Transformer Loss Measurement Systems

- **138kV, 2500A** - 3 phase loss measurement system for load & no load loss measurement of power transformers
- **Combined CT & VT** Metering units for measuring both current & voltage
- **7 Channel** Temperature sensing facility for connection to test specimen
- Fully automated measurement with manual override
- Real time measurement and graphical bar graph & wave form display for analysis.
- Wide measurement range from **100V to 138kV & 1A to 2500A**
- Test winding provided for ease of calibration & self checking
- Measures & displays voltage, current & power for each phase; computes & displays three phase values.
- Displays test waveforms
The losses of power system equipment, such as transformers, motors and generators have traditionally amounted to a very large value every year. These losses are becoming increasingly significant with the increasing cost of electricity. The value of losses varies per kilowatt depending on the power system and if these are core (voltage) or copper (load) loss related. Therefore, it is very important for an electrical equipment manufacturer to quantify these losses at the development and production level to come up with acceptable efficiency for their equipment and then to confirm the efficiency by actually measuring the losses during open circuit and short circuit tests.

**GENERAL DESCRIPTION**

The Transformer Loss Measuring System (TLMS) manufactured by ELTEL Industries is the measurement system for the accurate measurement of impedance and loss of single-phase or poly-phase power and distribution transformers. These measurements are typically conducted during short-circuit and open-circuit test of transformers. In addition to measuring transformer, these metering systems can be used to measure the characteristics of generators, or motors using the two-frequency load test. The system offers AUTOMATIC computer operation with MANUAL override and provides high accuracy over a very wide range of voltage, current and power factor. A variety of voltage and current ratings are available for each specific application.

As the typical test samples exhibit a low power factor and a wide range of impedance, meaningful measurements of losses is possible only if the test equipment offers accurate measurement of losses at Low power factor, and over a very wide operating range of voltage and current. Measurement accuracy, linearity, consistency and repeatability are also very critical. These important factors, combined with a variety of other significant features have been incorporated into the design of the TLMS that can be used on single-phase or three-phase equipment.

Each TLMS consists of three sensing or metering units, an analog and digital processing unit and a personal computer system. Each sensing unit comprises a loss free capacitor for test voltage measurement and a two-stage torroidal current sensor for measuring the test current. An analog and digital processing unit measures the signals from the voltage and current sensors and these are displayed on the screen of the computer system.

**APPLICATION**

Factory testing of core loss tests (open circuit test) and copper loss tests (short circuit test) on large power transformers

Heat run and induced voltage tests during transformer production testing

Zero sequence test

Research and development institutions for conducting loss measurements for type testing.

The TLMS is configured to allow convenient calibration that complies with: NBS Technical Note 1204, “Calibration of Test Systems for Measuring Power Losses of Transformers”. In addition to this, the systems are equipped with other features not available on any competitive equipments - that allow simple and easy calibration of the system. One of these is the use of “test windings”, another one is the provision for conventional 100volt and 5 amperes metering circuits to be measured accurately. They can monitor the loading of auxiliary circuits during performance tests. These inputs are also used during the test and calibration of the equipment.

The TLMS does not use instrument transformers that would power conventional instruments with nominal voltages (100 volts) and nominal current (5 amperes), but rather converts the measuring voltage and current to a low voltage signals that are directly suitable for digital converters (ADC) and digital signal processors (DSP). This reduces the complexity of the measuring system, increases its reliability and improves its accuracy.
**ELECTRONICS**

The analog and digital electronics process the signals from the voltage and current sensors providing a multiplicity of voltage and current ranges, calculating the voltage, current and power in the test circuit, determining optimum range settings, and providing the PC with the measured values for display and report applications.

The electronics module is line powered from 100 . . . 260 volts, 50, 60 Hz and is housed in a 19-inch rack cabinet.

**COMPUTER SYSTEM**

The TLMS is a computerized automated system and does not have any manual controls to perform its operation. A high configuration, Industrial IBM compatible PC system including a fast Pentium processor, ample memory, CD drives, a 19-inch flat-screen colour LCD display with a keyboard and a laser printer is part of the TLMS system. The PC is operated on the Windows operating system and uses the customized operating software. This software package is a sophisticated menu structured program which gives the user complete flexibility and control along with an unsurpassed data management system.

