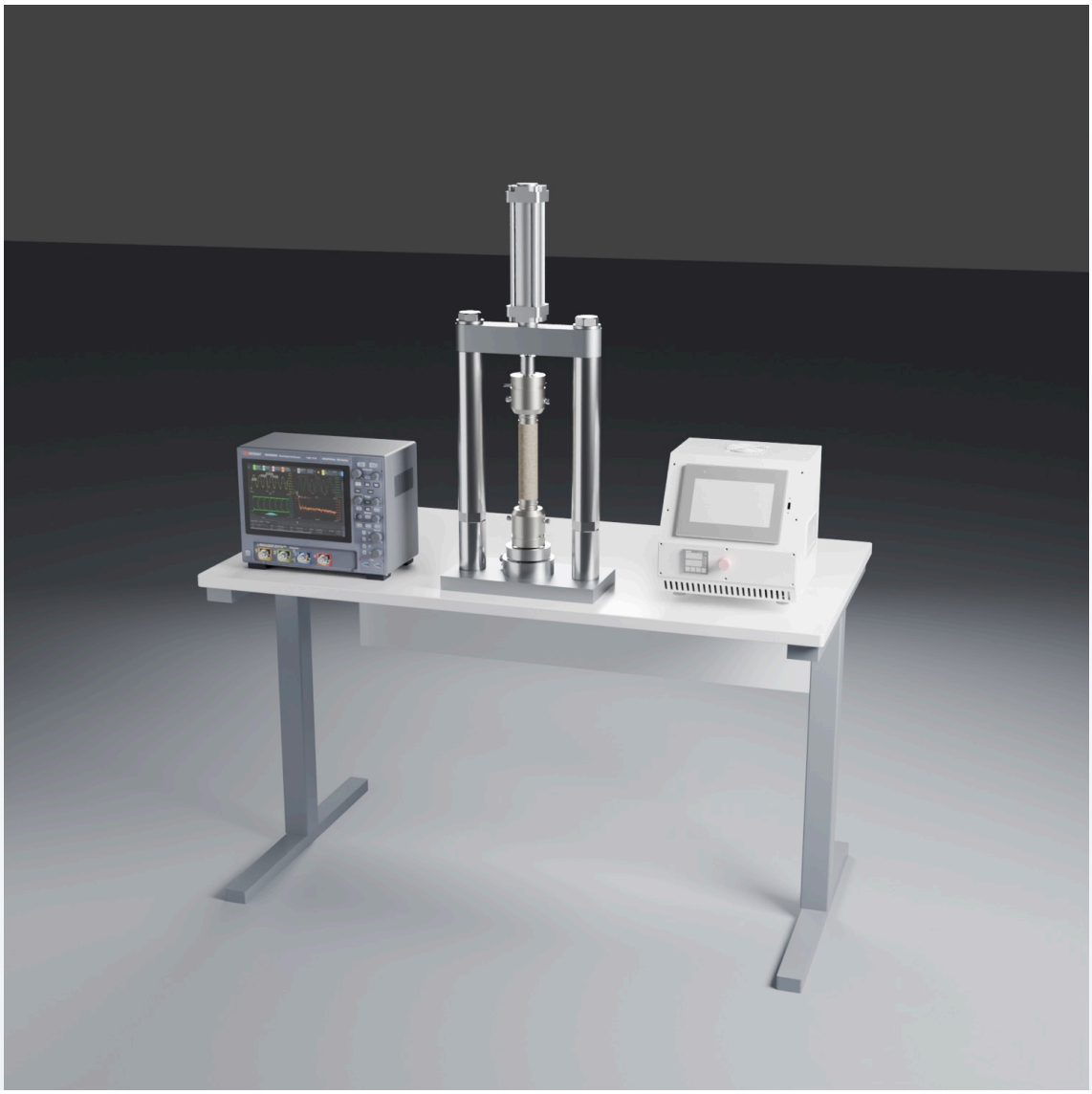
BENCHTOP SYSTEM · AMBIENT PRESSURE

CT-UVS-150

P / S1 / S2 Ultrasonic Velocity System

Through-transmission measurement of compressional and two orthogonally polarized shear-wave velocities on rock and cement specimens, with measured and recorded transducer contact force.



