Color Waveform
Ultrasonic Thickness Gauge
UM-4 Series

Operating Manual

YUSHI INSTRUMENTS

CONTENT

1. General Introduction

UM-4 series ultrasonic thickness gauge made by our factory with 2.4 inch 320*240 Color Dot Matrix LCD Screen, built-in A-SCAN snapshot, great capacity data storage and through coating thickness function is a kind of high precision, new-type, and portable industrial nondestructive testing instruments according to ultrasonic measuring principle.

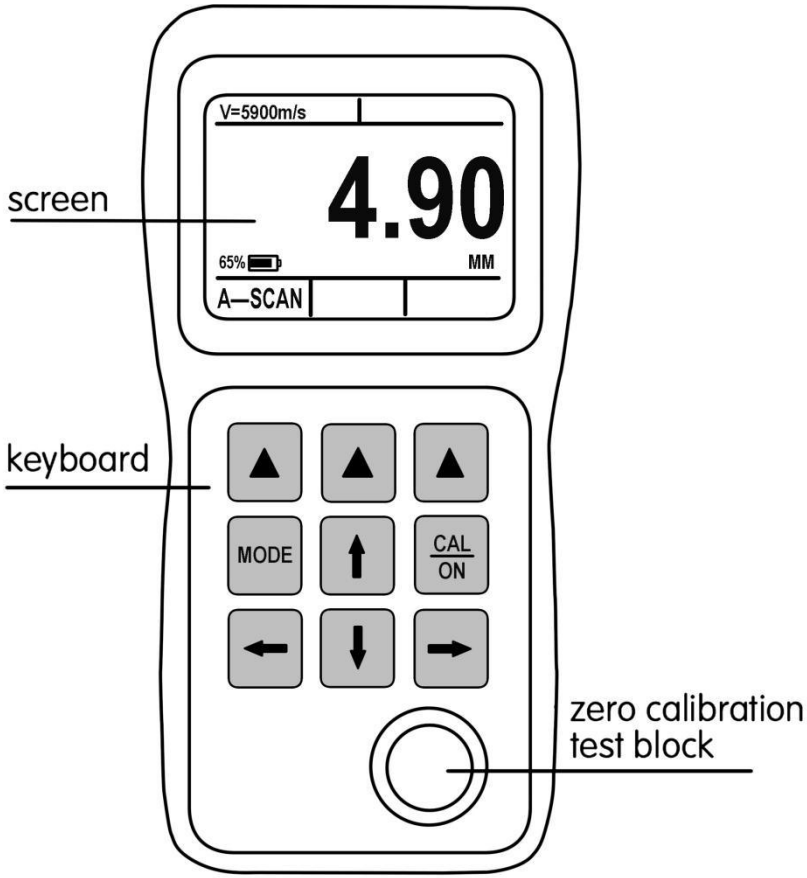
As the essential NDT instrument, UM-4 series can be widely applied in the detecting fields like manufacturing, metal processing, chemical industry, commodity inspection industry and so on. It can not only measures various kinds of panels and processing components precisely, but also monitor the thickness minus of tubes and pressure vessels in the manufacturing instruments after corrosion.

All models of this series' gauges are standard with A-scan snapshot function; it can help user better control measurement and avoid the inaccurate measurement value caused by the factor of material itself. And the UM-4DL with great capacity data storage function can save a total of 100,000 sets of data, and can be output to the computer via USB to archive and data analysis.

UM-4D and UM-4DL have through coating function: when there is coating layer on the surface of the material, the net thickness of the material can be directly measured without removal of the coating layer.

The UM-4DL also has a large-capacity data storage function, it can store 100,000 measurements Data, and be imported to computer via USB, using the random DataView software to make Statistics, analysis, archiving, printing reports, etc.

