

CENTRAL POWER RESEARCH INSTITUTE



CPRI

TEST REPORT

Test Report Number : UHV3841516 **Dated:** 31.03.2016

Name & Address of the Customer : M/s. Crompton Greaves Limited,
D2, MIDC Waluj, Aurangabad, Maharashtra – 431136

Name & Address of the Manufacturer : M/s. Crompton Greaves Limited,
D2, MIDC Waluj, Aurangabad, Maharashtra – 431136

Particulars of sample tested

Condition of the sample on receipt : New

Type : IVT:123/230/550

Designation : 123 kV Inductive voltage transformer

Serial Number : 151347

Number of samples tested : One

Date(s) of test(s) : 21.03.2016 to 24.03.2016

CPRI Sample Code no(s) : UHV16S0071

Particulars of test conducted

1. Temperature rise test

2. Impulse voltage test on primary terminals

3. Electromagnetic Compatibility test

4. Short circuit withstand capability test

5. Measurement of capacitance and dielectric dissipation factor

Standard/ Specification : As per IEC 61869-1:2007 and IEC 61869-3:2011

Sampling plan : Not applicable

Customer's requirement : Nil

Deviations if any : 1. Capacitance and dielectric dissipation factor measurement test conducted without performing power frequency voltage test due to test facility limitation

2. The dielectric test before and after test 4 has not been done due to test facility limitation

Name of the witnessing persons

Customer representatives : Mr. Rupesh Malunekar, Executive - Technology

Other than customer's representatives : Nil

Test subcontracted with address of the laboratory : Nil

Documents constituting this report (in words)

Number of sheets : Ten

Number of oscillogram/s : five in two pages

Number of graphs : Nil

Number of photos : Nil

Number of test circuit diagrams : Six

Number of drawings : Three

(Dr. P. RAJAMANI) (K. A. ARAVIND) (K. DEVENDER RAO)

Test Engineers

(Dr. PRADEEP M NIRGUDE)

Joint Director

CENTRAL POWER RESEARCH INSTITUTE



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MOUNTING ARRANGEMENTS & TEST CONNECTIONS DURING TEST:

Mounting arrangement: Sample consists of the material as per the following.

Sl. No.	Drawing No.	Description	Make	Remarks
01	413766485 IVT 1 GA/R0	General Arrangement drawing 110 kV Inductive Voltage Transformer Type- IVT:123/230/550	M/s. Crompton Greaves Ltd, Aurangabad	IVT placed at outdoor
02	413766485 IVT 1 RS/R0	Rating & Schematic diagram for 110 kV Inductive Voltage Transformer Type- IVT:123/230/550		
03	413766485 IVT 1 SB/R0	Secondary Box assembly for 110 kV Inductive Voltage Transformer Type- IVT:123/230/550		

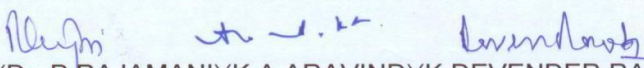
Test Connections:

Test no.	Test connection
1	Test connections is indicated in results and observation
2	Impulse voltage source connected to primary terminal of the IVT. Terminal 'CK' connected to earth through shunt. Terminal 'N' and one end of all secondary winding terminals connected to earth along with base tank.
3	High voltage AC source connected to primary terminal of the IVT. Terminals N, 1n, 2n and 3n connected to earth along with base tank. Terminals 1a, 2a and 3a kept open.
4	Test connections is indicated in results and observation
5	High voltage AC source connected to primary terminal of the IVT. Terminal 'C _k ' connected to C & Tan δ measuring bridge. Earth connected to base tank.

AMBIENT CONDITIONS:

Test no.	Test	Temperature (°C)		Atmospheric Pressure (kPa)
		Dry bulb	Wet bulb	
1	Temperature rise test	30	24	96.26
2	Impulse voltage test on primary terminals	32	22	96.26
3	Electromagnetic compatibility test	30	24	96.37
4	Short circuit withstand capability test	30	24	96.37
5	Measurement of capacitance and dielectric dissipation factor	30	24	96.37

TEST PROCEDURE: As per IEC 61869-1:2007 and IEC 61869-3:2011


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RESULTS & OBSERVATIONS:

Test 1: Temperature rise test

The high voltage AC source is connected to primary terminal of IVT. The secondary winding terminals 1a -1n, 2a - 2n and 3a-3n were loaded with unity power factor burden corresponding to rated VA burden. Resistance of the primary and secondary windings measured before start of the test at ambient temperature. The IVT excited to 120% of rated voltage (i.e., $1.2 \times 110 \text{ kV} / \sqrt{3} = 76.2 \text{ kV}_{\text{rms}}$). The temperature at various places as indicated by the customer, viz. bellow, porcelain part and middle of the housing were measured and recorded. After achieving steady state, i.e., when temperature rise of 1°C per hour is reached, the secondary winding resistance is measured. Then, the voltage is increased to 150% of the rated voltage (i.e. $1.5 \times 110 \text{ kV} / \sqrt{3} = 95.3 \text{ kV}_{\text{rms}}$) and maintained for 30 seconds. All temperature and winding resistance measurement is repeated after this application. The temperature of secondary windings is also calculated by resistance method.

1.1. Temperature rise of IVT

Sl. No.	Time	Ambient Temperature ($^\circ\text{C}$)	Temperature Measured at ($^\circ\text{C}$)		
			Bellow	Porcelain	Middle of Housing
01	18.00	33.7	33.6	34.1	33.9
02	19.00	33.5	33.4	33.7	33.5
03	20.00	33.2	33.1	33.6	33.4
04	21.00	33.1	33.5	33.5	33.6
05	22.00	32.9	33.4	33.3	33.2
After 30 s at 150% of rated primary voltage					
08	22:05	32.9	33.6	33.5	33.4
Rise in Temp. observed from ambient			0.7	0.5	0.5

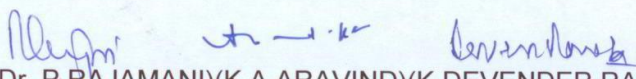
1.2. Measured resistance of primary /secondary windings:

Sl. No	Winding under test	Before start of the test	After steady state at 120% of rated voltage	After 150% of rated voltage for 30seconds
1	1a - 1n	73.56 m Ω	74.33 m Ω	77.949 m Ω
2	2a - 2n	177.80 m Ω	181.30 m Ω	182.58 m Ω
3	3a - 3n	39.616 m Ω	41.56 m Ω	42.2 m Ω
4	Primary Winding	30.19 k Ω	31.1 k Ω	31.6 k Ω

1.3. Temperature rise of secondary windings by resistance method:

Sl. No	Winding under test	After steady state at 120% of rated voltage ($^\circ\text{C}$)	After 150% of rated voltage for 30 seconds ($^\circ\text{C}$)
1	1a - 1n	3.61	16.80
2	2a - 2n	6.08	8.01
3	3a - 3n	13.96	18.29
4	Primary Winding	8.88	13.33

Test Result: Temperature rise by thermocouple method and by resistance method within the limits.


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Test 2: Impulse Voltage test on Primary terminals

Polarity	Lightning impulse	No. of Impulses applied	Test voltage* kV _p	Reference oscillogram E:\CPRIDAQ-533\CGLABD 15032016 123KVIVT\LI...acq	Remarks
Negative	Reduced Full Wave	1	333	1	Withstood
	Full Wave	15	550	15	
Positive	Reduced Full Wave	1	413	21	
	Full Wave	15	550	36	

*These are the test voltages for the ambient atmospheric conditions mentioned

Test 3: Electromagnetic Compatibility Test

Applicable additional standard: CISPR 18-2:2010 **Detector:** Quasi Peak

Measuring frequency: 1 MHz; **Ambient RIV level across 300 Ω :** 156.675 μ V

The sample pre-stressed at 106.5kV_{rms} for 30 seconds and reduced to measuring voltage 78.1kV_{rms} within 10 seconds, and maintained for 30 seconds,

Measuring voltage (kV _{rms})	Measured RIV level across 300 Ω impedence (μ V)
78.1	295.12

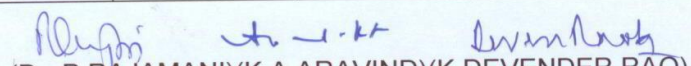
Test 4: Short circuit withstand capability test

Accuracy of Measuring Voltage Transformer before short circuit withstand capability test

Ambient condition: T_d: 30°C, T_w: 25°C, Pressure: 96.26 kPa

The power frequency AC voltage was applied on the primary terminal of the IVT. Terminals 'N' and Ck are connected to earth along with the tank. The secondary terminals 1n and 2n connected to earth.

