CYGNUS 1
INTRINSICALLY SAFE
ULTRASONIC
THICKNESS GAUGE

CYGNUS 1 INTRINSICALLY SAFE ULTRASONIC THICKNESS GAUGE

OPERATION MANUAL

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CYGNUS 1 INTRINSICALLY SAFE GAUGE

The ***Cygnus 1 Intrinsically Safe Multiple-Echo Ultrasonic Thickness Gauge*** is a rugged, handheld, battery-powered instrument designed for high-reliability thickness measurement using the multiple-echo technique.

The ***Cygnus 1 Gauge*** can be used with a choice of single-crystal Ultrasonic Probes, depending on the thickness and type of material which is to be measured.

Measurement can be displayed in Metric (mm) or in Imperial (inch) units, and measurement resolution can be selected for either 0.1 or 0.05 mm, (or 0.005 or 0.002 inch).

Crystal-controlled Calibration provides stability and accuracy – Calibration can be made to a known thickness, or to a known Velocity of Sound. Velocity of Sound is displayed in either metres/second or inches/microsecond, depending on the current selection for Measurement Units

*The **Cygnus 1 Intrinsically Safe Gauge** is a solid-state electronic instrument which, under normal operating conditions, will give many years of active service.*

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

INTRINSIC SAFETY CERTIFICATION

- This instrument is Certified Intrinsically Safe to:

ATEX	**II 1 G Ex ia IIC T6 Ga (Tamb = -20°C to 40°C)** **I M 1 Ex ia I Ma (Tamb = 0°C to 45°C)** **Certificate No. BAS00ATEX1108**
IECEx	**Ex ia IIC T2/T3/T6 Ga (Tamb = -20°C to 40°C)** **Ex ia I Ma (Tamb = 0°C to 45°C)** **Certificate No. IECEx BAS 19.0021**
UKEX	**II 1 G Ex ia IIC T6 Ga (Tamb = -20°C to 40°C)** **I M 1 Ex ia I Ma (Tamb = 0°C to 45°C)** **Certificate No. BAS21UKEX0661**
CSA	**Class 1 Group A, B, C, D Division 1** **Certificate No. 215944**

- The instrument may be used only by Trained Personnel, and with due consideration to Intrinsic Safety requirements for use within hazardous areas.
- The instrument must not be modified in any way - maintenance and repair may only be carried out by Cygnus Instruments at the address shown on page 8.
- The instrument must be operated only as described within this manual, and with reference to the special *Intrinsic Safety Requirements* on page 35.

CYGNUS INSTRUMENTS

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

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

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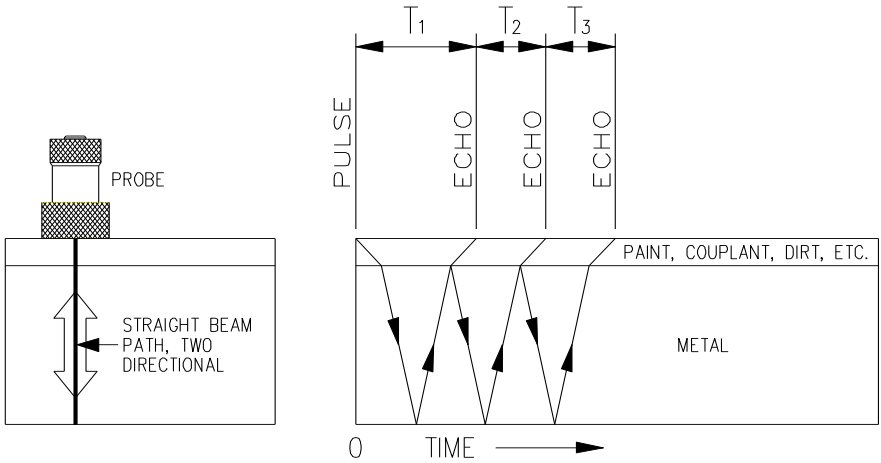
THE MULTIPLE-ECHO METHOD

The *Cygnus 1 Ultrasonic Thickness Gauge* works on the pulse-echo principle. The Probe is made to vibrate for a very short period, creating a pulse of ultrasound which enters the test piece. The Probe waits for returned echoes and acting as a receiver, converts them into electrical signals which are processed to produce timings in digital form.



The *multiple-echo* beam travel is depicted above, spread out for time, to illustrate the timing method. The beam path is in fact straight, at 90 degrees to the surface and the ultrasonic energy reverberates up and down within the metal (as shown in the small sketch above - left). Each time the echo is reflected back down, a small portion of the energy comes up through the coatings, striking the Probe which now acts as a receiver.

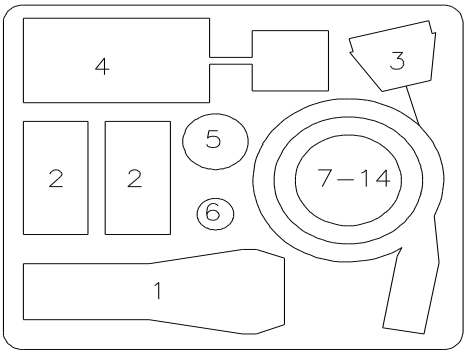
The delay between echoes at the Probe-face is exactly equal to the time taken to pass through the metal twice, therefore coatings such as paint are ignored and the measurement displayed is of the metal thickness only.

