CYGNUS
INSTRUMENTS
Reliable Ultrasonic Measurement

Hand-Held Multi-Mode Ultrasonic Thickness Gauge

for Divers

Operating Manual

Covers Gauge Models:

UNDERWATER STANDARD
UNDERWATER PLUS
UNDERWATER PRO

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1. Important Notices

Important
This 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.

2. Introduction

Cygnus Underwater Thickness Gauge

The Cygnus Underwater Thickness Gauge has been specifically designed for the professional diver undertaking metal thickness surveys in both shallow and deep water sites. It has been designed to withstand the extreme environments encountered while providing quick, clear, and accurate metal thickness measurements using the Cygnus Multiple Echo technique and Single Echo / Echo-Echo options.

The Cygnus Underwater Thickness gauge is pressure rated to a maximum depth of 300 meters sea water (984 ft).

A bright colour LCD display shows the thickness measurement in large numbers. Thickness measurements are further backed up by an A-scan display. Measurement data can be sent to the surface via a RS-485 serial data link where they can be data logged and used to produce a survey report using Cygnus' CygLink software.

Measurements can be displayed in Metric (mm) or Imperial (inch) units and measurement resolution can be selected from 0.01, 0.05 or 0.1 mm, (0.001, 0.002 or 0.005 inch). Thickness measurements can easily be calibrated to a known thickness or to a known Velocity of Sound.

Important
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 first time users 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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Website: **www.cygnus-instruments.com**
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sales@cygnus-instruments.com

For all Cygnus offices in UAE, USA, Singapore, and Authorised Cygnus Service Centres and Distributors please refer to the Cygnus website Worldwide Distribution page.

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

Register Your Gauge

Please take a moment to register your gauge with Cygnus and start your 3-year warranty, by registering you can receive updates on

- Technical Information
- Notification of new firmware
- Product updates

https://cygnus-instruments.com/service/product-registration/

Kit Content

- Cygnus Underwater Gauge
- Two Rechargeable Batteries
- Battery Charger
- Ultrasonic Probe(s)
- Operating Manual
- Spare pack of O-Rings
- O Ring Removal Tool
- Molykote O Ring Grease
- 15mm or ½" Steel Test Block
- Security Lanyard
- Spare Probe Membranes[1]
- Membrane Key[1]

Optional / Additional Items

- USB Interface Cable (SubConn to USB) (1.8m)
- Umbilical to USB Cable (9D to USB)

[1] If a Single Element Probe Supplied in Kit

3. Gauge Variants

The Cygnus Underwater gauge is available to order in three variants, you can change the variant at a later date by purchasing an Update Code from Cygnus.

Feature	Variant		
	STANDARD	**PLUS**	**PRO**
Multiple-Echo Measurements (ME)	■	■	■
Single Echo Measurements (SE)		■	■
Echo-Echo Measurements (EE)		■	■
Depth Sensor	■	■	■
Deep Coat	■	■	■
Data Logging			■
A-Scan Display		■	■
Battery with Umbilical Connector			■
USB Interface Cable			■

4. The Underwater Gauge

Features of the Underwater Gauge

Assembling the Instrument

Assembling of the Cygnus Underwater Gauge is comprised of these steps:

1. Fitting the O-rings (page 15)
2. Connecting the Battery (page 19)
3. Connecting the Ultrasonic Probe (page 20)
4. Attaching the Lanyard (page 22)

The Cygnus Underwater instrument parts:

Instrument body	Cygnus Ultrasonic Probe	Battery Pack
		

Body O-rings	Battery O-rings	Lanyard
		

Fitting the O-rings

There are three O-ring seals fitted - two to the Gauge body and one to the Battery pack. Spare O-rings are included in the kit.

Gauge Body O-rings	The Battery O-ring
	

Important
Do not use a sharp instrument to remove the O-rings as damage to the sealing area may occur.

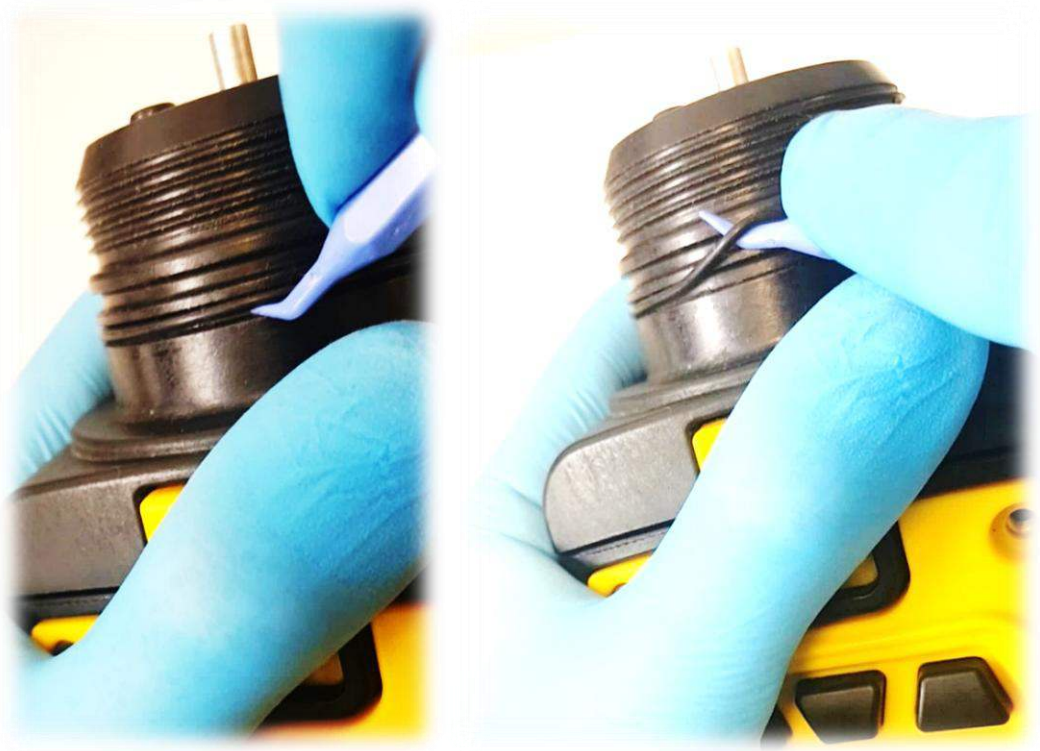
1. Remove the old O-rings using the pick tool provided and destroy them
2. Clean the O-ring locations removing all grease and dirt
3. Pre-lubricate the new O-rings with silicone grease
4. Gently fit the new O-rings into position

Fitting the Gauge body O-rings

Step 1 Place the body O-ring into the groove and hold with index and middle fingers 	Step 2 Gently pull the O-ring over the threads 
Step 3 Slide the O-ring into the groove 	1st O-ring is now in place. Repeat for the 2nd O-ring. 

Removing Gauge Body O-Rings

Step 1
Hook the O- Ring out from its groove



Step 2
Push the O-Ring against the pick stick

Step 3
Pull the O-Ring off the body

Fitting the Battery O-Ring

Apply a thin coat of silicone grease to a new O-ring. The O-Ring is then pushed into the groove on the end of the battery housing.	

Removing the Battery O-Ring

Use the O-Ring removal tool to pick the O-Ring out of the groove. Once removed, cut the O-ring so it can't be used again.	

Checking the O-rings

To ensure the gauge remains water-tight, all O-rings must be checked each time after removing and before connecting the battery pack. It is recommended to replace the O-rings if in any doubt as to their condition or age.

- ✔ Check the O-rings whenever you remove the battery
- ✔ Check the O-rings before you connect the battery
- ✔ Always lightly lubricate the O-rings with silicone grease
- ✘ Do not use old or damaged O-rings
- ✘ Never use the Gauge without any O-rings fitted

Spare O-rings are included in the Kit and can be ordered from Cygnus Instruments.

Things to look for when inspecting the O-rings are:

- Any flats or signs of wear
- Any signs of pinching or trapping
- Any sand or dirt in the silicone grease
- Any cuts or cracks

Connecting the Battery

The battery packs are supplied uncharged therefore both will require a full charge before use (*see Charging the Batteries on page 22*).

Battery packs is screwed onto the gauge body by hand. Do not over-tighten the battery packs – hand tight is sufficient.

Important
The battery MUST be fitted BEFORE the Underwater gauge is immersed into water.

Important
The battery MUST be removed when the gauge is no longer being used and/or stored in its case.

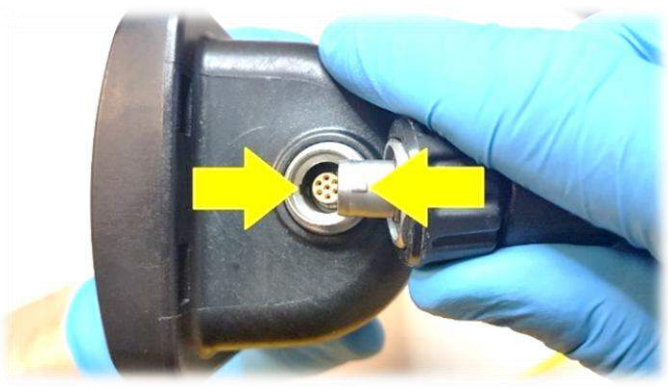
Important
The battery MUST NOT be removed while the gauge is underwater.

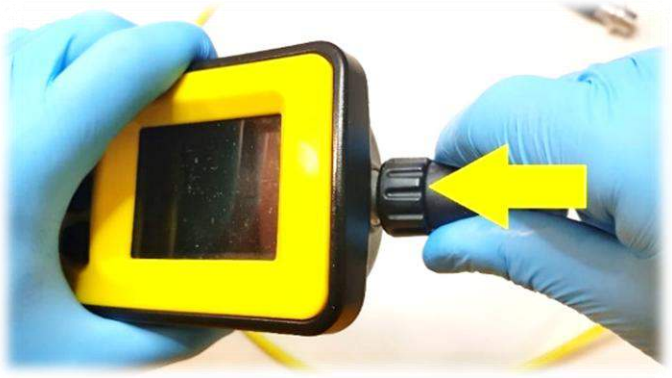
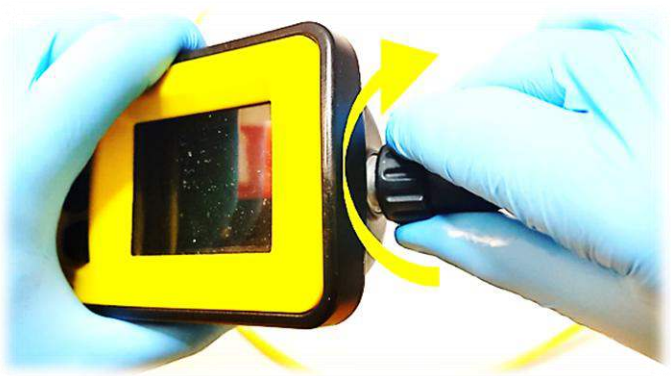
Important
The battery MUST NOT be removed while the gauge is operational. Always check the gauge is powered off.

Hold the gauge body in left and the battery in right hand.	
Screw on the battery – simultaneous slight push and clockwise twist.	

Connecting the Ultrasonic Probe

Important
The probe MUST NOT be removed while the gauge is underwater.

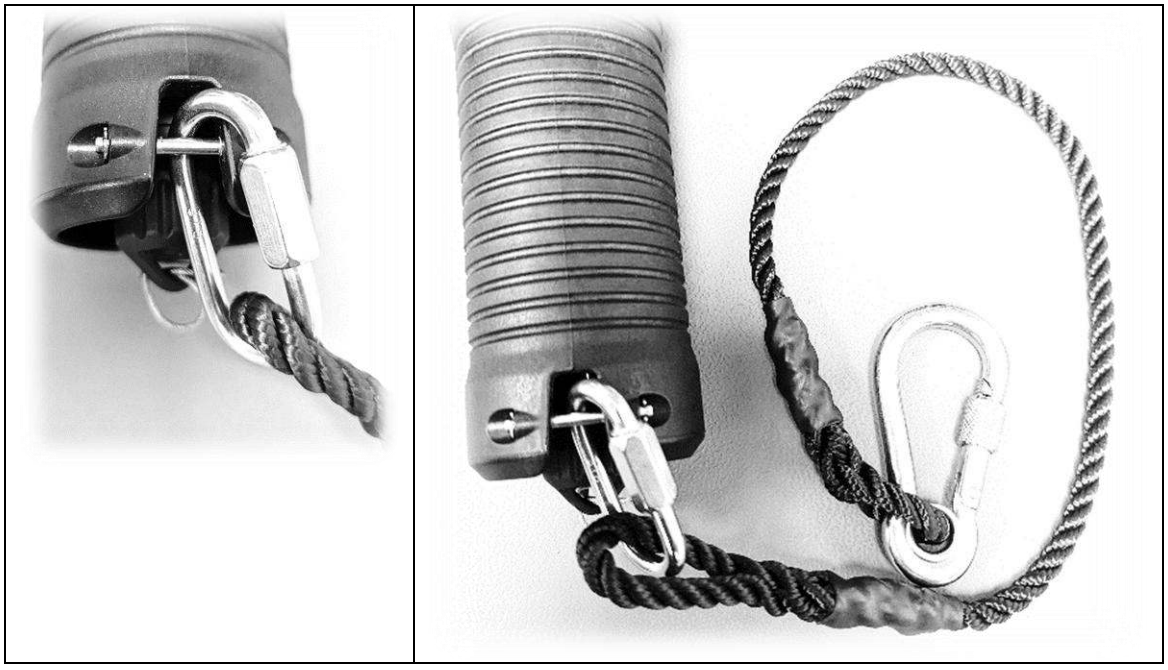
Align the Key.	

Plug the probe connector into the socket on the gauge body.	
Fasten the coupling nut.	

Attaching a Lanyard

A lanyard is supplied with the kit for attaching the assembled gauge to a diver's belt. The small screw-locking gate should be attached to the battery pack; the other larger carabiner can then be attached to a belt.

Important
The protective cap needs to be removed from the connector in order to fit the lanyard to batteries with an umbilical connector.



Charging the Batteries

- The batteries must only be charged using the charger supplied with the kit.
- The charge time of a new battery from fully discharged state is about 2 hours.
- As the batteries use NiMH cells, there is no need to discharge the cells before charging - the batteries can be 'topped up' after use.
- There is a charge indicator LED on the top of the charger to show the state of the charger and charge cycle.
- The charger is designed for indoor use only.

Important

Always wait for charger LED to go YELLOW before connecting a battery.

Do not connect the next battery until the charger LED is YELLOW

(This takes around 15 seconds after unplugging a battery).

To Charge the Battery

1. With the Charger not connected to a battery, plug the Charger into the mains power supply and switch the mains power on. The LED is ORANGE. *To achieve a proper battery charge, it is important that the charger is not connected to a battery when powered on so it can initialise its internal state.*
2. Wait until the charger LED is YELLOW.
3. Connect the Charger to the Battery-module – charging will commence and after a short while the indicator on the Charger will show ORANGE. The Battery is now charging.
4. After a maximum 2 hours the Battery will normally be fully charged - the Charger will stop charging, and the indicator will now show GREEN (or GREEN with intermittent YELLOW flash)
5. Disconnect the battery from the Charger – the Battery is now ready for use.
6. After disconnecting the charged battery wait till LED shows YELLOW. This might take ~15seconds. Only when LED shows YELLOW, another battery may be connected for charging.

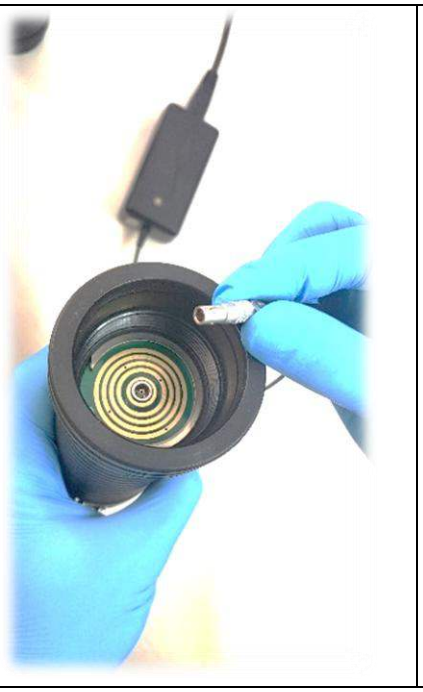
There is no harm in leaving the Battery connected after charging has finished – it is recommended periodically to leave the Battery in this state for 14-16 hours to recondition the Battery and extend its usable life.

Charger LED Colours

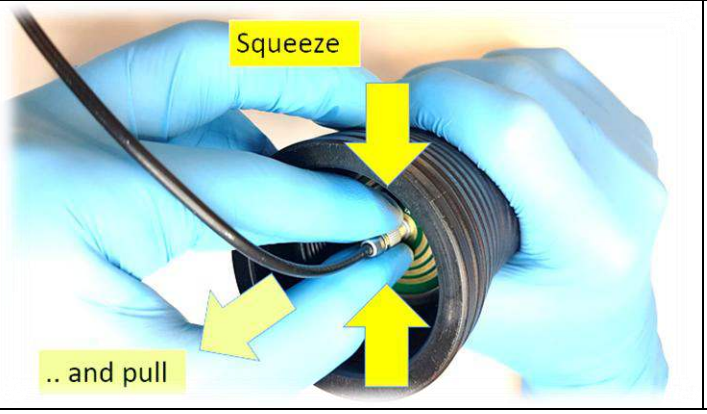
LED colour	Charger state
YELLOW	Battery not connected, or charger is initialising after a battery has been connected.

ORANGE	Fast charging
GREEN or GREEN / YELLOW flashing	Battery charged
ORANGE / GREEN alternating	Error

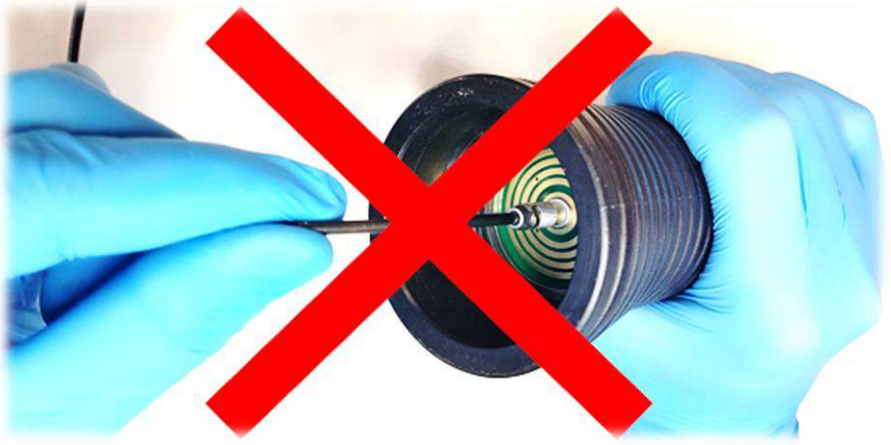
Battery charger connects to the battery with self-latching push-pull connector.



To unplug the connector from the battery, grip the connector by its body/sleeve and pull back to release.



Important
Do not pull the charger cable.



Not Using the Gauge Frequently?

To extend the life of the batteries, please read the section on **Battery Care** on page 97

5. Ultrasonic Probes (Transducers)

Important
The gauge should only be used with ultrasonic probes supplied by Cygnus Instruments.

Probe Types

There are two types of probe that can be supplied with the Underwater gauge; **Single and Twin Element**.

Typically, marine surveyors have used **single element** probes with multiple echo measurement which gives reliable measurement even through coatings.

Typically, the general NDT industry has used **twin element** probes with single and echo-echo measurement which can offer better detection of corrosion defects but require more awareness and training to avoid measurement errors.

Ideally a surveyor's kit would contain one of each probe type enabling any survey to be tackled with the confidence you'll be able to get reliable measurements whatever the condition of the metal.

Single Element Probes

Cygnus pioneered the use of single element transducers and the multiple echo technique. **Multiple Echo** measurement offers the most reliable and accurate type of thickness measurement through coatings.

However, there are situations when getting a measurement with a single element probe using Multiple Echo is difficult or impossible – in these situations the **twin element** probe will allow thickness measurements to continue to be taken.

Twin Element Probes

Twin Element probes can be used to take thickness measurements on both **Coated** and **Un-Coated** metals.

When measuring on Uncoated surfaces **Single Echo** mode can be used. Single Echo mode will also work best when measuring Heavy Corrosion – heavy corrosion will absorb and scatter the ultrasound signal so there is often only enough ultrasound reflected back to the probe to provide a single echo.

Identifying Single or Twin Element Probes

You can easily identify each type of probe by looking at the probe face;

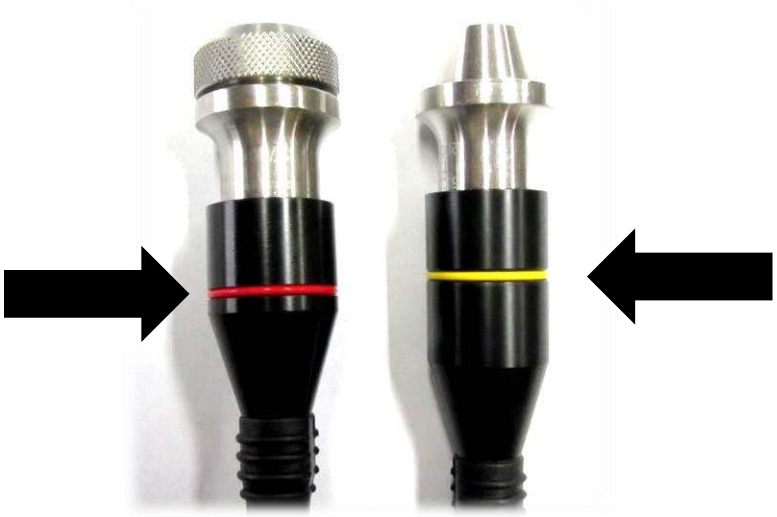
The Twin Element probe has two visible sections and NO protective membrane	The Single Element probe has a single black face with a protective membrane

Twin Crystal Probe

Single Crystal Probe

Probe Identification Band

Each probe also has a coloured band fitted to help identify the probe type and frequency.



Probe Identification Bands

Probe Frequencies

As well as the two different probe types there are different frequencies available in each probe type. These different probe frequencies allow measurement of different materials

Twin Element Probes			
Probe Type	**Details**	**Applications**	**Identification**
T5B	5 MHz 2 x 8 mm (0.5”)	A twin element probe suitable for most applications, including heavily corroded and pitted steels.	Yellow Band
T2C	2.0 MHz 2 x 13 mm (0.5”)	Cast Irons Plastics	Blue Band

Single Element Probes			
Probe Type	**Details**	**Applications**	**Identification**
S2C	2.25 MHz 13 mm (0.5”)	A single element probe suitable for most applications.	Red Band
S3C	3.5 MHz 13 mm (0.5”)	Suitable for measurement on thinner sections where surfaces are relatively rough	Orange Band
S5C	5.0 MHz 13 mm (0.5”)	Ideal for thin sections without heavy corrosion.	Black Band
S5A	5.0 MHz 6 mm (0.5”)	The higher frequency and narrower beam make this Probe ideal for measuring small-	Black Band

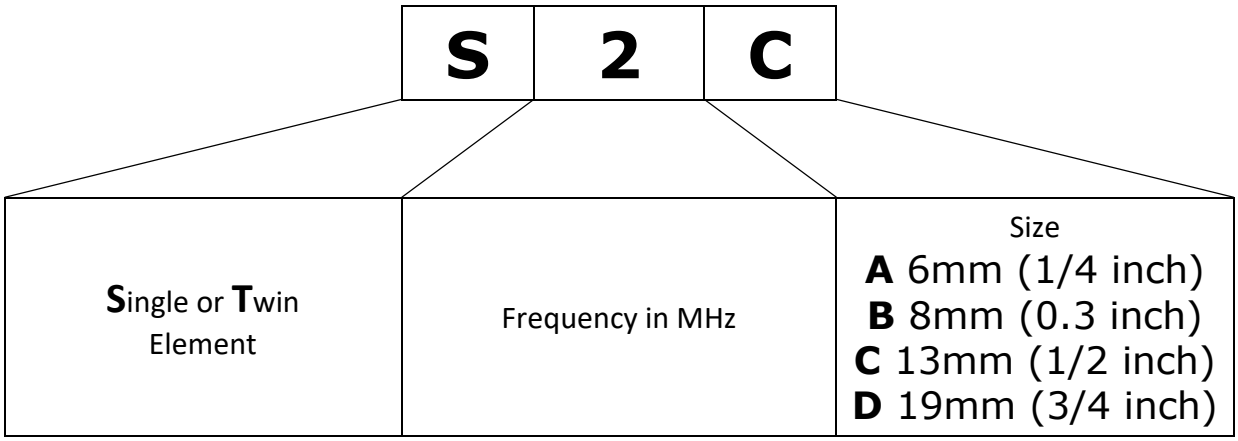
Single Element Probes			
Probe Type	**Details**	**Applications**	**Identification**
		bore tubing, thin section plate and other areas where access is limited.	

