SOUND IMPACT EVALUATION AND ASSESSMENT

Bridgehampton Substation Upgrade Project
Hamlet of Bridgehampton, Town of Southampton
Suffolk County, New York

Prepared for:

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March 2022

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EXECUTIVE SUMMARY

PSEG Long Island LLC (PSEG Long Island) requested that PS&S Engineering, PC (PS&S) perform a Sound Impact Evaluation and Assessment ("the Assessment") for the Proposed Bridgehampton Substation Upgrade, located at 1295 Bridgehampton-Sag Harbor Turnpike, in the Hamlet of Bridgehampton, Town of Southampton, Suffolk County, New York to assess the potential sound-level impacts at the nearest boundaries of the Substation Property. PS&S completed the requested Assessment in accordance with accepted noise level evaluation standards, procedures, requirements, and guidelines.

The existing total daytime sound levels around the Substation Property were 58 A-weighted decibels (dBA), and existing total nighttime sound levels were 48 dBA. Sound level measurements were taken at the property line of the Substation Property closest to the Old Sag Harbor Landfill – the closest commercial receptor. Ambient sound levels were influenced by the local traffic along Bridgehampton-Sag Harbor Turnpike, as well as existing substation noise (including two existing transformers operating within the substation) and non-anthropogenic sources such as birds, insects, and wind rustling leaves.

Sound propagation modeling of the area was performed using SoundPLAN Essential 5.0 to identify and incorporate all known sound sources around the Substation Property, after completion of Proposed Substation Upgrades. The sound propagation modeling results indicate that the completion of the Proposed Substation Upgrades would neither raise sound levels above existing total sound levels at the adjacent commercial property nor raise sound levels above 65 dBA.

1.0 INTRODUCTION

PSEG Long Island LLC (PSEG Long Island) is proposing the installation of new equipment at the existing Bridgehampton Substation. The site encompasses 11.70-acres (Section 39, Block 1, Lot Nos. 26 and 27 as identified on Suffolk County Tax Map Division) located at 1295 Bridgehampton-Sag Harbor Turnpike, hamlet of Bridgehampton, Town of Southampton, Suffolk County, New York and owned by Long Island Lighting Company (LILCO) ("Substation Property"). The Proposed Substation Upgrades will include one new 69/13 kV transformer bank and one new switchgear enclosure. The purpose of the Proposed Substation Upgrades is to improve electric service reliability and capacity to the surrounding service area.

New noise generating equipment includes one (1) new 33 MVA 69/13 kV transformer.

PS&S Engineering, PC (PS&S) performed a Sound Impact Evaluation and Assessment ("Assessment") for the Proposed Substation Upgrades to assess potential sound-level impacts at receptors in the vicinity of the Substation Property. PS&S completed the Assessment in accordance with accepted noise level evaluation standards, procedures, requirements, and guidelines. The Assessment included the following:

- Measurement of existing ambient total daytime and nighttime sound levels at the property boundaries of the Substation Property, and identification and characterization of noise source influences in the area;
- Sound propagation modeling of anticipated sound-level contributions from the Proposed Substation Upgrades using the nationally recognized SoundPLAN Essential (V. 5.0) three-dimensional acoustic propagation model software; and
- Comparison of the results of the sound propagation modeling to the applicable New York State Department of Environmental Conservation (NYSDEC) Noise Policy Guidelines.

2.0 PROJECT LOCATION & SOUND LEVEL STANDARDS

2.1 Site Location

The site will encompass 11.70-acres (Section 39, Block 1, Lot Nos. 26 and 27 as identified on Suffolk County Tax Map Division) located at 1295 Bridgehampton-Sag Harbor Turnpike, hamlet of Bridgehampton, Town of Southampton, Suffolk County, New York ("Substation Property"). The Site is an operational substation. Properties adjacent to the Substation Property primarily consist of trees and other vegetation, with Bridgehampton-Sag Harbor Turnpike located to the east of the Substation Property. A commercial property (Old Sag Harbor Landfill) is located across Bridgehampton-Sag Harbor Turnpike, to the northeast of the Substation Property.

The nearest residential property lines, along Bridgehampton-Sag Harbor Turnpike (Locations 2 and 3), are approximately 400-500 feet south of the substation fencing and are separated by vegetated areas that are on the Substation Property.

2.2 Noise/Sound-Level Standards & Criteria

NYSDEC Noise Policy Guidelines are detailed in the Program Policy Memorandum/Noise Policy Guidelines titled *Assessing and Mitigating Noise Impacts* (NYSDEC, October 6, 2000, Revised February 2, 2001). The NYSDEC Noise Policy Guidelines (included as **Appendix A)** provide guidance on when sound-levels resulting from proposed projects have the potential for adverse noise impacts and details when projects may require review and possible mitigation measures. This guidance document states that sound pressure levels be measured on the A-weighted decibel scale dB(A) which is weighted towards those portions of the frequency spectrum, between 20 and 20,000 Hertz, to which the human ear is most sensitive. NYSDEC Guidance states that the goal for any new operation should ideally not exceed existing ambient noise levels by more than 6 dBA at the receptor. A Sound Pressure Level (SPL) increase of 10 dBA, which results in a perceived doubling of loudness, "deserves consideration of avoidance and/or mitigation measures in most cases."

The guidance also states that SPL increases ranging from 0 to 3 dBA should have no appreciable effect on receptors. Furthermore, the addition of any new noise generating equipment in a non-industrial (e.g., residential) setting should not raise the ambient noise level above a maximum of 65 dBA, which is the level that allows for undisturbed speech at a distance of approximately three feet.

3.0 EXISTING SOUND MONITORING SURVEY

3.1 Sound-Level Monitoring

Existing sound levels were measured in the vicinity of the Substation Property on June 10, 2021, during both daytime (7 AM – 10 PM) and nighttime (10 PM – 7 AM) periods. Existing sound sources potentially influencing the area and observed during sound monitoring activities were also noted.

The sound level measurements were obtained with a certified and calibrated Quest SoundPro DL-1-1/3 Sound Level Meter set to the "A-weighting" scale and "slow" measurement speed. A wind screen was used on the sound level meter during all readings. The wind speed and temperature were recorded at the beginning and end of each measurement period to ensure changing weather conditions did not impact sound level measurements. The noise-level meter was calibrated at hourly intervals as well as at the beginning and end of the sound level monitoring during the survey.

3.2 Sound Monitoring Locations

The sound monitoring location is shown in **Figure 3-1**. This sound monitoring location was selected to document the existing ambient total sound levels in the vicinity of the Substation Property. Existing ambient total sound levels were not measured at the adjacent property to the south of the Substation Property (Locations 2 and 3).

3.3 Sound-level Measurements (A-weighted)

A summary of the sound monitoring data is presented in **Table 3-1** below. This table lists the observed total sound levels at the monitoring location during the daytime and nighttime periods. The observed daytime total sound level in the vicinity of the Substation was 58 dBA, and the nighttime sound level was 48 dBA. Reported total sound levels are the highest regularly occurring sound levels observed from sound sources in the area.

The major sound-level influences in the vicinity of the Substation Property were from local vehicular roadway traffic, along Bridgehampton-Sag Harbor Turnpike, as well as existing substation noise, and minor contributions from non-anthropogenic sources such as birds, insects, and wind rustling leaves.

TABLE 3-1
SOUND-LEVEL MEASUREMENT DATA SUMMARY

MONITORING LOCATION ID	MONITORING LOCATION DESCRIPTION	DAYTIME MEASURED TOTAL SOUND LEVELS (dBA)	NIGHTTIME MEASURED TOTAL SOUND LEVELS (dBA)
1	**Bridgehampton Substation – Bridgehampton-Sag Harbor Turnpike**	**58**	**48**

NOTES:
Sound-level measurement data was collected on 06/10/2021.
Reported data are the highest regularly occurring sound levels. Highest regularly occurring sound is defined as the highest reading in a range of non-extraneous sounds collected at each location.
Locations 2 and 3 were not monitored for total sound levels.

Legend

- Noise Monitoring Location
- Existing Substation Limits
- Site Boundaries

PS&S
3 MOUNTAINVIEW ROAD
WARREN, NEW JERSEY 07059
PHONE: (732) 560-9700

NOISE MONITORING LOCATION MAP

PSEG Long Island

Bridgehampton Substation Upgrade Project

Hamlet of Bridgehampton, Town of Southampton

Suffolk County, New York

Drawn By: ML	Scale: 1" = 300'	Project No. 01315.0886
Chk'd By: ES	Date: 3/22/2022	Figure No. 1

Sources:
Esri, World Transportation, 2022
Esri, World Imagery, 2020

Path: P:\01315\0886\DWGs\Y-GIS\Maps\Fig01_NoiseMonitoring_20220321_00.mxd

4.0 SOUND MODELING

4.1 Proposed and Existing Equipment

The new sound-generating substation equipment consists of one (1) 33 MVA 69/13kV transformer bank (Bank #3). One (1) switchgear enclosure, which does not include noise-generating equipment, is also proposed for the Substation Property.

The existing substation equipment consist of two (2) 69/13 kV transformer banks (Banks #1 and #2), one (1) switchgear enclosure, and one (1) battery room/control enclosure.

The proposed layout of the Site after completion of the Proposed Substation Upgrades is included as **Appendix B.**

4.2 Sound Sources – Assumptions and Model Inputs

The sound propagation modeling performed for this assessment conservatively assumes that:

- All of the above-specified equipment is installed;
- The noise-generating equipment will be operating at full load with all fans in operation.

Transformers

The proposed transformer bank for the Proposed Substation Upgrades is a Pennsylvania Transformer Technology, Inc. LTC Transformer, which is rated for 33MVA, 69/13 kV.

The existing transformer banks are a VRT Power Transformer and a Pauwels Trafo Transformer, which are both rated for 33MVA, 69/13 kV.

Based on manufacturer specifications, the new transformer will produce sound levels of 47 dBA at a distance of 50 feet from the source. Manufacturer specifications for the proposed transformer banks are included in **Appendix C**.

All transformers are modeled as operating under "full load" conditions with all cooling fans in operation. Full load conditions are expected to occur only occasionally, during the hot summer season.

Existing Total Sound Levels

The locations of the proposed transformer banks, substation structures, the existing off-site structures, and the sound monitoring locations used in the computer sound propagation modeling, are depicted on **Figure 4-1**.

Existing total sound levels were measured around the Substation Property, as reported in Section 3. Existing sound sources can have an additive effect on total sound levels, following completion of the Proposed Substation Upgrades.

4.3 Sound Impact Modeling

Sound-level contributions from the equipment were predicted using SoundPLAN Essential (V. 5.0) three-dimensional acoustic propagation model software (Braunstein and Berndt, GmbH/SoundPLAN LLC, 2019). The SoundPLAN industrial noise type option was used for the sound modeling calculations.

The SoundPLAN software allows for calculation of sound from multiple sound sources at multiple receivers while accounting for specific Substation Property sound radiation patterns and propagation effects of structures. The sound sources are identified in the propagation modeling with x and y coordinates and a relative height above terrain. The Proposed Substation Upgrade equipment identified in this assessment was modeled as point sources and digitized in a geo-referenced coordinate system based on Substation Property plan dimensions. The model receptors are also identified with three-dimensional x, y, and z coordinates. Model receptors were located along the nearest property boundaries at an average ear level height of 1.5 meters above ground level in accordance with applicable modeling guidance. The projected sound-level changes were then compared to NYSDEC Noise Policy Guidelines.

In addition to the proposed noise sources, existing noise sources, specific site conditions, and equipment layout can influence sound propagation, as described below.

Elevation

SoundPLAN software uses a digital ground model (based on elevation contours). Existing ground elevations for the immediately surrounding properties for the Substation Property were used in the modeling, based on data incorporated from Google Earth. No change in the existing ground elevations were assumed under the build condition for the modeling.

Buildings

Existing buildings were digitized from Google Earth, while PSEG Long Island-provided Site plans and proposed dimensions that were included in the model calculations (i.e., calculation of diffraction around buildings).

Structure Reflections

Structures may modify the noise radiation patterns of equipment. The SoundPLAN software includes calculations to account for potential sound amplification from reverberation/reflection off the exterior surfaces of the existing and proposed structures based on the structure's facade. A reflection loss coefficient is assigned to each building or structure based on the material of the facade. All structures were conservatively modeled as "minimally absorbent" (default reflection loss of 1 dB).

4.4 Modeling Results (Projected A-weighted Sound Pressure Levels)

A summary of the projected (modeled) cumulative equipment sound levels at the modeling locations is presented in **Table 4-1** below. Modeled sound levels include the effects of both existing (ambient) total sound levels and sound sources from the Proposed Substation Upgrades.

The full load sound level around the Proposed Substation was modeled to be no greater than 56 dBA at the nearest residential property lines, and no greater than 58 dBA at the nearest commercial property lines to the Substation Property.

TABLE 4-1
SUMMARY OF MODELED FULL LOAD FUTURE SOUND-LEVELS GENERATED BY PROPOSED SUBSTATION UPGRADES AT SELECTED PROPERTY BOUNDARIES

RECEPTOR NO.	RECEPTOR LOCATION	DAYTIME TOTAL SOUND LEVELS WITH ALL EQUIPMENT OPERATING AT FULL LOAD (dBA)	DAYTIME MEASURED AMBIENT TOTAL SOUND LEVELS (dBA)	NIGHTTIME TOTAL SOUND LEVELS WITH ALL EQUIPMENT OPERATING AT FULL LOAD (dBA)	NIGHTTIME MEASURED AMBIENT TOTAL SOUND LEVELS (dBA)
1	Old Sag Harbor Landfill	58	58	48	48
2	Eastern Building at 1297 Bridgehampton-Sag Harbor Turnpike	56	--	46	--
3	Western Building at 1297 Bridgehampton-Sag Harbor Turnpike	48	--	38	--

Figure 4-1
PSEG Long Island
Bridgehampton Substation

MODELED FULL LOAD FUTURE SOUND LEVELS WITH SUBSTATION NOISE GENERATING EQUIPMENT OPERATING AT MAXIMUM CAPACITY

The Substation was modeled based on the Plot Plan and Equipment Specs provided by PSEGLI.

Substation Sound Sources:
- Two (2) Existing 33 MVA 69/13kV Transformersat 47.0 dBA each at a distance of 50 feet; and
- One (1) Proposed 33 MVA 69/13kV Transformerat 47.0 dBA at a distance of 50 feet.

Signs and symbols

Substation Boundary

Existing Building/Structure

Proposed Switchgear Building

Receiver

Point source

Level Table

Modeled Sound Levels [dBA] (Day/Night)

1 : 1921

0 10 20 40 60 80 m

PS&S 60 YEARS

5.0 SUMMARY AND CONCLUSIONS

The sound propagation modeling results indicate that the projected noise levels will be no greater than 56 dBA at the nearest residential property lines (Location 3), and no greater than 58 dBA at the property lines closest to the Substation Property (Location 1).

As the modeling demonstrates, completion of the Proposed Substation Upgrades would not increase total sound levels above existing ambient total sound levels at the nearest commercial property. NYSDEC Noise Policy Guidelines state that increases ranging from 0-3 dB should have no appreciable effect on receptors. The modeling also demonstrates that the Proposed Substation Upgrades would not increase total sound levels beyond the NYSDEC Noise Policy Guideline Limit of 65 dBA.

6.0 REFERENCES

Braunstein and Berndt. SoundPLAN Essential Version 5.0. Braunstein and Berndt GmbH/ SoundPLAN LLC, May 2019.

New York State Department of Environmental Conservation (NYSDEC). Assessing and Mitigating Noise Impacts. Department ID: DEP-00-1. Office of Environmental Permits. October 6, 2000, Revised February 2, 2001.

APPENDIX A

NYSDEC Noise Policy Guidance

Assessing and Mitigating Noise Impacts

New York State
Department of Environmental Conservation

PROGRAM POLICY	**Department ID:** **DEP-00-1**	**Program ID:** **n/a**
Issuing Authority: Environmental Conservation Law Articles 3, 8, 23, 27	**Originating Unit: Division of Environmental Permits**	
Name: Jeffrey Sama	Office/Division: Environmental Permits	
Title: Director	Unit:	
Signature: /S/ Date: 10/6/00	Phone: (518) 402-9167	
Issuance Date: October 6, 2000 Revised: February 2, 2001	Latest Review Date (Office Use):	

Abstract: Facility operations regulated by the Department of Environmental Conservation located in close proximity to other land uses can produce sound that creates significant noise impacts for proximal sound receptors. This policy and guidance presents noise impact assessment methods, examines the circumstances under which sound creates significant noise impacts, and identifies avoidance and mitigative measures to reduce or eliminate noise impacts.

Related References: See references pages 27 and 28.

I. PURPOSE[1]

This policy is intended to provide direction to the staff of the Department of Environmental Conservation for the evaluation of sound levels and characteristics (such as pitch and duration) generated from proposed or existing facilities. This guidance also serves to identify when noise levels may cause a significant environmental impact and gives methods for noise impact assessment, avoidance, and reduction measures. These methods can serve as a reference to applicants preparing environmental assessments in support of an application for a permit. Additionally, this guidance explains the Department's regulatory authority for undertaking noise evaluations and for imposing conditions for noise mitigation measures in the agency's approval

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[1] A Program Policy Memorandum is designed to provide guidance and clarify program issues for Division staff to ensure compliance with statutory and regulatory requirements. It provides assistance to New York State Department of Environmental Conservation (DEC) staff and the regulated community in interpreting and applying regulations and statutes to assure that program uniformity is attained throughout the State. Nothing set forth in a Program Policy Memorandum prevents DEC staff from varying from that guidance as specific circumstances may dictate, provided the staff's actions comply with applicable statutory and regulatory requirements. As this guidance document is not a fixed rule, it does not create any enforceable right by any party using the Program Policy Memorandum.

of permits for various types of facilities pursuant to regulatory program regulations and the State Environmental Quality Review Act (SEQR).

II. BACKGROUND

Noise is defined as any loud, discordant or disagreeable sound or sounds. More commonly, in an environmental context, noise is defined simply as unwanted sound. Certain activities inherently produce sound levels or sound characteristics that have the potential to create noise. The sound generated by proposed or existing facilities may become noise due to land use surrounding the facility. When lands adjoining an existing or proposed facility contain residential, commercial, institutional or recreational uses that are proximal to the facility, noise is likely to be a matter of concern to residents or users of adjacent lands.

A. Sources of Noise Generation

The three major categories of noise sources associated with facilities are (1) fixed equipment or process operations; (2) mobile equipment or process operations; and (3) transport movements of products, raw material or waste. The fixed plant may include a very wide range of equipment including: generators; pumps; compressors; crushers of plastics, stone or metal; grinders; screens; conveyers; storage bins; or electrical equipment. Mobile operations may include: drilling; haulage; pug mills; mobile treatment units; and service operations. Transport movements may include truck traffic within the operation, loading and unloading trucks and movement in and out of the facility. Any or all of these activities may be in operation at any one time. Singular or multiple effects of sound generation from these operations may constitute a potential source of noise.

B. Potential for Adverse Impacts

Numerous environmental factors determine the level or perceptibility of sound at a given point of reception. These factors include: distance from the source of sound to receptor; surrounding terrain; ambient sound level; time of day; wind direction; temperature gradient; and relative humidity. The characteristics of a sound are also important determining factors for considering it as noise. The amplitude (loudness), frequency (pitch), impulse patterns and duration of sound all affect the potential for a sound to be a noise. The combination of sound characteristics, environmental factors and the physical and mental sensitivity of a receptor to a sound determine whether or not a sound will be perceived as a noise. This guidance uses these factors in assessing the presence of noise and the significance of its impacts. It relies upon qualitative and quantitative sound evaluation techniques and sound pressure level impact modeling presented in accepted references on the subject.

C. Mitigation

Mitigation refers to actions that will be taken to reduce the effects of noise or the noise levels on a receptor. Adverse noise effects generated by a facility can be avoided or reduced at the point of generation thereby diminishing the effects of the noise at the point of reception. This guidance identifies various mitigation techniques and their proper application either at the source of noise generation or on a facility's property. Alternative construction or operational methods, equipment maintenance, selection of alternative equipment, physical barriers, siting of activities, set backs, and established hours of construction or operation, are among the techniques that can successfully avoid or reduce adverse noise effects.

D. Decision Making

When an assessment of the potential for adverse noise impacts indicates the need for noise mitigation, it is preferred that specifications for such measures be incorporated in a noise analysis and in the applicant's work or operational plan necessary for a complete application. Presenting a plan that incorporates effective noise mitigation provisions facilitates the Department's technical and environmental review and minimizes or negates the imposition of permit conditions by the Department. Adherence to these plans becomes a condition of a permit.

Noise avoidance and mitigation measures may also be imposed directly as conditions of permit issuance. This guidance will review the statutory authority under which the Department can require the mitigation of noise effects.

III. POLICY

In the review of an application for a permit, the Department of Environmental Conservation is to evaluate the potential for adverse impacts of sound generated and emanating to receptors outside of the facility or property. When a sound level evaluation indicates that receptors may experience sound levels or characteristics that produce significant noise impacts or impairment of property use, the Department is to require the permittee or applicant to employ reasonable and necessary measures to either eliminate or mitigate adverse noise effects. Options to be used to fulfill this guidance should be implemented within the existing regulatory and environmental review framework of the agency.

Regulatory authority for assessing and controlling noise effects are contained in both SEQR and specific Department program regulations. Specific regulatory references are as follows:

Section 3-0301(1)(i) of the Environmental Conservation Law (ECL) states that the commissioner shall have the power to: "i. Provide for prevention and abatement of all water, land and air pollution including but not limited to that related to particulates, gases, dust, vapors, noise, radiation, odor, nutrients and heated liquids."

To comply with Article 8 of the ECL and 6 NYCRR Part 617, State Environmental Quality Review Act, consideration of all relevant environmental issues must be undertaken in making a determination of environmental significance. Noise impact potential is one of many potential issues for consideration in a SEQR review.

Environmental Conservation Law (ECL) Article 23, Title 27, Mined Land Reclamation Law (MLRL), requires applicants for permits to prepare and submit a mined land use plan to the Department for approval. The plan must describe, "the applicant's mining method and measures to be taken to minimize adverse environmental impacts resulting from the mining operation." The provisions to be incorporated in a Mined Land Use Plan, as specified in 6 NYCRR Section 422.2, include the control of noise as a component of the plan.

The solid waste regulations at 6 NYCRR Subdivision 360-1.14(p), establish A-weighted decibel levels that are not to be exceeded at the property line of a facility.

The Division of Air Resources has regulations in 6 NYCRR Parts 450 through 454 that regulate the allowable sound level limits on certain motor vehicles. The statutory authority for these regulations is found in the New York State Vehicle and Traffic Law, Article 10, Section 386.

This guidance does not supercede any local noise ordinances or regulations.

IV. RESPONSIBILITY

The environmental analyst, acting as project manager for the review of applications for permits or permit modifications and working in concert with the program specialist, is responsible for ensuring that sound generation and noise emanating from proposed or existing facilities are properly evaluated. For new permits or significantly modified permits, there should be a determination as to the potential for noise impacts, and establishment of the requirements for noise impact assessment to be included in the application for permit. Where the Department is lead agency, the analyst is responsible for making a determination of significance pursuant to SEQR with respect to potential noise impacts and include documentation for such determination.

Where impacts are to be avoided or reduced through mitigation measures, the analyst, or where there are program requirements to address noise, the program specialist, should determine the effectiveness and feasibility of those measures and ensure that the permit conditions contain specific details for such measures. It should also be determined if additional measures to control noise are to be imposed as a condition of permitting. Appropriate permit language for the permit conditions should be developed by the program specialist and the analyst. The results of noise impact evaluations and the effectiveness of mitigation measures shall be incorporated into SEQR documents and, where necessary, permit conditions shall be placed in final permits to ensure effective noise control.

When it is determined that potential noise effects, as well as other issues, warrant evaluation of impacts and mitigation measures in a Draft Environmental Impact Statement (EIS) prepared pursuant to SEQR, the environmental analyst with the Division of Environmental Permits assumes responsibility for determining the level of evaluation needed to assess sound level generation, noise effects, and mitigation needs and feasibility.

For existing facilities, the program specialist will determine the need for additional mitigation measures to control noise effects either in response to complaints or other changes in circumstances such as new noise from existing facilities or a change in land-use proximal to the facility.

The applicant or their agent, in preparing an application for a permit and supporting documentation, is responsible for assessing the potential noise impacts on area receptors. When potential adverse noise impacts are identified, the applicant should incorporate noise avoidance and reduction measures in the construction or operating plans. The applicant’s submittal should also assess the effectiveness of proposed mitigation measures in eliminating adverse noise reception. Where noise effects are determined to be a reason in support of a SEQR positive declaration, the applicant shall assess noise impacts, avoidance, and mitigation measures in a Draft EIS using methodologies acceptable to this Department.

V. PROCEDURE

The intent of this section is to: introduce terms related to noise analyses; describe some of the various methods used to determine the impacts of sound pressure levels on receptors; identify some of the various attenuators of noise; and list some of the mitigative techniques that can be used to reduce the effects of noise on a receptor. At the end of the section three levels of analysis are described. The first level determines the potential for adverse noise impacts based on noise characteristics and sound pressure increases solely on noise attenuation over distance between the source and receptor of the noise. The second level factors other considerations such as topography and noise abatement measures in determining if adverse noise impacts will occur. The third level evaluates noise abatement alternatives and their effectiveness in avoiding or reducing noise impacts.

The environmental effects of sound and human perceptions of sound can be described in terms of four characteristics:

1. Sound Pressure Level (SPL may also be designated by the symbol L_p) or perceived loudness is expressed in decibels (dB) or A-weighted decibel scale dB(A) which is weighted towards those portions of the frequency spectrum, between 20 and 20,000 Hertz, to which the human ear is most sensitive. Both measure sound pressure in the atmosphere.
2. Frequency (perceived as pitch), the rate at which a sound source vibrates or makes the air vibrate.
3. Duration i.e., recurring fluctuation in sound pressure or tone at an interval; sharp or startling noise at recurring interval; the temporal nature (continuous vs. intermittent) of sound.
4. Pure tone which is comprised of a single frequency. Pure tones are relatively rare in nature but, if they do occur, they can be extremely annoying.

Another term, related to the average of the sound energy over time, is the Equivalent Sound Level or $L_{eq.}$ The L_{eq} integrates fluctuating sound levels over a period of time to express them as a steady state sound level. As an example, if two sounds are measured and one sound has twice the energy but lasts half as long, the two sounds would be characterized as having the same equivalent sound level. Equivalent Sound Level is considered to be directly related to the effects of sound on people since it expresses the equivalent magnitude of the sound as a function of frequency of occurrence and time. By its derivation L_{eq} does not express the maximum nor minimum SPLs that may occur in a given time period. These maximum and minimum SPLs should be given in the noise analysis. The time interval over which the L_{eq} is measured should always be given. It is generally shown as a parenthetic; $L_{eq\ (8)}$ would indicate that the sound had been measured for a period of eight hours.

Equivalent Sound Level (L_{eq}) correlates well and can be combined with other types of noise analyses such as Composite Noise Rating, Community Noise Equivalent Level and day-night noise levels characterized by L_{dn} where an $L_{eq(24)}$ is measured and 10 dBA is added to all noise levels measured between 10 pm and 7 am. These different types of noise analyses basically combine noise measurements into measures of cumulative noise exposure and may weight noise occurring at different times by adding decibels to the actual decibel level. Some of these analyses require more complex noise analysis than is mentioned in this guidance. They may be used in a noise analyses prepared for projects.

Designations for sound levels may also be shown as $L_{(10)}$ or $L_{(90)}$ in a noise analysis. These designations refer to the sound pressure level (SPL) that is exceeded for 10% of the time over which the sound is measured, in the case of $L_{(10)}$, and 90% of the time, in the case of $L_{(90)}$. For example, an $L_{(90)}$ of 70 dB(A) means that 70 dB(A) is exceeded for 90% the time for which the measurement was taken.

A. Environmental Setting and Effects on Noise Levels

1. Sound Level Reduction Over Distance - It is important to have an understanding of the way noise decreases with distance. The decrease in sound level from any single noise source normally follows the “inverse square law.” That is, SPL changes in inverse proportion to the square of the distance from the sound source. At distances greater than 50 feet from a sound source, every doubling of the distance produces a 6 dB reduction in the sound. Therefore, a sound level of 70 dB at 50 feet would have a sound level of approximately 64 dB at 100 feet. At 200 feet sound from the same source would be perceived at a level of approximately 58 dB.

