AE Automatic Electric Ltd.

Instrument
Transformer Division

Current Transformers

INDOOR RESIN CAST SINGLE PHASE SINGLE POLE POTENTIAL TRANSFORMERS

RECTANGULAR TYPE
CTS (PROTECTION) RESIN

INDOOR
RESIN CAST TYPE

INDOOR
RESIN CAST RING TYPE

HIGH VOLTAGE BREAK-DOWN TESTER

INDOOR RESIN CAST SUMMATION CURRENT TRANSFORMERS

RECTANGULAR TYPE
CTS (METERING)

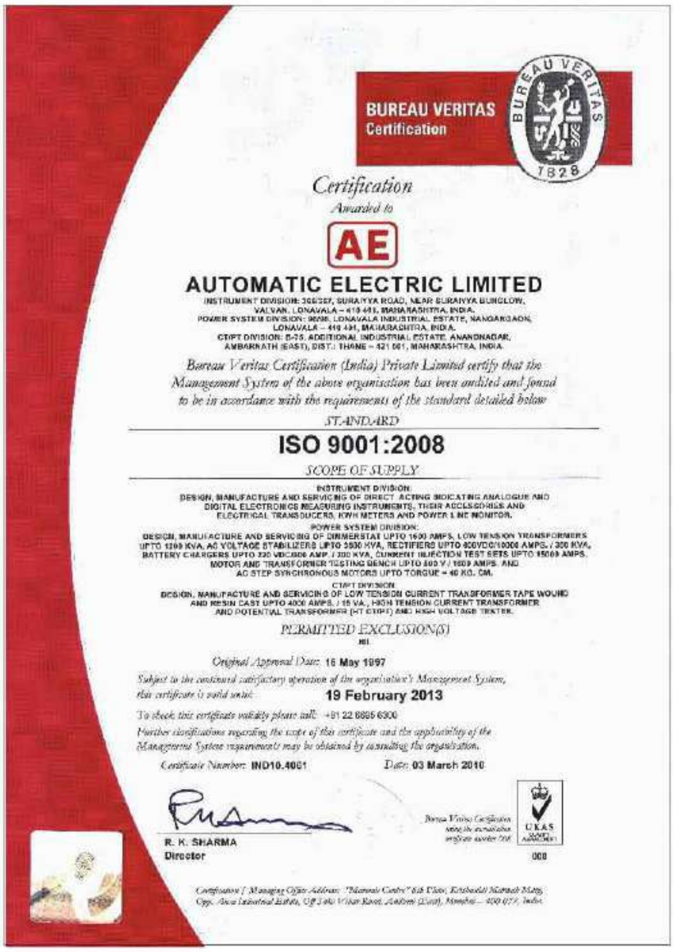
CT-PT Metering Units, Oil filled, Outdoor

CT-PT Metering Cubicles, Indoor, Resin Cast

AE Automatic Electric Ltd.

Index

Instrument Transformer Division



BUREAU VERITAS Certification

BUREAU VERITAS 1828

Certification

Awarded to

AE

AUTOMATIC ELECTRIC LIMITED

INSTRUMENT DIVISION: 366/367, SURAIYYA ROAD, NEAR SURAIYYA BUNGLOW, VALVAN, LONAVALA – 410 401, MAHARASHTRA, INDIA.
POWER SYSTEM DIVISION: 98/98, LONAVALA INDUSTRIAL ESTATE, NANGARGAON, LONAVALA – 410 401, MAHARASHTRA, INDIA.
CT/PT DIVISION: B-75, ADDITIONAL INDUSTRIAL ESTATE, ANANDNAGAR, AMBARNATH (EAST), DIST.: THANE – 421 501, MAHARASHTRA, INDIA.

Bureau Veritas Certification (India) Private Limited certify that the Management System of the above organisation has been audited and found to be in accordance with the requirements of the standard detailed below

STANDARD

ISO 9001:2008

SCOPE OF SUPPLY

INSTRUMENT DIVISION:
DESIGN, MANUFACTURE AND SERVICING OF DIRECT ACTING INDICATING ANALOGUE AND DIGITAL ELECTRONICS MEASURING INSTRUMENTS, THEIR ACCESSORIES AND ELECTRICAL TRANSDUCERS, KWH METERS AND POWER LINE MONITOR.

POWER SYSTEM DIVISION:
DESIGN, MANUFACTURE AND SERVICING OF DIMMERSTAT UPTO 1600 AMPS, LOW TENSION TRANSFORMERS UPTO 1200 KVA, AC VOLTAGE STABILIZERS UPTO 3500 KVA, RECTIFIERS UPTO 400VDC/10000 AMPS. / 300 KVA, BATTERY CHARGERS UPTO 220 VDC/800 AMP. / 300 KVA, CURRENT INJECTION TEST SETS UPTO 15000 AMPS, MOTOR AND TRANSFORMER TESTING BENCH UPTO 600 V / 1600 AMPS. AND AC STEP SYNCHRONOUS MOTORS UPTO TORQUE = 40 KG. CM.

CT/PT DIVISION:
DESIGN, MANUFACTURE AND SERVICING OF LOW TENSION CURRENT TRANSFORMER TAPE WOUND AND RESIN CAST UPTO 4000 AMPS. / 15 VA., HIGH TENSION CURRENT TRANSFORMER AND POTENTIAL TRANSFORMER (HT CT/PT) AND HIGH VOLTAGE TESTER.

PERMITTED EXCLUSION(S)

NIL

Original Approval Date: 16 May 1997

Subject to the continued satisfactory operation of the organisation's Management System, this certificate is valid until: **19 February 2013**

To check this certificate validity please call: +91 22 6695 6300

Further clarifications regarding the scope of this certificate and the applicability of the Management System requirements may be obtained by consulting the organisation.

Certificate Number: IND10.4001 *Date:* 03 March 2010

R. K. SHARMA
Director

UKAS 008

Current Transformer

Instrument Transformer
Division

33KV CT

220KV CT

132KV DEAD TANK CT

GENERAL

AUTOMATIC ELECTRIC LTD. introduced their indigenously developed Instrument transformers in the year 1968. Since then 'AE' are one of the leading Manufacturers in the Country for quality Instrument Transformers.

