05/22/07

Models 8800/8810

Gaging Systems

User Manual

Revision A

Part Number 037893-01

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Revision History of this Manual

rev	date	description of change
A	05/22/07	first release (Document Release #1784)

Introduction 1

Overview

ADE MicroSense 8810 and 8800 capacitive gaging modules, combined with our Series 2000 probes (sensors) are ideal for high resolution, non-contact linear displacement measurements and linear position sensing. This product family includes:

- Model 8810 stand-alone gaging module, including low noise power supply
- Model 8800 rack-mount gaging module, in standard 3U Eurocard format
- Series 2000 Measurement Probes

Applications

High Accuracy Dimensional Measurement

Customers worldwide depend on ADE Technologies for solutions to their most demanding linear displacement measurement applications. ADE's dimensional gaging systems, based on patented capacitance sensing technology, are used to make very precise, high bandwidth measurements of precision products such as hard disk drive motors, air bearing spindles, precision X-Y stages, optical disks, automotive parts and machine tools. ADE's capacitive gages provide the highest resolution in the industry, with virtually unlimited service life.

High Resolution Linear Position Sensing

ADE capacitive gages and sensors are ideal for linear position sensing and ultra-high resolution servo system feedback. Leading equipment manufacturers around the world use ADE capacitance sensors in wafer lithography systems, autofocus mechanisms, nanopositioning stages, metrology tools and flat panel display manufacturing equipment. Capacitive sensors provide sub-nanometer resolution, over short ranges, at a fraction of the cost of laser distance measuring interferometers. Our high vacuum-compatible capacitance sensors are ideal for linear position sensing in scanning electron microscope (SEM) and focused ion beam (FIB) systems.

Configuration

The 8810/8800 modules are 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 this manual.

Power Requirements

The 8810/8800 modules must be powered with regulated ±15 VDC (± 0.1 volts) power at its power pins as tabulated below.

	Models 8810	Model 8800
+15 VDC at 0.120 Amp Max	P22, pins 9A,9B or 9C	P19, pins 6 or 18
Power Common (Ground)	P22, pins 10A, 10B, or 10C	P19, pins 5 or 17
-15 VDC at 0.120 Amp Max	P22, pins 11A, 11B, or 11C	P19, pins 4 or 16

NOTE: Only one connection is required for each of the above requirements. The available pins are interconnected on the printed circuit board inside the 8810/8800.

About the System's Probes

The patented measurement probes which are included with the 8810/8800 modules may be selected from a vast variety of available models which vary in diameter and operating range.

The probes are quite rugged, but should be handled with care. Try to avoid scratching the probe's sensor.

Each probe has been calibrated for use with a particular Gage board, and should be used with that Gage board for most accurate operation. Most probes have a 3-meter (10-foot) cable which connects to the Gage board.

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.

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**. At **Near Standoff**, the probe is at the smallest probe-to-target distance within the probe's operating range. At **Far Standoff**, the probe is at its largest probe-to-target spacing. The 8810/8800 modules can be set for three different output-voltage scalings as tabulated below:

	±10 volt Output (default setting)	**0 to 10 volt output**	**±5 volt output**
Near Standoff	-10 volts	0 volts	-5 volts
Nominal Standoff	0 volts	+5 volts	0 volts
Far Standoff	+10 volts	+10 volts	+5 volts

1 *Introduction*

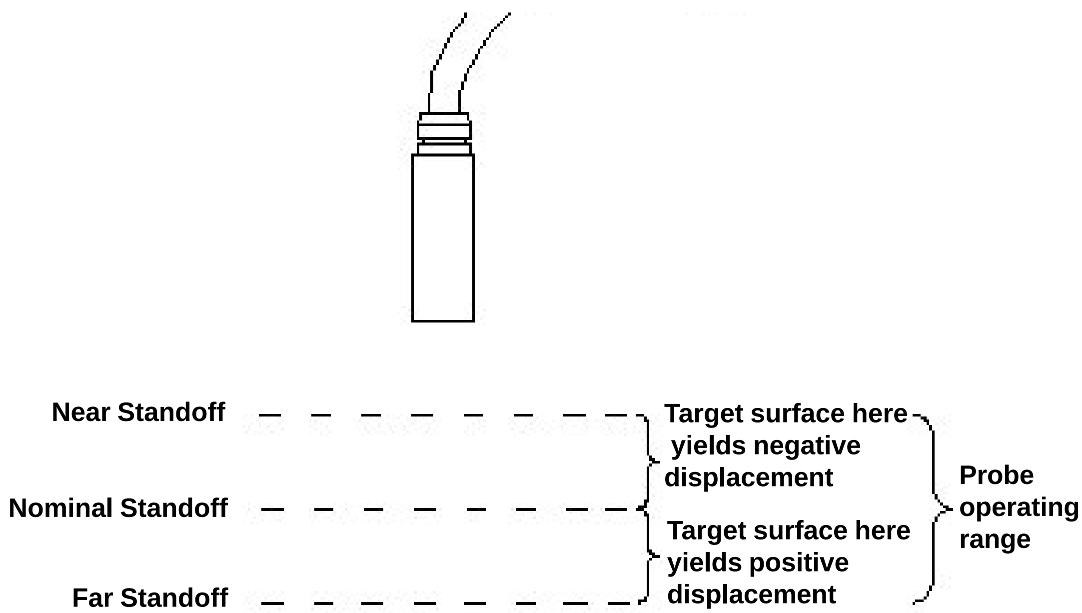


Figure 1: Illustration of Near, Nominal and Far Standoffs

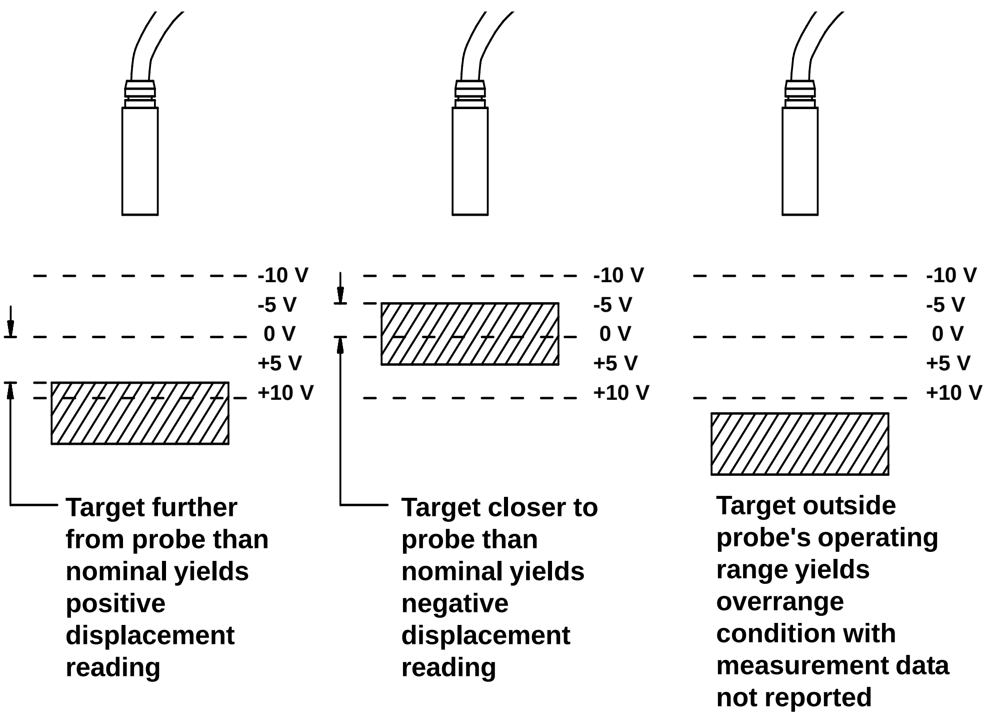


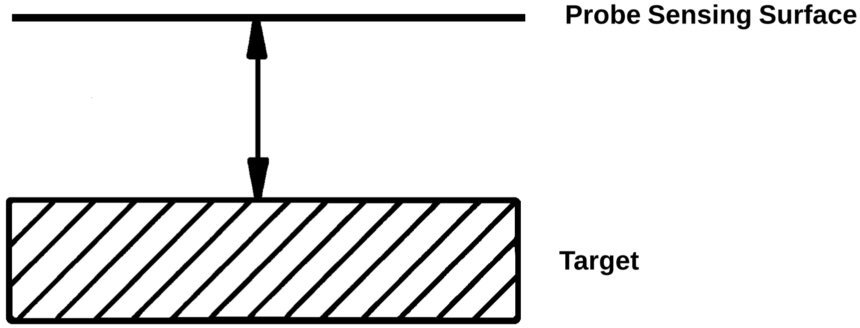
Figure 2: Example Outputs for Default Output Scaling

Selected Measurement Concepts

Microsense probes measure displacement. Measurements which may be derived using the Model 8810/8800 gaging systems 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.

