

# User Manual

CT PT ANALYZER

ATO-CTTHM404




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## Warning

This manual will help users to operate CT/PT Analyzer properly. The main contents of this manual include functions, technical index, operation, test connection and potential risks of Analyzer. Please read this manual carefully before you start to use CT/PT Analyzer. It will save your time and cut down the risks in test procedure.

The operation of CT/PT test with CT/PT Analyzer should follow associated international standards constraints. This manual can not replace international standards of electrical tests. The operator should have the certificate of high voltage electrical test when CT/PT Analyzer works in high voltage station.

Safety regulations for CT/PT Analyzer application

- 1) All technical index should keep in work condition before testing with Analyzer.
- 2) Please follow associated international standards in a special application.

- 3) Forbid high voltage or high current connected to CT/PT Analyzer directly.
- 4) All tests need to follow procedure in user manual.
- 5) It is forbid to open the box of CT/PT Analyzer. Otherwise, the quality assurance will be invalid.
- 6) It is forbid to update or extend the tester without manufacturer authorization.
- 7) Please use the original accessories for Analyzer.
- 8) It is forbid to cut off test connection before LED indicator light is OFF.
- 9) Please connect Analyzer to ground with grounding cable in no laboratory application.
- 10) Please confirm that one terminal of sample CT primary connected to ground.
- 11) Do not run Analyzer in extreme moist condition.
- 12) Please confirm that all terminals connected to Analyzer have no voltage. All voltage outputs are from CT/PT Analyzer.
- 13) Please confirm that voltage had been injected to CT secondary winding in CT test. Otherwise, CT/PT Analyzer will be damaged possibly.
- 14) Please confirm that voltage had been injected to PT primary winding in PT ratio test. Otherwise, CT/PT Analyzer will be damaged possibly.
- 15) **The ratio error and phase angle error test is valid for electromagnetic voltage transformer only. It can not applied in CVT test.**

## 1. Application and Technical Index of CT/PT Analyzer

### 1.1 Application

#### Tests for Current Transformer:

- 1) Excitation curve and parameters test
- 2) Turns ratio test
- 3) Ratio and phase error test
- 4) Polarity mark check
- 5) Winding resistance measurement
- 6) Secondary loop burden measurement
- 7) Error line curve test for protection CT
- 8) Transient CT parameters test
- 9) CT nameplate guess
- 10) Saturation hysteresis loop curve measurement

#### Tests for Voltage Transformer:

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- 1) Turns ratio test
- 2) Ratio error and phase angle error test
- 3) Polarity test
- 4) Secondary burden test
- 5) Winding resistance test

**Applications of CT/PT Analyzer:**

- 1) CT nameplate check
- 2) CT parameters check in work burden
- 3) CT transient parameters analysis
- 4) CT ratio and phase error calibration
- 5) PT routine test

## 1.2 CT/PT Analyzer Function and Technical Index

- 1) Test standards: IEC60044-1, IEC60044-6, IEC60044-2, IEC60044-5, C57.13
- 2) Power supply: AC220V±10%, 50/60Hz±10%
- 3) Voltage output: 0.1~180V (AC)
- 4) Current output: 0.001~5A(RMS)
- 5) Power output: 500VA
- 6) Maximum knee voltage measurement: 45KV
- 7) Current measurement:  
 Range: 0~10A (automatically change range in 0.1/0.4/2/10A)  
 Error: <±0.1%+0.01%FS
- 8) Voltage measurement:  
 Range: 0~200V (automatically change range in 1V/10V/70V/200V)  
 Error: < ±0.1%+0.01%FS
- 9) Turns ratio measurement:  
 Range: 1~35000  
 1~5000      error<0.05%  
 5000~35000   error<0.1%
- 10) Phase measurement: error: ±2min; resolution: 0.01min
- 11) Winding resistance measurement:  
 Range: 0~8kΩ (automatically change range in 2ohm/20ohm/80ohm/800ohm/8kohm)  
 Error: < 0.2%RDG+0.02%FS  
 Maximum resolution: 0.1mΩ

- 12) Temperature measurement: -50~100 Celsius degree; error < 3 Celsius degree
- 13) CT Secondary burden:
  - Range: 0~160ohm (automatically change range in 2ohm/20ohm/80ohm/160ohm)
  - Error: < 0.2% RDG + 0.02% FS
  - Maximum resolution: 0.001ohm
- 14) PT Secondary burden:
  - Range: 0~80kohm (automatically change range in 800ohm/8kohm/80kohm)
  - Error: < 0.2% RDG + 0.02% FS
  - Maximum resolution: 0.1ohm
- 15) PT ratio measurement:
  - Range: 1~35000
  - 1~10000 error < 0.1%
  - 10000~35000 error < 0.2%
- 16) PT ratio error measurement: Typical error < 0.05%, Maximum Error < 0.1%
- 17) PT phase angle measurement: maximum error < 3min
- 18) Make evaluation for test results according to selected standards
- 19) Make word report for test result
- 20) Make word reports one time for multi-group test records on the PC
- 21) Calculate the ratio errors and phase angle errors at rated burden and working burden in one time test
- 22) Compare excitation curves with saved excitation curves in the same window
- 23) Memory capacity: > 1000 groups test results
- 24) Working condition: temperature: -10°C ~ 50°C; moist: ≤ 90%
- 25) Size: 485mm × 356mm × 183mm
- 26) Weight: < 15kg

## 2. Hardware

### 2.1 Introduction

The appearance of CT/PT Analyzer is as figure 2.1.



Figure 2.1 CT/PT Analyzer

### 2.2 Power Supply

Power supply connection of CT/PT Analyzer is located at right side. It is showed as figure 2.2. Power supply range is AC220V $\pm$ 10%, 50/60Hz $\pm$ 10%. There is a fuse installed in the internal of power supply connector.

### 2.3 Test Connection Terminals

There are 3 groups of test connection terminals on the surface panel of CT/PT Analyzer. They are power output, CT secondary input and CT primary input.

Power output terminals: voltage output range AC0~180V, current output range AC0~5A.

CT secondary/PT primary input terminals: CT secondary or PT primary voltage measurement input range AC0~180V.

CT primary/PT secondary input terminals: CT primary or PT secondary voltage measurement input range AC 0~5V

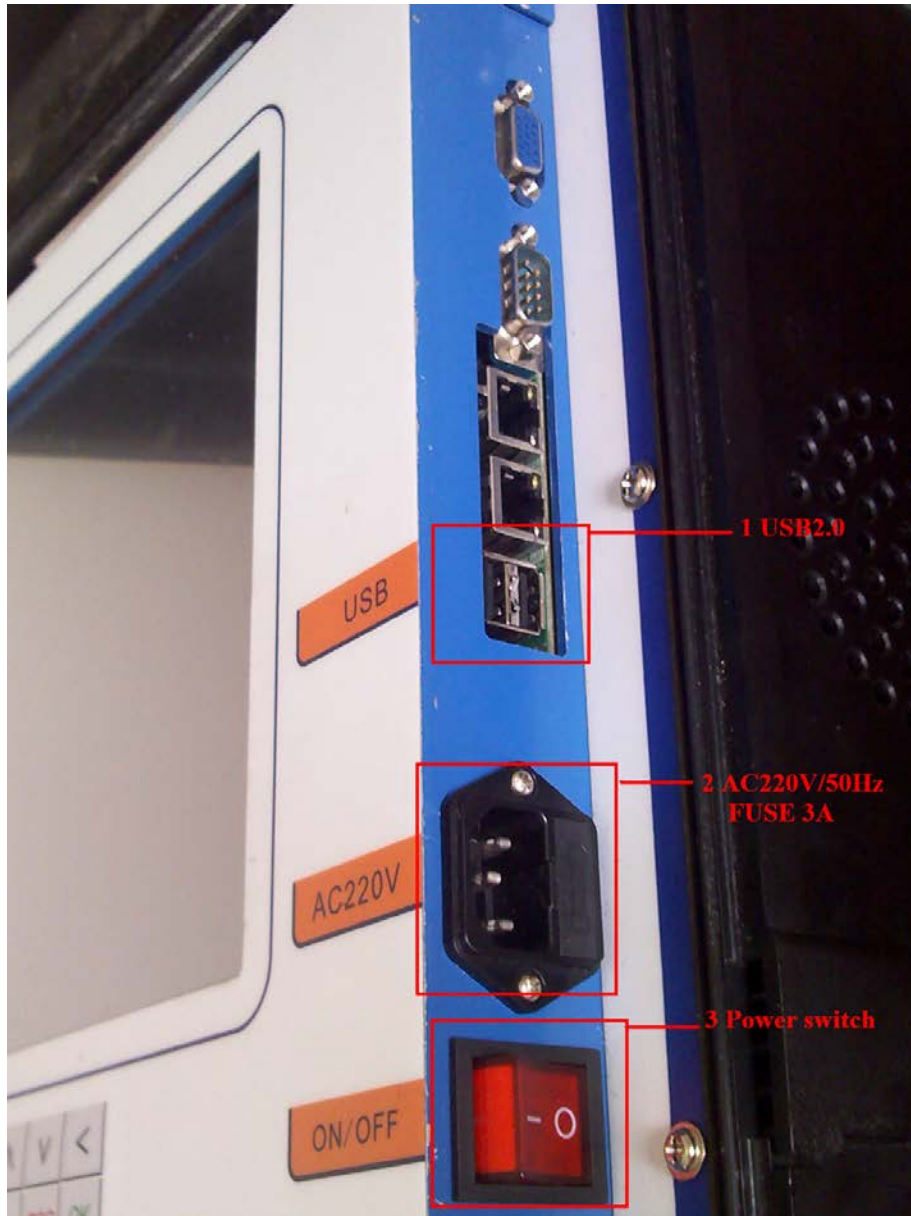





Figure 2.2 Power supply panel

## 2.4 Hardware Schematic Diagram

The schematic diagram of CT/PT Analyzer is as figure 2.3. Constant voltage and current source is isolated with AC220V power supply. DSP system controls the constant voltage and current source output and amplitude. This source can generate AC0-180V voltage or DC 0~0.5A

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current to sample CT.

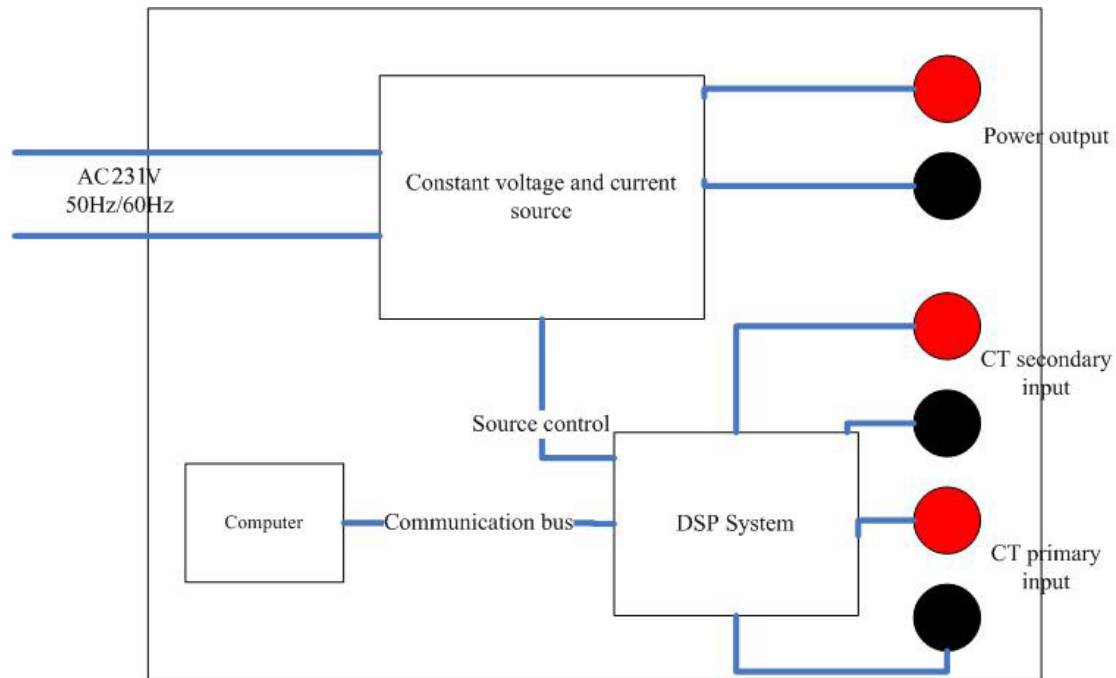


Figure 2.3 CT/PT Analyzer schematic diagram

The main functions of DSP system are as following:

- 1) Constant voltage and current source control
- 2) Data sample
- 3) Communication with computer.

There is a computer integrated into the Analyzer. Large memory capacity to make sure that Analyzer can save over 1000 groups testing data.

## 2.5 Keyboard

### 2.5.1 Physical Keyboard




There is 16 keys small keyboard installed in Analyzer. The appearance of keyboard is showed as figure 2.4



Figure 2.4 Keyboard

The definitions of keys are as following:

- 1) 0~9 digital input

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- 2) ^ up direction input
- 3) v down direction input
- 4) < Delete
- 5) ● Dot input
- 6) ESC: cancel selection
- 7) OK: enter or select

### 2.5.2 Virtual Keyboard

There is a symbol of virtual keyboard in the upper right corner of LCD screen after turning ON Analyzer. The symbol of virtual keyboard is as figure 2.5. After clicking the symbol button, the keyboard will be showed on the LCD as figure 2.6.



Figure 2.5 Symbol of Virtual Keyboard

Esc	Ins	Del	/	;	'	[	]	\	-	=	Hide
`	1	2	3	4	5	6	7	8	9	0	<--
Tab	q	w	e	r	t	y	u	i	o	p	Ent
Cap	a	s	d	f	g	h	j	k	l		
Shf		z	x	c	v	b	n	m	,	Up	.
Ctl	Fn	Alt	Win					Mnu	<<	Dn	>>

Figure 2.6 Virtual Keyboard

The main function of virtual keyboard is the same as physical keypad. The definition of the main keys are as following:

- 1)“Hide”: hide the keyboard. If this key is clicked, the virtual keyboard will be disenabled.
- 2)“Ent”: confirm the input selection.
- 3)“>>” and “<<”: move the cursor to right or left.

4)“Up” and “Down”: move the cursor to up or down.

### 3. Test Connection

#### 3.1 CT Secondary Burden Test

Please connect Analyzer and sample CT as figure 3.1 in CT secondary burden test

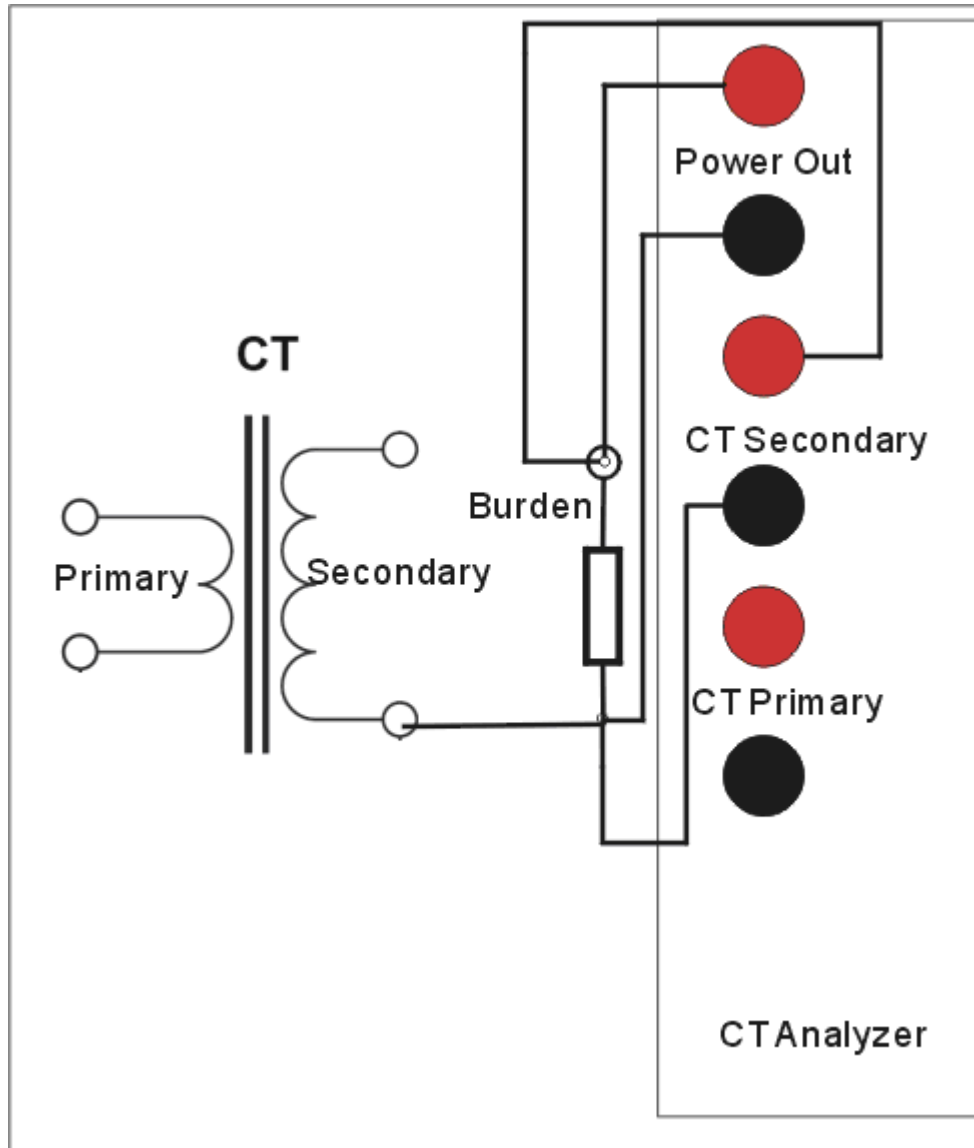





Figure 3.1 Secondary burden test connection

The detailed test connection procedures are as follow::

- 1) Connect Analyzer grounding terminal to protection earth(PE).
- 2) Disconnect sample CT secondary winding with secondary loop as figure 3.1.
- 3) Connect power output red terminal of Analyzer to one side of CT secondary circuit.
- 4) Connect power output black terminal of Analyzer to another side of CT secondary circuit.
- 5) Please keep the voltage measurement connection behind the power output connection so

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that contact resistance has no effect in test results. Reference connection is showed as figure 3.2

**Warning: Please disconnect CT secondary winding to secondary loop. Otherwise, test results will be wrong. It is the combination of secondary loop burden and secondary winding. There is no degauss procedure when making burden test. So if the connection to secondary winding was not disconnected, the CT secondary winding will work in saturation state.**

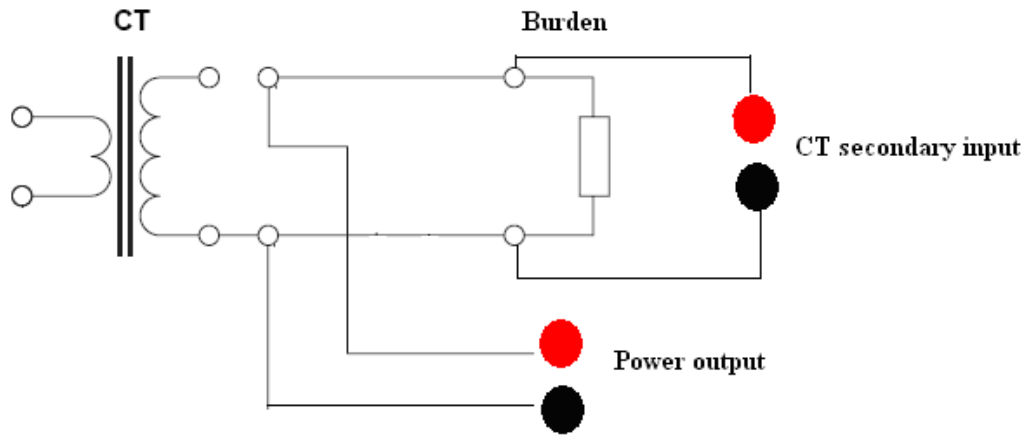


Figure 3.2 Reference connections to clear contact resistance effect

### 3.2 CT Analysis, Ratio and Polarity Test

Please connect Analyzer and sample CT as figure 3.3 in CT analysis, ratio and polarity test. It is the same in test connection for all these three tests.

