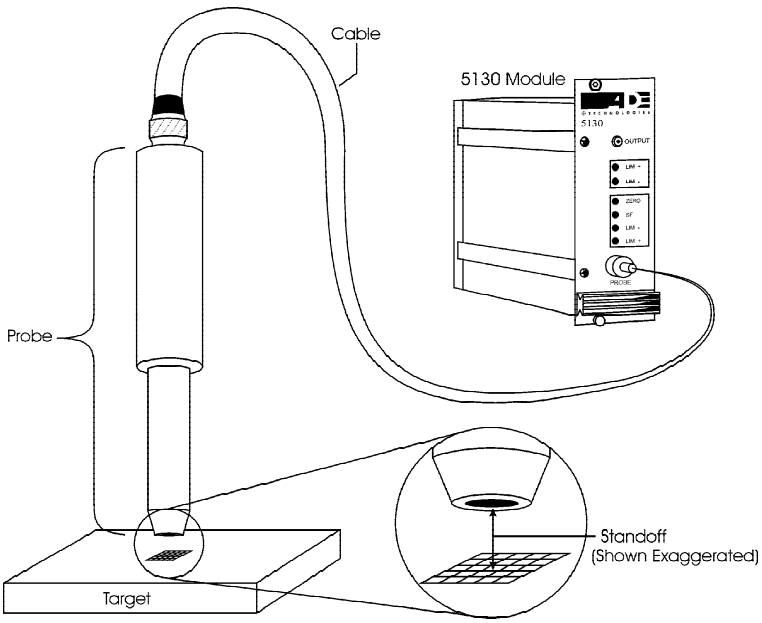
2) a driver circuit board mounted adjacent to the tip containing electronic circuitry

3) a 3-meter detachable cable which carries signals from the probe to the gaging console.

In order to accommodate a wide range of physical constraints, Microsense probes are available in a variety of physical configurations (such as axial and blade).

The surface of the probe tip contains a sensor, insulated from the housing. During operation, the sensor is mounted in close proximity to a target. This creates a capacitor, with the probe sensor and target surface serving as its plates. The driver supplies a high-frequency voltage signal to the sensor. Circuitry in the probe measures the capacitance and generates a current signal representing probe-to-target displacement. The probe cable routes this signal from the probe to the console.

Probes are housed in stainless steel of sufficient strength to withstand forces inherent in proper fixturing. Low profile probes have holes in their housing to accept mounting hardware. Careful probe handling is required to avoid scratching the probe's sensing area.



Usage Diagram for Series 5000 Probes

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Probe Theory of Operation

Microsense noncontact probes measure displacement using a capacitive principle. A sensor in the probe tip is driven with a voltage signal, forming a capacitor with the grounded target surface. Circuitry in the probe tip measures the resulting capacitance and provides a current related to probe-to-target distance. The measured capacitance is given by the following equation:

$$C = kA/d + Co$$

where: C is the capacitance measured between sensor and target surface,
k is the dielectric constant of free space,
A is the surface area of the probe sensor,
d is the probe-to-target distance, and
Co is the stray capacitance, arising primarily from electric field effect and characteristics of probe construction.

The adverse effects of stray capacitance on measurements can be minimized by keeping the stray capacitance constant over the temperature and measurement ranges to be used, or by constructing the probes in such a way as to reduce stray values as much as possible. If probe components are selected with matching coefficients of thermal expansion, measurement problems stemming from temperature-related stress and distortion can be kept to insignificant levels over the specified range of operating temperature.

Probe Placement

The sensing area of the probe should be positioned parallel to the target surface, such that the probe-to-target distance is within the probe's standoff range. Ideally, the sensor should also be positioned at least a sensor diameter distance from the nearest edge of a flat target surface. Cylindrical target surfaces should have diameters of at least four times the sensor diameter. Spherical target surfaces should have diameters of at least five times the sensor diameter/dimension.

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Probe Mounting

Probes are mounted in one of two ways. Axial units are secured by clamping pressure evenly distributed around the probe tip. Others are mounted with screws inserted into the probe (blade type). Probes have a preferred clamping area, indicated on the probe outline drawing. Do not use screws to mount probes not designed to be screw-mounted.

All system fixturing should be rigid and free from any stress that could cause flexing of the surfaces. Stainless steel or cast-iron fixtures and granite surfaces work well.

The probe should be mounted in a stand that will prevent a collision with the sample. The fixturing stand should be close enough to the console to allow cable connection. If the probe cable becomes damaged, it may be easily replaced.

Cleaning Probes

In order to provide accurate measurements, the system probe(s) should be protected from excessive dirt and dust. Remove foreign materials that may accumulate during normal operation by cleaning the probe's sensing areas periodically:

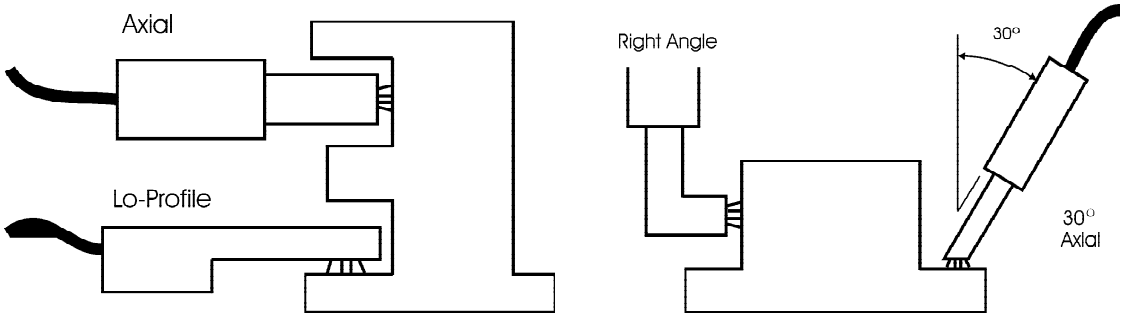
- Use a cotton swab with denatured or isopropyl alcohol to clean the sensing area. Let dry completely.

When not in use, it is recommended to keep the sensing areas covered with the provided caps.

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Available Probe Styles

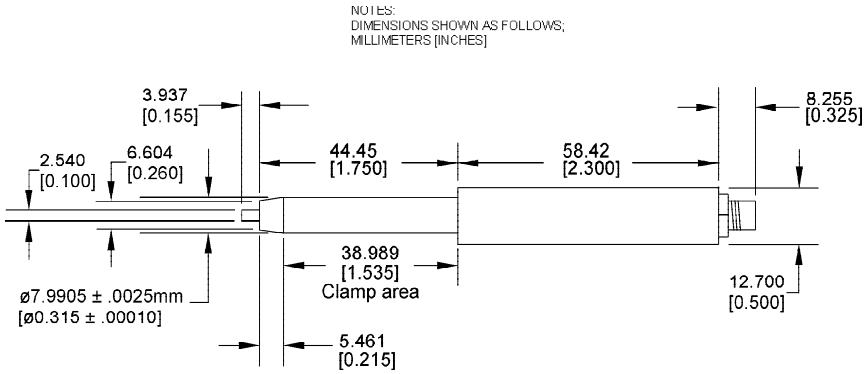
The Series 5000 Microsense probe family has been designed to accommodate an extensive range of target dimensions and motion envelopes, as well as a variety of fixturing and target-access limitations. Series 5000 Microsense probes are offered in a variety of shapes and sizes. Axial style is usually preferred, however other styles are available to facilitate target access. Refer to the outline diagrams provided for each probe.



