Cygnus 4+

Multi-Mode Ultrasonic Thickness Gauge

Operating Manual

for John Deere



Covers Gauge Model : M5-C4P-JD

Doc No. M5-C4P JohnDeere (Issue 7).docx
11 November 2026

1. Introduction 6
Cygnus 4+ Thickness Gauge 6
Cygnus Instruments 7
Contact Details 7
Gauge Kit Contents 8
Basic Gauge Kit 8
Kit supplied with Single Element Probe 8
Kit supplied with Twin Element Probe 8
2. Gauge Preparation 9
Fitting the Batteries 9
Micro SD card Location 10
Connecting the Probe 11
Fitting the Neck Strap 12
3. Selecting the Right Probe 13
Measuring Metals 13
Measurement Modes Explained and Compared 13
Single Echo Mode (SE) (Mode 2) 13
Echo-Echo Mode (EE) (Mode 3) 14
Measuring Non-Steels 15
Measuring Non-Metals 15
Measuring Higher Temperatures 16
Summary of Cygnus Probes 16
Twin Element probes 16
The 'Probe Type' Code 17
4. Gauge Operation 18
Gauge Controls 18
Turning the Gauge On 19
Turning the Gauge Off 19
Automatic Power Off 19
Measurement Screen Views 20
Status Information 20
Taking Thickness Measurements 21
Zeroing the Probe (twin element probes) 22
Taking the Thickness Measurement 22
Measurement Stability Indication in SE & EE Modes 22
Measuring Small Diameter Pipe & Tubes 23
Display Hold Function 24
Battery Life 25
Battery Level 25

Low Battery Indication....26
5. Using the A-Scan Display....27
Single Echo Mode....27
Measuring Over Corrosion Pits....28
Echo-Echo Mode....29
6. Calibration....31
Why should I Calibrate my Thickness Gauge?....31
Calibration Options....32
Calibrating to a known thickness (Single or 1 Point)....32
Two Point Calibration....34
Ladder Step Wedge....34
Two Point Calibration Procedure....35
Probe Zero (twin element probes)....37
Starting a Probe Zero from the Main Menu....38
Probe Zero Function....38
Setting the Velocity of Sound....39
7. Gauge Setup....41
Menu Operation....41
Settings are Saved with the Probe Type....42
Inputting Numeric Values using the Navigation Keys....43
Inputting Text using the Navigation Keys....43
Selecting the Probe Type....45
Automatic Probe Detection....46
Measurement Units....47
Resolution Setting....48
8. Manual Gain Adjustment....50
Manual Gain Mode....50
Turning on Manual Gain....50
Manual Gain Menu....51
Adjusting the Gain....52
Adjusting the Range....53
Measuring Below the Probes Minimum Thickness Specification....54
9. Setup Menu....55
Set Defaults....55
A-Scan Range....56
Automatic....56
Manual....56
Vibrate Feature....56
Brightness Setting....56

Power Off Setting 57
Bluetooth® 57
Turning Bluetooth On 57
Connection Status 58
Set Time and Set Date 59
Set Time and Set Date 59
10. General Points On Thickness Gauging 60
11. Troubleshooting 61
The Gauge will not Switch On 61
Difficulty obtaining a Reading 61
If Readings are Erratic or Unstable 61
Tips for Optimising Battery Life 61
12. Updating your Gauge 63
Update Software 63
Gauge Firmware Files 63
13. Care and Servicing 64
Cleaning the Gauge 64
Batteries 64
Environmental 64
Repairs 64
Returning the Gauge for Servicing 65
14. Information 66
Technical Specifications 66
Table of Sound Velocities 70
Reading Conversions 71
15. Recycling and Disposal (EC Countries) 72
16. Warranty Information 73
17. Index 74

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 4+ Thickness Gauge

The **Cygnus 4+ Ultrasonic Thickness Gauge** is a rugged, handheld, battery-powered instrument designed for high-reliability thickness measurements in harsh environments using ultrasound. It features a colour LCD display which can be easily read in most light situations including sunlight.

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

The gauge can measure material thickness using three methods; Single Echo, Echo-Echo or Multiple Echo. Echo-Echo and Multiple Echo allow measurements through surface coatings which are ignored. An A-Scan display provides the user with information that can be used to visually verify the thickness measurement which can displayed in Metric (mm) or Imperial (inch) units.

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.

Contact Details

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For all Cygnus offices and Authorised Cygnus Service Centres and Distributors around the world please refer to the Cygnus website Worldwide Distribution page.

https://cygnus-instruments.com/about-us/worldwide-distributors/

Gauge Kit Contents

Basic Gauge Kit

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

Kit supplied with Single Element Probe

1. Ultrasonic Probe
2. Moulded Probe Cable (in side pouch)
3. 15mm (or ½") Steel Test Block
4. Spare Membranes
5. Membrane Key
6. Membrane Couplant

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.

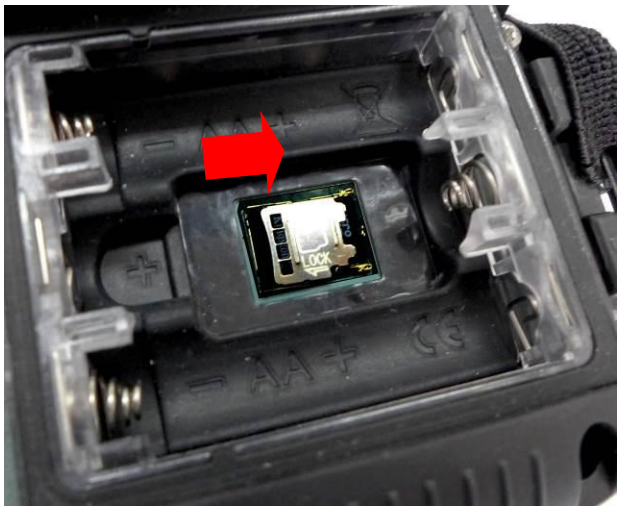
The gauge can be fitted with NiCad or NiMH rechargeable batteries but this may alter the specified operating time.

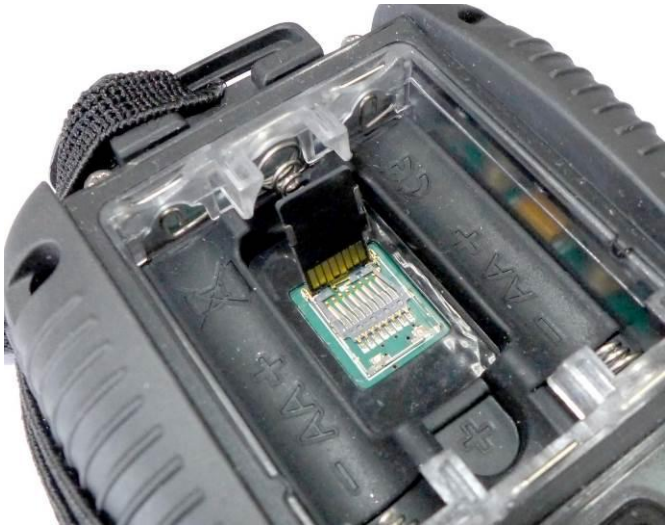
To avoid damage from leaking batteries **always** remove the batteries if the gauge will be unused for any length of time.

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.

Micro SD card Location

The Cygnus 4+ comes fitted with a Micro SD card that is used to store results. Data stored on the card can either be read using the gauges USB connection and CygLink or by removing the card from the gauge and using a computer to read the contents. The Micro SD card is located within the battery compartment underneath the battery below a cover.

	Removing the batteries will reveal the Micro SD card cover which can be lifted up to reveal the Micro SD card.
	Micro SD card cover removed. To the remove the card, slide the metal cover in the direction show by the arrow marked “OPEN”. The card socket will pop up.

	Carefully remove the card by sliding it out. To refit the card slide it back into the metal flap. Lower the card back down and then slide the metal frame in the direction of "LOCK" arrow.

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 45.

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”+)	**T5B**	**Single Echo**
Cast Iron	Non	Non to Moderate	2.5 mm+ (0.1”+)	**T2C**	**Single Echo**

When measuring in Multiple Echo mode the coating will be ignored and just the metal thickness measured.

It is possible to use a Twin Element (T**) probe in Echo-Echo Mode to ignore thin paint coatings. However this method does not have the ability to verify measurements and without observing the A-Scan display it is possible to get incorrect measurements.

Measurement Modes Explained and Compared

Single Echo Mode (SE) (Mode 2)

Single Echo measurement mode is most useful on heavily corroded metals where Multiple Echo fails. 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.

To overcome some of the drawbacks of Single Echo measurements the gauge has an A-Scan display that can be used to visually verify the thickness measurements are sensible and therefore reliable. See section Using the A-Scan Display on page 27.

Echo-Echo Mode (EE) (Mode 3)

Echo-Echo mode uses a twin element probe, but measures between the first two echoes. This method is intended to ignore any thin surface coatings whilst still using a twin element probe.

Echo-echo mode is not able to verify its measurements unlike Multiple echo mode, therefore it is liable to give incorrect readings. But as the Cygnus 4^+ gauge has an A-Scan display you can use this to visually decide if the measurement given is correct.

Echo-echo mode must therefore be used with caution, and only on thin paint surface coatings (less than 0.5mm). It is recommended a Single Echo measurement should also be made to help verify the measurement makes sense (the Single Echo measurement should always be slightly thicker due to the coating thickness).

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

Measuring Higher Temperatures

The polyurethane membranes fitted to the single element probes are suitable for measuring surface temperatures up to **70°C** (160°F). For measuring higher temperatures Teflon membranes are available and suitable for surface temperatures up to **150°C** (300°F) with intermittent contact. Contact Cygnus instruments to order Teflon membranes.

