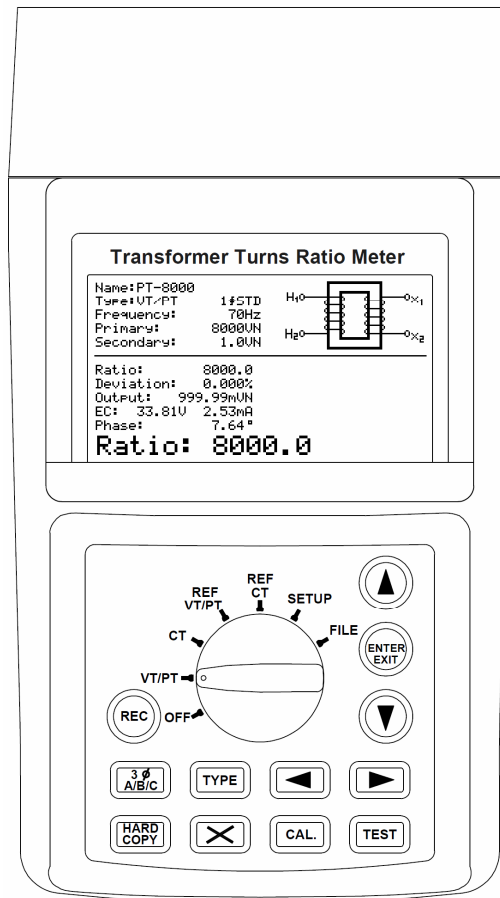


PROVA 1660

Transformer Turns Ratio Meter

Users Manual



April 2015

Version: 201500416

Specifications are subject to change without notice.

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PROVA INSTRUMENTS INC.

This unit passes the following tests:



EN 61010-1: 2010
EN 61010-2-030: 2010
CAT IV 50V
Pollution Degree 2



EN 61326-1: 2013
(CISPR 11: 2009+A1: 2010 Group 1 Class B,
EN 61326-1: 2013, IEC 61000-4-2: 2008,
IEC 61000-4-3: 2006+A1:2007+A2:2010,
IEC 61000-4-8: 2009)

Safety Symbols



WARNING

Please read the statement thoroughly to prevent injury or loss of life, and prevent damage to this product.



Earth (ground)



DC (Direct Current)



Conforms to relevant European Union directives.



Do not dispose of this instrument as unsorted municipal waste. Contact a qualified recycler for disposal.

Caution:

1. The ventilation openings on the unit should not be blocked.
2. Please pay attention to polarity of DC input, follow the polarity info by the input jack.



Caution, Risk of Electric Shock.



Please remove all the test leads before performing maintenance, cleaning, battery replacement, fuse replacement, etc.



Do Not plug in the AC adapter when the ambient temperature exceeds 45°C / 113°F.



Do Not charge the lithium battery when the ambient temperature exceeds 45°C / 113°F.

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I. Preparation

(In this manual the Transformer Turns Ratio Meter will be hereafter referred to as **METER**.)

This METER uses a rechargeable lithium battery.

The rechargeable lithium battery is pre-installed in the METER at the factory.

Before using the new rechargeable lithium battery, please charge it for 10~12 hours continuously for better battery life.

Users can plug in the AC power adaptor and no need to turn on the METER. Then the rechargeable lithium battery is charged automatically.

