TUD300 Ultrasonic Detector
Operation Instructions

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Content

Chapter I. Overview

This is a portable industrial non-destructive flaw detector, which can rapidly, easily and accurately inspect, locate, evaluate and diagnose various defects (crack, inclusion and pinhole, etc.) in a workpiece without destruction. The instrument can be widely used in any fields that need defect inspection and quality controlling e.g. manufacturing industry, iron & steel metallurgical industry, metalworking, chemical industry, etc., also be broadly used in the active safety inspection and service-life evaluation in such fields as aerospace, railway transportation and boiler pressure vessels, etc.

When the ultrasonic wave propagates in a job, one can detect the defect in it by the influence on the propagation of ultrasonic wave based on the acoustic characteristic demonstrated by the defect in the material. Based on this principle, by using ultrasonic wave one can measure such defects as crack, pinhole and inclusion in such media as metal, non metal and composite, etc.

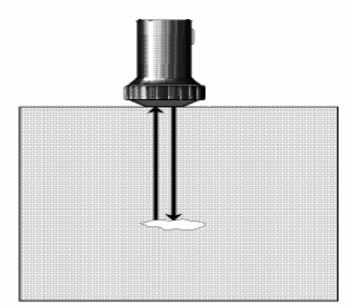


Fig. 1.1Basic working principle for ultrasonic detection

1.1 How to Use the Instruction Manual

It is necessary to read chapter 1, 2, 3 and 4 of the Instructions before operating instrument for the first time. The descriptions in the chapters are necessary for operating the instrument, which will describe all keys and displays on screen, and explain the operation principle.

By following the directions, you can avoid error or failure due to operation mistake and can have a clear concept about all functions of the instrument.

1.1.1 Layout of Pages and Conventions of Expressions

In order that you can use the Instructions easily, all operation steps and matters needing attention are arranged in a consistent way. This is helpful for getting each independent information. The structure of Contents for the Instructions is as deep as up to the 4th level, and the items after the 4th level will be indicated in bold titles.

Signs for Notes and Remarks

Note: the sign of "Note" indicates the features and special aspect that may influence the accuracy of result during operation.

Remarks: explanation, may include reference to other chapters or special introduction on a certain function.

List of item

The list of item is expressed in the following way

Item A

Item B

...

Operation procedure

The expressing way for operation procedure is as that shown in the following example

- By <Page up> key switch the function page.
- By <F1> key you select BASE functional group, and by <Menu> key, you select the functional menu for RANGE, and then adjust parameters for RANGE by key Coder.
- You can shift the Rough and Fine adjusting mode by Enter key ↵.

Chapter II Technical Parameters and Performance Features of the Instrument

2.1 Measuring Range and Measuring Error

Range of scanning:	2.5 mm ~5000 mm
Resolution for scanning:	0.1mm (2.5mm ~100mm)
	1mm (100 mm ~5000mm)
Range of gain:	0dB ~110 dB
D-Delay:	-20μs ~ +3400μs
P-Delay:	0μs ~ 99.99μs
Sound speed :	1000 m/s ~ 9999m/s

2.2 Operation Environment

Temperature: -15℃~50℃

Humidity: 20% ~ 90%RH

Free of strong magnetic field and corrosion.

2.3 Power supply

Li battery 4×3.6V 4000mAh

2.4 Overall Dimension and Weight

Overall dimension: 243mm×173 mm×70 mm
Weight: 1.47kg

2.5 Performance Features

- Measurement displaying mode: type A displaying mode, type B displaying mode;
- switch over arbitrarily among three detecting modes: single-probe , dual-probe ones and through transmission;
- There are four Rectify Ways at your selection: positive half-wave, negative half-wave, full wave and radio frequency.
- Users can upgrade all built-in software on PC;
- The probe damp will be shifted between 50, 150, 400 through menu selection;
- Automatic generation of DAC curve by standard test block, 30 points can be recorded at most, three adjustable bias curves are generated with the function of Correction.
- It is provided with linear reject function, the highest reject is 80% of the screen height;
- It has gate setting and alarming function. Can set the position and width of gate freely on the screen, and can set alarm for forbidden wave and loss wave respectively;
- Can freeze and defreeze waveform and detection parameters;
- Can lock/unlock the system parameters;
- Measuring of sound path and analyze of echo times;
- It is provided with memory function, 30 A scanned images, parameters and DAC curves can be stored in every channel (10 channels in all); 30 groups of thickness values can be stored in every channel with 100 thickness values in every group;
- Can indicate power state in real time;
- Real-time clock;
- Two measuring unit: mm/inch;
- Function of printing, print the report on thickness and wave amplitude curve through a serial printer;
- Can be communicated with PC, uploading the measuring data and system configuration parameters to PC for further processing (e.g. to generate report on detection, printing, etc.);
- RS232 communication port available;
- Having buzzer prompt during operation;
- Compact, light and easy to operate.
- 10 detecting channels are available with a separate detecting parameter and DAC curve in every channel.

- Memory of peaks.
- Two input methods, angles and K value.
- Auto-calibration of probe.
- Auto-gain
- Manual B scanning.

Chapter III Operation

3.1 Overview of the Instrument

3.1.1 Designation of the Instrument's Components

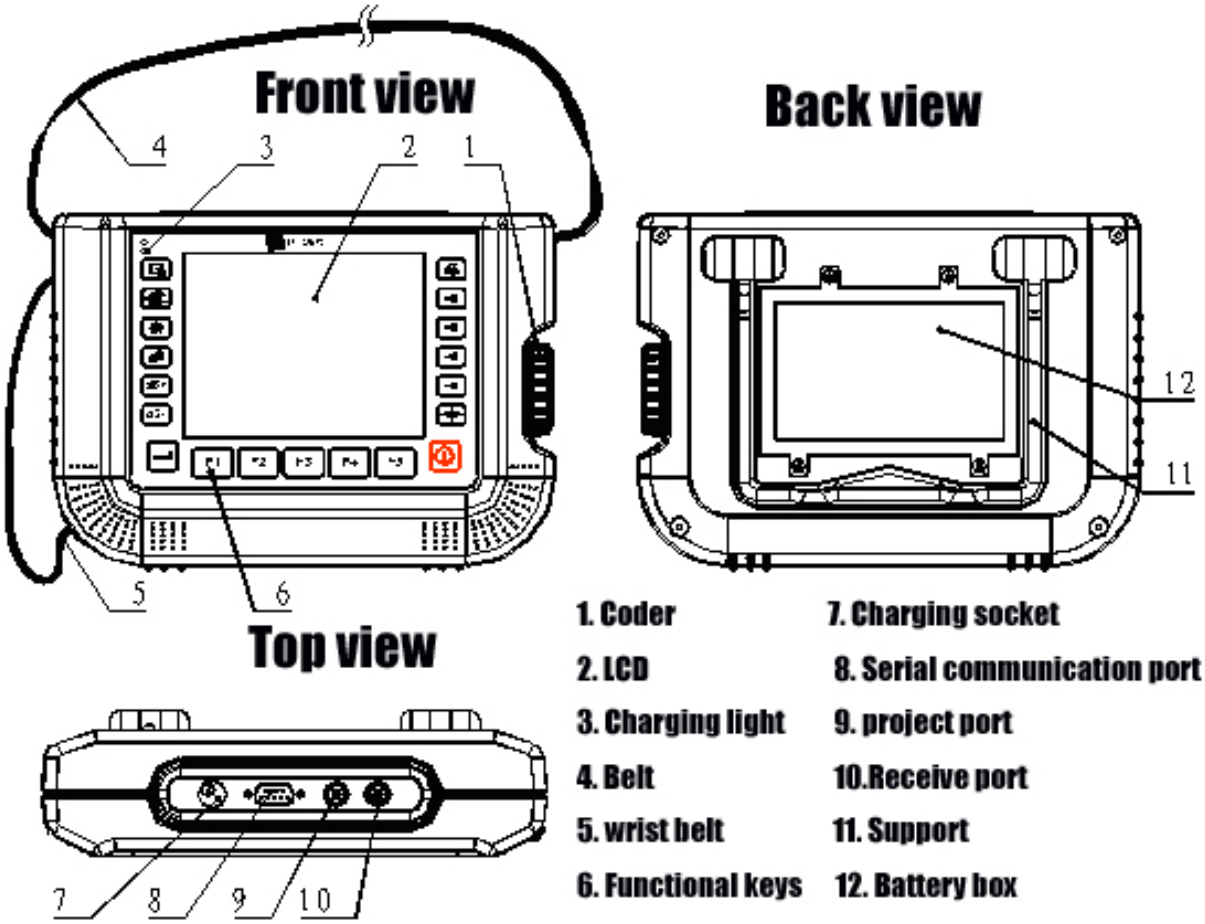


Fig. 3.1 Outside Drawing of the Instrument

3.1.2 Functional Keyboard

Keys of TUD300 are included in three groups: Function group, Menu group and special function group. There are 6 keys in Functional group, in which F1, F2, F3, F4, F5 are corresponding with the 5 functional groups on screen, and the key <> is used for switching of pages; Menu group comprises 4 key: S1, S2, S3, S4, they are used for operating on the corresponding 4 menu in every functional group; and special function group consists of 8 keys: on/off key, full screen key, extend key, freeze key, printing key, gain step key, dB+, dB- and Enter key. Overall arrangement of the whole face is as following picture.

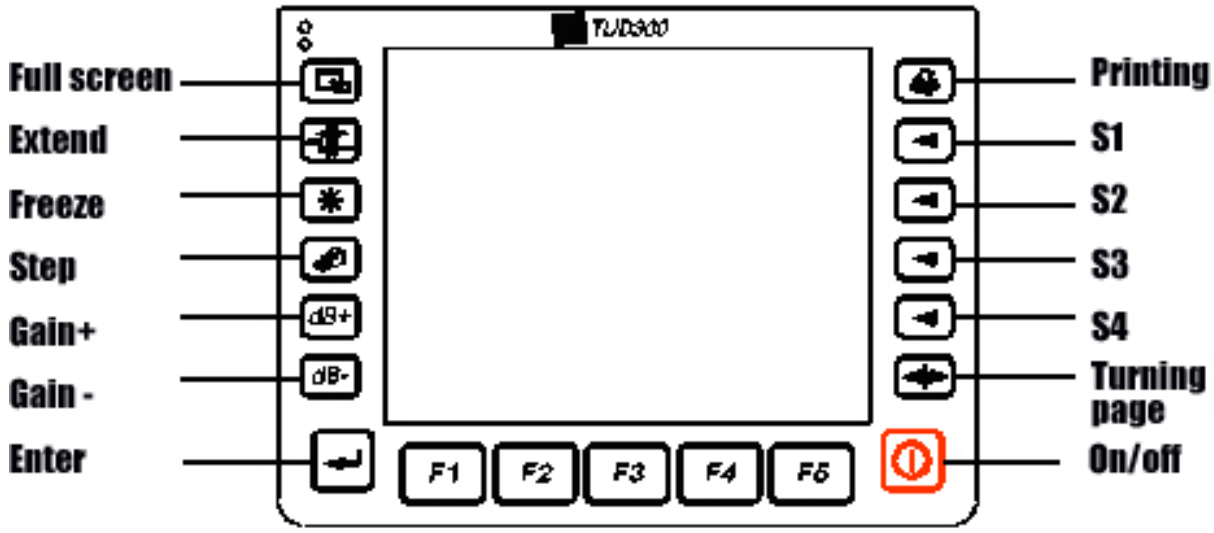


Fig. 3.2 Functional Keyboard

3.1.3 Using of Power Supply

TUD300 can work with plug-in power supply (AC, DC adaptor) or battery.

The detector will switch the power supply to adapter automatically when the power supply adapter is used.

The detector will switch the power supply to battery automatically when the power supply adapter is turned off.

The batteries will be charged automatically When TUD300, which is equipped with battery , is power supplied with adapter.

3.1.3.1 Supplying Power by Using AC Power Supply Device

Connecting the Instrument

Connect TUD300 to AC power through the special AC adaptor.

Note: 1. If you cut off the instrument's power forcefully (by opening the battery compartment or pulling out power plug), you will have no way to turn off the Instrument normally.

2. To turn off the instrument correctly, please press the ON/OFF key of the host.

3.1.3.2 Working with Battery

When you use battery to supply power to the instrument, please use the battery product recommended by us.

Putting in battery

The battery compartment is at back of the instrument. Open the battery compartment cover with a screwdriver, put the battery into the compartment, insert the plug of battery into the socket of battery, cover the battery compartment.

Indicator for charging

At lower right corner of TUD300 horizontal scale, there are symbols for battery voltage:

Fig. 3.3 Battery voltage high

Fig. 3.4 Battery voltage drops

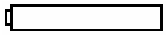


Fig. 3.5 Battery voltage low

If it shows the symbol for low voltage, you must stop detection immediately and replace the battery or charge it.

Remarks: If it is to have field measurement, please carry standby battery along with you.

Charging the Li Battery.

You can charge the Li battery by using an external battery charger. It is recommended to charge by using the power adaptor in the standard kit of TUD300. Before using the charger, please read carefully the Operation Instructions for it. The continuous charging time for Li (4Ah) battery is about 4h～5h.During the charging, Rapid Charging indicator lamp (green) will light up; when the charging completes, the Rapid Charging indicator lamp goes out.

3.1.4 Connecting the Probe

Proper probe shall be connected when using TUD300 to inspect. So long that you have a proper cable, and the working frequency is within proper range, any probe made by our company is suitable for TUD300.The probe connector for TUD300 is BNC.

The probe shall be connected to the socket at right of the instrument casing. With Single-Probe mode, both connector sockets (which are parallel internally) have the same function. When connecting a double-wafer (TR) probe (one wafer for sending, another for receiving) or two probes (one for sending, another for receiving), take care that the sending probe shall be connected to the socket at right (with "—>" mark at back of instrument casing) and receiving probe to the socket at left (with "<—>" mark). Otherwise, it may result in loss or disorder echo waveform.

3.1.5 Starting and Turning off the Instrument

a) Get ready the job;

b) Insert the probe plug into the probe socket of the host, rotate tightly the locking nut;

c) Select the working power supply per 3.1.3, press ⊖, turn on the instrument;

d) It will carry out self test;

In normal case, when you turn on the unit, it will automatically enter into the status that it is in during last turning off. The instrument parameters are consistent with last turning off, but the waveform during last turning off will not display.

e) Check voltage of the battery;

Remarks: Please check the power-monitoring icon at lower right corner of the display screen. There are three status:

Fig. 3-3, normal voltage;

Fig. 3-4, voltage has dropped;

Fig. 3-5, voltage is low, it is necessary to replace battery,

If the power monitor shows that the voltage is low, it will turn off automatically 1 min after alarming bell.

