OPERATING MANUAL
FOR
NOVA 100-D MINIATURE
ULTRASONIC THICKNESS GAGE

– WARRANTY –

NDT Instruments, Inc. warrants the **NOVA 100-D** under conditions of normal usage, as directed, against defective materials and workmanship for a period of one year from the date of initial shipment. NDT Instruments, Inc., will repair or replace the product if determined to be defective within the warranty period, provided that the product is returned, freight prepaid, to NDT Instruments, Inc.

This warranty does not apply to products subjected to misuse, abuse, alteration, improper installation, improper repair, neglect or accident. Excluded from this warranty are accessories such as transducers (probes), cables and batteries.

NO OTHER WARRANTIES ARE EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NDT INSTRUMENTS, INC. IS NOT LIABLE FOR CONSEQUENTIAL DAMAGES.

This warranty applies only to the original purchaser and is not transferable. Contact NDT Instruments, Inc., for further details of warranty.

– SERVICING –

Prompt customer service is available from the Service Center at NDT Instruments, Inc., should servicing or repair be necessary.

– CAUTION TO OPERATOR –

PLEASE READ AND UNDERSTAND THIS MANUAL BEFORE ATTEMPTING TO OPERATE THE NOVA 100-D. AS WITH ANY GAGING INSTRUMENT, IMPROPER USE CAN LEAD TO ERRONEOUS RESULTS.

NOTES

TABLE OF CONTENTS

1. SPECIFICATIONS

OPERATING PRINCIPLE	Pulse-Echo Ultrasonic, Dual-Element Probe
ELECTRONIC DESIGN	Microprocessor-Based (U.S. Patent Pending)
DISPLAY	High-Contrast, Four Digit Liquid Crystal Display (LCD)
GAGING RANGE	*English Mode:* 0.040 to 9.999 In.; *Metric Mode:* 1.00 to 199.9 mm (Depending Upon Material And Probe)
GAGING RESOLUTION	*English Mode:* ±0.001 In.; *Metric Mode:* ±.02 mm up to 99.98 mm; 0.1 mm from 100.0 mm to 199.9 mm
MATERIAL VELOCITY RANGE	*English Mode:* Up To 0.9999 In./Microsecond *Metric Mode:* Up To 9.999 mm/Microsecond
DISPLAY RESPONSE SPEED	Approximately ¼ Sec.
CONTROLS	Membrane-Sealed Push-Button
AUTO-ZERO	Push-Button Probe Zero Set, Zero Feedback To Display
VELOCITY/THICKNESS ADJUST	Bi-Directional Push-Button Digital Scrolling
CONTROL LOCK	Push-Button Code With "L" Annunciator In Display
PENETRATING POWER OVERRIDE	Push-Button Manual Override With Annunciator In Display
AUTO-HOLD	Display Holds Last Thickness Reading
COUPLING INDICATOR	Bar Symbol Annunciator In Display Showing Ultrasonic Contact
AUTO-ACCURACY CORRECTION	Microprocessor Program To Further Linearize Thickness Response
AUTO-VELOCITY COMPENSATION	Microprocessor Program To Optimize For Impedance/Refraction Differences In Certain Materials
AUTO-SHUTOFF	Gage Power Turned Off Several Minutes After Last Reading
POWER/OPERATING TIME	200 Hours Typical Operation From Two AA-Size Alkaline Batteries
LOW BATTERY INDICATOR	Blinking "BAT" Annunciator In Display When 8 Hours Battery Life Remain
MARGINAL BATTERY CUTOFF	Gage Turned Off When Marginal Battery Power Remaining
AUTO-ZERO REFERENCE DISC	Built Into Face Of Gage For Probe Zeroing
PROBES	Standard Probe For Surface Temperature To Approximately 600°F (316°C), Mini-Probe, Hi-Power Probe, Ultra-Hi-Temp Probe For Surface Temperature To Approximately 1,000°F (538°C)
DIGITAL OUTPUT	Optional End-Cap, With Connector To Feed NOVA MINI-LOGGER
OPERATING TEMPERATURE RANGE	14°F to 140°F (−10°C to 60°C) Ambient For Gage
INSTRUMENT CASE	Aluminum Extrusion With Gasketed End-Caps
SIZE	5 × 2⅝ × 1¼ In. (127 × 67 × 32 mm), (H × W × D)
WEIGHT	11 Ounces (312 Grams)

Specifications Subject To Change Without Notice

2. INTRODUCTION

You are about to become familiarized with the **NOVA 100-D** – the best miniature ultrasonic thickness gage in the world today! Featuring a novel *microprocessor-based design**, this rugged, pocket-sized instrument offers you unparalleled performance for numerous thickness gaging applications throughout industry. The membrane-sealed **TOUCH-COMMAND** control makes setup and use so simple, you'll be amazed.

Gaging is basically performed by touching a small hand-held probe (transducer) to only one surface of the material. Thickness is instantly registered on the **NOVA 100-D's** high-contrast liquid crystal display (LCD).

