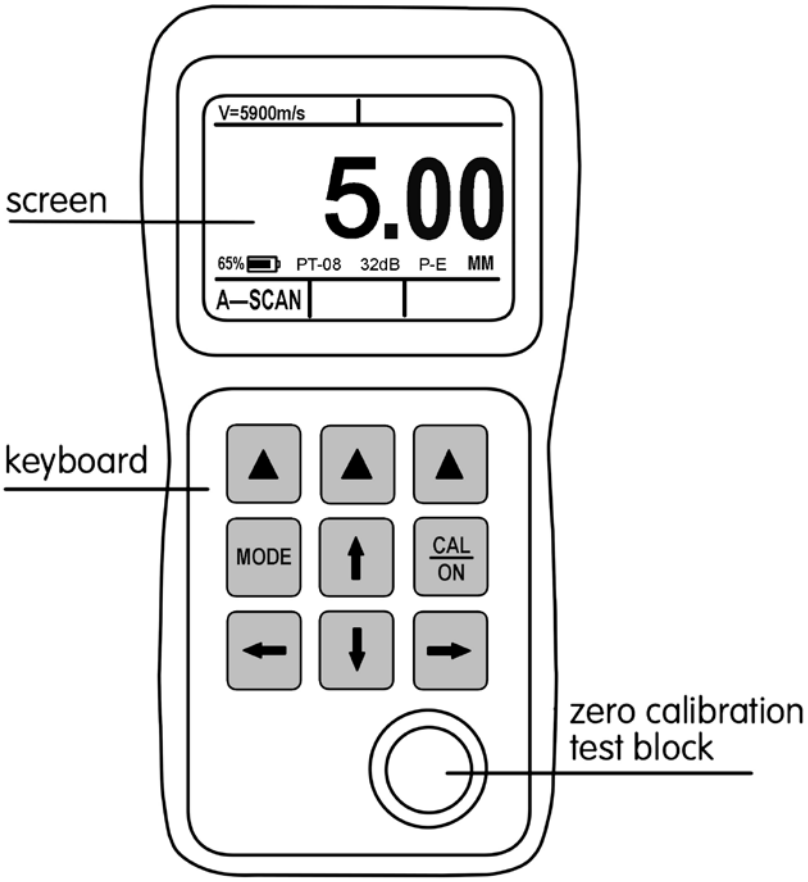
CONTENT

1. GENERAL INTRODUCTION

TM281 series ultrasonic thickness gauge, Launch the ultrasonic through one side of the object, measure the digitized thickness real-timely, without cutting the object. As a subminiature measuring gauge, is researched and developed by our company according to the ultrasonic measuring theory. The features include fast response, non-destruction and precise measuring. In addition, A/B-scan waveform display is available by showing the echoes, which enables the more extensive measure range, more precise result and very little measurement error and finally makes the measuring processes more controllable.

TM281 series ultrasonic thickness gauge, as the essential NDT instrument, can be widely applied in the detecting fields like manufacturing, metal processing, chemical industry, commercial inspecting and so on. It can not only precisely measure various kinds of panels and processing components but also monitors the thickness minus of tubes and pressure vessels in the manufacturing instruments after corrosion.

1.1 CONSTRUCTION OF THE GAUGE



1.2 STANDARD CONFIGURATIONS

NAME	NUMBER
THICKNESS GAUGE	1
PROBE	1
ALKALINE BATTERY	2
COUPLANT	1
CARRYING CASE	1
OPERATING MANUAL	1
USB CABLE	1(ONLY TM280DL)
SOFTWARE CD	1(ONLY TM280DL)

1.3 OPTIONAL CONFIGURATIONS

HIGH-TEMPERATURE PROBE	CAST IRON PROBE
SMALL PROBE	MINI PROBE
PROBE CABLE	STEPPED CALIBERATION BLOCK
RUBBER SHEATH	STORAGE OPTION(ONLY TM280)

1.4 SPECIFICATIONS

Display Type	2.4" color OLED, 320 X 240 pixels, contrast 10,000:1
Operating Principle	Pulse echo with dual element transducers
Measuring Range	0.50mm to 508mm(0.02" to 20.00"), depending on material, probe and surface condition
Measuring Resolution	Selectable 0.01mm, 0.1mm(selectable 0.001", 0.01")
Units	Inch or Millimeter
Rectify Modes	RF+, RF-, HALF+, HALF-, FULL
Display Mode	Normal, Minimum / Maximum capture, DIFF/RR%, A-Scan, B-Scan
V-Path Correction	Automatic
Update Rate	Selectable 4Hz, 8Hz, 16Hz
Material Velocity Range	500 to 9999m/s (0.0197 to 0.3937in/us)
Languages	English

