6.1.7 Magnetic Balance test:

1-Phase supply Apply **Tap No. 5**

1U – 1N (Volt)	1V – 1N (Volt)	1W – 1N (Volt)
232.0	203.3	26.1
126.1	**229.0**	103.1
29.0	199.0	**229.1**

6.1.8 Sweep Frequency Response Analysis test:

Brief Description of SFRA:

The SFRA test involves measuring the frequency responses of each individual winding. The frequency response is measured by injecting a sine wave signal with respect to earth at one end of winding to be tested and measuring the signal amplitudes there and at other end of the winding as shown in Figure 2 . The attenuation (in dB) of the transmitted signal relative to reference signal at the input terminal is measured over a frequency range from 10 Hz to 2 MHz.

Measurement of Open circuit SFRA plot of winding:

Sr. No.	Test winding	SFRA connections
1	HV winding Open circuit SFRA plot **HV terminals- HV** **HV terminals- N**	Signal injected in "HV" bushing terminal with respect to earth and measured at "N" bushing terminal with respect to earth.
2	LV winding Open circuit SFRA plot **LV terminal – LV** **Neutral Terminal –LV**	Signal injected in "LV1" bushing Terminal with respect to earth and measured at "LV2" bushing terminal with respect to earth.

- All other bushings were floating and not connected to ground during the individual measurement. Measurements were carried out for tap no. 5.

Measurement of Short circuit SFRA plot of winding:

Sr. No.	Test winding	SFRA connections
1	HV winding Short circuit SFRA plot	Signal injected in "HV" and "N" bushing terminal with respect to earth and measured at phase bushing terminal with respect to earth. Terminal of LV winding was shorted for the test.

- All other bushings were floating and not connected to ground during the individual measurement.
- Measurement was carried out at tap no 5 .

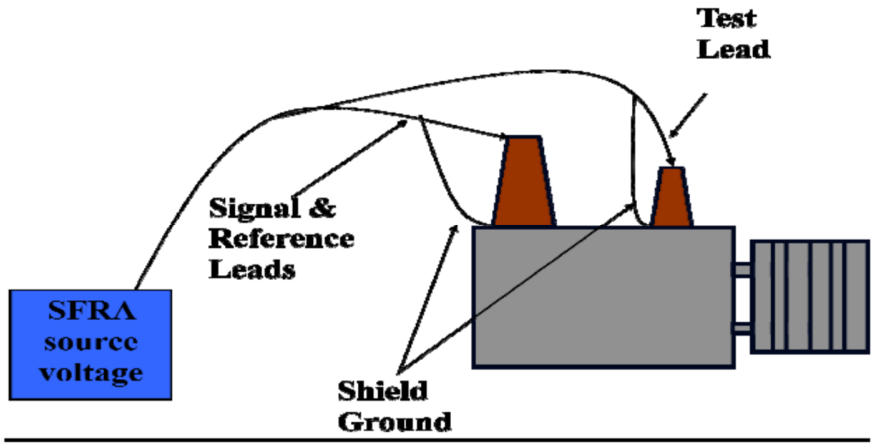


Figure 2: Circuit description of SFRA

PURPOSE:

- Assess Mechanical Condition of Transformers (Mechanical distortions)
- Detect Core and Winding Movement due to large electromagnetic forces from fault currents
- Winding Shrinkage causing release of clamping pressure
- Transformer Relocations or Shipping damages

REMARKS:

- **The SFRA plots are enclosed inAnnexure-1 of this report.**
- These plots are taken as initial signatures and may be compared with any SFRA measurements taken in future.
- For HV winding the SFRA Open and Short circuit plots are identical when compared on three phase basis, which indicates that there is no significant winding movement in this transformer as shown in Annexure 1.
- For LV winding also, the SFRA Open circuit plots are identical when compared on three phase basis, which indicates that there is no significant winding movement in the transformer as shown in Annexure 1.

