proceq

Grid 02	✏	》Pulse Velocity ∨	54 kHz ☐☐P	10:25	🔋

Gain ∧ 20x ∨

Voltage ∧ 100V ∨

Δ 22.8 µs
Δ 2976 m/s

proceq

Scope of Delivery

A Pundit Touchscreen

B Battery

C 2 Transducers 54 kHz*

D 2 BNC Cables 1.5 m*

E Couplant*

F Calibration Rod*

G BNC Adapter Cable

H Power Supply

I USB Cable

J DVD with Software

K Documentation

L Carrying Strap

*Not part of the package if only bought "Pundit Touchscreen without transducers" (Part No. 327 10 002)

Overview Pundit PL-200

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.

2. Technical Specification

Instrument

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
Receiver Gain	1x – 10'000x (0 – 80dB) [11 steps]
Receiver Sensitivity	10 µV
Receiver Input Impedance	7 kΩ
Bandwidth	20 – 500 kHz
Memory	Internal 8 GB Flash memory
Regional Settings	Metric and imperial units and multi-language supported
Battery	Lithium Polymer, 3.6 V, 14.0 Ah
Mains	9 V – 15 V / 2.0 A
Weight	About 1525 g (incl. Battery)
Dimensions	250 x 162 x 62 mm
Operating Temperature	0°C – 30°C (Charging*, running instrument) 0°C – 40°C (Charging*, instrument is off) -10°C – 50°C (Non-charging)
Humidity	< 95 % RH, non condensing
IP Classification	IP54
Standards and Directives	CE certification

Battery Lifetime	> 8h (in standard operating mode)
Pollution Degree	2
Installation Category	2

*charging equipment is for indoor use only (no IP classification)

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

3. Operation

3.1 Getting Started

Battery Installation

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

There are two status LEDs 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.

> **i** NOTE! Only use the power supply provided.

- A complete charge requires < 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 < 4h for a complete charge.

Energy Saving

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

Connecting the Transducers

(G)

Connect the Transducers (C) to the Pundit Touchscreen Unit (A) using the BNC Adapter Cable (G) and the BNC Cables (D). Ensure that the screws are fastened on the BNC adapter cable.

USB Host:

Connect a mouse, keyboard or USB stick.

USB Device:

Connect application specific probes and PC.

Ethernet:

Connection for firmware upgrades.

Power Supply:

Connect the power supply through this connection.

USB Host
USB Device
Ethernet
Power Supply

Buttons

Lift the protective visor.
The upper right of the screen there are three buttons (see page 3).

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

Soft Key – Switches in and out of full screen view.

Back Button – returns to previous screen.

3.2 Main Menu

On start up the main menu is displayed. 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.

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.

3.3   Settings

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 PL-200 should be zeroed.

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

Couple the transducers to the Calibration Rod (F) using the ultrasound Couplant (E) 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, there-

fore, 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 "3.5 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 "3.4 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"3.6 Measuring with Pundit PL-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.

3.4 Measurement Screen

The standard measurement screen is shown on page 3. 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.

(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 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.

3.5   Basic Measurement Modes

Transmission Time

139.5 µs

The measured transmission time between the transducers.

Distance

3700 m/s

Enter the pulse velocity of the material under test.

89.2 µs
0.330 m

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

Pulse Velocity

0.250 m

Enter the distance between the transducers.

51.5 µs
4854 m/s

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.

RILEM-NDT

Select the correlation curve.

0.250 m

Enter the distance between the transducers.

50.0 X

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.

51.5 µs
100 MPa

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

3.6   Special Measurement Modes

Crack Depth

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

b: 0.060 m

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.

t1: 74.5 µs

t2: 113.5 µs

d: 0.068 m

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).

> ℹ️ 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 PL-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.

b: 0.060 m — Enter the distance 'b' as indicated in the diagram shown on the screen.

N: 4 — Enter the number of measurements to be made.

