Frequency Response Analysis: Failure Mode Analysis

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Applications Engineers

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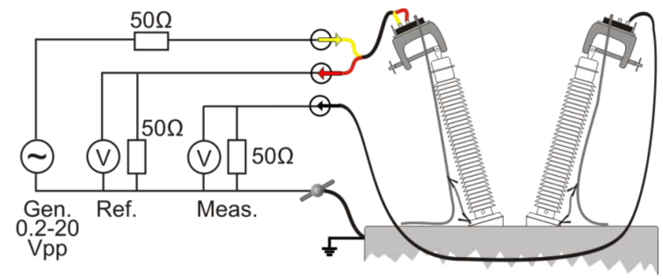
FRA:

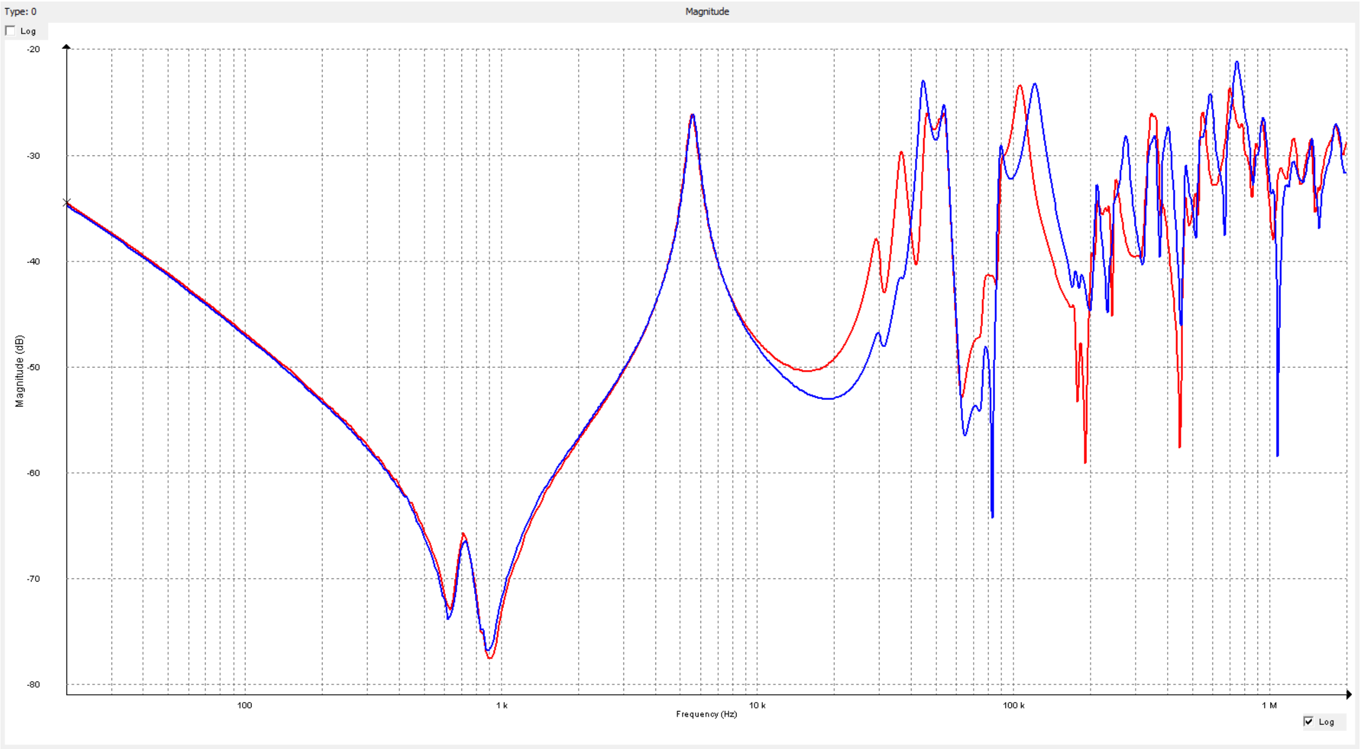
- Sensitive diagnostic test to detect damage in the electrical/mechanical configuration of a transformer
  - **Windings**, core, leads, insulation, tap changer, etc.
- Measures the response to a signal of variable frequency injected at one terminal and measured at another



- Results are **compared** with a reference response – “fingerprint” to make a diagnostic
- Has the potential to detect minor damage not evident in other electrical tests

Introduction

- Results are **compared** with a reference response – “fingerprint” expecting a perfect match
- No match = change in configuration = problem



Standardization

- IEEE C57.149-2012
  - “Guide for the Application and Interpretation of Frequency Response Analysis for Oil-Immersed Transformers”
- IEC60076-18 Ed. 1 – 2012
- Std. DL/T911-2004
- Cigré Technical Brochure No. 342, April 2008

Introduction

- Review of IEEE C57.149-2012
- Recommendations from other Standards
- C57.149-2012 Failure Modes
- Real Life Failure Mode Analysis
- FRA Case Studies
- Conclusion
- Summary

RECOMMENDED PRACTICES BY IEEE STD C57.149-2012 FOR FRA MEASUREMENT

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Test Instrument

- Minimum 200 points per decade, XML format
- Three lead configuration (signal, reference, and test),
  - coaxial cables and with length up to 30m
- Frequency range wide enough to diagnose problems in the core, clamping structure and winding/interconnections.

Specimen Scope

- Explicit for oil-immersed transformers – No limits on V or MVA
- Test after any situation that can cause mechanical movement or electrical damage
  - Short circuit: factory test or through fault
  - Installation, relocation or catastrophic event
  - Routine diagnostic measurement protocol
  - After a transformer alarm, change in electrical test conditions (i.e., a change in winding capacitance)

Test Conditions

<u>All</u> terminals disconnected

CT's connected for in-service conditions

If possible, all test leads connections should go directly to the bushing terminal.

LTC:
- Test in extreme raise position
- Neutral: preferred to arrive from raise position

DETC
- determined by in-service conditions
- Operation up to the decision of the owner

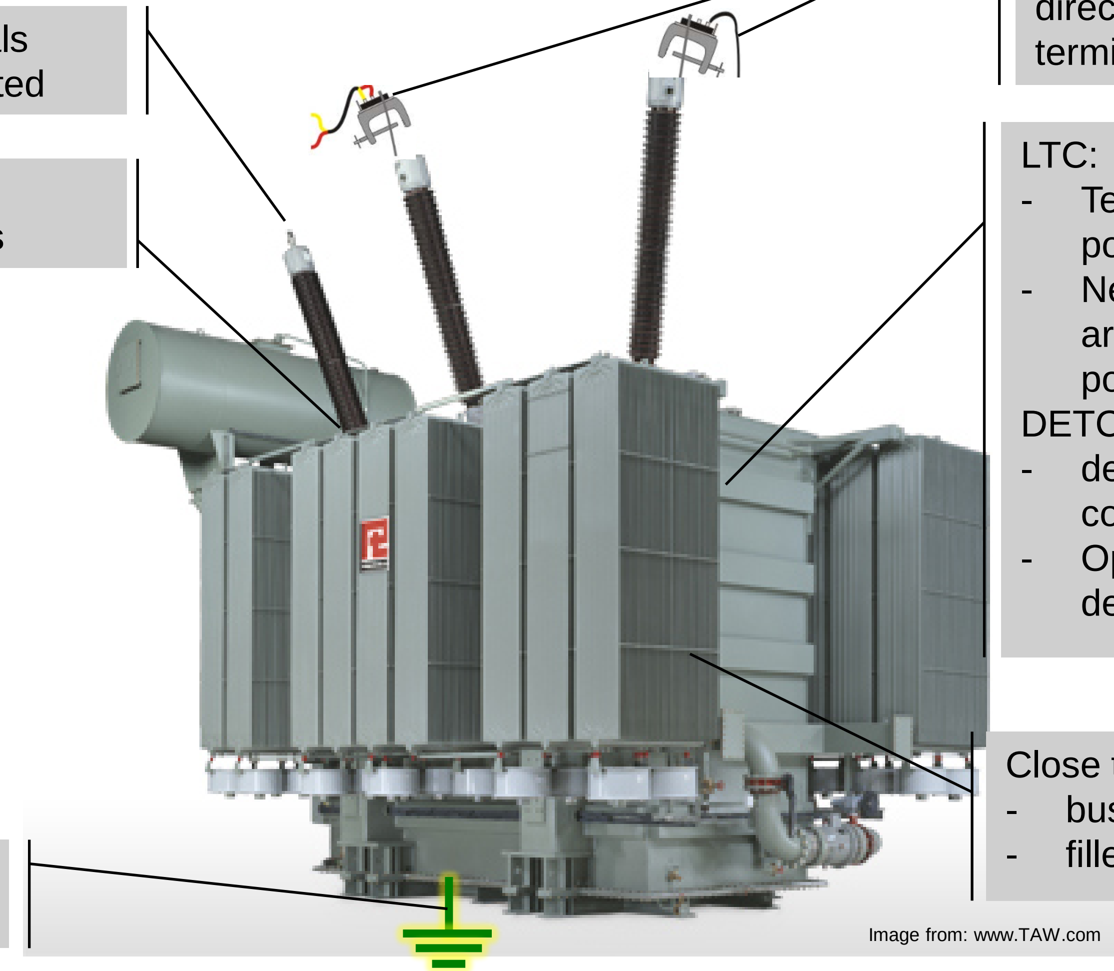


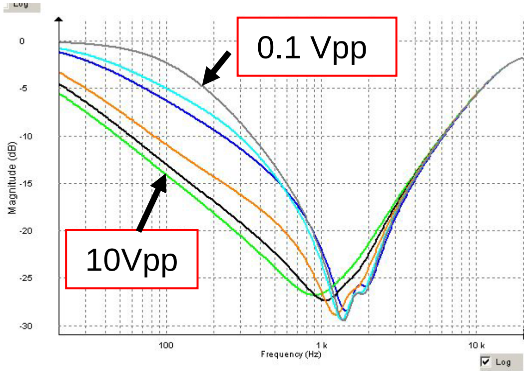
Image from: www.TAW.com

Close to in-service condition:
- bushings installed
- filled with oil (preferred)

Tank should be grounded

Test Voltage

- Use the same voltage for every test to guarantee repeatability below 10 KHz
- Avoid applying excessive voltages to transformers without oil



Frequency Range

- IEEE has no specific recommendation or requirement for the frequency range setting
- It analyzes different failures in a frequency range from 20 Hz to 1 MHz
- A response greater than 1 MHz is irregular and complex, it may contain important information from the leads of taps but it is also affected by the grounding leads.

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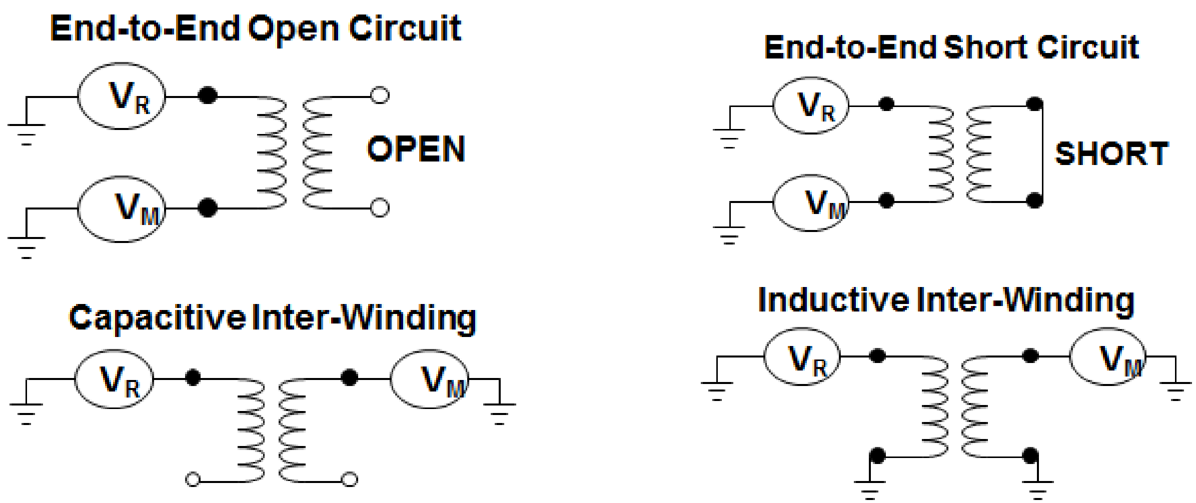
Measurement Types



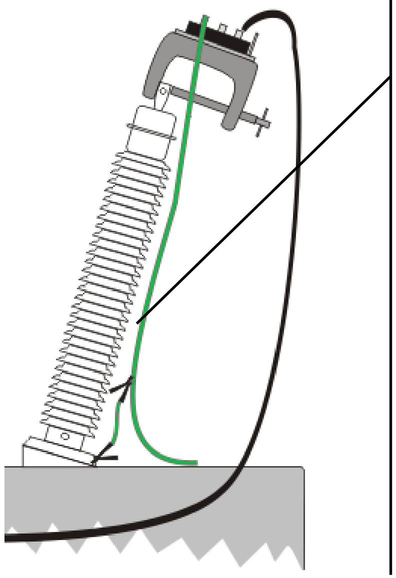
- Minimum requirement: all open circuit tests
- Recommended: all end-to-end open and short circuit tests
- LTC should be set in extreme position to include all tap windings in the circuit

Instrument and Tests Verification

- Run a self-check of the instrument on a standard test object with a known response

Test Lead Connections

- ***Sequence of connections:***
  - The purpose is to test all windings
  - Measurements should be done from head-to-tail, following winding configuration (vector group)
  - Variations on sequence or polarity are accepted
- ***Shield grounding:***

