



**GOPAL ELECTRONICS**

**EP-350**

Digital Epstein Tester

Operation Manual



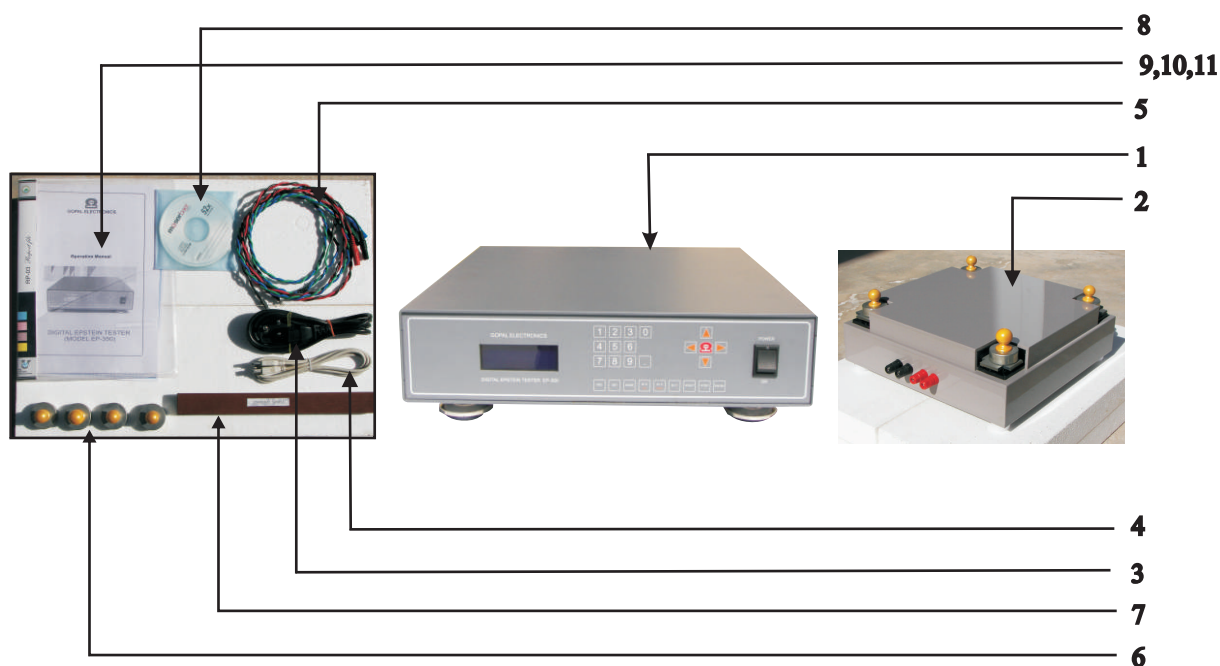
# TABLE OF CONTAIN

<b>Chapter 1. Unpacking your Epstein Tester carton .....</b>	<b>1</b>
<b>Chapter 2. Identification</b>	
2.1 Epstein Tester .....	2
2.2 Epstein Bridge .....	3
<b>Chapter 3. Introduction .....</b>	<b>4</b>
<b>Chapter 4. Technical data</b>	
4.1 Precaution .....	5
4.2 Block diagram of EP-350 .....	5
4.3 Connection diagram.....	6
4.4 Appendix A .....	6
4.5 Standard Equation .....	7
4.6 Specification of EP-350.....	8
<b>Chapter 5. Working</b>	
<b>5.1 Software</b>	
5.1.1 Software installation procedure .....	9
5.1.2 USB driver setting .....	10
5.1.3 Com port rename .....	10
5.1.4 Over view of software .....	11
5.1.5 Report creation .....	11
<b>5.2 Specimen insertion method .....</b>	<b>11</b>
<b>5.3 Different Modes</b>	
5.3.1 25cm Epstein mode .....	12
5.3.2 User mode .....	12
<b>5.4 Function of keys</b>	
5.4.1 ESC key .....	12
5.4.2 SET key .....	12
5.4.3 MODE key .....	12
5.4.4 B1.0 key .....	13
5.4.5 B1.5 key .....	13
5.4.6 B1.7 key .....	13
5.4.7 START key .....	13
5.4.8 STOP key .....	13
5.4.9 ENTER key .....	13
5.4.10 Numbering keys .....	13
<b>5.5 Step by step procedure</b>	
5.5.1 Without computer .....	13
5.5.2 With computer .....	14

**Congratulation and thanking you for purchasing Gopal make Digital Epstein Tester EP-350 the most advance tool for magnetic measurement. Please read manual throughly before operating instrument.**