2. Additive Effects of Multiple Sound Sources - The total sound pressure created by multiple sound sources does not create a mathematical additive effect. Below Table A is given to assist you in calculating combined noise sources. For instance, two proximal noise sources that are 70 dBA each do not have a combined noise level of 140 dBA. In this case the combined noise level is 73 dBA. Since the difference between the two sound levels is 0 dB, Table A tells us to add 3 dB to the sound level to compensate for the additive effects of the sound. To find the cumulative SPL assess the SPLs starting with the two lowest readings and work up to the difference between the two highest readings. For several pieces of equipment, operating at one

time, calculate the difference first between the two lowest SPLs, check Table A and add the appropriate number of decibels to the higher of the two sound levels. Next, take the sound level that was calculated using Table A and subtract the next lowest sound level to be considered for the operation. Consult Table A again for the additive effect and add this to the higher of the two sound levels. Follow this process until all the sound levels are accounted for. As an example, let us say that an area for a new facility is being cleared. The equipment to be used is: two chainsaws, one operating at 57 dBA and one at 60 dBA; a front end loader at 80 dBA; and a truck at 78 dBA. Start with the two lowest sound levels: 60 dBA - 57 dBA = 3 dBA difference. Consulting the chart add 2 dBA to the higher sound level. The cumulative SPL of the two chainsaws is 62 dBA. Next, subtract 62 dBA from 78 dBA. 78 dBA - 62 dBA = 16 dBA. In this case, 0 dBA is added to the higher level so we end up with 78 dBA. Lastly, subtract 78 dBA from the 80 dBA. 80 dBA - 78 dBA = 2 dBA a difference of 2 dBA adds 2 dBA to the higher SPL or 82 dBA. The SPL from these four pieces of equipment operating simultaneously is 82 dBA.

Table A

Approximate Addition of Sound Levels

Difference Between Two Sound Levels	Add to the Higher of the Two Sound Levels
1 dB or less	3 dB
2 to 3 dB	2 dB
4 to 9 dB	1 dB
10 dB or more	0 dB

(USEPA, Protective Noise Levels, 1978)

3. Temperature and Humidity - Sound energy is absorbed in the air as a function of temperature, humidity and the frequency of the sound. This attenuation can be up to 2 dB over 1,000 feet. Such attenuation is short term and, since it occurs over a great distance, should not be considered in calculations. Higher temperatures tend to increase sound velocity but does

not have an effect on the SPL. Sound waves bend towards cooler temperatures. Temperature inversions may cause temporary problems when cooler air is next to the earth allowing for more distant propagation of sound. Similarly, sound waves will bend towards water when it is cooler than the air and bounce along the highly reflective surface. Consequently large water bodies between the sound source and the receptor may affect noise attenuation over distance.

4. Time of Year - Summer time noises have the greatest potential for causing annoyance because of open windows, outside activities, etc. During the winter people tend to spend more time indoors and have the windows closed. In general, building walls and windows that are closed provide a 15 dB reduction in noise levels. Building walls with the windows open allow for only a 5 dB reduction in SPL.

5. Wind - Wind can further reduce the sound heard at a distance if the receptor is upwind of the sound. The action of the wind disperses the sound waves reducing the SPLs upwind. While it is true that sound levels upwind of a noise source will be reduced, receptors downwind of a noise source will not realize an increase in sound level over that experienced at the same distance without a wind. This dispels the common belief that sound levels are increased downwind due to wind carrying noise.

6. Land forms and structures - In certain circumstances, sound levels can be accentuated or focused by certain features to cause adverse noise impacts at specified locations. At a hard rock mine, curved quarry walls may have the potential to cause an amphitheater effect while straight cliffs and quarry walls may cause an echo. Buildings that line streets in cities can cause a canyon effect where sound can be reflected from the building surfaces similar to what might happen in a canyon. Consideration of noise impacts associated with these types of conditions may require specialized expertise to evaluate impact potential and to formulate suitable mitigation techniques.

Consideration of existing noise sources and sound receptors in proximity to a proposed activity can be important considerations even when the activity under review is not a noise source. Topography, vegetation, structures and the relative location of noise receptors and sources to these features are all aspects of the environmental setting that can influence noise impact potential. As such, land alteration may also indirectly create an adverse noise impact where natural land features or manmade features serve as a noise barrier or provide noise attenuation for existing sources of noise, i.e. highway, railroads, manufacturing activity. Removal of these features, i.e. hills, vegetation, large structures or walls, can expose receptors to increased sound pressure levels causing noise problems where none had previously existed.

B. Impact Assessment

1. Factors to Consider

Factors to consider in determining the impact of noise on humans, are as follows:

a. Evaluation of Sound Characteristics

(1) Ambient noise level - A noise can only intrude if it differs in character or SPL from the normal ambient sound. Most objective attempts to assess nuisance noise adopt the technique of comparing the noise with actual ambient sound levels or with some derived criterion.

(2) Future noise level - The ambient noise level plus the noise level from the new or proposed source.

(3) Increase In Sound Pressure Level - A significant factor in determining the annoyance of a noise is Sound Pressure Level (SPL). SPLs are measured in decibels.

(4) Sharp and Startling Noise - These high frequency and high intensity noises can be extremely annoying. When initially evaluating the effects

of noise from an operation, pay particular attention to noises that can be particularly annoying. One such noise is the back-up beepers required to be used on machinery. They definitely catch one's attention as they were meant to do. Continual beeping by machinery can be mitigated (see Section V.C. Mitigation - Best Management Practices). Another impulse noise source that can be very annoying is the exhaust from compressed air machinery. This exhaust is usually released in loud bursts. Compressed air exhaust can also be mitigated if it causes a noise problem by using readily available mufflers or specifically designed enclosures.

(5) Frequency and Tone - Frequency is the rate at which a sound source vibrates or makes the air vibrate. Frequency is measured in Hertz (Hz). Frequency can also be classified as high ("sharp"), low ("dull"), and moderate. Pure tones are rare in nature. Tonal sounds usually consist of pure tones at several frequencies. Pure tones and tonal sounds are discerned more readily by the human ear. Pure tones and tonal sounds are compensated for in sound studies by adding a calculated number of dB(A) to the measured sound pressure.

(6) Percentile of Sound Levels - Fluctuations of SPLs can be expressed as a percentile level designated as $L_{(n)}$ where a given decibel level is exceeded *n* % of the time. A designation of $L_{(10)}$ = 70 dBA means the measured SPLs exceeded 70 dBA 10% of the time. A designation of $L_{(90)}$ = 70 dBA means the measured SPLs were exceeded 90% of the time. $L_{(90)}$ is often used to designate the background noise level.

(7) Expression of Overall Sound - Part of the overall assessment of sound is the *Equivalent Sound Level* (L_{eq}) which assigns a single value of sound level for a period of time in which varying levels of sound are experienced over that time period. The L_{eq} value provides an indication of the effects of sound on people. It is also useful in establishing the ambient sound levels at a potential noise source.

In order to evaluate the above factors in the appropriate context, one must identify the following: 1) appropriate receptor locations for sound level calculation or measurement; 2) ambient sound levels and characteristics at these receptor locations; and 3) the sound pressure increase and characteristics of the sound that represents a significant noise effect at a receptor location.

b. Receptor Locations

Appropriate receptor locations may be either at the property line of the parcel on which the facility is located or at the location of use or inhabitance on adjacent property. The solid waste regulations require the measurements of sound levels be at the property line. The most conservative approach utilizes the property line. The property line should be the point of reference when adjacent land use is proximal to the property line. Reference points at other locations on adjacent properties can be chosen after determining that existing property usage between the property line and the reference point would not be impaired by noise, i.e., property uses are relatively remote from the property line. The location of the facility should be shown on a map in relation to each potential receptor. Any future expansion should be described in a narrative as well as depicted on a map. The map and narrative should also include the distance of the operation to each point of reception including the distance at the point in time when an expanding operation will be closest to the receptors.

c. Thresholds for Significant Sound Pressure Level (SPL) Increase

The goal for any permitted operation should be to minimize increases in sound pressure level above ambient levels at the chosen point of sound reception. Increases ranging from 0-3 dB should have no appreciable effect on receptors. Increases from 3-6 dB may have potential for adverse noise impact only in cases where the most sensitive of receptors are present. Sound pressure increases of more than 6 dB may require a closer analysis of impact potential depending on existing SPLs and the character of surrounding land use and receptors. SPL increases approaching 10 dB result in a perceived doubling of SPL. The perceived doubling of the SPL results from the fact that SPLs are measured on a logarithmic scale. An increase of 10 dB(A) deserves consideration of avoidance and mitigation measures in most cases. The above thresholds as indicators of impact potential should be viewed as guidelines subject to adjustment as appropriate for the specific circumstances one encounters.

Establishing a maximum SPL at the point of reception can be an appropriate approach to addressing potential adverse noise impacts. Noise thresholds are established for solid waste management facilities in the Department's Solid Waste regulations, 6 NYCRR Part 360. Most humans find a sound level of 60 - 70 dB(A) as beginning to create a condition of significant noise effect (EPA 550/9-79-100, November 1978). In general, the EPA's "Protective Noise Levels" guidance found that ambient noise levels # 55 dBA $L_{(dn)}$ was sufficient to protect public health and welfare and, in most cases, did not create an annoyance (EPA 550/9-79-100, November 1978). In non-industrial settings the SPL should probably not exceed ambient noise by more than 6 dB(A) at the receptor. An increase of 6 dB(A) may cause complaints. There may be occasions where an increase in SPLs of greater than 6 dB(A) might be acceptable. The addition of any noise source, in a non-industrial setting, should not raise the ambient noise level above a maximum of 65 dB(A). This would be considered the "upper end" limit since 65 dB(A) allows for undisturbed speech at a distance of approximately three feet. Some outdoor activities can be conducted at a SPL of 65 dB(A). Still lower ambient noise levels may be necessary if there are sensitive receptors nearby. These goals can be attained by using the mitigative techniques outlined in this guidance.

Ambient noise SPLs in industrial or commercial areas may exceed 65 dB(A) with a high end of approximately 79 dB(A) (EPA 550/9-79-100, November 1979). In these instances mitigative measures utilizing best management practices should be used in an effort to ensure that a facility's generated sound levels are at a minimum. The goal in an industrial/commercial area, where ambient SPLs are already at a high level, should be not to exceed the ambient SPL. Remember, if a new source operates at the same noise level as the ambient, then 3 dB(A) must be added to the existing ambient noise level to obtain the future noise level. If the goal is not to raise the future noise levels the new facility would have to operate at 10 dB(A) or more lower than the ambient.(see Table A)

Table B

HUMAN REACTION TO INCREASES IN SOUND PRESSURE LEVEL

Increase in Sound Pressure (dB)	**Human Reaction**
Under 5	Unnoticed to tolerable
5 - 10	Intrusive
10 - 15	Very noticeable
15 - 20	Objectionable
Over 20	Very objectionable to intolerable

(Down and Stocks - 1978)

Impact assessment will vary for specific project reviews, but must consist of certain basic components for all assessments. Additional examination of sound generation and noise reception are necessary, where circumstances warrant. Sound impact evaluation is an incremental process, with four potential outcomes:

- exemption criteria are met and no noise evaluation is required;
- noise impacts are determined to be non-significant (after first-level evaluation);
- noise impacts are identified as a potential issue but can be readily mitigated (after second level evaluation); or
- noise impacts are identified as a significant issue requiring analysis of alternatives as well as mitigation (third level evaluation).

All levels of evaluation may require preparation of a noise analysis. The required scope of noise impact analysis can be rudimentary to rather sophisticated, depending on circumstances and the results obtained from initial levels of evaluation. Recommendations for each level of evaluation are presented below.

2. Situations in Which No Noise Evaluation is Necessary

When certain criteria are satisfied, the need for undertaking a noise impact analysis at any level is eliminated. These criteria are as follows:

a. The site is contained within an area in which local zoning provides for the intended use as a “right of use”. It does not apply to activities that are permissible only after an applicant is granted a special use permit by the local government; and

b. The applicant’s operational plan incorporates appropriate best management practices (BMPs [see Section V.C. Mitigation - Best Management Practices]) for noise control for all facets of the operation.

Where activities may be undertaken as a “right of use”, it is presumed that noise has been addressed in establishing the zoning. Any residual noise that is present following BMP implementation should be considered an inherent component of the activity that has been found acceptable in consideration of the zoning designation of the site.

3. First Level Noise Impact Evaluation

The initial evaluation for most facilities should determine the maximum amount of sound created at a single point in time by multiple activities for the proposed project. All facets of the construction and operation that produce noise should be included such as land clearing activities (chain saw and equipment operation), drilling, equipment operation for excavating, hauling or conveying materials, pile driving, steel work, material processing, product storage and removal. Land clearing and construction may be only temporary noise at the site whereas the ongoing operation of a facility would be considered permanent noise. An analysis may be required for various phases of the construction and operation of the project to assure that adverse noise effects do not occur at any phase.

To calculate the sound generated by equipment operation, one can consult the manufacturers' specifications for sound generation, available for various types of equipment. Another option for calculating the sound to be generated by equipment is to make actual measurements of sound generated by existing similar equipment, elsewhere.

Tables C and D summarize noise measurements from some common equipment used in construction and mining. Table E summarizes the noise level, in decibels (dB[A]), from some common sources. This information can be used to assist Department staff in relating potential noise impacts to sound levels produced by commercial and industrial activities. Use of these tables in the first level of analysis will help determine whether or not noise will be an issue and whether actual measurements should be made to confirm noise levels.

Table C
PROJECTED NOISE LEVELS

Noise Source	Measurements	1,000 feet	2,000 feet	3,000 feet
Primary and secondary crusher	89 dB(A) at 100 ft	69.0 dB(A)	63.0 dB(A)	59.5 dB(A)
Hitachi 501 shovel loading	92 dB(A) at 50 ft	66.0 dB(A)	60.0 dB(A)	56.5 dB(A)
Euclid R-50 pit truck loaded	90 dB(A) at 50 ft	64.0 dB(A)	58.0 dB(A)	54.4 dB(A)
Caterpillar 988 loader	80 dB(A) at 300 ft	69.5 dB(A)	63.5 dB(A)	60.0 dB(A)

(The Aggregate Handbook, 1991)

Table D
Common Equipment Sound Levels

EQUIPMENT	**DECIBEL LEVEL**	**DISTANCE** in feet
Augered earth drill	80	50
Backhoe	83-86	50
Cement mixer	63-71	50
Chain saw cutting trees	75-81	50
Compressor	67	50
Garbage Truck	71-83	50
Jackhammer	82	50
Paving breaker	82	50
Wood Chipper	89	50
Bulldozer	80	50
Grader	85	50
Truck	91	50
Generator	78	50
Rock drill	98	50

(excerpt and derived from Cowan, 1994)

Table E

Sound Source	dB(A)°	Response Criteria
	150	
Carrier Deck Jet Operation	140	
	130	Painfully Loud Limit Amplified Speech
Jet Takeoff (200 feet)	120	
Discotheque Auto Horn (3 feet) Riveting Machine	110	Maximum Vocal Effort
Jet Takeoff (2000 feet) Shout (0.5 feet)	100	
N.Y. Subway Station Heavy Truck (50 feet)	90	Very Annoying Hearing Damage (8 hours, continuous exposure)
Pneumatic Drill (50 feet)	80	Annoying
Freight Train (50 feet) Freeway Traffic (50 feet)	70	Telephone Use Difficult Intrusive
Air Conditioning Unit (20 feet)	60	
Light Auto Traffic (50 feet)	50	Quiet
Living Room Bedroom	40	
Library Soft Whisper (15 feet)	30	Very Quiet
Broadcasting Studio	20	
	10	Just Audible
	0	Threshold of Hearing

(The Aggregate Handbook, 1991)

The sound level at receptor locations should be calculated using the inverse square rule whereby sound is attenuated over distance. Again, each doubling of the distance from the source of a noise decreases the SPL by 6 dB(A) at distances greater than 50 feet. This calculation should first consider the straight line distance between the point of noise generation and the point of noise reception with the presumption that no natural or manmade features exist along the transect between the two points that would further attenuate sound level. Calculations should be performed for each point of reception in all directions being careful to evaluate the worst case noise impact potential by considering activities at the point where they would be closest to a receptor. The sound level calculated for the point of reception should be related to ambient sound levels. Ambient sound levels can be either measured or assumed based on established references for the environmental setting and land use at the point of reception. For estimation purposes, ambient SPLs will vary from approximately 35 dB(A) in a wilderness area to approximately 87 dB(A) in a highly industrial setting. A quiet seemingly serene setting such as rural farm land will be at the lower end of the scale at about 45 dB(A), whereas an urban industrial area will be at the high end of this scale at around 79 dB(A) (EPA 550/9-79-100, November 1978). If there is any concern that levels based on reference values do not accurately reflect ambient SPL, field measurements should be undertaken to determine ambient SPLs.

Where this evaluation indicates that sound levels at the point of reception will not be perceptible, similar to or only slightly elevated as compared to ambient conditions, no further evaluation is required. When there is an indication from this initial analysis that marginal or significant noise impact may occur, further evaluation is required. In determining the potential for an adverse noise impact, consider not only ambient noise levels, but also the existing land use, and whether or not an increased noise level or the introduction of a discernable sound, that is out of character with existing sounds, will be considered annoying or obtrusive. (see B.1.a Evaluation of Sound Characteristics)

4. Second Level Noise Impact Evaluation

Further refine the evaluation of noise impact potential by factoring in any additional noise attenuation that will be provided by existing natural topography, fabricated structures such as buildings, walls or berms or vegetation located between the point of noise generation and noise reception. This analysis may require consideration of future conditions and the loss of natural noise buffers over time.

Dense vegetation that is at least 100 feet in depth will reduce the sound levels by 3 to 7 dB(A). Evergreens provide a better vegetative screen than deciduous trees. Keep in mind that if a vegetative screen does not currently exist, planting a vegetative screen may require 15 or more years of growth before it becomes effective.

The degree to which topography attenuates noise depends on how close the feature is located to the source or the receptor of the noise. Topography can act as a natural screen. The closer a hill or other barrier is to the noise source or the receptor, the larger the sound shadow will be on the side opposite the noise source. Certain operations such as mining and landfills may be able to use topography to maintain a screen between the operation and receptors as they progress. Mining operations may be able to create screens by opening a mine in the center of the site using and maintaining the pit walls as barriers against sound (Aggregate Handbook, 1991).

If after taking into account all the attenuating features the potential still exists for adverse noise impact, other types of noise analyses or modeling should be used to characterize the source. An Equivalent Sound Level (L_{eq}) analysis or a related type of noise analysis may better define activities or sources that require more mitigation or isolation so that noise emanating from these sources will not cause an adverse impact.

Where it is demonstrated that noise absorbing or deflecting features further attenuate sound reception to a level of no significant increase, no further analysis is necessary. Where it is determined that noise level or the character of the noise may have a significant adverse effect on receptors, other noise mitigation measures should be evaluated in an expanded noise analysis.

5. Third Level - Mitigation Measures

When the above analyses indicate significant noise effects may or will occur, the applicant should evaluate options for implementation of mitigation measures that avoid, or diminish significant noise effects to acceptable levels (see Section V.C. Mitigation - Best Management Practices). Adequate details concerning mitigation measures and an evaluation of the effectiveness of the mitigative measures through additional sound level calculations should be provided in a noise analysis. These calculations are to factor in the noise reduction or avoidance capabilities of the mitigation measures. In circumstances where noise effects cannot readily be reduced to a level of no significance by project design or operational features in the application, the applicant must evaluate alternatives and mitigation measures in an environmental impact statement to avoid or reduce impacts to the maximum extent practicable per the requirements of the State Environmental Quality Review Act (SEQR).

The noise analysis should be part of the application or a supplement to it, and will be part of the SEQR environmental assessment by reference. Duplicative noise analysis information is not required for the permit application and the assessment of impacts under SEQR. A proper analysis can satisfy information needs for both purposes.

C. Mitigation - Best Management Practices (BMP) for Reducing Noise

Various noise abatement techniques are available for reducing frequency of sound, duration of sound or SPLs at receptor locations. The mitigation techniques given below are listed according to what sound characteristic they mitigate.

1. Reduce noise frequency and impulse noise at the source of generation by:

    a. Replacing back-up beepers on machinery with strobe lights (subject to other requirements, e.g., OSHA and Mine Safety and Health Administration, as applicable). This eliminates the most annoying impulse beeping;

    b. Using appropriate mufflers to reduce the frequency of sound on machinery that pulses, such as diesel engines and compressed air machinery;

    c. Changing equipment: using electric motors instead of compressed air driven machinery; using low speed fans in place of high speed fans;

    d. Modifying machinery to reduce noise by using plastic liners, flexible noise control covers, and dampening plates and pads on large sheet metal surfaces; and

2. Reduce noise duration by:

    a. Limiting the number of days of operation, restricting the hours of operation and specifying the time of day and hours of access and egress can abate noise impacts.

    b. Limiting noisier operations to normal work day hours may reduce or eliminate complaints.

    Limiting hours of construction or operation can be an effective tool in reducing potential adverse impacts of noise. The impacts of noise on receptors can be significantly reduced by effectively managing the hours at which the loudest of the operations can take place.

Implementation of hours of operation does not reduce the SPL emanating from a facility. Determining whether or not hours of operation will be effective, mitigation requires consideration of: public safety, for example road construction at night may reduce traffic concerns and facilitate work; duration of the activity, is it a one time event necessary to meet a short term goal or will the activity become an ongoing operation; and surrounding land use, consider what type(s) of land use is proximal to the activity and at what time(s) might a reduction of noise levels be necessary. There may be other factors to consider due to the uniqueness of a given activity or the type of land use adjacent to the activity. Hours of operation should also consider weekend activities and legal holidays that may change the types of land use adjacent to the permitted activity or increase traffic levels in an area.

The best results from using hours of operation as a mitigative measure will be obtained if the hours are negotiated with the owner or operator of the facility. The less noisy aspects of an operation may not have to be subject to the requirements of hours of operation such as preparing, greasing and maintaining machinery for the upcoming day's operation. The more noisy operations can be scheduled to begin when people in the receptor area are less likely to be adversely effected. Hours of operation should be included in the operation plans for a facility that becomes part of the permit, or in the event that there is no operation plan, can be included as a permit condition.

3. Reduce Noise sound pressure levels by:

   a. Increasing the setback distance.
   b. Moving processing equipment during operation further from receptors.
   c. Substituting quieter equipment (<u>example</u> - replacing compressed air fan with an electric fan could result in a 20 dB reduction of noise level).

d. Using mufflers selected to match the type of equipment and air or gas flow on mechanical equipment.
e. Ensuring that equipment is regularly maintained.
f. Enclosing processing equipment in buildings (example - enclosing noisy equipment could result in an 8-10 dB noise level reduction, a 9 inch brick wall can reduce SPL by 45-50 dB).
g. Erecting sound barriers such as screens or berms around the noise generating equipment or near the point of reception. The angle of deflection also increases as the height of a screen or barrier increases. Screens or barriers should be located as close to the noise source or the receptor as possible. The closer the barrier is located to the source or the receptor, the greater the angle of deflection of the sound waves will be creating a larger "sound shadow" on the side opposite the barrier. Stockpiles of raw material or finished product can be an effective sound barrier if strategically placed.
h. phasing operations to preserve natural barriers as long as possible.
i. altering the direction, size, proximity of expanding operations.
j. Designing enclosed facilities to prevent or minimize an SPL increases above ambient levels. This would require a noise analysis and building designed by a qualified engineer that includes adequate ventilation with noise abatement systems on the ventilation system.

Public notification of upcoming loud events can also be used as a form of mitigation although it doesn't fit easily into the categories above. People are less likely to get upset if they know of an upcoming event and know that it will be temporary.

The applicant should demonstrate that the specific mitigation measures proposed will be effective in preventing adverse noise effects on receptors.

D. Decision Making - Conditioning Permits to Limit Noise Impacts

Preferably, the mitigation measures as outlined in the construction and operational plans should be relied upon to mitigate the effects of noise on receptors. The permit should state that the activity will be conducted in accordance with the approved plan. Otherwise, mitigation measures and BMP's can be imposed within specific permit conditions.

It is not the intention of this guidance to require decibel limits to be established for operations where such limits are not required by regulation. There are, however, instances when a decibel limit may be established for an operation to ensure activities do not create unacceptable noise effects, as follows:

1. The review of a draft and final environmental impact statement demonstrates the need for imposition of a decibel limit;
2. A decibel limit is established by the Commissioner's findings after a public hearing has been held on an application;
3. The applicant asks to have a decibel limit to demonstrate the ability to comply; or
4. A program division seeks to establish a decibel limit as a permit condition, when necessary to demonstrate avoidance of unacceptable noise impact.

Ultimately, the final decision must incorporate appropriate measures to minimize or avoid significant noise impacts, as required under SEQR. Any unavoidable adverse effects must be weighed along with other social and economic considerations in deciding whether to approve or deny a permit.

REFERENCES

1) Cowan, James P., Handbook of Environmental Acoustics, Van Nostrand Reinhold, 1994.

2) Down, C.G. and Stocks, J.; Environmental Impact of Mining. Applied Science Publishers Ltd., ISBN 0853347166, 1978.

3) U.S. Dept of Transportation - Federal Highway Administration Office of Research and Development; Highway Noise-A Manual for Highway Noise and Land Use, Nov. 1974.

4) New York State Motor Vehicle Law, Chapter IV, Subchapter E, 450.2, Part 450, "Noise From Heavy Motor Vehicles," 200.701 CN, February 28, 1997.

5) Beranek, L.A. ed., Noise and Vibration Control. Cambridge, MA: Institute of Noise Control Engineering, 1971, pp. 164-174 and 182-191.

6) Barksdale, R.D., editor, 1991. The Aggregate Handbook: National Stone Association (Washington, DC), 1.V.

7) Norman, David K., Wampler , Peter J., Throop, Allen H., Schnitzer, E. Frank, and Roloff, J., 1996. "Best Management Practices for Reclaiming Surface Mines in Washington and Oregon." Oregon Dept. of Geology and Mineral Industries, Open File Report 0-96-2.

8) United States Environmental Protection Agency, Protective Noise Levels, Condensed Version of EPA Levels document, EPA 550/9-79-100, November 1978, Office of Noise Abatement & Control, Washington, D.C.

9) United States Environmental Protection Agency, Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, EPA 550/9-74-004, March 1974, Office of Noise Abatement and Control, Washington, D.C.

10) City of Davis General Plan, Appendix E Background Information on Environmental Acoustics, November 1996.

11) The Australian National University, "Physics and Psychophysics of Music", ACAT 1003, David Worrall, http://www.anu.edu.au/ITA/ACAT/drw/PPofM/Intensity2.html, 1998.

12) Danish Wind Turbine Manufacturers Association, Measuring and Calculating Sound Levels, November 18, 1997.

Additional Reading

a. Beranek, Leo L. and Istavan L. Ver, Noise and Vibration Control Engineering, John Wiley & Sons, Inc. New York, 1992.

b. Beranek, Leo L., Noise and Vibration Control, Institute of Noise Control Engineering, Revised Edition, Washington, C.C., 1988.

c. Diehl, George, M., Machinery Acoustics, John Wiley & Sons, New York, 1973.

d. Erwin, J.D., Graf, E. R., Industrial Noise and Vibration Control, Prentice Hall, Englewood Cliffs, New Jersey, 1979.

e. Jensen, Paul, et al, Industrial Noise Control Manual, U.S. Department of Health, Education and Welfare, Public Health Service, Cincinnati, 1978.