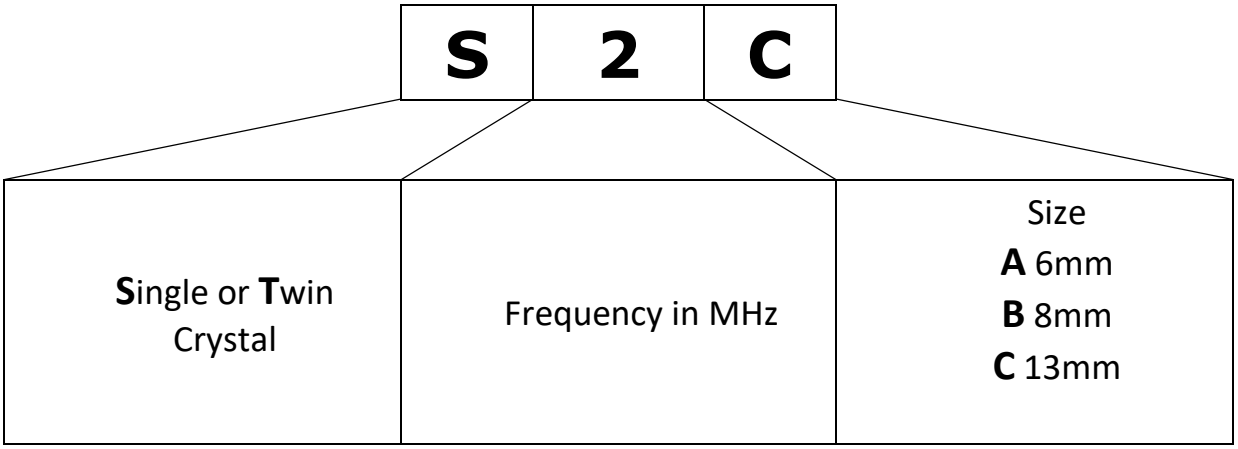
When measuring high temperatures limit the time the probe is in contact with the hot surface to less than 4 seconds and ensure the probe has sufficient time between measurements to cool down.

Summary of Cygnus Probes

Twin Element probes

Probe Type	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.
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

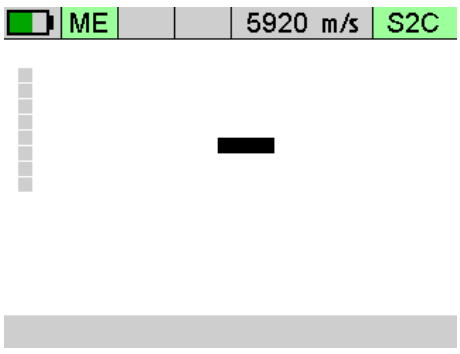


End view of gauge

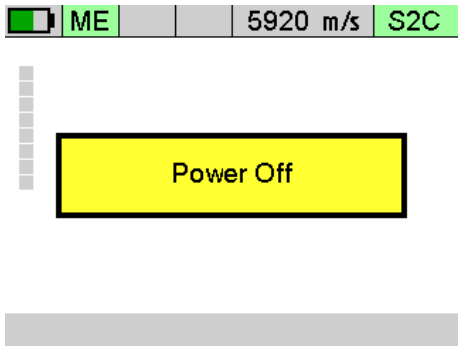


Front view of gauge

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

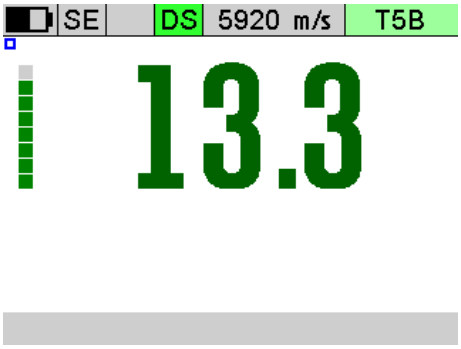
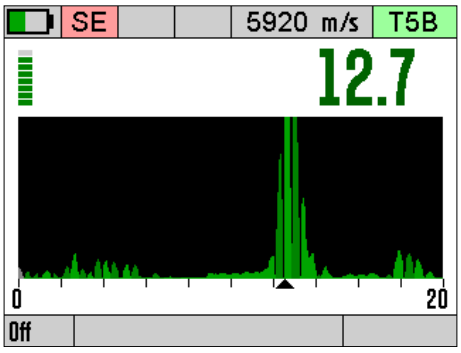
By default the gauge will turn off automatically after 5 minutes of in activity.

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 57.

Measurement Screen Views

The gauge has three measurement screens that can be quickly changed using the left and right navigation keys. These screens offer three views to suit the situation.

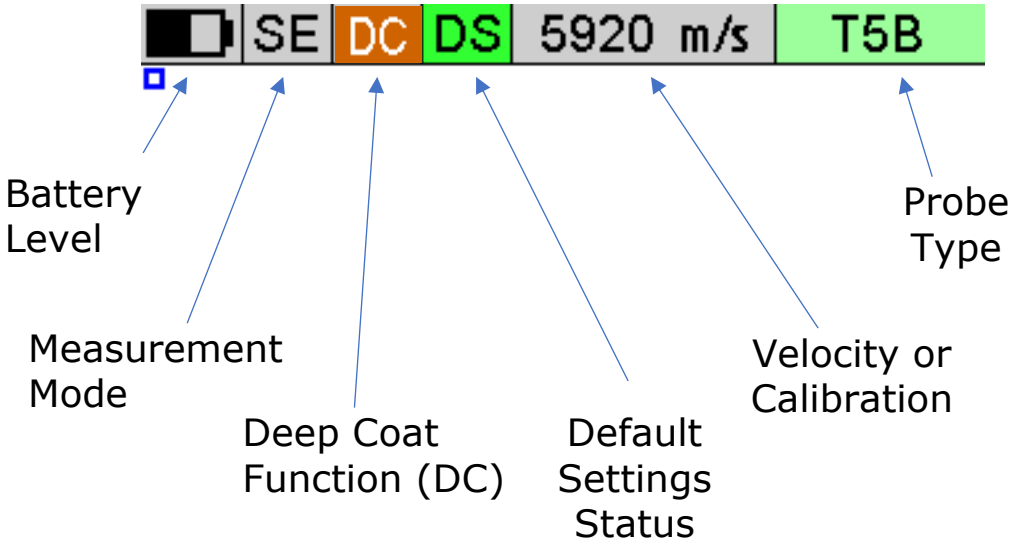
1.	Use the Left and Right navigation keys to move between the three screens	
2.	**Basic Screen** Just shows a large thickness measurement value.	
3.	**A-Scan Screen** Show the thickness measurement and a live A-Scan display of the ultrasound signals received.	

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
- Deep Coat Function
- Default Settings Status



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

Measurement Modes;

ME	Multiple Echo
EE	Echo-echo
SE	Single Echo

Default Setting Status;

DS	Default Set
ND	Not Default

Taking Thickness Measurements

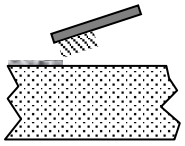
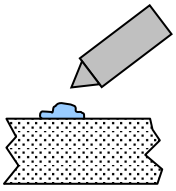
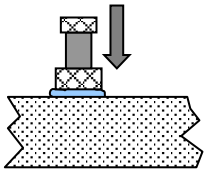
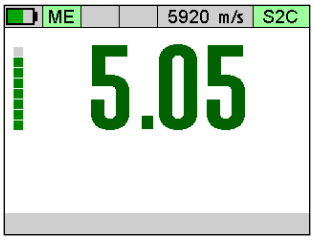
Taking ultrasonic thickness measurements is a straight forward process that involves first making sure the surface is clean and prepared, applying an ultrasonic couplant gel then placing the probe on the surface and observing the display for the measurement.

Zeroing the Probe (twin element probes)

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 38.

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. (Or an indication of Echo Strength if no valid measurement has been found in Multiple Echo mode).	

To help obtain a multiple echo reading the operator should continue to move the probe around to locate a suitable reflector, using a slight rocking motion.

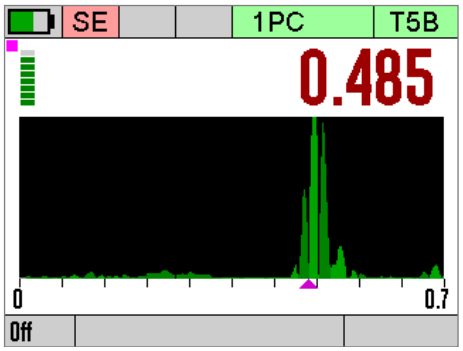
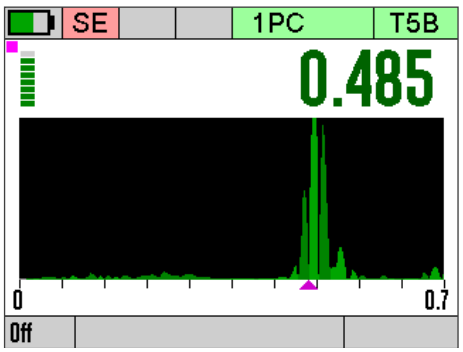
Measurement Stability Indication in SE & EE Modes

To help indicate when a Single Echo or Echo-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 or Echo-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.

1.	Initial measurements will be displayed as red numbers.	
2.	If the measurement remains stable for 2 consecutive seconds then the measurement will change to green.	

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

Example.

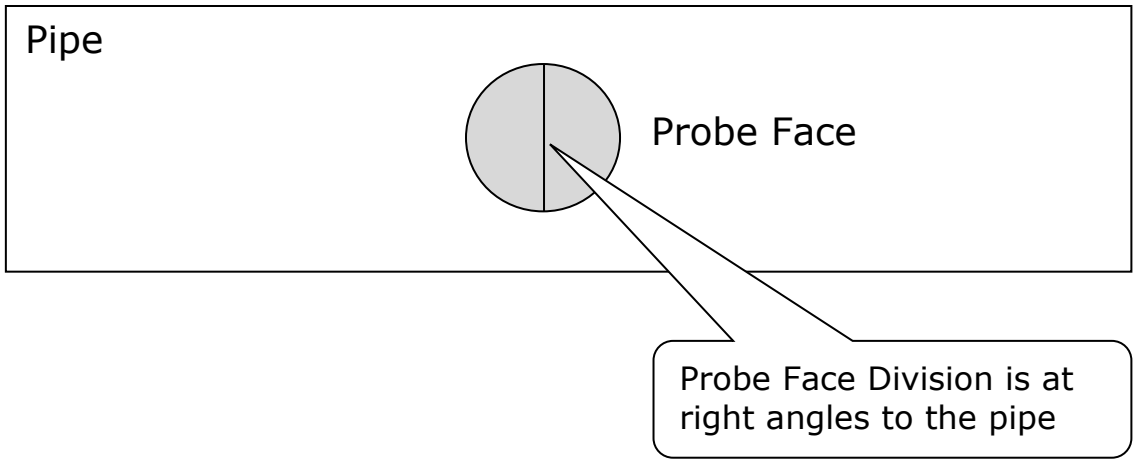
The Resolution is set to 0.05mm, therefor the thickness measurement must not change by more than +0.05mm or -0.05mm for 2 seconds or more to be "stable".