Lower frequency probes offer better penetration on heavy corrosion/coatings.

Probe Type	Measurement Range (in steel)	
T5B	2.0 – 100 mm (SE) 4.0 – 50 mm (EE)	0.08 – 4 inch (SE) 0.16 – 2 inch (EE)
T2C	3.0 – 150 mm (SE) 6.0 – 50 mm (EE)	0.12 – 6 inch (SE) 0.24 – 2 inch (EE)
S2C	3.0 – 250 mm[2]	0.12 – 10 inch
S3C	2.0 – 150 mm	0.08 – 6 inch
S5C	1.0 – 50 mm	0.04 – 2 inch
S5A	1.0 – 50 mm	0.04 – 2 inch

[2] To measure thicknesses on tall thin cylinders or columns the height-width ratio should be no less than 1.0:0.6 (Height:Width) otherwise side reflections prevent measurement.

The three letter Probe Type code can be easily decoded;



Probe Selection Chart

Use this chart as a guide to select the right probe for your application.

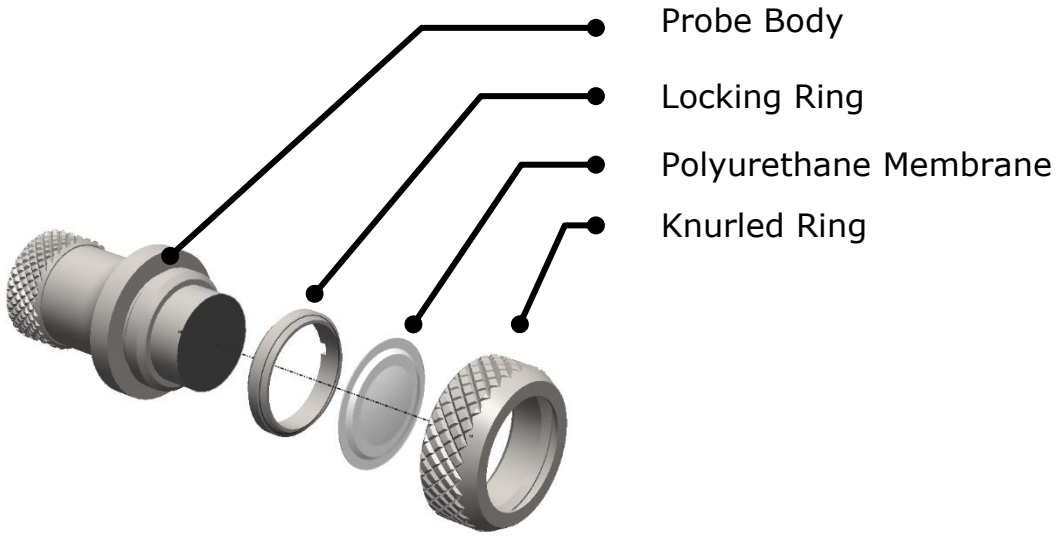
No	Application / Probe Type	S2C	S3C	S5C	S5A	T5B	T2C
1	Painted, coated & bare metals. Coatings up to 20mm (3/4in) thick [2]. Corrosion: non to moderate. Thickness: 3 to 250mm (1/8in to 10in) [1]. Class Shipping Surveys. **General purpose use.**	√					
2	Painted & bare metals. Corrosion: non to moderate. Thickness: 2 to 150mm (0.1in to 6in)[1].		√				
3	Painted & bare metals. Corrosion: non to light. Thickness: 1 to 50mm (0.05in to 2in)[1].			√			
4	Small diameter pipes. Boiler tubes. Corrosion: non to light. Thickness: 1 to 25mm (0.05in to 1in) [1].				√		
5	Uncoated or coated metals [3]. Corrosion: very heavy, pitting. Thickness: 2.0 to 100mm (0.08in to 2in) [1]. **General purpose use.**					√	
6	Uncoated or coated metals [3]; Cast Iron. Wrought Iron. Plastics. Corrosion: very heavy, pitting. Thickness: 3.0 to 150mm (0.12in to 6in) [1].						√

Notes.

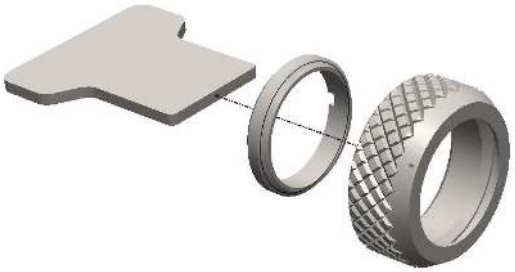
1. Thicknesses stated are for steel with a velocity of 5920 m/s (0.2331 in/µs), this will vary with different metals/materials.
2. S2C Probe using Deep Coat mode to measure through thick coatings.
3. T5B & T2C Probes will include any coating thickness in the metal thickness measurement when used in Single Echo mode.

Single Element Probes and Protective Membranes

All Cygnus single element probes have a soft face and are therefore fitted with a Polyurethane Membrane which provides better contact on rough surfaces and protects the probe face from wear, prolonging the life of the probe.
Check the membrane regularly as it is important the membrane is changed as soon as it shows any signs of wear.

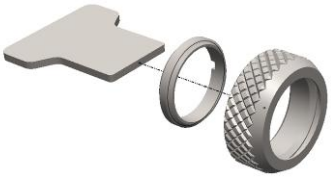
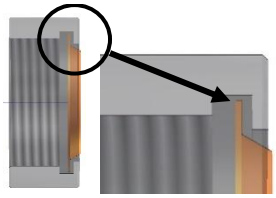
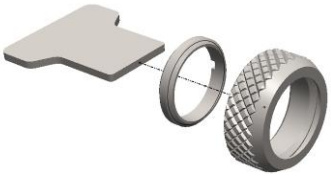


Single Element Probe Membrane Parts.



Single Element Probe Membrane Locking Key

Changing the Protective Membrane on Single Element Probes

1.	Unscrew the Knurled Ring from the end of the Probe.	
2.	Use the Membrane Key to unscrew the Locking Ring from inside the Knurled Ring. The old membrane can then be removed and discarded.	
3.	Place a new membrane into the end of the Knurled Ring ensuring it locates in the groove.	
4.	Screw the Locking Ring back inside the Knurled Ring and tighten with the Membrane Key.	
5.	Place a few drops of Membrane Couplant on to the probe face.	
6.	Screw the Knurled Ring back onto the probe. Use your thumb to squeeze the couplant from under the membrane as you tighten the Knurled Ring down.	
7.	You should see the membrane has a very thin film of couplant between itself and the probe face with no air bubbles.	

Automatic Probe Type Detection (APD)

The Underwater gauge can automatically determine the probe type whenever it is connected to the gauge, setting the appropriate parameters to suit the Probe Type.

This feature will operate when the APD is enabled (**[Menu:Setup:APD(On)]**, see page 89).

When APD is disabled it is up to user to select correct probe. This is done via **[Menu:Probe:Probe]** (see chapter Probe on page 82).

6. Measure Modes

The Measure Mode determines how the gauge uses the ultrasound signals to get a thickness measurement. There are three measurement modes used in the Underwater gauge;

- **Multiple Echo Mode - Single Element Probes Only**
- **Single Echo Mode - Twin Element Probes Only**
- **Echo-Echo Mode - Twin Element Probes Only**

The gauge will automatically set the measure mode to match the probe type selected.

Multiple Echo Mode (ME)

Multiple Echo measurement mode is by far the most reliable and quickest method for thickness measurements because it works by looking for three matched echoes it can **verify** the thickness measurement is valid. This method has been used in all Cygnus gauges since the late 1970s.
Multiple echo mode will ignore surface coatings (Through Coating mode) there is no need to remove the paint to take a measurement.
Also, because it uses a single element (or single crystal) probe there are no errors due to the V-path of the ultrasound beam found in all twin element probes. This makes it simple to calibrate – two point calibrations are not required.
However, because it requires three echoes to take a measurement, in heavily corroded steels there is often an insufficient number of echoes so measurements may not be possible.

Single Echo Mode (SE)

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 incorrect 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.

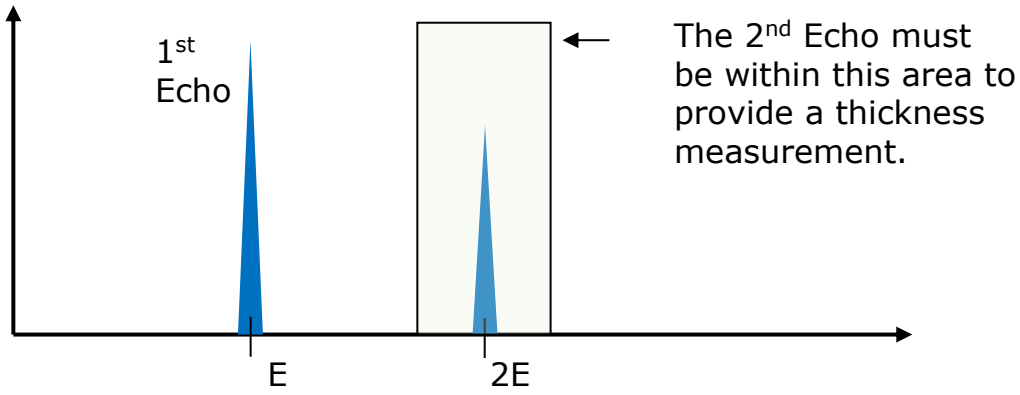
Twin element probes require "zeroing" at regular intervals, especially if the ambient temperature is changing. To zero a probe run **[Menu:Probe:Zero]**.

Probe Zero can be done when the instrument is in water.

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.

Echo-Echo Mode (EE)

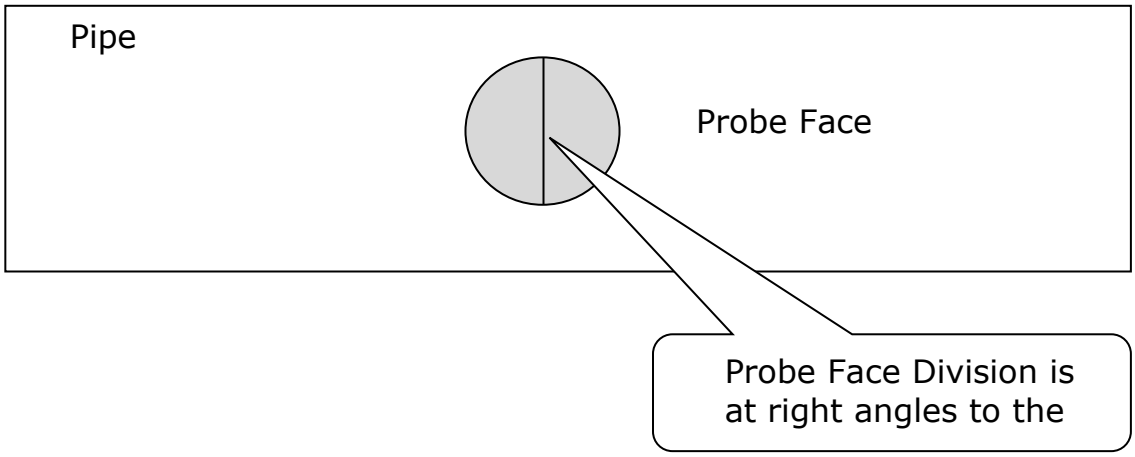
Echo-Echo mode uses a twin element probe, but measures between the first two echoes. This method is intended to ignore any thin surface coatings whilst still using a twin element probe.
Echo-Echo mode is not able to verify its measurements unlike Multiple Echo mode, therefore it is possible to give incorrect readings. But as the Underwater 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/0.02"). 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).
The Underwater gauge will perform a basic verification check on any Echo-Echo signal before it calculates thickness. If the position of the 2nd echo is not within the expected region for a 2nd echo then it is ignored and not used to give a thickness measurement. This check will help ensure Echo-Echo measurements are correct and discard any impractical measurements.



Measuring Small Diameter Pipe & Tubes

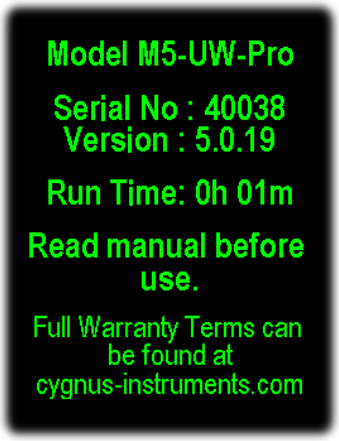
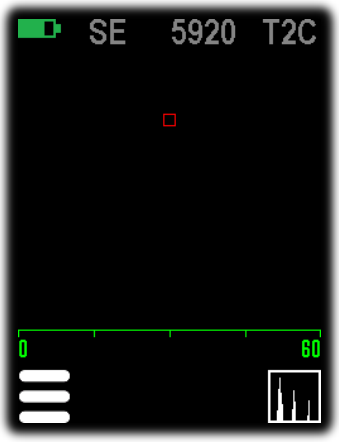
When measuring small diameter pipe and tubes with a twin element probe, 75mm (3”) or under, you must ensure the face of the probe is correctly aligned to the curvature of the pipe otherwise measurements may be inaccurate.

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



7. Using the Underwater Gauge

Turning the Gauge On

1.	Sliding the Power switch forward turns the gauge on.	
2.	The gauge will display the Cygnus logo screen while it starts up.	
3.	The next screen displays the gauge: Model Serial Number Software Version Run Time. *You can freeze the screen by pressing and holding any key.* Your attention is drawn to the warranty statement.	
4.	The next screen is the measurement screen.	

Turning the Gauge Off

Sliding the Power switch forward and holding for at least 1s turns the gauge off.	The gauge will display the Power Off screen.
	

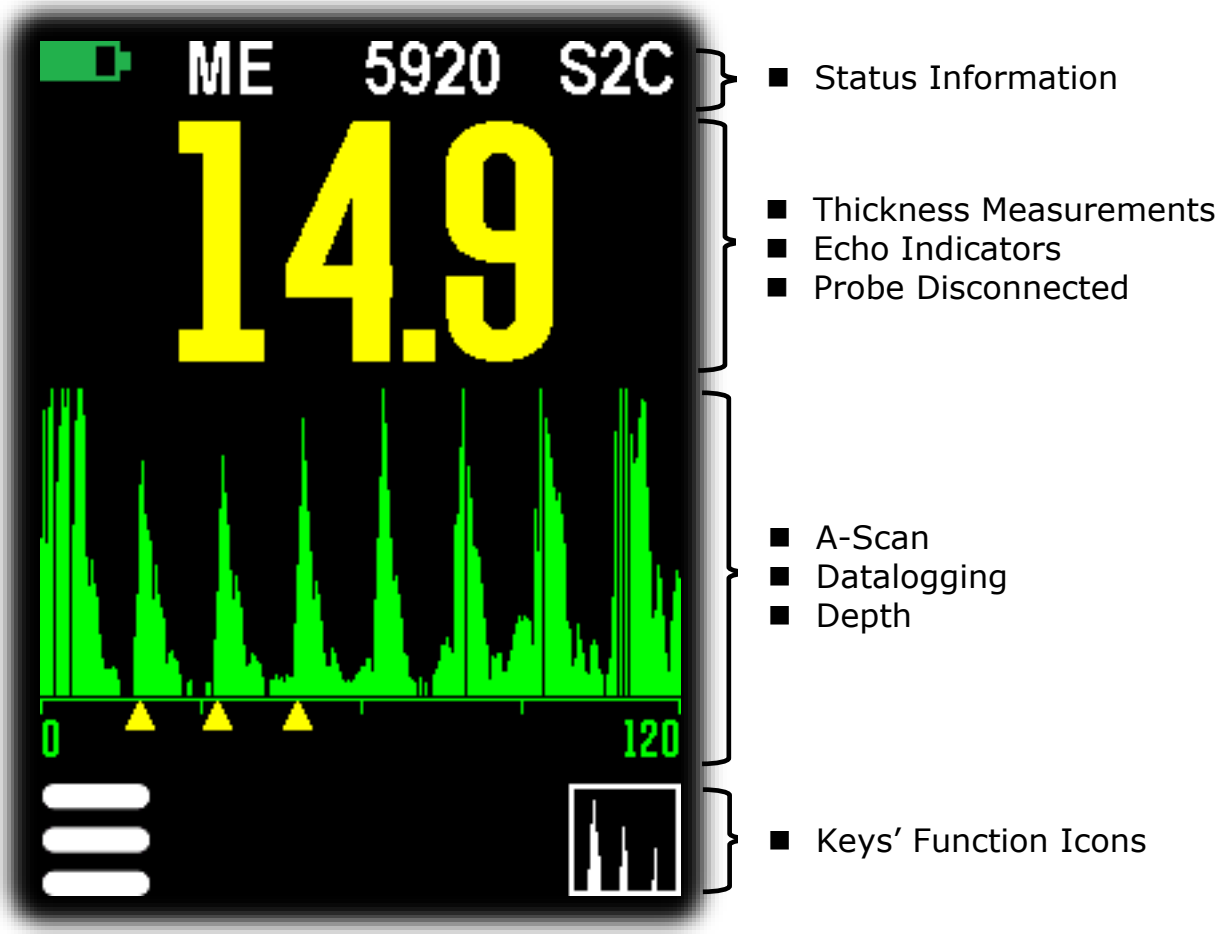
Before Each Dive

It is recommended you test the operation and calibration of the gauge before each dive. Follow these steps to ensure the equipment is functioning correctly:

1. **Make sure the battery is charged**
2. **Fit the battery and the gauge body with O-rings**
3. **Check the probe membrane is in good condition and there are NO air bubbles between the membrane and probe face**
4. **Plug in the probe connector and check the gauge identifies the probe correctly**
5. **If required Zero the probe as instructed**
6. **Test gauge operation by measuring the Test Block included in the kit (use a drop of couplant gel)**
7. **Check the calibration is correct for the material you will be measuring, ideally measuring a known thickness of the material (For mild steel set the 'default' velocity to 5920 m/s)**
8. **If you are using a top-side link check its operation**
9. **Visually check the condition of the lanyard**

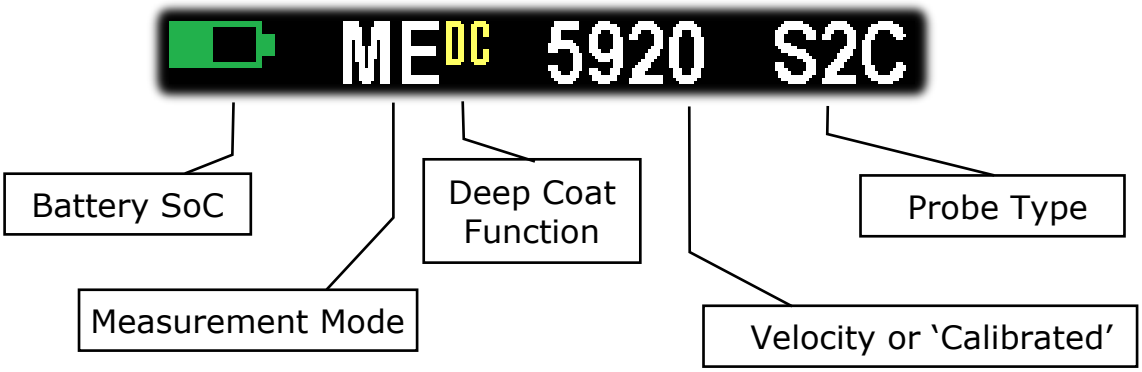
The Measurement Screen

When the gauge is operating the measurement screen is displayed. The screen can be divided into 4 areas:



Screen Area 1: Status Information

This area shows information about the gauge's status and settings.



Deep Coat Function

When 'Deep Coat' function is enabled yellow text 'DC' flashes. (see '*Deep Coat' on page 80*)

Measurement Mode

This text is an acronym of current measurement mode. Possible modes are:

ME - Multiple Echo (Single Crystal Probes)
EE - Echo-Echo (Twin Crystal Probes)
SE - Single Echo (Twin Crystal Probes)

The mode displayed mirrors setting in **[Menu:Measurement:Mode]** (see 'Measure Mode' on page 80).

Velocity of Sound value / Calibration Status

The velocity of sound can be displayed in 2 ways:

	Range	Example
Meters per second	2000 - 9000	
Inch per microsecond	0.0787 - 0.3543	

The value mirrors what is set in **[Menu:Calibration:Velocity]** (see page 84).

When velocity is set through the calibration procedure, calibration type is displayed instead:

Text	Meaning	Example
1PC	One Point Calibration (Single Crystal Probes)	
2PC	Two Point Calibration (Single and Twin Crystal Probes)	

Probe Type

When the probe is connected the text colour is grey, when disconnected it is red.

Probe connected	
Probe disconnected	

Battery Level

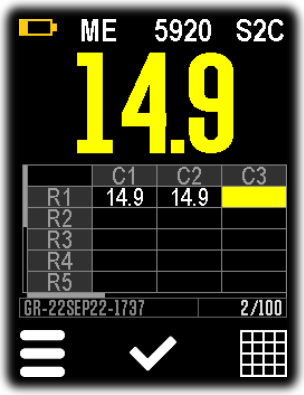
A "LOW BATTERY" warning starts flashing at the top of the screen when the battery is close to empty. As it depends on many factors (e.g. battery age, temperature) it is difficult to tell for how long the battery will last from this moment - the brand new battery at 20°C might last 1h, the old one at 5°C no more than 15minutes.

Screen Area 2: Thickness Measurement

1.	Thickness	
2.	Echo Indicators	
3.	Probe Disconnected	

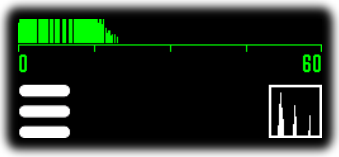
Screen Area 3: A-Scan, Datalogging, Depth, Basic

Depending on the gauge variant, there can be up to 4 screens. Pressing the right key cycles through active screens.

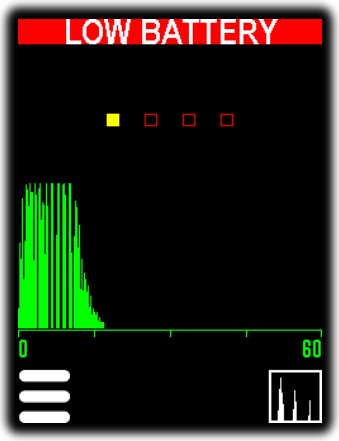
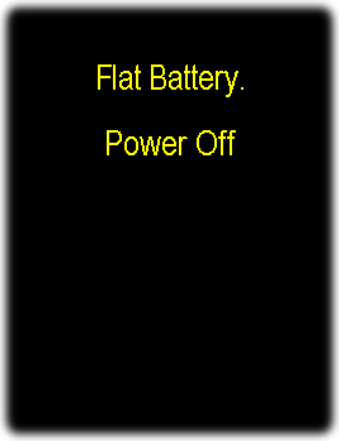
A-Scan	Datalogging	Depth	Basic
			

Screen Area 4: Key Function Icons

The key function changes depending on which screen is displayed, the Icon above the key indicates its current function.

1.	Left Key – Enter Menu Middle Key – No function Right Key - A-Scan Screen	
2.	Left Key – Navigate Through Menu Items Middle Key – Enter Menu Item Right Key - Return to Previous Menu Item	
3.	Left Key – Navigate Through Menu Items Middle Key – Change/Edit Item Right Key - Return to Previous Menu Item	
4.	Left Key – Decrement Value Middle Key – Confirm Value Right Key - Increment Value	
5.	Left Key – Confirm Decision Middle Key – No function Right Key - Cancel Decision	

Low Battery Warning

When the battery level is 10% or less a **Low Battery** message is flashed at the top of the screen.	
When the battery is flat the gauge will be turned off automatically. A message will be briefly displayed as the gauge turns off.	