'AE' manufactures OUTDOOR OILCOOLED CURRENT TRANSFORMERS ranging from 11kv to 220 kv. The Modern Plant situated at Ambernath is equipped with full range of testing equipments and plant & machinery to manufacture INSTRUMENT TRANSFORMERS. 'AE' have supplied thousands of these transformers in almost all the STATE ELECTRICITY BOARDS and Utilities in the country. These instrument Transformers are working satisfactorily under different service conditions at the sites. 'AE' are also EXPORTING these transformers. The Instrument transformers are fully type tested in accordance with latest I.S. / I.E.C. specifications.

APPLICATION

Direct measurement of current in High Voltage System is not possible because of insulation problem of measuring instruments. It is also not possible to use current flowing through the system directly for protection purpose due to its high value and high insulation problem.

BASIC FUNCTIONS OF CURRENT TRANSFORMERS ARE:

1. To reduce the line current to a value which is suitable for standard measuring Instruments, relays etc.
2. To isolate the measuring instruments. Meters, relays etc. from high voltage side of an installation.
3. To protect measuring instruments against short circuit currents.
4. To sense abnormalities in current and give current signals to protective relays to isolate the defective system.

THEORY

A current transformer operates on the principle of balance of Ampere turns in primary and secondary winding. Theory of current transformers can easily be understood with the help of vector diagram give in FIG. No. 1

Voltage Es developed across secondary of the current transformer can be represented as Es = Zs x Is where Zs is impedance of burden, connecting leads and CT secondary. The flux Φ required to develop voltage Es needs excitation current Io. This excitation ampere turns are supplied through total primary ampere turns causing error in the transformation ratio of the CT. Due to non-linear characteristics of magnetic material, errors in the current transformers are also non- linear over the current range of 120% to 5%. Refer Error Curve given in FIG. NO.2.

There are four main factors which determine the capability of current transformer i.e.

- Insulation Level (Service Voltage)
- Rated primary current
- Short time withstand current
- Burden and Accuracy

Current Transformer

Instrument Transformer
Division

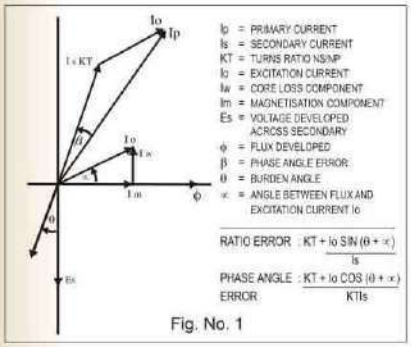
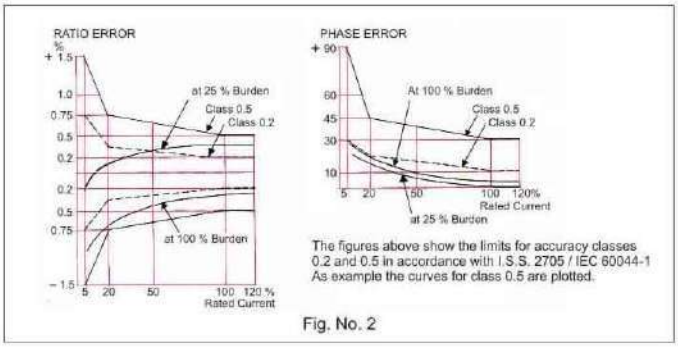
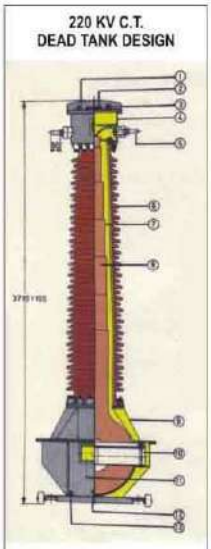


Fig. No. 1



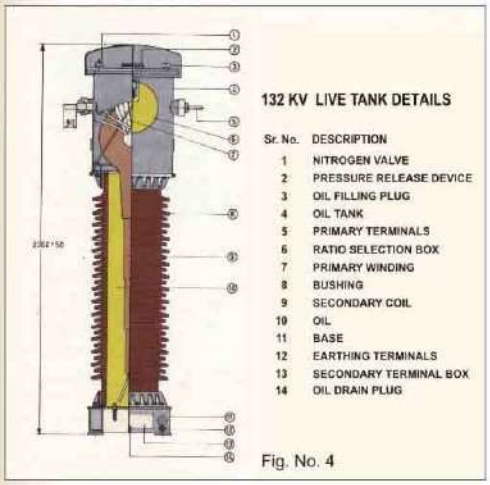
The figures above show the limits for accuracy classes 0.2 and 0.5 in accordance with I.S.S. 2705 / IEC 60044-1 As example the curves for class 0.5 are plotted.

Fig. No. 2



Sr. No.	DESCRIPTION
1	OIL FILLING PLUG
2	PRESSURE RELEASE DEVICE
3	NITROGEN VALVE
4	OIL EXPANSION CHAMBER
5	PRIMARY TERMINALS
6	BUSHING
7	OIL
8	COIL
9	OIL TANK
10	SECONDARY CORE
11	SECONDARY TERMINAL BOX
12	OIL DRAIN PLUG
13	EARTHING TERMINALS

Fig. No. 3



Sr. No.	DESCRIPTION
1	NITROGEN VALVE
2	PRESSURE RELEASE DEVICE
3	OIL FILLING PLUG
4	OIL TANK
5	PRIMARY TERMINALS
6	RATIO SELECTION BOX
7	PRIMARY WINDING
8	BUSHING
9	SECONDARY COIL
10	OIL
11	BASE
12	EARTHING TERMINALS
13	SECONDARY TERMINAL BOX
14	OIL DRAIN PLUG

Fig. No. 4

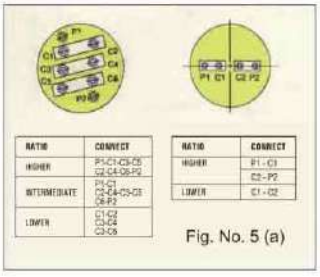


Fig. No. 5 (a)

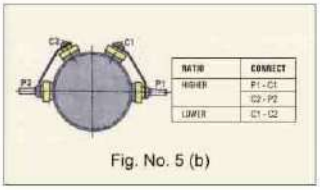


Fig. No. 5 (b)

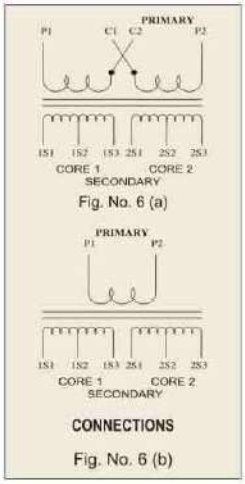


Fig. No. 6 (a)

Fig. No. 6 (b)

THE CURRENT TRANSFORMER MUST

1. Withstand operational voltage and over voltage in the network
2. Withstand rated primary current in continuous operation without exceeding maximum allowed temperature rise.
3. Be capable to sustain thermal and mechanical stresses developed due to system fault current
4. Feed current to external circuit with specified accuracy at specified primary currents.

