ZXHQ-Y
Transformer Field Calibrator

CONTENTS

Warning

This manual would help user to operate CTPT analyzer in right condition. The main content of this manual include functions, technical index, operation, test connection and potential risks of analyzer. Please read this manual carefully before you start work with CTPT analyzer. It would save your lots of time and cut down the risks in test procedure.

The operation of CT test with CTPT analyzer should follow associated national standards constraints. This manual can not replace national standards to electrical tests. The operator should have the certificate of high voltage electrical test when CTPT analyzer works in high voltage station.

Safety regulations for CTPT analyzer application

1) All technical index should keep in work condition before test with analyzer
2) Please follow associated national standards in a special application
3) Forbid high voltage or high current connected to CTPT analyzer direct
4) All tests should follow procedure in user manual
5) It is forbid to open the box of CTPT analyzer. Otherwise the quality assurance would 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 power out LED out.
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 output from CTPT analyzer.**
13) **Please confirm that voltage had been injected to CT secondary coil in CT test. Otherwise the analyzer may be damaged.**
14) **Please confirm that voltage had been injected to PT primary coil in PT ratio test. Otherwise the analyzer may be damaged.**

1 Application and technical index of CTPT 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）Coil 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:

1）Turns ratio test
2）Polarity test
3) Secondary burden test
4) Coil resistance test

Applications for CTPT 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 CTPT analyzer technical index

1. Test standards： IEC60044-1, IEC60044-6, GB1208, GB16847, C57.13
2. Power supply： AC220V±10%，50Hz/60Hz±10%
3. Power output： 0.1~125V (AC)
4. Current output： 0.001~5A(RMS)

5. Power output：300VA

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：0~200 V (automatically change range in 1V/10V/70V/200V)

Error < ±0.1%+0.01%FS

9. Turns ratio measurement：

Range ：1~30000，

1~2000 error<0.05%

2000~5000 error>0.1%

5000~30000 error<0.2%

10. Phase measurement： error：±2min，resolution：0.01min

11. Coil 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 ：1~30000，

1~5000 error<0.2%

5000~30000 error<0.5%

16. Saved data groups：>1000groups

17. Work condition： Temperature：-10℃～50℃， moist：≤90%

18. Size： 485mm×356mm×183mm

19. Weight： <15Kg

2 Hardware

2.1 Introduction

The appearance of CTPT analyzer is as figure 2.1.

Figure2.1 CTPT analyzer

2.2 Power supply

Power supply connection of CTPT analyzer is located at right side. It is showed as figure 2.2. Power supply range is AC220±10% ， 50/60Hz±10%. There is an AC250V/3A 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 CTPT analyzer. They are power output, CT secondary input and CT primary input.

Power output terminals: voltage output range AC0~125V, current output range AC0~5A.

CT secondary/PT primary input terminals: CT secondary or PT primary voltage measurement input range AC0~125V

CT primary/PT secondary input terminals: CT primary or PT secondary voltage measurement

input range AC0~5V

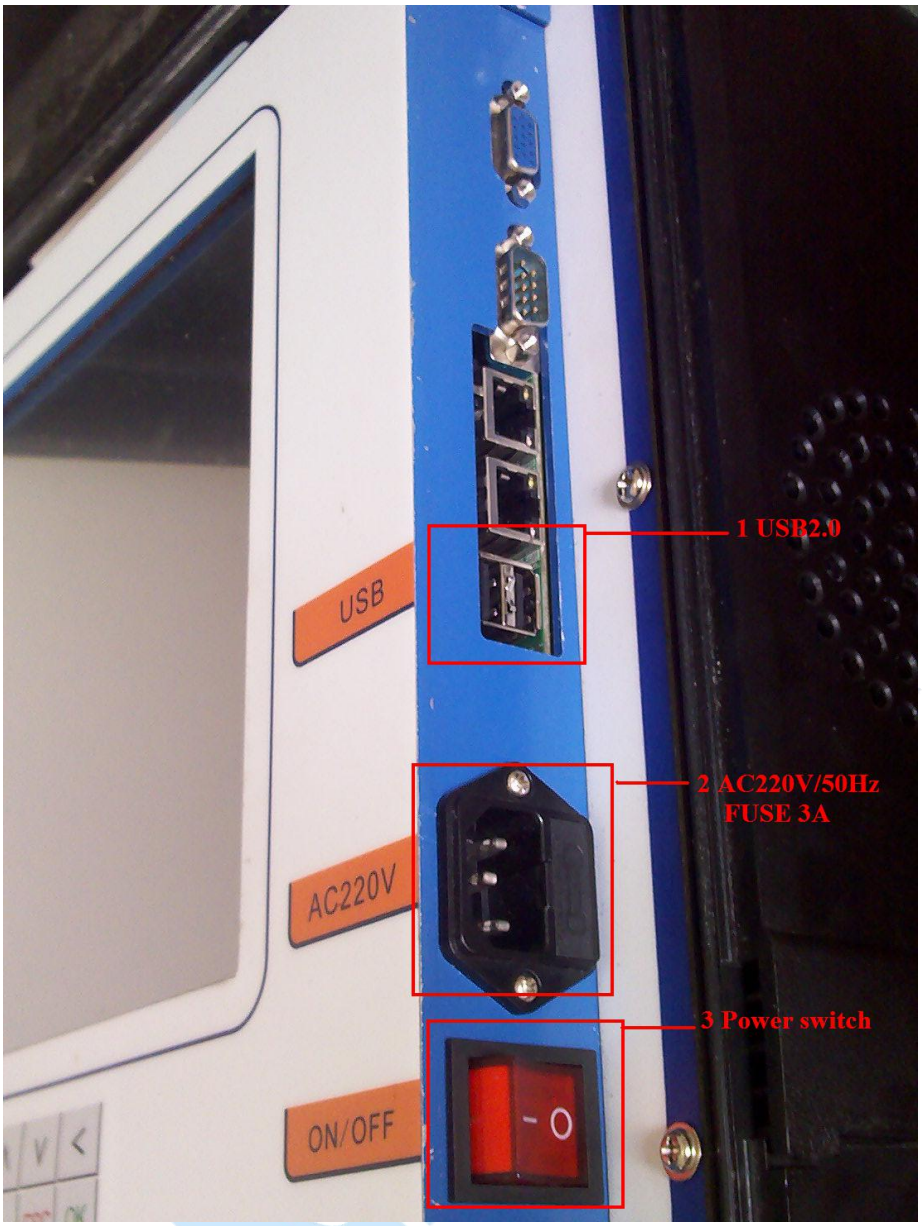


Figure 2.2 Power supply panel

2.4 Hardware schematic diagram

The schematic diagram of CTPT 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 could generate AC0-125v voltage or DC 0~0.5A current to sample CT.

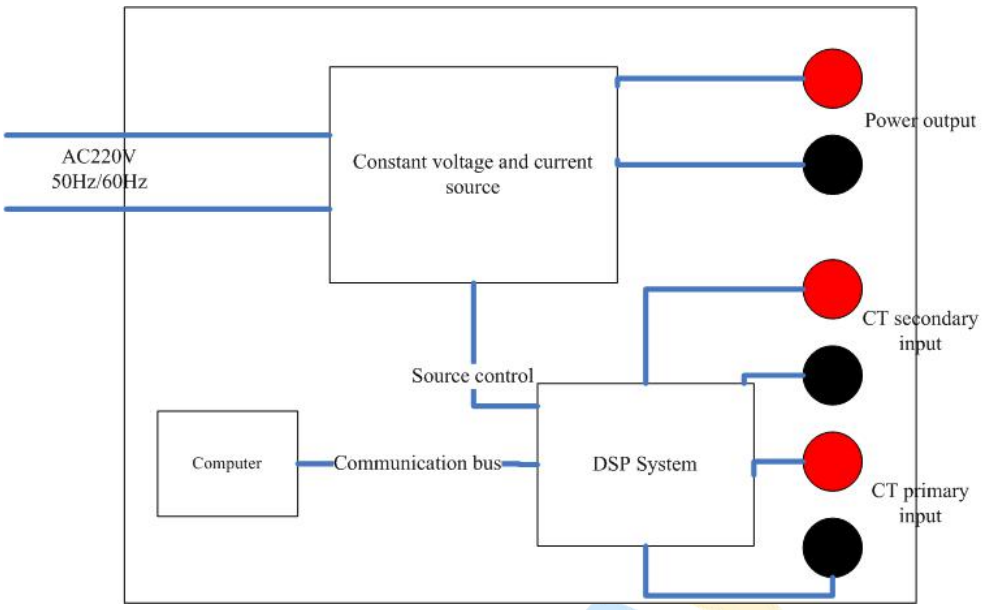


Figure2.3 CTPT analyzer schematic diagram

The main functions of DSP system are as follow:

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

There is a computer integrated in the tester. Large memory capacity make the tester could save over 1000 groups of test data.

2.5 Keyboard

There is 16keys small keyboard installed in analyzer. Keyboard appearance showed as figure 2.4

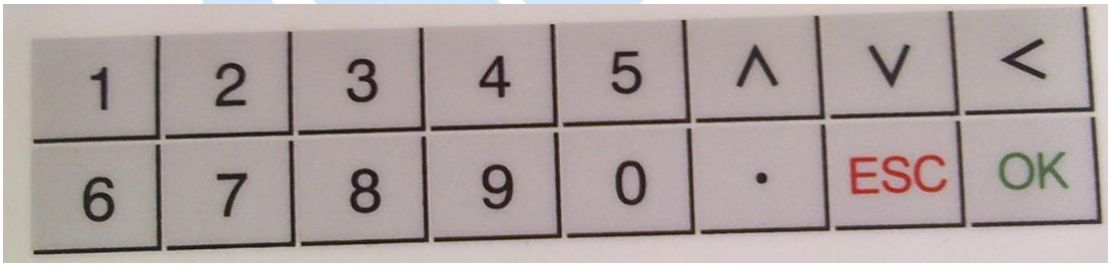


Figure 2.4 Keyboard

The definitions of keys are as follow

1) 0~9 digital input
2) ∧ up direction input
3) ∨ down direction input
4) ＜ Delete
5) . Dot input
6) ESC: cancel selection
7) OK: Enter or select

3 Test connection

3.1 CT Secondary burden measurement

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

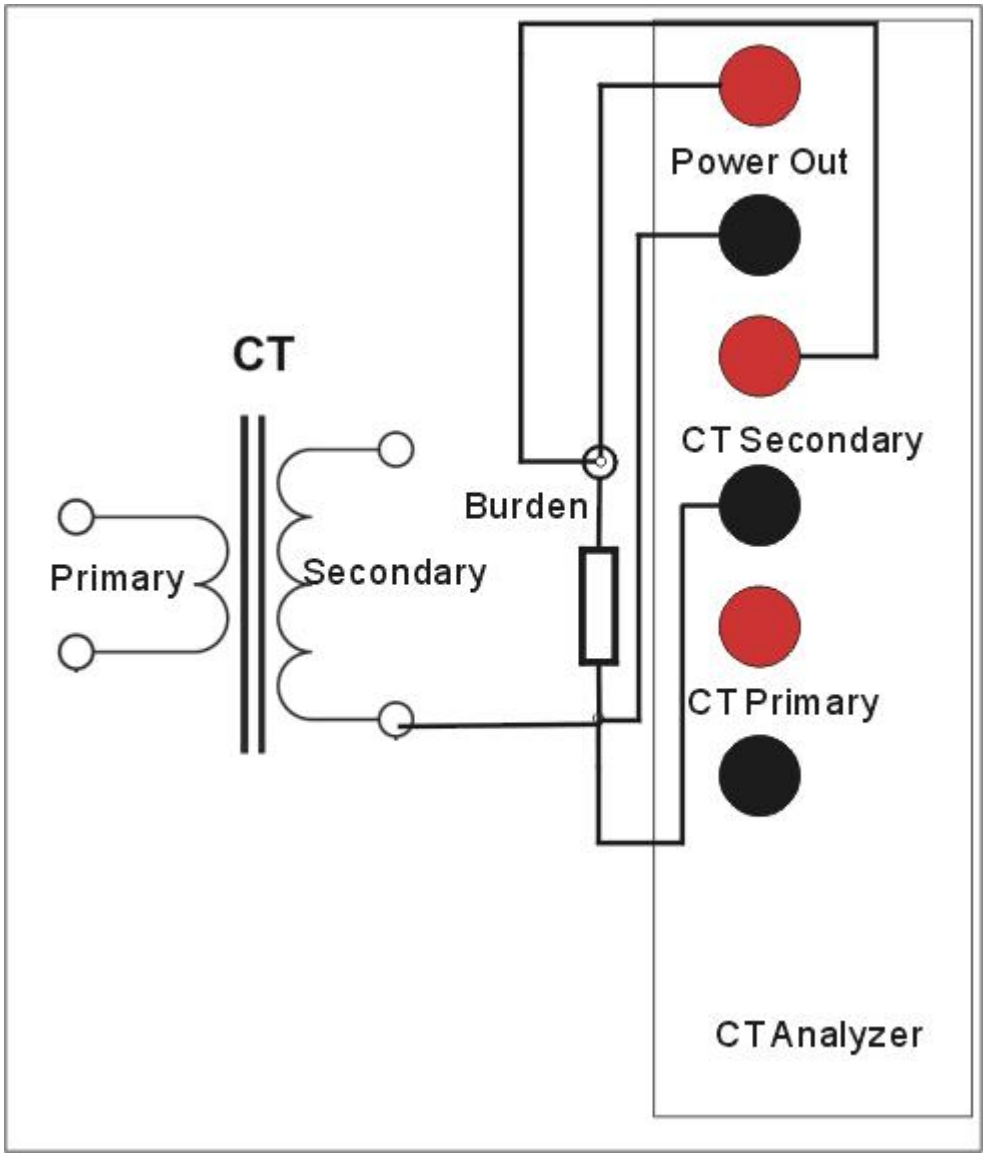


Figure 3.1 Secondary burden test connection

Detail test connection procedures are as follow:：

1）Connect analyzer grounding terminal to protection earth(PE).