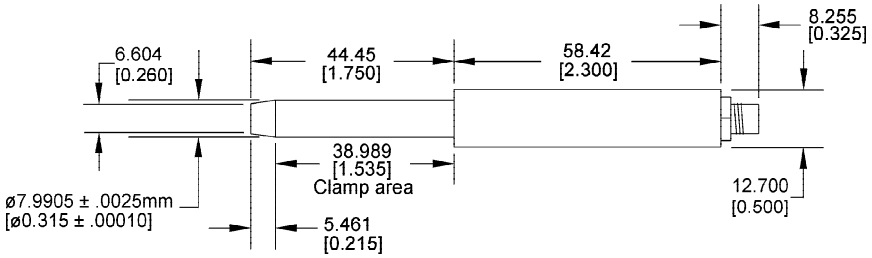
Available Series 5000 Microsense Probe Styles

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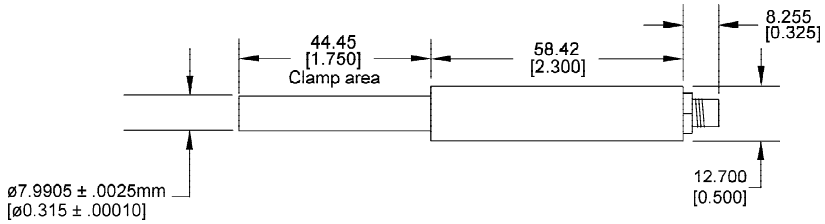
Axial Probes



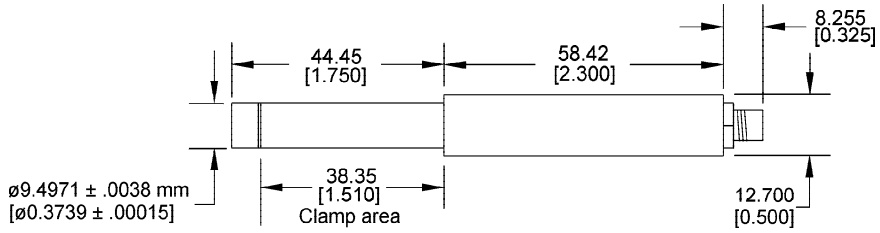
Model 5504 Axial Probe



Model 5501 Axial Probe



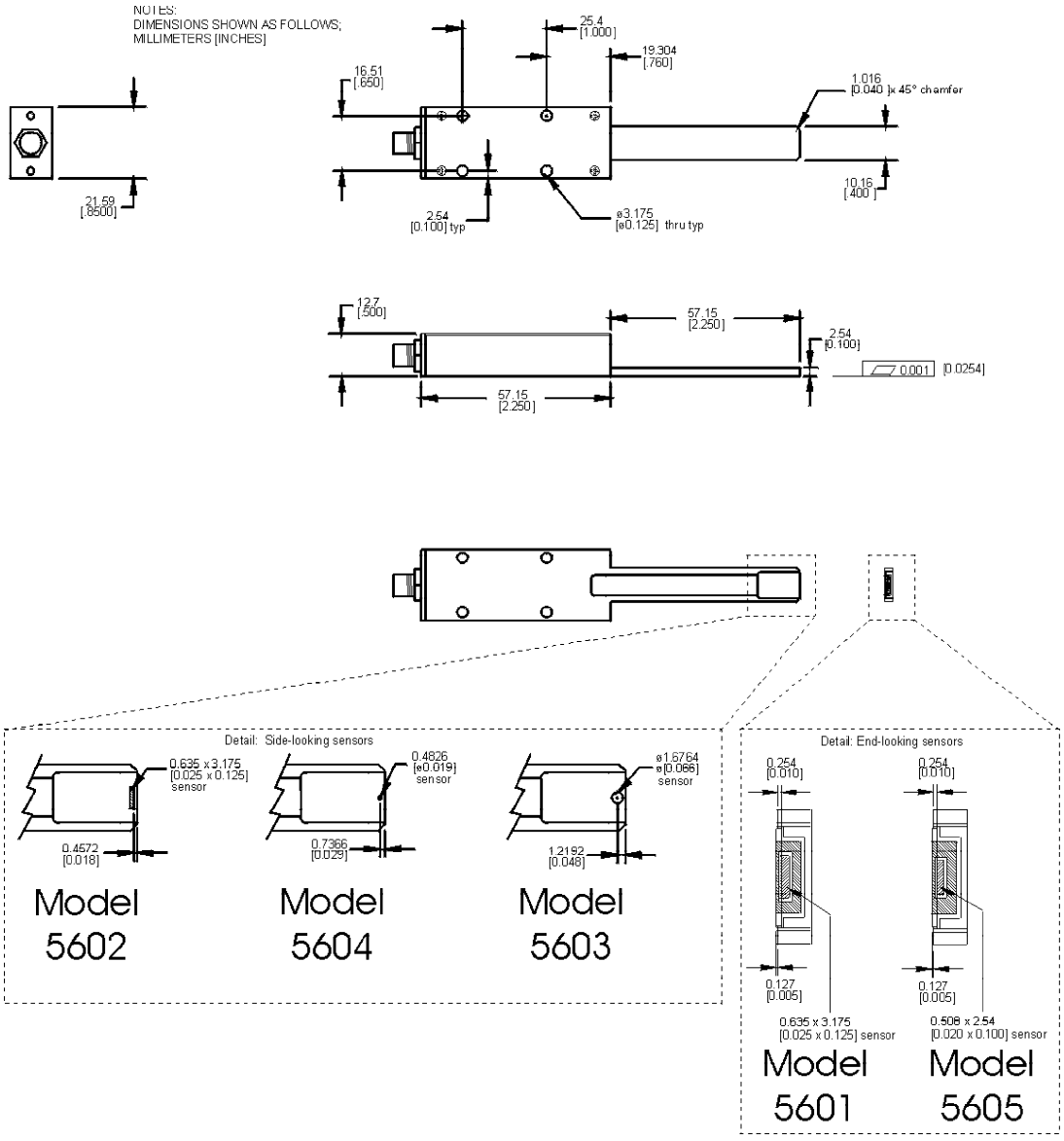
Model 5502 Axial Probe



Model 5503 Axial Probe

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Blade Probes



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Environmental Considerations

Several factors may affect measurement accuracy or repeatability. Most of these factors do not affect the Microsense circuitry directly, but alter the sample or the measurement setup.

Temperature Stability

Changes in temperature may cause expansion or contraction of the material being measured or the gage fixture. Depending on the materials used and the amount of temperature change, these variations may be great enough to create inaccurate readings. For this reason, a constant temperature should be maintained in the gaging area.

Humidity

The Microsense probe operates on a capacitance principle, using the air between the probe and surface being measured as a dielectric. Excess humidity can change the electrical characteristics of the dielectric, or cause water to condense on the probe tip. The humidity in the gaging area should be kept low and constant.