## **1. UNPACKING YOUR EPSTEIN TESTER CARTON**

**While unpacking your Epstein Tester make sure that the carton contains following items: -**

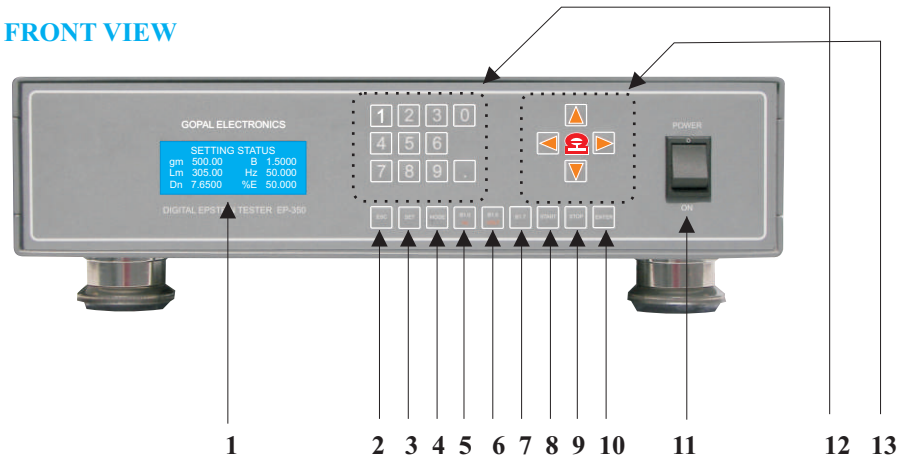


Sr. No.	Particulars	Quantity
1	Epstein Tester EP-350 main unit	1 No.
2	25 cm Epstein Bridge	1 No.
3	Mains cord	1 No.
4	USB cable	1 No.
5	Connection wires for Bridge	4 Nos.
6	Corner weights	4 Nos.
7	Bunch of standard test sample (Strips)	1 Set
8	Software CD	1 No.
9	Operation manual	1 No.
10	Calibration certificate	1 No.
11	Test report of standard sample	1 No.

## 2. IDENTIFICATION

### 2.1 Epstein Tester

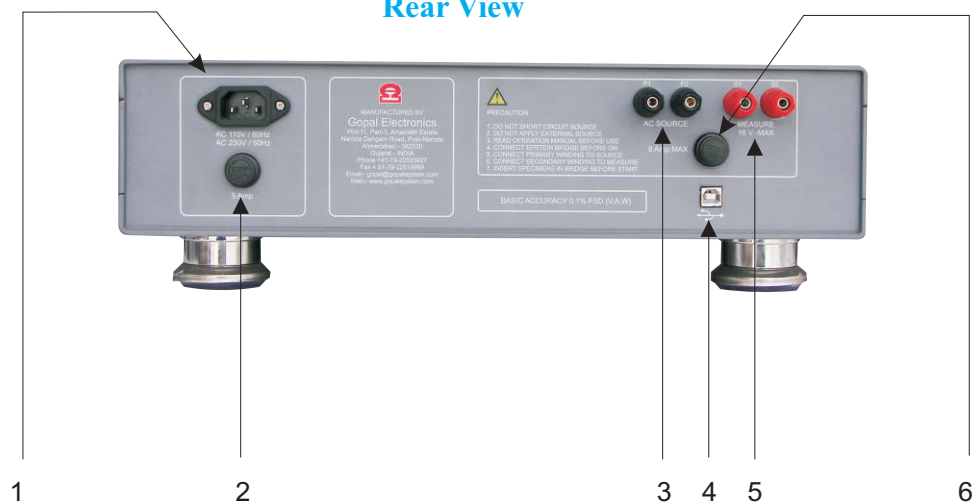
FRONT VIEW



- [1] LCD display
- [2] ESC Key
- [3] SET Key
- [4] MODE Key
- [5] B1.0 Key
- [6] B1.5 Key
- [7] B1.7 Key

- [8] START Key
- [9] STOP Key
- [10] ENTER Key
- [11] Power on/off switch
- [12] Input numbering keys
- [13] Up-down-shift keys

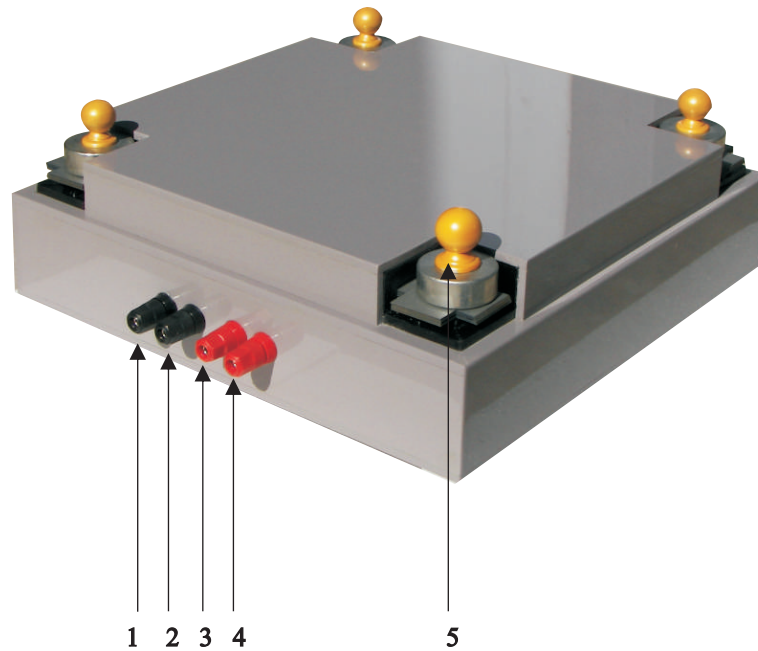
Rear View



- [1] Power Input Socket AC 230 Volt @ 50Hz
- [2] 5 Amp Fuse
- [3] Source output (always connect to primary)

- [4] USB port
- [5] Input of Voltage (always connect to secondary)
- [6] 8 Amp Fuse.