CYGNUS 1 INTRINSICALLY SAFE GAUGE SPECIFICATION

Materials	Sound Velocity from 2000 m/s to 7000 m/s [*0.0800 in/uS to 0.2780 in/uS*]
Range	*Measurement Range in Steel :* 2¼ MHz probe : 3 mm to 250 mm [*0.120 in. to 10.00 in.*] 3½ MHz probe : 2 mm to 150 mm [*0.080 in. to 6.000 in.*] 5 MHz probe : 1 mm to 50 mm [*0.040 in. to 2.000 in.*]
Resolution	0.1 mm [*0.005 in.*] *or* 0.05 mm [*0.002in.*]
Accuracy	± 0.1 mm [± *0.005 in.*] *or* ± 0.05 mm [± *0.002 in.*]
Probes	*Single-Crystal, Soft-face Probes :* ➢ 2¼ MHz : 13mm [*0.5 in.*] ➢ 2¼ MHz : 19mm [*0.75 in.*] ➢ 3½ MHz : 13mm [*0.5 in.*] ➢ 5MHz : 13mm [*0.5 in.*] ➢ 5MHz : 6mm [*0.25 in.*]
Battery-life	*Typical life from a fully-charged battery :* approx. 12 hours continuous usage (5.4Ah Battery)
Display	4-character seven-segment high brightness red LED display
Size	*Including Probe-head and Battery-pack :* Length 235 mm x Diameter 75 mm [*9.3 in. x 2.9 in.*]
Weight	*Including Battery-pack :* With Remote Probe - 910 gm [*32 ounce*] with Fixed-Head Probe – 819 gm [*29 ounce*]
Operating Temp.	*Recommended* : -10°C to +50°C [*14°F to 122°F*]
Storage Temp.	*Recommended* : -10°C to +60°C [*14°F to 140°F*]
Environmental	Case-rating : IP65 - the instrument is shock-proof and splash-proof, but should not be immersed in water

GETTING TO KNOW THE GAUGE

CYGNUS 1 INTRINSICALLY SAFE GAUGE – KIT OF PARTS



1. Instrument Body
2. Battery Module
3. Heavy Duty Remote Probe
4. Battery Charger
5. Bottle of Couplant
6. Bottle of Membrane Oil
7. Membranes
8. O-Rings
9. Nose Cone Torque Bar
10. Calibration Jumper Lead
11. Locking Ring Key
12. Steel Test Block
13. Calibration Trim Tool
14. Hex Key

BATTERY ASSEMBLY

✕ ***To comply with Intrinsic Safety Requirements : before entering a Hazardous Area, the Battery must be secured in place by tightening the grub screw using the Hex-key*** See *Intrinsic Safety Requirements*, page 31

ⓘ Note *: Rechargeable Batteries are supplied* uncharged *and should be given a full charge before using the Gauge - see* Battery-Charging Procedure *on page 24*

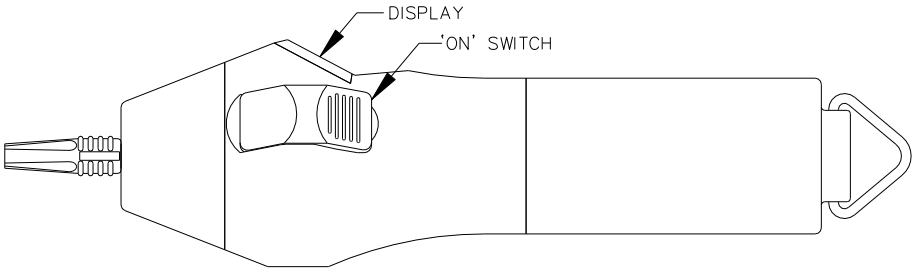
⇨ Before fitting a Battery-module to the instrument check that the O-Ring is properly located in its groove at the base of the instrument body.
See diagram on page 15.
⇨ Screw on the Battery-module until hand-tight :
do not overtighten.
⇨ Now tighten the grub screw

✕ ***Always unscrew the Battery-Module if the Gauge is going to be left unused for more than a few days***

CONTROLS

The Cygnus 1Gauge is designed for ease of operation and has only three controls :

- ***ON/OFF Switch*** on the outside of the instrument
- ***Calibration Trim-screw*** on the inner face of the instrument
- ***Selector Button*** on the inner face of the instrument



To switch the instrument on

To switch the instrument on push and release the **ON/OFF** *switch :*

- ⇨ all digits illuminate '***8.8.8.8.***' showing that self-test has been performed and the instrument has been activated.
- ⇨ the symbol '***bAtt***' is briefly displayed as the battery is tested
- ⇨ the current Calibration setting of the instrument is briefly displayed
  Sound Velocity : shown in the same units that the instrument is currently set for

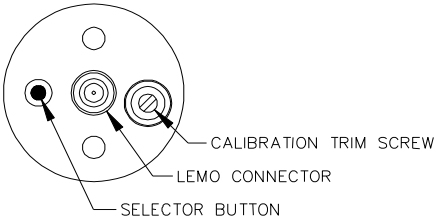
The Gauge is now ready to take measurements– the display will show a decimal point, and a single flashing bar :

