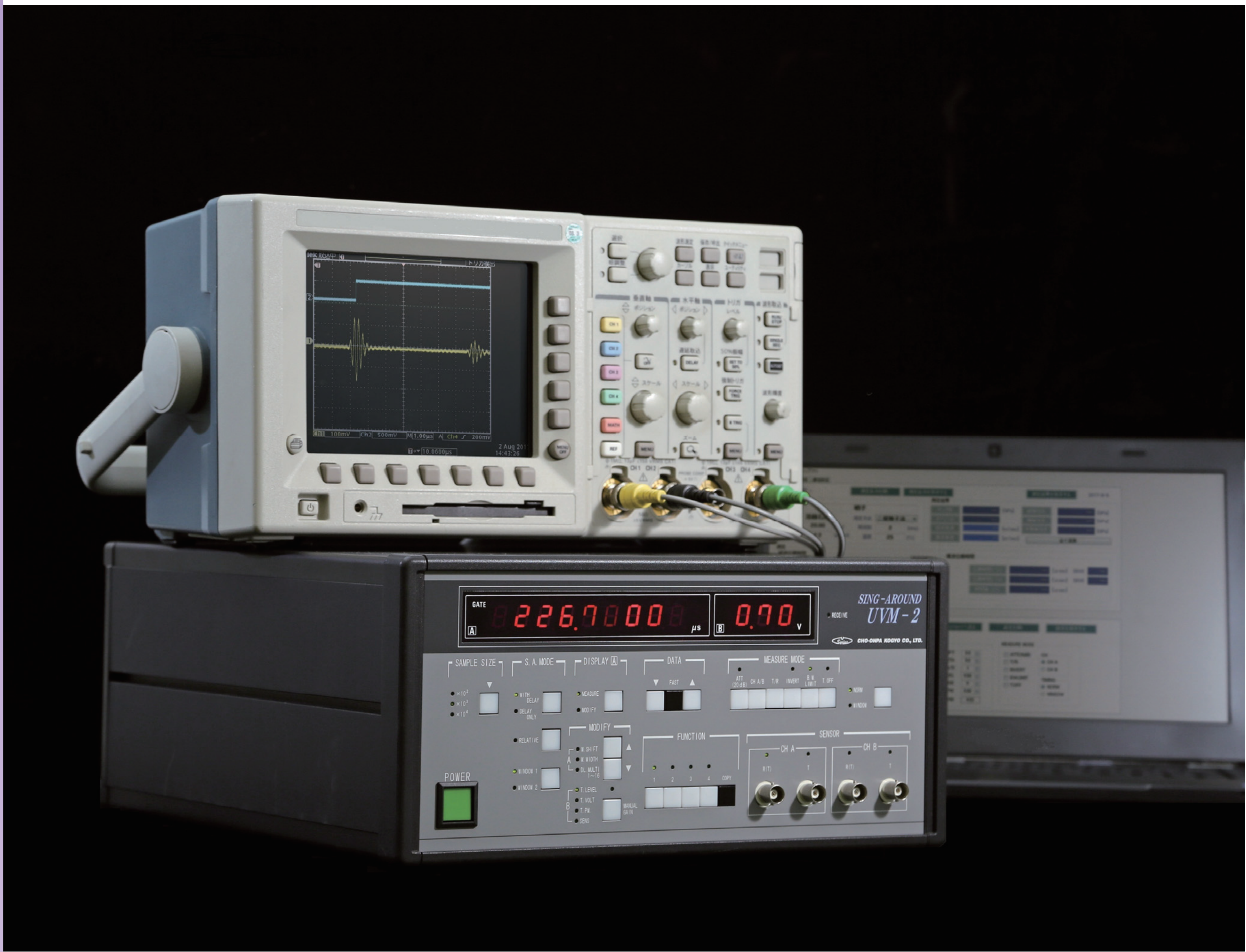
ULTRASONIC VELOCITY MEASUREING INSTRUMENT

MODEL UVM-2



ULTRASONIC ENGINEERING CO., LTD.

FOR MEASURING THE SONIC VELOCITY IN THE NEW MATERIALS, NEW CERAMICS, AND LIQUIDS

This instrument is designed for measuring the Young's modulus and sonic velocity and the concentration of various liquids by transmitting ultrasonic pulses through metals, ceramics, single crystals, plastics, liquids and other various materials by using the "sing-around" technology.

This technology enhances the measuring accuracy by means of the "sing-around" of ultrasonic pulses. This measuring instrument digitally displays the sonic velocity of testpieces quickly with high accuracy by the method of eliminating the influence of the reverberation of multiple-echoes which disturb the sing-around and the zero cross time detection circuit.