DESIGN

'AE' manufacture current transformers in both type i.e. Live Tank Design and Dead Tank Design FIG. 3 shows basic construction of Dead Tank design whereas FIG. 4 shows construction of Live Tank design.

Current transformer can be designed for single ratio or multi ratio. The ratio selection can be achieved by providing two or four sections of primary for series/parallel reconnection as show in FIG . 5 (a) and FIG. 5(b). However the current ratios shall be in proportion of 1:2:4 The advantage of this type of ratio selection is that output from each secondary remains constant for any selected ratio.

Ratio selection is also possible by giving taps on the secondary winding as shows in FIG. 6(b). Advantage of this type is that ratio can be achieved in any multiple fo the lowest ratio. It is also possible to change the ratio on CT without taking shutdown on the main system. However, it is obvious that output rating shall change as per the ratio.

For multi ratio CT. 2 or 3 ratios can be provided by primary Series / Parallel reconnection and additional ratios by secondary tape shown in FIG 6(a).

High output (Burden/knee point voltage/Accuracy Limiting Voltage) with minimum excitation current and better accuracy class can be provided on the CT if primary current is higher. Higher output can also be obtained with multi-turn primary design. Limitations on No. of primary turns are however, imposed by short time current rating and peak dynamic current. It is advisable to provide minimum primary turns to limit the dynamic forces and mechanical stress experienced by the CT under fault condition. the limitations on output of each core of CT also depends on a number of cores provided in a single CT.

CONSTRUCTION

Core & Secondary winding:

High permeability. CRGO silicon steel is used as core material. Toroidal cores from continuos strips are made at our works and annealed in controlled atmosphere to achieve best quality secondary cores. Secondary winding is done on automatic winding machine and is distributed equally on the periphery of the core to minimise leakage reactance. Best quality enamelled wire with adequate inter-layer insulation is provided to avoid secondary winding short circuiting in most adverse conditions.

PRIMARY WINDING

Primary winding is of braided electrolytic copper conductor with double cotton covering. Varnished fibreglass sleeve is provided as an additional insulation on this conductor. In case of live tank construction, the primary is wound on insulated secondary. The primary is positioned properly to sustain dynamic forces developed during short circuit condition. In case of Dead Tank construction, the primary is encapsulated in circular rigid fibre glass ring and aluminum pipe to form EYE BOLT construction.

INSULATION

High quality crepe insulating paper is used to build up main insulation of the CT. In live tank design, insulation is built up on secondary core and secondary leads are brought out through a metallic galvanised pipe. In Dead Tank CT primary Winding is encapsulated in fibre glass ring and Aluminum pipe. Main insulation is built up on primary winding (Paper condenser is formed on the pipe) with fine grading of insulation. Semiconducting shield is used togive linear distribution of Electric stress along the length of the bushing the paper insulation is dried in oven under very high vacuum and strictly controlled conditions. Filtered and de-aerated EHV Grade oil is filled in CT while CT is under vacuum. To seal it, the space left for expansion on the top is filled with dry and pure nitrogen through non-returanable valve at pre-determined pressure.

PORCELAIN INSULATOR

Brown Glazed porcelain bushings with different shed profiles to suit different pollution conditions are used. These Bushings are hollow cylindrical type conforming to IS 5621/IEC 60044-1

Bushings with Collar at both the ends are clamped using. Aluminum Flange. Nitrile and Neoprene Gaskets are used at both sides of collar to form flexible joint. This joint can sustain vibrations without damaging bushing. Bushings with cemented flanges are also used.

TANK & BASES

Top tank (which also acts as oil Expansion Chamber) of the CT having current less than 1200 Amps. are made of MS sheet. Stainless Steel Tanks are used for CTs with primary current of 1200 Amps and above. Bases are fabricated from MS Plates and Channels. All MS Tanks and Bases are painted with oven baked paint, after cleaning by seven tank process. All surfaces which come in contact with oil are painted with oil Insoluble Paint. All MS parts can be supplied Hot Dip Galvanised on request.

TESTING

Our Testing Lab is equipped with modern test facilities to carry out all routine tests including temperature rise test. Partial Discharges test plays vital role in quality control of insulation. All our CTs are tested for Partial Discharge on most modern bridge type Partial Discharge Test Set.All the CTs pass through a standardized quality assurance plan to ensure requisite top quality at every stage and in the final product..

PACKING & TRANSPORTATION

All CTs are packed with strong jungle wood to take care of most adverse conditions of transportation all over the country. Special Sea-worthy packing is done for the CTs for EXPORT. All CTs upto 145kV Class are packed to transport vertically. 245 kV Class Cts are transported horizontally.

MAINTENANCE

The CTs do not require maintenance apart from occasional cleaning of Bushings and checking of Nitrogen pressure. For more details refer Instruction Manual supplied with the CT.

HOW TO SELECT THE C.T.

It is important to specify correct parameters of CT while ordering for optimum design. Following are main factors for selecting current transformer.

1. Service Voltage :

System Voltage is which CT is to be installed e.g. 11 kV, 22 kV, 33 kV. etc.

2. Installation :

Whether OUTDOOR or INDOOR

3.Atmospheric Conditions :

Such as condition of Pollution, Altitude Ambient Temperature etc.

4. Insulation Level :

If insulation level other than associated with service voltage is required, it should be specifically mentioned

5. Rated primary current :

Specify rated primary current / currents (if required more than one value) Also indicate if different primary current is required for different cores.

6. Continuous Primary current :

Max. primary current that can be withstood continuously by current transformer e.g. 120% of primary current.

7. Rated secondary current :

Whether 1 Amp or 5 Amps

8. Short Time Current & its Duration :

Specify fault current of the system in which CT is to be installed along with its duration. It is most important to specify realistic value of S.T.C. as at lower primary current, higher S.T.C. value necessitates bulky & costlier design. Also specify dynamic current if other than 2.5 times S.T.C. is required.