1.1 Construction of the Gauge



1.2 Standard Configuration

NAME	NUMBER
MAIN UNIT	1
PROBE	1
PROBE CABLE	1
ALKALINE BATTERY	2 (Prohibition of air transport)
COUPLANT BOTTLE	1 (Prohibition of air transport)
CARRYING CASE	1
OPERATING MANUAL	1
USB CABLE	1(ONLY UM-4DL)
SOFTWARE	1(ONLY UM-4DL)

1.3 Optional Configuration

HIGH-TEMPERATURE PROBE	CAST IRON PROBE
SMALL TUBE PROBE	FINGERTIP PROBE
PROBE CABLE	STEPPED CALIBRATION BLOCK
RUBBER SHEATH	STORAGE OPTION(ONLY UM-4)

Probe's Option and Measuring Range

Probe Description	Frequency (MHZ)	Diameter of Contact Surface	Measuring Range(steel)	Available Contact Temperature
Cast Iron Probe ZT-12	2	17mm	(4.0～508.0)mm	(-10～60)℃
Standard Probe PT-08	5	11mm	(0.8～100.0)mm	(-10～60)℃
Standard Probe TC510	5	13.5mm	(1.2～200.0)mm	(-10～70)℃
Composite Crystal Probe TC550	5	13.5mm	(1.2～200.0)mm	(-10～70)℃
Small Tube Probe PT-06	**7.5**	8.7mm	(0.8～30.0)mm	(-10～60)℃
Fingertip Probe PT-04	10	7.0mm	(0.7～12.0)mm	(-10～60)℃
High Temperature Probe GT-12	5	15.0mm	(4.0～80.0)mm	Under 480℃

1.4 Specification

Display Type	2.4 inch 320*240 Color Dot Matrix LCD Screen
Main Feature	A-SCAN Snapshot Function
Operating Principle	Ultrasonic pulse echo and echo-echo method with dual element probe
Measuring Range	0.60mm to 508mm(0.025" to 20.00"), depending on material, probe and surface condition
Measuring Resolution	Selectable0.01mm,0.1mm (selectable 0.001", 0.01")
Measuring Error	±0.05 (H＜10mm), ±(0.5%H+0.01) (H≥10mm） H is the thickness
Measuring Limits of Tube (Steel)	Φ20mm×3.0mm(Standard probe PT-08) Φ15mm×2.0mm(PT-06 probe) The measuring error is up to ±0.1mm
Units	Inch or Millimeter
Gain	Low, Medium or High
Display Mode	Normal, Minimum/ Maximum capture, DIFF/RR%
V-Path Correction	Automatic
Update Rate	Selectable 4Hz, 8Hz, 16Hz
Material Velocity Range	500 to 9999m/s (0.0197 to 0.3937in/us)
Aarm Settings	Minimum and Maximum alarms. Range of 0.25 mm to 508 mm (0.010" to 20.00"). Dynamic waveform color change on alarm
Languages	Selectable Chinese, English, Germany, etc.
Power supply	Two 1.5V AA batteries, 24 hours standby time
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)
Dimensions	153mm × 76mm ×37mm(H × W × D)
Weight	200g(including batteries）
Warranty	One year

1.5 Main Function

1.Parameter configuration interface is simple and easy operation
2.A-scan snapshot: Users could see ultrasonic signal waveform on the screen directly to verify the thickness value and analyses the cause of the problem, then find a solution.
3.When the probe is coupled with the workpiece, the white font is the thickness value.
4.Alarm Mode: Programmable Hi-Low alarm set point with Dynamic change thickness value's color.
5.Limit Value Mode: Catching the minimum and maximum value during measurement.
6.Difference Mode: Getting the difference between the actual value and the normal value as well as the percentage of difference value and normal value.
7. Selectable units of mm and inch.
8. Great Capacity Data Storage: Stores 100,000 thickness values. (only UM-4DL).
9. Measure the net thickness of the workpiece through the coating layer. (only UM-4D&UM-4DL)
10. Optional Resolution: ×.×× mm /×.× mm; ×.××× inch / ×.×× inch.
11.Multi-languages.Available:Chinese/English/German/French/Japanese, etc.
12. Battery Life: About 24 hours.

