phase II+
"The Source of Quality"

Ultrasonic Thickness Gauge w/ A & B Scan

CONTENT

1. GENERAL INTRODUCTION

Utilizing live A-scan and time based B-scan for absolute correctness, this new state of the art thickness gauge is packed with useful features allowing users to be confident of the displayed values on the most critical of applications. This multi-functional unit offers everything from basic measurement, Scan with Min/Max viewing, GO/NO GO display and Adjustable Sound Velocity. This dynamic sonic gauge is designed to measure the thickness of metallic and non-metallic materials in critical situations that ordinary thickness gauges couldn't do.

The UTG-4000 will accurately display readings in either inch or millimeter after a simple calibration to a known thickness or sound velocity.

DISCLAIMER:

The UTG-4000 is a mulit-functional thickness gauge that allows the user tremendous control over the functionality and performance of this instrument. Although this provides the user with control and versatility for numerous applications, it also requires that the user be familiar with the function, operation and waveform interpretation of the instrument as well.

It is recommended that the user spend a sufficient amount of time working with this instrument prior to field use.

Responsibility for proper use rests solely with the use of this instrument.

1.1 CONSTRUCTION OF THE GAGE

1.2 STANDARD CONFIGURATION

	Qty
Thickness Gauge	1
5MHz PROBE	1
AA Batteries	2
2oz Couplant Gel	1
Rugged Carry case	1
Operation Manual	1

1.3 OPTIONAL ACCESSORIES

High-temperature probe	Cast iron probe
Small Probe (6mm)	Mini Probe(4mm)
Probe cable	5-Step block

1.4 SPECIFICATIONS

Operating Principle	Ultrasonic pulse/echo method with dual element probe
Display type	2.4" Color Screen
Resolution	0.001", .01" /0.01mm (Inch/Metric selectable)
Measuring Range	0.02-20.0" *Dependant upon probe & material*
Repeatability	+/-.001" (+/-0.05mm)
Sound velocity range	0.0197-0.3937in/us (500-9999m/s)
Measuring Error:	0.001"(up to 0.984") 0.007"(up to 3.03" 0.019"(4" and above)
Display Modes:	Digital Thickness Readout A-scan or B-scan Min/Max Capture Diff-Value / Reduction
V-Path Correction	Automatic
Update Rate	Selectable: 4Hz, 8Hz, 16Hz
Refresh rate	4/second
Alarm Settings	Min/Max Alarm Dynamic waveform color change on alarm
Operating temperature	14-122ºF (-10ºC - +50ºC)
Auto Shut-Off	After 5 minutes
Power supply	3v AA alkaline batteries (2pc)
Operating Time	Approx. 36 hours
Dimensions	6.02" x 2.99" x 1.45" (153 x 76 x 37mm)
Weight	9.9oz (280g)

1.5 MAIN FUCTIONS

1. User-friendly interface

2. Optional A-scan waveform display

3. Time based B-scan function displays cross section of test piece

4. Different coupling status showing in different colors

5. Thickness alarm: automatic alarm when the result exceeds the preset thickness range

6. Limits value mode: Displays the minimum and maximum values when measuring

7. Difference mode: getting the difference between the actual value and the normal value as well as the percentage

8. Inch / Metric Conversion

9. Extra large memory: up to 100,000 values & 1000 waveforms

10. Selectable Resolution: 0.001", 0.01" or .01mm

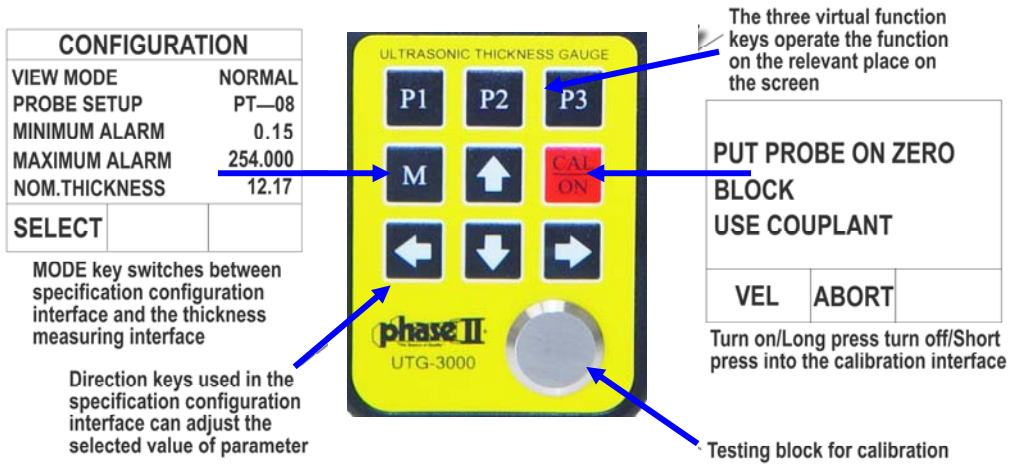
11. Optional rectification mode: RF, full wave, half +, half -