Whether intended for indoor or outdoor use, the ultra-portable **NOVA 100-D** will provide you with many years of dependable performance.

3. AREAS OF APPLICATION

Metals, plastics, ceramics, glass or virtually any other material which satisfactorily conducts ultrasound, and has parallel (or concentric) surfaces, can be gaged for thickness over a wide range. The actual range is material and application dependent.

While the **NOVA 100-D** is primarily intended for rugged gaging applications in the heavier industrial environments, it is also well suited for use in less rugged areas where its inherent high measurement accuracy is needed.

A major application for the **NOVA 100-D** is assessing wall thinning due to *corrosion and erosion* (including many types of pitting action). Materials at elevated temperatures can also be gaged.

*Patent Pending

Some typical application areas include:

heat exchanger tubing	rolls
pressure vessels	machined parts
castings	bridges
ship hulls/decking	glass plate
plastic shapes and pipe	storage tanks
containers	boilers
bulkheads	steamlines
axles, wheels, rails	flanges
pipe/tubing	casings
plates/slabs/blooms	extrusions
billets/bars	beams/struts
forgings	airframes/aircraft windows

4. PRINCIPLE OF OPERATION

The **NOVA 100-D** operates on a principle similar to SONAR except at much higher frequencies (Megahertz range) and at higher electronic speeds.

Figure 4.1 basically explains how the ultrasonic pulse-echo principle is employed by the **NOVA 100-D** and its dual element probe (transducer). The probe's transmitter element (T) sends a short ultrasonic pulse into the material. The pulse, reflected as an echo from the opposite, parallel surface of the material, subsequently returns to the probe's receiver element (R).

This round trip time is directly related to the material's thickness, i.e., the thicker the material, the longer the round trip time. By precisely measuring the round trip time and compensating for the characteristic ultrasonic velocity of the material being gaged (sound travels at different speeds in different types of materials), an accurate indication of thickness is obtained.

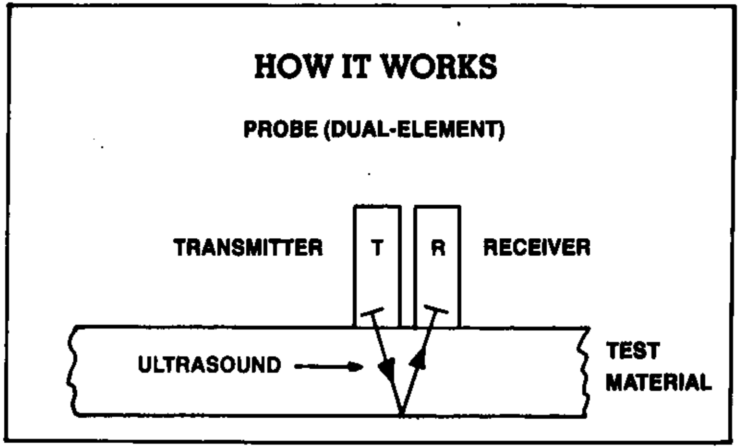


Figure 4.1 Ultrasonic Pulse-Echo Principle

5. BASIC DESIGN

The **NOVA 100-D** is totally designed around the advanced capabilities of a C-MOS mircoprocessor. Through sophisticated on-board programming, the microprocessor computes, compensates, linearizes and directs numerous operations at high speeds. The microprocessor also offers simplified external programming (gage calibration) via four **TOUCH-COMMAND** push-buttons.

The powerful transmitter pulser, high sensitivity receiver and informative digital display function in concert with the microprocessor (Figure 5.1) to produce the unparalleled performance offered by the **NOVA 100-D.**

