Cygnus 3+

Ultrasonic Thickness Gauge

Operating Manual



Covers Gauge Model : M5-C3P-EN

Doc No. M5-CYG3P-M-01-EN_Iss4.doc
22 October 2026

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Important Notice



The following important information must be read and understood by all users of Cygnus ultrasonic thickness gauges.

The correct use of Cygnus ultrasonic thickness gauges requires identification of the correct equipment for the specific application coupled with an appropriately trained and qualified operator or technician. The incorrect use of this equipment, along with its incorrect calibration, can result in serious financial loss due to damage to components, facilities, personal injury and even death.

Neither Cygnus Instruments nor any of its employees or representatives can be held responsible for improper use of this equipment. Proper training, a complete understanding of ultrasonic wave propagation, thorough reading of this manual, proper transducer selection, correct zeroing of the transducer, correct sound velocity, correct use of the appropriate test blocks, proper cable length and proper couplant selection all play a factor in successful ultrasonic thickness gauging. Of critical importance is the process of complete and accurate calibration of the instrument.

This manual will provide instructions in the set up and operation of the thickness gauge. Additional factors that can affect the use of ultrasonic equipment are beyond the scope of this manual and to that end it is understood that the operator of this equipment is a well-trained inspector qualified by either their own organisation or another outside agency to the appropriate level of both theory and practical application of ultrasonics.

Therefore, Cygnus Instruments recommends that users of its ultrasonic thickness gauges should be formally qualified to a minimum of UT “Level 1” (ASNT or PCN) which will provide approximately 40 hours of training.

1. Introduction

Cygnus 3+ Thickness Gauge

The **Cygnus 3+ Ultrasonic Thickness Gauge** is a rugged, handheld, battery-powered instrument designed for high-reliability thickness measurements in harsh environments using ultrasound. It features a main colour LCD display which can be easily read in most light situations including sunlight, and a second end mounted LCD display for when access is tight, and the gauge is placed in a pocket.

The gauge can be used with a choice of Ultrasonic Probes, selected to suit the material and thickness range to be measured.

The gauge measured material thickness using the Single Echo method (UT Mode 2).

The gauge can easily be calibrated to a known thickness or to a known Velocity of Sound.

The gauge is able to operate accurately over a wide range of ambient temperatures and is environmentally sealed to IP67 for use in wet conditions.



The gauge is a solid-state electronic instrument which, under normal operating conditions, will give many years of active service.

Although designed for ease of operation the first-time user should carefully read this manual to familiarise themselves with the features of the Gauge.

Cygnus Instruments

Cygnus Instruments Limited, founded in 1983, pioneered the development of the Digital *Ultrasonic Multiple-Echo Technique* used for measurement through coatings. This has long since been the standard required to ensure that accurate measurements are taken without the need to zero the gauge or remove any coatings first.

Our philosophy is to work closely our customers to provide high quality products, engineered to serve heavy industry & harsh environments. Cygnus Ultrasonic thickness gauges are designed to be reliable and simple to use. We have an unrivalled reputation in over 45 countries around the world.

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Gauge Kit Contents

Basic Gauge Kit

1. Cygnus 3^{+} Gauge
2. Operating Manual (in side pouch)
3. Neck Strap (in side pouch)
4. Accessory Pouch, containing;
   - 3 x AA Batteries
   - Blue Couplant Gel.
   - 15mm Steel Test Block

Kit supplied with Twin Element Probe

1. Ultrasonic Probe
2. Moulded Probe Cable (in side pouch)



2. Gauge Preparation

The gauge is supplied ready to use out of the box. Just insert the batteries, connect the probe to the gauge, turn on the power, calibrate and you are ready to begin taking thickness measurements.

Fitting the Batteries

The gauge requires 3 x AA/LR6/UM3 Batteries. Cygnus supplies and recommends Duracell Alkaline batteries. The batteries are located behind a cover on the rear of gauge. The hand strap can be separated by a push-button buckle to gain access to the battery cover. The battery cover is removed by pressing in with your thumb the at the base to release the clip.

	Press the bottom of the battery cover to release the retaining clip and lift up the battery cover.
	The batteries are located underneath. The gauge is protected against electrical damage from incorrect battery insertion. The battery compartment itself is sealed to contain any battery fluids that may leak out.

The gauge can be fitted with NiCad or NiMH rechargeable batteries but this may alter the specified operating time.

To avoid damage from leaking batteries **always** remove the batteries if the gauge will be unused for any length of time.

If the batteries run flat, they may leak acid into the battery compartment and damage the electrical contacts. This would not be covered by the warranty.

Connecting the Probe

The Cygnus probe lead uses a custom-made cable that offers superior flexibility and resistance to oils and ultraviolet light. The twin connectors are over-mounded to form a tough housing that will provide a long-lasting probe cable. Depending on the type of probe supplied the probe end will have either a BNC or single Lemo® '00' connector.



The connector is orientated with a 'pip' and can only be plugged in one-way around.

To release the connector simply pull back on the connector body. DO NOT pull the cable.

Fitting the Neck Strap

The gauge is supplied with an adjustable Neck Strap. The ends of the neck strap clip onto two wire loops fitted to the gauge. These wire loops are made from coated stainless steel.

	Wire loop fitted to the gauge body. Simply pass the loop through the hole in the gauge and back over the other end.
	The neck strap can then be clipped on to the loops.

3. Selecting the Right Probe

The performance of any thickness gauge, and its ability to get a reliable measurement depends on selecting the right ultrasonic probe for the application and conditions. Cygnus gauges are therefore offered with a selection of probes suitable for most thickness gauging applications.

The following section helps you select the right probe for the application.

The gauge **must** be set for the probe connected to it, see Selecting the Probe Type on page 36.

Measuring Metals

Material	Coating	Corrosion	Typical Thickness	Recommended..	
				Probe	Measurement Mode
Steels	Non	Non to Heavy	0.8 mm+ (0.03”+)	**T7A**	**Single Echo**
Steels	Non	Non to Heavy	1.5 mm+ (0.06”+)	**T5A**	**Single Echo**
Steels	Non	Non to Heavy	1.5 mm+ (0.06”+)	**T5B**	**Single Echo**
Cast Iron	Non	Non to Moderate	2.5 mm+ (0.1”+)	**T2C**	**Single Echo**

Measurement Modes Explained and Compared

Single Echo Mode (SE) (Mode 2)

Single Echo measurement mode is most useful on heavily corroded metals. Because it only needs the first return echo to take a measurement it performs well on virtually all steel conditions.

However single echo mode will not ignore any surface coatings, so if you measure through a coating it will give an incorrectly metal thickness measurement. If the surface coating is very thin (0.2mm / 0.01”) paint you can make an allowance for this error, but thicker coatings introduce too much error to be practical.

Single echo measurements use a twin element (twin crystal) probe, because there are two elements angled to a focal point there is a v-path error introduced. However this v-path error is mostly corrected by the gauge, and furthermore by performing a two point calibration.

Twin element probes require "zeroing" at regular intervals, especially if the ambient temperature is changing.

Measuring Non-Steels

The gauge will measure the following non-steels;

- Aluminium alloys
- Copper and Brass alloys
- Titanium

Use the same rules as steels when selecting a suitable probe. The gauge will ideally be re-calibrated to suit the metal being measured, or the standard velocity of sound for that material would be entered into the gauge.

Measuring Non-Metals

You can measure certain types of plastics with the gauge using a twin element probe and the gauge set to Single Echo measurement mode. Generally, the harder the plastic the better, soft materials like rubber or TPEs tend to absorb too much ultrasound so only thin samples can be measured.

Engineering plastics like Acetal, Tufset (Polyurethane), Nylon and High-density polyethylene (HDPE) can be measured successfully.

Rotationally Moulded parts can generally be measured successfully.

- You must use Single Echo mode to measure plastics.

- You must generally use a low frequency probe (i.e. **T2C**) to measure plastics, but this will depend on the properties of the material.

- Any material with a closed-cell construction cannot be measured.

- Any material with internal voids, air bubbles or honeycomb cannot be measured.