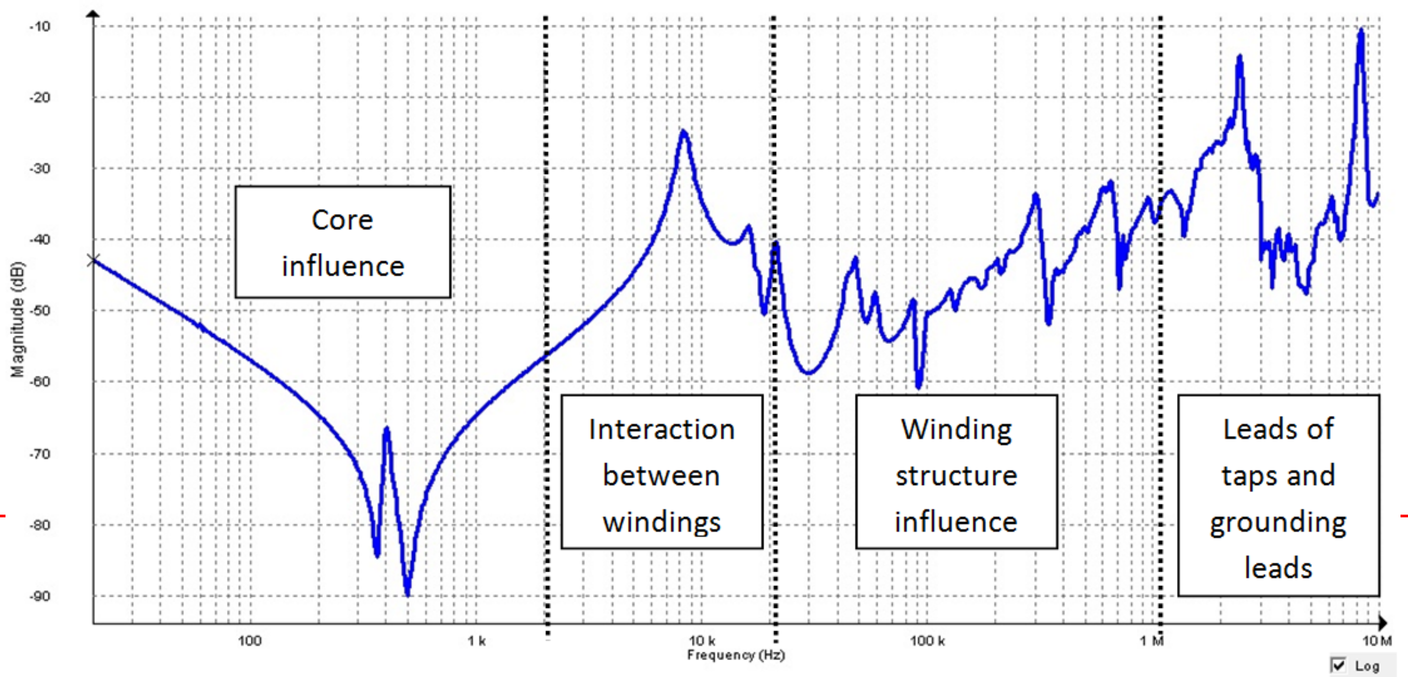


- Run an extension of the grounding cable from the top of the bushing (lead connection) to the flange of the bushing.

- Grounding techniques, conductors, routing and any other aspect related to it should be precise, repeatable and documented.

Test Result Analysis

- Main purpose is to determine if the physical condition has changed
- Secondary purpose is to determine the type of mechanical failure, e.g., radial deformation, axial elongation, core defects and turn-to-turn short circuit, among others
- The two basic analysis tools are: **Trace comparison** and **Identification of trace characteristics**



Trace Comparison

- Primary tool for analysis
- Compares to a previous measurement, similar units or the other phases on the same unit as a reference
- A comparison to a previous measurement should overlay almost perfectly
- Method 1: **Plot inspection**
  - It is the method used to determine the different failure modes
  - Evaluate trace resonances and magnitude and phase deviations as well as the general patterns
  - Any deviation may be an indication of a mechanical change
- Method 2: **Difference Plotting**
  - Any deviation from zero requires a detailed evaluation
- Method 3: **Correlation coefficients**
  - Determines how random or similar two traces are

Trace Characteristics

- There is a general characteristic response for each type of test and frequency region
- Knowing the characteristics helps in identifying problems and narrowing them to a specific component of the transformer
- There are significant indicators for two general problems:
    1. Winding deformation/Insulation degradation:
        - New resonances or loss of resonances
        - Shift in frequency for an existing resonance
    2. Winding looseness:
        - Continuous increment of magnitude compared to the reference trace with a similar shape as frequency increases above 500 KHz.
- Each type of test has its own general expected characteristic

RECOMMENDATIONS FROM OTHER STANDARDS

- CIGRE Technical Brochure No. 342
- Chinese Standard DL/T911-2004
- IEC Standard 60076-18 Ed.1

Frequency Range

- Cigré: shows the typical ranges response for high voltage (HV), low voltage (LV), and regulating windings of large and medium MVA rating

Transformer component (> 100 MVA/limb)	Typical range for natural frequency start [kHz]	stop [kHz]
HV disk winding	10	200
LV layer winding	10	1000
Regulating winding	100	1000

Transformer component (< 30 MVA/limb)	typical range for natural frequency start [kHz]	stop [kHz]
HV disk winding	10	1000
LV layer winding	50	1500
Regulating winding	100	1500

Frequency Range (cont.)

Standard	Range
DL/T911-2004	1 KHz to 1 MHz
IEC 60076-18 Ed.1	≤20 Hz to 1 MHz for test objects >72.5 KV ≤20 Hz to 2 MHz for test objects ≤72.5 KV

- IEC recommends using at least 2 MHz in all tests for compatibility and simplicity

Sequence of Connections

- **IEC:**
  - Yn Windings: Source to the line terminal, measurement on the neutral
  - Delta Windings and Y (w/o neutral): Follow the terminal numbering or labeling in ascending order
  - It also defines the connections for zigzag windings, autotransformers, phase shifting transformers and reactors

Sequence of Connections

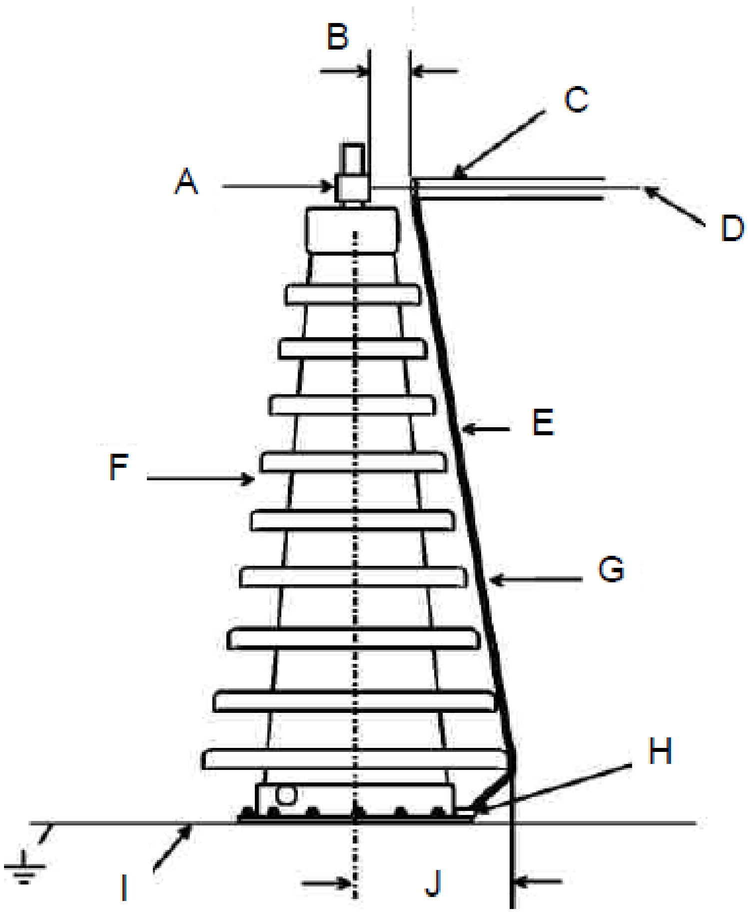
- **IEC (cont):**
  - Provides a table to specify additional measurements if required. connection terminals for each test: signal/reference, response, grounded, floating, shorted; tap position and previous position.

Measurement	Tap	Previous tap	Source and reference (V_{in})	Response (V_{out})	Terminals earthed	Terminals connected together	Comments
1							
2							
3							
-							
-							
-							

- **Chinese Standard**
  - Follows the same criteria as IEC but swaps the location of the leads; it states to connect the source to the tail and the measurement to the head.

Shield Grounding

- **IEC:**
  - **1st Method (Preferred)**:
    - Allows interpretation up to 2 MHz
  - **2nd Method:**
    - Use a fixed length wire or braid
    - May affect amplitude (dB) measurements above 500 kHz and resonant frequencies above 1 MHz



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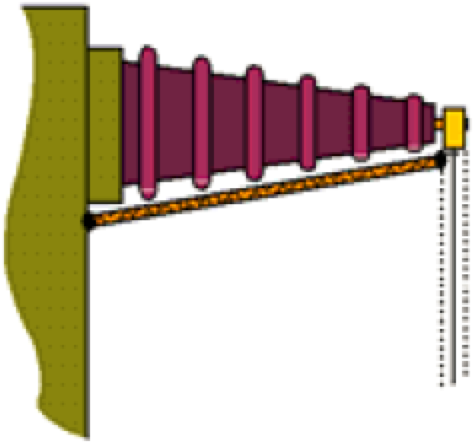
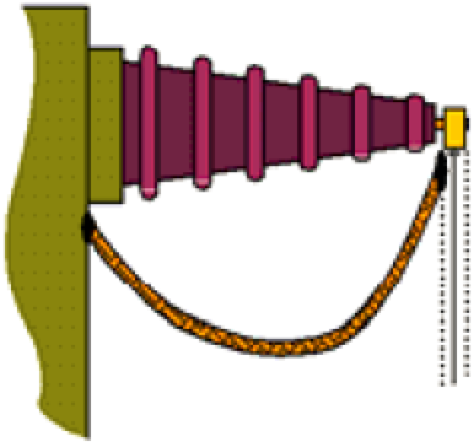
Shield Grounding

- Cigré:





Recommended grounding practice

Bad grounding practice

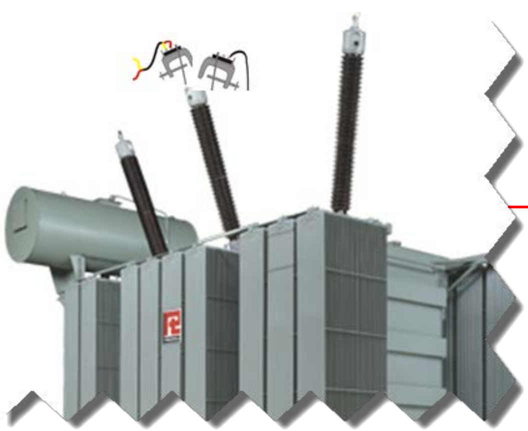
Figure 14: Recommendations for grounding the high-frequency cables.

Instrument and Tests Verification

- **Cigré**
  - Run an integrity verification:
    - Object of a known response
    - By means of connecting the test leads together: 0 dB response
  - Run a repeatability check, especially across bushings rated 400 kV and higher:
    - To determine the maximum usable frequency for results analysis
    - Consists of repeating a test after removing the test leads and reconnecting them
    - Maximum usable frequency: the point where the two results start to deviate significantly.
    - For bushings of lower voltages, the issues of repeatability are above 1 MHz

Instrument and Tests Verification

- **IEC:**
  - Instrument performance: This is same as the integrity verification of Cigré
  - Repeatability: It recommends repeating the first test after completion of the measurements
  - Zero check:
    - Optional
    - Purpose: To determine the highest frequency usable for interpretation on each side of the transformer.
    - Consists of making two measurements. First with all the test leads connected to one of the HV terminals and then to one of the LV terminals.



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IEEE C57.149-2012
FAILURE MODES

Radial Deformation → Case 2

<table>
<tr><th rowspan="5">It is a radial (inward) compressive failure. The result is a buckling along the winding.

Deformation can occur in two forms, free and forced, and forces are concentrated on the inner windings.</th><th>Frequency Range</th><th>Open Circuit</th><th>Short Circuit</th></tr>
<tr><td>20 Hz - 10 kHz</td><td>Generally unaffected</td><td>Slight attenuation</td></tr>
<tr><td>5 kHz - 100 kHz</td><td colspan="2">Minimal shifts or new resonances</td></tr>
<tr><td>50 kHz - 1 MHz</td><td colspan="2">Obvious shifts or new resonances</td></tr>
<tr><td>> 1 MHz</td><td colspan="2">Unaffected</td></tr>
</table>

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Axial Deformation → Case Study 2

<table>
<tr><th rowspan="6">The winding will be stretched and its radius will be reduced.

The response might show multiple resonances shifting in a broad frequency range.</th><th>Frequency Range</th><th>Open Circuit</th><th>Short Circuit</th></tr>
<tr><td>20 Hz - 10 kHz</td><td>Generally unaffected</td><td>Change in magnitude</td></tr>
<tr><td>5 kHz - 100 kHz</td><td colspan="2">Obvious shifts or new resonances</td></tr>
<tr><td>50 kHz - 1 MHz</td><td colspan="2">Possible shifts or new resonances</td></tr>
<tr><td>> 1 MHz</td><td colspan="2">Unpredictable</td></tr>
</table>

Bulk Winding Deformation

<table>
<tr><th rowspan="5">Corresponds to the movement of coils due to high currents, shocks during transportation or natural disasters.</th><th>Frequency Range</th><th>Open Circuit</th><th>Short Circuit</th></tr>
<tr><td>20 Hz - 10 kHz</td><td>Generally unaffected</td><td>Generally unaffected</td></tr>
<tr><td>5 kHz - 100 kHz</td><td colspan="2">Obvious new resonances
Possible shifting</td></tr>
<tr><td>50 kHz - 1 MHz</td><td colspan="2">Possible shifting at the higher frequencies</td></tr>
<tr><td>> 1 MHz</td><td colspan="2">Possible shifting</td></tr>
</table>

Core Defects

	Frequency Range	Open Circuit	Short Circuit
A physical change in the transformer core: shorted or burnt laminations, disconnected core ground or unintentional core grounds, and joint movements.	**20 Hz - 10 kHz**	Changes in the primary resonance. Discard magnetization effects.	Generally unaffected
	5 kHz - 100 kHz	Possible shifts or new resonances	
	50 kHz - 1 MHz	Possible shifting at the higher frequencies	
	> 1 MHz	Possible shifting	

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Contact Resistance

	Frequency Range	Open Circuit	Short Circuit
More than a failure mode it is an indication of poor contact on the bushing to winding connection, LTC or DETC that can cause changes in low and high frequencies.	**20 Hz - 10 kHz**	Generally unaffected	Affected winding will show offset
	5 kHz - 100 kHz	Possible shifts or new resonances	
	50 kHz - 1 MHz	Possible shifts or new resonances	
	> 1 MHz	Possible shifts or new resonances	

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Turn-to-turn short circuit

	Frequency Range	Open Circuit	Short Circuit
Low or high impedance shorts between turns easily detected with a FRA test. The open circuit diagnose response will look like a short circuit test.	**20 Hz - 10 kHz**	Response similar to a short circuit test	Obvious differences. Affected winding shows offset
	5 kHz - 100 kHz	Possible shifts or new resonances	
	50 kHz - 1 MHz	Possible shifts or new resonances	
	> 1 MHz	Possible shifts or new resonances	

Open Winding

	Frequency Range	Open Circuit	Short Circuit
High impedance due to loose connections or burned through coils from thermal failure. Complete open circuits will show results close to the noise floor.	**20 Hz - 10 kHz**	Changes in the primary resonance. Discard magnetization effects	Obvious differences. Affected winding shows offset
	5 kHz - 100 kHz	Obvious new resonances. Possible shifting	
	50 kHz - 1 MHz	Possible shifts or new resonances	
	> 1 MHz	Possible shifts or new resonances	

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Winding Looseness → Case 1

It is a spreading of the disk-to-disk or turn-to-turn axial distances caused by the loosening of a clamping structure. Commonly caused by transportation.	Frequency Range	Open Circuit
	20 Hz - 500 kHz	Generally unaffected
	500 kHz – 2 MHz	Some detectable increasing differences
	1 MHz – 5 MHz	Largest increasing differences.