12. Optional waveform: outline mode or filled mode

13. Approx. battery Life: 35 hours

2. KEYBOARD FUCTIONS

Totally, there are 9 keys on the keyboard, including 3 virtual function keys ( ), four direction keys ( ), two specialized function keys (CAL ON MODE). See the following illustration (2.1)



2.1 KEYBOARD FUCTION ILLUSTRATION

3. MEASURING THICKNESS

3.1 Sound Velocity Calibration

In order for the gauge to make accurate measurements, it must be set to the correct sound velocity for the material being measured. Different types of material have different inherent sound velocities. If the gauge is not set to the correct sound velocity, all of the measurements the gauge makes will be erroneous by some fixed percentage. The **One-Point** calibration is the simplest and most commonly used calibration procedure optimizing linearity over large ranges. The T**wo-point** calibration allows for greater accuracy over small ranges by calculating the probe zero and velocity.

Note: **One** and **Two** point calibrations must be performed on material with the paint or coating removed. Failure to remove the paint or coating prior to calibration will result in a multi material velocity calculation that may be different from the actual material velocity intended to be measured.

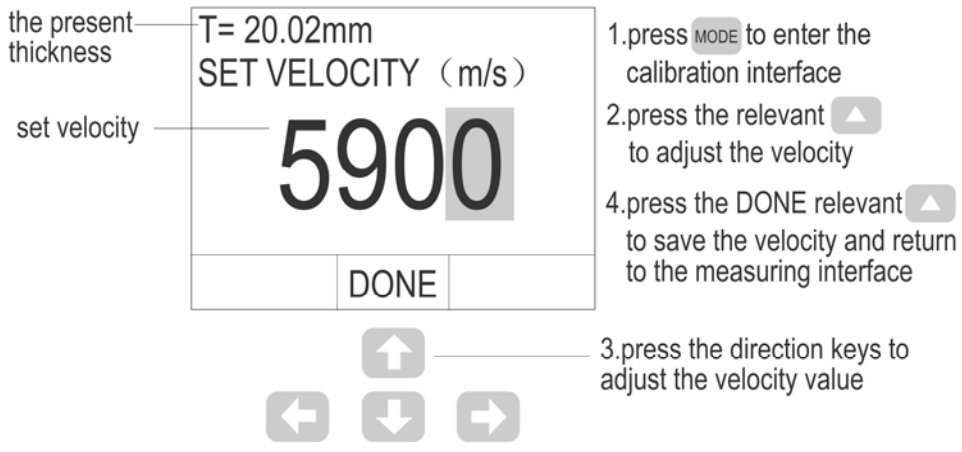
Calibration to a known thickness

Note: This procedure requires a sample piece of the specific material to be measured, the exact thickness of which is known, e.g. from having been measured by some other means such as a caliper or micrometer.

1) Perform a test on the built-in test block to verify unit is functioning properly
2) Apply couplant to the sample piece.
3) Press the transducer against the sample piece, making sure that the transducer sits flat against the surface of the sample. The display should show some thickness value, and the coupling status indicator should appear steadily.
4) Having achieved a stable reading, remove the transducer. If the displayed thickness changes from the value shown while the transducer was coupled, repeat step 3.

（5） Press the direction keys to adjust the velocity to make the actual thickness value be same with the known value.

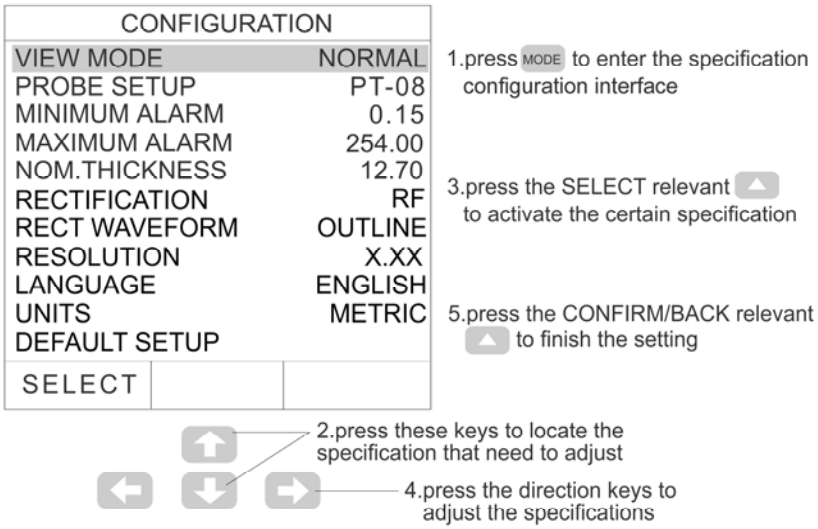
2. Adjust the velocity directly if the material velocity is known. See illustration 3.1:



3.1 VELOCITY ADJUSTING STEPS

3.2 PRESET OTHER SPECIFICATIONS

Press "**M**" to enter the user interface, which allows you to select and adjust options like VIEW MODE, PROBE SETUP, MINIMUM ALARM, MAXIMUM ALARM, NORMAL THICKNESS, MINIMUM of B-SCAN, MAXIMUM of B-SCAN, RECTIFICATION, RECTIFICATION WAVEFORM, RESOLUTION, LANGUAGE, UPDATE RATES, UNITS, AND DEFAULT SETUP. See the following figure:



3.2 Menu Selections

VIEW MODE: normal mode, difference mode and limit scanning mode.

PROBE SETUP: PT-10/PT-08(normal probe), PT-06(small probe), PT-04(mini probe), GT-12(high-temperature probe), and ZT-12 (cast iron probe).

MINIMUM ALARM: set the minimum thickness alarm value. The result will be displayed in red if the actual thickness is less than the minimum value preset.

MAXIMUM ALARM: set the maximum thickness alarm value. The result will be displayed in red if the actual thickness is more than the maximum value preset.

NORMAL THICKNESS: set the normal thickness. The real concrete application will be introduced in the **DIFFERENCE MODE**.

MINIMUM of B-SCAN: set minimum thickness for B-scan

MAXIMUM of B-SCAN: set maximum thickness for B-scan

RECTIFICATION MODE: RF, full wave, half -, half +. RF describes the complete echo waveform; full wave indicates the half + echo and the overturned half - echo; half – means putting off the half + echo and turn the half – over to +; half + means putting off the half – echo and only left the half + echo.

RECTIFICATION WAVEFORM: outline mode and fill mode.

RESOLUTION: Selectable Resolution: 0.001", 0.01" or .01mm

LANGUAGE: the interface language: Chinese or English.

UNITS: Selectable: mm or inch.

UPDATE RATE: Update the rate of measurement result. Optional 4, 8 or 16Hz.

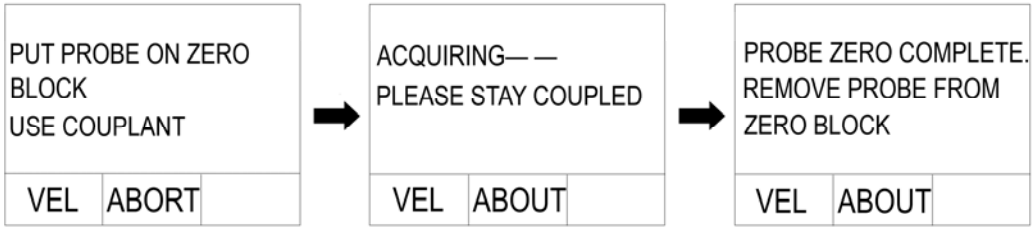
AUTO POWER DOWN: The device can be set to shut off after 5, 10, 20 minutes of inactivity. If set to OFF then the ***Cal/ON*** button will power the unit on or off when pressed.

DELETE ALL FILES: Empty all memory of values and waveforms.

DEFAULT SETUP: Brings unit back to original factory settings

3.3 CALIBRATION

Before using the UTG-4000, calibrating the gage as well as the probe is necessary. See the following steps:



3.3 CALIBRATION STEP ILLUSTRATION

1. Adjust the sound velocity to 5900m/s according to the method in chapter 3.1.

2. After turning on the gage, press CAL/ON to enter the calibration interface. The screen shows *PUT PROBE ON ZERO BLOCK USE COUPLANT*.

3. Spread the couplant according to the presentation, then put the probe on the zero block and make it coupled completely until the screen shows *ACQUIRING PLEASE STAY COUPLED.*

4. Hold a few seconds, and the screen will display *PROBE ZERO COMPLETE REMOVE PROBE FROM ZERO BLOCK.* Remove the probe from the zero block and it goes back to the measuring interface automatically.