- *In Metric mode the display will show* ONE *or* TWO *digits after the decimal point*
- *In Imperial mode there will be* THREE *digits after the decimal point.*

To switch the instrument off

The instrument can be turned off in one of three ways :

- ⇨ ***Manually*** : press and release the **ON/OFF** switch - the message '***Shutoff***' will scroll through the display, and then the Gauge will turn itself off.
- ⇨ ***Automatically*** : the Gauge will turn itself off 10 minutes after the last reading
- ⇨ ***Low-Battery*** : see *Low-Battery Warning*, page 24



Calibration Trim-screw

This is used to calibrate the Gauge Sound Velocity setting for the material under test.
See *Calibrating the Gauge*, on page 19
A *Guide to Sound Velocities* can be found on page 28

Selector Button

This is used to change four Gauge-settings :

- ⇨ ***Probe-setting*** can be preset between three Probe-types : *2¼, or 3½, or 5 MHz*
- ⇨ ***Gain-setting*** can be reduced to prevent standing readings from over-sensitive Probes
- ⇨ ***Units-setting*** can be preset between *Imperial (inch)* units, and *Metric (mm)* units
- ⇨ ***Resolution-setting*** can be switched between 0.1mm and 0.05mm [*0.005 inch and 0.002 inch*] according to preference

See *Changing Gauge-Settings*, page 20

MEASUREMENT

The Cygnus 1 Gauge is designed to provide accurate, reliable readings on most types of surfaces using the Multiple-echo method described on page 6

Preparing to take measurements

- ⇨ *When measuring underwater* : there is no need to use a couplant - the water itself is a good couplant
- ⇨ *When measuring in air* : always use a couplant to enable ultrasound to enter the test material.
  Water, oil or gel are all suitable couplants, depending on application and preference.
- ⇨ Ensure that the Probe is correctly fitted with a membrane, and with membrane oil correctly applied. See *Probe / Knurled-Ring Assembly*, page 14
- ⇨ Remove all scale, calciferous marine growth, dirt or loose coating and brush or scrape the test area clean.
- ⇨ Protective coatings such as paint or epoxy resin need not be removed, provided that their adherence is good.
- ⇨ Place the Probe-face on the clean, lubricated test surface and make firm contact.

Echo-Strength meter

When there is difficulty in obtaining a measurement the Gauge aids the operator by displaying flashing bars as an indication of signal strength and coupling :

- ➢ one flashing bar only : no echoes are being returned
- ➢ one bar + one flashing: 1 echo only is being returned
- ➢ two bars + one flashing : 2 echoes only are being returned
- ➢ three bars + one flashing : 3 echoes are being returned but are not matching to give a valid *multiple-echo measurement*

While the display is showing these indicators the operator should continue to move the Probe around to locate a reflector, using a slight rocking movement.

CALIBRATION

✕ ***To comply with Intrinsically Safe Requirements : Calibration must only be carried in a Safe Area***

Calibration adjusts the Gauge Sound Velocity setting for the material under test.
See *Calibrating the Gauge*, on page 19
A *Guide to Sound Velocities* can be found on page 28

- Cygnus Gauges are always delivered calibrated for Steel.
  The Calibration is stable and there is no warm-up time.

- There is no zero-adjustment since the multiple-echo technique zeros automatically – the timing starts when the first echo is received.

- There is no '*ranging in*' since the straight beam path of the single-crystal Probe ensures that the timing is related to the thickness – the linearity is perfect.

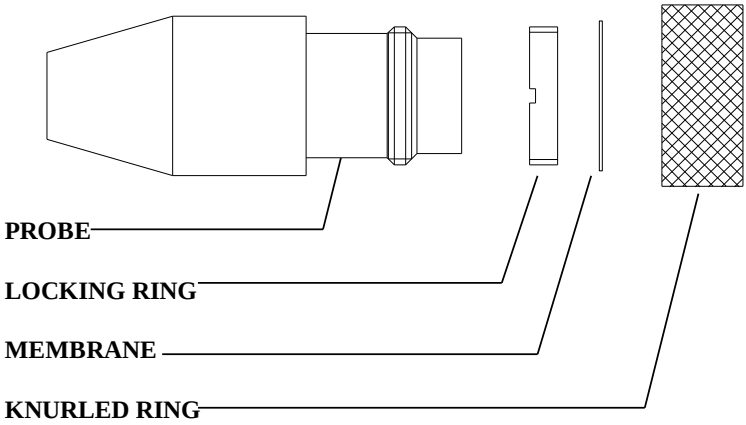
- *Calibration is vital* : whenever a reading is suspect, check that the test material is the same as the one for which the instrument has been calibrated.

- Some castings have unreliable sound velocity values - allow for greater inaccuracies.
  Many castings are also difficult to penetrate with high frequencies, making it difficult to obtain three echoes : the larger the Probe the better.