APPENDIX B

Proposed Site Layout

Legend

Existing Substation Limits

3 MOUNTAINVIEW ROAD
WARREN, NEW JERSEY 07059
PHONE: (732) 560-9700

PROPOSED SITE LAYOUT MAP

PSEG Long Island
Bridgehampton Substation Upgrade Project
Hamlet of Bridgehampton, Town of Southampton
Suffolk County, New York

Sources:
Esri, World Transportation, 2022
Esri, World Imagery, 2020

Drawn By: DM	Scale: 1" = 300'	Project No. 01315.0886
Chk'd By: ES	Date: 3/23/2022	Appendix B

Path: P:\01315\0886\DWGs\Y-GIS\Maps\AppB_SiteLayout_20220323_00.mxd

APPENDIX C

Manufacturer Specifications

TRANSFORMER FACTORY CERTIFIED TEST REPORT

PSE&G LONG ISLAND
FAR ROCKAWAY # 8

PURCHASE ORDER # 5000022900
UNIT SER. # E5119

September 24, 2020

3550 MAYFLOWER DRIVE
LYNCHBURG, VA 24501
(434) 845-0921*(800) 368-3017
FAX (434) 845-7089

PSE&G LONG ISLAND
FAR ROCKAWAY # 8
Project # NP # 967
Purchase Order # 5000022900
UNIT SER. # E5119
September 24, 2020

DELTA STAR INCORPORATED

Part I - Executive Summary

General and Rating Data

Date	September 24, 2020		
Customer	**PSE&G LONG ISLAND FAR ROCKAWAY # 8**		
Project #	NP # 967		
Purchase Order #	5000022900		
Delta Star Inc. Factory Serial #	E5119		
Transformer Type	Load Tap Changing Transformer		
Type of Construction	Core Form		
Cooling Class	ONAN/ONAF/ONAF/ONAF		
Number of Phases	3		
Frequency [Hz]	60		
Insulating Medium	Mineral Oil		
Temperature Rise [ºC]	65		
Type of Fluid Flow	Non-Directed		
Polarity (For Single-Phase Only)	N/A		
Winding Ratings			
Connection	**HV**	**LV**	**TV**
	WYE	WYE	DELTA
Voltage [kV]	67.65	13.80GrdY/7.97	11.66
Power [MVA @ ºC]	16.8/22.4/28/33 @ 65 ºC	16.8/22.4/28/33 @ 65 ºC	5.6/7.5/9.3/11 @ 65 ºC
Line BIL [kV]	350	150	110
Neutral BIL [kV]	---	110	-

Nameplate Drawing Number - E511810
Outline Drawing Number - E511830

PSE&G LONG ISLAND
FAR ROCKAWAY # 8
Project # NP # 967
Purchase Order # 5000022900
UNIT SER. # E5119
September 24, 2020

DELTA STAR INCORPORATED

Guaranteed and Reported data

Total, Load, No-load Losses, Impedance and Exciting Current Tests

No Load Loss and Exciting Current						
Reference Temp.	Exciting Current as % of Rated Current at ONAN MVA		No Load Loss @ 100% of Rated Voltage [kW]		No Load Loss @ 110% of Rated Voltage [kW]	
	Guaranteed	Reported	Guaranteed	Reported	Guaranteed	Reported
20 °C	0.400	0.093	15.00	13.69	[illegible]	[illegible]

Load Loss and Impedance												
Reference Temp.	67.65 to 13.80 kV @ 16.8 MVA				70.95 to 13.80 kV @ 16.8 MVA				64.35 to 13.80 kV @ 16.8 MVA			
	Guaranteed		Reported		Guaranteed		Reported		Guaranteed		Reported	
	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]	Load Losses [kW]	Imp. [%]
85 °C	58.70	9.00	57.54	8.63	-	-	56.64	8.51	-	-	59.33	8.86

Cooling Equipment Losses [kW] (losses in control equipment not included)		Total losses @ ONAN MVA [kW] (cooling and other control equipment not included)	
Guaranteed	Reported	Guaranteed	Reported
2.500	2.453	73.70	71.23

Efficiency and Regulation

MVA	Winding Connection		% Regulation @ Lagging PF [%]				% Efficiency @ Load [%]			
			100	90	80	70	100	75	50	25
16.8	67.65 to 13.80 kV	Guaranteed	0.75	4.53	5.90	-	99.56	99.62	99.64	99.55
		Calculated	0.71	4.34	5.66	6.55	99.58	99.64	99.67	99.59

PSE&G LONG ISLAND
FAR ROCKAWAY # 8
Project # NP # 967
Purchase Order # 5000022900
UNIT SER. # E5119
September 24, 2020

Temperature Rise Test

All temperature rises measurements are presented in degrees Celsius (ºC) with average winding rise being corrected to the instance of shutdown and the windings loaded until constant temperature rise had been reached. Maximum (hottest-spot) winding rises above ambient were determined per sub clause 5.11.1.1c of IEEE C57.12.00-2015. Thermal images were recorded prior to the highest MVA heat run shutdown; electronic data provided upon request.

MVA	kV			Amps			Taps		Total Losses	Type of Cooling	Quantity	
	HV	LV	TV	HV	LV	TV	DETC	LTC			Fans	Rads
16.8	64.4	12.5	11.7	151	775	832	5	15L	84.1	ONAN	0	7
33.0	64.4	12.5	11.7	296	1523	1634	5	15L	277.7	ONAF	4	7
24.8	64.4	12.5	11.7	222	1142	1226	5	15L	162.8	ONAF	4	7
41.3	64.4	12.5	11.7	370	1904	2043	5	15L	426.4	ONAF	4	7

MVA	Winding and Oil Guarantee	Phase	Reported Fluid Rise		Average Winding Rise by Resistance			Ambient	Winding Hottest Spot Rise by Calculation		
			Top	Bottom	HV	LV	TV		HV	LV	TV
16.8	65	A	-	-	-	-	-	-	-	-	-
		B	35.8	19.8	35.6	37.0	-	26.3	43.9	46.5	-
		C	-	-	-	-	-	-	-	-	-
33.0	65	A	50.8	24.5	51.8	54.6	-	26.4	65.4	70.4	-
		B	50.8	24.5	51.8	54.6	-	26.4	65.4	70.4	-
		C	50.8	24.5	52.8	57.1	-	26.4	66.4	73.4	-
24.8	65	B	33.0	11.0	35.0	40.0	-	30.0	46.0	54.0	-
41.3	---	B	72.0	36.0	74.0	85.0	-	32.0	93.0	108.0	-

*Note: Thermal data for 75%FA & 125% FA is from duplicate unit N2195.
All reported temperatures are for 1000/3300 [m/ft] elevation.

Oil Time Constant (Hours)		Wndg Time Const. (Mins)			M Exponent			N Exponent
Cool Down	Heat Up	HV	LV	TV	HV	LV	TV	
-	1.7	5.7	7.4	-	0.68	0.69	0.68	0.81

Sound Pressure Test

Cooling Class	kV		A - Weighted Sound Pressure/Intensity Level [dB]		Type of Instrument
	HV	LV	Guaranteed	Reported	
ONAN	67.7	12.51	62	54.6	Bruel and Kjaer 2250
ONAF	67.7	12.51	64	55.5	
ONAF/ONAF	67.7	12.51	65	55.5	

Part II - Additional Reported Data and Confirmation of Tests Performed

Turns Ratio

Ratio, polarity and phase rotation measurements were performed as per *IEEE C57.12.00* requirements on all taps, with ratio results within +/- 0.5% of indicated nameplate voltage ratios, correct phase and polarity. Recorded data provided in Attachments.

DC Winding Resistance Test: Sum of Three Phases

Refer. Temp. [°C]	Tap Position	Resistance [Ω]		
		HV	LV	TV
85	**1**	1.4393		
85	**2**	1.4054		
85	**3**	1.3741		
85	**4**	1.3399		
85	**5**	1.3059		
85	**N**		0.04435	
85	**16R**		0.04895	
85	**16L**		0.04897	

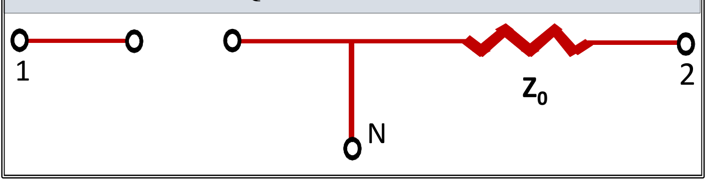
Additional data is provided in Attachments.

No Load Loss and Exciting Current

Refer. Temp. [°C]	Rated Voltage [%]	Taps		Exciting current [%]		No load loss [kW]	
		DETC	LTC	Before Dielectrics	After Dielectrics	Before Dielectrics	After Dielectrics
20	100	3	N	0.093	0.093	13.64	13.69
20	90	3	N	0.081	0.080	10.98	10.85
20	110	3	N	0.126	0.126	17.52	17.61
20	100	3	15L	1.403	-	17.11	-
20	100	3	16L	0.095	-	13.80	-
20	100	3	15R	1.423	-	17.40	-
20	100	3	16R	0.101	-	13.97	-

Zero-phase Sequence Impedance Test

"T" EQUIVALENT NETWORK



DETC	LTC	MVA	Z_0 [%]	Z_0 (R + jX) [%]
1	N	16.8	7.304	0.932+7.244j
3	N	16.8	7.320	0.941+7.259j
5	N	16.8	7.324	0.942+7.263j
1	16R	16.8	6.786	0.917+6.724j
3	16R	16.8	6.784	0.915+6.722j
5	16R	16.8	6.799	0.920+6.737j
1	16L	16.8	8.179	1.001+8.118j
3	16L	16.8	8.182	1.002+8.120j
5	16L	16.8	8.181	1.002+8.120j

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Load Losses and Impedance

Refer. Temp. [°C]	LTC Tap	MVA	HV 71.0 kV		HV 69.3 kV		HV 67.7 kV		HV 66.0 kV		HV 64.4 kV	
			Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]	Load Losses [kW]	Imp. R + Xj [%]
85	N	16.8	56.64	0.34 + 8.51j	57.02	0.34 + 8.53j	57.54	0.34 + 8.62j	58.37	0.35 + 8.72j	59.33	0.35 + 8.85j
85	16R	16.8	55.09	0.33 + 8.82j	-	-	56.32	0.34 + 8.97j	-	-	58.19	0.35 + 9.23j
85	16L	16.8	65.29	0.39 + 8.26j	-	-	66.16	0.39 + 8.36j	-	-	67.63	0.40 + 8.58j
85	1L	16.8	-	-	-	-	-	-	-	-	60.26	0.36 + 8.86j
85	8L	16.8	-	-	-	-	-	-	-	-	63.76	0.38 + 8.79j
85	14L	16.8	-	-	-	-	-	-	-	-	66.40	0.40 + 8.67j
85	15L	16.8	-	-	-	-	-	-	-	-	66.96	0.40 + 8.62j
85	N	33.0	218.56	0.66 + 16.71j	220.01	0.67 + 16.75j	222.01	0.67 + 16.93j	225.21	0.68 + 17.13j	228.92	0.69 + 17.38j
85	16R	33.0	212.56	0.64 + 17.33j	-	-	217.29	0.66 + 17.61j	-	-	224.53	0.68 + 18.14j
85	16L	33.0	251.90	0.76 + 16.23j	-	-	255.26	0.77 + 16.42j	-	-	260.95	0.79 + 16.85j
85	1L	33.0	-	-	-	-	-	-	-	-	232.50	0.70 + 17.40j
85	8L	33.0	-	-	-	-	-	-	-	-	246.02	0.75 + 17.27j
85	14L	33.0	-	-	-	-	-	-	-	-	256.18	0.78 + 17.02j
85	15L	24.8	-	-	-	-	-	-	-	-	145.68	0.59 + 12.70j
85	15L	33.0	-	-	-	-	-	-	-	-	260.45	0.79 + 16.94j
85	15L	41.3	-	-	-	-	-	-	-	-	409.33	0.99 + 21.17j

Lightning Impulse

Lightning Impulse tests were performed on all line and neutral terminals as follows:

HV Line	350	kV BIL
LV Line	150	kV BIL
LV Neutral	110	kV BIL
TV Line	110	kV BIL

Recorded oscillograms and the summary of key parameters are provided in Attachments

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Applied Voltage Test

AC voltage was applied to each winding, with all other windings, tank and core grounded, as follows:

Winding rating [kV]	Voltage applied [kV rms]	Duration [sec]
67.65	140	60
13.80GrdY/7.97	34	
11.66	-	

Induced Voltage Test

An induced voltage test for 7200 cycles was performed at enhancement level with 124.71 kV applied across full HV winding.

Partial Discharge Test

The 7200 cycle enhancement level test was followed by a 1 hour partial discharge test. Highest partial discharge and radio-influence voltage readings were less than 300 pC and 50 µV respectively. Recorded data is provided in Attachments.

Overall Insulation Power Factor and Capacitance Test (Before Dielectrics)

Insulation	Power factor corrected to 20ºC [%]	Capacitance [pF]
$C_H + C_{HL}$	0.19	10550.5
C_H	0.29	2049.2
C_{HL}	0.17	8501.55
$C_L + C_{LT}$	0.20	19578.80
C_L	0.23	11075.20
C_{LT}	0.18	8503.27

The detailed data for overall and bushing tests is included in electronic files available upon request.

Overall Insulation Power Factor and Capacitance Test (After Dielectrics)

Insulation	Power factor corrected to 20ºC [%]	Capacitance [pF]
$C_H + C_{HL}$	0.20	10554.1
C_H	0.28	2048.6
C_{HL}	0.33	8505.5
$C_L + C_{LT}$	0.21	19571.7
C_L	0.23	11070.0
C_{LT}	0.18	8501.7

The detailed data for overall and bushing tests is included in electronic files available upon request.

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Single-Phase Exciting Current Test

DETC	LTC	Voltage [kV]	Exiting current [mA]		
			H1-H0	H2-H0	H3-H0
3	16L	8.00	28.25	14.59	13.78
3	15L	8.00	191.28	177.94	175.86
3	14L	8.00	28.25	14.61	13.79
3	13L	8.00	67.03	54.31	53.06
3	12L	8.00	28.29	14.62	13.80
3	11L	8.00	67.06	54.28	53.08
3	10L	8.00	28.31	14.63	13.80
3	9L	8.00	191.80	178.45	176.35
3	8L	8.00	28.33	14.64	13.81
3	7L	8.00	67.12	54.35	53.10
3	6L	8.00	28.33	14.64	13.82
3	5L	8.00	67.13	54.37	53.13
3	4L	8.00	28.35	14.65	13.82
3	3L	8.00	191.70	178.58	176.34
3	2L	8.00	28.36	14.66	13.83
3	1L	8.00	67.14	54.36	53.11
1	N	10.00	24.95	13.07	12.15
2	N	10.00	26.03	13.55	12.64
3	N	10.00	27.06	14.01	13.07
4	N	10.00	28.26	14.57	13.63
5	N	10.00	29.54	15.15	14.22
3	1R	8.00	66.98	54.25	52.83
3	2R	8.00	28.29	14.63	13.65
3	3R	8.00	191.36	178.04	175.73
3	4R	8.00	28.32	14.64	13.67
3	5R	8.00	67.09	54.33	52.91
3	6R	8.00	28.33	14.65	13.68
3	7R	8.00	67.11	54.33	52.94
3	8R	8.00	28.34	14.66	13.69
3	9R	8.00	191.73	178.49	176.25
3	10R	8.00	28.35	14.67	13.70
3	11R	8.00	67.17	54.38	52.98
3	12R	8.00	28.37	14.68	13.70
3	13R	8.00	67.18	54.41	52.99
3	14R	8.00	28.37	14.68	13.71
3	15R	8.00	191.85	178.52	176.25
3	16R	8.00	28.38	14.69	13.72

Insulation Resistance Test (Corrected to 20 °C)

Insulation	Insulation Resistance at 2.5 kV DC for 1 Min. Duration [MΩ]
HV-LV & GND	14926
LV-HV & GND	5960
HV-GND (LV Guarded)	84660
LV-GND (HV Guarded)	9520

Insulation	Insulation Resistance at 1 kV DC for 1 Min. Duration [MΩ]
Main Core to Ground	8602
Main Frame to Main Core	7616
Main Frame to Ground	850
PA Core to Ground	41922

LTC Operational Test

The LTC was operated from one extreme to the other at 100% rated no load voltage, and with FA load current applied. The LTC passed both tests.

Winding Temperature Indicator

Winding temperature indicator 49T is set at 22.63 °C to reflect gradient of winding hot-spot temperature above top oil temperature.

Frequency Response Analysis Test

Frequency response analysis measurements were performed in accordance with Doble Engineering recommendations. The detailed data is included in electronic files available upon request.

Current Transformers Tests

All current transformers and associated wiring circuits passed an applied voltage test at 2.5 kV AC for 60 seconds and were checked for proper polarity, ratio, and excitation.
Recorded data with key parameters is provided in Attachments.

Control Wiring Applied Voltage Test

All control wiring and auxiliary circuits passed an applied voltage test at 1.5 kV AC for 60 sec.

Control Functions

All electrical and electro-mechanical devices in the control circuits have been operated for proper sequence/staging and functions.

Pressure/Leak Test

Transformer passed pressure test at 68.94 kPa (10 lbf/in^2) for 24 hrs.

Harmonic Factor

Harmonic factor is less then 5%

Accuracy Statement

The accuracy of the loss measurement system is traceable to the National Bureau of Standards per technical note 1204 "Calibration of Test Systems for Measuring Power Losses of Transformers". All testing is performed in accordance with IEEE C57.12.00-2015 and IEEE C57.12.90-2015. Connection diagrams for test are as shown in IEEE C57.12.90-2015. The system for measuring losses is a 3 single-phase wattmeter system utilizing IEEE C57.12.90-2015 method (p.23, Fig.18), and is calibrated annually.

PSE&G LONG ISLAND
FAR ROCKAWAY # 8
Project # NP # 967
Purchase Order # 5000022900
UNIT SER. # E5119
September 24, 2020

Part III – Attachments

1) Voltage Ratio
2) CT Ratio
3) Winding Resistance
4) Impulse Oscillograms with Summary
5) Partial Discharge Summary
6) DTA, SFRA Results
7) Sound Pressure Reported Data
8) Heat Run Thermal Images
9) Losses Data Reported
10) Dissolved Gas Analysis

All testing provided is in conjunction with the *IEEE Std C57.12.00-2015* and *IEEE Std. C57.12.90-2015*. The data and the statements included in this report to the of my knowledge are true, correct and complete.

Test Manager:
Scot Hamrick

Approved:
Design Engineer
Sergio Coreno

Final Winding Ratio

HV TAP	LV TAP	HV (VOLTS)	LV (VOLTS)	VOLTS RATIO	HV-LV			MAX RATIO	MIN RATIO	CURRENT (mA)			RATIO CALCULATIONS			
					PHASE A	PHASE B	PHASE C	+0.5%	-0.5%	PHASE A	PHASE B	PHASE C	PHASE A	PHASE B	PHASE C	PH-PH DIFF.
1	N	70950	13800	5.1413	5.1410	5.1410	5.1410	5.1670	5.1156	1.6	0.7	0.7	PASS	PASS	PASS	0.00%
2	N	69300	13800	5.0217	5.0195	5.0195	5.0195	5.0468	4.9966	1.7	0.8	0.7	PASS	PASS	PASS	0.00%
3	N	67650	13800	4.9022	4.9068	4.9068	4.9068	4.9267	4.8777	1.9	0.9	0.8	PASS	PASS	PASS	0.00%
4	N	66000	13800	4.7826	4.7856	4.7856	4.7856	4.8065	4.7587	2.0	0.9	0.8	PASS	PASS	PASS	0.00%
5	N	64350	13800	4.6630	4.6640	4.6640	4.6640	4.6864	4.6397	2.1	1.0	0.9	PASS	PASS	PASS	0.00%
3	16R	67650	15180	4.4565	4.4496	4.4496	4.4496	4.4788	4.4342	1.9	0.9	0.8	PASS	PASS	PASS	0.00%
3	15R	67650	15090	4.4831	4.4940	4.4940	4.4940	4.5055	4.4607	7.7	6.6	6.4	PASS	PASS	PASS	0.00%
3	14R	67650	14990	4.5130	4.5264	4.5264	4.5264	4.5356	4.4904	2.0	0.9	0.8	PASS	PASS	PASS	0.00%
3	13R	67650	14920	4.5342	4.5475	4.5475	4.5475	4.5569	4.5115	3.2	2.0	2.0	PASS	PASS	PASS	0.00%
3	12R	67650	14840	4.5586	4.5656	4.5656	4.5656	4.5814	4.5358	1.9	0.9	0.8	PASS	PASS	PASS	0.00%
3	11R	67650	14750	4.5864	4.5872	4.5872	4.5872	4.6094	4.5635	3.0	2.0	2.0	PASS	PASS	PASS	0.00%
3	10R	67650	14660	4.6146	4.6054	4.6054	4.6054	4.6377	4.5915	2.0	0.9	0.8	PASS	PASS	PASS	0.00%
3	9R	67650	14580	4.6399	4.6532	4.6532	4.6532	4.6631	4.6167	7.8	6.5	6.5	PASS	PASS	PASS	0.00%
3	8R	67650	14470	4.6752	4.6878	4.6878	4.6878	4.6986	4.6518	1.9	0.9	0.9	PASS	PASS	PASS	0.00%
3	7R	67650	14400	4.6979	4.7108	4.7108	4.7108	4.7214	4.6744	3.1	2.0	2.0	PASS	PASS	PASS	0.00%
3	6R	67650	14320	4.7242	4.7300	4.7300	4.7300	4.7478	4.7005	2.0	0.9	0.8	PASS	PASS	PASS	0.00%
3	5R	67650	14230	4.7540	4.7532	4.7532	4.7532	4.7778	4.7303	3.1	2.0	2.0	PASS	PASS	PASS	0.00%
3	4R	67650	14150	4.7809	4.7730	4.7730	4.7730	4.8048	4.7570	1.9	0.9	0.8	PASS	PASS	PASS	0.00%
3	3R	67650	14060	4.8115	4.8246	4.8246	4.8246	4.8356	4.7875	7.8	6.5	6.5	PASS	PASS	PASS	0.00%
3	2R	67650	13950	4.8495	4.8618	4.8618	4.8618	4.8737	4.8252	1.9	0.9	0.8	PASS	PASS	PASS	0.00%
3	1R	67650	13890	4.8704	4.8860	4.8860	4.8860	4.8948	4.8461	3.1	2.0	1.9	PASS	PASS	PASS	0.00%
3	1L	67650	13710	4.9344	4.9316	4.9316	4.9316	4.9590	4.9097	3.1	2.0	1.9	PASS	PASS	PASS	0.00%
3	2L	67650	13630	4.9633	4.9532	4.9532	4.9532	4.9881	4.9385	1.8	0.8	0.8	PASS	PASS	PASS	0.00%
3	3L	67650	13540	4.9963	5.0070	5.0070	5.0070	5.0213	4.9713	7.6	6.5	6.4	PASS	PASS	PASS	0.00%
3	4L	67650	13440	5.0335	5.0485	5.0485	5.0485	5.0586	5.0083	1.8	0.8	0.8	PASS	PASS	PASS	0.00%
3	5L	67650	13370	5.0598	5.0745	5.0745	5.0745	5.0851	5.0345	3.0	2.0	1.9	PASS	PASS	PASS	0.00%
3	6L	67650	13280	5.0941	5.0975	5.0975	5.0975	5.1196	5.0687	1.8	0.8	0.8	PASS	PASS	PASS	0.00%
3	7L	67650	13200	5.1250	5.1240	5.1240	5.1240	5.1506	5.0994	3.1	1.9	1.9	PASS	PASS	PASS	0.00%
3	8L	67650	13110	5.1602	5.1475	5.1475	5.1475	5.1860	5.1344	1.8	0.8	0.8	PASS	PASS	PASS	0.00%
3	9L	67650	13020	5.1959	5.2055	5.2055	5.2055	5.2218	5.1699	7.6	6.5	6.3	PASS	PASS	PASS	0.00%
3	10L	67650	12920	5.2361	5.2500	5.2500	5.2500	5.2622	5.2099	1.9	0.8	0.8	PASS	PASS	PASS	0.00%
3	11L	67650	12850	5.2646	5.2785	5.2785	5.2785	5.2909	5.2383	3.0	2.0	1.9	PASS	PASS	PASS	0.00%
3	12L	67650	12770	5.2976	5.3030	5.3030	5.3030	5.3241	5.2711	1.8	0.9	0.8	PASS	PASS	PASS	0.00%
3	13L	67650	12680	5.3352	5.3320	5.3320	5.3320	5.3618	5.3085	3.2	2.0	2.0	PASS	PASS	PASS	0.00%
3	14L	67650	12600	5.3690	5.3570	5.3570	5.3570	5.3959	5.3422	2.0	0.9	0.9	PASS	PASS	PASS	0.00%
3	15L	67650	12510	5.4077	5.4200	5.4200	5.4200	5.4347	5.3806	7.6	6.4	6.3	PASS	PASS	PASS	0.00%
3	16L	67650	12400	5.4556	5.4690	5.4685	5.4690	5.4829	5.4284	1.9	0.8	0.8	PASS	PASS	PASS	0.01%

CALCULATED PHASE ANGLE 30 **MEASURED PHASE ANGLE**

MR 5119 **TESTED BY** JY/TJ **DATE** 9/11/2020 **EQUIPMENT #** 9879

FLICKER TEST		
X1-X0	X2-X0	X3-X0
√	√	√

ANTI-FLICKER TEST		
AØ P2-P3	BØ P2-P3	CØ P2-P3
√	√	√

CORE GROUND(S)		
MAIN CORE GND	4240.000	MΩ
MAIN FRAME-CORE	3720.000	MΩ
MAIN FRAME-GND	30.600	MΩ
PA CORE GND	12060.000	MΩ
REACTOR GROUND	4380.000	MΩ

FINAL C.T. RATIO

MR.	5119	EQUIPMENT DSE #	0113
TESTED BY	JY/TJ	DATE	9/15/2020

CALC. RATIO	SECONDARY TAPS		CT 1	CT 2	CT 3	CT	CT	CT	CT	CT	CT	CT
300	X1	X5	300	300	300							
240	X2	X5	240	240	240							
160	X3	X5	160	160	160							
120	X4	X5	120	120	120							
CALC. RATIO	SECONDARY TAPS		CT 4	CT 5	CT 6	CT 7	CT L	CT	CT	CT	CT	CT
400	X1	X5	400	400	400	400	400					
320	X2	X5	320	320	320	320	320					
160	X3	X5	160	160	160	160	160					
100	X4	X5	100	100	100	100	100					
CALC. RATIO	SECONDARY TAPS		CT T1	CT	CT	CT	CT	CT	CT	CT	CT	CT
60	X1	X2	60									
CALC. RATIO	SECONDARY TAPS		CT T2	CT	CT	CT	CT	CT	CT	CT	CT	CT
320	X1	X2	320									

C.T. SHORTED: x

C.T. SHORTED CHECKED: x

PAGE 1 — **CERTIFIED CURRENT TRANSFORMER TEST REPORT**

DELTA STAR VA

[illegible]	[illegible]
[illegible]	[illegible] - [illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	
[illegible]	[illegible]
[illegible]	
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]

MERAMEC
Instrument Transformer Co.

FINISHED DIMENSIONS

[illegible]

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

LEGEND

Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

[illegible] Fran Godat

Certificate of Compliance

Each unit was tested in full accordance with the referenced standard. All information reported in this document is certified to be true, accurate and complete. All units listed herein were found to be in full compliance.

APPLIED POTENTIAL TEST:

[illegible]

INTER-TURN INSULATION TEST:

[illegible]

Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	Ω @ FULL [illegible]	
TESTING LIMITS:	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	
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CERTIFIED CURRENT TRANSFORMER TEST REPORT

DELTA STAR VA

[illegible]

MERAMEC
Instrument Transformer Co.

FINISHED DIMENSIONS

[illegible]

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

Certificate of Compliance

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LEGEND

Green cells (light shade in B&W) indicates PASS, Red cells (dark shade in B&W) indicates FAIL.

Fran Godat

APPLIED POTENTIAL TEST:

[illegible]

INTER-TURN INSULATION TEST:

[illegible]

Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

TESTING LIMITS:	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	Ω @ FULL [illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
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CERTIFIED CURRENT TRANSFORMER TEST REPORT

DELTA STAR VA

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[illegible]	[illegible]

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

MERAMEC
Instrument Transformer Co.

FINISHED DIMENSIONS

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

Certificate of Compliance

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LEGEND

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[illegible] Fran Godat

APPLIED POTENTIAL TEST:

[illegible]

INTER-TURN INSULATION TEST:

[illegible]

Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

[illegible]									[illegible]	[illegible]	Ω @ FULL [illegible]	
[illegible]	[illegible]		[illegible]				[illegible]					
TESTING LIMITS:	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
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CERTIFIED CURRENT TRANSFORMER TEST REPORT

DELTA STAR VA

[illegible]

MERAMEC
Instrument Transformer Co.

