

**Color Screen  
Leeb Hardness Tester  
LM500  
Operating Manual**

**YUSHI INSTRUMENTS**

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# 1.Principle of Leeb Hardness Testing Method

The impact body, which is equipped with tungsten carbide, impacts into the work piece and rebounds back. The rebound and impact velocities are measured at the 1mm point from the work piece in the following way: the integrated permanent magnet will produce directly proportional voltage with the impact velocity. The Leeb hardness values are calculated by the following formula:

$$HL=1000\times(V_b/V_a)$$

In Which: HL: Leeb hardness values

$V_b$  : the voltage produced during the rebound of impact body

$V_a$  : the voltage produced during the impact of impact body

Figure 1 shows the voltage produced during the impact and rebound of impact body:

voltage features of output signal

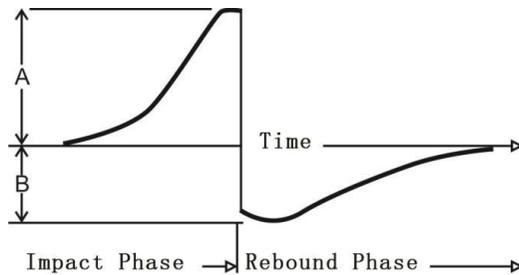


Figure 1.1

# 2. Instrument and Impact Device Diagram

## 2.1 Instrument Diagram



Figure 2.1

## 2.2 D Type Impact Device Diagram

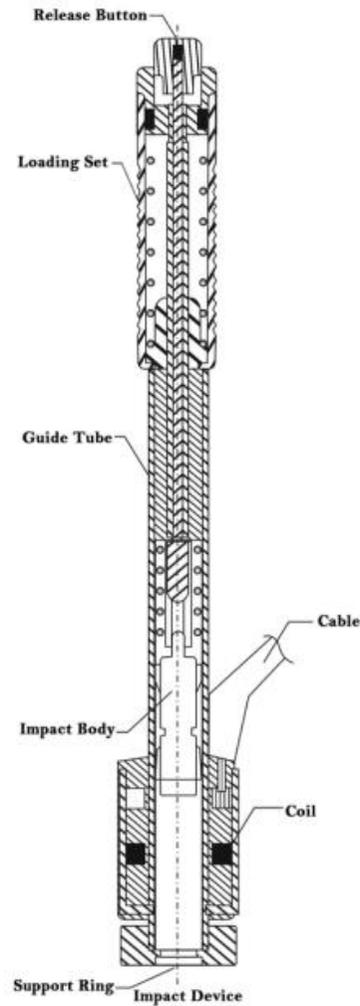


Figure 2.2

## 2.3 Types of Impact Device

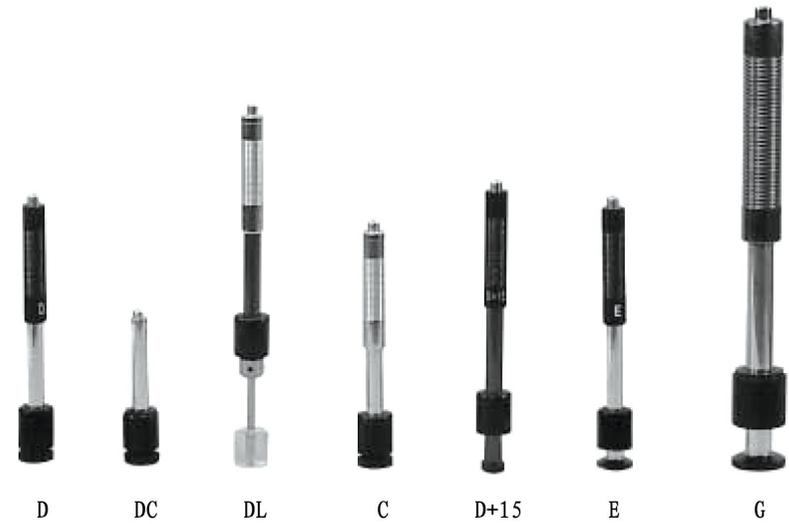


Figure 2.3

## 2.4 Impact Devices Specification:

Special Impact Device	D/DC/DL	D+15	C	G	E
Impact Energy	11mJ	11mJ	11mJ	11mJ	11mJ
Mass of Impact Body	5.5g/7.2g	7.8g	3.0g	20.0g	5.5g
Test Tip Hardness	1600HV	1600HV	1600HV	1600HV	5000HV
Test Tip Diameter	3mm	3mm	3mm	5mm	3mm
Test Tip Material	Tungsten Carbide				
Impact Device Diameter	20mm	20mm	20mm	30mm	20mm
Impact Device Length	86/147/75	162mm	141mm	254mm	155mm
Impact Device Weight	50g	80g	75g	250g	80g
Max. Hardness of Sample	940HV	940HV	1000HV	650HV	1200HV

Average Surface Roughness Ra:	1.6 μ m	1.6 μ m	0.4 μ m	6.3 μ m	1.6 μ m	
Min. Weight of Sample: (kg)						
Directly Measurable	>5	>5	>1.5	>15	>5	
Need Stable Support	2-5	2-5	0.5-1.5	5-15	2-5	
Tightly Coupled	0.05-2	0.05-2	0.02-0.5	0.5-5	0.05-2	
Min. Thickness of Sample:						
Tightly Coupled	5mm	5mm	1mm	10mm	5mm	
Min. Depth of Hardnes Layers	» 0.8mm	» 0.8mm	» 0.2mm	» 1.2mm	» 0.8mm	
Indentation Dimension of Test Tip						
With 300HV	Diameter	0.54mm	0.54mm	0.38mm	1.03mm	0.54mm