Typically these materials cannot be measured with the gauge;

- Concrete
- Wood
- Thermal insulation materials
- Foams
- Composites

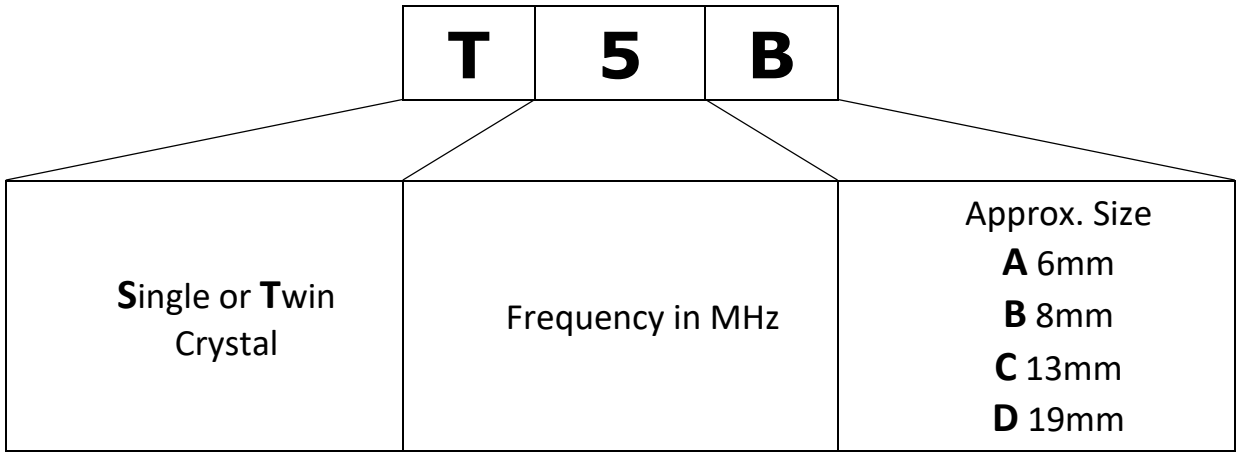
Summary of Cygnus Probes

Twin Element probes

Probe Type	Crystal Size	Frequency	Range in Steel (SE Mode)	Typical Uses
T2C	12mm	2 MHz	2.5 to 250 mm 0.1 to 10”	Attenuative materials Cast irons, plastics
T5B-CSL	8mm	5 MHz	1.5 to 200 mm 0.06 to 8”	General purpose Most metals
T5B-CSW	8mm	5 MHz	1.5 to 200 mm 0.06 to 8”	General purpose Most metals Note: Smaller probe body than T5B-CSL, fixed cable.
T5A	6.4mm	5 MHz	1.5 to 150 mm 0.06 to 6”	General purpose Most metals

T7A	5mm	7.5 MHz	0.8 to 50 mm 0.03 to 2”	Thin metals

The ‘Probe Type’ Code



4. Gauge Operation

Gauge Controls

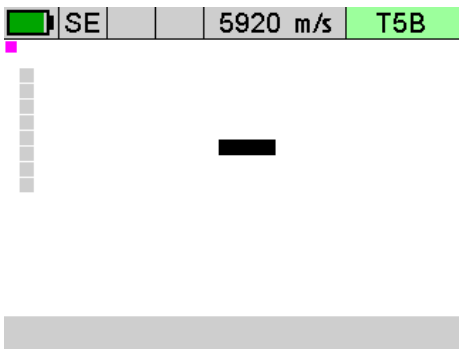


End view of gauge

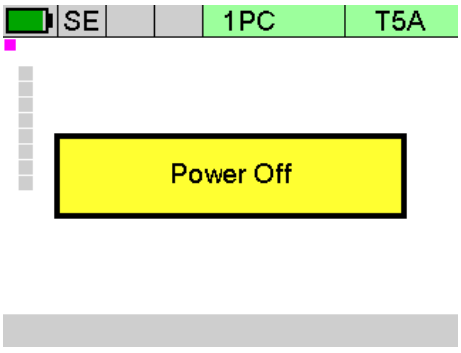


Front view of gauge

Turning the Gauge On

1.	Press the Power key	
2.	Cygnus Instruments Logo is displayed	
3.	The gauge details are displayed; Model Serial Number Version Number Run Time	
4.	The gauge is ready to use	

Turning the Gauge Off

1.	Press & Hold the Power key,	
2.	The display shows 'power-off' and the gauge turns off.	

Automatic Power Off

By default the gauge will turn off automatically after 5 minutes of in activity.

Taking thickness measurements or accessing the menu will reset the activity timer back to zero.

You can change the activity time value the Setup menu, see Power Off Setting on page 40.

Status Information

At the top of the display is an area that shows information about the gauge's status;

- Battery Level
- Velocity of Sound value / Calibration Status
- Probe Type
- Measurement Mode (SE = Single Echo)



Probe Type; when the probe is connected the background colour is green, when disconnected it is grey.

Taking Thickness Measurements

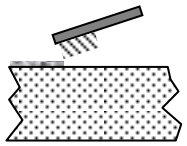
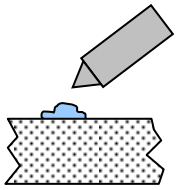
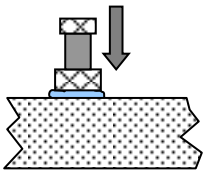
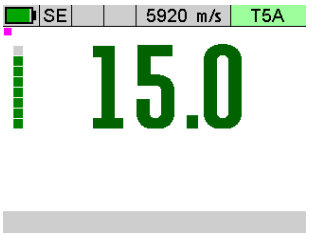
Taking ultrasonic thickness measurements is a straight forward process that involves first making sure the surface is clean and prepared, applying an ultrasonic couplant gel then placing the probe on the surface and observing the display for the measurement.

Zeroing the Probe

When a twin element probe is connected to the gauge (and the gauge is set to the correct probe) you must first perform a **Probe Zero** before you can begin taking measurements. For instructions see Probe Zero Function on page 30.

It is recommended to frequently perform a Probe Zero especially if conditions such as temperature are changing.

Taking the Thickness Measurement

1.	Remove all scale, rust, dirt or loose coatings and brush the test area clean.	
2.	Apply ultrasonic couplant to the test surface.	
3.	Place the probe-face on the clean, lubricated test surface and make firm contact applying gentle pressure.	
4.	The gauge will display a thickness measurement.	

Measurement Stability Indication

To help indicate when a Single Echo measurement is stable – and thus probably reliable – the gauge changes the thickness measurement number colour from Red to Green when the measurement has been stable for 2 consecutive seconds.

When measuring using Single Echo mode once you have a measurement keep the probe still and wait for the gauge to signal a “stable reading”.

If the ultrasound signal is poor or erratic, then the thickness value may remain red – thus indicating the measurement may not be reliable.

Stable is defined as; the thickness measurement changing no more than + or - the Resolution setting.

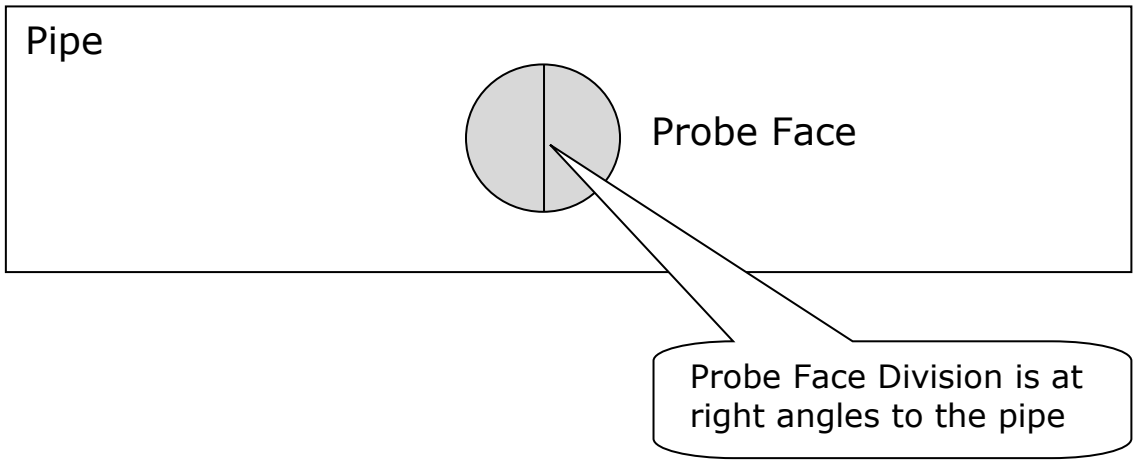
Example.

The Resolution is set to 0.05mm, therefor the thickness measurement must not change by more than +0.05mm or -0.05mm for 2 seconds or more to be "stable".