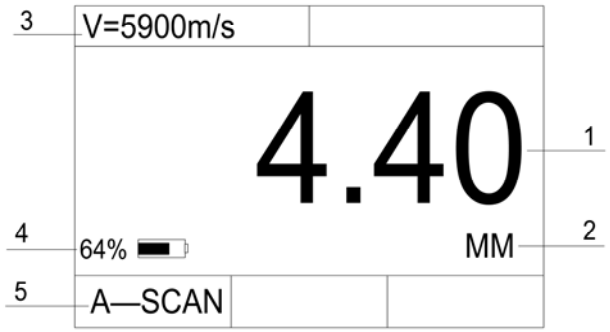
5. During the calibration, press the ABORT △ at any time to stop calibrating and the unit will go back to the measuring interface.

3.4 DISPLAY MODES

There are three measuring interface display modes: normal mode, A-scan mode and B-scan mode. And there are three display modes of Normal interface: The thickness value mode, Difference/rate of reduction measurement mode, MAX/MIN measurement mode. Select this in “VIEW MODE” of configuration.

ATTENTION: When the probe is properly “coupled” to the surface of the object being tested, the display will be shown in WHITE. If not coupled properly then the values will be shown in GREEN. When the values exceed the upper or lower limit setting then the values will be shown in RED.

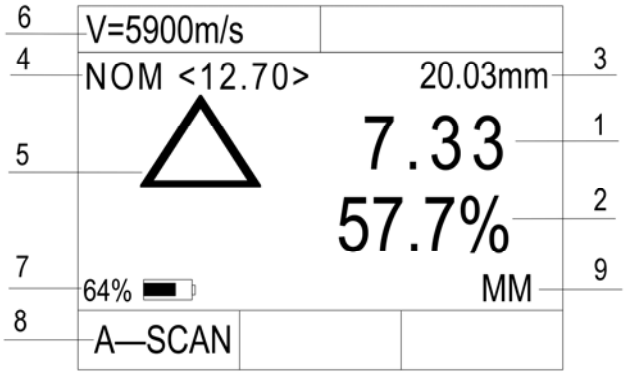
THICKNESS VALUE MODE: This interface mainly shows the velocity of material, the present thickness value and unit.



3.4 NORMAL MODE INTERFACE

1—the present thickness value 2—unit 3—material velocity 4—battery power 5—A—scan interface

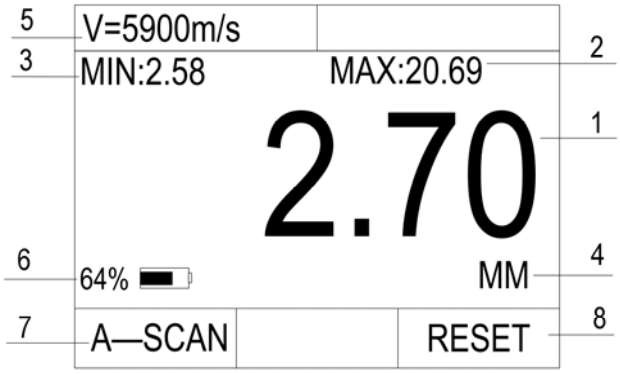
DIFFERENCE/RATE-OF-REDUCTION MODE: This interface shows the measured value, the preset nominal thickness value, the difference between the measured value and the preset value and the ratio between the difference and the normal value. Before using this mode, presetting the nominal thickness is needed. The method can be taken according to chapter 3.6.



3.5 DIFFERENCE MODE INTERFACE

1—the difference between the normal value and the preset value 2—the ratio between the difference and the nominal value 3—the present thickness value 4—the normal value 5—difference signal 6—material velocity 7—battery power 8—A—scan interface

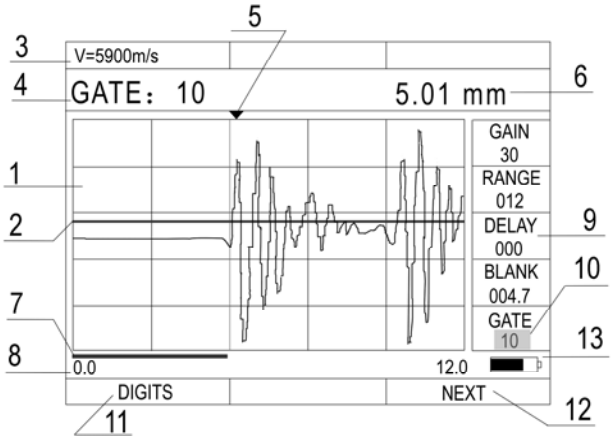
LIMITS VALUE SCANNING MODE: this mode allows the customer to test the thickness of material continuously and to show the upper/lower limits after the tests. It shows the minimum and maximum values during the tests as well as the present thickness. Press the RESET △ to get the limits when measuring the thickness.



