Z-Mike™

1200 Series

Laser Bench Gauges

Operation and Maintenance Manual

OMP-0205F

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MANUAL REVISION INFORMATION

The document number and latest publication date for this manual appear on the title page. Any revision letter following the document number indicates that the manual has been revised and shows its current revision level. An appropriate revision letter also appears at the bottom of each revised page.

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NOTICE

This manual contains descriptions, drawings, and specifications for a Z-Mike product. Equipment or products made prior to or subsequent to the publication date of this manual may have parts, features, options, or configurations that are not covered by this manual.

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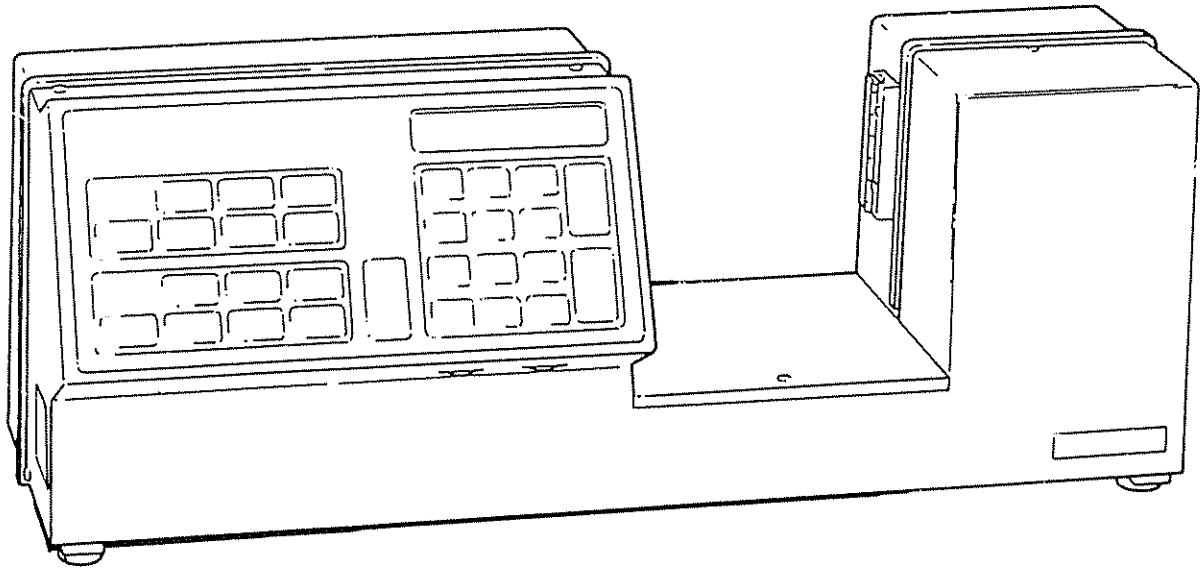
Chapter 1
INTRODUCTION

GENERAL DESCRIPTION

The 1200B Series Laser Bench Gauges* are noncontact gauges that use a scanning laser beam to measure part size or position quickly and easily with excellent repeatability. A liquid crystal display shows either the part's dimension or the measured deviation from a user-selected nominal dimension. The High/Low Limit Alarm feature alerts the gauge operator when either the upper or lower tolerance limit has been exceeded. The Maximum/Minimum Signal Retention feature keeps track of the largest and smallest dimensions measured, and the mathematical difference between the two (TIR). The Statistical Analysis functions keep track of how many parts were measured, the average dimension, and standard deviation of the parts in a batch.

*U.S. Patent 3,907,439 and foreign.



1200B Series Bench Gauge (Model 1201 Shown)
Figure 1

OUTPUT AND CONTROL ALTERNATIVES

The 1200B Series gives you a choice of devices for controlling the gauge. You can use the gauge's built-in keypad and/or the standard bidirectional RS-232C serial interface feature. You can use these control devices either singly or simultaneously. You can also connect other devices, such as the Model 3037 Alphanumeric Remote Display (if you would like to have a larger display visible in your shop from greater distances), or the Model 3020 Digital Printer to create paper copies of your measuring runs. (Chapter 2 lists the available options and accessories.)

HOW THE LASER BENCH GAUGE S WORK

The gauge's transmitter section emits a laser beam which continuously scans across the measurement area at high speed. When an object is placed in the measurement area, it interrupts the laser scan and casts a shadow. The receiver section detects the edges of the shadow and converts the "edge" data to electrical signals. The gauge's internal processor calculates the size of the object by measuring the time interval between the edges of the shadow. The calculated dimension appears on the built-in LCD display and can be output on the RS-232C interface.

MEASUREMENT STABILITY

To achieve high measurement accuracy and stability, the 1200B Series gauges have a unique design and use low-expansion materials for critical components. (Their coefficient of thermal expansion is almost zero.) Heat-producing elements are isolated from the optical path, and thermal convective heat transfer is minimized by the internal optical baffle. This design provides consistent measurement performance throughout the entire measurement range ("small-to-large"), and throughout the entire measurement area. This performance is traceable to the U.S. National Institute of Standards and Technology (formerly the National Bureau of Standards).

The auto-calibration assembly calibrates the gauge by continuously monitoring the speed of the scanning laser beam and compensating the measured dimension in accordance with any variations. As a result, the 1200B Series Bench Gauges produce accurate, drift-free measurements, regardless of the environment.

OPERATION MANUAL

This manual provides instructions for setting up and operating the Model 1201B and Model 1202B Bench Gauges. These gauges are operationally identical; they differ mainly in the range of sizes that they can measure and in the accuracy of their measurements. (Chapter 2 lists these specifications.)

Following is a summary of the information included in this manual.

- Chapter 2 provides basic system specifications.
- Chapter 3 contains information and guidelines for the safe use of lasers.
- Chapter 4 explains how to unpack the gauge and provides guidelines for installation.
- Chapter 5 gives a brief description of the function of each key on the keypad.
- Chapter 6 outlines the keystrokes necessary to control a particular function of the gauge.
- Chapter 7 provides an operational demonstration of the High/Low Limit Alarm and Maximum/Minimum/TIR Measurement Retention features.
- Chapter 9 lists and explains the gauge's "Error Signals", and possible sources of measurement errors.
- Chapter 11 describes some basic maintenance procedures.
- Chapter 12 defines some of the terms associated with the performance of the gauge.

OTHER 1200 SERIES MANUALS

The following 1200 Series manuals are also available:

OMP-0185 1200 A Series Operation Manual

OMP-0059 1200 Series Service Manual

OMP-0126 1200 Series Options Manual

OMP-0184 1200 Series Accessories Manual

Chapter 2
SPECIFICATIONS

PERFORMANCE SPECIFICATIONS - 2 inch (50mm) Laser Micrometers

Model		1201B	1201HP
Measurement Range [1]		0.010 to 2.0 in (0.25 to 50.8 mm)	
Repeatability [2]		±0.00002 in (±0.5 µm)	±0.00001 in (±0.3 µm)
Accuracy [3]	Remastered Mode	±0.00003 in (±0.8 µm)	±0.00002 in (±0.5 µm)
	Absolute Linearity	±0.00006 in (±1.5 µm)	±0.00004 in (±1.0 µm)
Measurement Area Passline		2.625 in (66.7 mm)	
Measurement Area Depth of Field		±0.125 x 2.0 in (±3.18 x 50.8 mm)	
Laser Beam Spot Size		0.008 in (0.2 mm)	
Scanning Beam Thickness at passline		0.020 in (0.5 mm)	

1 Gap measurement accuracy valid for range ≥0.020 inch (≥0.5mm)

2 Specified repeatability applicable with 256 or more scans averaged, based @ 2σ (95% confidence level). Repeatability is ±0.0015% of measured dimension, whichever is larger for 1201B; ±0.0010% of measured dimension, whichever is larger for 1201HP.

3 Based on standard factory calibration @ 68°F (20°C) with 50% relative humidity. Note: May require user field remastering in nonstandard enviromental conditions.

Repeatability vs. Measurement Rate for 2 inch (50mm) Laser Bench Micrometers

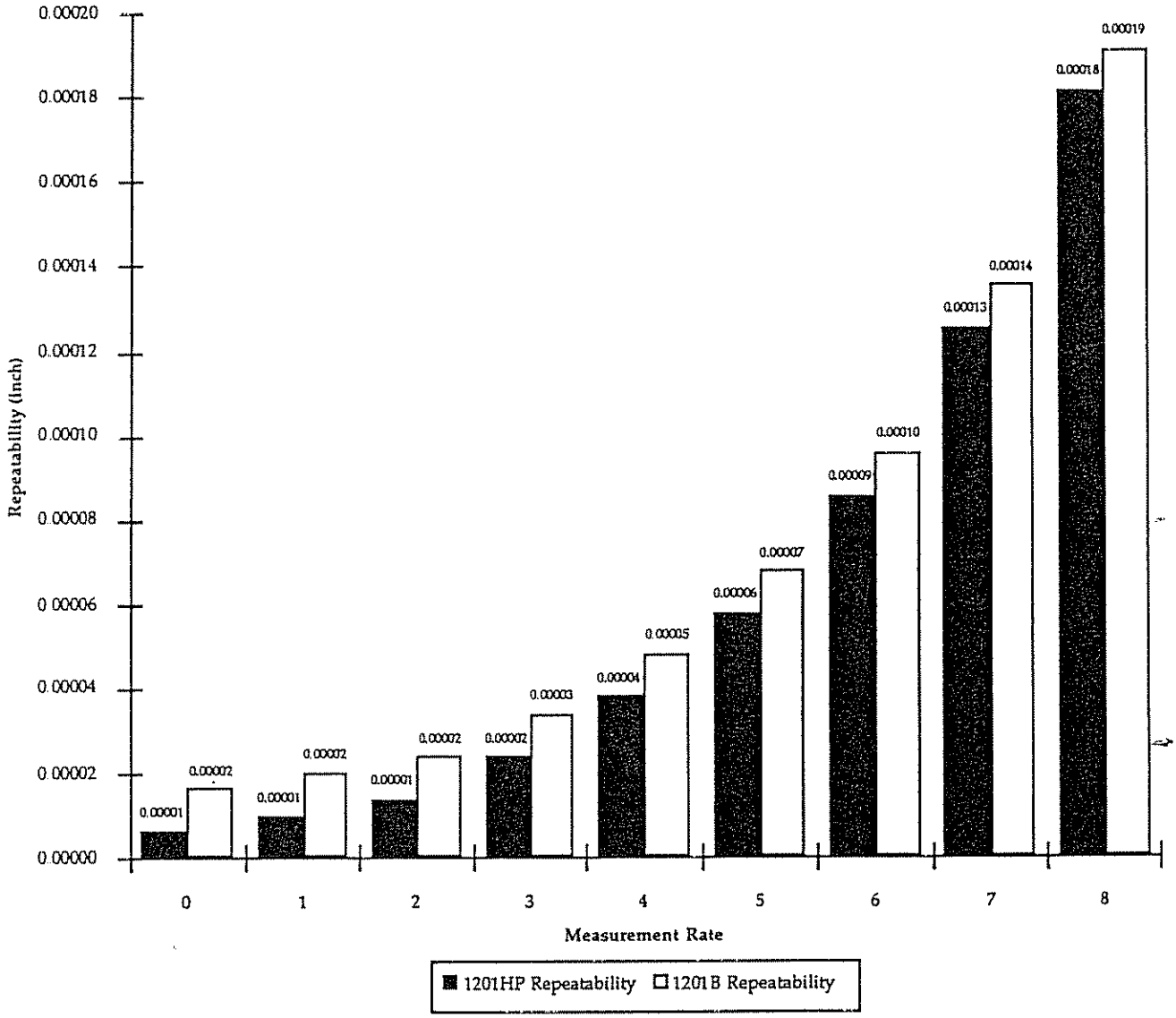
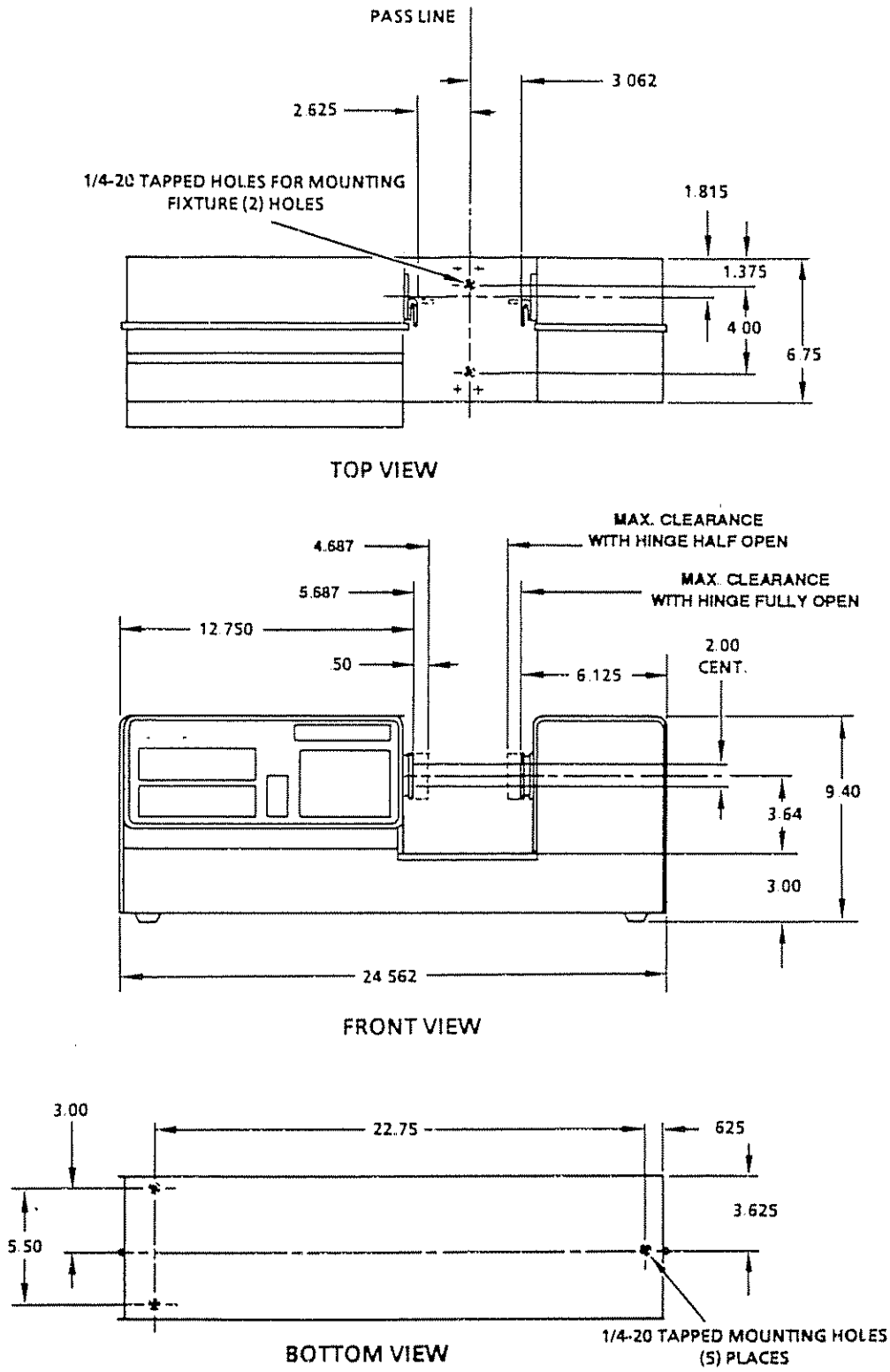


Figure 1 illustrates measurement performance for typical 1 inch part measured with the Z-Mike 2 Inch (50mm) Laser Bench Micrometers at various measurement rates

Figure 2-1



Views of the Model 1201B and Measurement Region
Figure 2-2

PERFORMANCE SPECIFICATIONS - 1 inch (25mm) Laser Micrometers

Model	1202B	1202HP
Measurement Range [1,4]	0.003 to 1.0 in (0.08 to 25.4 mm)	
Repeatability [2]	±0.00001 in (±0.3 µm)	±0.00001 in (±0.2 µm)
Accuracy [3] Remastered Mode	±0.00002 in (±0.4 µm)	±0.00001 in (±0.3 µm)
Absolute Linearity	±0.00003 in (±0.9 µm)	±0.00002 in (±0.6 µm)
Measurement Area Passline	2.062 in (52.4 mm)	
Measurement Area Depth of Field	±0.060 x 1.0 in (±1.52 x 25.4 mm)	
Laser Beam Spot Size [4]	0.004 in (0.1 mm)	
Scanning Beam Thickness at passline	0.010 in (0.25 mm)	

1 Gap measurement accuracy valid for range ≥0.020 inch (≥0.5mm)

2 Specified repeatability applicable with 256 or more scans averaged, based @ 2σ (95% confidence level). Repeatability is ±0.0015% of measured dimension, whichever is larger for 1202B; ±0.0010% of measured dimension, whichever is larger for 1202HP.

