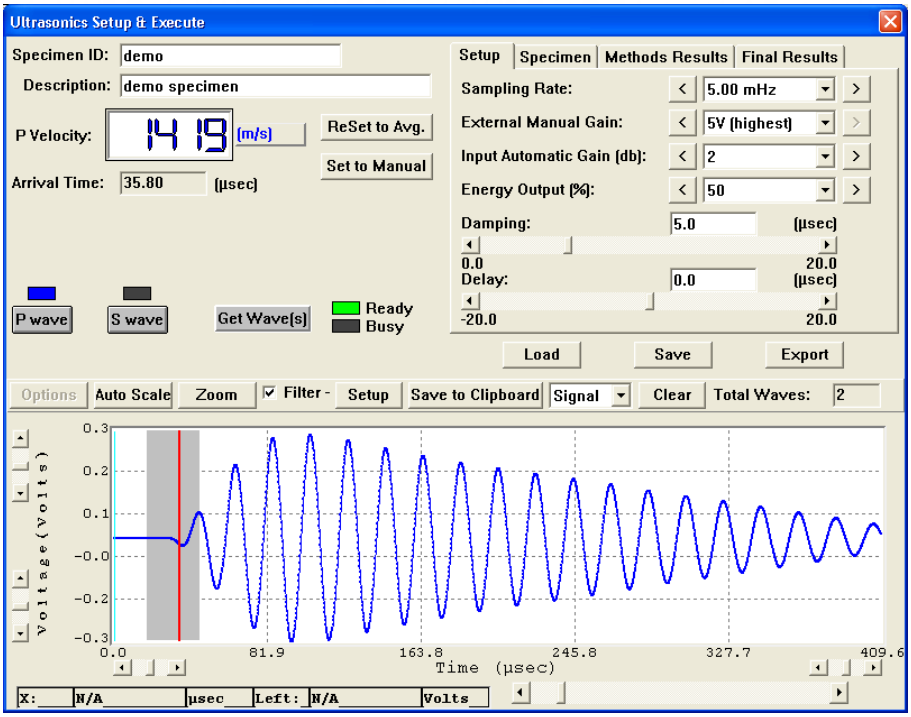
GCTS is committed to designing accurate testing systems by integrating innovative software engineering with advanced hardware. GCTS systems perform at the highest levels of reliability, providing efficient systems that satisfy customer needs and expectations.

GCTS TESTING SYSTEMS

ULT-100
Ultrasonic Velocity Measurement System



- **Automatic Ultrasonic Velocity Measurements of Compression & Shear Waves**
- **Test Soil, Rock, Asphalt & Concrete Specimens**
- **Digitally Controlled Pulser & Receiver**
- **State-of-the-art Software for Data Analysis, Storage, Plotting, & Reporting**
- **0-10 VDC Outputs Proportional to P- and S-Wave Velocity to Interface with External Data Acquisition Systems**
- **Transducer Platens Available for Use Inside Soil & Rock Triaxial Cells**

DESCRIPTION

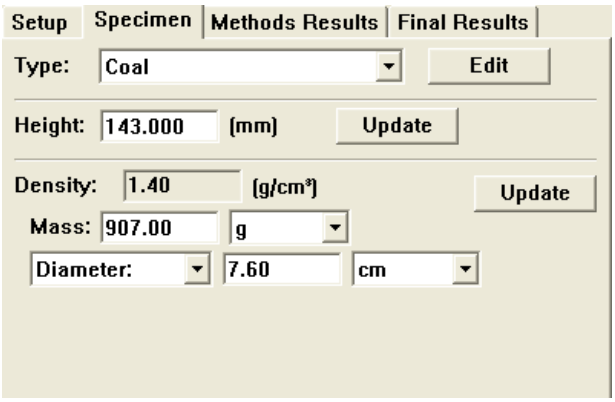
Laboratory ultrasonic velocity measurements are used to study the elastic behavior of geological materials at simulated in situ stress conditions. Ultrasonic testing is non-destructive and provides compression (P) wave and shear (S) wave velocity information which can be used in calculating dynamic elastic constants such as Poisson's Ratio (u), Young's Modulus (E), Bulk Modulus (K), and Shear Modulus (G).

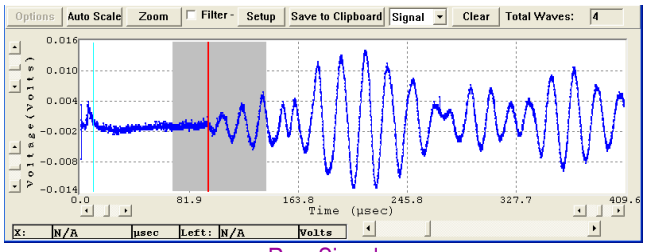
The GCTS Ultrasonic Velocity Test System is a turnkey system and includes everything required to perform Ultrasonic Velocity measurements on laboratory specimens. The system can be programmed to obtain an instantaneous measurement or programmed for several measurements at prescribed times and/or other test parameter events.