Floating Static Shield with Carbonization

Loose electric contact of the copper bonding braid on the aluminum shield strips	Frequency Range	Open Circuit
	<100 kHz	Some differences
	100 kHz – 500 kHz	Possible large differences in magnitude of resonances
	1 MHz – 3 MHz	Largest differences in magnitude of resonances

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REAL LIFE FAILURE MODE ANALYSIS

Case 1

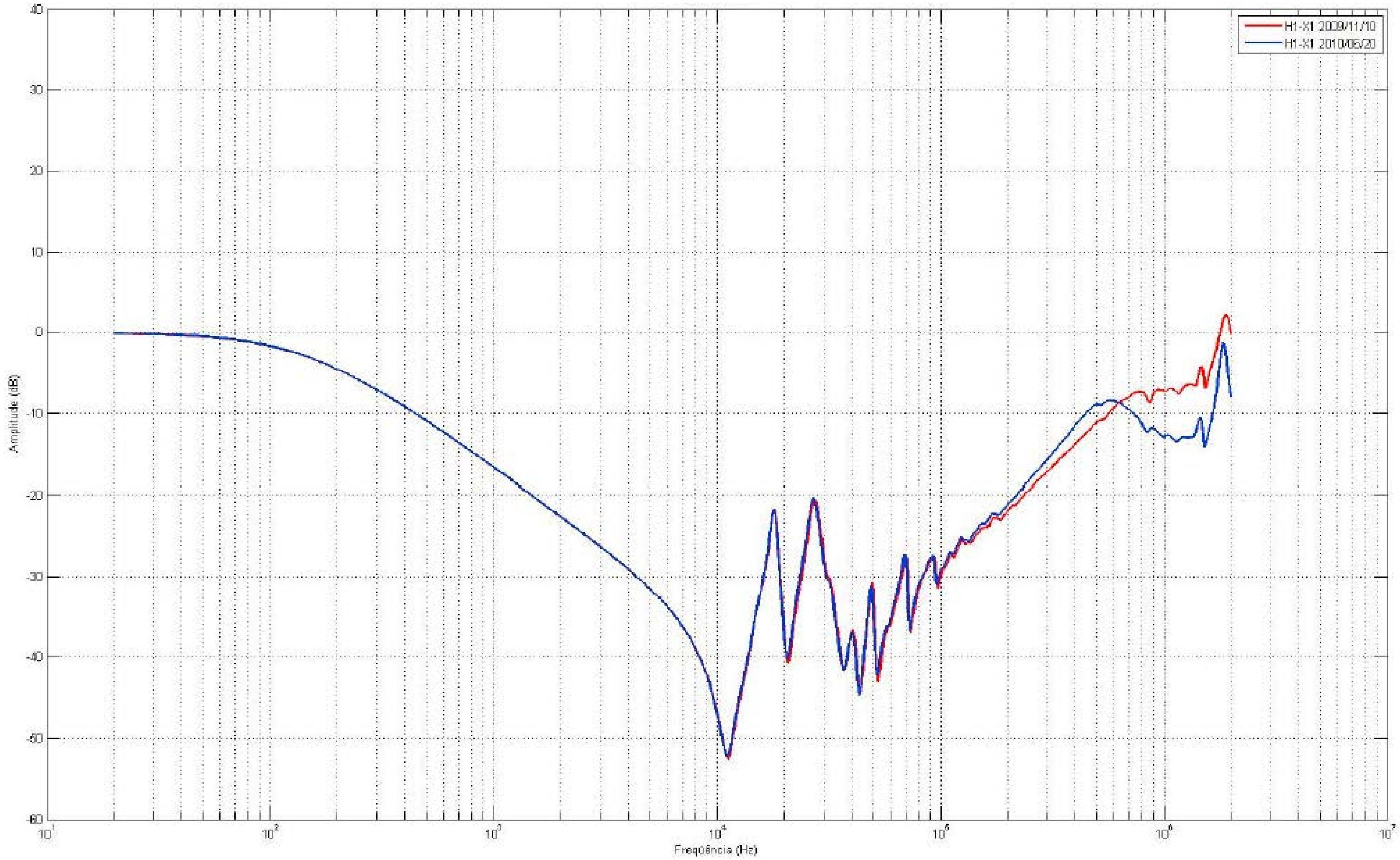
History

- Four single-phase regulating autotransformers, 130/130/16.5 MVA, 230/√3 / 161/√3 / 69 kV, in process of installation and commissioning experienced a major earthquake of very high intensity.

- Fingerprints taken at the delivery of the autotransformers were compared to test performed after the earthquake and significant deviations were detected on <u>three</u> out of the four autotransformers.

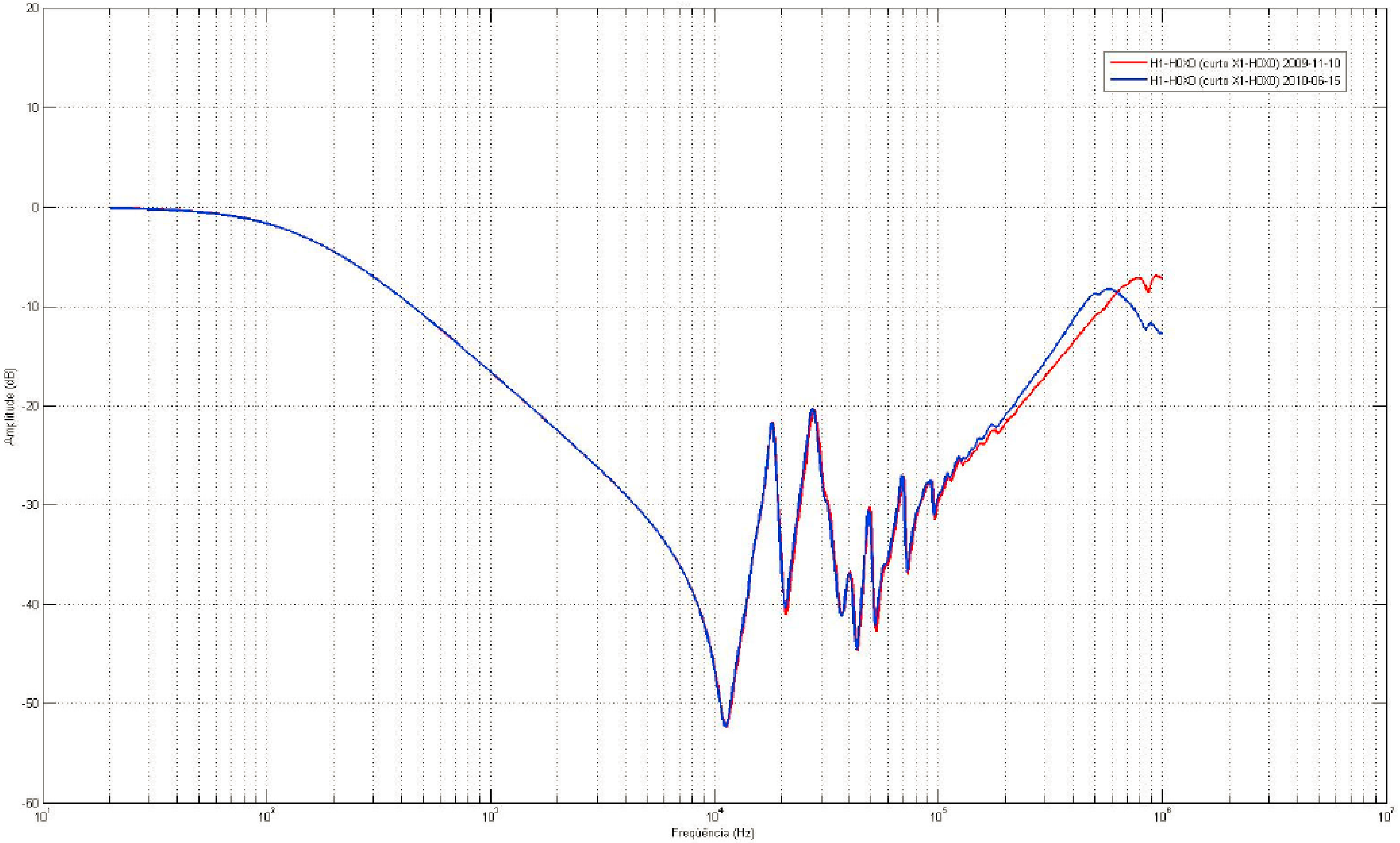
- The deviations were noticeable on the short circuit test H1-H0X0 [with shorted X1-H0X0].

Auto Transformer 1



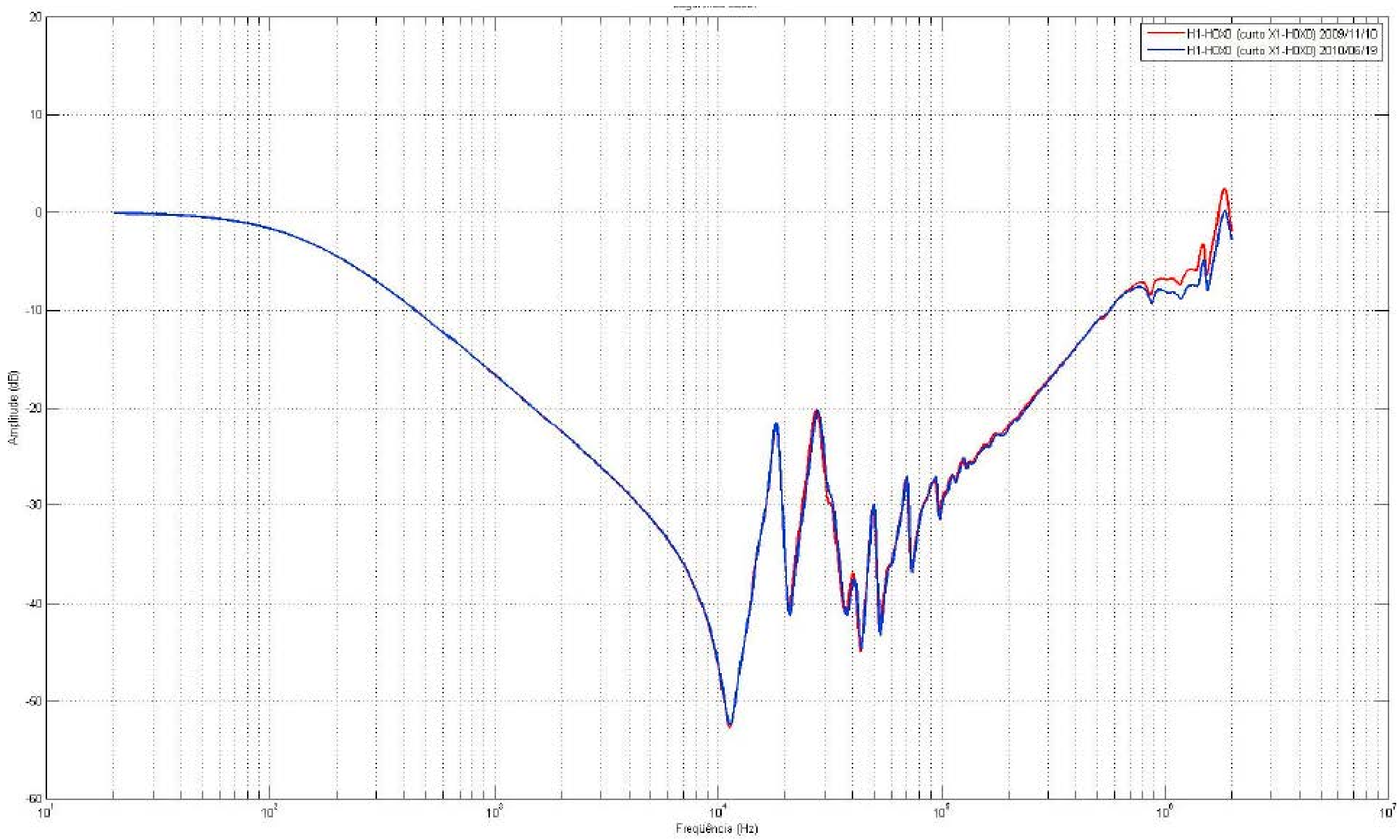
Comparison of short circuit responses before and after earthquake

Auto Transformer 2



Comparison of short circuit responses before and after earthquake

Auto Transformer 3



Comparison of short circuit responses before and after earthquake

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Analysis

- On evaluating the short circuit results, significant differences were observed in the following high frequency ranges:
  - Autotransformer 1: 150 KHz to 2 MHz
  - Autotransformer 2: 200 KHz to 1 MHz
  - Autotransformer 3: 700 KHz to 2 MHz

- A common characteristic for each comparison is an increasing magnitude difference in the high frequencies area. This is a typical indicator of winding looseness as described in the failure modes section of IEEE guide.

Conclusion

- It was decided to inspect the transformers on site.
- Visual inspection was performed and it was found that the three autotransformers were longitudinally displaced.
- There was a bigger separation between the turns of the winding due to the loosening of the blocking structure.
- The FRA diagnosis was able to detect the internal winding movement and issue was resolved at site by transformer manufacturer before the commissioning of the auto transformers.