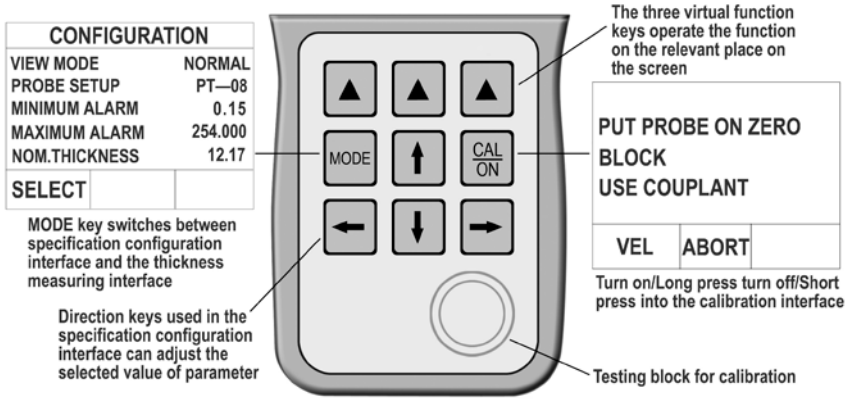
Alarm Settings	Minimum and Maximum alarms. Range of 0.25 mm to 508 mm (0.010" to 20.00"). Dynamic waveform color change on alarm
Power Requirements	2 AA size batteries
Operating Time	Approximately 40 hours
Instrument Shut-off	Selectable ALWAYS ON or AUTO OFF after 5, 10, 20 minutes of inactivity
Operating Temperature	-10°C to +50°C (+10°F to +120°F)
Size	153mm × 76mm ×37mm(H ×W ×D)
Weight	280g including batteries

1.5 MAIN FUNCTONS

1. Parameter configuration interface is simple and easy to operate
2. Adjustable Live A-scan waveform display, control of Gain, Blanking, Gate, Range and Delay etc.
3. Time-based B-scan function, displays a cross section of the test piece, for observing the underside outline of the piece.
4. Numerical view, display thickness values with big digit.
5. Thickness alarm: programmable Hi-Low alarm set point with dynamic change thickness value’s color.
6. Limit value mode: catching 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 of difference value and normal value.
8. Selectable units of Mm and inch.
9. Optional resolution: X.XX mm /X.X mm; X.XXX inch / X.XX inch.
10. Optional waveform style: outline mode or fill mode
11. Optional rectification mode: RF+, RF-, full wave, half +, half -
12.Multi-languages Available: Chinese, English, German, Spanish, and Japanese, ahead of agreeing with the company.
13. Approx. battery life: 35hours.
14.Great capacity data storage function: Stores 100,000 thickness values&1000 waveforms(only TM280DL).
15.Measure the net thickness of the workpiece through the coating layer (only TM280&TM280DL).

2. KEYBOARD FUNCTIONS

There are 9 keys on the keyboard totally, 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 INSTRUMENT CALIBRATION

Before using TM281 series, the instrument and probe must be calibration. Purpose of calibration is performing probe zero procedure and obtain the sound velocity of the material being tested. And it's important to set up the correct probe model firstly before the calibrating process. TM280 series' calibration divided in to the following:

1. Probe zero procedure：Use the zero block on the instrument to set up the probe zero procedure.

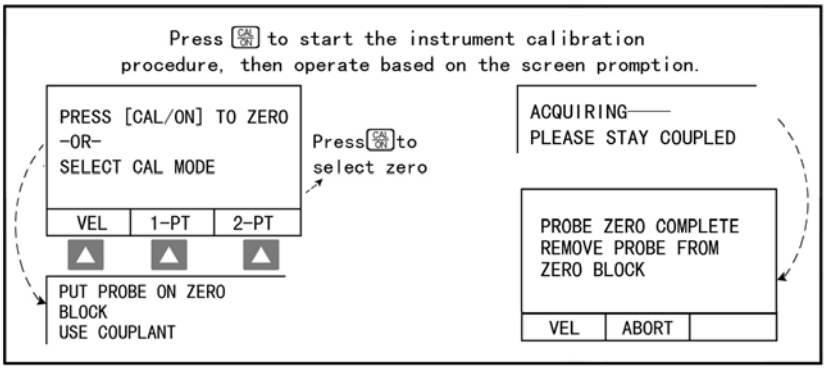
2. One point calibration：Use the zero block on the instrument to set up the probe zero procedure first, then obtain the velocity from the test block of known thickness.

3. Two point calibrations：Calibrate the probe zero and the velocity of test block from two known thickness and same material standard blocks.

