TLMS Series

Transformer Loss Measuring System

In the recent years, the measurement of electric power at high voltage and current at very low power factor is becoming increasingly important economically as a way to reduce costs in an ever-growing industrial economy. **TLMS Series Transformer Loss Measuring System** offer a perfect solution to accuracy measuring the losses at no load and load condition, even cover quality factor is lower to 0.008.

TLMS Series Transformer Loss Measuring System is allowed to auto ranging when on load condition. Not only efficiency is increased, also it avoids serious damage for CTs and voltage divider by select wrong measuring range.

TLMS Series Transformer Loss Measuring System combines well-established and reliable hardware with up-to-date and powerful software. The system can be integrated into a computerized test field. The control computer can be connected to the factory LAN and therefore the measuring data can be externally accessed for backup and further processing.

For each current transformer we use two separate CTs to cover the difference measuring ranges, typical from 0.5A-2000A (4000A), in whole range, high accuracy is be guarantee. Compare to traditional PT, a standard voltage

divider is be used, the prefect linear characteristic and lowest tanδ guarantee very high accuracy typical from 50V-100kV (200kV). Base on above design, **TLMS Series Transformer Loss Measuring System** can be used for testing small, medium, large power transformers and shunt reactors as well as motors and turbines up to 400Hz.

TLMS Series Transformer Loss Measuring System can select NORMA 5000 or WT 3000, both of them are best precision power analyzer what can be chosen in the market. Also both of them has been accepted and installed by transformer manufacturers around the world and distinguished itself in the rugged transformer manufactory environment.

Applications:

- Research & Development
- Transformer Manufacturers
- Transmission Network Service Providers
- Distribution Network Service Providers

Measurement Applications:

- No Load Measurement
- Load Loss Measurement
- Induce Voltage Measurement
- Heat Run
- Zero Sequence Measurement

Benefit and Advantage:

- High loss measuring accuracy up to ±1.15% at very low quality factor 0.008;

- Manual or automatic ranging for current and voltage channels;
- All range of CTs and voltage divider can be on load change;
- Full scale accuracy can be guarantee over the full range of both voltage and current;
- Shielding control cabinet is used to against outside interference;
- Special design of the electromagnetic current transformer has two separate cores in one body to guarantee the accuracy and cover the all working range;
- Automatic calculate & display the test result;
- Built in waveform analyzer for extracting harmonics on each voltage and current channels;
- High accuracy first time measurements maximize testing time and production throughput resulting in a shorter payback period, increased ROI and lower operating cost;
- High operating convenience reduces the learning process and minimizes faulty operations;

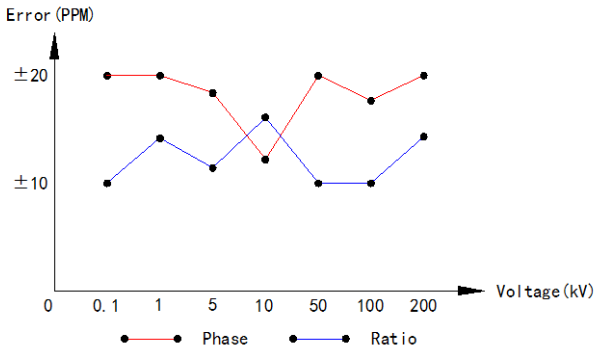
System Measurements:

Voltage: 3 units double shielded standard voltage dividers are be used to measure the voltage signal. Each standard voltage divider consist of one unit high voltage SF_6 standard capacitor and three units low voltage SF_6 standard capacitors. The three output of the standard voltage divider is connected to the voltage input of the instrument rack.

Due to the very low dielectric loss of the each capacitors what be used in standard voltage divider and its linear characteristic. The very high accuracy of ratio and phase angel error can be achieved over the full range. It prefect instead of traditional PT, it get better accuracy in larger test range.