2）Disconnect sample CT secondary coil 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 that contact resistance has no effect in test results. Reference connection is showed

as figure 3.2

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

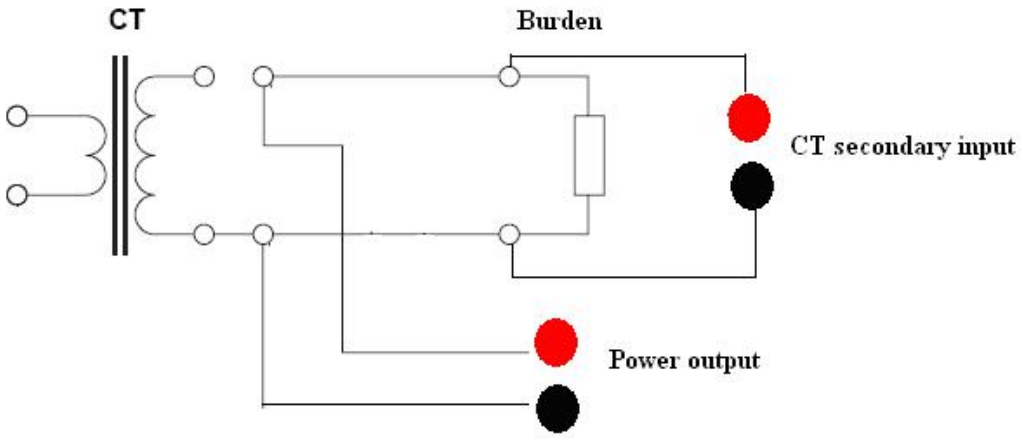


Figure 3.2 Reference connections to clear contact resistance effect

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 the three tests.

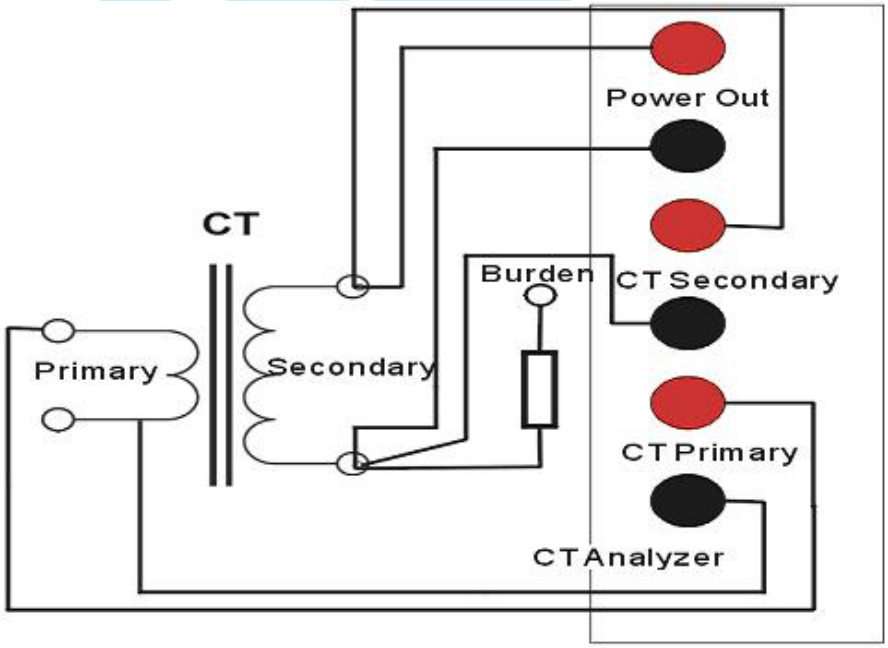


Figure 3.3 Connection for CT analysis, ratio and polarity test

Detail test connection procedures are as follow.

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 would bring lots of noise signal when testing

3）Connect power output red terminal of analyzer to one side of CT secondary coil.

4) Connect power output black terminal of analyzer to another side of CT secondary coil.

5) Connect one side of CT primary coil to CT primary black terminal of analyzer

6) Connect another side of CT primary coil to CT primary red terminal of analyzer

7) Connect one side of CT secondary coil to CT secondary black terminal of analyzer

8) Connect another side of CT secondary coil 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

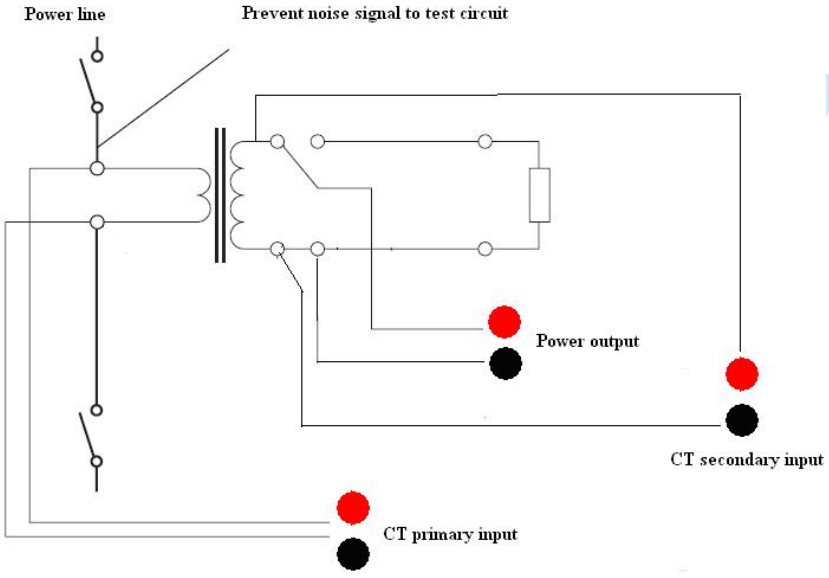


Figure 3.4 Reference connections for CT analysis, ratio and polarity test

CAUTION: 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 have 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

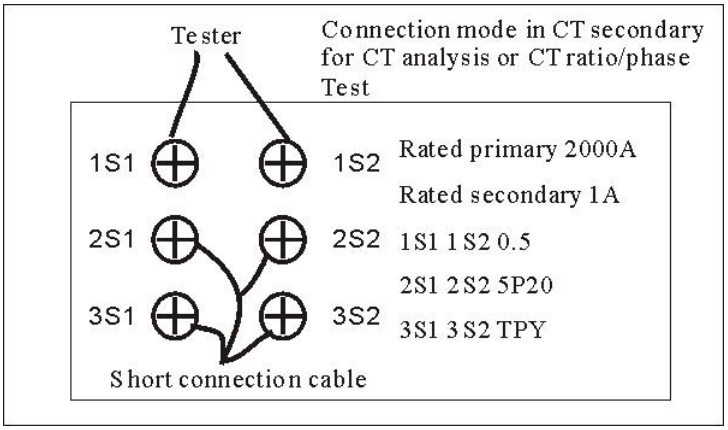


Figure 3.4.1 Short connection for CT analysis and ratio/phase test

3.3 CT Coil resistance test

Please connect analyzer and sample CT as figure 3.5 in CT coil resistance test

1) Connect analyzer grounding terminal to protection earth (PE).

2) Disconnect sample CT secondary coil with secondary loop as figure 3.5.

3) Connect power output red terminal of analyzer to one side of CT secondary coil.

4) Connect power output black terminal of analyzer to another side of CT secondary coil.

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

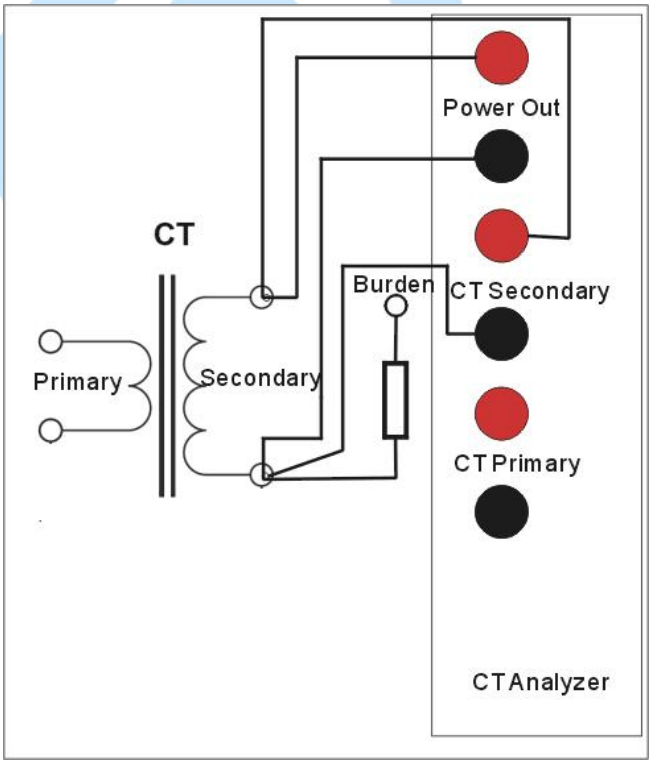


Figure 3.5 Reference connections for CT coil resistance test

3.4 PT Secondary burden test

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

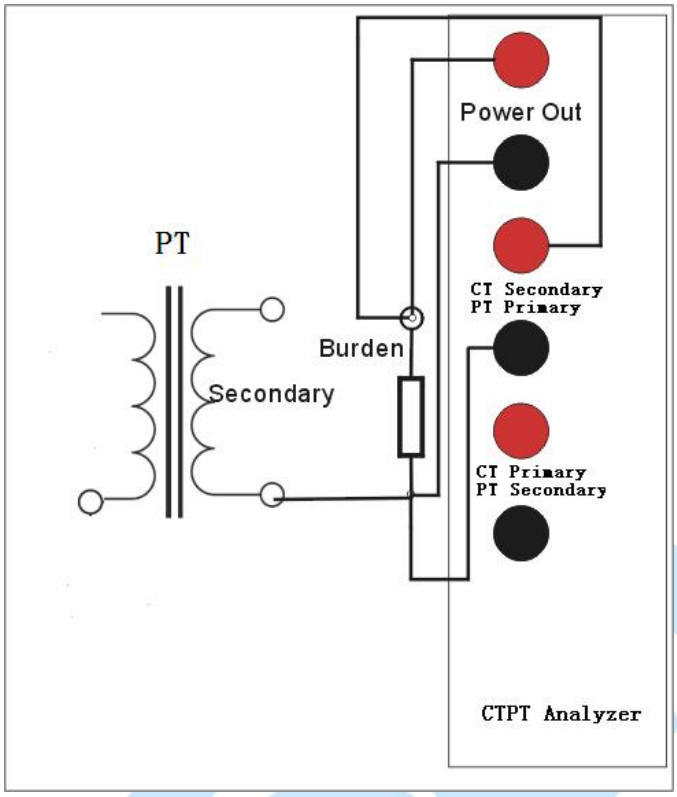


Figure 3.6 PT secondary burden test connection

Detail test connection procedures are as follow:：

1）Connect analyzer grounding terminal to protection earth(PE).

2）Disconnect sample PT secondary coil 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 coil to secondary loop. Otherwise test results would be wrong. It is the combination of secondary loop burden and secondary coil.

3.5 PT coil resistance test

Please connect analyzer and sample PT as figure 3.7 in PT coil resistance test

1) Connect analyzer grounding terminal to protection earth (PE).

2) Disconnect sample PT coil with loop as figure 3.7.

3) Connect power output red terminal of analyzer to one side of PT coil.

4) Connect power output black terminal of analyzer to another side of PT coil.

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

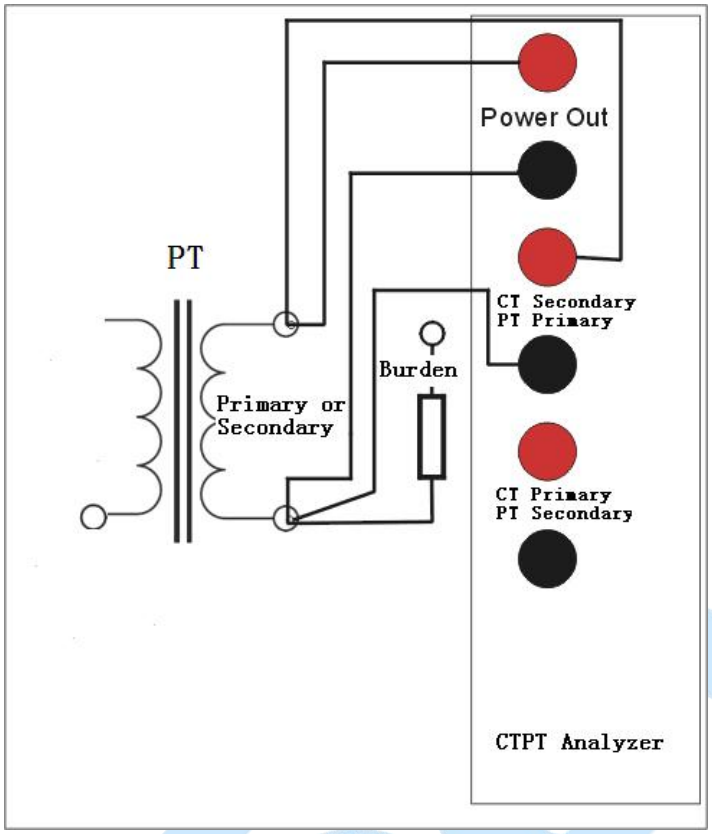


Figure 3.7 Coil resistance test connection

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.