Electrical Grounding

All measurement surfaces that are electrical conductors must be grounded to the gaging console during measurement. Grounding is accomplished either by electrically connecting the holding fixture to the console, the surface being measured, and the probe housing, or by directly grounding the sample surface to the console. The probe is grounded to the console through the probe cable. A single ground point for all grounding requirements is recommended. In dynamic measurements, such as spindle runout, some type of brush contact to the moving part may be necessary to provide this ground.

For static or low (under 60 Hz) frequency measurements, the capacitance of the part being measured is usually great enough to make a separate ground lead unnecessary. The need for ground for static measurements may be determined by fixturing a part to be measured and then momentarily making or breaking a ground connection to the part while observing the output display. For TIR measurements, the need for a ground may be determined by measuring the TIR of a part both with and without a separate ground lead and comparing the results. In either case, an apparent reading variation of 1% or less may be safely ignored, provided that the part will always be either grounded or ungrounded during the measurement.

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Setting Up The Model 5300 Gaging System

The Model 5300 gaging system allows up to four probe channels. A procedure for setting up the system for a single channel (one probe) measurement follows:

1) Turn the system on and allow a one half-hour warmup time.
2) Center each ZERO control (on each Model 5130 module) by turning the knob fully clockwise and reversing by 7½ full turns.
3) Set the Display Module Selector Switch to position "A".
4) Position Probe A (leftmost channel) over the reference surface. Adjust the probe (or reference surface) until the meter reads approximately zero.
5) Secure the probe into place.
6) Adjust the ZERO A control to obtain an exact zero reading, if required.
7) Repeat Steps 2 through 6 if two or more probes are to be used.

The system is now set up and ready to make measurements. Negative readings at the Model 5130's connector indicate surfaces closer to the probe than the reference surface; positive readings indicate surfaces further from the probe than the reference surface; zero readings indicate a probe-to-surface displacement equal to the reference displacement.

There are many applications for single-channel measurements. When this setup procedure is followed, displacement measurements can be made on stationary or moving objects.

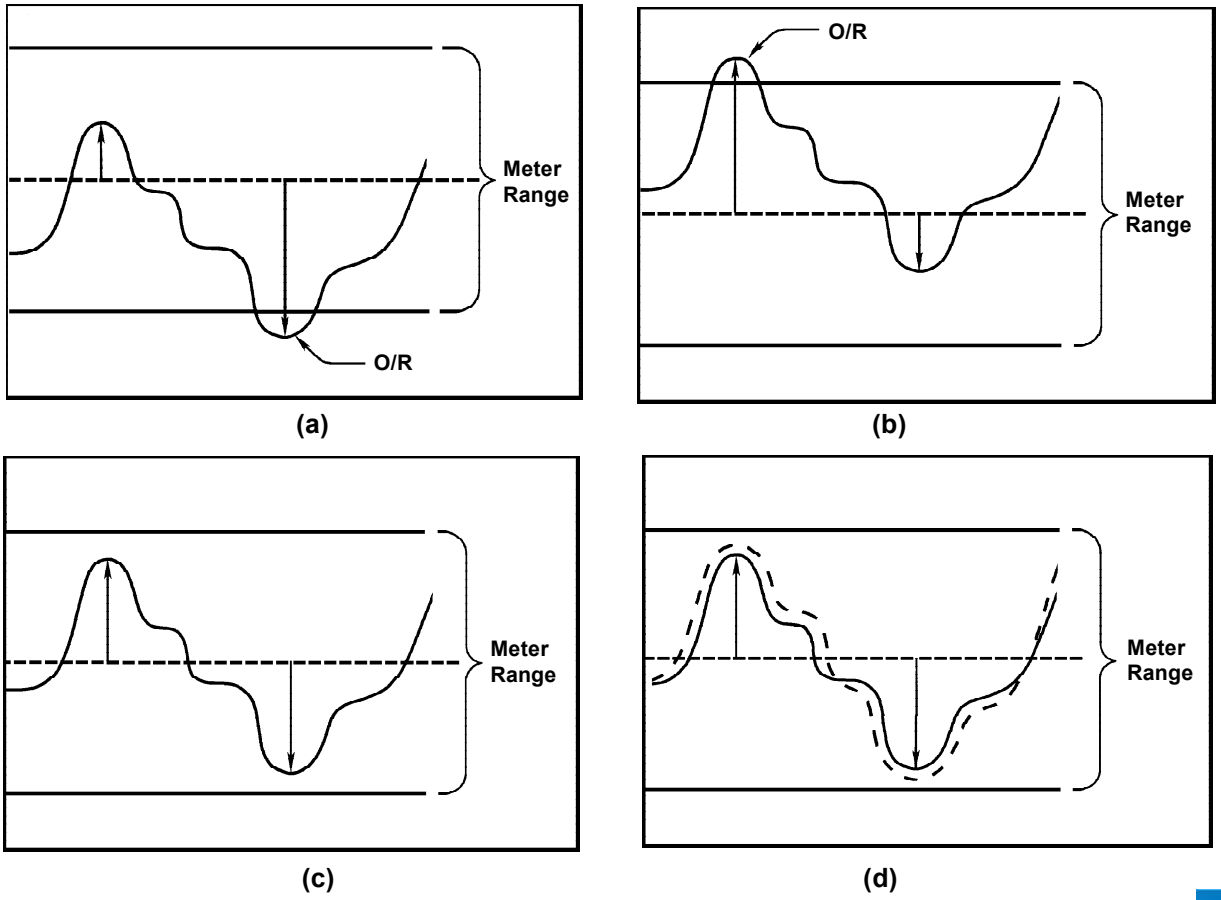
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Setup Suggestions: Runout Measurements

Runout measurements examine variations in moving or rotating objects. In measurements where a large runout is expected (close to the full range of the gage), it is important to make certain that the probe is actually in range over the entire surface to be measured before attempting dynamic measurements. This ensures that an overrange condition will not occur even though the runout (change in displacement) does not exceed the range of the gage. In this case, instead of positioning the probe for a zero readout over any point on the surface, it may be more convenient to position the probe for an approximate full scale indication at a known low point on the surface (such as the lobe of the cam or major diameter of an eclipse) or to position for an approximate negative full scale reading at a known high point on the surface.

If the change in runout is measured with respect to the change in rotational speed or start up "chatter" of a spindle, the fullest dynamic range of the probe can be obtained by making a single rotation and/or a single longitudinal pass along the section to be measured. While doing this, observe the displacement output of the probe and reposition the probe to balance the positive and negative meter deflections over the surface to be measured. If the largest positive reading is greater than the largest negative reading, the probe is too far and should be moved closer. If the largest negative reading is greater than the largest positive reading, the probe is too close and should be farther away.

The figure shown below illustrates the effects of the datum reference determined by probe position on runout measurements. When the probe is too far from the examined surface (a), an overrange condition may result for negative peaks. Similarly, when the probe is too close to the examined surface (b), an overrange condition may result for positive peaks. The probe should be placed so that the nominal reading is halfway between the two peaks (c), to allow all measured points on the moving surface to be in range. Selecting a good datum reference allows "exaggerated" peaks due to axis movement, vibration, or startup chatter to also remain in range (d).