	Depth	24 μ m	24 μ m	12 μ m	53 μ m	24 μ m
With 600HV	Diameter	0.54mm	0.54mm	0.32mm	0.90mm	0.54mm
	Depth	17 μ m	17 μ m	8 μ m	41 μ m	17 μ m
With 800HV	Diameter	0.35mm	0.35mm	0.35mm	--	0.35mm
	Depth	10 μ m	10 μ m	7 μ m	--	10 μ m
Impact Device Applicable Scope						
DC	Used for very confined spaces such as holes, cylinders internal measurement					
DL	Used for extremely confined spaces.					
D+15	Used for measuring in grooves, recessed surface.					
C	Used for testing case hardened or thin walled components.					
G	Used for solid heavy component, such as rough castings and forgings.					
E	Used for high hardness material.					

Table 2.1

## 2.5 Standard Configuration

- ◆ LM500 Main Unit
- ◆ D type Impact Device
- ◆ HLD Value Standard Test Block
- ◆ DataView Software
- ◆ USB Communication Cable
- ◆ Small Supporting Ring
- ◆ Cleaning Brush
- ◆ 2 AA Battery
- ◆ Operation Manual
- ◆ Instrument Case

## 2.6 Optional Accessories

- ◆ Impact Device: C/G/DC/DL/D+15
- ◆ Standard Test Block
- ◆ Rubber Sheath
- ◆ Belt
- ◆ Standard Supporting Ring
- ◆ Small Supporting Ring
- ◆ Special Supporting Rings ( See table 2.2 )

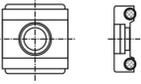
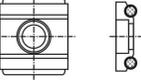
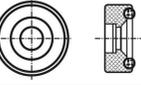
No.	Code	Model	Special Support Ring Sketch	Remark
1	03-03.7	Z10-15		Measure outside the cylindrical surface R10~R15
2	03-03.8	Z14.5-30		Measure outside the cylindrical surface R14.5~R30
3	03-03.9	Z25-50		Measure outside the cylindrical surface R25~R50
4	03-03.10	HZ11-13		Measure inside the cylindrical surface R11~R13
5	03-03.11	HZ12.5-17		Measure inside the cylindrical surface R12.5~R17
6	03-03.12	HZ16.5-30		Measure inside the cylindrical surface R16.5~R30
7	03-03.13	K10-15		Measure outside the spherical surface SR10~SR15
8	03-03.14	K14.5-30		Measure outside the spherical surface SR14.5~SR30
9	03-03.15	HK11-13		Measure inside the spherical surface SR11~SR13
10	03-03.16	HK12.5-17		Measure outside the spherical surface SR12.5~SR17
11	03-03.17	HK16.5-30		Measure outside the spherical surface SR16.5~SR30
12	03-03.18	UN		Measure outside the cylindrical surface, adjustable radius R10~∞