Secondary winding under test	Burden (VA) 3a – 3n	Test voltage (% of primary voltage)	Percentage voltage (Ratio) Error	Phase Displacement (Minutes)	Results
3a – 3n Accuracy class:0.2	250	120	- 0.1344	- 0.741	The winding is within limits of voltage error and phase displacement as specified in the standard
		100	- 0.1061	- 1.553	
		80	- 0.0899	- 1.721	
	62.5	120	0.1608	0.466	
		100	0.1826	- 0.656	
		80	0.1914	- 1.028	


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Accuracy of Protective Voltage Transformer before short circuit withstand capability test

The power frequency AC voltage was applied on the primary terminal of the IVT. Terminals 'N' and Ck are connected to earth along with the tank. The secondary terminals 2n and 3n connected to earth.

Secondary winding under test	Burden (VA)	Test voltage (% of primary voltage)	Percentage voltage (Ratio) Error	Phase Displacement (Minutes)	Results
1a – 1n Accuracy class:3P	150	150	- 0.288	5.92	The winding is within limits of voltage error and phase displacement as specified in the standard
		120	- 0.1437	- 1.105	
		100	- 0.1257	0.220	
		5	- 0.407	- 5.63	
		2	- 1.184	- 3.11	
	37.5	150	0.0108	6.40	
		120	0.1680	0.901	
		100	0.1891	0.170	
		5	- 0.0174	- 3.35	
		2	- 0.1648	- 6.43	

The power frequency AC voltage was applied on the primary terminal of the IVT. Terminals 'N' and Ck are connected to earth along with the tank. The secondary terminals 1n and 3n connected to earth.

Secondary winding under test	Burden (VA)	Test voltage (% of primary voltage)	Percentage voltage (Ratio) Error	Phase Displacement (Minutes)	Results
2a – 2n Accuracy class:3P	150	150	- 0.0225	5.55	The winding is within limits of voltage error and phase displacement as specified in the standard
		120	0.1252	0.553	
		100	0.1610	-0.480	
		5	0.428	2.59	
		2	0.875	11.11	
	37.5	150	0.244	5.94	
		120	0.399	0.866	
		100	0.435	-0.300	
		5	0.686	3.40	
		2	1.129	8.10	

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Short circuit withstand capability test:

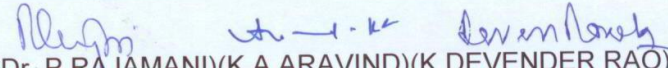
The power frequency AC voltage was applied on the primary terminal of the IVT. Terminals N, 1n and 2n were connected to earth along with the tank. The secondary winding terminals 3a - 3n were shorted for a duration of 1 s at rated primary voltage (U_p) i.e., 63.5 kV_{rms} using contactor. The secondary current was measured using a CT of 300 / 5 A ratio along with a burden of 1 Ω connected across CT secondary. The primary voltage, secondary voltage and the secondary current through 3a - 3n were recorded using a four channel digital storage oscilloscope. It is indicated as upper, middle and lower traces, respectively in the oscillogram, CGSCWCT123.

Accuracy of Measuring Voltage Transformer after short circuit withstand capability test

Secondary winding under test	Burden (VA)	Test voltage (% of primary voltage)	Percentage voltage (Ratio) Error	Phase Displacement (Minutes)	Results
	3a - 3n				
3a - 3n Accuracy class:0.2	250	120	-0.1450	0.783	The winding is within limits of voltage error and phase displacement as specified in the standard
		100	-0.1097	-0.485	
		80	-0.1040	-0.637	
	62.5	120	0.1958	1.141	
		100	0.232	0.034	
		80	0.236	-0.166	

Accuracy of Protective Voltage Transformer after short circuit withstand capability test

Secondary winding under test	Burden (VA)	Test voltage (% of primary voltage)	Percentage voltage (Ratio) Error	Phase Displacement (Minutes)	Results
	1a - 1n				
1a - 1n Accuracy class:3P	150	150	-0.286	7.15	The winding is within limits of voltage error and phase displacement as specified in the standard
		120	-0.1271	1.942	
		100	-0.0882	0.817	
		5	0.0808	-0.376	
		2	0.466	-2.08	
	37.5	150	0.0336	6.61	
		120	0.204	1.179	
		100	0.241	0.141	
		5	0.662	-0.763	
		2	0.616	-1.421	


