proceq

pundit®

Operating Instructions

Design Patent Pending

Swiss Solutions since 1954

Contents

1. Safety and Liability

1.1 General Information

This manual contains important information on the safety, use and maintenance of the Pundit Touchscreen. Read through the manual carefully before the first use of the instrument. Keep the manual in a safe place for future reference.

1.2 Liability

Our “General Terms and Conditions of Sales and Delivery” apply in all cases. Warranty and liability claims arising from personal injury and damage to property cannot be upheld if they are due to one or more of the following causes:

- Failure to use the instrument in accordance with its designated use as described in this manual.
- Incorrect performance check for operation and maintenance of the instrument and its components.
- Failure to adhere to the sections of the manual dealing with the performance check, operation and maintenance of the instrument and its components.
- Unauthorised modifications to the instrument and its components.
- Serious damage resulting from the effects of foreign bodies, accidents, vandalism and force majeure.

All information contained in this documentation is presented in good faith and believed to be correct. Proceq SA makes no warranties and excludes all liability as to the completeness and/or accuracy of the information.

1.3 Safety Instructions

The equipment is not allowed to be operated by children or anyone under the influence of alcohol, drugs or pharmaceutical preparations. Anyone who is not familiar with this manual must be supervised when using the equipment.

- Carry out the stipulated maintenance properly and at the correct time.
- Following completion of the maintenance tasks, perform a functional check.

1.4 Correct Usage

- The instrument is only to be used for its designated purpose as describe herein.
- Replace faulty components only with original replacement parts from Proceq.
- Accessories should only be installed or connected to the instrument if they are expressly authorized by Proceq. If other accessories are installed or connected to the instrument then Proceq will accept no liability and the product guarantee is forfeit.

The following statement applies to the products covered in this manual, unless otherwise specified herein. The statement for other products will appear in the accompanying documentation.

NOTE! This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules and meets all requirements of the Canadian Interference-Causing Equipment Standard ICES-003 for digital apparatus. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/T.V. technician for help

This device complies with part 15 of the FCC:

Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation."

This Class B digital apparatus complies with Canadian ICES-0003.

2. Technical Specifications

Pundit Touchscreen

Display	7" colour display 800x480 pixels
Memory	Internal 8 GB flash memory
Regional settings	Metric and imperial units and multi-language and timezone supported
Power input	12 V +/-25 % / 1.5 A
Battery	3.6 V, 14 Ah
Battery lifetime	> 8h (in standard operating mode)
Humidity	< 95 % RH, non condensing
Operating temperature	-10°C to +50°C
IP classification	IP54
Dimensions	250 x 162 x 62 mm
Weight	~ 1.5 kg (incl. battery)
Standards and Directives	CE certification
Pollution Degree	2
Installation Category	2

Power Supply

Model	HK-AH-120A500-DH
Input	100-240 V / 1.6 A / 50/60 Hz
Output	12 V DC / 5 A
Max. Altitude	2’500 m above sea level
Humidity	< 95%
Operating Temperature	0°C - 40°C
Environment	Indoor use only
Pollution Degree	2
Installation Category	2

Pundit 200 and Pundit 200 Pulse Echo

Range	0.1 – 7930 µs
Resolution	0.1 µs (< 793 µs), 1 µs (> 793 µs)
Display	7” colour display 800x480 pixels
Pulse Voltage UPV	100 Vpp – 450 Vpp
Pulse Voltage UPE	100 Vpp - 400 Vpp
Receiver Gain	1x – 10’000x (0 – 80dB) [11 steps]
Receiver Sensitivity	10 µV
Receiver Input Impedance	7 kΩ
Pulse Echo Range	0.1 – 1200 µs
Transducer Frequency	50 kHz
Aperture Size	2x25 cm^2
Bandwidth	20 – 500 kHz

Pundit 250 Array

Receiver

Gain	0 – 80 dB
Analog Bandwidth	15 kHz – 100 kHz
Nominal transducer frequency	50 kHz shear wave
Range	0 – 1000µs
Resolution	1 µs

Transmitter

Pulse Voltage	+/-150 V
Pulse Shape	rectangle
Pulse Delay	8 ms – 200 ms

Power Supply

Batteries	6 x NiMH, Size AA, 2300 mAh (can be replaced by the user)
Battery lifetime	> 7 h
Mains	12 V – 15 V
Operating Time	min. 7 h
Charging Time	approx. 150 min

Aperture	
Number of Channels	8 (with upgrade option to 16)
Transducers per Channel	3
Wave Type	shear wave, horizontally polarized
Center Frequency	approx. 45 kHz
Transducer Bandwidth	80 % – 100 %
Channel distance	3 cm
Aperture Size	21 cm x 5 cm
Miscellaneous	
Weight	~ 3 kg
Operating Temperature	-10° – 50°
Humidity	< 95 % RH, non condensing
Dimensions	240 x 273 x 153 mm
Laser	used for positioning support
Camera	240 x 320 Pixel

3. Operation

The information provided in this manual covers all applications supported by the Pundit Touchscreen.

3.1 Getting Started

Battery Installation Pundit Touchscreen

To install the Battery into the Pundit Touchscreen Unit, lift the stand as shown. Insert the battery and fasten in place with the screw.

There are two status LEDs **1** (see page 11) and above them a light sensor. The upper LED is red while charging and turns to green when it is fully charged. The other LED is application specific.

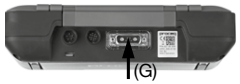
NOTE! Only use the power supply provided.

- A complete charge requires approx. 9h (Instrument not operating).
- Charging time is much longer if the instrument is in use.
- An optional quick charger (Part No. 327 01 053) can be used to charge a spare battery or to charge the battery outside of the instrument. In this case it takes approx. 4h for a complete charge.

Energy Saving

Energy saving may be programmed as desired under System/Power settings.

Connecting the Transducers



Connect the Transducers to the Pundit Touchscreen Unit using the BNC Adapter Cable and the BNC Cables. Ensure that the screws are fastened on the BNC adapter cable.

USB Host:
Connect a mouse, keyboard or USB stick.

USB Device:
Connect to a PC.

Ethernet:
Connection for firmware upgrades.

Power Supply:
Connect the power supply through this connection.

Buttons

Lift the protective visor.
At the upper right of the screen there are three buttons 2 (see page 11).

Power On/Off – Press to power on. Press and hold to power off.

Soft Key – Open a pdf document (e.g. Operating instructions) or toggle full screen view.

Back Button – returns to previous screen.

Battery Installation Pundit Array Transducer

Remove the battery pack from the Pundit Array Transducer by loosening the two screws and pulling out the battery pack. On the underside there is a plate which has to be removed by unscrewing two screws to access the battery compartment.

NOTE! Insert the six AA NiMH rechargeable batteries into the battery pack being sure to observe the correct polarity and replace into the Pundit Array Transducer. Before first use, fully charge the batteries using the charger provided. While the battery is charging the status LED is green. It will extinguish when fully charged. A full charge takes about 2.5 hours.

By pressing and holding the fuel gauge button, the actual charge statues can be seen. Each LED represents 20% charge, so all 5 LEDs lit indicates a charge of more than 80%.

Any AA batteries may be used with the instrument, but the fuel gauge is only accurate when the recommended NiMH batteries are used.

WARNING!

If standard alkaline batteries (non-rechargeable) are used, it is very important not to connect the charger as this will result in damage to the instrument.

3.2 Main Menu

On start up the main menu containing 6 icons is displayed.

Measurement:	Application specific measurement screen.
Settings:	For application specific settings.
Explorer:	File manager functionality for reviewing measurements saved on the instrument.
System:	For system settings, e.g. language, display options, power settings.
Information:	For device information and operating instructions.
Exit:	Power Off.

All functions may be accessed directly via the touch screen. Return to the previous menu by pressing the back button or the return icon (arrow) at the top left of the touch screen.

3.3 Pundit 200

Scroll up and down the screen by dragging your finger up or down the screen. The current setting is displayed on the right hand side. Tap on an item to adjust it.

Transducer

Connected transducer

Select the frequency of the transducer to be used. The custom transducer setting allows non-standard transducers up to 500 kHz to be used. If this option is selected, the transducer frequency must also be entered.

NOTE! When a transducer frequency is selected, the factory settings are automatically loaded for that transducer, based on 1.5m cables being used. Generally, the accuracy this provides is sufficient for most applications, so zeroing is not required with this configuration.

Zeroing Transducer

For increased accuracy or when working with different cable lengths, the Pundit 200 should be zeroed.

Enter the expected calibration value as it is marked on the Calibration Rod.

Couple the transducers to the Calibration Rod using the ultrasound Couplant and press firmly together.

Tap on the start icon to carry out the zeroing.

On completion “Zeroing succeeded” will be displayed.

Tap to return to the settings menu.

Tap to return to the zeroing start screen.

Tap to reload the factory calibration values for the transducer. This setting provides sufficient accuracy for most measurements, but for exact zeroing, perform the procedure described above.

Measurement Settings

Measurement Range
Short range (default). For measurements up to approximately 800 µs. This corresponds to a path length of approximately 3 m for normal concrete. This provides the maximum measurement resolution of 0.1 µs.

For larger objects select the long range. In this case the measurement resolution is 1 µs.

The measurement screen indicates (--- µs) if a measurement is out of range.

Pulse Repetition Frequency
Pulse Repetition Frequencies (PRF) of 5 Hz to 40 Hz (measurements per second) may be selected. High values should be selected only when the instrument is used on large objects with high receiver amplification settings. In such cases, it helps to increase the update rate on the display. For general concrete or ceramic materials testing a PRF of between 10-30 Hz is normally used.

The transducers supplied with the instrument are not damped and, therefore, on being excited by the transmitter they have a long ring-down time. The ring-down time may exceed the pulse interval when the PRF is set to high values, i. e. the previous pulse may still be ringing as the next pulse arrives. This effect may cause errors when testing short path length specimens having low internal damping. If this occurs reduce the PRF.

Line Scan

Line Scan provides the capability to measure along a linear grid at equal spacing. The distance between the transducers may be varied for each measurement to accommodate irregular shaped objects (see “3.4.2 Measurement Modes” – Line Scan).

Series Length
Set the number of measurements to be made or leave it open ended.

Distance between Measurements
Set the spacing.

Unit
Choose between pulse velocity or transmission time as the unit for the graphical display of the results.

Units

Unit
Choose between metric and imperial units.

Amplitude Unit
Choose to display the receive signal amplitude either as a percentage or in decibels.

Compressive Strength Unit
Choose the unit for compressive strength correlations.

E-modulus Unit
Choose the unit for E-modulus calculations.

E-modulus Density Unit
Choose the unit for entering density for E-modulus calculations.

Trigger

Amplitude Trigger
When selected, allows a user defined amplitude threshold for triggering.

Drag the horizontal cursor to the desired trigger level. The zoom function is useful to set a specific trigger threshold.

Follow Trigger
When selected, the point at which the trigger occurs is always displayed in the centre of the screen, irrespective of the measured transmission time. This does not apply if manual triggering or dual cursor triggering is being used (see “3.3.1 Measurement Screen”).

NOTE! Both triggering options can be selected at the same time. If none are selected then the triggering is carried out automatically as normal.