Whether it needs to calibrate the instrument, if yes, ask a professional technician to calibrate it (refer to chapter IV);

f) Measure;

g) Turn off the instrument;

If the self test when turning on the instrument is abnormal, you can first turn off then re-start it, if the self test still fail, you can reset the instrument to the status when the instrument is shipped (refer to 3.14.10).

3.1.6 Description about Screen Display

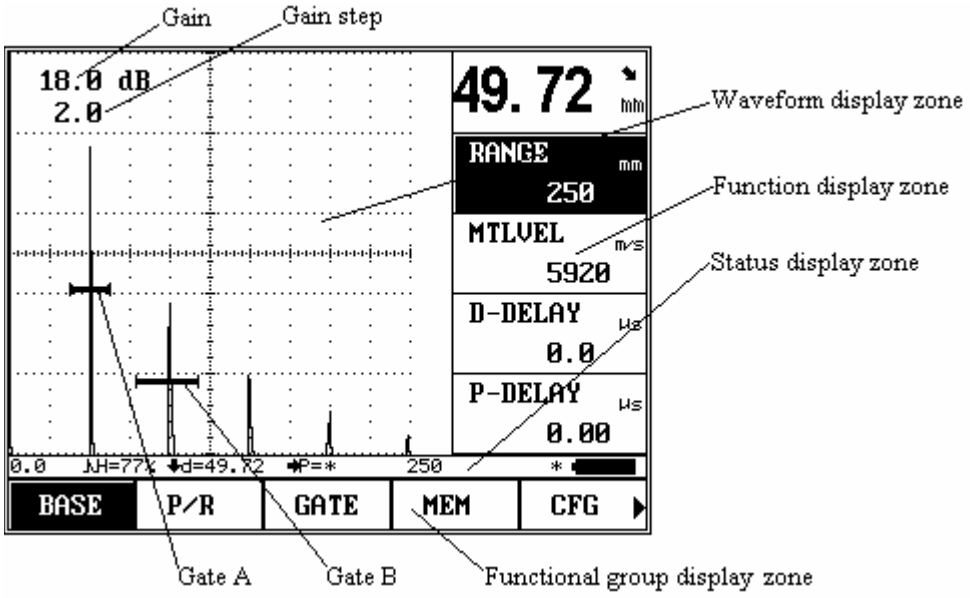


Fig. 3.6 Description about screen

3.1.6.1 Two Display Modes of TUD300 Screen

•A-scan at normal mode

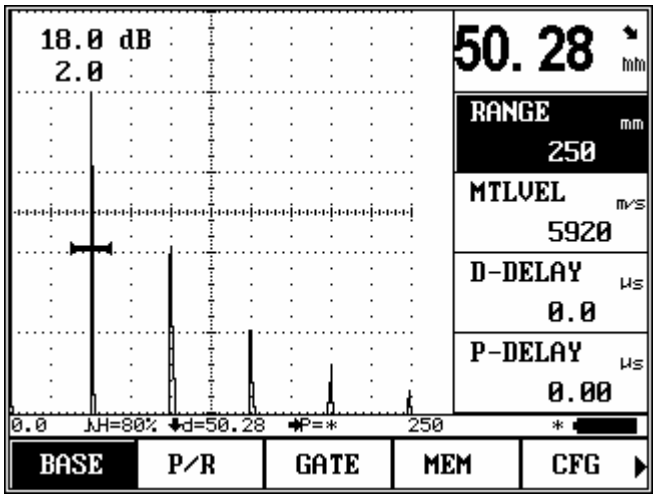


Fig. 3.7 A-scan at normal mode

•A-scan at Enlarged mode

You can activate Enlarge mode by  . The gain and selected dB step value will be always displayed on the screen. And at the same time, all other functions are locked.

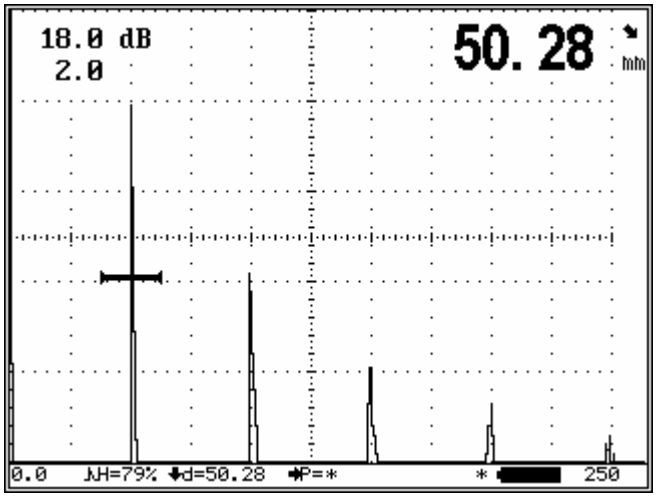


Fig. 3.8 A-scan at Enlarged mode

•Manual B-scanning

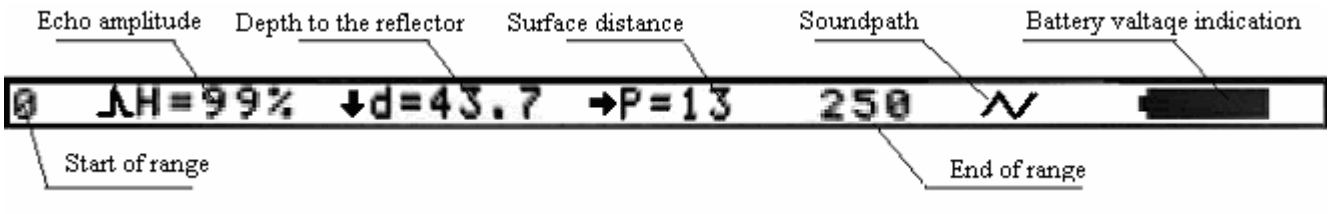
3.1.6.2 Function Displaying Items

The 10 functional groups are displayed at lower part of the screen in two pages. The current functional group will be highlighted. and at the same time, the current function in the current functional group will also be highlighted. Under Enlarged mode, the display of functional groups disappears.

3.1.6.3 Other Display

The data and symbols in the line of measurement data below horizontal reticle show partial configurations, readout and status symbol.

3.1.6.4 Description about Symbols Displayed on Screen



In the fig above, echo amplitude H=99%, depth to the reflector=43.7mm, surface distance=13mm, echo times is 3, and battery voltage is high, start of range=0.0mm, end of range=250.0mm

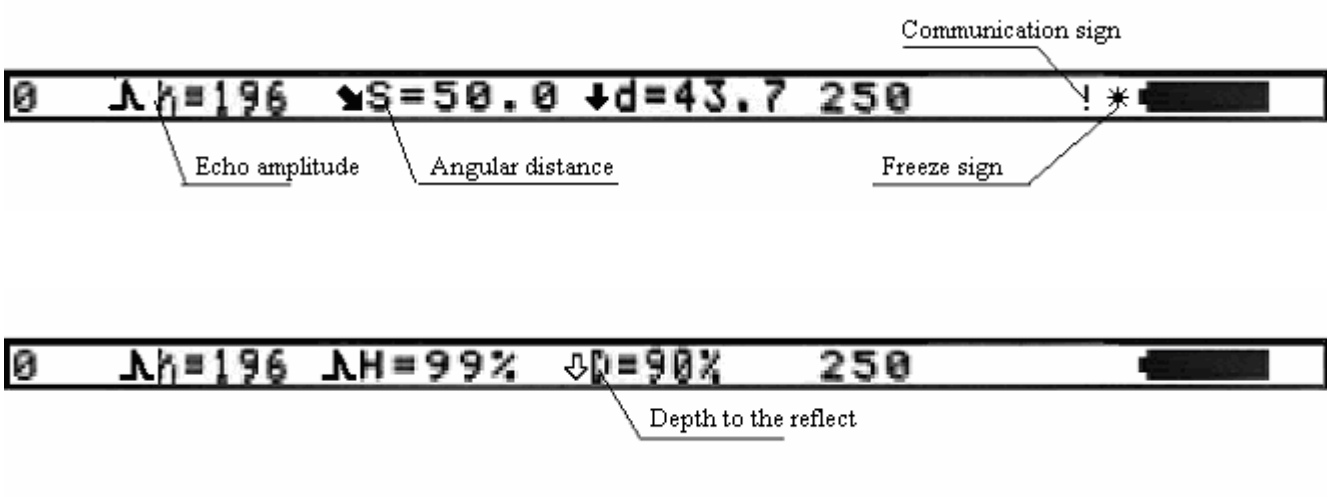


Fig. 3.9 Description about the display field in screen

3.1.6.5 Display of echo times

When the angle of probe is not zero and the measured echo is multi-echo, the echo times will be drew on the status column as the following.

/ one time echo

/\ two times echo

/\/ three times echo

/\/\ four times echo

/\/\— five and more times echo

3.2 Overview of Instrument Description

3.2.1 Function of the Keys

With key combination of function selection, function adjustment group of TUD300, you can select the functions of instrument and adjust the functional values; and with keys of Special Functional group, you can directly start the special functions of the instrument. The following is the detailed description about the functions that can be achieved by different keys.

F1 key

By pressing F1key, users can select the basic (bevel probe) function groups listed at the lower part of screen, at the same time of choosing some group all functions within the group will be displayed on the right of screen.

F2 key

By pressing F2 key, users can select the receiving & sending function group (DAC1)listed at the lower part of screen, details of the functions will appear on the right of the screen when certain function is selected.

F3 key

By pressing F3 key, users can select the gate function group (DAC2)listed at the lower part of screen, details of the functions will appear on the right of the screen when certain function is selected.

F4 key

By pressing F4 key, users can select the storing function group (advanced)listed at the lower part of screen, details of the functions will appear on the right of the screen when certain function is selected.

F5 key

By pressing F5 key, users can select the setting function group (scanning B)listed at the lower part of screen, details of the functions will appear on the right of the screen when certain function is selected.

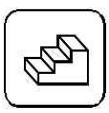
Menu key

There are 4 menu keys in all, corresponding with 4 items. Repeating these keys users will get more functions such as submenu, switch between rough and inching adjustment, switch between storing of thickness and waveform, confirm of deleting, confirm of transducer calibration and so on

ON/OFF

ON/OFF of the gauge

Gain step



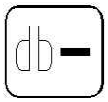
By pressing Gain Step, the gain step will change cyclically in 7 steps i.e. 12.0dB, 6.0dB, 2.0dB, 1.0dB, 0.5dB, 0.2dB and 0dB; by selecting a proper gain step, you can adjust rapidly the gain to the desired value.

Gain +

By pressing Gain +, the gain will increase in the set gain step, the adjusting range for gain is

0dB~110dB.

Gain -



By pressing Gain -, the gain will decrease in the set gain step, the adjusting range for gain is 0dB~110dB.

Enter key

If you press Enter key on a function item with multipurpose functions, you can shift between the functions; and can shift the Rough or Fine adjustment way for any function item with two adjusting modes as Rough and Fine.

Page Up

Turning the pages containing function groups.

Full-screen key

Under A-scan mode, by pressing Enter key, you can shift the display modes for the screen, and shift between normal and Enlarged mode.

Print key

Under A-scan mode, by pressing Enter key, you can shift the display modes for the screen, and shift between normal and Enlarged mode.

Freeze key

During operation, by pressing Freeze key, you can freeze the waveform and data displayed on the screen at that time, and by pressing the key again you can defreeze that.

Extend key

By pressing down Extend key, you can extend wider the waveform covered by the gate, so that you can observe the details of the waveform.

Coder By Coder, you can adjust or decrease incrementally the data of the selected function (highlighted) displayed at left of screen.

3.2.2 Overview of All Functions

The functions of TUD300 are included in 10 functional groups and several special functions.

The functional groups include BASE, P/R, GATE, MEM, CFG, AGLEY, DAC1, DAC2, ADV, BSCAN, etc., they will be introduced in the following table.

Functional group	Functions	Description
BASE	RANGE, MTLVEL, D-DELAY , P-DELAY	Basic adjustment items necessary for the display range
P/R	DAMP, PROBE TYPE, FEQUENCY/RECTIFY, REJECT/DATUM LINE, CALIBRATE	Sending and receiving the adjustment items needed
GATE	GATE LOGIC/ALARM, aSTART/bSTART, aWIDTH/bWIDTH, aTHRESH/bTHRESH	Relative items for gate configuration
MEM	DATA NO, RECALL, SAVE, DELETE	Setting of data memory
CFG	DETECT/PEAKMEM, COORDINATE/BRIGHTNESS, FILL/BUZZER, LANGUAGE/UNIT	Setting of relative state
ANG	ANGLE/K-VALUE, T-VALUE, X-VALUE/X-COORD,	Setting relative with angle probe

	MTLVEL	
DAC1	DAC/REVISE, RECORD/REVISE POS, aSTART/aWIDTH, AUTO-80	Plotting DAC curve
DAC2	DAC-EL, DAC-SL, DAC-RL, CORRECT	Setting relative with DAC curve
ADV	CHANNEL/SAVE, RECALL, VALUEDIS/RS232 SET, DATE/TIME	Advanced function
B-SCAN	B-SCAN/A-SCAN, SCAN WAY	Setting of B-SCAN

Other special functions can be realized by Special Function (SF) keys. The functions of each SF keys are introduced in the following table.

Special Functions	Description of function
Gain step	To adjust the gain step
dB+、dB-	To adjust the gain
Full-screen	To switch over in full screen
Zoom	To extend width within the gate
Freeze	To freeze waveform
Print	To print report
Enter	Switch of multi-menu, parameters, confirmation of functions
Page up	Switch function page

3.2.3 Basic Operation Way

You can select a functional group by <Fn> key; select certain function by <Menu> key and ↵; at this time, you can modify parameters of this current menu by Coder And for some functional menus, they are shared by two functions, when you have selected such a function, by pressing ↵ or the corresponding <Menu> key, it can be shifted to another function.

3.2.3.1 Selection of Functions

There are 5 functional groups displayed below the A-scan zone, which can be selected by the corresponding <Fn> key, and the selected one will be highlighted. The four corresponding function items will be displayed closely next to the right of A-scan zone, which can be selected by <Menu> key.

3.2.3.2 Multipurpose Function Items

In some cases, a functional item has two functions. thus they can be shifted by pressing down the <Menu> key again or striking ↵ key. The symbol “>” displayed behind the function name means that it is a multipurpose function item.

Function I	Function II	Functional group to which it belongs

DAMP	PROBE TYPE	P/R
FREQUENCY	RECTIFY	P/R
REJECT	DATUM LINE	P/R
GATE LOGIC	ALARM	GATE
aSTART	bSTART	GATE
aWIDTH	bWADTH	GATE
aTHRESH	bTHRESH	GATE
DATA NO（for Wave）	DATA NO（for Thickness）	MEM
DETECT	PEAKMEM	CFG
COORDINATE	BRIGHTNESS	CFG
FILL	BUZZER	CFG
LANGUAGE	UNIT	CFG
ANGLE	K-VALUE	ANG
X-VALUE	X-COORD	ANG
DAC	REVISE	DAC
RECORD	REVISE POS	DAC
aSTART	aWIDTH	DAC
CHANNEL	SAVE	ADV
DATE	TIME	ADV
B-SCAN	A-SCAN	B-SCAN

3.2.3.3 Rough and Fine Adjustment of Functions

For some functions, rough and fine adjustment are available. By pressing down the corresponding ↵ key, you can shift between these two adjusting modes. With a symbol "*" in front of the function item that means it is in fine adjustment mode.

