

Portable Friction Meter

HEIDON Tribo Gear μ s Type 94i



User's Manual

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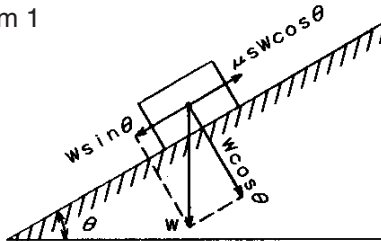
1. Introduction

The HEIDON Tribo Gear μ s Type 94i is a portable measuring device which makes it easy for anyone to measure the static friction coefficient of objects. In the past, static friction was typically measured using the incline method and a strain gauge. However, this method poses many difficulties when used in confined spaces such as laboratories, etc. The HEIDON Tribo Gear μ s Type 94i is a new type of static friction measuring device which completely eliminates these difficulties.

2. Measurement Principle

Static friction is generally measured using the incline method. As illustrated in Diagram 1 below, when an object of weight W is placed upon a surface which is gradually inclined at an increasing angle, at some angle of inclination the acceleration of gravity acting upon the object will exceed the static friction which tends to keep the object in place and the object will begin to slip. This angle θ (theta) is referred to as the friction angle. Taking μ_s as the coefficient of static friction, the force of friction is the vertical force with which the object pushes down upon the surface ($W \cos \theta$) and the area μ_s ($\mu_s W \cos \theta$). Therefore, the force with which the object tends to slip down the slope ($W \sin \theta$) is thus $\tan \theta$. In this way, the coefficient of static friction can be obtained by measuring the friction angle θ .

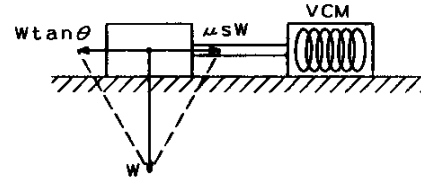
Diagram 1



$$W \sin \theta = \mu_s W \cos \theta$$

$$\mu_s = W \sin \theta / W \cos \theta = \tan \theta$$

Diagram 2



$$W \tan \theta = \mu_s W$$

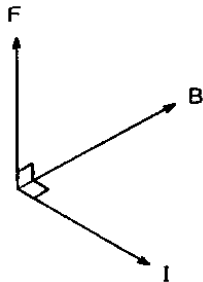
$$\mu_s = W \tan \theta / W = \tan \theta$$

Applying this principle, a VCM (voice coil motor) is used to apply a horizontal force to an object of weight W as illustrated in Diagram 2. The object will begin to move the instant that the force thus applied exceeds the force of friction. The force (F) generated at this time is obtained by the formula $F = ki$. Therefore, the coefficient of static friction is obtained by the formula ki/W .

- k : Constant force applied by the VCM
- i : Current at the instant the object began to move.
- W : Weight of the object (g)

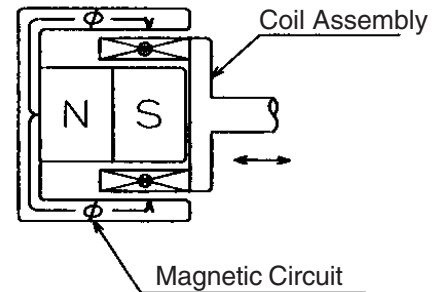
3. The VCM Principle

The VCM (voice coil motor) operating principle is an application of Fleming's left hand rule. As illustrated in the diagram below, the VCM is composed of a magnetic circuit and coil assembly. When a current passes through the coil placed in the magnetic field, the current, magnetic field and force move at right angles to each other. This results in a force being applied to the coil assembly. This force is proportional to the value of the current passing through the coil. Because this is efficient, a large force can be generated even with low current levels.