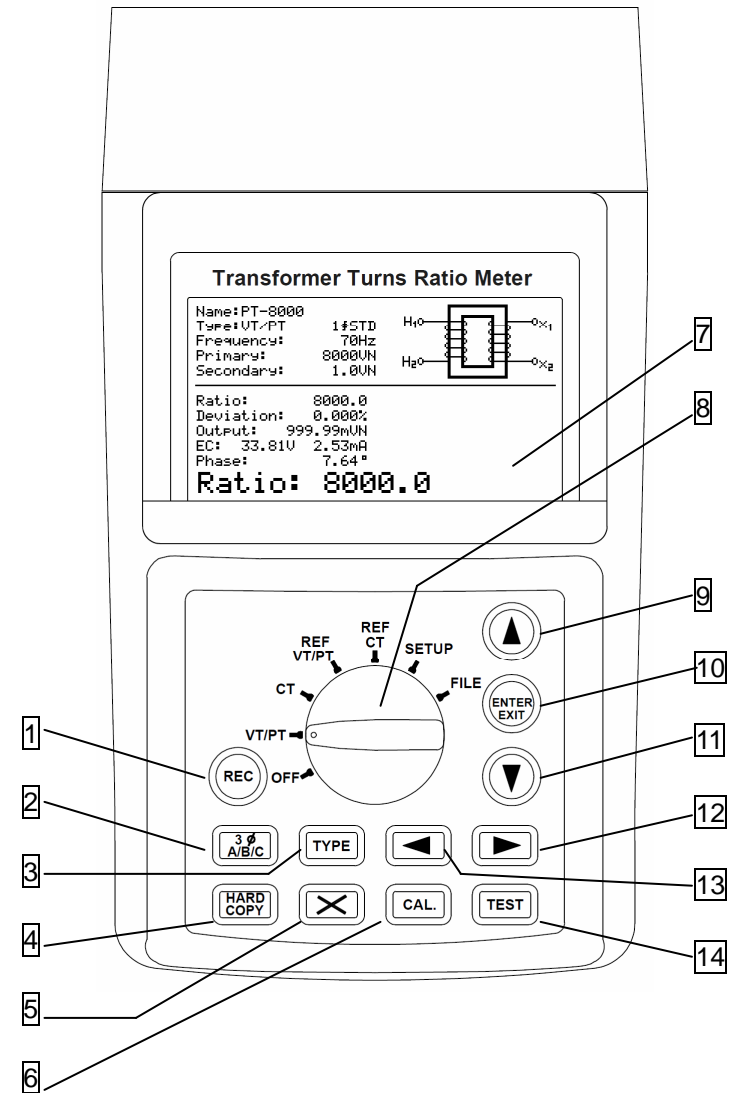
II. Features

- Measurements of 1 Φ and 3 Φ **Transformer/VT/CT Turns Ratio**.
- VT/PT ratio **0.8~10000**, CT ratio **0.8~2000**.
- **Graphical and Literal Illustration** of Measurements and Connections with Large Back-lighted Dot Matrix 240 x 128 LCD. Display Test Data with Nameplate Transformer Values for Easy Interpretation.
- **Ten Test Frequencies** (50~400Hz).
- Display **Turns Ratio, Deviation, Secondary Output, Excitation Voltage and Current, Phase Angle and Nameplate Transformer/VT/CT Values** in one page for easy transformer quality interpretation.
- Check for **Live Test Points, Short Circuit, Open Circuit, and Reverse Polarity** before Each Measurement.
Message is displayed to Warn Users (But, checking is not performed once measurement starts).
- **Store 4096 Files** of Transformer Nameplate Values (VT/PT/CT, 1 Φ /3 Φ , Test Frequency, Primary and Secondary Voltages or Ratio, RCF) and Measuring Data.
- **9 types of 3 Φ Windings** Connections pre-installed for easy user selection.
- **Wireless Blue Tooth** Communication with PC.
- **Select Filter** to Remove Field Noise (Slow, Normal, Fast).
- Disable or Enable **Auto-Power-Off** with Programmable Time.
- Built-in calendar clock.
Records with Date and Time Stamp.

- Powerful **Lithium Battery** (3400mAH) with built-in Charging Circuit.
- **User Programmable RCF** (Reference Correction Factor, 0.99~1.01) to Correct Accuracy within 1% Error.
- Friendly **File System** for Easy On-site Data Retrieval and Nameplate Values Management.
- PC Application **Software** included.

III. Panel Description

A. Front Panel



1.  **REC button**

- (1) After finishing measurements, press this button to record measurement data.
- (2) How to clear recorded data: keep pressing REC button and turn on the METER, then all the data recorded in the METER will be completely deleted. And the factory defaults will be restored.

2.  **3Φ A/B/C button**

When measuring 3-phase transformer, press this button to switch among A phase, B phase and C phase.

3.  **TYPE button**

In **REF VT/PT** range, press this button to select the type of Transformer winding connection. In **FILE** range, press this button to switch the display among VTM, CTM, VTR, CTR, BMP.

4.  **HARD COPY button**

Press this button to save the current LCD screen as a BMP file.

5.  **Delete button**

(In **FILE** range) Press this button to delete one selected file data.

6.  **Phase Angle Calibration button**

In **VT/PT** or **CT** range, connect YELLOW testing clip with RED one, connect BLUE testing clip with BLACK one. Then press this button to perform Phase Angle calibration. Performing Phase Angle calibration regularly can help the METER maintain accuracy.

7. **LCD**

LCD can display measurement values, parameters setting up (SETUP), File List, etc.

8. **Switch**

Users can turn this switch to select one of the following ranges: OFF, VT/PT, CT, REF VT/PT, REF CT, SETUP, FILE.

9.  **button**

In **REF VT/PT**, **REF CT**, **SETUP** range or **File List**, press this button to select last item or last file.

10.  **ENTER EXIT button**

In **REF VT/PT** or **REF CT** range: for **Name** item – press this button to display or conceal the SOFTWARE KEYBOARD (which can be used to type in characters). In **File List**, press this button to select or exit a file.

11.  **button**

In **REF VT/PT, REF CT, SETUP** range or **File List**, press this button to select next item or next file.

12.  button

In **REF VT/PT, REF CT, SETUP** range or **File List**, press this button to increment value by 1 or display the file of next page. Or keep pressing this button for 2 sec. to quickly increment values.