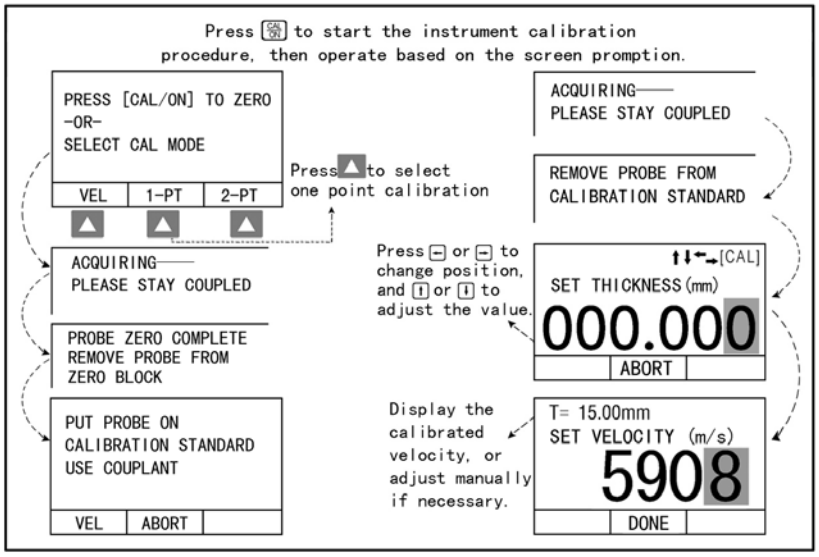
4. Dual Echo calibration：Calibrate the velocity from the test block of known thickness.

5. Setting the velocity manually：If the material velocity is known, for example the velocity of steel is 5900m/s. The sound velocity can be setting manually.