**The integrated software features include:**

- Display of the per-phase and the three-phase- average test results for voltage, both RMS and FLUX, current and power.
- Plot Bar-graphs for indicating the voltage, current and power level for each phase.
- Setting of the current and voltage ranges or let the instrument auto-range to the most optimal range.
- Select other electrical parameters such as apparent power, impedance and power factor to be determined and displayed.
- The wave-shapes of the voltage or current being measured can be displayed on the PC screen.
- The concept of “soft-keys” is employed to minimize Data entry through the keyboard while maintaining a high degree of flexibility.
- Entry of test conditions, such as date, time, serial number, environmental conditions etc.
- Printing of customized test report. Other important information, such as the turn ratio and winding resistance can also be incorporated into the test report by entering the information through the keyboard.
- Test results can be permanently saved for future reference or statistical analysis.
- Allows the operator to search for previous reports based on serial number, test date, type of test object and other Variables.

**PRELIMINARY SPECIFICATIONS AND RANGES**

1. Current Measurement: accurate over a 10,000 to 1 range of current.
2. Voltage Measurement: accurate over a 1000 to 1 range of voltage.
3. Power Measurements: accurate over power factor range of 0.01 leading to 1.0 - to 0.01 lagging.
5. “Line-to-Line” or “Line-to-Ground” voltage measurement and indication.
7. The per-phase or the three-phase values are displayed simultaneously.
8. “Four-Terminal” Measurement: to eliminate the losses in the connection leads and sensors from the measurement.
RANGES
Voltage : Seamless operation from 0 to 100% of rated line-to-line voltage. Typical line-to-line ratings include: 1.5 V, 12kV & 138kV.
Current : Seamless operation from 0 to 100% of rated current. Typical current ratings include: 2500A, 320A, 80A, 20A amperes.

ACCURACY
Voltage : ±0.15% of reading for inputs from 1%-100% of full-scale rating. ±0.3% of reading for voltages below 1% of full-scale rating.
Current : ±0.15% of reading for inputs from 0.1%-100% of full-scale rating. ±0.3% of reading for currents below 0.1% of full-scale rating.
Power : ±0.15% of reading at 1.0pF, with voltage from 1%-100% of full-scale rating current and from 0.1%-100% of full-scale rating. ±0.3% of reading at 0.1pF, with voltage from 1%-100% of full-scale rating current from 0.1%-100% of full-scale rating. ±1.5% of reading at 0.01pF, with voltage from 1%...100% of full-scale rating and current from 0.1%...100% of full-scale rating.

HIGH POT TEST
The high voltage sensing units are high potted at 120% of the rated voltage.

EXTERNAL INPUTS
Voltage : 150 Volts maximum.
Ranges : seamless operation from 1.5 ....150 volts.
Current : 5 Amperes maximum.
Ranges: seamless operation from 0.05 .....6.6 amperes.
Frequency : TLMS for transformers : 50 or 60 Hz.
TLMS for motors using the two frequency test:40-70Hz.

SPECIAL FEATURES.

Current Sensors
Two stage torroidal current transformer, with a secondary, tertiary and a tapped test primary winding. The test primary winding is provided to allow simple calibration of the current circuit.

Voltage Sensors
Gas (Sulfur Hexafluoride, SF6) dielectric shielded capacitor typically of coaxial geometry, characterized by very high linearity, high stability and low loss. Nominal capacitance values vary with the voltage rating of the system.

Analog Outputs
The system provides a normalized signal proportional to the voltage and current being measured. The signal is accurate with respect to ratio, phase and wave shape of the applied voltages and currents. These signals are used during the calibration of the metering system and can be used to monitor the current-voltage waveforms during tests.

External Inputs
External voltage and current inputs to the metering system can be used for measuring the output of conventional current and potential transformers. They can monitor the loading of auxiliary circuits during performance tests. These inputs are also used during the test and calibration of the equipment.

Test Windings
The test windings are associated with each of the current sensors and are accessible to the user for calibration purposes. These test windings allow the current sensors to be calibrated on the high current ranges by simply applying and measuring a nominal current of 5 ampere and without resorting to high current test conditions.