Surface Preparation

The Underwater gauge will not measure through barnacles or similar hard encrusters. You must therefore remove any hard marine growth before attempting a thickness measurement, typically divers use a scraper to do this.

Surface with barnacles removed

Thin layers of green algae over paint don't generally need to be removed.

When using Multiple Echo mode, you **DO NOT** need to remove any paint or surface protection – the gauge is designed to read through and ignore these layers.

If there is loose rust (rusticles) or de-lamination of the metal surface then you will probably need to remove these loose outer layers with a scraping tool. Sometimes a chipping hammer is used to remove stubborn rust layers.

Taking Thickness Measurement

Taking ultrasonic thickness measurements is a straightforward 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.

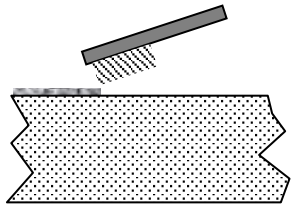
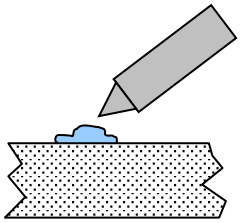
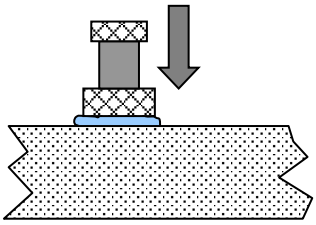
Zeroing the Probe (Twin Crystal Probes)

When a twin element probe is connected to the gauge (and either APD is active, or the gauge is set to the twin probe in manual mode) probe zero is run automatically.

Important
It is recommended to frequently perform a Probe Zero especially if conditions such as temperature are changing. At least every 30 minutes.

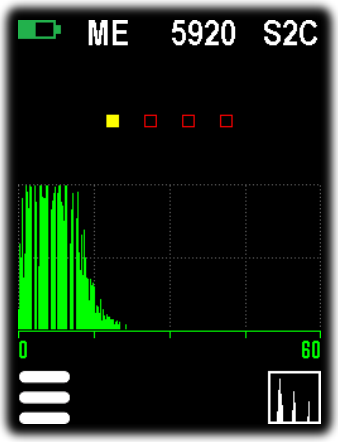
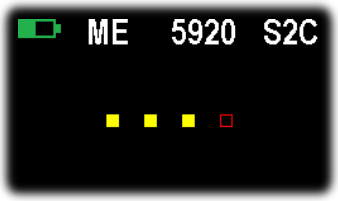
Probe Zero can be done when the instrument is in water.

Taking the Thickness Measurement

1.	Remove any marine growth, loose rust or loose coatings and brush the test area clean.	
2.	When measuring underwater there is no need to use a couplant - the water itself will act as a couplant.	
3.	When measuring in air apply some couplant gel to the test surface.	
4.	Place the probe-face on the prepared test surface and make firm contact applying gentle pressure.	
5.	The gauge will display a thickness measurement. (Or an indication of Echo Strength if no valid measurement has been found in Multiple Echo mode).	

Echo Indicators in Multiple Echo Mode

Should the gauge be unable to detect a stable multiple-echo signal it displays an Echo Indication to help the operator locate a suitable position.

1.	1 Indicator Flashing: *No echoes detected*	
2.	1 Steady + 1 Indicator Flashing: *Only 1 echo detected*	
3.	2 Steady + 1 Indicator Flashing: *Only 2 echoes detected*	
4.	3 Steady + 1 Indicator Flashing: *3 echoes detected but they are not matched*	

To help obtain a Multiple Echo reading the operator should continue to move the probe around using a slight rocking motion to locate a suitable reflector. Note: When using the gauge underwater the ultrasound will travel through the water and can get reflected back to the gauge by nearby surfaces, causing the echo bars to increase - this is normal.

Stability Indication in Single Echo & Echo-Echo 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 Yellow 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 thickness number colour change to yellow (signalling 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.

When unable to get a stable measurement try smaller resolution (see **[Menu:Measurement:Resolution]** on page 80)

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, therefore the thickness measurement must not change by more than +0.05mm or -0.05mm for 2 seconds or more to be "stable".

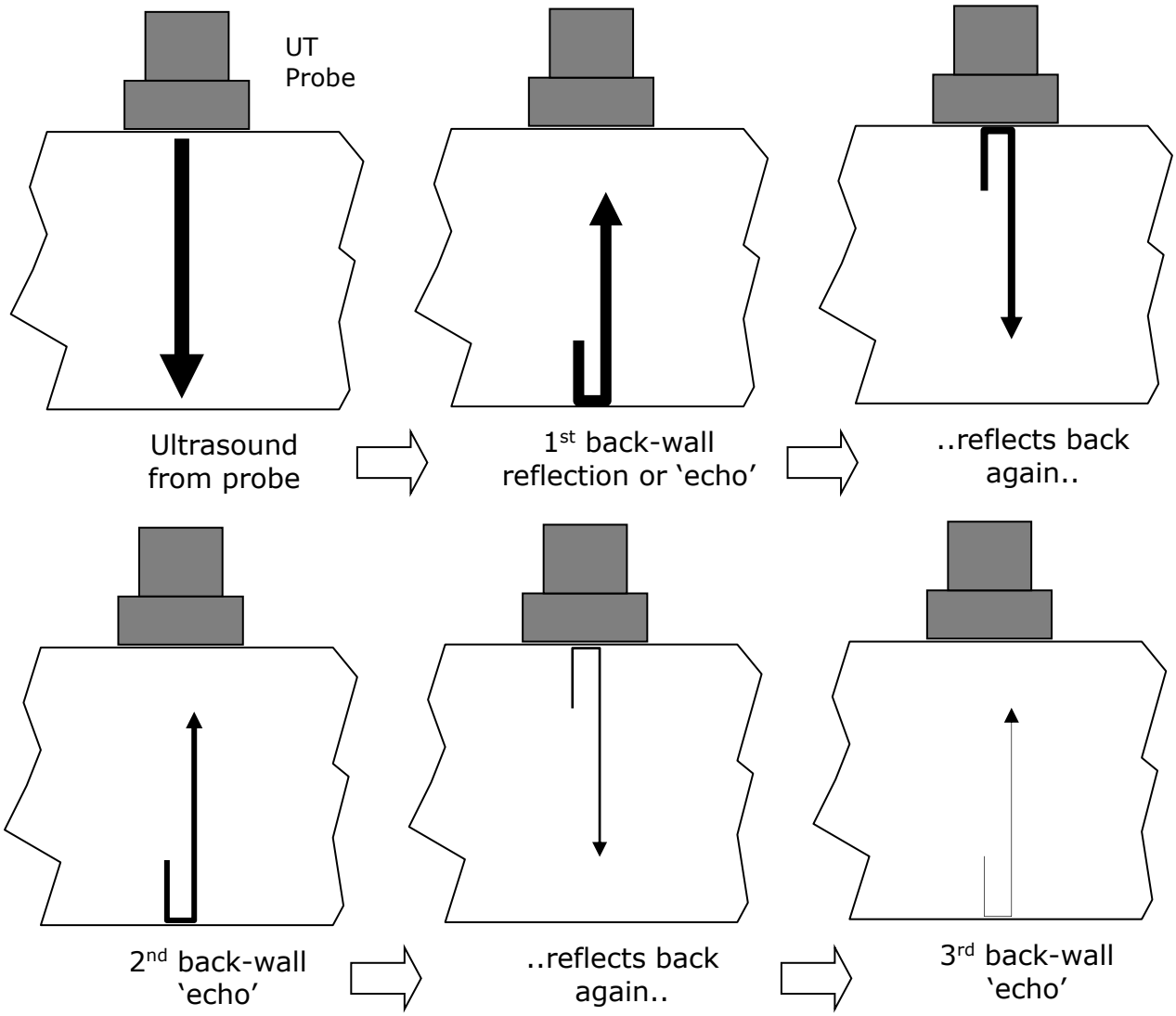
The Resolution is set to 0.002", therefore the thickness measurement must not change by more than +0.002" or -0.002" for 2 seconds or more to be "stable".

8. Interpreting the A-Scan Display in Multiple Echo Mode

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

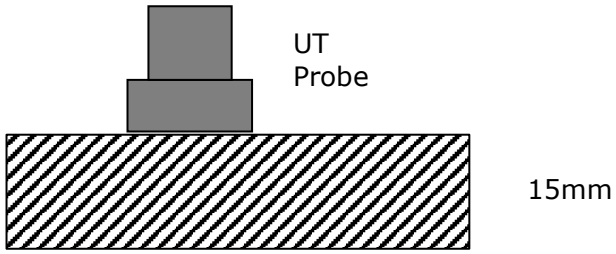
In Multiple Echo mode the gauge works by generating a short pulse of ultrasound that is coupled into the object you are measuring. This pulse then travels through the object (both paint and metal) and is reflected back to the probe as an echo by either the back-wall of the object and/or any internal flaws or corrosion pits.

This echo pulse will then continue to reflect back and forth inside the object until it finally runs out of energy. Each time the echo pulse hits the probe surface a signal is received by the Underwater gauge; this signal is shown on the A-scan display as an echo peak.



Pits and Flaws

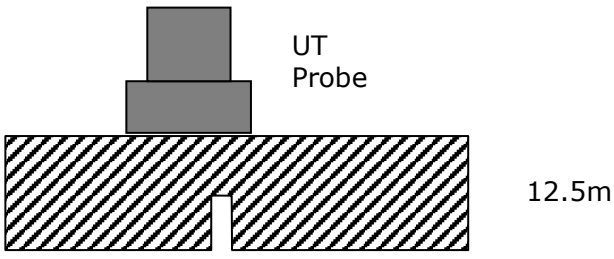
To obtain a reliable Multiple Echo thickness measurement the gauge must be able to see three distinguishable equi-spaced return echo pulses. The A-scan below shows the echo pulses of ultrasound as measured in a flat, un-corroded, unpainted piece of steel 15mm thick:



Flat, new steel 15mm thick.

You can easily identify the individual echo pulses and the gauge correctly measures the thickness and marks the echo pulses it used with three small yellow arrow markers.

If we introduce a flat bottom hole into the steel, drilled halfway through we can have a situation where the echo pulses from the hole are visible on the A-scan.

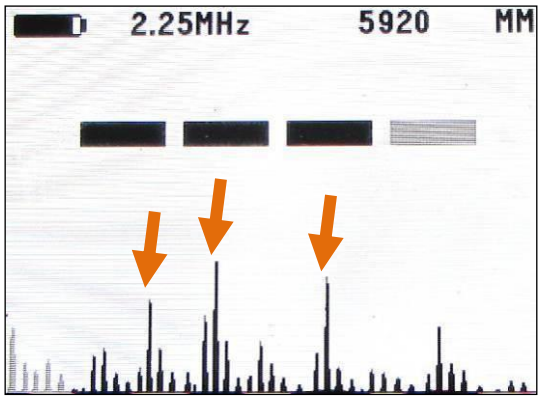


Flat, new steel 12.5mm thick with blind hole (DIVE gauge screenshot).

Now although the gauge is still correctly measuring 12.5mm you can see the echo pulses from the bottom of the blind hole (arrowed).

In practice - if you see smaller peaks between the larger peaks - it could be indication of pits or flaws inside the material you are measuring. By moving the probe around and observing the A-scan, you may be able to identify an area with better, more distinct ultrasound echo pulses.

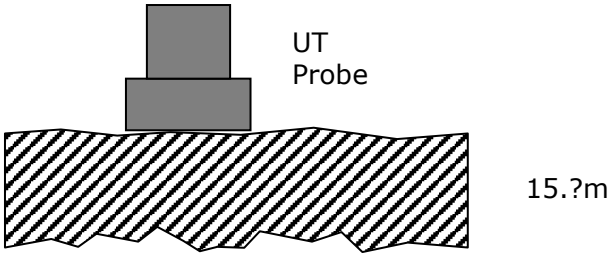
If the echo pulses from the pit or flaw obscure the pulses from the material back-wall the gauge may not be able to determine a Multiple Echo thickness measurement, the A-scan below shows a mixture of echo pulses that are spaced irregularly and as a result no thickness measurement has been located.



Uneven echo pulses from multiple uneven reflectors (DIVE gauge screenshot).

Heavy Corrosion

Measuring on heavily corroded steel will cause the ultrasound echo pulses to scatter and be absorbed. The ultrasound will be reflected from multiple points as there is no one true metal thickness. This makes it difficult for the gauge to identify the three equi-spaced echo pulses. What you might see on the A-scan display is only one or two echo pulses as shown below:



Heavily Corroded Steel Sample.

The best approach when having trouble getting Multiple Echo measurements is to try slowly moving the probe around the area looking for points where the echo pulses are stronger and more defined, keeping an eye on the A-scan so you spot “better” areas.

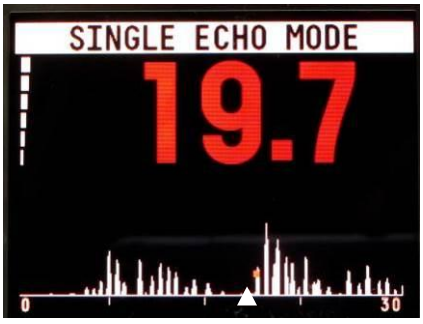
If you still are unable to get Multiple Echo measurements, then you have the option of using a twin crystal probe and using the gauge in Single Echo mode.

9. Interpreting the A-Scan Display in Single Echo Mode

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

In Single Echo mode 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 A-Scan display is very useful when measuring in Single Echo mode, as there is no Verification of the thickness measurement in Single Echo mode observing the A-Scan display will help the user verify the echo detected is the correct one – the back-wall echo. Screenshots in the following table are from DIVE gauge.

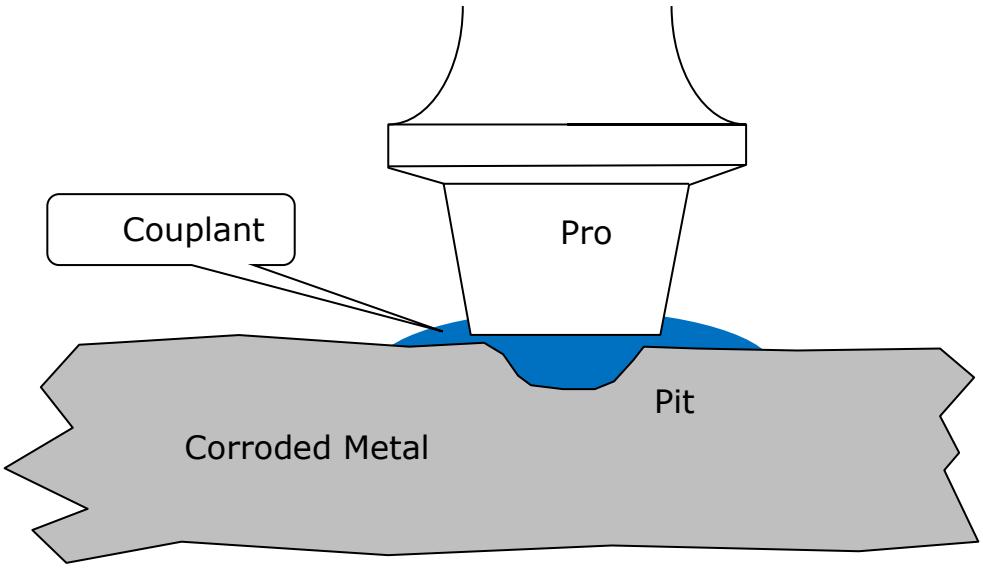
Good Signal This A-Scan shows a good clear ultrasound signal. There is a well-defined back-wall echo and the arrow is correctly placed at the start. The measurement value of 14.6 is stable when yellow in colour.	
Poor Signal This A-Scan shows a very weak ultrasound signal. There is no clear correct back-wall echo. Although a measurement of 19.7 has been displayed, it's not stable and should not be relied on. The measurement value is red in colour when unstable.	

Cast Iron This is an A-scan from a T2C probe measuring cast iron. This A-Scan shows a good clear ultrasound signal with a distinctive back-wall echo. Even though there are small echoes before the back-wall peak, the arrow is correctly placed under the start of the biggest echo peak. The measurement value of 39.2 is stable and yellow in colour.	
Cluttered Signals This A-Scan shows a very unclear ultrasound signal. There are lots of echoes and it's not very clear which is the correct back-wall echo. It is probably the biggest peak ¾ of the way across the A-scan graph – but the gauge may not detect this. You can use the A-scan to check that the gauge has identified the correct peak which is marked by the arrow. If it looks right and the arrow is in the correct position, then you can decide to use the thickness measurement. If it looks wrong, then try another location.	 

Measuring Over Corrosion Pits

Important
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.

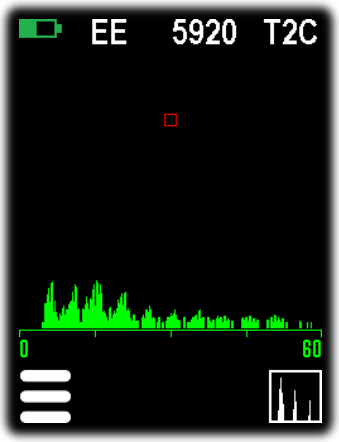


Avoid Measuring Directly Over Corrosion Pits.

The A-Scan display can assist you - you will see an unclear ultrasound signal with no distinct back-wall echo.

10. Interpreting the A-Scan Display in Echo-Echo Mode

Like Single Echo mode the A-Scan can be very useful when taking measurements through coatings 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.

Good Echo-Echo Signal. This A-Scan shows a clear 1st and 2nd echo and the gauge has correctly measured 16.2 mm. The echo-echo measurement is indicated by the solid Yellow which starts at the 1st echo and ends at the 2nd ec;ho.	
Poor Signal – Noisy. The gauge has been unable to locate a suitable 1st and 2nd echo in the correct position. The signal is noisy (possibly very corroded metal). Try moving to a different location or rotating the probe.	

11. 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;

$$Thickness = \frac{time * velocity}{2}$$

Modern thickness gauges are easily capable of measuring **time** accurately to 10 Nano seconds (0.000,000,01 seconds) 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 micro-meter.

Your measurements are only as good as your calibration.

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.

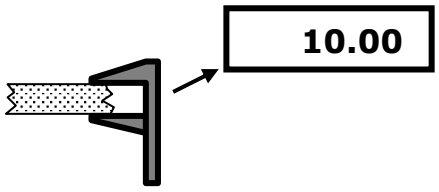
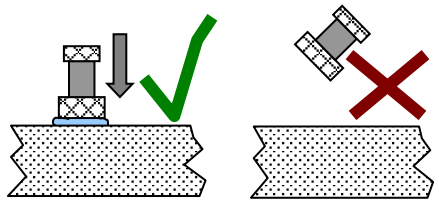
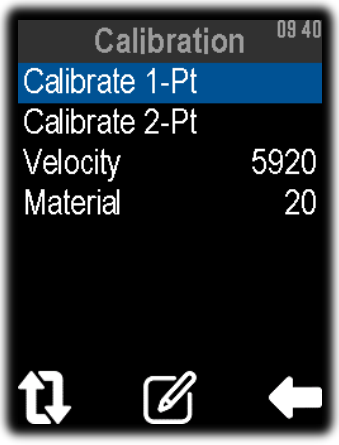
Either a 15mm or 1/2" **Test Block** is supplied with the kit so the Gauge can be quickly checked for correct operation. Note, this test block is not intended to be used for calibration of the Gauge.

Important
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.

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.

Single Point Calibration Procedure

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.	Select **[Menu:Calibration:Calibrate 1-Pt.]** Press the middle key to start calibration process.	

4.	While holding the probe firmly on the sample and while a steady thickness measurement is displayed use the Left and Right keys to adjust the thickness to the required value. When done press the middle key to save the calibration.	
5.	Press the left key (Yes) to save the calibration and exit or press the right key (No) to exit without saving the calibration.	

When a Calibration has been made a '1PC' indicator 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.

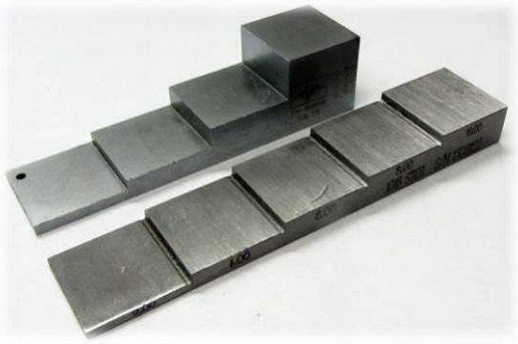
Important
To achieve maximum accuracy in Single Echo mode you must perform a Two Point Calibration – your measurement is only as good as your calibration.

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

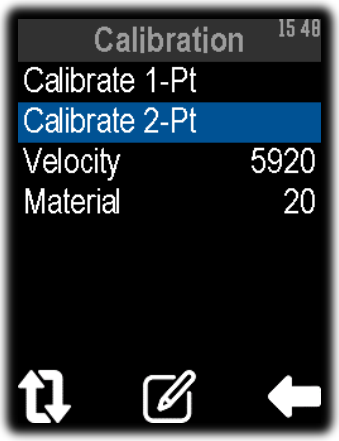
Typically, a Ladder Step Wedge is used to calibrate the probe and gauge for Steel. The ladder step wedge has 4 or 5 different thicknesses typically ranging from 2.5 to 20.0 mm (0.1 to 0.5”). You would typically choose to calibrate using the 2.5 and 20 mm thicknesses.

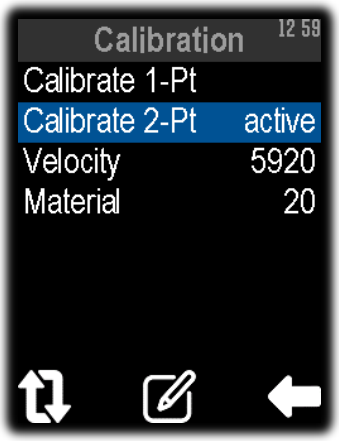


Ladder Step Wedges

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.	Select **[Menu:Calibration:Calibrate 2-Pt]** Press the middle key to start calibration process.	
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 -/+ (the Left/Right keys) to adjust the thickness to the required value – 25mm in this step. When done press the middle key to continue to the next Yes/No screen and choose: YES to continue to the Thin sample NO to abort the calibration	
7.	Next measure the Thin sample – Minimum thickness.	

8.	While holding the probe firmly on the thin sample and while a steady thickness measurement is displayed use the -/+ (Left/Right keys) to adjust the thickness to the required value – 10mm in this step. When done press the middle key to continue to the next screen.	
9.	Press the left key (Yes) to save the calibration and exit or press the right key (No) to exit without saving the calibration.	
10.	If calibration is saved (Yes pressed in the previous step) there is a text **active** displayed next to **Calibrate 2-Pt.**	

When a Calibration has been made a '2PC' indicator is displayed at the top of the measurement screen in the status area (*2PC = Two Point Calibration*).

'2PC' indicator

Setting the Velocity of Sound

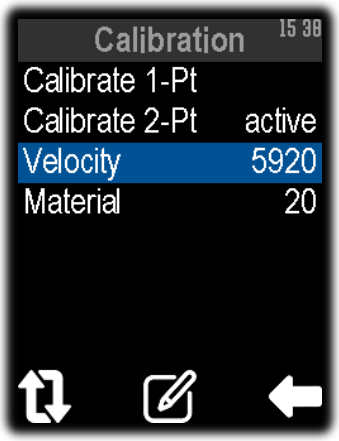
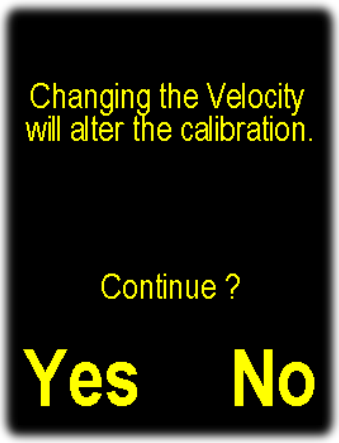
The gauge uses the Velocity of Sound value to calculate the material thickness value. It is therefore important the velocity value is set correctly for the material being measured.

Important
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 in section **Table of Sound Velocities** on page 128.