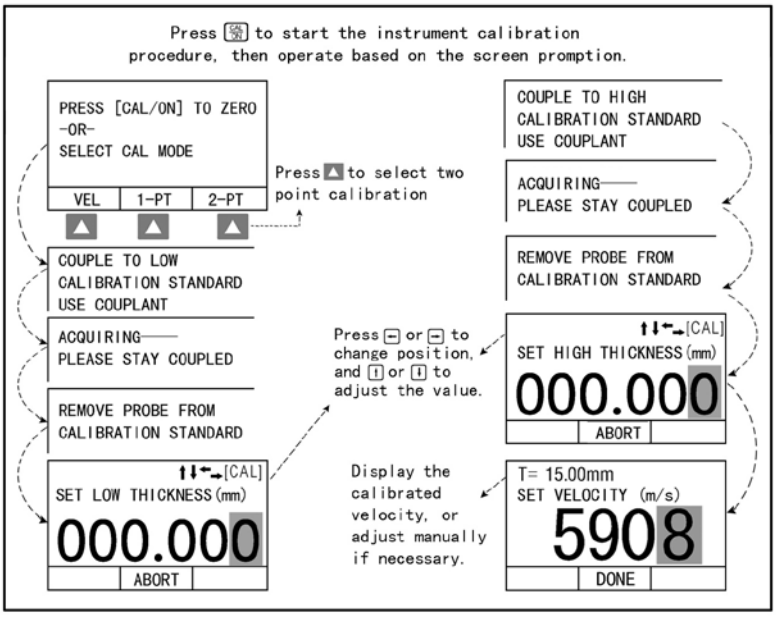
3.1.1 Probe zero procedure



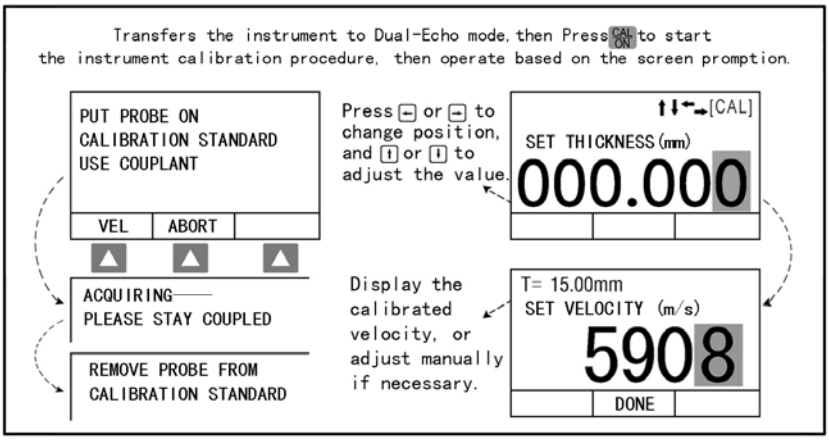
3.1.2 One point calibration



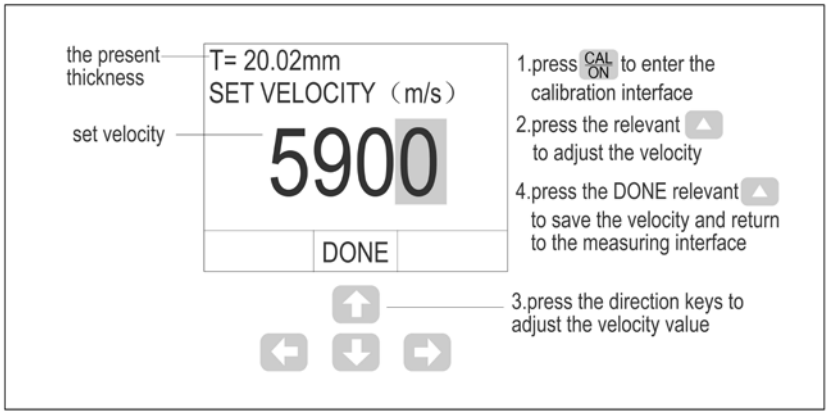
3.1.3 Two point calibrations



3.1.4 Dual Echo calibration



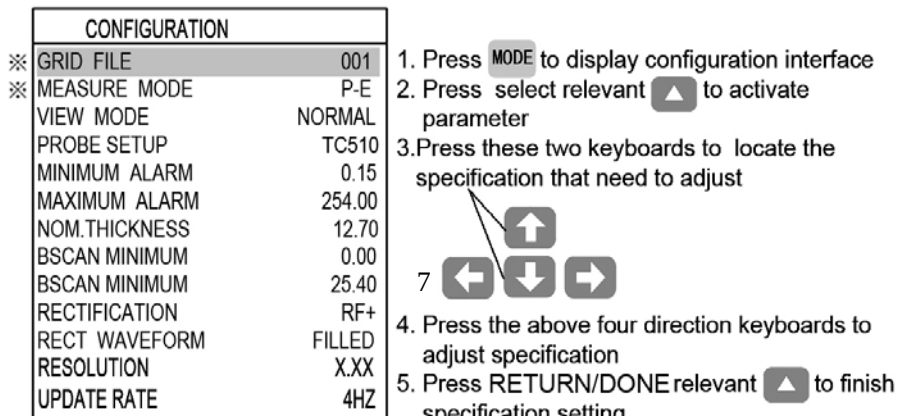
3.1.5 Velocityadjusting steps



Attention 1: Measure the standard block before the calibration, to ensure that the current setting of instrument parameters can measure the standard test block correctly.
Attention 2: probe zero procedure, one point calibration and two point calibrations is suitable for single echo mode, dual echo calibration is suitable for dual echo mode.

3.2 PRESET OTHER SPECIFICATIONS

Press MODE to enter the specification configuration interface, which including many specification adjusting options like FILE NUMBER, MEASURING MODE, VIEW MODE, PROBE SETUP, MINIMUM ALARM, MAXIMUM ALARM, NORMAL THICKNESS, THE MINIMUM OF B SCAN, THE MAXIMUM OF B SCAN, RECTIFICATION, RECTIFICATION WAVEFORM, RESOLUTION, UPDATE RATE, LANGUAGE, UNITS, AND DEFAULT SETUP. See the following figure:



3.1 SPECIFICATION ADJUSTING STEPS

FILE NUMBER – Select the current file. Total 400 files, and each file could save 252 thickness values or waveforms.

MEASUREMENT MODE - Single echo and dual-echo mode. Single-echo mode is used for Common measurement; dual-echo mode is used for through coating function.

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

PROBE SETUP: Many probe models selectable, including TC510 (dedicated probe for thru-coating, standard on TM281D&TM281DL),) PT-08(normal probe, standard on TM281), PT-06(small probe), PT-04(mini probe), GT-12(high-temperature probe), ZT-12 (cast iron probe), and PT-12(normal probe).

MINIMUM ALARM: Set the minimum thickness alarm value, range of 0.15-635mm. The result will be displayed in red if the actual thickness is less than the minimum value preset.

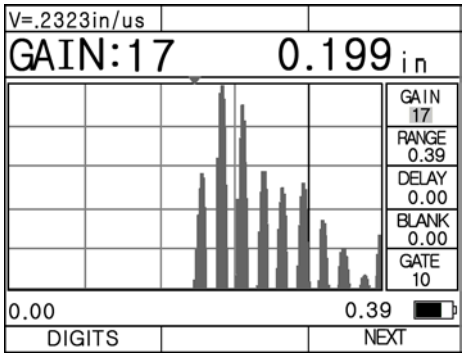
MAXIMUM ALARM: Set the maximum thickness alarm value, range of 0.15-635mm. The result will be displayed in red if the actual thickness is more than the maximum value preset.

NORMAL THICKNESS: Set the normal thickness, range of 0.15-635mm. The real concrete application will be introduced in the DIFFERENCE MODE.

MINIMUM OF B SCAN: Set the minimum thickness of the B scan.

MAXIMUM OF B SCAN: Set the maximum thickness of the B scan.

RECTIFICATION MODE: RF+, full wave, half -, half +, RF-. 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. RF- indicates the phase waveform of RF+.



