《OPERATION INSTRUCTION》



M-ULTRA SERIES

ULTRASONIC FLAW DETECTOR

PT-CC-V001 / A/0



Catalogue

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Version: V1.0 I
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Chapter 1 Overview

The digital ultrasonic flaw detector is a new generation practical flaw detector specially developed by Botech Company based on customer operating habits. It not only operates conveniently and quickly, but also adheres to the concept of Botech's excellent product performance and industry-leading. Its comprehensive performance and indicators have significant advantages in similar products.

Due to its compact size, easy grip, and equipped with a high brightness display screen, it is very suitable for mobile outdoor and elevated aerial operations; In conventional mode, it can also be used as a universal instrument for ultrasonic testing of general workpieces such as welds and forgings.

Main functional features:

- The multifunctional shuttle key, directional keys, and shortcut keys work together to make the new menu operation more efficient
- A/B dual gates automatically trap echoes, with one click quick calibration for sound speed, delay, and angle;
- Automatically provide recommended parameter values, which can be quickly used with simple settings;
- gate A quickly and automatically searches for waves, while gate B widens the entire screen;
- 5 sets of 50 channel parameters can be set, and 460 sets of data can be obtained;
- Automatic adjustment of DAC curve standard quick selection, evaluation line, quantitative line, and rejection line height;
- Peak memory and envelope functions can be quickly activated with just one click;
- One click quick activation of peak memory and envelope functions;
- 400MHz hardware real-time sampling, combined with recording and playback functions, makes the flaw detection graphics realistic and delicate;
- 20MHz broadband low-noise amplifier, can be used with various probes to achieve high sensitivity or high resolution flaw detection;
- Compact in size, waterproof and earthquake resistant, especially suitable for outdoor and elevated aerial inspection operations.

Chapter 2 Basic Performance Indicators

Comparison Table of Instrument Parameters				
Name				
Range	5-5000	0-10000mm	0-15000mm	0-25000mm
Sound velocity	1000-15000	1000-15000	1000-20000	1000-25000
Sensitivity margin for flaw detection	≥60dB	≥62dB	≥65dB	≥66dB
Dynamic range	≥42dB	≥46dB	≥48dB	≥50dB
Horizontal linear error	≤0.2%	≤0.1%	≤0.1%	≤0.1%
Vertical linear error	≤3%	≤3%	≤2.5%	≤2%
Far-field resolution	26dB	28dB	30dB	≥32dB
Memory	8G	8G	8G	8GB/expandable to 64GB
Working frequency	0-5,5-10	0-5,5-15	0-5,5-15,15-25	0-5,5-15,15-25
Clutter suppression	NO	YES	Up to 60% inhibition	Up to 60% inhibition
Noise reduction	NO	NO	Four level noise reduction	Four level noise reduction
Launch pulse	400V sharp pulse	400V sharp pulse	400V sharp pulse	Sharp pulse/square wave
Secondary wave color	NO	YES	YES	YES
American Welding Society Standard AWS	NO	YES	YES	YES
Comparison of waveforms	NO	NO	YES	YES
Probe delay	0.0~199.9us			
Gain adjustment	0~110dB, divided into 0.0/0.1/0.5/1.0/2.0/6.0dB step adjustment			
Damping	High, low			

Operation mode	Single probe or dual probe
Detection mode	Full wave/positive half wave/negative half wave/RF
Repetition frequency	Available in three gears of 40/250/1000Hz
Pulse shift	-10.0~2000mm
Sampling rate	Hardware sampling rate 400MHz
Measurement mode	Frontier or peak
Automatic gain	20%~85% Step by 5%
Communication interface	There are two A/B type USB interfaces in total
Display	5.0 "high brightness TFT color LCD screen, 800 * 480 pixels
Power supply	AC:100-240V DC:15V3.8A
Working hours	Sustainable power supply for more than 6 hours
Working environment temperature	-10~+50℃
Whole machine weight	About 1.0kg (including battery)

Chapter 3 Instrument Appearance Structure

3.1 Instrument panel

The appearance of the instrument is shown in Figure 3-1.

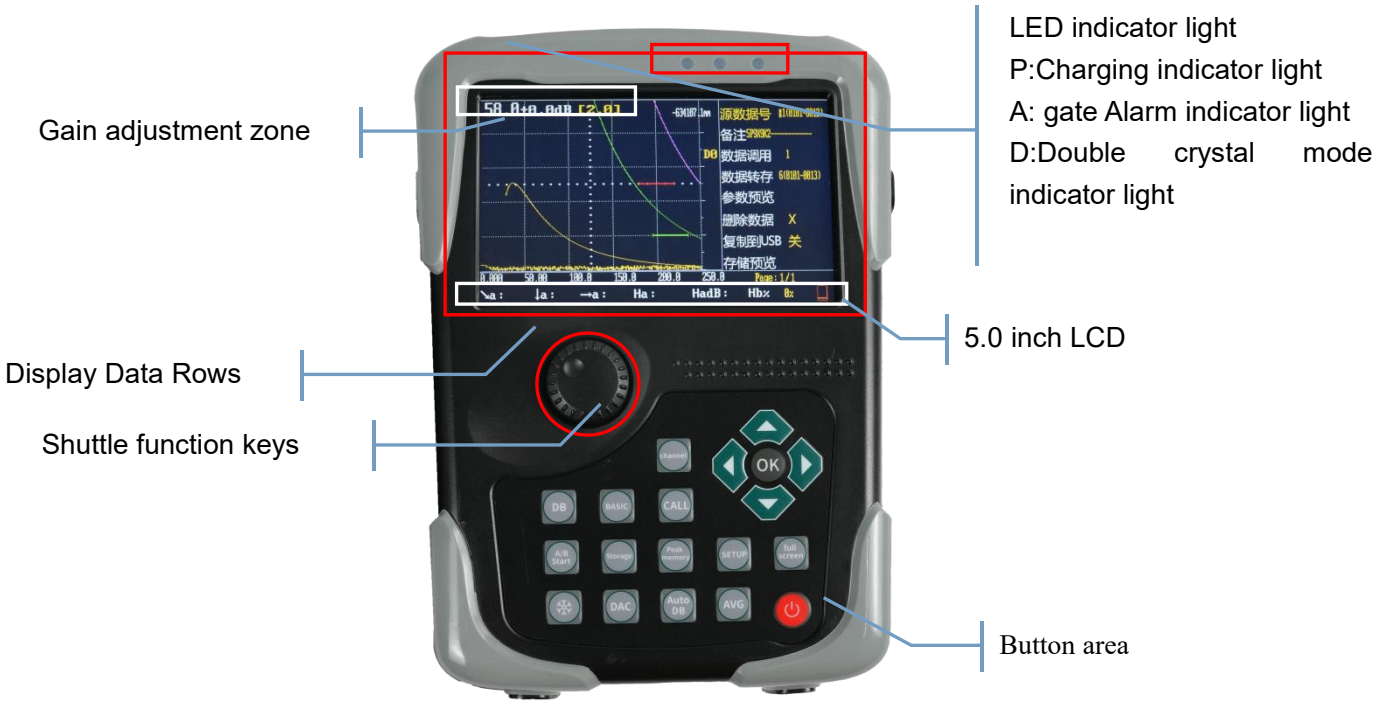


Figure 3-1 Instrument Panel

3.2 Instrument interface

The interfaces of the instrument are shown in Figures 3-2 and 3-3, respectively. Tighten the quick screws of the battery as shown in Figure 3-4.

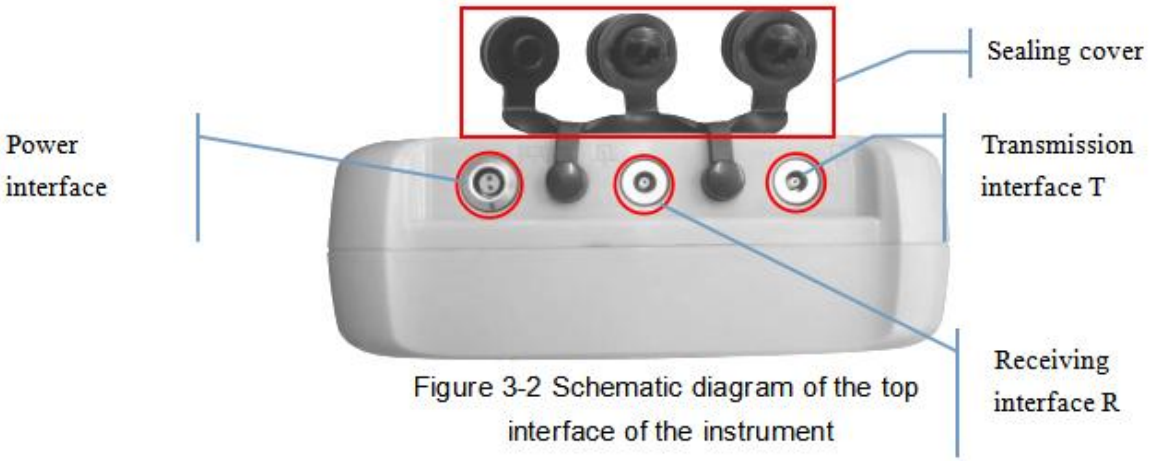


Figure 3-2 Schematic diagram of the top interface of the instrument

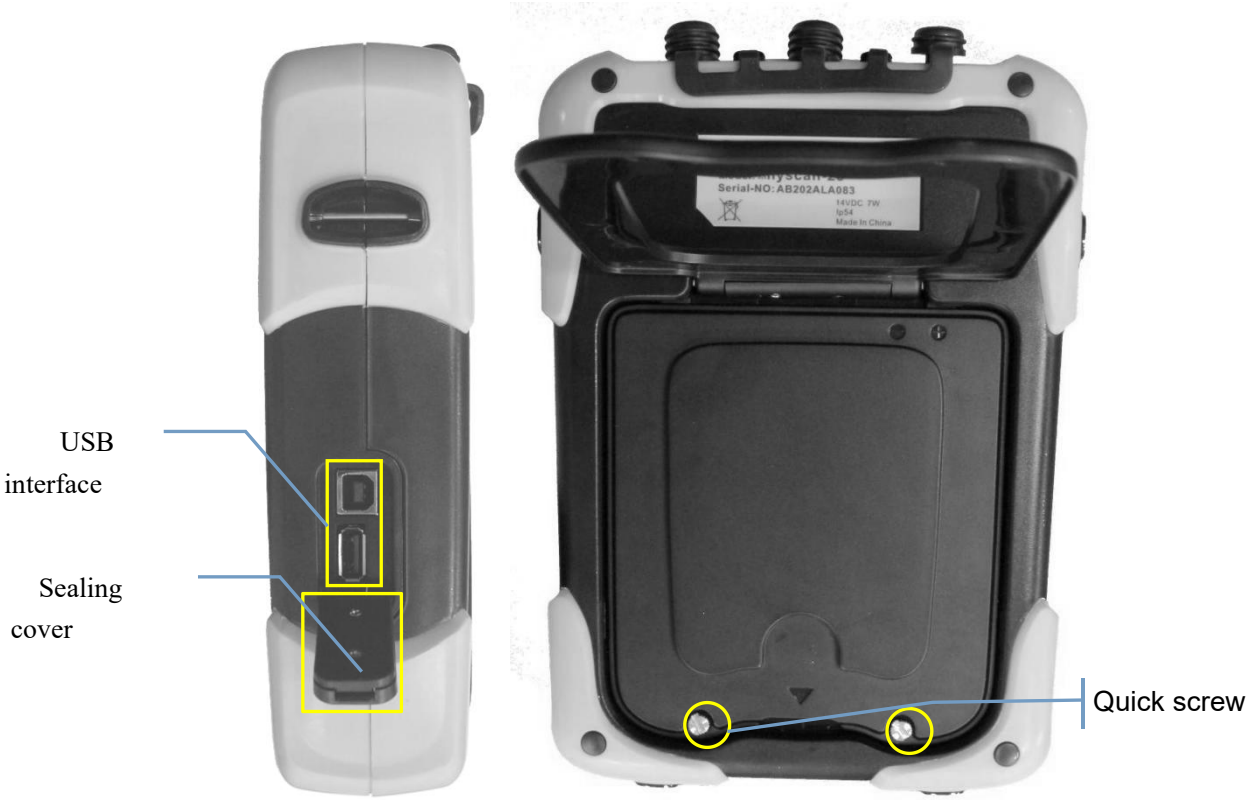


Figure 3-3 Interface on the side of the instrument Figure 3-4 Quick screws

3.3 Introduction of Software Interface

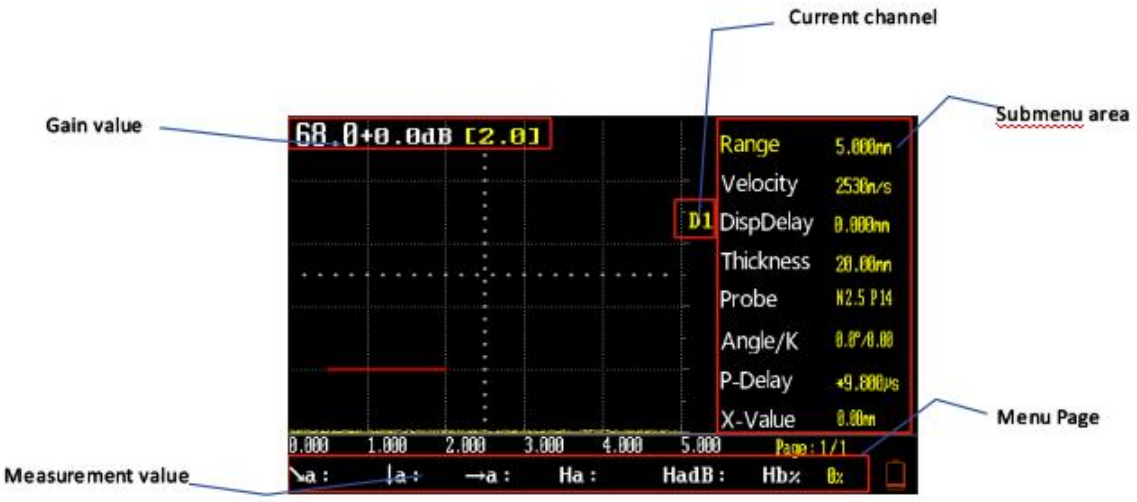


Figure 3-5 Schematic diagram of screen display partition

Table 3-1 Explanation of the Meaning of Parameters and Symbols

Parameters and symbols	**significance**
↘a	Sa, The sound path of the highest echo * inside the gate A.
↓a	Da, the vertical distance (depth) of the highest echo inside the gate A.
→a	Pa, the horizontal distance from the highest echo inside the gate A to the front edge of the probe.
Ha	The amplitude of the echo measurement point inside the gate A (expressed as a percentage)
Hadb	The difference between the amplitude of the echo measurement point and the height of the gate inside gate A (expressed in dB)
Hb	The amplitude of the echo measurement point inside the gate B (expressed as a percentage)

***Note:**

1. **The default measurement point of the instrument is selected as "peak". When the measurement point is changed to "front", Sa/Da/Pa are both the first in the gate The measured value of the echo, and at this time Ha has no reading;**
2. **The first five items in the measurement value area are fixedly displayed, and the last item is set as default in the "Measurement Options" section of the "Settings" shortcut**

key .The display parameters can be customized and replaced with other measurement values. The optional measurement values can be found in the appendix.