P, S1, S2
three channels, S1 and S2 polarized at 90°

50 – 1000 N
pneumatic contact force, measured by load cell

25.4 / 38.1 mm
standard platen sets; length up to 152 mm

14-bit
digitizer, 3.2 GSa/s, raw waveforms stored

Test method reference: ASTM D2845 pulse-transmission method

01 System function

The CT-UVS-150 measures the travel time of an ultrasonic pulse through a cylindrical specimen held between two coaxial platens. From the travel time and the measured specimen length it reports compressional velocity Vp and two shear velocities Vs1 and Vs2. With bulk density entered, it calculates the dynamic elastic constants.

The load frame applies the transducer contact force with a pneumatic actuator. A load cell under the lower platen reads the actual force, and the software stores that value with every waveform. Two specimens tested on different days are therefore tested at the same contact force, and the coupling condition is part of the test record. Hand-held probes are not used at any stage.

1 MHz standard platen frequency; 0.5 MHz option	**±2 %** contact force set-point repeatability	**0.3 ns** transit-time sampling interval	**< ±1 %** typical velocity uncertainty, length ≥ 25 mm

Controlled variables

Variable	How it is set
Contact force	Precision air regulator on the actuator; read by load cell, logged per waveform
Wave mode	P, S1 or S2 selected by software through the channel switch
Excitation	Pulse amplitude and repetition rate adjustable
Receiver gain and filter	Adjustable gain and band-pass filter per channel
Polarization angle	Both platens rotate together about the specimen axis, angular scale with lock
Stacking	Number of averaged pulses set per test