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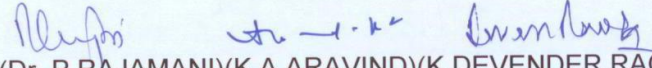
Secondary winding under test	Burden (VA) 2a – 2n	Test voltage (% of primary voltage)	Percentage voltage (Ratio) Error	Phase Displacement (Minutes)	Results
2a – 2n Accuracy class:3P	150	150	-0.0098	5.92	The winding is within limits of voltage error and phase displacement as specified in the standard
		120	0.1433	0.784	
		100	0.1689	-0.282	
		5	0.284	0.036	
		2	0.534	-0.853	
	37.5	150	0.261	6.09	
		120	0.411	1.069	
		100	0.444	-0.061	
		5	0.574	1.421	
		2	0.848	-0.514	

Observations:

1. No physical damage was observed to the IVT after the test
2. Its error does not differ from those recorded before the tests by more than half the limits error in its accuracy class
3. The current density calculated based on measured symmetrical short circuit current in the secondary winding and found less than 180 A/mm²

Test 5: Measurement of capacitance and dielectric dissipation factor

Test Voltage, kV _{rms} , 50 Hz	Measured Capacitance, pF	Tan δ
71.0	299.33	0.002210


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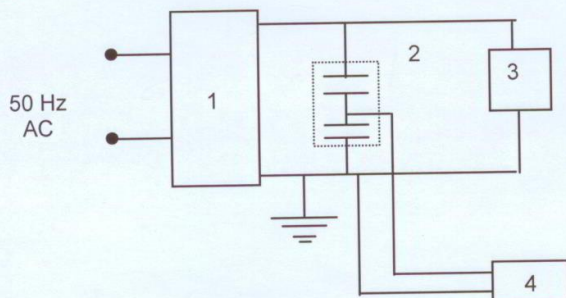
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Test Circuit Diagrams

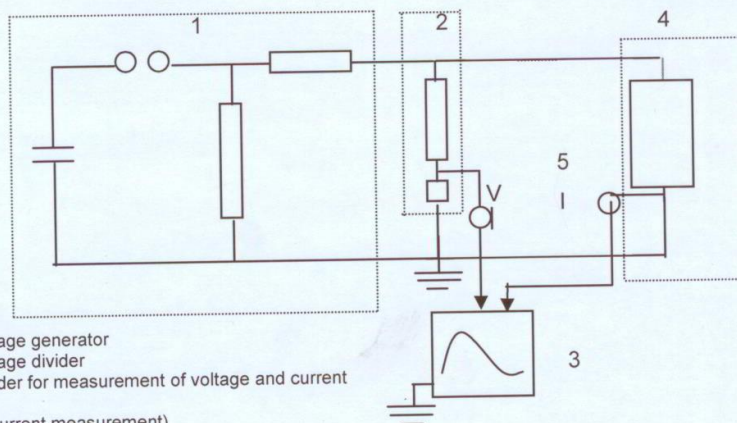
Test 1:



Legend:

- 1: HV AC source
- 2: Voltage Divider
- 3: Test Sample
- 4: RMS Voltmeter

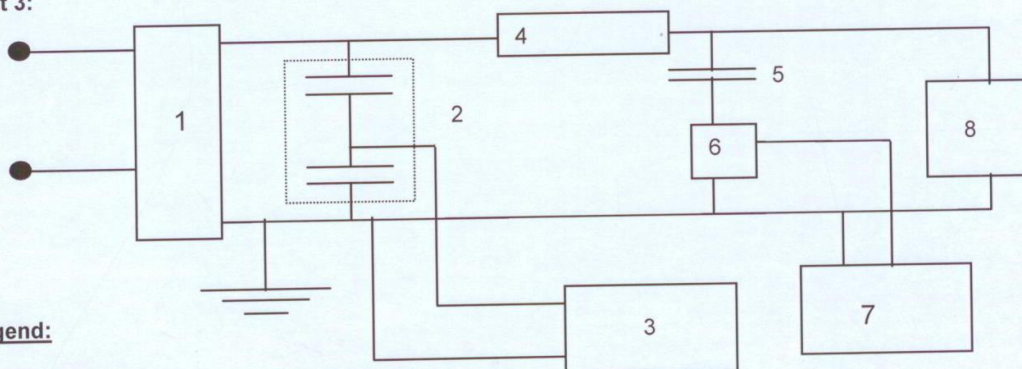
Test 2:



Legend:

- 1: Impulse voltage generator
- 2: Impulse voltage divider
- 3: Digital recorder for measurement of voltage and current
- 4: Test object
- 5: Shunt (for current measurement)
- V: Voltage
- I: Current