3.4 Battery replacement

- The M-Ultra battery is designed in an integrated mode with the instrument back cover, which is practical and easy to install and disassemble: simply remove the two locking screws to remove the battery, as shown in Figure 3-4.

***Note: When there is no battery, the red light will turn on when plugged in, and it will also turn red when charging is not completed. After charging is completed, the indicator light (P on the upper panel) will turn green.**

Chapter 4 Menu and Parameter Settings

4.1 Classification and operation methods of panel buttons

The panel buttons of this instrument can be divided into three categories: power button, function shortcut key, and parameter setting shortcut key. The function shortcut key includes "gain", "storage", "peak memory", "full screen", "freeze", and "automatic gain". Except for the "storage" key which also has the function of "parameter setting shortcut key", other "function shortcut keys" have no subordinate submenus.

The parameter setting shortcut keys include "Channel", "Basic", "Calibration", "Gate", "Storage", "Settings", "DAC", "AVG". After pressing the parameter setting shortcut key once (where the "Storage" key needs to be long pressed), the corresponding submenu will be displayed and the first item will be selected by default. At this point, the "Up/Down" key is used to move the cursor to select a submenu, and the "Left/Right" key or rotate the "Shuttle" key is used to adjust the parameters in the cursor indication submenu. In the pop-up window operation, unless otherwise specified, the down key can be used to exit the current operation.

***Note: Long press the shortcut keys with dual functions as follows:**

Press the "Storage" shortcut key once for quick storage function, long press to enter the corresponding submenu;

Press and hold "Gain" once to select the basic gain, and long press to select the reference gain;

Press "Gate" once to enter the main menu of gate settings, long press to activate the automatic wave finding function;

Press and hold "Peak Memory" once to activate the function, and long press to activate the envelope function;

Press "Full Screen" once to activate the full screen flaw detection mode. Long press to save the current waveform in a pre inserted USB drive.

4.2 Confirmation and saving of parameters

When this instrument uses a menu to exit or transfer, the original set

parameters will be confirmed and saved, making it very convenient to use proficiently.

After selecting the menu with the cursor, there are two ways to set and save parameters:

(1) **Press the "Left/Right" button to modify the parameters (this method is recommended):** Press the "Left/Right" button to modify the parameters, and the parameter values will be saved in real-time directly; The submenu contains multiple digits (such as probe model, date and time). After entering, the cursor is placed in the first digit. Press the "Left/Right" key to change the value, and press the "Confirm" key to rotate the cursor. The modified parameter values are saved in real time.

(2) **Rotate the "Flying Shuttle" to modify parameters:** Rotate the "Flying Shuttle" to modify parameters, and directly save the parameter values in real time; The submenu contains multiple digits (such as probe model, date and time). After entering, the cursor is placed in the first digit. Rotate the "Flying Shuttle" to change the value, press the "Flying Shuttle" key to rotate the cursor, and the modified parameter values are saved in real time.

4.3 Page flipping operation

For shortcut keys containing multi page submenus, pressing the corresponding shortcut key can cycle through pages, making it convenient to quickly search for parameters; Alternatively, press the up and down arrow keys to continuously scroll through all the submenus under that shortcut key.

4.4 Function Shortcut Keys Introduction

4.4.1 Passage way

This instrument is preset with 50 detection channels, divided into five groups: A/B/C/D/E, A0-A9, B0-B9, C0-C9, D0-D9, E0-E9. Among them, the A/B/C three groups of flaw detection channels are set according to the common parameters of oblique probe detection by default, while the D/E two groups of flaw detection channels are set according to the common parameters of straight probe detection by default. During detection, you can choose and adjust the parameters according to your needs.

The waveform display area on the software interface displays the current channel number in the upper right corner. Press the shortcut key "Channel" once to quickly select and press the "Confirm" key to access the channel. Long press the shortcut key "Channel" to directly preview or modify the current flaw detection channel parameter settings, see 5.1 for details.

4.4.2 gain

The gain value range is 0.0~110.0 dB, with steps of 0.0/0.1/0.5/1.0/2.0/6.0 dB. The default step is 2.0 dB, and the step of 0.0dB is to prevent on-site misoperation. The gain cannot be adjusted under this step, so be careful when using it. The display mode of gain is "basic gain+reference gain", such as "40.0dB+0.0dB". The factory default setting for gain is 20.0dB. The specific operation method is shown in 5.3.

***Note: All default settings in this manual are based on the oblique probe inspection channel as an example. Except for important parameters, the default values of the straight probe channel parameters will not be listed together.**

4.4.3 Peak memory (long press as envelope)

Press once to switch between "on/off" in "peak memory"; When the "peak memory" function is activated, the top of the highest echo inside the gate is marked with an "X" sign; When the highest echo drops or disappears, the "x" sign remains stationary. If a new highest echo appears inside the gate, the "x" sign will be used to indicate the position of the new echo peak point.

Long press this button to switch between "on/off" of the "envelope" function; When the "envelope" function is enabled, use a purple line to record the change trajectory of the echo peak in the waveform area. The convenient method for observing changes in echo height in probe performance testing and defect detection is to use the "envelope" function to display the dynamic echo trajectory in its entirety on the screen.

4.4.4 freeze

Switch between "freeze" and "thaw" waveforms with each press. When the waveform is frozen, the range, sound speed, gain and other parameters that

affect the waveform state cannot be adjusted, while some parameters such as gate position can be adjusted.

4.4.5 automatic gain

Every time you press, the echo amplitude inside gate A is automatically adjusted to a certain height (which can be set by yourself in the "Settings" main menu, and the instrument defaults to 80%), regardless of its original height. It is very convenient for instrument calibration and creating DAC curves.

After "automatic gain", the total gain value of the instrument will be displayed in the "basic gain" value in the upper left corner of the screen, such as "40.0dB+0.0dB".

4.4.6 Full screen and screenshot

Full screen is a shortcut key for zooming in and out on the screen. Press once to switch between "full screen inspection" and "menu settings". When conducting full screen inspection, except for some shortcut keys (such as "gain", "storage", "peak memory", "full screen", "freeze", "automatic gain", etc.) that can be used, the menu selection and setting are all blocked to facilitate the prevention of on-site misoperation.

In addition, for the convenience of directly saving the instrument screen for preparing teaching materials, process cards, homework guides and other enterprise documents, this machine also has a "screenshot" function. When a USB flash drive is inserted, long press the "Full Screen" shortcut key to save a screenshot of the current status of the instrument screen. If the screenshot is successful, there will be a prompt.

4.4.7 Power button

The circular orange red button in the lower right corner of the instrument is used for the on/off operation of the instrument. Press and hold for about 2 seconds to turn off or on.

4.5 Introduction to shortcut keys for parameter settings

4.5.1 Basic

Table 4-1 Shortcut Keys **Basic**

Page	Submenu	Explanation

number		
1/1	Scope	Detection range: 0.5~5000mm (steel longitudinal wave); The factory default setting is 120mm.
	Speed of sound	Sound speed range: 1000-1500m/s, including commonly used sound speed quick selection.
		When selecting straight probe N for "Probe Specification", the default setting is "5920m/s".
		When selecting oblique probe A for probe specifications, the default setting is 3230m/s.
	Pulse shift	Range: -10.0-2000mm; The factory default setting is "0.0mm".
	Workpiece thickness	Range: 1.0-5000mm, default to 20.00mm.
	Probe	Input probe model specifications: probe type+probe frequency+chip material+chip size specifications; Except for "chip material", each item in the model can be set item by item, such as A 5 P 8 × 12.
		The default factory setting for A (oblique probe) is "A2.5P8 × 12"; The default factory setting for N (straight probe) is N2.5P20.
	Angle/K value	Angle: The refractive angle of the probe in the workpiece is 0.0 °~90.0 °. Press the "Left/Right" button or turn the "Flying Shuttle" button to switch between several commonly used angles. If you need to adjust the angle finely, press the middle confirmation button, and an * sign will appear before the angle to adjust the number of angle digits; Press the confirm button again and two asterisks will appear. At this point, the angle value can be changed in steps of 0.1 °.
		K value: the tangent value of the refractive angle of the probe in the workpiece; Range: 0.00~3.01, ∞.
		When selecting oblique probe A in the "Probe Specifications", the default setting is "63.4 °/2.00"; When selecting the straight probe N in the "Probe Specification", the factory default setting is "0.0 °/0.00".
		Note: The angle and K value are interrelated, and as the angle changes, the K value also changes accordingly.
	Probe	Zero point adjustment of sound beam incidence,

	delay	range: 0.0~199.9 μ S; The factory default setting is 0.000 μ S.
	Frontier	The distance between the front end face of the oblique probe housing and the incident point of the probe. Range: 0.0~100.0mm Note: Selecting the straight probe N is invalid; When oblique probe A is selected, it defaults to 12.0mm

4.5.2 Gate

Table 4-2 Shortcut Keys **for Gates**

Page number	**Submenu**	**Explanation**
1/1	Gate logic	Used to select the working mode and alarm logic of gate A; Positive/negative/off; The factory default setting is "positive".
		Close: Close gate A, that is, turn off the alarm and measurement functions.
		Positive: Forward wave alarm, that is, within the coverage range of gate A. If the echo height exceeds the preset gate height, the alarm light A will light up. If the "Alarm Switch" in the "Settings" menu is set to "On", an audible alarm will sound.
		Negative: Loss of wave alarm, that is, within the coverage range of gate A. If the echo height is lower than the preset gate height, the alarm light A will light up. If the "Alarm Switch" in the "Settings" menu is set to "On", an audible alarm will sound.
	Gate starting point	Range: 0.0~5000mm; The factory default setting is 40.0mm.
	Gate width	Range: 0.02-5000mm; The factory default setting is 20.0mm.
	Gate height	Range: 5% to 90%; Step value is 1%; The factory default setting is "40%".
	Gate logic	Off/positive/negative; The factory default setting is "off".
	Starting	Range: 0.0~5000mm; The factory default setting is

	point of gate B	80.0mm.
	Gate width	Range: 0.02-5000mm; The factory default setting is 40.0mm.
	Gate height	Range: 5% to 90%; Step value is 1%; The factory default setting is "30%".
***Note: gate B cannot be used to create DAC curves.**		

4.5.3 Calibration

Table 4-3 Quick Key **Calibration**

Page number	**Submenu**	**Explanation**
1/2	project	Default "sound speed+delay"
	Gate starting point	Range: 0.0~5000mm; The default setting under this menu is 45.0mm.
	Reference 1	0.0-500.0mm; The default setting is 50.0mm.
	Reference 2	0.0-1000 mm; The default setting is "100.0mm". (When modifying "Reference 1", "Reference 2" automatically adjusts according to a 2-fold relationship. When modifying "Reference 2", "Reference 1" remains unchanged).
	Starting point of gate B	Range: 0.0~5000mm; The default setting under this menu is 95.0mm.
	Speed of sound	Same as "Sound Speed" under the "Basic" menu.
	Probe delay	Same as "Probe Delay" under the "Basic" menu.
	Frontier	The distance between the front end face of the oblique probe housing and the incident point of the probe. Range: 0.0~100.0mm Note: Selecting the straight probe N is invalid; When oblique probe A is selected, it defaults to 12.0mm
2/2	project	The default "angle/K value".

	Gate starting point	Range: 0.0~5000mm; The default setting under this menu is "10.0mm".
	Hole depth	Range: 0.0~100.0mm; Directly press the "Left/Right" button or rotate the "Flying Shuttle" button to switch between several commonly used hole depths of 15mm, 30mm, and 70mm; The instrument will automatically provide the appropriate hole depth according to the set probe angle.
	Aperture	Range: 0.0~50.0mm; Directly press the "Left/Right" button or rotate the "Flying Shuttle" button to switch between several commonly used apertures of 1.5mm and 50mm; When selecting "hole depth=15mm" quickly, it automatically gives "hole diameter=1.5mm"; When selecting "hole depth=30mm or 70mm" quickly, it will automatically give "aperture=50mm".
	Scope	Detection range: 0.5~5000mm (steel longitudinal wave); Same as "Scope" in the "Basic" menu.
	Angle/K value	Same as "Angle/K Value" under the "Basic" menu.
	Frontier	The distance between the front end face of the oblique probe housing and the incident point of the probe. Range: 0.0~100.0mm Note: Selecting the straight probe N is invalid; When oblique probe A is selected, it defaults to 12.0mm
	Speed of sound	Same as "Sound Speed" under the "Basic" menu.