## 2.2 EPSTEIN BRIDGE



- [1.] Terminal of primary coil (Connect with AC Source terminal of main unit)
- [2.] Terminal of primary coil (Connect with AC Source terminal of main unit)
- [3.] Terminal of secondary coil (always connect to measure of main unit)
- [4.] Terminal of secondary coil (always connect to measure of main unit)
- [5.] Corner Weight

### Specifications:

- [1.] Number of primary turns = 700
- [2.] Number of secondary turns = 700
- [3.] Bobbin inside size = approximately 6 mm X 30 mm
- [4.] Specimen width = 30.0 mm
- [5.] Specimen length recommended = 305.0 mm
- [6.] Specimen length can be test = 280.0mm to 310.0mm

**Note: - Air flux compensator coil is mounted at the center of Bridge.**

### 3. INTRODUCTION

EP-350 is designed to achieve hassle free operation in single unit, for measurement of AC magnetic properties of flat rolled magnetic materials, at high frequency by using Wattmeter, Ammeter, Voltmeter and source. This test method is a fundamental method for evaluating the magnetic performance of flat-rolled magnetic materials in either as sheared or stress relief annealed condition. This test method is suitable for design, specification acceptance, service evaluation, and research and development.

EP-350 has digital controlled crystal accurate 16 Bit sine wave Generator, which provides 25 Hz to 450 Hz harmonics free non distorted power for testing of specimen. It has built in required (digital sampling) measuring meter, as Flux Voltmeter, RMS Voltmeter, RMS Ammeter, Peak Ammeter, Wattmeter and Power Factor meter. These measuring devices are (temperature proof) precisely calibrated to achieve high accuracy and long term stability. Accuracy and stability of EP-350 is better than specified in national and international standards. (Reference to ASTM: 343, IEC: 60404-2, BIS: 649)

USER FRIENDLY operation and multiple use of EP-350, make it world leader of magnetic measurement. It has two operation modes one is standard 25 cm Bridge mode and another is User Mode. User can test 30 mm wide and 305 mm long strips specimen in 25 cm Bridge mode. Convention method consist of individual mounting of source and measure so they do not link each other hence a qualified engineer is required to handle these devices, that for most of technical people think that Epstein Tester is too much complicated method to test Electrical steel sheet. EP-350 has been removed those types of complications, so only details of specimen like Weight, Length, Density, Frequency, % of eddy current and Induction has to be enter by simply using instrument keys. After proper feedings of required data, only press a Start Key and instrument shows Watt per kg, Watt per pound, AT/m, Magnetizing force and Permeability, without any calculation, all measured details to be displayed in LCD display.

EP-350 has USB PORT and software to connect with computer for performs very fast operation. Using computer with its Software, user can test a specimen with nine different Inductions in about five minutes. The software automatic communicate with EP-350 and set required Induction and get data, then collected data automatically transferred to MS-Excel and created Test Report, which comply international standards. Test report also plots various curve to analyze magnetic property.

USER MODE is provided for convenience for user, because "25 CM BRIDGE" MODE automatically perform required necessary function and calculation, hence user does not have any control on it to do some thing different, beyond theory of Epstein Test method.

FOR EXAMPLE user wants to test small Transformer, EI core, Toroid Core, Ring type core, and any different shape of core, then user mode provide facility to source and set required Voltage and Frequency within Instrument specifications, and simultaneously displays Flux Volt, RMS Volt, RMS Amp, Peak Amp, Watt and Power Factor so user can analyses by self, what is Iron Loss, AT/m, Magnetizing force and permeability. Normally this type of operation required technical person, to calculate various parameters, like core area effective weight, Flux Volt, Watt per kg etc.