Corrections

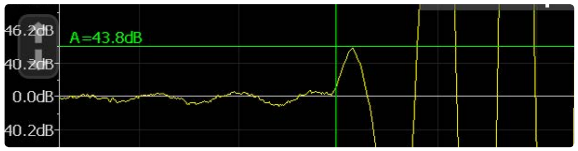
Temperature correction UPV
Pulse velocity measurements are affected by several factors. Two key factors are the moisture content of the concrete and the temperature. The table below shows the correction factor that should be entered based on the recommendations made in BS 1881: Part 203.

Temperature	Dry concrete	Wet concrete
10 °C – 30 °C	1.0 (No correction)	1.0 (No correction)
60 °C	1.05	1.04
40 °C	1.02	1.02
0 °C	0.99	0.99
-4 °C	0.98	0.92

The correction factor is applied to pulse velocity calculations. The measured transmission time is unaffected.

Amplitude Analysis

Marker
When selected a marker is activated that can be used to record the amplitude of the received signal (see”3.3.5 Measuring with Pundit 200”).



Area Scan

Raster X: set the grid spacing for the X-axis.

Raster Y: set the grid spacing for the Y-axis.

Measurement count X: Set the number of measurements to be made in the X-direction.

Measurement count Y: Set the number of measurements to be made in the Y-direction.

Colour Scheme: Select the colour scheme (can be adjusted later in the explorer).

Result: Select the measurement parameter you wish to display.

Auto Color Range: On or off. If not selected then the user may define minimum and maximum settings for the colour range and these may also be adjusted later in the explorer. The color scheme may also be inverted by setting the maximum value lower than the minimum.

Data Logging Mode

Interval: Select the interval between measurements. (Minimum interval is 1 minute).

Number of events: Until the test is completed. (Maximum number of events is 3000).

Averaging: Determines the number of readings to be taken and averaged at each interval measurement.

Result: select transmission time or pulse velocity.

Distance between transducers: This must be set if pulse velocity is selected as the test result unit.

3.3.1 Measurement Screen

The standard measurement screen is shown. All settings are directly accessible from the measurement screen.

Zoom

Zoom in by placing thumb and index finger together on the screen and spreading them apart. This can be used in both the horizontal and vertical directions when making a measurement.

Zoom out by placing thumb and index finger apart on the screen and pinching them together.

Pan

Pan the image from left to right by dragging.

Measuring screen controls

1 **Filename:** Enter the file name and press return. Saved measurements will be stored with this file name. If several measurements are made under the same file name, a suffix increments after each measurement.

2 **Measurement mode:** Select the type of measurement to be carried out (see section “3.4.2 Measurement Modes”).

3 The top right hand corner of the display shows the current transducer selected, current time and the battery status.

4 **Gain:** Adjust the receiver gain, from 1x up to a maximum of 10 000x.

5 **Voltage:** Adjust the transmitter voltage. For best results, it is best to begin with low transmitter voltage and a low gain setting. Then increase until a stable signal level is achieved. Signal clipping should be avoided.

6 **Continuous/Burst Transmission:**

Continues transmitting until the stop icon is pressed.

Records a measurement as soon as a stable signal is detected.

7 **Settings:** Enter the settings menu.

8 **Stop/Save:**

Stop the current measurement.

Save the current measurement.

Save the current series and continue the measurement.

9 **Start/Snapshot:**

Begin the measurement.

Save the current measurement as displayed on the screen and continue measuring.

10 **Cursor Selection:**

Automatic triggering.

Note: In data logging mode triggering is always automatic, but may be adjusted manually in PL-Link.

Manual triggering. Set the cursor position manually, by dragging it to the left or right. The trigger position may also be adjusted later on the saved waveform in the Explorer.

Dual cursor. Transmission time mode only. Both cursors have to be set manually. The second cursor is particularly useful when measuring with shear wave transducers. Dual cursor is selected automatically when measuring in E-modulus mode.

11 **Zoom:**

Zoom in and out of the current measurement.

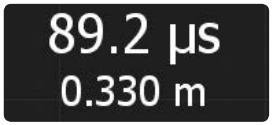
3.3.2 Basic Measurement Modes

Transmission Time

The measured transmission time between the transducers.

Distance

Enter the pulse velocity of the material under test.



Result is the transmission time and the distance between the transducers.

Pulse Velocity

Enter the distance between the transducers.

Result is the transmission time and the pulse velocity of the material under test.

Compressive Strength

Prior to carrying out this measurement, a conversion curve valid for the concrete under test must be created in PL-Link and downloaded to the instrument.

Select the correlation curve.

Enter the distance between the transducers.

If a SONREB curve is selected, enter the rebound value determined at the same location as the pulse velocity measurement.

SONREB is a method of combining an ultrasonic pulse velocity measurement with a rebound hammer measurement to improve the accuracy of compressive strength estimation.

Result is the transmission time and the compressive strength of the material under test.

3.3.3 Special Measurement Modes

Crack Depth

The crack depth measurement implemented in Pundit 200 is in accordance with the method described in BS 1881:Part 203.

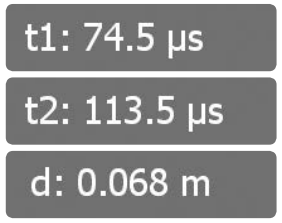
Enter the distance ‘b’ as indicated in the diagram shown on the screen.

Position the transducers as shown in ‘Step 1’ on the screen.

Measure t1.

Position the transducers as shown in ‘Step 2’ on the screen.

Measure t2.



Result shows the transmission times t1 and t2 and the crack depth ‘d’.
An incorrect measurement of t1 or t2 may be deleted and repeated before continuing.
An error message is displayed for an invalid measurement
(t2 < t1 or t2 > 2 x t1).

NOTE! For this method to give good results, the crack must be perpendicular to the surface. It must also be free of water or debris which would allow the wave to propagate through the crack. The crack must be sufficiently wide to prevent the wave from simply propagating around it. There must also be no rebars within the vicinity of the crack. If any of these conditions occur, the result will be severely affected and it may appear that the crack depth is much shallower than is actually the case.

Surface Velocity

The surface velocity measurement implemented in Pundit 200 is in accordance with the method described in BS 1881:Part 203.

The transmitter remains in a fixed position. The receiver is moved at a fixed interval.

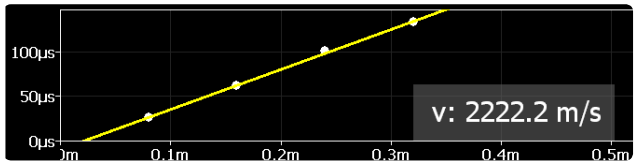
Enter the distance ‘b’ as indicated in the diagram shown on the screen.

Enter the number of measurements to be made.

Measure the transmission time at distance ‘b’.

Record the first measurement at distance ‘b’.

Move the receiver a further distance ‘b’ and measure again. Continue until you have completed the series.



The pulse velocity is calculated from the slope of the curve.

NOTE! If the points recorded show a discontinuity, it is likely that a surface crack or surface layer of inferior quality is present. In this case the measured velocity is unreliable.

E-Modulus

The dynamic E-modulus and the Poisson’s Ratio of a material (e.g. concrete or rock) may be determined by measuring the P- and S-wave pulse velocities. The method is described in the following two standards and is equally applicable to concrete or other solids:

ASTM D 2845 – Standard Test Method for Laboratory Determination of Pulse Velocities and Ultrasonic Elastic Constants of Rock.

ISRM – Aydin A., Upgraded ISRM Suggested Method for Determining Sound Velocity by Ultrasonic Pulse Transmission Technique: Rock Mech Rock Eng (2014) 47:255-259, DOI: 10.1997/s00603-013-0454-z).

Measuring with Dry Point Shear Wave Transducers

The dual cursor mode is automatically activated.
Use the first cursor to mark the onset of the P-wave component.
Press stop, then press P – S to switch transducers. Select the DPC S-wave transducer 40 kHz.
Use the second cursor to mark the onset of the S-wave component.
In order to calculate the E-modulus it is necessary to enter the density of the material.
When downloaded to PL-Link, the Poisson's Ratio of the material is also calculated.

P-waves vs. S-waves

In a P-wave (longitudinal wave) the particle displacement is parallel to the direction of wave propagation. The particles oscillate back and forth about their individual equilibrium positions. In an S-wave (shear wave) the particle displacement is perpendicular to the direction of wave propagation. The particles oscillate up and down about their individual equilibrium positions as the wave passes by.

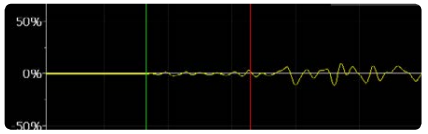
Measuring with traditional S-wave Transducers

Detection of the shear wave (S-wave) requires the use of the waveform display in order to manually locate the onset of the shear wave echo as it is always preceded by a weak P-wave component that is detected by the automatic triggering.

NOTE! This p-wave component can be used to perform zeroing with the shear wave transducers using the recommended procedure described in chapter 3.3.

S-waves travel in a one-dimensional plane. The strongest signal appears when the transducers are correctly aligned. This property can be used to correctly detect the S-wave component of the received signal. When measurements with the 250 kHz shear wave transducers are performed, it is crucial to use the special shear wave coupling paste, otherwise shear waves cannot be properly transmitted into the object under test.

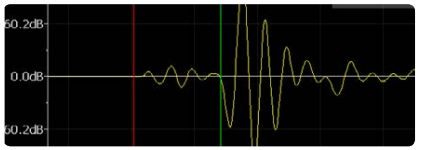
Misaligned by 90°
Weak S-wave component



Weak S-wave component with the transducers misaligned.

Rotate one transducer into and out of alignment and watch the S-wave component increase and decrease.

Correctly aligned
Strong S-wave component

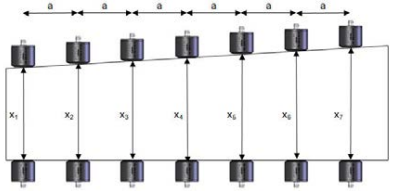


Much stronger S-wave component when the transducers are correctly aligned.

3.3.4 Multi-Measurement Modes

Line Scan

The distance ‘a’ is entered in the ‘Settings’ menu.



Position the transducers at the starting position and enter the distance x1. (Not required if transmission time only is being measured.)

Press the start icon to begin.

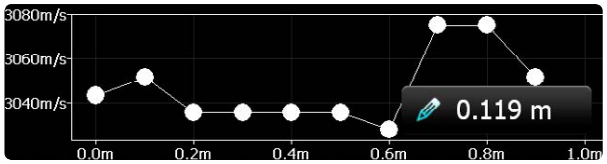
Press the snapshot icon and record the first measurement. If burst mode is selected this will be recorded automatically.

Move the transducers the distance ‘a’ to the next point on the grid.

If the distance ‘x’ does not change press the snapshot icon again to make the second measurement and so on.

Press this icon to save the current series. If the distance ‘x’ is different at the new position a new value may be entered before proceeding with the scan.

Enter the new distance ‘x’.



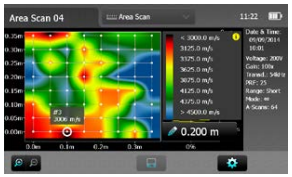
Press to continue the scan.

Use this icon to delete the last measurement made.

Press the to save the current series and reset the instrument for a new series.

Area Scan

Area scan allows a 2D visualization of an element based on pulse velocity, transmission time or distance measurements. The measurement grid is defined in ‘Settings.’ If the expected variation of the measured parameter is not known then select ‘Auto color range.’ This may be subsequently adjusted in the explorer. If the expected range is known, the color range may be defined by setting a maximum value and a minimum value. E.g. The Indian standard IS 13311 defines pulse velocity bands for concrete quality classification.