1.	Select [Menu:Calibration:Velocity]. Press the middle key to start the 'Velocity' adjustment screen.	
2.	If there has been a previous Calibration a message will warn that changing the velocity will alter the calibration. Press the left key (Yes) to continue, or the right key (No) to abort.	

3.	Use the -/+ (the Left/Right keys) to adjust the velocity value as required. When done press the middle key to continue to the next screen.	
4.	Press the left key (Yes) to save the velocity and exit or press the right key (No) to exit without saving the velocity.	

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'

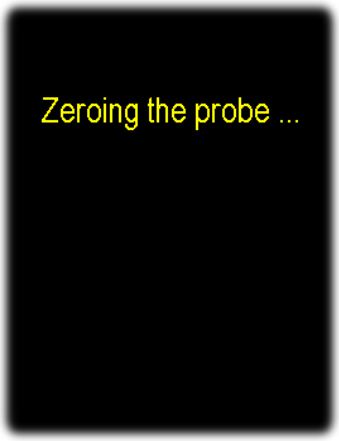
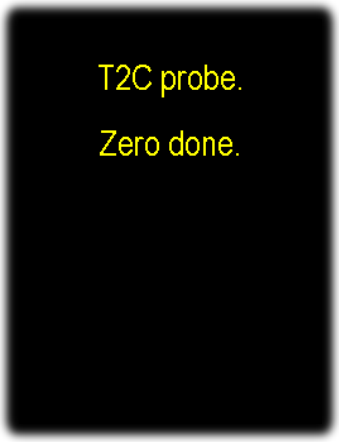
Probe Zero (twin element probes)

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 (68°F) change in temperature the measurements can shift by 0.1 mm (0.04").

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

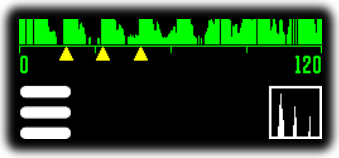
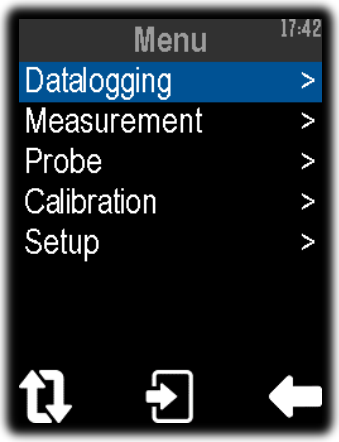
Starting a Probe Zero from the Main Menu

1.	Access the Menu and scroll down to the 'Probe' group. Then select 'Zero Probe' item. Press the middle key to start the 'Zero' process.	
2.	The gauge measures the probe zero point. This takes few seconds.	
3.	**Success** If Probe Zero was successful, this screen is displayed.	

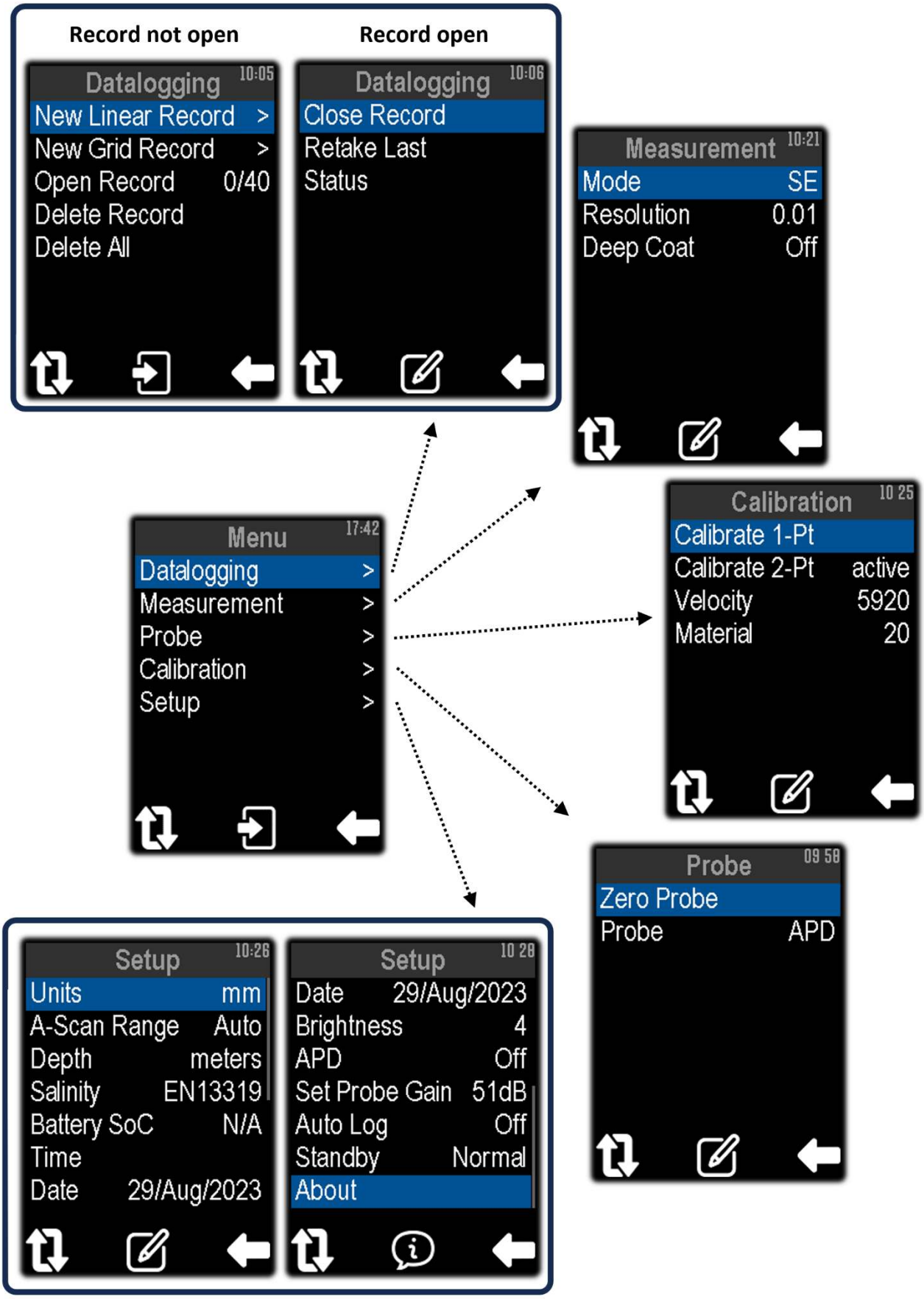
4.	**Failure** If the Probe Zero fails a message will be displayed. Check the probe has not been unplugged or the cable is damaged/faulty. The probe face must be clean and in the air. Are you using a non-Cygnus probe? You must un-plug the probe, then plug it back in to re-try the Probe Zero process.	

12. Gauge Setup

Menu Operation

1.	 Press the left key to show the menu.	
2.	At the top is the current menu name and the current time at the top right corner.  'Scroll-Around items' key  'Enter submenu' key  'Go back' key.  This glyph means that pressing the middle key opens submenu.	
3.	A short slide of the Power switch quits menu from any level and aborts	

Menu Content



13. Menu Content: Datalogging

Overview

The Datalogger feature allows the user to log thickness measurements in a structured record which can be saved to a file. Records can be created, saved, deleted, closed and re-opened to continue datalogging at any time. Records are saved as files in the gauges file system, each record is one file.

A single record file can hold up to 5000 thickness measurements including the A-scan graph. These measurements are then retrieved from the gauge by connecting to a computer which has Cygnus CygLink installed, the logged measurements are then transferred in to the computer and can be presented as a report, saved, emailed or exported to a spread-sheet application.

The gauge uses an AutoLog feature to enable the diver to data log measurements without pressing any buttons. Because the AutoLog feature works on timing it is best to practice data logging before the dive so you understand how to log the desired measurements.

AutoLog Feature

To remove the necessity for a "log" button but still enable the diver to log measurements the AutoLog feature was developed. The AutoLog feature uses timing of 'stable measurements' and 'no measurements' to decide when to log a reading.

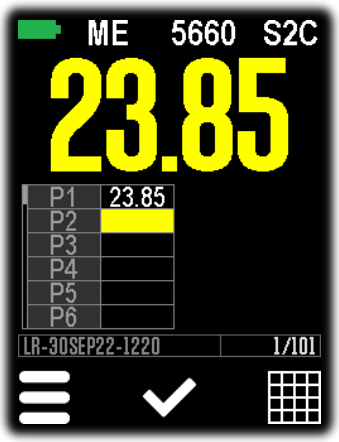
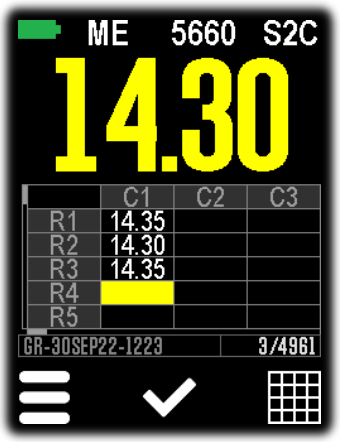
To data-log a measurement, the diver simply HOLDS the probe stable, maintaining the measurement for a minimum set time – the measurement is then automatically logged. To allow the next measurement to be logged the diver must then RELEASE the probe from the surface for a minimum set time – the gauge is ready to log the next measurement when required.

In summary, to Auto Log a measurement:

1	The diver places the probe on the surface and obtains a stable thickness measurement.
2	The diver Holds the probe still and maintains the stable thickness measurement.
3	After the set hold time the thickness measurement will be logged.
4	The diver removes the probe from the surface for at least the set release time.
5	For the next measurement repeat again from step one.

Record Types

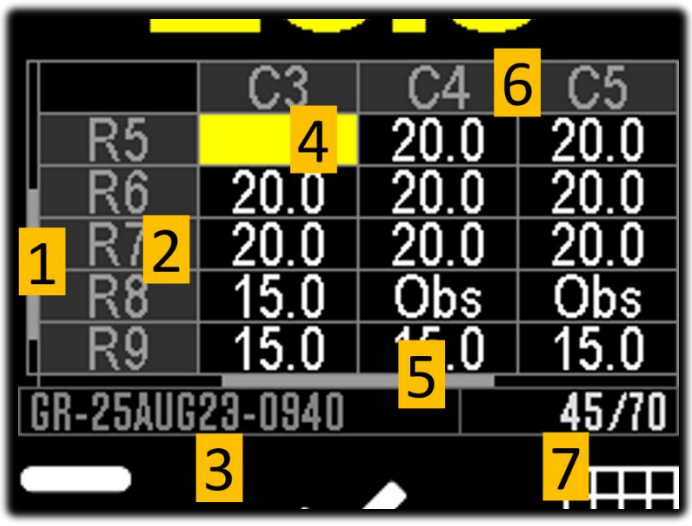
There are two types of Record that can be created.

Linear	Grid 2D
One-dimensional list of measurement points	Two-dimension grid of measurement points.
	

Measurement Screen while Data Logging

When the gauge is data logging the measurement screen will show details of the last few measurements and the number logged.

When the gauge is data logging the measurement screen will show details of the last few measurements and the number logged.
When the A-scan display is turned on the display will look like;

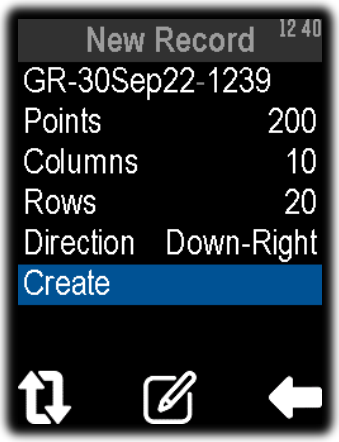
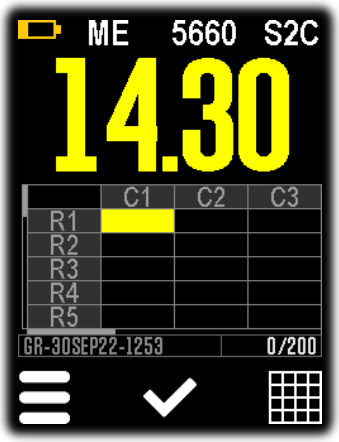


1. Position bar along rows
2. Rows' names
3. Record name
4. Current position
5. Position bar along columns
6. Columns' names
7. Number of recorded measurements

Datalogger Features

- Each record can have a maximum of 5000 measurement points.
- Each measurement point includes an A-Scan 'snapshot'.
- Grid records can have a 'grid patten' specified.

Creating a New Record

1.	Select **[Menu:Datalogging:New Grid Record]** Press the middle key to show record's parameters.	
2.	Set the parameters for the new record in the list displayed. Use the middle key to edit a record's parameters. When all parameters have been set, select Create item and press the middle key to create new record.	
3.	Start logging.	

Record Names

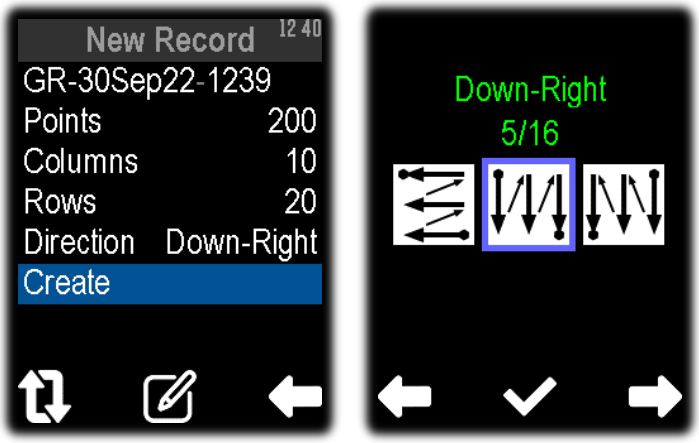
When a new record is created, it is given a default record-name (and thus filename) based on the record type and the time and date.

Linear Record = LR-30Sep22-1245
Grid Record = GR-30Sep22-1245

A record file of a given type (Linear, Grid) can be created only once every minute as a record file name must be unique.

Grid Record Patterns

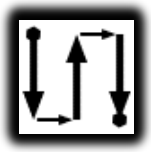
Grid records have a choice of 16 pattern describing how to move the cursor around the grid as measurements are taken.



Grid Record and Grid Patterns

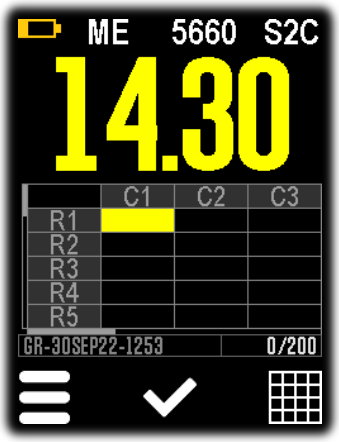
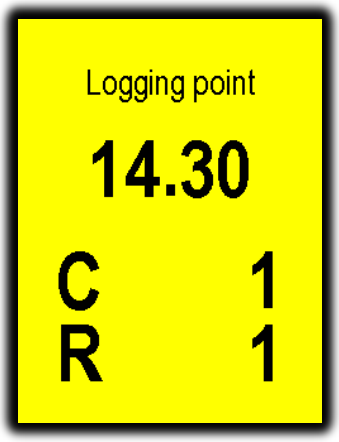
Example Patterns

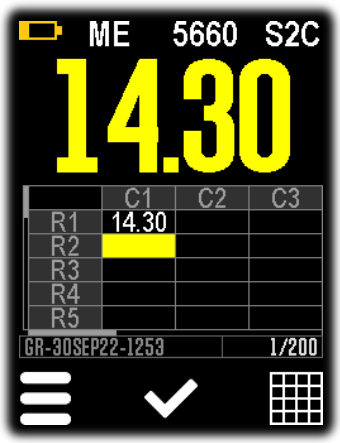
	Right Down, Right Down	This is a **Horizontal** Measurement pattern. First move **right** across the columns, then move **down** to the next row. Repeat.

	Up Left, Up Left	This is a **Vertical** Measurement pattern. First move **up** through the rows, then move **left** to the next column. Repeat.
	Down Right, Up Right	This is a **Vertical-S** Measurement pattern. First move **down** through the rows, then move **right** to the next column. Then move back **up** through the rows, then move **right** again to the next column. Repeat.

Logging Measurements

Manual Measurement

1.	 To log a thickness measurement, press the middle key once in any measurement screen.	
n2.	Confirmation message about the point logged within the record. Column 1, Row 1 in this case.	

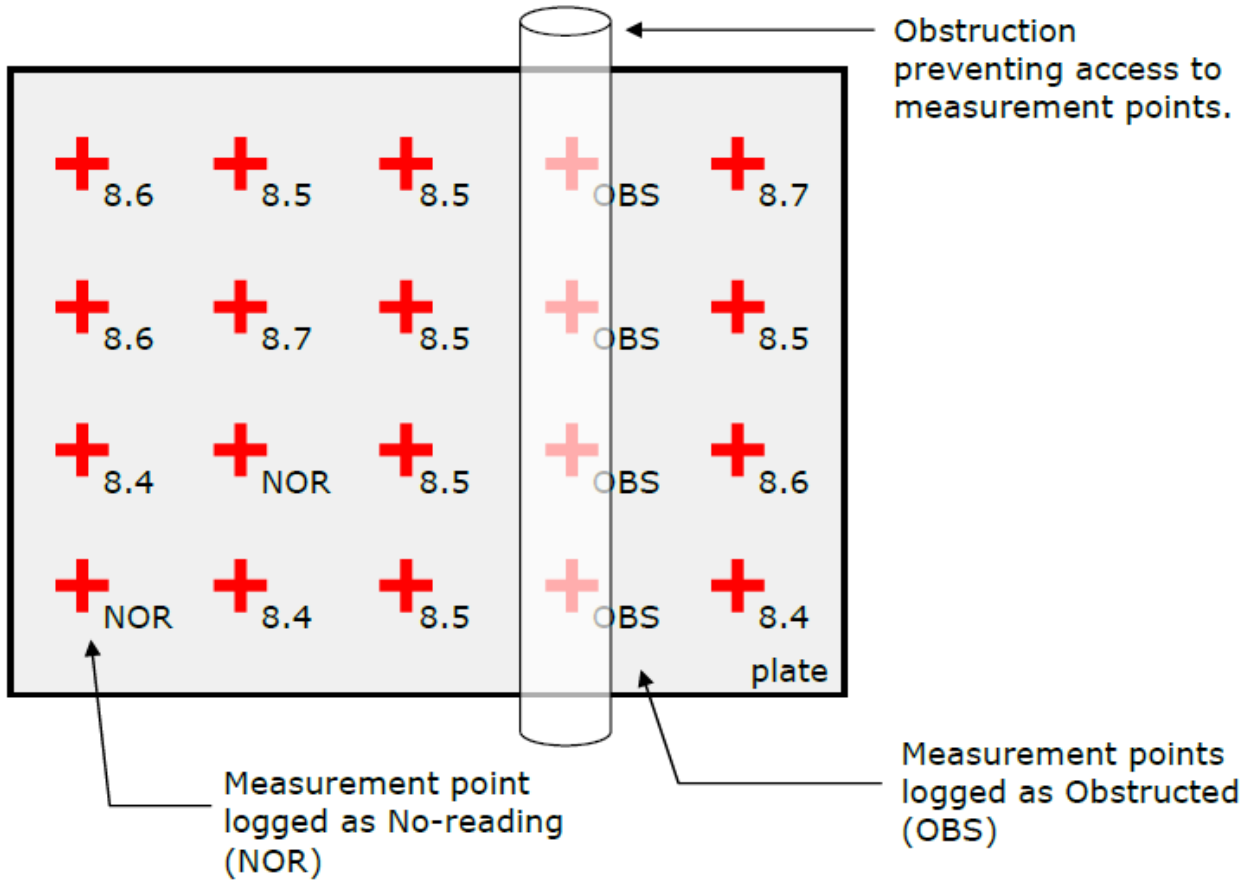
3.	Next point is C1R2.	

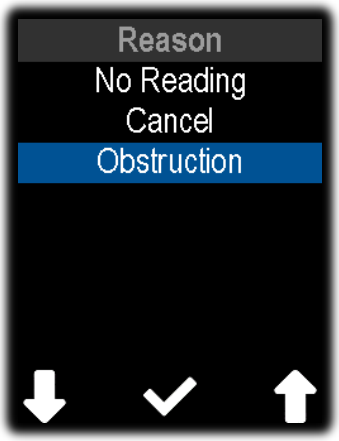
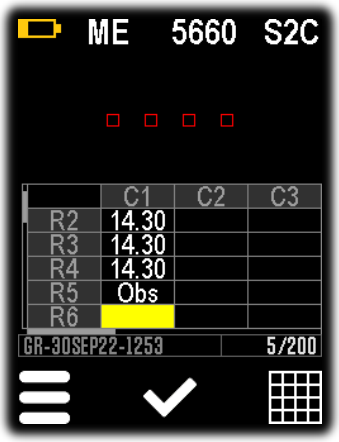
Auto-Logging Feature

When the Auto-Log feature is turned on (see **[Menu:Setup:Auto Log(On)]** page 93), Auto-Log will automatically log a stable thickness measurement after a period of time if the measurement is maintained.

Logging Obstructed (Obs) Measurements

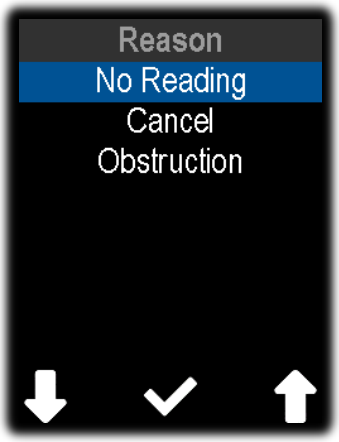
When you can't physically access a thickness measurement location, but need to record something in the record, you can choose to log a **Obs** (**Obstructed**) measurement.

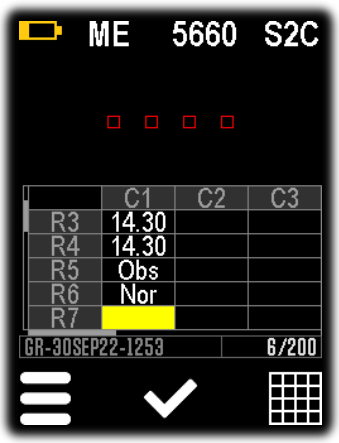


1.	In a measurement screen, make sure there is no thickness measurement displayed. After pressing the middle key to log, screen prompts for a select **Reason** for not logging a thickness measurement. Select and confirm **Obstruction**.	
2.	Point C1R5 is marked as **Obs**.	

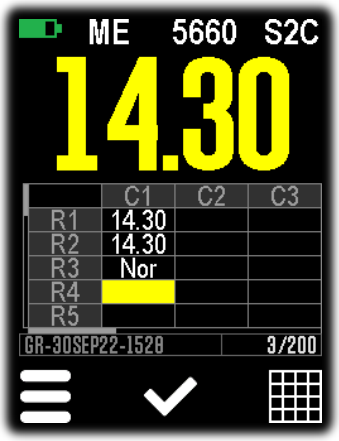
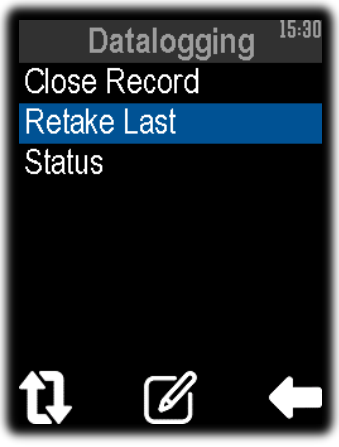
Logging No-Reading (NOR) Points

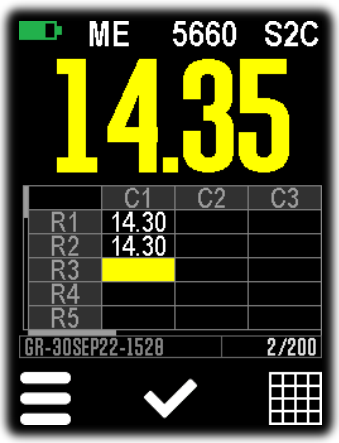
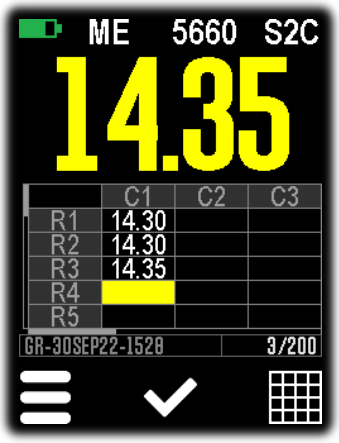
When you can't get a thickness measurement at the current location, but need to record something in the record, you can choose to log a **Nor** (**No Reading**) measurement.