▶ Measure the transmission time at distance 'b'.

📷 1/4 Record the first measurement at distance 'b'.

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

v: 2222.2 m/s
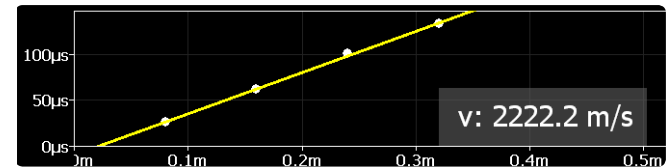
The pulse velocity is calculated from the slope of the curve.

> ℹ️ 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).

The dual cursor mode is automatically activated. Use the first cursor to mark the onset of the P-wave component.
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 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.

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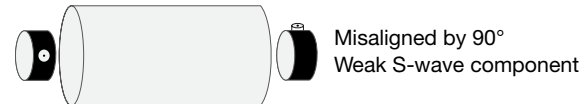
Rotate one transducer into and out of alignment and watch the S-wave component increase and decrease.

Correctly aligned
Strong S-wave component

Much stronger S-wave component when the transducers are correctly aligned.
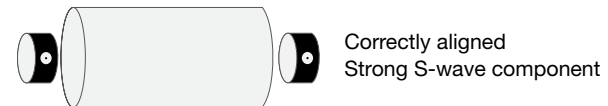
3.7   Multi-Measurement Modes

Line Scan

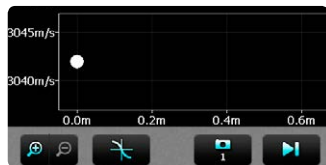The distance 'a' is entered in the 'Settings' menu.
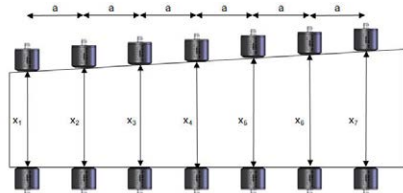
 Position the transducers at the start-ing position and enter the distance x1. (Not required if transmission time only is being measured.)

 Press the start icon to begin.

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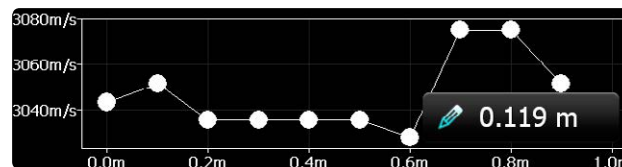

Move the transducers the distance 'a' to the next point on the grid.

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 dis-tance '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 instru-ment for a new series.

Area Scan

Area scan allows a 2D visualization of an element based on pulse ve-locity, 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 sub-sequently 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.
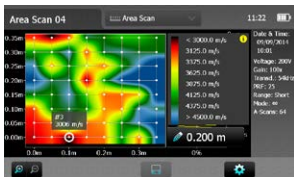
> 4'500 m/s: Excellent

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.
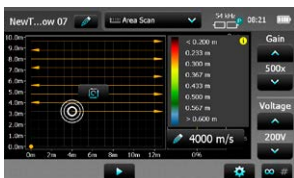
You may drag the cursor to the position on the grid where you wish to start measuring. Arrows indicated the direction of proceeding with the measurement.
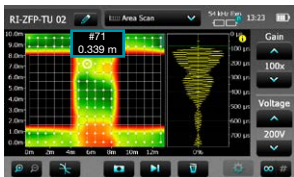
It is possible to drag the cursor to another location on the grid in order to avoid obstacles etc. It is also possible to drag the cursor back to previous measurement and either delete it, or measure it again. In the example below measurement #71 is indicated and may be deleted or repeated. If the measurement 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.
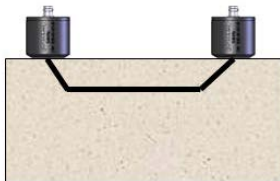
3.8   Measuring with Pundit PL-200

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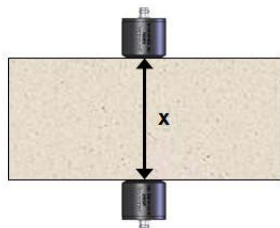
Direct Transmission: The optimum configuration with maximum signal amplitude. The most accurate method of pulse velocity determination. Path length is measured from centre to centre of the transducers.