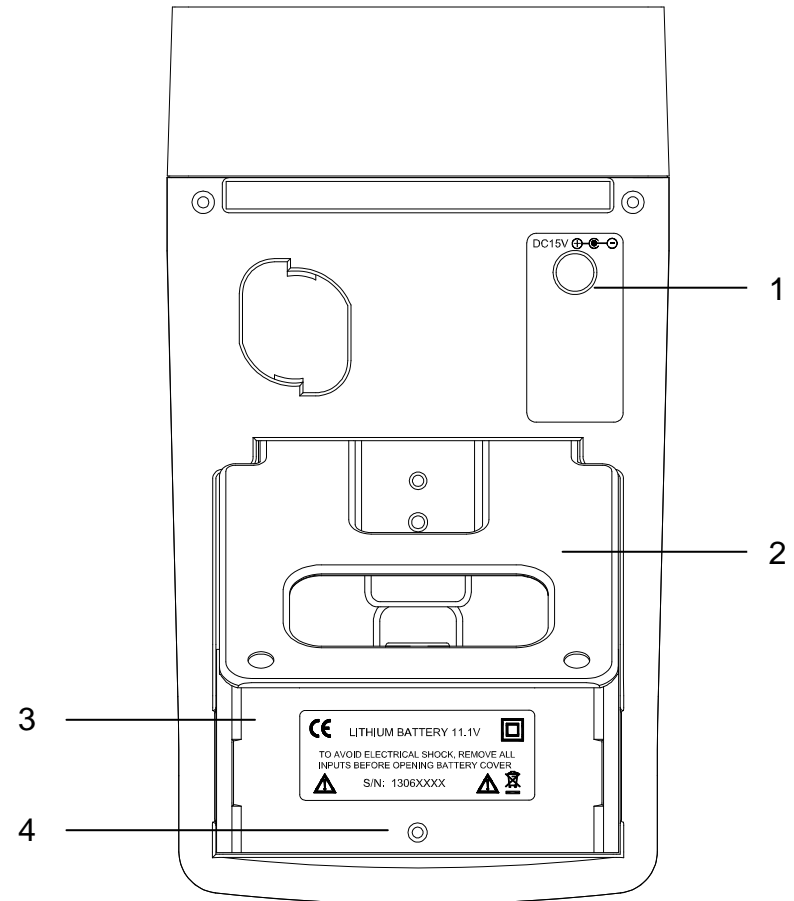
13.  button

In **REF VT/PT, REF CT, SETUP** range or **File List**, press this button to decrement value by 1 or display the file of previous page. Or keep pressing this button for 2 sec. to quickly decrement values.

14.  **TEST button**

Press this button to start measuring Transformer/VT/CT Turns Ratio.

B. Rear Panel



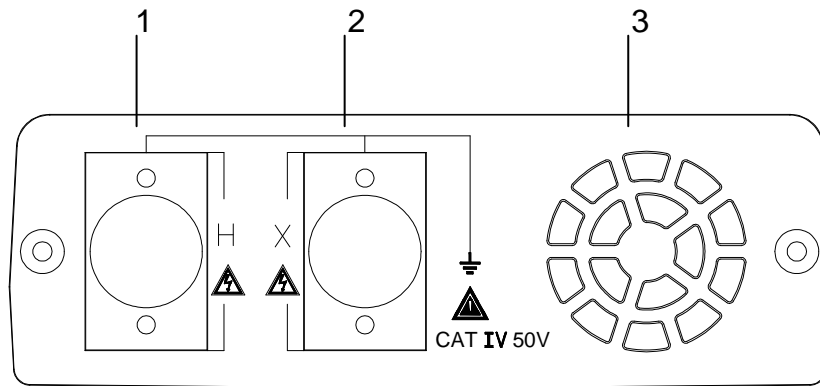
1. AC to DC power adaptor input.

2. Stand

3. Battery cover

4. Screw of battery cover

C. Top Panel



1. (Primary) Terminals for Testing leads with RED/BLACK clips.
2. (Secondary) Terminals for Testing leads with YELLOW/BLUE clips.
3. Ventilation openings.

IV. Operation



Warning: This METER is for measuring “de-energized Transformer” ONLY. Make sure the object for measurement is completely separated from any voltage and is fully discharged.



Warning: The AC power adaptor is for lithium battery recharging only. When users operate the METER please always use the lithium battery as power source (and do not use the AC power adaptor as power source).



Warning: Never use any tool to touch the parts inside through the ventilation openings to prevent from Electric shock or damaging the METER.



Warning: When users operate the METER please always use the lithium battery as power source - and during operation DO NOT plug in the AC power adaptor - otherwise the power source will be interrupted and the data will disappear.



Note: This METER is for measuring “step-down transformer”. As for measuring “step-up transformer” users just need to exchange the Primary and Secondary testing leads.



Note: When the power source is AC power adaptor and users can not turn on the METER correctly:
 (1) please turn off the METER and then turn it on again;
 (2) or remove the AC power adaptor and then turn on the METER again.



Note: when press any button users will hear a sound of buzzer; when press any button for over 2 sec. users will hear another sound of buzzer.

A. Graphical Illustration of Winding Connection

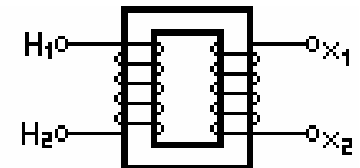
1. Connect the RED/BLACK testing leads with the “H” Terminals on METER Top panel.
2. Connect the YELLOW/BLUE testing leads with the “X” Terminals on METER Top panel.
3. Connect windings according to the graphical illustration displayed on METER LCD.