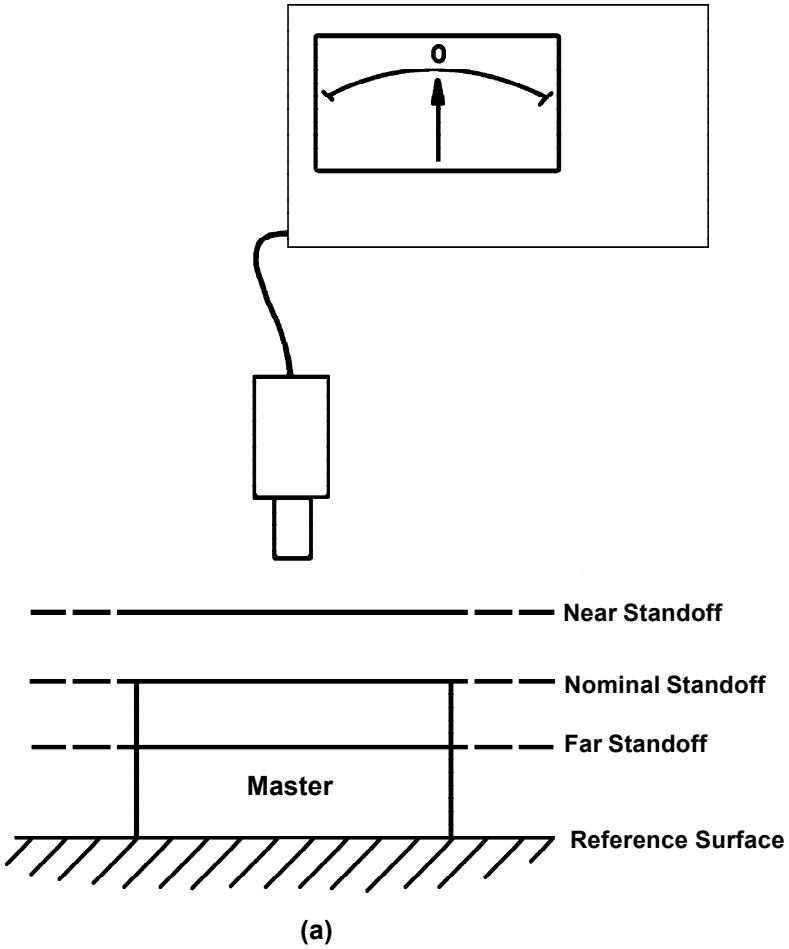


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Setup Suggestions: Mastering

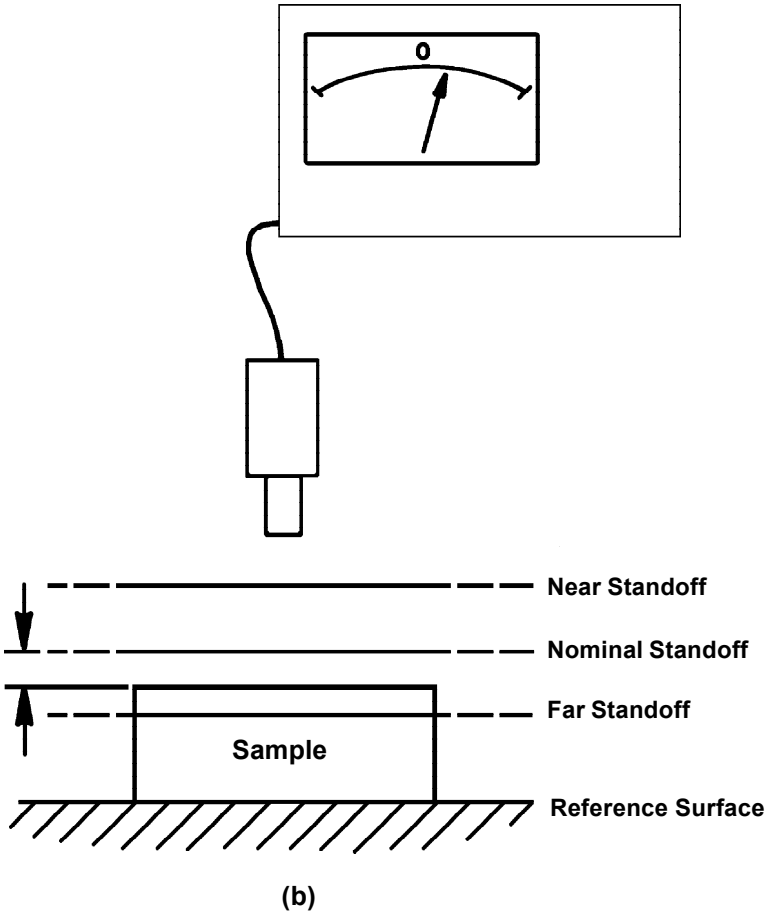
The Model 5300 gaging system is not limited only to measuring displacement variations and comparing two displacement measurements to each other. The system can also be used for "mastering", which allows measurements to take on absolute, rather than relative, values. When a reference surface is positioned at a known distance from the gaging reference surface or from the probe, measurements are expressed as a value relative to this known ("master") displacement. The height of the surface from the gaging surface is then the sum of the master height and the value displayed on the meter. The probe-to-surface distance is obtained by subtracting the system output from the displacement to the master surface.

In the figure shown below, the system is set up to provide a zero reading for the displacement to the master part (Figure a). When the master part is replaced by a sample part (Figure b), the meter indicates a slightly negative value. The height of the sample surface from the gaging surface is the sum of the known master height and this negative value, or less than that of the known master height.