Measuring Small Diameter Pipe & Tubes

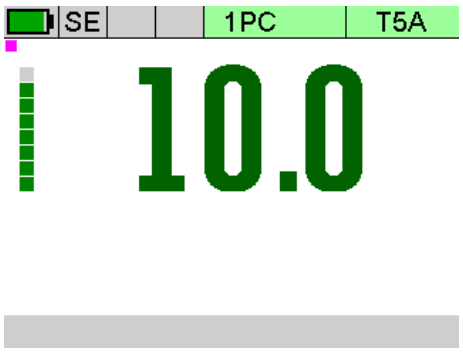
When measuring small diameter pipe and tubes with a twin element probe, 75mm (3") or under, its best to ensure the face of the probe is aligned to the curvature of the pipe otherwise measurements may be inaccurate.

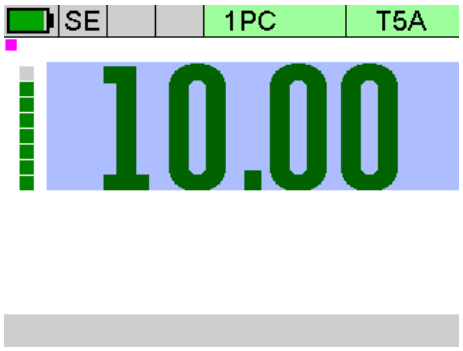
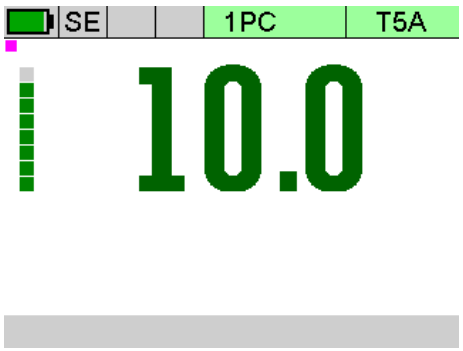
The dividing line on the face of the probe should be at right angles to the length of the pipe.



Display Hold Function

The thickness measurement can be 'Held' or frozen by simply pressing the X/Cancel key while in any measurement screen.

1.	A thickness measurement is displayed	

2.	Press the X/Cancel key to hold the thickness measurement. The measurement value now has a light blue border to indicate it's held or froze.	
3.	Press the X/Cancel key to un-hold the thickness measurement.	

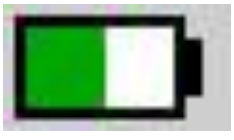
Battery Life

The gauge will operate continuously for approximately 10 hrs when fitted with Duracell Alkaline 1500 mA/hr batteries.

Battery Level

A battery level graphic is displayed at the top left position of the display;



Battery almost full	
Battery about 1/2 full	
Battery low	

Low Battery Indication

The gauge will periodically flash a red Low Battery warning sign when the batteries have approximately 1 hour of use remaining.

Low battery indication	

When the batteries are exhausted the gauge will display a **Flat Battery** message for 5 seconds then turn off automatically.

Flat Battery message	

5. Calibration

Why should I Calibrate my Thickness Gauge?

Ultrasonic thickness gauges measure time in order to measure the thickness of the material being tested. It relies on the principal that sound travels through a material at a constant velocity or speed. If you can accurately measure the time it takes to travel through a material, and you know its velocity then you can calculate its thickness;

$$\text{Thickness} = \frac{\text{time x velocity}}{2}$$

Modern thickness gauges are easily capable of measuring **time** accurately to 10 Nano seconds (0.000,000,01 second) so this is considered to be more than sufficiently accurate.

This means the accuracy of any thickness gauge measurement relies principally on the **velocity** being correct for the material being measured.

There are tables listing the velocity of most common metals and materials, but these velocities are only "typical" values. For example, Mild Steel has a typical velocity of 5920 m/s – but in practice when measuring a variety of mild steel samples, the velocity can range anywhere from 5860 to 5980 m/s.

This means if you want to achieve the most accurate thickness measurements you must calibrate your thickness gauge to a sample of the same material you will be testing – and a sample that you can accurately measure the thickness of with a Vernier or Micrometer.

Your measurements are only as good as your calibration

Instructions for calibrating the gauge can be found on page 24 onwards.

Calibration Options

The Gauge is supplied tested and calibrated. The Gauge will have been calibrated to measure thickness through steel (grade S355JO) with a velocity of sound of 5920 m/s.

Either a 15mm or 1/2" **Test Block** is supplied with the kit so the Gauge can be quickly checked for correct operation. Note, this test block is not intended to be used for calibration of the Gauge.

The best way to calibrate the Gauge is to Calibrate using a Known Thickness using a sample of the material you intend to measure. This method determines the velocity of sound for the material sample, which will always be more accurate than using a 'general' velocity value. For calibration instructions see page 24.

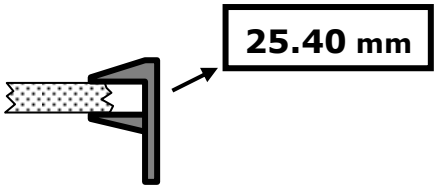
If there is no test sample available, the Gauge can be calibrated by Setting the Velocity of Sound directly. A table on page 49 at the back of this manual lists common materials and their velocity of sound value. For calibration instructions see page 25.

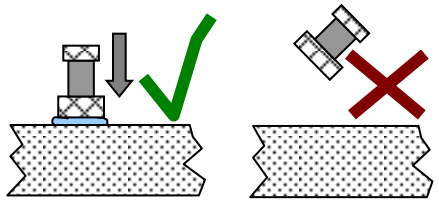
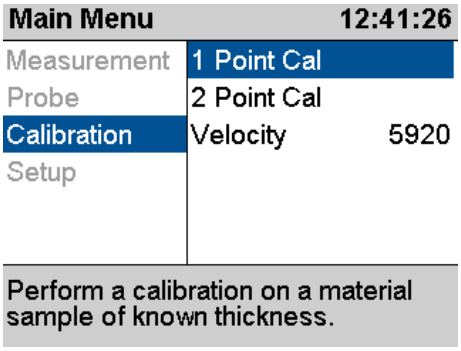
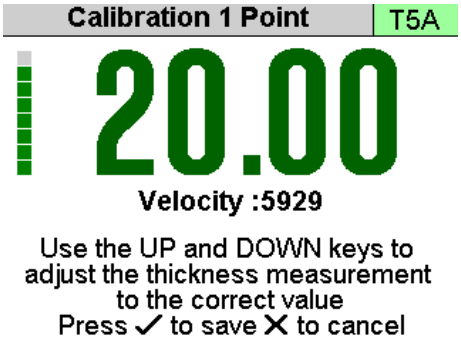
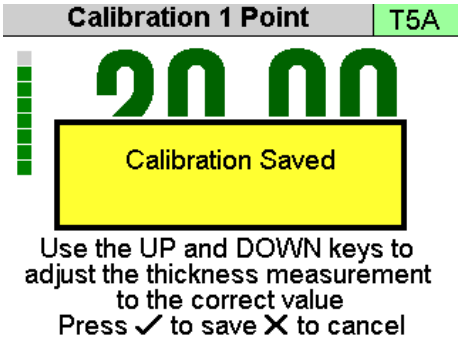
A third method is to leave the Gauge set to its factory-preset value for Steel [5920 m/s or 0.2332 in/us], and then use a Conversion Factor from the table of velocities on page 49.

Calibrating to a known thickness (Single or 1 Point)

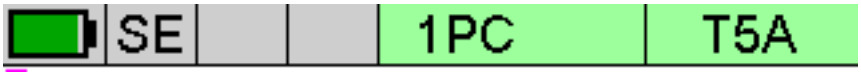
This method of calibrating the gauge is more accurate than using a standard velocity value as the gauge calculates the velocity of sound for the sample material.

You can use this calibration method for all measurement modes.

1.	Accurately measure the thickness of your sample material.	

2.	Place the Probe on the sample and verify the gauge can get a thickness value.	
3.	Access the Menu and scroll down to the 'Calibration' group. Then scroll right to the '1 Point Cal' item. Press the Ok/Select key to open the '1 Point Cal' function	
4.	While holding the probe firmly on the sample and while a steady thickness measurement is displayed..	
5.	...use the Up and Down keys to adjust the thickness to the required value.	
6.	When done press the OK/Select key to save the calibration. A Calibration Saved message will be shown. Or press the X/Cancel key to exit without saving the calibration.	

When a Calibration has been made a '**1PC**' indictor is displayed with a green background at the top of the measurement screen in the status area (*1PC = Single Point Calibration*).



'1PC' Indicator

Two Point Calibration

Two-point calibration allows the gauge to be calibrated against two reference thicknesses of the same material, one at the minimum (thin) thickness range the other at the maximum (thick) thickness range.