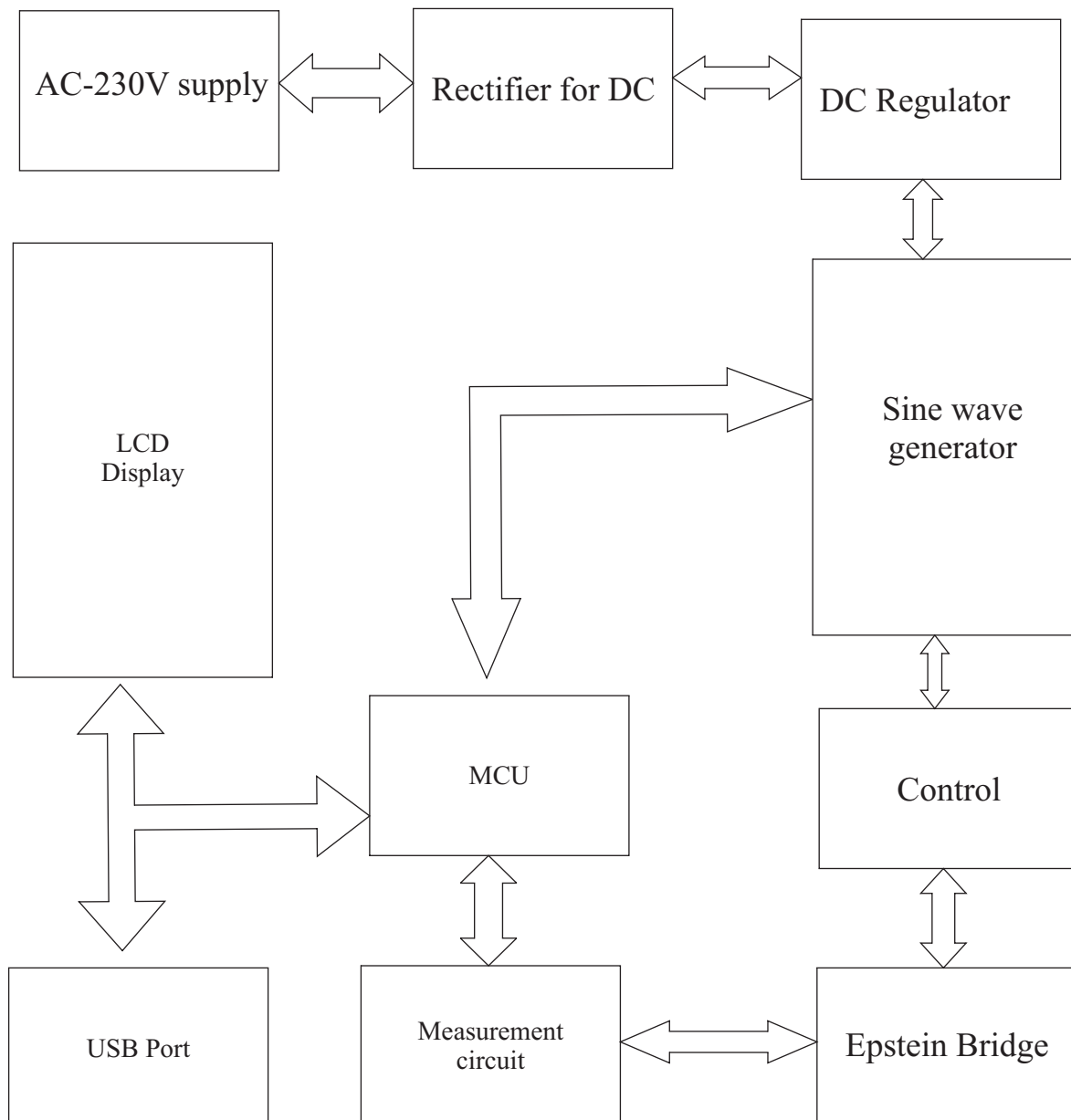
When you want to check calibration or Calibration Lab going to calibrate it, then user mode perform an excellent roll. Technician can connect a precision Power Analyzer in series of load and set source to compare and calibrate EP-350. That's why EP-350 is not only Epstein Tester but it is an extraordinary Testing and Measuring Instrument.

## 4. Technical Data

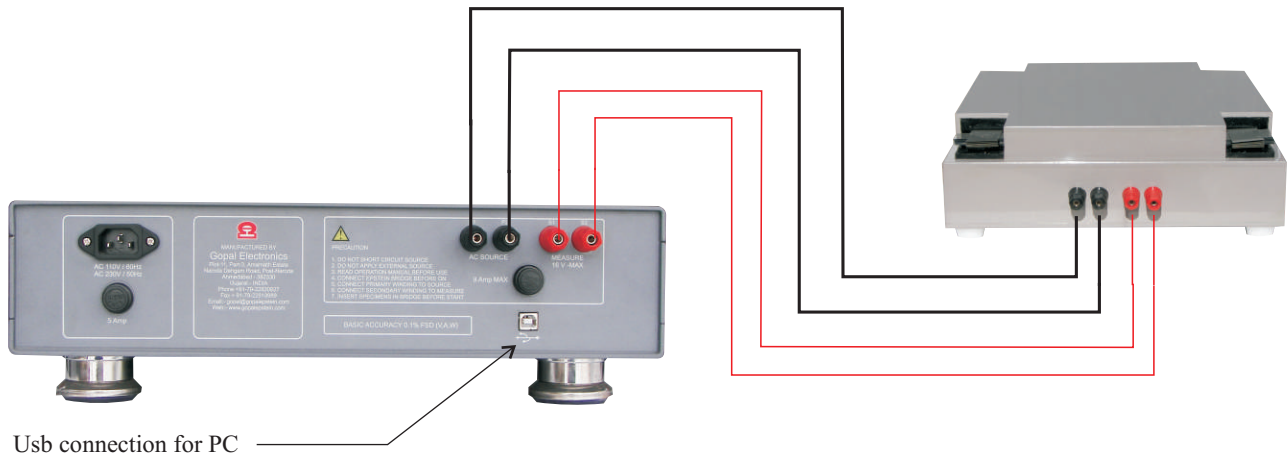
### 4.1 Precaution

- [1] Power supply voltage should be 230V @ 50Hz.  $\pm 20\%$
- [2] Never use high capacity fuse. ( Specified limit 5 Amp ).
- [3] Please do not turn On and Off instantly (Duration should be at least 1 minute). Otherwise It hang up the equipment.
- [4] Magnetic material should be keep away from the equipment.
- [5] It is recommended that the Equipment should be operated in Temperature  $27^{\circ}\text{C} \pm 5^{\circ}\text{C}$  & Humidity less than 70% to get accurate measurement.
- [6] Please do not open the instrument some critical components inside may be damage.

### 4.2 Block diagram of EP-350



### 4.3 Connection diagram



#### How to connect-

1. Kindly refer the above figure for proper connection.
2. Do not place the Epstein Bridge on the Equipment. This will effect on performance of the Equipment.
3. Kindly place the bridge as far as possible.
4. Use thick wire for primary connection and thin wire for secondary connection.