PROBE/KNURLED RING ASSEMBLY

Use of the Membrane

- *The polyurethane membrane covering the Probe-face provides better contact on rough surfaces and protects the Probe-face from damage.*
- *To avoid excessive wear of the membrane, do not use pressure nor 'screw' the Probe when trying to obtain readings on rough surfaces - a light touch is normally sufficient*
- *Check the membrane regularly and renew when it becomes worn.*



Replacing the Membrane in the Knurled-ring

- ⇨ To replace the membrane unscrew the Knurled-ring from the end of the Probe. The membrane is held in place by a locking-ring.
- ⇨ Unscrew the locking-ring using the locking-ring key provided
- ⇨ Remove the old membrane and clean the locating groove in the knurled ring before fitting a new membrane
- ⇨ Replace the locking-ring and screw up tight, checking that the membrane is properly located.

Refitting the membrane

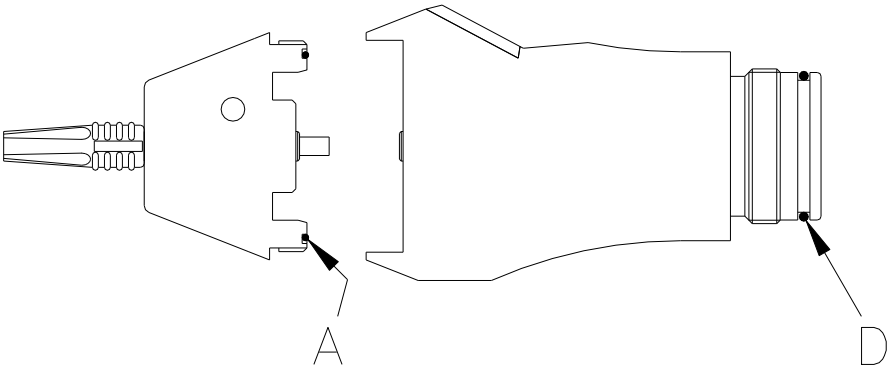
- ✕ ***There must always be a thin film of mineral oil such as glycerine or liquid paraffin between the membrane and the Probe-face to ensure good contact and exclude any air.***
- ✕ ***Do not overtighten the knurled ring assembly as this will affect the performance of the Probe.***

PROBE MODULE ASSEMBLY

✕ ***To comply with Intrinsically Safe Requirements : only Probes certified and labelled Intrinsically Safe may be used. Changing of Probes must only take place in a Safe Area.***

Before fitting the Heavy-Duty Remote Probe check that the O-Ring type 'A' is properly located in the groove within the nose cone housing

See diagram of O-Ring locations below.



✕ ***When fitting the nose cone it should be firmly hand tightened only - the nose cone torque bar is only used for releasing the nose cone after use.***

ⓘ *This same procedure should be observed when fitting the Fixed-Head Probe.*

PROBE USAGE

✕ ***When a Probe of different Frequency is used it is essential that the Gauge Probe-setting is changed accordingly.***
See *Changing the Probe-Setting*, page 21

Probe face colour

Cygnus 1 Gauges should only be used with soft-face Probes, as supplied by Cygnus.

The colour of the Probe face indicates the Probe frequency
See *Table of Probe Types*, page 17

Probe Selection

Apart from the physical limitations of the Probe size, the diameter of the crystal affects the probe performance :

- Larger diameter crystals produce more energy, which in turn gives better penetration.
- Smaller diameter crystals produce a narrower beam, which is a distinct advantage when looking for small reflectors - they are particularly useful on tubes of small diameter

Using Probes at high temperature

Heat can damage the Probe crystal - in Cygnus Probes the crystal is very near to the face. *The higher the temperature of the test material and the longer the contact with the Probe, the greater the likelihood of eventual damage to the crystal.*

- *At temperatures above normal, ie : above 75°C (170°F), always avoid prolonged contact.*
- *Teflon (PTFE) membranes are available for measurements up to 150 °C (318 °F).*

- *Thin oil couplants evaporate rapidly at high temperature – high melting-point grease is more suitable in such cases.*

TABLE OF PROBE TYPES

CRYSTAL DIAMETER	*FREQUENCY*	*MEASUREMENT RANGE*	*APPLICATION*
13 mm ½ inch	2¼ MHz *Red band*	3.0 – 250 mm *0.12 – 10 inch*	*This is the standard probe – suitable for most applications*
19 mm ¾ inch	2¼ MHz *Red face*	3.0 – 250 mm *0.12 – 10 inch*	*Use with castings and other attenuative materials if the 13mm probe is inadequate – the larger diameter gives greater penetration power on badly corroded or heavily coated steel. Some metallic coatings are also highly attenuative.*
13 mm ½ inch	3½ MHz *Orange band*	2.0 – 150 mm *0.08 – 6 inch*	*Suitable for measurement on thinner sections where surfaces are relatively rough*
6 mm ¼ inch	5 MHz *Black face*	1.5 – 50 mm *0.06 – 2 inch*	*The higher frequency and narrower beam makes this Probe ideal for measuring small-bore tubing, thin section plate and other areas where access is limited.*
13 mm ½ inch	5 MHz *Black band*	1.0 – 50 mm *0.04 – 2 inch*	*Ideal for thin sections without heavy corrosion*

ⓘ *13mm Probes use a Coloured Band to indicate probe frequency.*
ⓘ *6mm & 19mm probes use probe face colour to indicate probe frequency.*

✕ ***Important : always ensure that the Gauge is set for the actual Probe in use***
See *Changing the Probe-Setting*, page 21

WORKING WITH THE GAUGE

CALIBRATING THE GAUGE

✕ ***To comply with Intrinsic Safety Requirements : Calibration must only take place in a Safe Area.***

- ***Calibration on a Test Sample** : if possible the Gauge should always be calibrated on the actual material under test or on a measured test sample of the same material*
- ***Calibration by Sound Velocity** : if there is no test sample available the Gauge can be calibrated by setting the value of Sound Velocity directly*
- *A third method is to leave the Gauge set to its factory-preset value for Steel [5920 m/s or 0.2332 in/us], and then use a Conversion Factor : see page 28*

Setting-up for Calibration

Unscrew the Battery-module, and then connect to the Gauge using the *Calibration Jumper-lead* supplied.