3 Based on standard factory calibration @ 68°F (20°C) with 50% relative humidity. Note: May require user field remastering in nonstandard enviromental conditions.

4 Available with special 0.002 inch (50µm) laser beam spot size; Designed for applications measuring small parts or characteristics

Repeatability vs. Measurement Rate for 1 inch (25mm) Laser Bench Micrometers

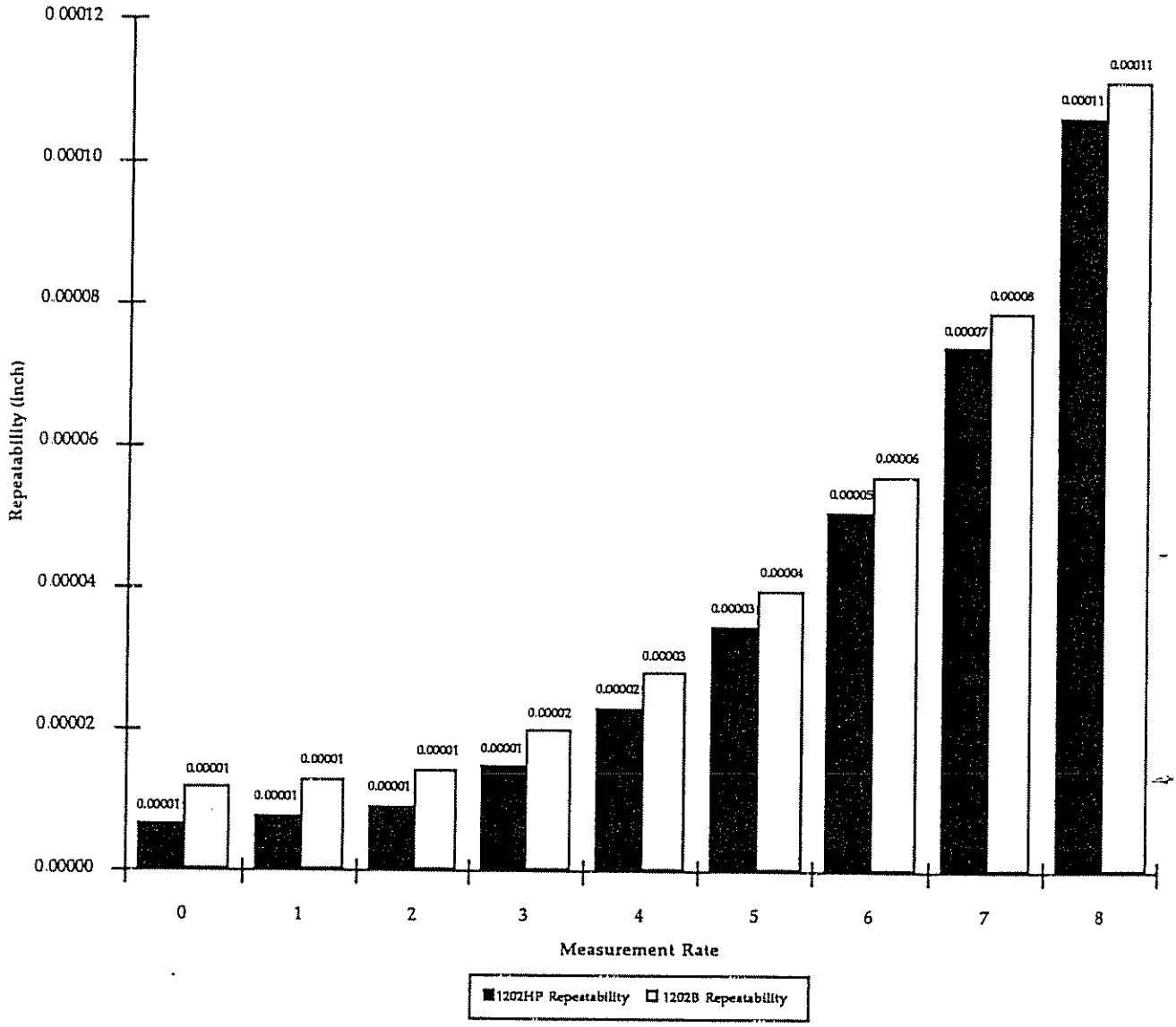
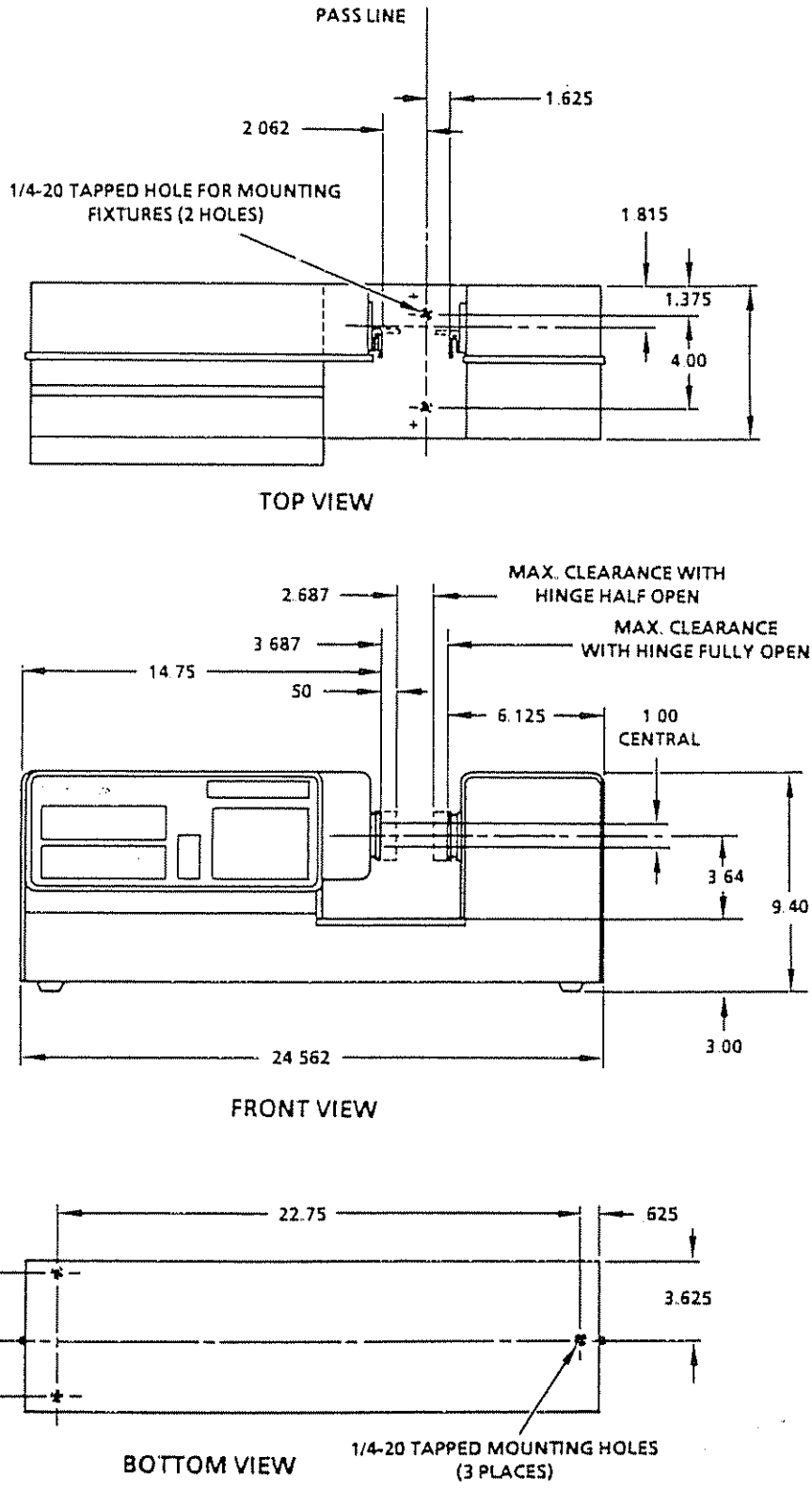


Figure 3 illustrates measurement performance for typical 0.5 inch part measured with the Z-Mike 1 Inch (25mm) Laser Bench Micrometers at various measurement rates

Figure 2-3



Views of the Model 1201B and Measurement Region
Figure 2-4

GENERAL SPECIFICATIONS

Mounting Holes	Two (2) mounting holes at passline location; 1/4 in. x 20 pitch/in. (U.S.) or M6 (all others)
Temperature Coefficient:	≤0.000004 in./°F (≤0.2µm/°C)
Operating Temperature:	40 to 92°F (5 to 33°C) at <90% relative humidity
Stoarage Temperature:	-4 to 140°F (-20 to 60°C)
Warm Up Period:	45 minutes
Set-up Parameters:	Non-Volatile Memory (NVM)
Calibration:	Factory standard calibration User remastering procedures
Dimensions:	(HWD) 9-1/2 x 24-1/2 x 8-5/8 inches (241.3 x 622.3 x 219.1 mm)
Weight:	26 lbs.(11.7 kgs.)
Laser Source:	HeNe gas laser; ≤1 mw output
Display:	7-digit alphanumeric liquid crystal
Display Resolution (selectable):	0.001 - 0.00001 inch (0.01 - 0.0001 mm)
Scan Rate:	120 per sec. (at 60Hz) 100 per sec. (at 50Hz)
Operator Controls:	Soft touch keypad
Power Requirements (specify):	100 VAC (-10% to +5%), 50 Hz (±2 Hz) 100 VAC (-10% to +5%), 60 Hz (±2 Hz) 115 VAC (-10% to +5%), 60 Hz (±2 Hz) 220 VAC (-10% to +5%), 50 Hz (±2 Hz) 240 VAC (-10% to +5%), 50 Hz (±2 Hz) 100 Watts total power

Available Options:

Second RS-232C Interface (Model 1221)

Chart Recorder Output (Model 1222)

Solid State Relay Output (Model 1223)

Transparent Object Measurement (Model 1224)

I/O Accessories:

80-Column Digital Printer (Model 3020)

24-Column Printer (Model 3022)

Solid State Relays (Model 3230)

Solid State Relay/Visual Alarm Panel (Model 3233)

Remote Footswitch (Model 3235)

Remote Display (Model 3037)

Standards and Fixtures:

1201B Class XXX Inch Master Pin Gauge Set (Model 3042)

1201B Class XXX Metric Master Pin Gauge Set (Model 3043)

1202B Class XXX Inch Master Pin Gauge Set (Model 3048)

1202B Class XXX Metric Master Pin Gauge Set (Model 3049)

Universal Slide Fixture (Model 3250)

Universal V-Block (Model 3251)

Adjustable V-Block (Model 3252A)

Adjustable Centers Fixture (Model3253)

Modular V-Block (Model 3257)

Standards and Fixtures (continued): Flat Test Fixture (Model 3258)

Insulated Base Support (Model 3259)

Adjustable Live Center Fixture (Model 3260)

Concentricity Fixture (Model 3261)

Reference Edge (Mofel 3262)

Leadscrew Positioner with DRO (Model 3263)

Supplies: Foreign Language Legends (Model 3283)

Operator Maintenance Kit (Model 3290)

Carrying Case (Model 3292)

Anti-Static Dust Cover (Model 3293)

Metric Datum Plate (Model 3294)

Extended Warranty Program (Model 3296)

Certificate of Compliance (Model 3299)

Chapter 3
LASER RADIATION SAFETY INFORMATION

LASER SAFETY

The laser used in a 1200B Series gauge emits visible red light only. No invisible or otherwise harmful radiation is emitted.

The radiant output power of the internal laser and of the instrument is relatively low. The radiation emitted is incapable of burning or drilling holes, even if a lens is used to focus the light. However, the laser light emitted from the gauge should be treated with caution and common sense. The laser light will not hurt your skin, but be careful not to look directly into a laser beam or stare at its bright reflections.

The American National Standard for the Safe Use of Lasers (ANSI Z136.1--1980) classifies this laser product as Low Power - Class II (per Table A1), and provides reasonable and adequate guides for its safe use. The user and personnel responsible for the safe use of the gauge in the user's organization should consult this ANSI standard. It is available from:

American National Standards Institute

1430 Broadway

New York, New York 10018

NCDRH REGULATIONS

Effective August 2, 1976, the National Center for Devices and Radiological Health (NCDRH) of the Food and Drug Administration has established regulations for laser products manufactured after August 1, 1976.

OUTPUT BEAM DATA

Emission Duration: more than 0.25 second
Radiant Power: less than 1 milliwatt
Wavelength: 632.8 nanometers (only)

LABELS

The 1200B Series of gauges carry the following laser safety labels: Product Warning Logotype label, Product Identification label, Product Certification label, Noninterlock Protective Housing label, and Aperture label (Figure 3-1).

ADDITIONAL INFORMATION

Emission Indicator - A green light on the gauge's control panel (Figure 3-1) lights up when the laser power is switched on. It provides a visible signal that indicates the accessibility of Class II emissions during operation.

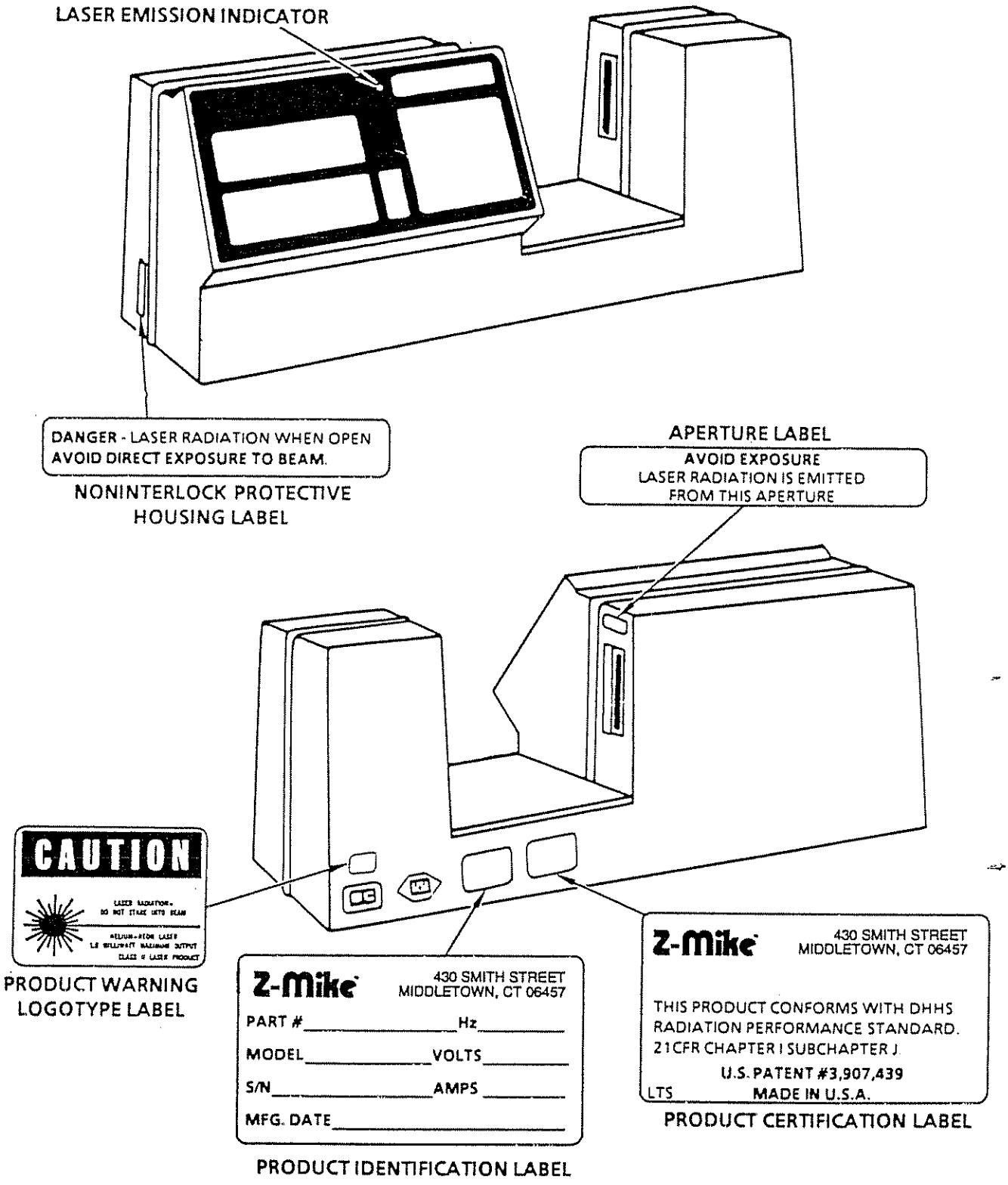
Beam Attenuator - Located at the side of the laser aperture is a hinged door which serves as a mechanical beam shut-off. In the closed position it shuts off all access to laser radiation. Opening the door allows access to the laser radiation.