Measuring Small Diameter Pipe & Tubes

When measuring small diameter pipe and tubes with a twin element probe, 75mm (3") or under, you must ensure the face of

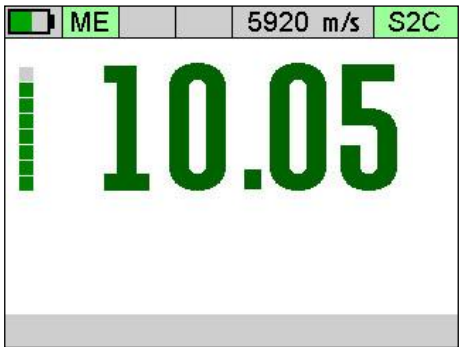
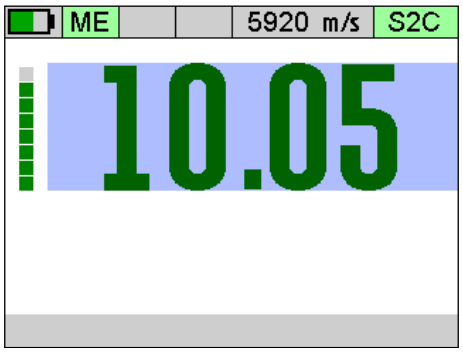
the probe is correctly aligned to the curvature of the pipe otherwise measurements may be inaccurate.

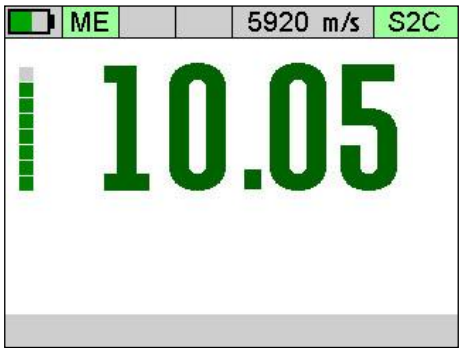
The dividing line on the face of the probe should be at right angles to the length of the pipe.



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.	

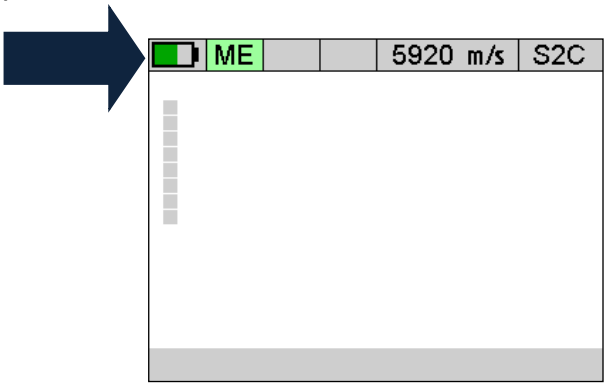
3.	Press the X/Cancel key to un-hold the thickness measurement.	

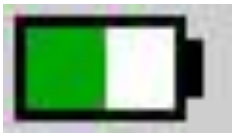
Battery Life

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 (arrowed);



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. Using the A-Scan Display

To help ensure reliable measurements in Single Echo and Echo-Echo measurements the gauge has an A-Scan display that can be used to visually verify the thickness measurements are sensible and therefore reliable. With some practice any user can quickly and easily use the A-Scan to decide if the measurement is correct.

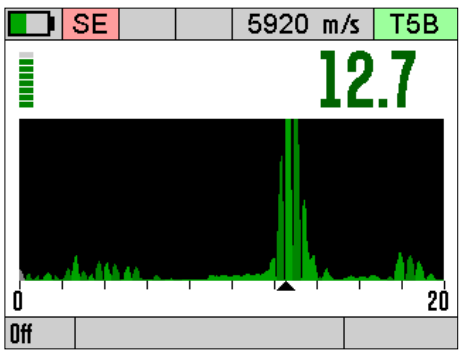
To view the A-Scan display use the Left and Right navigation keys to switch between the measurement screen views (see Measurement Screen Views on page 20).

The A-Scan display shows the actual ultrasound echo pulses as received by the gauge; these echo pulses are used by the gauge to determine the thickness measurement if possible.

The gauge works by generating a short pulse of ultrasound that is coupled into the object you are measuring. This pulse then travels through the object and is reflected back to the probe as an echo by either the back-wall of the object and/or any internal flaws or corrosion pits. When the echo pulse hits the probe surface a signal is received by the gauge, this signal is shown on the A-scan display as an echo peak, the taller the peak the stringer the signal.

Single Echo Mode

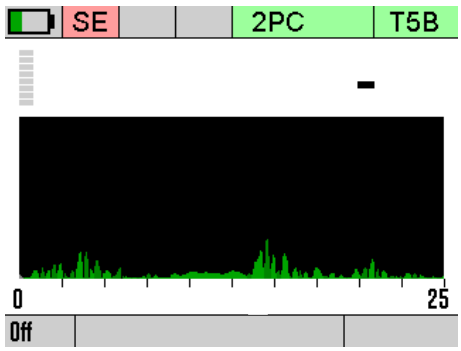
The A-Scan display is very useful when measuring in Single Echo modes, as there is no verification of the thickness measurement observing the A-Scan display will help the user verify the echo detected is the correct one – the back-wall echo.

This A-Scan shows a good clear ultrasound signal. There is a well-defined back-wall echo and the arrow is correctly placed. The measurement value of 12.7 is stable when green in colour.	 Good Signal

This A-Scan shows a very weak ultrasound signal.

There is no clear correct back-wall echo and the gauge is unable to determine a thickness measurement.

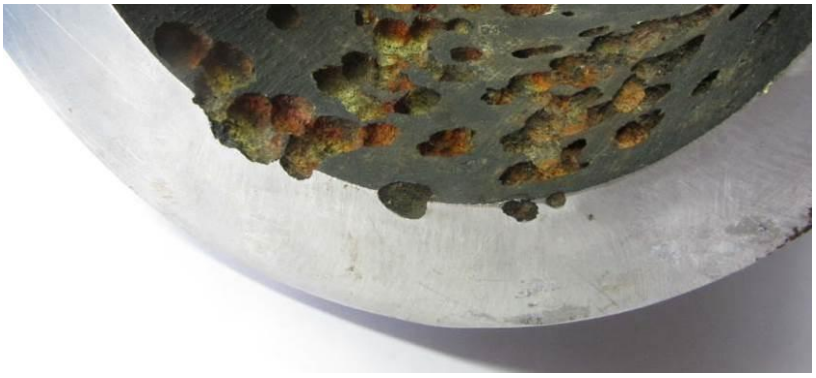
You should try moving the probe to find a better reflector, first rotate the probe to see if that gets a measurement, if that fails then try another position.

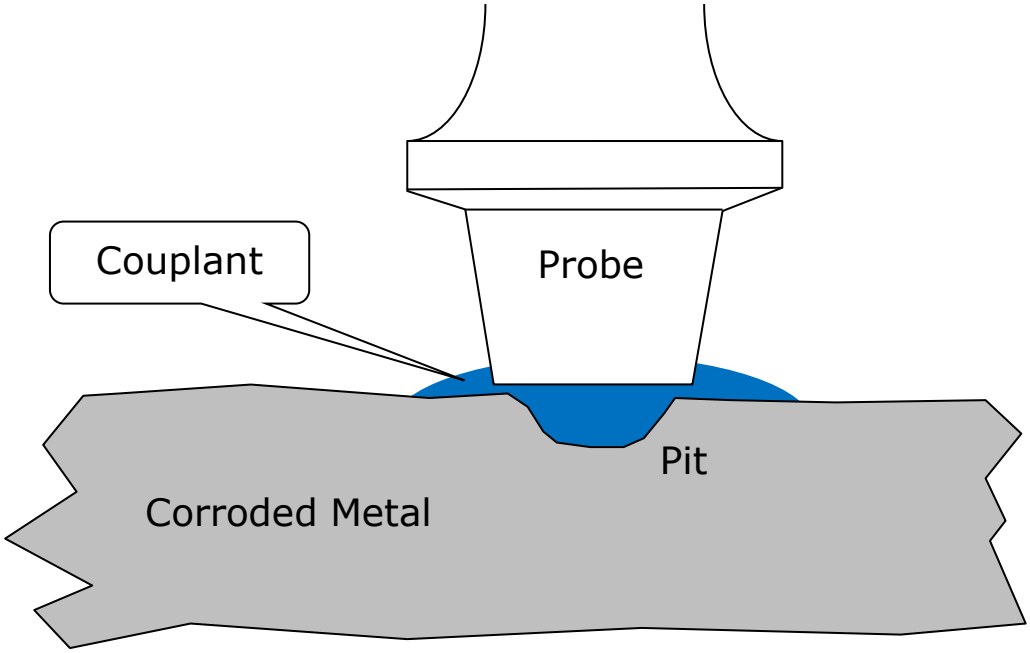


Weak Signal

Measuring Over Corrosion Pits

You should be careful not to attempt to take a single echo thickness measurement when there is a void or corrosion pit directly underneath the probe face as the gauge may incorrectly measure the depth of the couplant.

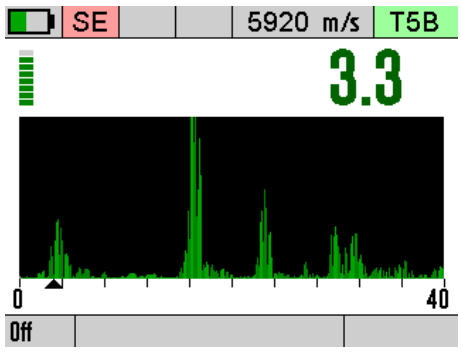

Large Corrosion Pits.



Avoid Measuring Directly Over Corrosion Pits.

The A-Scan display can assist you - you will see an unclear ultrasound signal with unclear back wall reflections.

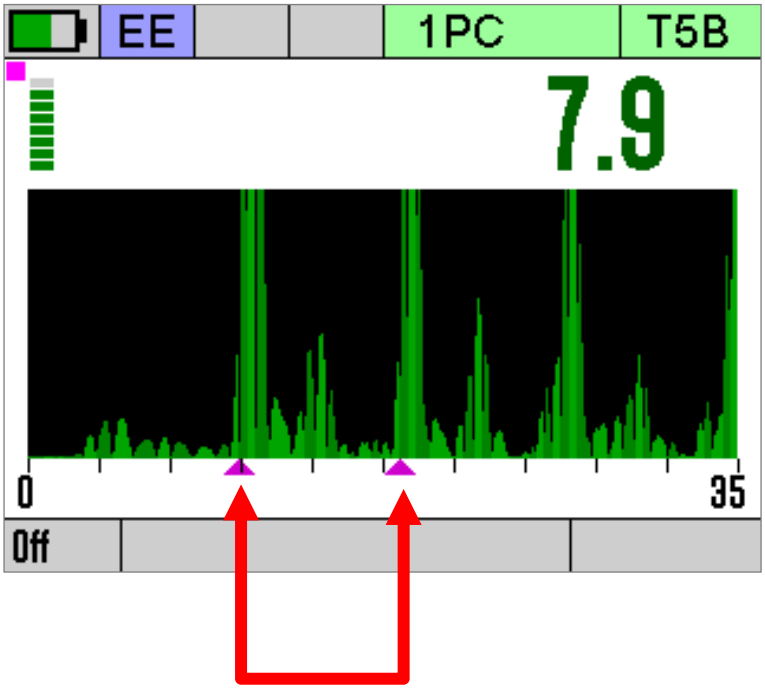
This A-Scan shows an incorrect measurement that may be from measuring couplant inside a pit.