Case 2

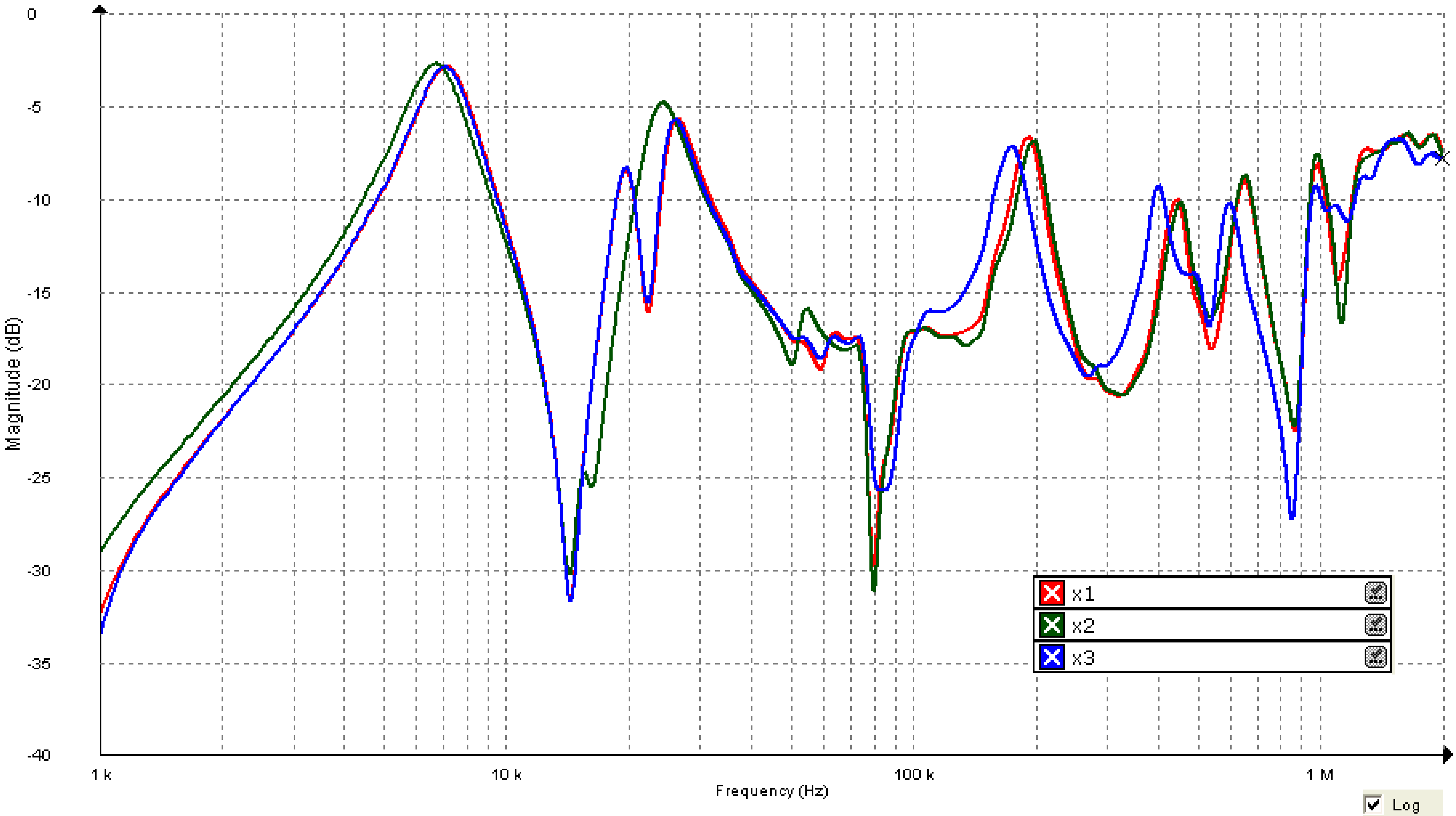
History

- A 40 MVA, 115/13.8 kV wye-wye transformer installed in 1991, showed an increase in PF and LV side capacitance readings after maintenance was performed as a result of reported oil leaks

- Under scheduled maintenance the next year, LV side capacitance showed a further increase in readings.

- FRA test was performed as a part of advanced diagnosis. There were no baseline curves available for the transformer.

FRA Open Circuit Test of LV Windings



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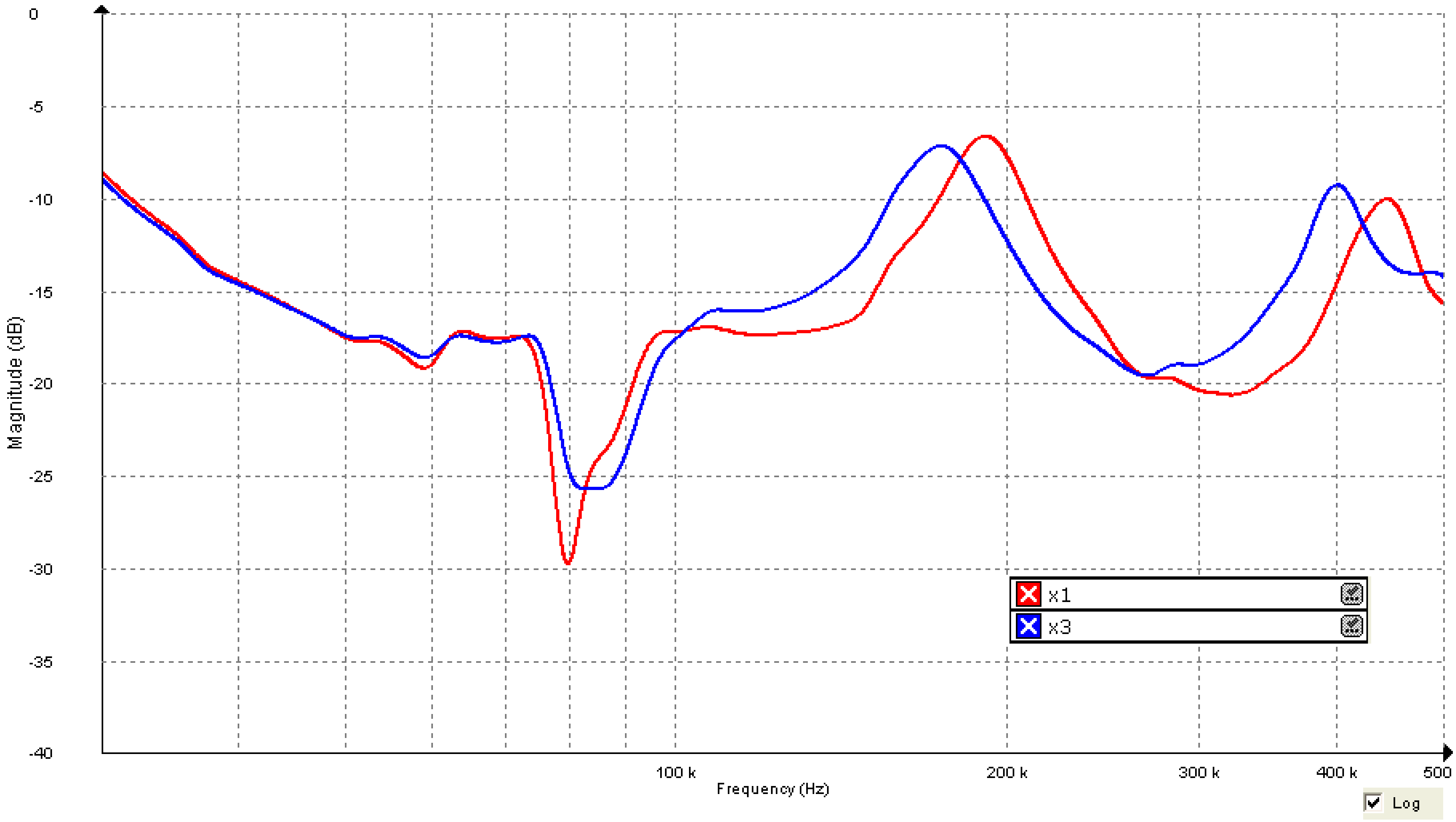
Analysis

- All three phases were compared to determine any mechanical changes within the transformer
- The three LV windings showed a lot of asymmetry in the frequency range of 20 kHz- 1 MHz
- Possible LV main winding movement was suspected based upon the FRA curves
- Results were further analyzed to compare A (X1-X0) and C (X3-X0) phase traces that should have similar resemblance.

FRA Open Circuit Test of LV Windings



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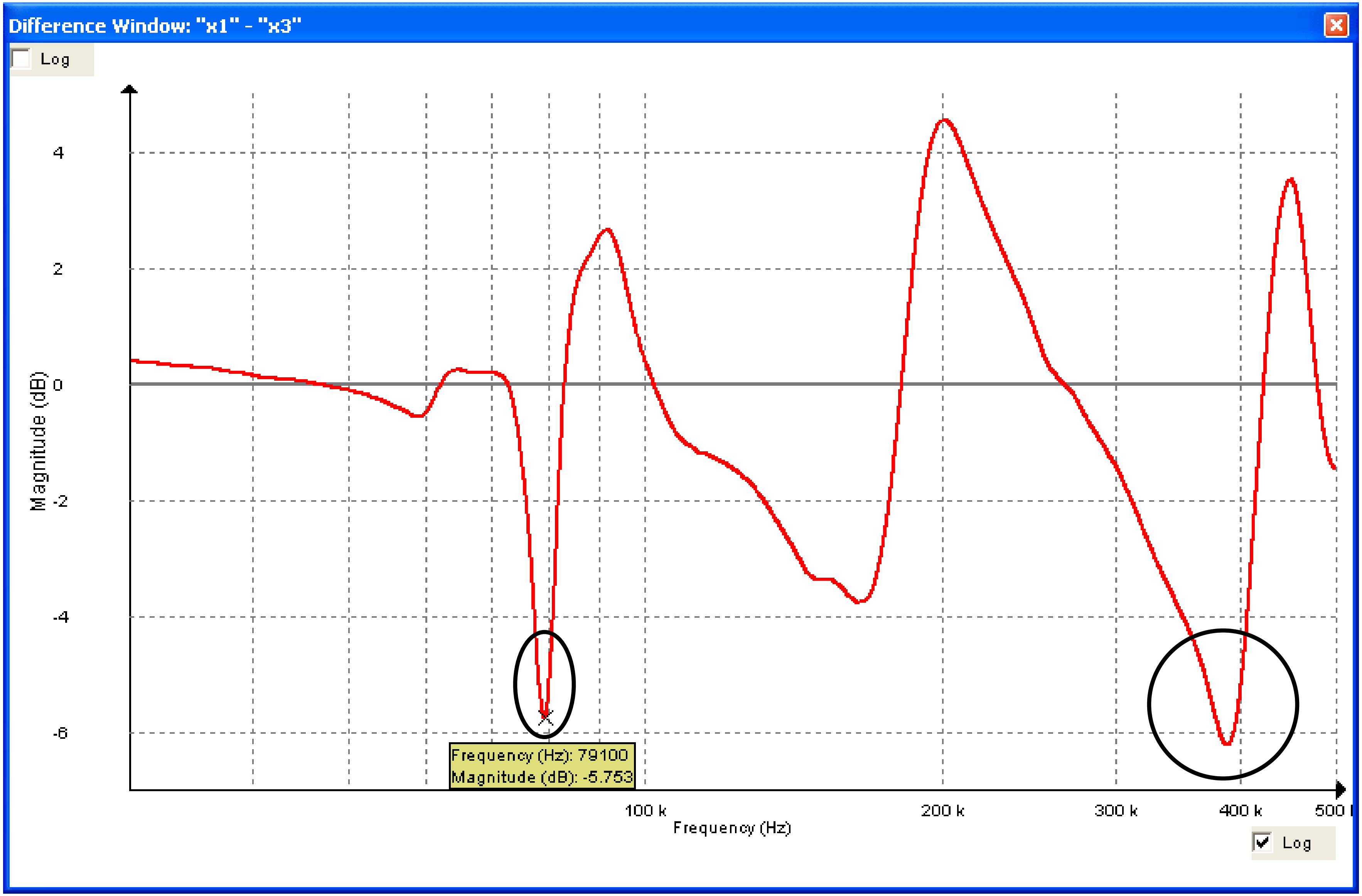
Difference in dB X1-X3



Analysis

- Traces were compared in the frequency range of 30-500 kHz that corresponds to the main winding section.
- Two traces showed extensive asymmetry; suspected winding movement was further strengthened.
- As per IEEE guide, radial winding deformation or hoop buckling is most visible in FRA trace in the 50 kHz – 1MHz frequency range

In Service Trip

- Transformer was placed under watch list. It was put back in service.
- In the same year, a few months later the transformer tripped out due to a fault.
- It was decided not to put this transformer back in service based upon a further increase in LV side capacitance (PF test) after the fault.
- Transformer was sent for inspection and repair.

Winding Radial Hoop Buckling

Winding Deformation

Conclusion

- Upon de-tanking and tear down, it was found that all three low side windings were severely deformed showing signs of radial buckling due to lack of strength to withstand through fault conditions.

- After diagnosing the problem, the transformer was rebuilt and put back in service at a different location.

- A new FRA fingerprint was taken before putting it back in service for any future investigation and analysis.

FRA CASE STUDIES

Case Study 1

History

- A 22 kV/4160 V delta wye transformer showed questionable readings on routine electrical tests.
- Winding resistance readings on low side B phase showed a difference of more than 17% as compared to A & C phase.
- The excitation current showed very high values on B phase when compared against A and C phase excitation currents.
- Because of such high excitation current, it was only possible to perform the test at 5 kV to avoid test instrument tripping out.