Replacement of Laser Heads and/or Laser Power Supplies - Only a Z-Mike supplied laser head and/or power supply, which is labeled for use in a 1200B Series bench gauge, should be used as a replacement. The replacement should be installed according to the procedure specified in the 1200 Series Service Manual (SP- 0059) to assure conformity to federal radiation standards.

Federal regulations require inclusion of the following statement in this manual:

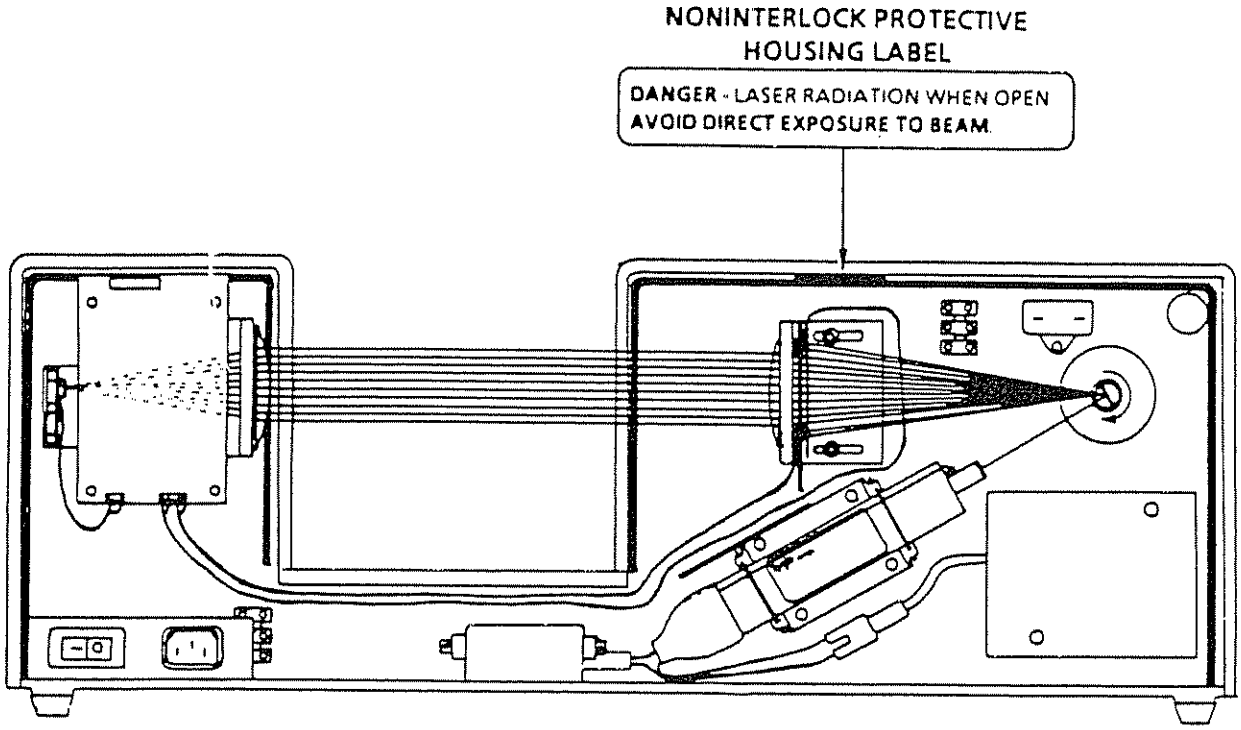
WARNING:

The use of controls or adjustments, or performance of procedures other than those specified herein, may result in hazardous radiation exposure.

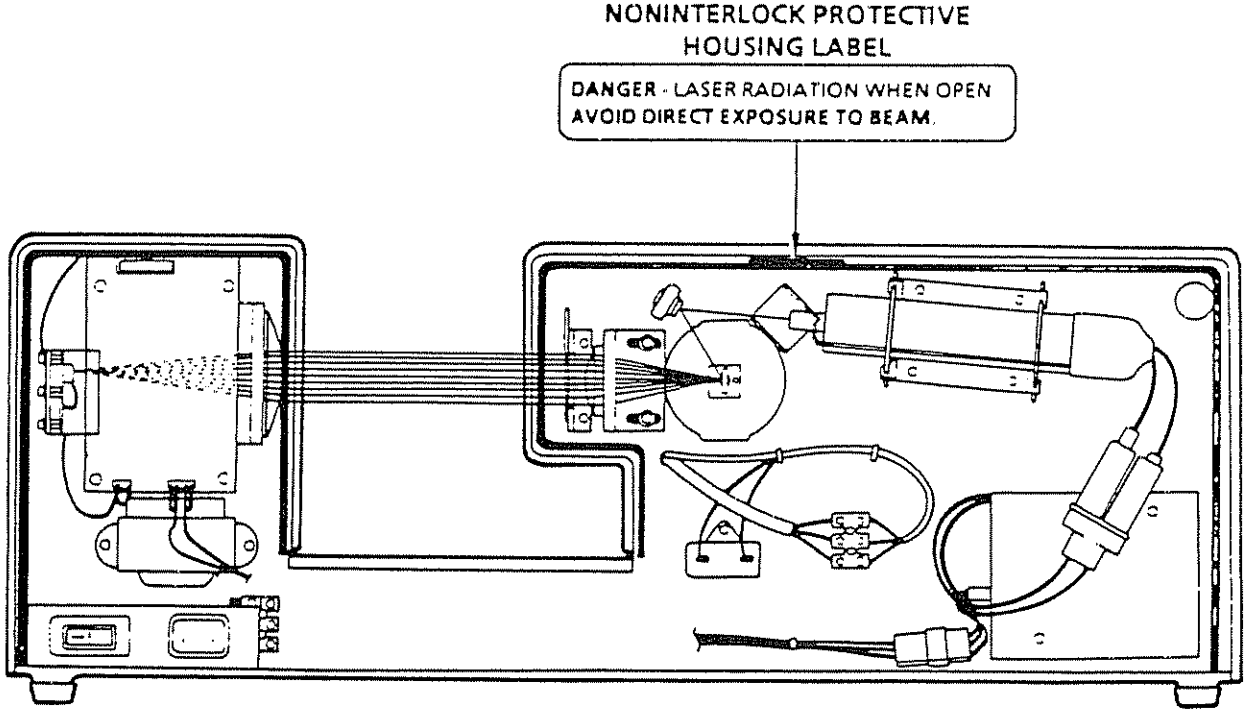


Laser Safety Label Locations

Figure 3-1



MODEL 1201B BENCH GAUGE (REAR COVER REMOVED)



MODEL 1202B BENCH GAUGE (REAR COVER REMOVED)

Laser Safety Label Locations

Figure 3-1

Chapter 4
UNPACKING AND INSTALLATION

UNPACKING

1. Inspect the exterior of the shipping container for damage. If it is damaged, don't open it - contact the carrier and Z-Mike immediately.
2. If the shipping container is intact, remove the packing list and note what equipment is inside.
3. Carefully open the container, remove the shipping spacers, and proceed to unpack the gauge.

   Note: Do not destroy or discard the original shipping carton and packing materials. Should it be necessary to return the unit to the factory for service, these materials will provide assurance against shipping damage.

4. Inspect the gauge for any concealed damage. If damage is suspected, contact the carrier immediately.
5. Check the packing list to be sure all items have been received. If all items have been received undamaged, proceed to install the system.

INSTALLATION CONSIDERATIONS

Installation of the bench gauge is very simple. It may be used on any horizontal surface such as a desk or bench top, as long as physical vibration is not excessive. The gauge should not be located where it will accumulate any amount of dust, or mist.

Chapter 5
INPUTS, OUTPUTS, AND CONTROLS

This section explains the inputs, outputs and controls of the Z-Mike Bench Gauge. Refer to Figure 5-1 for locations.

INPUTS

AC Power

The gauge's AC power cord must be plugged into a grounded receptacle with adequate power. The gauge's power requirements are printed on the label located near the AC connector socket.

The main power switch is located on the back of the gauge. When the power is switched on, the laser emission indicator on the gauge's keypad lights up, indicating the presence of Class II laser radiation.

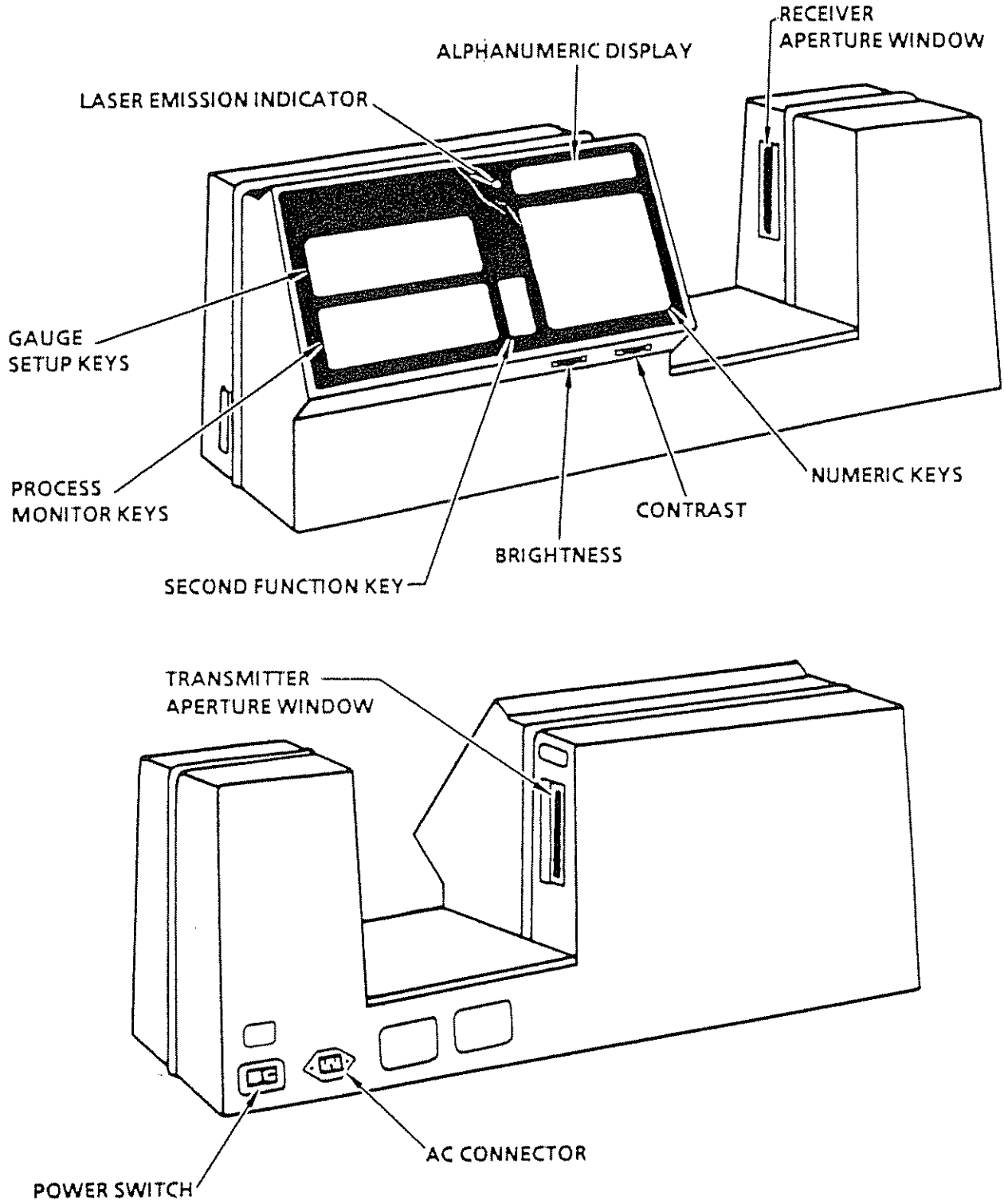
DIGITAL DISPLAY

The digital display on the gauge's keypad keeps the user informed about the gauged dimension, and the gauge's operational status.

The display consists of two main areas (Figure 5-2).At the left side of the display are seven 0.4-inch high alphanumeric digits that display the gauged dimension and statistical data. If there are no objects in the measurement region, these digits flash the last good measurement that was taken. If no measurements have been taken (such as when the gauge is first turned on), the digits flash large asterisks.

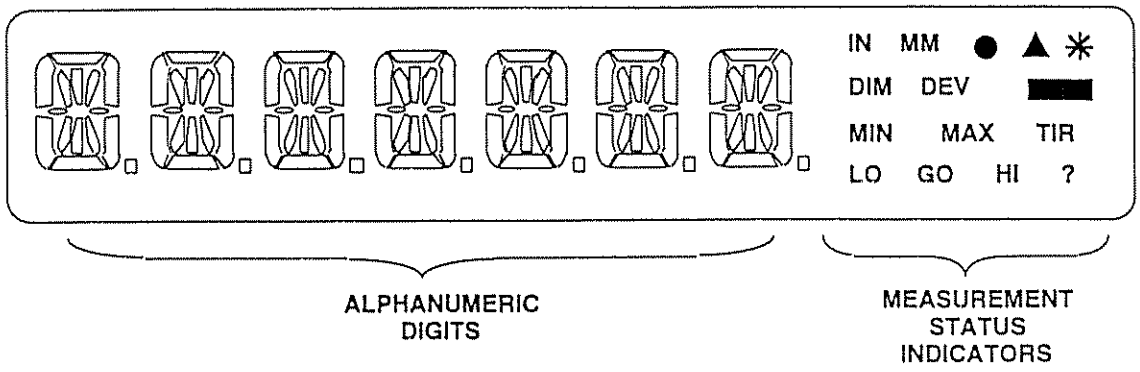
Display Controls

The digital display has controls that allow you to adjust the backlighting brightness and contrast of the display.



1200B Series Bench Gauge

Figure 5-1



Liquid Crystal Display
Figure 5-2

Backlighting Brightness - A backlighting panel, mounted behind the digital display, helps make the display visible in poorly lighted areas. The brightness of the backlighting is adjustable with a thumbwheel control located on the front of the gauge, just below the keypad area (Figure 5-1). In a fully lighted room, the backlighting is difficult to see, even when the brightness is turned all the way up.

Contrast - The digital display used in the 1200B Series is known as a liquid crystal display (LCD). One of the characteristics of this type of display is that the darkness of the digits appears to change as you look at it from different angles. The Contrast control allows you to adjust the darkness of the digits to suit your angle of view. The control is located on the front of the gauge, next to the Backlighting control (Figure 5-1).

Status Indicators

A group of status indicators are located to the right of the digits on the display (Figure 5-2). Each indicator is explained in the following paragraphs.

IN This indicator appears when the gauge is set up to display measurements in inches. If this indicator is flashing when the High Limit, Low Limit, or Nominal Value is displayed, it indicates that the value was entered in inches but the gauge is currently set up to display measurements in millimeters.

MM This indicator appears when the gauge is set up to display measurements in millimeters. If this indicator is flashing when the High Limit, Low Limit, or Nominal Value is

displayed, it indicates that the value was entered in millimeters but the gauge is currently set up to display measurements in inches.

● (dot) — The dot indicates whether the gauge is setup for Single or Continuous measurements. In the Single measurement mode, the dot appears while the gauge is taking a measurement, then it disappears. In the Continuous measurement mode, the dot stays on because measurements are taken continuously.