When measuring **Transformer:**

please follow below LCD display to

- (1) connect RED/BLACK testing leads with the Primary of Transformer;
- (2) connect YELLOW/BLUE testing leads with the Secondary of Transformer.

```
Name:PT_DEFAULT  [BB]BT
Type:UT/PT      1φSTD
Frequency:      70Hz
Primary:       7200VN
Secondary:    120VN
```



```
Ratio:
Deviation:
Output:
EC:
Phase:
```

```
H RED →H1 X YELLOW→X1
H BLACK→H2 X BLUE →X2
```

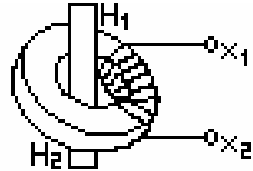
Graphical Illustration of Winding Connection for Transformer

When measuring **CT**:

please follow below LCD display to

- (1) connect YELLOW/BLUE testing leads with the Primary of CT;
- (2) connect RED/BLACK testing leads with the Secondary of CT.

```
Name: CT_DEFAULT 100BT
Type: CT
Frequency: 70Hz
Primary: 3000 A
Secondary: 5.0 A
```



```
Ratio:
Deviation:
Output:
EC:
Phase:
```

```
H RED →X1 X YELLOW→H1
H BLACK→X2 X BLUE →H2
```

Graphical Illustration of Winding Connection for CT

B. Transformer/VT Measurement

1. Turn the switch to FILE. In VTM File List select one proper file as the Reference.
2. Turn the switch to VT/PT. Connect the test leads to the voltage transformer (VT) according to LCD graphical illustration.
3. Press **TEST** button to start measuring. After the measurement is finished, the result will be displayed as Fig. 1 and 2.
4. For 3-phase transformer: after measuring A-phase, press **3Φ A/B/C** (**3Φ**

A/B/C) to switch to B-phase, then press **TEST** (**TEST**) to start measuring B-phase; and C-phase measurement can be done in the same manner.

5. The measurement result displayed on METER LCD:


Ratio: Turns Ratio of Primary and Secondary

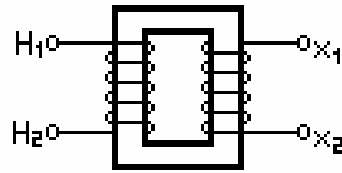
Deviation: The error (in %) between the Ratio and the Reference Ratio

Output: Secondary Turns Ratio or Voltage

EC: Excitation Voltage and Current

Phase: Phase Angle of Primary and Secondary


Name: UT-8000 
 Type: UT/PT 1 Φ STD
 Frequency: 70Hz
 Primary: 8000UN
 Secondary: 1.0UN

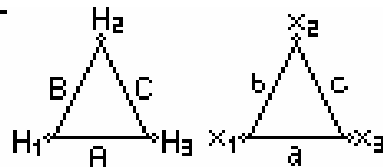


Ratio: 8000.0
 Deviation: 0.000%
 Output: 999.99mUN
 EC: 33.81V 2.53mA
 Phase: 1.22°

Ratio: 8000.0

(Figure 1: Measurement result for 1 Φ Transformer)

Name: PT-8000 
 Type: UT/PT STD 3 Φ Δ - Δ
 Frequency: 70Hz
 Primary: 8000UN
 Secondary: 1.0UN



Ratio: 8000.0	8000.0	8000.0
Deviation: 0.000%	0.000%	0.000%
Output: 999.99mUN	999.99mUN	999.99mUN
EC: 33.81V 2.53mA	2.53mA	2.53mA
Phase: 1.22°	1.22°	1.22°


Ratio: 8000.0


(Figure 2: Measurement result for 3 Φ Transformer)

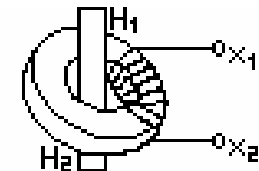
Note:

1. If Ratio value is with "*" mark, it means this measurement result is corrected by RCF (Reference Correction Factor), i.e. RCF \neq 1.
2. If Phase value is displayed in reverse video, it means wrong polarity, i.e. Primary and Secondary polarities are in reverse.

C. CT Measurement

1. Turn the switch to FILE. In CTM File List select one proper file as the Reference.
2. Turn the switch to CT. Connect the test leads to the current transformer (CT) according to LCD graphical illustration.
3. Press  (TEST) button to start measuring. After the measurement is finished, the result will be displayed as Fig. 3.
4. For nomenclature, please refer to the chapter of **Transformer/VT Measurement**.

Name: CT-25 
 Type: CT
 Frequency: 70Hz
 Primary: 125 A
 Secondary: 5.0 A



Ratio: 24.962
 Deviation: -0.148%
 Output: 5.0074 A
 EC: 1.43V 0.63mA
 Phase: 0.74°

Ratio: 24.962


(Figure 3: Measurement result for CT)

Note:






1. If Ratio value is with "*" mark, it means this measurement result is corrected by RCF (Reference Correction Factor), i.e. RCF \neq 1.
2. If Phase value is displayed in reverse video, it means wrong polarity, i.e. Primary and Secondary polarities are in reverse.

D. File List

1. Turn the switch to FILE. VTM File List will be displayed as Fig. 4.
2. In the VTM File List users will see file name, file type, file date, and file time.
3. In FILE range, there are 5 file Types: VTM, CTM, VTR, CTR, BMP.

Users can press  (**TYPE**) button to switch among these 5 file types.