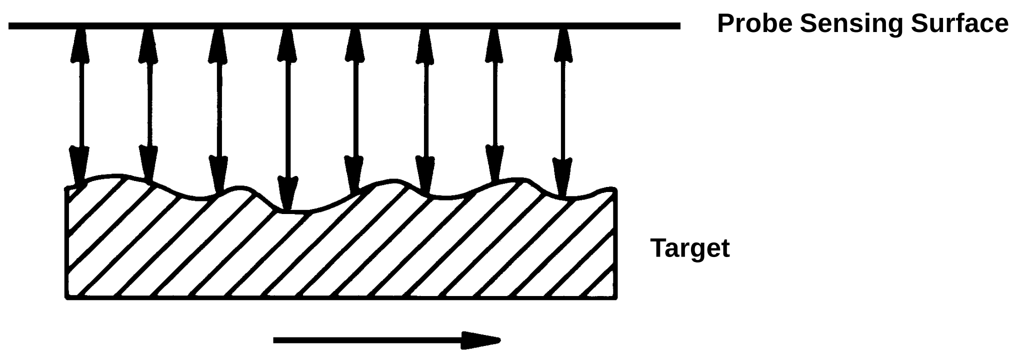


Figure 3: Displacement Illustrations

Runout

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

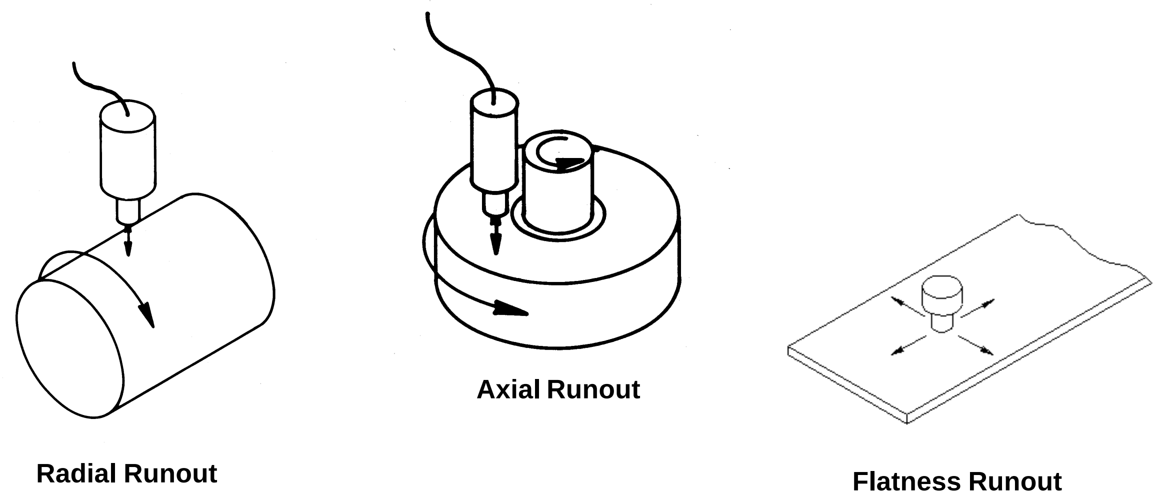


Figure 4: Runout Illustrations

"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.

Step Height

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

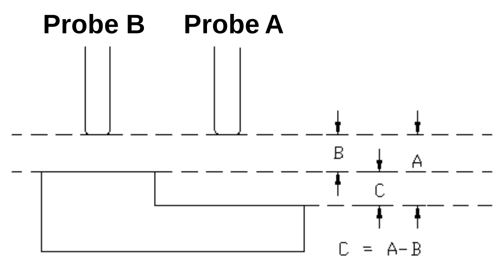


Figure 5: Step Height Illustration

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.

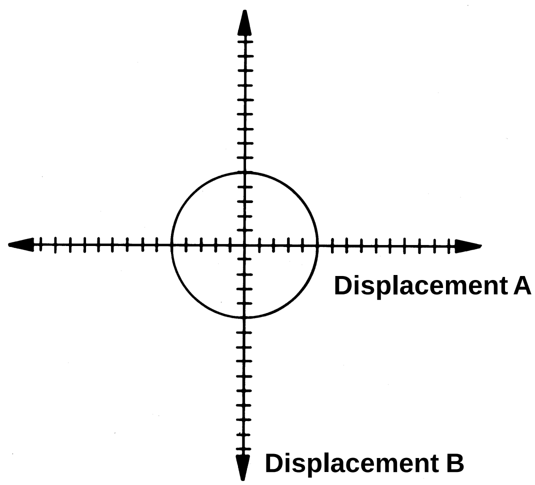


Figure 6: Displacement A & B Illustration

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.

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).