Echo-Echo Mode

Like Single Echo mode the A-Scan can be very useful when taking measurement through coating using Echo-Echo mode. Echo-Echo mode measures thickness by measuring the time between two consecutive echo signals, in ideal conditions this is a good reliable method of thickness measurement thorough coating, but when corrosion starts to degrade the echoes the gauge could measure between two incorrect echoes and give a wrong reading. Here the

A-Scan can assist, by observing the echo signals you can decide of the thickness measurement given makes sense and is reliable.

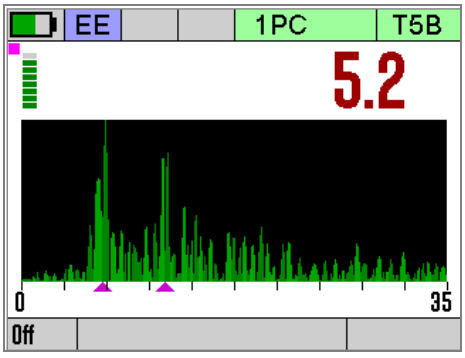


The gauge measures between these two echo signals to calculate the thickness. This is a good clear signal so the measurement is reliable.

The two purple arrows mark the points the gauge has measured between.

This A-Scan shows an unclear Echo-Echo measurement.

The echoes are scattered and although the gauge has given a thickness measurement of 5.5mm it may not be accurate. Try first rotating the probe then another location.



6. 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 gauge 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 32 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 32.

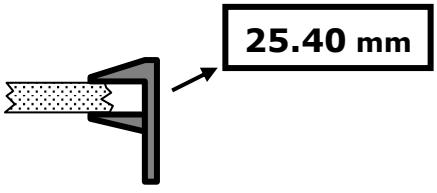
If there is no test sample available the Gauge can be calibrated by Setting the Velocity of Sound directly. A table on page 70 at the back of this manual lists common materials and their velocity of sound value. For calibration instructions see page 33.

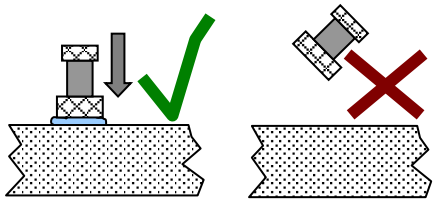
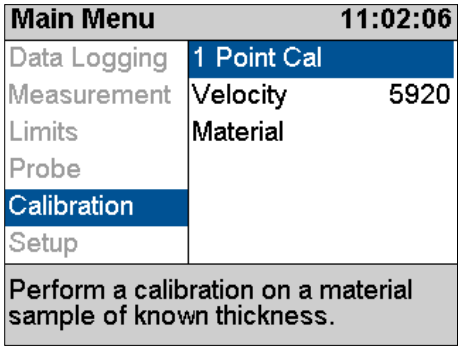
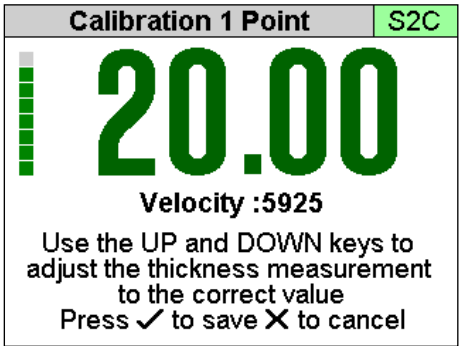
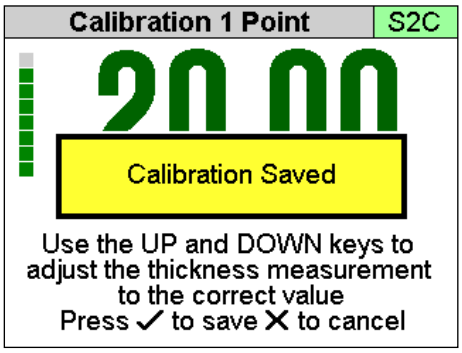
A third method is to leave the Gauge set to its factory-preset value for Steel [5920 m/s or 0.2332 in/us], and then use a Conversion Factor from the table of velocities on page 70.

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 at the top of the measurement screen in the status area (*1PC = Single Point Calibration*).



'1PC' Indicator

Two Point Calibration

The Two Point Calibration option is only available in Single Echo and Echo-Echo modes.

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.

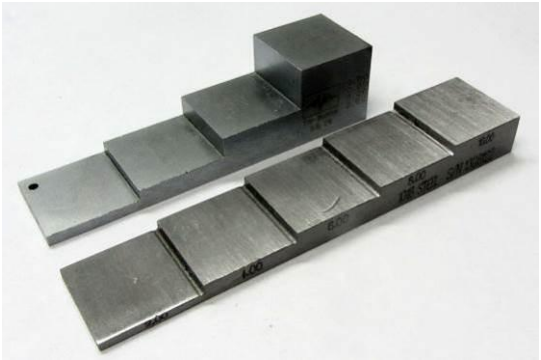
To achieve maximum accuracy in Single Echo mode you must perform a Two Point Calibration – your measurement is only as good as your calibration.

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.

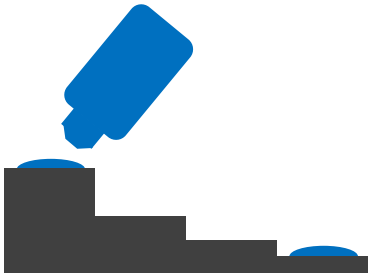
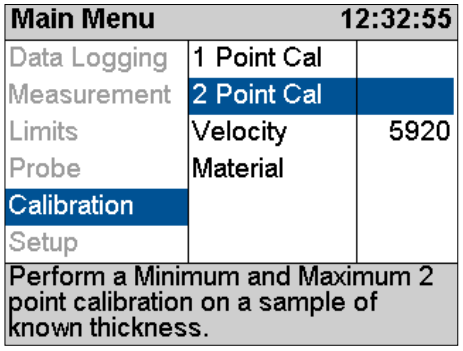
Ladder Step Wedge

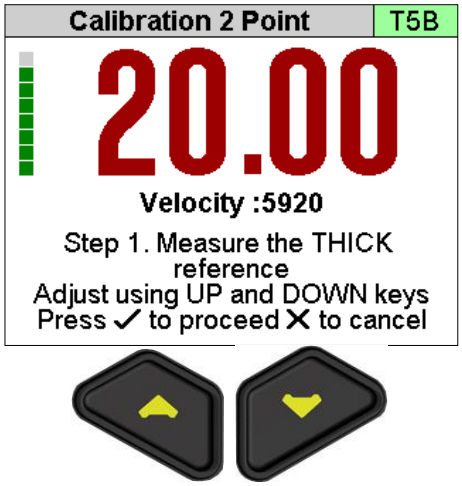
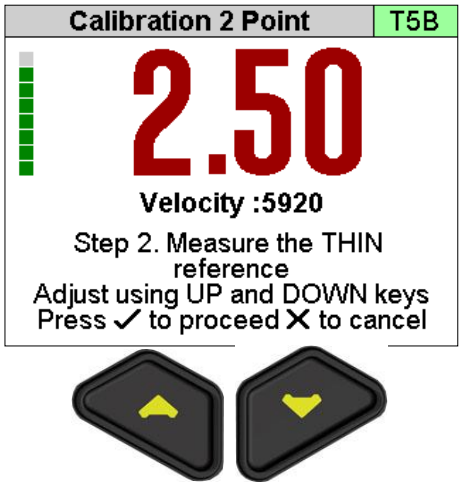
Typically a Ladder Step Wedge is used to calibrate the probe and gauge for Steel. The ladder step wedge has 4 or 5 different thicknesses typically ranging from 2.5 mm to 20.0 mm. You would typically choose to calibrate using the 2.5 and 20 mm thicknesses.

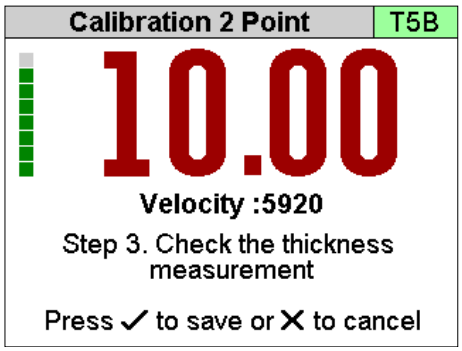
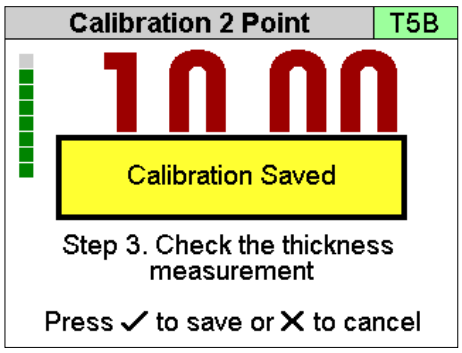


Ladder Step Wedges

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)

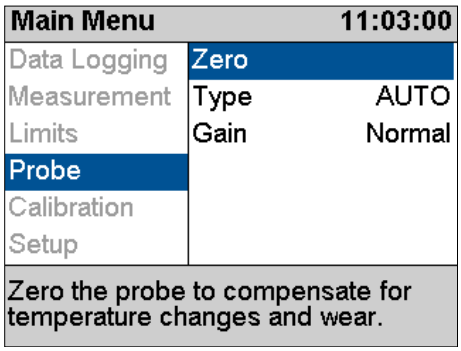
Twin element probes must be zeroed to compensate for any wear or operating temperature changes. The gauge will always perform a Probe Zero when first turned on or when a twin element probe is connected.

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.