4. "VTM" is a VT/PT reference file.
"CTM" is a CT reference file.
"VTR" is a VT/PT measurement data file.
"CTR" is a CT measurement data file.
"BMP" is a LCD screen HARD COPY file.
5. "VTM" or "CTM" file with "*" mark: it means this is the reference file being used by the ANALYZER at the moment.

6. Users can press  or  button to select a file. The selected file will be displayed in reverse video. Press  (delete) button to remove a selected file. Press  or  button to display files of previous page or next page.
7. Press **ENTER EXIT** button to open the data in a file. Open a "VTM" or "CTM" file means it is being set up as the current reference file. Open a "VTR" file to display a VT/PT measurement data file. Open a "CTR" file to display a CT measurement data file. Open a "BMP" file to display

the previous LCD screen. Press **ENTER EXIT** button again to exit the current screen.

```

VTM File List  █64█BT 13/4083
PT_DEFAULT    UTM  2014/10/28 14:37:42
PT-20         UTM  2014/10/28 14:36:38
PT-40         UTM  2014/10/28 14:36:45
PT-60         UTM  2014/10/28 14:36:54
PT-80         UTM  2014/10/28 14:37:05
PT-100        UTM  2014/10/28 14:37:14
PT-200        UTM  2014/10/28 14:39:22
PT-400        UTM  2014/10/28 14:39:30
PT-600        UTM  2014/10/28 14:39:38
PT-800        UTM  2014/10/28 14:39:46
PT-1000       UTM  2014/10/28 14:39:55
PT-2000       UTM  2014/10/28 14:40:15
PT-4000       UTM  2014/10/28 14:40:22
  
```

(Figure 4: VTM File List)

Note:

1. The symbol █64█ means the ANALYZER battery power remains 64%.
2. BT (next to the symbol █64█) means the ANALYZER already communicates with PC by wireless blue booth.


E. Transformer/VT Parameters (REF VT/PT)

Users can open, modify or remove Transformer/VT parameters. But the default VTM parameter file (PT_DEFAULT) can not be modified or removed.


1. Turn the switch to **REF VT/PT** to enter Transformer/VT parameter setting function as Fig. 5.

2. Transformer/VT parameters are:

- Name :** Transformer/VT name which can be set up by using Software keyboard.
- Type :** Transformer/VT winding type.
- Frequency :** Transformer/VT test frequency.
- Primary :** Transformer/VT Primary turns ratio or voltage.
- Secondary :** Transformer/VT Secondary turns ratio or voltage.
- RCF :** Reference Correction Factor. Transformer/VT ratio will be multiplied by RCF.

3. Users can press  (**TYPE**) button to change Transformer/VT winding type.

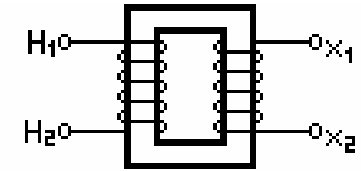
4. Users can press  or  button to select previous or next

parameter. Press  or  button to change the parameter setting value, or press these two buttons for 2 sec. to quickly increase or decrease the setting value.

5. After setting the parameters, select **Save** and then press **ENTER** button to replace the original VTM parameter file; or select **Save As** and then

press **ENTER** to save it as a new VTM parameter file.


```
Name:PT_DEFAULT  [62]BT
Type:VT/PT      1#STD
Frequency:      70Hz
Primary:        7200VN
Secondary:      120VN
RCF:            1.00000
```



```
Save
Save As...
```

(Figure 5: Transformer/VT Parameter Setting)

Note:

1. If users exit Transformer/VT parameter setting function before saving the new parameters, then the previous Transformer/VT parameters will be retrieved and used.
2. Primary setting value must be bigger than or equal to Secondary setting value.
3. Transformer/VT Name: users must press  button to select Name.

F. CT Parameters (REF CT)

Users can open or modify or remove CT parameters. But the default CTM parameter file (CT_DEFAULT) can not be modified or removed.

1. Turn the switch to **REF CT** to enter CT parameter setting function as Fig. 6.
2. CT parameters are:

Name : CT name which can be set up by using Software keyboard.





Type : CT winding type.

Frequency : CT test frequency.

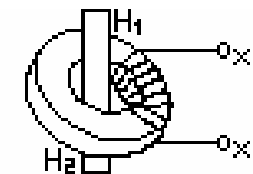
Primary : CT Primary turns ratio or current.

Secondary : CT Secondary turns ratio or current.

RCF : Reference Correction Factor. CT ratio will be multiplied by RCF.

3. Users can press  or  button to select previous or next parameter. Press  or  button to change the parameter setting value, or press these two buttons for 2 sec. to quickly increase or decrease the setting value.
4. After setting the parameters, select **Save** and then press **ENTER** button to replace the original CTM parameter file; or select **Save As** and then press **ENTER** to save it as a new CTM parameter file.


```
Name:CT_DEFAULT  [62]BT
Type:CT
Frequency:70Hz
Primary:3000 A
Secondary:5.0 A
RCF:1.00000
```



```
Save
Save As...
```








(Figure 6: CT Parameter Setting)

Note:

1. If users exit CT parameter setting function before saving the new parameters, then previous CT parameters will be retrieved and used.
2. Primary setting value must be bigger than or equal to Secondary setting value.
3. CT Name: users must press  button to select Name.