▲ (triangle) — The triangle indicates that the Part Mastering feature is being used.

* (asterisk) — The asterisk indicates that the gauge has detected an error condition. If the asterisk appears briefly and then disappears, an error condition has occurred but was not present long enough for an error signal (Chapter 8) to be displayed. If the asterisk stays on, an error signal is being displayed also.

DIM — This indicator appears when the gauge is set up to display the dimension of the part being measured.

DEV — This indicator appears when the gauge is set up to display the measured deviation from a nominal value.

▬ (bar) — The "bar" indicator appears briefly each time the digital display is updated. The frequency of display updates is determined by the Measurement Rate selected.

MIN — This indicator appears when the operator presses the MIN key and the minimum measurement is displayed.

MAX — This indicator appears when the operator presses the MAX key and the maximum measurement is displayed.

TIR — This indicator appears when the operator presses the TIR key and the Total Indicated Runout measurement is displayed.

LO — The abbreviation "LO" flashes when the gauged dimension is less than the preset Low Limit dimension.

GO The word "GO" appears when the gauged dimension is within the preset High and Low Limit dimensions.

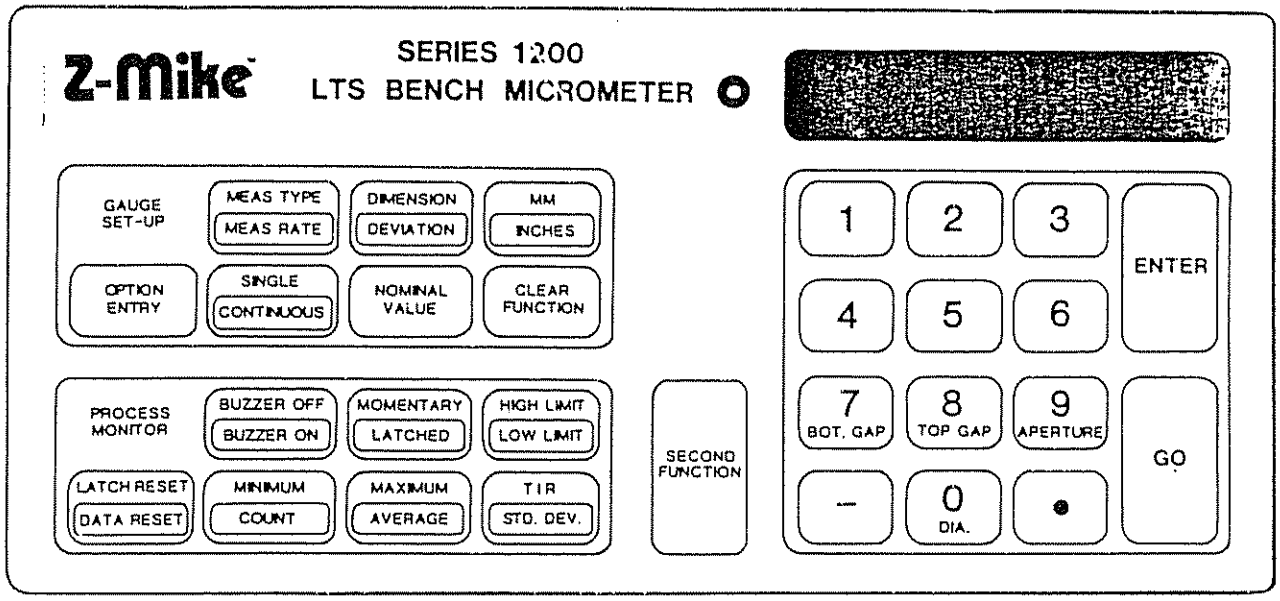
HI The abbreviation "HI" flashes when the gauged dimension exceeds the preset High Limit dimension.

? The question mark symbol appears when the user presses the wrong key. Several "beeps", in rapid succession, will be heard at the same time.

CONTROLS

All controls to operate the gauge's measurement functions are on the soft-touch keypad on the front of the unit (Figure 5-3). All of these keys have "immediate execute" functions, meaning that the function stated on the brown part of the key takes place as soon as the key is pressed. Some of the keys also have a "second function" assigned to them. If a key has a second function, it has an orange area with the function stated on it. That function of the key will only work if the SECOND FUNCTION key (large orange key in the center of the keyboard) is pressed first.

In the sections that follow, the words in **BOLD TYPE** represent keys on the keypad. Press the keys one at a time in the sequence in which they are listed. When a sequence is complete, proceed directly to any of the other GAUGE SETUP or PROCESS MONITOR functions. If none of the other functions are needed, press **GO** to return to the Dimension (or Deviation) display.



1200B Series Keypad
Figure 5-3

If you press the wrong key, you will hear several "beeps" in rapid succession. Re-check the instructions, then press the correct key. If you wish to start a key sequence over because of a mistake (or any other reason), press CLEAR FUNCTION then reenter the sequence (starting with the first key in the sequence. For example, MEAS RATE, NOMINAL VALUE, etc.).

> CAUTION: Use your finger or a soft, blunt object (such as the eraser end of a pencil) to press the keys. Never use a hard or sharp object. The keys may be damaged.

GAUGE SET-UP Keys

The following is a description of each key in the GAUGE SETUP section of the keypad. Refer to Figure 5-3.

MEAS TYPE/MEAS RATE Key - This key has two functions. MEAS TYPE is used to configure the gauge for a particular measurement setup, and MEAS RATE is used to select the number of measurements averaged for each output.

MEAS TYPE is this key's immediate execute function. The gauge measures objects that are placed in its laser scan. It will measure the diameter of a single object, the gap between an object and a reference edge, the gap between two objects, and nine other measurement configurations. The MEAS TYPE key allows you to program the gauge for the type of measurement setup that you are using.

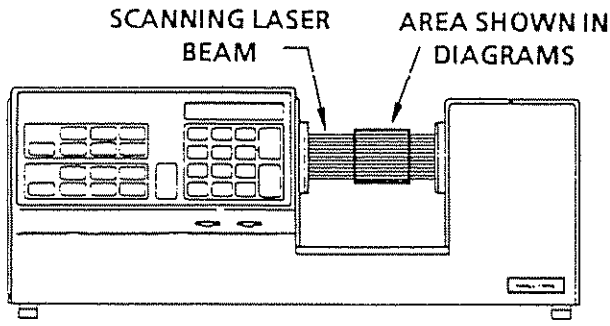
> Note: When measuring the space between two edges (Measurement Type 9), it is recommended that you "remaster" the gauge to obtain the best possible performance. Remastering is explained in Chapter 6.

Look at Figure 5-4 and determine which illustration corresponds to the measurement setup you want to use. Press the MEAS TYPE key, press the numeric key that corresponds to the desired measurement type, press ENTER, then press GO. For example, to measure diameter, press MEAS TYPE, 0, ENTER. Then press GO to display a measurement.

> Note: If using reference edges in the measurement setup (measurement types 7, 8, 9, 10, and 11), they must be positioned within the gauge's measurement area. Refer to the SPECIFICATIONS section in this manual for the location and size of the measurement area.

MEAS RATE is this key's second function. The part being measured is scanned by the laser beam 120 times per second. The MEASUREMENT RATE function defines how many of these scan measurements are averaged for each display update.

Averaging a large number of scan measurements reduces random errors to insignificant levels, thereby increasing the repeatability of the gauge. Averaging only a small number of scan measurements increases the speed (update rate) of the gauge, but degrades the repeatability.



Measurement Type 0

Measures the diameter of an object placed in the laser scan.

Measurement Type 1

Measures the diameter of the lower object when two objects are in the laser scan.

Measurement Type 2

Measures the space between the upper and lower objects.

Measurement Type 3

Measures the diameter of the upper object when two objects are in the laser scan.

Measurement Type 4

Measures the distance between the bottom edges of the two objects.

Measurement Type 5

Measures the distance between the top edges of the two objects.

Measurement Type 6

Measures the distance between the top edge of the upper object and the bottom edge of the lower object.

Measurement Type 7

Measures the space between the bottom edge of the object and the reference edge under it. (Two reference edges used.)

Measurement Type 8

Measures the space between the top edge of the object and the reference edge above it. (Two reference edges used.)

Measurement Type 9

Measures the space between the two edges in the laser scan.

Measurement Type 10

Measures the space between the top edge of the object and the reference edge above it. (Only one reference edge used.)

Measurement Type 11

Measures the space between the bottom edge of the object and the reference edge below it. (Only one reference edge used.)

Measurement Type 12

Measures the space between the bottom edge of the object and an internal reference point (below the laser scan).

Standard Measurement Types

Figure 5-4

Table 5-1 shows the nine measurement rate settings available. Also provided in this table are the number of scans that are averaged at each setting, and the resulting update rate. To program the gauge for a particular measurement rate, press **MEAS RATE**, use the numeric keys to select the corresponding Measurement Rate code (0-8), press **ENTER**, press **GO**.

"MEASUREMENT RATE" CODE	NUMBER OF SCANS AVERAGED	APPROXIMATE UPDATE RATE (per second, at 60 Hz)	APPROXIMATE UPDATE RATE (per second, at 50 Hz)
0	1024	1 per 8 sec.	1 per 10 sec.
1	512	1 per 4 sec	1 per 5 sec.
2	256	1 per 2 sec.	1 per 2.5 sec.
3	128	1	1
4	64	2	2
5	32	4	3
6	16	8	6
7	8	15	13
8	4	30	25

The "bar" indicator to the right of the measurement display appears for approximately 1/2 second each time the display is updated. When the update rate is two per second or faster (measurement rate codes 4-8), the bar is displayed continuously.

DIMENSION/DEVIATION Key - This key allows the user to choose the type of measurement information to be shown on the digital display.

DIMENSION is this key's immediate execute function. It causes the display to show the actual dimension of the part being gauged.

To select Dimension display, press **DIMENSION**. The display will show the abbreviation "DIM". Press **GO**. The display will show Dimension readings. The abbreviation "DIM" (in small letters) will appear to the right of the displayed reading indicating that it is a dimension.

DEVIATION is this key's second function. It causes the display to show the mathematical difference between the dimension of the part being measured and a preset Nominal dimension. For example, if the Nominal dimension is

set for 1.00 inch, and the actual measured dimension is 1.25 inches, the displayed deviation will be 0.25 inch.

To select Deviation display, press SECOND FUNCTION, then press DEVIATION. The abbreviation "DEV" will be displayed. Press GO. The gauge will display the measured Deviation reading. The abbreviation "DEV" will appear (in small letters) to the right of the reading, indicating that it is a deviation.

When the gauge is operating in the deviation mode, the MAXIMUM, MINIMUM, and AVERAGE functions are affected also. The AVERAGE function will display the average deviation reading, the MAXIMUM function will display the measured deviation of the maximum dimension from the nominal value, and the MINIMUM function will display the deviation of the minimum dimension from the nominal value.

NOMINAL VALUE Key - The Nominal value of a part is its specified or "ideal" dimension, and must be entered in order for the gauge to output Deviation readings. The NOMINAL VALUE key is used to display the current Nominal dimension or to enter a new Nominal dimension. This key is also used to enter the master part's dimension when utilizing the gauge's Part Mastering feature.

To use this function, press NOMINAL VALUE. The current Nominal value will be shown on the display.* If that value is acceptable, press GO to resume the measurement display. If you wish to change the Nominal, use the numeric keypad to enter the desired value (the keys pressed will appear on the display). Press ENTER to complete the entry. Press GO to resume the measurement display.

MM/INCHES Key - This key allows the user to choose the units of measure that readings will be displayed in.

MM (millimeters) is this key's immediate execute function. When pressed, it causes all readings (dimension, deviation, etc.) to be displayed in millimeters.

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* If either the "IN" or "MM" display units indicator (to right of the display) is blinking, it indicates that the value shown was not entered in the same units of measure that the gauge is currently set for.

To select MILLIMETER display units, press **MM**. The letters "MM" will be displayed. Press **GO**. The current reading will be displayed in millimeters. The letters "MM" will appear (in small letters) to the right of the reading, indicating that it is being displayed in millimeters.

INCHES is this key's second function. It allows the user to program the gauge to display all readings (dimension, deviation, etc.) in inches.

To select INCHES, press **SECOND FUNCTION**, then **INCHES**. The word "INCHES" will be displayed. Press **GO**. All readings will now be displayed in inches. The letters "IN" to the right of the reading indicate that it is being displayed in inches.

OPTION ENTRY Key - The Option Entry key is used in conjunction with the numeric keypad to: access the Part Mastering feature, the self test programs, and the purchased options; and to select the display resolution and sigma multiplier.

SINGLE/CONTINUOUS Key - This key gives the user the option of taking measurements on a continuous basis, or taking measurements one at a time, on command from the user.

SINGLE is this key's immediate execute function. It is used to instruct the gauge to take and display only one measurement each time the GO key is pressed. This feature is very useful when using the gauge's Statistical Analysis functions and when gauging individual parts. It eliminates measurement errors which may occur when a part is inserted or removed from the measurement region.

To put the gauge in the SINGLE measurement mode, press **SINGLE**. The word "SINGLE" will be displayed. Press **GO**. The display will show asterisks momentarily (while the gauge measures the part), then the reading will be shown. Nothing else will happen until the **GO** key is pressed again.

CONTINUOUS is this key's second function. It is used to instruct the gauge to take measurements and update the display continuously (without waiting for a command from the user).

To put the gauge in the CONTINUOUS measurement mode, press **SECOND FUNCTION**, then press **CONTINUOUS**. The abbreviation "CONTIN" will be displayed. Press **GO**. The current reading will be displayed. The "bar" symbol to the right of the reading will appear each time the display is updated.

CLEAR FUNCTION - This is an immediate execute key and has no second function. It is used in the event the operator does not wish to complete a numeric keystroke sequence (entering a Nominal Value, etc.). Pressing this key cancels all the keystrokes made since the beginning of the sequence. Press GO to resume measurement display, or press the desired function key (Nominal Value, High Limit, etc.) to begin the sequence again.

This key is also used to delete the most recent reading from the Statistical Analysis data base. Refer to the "STATISTICAL ANALYSIS" section of Chapter 6 for details on how to do this.

> Note: If this key is pressed at any other time, the digits on the display will disappear. Press GO to resume measurement display.

PROCESS MONITOR Keys

The following is a description of each key in the PROCESS MONITOR section of the operator keypad (Figure 5-3).

HIGH LIMIT/LOW LIMIT Key - The HIGH LIMIT/LOW LIMIT Alarm feature compares the current measurement to the maximum and minimum allowable dimensions which are preset by the user. If the current dimension exceeds the maximum allowable dimension (HIGH LIMIT), the display will indicate "HI". If the current dimension falls below the minimum allowable dimension (LOW LIMIT), the display will indicate "LO". If the current dimension is within the limits, the display will indicate "GO".

The HIGH LIMIT/LOW LIMIT key is used to display (or change) the upper and lower tolerance limits. HIGH LIMIT is the immediate execute function and LOW LIMIT is the key's second function.

To enter a HIGH LIMIT, press the HIGH LIMIT key. The current High Limit value will be shown on the display.* If no change is required, press GO to resume measurement display. If you wish to change the High Limit value,

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* If either the "IN" or "MM" display units indicator (to right of the display) is blinking, it indicates that the value shown was not entered in the same units of measure that the gauge is currently set for.

use the numeric keypad to enter a new value, then press ENTER to complete the entry. Press GO to resume measurement display.

To enter a LOW LIMIT, press SECOND FUNCTION, then the LOW LIMIT key. The current Low Limit value will be shown on the display.* If no change is required, press GO to resume measurement display. If you wish to change the Low Limit value, use the numeric keypad to enter a new value, then press ENTER to complete the entry. Press GO to resume measurement display.

Be sure to enter HIGH and LOW LIMITS in the same units of measure that the gauge is currently set for.

MOMENTARY/LATCHED Key - This key controls the function of the visual and audible alarms of the HIGH/LOW LIMIT Alarm feature. In the MOMENTARY mode, the alarms will be activated only as long as the out-of-tolerance condition exists. The LATCHED mode causes the alarms to remain activated even if the out-of- tolerance condition is no longer present.

To select the MOMENTARY mode, press the MOMENTARY key. The abbreviation "MOMENT" will be displayed. Press GO to resume measurement display.

To select the LATCHED mode, press SECOND FUNCTION, then press LATCHED. The word "LATCHED" will be shown on the display. Press GO to resume operation.