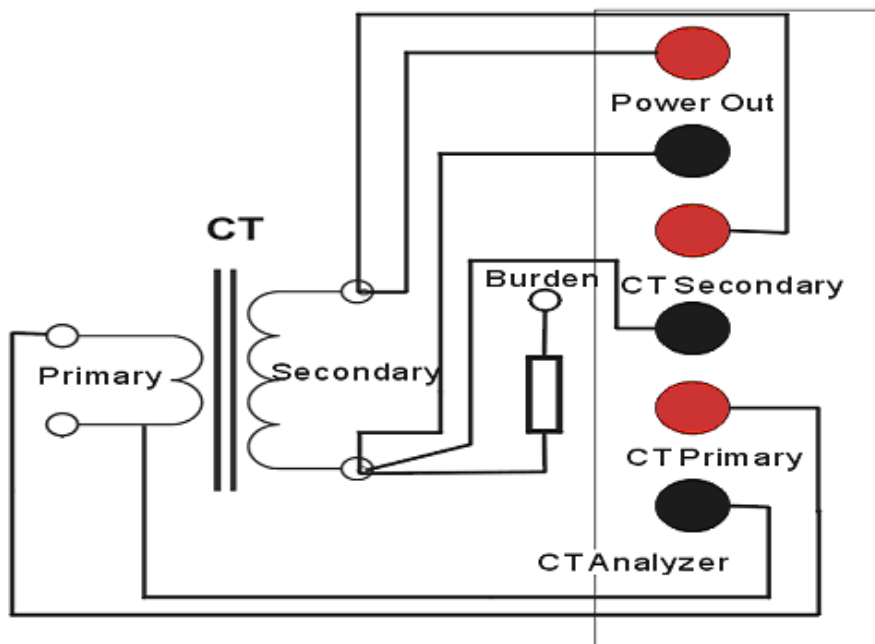


Figure 3.3 Connection for CT analysis, ratio and polarity test

The detailed test connection procedures are as following.

- 1) Connect Analyzer grounding terminal to protection earth (PE).
- 2) Disconnect power line connection in primary of CT as figure 3.4. Power line which is not connected to earth will bring lots of noise signal when testing.
- 3) Connect power output red terminal of Analyzer to one side of CT secondary winding.
- 4) Connect power output black terminal of Analyzer to another side of CT secondary winding.
- 5) Connect one side of CT primary winding to CT primary black terminal of Analyzer.
- 6) Connect another side of CT primary winding to CT primary red terminal of Analyzer.
- 7) Connect one side of CT secondary winding to CT secondary black terminal of Analyzer.
- 8) Connect another side of CT secondary winding to CT secondary red terminal of Analyzer.
- 9) Please keep the voltage measurement connection behind the power output connection so that contact resistance has no effect in test results. Reference connection is showed as figure 3.4

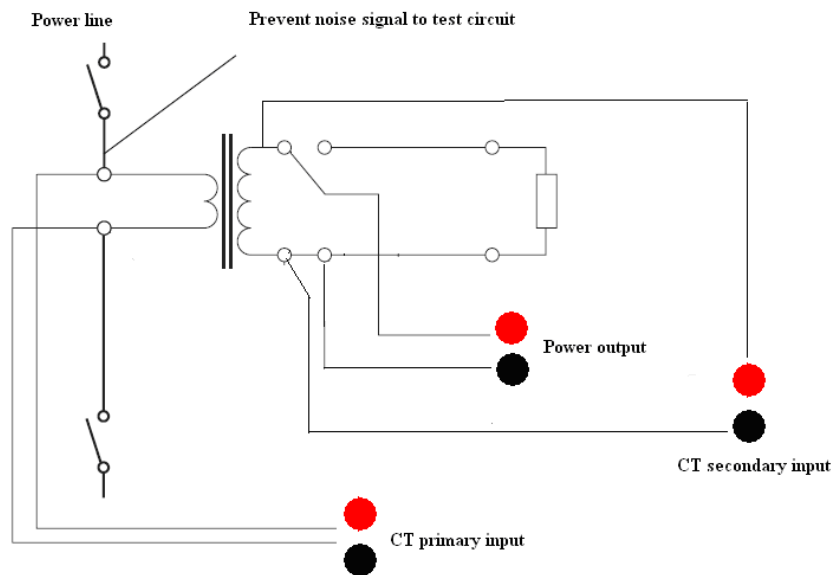


Figure 3.4 Reference connections for CT analysis, ratio and polarity test

**Warning: Please short connect other non-test secondary windings for CT that have multiple secondary windings while the rated primary and secondary current are the same in CT analysis or ratio test. For example, one sample CT which has three secondary windings as figure 3.4.1. When the winding 0.5 class is being tested, please short connect the 10p and TPY windings as figure 3.4.1**

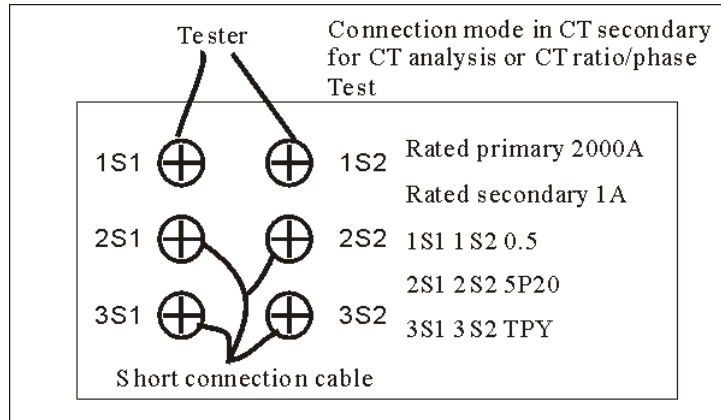


Figure 3.4.1 Short connection for CT analysis and ratio/phase test

### 3.3 CT Winding Resistance Test

Please connect Analyzer and sample CT as figure 3.5 in CT winding resistance test

- 1) Connect Analyzer grounding terminal to protection earth (PE).
- 2) Disconnect sample CT secondary winding with secondary loop as figure 3.5.
- 3) Connect power output red terminal of Analyzer to one side of CT secondary winding.
- 4) Connect power output black terminal of Analyzer to another side of CT secondary winding.
- 5) Please keep the voltage measurement connection behind the power output connection so that contact resistance has no effect in test results. Reference connection is showed as figure 3.4

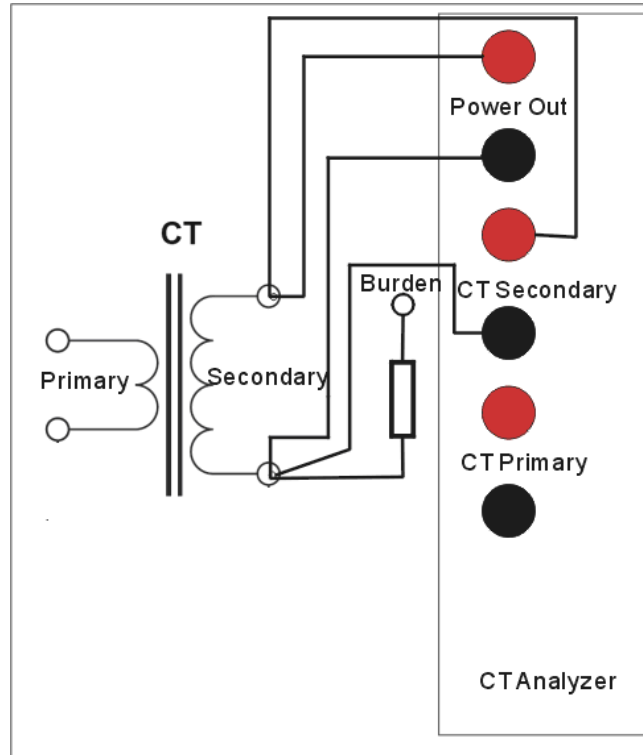


Figure 3.5 Reference connections for CT winding resistance test

### 3.4 PT Secondary Burden Test

Please connect Analyzer and sample PT as figure 3.6 in PT secondary burden test.



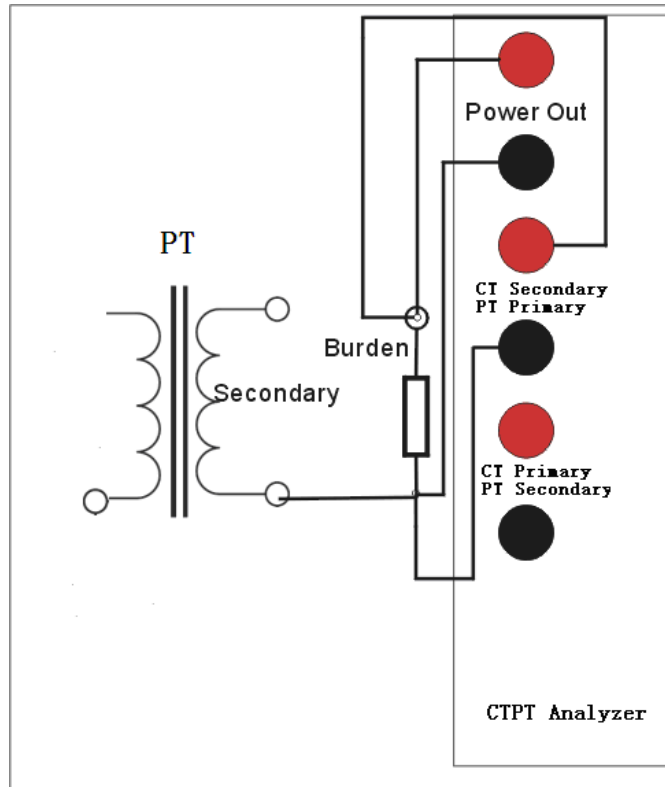


Figure 3.6 PT secondary burden test connection

The detailed test connection procedures are as following:

- 1) Connect Analyzer grounding terminal to protection earth(PE).
- 2) Disconnect sample PT secondary winding with secondary loop as figure 3.6.
- 3) Connect power output red terminal of Analyzer to one side of PT secondary circuit.
- 4) Connect power output black terminal of Analyzer to another side of PT secondary circuit.

**Warning: Please disconnect PT secondary winding to secondary loop. Otherwise, test results will be wrong. It is the combination of secondary loop burden and secondary winding.**

### 3.5 PT Winding Resistance Test

Please connect Analyzer and sample PT as figure 3.7 in PT winding resistance test.

- 1) Connect Analyzer grounding terminal to protection earth (PE).
- 2) Disconnect sample PT winding with loop as figure 3.7.
- 3) Connect power output red terminal of Analyzer to one side of PT winding.
- 4) Connect power output black terminal of Analyzer to another side of PT winding.
- 5) Please keep the voltage measurement connection behind the power output connection so that contact resistance has no effect in test results. Reference connection is showed as figure 3.4

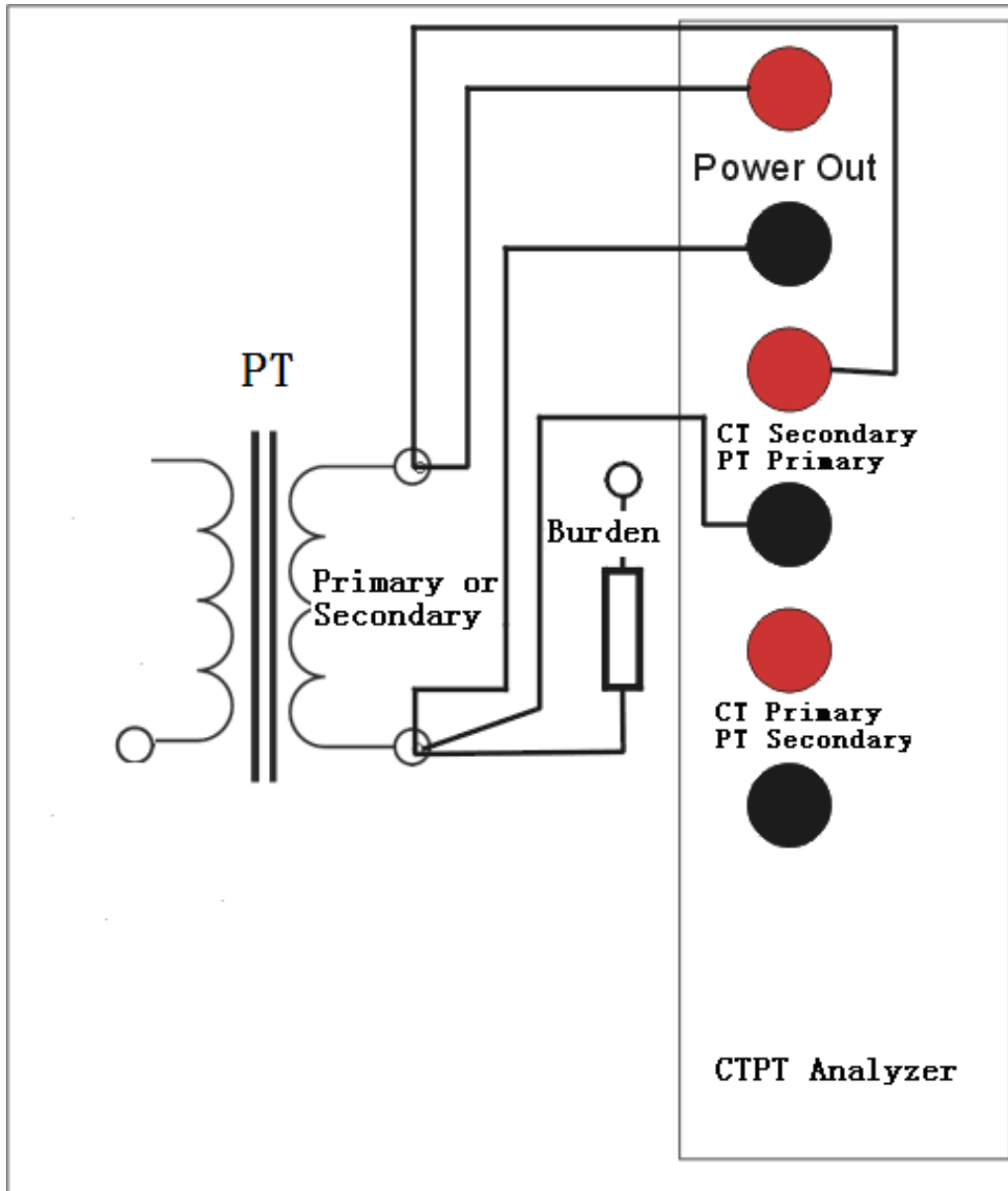


Figure 3.7 Winding resistance test connection

### 3.6 PT Turns Ratio and Polarity Test

Please connect Analyzer and sample PT as figure 3.9 in PT turns ratio test and polarity test. It is the same in test connection for both tests.