Table 2.2

### 3. Functions and Applications

#### 3.1 Technical Specifications

Measuring Method: Leeb Hardness Testing method

Hardness Scale: HL, HB, HRB, HRC, HV, HS,  $\sigma_b$

Measuring Range : HLD (200-960), HRC (19.8-68.5) , HB (30-651) , HV (80-976) , HS (26.4-99.5) HRB (13.5-100) ,  $\sigma_b$  (375-2639).

Impact Device: D type impact device (Standard); Optional C/G/DC/DL/D+15

Accuracy:  $\pm 6HLD$  (HLD=800), Repeatability 6HLD (HLD=800)

Measuring Direction: Vertically downward, inclined downward, Level, inclined upward, vertically upward

Material : Steel & Cast Steel, Stainless Steel, GC IRON, NC IRON, Cast Aluminum Alloy, Copper-Zinc Alloy, Copper-Tin Alloy, Brass, Alloy Tool Steel, Forging Steel.

Resolution: 1HL, 1HV, 1HB, 0.1HRB, 0.1HRC, 0.1HS

Display: Color HD IPS Screen

Memory: 11000 Groups (impact times 1-8 )

Power: 2 AA batteries, 1.5V

Working temperature:  $-10^{\circ}\text{C} \sim +50^{\circ}\text{C}$

Size:  $153 \times 76 \times 37$  (mm) (H×W×D)

Weight: 242g ( include battery )

Standard: GB/T 17394-2014, ASTM A956

### 3.2 Applications

Installed machinery and Permanent assembly parts

Mould cavity

Heavy workpieces

Failure analysis of pressure vessel, turbine and other equipments

Small test area

The production line of Bearings and other parts

Distinguish the material of the metal material warehouse

## 4 .Pre-Treatment of Workpiece

### 4.1 Workpiece Requirements

#### 4.1.1 Surface Roughness requirements

Surface roughness is an important requirement for the surface of the test piece, it should be smooth and no oil, or will cause measurement errors.

The surface roughness of the test piece should not exceed the value in the following table :

Impact Device Type	Workpiece Surface Roughness Ra
D、 DC、 DL 、 D + 15	2 $\mu$ m
G	7 $\mu$ m
C	0.4 $\mu$ m

Table 4.1

#### 4.1.2 Weight and Thickness Requirements

The requirements of different types of impact devices for the quality and thickness of the test piece in the following table:

Impact Device Type	Min weight	Min thickness (no coupling)	Min thickness (coupling)
D、 DC、 DL、 D + 15	0.05~2.0	2.0~5.0	>5.0
G	0.5~5.0	5.0~15.0	>15.0
C	0.02~0.5	0.5~1.5	>1.5

Table 4.2

#### 4.1.3 Surface Hardened Layer Thickness

The requirements of the thickness of the hardened layer on the surface of the test piece in the following table:

Impact Device Type	Min. Thickness of Surface Hardened Layer (mm)
D、 DC、 DL、 D + 15	0.8
C	0.2

Table 4.3

#### 4.1.4 Curved Surface Requirements

Curved surface: The best testing surface of sample is flat. When the curvature radius R of the surface to be tested is smaller than 30mm (D, DC, D+15, C, E and DL type of impact device) and smaller than 50mm (G type of impact device), the small support ring or the special support rings should be selected.