The following are the functional items with optional rough and fine adjustment

Functions	Functional group
RANGE	BASE
MTLVEL	BASE/ANG
D-DELAY	BASE
T-VALUE	ANG

3.2.3.4 Example of Function Operation:

Suppose that the function of RANGE in BASE functional group is selected currently, and you want to select RECTIFY under P/R, what to do?

Firstly Select the P/R group by the key <F2>, and then select FREQU/RECTIFY functional menu by the key <Menu>. this functional menu is multipurpose for Frequency and Rectify way, so user has to shift the two functions as he needs. if it displays Rectify way, the operation completes; if it displays Frequency, shift it to Rectify way by key ↵, and now the operation of function selection is completed.

3.2.4 Important Basic Settings

3.2.4.1 Selection of Language

To set the language for instrument display.

Options: Chinese, English

Operation procedure:

- By <Page up> key switch the function page.
- By <F5> key select the CFG functional group, and by <Menu> key, select the functional menu for LANGUAGE/UNIT, and then set language by key Coder.
- Unit selection is included in the same menu, they can be shifted by the key ↵.

3.2.4.2 Selection of Unit

This is to select the unit for detection parameters of the instrument. If you select mm, it will use metric unit; and if you select inch, then it will use imperial one.

Options: mm, inch

Operation procedure:

- By <Page up> key switch the function page.
- Select CFG functional group by <F5> key, and then select the functional menu of LANGUAGE/UNIT by <Menu> key, and set unit by key Coder.
- User can shift the functions for language and unit by Enter key ↵.

3.2.4.3 Setting of Background Light (Background Lighting)

User can select the intensity of background light of the display screen by functional item BRIGHTNESS (functional group CFG), which has four grades.

Remarks: The brighter the background light, the shorter the working duration of battery. Therefore, when it

is not necessary to use backlit brightness, you'd better adjust the background brightness to the lowest grade as far as possible.

Operation procedure:

- By <Page up> key switch the function page.
- By <F5> key you select CFG functional group, and by <Menu> key, you select the functional menu for BRIGHTNESS /COORDINATE, and then set the intensity grade of background brightness by key Coder.
- User can shift the functions for brightness and coordinate by Enter key ↵.

3.2.4.4 Set Displaying Way of Scale

User can select the displaying way of coordinate grid by functional item COORDINATE (functional group CFG), which has four types.

Remarks: select the proper displaying way for coordinate grid as user's like..

Operation procedure:

- By <Page up> key switch the function page.
- By <F5> key you select CFG functional group, and by <Menu> key, you select the functional menu for BRIGHTNESS /COORDINATE, and then set the displaying way of coordinate grid by key Coder.
- User can shift the functions for brightness and coordinate by Enter key ↵.

3.2.4.5 Set A-scan Mode

A-scan can be set to normal and Enlarged mode, under the normal mode, it will display the functional group and function items, status field; under the enlarged mode, it displays only the echo in the measuring area and status field, this is helpful for observing the waveform and measurement. During the detection, generally it is set to Normal mode, when it detects any defect, you will change it into Enlarged mode to observe that. You can shift between Enlarged and Normal mode by Full-screen key ⛶.

3.2.5 Basic Setting before Detection

3.2.5.1 Basic Setting of the Base Group

Before starting detection, set of RANGE, MTLVEL, D-DELAY, P-DELAY in the BASE group must be completed, for details please refer to section 3.4 Adjustment of Base Group.

3.2.5.2 Basic Setting of the P/R Group

Before starting detection, it is necessary to set the DAMP, FREQUENCY/RECTIFY, REJECT/DATUM LINE, DUAL PROBE in the P/R group. As for the concrete setting ways, please refer to section 3.5 Adjustment of P/R Group.

3.3 Overview of Functional Groups

BASE The function of this functional group is adjusting items necessary for screen display.

P/R The function combined in this group is for adjusting the pulse generator.

GATE All functions for setting (double) gates are included in this group.

MEM These functions are for saving, retrieving and deleting the data.

CFG The function of this group is for function setting relative with measurement.

ANG The function of this group is for corresponding setting and operation when an angle probe is used to measure.

DAC1 This functional group is used for demarcate DAC curve.

DAC2 This functional group is used for setting and calibrating DAC curve.

ADV This functional group is used for some special application of the gauge.

B-SCAN This functional group is used for setting of B scanning parameters.

3.4 Adjustment of BASE Group

In the BASE functional group, users can adjust and set the functional items relative with the display range, including RANGE, MTLVEL, D-DELAY and P-DELAY.

During the detection, the display range of screen is in great relation to the material of workpiece and probe's nature. The workpiece material will influence the transmission velocity of ultrasonic wave, and the character of probe determines the P-DELAY.

Remarks: In order to set the sound velocity of ultrasonic wave in workpiece and P-DELAY, Do please refer to Chapter IV Calibration of Instrument.

3.4.1 Detection Range (RANGE)

It is to set the measuring range for screen display during detection

Range: 2.5mm ~ 5000mm/0.1" ~ 200"

If what selected currently is RANGE functional menu, then by pressing ↵, it is allowed to shift between Rough and Fine adjustment.

Rough adjustment: 2.5mm, 5mm, 10mm, 20mm, 30mm, 40mm, 50mm, 60mm, 70mm, 80mm, 90mm, 100mm, 150mm, 200mm, 250mm, 300mm, 350mm, 400mm, 450mm, 500mm, 600mm, 700mm, 800mm, 900mm, 1000mm, 2000mm, 3000mm, 4000mm, 5000mm

Fine adjustment:

Range	Step graduation
⩽100.0mm	0.1mm
>100mm	1mm

Operation:

- By <Page up> key, switch the function page.
- Select BASE functional group by <F1> key, and by <Menu> key, select the functional menu for RANGE, and then adjust parameters for RANGE by key Coder.
- Users can shift the Rough and Fine adjusting mode by key ↵.

3.4.2 Material velocity (MTLVEL)

Users are allowed to set the transmission velocity of ultrasonic wave in workpiece.

Range: 1,000m/s ~ 9,999m/s or 0.0394in/μs ~ 0.3937in/μs

If what selected currently is MTLVEL function menu, then by the key ↵, it is allowed to shift between Rough and Fine adjustment.

Rough adjustment:

2,260m/s	0.089 in /μs	Sound velocity of transverse wave in copper
2,730m/s	0.107 in /μs	Sound velocity of longitudinal wave in organic glass
3,080m/s	0.121 in /μs	Sound velocity of transverse wave in aluminum
3,230m/s	0.127 in /μs	Sound velocity of transverse wave in steel
4,700m/s	0.185 in /μs	Sound velocity of longitudinal wave in copper
5,920m/s	0.233 in /μs	Sound velocity of longitudinal wave in steel
6,300m/s	0.248 in /μs	Sound velocity of longitudinal wave in aluminum

Fine adjustment: Step is 1m/s or 0.0001in/μs

Operation:

- By <Page up> key, switch the function page.
- Select BASE functional group By <F1> key, and by <Menu> key, select the functional menu for MTLVEL, and then adjust parameters for MTLVEL by key Coder.
- Users can shift the Rough and Fine adjusting mode by Enter key ↵.

Remarks: Do guarantee the correctness of sound velocity (level), because partial measuring results displayed in the status lines of the instrument are calculated based on the sound velocity.

3.4.3 Display starting point (D-DELAY)

Can set the pulse shift during detection, viz. D delay. By which, users are allowed to adjust the starting position for waveform, as well as adjusting the zero point of pulse, so as to make sure that it is at the surface or a starting face inside the workpiece. If the pulse has to be started from the surface of workpiece, D delay must be set to 0.

Range: -20μs ~ 3400μs

Step: 0.1μs

Operation:

- By <Page up> key, switch the function page.
- Select BASE functional group by <F1> key, and by <Menu> key, select the functional menu for D-DELAY, and then adjust parameters for D-DELAY by key Coder.
- Users can shift the Rough and Fine adjusting mode by key ↵.

3.4.4 Probe delay (P-DELAY)

Can set the zero point of probe during detection, viz. P Delay. It is necessary to compensate the delay in probe resulted from acoustic beam in the pitch interval from energy exchanger to workpiece by P Delay.

Range: 0μs ~ 99.99μs

Step graduation: 0.01μs

Operation:

- By <Page up> key, switch the function page.
- Select BASE functional group By <F1> key, and by <Menu> key, select the functional menu for P-DELAY, and then adjust parameters for P-DELAY by key Coder.

Remarks: If P Delay is unknown, please do refer to Chapter IV Calibration of Instrument.

3.5 Adjustment of P/R Group

With this functional group, it is allowed to adjust and set the functional items in relation to ultrasonic sending and receiving, including DAMP/PROBE TYPE, FREQUENCY/RECTIFY, REJECT/DATUM LINE, CALIBRATE.

3.5.1 Probe matching (DAMP)/Probe type (PROBE TYPE)

This functional menu is multipurpose for filter probe matching and probe type.

DAMP:

This function is for matching the ultrasonic probe with the acoustic impedance of the measured material by adjusting the damp, so as to improve the amplitude, width and resolution for echo display. The higher the damp selected, the narrower and lower the echo waveform, and the higher the echo resolution is.

Options:50Ω, 150Ω, 400Ω

Operation procedure:

- By <Page up> key switch the function page.
- By <F2> key select P/R functional group, and by <Menu> key, select the functional menu for DAMP, and then adjust parameters for DAMP, by key Coder.
- Switch of DAMP and P/R is available by the same key <MENU>.

PROBE TYPE:

Setting of ultrasonic probe. If the current probe is an echo probe, then set it to single; if it is a double-wafer probe, set it to DUAL, and if it is a through transmission probe, set it to THRU.

Options: P/R: Single element transducers. Use either transducer connector.

DUAL: One connector acts as a transmitter, the other acts as a receiver. The red transducer connector is designated as the transmitter.

THRU: Two separate transducers, typically on opposite sides of the test specimen. Use the red transducer connector as the transmitter.

Operation procedure:

- By <Page up> key switch the function page.
- By <F2> key select P/R functional group, and by <Menu> key, select the functional menu for PROBE TYPE, and then adjust parameters for PROBE TYPE by key Coder.
- Users can shift the functions for DAMP and ROBE TYPE by key ↵.

3.5.2 Frequency range (FREQUENCY)/Rectify way (RECTIFY)

This menu is multipurpose for filter frequency band and rectify way.

FREQUENCY:

The Frequency selected must be accordant with frequency of current probe. Three frequency bands are available.

Options: LOW (0.2 MHz ~ 1 MHz)

MID (0.5 MHz ~ 4 MHz)

HIGH (3.0 MHz ~ 15 MHz)

Operation:

- By <Page up> key switch the function page.
- By <F2> key select P/R functional group, and by <Menu> key, select the functional menu for FREQUENCY, and then adjust the option for FREQUENCY by key Coder.
- Users can shift the functions for FREQUENCY and RECTIFY by Enter key ↵.

RECTIFY:

There are 4 ways available. When the DAC curve or B-scan is turned on, RF is ineffective.

Options: POS Positive half wave

NEG Negative half wave

FULL Full wave

RF Radio frequency

Operation:

- By <Page up> key switch the function page.
- By <F2> key select P/R functional group, and by <Menu> key, select the functional menu for RECTIFY, and then adjust the option for RECTIFY by key Coder.
- Users can shift the functions for FREQUENCY and RECTIFY by key ↵.

3.5.3 REJECT/ DATUM LINE

This functional menu is multipurpose for reject and rectify reference.

REJECT:

This menu is used to reject the echo's display amplitude, for example, to remove the structural noise in the job. It is to reject the display of echo whose amplitude is lower than the setting value by setting a percentage (i.e. percentage at full amplitude).

The suppressing percentage (i.e. percentage at full amplitude) indicates the min. echo height to be displayed. Any echo amplitude lower than this height will be neglected and recorded as zero amplitude.

Parameter range:0%~80%

Step graduation:1%

Operation procedure:

- By <Page up> key switch the function page.
- By <F2> key select P/R functional group, and by <Menu> key, select the functional menu for REJECT, and then adjust suppression percentage by key Coder.
- Users can shift the functions for REJECT and DATUM LINE by key ↵.

Note: 1. Please be cautious in using this function, in case that the wave of defect is also suppressed. Additionally, this function is forbidden in some norm for detection.

2. The function of suppression will not influence the waveform display under radio frequency state, and can't be adjusted under radio frequency state.

DATUM LINE:

This menu is for setting the reference for rectification, so as to adjust the position of echo displayed on the vertical graduation. By adjusting the Rectify Reference, users can move the central line of echo up and down in the screen. Its parameter means the numberof pixels on the screen.

Parameter range: -128~128

Step: 1

Operation:

- By <Page up> key switch the function page.
- By <F2> key select P/R functional group, and by <Menu> key, select the functional menu for DATUM

LINE, and then set the reference position for rectification for rectification by key Coder.

- Users can shift the functions for REJECT and DATUM LINE by key ↵.

3.5.4 Calibration of Probe

For the convenience of user's calibration of probe zero point and sound speed of material, the function of calibration is built in the gauge. Further more, users can also do the calibration of probe as what is shown in chapter 4.

Straight probe can be calibrated with the following method, and angle probe needs to be calibrated on X-VALUE and ANGLE first, and then the calibration with the same method.

For example of the standard straight probe which is frequency 2.5MHz, diameter 20mm and single. Two test blocks which are the same material with the measured object, and thickness determinate are needed. And the thickness of the two test blocks had better to be one is less than the min. thickness of the measured object and the other is more than the max thickness of measured object.

Suppose that the probe is calibrated with two test blocks whose thickness are 50mm and 100mm, the operation steps are as following:

(1) set the sound speed value to 5920 approximately, and set the zero value of probe to 0.00us;
(2) adjust the gate logic to single gate;
(3) adjust the detecting range to make the echo over 100mm can be displayed on the screen;
(4) couple the probe on the thin test block(50mm), move gate A start to echo and cut with it.
(5) Select the probe calibration menu in group ADV, confirm the sound distance, then the gauge will adjust the gain automatically to make amplitude of the largest echo in gate equal 80% of the screen, and at the same time, a number appears in the probe calibration menu, adjust this number to make it the same with actual S-PATH of test block, that is 50mm.
(6) Couple the probe on the thick test block(100mm), move gate A start to echo and cut with it.
(7) Select the probe calibration menu in group ADV, confirm the sound distance, then the gauge will adjust the gain automatically to make amplitude of the largest echo in gate equal 80% of the screen, and at the same time, a number appears in the probe calibration menu, adjust this number to make it the same with actual S-PATH of test block, that is 100mm.
(8) Press the ENTER key to confirm and finish the calibration, now the material sound speed and probe zero point of gauge will get to accurate value automatically.
(9) Before step 8, the key <FREEZE> can be used to cancel calibration.