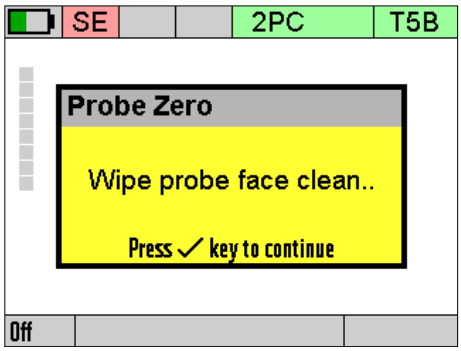
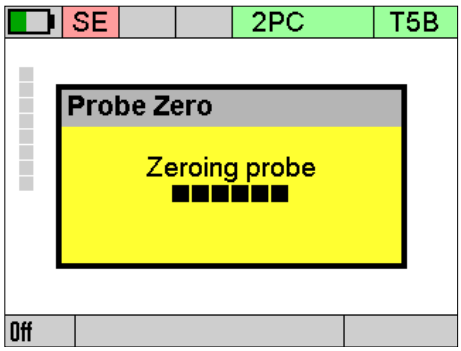
It is recommended to frequently perform a Probe Zero especially if conditions such as temperature are changing.

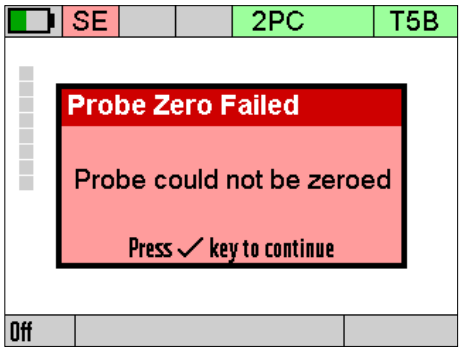
See also Zeroing the Probe (twin element probes) on page 22.

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.	

Setting the Velocity of Sound

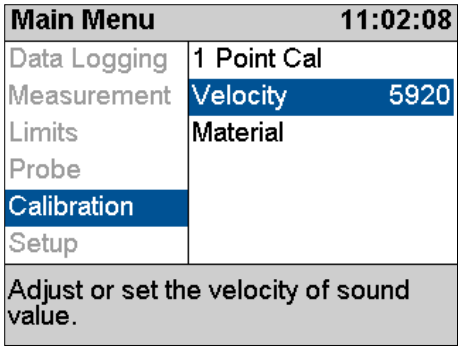
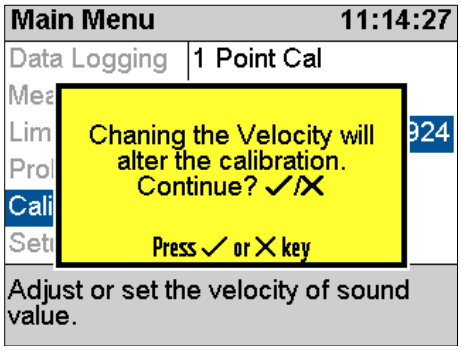
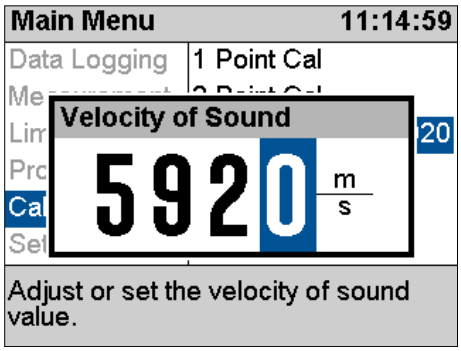
The gauge uses the Velocity of Sound value to calculate the material thickness value. It is therefore important the velocity value is set correctly for the material being measured.

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 70.

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.	

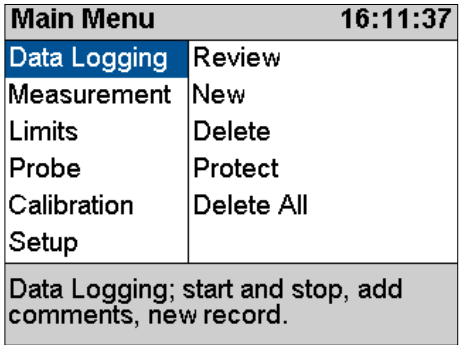
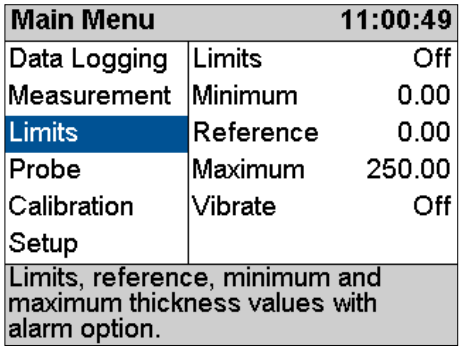
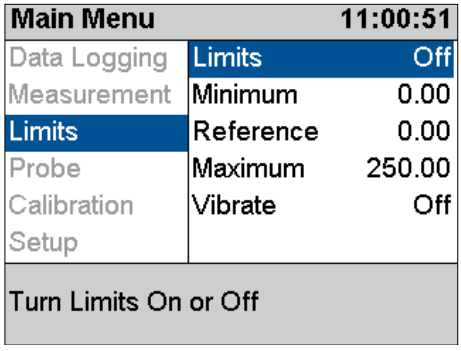
When the velocity has been manually set the value is displayed at the top of the measurement screen in the status area.

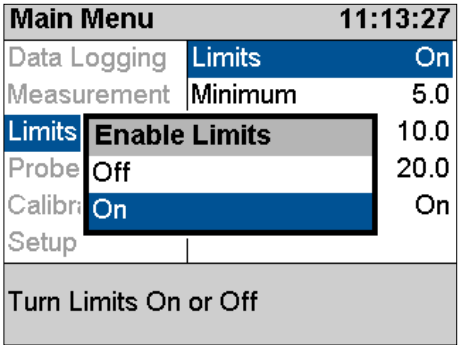
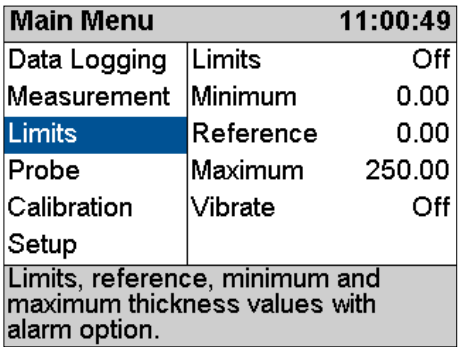


Velocity of Sound value '5920 m/s'

7. 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

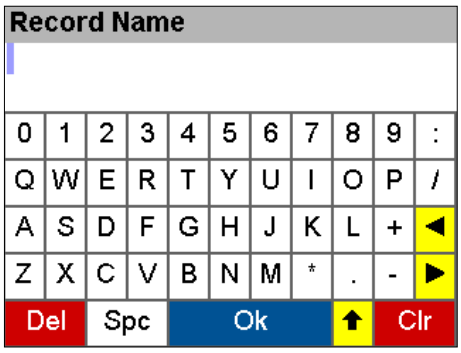
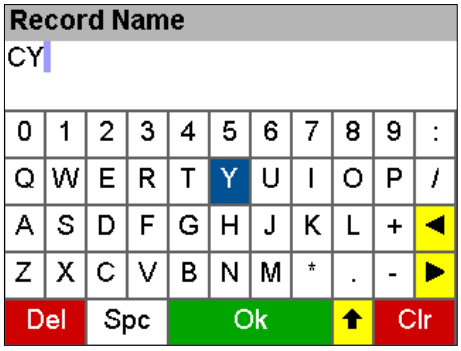
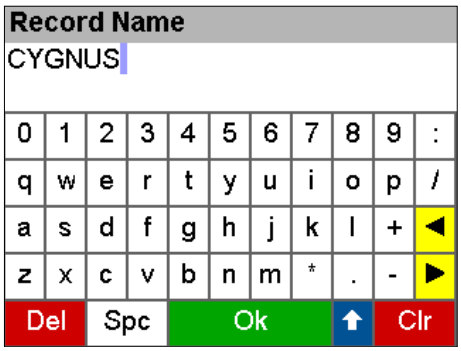
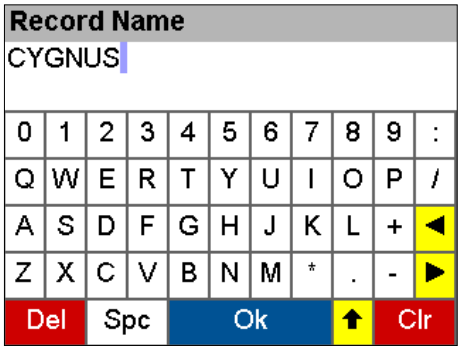
Inputting Numeric Values using the Navigation Keys

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.	

Inputting Text using the Navigation Keys

Some functions may require alphanumeric text to be input into the gauge. This is done using a special alphanumeric entry screen and the navigation keys.

1.	The screen is divided into 'virtual' keys like a QWERTY keyboard. You move the Blue highlight around using the 4 navigation keys. Then press the Ok/Select key to enter the character or perform the function.	
2.	To enter the word CYGNUS you would move the blue highlight from Ok to 'C' then press the Ok/Select key, then move to the 'Y'…	
3.	There are 'keys' for Delete last = Del Space = Spc Clear all = Clr Move = ◀ ▶ Toggle case = ▲	
4.	When you have entered your word just move the highlight to the green 'Ok' at the bottom and press the Ok/Select key.	

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 gauge can Auto Detect certain types of probes when they are first connected to the gauge, or you can manually select the probe from a list.

These probes can be Auto Detected;

T2C, T5B, T7A

These probes must be selected manually;

S2C, S3C, S5A, S5C & T5BH

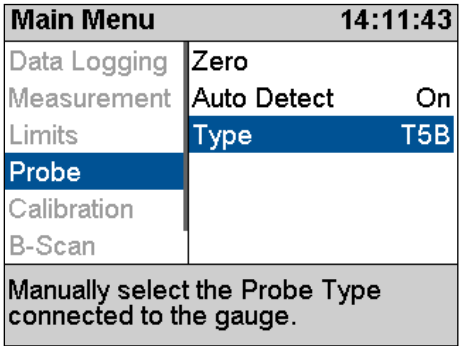
The Probe Type is displayed is displayed at the top of the measurement screen in the status area. When a probe is connected the background is green. When no probe is detected the background is grey.

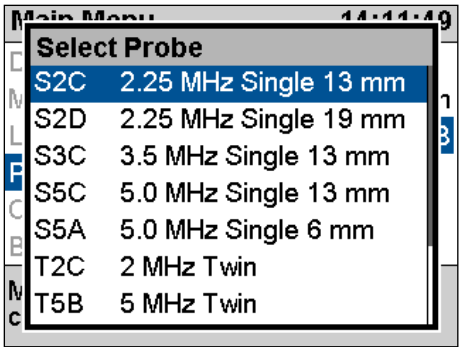


S2C Probe Selected and Connected



S2C Probe Selected but NOT Connected

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.