> 4’500 m/s: Excellent

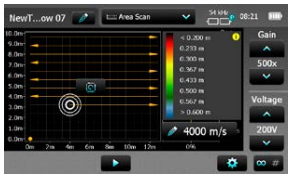
3’500 – 4’500 m/s: Good

3’000 – 3’500 m/s: Medium

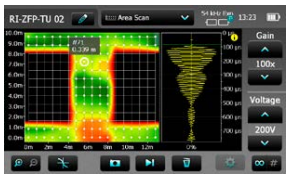
< 3’000 m/s: Doubtful

Setting the maximum speed to 4’500 m/s and the minimum speed to 3’000 m/s provides a simple visualization of areas of the structure that require attention.

The cursor position indicates the position of the next measurement. Ensure that this aligns with a grid drawn out on the test structure.



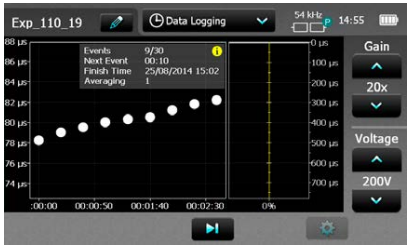
You may drag the cursor to the position on the grid where you wish to start measuring. Arrows indicated the direction of proceeding with the measurement.



It is possible to drag the cursor to another location on the grid in order to avoid obstacles etc. It is also possible to drag the cursor back to previous measurement and either delete it, or measure it again. In the example below measurement #71 is indicated and may be deleted or repeated. If the measurement is repeated by pressing the snapshot button, the previous value is overwritten. The black areas were excluded by dragging the cursor to the next position to be measured.

Data Logging

The data logging mode allows the user to program a test sequence. A typical application for this would be to track the pulse velocity change as concrete sets. The parameters must be set in Settings. Initially the information box shows the current settings. During the test a countdown timer indicates the remaining time to the next measurement, the number of measurements already made and the time at which the test will be concluded.

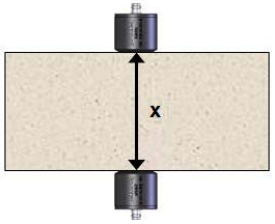


The test may be stopped at any time by pressing on the  icon.

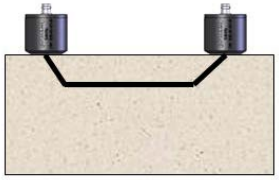
The information screen may be switched in and out by pressing on the ‘i’ button. The waveforms are saved with each measurement and may be viewed by tapping on the marker. The trigger points may be adjusted manually if necessary once the data has been exported to PL-Link.

3.3.5 Measuring with Pundit 200

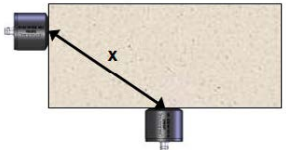
Three transducer arrangements are commonly used.



Direct Transmission: The optimum configuration with maximum signal amplitude. The most accurate method of pulse velocity determination. Path length is measured from centre to centre of the transducers.



Indirect Transmission: Signal amplitude is approximately 3 % of signal amplitude when compared to direct transmission. Path length may be uncertain. Use the surface velocity mode to eliminate this uncertainity. The pulse velocity will be influenced by the concrete surface zone. Where possible, carry out a comparison with a direct transmission measurement to eliminite any uncertainly.



Semi-direct Transmission: Sensitivity is somewhere between the other two methods. Path length is measured from centre to centre of the transducers.

Preparation

Basic preparations are common to each application. The distance (path length) between the transducers should be measured as accurately as possible (unless you are measuring in transmission time mode).

It is essential in all ultrasonic pulse tests to use some form of couplant between the faces of the transducers and the material under test. Failure to do so will result in a loss of signal due to inadequate acoustic coupling. The ultrasound couplant provided provides good coupling when used on concrete or other materials having smooth surfaces. Silicone grease, medium bearing grease or liquid soap may also be used to good effect. For rougher surfaces, a thick grease or petroleum jelly is recommended.

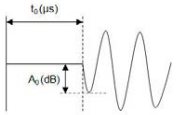
In some cases it may be necessary to prepare the surface by smoothing it. If this is not possible the exponential transducers (Part No. 325 40 170) should be considered.

For line scans a test grid should be drawn out on the surface.

Amplitude Analysis

Amplitude analysis is a method developed at Tonji University in Shanghai and is widely used throughout China for comparison testing of concrete in structures.

In order to record the amplitude the Amplitude Analysis Marker must be set in the settings menu . When this is set, the amplitude is recorded along with the transmission time as part of the test result.

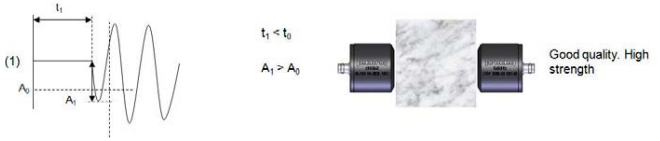


A reference measurement is made on a section of concrete of known quality.

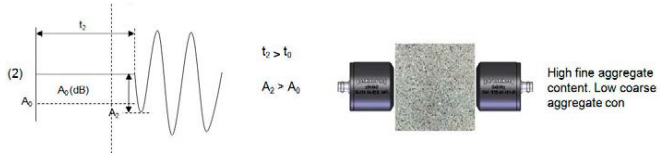
t_0 : Reference transmission time
A_0 : Reference receive level

Subsequent measurements on the structure are compared with these two values and an inference is made about the concrete quality based on this.

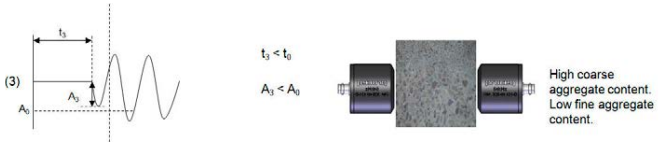
Six different cases are identified which allow the user to make a statement about the concrete quality.



Good quality – High strength.

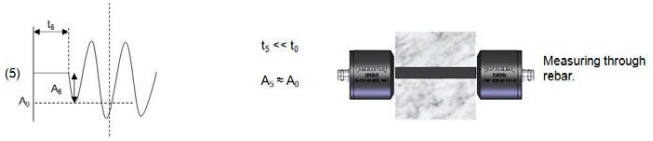


High fine aggregate content. Low coarse aggregate content.

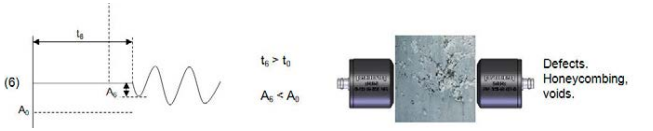


High coarse aggregate content. Low fine aggregate content.

Defect on surface. Poor coupling.



Measuring through rebar.



Defects, honeycombing, voids.

3.3.6 Transducer Selection Guideline

Physical Influences on Transducer Selection

The selection of the correct transducer for the application is largely dependent on the aggregate (grain) size and the dimensions of the test object.

Effect of particle size

Inhomogeneities (e.g. aggregate particles, voids) in concrete influence the propagation of an ultrasound pulse. They will scatter the signal. The effect is very large if the size of the aggregate is equal to or larger than the wavelength of the ultrasonic signal. This influence can be significantly reduced by choosing the pulse frequency, such that the wavelength is at least twice as large as the aggregate size.

It also follows that it is very difficult to detect an anomaly if it is smaller than half the wavelength.

For rocks and other fine grained materials such as ceramics and wood, the grain size is less significant. For such materials, the size of the object to be tested is the most significant factor.

Best results have been obtained on wood with 54 kHz.

For ceramics, the small sample size and fine grain means that 250 kHz or 500 kHz is most widely used.

Effect of sample size

The pulse velocity is reduced significantly if the lateral dimensions (perpendicular to the direction of transmission) is less than the wavelength.

Higher frequency signals, have a better defined edge and therefore make it easier to identify the onset of the received pulse. However they are more influenced by scattering. A 500 kHz signal has a wavelength of around 7 mm (assuming the speed of sound to be 3500 m/s) and is heavily scattered by the coarse aggregate in concrete, limiting the transmission to a few decimeters at most. A 24 kHz signal has a wavelength of around 150 mm and is largely unaffected by scattering. The maximum transmission range may be several meters.

Transducer Wavelength

The wavelength may be easily calculated:

Wavelength = ultrasonic pulse velocity / frequency

For concrete, the ultrasonic pulse velocity ranges from 3000 m/s (poor quality) to 5000 m/s (high quality). An average value for ordinary concrete of 3700 m/s (longitudinal wave) and 2500 m/s (shear wave) have been used for the computation of the wavelengths, the maximum aggregate size and the minimum lateral dimension of the test object.

NOTE! For ultrasonic measurements made on rock, ASTM D2845 recommends a minimum lateral dimension of 5x the wavelength. It also recommends using a wavelength at least 3x the average grain size. e. g. An NX core specimen has a diameter of 54.7 mm A transducer frequency of 250 kHz or 500 kHz would be recommended for this size of specimen based on this recommendation, (depending on pulse velocity of the rock types to be tested). Maximum grain size would be 5 mm or 2.33 mm respectively.

P-wave Transducers

	Test Object Limitations			Application
	Wavelength	Maximum grain size	Minimum lateral dimension	
24 kHz Part No. 325 40 026	154 mm	≈ 77 mm	154mm	**Concrete:** Very coarse, aggregate, Large objects (several meters)
54 kHz Part No. 325 40 131	68.5 mm	≈ 34 mm	69 mm	Concrete, Wood, Rock
150 kHz Part No. 325 40 141	24.7 mm	≈ 12 mm	25 mm	Fine grained material, Refractory bricks Rock (NX cores)
250 kHz Part No. 325 40 177	14.8 mm	≈ 7 mm	15 mm	Fine grained material, Refractory bricks, Rock, Small samples
500 kHz Part No. 325 40 175	7.4 mm	≈ 3 mm	7 mm	Fine grained material, Refractory bricks Rock, Use on small samples limited by size of transducer

Exponential Transducer

54 kHz Part No. 325 40 170	68.5 mm	≈ 34 mm	69 mm	Concrete: rough surfaces, rounded surfaces. (No couplant required.) Wood, Rock (heritage sites)

The signal strength is not as strong as the standard transducer and therefore it is recommended to use this transducer with a high receiver gain and also to verify the trigger point using the waveform display.

S-wave Transducer

40 kHz Part No. 325 40 210	≈ 5 mm	Greater than the thickness of the object.	Used for determination of elastic modulus, Concrete, wood, rock.

3.4 Pundit 200 Pulse Echo

Connected Transducer

If a Pulse Echo Transducer is connected this will be recognized automatically.

Test Transducer

Each individual dry contact transducer can be tested for correct functionality.

The graphic on the right hand side of the screen indicates which transducer pair is to be tested (blue highlight). Press the Pulse Echo Contact Tester onto the transducer pair as shown.

A successful test is indicated by the transducer pair being highlighted green.

The next pair to be tested is then highlighted blue.

Continue until each transducer pair has been tested.

If one contact pair fails the test, it may be repeated before continuing.

A-scan Analysis

Echo Tracking

This is particularly useful if a quick read-out of slab thickness is desired.

For complex objects containing internal defects, pipes and rebars it is recommended to perform a complete B-scan for analysis of the object.

