Relaying Current Transformer Analyser

CTERP-2000

F E A T U R E S

- Measures Ratio, Excitation Characteristics, Polarity, Winding Resistance, Remanance, and Insulation Resistance of secondary winding.
- Determines Composite Error.
- Used to test un-mounted CTs or CTs that are mounted but isolated inside the power system equipment.
- Conducts a whole series of tests automatically, thus speeding up the time to commission CTs and relaying systems.
- Battery powered test set - light weight & fully portable.
- Provides a graphical presentation of the CT excitation characteristics.
- Determines the IEC 10/ 50 knee point and the point of maximum permeability (ANSI 45^{o} Slope Point).
- Detects shorted turns or insulation problems within the test CT, thus avoiding commissioning of faulty equipment.
- Measures the Hysteresis loss and plots hysteresis curves of CT cores.
- Automatically demagnetizes the test CT.
- RS-232 for Computer Interface.
- USB port for Printer Interface.
- Graph printing provided through PC.
- Data Storage facility - can store 50 results.
- Windows Interface Software available.

DESCRIPTION

The Eltel CTERP-2000 is a new generation, fully automatic, microprocessor based instrument for testing relaying current transformers to International & National Standards. The instrument is a lightweight and portable test set that determines the excitation characteristics, turns ratio, winding polarity and winding resistance of single-ratio or multi-ratio relaying current transformers.

The CTERP-2000 is suitable for making complete commissioning tests on relaying CTs according to ANSI Specification C57.13.1 as well as IEC Specification IEC 44-1 that would be normally conducted prior to connecting such CTs to protective relays and commissioning the protective relaying system.

PRINCIPLE OF OPERATION

The CTERP-2000 operates and relies on fundamental physical principles. Measurements of the fundamental magnetic quantities of field strength and flux density are conducted on the CT and these measurements allow the instrument to calculate and provide the desired results. The CTERP-2000 applies magnetic flux density, in volt-seconds, and measures the resulting magnetic field strength, in amperes. This process allows one to draw a full hysteresis loop. Multiple hysteresis loops allows the CTERP-2000 to calculate the V/I excitation characteristics for the test CT specimen.

The hysteresis loops that are conducted on the test specimen use a special procedure that allows the CTERP-2000 to separate the excitation power loss into the "hysteresis loss" and the "eddy current loss". The ability to measure the "eddy current loss" makes the CTERP-2000 very sensitive to problems with the core or shorted turns.

As the instrument applies "volt seconds" rather than "volts" during the test, it can test CTs, over the range of <10 volts to >10 kilovolts. The specimen with a high knee-point voltage only takes a bit longer to test. As no actual "high voltage' is applied, the test is very safe to conduct. As the actual excitation characteristics are calculated from DC values, the measurements are very repeatable, and not influenced by the frequency stability or the distortion of the power line.

In addition to measuring the magnetic characteristics of the test CT, the CTERP-2000 also measures the insulation resistance of the secondary winding.

The application of voltage and the measurement of current is simple - but an incomplete method of testing the performance of a CT for relaying applications. This method has been used for a long time because other test methods were not available.

The ANSI and IEC specifications require one to obtain the excitation characteristics for the CT winding, suggesting that one way of doing this is to apply a known sinusoidal voltage at the required frequency, and then measure the excitation current and excitation loss. The standards do not comment on the use of other test methods that provide the required information - namely excitation characteristics.

The CTERP-2000 tests the characteristics related to the core and the winding of the test CT & uses this information to calculate the performance of the CT for relaying applications. The CTERP-2000 measures more characteristics than are required by ANSI C-57.13.1 or IEC 60044-1 specifications. These additional measurements include core loss, residual magnetism and eddy current component of loss.

Even though the test is conducted using DC, the excitation characteristics that the CTERP-2000 provides is for a pure sinusoidal voltage of the required frequency against the RMS value of current, all as per the requirements of the standards.

THE MEASURING SEQUENCE

The measuring sequence is designed to obtain all the pertinent information from the CT in the shortest possible time. The test procedure is as follows:

- **Insulation Test** – measures insulation resistance of secondary winding at 500 volts DC.
- **Remanence Measurement** – The CT is saturated in the (+) & (-) polarity and remanence is calculated. Also, the winding resistance is measured during this process.
- **Excitation characteristics** – Repetitive hysteresis curves are taken at gradually decreasing excitation values. When completed, the CT core is typically left with remanence in the order of 2%.The hysteresis test results are used to compute the voltage vs. current characteristics at the specified frequency for the test CT. The measurement of ratio is conducted at the same time.

  It should be pointed out that the measurements of remanence can be made ONLY ONCE. The measurement of remanence by any known means automatically destroys the existing value of remanence.

TESTS AND TEST RESULTS

When testing CTs, the CTERP-2000 measures and displays the following information:

Ratio ■ Polarity ■ Winding resistance ■ Excitation Characteristics ■ Excitation loss of CT Core ■ Power factor of CT Core loss ■ Remanence ■ Insulation resistance ■ 3 x 3 cycle log curve of the excitation characteristics ■ Access to all the excitation curve test points.