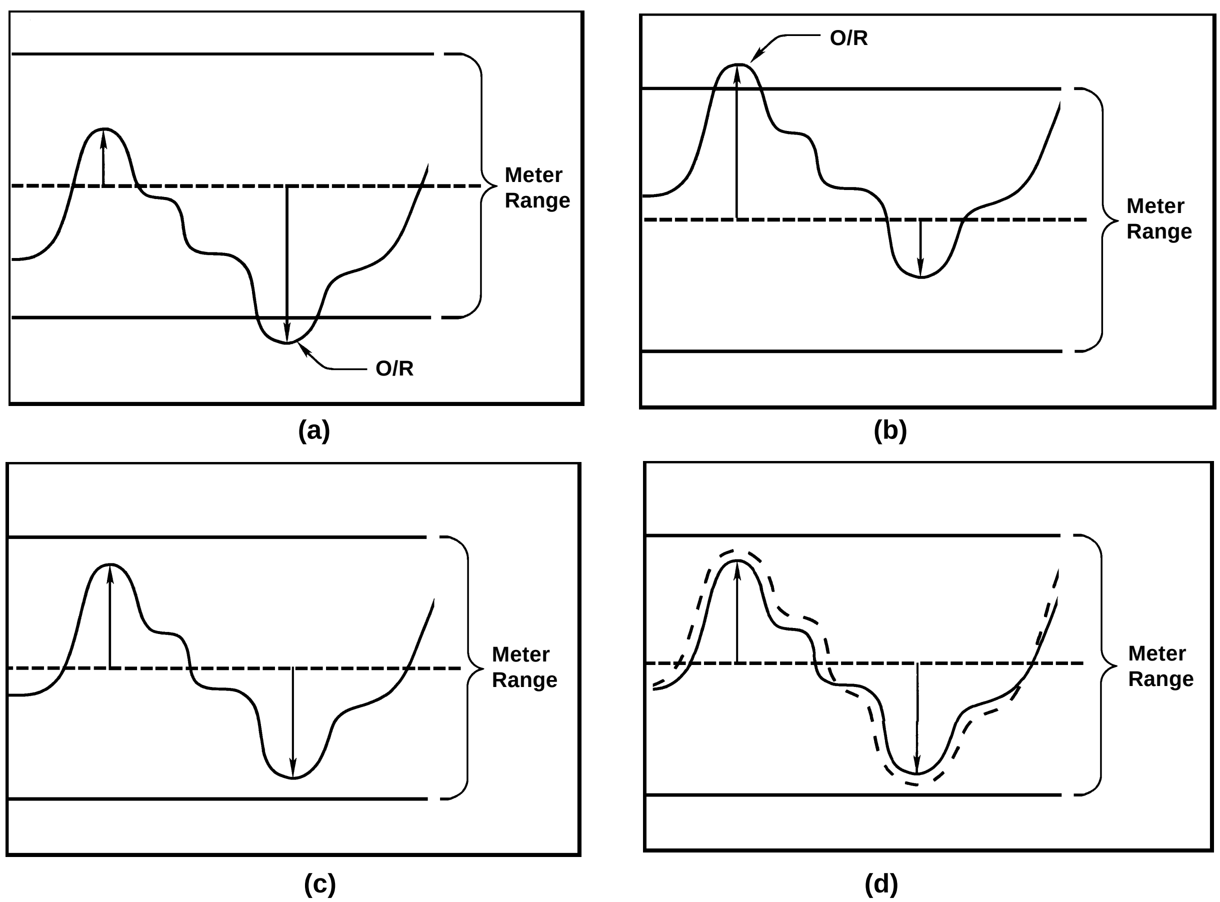
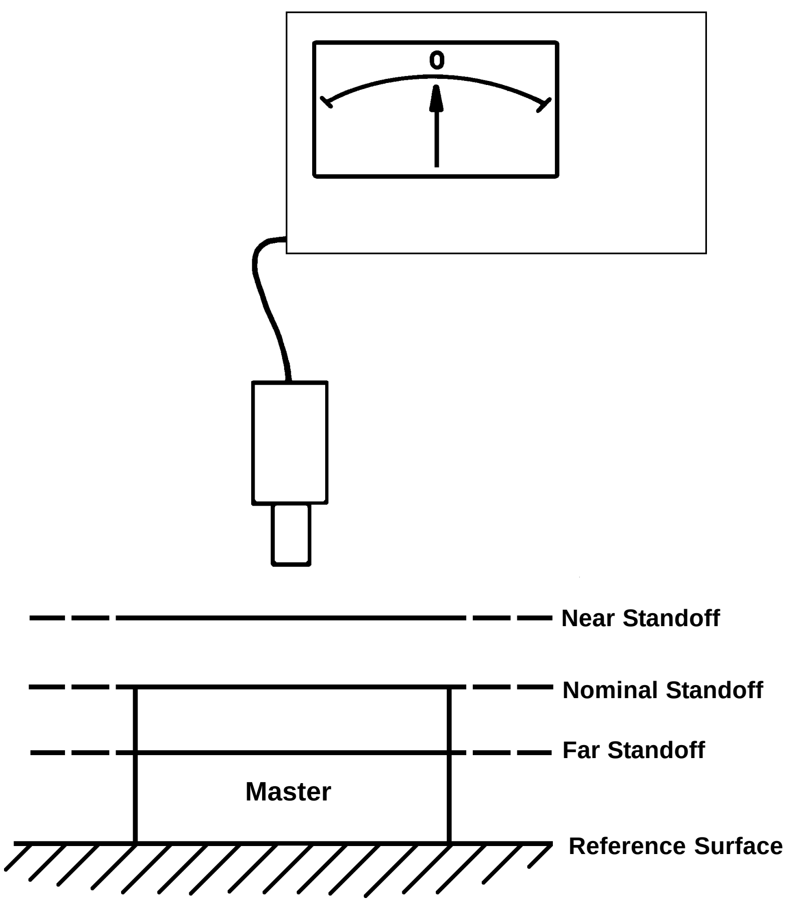


Figure 7: Runout Measurements

Setup Suggestions: Mastering

The Model 8810/8800 gaging modules are not limited only to measuring displacement variations and comparing two displacement measurements to each other. The modules 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.



(a)

Figure 8: Zero Reading with Master

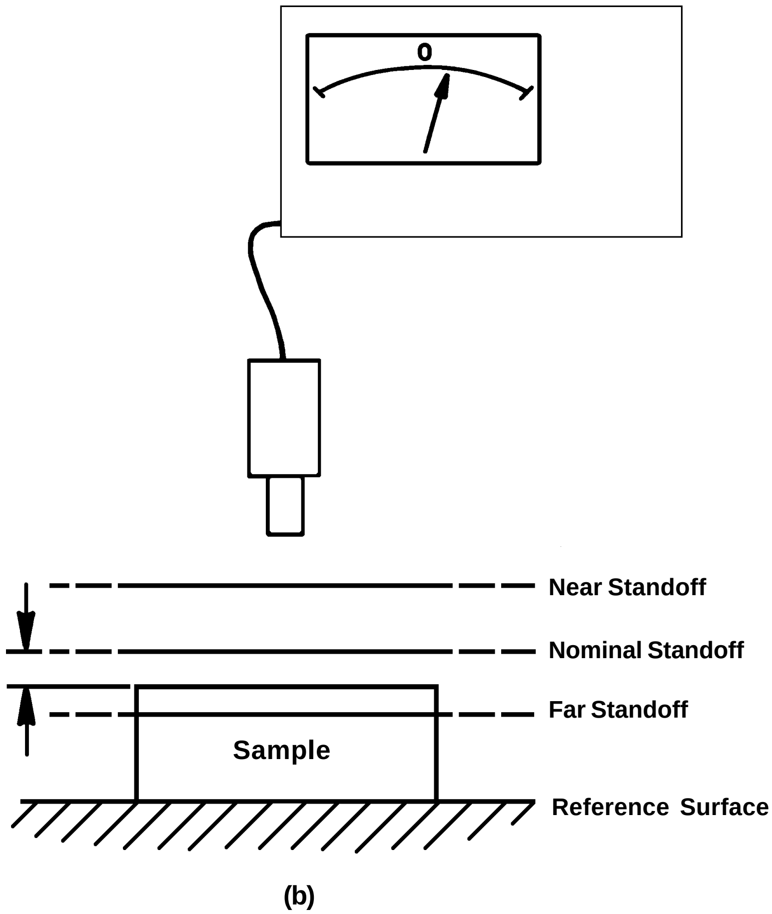


Figure 9: Negative Reading with Sample

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.