3.2 HALF-WAVE POSITIVE

RECTIFICATION WAVEFORM: outline mode and filled mode.

RESOLUTION: Set the decimal digits of the measurement result. Metric of X.X and X.X X and imperial of X.XX and X.XX X.

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

LANGUAGE: Set the interface language: Chinese or English only or contact our factory for other languages.

UINTS: Selectable units of mm/inch.

AUTO POWER DOWN: The device will be automatic shut off if no key presses or measurements occur for set 5 minutes, 10 minutes or 20 minutes. If set to OFF, the instrument is only powered off when press and hold CAL ON DELETE ALL FILES – Empty the thickness readings and waveforms of all files.

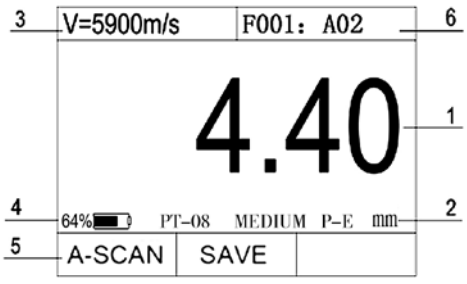
DEFAULT SET UP – Set all parameters to their factory default values.

3.3 NORMAL MODE

TM281 series have three measuring interface: normal mode, A-scan interface, B-scan interface. And there are three display modes of normal interface: Thickness value mode, difference/rate-of-reduction measurement mode, MAX. /MIN. measurement mode. Select in the “VIEW MODE” of CONFIGURATION.

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

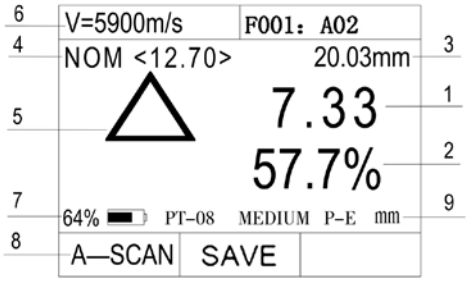
THICKNESS VALUE MODE: the acquiescent opening interface. This interface mainly shows the present thickness value with large digits.



3.3 NORMAL MODE INTERFACE

1—the present thickness value 2—probe types, gain degree, single-echo, measuring units 3—material velocity 4—battery power display 5—A—scan interface

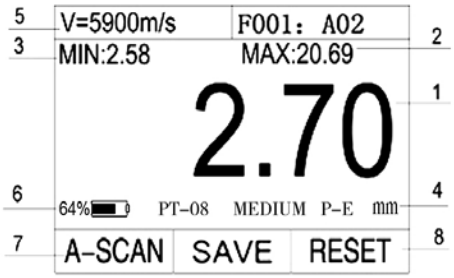
DIFFERENCE/RATE-OF-REDUCTION MODE: this interface displays the currently measured and a nominal thickness input by user, the difference between the currently measured thickness and the nominal thickness and the ratio between the difference and the nominal thickness. Before using this mode, presetting the nominal thickness is needed. The method can be taken according to chapter 3.6.



3.4 DIFFERENCE MODE INTERFACE

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

LIMITS VALUE SCANNING MODE: This mode allows the user to catch the real-time maximum and minimum thicknesses when test the thickness of material continuously. It shows the minimum and maximum values during the tests as well as the currently thickness. Press the RESET relevant ▲ to get the limits when measuring the thickness.



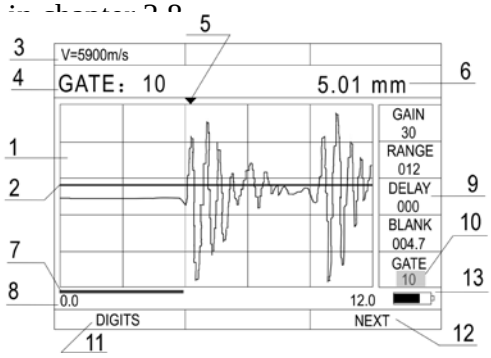
3.5 LIMITS VALUE MODE INTERFACE

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

3.4 A-SCAN INTERFACE MODE

In this mode, users could view the current thickness value and the A-scan waveform at the same time. The right side of the interface is the specification adjusting area, in which the specifications can be adjusted and finally solve various difficult and complicated thickness measuring applications to the capacity. The detailed

introduction can be seer



3.6 A-SCAN MODE INTERFACE

1—waveform display area 2—gate 3—material velocity 4—the magnifying selected 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 beginning coordinate on the screen 9—the specification adjusting area 10—the selected specification 11—large digits mode 12—specification choosing 13—battery power

Attention: when the probe and the object are not complete coupled, the letters in the various interfaces are in GREEN, while if they coupled well, in WHITE color and when the either the upper or lower limited are exceed; the letters are displayed in RED color..

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 large increments.