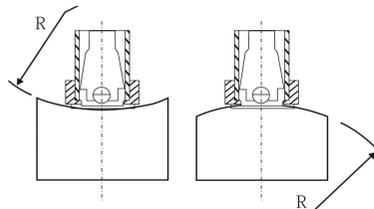


Figure 4.1

## 4.2 Support of Test Piece

- ◆ The heavy workpiece do not need support.
- ◆ The Mid-heavy workpiece must be placed on a flat, sturdy surface, and absolutely smooth placement, without any shaking.
- ◆ Light workpiece must be tightly coupled with the solid support body, the coupling surface must be smooth, and coupled dosages don't too much, Test direction must be perpendicular to the coupling surface.
- ◆ When the workpiece is a large area of Sheet, Pole and Bending Parts, Even if a large weight and thickness may still cause deformation, so reinforcement and support in the rear surface of the test point is necessary.

## 5. Operation

### 5.1 View Switching

There are three testing interface optional. With the first function button corresponding to the "VIEW" can switch display interfaces after starting up. The default interface is the big font like the following (Fig.5.1) . Press the first function button corresponding to the "VIEW" can switch to the multiple standard display interface (Fig.5.2) and curve interface (Fig. 5.3) in turns.

The multiple standard display interface shows not only the testing value of the standard that you have set, but also the two testing values of common standards at the same time without interchange.

Under the curve interface, shows not only the testing value of three hardness standards under the multiple standard, but also the curve of the latest testing values, the testing points gradually increase from 10 to 30 on a screen, which reflects the uniformity of the workpiece vividly.

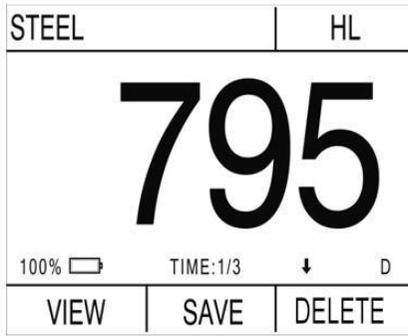


Figure 5.1

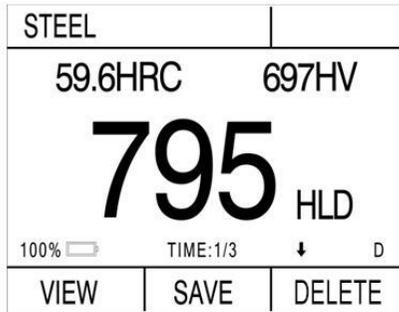


Figure 5.2

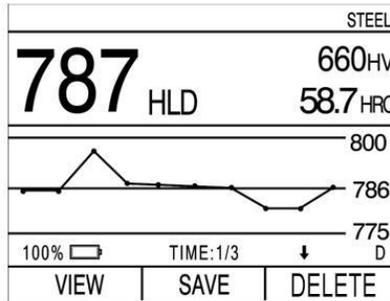


Figure 5.3

## 5.2 Keyboard

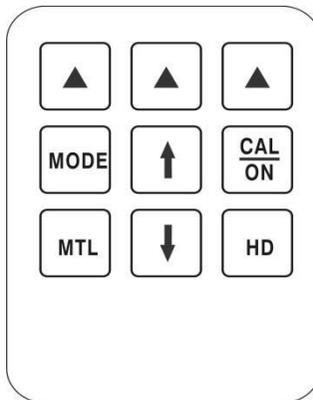


Figure 5.4

## 5.3 Turn on the Instrument

Press “on” to enter into the big font testing interface. It displays the default parameter for the very first start, and it displays the parameters automatically before power off for the next start.

## 5.4 Parameters Setting

Press “MODE” to enter into the parameter configuration interface, under which through pressing up and down arrow to move the cursor to the parameter item which needs to be changed. Press the first function button corresponding to the “SELECT” prompted on the screen to move the cursor to the parameter and press up and down button to adjust the parameters and then press return button.

### 5.4.1 File Number Setting

Under the specification configuration interface, adjust the file number as needed if possible. The instrument can save up to 200 files, in which each file can save 55 testing value groups, and each group includes 1-8 testing values and one average value. When the cursor displays the file number parameter item, press the second function button corresponding to the “OPEN” to open the current file and browse the stored data in the file.