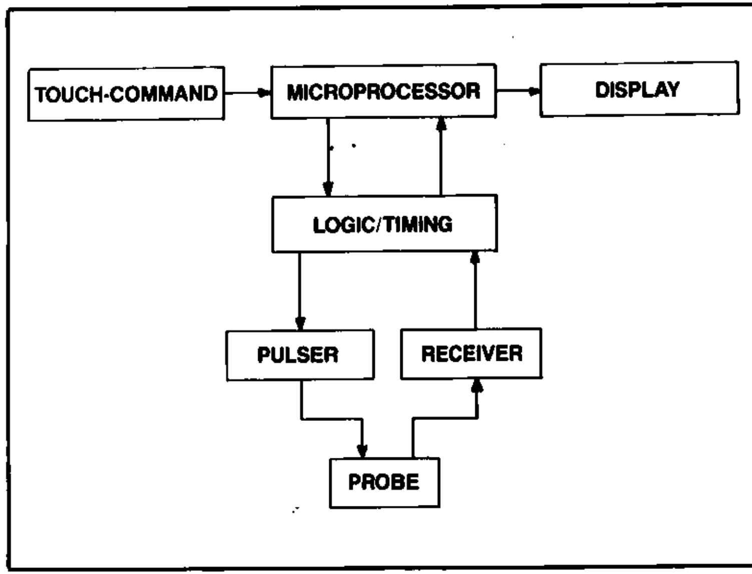


Figure 5.1 Basic Functional Diagram of **NOVA 100-D**

6. DESCRIPTION OF CONTROLS

1. Transmitter Output Connector: Mates with corresponding connector (having black plastic boot) on probe cable.

2. Receiver Input Connector: Mates with corresponding connector (having red plastic boot) on probe cable.

3. Liquid Crystal Display: Provides readout of thickness, velocity and annunciators.

4. L: Annunciator which appears when **TOUCH COMMAND** buttons are programmed into the locked mode.

5. [1.496] : Readout area which displays thickness or velocity numerals, plus, on command, the Power Mode annunciator (See Section 8.4). Thickness overrange annunciator (OVER) also appears here.

6. –: Couplant bar annunciator which appears when ultrasonic coupling has been made between probe and material surface.

7. BAT: Annunciator (flashing) which appears when remaining battery life is less than approximately 10 hours.

8. : **TOUCH-COMMAND** for turning power on (momentary touch) and for displaying velocity (depressed and held).

9. : **TOUCH-COMMAND** for scroll-increasing velocity or thickness reading.

10. : **TOUCH-COMMAND** for scroll-decreasing velocity or thickness reading.

11. : **TOUCH-COMMAND** to compensate for specific probe used.

12. Auto-Zero Reference Disc: Used with probe during probe zeroing.

13. Threaded Hole: For attaching swiveled wriststrap.

14. Locking Screw: Captive screw for removing battery chamber.

15. English/Metric Switch (Not Shown): Internal switch for selecting readout units. See Section 7.3.

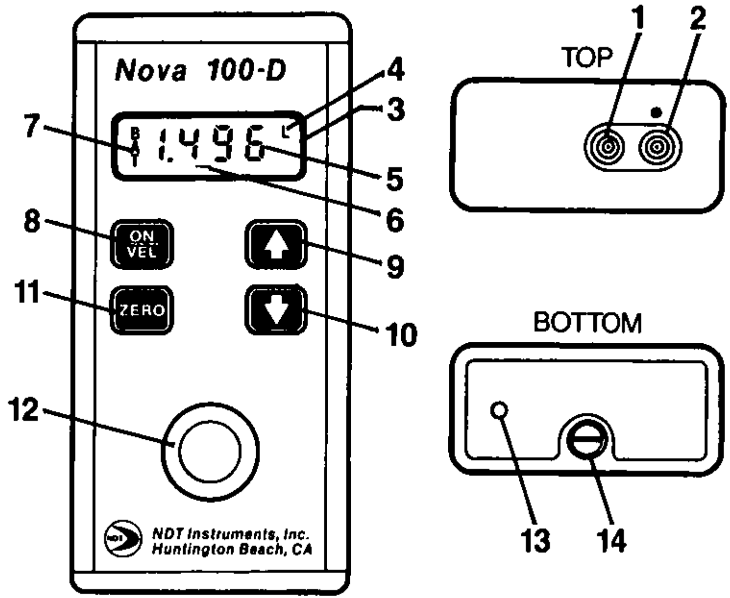


Figure 6.1 Locations And Descriptions Of Controls

7. PREPARATION FOR USE

7.1 Battery Check/Power-Guard

The **NOVA 100-D** comes equipped with two AA-size alkaline batteries installed in its battery chamber. To check for satisfactory battery life, press the **TOUCH-COMMAND** to turn power on. Any readout appearing in the LCD indicates satisfactory operational battery power. If a blinking BAT annunciator also appears on the left side of the LCD display, less than 10 hours of satisfactory battery life remain. A readout appearing with no blinking BAT annunciator means that the available battery life is somewhere between approximately 10 and 200 hours of typical use. A lack of display readout after pressing means that either the batteries need replacement or there are no batteries in the gage. During use, a Power-Guard Marginal Cutoff feature will automatically turn the power off permanently when the battery life becomes marginal.

7.2 Battery Replacement

Loosen (¼ turn counterclockwise) the large captive screw located on the bottom of the gage and withdraw the end-cap/battery chamber from the instrument case. Remove the discharged batteries and replace them with two new AA-size alkaline batteries, noting proper polarity installation as indicated on the bottom of the battery chamber. See Figure 7.1. Replace the end-cap/battery chamber back into gage and tighten captive screw ¼ turn clockwise. The gage's calibration (see Section 12) setting will need to be re-established whenever the batteries completely discharge or whenever they are removed or replaced.

7.3 English/Metric Readout Selection

Loosen the large captive screw located on the bottom of the gage and remove the end-cap/battery chamber. Note the dual-switch assembly adjacent to the screw lock bracket, as shown in Figure 7.2. For readout in English units (thickness in inches and velocity in inches per microsecond), position the switch labelled #1 so it points away

from the #1 label. For metric readout (thickness in millimeters and velocity in millimeters per microsecond), position the switch labelled #1 so it points toward the #1 label. Disregard optional accessory switch #2.