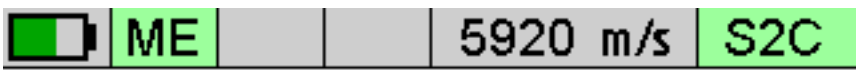
The reason settings are saved with each probe type is so you can swap probes during a survey without having to re-calibrate each time.

Automatic Probe Detection

The Automatic Probe Detection feature works by listening to how the probe behaves when it is first plugged in. For that reason the probe MUST BE in the air and not coupled to a surface when plugging in or turning on the gauge.

You can turn the automatic probe detection feature on or off from the Probe menu using the **Auto Detect** item.

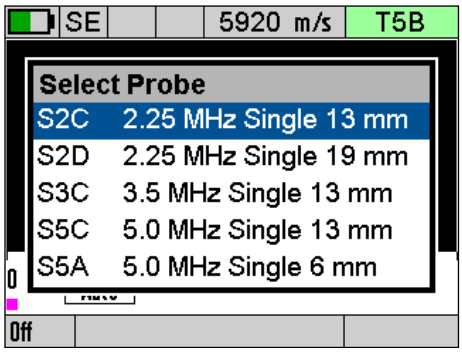
When Probe Type set to **Auto** and a probe is connected the gauge will try and determine the probe type – this will be displayed at the top of the screen on the right.



S2C Probe Selected and Connected

Observe this probe type displayed and check it matches the probe connected to the gauge.

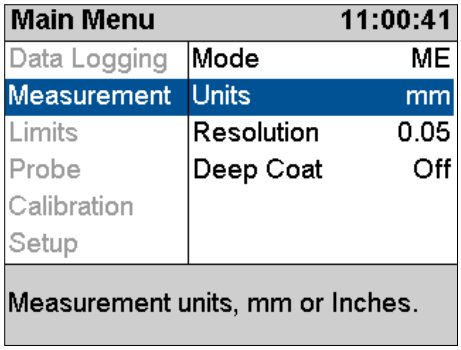
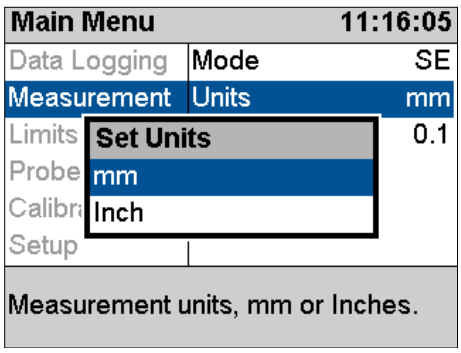
If the gauge fails to correctly detect the probe type then you must select if manually from the list of probes. See Selecting the Probe Type on page 45.



Manual Probe Selection – Single Element Probe Detected.

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.	

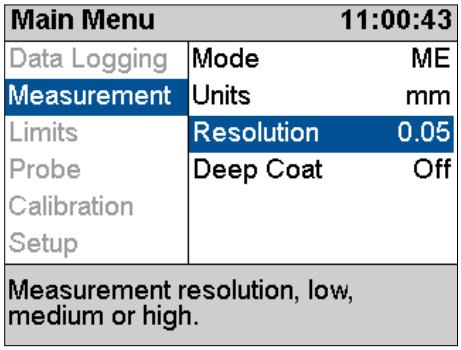
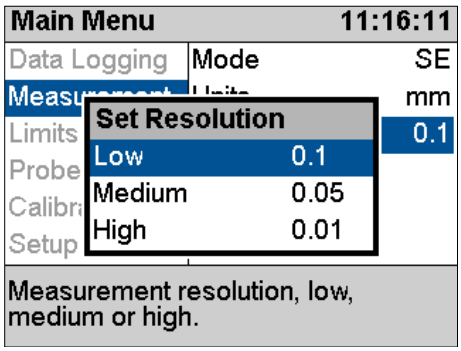
Resolution Setting

The gauge can display thickness measurements in three resolution settings:

- 0.1 mm 0.005 inch All Modes
- 0.05 mm 0.002 inch ME mode only
- 0.01 mm 0.001 inch SE and EE Modes only

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.	

8. Manual Gain Adjustment

The gauge will normally operate in automatic gain mode and this will be suitable for virtually every measuring scenario. The automatic gain mode has been designed to find the optimum gain setting during the measurement process and is imperceptible to the operator. It is therefore only recommended to use manual gain mode if you have suitable ultrasonic training and experience and understand the consequences to the measurement if the gain is set incorrectly.

The gauge will default back to Automatic Gain mode when the gauge is turned on or the probe is changed.

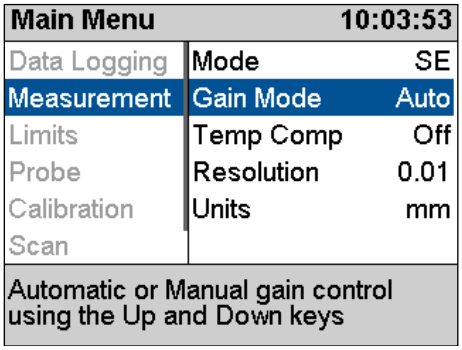
Manual Gain Mode

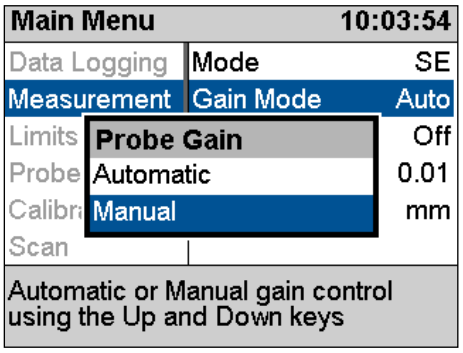
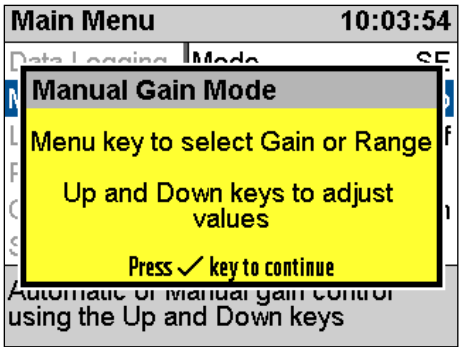
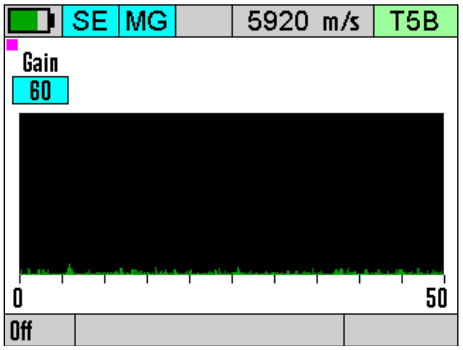
When the gauge is in manual gain mode the operator can manually adjust either the Gain or A-scan Range using the Up and Down keys during measurement.

The Gain value is in dB can be adjusted in 1 dB steps with each ⇧ or ⇩ key press.

When in manual gain mode the Basic measurement screen is disabled as the A-scan screen should be observed.

Turning on Manual Gain

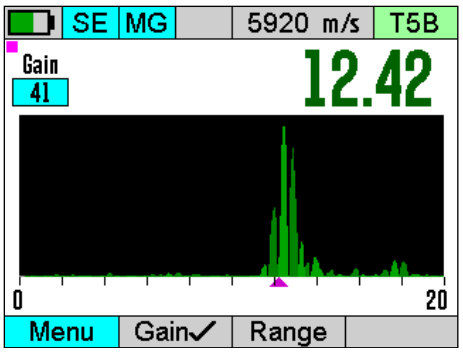
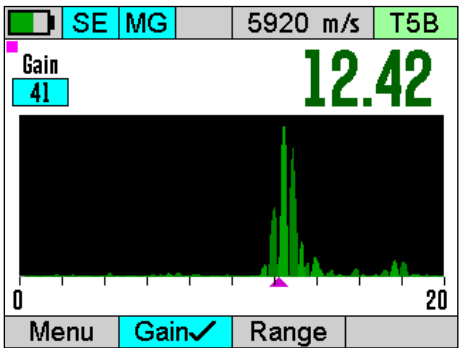
1.	Access the Menu and scroll down to the 'Measurement' group. Then scroll right and select 'Gain Mode'. Press the √ key to select	

2.	Use the ⇩ key to select Manual gain mode. Or select Automatic to turn off manual gain mode. Press the √ key to select	
3.	When Manual gain mode is selected a message is displayed informing how the Gain or Range is adjusted. Press the √ key to continue.	
4.	[MG] is displayed in blue at the top to show Manual Gain mode is active. The Gain setting is shown in blue to show it is active [60]	

Manual Gain Menu

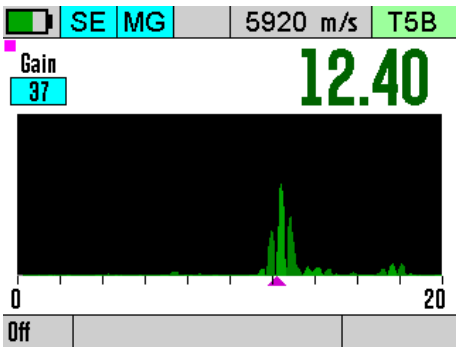
When in manual gain mode a small 'quick menu' is first displayed at the bottom of the screen when the Menu key is pressed, this allows quick selection of Gain, Range or Menu.

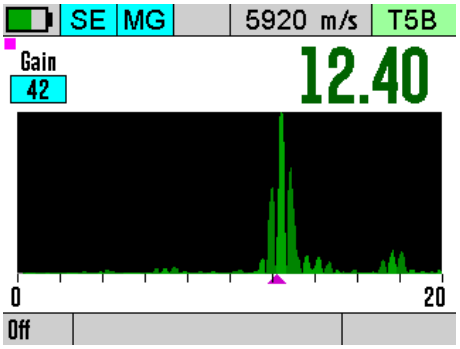
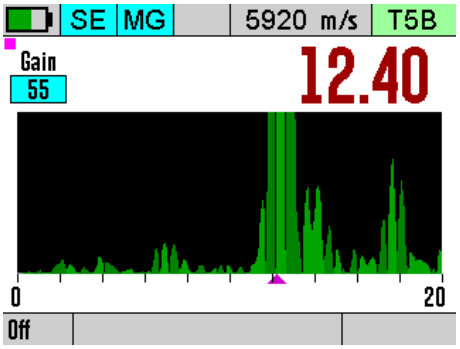
A tick is displayed next to Gain or Range to indicate which will be adjusted when the ⇧ or ⇩ keys are pressed.

