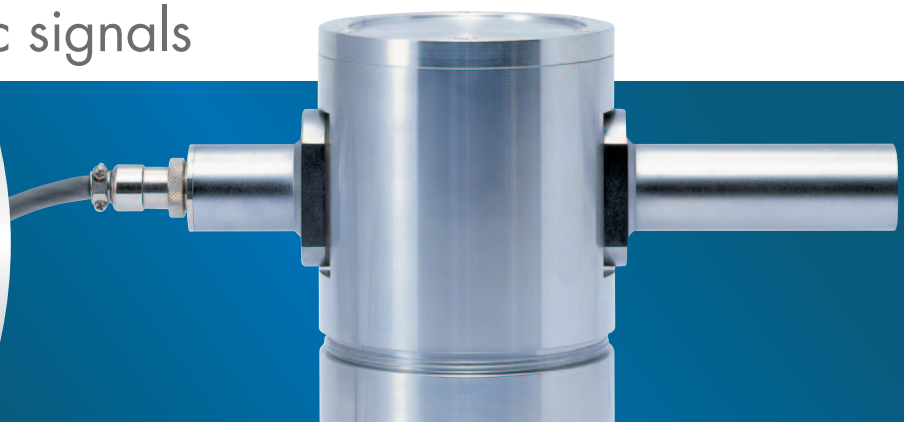
RION

RION Volume Meter
Revolutionary Instrument to Measure Volume with Acoustic signals