P.O Box 23686 Tempe AZ 85283 U.S.A. Tel: (480) 456-0110 Fax: (480) 456-4727 gcts.com

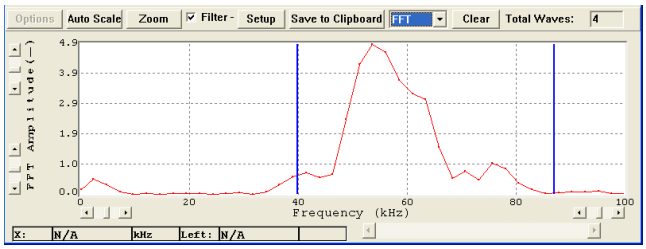
The GCTS Ultrasonic Velocity Software determines shear and compression wave velocities and stores the waveforms digitally. The system utilizes a computer board for high-speed data acquisition and a sophisticated computer software package for data analysis. The computer software is integrated within the GCTS CATS Software Environment. The pulse amplitude, sampling rate, input gain, and waveform enhancement are controlled by the software while the wave form is being viewed on the computer screen. The "face to face" platen corrections can be entered into the software so that the shear and compression wave velocities can be calculated simultaneously. The data can then be stored to disk for further analysis using the software. The software allows the operator to view the original data and the frequency spectrum of the waveform. Waveform filters, degree of waveform filtration, Band Pass frequency selections (low/high), Stop Band Rejection (dB) and Transition Band Width (kHz) can be applied to the original data to produce a "filtered" waveform, which is very convenient when dealing with a poor "raw" waveform. The GCTS Ultrasonic Velocity Software can be used within a variety of laboratory test systems, which simulate in-situ stress conditions or "bench" test (i.e., no additional stresses applied to the test specimen). Systems that simulate in situ stress conditions include triaxial cells and polyaxial ("true" triaxial) cells as well as in situ field tests. This system also includes a general data acquisition system to record other test parameters like load and deformation.

The ULT-100 system uses a fast-acting pulser that provides excitation to the ultrasonic sensor and an ultra high speed Analog-to-digital converter for storing the resulting waveforms signals. The sampling rate can be selected from 20 MHz to a sampling rate as low as 156 Hz allowing the user to capture a wide range of ultrasonic signals. Added features such as “Automatic Gain Selection”, “Energy Output”, “Damping”, and delay selections can aid in the interpretation of resulting waveforms. Also included within the ULT-100 is an 8 channel general purpose data logging device that accepts ±10 VDC signals for recording parameters such as load and displacement. In addition, two 0-10 VDC analog signals supply constant outputs proportional to the P- and S-wave velocities for interfacing with external data loggers. Within the CATS Ultrasonic software the user is able to digitally control the receiver and pulser ensuring an easy setup and high degree of repeatability.