G. Software Keyboard

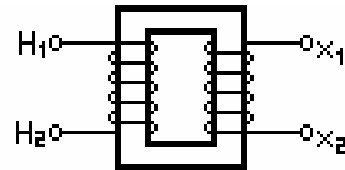
Users can use Software Keyboard to type in characters, numbers, and symbols.

1. Move the cursor to the parameter (like Transformer/VT Name) where you want to type in or modify characters.
2. Press  or  button to move the cursor to the entry where you want to type in or modify characters.
3. Press  (**ENTER EXIT**) button to display Software Keyboard like below.
4. Press  or  or  or  button to select characters.

After selecting characters, press  (**ENTER EXIT**) button again to update the characters.

```

Name: NEW-PT-800 
Type: UT/PT      1#STD
Frequency:       70Hz
Primary:         800VN
Secondary:       1.0VN
RCF:             1.00000
    
```



```


! " # $ % & ' ( ) * + ,
- . / 0 1 2 3 4 5 6 7 8 9
: ; < = > ? @ A B C D E F
G H I J K L M N O P Q R S
T U V W X Y Z [ \ ] ^ _ `
    
```

Save
Save As...

H. Phase Angle Calibration (CAL.)


Before measurements please perform Phase angle calibration to improve the ANALYZER accuracy.

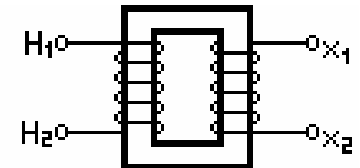
Turn the switch to VT/PT or CT range. Connect YELLOW testing clips with RED ones. Connect BLUE testing clips with BLACK ones. Then press

 (**CAL.**) button to perform Phase angle calibration. After a period of calibration, on the LCD you will see Ratio is nearly equal to 1 and Phase is nearly equal to 0.

Regular Phase angle calibration will help the ANALYZER maintain the accuracy.

```

Name: PT_DEFAULT 
Type: UT/PT      1#STD
Frequency:       70Hz
Primary:         7200VN
Secondary:       120VN
    
```




```


Ratio:           1.0000
Deviation:       -98.33%
Output:          7.2000KUN
EC: 33.14V 0.57mA
Phase:           0.00°
    
```

Ratio: 1.0000

I. Datalogging


(A) VT/PT Measurement:

Turn the switch to VT/PT range, press  (**TEST**) button to start

measuring. After the measurement is finished, press  (**REC**) button to record the measurement result as a VTR file. Then users can turn the switch to FILE, open VTR File List, and then open the VTR file to view the measurement result.

(B) CT Measurement:

Turn the switch to CT range, press  (**TEST**) button to start measuring.



After the measurement is finished, press  (**REC**) button to record the measurement result as a CTR file. Then users can turn the switch to FILE, open CTR File List, and then open the CTR file to view the measurement result.



Note:

Please use the application software for the ANALYZER in the provided software CD to read the saved measurement results. (refer to Software manual.)

J. Hard Copy LCD Screen

1. Turn the switch of the Analyzer to any range except OFF.
2. Press  (**HARD COPY**) button to save the current LCD screen as a BMP file.
3. Turn the switch of the Analyzer to FILE. Press  (**TYPE**) button to display BMP File List. Open a file to view the saved BMP file.

K. Clear Recorded (File) Data and Restore Defaults

Users can clear the recorded data saved in the Analyzer and restore the factory defaults. The procedures are:

1. Keep pressing **REC** button and turn on the Analyzer at the same time.
2. After turning on the Analyzer, users will be asked if they really want to Restore Factory Settings & MEMORY FORMAT. If users choose YES, then all the data recorded in the Analyzer (memory) will be completely deleted. And the factory default settings will be restored (Filter: Normal; Auto Power Off: 15 min.).





Note:

1. After performing this CLEAR function, all the recorded data in Analyzer (memory) will be deleted completely and can not be restored. If it is necessary to keep the testing data, please use the Application Software to download/save them before deleting them from the Analyzer. (refer to the Software Manual)



2. After the factory defaults are restored, the parameters (like Select Filter, Auto Power Off, ...) in SETUP will be restored to the defaults set at factory. Hence, users will have to set the parameters in SETUP again.

L. SETUP Parameters

1. Turn the Analyzer switch to SETUP to enter Parameter setting screen like below.
2. Press  or  button to select the parameter you want to set up. Press  or  button to modify the setting value, or press these two buttons for 2 sec. to quickly increase or decrease the values.
3. When finish the setup, turn the switch to exit the Parameter setting up screen.

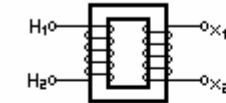
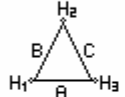
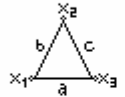
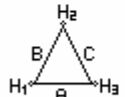
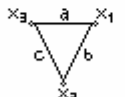
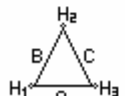

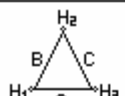
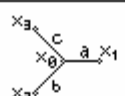
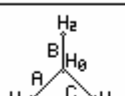
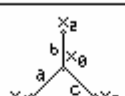
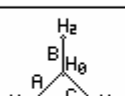
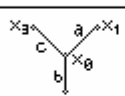
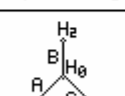
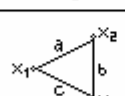
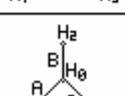
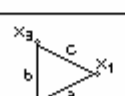
```
56 BT          U1.04
Select Filter:  Normal
Auto Power Off: 15 min
CURRENT DATE&TIME: 2014/11/07 10:35:10
```

- (1) **Select Filter** : Select a Filter (among Fast, Normal, Slow) to remove the field noise.
- (2) **Auto Power Off** : set up the Auto-Power-Off period of the Analyzer. When the time reaches the Auto-Power-Off period but the Analyzer has not yet been operated, it will turn off the power

automatically to save power consumption. Users can select among Disabled, 15 min, 30 min, 60 min.