Acoustical Capacity Meter

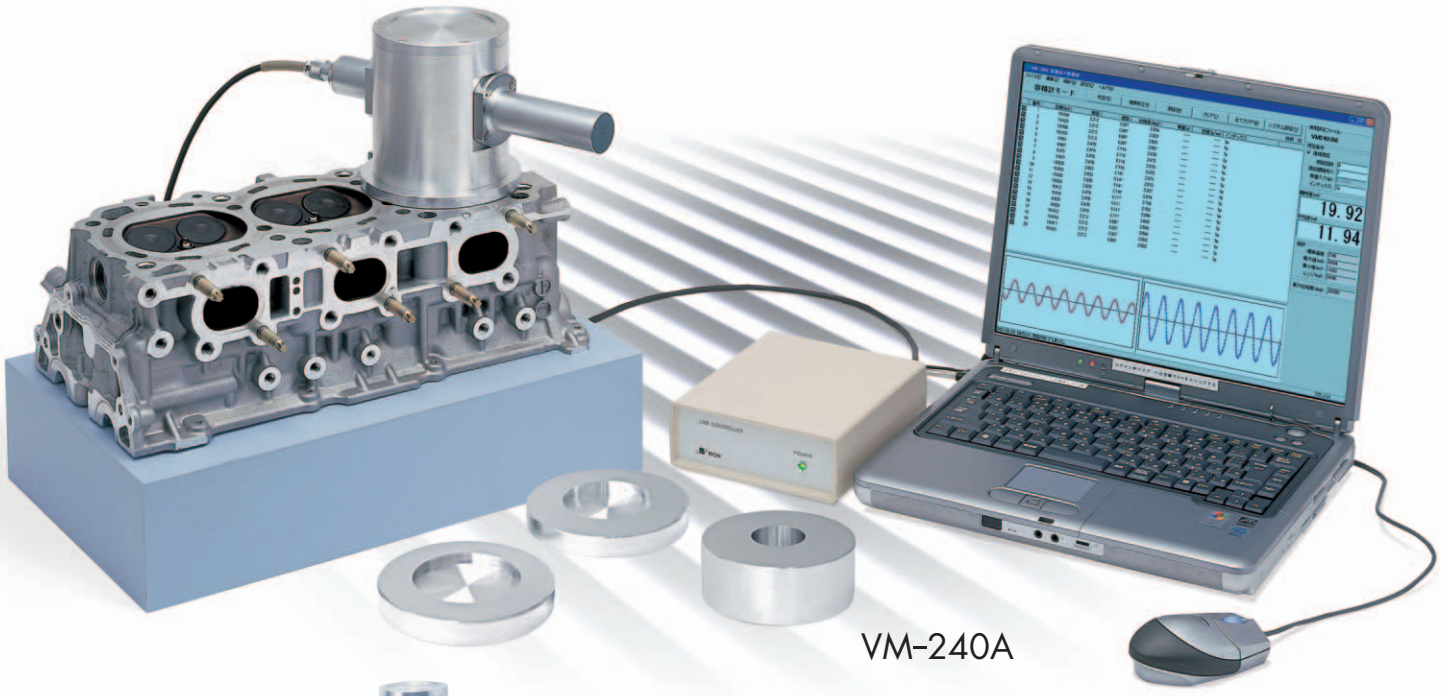
Acoustical Volume Meter



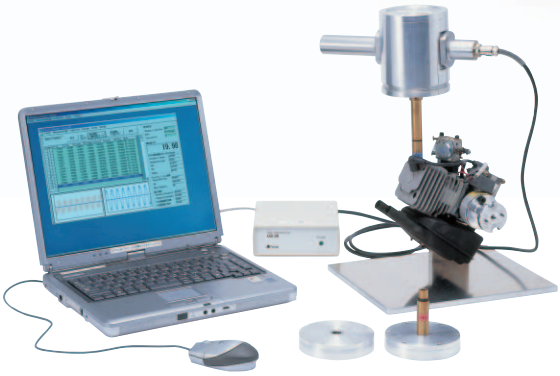
VM-240A/230

Acoustic Measurement of Capacity / Volume

Now precision measurement in dry condition is possible of any shaped object under measurement.



VM-240A



VM-230

Acoustical Capacity Meter (Chamber Volume Meter)

Enables measurement of the volume of any shaped chamber by acoustical method.

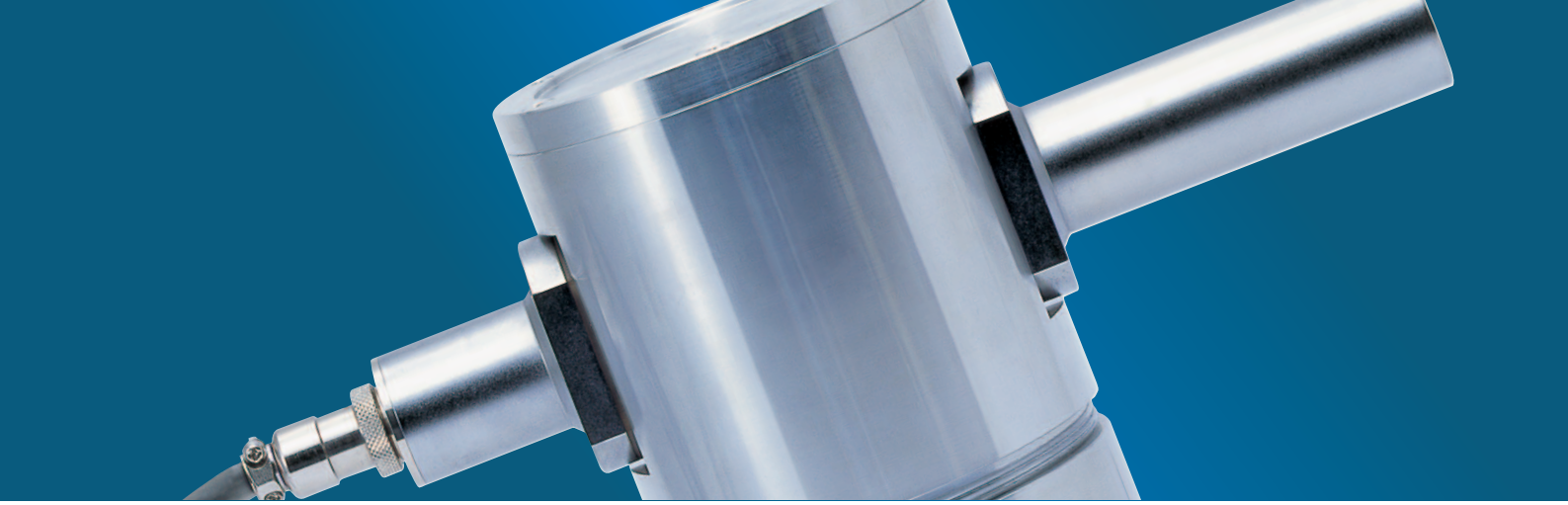
- Attach the measurement device to the chamber of the engine head during the assembly process.
- Enables measurement of the chamber volume of completed engine with using joining pipe to igniter plug hole.
- The measurement of volume is completed in about 2sec in dry conditions.