FINISHED DIMENSIONS

[illegible]

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

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LEGEND

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Fran Godat

APPLIED POTENTIAL TEST:

[illegible]

INTER-TURN INSULATION TEST:

[illegible]

Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

[illegible]	[illegible]								[illegible]	[illegible]	Ω @ FULL [illegible]	
TESTING LIMITS:	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
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PAGE 1

CERTIFIED CURRENT TRANSFORMER TEST REPORT

DELTA STAR VA

MERAMEC
Instrument Transformer Co.

FINISHED DIMENSIONS

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

LEGEND

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Fran Godat

Certificate of Compliance

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APPLIED POTENTIAL TEST:

INTER-TURN INSULATION TEST:

The ordinates must lie within a parallelogram when expressed as TCF=RCF-PA/2600 where limits of RCF are the same as TCF

TESTING LIMITS:

CERTIFIED CURRENT TRANSFORMER TEST REPORT

DELTA STAR VA

MERAMEC Instrument Transformer Co.

FINISHED DIMENSIONS

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VERIFIED: ✓

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LEGEND

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Fran Godat

APPLIED POTENTIAL TEST:

INTER-TURN INSULATION TEST:

Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

											Ω @ FULL	
TESTING LIMITS:	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
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CERTIFIED CURRENT TRANSFORMER TEST REPORT

DELTA STAR VA

MERAMEC
Instrument Transformer Co.

FINISHED DIMENSIONS

TURNS RATIO, POLARITY, & CT DIMENSIONS ARE VERIFIED ON EACH UNIT.

VERIFIED: ✓

LEGEND

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Fran Godat

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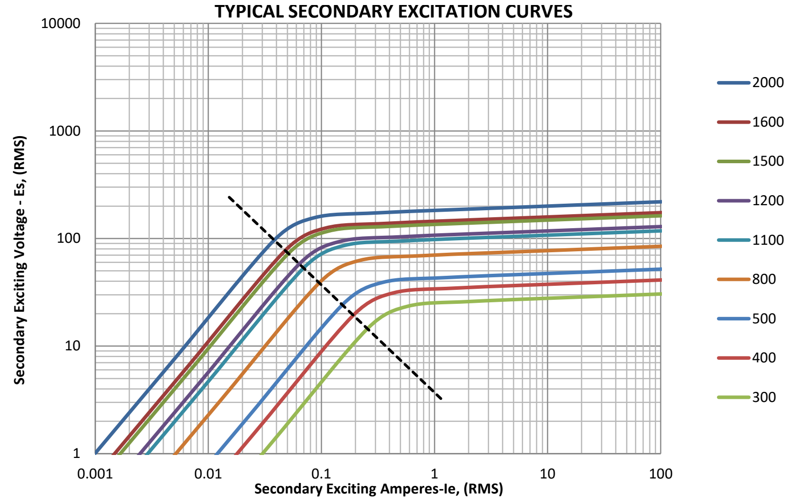
APPLIED POTENTIAL TEST:

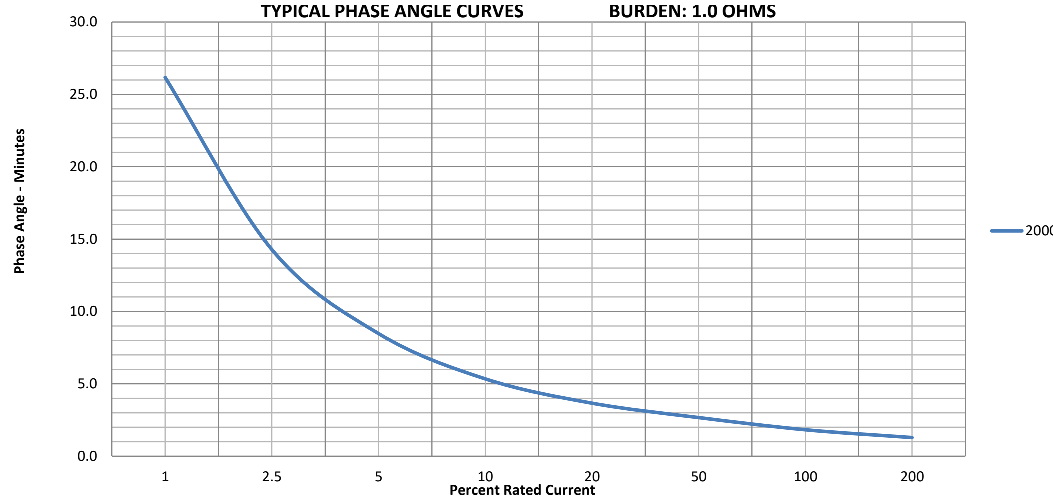
INTER-TURN INSULATION TEST:

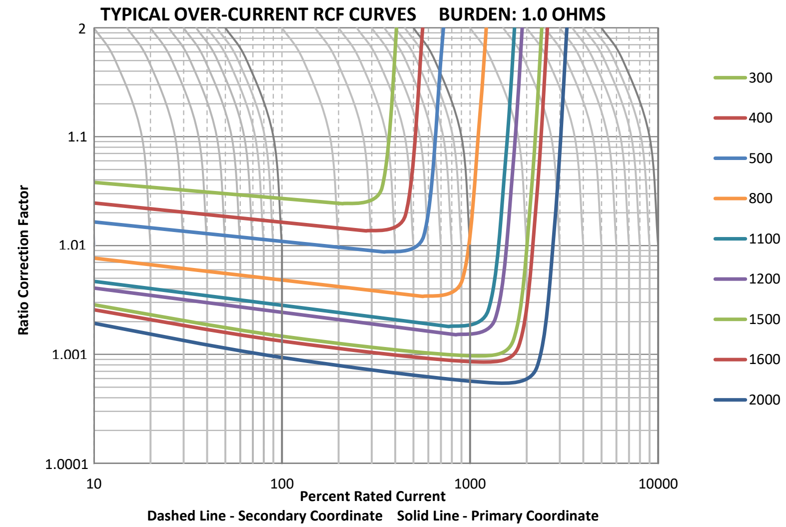
Limits set forth for secondary excitation are derived from the Meramec published curves using tolerances as defined in IEEE C57.13

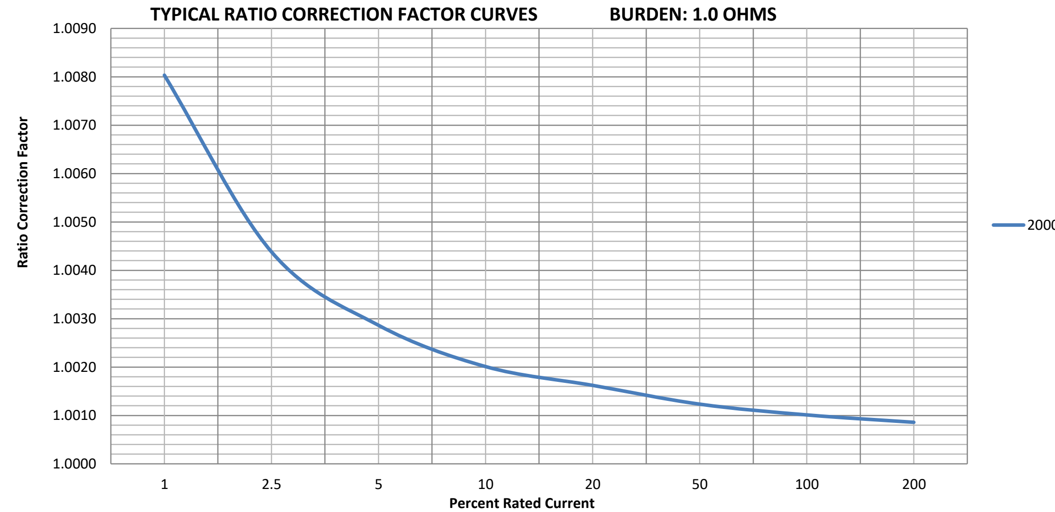
Ω @ FULL

TESTING LIMITS:









DESIGN SPECIFICATIONS

FINISHED OUTSIDE DIAMETER:	12.0 inches / 305 mm
FINISHED INSIDE DIAMETER:	6.5 inches / 165 mm
FINISHED HEIGHT:	1.75 inches / 44 mm
FINISHED WEIGHT:	18.1 lbs / 8.2 kgs
STANDARD:	IEEE C57.13
TYPE:	BUSHING CURRENT TRANSFORMER
INSULATION LEVEL:	0.6kV CLASS
TEMPERATURE CLASS:	105° C.
FREQUENCY:	60 Hz
DESIGN RATIO:	2000:5MR
GUARANTEED @ RATIO:	2000 : 5
TOTAL SECONDARY TURNS:	400
SECONDARY RESISTANCE @ 75° C:	0.0013 OHMS / TURN
FULL WINDING RESISTANCE: (including leads)	0.5709 OHMS
LEAD RESISTANCE @ 75° C: (#12 guage)	0.0022 OHMS / FT
CONTINUOUS THERMAL RATING FACTOR:	2.0 TIMES RATED @ 95° C @ ALL TAPS
THERMAL 1 SECOND: (94.8 times nominal ratio)	189.6 kA RMS SYM @ FULL RATIO
THERMAL 3 SECOND: (55 times nominal ratio)	110.0 kA RMS SYM @ FULL RATIO
DYNAMIC RATING: (256 times nominal ratio)	511.9 kA pk MAX
ACCURACY CLASS:	C100 @ 2000:5

TYPICAL CHARACTERISTIC CURVES

DESIGN NOTES

REVISION HISTORY

REV.	DATE	DESCRIPTION

RATIO	TURNS	CONNECTION
300 : 5	60	X3-X4
400 : 5	80	X1-X2
500 : 5	100	X4-X5
800 : 5	160	X2-X3
1100 : 5	220	X2-X4
1200 : 5	240	X1-X3
1500 : 5	300	X1-X4
1600 : 5	320	X2-X5
2000 : 5	400	X1-X5

The Secondary Excitation Curves dashed (---) line represents the knee point (Ek) which is defined as the point where the tangent is at 45° to the abscissa. Above this line the voltage for a given exciting current for any unit will not be < 95% of the curve value. Below this line the exciting current for a given voltage for any unit will not exceed the curve value by > 25%.

DELTA STAR NORTH

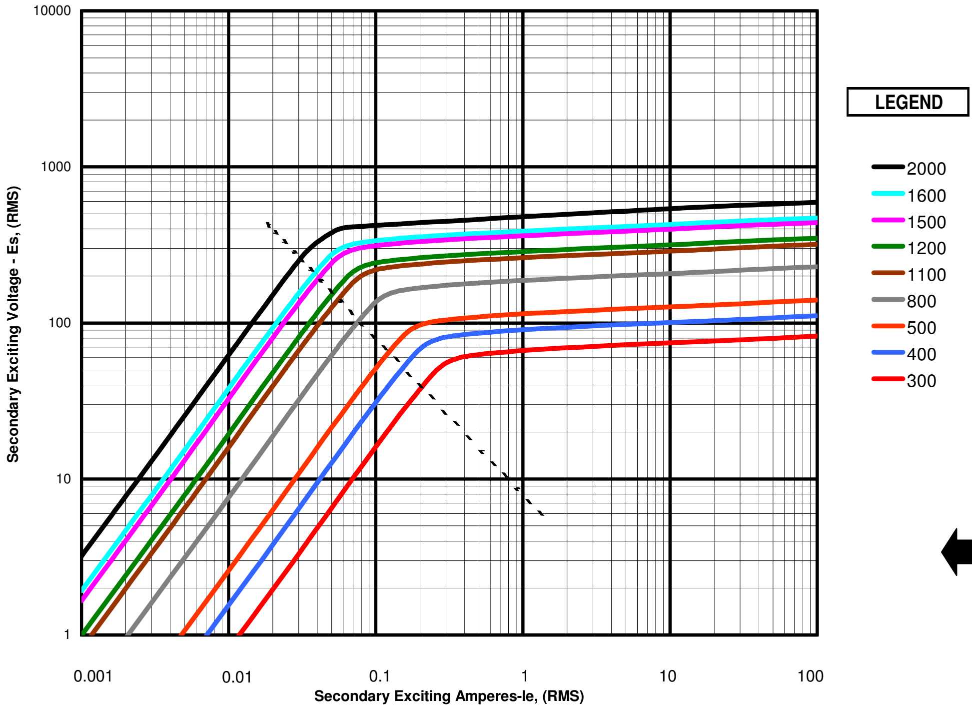
Part Number: R-09A-058-105

Drawn by: Kenny Sumner 02/10/20

Meramec Drawing: 09A-058-105 REV. 00

MERAMEC Instrument Transformer Co.

TYPICAL SECONDARY EXCITATION CURVES



DESIGN PARAMETERS

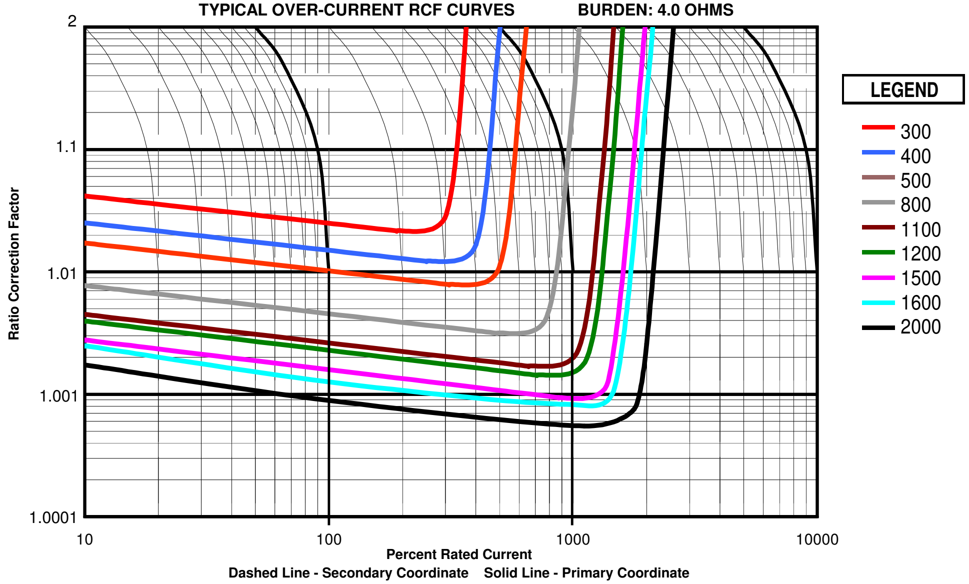
STANDARD:		IEEE C57.13	
TYPE:		BUSHING CURRENT TRANSFORMER	
INSULATION LEVEL:		0.6kV CLASS	
TEMPERATURE CLASS:		105° C.	
FREQUENCY:		60 HZ	
MAXIMUM RATIO:		2000 : 5	
TOTAL SECONDARY TURNS:		400	
SECONDARY RESISTANCE @ 75° C:	(0.729 full winding w/ leads)	0.00168	OHMS/TURN
ACCURACY CLASS:		C400 & 0.3B1.8 @ 2000:5	
CONTINUOUS THERMAL RATING FACTOR:		2.0	TIMES RATED @ ALL TAPS
THERMAL RATING @ 3 SECONDS:	(55 times nominal)	110.0	KA RMS SYM. @ FULL RATIO
MECHANICAL RATING @ SECONDS:	(110 times nominal)	219.9	KA RMS SYM. @ FULL RATIO

DESIGN NOTES

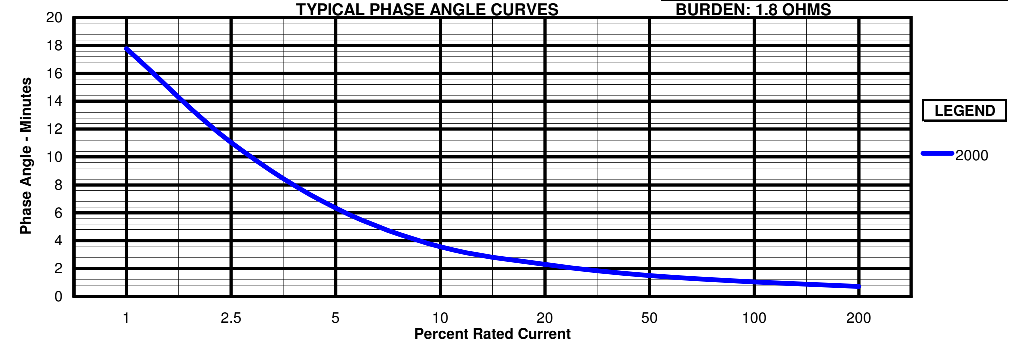
RATIO	TURNS	CONNECTION
300 : 5	60	X3-X4
400 : 5	80	X1-X2
500 : 5	100	X4-X5
800 : 5	160	X2-X3
1100 : 5	220	X2-X4
1200 : 5	240	X1-X3
1500 : 5	300	X1-X4
1600 : 5	320	X2-X5
2000 : 5	400	X1-X5

The dashed (---) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Ie.
TOLERANCE OF CURVE VALUE:
To the right of this line at any current Ie the voltage Es cannot be <95%
To the left of this line at any voltage Es the current Ie cannot be >125%

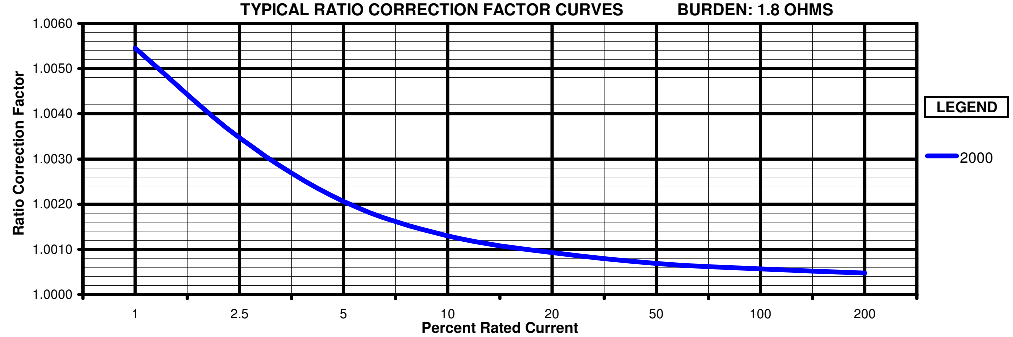
TYPICAL OVER-CURRENT RCF CURVES   BURDEN: 4.0 OHMS



TYPICAL PHASE ANGLE CURVES   BURDEN: 1.8 OHMS



TYPICAL RATIO CORRECTION FACTOR CURVES   BURDEN: 1.8 OHMS



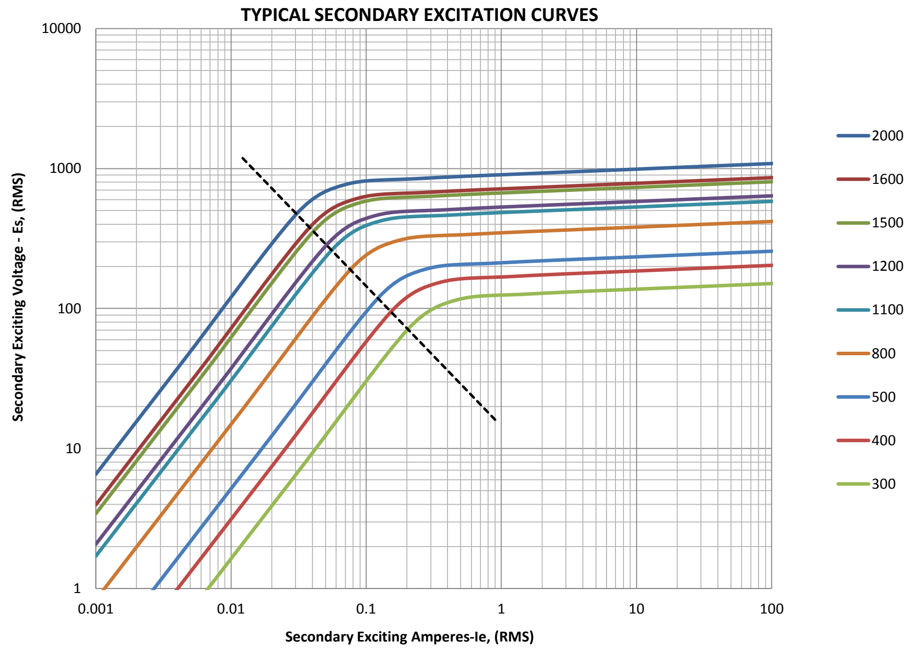
REV.	DATE	CURVE REVISION HISTORY
01	09/03/09	INITIAL CURVE CREATION UPDATE

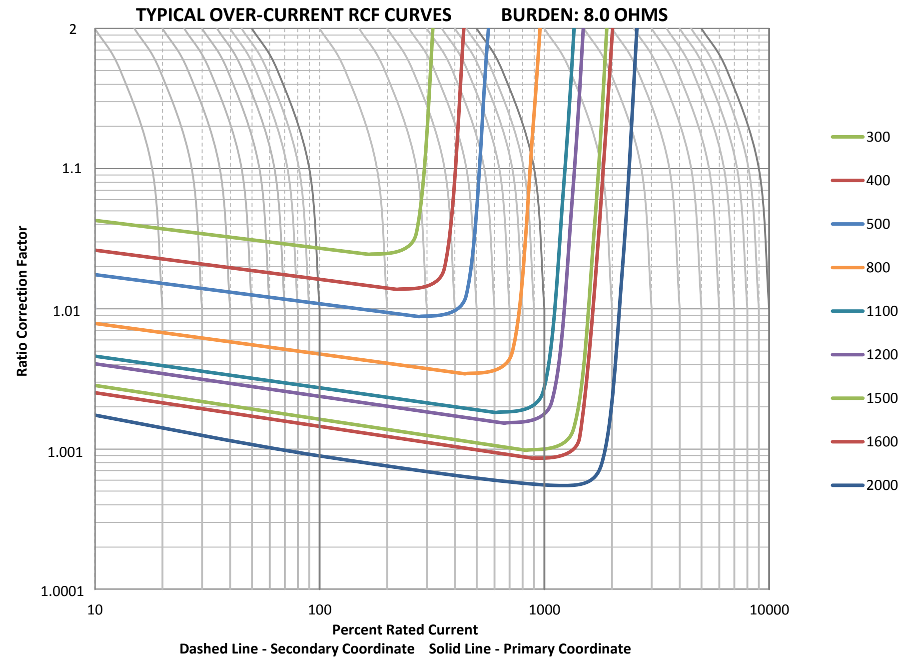
drawn for:	DELTA STAR		
part number:	C-204-126530M		
drawn by:	[signature]	12/21/09	Drawing Design Number
checked by:	[signature]	12/21/09	09A-033-038

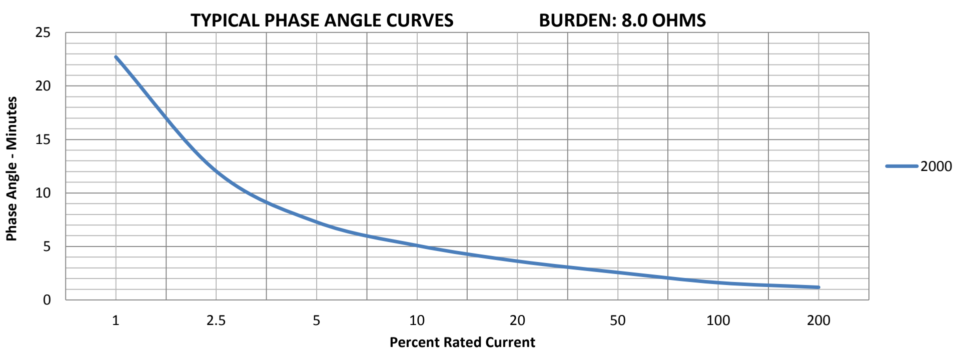
MERAMEC
Electrical Products Co., Inc.

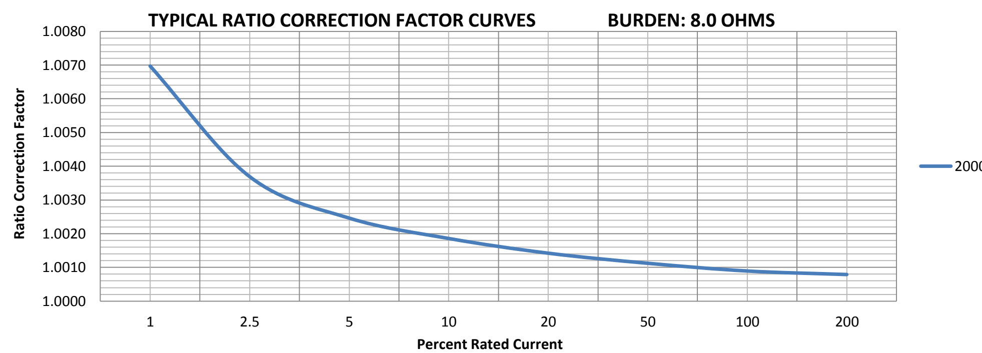
TYPICAL CHARACTERISTIC CURVES

REV. 01









DESIGN SPECIFICATIONS

FINISHED OUTSIDE DIAMETER:		12.0 inches / 305 mm
FINISHED INSIDE DIAMETER:		6.5 inches / 165 mm
FINISHED HEIGHT:		4.5 inches / 114 mm
FINISHED WEIGHT:		64.8 lbs / 29.4 kgs
STANDARD:		IEEE C57.13
TYPE:		BUSHING CURRENT TRANSFORMER
INSULATION LEVEL:		0.6kV CLASS
TEMPERATURE CLASS:		105° C.
FREQUENCY:		60 HZ
DESIGN RATIO:		2000:5MR
GUARANTEED @ RATIO:		2000 : 5
TOTAL SECONDARY TURNS:		400
SECONDARY RESISTANCE @ 75° C:		0.0023 OHMS / TURN
FULL WINDING RESISTANCE:	(including leads)	0.9988 OHMS
LEAD RESISTANCE @ 75° C:	(#12 guage)	0.0022 OHMS / FT
CONTINUOUS THERMAL RATING FACTOR:		2.0 TIMES RATED @ 95° C @ ALL TAPS
THERMAL 1 SECOND:	(94.8 times nominal ratio)	189.6 kA RMS SYM @ FULL RATIO
THERMAL 3 SECOND:	(55 times nominal ratio)	110.0 kA RMS SYM @ FULL RATIO
MECH. / DYNAMIC RATING:	(256 times nominal ratio)	511.9 kA pk MAX
ACCURACY CLASS:		C800 @ 2000:5

TYPICAL CHARACTERISTIC CURVES

DESIGN NOTES

REVISION HISTORY

REV.	DATE	DESCRIPTION

RATIO	TURNS	CONNECTION
300 : 5	60	X3-X4
400 : 5	80	X1-X2
500 : 5	100	X4-X5
800 : 5	160	X2-X3
1100 : 5	220	X2-X4
1200 : 5	240	X1-X3
1500 : 5	300	X1-X4
1600 : 5	320	X2-X5
2000 : 5	400	X1-X5

The Secondary Excitation Curves dashed (---) line represents the knee point (Ek) the point tangent to the curve at 45° to the exciting current Ie. TOLERANCE OF CURVE VALUE: To the right of this line at any current Ie the voltage Es cannot be <95%. To the left of this line at any voltage Es the current Ie cannot be >125%.

DELTA STAR

Part Number: R-208-126545M

Drawn by: [signature] 11/07/11

Meramec Drawing: 09A-037-841 REV. 00

MERAMEC
Instrument Transformer Co.