3.6 LIMITS VALUE MODE INTERFACE

1—the present thickness value 2—the maximum value 3—the minimum value 4—unit 5—material velocity 6—battery power 7—A—scan interface 8—reset

A-scan mode: This interface allows you to see the present thickness value and the A-scan waveform at the same time. The right side of the interface is the specification adjusting area, which can be adjusted for a more precise result. The detailed introduction can be seen in chapter 3.5.



3.7 A-SCAN MODE INTERFACE

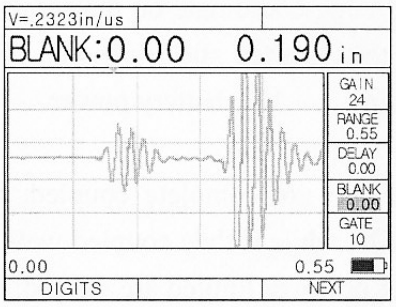
1—waveform display area 2—gate 3—material velocity 4—the present highlighted specification 5—measuring point(the first point of intersection between the waveform and the gate) 6—the present thickness value 7—the blank confines
8—the range confines 9—the specification adjusting area 10—highlighted signal
11—digit mode 12—specification switch 13—battery power

ATTENTION: When the probe and the object are not completely coupled, the letters in the various interfaces are shown in GREEN, when properly coupled, they are displayed in WHITE color and when the either the upper or lower limits are exceeded, the letters are displayed in RED color.

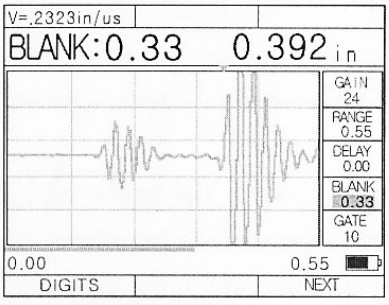
3.5 ADJUSTING THE SPECIFICATIONS IN A-SCAN INTERFACE

In the A-scan interface, press the bottom right button NEXT to highlight the value to be adjusted. Then press the direction keys to adjust the values. Up and down keys are used for small increments, while left and right for larger increments.
GAIN—adjust the sensitivity of the gage with unit dB. The larger the gain is, the higher the sensitivity is. The gain ranges from 8 to 55dB.
RANGE—adjust the testing range that the screen displays. The range is 0.393" to 5.70" (10~145mm).
DELAY—shown at the beginning point of the screen. The waveform will move horizontally when adjusting this value.

BLANK—hide the unnecessary and useless clutter in front of the main waves. The red line on the bottom of the screen shows the blank confines. The adjusting blank confines are the present range confines. Incorrect readings can be caused by material issues such as corrosion, internal material defects or even a specific material such as aluminum. Only adjustments in the Gain can solve part of the problem.



3.9 The waveform without

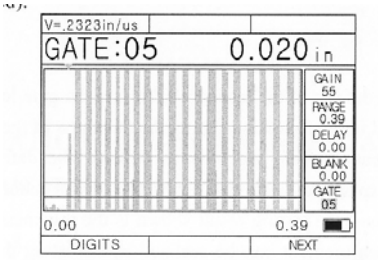


3.10 omit the front noise waves by blanking

GATE—lock the echo and show the thickness value of the highest echo. Adjusting the height of the gate. The gate ranges from 1 to 50mm. Only when the waveform is higher than the gate will this gauge be able to take the echo and show the value.

Attention: this will only show when the GATE specification is highlighted.

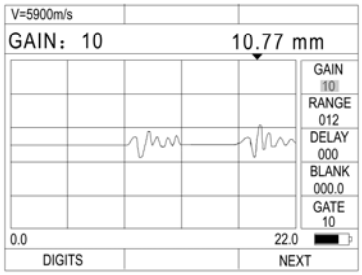
The first intersection point between the waveform and gate is shown with a RED arrow which will help you determine if this thickness value is correct. If correctly tested, the red arrow should point to the front of the first bottom echo.



3.11 waveform of the 0.02in sheet by PT04

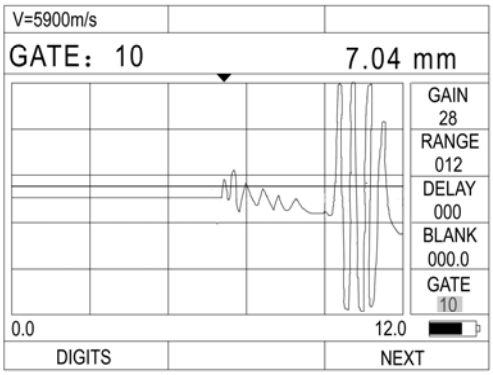
3.6 REAL CASE ANALYSIS

1. When measuring the thickness, its possible that small gains prevent the precise results. As shown in the following figure, the thickness of the testing object is about 5mm, but as for the over small gain, the measuring result is 10.77mm as the first echo has not broken the gate and the gate locates the second echo automatically. This is obviously an incorrect result, and customer can pull up the echo by enhancing the gain setting to make the first echo break the gate and finally pinpoint the correct measurement.