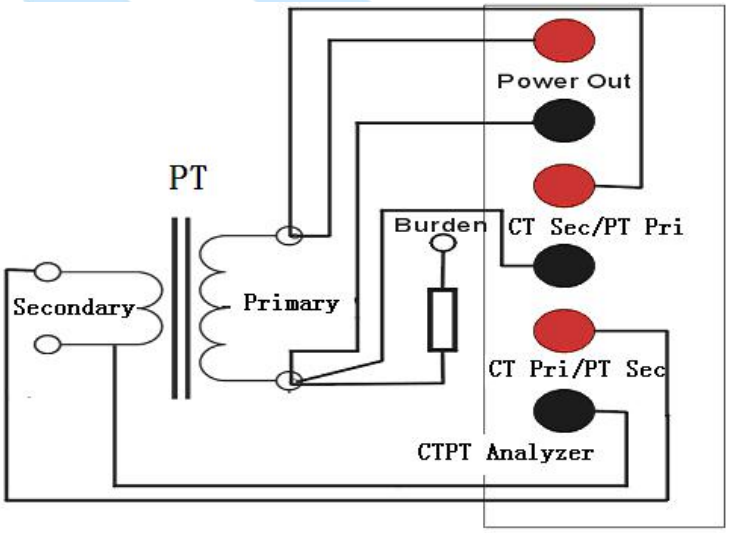


Figure 3.9 PT turns ratio and polarity test connection

Detail test connection procedures are as follow.

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 would bring lots of noise signal when testing

3）Connect power output red terminal of analyzer to one side of PT primary coil.

4) Connect power output black terminal of analyzer to another side of PT primary coil.

5) Connect one side of PT secondary coil to PT secondary black terminal of analyzer

7) Connect another side of PT secondary coil to PT secondary red terminal of analyzer

8) Connect one side of PT primary coil to PT primary black terminal of analyzer

9) Connect another side of PT primary coil 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

4 User interface

4.1 Software panel

Six work states had been defined in CTPT 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 the 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 show in work panel when it works in different state.

4.2 Toolbar panel

The toolbar panel of analyzer includes lots of tester command button. They are “new test”, ”save”, “read”, “system setting”, “language selection”, “transformer setting”, “data export” and “help” buttons.

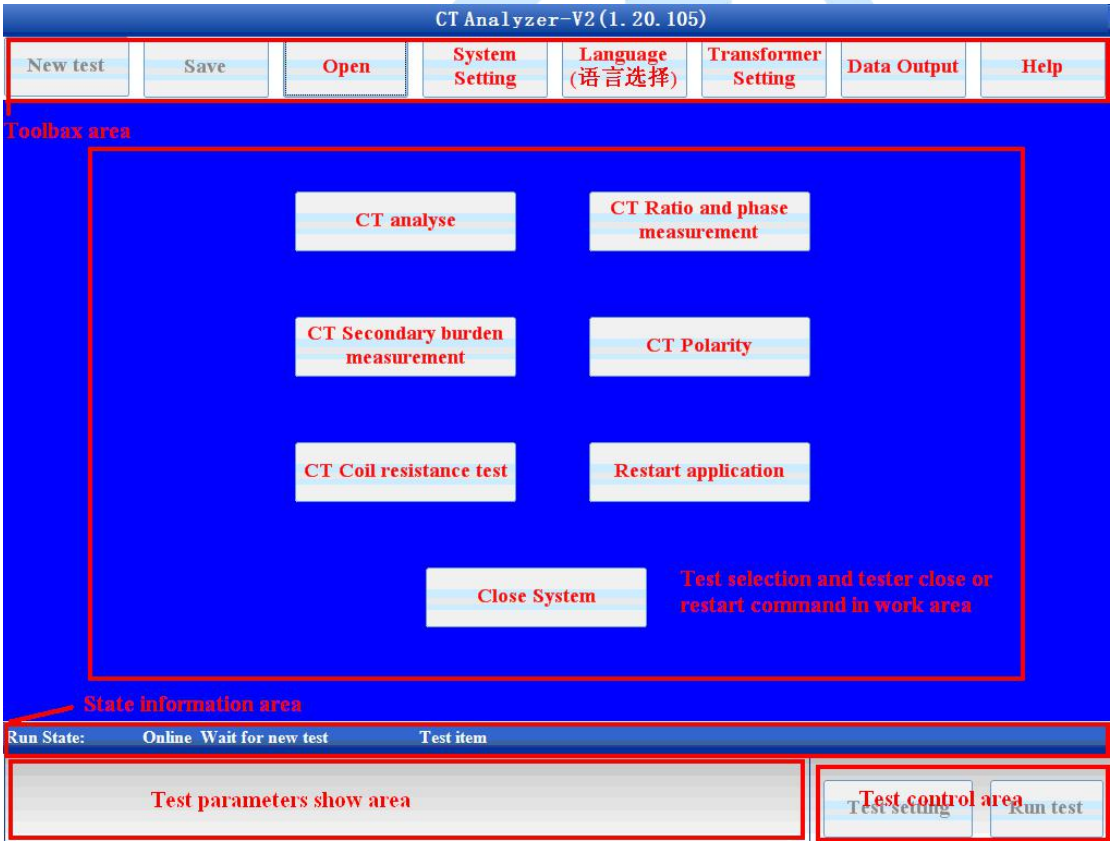


Figure 4.1 Software panel in “Wait for new test” state

4.2.1 New test command

The functions of new test command are that end current test selection and make analyzer work in “wait for new test” state. Panel as figure 4.1 would be load 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 coil resistance”. System close and software restart commands are also located at this panel.

4.2.2 Save

The function for save command is that 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 follow mode:

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

For example: 2011-04-08 11:12:30 HYDL CT analysis.cta

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

4.2.3 Read

The function of read command is that reload the saved results to software panel. Panel as figure 4.2 would be showed when we click read command.

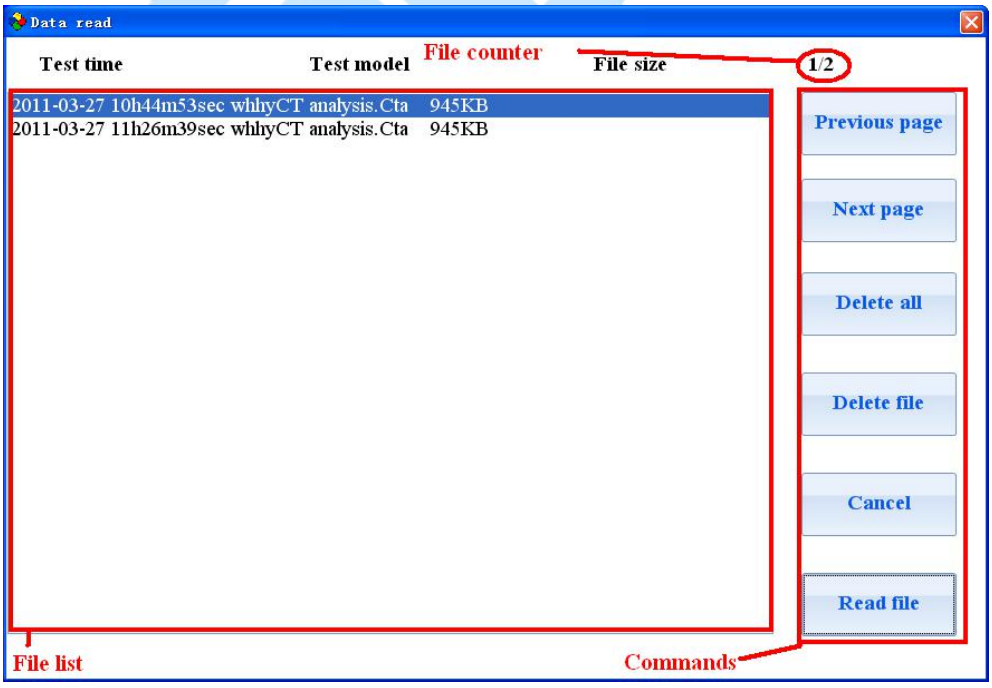


Figure 4.2 Saved files read window form

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 in top of the panel.

All commands to saved files are as follow:

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 files” deletes all files saved in analyzer
4) “Delete file” deletes current selection file in analyzer.
5) “Cancel” close the read file window form
6) “Read” load test results in current selection file to software panel

4.2.4 System setting

The function of system setting command is that set the system run parameters such as system time, operator, and test address and so on. Panel as figure 4.3 would be showed on LCD when system setting button is clicked.

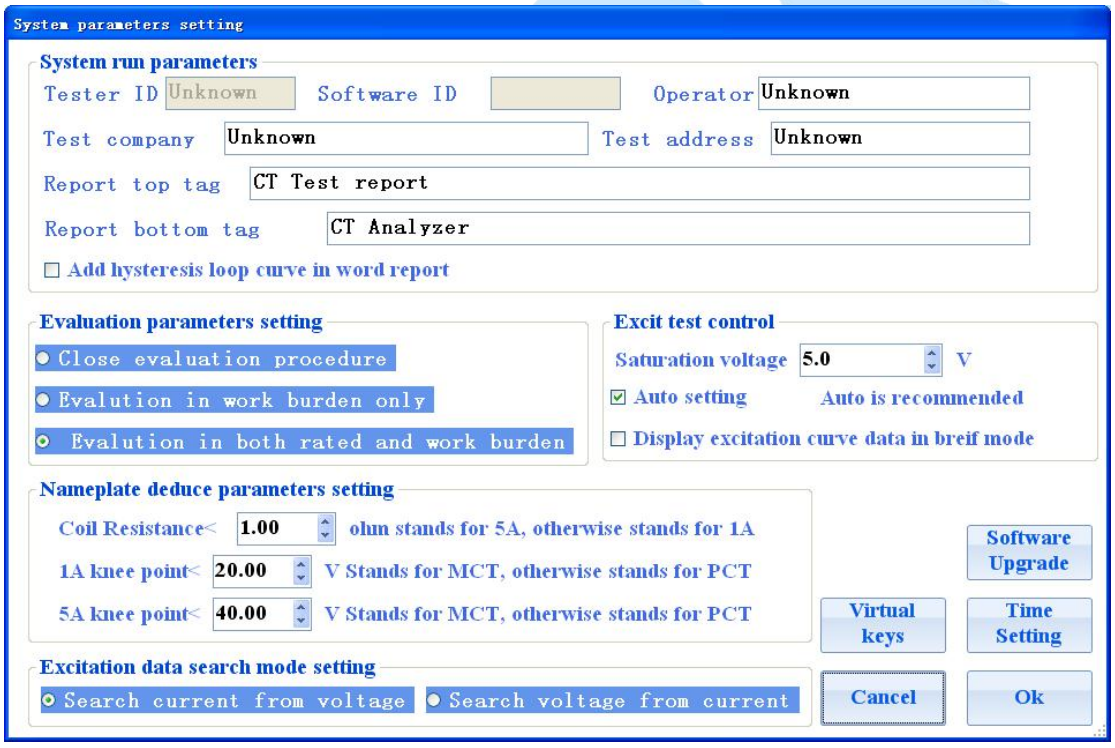


Figure 4.3 System setting window form

System run parameters in system setting 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
Add hysteresis loop curve in word report	If this item is checked the hysteresis loop curve and data will be inserted into the word test report

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

Table 4.2 System setting parameters

Parameters name	Description
Automatic evaluation	1） If “Close evaluation” is selected analyzer would offer parameter results of CT only when CT analysis test is end. Analyzer would not evaluate the test results according to selected standard 2） If “Evaluation for work burden” is selected analyzer would 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. 3） If “Evaluation for both work and rated burden” is selected analyzer would 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 work and rated burden.
Excitation test control	Measure saturation voltage automatically is factory setting. This parameter affect CT analysis and ratio test. If measure saturation voltage automatically is selected analyzer would select a special test frequency according to saturation value in excitation curve measurement. Otherwise analyzer would not measure saturation voltage before excitation curve test start. Warning: 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.
Show excitation curve data in brief mode	If Show excitation curve data in brief mode has been selected the excitation data table items would 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.

	If this item are not selected all the excitation curve data would been showed in excitation curve data table.
Transformer secondary current guess threshold value	This parameter is valid in nameplate information guess. Analyzer guesses the rated secondary current of CT according to this parameter. If the coil resistance measured in CT secondary is lower than this value analyzer set the rated secondary current of CT to 5A. Otherwise the rated secondary current of CT is 1A.
1A CT core type guess threshold value	This parameter is valid in nameplate information guess. Analyzer guesses the core type of 1A CT according to this parameter. If the knee point voltage of 1A transformer is lower than this value analyzer set the core type of CT to measurement. Otherwise the core type of CT is protection.
5A CT core type guess threshold value	This parameter is valid in nameplate information guess. Analyzer guesses the core type of 5A CT according to this parameter. If the knee point voltage of 5A transformer is lower than this value analyzer set the core type of CT to measurement. Otherwise the core type of CT is protection.
Excitation data search mode	If search current from voltage is selected the tester would find the right current value in excitation curve by the voltage value inputted If search voltage from current is selected the tester would find the right voltage value in excitation curve by the current value inputted

4.2.5 Language selection

CTPT analyzer support both English and Chinese language. The function of this command is that change current language show in software. If English is selected the work text in software is showed in English. Otherwise Chinese would be the work language.