CONFIGURATION	
FILE No.	001
MATERIAL	STEEL
HARDNESS	HL
IMPACT DIRECTION	↓
IMPACT TIMES	3
SELECT	OPEN

Figure 5.5

### 5.4.2 Testing Material Setting

Can be set both in the specification configuration interface, and in the testing interface by pressing "MATERIAL" button, see the following table:

Hardness	Tensile Strength
Steel and Cast Steel	C
GC. IRON	CrNi
NC. IRON	CrMo
C. ALUM	CrV
BRASS	CrMnSi
BRONZE	SSST
COPPER	SST
SST	CrNiMo
Forging Steel	Cr
Alloy tool steel	

Table 5.1

### 5.4.3 Hardness Scale Setting

Under the parameter configuration interface can adjust the hardness scales, and under the testing interface press "HD" button can also adjust the hardness scales. The Hardness Standard is as follows:

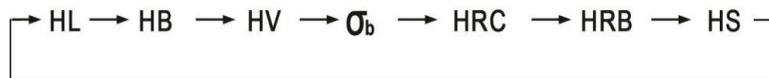


Figure 5.6

### 5.4.4 Impact Direction

Under the parameter configuration interface can adjust the impact direction.

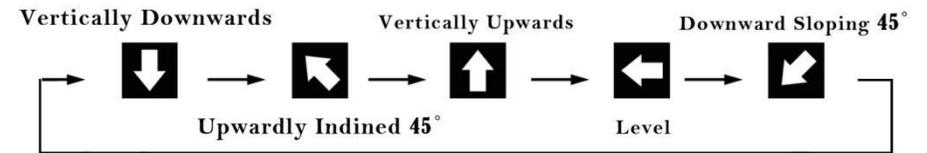


Figure 5.7

### 5.4.5 Impact Times

Under the parameter configuration interface can set the impact times, which is available from 1-8 times.

### 5.4.6 Set Upper Limit and Lower Limit Alarm

Under the parameter configuration interface can choose whether to use the this function. The default function of setting the upper limit and lower limit alarm is close, at this time the both upper limit and lower limit value is grey. Put the cursor on the upper and lower limit alarm, can turn on or off the function by press the third function button, according to the screen prompt. When the function starts, the color of the limit values is green, also at the right side displays the specific values of upper limit and lower limit. At this time press the "SELECT" corresponding to the first function button, the cursor displays on the values, through pressing the corresponding arrow to the third function button to adjust the digit (the unit, decade or hundreds), press up and down button to adjust the figure. After adjusting to the required value, press the first function button corresponding to the "RETURN" to complete the adjustment.

After setting up, when doing the testing under the testing interface, if the impact value is greater or smaller than the set one before, the impact value turns red. Under the curve interface, two straight lines and numerical value will be displayed to indicate the display position of the upper and lower limits. when the impact value is greater or smaller than upper or lower limit, the testing value is displayed in red, and the position of the point is also out of the upper and lower limits.

### 5.4.7 Impact Devices

Under the parameter configuration interface can set the type of the probes among D,C,G and DL.

### 5.4.8 Languages

Under the parameter configuration interface can interchange the languages among Chinese, English, Japanese, French and Italian.

### 5.4.9 Auto Power-Off Setting

Under the parameter configuration interface can set the standby time among 5 Min, 10 Min, 20 Min and automatic power off.

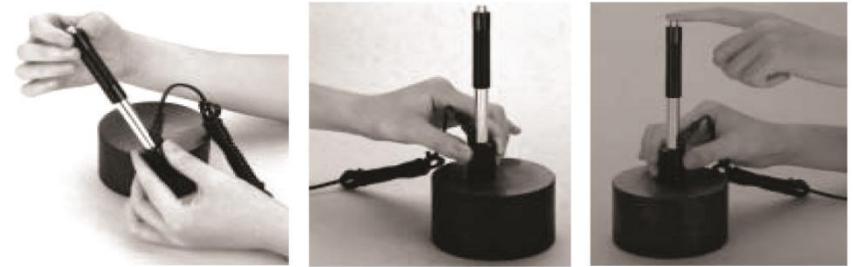
### 5.4.10 Delete All Files

Under the parameter configuration interface can choose delete all to delete the whole file that have saved.