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)

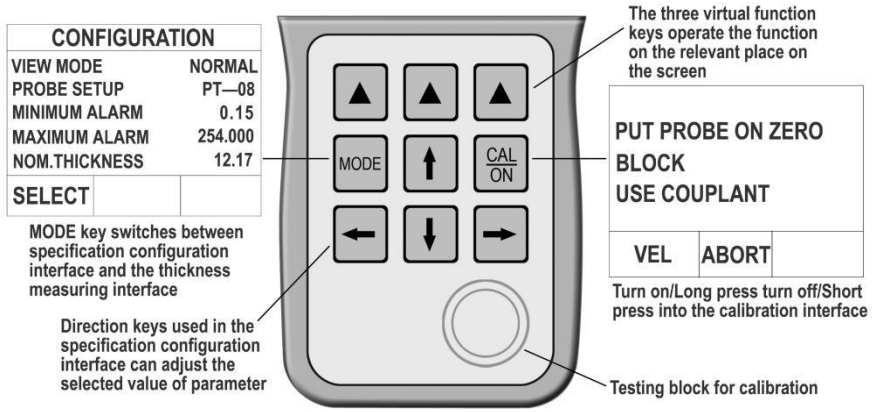


Figure 2.1 KEYPAD FUNCTION ILLUSTRATIONS

3. Measuring the Thickness

3.1 Instrument Calibration

Before using UM-4 series, the instrument and probe must be calibrated. The 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. UM-4 series' calibration divided in to the following:

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

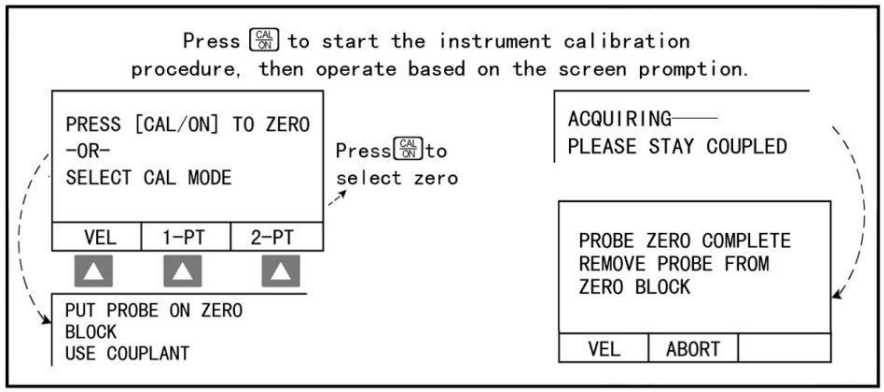
2. One point calibration：Use the zero block on the instrument to set up the probe zero procedure first, and then obtain the velocity from the test block of known thickness.

3. Two point calibrations： Calibrate the probe zero and the velocity of test blocks.

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

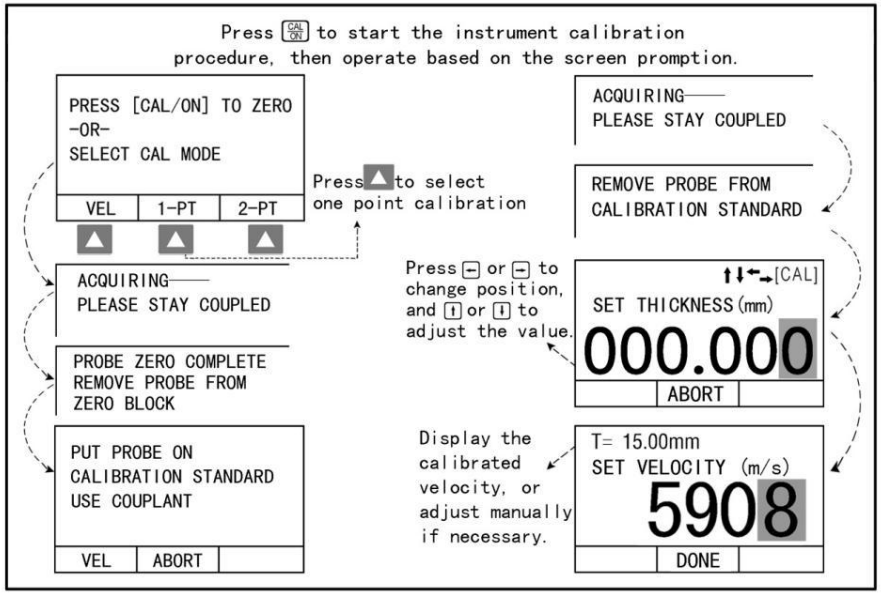
5.Setting the velocity manually： If the material velocity is known, for example the velocity of steel is 5900m/s. The sound velocity can be setting manually.