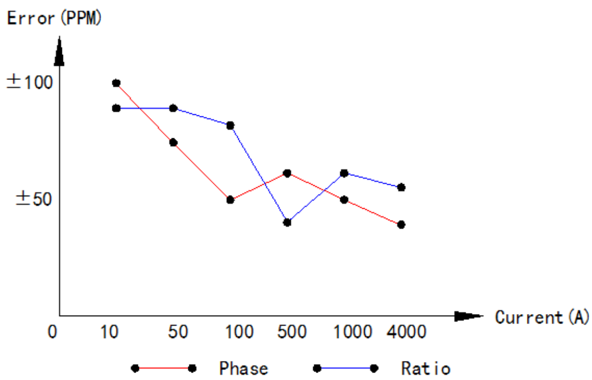
More than 25 years experience in standard capacitor manufacture, it make our divider has extremely good quality and reliability.

Voltage Divider Error (1 Phase)

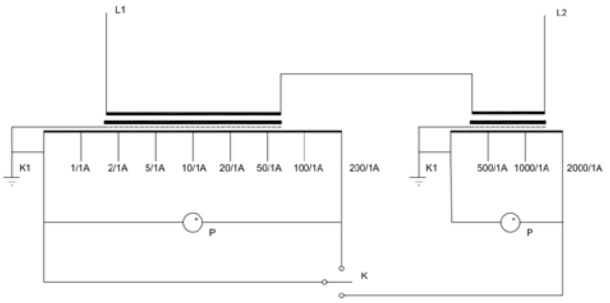


Current: 3 units multiple taps current transformers are be used to measure the current signal. The current transformer is special design by Samgor and it is be patent. Each current transformer has two separate winding to achieve the accuracy over the whole test range.

Current Transformer Error (1 Phase)



Principle Drawing



Loss Measurement: Loss measurement can select NORMA 5000 or WT 3000, both of them are best precision power analyzer what can be chosen in the market. Also both of them has been accepted and installed by transformer manufacturers around the world and distinguished itself in the rugged transformer manufactory environment.

Wattmeter displays the power of all three phases at the input to the wattmeter. The sum of the three phases is calculated and displayed on the 24" controller screen. System will automatic range to ensure the wattmeter always working in the best accuracy area, the values are calculated and displayed with 5 digit numbers on the screen.

For total losses of the transformer, it is sum of the no load and load losses. In general the actual loss figure has to be guaranteed by the manufactory and verified by customer by finial acceptance test.

No Load Measurement

ANSI/IEEE C57.12.90

The power is corrected with the formula:

$$P = \frac{Pm}{P_1 + \left(\frac{U_{RMS}}{U_{MEAN}}\right)^2 P_2}$$

$$P_2 = 1 - P_1$$

P	measured no-load power
P_m	corrected no-load power
U_{RMS}	effective value of measured voltage
U_{MEAN}	average value of measured voltage

Optional temperature correction

Optionally, the no-load loss power can be corrected to the rated temperature of the transformer:

$$P_c = P(1 - (k(T - T_a)10^{-4}))$$

P_c	no-load power corrected for temperature
k	temperature coefficient
T	standard temperature
T_a	temperature of no-load measurement

Load Measurement

ANSI/IEEE,DIN/VDE,IEC

Step 1: Relate to rated current

$$P_{chg\,n} = P_{chg}\left(\frac{I_{Nsp}}{I_n}\right)^2$$

$$U_{ccg\,n} = U_{ccg}\left(\frac{I_{Nsp}}{I_N}\right)$$

$P_{chg\,n}$	load-loss power reduced to rated current
P_{chg}	measured load-loss power
I_{Nsp}	rated current of the winding being fed
I_n	measured short-circuit current
$U_{ccg\,n}$	short-circuit voltage reduced to rated current
U_{ccg}	measured short-circuit voltage

$$I_{Nrel} = I_N\left(\frac{S_{SC}}{S_{SUP}}\right)$$

I_{Nrel}	related rated current
I_N	rated current
S_{SC}	app. Power (short-circuited winding(s))
S_{SUP}	app. Power (supplying winding)

