SW6/SW7

Ultrasonic Thickness Gauge

User’s Manual

Version： V1.1.1

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CONTENTS

1 OVERVIEW

Thank you for using Qawrums' Ultrasonic Thickness Gauge. Please read the operating manual in detail before use as this will enable you to use the gauge in the shortest amount of time. The manual includes information on the functions, specifications, settings, operation and calibration of the gauge.

1.1 SPECIFICATIONS

SW6: large range, high resolution mode, measuring range of 0.65mm-500mm, display resolution of 0.01mm, capacity for data storage.

SW7: large range, high resolution mode, ECHO-ECHO mode, measuring range of 0.65mm～500mm (standard), 3.0～50mm (ECHO-ECHO mode), display resolution of 0.01mm, capacity for data storage.

Table 1-1: SPECIFICATIONS

	SW6	**SW7**
Measuring Range (Standard mode)	0.65～500mm	
Measuring Range (Echo-Echo mode)	-	3.0～50.0mm (Steel, depend on probe)
Lower limit of steel pipe measurement: (Depend on the probe type)	Φ 15mm×2.0mm (Probe: 5MHz, Φ10mm) Φ 15mm×1.0mm (Probe: 7.5MHz, Φ6mm) Φ 10mm×1.2mm (Probe: 7.5MHz, Φ6mm)	
Display Resolution	0.01mm/0.001inch	
Material Velocity	509～18699m/s	
Measurement Resolution	±(0.5%H+0.05) mm (H means the thickness of the testing workpiece)	
Bandwidth	1MHz～10MHz(-3dB)	
Measuring Rate	2～20 times/sec (settable l)	
Power Supply	3VDC (two AA batteries)	
Work Time	280 hours (Backlight off) 100 hours (Backlight on)	
Screen	128×64 LCD	
Size	136(L)×72(W)×20(H)mm	
Weight	176g (Battery included)	
Applicable Temperature	-10℃ ~ 50℃ (Ambient temperature) -10℃ ~ 300℃ (High temperature)	
Work Humidity	20%～90%RH	

1.2 FEATURES

- Measuring ranges from 0.65mm to 500mm (dependent on the gauge, probe and material).

- Suitable for different types of probes.
- Material velocity can be chosen or inputted directly. An unknown velocity can be found automatically by one-point or two-point velocity calibration.
- Numerous kinds of measurement modes: standard, scan, alarm, difference, high-temperature (match high-temperature probe), average, pipe-wall, echo-echo.
- Special pipe wall measurement mode improves the measuring accuracy of curved surfaces.
- Auto-matching makes the gauge suitable for various materials including metal, glass, plastic, rubber and gray cast.
- High-capacity data storage for up to 2000 data sets.

1.3 INCLUDED COMPONENTS & PROBE SELECTION

Table 1-2: INCLUDED COMPONENTS

Product	Quantity	Note
Main Unit	1	
Probe	1	
Couplant	1	There is no couplant for foreign orders due to transportation problems
Battery	2	2 AA batteries 3VDC
USB cable	1	Optional
PC software	1	Optional

Table 1-3: PROBE SELECTION

Probe type	Specification	Measuring range	Probe Diameter	Frequency	Temperature
Standard type (suitable for coating workpiece)	5M, D10	0.8~300mm 3.0~50mm (coating)	10mm	5MHz	-10~+50℃
Small-diameter type	5M, D6	0.70~60mm	6mm	5MHz	-10~+50℃
Standard type	2.5M, D12	3.0~500mm	12mm	2.5MHz	-10~+50℃
Micro-diameter type	7.5M, D6	0.65~25mm	6mm	7.5MHz	-10~+50℃
High precision type	7.5M, D10	0.65~250mm	10mm	7.5MHz	-10~+50℃
High temperature type	ZW5P	4.0~80mm	12mm	5MHz	-10~+300℃
Special cast iron type	2M, D22	3.0~50mm (cast iron)	22mm	2MHz	-10~+50℃

Note: Measuring range depends on the probe, material, structure, surface condition and so on. High temperature tolerance depends on the probe property and couplant.

2 INTRODUCTIONS OF THE GAUGE AND BASIC OPERATION

2.1 THE MAIN UNIT

The main unit of the gauge is shown in Figure 2-1:

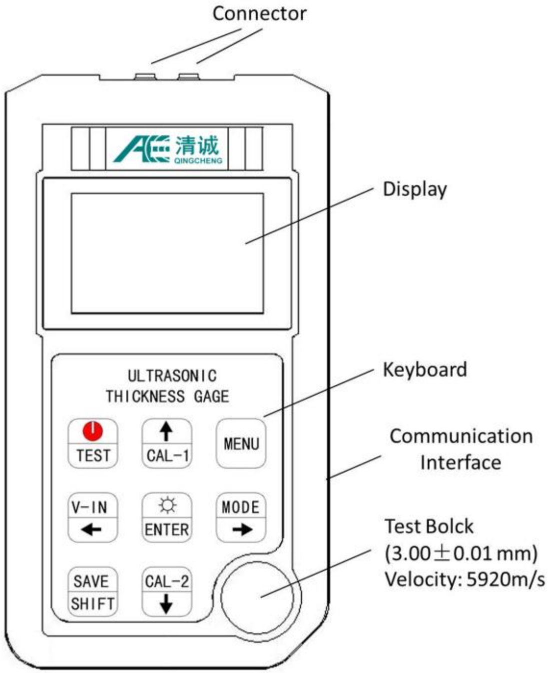


Fig. 2-1: Main Unit

2.2 KEYBOARD

The keyboard is shown in Figure 2-2:

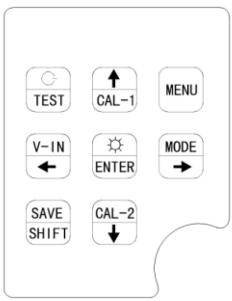
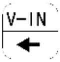


Fig. 2-2: Keyboard

The function of each key is explained below:

- 

POWER/TEST: power on the gauge and simultaneously carry out self-checking; return directly to the measuring interface when in the menu or sub-menu; power off in the measuring (long press).
- 

SAVE/SHIFT: save or cancel data in the measuring interface; turn to the next page in the main menu.
- 

V-IN/LEFT: open the sound velocity table or enter velocity; shift the cursor left when adjusting readings or when in the main menu.
- 

MODE/RIGHT: open the measurement mode menu; shift the cursor right when adjusting readings or when in the main menu.
- 

CAL-1/UP: carry out a one-point calibration for sound velocity in the measuring interface; increase the indicated value or shift the cursor up in the main menu.
- 

CAL-2/DOWN: carry out a two-point calibration for sound velocity in the measuring interface; decrease the indicated value or shift the cursor down in the main menu.
- 

ENTER/BACKLIGHT: turn the backlight on or off in the measuring interface; to confirm your setup or menu selection.
- 

MENU: open the main menu from the measuring interface or return to the menu.

2.3 BASIC OPERATION

The purpose of this section is to demonstrate how basic measurements can be made with the gauge. The unit has been shipped from the factory with the following default conditions:

- **SOUND VELOCITY:** 5920m/s (approximate sound velocity for the steel test bar provided with the gauge) (see "Note" below)
- **BACKLIGHT:** ON
- **UNITS:** mm/inch
- **LANGUAGE:** ENGLISH

- **MEASUREMENT RATE:** 4 times/s
- **DISPLAY RESOLUTION:** 0.01mm/0.001inch

A further explanation of these default conditions can be found in later sections of this manual. It is recommended that they only be changed by the operator after they have become familiar with the more sophisticated features of the gauge.

Note: The default value for sound velocity is only an approximation of the sound velocity in the test block material. The sound velocity of stainless steel is typically 5663m/s. Therefore, if you find the default value gives inaccurate results on your material, please refer to Section 3 for calibration instructions.

2.3.1 INITIAL SETUP

In this section, general operation procedure when in the standard measurement mode will be introduced. Please follow this procedure when operating the gauge for the first time.

- **STEP 1:** Plug the probe into the gauge at the top end of the gauge.
- **STEP 2:** Power on the gauge by long pressing **TEST/BACKLIGHT**. The measuring interface will appear in turn (initial setup as shown in Figure 2-3). The gauge will auto-recover the setup from the previous use.

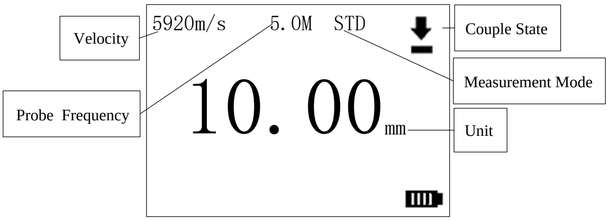


Fig. 2-3: Standard Measurement Interface

- **STEP 3: Velocity Input or Zero Calibration.**

  Material velocity must be correct when measuring. If the velocity of the material to be measured is known, please input it first (refer to Section 3.1), otherwise the velocity should be calibrated. To calibrate the velocity, refer to Section 3.2. Following this, zero calibration should be carried out (refer to Section 3.1).
- **STEP 4: Measurement**

  Firmly couple the probe to the surface of the material to be measured. Ensure couplant is applied at the point of contact (refer to Section 2.3.2 for more detail on measurement).
- **STEP 5: Save**

Refer to Section 4.1.2

- **STEP 6: Upload data (Connect gauge to computer with USB cable)**

  To upload the saved data to the computer for processing, complete the following:

  1. Press MENU to enter the main menu (as shown in Figure 4-1).
  2. Select **SAVE.**
  3. Press **ENTER** to enter the SAVE interface.
  4. Select **UPLOAD**.
  5. Press **ENTER** to start upload.
  6. Press **TEST** to return to the measuring interface.
  7. If you want to check the saved data, refer to Section 4.1.2.1.

2.3.2 MEASUREMENT

- **STEP 1:** Apply couplant to the test block or material at the spot to be measured. In general, the smoother the material surface, the thinner the couplant may be. Rough surfaces require more viscous couplant such as gel or grease. Special couplant may be required for high temperature applications.
- **STEP 2:** Press the contact surface of the probe to the surface of the material to be measured. Use firm pressure and keep the probe as flat as possible on the material surface.
- **STEP 3:** Read the material thickness on the gauge display.

Note: For highest accuracy, the velocity of the material must be correct. Refer to Section 3, VELOCITY SETUP, for this procedure.

3 CALIBRATION

Calibration is the process of adjusting the gauge so that it measures accurately on a particular material using a particular probe at a particular temperature. Calibration should be carried out when using the gauge for the first time or when probe is changed. Below are the gauge's various calibration procedures.

3.1 ZERO CALIBRATION

If the probe's zero is not calibrated correctly, all measured values will have a fixed error. When the probe's zero is calibrated correctly, the unit can measure the fixed value and correct all subsequent measurements accordingly. To zero calibrate, follow the below operation:

- **STEP 1:** Press **MENU** and **SHIFT**, select **PROBE-ZERO-CAL**, and then press **ENTER**. The display will now show **CAL STD BLOCK** interface.
- **STEP 2:** Clean the probe surface and apply couplant to the built-in 3mm Test Block.
- **STEP 3:** Couple the probe to the block and the gauge will automatically complete zero

calibration.

3.2 MATERIAL VELOCITY CALIBRATION

In order for the gauge to make accurate measurements, it must be set to the correct sound-velocity depending on the material being measured. Different types of materials have different inherent sound-velocities: for example, the velocity of sound through steel #45 is approximately 5900m/sec, whereas that of stainless steel is approximately 5663m/sec (a further list of ultrasonic velocities of common materials can be found in the Appendix 1). If the gauge is not set to the correct sound-velocity, all of the measurements made by the gauge will be erroneous by a fixed percentage.

3.2.1 SINGLE-POINT CALIBRATION

Material velocity calibration of a material can be done by using a thick test block (with a known thickness) of that exact material. Calibration must be performed for each new type of material where the sound velocity is unknown. The procedure is outlined below:

- **STEP 1:** Press **CAL-1** to enter the **BLOCK THICKNESS** interface.
- **STEP 2:** Input the known thickness of the test block.
- **STEP 3:** Press **ENTER** to proceed to the next step.
- **STEP 4:** Clean the probe surface and apply couplant to the test block.
- **STEP 5:** Couple the probe to the test block and calibration will be completed after 4 seconds.

3.2.2 TWO-POINT CALIBRATION

Material velocity calibration of a material can also be completed by using both a thin test block and a thick test block (with known thicknesses) of that exact material. It requires that the thickness of the material to be measured be within the range of the thicknesses of the two test blocks. This method can reduce non-liner error and obtain a result of higher precision. The procedure is outlined below:

- **STEP 1:** Press **CAL-2** to enter the **THIN BLOCK** interface.
- **STEP 2:** Input the thin block's thickness.
- **STEP 3:** Press **ENTER** to enter the **THICK BLOCK** interface.
- **STEP 4:** Input the thick block's thickness.
- **STEP 5:** Press **ENTER** to enter the **CAL THIN BLK** interface.
- **STEP 6:** Clean the probe surface, apply couplant to the thin test block, couple the probe to the thin test block and when the reading is stable for 4 seconds the gauge will automatically proceed to the **CAL THICK BLK** interface;
- **STEP 7:** Couple the probe to the thick test block and when the reading is stable for 4 seconds the interface will display **CAL COMPLETE**. Following this, the gauge will return back to the main menu.

3.2.3 SET THE VELOCITY

Press **V-IN** to open the velocity table and select the preset velocity. If the exact velocity of a material is known, you can also press **ENTER** to open the **INPUT VELOCITY** interface and directly input the velocity.

4 FUNCTION AND SETUP

4.1 MAIN MENU

Press **MENU** to open the main menu (shown in Fig. 4-1).

MAIN MENU 1

ECHO-ECHO SAVE
ALM UNITS SCAN
DIFF HTEM AVG
[SHIFT] Next Page 1

MAIN MENU 2

STD RESL RATE
AUTO-OFF RESET
CONTR LANGUAGE
[SHIFT] Next Page 2

MAIN MENU 3

PROBE-ZERO-CAL
MANU-SELECT-PRB
SND-SET ROTATE
[SHIFT] Next Page 3

MAIN MENU 4

CAL-1 CAL-2
V-IN BACKLIGHT
DIAMETER
[SHIFT] Next Page 4

MODE MENU

MEASURE MODE:
STD SCAN ALM
DIFF HTEM AVG
DIM ECHO-ECHO

Fig. 4-1: Main menus 1-4 and measurement mode menu of the SW7 models

4.1.1 ECHO-ECHO (ECHO-ECHO MEASUREMENT MODE)

If you want to measure a material covered with paint, please select this measurement mode.

4.1.2 SAVE (DATA PROCESSING)

SAVE has five options including CHECK, UPLOAD, DEL-ALL, DEL-GRP, SAVE-SET.

4.1.2.1 CHECK

To view your completed measurements, select **SAVE** in the main menu and then select **CHECK.** The group and serial number can be inputted.

4.1.2.2 UPLOAD

To transmit all measurement readings to a PC via USB cable, follow the procedure as below:

- **STEP 1:** Install the driver on the PC.
- **STEP 2:** Connect the gauge and the PC with the USB cable.

- **STEP 3:** Right-click on "My Computer", select "Manage", then select "Device Manager". Find the port of the connected gauge and remember its name.
- **STEP 4:** Start "SeriePort.exe" and select the port of the connected gauge.
- **STEP 5:** Select UPLOAD on the menu of the gauge and press **ENTER**. "CONNECTING" and "UPLOADING" will be indicated on the display.
- **STEP 6:** Click "RECEIVE" in the window of SeriePort.exe to transmit all measurement readings to the PC. When completed, the display of gauge will flash "DONE" and automatically return to the menu, indicating completed data transmission.
- **STEP 7:** Click "SAVE" in SeriePort.exe to store the data in the PC (.txt format).

Note 1: If the gauge can't be powered on normally when it is connected with PC, please disconnect the gauge and power it on again.

Note 2: If "FAIL TO OPEN THE PORT" is displayed when "RECEIVE" is clicked (in STEP 6), STEP 5 has not been carried out properly.

Note 3: To protect your computer, exit "SeriePort.exe" before disconnecting the gauge.

4.1.2.3 DEL-ALL

Delete all the data saved in the gauge's memory. Note that deleted data can't be recovered.

4.1.2.4 DEL-GRP

Delete selected group of data saved in the gauge's memory. Note that deleted data can't be recovered.

4.1.2.5 SAVE-SET

This option activates the manual save mode for a data set. First, set the size of each data set according to your requirements (five measurement readings are saved under the default setup). The maximum data storage capacity of a single set is 99. The procedure is outlined below:

- **STEP 1:** Select **SAVE-SET** in the main menu**.**
- **STEP 2:** Set the data size of your set.
- **STEP 3:** Return to the measuring interface and press **SAVE**. **[SV&NO]** will be displayed on the right of the screen.
- **STEP 4:** Make your first measurement. **[NO:01]** will be displayed on the right of the screen.
- **STEP 5:** Make the second measurement. **[NO:02]** will be displayed on the right of the screen.
- **STEP 6:** Continue making measurements until the set is completed, after which the display on the right of the screen will disappear.
- **STEP 7:** Press **SAVE** again to save the next set, and repeat steps 4 to 6.

Note 1: Before measuring the next data set, wait for the coupling flag to appear after the first data set is completed.

Note 2: The reading will be stored repeatedly if **SAVE** is pressed repeatedly.

4.1.3 ALM (ALARM MEASUREMENT MODE)

In this mode, the user will be notified when the measurement either drops below a lower limit or exceeds an upper limit. To set the lower and upper limits, select **ALM** in the main menu, set the upper limit value using and lower limit value, and press **ENTER** to complete. The measuring interface is shown in Figure 4-2.

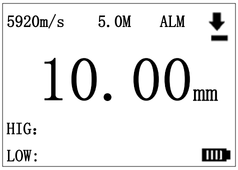


Fig.4-2: Alarm Measurement Interface

4.1.4 UNITS

The measured thickness can be displayed in either inches or millimeters. To change from one unit to the other, press **MENU** to enter the main menu, select **UNITS**, press **ENTER**, and select either **MM** or **INCH**. The current units in use are indicated on the right of the standard measurement interface (see Figure 2-3).

Note: If the gauge is turned off before the **ENTER** key is pressed, the units will not be changed.

4.1.5 SCAN (SCAN MEASUREMENT MODE)

Whilst the material is being measured by the probe, the gauge can record the smallest and largest values. To activate this mode, select **SCAN** in main menu and slowly drag the probe along the surface of the material (ensuring good coupling) (the measurement interface is shown in Figure 4-3).

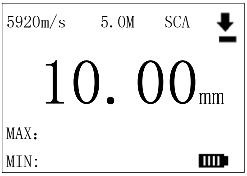


Fig. 4-3: Scan Measurement Interface

4.1.6 DIFF (DIFFERENTIAL MEASUREMENT MODE)

Differential mode can be used to measure the difference between the tested object’s thickness and that of the reference value. Follow the procedure below:

- **STEP 1:** Select **DIFF** in the main menu and **ENTER** to change the reference value (the default value is 10mm).

- **STEP 2:** Press **ENTER** to complete and return to the main menu.
- **STEP 3:** Press **TEST** to return to the differential measuring interface (as shown in Figure 4-4), and the set reference value will be displayed at the top left of screen.
- **STEP 4:** Measure the object and the difference in thickness of the measured material compared to the reference value will be displayed. The symbol “-” will be displayed at the top right when the difference is negative.

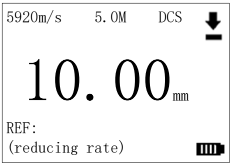


Fig. 4-4: Differential Measurement Interface

4.1.7 HTEM (HIGH TEMPERATURE MEASUREMENT MODE)

To measure the thickness of a high temperature object, select an appropriate high temperature probe where the temperature of the measured object is within the working temperature range of the probe. Please refer to the following procedure: select **HTEM** in main menu, and press **ENTER** to enter the setup interface. Input the material’s temperature, and press **ENTER** to complete and return to the main menu (the high temperature measuring interface is shown in Figure 4-5).

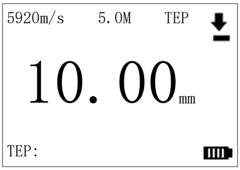


Fig. 4-5: High Temperature Measurement Interface

4.1.8 AVG (AVERAGE MEASUREMENT MODE)

Average mode is used to measure the average of several completed measurements. The size of your data set can range from 2 to 99. To operate this mode, follow the below procedure:

- **STEP 1:** Select **AVG** in the main menu and press **ENTER** to enter the setup interface where the average group size can be changed (the default value is 5).
- **STEP 2:** Press **ENTER** to complete setup and return to the main menu.
- **STEP 3:** Press **TEST** to return to the average measuring interface (As shown in Figure 4-6);

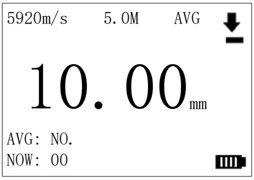


Fig. 4-6: Average Measurement Interface

- **STEP 4:** Ensuring good coupling, measure the thickness of point N. Then lift the probe and measure the thickness of the next point and repeat until all data points are measured. Each measurement reading will be displayed in the center of the screen as they are made, and the number of the current measurement being made is displayed after **NOW** in the bottom-left of the screen. After completing all measurements, the average thickness will be displayed in the center of the screen.

4.1.9 STD (STANDARD MEASUREMENT MODE)

Standard mode is a basic measurement mode that can be used to measure the thickness of a material. Select **STD** in the main menu and press **ENTER** to complete setup. Press **TEST** to return to the measuring interface (As shown in Figure 4-7);

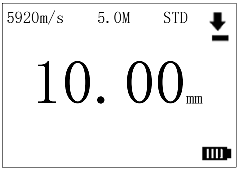


Fig. 4-7: Standard measurement Interface

4.1.10 RESL (DISPLAY RESOLUTION)

The display resolution (the number of digits shown to the right of the decimal point of a reading) can be changed using this setting. This may be useful in some applications where the extra precision of the last digit is not required or where extremely rough outside or inside surfaces make the last digit unreliable. There are two resolutions to select from: 0.01mm and 0.1mm.

To change the display resolution, select **RESL** in the main menu and press **MENU.** Then select 0.01 or 0.1. Press **ENTER** to complete the display resolution setup and to return to the main menu.

Note: If the gauge is turned off before the **ENTER** key is pressed, the display resolution will retain the previous resolution.

4.1.11 RATE (MEASUREMENT RATE)

This option allows the measurement rate of the gauge to be changed (this affects the power of the gauge). The measurement rate can be changed from 2 times per second to 20 times per second. Select **RATE** in the main menu and press **ENTER.** The current frequency will be displayed, and the frequency can be adjusted. Press **ENTER** to complete the measuring frequency setup and return to the menu.

Note: If the gauge is turned off before the **ENTER** is pressed, the measurement rate will retain the previous current value.

Note: The battery drain rate is increased when the measurement rate is increased.

4.1.12 AUTO-OFF

The gauge is programmed to automatically shut-down after 3 minutes without operation. For convenience, this can be changed to suit the user's needs. Select **AUTO-OFF** in the main menu and adjust the shut-down time (in minutes). The user can also press **SHIFT** to select **NOT AUTO SHUT** (no automatic shut-down).

4.1.13 RESET

To restore the gauge to its default setup, press and hold both **CAL-1** and **CAL-2** keys and then press **TEST** to power on the gauge. This may be useful for new operators whilst they become familiar with the setup of individual features as described previously. This may also be useful for experienced operators as an efficient short-cut to a known configuration. You can also restore the gauge to its default setup by selecting **RESET** in the main menu.

4.1.14 CONTR (DYNAMIC CONTRAST)

To adjust dynamic contrast, select **CONTR** in the main menu using and adjust the dynamic contrast to your requirements.

- Default: 5
- Range: 1–32
- Step size: 1

4.1.15 LANGUAGE

You can change the operating language of the gauge. Select **LANGUAGE** in the main menu, press **ENTER** to proceed, and select either **ENGLISH** or **CHINESE**.

Note: If the gauge is turned off before the **ENTER** key is pressed, the language will not be changed but instead will retain the previous current units.

4.1.16 PROBE-ZERO-CAL

Whenever the probe is changed, it is recommended to do a probe zero calibration to improve measuring accuracy and to ensure proper probe functionality. This can be completed by selecting **PROBE-ZERO-CAL** from the main menu, and **ENTER**.

Note: Keep the probe clean before calibrating, and wipe any couplant from the probe.

4.1.17 MANU-SELECT-PRB (MANUALLY SELECT PROBE)

To manually select a probe, select **MANU-SELECT-PRB** from the main menu, and press **ENTER** to complete.

Note: Keep the probe clean before calibrating, and wipe any couplant from the probe.

4.1.18 SND-SET (KEY SOUND SETUP)

Sound in the gauge can be switched on or off by selecting **SND-SET** from the main menu.

4.1.19 ROTATE (SCREEN ROTATE)

For inverted inspections, the display can be rotated 180°. To do this, select **ROTATE** from the main menu.

4.1.20 CAL-1 (SINGLE-POINT CALIBRATION)

For a single-point calibration of a known material velocity (using one thick test block), select **CAL-1** in the main menu. The procedure for single-point calibration can be found in Section 3.2.1.

4.1.21 CAL-2 (TWO-POINT CALIBRATION)

For a two-point calibration of a known material velocity (using one thin and one thick test block), select **CAL-2** in the main menu. The procedure for two-point calibration can be found in Section 3.2.2.

4.1.22 VELOCITY PRESET (VELOCITY TABLE)

If the sound velocity of a material is known, calibration is not necessary and the velocity may be entered directly as a known velocity as discussed in Section 3.2.3 (the initial setup of the gauge is 5920m/s). The gauge is also pre-installed with 9 different material velocities that can be found in the velocity table. This can be accessed by selecting **V-IN** in the main menu or pressing **V-IN** key to enter the VEL TABLE, where you can select the appropriate velocity.

Note: If the gauge is turned off before **ENTER** is pressed, the velocity will not be updated to the new value but instead will retain the previous current value.

4.1.23 BACK-LIGHT

The display backlight feature internally illuminates the liquid crystal display with a bright uniform light. This allows the display (which has excellent visibility in normal to high ambient light conditions) to be viewed in low to zero ambient light conditions. To adjust back light settings, select **BACK-LIGHT** in the main menu, and select **AUTO, ON or OFF**. Additionally, you can press **BACK LIGHT key** to turn the backlight on or off.

- **AUTO**: the light turns on and off automatically.
- **ON:** the light is always on.
- **OFF:** the light is always off.

Press **ENTER** to complete the backlight setup and return to the main menu.

4.1.24 DIM (PIPE-WALL MEASUREMENT MODE)

If the thickness of a pipe wall is to be measured, please select this measurement mode from the main menu.

5 APPLICATION NOTES

5.1 FACTORS AFFECTING PERFORMANCE AND ACCURACY

5.1.1 SURFACE CONDITION

Loose or flaking rust, corrosion or dirt on the outside surface of a test piece may interfere with the coupling of sound energy from the probe into the test material. Thus, any loose debris of this sort should be cleaned from the specimen with a wire brush or file before measurements are attempted. Generally, it is possible to make measurements through thin layers of rust, as long as the rust is smooth and well bonded to the metal below. However, very rough cast or corroded surfaces may have to be filed or sanded smooth in order to ensure proper sound coupling. It may also be necessary to remove paint if it has been applied in thick coats or if it is flaking off the metal.

Severe pitting on the outside surface of a pipe or tank can be a problem. On some rough surfaces, using gel or grease rather than a liquid couplant can help transmit sound energy more effectively into the test material. In extreme cases, it may be necessary to file or grind the surface sufficiently flat to permit good contact with the face of the probe. In applications where deep pitting occurs on the outside of a pipe or tank it may be necessary to measure the remaining metal thickness from the base of the pit to the inside wall. The conventional technique is to measure the un-pitted metal thickness ultrasonically, measure the pit depth mechanically, and subtract the pit depth from the measured wall thickness. Alternately, one can file or grind the surface down to the base of the pits and measure normally.

As with any difficult application, experimentation with actual product samples is the best way to determine the limits of a particular gauge/probe combination on a given surface.

5.1.2 PROBE POSITIONING/ALIGNMENT

For proper sound coupling, firmly press the probe against the test surface. On small diameter cylindrical surfaces such as pipes, hold the probe so that the sound barrier material visible on the probe face is aligned perpendicular to the center axis of the pipe (refer to Figure 6.1).

Fig. 5-1: Correct positioning of probe against a small diameter cylindrical surface

It is possible that on some severely corroded or pitted materials there will be spots where readings cannot be obtained. This can happen when the inside surface of the material is so irregular that the sound energy is scattered rather than reflected back to the probe. The lack of a reading may also indicate a thickness measurement outside the suitable range for the probe and gauge. Generally, however, an inability to obtain a valid thickness reading at a particular point on a test specimen is a sign of a seriously degraded wall which may warrant investigation by other means.

5.1.3 CALIBRATION

The accuracy of measurements is only as good as the accuracy and care with which the gauge has been calibrated. It is essential that velocity and zero calibrations (zero calibration is done automatically in this type of gauge) be performed whenever the test material or probe is changed. Periodic checks with samples of known thicknesses are recommended to verify that the gauge is operating properly.

5.1.4 TAPERING& ECCENTRICITY

If the contact surface and the back surface are tapered or eccentric with respect to each other, the return echo again becomes distorted and the accuracy of measurement is diminished.

5.1.5 ACOUSTIC PROPERTIES OF THE MATERIAL

There are several conditions found in engineering materials that can severely limit the accuracy and thickness range that can be measured.

Sound Scattering:

In some materials – notably certain types of cast stainless steel, cast irons and composites – the sound energy is scattered from individual crystallites in the casting or from dissimilar materials within the composite. This effect reduces the ability to discriminate a valid return echo from the back side of the material and limits the ability to gauge the thickness of the material ultrasonically.

Velocity Variations:

A number of materials exhibit significant variations in sound velocity from point-to-point within the material. Certain types of cast stainless steels and brass exhibit this effect due to a relatively large grain size and the anisotropy of sound velocity with respect to grain orientation. Other materials show a rapid change in sound velocity with temperature. This is characteristic of plastic materials where temperature must be controlled in order to obtain maximum precision in the measurement.

Sound Attenuation or Absorption:

In many organic materials, such as low-density plastics and rubber, sound is attenuated very rapidly at the frequencies used in normal ultrasonic thickness gauging. Therefore, the maximum thickness that can be measured in these materials is often limited by sound attenuation.

5.2 PROBE SELECTION

For any ultrasonic measurement system (probe and gauge together) there will be a minimum material thickness below which valid measurements are not be possible. Normally this minimum range will be specified in the manufacturer's literature. Generally, however, as probe frequency increases, the minimum measurable thickness decreases. In corrosion applications, where minimum remaining wall thickness is normally the parameter to be measured, it is particularly important to be aware of the specified range of the probe being used. If a measurement system is used to measure a test piece that is below its designed minimum range, the gauge may detect invalid echoes and display an incorrectly high thickness reading.

Table 1-3 lists the approximate minimum measurable thicknesses in steel for the standard and optional probes used with the gauge. Note that these figures are approximate; the exact measurable minimum in a given application depends on material velocity, surface conditions, temperature and geometry. It is recommended that the measurable minimum be determined experimentally by the user.

In selecting a probe for a corrosion application, it is also necessary to consider the temperature of the material to be measured. Not all probes are designed for high temperature measurements. Table 1-3 also lists recommended temperature ranges for the probes used with the gauge. For other probes, consult the manufacturer's catalogue or data sheets. Using a probe on materials that have temperatures beyond the specified range can damage or destroy the probe.

5.3 HIGH TEMPERATURE MEASUREMENT

Corrosion measurements at elevated temperatures require special consideration. Please keep in mind the following:

- Be sure that the surface temperature of the test piece does not exceed the maximum specified temperature for the probe and couplant that you are using. Some probes are designed for room temperature measurements only.
- Use a couplant rated for the temperature at which you will be working. All high temperature couplant will boil off at some temperature, leaving a hard residue that is not able to transmit sound energy. Panametrics-NDTTM Couplant E (Ultratherm) can be used at temperatures up to 1000°F/540℃, although it will similarly boil as the upper limit is reached. Maximum recommended temperatures for Panametrics couplants are in the table below：

Couplant	Type	Maximum Recommended Temperature
A	Propylene Glycol	300°F/150°C
B	Glycerin	200°F/90°C
C	Gel	200°F/90°C
E	High Temperature	1000°F/540°C
F	Medium Temperature	500°F/260°C

- Make measurements quickly and allow the probe body to cool between readings. High temperature probes have delay lines made of thermally tolerant material, but with continuous exposure to very high temperatures the inside of the probe will heat to a point where the probe may be permanently damaged.
- Remember that both material sound velocity and probe zero offset will change with

temperature. For maximum accuracy at high temperatures, perform a velocity calibration using a section of the test bar of known thickness heated to the temperature at which measurements are to be taken. The gauge has a semiautomatic zero function that can be employed to adjust zero setting at high temperatures. See Section 3 for details.

- Note that a corrosion gauge is not designed for flaw or crack detection, and cannot be relied upon to detect material discontinuities. A proper evaluation of material discontinuities requires an ultrasonic flaw detector such as the **QingCheng SUB180** used by a properly trained operator. In general, any unexplained readings by a corrosion gauge merit further testing with a flaw detector.

For further information on the use of dual element probes, or for information on any aspect of ultrasonic testing, please contact us.

6 MAINTENANCE AND TROUBLE SHOOTING

6.1 ROUTINE CARE AND MAINTENANCE

The case of the gauge is sealed to prevent intrusion of environmental liquids and dust. However, it is not completely waterproof and thus should never be immersed in any fluid. To clean the case, keyboard and display window, use a damp cloth (and mild detergent if necessary). Do not use strong solvents or abrasives.

6.2 PROBES

To ensure the longest lifespans for your ultrasonic probes, please pay attention to the following:

- The cables can be damaged by cutting, pinching, or pulling on them. Take care to prevent any mechanical damage to the cables. Never leave a probe where a heavy object can be placed on the cable. Never remove a probe from the gauge by pulling on the cable. Pull on the molded connector housing only. Never tie a knot in a probe cable.
- Do not twist or pull the cable at the point where it connects to the probe. These precautions are particularly important for all probes other than the models which have field-replaceable cables. For repair of damaged probes, please return them to the QingCheng Customer Service Department.
- Probe performance will be degraded by excessive wear at the tip. To minimize wear, do not scrape or drag the probe across rough surfaces. When a probe tip becomes too rough, concave, or otherwise non-flat, operation may become erratic or impossible. Although some wear is normal in corrosion-gauging applications, severe wear will reduce the probe life. A probe resurfacing procedure can be performed to improve performance of worn probes. Please contact us for details.

6.3 OTHER ERROR OR PROBLEM INDICATIONS

6.3.1 TURN ON AND LOW BATTERY PROBLEMS

If the gauge turns off immediately after power-on, or if it does not turn on at all, then the battery is probably completely discharged and should be replaced. If the unit will still not turn on after replacing the battery, there may be a component failure within the gauge and it should be serviced.

6.3.2 COUPLING PROBLEMS

If no thickness measurement is displayed when the probe is coupled to a test material, make sure that the probe is plugged in properly (see Section 2.1). If there is still no measurement display, the probe may be defective – try another one if possible, or try a different cable if it is the type of probe that uses replaceable cables.

6.3.3 IDENTIFY PROBE PROBLEM

If the gauge doesn't register the probe being plugged in, please first ensure that the probe is well connected to the gauge. If the gauge still doesn't register the probe, please exchange the plugs and make sure they are well connected to the gauge. If the problem persists, select **MANU-SELECT-PRB** from the main menu, and select the appropriate probe.

6.3.4 MEASUREMENT PROBLEMS

If measurements cannot be made, there is either a problem with the probe, the pulser/receiver assembly, or there is not a large enough echo being returned from the far wall of the material. In order to further diagnose the problem, please perform the following procedure:

- **STEP 1:** Wipe off any couplant from the probe and do a VELOCITY CALIBARATION. If a number is displayed alongside the VELOCTIY CALIBARATION flag, both the probe and pulser/receiver assembly are working (proceed to step 2). If otherwise, proceed to step 6.
- **STEP 2:** Make sure sufficient couplant is applied, especially on rough or curved surfaces. Proceed to step 3.
- **STEP 3:** Try the same probe on a smooth, flat surfaced test sample.
- **STEP 4:** If steps 1, 2 and 3 all succeed but measurements still cannot be made, try a different type of probe which has greater sensitivity to the thickness range in which you are working.
- **STEP 5:** If another probe of the same type is available, use it to make measurements and repeat step 1. If this works, then the original probe is likely to be defective. Otherwise, the pulser/receiver assembly is probably defective.
- **STEP 6:** If the above tests indicate that there is a problem with the gauge or probe, then the unit(s) may be returned to us for repair or replacement. If the above tests indicate that the gauge and probe are working properly, then the test material itself is likely to be defective for the following reasons:
    - Extreme near side or far side surface roughness.
    - Extremely high sound attenuation or scattering due to graininess, inclusions, voids or other material properties.
    - Extreme non-parallelism.
    - Excessively sharp curvature.

APPENDIX Ⅰ

SOUND VELOCITIES

The following table provides a list of the ultrasonic velocities in a variety of common materials. It is provided only as a guide as the actual velocities in these materials may vary significantly due to numerous factors, such as composition, preferred crystallographic orientation, porosity, and temperature. Therefore, for maximum accuracy, it is recommended that the sound velocity be experimentally determined by first testing a sample of the material.

Sound Velocities of Various Materials Longitudinal Wave Velocity

Material	Velocity(m/s)	Material	Velocity(m/s)
Water(20℃)	1480	Stainless steel (304)	5663
Glycerin	1920	Brass, yellow	4640
Water-glass	2350	Copper	4700
Nylon	2620	Glass	5440
Acetic acid resin	2670	Nickel	5630
Acrylic acid resin	2730	Steel 330	5600
Tin	3230	Steel 4330	5850
Gold	3240	Iron, steel	5920
Phosphor bronze	3530	Titanium	6070
Silver	3600	Magnesium	6310

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