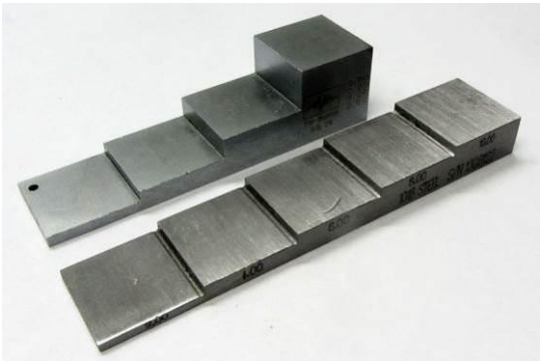
To achieve maximum accuracy in Single Echo mode you must perform a Two Point Calibration – your measurement is only as good as your calibration.

When performing a two-point calibration both sample thicknesses should be made from the same material. The temperature of the sample material should be the close to the temperature of the material to be measured.

The gauge will automatically compensate for v-path error in addition to either single- or two-point calibrations.

Ladder Step Wedge

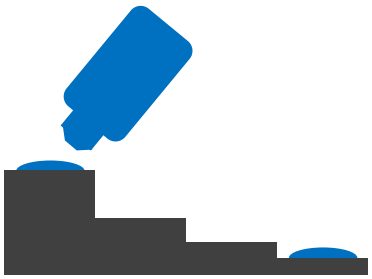
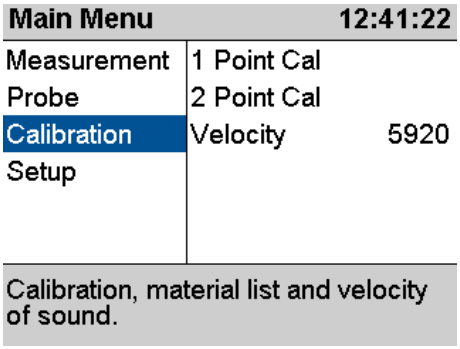
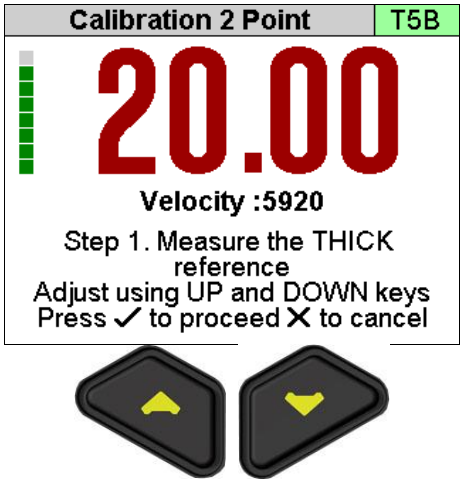
Typically, a Ladder Step Wedge is used to calibrate the probe and gauge for Steel. The ladder step wedge has 4 or 5 different thicknesses typically ranging from 2.5 mm to 20.0 mm. You would typically choose to calibrate using the 2.5mm and 20 mm thicknesses.

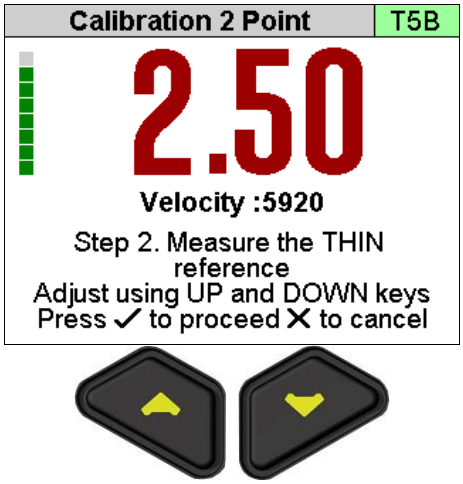
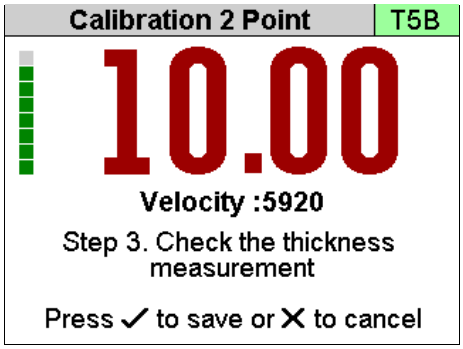


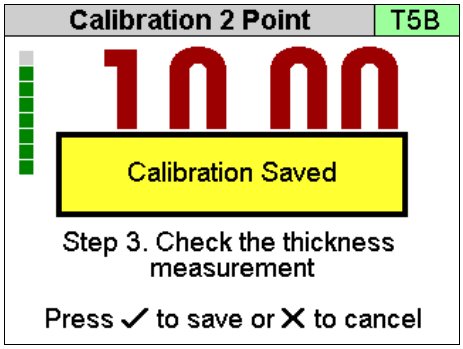
Ladder Step Wedges

Two Point Calibration Procedure

1.	Assuming you have a step wedge of known thicknesses	

2.	Wipe clean the step wedge then add some fresh couplant to the step wedge	
3.	Place the Probe on the sample and verify the gauge can get a thickness value.	
4.	Access the Menu and scroll down to the 'Calibration' group. Then scroll right to the '2 Point Cal' item. Press the Ok/Select key to open the '2 Point Cal' screen	
5.	Start with the Thick sample – Maximum thickness.	
6.	While holding the probe firmly on the thick sample and while a steady thickness measurement is displayed.. ...use the Up and Down Select keys to adjust the thickness to the required value.	

7.	When the correct measurement is displayed press the OK/Select key	
8.	Next measure the Thin sample – Minimum thickness.	
9.	While holding the probe firmly on the thin sample and while a steady thickness measurement is displayed. ...use the Up and Down Select keys to adjust the thickness to the required value.	
10.	When the correct measurement is displayed press the OK/Select key	
11.	The 3rd screen lets you check the calibration is correct my checking a few different measurements on the step wedge.	

12.	When done press the OK/Select key to save the calibration. A Calibration Saved message will be shown. Or press the X/Cancel key to exit without saving the calibration.	

Probe Zero

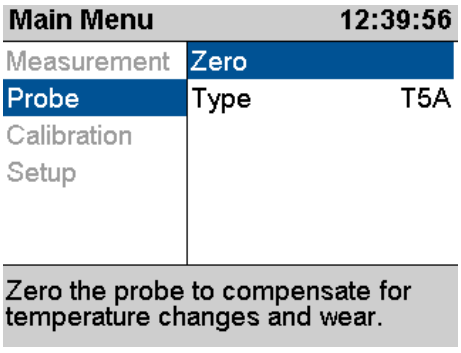
Twin element probes must be zeroed to compensate for any wear or operating temperature changes. The gauge will always perform a Probe Zero when first turned on or when a twin element probe is connected.

If the probe gets significantly warmer during use this can cause a shift in the zero position and thus introduce small errors in the thickness measurement. Typically, a 20° C change in temperature the measurements can shift by 0.1 mm.

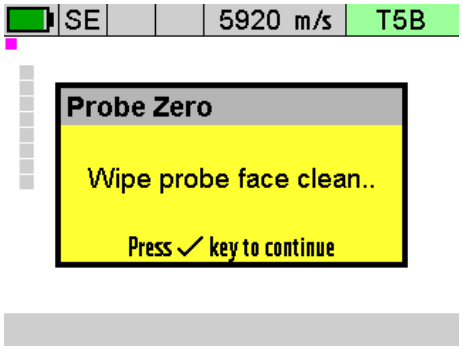
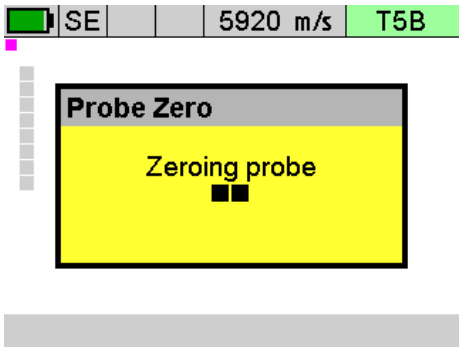
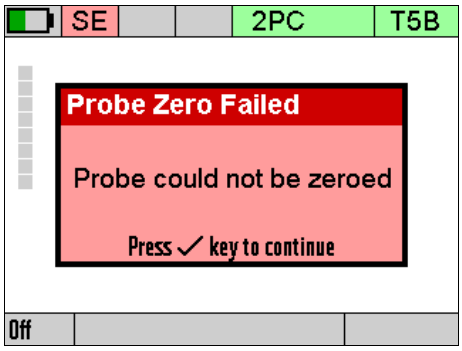
It is recommended to frequently perform a Probe Zero especially if conditions such as temperature are changing.

See also Zeroing the Probe (twin element probes) on page 18.