> Note: When operating in the LATCHED mode, the LATCH RESET key is used to reset (unlatch) the alarms.

BUZZER OFF/BUZZER ON Key - This key is used to enable and disable the beeping alarm of the HIGH/LOW LIMIT Alarm feature. BUZZER OFF is an immediate execute function. It disables the alarm beeper. BUZZER ON is this key's second function. It enables the alarm beeper so it will alert the operator when an out-of-tolerance condition occurs.

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* If either the "IN" or "MM" display units indicator (to right of the display) is blinking, it indicates that the value shown was not entered in the same units of measure that the gauge is currently set for.

To enable the alarm, press SECOND FUNCTION, then press BUZZER ON. The word "ON" will be displayed. Press GO to resume measurement display. To disable the alarm, press BUZZER OFF. The word "OFF" will be shown on the display. Press GO to resume measurement display.

MINIMUM/COUNT Key - This key has two functions. MINIMUM shows the smallest measured dimension, and COUNT shows the number of measurements taken

MINIMUM is this key's immediate execute function. When the gauge is operating in the DIMENSION measurement mode, pressing this key displays the Minimum dimension that was measured since the measurement cycle was started.**

You can determine the Minimum dimension observed so far by pressing MINIMUM. The display will show the reading. The abbreviation "MIN" will appear (in small letters) to the right of the main display. Press GO to resume measurement display.

> Note: When measuring individual parts, it is recommended that the SINGLE measurement mode be used in order to obtain an accurate MINIMUM reading for the batch.

COUNT is this key's second function. It keeps track of how many measurements the gauge has taken since the measurement cycle was started.* If you are operating the gauge in the SINGLE measurement mode, and each part is measured once, the COUNT reading is also the number of parts that have been measured. To display the measurement count, press SECOND FUNCTION, then press COUNT. The display will show the measurement count. Press GO to resume measurement display.

> Note: If the number of measurements (COUNT) exceeds 65,534, the word "OVERFLO" will appear on the display.

** For information on starting and stopping measurement cycles, see the description for the "DATA RESET" key.

MAXIMUM/AVERAGE Key - This key has two functions. MAXIMUM shows the largest measured dimension, and AVERAGE shows the average dimension.

MAXIMUM is this key's immediate execute function. When the gauge is operating in the DIMENSION measurement mode, pressing this key displays the Maximum dimension that was measured since the measurement cycle was started.*

To determine the Maximum dimension measured, press the MAXIMUM key. The display will show the reading. The abbreviation "MAX" will appear (in small letters) to the right of the reading. Press GO to resume measurement display.

AVERAGE is this key's second function. As each measurement is taken, it is averaged in with all of the previous measurements taken since the measurement cycle was started.** To display the AVERAGE, press SECOND FUNCTION, then press AVERAGE. The display will show the average measurement.

> Note: When measuring individual parts, it is recommended that the SINGLE measurement mode be used, in order to obtain accurate AVERAGE and MAXIMUM readings.

TIR/STD DEV Key - This key has two functions. It shows Total Indicated Runout and Standard Deviation.

TIR is this key's immediate execute function. Pressing this key displays the mathematical difference between the largest and smallest dimensions gauged since the measurement cycle was started (regardless of whether the gauge is setup to display dimension or deviation).

To determine the TIR, press the TIR key. The display will show the reading. The abbreviation "TIR" will appear (in small letters) to the right of the reading. Press GO to resume measurement display.

** For information on starting and stopping measurement cycles, see the description for the "DATA RESET' key.

STD. DEV. (Standard Deviation) is this key's second function. Standard Deviation (also known as sigma) is a statistical analysis function which gives an indication of how much variance there is between the measurements taken and the average of the measurements. The larger the Standard Deviation reading is, the more variation there is in the measurements.

The Standard Deviation reading shown on the digital display (and outputted on the RS-232C interface) is actually the product of the Standard Deviation reading and the Sigma Multiplier. The Multiplier can be any number from 1 to 9 and is entered with the Option Entry key. Refer to the "STATISTICAL ANALYSIS" section of Chapter 6 for details.

To display the Standard Deviation of a batch of parts, press **SECOND FUNCTION**, then press **STD. DEV.** The display shows the Standard Deviation of the parts measured since the measurement cycle was started.**

> Note: When measuring individual parts, it is recommended that the SINGLE measurement mode be used in order to obtain an accurate Standard Deviation reading.

The mathematical equation that the 1200B Series uses to calculate the standard deviation is:

$$\text{Standard Deviation} = \sqrt{\frac{\Sigma X_i^2 - (\Sigma X_i)^2/N}{N-1}}$$

LATCH RESET/DATA RESET Key - This key has two functions. LATCH RESET is used with the High/Low Limit Alarm feature, and DATA RESET is used with many of the Statistical Analysis features.

LATCH RESET is this key's immediate execute function. When the HIGH/LOW LIMIT Alarm is operated in the LATCH mode, the LATCH RESET key resets the audible and/or visual alarms (providing that the out-of-tolerance condition is no longer present). To reset the alarms, press **LATCH**

** For information on starting and stopping measurement cycles, see the description for the "DATA RESET" key.

RESET. The word "UNLATCH" will be displayed. Press GO to resume measurement display.

DATA RESET is this key's second function and is used to control the measurement cycles for the MAXIMUM, MINIMUM, TIR, COUNT, AVERAGE, and STANDARD DEVIATION functions. To end the current measurement cycle and simultaneously begin a new one, press SECOND FUNCTION, then DATA RESET. The word "RESET" will be displayed. Press GO to resume measurement display. (In the SINGLE measurement mode, do not press GO until the next part is in position and ready to be measured.)

Second Function

The SECOND FUNCTION key is the large, orange key located approximately in the center of the operator's keypad. It is used to enable the "second function" of the keys that have an orange area on them.

Numeric Keypad

The following is a description of the Numeric keypad section at the right side of the operator's keypad. All of the keys in this section are immediate execute functions.

0-9 and Decimal Point - The 0-9 and decimal keys are used for numeric entry of NOMINAL VALUE, HIGH LIMIT, LOW LIMIT, MEASUREMENT RATE, MEASUREMENT TYPE, and OPTION ENTRY.

- (minus sign) - The minus sign is used to enter a negative number.

ENTER - The ENTER key is used to complete a numeric entry such as the parameter of a function (Measurement Rate, Measurement Type, Option Entry) or a dimensional value (High Limit, Low Limit, Nominal Value). It specifies that the number(s) keyed in should replace the current value.

GO - GO is an immediate execute function which is used to resume the Dimension (or Deviation) display after using one of the other keys on the GAUGE SETUP or PROCESS MONITOR sections of the keypad. It is also used to initiate a measurement when in the SINGLE measurement mode.

Chapter 6
OPERATION

Before using the step-by-step setup and operation procedures in this section, read Chapter 5 of this manual to become familiar with the gauge's controls.

SETUP PROCEDURE

1. POWER UP - Remove all objects from the measurement region and make sure both of the laser attenuator shutters are open. Turn the unit on with the power switch on the rear of the unit. There will be a brief delay (accompanied by a beep) while the gauge performs a self test on its circuitry. If all the test results are good, "ZYGO" will appear on the digital display.

   If the gauge's circuitry fails one or more of the tests, a "FAIL" message will be shown on the display (approximately 5 seconds for each test that was failed) and the gauge will "beep". In this case, "ZYGO" will not appear on the display. Contact the Z-Mike Service Department for assistance.

   Press the GO key to enable the measurement display. Since there are no objects in the measurement region, the display will be flashing six large "asterisks".

2. SELECT A MEASUREMENT TYPE - Press the **MEAS TYPE** key. The number that appears on the display represents the measurement type for which the gauge is currently programmed. If the measurement type shown is acceptable, proceed to the next step. If you want to change the measurement type, press the key on the numeric keypad that corresponds to the desired measurement type, then press **ENTER**.

3. SELECT A MEASUREMENT RATE - Press the **SECOND FUNCTION** key, then press the **MEAS RATE** key. The number that appears on the display corresponds the measurement rate for which the gauge is currently set.

   If the measurement rate shown is acceptable, proceed to the next step. If you want to change the measurement rate, press the key on the numeric keypad that corresponds to the measurement rate desired, then press **ENTER**.

4. SELECT UNITS OF MEASURE - To determine the units of measure that the gauge is currently set up for, look at the display. The abbreviation "IN" (inches) or "MM" (millimeters) will be shown at the right side of the display.

   If the units of measure shown are acceptable, proceed to Step 5. If you want to change the units of measure, press the MM key to select millimeters or press SECOND FUNCTION, then INCHES to select inches. If you select inches, the display will show "IN" in large letters. If you select millimeters, the dis play will show "MM" in large letters. Proceed to Step 5 after you make your selection.

5. SELECT DIMENSION or DEVIATION - To the right of the flashing asterisks, the display will show the abbreviation "DIM" or "DEV" (in small characters).

   If you want to display Dimension: Look at the display. If it says "DIM", the gauge is already setup to display dimensions. Proceed to Step 7. If, however, it says "DEV", press the DIMENSION key. The display will show the abbreviation "DIM" in large letters. Press GO, then proceed to Step 7.

   If you want to display Deviation: Look at the display. If it says "DEV", the gauge is already setup for Deviation display, proceed to Step 6 to set a Nominal dimension. If it says "DIM", press SECOND FUNCTION, then press DEVIATION. The display will show the abbreviation "DEV" in large letters. Proceed to Step 6 to set a Nominal dimension.

6. ENTER A NOMINAL VALUE - In order to display the measured DEVIATION from a nominal dimension, a nominal value must be entered. Press the NOMINAL VALUE key, the display will show the current Nominal value. If the displayed Nominal is acceptable, proceed to Step 7. To change the NOMINAL VALUE, use the numeric keypad to enter a new number. The numbers will appear on the display as the numeric keys are pressed. Press the ENTER key to complete the entry.

   Note: Make sure you enter the Nominal value in the same units of measure that the gauge is currently set for.

7. SELECT SINGLE or CONTINUOUS MEASUREMENTS - If you want the gauge to take SINGLE measurements, press the **SINGLE** key. The word "SINGLE" will appear on the display.

   If you want the gauge to take CONTINUOUS measurements, press the **SECOND FUNCTION** key, then press the **CONTINUOUS** key. The abbreviation "CONTIN" will appear on the display.

8. SELECT THE DISPLAY RESOLUTION - The gauge's digital display has a maximum resolution of five digits to the right of the decimal point (0.00001 inch). If your situation doesn't require this degree of resolution, you can configure the gauge to round off the reading to four digits of resolution, or even three. Press **OPTION ENTRY, <number of digits>, ENTER**. The <number of digits> can be 3, 4, or 5.

   > Note: Accidentally pressing 6 as the <number of digits> causes the gauge to stop outputting measurements on the RS-232C interface. Press **OPTION ENTRY, 7, ENTER** to resume measurement output.

If the gauge is configured to measure in millimeters, the display resolution will be one less than the <number of digits> entry. For example, pressing **OPTION ENTRY, 4, ENTER** causes the display to be rounded off to three digits of resolution (0.001 mm).

> Note: The selectable resolution feature applies only to the dimension readings shown on the gauge's display. Deviation, maximum, minimum, TIR, standard deviation, average, and all readings (including dimension) output on the RS-232C interface have the maximum resolution.

9. MEASURE - This completes the basic setup procedure for the gauge. Place the object that you want to measure in the measurement region. Press **GO**. The gauge will start taking measurements in the modes of operation you have selected. As you gain experience with the unit, you can modify this setup procedure, or skip over some of the steps to suit individual needs.

The gauge has a special type of memory that isn't erased when you turn off the gauge or unplug it. This means that you don't have to perform the setup

steps when you turn it on again (unless you want to change something). The settings that were in effect when the gauge was turned off are implemented automatically.

The sections that follow describe the use of the HIGH/LOW LIMIT Alarm feature, the MAXIMUM/MINIMUM/TIR Signal Retention functions, and the Statistical Data Analysis functions.

HIGH/LOW LIMIT ALARM FEATURE

The HIGH/LOW LIMIT Alarm feature activates audible and/or visible alarms when the current gauge dimension exceeds the allowable oversize or undersize part dimensions (HIGH and LOW LIMITS) which are preset by the operator.

1. ENTER A HIGH LIMIT - To set the HIGH LIMIT, press the **HIGH LIMIT** key. The display will show the current High Limit dimension. If no change is required, proceed to Step 2 to set the LOW LIMIT. If you want to change the HIGH LIMIT, use the numeric keys to enter a new value, then press **ENTER**. Either press **GO** to resume measurement display, or proceed to the next step.

2. ENTER A LOW LIMIT - To set the LOW LIMIT, press **SECOND FUNCTION**, then press **LOW LIMIT**. The display will show the current Low Limit dimension. If no change is required, proceed to the next step. If you want to change the LOW LIMIT, use the numeric keys to enter a new value, then press **ENTER**. Either press **GO** to resume measurement display, or proceed to the next step.

   Note: When setting the HIGH and LOW LIMITS, be sure to enter them in the same units of measure that the gauge is currently operating in. For example, if the gauge is operating in INCHES, enter 1.000 instead of 25.4 (mm).

3. SELECT BUZZER ON or BUZZER OFF - If you want an audible alarm to sound when an out-of-tolerance condition occurs, press **SECOND FUNCTION** then press **BUZZER ON**. The word "ON" will appear on the display. To keep the audible alarm silent, press the **BUZZER OFF** key. The word "OFF" will appear on the display. Either press **GO** to resume measurement display, or proceed to the next step.

4. SELECT LATCHED or MOMENTARY ALARMS - The LATCHED mode causes the audible and/or visual alarms to remain activated even after the out-of-tolerance condition is no longer present. To set the alarms in the LATCHED mode, press SECOND FUNCTION, then press LATCHED. The word "LATCHED" will appear on the display. Press GO to resume measurement display. To reset the alarms after the out-of-tolerance condition has passed, press LATCH RESET. The display will read "UNLATCHED". Press GO to resume measurement display.

   If you want the alarms to remain activated only as long as the out-of-tolerance condition exists, press MOMENTARY. The abbreviation "MOMENT" will appear. Press GO to resume measurement display.

5. DISABLING THE HIGH/LOW LIMIT ALARM FEATURE - If you do not want to use the HIGH/LOW LIMIT Alarms at all, enter 0.0000 for the LOW LIMIT, and enter 2.0000 (in inches) or 46.0000 (in millimeters) for the upper tolerance limit. This way, all gauged dimensions will be "in-tolerance", and the "GO" indicator (on the right side of the display) will remain on.

MAXIMUM/MINIMUM/TIR SIGNAL RETENTION FEATURE

1. To use the MAXIMUM/MINIMUM/T.I.R Signal Retention feature, press DATA RESET then proceed to gauge the batch of parts. To display the MAXIMUM measurement observed so far, press MAXIMUM. To display the Minimum measurement observed so far, press MINIMUM. To display the mathematical difference between the largest and smallest dimensions observed so far, press TIR. You can display the MAXIMUM, MINIMUM, and TIR readings as often as you wish, without disrupting the measurement cycle. Press DATA RESET when you want to restart the measurement cycle.

   Note: Use the SINGLE measurement mode when measuring a batch of individual parts.

STATISTICAL ANALYSIS

COUNT - To use the gauge's COUNT function, do the following. Reset the gauge's statistical functions by pressing SECOND FUNCTION then DATA RESET. Proceed to gauge the batch of parts in the usual manner. Display the

number of measurements taken so far (since DATA RESET) by pressing SECOND FUNCTION then COUNT. Press GO to resume measurement display, or reset the statistical functions to start a new measurement count (from zero).

> Note: The COUNT function keeps track of how many actual measurements have been taken since the last DATA RESET. If the gauge is used in the SINGLE measurement mode and each part is measured once, the number of measurements taken (COUNT) will equal the number of parts measured.

AVERAGE - To use the AVERAGE function, do the following. Reset the gauge's statistical functions by pressing SECOND FUNCTION then DATA RESET. Proceed to gauge the batch of parts in the usual manner. Display the average measurement of the parts gauged so far (since DATA RESET) by pressing SECOND FUNCTION then AVERAGE. Press GO to resume measurement display (and averaging), or reset the statistical functions again to start a new averaging cycle.

> Note: To obtain a significant AVERAGE reading, use the SINGLE measurement mode when measuring individual parts.