I : Current
B : Magnetic flux density
F : Force

Fleming's Left-hand Rule



VCM Cut Away Diagram

Force $F = BIL$

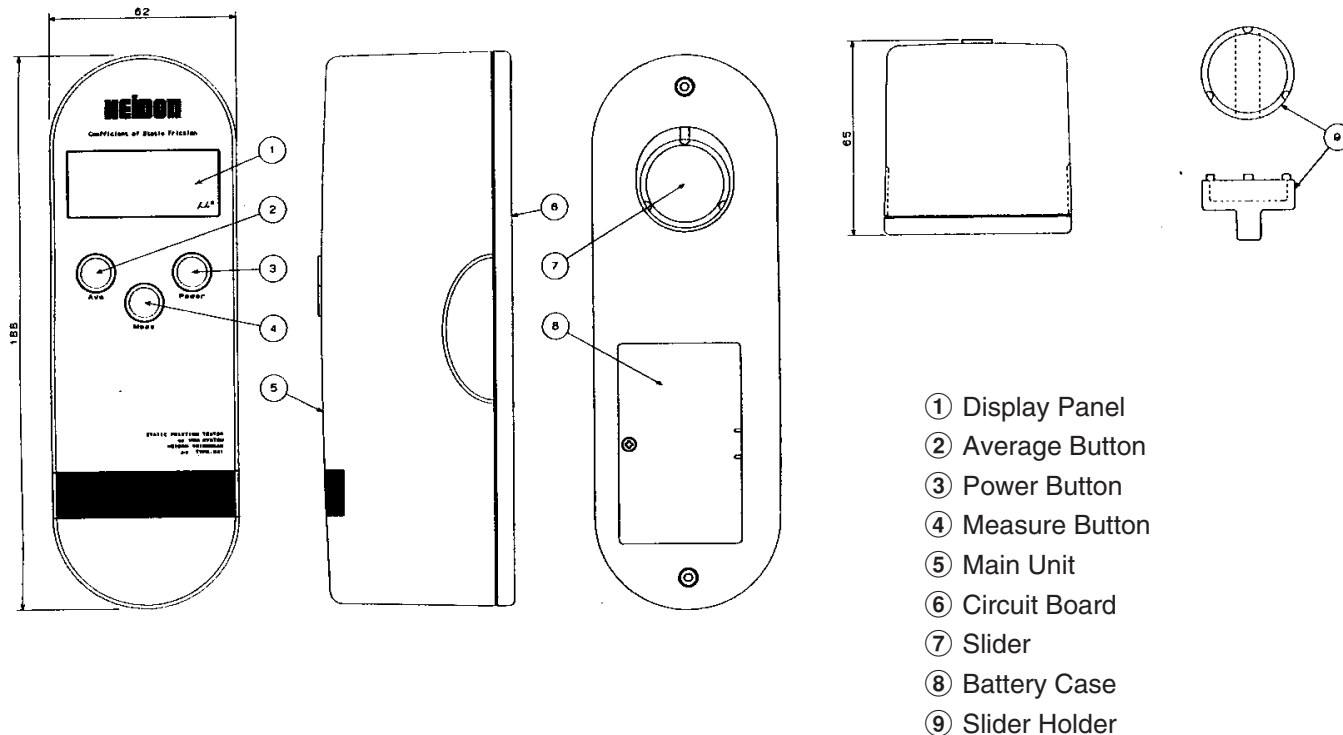
F : Force (N)

B : Magnetic Flux Density (T)

I : Current

L : Total length of coil (m)

4. External View and Part Names



5. Using the Portable Friction Meter

1 Attach a Sample

The coefficient of friction between two samples can be measured either by attaching the samples to the slider with two-sided tape or by fixing the samples in place using the O ring supplied attached to the slider.

① Affixing samples using two-sided tape

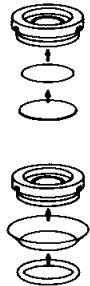
Use a piece of two-sided tape pre-cut to a size slightly smaller than the samples to affix the samples to the slider.

② Affixing samples using the O-ring

Remove the O-ring which is attached to the slider and then wrap the O-ring around the samples so that they are fixed in place. This method should only be used for thin samples.

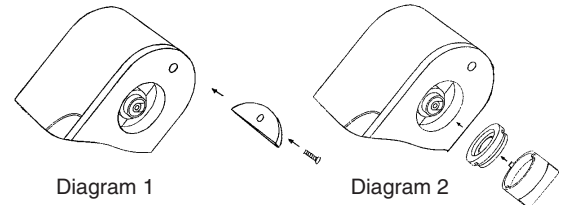
* The displayed coefficient of friction is calculated based upon the weight of the slider (40g). It is therefore necessary to take the weight of the attached samples into consideration.

* When measuring the coefficient of friction between samples, a maximum thickness of 1mm of sample material may be attached.



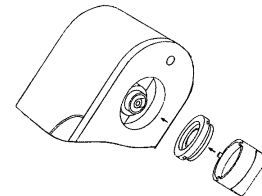
2 Installing the Rubber Slider

- 1 Remove the two bolts which hold the bottom cover in place.
- 2 Use screws to fix the spacers in place (2 locations). (Refer to diagram 1.)
- 3 Install the rubber slider. (Refer to diagram 2.)