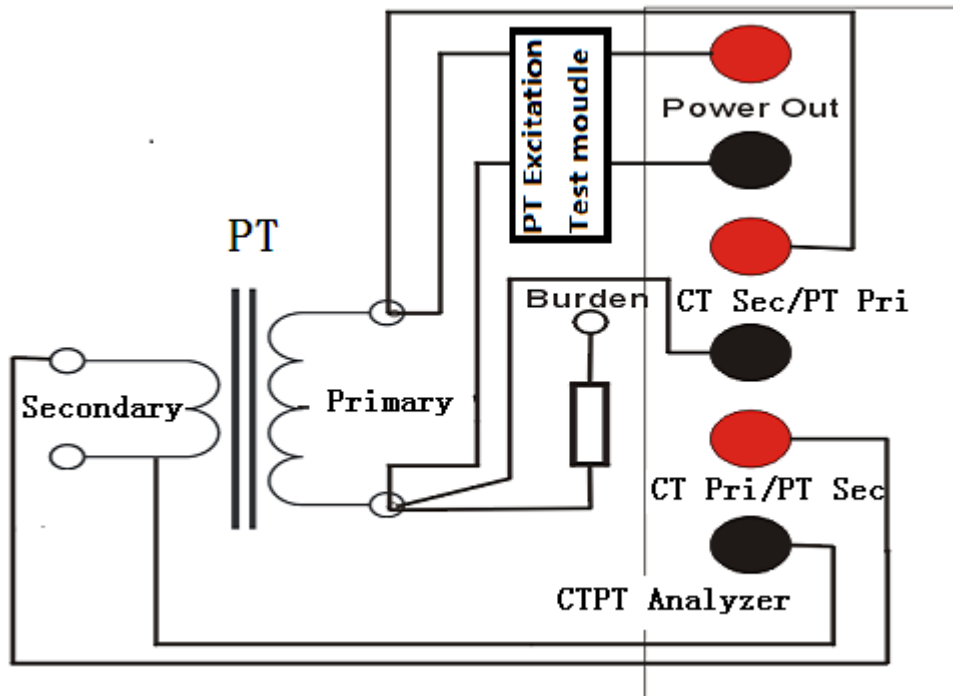


Figure 3.9 PT turns ratio and polarity test connection

The detailed test connection procedures are as following.

- 1) Connect Analyzer grounding terminal to protection earth (PE).
- 2) Disconnect power line connection in primary of PT. Power line which is not connected to earth will bring lots of noise signal when testing
- 3) Serial Connection the PT Excitation module to the power output as figure 3.9
- 4) Connect PT Excitation module red terminal to one side of PT primary winding.
- 4) Connect PT Excitation module black terminal to another side of PT primary winding.
- 5) Connect one side of PT secondary winding to PT secondary black terminal of Analyzer.
- 7) Connect another side of PT secondary winding to PT secondary red terminal of Analyzer.
- 8) Connect one side of PT primary winding to PT primary black terminal of Analyzer.
- 9) Connect another side of PT primary winding to PT primary red terminal of Analyzer.
- 10) Please keep the voltage measurement connection behind the power output connection so that contact resistance has no effect in test results. Reference connection is showed as figure 3.4

### 3.7 PT Excitation and Ratio Error Test

Please connect Analyzer and sample PT as figure 3.10 in PT excitation and ratio error test.

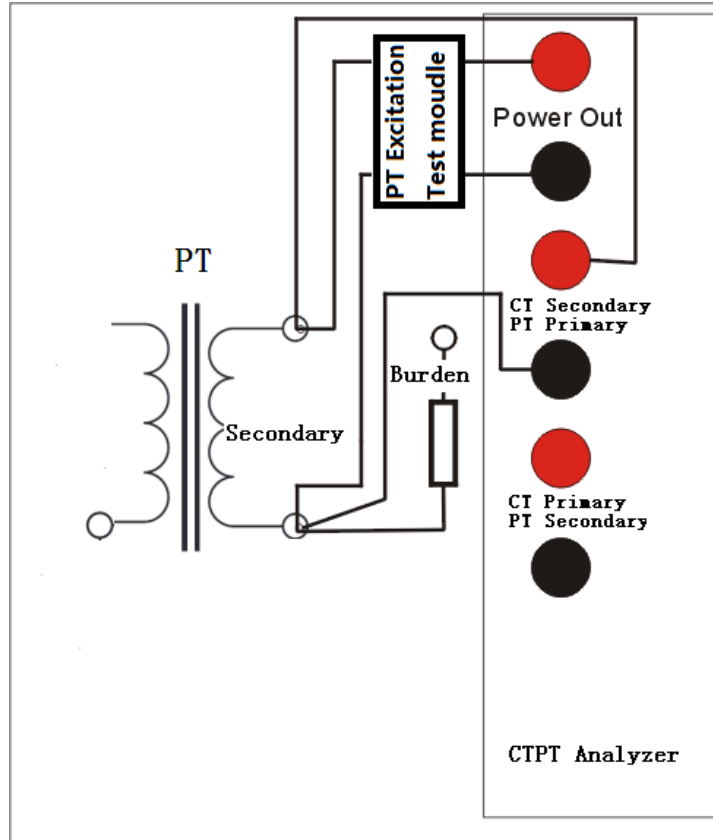


Figure 3.10 PT Excitation and Ratio Error Test

The detailed test connection procedures are as following.

- 1) Connect Analyzer grounding terminal to protection earth (PE).
- 2) Disconnect power line connection in primary of PT and keep enough insulation in the primary of PT
- 3) Serial Connection the PT Excitation module to the power output as figure 3.9
- 4) Connect PT Excitation module red terminal to one side of PT secondary winding.
- 4) Connect PT Excitation module black terminal to another side of PT secondary winding.
- 5) Connect one side of PT secondary winding to PT Pri black terminal of Analyzer.
- 7) Connect another side of PT secondary winding to PT Pri red terminal of Analyzer.
- 8) Please keep the voltage measurement connection behind the power output connection so that contact resistance has no effect in test results. Reference connection is showed as figure 3.4

## 4. User Interface

### 4.1 Software Panel

Six work states had been defined in CT/PT Analyzer. They are “wait for new test”, “wait for view saved data”, “wait for test”, “Run”, “View results” and “View saved results”. The software panel is different when Analyzer works in different state. The whole software panel is divided into 5 areas generally. All these five areas are showed as figure 4.1. The names of the 5 areas are toolbar panel, work panel, state information panel, test parameters panel and test control panel. Analyzer changes the software showed in work panel when it works in different state.

### 4.2 Toolbar Panel

The toolbar panel of Analyzer includes seven command buttons. They are “Main Menu”, ”Save”, “Open”, “System Setup”, “CT Setup”, “Data Output” and “Help” buttons.



Figure 4.1 Software panel in “Wait for new test” state

### 4.2.1 Main Menu

The functions of main menu command are to end current test selection and make Analyzer work in “wait for new test” state. Panel as figure 4.1 will be loaded to LCD if Analyzer works in “Wait for new test” state. You can select a new test in this panel. The tests in Analyzer include “CT Analysis”, “CT Ratio and Phase Error”, “CT Secondary Burden”, ”CT Polarity” and “CT Winding Resistance”. The system close and software restart commands are also located in this panel.

### 4.2.2 Save

The function for save command is to save test results showed in current panel. Save command is also valid when both saved results are reloaded to panel and the display mode is changed (such as standard selection or accuracy selection changed).

The file name of test results saved is constructed as following mode:

month-date-year Hour: minute: second Transformer ID Test name .cta

For example: 04-08-2012 11:12:30 CT analysis.cta

The date time in first part of file name is the value when test was started. So the original file will be overwritten when you save the test results in “view saved data” state. There is no another copy created.

### 4.2.3 Open

The function of Open command is to reload the saved results to software panel. Panel as figure 4.2 will be showed when you click Open command.

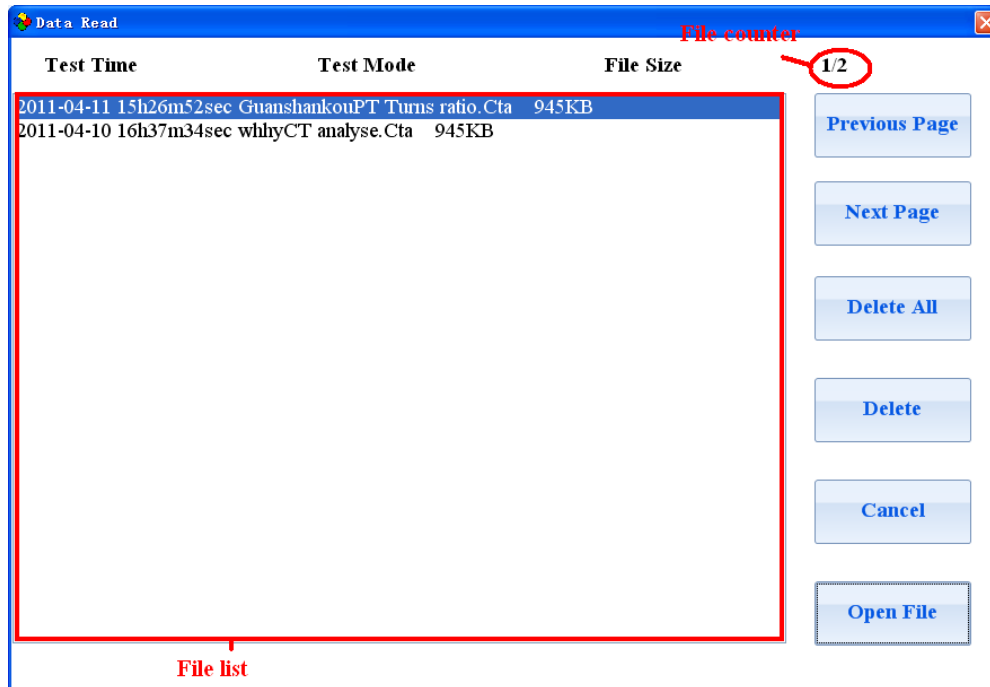


Figure 4.2 Saved files read window form

The list box in left side of panel shows all files saved in Analyzer. All commands to saved files are located at right side of panel. There is a counter to show current selection index and total files on top of the panel.

All commands to be saved files are as following:

- 1) “Previous Page” shows saved files of previous page in list box.
- 2) “Next Page” shows saved files of next page in list box.
- 3) “Delete All ” deletes all files saved in Analyzer.
- 4) “Delete” deletes current selection file in Analyzer.
- 5) “Cancel” close the read file window form.
- 6) “Open File” load test results in current selection file to software panel.

#### 4.2.4 System Setup

The function of system setup command is to set the system running parameters such as system time, operator, and test address and so on. Panel as figure 4.3 will be showed on LCD when system setup button is clicked.

Figure 4.3 System setup window form

System run parameters in system setup panel have no effect in test control. All system run parameters only affect word test report. The name and definition of system run parameters are showed in table 4.1.

Table 4.1 System run parameters

Parameters name	Description
Tester ID	The identification number offered by manufacturer
Soft ID	Software version
Operator	Operator name in word test report
Test company	Test company in word test report
Test address	Test address in word test report
Report header	Document header in word test report
Report footer	Document footer in word test report

Other parameters in system setting panel are response for test control. The detailed information of those parameters is as table 4.2

Table 4.2 System setup parameters

Parameters name	Description
Automatic evaluation	1) If “Close evaluation procedure” is selected, Analyzer will offer parameter results of CT only when CT analysis test is end. Analyzer will not evaluate the test results according to selected standard



	<p>2) If “Evaluation in working burden only” is selected Analyzer will offer both parameter results of CT and evaluation results according to selected standard when CT analysis test is end. But the evaluation results only include the parameters calculated in work burden.</p> <p>3) If “Evaluation in both working and rated burden” is selected, Analyzer will offer both parameter results of CT and evaluation results according to selected standard when CT analysis test is end. The evaluation results include the parameters calculated in both working and rated burden.</p>
Excitation test control	<p>Auto setting is factory setting. This parameter affects CT analysis and ratio test. If measure saturation voltage automatically is selected, Analyzer will select a special test frequency according to saturation value in excitation curve measurement. Otherwise Analyzer will not measure saturation voltage before excitation curve test starts.</p> <p><b>Warning:</b> Please select automatic mode in most of time. Just set the saturation value when you can not get the correct excitation curve in automatic mode.</p>
Show excitation curve data in brief mode	<p>If Show excitation curve data in brief mode has been selected, the excitation data table items will be not more than 30 points, 15 points before knee point and 15 points after knee point. All those points are sampled from excitation curve measured in the same step.</p> <p>If this item is not selected, all the excitation curve data will be showed in excitation curve data table.</p>
Transformer secondary current guess threshold value	<p>This parameter is valid in nameplate information guess. Analyzer guesses the rated secondary current of CT according to this parameter.</p> <p>If the winding resistance measured in CT secondary is lower than this value, Analyzer will set the rated secondary current of CT to 5A. Otherwise, the rated secondary current of CT is 1A.</p>
1A CT core type guess threshold value	<p>This parameter is valid in nameplate information guess. Analyzer guesses the core type of 1A CT according to this parameter.</p> <p>If the knee point voltage of 1A transformer is lower than this value, Analyzer will set the core type of CT to measurement. Otherwise, the core type of CT is protection.</p>

5A CT core type guess threshold value	<p>This parameter is valid in nameplate information guess. Analyzer guesses the core type of 5A CT according to this parameter.</p> <p>If the knee point voltage of 5A transformer is lower than this value, Analyzer will set the core type of CT to measurement. Otherwise, the core type of CT is protection.</p>
Excitation data search mode	<p>If search current from voltage is selected, Analyzer will find the right current value in excitation curve by the voltage value inputted.</p> <p>If search voltage from current is selected, Analyzer will find the right voltage value in excitation curve by the current value inputted.</p>

### 4.2.5 CT Setup

The function of CT Setup command is to set the parameters of sample CT for analysis and ratio test. Panel as figure 4.5 will be loaded when CT Setup button is clicked. The detailed information of parameters in this panel is the same as analysis test parameters setting. Please refer to Chapter 5.2.

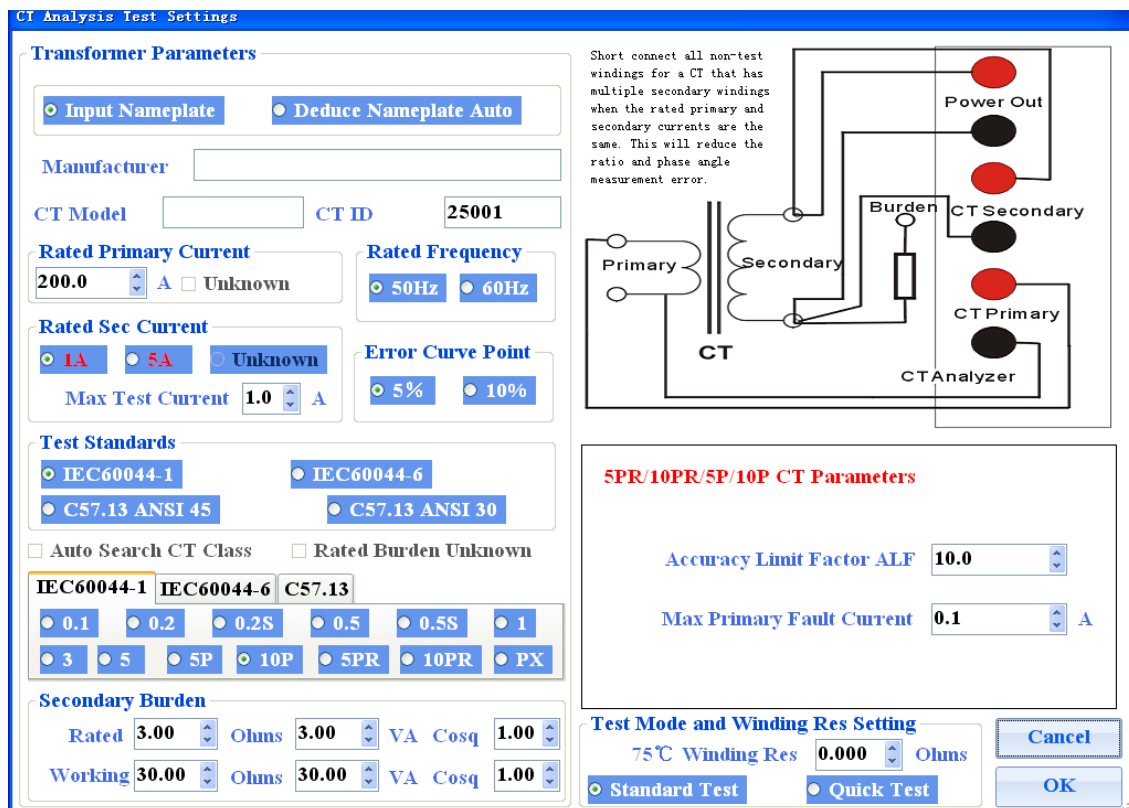


Figure 4.5 CT Setup

### 4.2.6 Data Output

The function of data output command is to export the data file or word report saved in

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Analyzer to removable disk. Panel as figure 4.6 will be loaded when data output button is clicked.

The list box in left side of panel shows all files saved in Analyzer. All export form commands to saved files are located at right side of panel. There is a counter to show current selection index and total files in top of the panel. The combo list top of export window form is response for file type show. “.cta” data files will be showed in list box if “\*.cta” had been selected in this combo list. Otherwise, “.doc” word files will be showed in list box.

All commands to saved files in export file window form are as following:

- 1) “Previous page” shows saved files of previous page in list box.
- 2) “Next page” shows saved files of next page in list box.
- 3) “Clear memory” delete all files saved in directory “work data\analyzer test data” in removable disk.
- 4) “Delete All” deletes all files saved in Analyzer.
- 5) “Delete” deletes current selection file in Analyzer.
- 6) “Export All Files” export all files in selected type (word or \*.cta data files) to removable disk. The saved directory in removable disk is “work data\analyzer test data\”.
- 7) “Export File” export current selected file to removable disk. The saved directory in removable disk is “work data\analyzer test data\”.
- 8) “Cancel” close the read file window form.