4.2.6 Transformer setting

The function of transformer setting command is that set the parameters of sample CT for

Figure 4.4 Language selection

analysis and ratio test. Panel as figure 4.5 would be load when transformer setting button is clicked. The detail information of parameters in this panel is the same as analysis test parameters setting. Please refer to chapter 5.2

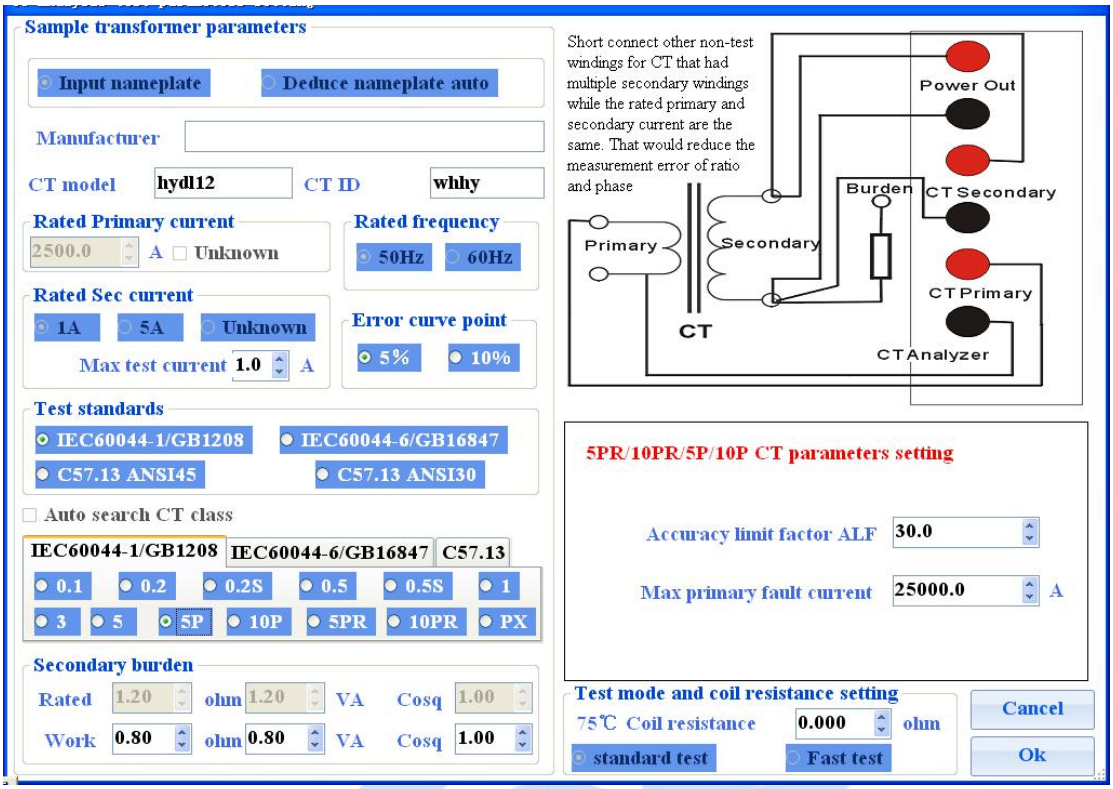


Figure 4.5 Transformer parameters setting

4.2.7 Data export

The function of data export command is that export the data file or word report saved in analyzer to removable disk. Panel as figure 4.6 would be loaded when data export 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 would be showed in list box if "*.cta" had been selected in this combo list. Otherwise ".doc" word files would be showed in list box.

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

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 files" deletes all files saved in analyzer

4) "Delete file" deletes current selection file in analyzer.

5) "Cancel" closes the read file window form

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) “Clear memory” delete all files saved in directory “work data\analyzer test data” in removable disk.

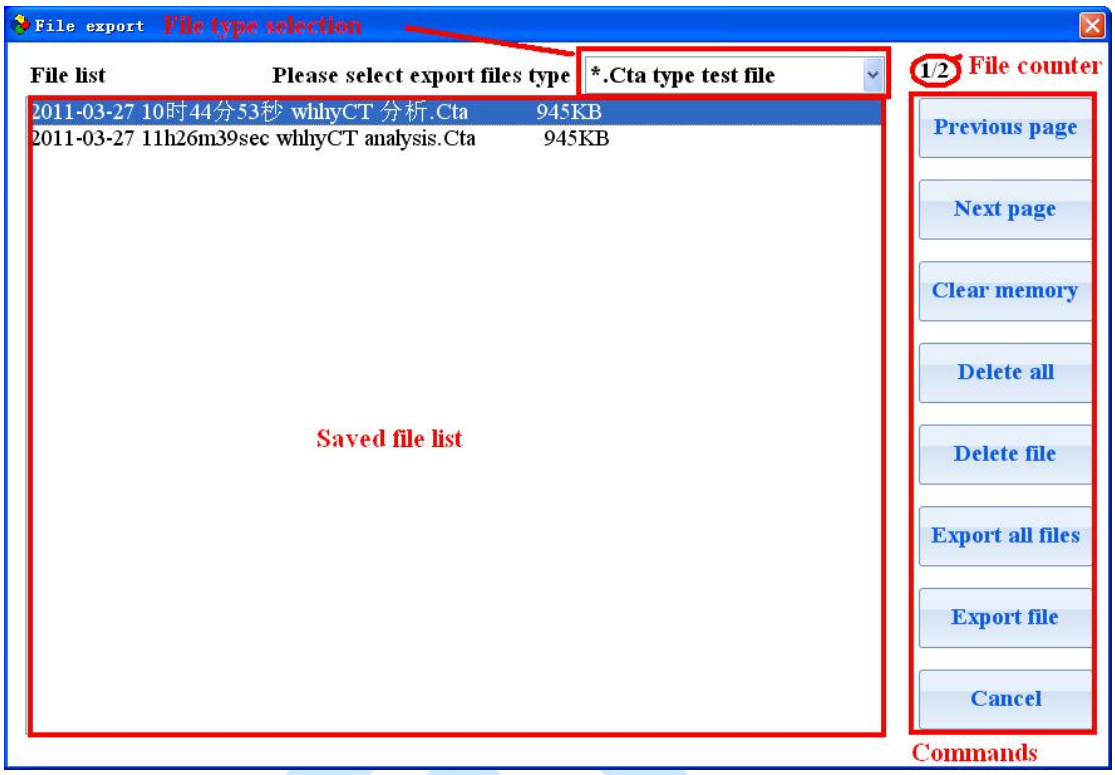


Figure 4.6 file export window form

4.2.8 Help

The help document would be loaded when this help command button is clicked. The help document would be showed in “*.pdf” document 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 would be loaded if analyzer works in “wait for new test” state. Panel as figure 4.7 would 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 follow:

1) Analyzer work state. For example “wait for new test”, “wait for test”, “View results”,

"View saved results" and "wait for view results"

2) Communication state. If communication between DSP system and computer system is success online would be showed. Otherwise off line would be showed. All test is valid only when analyzer work in online condition

3) Current test name. For example: "CT analysis", "Ratio and phase error" and so on.

4) System time and date

5) Current room temperature

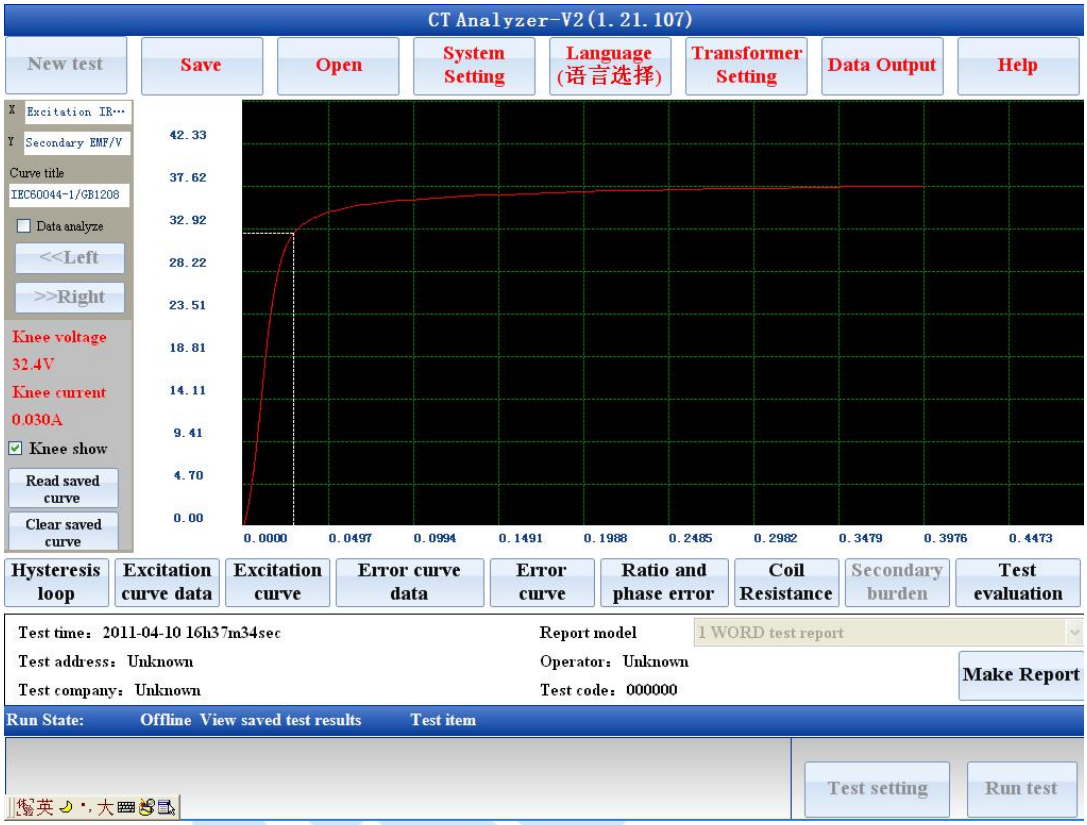


Figure 4.7 Excitation curve show

4.5 Test control panel

Test control panel include test parameters setting button and test start button. Test parameters setting button is valid when analyzer work in "wait for test" state. Special parameters setting window form which is associated to a special test would be loaded when test parameters setting button is clicked.

Test would be started when test start button is clicked and the text of test start button would be changed to be stop. Click this button again tests would be forced to stop. The work state of analyzer would be changed to be "run" when test is started. And the work state would 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 would have to click "new test" button first and then analyzer enter "wait for new test" state. The procedure of a new test start is as follow:
"Wait for new test"-> "Wait for test"-> "Run"-> "View results"

4.6 Analyzer start and close

Analyzer application in computer would be loaded automatically when analyzer is power on. The Analyzer would stay in "Wait for new test" first.

Please close the analyzer by software command "close system" first and then cut off power supply when "It is safe to shutdown now" is showed on LCD

Please cut off power supply direct in emergency.

5 Test operation

5.1 Common procedure of test run

There are 6 work states which had been listed in chapter 4 in analyzer. The common work state changing procedures for test in analyzer are as follow.

1）Run a new test from “wait for new test” after analyzer power on

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

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

2> It would turn to “wait for test” state when one of the test buttons is clicked.

3>Test is started by “start” button.

4>Analyzer would turn to “Run” state when start button is clicked.

5>Analyzer would be 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 would be stay at view results when test is end. All results would be showed in work area.

2> Click “new test” button and then analyzer would be turn to “wait for new test” state.

3> the other steps are the 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 the parameters need to be set in ratio and phase error test should be set in CT analysis test also.

All the parameters set in CT analysis are divided to be two parts. First part of that 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 follow:

1) Connect the analyzer with sample CT according to instruction manual
2) Click CT analysis button in “wait for new test” state
3) Set parameters for CT analysis test
4) Run test by start button
5) Wait for the end of CT analysis test
6) Analyses test results

Warning: The test cycle would be 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 follow:

Coil 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 degaussing first would be ignore.

2) If the saturation of CT is low the procedure of rough voltage regulation would be ignore

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

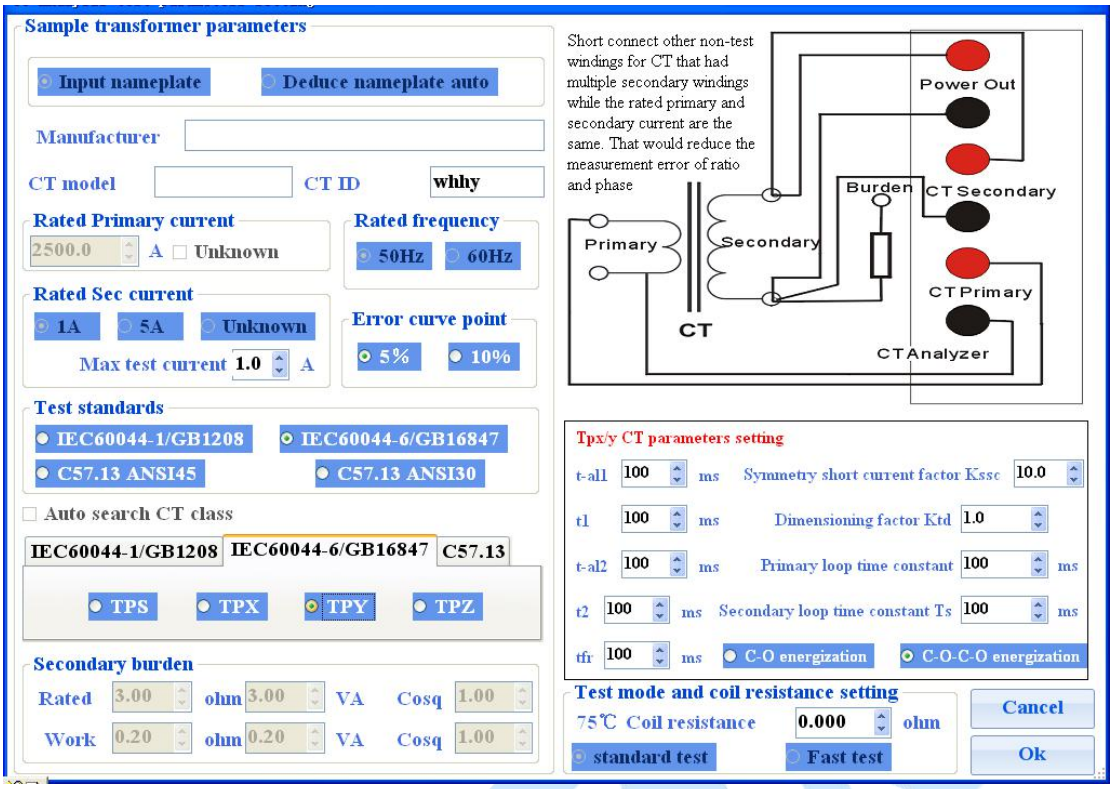


Figure 5.1 Parameters setting for CT analysis

The record points would be little and the rise step voltage would be high if we select fast test mode. So the excitation curve would not be smooth for saturation and the excitation parameters would 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 would get exact and high resolution excitation curve. But the test period is 2 times of fast 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 would not guess the nameplate information. Otherwise analyzer would guess nameplate information according to missing item. The items which could 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 set to be missing analyzer would guess the value according to turns ratio measured and rated secondary current.
Rated secondary current	Rated secondary current. If it is set to be missing analyzer would guess the value according to coil resistance measured

Rated frequency	Rated frequency for CT. Analyzer would 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 would calculate 5% or 10% error line curve according to the selection of this item.
Test Standards	The standard of sample CT is designed according to. Different standard selected in test would 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 would 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
Coil resistance in 75 Celsius degree	Coil resistance in 75 Celsius degree marked in nameplate of CT

Table 5.2 Parameters setting for IEC60044-1/GB1208 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/GB1208 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/GB1208 PX CT

Parameters name	Description
ALF	Accuracy limit factor in nameplate. Range 1~300
Ktd	Transient dimension factor in nameplate. Range1~300
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. Range1~300
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. Range1~300
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. Range1~300
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 would calculate the ratio and phase error at RF*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 would be showed on LCD first 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 follow:

1 Hysteresis loop curve and data

Click on “hysteresis loop” button. The hysteresis loop curve will be showed on the screen as figure 5.2.1. 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 on the “data analyze” check box you can read the current, rise curve flux value and fall curve flux value from the curve. Click on the hysteresis loop data. All the rise curve data and fall curve data will be listed on the window.