Test 3:



Legend:

- 1: AC Transformer
- 2: Voltage Divider
- 3: RMS Voltmeter
- 4: RF Rejection Coil
- 5: Coupling Capacitor
- 6: Impedance Box
- 7: EMI Test receiver
- 8: Test Sample

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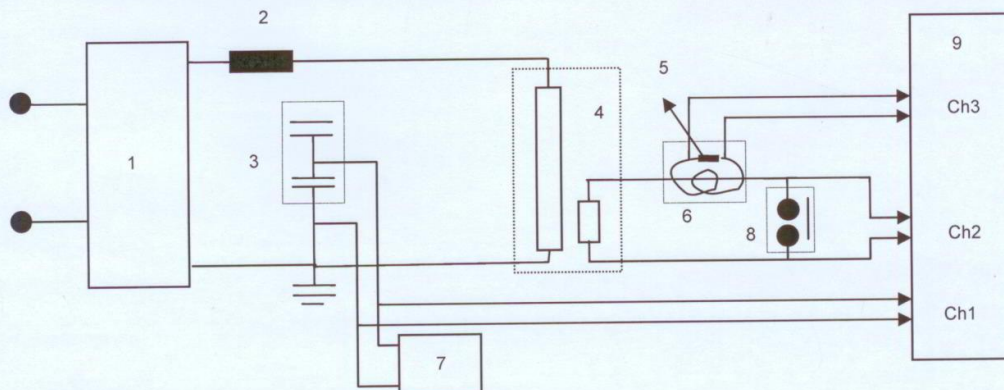


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Test 4: Short circuit withstand capability test (SCWCT)



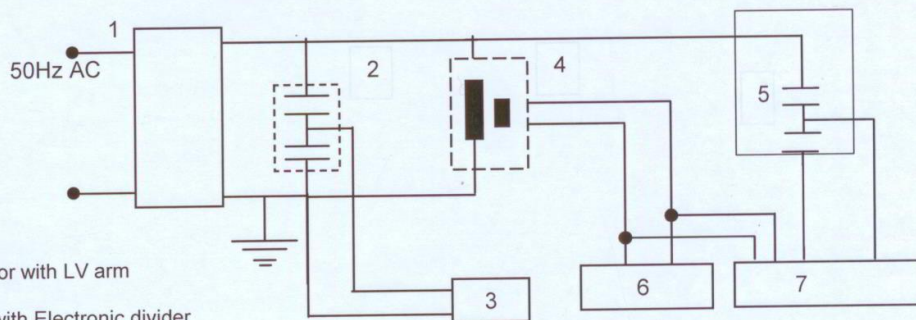
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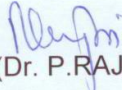
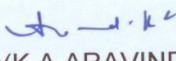
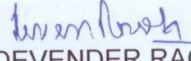
- | | |
|---|------------------------|
| 1: HV AC source | 2: Protective Resistor |
| 3: Voltage divider | 4: Test Sample |
| 5: Burden (1.0 Ω) | 6: 300 / 5 A CT |
| 7: Peak / RMS voltmeter | 8: Contactor |
| 9: 4 Channel digital storage oscilloscope | |

Measurement & Accuracy test (before & after)

Legend:

- | |
|--|
| 1: HV AC Source |
| 2: HV Divider |
| 3: RMS Voltmeter |
| 4: IVT under test |
| 5: Standard Capacitor with LV arm |
| 6: Burden |
| 7: Accuracy bridge with Electronic divider |






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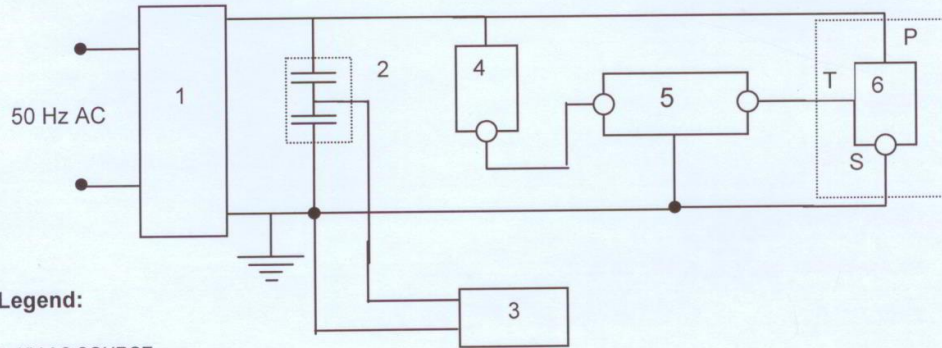