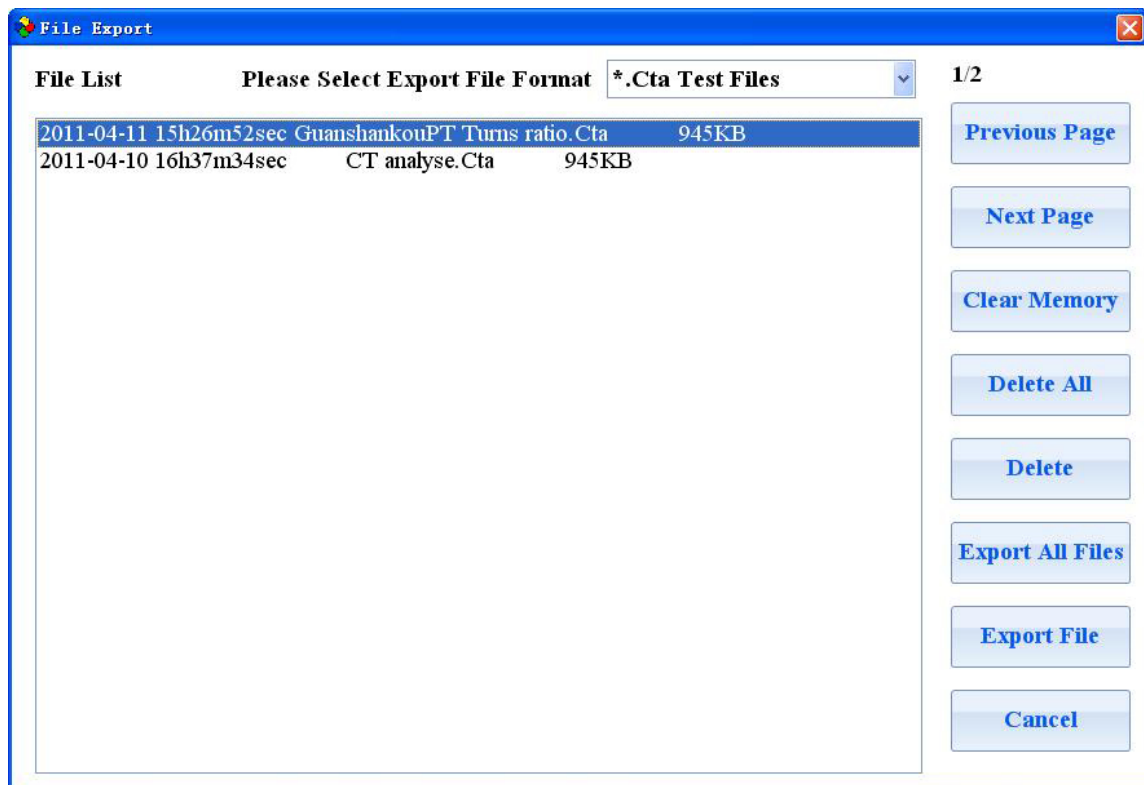


Figure 4.6 File export window form

## 4.2.7 Help

The help document will be loaded when help command button is clicked. The help document will be showed in “\*.pdf” format.

## 4.3 Work Panel

Work panel is located at center of the software panel. The content of work panel is changed according to Analyzer work state. Fox example, panel as figure 4.1 will be loaded if Analyzer works in “wait for new test” state. Panel as figure 4.7 will be loaded if Analyzer works in “View results” state and excitation curve show had been selected.

## 4.4 State Information Panel

The content of state information panel is as following:

- 1) Communication state. If communication between DSP system and computer system is success, online will be showed. Otherwise, off line will be showed. All tests are valid only when Analyzer works in online condition
- 2) Current test name. For example: “CT Analysis”, “Ratio and Phase Error” and so on.
- 3) System time and date
- 4) Current room temperature.

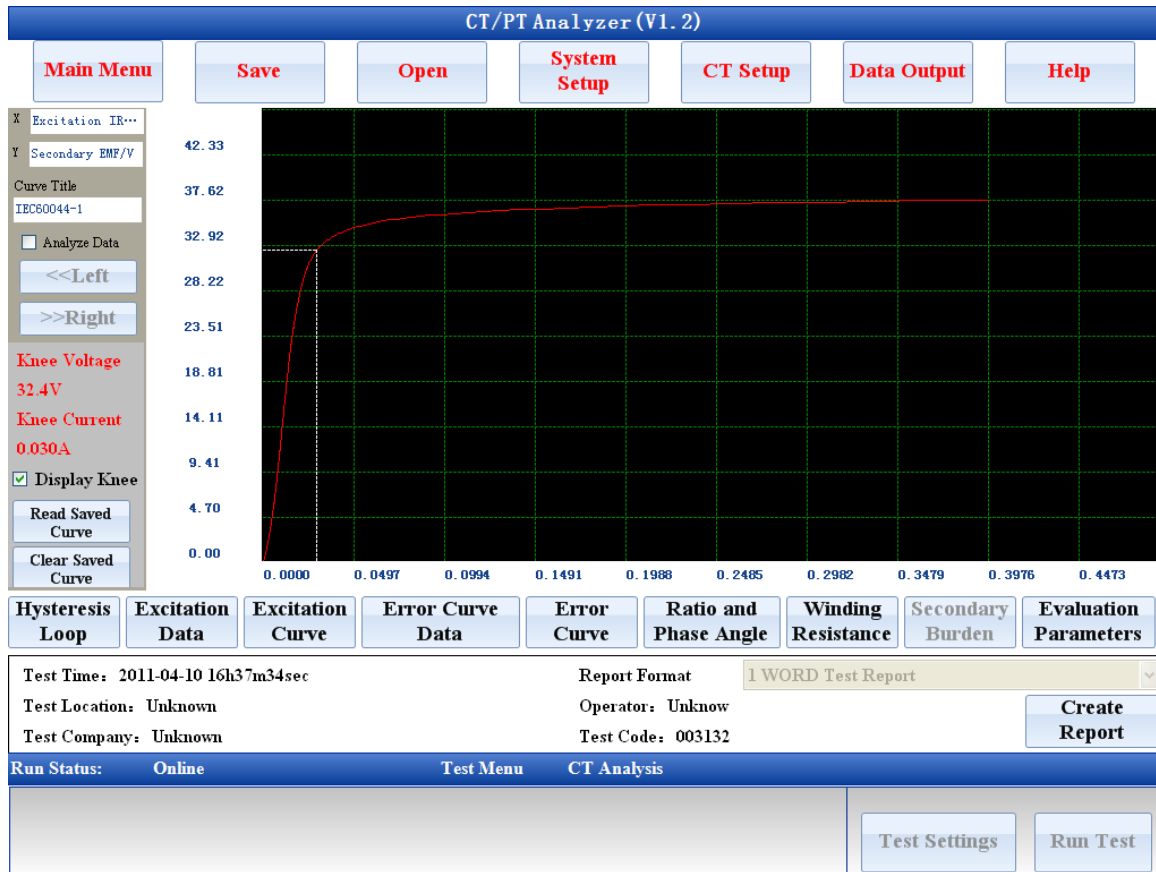


Figure 4.7 Excitation curve show

## 4.5 Test Control Panel

Test control panel includes test parameters setting button and test start button. Test parameters setting button is valid when Analyzer works in “wait for test” state. Special parameters setting window form which is associated to a special test will be loaded when test parameters setting button is clicked.

Test will be started when test start button is clicked and the text of test start button will be changed to be stop. Click this button again, test will be forced to stop. The working state of Analyzer will be changed to be “run” when test is started. And the work state will be changed to be “view results” when test is end or forced to stop.

**Warning: if you want to start a new test in “view saved data results” state, you will have to click “new test” button firstly, and then make Analyzer enter “wait for new test” state.**

**The procedure of a new test start is as following:**

**“Wait for new test”-> “Wait for test”-> “Run”-> “View results”**

## 4.6 Analyzer Start and Close

Analyzer application in computer will be loaded automatically when Analyzer is power on. The Analyzer will stay in “Wait for new test” firstly.

**Please close the Analyzer by software command “Shut Down” firstly, and then cut off power supply when “It is safe to shutdown now” is showed on screen.**

**Please cut off power supply directly in emergency.**

## 5. Test Operation

### 5.1 Common Procedure of Test Run

There are 6 work states which had been listed in Chapter 4. The common work state changing procedures for test in Analyzer are as following:

1) Run a new test from “wait for new test” after Analyzer is power on.

**“Wait for new test”-> “wait for test”-> “Run”-> “View results”**

1> Analyzer will stay at “wait for new test” state after power on.

2> It will be turned to “wait for test” state when one of the test buttons is clicked.

3> Test will start after “start” button is clicked.

4> Analyzer will be turned to “Run” state when start button is clicked.

5> Analyzer will stay at “View results” state when test is end.

2) Run a new test from “view results” work state

**“View results”-> “Wait for new test”-> “Wait for test”-> “Run”-> “View results”**

1> Analyzer will stay at view results when test is end. All results will be showed in working area.

2> Click “new test” button, and then Analyzer will be turned to “wait for new test” state.

3> Other steps are same as procedure 1.

3) Repeat current test

**“View results”-> “Run”-> “View results”**

This procedure is simple. Just click restart button in “View results” state.

### 5.2 CT Analysis

#### 5.2.1 Parameters Setting for CT Analysis

Parameters setting window of CT analysis is showed as figure 5.1. The window of CT analysis and ratio test is the same. All parameters need to be set in ratio and phase error test and CT analysis test as well.

All parameters set in CT analysis are divided to be two parts. First part is associated to CT accuracy and the other is not associated to CT accuracy. The parameters which are not associated to CT accuracy are described in table 5.1. Other parameters which are related to CT accuracy are

described in table 5.2 to table 5.6.

## 5.2.2 Test Procedure for CT Analysis

The test procedures for CT analysis are as following:

- 1) Connect the Analyzer with sample CT according to user manual.
- 2) Click CT analysis button in “wait for new test” state.
- 3) Set parameters for CT analysis test.
- 4) Run test after clicking start button.
- 5) Wait for the end of CT analysis test.
- 6) Analysis test results

**Warning: The test cycle will last for 30 minutes when the saturation of CT is high. The lowest frequency of voltage output is 0.25Hz. Please do not disconnect the connection before test is end.**

The whole test procedure of CT analysis is as following:

Winding resistance test->Degaussing first->Degaussing second-> Accuracy voltage regulation for ratio and phase error measure-> Rough voltage regulation for ratio and phase error measure -> CT Excitation test

- 1) If the parameters of saturation is set to be non-automatically the procedure of first degaussing will be ignored.
- 2) If the saturation of CT is low the procedure of rough voltage regulation will be ignored.

The state of power output will be showed in state information area of software panel.



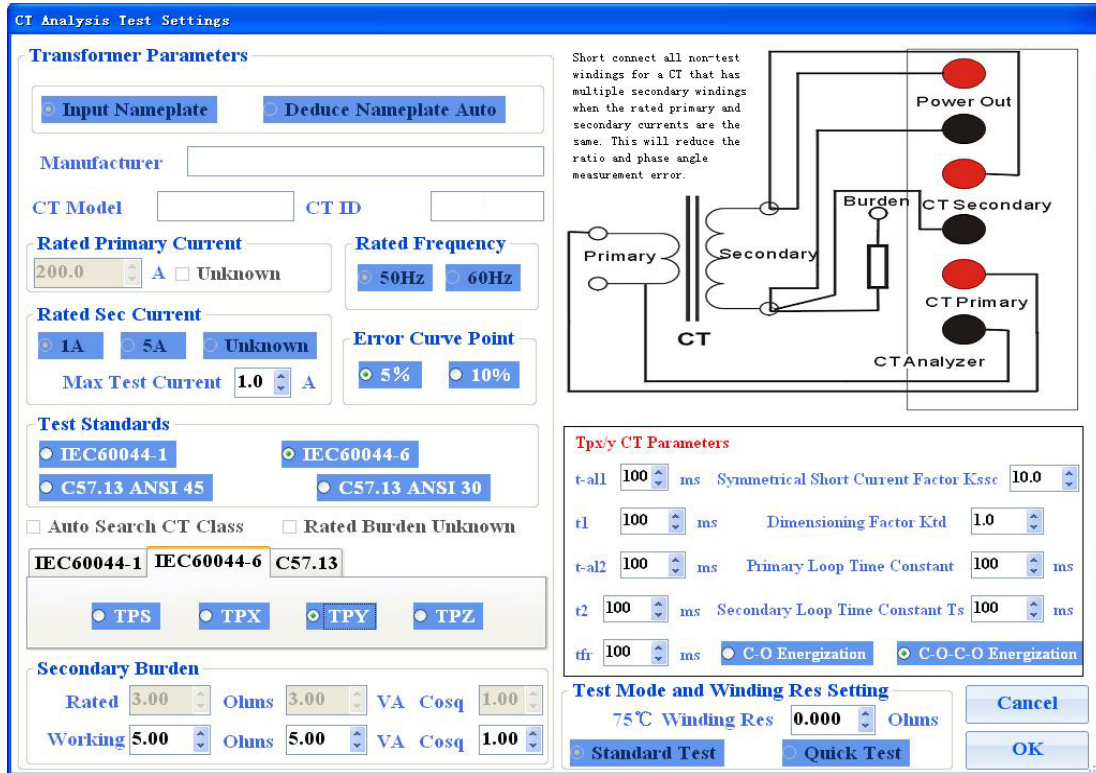


Figure 5.1 Parameters setting for CT analysis

**Warning:** The record points will be little and the rise step voltage will be high if we select Quick Test mode. So the excitation curve will be not smooth for saturation and the excitation parameters will be un-exact if the sample CT's knee point is low (less than 250V) and remanence flux factor is high. Please select standard mode test for this CT.

Standard test will get exact and high resolution excitation curve. But the test period is 2 times of Quick Test.

Table 5.1 Parameters setting for CT analysis

Parameters name	Description
Guess nameplate	This parameter is only response for CT analysis, ratio and phase error test. If the option “Set nameplate” is checked, Analyzer will not guess the nameplate information. Otherwise, Analyzer will guess nameplate information according to missing item. The items which can be guessed in nameplate include rated primary current, rated secondary current and CT accuracy.
Manufacturer	Manufacturer in word test report
CT type	CT type in word test report
CT ID	CT ID in word test report and saved file name
Rated primary current	Rated primary current. If it is missed, Analyzer will guess the value according to turns ratio measured and rated secondary current.
Rated secondary current	Rated secondary current. If it is missed, Analyzer will guess the value

	according to winding resistance measured.
Rated frequency	Rated frequency for CT. Analyzer will set the voltage frequency in this value in ratio and phase error measurement test
Error curve calculation	This parameter is valid in IEC60044-1 protection CT. Analyzer will calculate 5% or 10% error line curve according to the selection of this item.
Test Standards	The sample CT is designed according to international standard. Different standard selected in test will get different test results.
CT Accuracy	The accuracy series defined in a special standard
Secondary Burden	The results calculated in CT analysis and ratio test are associated to secondary burden. Different burden connected in CT secondary loop circuit will get different error results. The calculation in Analyzer is divided to be two burden conditions. Rated burden: the rated burden value get from CT nameplate Work burden: The actual burden value measured from secondary loop circuit of sample CT. Burden set range: 0~100.00 power factor: 0~1.00
Winding resistance in 75 Celsius degree	Winding resistance in 75 Celsius degree marked in nameplate of CT.

Table 5.2 Parameters setting for IEC60044-1 measurement CT

Parameters name	Description
FS	Instrument security factor in nameplate. Range 1~300
Ext	Extended ratio error calculation point. Range 0%~400%

Table 5.3 Parameters setting for IEC60044-1 5P/10P/5PR/10PR CT

Parameters name	Description
ALF	Accuracy limit factor in nameplate. Range 1~300
Max primary current	Max current in the primary circuit of CT in grid fault state

Table 5.4 Parameters setting for IEC60044-1 PX CT

Parameters name	Description
ALF	Accuracy limit factor in nameplate. Range 1~300
Ktd	Transient dimension factor in nameplate. Range 1~300
Accuracy limit voltage	Accuracy limits voltage in nameplate. Range 0~10000.00
Accuracy limit current	Accuracy limits current in nameplate. Range 0~9.9999A

Table 5.5 Parameters setting for IEC60044-6 TPS CT

Parameters name	Description
Kssc	Symmetric short circuit current factor. Range 1~300

Ktd	Transient dimension factor in nameplate. Range 1~300
Tp	Primary loop time constant. Range 0~10000ms
Val	Accuracy limits voltage in nameplate. Range 0~10000V
Ial	Accuracy limits current in nameplate. Range 0~9.9999A

Table 5.6 Parameters setting for IEC60044-6 TPX/TPY CT

Parameters name	Description
Kssc	Symmetric short circuit current factor. Range 1~300
Ktd	Transient dimension factor in nameplate. Range 1~300
Tp	Primary loop time constant. Range 0~10000ms
Ts	Secondary loop time constant. Range 0~100000ms
Duty cycle	C-O or C-O-C-O duty cycle selection. This parameter is response for calculation and evaluation.
t1	The duration of first current flow. Range 0 ~ 10000ms. This parameter is response for calculation and evaluation.
t2	The duration of second current flow. Range 0 ~ 10000ms. This parameter is response for calculation and evaluation.
t-al1	The time specified accuracy being maintained during in first current flow. Range 0~10000ms. This parameter is response for calculation and evaluation.
t-al2	The time specified accuracy being maintained during in second current flow. Range 0~10000ms. This parameter is response for calculation and evaluation.
tfr	Time interval between interruption and re-application of primary short-circuit current during a circuit breaker auto-reclosing duty cycle. Range: 0~5000ms

Table 5.7 Parameters setting for IEC60044-6 TPZ CT

Parameters name	Description
Kssc	Symmetric short circuit current factor. Range 1~300
Ktd	Transient dimension factor in nameplate. Range 1~300
Tp	Primary loop time constant. Range 0~10000ms
Ts	Secondary loop time constant. Range 0~100000ms

Table 5.8 Parameters setting for C57.13 CT

Parameters name	Description
RF	Continuous thermal current rating factor in nameplate. Range 0~10.00 If the parameter is not 0, Analyzer will calculate the ratio and phase

	error at $RF \times$ Rated current. This parameter is response for calculation and evaluation.
VB	Rated secondary voltage in nameplate. This parameter is response for calculation and evaluation. Range 0~10000.0V

### 5.2.3 Test Results for CT Analysis

Panel as figure 4.7 will be showed on LCD screen firstly when CT analysis test is end. Click the button on the bottom of the panel you can get different results item for CT analysis. The functions of those buttons are as following:

#### 1) Hysteresis Loop Curve and Data

Click “Hysteresis Loop” button, the hysteresis loop curve will be showed on the screen as figure 5.2. This curve is the saturation hysteresis loop curve which is measured in a constant frequency sine voltage. The test frequency is listed on the left of the panel. The X coordinates of the curve is the instantaneous current value and the Y coordinates of the curve is the core flux value. The whole hysteresis loop curve is consisted by rise curve and fall curve. Click “data analyze” check box you can read the current, rise curve flux value and fall curve flux value from the curve. Click “hysteresis loop data”, all rising curve data and fall curve data will be listed in the window.