Enable Gate

The gate function is used to search for the correct echo in a specific section of the A-scan. It is used in the measurement modes Distance, Pulse Velocity and Area Scan. See chapter “3.4.2 Measurement Modes”.

Filter

Filters are used to filter out unwanted noise, to make it easier to identify the correct echo.

- OFF – No filter is applied. The raw signal is displayed.
- Normal – Applies a medium band filter to the received signal.

The received signal is saved post-filtering, so it is not possible to alter the filter afterwards. Switching the filter off allows the raw data to be viewed.

Time Gain Compensation

When switched on amplifies signals that are further away from the transducer.

Area Scan

Raster X: set the grid spacing for the X-axis.

Raster Y: set the grid spacing for the Y-axis.

Measurement count X: Set the number of measurements to be made in the X-direction.

Measurement count Y: Set the number of measurements to be made in the Y-direction.

Colour Scheme: Select the colour scheme (can be adjusted later in the explorer).

Result: Select the measurement parameter you wish to display.

Auto Color Range: On or off. If not selected then the user may define minimum and maximum settings for the colour range and these may also be adjusted later in the explorer. The color scheme may also be inverted by setting the maximum value lower than the minimum.

B-scan

Distance between measurements

Set the spacing between measurements. For good resolution images, a spacing of 1 cm is recommended. For a quicker initial scan a coarser spacing may be used, e. g. 2.5 cm corresponding to the spacing markers on the Pulse Echo Transducer. When searching for larger objects such as delaminations or thickness variations, much coarser grid spacings may be used, e. g. 10 cm and upwards.

SAFT

When activated, applies a Synthetic Aperture Focusing Technique to the raw data to produce a sharper image.

SAFT uses path length and positioning information to correct the image. The quality of the final image is dependent on the spacing of the measurements.

Envelope

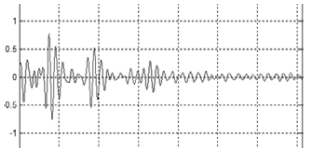
When this setting is activated it uses an envelope of the A-scan to generate the B-scan image. This can also help to generate a clearer B-scan image.

Color Range and Color Scheme

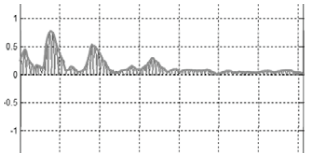
Color range may be automatic or manual. When set to manual, the color gain icon (9) appears on the measurement screen.

Four different color schemes may be chosen according to preference.

Original – Original signal is used to generate the B-scan.



Envelope – Envelope signals is used to generate the B-scan.



Units

Choose between metric and imperial units

3.4.1 Measurement Screen

The standard measurement screen is shown on page 24. All settings are directly accessible from the measurement screen.

Zoom

Zoom in by placing thumb and index finger together on the screen and spreading them apart. This can be used in both the horizontal and vertical directions when making a measurement.

Zoom out by placing thumb and index finger apart on the screen and pinching them together.

Pan

Pan the image from left to right by dragging.

Measuring screen controls

(1) **Filename:** Enter the file name and press return. Saved measurements will be stored with this file name. If several measurements are made under the same file name, a suffix increments after each measurement.

(2) **Measurement mode:** Select the type of measurement to be carried out (see section “3.4.2 Measurement Modes”).

(3) The top right hand corner of the display shows the current transducer selected, current time and the battery status.

(4) **Gain:** Adjust the receiver gain, from 1x up to a maximum of 10 000x.

(5) **Voltage:** Adjust the transmitter voltage. For best results, it is best to begin with low transmitter voltage and a low gain setting. Then increase until a stable signal level is achieved. Signal clipping should be avoided.

(6) **Settings:** Enter the settings menu.

(7) **Stop/Save (Right Button on Transducer):**

Stop the current measurement.

Save the current measurement.

Save the current series and continue the measurement.

(8) **Start/Snapshot (Left Button on Transducer):**

Begin the measurement.

Save the current measurement as displayed on the screen and continue measuring.

9 Cursor Selection

Automatic triggering.

Manual triggering. Set the cursor position manually, by dragging it to the left or right. The trigger position may also be adjusted later on the saved waveform in the Explorer or in PL-Link.

Available in transmission time mode only. Allows a marker to be set on a second echo and the difference between thet two echos is displayed.

Manually adjust the colour intensity.

10 Automatic Estimation of Pulse Velocity

This setting is available in the Distance and B-scan modes. The pulse velocity may be entered manually after having made a control measurement on an object of known thickness. Alternatively, it is possible to estimate the pulse velocity directly on surface of the test object. Tap on this button and press the transducer against the surface to make a measurement. A number of measurements can be made and an average value is calculated. Tap  to apply the pulse velocity setting. Pulse velocity may be subsequently adjusted on saved files in the Explorer or in PL-Link.

NOTE! Typical shear wave pulse velocities for concrete are in the region 2000 - 2500 m/s

3.4.2 Measurement Modes

Transmission time
The measured transmission time between the transmitter and receiver.

Distance
Enter the pulse velocity of the material under test or perform an “Automatic Estimation of Pulse Velocity” as described in the previous chapter.

The result is the thickness of the slab or distance to the internal object (e. g. void, delamination) that is the source of the echo.

Pulse Velocity
Enter the thickness of the object under test.

The result is the transmission time and pulse velocity of the material under test.

Area Scan

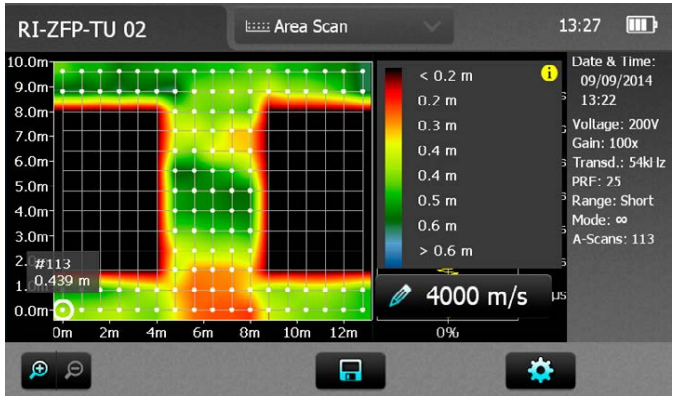
Area scan allows a 2D visualization of an element based on pulse velocity, transmission time or distance measurements.

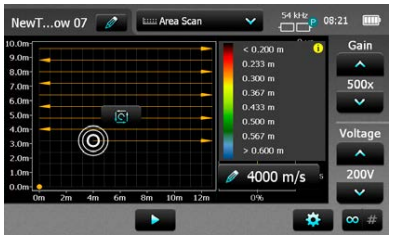
The measurement grid is defined in ‘Settings.’ If the expected variation of the measured parameter is not known then select ‘Auto color range.’ This may be subsequently adjusted in the explorer.

If the expected range is known, the color range may be defined by setting a maximum value and a minimum value.

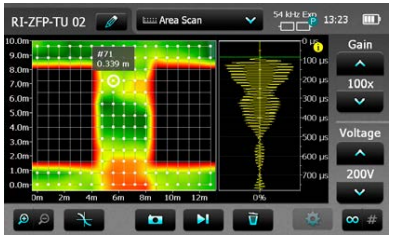
e.g. The German guideline RI-ZFP-TU for Non-Destructive Assessment of Tunnel Inner Shell Thickness specifies a measurement grid of 80 cm. The purpose of the test is to determine areas of reduced thickness in tunnel shells and also to locate possible voids between the tunnel shell and the rock surface.

Setting the result to distance allows areas of reduced thickness to be easily identified.





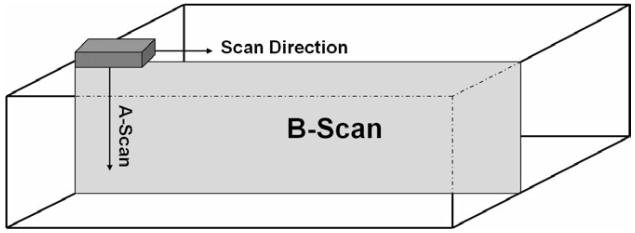
The cursor position indicates the position of the next measurement. Ensure that this aligns with a grid drawn out on the test structure. You may drag the cursor to the position on the grid where you wish to start measuring. Arrows indicated the direction of proceeding with the measurement.



It is possible to drag the cursor to another location on the grid in order to avoid obstacles etc. It is also possible to drag the cursor back to previous measurement and either delete it, or measure it again. In the example below measurement #71 is indicated and may be deleted or repeated. If the measurement is repeated by pressing the snapshot button, the previous value is overwritten. The black areas were excluded by dragging the cursor to the next position to be measured.

B-scan

Provides a cross sectional image of the test object perpendicular to the scanning surface in the plane through which the individual A-scans have been collected.



The spacing between A-scans is entered in the “Settings” menu.

Position the transducer at the starting position.

Press the start icon to begin or the left button on the transducer.

Record the first measurement. The measurement may also be recorded by pressing the left button on the transducer.

- The LED’s on the transducer provide a visual feedback when a measurement has taken place successfully. This is accompanied by an acoustic tone on the display device. The volume of the tone may be adjusted in system settings.
- Move the transducers to the next point of the scan. Make the second measurement and continue.
- The current A-scan is shown on the right hand side of the screen.
- The current status of the B-scan is shown on the main part of the screen.

Press this icon or the right button on the transducer to save the current B-scan.

Press this icon or the right button on the transducer to continue the current B-scan.

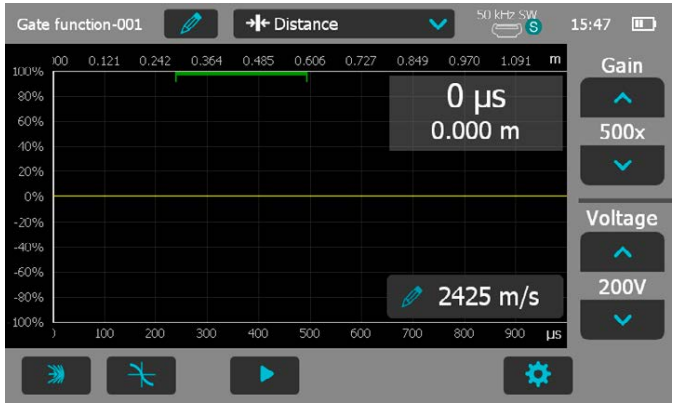
Use this icon to delete the last measurement made.

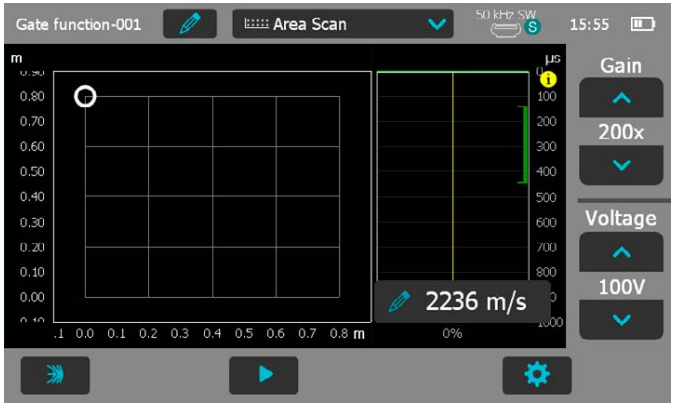
Press the to save the current series and reset the instrument for a new series.