3.1.1 Probe zero procedure

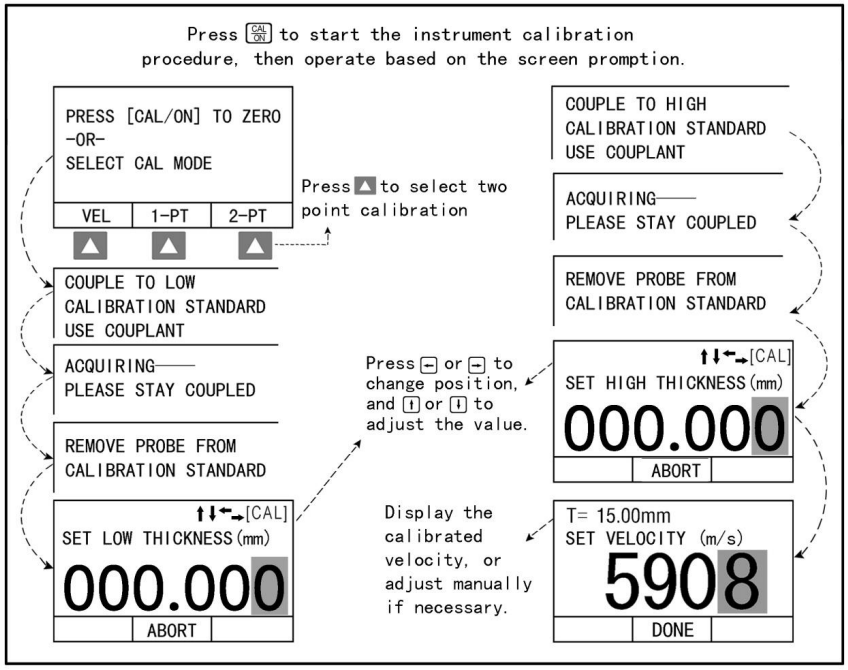


Note: Only when the sound velocity is 5900m/S, the zero calibration result is 4.00mm