Calibration on a Test Sample

⇨ Turn the Gauge on as normal, and place the Probe on the measured test sample.

The Calibration trim-screw is located on the inner face of the instrument body as illustrated on page 10 :

⇨ using the Calibration trim-tool, turn the trim-screw until the correct reading is displayed : *the Gauge is now Calibrated*

Calibration by Sound Velocity

⇨ Do not turn the Gauge on as normal – instead, ***press and hold*** the ON-switch until the display shows the current setting of Sound Velocity, then release the switch :
The display will now continuously flash the Sound Velocity value.

⇨ Turn the Calibration trim-screw until the desired Sound Velocity is displayed.

⇨ Now press and release the ON-switch again :
Calibration is complete, and the Gauge now returns to normal measurement mode.

ⓘ *Sound Velocity is displayed in the same units as the Gauge is currently preset for. For example - if the Gauge is calibrated for Steel [5920 m/s or 0.2332 in/us] :*

- *the display will flash '**5920**' if the Gauge is preset for Metric units*
- *the display will flash '**2332**' if the Gauge is preset for Imperial units*

See Table of Sound Velocities, page 29

ⓘ *Cygnus 1 Gauge has a Sound Velocity range of 2000 m/s to 7000 m/s when preset for Metric units, and 0.0800 in/us to 0.2782 in/us when preset for Imperial units.*

When Calibration is complete

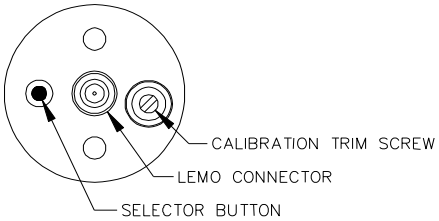
✕ ***Turn the Gauge off and remove the Calibration Jumper-lead.***
Screw the Battery-module back onto the Gauge, then tighten the Battery grub-screw using the Hex-key.

CHANGING GAUGE-SETTINGS

✕ ***To comply with Intrinsic Safety Requirements : changing Settings must only take place in a Safe Area.***

Settings for Probe-Frequency, Probe-Gain, Measurement-Units, and Measurement-Resolution can be changed by the User, using the Selector-Button and the ON/OFF Switch.

The Selector-Button is located on the inner face of the instrument body :



Preparing the Gauge to change Gauge-settings

⇨ Unscrew the Battery-module, and then connect it to the Gauge using the *Calibration Jumper-lead* supplied

⇨ Turn the Gauge on using the *ON/OFF Switch*

- The Gauge is now in ***Measurement*** mode, as normal

Stepping through the Settings-menu

Keep pressing the Selector-Button until the setting you want to change appears flashing on the display :

⇨ Press the *Selector-Button* once

- The Gauge is now in ***Probe-Setting*** mode
  with the display flashing '***Prob***' and the current Probe-selection

⇨ Press the *Selector-Button* a second time

- The Gauge is now in ***Gain-Setting*** mode
  with the display flashing '***GAin***' and the current Gain-value

⇨ Press the *Selector-Button* a third time

- The Gauge is now in ***Units-Setting*** mode
  with the display flashing '***Unit***' and the current Units-setting

⇨ Press the *Selector-Button* a fourth time

- The Gauge is now in ***Resolution-Setting*** mode
  with the display flashing '***rES***' and the current Resolution-setting

⇨ If you press the *Selector-Button* once more

- The Gauge will now return to ***Measurement*** mode
  with all of the Gauge-settings unchanged

Changing the selected value

When the setting you want to change is flashing on the display :

⇨ Keep pressing the *ON/OFF Switch* until the new value you want for this setting appears on the display

⇨ Now press the *Selector-Button* once more

- The Gauge will now reset and quit *Gauge-setting* mode, and then return to normal *Measurement* mode
- *The display will now show the same sequence as seen when the Gauge is first turned-on, followed by '**Stor** ', telling you that the new setting has been stored*

After changing any of the Gauge-settings

⇨ Turn the Gauge off and remove the Calibration Jumper-lead

✕ ***Screw the Battery-module back onto the Gauge, then tighten the Battery grub-screw using the Hex-key.***

ⓘ *The new setting has been stored – and this new setting will now be in use each time the Gauge is turned-on*

CHANGING THE PROBE-SETTING

✕ ***When a Probe of different Frequency is used it is essential that the Gauge Probe-setting is changed accordingly – if the Probe-setting does not match the Probe in use it may be difficult or impossible to obtain correct Readings***

To change the Probe-frequency setting

⇨ Prepare the Gauge as described above, and then turn the Gauge on as normal

⇨ *Press and release the Selector-Button* ***once***.