4.5.4 DAC

Table 4-4 Shortcut Key **DAC**

Page number	**Submenu**	**Explanation**
1/3	DAC	Turn off/record/correct, this page defaults to "off".
2/3	DAC	Select DAC mode: Record
	DAC echo	Display the number of current echo reference points (up to 20).

	Gate starting point	Range: 0.0~5000mm; The default setting is 10.0mm.
	Scope	Enter the detection range, which is the same as the range under the "Basic" menu.
	Judging scrap lines RL	According to the selected "standard name" and "standard level" on the next page, as well as the set "workpiece thickness", it will be automatically given, such as "+5.0dB"; It can also be manually adjusted as needed.
	Quantitative line SL	According to the selected "standard name" and "standard level" on the next page, as well as the set "workpiece thickness", it will be automatically given, such as "-3.0dB"; It can also be manually adjusted as needed.
	Evaluation line EL	According to the selected "standard name" and "standard level" on the next page, as well as the set "workpiece thickness", it will be automatically given, such as "-9.0dB"; It can also be manually adjusted as needed.
	Curve selection	The curve used to determine the equivalent value of defects in gate A has three options: "evaluation line/quantitative line/scrap line", with the default being "quantitative line"; The upper right corner of the waveform area on the screen will display the equivalent of the echo within gate A relative to the selected curve, such as "SL+3.0dB".
	***Note: When selecting GB11345, the name and number of curves will change accordingly based on the selected acceptance level, and will not be listed one by one here.**	
3/3	DAC	Select DAC mode: Fix
	Standard name	JB/T 4730 NB/T47013 GB11345, default NB/T47013.
	Standard level	Choose the type of test block and the thickness level of the workpiece to be tested for DAC production.
	Curve correction	Use the "Left/Right" or "Shuttle" keys to select the point that has already been made, and use the "Up/Down" keys to make corrections and adjustments. Adjust the height range of the selected point to 5% to 100%.
	Surface compens	Set surface compensation values- 19.0~20.0dB; The factory default setting is "0.0dB".

	ation	
	Curve deletion	Delete the current DAC curve, default to "off"; When set to "on", a confirmation prompt will pop up to prevent accidental deletion.
	Hidden busbar	Show or hide the DAC bus, default to "off", which shows the DAC bus.
	Curve selection	Same as the explanation on page 2/3.

4.5.5 AVG

Table 4-5 Shortcut Keys **AVG**

Page number	**Submenu**	**Explanation**
1/3	AVG	Turn off/record/display, this page defaults to "off".
2/3	AVG	Select AVG mode: Record.
	Gate starting point	Range: 0.0~5000mm; The default setting is 40.0mm.
	Reference aperture	0.0~23 mm/∞ (large flat bottom); Input the diameter of the flat bottom hole of the test block used to create the AVG curve, which is set to "2.0mm" by default at the factory.
	AVG curve 1	Set the equivalent value of the flat bottom hole for the target curve, with a default value of "2.0mm"; Range: 0.0~23 mm/∞ (large flat bottom).
	AVG curve 2	Set the equivalent value of the flat bottom hole for the target curve, with a default value of "3.0mm"; Range: 0.0~23 mm/∞ (large flat bottom).
	AVG curve 3	Set the equivalent value of the flat bottom hole for the target curve, with a default value of "5.0mm"; Range: 0.0~23 mm/∞ (large flat bottom).
	Compensation	Compensation between the theoretical amplitude difference and the actual difference between the benchmark large flat bottom and the same distance flat

		bottom hole test blocks; Range: -20~20dB, factory default is 0dB.
	AVG deletion	Delete the current AVG curve, default to "off"; When set to "on", a confirmation prompt will pop up to prevent accidental deletion.
3/3	AVG	Select AVG mode: Display.
	Gate starting point	Range: 0.0~5000mm; The default setting is 40.0mm.
	Reference aperture	0.0~23 mm/∞ (large flat bottom); Input the diameter of the flat bottom hole of the test block used to create the AVG curve, which is set to "2.0mm" by default at the factory.
	AVG curve 1	Set the equivalent value of the flat bottom hole for the target curve, with a default value of "2.0mm"; Range: 0.0~23 mm/∞ (large flat bottom).
	AVG curve 2	Set the equivalent value of the flat bottom hole for the target curve, with a default value of "3.0mm"; Range: 0.0~23 mm/∞ (large flat bottom).
	AVG curve 3	Set the equivalent value of the flat bottom hole for the target curve, with a default value of "5.0mm"; Range: 0.0~23 mm/∞ (large flat bottom).
	Compensation	Compensation between the theoretical amplitude difference and the actual difference between the benchmark large flat bottom and the same distance flat bottom hole test blocks; Range: -20~20dB, factory default is 0dB.
	AVG deletion	Delete the current AVG curve, default to "off"; When set to "on", a confirmation prompt will pop up to prevent accidental deletion.

4.5.6 Storage

Table 4-6 Shortcut Keys **"Storage"**

Page number	Submenu	Explanation
1/1	Source data	Number 0-459, a total of 460 sets of data storage; Use the "Left/Right" or "Shuttle" keys to adjust the selection

	number	data number, and use the "Confirm" key to adjust the step.
	Remarks	In the "Remarks" menu, you can enter 0-19 digits or uppercase English letters in sequence, which are used to simply label the key points of stored content, such as standard number, user, or weld thickness, for easy selection when calling up. The modification method can be found in section 5.11.2.
	data calling	Use the "Left/Right" or "Shuttle" keys to adjust and select the data number that needs to be called up, and use the "Confirm" key to call it up. ***Note: When adjusting the "source data number", the "data call" number will automatically change accordingly (unchanged when the data in the "source data number" is empty), to facilitate quick retrieval of data under the current non empty data number.**
	Data transfer	Transfer the data from the "source data number" to a new storage number in the "data transfer". Use the "Left/Right" or "Shuttle" keys to adjust the selection data number, and press the "Confirm" key to save it. ***Note: If there is already data in the new storage number, a prompt will pop up indicating whether to overwrite it to prevent accidental operation and loss of data.**
	Parameter preview	Press the "Confirm" button to enter and view the parameter settings corresponding to the data in the current "Source Data Number".
	Delete data	Press the "Confirm" button to enter, and follow the prompts on the screen to select "Confirm" to delete or "Cancel" to prevent data from being accidentally deleted.
	Copy to USB	Current/All/Off; Default off; Use the "left/right" or "shuttle" keys to select, and press the "confirm" key to copy the data from the current "source data number" to the USB storage device.
	Storage Preview	Press the "Confirm" button to enter and check the data storage status of the memory. Display all non empty storage numbers and note information that have

		already stored data in a table. You can use the "Left/Right" button or the "Shuttle" button to quickly select and turn pages. Press the "Confirm" button to enter a quick preview and retrieve data.

4.5.7 Set Up

Table 4-7 Shortcut Keys **"Settings"**

Page number	**Submenu**	**Explanation**
1/4	B gate widening	On/off, default to "off"; See 5.8 for details.
	Measurement points	Peak/Frontier, default to "Peak". Please refer to 5.16 for details.
	Measurement value	Default Hb%, other options can be found in the appendix.
	AWS	On/off, default to "off". When setting "on", the following menu will pop up. Please refer to 5.13 for specific usage methods.
		B reference value X.X dB Indicator value X.X dB C attenuation factor X.X dB D rated value X.X dB gain Gate starting point X.XXX mm Scope XXX X mm quit
	Dynamic recording	Record/replay/transfer, default to "record".
		(1) Select "Record" and press the "Confirm" button. Three selection boxes "Start (Stop)/Transfer/Exit" will pop up at the bottom of the screen. Click "Start" to start recording data. After "Stop", click "Transfer" to transfer data to a USB drive; (2) Select "playback" and press the "confirm" button. Three selection boxes "start (stop)/transfer/exit" will pop up at the bottom of the screen. Click "start" to start playback of data. After "stop", click "transfer" to transfer to a USB drive;

		(3) Select "Transfer" and press the "Confirm" button to transfer the recorded dynamic waveform data to a USB flash drive; ***Note: If there are no dynamic records in the memory, the playback and transfer functions are not available.**
	Weld seam diagram	On/off, default to "off". When set to "on", the weld seam setting menu pops up. (This feature is currently not open)
	Waveform comparison	On/off, default to "off". When set to "on", the current echo is frozen, making it easier to compare with the active echo.
	Secondary wave color	Off/On, default to "off"; According to the thickness value of the workpiece, distinguish and display the first and second waves (odd and even waves under multiple waves) in different colors. Please refer to 5.15 for details.
2/4	Twin crystal	Off/On, default to "off", meaning that a single straight or oblique probe works. When set to "on", use the dual crystal probe or the dual probe "one send one receive" working mode.
	Damping	High/Low; The factory default setting is "low".
		By adjusting damping, the height, width, and resolution of the echo signal can be changed. When the damping is low, the echo height is higher and the width is wider, resulting in lower detection resolution; When the damping is high, the echo height is low, the echo width is narrow, and the detection resolution is high.
	Power	High/Low, factory default set to "high".
	PRF	40/250/1000 Hz three speed automatic/manual options, factory default set to "250Hz".
	Bandwidth	0.5~6/3~22MHz is optional, and the instrument will automatically provide appropriate frequency band recommendations based on the probe frequency set in the "Probe Specifications". It can also be manually selected.
	Detection	Full wave/positive half wave/negative half wave/RF; The factory default setting is "full wave".
	Inhibition	Off/1% to 90%; The factory default setting is "off", and when using suppression, the screen prompts the red

		letter "RJ". ***Note: Be very careful when using the suppression function, as this operation may remove defect signals.**
	Noise reduction	0-4; The factory default is "0".
3/4	Language	Chinese/English, the domestic version defaults to "Chinese", and the foreign version defaults to "English".
	Scale	The horizontal scale is represented in four ways: sound path/division/horizontal distance/vertical distance; The factory default is "sound path".
		Sound path: The horizontal scale displays the sound path value of the echo. Divisions: The horizontal scale is displayed as 10 equal divisions. Horizontal distance: The horizontal scale displays the horizontal distance of the defect (only valid for oblique probes). Vertical distance: The horizontal scale displays the vertical distance of the defect (only valid for oblique probes).
	Color scheme	There are a total of 1 to 6 color schemes, with a factory default setting of "1".
		1: Black screen background, yellow waveform; 2: Black screen background, green waveform; 3: Green screen bottom, yellow waveform; 4: Green screen bottom, red waveform; 5: White screen background, black waveform; 6: White screen background, red waveform.
	Backlight	Divided into three levels: low, medium, and high; The factory default setting is "medium".
	automatic gain	20% to 85%; Default "80%"; To be used in conjunction with the "Auto Gain" shortcut key, please refer to 5.5 for details.
	Screen saving	Off/On, default to "off"; After turning on, press the confirm button to save the current screenshot to the USB storage device.
	Alarm switch	Off/On, default to "off"; When set to "open", the sound of opening the gate will sound an alarm.

		***Note: A/B gates will sound and light an alarm as long as one of the alarm conditions is met.**
	wipe data	Off/On, default to "off"; All data in the memory can be deleted with one click. When set to "on", a confirmation window will pop up on the screen to avoid accidental deletion.
4/4	Surface correction	Invalid/Flat/ φ 2000~ φ 200.0mm; Invalid when using a straight probe; When using an oblique probe to detect curved workpieces, it is used to correct measurement values such as depth and level of defect echo signals.
	System upgrade	Off/On, default to "off"; Insert a USB drive containing the upgraded version of the instrument software, and when set to "on", a prompt will pop up on the screen to confirm whether to proceed with the system upgrade again to prevent accidental operation. ***Note: Under normal circumstances, system upgrades will not delete saved detection data and saved channel parameter settings in the instrument.**
	Factory settings	Off/On; Default "off"; Used to restore all channel parameters to their factory default values. When set to "on", a prompt will pop up on the screen for secondary confirmation of whether to restore the factory settings to prevent accidental operation. ***Note: Under normal circumstances, restoring the factory settings will not delete the saved test data in the instrument.**
	Date	The display format is "yyyy mm dd", for example, "2015-10-10" represents October 10th, 2015.
	Time	The time display format is "hh: mm: ss", for example, "14:27:56" represents 14:27:56 seconds.

4.6 Probe setting method

The instrument defaults to an oblique probe at the factory. Taking A5P13 * 13 changed to N5P20 as an example, explain the process of modifying the probe model.

When selecting the "Probe" submenu, the default blue rectangular cursor is at the position of letter A. Press the "Left/Right" button or rotate the "Flying Shuttle"

button to switch between "N/A (straight/oblique probe)" letters. Press the "Confirm" button to automatically move the cursor to probe frequency 5. Press the "Left/Right" button or rotate the "Flying Shuttle" button to change the frequency value. Press the "Confirm" button to automatically move the cursor to the chip size position. Press the "Left/Right" button or rotate the "Flying Shuttle" button to change to 20.

Chapter 5 Main Functions and Operating Methods of the Instrument

Although the M-Ultra model is compact in size, it has excellent performance and powerful functions. It is not only very suitable for welding seam inspection operations with high fluidity and elevated spaces, but also conveniently used for high-sensitivity and high-resolution ultrasonic testing of forgings, aircraft components, etc. This chapter focuses on the functional application characteristics of the instrument.