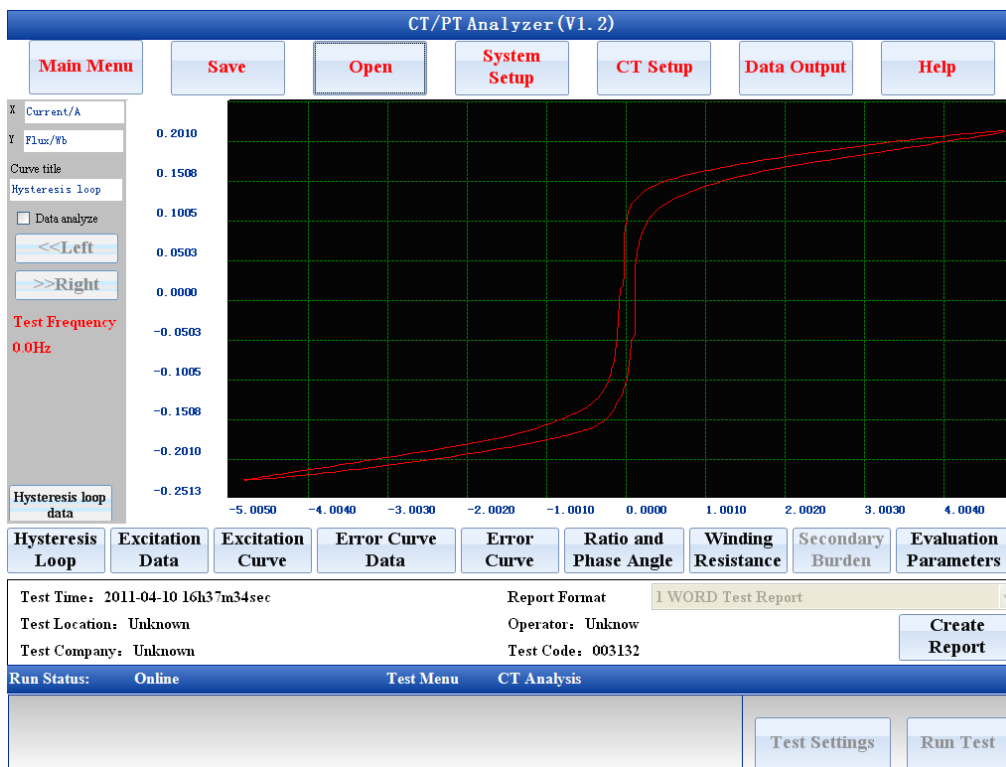


Figure 5.2 Hysteresis loop curve

## 2) Excitation Data

Panel as figure 5.2.1 will be showed on LCD screen when Excitation Data button is clicked. All data which construct the excitation curve will be showed in the list box. Drag the slide on the right of the panel you can view all data in the list box.

The knee voltage and current of excitation curve are showed on the bottom of the panel. There is a search function excitation data show panel. You can find the excitation current quickly by searching the excitation point according to excitation voltage.

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Main Menu Save Open System Setup CT Setup Data Output Help

**Excitation Data**

Group	Excitation I	Excitation V	Group	Excitation I	Excitation V
1	0.0000A	0.000V	187	0.0133A	19.00V
2	0.0004A	0.105V	188	0.0133A	19.11V
3	0.0005A	0.206V	189	0.0134A	19.21V
4	0.0007A	0.307V	190	0.0134A	19.31V
5	0.0008A	0.410V	191	0.0135A	19.41V
6	0.0010A	0.512V	192	0.0136A	19.52V
7	0.0011A	0.615V	193	0.0136A	19.62V
8	0.0013A	0.715V	194	0.0137A	19.72V
9	0.0014A	0.816V	195	0.0137A	19.82V
10	0.0015A	0.918V	196	0.0138A	19.92V
11	0.0017A	1.022V	197	0.0139A	20.02V
12	0.0018A	1.123V	198	0.0139A	20.13V

**Knee Point**

Knee Voltage  V Knee Current  A Find Excitation Data  V  A

Hysteresis Loop Excitation Data Excitation Curve Error Curve Data Error Curve Ratio and Phase Angle Winding Resistance Secondary Burden Evaluation Parameters

Test Time: 2011-04-10 16h37m34sec Report Format: 1 WORD Test Report  
 Test Location: Unknown Operator: Unknown Create Report  
 Test Company: Unknown Test Code: 003132

Run Status: Online Test Menu CT Analysis

Test Settings Run Test

Figure 5.2.1 Excitation data

## 3) Excitation Curve

The panel of excitation curve is as figure 5.3. The content of excitation curve panel includes following items.

- 1) Excitation curve.
- 2) Knee point voltage and current.
- 3) Knee point is showed in check box. If the box is checked the knee point will be marked on the curve. Otherwise there is no mark on the curve.
- 4) Excitation curve analysis buttons and data are showed in panel. If excitation curve analysis check box is checked there is vertical line on the excitation curve. The voltage and current value

which is the same position as the vertical line will be showed on the top panel.

5) Excitation curve compares with saved curve. The saved curve can be loaded to current results panel when “read saved curve” button is clicked. Both two curves are drawn on the same scope as figure 5.3, you can find the exact change in transformer excitation curve by this function. The saved curve will be cleared when “clear saved curve” button is clicked.

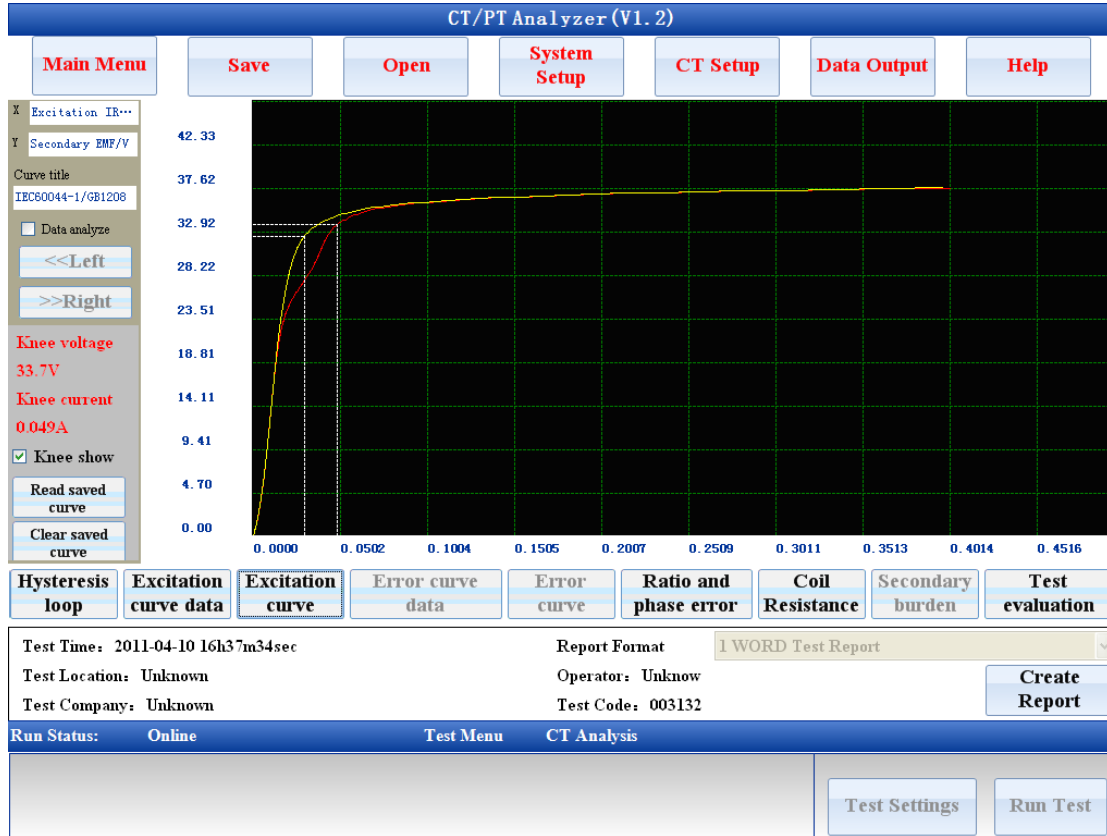


Figure 5.3 Excitation curve

#### 4) Error Curve Data and Error Curve

There are error curve data and error curve results when the accuracy of CT is set to be IEC60044-1 protection type. The panel of error curve data and error curve are showed as figure 5.4 and figure 5.2. There is no knee point in error curve.

The X coordinates of error curve is maximum burden value allowed. The Y coordinates of error curve is the times of rated primary current. If the value of secondary burden over than the maximum value in error curve the ratio error of sample CT would over than 10%(or 5%).

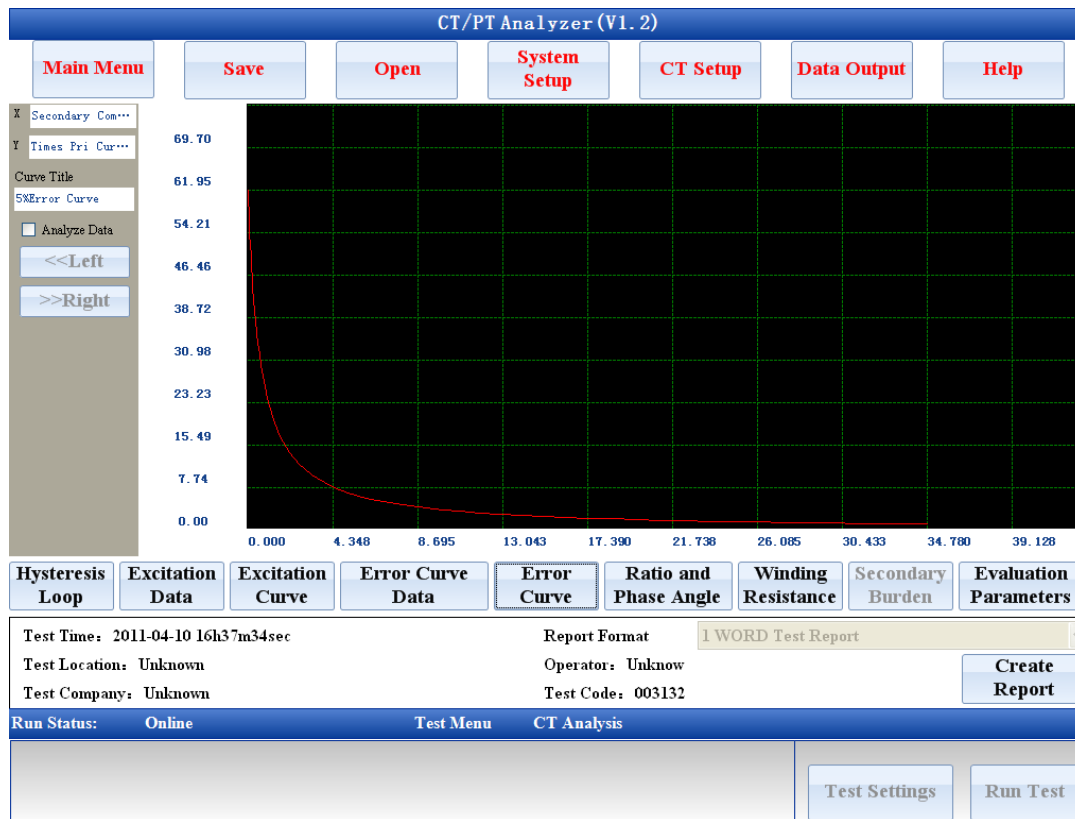


Figure 5.4 Error curve

### 5) Ratio and Phase Angle Error

The ratio error, phase error, turns ratio, turns ratio error and polarity will be showed on the panel as figure 5.5 when ratio and phase error or CT analysis test is end. The definitions of parameters in figure 5.5 are described as table 5.9.

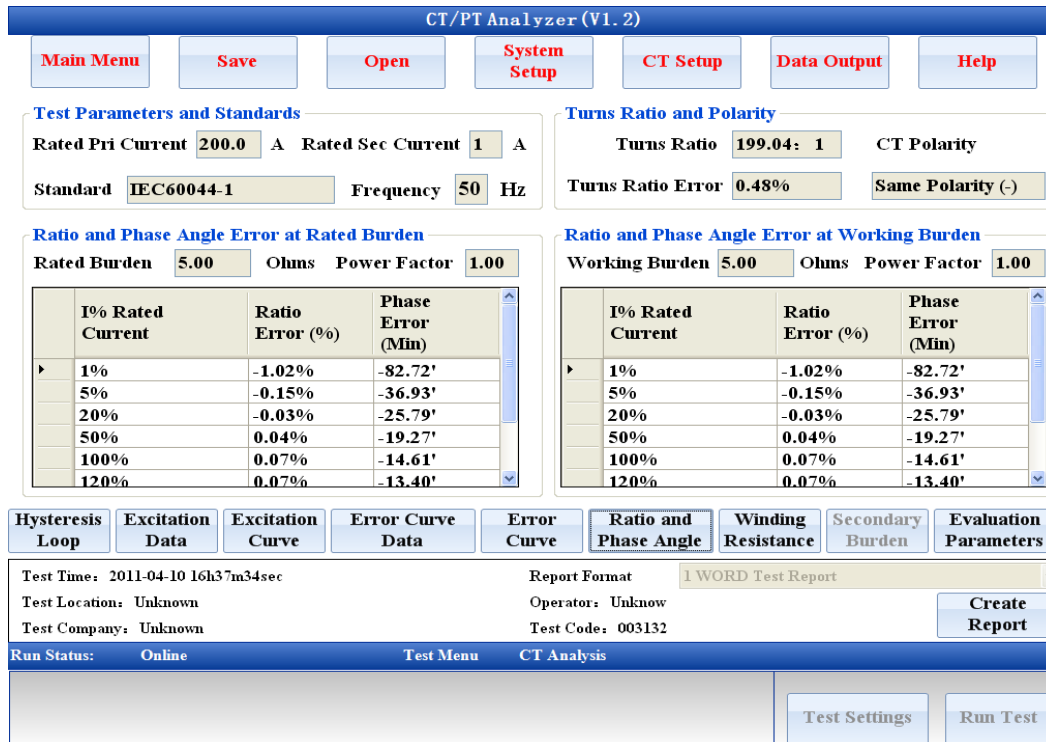


Figure 5.5 Results of ratio and phase error

Table 5.9 Ratio and phase error results panel

Parameters Name	Description
Rated primary current	Response for turns ratio error calculation
Rated secondary current	Response for turns ratio error calculation and test procedure control
Standard	Response for ratio and phase error calculation
Test frequency	Response for ratio and phase error test procedure control
Turns ratio	Turns ratio measured
Turns ratio error	Turns ratio error. Calculated by (Turns ratio measured-Rated current ratio) /Rated current ratio. Rated current ratio= (rated primary current/rated secondary current)
Polarity	The polarity measured of current connection. The polarity is either same polarity(-) or reverse polarity(+)
Rated burden	Rated burden marked in nameplate. It is response for ratio and phase error calculation
Power factor of Rated burden	Power factor of rated burden. It is response for ratio and phase calculation
Ratio and phase error in rated burden	Ratio and phase error which are calculated by rated burden
Work burden	The actual burden connected to the sample CT secondary circuit



Power factor of work burden	Power factor of work burden. It is response for ratio and phase calculation
Ratio and phase error in work burden	Ratio and phase error which are calculated by work burden

### 6) Winding Resistance

Panel as figure 5.6 will be showed on LCD screen if “winding resistance” button is clicked when CT analysis is end.