- The Gauge is now in *Probe-setting mode* - the display will now alternate between '**Prob** ' and the current Probe frequency value
- The Probe-frequency values are displayed as :
  - '**2.2** ' [2¼ MHz]
  - '**3.5** ' [3½ MHz]
  - '**5.0** ' [5 MHz]

⇨ *Press and release the ON-switch* : the Probe-frequency value will now change. Keep pressing the ON-switch until the desired value is now being shown.

⇨ *When the display shows the desired Probe-frequency :* press the Selector-Button once more

- This completes Probe-setting, and the Gauge will now reset itself

CHANGING THE GAIN-SETTING

✕ ***Gain-setting should not be changed unless the Gauge is being used with an over-sensitive Probe – beware, that if the Gain value is set too low, it may be difficult or impossible to obtain Readings.***

Gain-setting allows the sensitivity of the Probe to be reduced – this is only required if an extra-sensitive Probe is used, and standing readings are being obtained : ie there are readings with a Probe connected, even though the Probe is not in contact with anything.

Gain-setting should always be set to the highest possible value, for maximum sensitivity and ease of obtaining measurements

ⓘ Standing readings can occur if there is excess couplant on the Probe-face, or if the Probe-membrane has been overtightened.

ⓘ The Cygnus 1 Gauge is always supplied with the Gain set correctly for the Probe supplied with the Gauge

To change the Gain-setting

⇨ Prepare the Gauge as described above, and then turn the Gauge on as normal
⇨ *Press and release the Selector-Button* ***twice***.
  - ➢ The Gauge is now in *Gain-setting mode* - the display will now alternate between '***GAin***' and the current Gain value.
  - ➢ The Gain value can be set between 1 [low sensitivity] and 12 [high sensitivity]

⇨ *Press and release the ON-switch* : the Gain value will now change.
Keep pressing the ON-switch until the desired value is now being shown.
⇨ *When the display shows the desired Gain-value :* press the Selector button once more
  - ➢ This completes Gain-setting, and the Gauge will now reset itself.

CHANGING THE UNITS-SETTING

The Cygnus 1 Gauge always displays the Thickness value , and also Velocity of Sound value, in the Measurement-Units which have been stored in internal memory.

The Gauge can be preset to either Metric[mm] or Imperial[inch] Measurement-Units.

To change the Units-setting

⇨ Prepare the Gauge as described above, and then turn the Gauge on as normal
⇨ *Press and release the Selector-Button* ***three times***
  - ➢ The Gauge is now in *Units-setting mode* - the display will now alternate between '***unit***' and the current Units-setting
  - ➢ Units-settings are shown as :
    - '***Euro***' [Metric, mm]
    - '***inch***' [Imperial, inch]

⇨ *Press and release the ON-switch* : the units-setting will now change.
Press the ON-switch again to return to the previous setting, if desired.
⇨ *When the display shows the desired units-setting :* press the Selector once more
  - ➢ This completes Units-setting, and the Gauge will now reset itself

CHANGING THE RESOLUTION-SETTING

The Cygnus 1 Gauge can display thickness measurements in one of two Resolution-settings – the Resolution should be chosen according to your own preference.

The exact value of the Resolution-setting will also depend on whetherMetric or Imperial Units is currently selected

To change the Resolution-setting

⇨ Prepare the Gauge as described above, and then turn the Gauge on as normal
⇨ *Press and release the Selector-Button* ***four times***
  - ➢ The Gauge is now in *Resolution-setting mode* - the display will now alternate between '***rES***' and the current Resolution-setting
  - ➢ Resolution-settings are shown as :
    - '***HI***' [High-Resolution : 0.05mm, or 0.002 inch]
    - '***LO***' [Low-Resolution : 0.1mm, or 0.005 inch]

⇨ *Press and release the ON-switch* : the units-setting will now change.
Press the ON-switch again to return to the previous setting, if desired.
⇨ *When the display shows the desired Resolution-setting :* press the Selector once more
  - ➢ This completes Resolution-setting, and the Gauge will now reset itself

LOW BATTERY WARNING

The instrument shows a warning message as the battery is coming to the end of its useful charge :

- '***bAtt***' is briefly flashed once every four seconds -
  There is no need to replace the battery immediately, the instrument will continue to measure as normal for some time yet : the exact period depends on battery-type.

- When the battery is finally exhausted the '***bAtt***' message will flash continuously for about five seconds, and the instrument will then switch itself off.

The Battery should now be recharged as described below.

BATTERY-CHARGING PROCEDURE

✕ ***To comply with Intrinsic Safety Requirements : the Battery-module must only be removed in a Safe Area, and must only be charged in a Safe Area.***

Cygnus Chargers are supplied for use with either 110V or 230V mains supply – the User must ensure that the Charger is suitable for the local mains supply.

Cygnus Battery-modules should only be charged with the supplied Charger, and always using the following sequence :

⇨ Plug the Charger into the mains power supply, and switch the mains power on.

⇨ Connect the Charger to the Battery-module – charging will commence immediately, and the indicator on the Charger will show **RED**
The Battery is now fast-charging.