1.	In a measurement screen, make sure there is no thickness measurement displayed. After pressing the middle key to log, screen prompts for a select **Reason** for not logging a thickness measurement. Select and confirm **No Reading**.	

2.	Point C1R6 is marked as **Nor**.	

Re-Taking the Last Thickness Measurement

1.	To re-take the last point (C1R3) select **[Menu:Datalogging:Retake Last]**	
2.	 Press the middle key	

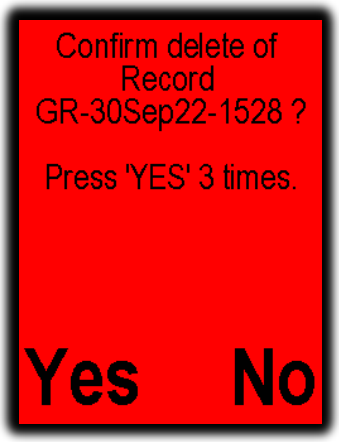
3.	The logging cursor moved one step back – from cell C1R4 to cell C1R3	
4.	 Press the middle key to log new measurement.	

Deleting Records

You can delete datalogger records from the gauge, either by selecting individual records, or by deleting all the records in one go. Only un-protected records can be deleted.

Deleting Individual Records

1.	First, close any Open record - **[Menu:Datalogging:Close Record]**	
2.	Select the **[Menu:Datalogging:Delete Record]**  Then press the middle key.	

3.	Select the record to delete. Then press the middle key to delete. You will be prompted to confirm the deletion.	
4.	Press the left key (Yes) 3 times to delete, or the right key (No) to cancel.	

Deleting All Records

1.	Select the **[Menu:Datalogging:Delete All Record]** Then press the middle key to Delete.	
2.	Press the left key (Yes) 3 times to delete all records, or the right key (No) to cancel.	

14. Menu Content: Measurement

Measure Mode

The Measure Mode determines how the gauge uses the ultrasound signals to get a thickness measurement. There are three measurement modes;

ME	Multiple Echo	Single Crystal Probes e.g. S2C
EE	Echo-Echo	Twin Crystal Probes e.g. T5B
SE	Single Echo	Twin Crystal Probes

The gauge will automatically set the measure mode to match the probe type selected. The current Measure Mode is displayed on the Measurement screen.

Resolution

Measure Mode	Resolution Available
Multiple Echo (ME)	0.05mm or 0.1mm resolutions (0.002 or 0.005 Inch)
Single Echo (SE) Echo-Echo (EE)	0.01mm or 0.1mm resolutions (0.001 or 0.005 Inch)

Decreasing the resolution may help the gauge to obtain a Multiple Echo thickness measurement on heavily corroded materials as the return echoes don't have to be matched as precisely.

Deep Coat

With the Deep Coat feature turned Off and in multiple echo (ME) mode the gauge can measure through most protective coatings up to 3 mm (0.12") thick when using a **S2C** type probe. Coatings like paint, anti-foul, hard plastics and epoxy should present no problems as long as they have not de-laminated/de-bonded from the metal surface.

With the Deep Coat feature turned On this will allow the gauge to measure through coatings over 3mm (0.12") thick up to a maximum of around 20 mm (0.8") depending on the properties of the coating material.

Measuring through thick coatings is ultimately limited by how well the coating material allows the ultrasound to pass through, soft coatings like rubber or bitumen don't transmit ultrasound very well.
When Deep Coat feature is enabled text 'DC' starts flashing on the Status area of the Measurement screen.

Using Deep Coat will not affect the calibration.

Important
Turn Deep Coat Off when NOT measuring through thick coatings otherwise this may cause inaccurate measurements.

15. Menu Content: Probe

Zero

See section Probe Zero (twin element probes) page 65.

Probe Zero can be done when the instrument is in water.

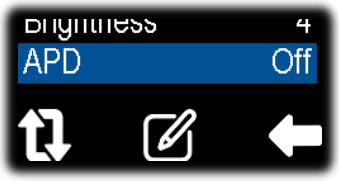
Probe

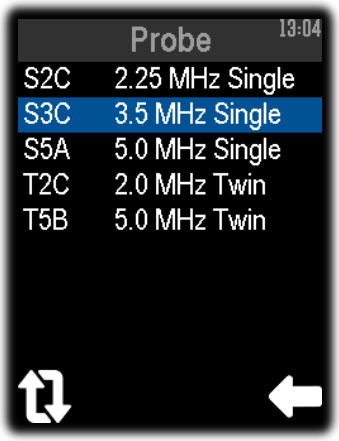
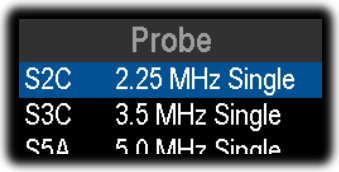
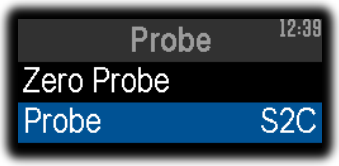
The gauge can automatically detect the type of probe connected (set **[Menu:Setup:APD(on)]**, see page 89).

In case **Auto Probe Detection** feature is disabled (**[Menu:Setup:APD(off)]**), **[Menu:Probe:Probe]** provides the user with a list of probes to choose from manually.

Important
The probe type must be correctly set to match the probe being used otherwise thickness measurements will be impossible or incorrect.

Setting probe type manually

1.	Disable ADP feature **[Menu:Setup:APD]** Press the middle key so that **APD** is **Off**.	
2.	Navigate to **[Menu:Probe:Probe].** It is active now. Press the middle key to show list of probes.	

3.	The line with the current probe is highlighted.  Press the left key to select new probe.	
4.	S2C selected.  Press the middle key to load selected probe.	
5.	**[Menu:Probe:Probe]** shows new probe now.	

16. Menu Content: Calibration

Calibrate 1-Pt

See section **Calibrating to a known thickness (Single or 1 Point)** (p. 59).

Calibrate 2-Pt

See section **Two Point Calibration** (p. 60)

Velocity

See section **Setting the Velocity of Sound** (p. 64)

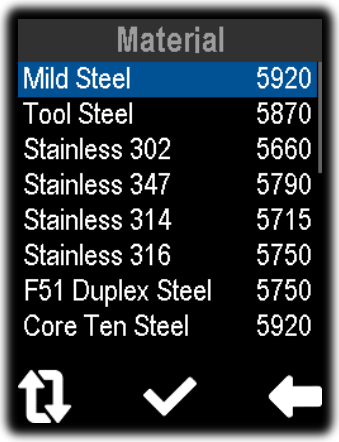
Material

The gauge holds a list of common materials and their typical velocity of sound values under **[Menu:Calibrate:Material]**. You can use the material list to quickly set the gauge to measure different materials.

This list uses typical velocity values, in practice the actual velocity will vary according to the precise grade and processing conditions of the material being measured.

This list is provided 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.



17. Menu Content: Setup

Units

The Gauge can display thickness measurements and Velocity of Sound in either Metric (mm, m/s) or Imperial (inch, inch/us). Changing the measurement units will not affect the calibration.

A-Scan Range

The X-axis of the A-Scan graph is ideally set to show the best number of return echoes in the material being measured. The gauge can **automatically** adjust the A-Scan range using the thickness measurement, or you can **manually** set the range to suit the material thickness you expect to measure.

The A-Scan range setting does not affect the thickness measurement.

Range Change : 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 of thicknesses, the A-Scan range will always be set so you can observe the required number of echoes.

Range Change : Manual

You can choose from the following A-Scan range values:

Units	Ranges						
mm	15	30	60	120	200	400	Auto
inch	0.6	1.2	2.4	4	8	16	Auto

In Multiple Echo mode the A-Scan graph axis is set to 4 times the A-Scan Range setting – this is to ensure at least three back wall echoes can be displayed.

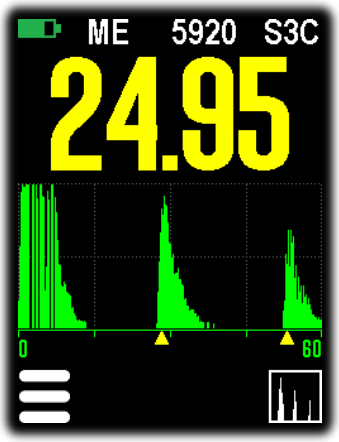
Example 15mm x 4 = 60mm.

In Single Echo mode the A-Scan graph axis is set to the A-Scan Range setting – this is because you only need to see one back wall echo.

Next is an example of A-Scan of the same thickness for different range selected.

Multiple Echo (ME)

The range of X axis is 4x the range set in A-Scan Range

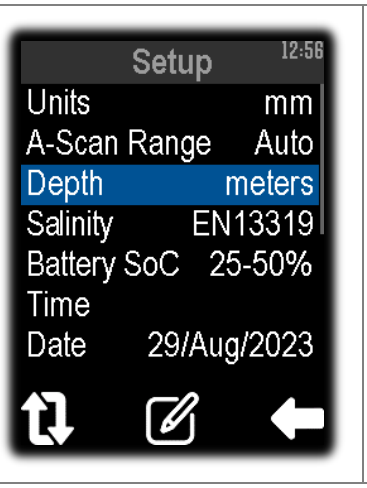


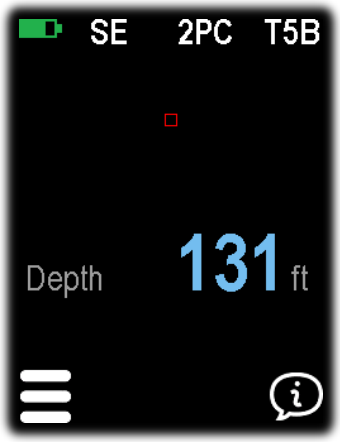
Single Echo (SE)

The range of X axis is equal to the range set in A-Scan Range

Depth units

The Gauge can display its depth on measurement screen in either Metric (m) or Imperial (feet) units.





Salinity

Water type (salinity) affects how the measured pressure is converted to depth. The different settings available are:

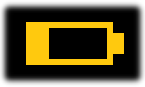
- Fresh
- EN13319 (default)

- Salt

Density of freshwater and saltwater differ by about 3%. Saltwater, being denser, will display a shallower depth for the same measured pressure versus the Fresh setting. The EN13319 value is set between Fresh and Salt.

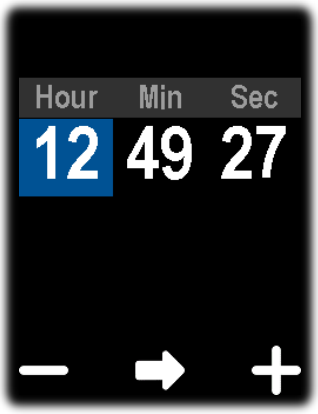
Battery State of Charge (SoC)

Battery SoC can show these values:

Battery SoC N/A		Gauge requires ~1 minute to start displaying SoC. During that time, 'SoC Not Available' is displayed.
Battery SoC 100%		Battery fully charged
Battery SoC 50-100%		
Battery SoC 25-50%		The range where battery spends most of its time.
Battery SoC 0-25%		Consider replacing the battery. When approaching 10%, 'LOW BATTERY' warning is displayed on the top of the measuring screen. See *Low Battery on p. 45* 

Time and Date

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

 Move to the next field and exit.  Increase the value.  Decrease the value.		

Brightness

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

The value is changed by pressing the middle key. There are 5 levels of brightness.

APD (Auto Probe Detection)

The gage can automatically detect the type of probe connected. The APD can be turned On or Off. When Off the type of connected probe must be set manually by selecting from list of probes in **[Menu:Probe:Probe]**.

When **[Menu:Setup:APD]** is **On** Probe type cannot be changed manually. **[Menu:Probe:Probe]** shows 'APD'.	
When **[Menu:Setup:APD]** is **Off** Probe type can be changed manually. **[Menu:Probe:Probe]** shows currently selected probe.	

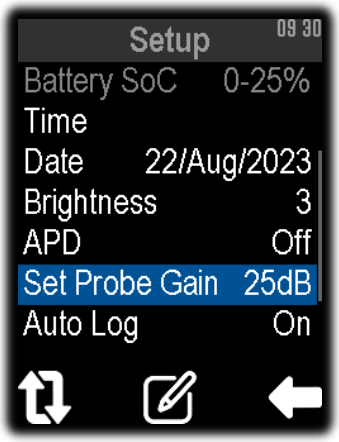
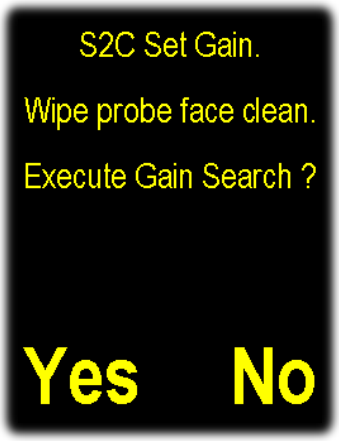
Set Probe Gain

The probe gain can be auto-set by the gauge to allow for sensitivity variations in the probe. This ensures the optimal gain settings are used for the probe connected.

You can perform a Autoset Gain function at any time.

Set Gain: Single Element Probes

The gain is optimised when the probe is uncoupled.

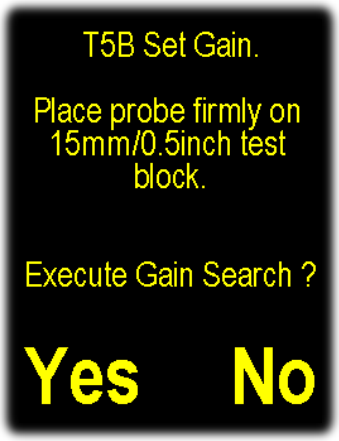
1.	Select **[Menu:Setup:Set Probe Gain]** Press the middle key to start gain setting procedure.	
2.	Follow the instructions wiping clean the probe face. Press the left key to start, right to abort.	
3.	It takes few seconds to find a gain.	
4.	**Success** The gauge finds an optimal gain value, and this is confirmed by a message and gain value in the **Setup** screen.	

		
5.	**Failure** The gauge fails to find an optimal gain value, and this is confirmed by an error message and gain value in the **Setup** screen is set to X.	 

Set Gain: Twin Element Probes (15mm/0.5inch test block)

The gain of a Twin Element Probe is optimised when the probe is placed on a 15mm(0.5inch) steel Test Block (also supplied with the kit).

1.	Prepare the **Test Block**	
2.	Select **[Menu:Setup:Set Probe Gain]** Press the middle key to start gain setting procedure.	

3.	Follow the instructions placing the probe on the block (15mm/0.5inch).	
4.	Place and hold the probe steady on the block. Press the left key to start, right to abort.	
5.	It takes few seconds to find a gain. Hold the probe steady on the block	
6.	**Success** The gauge finds an optimal gain value, and this is confirmed by a message and gain value in the **Setup** screen. The probe can be removed from the block.	 
7.	**Failure** The gauge fails to find an optimal gain value, and this is confirmed by an error message and gain value in the **Setup** screen is set to X. The probe can be removed from the block.	

Auto Log

When Data Logging the Auto-Log feature will automatically log a stable thickness measurement after a period of time if the measurement is maintained. This setting turns the Auto-Log feature On or Off as required.

When unable to get a stable measurement try smaller resolution (see **[Menu:Measurement:Resolution]** on page 80)

Standby

The gauge has a power save feature that helps to increase battery life when the gauge is not measuring. You can choose from three power-saving settings. These determine how long before the gauge will dim the display.

	Mode	**Dim display Time** [seconds]
1.	Short	10
2.	Normal	20
3.	Long	60

About

1.	Model	Model of the gauge: Standard, Plus, Pro	
2.	Serial No.	Serial number of the gauge	
3.	SW-HW ver	Software(5.0.25) and Hardware(9) versions of the gauge	
4.	Run Time	Total time of the gauge operation since it left the factory.	
5.	Uptime	Elapsed time since last Power On (current session)	

6.	Humidity	Percentage, temperature	
7.	Max. Depth	Maximum Depth in which the gauge was submerged.	
8.	QR code	Link to this manual.	

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:

- Measurement Mode
- Resolution
- Velocity of sound
- Calibration
- Probe Gain

18. Care and Servicing

Cleaning the Gauge

- ✔ After each dive while the Battery is still attached to the Gauge, wash the unit in fresh water and dry
- ✔ A mild detergent may be necessary to remove grease from the O-ring grooves
- ✘ Do not use solvents to clean the Gauge
- ✘ Do not use any abrasive cleaner, especially on the display window

Power Switch Cleaning

If the Power Switch becomes difficult to operate it may have sand or sediment in the switch mechanism, you can usually flush out any debris easily, or you can remove the power switch for more thorough cleaning.

- With the gauge in water, gentry push the switch back and forth to allow any debris exit the mechanism. This can normally get the switch operating again.
- With the gauge out of the water and the battery still screwed on, you can spray WD-40® or similar to help lubricate and free up the switch mechanism.

Removing the Power Switch

To remove the switch for cleaning, use a small flat-blade screwdriver and gentry prise the switch assembly out of the gauge body – there is a small slot at the bottom of the switch for the screwdriver. The switch is a push-fit into the gauge body, to replace simply push back into the recess until it clicks into position. With the switch removed you can clean in a water and detergent solution until its operating smoothly again.

Slide the Power Switch back and use a small screwdriver to lift the yellow switch out of the gauge body.	
Lift the switch out of its recess until you can remove it with your fingers.	
To refit the power switch simply push it back into its recess in the gauge body.	

O-ring Seals

- ✔ Always clean and lightly lubricate the O-rings before and after every dive.
- ✔ Inspect the O rings and if in any doubt about the sealing capability of an O-ring, always discard and replace (damage/dirt/debris/shape).
- ✘ Never use a sharp or pointed object to remove an O-ring, only an O-ring remover tool – you could damage the O ring on removal.
- ✘ Don’t over grease; Too much grease attracts debris that will disrupt the seal and cause flooding. Silicone grease is not a sealant, it only protects the O-ring from abrasion and assists in smooth seating. A perfectly greased O-ring looks moist and shiny.

Battery Care

The battery packs contain NiMH cells which if unused for long periods of time will slowly degrade and may not be recoverable. Therefore, when not using the gauge you must periodically charge the batteries.

Every 6 months fully charge both the batteries to recondition them and extend their life.

- ✔ Always remove the battery pack if the Gauge will not be used for more than a few days
- ✔ Only recharge the battery packs with the supplied charger
- ✔ Recharge the batteries periodically even if the Gauge will be left unused for more than a few days
- ✘ Do not attempt to disassemble the battery - it contains no serviceable parts.
- ✘ Do not change the battery pack while underwater.

Environmental

- ✘ Do not subject the Gauge to temperatures greater than 60° C (140° F)
- ✘ Do not store the Gauge and its kit 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.

Disassembly

Important
Do not remove the two screws next to the battery connection in an effort to open up the gauge, without specialist tools and removal of the display window, you will be unable to re-assemble the gauge, this will also void any subsequent warranty claim.

DO NOT REMOVE THESE SCREWS	

Display Bezel Removal

The yellow display bezel is secured to the gauge body with two screws. While not recommended, the bezel can be removed for cleaning of the three push buttons should this be required, but re-fitting the bezel and buttons can be difficult due to the magnets inside the buttons.

Note, the display window cannot be removed without specialist equipment.

To refit the bezel and three buttons;

1. Turn the bezel upside down and hold level
2. Place the three buttons and springs into the bezel
3. Keeping the bezel level, manoeuvre the gauge body so the two tabs in the bezel align into the gauge body
4. Bring the gauge body down so the three buttons go into the recesses in the display window
5. Hold together while you turn the gauge body over, keeping the bezel in position
6. Re-fit the two screws and hand tighten.

Returning the Gauge for Servicing

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

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

Cygnus gauges are world 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 your gauge for Repair, please let us know the details of the problem to help us guarantee the best possible service:

- Is the problem of an Intermittent Nature?
- Is there a problem turning the gauge On? Or a problem with the gauge turning itself Off?
- Does the gauge consistently give Incorrect or Unsteady Readings?
- Is it not possible to Calibrate the gauge?

19. Spares and Accessories List

There is a complete range of spares and accessories available from Cygnus Instruments Ltd. Please contact Cygnus, or their distributor in your area with your requirements.

- Spare O-Ring Packs
- Ultrasonic Probes
- Spare Batteries
- Batteries with Umbilical Data Connectors
- Membrane Packs for Single Element Probes
- Membrane Couplant for Single Element Probes
- USB Interface Cables
- Conversion Kits for adding a Topside Link via an Umbilical Cable
- Umbilical Cables

CYGNUS Instruments Ltd.
Cygnus House, 30 Prince of Wales Road,
Dorchester, Dorset, DT1 1PW England.

Website: **www.cygnus-instruments.com**
Tel: 00 44 (0) 1305 265533
sales@cygnus-instruments.com

For all Cygnus offices in UAE, USA, Singapore, and Authorised Cygnus Service Centres and Distributors please refer to the Cygnus website Worldwide Distribution page.

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

20. CygLink Computer Software

CygLink is a Windows® program that is used to display live thickness measurements at the surface, or when at the surface after a survey transfer Data Logger records from the gauge so they can be reviewed, edited and reports produced.

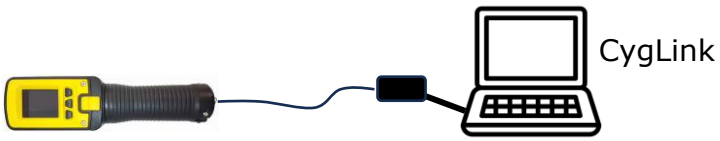
CygLink offers the following features;

- When the Gauge is being used subsea
  - Display live thickness measurements and A-Scans from the gauge.
  - Control the measurement setup of the gauge from the surface.
- After measurements have been logged and the Gauge is at the surface
  - Create Surveys to contain your data logger records and measurements
  - Transfer your data logger records from the gauge
  - Organise your records and measurement points
  - View A-Scan graphs
  - Add comments to individual measurement points
  - Create a PDF report of a survey
  - Export data from the survey to a CSV file

Information is transferred between the Gauge and CygLink using serial RS485 data send via an umbilical cable. A special battery with a wet-mateable connector is used to connect the gauge to the subsea umbilical cable. At the surface, the umbilical is connected to the computer via a USB data converter lead.

Transferring Data on the Desk

To transfer data logger records from the gauge to a Cyglink, the gauge is typically on the desk next to the computer, a short USB Interface Cable is used to connect from the connector on the battery to a computers USB port.



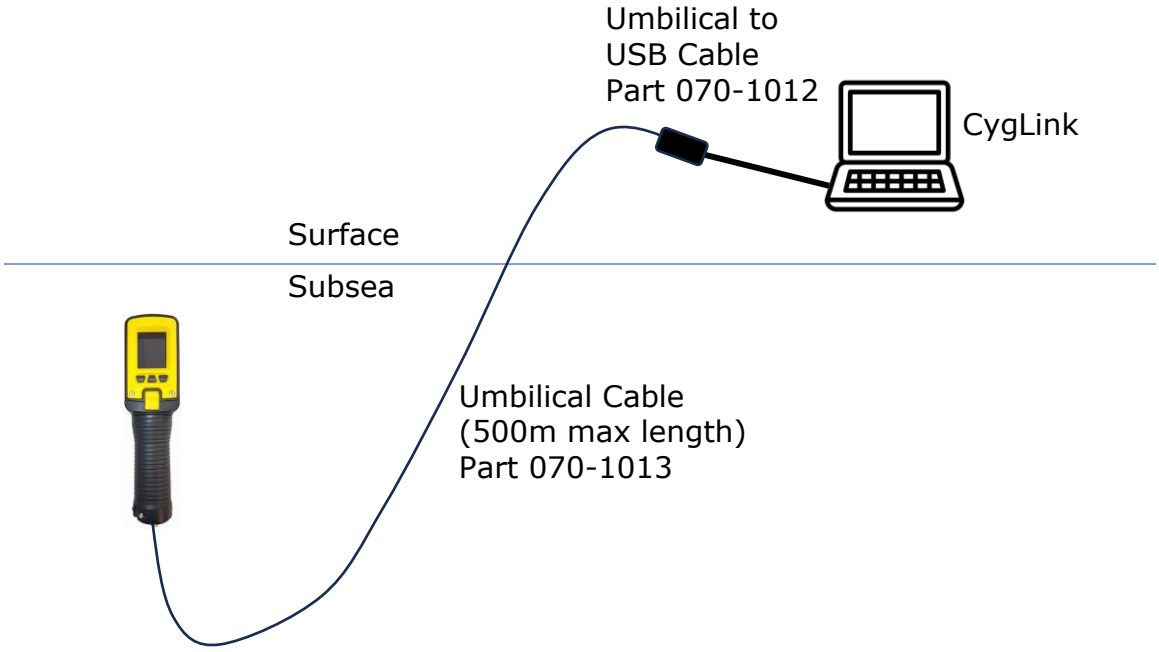
USB Interface Cable
Part No. 070-1010

Pro variant gauges are supplied with this USB Cable in the kit.