1.	Pressing the Menu key displays the Manual Gain menu as the bottom of the screen. The √ shows that Gain adjustment is currently selected.	
2.	Pressing the Menu key again will go straight to the Main Menu as normal.	
3.	Use the Left and Right keys to navigate between Menu, Gain and Range. The selected item will be highlighted in blue. Use the √ key to select. Use the **X** key to cancel.	

Adjusting the Gain

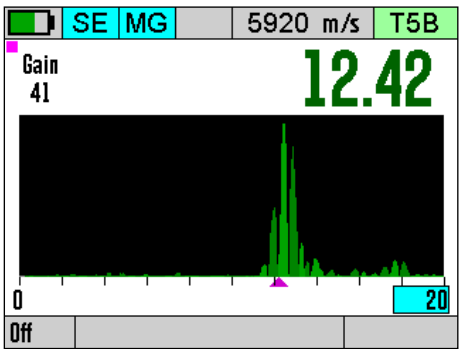
Press the Menu key and check that Gain is ticked – select it if it isn't. Then in the measurement screen with the A-scan displayed use the ⇧ or ⇩ keys to adjust the gain as required.

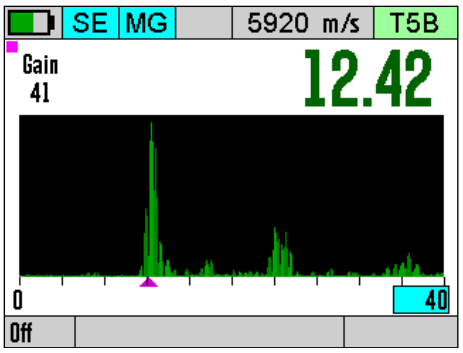
1.	The Gain is set to 37 dB. The A-Scan shows a back wall echo signal around 50% height but there is a thickness value. *Ideally you would increase the gain to get a 100% high signal.*	

2.	The Gain is set to 42 dB. The A-Scan shows a back wall echo signal around 100% height and there is a thickness value. <u>This is the optimum setting.</u>	
3.	The Gain is set to 55 dB. The A-Scan shows a back wall echo signal which goes off the screen, there are also other earlier smaller echoes that are becoming significant. The thickness measurement is still ok however. *Ideally you would reduce the gain down to get a 100% high signal.*	

Adjusting the Range

Press the Menu key and check that Range is ticked – select it if it isn't. Then in the measurement screen with the A-scan displayed use the ⇧ or ⇩ keys to adjust the Range as required.

1.	When Range is selected the range value is highlighted blue. Here the range is set to 20mm [20]	

2.	Use the ⇧ or ⇩ keys to adjust the value. Here it's set to 40mm [40]	

Measuring Below the Probes Minimum Thickness Specification

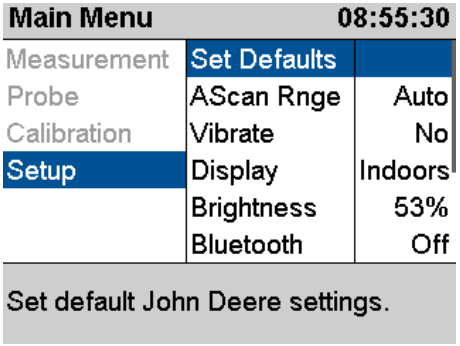
The minimum thickness measurement specified for the Twin Element probes is valid for when Automatic Gain Mode is selected - this is the default gain mode when the gauge is turned on.

By manually adjusting the gain and observing the A-Scan display it may be possible to measure less than the minimum specified thickness.

This should only be attempted by experienced operators with a good understanding of ultrasound principals.

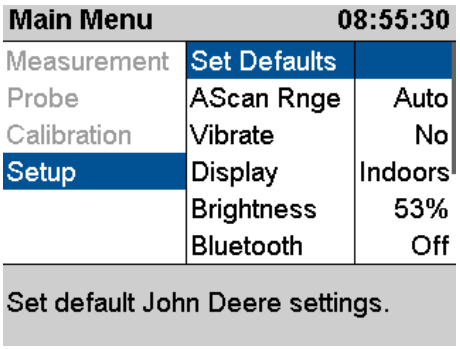
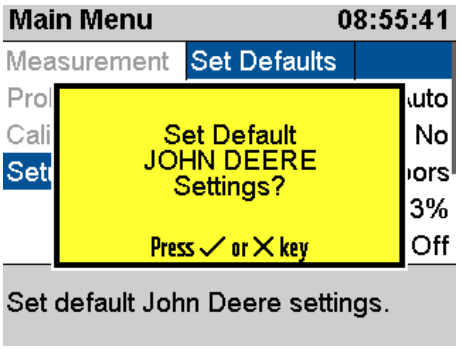
9. Setup Menu

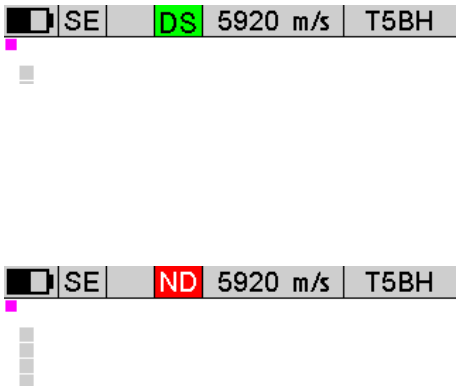
The Setup group is found at the bottom of the menu, it holds various gauge setup options.

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.	

Set Defaults

This restores the default **John Deere** setup to the gauge. If you are unsure if the gauge setting have been changed, use this function to reset the settings.

1.	Access the Menu and scroll down to the 'Setup' group. Then scroll right to select the 'Set Defaults item Press the √ key to select the item.	
2.	Then press the √ key to restore the John Deere settings.	

3.	When defaults are set, the measurement screen shows a green box with DS to indicate the gauge has **D**efault **S**ettings. If any settings change, this box will change to a red ND to indicate **N**ot **D**efault settings.	

A-Scan Range

The A-Scan range setting sets how the A-Scan X axis scale is set. This can be either Manually or Automatically.

Automatic

When set to Automatic (Auto) the X scale is set using the measured thickness value and the measurement mode. This means when measuring a range if thicknesses the A-Scan range will always be set so you can observe the required number of echoes.

Manual

When set to Manual (Man) you can set the A-Scan range to any value between 5 mm and 1000 mm (0.2” and 39”).

Vibrate Feature

The Vibrate feature will vibrate the gauge when a verified thickness measurement is found to alert the user. You can use this menu item to turn this On or Off as required.

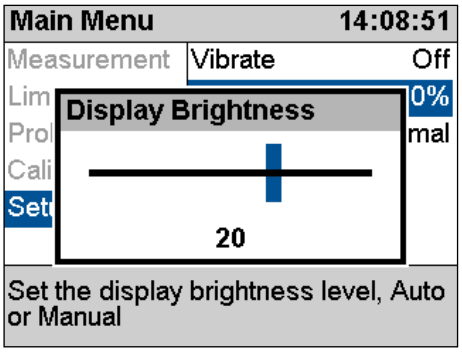
Brightness Setting

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.

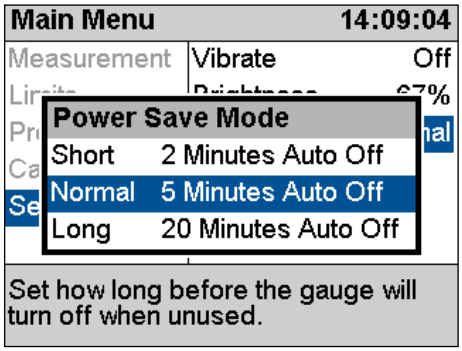
In Manual mode you can adjust the brightness over 20 levels, 0 is the lowest level, 10 is the normal level.



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.

Bluetooth®

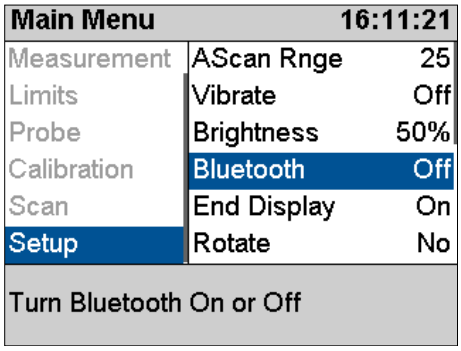
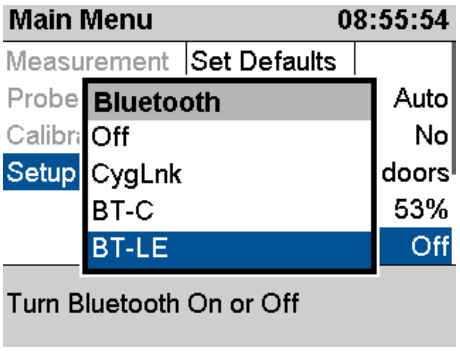
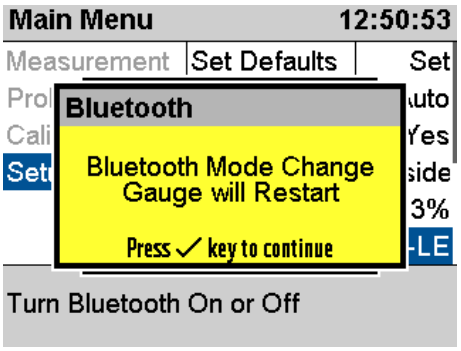
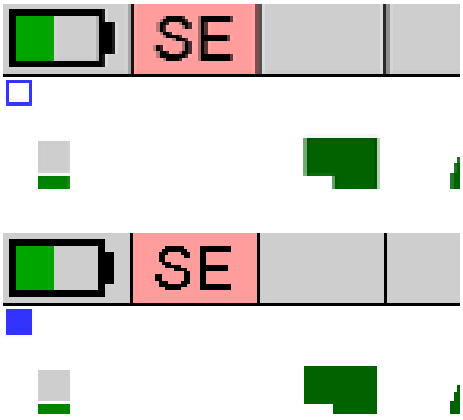
The gauge has a Bluetooth module that can be used to connect and pair with a Windows computer so you can transfer Data Logger records and settings wirelessly. The process of pairing the gauge with a computer is simple, once paired the gauge will retain the link information so subsequent connections are automatic.

The Bluetooth module is intended for short range connections (<10 meters), however the actual distance achieved will also depend on the Bluetooth transceiver at the computer end and the environment.

Turning Bluetooth On

By default, the Bluetooth mode is set to **BT-LE** mode for the John Deere application.

When Bluetooth is turned on the USB port is disabled.