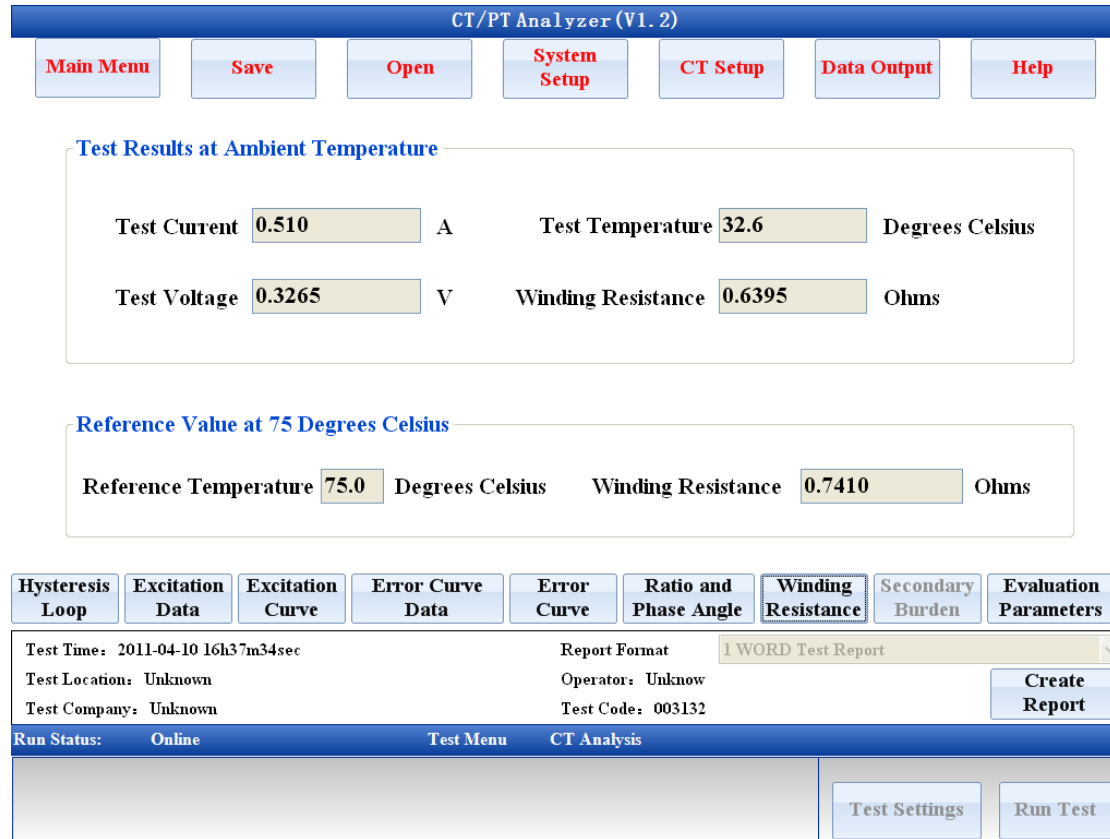


Figure 5.6 Results of winding resistance

The parameters definitions in winding resistance panel are as table 5.10

Table 5.10 results of winding resistance

Parameters name	Description
Test current	The current applied to CT secondary winding
Test temperature	The actual atmospheric temperature of test start
Test voltage	The DC voltage measured from CT winding
Winding resistance	Winding resistance in test temperature
Reference temperature	The reference temperature marked in CT nameplate
Winding resistance in reference	The formula for winding resistance in reference temperature is

temperature	$R_{ref} = R \times (1 + TK_{copper} (T_{ref} - T_{meas}))$ <p>Kcopper is the temperature factor for copper material</p>
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**7) Evaluation Parameters**

The panel of evaluation parameters is showed as figure 5.7. The excitation result items are different for different accuracy CT. Please refer to Chapter 6 for detailed information.

The evaluation result items are showed in bottom list box of figure 5.7. The evaluation items of CT analysis are constructed by different single item evaluation result. If one of the evaluation items is fail the item will be marked in red color. The final evaluation passes only when all single item evaluation pass. Please refer to Chapter 6 for detailed definition of evaluation for different accuracy CT.

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Main Menu	Save	Open	System Setup	CT Setup	Data Output	Help
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Calculation Parameters	Value	Calculation Parameters	Value
Accuracy Factor ALF at Rated Burden	6.6	Saturation Conductor Ls	3mH
Error at ALF at Rated Burden	Error	Un-saturation Conductor Lm	3.92H
Accuracy Factor ALF at Working Burden	6.6	Remanence Flux Kr	93.0%
Error at ALF at Working Burden	Error	Rated Secondary Max EMF	57.410
Secondary Loop Time Constant Ts at Rated Burden	0.682s	Knee Point Secodary EMF	32.373
Secondary Loop Time Constant at Working Burden	0.682s	Dimensioning Factor Ktd	11277.82

Evaluation Parameters	Evaluation Standards	Results
Accuracy Factor ALF at Rated Burden 6.6	>Accuracy Factor ALF from Nameplate 10.0	Fail
Ratio Error at 100% Rated Current at Rated Burden(0.07%)	Maximum Error 3.00%	Pass
Accuracy Factor ALF at Working Burden 6.6	>Accuracy Factor ALF from Nameplate 10.0	Fail
Ratio Error at 100% Rated Current at Working Burden(0.07%)	Maximum Error 3.00%	Pass

**Evaluation Standards IEC60044-1 10PClass** **CT Evaluation Fail**

Hysteresis Loop	Excitation Data	Excitation Curve	Error Curve Data	Error Curve	Ratio and Phase Angle	Winding Resistance	Secondary Burden	Evaluation Parameters
-----------------	-----------------	------------------	------------------	-------------	-----------------------	--------------------	------------------	-----------------------

Test Time: 2011-04-10 16h37m34sec	Report Format: 1 WORD Test Report
Test Location: Unknown	Operator: Unknow
Test Company: Unknown	Test Code: 003132

Run Status: Online Test Menu   CT Analysis

	Test Settings	Run Test
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Figure 5.7 Excitation and evaluation results panel

**5.3 CT Ratio and Phase Error Test**

**5.3.1 Parameters setting for ratio and phase error test**

The panel of ratio and phase error test is the same as CT analysis test. Please reference to Chapter 5.2.

### 5.3.2 Test procedure for ratio and phase error test

The connection and test procedure is the same as CT analysis test except excitation curve measurement. There is no excitation test in ratio and phase error test. The typical procedure for ratio and phase error test is as following:

**Winding resistance test->Degaussing first->Degaussing second-> Accuracy voltage regulation for ratio and phase error measure-> Rough voltage regulation for ratio and phase error measure**

- 1) If the parameters of saturation is set to be non-automatically, the procedure of first degaussing will be ignored.
- 2) If the saturation of CT is low, the procedure of rough voltage regulation will be ignored.

### 5.3.3 Ratio and phase error results

The panel of ratio and phase error results is the same as CT analysis test. Please reference to Chapter 5.2.

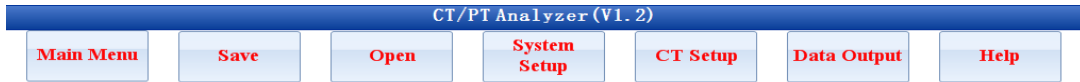
## 5.4 CT Winding Resistance Test

There is no parameters which need to be set except CT ID in winding resistance test. Analyzer injects a 0.5A DC current to CT secondary winding when winding resistance test is started. The winding resistance value will be stable when winding was charged to saturation. The test records the winding resistance, current temperature, test current and winding voltage when the test is end.

The results of winding resistance test include winding resistance in current temperature, actual test current, actual winding voltage and winding resistance in reference temperature. The results panel of winding resistance test is the same as in CT analysis test.

## 5.5 CT Polarity Test

There is no parameters which need to be set except CT ID in polarity test. Analyzer injects AC voltage to CT secondary winding when polarity test is started. Both primary and secondary winding voltage will be sampled at the same time. The test will be ended when primary voltage reached a threshold value or secondary voltage reached to the maximum value.



# Same polarity (-)

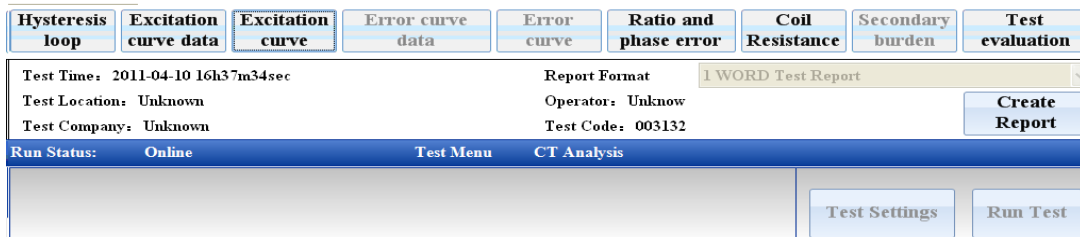


Figure 5.8 Test results of polarity test

If there is a normal end in polarity test, the result will be either same polarity (-) or reverse polarity (+). The abnormal end conditions are as following:

- 1) The test is stopped manually.
- 2) There is wrong connection in primary and secondary.

The test result is same polarity if the phase difference is in primary voltage and secondary voltage is less than 90 degree. Otherwise, the test result is reverse polarity.

The results panel of polarity test is showed as figure 5.8.

## 5.6 CT Secondary Burden Test

### 5.6.1 Parameters setting for secondary burden test

The parameters which are applied to CT burden test include test current, test frequency and CT ID. The panel of secondary burden setting is showed as figure 5.9.

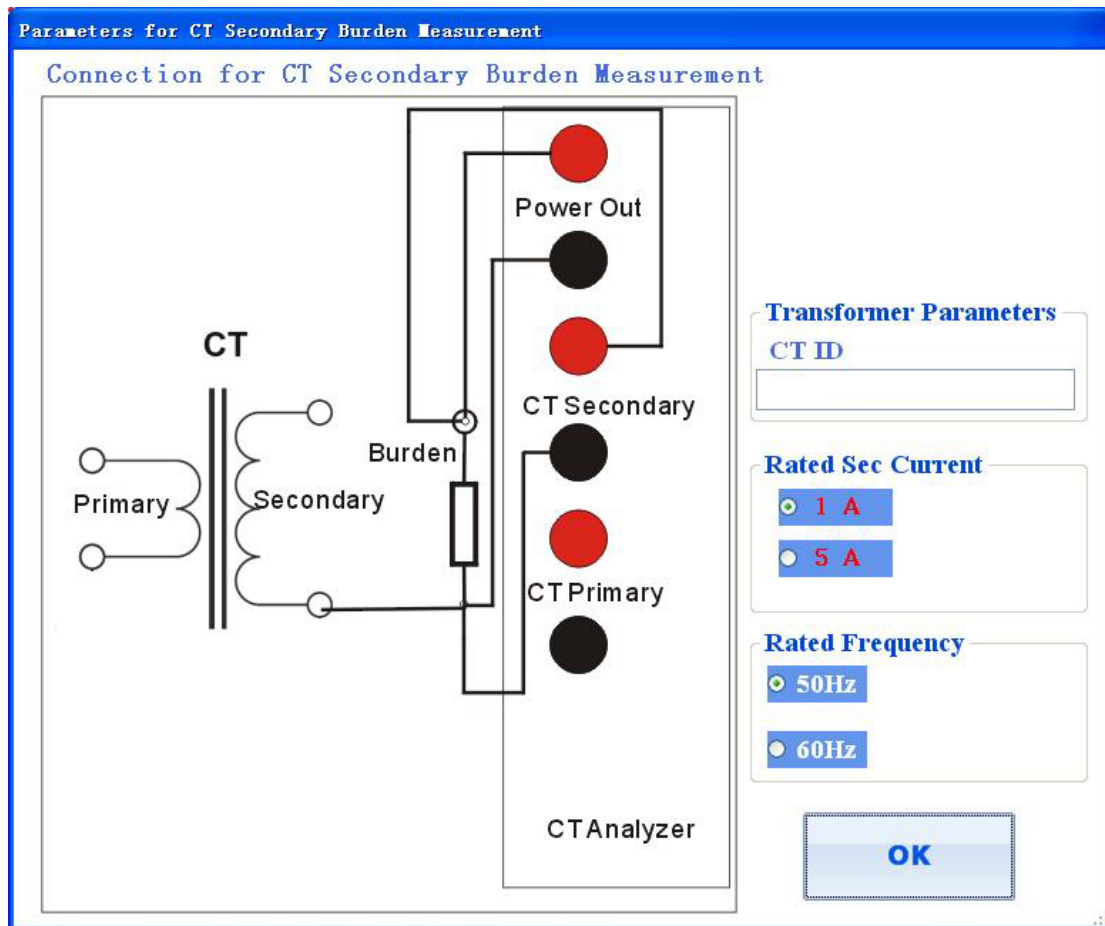


Figure 5.9 Parameters setting for secondary burden test

The definitions of those parameters are as following:

1) Test current

Test current is RMS value of current which will be injected to CT secondary circuit.

2) Test frequency

Test frequency is the frequency of test current which will be injected to CT secondary circuit.

There are 50Hz and 60Hz for selection in test.

3) CT ID

It is construction of saved file name.

### 5.6.2 The test procedure for secondary burden test

The test current is divided to be two ranges in secondary burden test. The current value and measurement range are as following:

1) Test current 0.5A (RMS), measurement range 0~80ohm

2) Test current 0.25A (RMS), Measurement range 0~160ohm

Analyzer will inject AC 0.5A (or 0.25A) constant sine current to CT secondary circuit when

secondary burden test is starting.

### 5.6.3 The test results of secondary burden test

The results panel of CT secondary burden is showed as figure 5.10.

Figure 5.10 Test results of CT secondary burden test

The results parameters of CT secondary burden test are as table 5.11.

Table 5.11 Test results of CT secondary burden test

Parameters Name	Description
Rate secondary burden	Rated secondary burden showed in VA mode
Rated power factor	Power factor of rated secondary burden
Test current	The RMS value of test current
Test voltage	The RMS value measured from CT secondary loop.
Test frequency	The frequency of test current
Work burden	The burden value measured from CT secondary loop. It is showed in VA.
Work power factor	Power factor of work burden

Work resistance	The resistance of work burden. It is showed in ohm
-----------------	---

### 5.7 PT Winding Resistance Test

The parameters setting panel of PT winding resistance test is showed as figure 5.11. There are two parameters need to be set in this test. PT ID in PT winding resistance test has no effect in test control. There are three selection items for test current. Please select right current according to sample resistance range.

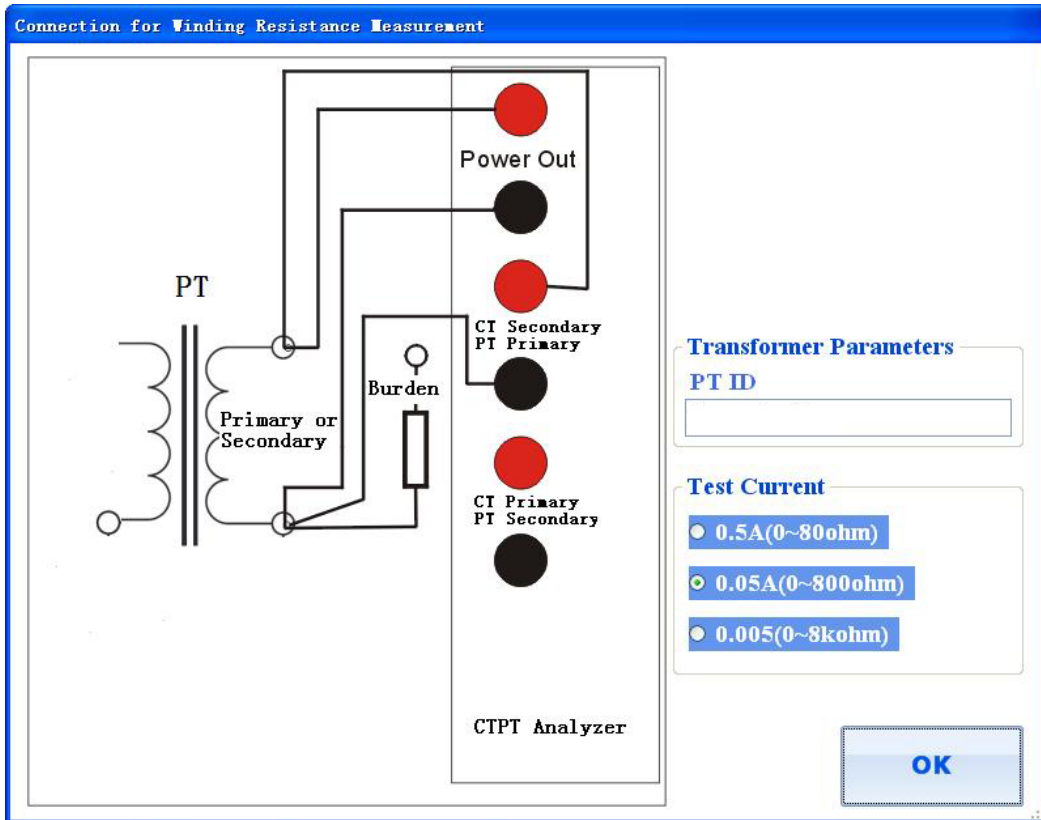


Figure 5.11 Parameters setting for PT winding resistance test

The results of PT winding resistance test include winding resistance in current temperature, actual test current, actual winding voltage. The results panel of winding resistance test is same as in CT winding resistance except resistance in reference temperature.

### 5.8 PT Polarity Test

There is no parameter which need to be set except PT ID in PT polarity test. Analyzer injects AC voltage to PT primary winding when polarity test is started. Both the primary and secondary winding voltage will be sampled at the same time. The test will be ended when secondary voltage

reached a threshold value or primary voltage reached to the maximum value. The results panel of PT polarity is same as CT polarity test.

If there is a normal end in PT polarity test, the result will be either same polarity (-) or reverse polarity (+). The abnormal end conditions are as following:

- 1) The test is stopped manually.
- 2) There is wrong connection in primary and secondary.

The test result will be same polarity if the phase difference is in primary voltage and secondary voltage is less than 90 degree. Otherwise, the test result is reverse polarity.