Preliminary Winding Resistance Measurements

MR #:	5119	Reference Temp:	85.000
DSE EQUIPMENT #:	I30412	Top Oil Temp:	30.80
Tested By:	JY/TJ	Top Header Temp:	29.40
Date:	9/15/2020	Bottom Header Temp:	26.20
		Average Winding Temp:	29.200

HV Winding Resistance

	Measured Per Phase (Ω)				
DETC Tap	H1-H2	H1-H3	H2-H3	3 Phase Average	Corrected Total Ohms
1	0.79235	0.79150	0.79195	0.791933	1.439265
2	0.77370	0.77295	0.77330	0.773317	1.405430
3	0.75650	0.75565	0.75605	0.756067	1.374080
4	0.73765	0.73685	0.73720	0.737233	1.339852
5	0.71895	0.71820	0.71850	0.718550	1.305897

LV Winding Resistance (Line to Neutral)

	Measured Per Phase (Ω)				
OLTC Tap	X1-X0	X2-X0	X3-X0	3 Phase Average	Corrected Total Ohms
16R	0.013454	0.013414	0.013531	0.013466	0.048948
15R	0.013255	0.013222	0.013329	0.013269	0.048229
14R	0.013256	0.013224	0.013345	0.013275	0.048252
13R	0.013139	0.013108	0.013218	0.013155	0.047816
12R	0.013167	0.013135	0.013258	0.013187	0.047931
11R	0.013038	0.013013	0.013121	0.013057	0.047461
10R	0.013066	0.013038	0.013158	0.013087	0.047570
9R	0.012870	0.012844	0.012951	0.012888	0.046847
8R	0.012887	0.012852	0.012961	0.012900	0.046889
7R	0.012754	0.012720	0.012830	0.012768	0.046409
6R	0.012779	0.012743	0.012867	0.012796	0.046512
5R	0.012663	0.012629	0.012745	0.012679	0.046086
4R	0.012705	0.012662	0.012781	0.012716	0.046220
3R	0.012486	0.012448	0.012564	0.012499	0.045433
2R	0.012499	0.012449	0.012579	0.012509	0.045468
1R	0.012238	0.012214	0.012325	0.012259	0.044559
N	0.012179	0.012160	0.012268	0.012202	0.044353
1L	0.012230	0.012214	0.012321	0.012255	0.044545
2L	0.012462	0.012416	0.012564	0.012481	0.045365
3L	0.012458	0.012425	0.012553	0.012479	0.045358
4L	0.012659	0.012624	0.012767	0.012683	0.046102
5L	0.012635	0.012604	0.012729	0.012656	0.046002
6L	0.012756	0.012721	0.012864	0.012780	0.046454
7L	0.012732	0.012704	0.012827	0.012754	0.046360
8L	0.012860	0.012828	0.012968	0.012885	0.046836
9L	0.012856	0.012823	0.012944	0.012874	0.046796
10L	0.013060	0.013017	0.013142	0.013073	0.047518
11L	0.013028	0.012993	0.013112	0.013044	0.047414
12L	0.013160	0.013115	0.013252	0.013176	0.047891
13L	0.013135	0.013094	0.013220	0.013150	0.047797
14L	0.013265	0.013214	0.013346	0.013275	0.048252
15L	0.013255	0.013208	0.013332	0.013265	0.048216
16L	0.013466	0.013411	0.013542	0.013473	0.048972

project : 5119	test date 9/17/2020	page 1

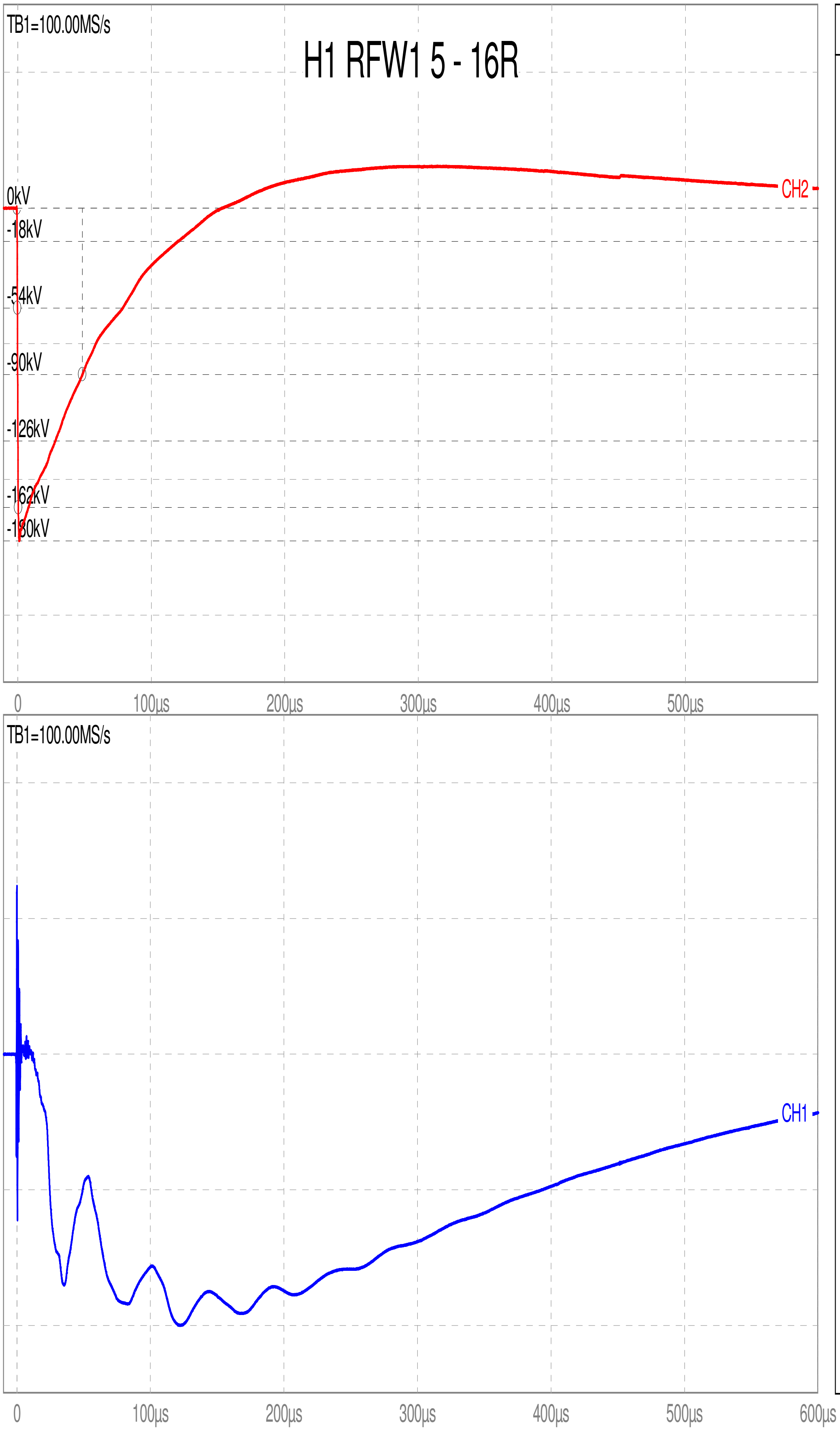
Climate - Data

temperature	℃	humidity	%
		air-pressure	hPa

LI lightning-impulse

no.	Up [kV]	T1[µs]	T2[µs]	remark
1	-180.1	1.15	49	H1 RFW1 5 - 16R
2	-180.1	1.15	49	OVERLAY: H1 RFW1 FW1 5 - 16R
3	-180.1	1.15	49	OVERLAY: H1 RFW1 FW2 5 - 16R
4	-180.1	1.15	49	OVERLAY: H1 RFW1 FW3 5 - 16R
5	-348	1.15	49.3	H1 FW1 5 - 16R
6	-383.5	1.16		H1 CW1 5 - 16R
7	-388.3	1.19		H1 CW2 5 - 16R
8	-350.8	1.16	49.4	H1 FW2 5 - 16R
9	-350.7	1.16	49.4	H1 FW3 5 - 16R
10	-179.9	1.15	49	H1 RFW2 5 - 16R
11	-180.3	1.15	50.1	H2 RFW1 3 - 1L
12	-180.3	1.15	50.1	OVERLAY: H2 RFW1 FW1 3 - 1L
13	-180.3	1.15	50.1	OVERLAY: H2 RFW1 FW2 3 - 1L
14	-180.3	1.15	50.1	OVERLAY: H2 RFW1 FW3 3 - 1L
15	-350.9	1.15	50.5	H2 FW1 3 - 1L
16	-387	1.17		H2 CW1 3 - 1L
17	-385.8	1.16		H2 CW2 3 - 1L
18	-351.2	1.16	50.6	H2 FW2 3 - 1L
19	-351.3	1.15	50.5	H2 FW3 3 - 1L
20	-180.1	1.15	50.2	H2 RFW2 3 - 1L
21	-179.8	1.16	51.1	H3 RFW1 1 - 16L
22	-179.8	1.16	51.1	OVERLAY: H3 RFW1 FW1 1 - 16L
23	-179.8	1.16	51.1	OVERLAY: H3 RFW1 FW2 1 - 16L
24	-179.8	1.16	51.1	OVERLAY: H3 RFW1 FW3 1 - 16L
25	-351.2	1.16	51.4	H3 FW1 1 - 16L
26	-386.9	1.18		H3 CW1 1 - 16L
27	-387.2	1.18		H3 CW2 1 - 16L
28	-350.5	1.16	51.4	H3 FW2 1 - 16L
29	-351.3	1.16	51.4	H3 FW3 1 - 16L
30	-180.5	1.16	51.1	H3 RFW2 1 - 16L
31	-80.45	1.29	48	X3 RFW1 1L-3
32	-80.45	1.29	48	OVERLAY: X3 RFW1-FW1 1L-3
33	-80.45	1.29	48	OVERLAY: X3 RFW1-FW2 1L-3

34	-80.45	1.29	48	OVERLAY: X3 RFW1-FW3 1L-3
35	-150.5	1.26	48.2	X3 FW1 1L-3
36	-165.3	1.27	4.88	X3 CW1 1L-3
37	-165.6	1.27	4.52	X3 CW2 1L-3
38	-150.5	1.26	48.2	X3 FW2 1L-3
39	-150.4	1.26	48.2	X3 FW3 1L-3
40	-80.55	1.28	48	X3 RFW2 1L-3
41	-81.47	1.32	48.6	X2 RFW1 16R-5
42	-81.47	1.32	48.6	OVERLAY: X2 RFW1-FW1 16R-5
43	-81.47	1.32	48.6	OVERLAY: X2 RFW1-FW2 16R-5
44	-81.47	1.32	48.6	OVERLAY: X2 RFW1-FW3 16R-5
45	-149.7	1.3	48.9	X2 FW1 16R-5
46	-165.3	1.31		X2 CW1 16R-5
47	-165.2	1.3		X2 CW2 16R-5
48	-150.3	1.3	48.9	X2 FW2 16R-5
49	-150.3	1.3	48.9	X2 FW3 16R-5
50	-80.89	1.32	48.6	X2 RFW2 16R-5
51	-80.01	1.26	47	X1 RFW1 16L-1
52	-80.01	1.26	47	OVERLAY: X1 RFW1-FW1 16L-1
53	-80.01	1.26	47	OVERLAY: X1 RFW1-FW2 16L-1
54	-80.01	1.26	47	OVERLAY: X1 RFW1-FW3 16L-1
55	-149.9	1.25	47.2	X1 FW1 16L-1
56	-165.4	1.25		X1 CW1 16L-1
57	-165.2	1.26		X1 CW2 16L-1
58	-150.5	1.25	47.2	X1 FW2 16L-1
59	-150.4	1.24	47.2	X1 FW3 16L-1
60	-80.16	1.26	47.1	X1 RFW2 16L-1



No.: 1

CH1 No. 1

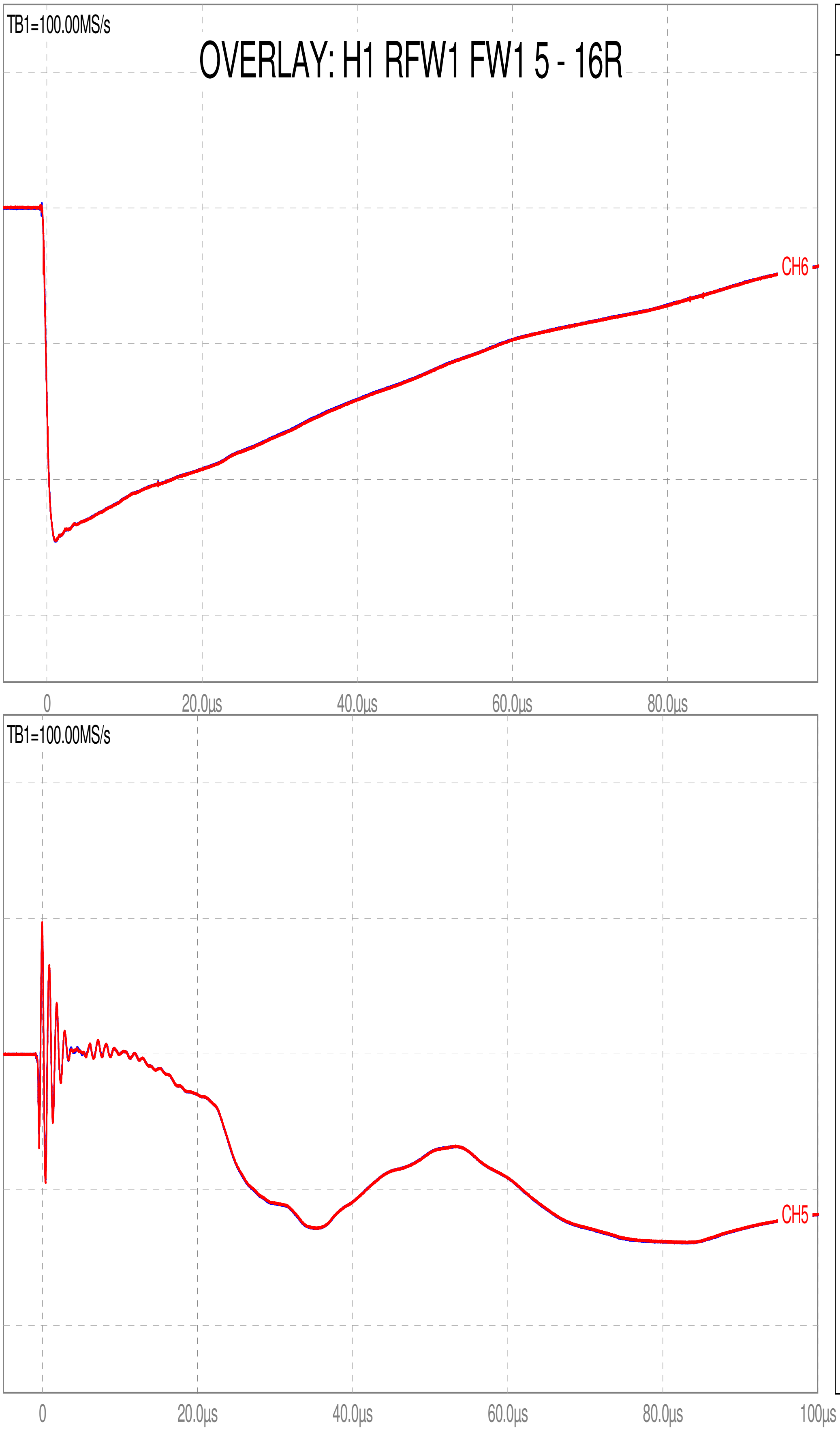
Ip= -120.5A

CH2 No. 1

Up= -180.1kV

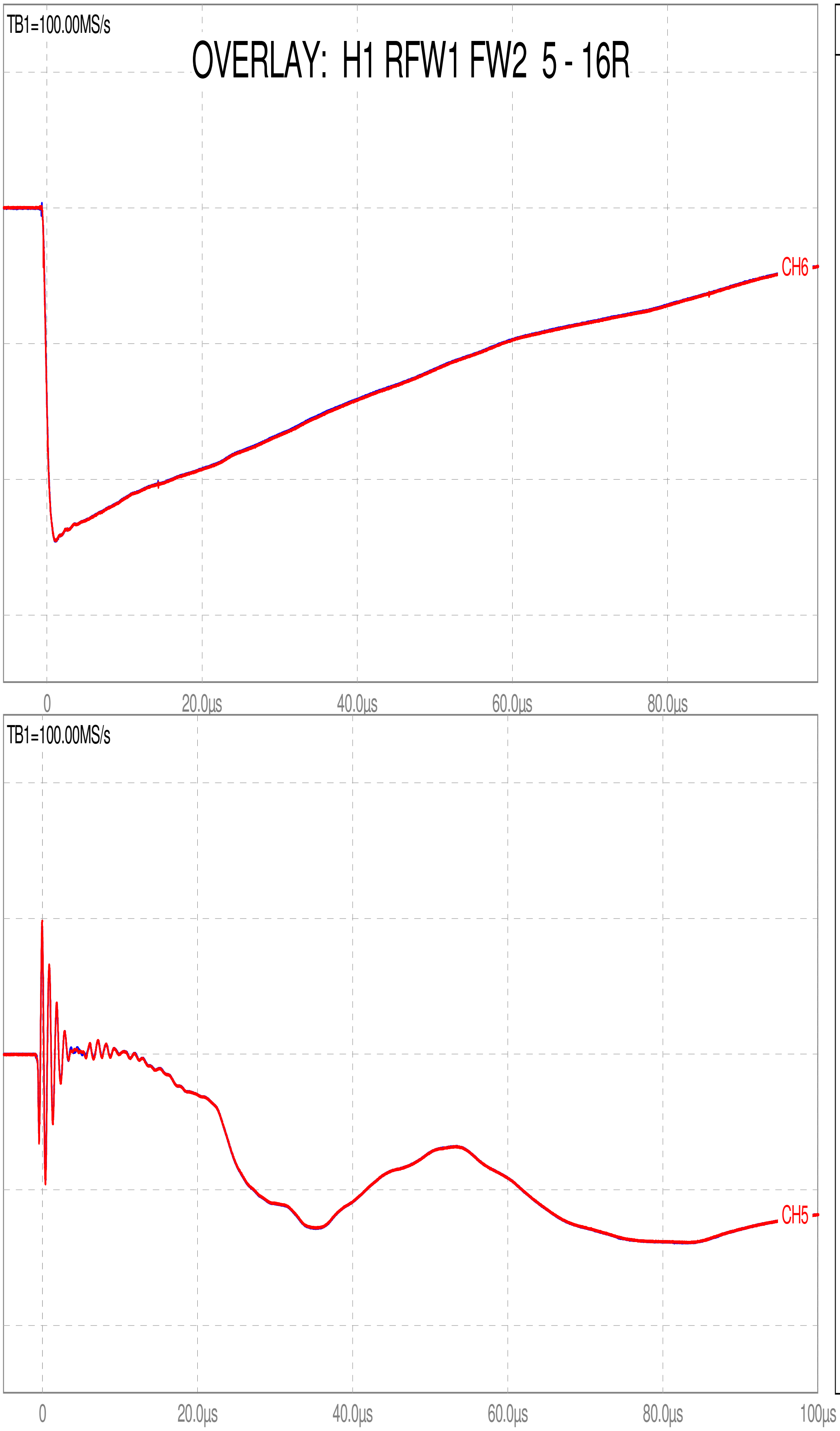
T1= 1.15µs

T2= 49µs

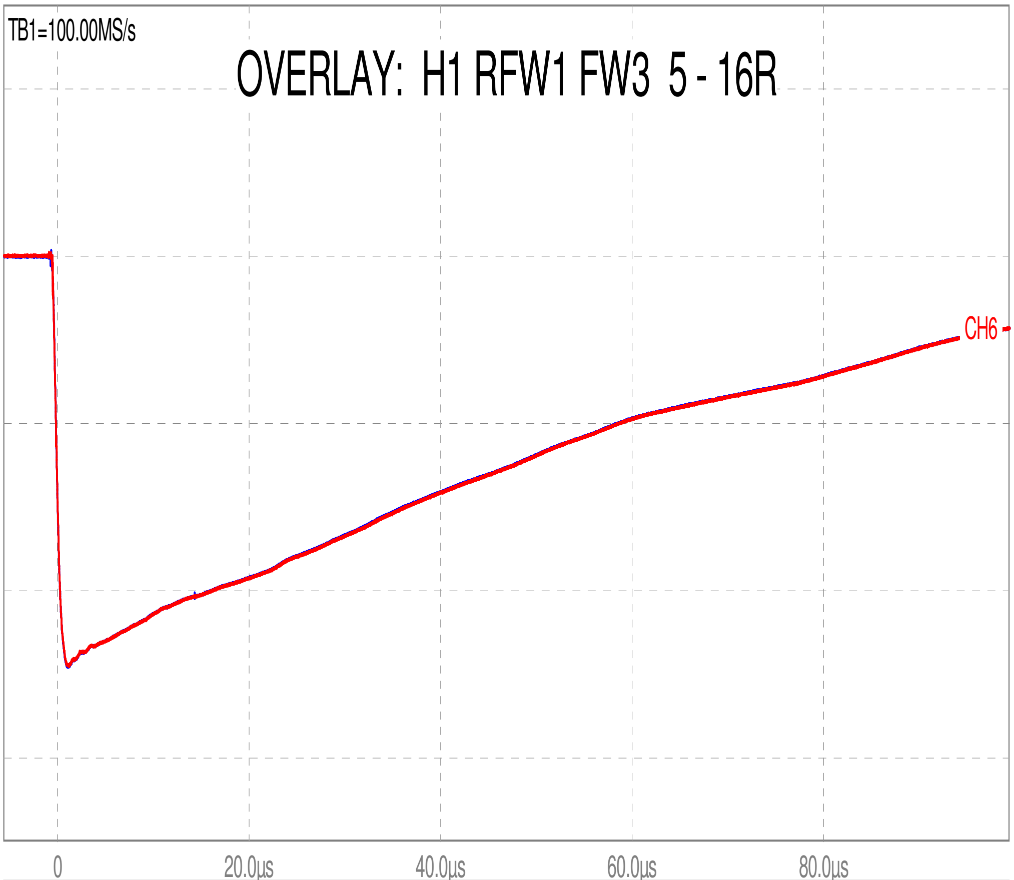


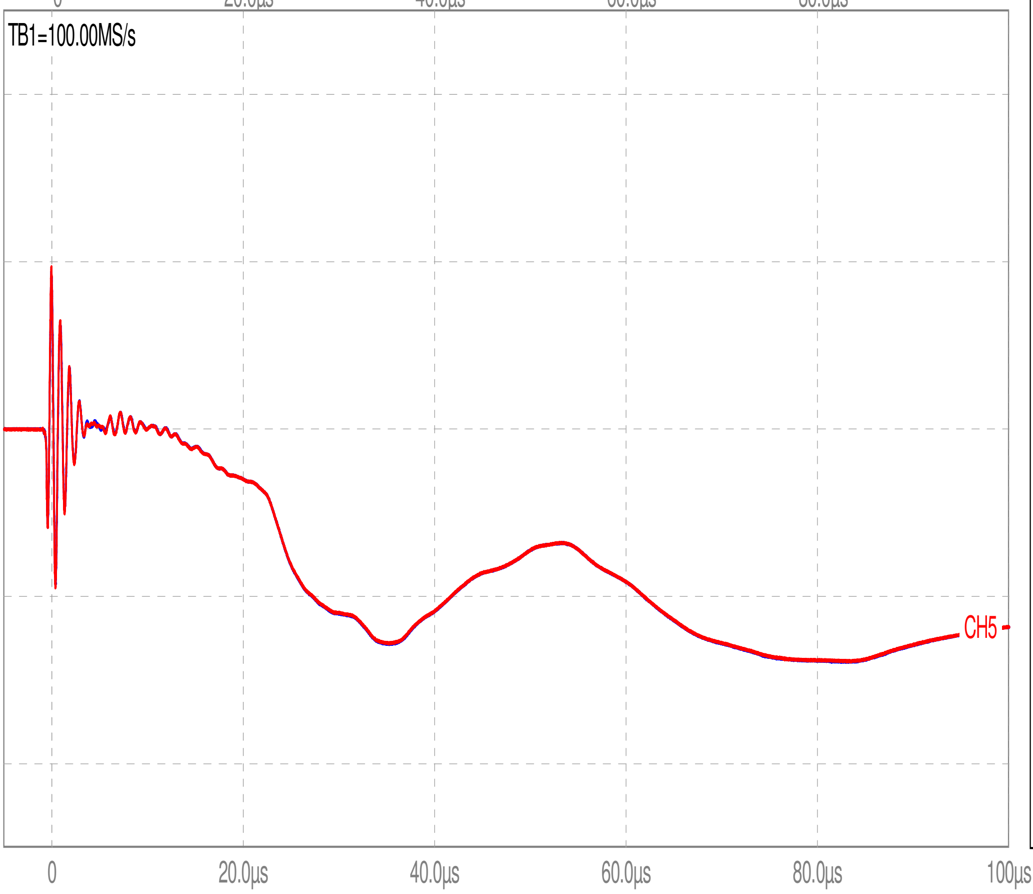
No.: 2

CH1 No. 2
Ip= -120.5A
CH2 No. 2
Up= -180.1kV
T1= 1.15µs
T2= 49µs
CH5 No. 121170
CH6 No. 121170



No.: 3
CH1 No. 3
Ip= -120.5A
CH2 No. 3
Up= -180.1kV
T1= 1.15µs
T2= 49µs
CH5 No. 121173
CH6 No. 121173