Step 2: Calculate ohmic losses at T_{Res}

1- Phase transformator:

$$P_{ohm\,T\,Res} = \sum_n I_N R_g$$

3- Phase transformator:

$$P_{ohm\,T\,Res} = 3\sum_n I_{act} R_{act}$$

$P_{ohm\,T\,Res}$	ohmic losses at T_{Res}
T_{Res}	temperature of resistance measurement
N	all current-carrying windings
I_{act}	active current in the winding
I_N	rated current of the winding
R_{act}	resistance in the winding
R_g	measured resistance at T_{Res}

Y , Z:

$$R_{act} = \frac{1}{6}\sum_3^1 R_g \; , I_{act} = I_N$$

Yn, Zn:

$$R_{act} = \frac{1}{3}\sum_3^1 R_g \; , I_{act} = I_N$$

△open:

$$R_{act} = \frac{1}{3}\sum_3^1 R_g \; , I_{act} = \frac{I_N}{\sqrt{3}}$$

△closed:

$$R_{act} = \frac{1}{2}\sum_3^1 R_g \; , I_{act} = \frac{I_N}{\sqrt{3}}$$

Step 3: Correct ohmic losses to T_g

$$P_{ohm\,Tg} = P_{ohm\,T\,Res}\left(\frac{T.C.R.+T_g}{T.C.R.+T_{Res}}\right)$$

$P_{ohm\,Tg}$	ohmic losses at T_g
T_g	temperature of short-circuit measurement
T_{Res}	temperature of resistance measurement
T.C.R.	temperature coefficient of resistance

Step 4: Subtract losses at T_g

$$P_{add\,Tg} = P_{ch\,g} - P_{ohm\,Tg}$$

$P_{add\,Tg}$ additional losses at T_g

Step 5: Correct to standard temperature T_{st}

$$a = \frac{T_c + T_{st}}{T_c + T_g}$$

$$P_{add\,Tst} = P_{ch\,Tst} - P_{ohm\,Tst}$$

$$P_{ch\,Tst} = P_{ohm\,Tst} - P_{add\,Tst}$$

$$= (P_{ohm\,Tst} * a) + \left(P_{add\,Tg} * \frac{1}{a}\right)$$

$P_{ohm\,Tst}$	ohmic losses at T_{st}
$P_{add\,Tst}$	additional losses at T_{st}
T_{st}	standard temperature
$P_{Ch\,Tst}$	calculated load losses at T_{st}
T_c	Temperature coeffitient
	235 IEC Copper
	234.5 Ansi Copper
	225 Aluminium

Step 6: Calculation of R_k, $-Z_k$ and $-X_k$

1- Phase transformator:

$$Z_k = \frac{U_{ccgn} * U_N}{I_{ccgn} * I_N} \qquad R_k = \frac{P_{chgn}}{P_N}$$

$$X_k = \sqrt{Z_k^2 - R_k^2}$$

At standard temperature:

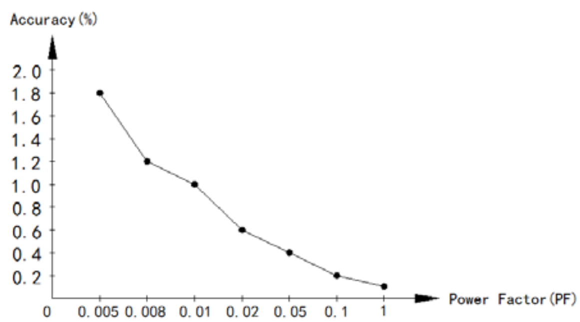
$$R_{kTst} = \frac{P_{chTst}}{P_N}$$

$$X_{kTst} = X_k$$

$$Z_{kTst} = \sqrt{R_{kTst}^2 + X_{kTst}^2}$$

P_{chgns}	load-loss power reduced to rated current
P_{ChTst}	calculated load losses at T_{st}
P_N	rated power of the winding
U_N	rated voltage of the winding
I_N	rated current of the winding
U_{ccgn}	short-circuit voltage related to rated current
I_{ccgn}	short-circuit Current related to rated current
Z_k	short-circuit impedance
X_k	short-circuit reactance
R_k	short-circuit resistance
Z_{kTst}	short-circuit impedance at T_{st}
X_{kTst}	short-circuit reactance at T_{st}
R_{kTst}	short-circuit resistance at T_{st}