Note: 1. the function of auto-calibration can also be used in a single thickness determinate test block. Users can do that by repetitious echoes, moving gate A to each echo and entering the correct thickness value.

2. during the calibration of angle probe, the entering value is not thickness of test block or depth of holes, but S-PATH, that is S value. So for the convenience of entering S value, please use the echo of test block CSK-1A R100 and R50 when doing calibration on angle probe with this method.

Otherwise, please calculate the S value according to the probe angel and depth.

3.6 Adjustment of GATE Group

It is used for adjustment of gate settings, including Gate logic, Gate alarm, Gate start, Gate width and Gate height.

Functions of gate during detection:

- To monitor whether the job has flaws in the set logic and range, if yes, it will alarm.
- To measure the position and size of flaw echo.

TUD300 is equipped with double-gate function: Gate A and Gate B, normally Gate A is used alone for detecting the workpiece flaw, and the double-gate is usually used in the measuring and calibration of multi-echo, eg. Measuring the distance between surface echo and first echo during thickness measurement.

3.6.1 GATE LOGIC/ ALARM

This menu is multipurpose for gate logic and gate alarm.

GATE LOGIC:

Gate logic has four options: NONE, POS, NEG, MUL.

Options: NONE: gate monitoring is off
POS: when the echo amplitude is higher than the preset threshold of the gate, it will alarm
NEG: when the echo amplitude is lower than the preset threshold of the gate, it will alarm
MUL: state of double gates

Operation:

- By <Page up> key switch the function page.
- By <F3> key select GATE functional group, and by <Menu> key, select the functional menu for GATE LOGIC, and then adjust the gate logic by key Coder.
- Users can shift the functions for GATE LOGIC and ALARM by Enter key ↵.

ALARM:

Setting of gate alarm.

It can be used for alarm of forbidden wave and loss wave depending on the setting of Gate Logic. That is, if the gate is at positive logic, when the echo amplitude is higher than the threshold, the buzzer alarms; if the gate is at negative logic, when the echo amplitude is lower than the threshold, the buzzer alarms.

Options: ON: the buzzer is on
OFF: the buzzer is off

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select GATE functional group, and by <Menu> key, select the functional menu for ALARM, and then turn on/off the buzzer by key Coder.
- Users can shift the functions for GATE LOGIC and ALARM by key ↵.

3.6.2 Starting point of the gates (aSTART/bSTART)

This functional menu is multipurpose for Start of Gate A and Gate B.

aSTART:

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select GATE functional group, and by <Menu> key, select the functional menu for aSTART, and then adjust the starting position of Gate A by key Coder.
- Users can shift the functions for aSTART and bSTART by key ↵.

bSTART:

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select GATE functional group, and by <Menu> key, select the functional menu for bSTART, and then adjust the starting position of Gate B by key Coder.
- Users can shift the functions for aSTART and bSTART by key ↵.

Remarks: ***Gate B is independent from Gate A. The three gate parameters: Gate Start, Gate Width and Gate Height can be adjusted separately without disturbing each other.***

3.6.3 Width of the gates (aWIDTH/bWIDTH)

This functional menu is multipurpose for Width of Gate A and Gate B, when this menu is selected, by ↵ you can shift the two functions.

aWIDTH:

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select GATE functional group, and by <Menu> key, select the functional menu for aWIDTH, and then adjust the width of Gate A by key Coder.
- Users can shift the functions for aWIDTH and bWIDTH by key ↵.

bWIDTH:

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select GATE functional group, and by <Menu> key, select the functional menu for bWIDTH, and then adjust the width of Gate B by key Coder.
- Users can shift the functions for aWIDTH and bWIDTH by key ↵.

3.6.4 Response and measurement threshold (aTHRESH/bTHRESH)

This functional menu is multipurpose for Threshold of Gate A and Gate B, when this menu is selected, by ↵ you can shift the two functions.

a THRESH:

It is to set the threshold of Gate A. The parameter is expressed in percentage, i.e. the percentage in relative to the full amplitude.

Parameter range: 2% ~ 90%

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select GATE functional group, and by <Menu> key, select the functional menu for aTHRESH, and then adjust the threshold of Gate A by key Coder.
- You can shift the functions for aTHRESH A and bTHRESH by Enter key ↵.

bTHRESH:

It is to set the threshold of Gate B. The parameter is expressed in percentage, i.e. the percentage in relative to the full amplitude.

Parameter range:2% ~ 90%

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key you select GATE functional group, and by <Menu> key, you select the functional menu for bTHRESH, and then adjust the threshold of Gate B by key Coder.
- You can shift the functions for aTHRESH A and bTHRESH by Enter key ↵.

3.7 Adjustment of MEM Group

This is for adjusting the memorizing modes, calling out, deleting and saving the configured data and detection parameters. It includes such functional menus as DATA NO, RECALL, SAVE and DELETE.

This instrument can memory 300 sets of data and detection parameters as well as DAC curves from A-scan, 300 sets of thickness values (each set can memory 100 thickness values, so 300 sets can memory 30000 thickness values),These data are distributed in 10 detection channels.

Note: ***When the MEM mode is waveform memory, the data saved includes waveform data of A-scan at that time and present detection parameters and DAC curve. This means, when calling a set of saved data, not only the waveform displayed currently will change into the waveform saved, but also current instrument's detection parameters will also change into the saved data.***

3.7.1 Function group MEM (DATA NO.)

It is for setting the MEM group No. after selecting the functional menu for Group No., by pressing ↵ users

can switch over the MEM modes. If waveform symbol appears after the Group No., that means currently it is in Waveform Save Mode; if it displays symbol of thickness, that means currently it is in Thickness Save Mode.

Parameter range: For waveform save, 1~30
For thickness save, 1~30

MEM mode: waveform, thickness

Operation:

- By <Page up> key switch the function page.
- By <F4> key select MEM functional group, and by <Menu> key, select the functional menu for DATA NO, and then set group no. by key Coder.
- Users can shift the MEM modes by Enter key ↵.

Remarks: Under Waveform Save mode, if * appears before group No. that means there has been data stored in; if it displays ¥ before group No., that means data has exist in this group and it has been locked; under Thickness Save mode, if it displays # before group No., that means the group is full.

3.7.2 Recalling a stored data set (RECALL)

It is to recall data under Waveform Save mode, and call out the data corresponding to current group No. Under Thickness Save mode, it is impossible to call out data. When the recalling succeeds, the current waveform and detection parameters will be substituted by the saved waveform and detection parameters, and the waveform is frozen.

Operation procedure:

- By <Page up> key switch the function page.
- By <F4> key select MEM functional group, and by <Menu> key, select the functional menu for RECALL, and then carry out calling by key Coder.
- If current group no. has no data in it, by key Coder, this functional menu will always display OFF; if there is data existing in the group, by key Coder, it will show "Yes/No", and now press the corresponding menu key or ↵, the data will be recalled, and press any other key to cancel recalling.

3.7.3 Storing a data set (SAVE)

This functional menu is for saving data. It is to save the current waveform data or thickness value into the current group no. depending on the displayed save mode. This instrument can save 300 sets of waveform data and 30000 thickness values.

Operation:

- By <Page up> key switch the function page.
- By <F4> key select MEM functional group, and by <Menu> key, select the functional menu for SAVE, and then carry out saving by key Coder.

Note: ***1. Before saving data, do make sure that there is no data in the data group corresponding to current group no, otherwise it will not work.***

2. Set the current saving mode correctly.

3. If you need to upload the DAC curve to PC, please adjust the settings and DAC parameters firstly, and then save the data.

4. If the current group has already got waveform data or full thickness values, the saving action is invalid and it will prompt with buzz.

3.7.4 Deleting a data set (DELETE)

It is to delete data. This is to delete the data corresponding to current group No. When the deletion succeeds, "*" before this group no. disappears.

Operation:

- By <Page up> key switch the function page.
- By <F4> key select MEM functional group, and by <Menu> key, select the functional menu for DELETE, and then carry out deleting by key Coder.
- If current group has no data in it, by key Coder, this functional menu will always display OFF; if there is data in the group and it is not locked, by key Coder. it will show "Yes/No", and now press the corresponding menu key or ↵, the data will be deleted, and the deleting will be canceled by press any other key.

Remarks: In the mode of thickness saving, this function is to delete the thickness values corresponding to current group no.

3.8 Adjustment of CFG Group

Settings of DETECT/PEAKMEM, BRIGHNESS/COORDINATE, FILL/BUZZER and LANGUAGE/UNIT are completed in this group.

3.8.1 Measuring way (DETECT)/Peak memory (PEAKMEM)

This functional menu is multipurpose for Measuring way and Peak memory.

DETECT:

To select measuring way.

Option: PEAK, EDGE

Operation:

- By <Page up> key switch the function page.
- By <F5> key select CFG functional group, and by <Menu> key, select the functional menu for DETECT, and then set the measuring way by key Coder.
- By Left/Right key , select CFG functional group, and by Up/Down key , select the functional menu for DETECT, and then set the measuring way by key .
- Users can shift the functions for DETECT and PEAKMEM by Enter key .

PEAKMEM:

Peak Memory is used for users to conveniently find out the flaw peak and estimate the flaw accurately.

Option: ON, OFF

Operation:

- By <Page up> key switch the function page.
- By <F5> key select CFG functional group, and by <Menu> key, select the functional menu for PEAKMEM, and then set ON/OFF the peak memory by key Coder.
- Users can shift the functions for DETECT and PEAKMEM by Enter key .

3.8.2 Coordinate grid (COORDINATE)/LCD backlight (BRIGHTNESS)

This menu is multipurpose for Scale and Brightness.

COORDINATE:

It is to set the displaying way of coordinate grid.

Options:0~3

Operation:

- By <Page up> key switch the function page.
- By <F5> key select CFG functional group, and by <Menu> key, select the functional menu for COORDINATE, and then set the displaying way of coordinate grid by key Coder.
- User can shift the functions for BRIGHNESS and COORDINATE by Enter key .

BRIGHTNESS:

It is to set the brightness of the screen.

Options:0~3

Operation procedure:

- By <Page up> key switch the function page.
- By <F5> key, select CFG functional group, and by <Menu> key, select the functional menu for BRIGHNESS, and then adjust brightness by key Coder.
- User can shift the functions for BRIGHNESS and COORDINATE by Enter key .

3.8.3 Echo display mode (FILL)/Sound of the Buzzer (BUZZER)

This menu is multipurpose for Fill and Buzzer.

FILL:

It is used for displaying under the state of waveform filling.

Options: ON, OFF

Operation:

- By <Page up> key switch the function page.
- By <F5> key select CFG functional group, and by <Menu> key, select the functional menu for FILL, and then set the filling state by key Coder.
- User can shift the functions for FILL and BUZZER by Enter key ↵.

BUZZER:

It is used to turn ON/OFF the buzzer.

Options: ON, OFF

Operation:

- By <Page up> key switch the function page.
- By <F5> key select CFG functional group, and by <Menu> key, select the functional menu for BUZZER, and then set ON/OFF the buzzer by key Coder.
- Users can shift the functions for FILL and BUZZER by Enter key ↵.

3.8.4 Selecting the language (LANGUAGE)/Selecting the units (UNIT)

This menu is multipurpose for setting language and unit.

LANGUAGE:

To set the language of displaying.

Options: Chinese, English

Operation:

- By <Page up> key switch the function page.
- By <F5> key select CFG functional group, and by <Menu> key, select the functional menu for LANGUAGE, and then set the type of language by key Coder.
- Users can shift the function for LANGUAGE and UNIT by Enter key ↵.

UNIT:

It is to select the unit for detection parameters of the instrument.

Options: mm, inch

Operation:

- By <Page up> key switch the function page.
- By <F5> key select CFG functional group, and by <Menu> key, select the functional menu for UNIT, and then set parameter unit by key Coder.
- Users can shift the function for LANGUAGE and UNIT by the Enter key ↵.

3.9 Adjustment of ANG Group

The Angle Probe group is used for adjusting and setting the parameters necessary for detection when using an angle probe. It includes ANGLE/K-VALUE, T-VALUE, X-VALUE/X-COORD, and MTLVEL.

3.9.1 Probe Angle (ANGLE)/Probe K Value (K-VALUE)

This menu is multipurpose for setting probe angle and probe k value.

ANGLE:

It is to adjust the angle of a probe.

Range: 0.0° ~ 89.0°

Step: 0.1°

Operation:

- By <Page up> key switch the function page.
- By <F1> key select ANG functional group, and by <Menu> key, select the functional menu for ANGLE, and then adjust the probe angle by key Coder.
- By key ↵ , shift between ANGLE and K-VALUE.

K-VALUE:

Range: 0.00 ~ 57.29

Step: 0.01

Operation:

- By <Page up> key switch the function page.
- By <F1> key select ANG functional group, and by <Menu> key, select the functional menu for K-VALUE, and then adjust the probe k value by key Coder.
- By key ↵ , shift between ANGLE and K-VALUE.

3.9.2 Thickness of workpiece (T-VALUE)

It is to set the thickness of workpiece during detection.

Thickness range:5mm ~ 1000mm

Rough and Fine adjustment can be switched by the key ↵.

Rough adjustment: 5 mm, 10 mm, 20 mm, 50mm, 100mm, 200mm, 300mm, 400mm, 500mm, 600mm, 700mm, 800mm, 900mm and 1000mm

Fine adjustment: 0.1mm <100 mm

1mm >100 mm

Operation:

- By <Page up> key switch the function page.
- By <F1> key select ANG functional group, and by <Menu> key, select the functional menu for T-VALUE, and then adjust the job's thickness by key Coder.
- Users can shift the Rough and Fine adjusting mode by Enter key ↵.

3.9.3 Probe's Front Edge (X-VALUE)/Coordinate mode (X-COORD)

This menu is multipurpose for setting probe's front edge and coordinate mode.

X-VALUE:

It is to set the front edge of probe.

Range: 0.00mm ~ 50.0mm

Step: 0.01mm

Operation:

- By <Page up> key switch the function page.
- By <F1> key, select ANG functional group, and by <Menu> key, select the functional menu for X-VALUE, and then adjust the probe front edge by key Coder.
- By key ↵, shift between X-VALUE and X-COORD.

X-COORD：

Coordinate mode means the definition of the horizontal coordinate line, including “S-PATH” “P-VAL” and “DEPTH”, when the refraction angle is not zero, the function above is effective, when it is zero, the coordinate is defined as S-PATH.