## 5.9 PT Secondary Burden Test

### 5.9.1 Parameters setting for PT secondary burden test

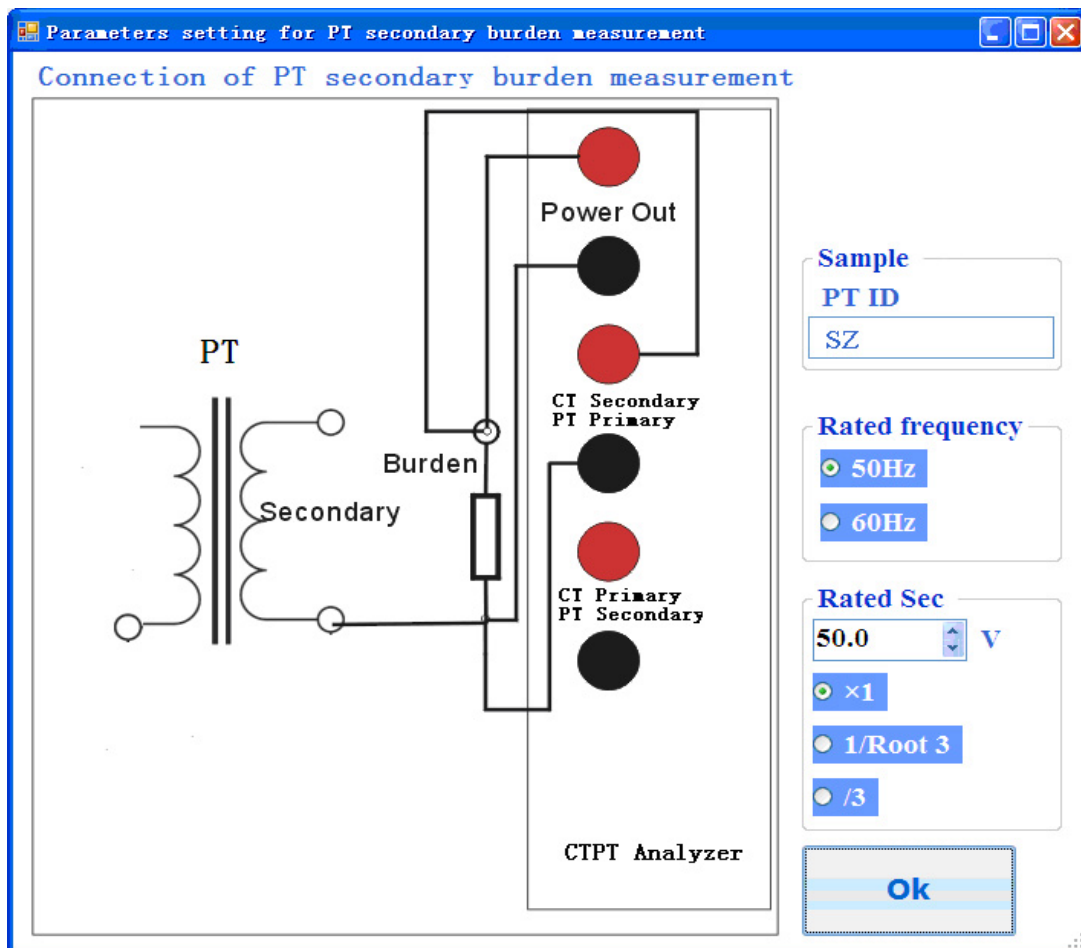


Figure 5.12 Parameters setting for PT secondary burden test

The parameters applied to PT burden test are rated secondary voltage, test frequency and PT ID. The panel of PT secondary burden setting is showed as figure 5.12.



The definitions of those parameters are as following:

1) Rated secondary voltage

The value measured by Analyzer in PT secondary loop is complex resistance. Then Analyzer calculates the burden by rated secondary voltage and the resistance measured. The unit format of PT burden in Analyzer is VA. The formula of burden calculation is :

$$V_{rated} * V_{rated} / R.$$

$V_{rated}$  is the rated secondary voltage

$R$  is the mod of complex resistance measured.

2) Test frequency

Test frequency is that the frequency of test voltage which will be injected to PT secondary loop. There are 50Hz and 60Hz for selection in test.

3) PT ID

It is a part of saved file name.

### 5.9.2 The test procedure for PT secondary burden test

Analyzer injects voltage to PT secondary loop when test is started. The test would be end in one of the follow two conditions:

1) The current of circuit reach at 0.2A

2) The voltage of Analyzer output reach at rated secondary voltage of PT

The results panel of PT secondary burden test is the same as CT secondary burden test. But there is no rated burden value showed in PT burden test.

## 5.10 PT Ratio and Phase Angle Error Test

PT ratio test is different with CT ratio test. There is no ratio error at preset burden measured in PT ratio test in Analyzer. Only turns ratio, turns ratio error, winding resistance in PT primary and polarity will be measured in PT ratio test. The parameters setting panel of PT ratio test is as figure 5.13.

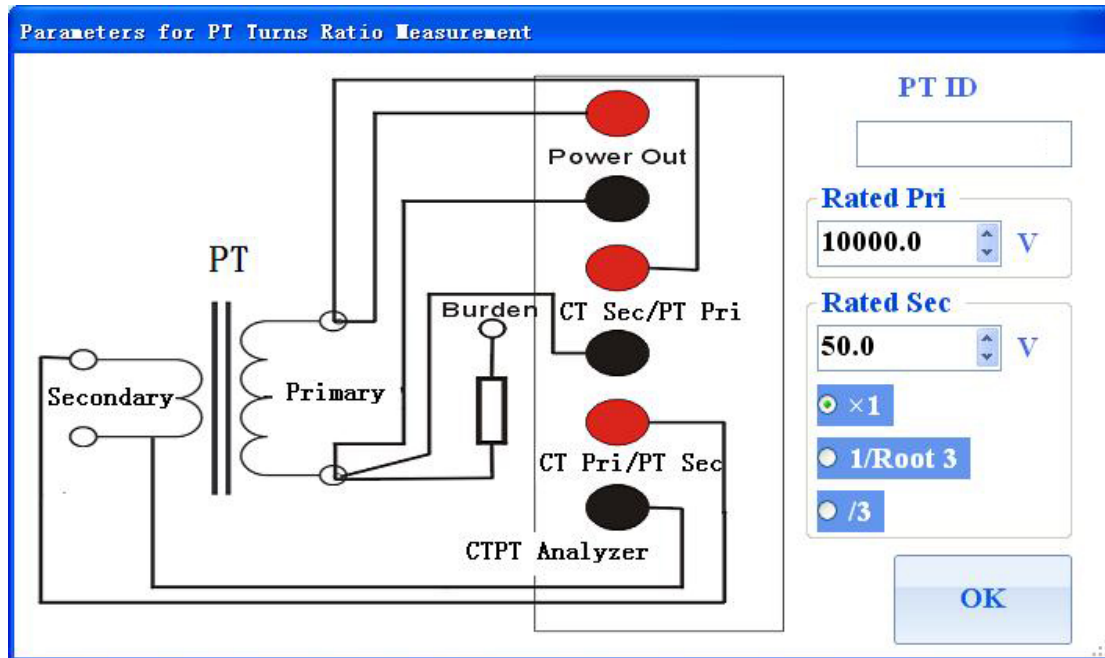


Figure 5.13 Parameters setting for PT ratio test

- 1) PT ID is a part of saved file name.
- 2) Rated primary voltage and rated secondary voltage are applied to calculate the standard turns ratio and turns ratio error of PT.

The Analyzer will output a sine voltage which is from 10V~180V to the primary of PT, when PT ratio test is started. The Analyzer will measure the inductive voltage from secondary winding of PT and primary voltage at the same time. The ratio and phase angle error is calculated from those two voltage values.

The input resistance of PT primary terminals of the Analyzer is more than 100Mohm. So if the PT secondary circuit keeps open when testing, both the test voltage and secondary burden are low in this test procedure. The effective of burden and excitation losses to the accuracy are not included in this test result. If the secondary burden circuit of PT keeps connected when testing, the effective of burden to accuracy will be included in the test result.

The test results panel of PT Ratio is as figure 5.14. Turns Ratio, Turns Ratio Error, Phase Angle Error and Polarity will be showed on this panel.

CT/PT Analyzer (V1.3)						
Main Menu	Save	Open	System Setup	CT Setup	Data Output	Help

Test Parameters and Standards	Turns Ratio and Polarity
Rated Pri Voltage: 10000.0 V	Turns Ratio: 9999.41: 57.735
Rated Sec Voltage: 57.735 V	Turns Ratio Error: 0.01%
Standard: IEC60044-2	PT Polarity: Same Polarity (-)
	Angle Error: 0.07 Degree (4.0Min)

Hysteresis Loop	Excitation Data	Excitation Curve	Error Curve Data	Error Curve	Ratio and Phase Angle	Winding Resistance	Secondary Burden	Evaluation Parameters
Test Time: 07-24-2013 18h24m44sec			Report Format: 1 WORD Test Report					
Test Location:			Operator:			Create Report		
Test Company:			Test Code: 002857			Create Report		
Run Status: Offline		Test Menu						
						Test Settings	Run Test	

Figure 5.14 Test results of PT ratio

## 5.11 PT Excitation and Ratio Error Test

### 5.11.1 PT Excitation and Ratio Test Setting

The Parameters setting window for PT Excitation and Ratio Error Test is as figure 5.15 and the definition of parameters is as table 5.12

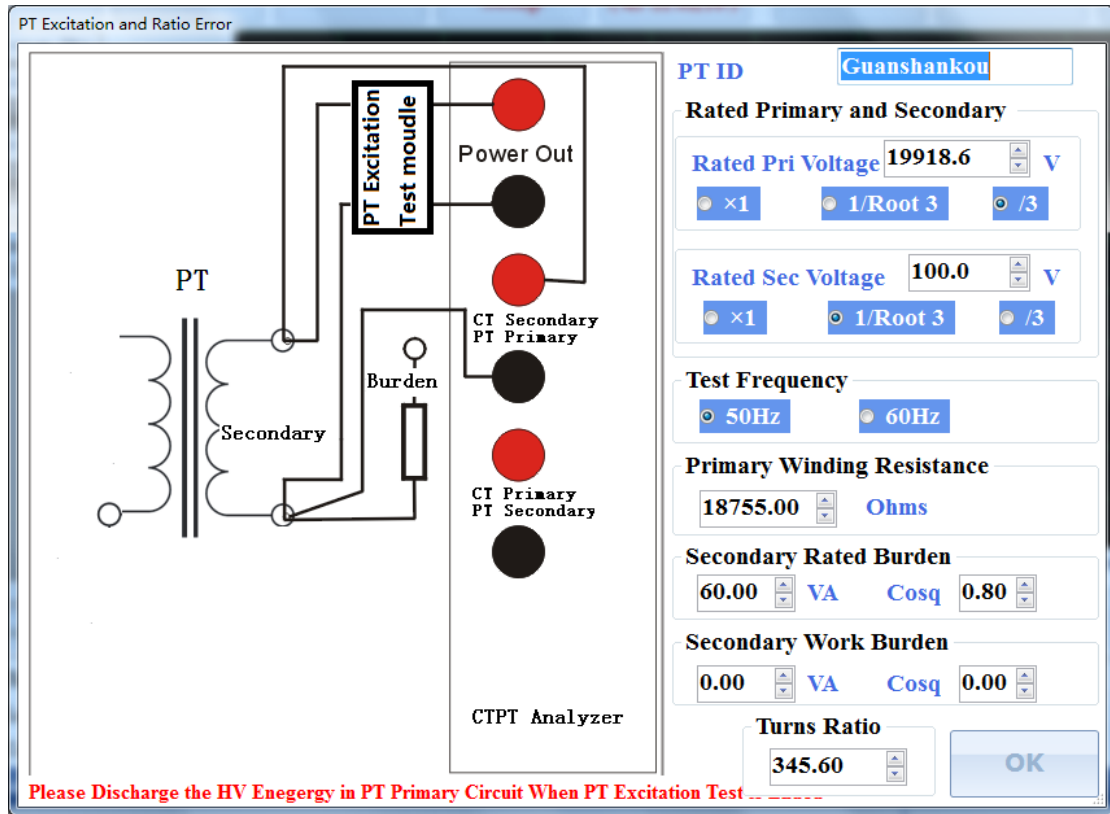


Figure 5.15 Parameters Setting Window for PT Excitation and Ratio Error Test

Table 5.12 Parameters Description for PT Excitation and Ratio Error Test

Parameters Name	Description
PT ID	Applied in the test report and saved file name. It is a part of the saved file name.
Rated Primary Voltage	Set the primary voltage for standard ratio calculation. The primary voltage is consisted by two parts. The multiply of the two parts is the final voltage value
Rated Secondary Voltage	Set the secondary voltage for standard ratio calculation. The secondary voltage is consisted by two parts. The multiply of the two parts is the final voltage value
Test Frequency	The rated frequency of voltage transformer. This value will affects the test frequency of excitation and the calculation of ratio error and phase angle error
Primary Winding Resistance	The winding resistance of voltage transformer primary winding. This value will affects the calculation of ratio error and phase angle error
Secondary Rated Burden	The burden of secondary circuit. This value will affects the calculation of ratio error and phase angle error at rated burden

Secondary Working Burden	The burden of secondary circuit. This value will affects the calculation of ratio error and phase angle error at working burden
Turns Ratio	Turns ratio of voltage transformer. This value will affects the calculation of ratio error and phase angle error

### 5.11.2 The Test Results of PT Excitation and Ratio Error Test

The test results of PT Excitation and Ratio Error Test are as follow:

- 1> Excitation current at 20%, 50%, 80%, 100% and 120% of rated secondary voltage.
- 2> Winding Resistance of secondary winding of voltage transformer
- 3> Ratio error and phase angle error at 80%, 100% and 120% of rated secondary voltage at rated burden
- 4> Ratio error and phase angle error at 80%, 100% and 120% of rated secondary voltage at working burden

Click at “Evaluation Parameters”, “Winding Resistance” or “Ratio and Phase Angle” buttons to view all those test results in the test results window.

## 5.12 Create Test Report

You can create word test report in Analyzer when it is in “view results” or “View saved results” work state. Also this word report can be made in computer application offered by us.

The format of word report is MS word 2003. The header and footer of word report can be set in system setting panel. The appearance of CT analysis test word report is showed as figure 5.17.

CT analysis report

---

### CT analyse test report

**Test setting**

Test time: 2011-03-27 11h26m39sec  
 Test address:  
 Test company: TOPTEST  
 Operator: Unknown Test code: 001994

**2 Test results**

**CT parameters**

Manufacturer:  
 CT model:  
 CT ID:  
 Rated Pri current: 200.0A Rated Sec current: 1.0A  
 Test Frequency: 60.0Hz  
 Test standards: IEC60044-1  
 Accuracy class: 10P Class

**Ratio and phase error at rated burden(Rated burden 0.2VA/Power factor 1.00)**

%Rated Pri current	Ratio error(%)	Phase error(min)
1%	-0.95%	-72.23'
5%	0.21%	-14.61'
20%	0.39%	-5.73'
50%	0.42%	-4.49'
100%	0.42%	-3.82'
120%	0.43%	-3.68'
Est100.0%	0.42%	-3.82'

**Ratio and phase error at work burden(Work burden 0.2VA/Power factor 1.00)**

%Rated Pri current	Ratio error(%)	Phase error(min)
1%	-0.95%	-72.23'
5%	0.21%	-14.61'

CT TEST REPORT

Figure 5.17 CT analysis test word report

## 6. Evaluation and Nameplate Guess

### 6.1 Evaluation

#### 6.1.1 Definition of evaluation

The definition of evaluation is to compare the test results with the limit of selected test standard. The evaluation will pass if all test results meet the requirements of selected standard. Otherwise, the evaluation will be failure.

Many parameters of CT are associated with the secondary burden. So the test results will be different if the secondary burden connected to CT is different.

The evaluation module has 3 modes for selection. They are evaluation noting, evaluation for work burden only and evaluation for both rated and work burden.

1) The evaluation procedure will be closed if evaluation nothing is checked.

2) If the evaluation for work burden only is checked, Analyzer will compare test results calculated in work burden only with selected standards. The results calculated from rated burden will be ignored. If all those parameters meet the requirements of selected standards, the final evaluation will be passed. Otherwise, the final evaluation is failure.

3) If the evaluation for both rated and work burden selected, Analyzer will compare both test results calculated in rated and work burden with selected standards. If all those parameters meet the requirements of selected standards, the final evaluation will be passed. Otherwise, the final evaluation is failure.

#### 6.1.2 The item and pass condition for evaluation

The items of evaluation are different for different accuracy transformer. The detailed information of evaluation items is as table 6.1 to table 6.5.