The green cursor (cross-hairs) may be moved to any point on the B-scan simply by dragging. The actually cursor position is displayed on the axes. The current A-scan selected changes with the cursor position. This is indicated by the A-scan number at the top of the chart and also on the A-scan display at the right side of the measurement screen. This feature is also available on saved B-scans in the Explorer or in PL-Link.

Gate Function

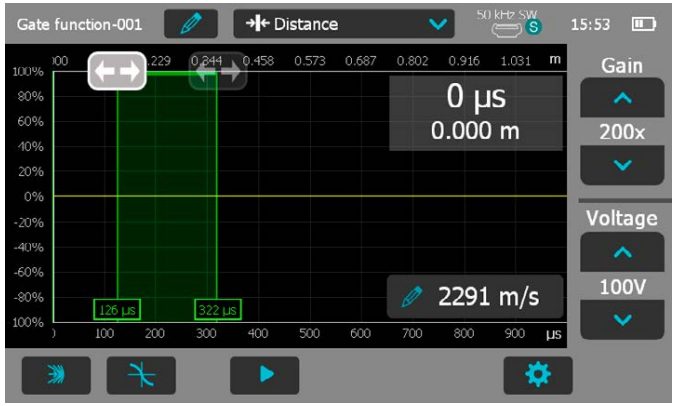
The gate function is used to search for the correct echo in a specific section of the A-scan. It is used in the measurement modes Distance, Pulse Velocity and Area Scan. Without the gate function, it can occur that the echo detected by the echo tracking function is not the one received from the back wall of the test object. When the gate function is enabled, the “gate” will be visible as a green band in measurement screen and the echo tracking function will only look in the region defined for the correct echo.



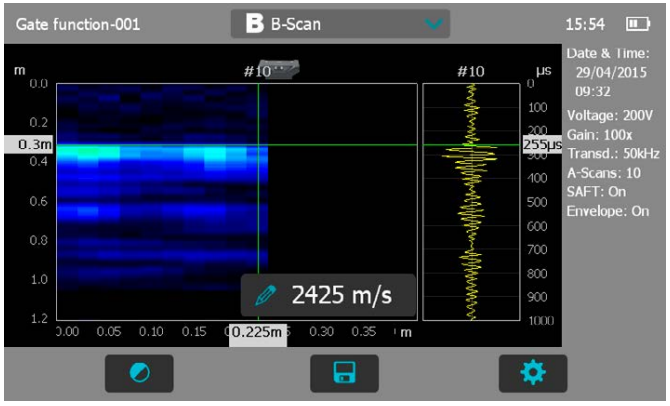


In the Distance and Pulse Velocity modes it is at the top of the measurement screen. In the Area Scan mode it is located in the A-scan window at the right side of the screen.

Press and drag on either end of the gate to adjust the range.



In order to find a suitable range, it is advisable to first carry out an automatic pulse velocity estimation and then to do a quick B-scan to determine the range of the back wall.



In this example the back wall is at 0.3m with a transmission time of 255 µs. If the aim were to look for variation in thickness it would be reasonable to set the gate between 200 µs and 300 µs.

In the distance mode, the gate can also be set using the distance scale at the top of the screen as an aid.

3.4.3 Measuring with Pundit 200 Pulse Echo

NOTE! Testing with Pulse Echo Technology requires in-depth knowledge of the test object and application characteristics. Proceq offers comprehensive ultrasonic training seminars imparting this knowledge as well as all functionalities and features of the Pundit instruments. Pundit 200 Pulse Echo users are recommended by Proceq to register for the Advanced Ultrasonic Tomography Applications training. Details can be found on the Proceq website.

Preparation

- Very few preparations are necessary when measuring with the Pulse Echo Transducer.
- The dry-contact transducer means that acoustic coupling is ensured without the use of any couplant.
- The contacts are sprung and can accommodate surface irregularities to a depth of 7 mm, so smoothing of the surface is also unnecessary.
- For Area Scans and B-scans a test grid should be drawn out on the surface. Alternatively Proceq provide a calibrated tape (Part No. 327 010 71) that can be stuck on the surface for the test and then removed afterwards.
- For best results with Distance, Pulse Velocity and Area Scan measurements make sure that Echo Tracking and Enable Gate are activated in Settings.

Calibration

The most accurate results can be obtained if the instrument is calibrated for the material under test.

- This is done by performing a pulse velocity measurement on a section of the structure of known thickness.
- Alternatively, perform the automatic estimation of pulse velocity as described in chapter 3.4.1.

Physical influences on the Measurement

Inhomogeneities (e. g. aggregate particles, voids) in concrete influence the propagation of an ultrasound pulse. They will scatter the signal. The effect is very large if the size of the aggregate is equal to or larger than the wavelength of the ultrasonic signal. This influence is significantly reduced when the wavelength is at least twice as large as the aggregate size. It also follows that it is very difficult to detect an anomaly if it is smaller than half the wavelength.

The Pulse Echo Transducer is a shear wave transducer with a frequency of 50 kHz.

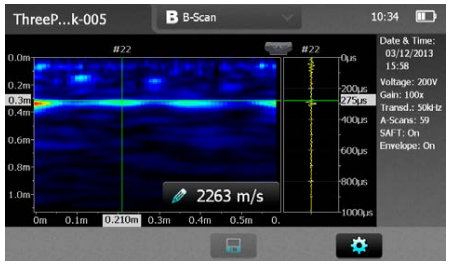
Assuming a typical pulse velocity of 2500 m/s, the wavelength is 50 mm. This means that anomalies smaller than 25 mm will be invisible.

Effect of sample size

The geometry of the object is very important for obtaining good results.

- The maximum penetration depth depends on the quality of the concrete and also on the amount of rebars present. Typically the maximum transmission depth lies between 50 cm (19.7”) and 1m (39.4”).
- Generally, the minimum lateral dimension should be two times the thickness of the object, or the depth of the anomaly you are trying to detect. The reason for this is that if the object is too narrow, reflections from the side walls will interfere with the echo from the rear wall.

3.4.4 Analysis of B-scans



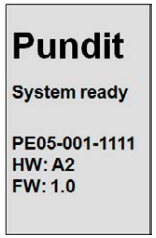
Please refer to the separate booklet Pundit 200 Pulse Echo B-scan Measurement Examples.

Explorer provides a number of tools that assist in the analysis of B-scans.

- Drag the cross hairs to a point of interest. (e. g. back wall of sample as shown here)
- The object thickness (e. g. 0.3m) is displayed on the y-axis.
- The object position from the beginning of the scan is displayed on the x-axis.
- The current A-scan (e. g. #22) is indicated above the B-scan and also in the the A-scan window.
- The current transmission time is displayed at the right hand side of the of the screen.
- The cursor position may also be adjusted by dragging on the position display boxes.
- SAFT and Envelope may be switched ON/OFF in Settings.
- Pulse velocity may be corrected.
- Spacing between measurements may be corrected.
- The color scheme may be adjusted.
- Any modifications made to the scan may be saved.
- All of these items may be adjusted later in PL-Link once the files have been downloaded to a PC.

3.5 Pundit 250 Array

Press the power button for ca. 1 second to turn the transducer on. It takes about 20 – 25s to boot up.



When it is ready the start up screen will be displayed which also displays information about the transducer serial number and the hardware and firmware versions.

By entering the Settings menu, a screen showing various settings/actions appears:

Connecting Transducer

Connect the Pundit Array Transducer to the 12 pin connector of the Pundit Touchscreen Unit using the cable provided. The Pundit Array Transducer will be recognized automatically.

NOTE! If you have purchased the upgrade kit Part No. 327 30 130) you will need to enter the activation key provided, before the Pundit Touchscreen recognizes the Array Transducer. To do this enter the menu System/Features/Enter Activation Key.

Test Transducer

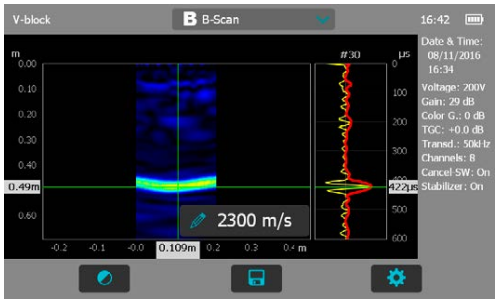
Each individual dry contact transducer can be tested for correct functionality. After having started the test procedure the graphic on the Pundit Touchscreen Unit indicates which transducer row is to be tested (blue highlight).

Press the Pundit Array Contact Tester onto the transducer row as shown. A successful test is indicated by the transducer row being highlighted green. The next row to be tested is then highlighted blue. Continue until each transducer row has been tested.

If one row fails the test, it may be repeated before continuing. If it continues to fail the test, contact a Proceq service centre.

A-scan Analysis

A-scan Presentation
Determines how the A-scan is displayed. Choose between: Signal, Envelope or Signal and Envelope. The A-scan is shown on the right hand side of the measurement screen as seen below. The signal is shown in yellow and the envelope (if selected) is shown in red.



B-scan

All of these settings can be applied or removed from saved scans.

Surface Wave Cancellation
Removes the surface wave component from the displayed B-scan.

B-scan Stabilizer
Normalizes the signal strength to compensate for variations in the pressure applied to individual transducer elements. This allows a B-scan image to be obtained without having to press hard against the test object.

Color Scheme

Four different colour schemes are available.

Panorama B-scan

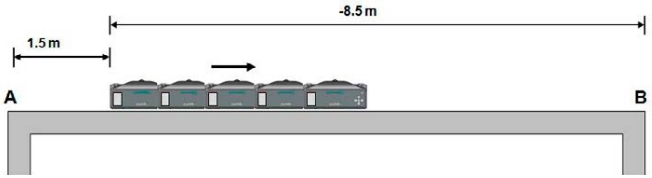
Two settings are used to create the image and to align it to the structural element being tested.

Overlap of B-scans
Set the amount by which individual scans overlap when creating a panorama B-scan. The overlap range is from 0.21m corresponding to an overlap of one complete transducer (only relevant for the 16-channel con-

figuration) to a negative overlap of -5m. The overlap is explained in the chapter “Measurement Modes”.

Horizontal Panorama Offset

This setting enables the user to align a panorama B-scan to the structural drawings.



In this example the scan can be aligned to:

- point A, in which case the horizontal panorama offset would be set to 1.5 m
- point B, in which case the horizontal panorama offset would be set to -8.5 m

Corrections

Signal Zero Offset

This feature allows the user to work with the envelope peak for depth measurements. This is much easier than trying to locate the beginning of a pulse. The default value is zero. In order to use this feature, enter the offset in microseconds determined when estimating the pulse velocity using an echo. (See “3.5.2 Measurement Modes” Estimate by Echo).

Time Gain Compensation

This feature amplifies echoes that are further away from the transducer to provide a more balanced B-scan. The amount of amplification can be adjusted by the user either here in the settings or directly on the transducer while carrying out a B-scan. (See Transducer Controls.)

Data Acquisition

Pulse Delay

The default value is 8ms. This will give the fastest screen refresh when carrying out a real time B-scan.

For narrow objects and objects with very little attenuation the delay between pulse cycles can be increased. This reduces the noise effect of reflections from side walls etc.

Units

Choose between metric and imperial units.

Transducer Energy Settings

Transducer Backlight

Turn the backlight of the auxiliary display on and off.

3.5.1 Measurement Screen

Measuring screen controls

1 **Filename:** Enter the file name and press return. Saved measurements will be stored with this file name. If several measurements are made under the same file name, a suffix increments after each measurement.