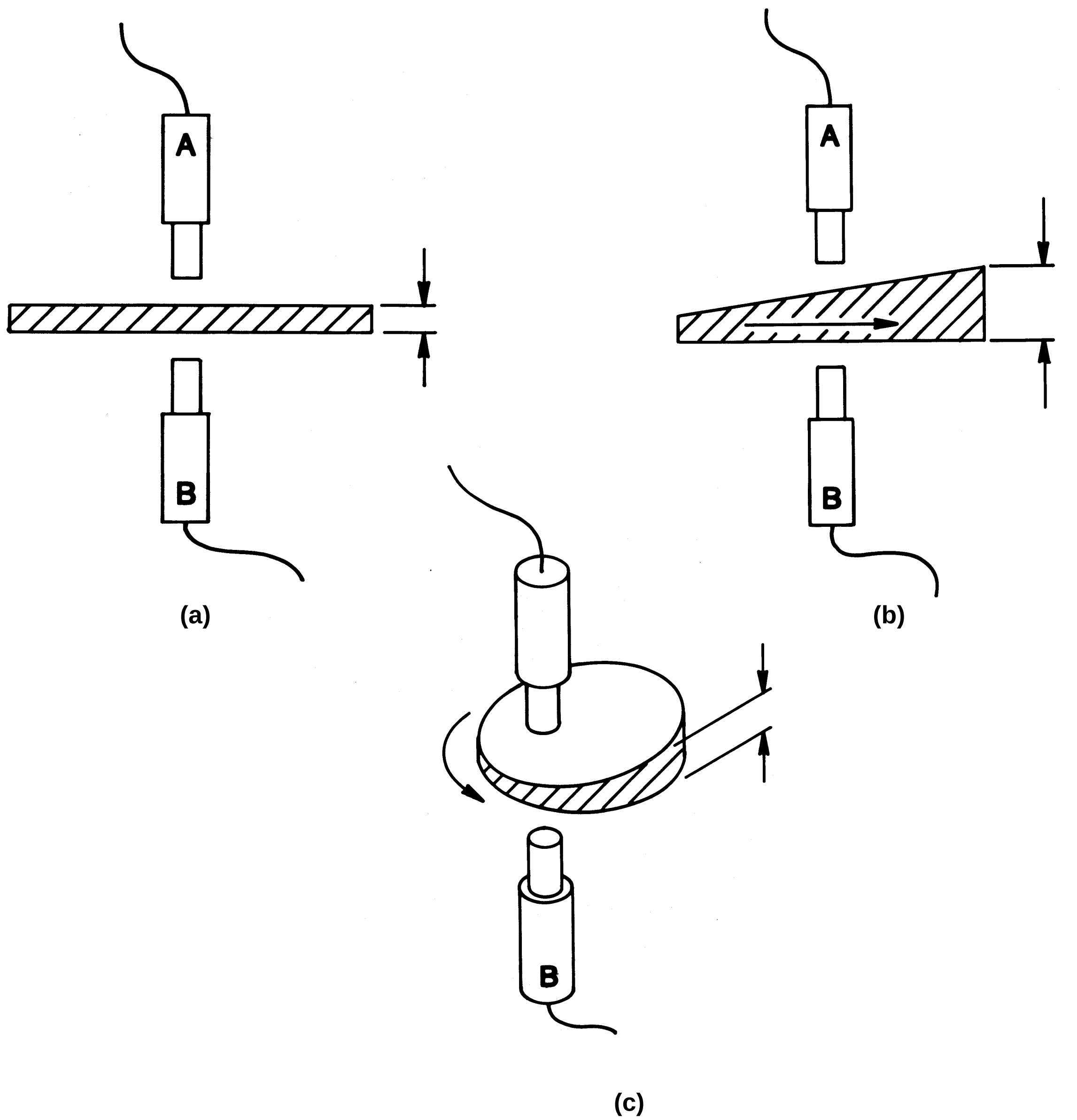


Figure 10: A+B Thickness Measurement Applications

Notes:

Connecting To The 8810/8800

The modules' connection scheme has been designed to be simple and flexible. The 8810/8800 modules can be used as a single stand-alone gage or used in an application requiring several channels. When multiple units are required, the systems should be connected together (synchronized).

When the 8810/8800 module is used as a single-channel gage, power is supplied on the designated pins described below.

Refer to Figure 11 for locations of front panel indicator lights, probe and output connectors.

Configuring System Outputs

Refer to pinout charts in Section 2 of this manual.

+ ANALOG OUT: 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.

- ANALOG OUT: 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.

FAR LIMIT This output is TTL low when the corresponding front panel LED is lit, and TTL high when the LED is off.

NEAR LIMIT: This output is TTL low when the corresponding front panel LED is lit, and TTL high when the LED is off.

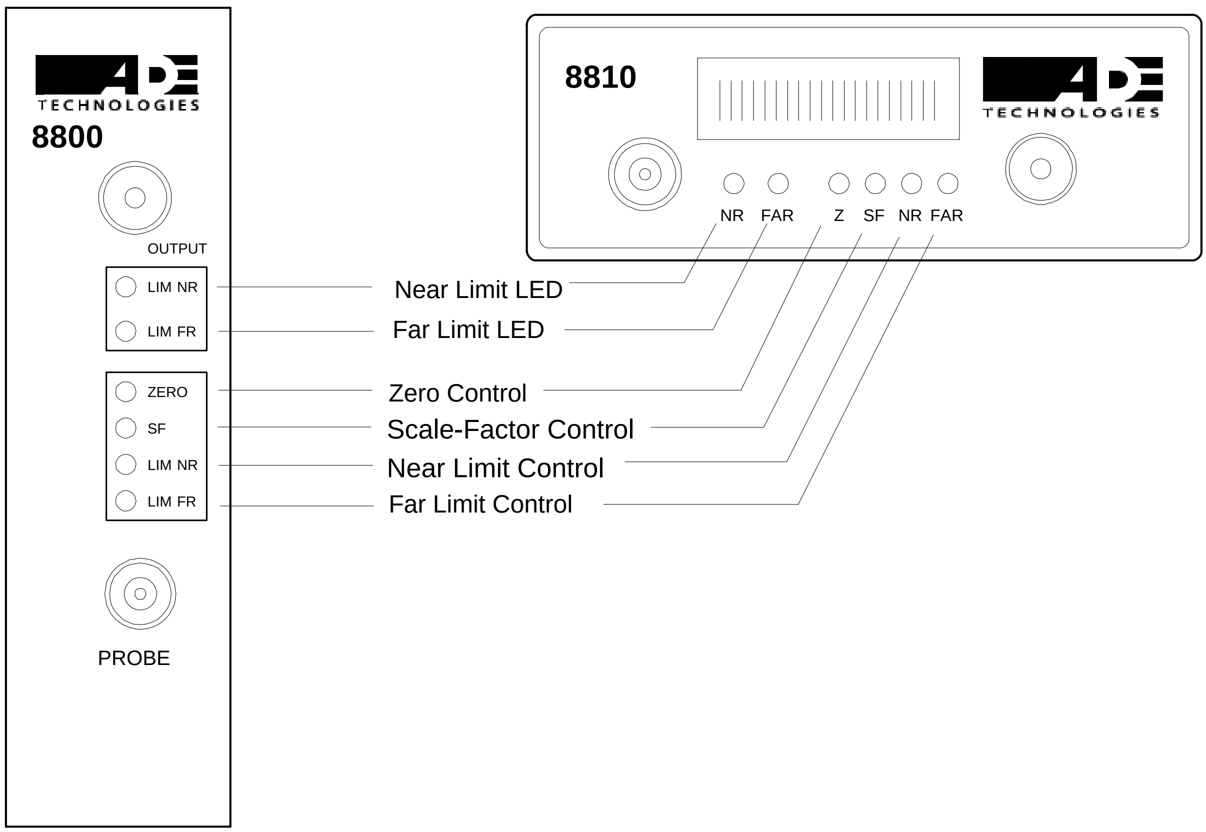


Figure 11: Front Panels of Rackmount (Model 8800) and Stand-Alone (Model 8810) Gages

Connecting the Probes

Connect the probe to the 8810/8800 gaging module at the front panel connector. Use care when handling probes and cables. **DO NOT PULL ON THE PROBE CABLE(S).**

The probe cable and its connectors must not be cut, spliced, or disassembled.

NOTE: The target MUST be at the same potential as analog ground. The housing of most models of 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.

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

The limit outputs on connector P22 or P24 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.

To set the tolerance limits:

Two limit potentiometers are available for setting trip points of the NEAR and FAR limit lines and LEDs. These are located on the front panel on the gaging modules. 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).

Making Fine Adjustments to Scale Factor

A scale factor adjustment is available on the front panel. This potentiometer, marked "SF", allows for fine adjustments to the probe scale factor for periodic calibration. The scale factor is the displacement-to-voltage ratio. Refer to the "Calibration" section of this manual for more details.

NOTE: Calibration is done at the factory and should usually not need to be adjusted.