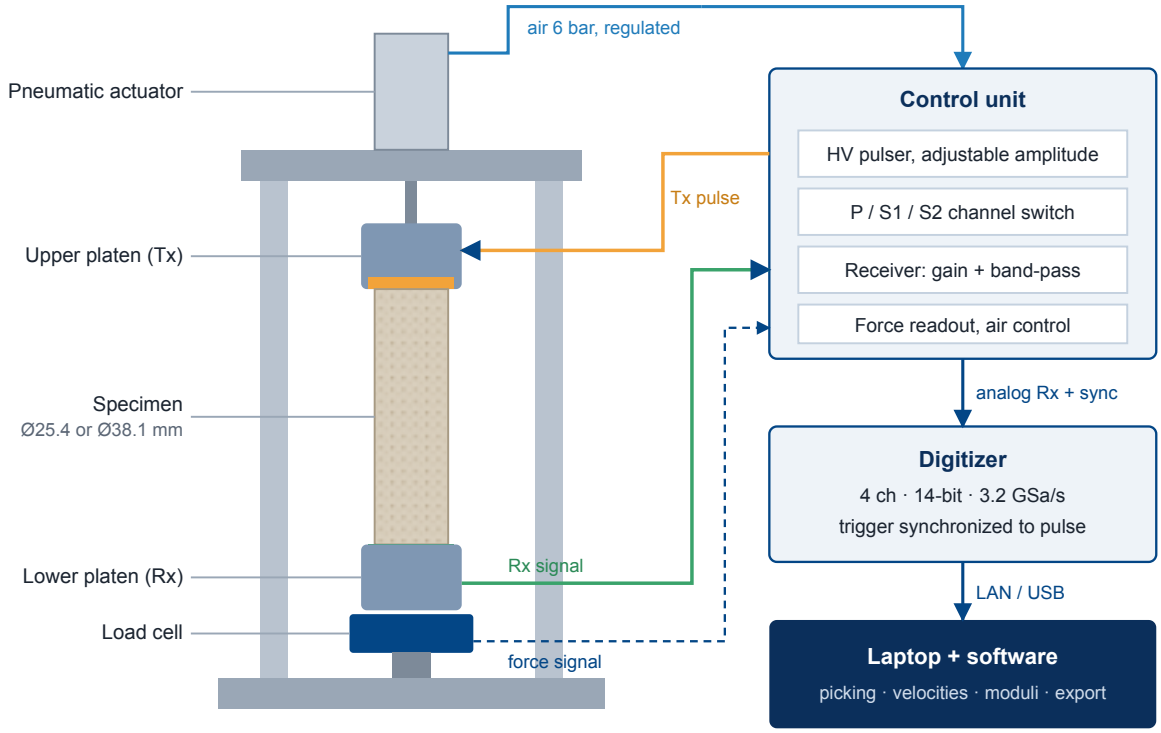
Measured outputs

Output	Basis
Transit time tP, tS1, tS2	First-arrival pick minus system delay t_0
Vp, Vs1, Vs2	Specimen length / corrected transit time
Shear-wave splitting	(Vs1 − Vs2) / Vs, versus polarization angle
Dynamic E, G, K, ν	From Vp, Vs and entered bulk density; flagged as isotropic estimate
Contact force record	Load cell value stored with each waveform
Raw waveforms	Full records, open CSV/TXT export

Typical applications. Routine Vp and Vs on sandstone, carbonate and crystalline core plugs; shear-wave anisotropy in shale with S1 and S2 aligned to bedding; dynamic moduli of cement and other geomaterials; quality control of plug sets before triaxial or acoustic-under-stress programs.

02 System architecture

Three modules on one bench: the load frame with the specimen assembly, the control unit with pulser, receiver and channel switching, and the digitizer with the acquisition and analysis software on a laptop.



Load frame

Base plate, two columns and a crosshead on one axis. The actuator, upper platen, specimen, lower platen and load cell are coaxial. Bench-mounted, about 800 mm high.

Control unit

Generates the excitation pulse, routes it to the selected P, S1 or S2 element, conditions the received signal and reads the load cell. Channel selection is software-driven.

Digitizer and software

Four-channel digitizer, triggered by the pulse, with averaging of repeated shots. The software picks arrivals, applies delay corrections, calculates results and stores every raw waveform.

Modules on the bench

Module	Size, approx.	Mass, approx.	Connections
Load frame	320 × 160 mm base, 800 mm high	36 kg	Air in, 2 coaxial lines per wave mode, load cell cable
Control unit	310 × 290 × 290 mm	10 kg	Mains, air, coaxial lines to platens and digitizer, LAN
Digitizer	335 × 262 × 168 mm	5.3 kg	Mains, analog inputs, trigger, LAN / USB
Laptop	standard	—	LAN / USB

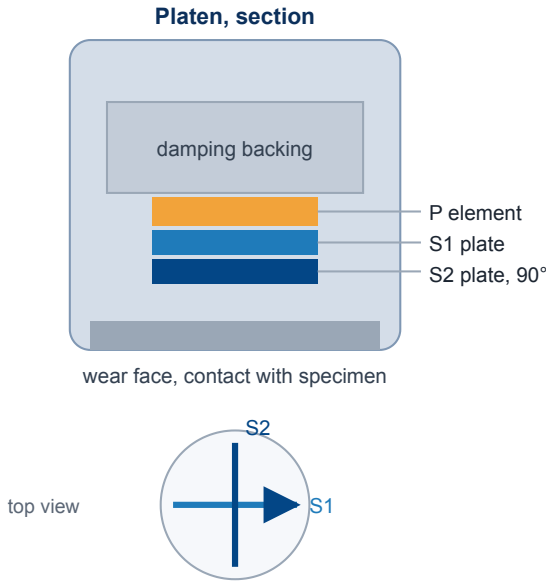
Dimensions and masses are reference values for bench planning. Final values are stated in the project datasheet.

03 Platens and contact force

Platen element stack

Each platen carries three piezoceramic elements on its axis: one thickness-mode element for P and two shear plates for S1 and S2. The shear plates are rotated 90° to each other. Transmitter and receiver platens are mechanically identical and assembled with the same orientation, so S1 sends to S1 and S2 to S2.