- (3) **CURRENT DATE&TIME:** users can set up the Date and Time (except the second) of the Analyzer.
- (4) **V1.04** in the screen means the firmware version of the Analyzer.

M. Multi-phase Connection

REF NO.	TRANSFORMER		XFMR TYPE	PHASE	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING	TURNS RATIO
	HIGH VOLTAGE WINDING	LOW VOLTAGE WINDING					
1			STD 1φ	1φ	H ₁ -H ₂	X ₁ -X ₂	$\frac{V_H}{V_X}$
2			STD Δ-Δ	A	H ₁ -H ₃ (A)	X ₁ -X ₃ (a)	$\frac{V_H}{V_X}$
				B	H ₂ -H ₁ (B)	X ₂ -X ₁ (b)	
				C	H ₃ -H ₂ (C)	X ₃ -X ₂ (c)	
3			REV Δ-Δ	A	H ₁ -H ₃ (A)	X ₁ -X ₃ (a)	$\frac{V_H}{V_X}$
				B	H ₂ -H ₁ (B)	X ₂ -X ₁ (b)	
				C	H ₃ -H ₂ (C)	X ₃ -X ₂ (c)	
4			STD Δ-Y	A	H ₁ -H ₃ (A)	X ₁ -X ₀ (a)	$\frac{V_H \cdot \sqrt{3}}{V_X}$
				B	H ₂ -H ₁ (B)	X ₂ -X ₀ (b)	
				C	H ₃ -H ₂ (C)	X ₃ -X ₀ (c)	
5			REV Δ-Y	A	H ₁ -H ₃ (A)	X ₁ -X ₀ (a)	$\frac{V_H \cdot \sqrt{3}}{V_X}$
				B	H ₂ -H ₁ (B)	X ₂ -X ₀ (b)	
				C	H ₃ -H ₂ (C)	X ₃ -X ₀ (c)	
6			STD Y-Y	A	H ₁ -H ₀ (A)	X ₁ -X ₀ (a)	$\frac{V_H}{V_X}$
				B	H ₂ -H ₀ (B)	X ₂ -X ₀ (b)	
				C	H ₃ -H ₀ (C)	X ₃ -X ₀ (c)	
7			REV Y-Y	A	H ₁ -H ₀ (A)	X ₁ -X ₀ (a)	$\frac{V_H}{V_X}$
				B	H ₂ -H ₀ (B)	X ₂ -X ₀ (b)	
				C	H ₃ -H ₀ (C)	X ₃ -X ₀ (c)	
8			STD Y-Δ	A	H ₁ -H ₀ (A)	X ₁ -X ₂ (a)	$\frac{V_H}{V_X \cdot \sqrt{3}}$
				B	H ₂ -H ₀ (B)	X ₂ -X ₃ (b)	
				C	H ₃ -H ₀ (C)	X ₃ -X ₁ (c)	
9			REV Y-Δ	A	H ₁ -H ₀ (A)	X ₁ -X ₂ (a)	$\frac{V_H}{V_X \cdot \sqrt{3}}$
				B	H ₂ -H ₀ (B)	X ₂ -X ₃ (b)	
				C	H ₃ -H ₀ (C)	X ₃ -X ₁ (c)	

N. Error Messages

When users perform measurements or calibration but fail, the Analyzer will display an error message.

The list of error messages are as below:

Live Test Points (Live VT/CT)	The Transformer or VT/CT is live with voltage or potential.
High Excitation Current Check For Short Circuit	The excitation current is too high. Check if it's short circuited.
H RED H BLACK Open	Primary open circuit. Check for proper test leads connection. If test leads are properly connected, check for the discontinuity/disconnection within the Primary windings.
X YELLOW X BLUE Open	Secondary open circuit. Check for proper test leads connection. If test leads are properly connected, check for the discontinuity/disconnection within the Secondary windings.
Test canceled by users	The measurement is canceled by the user.
H X Cable Reversal	Primary testing leads and Secondary testing leads are reversed.

VT/CT Ratio Over Range	The Transformer/VT/CT turns ratio is out of the spec.
Low Battery Test Is Not Complete	The battery power is too low to finish the measurement.

V. Specifications

A. ELECTRICAL

Reference Conditions : 23°C ± 5°C (30 to 50% RH) range. Add 25ppm/°C for 0° to 18°C and 28° to 50°C to all accuracy specifications. No external electrical or magnetic fields. Output current ≤150 mA for VT/PT and ≤50mA for CT. Calibration cycle is 1 year.