1.	Access the Menu and scroll down to the 'Setup' group. Then scroll right to select the 'Bluetooth' item Press the √ key to open the item.	
2.	Select the Mode as required. For John Deere the default setting is **BT-LE** Press the √ key to save your choice.	
3.	When changing the Bluetooth Mode, the gauge must be re-started to correctly initialise the Bluetooth system. Press the √ key to continue, the gauge will then restart.	
4.	A Blue box will appear in the measurement screen to show the Bluetooth **Connection Status,** this box can be empty or filled depending on the status (see below).	

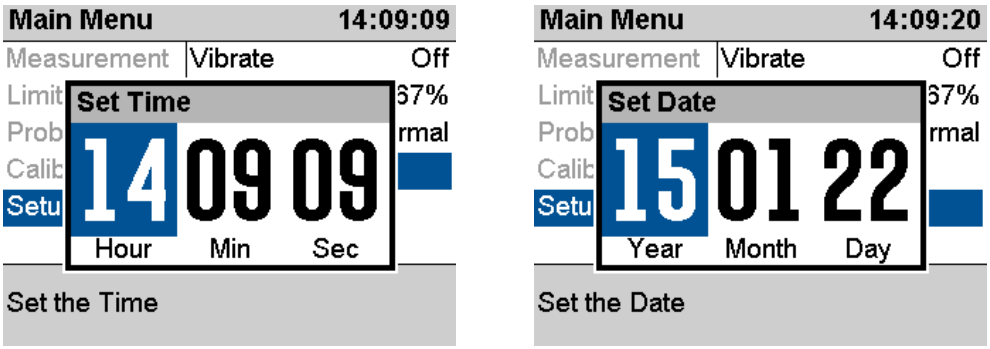
Connection Status

☐ Bluetooth not connected to a device.

Bluetooth connection to a paired device is active and data is being sent.

Set Time and Set Date

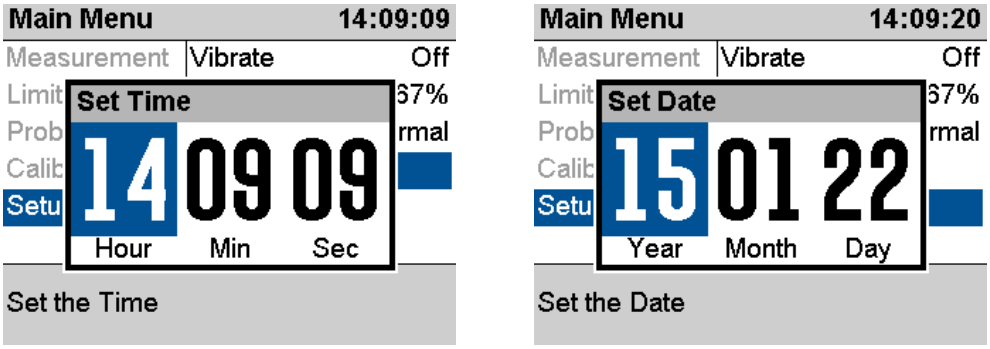
These two items allow the user to set the gauges Time and Date. The time and date are used by the Data Logger.



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.

10. 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.

Beware that the multiple-echo technique will not work if the front and back surfaces of the material being measured are not close to parallel. Also note that long narrow bars cannot be gauged along their length with the multiple-echo method.

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

11. 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.
- Check the Probe and its membrane are properly assembled (if a single element probe).
- 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 that the Probe and its membrane are correctly assembled with sufficient couplant between the probe face and membrane (if a single element probe).
- 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.
- Turn Bluetooth off if you are not using it.

- When measuring on very heavily corroded metal with single element probes the gauge uses more power searching for a multiple echo match – this can significantly reduce battery life. So if you are frequently measuring on very heavy corrosion consider using a twin element probe as this will require less power to get measurements.

12. 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 19). 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, there are three to choose from; Cygnus 2/2$^+$, Cygnus 4/4$^+$ or Cygnus 6$^+$ PRO.

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.

13. 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?

14. Information

Technical Specifications

Cygnus M5-C4P 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	Multiple-Echo mode with Single element 0° probe; • Through coating measurement for coatings up to 3 mm thick as standard depending on coating velocity. • Deep Coat mode provides ability to measure through thicker coatings depending on coating material. Echo-Echo mode with Twin element probe; • Through coating measurement for coatings up to 1 mm thick as standard depending on coating velocity.
Materials	Sound velocity from 1000 m/s to 9000 m/s [0.0390 in/us to 0.3543 in/us]

Cygnus M5-C4P Technical Specifications			
Measurement Ranges	Single element 0° probes in Multiple Echo mode;		
	S2C probe	3 to 250 mm	[0.120 in. to 10.00 in.]
	S3C probe	2 to 150 mm	[0.080 in. to 6.000 in.]
	S5C/A probes	1 to 50 mm	[0.040 in. to 2.000 in.]
	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.]
	T7A probe	0.8 to 50 mm	[0.031 in. to 2.000 in.]
	T5B-MAUH (T5BH) probe	1.5 to 150 mm	[0.059 in. to 6.000 in.]
	Twin element probes in Echo-Echo mode;		
	T2C probe	5.0 to 50 mm	[0.200 in. to 2.000 in.]
	T5B probe	4.0 to 50 mm	[0.160 in. to 2.000 in.]
	T7A probe	3.0 to 25 mm	[0.120 in. to 1.000 in.]
	T5B-MAUH (T5BH) probe	4.0 to 50 mm	[0.160 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. Single element probes in multiple echo mode do not need to be zeroed.		
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) Echo-Echo mode with Twin element probe. Measures thickness using the time between the first and second back-wall echoes. (UT Mode 3) Multiple Echo using Single element probe. Uses three matched and verified back-wall echoes to determine the material thickness and ignore surface coatings.		
High Temperature Measurement	All standard single element and twin element probes: Allows continuous measurement up to 75°C (160°F). T5B-MAUH (T5BH) probe: Allows continuous measurement up to 150°C (300°F) and measurement with intermittent surface contact to 300°C (570°F). Compensation for velocity change at high temperature using ASME rule "Reduce 1% per 55°C (100°F)"		

Cygnus M5-C4P Technical Specifications			
Resolution	Single Echo and Echo-Echo measurement modes;		
	Low	0.1 mm	[0.005”]
	High	0.01 mm	[0.001”]
	Multiple Echo measurement modes;		
	Low (measurement > 120 mm)	0.1 mm	[0.005”]
	Medium (measurement < 120 mm)	0.05 mm	[0.002”]
Accuracy	±0.05 mm (±0.002”) - in Multiple-Echo measurement mode, when calibrated and measuring the same material as calibrated on. ±0.1 mm (±0.004”) or 0.1% of thickness measurement whichever is the greatest - in Single-Echo & Echo-Echo measurement modes, when calibrated and measuring the same material as calibrated on.		
Display			
Type of Display	Colour TFT LCD with LED Backlight (front)		
Display Size	240 x 128 Pixels QVGA. 2.4“, 47 mm (W) x 37 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	S2C : 220 ns S3C : 100 ns S5A / S5C : 67ns T2C : 220 ns T5B : 100 ns T7A : 67 ns T5B-MAUH : 100 ns		
Receiver			
Gain Control	Automatic Gain Control depending on probe and measurement mode. Manual Gain control option in 1dB steps from 20 to 70 dB.		
Frequency Range	1.0 MHz to 10.0 MHz (-6dB)		
Other Information			
Data Output and Storage	Data stored on removable micro-SD card. Data output via USB serial connection to computer.		
Data Connector	USB Mini B Connector under battery cover. Can be used to update the gauge firmware and load gauge settings.		
Calibration setting storage	Calibration Data stored to Internal Flash Memory		
Calibration Mechanisms	Not required for Multiple Echo mode. Automatic V-path correction for twin element probes.		

Cygnus M5-C4P Technical Specifications	
	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
Bluetooth	Class 1. V2.1 +EDR. 10.5dBm TX Power. SPP/RFCOM Profile.
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) MIL STD 810G Method 516.7 (Shock 20g) MIL STD 810G Method 516.7 (Transit Drop 1.22m)
Use in Explosive Atmospheres	Locations : Class I, Division 2, Group D only. Tested : using MIL-STD-810G, Method 511.5, Procedure I.
Compliance	EMC : CE, UKCA, FCC RoHS
Bluetooth Compliance	Bluetooth Module Panasonic PAN1326B with Internal Antenna - Complies with Part 15 of the FCC Rules. - Class B digital device. - The device meets the requirements for modular transmitter approval as detailed in FCC public Notice DA00-1407 - FCC ID T7V1316
Designed for	BS EN ISO 16831

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: $f = V_{COPPER} / V_{STEEL}$]

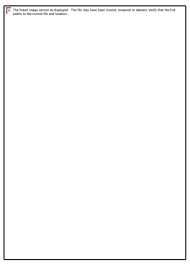
where : **T = true thickness of Copper being measured**
t = actual reading obtained
f = Conversion Factor (from table)
V_{COPPER} = Sound Velocity in Copper : 4700 m/s
V_{STEEL} = Sound Velocity in Steel : 5920 m/s

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

15. 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.

16. Warranty Information

LIMITED FIVE YEAR WARRANTY FOR JOHN DEEERE
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 five 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.

17. Index

A-Scan
  Backwall Echo, 28
  Range Adjustment, 54
Automatic Power Off, 21
Batteries
  Fitting, 10
  Level, 26
  Life, 26
  Low Battery Warning, 27
  NiCad, 10
  NiMH, 10
Bluetooth, 58
BS EN 15317:2007, 33
Calibration
  Conversion Factor, 72
  Known Thickness, 33
  Ladder Step Wedge, 35
  Single Point, 33
  Two Point Calibration, 35
  Velocity of Sound, 40
Chipping Hammer, 61
Disposal, 73
Echo-Echo, 15
Gain
  dB Values, 51
  Manual Gain, 51
Gauge
  Cleaning, 65
  Display, 19
  Keys, 19
  Serial Number, 20
Imperial, 48
Main Menu, 42
Measurement
  Pitted surface, 61
Measurement
  Resolution, 49
  Rough surfaces, 61
  Small Pipes, 25
  Stability, 24
  Units, 48
Metric, 48
Neck Strap, 13
Plastics, 16
Power button, 20
Probes
  Automatic Detection, 47
  Connector, 19
  Type, setting, 46
  Zero, 38
Recycling, 73
Repair, 66
Resolution, 49
Service, 66
Single Echo, 15
Sound Velocities, 71
Test block, 33
Thickness Measurement, 23
Troubleshooting, 62
Units, 48
Warranty, 74
WEEE Directive, 73
Zeroing, 38