- Nominal centre frequency 1 MHz; damped backing for a short, broadband pulse.
- Active element footprint 15 mm.
- Shear polarization direction marked on the platen body.
- Replaceable hardened stainless-steel wear face.
- Couplant: gel for P, high-viscosity shear couplant for S.



Polarization relative to fabric

Both platens rotate together about the specimen axis against an angular scale and lock in position. S1 and S2 can be aligned parallel and normal to bedding or to a known fracture direction, and the test can be repeated at several angles.

Contact force control

Item	Standard configuration
Actuator	Single-acting pneumatic cylinder on the frame axis, supply 6 bar dry air
Force range	50 to 1000 N at the specimen
How force is set	Precision regulator set point, recalled per test method
How force is verified	Load cell directly under the lower platen, rated 2.5 kN, digital readout in the software
Repeatability	Set point reproduced within ±2 % from specimen to specimen
Record	Force value stored in the data file of every waveform

> **Design note.** Coupling quality changes travel time and amplitude, especially for shear waves. Measuring the force at the specimen, rather than inferring it from air pressure alone, removes friction in the actuator from the result and makes the contact condition traceable.

04 Test sequence and calculation

Test sequence

1. **System delay.** Platens face to face without a specimen; the software records t_0 for P, S1 and S2.
2. **Specimen.** Length measured with a micrometer, ends flat and parallel; couplant applied to both ends.
3. **Contact force.** Actuator closes at the method set point; the load cell value is checked and logged.
4. **P channel.** Repeated pulses are averaged until the first arrival is clear of noise.
5. **S1 and S2 channels.** Same procedure on each shear channel; optional repeat at other polarization angles.
6. **Picking.** Automatic first-arrival pick with operator review; manual pick available on the stored waveform.
7. **Results.** Velocities, moduli and the full waveform set saved to one test file and exported.

Calculation

$$V_p = L / (t_p - t_{0,p})$$

$$V_{s1,s2} = L / (t_s - t_{0,s})$$

$$G = \rho \cdot V_s^2$$

$$\nu = (V_p^2 - 2V_s^2) / (2(V_p^2 - V_s^2))$$

$$E = 2G (1 + \nu)$$

$$K = \rho (V_p^2 - 4/3 \cdot V_s^2)$$

ρ is the bulk density entered by the user. Dynamic moduli assume an isotropic, homogeneous specimen and are labelled as such in the report. Where Vs1 and Vs2 differ, both values are reported and the moduli are calculated from their mean.

Uncertainty budget, typical

Case	Transit time	Velocity
L 50 mm, Vp 4000 m/s	12.5 µs ± 20 ns	± 0.2 %
L 25 mm, Vp 7000 m/s	3.6 µs ± 20 ns	± 0.6 %
Length, ± 0.02 mm on 25 mm	—	± 0.1 %

Pick uncertainty assumes a clean 1 MHz arrival after stacking. Highly attenuating specimens increase the pick uncertainty; the 0.5 MHz option is offered for those.

Velocity range, typical

1000 – 8000 m/s	**500 – 5000 m/s**	**0.3 ns**	**20 Mpts**
compressional, Vp	shear, Vs1 and Vs2	sampling interval at 3.2 GSa/s	record length per channel

The lower velocity limit is set by attenuation in weak and unconsolidated material; the upper limit by the shortest practical transit time on short, stiff specimens.

05 Specimens and transducer selection

Specimen size limits follow from the platen footprint, the wavelength in the specimen and the near field of the transmitter. ASTM D2845 asks for a lateral dimension of at least five wavelengths; the limits below apply that rule to the standard 1 MHz platens.