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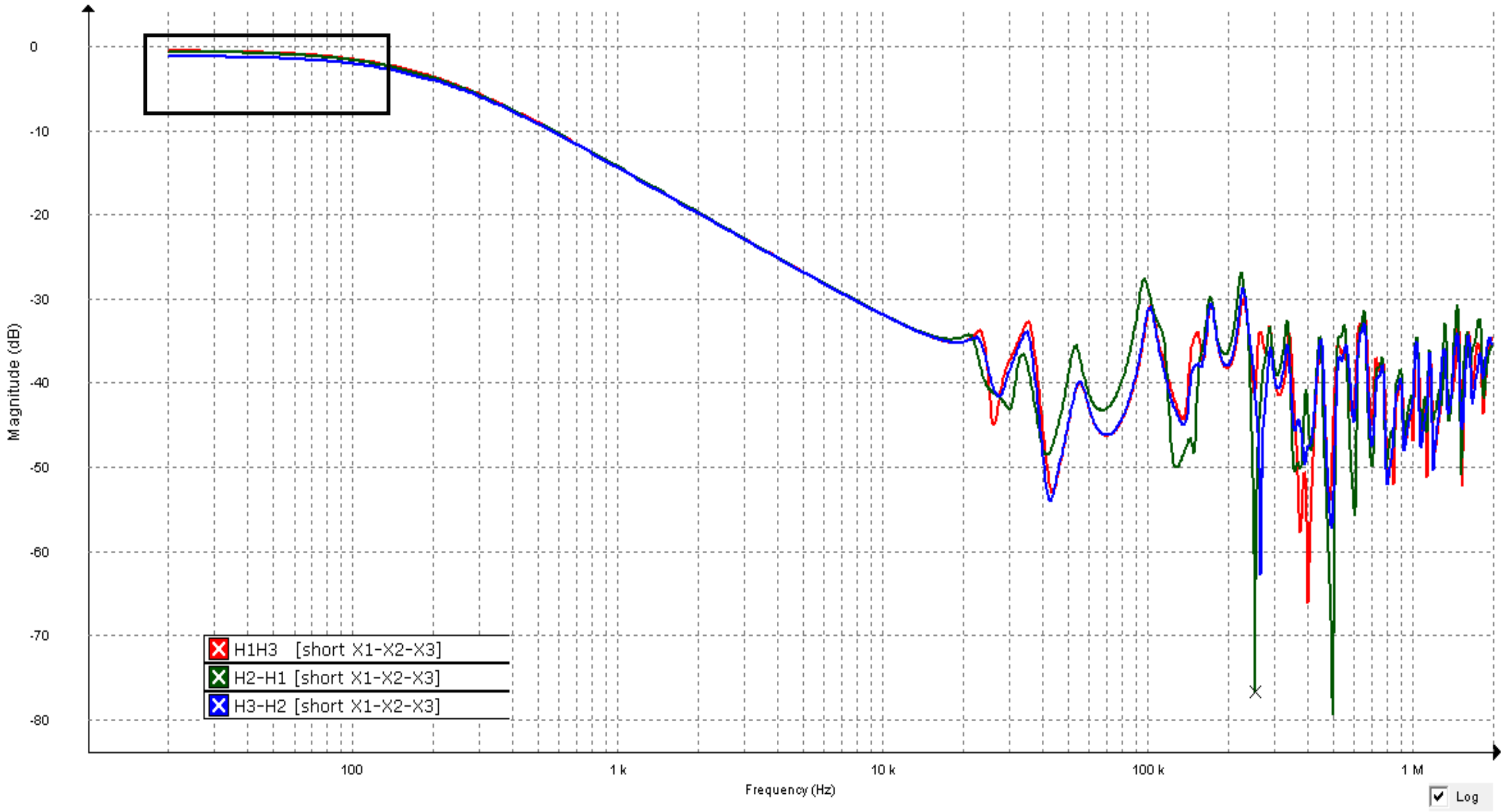
Advanced Diagnostics

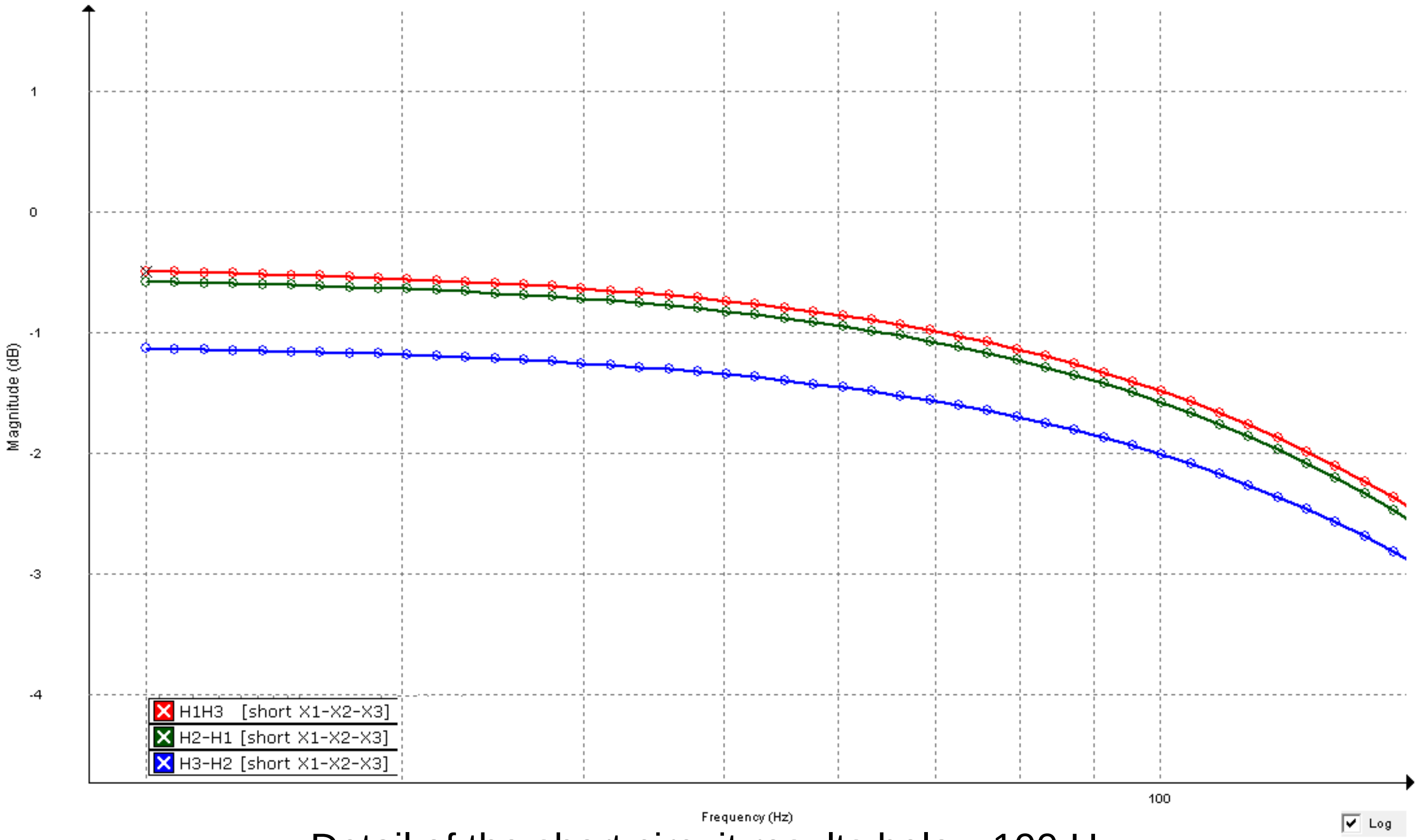
- FRA test was performed to do advanced diagnostics.
- No baseline results or similar transformer traces were available to compare the traces.
- The three phases were compared against each other to perform the diagnosis.

Short Circuit Results Analysis



Comparison of the short circuit results of the three phases

Short Circuit Results Analysis



Detail of the short circuit results below 100 Hz

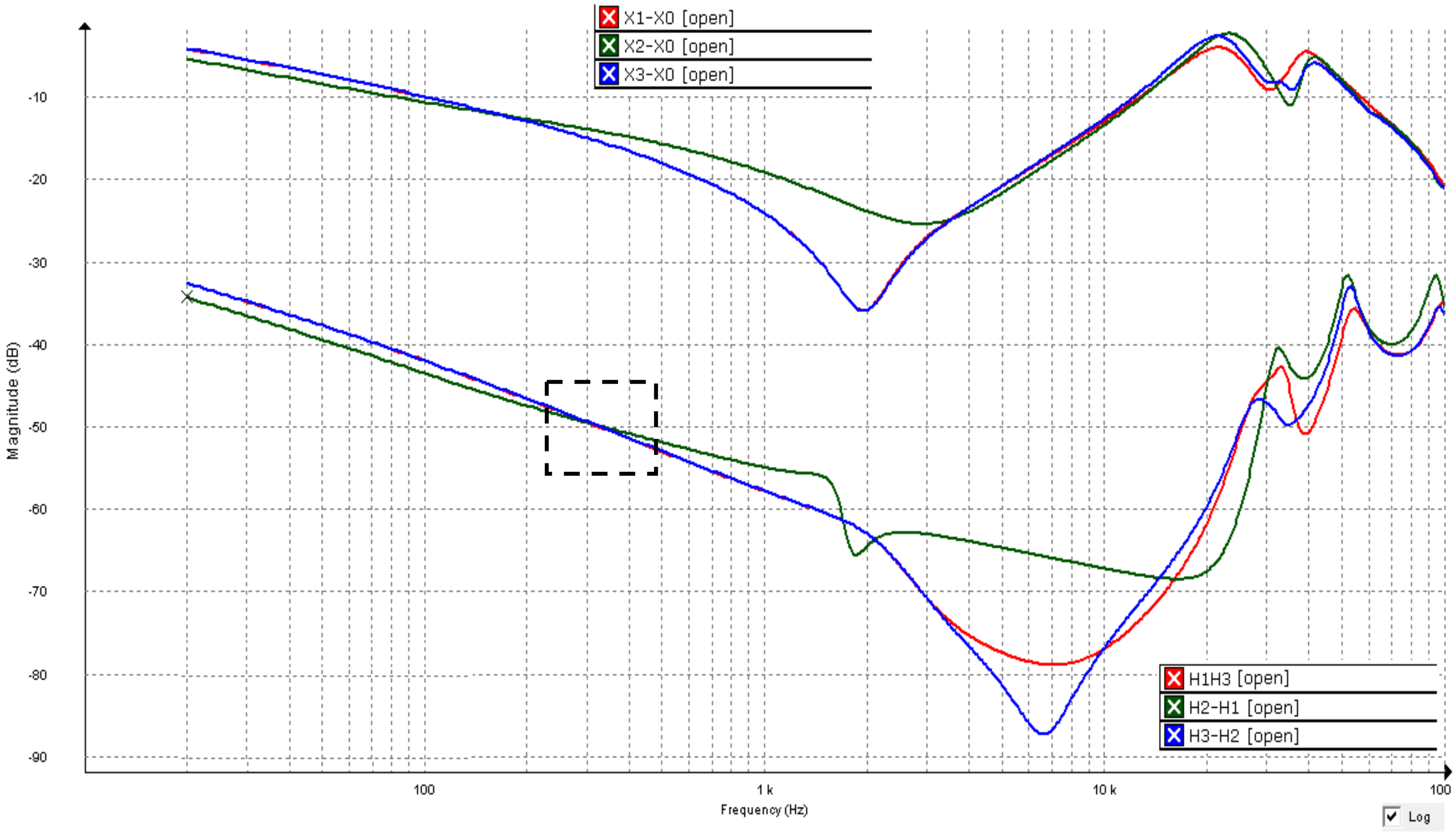
Analysis

- IEEE guide recommendation for comparing FRA short circuit results with DC winding resistance tests states that if the short-circuit test produces a horizontal response at frequencies, less than 30 Hz, then the FRA results can be compared to the DC winding resistance results.

- Any differences between phases at these low frequencies should be checked with a DC winding resistance test.

- This analysis supports the questionable readings obtained in winding resistance test.

Analysis

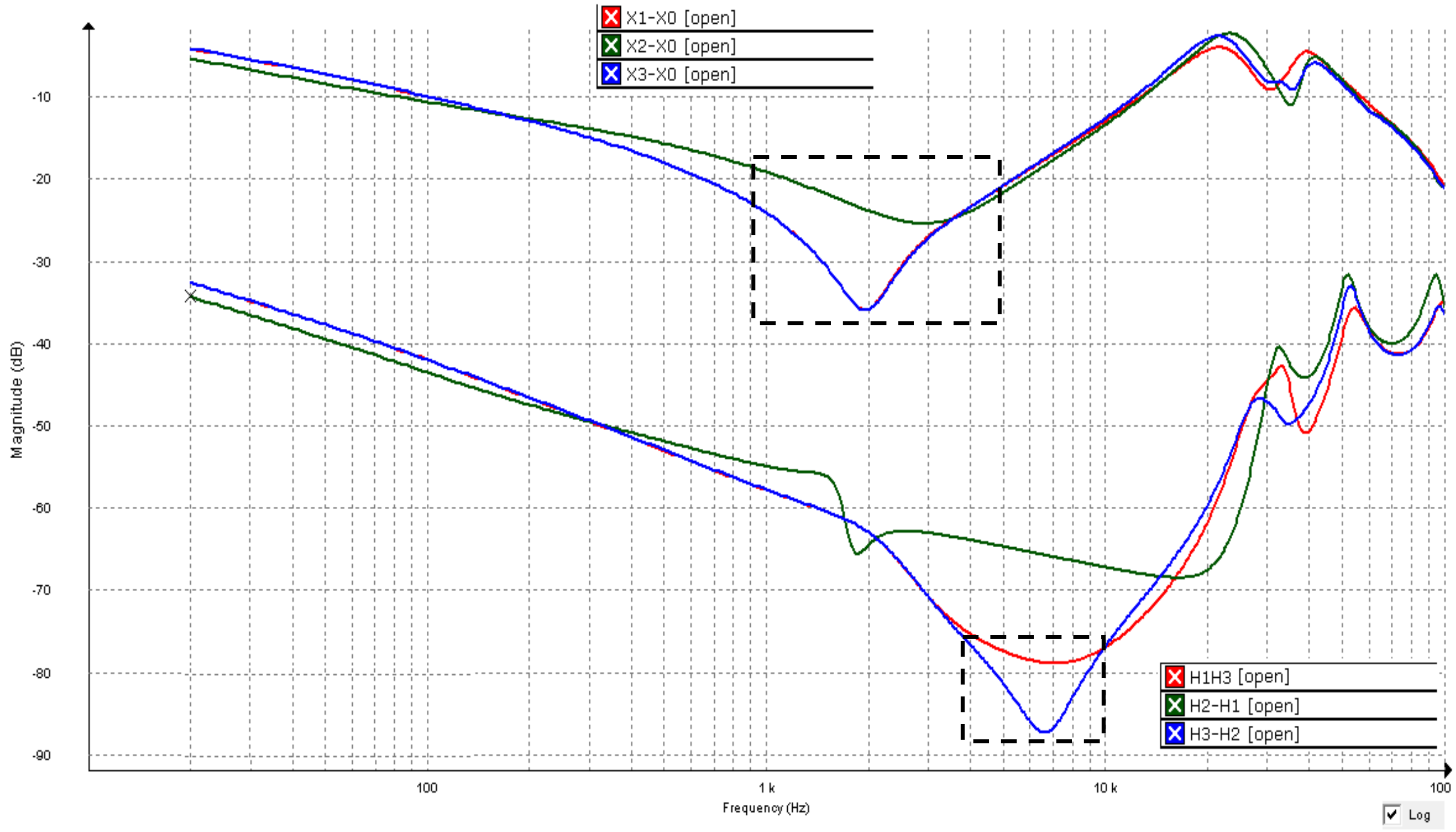


Open circuit results for HV and LV sides for all the three phases

Analysis

- B phase trace which usually have a distinct pattern and offset throughout the low frequency region up to 1 kHz showed a cross over point where it crossed A and C phase traces. This kind of response is unusual and typically not expected.