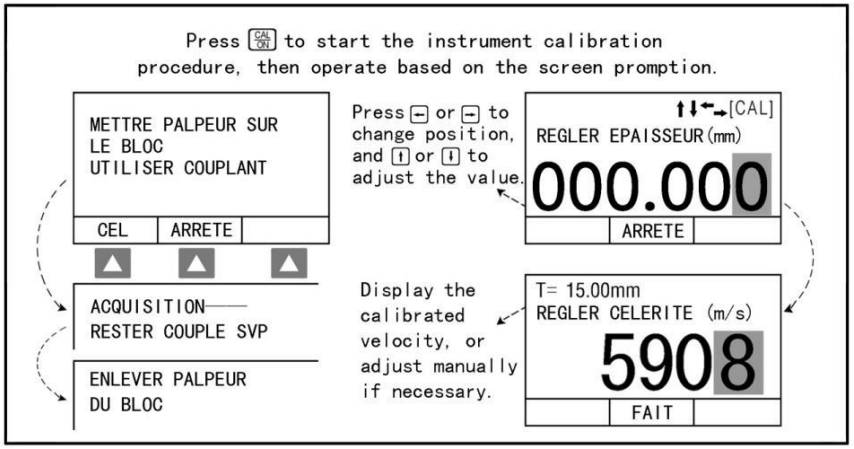
3.1.2 One point calibration



3.1.3 Two point calibrations



3.1.4 Dual Echo calibration



3.1.5 Sound velocity adjustment

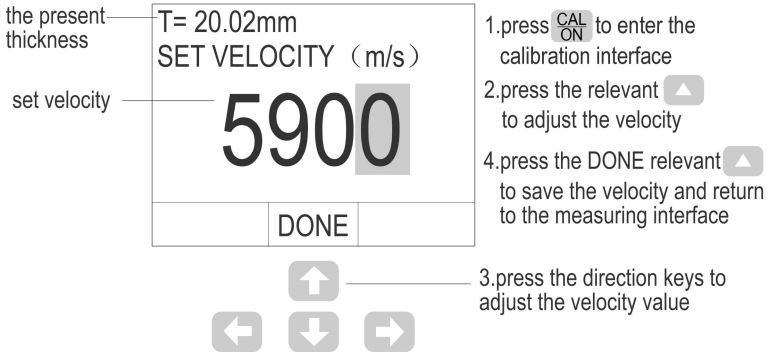


Figure 3.1 Velocity adjusting steps

Attention 1: Measuring the standard block before 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 are 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, GAIN, RESOLUTION, UPDATE RATE, LANGUAGE, UNITS, AUTO POWER-OFF, DELETE ALL FILES AND DEFAULT SETUP. See the following figure:

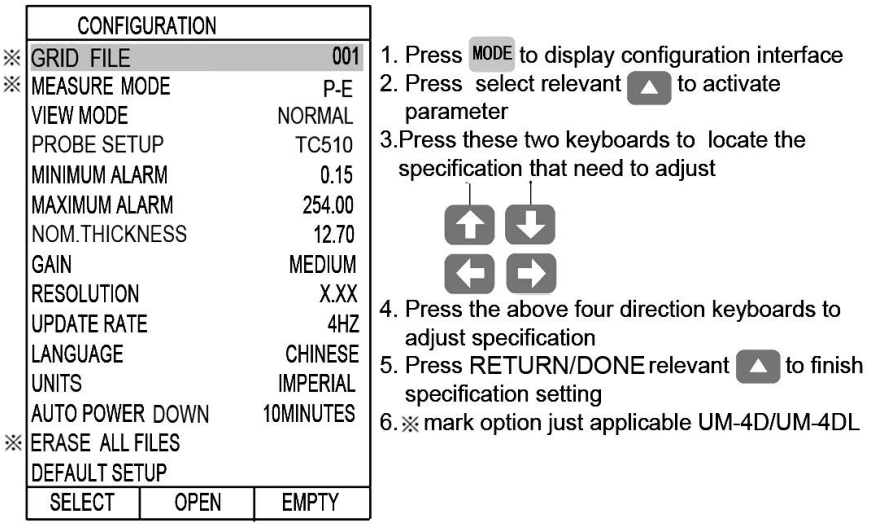


Figure 3.2 SPECIFICATION ADJUSTING STEPS

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

MEASUREMENT MODE - Single echo and dual-echo mode, single-echo mode is used for common measurement, dual-echo mode is used for through coating measuring.

VIEW MODE: Normal mode, differential mode and limit scanning mode.

PROBE SETUP: Many kind of probes are available:

TC510 (Standard)

TC550 (Composite Crystal Probe)

PT-08(Normal)

PT-06(Small Tube Probe)

PT-04(Fingertip Probe)

GT-12(High Temperature Probe)

ZT-12 (Casting Iron Probe)

NULL: Other Type Probes

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.

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

UPDATE RATE: Selectable 4Hz, 8Hz, 16Hz

LANGUAGES: Selectable Chinese, English, Germany, etc.

UNIT: Selectable units of mm and inch.

DEFAULT SETUP: Default settings out of the factory.

AUTO POWER-OFF: Auto shut-off - automatic power off with no operation, optional duration: 5 minutes, 10 minutes, and 20 minutes.

GAIN: Select the default value or reduction rate corresponding with the current setup, that is to say, adjust voltage magnification with high, middle and low three settings choices.

CLEAR ALL FILES: clear the thickness data in all files.

3.3 Display Modes

UM-4 series have three measuring interface display modes: normal mode, difference mode, limits value mode, and A-scan snapshot could be recalled on each mode. Select in “VIEW MODE” of CONFIGURATION.