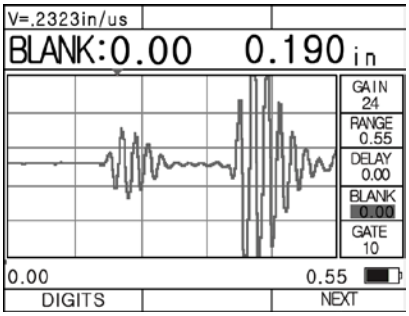
GAIN—adjust the sensitivity of the gauge with unit db. The larger the gain is, the higher the sensitivity is. The gain ranges from 8 to 55db. This function is very useful for the testing of attenuation materials (like metal cast).

RANGE—adjusting the range of waveform that the screen displays. The waveform can be compressed or spread visually and it's invisible if the display range is set incorrectly and the echo waveform is beyond the display area, however, the testing value can also be read correctly. The range is 0.393″ to 5.70″ (10-145mm).

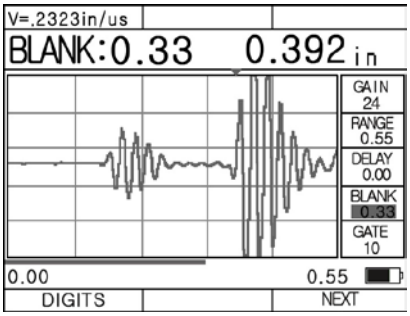
DELAY—Shown at the beginning point of the screen. The waveform will move horizontally adjusting this value, and it's invisible if the delay is set incorrectly and the echo waveform is beyond the display area, however, the testing value can also be read correctly.

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. In the real testing, wrong measurement due to the material may exist, such as near surface serious corrosion, AL material, inside defects, uneven component, lamination structure and so on. While adjusting the gain

or gate can solve part of the problem, but only blank function can avoid the mistake when those clutter echoes are higher than the bottom echoes.

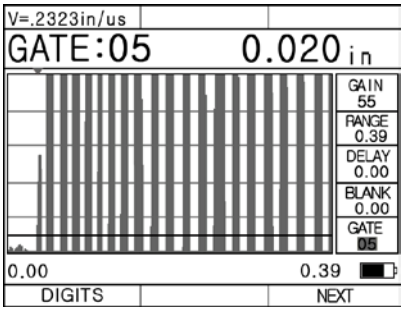


3.7 The waveform without



3.8 omit the front noise waves by blanking

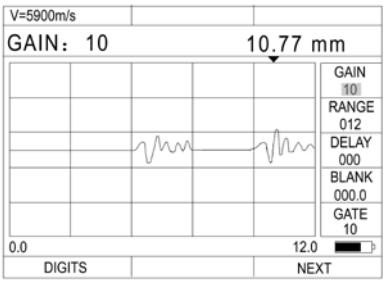
GATE—adjusting the height of the gate. Range from 1 to 50mm. Only when the waveform is higher than the gate, the gage can take the echo and show the value. Attention: this will only show when the GATE specification is highlighted. The first intersection point between the waveform and gate is pointed by a red arrow, which can help judging whether the thickness value is correct (the red arrow should point the front of the first bottom echo if correctly tested).



3.9 waveform of the 0.02in sheet by

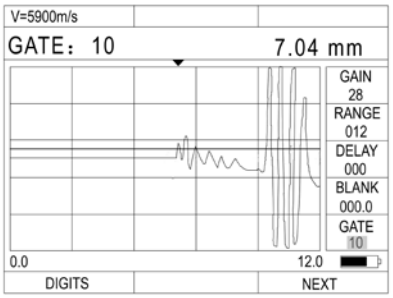
3.5 REAL CASES ANALYSIS OF A-SCAN

1. When measuring the thickness, it's possible that that over small gains prevent the precise results. As showed 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 brake the gate and finally pinpoint the correct measurement.



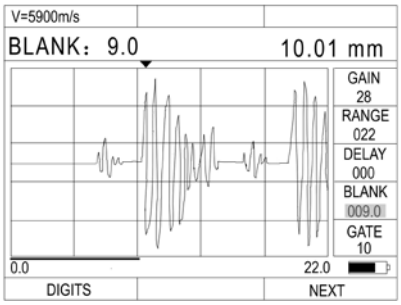
3.10 REAL CASE 1

2. There are some defects in the testing object, and the gate locks the defect echoes. As showed in the following figure, the thickness of the testing object is about 10mm, but as there are obvious defects (the defect echoes are showed 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.



3.11 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 showed 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.