Analysis



Open circuit results for HV and LV sides for all the three phases

Analysis

- The IEEE guide explains that Delta connected windings will usually show two further resonances spaced apart in frequency range from 20Hz to 5 kHz. In the HV winding open circuit test results for A and C phases, the two resonances as described in guide were missing.

- When analyzing the minima (anti resonance) in low frequency region, A phase minima was attenuated, smoothing the sharpness of parallel LC resonance.

- On analyzing the low side open circuit traces, A and C phases matched very closely in low frequency region, however the B phase showed great amount of resonance shift and attenuation.

Conclusion

- FRA Short circuit results confirmed the problem identified with the winding resistance test.
- In the absence of baseline measurements, when the three phases open circuit results were compared, a lot of anomalies were found that indicated problem related to core and windings.
- FRA trace characteristics analysis helped in confirming the questionable readings obtained from other electrical tests.
- Transformer was in service for more than 50 years therefore it was decided to retire the transformer to avoid any possible future catastrophic failure.

Case Study 2

History

- A 66 MVA 115/34.5 kV Autotransformer without tertiary showed an increase in winding capacitance to ground of 7% in scheduled maintenance test. DGA analysis showed high levels of hydrogen gas and ethane.

- It was informed that transformer saw a full short circuit fault because of B phase explosion of three phase station service transformer connected to the low side bus of the auto transformer.

- It was decided to perform FRA tests as per IEEE guidelines

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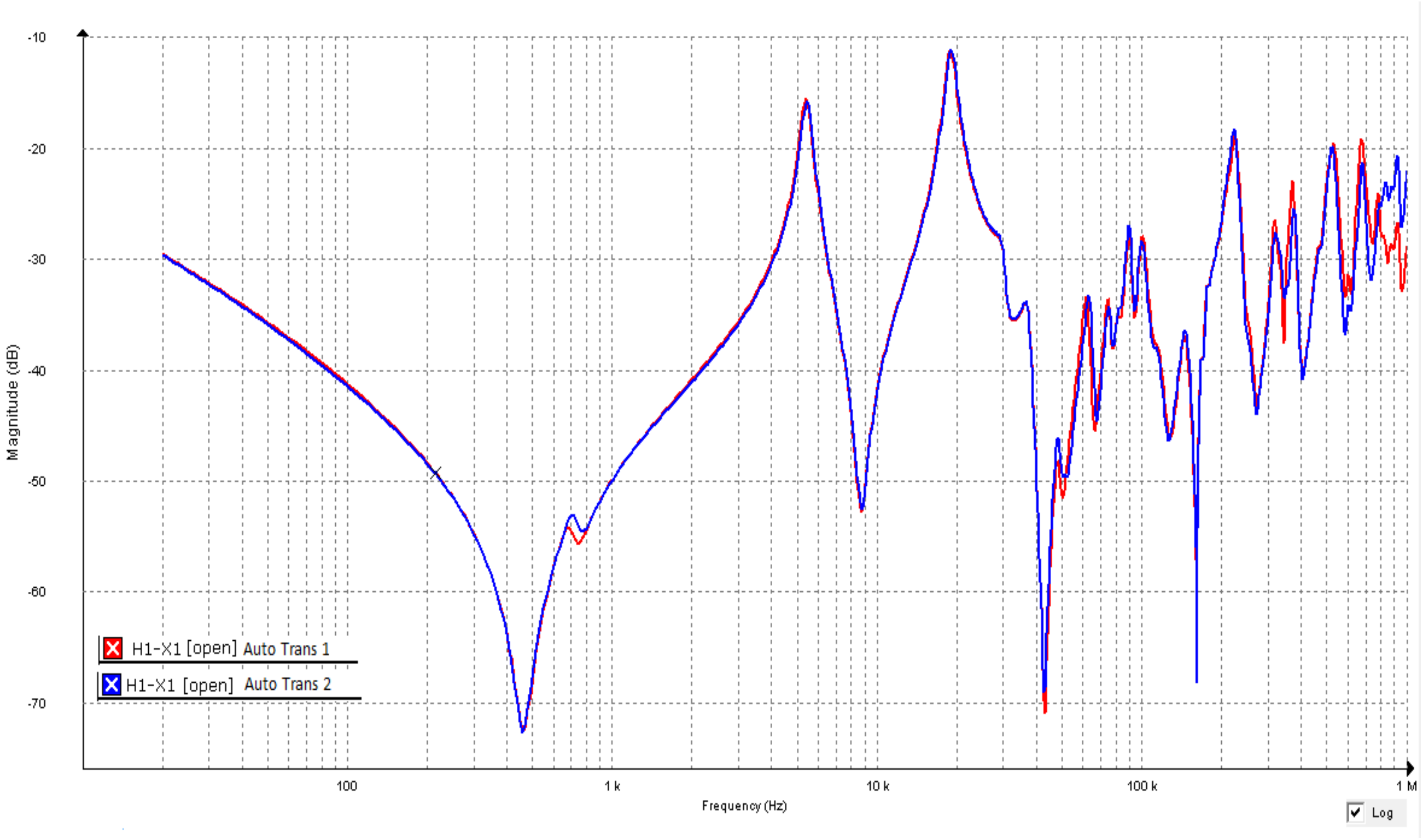
FRA Test on Similar Transformer

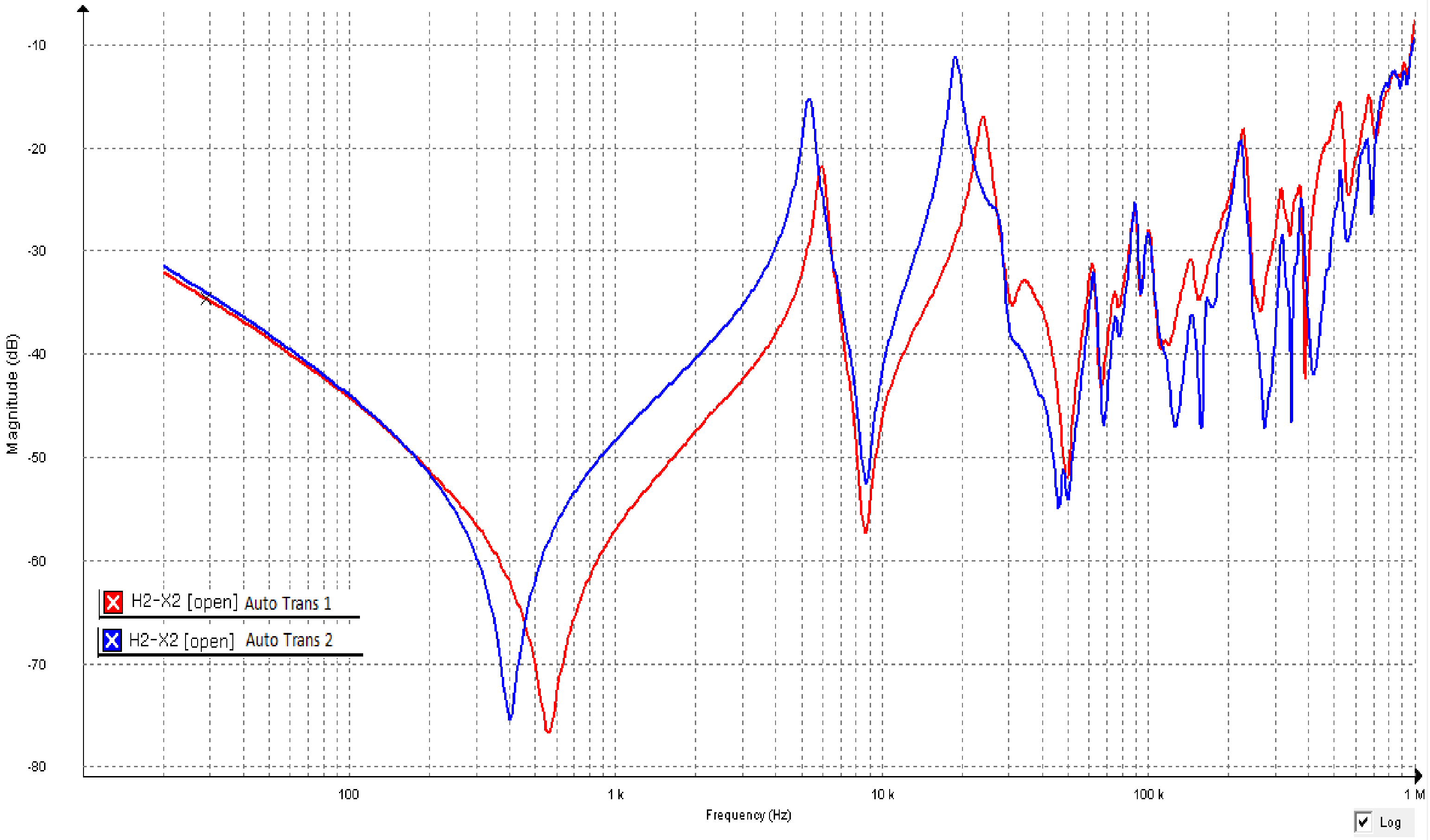
- In the absence of baseline measurements, the three phases were analyzed together.
- The comparison between the phases was inconclusive.
- It was decided to perform the FRA test on sister autotransformer 2 in the same substation. Both the auto transformers had similar nameplate information and serial numbers were consecutive.

Analysis



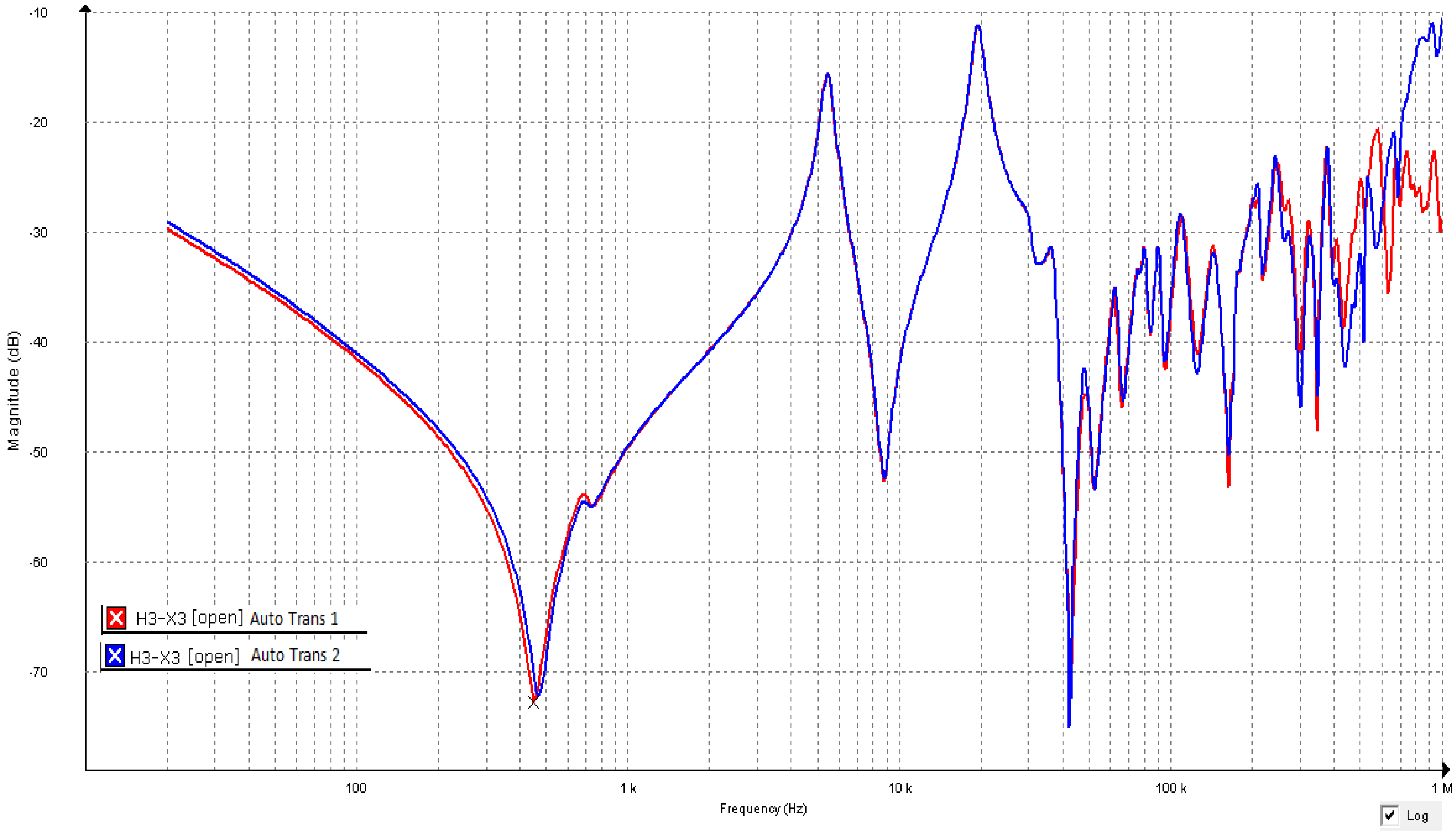
Comparison of phase A of autotransformers 1 and 2