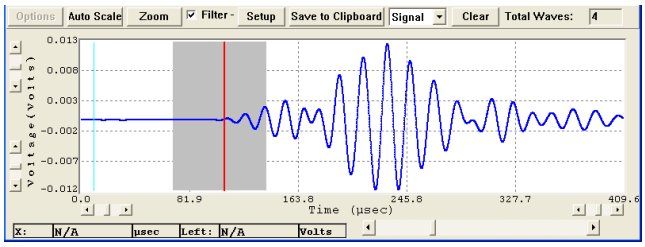




Raw Signal



FFT plot

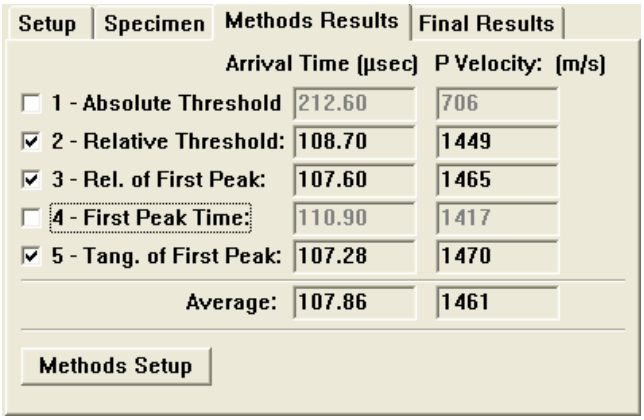


Filtered Signal

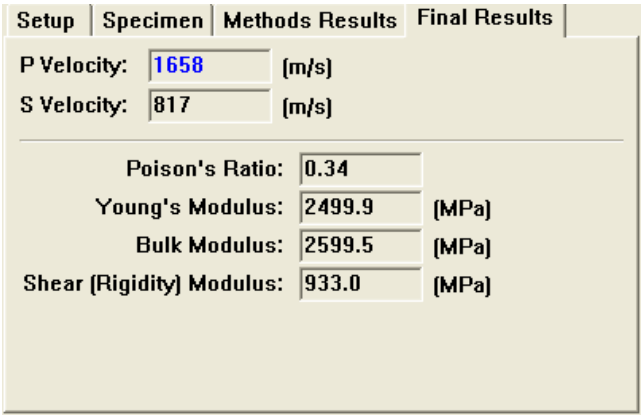
The software contains an extensive database of ultrasonic velocities for common materials such as metals, rocks, and soils and graphically suggests where the arrival time should be picked. This data base is also used to warn the user if the automatic velocity calculated by the software does not fall within the material’s range.

The CATS Ultrasonic software also has user selectable units for velocity and time/frequency as well as independent parameters for compression (P) and shear (S) waves. Within the software, multiple waveforms can be “stacked” for noise reduction and waveform enhancement. The CATS Ultrasonic software can display the received signal in raw or filtered format, the FFT (Fast Fourier Transform) of the signal, and also the “energy” plot.

The user has the ability to apply advanced filtering techniques to filter the noise from the raw signal. Filters can be easily designed graphically in the frequency domain with a few clicks of the mouse. Different filter types and modes can be used when the default program selection is not enough to clean the acquired waveform (expert mode for samples where pulse transmission is not adequate). Among some of the advanced filter types provided are Chebyshev (Type I and Type II) and Butterworth with selections for filter order and filer mode (low pass, high pass, band pass, etc.) Filter and pulser settings are saved and used by this program when the automatic determination of ultrasonic velocity is employed.



The software uses 5 different methods to automatically determine the ultrasonic velocity of the test specimen: Absolute threshold value, threshold value relative to maximum waveform amplitude, threshold value relative to first waveform amplitude, first peak, and zero crossing of first peak tangent. The user also has the ability to determine velocity manually, if so desired. Once the ultrasonic P and S velocities are determined, by simply entering in a few parameters for the specimen, the CATS Ultrasonic software determines the Poison's Ratio, Young's Modulus, Bulk Modulus and Shear Modulus results.



GCTS also manufactures a variety of ultrasonic platens or sensors including compression and shear crystals or bender elements (for soft materials). Compression and shear crystals can be ordered with resonant frequencies from 50 kHz to 1 MHZ. Different configurations for testing asphalt, concrete, rocks and soils are available including platens for measuring P and S wave velocities inside pressure cells. Bender elements are recommended for soil samples where pulse energy is not transmitted well. However, bender elements are less durable than embedded crystals and can easily break.

Platen for Solid Soil Specimens with
Embedded Compression and Shear Crystals

Platen for Solid Soil Specimens with Embedded
Compression Crystal and Protruding Bender Element

Platen for Hollow Soil Specimens with Embedded
Compression Crystal and Protruding Bender Element

Platen for Rock Specimens with
Embedded Compression and Shear Crystal

SPECIFICATIONS

Signal Conditioning and Pulse Generation:

- Digitally controlled pulser and receiver including anti-alias filter.
- 20 MHz acquisition rate with 12 bit resolution digitizing board (with 8 ranges:156 kHz, 312 kHz, 625 kHz, 1.25 MHz, 2.5 MHz, 5 MHz, 10 MHz, and 20 MHz)
- 10 MHz Bandwidth receiver.
- User selectable pulse energy amplitude.
- Pulse raise time less than 5 nano-seconds.

Computer Interface & Data Acquisition:

- 8 analog inputs with 200 Hz anti-alias filter.
- 12-bit resolution, ±10 volt, A/D data acquisition board (10 kHz sampling rate).
- 2 D/A channels for P & S wave velocity output to an external acquisition or control system.

Ultrasonic Velocity & Data Acquisition Controller:

- Micro-processor based digital signal processing and signal enhancement controller
- wave form stacking
- filtering
- spectral analysis
- Computer controlled selector switch for the automatic selection of P or S pulser and receiver transducers
- Automatic velocity calculation with the following methods:
  1. Absolute threshold
  2. Relative threshold of maximum amplitude
  3. Relative threshold of first peak
  4. First peak
  5. Tangent of first peak

Interface:

- Windows 2000/XP computer (not included).
- Serial or USB 2.0 communications.