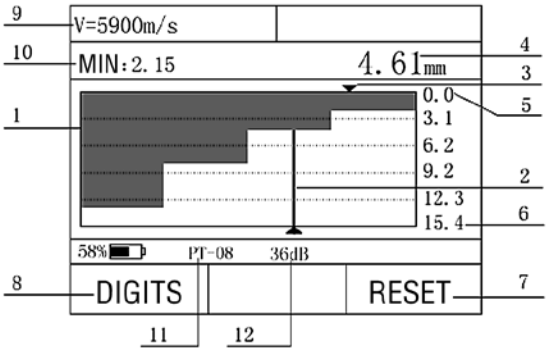


3.12 REAL CASE 3

0.15-635mm. The result will be displayed in red if the actual thickness is less than the minimum value preset.

3.6 OPERATION OF B-SCAN INTERFACE

3.6.1 B-SCAN DISPLAY



3.13 B scan interface diagram

1-B-scan image display 2-White pointer 3-Red triangle (display the min. thickness value) 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-scan 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

3.6.2 Introduction of B-Scan

TM281 thickness gauge has time-base B-scan function. Move the probe along the workpiece surface, then the cross-sectional profile of the workpiece display, use for observe the underside contour of the workpiece.

When remove the probe from workpiece, it could be automatically capture a minimum value of the B-scan image, and indicate the position of the minimum by a red triangle. You can see any point thickness value of the B-scan image by moving the pointer.

3.7 DUAL-ECHO (THRU-COATING) MODE

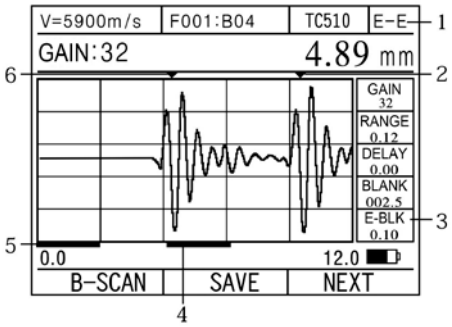
For protect coatings and paint, the thickness measurement of the underlying metal will lead significant error when using conventional thickness gauge. TM281D and TM281DL can accurate measure the actual thickness of the underlying metal with dual-echo measurement principle and without having to remove the coatings or destroy the surface process. This function is achieved by measuring the two consecutive bottom echo of base material.

Press MODE into parameter configuration interface, set the measurement mode to dual-echo and press MODE again back to thickness measurement interface. And then user can measure the thickness through coating.

3.7.1 A-SCAN INTERFACE IN DUAL-ECHO MODE

The menu options on the right side have changed of A-scan interface under echo-echo

mode, added E-blanking option, and canceled GATE option. The blue strips area indicate the length of echo-blanking when measuring, the waveform above the blue strips is invalid. See following figure 3.16.



3.14 A-scan interface in dual-echo mode

1. identification of dual-echo measurement mode 2. Blue arrow indicate the secondary echo 3. E-blanking 4. Blue line: the length of echo-blanking 5. Red line: the length of initial-blanking 6. Red arrow indicate the first echo

Blanking in the dual-echo mode:

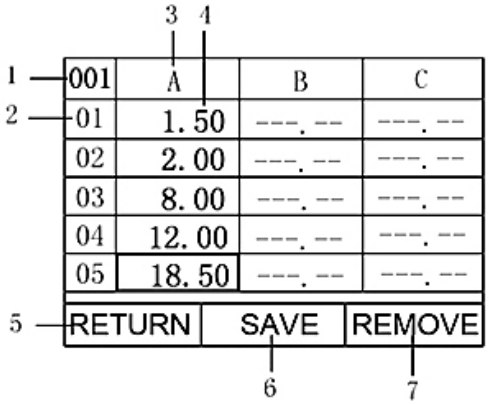
1. Initial-blanking: red blanking line indicated on the screen, starting at zero, so named initial blanking. Waveform with the scope of red strip is invalid, for omitted the clutter between the starting point and the first echo.
2. E-blanking (echo-blanking): blue blanking line indicated on the screen, only appearance when success measuring. Starting at the first echo measurement point, so named echo-blanking. Waveform within the scope of blue stripe is invalid, for omitted the clutter between the first echo and secondary echo.

NOTE: This instrument is not require zero calibration in the dual-echo measurement mode. For zero calibration, please enter the single-echo measurement mode.

4. DATA STORAGE FUNCTION

TM281DL adopt the storage mode of microgrid format(the follow Figure3.17), it can save one hundred thousand thickness values and one thousand A/B-scan waveforms, waveform and thickness values can be mixed stored in the same file. The measurement data files can be transferred from the instrument to a PC via USB communication generate EXCEL or TXT format files. Using our powerful DataView software to statistical and analyze measurement, report via connect printer.

4.1THICKNESS VALUE AND WAVEFORM STORAGE



4.1 GRID FORMAT STORAGE MODE

1—storage file number 2—line mark 3—row mark 4—data in stored
5—back to the previous menu 6—save the current thickness value or waveform
7—delete the selected data

Whether it is in the interface of thickness value, A-scan or B-scan, the current measured thickness values will be stored for short press SAVE, and the current waveform will be stored for long press SAVE. A-scan waveform will be stored in the A-scan interface, and B-scan image will be stored in the B-scan interface.