Loss Measurement Accuracy

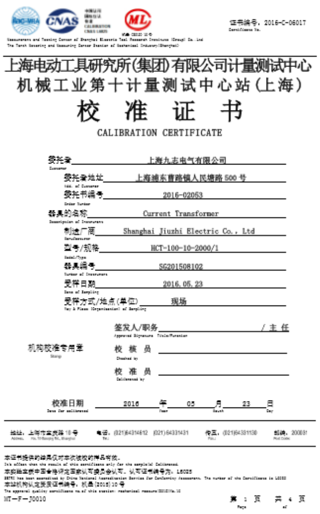


ΔP%=0.0291δtgφ%+ A

δ: Phase angel error (CT + Voltage divider) φ: Quality factor A: Power Analyzer error

For loss measurement accuracy, **TLMS Series Transformer Loss Measuring System** offers a complete calibration certificate which attests the attest the accuracy of the system prior to shipping. The calibration certificate is performed with CNAS test lab.

TLMS Series Transformer Loss Measuring System recommends to done recalibration in every two years. Due to CTs and voltage dividers, lots of third party lab can done the onsite calibration for our TLMS.



证书编号：2016-C-06017

上海电动工具研究所(集团)有限公司计量测试中心
机械工业第十计量测试中心站(上海)

校 准 证 书

CALIBRATION CERTIFICATE

委托者 上海九志电气有限公司
委托者地址 上海浦东曹路镇人民塘路 500 号
委托书编号 2016-02053
器具的名称 Current Transformer
制造厂商 Shanghai Jiuzhi Electric Co., Ltd
型号/规格 HCT-100-10-2000/1
器具编号 SG201508102
受样日期 2016.05.23
受样方式/地点(单位) 现场

签发人/职务 / 主 任
机构校准专用章 校 核 员
校 准 员

校准日期 2016 年 05 月 23 日

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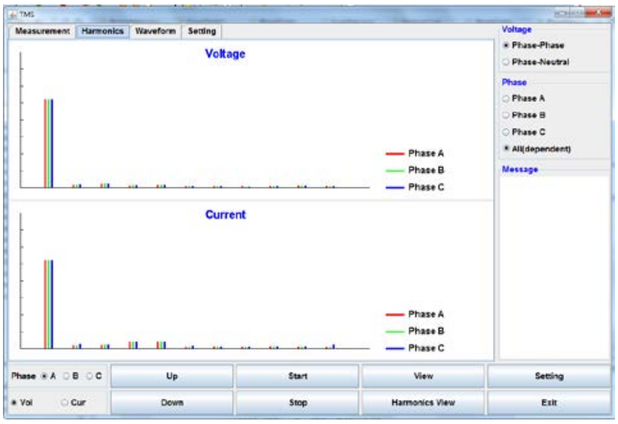
Software:

Software for **TLMS Series Transformer Loss Measuring System** utilizes the globally recognized cross platform JAVA interface, software communicate the Nomra 5000 or WT3000 via Ethernet. The software runs in a Windows 10 operating system and is fast, easy and intuitive.

This software has been especially designed for intuitive, fast, easy and safe user interrogations. Status information and test results are visualized by graphical symbols, colored values, pop-up windows and detailed graphs. Large buttons and standardized input fields ensure a correct and easy operation of the system.

Beside the display of normal measuring values the TLMS software allows also harmonics to be measured and displayed. This is especially helpful when measuring no load losses to verify voltage and current distortions.