3 Installing the 6-Point Bowl Slider

- 1 Use a slider holder to install the slider as illustrated in the diagram.
- 2 Install the 6 point bowl slider in the same way.



4 Check the Power Supply Voltage

After turning on the power, check to make sure that the LED display reads "0.000".

The batteries need to be replaced if the LED display reads "••••". To replace the batteries, use the supplied screwdriver to remove the screws which hold the battery case cover in place. (The battery case cover is located on the bottom of the main unit.) Pull out the battery holder and replace the 4 batteries. Use only new size AA alkaline batteries. After replacing the batteries, insert the holder back into the unit, replace the cover and then replace the screws which hold it in place.

5 Measurement Method

Place the object to be measured upon a horizontal surface and set the unit down gently. (The center of the slider is located directly below the LED display panel.) Press the Measure button. The value displayed is the coefficient of static friction.

6 The Average Function

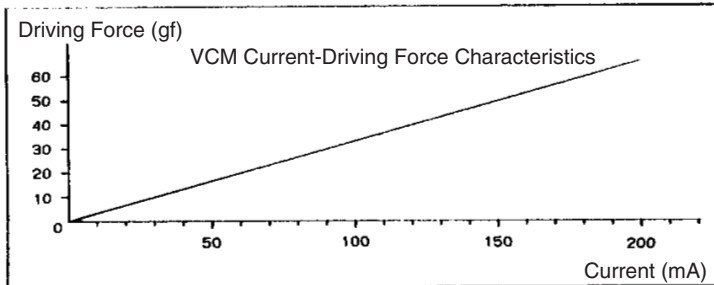
Press the average button after marking number of measurements (Max 769 times.)

The coefficient of static friction is a rough guide to the friction between objects. Measured values may vary depending upon conditions under which measurements are performed. Therefore, taking the average of several measurements provides a more accurate value.

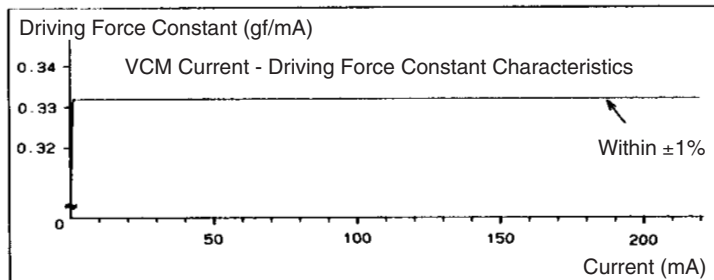
6. Notes Regarding Handling of the Friction Meter

- Do not drop the unit or subject it to strong physical shocks.
- Do not allow the unit to become wet.
- The sensor and VCM sections are extremely delicate. Do not disassemble them.
- In order to avoid dust contamination, store the unit in its case when it will not be used for an extended period of time.
- The condition of the slider's surface has a great effect upon measurement values. Handle it with great care.
- Avoid making measurements on vibrating surfaces.

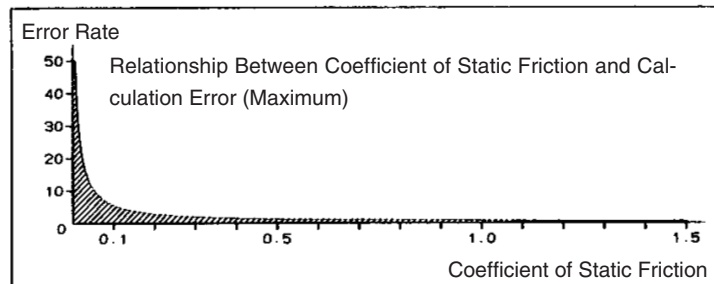
7. Characteristics and Performance



- Driving force generated by VCM calculated using a strain gauge (Actual measurement example)



- VCM driving force constant calculated using a strain gauge (Actual measurement example)



- Calculation error due to circuit resolution.

8. Specifications

Model	HEIDON TRIBO GEAR μ S Type: 94i
Measurement Range	Coefficient of static friction (0.000 ~ 1.300)
Measurement Precision	Refer to graphs provided in part 7, Characteristics and Performance
Display Resolution	0.01
Detector	VCM Photo sensor
Display	7 Segment LED (RED), (4 digits)
Materials	Main Unit : ABS, Aluminum Slider : Brass (hard chrome treated) 40g
Power Supply	Alkaline batteries (4 size AA)
Dimensions	188mm x 62mm x 65mm



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