5.1 Channel selection and parameter settings

This instrument is preset with 50 detection channels, divided into five groups: A/B/C/D/E, A0-A9, B0-B9, C0-C9, D0-D9, E0-E9. Among them, the A/B/C three groups of flaw detection channels are set according to the common parameters of oblique probe detection by default, while the D/E two groups of flaw detection channels are set according to the common parameters of straight probe detection by default. During detection, you can choose and adjust the parameters according to your needs.

The waveform display area on the software interface displays the current channel number in the upper right corner. Press the "Channel" shortcut key once, and the following channel selection window will pop up. Press the "Up/Down" direction key to cycle through the five sets of flaw detection channels A~E. Press the "Left/Right" direction key to cycle through the numbers 0-9. You can quickly select and press the "Confirm" button to call up the channel.

Table 5-1 List of Inspection Channels

A	0	1	2	3	4	5	6	7	8	9
B	0	1	2	3	4	5	6	7	8	9
C	0	1	2	3	4	5	6	7	8	9
D	0	1	2	3	4	5	6	7	8	9
E	0	1	2	3	4	5	6	7	8	9

After selection, press the "Confirm" button to call up the "Parameter Preview Table" of "Table 5-2".

Almost all menu parameters in the "Parameter Preview Table" have chosen the most commonly used parameters as default values. Generally, only the "Probe Specification", "Probe Angle", and "workpiece thickness" need to be set, and other menus can be slightly confirmed.

After the "Parameter Preview Table" pops up, if you need to modify the parameters in the list, you can use the "Up/Down/Left/Right" directional keys to select the parameters, and then rotate "Flying Shuttle" to make the changes; If you need to change the step value, you can press the "Shuttle" or "Confirm" button to cycle through the step gear. After all the parameters are changed, press the "Channel" key or other shortcut keys to save the channel parameters and call them up.

If you need to preview or modify the current channel, you can long press the "Channel" button to enter the current channel parameter list, and all other operations are the same.

Table 5-2 List of Testing Channel Parameters

Probe specifications A2.5P8X12	Basic gain 20.0dB	Relative gain 0.0dB	Scope 120.0mm	Speed of sound 3230m/s	Workpiece thickness 20.00mm
Probe delay zero μ S	Probe angle 63.4 °/2.00	Pulse shift 0.000mm	Gate starting point 40.00mm	Gate width 20.00mm	Gate height 40%
Starting point of gate B 80.00mm	Gate width 40.00mm	Gate height 30%	Measurement point selection peak value	Measurement options Off	Repetition frequency 250Hz
Judging scrap	Quantitative line	Evaluation line	Surface compensa	Double crystal	detection mode

lines 5.0dB	-3.0dB	-9.0dB	tion 0.0dB	switch shut	full wave
Bandwidth 0.5-6MHz	Damping low	Surface correction flat	Weld seam diagram	Date 2015-10- 10	Time 09:58:45

5.2 Gate setting and automatic wave finding

This instrument is equipped with a/b dual gate, and the method for setting gate parameters is as follows:

Press the "Gate" shortcut key to pop up the relevant submenu of "Logic/Starting Point/Width/Height" for the gate. Directly press the "Left/Right" directional key or the "Shuttle" key to modify the numerical value, and press the "Confirm" key to adjust the step. The up/down arrow keys can be used to cycle through various submenus.

This instrument is equipped with an automatic wave finding function for gate A, and the operation method is as follows:

Long press the "Gate" shortcut key, and the "A gate Start Point" will automatically increase (i.e. the gate will move from left to right) until it captures an echo that exceeds the "height" of the gate. Then long press the "Gate" shortcut key, and the gate will continue to move to capture the second echo that exceeds the "height" of the gate. If there is no echo exceeding the height of the gate within the detection range during the gate search process, the gate will automatically return to its original position.

In digital ultrasonic flaw detectors, gates are more commonly used for measuring echo distance and amplitude, leading to various automatic correction functions such as "material sound velocity", "probe delay", "probe angle", etc. In addition to the conventional "incoming/lost wave" alarm function, it also has the following purposes:

(1) Measure the distance and amplitude of the echo inside the gate, and the distance measurement value is displayed in the data line of the screen by default;

(2) Measure the sound path, horizontal distance, and vertical distance of the oblique probe echo inside the gate And display them on the screen data line;

(3) Used for probe delay calibration, angle calibration, and material sound velocity calibration, etc;

(4) When conducting flaw detection, the "B gate widening" function can be

activated to widen the "B gate width" to full screen, thereby widening the far-field echo inside the gate And making it easy to observe the details; (See 5.8 for details)

(5) A gate can be used to create DAC curves.

***Note: When using gates to measure echoes, in order to ensure sufficient accuracy of the measurement results, "Peak" or "Frontal" should be selected in the "Settings Measurement Points" submenu before starting the measurement. For the convenience of use, this instrument has set default values according to different measurement requirements. It can be checked slightly during initial use.**

5.3 Gain adjustment

Press the "Gain" shortcut key, and the "Basic Gain" in the upper left corner of the screen will flash. The initial gain step value is 2.0 dB. Press the "Left/Right" key to cycle between 0.0/0.1/0.5/1.0/2.0/6.0. Rotate the "Shuttle" or press the "Up/Down" direction keys to increase or decrease the "Basic Gain" according to the currently selected steps. After setting, press the "Shuttle" or "Confirm" keys to complete the changes and exit the gain adjustment operation. Or wait for the cursor to continue flashing for about 3 seconds. If there are no further actions, the flashing will stop and automatically exit.

Note: When the current step is 0.0, the gain cannot be adjusted, which can prevent misoperation in this state.

Long press the "Gain" shortcut key, and the "Reference Gain" in the upper left corner of the screen will flash. The initial gain step is 1.0 dB. Press the "Left/Right" key to cycle between 0.0/0.1/0.5/1.0/2.0/6.0. Rotate the "Shuttle" or press the "Up/Down" direction keys to increase or decrease the "Reference Gain Value" according to the currently selected steps. After setting, press the "Shuttle" or "Confirm" keys to complete the changes and exit the gain adjustment operation. Or wait for the cursor to continue flashing for about 3 seconds. If there are no further actions, the flashing will stop and automatically exit.

5.4 Calibration function (double gate Automatic echo retrieval calibration)

5.4.1 Sound speed+delay calibration

Generally speaking, straight probes, oblique probes, twin crystal straight probes, and other probes with delay blocks require "delay calibration" to facilitate defect localization. The operation methods for sound speed calibration and delay calibration are completely the same, so calibrating them together can improve efficiency. Taking the example of using CSK-IA test blocks for calibration of oblique probes, this article briefly describes the specific calibration method. Other probes and test blocks can be used as reference.

(1) **Recommended test block:** CSK-IA test block. This instrument has set relevant default values according to the most commonly used CSK-IA block calibration method in China, and the calibration efficiency has doubled.

(2) **Set "Probe":** Set the "Probe**" model** in the "Channel Parameter Preview Table" or the "Basic" main menu, and enter the relevant parameters of the probe to be tested, such as A2.5P10 × 10.

***Note: When selecting oblique probe A, the default sound speed is 3230m/s automatically, and when selecting straight probe N, the default sound speed is 5920m/s.**

(3) Press the "Calibration" shortcut key to enter the "Calibration" main menu, select "Sound Speed+Delay" for "Project": gate A and gate B will automatically open. Simply check if the default settings for "Sound Speed", "Reference 1", "Reference 2", etc. are correct.

***Note: Reference 1 defaults to 50mm, and Reference 2 defaults to 100mm.**

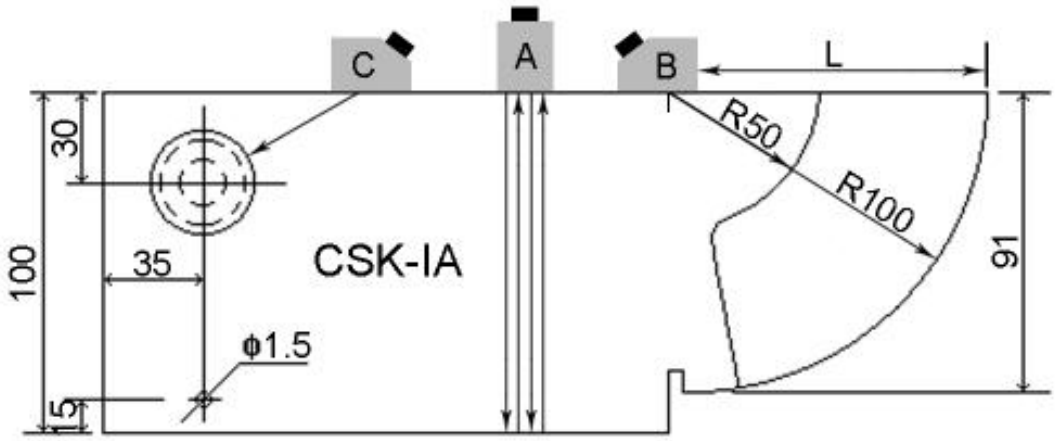


Figure 5-1: Tightly coupling the probe to the upper surface of the CSK-IA test block

(4) Connect the oblique probe to be tested and couple it to the CSK-IA test block B position in Figure 5-1, moving left and right to obtain the highest echo of the R50 and R100 arc surfaces. Under normal circumstances, gate A and gate B will automatically trap the echoes of R50 and R100, respectively. (As shown in Figure 5-2)

***Note 1: During the process of searching for the highest echo, you can long press the "Peak Memory" shortcut key to activate the "Envelope" function, so as to simultaneously find the highest echo of R50 and R100 circular surfaces.**

***Note 2: In some special cases, the echo may not be within the range of the gate. In this case, it is necessary to manually adjust the positions of gate A and gate B to respectively trap the R50 and R100 curved surface echoes.**

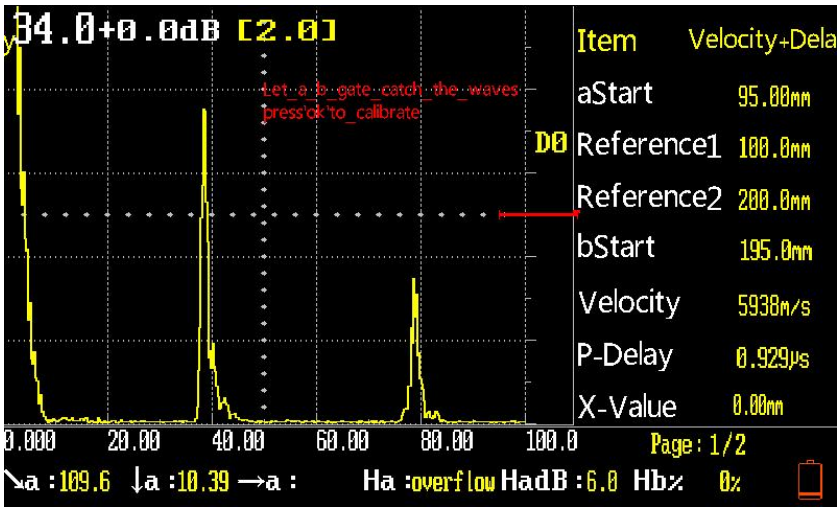


Figure 5-2: Gates a/b automatically trap R50 and R100 echoes, respectively

(5) When the submenu selection cursor is in the "Project" column (i.e. when "Project" is in yellow font), press the "Confirm" button to automatically complete the "Sound Speed+Delay" calibration. At this time, the screen will prompt: "Calibration completed, sound speed XXXX m/s, delay X.XX" μS", and two selection boxes "Confirm" and "Cancel" will pop up. Press "Confirm" to update the sound speed and delay to the calibrated results; Press "Cancel" to exit calibration and keep the values before calibration. (As shown in Figures 5-3)

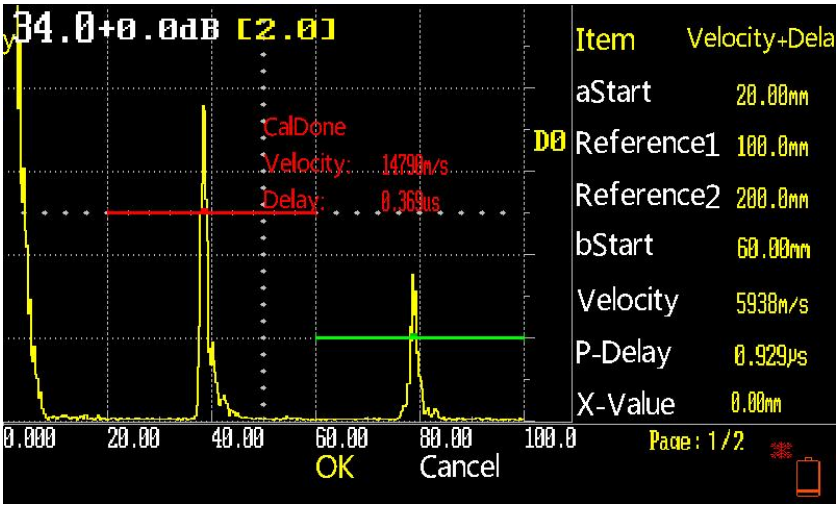


Figure 5-3 Screen prompts for calibration results of "sound speed and delay"

In situations where high precision is required for defect localization, the straight probe should also first correct its delay. The reason is that the starting wave front displayed on the detector screen is only the zero point of the emitted pulse "electricity", and the zero point of the probe itself "sound" is slightly delayed. When calibrating, place the straight probe at a thickness of 100.0mm (position A) on the CSK-IA test block to obtain a secondary echo, and then refer to the above method to "determine". The separate calibration method for sound speed or delay is the same as above, and will not be repeated here.