Making Fine Adjustments to Output Voltage Offset

A front panel potentiometer, marked "ZERO" (or "Z"), 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 $\pm$10% of the full scale operating range.

NOTE: Adjusting the Zero pot has no effect on the Scale Factor.

Input/Output Connections

The 8810/8810 gaging modules have three input/output connections to be aware of:

P24 and P19 (for the Model 8810 module) and P22 (for the Model 8800 module).

- P24 is a 9-pin female “D” subminiature connector.
- P19 is a 25-pin male “D” subminiature connector.
- P22 is a 96-pin male "DIN 41612" connector.

The connectors have the following pinouts:

P24 9-Pin Connector (on the Model 8810 Gaging Module)

1	Target	Connection to probe target if required
2	Near Limit	TTL output, low = limit asserted
3,7,8	Agnd	Ground reference for output signals
4	+Aout	Analog output as defined in section 1.3
5	Artn	External output ground input (see text)
6	Far Limit	TTL output, low = limit asserted
9	-Aout	Inverted Analog output

P19 25-Pin Connector (on the Model 8810 Gaging Module)

1	Exc Off	2.5 ma from +Exc Off to -Exc off turns off probe excitation
2	+Exc Off	
3	n.c.	
4,16	-15	-15 VDC “0.1V @ 0.120 A max
5,17	Com	Power common (ground)
6,18	+15	+15 VDC “0.1V @ 0.120 A max
7	-Phase	Board synchronization signal
8	+Phase	Board synchronization signal
9	+5 Out	+5 VDC Out @ 10 ma (not normally used)
10	+Load In	Calibration load signal
11	-Data In	Calibration data in
12	+Clk In	Calibration clk in
13	+Data Out	Calibration data out
14,15	n.c.	
19	Dig Gnd	Calibration ground (not normally used)
20	+Pclock	Board synchronization signal
21	-Pclock	Board synchronization signal
22	-Load In	Calibration load signal
23	+Data In	Calibration data in
24	-Data Out	Calibration data out
25	-Clk In	Calibration clk in

P22 96-Pin Connector (on the Model 8800 Gaging Module)

1A	+Data Out	Calibration data out
1B	-Clk In	Calibration clk in
1C	+Clk In	Calibration clk in
2A	-Data Out	Calibration data out
2B	-Data In	Calibration data in
2C	+Data In	Calibration data in
3A	n.c.	
3B	+Load In	Calibration load signal
3C	-Load In	Calibration load signal
4A,B,C	Dig Gnd	Calibration ground (not normally used)
5A,B,C	+5 Out	+5 VDC Out @ 10 ma (not normally used)
6A	+Phase	Board synchronization signal
6B	-Pclock	Board synchronization signal
6C	+Pclock	Board synchronization signal
7A	-Phase	Board synchronization signal
7B,C	n.c.	
8A,B,C	n.c.	
9A,B,C	+15	+15 VDC 0.1V @ 0.120 A max
10A,B,C	Com	Power common (ground)
11A,B,C	-15	-15 VDC 0.1V @ 0.120 A max
12A,B,C	n.c.	
13A	+Exc Off	2.5 ma from +Exc Off to -Exc off turns off probe excitation
13B,C	n.c.	
14A	-Exc Off	
15,16,17	n.c.	
18,19	n.c.	
20A,B,C	Target	Connection to probe target if required
21A,B,C	n.c.	
22A,B,C	Near Limit	TTL output, low = limit asserted
23A,B,C	Far Limit	TTL output, low = limit asserted
24A,B,C	Agnd	Ground reference for output signals
25A,B,C	+Aout	Analog output as defined in section 1.3
26A,B,C	-Aout	Inverted analog output
27A,B,C	Artn	External output ground input (see text)
28A,B,C	Agnd	Ground reference for output signals
29A,B,C	Agnd	Ground reference for output signals
30,31,32	n.c.	

External Module Calibration

Normally, the module calibration is factory set. However, the Model 8810/8800 gaging modules allow the calibration, which consists of a scale-factor and linearity setting, to be downloaded to the module at power-up. For instructions on using this feature, refer to Appendix B.

Noise Immunity (ARTN)

- Pin 5 of P24 Connector (Model 8810 module)
- Pin 27A,B,C of P22 Connector (Model 8800 module)

The ARTN connection may be used to reduce noise due to non-uniform grounds between the 8810/8800 modules 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.

2 *Setup & Configuration*

Making Configuration Adjustments

The Model 8810/8800 modules include features which enable 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)
Master/Slave:	Master (Single unit operation)
Drive Phase:	0 Degrees
Output Scaling:	±10 volts for probe range
Bandwidth:	1 kHz
Chassis GND Enable:	Grounded (See Appendix A)
Gain Setting:	Adjusted at factory
Linearity Setting:	Adjusted at factory
Front End Gain:	Adjusted at factory

NOTE: ***Probe range is a function of the last three items listed above. These jumpers are set at the factory for a specific range. Refer to the data sheet which was included with your unit. Please contact ADE Technologies for more information.***

Descriptions of individual parameters follow. If any configurable items need to be changed, refer to Figure 12 to locate the position of the jumpers on the PCB.

Getting Access to the Printed Circuit Board and Jumpers

For the Model 8810, remove the four screws that attach the rear panel to the chassis. For the Model 8800, remove the four screws that hold the cover on (two at the DIN connector and two along the sides).

Jumper Settings (Defaults are starred *)

Bandwidth The 8810/8800 modules may be set to one of four bandwidths. Use the following table to determine the jumper settings:

Bandwidth	P10	P11	P12	P13	P30
10 Hz	N	Y	N	Y	Y
100 Hz	Y	Y	Y	Y	Y
1 kHz *	N	N	N	N	Y
10 kHz	Y	N	Y	N	N

*default setting

Drive Synchronization (Phase Locking)

When two or more Model 8810/8800 gaging modules are used to look at the same target, it is usually advisable to phase lock the excitation to the probes–especially if the target is not well grounded. To do this, the board synchronization signals must be bussed across all modules. So, all +Phase signals are connected together, all -Phase signals are connected together, all +Pclock signals are connected together, and all -Pclock signals are connected together.

Drive synchronization is a method of phase locking the probe drives of two or more units to prevent any probe-to-probe interactions. When more than one unit is used (one master unit with several slave units), the phase of the probe drives may be set to an appropriate angle with respect to the master. This patented feature allows for the gaging of poorly grounded targets using two or more probes. Refer to Figure 13 for an illustration of the electrical connections for multiple units.

Configuration	P2
Master *	N
Slave	Y

*default setting

NOTE: A slave will not operate without the master unit connected and powered.

To choose the proper phase angle, determine the phase angle spacing P by dividing 360 by the number of probes that are gaging the same target. The first probe should have a phase of 0. The second probe should have a phase as close to 2P as possible. The third probe's phase should be as close to 3P as possible, etc. Here are some examples.

1. If all probes are independent, a phase angle of zero is recommended on all boards (default setting).

2. If two probes are used, the first board should be set to 0 and the second set to 180.

3. If three probes are used, the first board should be set to 0, the second set to 120, and the third set to 240.

4. If four probes are used, the first board should be set to 0, the second set to 180, the third set to 0, and the fourth set to 180.

5. If five probes are used, the boards should be set to 0, 72, 144, 216 and 288 respectively.
   NOTE: The master must be set to 0 degrees.

   The chart below shows the jumper configurations for different phase angles.

Phase	P26	P27	P28
0*	N	N	N
180	Y	N	N
120	N	Y	N
240	N	N	Y
72	Y	Y	N
144	N	Y	Y
216	Y	N	Y
288	Y	Y	Y

*default setting

2 Setup & Configuration

Output Scaling The analog output level of the Model 8810/8800 gaging modules 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. (W1 - W5 set the scale factor while W10 is an offset jumper for configuration of bipolar/unipolar output.)