Parameter	P wave	S waves
Standard platen sets	25.4 mm (1 in) and 38.1 mm (1.5 in), with centering collars	
Diameter range	20 to 54 mm	20 to 54 mm
Length range	15 to 150 mm	25 to 150 mm
Maximum length	152 mm (6 in)	
Minimum reliable size	Ø20 × 15 mm	Ø20 × 25 mm
Fast rock, Vp above 5 km/s	Minimum diameter rises to 30 mm on 1 MHz platens (five-wavelength rule)	
End preparation	Ends flat and parallel per ASTM D4543	

Recommended configuration by material

Material	Platens	Notes
Sandstone, carbonate	1 MHz, 1 in or 1.5 in	Standard set-up; saturated or dry specimens
Crystalline rock	1 MHz, 1.5 in	Larger diameter keeps the five-wavelength rule at high Vp
Shale	1 MHz; 0.5 MHz if attenuation is high	Align S1 and S2 with bedding; report shear-wave splitting
Cement, mortar	0.5 MHz, 1.5 in or larger	Coarse aggregate and pores attenuate 1 MHz signals

Specimens below 25 mm

A small platen pair with reduced element footprint and higher frequency is available as an option for specimens below 25 mm diameter. The smallest practical size is stated per project from the expected velocity and attenuation. A 10 mm specimen is not offered as a validated configuration.

06 Software, data and calibration

Acquisition and analysis

- Live waveform display for P, S1 and S2, with gain, filter and stacking controls.
- Automatic first-arrival picking with operator review; manual picking on any stored record.
- Test metadata saved with the waveforms: specimen ID, length, diameter, mass, density, contact force, polarization angle, operator, date.
- Stored tests can be reopened and re-picked; the original waveforms are never overwritten.
- Report per specimen: transit times, Vp, Vs1, Vs2, dynamic moduli, force record.

Data access

- Raw waveforms and results exported as CSV or TXT.
- Runs offline on the supplied laptop. Perpetual licence, no cloud account and no recurring fees.

Calibration and verification

- Face-to-face system delay for each channel, built into the software.
- Aluminium reference specimen with stated Vp and Vs supplied with the system.
- Recommended check: start of each test day and after any platen or cable change.
- Load cell supplied with calibration certificate.



Typical bench arrangement: load frame in the centre, digitizer on the left, control unit on the right, monitor on an arm. Illustration.

07 Reference specification

Parameter	Standard configuration
Measurement	Through-transmission, P, S1, S2; ambient pressure and temperature
Platens	1 MHz nominal, 15 mm active footprint, sets for 25.4 and 38.1 mm
Specimen	Ø20 to 54 mm; length 15 to 150 mm (P), 25 to 150 mm (S)
Contact force	50 to 1000 N, pneumatic, load cell readout, ±2 % set-point repeatability
Digitizer	4 channels, 14-bit (16-bit in high-resolution mode), 3.2 GSa/s, 200 MHz, 20 Mpts per channel
Velocity range, typical	Vp 1000 to 8000 m/s; Vs 500 to 5000 m/s
Outputs	Transit times, Vp, Vs1, Vs2, dynamic E, G, K, v; raw waveforms
Export	CSV / TXT, offline software, perpetual licence
Method reference	ASTM D2845-08 pulse-transmission method (withdrawn by ASTM in 2017, still the common reference); ends per ASTM D4543
Utilities	100 to 240 VAC, 50/60 Hz; dry compressed air 6 bar. No water, drain, vacuum or gases
Footprint and mass	Load frame 320 × 160 mm base, about 800 mm high, about 36 kg. Complete system about 55 kg. Bench space 1.2 × 0.7 m

Included hardware

- Load frame with pneumatic actuator, regulator and load cell
- Platen pair P/S1/S2 with collars for 25.4 and 38.1 mm
- Control unit: pulser, channel switch, receiver
- Four-channel digitizer and laptop with software
- Cable set, P and S couplants, spare wear faces
- Aluminium reference specimen

Options

- 0.5 MHz platen pair for attenuating and coarse-grained material
- Small-specimen platen pair, below 25 mm
- Installation, commissioning and operator training on site
- Consumables kit: couplants, wear faces

Information for a quotation

- Specimen diameters and lengths, material types
- Expected velocity and attenuation range
- Power and air available at the bench

> This document defines the product family. Guaranteed performance, included hardware, exclusions, interfaces and acceptance criteria are stated only in the project-specific technical proposal and approved datasheet.

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