5.4.2 Angle/K-value calibration

The refractive angle of the oblique probe needs to be calibrated regularly due to various factors such as processing accuracy, wear, and environmental

temperature changes.

(1) The recommended test block and probe parameter settings are the same as "sound speed+delay calibration".

(2) Select the "Angle/K value" option, and the instrument will automatically select the appropriate "hole depth" and "aperture" based on the set probe "Angle/K value". It can also be manually adjusted as needed.

***Note 1: CSK-IA test blocks are used by default, so when setting the probe angle β≤ 60°, the instrument will automatically set the hole depth to 70mm; β≥60°, the instrument will automatically set the hole depth to 30mm; The instrument automatically sets the aperture to 50mm.**

***Note 2: There are commonly used parameter options for hole depth, such as "15mm", "30mm", and "70mm". The aperture will automatically correspond to "1.5mm", "50mm", and "50mm".**

(3) Connect the probe and couple it to position C of the CSK-IA test block in Figure 5-1 to obtain the highest echo of Φ50 holes, under normal circumstances, gate A can automatically trap this echo. (As shown in Figures 5-4)

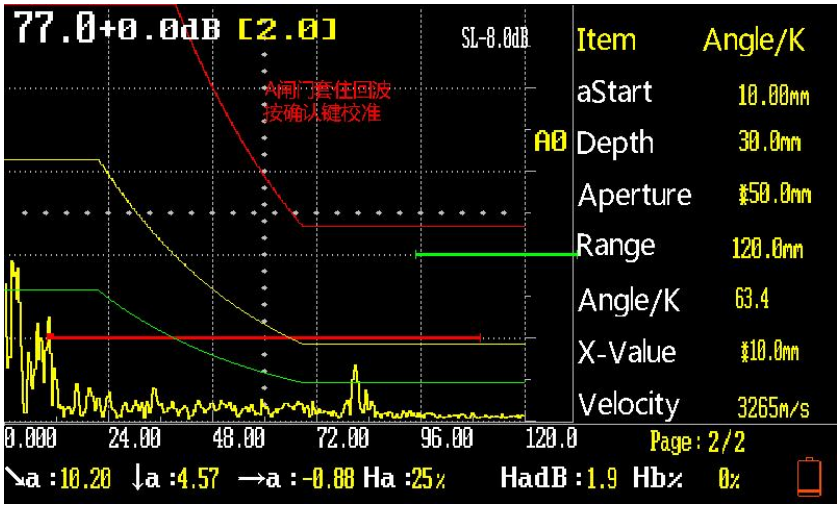


Figure 5-4: gate A automatically catches Φ 50 hole echo

(4) When the submenu selection cursor is in the "Project" column (i.e. when the "Project" is in yellow font), press the "Confirm" button to automatically complete the "Angle/K Value" calibration. At this time, the screen will

prompt: "Angle calibration successful, new angle: XX. X °", and two boxes "Confirm" and "Cancel" will pop up. Press "Confirm" to update both the angle and K value to the calibrated result; Press "Cancel" to exit calibration and keep the values before calibration. (As shown in Figures 5-5)

***Note: In some special cases, the echo may not be within the range of gate A. In this case, it is necessary to manually adjust the position of gate A to trap it Φ The highest echo of 50 holes.**

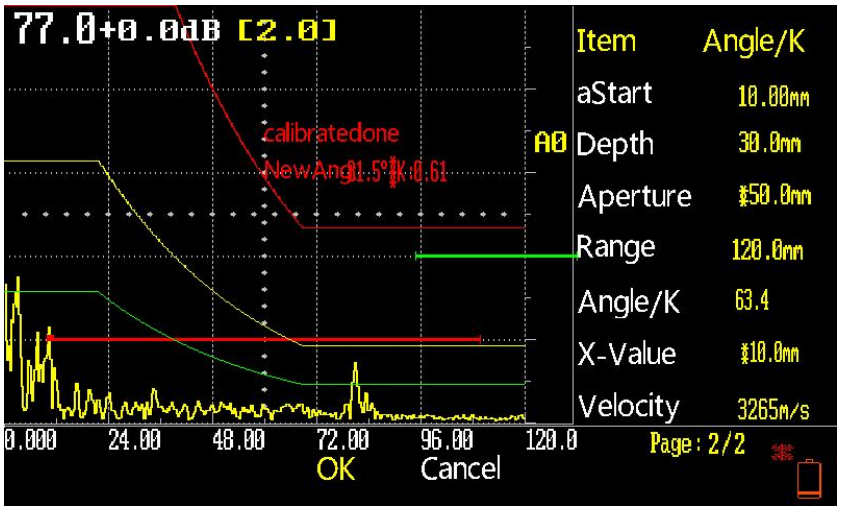


Figure 5-5 Screen prompts for "angle" calibration results

5.4.3 Probe front edge

When using an oblique probe for flaw detection, the known probe "leading edge" should be input for defect localization. Especially when the "weld seam diagram" function is enabled in this instrument, the position of the probe and defects must be calculated and displayed based on the "front edge" of the probe.

Close couple the oblique probe to position B of the CSK-IA test block (as shown in Figure 5-1), adjust the gain value, and find the highest reflected echo of the R100 circular arc surface. The leading edge value of the Botech company's oblique probe can be directly read from the scale value on the probe housing aligned with the R100 center line. Other companies can use a ruler to measure the L value in Figure 5-1 and calculate it using the formula "Leading edge=100-L".

To simplify the operation, this instrument places the "front" item of the probe in the "calibration" menu. The "front" measurement can be performed together with

the "sound speed+delay" calibration. After the measurement is completed, please manually enter the "front" value.

5.5 Automatic gain

"Gain" is one of the most frequently adjusted items in ultrasonic flaw detector. For the convenience of use, this instrument is equipped with an "automatic gain" shortcut key and a submenu. The parameter setting range of the "Auto Gain" menu is "20% to 85%" (in steps of 5%), and the instrument defaults to "Auto Gain=80%". When in use, press the "Auto Gain" shortcut key, and the instrument can automatically adjust the "Gain" value to make the echo amplitude in gate A exactly match the set value in the "Auto Gain" menu, such as 80%.

5.6 Peak Memory/Envelope

The peak echo is one of the most important parameters in ultrasonic testing, and many times it is necessary to make judgments based on it, so most instruments have the function of "peak memory".

Pressing the shortcut key "Peak Memory", the instrument displays the peak value and position of the dynamic waveform on the screen with an "X" symbol, and refreshes it when a new peak value appears. This is a common method for determining the echo peak value in on-site flaw detection scanning.

The convenient method for observing the trajectory of echo height changes in probe performance testing and defect detection is to use the "envelope" function to fully display the dynamic echo trajectory on the screen. Long press the "Peak Memory" shortcut key on this instrument to turn on or off the "envelope" function. The color of the echo envelope is purple, clear and delicate.

5.7 Weld seam diagram

Weld seam inspection is one of the most extensive applications in ultrasonic testing, so the instrument has a special submenu for "weld seam diagram". When in use, not only can the location parameters of defects be accurately calculated and displayed, but also after correctly inputting the welding seam parameters and probe positions, the specific location of defects can be clearly and intuitively marked in the welding seam diagram at the bottom of the screen. After the application of the weld seam diagram, parameters related to the weld seam icon

are locked (such as workpiece thickness and probe front edge, etc.). (This feature is currently not open)

5.8 B gate widening

Due to the difficulty of clearly displaying the near-field/far-field echoes of large workpieces on the limited screen of the instrument, the "B gate widening" function was set up. When in use, the width of the "B gate" is widened to full screen, and the echo inside the gate is "horizontally enlarged" to fully display its details.

With the support of high-speed hardware, this instrument can widen the "B gate width" as small as 0.1mm to full screen.

It should be noted that the effect of "widening the B gate" only depends on the width of the B gate itself and is not related to the size of the "detection range", nor does it affect the original amplitude of the echo; When in use, it is even possible to adjust the "starting point" and "width" of the B gate to freely widen and observe the echo details between any small section within the "detection range", which is convenient and practical. Therefore, it is of great significance in the inspection of large forgings and aircraft components.

5.9 The production and application of DAC curves

When ultrasonic waves propagate in materials, attenuation occurs, causing reflectors with the same equivalent but different distances to exhibit different echo amplitudes. Therefore, the concept of "distance wave amplitude" curve is introduced to visualize this attenuation and facilitate on-site applications. DAC is the English abbreviation for the distance amplitude curve when it was introduced from Germany and has been used ever since.

5.9.1 Production of DAC curves

This instrument can use up to 20 point method to produce DAC curves. Taking the A5P13 × 13K2 oblique probe and CSK - IIIA test block as an example to illustrate:

(1) Select "Channel", set the relevant parameters, press the "DAC" shortcut key, and defau**lt t**o the DAC "Record" page.

(2) Connect the probe and couple it to the CSK-IIIA test block (as shown in

Figure 5-6); Move the probe to a depth of 10mm Φ The echo of 1 × 6 holes is the highest.

***Note: At this time, you can press the "Peak Memory" shortcut key to activate the "Peak Memory" function, or long press the "Peak Memory" shortcut key to activate the "Envelope" function, which can more conveniently find the highest point of the echo.**

(3) When creating a DAC curve, the default "starting point" of gate A is 10mm and "width" is 150mm. Therefore, when creating a DAC curve for welding seam detection with a plate thickness of ≤ 30mm (i.e. within 6 points), almost no adjustment of the gate is needed during the point selection process to automatically capture the echoes at each point.

***Note: In some special cases, if the A gate does not automatically trap the echo, the A gate can be manually adjusted to trap the echo by adjusting the "A gate starting point" position. You can also reduce the width of gate A and long press the "Gate" shortcut key to use the "Automatic Wave Finding" function of gate A to quickly capture the echo.**

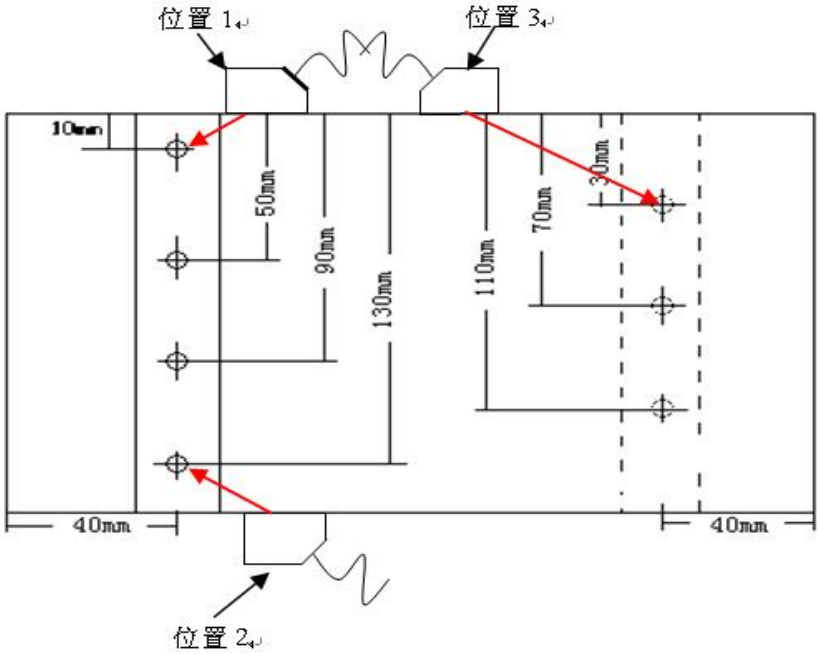
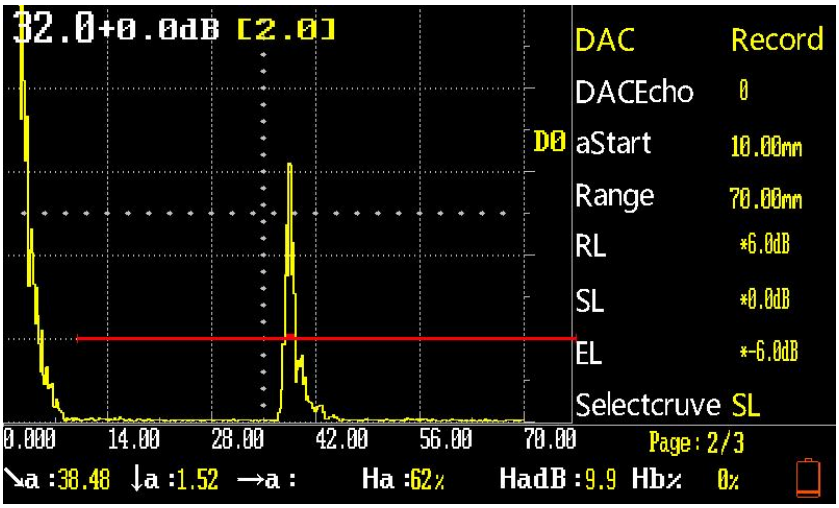


Figure 5-6 Interface of Connecting Probes and Coupling to CSK-IIIA Test Blocks

(4) Press the "Auto Gain" shortcut key to automatically increase the echo

height to 80%. On the "DAC Echo" submenu, press the "Right" button, and the "DAC Echo" will change from "0" to "1". The first point of the DAC curve will be recorded (as shown in Figure 5-7).



Interface of DAC curve in the first segment of Figure 5-7

(5) Using the same method, identify the highest echo of the short transverse hole with a depth of 20/30/40/50/... and confirm it. The screen will display a complete set of DAC curves, as shown in Figure 5-8.