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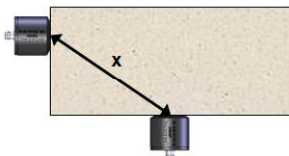
Semi-direct Transmission: Sensitivity is somewhere between the other two methods. Path length is measured from centre to centre of the transducers.

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.
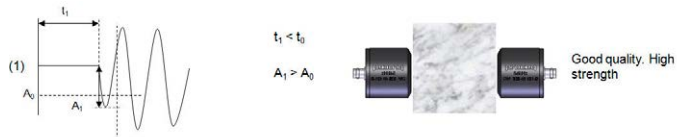

A reference measurement is made on a section of concrete of known quality.
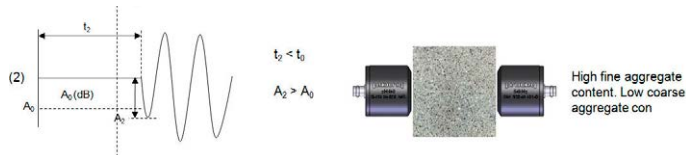
t_0 : Reference transmission time
A_0 : Reference receive level

Subsequent measurements on the structure are compared with these two values and an inference is made about the concrete quality based on this.
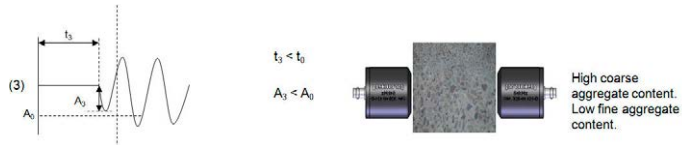
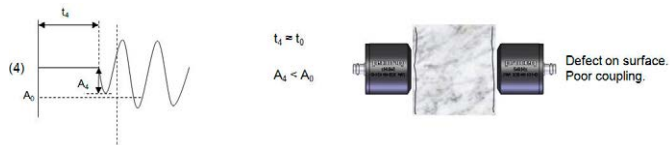Six different cases are identified which allow the user to make a statement about the concrete quality.

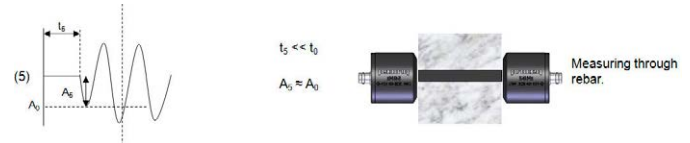$t_1 < t_0$

$A_1 > A_0$

(1)

Good quality. High strength

Good quality – High strength.

$t_2 < t_0$

$A_2 > A_0$

(2)

High fine aggregate content. Low coarse aggregate con

High fine aggregate content. Low coarse aggregate content.

$t_3 < t_0$

$A_3 < A_0$

(3)

High coarse aggregate content. Low fine aggregate content.

High coarse aggregate content. Low fine aggregate content.

$t_4 \approx t_0$

$A_4 < A_0$

(4)

Defect on surface. Poor coupling.

Defect on surface. Poor coupling.

$t_5 \ll t_0$

$A_5 \approx A_0$

(5)

Measuring through rebar.

Measuring through rebar.
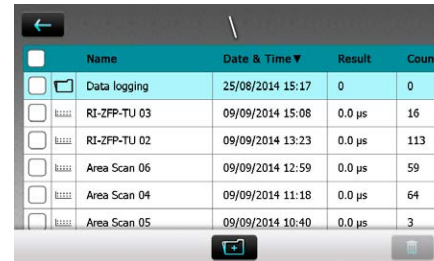

$t_6 > t_0$

$A_6 < A_0$

(6)

Defects. Honeycombing, voids.
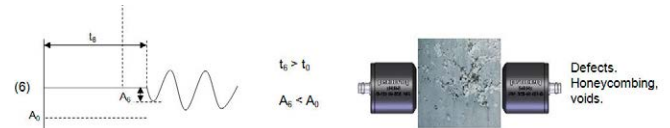
Defects, honeycombing, voids.