9. No. of cores Their Burdens Accuracy :

Basis of application, No. of cores, their burdens and accuracy class should be specified. It is advisable to specify minimum required Burden for metering core as unnecessary high burden will necessitate for bulky and costlier design. Specified accuracy is guaranteed for 100% to 25% of rated burden only. Current transformer offers minimum error if 75% to 60% burden is connected to secondary. Therefore, ideally rated burden higher than 1.5 time actual burden should be specified.

Also, it is important to specify correct burden in context of Instrument Security Factor (I.S.F.) The I.S.F. indicates the over current as multiple of rated current at which the metering core will saturate, thus limiting the secondary current flowing through meter and protect it from damage. If actual burden connected is half of the rated burden, the actual I.S.F. will increase two-fold of its rated value.

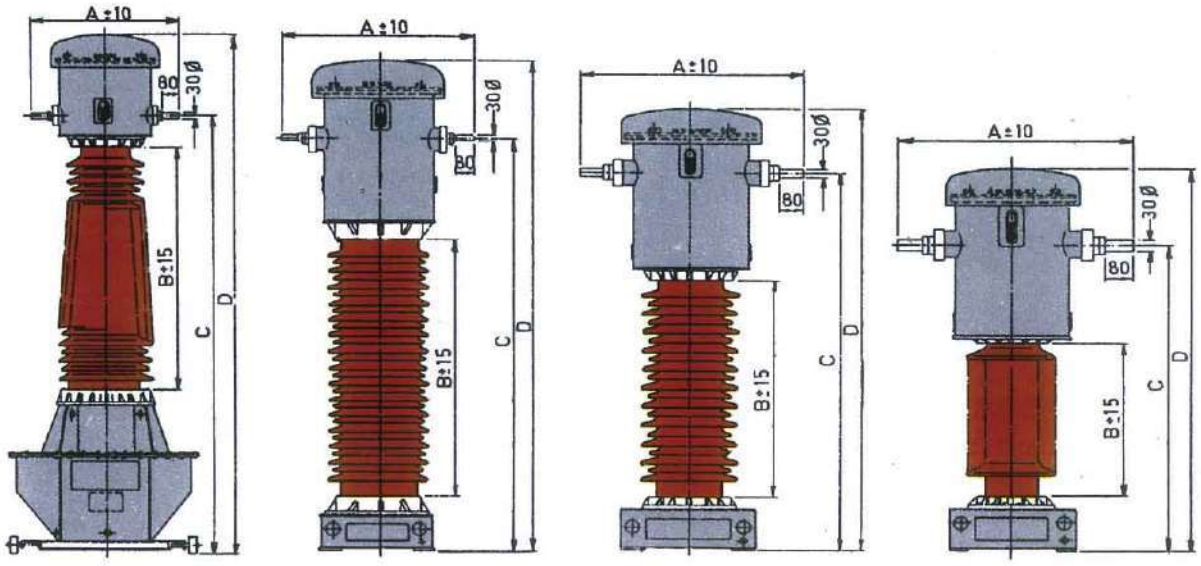
10. Knee point voltage, Secondary resistance and excitation current :

For differential protection. R.E.F. Protection, Bus Bar Protection. C.T. with accuracy class PS is required. The Knee Point Voltage. Secondary resistance and excitation current should be specified for this core. It is always better to specify Formula for Knee Point Voltage related to relay used for the protection. This will help designer to optimise the design.

CT Testing Bench

Vacuum Drying Oven

High Voltage Testing

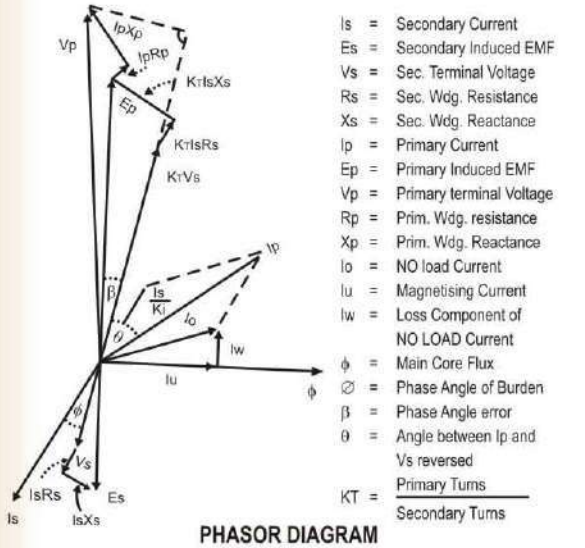


TYPE	VOLTAGE CLASS	DIMENSIONS				MOUNTING	TOTAL CREEPAGE IN mm	TOTAL WEIGHT IN kg (Approx)
		A	B	C	D			
OC AS 220	220kV	770	2130	3240 ± 75	3710 ± 100	750 X 750	6125	1050
OC AS 132	132 / 110 / 100kV	825	1215	1935 ± 35	2300 ± 50	400 X 400	3625	465
OC HP 66	66kV	750	805	1390 ± 35	1625 ± 50	375 X 375	2310	250
OC NP 33	33 / 22 /kV		450	980 ± 20	1160 ± 35	300 X 300	900	140
OC NP 33		710	310	840 ± 20	1020 ± 35		620	135
OC NP 33			450	980 ± 20	1160 ± 35		1320	140

PRINCIPLE DIMENSIONS OF OIL COOLED CURRENT TRANSFORMERS

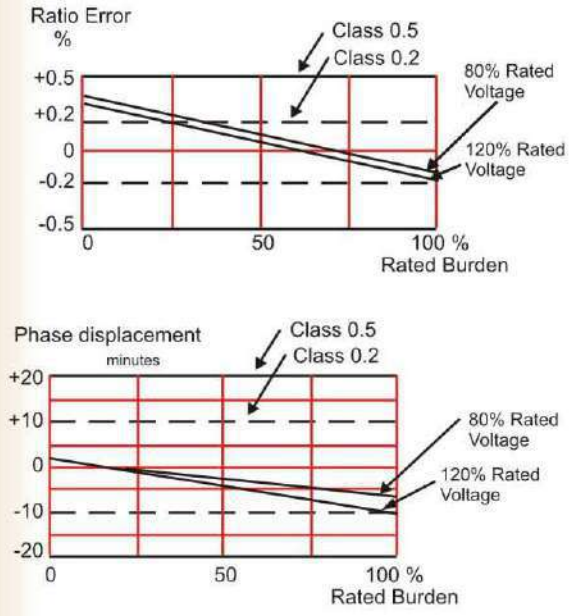
Voltage Transformer

Instrument Transformer
Division



PHASOR DIAGRAM

Fig. No.1



TYPICAL ERROR CURVES & LIMITS FOR CLASSES 0.2 & 0.5 I.S. 3156 / IEC 60044-2

Fig. No.2

Standard Voltage Transformer with standard burden

GENERAL

AUTOMATIC ELECTRIC LTD. introduced their indigenously developed INSTRUMENT TRANSFORMERS in the year 1968. Since then 'AE' are one of the leading Manufacturers in the Country for quality instrument Transformers.