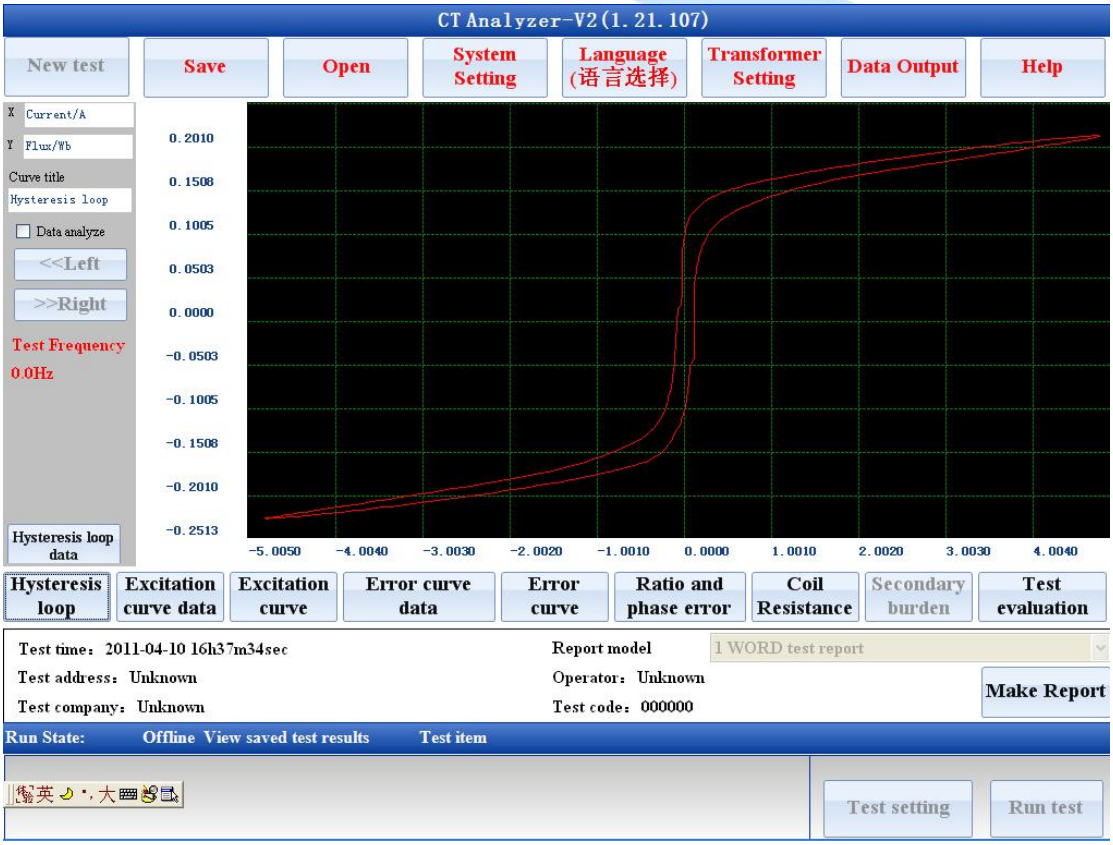


Figure 5.2.1 Hysteresis loop curve

2 Excitation curve data

Panel as figure 5.2 would be showed on LCD when this button is clicked. All the data which construct the excitation curve would 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 fast by

search the excitation point according to excitation voltage.

	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

Figure 5.2 Excitation curve data

3 Excitation curve

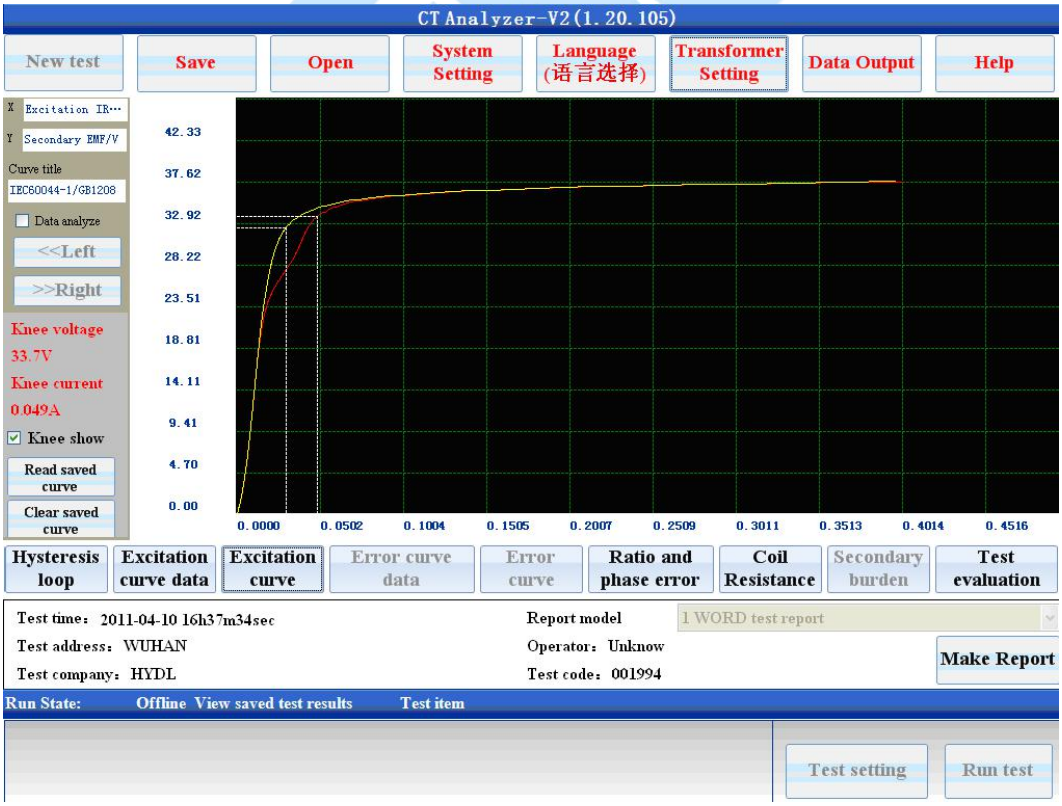


Figure 5.3 Excitation curve compare

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

1) Excitation curve
2) Knee point voltage and current
3) Knee point show check box. If the box is checked the knee point would be marked on the curve. Otherwise there is no mark on the curve.
4) Excitation curve analysis buttons and data show 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 would be showed on the top panel.
5) Excitation curve compare with saved curve. The saved curve could be load to current results panel when “read saved curve” button is clicked. Both the two curves are drawn on the same scope as figure 5.3. We can find the exact change in transformer excitation curve by this function. The saved curve would be cleared when “clear saved curve ” is clicked.

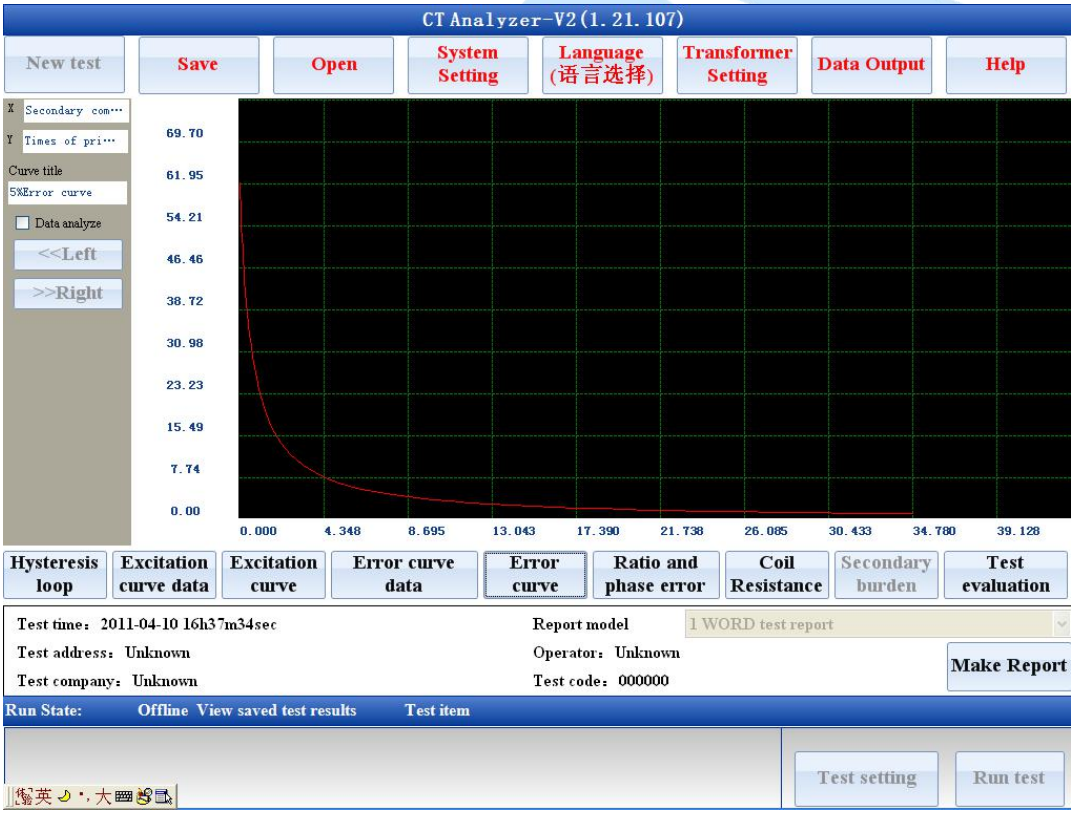


Figure 5.4 Error curve

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%).

5 Ratio and phase error

The ratio error, phase error, turns ratio, turns ratio error and polarity would 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.

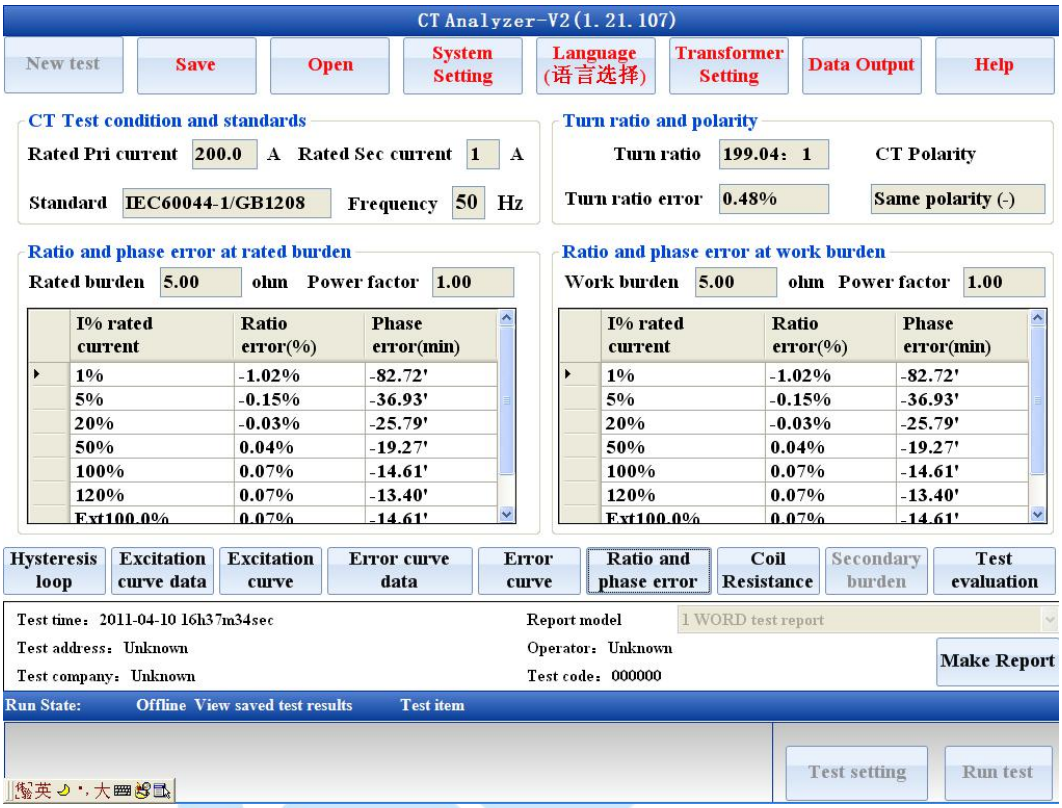


Figure 5.5 the results of ratio and phase error

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 Coil resistance

Panel as figure 5.6 would be showed on LCD if the button of coil resistance is clicked when CT analysis is end.