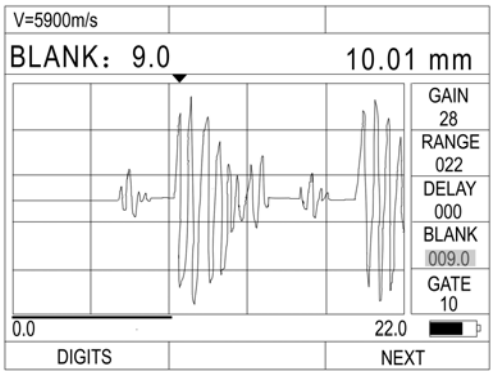
3.8 REAL CASE 1

2. There are some defects in the testing object, and the gate locks the defect echoes. As shown in the following figure, the thickness of the testing object is about 10mm, but as there are obvious defects (the defect echoes are shown on the display) and the gate locks the defect echoes which have broken the gate, thus, the testing result shown is the thickness of the defect area. The right measurement can be realized by adjusting the gate setting above the defect echoes.



3.9 REAL CASE 2

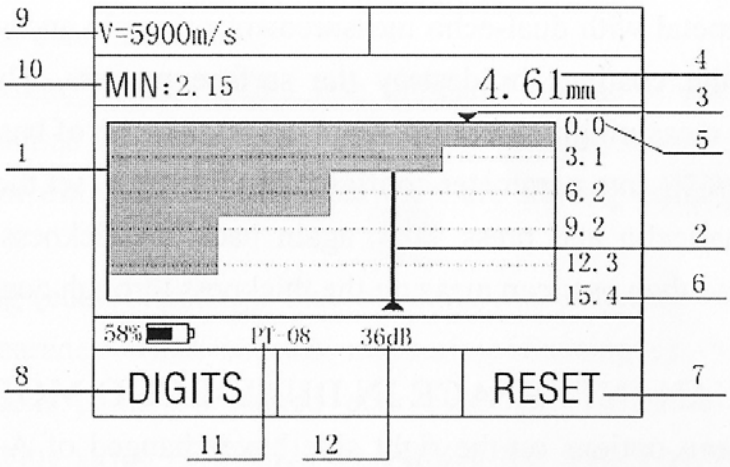
3. If there are some surface faults in the testing object and the gate locks the defect echoes, the measuring result will be the thickness of the defect area. In this condition, the customer can use the BLANK function to get the correct testing result. As shown in the following figure, the line on the bottom of the screen, which we use to shield the defect echoes, indicates the blank confines and makes the gate not catch the echoes within the blank confines, thus, the right thickness value is acquired.



3.10 REAL CASE 3

3.7 OPERATION OF B-SCAN INTERFACE

3.7.1 B-Scan Display



3.12 B scan interface diagram

1) B-scan image display
2) White pointer
3) Red triangle(displays min thickness)
4) The thickness value of the pointer position
5) The minimum thickness range in B-scan
6) The maximum thickness value in B-scan
7) Erasing the current B-0scan images and measurements
8) Enter the numerical measurement interface
9) Sound velocity
10) The minimum thickness value on the B-scan image
11) Parameter display area
12) Gain value

3.72 Introduction to B-scan

The UTG-4000 has a time base B-scan function. By moving the probe across the surface of the workpiece you can obtain a cross sectional profile of your part. This allows for viewing the contour of your part.

When you remove the probe from the workpiece, the gauge can obtain the minimum value of the B scan image and indicate that position with a RED arrow. You can see any point thickness value of the B scan image by moving the pointer to any position.

3.8 DUAL-ECHO (THRU-COATING) MODE

The UTG-4000 can accurately measure the actual material below the coating utilizing the dual echo measurement principle. This feature allows you to measure the material without having to destroy or remove the protective coating of a surface.
Press “M” to go into the parameter interface and set Measurement mode to DUAL-ECHO and press “M” to return to the main measurement screen.