6.1.9 Frequency Domain Spectroscopy (FDS) Analysis test:

Moisture Analysis of Transformer Insulation:

The dryness of the oil-paper insulation systems in power transformers is a key factor in both their short and long term reliability since moisture has deleterious effects on dielectric integrity and insulation ageing rates.

The dielectric frequency response analysis method, which is based on wide range measurements in time and frequency domains, is a useful tool to evaluate the moisture condition of the electrical insulation systems.

In the Dielectric method using the Frequency Domain Spectroscopy (FDS), the dissipation factor of the insulation system under test is measured by frequency sweep. The onsite measurement is considerably accelerated by a combination of time and frequency domain measurements. The frequency range from 1 kHz down to 0.1 Hz is measured in frequency domain, whereas the range from 0.1 Hz down to 0.1 mHz is measured in time domain.

A dielectric response measurement is a three terminal measurement that includes the output voltage, the sensed current and a guard as shown in Figure 2. The moisture analysis is obtained for the solid insulation between HV and LV winding separately as indicated in Table below.

Insulation	Moisture Content of inter winding insulation	Remark
HV-LV	0.7 %	Dry

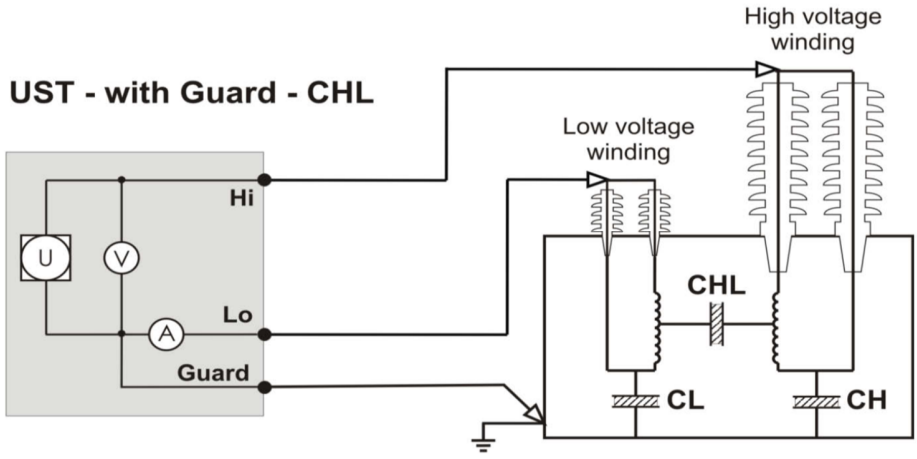
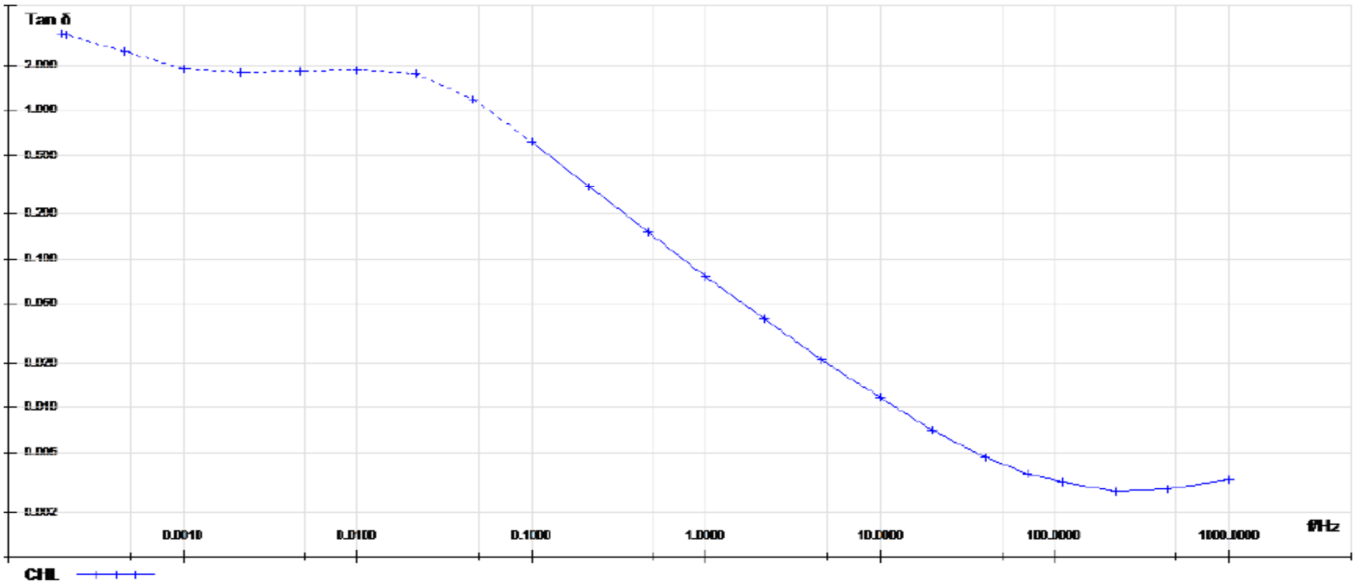