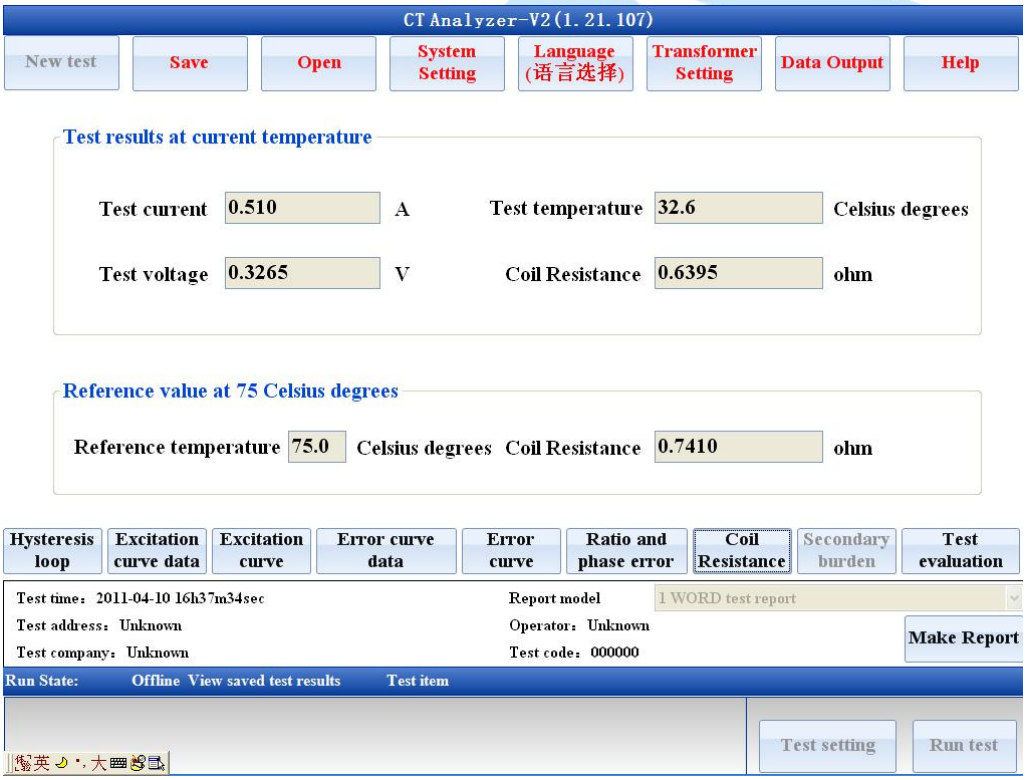


Figure 5.6 the results of coil resistance

The parameters definitions in coil resistance panel are as table 5.10

Table 5.10 results of coil resistance

Parameters name	Description
Test current	The current applied to CT secondary coil
Test temperature	The actual atmospheric temperature of test start
Test voltage	The DC voltage measured from CT coil

Coil resistance	Coil resistance in test temperature
Reference temperature	The reference temperature marked in CT nameplate
Coil resistance in reference temperature	The formula for coil resistance in reference temperature is $R_{ref} = R \times (1 + TK_{copper}(T_{ref} - T_{meas}))$ Kcopper is the temperature factor for copper material

7 Excitation parameters and evaluation item,

The panel of excitation and evaluation item is showed as figure 5.7. The excitation result items are different for different accuracy CT. Please refer to Chapter 6 for detail 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 would be marked in red color. The final evaluation passes only when all single item evaluation pass. Please refer to chapter 6 for detail definition of evaluation for different accuracy CT.

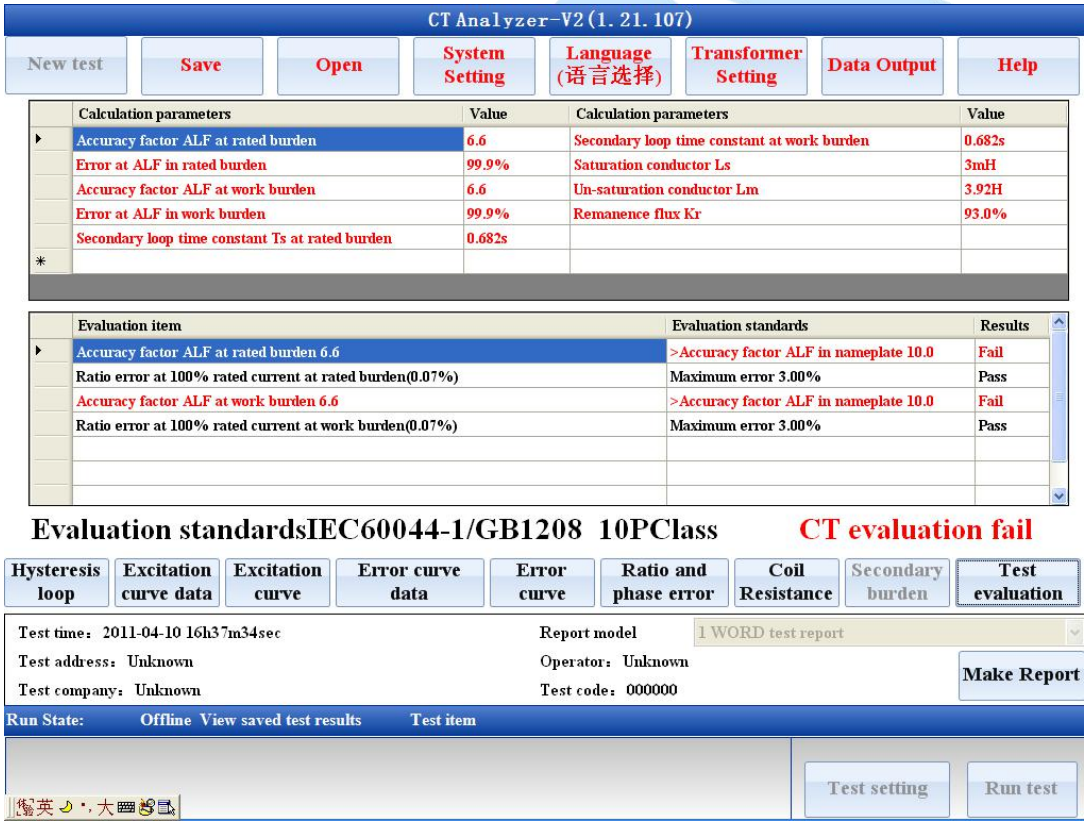


Figure 5.7 Excitation and evaluation results panel

5.3 CT ratio and phase error measurement

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 follow:

Coil 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 degaussing first would be ignore.

2) If the saturation of CT is low the procedure of rough voltage regulation would be ignore

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 coil resistance measurement

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

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

5.5 CT polarity test

There is no parameters need to be set except CT ID in polarity test. Analyzer injects a AC

voltage to CT secondary coil when polarity test is started. Both the primary and secondary coil voltage would be sampled at the same time. The test would be end when primary voltage reached a threshold value or secondary voltage reached to the maximum value.

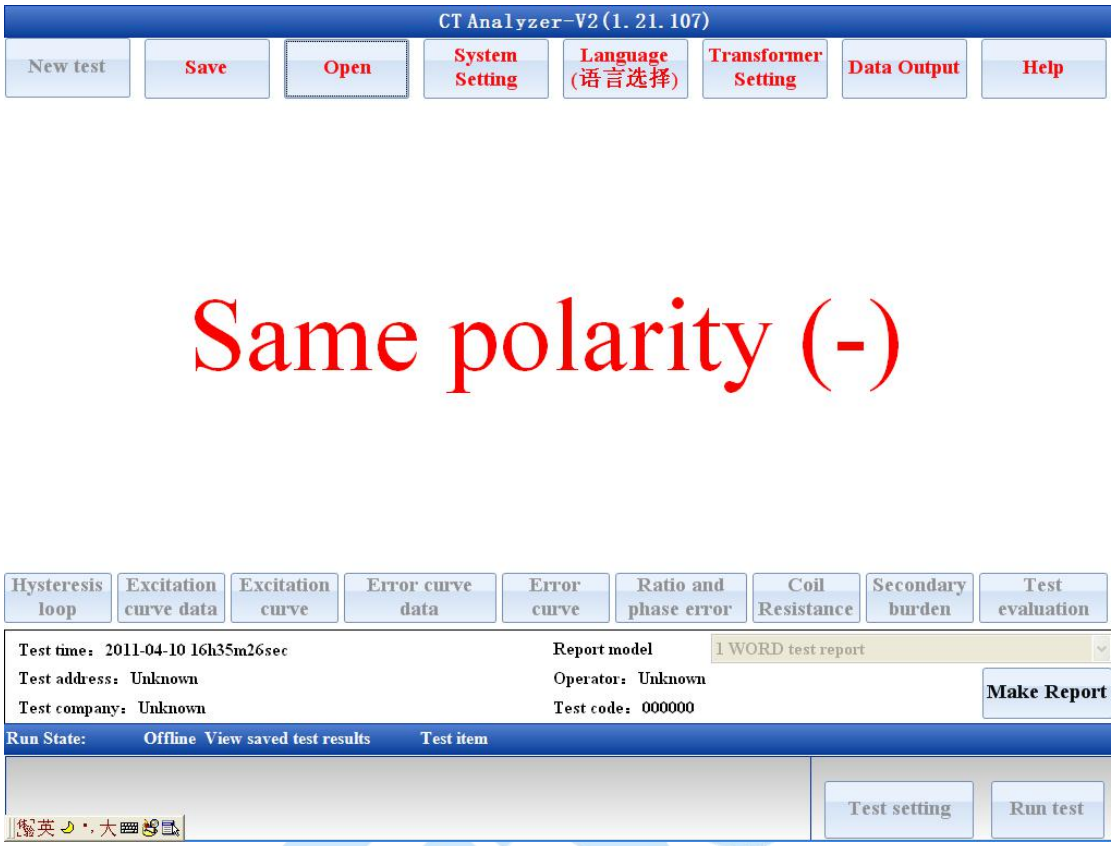


Figure 5.8 Test results of polarity test

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

1) The test is stopped manual
2) There is wrong connection in primary and secondary

The test result would be same polarity if the phase difference 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.

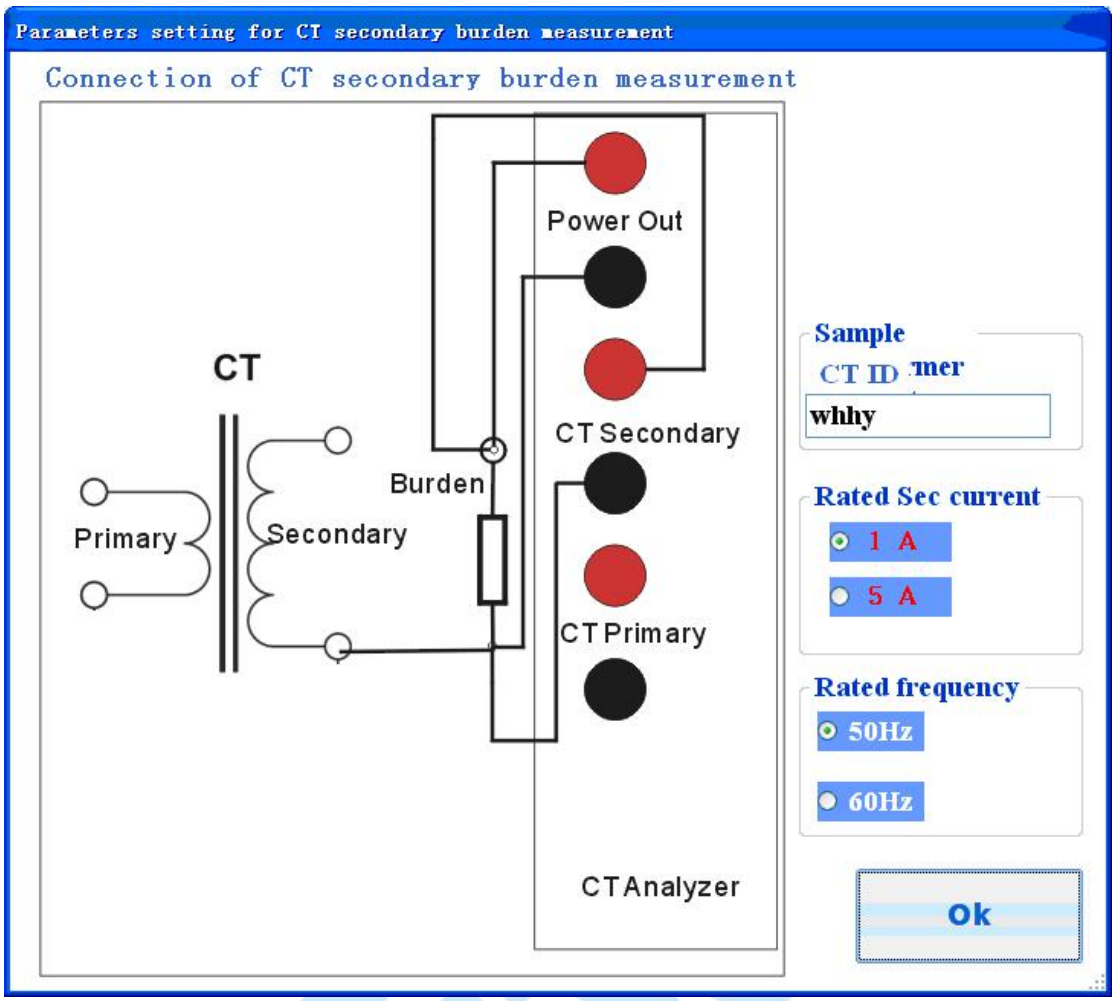


Figure 5.9 Parameters setting for secondary burden test

The definitions of those parameters are as follow:

1) Test current

Test current is that the RMS value of current which would be injected to CT secondary circuit.

2) Test frequency

Test frequency is that the frequency of test current which would 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 range in secondary burden test. The current value and measurement range are as follow::

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

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

Analyzer would inject a AC0.5A (or 0.25A) constant sine current to CT secondary circuit

when secondary burden test is started.