3.8.1 A-Scan interface in dual-echo mode

The UTG-4000 allows you to use A-scan while in the dual-echo mode. This feature has added E-blanking option as well as the option to cancel GATE. When measuring, the blue strip area indicates the length of echo blanking./ the waveform above this is considered invalid.
See fig 3.16 below:

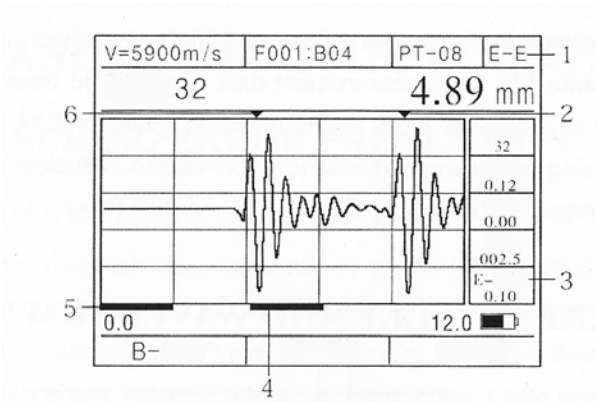


Figure 3.16 A-scan interface in dual-echo mode

1) Identification of dual-echo mode
2) Blue arrow indicates secondary echo
3) E-blanking
4) Blue line: the length of echo-blanking
5) Red line: length of initial blanking
6) Red arrow: indicates first echo

Blanking in Dual-Echo Mode:

a) ***Initial blanking:*** The red blanking line starts at zero. The waveform within the scope of the red strip is considered invalid due to lack of clutter between the starting point and the first echo.
b) ***E-Blanking(echo blanking):*** the blue line indicated on the screen appears when a measurement has been successfully taken. This line starts at the first echo measurement point. A waveform within the scope of the blue stripe is also considered invalid due to lack of clutter between the first echo and secondary echo.

4. DATA STORAGE FUNCTIONS

The UTG-4000 utilizes a micro grid format allowing this unit to store up to 100,000 thickness values and 1,000 A/B scan waveforms. ***See Fig 3.17 below***
Thickness values and waveforms can be mixed and stored in the same file. The stored data can be transferred to your PC via USB output and saved as an EXCEL or TXT file.

4.1 THICKNESS VALUE AND WAVEFORM STORAGE

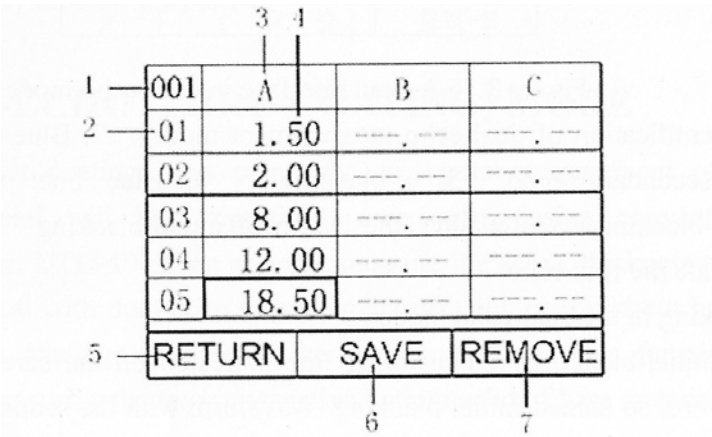


Figure 3.17 GRID FORMAT STORAGE MODE

1) Storage file number
2) Line mark
3) Row mark
4) Data in memory
5) Return to main menu
6) Save current value or waveform
7) Delete the selected data

4.2 Browsing stored data

Press “M” to enter the configuration display. Highlight “GRID FILE” and press the P1 button to select. Use the up and down arrows to choose the data you want to recall. Press the CAL/ON button to confirm.

5. CARE AND MAINTENANCE

5.1 POWER SOURCE INSPECTION

During the usage of the gage, the current battery power will be shown on the display. When the battery power is low, the customer should change the batteries promptly so that the measuring accuracy won't be influenced. The steps of changing batteries are as follow:

1. Turn off the gage.
2. Loosen the screws on the back of the unit and remove the battery cover.
3. Take out the batteries and replace with new ones. Pay careful attention to polarity.

Attention: when not using the gauge for extended periods of time, please remove batteries to prevent any leakage or corrosion.

5.2 Maintenance:

1. Always keep your gauge, probe, cable clean of any dirt, dust, fluids, etc to prevent early wear of these parts.
2. Be sure to avoid any caustic liquid such as alcohol or viscous fluids to prevent corrosion to the cover and the display window. Clean with water only.
3. Avoid scratching the surface of the probe. A worn probe will cause unstable readings.

5.3 Service/Support

Contact Phase II for all technical support and/or service.
To send your unit in for any type of service, please call for a RMA#.
(201) 962-7373

Applications Notes:

Measuring pipe and tubing.

When measuring a piece of pipe to determine the thickness of the pipe wall, orientation of the transducers is important. If the diameter of the pipe is larger than approximately 4 inches, measurements should be made with the transducer oriented so that the gap in the wearface is perpendicular (at right angle) to the long axis of the pipe. For smaller pipe diameters, two measurements should be performed, one with the wearface gap perpendicular, another with the gap parallel to the long axis of the pipe. The smaller of the two displayed values should then be taken as the thickness at that point.