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Test 5:

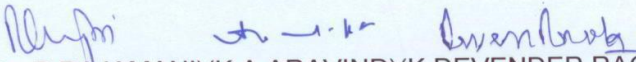


Legend:

- 1: HV AC SOURCE
- 2: VOLTAGE DIVIDER
- 3: RMS VOLTMETER
- 4: STANDARD CAPACITOR
- 5: CAPACITANCE & TAN-DELTA MEASURING BRIDGE
- 6: TEST SAMPLE
- T: C₁ TERMINAL OF IVT
- P: PRIMARY TERMINAL OF IVT
- S: Tank of IVT

NOTE

- a) The test results relate only to the items tested.
- b) Publication or reproduction of this report in any form other than by complete set of the whole report and in the language written is not permitted without the written approval of CPRI.
- c) Corrections/erasing invalidate the test report.
- d) Any anomalies/discrepancies in the test report should be brought to our notice within 45 days from the date of issue


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Test Engineers

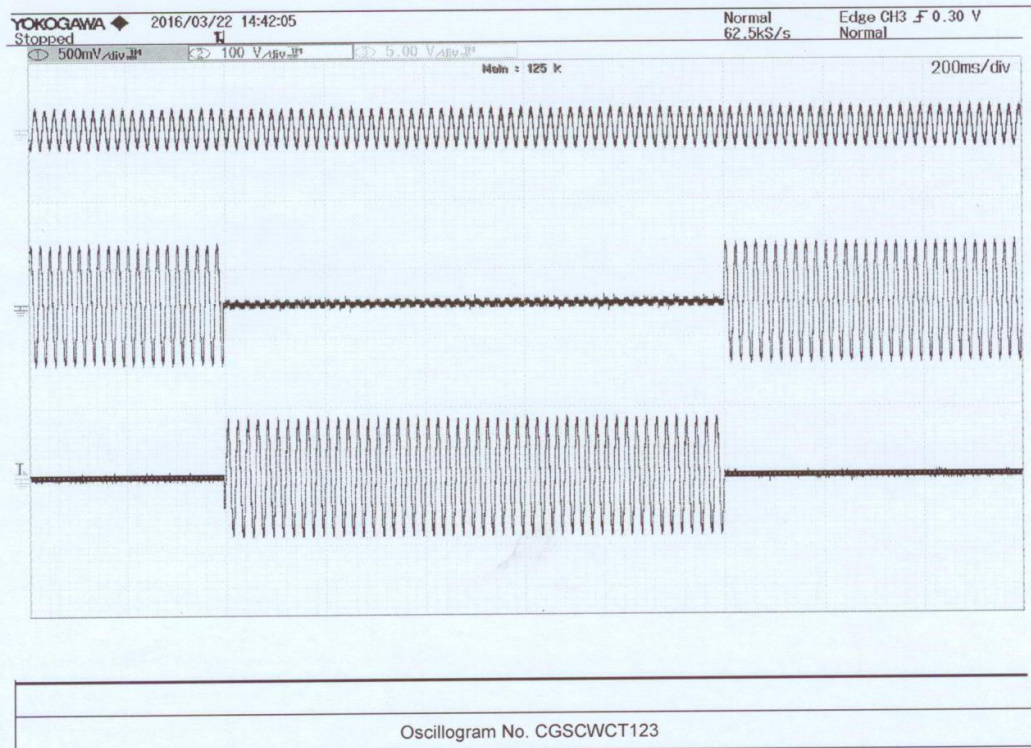
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SHORTCIRCUIT WITHSTAND CAPABILITY TEST OSCILLOGRAM