### 4.4 Appendix A

		Eddy-Current Loss (Typical)						
Material	Specimen	Assumed Eddy-Current Loss, percent (at 50 or 60 Hz), for Strip Thicknesses in. and [mm]						
		0.007 [0.18]	0.009 [0.23]	0.011 [0.27]	0.012 [0.30]	0.014 [0.35]	0.019 [0.47]	0.025 [0.64]
Nonoriented materials A	half and half	...	....	...	....	20	30	40
Nonoriented material A	Parallel	....	....	.....	...	25	35	45
Oriented material B	Parallel	35	45	50	55	...	....	.....



### 4.3 Standard Equation

#### Area Calculation:-

**Eq.1:-**  $A = m / (4 \times L \times ds)$

Where,

A = Cross sectional Area of test Specimen in  $m^2$   
m = mass in kg  
L = length in m  
ds = density of test specimen material in  $kg/m^3$

e.g.

m =  $401.6 \times 10^{-3}$  kg  
L =  $30.5 \times 10^{-2}$  m  
ds =  $7.75 \times 10^3$   $kg/m^3$   
A =  $0.4016 / (4 \times 0.305 \times 7750)$   
=  $0.4247 \times 10^{-4}$   $m^2$

#### Flux volt calculation:-

**Eq.2:-**  $Ef = 4.44 \times B_{max} \times A \times N \times f$

Where,

Bi = Max. intrinsic flux density, T  
A = Cross-sectional area,  $m^2$   
N = Number of turns in secondary winding  
f = Frequency, Hz

e.g.

Bi = 1.5 Tesla  
A =  $0.4247 \times 10^{-4}$   $m^2$   
N = 700  
f = 50 Hz  
Ef =  $4.44 \times 1.5 \times 0.4247 \times 10^{-4} \times 700 \times 50$   
= 9.899757 Volt

#### Effective mass calculation:-

**Eq.3:-**  $Ef.m = (m \times 0.94) / (L \times 4)$

Where,

L = Actual strip length in m  
m = Mass in kg  
Ef.m = Effective mass in kg

e.g.

m = 0.4016 kg  
L = 0.305 m  
Ef.m =  $(0.4016 \times 0.94) / (0.305 \times 4)$   
= 0.30942 Kg

#### watt / kg calculation:-

**Eq.4:-**  $Watt / kg = W / Ef.m$

e.g.

Ef.m = 0.30942 kg  
Watt/kg =  $W / Ef.m$   
=  $0.9999 / 0.30942$   
= 3.23152

For perfect calculation please follow  
IS:- 649 and ASTM- 343

#### VA/kg calculation:-

**Eq 5:-**  $VA / kg = (V \times I) / Ef.m$

Where,

V = Rms Voltage  
I = Rms Amp

e.g.

V = 7.92585846 V  
I = 0.151 A  
VA/kg =  $(V \times I) / Ef.m$   
=  $(7.92585846 \times 0.151) / 0.30942$   
= 3.86789

#### AC magnetizing force Hz in AT/m calculation:-

**Eq 6:-**  $H_z = (1.414213562 \times N \times I) / L$

Where,

$H_z$  = Magnetizing Force, AT/m.  
N = No. of turns in primary winding.  
I = Current through magnetized winding In Ampere  
 $L_1$  = Mean magnetic path length, mm.

e.g.

N = 700  
I = 0.151  
 $L_1$  = 0.94 m.  
Hz =  $(1.414213562 \times 700 \times 0.151) / 0.94$   
= 159.024

**Peak magnetizing force  $H_p$  in AT/m calculation:-**

**Eq 7:-  $H_p = (N \times I_p) / L_1$**

Where,

$H_p$  = Peak magnetizing force.

$I_p$  = Peak exciting current , Amp.

$L_1$  = mean magnetic path length ,mm.

e.g.

$I_p = 0.196$

$H_p = (700 \times 0.196) / 0.94$   
 $= 145.957$

**AC (Relative) Permeability  $U_a$  H/m calculation:-**

**Eq 8:-  $U_a = B / (H_z \times U_0)$  H/m**

Where,

$U_a$  = AC Permeability in H/m.

$B$  = Maximum intrinsic flux density, Tesla.

$H_z$  = AC magnetizing force AT/m

$U_0$  = Permeability of Air in H/m.

e.g.

$B = 1$

$U_a = B / (H_z \times 4 \times 3.14 \times 0.0000001)$   
 $= B / (H_z \times 12.5663706 \times 0.0000001)$   
 $= 5004.12 \text{ H/m}$

**Peak (Relative) Permeability  $U_p$  calculation:-**

**Eq 9:-  $U_p = B / (H_p \times U_0)$**

Where,

$U_p$  = Peak permeability in H/m.

$B$  = Maximum intrinsic flux density, T.

$H_p$  = Peak magnetizing force in AT/m

e.g.

$B = 1$

$U_p = B / (145.957 \times 12.5663706 \times 0.0000001)$   
 $= 5452.1 \text{ H/m}$

**Form Factor K calculation:-**

**Eq 10:-  $K = (RMS V / FV) \times 1.11072$**

e.g.