4.2BROWING THE STORED DATA

Press MODE to access the configuration display and select FILE NUMBER, then press ▲ below OPEN, the file list with thickness value will appear on the display. Press ⬆ or ⬇ to select the stored file you want to recall, then press CAL ON to confirm.

5. MEASUREMENT APPLYING SKILLS

5.1MEASURING ERROR PREVENTION

1. MATERIAL INFLUENCE

In many materials like nonmetal or plastic, the change of velocity is obvious, thus, the accuracy of measuring is influenced. If the material of the object is not isotropic, the velocity varies in different directions. In this condition, the preset velocity should be the average value among the testing range, which can be acquired through testing a block with the same velocity as the object average velocity value.

2. ULTRA-THIN MATERIAL

When the thickness of the testing object is below the minimum value of the probe limit, the result may be incorrect, and the thickness can be acquired by contracting the blocks when necessary.

When testing ultra-thin materials, sometimes DUAL-ECHO happens, which is a kind of incorrect result and the result is twice of the real one. Another incorrect result called PULSE ENVELOPE AND CIRCULATORY JUMPING, which means that the

testing result is higher than the real one. In order to prevent this kind of error, when testing the object with the appropriate thickness as the minimum limit and judgment is available, customer should pay attention to the waveform displayed and adjust the gain or use blank function.

3. SURFACE CLEANING INFLUENCE

Before measuring, all the dust, dirt and corrosion should be cleaned and the cover like paint should be removed.

4. ROUGHNESS INFLUENCE

The extremely rough surface may arouse measuring error or even reading lost, therefore, the surface of the material should be smooth before measuring through polishing, filing, grinding or using high-viscosity couplant.

5. SURFACE OF THE ROUGH MACHINE PROCESSING

The regular slugs after rough machine processing (such as lathing or planning) on the surface of the work-piece may also arouse measuring errors. Except for the compensation methods mentioned above in 4, adjusting the angle between and sound insulating wall (the metal film through the center of the probe bottom) of the probe and the slugs of the material and making them perpendicular or parallel with each other to get the minimum reading as the thickness value is also efficient.

5.2 MEASURING METHODS

1. SINGLE-POINT MEASUREMENT

Using the probe to measure a random point on the surface of the object, the reading displayed is the thickness value.

2. DOUBLE-POINT MEASUREMENT

Measuring twice at the same spot on the object, and making the probe inclines 90°in the second measurement, the thinner reading is the thickness value.

3. MULTIPLE-POINT MEASUREMENT

When the reading is unstable, measuring several times within a circle with a certain point as center and 30mm as diameter, the thinnest reading is the thickness value.

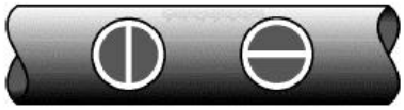
4. CONTINUOUS MEASUREMENT

Taking continuous measurements along a specified path at intervals of 5mm or less according to the single measurement method, the thinnest reading is the thickness value.

5.3 PIPE WALL MEASUREMENT

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

5.4 CAST MEASUREMENT

It's difficult to measure cast work-piece because there are some special features of the cast measurement: the rough grain of cast material, the loose structure, and the rough surface measuring status. So there are some tips to follow:

1. Use low frequency probe like ZT-12-2 in our company.

2. When measuring the non-processing surface of some cast work-piece, high viscosity couplant such as machine oil, grease or water glass is needed.

3. Calibrate the sound velocity with the standard block which shares the same material and same measuring direction with the testing object.

5.5 HOT SURFACE MEASUREMENT

The velocity of sound through a substance is dependent 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.

5.6 LAMINATED MATERIALS MEASUREMENT

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.

6. CARE AND MAINTENANCES

6.1 POWER SOURCE INSPECTION

During the usage of the gauge, 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 gauge.
2. Loosen the screws on the back of the units and remove the battery cover.
3. Take out the batteries and replaces 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.

6.2 CONSIDERATIONS

1. Please be cautious of the zero block's getting rust as couplant will be spread on the surface of it when calibrating the gauge. After using, clean the zero block. Avoid dripping sweat on the gauge in high temperature. Some
grease spreading on the surface of zero block is useful to avoid rusting if the gauge will be spared for long. Wipe the grease out when reusing.
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.

6.3 MAINTENANCES

Contact with the maintaining department of our company if the following problems appears:
1. Components damage and the gauge fail to measure.
2. The display of the screen is disordered.
3. The measuring error is abnormally big in normal situation.
4. Keyboard operating is disordered or keyboard doesn't work.
As the TM280 series ultrasonic thickness gauge is high-tech product, the maintaining work should be made by professional operator and please avoid self-acting operations.

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
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