Zero Reading with Master

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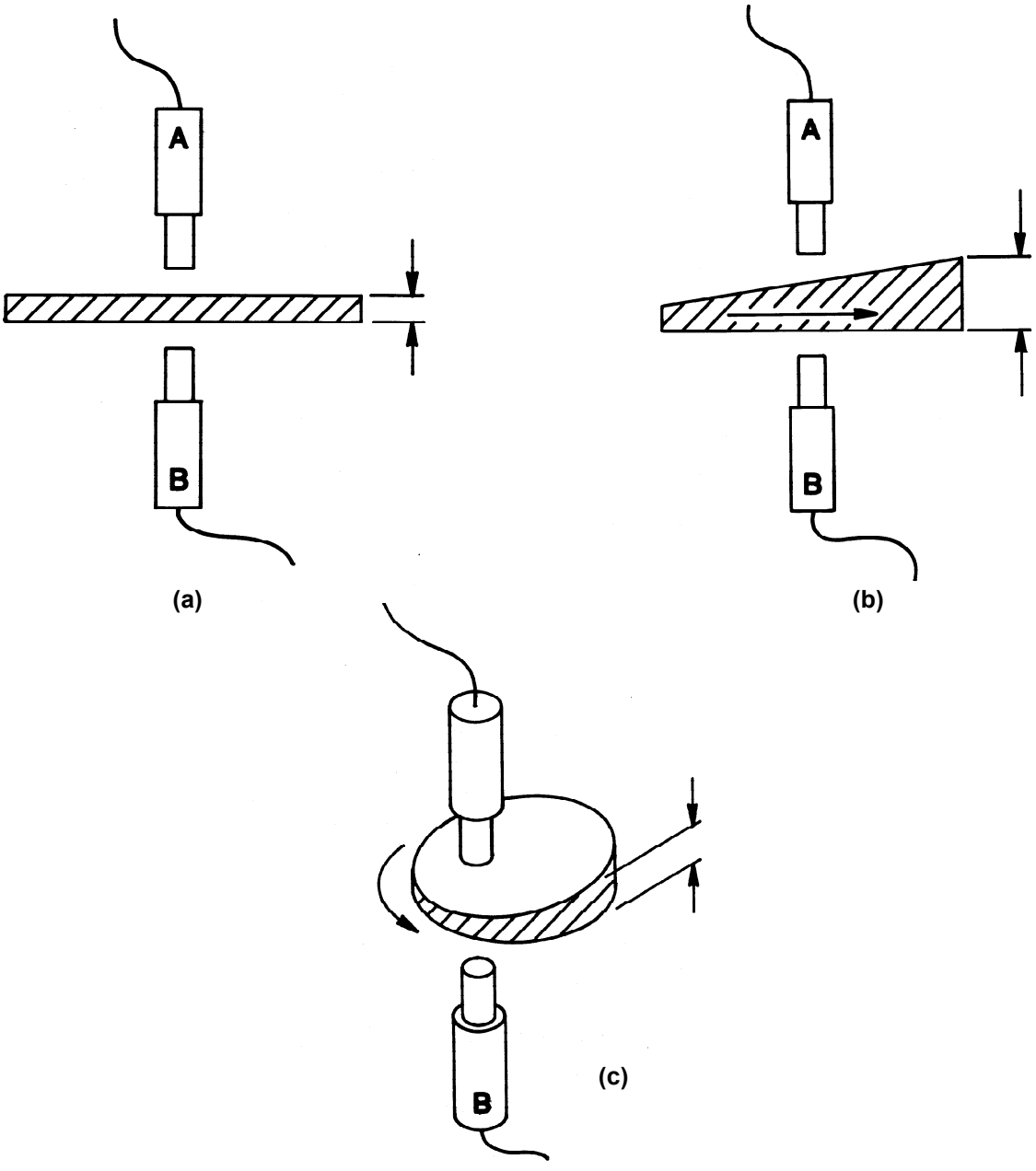
Negative Reading with Sample

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Setup Suggestions: A+B

Thickness measurements provide data for a wide variety of applications, as shown in the illustration below. Thickness can be measured at one point of a stationary part (a), at many points of a moving part (b), or at many points of a rotating part (c).

Positioning two probes facing toward each other allows space measurements between two surfaces. Concentricity is examined by measuring the spacing between circular parts.



A+B Thickness Measurement Applications

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Microsense™ II Model 5130 Gaging Module

Overview

The Model 5130 Gaging Module is a non-contact capacitive dimensional gaging system designed for maximum flexibility combined with ease of use. Capacitive transduction converts variations in a probe-to-target distance into an electrical signal.

The system consists of the following items:

1. Model 5130 Gaging Module
2. spare jumpers
3. probe and cable

Model 5130 Specifications

Dimensions:	Height: 5.06 " at front panel Width: 1.40" at front panel Depth: 6.75" (Eurocard format 100mm x 160mm)
Measurement Range:	± 25µm to ±1000µm full scale, depending on probe selection
Measurement Resolution:	Typically 1 to 10 nanometers rms. Actual resolution depends on probe selection, bandwidth, and operating range. Resolution improves with larger sensor area, reduced bandwidth, and smaller range.
Bandwidth:	Jumper selectable from: 1 kHz, 5 kHz, 20 kHz, 100 kHz
Linearity:	Typically 0.1% over full scale range, depending on probe model and operating range.
Stability:	Typically better than 200 ppm per degree Celsius over temperature range of 15 degrees Celsius to 35 degrees Celsius.
Operating Temperature:	5 degrees to 50 degrees Celsius (41 degrees to 122 degrees Fahrenheit)
Humidity:	0 to 95% RH, non-condensing

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Probes

The patented measurement probes that are included with the Model 5130 may be selected from a vast variety of available models which vary in diameter and operating range.

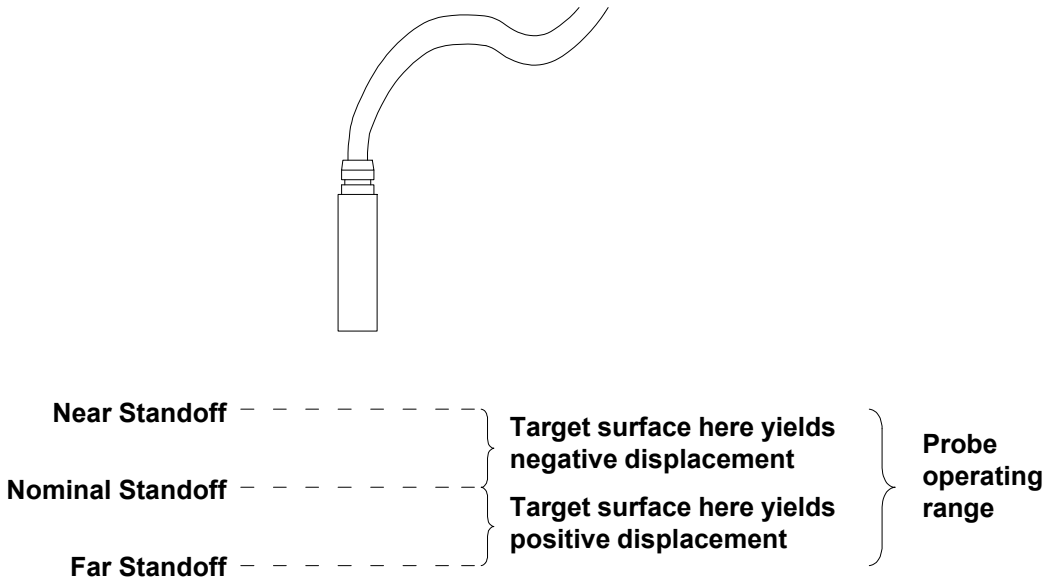
The probes are transducers which form a capacitor with the target surface. Because the area of the formed capacitor is constant, variations in capacitance are related to variations in the distance between the probe and the target surface.

Use care when handling the probes, and especially avoid scratching the sensor.