$RMSV = 7.92585846$

$FV = 7.92586$

$K = (RMS V / F.V) \times 1.11072$   
 $= (7.92585846 / 7.92586) \times 1.11072$   
 $= 1.110719$

**4.4 Specification of EP-350**

1. Sine wave Generator	= 25 to 450 Hz
2. Accuracy of frequency	= 0.03% which instrument can set
3. Source capacity	= 11.2 Amp Peak
4. Source max. Voltage	= 16.0 Volt RMS
5. Distortion of Sine wave	= 0.025%
6. Protection (Auto)Source	= Greater than 8.0 Amp RMS + Fuse
7. Protection of power input	= Fuse
8. Input voltage	= 230V @ 50 Hz $\pm$ 20%
9. Operation temperature	= 20° to 45° Celsius
10. Operation humidity	= Less than 70%
11. Dimensions	= Wide=425mm Depth =557mm Height =100 mm +Leag
12. Weight	= 14.5 Kg
13. Accuracy of Voltmeter	= 0.1% FSD True RSM Volt
14. Accuracy of Flux meter	= 0.2% FSD Rectified mean Volt
14. Accuracy of Ammeter	= 0.1% FSD True RMS
15. Accuracy of Peak Ammeter	= 0.2% FSD
16. Accuracy of Power meter	= 0.1% FSD From 0.15PF to 1.00PF
17. Accuracy of PF meter	= 0.2% From 0.15PF to 1.00PF

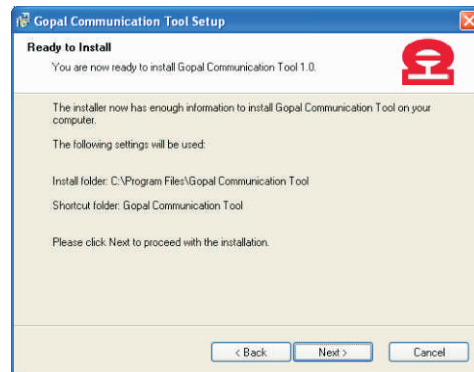
## 5. Working

### 5.1.1 Software installation procedure

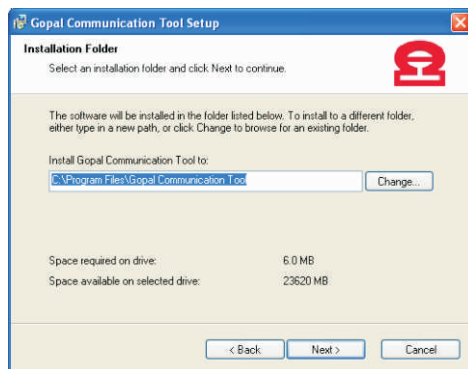
[1] Insert software CD in CD drive. Wait until the following screen appear. and click on next button



[5] Press next button in following screen.



[2] Again press next button in following screen.

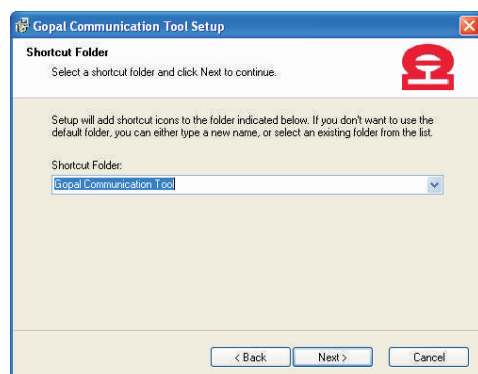


[6] Now the installation procedure is completed and a shortcut icon of Gopal Communication Tool is created on desktop.

[7] Pin no should be enter when the software going to be run first time.

Pin no = 700

[3] Again press next button in following screen.



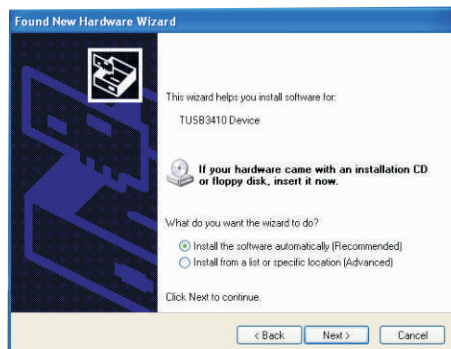
## 5.1.2 USB driver setting

[1] While installing USB driver instrument should be turn off and USB cable should be connected

[2] Keep software CD in CD drive and, following screen will be appear, select “yes, this time only” option and then click on next button.



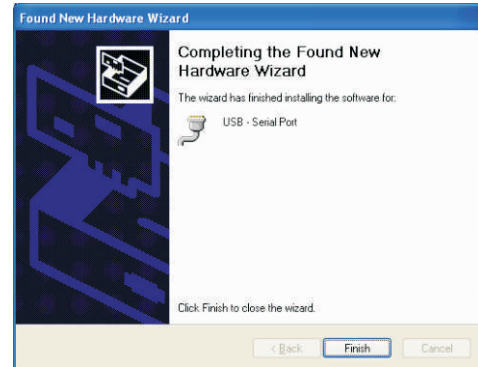
[3] Then select first option “install the software automatically (recommended)” option and then click on next button as shown in following screen.



[4] Now following screen will appear. Press “Continue Anyway” button.



[6] Now finish your driver setting process by pressing “Finish” button



## 5.1.3 Com port rename

[1] Open the control panel of your operating system

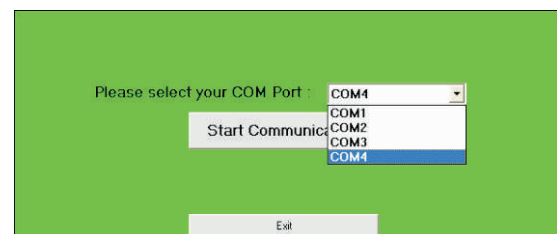
[2] Please go through the following path

system/hardware/device manage/  
ports(SOM & LPT)/ USB serial port (com)/  
port setting/ advanced/ com port number

[3] Now select any one com port number between COM1 to COM4 which is usable.