Starting a Probe Zero from the Main Menu

1.	Access the Menu and scroll down to the 'Probe' group. Then scroll right to the 'Zero' item. Press the Ok/Select key to start the 'Zero' function	

Probe Zero Function

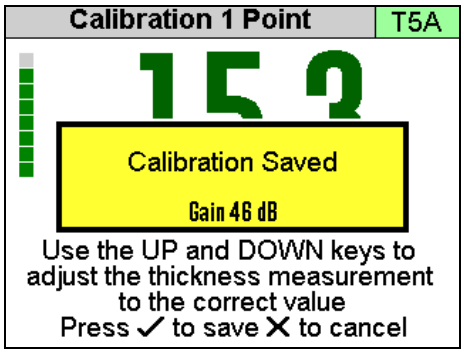
2.	Display shows the Zero Probe message. **Important** - Wipe any couplant from the probe face	
3.	Press the OK/Select key to proceed The gauge measures the probe zero point… ..this takes about 2 seconds.	
4.	If the Probe Zero fails a message will be displayed. • Check the probe has not been unplugged or the cable is damaged/faulty. • The probe face must be clean and in the air. • Are you using a non-Cygnus probe? You must un-plug the probe, then plug it back in to re-try the Probe Zero process.	

Probe Gain Optimisation

To ensure the optimum gain is used with a probe you can perform a Single Point Calibration on the 15mm Steel Test block supplied with the kit.

First set the velocity of sound is set to 5920 m/s. When you calibrate the gauge will automatically find and set the optimum

gain for the probe connected. This gain will be stored and used every time this type of probe is connected



Probe Gain Set Message

You can perform the gain optimisation at any time, but usually it is only required when a new or replacement probe has been supplied.

Setting the Velocity of Sound

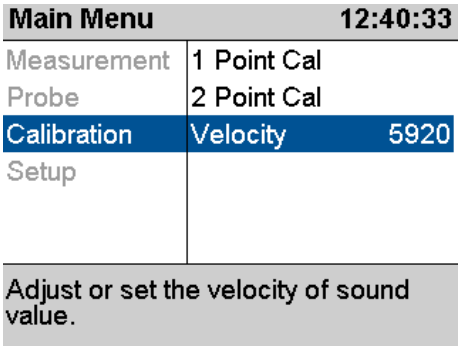
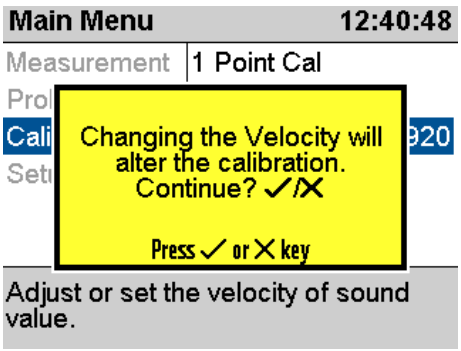
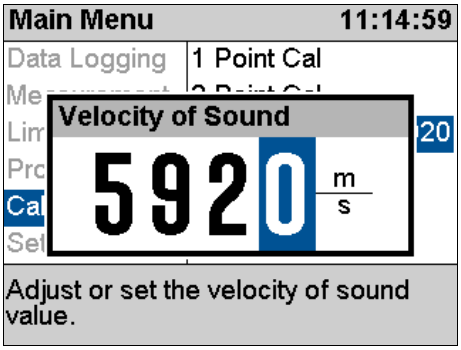
The gauge uses the Velocity of Sound value to calculate the material thickness value. It is therefore important the velocity value is set correctly for the material being measured.

If you perform a Calibration the Velocity of Sound will be set for you during the calibration – so you don't need to adjust it afterwards.

You can manually set the velocity of sound value if required; normally you would do this if;

- You can't perform a calibration
- You want to use the same velocity setting as last time
- You want to use a velocity from a material list

A list of velocity of sound values for common material can be found on page 49.

1.	Access the Menu and scroll down to the 'Calibration' group. Then scroll right and select 'Velocity'. Press the Ok/Select key to open the 'Velocity'' function	
2.	If there has been a previous Calibration a message will warn that changing the velocity will alter the calibration; Press the OK/Select key to continue, or X/Cancel to abort.	
3.	Use the Up and Down keys to adjust the velocity value as required Use the Left and Right keys to highlight the digit to change.	
4.	When done press the OK/Select key to save the changes. Or press the X/Cancel key to exit without saving.	

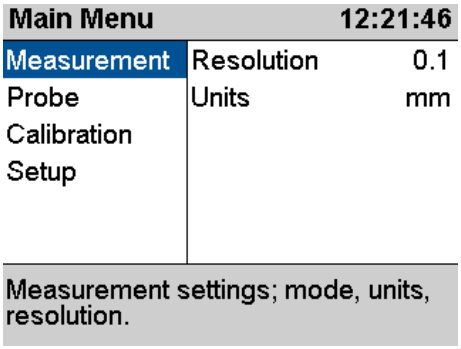
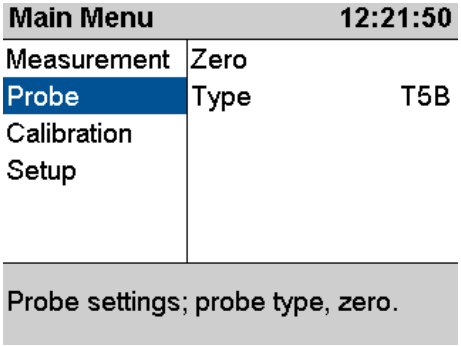
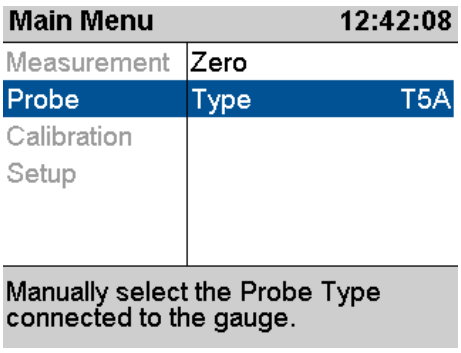
When the velocity has been manually set the value is displayed at the top of the measurement screen in the status area.

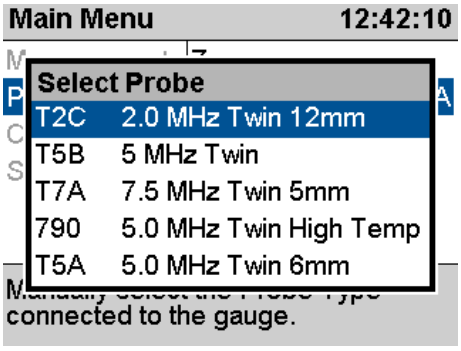
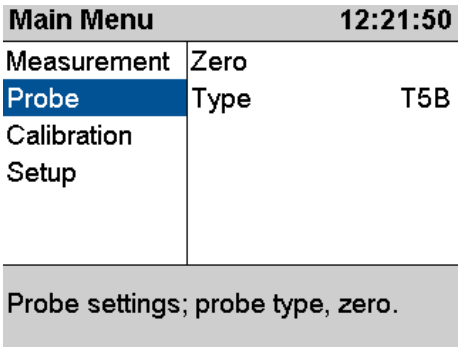


Velocity of Sound value '5920 m/s'

6. Gauge Setup

Menu Operation

1.	Press the Menu key,	
2.	the Main Menu is displayed	
3.	Use the four Navigation keys to scroll around the Main Menu	
4.	Use the Up and Down keys to select a group in the left column.	
5.	Press the Right key to move to the items in that group in the right column. Then use the Up and Down keys to select from the right column	

6.	If you want to change or select the item currently displayed simply press the green Ok/Select button	
7.	Then use the Navigation keys to highlight the required setting or option	
8.	Press the green Ok/Select key to save your choice	
9.	Or press the red X/Cancel key to abort	
10.	Press the Left key to go back to the main group if you want to make another selection	
11.	To exit the menu press the Menu or red X/Cancel key once.	