FEATURES

1. ***High measuring accuracy***
   The multiple delay circuit (patented) eliminates an error caused by multiple-echoes and the zero cross time detection circuit free from the influence of the receiving wave amplitude fluctuation ensures high accuracy measurements.

2. ***Young's modulus measurable***
   The Young's modulus can be calculated from the sonic velocity of transversal waves and longitudinal waves, and also thickness and density of testpieces.

3. ***Both one-probe and two-probe methods applicable***
   Since one-probe (reflection) method and two-probe (transmittance) method are selectable, this instrument can perform wide range applications.

4. ***Digital display available***
   The transmitting voltage, window gate, and other measuring conditions are programmable.
   The presettings are easily changeable by key operation on the panel, and measured results are digitally displayed.

5. ***Both direct and immersion methods applicable***
   2 measurements, namely direct and immersion measurements are available for solid testpieces.
   Test liquids can be measured in measuring cell. (Refer to Measuring Methods.)

APPLICATION EXAMPLES

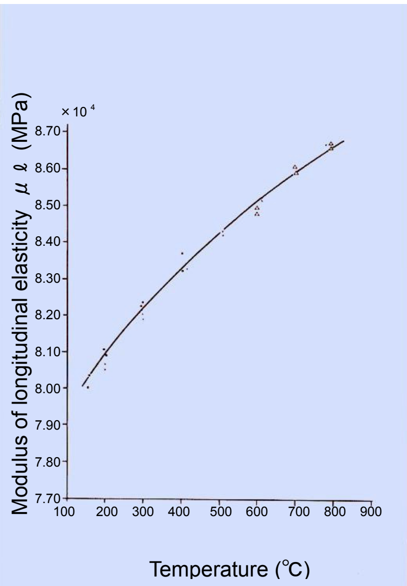


Fig. 1
Temperature characteristic of the modulus of longitudinal elasticity (Young's modulus) of fused quartz

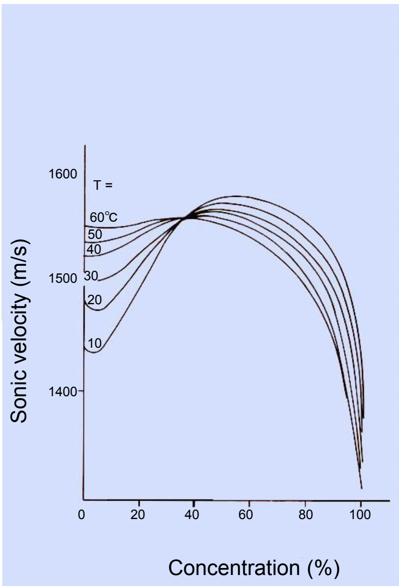


Fig. 2
Sonic velocity and concentration characteristic of sulfuric acid solution

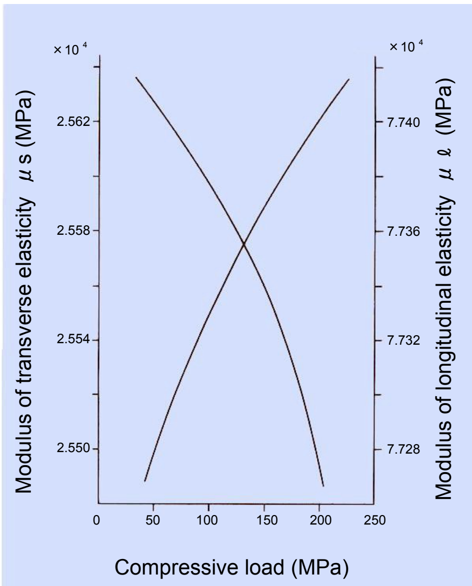


Fig. 3
Compressive load and elastic modulus in Al

MEASURING PRINCIPLE

Measuring sequence is as follows: Ultrasonic pulse oscillation -Transmitting probe-Testpiece-Receiving probe-AGC amplifier -Zero cross time detection-Multiple delay-Synchronizing pulse oscillation-return to Ultrasonic pulse oscillation.

Such repetitive sequence is taken place in the closed circuit. (The sequence is called "SING AROUND".) By measuring the average periods of N-times of this sing-around loop, the N-times measuring accuracy is obtainable and the high-accuracy propagation time measurement is feasible, basing on the principle of the periodic measurements.

AGC amplifier controls the peak voltage of receiving signals selected by the window gate to keep constant.

Zero cross time detection circuit initially selects a wave passing over the trigger level among amplified receiving waves, and then signals the time of the selected waveform crossing the zero voltage. Multiple delay circuit delays the synchronizing pulse generation until multiple-echoes in a testpiece are attenuated.