'AE' manufactures OUTDOOR OIL COOLED VOLTAGE TRANSFORMERS ranging from 11kv to 220kv. The Modern Plant situated at Ambernath is equipped with full range of testing equipments, plant & machinery to manufacture INSTRUMENT TRANSFORMERS. 'AE' have supplied thousands of these transformers to almost all the STATE ELECTRICITY BOARDS and utilities in the Country. These INSTRUMENT TRANSFORMERS are working satisfactorily under different service conditions at the sites. 'AE' are also EXPORTING transformers. The instrument transformers are fully type tested in accordance with latest I.S. /I.E.C. Specifications.

APPLICATION

Direct measurement of voltage in High Voltage System is not possible because of insulation problem of measuring instruments. It is also not possible to use direct voltage for the system protection purpose due to its high value and high insulation problem of protective relays. Therefore, voltage transformers are used to step-down the high system voltage to low standard value accurately in proportion to their ratio.

BASIC FUNCTIONS OF VOLTAGE TRANSFORMERS ARE:

1. To reduce the line voltage to a value which is suitable for standard measuring instruments, relays etc.
2. To isolate the measuring instruments, meters relays etc. from high voltage side of an installation.
3. To sense abnormalities in voltage and give voltage signals to protective relays to isolate the defective system.

THEORY

General principle of power transformer design also apply to the voltage transformers but there are certain considerations of performance which are of particular importance. In the electromagnetic voltage transformers, accuracy depends on leakage reactance and winding resistance. These determine how the phase error and voltage error vary as the burden on secondary increases (Refer Fig.2) The permeability and power dissipation of core material affects the exciting current and thus the error at zero burden.

To comply with the requirement of I.S. 3156/IEC 60044-2, Flux density employed in voltage transformer is much less than the value generally used in power transformer. The turn ratio and voltage drop due to leakage reactance and the winding resistance must be carefully determined, in order that the permissible error is not exceeded.

Theory of voltage transformer can be established more clearly with the help of phasor diagram as given in FIG.1

Voltage Transformer

Instrument Transformer
Division

DESIGN

Single phase Electromagnetic voltage transformer (EMV) is manufactured in two types (i) single pole (To connect between lines & earth) (ii) Both pole (to connect between Line-to-Line) 3 phase voltage transformers are of star/star connected or star/open delta connected (residual Voltage Transformer) type. Single phase voltage transformers are manufactured for 11kv to 220 kv system voltage. whereas 3 phase voltage transformers are manufactured for 11kv to 33kv system voltage.

CONSTRUCTION : VOLTAGE TRANSFORMER MAINLY CONSISTS OF:

1. Primary & Secondary Winding
2. Electromagnetic Core
3. Bottom Tank & Oil Expansion Chamber
4. Porcelain Bushing

PRIMARY & SECONDARY WINDING

Copper enameled wire is used for winding. Primary is wound with multilayer and graded insulation. The diameter and length of each layer is selected such that surge voltage is distributed equally in all layers of the Winding. Multilayer Kraft Paper insulation is provided between winding layers. Stress equalising shield is provided on last layer of the winding. H.T. Connection is brought out through metallic pipe.

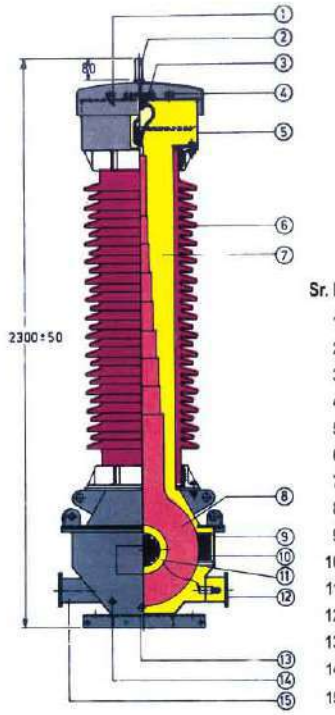
Secondary is separately wound and inserted in the primary winding as per the requirement. Winding and tapping of V.T. is done in dust-free atmosphere.

ELECTROMAGNETIC CORE

C.R.G.O. Silicon Steel is used for building up Electromagnetic core. Shell type construction is used to minimise leakage reactance.

BOTTOM TANK & OIL EXPANSION CHAMBER

Bottom tank and oil expansion chamber are made of M.S. Sheet. All tanks and chambers are painted with Oven baked paint, after cleaning by seven tank process. All surface which come in contact with oil are painted with oil insoluble paint. M.S. parts can be hot dip galvanised on request



Sr. No.	DESCRIPTION
1	OIL FILLING PLUG
2	H.T. TERMINAL
3	PRESSURE RELEASE DEVICE
4	NITROGEN VALVE
5	OIL EXPANSION CHAMBER
6	PORCELAIN BUSHING
7	OIL
8	H.T. COIL
9	OIL TANK
10	CORE LAMINATION STACK
11	L.T. COIL
12	EARTHING TERMINAL BOX
13	OIL DRAIN PLUG
14	EARTHING TERMINALS
15	SECONDARY TERMINAL BOX

CONSTRUCTION DETAILS OF 132 kV V.T.

Fig. No. 3

Taping of PT Coil

11 KV CTPT

25 KVPT

33 KV CTPT

33 KVPT

150 KV HV Transformer

Voltage Transformer

Instrument Transformer
Division

PORCELAIN BUSHING

Brown Glazed Porcelain bushing with different shed profiles to suit different pollution conditions is used. These bushings are Hollow Cylindrical Type conforming to I.S. 5621/I.E.C.815 . Bushing with collar at both the ends is clamped using Aluminium Flanges. Nitrile and Neoprene Gaskets are used at both sides of collar to form flexible joint. This joint can sustain vibrations without damaging bushing. Bushings with Cemented flanges are also used.