Transferring Data when Subsea

When transferring data subsea an umbilical cable is used. This cable can be up to 500m long.

Cygnus can supply a ready-made umbilical cable [Part No 070-1013] the length is specified when ordering. To connect the umbilical cable to the computers USB port a short cable is also required [Part No 070-1012].



Subsea Umbilical Cable Arrangement.

Battery Pack with Umbilical Connection

To connect an umbilical cable to the gauge, a battery pack with a SubConn wet-mate connector is required.

Battery with Umbilical Connector. Part No 070-1050

Pro variant gauges are supplied with two batteries that have umbilical connectors.

Installing CygLink

CygLink is supplied with the kit on a USB Flash Drive, or it can be downloaded from the Cygnus Instruments website. If you want to make sure you are installing the latest version then downloading from the website is the best route.

Requirements

To install and run CygLink the computer must:

1. Be running Windows 10 or newer
2. Have sufficient resources for Microsoft .NET Framework installation
3. We recommend a screen resolution of 1280 x 720 or greater
4. We recommend at least 1GB of memory

Upgrading

You can check the Cygnus Instruments website for the latest version of CygLink.

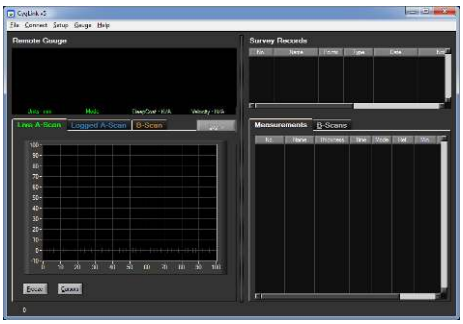
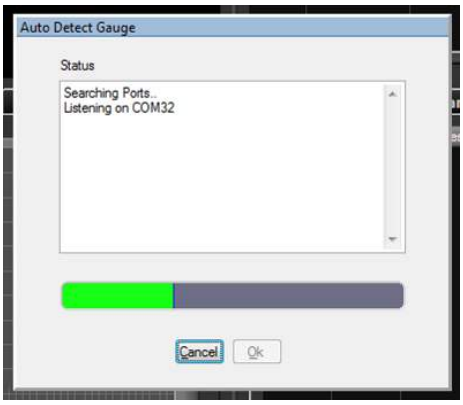
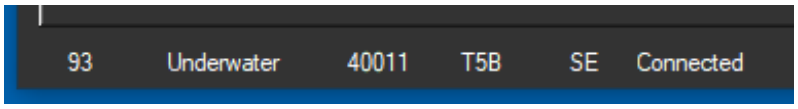
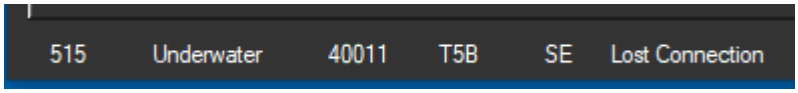
If you are upgrading from an older version of CygLink then you must uninstall the old version of CygLink first.

Installing

If you downloaded the CygLink installer file from the Cygnus website then this may be a single self-extracting ZIP file.

Double click the ‘setup’ or ‘CygLink…’ exe file to start installation. You will need to agree to the license terms and conditions. There are no options to select so installation is straight forward.

Connecting the Gauge to CygLink for the First Time

1.	Turn on the gauge	
2.	Start CygLink	
3.	From the Menu click; **Connect** **└ Discover new Gauge and Connect**	
4.	CygLink will search all the available Com ports listening for a Cygnus gauge.. If a gauge is detected then it will connect and save these settings for next time.	
5.	When connected you should see details of the gauge in the status bar at the bottom and 'Connected'	
		
6.	If the connection is ever lost the status bar will show 'Lost Connection'	
		

Manual Connection Settings

If you need to manually set the connection settings then select the **Connection Settings** option from the **Connect** menu, here you can specify the COM Port number, gauge type and baud rate.

Status Bar

At the bottom of the CygLink screen is the Status Bar, it shows information about the gauge and the connection.

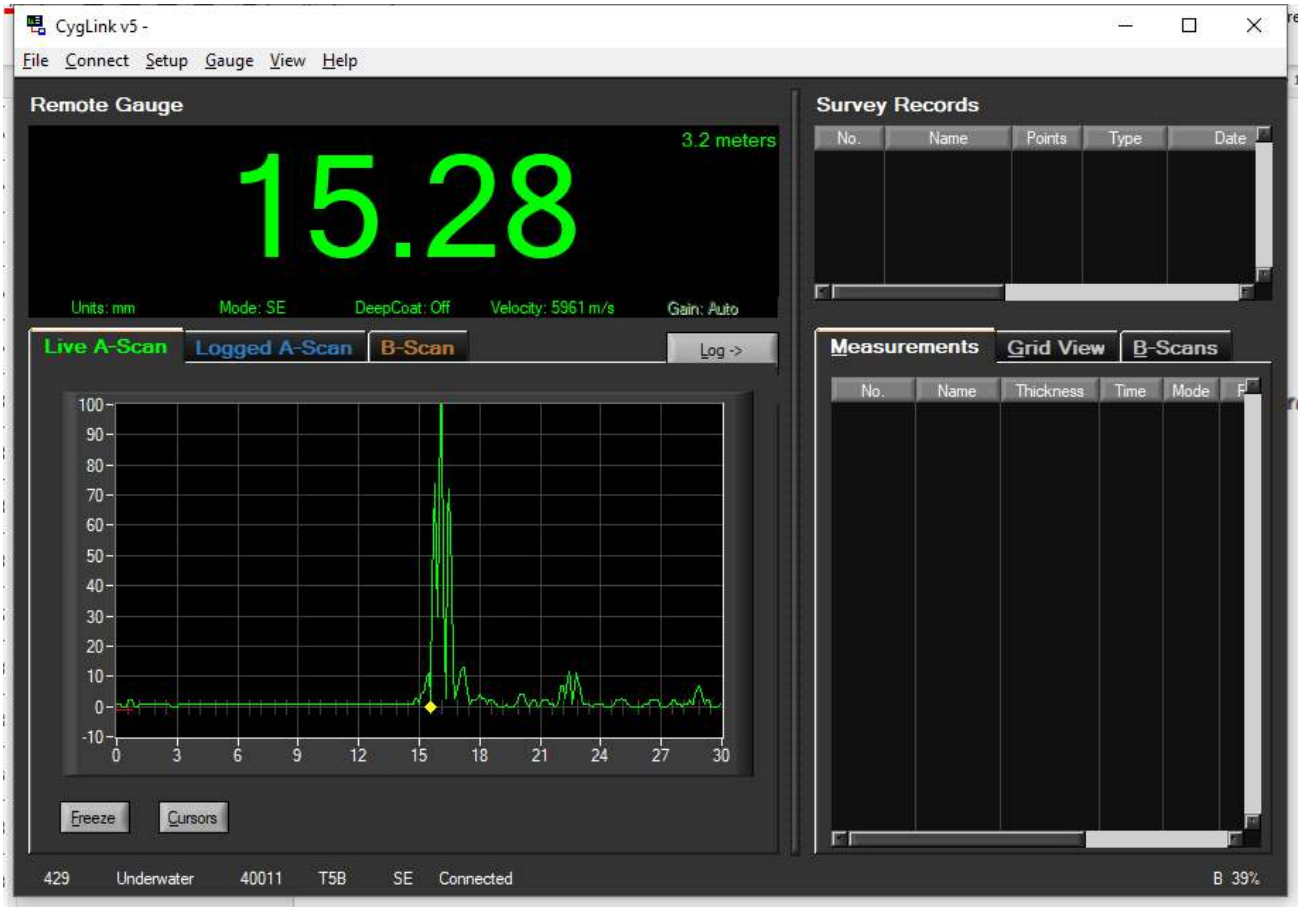
Status Bar

From left to right;

1. Received message counter (increase as message arrive from the gauge)
2. The Gauge Type
3. The gauge's serial number
4. The probe type connected to the gauge
5. The gauge's measurement mode
6. The connection state (Connected, Lost Connection, Disconnected)
7. The gauge's battery level

Live Measurements

When the gauge is operating and connected to CygLink is will display live measurements and A-Scans with an update rate of 8 per second. The current depth is also displayed at the top right corner of the thickness measurement area.



CygLink Live Measurement and A-Scan.

Freezing The Measurement

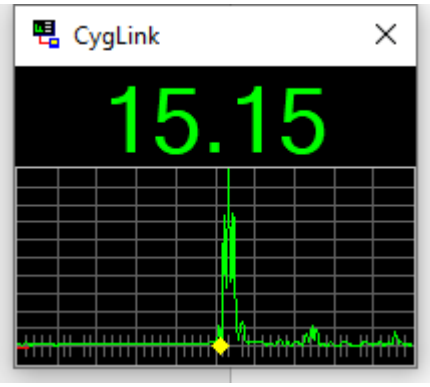
The **Freeze** button under the A-Scan can be used to Freeze the measurement so you can inspect the A-Scan using the cursors. Pressing Freeze again will un-freeze the display.

Logging Live Measurements

You can Log a Live Measurement using the **Log->** button under the thickness display, this will add the measurement to the existing record if open or create a new record if there isn't one it can use.

Compact View Mode

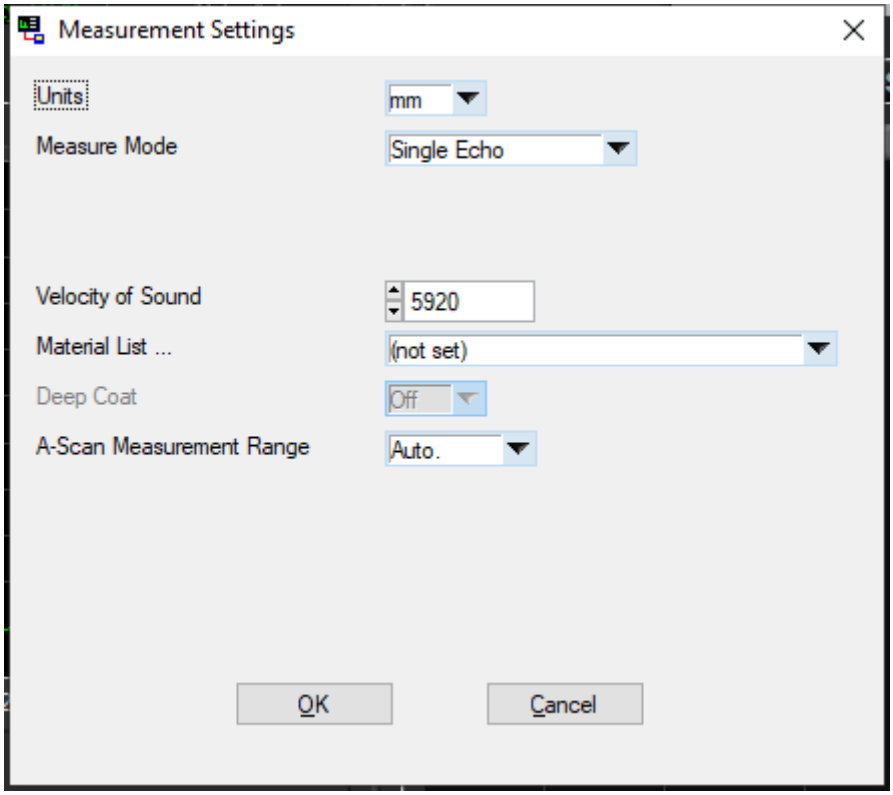
If you want to reduce CygLink to a small area on the computer screen, the compact view feature displays a small measurement and A-scan that can be positioned anywhere on the desktop. From the menu select **View->Compact View**, or press F9 key. To exit the compact view display, click on the **X** top right.



Compact View Display.

Controlling the Gauge from CygLink

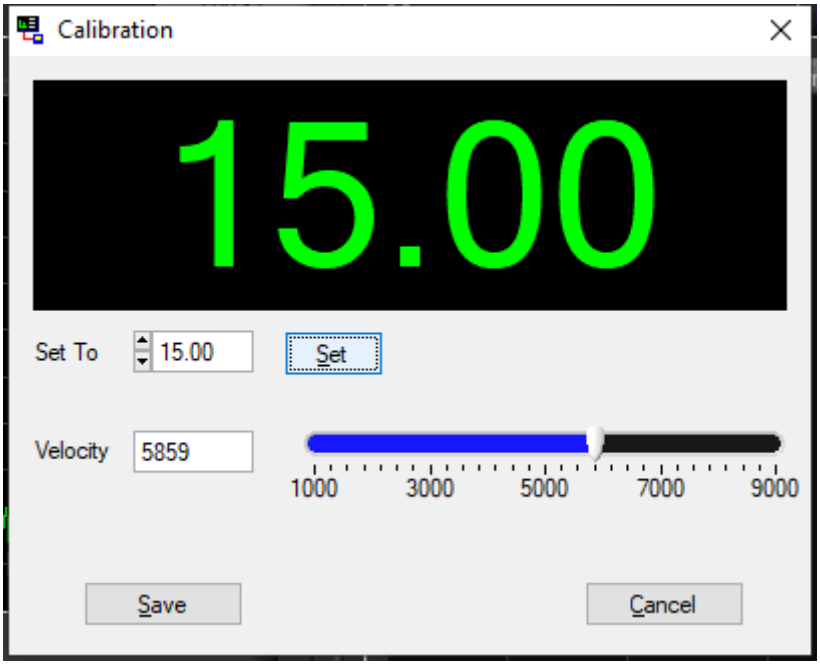
You can set the Units, Velocity, Measurement Mode and A-Scan Range on the gauge from CygLink, from the menu select **Setup->Measurement Setup**.



Measurement Setup Dialog.

Calibration on CygLink

You can perform a Single Point calibration from CygLink, this will set the Velocity of Sound value on the gauge and in CygLink. From the menu select **Setup->Calibrate Thickness Measurement**.



Calibration Dialog.

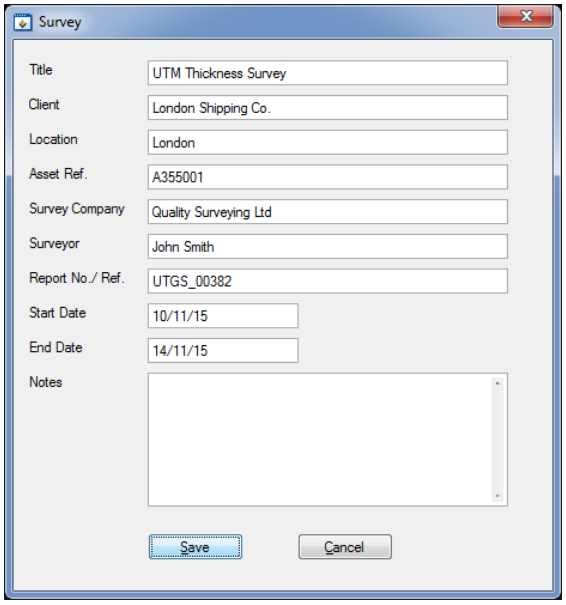
Surveys

A Survey is a container for all your data logger records and measurements. A Survey can be saved to a single file which can be copied or send electronically to another CygLink user. The Survey file is binary and cannot be tampered with.

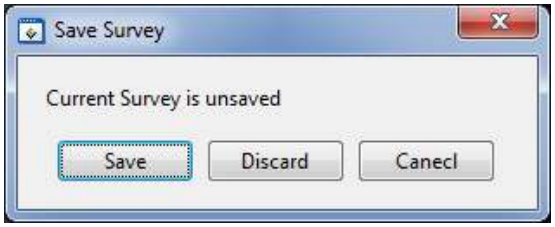
Creating a new Survey

You don't have to create a Survey, but it does create the container for any records that you transfer from the gauge. If you intend to save the records transferred to a file then you will need to create a Survey first.

1.	From the Menu click; **File** └ **New Survey**

2.	Complete as many fields as required, you can always go back and edit this information. This information will appear on the PDF report and the export to CSV file output.	
3.	You can save your new Survey to a file, from the Menu click; **File** **└ Save Survey** Entering your filename and location.	

Opening an Existing Survey

1.	From the Menu click; **File** **└ Open Survey**	
2.	You may be prompted to save any unsaved data first	

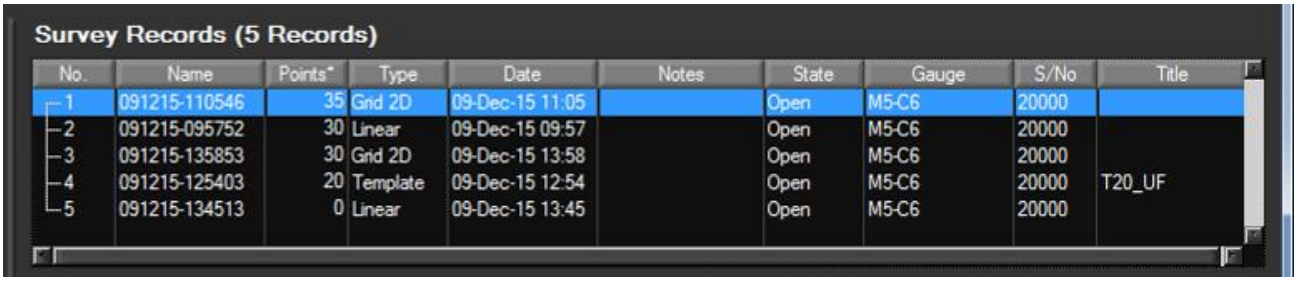
Editing the Survey Info

1.	From the Menu click; **File** **└ Edit Survey Info**

Managing the Survey

Sorting Survey Records

You can sort some of the columns in the Survey Records list by clicking on the column header. A column that has been sorted is marked with an asterisk after the column name. Clicking the column header a second time will toggle between an ascending or descending sort.



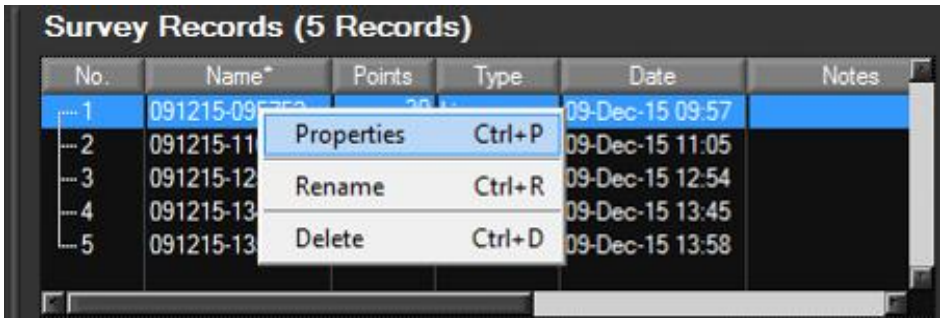
Survey Records List

Survey list columns that can be sorted;

- Name (ascending or descending)
- Points (ascending or descending)
- Type
- Date (ascending or descending)

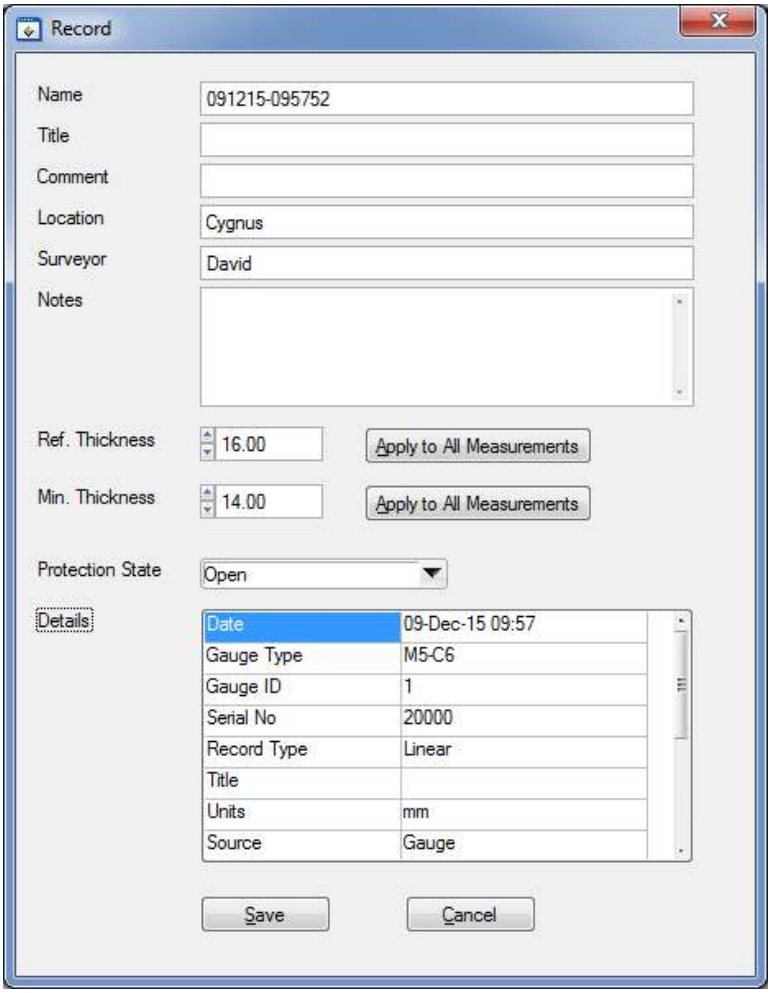
Viewing Record Information

You can view the details of a record by right-clicking on the record in the list which will display a context menu, select the Properties item.



Record Properties Screen

The Record Properties will be displayed;



Record Properties Screen

You can edit the fields in this screen, the **Details** table is read only and contains details about the record and summary information about its measurements.

Ref and Min Thickness

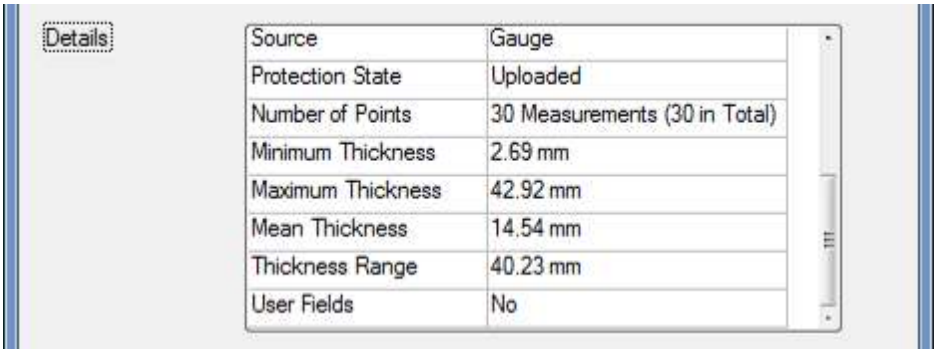
You can set and apply a Reference and Minimum thickness value for the record, click the **Apply..** button to apply this values to the measurement points in the record.

Protection State

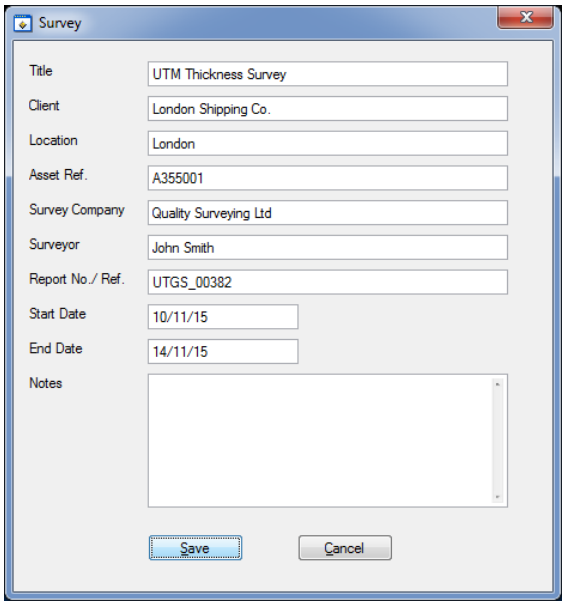
You can set a record to be Protected or Open, when Protected it will prevent users from editing the measurement points or deleting them.

Measurement Summary Stats

If you scroll down the **Details** table you will see summary information about the measurements contained in the records;



Record Properties Screen - Stats

2.	This information will appear on the PDF report and the export to CSV file output.	

Data Logger Records

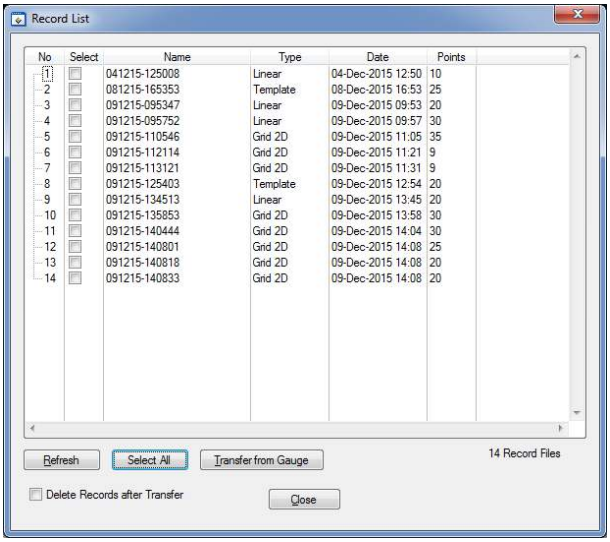
Transferring Records from the Gauge

You need to be connected to the gauge to transfer records.

1.	From the Menu click; **Gauge** **└ Transfer Records from Gauge**

2. A list of records stored on the gauge will be displayed. You can select the individual record you wish to transfer or click **Select All**.

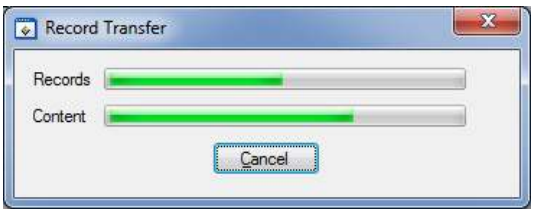
If you check **Delete records after Transfer** they will be deleted from the gauges memory card after transferring.



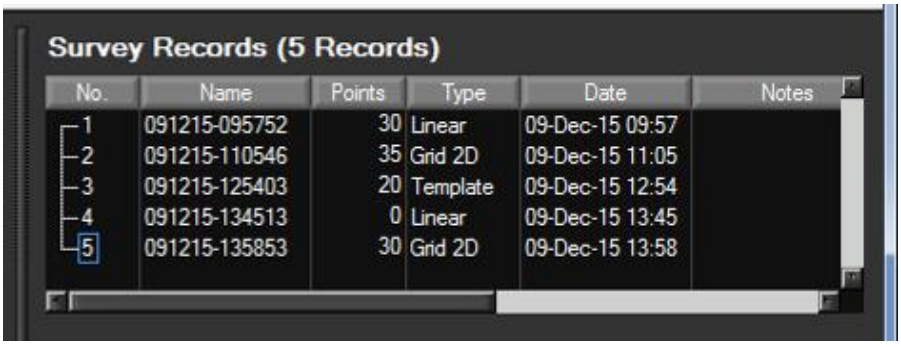
3. To start the transfer click **Transfer from Gauge**

Click **Transfer** to confirm..

During the transfer process a progress screen is displayed



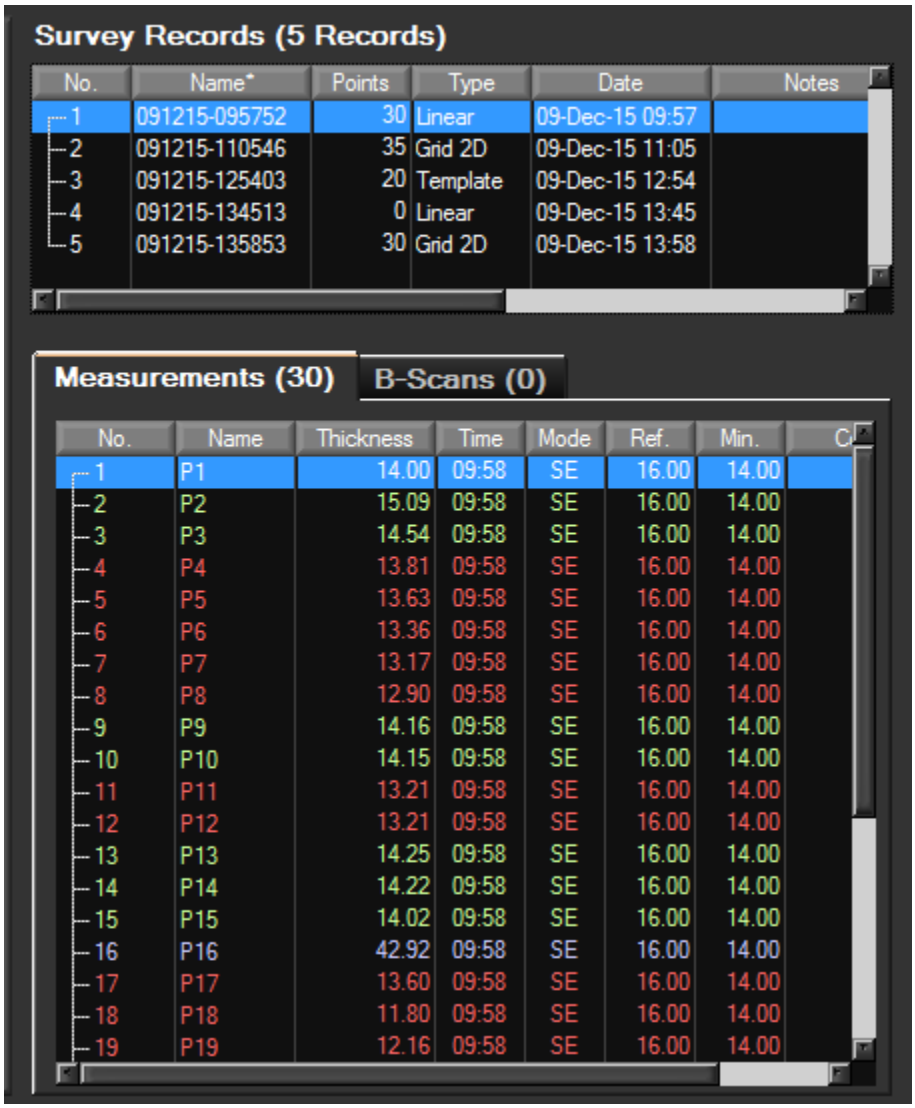
4. When all the records have been transferred they will be listed in the **Survey Records** list



5.	You should save the Survey file now, from the Menu click; **File** └ **Save Survey**

Viewing Thickness Measurements in a Record

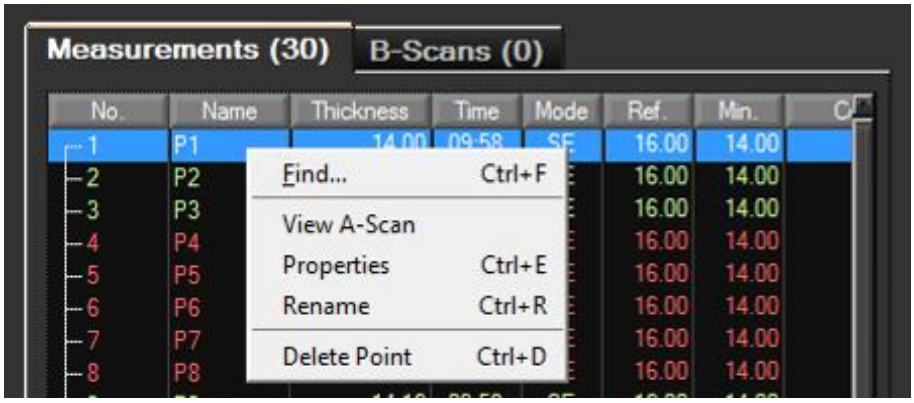
To display the list of thickness measurements in a record click on the record in the **Survey Records** list, the **Measurements** tab below will display the measurements belonging to the record;



Record and Measurements Tab

Managing Measurements

You can right-click a selected measurement to display the context-menu;



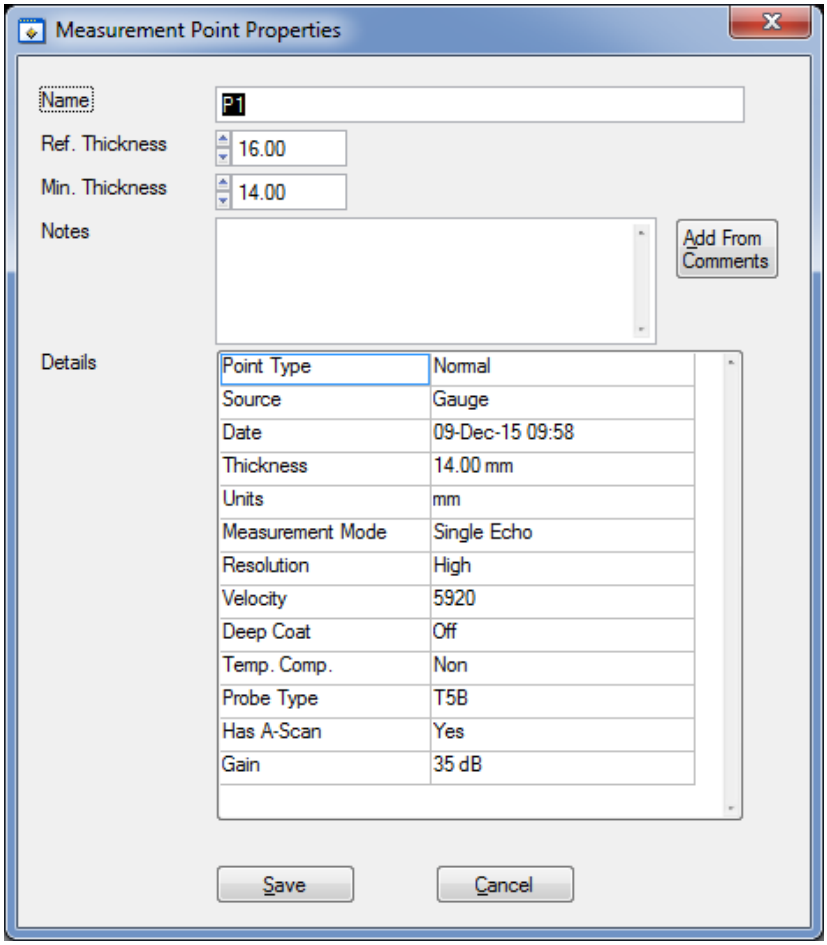
Measurements Context Menu

This menu allows you to **Find**, **Rename** and **Delete** a measurement point, you can also view information about the measurement or display its **A-Scan** graph if it has one.

Note there is no undo function - once deleted the measurement point is lost, unless you have saved a copy of the survey, or the record is still saved on the gauge.

Viewing Measurement Information

Clicking Properties from the context menu will display the measurement properties screen;

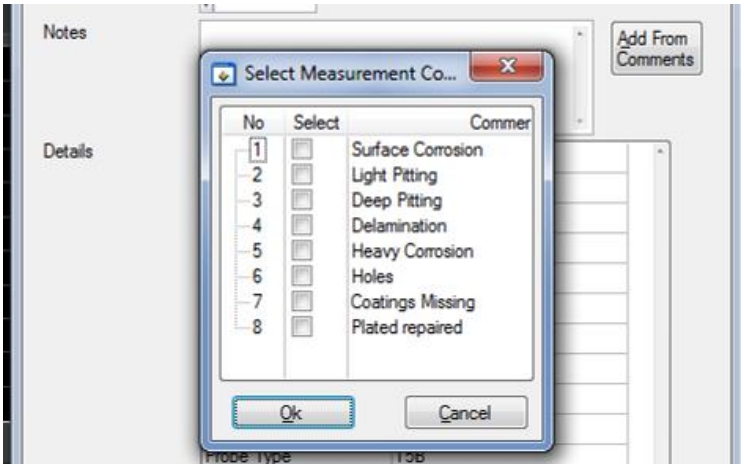


Measurements Properties Screen

Adding Comments to Measurements

You can add comments to a measurement point using the measurement properties screen. The **Notes** field can be directly typed into, or you can click the **Add From Comments** button to select a comment from the pre-defined list.

Comments will appear next to the measurement in the PDF report.

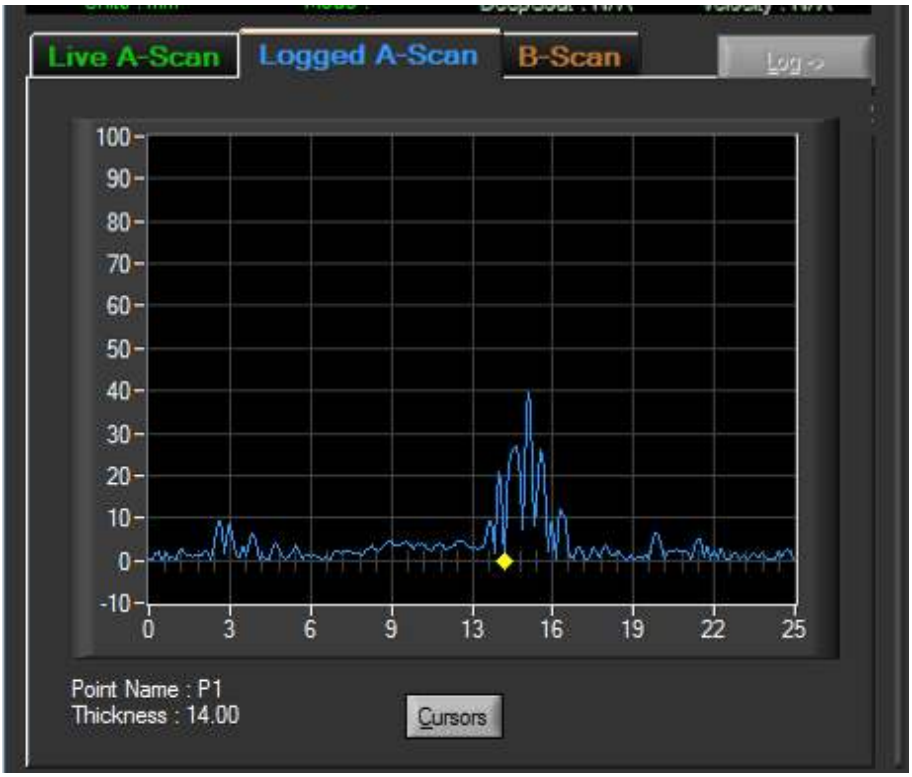


Selecting Measurements Comments from the List

Just select the required comments in the list and click **Ok**.

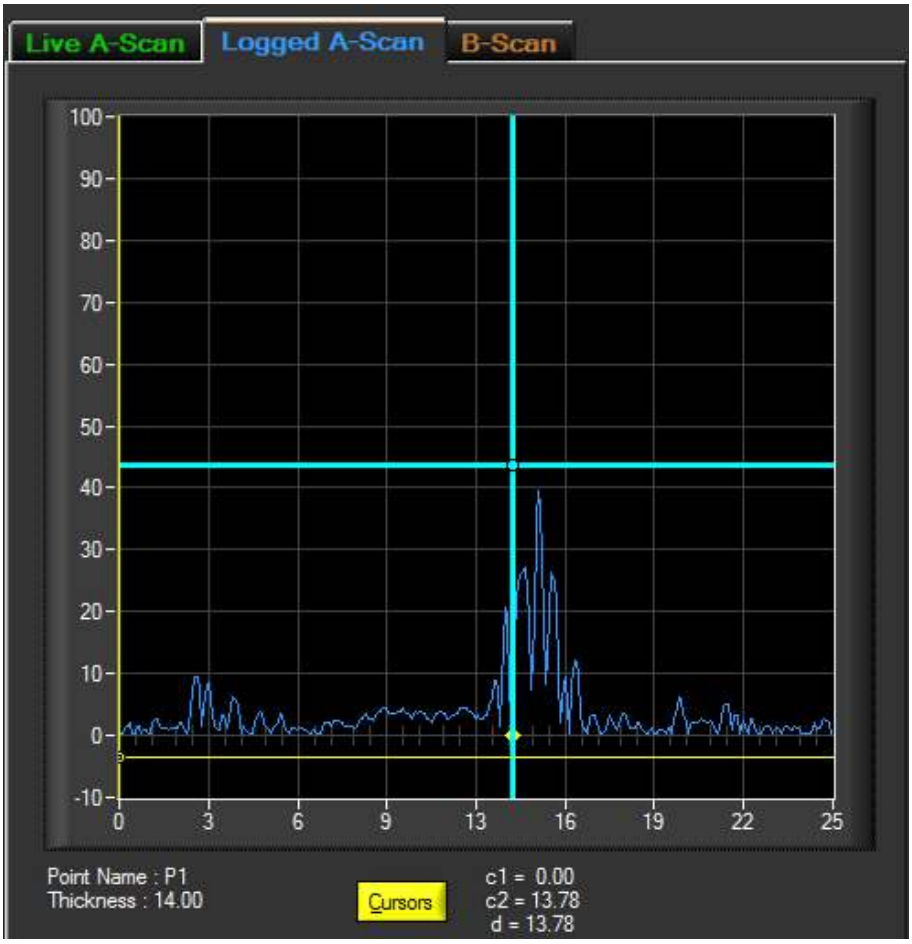
Viewing an A-Scan Graph

You can select the **View A-Scan** item from the measurements context menu or double click the measurement row. The A-Scan graph will be displayed in the **Logged A-Scan** tab section on the left.



Logged A-Scan Graph

You can toggle the measurement cursors on and off by clicking the **Cursors** button;



Logged A-Scan Graph with Measurement Cursors

The thickness values of the two cursors (c1 = yellow, c2 = blue) are displayed to the right of the Cursor button along with the difference between the two cursors for relative measurements (d).

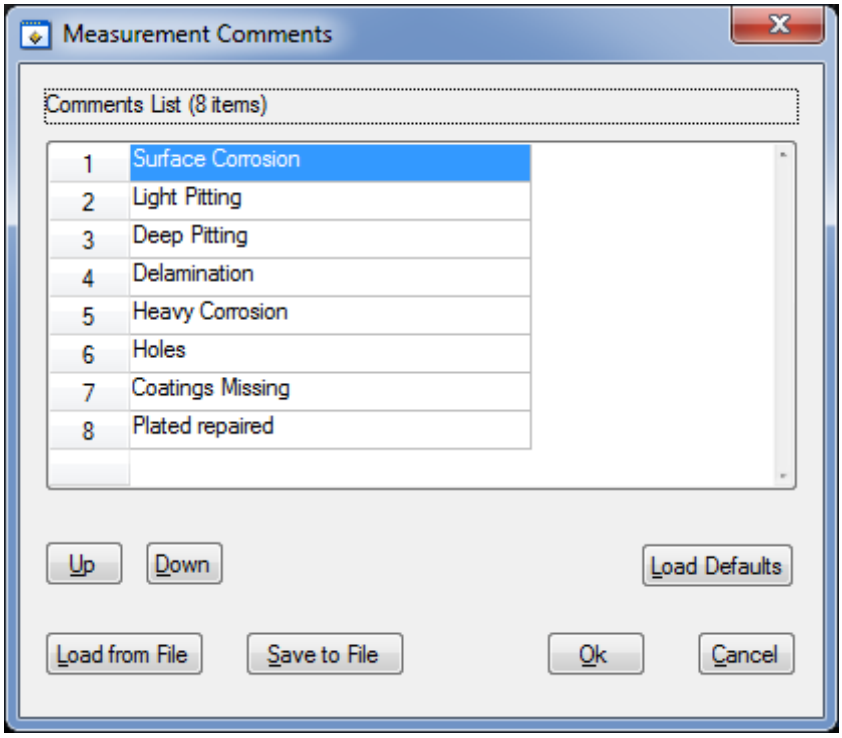
Deleting all Records from the Gauge

After you have transferred your records from the gauge into the Survey and saved the survey file you can delete these records from the gauge memory, so the gauge is 'clean' and ready for new records to be created.

1.	From the Menu click; **Gauge** **└ Delete All Records in Gauge**
2.	When successful the gauge will show a "Records Deleted" message on its display.

Measurement Comment List

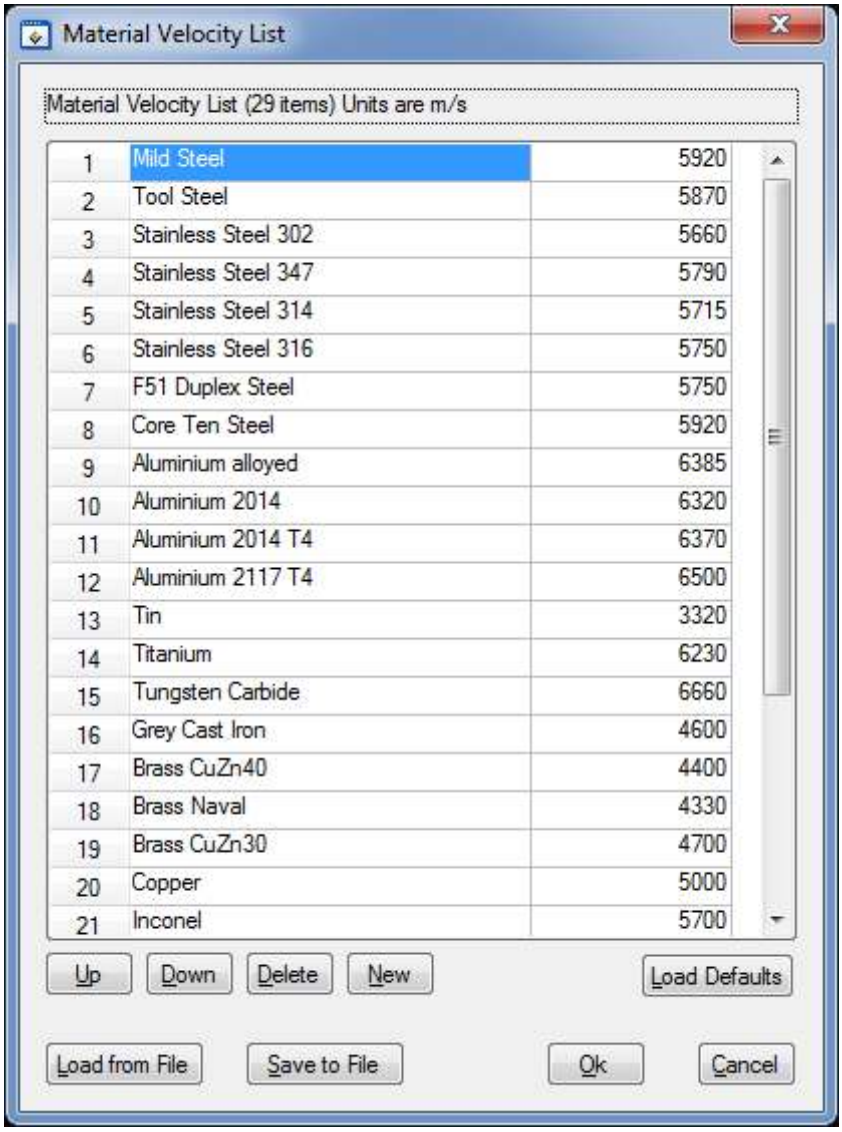
The Measurement Comment List is a list of 8 pre-set text comments that can be added to data logged measurement points. The Underwater gauge also holds a copy of these comments for use during data logging. You can edit these comments using CygLink then send them to the gauge when connected to CygLink.