## 5.5 Measuring

After finish the parameters setting, then start measuring:

- ◆ Load the impact body: Pushing the loading-tube until contact is felt. Then allow it to slowly return to the starting position locking the impact body. (see Figure 1)
- ◆ Fixed position: Press the impact device support ring firmly on the surface of the sample. (see Figure 2)
- ◆ Release the impact body: Press the release button on the upside of the impact device to test. The sample and the impact device as well as the operator are all required to be stable now. The impact direction should be vertical to the testing surface. (see Figure 3)



Figur(1)

Figur(2)

Figur(3)

## 5.6 Average Value

Normally, the measurements should be the average value of 3-5 times testing results. After setting the impact times, the impact times reach the setting value, the white font display the average value.

## 5.7 Delete the Gross Error Value Manually

Under the testing interface, it is regarded as the gross error value when the impact value is obvious much greater than the normal standard. By this time, press the "DEL" corresponding to the third function button to delete. Under the big font and multiple standard interface, press delete button can delete the gross error value in the present testing group. Under the curve interface, can delete all the testing points and the curve.

## 5.8 Data Saving and Read Setting

### 5.8.1 Storage Testing Result

Under the testing interface, press the save button, namely the "SAVE" corresponding to the second function button on the display, to start the save function and display the current stored file No. and the group No. in the. After start the function, it saves the impact value automatic, and press again to cancel the save function.

### 5.8.2 Reading

Long press the save button to turn on the reading mode (see Fig. 5.8) , by this time it displays the latest a group saved value and the Max. value, the Min. value and the Max. error.By pressing the up and down button to browse the all the saved values. Then press the return button to exit the reading mode.

F001-01		STEEL	
<b>781</b> <sub>HLD</sub>		654 <sub>HV</sub> 58.0 <sub>HRC</sub>	
Statistics	n	HLD	n HLD
MAX:784	1:	782	5: 782
MIN:780	2:	781	6: 780
R:4	3:	780	7: 784
N:8	4:	781	8: 784
DEL-FILE	DELETE		RETURN

Figure 5.9

### 5.8.3 Delete

Under the reading interface, press the "DEL" corresponding to the second function button to delete one group saved value. Or press the first function button corresponding to "DEL" to delete all the saved values in the current files.

### 5.8.4 Data Transmission

The data in stored can be transferred from the instrument to a PC via communication software, to save, statistic and analyze the measurement. (See the help documentation in communication software for details)

## 5.9 Calibration

After a long time of using, the test tip on the impact device will has abrasion, this will cause the measuring error, so we design a calibration procedure of using the standard testing block to calibrate.

After starting up, press CAL to enter the calibration mode, then impact the standard block with the impact device, measure 1-8 times selectable to get the average value, then press “up” and “down” button to adjust the

measured value to the standard value. By this time press the “CAL” corresponding to the first function button to finish the calibration. The instrument will save the calibrated data.Press the “ DELETE ” corresponding to the second function button to delete the current saved cal data, if the calibrated data to be deleted . Press "RETURN" corresponding to the third function button to exit the calibration mode.

CAL=100.0%		
████████████████████		
100%	TIME:1/3	↓ D
CAV	DELETE	RETURN

Figure 5.10

## 6.Maintenance & Servicing

### 6.1 Clean the Impact Device

After long time using, please use the cleaning brush to clean the tube and impact body.

- ◆ Unscrew the support ring , take out the impact body.
- ◆ Spiral the nylon brush in counter-clock direction into the bottom of the tube and pull it out, repeat many times.
- ◆ Install the impact body and support ring.
- ◆ Release the impact body after testing every times.

### 6.2 Servicing

LM500 Leeb hardness tester is a high-tech product, maintenance work should be operated by professionals, please do not operate by yourself.