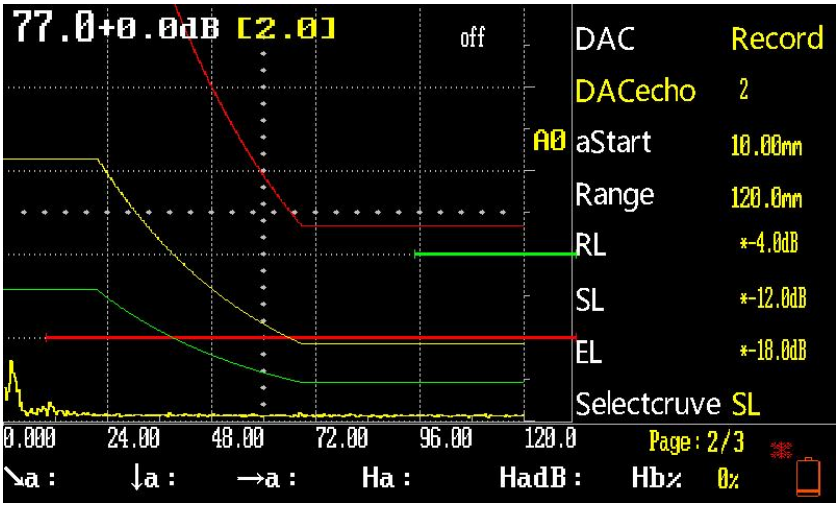


Figure 5-8 Interface of a complete set of DAC curves

(6) To hide the current curve, adjust "DAC" to "off".

***Note: Given that the hole depth dimensions of CSK-IIIA test blocks are arranged on both sides in odd or even numbers, for the**

convenience of application, this instrument has a special function to automatically identify the echo sound path, so there is no need to make DAC curves point by point (that is, they can be staggered) according to the order of the test blocks. If 10mm and 50mm points are first made, then 30mm and 70mm points are made, and finally 20mm and 40mm points are made, etc. After all points are completed, the instrument will automatically combine them into a complete set of DAC curves.

(7) Standard application. Press the DAC shortcut key again to enter the menu on page 3 of the DAC. The instrument defaults to standard NB/T-47013 and selects specific standard levels based on the type of test block and workpiece thickness (the instrument automatically selects the corresponding "standard level" based on the set "workpiece thickness" by default). The instrument will automatically generate scrap lines, quantitative lines, and evaluation lines based on the selected "standard name" and "standard level". You can also manually modify the dB difference of the three curves relative to the "DAC bus" in the menu on page 2 of the DAC.

***Note: When choosing GB11345, the name and number of curves change, please refer to GBT 29712-2013 for details.**

(8) When using DAC curves for weld seam detection, when there is a defect echo within the measurement range of gate A, "SL+x.xdB" will be displayed in the upper right corner of the screen waveform area (representing the dB difference between the peak echo inside the gate And the "quantitative line" of the currently selected curve).

5.9.2 DAC curve correction

After the production of DAC curves, if you are not satisfied with a certain point, you can enter the "Curve Correction" submenu item on page 3 of DAC to modify it:

Press the "Confirm" button, a white box prompt will appear at the first point of the DAC curve by default, and a prompt will pop up on the screen saying "Start correction, press the" Left/Right "button or rotate the" Shuttle "to select the point to be corrected, and press the" Up/Down "button to adjust the curve amplitude." The prompt will disappear after about 2 seconds. The adjustment range of curve

amplitude is 5% to 100%. After making the modifications, press the "Confirm" button again to save the correction results and exit the correction status.

5.9.3 Storage of DAC curves

The pre made DAC curve will be automatically saved to the selected "channel" and can be directly selected for the next use.

5.9.4 Delete DAC curve

(1) Go to the "Curve Delete" submenu item on page 3 of DAC (default to "off").

(2) Press the left and right keys to set it to "On", and a prompt will appear on the screen saying "Confirm to delete curve?" Confirm to delete, and Down to exit. Follow the prompts and press" Confirm "to delete the DAC curve. Press" Down "to cancel the deletion, and" Curve deletion "will return to" Off ".

5.9.5 The application of DAC curve and its precautions

5.9.5.1 Application of DAC Curve

The laboratory uses comparative test blocks to create DAC curves and stores them, making it very convenient to retrieve and apply them during on-site testing. Manifested in:
(1) The instrument parameters are complete and correct, and can be used immediately upon retrieval; If gain compensation is needed for the surface condition, after calling up the curve, long press the "Gain" shortcut key to enter the reference gain adjustment mode, rotate the shuttle or use the up and down keys to adjust the compensation value.
(2) Defect detection with the same equivalent but different distances is intuitive and convenient:
(3) The detection results are stored simultaneously with the DAC curve, making it convenient for experts to diagnose and print the detection report.

5.9.5.2 Precautions

When applying DAC curves, the following points should be noted:
(1) The DAC curve is made using a probe on a reference block, strictly speaking, it is only valid for that probe. Given the differences in probe performance, even when using similar probes, they should be validated first (especially in the near-field region of the probe).

(2) The angle and performance of the angle probe may change due to repeated wear and tear, and it should be corrected before being used with the DAC curve to meet the requirements for curve production.
(3) The surface condition of the workpieces to be inspected on site is mostly not as smooth and polished as the reference block, so corresponding surface compensation must be carried out when the DAC curve is adjusted for application.

5.10 The production and application of AVG curves

The AVG curve of this instrument is only applicable to straight probes and is only effective outside the 3x near-field range, for reference only within the 3x near-field range. The operation steps are as follows:

(1) After selecting the "channel" and setting the relevant parameters, press the "**AVG"** shortcut key to enter the AVG "record" page.

***Note: When the DAC curve is in a non closed state, the AVG curve will not be able to open.**

(2) Select "Reference Aperture", press the "Left/Right" directional keys or rotate the "Flying Shuttle" to set the aperture value of the selected test block, with a default of 2.0mm.

***Note: The reference aperture refers to the flat bottom hole aperture of the reference block or workpiece used. If the reference aperture is set to "∞", it indicates that the reference block or workpiece used is of the large flat bottom type.**

(3) Input the equivalent aperture of the flat bottom hole for the three generated AVG curves. Select the submenus "AVG Curve 1", "AVG Curve 2", and "AVG Curve 3" respectively, press the "Left/Right" directional keys or rotate the "Flying Shuttle" to adjust the value, and press the "Confirm" key to adjust the step. The default values for the three curves are 2.0, 3.0, and 5.0mm, respectively.

(4) Enter the compensation value. "Compensation" is used to compensate for the difference between the bottom echo amplitude of the reference flat bottom hole test block used and the actual bottom echo amplitude of the workpiece. It is recommended to input the actual difference between the echo amplitude on the bottom of the actual workpiece and the echo amplitude on the bottom of the selected flat bottomed hole test block at the same distance (different distances can be calculated using theoretical

formulas) as the compensation value to make the calculation more accurate.

(5) In general, according to the default setting of the instrument, the A gate will automatically trap the echo to be recorded. If it is automatically locked, you can manually adjust the "gate opening position" to lock the gate And record the echo. Press the "automatic gain" shortcut key to make the echo amplitude reach 80%. Under the "AVG recording" submenu item, press the "confirm" key to record the echo. At this point, the instrument will automatically generate three AVG curves.

(6) When working with AVG curves, the equivalent flat bottom hole value (in mm) of the current echo in gate A will be displayed in the upper right corner of the waveform area on the screen.

(7) When there is no need to display or use AVG curves, select "AVG Off" to turn off the current AVG curve.

***Note: In recording mode, pressing the confirm button will generate a new AVG curve and overwrite the previous curve.**

(8) To delete the AVG curve, enter the "AVG Delete" submenu item (default to "Off"), press the "Left/Right" key or rotate the "Flying Shuttle" to adjust "Off" to "On". The screen will pop up a second confirmation prompt. Follow the prompts to avoid accidental deletion.

5.11 Storage of flaw detection data

5.11.1 Storage

This instrument has a total of 460 storage numbers (0-459), which can store 460 sets of screen waveforms and related parameter data. The stored content of each set can be accessed and used at any time. This instrument can achieve fast data storage, number selection storage, data calling, data transfer, data deletion, and other operations. The specific operations for data storage are as follows:

(1) **Quick storage of data:** Simply press the "Store" shortcut key once to save the data in the smallest empty storage number.

(2) **Data selection and storage:** Long press the "Storage" shortcut key to

enter the "Storage" main menu, select the data number to be stored in the "Source Data Number" submenu, and press the "Storage" key to save; The storage number of existing data is marked with a date and time in parentheses. For example, (0701-0910) refers to the storage time of the data being 9:10 am on July 1st. When you need to overwrite, the screen will pop up a prompt saying "The target data is not empty, do you want to overwrite it?" Follow the on-screen prompts and select "Confirm" or "Cancel".

(3) **Data transfer:** First, select the data to be transferred in the "Source Data Number", then select the storage number to be stored in the "Data Transfer", and press the "Confirm" button. If the storage number to be stored is not empty, a prompt will appear saying "Target data is not empty, do you want to overwrite it?" Follow the on-screen prompts and select "Confirm" or "Cancel".

5.11.2 Remarks

In the "Remarks" menu, you can enter 19 digits or uppercase English letters in sequence, which are used to simply label the key points of stored content, such as standard number, user or weld thickness (users can develop their own note naming rules), making it easy to select when calling up.

The input method for note information is: after selecting the submenu "Notes", press the "Left/Right" directional keys to move the blue rectangular cursor to the position that needs to be changed, rotate "Flying Shuttle" or press the "Confirm" key to cycle through 36 numbers and letters, including "0-9" and "A-Z". After entering the current position, you can continue to press the left/right arrow keys to switch to other positions and write numbers or letters.

***Note: The instrument will automatically save the "write" or "change" note information in real time. According to different user operating habits, users can choose whether to "store data first, write notes later" or "write notes first in empty data numbers, and then store data".**

5.11.3 Call out

The operation steps for retrieving data from the memory are as follows:

(1) Long press the "Storage" shortcut key to enter the "Storage" main menu;

(2) Select the data number to be retrieved from the "Source Data Number" (the number in "Data Call" will change synchronously). You can view the date and time of data generation through the content in parentheses after the data number, and understand the data content through "Remarks";

(3) If the desired data number is accurately known, step (2) can be omitted and the desired data number can be directly selected in "Data Call". After pressing the "Confirm" button, the echo graphics from the retrieved storage number will be displayed in frozen mode on the left side of the screen, and the current main instrument parameters will be displayed on the right side. Follow the on-screen prompts and select "Confirm" or "Cancel" to proceed.

***Note: When there is no data in the memory, the default display for data calls is "0". When called, the screen prompts "Data is empty".**

5.11.4 Delete individual data

The steps to delete individual data are as follows:

(1) Long press the "Storage" shortcut key to enter the "Storage" main menu;

(2) Select the number of the data to be deleted in the "Source Data Number";

(3) Press the "Confirm" button under the "Delete Data" submenu item (default to "X"), and the menu status will change from "X" to "√", with a prompt of "Delete Current Data?" for a second confirmation to prevent accidental deletion. Follow the on-screen prompts and select "Confirm" or "Cancel" to proceed.

***Note: Once stored data is deleted, it cannot be restored. Please use with caution!**

5.11.5 Wipe data

After the data is transferred to the backup file, sometimes it is necessary to clean

up a large amount of data in the instrument. In order to facilitate batch deletion of data, this instrument has specially designed a function to delete all data. The operation steps are as follows:

(1) Press the "Settings" shortcut key to enter the "Settings" main menu;

(2) Select the "Clear Data" submenu item on page 3 (default to "Off"), press the "Left/Right" key or rotate the "Flying Shuttle" to change the menu status from "Off" to "On", and prompt "Confirm to clear? Operation cannot be restored!". Press the "Confirm" button according to the screen prompt to confirm clearing data, and press the "Down" button to cancel.

***Note: Once all stored data is deleted, it cannot be restored. Please use with caution!**

5.11.6 Parameter preview

Enter the "Parameter Preview" submenu item to view the main instrument parameters when saving data in the current "Source Data Number". The operation steps are as follows:

(1) Long press the "Storage" shortcut key to enter the "Storage" main menu;

(2) Select the data storage number in the "Source Data Number" to view the parameters;

(3) Press the "Down" button to move the cursor and select the "Parameter Preview" submenu item, then press the "Confirm" button to enter. The preview list will pop up on the screen as follows (all parameters are for viewing only and cannot be modified). Press the "Down" button again to exit the parameter preview status.

Table 5-3 Parameter List

Probe specifications A2.5P8X12	Basic gain 20.0dB	Relative gain 0.0dB	Scope 120.0mm	Speed of sound 3230m/s	Workpiece thickness 20.00mm
Probe delay zero μ S	Probe angle 63.4 °/2.00	Pulse shift 0.000mm	Gate starting point 40.00mm	Gate width 20.00mm	Gate height 40%

Starting point of gate B 80.00mm	Gate width 40.00mm	Gate height 30%	Measurement point selection peak value	Measurement options Off	Repetition frequency 250Hz
Judging scrap lines -4dB	Quantitative line -12dB	Evaluation line -18dB	Surface compensation 0.0dB	Double crystal switch shut	detection mode full wave
Bandwidth 0.5-6MHz	Damping low	Surface correction flat	Weld seam diagram	Date 2015-10-10	Time 09:58:45

5.11.7 Storage Preview

The "Storage Preview" submenu allows you to view the storage status of 460 sets of data space in the instrument, accurately obtain the number of stored data and the remaining number of empty storage numbers. Data can also be viewed and accessed. The operation steps are as follows:

(1) Long press the "Storage" shortcut key to enter the "Storage" main menu;

(2) Select the "Storage Preview" submenu and press the "Confirm" button to enter table of stored data storage numbers will pop up on the screen, with each storage number cell displayed in two rows. The first row is the storage number code, and the second row is the note information, making it easy for users to distinguish; At this point, press the "Storage" button to exit "Storage Preview" and return to the "Storage" main menu.