7.4 Probe Selection

A variety of probes is available to optimize performance for the broad spectrum of gaging applications that may be encountered. The Standard Probe should be used for most applications and surface temperatures up to about 600°F (316°C). An Ultra-Hi-Temperature probe, having a fused quartz delay line, should be used on surfaces with temperatures between about 600-1000°F (316-538°C). Smaller-sized Mini-Probes are available for use on smaller surface radii or for gaging in confined locations. A Hi-Power Probe is available for gaging materials with high ultrasonic attenuation or rough surfaces (materials which cannot be penetrated with the Standard Probe). Select the best-suited probe for your application and only use probes manufactured by NDT Instruments, Inc.

7.5 Probe Attachment

All probes, except for normal Mini-Probes, have detachable dual cables for connecting them to the **NOVA 100-D.** Connect the dual cable to the probe using the cable end with the smaller red-sleeved and black-sleeved Microdot screw-on connectors (certain probes may require attaching the red-sleeved and black-sleeved connectors to the correspondingly-marked polarized connectors on the probe). Connect the other end of the dual cable with larger red-sleeved and black-sleeved push-on/pull-off Lemo connectors to the corresponding connectors located on top of the gage. Be certain to connect the red-sleeved connector to the gage connector with the adjacent red dot and the black-sleeved connector to the other unmarked gage connector.

7.6 Couplant Selection

A liquid couplant film is *always* needed to transfer the high frequency ultrasonic energy between the probe and the material. Normally, the couplant is generously applied to the material surface, although it sometimes can be initially applied to the bottom of the probe (as during some high temperature applications).

The type of couplant used is *very important* if optimum performance is desired. For smooth material surfaces a lower viscosity liquid couplant such as light machine oil is satisfactory, while for rougher (or vertical/overhead) material surfaces a higher viscosity couplant, such as glycerine or grease, is necessary. For hot materials, only special high temperature couplants should be used.

There are numerous ultrasonic couplants sold commercially which cover virtually all application areas for the **NOVA 100-D.** These specially-formulated couplants should be used whenever possible.

7.7 Reference Samples

To calibrate the **NOVA 100-D** a *known thickness or a known ultrasonic velocity for the material* is needed. Either calibration technique requires (at least, initially) a reference sample representing the material to be gaged.

The closer the reference sample matches the actual material, the better the gaging accuracy. The "ideal" reference would be pieces of the actual material/product to compensate for calibration factors, such as material composition (most important), micro-structure/heat treat condition (alloys), grain direction (alloys), thickness ranges, surface roughness and contour. Such a set of reference samples should be used for critical applications or those requiring maximum gaging accuracy.

For most applications, satisfactory gaging accuracy can be obtained by using only a single reference sample. This sample should have the *same composition and same nominal thickness (accurately measured)* as the actual material/product. Frequently, even the material or

product itself can be used by simply using a micrometer to accurately measure an accessible representative thickness.

When gaging thin materials approaching the lower performance limits of the gage/probe, use reference samples to experimentally determine the actual lower limit. Do not gage materials thinner than this limit (also see Section 15.1).

If a thickness range is anticipated, then a reference sample representing the thicker end of the range should be used. For exceptionally large thickness ranges, particularly in alloys where microstructural variations occur, separate samples and calibration setups at selected intervals across the range are recommended.

The microstructure of many wrought and cast metals exhibits directionality, causing a slight variation in ultrasonic velocity depending upon the beam direction. For improved accuracy, reference samples should have the same directionality/sound beam orientation as that for the material to be gaged.

A commonly used (and convenient) reference sample is a machined step-wedge having thicknesses across the range of interest (flat steps for flat materials or concentric steps for smaller-diameter tubing).

Under certain conditions, the published ultrasonic velocity value for a given material (See Table 13.1) can be used instead of a reference sample. Such a procedure is only satisfactory if the material's velocity is known and constant and the intended application does not require relatively high gaging precision. This is a reasonable approach for many of the simpler, more-rugged applications involving the gaging of mild steel (plain carbon steel). In some cases, published velocity values will be found to differ appreciably depending upon the source of the publication. This is due to inherent material chemical/physical variations. Published velocity data tend to be useful only where approximate or relatively coarse thickness gaging precision is acceptable.

Figure 7.1 Installation Of Batteries

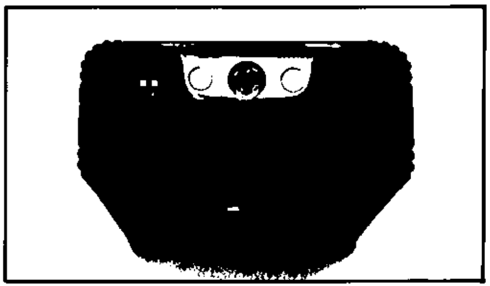


Figure 7.2 Location Of Readout Switch #1 For English Or Metric Display

8. TOUCH-COMMAND OPERATION

8.1 Dual TOUCH-COMMAND

The **NOVA 100-D** power is turned on by momentarily depressing . Once the power is on and no **TOUCH-COMMAND** buttons are depressed, the display will intially show the Power Mode Annunciator (either the Normal Mode symbol , or the Special Mode symbol). The Power Mode annunciator will remain displayed until (1) overridden by taking a thickness reading, (2) temporarily interrupted by a velocity reading or (3) the gage automatically turns off. Refer to Section 8.4 for the use of the Power Mode.

By depressing and holding at any time (even without a probe attached), the ultrasonic velocity currently in memory will be displayed.

8.2 Scrolling Commands

The Scroll Commands are operative (activated) only when (1) the velocity is being displayed or (2) when the probe is coupled to a material and a thickness reading is being displayed.

Once the Scroll Commands are operative, the displayed readout can be made to scroll (continuously change) by depressing either- for readout increases or for readout decreases.

Once an operative Scrolling Command is depressed and held, scrolling will initially take place at a slow rate and, then, after several seconds, the scroll rate will appreciably increase. Release of the scroll command pushbutton will stop the scrolling action and automatically reset it to the initial state. The change in scroll rate is highly advantageous because it readily allows (1) coarse (large) numerical display changes in a short period of time by continuous command depression or (2) fine (small) numerical display changes – as small as one unit – by quick momentary depressions (bumping) of the command.

8.3 Command

The Auto-Zero Command is used during calibration to compensate for the individual characteristics of the specific probe being used. This procedure consists of first coupling the probe to the metal Auto-Zero Reference Disc located on the front of the gage (with power on) and then depress and hold the Command. The display will read as a positive feedback to assure that the zeroing has, in fact, taken place. The will be displayed as long as is depressed *and* the probe coupled. Simply depressing with no probe coupling will not affect any formerly-stored data.

When the probe is placed on the Zero Disc and is not being depressed, the display will read a numerical value representative of the Zero Disc Thickness.

Do not zero the probe on any other material sample except the Auto-Zero Reference Disc, as this procedure will cause substantial gaging errors.

8.4 Power Mode Selection

The **NOVA 100-D** features two modes of power operation: a normal mode and a special mode. The ability to select power mode provides versatile performance on a wide range of materials. The operative power mode annunciator is displayed (See Figure 8.1) after is momentarily depressed and released without the probe being coupled to the material.

The power mode is manually selectable only when the ultrasonic velocity setting is less than the *crossover velocity* of 0.2450 inches/microsecond (6.223 mm/microsecond), i.e., on materials whose velocity is less than that for aluminum.

Power mode selection is made by first momentarily depressing and releasing to display the annunciator indicating which power mode is operative. If the other power mode is desired, then simultaneously depress both the and scroll commands for several seconds until the displayed power mode annunciator changes. To change back

to the former power mode, simultaneously depress the two scroll commands again for several seconds until the annunciator changes.

Except for aluminum and other higher velocity materials, the Normal Power Mode should *always* be tried initially because it has been designed to satisfactorily handle the majority of gaging applications. If the Normal Power Mode fails to yield satisfactory performance, then the Special Power Mode should be tried.

The Special Power Mode can be particularly useful for certain difficult-to-gage materials, such as some types of castings (like cast iron), or other heterogeneous materials which have an ultrasonically noisy internal structure and for unusually rough material surfaces. *Do not use* the Special Power Mode for applications where a metal thickness may be less than about 0.060 inch (1.5 mm). *Always check* the power mode setting before proceeding with any gaging procedure.

When the ultrasonic velocity is scrolled to values exceeding the *crossover velocity* of 0.2450 inch/microsecond (6.223 mm/microsecond), the **NOVA 100-D** will automatically operate *only* in the Special Power Mode. When the velocity is scrolled to values less than the *crossover velocity*, the **NOVA 100-D** will automatically operate at whatever power mode setting was *last operative* in this lower velocity range.

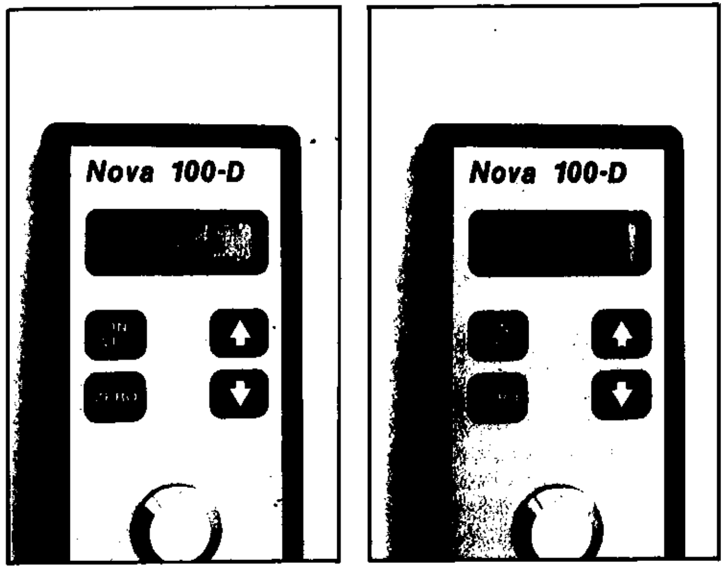
The Special Power Mode, unchangeable above the crossover velocity, is designed to optimize performance on *aluminum alloys* and other such high velocity materials with similar refractive indexes.