Figure 2: Schematic for UST connection of dielectric response measuring system to a transformer for CHL configuration

Transformer Remaining Life Assessment Report			
Project	**: RLA of Transformer**	**Client**	**: Reliance Industries Ltd**
Rating	**: 161 MVA,231/14.5 kV**	**Sr. No.**	**: TWB0-6674/B-30082**
Location	**: MSU-4, ZCPP Plant**	**Date**	**: 24-04-2019 to 25-04-2019**

Moisture Assessment curve for CHL insulation measured by FDS+PDC combined method
Plot:



Remarks:

Moisture measurement by FDS+PDC method (DIRANA Test) indicates a Dry insulation (as per International Standards for in-service Auto Transformers). Note that moisture reduces the breakdown strength of paper and has direct impact on life of transformer.

6.2 On Line Test data:

6.2.1. Oil Analysis:

Sl No	Test Description	Test Method	Unit	Result	Requirement as per Specification
1	Breakdown Voltage	**IEC 60422**	KV	69	**30 KV Min**
2	Flash point	**IEC 60296**	-	141	**135°C Min**
3	Water Content	**IEC 60422**	ppm	6	**25 Max.**
4	Inter Facial Tension	**IEC 60422**	mN/m at 27◦c	38	**22 Min.**
5	Total Acid Number	**IEC 60422**	mgKOH/g	0.006	**0.3 Max.**
6	Sludge	**IEC 60422**	%Wt	N/D	**<0.02%**
7	Specific Resistivity at 90°C	**IEC 60666**	Ohm.cm	$250*10^{12}$	0.2×10^{12} Min.
8	Dissipation Factor @90°C	**IEC 60422**	-	0.0003	**0.5 Max.**
9	**Furan Analysis**	**IEC-61198: BS148**			
	5-hydroxy-methyl-2-furfuraldehyde		Ppm	NIL	
	2-furfural		Ppm	NIL	
	2-Acetyl furan		Ppm	NIL	
	5-methyl-2-furaldehyde		Ppm	NIL	
	2-furfuryl alcohol		Ppm	NIL	
	Total Furan		Ppm	NIL	5 ppm Max
10	**Dissolved Gas Analysis**	**IEEE-C57.104-2008**			
	Hydrogen H2		Ppm	6	100
	Methane CH4		Ppm	24	120
	Ethane C2H6		Ppm	17	65
	Ethylene C2H4		Ppm	18	50
	Acetelyne C2H2		Ppm	BDL	1
	Carbon Monoxide CO		Ppm	140	350
	Carbon Di Oxide CO2		Ppm	1574	2500
	Oxygen O2		Ppm	14748	-
	Nitrogen N2		Ppm	33920	-