Configuration.	P6	P8	P9
±10 V (Bipolar) *	Y	N	N
±5 V (Bipolar)	Y	Y	N
0 to 10 V (Unipolar)	Y	Y	Y

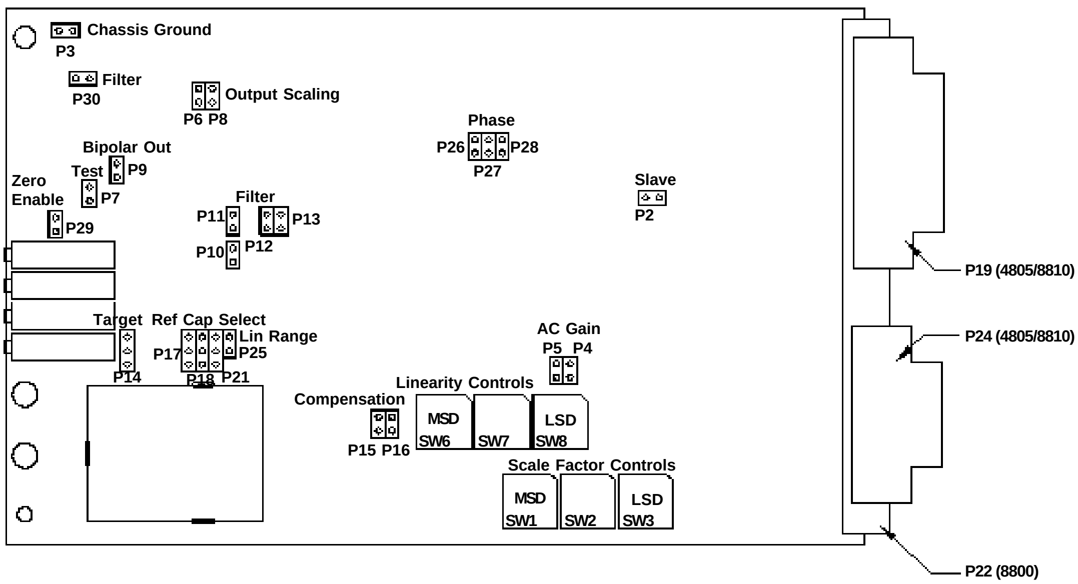
*default setting

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 8810/ 8800 gaging modules to be either grounded or ungrounded. See Appendix A for more grounding information.

Configuration	P3
Chassis Grounded *	Y
Chassis Ungrounded	N

*default setting



Default Control Settings:

Function	Setting	Control Position
Master/Slave	Master	P2 out
Phase	0 degrees	P26, P27, P28 out
Output scaling	±10 Volts	P6 in, P8, P9 out
Filter	1 kHz	P10, P11, P12, P13 out, P30 in
Zero	Enabled	P29 in
Chassis Gnd	Connected	P3 in
Compensation	Set at Calibration	
Scale Factor	Set at Calibration	
Target	Grounded	P14 lower
Lin Range	Factory Set	P25 out
AC Gain	Factory Set	P5 in, P4 out

Figure 12: Location of Jumpers on PCB

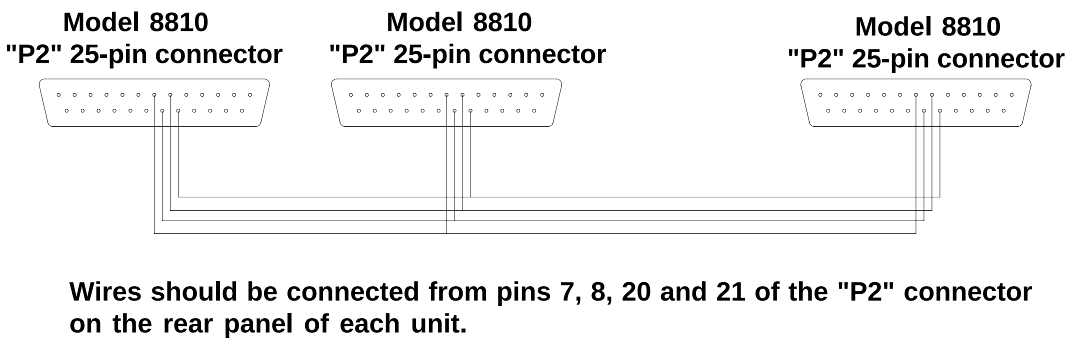


Figure 13: Electrical Connections for Multiple 8810 Units in Synchronization (As Shown from the Rear)

Procedure for Adjusting Scale Factor

The Model 8810/8800 gaging modules' scale factor may be adjusted via a front panel potentiometer. This pot is labeled "SF" on the front panels of the Models 8810/8800 units.

The following procedure should be followed to adjust the scale factor:

Equipment Needed:

1. Digital Volt Meter 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 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 um range, increase by 200um). Measure according to the fixturing equipment.

3. Note this voltage.

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

   10 + [(10 - [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 adjustment. The procedure 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.*

3 *Calibration*

Range Adjustment

The Model 8810/8800 gaging modules incorporate a flexible architecture which permits you to perform a full calibration of the system. This will allow you to install a new probe or change ranges as needed.

The range adjustment 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 Technical Support for further information.

Grounding

Electrical 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 8810/8800 gaging modules.

Target Grounding

The target must be connected to the circuit ground of the gaging system. The Model 8810/8800 gaging modules have 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. If this is not possible, a wire may be run from the Model 8810/8800 gaging modules directly to the target.

Chassis Grounding

A jumper has been provided (P3) 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 8810/8800 gaging modules.

Notes:

Models 4800/5800/8800 Calibration Interface

Introduction

The 4800, 4810, 5800, 5810, 8800, and 8810 are provided with a calibration interface for those customers who wish to download calibration information from a system controller to their ADE gage modules. The interface uses serial, differential connections and a simple protocol. Any number of modules can be daisy chained, which elminates the problem of increasing the complexity of the interface as the number of modules to be calibrated increases.

Calibration Methodology

Both the 48XX, 58XX and 88XX gage modules require two calibration constants, one for setting the scale factor, and one for adjusting the linearity. These constants are stored as two 12-bit binary numbers by setting six hex switches located on the PC board. However, the outputs of these switches are wired-ored with the output from a 24-bit shift register. So, if all the outputs of the hex switches are set to be open, the shift register can control the calibration settings. It is this shift register, along with additional circuitry, that implements the remote calibration interface.

Connections

All connections for the calibration interface are provided at the rear-panel connector(s). The pinouts are as follows:

Signal:	**Pin: 4800, 5800, 8800** **(96-pin male DIN 41612)**	**Pin: 4810, 5810, 8810** **(25-pin male DSUB)**
+Data Out	1A	13
-Data Out	2A	24
+Data In	2C	23
-Data In	2B	11
+Clock In	1C	12
-Clock In	1B	25
+Cal Enable	3B	10
-Cal Enable	3C	22
+5 VDC	5A,B,C	9
GND	4A,B,C	19

B *Appendix*

Protocol

The serial data to be downloaded to the gage module is clocked into the shift register on the rising edge of the clock. The Cal Enable signal determines whether or not the shift register's output is tri-stated or presented to the gage board.

The order of the shifted data is as follows: MSB of the scale-factor word first, and LSB of the linearity word last, so:

→LIN0, LIN1, LIN2…SF0, SF1, SF2…SF11 →

An example data stream would look like:

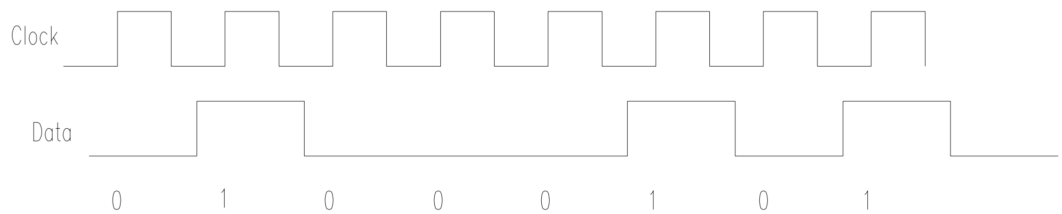


Figure 13: Example of a Data Stream

Note that although one clock, and one data signal is shown in the example above, these lines are differential, so each signal comprises two connections. **Note also that the calibration information is not stored in non-volatile memory, and therefore, it must be downloaded to the board on power-up.**

Wiring

The calibration interface can be configured as either a two-wire or three-wire interface. A typical three-wire scheme is shown below.