Settings are Saved with the Probe Type

Certain gauge settings are saved against the probe type. This allows each probe type to have different settings that will be recalled when that probe is re-connected, and the probe type is correctly set. The following settings are saved with each probe type;

- Units
- Resolution
- Velocity of sound
- Calibration
- Deep Coat

Inputting Numeric Values using the Navigation Keys

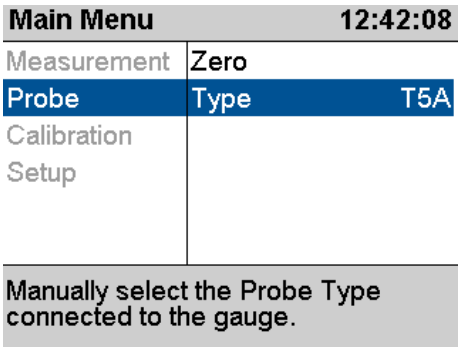
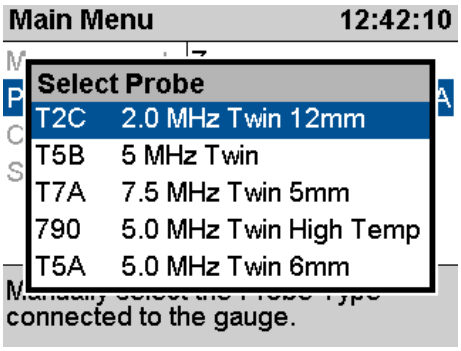
Some menu functions require the user to input a numeric value using the navigation keys. This is done 'digit' as a time, using the Left and Right keys to select the digit, then the Up and Down keys to change the highlighted digits value.

1.	The units digit is highlighted. Pressing Up or Down will change the units value only.	
2.	Pressing the Left key will move the highlight to the tens digit. Pressing Up or Down will change this value only.	
3.	Pressing the Left key will move the highlight to the hundreds digit. Pressing Up or Down will change this value only.	
4.	Pressing the Left key will move the highlight to the thousands digit. Pressing Up or Down will change this value only.	

Selecting the Probe Type

The Probe Type must be set to match the probe connected to the gauge. If the wrong probe is selected the gauge will not measure accurately if at all.

The Probe Type is displayed is displayed at the top of the measurement screen in the status area. When a probe is connected the background is green. When no probe is detected the background is grey.

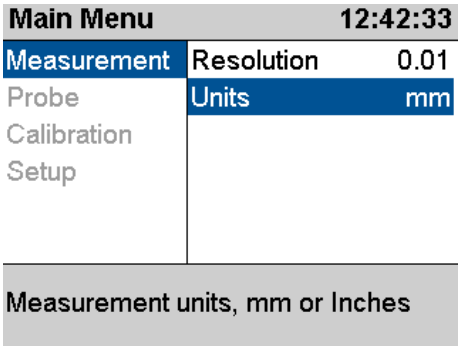
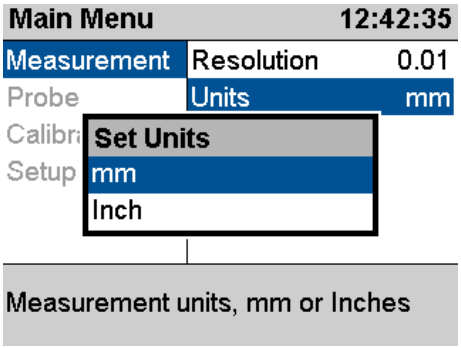
1.	Access the Menu and scroll down to the 'Probe' group. Then scroll right and select 'Probe Type'. Press the Ok/Select key to open the 'Probe Type' function	
2.	Use the Up and Down keys to select the Probe Type required	
3.	Press the OK/Select key to save. Or press the X/Cancel key to exit without saving.	

Remember settings and calibration is saved with each probe type. So, if you change the probe type you may find a setting has changed – this is normal.

The reason settings are saved with each probe type is so you can swap probes during a survey without having to re-calibrate each time.

Measurement Units

The Gauge can display thickness measurements in either Metric (mm) or Imperial (inch). Changing the measurement units will not affect the calibration.

1.	Access the Menu and scroll down to the 'Measurement' group. Then scroll right and select 'Units'. Press the Ok/Select key to open the 'Units' function	
2.	Use the Up and Down keys to switch from mm to Inch	
3.	Press the OK/Select key to save. Or press the X/Cancel key to exit without saving.	

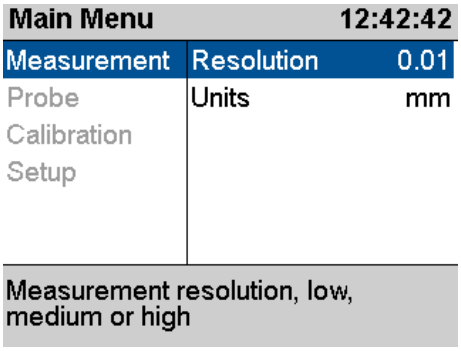
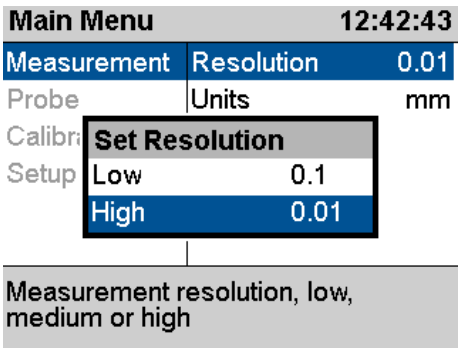
Resolution Setting

The gauge can display thickness measurements in three resolution settings:

- 0.1 mm 0.005 inch Low
- 0.01 mm 0.001 inch High

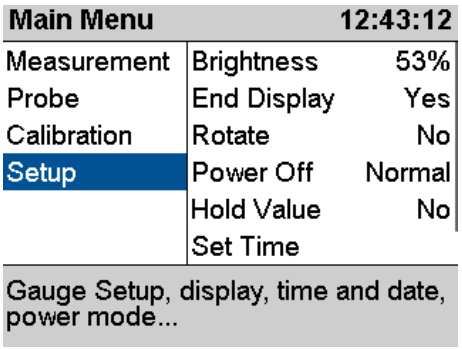
For general metal corrosion measurement the 0.1 mm resolution setting is recommended.

To change the Resolution setting:

1.	Access the Menu and scroll down to the 'Measurement' group. Then scroll right and select 'Resolution'. Press the Ok/Select key to open the 'Resolution' function	
2.	Use the Up and Down keys to select the required Resolution	
3.	Press the OK/Select key to save. Or press the X/Cancel key to exit without saving.	

7. Setup Menu

The Setup group is found at the bottom of the menu, it holds various gauge setup options.

1.	Access the Menu and scroll down to the 'Setup' group. Then scroll right to select the required item Press the Ok/Select key to open the highlighted item.	

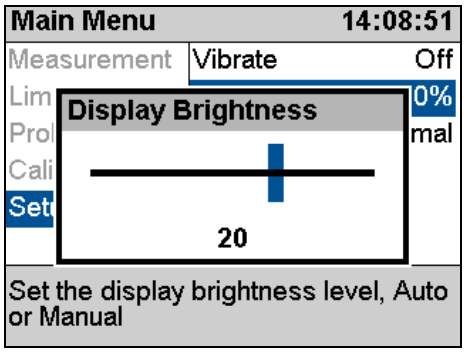
Brightness Setting

The display brightness can be set Manually or Automatically using the ambient light level sensor.

Higher brightness will consume more power so reduce the battery life. To maximum the battery life choose the lowest brightness that still allows you to read the display.

In Automatic mode the brightness is dimmed when in dark conditions and increased when in bright light conditions.

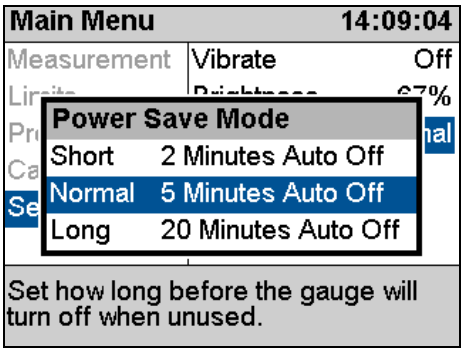
In Manual mode you can adjust the brightness over 20 levels, 0 is the lowest level.



Manual Brightness Setting.

Power Off Setting

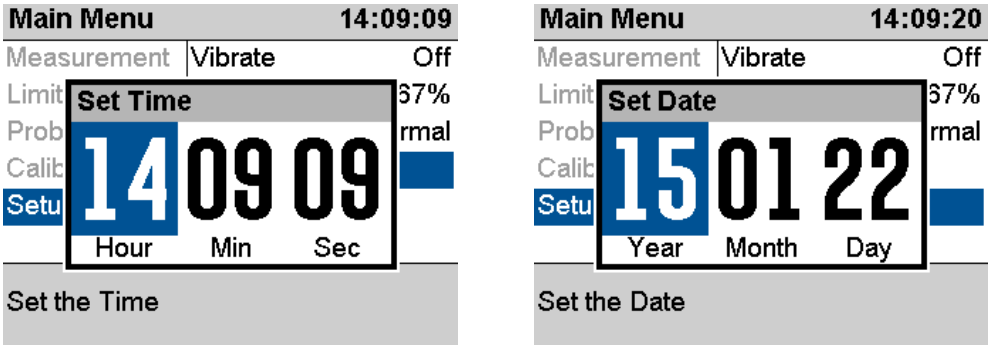
You can choose from three power-saving settings, these determine how long before the gauge will dim the display and ultimately turn off when the gauge is inactive (inactive = no key presses and no thickness measurements).