5.6.3 The test results of secondary burden test

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

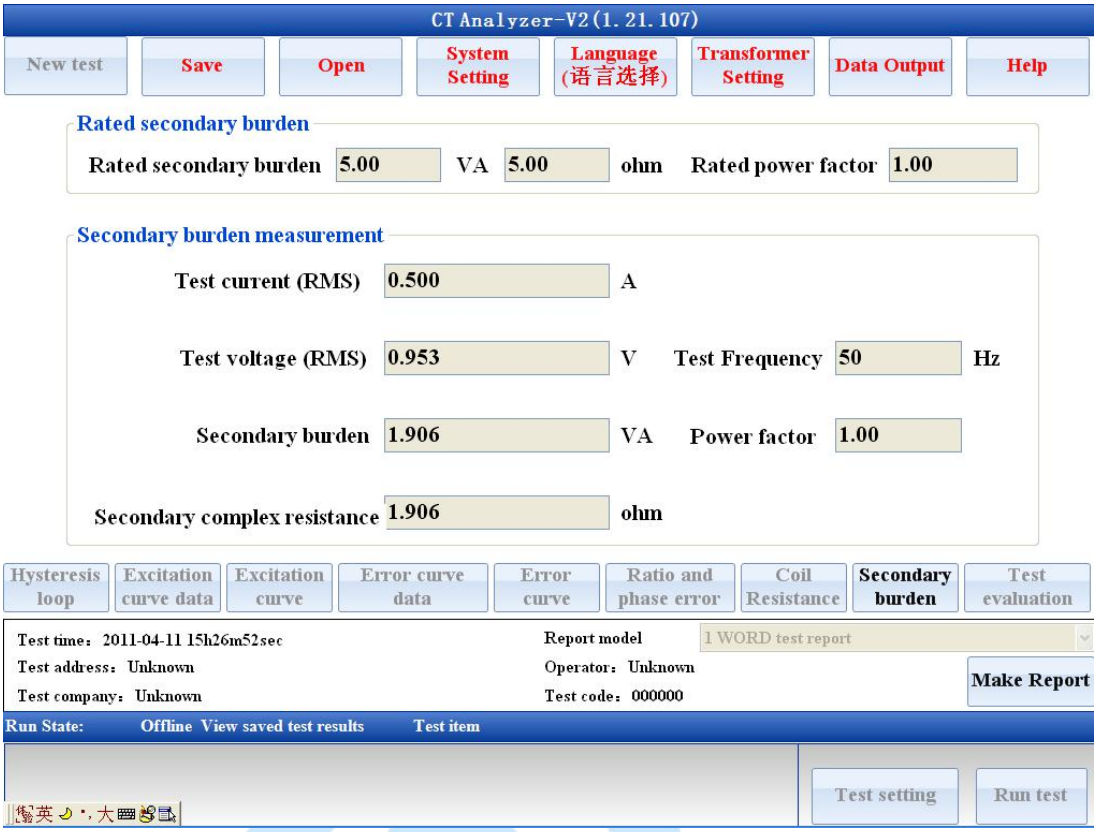


Figure 5.10 Test results of CT secondary burden test

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 Coil resistance measurement

The parameters setting panel of PT coil resistance test is showed as figure 5.11. There are two parameters need to be set in this test. PT ID in PT coil 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.

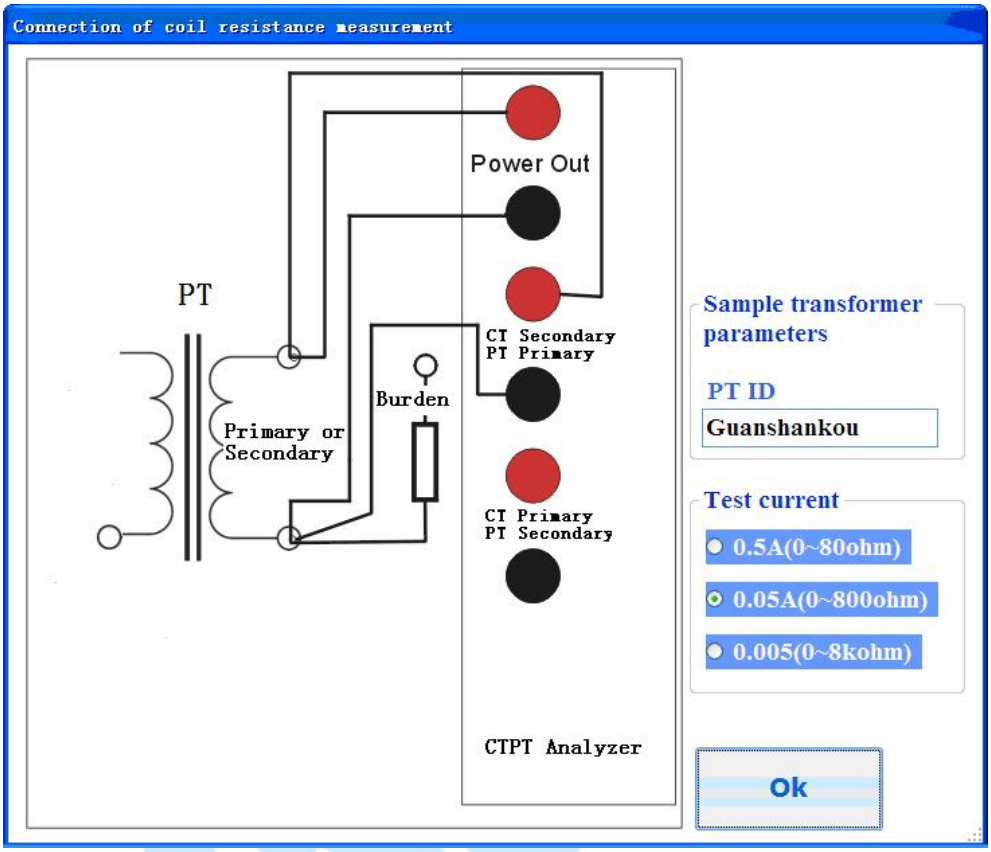


Figure 5.11 Parameters setting for PT coil resistance test

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

5.8 PT polarity test

There is no parameters need to be set except PT ID in PT polarity test. Analyzer injects an AC voltage to PT primary coil when polarity test is started. Both the primary and secondary coil voltage would be sampled at the same time. The test would be end when secondary voltage reached a threshold value or primary voltage reached to the maximum value. The results panel of PT polarity is the same as CT polarity test.

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

1) The test is stopped manual

2) There is wrong connection in primary and secondary

The test result would be same polarity if the phase difference 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

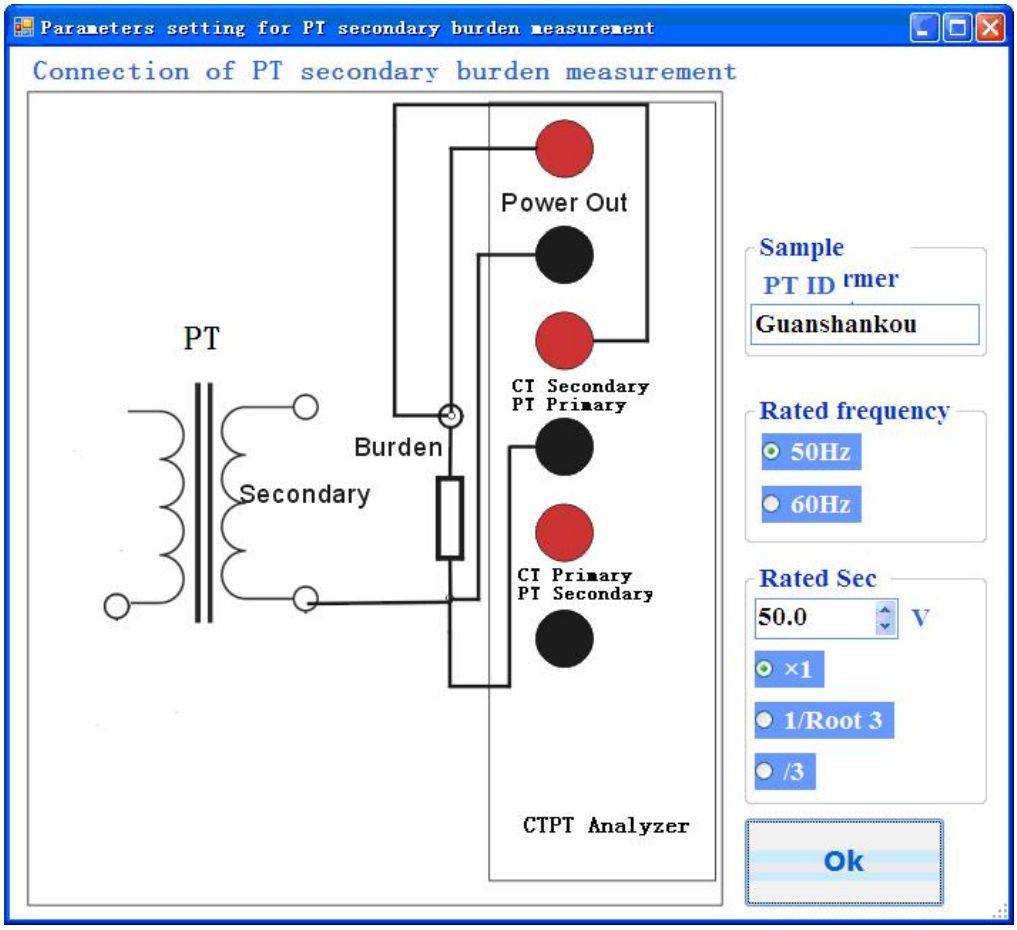


Figure 5.12 Parameters setting for PT secondary burden test

The parameters which are 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 follow:

1) Rated secondary voltage

The value measured by analyzer in PT secondary loop is complex resistance. And 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 that Vrated*Vrated/R.

Vrated 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 would 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 test

PT ratio test is different with CT ratio test. There is no ratio error and phase error measured in PT ratio test in analyzer. Only turns ratio, coil resistance in PT primary and polarity would be measured in PT ratio. The parameters setting panel of PT ratio test is as figure 5.13.

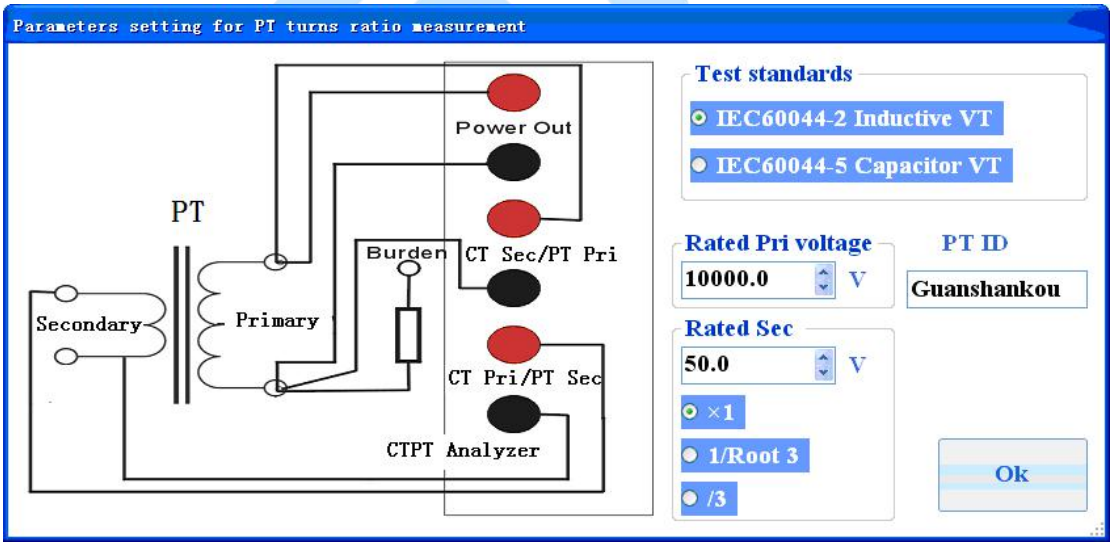


Figure 5.13 Parameters setting for PT ratio test

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.

3) Test standard. Different test standard in PT ratio test would get different test procedure.

If IEC60044-2/GB1207 has been selected analyzer would measure the primary coil resistance

first in ratio test. It is mean that the sample PT is an inductive voltage transformer.

If IEC60044-5/GBT4703 has been selected analyzer would not measure the primary coil resistance in ratio test. There is no coil resistance in primary of capacitor voltage transformer. Please set right test standard for sample PT before test is started.

The test results panel of PT ratio is as figure 5.14. Only turns ratio, turns ratio error and polarity would be showed on this panel.