Options: S-PATH, P-VAL, DEPTH

Operation:

- By <Page up> key switch the function page.
- By <F1> key select ANG functional group, and by <Menu> key, select the functional menu for X-COORD, and then adjust the coordinate mode by key Coder.
- By key ↵, shift between X-VALUE and X-COORD.

3.9.4 Material velocity (MTLVEL)

The instrument working with angle probe is also equipped with sound speed setting function, for whose details please refer to 3.4.2.

3.10 Adjustment of DAC1 Group

The DAC1 group is for setting the parameters necessary for plotting a DAC curve. It includes DAC/REVISE, RECORD/REVISE POS, aSTART/aWIDTH, AUTO-80.

Please refer to 4.4 for making DAC curve.

3.10.1 DAC display control (DAC)/DAC Revise (REVISE)

This menu is multipurpose for DAC display control and DAC Revise.

DAC:

It is to turn on/off the DAC display. It will be ineffective when B-scan is on.

Options: ON, OFF

Operation:

- By <Page up> key switch the function page.
- By <F2> key select DAC1 functional group, and by <Menu> key, select the functional menu for DAC, and

then set ON/OFF for DAC Curve by key Coder.

- Users can shift the functions for DAC and REVISE by Enter key ↵.

Note: DAC Display ON/OFF will work only when it has at least 2 DAC record points.

REVISE:

Re-plot the revision point in 3.10.2. if the curve is not well drawn due to some plotting point with big plotting error, users can select the corresponding plotting point and adjust the gate to corresponding position, re-plot that point by the function of re-plotting.

Option: ON, OFF

Operation:

- By <Page up> key switch the function page.
- By <F2> key you select DAC1 functional group, and by <Menu> key, you select the functional menu for REVISE, and then revise plotting by key Coder.
- You can shift the functions for DAC and REVISE by Enter key ↵.

3.10.2 DAC Plotting Point (RECORD) /DAC Revise Position (REVISE POS)

This menu is multipurpose for DAC plotting point and DAC revise position.

DAC plot is used for recording the echo information necessary for making DAC curve, and DAC revise position is used for positioning the plotting point who needs revising.

RECORD:

Range: 1 ~ 30

Operation:

- Confirm that the gate is working under the state of single gate.
- By <Page up> key switch the function page.
- By <F2> key, select DAC1 functional group, and by <Menu> key, select the functional menu for RECORD.
- Before each plotting, move gate A to the needed reference echo, and make sure that the reference echo is located within the gate, then add or delete a plotting point by key Code.
- Users can shift the functions for RECORD and REVISE POS by Enter key ↵.

REVISE POS:

Parameter range:1 ~ 30, not more than DAC plotting point value

Operation:

- By <Page up> key switch the function page.
- By <F2> key, select DAC1 functional group, and by <Menu> key, select the functional menu for REVISE POS, and then position the revision point by key Coder
- Users can shift the functions for RECORD and REVISE POS by Enter key ↵.

3.10.3 Starting of the A gate (a START) / Width of the A gate (a WIDTH)

This menu is multipurpose for Start of Gate A and Calibrating Mode, the reason for setting Gate A here again is to make it easy for DAC recording under manual mode; by ↵, shift the two functions, for details please refer to 3.6.2 and 3.6.3 for operation.

3.10.4 AUTO-80/ DAC-REF

This menu is multipurpose for using AUTO-80% and DAC-REF.

AUTO-80:

AUTO-80% is an excellent tool to quickly adjust gain (dB) setting, bringing the peak of a reference echo to 80% full screen height. AUTO-80% is especially useful with general welding applications and codes that require quick gain adjustments to bring an echo to 80% screen height.

Operation procedure:

- By <Page up> key switch the function page.
- By <F2> key select DAC1 functional group, and by <Menu> key, select the functional menu for AUTO-80, and then turn on the AUTO-80 function by key Coder.
- By key ↵, shift between AUTO-80 and DAC-REF.

DAC-REF：

DAC-REF means the curve which flaw echo confirm to as standard, “generatrix” or “quantify” is often used, in which generatrix means the primary plotting curve of DAC, another available three standards are all DAC offset. The standard above works only when the DAC is well completed.

Options: GL, RL, SL, EL

Operation procedure:

- By <Page up> key switch the function page.
- By <F2> key select DAC1 functional group, and by <Menu> key, select the functional menu for DAC-REF, and then select the reference curve by key Coder.
- By key ↵, shift between AUTO-80 and DAC-REF.

3.11 Adjustment of DAC2 Group

DAC Group is used for adjusting the relative parameters necessary for plotting a DAC curve. It includes DAC-EL, DAC-SL, DAC-RL, CORRECT.

In order to meet the standard for plotting DAC curve in different industries, the instrument is equipped with three DAC curves with adjustable offsets, which are DAC-EL (evaluating line), DAC-SL (quantifying line), DAC-RL (reject-judging line). In addition, in order that DAC curve can be adaptive to different ambient conditions, Gain Compensation function is provided. The three offset curve are all generated from generatrix, and the generatrix is drawn according to the plotting points and the ultrasonic attenuation. According to their different functions, they appear seperatly as DAC-RL, DAC-SL and DAC-EL on the screen from top to bottom. CORRECT works for

compensating the difference between the surfaces of test block and detected object which will influence the ultrasonic transmission between them. When the CORRECT gets increased, the three DAC offset curve will get lower correspondingly, and contrarily they will get higher.

3.11.1DAC evaluating line (DAC-EL)

It is to set the offset of DAC evaluating line.

Parameter range:-50dB ~ 50dB

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select DAC2 functional group, and by <Menu> key, select the functional menu for DAC-EL, and then set the offset of DAC evaluating line by key Coder.

3.11.2DAC quantifying line (DAC-SL)

It is to set the offset of DAC quantifying line.

Parameter range:-50dB ~ 50dB

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key you select DAC2 functional group, and by <Menu> key, you select the functional menu for DAC-SL, and then set the offset of DAC quantifying line by key Coder.

3.11.3DAC reject-judging line (DAC-RL)

It is to set the offset of DAC reject-judging line.

Range: -50dB ~ 50dB

Operation procedure:

- By <Page up> key switch the function page.
- By <F3> key select DAC2 functional group, and by <Menu> key, select the functional menu for DAC-RL, and then set the offset of DAC reject-judging line by key Coder.

3.11.4DAC correction (CORRECT)

Set the CORRECT of DAC.

Parameter range:-50dB ~ 50dB step: 0.1dB

Operation:

- By <Page up> key switch the function page.
- By <F3> key select DAC2 functional group, and by <Menu> key, select the functional menu for CORRECT, and then adjust parameters for CORRECT by key Coder.

3.12 Adjustment of ADV Group

ADV Group is for adjusting and setting of special application of the instrument. It includes CHANNEL/SAVE, RECALL, VALUE DIS/RS232 SET, and DATE/TIME.

3.12.1 Detection Channel (CHANNEL)/Saving setting (SAVE)

This functional menu is multipurpose for detection channel and saving setting, when this menu is selected, by ↵ you can shift the two functions.

CHANNEL:

During the detecting in scene, users usually need to do the detection on several kinds of work piece or change the probe, thus they need to calibrate the instrument time after time. To solve this problem, 10 detecting channels are available in TUD300, users can set 10 different channels and save them, switch among the channels when it needed.

Further more, 30 A scanning data and 30 groups (100 values in each group) of thickness values can be stored in every channel. For operation process, please refer to 3.7.

Parameter range:NO.1 ~ NO.10

Operation procedure:

- By <Page up> key switch the function page.
- By <F4> key select ADV. functional group, and by <Menu> key, select the functional menu for CHANNEL, and then adjust parameters for CHANNEL by key Coder.
- By key ↵, shift between CHANNEL and SAVE.

SAVE：

This functional menu is for saving setting.

Operation procedure:

- By <Page up> key switch the function page.
- By <F4> key select ADV. functional group, and by <Menu> key, select the functional menu for SAVE, and then adjust parameters for SAVE by key Coder.
- By key ↵, shift between CHANNEL and SAVE.

Note: 1. A symbol "*" appears before the channel number means that this channel has been set.

2. The new setting will replace the old one in the channel which has been set before.

3. The new setting saved will not include DAC parameter setting which is auto-saved in the current channel .

4. If the current channel is locked, the saving of setting will not work.

3.12.2 Recall of settings (RECALL)

Recalling the setting in detection channel, when it is completed successfully, the current detection parameter

setting will be replaced by the recalled one.

Operation:

- By <Page up> key switch the function page.
- By <F4> key select ADV. functional group, and by <Menu> key, select the functional menu for RECALL, and then carry out calling by key Coder.
- If current channel has no setting, by key Coder, this functional menu will always display OFF; if it has any setting, by key Coder, it will show "Yes/No", if you press key ↵ you will call out settings, and by pressing any other keys, you will cancel the calling.

Note: ***The RECALL function recalls the parameters except DAC information. The DAC parameter in current channel will change according to the switch of channels automatically, not need recalling. If the DAC curve does not appear after switching the channels, please check if the settings in DAC1 menu is correct.***

3.12.3Value display (VALUE DIS)/RS232 set (RS232 SET)

This functional menu is multipurpose for value display and RS232 set, when this menu is selected, by ↵ you can shift the two functions.

VALUE DIS:

When the group number in memory function group is switched to thickness value, a measuring data will appears on the top right corner of display area. This function is just for what data will displayed here. One of S-path, Projection and Depth will be dislayed here and the other two will appear in the status bar. When dB is displayed , values S-path data got from DAC curve will appear on the screen. If DAC curve is turned off or the waveform in gate is over the screen, dB will appear as "*".

As it can display only two status parameters in the status line, and it totally has 6 status parameters to show, that's why Scroll Screen key ✋ is used for realizing the screen-scrolling display of status parameters.

Option: S-PATH, P-VAL, DEPTH, VAL-SZ, VAL-mm

Operation procedure:

- By <Page up> key switch the function page.
- By <F4> key select ADV. functional group, and by <Menu> key, select the functional menu for VALUS DIS, and then adjust option for VALUS DIS by key Coder.
- By key ↵, shift between VALUS DIS and RS232 SET.

RS232 SET:

For adapting to different serial equipment, proper baud rate can be set for different equipment. In the options, part one is baud rate, part two is calibration mode and part three is data position, among which only part one is adjustable. For example, a serial printer needs the baud rate 9600, and any baud rate will work with communication with PC, high baud rate, high communicating speed, but lower reliability.

Option: 2400,n,8、4800,n,8、9600,n,8、19200,n,8、38400,n,8

Operation procedure:

- By <Page up> key switch the function page.

- By <F4> key select ADV. functional group, and by <Menu> key, select the functional menu for RS232 SET, and then adjust option for RS232 SET by key Coder.
- By key ↵, shift between VALUS DIS and RS232 SET.

3.12.4 Setup Date (DATE)/Setup Time (TIME)

The functional group of Time is for adjusting and setting the real-time clock for the detector. It includes YEAR, MONTH, DAY, HOUR, MINUTE, SECOND, when this menu is selected, by ↵ you can shift the six functions, and then adjust parameters by key Coder.

In the function of date, date form is M.D.Y, and in time function, time form is H:M:S.

Month Setting：setting the month.

Parameter range: 1 ~ 12

Day Setting：setting the day

Parameter range: 1 ~ 31

Year Setting：setting the year

Parameter range: 2000 ~ 2099

Hour Setting：setting the hour

Parameter range: 0 ~ 23

Minute Setting：setting the minutes

Parameter range: 0 ~ 59

Second Setting：setting the seconds

Parameter range: 0 ~ 59

3.13Adjustment of B-SCAN Group

B-scan is used for the area difficult to detect and displaying the section plane graph data of this area, the graph shows how the flows locate in the scanning direction in work piece. B-scan can be set beforehand, including B-SCAN/A-SCAN, and SCAN WAY.

3.13.1 B scan mode select (B-SCAN)/ A scan mode select (A-SCAN)

This menu is multipurpose for B scan mode select and A scan mode select.

B-SCAN：

The switch on/off of B-scan mode. When B-scan is turned on, B-scan mode will be displayed on screen. And when DAV curve is turned on, the switch of B-scan mode will not work. Option: ON,OFF

Operation procedure:

- By <Page up> key switch the function page.
- By <F5> key select B-SCAN functional group, and by <Menu> key, select the functional menu for B-SCAN, and then adjust option for B-SCAN by key Coder.
- By key ↵,shift between B-SCAN and A-SCAN.

A-SCAN：

The switch on/off of A0-scan. When the B-scan is on, turn on A-scan, the screen will both of them half and half.

Option: ON,OFF

Operation procedure:

- By <Page up> key switch the function page.
- By <F5> key select B-SCAN functional group, and by <Menu> key, select the functional menu for A-SCAN, and then adjust option for A-SCAN by key Coder.
- By key ,shift between B-SCAN and A-SCAN.

3.13.2 Scan way (SCAN WAY)

Scan way determines the refresh way. “left → right” and “right → left” are available.

Option: L->R、R->L

Operation procedure:

- By <Page up> key switch the function page.
- By <F5> key, select B-SCAN functional group, and by <Menu> key, select the functional menu for SCAN WAY, and then adjust option for SCAN WAY by key Coder.

3.14 Adjusting of Special Functions

In order to make it easy for the user to operate, on the instrument’s panel, in addition to the selection for menu-type functional groups, there are also 7 keys of Special Functions that are used frequently, including Adjust of Gain Step, Gain+/-, Print Report, Full-screen Display, Waveform Freeze and extend, etc.

3.14.1 Gain Step

It is to adjust the length of gain step.

Options:0dB, 0.2dB, 0.5dB, 1.0dB, 2.0dB, 6.0dB and 12.0dB

Operation procedure:

- By pressing Gain Step , the gain’s step graduation will change cyclically in the option.

3.14.2 Gain

When the gain step is adjusted to proper option, you can set the gain by Gain +/- .

Parameter range:0dB~110dB

Operation procedure:

- By pressing key +/- , the gain will change in the gain step set at present.

3.14.3 Print

This is to print the data corresponding to current group No. depending on current Save mode.

Under Waveform Save mode, it can print parameters on screen and parameters set, under Thickness Save mode, it can print the saved value in current group.

Operation procedure:

- Select the group number needing printing, waveform data needs to be recalled to print, please refer to 3.7 for recalling.
- Users can perform the function of printing by pressing Print key .

Note: 1. The printed results are different for different settings of Save mode; when current save mode is Waveform Save, it will print the report of detection waveform, and when current save mode is Thickness, it will print report of thickness.

2. If you want to print the waveform report, please recall the data firstly. If not, the current waveform and its parameters will be printed out. If you want to print the thickness value, it can be printed out directly.

3.14.4 Full-screen

It is used to switch between full-screen display and normal display for waveform.

Operation:

- Users can switch over full-screen and normal display modes by pressing full-screen key .