⇨ After a maximum 2 hours the Battery will normally be fully charged - the Charger will stop fast-charging, and the indicator will now show **GREEN**
Disconnect the Battery from the Charger – the Battery is now ready for use.

⇨ If another discharged Battery needs to be charged, it may now be connected -
the Charger will reset itself, to begin fast-charging again.

✕ ***Before use in a Hazardous Area : screw the Battery-module back onto the Gauge and then tighten the Battery grub-screw using the Hex-key.***

ⓘ *There is no harm in leaving the Battery connected after fast-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.*

TROUBLESHOOTING

If the Gauge does not switch on

- only if the batteries are *completely dead* will the Gauge not display anything when the **ON**-switch is pressed.
- otherwise, if the batteries are at the end of their useful charge the Gauge will normally flash '***bAtt***' several times and then turn off again - see *Low-Battery Warning*, page 24
  - ⇨ *in either case replace or recharge the Battery*

- if the **ON**-switch will not always function properly, it may have become contaminated or defective :
  - ⇨ *the Gauge will need to be returned for Manufacturer's Service*

If it is difficult to obtain a reading

- if there is only a single flashing bar on the display - this means the Gauge is not receiving any echoes :
  - ⇨ *check that the Probe-lead is properly connected to both Probe and Gauge.*
  - ⇨ *check the condition of the lead; replace if necessary.*
- if there is mostly one fixed bar plus one flashing bar this means that the Gauge is having difficulty obtaining more than one echo :
  - ⇨ *check the Probe and its membrane are properly assembled – see page 14*
  - ⇨ *also see General Point on Thickness Gauging, page 26*
- if there is up to three fixed bars plus one flashing bar, but never any reading - this means the Gauge is receiving unrelated echoes from more than one reflector :
  - ⇨ *on heavily corroded areas this is often a problem; try check measurements on an adjacent area of the same material. See General Points*
  - ⇨ *check the Gauge and Probe together on a test block; if there is still no reading the Gauge may require servicing.*

If readings are erratic or unstable

- Check that the Probe-lead is properly connected to both Probe and Gauge; check that the O-Rings are properly seated in their correct positions; check that the Probe and its membrane are correctly assembled with sufficient couplant

- Check that the Gauge is set for the same Probe-frequency as the actual Probe being used see *Changing the Probe-Setting*, page 21

- The User should ensure that the Probe-frequency is suitable for the *probable minimum thickness* of the material being measured – Probe-frequency *too low* causes doubling and tripling of the actual thickness - see *Probe Usage*, page 16, and *Changing the Probe-Setting*, page 21.

GENERAL POINTS ON THICKNESS GAUGING

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

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

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

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

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

THE FIVE-POINT CHECK

The most frequent reasons found which cause difficulty getting readings

- Is the Probe-membrane fitted correctly ?
  see : *Probe/Knurled Ring Assembly*, page 14
  Check that there is a thin layer of oil between the membrane and Probe-face, and with no air-bubbles trapped

- Is the Probe-lead OK ?
  see : *Probe Usage*, page 16
  Check that the lead in good condition, and is it correctly inserted into both the Probe and the Gauge

- Is the Probe-setting correct ?
  see : *Changing the Probe-Setting*, page 21
  Check on the Gauge that the Probe-setting is correct for the actual Probe in use

- Is there adequate couplant applied to the material being measured, and is the surface properly prepared ?
  see : *Preparing to take measurements*, page 12
  Check that there is plenty of couplant applied, and that there are no air-gaps between the Probe and the material when measuring

- Is the material measurable at all ?
  - Are the front and back faces of the material parallel ?
  - Is the material not too corroded ?
  - Is the material not too thin for the Probe being used ?
  It is often worth confirming that the Gauge is operating OK using a test sample – and also to confirm that the material can actually be measured by ultrasonic multiple-echo thickness measurement.

A GUIDE TO SOUND VELOCITIES

Table of Sound Velocities

- Velocities can vary according to the precise grade and processing conditions.
  This table is included as a guide only.
  Wherever possible, the Gauge should always be calibrated on the material under test.

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

- Velocities given are the compressional wave velocity c_l.

Reading Conversion

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 – if the Gauge is calibrated for Steel [5920 m/s], and a 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 : **T = *true thickness of Copper being measured***
t = *actual reading obtained*
f = *Conversion Factor*
V_{COPPER} = Sound Velocity in Copper : 4700 m/s
V_{STEEL} = Sound Velocity in Steel : 5920 m/s

***Conversion Factor* f** : is given for various materials in the *Table of Sound Velocities* on page 29

TABLE OF SOUND VELOCITIES

Material	***Velocity of Sound***		***Conversion Factor***
	m/s	***in/us***	
Aluminium	6320	0.2488	1.068
Epoxy	2500	0.0986	0.422
Copper	4700	0.1850	0.794
Grey Cast Iron	4600	0.1812	0.777
Magnesium	5770	0.2272	0.975
Nickel	5630	0.2218	0.951
Acrylic	2730	0.1076	0.461
Nylon (Polyamide)	2620	0.1032	0.443
Porcelain	5600	0.2206	0.946
Glass			
Quartz	5570	0.2194	0.941
Soda-lime	6000	0.2362	1.014
Borosilicate	5640	0.2222	0.953
Steel			
Mild	5920	0.2332	1.000
Tool	5870	0.2312	0.992
Stainless 302	5660	0.2228	0.956
Tungsten	5460	0.2150	0.922
Monel	5400	0.2126	0.912
Inconel	5700	0.2244	0.963
Phosphor Bronze	3530	0.1390	0.596
Brass (70% Cu)	4700	0.1850	0.794