No.: 4

CH1 No. 4

Ip= -120.5A

CH2 No. 4

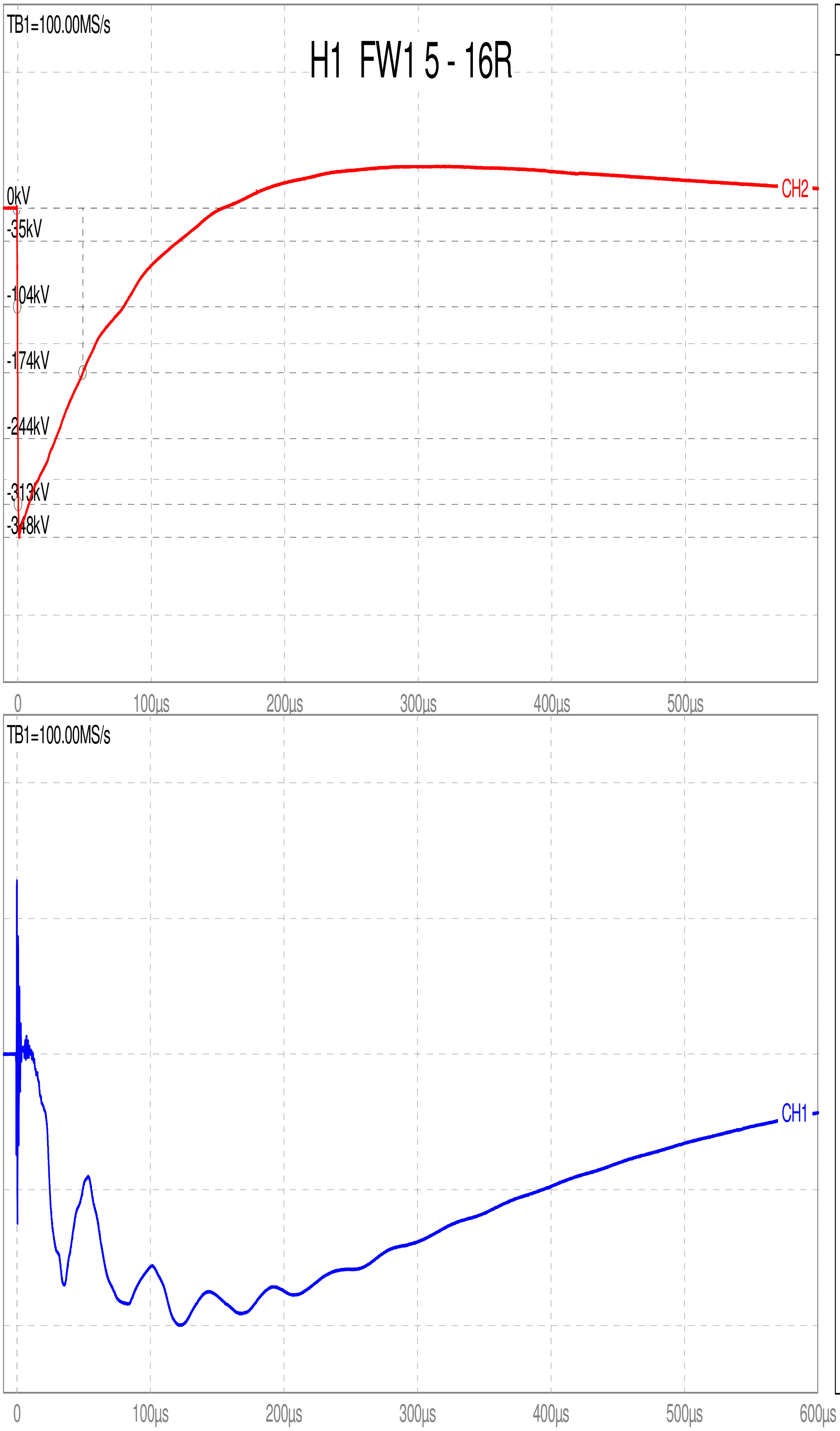
Up= -180.1kV

T1= 1.15µs

T2= 49µs

CH5 No. 121174

CH6 No. 121174



No.: 5	
CH1 No. 5	
Ip=	-234.4A
CH2 No. 5	
Up=	-348kV
T1=	1.15µs
T2=	49.3µs

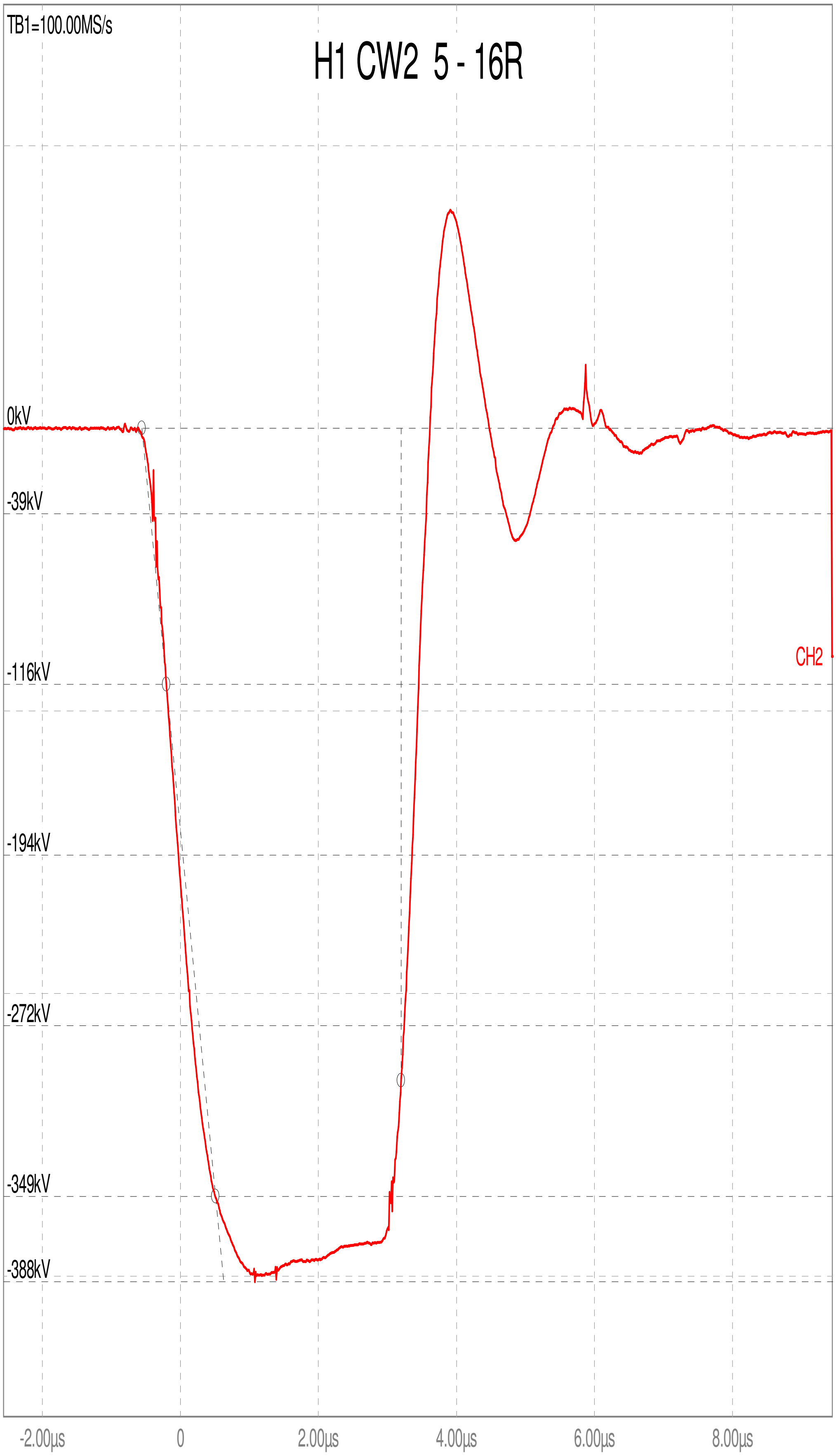
No.: 121171

CH2 No. 121171

Up= -383.5kV

T1= 1.16µs

Tc= 3.93µs



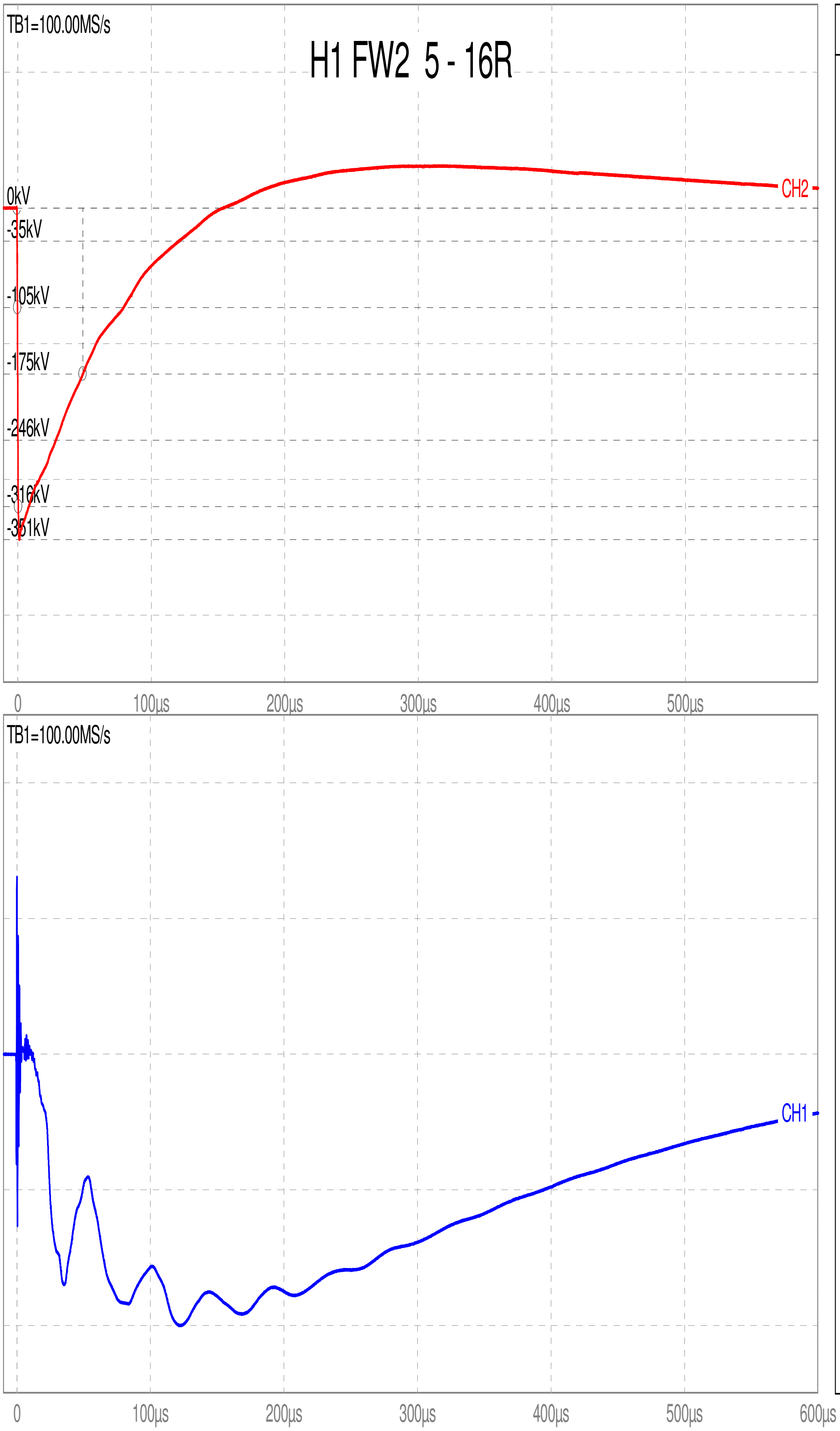
No.: 121172

CH2 No. 121172

Up= -388.3kV

T1= 1.19µs

Tc= 3.76µs



No.: 8

CH1 No. 8

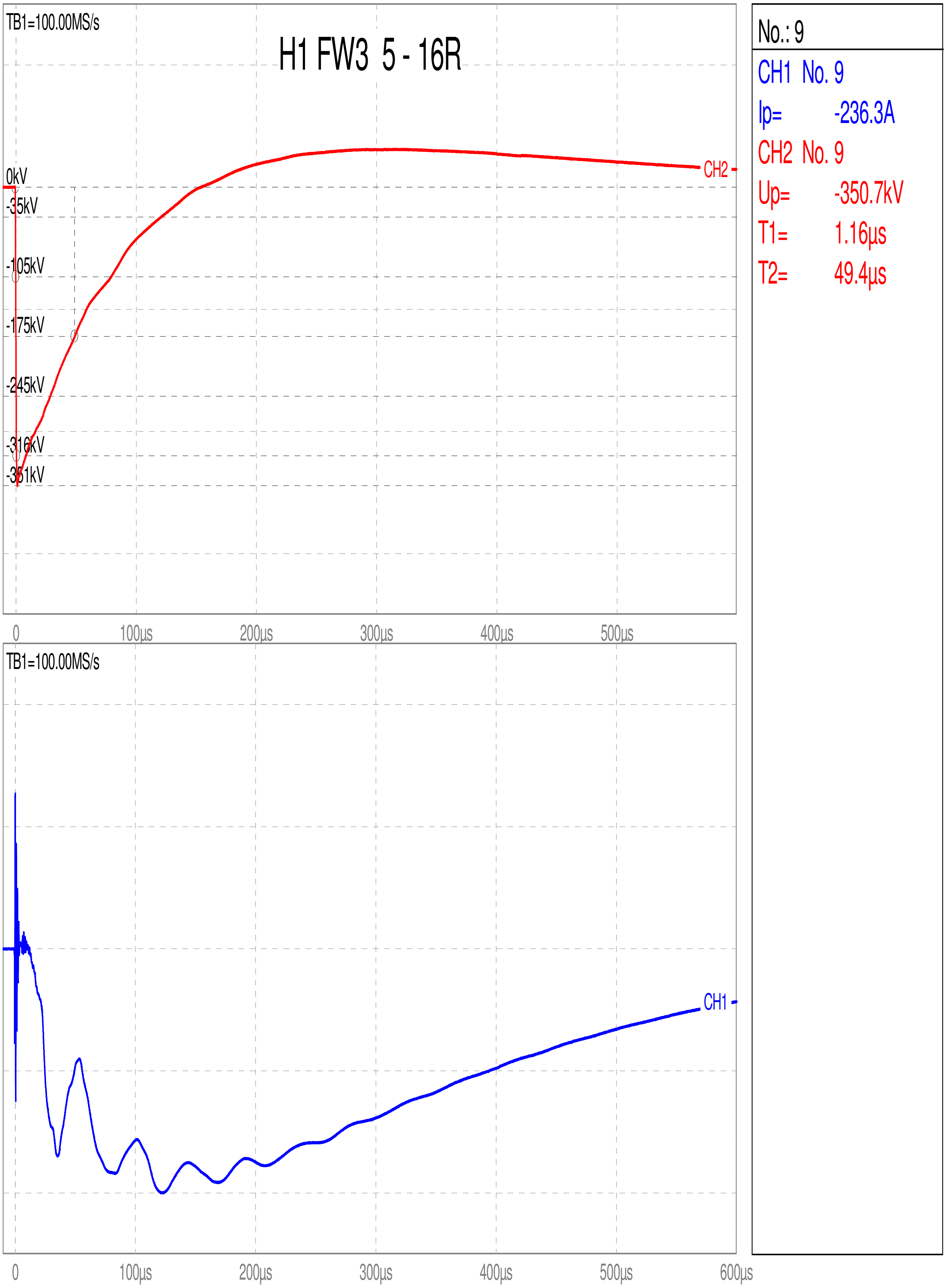
Ip= -236.5A

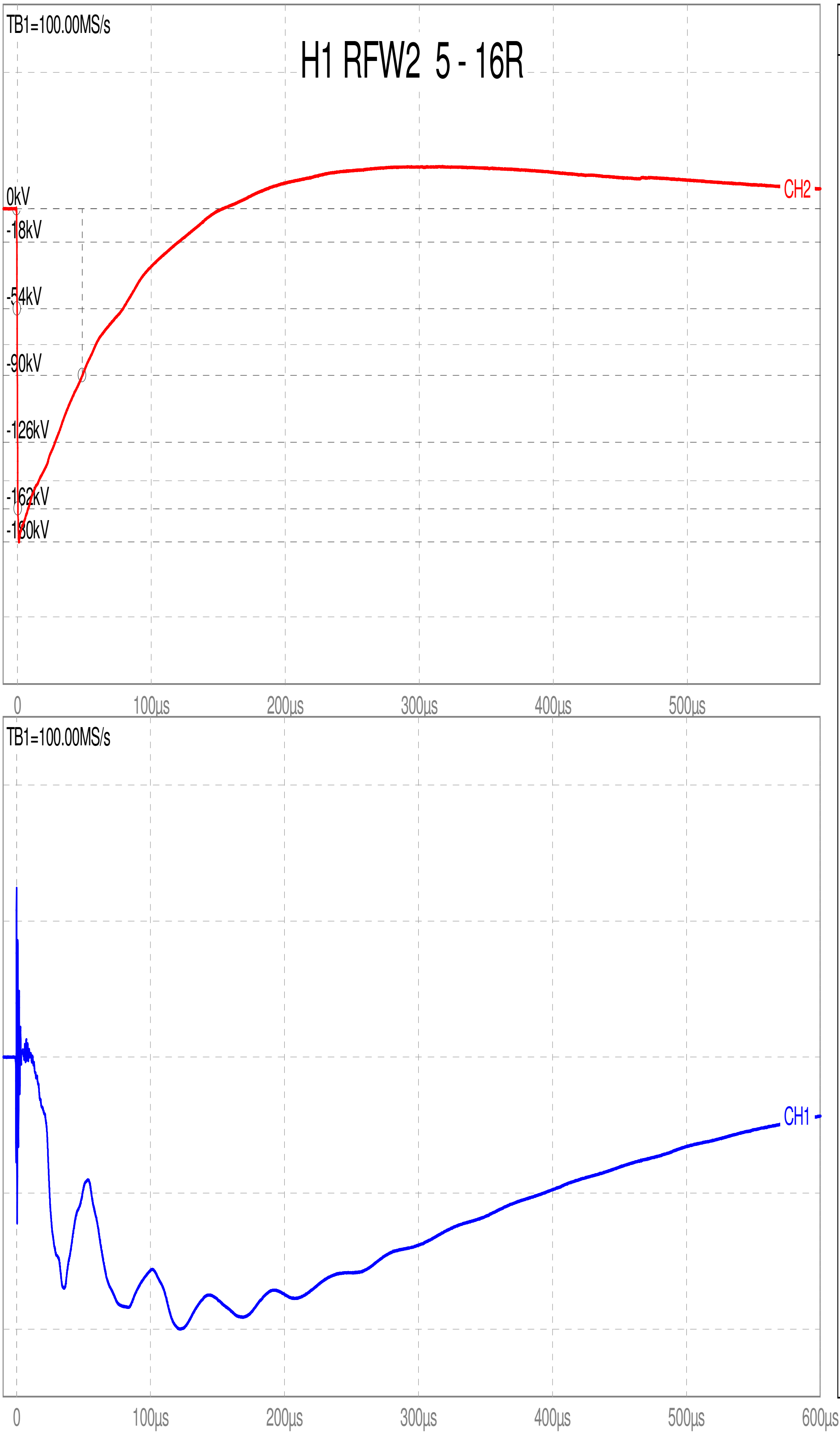
CH2 No. 8

Up= -350.8kV

T1= 1.16µs

T2= 49.4µs


TB1=100.00MS/s
H1 FW3 5 - 16R
0kV
-35kV
-105kV
-175kV
-245kV
-316kV
-351kV
CH2
0
100µs
200µs
300µs
400µs
500µs
TB1=100.00MS/s
CH1
0
100µs
200µs
300µs
400µs
500µs
600µs
No.: 9
CH1 No. 9
Ip= -236.3A
CH2 No. 9
Up= -350.7kV
T1= 1.16µs
T2= 49.4µs