8.5 Lock/Unlock Command

The **NOVA 100-D** features an electronic Lock/Unlock Touch-Code to either enable or disable the **TOUCH-COMMAND** pushbuttons for calibration or operational modes. This feature protects the gage's calibration settings from being accidentally changed during either its use or storage. The gage is in the locked condition whenever the locked annunciator "L" appears continuously on the right side of the display. See Figure 8.1.

The Touch-Code procedure to alternately change the lock/unlock status consists of simultaneously depressing both [ON] and [ZERO] for several seconds, until the "L" annunciator either appears or disappears.

The Lock/Unlock Touch-Code does not disable the power turn-on/off, velocity display or power mode display.



NORMAL MODE **SPECIAL MODE**

Figure 8.1 Power Mode Annunciators Showing Normal And Special Power Modes Operative

9. COUPLANT BAR

A "–" Couplant Bar Annunciator automatically appears in the lower-central portion of the display (see Figure 5.1) to help qualify the integrity of the accompanying thickness reading. It helps indicate (1) satisfactory coupling, (2) adequate material penetration and (3) proper probe/beam normalization (perpendicularity to surface).

Thickness readings must not be considered reliable if the Couplant Bar fails to concurrently appear, intermittently blinks or flickers.

10. AUTO-SHUTOFF

The **NOVA 100-D** will automatically turn itself off approximately two minutes after non-use thereby eliminating the need for an "off" switch. The time before turn-off will reset back to the full two minutes by either making a thickness reading or depressing .

All **TOUCH-COMMAND** settings (calibration settings plus Touch Codes) are retained in memory even when the gage turns its power off. By momentarily depressing , and turning the gage on, these former settings in memory are immediately back in control.

11. AUTO-HOLD

When a coupled probe is lifted from the material surface, the last thickness reading taken is conveniently retained on the display until (1) another thickness reading is taken, or (2) the two-minute non-usage lapse (Auto-Shutoff) occurs, or (3) the Command is depressed. This Auto-Hold feature does not affect readings as the coupled probe is scanned over a surface. The display updates approximately four times per second whenever the probe has valid coupling with the surface of a test object.

12. CALIBRATION PROCEDURES

With prior reference to all other sections of this manual, the following procedure should be used to calibrate the **NOVA 100-D.**

12.1 Connect the probe and cable to the gage.

12.2 Momentarily depress . to turn power on.

12.3 Be certain the **TOUCH-COMMAND** pushbuttons are in the unlocked condition with no L annunciator appearing in display. See Section 8.5.

12.4 Select the Power Mode suitable for the intended application. See Section 8.4.

12.5 Couple the probe to the metal Auto-Zero Reference Disc on the front of the gage and depress . The gage will indicate acceptance of this zeroing command by registering a in the display. See Section 8.3.

12.6 Calibration By Thickness Scrolling: Couple the probe to an accurately-known thickness of the material (reference sample) to be gaged (see Section 7.7) while scrolling or until the display precisely reads the reference thickness (see Section 8.2 regarding scrolling), *or:*

12.7 Calibration By Velocity Scrolling: If the ultrasonic velocity of the test material is known, depress and hold while simultaneously scrolling or until the display precisely reads this velocity value (see Section 8.2 regarding scrolling). If the velocity is not known, it can be determined in accordance with the procedure specified in Section 13.

12.8 The gage is now calibrated. As a final step, enter the Touch-Code Lock Command (see Section 8.5) to prevent these **TOUCH-COMMAND** calibration settings from being accidentally changed during use.

12.9 Also, for a convenient reminder, this basic calibration procedure is *outlined* on the back side of the gage.

12.10 As is recommended with any precision measurement tool the calibration accuracy should be checked periodically during use. More frequent checks are recommended if there are changes in the temperature of the test objects or in the ambient conditions.

13. ULTRASONIC VELOCITY MEASUREMENT

13.1 First, calibrate the gage by thickness scrolling as specified in Sections 12.1 through 12.6 using a material reference sample of precisely-known thickness.

13.2 Remove the probe from the material reference sample, depress ON/VEL and read the displayed velocity for this particular material. This velocity value can now be used in the future to calibrate the gage by velocity scrolling per Section 12.7.