INSULATION

High quality electrical grade kraft paper and crepe paper is used for insulating primary and secondary winding of V. T. The high voltage connection is brought out through paper condenser formed on metallic pipe using fine grading of insulation. Semiconducting shield is used to give linear distribution of electric stress along the length of the bushing. The paper insulation is dried in over under very high vacuum and strictly controlled conditions. Filtered and de-aerated EHV grade oil is filled in V.T. while V.T. is under vacuum. To seal it, the space left for expansion on the top is filled with dry and pure nitrogen through non-returnable valve at pre-determined pressure.

Oil Filtration Machine

Oil Testing Kit

Testing Laboratory

TESTING

AE testing Lab is equipped with modern test facilities to carry out all routine tests, including Temperature Rise Test. Partial discharge Measurement plays a vital role in quality control of insulation. All our V.Ts. are tested for Partial Discharge on most modern bridge type Partial Discharge Test Set.

All the V.Ts. pass though a standardized quality assurance plan to ensure requisite top quality at every stage and in the final product.

PACKING & TRANSPORTATION

All V.Ts. are packed with strong jungle wood to take care of most adverse conditions of transportation all over the country. Special sea-worthy packing is done for the V.Ts. for Export. V.Ts. upto 132kv class are transported vertically. 220 kv. V.Ts. are transported horizontally.

MAINTENANCE

V.Ts. do not require maintenance apart from occasional cleaning of Bushing and checking of Nitrogen Pressure. For more details refer Instruction Manual supplied with the V.T.

HOW TO SELECT THE V.T.

It is Important to specify correct parameters of V.T. while ordering for optimum design.

Following are main factors for selecting Voltage Transformer.

1. **Service Voltage**

   System Voltage in which V.T is to be installed e.g. 11kv, 22kv, 33kv etc.

2. **Installation**

   Whether OUTDOOR or INDOOR

3. **Atmospheric Conditions**

   Such as condition of Pollution, Altitude, Ambient Temperature etc.

4. **Insulation Level**

   If insulation level other than associated with service voltage is required, it should be specifically mentioned.

5. **Rated Primary Voltage**

   Rated primary voltage is generally rated system voltage for unearthed type V.Ts. and rated system voltage divided by square root of three for earthed type V.Ts. The V.Ts. can be manufactured suitable for more than one system voltage. In such cases, different primary voltages required may be indicated.

6. **Rated Secondary Voltage**

   Standard Values of Secondary voltages are 110v or 110v/√3 depending on application of the secondary winding. V.Ts. with different secondary voltages other than those mentioned above can be manufactured and supplied.

7. **Voltage Factor**

   All V.Ts. are manufactured suitable for continuous voltage factor of 1.2. As per I.S. / L.E.C. Specifications, short time voltage factor is different for different earthing systems. Therefore appropriate system earthing conditions may be specified.

8. **Number of secondary windings. Their burdens & accuracy classes**

   Number of secondary windings, their burdens and accuracy classes are selected on the basis of application. Two types of classes are available, one for metering and other for protection. Unlike current transformers, accuracy of one winding is influenced by loading of other winding. Due to this reason burden of each winding should be correctly mentioned. Accuracy of V.T. is guaranteed at the secondary terminals of the V.T. The impedance of cable connecting secondary terminal to load (Relay or Meter) offers series drop in output voltage. This causes additional errors in secondary winding at the measuring end of cable and is proportional to the load on the secondary. Therefore, it is advisable to select separate metering and protection winding. Alternatively, single winding can be used for metering and protection if separate cables are used for connections. (Cable of 4 sq. mm. cross section offer 2% voltage drop at 100 metres distance will 100 VA burden for secondary voltage of 110v/√3).

VT-Coil winding unit

Ct's & PT's

Vacuum Drying Oven

EPOXY Casting Plant

Induced Generator Set for Voltage Transformer Testing

Core Testing Unit

RESIDUAL VOLTAGE TRANSFORMER

RESIDUAL VOLTAGE TRANSFORMER is used to detect unbalanced voltage in three phase system and to supply voltage to directional earth-fault relay.

For directional earth-fault relay. It is necessary that the voltage applied to voltage coil of the relay corresponds in phase to that of the current in current coil. Such voltage will be the Residual voltage of the system and will be the phasor sum of the three line-to-earth voltages.

Residual voltage can be achieved by connecting secondaries of three single phase V.Ts. connected in three phase in open-delta fashion. It is, however, economical to use three phase V.Ts. instead of Three nos. single phase V.Ts. 'AE' manufactures three phase R.V.Ts. suitable upto 33kV system voltage.

In normal three phase limb V.T. when one phase experiences earth fault, the resultant flux due to two healthy lines returns through transformer limb of faulty line, inducing a heavy short circuit current in the winding on the limb. Also voltage induced in secondary open-delta winding is not true residual voltage. To overcome this difficulty two separate limbs are provided in the magnetic circuit of three phase Voltage Transformer to form Five limb Voltage Transformer as shown in Fig. No. 4

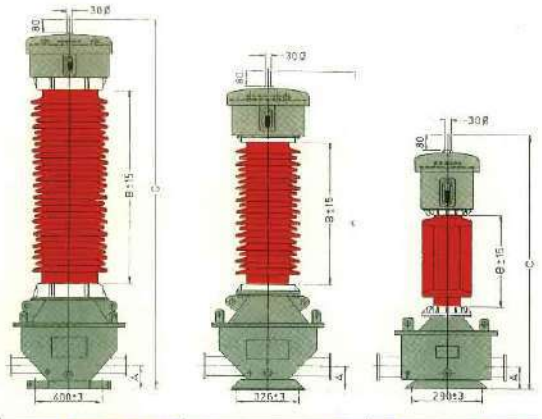
The use of an open-delta connected winding to give true residual voltage in demonstrated in Fig. No. 5 with three cases:

5A) Under healthy condition all three phases will be balanced and hence residual voltage VR will be zero.

5B) In system with unearthed neutral. if here is earth fault on one line, neutral of V.T. will be shifted, such that each healthy phase winding will have line-to-line voltage with 60° phase difference. The resultant open-delta voltage shall be therefore three times phase voltage (VR = 3 VS)

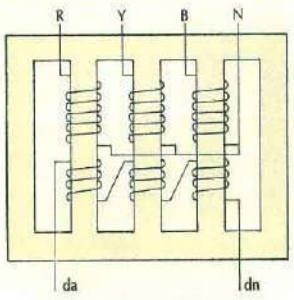
5C) In Solidly earthed system, neutral of the V.T. does not get shifted due to earth-fault one line. Therefore, the resultant open-delta residual voltage remains phase voltage only (VR = VS)

Primary winding of R.V.T. is connected in star. The secondary winding is connected in open-delta. Sometimes additional secondary winding is provided in R.V.T. for measuring purpose and is connected in Star. Ratio of R.V.T. is generally specified as line-to-line primary voltage to open-delta residual voltage. It, therefore, becomes necessary to mention system neutral condition so as to select phase voltage of the open-delta winding correctly. When R.V.Ts. are used along with Capacitor Bank capacitor bank gets discharged through primary winding 'AE' make R.V.Ts. are suitable for such applications also.