Note: 1. Under full-screen state, only Special Functions of the instrument are effective, and all other functions will not work.

2. Full-screen can not work when the detecting displaying is dB or under B-scan mode.

3.14.5 Freeze

It is used to freeze the waveform.

Operation procedure:

- The gauge can be switched between freezing and non-freezing by the Freeze key .
- Under Freeze state, prompting icon * appears in the status line.

Note: Under Freeze state, both the functions for Gate Group and MEM Group of the instrument are effective, DAC On/Off can switch over. The functions of other functional groups will not work.

3.14.6 Extend

It is used to extend the waveform for details by key  .

Operation:

- Loop the waveform to be observed by gate, press down the key  , then the extended waveform will be displayed.

3.14.7 Locking the Menus

In order to avoid modifying wrongly current detection parameters, each functional menu can be locked.

Operation:

- Select the functional menu to be locked
- Meanwhile press down the key  , in this case the parameters of this functional menu can't be changed
- To unlock it, press down  again.

3.14.8 Locking the Data Group

In order to avoid deleting wrongly the waveform data group and DAC record, you can lock the data.

Operation procedure:

- By <Page up> key switch the function page.
- By <F4> key select MEM functional group, and by <Menu> key, select the functional menu for DATA NO.
- First set the Save mode as Waveform Save, then set and select the group no. of MEM group.
- Meanwhile press down  and  (S1), you can lock this group of data, in this case the data group can't be deleted or changed.
- To unlock it, press down  and  (S1) at the same time.

Note:The data group can not be locked unless the data group has data stored in it.

3.14.9 Locking the Channel

In order to avoid deleting wrongly the setting in the channel, lock of channel is available.

Operation:

- By <Page up> key switch the function page.
- By <F4> key select ADV. functional group, and by <Menu> key, select the functional menu for CHANNEL, and then adjust parameters for CHANNEL by key Coder.
- Meanwhile press down  and  (S1), user can lock this group of the channel, in this case the channel group can't be deleted or changed.
- To unlock it, press down  and  (S1) at the same time.

Note:Only when a channel group is saved with setting, can the channel group be locked.

3.14.10 Reset the Ex-factory Setting

Users can recover the ex-factory parameter setting when turning on the machine if necessary.

Operation:

- When it displays the progress bar for Turn on screen by pressing down full-screen key and Extend key , you can recover the ex-factory setting.

Note: 1. Only one of the recovered ex-factory setting and recovered setting at last turning off is valid at the same time.

2. The settings in all the channels will be canceled if resetting the Ex-Setting.

3.14.11 Instrument program upgrade

TUD300 provides online upgrade function, and operator can perform program upgrade process by tools DataView for TUD300 after getting necessary upgrade files.

Operation:

- Connect interface of the instrument and PC by the special-purpose communication cable (Reference the chapter V).
- Freezing screen by pressing Freeze key on the operation interface (If the instrument cannot set up normally, operator can press the keys of when it displays the progress bar for Turn on screen. Thus, the instrument will keep the turn on screen but not shift to the operation interface).
- Finish program upgrade according to《TUD300 Ultrasonic Detector Operation Instructions for PC Data Processing Software》

Chapter IV Calibrating the Instrument and Measuring

Before working, it is necessary to calibrate the sound speed, pitch interval and probe delay for the instrument, so as to be adaptive to the detection condition. Where, the reason for calibrating sound speed and probe delay is that the calculation of parameters displayed in the status line is relative with sound speed and probe delay, therefore you must calibrate before detection; while the purpose for calibrating pitch interval is to make it display waveform in proper range of pitch interval on the screen, so as to judge and evaluate the defects better.

In order to operate the instrument safely and correctly, the calibrated shall be calibrated by a professional technician from field of ultrasonic detection.

In order to illustrate well the calibrating way and steps, examples will be given later.

4.1 Calibration of Single Probe

You should determine the calibrating procedures depending on the known condition of sound speed and probe delay. If the sound speed is unknown, you first calibrate the sound speed by way of "Two Points"; if the sound speed is known, calibrate the probe delay by one-point way after adjusting the sound speed into the known one.

4.1.1 Calibration with Known MTLVEL

Procedure:

- The MTLVEL setting is the known sound speed of the material,
- Couple the probe with the calibrating test block,
- Set the Gate Logic into Single-Gate mode, i.e. Positive or Negative logic, loop the gate on the primary echo, now the pitch interval measured is the pitch interval at primary echo,
- Adjust the probe delay, so that the measurement of pitch interval in the status line is the same with the known thickness of the test block.

Note: ***For an angle probe, before calibration, you have to enter thickness T of the test block and probe's front edge X, the rest calibrating steps are the same.***

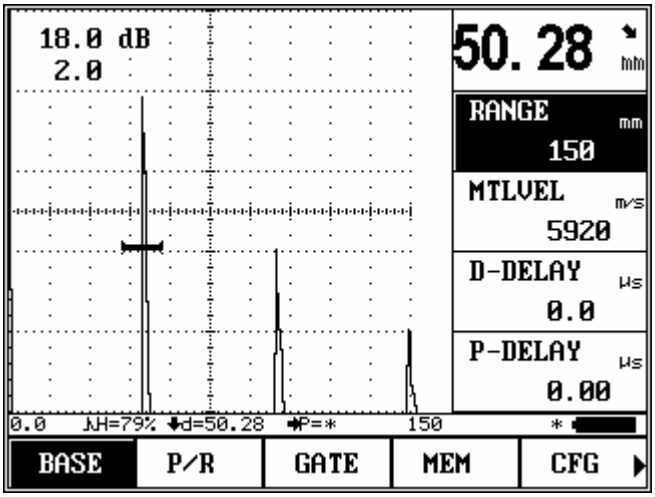
4.1.2 Calibrating with Unknown MTLVEL

Procedure:

- First set a rough sound speed value;
- Adjust the gate logic into Double Gate mode;

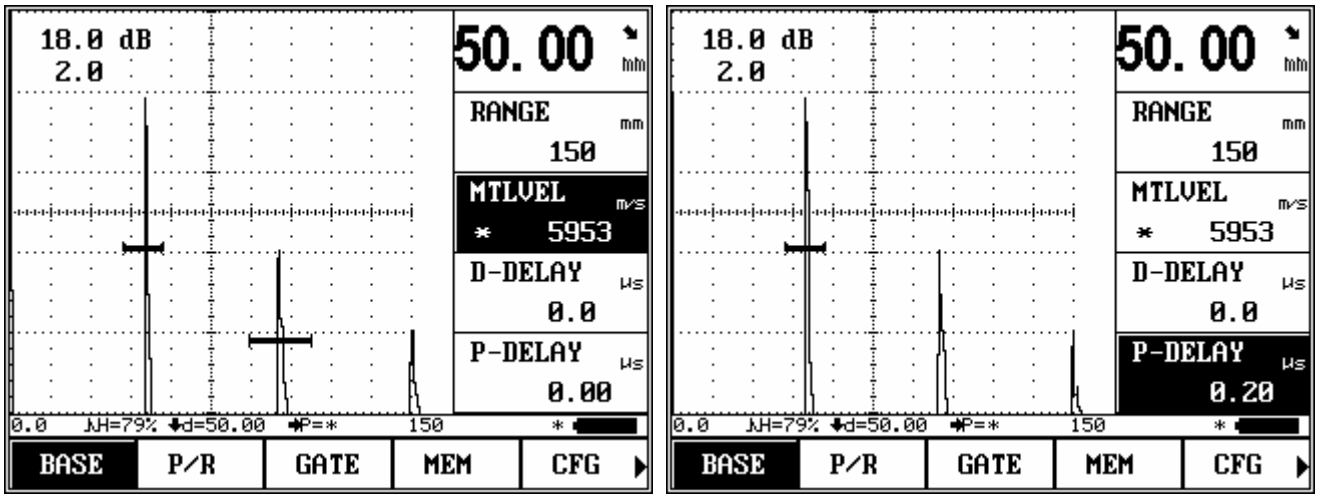
- Couple the probe with a test block for which the thickness is known and that is of the same material with the job;
- Move the start of gate A to the primary echo and make them intersect, adjust the height of gate A to be lower than the max. amplitude of primary echo and to a proper position, and gate A shall not intersect with the secondary echo;
- Move the start of gate B to the secondary echo and make them intersect, adjust the height of gate B to be lower than the max. amplitude of secondary echo and to a proper position, and gate B shall not intersect with the primary echo;
- Then adjust the sound velocity, so that the pitch interval displayed in the status line is same with the actual thickness of the test block. The sound velocity got now is the actuate sound velocity under this detection condition;
- Set the Gate Logic into Single-Gate mode, i.e. Positive or Negative logic, the pitch interval measured at this time is the pitch interval at primary echo;
- Adjust the probe delay, so that the measurement of pitch interval in the status line is the same with the known thickness of the test block. The probe delay measured at this time is the exact P delay of this probe.

In the following we'd like to illustrate by an example:



MTLVEL is unknown, set the approximate MTLVEL as 5920m/s, set the Gate Logic as double gate mode, meanwhile set the P delay as 0;

Couple the probe with a calibrating test block of 50 mm, and adjust the gate A to a position intersecting with the primary echo, Adjust gate B to a position intersecting with secondary echo;



Increase MTLVEL, till the displayed pitch interval between the primary and secondary echo is 50mm, now we get the exact sound velocity of the material, i.e. 5953m/s;

Set again the gate as Single Gate mode, measure the pitch interval at the primary echo, adjust continuously P Delay till the pitch interval measured at the primary echo is 50 mm, now we get the exact P Delay, i.e. 0.20us.

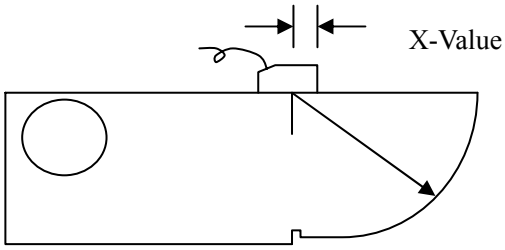
4.2 Calibrating of Double Probe

Calibrating procedure:

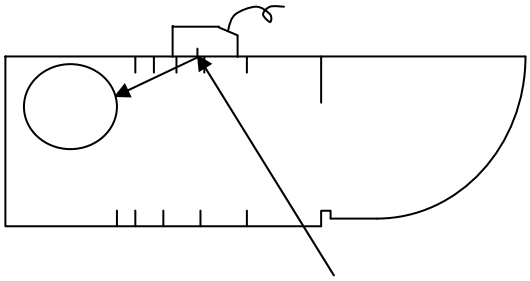
- Set double-probe state in P/R group;
- Set the pitch interval, functional items in P/R group depending on current testing task and probes selected;
- Couple the probes with the calibrating test block, adjust the P Delay in Base group till the calibrating echo approaches to the desired position, meanwhile the secondary echo is also within the display range;
- Adjust the gain till the echo with the max. amplitude approaches to the full-screen height;
- Turn on double gates in Gate group;
- Select Front-edge measuring way in CFG group;
- Move the start of Gate A to the primary echo and intersects with it, and Gate A shall not intersect with the secondary echo;
- Move the start of Gate B to the secondary echo and intersects with it, and Gate B shall not intersect with the primary echo;
- Adjust gate heights, so that they are at the same positions of the front edges of two standard echoes;
- Change the sound velocity, till it displays the thickness value of the standard test block;
- Set the Gate Logic into Single-Gate mode, i.e. Positive or Negative logic, the pitch interval measured at this time is the pitch interval at primary echo;
- Adjust the probe delay, so that the measurement of pitch interval in the status line is the same with the known thickness of the test block.

4.3 Calibrating of Angle Beam Probe

calibrating of angle beam probe is usually as following: 1. calibration of incidence angle (X-Value); 2. calibration of probe angle (K-Value); 3. calibration of material sound speed; 4. calibration of probe Zero point.



1. Calibration of incidence angle (X-Value): Test the probe zero point with ⅡW test block (Holland test block) or CSK-ⅠA test block, firstly adjust the sound speed to 3230m/s, detecting range to 150mm, then start the testing, locate the probe on test block and move it as the right figure to make sure you have got the highest echo on R100mm reflector, measure the distance, which is the X-Value of probe, between the front face of probe and cycle center of R100m arc. The point corresponding to the cycle center of R100mm arc is just the incidence point of probe.



Probe angle

2. Calibration of probe angle (K-Value): the probe plotted with angle value can be calibrated with ⅡW test block, and the probe plotted with K-Value can be calibrated with CSK-ⅠA test block. Both the two kinds of test blocks have the scales of angle and K-Value, select the proper scale for the probe(as shown on the right figure, on the upside of ⅡW test block probe of 60~76 degrees can be calibrated, the downside is suitable for the probe of 74~80 degrees. And on the upside of CSK-ⅠA test block probe of K2.0, K2.5, K3.0 can be calibrated, the downside is suitable for probe of K1.0, K1.5). locate the probe as the right figure shows, move the probe back and forth to make sure you have got the highest echo, and now the scale corresponding with incidence point is the probe angle or K-Value.
3. Calibration of sound speed: find out the highest echo in item 1, and adjust the detecting range to make sure the second echo of this echo can be displayed on the screen, switch the gate mode to double gate, adjust the A gate to cut with the first echo, and adjust B gate to cut with the second echo, adjust the sound speed to make the value of sound path(S) be 100, now the sound speed value you get is the actual sound speed.
4. calibration of probe zero point. Keep the testing status above, and change the gate mode to plus or minus, adjust the probe zero point to make the value of sound path (s) return to 100, now the zero point value is the actual zero point value.

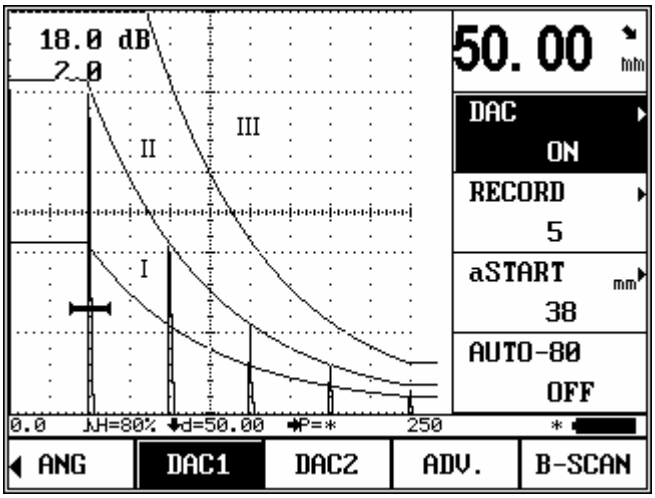
Angle beam probe can be calibrated in many ways, not only by standard test blocks, it can also be done with a thickness known hole, theoretically, smaller of the reference reflector more accurate calibration you will get, however, it will be more difficult to do so. When calibrating with holes, we can do the calibration on angle by working out slope through measuring the depth and level position of hole, and with which processing the calibration of sound speed and probe zero point.