1.	From the Menu click; **File** **└ Measurement Comments**
2.	You can then Add, Edit, or Remove the entries in the comment list
	
3.	To send the new comments to the gauge, from the Menu click; **Gauge** **└ Transfer Measurement Comments to Gauge** The gauge will display a conformation message when the new comments list has been received successfully.

Material Velocity List

The Material Velocity List is a table of materials along with their velocity of sound value. CygLink comes with a pre-defined list but you can create your

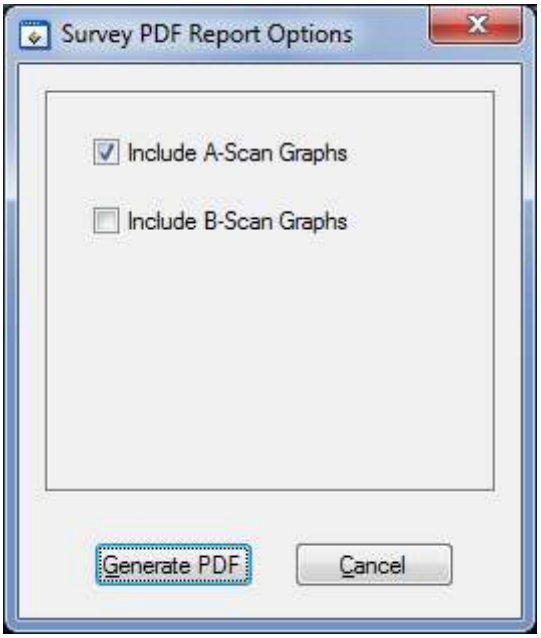
own list of materials specifically to suit your application. This list can be send to the gauge when connected to CygLink.

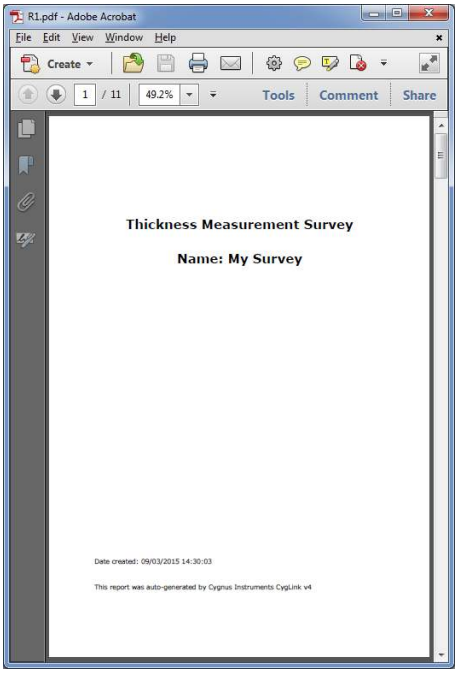
1.	From the Menu click; **File** **└ Material Velocity List**
	
2.	You can Edit, Add, Delete or Re-arrange the items in the list. Note the velocity is in metric (m/s) by default. You can edit the table in imperial (in/µs) by setting the Measurement Units to Inch from the Setup – Measurement Setup item.
3.	To send the velocity list to the gauge, from the Menu click; **Gauge** **└ Transfer Material Velocity List to Gauge**

	The gauge will display a conformation message when the new velocity list has been received successfully.

Creating a PDF Survey Report

A PDF report can be produced containing all the Survey Records and thickness measurements in the Survey, grouped by each Survey Records. Once the export process is complete, your report will automatically be displayed in your installed PDF viewer. The export may take a few seconds, depending on the number of measurements contained in the survey.

1.	From the Menu click; **File** **└ Create Survey Report PDF**	
2.	You can choose to include A-Scan graphs in the report.	
3.	A report filename may be suggested, you can continue with the filename or type your own as required.	

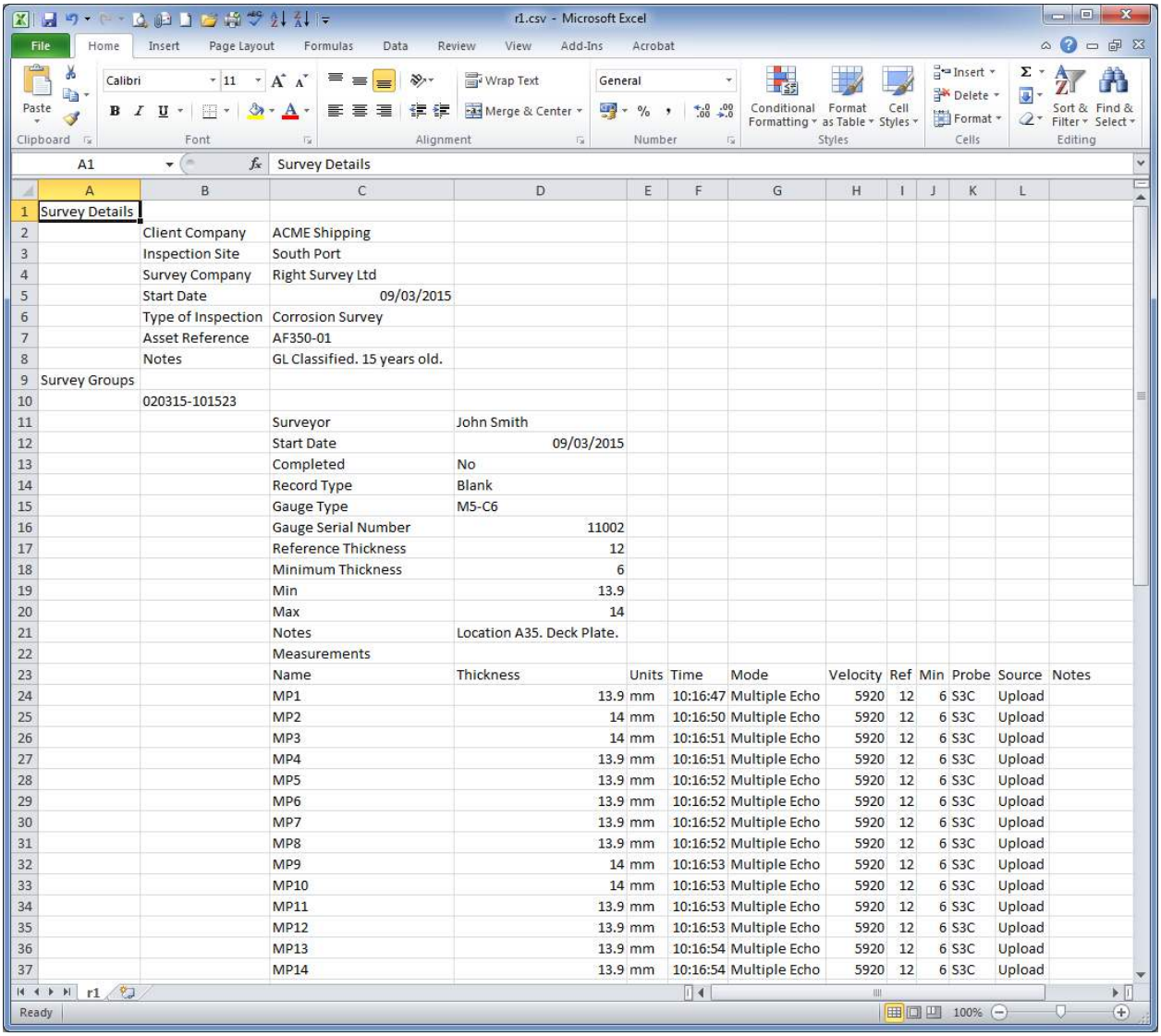
4.	The report is then created and will open in your PDF viewer.	
5.	The PDF report is arranged into the following sections; • Title Page • Survey Details Page • Survey Record details and measurements for each survey • Appendix of all the A-Scan Graphs	

Exporting a Survey to a CSV File

You can export the textual and numeric data from the whole survey to a CSV[3] file that can be opened with a spreadsheet such as Microsoft Excel. An example of a CSV export opened in Excel is shown below;

1.	From the Menu click; **File** **└ Export Survey to CSV File**
2.	A filename may be suggested, you can continue with the filename or type your own as required.

[3] CSV - Comma Spaced Variable



r1.csv - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L
1	Survey Details											
2		Client Company	ACME Shipping									
3		Inspection Site	South Port									
4		Survey Company	Right Survey Ltd									
5		Start Date	09/03/2015									
6		Type of Inspection	Corrosion Survey									
7		Asset Reference	AF350-01									
8		Notes	GL Classified. 15 years old.									
9	Survey Groups											
10		020315-101523										
11			Surveyor	John Smith								
12			Start Date	09/03/2015								
13			Completed	No								
14			Record Type	Blank								
15			Gauge Type	M5-C6								
16			Gauge Serial Number	11002								
17			Reference Thickness	12								
18			Minimum Thickness	6								
19			Min	13.9								
20			Max	14								
21			Notes	Location A35. Deck Plate.								
22			Measurements									
23			Name	Thickness	Units	Time	Mode	Velocity	Ref	Min	Probe	Source	Notes
24			MP1	13.9	mm	10:16:47	Multiple Echo	5920	12	6	S3C	Upload	
25			MP2	14	mm	10:16:50	Multiple Echo	5920	12	6	S3C	Upload	
26			MP3	14	mm	10:16:51	Multiple Echo	5920	12	6	S3C	Upload	
27			MP4	13.9	mm	10:16:51	Multiple Echo	5920	12	6	S3C	Upload	
28			MP5	13.9	mm	10:16:52	Multiple Echo	5920	12	6	S3C	Upload	
29			MP6	13.9	mm	10:16:52	Multiple Echo	5920	12	6	S3C	Upload	
30			MP7	13.9	mm	10:16:52	Multiple Echo	5920	12	6	S3C	Upload	
31			MP8	13.9	mm	10:16:52	Multiple Echo	5920	12	6	S3C	Upload	
32			MP9	14	mm	10:16:53	Multiple Echo	5920	12	6	S3C	Upload	
33			MP10	14	mm	10:16:53	Multiple Echo	5920	12	6	S3C	Upload	
34			MP11	13.9	mm	10:16:53	Multiple Echo	5920	12	6	S3C	Upload	
35			MP12	13.9	mm	10:16:53	Multiple Echo	5920	12	6	S3C	Upload	
36			MP13	13.9	mm	10:16:54	Multiple Echo	5920	12	6	S3C	Upload	
37			MP14	13.9	mm	10:16:54	Multiple Echo	5920	12	6	S3C	Upload	

Survey CSV Export opened in Excel.

Other Features

Setting the Time and Date on the Gauge

You can send the computers current Time and Date to the connected gauge so it can update its internal clock calendar.

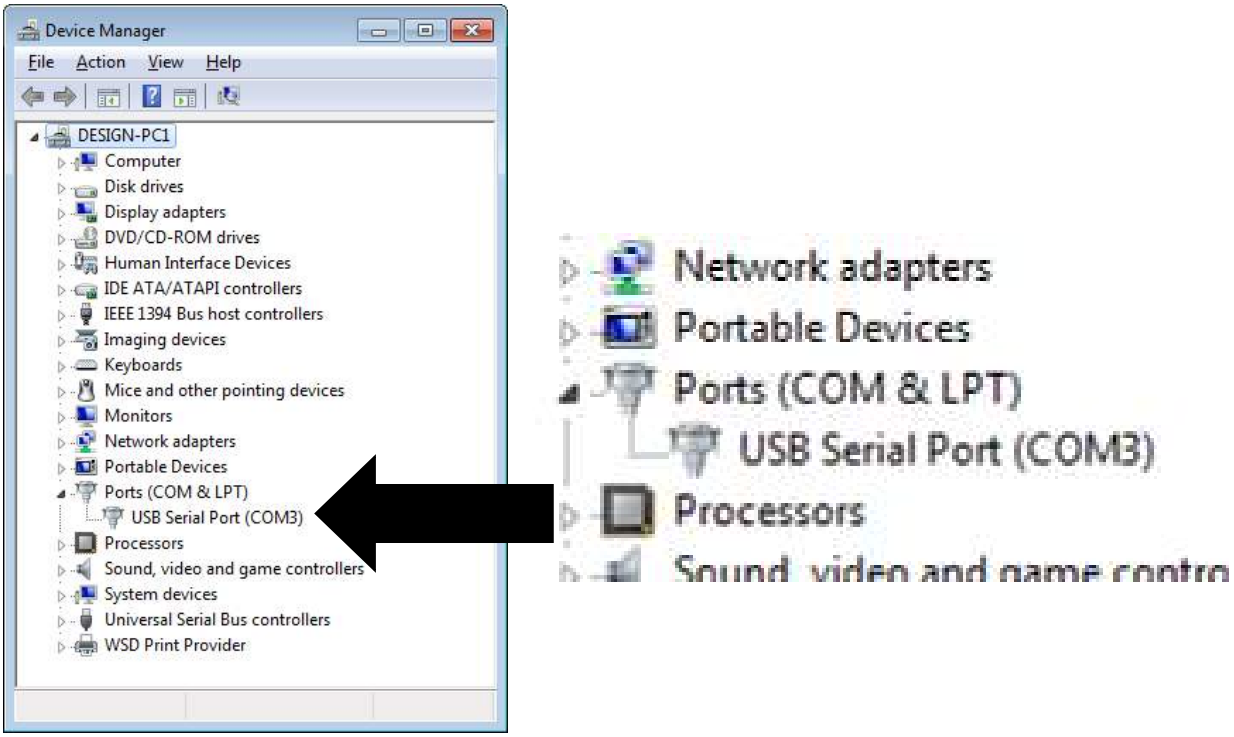
1.	To set the Time and Date in the gauge, from the Menu click; **Gauge** **└ Set Time and Date in Gauge**

COM Port Numbers

CygLink should automatically find the COM port number assigned to the USB converter when you click "Connect" so you don't need to search for the port number Windows has assigned.

Finding your COM Port Number

With the USB lead plugged into your computer, open Windows Device Manager – to do this press the **Windows**® key and the '**R**' key together, then type "**devmgmt.msc**" into the prompt followed by enter key. In the **Ports** section, look for the USB Serial Port entry. Remember the COM number listed as this will need to be selected within CygLink's settings menu.



Windows® Device Manager

21. Information

Technical Specifications

Cygnus Underwater Technical Specifications	
General Attributes	
Size	80mm x 305 mm x 65 mm (W x L x D)
Weight	Gauge with batteries 1 Kg (2.2 lb.)
Power Supply	Ni-MH Battery Pack 1.8 Ah (min)
Probe Socket	Lemo FVG/HVG
Operating Temperature Range	-10°C to +50°C
Storage Temperature Range	-20°C to +60°C
Battery Operation Time	Minimum 8 hrs of continuous measurement.
Battery Voltage Range	6.0V to 6.5V
Battery Type	Ni-MH Cells
Low Battery Indication	'Low Battery' warning message when battery approaches 10% of its capacity.
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 and probe type. Deep Coat mode provides ability to measure through thicker coatings depending on coating material. Typically, 20mm of hard plastic with S2C probe. Echo-Echo mode with Twin element probe; Through coating measurement for coatings up to 1 mm thick as standard depending on coating velocity and probe type.
Materials	Sound velocity from 2000 m/s to 9000 m/s [0.0787 in/us to 0.3543 in/us]

Cygnus Underwater 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.]
	S5A/C 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.]
	Twin element probes in Echo-Echo mode;		
	T2C probe	5 to 50 mm	[0.200 in. to 2.000 in.]
	T5B probe	4 to 50 mm	[0.160 in. to 2.000 in.]
Probe Zero	Twin element probes are zeroed 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.		
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”]

Cygnus Underwater Technical Specifications			
	Medium (measurement < 120 mm)	0.05 mm	[0.002”]
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)		
Display Size	320 x 240 Pixels ¼ VGA. Size 2.4“ Portrait.		
Display Information	Digital Thickness Value. Settings (probe, velocity, units, mode). A-Scan display. Data logging contents in tabular format.		
Transmitter			
Shape of Pulse	Square		
Pulse Energy : Voltage (peak-to-peak)	80 V p-p		
Pulse Energy : Rise Time	3 ns (max)		
Pulse Energy : Pulse Duration	S2C : 220 ns S3C : 100 ns S5A : 67ns T2C : 220 ns T5B : 100 ns		
Receiver			
Gain Control	Automatic Gain Control.		
Frequency Range	0.5 MHz to 20.0 MHz (-6dB)		
Other Information			
Data Output and Storage	Data stored on internal Flash Memory (non-removable). Data output via RS-485 serial connection.		
Interface Connector	SubConn MCIL5M. Can be used to update the gauge firmware and load gauge settings.		

Cygnus Underwater Technical Specifications	
Data Logger	Maximum number of measurement points per Record : 5000 Maximum number of Records : 40 Data stored on internal flash memory device, non-removable.
Calibration setting storage	Calibration Data stored to Internal Flash Memory
Calibration Mechanisms	Option of Two Point and Single Point calibration for all probes. Automatic V-path correction for twin element probes.
Display & Recall Facilities	N/A
Display Response Time	125 ms / 500 ms
Printer Output	N/A
Lanyard Fixing	Stainless steel fixing point for lanyard at the base of the gauge body.
Battery Charger	AC Power Source 100 to 240 V AC, 50 to 60 Hz, 0.35 A. Typical charge time of 2 hours. For indoor use only.
Depth Sensor	Range 0 to 300m (30Bar) Selectable for use in salt or fresh water. Only to be used a guide and not for life support.
Environmental Rating	Depth rated for 300m continuous immersion in water.
Compliance	RoHS Compliant. Designed for BS EN 15317. CE Marked including EMC.

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.

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

Important
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 c1

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

Umbilical Cables

If you need to make you own umbilical cable the following information must be followed to ensure a reliable connection and not cause damage to the gauge or USB interface.

The serial data format is;

- RS485 2-Wire, Half Duplex.
- Baud Rate is 115200, 8 Data bits, 1 Stop Bit, No Parity.
- The Gauge is the bus master and sends packets at regular intervals.
- Line Biasing is provided in the Umbilical USB Interface Cable

Umbilical Cable

Two x Twisted Pairs, Screened.

Connections

Gauge End

Connector Fitted to Umbilical = SubConn MacArtney **MCIL5M**

No.	Colour	Signal
1	Black	0V
2	White	RS485-B
3	Red	RS485-A
4	Green	N/C (DC power out)
5	Orange	Ground

Topside End

Connector Fitted to Umbilical = 9 Way D-Sub Plug

Pin	Signal
1, 4	Ground & Screen
2	RS485-A
3 & 7	RS485-B

Cable

Link the Black and Orange Sub-Conn wires together.

Sub-Conn		Signal	Umbilical Cable	D-Sub Plug Pin
No.	Colour			
1	Black	0V	Pair-2	1 & 7
2	White	RS485-B	Pair-1	3 & 7
3	Red	RS485-A	Pair-1	2
4	Green	N/C (DC power out)		
5	Orange	Ground		
-	-	-	Screen	1 & 4

22. 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.

23. Revision History

Date	Issue	Changes
19-Sep-2023	9	Updated various images. Updated O-Ring seal maintenance section.
19-Oct-2023	10	Added CygLink Section. Revised Kit Contents. Added Umbilical Cable Details.
13-Dec-2023	11	Updated screens with battery SoC icon.
31-Jul-2024	12	Added additional battery care information.
03-Jun-2025	13	Updated Gauge variant naming convention

24. Warranty Information

Terms of Warranty

1. Product Registration

1.1 Cygnus Instruments Ltd. ("Cygnus") collaborates with all its resale partners, but resale of Cygnus products ("Products") by the Customer risks loss of traceability to end users of the Products. Manufacturer's support for the Products, including but not limited to firmware updates or product recall requirements, can only be provided by Cygnus with contact details of the end user, since support communication cannot be guaranteed via a resale partner or any other third party. **Cygnus guarantees provision of proactive support and transfer of warranties for the Products to end users of the Products who register their Products at: https://cygnus-instruments.com/service/product-registration/**

1.2 Cygnus stipulates that Product Registration as set out in paragraph 1.1 is a mandatory requirement for the Cygnus 1 Ex Ultrasonic Thickness Gauge in accordance with manufacturer responsibilities under the ATEX/IECEx/UKEX certification requirements.

1.3 All information relating to an individual person provided to Cygnus will remain confidential and protected under privacy policy terms found at: https://cygnus-instruments.com/privacy-policy/

2. Warranty

2.1 Subject to paragraph 3.2 and the following provisions, Cygnus warrants that:

2.1.1 the Products manufactured by it will correspond with their specification and be free from defects in material and workmanship for a standard period of **three (3) years** from the date of purchase from Cygnus;

2.1.2 except for batteries, probes, leads, microphones, telescopic extensions, which are warranted for six (6) months;

2.1.3 in the case of Products or equipment manufactured by a third party, Cygnus shall assign to the Customer the benefit of any warranty, guarantee or indemnity given by the company supplying the goods to Cygnus;

2.1.4 except for consumables, which are not warranted at all;

2.1.5 in the case of Equipment Service, the service will be provided using reasonable care and skill;

2.1.6 in the case of bespoke Products or which have (at the request of or by agreement with the Customer) been modified by Cygnus prior to sale, Cygnus warrants (subject as aforesaid) that any design or engineering services carried out by Cygnus will be supplied with reasonable care and skill.

2.2 The warranties referred to above are given by Cygnus, who shall, at its option, repair, replace or refund the price of the defective Products in full, provided:

2.2.1 the Customer gives notice in Writing during the warranty period within a reasonable time of discovery that some or all of the Products do not comply with the warranty set out in paragraph 2.1;

2.2.2 the Customer returns such Products to Cygnus' place of business at the Customer's cost;

2.2.3 Cygnus is given a reasonable opportunity of examining such Products.

2.3 Cygnus shall be under no liability for the Products' failure to comply with the warranties if:

2.3.1 any defect in the Products arises from any drawing, design, specification information or instructions supplied by the Customer, or arises from their late arrival or non-arrival, or any other fault of the Customer;

2.3.2 the Customer integrates into any system, alters, modifies or repairs such Products without the prior written consent of Cygnus;

2.3.3 the defect arises because the Customer failed to follow Cygnus oral or written instructions as to the storage, installation, calibration, integration into a system, commissioning, use or maintenance of the Products or (if there are no such instructions) good trade practice;

2.3.4 the defect arises as a result of fair wear and tear, wilful damage, negligence, or abnormal working conditions;

2.3.5 the total price for the Products has not been paid by the due date for payment.

2.4 The warranty in this section 2 is the only warranty provided by Cygnus to the Customer in relation to the Products. All other statements, conditions, representations, warranties, whether express or implied, including any implied warranty of fitness for any particular purpose or satisfactory quality, are expressly excluded.

3. Products returned immediately after receipt

3.1 The Customer shall inspect the Products, or any instalment of the Products, immediately upon receipt. If the Products are damaged or do not comply with the warranty in paragraph 2.1, the Customer shall:

3.1.1 provide Cygnus with details of the problem with the Products in Writing; and

3.1.2 store the Products until it receives Cygnus' Written instructions in relation to the Products.

3.2 Cygnus' only liability and the Customer's sole right and remedy in respect of Products which at the time of delivery are damaged or do not meet the warranty in section 2 shall be at Cygnus' option either the supply of replacement Products (or the part in question) or a refund of the price paid (or a proportionate part of the price) to Cygnus in respect of such Products, in which case Cygnus shall have no further liability to the Customer. For the avoidance of doubt, Cygnus shall not be liable to the Customer for any damage to the Products , which occurs after the time of delivery, however the Customer may make a claim in respect of any such damage under the appropriate insurance policy.

4. Liabilities

4.1 Subject as expressly provided in these terms or in Cygnus' Terms of Sale, and except where the Products are sold to a person dealing as a consumer (within the meaning of the Unfair Contract Terms Act 1977), all warranties, conditions or other terms implied by statute or common law are excluded to the fullest extent permitted by law.

4.2 Except in respect of death or personal injury caused by Cygnus' negligence or liability for defective Products under the Consumer Protection Act 1987 Cygnus shall not be liable to the Customer 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 (including any delay in supplying or any failure to supply the Products in accordance with the Contract or at all) or their use or resale by the Customer. The entire liability of Cygnus under or in connection with the Products shall not exceed the price of the Products, except as expressly provided in these terms.

25. Pressure Test Statement

All Cygnus UNDERWATER gauges are tested in water at low and high pressures as part of our manufacturing test procedures.

Please refer to the environmental rating section for further information.