Nominal, Near and Far Standoffs

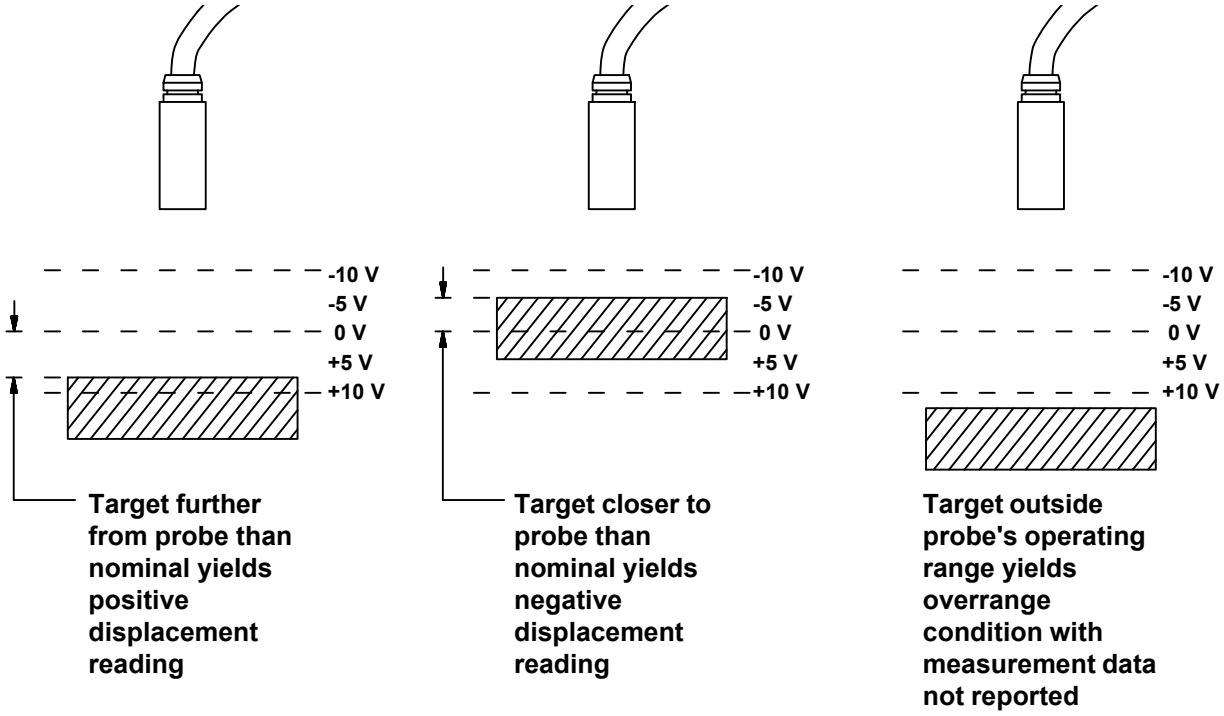
Note that the system does not measure the absolute distance between the probe and target surface, but variations from a nominal position known as the probe's **Nominal Standoff**. This probe-to-target distance, at the midpoint of the probe's operating range, yields an output of 0 V. As the target moves closer to the probe, the voltage decreases.

At **Near Standoff**, the smallest probe-to-target distance within the probe's operating range, the output is -10 V. At **Far Standoff**, the largest probe-to-target distance within the probe's operating range, the output is +10 V.



Probe Operating Range and Standoffs

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Probe-to-Target Distances

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Gage Setup

Configuration

The Model 5130 is supplied from the factory with a default configuration. Any adjustments to this configuration should be made prior to installation. The configurable items, their default settings, and instructions to change them are described in the pages which follow.

Power Requirements

The Model 5130, when used by itself, must be powered with regulated ±15 VDC (±0.1 volts) power at the power pins of the I/O connector.

Voltage	Pins	Current Drain
+ 15V	9 A,B,C	0.20 A max
- 15V	11 A,B,C	0.10 A max
GND	10 A,B,C	

NOTE: ***The three available pins are interconnected on the printed circuit board inside the Model 5130.***

Probe Connection

Connect the probe to the Model 5130 front panel receptacle. Use care when handling probes and cables. **Do not pull on the cable. The probe cable and its connectors should never be cut, spliced, or disassembled.**

NOTE: ***The target MUST be at the same potential as analog ground. The housings of all probes are grounded via the probe cable. In most cases, electrically attaching the target to the probe shell will result in a well grounded target.***

See Appendix A for more information on grounding.

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Tolerance Limits

Two limit adjustments are supplied to indicate a gage reading outside of an expected value. The limits may be set to any point in the gage's operating range (±10 Volts).

The FAR LED lights when the probe-to-target distance is greater than its set point.
The NEAR LED lights when the probe-to-target distance is less than its set point.

The limit outputs on the I/O connector are TTL low (less than 0.8 VDC) when the LED is lit and TTL high (greater than 3.5 VDC) when the LED is off.

Default Limit Configuration:

The limits are factory-set at the end of the probe range. The FAR limit trips when the gage output (+ANALOG OUT) is greater than 10.00 volts. The NEAR limit trips when the gage output is less than -10.00 volts.

Outputs

Outputs are available on the designated pins of the I/O connector.

+ ANALOG OUT:	Pin 25	This output is the standard analog output. Voltage increases with distance. At Near displacement, the voltage will be negative and will increase with increasing distance. This voltage is relative to analog ground (P1 pin 4).
- ANALOG OUT:	Pin 26	Voltage decreases with distance. At Near displacement, the voltage will be positive and will decrease with increasing distance. This voltage is relative to analog ground (P1 pin 4).
FAR	Pin 23	This output is TTL low when the corresponding front panel LED is lit, and TTL high when the LED is off.
NEAR	Pin 22	This output is TTL low when the corresponding front panel LED is lit, and TTL high when the LED is off.

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Connections

Pinouts

The Model 5130 Gaging Module has a single I/O connector. It is a DIN type 41612 96-pin unit. The following pins are used:

Signal	Pin Number
+ Analog Out	25A, 25B, 25C
- Analog Out	26A, 26B, 26C
Analog Return	27A, 27B, 27C
Analog Ground	24A, 24B, 24C
Far	23A, 23B, 23C
Near	22A, 22B, 22C
+ 15 Volt Power	9A, 9B, 9C
Power Common	10A, 10B, 10C
- 15 Volt Power	11A, 11B, 11C
+ Clock In	1C
- Clock In	1B
+ Data In	2C
- Data In	2B
+ Load In	3C
- Load In	2C
+ Data Out	2A
- Data Out	1A

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These connections can be grouped into the following categories:

Power - Pins 9, 10,11:
Power to the board is supplied by these pins. Power requirements are +15 VDC at 200 mA and -15VDC at 100mA. Both supplies must be regulated.

Displacement Outputs - Pins 25, 26:
The analog displacement signal is available on these pins. "+ ANALOG OUT" voltage will increase as distance increases, while "- ANALOG OUT" voltage will decrease as distance increases.

Limits - Pins 22, 23:
Limit outputs are open collector, TTL-compatible signals representing the state of the limit LEDs.

Noise Immunity (ARTN) - Pin 27:
The ARTN connection may be used to reduce noise due to non-uniform grounds between the Model 5130 and any data collection equipment. ARTN is a separate return which allows external equipment to float ±0.1v from analog ground. This allows the creation of a "pseudodifferential" connection to external monitoring equipment to prevent ground loops. See Appendix A for more information on grounding. **This feature is only applied to the -Analog Out signal.**

Calibration Constant Download
The calibration constant of the 5130 can be remotely downloaded via computer interface.
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User Adjustments

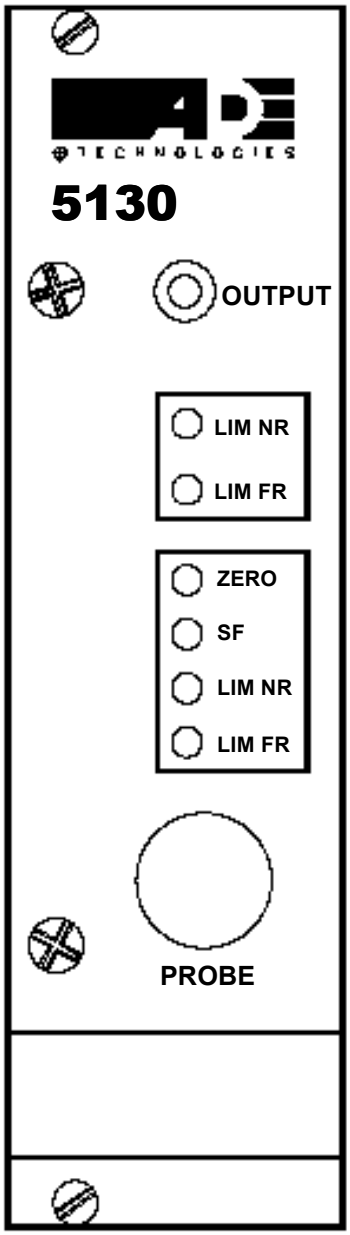
Front Panel Adjustments

Calibration (this is factory-set and should not usually be adjusted)
A scale factor adjustment is available on the front panel. This pot, marked "SF", allows for fine adjustments to the probe scale factor for periodic calibration. The scale factor is the displacement-to-voltage ratio.