2 **Measurement mode:** Select the type of measurement to be carried out (see section “3.5.2 Measurement Modes”).

3 The top right hand corner of the display shows the current transducer selected, current time and the battery status.

4 **Gain:** Adjust the receiver gain from 0 – 62 dB

5 **Settings:** Enter the settings menu.

6 **Delete last measurement**

7 **Stop/Save (Right Button on Transducer):**

Stop the current measurement.

Save the current measurement.

Save the current series and continue the measurement.

8 **Start/Snapshot:**

Begin the measurement.

Save the current measurement as displayed on the screen and continue measuring.

9 **Cursor Selection**

Manually adjust the colour intensity.

10 **Automatic Estimation of Pulse Velocity**

See section “3.5.2 Measurement Modes”

11 **B-scan** (real time) Cursor shows depth and horizontal position

12 **A-scan** (with envelope)

Keypad Controls
The gain can be adjusted directly on the transducer. Also the alignment laser can be turned on and off at any time.

Handle Controls
There are three buttons on the handle. The centre button corresponds to the control buttons 7 and 8 on the Pundit Touchscreen.

The outer buttons are used to adjust the gain. The functionality is summarized in the following table.

Function	Keypad	Single Handle	Dual Handle Left	Dual Handle Right
8 Start / Snapshot		Press once	Press once	
7 Stop / Save		Press and hold		Press once
Adjust gain				
Adjust end gain (TGC)				
Toggle Alignment Laser				

NOTE! Gain adjustment is blocked once a panorama B-scan has been started.

3.5.2 Measurement Modes

Pulse Velocity Estimation

Pundit 250 Array has two different methods available for estimating pulse velocity.

Pressing the key brings up the pulse velocity estimation screen.

Estimate by surface wave

This option should be used when the thickness of the test object is not known. The pulse velocity of signals travelling near the surface of the concrete is determined. Press the transducer against the surface to make a measurement. A number of measurements can be made using the snapshot key at different locations and an average value is calculated.

Tap to apply the pulse velocity setting.

Estimate by echo

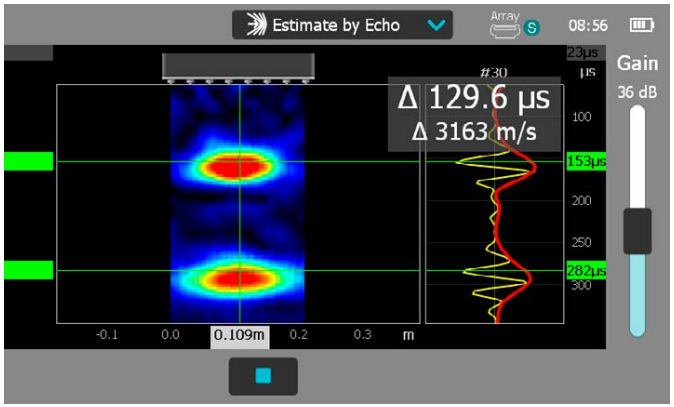
The second and more accurate option should be used if the thickness of the test object is known.

The thickness of the object must be entered manually.

Then press the transducer against the surface and begin a measurement. The ideal situation is when multiple back wall echoes are visible.

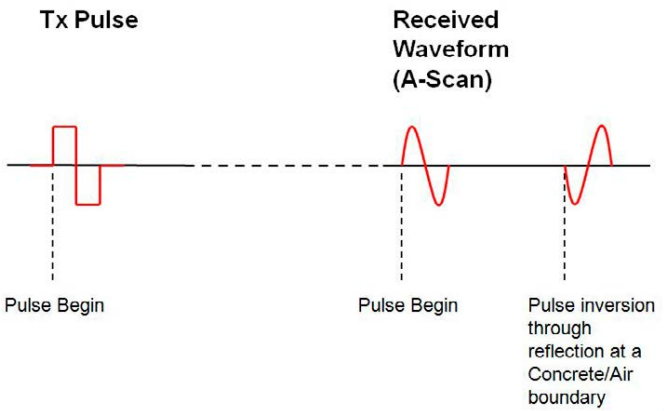
Use the cursors to mark the position of the first and second back wall echo, using the A-scan envelope to identify the peaks.

The transit time is calculated from peak to peak as seen in the screen shot below. The offset is shown in the very top right of the measurement screen (23us in this example). This value can be entered in Signal Zero Offset setting, allowing the user to work with the envelope peak for depth measurements.

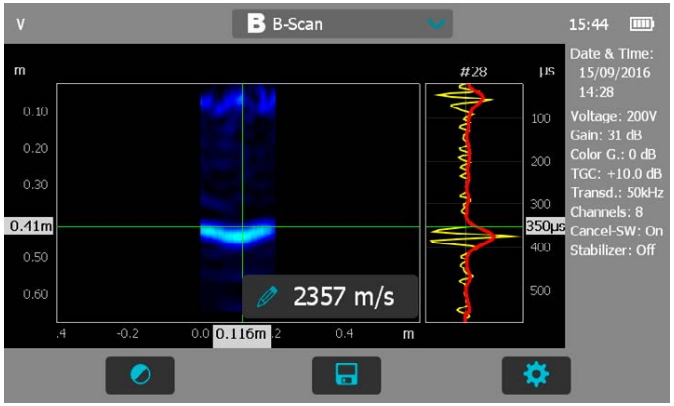


For thicker objects a second back wall echo is not always visible. In this case it is still possible to estimate the pulse velocity by echo but the procedure is slightly different.

The first cursor remains at the ‘0’ position and the second cursor is moved to the position of the back wall echo. In this case however it is necessary to identify the beginning of the pulse using the A-scan rather than work with the peaks. The diagram below shows the form of the transmission pulse which is a square wave. The received format is shown on the left hand side. This is important to understand when trying to locate the depth of objects in the scan.

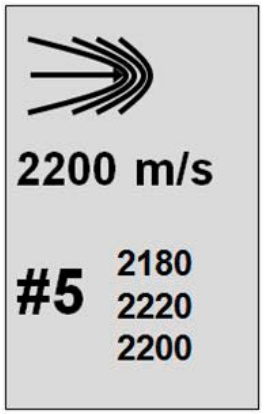


The scan below shows the correct identification of the back wall echo using the beginning of a pulse. If the Signal Zero Offset has been correctly determined, the peak of the envelope may be used instead.



During the pulse velocity estimation procedure “Estimate by surface wave” the auxiliary display on the transducer shows the number of measurements made, the last three measurements made and the average pulse velocity.

When using the procedure “Estimate by echo”, it simply shows the pulse velocity calculated from the echo and the object thickness input by the user.

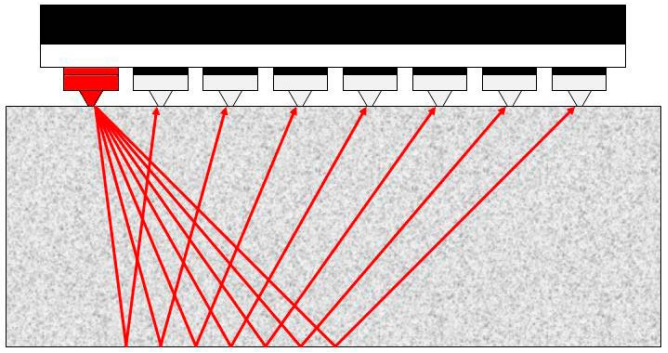


Estimate by surface wave

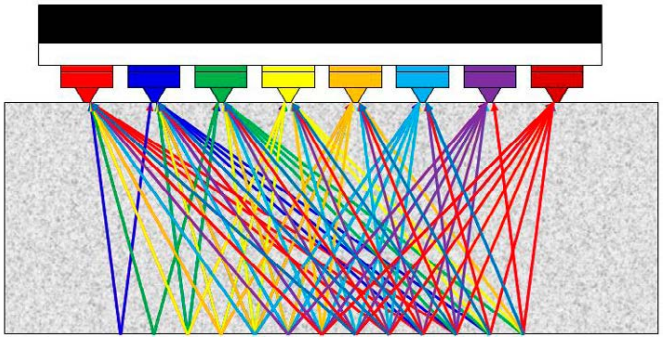
Estimate by echo

B-scan

Provides a cross sectional image of the test object perpendicular to the scanning surface in the plane through which the individual A-scans have been collected. The width of the B-scan corresponds to the width of the aperture, i.e., width = (number of channels-1) x 3 cm.



The Pundit Array Transducer is an 8 channel transducer. One channel transmits and the echoes are received by the other seven channels. Each channel transmits in turn.

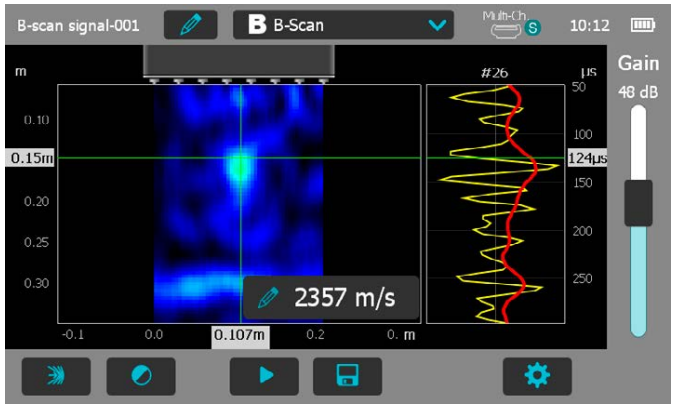


A complete cycle consists of 28 individual A-scans. These are used to

create a B-scan which is displayed in real time on the measurement screen. This is extremely useful for carrying out quick spot checks at any point of the structure without the need to save any data. Once areas of interest have been located, more extensive scans can be made as described in the next chapter.

The cursor can be dragged to any point on the B-scan and the corresponding A-scan will be displayed in the right hand window.

As the cursor is moved around the B-scan, the left hand scale shows the depth at which the cursor is located. The bottom scale shows the cursor position relative to the left hand side of the transducer and the right hand scale shows the transmission time.



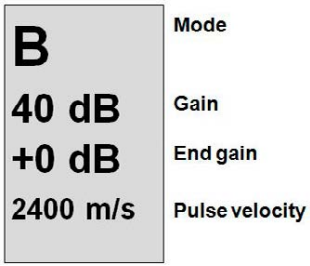
Correct depth indication depends on the accuracy of the pulse velocity setting. The pulse velocity (e.g. 2357 m/s in this example) can be entered manually if known, or it can be estimated automatically as described in the previous chapter.

Correct identification of the back wall echo is assisted by the A-scan analysis as described previously.

The B-scan can be optimized in real time also by adjusting the gain and the end gain (for time gain compensation) using the controls on the transducer as described under “Settings”.

B-scan Auxiliary Display

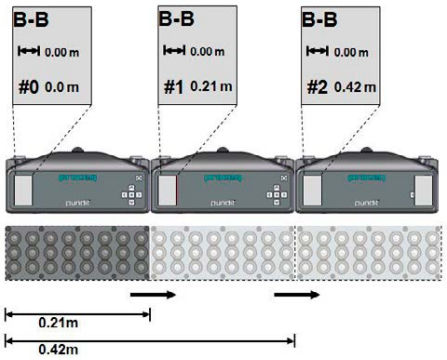
When carrying out a B-scan the auxiliary display provides useful information about the current settings.