Perpendicular Parallel

Measuring hot surfaces

The velocity of sound through a substance is dependant upon its temperature. As materials heat up, the velocity of sound through them decreases. In most applications with surface temperatures less than about 100□, no special procedures must be observed. At temperatures above this point, the change in sound velocity of the material being measured starts to have a noticeable effect upon ultrasonic measurement. At such elevated temperatures, it is recommended that the user perform a calibration procedure on a sample piece of known thickness, which is at or near the temperature of the material to be measured. This will allow the gauge to correctly calculate the velocity of sound through the hot material.

When performing measurements on hot surfaces, it may also be necessary to use a specially constructed high-temperature transducer. These transducers are built using materials which can withstand high temperatures. Even so, it is recommended that the probe be left in contact with the surface for as short a time as needed to acquire a stable measurement. While the transducer is in contact with a hot surface, it will begin to heat up, and through thermal expansion and other effects, may begin to adversely affect the accuracy of measurements.

Measuring laminated materials.

Laminated materials are unique in that their density (and therefore sound-velocity) may vary considerably from one piece to another. Some laminated materials may even exhibit noticeable changes in sound-velocity across a single surface. The only way to reliably measure such materials is by performing a calibration procedure on a sample piece of known thickness. Ideally, this sample material should be a part of the same piece being measured, or at least from the same lamination batch. By calibrating to each test piece individually, the effects of variation of sound-velocity will be minimized.

An additional important consideration when measuring laminates, is that any included air gaps or

pockets will cause an early reflection of the ultrasound beam. This effect will be noticed as a sudden decrease in thickness in an otherwise regular surface. While this may impede accurate measurement of total material thickness, it does provide the user with positive indication of air gaps in the laminate.

Suitability of materials

Ultrasonic thickness measurements rely on passing a sound wave through the material being measured. Not all materials are good at transmitting sound. Ultrasonic thickness measurement is practical in a wide variety of materials including metals, plastics, and glass. Materials that are difficult include some cast materials, concrete, wood, fiberglass, and some rubber.

Couplants

All ultrasonic applications require some medium to couple the sound from the transducer to the test piece. Typically a high viscosity liquid is used as the medium. The sound used in ultrasonic thickness measurement does not travel through air efficiently.

A wide variety of couplant materials may be used in ultrasonic gauging. Propylene glycol is suitable for most applications. In difficult applications where maximum transfer of sound energy is required, glycerin is recommended. However, on some metals glycerin can promote corrosion by means of water absorption and thus may be undesirable.

Other suitable couplants for measurements at normal temperatures may include water, various oils and greases, gels, and silicone fluids. Measurements at elevated temperatures will require specially formulated high temperature couplants.

Inherent in ultrasonic thickness measurement is the possibility that the instrument will use the second rather than the first echo from the back surface of the material being measured while in standard pulse-echo mode. This may result in a thickness reading that is TWICE what it should be. The Responsibility for proper use of the instrument and recognition of these types of phenomenon rests solely with the user of the instrument.

All velocities are approximations:

SOUND VELOCITY MEASUREMENT CHART

Material	Sound Velocity	
	Inch/µS	M/s
Air	0.013	330
Aluminum	0.250	6300
Alumina Oxide	0.390	9900
Beryllium	0.510	12900
Boron Carbide	0.430	11000
Brass	0.170	4300
Cadmium	0.110	2800
Copper	0.180	4700
Glass(crown)	0.210	5300
Glycerin	0.075	1900
Gold	0.130	3200
Ice	0.160	4000
Inconel	0.220	5700
Iron	0.230	5900
Iron (cast)	0.180	4600
Lead	0.085	2200
Magnesium	0.230	5800
Mercury	0.057	1400
Molybdenum	0.250	6300
Monel	0.210	5400
Neoprene	0.063	1600
Nickel	0.220	5600
Nylon, 6.6	0.100	2600
Oil (SAE 30)	0.067	1700
Platinum	0.130	3300
Plexiglass	0.110	1700
Polyethylene	0.070	1900
Polystyrene	0.0930	2400
Polyurethane	0.0700	1900
Quartz	0.230	5800
Rubber, Butyl	0.070	1800
Silver	0.140	3600
Steel, Mild	**0.233**	**5900**
Steel, Stainless	0.230	5800
Teflon	0.060	1400
Tin	0.130	3300
Titanium	0.240	6100
Tungsten	0.200	5200
Uranium	0.130	3400
Water	0.584	1480
Zinc	0.170	4200