Zero
A front panel pot is provided to allow fine adjustments of the output voltage offset to obtain a zero reading without having to move the probe or target. The allowable range is ±10% of the full scale operating range. Adjustment to the Zero pot has no effect on the Scale Factor.

Limits
Two limit pots are available for setting trip points of the + and - limit lines and LEDs. Both limit pots may be set anywhere in the range of the probe. The limits are set by adjusting the probe-to-target distance until the trip point voltage is obtained. The limit pot is then turned so that the trip point equals the probe voltage. This is defined as the point at which the LED changes state (ON to OFF or vice versa).

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Model 5130 Gaging Module Front Panel

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Configuration Adjustments

The Model 5130 has features enabling you to adjust electrical parameters of the internal printed circuit board to suit your application. These parameters are listed below, along with the default settings set at the factory.

Configurable Function	**Default Configuration (if applicable)**
Output Scaling:	±10 volts for probe range
Bandwidth:	20 kHz
Chassis GND Enable:	Grounded (See Appendix A)
Gain Setting:	Adjusted at factory
Linearity Setting:	Adjusted at factory

NOTE: ***Probe range is a function of the last two items listed above. These jumpers are set at the factory for a specific range.***

Descriptions of individual parameters follow. If any configurable items need to be changed, refer to the illustration titled "Model 5130 Jumper Locations" (in the pages which follow) to locate the position of the jumpers on the PCB.

Board/Jumper Access

Remove the four screws holding the aluminum cover on. Remove the cover.

Jumper Settings

Bandwidth The Model 5130 may be set to one of four bandwidths. Use the following table to determine the jumper settings:

Bandwidth	**P4**	**P14**	**P11**	**P15**
100 kHz	IN	OUT	IN	OUT
20 kHz *	OUT	OUT	OUT	OUT
5 kHz	IN	IN	IN	IN
1 kHz	OUT	IN	OUT	IN

*default setting

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Output Scaling The analog output level of the Model 5130 is configurable. The standard output is ±10 volts for the entire probe range. Shown is a table of other common output voltages that are available. (P6 - P10 set the scale factor while P5 is an offset jumper for configuration of bipolar/ unipolar output.)

Configuration.	P6	P7	P8	P9	P10	P5
±10V (Bipolar) *	IN	OUT	IN	OUT	IN	IN
± 5V (Bipolar)	IN	OUT	IN	IN	IN	IN
0 to 10V (Unipolar)	IN	OUT	IN	IN	IN	OUT

*default setting

NOTE: ***The voltage on -ANALOG OUT will be the negative of +ANALOG OUT. If you want a negative unipolar output, set up the jumpers as in case 3 above and use the -ANALOG OUT output. This will give you a 0 to -10 V swing.***

Chassis GND A jumper has been provided allowing the chassis of the Model 5130 to be either grounded or ungrounded. See Appendix A for more information on grounding.

Configuration	P13
Chassis DC Grounded *	IN
Chassis AC Grounded	OUT

*default setting

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Scale-Factor Adjustment

The Model 5130 gaging system's calibration may be adjusted via a front panel potentiometer, labeled "SF". The following procedure should be followed to calibrate the unit.

EQUIPMENT NEEDED:

1. Digital Volt Meter (DVM) with ±10 Volt range
2. Fixturing equipment capable of moving the target precisely throughout the measurement range
3. Small screwdriver to access the front panel scale factor potentiometer

NOTE:
Calibration is very dependent on fixturing. It is important that the probe sensing surface and target be parallel or calibration errors will occur.

PROCEDURE

1. Set the probe at near standoff so that the DVM reads -10.000 volts on +ANALOG OUT output.

2. Move the probe or target so that the gap between them increases by the total measurement range (i.e., for a ±100 µm range, increase by 200µm). Measure according to the fixturing equipment.

3. Note this voltage.

4. Adjust the potentiometer so that the reading on the DVM (+ANALOG OUT) is:

$$10 + [\,(10 - [\text{reading in step 3}]) / 2\,]$$

Example:

If step 3 reading = 9.900 V, adjust pot so that DVM reads 10.050 V.
If step 3 reading = 10.150 V, adjust pot so that DVM reads 9.925 V.

5. Repeat steps 1-4 to check the calibration. Calibration is complete when the reading is within a desired tolerance. Iteration may be necessary to precisely adjust the scale factor.

The scale factor may be adjusted to better than 10 mV.

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Range and Calibration Adjustment

The Model 5130 gaging system has a flexible architecture which will permit you to perform a full calibration of the system. This will allow you to install a new probe or change ranges as needed.

This feature requires specialized fixturing and is usually done at the factory. A description of this feature has not been included in this manual. Please contact ADE Technologies for more information.

The Model 5130 has a remote calibration feature. This feature allows two 12-bit calibration constants to be downloaded via a 3-wire serial interface. In addition, the interface allows any number of Model 5130 modules to be daisy-chained. Please contact ADE Technologies for additional information on this feature.

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Appendix A: Grounding

Electrical grounding issues are important to capacitive gaging. This type of transduction generally requires that the target be connected to the circuit ground of the Model 5130 module.

Target Grounding

The target must be connected to the circuit ground of the gaging system. The Model 5130 has been designed so that the probe housing is grounded. An electrical connection from the probe shell (or the fixture holding the probe) to the target will provide the necessary ground.