Panorama B-scan

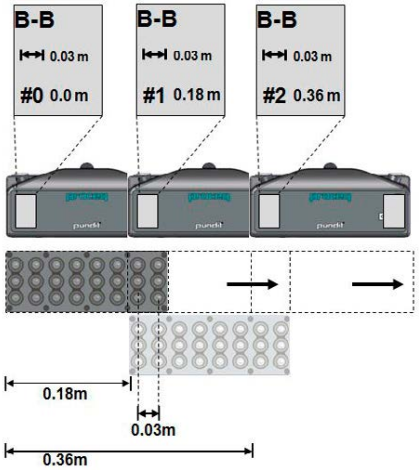
A panorama B-scan is created by stitching individual B-scans together to make a larger image. A scan is always carried out from left to right.

Zero Overlap means that the transducer is moved by a complete transducer length to create the next B-scan. When carrying out a panorama B-scan the auxiliary display shows the overlap, the number of scans made and the distance from the origin.

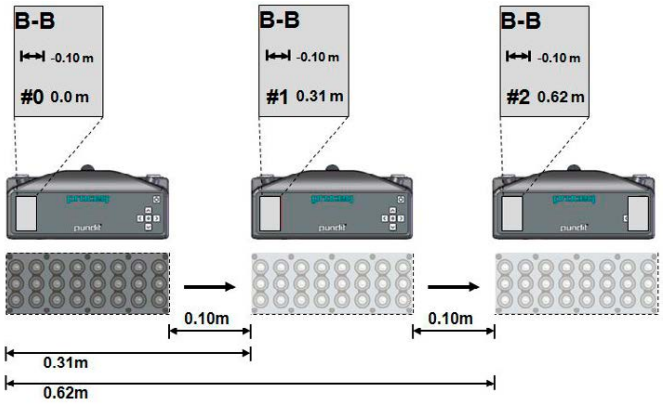


Due to the edge effects caused by the SAFT algorithm an image created with zero overlap can be disjointed at the borders. For this reason it is often better to use an overlap. For best results and ease of alignment when carrying out the scan it is best to set the overlap as a whole number of channels.

In this example the overlap is set to 3 cm which corresponds to a single channel overlap.

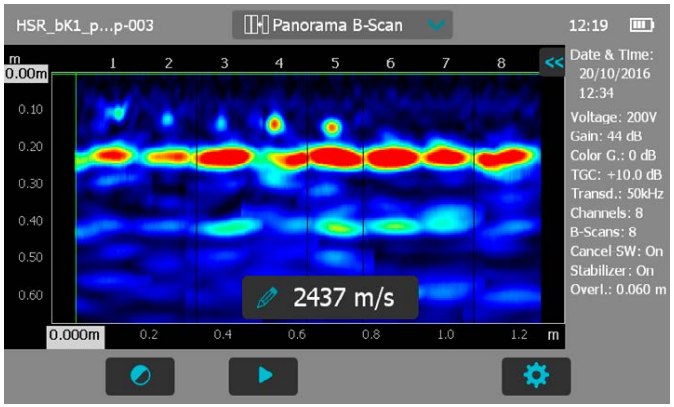


When carrying out a typical application like trying to determine the extent of a delamination on a large structure, it may be preferable to leave a gap between B-scans in order to reduce the effort. This can be achieved by setting a negative overlap as seen in the diagram below.



Here the overlap is set to -10 cm, so when carrying out the scan a gap of 10 cm is left from the end of one B-scan to the beginning of the next.

The image is constructed sequentially on the measurement screen as the scans are saved.



This image is created from 8 individual B-scans with an overlap of 6 cm (corresponding to two channels.)

The A-scan is blended out of the screen in order to provide more space for the image. In order to see the A-scan, tap on the double arrow symbol “<<” in the upper right hand corner of the screen.

3.5.3 Pundit 250 Array Modularity

Pundit 250 Array Transducer with single handle. Supplied as standard (Part No. 327 30 110).

Pundit 250 Array Transducer with dual handle. Requires dual handle kit accessory (Part No. 327 30 370).

Pundit 250 Array Transducer – 16 channels. Requires the following accessories:

- Pundit Array Transducer (Part No. 327 30 100)
- Pundit Array Transducer Extension Kit (Part No. 376 30 377)
- Dual Handle Kit (Part No. 327 30 370)

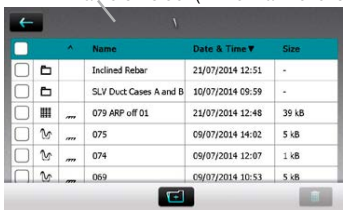
Changing from one model to another can be carried out simply on site. Watch this video for the instructions: https://youtu.be/51vet1aOGVM. Connect the Pundit Touchscreen with the right Pundit Array Transducer (primary). To start up, turn on the secondary transducer, then the primary, then the Pundit Touchscreen.

4. Explorer Document Handling

From the main menu select Explorer to review saved files.

If folders have been created they are shown in the first lines from the top (see following figure).

Name of folder (in the main level only \ is shown)

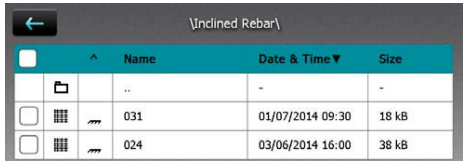


- Tap on a saved file to open it.
- Return to the Explorer list by pressing the back button.
- To delete a file tap in the check box to the left of the file and delete it.

- Tap on to access the files stored in it.
- To create a new folder tap on , write the name and tap on
- To cut/copy a file/files tap on to the left of the file(s) to become and tap on /
- To insert/copy a file tap on to open the folder and tap on

The cut and insert functions are useful in case a file is/files are stored in the wrong folder or a specific folder was only created after the files have been stored in the main level.

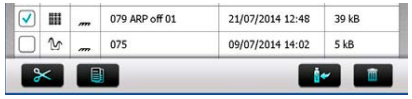
Below the subfolder “Inclined Rebar” is open



- Tap on the first 🗀 with the name ".." to go back to the upper folder

Download measuring files to an USB stick:

- Connect the USB-stick to the USB Device plug on the left side of the Profometer Touchscreen



- Click on the checkbox of each file to be downloaded and click on
- The name of the downloaded file is "PM-Product version_Year_Month_Day_Time"

Upload pdf-files from an USB-stick:

- Create the folder "PQ-Import" in the main directory of the USB-stick (not as a subfolder in another folder) and fill it with all the pdf-files to be uploaded to the Profometer Touchscreen
- Go to Information/Documents
- Connect the USB-stick to the USB Device plug on the left side of the Profometer Touchscreen
- Click on and confirm with click on Yes

The uploaded pdf-files appear on the bottom of the document list.

5. Ordering Information

5.1 Units

PART NO.	DESCRIPTION
327 10 002	**Pundit Touchscreen** without transducers consisting of Pundit Touchscreen, BNC adapter cable, power supply, USB cable, DVD with software, documentation, carrying strap and carrying case
327 10 001	**Pundit 200 Pulse Echo** consisting of Pundit Touchscreen, 2 Transducers 54 kHz, 2 BNC cables 1.5 m, couplant, calibration rod, BNC adapter cable, power supply, USB cable, DVD with software, documentation, carrying strap and carrying case
327 20 001	**Pundit 200 Pulse Echo** consisting of Pundit Touchscreen, Pundit Pulse Echo Transducer incl. cable, contact tester, power supply, USB cable, calibrated tape, DVD with software, documentation, carrying straps and carrying case
327 30 110	**Pundit 250 Array** consisting of Pundit Touchscreen, Pundit array transducer, Pundit 250 Array software, Pundit Array Cable 12-pin 1.5m, Pundit Array contact tester, 6x Rechargeable AA NiMH batteries, battery charger, USB cable, calibrated tape, DVD with software, documentation, carrying strap and carrying case Pundit Array
327 30 130	**Upgrade Kit to Pundit 250 Array** consisting of Pundit Array Transducer, Pundit 250 Array software, Pundit Array Cable 12-pin 1.5m, Pundit Array contact tester, 6x Rechargeable AA NiMH batteries, DVD with software, documentation, carrying case Pundit Array

5.2 Transducers

PART NO.	DESCRIPTION
325 40 026S	2 Transducers 24 kHz
325 40 131S	2 Transducers 54 kHz
325 40 141S	2 Transducers 150 kHz
325 40 177S	2 Transducers 250 kHz
325 40 175S	2 Transducers 500 kHz
325 40 176	2 Exponential Transducers 54 kHz, incl. calibration rod
325 40 210	Dry point shear wave transducer set
327 40 130	Pulse Echo Transducer, incl. cable, contact tester and documentation

5.3 Pundit Array Transducer Parts and Accessories

PART NO.	DESCRIPTION
327 30 370	Dual Handle Kit
327 30 100	Pundit Array Transducer
376 30 377	Pundit Array Transducer Extension Kit
327 30 337	Pundit Array Transducer Battery Pack Complete
327 01 085	Pundit Array Cable 12-pin 1.5m
327 30 381	Pundit Array contact tester

5.5 Accessories

PART NO.	DESCRIPTION
327 01 043	Carrying strap complete
325 40 150	Transducer holder complete
327 01 049	BNC adapter cable for Pundit 200
325 40 021	Cable with BNC-plug, 1.5 m (5 ft)
325 40 022	Cable with BNC-plug, 10 m (33 ft)
710 10 031	Ultrasound couplant, 250 ml
325 40 048	Shear wave couplant, 100 g
327 01 033	Battery complete
327 01 053	Quick charger
710 10 028	Calibration rod 25 µs for Pundit 200
710 10 029	Calibration rod 100 µs for Pundit 200
327 01 070	Snap Ferrite for BNC Adapter cable*
327 01 051	Pundit Pulse Echo Cable
327 00 027	Pundit Pulse Echo Contact Tester complete
327 20 002	Pundit 200 Pulse Echo UPV Kit including BNC adapter cable, 2x cable with BNC-plug, L=1.5m (5ft), Ultrasound couplant, 250ml bottle, 2 transducers 54 kHz, calibration rod
327 01 071S	Calibrated Tape (Set of 5)

* In the case that receiving equipment within a radius of 10m suffers from interference, it is possible to order a ferrite to fit onto the BNC adapter cable. This serve to further reduce the electromagnetic radiation produced by the instrument.

6. Maintenance and Support

6.1 Maintenance

To guarantee consistent, reliable and accurate measurements, the instrument should be calibrated on a yearly basis. The customer may however, determine the service interval based on his or her own experience and usage.

Do not immerse the instrument in water or other fluids. Keep the housing clean at all times. Wipe off contamination using a moist and soft cloth. Do not use any cleaning agents or solvents. Do not open the housing ofthe instrument yourself.

6.2 Support Concept

Proceq is committed to providing a complete support service for this instrument by means of our global service and support facilities. It is recommended that the user register the product on www.proceq.com to obtain the latest on available updates.

6.3 Warranty Information

Each instrument is backed by the standard Proceq warranty and extended warranty options.

- Electronic portion of the instrument: 24 months
- Mechanical portion of the instrument: 6 months

6.4 Disposal

Disposal of electric appliances together with household waste is not permissible. In observance of European Directives 2002/96/EC, 2006/66/EC and 2012/19/EC on waste, electrical and electronic equipment and its implementation, in accordance with national law, electric tools and batteries that have reached the end of their life must be collected separately and returned to an environmentally compatible recycling facility.

7. PL-Link Software

7.1 Starting PL-Link

Locate the file “PL-Link Setup.exe” on your computer or on the CD and click on it. Follow the instructions on the screen.