STANDARD DEVIATION - To use the gauge's Standard Deviation function, do the following:

1. Enter the Sigma Multiplier by pressing OPTION ENTRY, 3, <multiplier>, ENTER. The <multiplier> may be any number from 1 to 9. For example, if you want the Sigma Multiplier to be 4, press OPTION ENTRY, 34, ENTER.

2. Reset the gauge's statistical analysis functions by pressing SECOND FUNCTION then DATA RESET. Proceed to gauge the batch of parts in the usual manner. Display the standard deviation of the parts gauged so far (since DATA RESET) by pressing SECOND FUNCTION, then STANDARD DEVIATION. Press GO to resume measurement display, or reset the statistical analysis functions again to begin a new batch of parts.

Note: To obtain a meaningful STANDARD DEVIATION reading, use the SINGLE mode when measuring individual parts.

DELETE LAST READING - When using the Statistical Analysis functions, the gauge stores all the readings in a data base, and then analyzes them when you press the one of the Statistical Analysis keys (Count, Average, or Standard Deviation). If you get a bad reading while measuring a batch of parts, the DELETE LAST READING function allows you to remove the bad reading from the data base.

To delete the last reading from the Statistical Analysis data base, press the CLEAR FUNCTION key once.

REMASTERING FEATURE

The Remastering feature allows the user to remaster the gauge by offsetting the readings so that they correspond to the user's measurement standard. There are two types of remastering: Single Point and Dual Point.

The Single Point Remastering feature is most useful when you have a single "master" part to which you would like to compare the manufactured parts.

The Dual Point Remastering feature is used when you want to remaster the gauge using two calibrated gauge pins. Because the gauge is recalibrated over the entire measurement range (not just a single point), manufactured parts of various sizes can be measured accurately.

Single Point Remastering

The procedure is simple. It involves placing a master part of known dimension in the gauging fixture, and then entering the part's dimension into the gauge using the numeric keypad. The gauge determines the difference between the measured dimension and the dimension that was entered, then offsets all subsequent readings by that amount. As a result, the gauge is remastered using the master part as a reference. The gauge stays remastered (even if you turn it off) until you return it to the original factory calibration (as described later).

Use the following procedure to remaster the gauge using a master part as a reference:

1. Press SECOND FUNCTION, MEAS RATE, 0, ENTER. At this setting, the gauge averages 1024 scans per display update (provides greater accuracy).

2. Press MEAS TYPE, 0, ENTER. At this setting, the gauge measures the diameter of objects placed on the V-block.

3. Press DIMENSION, then press SINGLE. This configures the gauge to take a measurement whenever the GO button is pressed and to display the measured dimension. Place the master part in the gauging fixture and press GO. A measurement should be displayed after approximately 10 seconds.

4. Enable the gauge's special features by pressing OPTION ENTRY, 20, ENTER.

5. Enter the master part's dimension as if it were a nominal value. Example: If the master part's dimension is 0.50000, press NOMINAL VALUE, .50000, then press ENTER.

6. Press GO. (You may proceed to Step 7 without waiting for the measurement to appear.)

7. Select the Single Point Remastering feature by pressing OPTION ENTRY, 24, ENTER. Six large asterisks are displayed for approximately 10 seconds, and then a measurement is displayed. Verify that the display reads 0.50000 when the master part is measured. The triangle on the right side of the display indicates that the gauge is remastered.

8. Return the gauge to the normal update rate. Example: Press SECOND FUNCTION, MEAS RATE, 3, ENTER. You can also return the gauge to continuous measurements if so desired.

The gauge will remain "remastered" until it is returned to the original factory calibration.

Dual Point Remastering Feature

The Dual Point Remastering Feature is similar in concept to the Single Point Remastering feature described previously. It allows you to remaster the gauge to correspond to your own measurement standards.

Two calibrated test pieces are used as reference points to calculate the offset and slope of the correction factor. To achieve the greatest accuracy, the

diameters of the two test pieces should be as far apart as possible. One piece should be close to the upper limit of the gauge's range, and the other piece should be close to the lower limit of the gauge's range.

First, the larger piece is placed in the V-block and its diameter is entered as the nominal value. This piece is measured, and the gauge calculates the difference between the measured diameter and the diameter entered as the nominal value. This procedure is repeated with the smaller test piece. The gauge uses the two known diameters as reference points to determine the correction factor, and then implements it.

The gauge stays remastered (even if you turn it off) until you return it to the original factory calibration. Once it is returned to the factory calibration, the previous remastering correction factor is erased.

Use the following procedure to remaster the gauge using two calibrated test pieces for reference.

1. Press SECOND FUNCTION, MEAS RATE, 0, ENTER. At this setting, the gauge averages 1024 scans per display update (provides greater accuracy).
2. Press MEAS TYPE, 0, ENTER. At this setting, the gauge measures the diameter of objects placed on the V-block.
3. Press DIMENSION, then press SINGLE. This configures the gauge to take a measurement whenever the GO button is pressed and to display the measured dimension.
4. Press OPTION ENTRY, 20, ENTER. This enables the gauge's special features and allows you to access the gauge's Dual Point Remastering Feature.
5. Put the larger test piece in the V-block, and then enter its diameter as the nominal dimension. Example: If the test piece is 1.000 inch, press NOMINAL VALUE, 1.000, ENTER.
6. Press the GO button and wait for the measurement to appear on the display (about 10 seconds).
7. Press OPTION ENTRY, 26, ENTER and wait for the measurement to appear on the display (about 10 seconds).

Note: Do not be alarmed if the measurement on the display is incorrect. The remastering does not take effect until the entire procedure is completed.

8. Remove the larger test piece from the V-block and replace it with the smaller test piece. Enter the smaller test piece's diameter as the nominal dimension. Example: If the smaller test piece is 0.06250 inch, press NOMINAL VALUE, .06250, ENTER.

9. Press GO and wait for the measurement to appear on the display (about 10 seconds).

10. Press OPTION ENTRY, 26, ENTER. Wait for the measurement to appear on the display (about 10 seconds).

11. You should see a triangle ▲ on the right side of the display. The triangle indicates that the gauge is remastered. You can verify that the gauge is remasterd by placing the large and small test pieces in the V-block and measuring them.

Returning To The Original Calibration

The following procedure will return the gauge to the original factory calibration.

1. Enable the gauge's special features by pressing OPTION ENTRY, 20, ENTER.

2. Return to the original factory calibration by pressing OPTION ENTRY, 25, ENTER. Note that the triangle indicator ▲ is no longer displayed.

Z-Mike DIVISION OF LaserMike, Inc. SPECIAL INSTRUCTION

This Special Instruction provides supplementary information for the special feature(s) incorporated in a Z-Mike product. Please refer to the basic product manual(s) for general information on installation, operation, and maintenance.

SI-0290 July, 1987

1200 SERIES SOFTWARE ENHANCEMENTS

This Special Instruction explains recent additions to the 1200 Series software that are not explained in the 1200 Series Operation Manual (OMP-0205). These enhancements are summarized below:

1. The gauge now has a "Send" function which transmits measurements over the RS-232C interface only when you want them to be, even when using the "continuous" mode.

2. The new "Floating Nominal" function allows you to implement the current measured dimension as the new Nominal dimension by pressing a single key.

3. The new Measurement Type 13 allows you to measure the space between the top edge of the object and an internal reference point (above the laser scan).

4. The feature known as "Option 6", which was used primarily with the Zygo Gagetalker, has been eliminated. The task that it performed can be accomplished with the new "Send" function.

THE "SEND" FUNCTION

The Send function is useful when you want to send only selected measurements over the RS-232C interface. For example, if you are using the gauge in the continuous mode to measure parts, but you don't want to use up reams of paper printing out every single measurement, you can configure the gauge so that a measurement will be printed only when you press the decimal point (.) key.

To configure the Send function, do the following:

1. Enable the option slot that the RS-232C Interface option is in. For example, if the option is in slot 1, press:

   OPTION ENTRY 1 ENTER

2. Select the "Echo Console" mode of operation by pressing:

   OPTION ENTRY 2 3 2 ENTER

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Telephone 203-635-2100 Fax 203-635-8666

3. Enable the Send function by pressing:

OPTION ENTRY 4 0 ENTER

4. Each time you want to transmit a measurement over the interface, press the decimal point key (.) on the numeric keypad. Whatever reading is shown on the digital display will be transmitted over the interface (including MAX, MIN, etc.).

5. To disable the Send function, press:

OPTION ENTRY 4 2 ENTER

The Send function is also disabled whenever the gauge is turned off.

Using the Send function with the Gagetalker

When using the Gagetalker with the 1200, it is necessary to transmit the gauge's current Nominal dimension, HI Limit, and LO Limit values over the RS-232C Interface. To do this, use the following procedure.

1. If the Send function has been enabled, disable it (so that the decimal point key will operate normally) by pressing:

OPTION ENTRY 4 2 ENTER

2. Set the Nominal dimension the way you normally would (as explained in the 1200 Series Operation Manual, OMP-0205).

3. Enable the option slot that the RS-232C Interface option is in. For example, if the option is in slot 1, press:

OPTION ENTRY 1 ENTER

4. Disable the dimension "labels" by pressing:

OPTION ENTRY 2 1 0 ENTER

5. Select the "Echo Console" mode of operation by pressing:

OPTION ENTRY 2 3 2 ENTER

6. Enable the Send function by pressing:

OPTION ENTRY 4 0 ENTER

7. Press the key that corresponds to the value that you want to transmit. For example, to send the Nominal dimension, press:

NOMINAL ENTER

The value will be transmitted when the ENTER key is pressed.

FLOATING NOMINAL

The Floating Nominal function allows you to enter the current displayed dimension as the Nominal dimension with a single keystroke. For example, if the displayed dimension is 1.5002, pressing the minus sign key (-) enters 1.5002 as the Nominal dimension.

The following explains how to use the Floating Nominal function:

1. Enable the Floating Nominal function by pressing:

   OPTION ENTRY 4 1 ENTER

2. Place an object in the measurement area and measure it.

3. When you want to enter the displayed dimension as the Nominal dimenion, press the minus sign key (-).

   Note: If the Send function is enabled when using the Floating Nominal function, pressing the minus sign key also transmits the Nominal dimension over the RS-232C interface.

4. To verify that the dimension was implemented as the Nominal, press the NOMINAL key. The value that appears on the display is the new Nominal dimension.

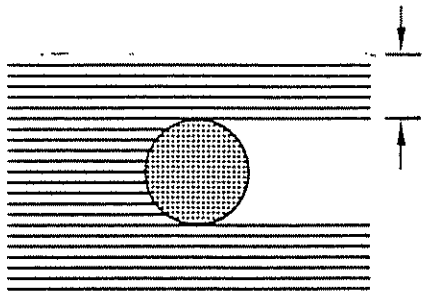
5. To disable the Floating Nominal function, press:

   OPTION ENTRY 4 2 ENTER

   The Floating Nominal function is also disabled whenever the gauge is turned off.

MEASUREMENT TYPE 13

A new Measurement Type has been added. It is used to measure the space between the top edge of the object and an internal reference point (above the laser scan). A diagram of Measurement Type 13 is shown in Figure 1.



Measurement Type 13

Figure 1

Chapter 7
OPERATION DEMONSTRATIONS

This section gives a step-by-step operational demonstration of the HIGH/LOW LIMIT Alarm feature and the MAXIMUM/MINIMUM/TIR Signal Retention feature.

HIGH/LOW LIMIT ALARM DEMONSTRATION

The HIGH/LOW LIMIT Alarm feature compares the current gauged dimension to the maximum and minimum allowable dimensions that the user has entered into the gauge's HIGH LIMIT and LOW LIMIT memory.

The following step-by-step procedure will demonstrate the functions of the HIGH/ LOW LIMIT Alarm feature. Use the setup procedure outlined earlier in this section to enter the following parameters: MEAS TYPE = 0 (diameter), MEAS RATE = 3 (1 update/sec), INCH units, DIMENSION display, CONTINUOUS measurements, BUZZER OFF, and MOMENTARY. In normal operation, you can use whatever parameters are desired; those listed here are just for demonstration purposes.

Also, obtain three objects to use as test samples. This demonstration will be using test samples of approximately 0.250 inch, 0.500 inch, and 1.000 inch. You can use any sizes you wish, but the dimensions that you enter for the HIGH and LOW LIMITS during this demonstration must be adjusted accordingly.

1. Place the 0.500-inch test sample in the measurement region, then press **GO**. The display will show the size of the test sample.
2. Press **HIGH LIMIT**. The display will show the current High Limit dimension. Use the numeric keypad to enter .750. Press **ENTER** to complete the entry.
3. Press **SECOND FUNCTION**, then press **LOW LIMIT**. The display will show the current Low Limit dimension. Use the numeric keypad to enter .400. Press **ENTER** to complete the entry.
4. Press **GO**. If the 0.500-inch sample is in the measurement region, the word "GO" will appear (in small letters) at the right side of the display,

indicating that the sample being measured is within the upper and lower tolerance limits.

5. Remove the 0.500-inch sample and replace it with the 0.250- inch sample. The word "LO" will be flashing (in small letters) at the right side of the display, indicating that the sample being measured is smaller than the Low Limit that was entered.

6. Remove the 0.250-inch sample and replace it with the 1.000- inch sample. The word "HI" will be flashing (in small letters) at the right side of the display, indicating that the sample being measured is larger than the High Limit that was entered.

7. Remove the 1.000-inch sample and place the 0.500-inch sample in the measurement region again. The word "GO" will appear again.

Audible Alarm

1. Press SECOND FUNCTION, then press BUZZER ON. The word "ON" will appear. Repeat the demonstration (Steps 1-7) described above. Each time an out-of-tolerance condition occurs, (when the words "LO" or "HI" flash) a "beeping" sound will be heard. The sound will stop when the word "GO" appears again (out-of- tolerance condition is no longer present). To disable the audible alarm, press BUZZER OFF. The word "OFF" will appear. Press GO to resume measurement display.

LATCH Mode

In some situations, it may be desirable to have the audible and visible alarms remain on (once they are activated) even if the sample being gauged is no longer exceeding the High or Low Limits.

To demonstrate this function, press SECOND FUNCTION, then LATCHED. The display will show the word "LATCH". Leave all other settings as they were in the previous example (the buzzer may be on or off).

1. Place the 0.250-inch sample in the measurement region. The word "LO" will flash. Replace the 0.250-inch sample with the 0.500-inch sample. The word "LO" will continue to flash, even though the part now being measured is within the tolerance limits. Press LATCH RESET. The display will show the word "UNLATCH" and the word "GO" will appear (in

small letters) at the right of the display. Press GO to resume measurement display.

2. Place the 1.000-inch sample in the measurement region. The word "HI" will flash. Replace the 1.000-inch sample with the 0.500-inch sample. The word "HI" will continue to flash even though the part now being measured is within the tolerance limits. Press LATCH RESET. The display will show the word "UNLATCH" and the word "GO" will appear (in small letters) at the right of the display. Press GO to resume measurement display.

MAXIMUM/MINIMUM/TIR SIGNAL RETENTION DEMONSTRATION

The following is a step-by-step demonstration of the MAXIMUM/MINIMUM/TIR Signal Retention feature. This feature will keep track of the Maximum and Minimum measurements observed since the measurement cycle was started.

Maximum/Minimum Dimension

When the gauge is operating in the Dimension display mode, this feature will keep track of Maximum and Minimum dimensions that are measured.

1. Start by setting up the gauge with the following parameters: MEAS TYPE = 0 (Diameter), MEAS RATE = 3 (1 update/sec), INCH units, DIMENSION display, and CONTINUOUS measurements. Press GO.

2. Obtain a tapered part that has a diameter of approximately 0.750 inch (or larger) at one end and tapers to 0.250 inch (or less) at the other. (One can easily be made from a piece of cardboard.) Insert the part in the measurement region and position it so that the Dimension display shows approximately 0.500 inch. Press SECOND FUNCTION, then DATA RESET. The display will show the word "RESET". Press GO. Move the tapered part until the Dimension display shows approximately 0.750 inch, then move it the other way until the display shows approximately 0.250 inch. Move the part back to its original position (0.500 inch).

3. Press MAXIMUM, the display will show the largest dimension that was measured (approximately 0.750 inch) and the word "MAX" will appear to the right of the display. Press MINIMUM, the display will show the

smallest dimension that was measured (approximately 0.250 inch) and the word "MIN" will appear to the right of the display.