This instrument can execute highly accurate "sing-around" measurements by reducing an error coming from a receiving waveform change utilizing the zero cross time detection circuit and also by preventing an error coming from the interferences of the multiple-echoes in a testpiece utilizing the multiple delay circuit.

The sing-around period is digitally displayed and the sonic velocity is calculated from the period and testpiece length.

Assume Vl and Vs be the ultrasonic velocity of longitudinal and transverse waves being propagated through a solid, and ρ be the density.

Solid elastic constants are represented by;

Longitudinal elastic modulus : $M=\rho Vl^2$ ………… (1)

Transverse elastic modulus : $G=\rho Vs^2$ ………… (2)

Bulk elastic modulus : $K=\rho (Vl^2-4/3Vs^2)$ ………… (3)

Young's modulus : $E=3\rho Vs^2 (Vl^2-4/3Vs^2)(Vl^2-Vs^2)^{-1}$ ………… (4)

Poisson's ratio : $\sigma=1/2\,[1-\{(Vl/Vs)^2-1\}^{-1}]$ ………… (5)

Assume C be the concentration of test solution, V and T be the sonic velocity and temperature of these solutions, and Auj be the concentration, C is represented by;

$$C=\sum_{n=0}^{N}\sum_{j=0}^{J} Auj\, V^n T^j \quad \cdots\cdots (6)$$

Constant Auj is an intrinsic constant determined according to the kinds of solutions, and it is experimentally obtained from a characteristic curve of sonic velocity, concentration, and temperature.

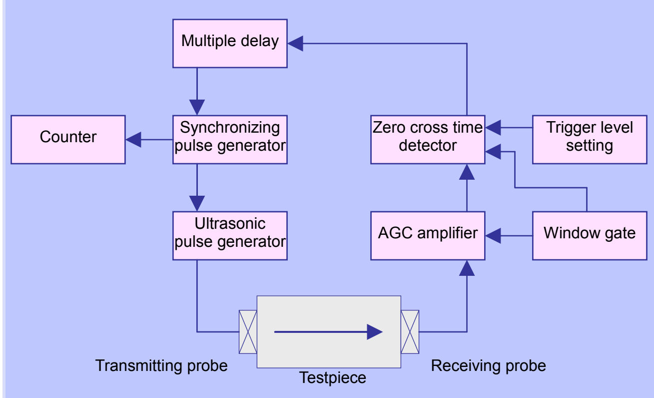


Fig. 4 Sing-around measuring system block diagram

SONIC VELOCITY OF SOLIDS AND WATER

〔General caution〕

The velocities of solids are not constant as compared with liquids. An error of about ±100m/s is normally found in metals depending on differences of purity, machining and thermal treatment of the testpieces.

The errors are far greater among other solids.

Solid and water	ρ g/cm^3	Vl m/s	Vs m/s
Aluminum (A)	2.7	6260	3080
Brass	8.1	3830	2050
Iron (Fe)	7.7	5850	3230
Copper (Cu)	8.9	4700	2260
Fused Quarts glass	2.7	5570	3515
Water (20℃)	1.0	1482.3	——

Quoted from "ultrasonic technology manual"
(Published by the Daily Industry Newspaper Co.)

MEASURING METHODS

1. ***Measurement of test liquid (Fig.5)***
   Assume T_1 and T_2 be the sing-around periods when the distance between the transmitting and receiving probes is L_1 and L_2 respectively, and we obtain Vw by;

$$Vw=(L_1-L_2)/(T_1-T_2) \quad \cdots\cdots (7)$$

   A Block gauge is used for high-accuracy measurement.

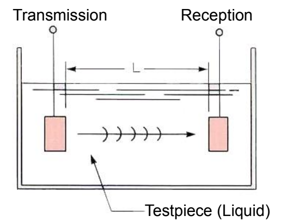


Fig. 5 Measurement of test liquid

2. ***Measurement of solid testpiece by the immersion method (Fig.6)***
   Assume T1 and T2 be the sing-around periods before and after inserting a testpiece, and we obtain;

$$Vm=\{\frac{1}{Vw}-(\frac{T_1-T_2}{L})\}^{-1} \quad \cdots\cdots (8)$$

   In this case, sonic velocity of the liquid should be measured by the method 1 in advance.

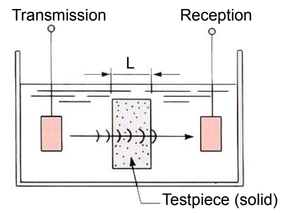


Fig. 6 Measurement of solid testpiece by the immersion method

3. ***Direct measurement of soild testpiece (Fig.7)***
   This measurement is done by direct contact of the transmitting and receiving probes to testpieces. Prepare two testpieces having each different length. Arrange the contact conditions of the pair of probes to each testpiece, and read the sing-around periods respectively.
   The sonic velocity is calculated by the same equation as (7).
   The sonic velocity of transverse waves of the testpiece is obtainable by measuring it using transverse wave probes as transmitting and receiving probes in this method.