Power Save Modes.

Set Time and Set Date

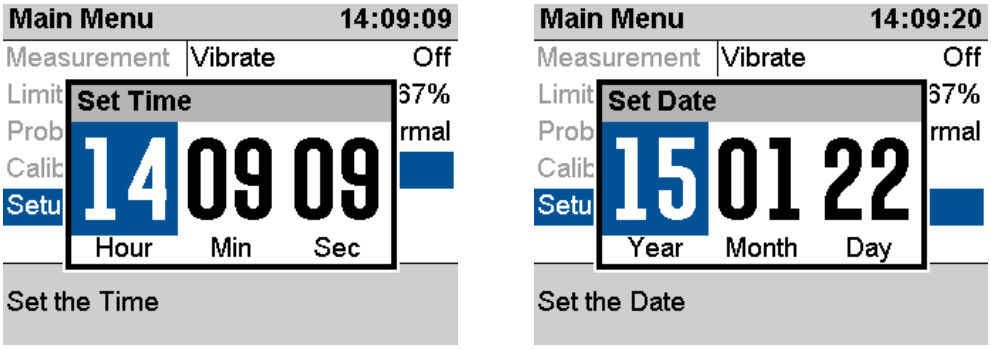
These two items allow the user to set the gauges Time and Date. The time and date are used by the Data Logger.



Set Time and Date Screens.

Set Time and Set Date

These two items allow the user to set the gauges Time and Date. The time and date are used by the Data Logger.



Set Time and Date Screens.

8. General Points On Thickness Gauging

On very rough surfaces and especially if both sides are badly corroded, it is often necessary to move the probe around to locate a back wall reflector. Sometimes a slight rocking movement can help find reflectors which are otherwise impossible.

Badly corroded sections can also be soaked with a light lubricating oil to improve ultrasound coupling through to the good material.

On heavily corroded steel the use of a Chipping Hammer is recommended to dislodge and loose or delaminated layers, the surface can also be 'prepared' by the action of the hammer's edge removing any uneven surfaces.



A Carbide Scraper can also help to prepare the surface and remove any loose rust or debris.



Good quality hammers and scrapers are available from Cygnus.

Always ensure that there is plenty of couplant present for good contact, but beware that on a pitted surface the Gauge may just measure the couplant-filled pit, always avoid measuring directly over external pits.

Beware that in extreme conditions or if the plate is of poor quality and contains many inclusions the ultrasound will be scattered to such an extent that measurement may not be possible.

The Gauge should not be used near arc-welding equipment, as this affects its performance.

9. Troubleshooting

The Gauge will not Switch On

- Are the batteries exhausted?
- Check the batteries are inserted correctly.

Difficulty obtaining a Reading

- Check that the Probe lead is properly connected to both Probe and Gauge.
- Check the gauge is set for the probe connected.
- Check the condition of the lead, replace if necessary.
- On heavily corroded areas this is often a problem, try and take measurements in adjacent areas of the same material.
- Check the Gauge and Probe together on a test block, if there is still no reading the Gauge may require servicing.

If Readings are Erratic or Unstable

- Check that the Probe-lead is properly connected to both Probe and Gauge.
- Check the Probe Type is suitable for the probable minimum thickness of the material being measured. Probe frequencies too low cause doubling and tripling of the actual thickness.

Tips for Optimising Battery Life

- Couplant left on the probe face will stop the gauge entering low power saving mode – so wipe couplant off the probe face between measurement sessions.
- Turning down the backlight brightness will extend battery life.

10. Updating your Gauge

As part of our policy of ongoing development and product improvement Cygnus may issue firmware updates for your model of gauge. The firmware on the gauge can be easily updated by the user using update software downloaded from the Cygnus website.

Before updating your gauge note the model and serial number of the gauge (see Turning the Gauge On on page 17). You can then check on the Cygnus website if your gauge has the latest firmware version, and if not proceed to download the update software.

You can check for the latest gauge firmware on the Cygnus website [http://www.cygnus-instruments.com]. Navigate to **Support** -> **Downloads** -> **Technical Software** and look for a PDF document called 'M5 Surface Gauge Firmware Version Info' view this document to find the latest version for your gauge along with any changes made. *Note you will need to create an account to access this section of the website.*

Update Software

To update a gauge you must first download and install the 'Cygnus M5 Surface Gauge Updater' software. This is available from the Cygnus website in the **Support** -> **Downloads** -> **Technical Software** section. There is a PDF document with instructions available.

Gauge Firmware Files

You must download the appropriate Gauge Firmware file for the model of gauge, a Cygnus 3^{+}

Once downloaded the gauge can be easily updates via the USB cable connecting the gauge to the computer. The whole process takes about 2 minutes. There is a PDF document with detailed instructions available on the website.

11. Care and Servicing

Cleaning the Gauge

- ✓ Clean the Gauge and accessories with a damp cloth. Use water with a mild detergent household cleaner.
- ✗ Do not use solvents to clean the Gauge.
- ✗ Do not use any abrasive cleaner, especially on the display window.
- ✗ Do not immerse the Gauge in liquid when cleaning.

Batteries

- ✓ Always remove the batteries if the Gauge will not be used for more than a few days.
- ✓ Only use leak-proof batteries, Cygnus recommend Duracell batteries.

Environmental

- ✗ Do not immerse the Gauge in liquids. The gauge is designed to be IP67 but it is not intended for use in water.
- ✗ Do not subject the Gauge to temperatures greater than 50°C (122°F).
- ✗ Do not store the Gauge for long periods in conditions of high humidity.

Repairs

- ✗ There are no user serviceable parts inside the Gauge. Therefore all repair work should be carried out by Cygnus Instruments or by an Authorised Cygnus Service dealer.

Returning the Gauge for Servicing

A full Manufacturer's Factory Service is available from Cygnus Instruments.

The Complete Kit should always be returned for Service or Repair, including all Probes and Leads.

Cygnus Gauges are renowned for their reliability, very often problems with getting measurements are simply due to the way the Gauge is being used.

However, if you do need to return you're Gauge for Repair please let us know the details of the problem, to help us guarantee the best possible service:

- Is the problem Intermittent Behaviour?
- Is there a problem turning the Gauge On?
  Or a problem with the Gauge turning itself Off?
- Does the Gauge constantly give Incorrect Readings, or Unsteady Readings?
- Is it not possible to Calibrate the Gauge?

12. Information

Technical Specifications

Cygnus M5-C3P Technical Specifications			
General Attributes			
Size	84 mm x 130 mm x 35 mm (W x H x D) (3.3 in x 5.1 in x 1.4 in)		
Weight	Gauge with batteries 300 g (10.5 oz.)		
Power Supply	3 x AA / R6 Batteries.		
Probe Sockets	2 x Lemo 00		
Operating Temperature Range	-10°C to +50°C (14°F to 122°F)		
Storage Temperature Range	-10°C to +35°C (14°F to 95°F)		
Battery Operation Time	Approximately 10 hrs. Continuous measurement with fully charged Duracell Alkaline LR6 batteries.		
Battery Voltage Range	Min 3.0 V dc, Max 4.5 V dc		
Battery Type	AA Size. LR6 Alkaline / HR6 NiMH.		
Low Battery Indication	Battery level indication on display with low battery warning message.		
PRF	N/A		
Monitor Outputs	N/A		
Through Coating Measurements	No		
Materials	Sound velocity from 1000 m/s to 9000 m/s [0.0390 in/us to 0.3543 in/us]		
Measurement Ranges	Twin element probes in Single Echo mode;		
	T2C probe	2.5 to 250 mm	[0.098 in. to 10.00 in.]
	T5B probe	1.5 to 200 mm	[0.059 in. to 7.900 in.]
	T5A probe	1.5 to 150 mm	[0.059 in. to 6.000 in.]
	T7A probe	0.8 to 50 mm	[0.031 in. to 2.000 in.]
Probe Zero	Twin element probes are zeroed in the air without the need of a zero block. The user is prompted to zero the probe at power up and after a probe change.		
Measurement Modes	Single Echo mode with Twin element probe. Measures thickness using the time from the delay line (zero point) to the first back-wall echo. (UT Mode 2)		
High Temperature Measurement	All standard twin element probes: Allows continuous measurement up to 75°C (160°F).		