4.4 Application of DAC Curve

DAC curve is used for distinguishing the reflectors with the same size and different distance. Normally, in work

piece, reflectors with the same size and different distance cause change in amplitude because of the attenuation of material and pervasion of beam. The DAC curve compensate for attenuation of material, magnetic field influence, pervasion of beam and surface smoothness in the way of graph. Normally, the echo peak points are all located in the same DAC curve. And in the same way, the echo created by smaller reflectors will be located under this DAC curve, and the bigger one will be above the curve.

1. **Selection of detecting channel**. Select the advanced function group by Page key and function key <F4>, adjust the detecting channel number, choose one as the current instrument setting channel, for example, No.1, (Note: One group of DAC plotting points can be saved in one channel, and they are saved automatically, not needing any operation, if you want to save the parameter setting at the same time, turn to the operation "ADV" ⟶"SAVE".
2. **Turning on DAC curve function**. Select the DAC1 function group through Page key and function key <F2>, and then select the DAC curve function through S1 and up/down keys, (if the DAC curve function doesn't lie in the current menu, please switch it by the key ↵ or S1, plot the revision function), set the DAC curve switch by coder.
3. **Making DAC curve**. Select the DAC1 function group through Page key and function key <F2>, Add plotting points according to 3.10.2, when two plotting points are finished, the DAC curve will be protracted automatically. (Note: Plot the points in the order of small to large according to the detecting range, and the echo height of latter one must not be higher than the fore one, other wise, the DAC curve will be a beeline.)
4. **Adjust the offset of the three offset curves**. Select the DAC2 function group through Page key and function key <F3>, adjust the three offset curves viz. DAC-EL, DAC-SL and DAC-RL to proper settings.
5. **Compensation for surface roughness**. Select the DAC2 function group through Page key and function key <F3>, adjust the gain correct menu to compensate for the surface roughness of work piece, for example, when 5dB is needed, just adjust the gain correct to -5dB, and now the three DAC curves will go down for 5dB.
6. The completed DAC curve:



The screen is divided into three areas, Ⅰ, Ⅱ and Ⅲ. The three curves will be drawn on the screen during the detecting, users can determine the flaw character by the height of the echoes.

7. **Calculation of the equivalent**. For measuring the equivalent of flaw echo in gate, select the ADV function

group by Page key and function key <F4>, and choose the function VALUEDIS, and then select the DAC1function group by Page key and function key <F2>, choose the function of equivalent standard, adjust the equivalent standard to make corresponding offset curve work as measuring standard.

8. Application in scene. Firstly select the group number of DAC curve created above, and now the DAC curve will appear on the screen (if not, please check if the DAC curve menu is set to "ON"), the parameter settings (including three DAC offset setting and gain correction) in this channel can also be reused by "ADV"-→ "RECALL".

4.5 Contents of Measurement

To use the detector for measuring, you shall carry out the following works:

Set the start of gate, gate width, gate threshold and gate alarming way.

Contents of measurement are:

S Pitch interval

H(%) Relative value of echo height in gate range (relative to the screen height)

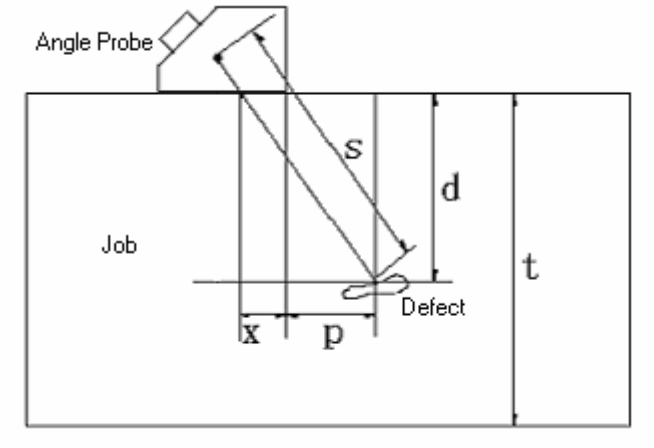
h Absolute value (in pixel) of echo height in gate range

d Depth of defect

D(%) Relative value of defect depth (relative to job's thickness)

P Horizontal distance of the defect from the probe's front edge

As for the meanings of above parameters, please refer to the following figure.



Where:

s: Pitch interval;

d: Depth of defect;

t: Thickness of job;

x: Distance of ultrasonic source to the probe's front edge;

p: Horizontal distance of the defect from the probe's front edge;

D: Is the relative value of defect depth, it is obtained by the following formula:

$$D = \frac{d}{t}$$

Matters needing attention before measuring:

The calibration including sound speed and P delay shall be completed, and the measuring way can be selected as front-edge and peak way. The wave amplitude measured is the max. echo amplitude within the gate. With front-edge measuring way, the pitch interval measured is the pitch interval at front edge of echo within gate (up line of echo waveform curve).Therefore, when front-edge way is selected, the measurement on echo amplitude in the gate is influenced by the gate threshold (height).

The measurement of pitch interval can be done only when the gate is open, before measuring, you should select the measuring way: edge way and peak way. Then select single or double gate way. Under single-gate way, the measurement is the pitch interval at echo's front edge or peak in the gate. Under double-gate way, the measurement is the pitch interval starting from the echo within gate A and ending at the echo in the gate B.

Chapter V Communication for the Instrument

The instrument is equipped with bi-directional full duplex RS232 and USB interface, can achieve communication with PC at up level and control the serial printer to print report on detection. Connect the instrument with PC's serial port or USB interface, and enter into the special operation software Data View for the instrument at PC.

5.1 Data Communication

In the instrument, the baud rate of RS232 serial port is fixed 9600, one start bit, two stop bits, 8 digital bits, and there is no check bit.

5.1.1 Connecting PC or Printer

RS232 connecting way One end of the standard RS232 serial cable connects with RS232 interface of the instrument, another end with COM1 (or COM2) port of PC. The instrument will upload the images and data saved through RS232 serial port to PC. The customer software installed on PC can edit, save or print the images and data.

Note: 1. Before connecting or disconnecting RS232 with/from the instrument or PC, please first turn off the instrument.

2. Before communication, please freeze the screen. During the communication, never remove the communication cable, turn off PC software or printer just as you like, otherwise the communication will fail hence the instrument will not work.

3. If any abnormality happens which results in failure in communication, please re-start the instrument.

Chapter VI Factors Influencing the Inspection Accuracy and Evaluating of Defect

Before using TUD300, please read the following technical materials, understand and follow concerned requirements. This is very important for avoiding the possible mistake operation which may result in wrong detection results. Invalid operation may also result in accident in personal safety or loss in property.

6.1 Essential Conditions for Using the Ultrasonic Flaw Detector

- Training the operator
- Knowledge about requirements and limitation for special technical test
- Selecting of proper testing device

6.1.1 Training the Operator

For operating an ultrasonic inspection device, an operator shall have received training on standard detection way. The standard training includes knowledge about the following contents. For example:

- Principle for sound propagation
- Influence of sound velocity of the measured material
- Features of acoustic wave in different material interfaces
- Influence of sound attenuation and surface status in the inspected material on the inspection

The lack in these knowledge may result in unexpected wrong detection result. You can contact with concerned non-destructive association or our company to get relative information on training of ultrasonic detection person and obtaining graded qualification certificate.

6.1.2 Technical Requirements for Flaw Detection

Each ultrasonic inspection must follow concrete inspection technical requirements. The most important requirements are:

- Definition of detection range
- Selecting of proper flaw-detecting way
- Considering the material characteristic
- Determining the range for recording and evaluation

6.1.3 Testing Range

The signal got during ultrasonic detection involves only the part of the job covered by acoustic beam of the probe. You must be very careful when applying the conclusion got from the inspected part into the not-inspected part

of the job. This kind of conclusion, as a rule, is applicable only with rich experience available and when it is proven to be correct by statistics data.

The acoustic beam can reflect completely from the interface in the job, therefore the defect and reflection points at deeper points may not be detected. Therefore, it is very important to ensure that all the detected parts of the job are within the range covered by the acoustic beam.

6.1.4 Measuring of Wall Thickness by Ultrasonic Way

All measuring of wall thickness ultrasonically is based on the measurement of propagation time. An exact measurement demands that the sound velocity in the job is constant. In a job made of steel (even various alloy components), sound velocity varies very low, it normally can meet this condition; and it has influence only when high-accuracy measurement involves. In other material (e.g. non metal or plastic), sound velocity may vary highly, therefore it will influence the measuring accuracy.

6.1.5 Measuring of the Residual Wall Thickness

For measuring of residual wall thickness of workshop devices (e.g. pipe, container and various reaction vessel whose inside is corroded or eroded), it needs a proper thickness gage, and special attention shall be paid on the selection and operation of the probe. The inspector shall know the corresponding rated residual wall thickness and possible loss in wall thickness.

6.2 Factors Influencing the detection Accuracy

a) Material of detecting object
b) Temperature
c) Surface roughness
d) Magnetic field
e) Substance attached
f) Shape of the flaw
g) Sound impedance of flaw
h) Surface of flaw (e.g. whether it is smooth)
i) Detecting way

All positioning of flaw for ultrasonic detection is based on the measurement of ultrasonic echo signal. Whether the sound velocity in the object inspected is constant is an important factor influencing the accuracy of the inspection results, therefore in order to perform high detecting accuracy, it should have a relative constant ultrasonic transmission speed in the detected object.

6.2.1 Influence of Material

In the object detected such as steel, even though it contains various alloy components, the sound velocity is thought to be almost constant. Whereas in many other material, for example, many non-ferrous metals or plastic, the

ultrasonic propagation velocity varies obviously, so this will influence the accuracy in measuring.

If the material of the detected object is not isotropic, the sound velocity in different directions will be different. In this case, you have to calculate with the average of sound velocity in the detection range. The average value is got by measuring the reference test block whose sound velocity is equivalent with the average sound velocity of the job.

6.2.2 Influence of Temperature

The sound velocity of material will change with temperature of it. If the instrument is calibrated in an environment with a relatively lower temperature, and it is used in an environment with a relatively higher temperature, the inspection will deflect from the real value. In order to avoid such influence of temperature, you can first warm up the reference test block before calibrating the instrument to a temperature same with that of the operation environment; or you can multiply the measurement by a factor of temperature influence.

6.2.3 Influence of Surface Roughness

The surface roughness of the job will influence the detection. The higher the roughness is, the higher its influence will be. A rough surface will result in systematic error and accidental error. During each measurement, you should increase the measuring times at different positions so as to avoid such kind of accidental error.

6.2.4 Influence of Substance Attached

Before conducting detection, you must remove the substance attached, so as to guarantee that the instrument's probe will contact directly the surface of the job.

6.2.5 Magnetic Field

The strong magnetic field generated by different electric devices surrounding will seriously disturb the detection.

6.3 Way of Evaluating Defect

For the detection practice at present, basically it has two different ways for evaluating defects:

a. If the diameter of acoustic beam is lower than the range of defect, the beam can be used for detecting the border of the defect and determining its range.

b. If the diameter of acoustic beam is bigger than the range of defect, you must compare the max. echo response of the deflect with the max. echo response of the comparing artificial defect.

6.3.1 Defect Bordering Way

The smaller the diameter of the acoustic beam of the probe is, the more accurate the border hence the defect range determined by the defect bordering way is. But if the acoustic beam is relatively wide, the defect range determined may be obviously different from the actual defect range. Therefore, you have to select cautiously a

probe that can get a narrow and concentrated acoustic beam at the defect position.

6.3.2 Way of Displaying and Comparing Echo

A small echo reflected by a natural defect is normally smaller than the echo reflected by an artificial comparing defect (e.g. disk defect of the same size). This is because (for example) the surface of a natural defect is rougher or the angle when the acoustic beam reaches to the defect is no good. If you haven't considered this fact when evaluating the natural defect, it will have risk for underestimating their equivalent value.

Due to unevenness or crack, e.g. shrinking hole in a casting, it will result in strong sound scattering on the border surface of the defect, and it generates no echo at all. In this case, you should select a different analyzing way, e.g. bottom-surface echo attenuation way for analysis.

The distance sensitivity of defect echo plays an important role in flaw detection for big workpiece. When selecting a way to compare defect artificially, you should note that these defects are same with the evaluated natural defect: they may be subjected to the same "distance changing rule".

Ultrasonic wave will attenuate in any material during propagation. This kind of attenuation is normally very small, for example, a component made of steel with fine and dense textures also include many small parts made of other materials. However, if the acoustic wave has to propagate a long distance in the material, it may generate a highly build-up sound attenuation (even if the attenuation coefficient of the material is very low).In this case the echo of the natural defect will appear to be too low. Therefore, you have to estimate the influence of attenuation in the evaluation result, and take into account it if necessary.

If the surface of the object inspected is rough, part of the incident sound energy will be scattered on the surface, this will influence the detection. The higher the scattering is, the smaller the reflection echo will be, and the higher the error in the evaluation result will result. Therefore, the surface state of the object detected will have an important influence on the echo height.

Chapter VII Maintenance and Repairing

7.1 Requirement on Environment

Avoid seriously bumping, heavy dust, damp, strong magnetic field and greasy dirt, etc.

It is strictly forbidden to wipe the casing with any solvent substance.

7.2 Charging the Battery.

The status sign for battery on LCD reflects in real time the condition of battery voltage. When the battery voltage is to low, i.e. when the status sign for battery on LCD becomes the sign of under voltage in the following, you have to charge the instrument as soon as possible.

The charging way is as follows (you can charge either with the instrument on or off):

a. Insert the power plug of the power adaptor into the charging socket;

b. Connect the power adaptor with 220V/50Hz local power supply, both the Charging indicator lamp (red) and rapid charging indicator lamp (green) light up;

c. When the rapid charging indicator lamp (green) goes out, the battery is fully charged. In a normal case, you can charge full the battery in about 4.5h.

d. Pull off the charging plug, the charging ends.

Tip

1. ***The input voltage of the power adaptor is 220V, its output is 9V DC, the max. current is about 1000mA, the max. charging time is about 6h.***
2. ***This instrument uses Li ion battery, therefore when sign of under voltage appears, you have to charge timely, and over discharge will damage the battery.***
3. ***If the instrument will not be used for a long time, it must be charged once a month to avoid over-discharging and damage the battery.***
4. ***If the battery can not work any more for over discharging(battery with no power and the charging indicator don't work), pull out the charger and wait for about two minutes then plug it again, repeat it several times, the battery will refresh on top of that.***
5. ***The instrument can work while charging.***

7.3 Replacing the Battery

The battery used in the instrument generally has a service life of 3 years. When the battery is out of service, you can change it by yourself in the following way:

a. Rotate down four screws at back of the host, separate the upper and lower cover;
b. Remove the battery-holding-down plate, dismount the power plug, and remove the old battery.
c. Connect the new battery in the same way and mount power plug (take care don't mount reverse the positive and negative pole);
d. Put in the new battery in place, mount the battery-holding-down plate, insert the power plug into the power socket, turn on power switch to check whether the instrument works normally;
e. Tighten four screws after mount upper and lower cover.