- When testing CTs to ANSI C57.13.1 Standard, the CTERP-2000 also provides:
  Excitation voltage for the 2.5 ampere excitation point.
  Point of Maximum Permeability (45° Slope Point)
  ANSI Relaying Accuracy Class.
- When testing CTs to IEC 44-1 Standard, the CTERP-2000 also provides:
  IEC 10/50 knee-point voltage and current values,
  IEC Relaying Accuracy Class (5%).
  Winding Resistance @ 75°C.
- CTERP-2000 conducts other tests as explained below
  HYSTRESIS TEST
  - Graphical representation of upper half of the hysteresis curve.
  - Hysteresis characteristics of CT core material,at present excitation values.
  - The shape ot the excitation characteristics.
  - Power factor of CT core loss.
  - The relative value of hysteresis loss in terms of %.
  - Some numerical values similar to ANSI and IEC test result.

  PS/X CLASS TEST
  - 10/50 Knee Point.
  - Vk/2, Ik/2, Vk/4 & Ik/4 values.
  - Winding Resistance @ 75°C.

  IS PROTECTION TEST
  - Accuracy class.
  - Value of composite error at point of max. Limiting E.M.F.
- The CT is always left in a demagnetized state after completion of any of the tests.

EXPLANATION & DESCRIPTION OF MEASURED QUANTITIES

Excitation Loss

Excitation loss includes active (W) and reactive (VAR) components and reflects the characteristics of the core material used in the CT. The excitation loss is responsible for the ratio and phase error of the CT under normal operating conditions.

Hysteresis Loss

Hysteresis loss is one part of the active loss. It is due to the characteristics of the core material used in the CT.

Eddy Current Loss

Eddy current loss is the second part of the active loss. Eddy current loss is due to circulating current within the core laminations and between the core laminations. Shorted turns on the CT show up as eddy current losses during the measurements.

Knee point

The "knee-point" used by the CTERP-2000 is that as defined by IEC. It is the 10/50 knee-point, meaning it is a point on the V-I excitation curve whose slope is 10/50, or where an increase by 10% in the excitation voltage causes a 50% increase in excitation current.

Since the CTERP-2000 uses a DC Voltage and the Volt-Seconds measurement principle, the knee point voltage of the CT is not a limitation. This is in contrast with a conventional measuring principle where the kVA rating of the power supply is a limitation - especially while measuring large CT ratios with high knee point voltage.

Point of Max permeability (45° slope point)

While conducting the ANSI test, the CTERP-2000 measures and displays the point of max permeability indicating the corresponding values of voltage & current. This is also referred to as the 45° slope point. (This feature is provided only in the CTERP-2000-5A model as ANSI only recognizes the sec current of 5A).

Winding Resistance

The resistance of the secondary winding is measured as it is required for the ANSI and IEC relaying accuracy calculations. Some specifications require the use of the winding resistance at 75°C. For correcting the winding resistance to 75°C, the CTERP-2000 assumes a 25°C ambient.

Remanence

Measuring remanence, or "residual magnetism" in the CT core, is a unique feature of the CTERP-2000. Remanence influences the performance of the CT under transient fault conditions that are found on the power system. Such transient fault conditions can be found at or near generating stations as well as on high voltage transmission networks. The larger the capacity of the generating station and the higher the voltage of the transmission network – the higher the incidence of faults with transients and the higher the importance of remanence on the performance of CTs and associated protective relays.
It must be pointed out that remanence can be measured ONLY ONCE. Its measurement automatically destroys it.

Composite Error

The CTERP-2000 determines and displays the "composite error" of protection CTs. The composite error is the square root of the sum of the squares of the ratio error and phase error. Its magnitude depends on the excitation characteristics of the CT, the current, the burden, and the winding resistance.

Demagnetization

Any application of DC to the CT winding, like while measuring continuity or winding resistance, will magnetize the CT core. It is undesirable to leave CT cores magnetized condition, as such magnetization (remanence or residual magnetism) may cause the CT to malfunction under transient fault conditions. Malfunction of CTs may in turn cause the protection relays to malfunction.

The CTERP-2000 test procedure has been specially organized in such a way so that it will always leave the test CT in a demagnetized (degaussed) condition when the test is completed. This avoids the need for separate demagnetization (degaussing).

Turns Ratio

The CTERP-2000 measures the ratio of the test CT, as such ratio measurement is also required when commissioning relaying systems. CT ratios affect the settings of distance and other relays on the power system.

Insulation Resistance

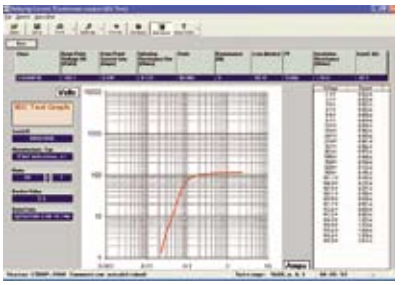
The CTERP-2000 verifies the insulation resistance of the secondary winding using a 500 volt DC test voltage. This test voltage is very safe to use as the winding should be capable of withstanding a much higher voltage test.