Table 6.1 Evaluation for IEC60044-1 measurement CT

Accuracy	Items	Pass condition
0.1 class	1) FS 2) Ratio and phase error in 5%,20%,50%,100% rated secondary current in 25% and 100% rated burden or work burden	1) FS measured $\leq$ FS rated 2) Ratio error in 5% Is $\leq$ 0.4% Ratio error in 20% Is $\leq$ 0.2% Ratio error in 100, 120% Is $\leq$ 0.1% Phase error in 5% Is $\leq$ 15min Phase error in 20% Is $\leq$ 8 min Phase error in 100, 120% Is $\leq$ 5min

		Is: Rated secondary current
0.2 class	1) FS 2) Ratio and phase error in 5%,20%,50%,100% rated secondary current in 25% and 100% rated burden or work burden	1) FS measured $\leq$ FS rated 2) Ratio error in 5% Is $\leq$ 0.75% Ratio error in 20% Is $\leq$ 0.35% Ratio error in 100, 120% Is $\leq$ 0.2% Phase error in 5% Is $\leq$ 30min Phase error in 20% Is $\leq$ 15 min Phase error in 100, 120% Is $\leq$ 10min
0.2S class	1) FS 2) Ratio and phase error in 1%,5%,20%,50%,100% rated secondary current in 25% and 100% rated burden or work burden	1) FS measured $\leq$ FS rated 2) Ratio error in 1% Is $\leq$ 0.75% Ratio error in 5% Is $\leq$ 0.35% Ratio error in 20,100, 120% Is $\leq$ 0.2% Phase error in 1% Is $\leq$ 30min Phase error in 5% Is $\leq$ 15 min Phase error in 20, 100, 120% Is $\leq$ 10min
0.5 class	1) FS 2) Ratio and phase error in 5%,20%,50%,100% rated secondary current in 25% and 100% rated burden or work burden	1) FS measured $\leq$ FS rated 2) Ratio error in 5% Is $\leq$ 1.5% Ratio error in 20% Is $\leq$ 0.75% Ratio error in 100, 120% Is $\leq$ 0.5% Phase error in 5% Is $\leq$ 90min Phase error in 20% Is $\leq$ 45 min Phase error in 100, 120% Is $\leq$ 30min
0.5S class	1) FS 2) Ratio and phase error in 1%,5%,20%,50%,100% rated secondary current in 25% and 100% rated burden or work burden	1) FS measured $\leq$ FS rated 2) Ratio error in 1% Is $\leq$ 1.5% Ratio error in 5% Is $\leq$ 0.75% Ratio error in 20,100, 120% Is $\leq$ 0.5% Phase error in 1% Is $\leq$ 90min Phase error in 5% Is $\leq$ 45 min Phase error in 20, 100, 120% Is $\leq$ 30min
1.0 class	1) FS 2) Ratio and phase error in 5%,20%,50%,100% rated secondary	1) FS measured $\leq$ FS rated 2) Ratio error in 5% Is $\leq$ 3% Ratio error in 20% Is $\leq$ 1.5%



	current in 25% and 100% rated burden or work burden	Ratio error in 100, 120% $I_s \leq 1.0\%$ Phase error in 5% $I_s \leq 180\text{min}$ Phase error in 20% $I_s \leq 90\text{ min}$ Phase error in 100, 120% $I_s \leq 60\text{min}$
3.0 class	1) FS 2) Ratio error in 50%,120% rated secondary current in 50% and 100% rated burden or work burden	1) FS measured $\leq$ FS rated 2) Ratio error in 50% $I_s \leq 3\%$ Ratio error in 120% $I_s \leq 3\%$
5.0 class	1) FS 2) Ratio error in 50%,120% rated secondary current in 50% and 100% rated burden or work burden	1) FS measured $\leq$ FS rated 2) Ratio error in 50% $I_s \leq 5\%$ Ratio error in 120% $I_s \leq 5\%$

Table 6.2 Evaluation for IEC60044-1 protection CT

Accuracy	Items	Pass condition
5P class	1)ALF 2)Ratio and phase error in 100% rated secondary current	1) ALF measured $\geq$ ALF rated 2) Ratio error in 100% $I_s \leq 1\%$ 3) Phase error in 100% $I_s \leq 60\text{min}$
10P class	1)ALF 2)Rated error in 100% rated secondary current	1) ALF measured $\geq$ ALF rated 2) Ratio error in 100% $I_s \leq 3\%$
5PR class	1)ALF 2)Ratio and phase error in 100% rated secondary current 3) Remanence factor $k_r$	1) ALF measured $\geq$ ALF rated 2) Ratio error in 100% $I_s \leq 1\%$ 3) Phase error in 100% $I_s \leq 60\text{min}$ 4) $K_r \leq 10\%$
10PR class	1)ALF 2)Rated error in 100% rated secondary current 3) Remanence factor $k_r$	1) ALF measured $\geq$ ALF rated 2) Ratio error in 100% $I_s \leq 3\%$ 3) $K_r \leq 10\%$
PX class	1) Turns ratio error 2) Accuracy limit voltage $E_k$ 3) Accuracy limit current $I_e$ 4) Dimension factor $K_x$ Winding resistance in 75 Celsius degree	1) Turns ratio error $\leq 0.25\%$ 2) $E_k$ measured $\geq E_k$ rated 3) $I_e$ measured $\geq I_e$ rated 4) $K_x$ measured $\geq K_x$ rated 5) Winding resistance in 75 degree $\leq$ Rated value in nameplate

Table 6.3 Evaluation for IEC60044-6 CT

Accuracy	Items	Pass condition
TPS class	1) Turns ratio 2) Accuracy limit voltage Val 3) Accuracy limit current Ial 4) Symmetric short current factor Kssc 5) Winding resistance in 75 Celsius degree	1) Turns ratio error $\leq 0.25\%$ 2) Val measured $\geq$ Val rated 3) Ial measured $\leq$ Ial rated 4) $K \cdot K_{ssc}$ measured $\geq K \cdot K_{ssc}$ rated 5) Winding resistance in 75 degree measured $\leq$ rated value in nameplate
TPX class	1) Ratio error in rated current 2) Phase error in rated current 3) Peak instantaneous error 4) $K_{ssc} \cdot K_{td}$ measured 5) Winding resistance in 75 Celsius degree	1) Ratio error in $I_s \leq 0.5\%$ 2) Phase error in $I_s \leq 30\text{min}$ 3) Peak instantaneous $\leq 10\%$ 4) $K_{ssc} \cdot K_{td}$ measured $\geq K_{ssc} \cdot K_{td}$ rated 5) Winding resistance in 75 degree measured $\leq$ rated value in nameplate
TPY class	1) Ratio error in rated current 2) Phase error in rated current 3) Peak instantaneous error 4) $K_{ssc} \cdot K_{td}$ measured 5) Winding resistance in 75 Celsius degree 6) Remanence factor $k_r$ 7) Secondary loop time constant $T_s$	1) Ratio error in $I_s \leq 1.0\%$ 2) Phase error in $I_s \leq 60\text{min}$ 3) Peak instantaneous $\leq 10\%$ 4) $K_{ssc} \cdot K_{td}$ measured $\geq K_{ssc} \cdot K_{td}$ rated 5) $T_s$ measured $\leq 30\%$ rated in nameplate 6) $K_r \leq 10\%$ 7) Winding resistance in 75 degree measured $\leq$ rated value in nameplate
TPZ class	1) Ratio error in rated current 2) Phase error in rated current 3) $K_{ssc} \cdot K_{td}$ measured 4) Winding resistance in 75 Celsius degree 5) Secondary loop time constant $T_s$	1) Ratio error in $I_s \leq 1.0\%$ 2) Phase error in $I_s \leq 180\text{min}$ 3) $K_{ssc} \cdot K_{td}$ measured $\geq K_{ssc} \cdot K_{td}$ rated 4) $T_s$ measured $\leq 30\%$ $T_s$ rated in nameplate 5) Winding resistance in 75 degree measured $\leq$ rated value in nameplate

Table 6.4 Evaluation for C57.13 measurement CT

Accuracy	Items	Pass condition
----------	-------	----------------

0.3 class	Ratio error in 10%,100% and RF*100% Is in rated or work burden	Ratio error in 10% $I_s \leq 0.6\%$ Ratio error in 100, $100 * RF\% I_s \leq 0.3\%$
0.6 class	Ratio error in 10%,100% and RF*100% Is in rated or work burden	Ratio error in 10% $I_s \leq 1.2\%$ Ratio error in 100, $100 * RF\% I_s \leq 0.6\%$
1.2 class	Ratio error in 10%,100% and RF*100% Is in rated or work burden	Ratio error in 10% $I_s \leq 2.4\%$ Ratio error in 100, $100 * RF\% I_s \leq 1.2\%$

Table 6.5 Evaluation for C57.13 CT

Accuracy	Items	Pass condition
C class	1) Vbmax measured 2) Secondary current Isec in Vbmax 3) Ratio error in $20 * I_{sn}$ 4) Ratio error in Vbmax rated	1) Vbmax measured $\geq V_{bmax}$ rated (If the value of Vbmax rated is missing Analyzer would set the value to $20 * I_s * \text{Rated burden}$ ) 2) Isec measured $\geq 20 * I_s$ rated 3) Ratio error $20 * I_{sn} \leq 10\%$ 4) Ratio error Vbmax rated $\leq 10\%$ $I_{sn}$ rated secondary current
K class	1) Vbmax measured 2) Secondary current in Vbmax 3) Ratio error in $20 * I_{sn}$ 4) Ratio error in Vbmax rated	1) Vbmax measured $\geq V_{bmax}$ rated 2) Isec measured $\geq 20 * I_s$ rated 3) Ratio error $20 * I_{sn} \leq 10\%$ 4) Ratio error Vbmax rated $\leq 10\%$ 5) Knee point voltage $\geq 70\%$ Vbmax rated
T class	1) Vbmax measured 2) Secondary current in Vbmax 3) Ratio error in $20 * I_{sn}$ 4) Ratio error in Vbmax rated	1) Vbmax measured $\geq V_{bmax}$ rated 2) Isec measured $\geq 20 * I_s$ rated 3) Ratio error $20 * I_{sn} \leq 10\%$ 4) Ratio error Vbmax rated $\leq 10\%$ $I_{sn}$ rated secondary current

## 6.2 Calculation of Excitation Parameters

One of CT analysis results panels is excitation and evaluation panel. The evaluation results and excitation calculation parameters are listed in this panel. The excitation parameters for different CT accuracy are listed in table 6.6, table 6.7 and table 6.8.

Table 6.6 Excitation calculation parameters for IEC60044-1

Parameters	Description	IEC60044-1	IEC60044-1
------------	-------------	------------	------------

		measurement CT	Protection CT
V-kn	Knee point voltage	√	√
I-kn	Knee point current	√	√
Ek	Accuracy limit voltage for PX		√
Ie	Accuracy limit current for PX		√
FS	Instrument security factor	√	
ALF	Accuracy limit factor		√
Kx	Dimension factor for PX CT		√
Ls	Saturation inductor	√	√
Lu	Non-saturation inductor	√	√
Ts	Secondary loop time constant	√	√
Kr	Remanence factor	√	√

Table 6.6 Excitation calculation parameters for IEC60044-6

Parameters	Description	TPS	TPX/Y	TPZ
V-Kn	Knee point voltage	√	√	√
I-Kn	Knee point current	√	√	√
V-al	Accuracy limit voltage for TPS	√		
I-al	Accuracy limit current for TPS	√		
Kssc	Symmtric short current factor			
Error	Peak instantaneous error in Emax		√	
Emax	Maximum EMF		√	
Ls	Saturation inductor	√	√	√
Lu	Non-saturation inductor	√	√	√
Ts	Secondary loop time constant	√	√	√
Kr	Remanence factor	√	√	√
Ktd	Dimension factor		√	√

Table 6.8 excitation parameters calculation for C57.13 CT

Parameters	Description	C57.13 measurement CT	C57.13 protection CT
V-kn	Knee point voltage	√	√
I-kn	Knee point current	√	√
FS	Instrument security factor	√	
ALF	Instrument security factor		√
Ls	Saturation inductor	√	√

Lu	Non-saturation inductor	√	√
Ts	Secondary loop time constant	√	√
Kr	Remanence factor	√	√

### 6.3 Definition of Knee Point and Excitation Curve

The definition of knee point and excitation curve is different for different test standard. The detailed information for knee point and excitation curve are as table 6.9 and table 6.10.

Table 6.9 Definition of excitation curve for different standard

Standard name	Y coordinates	X coordinates
IEC60044-1	Secondary terminal voltage in RMS	Excitation current in RMS
IEC60044-6	Secondary EMF in RMS	Excitation current in peak value
C57.13	Secondary EMF in RMS	Excitation current in RMS

Table 6.10 Definition of knee point for different standard

Standard name	Definition of knee point
IEC60044-1	The point that excitation current(RMS) rise rate over 50% when the voltage rise rate is 10% in excitation curve
IEC60044-6	The point that excitation current(Peak value) rise rate over 50% when the voltage rise rate is 10% in excitation curve
C57.13	The point that the positive cutting angle is 45 degree in excitation curve for C57.13 ANSI45 standard. The point that the positive cutting angle is 30 degree in excitation curve for C57.13 ANSI30 standard.

### 6.4 Nameplate Information Guess

The function of nameplate information guess is to get part of nameplate information from test results when nameplate is unknown. The information can be guessed, including rated primary current, rated secondary current and accuracy class.

The guess logic for Analyzer is as following:

- 1) If the value of rated secondary current is unknown, Analyzer will get the value from

the winding resistance measured. If the winding resistance in 75 Celsius degree is less than the threshold value, the rated secondary current will be 5A. Otherwise, the rated secondary current is 1A.

- 2) If the value of rated primary current is unknown, Analyzer will get the value from the turns ratio measured and rated secondary current. The primary current of CT is 1, 10,100 or 1000 times of 5,10,12,15,20 ,25,30,40,50,60 and 75A.
- 3) Guess the accuracy of CT

Firstly Analyzer guesses the transformer core type from the saturation voltage value. If the saturation voltage of CT is less than the threshold value, the core of CT is measurement. Otherwise, the core of CT is protection.

**If it is protection core, Analyzer will guess the accuracy class as following procedure.**

- 1) If the test standard is IEC60044-1, Analyzer will set the accuracy according to following step and evaluation for all the steps. The first class which passes the evaluation will be set to be the accuracy of the sample CT.

5PR->10PR->PX->5P->10P

- 2) If the test standard is IEC60044-6, Analyzer will set the accuracy according to following step and evaluation for all the steps. The first class which passes the evaluation will be set to be the accuracy of the sample CT.

TPY->TPX->TPZ->TPS

- 2) If the test standard is C57.13, Analyzer will set the accuracy according to following step and evaluation for all the steps. The first class which passes the evaluation will be set to be the accuracy of the sample CT.

K->C->T

**If it is measurement core, Analyzer will guess the accuracy class as following procedure.**

- 1) If the test standard is IEC60044-1, Analyzer will set the accuracy according to following step and evaluation for all the steps. The first class which passes the evaluation will be set to be the accuracy of the sample CT.

0.1->0.2S->0.2->0.5S->0.5->1.0->3.0->5.0

- 2) If the test standard is C57.13, Analyzer will set the accuracy according to following step and evaluation for all the steps. The first class which passes the evaluation will be set to be the accuracy of the sample CT.

0.3->0.6->1.2

## 7. Accessories List

### 7.1 CT/PT Analyzer Standard Configuration

Table 7.1 Standard configuration for CT/PT Analyzer

Name	quantity	Description
Host machine	1	
3M mask cable	2	Test cable for power out and CT secondary connection
10M mask cable	1	Test cable for CT primary connection
Grounding cable	1	
Big test pliers	2	One red and one black
Test gasket	4	Two red and two black
Test pin	4	Two red and two black
Test pliers	6	Three red and three black
Short connection cable	1	Including six connection terminals
3A fuse	3	
Power cable	1	
Accessories bag	1	
Production disk	1	Include Analysis application and user manual
User manual	2	
Inspection report	1	
Pass certificate	1	

## Appendix A Principle of Low Frequency Excitation Test

The voltage frequency of excitation test can be lower than power frequency as it is described in IEC60044-6 standard. So the capacity of test source is achievable and also the insulation of secondary terminal of CT is safety. The formula of flux offered by IEC60044-6 is as following:

$$\Psi(t) = \int_0^t [U_{CT}(t) - R_{CT}I_{CT}(t)]dt + \Psi_0 \quad (\text{A.1})$$

$R_{CT}$  : Stand for secondary winding resistance

$U_{CT}$  : Stand for secondary terminal voltage

$I_{CT}$  : Stand for secondary current

$\Psi_0$  : Stand for initial flux

$\Psi(t)$ : Stand for flux in time t

The definition of EMF is as following:

$$U_c(t) = U_{CT}(t) - R_{CT}I_{CT}(t) \quad (\text{A.2})$$

If  $U_c(t)$  is a sine signal:

$$U_c(t) = U_{Cm} \sin(\omega t + \frac{\pi}{2}) = \frac{d\Psi(t)}{dt} = \frac{d}{dt}(\Psi_m \sin \omega t) = \omega \Psi_m \sin(\omega t + \frac{\pi}{2}) \quad (\text{A.3})$$

$$U_{C_{rms}} = \frac{\omega \Psi_m}{\sqrt{2}} = \frac{2\pi f \Psi_m}{\sqrt{2}} = 4.44 f \Psi_m \quad (\text{A.4})$$

The f in formula is the frequency of sine signal. You can get the conclusion that the core voltage is proportional to the frequency. So just cut down the test frequency, you can get the excitation curve of high saturation voltage CT in low voltage.



## Appendix B 10% Error Curve Calculation

The main contribution of ratio error in CT is excitation current  $I_{ext}$ . The current convert from primary to secondary is constructed by vector sum of  $I_{ext}$  and secondary current  $I_{st}$ . So the value of primary is not equal to  $N \cdot I_{set}$  ( $N$  is the turns ratio). You can define the error curve line error value as following:

$$\varepsilon = \frac{I_1' - I_2}{I_1'} \times 100 = \frac{I_0}{I_1'} \times 100 \quad (\text{B. 1})$$

Relay protection system requires that the error is less than 10%. So you can get formula B.2 and B.3 if the power factor of burden is 1.0.

$$I_1' = 10I_0 \quad (\text{B. 2})$$

$$I_2 = 9I_0 \quad (\text{B. 3})$$

$M$  is defined as the times of rated primary current.  $K$  is the turn ratio of CT

$$M = \frac{I_{1M}}{I_{1N}} = \frac{K \times I_1'}{K \times I_{2N}} = \frac{10I_0}{I_{2N}} \quad (\text{B. 4})$$

$$Z_B = \frac{E_0}{I_2} - Z_2 = \frac{E_0}{9I_0} - Z_2 \quad (\text{B. 5})$$

$I_{1M}$  Maximum short circuit current in primary

$I_{1N}$  Rated primary current

$I_{2N}$  Rated secondary current

$Z_2$  Secondary winding resistance

$E_0$  EMF in secondary winding of CT

$Z_B$  Secondary burden

You can calculate the error curve according to formula B.4 and B.5. The X coordinates of the curve is secondary burden. The Y coordinates is the times of rated primary current.