Cygnus M5-C3P Technical Specifications			
Resolution	Single Echo measurement mode;		
	Low	0.1 mm	[0.005”]
	High	0.01 mm	[0.001”]
Accuracy	±0.1 mm (±0.004”) or 0.1% of thickness measurement whichever is the greatest.		
Display			
Type of Display	Colour TFT LCD with LED Backlight (front) Monochrome LCD (end).		
Display Size	Side : 320 x 240 Pixels QVGA. 2.4“, 47 mm (W) x 37 mm (H) End : 128 x 32 Pixels. 25.58 mm (W) x 6.38 mm (H)		
Display Information	Digital Thickness Value. Settings. Battery Level.		
Transmitter			
Shape of Pulse	Square		
Pulse Energy : Voltage (peak-to-peak)	70 V p-p		
Pulse Energy : Rise Time	3 ns (max)		
Pulse Energy : Pulse Duration	T2C : 220 ns T5B : 100 ns T5A : 100 ns T7A : 67 ns		
Receiver			
Gain Control	Automatic Gain Control depending on probe and measurement mode.		
Frequency Range	1.0 MHz to 10.0 MHz (-6dB)		
Other Information			
Data Output and Storage	N/A		
Data Connector	USB Mini B Connector under battery cover. Can be used to update the gauge.		
Data Logger	N/A		
Calibration setting storage	Calibration Data stored to Internal Flash Memory		
Calibration Mechanisms	Automatic V-path correction for twin element probes. Option of two point calibration for twin element probes.		
Display & Recall Facilities	N/A		
Display Response Time	125 ms / 500 ms		
Printer Output	N/A		
Environmental Rating	IPX67 (Water immersion 1 metre depth for 30 minutes) MIL STD 810G Method 501.6 (High Temp +55°C) MIL STD 810G Method 502.6 (Low temp -20°C) MIL STD 810G Method 507.6 (Humidity 95%) MIL STD 810G Method 512.6 (Immersion 1m, 30min)		
Shock & Impact	MIL STD 810G Method 514.7 (Vibration)		

Cygnus M5-C3P Technical Specifications	
	MIL STD 810G Method 516.7 (Shock 20g) MIL STD 810G Method 516.7 (Transit Drop 1.22m)
Standards	Designed for BS EN ISO 16831.
Compliance	CE, UKCA, RoHS

Specifications are subject to change for product improvement.

Table of Sound Velocities

Velocities will vary according to the precise grade and processing conditions of the material being measured.

This table is included as a guide only.
Wherever possible, the Gauge should always be calibrated on the material under test.

These Velocities are given in good faith and are believed to be accurate within the limits described above.
No liability is accepted for errors.

Velocities given are the compressional wave velocity c_l.

Material	Velocity of Sound (V)		Conversion Factor (f)
	m/s	in/us	
Aluminium (alloyed)	6380	0.2512	1.078
Aluminium (2014)	6320	0.2488	1.068
Aluminium (2024 T4)	6370	0.2508	1.076
Aluminium (2117 T4)	6500	0.2559	1.098
Brass (CuZn40)	4400	0.1732	0.743
Brass (Naval)	4330	0.1705	0.731
Brass (CuZn30)	4700	0.1850	0.794
Copper	4700 - 5000	0.1850 – 0.1969	0.794 – 0.845
Core Ten	5920	0.2331	1.000
Grey Cast Iron	4600	0.1811	0.777
Inconel	5700	0.2244	0.963
Lead	2150	0.0846	0.363
Monel	5400	0.2126	0.912
Nickel	5630	0.2217	0.951
Phosphor Bronze	3530	0.1390	0.596
Mild Steel	5920	0.2331	1.000
Tool Steel	5870	0.2311	0.992
Stainless Steel 302	5660	0.2228	0.956
Stainless Steel 347	5790	0.2279	0.978

Stainless Steel 304	5664	0.2229	0.956
Stainless Steel 314	5715	0.2250	0.965
Stainless Steel 316	5750	0.1163	0.971
Tin	3320	0.1307	0.561
Titanium	6100 - 6230	0.2402 – 0.2453	1.030 – 1.052
Tungsten Carbide	6660	0.2622	1.125

Reading Conversions

If only a few measurements are to be taken on a material other than Steel, it may be easier to leave the calibration set for Steel and merely convert the readings by multiplying by the **Conversion Factor** for the material being measured.

This method avoids unnecessary recalibration.

Example.

The Gauge is calibrated for Steel [5920 m/s], but the reading is being taken on Copper [4700 m/s] :

$T = t \times V_{COPPER} / V_{STEEL}$
$= t \times 4700 / 5920$
$= t \times 0.794$

thus : **$T = t \times f$** [where: $f = V_{COPPER} / V_{STEEL}$]

where : **T = true thickness of Copper being measured**
t = actual reading obtained
f = Conversion Factor (from table)
V_{COPPER} = Sound Velocity in Copper : 4700 m/s
V_{STEEL} = Sound Velocity in Steel : 5920 m/s

The **Conversion Factor f**: is given for various materials in the Table of Sound Velocities

13. Recycling and Disposal (EC Countries)

The WEEE Directive (Waste Electrical and Electronic Equipment 2002/96.EC) has been put into place to ensure that products are recycled using best available treatment, recovery and recycling techniques to ensure human health and high environmental protection.

The Gauge has been designed and manufactured with high quality materials and components which can be recycled and reused. It may contain hazardous substances that could impact health and the environment. In order to avoid the dissemination of those substances in our environment and to diminish the pressure on natural resources we encourage you to dispose of this product correctly.



DO NOT dispose of this product with general household waste.

DO dispose of the complete product including cables, plugs and accessories in the designed WEEE collection facilities.

This product may also be returned to the agent or manufacturer who supplied it for safe end-of-life disposal.

Cygnus Instruments Ltd registration number for The WEEE Directive is WEE/HE1274RU.

14. Warranty Information

LIMITED THREE YEAR WARRANTY
FOR CYGNUS ULTRASONIC THICKNESS GAUGES

1. Cygnus Instruments Limited ("CYGNUS") warrants that, subject as set out below, the Products manufactured by it (excluding consumables, batteries, probes, leads, microphones and telescopic extensions) will be free from defects in materials and workmanship for a period of three years from the date of purchase either from CYGNUS or from an Authorised CYGNUS Distributor. Batteries, probes, leads, microphones and telescopic extensions are warranted for 6 months. This warranty is limited to the original Purchaser of the Product and is not transferable. During the warranty period, CYGNUS will repair, replace or refund, at its option, any defective Products at no additional charge, provided that the product is returned by the original Purchaser, shipping prepaid, to CYGNUS or an Authorised CYGNUS Distributor. If shipped by mail or any common carrier, the Purchaser must insure and accept all liability for loss or damage to the Product and must use shipping containers equivalent to the original packaging. Replacement products or parts will be furnished on an exchange basis only. All replaced products or parts become the property of CYGNUS.

2. Any defects in materials or workmanship must be notified to CYGNUS by the Purchaser within seven days after the discovery of the defect or failure.

3. Dated proof of purchase must be provided by the Purchaser when requesting warranty work to be performed or making any other claim under this warranty. CYGNUS will not be liable under this warranty unless the total price for the Product was paid by the due date for payment.

4. This warranty does not extend to any products which have been damaged as a result of, accident, misuse or abuse, natural or personal disaster, service, modification or repair by anyone other than CYGNUS or an Authorised CYGNUS Service Centre, failure to properly store or maintain the Product, negligence, abnormal working conditions, fair wear and tear, or failure to follow the instructions issued by CYGNUS in relation to the Product.

5. Except as expressly set forth above or in the CYGNUS Terms of Sale, subject to which the Products were purchased, all warranties, conditions or other terms implied by Statute or Common Law are extended to the fullest extent permitted by law.

6. Except in respect of death or personal injury caused by the negligence of Cygnus, Cygnus shall not be liable to the Purchaser or to any other person by reason of any representation (unless fraudulent), or any implied warranty, condition or other term, or any duty at common law, or under the express terms of the contract for purchase of the Products, for loss of profit or for any indirect, special or consequential loss or damage, costs, expenses or other claims for compensation whatsoever (whether caused by the negligence of Cygnus, its employees or agents or otherwise) which arise out of or in connection with the supply of the Products or their use or resale by the Purchaser or by any other person. The entire liability of Cygnus under or in connection with the Products shall not exceed the price paid for the Products, except as expressly provided in this warranty.

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