(3) If you need to "view" or "retrieve" a certain data, press the "up/down/left/right" arrow keys or rotate the "shuttle" to view the stored data. Press the "confirm" button to pop up a preview waveform and main parameters of the data. Follow the on-screen prompts to select "confirm" to retrieve the data or "cancel".

***Note: When the cursor is on the top/bottom side of the table, if you press the "Up"/"Down" button again, you can preview the page turning of the table; If the amount of stored data is less than the maximum capacity of a table on one page (24), the page flipping function is not available.**

5.11.8 Copy data to USB storage device

This instrument can quickly copy individual or all data to USB storage devices such as USB drives. The specific steps are as follows:

(1) Long press the "Storage" shortcut key to enter the "Storage" main menu;

(2) Insert USB storage devices such as USB drives with sufficient space into the instrument's USB interface;

(3) In the "Copy to USB" submenu item, press the "Left/Right" key or rotate "Shuttle" to switch between "Off/Current/All". If you only need to copy the current data, select "Current". If you need to transfer all non empty storage numbers to a USB drive, select "All".

(4) Press the "Confirm" button to complete the data replication.

5.12 AWS usage method

This section introduces the welding grade calculation method for steel structural welds (D1.1) specified by the American Welding Society (AWS).

(1) To ensure the accurate reading of the sound path value Sa, the basic parameters of the probe should be correctly entered first, and the correct calibration of delay, angle, etc. should be carried out;

(2) Press the "Settings" shortcut key to enter the "AWS" submenu;

(3) Identify IIW or CSK-IA test blocks using an oblique probe cover the highest echo of the Φ1.5 horizontal hole with gate A, press the "Automatic Gain" shortcut key to automatically adjust the amplitude of the echo to 50% (instrument allowable error is ± 5%), select "B reference value", press the "Confirm" button again, and the submenu "B reference value" will automatically enter the current gain value of the instrument;

***Note: Under the "AWS" menu, every time you press the "Auto Gain" shortcut key, the auto gain height will automatically switch from the usual "80%" to "50%" for ease of use. You can also manually adjust the gain by pressing the shortcut key.**

(4) After discovering the defect echo during the flaw detection, use gate A to

cover it, press the "Automatic Gain" shortcut key, automatically adjust the amplitude of the defect echo to 50% (the instrument allows an error of ± 5%), select "A indication value", press the "Confirm" key again, or directly move the cursor to other menus. The submenu "A indication value" will automatically enter the current gain value of the instrument;

(5) After entering the "B reference value" and "A indicator value", the "C attenuation factor" is automatically calculated and generated by the instrument based on the defect sound path Sa. The formula is as follows:

(a) When measured in mm: C=(Sa/25.4-1) x 2, the result is rounded to one decimal place;

(b) When the unit is inch: C=(Sa-1) x 2, round the result to one decimal place.

(6) The "D rated value" is automatically calculated and generated by the instrument according to the following formula: D=A-B-C.

(7) According to the AWS D1.1 specification, the operator shall check the table to determine the level of weld defects and how to proceed with the next step of operation.

5.13 Dynamic recording

This instrument has the function of "dynamic recording" of waveform data, and the specific operating steps are as follows:

(1) Press the "Settings" shortcut key and select the "Dynamic Record" submenu item (default to "Record") on page 1 of the "Settings" main menu;

(2) Press the "Confirm" button to enter, and three options "Start/Transfer/Exit" will pop up at the bottom of the screen. Select "Start" and press the "Confirm" button to start recording waveforms and data;

(3) Press "Stop" to terminate the recording;

(4) Insert a USB flash drive and select "Transfer" to copy the newly recorded dynamic waveform data file to the USB flash drive;

(5) Select "Exit" to exit the "Dynamic Recording" status and return to the "Settings" main menu;

***Note: The instrument can only save one set of dynamic data by default, and subsequent entries will overwrite the previous dynamic record data. Therefore, please "transfer" the dynamic record data in a timely manner.**

If you need to perform "data playback", select "playback" under the "dynamic recording" submenu and press the "confirm" button to start playing back the previously recorded data on the screen.

Alternatively, after inserting the USB flash drive, select "Transfer" under the "Dynamic Record" submenu and press the "Confirm" button to transfer the recorded dynamic waveform data to the USB flash drive.

***Note: If there are no dynamic records in the memory, the "playback" and "transfer" functions are not available.**

5.14 Secondary wave color

For the convenience of defect detection, this instrument is equipped with a secondary wave color differentiation function. Calculate the range of secondary waves based on information such as the probe used and the thickness of the workpiece. Distinguish the primary and secondary waves (odd and even waves when there are multiple echoes on the screen) with different colors, which can better help users detect and distinguish defects.

5.15 Measurement point selection

When using a digital ultrasonic flaw detector to measure the distance and amplitude of the echo through A gate, the measurement accuracy is related to the selection of measurement points, so it is necessary to choose the correct one before measurement. The meanings of the "peak" and "front" methods listed in the "Settings Measurement Points" menu of this instrument are:

- Peak: represents the peak point of the highest echo inside the gate At the measurement point;
- Frontline: Refers to the intersection point between the rising edge of the first echo inside the gate And the gate As the measurement point.

***Note: The location of the measurement point is indicated by a small dot on the gate.**

Generally speaking, measurements related to echo amplitude should choose "peak", such as echo height Ha%, DAC curve production, etc; The measurement related to the echo distance should use the "front edge", such as the defect sound

path and delay automatic correction in oblique probe inspection. The M-Ultra model has set relevant default values for the menu that must be selected for "peak/front", and only a slight check is required for initial use.

***Note: The default setting for the instrument to start up at the factory is "peak". If using the echo inside the gate to measure thickness, the "measurement point" should be set to "front" first. This is particularly important for measuring the remaining wall thickness of corroded pipelines and thinner workpieces.**

5.16 Returning to factory state

After using the instrument for a period of time, if you feel that the saved channel parameters are messy or occasionally encounter software abnormalities, you can enter the "Settings - Factory Settings" submenu, press the "Left/Right" button or rotate the "Shuttle" to "On", and the instrument will pop up a prompt: "Restore factory settings?" You can choose "Confirm" or "Cancel" operation as needed.

***Note: Under normal circumstances, restoring the factory settings will not delete the saved detection data in the instrument. Only the set parameters in all 50 channels will be restored to the factory default values.**

Chapter 6 Introduction to Testing Applications

This chapter briefly introduces the specific application of M-Ultra in the detection of welds and forgings. It is expected that users can fully utilize the functional characteristics of this instrument, accurately detect defects, quickly process detection data and reports, and achieve twice the result with half the effort.

6.1 Preparation for flaw detection

Before starting the ultrasonic testing, one should be familiar with this user manual, understand the functions and operating points of the instrument, pay attention to safety electrical requirements and relevant regulations. These are the most basic regulations for the correct use of ultrasonic testing instruments and will not be repeated. Here are only a few key points to note:

(1) Prepare probes according to the flaw detection process, and manufacture or inspect DAC curves to ensure they meet the requirements;

(2) Understand the processing characteristics and surface conditions of the workpiece to be inspected, and calculate the set surface compensation (i.e. "gain correction") value;

(3) If using battery power for operation, the battery level should be checked first.

6.2 Weld inspection

Weld seam inspection is the most extensive and extensive application of ultrasonic inspection. This instrument has a compact size and excellent performance, and can fully meet the on-site inspection of various types of welds in thick, medium, and thin plates. The various shortcut keys and auxiliary functions of the instrument are mainly specially designed for weld seam inspection, making their application particularly convenient. Taking a 20mm thick V-shaped butt weld as an example, explain the operation steps of the instrument:

6.2.1 Probe measurement and instrument setup

(1) Select a 5P13 × 13K2 oblique probe according to the testing requirements.

Press the shortcut key "Channel" to select one of the 30 channels between groups A and C. After entering the channel, check the relevant parameters such as "Probe Specification", "Probe Angle", "workpiece thickness", etc. If there are any discrepancies, please manually modify them. You can also press the "Basic" shortcut key to modify the settings of "Probe", "Angle", "workpiece thickness" and other related parameters in the "Basic" menu.

(2) Connect the probe and place it on the CSK-IA test block for probe delay and angle correction (see 5.4.1 and 5.4.2 for details), which can simultaneously measure the front edge (incident point) of the probe (see 5.4.3 for details), and then input the relevant parameters into the corresponding submenu.

(3) Set the detection sensitivity on the CSK-IIIA test block: selected the highest echo of Φ1 × 6 holes is captured by gate A. After pressing the "Auto Gain" button once, the echo height is automatically adjusted to 80%. If 6dB surface compensation is required during on-site inspection, long press the "Gain" shortcut key to enter the reference gain adjustment mode, rotate the shuttle to set it to "6.0dB". Assuming the current basic gain is 40dB, the gain value in the upper left corner of the screen is displayed as 40.0+6.0dB, where "40.0" is the "initial sensitivity" and "+6.0" is the "additional gain" added by surface compensation.

(4) If necessary, the DAC curve can be made according to **5.9** (step (3) can be omitted when making the DAC curve).

(5) Based on the surface condition of the workpiece and past experience, determine the surface compensation value that needs to be added during on-site testing, in order to reserve sufficient margin for sensitivity calibration during testing.

6.2.2 Key points of flaw detection operation

(1) Check the surface condition of the weld again to determine if the originally expected surface compensation value is reasonable.

(2) After discovering the highest echo of the defect, long press the shortcut key

of the "Gate" to "automatically search for the wave", so that gate A can cover the echo. The wave height, sound path, horizontal distance, and vertical distance of the defect echo will be displayed below the screen.

(3) Press the "Store" shortcut key once to sequentially store the screen graphics and current instrument parameters.

(4) Transfer the stored data to the computer via a USB flash drive or data cable to print the inspection report.

6.3 Forging inspection

The inspection of forgings is more complex than that of welds, especially for large forgings in power plants, which require strict requirements for the sensitivity, resolution, stability, reliability, on-site operability, and anti-interference ability of the instrument. Although M-Ultra is a small product, it can basically meet the high indicators of forging inspection, especially the abnormal dynamic range of the instrument, gate widening, optional repetition frequency, and various functional shortcut keys, which provide great convenience for on-site inspection.

For example, according to the requirements of the flaw detection process, DC2.5P20N soft protective film probe is selected for inspection Φ 800 forged parts:

(1) Press the shortcut key "Channel" to select one of the 20 channels between groups D~E. After entering the channel, check the relevant parameters such as "Probe Specification" and "workpiece thickness". If there are any discrepancies, please manually modify them. You can also press the "Basic" shortcut key to modify the settings of "Probe", "workpiece thickness" and other related parameters in the "Basic" menu. Set the probe to "N2.5P20".

(2) Set the "range" to "850.0mm" and check if the "sound speed" is the default "5920m/s".

(3) Check the parameter settings related to "transmit/receive" in the main menu of "Settings", and then select 200- Φ Set the detection sensitivity on the 2-flat bottom hole test block: When the hole wave is at its highest, use A gate to cover it, press the "Automatic Gain" button once, and the "gain" will automatically adjust the hole wave to 80% (such as 42.0+0.0dB). On site detection will use this 42dB as the "initial sensitivity" (if the "bottom

wave attenuation method" is used to calibrate the instrument sensitivity on site, the operation method is basically the same).

(4) If necessary, AVG curves can be made according to 5.10.

***Note: After the above settings are completed, it is best to open the shortcut key of "Channel", call the "Menu Preview" list of the current channel, check it as a whole, and save it.**

(5) During on-site inspection, the compensation value is determined based on the surface and curvature of the workpiece. If the compensation is 12dB, press and hold the gain button to adjust the "reference gain" to 12dB.

(6) After discovering the highest defect echo, A gate or B gate can be selected according to operating habits to cover the defect echo (when selecting B gate, the "B gate widening" function can be used to facilitate observation of echo details), and the measured values of defect sound path, amplitude, etc. are displayed in the data line below the screen.

***Note: This instrument has an extraordinary dynamic range, so the wave base is clear and delicate, and the resolution is quite high. After the far-field defect echo of large workpieces is widened, it is easier to observe whether there are dense defects and other dangers.**

(7) If there are single or multiple fixed or moving unknown reflected waves during the scanning process, the method of reducing repetition frequency (PRF) can be used to determine whether it is a phantom wave (ghost wave) (the "PRF" submenu item is in the "Settings" main menu);

(8) If it is necessary to determine the direction and length of non-metallic inclusion like strip defects after discovering them, you can press the "Peak Memory" button to activate the "Peak Memory" function or long press the "Peak Memory" button to activate the "Envelope" function, which can easily determine the highest point of the echo and its scanning length.

(9) When defects are found during the scanning process, you can press the "Storage" shortcut key at any time to store the echo pattern of each defect along with the instrument parameters. If necessary, transfer it to the computer to print the defect detection report.

6.4 Testing of other mechanical parts

This section takes the inspection of a 160mm thick square aluminum billet as an example to illustrate the application characteristics of the instrument:

(1) **Testing requirements:** Equipped with a 5M10 (narrow pulse) probe, the scanning process should be able to simultaneously detect and distinguish 5mm from the surface and 5mm from the bottom, respectively Φ 1.2 Flat bottomed hole equivalent defect.

(2) **Instrument settings:** The transmission and reception should be set according to the following requirements, while others should be set as usual and will not be repeated:

(a) Power: low;

(b) Damping: high;

(3) **Difficulty in identifying injuries:** When the detection range is set to 170mm, the bottom resolution of the instrument can completely distinguish 5mm flat bottomed holes on the bottom, but the resolution near the surface is 5mm Φ 1.2 The flat bottom hole is difficult to distinguish whether there are nearby defects due to its adhesion to the initial wave, and its depth cannot be measured, resulting in difficulty in identifying injuries.