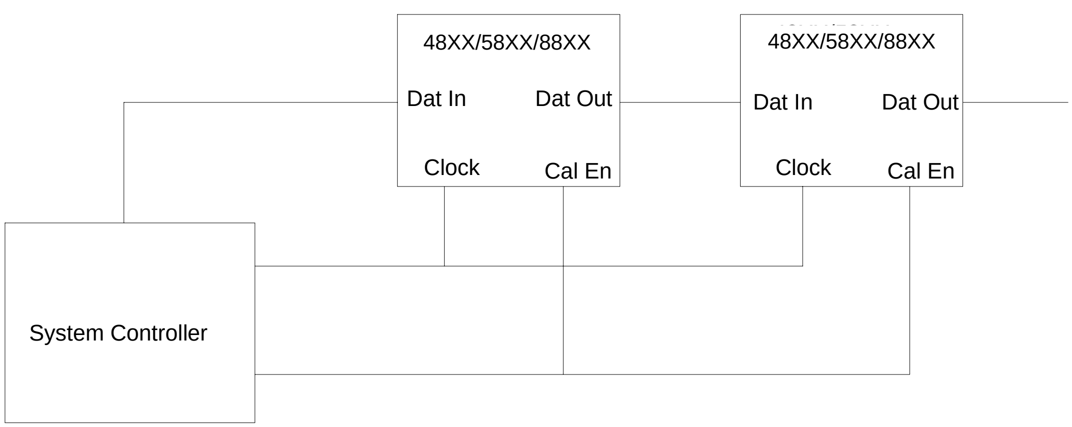


Figure 14: A Typical Three-Wire Interface

Although the Cal Enable is used in the above example, in most cases it will not be required. When not used, the +Cal Enable line can be tied to the GND connection of the 48XX/58XX/88XX output connector, and the –Cal Enable line can be tied to +5 VDC pin of the output connector. These connections will enable the remote interface. In general, the Cal Enable signal will only be required if it is necessary to avoid the module outputs from changing with every clock pulse during the time new calibration data is downloaded.

Grounding

The differential connections provide two distinct advantages, 1) they offer highly reliable data transfer, and 2) they eliminate potential ground loops between the gage modules and the system controller. If the gage's power supply is referenced to ground along with the system controller, there should be no need for a ground connection between the gage modules and the system controller. If the gage modules are not referenced to ground, a ground connection between the modules and system controller is necessary.

Pseudo Read-back

Although a true data read-back feature is not implemented in this interface, a pseudo read-back can be easily implemented by connecting the data output lines from the last gage board in the daisy chain back to an input of the system controller. To read the existing calibration data stored in the modules, simply issue n*24 clock pulses, where n is the number of modules. The data stream that comes back to the system controller is the calibration data that was stored in the modules. The data can then be downloaded back to the modules to restore the values.

To verify proper data transmission whenever loading new data to the modules, simply concatenate two complete data sets. The first data set will be clocked through the modules and returned to the system controller, and the second data set will remain in the modules.

Single-ended connections

If a short connection between the system controller and modules is used, and ground loops are not a problem, single-ended communications can be implemented by tying either the + or – input of the signal in question to about 1.5 volts for TTL-compatible outputs, or 2.5 volts for CMOS compatible outputs. This may be readily accomplished by using a resistor voltage divider from the input in question to +5 VDC and ground. Because the modules' calibration inputs are CMOS, resistor values need not be low. For example, a 10k resistor to +5 and a 4.7k resistor to ground would be fine for TTL-compatible outputs. For extra noise immunity, connect a 0.1 ìF cap from the input to ground.

B *Appendix*

I/O Hardware and Configuration

The differential calibration inputs and outputs are provided by Linear Technology LTC1690 ICs. These devices provide a ±7 V common-mode range, and are protected from ±15 kV ESD discharges (human body model). For complete specs, visit the Linear Technology website (www.linear.com).

All inputs have resistors to +5 VDC and ground installed on the gage module as shown below to ensure proper operating state when the external calibration feature is not used.

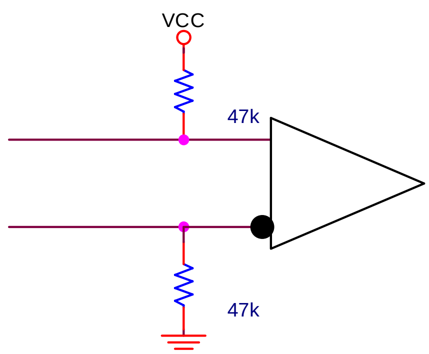


Figure 15: Resistors and Ground

Preparation of the Gage Module for External Calibration

In order to use the external calibration feature, the hex switches on the gage module must be properly set. If the modules have been previously calibrated, it might be useful to record the settings of the hex switches before proceeding.

- For the 4800, 4810, 8800 and 8810: Set SW6, SW6, and SW8 to 0s, and set SW1, SW2, and SW3 to Fs.

- For the 5800 and 5810: Set SW2 through SW7 to Fs.

Appendix C

Maintaining the R.F. Shielding of the Model 8810S

Introduction

The Model 8810S has various shielding elements designed to substantially reduce effects from R.F. interference. In order to maintain the effectiveness of this shielding, care must be used in connecting external signals to the 8810S module– external wires, if not properly shielded and terminated, form an easy path for R.F. to enter.

In general all connections to the module should be made with shielded wire. It is important for the shield to connect directly to the conductive shell of the connector. To provide broadband shielding, the shield, typically braided wire, should not be connected via a pigtail, but should directly contact the connector shell. Specific instructions are outlined below. For various technical reasons the connectors supplied with the 8810S are not filtered, so proper shielding is crucial.

Front-Panel BNC Connector

This connector, which provides access to the analog output of the module, is easily shielded by use of a standard coaxial cable. Because BNC connectors are designed for R.F. signals, virtually all BNC connectors provide proper shield termination. If, however, the device to which this signal is connected is not itself properly shielded, R.F. can gain an entry point via the center conductor of this cable.