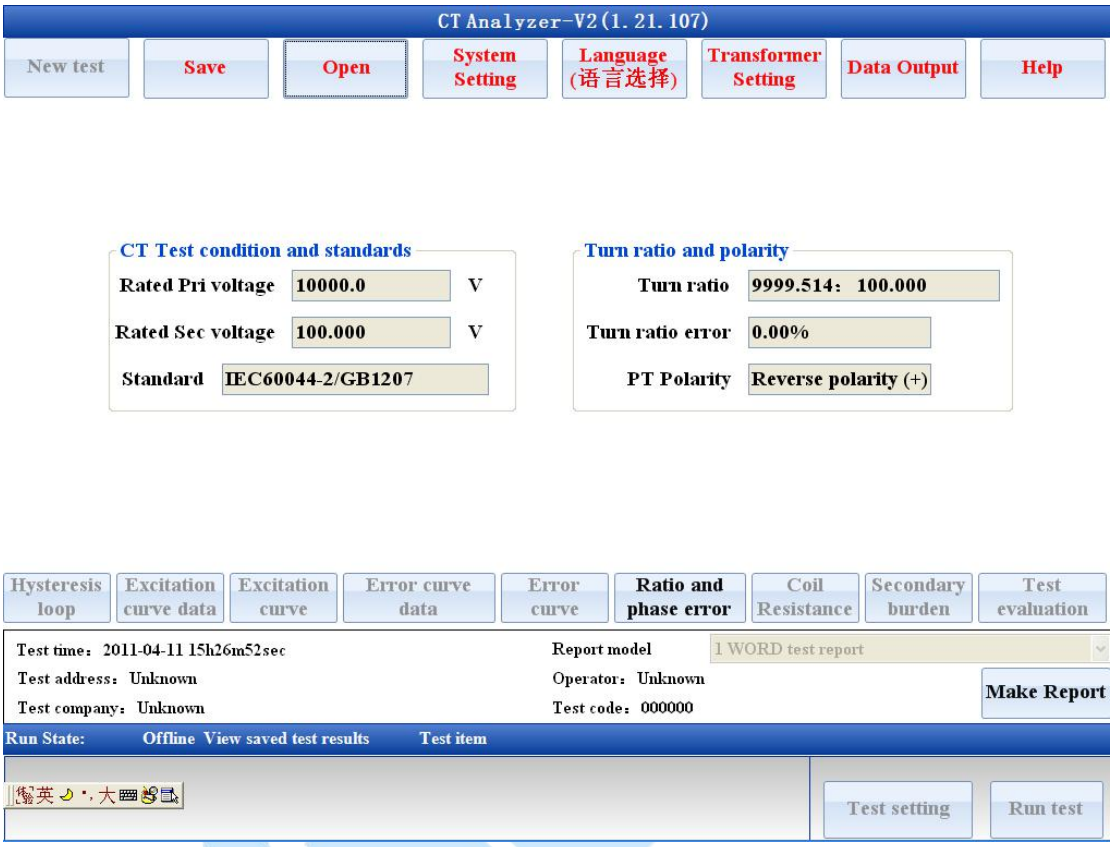
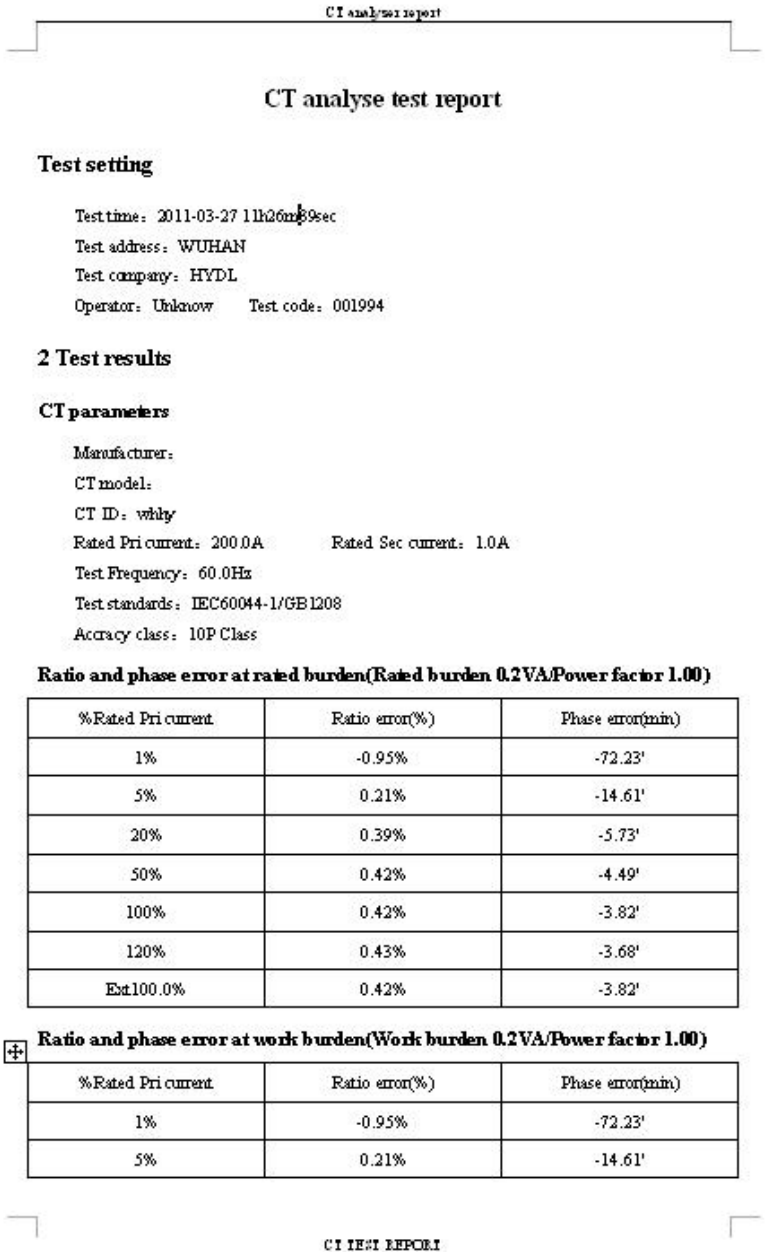


Figure 5.14 Test results of PT ratio

5.11 Make word test report

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

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



CT analyser report

CT analyse test report

Test setting

Test time：2011-03-27 11h26m39sec
Test address：WUHAN
Test company：HYDL
Operator：Unknow　　Test code：001994

2 Test results

CT parameters

Manufacturer：
CT model：
CT ID：whity
Rated Pri current：200.0A　　Rated Sec current：1.0A
Test Frequency：60.0Hz
Test standards：IEC60044-1/GB1208
Accracy 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'
Ext100.0%	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 that compare the test results with the limit of selected test standard. The evaluation is passing if all the test results meet the requirements of selected standard. Otherwise the evaluation would be failure.

Lots parameters of CT are associated with the secondary burden. So the test results would 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 would be closed if evaluation nothing is checked.

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

3) If the evaluation for both rated and work burden selected analyzer would 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 would be passing. 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 detail 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<=FS rated 2）Ratio error in 5% Is <=0.4% Ratio error in 20% Is<=0.2% Ratio error in 100，120% Is <=0.1% Phase error in 5% Is<=15min Phase error in 20% Is<=8 min Phase error in 100，120% Is<=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<=FS rated 2）Ratio error in 5% Is <=0.75% Ratio error in 20% Is<=0.35% Ratio error in 100，120% Is <=0.2% Phase error in 5% Is<=30min Phase error in 20% Is<=15 min Phase error in 100，120% Is<=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<=FS rated 2）Ratio error in 1% Is <=0.75% Ratio error in 5% Is<=0.35% Ratio error in 20,100，120% Is <=0.2% Phase error in 1% Is<=30min Phase error in 5% Is<=15 min Phase error in 20, 100，120% Is<=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<=FS rated 2）Ratio error in 5% Is <=1.5% Ratio error in 20% Is<=0.75% Ratio error in 100，120% Is <=0.5% Phase error in 5% Is<=90min Phase error in 20% Is<=45 min Phase error in 100，120% Is<=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<=FS rated 2）Ratio error in 1% Is <=1.5% Ratio error in 5% Is<=0.75% Ratio error in 20,100，120% Is <=0.5% Phase error in 1% Is<=90min Phase error in 5% Is<=45 min Phase error in 20, 100，120% Is<=30min
1.0 class	1） FS 2) Ratio and phase error in 5%,20%,50%,100% rated	1）FS measured<=FS rated 2）Ratio error in 5% Is <=3% Ratio error in 20% Is<=1.5%

	secondary current in 25% and 100% rated burden or work burden	Ratio error in 100，120% Is <=1.0% Phase error in 5% Is<=180min Phase error in 20% Is<=90 min Phase error in 100，120% Is<=60min
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<=FS rated 2）Ratio error in 50% Is <=3% Ratio error in 120% Is<=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<=FS rated 2）Ratio error in 50% Is <=5% Ratio error in 120% Is<=5%

Table6.3 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>=ALF rated 2) Ratio error in 100% Is<=1% 3) Phase error in 100% Is<=60min
10P class	1)ALF 2)Rated error in 100% rated secondary current	1）ALF measured>=ALF rated 2) Ratio error in 100% Is<=3%
5PR class	1)ALF 2)Ratio and phase error in 100% rated secondary current 3) Remanence factor kr	1）ALF measured>=ALF rated 2）Ratio error in 100% Is<=1% 3）Phase error in 100% Is<=60min 4）Kr<=10%
10PR class	1)ALF 2)Rated error in 100% rated secondary current 3) Remanence factor kr	1）ALF measured>=ALF rated 2）Ratio error in 100% Is<=3% 3）Kr<=10%
PX class	1) Turns ratio error 2) Accuracy limit voltage Ek 3) Accuracy limit current Ie 4) Dimension factor Kx Coil resistance in 75 Celsius degree	1）Turns ratio error<=0.25% 2）Ek measured>=Ek rated 3）Ie measured>=Ie rated 4）Kx measured>=Kx rated 5）Coil resistance in 75 degree <=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) Coil resistance in 75 Celsius degree	1) Turns ratio error <=0.25% 2) Val measured>=Val rated 3) Ial measured <= Ial rated 4) K*Kssc measured>=K*Kssc rated 5) Coil resistance in 75 degree measured <= rated value in nameplate
TPX class	1) Ratio error in rated current 2) Phase error in rated current 3) Peak instantaneous error 4) Kssc*Ktd measured 5) Coil resistance in 75 Celsius degree	1) Ratio error in Is<= 0.5% 2) Phase error in Is<=30min 3) Peak instantaneous <= 10% 4) Kssc*Ktd measured >= Kssc*Ktd rated 5) Coil resistance in 75 degree measured <= rated value in nameplate
TPY class	1)Ratio error in rated current 2)Phase error in rated current 3)Peak instantaneous error 4) Kssc*Ktd measured 5) Coil resistance in 75 Celsius degree 6) Remanence factor kr 7) Secondary loop time constant Ts	1) Ratio error in Is<= 1.0% 2) Phase error in Is<=60min 3) Peak instantaneous <= 10% 4) Kssc*Ktd measured >= Kssc*Ktd rated 5) Ts measured <= 30% rated in nameplate 6) Kr<=10% 7) Coil resistance in 75 degree measured <= rated value in nameplate
TPZ class	1)Ratio error in rated current 2)Phase error in rated current 3) Kssc*Ktd measured 4) Coil resistance in 75 Celsius degree 5) Secondary loop time constant Ts	1) Ratio error in Is <=1.0% 2) Phase error in Is <=180min 3) Kssc*Ktd measured >=Kssc*Ktd rated 4) Ts measured <= 30% Ts rated in nameplate 5) Coil resistance in 75 degree measured <= 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% Is<=0.6% Ratio error in 100,100*RF% Is<=0.3%
0.6 class	Ratio error in 10%,100% and RF*100% Is in rated or work burden	Ratio error in 10% Is<=1.2% Ratio error in 100,100*RF% Is<=0.6%
1.2 class	Ratio error in 10%,100% and RF*100% Is in rated or work burden	Ratio error in 10% Is<=2.4% Ratio error in 100,100*RF% Is<=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*Isn 4）Ratio error in Vbmax rated	1）Vbmax measured >=Vbmax rated (If the value of Vbmax rated is missing analyzer would set the value to 20*Is*Rated burden) 2）Isec measured >=20*Is rated 3）Ratio error 20*Isn<=10% 4）Ratio error Vbmax rated<=10% Isn rated secondary current
K class	1）Vbmax measured 2）Secondary current in Vbmax 3）Ratio error in 20*Isn 4）Ratio error in Vbmax rated	1）Vbmax measured >=Vbmax rated 2）Isec measured >=20*Is rated 3）Ratio error 20*Isn<=10% 4）Ratio error Vbmax rated<=10% 5) Knee point voltage>= 70% Vbmax rated
T class	1）Vbmax measured 2）Secondary current in Vbmax 3）Ratio error in 20*Isn 4）Ratio error in Vbmax rated	1）Vbmax measured >=Vbmax rated 2）Isec measured >=20*Is rated 3）Ratio error 20*Isn<=10% 4）Ratio error Vbmax rated<=10% Isn 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	IEC60044-1measur	IEC60044-1

		ement 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	√	√
Ktd	Dimension 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			
Eerror	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 detail 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 that get part of nameplate information from test results when nameplate is unknown. The information could be guessed include rated primary current, rated secondary current and accuracy class.

The guess logic for analyzer is as follow:

1) If the value of rated secondary current is unknown analyzer get the value from the coil resistance measured. If the coil resistance in 75 Celsius degree is less than the threshold value the rated secondary current would be 5A. Otherwise the rated secondary current is 1A.

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

3) Guess the accuracy of CT

First 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 guess the accuracy class as follow procedure.

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

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

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

TPY->TPX->TPZ->TPS

2) If the test standard is C57.13 analyzer set the accuracy according to follow step and evaluation for all the steps. The first class which passes the evaluation would be set to be the accuracy of the sample CT.

K->C->T

If it is measurement core analyzer guess the accuracy class as follow procedure.

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

   0.3->0.6->1.2

7 Accessories list

7.1 CTPT analyzer standard configuration

Table 7.1 Standard configuration for CTPT analyzer

Name	qty	Description
Host	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	12	Three red and nine 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 instruction manual
Instruction manual	1	
Inspection report/Warranty card	1	

Appendix A the principle of low frequency excitation test

The voltage frequency of excitation test could be low than power frequency as it described in IEC60044-6 standard. So that 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 follow:

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

R CT ： Stand for secondary coil resistance

U CT ： Stand for secondary terminal voltage

I CT ： Stand for secondary current

Ψ0 ： Stand for initial flux

Ψ(t)：Stand for flux in time t

The definition of EMF is as follow：

$$U_C(t) = U_{CT}(t) - R_{CT} I_{CT}(t) \qquad (A.2)$$

If U C (t) is a sine signal：

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

$$U_{Cms} = \frac{\omega \Psi_m}{\sqrt{2}} = \frac{2\pi f \Psi_m}{\sqrt{2}} = 4.44 f \Psi_m \qquad (A.4)$$

The f in formula is the frequency of sine signal. We can get the conclusion that the core voltage is proportional to the frequency. So just cut down the test frequency we 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 Iext. The current convert from primary to secondary is constructed by vector sum of Iext and secondary current Ist. So the value of primary is not equal to N*Iset(N is the turns ratio). We define the error curve line error value as follow。

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

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

$$I_1^{'} = 10 I_0 \qquad (B.2)$$

$$I_2 = 9 I_0 \qquad (B.3)$$

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

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

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

I1M Maximum short circuit current in primary

I1N Rated primary current

I2N Rated secondary current

Z2 Secondary coil resistance

E0 EMF in secondary coil of CT

ZB Secondary burden

We 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.