CARE AND SAFETY

Intrinsic Safety Requirements

ATEX Certification Labelling

EC Standards Compliance

Care of the Cygnus 1 Intrinsically Safe Gauge

Servicing and Repair

INTRINSIC SAFETY REQUIREMENTS

SGS Certified Product. Certificate Related Document.
Related to certificate number BAS00ATEX1108 and certificate variations.
No modifications permitted without the approval of Cygnus Instruments.

To comply with the Intrinsic Safety Requirements the following restrictions must be observed :

- ***Putting into Service***
  - ⇨ The instrument is supplied as a complete kit of certified Intrinsically Safe components – no components may be replaced by uncertified parts.
  - ⇨ The instrument must only be assembled and dismantled in a Safe Area.
  - ⇨ Calibration of the Gauge must always be undertaken in a Safe Area, prior to use in a Hazardous Area
- ***Certification labels***
  - ⇨ Certification labels must appear on the Instrument body, the Battery-Module, and the Probe-assembly.
    See *ATEX Certification Labelling*, page 32
  - ⇨ Labels must not be removed and must be remain legible.
- ***Battery-Module***
  - ⇨ Only the special Intrinsically Safe type battery, with breather hole, may be used.
  - ⇨ The Battery-module must be secured with the grub screw.
  - ⇨ The hex key must be left in a safe area.
  - ⇨ Charging and replacing of batteries must always be carried out in a Safe Area.
- ***Probes***
  - ⇨ Probes used must be certified and labelled Intrinsically Safe.
  - ⇨ The Probe used with the Gauge must only be changed in a Safe Area.
- ***Environmental***
  - ⇨ The instrument must only be operated with the environmental limits detailed in the Gauge Specification, on page 7
- ***Maintenance***
  - ⇨ If the Gauge is suspected of incorrect behaviour, troubleshooting as described on page 25 should be undertaken, provided that any dismantling of the Gauge takes place in a Safe Area.
  - ⇨ The Gauge should be cared for as described on page 33, provided that such care is undertaken in a Safe Area.
  - ⇨ If the Gauge requires Service or Repair this must only be carried out by Cygnus Instruments

EX CERTIFICATION LABELLING

To comply with Intrinsic Safety Requirements the following Certification labels must appear on the Instrument body, the Battery-Module, and the Probe-assembly :

Year of manufacture

The year of manufacture must appear in the space provided within the label on the Instrument body :

CARE OF THE CYGNUS 1 INTRINSICALLY SAFE GAUGE

The Gauge should be cared for as follows, subject to the restrictions listed in the Intrinsic Safety Requirements on page 31.

- *Cleaning the Gauge*
  - ⇨ Clean and service the Gauge periodically.
  - ⇨ Do not use solvents for cleaning - mild detergent is ideal.
  - ⇨ Do not use any abrasive cleaner, especially on the display window.
  - ⇨ Do not use excessive liquid when cleaning.

- *Care of O-Rings*
  - ⇨ Check the O-Rings regularly and replace if they are damaged or deformed.

- *Care of Batteries*
  - ⇨ Disconnect the Battery-module from the Gauge, if the Gauge will be left unused for more than a few days
  - ⇨ Recharge the Intrinsically Safe Batteries periodically, even if the instrument is not used for long periods.
  - ⇨ Occasionally give the Battery a recharge duration of 14-16 hours to recondition the Battery and to extend its useable life.

- *Environmental*
  - ⇨ Do not immerse the Gauge in liquid.
  - ⇨ Do not subject the Gauge body to temperature in excess of 60°C (140°F).
  - ⇨ Do not store the Gauge for long periods in conditions of high humidity.

SERVICING AND REPAIR

✕ ***To comply with Intrinsic Safety Requirements Servicing and Repair may only be undertaken by Cygnus Instruments, at the address shown on page 5.***

Returning your Gauge for Service

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

ⓘ *Please note : the complete Kit should always be returned for Service or Repair, including all Probes and Leads*.

Cygnus Gauges are renowned for their reliability – very often problems with getting measurements are simply due to the way the Gauge is being used
See : *Troubleshooting*, page 25, and *The Five-Point Check*, page 27

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

- ☐ Is the problem behaviour intermittent ?
- ☐ Is there a problem turning the Gauge on ?
- ☐ Is there a problem with the Gauge turning itself off ?
- ☐ Does the Gauge constantly give incorrect Readings, or unsteady Readings ?
- ☐ Is it not possible to Calibrate the Gauge ?
- ☐ Does the Gauge fail to operate correctly in certain ambient conditions ?

ⓘ *Please refer to the Gauge and Accessories brochure for our full range of Equipment.*

Cygnus Instruments has a policy of continual product improvement. We reserve the right to make changes to the product without prior notification to any person or organisation

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