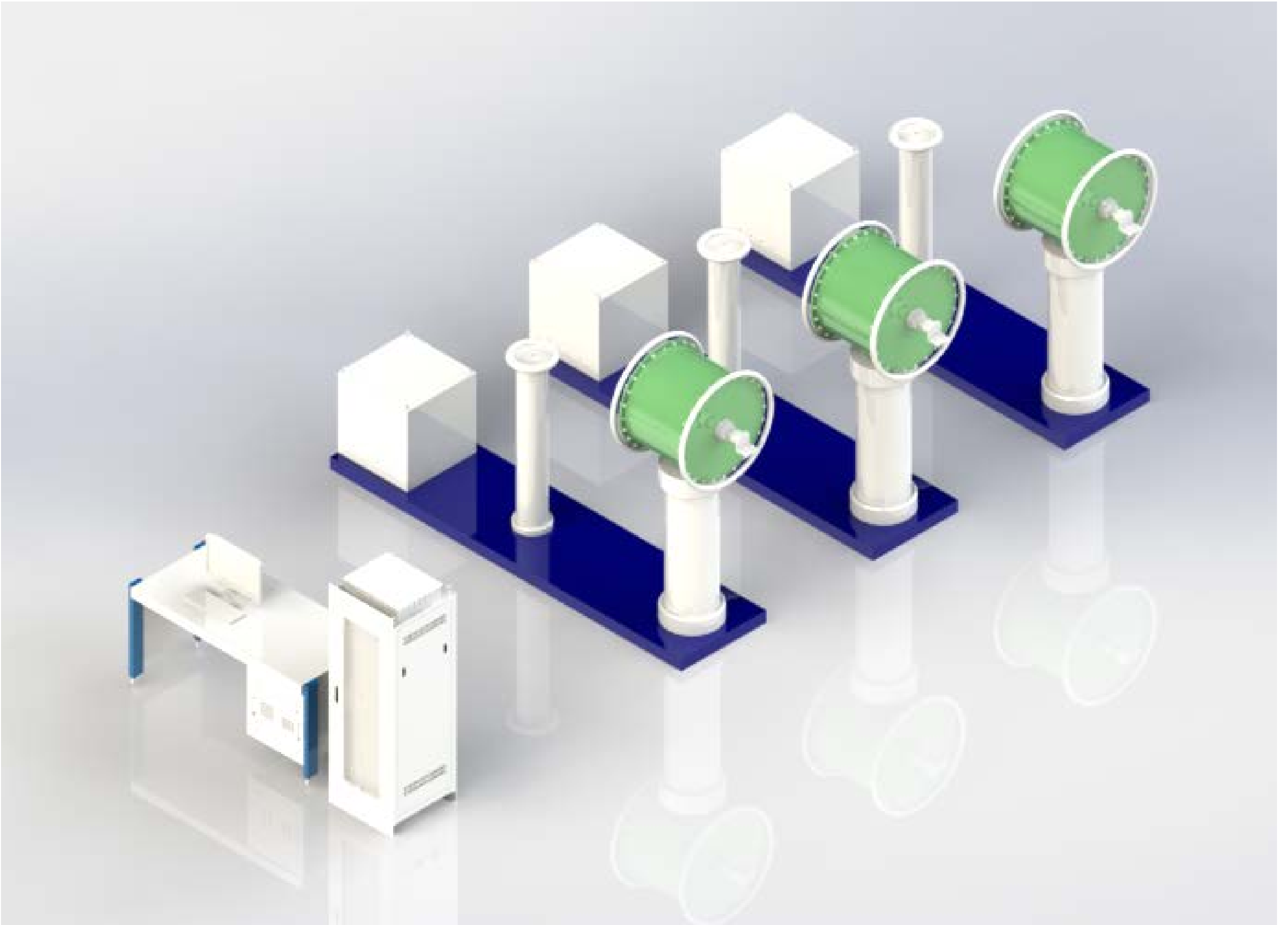


TLMS software can measure and calculate difference parameters what link to difference transformer test, such as no load loss, load loss, induce voltage, heat run, zero sequence.