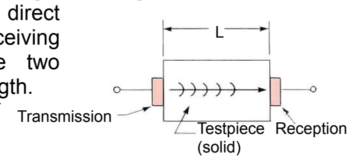


Fig. 7 Direct measurement of solid testpiece

4. ***Measurement by means of multiple-echoes (One-probe method) (Fig.8)***
   Assume T_1 be the sing-around period when the window is set to the position of the first reflected wave R_1, and T_2 be the sing-around period when the window is set to the position of the second reflected wave (multiple-echo) R_2.
   Then, sonic velocity V is obtainable by;

$$V=\frac{2L}{T_2-T_1}$$

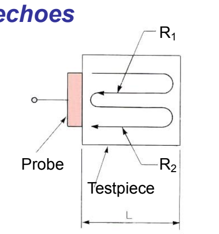


Fig. 8 Measurement by means of multiple-echoes

MAJOR SPECIFICATIONS

◆ SING-AROUND UNIT MODEL UVM-2-8

Transmitting frequency	: 1 to 10MHz or 0.5 to 5MHz (Transmitting pulse width is variable in a range of 0.5 to 0.05 μs)
Measuring mode	: One-probe method and two-probe method selectable
Multiple delay time	: 63.5 μs × N (N=1 to 16)
Delay time stability	: <±1ms/min at 63.5 μs
Display	: Sing-around period 8 digits, Minimum 0.01ns (10,000 times average)
Output	: (1) Counter output 0.5Vo-p 50Ω (2) USB interface
Working temperature and humidity	: 0 to 40℃, 90% RH max
Power requirement	: AC100V±10%, 50/60Hz, 30VA
External dimensions	: 320(W)×150(H)×350(D) mm
Weight	: 7 kg

＊COMPOSITION

Sing-around unit model UVM-2-8	: 1
Coaxial cable BNC-BNC for CRT monitor	: 3
Measuring coaxial cable (one of the following three cables)	
(1) BNC-microdot (for probes)	: 2
(2) BNC-BNC (for AC-M2)	: 2
Power source cable	: 1

◆ SOLID MEASURING CELL XM0031

The cell is for measurement by contacting the probes (longitudinal or transverse waves) to a solid testpiece.

To-be-measured testpiece	: Solid (Max. t30mm)
Probe	: For longitudinal or transverse waves
Frequencies	: 1～10MHz or 0.5MHz～1MHz
Working temperature	: 0 to 50℃
Minimum thickness readout value	: 0.001 mm
External dimensions	: 200(W)×510(H Max) ×180mm(D)
Weight	: 12 kg

◆ MEASUREING CELL AC-M2

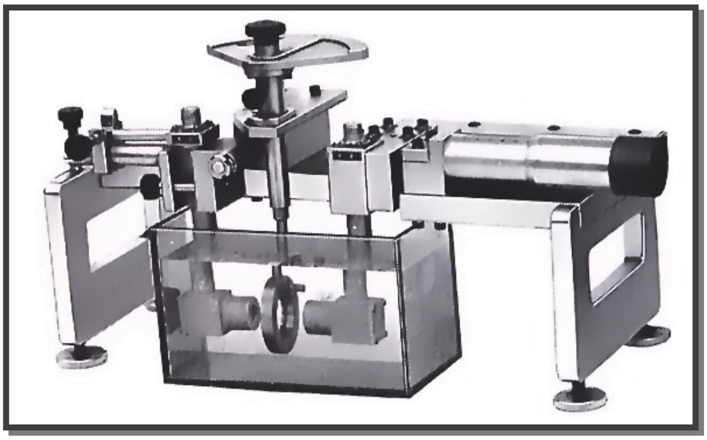
The cell is for high accuracy measurement of a test liquid and a solid testpiece (immersion method), feasible to be combined with an electric thermostatic circulation device and a thermostatic bath.

To-be-measured testpiece	: Liquids and solids (φ35×15mm thick)
Frequencies	: 1～10MHz or 0.5～5MHz
Working temperature	: -50 to+ 80℃
Travel distance of probe	: Max. 50 mm
Travel distance readout accuracy	: 5/1000 mm
External dimensions	: 500(W)×290(H)×190(D)mm
Weight	: 30 kg

◆ OPTIONAL DEVICE

Oscilloscope with Dual Trace delayed sweep
Frequency range : DC to 40MHz

Solid measuring cell XM0031



Measuring cell AC-M2

⚠ The specifications of this catalog might be changed without notice in case of the system being improved in the future.

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URL http://www.cho-onpa.co.jp/

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