ATTENTION: When the probe and the test material 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.

3.3.1 Normal Mode/ Thickness Value Mode

NORMAL MODE/THICKNESS VALUE MODE: The acquiescent opening interface. This interface mainly shows the present thickness value with big font.

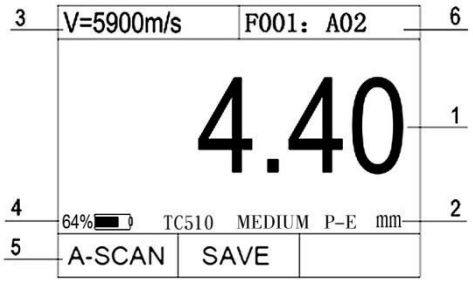


Figure 3.3 NORMAL MODE INTERFACE

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

3.3.2 Difference Mode

This interface shows the normal thickness value, the present thickness value, the difference between the normal value and the present value and the ratio between the difference and the normal value. Before using this mode, presetting the normal thickness is needed. The method can be taken according to chapter 3.2.

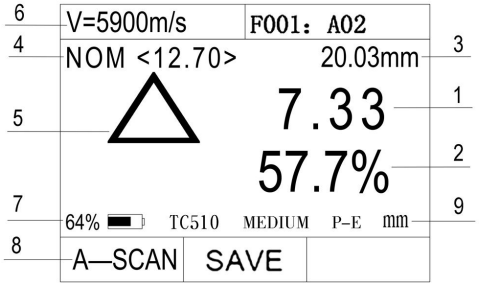


Figure3.4 DIFFERENCE MODE INTERFACE

1—the difference between the normal value and the present value. 2—the ratio between the difference and the normal value. 3—the present hickness value. 4—the normal value. 5—difference signal. 6—material velocity. 7—battery power. 8—A—scan snapshot interface 9--Measurement Unit

3.3.3 Limit Value Scan Mode

Limits value scanning mode: This mode allows the customer to test thickness of material continuously and to show the upper/lower limits after the tests. It shows the minimum and maximum values during testing as well as the present thickness. Press the RESET relevant ▲ to get the limits when measuring the thickness.

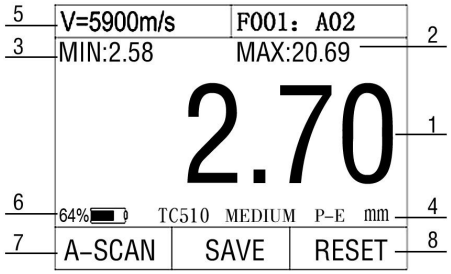


Figure 3.5LIMITS VALUE MODE INTERFACE

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

3.3.4 A-scan Snapshot Mode

A-scan snapshot model: in this mode, user could view the thickness values and A-scanning waveform snapshot.

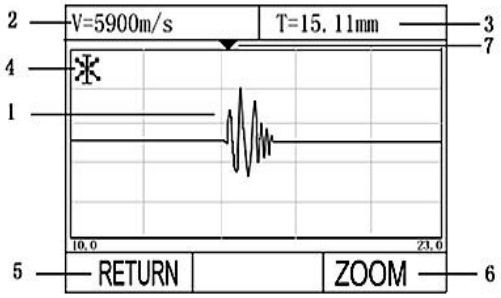


Figure3.6 A-SCAN SNAPSHOT INTERFACE INTRODUCTION

1—waveform snapshot display area 2—material velocity 3—present thickness value 4—A-scan snapshot state identification 5—back to the state of thickness value 6—magnify the current waveform 7— the triangle mark the location of the thickness value

3.3.5 A-scan Snapshot Amplification Mode

Enter A-scan snapshot amplification interface, at the same time, in the bottom left of the screen appears amplification identification, in this mode, you can see the A-scanning snapshot wave amplification figure of the current thickness value, which is convenient for the user to analysis and measure.