Chassis Ground

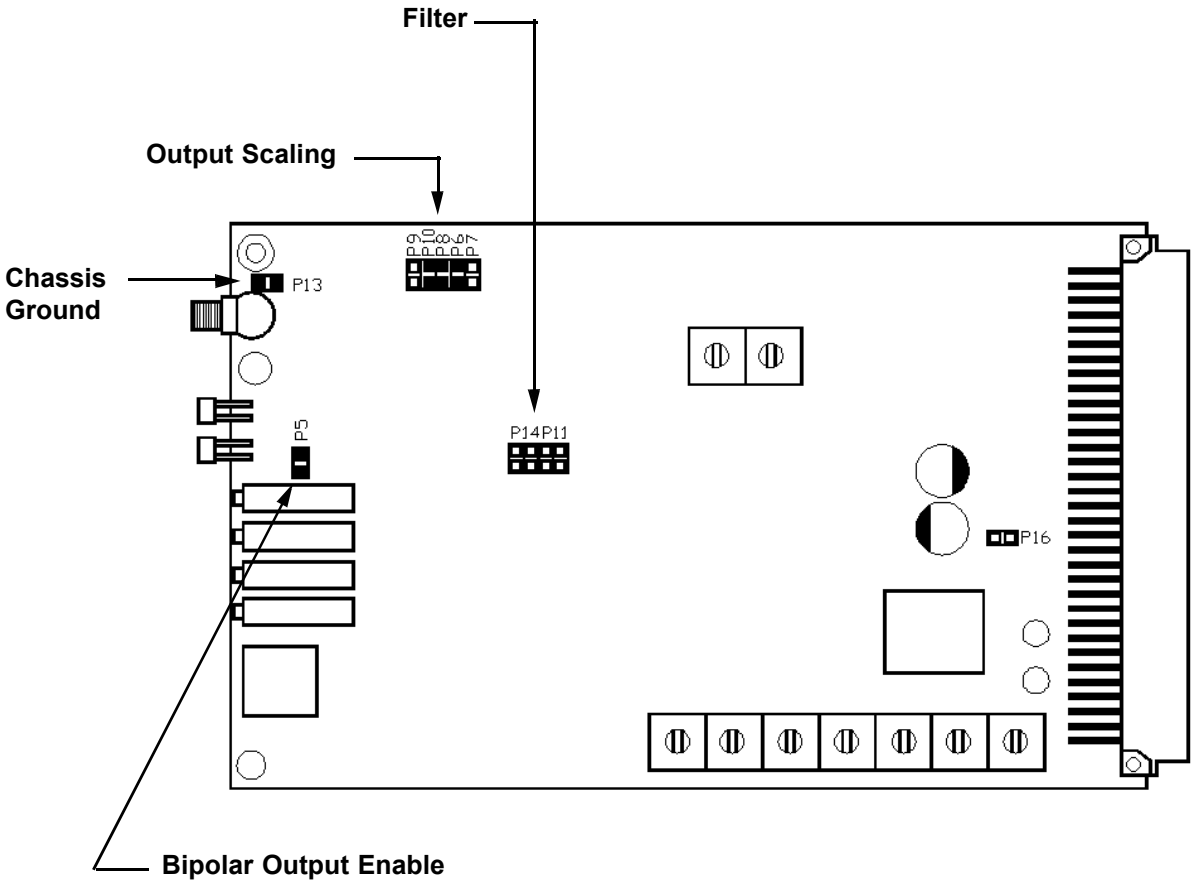
The chassis of the Model 5130 gaging module is always capacitively coupled to Analog Ground. A jumper has been provided (P13) which will explicitly ground the chassis. The default configuration is with the jumper in place. This will connect the case to ground directly.

For some applications, it may be desirable to remove this jumper to improve noise performance or remove ground loops caused by the fixtured position of the Model 5130 module.

Analog Return

The ARTN connection (P27) may be used to reduce noise due to non-uniform grounds between the Model 5130 and any data collection equipment. ARTN is a separate return which allows external equipment to float ±0.1V from analog ground. This allows the creation of a “pseudo-differential” connection to external monitoring equipment to prevent ground loops.

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Indicates jumper in default position

Model 5130 Jumper Locations

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NOTES:

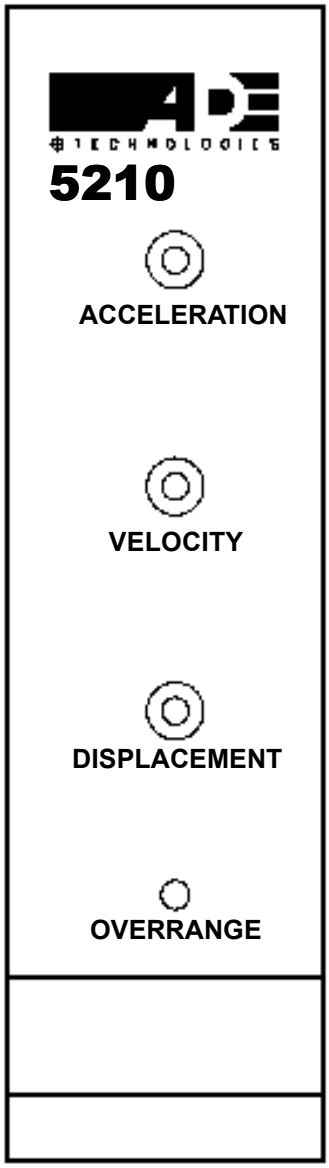
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Microsense™ II Model 5210
Velocity and Acceleration Module

Velocity and Acceleration Functions

Velocity if the first derivative of displacement. So, as expected, the 5210 module uses a differentiator circuit to produce its velocity signal. Any circuit that calculates the first derivative has a gain that increases linearly with frequency. Therefore, the bandwidth of such a stage must be limited for two reasons. First, infinite bandwidth requires infinite gain, and second, infinite gain would produce infinite noise. As a practical matter, it is important to limit the bandwidth of any such circuit to keep noise within reasonable bounds.

Acceleration is the second derivative of displacement. By cascading two differentiator circuits, the Model 5210 calculates acceleration. The gain of any circuit that calculates the second derivative increases with the square of the frequency. Therefore, it is even more important to limit bandwidth.



Model 5210 Front Panel

Velocity & Acceleration Outputs

The velocity output is scaled at 1000 times the full-scale displacement range per second. For example, a gage with a full-scale range of ±100 μm would have a velocity output of ±100 mm/second full scale. The acceleration output is scaled at 1,000,000 times the full-scale displacement range per second squared. For example, a gage with a full-scale range of ±100 μm would have a velocity output of ±100 m/sec^2 full scale.

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Available Filters

The Model 5210 has two, three-pole, plug-in filters available in a variety of frequencies and types for filtering. One is used for the velocity output and the other for acceleration. These filters may be field-interchanged if required. Contact ADE Technologies for instructions.

Bessel Filters:	**ADE Technologies Part Number**:
1 kHz	**028784-A01**
2 kHz	**028784-A02**
2.3 kHz	**028784-A03**
2.7 kHz	**028784-A04**
3 kHz	**028784-A05**
5 kHz	**028784-A06**
7 kHz	**028784-A07**
10 kHz	**028784-A08**
Butterworth Filters:	
1 kHz	**028784-A09**
3 kHz	**028784-A10**
5 kHz	**028784-A11**
7 kHz	**028784-A12**
10 kHz	**028784-A13**

Overrange Detector

The velocity and acceleration signals are, by their nature, zero-based. That is, no matter where the probe is positioned in its range, the velocity and acceleration outputs will be centered at zero volts. Therefore, unless one monitors the displacement input to the 5210, one could not tell by looking at the velocity or acceleration signals if the 5210's input had gone out of range and therefore was producing erroneous outputs. For this reason, the 5210 has an overrange circuit. This circuit lights an LED on the 5210 front panel and produces an isolated open-collector output at the rear-panel "Analog Output" connector. The rear-panel output is positive true, that is, a high indicates an overrange condition.

The overrange circuit monitors whatever channel or channels the 5210 's input is connected to. It will monitor channel A or B respectively when A or B is selected by the display module, or channels A and B when the display module selects A+B or A-B.

Arithmetic Circuits

The 5210 also calculates the sum of channels A and B (A+B) or the difference of these channels (A-B) when so instructed by the display module. When selected, these calculated values are applied to the differentiator circuits and also appear on the front-panel SMB connectors.

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