7.4 Troubleshooting

If the following failures occur,

a. The Instrument can't turn off automatically;
b. Can't measure;
c. The keys don't work;
d. The measurements change frequently,

the user shall not open the instrument and repair it by himself. After filling the Warranty Card, please send the instrument to the Maintenance Dep. of our company for executing the warranty regulations.

If you can brief the failure and send us the description, we'll be very gratified.

7.5 Tips on Safety

The design of the instrument meets relative safety standard. During the operation, it shall meet the specified external ambient condition, and the operator shall be furnished with concerned technology background, so as to guarantee safe operation. Before putting the instrument into operation, please read carefully the following tips on safety:

Note: 1. This instrument is a non-destructive inspection instrument for inspecting material, it is not allowed to use as a medical instrument.

2. The instrument is limited to be used in lab and industrial environment.

System Power Supply

The instrument can be supplied power either with external power adaptor or Li ion battery. When selecting power adaptor and battery, please use the products recommended by us.

For charging and replacing battery, please follow our operation procedures.

System Software

Any software may have error, but we have done our best to minimize the probability for this kind of error. The software of this instrument has passed overall and strict test.

Unexpected Fault

When the following abnormal situation happens, it means there is fault in the instrument, please turn off it and

take out the battery if necessary. And send the instrument to a specified service point for repairing.

a. The instrument has suffered obvious mechanical damage (e.g. serious extrusion or collision during transportation);
b. The instrument keyboard or screen display is abnormal;
c. It is stored in an environment with high temperature, high humidity or that is corrosive;

Appendix

Appendix I Notice to User

I. After purchasing product from our company, please fill carefully the *Warranty Registration Card* and seal your official stamp on it. Please send copy (I) and the copy of invoice to the User Service Dep. of our company, or you can ask the seller to send that on your behalf. The copy (II) will be sent to (left at) the maintenance station of local branch for going through registration formalities. For any area without maintenance station, please send copy (I) and (II) back to the User Service Dep. of our company. When the formalities are not complete, we can only maintain but offer no warranty service.

II. For any product from our company, since the date the user purchases it, if it has any fault in term of quality (except for non-warranty parts), please contact the maintenance stations of local branches at different areas of our company for repairing, replacing or returning by using the “Warranty Card” (the copy kept by the user himself) or the copy of the invoice issued when purchasing the product. During the warranty period, if one has no way to show the warranty card or the copy of the invoice, we will count the warranty period based on the shipping date, and the period is one year.

III. If any product of our company has fault after the warranty period, the maintenance stations at different areas will be responsible for the after-sale service, maintaining the product and charging the maintenance cost according to prescription of our company.

IV. The “special configuration” (shaped probe, special-purpose software, etc.) beyond our established product will be charged according to concerned criteria.

V. Our company will not warranty any product which is damaged because the user has disassembled by himself, due to improper transportation and storage or incorrect operation not following the “Operation Instructions”, as well as for which one has altered the Warranty Card and one has no Purchasing Proof, etc.

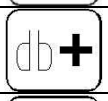
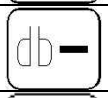
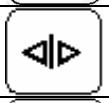
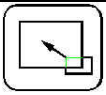
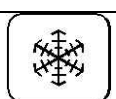
Appendix II Performance Specifications

Designation	Technical Data
Range of scanning (mm)	Range of scanning (mm): 2.5 ~ 5000 Steps: 2.5,5,10,20, 30,40,50,60,70,80,90, 100,150,200, 250, 300, 350, 400, 450,500, 600,700,800,900,1000,2000,3000,4000,5000. Adjusting step: 0.1mm（2.5 mm ~ 99.9mm）, 1mm（100mm ~ 5000mm）
D-delay (μs)	D-delay (μs): -20 ~ +3400 Steps: -20,-10,0.0, 10, 20, 50,100,150,200,250,300,350,400,450,500, 600, 700,800,900,1000,1500,2000,2500,3000,3400. Adjusting steps: 0.1（-20μs ~ 999.9μs）, 1（1000μs ~ 3400μs）
P-delay (μs)	P-delay: 0.0 ~ 99.99 Adjusting steps: 0.01
MTLVEL（m/s）	MTLVEL: 1000 ~ 9999 7 fixed levels: 2260,2730,3080,3230,4700,5920,6300 Adjusting steps: 1
Frequency of repeating transmitting (Hz)	>1000
Damp (Ω)	50，150，400
Working mode	Single probe (receiving and sending), double probe (one for receiving and another for sending), transmission (transmission probe)
Frequency range (MHz)	Low frequency 0.2-1, middle frequency 0.5-4, high frequency 3-15, three steps optional
Gain adjustment (dB)	0 ~ 110 Adjusting step: 0.0，0.2，0.5，1，2，6，12
Suppress	0% ~ 80% of screen height, step: 1%
Detection reference	Pixel -128 ~ 128, step: 1
Vertical linear error	Vertical linear error is not more than 3%
Horizontal linear error	Not more than 2% in the scanning range
Allowance of detection sensitivity	⩾60 dB
Dynamic range	⩾34 dB
Alarm	Three modes, i.e. forbidden wave, loss wave and auto
Monitoring door	2, expressed by bold transverse line, whose start, width and height are adjustable. Adjusting range of start (mm): horizontal pixel 0~208, the displayed value is relative with the scanning range. Step: value in mm corresponding to a pixel (relative with the scanning range) Adjusting range of width (mm): horizontal pixel 4 ~ 212, the displayed value is relative with the scanning range. Step: value in mm corresponding to a pixel (relative with the scanning range) Adjusting range of height: 2%~90% of vertical graduation Step graduation: 1%
Display	Display: EL high-brightness graphic lattice 320 × 240 4 levels of brightness are available for adjustment
A-Scan display area	Full screen or local A-Scan display freezing and de-freezing A-Scan filling

Waveform displaying way	Positive half wave, negative half wave, full wave and radio frequency
Designation	Technical Data
Detection channel	10
Distance-amplitude-defect-equivalent curve	>40dB dynamic range, can save 400 curves
Data save	300 A-Scan images (including setting of instrument) 30000 values of thickness (300 sets)
Standard communication interface with PC	RS232
Measuring unit	mm/inch
Battery	Li battery 4 × 3.6V 4000mAh
Power adaptor	Input 100 Hz -240 Hz ~ 50 Hz /60Hz Output 9V ~ 12VDC/3A ~ 4A
Working temperature	0℃ ~ 40℃
Overall dimension (mm)	243×173×70
Weight (kg)	1.47

Appendix Ⅲ List of Operations

All operations of TUD300 are realized by direct triggering of different key(s) on the panel or combination of them. The following list shows the concrete icons, names and functions of panel keys of TUD300.

Icon	Description of key	Description on functions	Section
	Gain step	To set gain step rapidly	3.14.1
	Gain +	To increase the gain with the set gain step	3.14.2
	Gain -	To decrease the gain with the set gain step	3.14.2
	Page up	To switch functional page	3.4，3.5，3.6，3.7，3.8，3.9，3.10，3.11，3.12，3.13
	F1 key	To select menus of a functional group	3.4，3.9
	F2 key	To select menus of a functional group	3.5，3.10
	F3 key	To select menus of a functional group	3.6，3.11
	F4 key	To select menus of a functional group	3.7，3.12
	F5 key	To select menus of a functional group	3.8，3.13
	Menu key	To select function options in a functional group	3.4，3.5，3.6，3.7，3.8，3.9，3.10，3.11，3.12，3.13
	Power key	To turn ON/OFF instrument	
	Enter key	To confirm a selection, shift multipurpose functions, shift rough and fine adjustment	3.4，3.5，3.6，3.7，3.8，3.9，3.10，3.11，3.12，3.13
	Print key	To start the printing function rapidly	3.14.3
	Full-screen key	To shift the full-screen and normal mode	3.14.4
	Freeze key	To start the waveform-freezing function rapidly	3.14.5
	Extend key	To extend the display and show detail of waveform	3.14.6

Appendix IV Interface

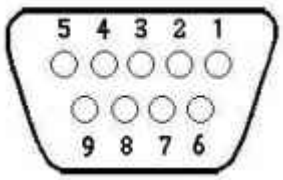
The instrument is equipped with bi-directional full duplex RS232, can achieve communication with PC at up level and control the serial printer to print report on detection. Definitions of the interfaces are:

Definitions of the interfaces:

Pin no.	Description	Input/Output	Type
1	Blank	Blank	
2	Data receiving	Input	RS232
3	Data sending	Output	RS232
4	Blank	Blank	
5	GND	GND	RS232
6	Blank	Blank	
7	Blank	Blank	
8	Blank	Blank	
9	Blank	Blank	

Note: ***Before connecting or disconnecting RS232 with/from the instrument or PC, please first turn off the instrument.***

The sequence of RS232 interface pins is as follows:



The sequence of RS232 pins

Appendix V Terms

This Appendix has listed the terms concerning ultrasonic non-destructive inspection involved in the Instructions, a good understanding of the exact meaning of these terms will be helpful for using the Instructions.

1. Pulse amplitude: voltage amplitude of a pulse signal. When type A display is used, normally it is the height from time base to the pulse peak.
2. Pulse length: duration of a pulse in term of time or no. of cycles.
3. dB: the logarithmic expression of the ratio of two amplitudes or strengths.
4. Sound impedance: ratio of sound voltage of acoustic wave to a particle's vibration speed, normally it is expressed by the product of density *p* times by velocity *c* of the media.
5. Matching of sound impedance: coupling of two media equivalent to the sound impedance.
6. Attenuation: the phenomenon that the sound voltage weakens gradually when an ultrasonic wave propagates in the media as the propagation distance increases.
7. Total attenuation: the weakening in sound voltage in special waveform for ultrasonic beams of any shape that is caused jointly by scattering, absorbing and diffuse of acoustic beam, etc. as the propagation distance increases.
8. Attenuation coefficient: loss of sound voltage in unit distance due to material scattering when the ultrasonic wave is propagating in media, normally it is expressed by dB/cm.
9. Defect: discontinuity whose size, shape, direction, position or nature will damage the effective use of a work piece, or that doesn't meet the specified acceptance standard.
10. Type A display: a kind of way for expressing information where horizontal base (X axis) is used for expressing distance or time, and the deflection which is vertical to the base (Y axis) is used to express the amplitude.
11. Sending pulse: electric pulse added to the energy exchanger for producing ultrasonic wave.
12. Time-base line: horizontal scan line expressing time or distance in type A display fluorescent screen.
13. Scan: the repeated movement of the same style from electronic beams that runs cross the detector's fluorescent screen.
14. Scan range: Max. pitch interval that can be displayed on the time base line of the fluorescent screen.
15. Scan speed: ratio of cross axis to corresponding pitch interval on the fluorescent screen.
16. Delayed scan: a kind of scanning way where the starting part of the time base will not show in type A or B display.
17. Horizontal linearity: the extent for the signal displayed on the time or distance axis of the ultrasonic detector's fluorescent screen to be proportional to the signal entered into the receiver (multiple echoes from the calibrated time generator or from a plate whose thickness is known).
18. Vertical linearity: the extent for the signal displayed on the time or distance axis of the ultrasonic detector's fluorescent screen to be proportional to the amplitude of signal entered into the receiver.
19. Dynamic range: with constant gain adjustment, ratio of wave height of the max. to the min. reflection area that can be identified on the ultrasonic detector fluorescent screen. It is normally expressed by dB.
20. Repeating frequency of pulse: no. of pulses the pulse generator uses for exciting the probe's wafer per second to generate the ultrasonic wave.
21. Inspection frequency: frequency of ultrasonic wave used during ultrasonic inspection. Normally it is 0.4 MHz

~15MHz.

22. Frequency of echo: inverse of time of peak interval obtained by observing when the echo extends on the time axis.
23. Sensitivity: a kind of dimension for the min. ultrasonic signal identifiable that is generated on the ultrasonic detector's fluorescent screen.
24. Allowance of sensitivity: difference between the standard and max. defect-detecting sensitivity in term of certain electric level in an ultrasonic detection system.
25. Resolution: capability of an ultrasonic detecting system for extinguishing two adjacent defects of certain size that are most close to each other in transverse, longitudinal or depth direction.
26. Suppress: a kind of controlling way to reduce or remove signal of low amplitude (electric noise or noise from material) so as to highlight the high signal in an ultrasonic detector.
27. Gate: An electronic method for selecting a time range for monitoring the detecting signal or for further processing.
28. Attenuator: a unit changing quantitatively the signal voltage (sound voltage).The attenuated volume is expressed by dB.
29. S/N ratio: ratio of ultrasonic signal's amplitude to the max. background noise's amplitude. It is normally expressed by dB.
30. Blockage: a phenomenon occurred in the moment after the receiver receives the sending pulse or strong pulse signal where its sensitivity drops or it fails.
31. Gain: the log form of voltage amplification of the receiving amplifier of the ultrasonic detector. It is expressed by dB.
32. Distance-amplitude curve (DAC): a set of curve plotted according to specified condition by three parameters, i.e. distance of the known reflector, gain of the detector and size of the reflector that generates echo. During the actual detection, one can estimate the equivalent size of defect from this curve based on the measured defect distance and gain.
33. Coupling: action that transmits acoustic wave between the probe and the inspected part.
34. Test block: a sample for determining the features and the detecting sensitivity of an ultrasonic detection system.
35. Standard test block: a test block whose material, shape and size are calibrated by a body in charge or authoritative institute. It is used for testing the performance and adjusting sensitivity of an ultrasonic detection unit or system.
36. Comparing test block: the test block used for adjusting the sensitivity of an ultrasonic detection system or comparing the defect. Generally it is made of the material similar with the material to be detected.
37. Probe: electric-sound converting component for sending or receiving (or both) ultrasonic energy. This kind of device normally consists of trademark, plug, casing, back lining, piezoelectric component, protective film or wedge.
38. Straight probe: a probe for vertical flaw detection, which is mainly for detecting longitudinal wave.
39. Angle probe: a probe for angle-sending flaw detection, which is mainly for detecting transversal wave.

Appendix VI National Standard and Industrial Standard Concerning Ultrasonic Flaw Detection

The national standards and industrial standards concerning ultrasonic flaw detection involved in TUD300 and the Instructions are:

1. GB/T 12604.1–90 Terms for Non-destructive Detection Ultrasonic Detection
2. JB/T 10061-1999 General Technical Conditions for Type A Pulse Reflection Ultrasonic Detector
3. JJG 746-91 Ultrasonic Flaw Detector National Metering & Calibrating Instructions of the People's Republic of China