Analysis



Comparison of phase B of autotransformers 1 and 2

Analysis



Comparison of phase C of autotransformers 1 and 2

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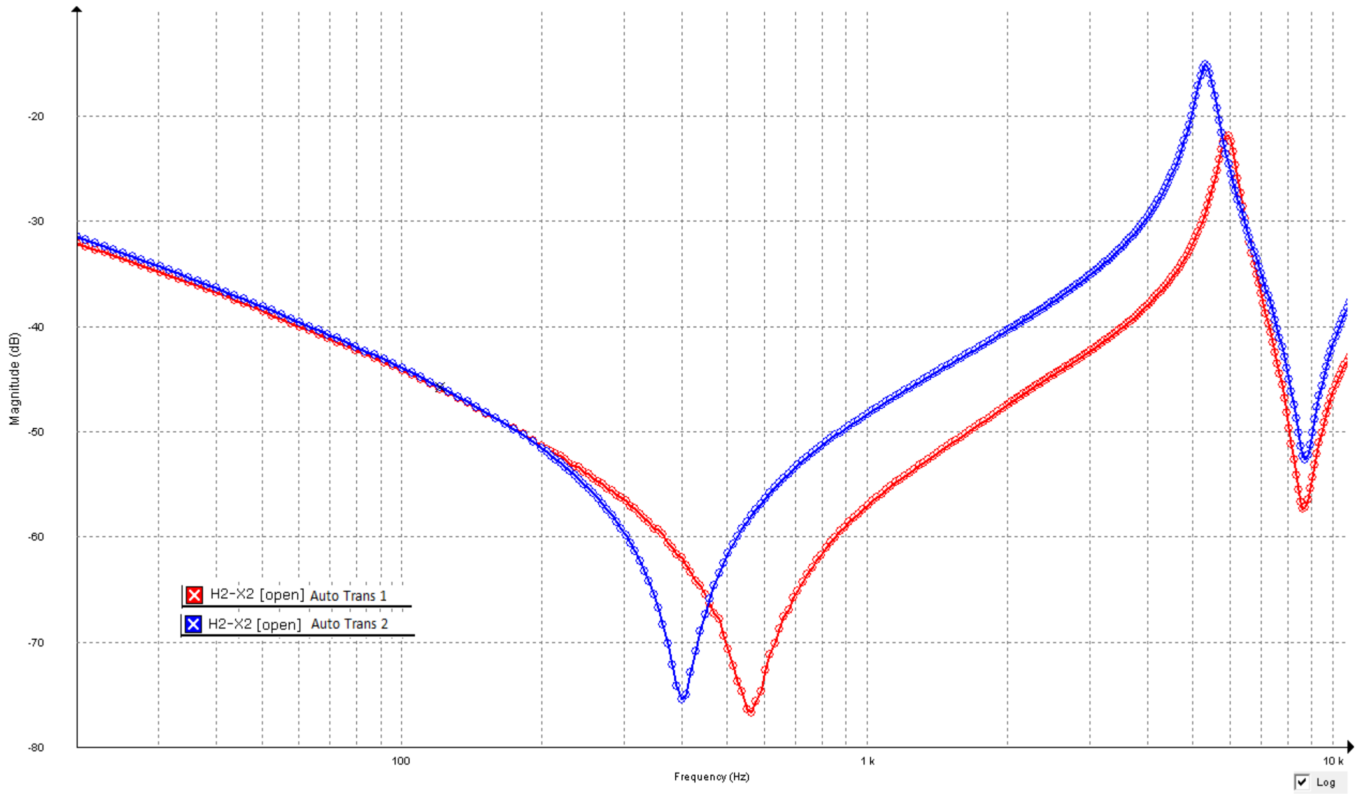
Analysis

- FRA trace comparisons between respective phases of two auto transformers showed a lot of symmetry for A and C phases with some curve mismatch in mid to high frequencies

- Phase B comparison showed shift in resonance, change in magnitude and loss of resonances in frequency range from 200 Hz to 600 kHz

- Phase B traces from two transformers were further compared in narrow frequency bands of 20 Hz -10 kHz and 5 kHz -100 kHz

FRA Low Frequency Region Analysis (20 Hz -10 kHz)



Comparison of B phase of autotransformers 1 and 2, low frequency area of 20 Hz – 10 kHz

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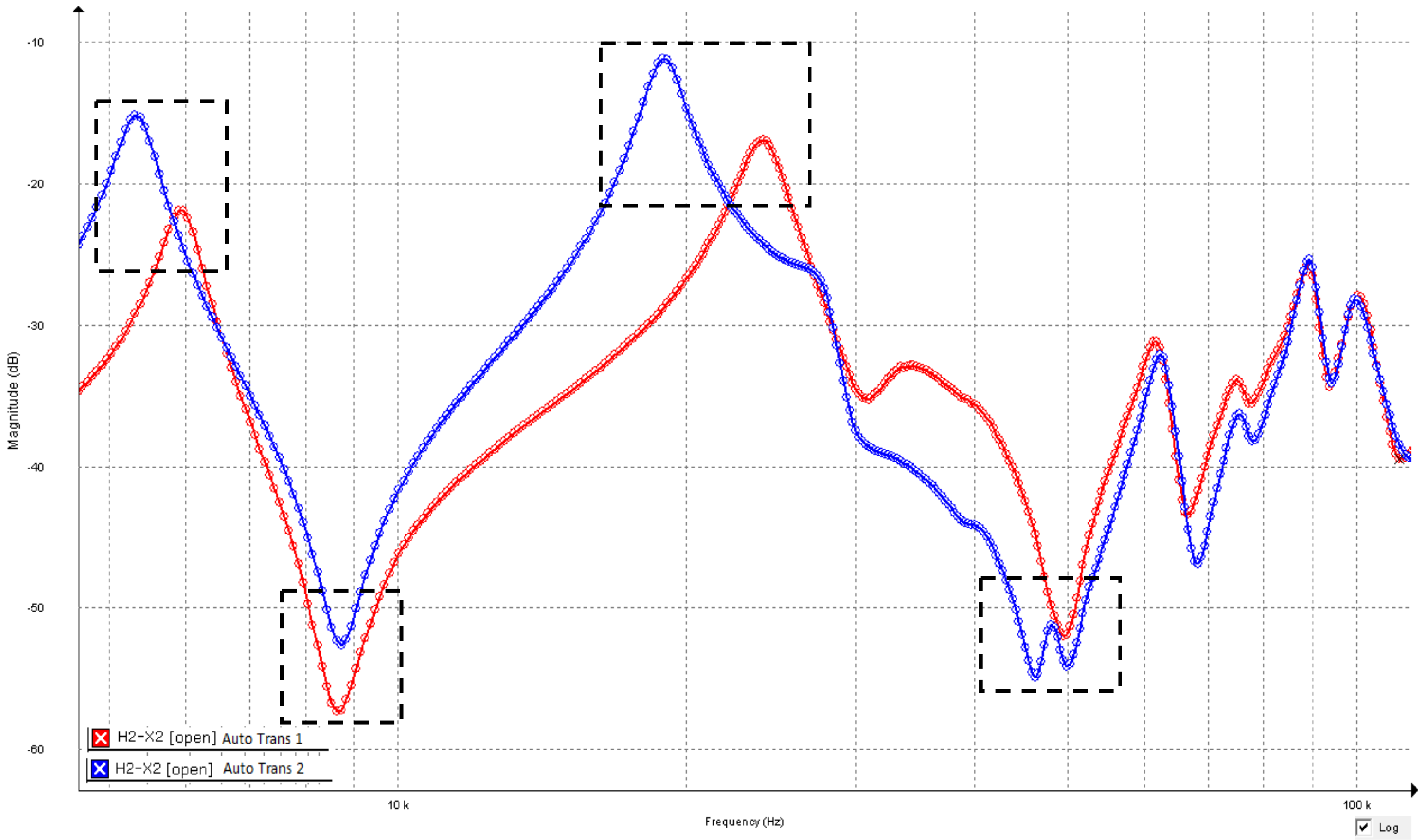
FRA Low Frequency Region Analysis (20 Hz -10 kHz)

- Core magnetization can affect the results in this region. However, no shift and change in magnitude (in lower portion of this frequency range), which rules out a core magnetization problem.

- It is easy to see change in primary resonance between the two traces. This shift could indicate problems associated with core defects like shorted or burnt laminations, disconnected core ground or unintentional core grounds and joint dislocations.

FRA Low-Mid Frequency Region Analysis (5 kHz -100 kHz)



Comparison of B phase of autotransformers 1 and 2, low frequency area of 5 kHz – 100 kHz

FRA Low-Mid Frequency Region Analysis (5 kHz -100 kHz)

- In this frequency band, multiple resonance shifts in broad frequency range can be observed. Additionally, some change in magnitude and loss of resonances were noticed as well.

- Traces exhibiting these symptoms could indicate problems associated with winding movement and in particular axial deformation.

Conclusion

- Based upon the FRA comparison of two auto transformers, it was determined that there has been some winding deterioration and movement in B phase of auto transformer 1. Other components of the transformer may have been affected as well.

- FRA analysis strengthened the conclusion drawn by other electrical tests performed on the transformer.

- Based upon the analysis, the transformer has been put under watch list with oil samples taken every 3 months and scheduled maintenance testing reduced from eight years to one year.

- Decision on when to replace the transformer would be taken based upon DGA analysis and scheduled maintenance test results in coming time.

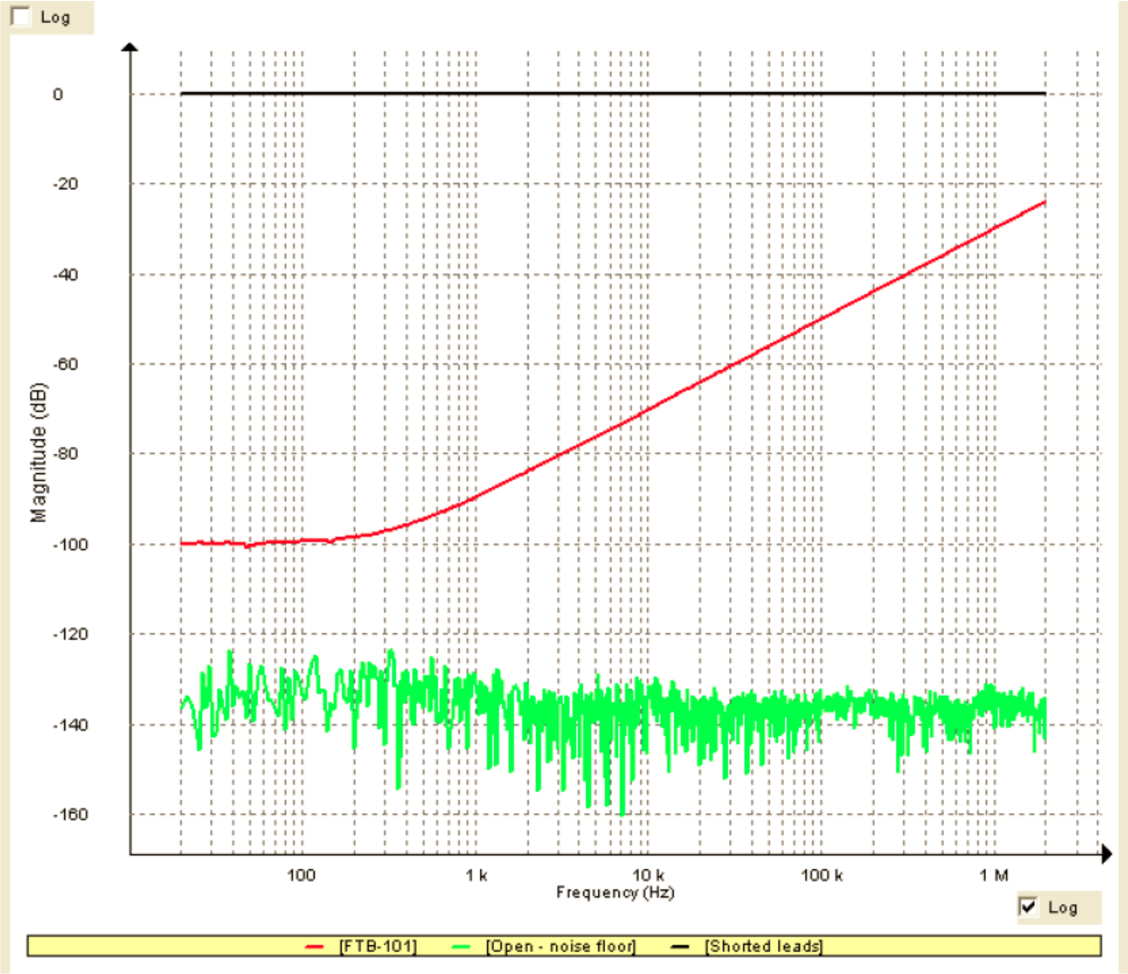
SUMMARY

Recommendation on Best Field Practices

Instrument Validation

- The test equipment should always be checked for its performance and validity using the supplied test leads before initiating the FRA test on a specimen.
- Cigré recommends running integrity verification with an object of a known response . A standard test object is usually offered by the test equipment manufacturer.
- In the absence of that, as an alternative, self check can be performed by shorting the test leads together, the user should expect a zero dB response.

Instrument Verification

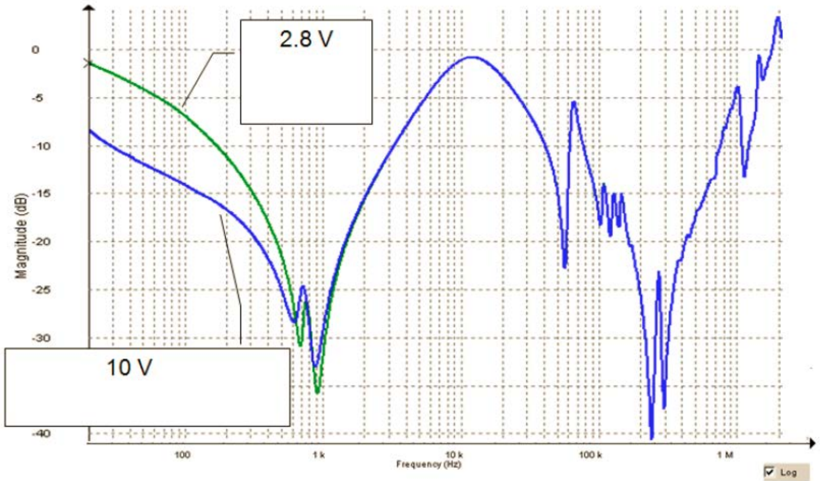


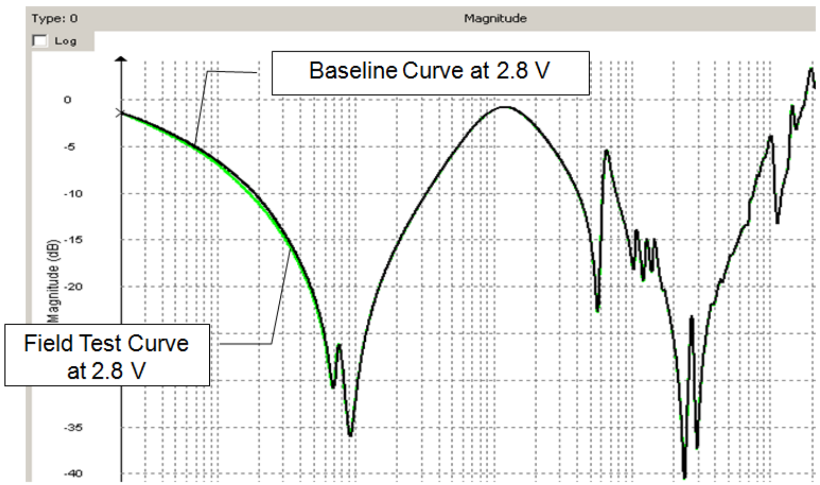
Core Residual Magnetism

- Core’s residual magnetism can affect the FRA response in lower frequency region up to 2 kHz.
- It is advisable to demagnetize the transformer before performing the FRA test.
- In the field, if resources are not available to demagnetize the transformer, it is recommended to perform FRA test before the dc winding resistance to minimize the effect of residual magnetism on FRA results.