[4] If COM1 to COM4 currently in use then first rename any one of them.

[5] Then select that one com port in the software and press “start communication” button as shown in following figure.



[6] Now software automatic detect the instrument.

### 5.1.4 over view of software:-

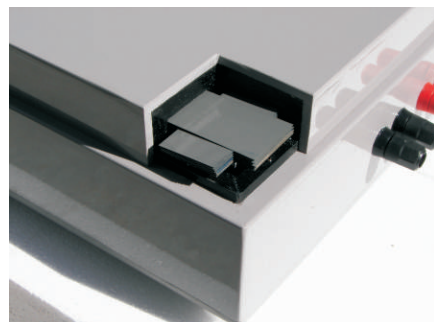
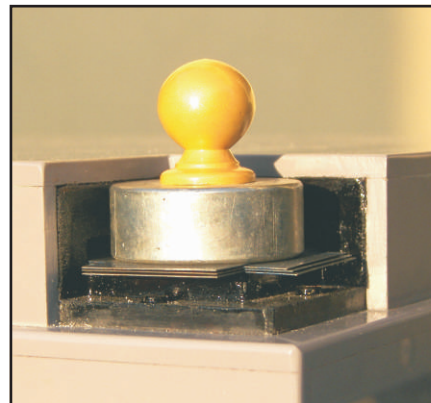
- [1] EP-350 is capable to communicate with PC by USB cable and for that a software “Gopal Communication Tool” is provided which is based on Gopal protocol.
- [2] Quite an easy and detailed measurement can perform by using this software. AUTO key has a great function after filling up the necessary data in software and it takes the reading automatically. Then press REPORT key in the software and it create a report in Ms Excel sheet. Then user can print and save it.

### 5.1.5 Creating Report using software:-

- [1] By clicking report button Report Sheet will appear.
- [2] The report and all graphs will found in MS-Excel File.
- [3] There are eight sheets in Report File.
  - (1) Input:- Test detail Sheet: Enter appropriate value of %eddy current in appropriate place.
  - (2) Report:- Test Report Sheet:- You will have result of testing in this Sheet.
  - (3) B-W :- Graph of Iron Loss(W/kg or W/Lb) Vs Flux density(T or G).
  - (4) B-VA:- Graph of Iron Loss(VA/kg or VA/Lb) Vs Flux density(T or G).
  - (5) B-H-rms:- Graph of AC magnetizing force (AT/m or Oe) Vs Flux density(T or G).
  - (6) B-H-peak:-Graph of Peak magnetizing force(AT/m or Oe)Vs Flux density(T or G).
  - (7) B-AC-V:- Graph of AC Permeability Vs Flux density(T or G).
  - (8) B-peak-V:- Graph of Peak Permeability Vs Flux density(T or G).
- [4] You can save and print it.

## 5.2 Specimen insertion method

- [1] Specimen should be cut in the following dimention  
30 x 305mm long
- [2] 250 to 500 gram of samples is required
- [3] Divide the test specimen strips into four groups containing equal numbers of strips, and very closely the same mass, for testing.
- [4] Insert the strips (always a multiple of four in number) into the test frame solenoids one at a time, starting with one strip in each of two opposite solenoids and then inserting a strip into each of the other two solenoids so that these latter strips completely overlap the former two at the four corners. This completes one layer of strips constituting a complete flux path with four overlapped joints. Build up successive layers in this same fashion until the specimen is completely assembled.
- [5] Put the corner weight on corner as shown in figure.



## 5.3 Different Modes

Two operating modes are provided in EP-350 to achieve maximum utility.

### [1] 25 cm EPSTEIN MODE

In this mode you just have to enter the input values. Remaining all kinds of calculation will be done by the instrument and user can test samples with and without computer.

### [2] USER MODE

USER MODE is provided to measure voltage, current, power, power factor, Peak ampere of your desired test. The B1.0 & B1.5 keys are used to set frequency and voltage respectively in this mode.

## 5.4 Function of Keys

### 5.4.1 ESC key:-

User will return to 'SETTING STATUS' page when he press ESC key. It is a default page.

gm = Weight of strips in gram

Lm = length of strips in mm

Dn = Specific Density of sample gram per centimeter<sup>3</sup>

B = Flux density

Hz = frequency

%E = % of eddy current

Fig-1

SETTING STATUS			
gm	500.00	B	1.5000
Lm	305.00	Hz	50.000
Dn	7.6500	%E	50.000

When pressing the ESC key the display will appear as same as the above

### 5.4.2 SET key:-

To enter the input values like weight, induction, length, frequency, density, % of eddy current etc. one by one by using up down Arrow keys.

Procedure to Enter the data :-

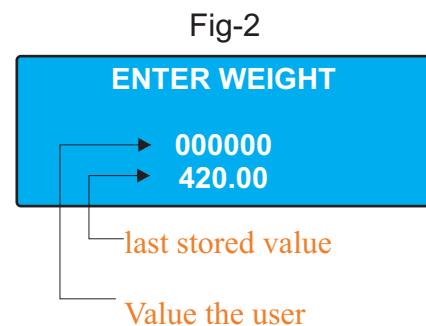
When user press SET key, firstly the display will be seen as shown in figure-2 and user have to enter weight in gram, induction, length in mm, density, % of eddy loss respectively by using numbering keyboard and then press ENTER Switch.