Make sure that the “Launch USB Driver install” tick is selected.

The USB driver installs a virtual com port which is needed to communicate with the Pundit Touchscreen Unit.

Double click on the PL-Link Icon on your desktop or start the PL-Link via the start menu.

The PL-Link starts with a blank list.

Application settings

The menu item “File – Application settings” allows the user to select the language and the date and time format to be used.

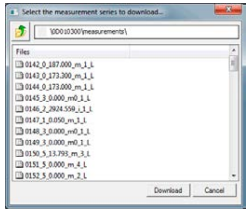
Connecting to a Pundit Touchscreen Unit

Connect the Pundit Touchscreen Unit to a USB port, then select the following icon to download data from the Pundit Touchscreen Unit.

The following window will be displayed: Select “USB” as the communi-

cation type.

Click on “Next >”. When a Pundit Touchscreen Unit has been found its details will be displayed on screen. Click on the “Finish” button to establish the connection.



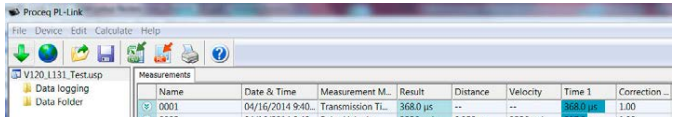
Select one or more measurements and click “Download”.

7.2 Viewing the Data

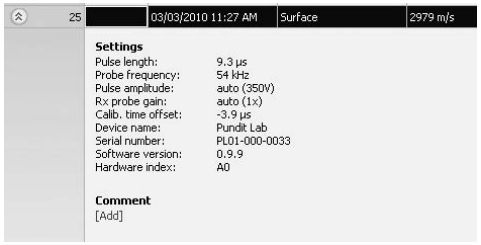
Measurement files stored on the device will be displayed in the following window:

Select one or more measurements and click “Download”.

The selected measurements on your Pundit Touchscreen Unit will be displayed on the screen:

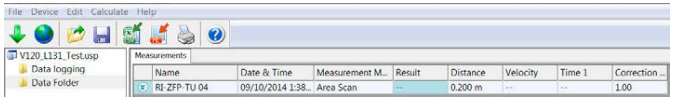


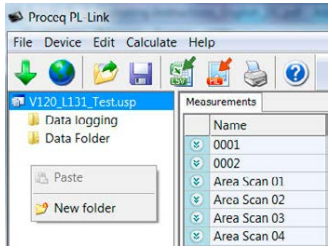
Click on the double arrow icon in the first column to see more details:



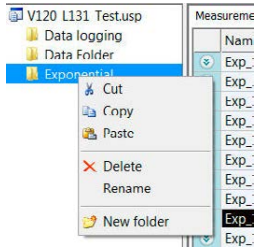
NOTE! Click on “Add” to attach a comment to the object.

The folder structure may be seen on the left hand side. Click on a folder to see the measurements stored in it.





Right click in the folder section to create a new folder.

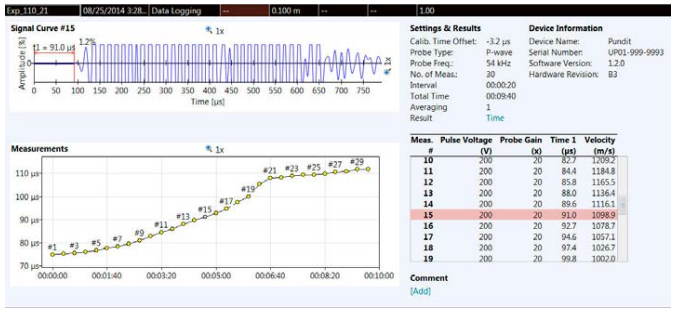


Measurements may be moved around between folders by using cut and paste functionality.

Right click on a measurement or a folder to see the options available.

8.2.1 Data Logging

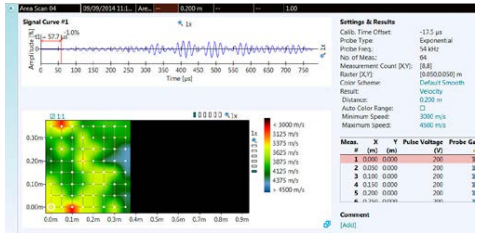
Move the cursor over a particular measurement to see the waveform. Scroll in the table either using the scroll bar or the mouse wheel. Click on a measurement to select it and highlight it on the measurement plot.



8.2.2 Area Scan

When the 1:1 check box is ticked it is possible to zoom in and out of the scan using the mouse wheel.

Click with the right mouse button to move the cursor to a new position.



Drag with the left mouse button pressed to move within the zoomed graphic.

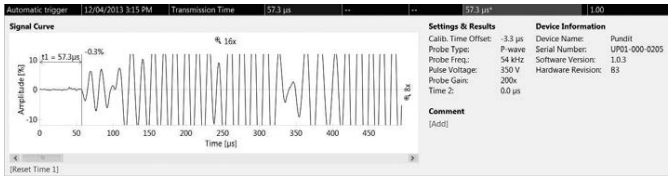
Click on the Symbol to obtain a larger graphical display of the scan in a separate window.

7.3 Adjusting the Settings

Each of the settings that were used in the Pundit Touchscreen Unit at the time of the measurement series can be adjusted subsequently in PL-Link. This can be done either by right clicking directly on the item in the appropriate column, or by clicking on the blue setting item in the detailed view of a measurement object.

In each case a drop down selection box will appear with the choice of setting.

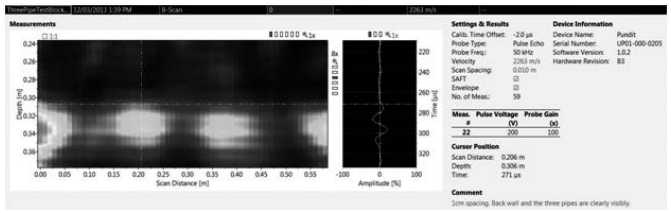
Manual Trigger



The trigger point of A-scans can be adjusted manually simply by dragging the cursor. If it has been adjusted it will be indicated with an asterisk.

The original transmission time can be reset by clicking on [Reset Time1]

7.4 Analysis of B-scans

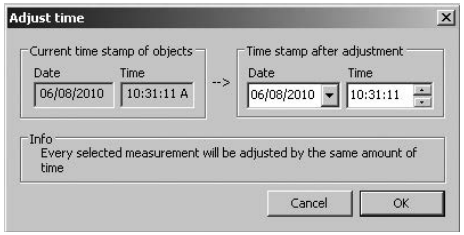


PL-Link provides a number of tools that assist in the analysis of B-scans.

- Zoom into the B-scan using the zoom boxes. A separate zoom box is available for the currently selected A-scan
- Move the B-scan in both x- and y-directions by dragging with the left mouse button.
- Move the A-scan in the y-direction by dragging with the left mouse button.
- Drag the cross hairs to a point of interest using the right mouse button. The position is shown in the details on the right hand side.
- The current A-scan (e. g. #22) is indicated in the table.
- All settings in blue text can be adjusted as necessary
- All check box settings may be activated or deactivated as desired to obtain the best image.

Adjusting the date and time

Right click in the “Date & Time” column.

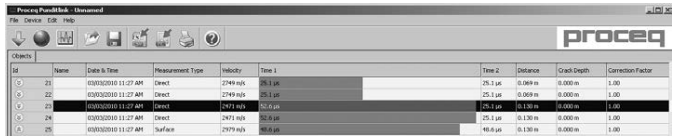


The time will be adjusted for the selected series only.

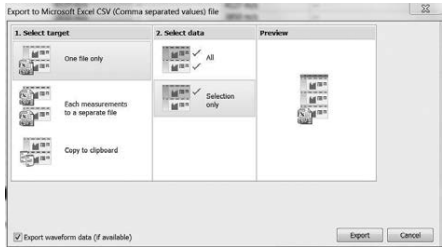
In “Data Logging” mode it is the date and time at which the measurement was made.

7.5 Exporting Data

PL-Link allows you to export selected objects or the entire project for use in third party programs. Click on the measurement object you wish to export. It will be highlighted as shown.



Click on the “Export as CSV file(s)” icon. The data for this measurement object is exported as a Microsoft Office Excel comma separated file or files. The export options may be chosen in the following window:



Select the option “Export waveform data (if available)” to export all saved waveform data for analysis in third party software.

Click on the “Export as graphic” icon to open the following window which allows the various export options to be chosen.

In both cases, the preview window shows the effects of the current output selection.

Finish by clicking on export to select the file location, name the file and in the case of a graphical output to set the output graphic format: .png, .bmp or .jpg.

7.6 Further Functions

The following menu items are available via the icons at the top of the screen:

“PQUpgrade” icon - Allows you to upgrade your firmware via the internet or from local files.

“Open project” icon – Allows you to open a previously saved .pql project.

“Save project” icon – Allows you to save the current project.

“Print” icon – Allows you to print out the project. You may select in the printer dialog, if you want to print out all of the data or selected readings only.

Clicking “Auto Scale” adjusts the zoom parameters of the waveform display to an optimum setting.

7.7 Conversion Curves

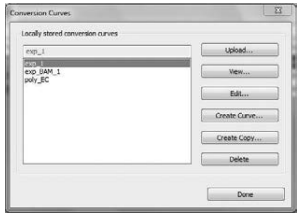
Pundit Touchscreen Unit allows compressive strength estimates to be made using pulse velocity measurements or a combination of pulse velocity and rebound hammer measurements.

To do this it is necessary to create a conversion curve and upload this onto the instrument.

Conversion curves are very much specific to the concrete under test and there are many examples in the literature.

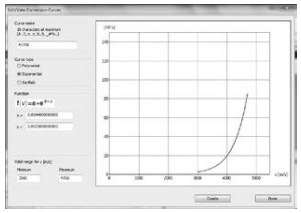
Pundit Touchscreen Unit allows either polynomial curves or exponential curves to be programmed and in the case of a combined ultrasonic/rebound value measurement a curve based on the SONREB (SONic REBound) method may be entered.

Select the menu item “Conversion Curves”

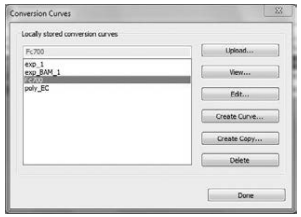


Here you can view existing curves stored on your computer, copy an existing curve for modification or:

Create new curve.

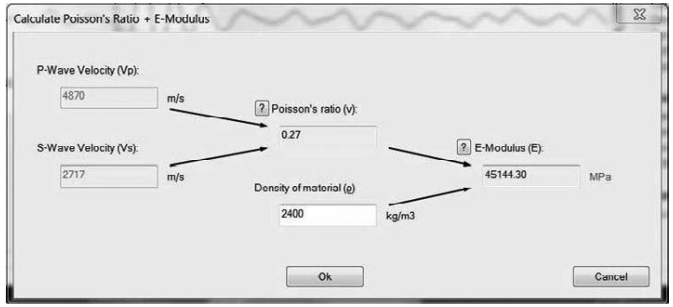


Enter the curve parameters and click on “Create”.



The new curve will now appear in the drop down list and may be loaded onto the Pundit Touchscreen Unit.

7.8 E-modulus Calculator



Enter the P- and S-wave pulse velocities to calculate the Poisson’s ratio. Additionally enter the density of the material to calculate the E-modulus.

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