13.3 Since many factors can affect ultrasonic velocity, the foregoing procedure should produce significantly more accurate results than using published data. However, if only "approximate" gaging accuracy is acceptable, then published data, as shown in Table 13.1, can be considered for use.

TABLE 13.1
PUBLISHED ULTRASONIC VELOCITY VALUES FOR A VARIETY OF COMMON INDUSTRIAL MATERIALS

MATERIAL	LONGITUDINAL ULTRASONIC VELOCITY	
	Inches/Microsecond	mm/Microsecond
Acrylic Resin	0.105*	2.67*
Aluminum	0.249	6.32
Brass, Naval	0.174*	4.43*
Bronze, Phosphor	0.139*	3.53*
Cast Iron	0.181*	4.60*
Copper	0.183*	4.66*
Glass, Window	0.267*	6.79*
Inconel	0.225*	5.72*
Iron	0.232	5.90
Magnesium	0.248	6.31
Monel	0.237	6.02
Nickel	0.222	5.63
Steel, Mild	0.232	5.90
Steel, 4340	0.230	5.85
Steel, 303 CRES	0.223	5.66
Titanium	0.239	6.07
Zirconium	0.183	4.65

*may exhibit wide velocity variations depending upon alloy or type.

NOTE

These reported ultrasonic velocities are only approximations because of effects due to chemical and physical variations.

14. GAGING TECHNIQUES

14.1 Clean Surface: Prior to gaging, always remove any dirt, loose scale, corrosion, particles, flaking paint or other foreign substances from the material surface (otherwise performance may be hindered).

14.2 Excessive Surface Roughness: Very rough surfaces can cause erratic, extremely low or no thickness readouts. In such cases, consider sanding, grinding or filing the surface smooth enough to obtain a proper response (provided such a procedure and the amount of metal removal are acceptable). High-viscosity couplants, the Special Power Mode or the Hi-Power Probe may also significantly improve the response.

14.3 Heavy Machine-Grooved Surfaces: A uniformly-grooved surface, such as produced by a single point cutting tool, can cause the same undesirable effects as described in Section 14.2. Try to remedy matters by using a high-viscosity couplant and orienting the probe's cross-talk barrier (located on the bottom of the probe) at right angles to the groove (pattern) direction. The Special Power Mode or Hi-Power Probe should be tried if the above procedure fails.

14.4 Gaging Cylindrical Sections: When gaging cylindrical shapes, such as pipe, tubing, tanks, etc., it is vitally important to establish probe normality (perpendicularity to surface) and to select the proper orientation of the probe's cross-talk barrier. The cross-talk barrier is the thin material which splits the bottom of the probe into halves (its direction is also marked on both sides of the probe housing).

To determine normality, rock the coupled probe back and forth along the curved direction on the material surface and watch the accompanying decrease – increase action of the thickness readout. Use the *minimum* thickness reading, as this represents probe normality.

Selection of probe cross-talk barrier orientation depends upon the material's surface diameter. See Figure 14.1. On large diameters, orient the probe so its barrier is perpendicular to the cylindrical axis of the material. On smaller diameters, initially orient the probe barrier

both perpendicular to and parallel with the material's cylindrical axis (at the identical location) and then use the direction which gives the smaller thickness readout.

14.5 Compound Contours: For gaging *elbows on cylinders,* (also see Section 14.4), rock the probe for a minimum reading in both the circumferential and longitudinal directions and then use the smaller of the two minimum readings. On *spherical sections,* rock the probe for a minimum reading in one direction and, again, for another minimum reading with the cross-talk barrier perpendicular to the first. Use the smaller of the two minimum readings. Compound contours are difficult to gage, so if successful results cannot be obtained, try using a NovaScope or ultrasonic flaw detector.

14.6 Non-Parallel Surfaces: The surfaces on either side of a section must be relatively parallel or concentric in order to obtain a satisfactory ultrasonic echo for a thickness reading. Non-parallel or tapered surfaces will yield either less accuracy or possibly no reading at all.

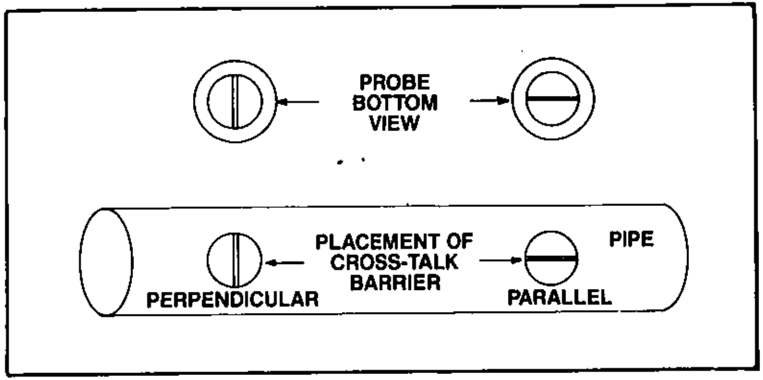
14.7 Material Temperature Effects: Both the dimensions and the ultrasonic velocity of a material change with temperature, which, in turn affects calibration. This undesirable effect holds true for the material being gaged as well as for the probe. Normally, the effect can be ignored for modest changes in ambient temperature although it's always good practice to re-calibrate when a noticeable change in ambient temperature occurs.