At last the display will appear "SAVE PARAMETERS" then also press ENTER key to save the all values permanently in memory, if user press ESC key than data will save for temporary.

**Note :-** It is recommended to avoid unnecessary save in memory.

### 5.4.3 Mode key :-

Mode key is used to change the operation mode. Press mode key again and again to scroll the mode and then press Enter key to select the mode.



When pressing the SET key the display will appear firstly as same as the above



- 5.4.4 B1.0 key** :- User can directly set flux density 1.0 Tesla by simply pressing this key in “25 cm Epstein MODE”. And in “USER MODE” this key is used to set frequency.
- 5.4.5 B1.5 key** :- User can directly set flux density 1.5 Tesla by simply pressing this key in “25 cm Epstein MODE”. And in “USER MODE” this key is used to set flux voltage.
- 5.4.6 B1.7 key** :- User can directly set flux density 1.7 Tesla by simply pressing this key in “25 cm Epstein MODE”.
- 5.4.7 START key** :- To start the source and measurement in both mode.
- 5.4.8 STOP key** :- To stop the source and measurement in both mode.
- 5.4.9 ENTER key** :- To save and set the value of input parameters.
- 5.4.10 Numbering keys** :- 0 to 9 numbering keys are provided to enter input data.

## 5.5 Step by step procedure

### 5.5.1 Without computer

- Step1: Cut the strips in the size of 30 x 305mm and weigh it.
- Step2: Measure thickness of strip and note down, it will use to know % of eddy current.
- Step3: if you not aware about the density then enter 7.65 for CRGO and 7.75 for other material.
- Step4: Insert test strips into the Bridge as instructed in topic 5.2.
- Step5: Put corner weight on the Bridge at corner.
- Step6: Make connections of the Bridge with the Equipment.
- Step7: After connecting EP-350 as instructed, Please recheck the connections.
- Step8: Connect Mains Cord to it's socket and turn ON the power switch.
- Step9: Please warm up the instrument at least 30 minutes first for specific accuracy.
- Step10: After starting messages, user can see the SETTING STATUS page.
- Step11: Press SET key for feeding data the first message will be ENTER WEIGHT on display, then you have to enter weight of total strips by using numbering keyboard and then press ENTER Switch.
- Step12: Then you have to enter induction, length in mm, frequency, density,% of eddy loss respectively by using numbering keyboard and then press ENTER Switch.
- Step13: At last the display will appear “SAVE PARAMETERS” then also press ENTER key to save the data permanently ,if you press ESC key than the data will save temporary.
- Step14: Then press START key and wait for result.
- Step15: Take the reading when the instrument complete its process and display automatically appear “FINISH” in place of “PLEASE WAIT”.

### 5.5.2 With computer

- Step1: It is assumed that the software and USB driver are installed properly on your computer. (Refer topic 5.1.1 and 5.1.2)
- Step2: Make connections of the Bridge with the Equipment. (Refer topic 4.2)
- Step3: Connect Mains Cord to it's socket and turn ON the power switch.
- Step4: Connect your computer to the Equipment by USB interface wire.
- Step5: After connecting EP-350 Exactly as instructed, Please recheck all connections.
- Step6: Cut the strips in the size of 30 x 305 mm and weigh it.
- Step7: Measure thickness of strip and note down, it will use to know % of eddy current.
- Step8: Insert test strips into the Bridge as instructed in topic 5.2.
- Step9: Put corner weight on the Bridge at corner.
- Step10: if you not aware about the density then enter 7.65 for CRGO and 7.75 for other material.
- Step11: Please warm up the instrument at least 30 minutes first for specific accuracy.
- Step14: Open software(Gopal Communication Tool) in PC and select proper communication port No. 1 to 4.
- Step15: Then click start communication button, If your selected port no. is invalid, then you have to rename com port setting.
- Step16: You can rename the com port as instructed in topic 5.1.2.
- Step17: Select unit for measurement from UNIT menu in software you can test in both system of units SI and CGS(Customary Unit) by selecting option in UNIT menu in software.
- Step18: Now fill up the necessary data(Weight in grams, Density in  $\text{g/cm}^3$ , Length of strip in mm and Frequency in Hz) in it's appropriate place. Frequency can not be set by the software so user have to set in the equipment. So, required flux voltage according to appropriate induction will be calculated and user will seen them on the screen of Monitor.
- Step19: You can also change Induction as per your requirement. Related Flux Voltage will be automatically calculated by software. Never enter invalid value in Flux Volt column.
- Step20: Press Auto Switch in the software.
- Step21: The software will automatically take the readings from main unit.
- Step22: Then press the Report button to create the report in Ms excel sheet.
- Step23: User can save and print the created report sheet.





**Manufactured By: -**

**Gopal Electronics**

Plot No. 11, Part 3, Amarnath Estate,  
Naroda-Dehgam Road, Post - Naroda,  
Ahmedabad - 382 330  
Gujarat - INDIA.

Ph: + 91 - 79 - 22820927

Fx: + 91 - 79 - 22819989

Email: [gopal@gopalepstein.com](mailto:gopal@gopalepstein.com)

Web : [www.gopalepstein.com](http://www.gopalepstein.com)