Test Voltage

- Applied test voltage can affect the FRA response in the lower frequency region up to 10 kHz.





- It is recommended to use same test voltage used for obtaining baseline results or when comparing traces between similar transformers.

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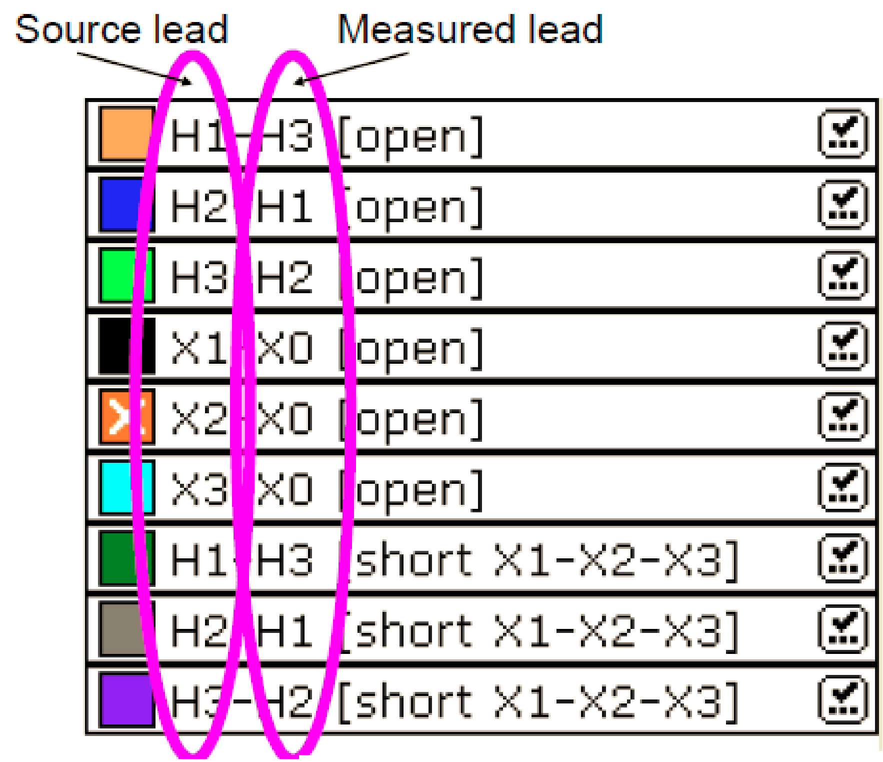
Connections

- Transformer configuration will vary from one specimen to the other.
- Placement of source and measuring leads need to be consistent and follow a set procedure.
- IEEE guide recommends to connect from head (source) to tail (measuring) of the vector for any phase measurement.



3 phase, 2 winding transformer test template

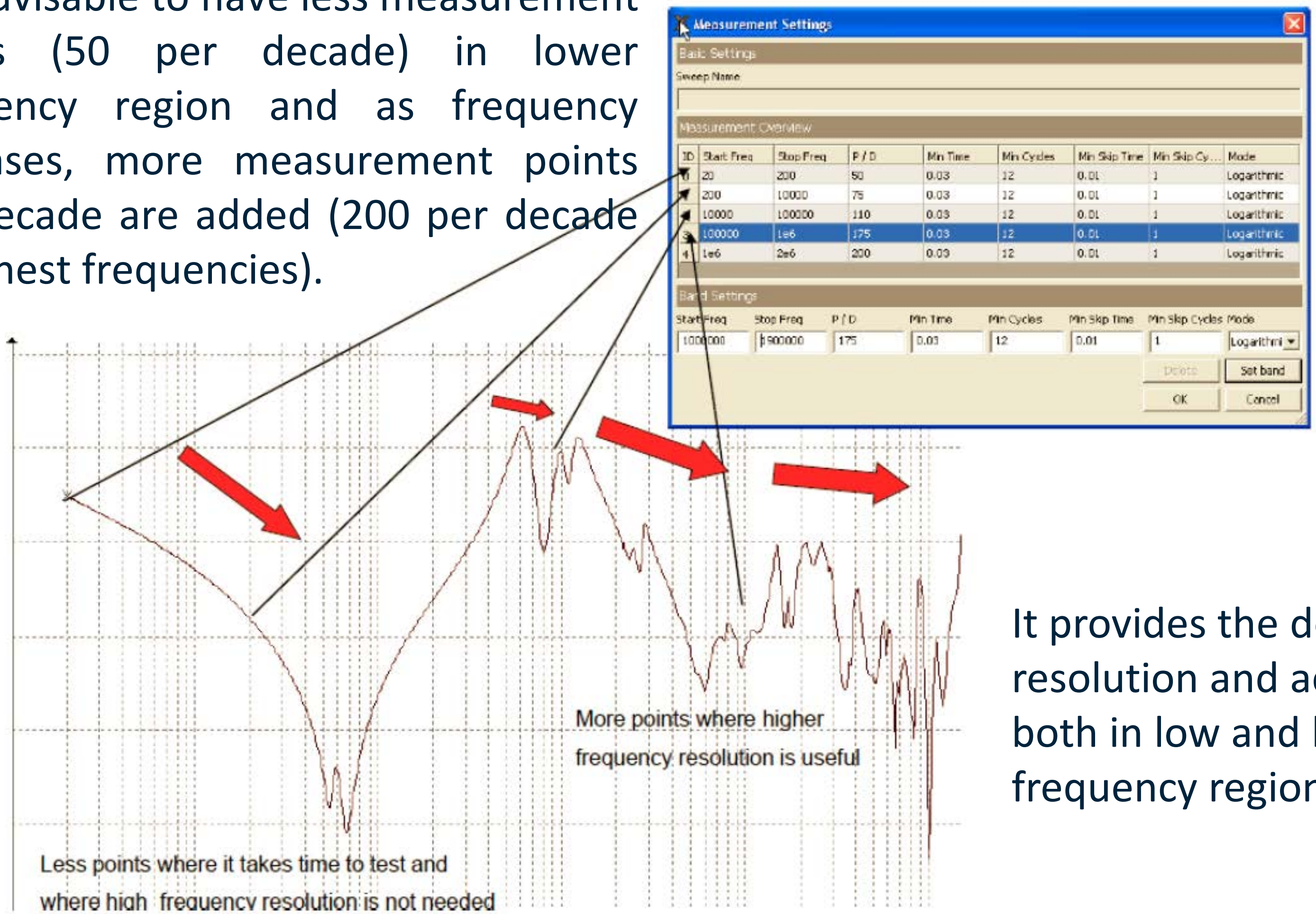
Connections and Documentation

- It is recommended to connect leads directly to the bushing terminals. In the FRA tests where shorting leads are used it is advisable to use shortest possible shorting leads and they should be isolated from ground.

- It is advisable to document as much as information as possible like manufacturer and serial number of transformer, vector configuration, test instrument used, operator, tap position, pictures of transformer, testing, shorting and grounding leads and other relevant information

Measurement Settings

- It is advisable to have less measurement points (50 per decade) in lower frequency region and as frequency increases, more measurement points per decade are added (200 per decade in highest frequencies).



It provides the desired resolution and accuracy both in low and high frequency regions.

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Tap Changer Position

- To obtain repeatable results, use the same tap position for each comparison test. It is recommended to use in service tap for DETC and extreme raise position for LTC

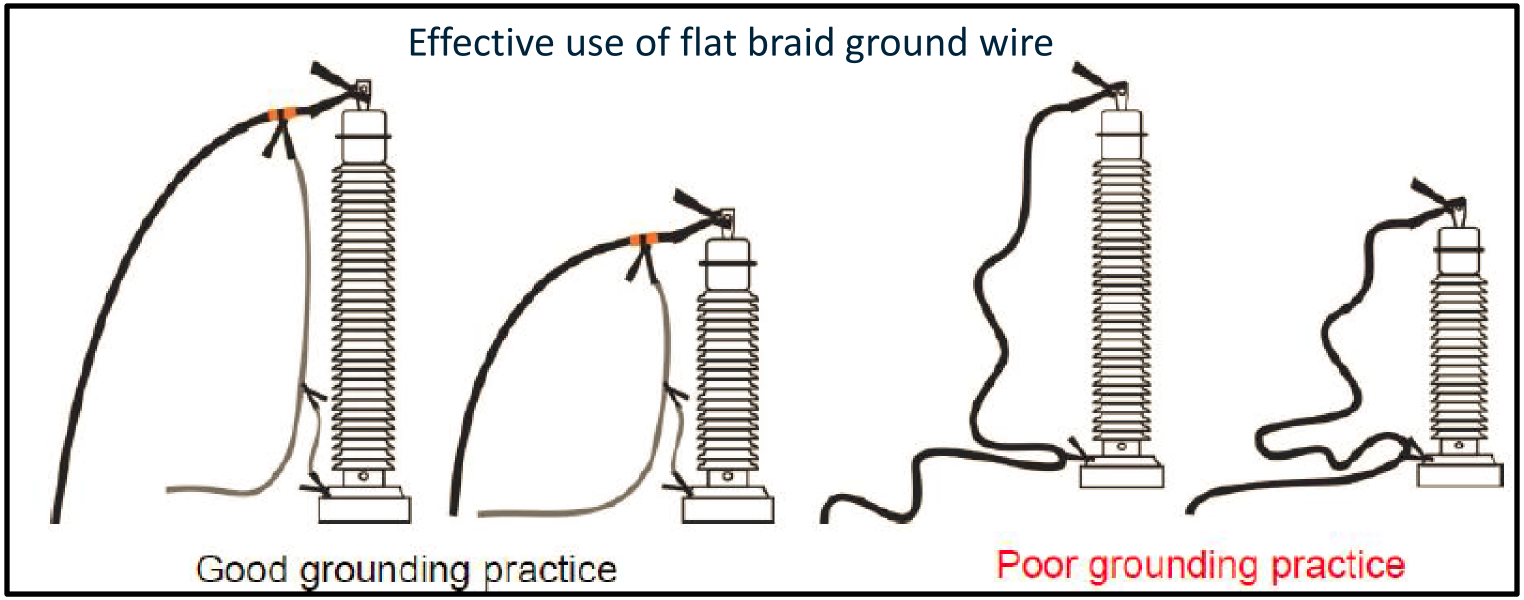
- If nominal tap is to be used for LTC, it is recommended to note down the previous tap position before nominal.

Grounding Technique

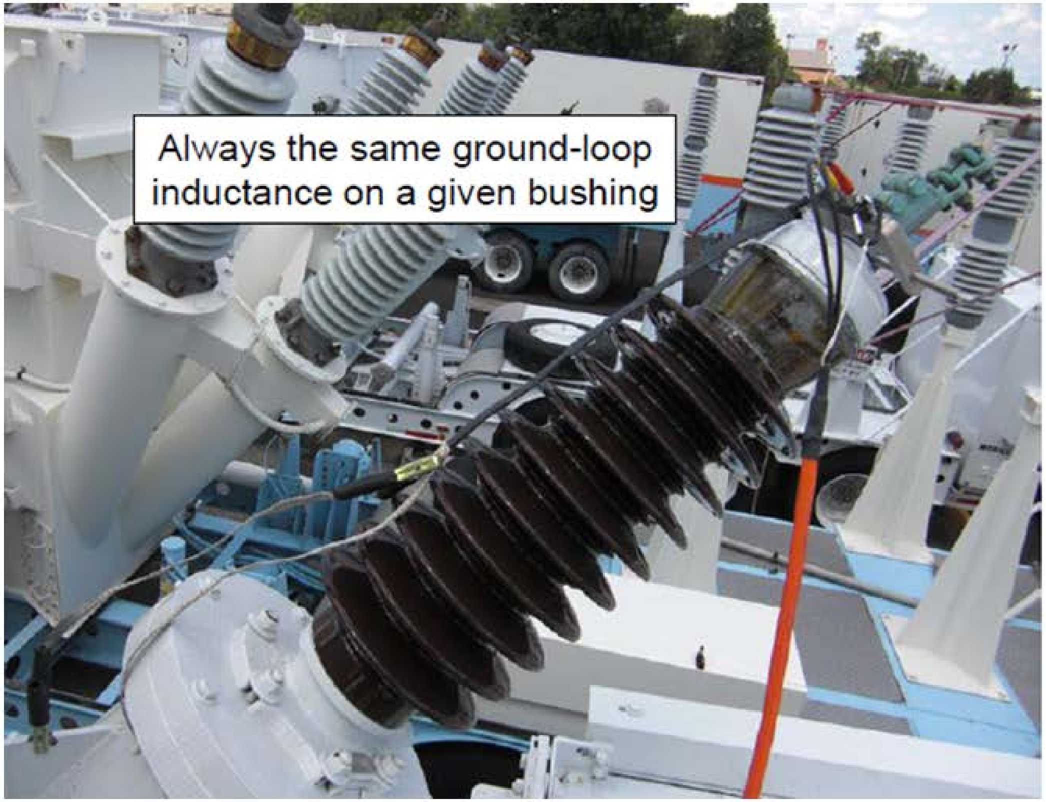
- It is very important to apply the same grounding practices each time to obtain consistent and repeatable results.

- “Shortest possible ground” technique provides the source and measuring leads the closest ground (reference) point with shortest length of ground braid.

- Inconsistent grounding practice can greatly affect the high frequency region of the FRA trace.



Shortest Ground Technique



Best grounding practices in field environment

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CONCLUSION

- Summary of IEEE FRA guide and recommendations from other standards provide the tools to perform the measurements correctly and interpret the FRA results to detect any defects in mechanical integrity associated with windings, core and other components of a transformer.

- FRA failure mode analysis assists in narrowing down the type of problem and related faulty section of the transformer.

- The case studies and its analysis based upon failure mode characteristics provide techniques and process to identify issues and utilize FRA measurements for advanced diagnosis.

THANK YOU !!

Questions