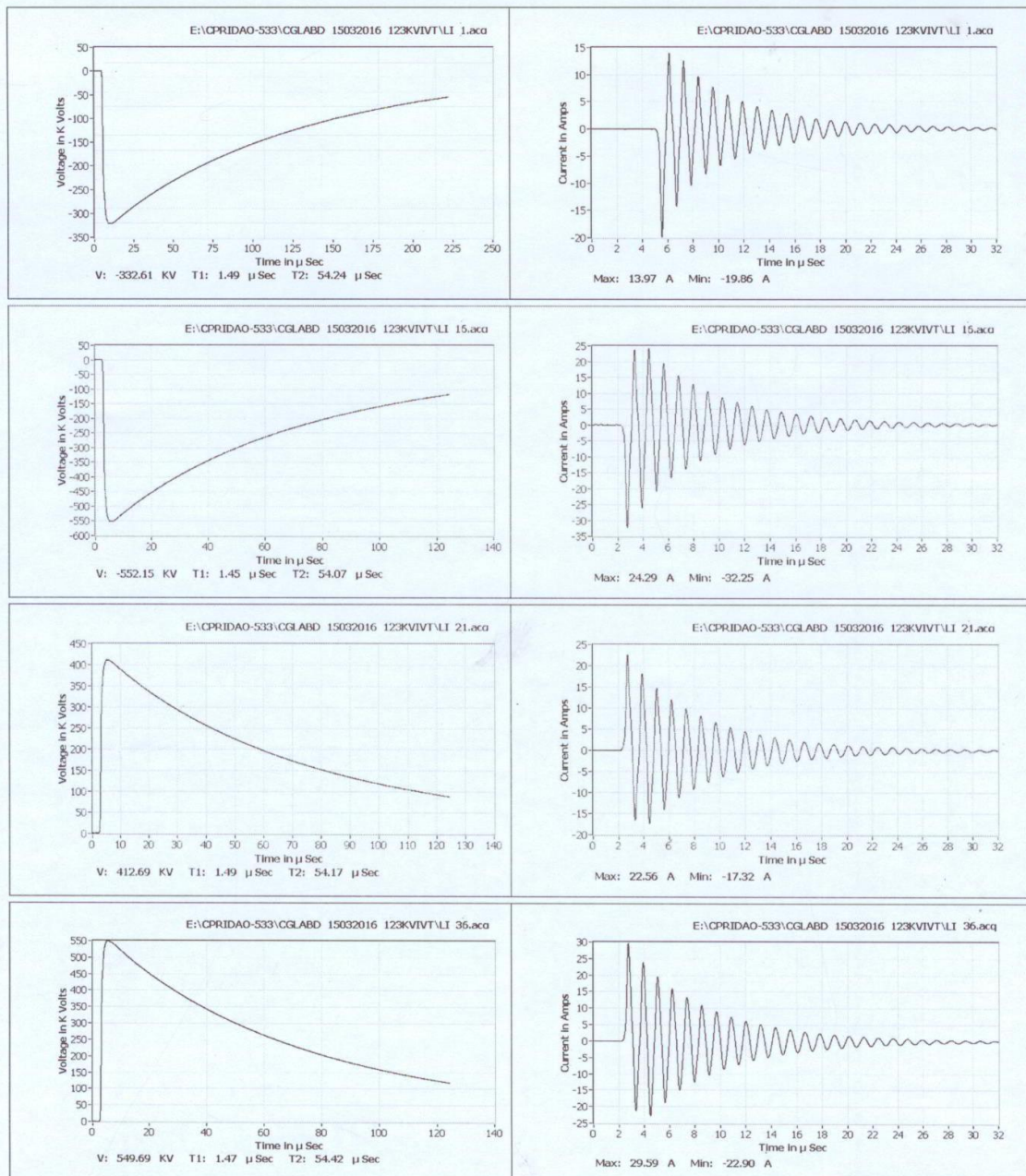


(Signature)
(Dr. P. RAJAMANI)
Test Engineer

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Test Report Number: UHV3841516

Date: 31.03.2016

(Signature)
(K. A. ARAVIND)
TEST ENGINEER

SR.NO.	QTY.	DESCRIPTION
1	1	HOOD
2	1	BELLOW LEVEL INDICATOR
3	1	BELLOW
4	1	ALUMINUM PRIMARY TERMINAL SIZE- $\phi 30 \times 80$ L
5	1	PORCELAIN INSULATOR (BROWN COLOUR)
6	2	PORCELAIN FLANGE
7	1	ACTIVE PART
8	1	HOUSING(TANK)
9	1	CORE
10	1	SECONDARY TERMINAL BOX
11	8	SECONDARY TERMINAL
12	1	GLAND PLATE
13	1	MONOBLOCK
14	1	RATING & SCHEMATIC DIAGRAM
15	1	OIL SAMPLING VALVE
16	2	EARTHING PAD

4-Holes of $\phi 20$ for Mounting

500 ± 4
400 ± 4
400 ± 4
725 ± 16

TOP VIEW

50 23 12

2-Holes of $\phi 14$ for Earthing

EARTHING PAD DETAILS

1 2 3 4

$\phi 30 \times 80$ L

5 6 7

8 9 10 11 12 13 14 15 16

SIDE VIEW

16

10

11

12

13

FRONT VIEW

IF IN DOUBT ASK

TECHNICAL DETAILS

123 KV INDUCTIVE VOLTAGE TRANSFORMER

TYPE = MT:123/230/550

HIGHEST SYSTEM VOLTAGE (LINE TO LINE) = 123 Kilo Volts.