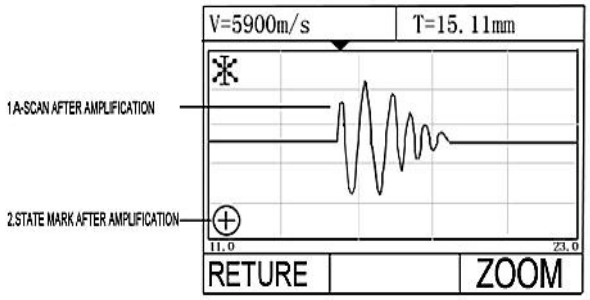


Figure3.7 A-SCAN SNAPSHOT AMPLIFICATION MODE

3.4 Through Coating Measuring Function

When measure a thickness of the object covered with coatings, there will be some errors. UM-4D and UM-4DL could accurately measure the net thickness of the object with double echo measurement principle without removing the coatings and destroy the surface process. This function is achieved by measure the two consecutive bottom echo of base material.

Press MODE into parameter interface, according to Figure 3.2, set the measurement mode to double echo and press MODE again back to thickness measurement interface. And then we can measure the thickness through coating, as the following 3.9.

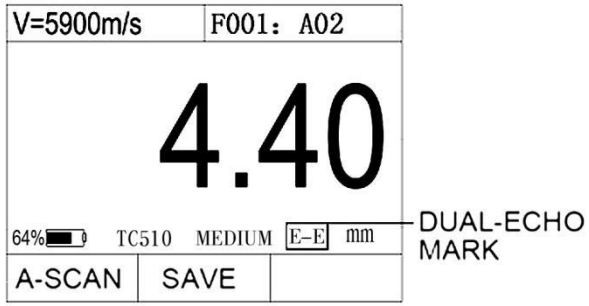


Figure3.9 THICKNESS MEASUREMENT INTERFACE WITH THROUGH COATING MODE

Note: UM-4 is the basic models without through coating function, UM-4D and UM-4DL have that function.

4. Data Storage Function

The UM-4DL have a powerful storage function, for saving one hundred thousand thickness values, it adopt the storage mode of microgrid (the follow Figure3.10). This is convenient for viewing and selecting the location of storage via adjusting And 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 Data View software to statistical and analyze measurement, report via connect printer.

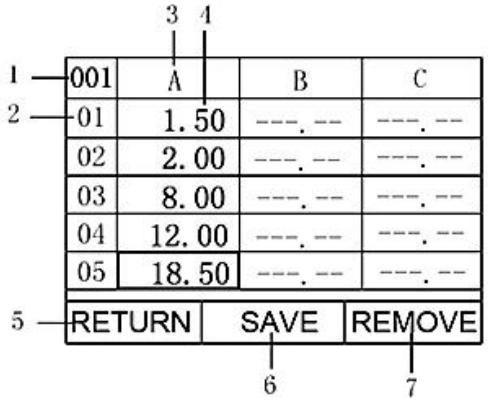


Figure4.1 GRID STORAGE MODE

1—storage file number 2—line mark 3—row mark 4—the location of thickness value or waveform 5—back to the state of thickness value 6—save thickness value or waveform 7—delete the selected data

Note: Only UM-4DL has the function of data storage and output in the standard configuration.

5. Measurement Applying Skills

5.1 Measuring 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 fine grooves caused by rough machined surfaces (such as lathes or planers) will also cause measurement errors. The solving method is the same as that of 4. In addition, adjust the angle between the sound insulation layer of the

probe and the fine grooves of the measured material to make the barrier plate and the slot are perpendicular or parallel to each other, and the minimum value in the reading is taken as the measured thickness, which can achieve better results.

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 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.

6. Care and Maintenances

6.1 Power Source Inspection

When the instrument cannot be turned on, the battery should be replaced first.

The battery replacement method is as follows:

1. Shut down
2. Loosen the screws and open the battery compartment cover
3. Take out the battery, put in a new battery, pay attention to the polarity

Note: The battery should be removed when the instrument is not in use for a long time, because even if it is turned off, there is a slight energy consumption, which affects the subsequent use.

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 UM-4 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
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
Zinc	0.170	4200

Note: The sound velocity in the above table is for reference only, please refer to section 3.1 for the actual sound velocity calibration