S P E C I F I C A T I O N S

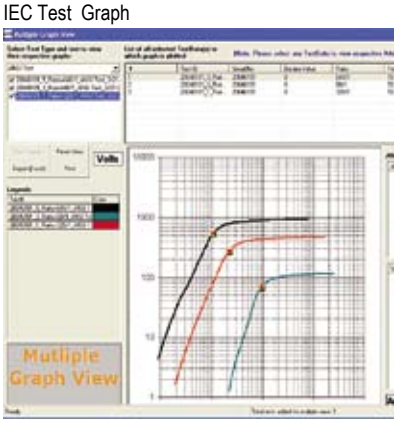
PARAMETER	CTERP-2000-5A	CTERP-2000-1A
Ratio	Range: 5/5 to 15,000/5 Accuracy: ±0.25 %(5/5 to 3,000/5) ±0.45 %(3000/5 to 15,000/5) Resolution: 4 digits	Range: 1/1 to 15,000/1 Accuracy: ± 0.25 %(1/1 to 3000/1) ± 0.45 %(3,000/1 to 15,000/1) Resolution : 4 digits
Winding Resistance	Range: 0 to 1000Ω Accuracy: ±1% Best Resolution: 1mΩ	Range: 0 to 1000Ω Accuracy: ±1% Best Resolution: 1mΩ
Insulation	Range: 1 MΩ to 10 GΩ Accuracy: ±3% Test Voltage: 500V Resolution: 3 digits	Range: 1MΩ to 10GΩ Accuracy: ±3% Test Voltage: 500V Resolution: 3 digits
Current Display	Range: 1mA to 15A Accuracy: ±2% (5mA to 15A) Resolution: 3 digits.	Range: 1mA to 10A Accuracy: ±2% (10mA to 10A) Resolution: 3 digits.
RMS	Range: 1mA to 10A Accuracy: ±2% (5mA to 10A) Resolution: 3 digits	Range: 1mA to 7A Accuracy: ±2% (5mA to 7A) Resolution: 3 digits
Voltage Display	Range: 1 to 10,000 V Accuracy: ±2% ±0.5V Resolution: 3 digits.	Range: 1 to 10,000 V Accuracy: ±2% ±0.5V Resolution: 3 digits.
Hysteresis Loss	Range: 0VA to 10KVA Best Resolution: 1mVA	Range: 0VA to 10KVA Best Resolution: 1mVA
Power Factor	Range: 0 to 1.0 Resolution: 0.01	Range: 0 to 1.0 Resolution: 0.01
Frequency	50 or 60Hz.	50 or 60Hz.
Remanence	Range: 0 to ±100% Resolution: ±1% Accuracy: ±3%	Range: 0 to ±100% Resolution: ±1% Accuracy: ±3%
Demagnetization	Accuracy: ±3%	Accuracy: ±3%
Output Voltage	12 volts DC	24 volts DC
Output Current	20 amperes maximum (Peak)	10 amperes maximum (Peak)
Operator Interface	240 x 128 dot matrix Back-lit LCD graphic display & 20 Membrane keyboard	240 x 128 dot matrix Back-lit LCD graphic display & 20 Membrane keyboard
PC Interface	RS-232 serial port	RS-232 serial port
Printer Interface	USB Port	USB Port
Power	Battery powered using 5AH,12V NimH Battery (Suitable for 6 hrs operation under average use).	Battery powered using 2 X 5AH,12V NimH Battery (Suitable for 6 hrs operation under average use)
Battery Charger	Input: 100-240 Volts, (2A) 50-60 Hz.	Input: 100-240 Volts, (1.5A) 50-60 Hz.
Charger Output	9.6 - 18.0V DC; 0.9A or 1.8A(33W)	19.2 – 24V DC; 1.5A(36W)
Dimensions	Approx. 355 x 280 x 170mm	Approx. 355 x 280 x 170mm
Weight	Approx. 13 Kgs.	Approx. 13 Kgs.
Temperature	0 – 50°C	0 – 50°C
Humidity	Ambient to 90% RH, non condensing	Ambient to 90% RH, non condensing

Note:The CTERP-2000-5A can also test 1A CTs at reduced accuracies.
Specifications are subject to change without notice. Additional features, improvements are being incorporated.

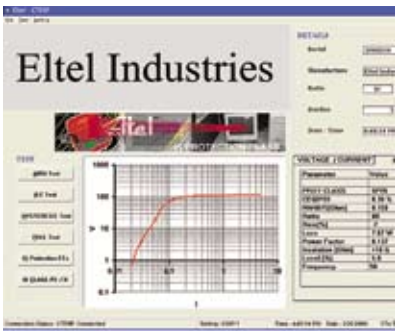
ANSI Test Graph



IEC Test Graph



Multi-Tap Plot graph



IS Protection Test graph

Cable Set for
CTERP-2000-1A and **CTERP-2000-5A**

- Secondary Cable - 3 mtrs.
- Primary Cable - 10/15 mtrs.
- Ground Cable - 3 mtrs.
- USB Cable - 2 mtrs.
- RS-232 Cable - 2 mtrs.

ACCESSORIES

- Windows interface Software
- Operation Manual
- Battery Charger

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