Ratio Range (VT/PT)	Autoranging : 0.8000 to 10000 : 1	
Accuracy (70Hz)	Ratio Range	Accuracy (% of Reading)
	0.8000 ~ 999.99	± 0.1%
	1000.0 ~ 4999.9	± 0.2%
	5000.0 ~ 10000	± 0.25%
Ratio Range (CT)	Autoranging : 0.8000 to 2000.0	
Accuracy (70Hz)	Ratio Range	Accuracy (% of Reading)
	0.8000 to 2000.0	± 0.5%
Excitation Signal	VT/PT Mode : 34Vrms max CT Mode : Auto Level 0 to 1A, 0.1 to 20Vrms	
Excitation Current	Range : 0 to 1000mA	
Display	Accuracy : ± (2% of Reading +2mA)	
Excitation Frequency (Hz)	50, 55, 60, 70, 100, 120, 200, 240, 300, 400	
Display	5" Large dot matrix LCD display (240*128) with backlight	

Power Source	Rechargeable Lithium Battery, 3400mAh
Battery Life	Over 10 hrs of continuous operation. Battery life (%) indication
Battery Charger	Universal input (90 to 264Vrms input)
Charging Time	< 4 hrs
Data Storage	4096 Files Each (VTM, CTM, VTR, CTR, BMP)
Date/ Time	Battery-backed, Real-time Calendar clock
Measurement Method	ANSI / IEEE C57.12.90 和 IEC 600076.1
Operation Environment	5°C ~ 50°C, 85% RH
Storage Environment	-20°C ~ 60°C, 75% RH

B. ACCESSORY

1. Test leads (set of 2)
2. Alligator clips (4pcs.)
3. Rechargeable lithium battery
4. User manual
5. AC adaptor
6. Power cord
7. Software CD & Manual
8. Carrying bag

VI. Battery Replacement (Recharging)

If the lithium battery can not be charged, users should always purchase a new lithium battery from the distributor or importer. The charging circuit built-in is designed only for the lithium battery.

The lithium battery of the Analyzer is always sold with the plastic battery cover. Do not purchase a lithium battery from a source which is not approved by the manufacturer.

Non-approved lithium battery could cause damage to the instrument or hazard to the users.



Steps to replace the lithium battery:

1. Unscrew and remove the lithium battery (with plastic battery cover).
2. Put in a new rechargeable lithium battery (with plastic battery cover).
3. Screw the battery cover.

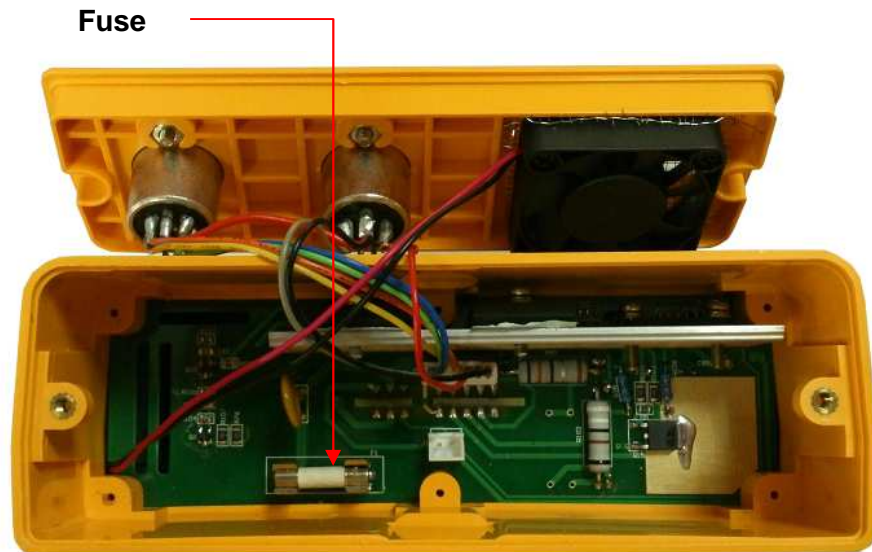
Steps to charge the lithium battery:

1. Connect the AC power adaptor with the Analyzer.
2. The battery can be charged without turning on the Analyzer.
3. The recharging takes about 4 hours. After recharging, remove the AC power adaptor.
4. Turn on the Analyzer, and the LCD displays "100".

VII. Fuse Replacement

When the Analyzer is correctly connected with the Transformer but the measurement fails and it keeps displaying the error message “H RED H BLACK OPEN.”, please check the fuse. If the fuse is damaged (burned), please replace a new fuse by following the procedures:

1. Turn off the Analyzer and remove all the connecting wires and power sources.
2. Unscrew the (2pcs.) screws of the top panel. Remove the top panel.
3. Remove the damaged (burned) fuse.
4. Put in a new fuse of the same specifications (2A / 250V).
5. Restore the top panel and screw the (2pcs.) screws of the top panel.



VIII. Maintenance & Cleaning

1. Servicing not covered in this manual should only be performed by qualified personnel. Repairs should only be performed by qualified personnel.
2. Periodically wipe the case and cables with a damp cloth and detergent; do not use abrasives or solvents.
3. Please remove the battery if the Analyzer won't be used for a long time.

Address of Agent, Distributor, Importer, or Manufacturer:

