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Model VG10

Velocity Gauge

Operating Instructions

This proudct meets the Eletromagnetic Compatibility Directive.

These operating instructions are available for download on our website www.elcometerndt.com.

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Thank you for purchasing this Elcometer product. Welcome to Elcometer NDT.
The Model VG10 Velocity Gauge is a world beating product. With the purchase of this gauge you now have access to the worldwide service and support network of Elcometer NDT. For more information visit our website at www.elcometerndt.com.

1 ABOUT YOUR GAUGE

The Model VG10 is a velocity gauge that measures with extreme versatility. It has the ability to measure the sound-velocity of a material while maintaining the ability to locate pits, flaws and defects in the material. Based on the same operating principles as SONAR, the Model VG10 is capable of measuring the sound-velocity of various materials with accuracy as high as 1 m/s (0.0001 in/µs). The principal advantage of ultrasonic measurement over traditional methods is that ultrasonic measurements can be performed with access to only one side of the material being measured.

1.1 STANDARDS

Your gauge can be used in accordance with the following Standards and test methods; ASTM E 797, EN 14127 and EN 15317.

1.2 WHAT THIS BOX CONTAINS

Model VG10, Bottle of couplant, Battery (2 x), Carrying case, Test certificate and Operating instructions.

*Note: The box does **not** include a transducer; these must be ordered separately. To order a transducer, contact Elcometer NDT or your local Elcometer NDT supplier.*

1.3 PACKAGING

The gauge is packed inside its carry case within a cardboard box. Please ensure that the packaging is disposed of in an environmentally sensitive manner. Consult your Local Environmental Authority for further guidance.

To maximise the benefits of your new Elcometer NDT gauge, please take some time to read these Operating Instructions. Do not hesitate to contact Elcometer NDT or your Elcometer NDT supplier if you have any questions.

2 THE KEYPAD

Key	Functions
	Press to switch the gauge on or off. When switching off, the gauge retains all of its settings. If the gauge is idle for 5 minutes, it will switch itself off.
	Press to change units (metric/imperial)
	This key has two functions: • Gauge in calibration mode: Increases numeric values on the display (press and hold to increase quickly). • Gauge not in calibration mode: Switches the Scan measurement mode on and off.
	This key has two functions: • Gauge in calibration mode: Decreases numeric values on the display (press and hold to decrease quickly). • Gauge not in calibration mode: Switches the display backlight between three settings; on, off and auto (in auto mode the backlight automatically illuminates while the gauge is making a measurement and switches off after several seconds, conserving battery life).
	Press to zero the gauge.
	Press to calibrate the gauge.

3 GETTING STARTED

3.1 FITTING BATTERIES

Your gauge may be used with dry cell batteries or rechargeable batteries. 2 x LR6 (AA) alkaline batteries are supplied with this gauge.

When the battery voltage is low the entire display will start to flash. When this occurs the batteries should be replaced.

To fit or replace batteries:

1. Locate battery compartment cover at top of gauge.
2. Unscrew battery compartment cover.
3. Referring to battery polarity instructions on rear of gauge, insert batteries into gauge ensuring correct polarity.
4. Replace battery compartment cover.

Note: Remove the batteries from the gauge if it is to remain unused for a long period of time. This will prevent damage to the gauge in the event of malfunction of the batteries.

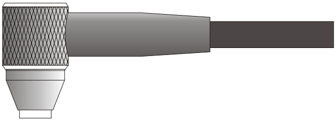
3.2 CHOOSING THE TRANSDUCER

When you purchased your gauge you should have also purchased a suitable transducer for your application. If you have not yet done so, refer to “Transducers” on page 19, which will help you identify the correct transducer type. Alternatively contact Elcometer NDT, your local Elcometer NDT supplier or visit www.elcometerndt.com

3.3 FITTING THE TRANSDUCER

The transducer transmits and receives ultrasonic sound waves that the gauge uses to calculate the speed of sound in the material being measured.

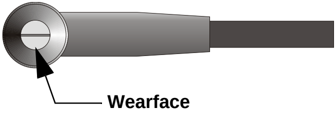
The transducer connects to the gauge via the attached cable, and two coaxial connectors. When using transducers manufactured by Elcometer NDT, the orientation of the dual coaxial connectors is not critical; either plug may be fitted to either socket.



The transducer must be used correctly in order for the gauge to produce accurate, reliable measurements.

The illustration shows the two semicircles of the wearface and the barrier separating them on a typical transducer.

One of the semicircles transmits ultrasonic sound into the material being measured, and the other semicircle receives the sound echoes back into the transducer. When the transducer is placed against the material being measured, it is the area directly beneath the centre of the wearface that is being measured.



3.4 SWITCHING ON/OFF

To switch on or off, press the on/off key .

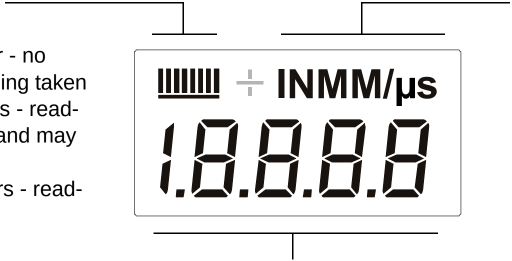
The gauge will switch off automatically after 5 minutes of inactivity.

4 THE DISPLAY

Stability indicator

Units (IN, MM, IN/µs, M/s)

- One vertical bar - no readings are being taken
- Less than 5 bars - reading is unstable and may be inaccurate
- More than 5 bars - reading is stable



Measurement value/Text

Note: The display will hold the last value measured, until a new measurement is made.

Note: When the battery voltage is low, the entire display will begin to flash. When this occurs, the batteries should be replaced.

5 SETTING UP THE GAUGE

5.1 TRANSDUCER - ZEROING

Setting the zero point for the transducer is important for the same reason that setting the zero on a mechanical micrometer is important. If the zero point of the transducer is not set correctly, all of the measurements the gauge makes will be in error by some fixed number. When the zero point of the transducer is set, this fixed error value is measured and automatically corrected for in all subsequent measurements.

Though the gauge will remember the last zero point, it is generally a good idea to set the zero point whenever the gauge is switched on, as well as any time a different transducer is used. This will ensure that the zero point of the instrument is always correct.

The zero probe routine *must* be done prior to calibration.

1. Switch on the gauge and connect the transducer.
2. Remove all couplant from the face of the transducer and check that the wearface of the transducer is clean and free of any debris.
3. Apply a drop of couplant on the transducer and place the transducer in steady contact with the probe zero disk (the battery cover located on the top of the unit), and obtain a steady reading.
   The display should show a thickness value, and nearly all the bars of the stability indicator should be illuminated.
   Note: The value that is displayed will change depending on the current velocity setting in your gauge. Disregard the value displayed; it is not important. What is important is accurately performing these steps to ensure reliability of the zero calculation.

4. While the transducer is firmly coupled to the disc, press PRB 0.

   The display will show ‘Prb0’ while it is calculating its zero point. When the probe zero is completed the measurement screen is displayed.
5. Remove the transducer from the probe zero disk.

Your gauge should now be calibrated.

5.2 CALIBRATING

In order for the gauge to make accurate measurements, it must be calibrated to the sound-velocity of the material being measured.

Different types of material have different sound-velocities. For example, the velocity of sound through steel is 5918 m/s (about 0.233 in/µs) and the velocity of sound through aluminium is 6350 m/s (about 0.248 in/µs). If the gauge is not set to the correct sound-velocity, all of the measurements the gauge makes will be erroneous by some fixed percentage.

There are two methods of calibrating your gauge:

Known thickness calibration: The gauge is calibrated by setting it to a single known thickness.

Known velocity calibration: The sound-velocity of the material being measured is entered directly into the gauge.

To achieve the most accurate measurements possible, it is generally advisable to calibrate the gauge to a sample piece of known thickness. Material composition (and thus, its sound-velocity) sometimes varies from lot to lot and from manufacturer to manufacturer. Calibration to a sample of known thickness will ensure that the gauge is set as closely as possible to the sound-velocity of the material to be measured.

5.2.1 Known Thickness Calibration

If the sound velocity of a material is unknown, a sample of known thicknesses can be used to determine the sound velocity.

Note: Known thickness calibration must be performed on material with the paint or coating removed. Failure to remove the paint or coating prior to calibration will result in a multi-material velocity calculation that may be different from the actual material velocity intended to be measured.

You should always calibrate on the high side of the intended range of material thicknesses you will be measuring. For example, if you are measuring material ranging from 2.54 mm to 25.4 mm (.100" to 1.0"), you should calibrate on a known thickness sample close to 25.4 mm (1.0").

Note: Before you start this calibration procedure, perform a probe zero.

1. Physically measure an exact sample of the material or a location directly on the material to be measured using a set of calipers or a digital micrometer.
2. Apply a drop of couplant on the transducer and place the transducer in steady contact with the sample or the material being tested. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable.
3. Having achieved a stable reading, remove the transducer. If the displayed value changes from the value shown while the transducer was coupled, repeat the previous step.
4. Press CAL .
   On the display, M/s (or IN/µs) will start flashing on and off.
5. Press CAL again.
   On the display, MM (or IN) will start flashing on and off.

6. Use the SCAN and ☀ arrows to adjust the displayed thickness until it matches the thickness of the sample of material.

7. Press CAL to exit the calibration routine.

Your gauge is now ready to perform measurements.

5.2.2 Known Velocity Calibration

If the material velocity is known, you can enter the velocity value directly into the gauge. A list of the sound velocities of common materials is given at the end of this instruction manual.

Note: Before you start this calibration procedure, perform a probe zero.

1. Apply a drop of couplant on the transducer and place the transducer in steady contact with the sample or the material being tested. Be sure that the reading is stable and the repeatability indicator, in the top left corner of the display, is fully lit and stable.

2. Press CAL.
   On the display, M/s (or IN/µs) will start flashing on and off.

3. Use the SCAN and ☀ arrows to adjust the displayed sound-velocity until it matches the known sound-velocity of the sample of material.

4. Press CAL.
   The display will show the thickness value calculated for the material.

5. Press CAL to exit the calibration routine.

Your gauge is now ready to perform measurements.

Note: During the calibration procedure when M/s (or IN/µs) is flashing, if you press PRB 0, the factory default sound-velocity for steel will be restored (5920 m/s or 0.2330 in/µs).

6 MEASUREMENT - TAKING READINGS

Disclaimer: Inherent in ultrasonic thickness measurement is the possibility that the instrument will use the second rather than the first echo from the back surface of the material being measured. This may result in a sound-velocity reading that is HALF what it should be.
Responsibility for proper use of the instrument and recognition of this phenomenon rests solely with the user of the instrument.
Other errors may occur from measuring coated materials where the coating is insufficiently bonded to the material surface. Irregular and inaccurate readings may result. Again, the user is responsible for proper use and interpretation of the measurements acquired.

6.1 BEFORE YOU START

- Prepare the surface - see "Condition and Preparation of Surfaces" on page 21.
- Set the zero point of the transducer - see "Setting up the Gauge" on page 7.
- Select units; press IN/MM to select metric (mm) or imperial (inches).

6.2 PROCEDURE

1. **Apply couplant**
   For the gauge to work correctly there must be no air gap between the transducer and the surface of the material to be measured. This is achieved using a couplant.
   Before the transducer is placed on the surface, put a small amount of couplant on the surface of the material. Typically a single drop is sufficient.
2. **Place transducer onto the surface of the material to be measured**
   Press the transducer wearface into the couplant. Moderate pressure on the top of the transducer using the thumb or index finger is sufficient; it is only necessary to keep the transducer stationary and the wear-face seated flat against the surface of the material.
3. **Read display**
   If six or seven bars of the stability indicator are showing, the display will be reading the correct sound-velocity of the material directly beneath the transducer.
   If the stability indicator has fewer than five bars showing, or the numbers on the display seem erratic, check to make sure that there is an adequate film of couplant beneath the transducer, and that the transducer is seated flat against the material.
   The gauge will perform a number of measurements every second when the transducer is in contact with the surface of the material. The display is updated as each reading is taken.
4. **Remove transducer from surface**
   The display will show the last measurement made.

Note: Occasionally, a small film of couplant will be drawn out between the transducer and the surface as the transducer is removed. When this happens, the gauge may perform a measurement through this couplant film, resulting in a measurement that is larger or smaller than it should be. This phenomenon can be seen when one sound-velocity value is observed while the transducer is in place, and another value is observed after the transducer is removed. If this happens, take the reading again using less couplant.

7 SCAN MODE

In normal operation, your gauge performs and displays four measurements every second, which is quite adequate for taking a measurement at a single point.

It is sometimes desirable however to examine a larger region, searching for the thinnest point. Your gauge includes a feature, called Scan Mode, which allows it to do just that.

In Scan Mode, the gauge performs 16 measurements every second, but does not display them, instead the display shows a moving series of dashes.While the transducer is in contact with the material being measured, the gauge memorises the lowest measurement it finds. The transducer can be ‘scrubbed’ across a surface, and any brief interruptions in the signal will be ignored. When the transducer loses contact with the surface for more than one second the gauge will display the lowest value it found.

To switch Scan Mode on/off:

When the gauge is not in calibration mode, press the 

arrow. A message will appear briefly in the display confirming the operation.

8 STORAGE

Your gauge has a Liquid Crystal Display. If the display is heated above 50°C (120°F) it may be damaged. This can happen if the gauge is left in a car parked in strong sunlight.

Always store the gauge in its case when it is not being used.

If the gauge is to remain unused for long periods of time, remove the batteries and store them separately. This will prevent damage to the gauge in the event of malfunction of the batteries.

9 MAINTENANCE

You own one of the finest velocity gauges in the world. If looked after, it will last a lifetime.

9.1 FAULTS

Your gauge is designed to give many years reliable service under normal operating and storage conditions. The gauge does not contain any user-serviceable components. In the unlikely event of a fault, the gauge should be returned to your local Elcometer NDT supplier or directly to Elcometer NDT. The warranty will be invalidated if the instrument has been opened.

9.2 TRANSDUCER

The transducer will wear with repeated use. Transducer life depends on the number of measurements taken and the manner in which readings are taken. To extend transducer life, always set the transducer down so that it is perpendicular to the panel surface. Dragging the transducer along the surface will reduce the life of the transducer. Replacement transducers are available from your local Elcometer NDT supplier or directly from Elcometer NDT.

10 TECHNICAL SPECIFICATION

Measurement Rate	Manual	4 readings per second
	Scan mode	16 readings per second
Measuring Range[a]	Sound Velocity	1250 m/s to 10000 m/s (0.0492 in/µs to 0.3930 in/µs)
	Thickness	0.63 mm to 500 mm (0.025” to 19.999”)
Measurement Resolution	Sound Velocity	1 m/s (0.0001 in/µs)
	Thickness	0.01 mm (0.001")
Velocity Calibration Range		1250 m/s to 10000 m/s (0.0492 in/µs to 0.3937 in/µs)
Weight (including batteries)		284 g (10 oz)
Dimensions (W x H x D)		63.5 mm x 114.3 mm x 31.5 mm (2.5” x 4.5” x 1.24”)
Gauge Operating Temperature		-30°C to 50°C (-20°F to 120°F)
Case		Aluminium case with gasket sealed end caps and waterproof membrane keypad
PC Connection		RS232 serial port. Windows PC interface software
Display		12.7 mm (0.5 “) high digits with LED backlight (on/off/auto).
Power Source		Two 1.5 V AA alkaline or 1.2 V rechargeable cells. Typically operates for 200 hours on alkaline and 120 hours on rechargeable cells (charger not included). *Note: Alkaline batteries must be disposed of carefully to avoid environmental contamination. Please consult your local environmental authority for information on disposal in your region. Do not dispose of any batteries in fire.*

a. Measuring Range depends on material, surface conditions and the transducer selected.

11 WARRANTY

Elcometer NDT warrants your gauge against defects in materials and workmanship for a period of two years from receipt by the end user.
Additionally, Elcometer NDT warrants transducers and accessories against such defects for a period of 90 days from receipt by the end user. If Elcometer NDT receives notice of such defects during the warranty period, Elcometer NDT will either, at its option, repair or replace products that prove to be defective. The warranty will be invalidated if the instrument has been opened.

11.1 EXCLUSIONS

The above warranty shall not apply to defects resulting from: improper or inadequate maintenance by the customer; unauthorised modification or misuse; or operation outside the environmental specifications for the product.
Elcometer NDT makes no other warranty, either express or implied, with respect to this product. Elcometer NDT specifically disclaims any implied warranties of merchantability or fitness for a particular purpose. Some states or provinces do not allow limitations on the duration of an implied warranty, so the above limitation or exclusion may not apply to you. However, any implied warranty of merchantability or fitness is limited to the two-year duration of this written warranty.
This warranty gives you specific legal rights, and you may also have other rights, which may vary from country to country, state to state or province to province.

11.2 OBTAINING SERVICE DURING WARRANTY PERIOD

If your hardware should fail during the warranty period, contact Elcometer NDT and arrange for servicing of the product. Retain proof of purchase in order to obtain warranty service.

For products that require servicing, Elcometer NDT may use one of the following methods:

- Repair the product
- Replace the product with a re-manufactured unit
- Replace the product with a product of equal or greater performance
- Refund the purchase price.

11.3 AFTER THE WARRANTY PERIOD

If your hardware should fail after the warranty period, contact Elcometer NDT for details of the services available, and to arrange for non-warranty service.

12 SPARES

Your gauge is complete with all the items required to get started and take measurements (transducers must be ordered separately). Over the life of the gauge replacement items may be required. The following replacement and optional items are available from your local Elcometer NDT supplier or directly from Elcometer NDT.

Description	**Sales Part No.**
2.25 MHz 1/4” Potted Side Transducer	TX2M25CP-2
5 MHz 1/4” Potted Side Transducer	TX5M00CP-4
5 MHz 1/4” Potted Side High Damped Transducer	TX5M00CP-10
7 MHz 1/4” Potted Side High Damped Transducer	TX7M50CP-6
10 MHz 1/4” Potted Side Transducer	TX10M0CP-4
Ultrasonic Couplant, 120 ml (4 oz)	TC-24034-1
Ultrasonic Couplant, 360 ml (12 oz)	TC-24034-2
Ultrasonic Couplant, High Temperature 340°C (650°F), 60 ml (2 oz)	TC-24034-4
Ultrasonic Couplant, High Temperature 480°C (896°F), 60 ml (2 oz)	TC-24034-5

Note: A wide range of other transducers and accessories is available - see www.elcometerndt.com for details.

13 TRANSDUCERS

Your gauge is capable of performing measurements on a wide range of materials, from various metals to glass and plastics. Different types of material, however, have different properties. The following paragraphs highlight the important properties of transducers which should be considered when assessing a particular measurement task.

The best measurement condition is one where sufficient ultrasonic energy is sent into the material being measured such that a strong, stable echo is received by the gauge.

Several factors affect the strength of ultrasound as it travels. These are outlined below:

13.1 INITIAL SIGNAL STRENGTH

The stronger a signal is to begin with, the stronger its return echo will be. Initial signal strength is largely a factor of the size of the ultrasound emitter in the transducer. A large emitting area will send more energy into the material being measured than a small emitting area. Therefore a 6 mm (1/4”) transducer will emit a stronger signal than a 3 mm (1/8”) transducer.

13.2 ABSORPTION AND SCATTERING

As ultrasound travels through any material, it is partly absorbed. If the materials through which the sound travels have any grain structure, the sound waves will experience scattering. Both of these effects reduce the strength of the waves.

Higher frequency ultrasound is absorbed and scattered more than ultrasound of a lower frequency. It may seem therefore that using a lower frequency transducer might be better in every instance, however low frequencies are less directional than high frequencies.

13.3 GEOMETRY OF THE TRANSDUCER

The physical constraints of the measuring environment sometimes determine the suitability of a transducer for a given job. The transducer may simply be too large to be used in confined areas. Also, the surface area available for contacting with the transducer may be limited. Measuring on a curved surface may require the use of a transducer with a matching curved wearface.

13.4 TEMPERATURE OF THE MATERIAL

When it is necessary to measure on surfaces that are exceedingly hot, special high-temperature transducers may be necessary. Additionally, care must be taken when performing a ‘Calibration to Known Thickness’ with a high temperature application.

13.5 SELECTING THE CORRECT TRANSDUCER

Elcometer NDT has a complete range of transducers to meet your requirements, including:

- A range of frequencies and sizes
- Straight and right angle
- Transducers available as potted or microdot transducers:
  Potted transducers - transducer cable is permanently fixed to the transducer head.
  Microdot transducers - transducer cable is fixed to the transducer head by a connector - allows transducer heads to be replaced quickly and easily.
- High temperature transducers - temperature up to 480°C (896ºF)

When selecting a transducer, it is important to choose one which will best meet your application, taking into consideration the measurement range, the type of material to be tested and the design of the transducer probe type. For full details of the Elcometer NDT range of transducers contact your local Elcometer NDT supplier, or visit the Elcometer NDT website www.elcometerndt.com

14 CONDITION AND PREPARATION OF SURFACES

The shape and roughness of the test surface are of paramount importance when carrying out ultrasonic thickness testing. Rough, uneven surfaces may limit the penetration of ultrasound through the material, and result in unstable, and therefore unreliable, measurements.

The surface being measured should be clean, and free of any small particles, rust, or scale. The presence of such obstructions will prevent the transducer from seating properly against the surface. Often, a wire brush or scraper will be helpful in cleaning surfaces. In more extreme cases, rotary sanders or grinding wheels may be used, though care must be taken to prevent surface gouging, which will inhibit proper transducer coupling.

Extremely rough surfaces, such as the pebble-like finish of some cast iron, will prove most difficult to measure. These kinds of surfaces act on the sound beam like frosted glass acts on light, the beam becomes diffused and scattered in all directions.

In addition to posing obstacles to measurement, rough surfaces contribute to excessive wear of the transducer, particularly in situations where the transducer is ‘scrubbed’ along the surface.

15 APPLICATION NOTES

15.1 MEASURING TUBING

When measuring a piece of pipe to determine the thickness of the pipe wall, orientation of the transducers is important.

If the diameter of the pipe is larger than approximately 100 mm (4”), measurements should be made with the transducer oriented so that the gap in the wearface is perpendicular (at right angles) to the long axis of the pipe.

If the diameter of the pipe is small, two measurements should be performed, one with the wearface gap perpendicular to the long axis of the pipe, another with the gap parallel to the long axis of the pipe - see illustration. The smaller of the two displayed values should then be taken as the thickness at that point.

Perpendicular **Parallel**

15.2 MEASURING HOT SURFACES

The velocity of sound through a material depends upon the temperature of the material. As materials heat up, the velocity of sound in the material decreases. In most applications with surface temperatures less than approximately 100°C (~200°F), no special procedures are required. At temperatures above 100°C (~200°F), the change in sound-velocity of the material being measured starts to have a noticeable effect upon the accuracy of ultrasonic measurement.

At such elevated temperatures, it is recommended that the user perform a calibration procedure on a sample piece of known thickness, which is at, or near, the temperature of the material to be measured. This will allow the gauge to correctly calculate the velocity of sound through the hot material.

When performing measurements on hot surfaces, it may also be necessary to use a high-temperature transducer. It is recommended that the transducer be left in contact with the surface for as short a time as needed to acquire a stable measurement. While the transducer is in contact with a hot surface, it will begin to heat up, and through thermal expansion and other effects, may adversely affect the accuracy of measurements.

15.3 MEASURING LAMINATED MATERIALS

The density (and therefore sound-velocity) of laminated materials may vary considerably from one piece to another. Some laminated materials may even exhibit noticeable changes in sound-velocity across a single surface. The only way to reliably measure such materials is by performing a calibration procedure on a sample piece of known thickness. Ideally, this sample material should be a part of the same piece being measured, or at least from the same lamination batch. By calibrating to each test piece individually, the effects of variation of sound-velocity will be minimised.

An additional consideration when measuring laminates, is that any air gaps or pockets within the laminate will reflect the ultrasound beam. This will be noticed as a sudden increase in sound-velocity in an otherwise regular surface. While this may impede accurate measurement of the material, it does provide positive indication of air gaps in the laminate.

16 SOUND VELOCITIES OF COMMON MATERIALS

Material	Sound velocity	
	(m/s)	(in/µs)
Aluminium	6350	0.250
Bismuth	2184	0.086
Brass	4394	0.173
Cadmium	2769	0.109
Cast Iron	4572	0.180 (Approx.)
Constantan	5232	0.206
Copper	4674	0.184
Epoxy Resin	2540	0.100 (Approx.)
German Silver	4750	0.187
Glass, Crown	5664	0.223
Glass, Flint	4267	0.168
Gold	3251	0.128
Ice	3988	0.157
Iron	5893	0.232
Lead	2159	0.085
Magnesium	5791	0.228
Mercury	1448	0.057
Nickel	5639	0.222
Nylon	2591	0.102 (Approx.)

Material	Sound velocity	
	(m/s)	(in/µs)
Paraffin	2210	0.087
Platinum	3962	0.156
Plexiglas	2692	0.106
Polystyrene	2337	0.092
Porcelain	5842	0.230 (Approx.)
PVC	2388	0.094
Quartz Glass	5639	0.222
Rubber, Vulcanised	2311	0.091
Silver	3607	0.142
Steel	5918	0.233
Steel, Stainless	5664	0.223
Stellite	6985	0.275 (Approx.)
Teflon	1422	0.056
Tin	3327	0.131
Titanium	6096	0.240
Tungsten	5334	0.210
Water	1473	0.058
Zinc	4216	0.166