TYPE	VOLTAGE CLASS	DIMENSIONS IN mm A	B	C	MOUNTING	TOTAL CREEPAGE IN mm	TOTAL WEIGHT IN kg (Approx.)
OP AS 132	132 / 110 / 100kV	145	1215	2300 ±50	400 X 400	3625	600
OP AS 66	66 kV	120	905	1710 ±50	325 X 350	2310	300
OP HP 33/1	33 / 22 kV	115	450	1275 ±35	250 X 250	900	130
OP HP 33/2		85		1150 ±35	200 X 305		
OP NP 33/1		115	310	1125 ±35	250 X 250	620	120
OP NP 33/2		85		1040 ±35	200 X 305		
OP AS 33/1		115	450	1275 ±35	250 X 250	1320	180
OP AS 33/2		85		1150 ±35	200 X 305		

Principle Dimensions of Oil Cooled Voltage Transformers



5 LIMB CONSTRUCTION OF RVT.

Fig. No. 4

TYPICAL R.V.T.

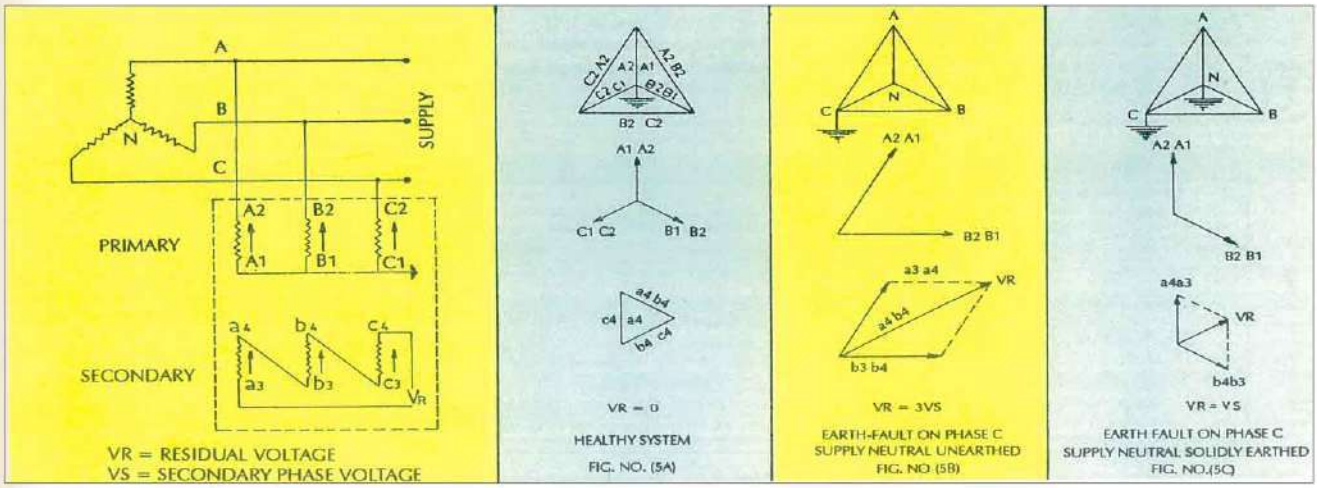


Fig No. 5 Principle of the Residual Voltage Transformer

Resin Cast CTs and PTs

Instrument Transformer Division

(Low Tension to Medium Voltage)

RANGE OF MANUFACTURE :

1. Tapewound ring type current Transformers with and without mounting arrangements.
2. Tapewound ring type CTs with sealing arrangements.
3. Tapewound wound primary CTs (WPL)
4. Resincast (epoxy) BPL CTs.
5. Resincast (epoxy) wound primary (WPL) CTs.
6. Bushing CTs (Fibreglass taped).

CORE BALANCE CTs (Resincast)

These are used in detecting earth faults of very small magnitude. A three phase cable is passed through these CTs & the unbalanced currents in the three phases set up a differential flux giving rise to a current on the secondary side of these CTs sufficient to actuate a relay.

INTERPOSING CURRENT TRANSFORMERS (RESINCAST) :

Used in matching the ratios of main feeder CTs for differential protection schemes. These also find application as saturable CTs used in conjunction with main feeder CTs and thus protect the meters connected to these by limiting the current flowing through the meters.

SUMMATION CTs (RESINCAST) :-

Current transformers intedned to summate the currents in a number of feeders in association with the feeder CTs is called summation Transformer. The performance / testing of these CTs are governed by IS-6949-1973, BS-3938, IEC-185.

BUSHING CTs (FIBREGLASS TAPED) :-

Widely used by Transformer manufacturers for use in oil.

PORTABLE CTs.

With class 0.2 accuracy for metering & testing purpose.

FURNACE CTs.

CTs. WITH ABS CASING AND WITH SEALING ARRANGEMENTS :-

Widely used by Electricity Board along with Energy meters.

LOW TENSION POTENTIAL TRANSFORMER (TAPEWOUND / RESINCAST)

These are offered in various ratios from 1100 /110V to 50 / 75V to suit the exact applications of the clients. Rated burdens upto 100 VA with accuracy classes of 1 or 0.5 can be offered. Various other types of low tension instruments transformers are also manufactured by us to suit the exact requirements of our clients. Our team of specialised Engineers will be pleased to be of

assistance to the clients in proper selection of instruments transformers for their applications.

PROTECTION AND CLASS PS (CLASS X) CTs. BOTH IN TAPEWOUND / RESINCAST :

CTs, With class'PS' / class 'X' for differential protection / BUS coupler application.

The CTs / PTs manufacture by us conform to ISS 2705, BS 3938 and IEC 185-186 standards.

H.V. Tester 2.5 to 200 KV

Instrument Transformer
Division

INTRODUCTION:

Every electrical apparatus or machine is provided with insulation between live part and earth or between two different sections of live parts. This Insulation is required to be tested at high voltage values recommended by applicable relevant standards.