Press TIR, the display will show the mathematical difference between the largest and smallest dimensions that were measured (approximately 0.500 inch in this example) and the letters "TIR" will appear to the right of the display.

4. Press SECOND FUNCTION, then DATA RESET. The display will read "RESET".

The MAXIMUM and MINIMUM functions are reset to the current gauged dimension, and the TIR function resets to zero. You can verify this by pressing each of the function keys as in Step 3.

Chapter 8
RS-232C INTERFACE

INTRODUCTION

The 1200B Bench Gauge's RS-232C interface provide a means for it to communicate with other types of computer equipment such as terminals, computers, and digital printers. This type of interface is a well-established industry standard for communication; therefore, your gauge should be able to communicate with just about any device that has an RS-232C interface.

The RS-232C Interface Option outputs, in Serial ASCII, either the gauged Dimension, the Deviation from the preset Nominal Dimension, or an echo of the values shown on the display. (Error codes are not output (except NO DATA and OVERFLO.)

The Nonstandard Standard

Even though RS-232C is a standard interface with defined specifications, almost every manufacturer modifies it, to some extent, when implementing it into his own products. Some use all of the available "handshaking" control lines, others use some of them, and still others use only the transmit, receive, and ground lines. For this reason, you should compare the information in these instructions to the related information for the device that you want the gauge to communicate with. If you need more information about the "ins and outs" of the RS-232C interface standard, a number of textbooks are available on this subject.

OPTION CODES

The RS-232C interface is configured for operation by a set of commands called "option codes". They are entered into the gauge with the Option Entry key on the gauge's keypad. The general format is as follows:

OPTION ENTRY <option code> ENTER

Following, is a listing of the option codes and a brief description of the function that each performs. Note that the last item under most of the headings starts with "Display . . ."

Perform Diagnostics - These functions perform some basic diagnostic tests.

200	echo input to output
201	output test pattern

Set Format - Sets the format of the values output on the interface. The value may be accompanied by annunciators that show the type of value (DIM, DEV, and so on) and the units of measure.

*210	(VALUE)
211	(TYPE OF VALUE)(SPACE)(VALUE)(SPACE)(UNITS)
212	(TYPE OF VALUE)(,)(VALUE)(,)(UNITS)
213	Display Format Option Code

Set Terminator - Sets the type of terminator that follows each value.

220	Carriage return only
*221	Carriage return linefeed
222	Display Terminator Option Code

Set Output - Determines what type of value will be output on the interface. It can be set to be always dimension, always deviation, or an echo of what is shown on the built-in display.

*230	Dimension
231	Deviation
232	Echo display**
233	Display output Option Code

Set Checksum - Determines whether the value will be followed by a checksum value (to verify accurate data transmission).

*240	No checksums
241	Checksums
242	Display Checksum Option Code

Set Handshake - Determines the mode of operation for the interface. The choices are explained later in this chapter.

*245	"Terminal"
246	"? - single"
247	"? - continuous"
248	Display Handshake

*Default setting.

Set Baud Rate - Sets the baud rate for the interface. If you change the baud rate, the new setting does not take affect until the gauge is turned off and turned on again.

250	110
251	150
252	300
253	600
*254	1200
255	2400
256	4800
257	9600
258	Display Baud Rate Option Code

Set Number of Stop Bits - Sets the number of stop bits per data transmission. If you change the stop bits setting, the new setting does not take affect until the gauge is turned off and turned on again.

*260	1 Stop Bit
261	2 Stop Bits
262	Display Stop Bits Option Code

Set Parity - Determines whether the parity bit is included with the transmission. If you change the parity setting, the new setting does not take affect until the gauge is turned off and turned on again.

265	Even
266	Odd
*267	None
268	Display Parity Option Code

Set Number of Data Bits - Sets the number of data bits used in data transmission. If you change the data bits setting, the new setting does not take affect until the gauge is turned off and turned on again.

270	7
*271	8
272	Display Data Bits Option Code

Set Wait Configuration - Determines whether or not the gauge will wait until the receiving device to echo the transmission before sending the next character.

*280	Don't Wait
281	Wait for Echo before sending next character
282	Display Wait Configuration Option Code

HANDSHAKE

There are three modes for the output of data from the 1200: Terminal, "?"-Single, and "?"-Continuous.

Terminal Mode (Code 245)

In this mode, the gauge transmits each measurement as soon as it is taken. If the receiving device sends an <XOF> or <NAK> the gauge will stop transmitting characters until the receiving device sends an <XON> or <ACK>.

Data transmission can also be controlled with the DTR line (pin 20). If the receiving device pulls the DTR line low, the gauge will stop transmitting data until the DTR line is released.

"?" Mode

The "?" mode is so named because the gauge will not output any values until it receives a "?" on the interface. This mode can be used in either of two ways, single or continuous.

"Single" (Code 246) - The gauge waits for a ? from the computer. The gauge then performs a GO function and sends the next measurement. If no measurement is ready within 15 seconds, a "NOT VALID" message is sent. In order to operate properly, the gauge should also be in the Single Measurement mode.

"Continuous" (Code 247) - The gauge waits for a ? from the computer. If a measurement is ready it is sent, otherwise a "NOT VALID" message is sent.

The gauge can be in either single or continuous mode.

> Note: The "NOT VALID" message will appear differently depending on the "Format" code selected. For example:

If Code 210 is selected, the output will be 9999.99.

If Code 211 is selected, the output will be NOT 9999.99 VALID.

If Code 212 is selected, the output will be NOT,9999.99,VALID.

SPECIAL MESSAGES

If the gauge is operating in the "Echo Display" mode (232) the error messages "NO DATA" and "OVERFLO" will appear in different formats depending on the "Format" code selected. For example:

If Code 210 is selected, NO DATA will be output as 8888.88 and OVERFLO will be output as 7777.77.

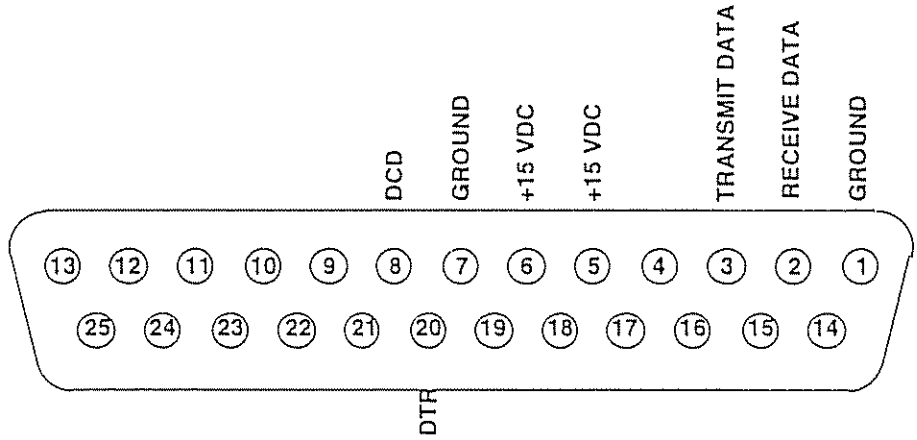
If Code 211 is selected, NO DATA will be output as NO 8888.88 DATA and OVERFLO will be output as OVER 7777.77 FLOW.

If Code 212 is selected, NO DATA will be output as NO,8888.88,DATA and OVERFLO will be output as OVER,7777.77,FLOW.

INTERFACE

The 1200 Series gauges are configured as Data Communication equipment (DCE). Data is transmitted on pin 3 and received on pin 2. If a 3-line handshake is used (Transmit, Receive, and Ground), the DTR line must be held high (+3 to +15 VDC) for the gauge to receive the question mark ? (Computer mode) or transmit data (Computer and Terminal mode). A convenient voltage source for this can be found on pin 5 or 6 as shown below.

> Note: If using the voltage on pin 5 or 6, use a pull-up resistor (470Ω - 1000Ω) in series to protect the gauge's power supply.



RS-232C Connector Pin Identification
Figure 1

Chapter 9
OPERATING YOUR GAUGE WITH A COMPUTER

The RS-232C Interface feature allows you to control your gauge with a terminal or computer. Almost any function that can be performed from the keypad can also be performed with commands from a computer, opening up numerous possibilities for automatic measurement and data gathering.

With a computer, you can program your gauge to output the type of information you need without having to enter each command on the keypad. You can also program the computer to manipulate the data in numerous ways.

This chapter provides information about the commands that you can use to control the gauge with a computer or terminal, and provides examples of command sequences that could be sent from such a device. However, you will also need to consult the manuals that came with your computer and its software to learn about the actual programming.

For information about configuring the RS-232C interface itself, refer to Chapter 8 of this manual, "RS-232C Interface".

COMMANDS

Table 9-1 lists all of the valid commands that may be used, the name of the corresponding key on the Remote Keypad, and the format that must be used when sending the command (syntax).

Any command that you enter will be executed only after you send a carriage return. The commands marked with an asterisk in Table 9-1 automatically activate the "GO" function when they are received. This is done to clear the command processor state and prevent an undefined state for the RS-232C command input. An undefined state is one in which a "GO" or other command could not be issued from the RS-232C port, but would have to be entered from the Remote Keypad.

COMMAND	CORRESPONDING KEY ON KEYPAD	SYNTAX
MT*	MEAS TYPE	MT <0-13> <cr>
MR*	MEAS RATE	MR <0-10> <cr>
NM	NOMINAL VALUE	NM <1.23456> <cr>
HI	HIGH LIMIT	HI <1.23456> <cr>
LO	LOW LIMIT	LO <1.23456> <cr>
IN	INCHES	IN <cr>
MM	MM (MILLIMETERS)	MM <cr>
DM	DIMENSION	DM <cr>
DV	DEVIATION	DV <cr>
GO	GO	GO <cr>
OP*	OPTION ENTRY	OP <parameter> <cr>
MX	MAXIMUM	MX <cr>
MN	MINIMUM	MN <cr>
DF	TIR	OF <cr>
AV	AVERAGE	AV <cr>
CT	COUNT	CT <cr>
AR	LATCH RESET	AR <cr>
CL	DATA RESET	CL <cr>
SD	STD. DEV.	SD <cr>
CE	CLEAR FUNCTION	CE <cr>
SM	SINGLE	SM <cr>
CM	CONTINUOUS	CM <cr>
AO	BUZZER ON	AD <cr>
AF	BUZZER OFF	AF <cr>
MO	MOMENTARY	MO <cr>
LA	LATCHED	LA <cr>

Operation Commands for the RS-232C Interface

Table 9-1

Entering Commands

Commands are entered by typing the two-letter label associated with the command, followed by the arguments if required. (Arguments are parameters, like 13 in "MT13" for measurement type No. 13.) Input characters may be either upper case or lower case. (The gauge automatically converts lower case characters to uppercase.) A space character or a comma may be used as a separator between the command label and optional arguments, but it is not required.

When entering either the nominal value, or the high limit or low limit values, a space or comma separating the command and the value will allow only four digits to be entered after the decimal point. If one of these values must be entered with precision to the 5th digit, do not use a comma or space separator.

Software Handshaking

When the gauge receives a carriage return, it sends an XOFF character back to signal the receipt of a command and to halt further input until the buffer is free to accept more characters. XON is transmitted by the gauge when decoding of the command input buffer is complete. XOFF and XON, for "transmit off" and "transmit on", are non-printable ASCII characters that the gauge sends to the remote control device (in this case, a computer) to tell it to stop or start sending characters. You will probably not see them on your screen unless you program your computer to display them.

OUTPUTTING WHAT YOU WANT

If the output of a specific data set is required, the gauge may be programmed to echo the built-in display. Data that would be seen on the display, such as measurements, statistical data, and some error messages, are automatically sent to the RS-232C port.

For example, if your gauge is currently in the Single mode and you wanted to output standard deviation to the RS-232C port in the Continuous mode instead, you would enter the following:

Command	Explanation
MT0 <cr>	Measurement Type 0 (diameter)
MR3 <cr>	Measurement Rate 3 (1 update/second)
OP n <cr>	Enable the RS-232C Interface Option "slot" (n = 1 or 2)*
OP 232 <cr>	Put the RS-232C Interface Option in the "Echo Console Mode"
CL <cr>	Reset the statistics data base
CM <cr>	Continuous measurement mode
GO <cr>	"GO" command
SD <cr>	Request the standard deviation value
OP 33 <cr>	Standard deviation = 3*sigma
CL <cr>	Reset the statistics data base
SD <cr>	Request the standard deviation value

"SINGLE" MODE OF OPERATION

The Single mode of operation from the RS-232C input is similar to operating the gauge in the Single mode of operation from the keypad.

Each time you need to make a measurement, the "GO" command must be entered. If the gauge is programmed to echo the keypad (digital display) output, any data may be requested after issuing the "GO" command. None of the statistical data is updated until the next "GO" command. For example, to set up in the single mode and get data after "GO" is pressed, you would enter the following:

Command	Explanation
OPn <cr>	Enable the RS-232C Interface Option "slot"(n = 1 or 2)*
OP33 <cr>	Standard deviation = 3·sigma
SM <cr>	Select Single measurement mode
CL <cr>	Clear statistics data base
GO <cr>	Take a measurement
CT <cr>	Request Count (number of measurements)
SD <cr>	Request the standard deviation value
GO <cr>	Take another measurement

Remember that some of the commands automatically issue a "GO" in their command sequence (the asterisked commands in Table 9-1). If any of these commands are used during the measurement set-up, a CL command should be issued to clear the statistics data base and allow Single mode operation of the gauge.

"?" MODE OF OPERATION*

The "?" mode of operation for the RS-232C Interface Option is essentially unchanged with the exception that the output that is sent when a "?" is received can be programmed by the operator. This mode can be helpful when you are using a BASIC routine to command the gauge to perform a specific set of tasks, and want the gauge to output data only when you send it a "?" prompt during the execution of those tasks. The BASIC language "input" statement sends a "?" and pauses indefinitely until data is received.

The two modes of "?" operation, "?" Continuous and "?" Single, are addressed in the Options Operation Manual (OMP-0126). A typical set-up for the "?" Single mode of operation would be:

Command	Explanation
OP211 <cr>	Output labels with measurement
OP232 <cr>	Echo Console mode
SM <cr>	Single measurement mode
GO <cr>	Initiates the Measurement Cycle
OP246 <cr>	Puts the gauge in "?" Single mode

With this set-up, the gauge will wait until it receives a "?" character before it outputs any data. The default data output will be the dimension value. If the operator desires a different output, it may be requested by entering the following commands. (Must already be in the "echo console" mode.)

Command	Explanation
SD <cr>	Sets up the interface to output standard deviation
?	The gauge outputs the standard deviation value with the proper labels
MX <cr>	Sets up the interface to output the maximum dimension
?	The gauge outputs the maximum dimension with labels

*Your version of the Options Operation Manual (OMP-0126) may refer to the "?" mode as the "Computer" mode. They are the same.

COMMAND ERROR MESSAGES

At present, there are two error messages associated with the RS- 232C commands that may be output from the RS-232C port:

"COMMAND NOT FOUND": This indicates that the characters received at the RS-232C port did not match any of the valid two- letter commands. The gauge checks characters in the command buffer only after the receipt of a carriage return.

"TOKEN NOT EXECUTED": This message is output if the gauge could not insert commands into the main command processor.

If this message is received at the terminal, the 1200 will have to be reset before further commands can be sent to the interface. Normally, this error message indicates that something is wrong with the communications protocol. Either characters are being sent to the gauge too quickly to be decoded, or no time delay is being allowed after the carriage return terminator.

The Remote Keypad Option will continue to operate normally.

> Note: If the "TOKEN NOT EXECUTED" signal is displayed, you must reset the gauge by turning it off and then on again before trying to send any more commands to it.

USING A COMPUTER TO SEND COMMANDS TO THE RS-232C PORT

The syntax of the commands must be as stated previously, i.e., a two-letter command with arguments where appropriate, always terminated with a single carriage return. If a data file is used to program the input, the command list must be a single column of commands.

> Note: The serial port on the 1200 does not provide any hardware handshaking of characters. (There are no control lines for the gauge to tell an external device, such as a computer or terminal, that it cannot accept any more characters.) Thus if the computer terminal does not automatically respond to the XON and XOFF characters sent by the 1200, some delay between commands is required. This delay can be added after the carriage return is sent. At a baud rate of 9600, some delay may also be needed between characters. This can be accomplished by using the MID$ function in BASIC and sending characters one (1) at a time.