The situation becomes more complex when the material temperature is considerably different than ambient. One solution is to calibrate on a reference sample at the same temperature as the material. Another solution is to calibrate on a reference sample at ambient temperature and then add an experimentally-derived correction factor for the temperature of the material.

Gaging hot steel products is an application where high temperatures will produce *significant* thickness readout errors (gage typically reads thinner than actual), unless some temperature correction or compensation technique is used.

14.8 Excessively Attenuative Materials: Some materials (fibrous, porous, large-grained, etc.) may absorb or scatter so much ultrasound that either a reading cannot be obtained or some abnormal reading (usually abnormally thin) occurs. In such cases, try the Special Power Mode or the Hi-Power Probe. If gaging is still unsuccessful, try using an ultrasonic flaw detector or NovaScope.

14.9 Grain Directionality Effects: In many wrought and cast metals, the microstructural properties are directional. This means the ultrasonic velocity (and calibration) can be different depending upon the beam direction, with respect to the grain direction. For improved accuracy, always calibrate and subsequently gage in the same material grain direction. Also, see Section 7.7.



14.1 Probe Orientation On Cylinders

15. GAGING PRECAUTIONS

15.1 Very Thin Sections: As with any ultrasonic thickness gage, when the sectional thickness falls below the minimum operating thickness for the specific probe being used, erroneous readings will result. It is virtually impossible to precisely specify the minimum thickness which can be gaged with a given probe/**NOVA 100-D** combination because the actual minimum thickness depends upon the particular application (material type, contour, surface conditions, temperature, etc.). Therefore, the minimum thickness limit should be determined (a close approximation) by experimentation on samples of the actual material/product.

One erroneous effect, called "doubling," sometimes occurs when gaging thicknesses below the minimum limit. It will produce large erroneous readings in the general vicinity of twice the actual thickness. Another effect known as "pulse-envelope cycle-jumping," will produce a reading somewhat larger than the actual thickness. It is advisable to double check critical thinner sections by other means, perhaps with either a NovaScope or ultrasonic flaw detector.

15.2 Pitting Corrosion: Pitted areas on the opposite metal surface can cause unexpected erratic changes in thickness readout or, in extreme cases, a lack of thickness readout. Very small (especially sharply-pointed) pits may even go undetected (especially isolated single pits). When pitting is either detected or suspected, the area should be very carefully scanned while changing the orientation of the probe's cross-talk barrier to enhance detectability of the thinnest pitted spot(s). When positive results cannot be obtained, particularly on critical structures, a NovaScope or ultrasonic flaw detector should be used as a supplementary test method.

15.3 Mis-Identification Of Material: Always be certain of the type of material (and its anticipated thickness) to be gaged. Incorrectly calibrating on one material and then deliberately or accidentally gaging another type will cause erroneous thickness readouts.

15.4 Worn Or Malfunctioning Probes: Immediately replace any probe malfunctioning or showing excessive or uneven wear.

15.5 Use Of ZERO Command: Zero the probe *only* on the metal Auto-Zero Reference Disc, located on the front of the gage. Depressing ZERO with the probe coupled to any other material will cause substancial gaging errors (loss of calibration).

15.6 Abnormal Thickness Readings: The operator should always qualify abnormal/questionable thickness indications. While such indications may be caused by corrosion/erosion, use of wrong material thickness and internal flaws, certain other materials or gage factors (as discussed in Sections 14 and 15) may be responsible.

15.7 Material Stacks: It is not possible to gage the stack thickness of uncoupled material sheets piled upon one another because ultrasound reflects totally from the bottom surface of the outer sheet.

16. NOVA 100-D ACCESSORIES

16.1 Standard Accessories: The standard **NOVA 100-D** Kit consists of the gage (batteries installed), Standard Probe, Probe Cable, Plastic Couplant Bottle, Detachable Wriststrap, Flared Probe Holder, Operating Manual and Accessory Carrying Case.

16.2 Optional Accessories: Mini-Probes with top or side-mounted integral cables, Ultra-Hi-Temperature Probe, Hi-Power Probe, Probe Cables, Spring-Loaded V-Groove Probe Housings and a Slip-On Protective Leather Case for the gage.

16.3 NOVA MINI-LOGGER: A miniature, battery-powered data logger (belt-mountable), used in conjunction with the **NOVA 100-D,** which digitally stores nearly three thousand thickness readings and their respective locations. It features an RS-232 output for unloading stored data into computers, digital printers, etc.

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