No.: 10

CH1 No. 10

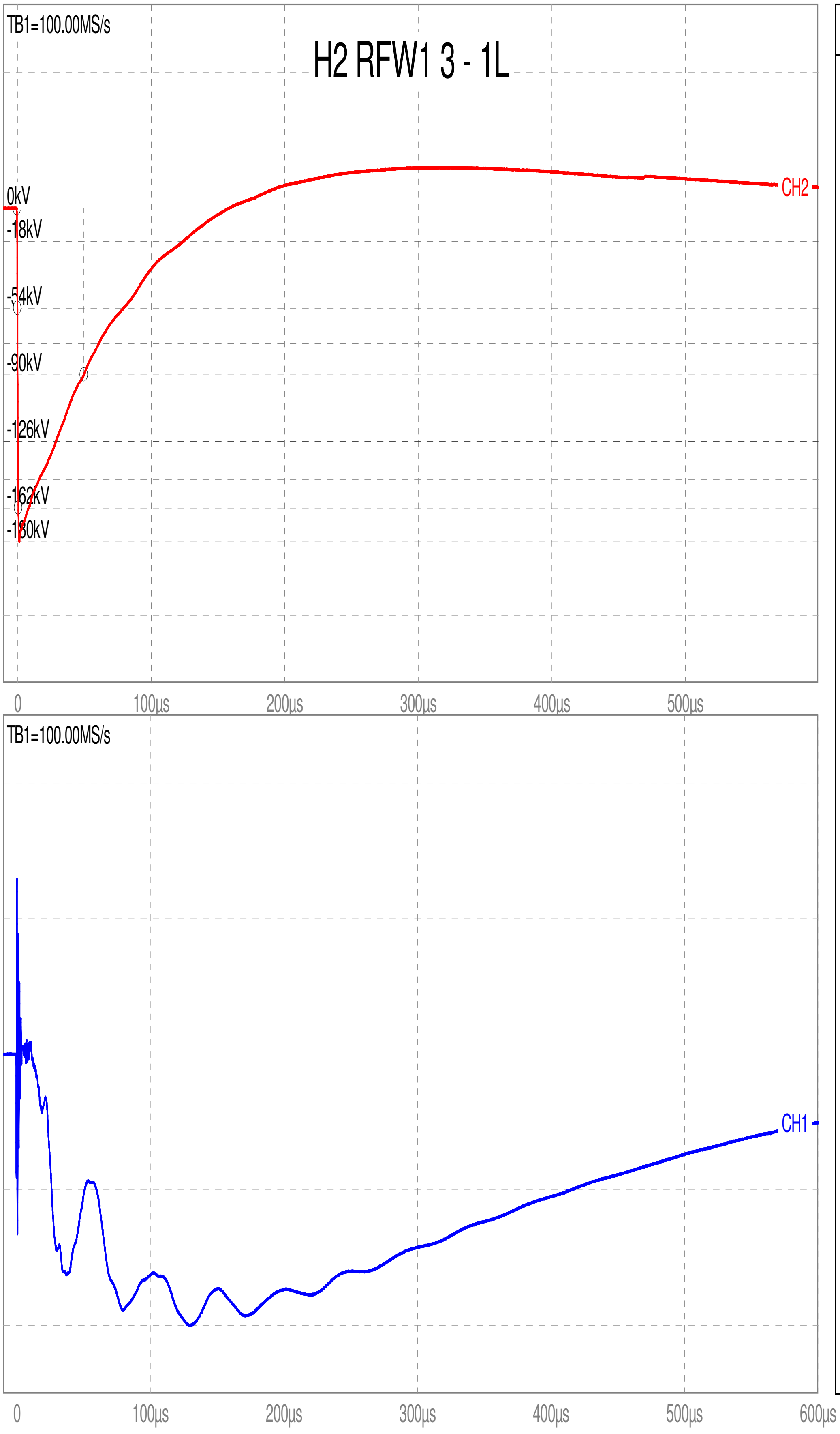
Ip= -120.7A

CH2 No. 10

Up= -179.9kV

T1= 1.15µs

T2= 49µs



No.: 11

CH1 No. 11

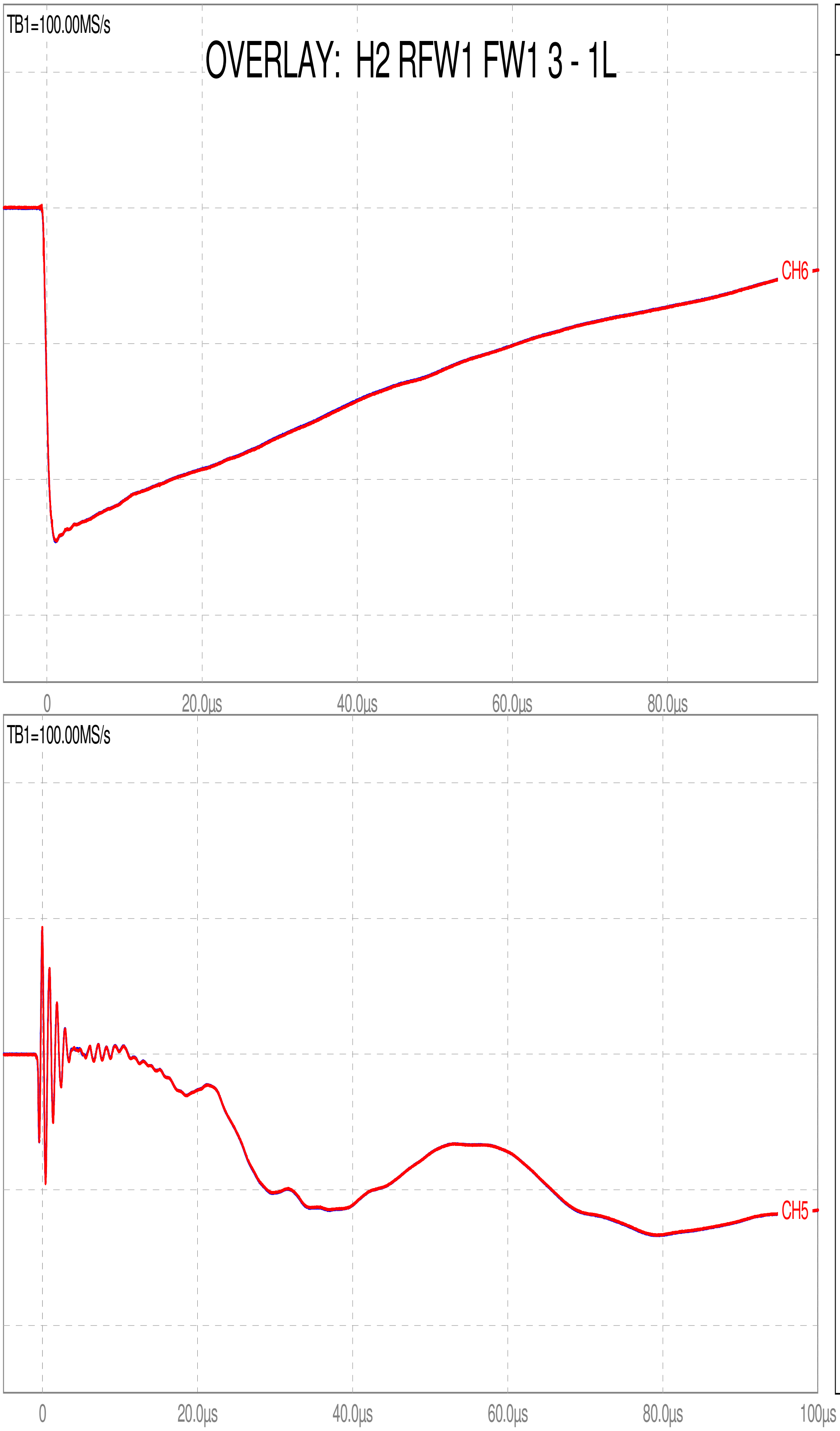
Ip= -113.1A

CH2 No. 11

Up= -180.3kV

T1= 1.15µs

T2= 50.1µs



No.: 12

CH1 No. 12

Ip= -113.1A

CH2 No. 12

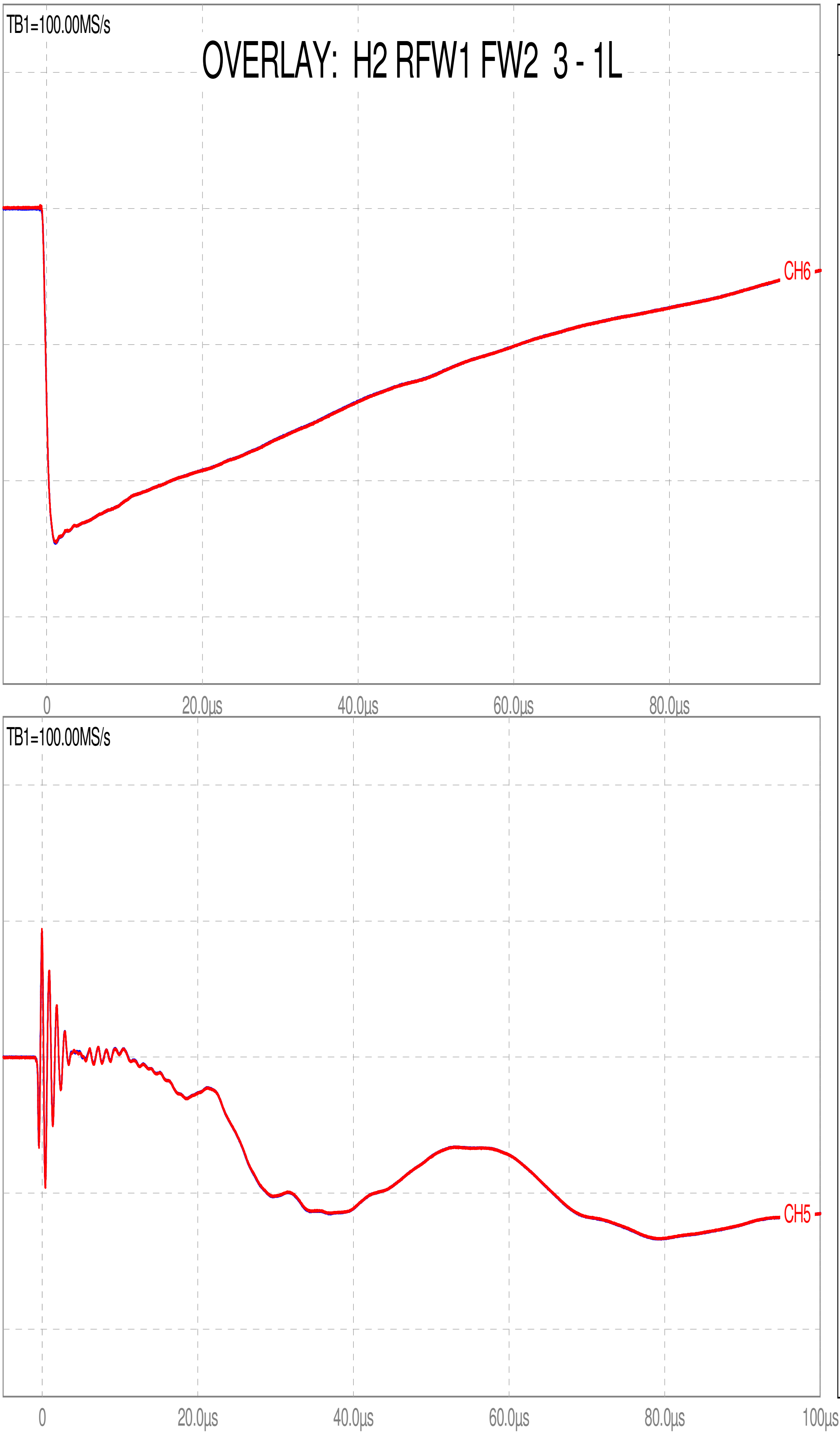
Up= -180.3kV

T1= 1.15µs

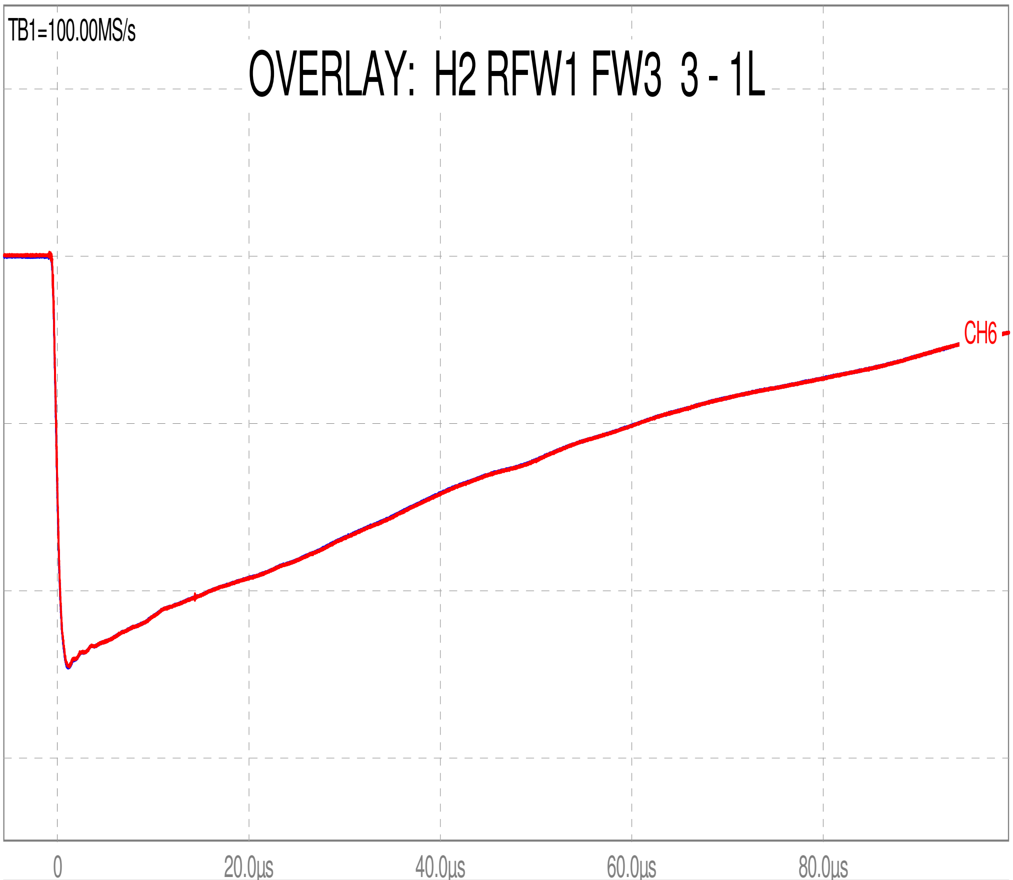
T2= 50.1µs

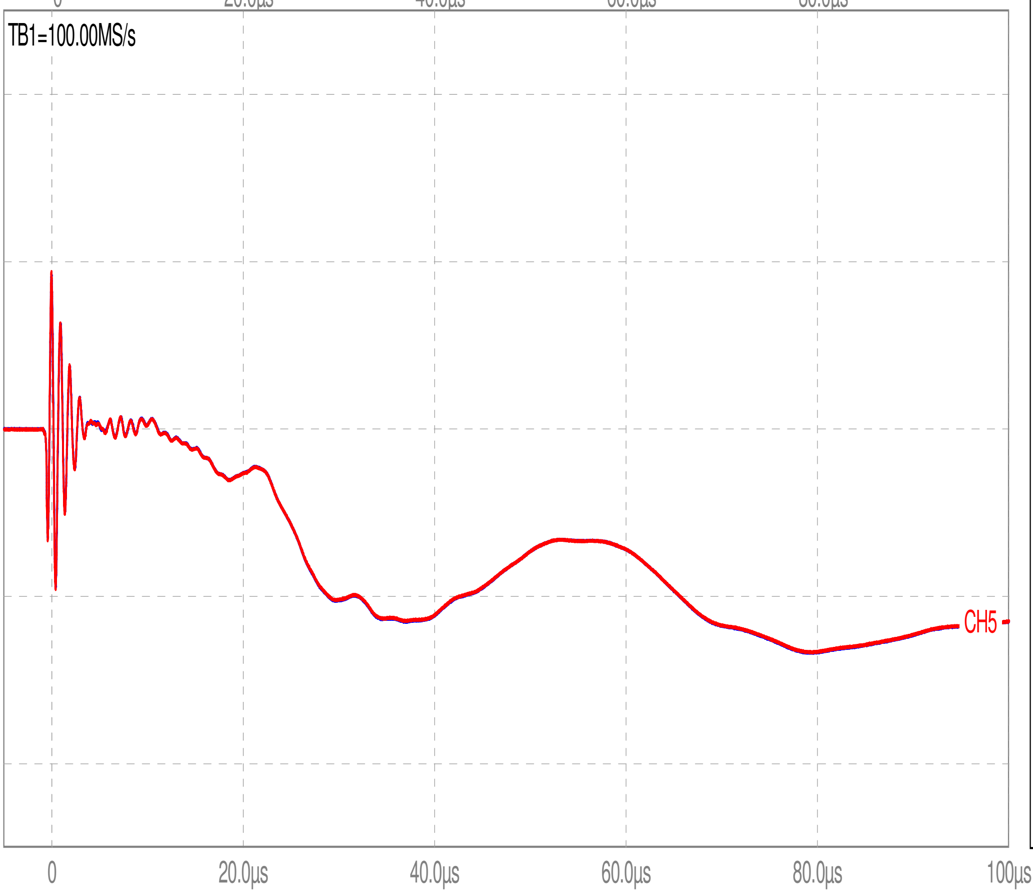
CH5 No. 121177

CH6 No. 121177



No.: 13	
CH1 No. 13	
Ip=	-113.1A
CH2 No. 13	
Up=	-180.3kV
T1=	1.15µs
T2=	50.1µs
CH5 No. 121180	
CH6 No. 121180	





No.: 14

CH1 No. 14

Ip= -113.1A

CH2 No. 14

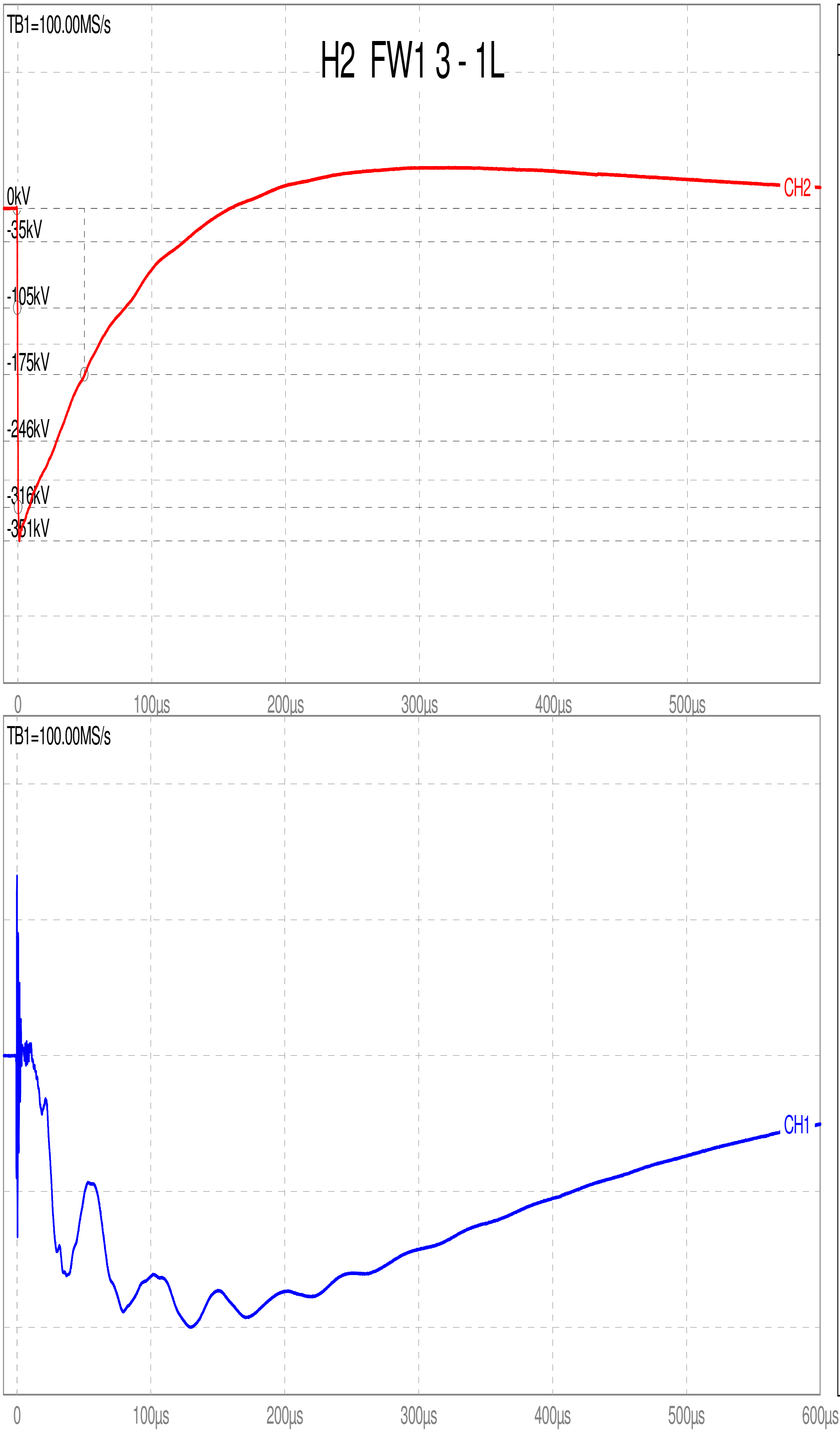
Up= -180.3kV

T1= 1.15µs

T2= 50.1µs

CH5 No. 121181

CH6 No. 121181



No.: 15

CH1 No. 15

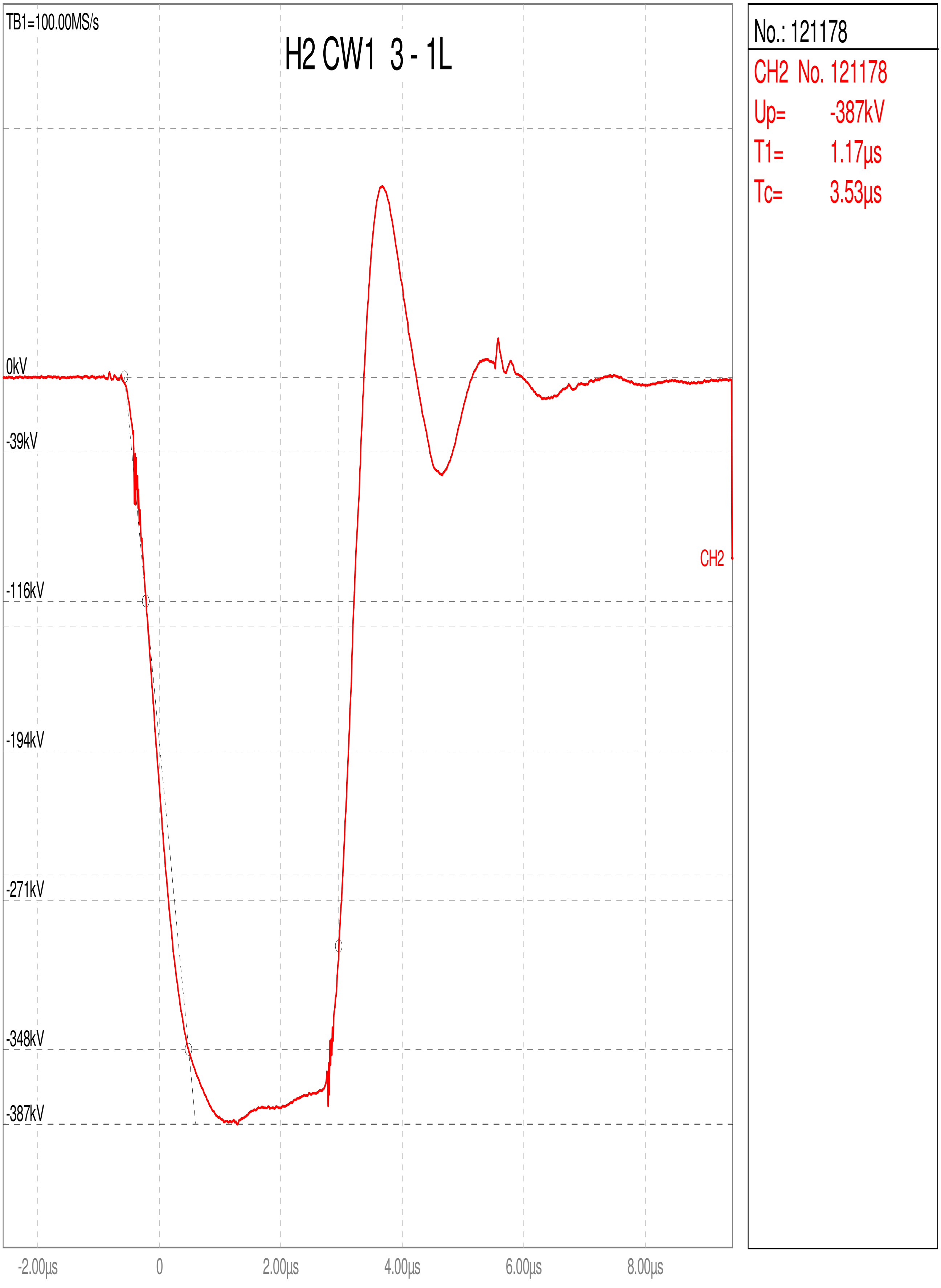
Ip= -222A

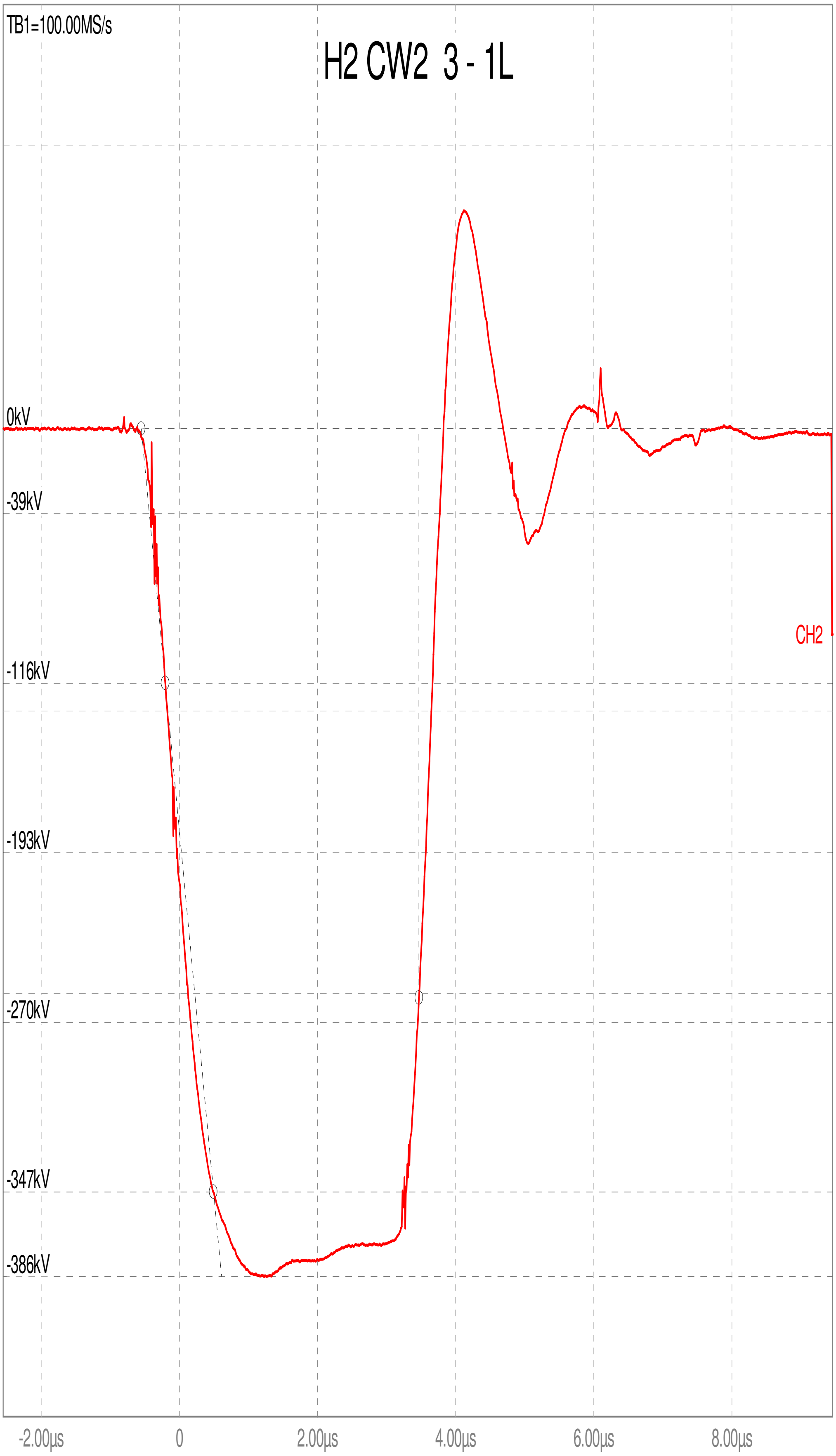
CH2 No. 15

Up= -350.9kV

T1= 1.15µs

T2= 50.5µs


TB1=100.00MS/s
H2 CW1 3 - 1L
0kV
-39kV
-116kV
-194kV
-271kV
-348kV
-387kV
CH2
-2.00µs
0
2.00µs
4.00µs
6.00µs
8.00µs
No.: 121178
CH2 No. 121178
Up= -387kV
T1= 1.17µs
Tc= 3.53µs