Acoustical Volume Meter (Densimeter)

With using Archimedes' Principle: measuring the buoyancy and immersing the target object in water.
Now, using Acoustic Volume Meter: the volume or density of the target object can be measured quickly keeping the object dry.

- The acoustic method, using the cycling of air-compression/distension, is used for measurement.
- Enables precision volume measurement of complicated shaped object so any shape of objects can be measured.
- Enables simultaneous measurement of volume and density using top loading electronic digital balance connecting USB 2.0.

VM-240A



■Measurement Method

CAPACITY

■ Measuring principle:

When a loudspeaker is placed between the reference chamber and the measurement chamber and driven by sinusoidal signal (sine wave), ultra small changes of volume and pressure, at the same absolute value but of opposite sign will occur inside each chamber.
These pressure changes are detected by microphones and the volume is calculated by the ratio of the pressure change.

$P \times V^{\gamma} = \text{const.}$ (γ is the ratio of specific heat for air, approx. 1.4)

$$\frac{\Delta P_1}{P_0} = \gamma \frac{\Delta V}{V_1} \qquad \frac{\Delta P_2}{P_0} = \gamma \frac{\Delta V}{V_2}$$

P_0 : Pressure in chamber (atmospheric pressure)
V_1 : Capacity of reference chamber (rear part of speaker)
V_2 : Total capacity of front part of speaker
(including combustion chamber V_S)
$V_2 = V_X + V_0$ (V_0 is common capacity)
ΔP_1 and ΔP_2 are small pressure changes in the reference chamber and the measurement chamber

$$V_2 = V_1 \frac{\Delta P_1}{\Delta P_2} \qquad (V_1 \text{ is constant})$$

Volume is proportional to the pressure ratio ($\frac{\Delta P_1}{\Delta P_2}$).

■ Measurement method

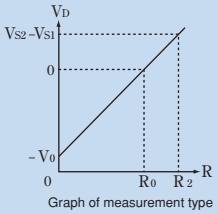
$$V_D = V_0 \left(\frac{R}{R_0} - 1\right)$$

V_D : volume difference against to the capacity reference container
R : ratio of amplitude ($\frac{e_1}{e_2}$) at measurement
e_1 : microphone output (rear part of speaker)
e_2 : microphone output (front part of speaker)
R_0 : ratio of amplitude at calibration with VS_1
R_2 : ratio of amplitude at calibration with VS_2
VS_1 : Volume of the first capacity reference container used for calibration
VS_2 : Volume of the second capacity reference container used for calibration

After above calculation, volume would be calculated by the following formula.

$$V_X = V_D + V_S$$

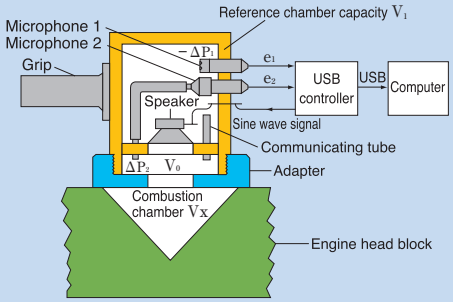
This formula is the linear expression of the parameter R to calculate the volume difference V_D by setting R_0 as the starting point



Graph of measurement type

■ Sectioned drawing

- Prior to the measurement, use a pair of the capacity-reference containers for calibration and get required the parameters.
- Measurement is done by attaching the reference chamber to the object.



VOLUME

■ Measuring principle:

When a loudspeaker is placed between the reference chamber and the measurement chamber and driven by sinusoidal signal (sine wave), ultra small changes of volume and pressure, at the same absolute value but of opposite sign will occur inside each chamber.
These pressure changes are detected by microphones and the volume is calculated by the ratio of the pressure change.

$P \times V^{\gamma} = \text{const.}$ (γ is the ratio of specific heat for air, approx. 1.4)

$$\frac{\Delta P_1}{P_0} = \gamma \frac{\Delta V}{V_1} \qquad \frac{\Delta P_2}{P_0} = \gamma \frac{\Delta V}{V_2}$$

P_0 : Pressure in chamber (atmospheric pressure)
V_1 : Capacity of reference chamber (rear part of speaker)
V_2 : Total capacity of front part of speaker
(including combustion chamber V_S)
$V_2 = V_0 - V_X$ (V_0 is empty capacity)
ΔP_1 and ΔP_2 are small pressure changes in the reference chamber and the measurement chamber

$$V_2 = V_0 - V_1 \frac{\Delta P_1}{\Delta P_2} \qquad (V_1 \text{ is constant})$$

Volume is proportional to the pressure ratio ($\frac{\Delta P_1}{\Delta P_2}$).