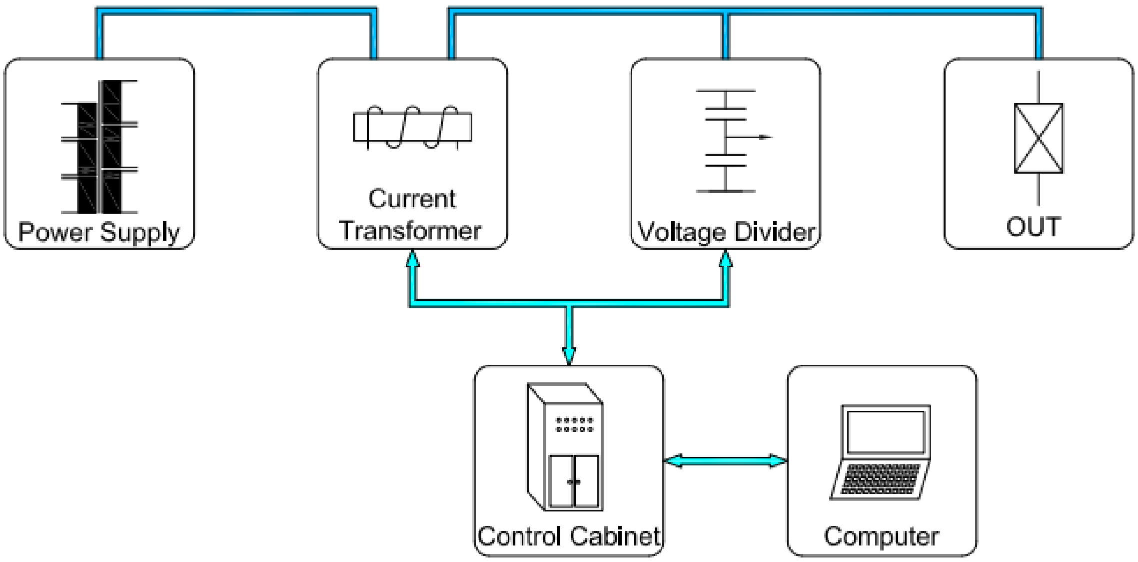
TLMS software has auto ranging function, software select right range of CTs and voltage dividers according to the real value of the sampling. At manual mode, if current or voltage are over load, software will indicate by red flash light.

TLMS software can create the test report. The report is stored in XML/CSV format.

Outlook Drawing:



Block Diagram:



Main Technical Data:

Voltage Measurement:

Model	Voltage Range	Accuracy*
TLMS3000-100/2000	0.05kV-100 kV (L-N)	0.06%
TLMS3000-100/4000	0.05kV-100 kV (L-N)	0.06%
TLMS3000-200/4000	0.05kV-200 kV (L-N)	0.06 %

Current Measurement:

Model	Voltage	Current Range	Accuracy*
TLMS3000-100/2000	100kV (L-N)	10A, 20 A, 40 A, 100 A, 200 A, 400 A, 1000 A, 2000 A	0.06%
TLMS3000-100/4000	100kV (L-N)	10A, 20 A, 40 A, 100 A, 200 A, 400 A, 1000 A, 2000 A, 4000A	0.06%
TLMS3000-200/4000	200kV (L-N)	10A, 20 A, 40 A, 100 A, 200 A, 400 A, 1000 A, 2000 A, 4000A	0.06%
* at 10-120% range utilization, includes uncertainty of calibration			

Power Measurement:

Power Factor	Range	Accuracy*
cosΦ = 1.000	≥ 0.1kV / ≥1 A	0.06%
cosΦ = 0.100	≥ 0.1kV / ≥1 A	0.16%
cosΦ = 0.050	≥ 0.1kV / ≥1 A	0.23%
cosΦ = 0.020	≥ 0.1kV / ≥1 A	0.65%
cosΦ = 0.010	≥ 0.1kV / ≥1 A	1.00%
cosΦ = 0.008	≥ 0.1kV / ≥1 A	1.15%

Safety Clearance:

Model	To Wall	Between Phases
TLMS3000-100/2000	>1m	>0.8m
TLMS3000-100/4000	>1m	>0.8m
TLMS3000-200/4000	>2m	>1.6m

Power Supply:

Voltage	110-240V
Frequency	50 Hz / 60 Hz
Power	600 VA (desk), 500 VA (control cabinet)

Weight:

Model	Weight
TLMS3000-100/2000	2450kg
TLMS3000-100/4000	2850kg
TLMS3000-200/4000	3500kg

For further information please contact:

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