HIGHEST SYSTEM VOLTAGE (LINE TO EARTH) = $123/\sqrt{3}$ Kilo Volts.

1 MIN. AC WITHSTAND VOLTAGE (DRY/WET) = 230 Kilo Volts.

LIGHTNING IMPULSE WITHSTAND VOLTAGE = 550 Kilo Volts(Peak)

TOTAL CREEPAGE DISTANCE (MIN.) = 3400 Millimeters.

SUITABLE FOR ALTITUDE = < 1000 Meter.

TOTAL WEIGHT = $315 \pm 10\%$ Kilogram.

OIL WEIGHT = $55 \pm 10\%$ Kilogram.

APPLICABLE STANDARDS = IEC:61869-1,3

VOLTAGE FACTOR = 1.2 CONTINUOUS/1.5-30SEC.

WINDING DETAILS AS PER RATING & SCHEMATIC DIAGRAM

DRG.NO. 413768485 INT RS

NOTES :

1) Primary winding number of turns : 33979

2) Cross section area of primary winding : 38 SMC(0.01824 Sqmm)

3) Secondary winding

Wind Wdg	Number of turns	SMC/Sqmm
1	34	(14x2)/8.485
2	59	(13x1)/4.300
3	34	(13x9)/25.8

4) Core material : C800 M4

DETAILS AT SECTIONAL A-A

NOTE : PLEASE REFER INSTRUCTION MANUAL FOR HANDLING & TRANSPORTATION OF MT.

NO	REVISION	SIGNATURE	NO	REVISION	SIGNATURE	NO	REVISION	SIGNATURE	NO	REVISION	SIGNATURE
R6			R4			R2					
R5			R3			R1					
NO											

SIGN	NAME	GENERAL ARRANGEMENT DRAWING
DRN	MRK	INDUCTIVE VOLTAGE TRANSFORMER
CHD	RSM	
APPD	YPS	

DRG. NO.	DATE	SCALE	N.T.S.	DATE	SCALE	N.T.S.
413768485 INT RS	12.03.2016					

SL.NO.	QTY	DESCRIPTION
6	8	SEC. TERMINAL BLOCK WITH TER. MARKER
5	1	DIN RAIL
4	1	GLAND PLATE
3	1	GASKET
2	1	COVER
1	1	AL-CAST SECONDARY BOX

TOP VIEW FROM 'A'

ELEVATION ↑ 'A'

SIDE VIEW

COVER

M4 BOSSES-4 NO'S

3

2

IF IN DOUBT ASK

TEST ENGINEER
Central Power Research Institute
HYDERABAD

Signature: *[Signature]*

UHV 384.1516 dt. 31.03.2016

सर्व चित्र परीक्षण दस्तवेज से
से मंजूरित है
This drawing pertains to test report
UHV 384.1516 dt. 31.03.2016
सर्व चित्र का सांख्यिकीय विमल की जांच में
शुद्धी है
Material of drawing is limited
to existing dimensions on

NOTES:

1) SECONDARY BOX ASSEMBLY TO CONFIRM IP55 AS PER IS:13947-1993.

2) FINISH : EPOXY PAINTED.

3) OK TERMINAL FOR CAPACITANCE AND TANDELTA MEASUREMENT ONLY.
SHOULD BE KEPT EARTHED WHEN NOT IN USE.

NAME	SIGN	DATE	REVISION	SIGN	DATE	NO
MRK						R2
RSM						R1
YPS						

DRN	CHD	APPD	SIGN	DATE	SCALE	N.T.S.	DATE	12.03.2016	ALL DIMENSIONS ARE IN mm

SECONDARY BOX ASSEMBLY	11KV/INDUCTIVE VOLTAGE TRANSFORMER
TYPE: WT-122200550	

NO	REVISION	SIGN	DATE	NO	REVISION	SIGN	DATE	NO
R6				R4				
R5				R3				

DRG.NO	413766485	MTI	SB/RO

IVT SR.NO.- 151347