Chapter 10
TROUBLESHOOTING

ERROR SIGNALS

The microprocessor electronics of the 1200B Series gauges are designed to detect system errors that occur as a result of improper part positioning, faulty keystrokes by the user, or component failure. When an error condition is detected, the gauge alerts the user either by showing a message on the display, or "beeping" at him (depending on the type of error).

Flashing Display

If the display is flashing on and off, it indicates that there are no objects at all in the measurement region of the scanning laser beam.

> Note: The error signals INVALID, OVERFLO and NO DATA will flash as part of their normal operation. It does not indicate that there are no objects in the measurement region.

"E0002LO"

When this sequence of numbers and letters is the displayed, it indicates that the laser scan is being completely blocked. Check to see if one of the aperture shutters is closed or if something is obstructing the beam.

"E0000LO"

When this sequence of numbers and letters is the displayed, it indicates that the laser is no longer functioning.
Note: If some other (similar) sequence of characters appears on the display (for example, E0002L1), contact the Z-Mike Service Department.

"TOO FEW"

If the words "TOO FEW" are displayed, it indicates that the object in the scanning laser beam does not correspond to the MEAS TYPE parameter. Check the MEAS TYPE parameter and the gauging setup. Adjust one or the other.

"TOO MANY"

If the words "TOO MANY" are displayed, it indicates that the object(s) in the scanning laser beam does not correspond to the MEAS TYPE parameter, or that the aperture windows (or the V-block fixture) may have dust or other particulate matter on them.

Recheck the gauging setup and/or the aperture windows.

"INVALID"

If the word "INVALID" is displayed, it indicates that the gauge did not recognize the numeric parameter that was keyed in. For example, MEAS RATE 24 would result in an "INVALID" display. When this occurs, the sequence must be reentered, beginning with the function key. In this example, the MEAS RATE key.

"OVERFLO"

If the gauge tries to output a numeric value that has more digits than the display can accommodate, the word "OVERFLO" will be shown (flashing) instead. This condition will result if the number of measurements in the COUNT function exceeds 65,534.

"NO DATA"

The words "NO DATA" will be flashing on the display, if the MINIMUM, MAXIMUM, TIR, AVERAGE, or STANDARD DEVIATION function keys are pressed before the gauge has had a chance to take a measurement (after a DATA RESET).

Beeping

If the user presses a key out of sequence, the gauge will "beep" several times in rapid succession. For example, pressing any key except ENTER or CLEAR FUNCTION after making a numeric entry will result in this warning signal.

* (asterisk)

The asterisk always accompanies an error message. If the asterisk appears briefly, it indicates that an error condition occurred, (one that is usually identified by the words TOO FEW, TOO MANY, E0002LO, or a Blinking Display) but was not present long enough for the message to be shown. When the asterisk appears, the measurement process in interrupted, and will not resume until the error condition is remedied.

Self-Test Error Messages

When the gauge is switched on, it automatically performs a "Self Test" of its circuitry. If a problem is detected, one of the following "FAIL" messages is displayed: CPU FAIL, MSP FAIL, RAM FAIL, CTC FAIL, RO1 FAIL, RO2 FAIL. (If more than one message is required, such as in the event of a multiple failure, each message is displayed for 5 seconds.)

If any of these messages appear, you should contact the Z-Mike Service Department for assistance. In most cases, the gauge will have to be returned to Z-Mike for repair.

> Note: In some cases, the gauge will still be able to function (or appear to function) even though one of these "FAIL" conditions exists. Since the probability of an inaccurate measurement is high in this situation, it is recommended that the gauge not be used until it has been properly serviced.

EXTERNAL ERROR SOURCES

Measurement errors can be introduced by both internal and external sources. The ultimate performance of the system is based on the composite effect of all errors from all sources. Random type errors in the system can be reduced by averaging, but systematic errors need to be reduced by proper installation and

maintenance. The primary external error sources (both random and systematic) and their characteristics follow:

> Note: These types of errors cannot be detected or identified by the gauge.

Atmospheric Effects (Random)

Since variation in the air's refractive index due to temperature differences are capable of deflecting a light beam 5-6 arc sec, individual measurements can flucuate several tenths of mils due to atmospheric turbulance and atmospheric temperature differences. Averaging substantially reduces this source of error.

Dirt and Dust in the Measurement Region (Random)

Particulate matter, oil droplets or other light beam interrupting substances present in the measurement region will, of course, modulate the measurement beam and therefore introduce uncertainty in the measurements. Averaging substantially reduces this random source of error.

Dirt and Dust on the Object Being Measured (Systematic)

An oil film or other matter on the object being measured can introduce systematic errors. The Laser Telemetric System will sense the film or dust as part of the object being measured and cause the object to appear oversize. The magnitude of the error depends on the size and nature of the contaminant. Make sure objects are clean before measuring them.

Alignment of Object Being Measured (Systematic)

If the dimension being measured is not perpendicular to the scan line of the measurement beam, a systematic error is introduced which is based on the degree of tilt. The error can be calculated using the formula:

$$\text{Error in inches} = d\left(\frac{1}{\cos\theta} - 1\right)$$

where: d is the diameter of the part

θ is the tilt angle

Errors for various common values of d and θ are given in Table 10- 1.

	Diameter of Part (Inches)				
Tilt Angle (Degrees)	0.25	0.50	0.75	1.0	2.0
0	0	0	0	0	0
0.5	0.000010	0.000019	0.000029	0.000038	0.000076
1.0	0.000038	0.000076	0.000114	0.000152	0.000305
2.0	0.000152	0.000304	0.000457	0.000609	0.001219

Measurement Error (in Inches) Due to Object Tilt
Table 8-1

Clearly, the allowable tilt decreases for a fixed allowable error as the dimension being measured increases.

Temperature of Object Being Measured (Systematic)

If an object of known dimension is warmer or cooler than the NBS "standard" temperature when measured by the Z-Mike gauge, the measured dimension will differ from the expected dimension by an amount proportional to the temperature difference and the material's coefficient of thermal expansion.

Oversize Readings

If the measured dimension is larger than it should be, it could be due to an unexpected heat source warming the object and causing it to expand. One possibility is heat from within the gauge being conducted to the object through a part-holding fixture attached to the gauge's datum plate. As a result, the temperature of the measured object may be several degrees higher than the standard temperature, thus causing the measured dimension to be noticeably larger than it is supposed to be. This is especially true if the object remains on the fixture for a long time; the longer it sits there, the more heat is conducted to it.

Other common sources of increased temperature are: holding the object in your hand before measuring it; and measuring an object soon after machining it.

Undersize Readings

The opposite effect will result if the ambient temperature is significantly lower than the standard temperature. This may cause the measured dimension to be smaller than expected; depending on how low the temperature is, the length of time the object is exposed to that temperature, and the material's coefficient of thermal expansion.

If an object is stored in a cool area and then placed on the gauge's fixture to be measured, the readings will probably start off undersize, grow to the expected dimension, and then continue to grow as the object is warmed by the gauge.

Calculating Dimension Changes

If measuring an object that is warmer or cooler than the standard temperature, you can calculate what its dimension would be at the standard temperature with the following equation:

$$Ds = Dm - ((Tm - Ts) \times (K) \times (Dm))$$

A similar equation may be used to determine the expected dimension of an object at a "nonstandard" temperature:

$$Dm = Ds + ((Tm - Ts) \times (K) \times (Ds))$$

The variables in the equations are defined as follows:

Tm = Temperature of the object being measured.

Ts = Standard temperature (usually 68 degrees F, 20 degrees C).

Dm = Dimension measured by the gauge.

Ds = Dimension of the object at the standard temperature.

K = Coefficient of thermal expansion (can be found in a materials handbook).

> Note: Variables Tm and Ts must be in the same units of measure. The coefficient of thermal expansion (K) must be in the same units as the temperature and dimension variables. The "solved-for" dimension will be in the same units of measure as the known dimension.

Example

In verifying the performance of the gauge, you place a calibrated gauge pin (marked as 0.75000 inch) on the V-Block and leave it there while you observe the readings. The readings produced by the gauge are somewhat higher than they are supposed to be: 0.75003 inch. A temperature probe tells you that the gauge pin is at 74 degrees Fahrenheit. What would this gauge pin's diameter be at 68 degrees Fahrenheit? (The coefficient of thermal expansion of gauge-pin steel is .000006 inch per inch per degree Fahrenheit.)

Plug the values into the first equation:

$$Ds = .75003 - ((74 - 68) \times (.000006) \times (.75003))$$

$$Ds = .75003 - .00003$$

$$Ds = .75000 \text{ inch}$$

OPTIONAL TESTING

To assist service personnel in troubleshooting the gauge, three "test programs" have been incorporated in the software. They are enabled by pressing the OPTION ENTRY key, then pressing 20, then ENTER. To run one of the test programs, press OPTION ENTRY, then the appropriate test program number, then ENTER.

#21 - Software/Model Identification

This test program causes the display to show the gauge's model number and software version number. To operate, press OPTION ENTRY, then 21 (on the numeric keypad), then ENTER. The gauge's model number and software version will be displayed. Press GO to resume measurement display.

#22 Digital Display Test

This test program does the following:

1. Shows each character that the display can produce, in sequence, on all seven digits.
2. Shows all decimal point position variations in sequence.
3. Shows each of the small abbreviations and symbols (to the right of the alphanumeric digits), in sequence, and at the same time, displays the name of each symbol.
4. Shows all segments of the display for 5 seconds, then blinks all segments of the display for 5 seconds.

To start this test, press OPTION ENTRY, then press 22 (on the numeric keys), then press ENTER. Once this test has been started, the only way to interupt it before it is finished is to shut off the gauge and turn it on again. Otherwise, the test will run until completed.

#23 Show Key Names on Display

In this test program, the name of each key will be shown on the display as the key is pressed.

To access this test program, press the OPTION ENTRY key, then press 23 (on the numeric keys), then press ENTER. The name of each key will be displayed when the key is pressed. To resume normal operation of the gauge, turn the gauge off, then turn it on again.

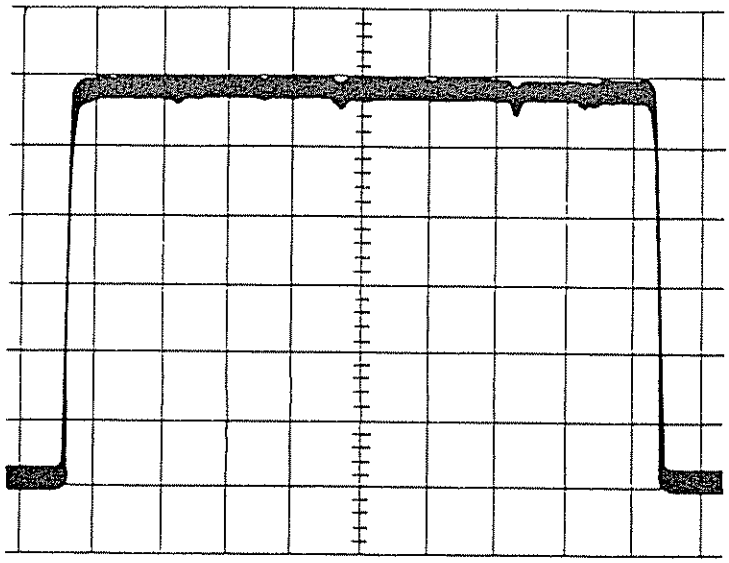
Chapter 11
MAINTENANCE

The 1200B Series bench gauge contains no user serviceable components. The only maintenance procedure that should be performed by the customer is the periodic checking and cleaning of the two aperture windows.

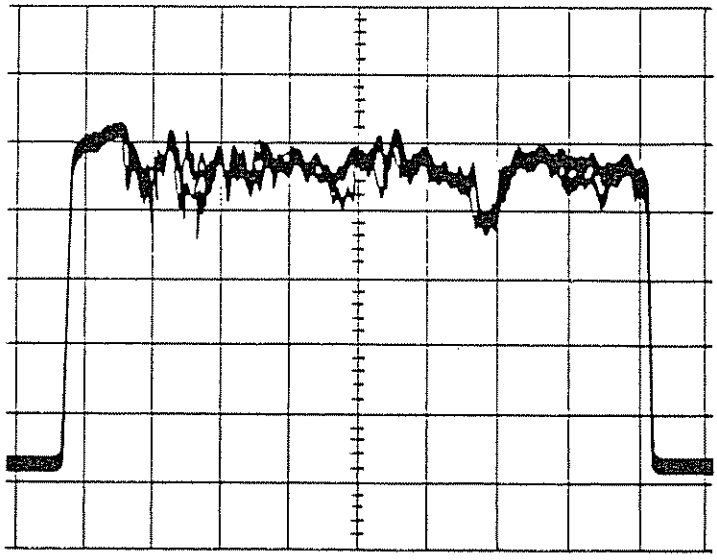
CHECKING THE LIGHT PULSE

The Light Pulse waveform provides valuable information about the cleanliness of the gauge's two aperture windows. If the windows have dust or smudges on them, the Light Pulse will clearly show it.

1. There are two plastic plugs on the receiver section of the gauge's rear cover. Use a small screwdriver to pry off the upper plug.
2. Shine a flashlight into the hole and locate the test point TP 1. Connect an oscilloscope probe to this test point and set the oscilloscope's controls as follows: **1 volt/division, 50µs/division.**
3. Compare the waveform on the oscilloscope to the waveforms in Figure 11-1. If the waveform resembles the "Good Light Pulse" drawing (smooth line on top), the windows do not need to be cleaned. If the waveform resembles the "Bad Light Pulse" drawing (sharp dropouts on the top line), use the window cleaning procedure in chapter.
4. After making sure the windows are clean, check the amplitude of the Light Pulse waveform. It should be +6 volts DC. If it isn't, remove the lower hole plug, shine a flashlight into the hole and locate the potentiometer R6. Adjust this potentiometer until the light pulse is +6 volts.
5. Be sure to replace both hole plugs.



Good Light Pulse



Bad Light Pulse

Light Pulse Examples
Figure 11-1

WINDOW CLEANING PROCEDURE

1. Remove the particulate matter from the window using clean, low-pressure air.
2. Remove remaining particles with a soft lens brush.
3. Gently wipe the surface of the window using a clean lens tissue or multilith pad moistened with acetone or alcohol.

WARNING:

Acetone or alcohol are flammable and toxic; handle with care.

CAUTION:

Use each tissue or pad for only one wipe across the surface of the glass. Continuous wiping with the same tissue or pad will scratch the optical coating on the window. Do not use eyeglass tissue for cleaning the windows; it is slightly abrasive and will scratch the optical coating.

4. Check that the windows appear uniformly blue under fluorescent or incandescent lights with no smears or streaks in the aperture.

Chapter 12
GLOSSARY

This section contains definitions of terms associated with the performance of the 1200B Series Bench Gauges, and Laser Telemetric Systems in general. They are provided to help you understand both the capabilities and the limitations of the gauge.

Display Resolution

the smallest increment of measure that the gauge's digital display can show. (It has nothing to do with accuracy, linearity, or repeatability.) The display resolution of the 1200B Series gauges is selectable. It can be 0.001, 0.0001, or 0.00001 inch (0.01, 0.001, or 0.0001 mm).

Linearity

the amount that the measured dimension may deviate from the part's actual dimension (accuracy) over the entire range of sizes that the gauge can measure. For example, if the gauge's linearity is specified as $\pm$0.00006 inch ($\pm$0.0015 mm), the measured dimension won't vary by more than 0.00006 inch (0.0015 mm) from the part's actual dimension, regardless of the size of the part.

The actual linearity of the gauge depends on the environmental conditions in which the measurements are made. The linearity specified for the 1200B Series is based on an ambient temperature of 68°F (20°C) with 50% relative humidity. If the environmental conditions where the gauge is used are different than these, the linearity may not be as specified unless the gauge is remastered.

Measurement Range

The range of part sizes that the gauge can measure to the specified repeatablity and linearity. The gauge may be able to measure parts that are slightly smaller than the smallest size in the range, but the results are not specified.

Repeatability

Refers to the precision with which the gauge can repeatedly measure the same part. If the gauge's repeatability is specified as ±0.00002 inch (±0.0005 mm), then the range of readings taken (of the same part) will not vary more than 0.00004 inch (0.0010 mm) from the smallest reading to the largest.

This term is sometimes mistakenly used interchangeably with accuracy. Accuracy is usually specified as the maximum amount that the measured dimension varies from the part's actual dimension (traceable to the National Bureau of Standards).