The standard Specification for various electrical apparatus specifies Power Frequency Voltage withstand test at different levels depending upon working voltage of electrical apparatus. It is observed from the various standards for electrical equipments that the minimum power frequency voltage withstand test level for electrical insulation is 2 kV for one minute.

We have, therefore, standardized on manufacture of 'AE' high Voltage Breakdown Testers with rated voltage of 5 kV.

High Voltage Tests Sets of higher voltage upto 600 kV are also manufactured against specific requirement. The standard voltages are 10kV, 15kV, 20kV, 25kV, 30kV, 50kV, 100kv, 150kV, 200kV & 300kV. The test sets upto 30kV are manufactured in Air Cooled design while the sets of 50kV and above are manufactured in Oil Cooled design. The output of this high voltage testers is single phase 50/60Hz. The standard H.T. current rating of air-cooled design as also of oil cooled design upto 150kV is 100mA for 30 minutes. For voltages ranges above 'AE' make 5kV A.C. (with 2.5kV tap) High Voltage Breakdown Tester is portable, sturdy & plug in to start type construction & requires minimum table space. It broadly consists of 3 main sections.

1) High Voltage Transformer
2) Variable Voltage Source
3) Control Circuit

1) HIGH VOLTAGE TRANSFORMER :

The High voltage transformer is single phase, single pole type & is of double wound resin moulded construction. The H.T. winding is provided with graded insulation such that one end is insulated for 2kV insulation and is earthed through a current sensing transformer & milliammeter whereas other end is insulated for full rated voltage & the same brought out through H.T. Cable & spring loaded Prod.

2) VARIABLE VOLTAGE SOURCE:

Variable Voltage supply is provided through a Dimmerstat (Variable auto-transformer) having a suitable rating corresponding to the rating of H.V. Transformer. Dimmerstat is rated for 230Volts A.C. input & 0-270V output. Limit switch at zero position end of Dimmerstat winding is provided to facilitate the H.T. winding.

3) CONTROL CIRCUIT & OTHER FEATURES:

- Manually operated control transformer (Variable auto-transformer)with zero interlock facility.
- 72mm sq. double range (0-2kV / 5kV) moving coil rectifier type voltmeter of class 1.5, provided to read NO LOAD H.T. Voltage.
- 72mm sq. double range (0-100mA) moving coil rectifier type A.C. Milliammeter of class 1.5, provided in the earth end of the H.T. winding to read H.T. Current.
- Automatic tripping circuit is provided for isolation of supply, in the event of failure of the object under test. Rotary switch with four different settings of 5,10,50 & 100mA is provided on front panel with LED indication.
- M.C.B. for short circuit protection of H.T. transformer & auto transformer.
- H.T. ON push button, Mains ON & H.T. ON LED indication.
- Range selection switch to select 2.5kV or 5kV range with LED indiction.
- Two spring loaded test prods with 1 meter long cable for safe & easy connection of high voltage to test object. (upto 5kV.)

LOW TENSION INDOOR MEDIUM VOLTAGE EPOXY RESIN CAST CURRENT & VOLTAGE TRANSFORMERS

CURRENT TRANSFORMER : ELECTRICAL SPECIFICATIONS

TYPE	:	Block Type (Wound Primary), Bar Type (Embedded bar).
OPERATING VOLTAGE (MAXIMUM)	:	3.6 KV, 7.2 KV, 12 KV, 24 KV, 36 KV
PRIMARY CURRENT	:	Upto 2500 Amps.
SECONDARY CURRENT	:	5 A OR 1A (Others on request).
SHORT TIME THERMAL CURRENT & ITS DURATION	:	Upto 40 KA for 1 Second (Others on request)
RATED BURDEN	:	5, 10, 15, 20, 30 VA (Others on request).
ACCURACY CLASS	:	0.2, 0.5, 1.0, 5P10, 5P15 (Others on request). For Differential Protection, Bus Bar Protection, CT with accuracy class PS can be offered.
FREQUENCY	:	50 Hz.
REFERENCE STANDARD	:	IS-2705 / I.E.C. 60044.1.

VOLTAGE TRANSFORMER

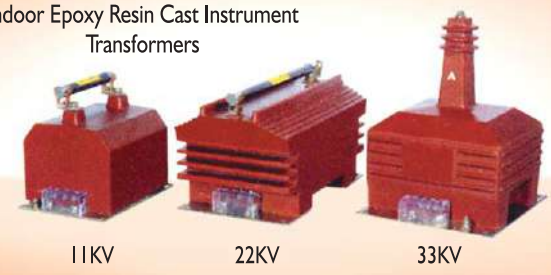
TYPE	:	Single Pole insulated & Double Pole insulated.
OPERATING VOLTAGE (MAXIMUM)	:	Single Pole insulated : 3.6 KV, 7.2 KV, 12 KV, 24 KV, 36 KV, Double Pole insulated : 3.6 KV, 7.2 KV, 12 KV, 24 KV.
SECONDARY VOLTAGE	:	110V, 110V/3, 110V/3 (Others on request).
RATED BURDEN	:	50 VA, 100 VA, 150 VA, 200 VA (Others on request).
ACCURACY CLASS	:	0.2, 0.5, 1.0, 3.0, 3P, 6P.
FREQUENCY	:	50 Hz.
SYSTEM EARTHING	:	Earhted / Unearthed.
REFERENCE STANDARD	:	IS-3156 / I.E.C. 60044.2.

Low Tension Instrument Transformers

Indoor Epoxy Resin Cast Instrument Transformers

Indoor Epoxy Resin Cast Instrument Transformers

Indoor Epoxy Resin Cast Instrument Transformers



H.V. TESTER 2.5 KV TO 200KV

FEATURES :

- Manually operated control transformer (Variable auto-transformer) with zero interlock facility.
- Double range (0-2kV / 0-5kV) voltmeter provided to read H.T. Voltage.
- Double range (0-100mA) A.C. Milliammeter provided in the earth end of the H.T. winding to read H.T. Current.
- Automatic tripping circuit is provided for isolation of supply, in the event of failure of the object under test.
  Rotary switch with four different settings of 5,10,50 & 100mA is provided on front panel with LED indication.
- M.C.B. for short circuit protection.
- H.T. On push button, Mains ON & H.T. ON LED indication.
- Range selection switch to select 2.5kV or 5kV range with LED indication.
- Two spring loaded test prods with 1 metre long cable for safe & easy connection of high voltage to test object.
- Applications - Testing of Insulation of electrical apparatus at high voltage values recommended by applicable relevant.