4. Explorer

From the main menu select Explorer to review saved files.

	Name	Date & Time ▼	Result	Count
	Data logging	25/08/2014 15:17	0	0
	RI-ZFP-TU 03	09/09/2014 15:08	0.0 µs	16
	RI-ZFP-TU 02	09/09/2014 13:23	0.0 µs	113
	Area Scan 06	09/09/2014 12:59	0.0 µs	59
	Area Scan 04	09/09/2014 11:18	0.0 µs	64
	Area Scan 05	09/09/2014 10:40	0.0 µs	3

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 the add folder icon to create a new folder to keep measurements organized.

To save measurements in a particular folder, select the folder, then exit explorer using the hardware button.

Subsequent measurements will be stored in this folder.

Exit a folder and return to the higher directory by pressing on .

5.   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
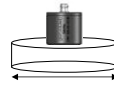
The pulse velocity is reduced significantly if the lateral dimensions (perpendicular to the direction of transmission) is less than the wavelength.

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

	Wavelength	Maximum grain size	Minimum lateral dimension	Application
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

	Wavelength	Maximum grain size	Application
250 kHz Part No. 325 40 049	≈ 5 mm	Greater than the thickness of the object.	Used for determination of elastic modulus, Concrete, wood, rock (small samples only), Requires special shear wave couplant

6. Ordering Information

6.1 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 PL-200** 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 PL-200PE** 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

6.2 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 40 049	2 S-Wave Transducers 250 kHz, incl. couplant
327 40 130	Pulse Echo Transducer, incl. cable, contact tester and documentation

6.3 Accessories

PART NO.	DESCRIPTION
327 01 043	Carrying strap complete
325 40 150	Transducer holder complete
327 01 049	BNC adapter cable for Pundit PL-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 PL-200
710 10 029	Calibration rod 100 µs for Pundit PL-200
327 01 070	Snap Ferrite for BNC Adapter cable*
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.

7. Maintenance and Support

7.1 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 of the instrument yourself.

7.2 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.

7.3 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

7.4 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.

8. PL-Link Software

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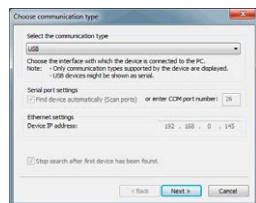
Click on "Next >". When a Pundit Touchscreen Unit has been found its details will be displayed on screen. Click on the "Finish" button to establish the connection.
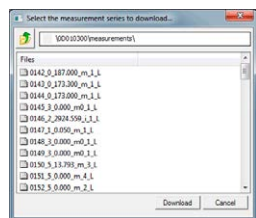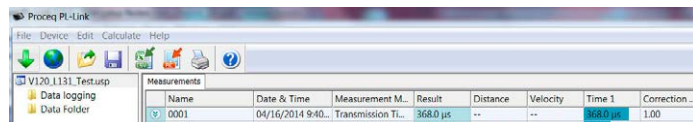

Select one or more measurements and click "Download".
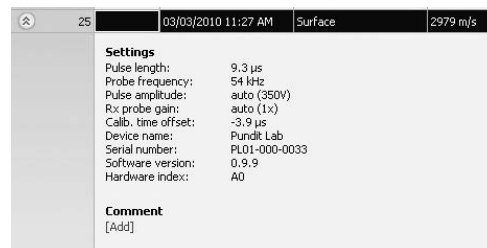
8.2 Viewing the Data

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:

Settings		
Pulse length:	9.3 µs	
Probe frequency:	54 kHz	
Pulse amplitude:	auto (350V)	
Rx probe gain:	auto (1x)	
Calib. time offset:	-3.9 µs	
Device name:	Pundit Lab	
Serial number:	PL01-000-0033	
Software version:	0.9.9	
Hardware index:	A0	

Comment
[Add]

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.
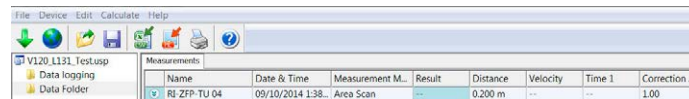
Right click in the folder section to create a new folder.
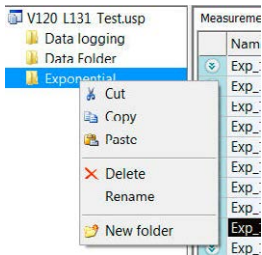
Measurements may be moved around between folders by using cut and paste functionality.

Right click on a measurement or a folder to see the options available.
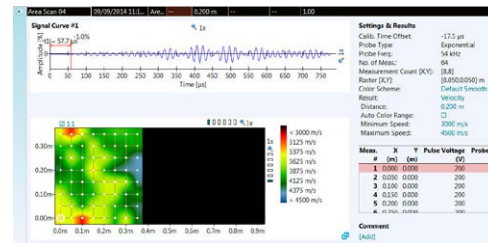
Drag with the left mouse button pressed to move within the zoomed graphic.

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

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.

8.3 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.
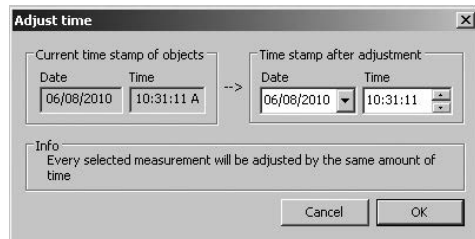
Manual Trigger
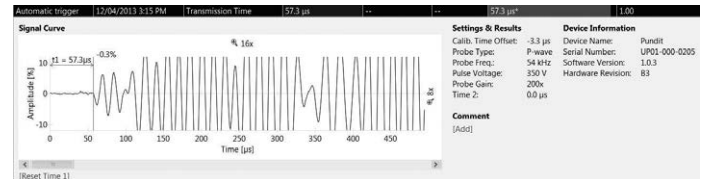
The trigger point of A-Scans can be adjusted manually simply by dragging the cursor. If it has been adjusted it will be indicated with an asterisk.

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

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.

8.4   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:
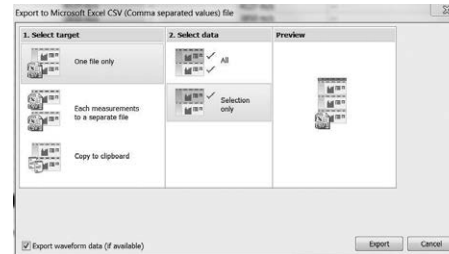
Select the option "Export waveform data (if available)" to export all saved waveform data for analysis in third party software.

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.

8.5   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.

8.6   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 RE-
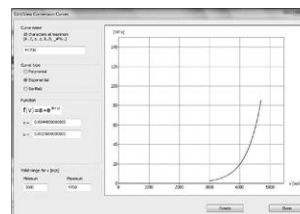
Bound) method may be entered.

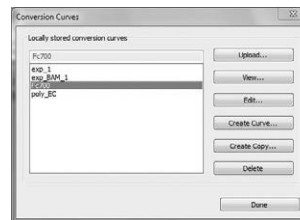Select the menu item "Conversion Curves"
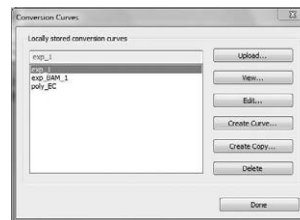
Here you can view existing curves stored on your computer, copy an existing curve for modification or:

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.

8.7   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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