■ Measurement method

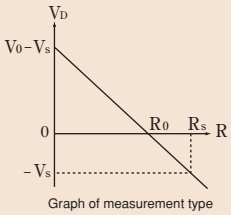
$$V_X = (V_0 - V_S)\left(1 - \frac{R}{R_0}\right)$$

V_X : object volume
V_S : volume of the reference object
R : ratio of amplitude ($\frac{e_1}{e_2}$) at measurement
e_1 : microphone output (rear part of speaker)
e_2 : microphone output (front part of speaker)
R_0 : ratio of amplitude at calibration with V_S
R_S : ratio of amplitude at calibration with empty chamber

After above calculation, volume would be calculated by the following formula.

$$V_X = V_D + V_S$$

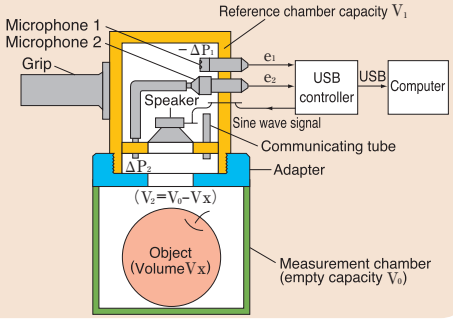
This formula is the linear expression of the parameter R to calculate the volume difference V_D by setting R_0 as the starting point



Graph of measurement type

■ Sectioned drawing

- Prior to the measurement, calibration is done with one piece of the reference object.
- Measurement is done putting the object into the measurement chamber.
- In case of measuring density, measurement is done by attaching the object onto the top loading electronic digital balance.



■SPECIFICATIONS

Measurement Science Lab.

	Acoustical Capacity Meter VM-240A / 230	Acoustical Volume Meter VM-240A
Reference chamber : inside dimensions, capacity and weight	90 mm (Diameter) × 91 mm (Height) Capacity ≒ 570 cm^2 Weight = 1.9 kg	
Capacity measurement : repeat precision	±0.1 cm^3 (0.006 in^3)	±0.3 cm^3 (0.018 in^3)
Required measurement time	Approx. 2 seconds (max) (setting unit: one second steps)	
Measurement frequency	30 Hz default: (setting range: 15 to 45 Hz / setting unit: one Hz steps)	
Sound pressure of reference chamber	Approx. 128 dB re 20 μPa (50 Pa rms)	
Sound pressure of measurement chamber	Approx. 124 dB re 20 μPa (30 Pa rms)	
Signal processor circuit	Control box (connected to PC with USB cable)	
Operating system	Microsoft Windows 2000 / XP	
Power requirements (during measurement)	+5 V, 475 mA (approx. 2.4 VA)	
USB Controller Dimensions and weight	54 (H) × 150 (W) × 170 (D) · 400 g (0.9 lb)	
Accessory	■ USB Cable ■ Control box with AC adapter ■ Program (CD-ROM)	■ USB Cable ■ Control box with AC adapter ■ Program (CD-ROM) ■ Case for measurement (M size) 120 mm (Diameter) × 110 mm (Height) 4.72 in (Diameter) × 4.33 in (Height)
Option	■ Carrying case ■ Reference capacity units The capacity of reference capacity units and number of units for customers' request.	■ Carrying Case ■ Mass meter for automatic calculation of density ■ Case for measurement MS : 100 mm (Diameter) × 92 mm (Height) 3.94 in (D) × 3.62 in (H) L : 165 mm (Diameter) × 150 mm (Height) 6.5 in (D) × 5.91 in (H) LL : 215 mm (Diameter) × 210 mm (Height) 8.46 in (D) × 8.27 in (H) LLL : 250 mm (Diameter) × 280 mm (Height) 9.84 in (D) × 11 in (H) *Other sizes can be custom-made ■ Reference volume units *The volume of reference volume units and number of units for customers' request.

United States Patent No, : US 7,017,401 B2

http://www.rion.co.jp/english/

＊ Windows is a trademark of Microsoft Corporation.
＊ Specification subject to change without notice.

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