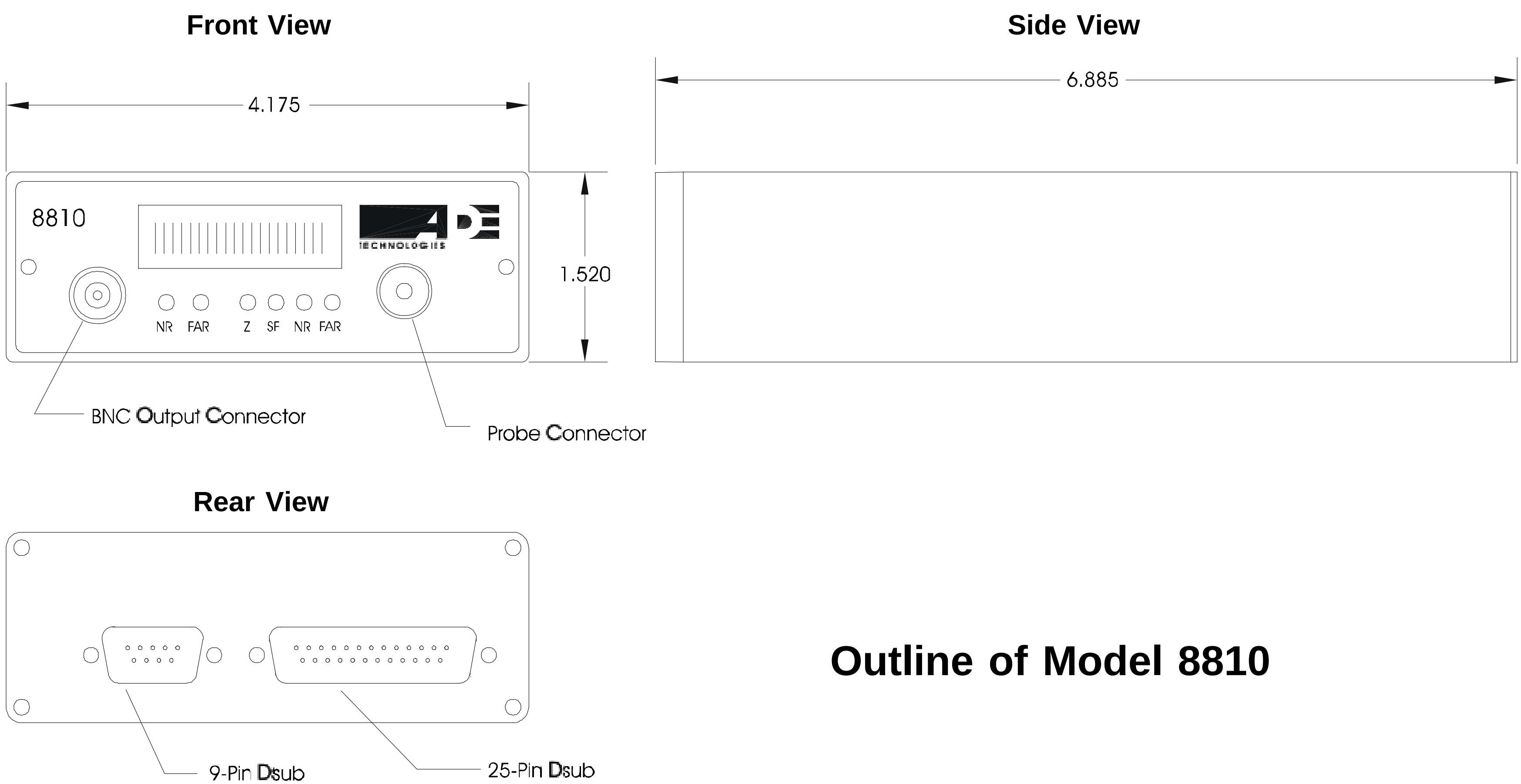
Should this occur, solder a 1 nF capacitor directly across the BNC terminals where they enter the offending equipment. Be sure that the capacitor is placed in immediate contact with the connector's terminals and use the absolute minimum lead length on the capacitor. To provide additional shielding, a 100-ohm to 1-kohm resistor can be placed in series with the lead that connects to the center conductor of this same BNC connector. Place the resistor as close as possible to the BNC connector in question.

Rear-Panel 9-Pin DSUB Connector

Follow all instructions listed above for the front-panel BNC connector. Use the supplied metallized backshell to shield any connections to this connector, and to terminate the braid of the shielded wire. To properly connect the braid to the backshell, first select whichever rubber grommet best fits your cable. The cable should go through the grommet, and the braid should be expanded and then folded back over the grommet so that when the backshell halves are screwed together, the braid will be squished between the grommet and the backshell.

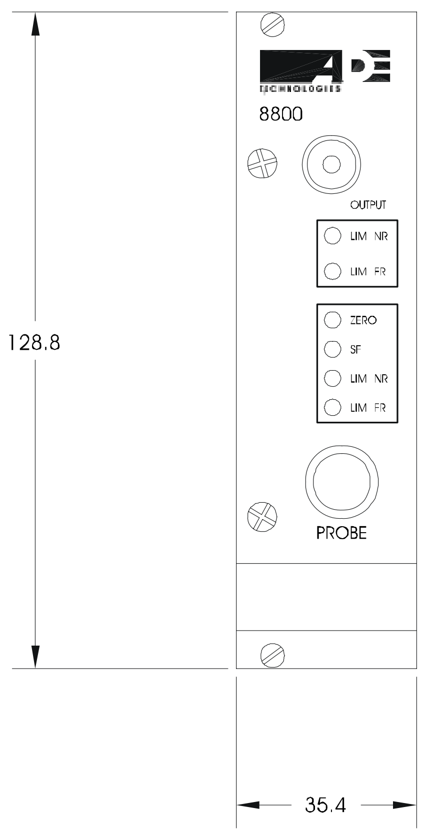
Rear-Panel 25-Pin DSUB Connector

This connector is used to supply power to the module and to sync multiple modules together to provide a known phase relationship between them. The power-supply connections to this connector have been bypassed at the connector and no further shielding of them should be necessary. Wires used for syncing should be shielded and the braid of the shielded wire must be terminated as described for the 9-pin connector. Please note that the rubber grommets supplied with the connector can be easily split to go around existing wires by using a single-edged razor blade or the like to cut through the grommet in one place. As an example, this procedure was used for the power-supply cable.

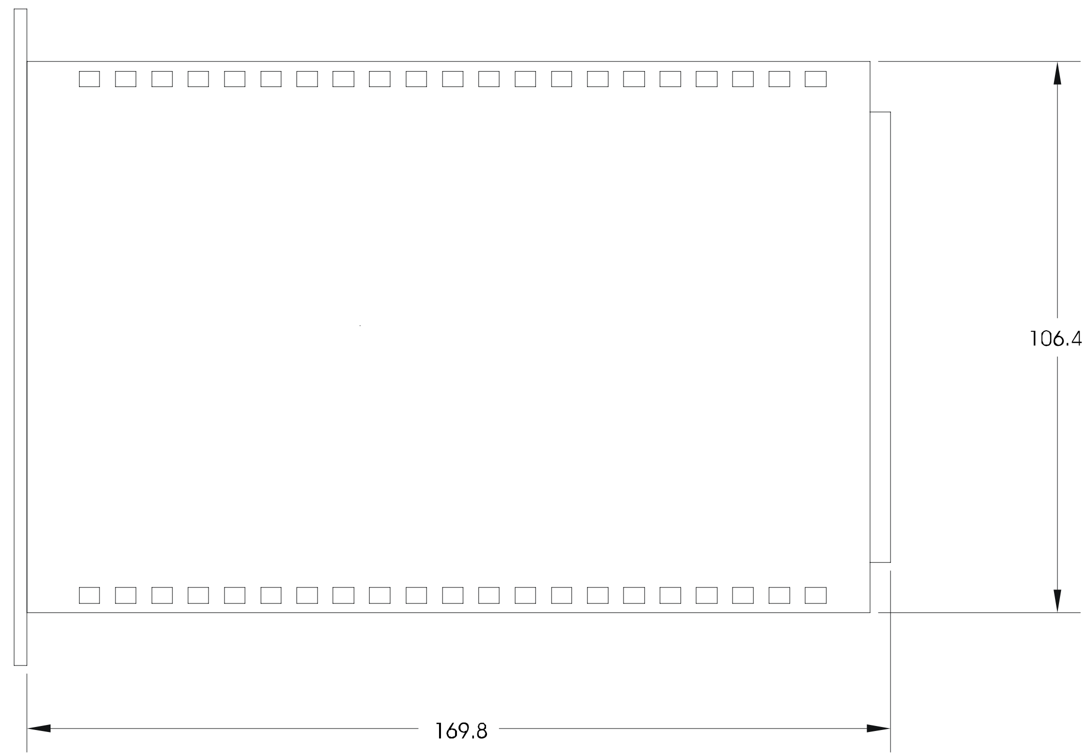


Outline of Model 8810

Front View



Side View



Outline of Model 8800