(4) **Solution:** If the initial wave is found to be widened during the scanning process, use the "B gate widening" function to widen and observe the back edge of the initial wave.

6.5 Issues to be Noticed in Ultrasonic Testing

Ultrasonic flaw detection is the use of the propagation characteristics of ultrasonic waves in workpieces to study their reflection, transmission, and scattering for macroscopic defect detection and other measurements. Therefore, in defect evaluation, the wavelength, incident direction, and resolution of ultrasonic waves for dense defects are crucial. So, when using an ultrasonic flaw detector, special attention should be paid to the following points.

6.5.1 Pay attention to whether the frequency range of the instrument meets the requirements of the nominal value

At present, the transmitting and receiving system, which basically belongs to the category of analog circuit, is responsible for stimulating the probe to generate ultrasonic waves in the workpiece, and then amplifying and processing the received weak signals. So it can be said that the "analog front-end" of transmitting and receiving is undoubtedly the heart of the ultrasonic flaw detector! Its performance determines the level of the instrument.

Therefore, if users want to use high-frequency probes above 10MHz for high-resolution detection, they must carefully inspect and distinguish the instrument when purchasing and using it, and if necessary, send it to authoritative institutions for measurement and appraisal to avoid abnormal phenomena where the detection sensitivity and resolution of imported high-frequency narrow pulse probes are not as good as those of low-frequency probes.

***Note: The amplification amount of 86.0dB and the "gain" adjustment amount of 110.0dB are not the same concept.**

6.5.2 Instrument setup for high-resolution flaw detection using high-frequency narrow pulse probes

High frequency narrow pulse probes such as 10C6N, 15P6Y, DN20, etc., are widely used for high-resolution detection of aircraft engines and automotive components due to their only 1.5-2 ringing cycles and sufficiently high negative echo amplitude. For example, inspection of the bonding quality of composite material sheets with a total thickness of 0.8mm, inspection of the quality of automotive spot welding, and so on.

High frequency narrow pulse probes, also known as high damping probes, are made with special chips and complex processes. The relative bandwidth of their echo spectrum at -6dB is generally over 60%, and high-level probes can even reach 80% to 100%. Therefore, the correct use of the probe and ensuring its wideband echo can be displayed with high fidelity put forward quite high requirements for the accompanying instruments.

（1） The rise time tr of the emission pulse front should be small enough, usually

requiring tr ≤ 10ns, otherwise it will affect the detection sensitivity.

(2) The working frequency range should be wide enough, generally requiring a -6dB bandwidth of ≥ 15MHz, preferably ≥ 20MHz, in order to ensure high fidelity transmission of probe echoes (i.e., after amplification, it still displays 1.5-2 ringing cycles without waveform distortion), thus achieving high resolution.

(3) The detection method must have the option of "positive half wave/negative half wave".

(4) The damping of the instrument must have a high electrical damping of ≤ 50 Ω.

***Note 1: For instruments, none of the above four points are indispensable;**

***Note 2: In the concept of "high damping" of the probe, it is not only required that the "electrical damping" is sufficiently high, but also that the "sound damping" with good coupling should be sufficiently good. Or in other words, when the coupling conditions are slightly poor, the high-resolution effect of the narrow pulse probe will decrease, so attention should also be paid when using it on site.**

6.5.3 Pay attention to the selection of measurement points

The selection of measurement points will directly affect the measurement accuracy displayed by the instrument. For the convenience of use, this instrument is equipped with two measurement point selection methods: "peak" and "front", and should be set as default settings as much as possible to reduce on-site operation trouble. However, when using the instrument for the first time, it should also be checked and familiarized.

Usually, the selection of measurement points can follow the following two principles:

(1) Measurement related to echo amplitude, using "peak";

(2) The measurement related to the echo distance adopts the "front edge".

***Note: The measurement point of "front edge" refers to the intersection**

point between the gate and the rising edge of the first echo inside the gate, and is therefore related to the "height" of the gate. Strictly speaking, when using the A/B two gate method to measure the distance between two echoes in multiple echoes, it should be ensured that their "measurement points" are the same "acoustic points", that is, the height of the A/B gate is not a contour line.

Chapter 7 Safety Tips for Use

This chapter focuses on providing necessary tips for the safe operation and use of instruments, with the aim of expecting users to use the instruments correctly and avoid potential safety hazards.

7.1 Familiarize oneself with the user manual and instruments

It is essential to understand and familiarize oneself with the structure, functional characteristics, basic operating methods, and safety precautions of the instrument through the product manual. This section will introduce each one as follows.

7.1.1 Introduction to Instrument Power on Work

7.1.1.1 Environmental condition requirements

This product belongs to the category of Class II electronic instruments. According to relevant standards, the working environment temperature of the instrument is 0-40 ℃, the relative humidity is 20% -90% RH (+40 ℃), and the storage environment temperature is -40~+60 ℃. Therefore, the use and storage under normal conditions should meet the above requirements to ensure the stability and reliability of the instrument.

The M-Ultra model is designed to operate safely in more harsh outdoor or elevated environments. Its working environment temperature has been extended to -10~+50 ℃ and it has a waterproof level that meets the IP54 standard. Therefore, even when working in winter, summer or light rain weather, it will not have a negative impact on the test results.

7.1.1.2 Working on battery power

The M-Ultra model uses a dedicated DC-20A (11.1V/3900mAh) lithium battery for power operation. A fully charged battery can enable the instrument to operate continuously for more than 6 hours.

Press the "Power" button on the panel for about 2 seconds to turn on the instrument power. After the screen displays the startup interface, enter the flaw detection work screen, and the menu settings are the settings from the moment before the last normal shutdown.

When the instrument is in working mode, pressing the "Power" button on the panel for about 2 seconds will turn off the power, and it is considered a normal shutdown. All originally set parameters will be confirmed and saved. If the instrument suddenly loses power while working (the battery is depleted or the AC adapter is disconnected), it is considered an abnormal shutdown. The parameters set at the moment before the power outage may not have been saved and should be checked.

The instrument is equipped with screen battery "battery level indicator" and "low voltage automatic shutdown alarm" functions, which are beneficial for reminding users to charge in a timely manner.

7.1.1.3 Charging and Protection of Batteries

The AC adapter equipped with the device can charge the battery installed in the instrument, with a conventional charging current of about 1A. The instrument is equipped with a power management system inside, which automatically switches to trickle charging mode and finally disconnects when the battery is almost fully charged, ensuring charging safety.

***Note: This instrument uses a high-capacity dedicated adapter. Battery charging and instrument power supply can be carried out simultaneously, but do not mix with other instruments or batteries.**

The optimal operating temperature for lithium batteries is around 25 ℃. Both high and low temperatures can affect their charging and discharging effects. Therefore, when the environmental temperature deviation is too large, attention should be paid to the efficiency of the battery.

Batteries generally have storage period regulations. Even if fully charged batteries are left for too long, they should be recharged before use to ensure sufficient power supply time.

Low battery life and prolonged storage of lithium batteries can easily cause internal damage, so the battery should be charged as soon as possible after discharge; And batteries that are not used for a long time should also be charged and discharged after being idle for a period of time.

7.1.2 On site inspection carrying method

M-Ultra comes with a wrist strap for easy one handed grip operation. The wrist strap can be tied to the left or right side of the instrument for the convenience of

customers with different operating habits on the left and right hands.

7.2 Emphasize basic training and application of ultrasonic testing

7.2.1 Certified for safe work

Ultrasonic testing is one of the important means to ensure equipment safety, and it is a highly professional technical work. The country has explicitly stipulated that practitioners must pass qualification certification and hold a certificate to work. Therefore, this manual only focuses on introducing the functions, performance, and application characteristics of the instrument. As for the principles of ultrasonic testing and defect evaluation, please refer to relevant training materials.

7.2.2 Strictly adhere to industry standards for regular testing of instruments

There are numerous regulations and industry standards for non-destructive testing, which not only specify the testing methods for materials, but also specify the compliance requirements for the instruments and equipment used, as well as the requirement for regular performance testing. Ultrasonic flaw detectors belong to precision electronic products and are used in relatively harsh environments. Their main performance is often checked, and a comprehensive measurement and evaluation after long-term use (such as six months or a year) is very important.

The standard echo probe PE-50 for M-Ultra is made by our company through selected materials and special processes, with a center frequency of 5MHz. The biggest feature of the PE-50 probe is that the echo amplitude and the distance between multiple echoes can remain stable for a long time (about several years), making it a simple and convenient tool for calibrating the sensitivity, vertical linearity, horizontal linearity, and detection range of instruments.

For example, during instrument acceptance, record the gain value of the first or second echo B1 or B2 of the PE-50 probe when the amplitude is 80%. Before each use, connect the echo probe to check, and any slight changes in sensitivity can be detected. In addition, if the echo pattern of PE-50 is stored during

acceptance, the above inspection will be more convenient.

7.2.3 Using expert diagnosis to reduce misjudgment rate

The data storage and waveform dynamic recording playback function of M-Ultra can store defect graphics or their dynamic flaw detection echoes on site, facilitating subsequent analysis, discussion, and expert diagnosis, providing favorable conditions for reducing misjudgments.

7.3 Pay attention to electrical safety

The AC adapter can charge the battery or operate the instrument in an AC power supply state, with an input voltage of 100-240Vac. When using, it is necessary to comply with the national laws and regulations on electricity safety to ensure safety.

Chapter 8 Maintenance and upkeep of instruments

This instrument belongs to precision electronic products, and should be strictly maintained in accordance with relevant specifications during use and maintenance.

8.1 Instrument maintenance

The installation and use of instruments should avoid strong electromagnetic interference in the surrounding area; If necessary, a good grounding device should be installed and shielding facilities should be strengthened to effectively prevent interference signals from entering the series and ensure stable and reliable operation of the instrument.

The instrument must be connected to the specified power supply and peripheral devices to work together. When the instrument is powered on, it is not allowed to open the casing. Hands or tools should be inserted into the instrument to avoid personal or instrument damage.

After using the instrument, cover it with a dust cover. During the rainy season, the instrument should be regularly powered on for 1-2 hours to dissipate internal moisture.

If you find that the instrument is not working properly, you should first carefully read the user manual and check if the operation method is correct. You can also consult experienced personnel or manufacturers. Do not disassemble the instrument for maintenance at will to avoid unnecessary trouble.

If users have any questions or need assistance during use, please feel free to contact us by email or phone. We promise to reply as soon as possible.

8.2 Instrument maintenance and warranty

The instrument should be stored indoors and off the ground under packaging conditions, with an ambient temperature of -10 ℃ to+50 ℃ and a relative humidity not exceeding 85% RH (non condensing). The air should not contain harmful substances that can cause corrosion.

Our company provides a one-year warranty period for our products. Within one year from the date of shipment of the product from our company, if the customer fully complies with the storage, installation, and usage rules specified in the user manual and finds that the product has poor manufacturing quality or

cannot function properly, our company is responsible for providing free repair or replacement under the condition of complete product sealing. After the one-year warranty period expires, our company will still be responsible for providing repair services.

When the product is repaired due to malfunction, it is necessary to use the original packaging box and inner lining to package the instrument in good condition, minimizing the possibility of damage during transportation, so as to ensure that the instrument can work normally after repair. For this reason, we strongly demand not to use unqualified packaging boxes to transport instruments. If the use of unqualified packaging boxes causes quality problems with the repaired instruments, our company is not responsible. So, after the newly purchased instrument is opened and used, please keep the original packaging box and padding properly for future use.

When the instrument is sent for repair, please provide detailed information such as the name of the shipping unit, department, communication office, contact person, contact phone number, and shipping station on the outside of the box; If necessary, it is best to contact us by phone or email in advance, and at the same time, print a copy of the above information, fault situation, and requirements into the box and send it to us for quick processing.

8.3 User Notice

After purchasing our company's products, please carefully fill out the "Warranty Registration Card" and stamp it with the company's official seal. Then, send the (1) copy back to our company's User Service Department, or entrust the sales unit to send it when purchasing the machine.

Within one year from the date of purchase by the user, if there is any quality failure (excluding non warranty parts) of our company's products, please contact our customer service department with the "warranty card" (user retention copy) to repair the product. During the warranty period, if the warranty card cannot be presented, our company will calculate the warranty period based on the date of manufacture, with a period of one year.

Special configurations (such as special-shaped probes and specialized software) outside of the company's standardized products will be charged according to relevant standards.

Our company cannot provide warranty for any product damage caused by

improper transportation, storage, or incorrect operation according to the "Product User Manual", as well as unauthorized tampering with the warranty card.

Appendix Measurement Options

As shown in **Appendix 1**.

Appendix 1 Measurement Value Display Options

Measurement value	**interpretative statement**
Sb	The sound path of the highest echo * inside the gate;
Sb-a	The difference in sound path between the highest echo inside gate A and gate B;
Hb%	The amplitude of the echo measurement point inside the gate (expressed as a percentage);
Hb dB	The difference between the amplitude of the echo measurement point inside the gate And the height of the gate (expressed in dB);
R-s	The starting point of the waveform area sound path range;
R-end	End point of waveform area sound path range;
Db	The vertical distance of the highest echo inside the gate;
Pb	The horizontal distance from the highest echo inside the gate to the front edge of the probe;
Ra	The horizontal distance from the highest echo inside the gate to the incident point of the probe sound beam;
Rb	The horizontal distance from the highest echo inside the gate to the incident point of the probe sound beam;

***Note: The default measurement point of the instrument is selected as "peak". When the measurement point is changed to "front", Sa/Da/Pa are all the first in the gate**

The measurement value of the echo.