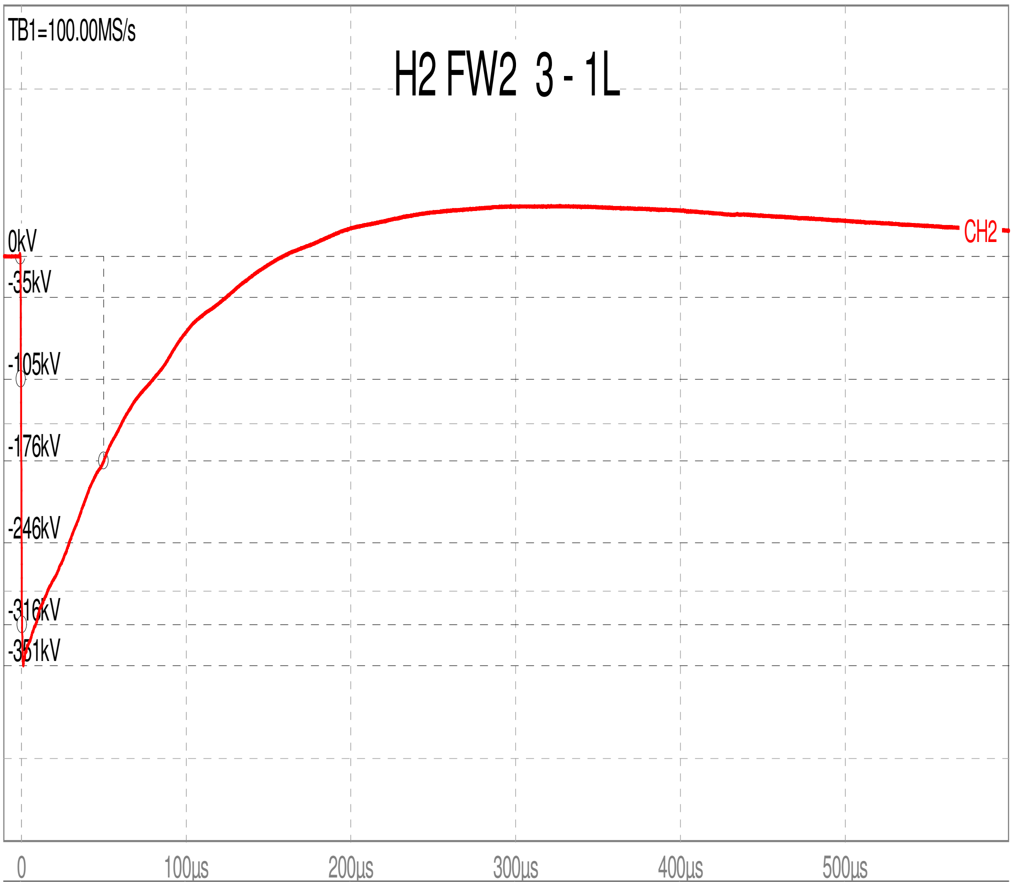
No.: 121179

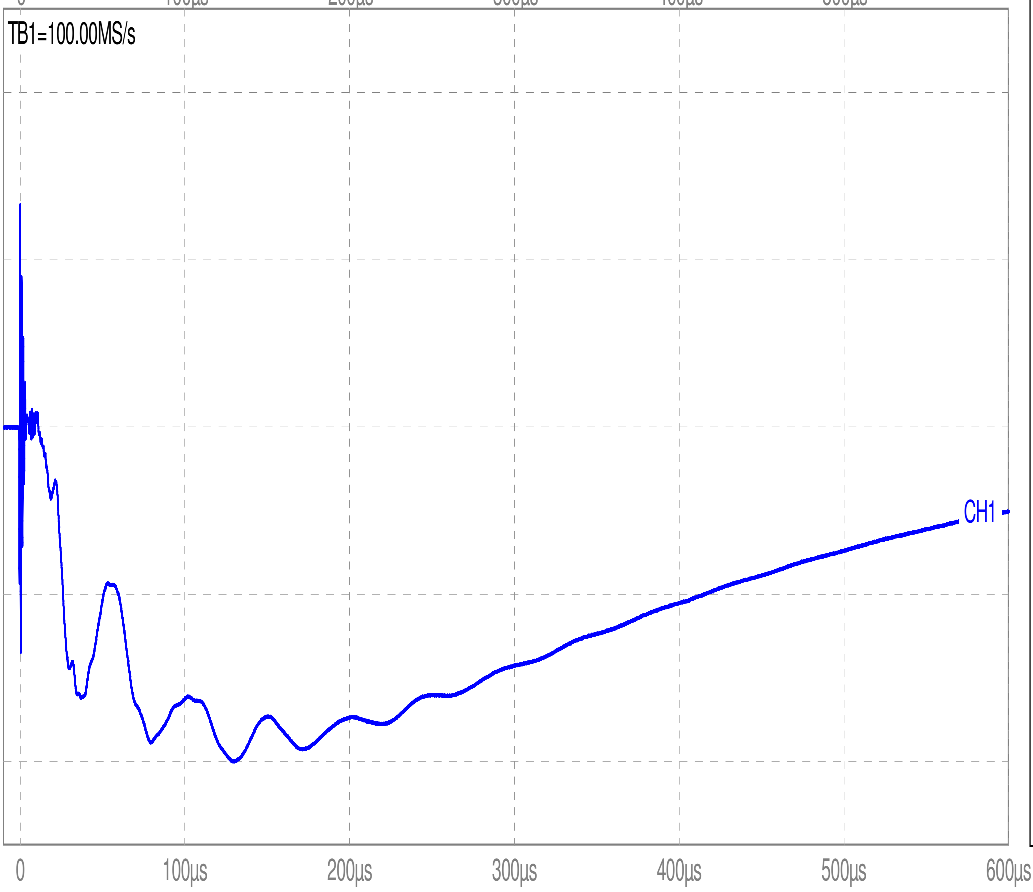
CH2 No. 121179

Up= -385.8kV

T1= 1.16µs

Tc= 4.02µs





No.: 18

CH1 No. 18

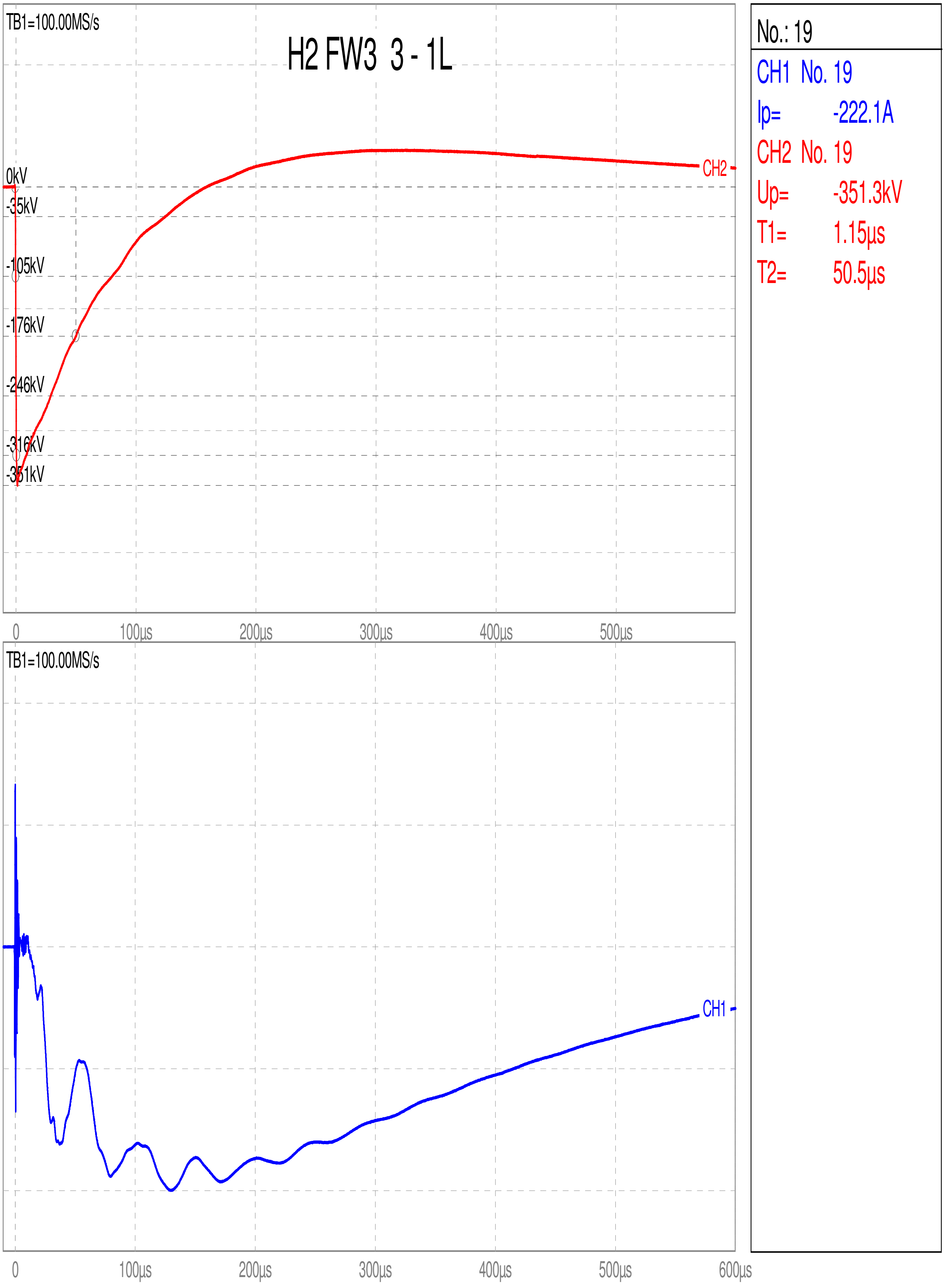
Ip= -221.9A

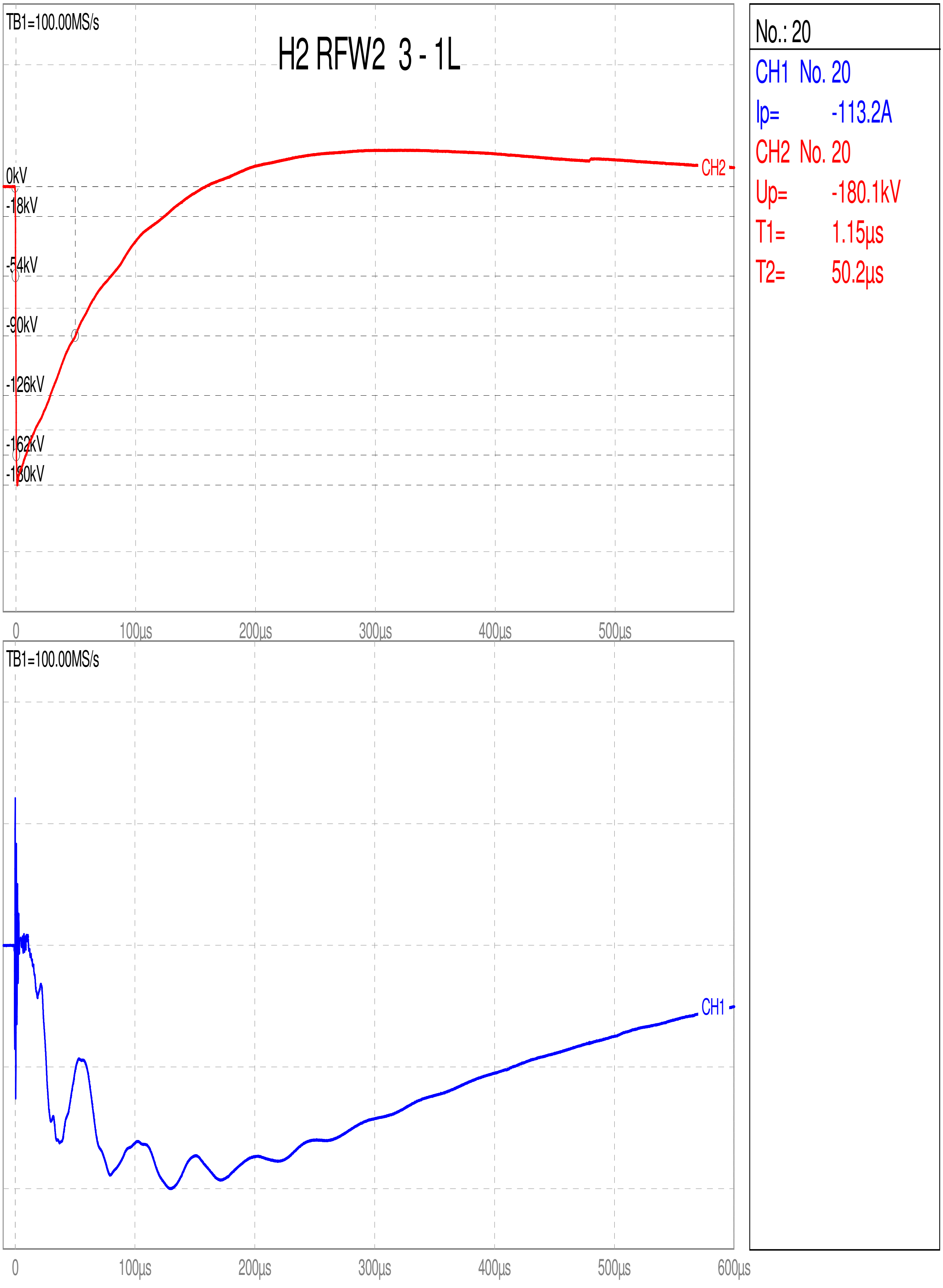
CH2 No. 18

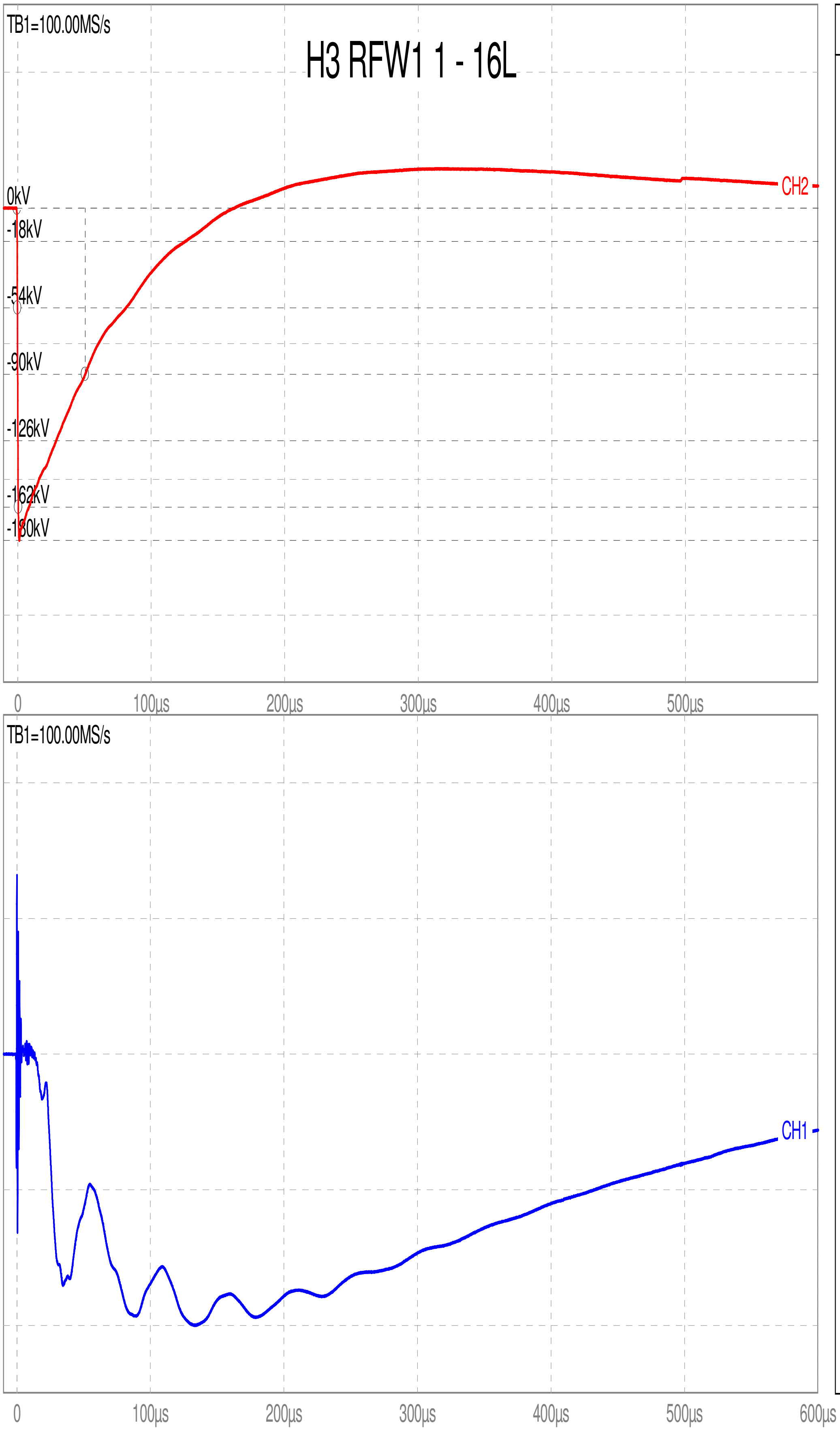
Up= -351.2kV

T1= 1.16µs

T2= 50.6µs


TB1=100.00MS/s
H2 FW3 3 - 1L
0kV
-35kV
-105kV
-176kV
-246kV
-316kV
-351kV
CH2
0
100µs
200µs
300µs
400µs
500µs
TB1=100.00MS/s
CH1
0
100µs
200µs
300µs
400µs
500µs
600µs
No.: 19
CH1 No. 19
Ip= -222.1A
CH2 No. 19
Up= -351.3kV
T1= 1.15µs
T2= 50.5µs


TB1=100.00MS/s
H2 RFW2 3 - 1L
0kV
-18kV
-54kV
-90kV
-126kV
-162kV
-180kV
CH2
0
100µs
200µs
300µs
400µs
500µs
TB1=100.00MS/s
CH1
0
100µs
200µs
300µs
400µs
500µs
600µs
No.: 20
CH1 No. 20
Ip= -113.2A
CH2 No. 20
Up= -180.1kV
T1= 1.15µs
T2= 50.2µs



No.: 21

CH1 No. 21

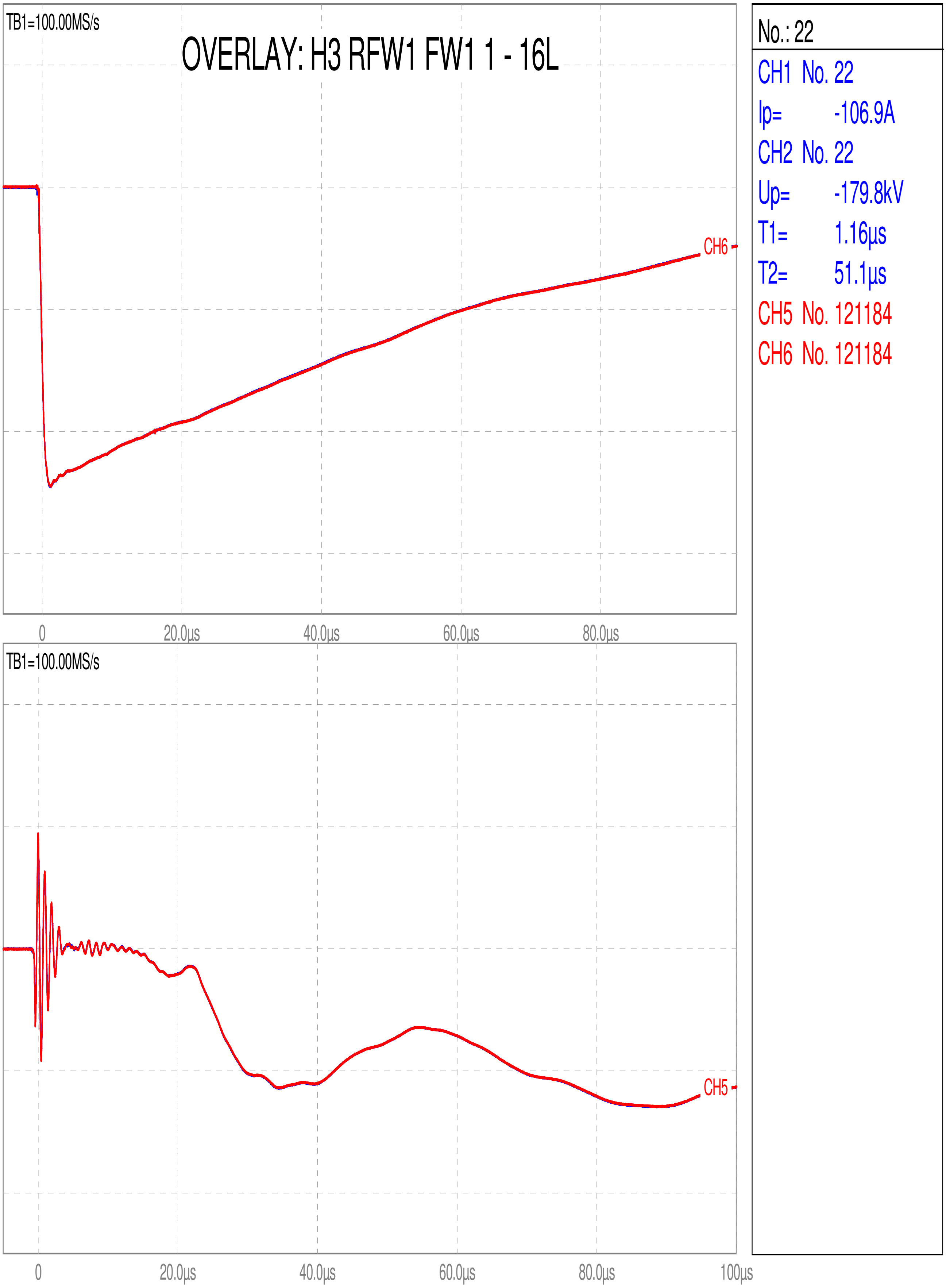
Ip= -106.9A

CH2 No. 21

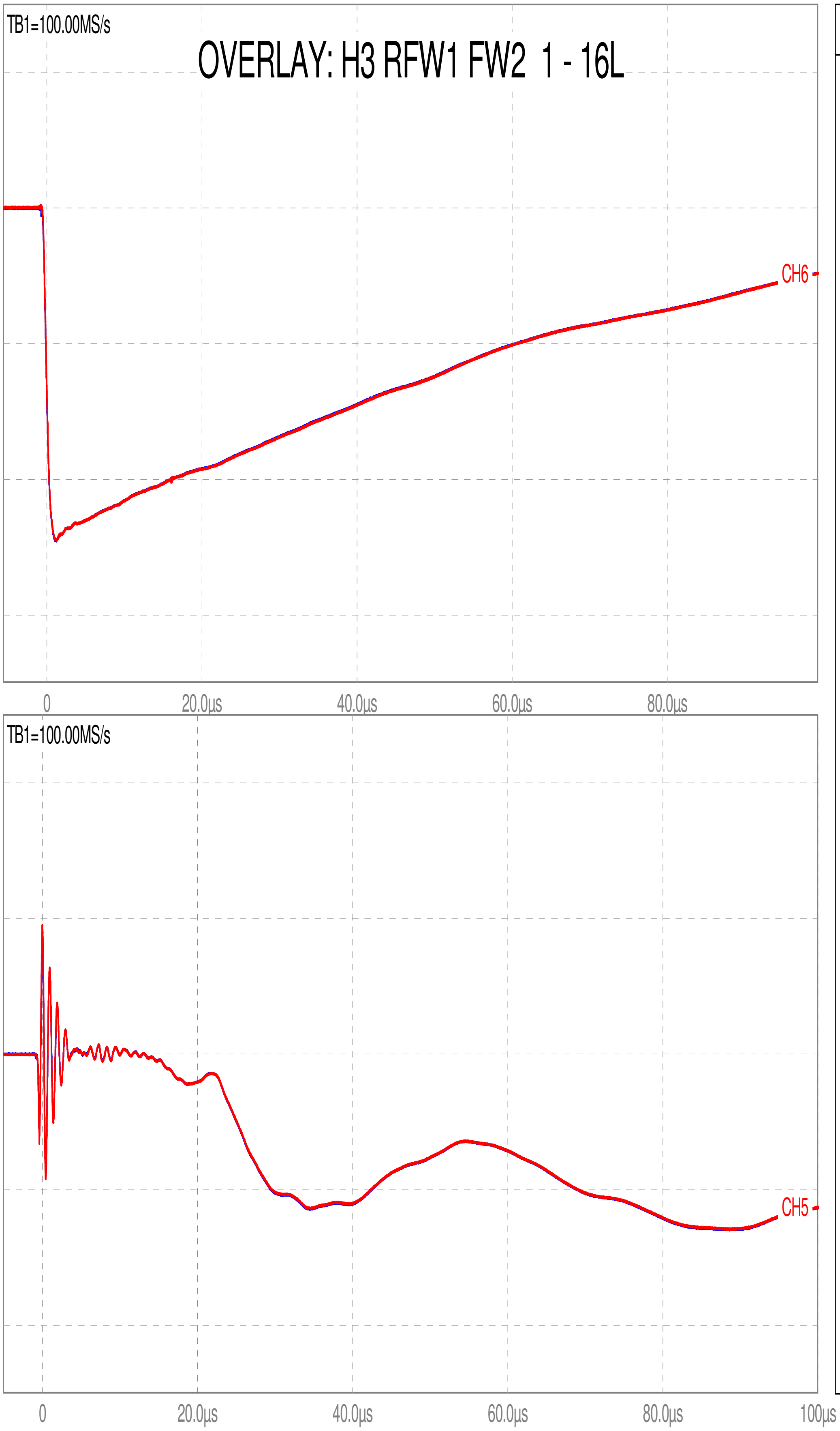
Up= -179.8kV

T1= 1.16µs

T2= 51.1µs



TB1=100.00MS/s
OVERLAY: H3 RFW1 FW1 1 - 16L
CH6
0
20.0µs
40.0µs
60.0µs
80.0µs
TB1=100.00MS/s
CH5
0
20.0µs
40.0µs
60.0µs
80.0µs
100µs
No.: 22
CH1 No. 22
Ip= -106.9A
CH2 No. 22
Up= -179.8kV
T1= 1.16µs
T2= 51.1µs
CH5 No. 121184
CH6 No. 121184



No.: 23

CH1 No. 23

Ip= -106.9A

CH2 No. 23

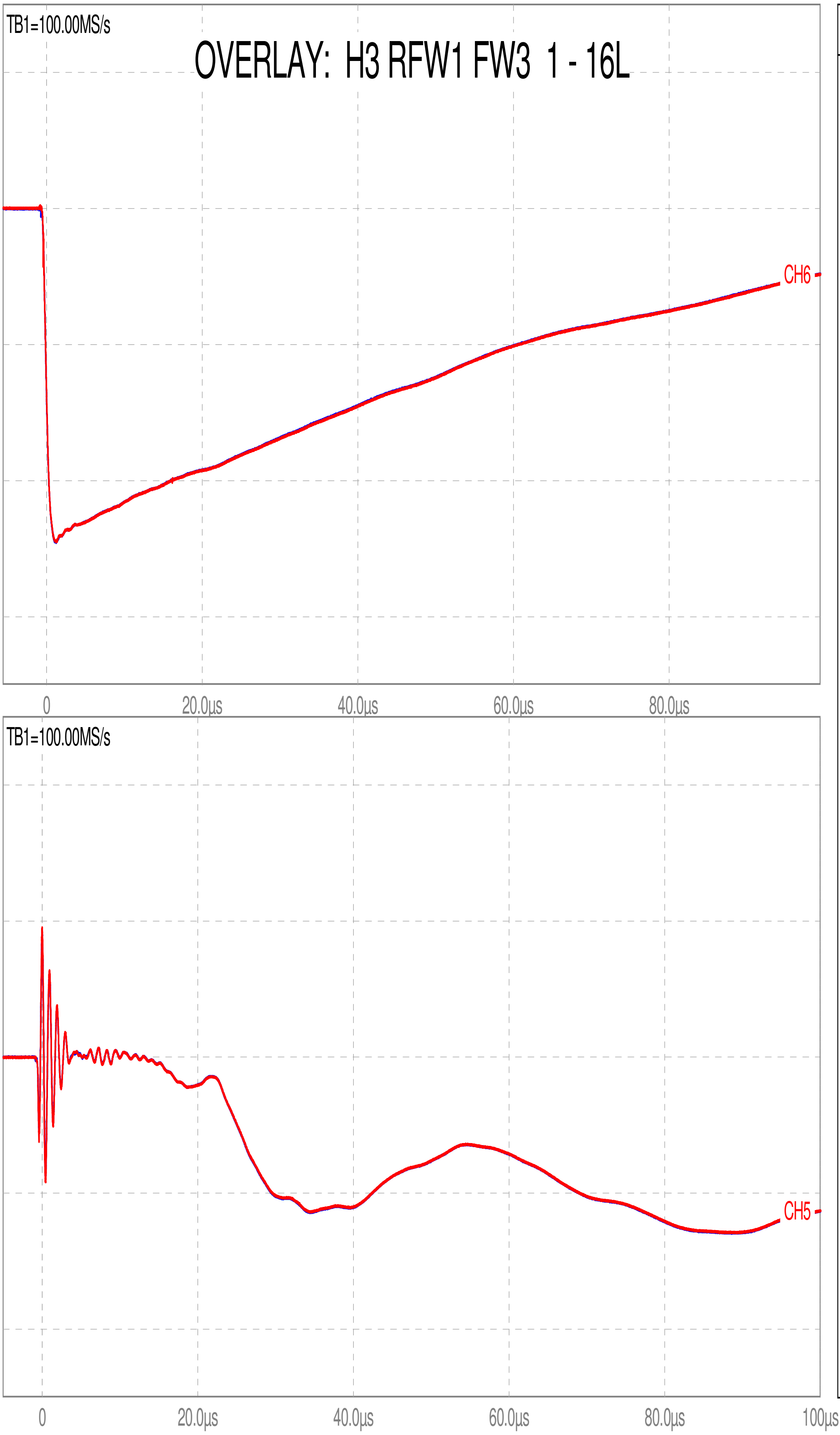
Up= -179.8kV

T1= 1.16µs

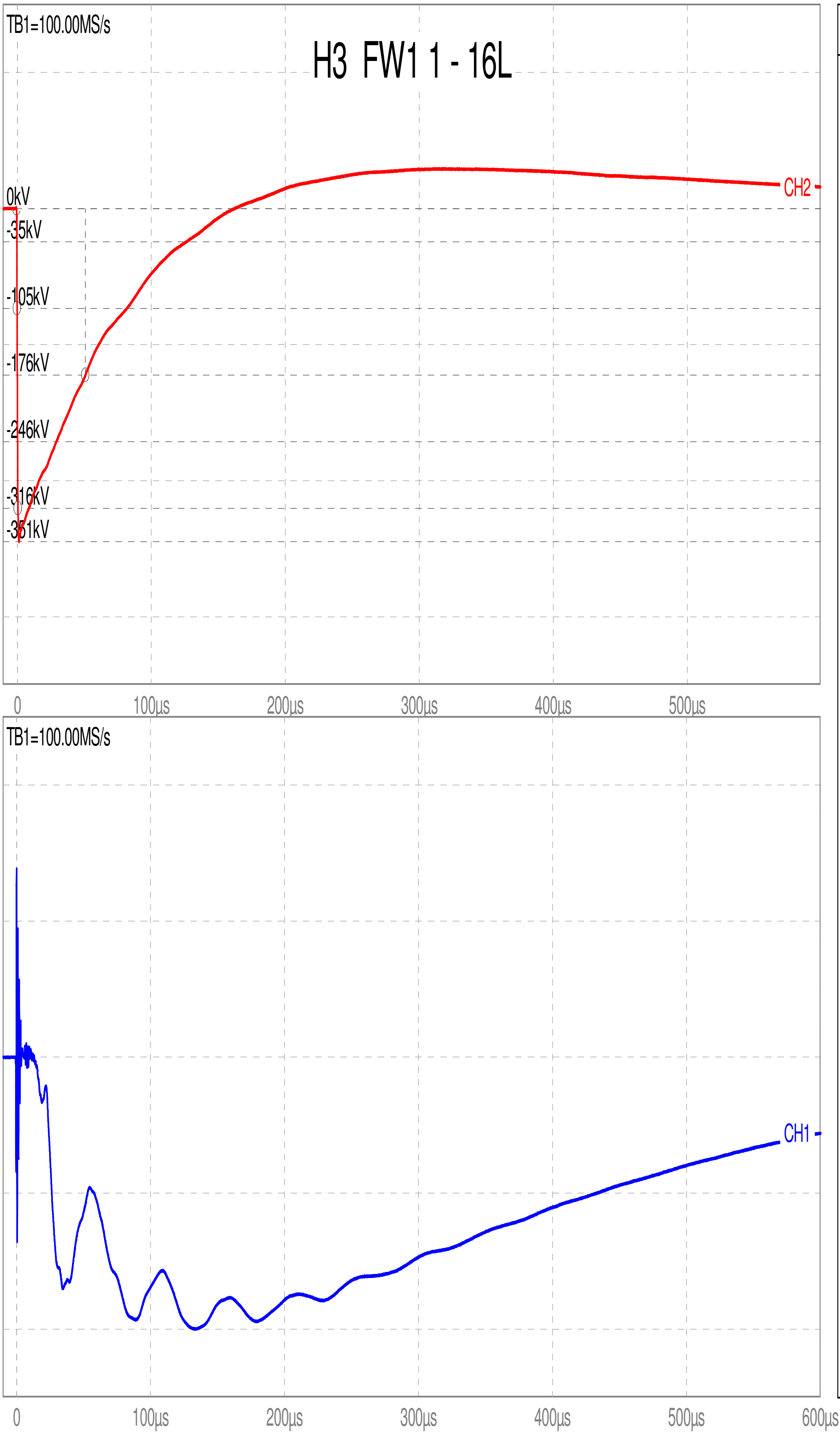
T2= 51.1µs

CH5 No. 121187

CH6 No. 121187



No.: 24
CH1 No. 24
Ip= -106.9A
CH2 No. 24
Up= -179.8kV
T1= 1.16µs
T2= 51.1µs
CH5 No. 121188
CH6 No. 121188



No.: 25

CH1 No. 25

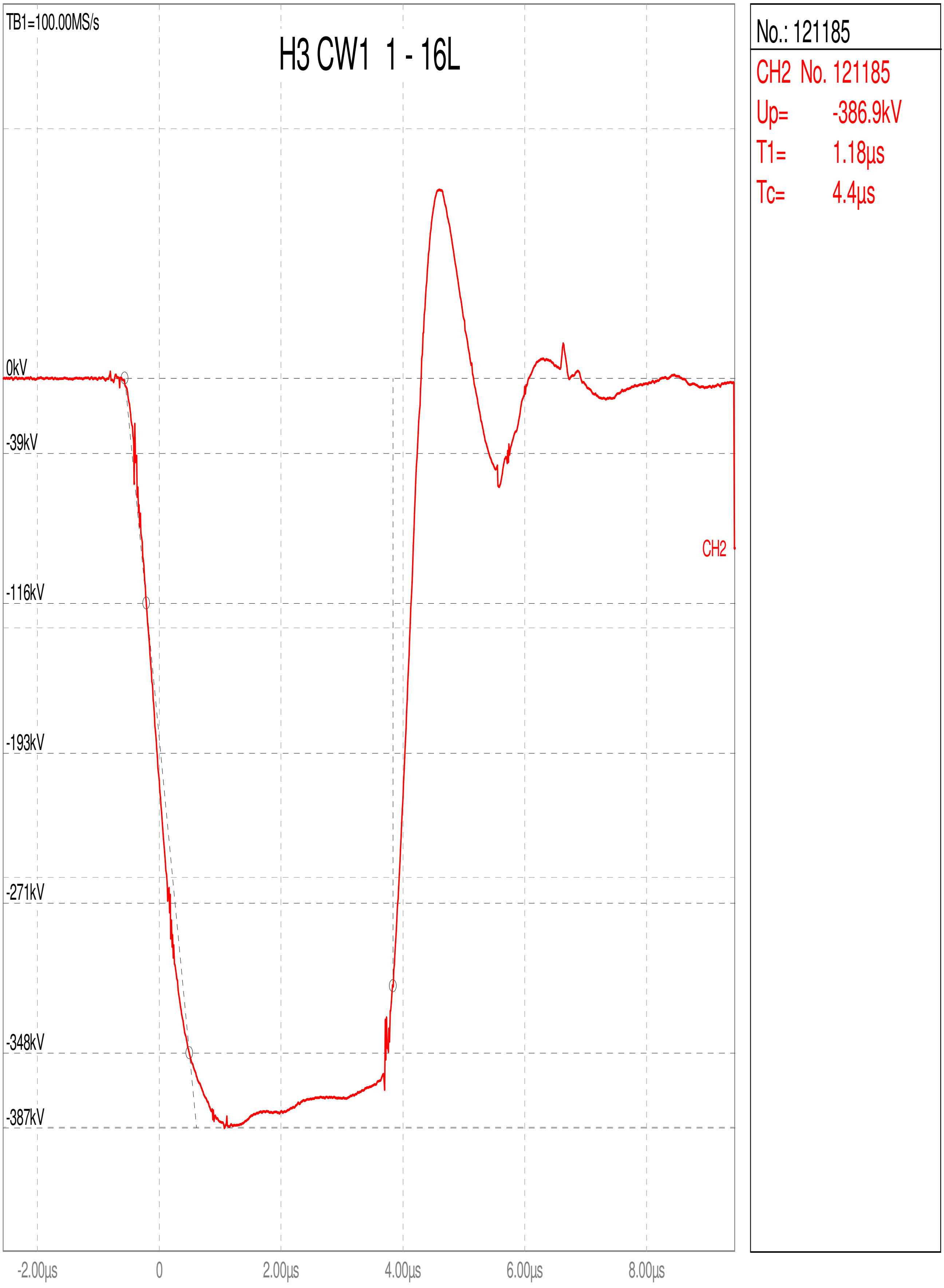
Ip= -210.2A

CH2 No. 25

Up= -351.2kV

T1= 1.16µs

T2= 51.4µs


TB1=100.00MS/s
H3 CW1 1 - 16L
0kV
-39kV
-116kV
-193kV
-271kV
-348kV
-387kV
CH2
-2.00µs
0
2.00µs
4.00µs
6.00µs
8.00µs
No.: 121185
CH2 No. 121185
Up= -386.9kV
T1= 1.18µs
Tc= 4.4µs

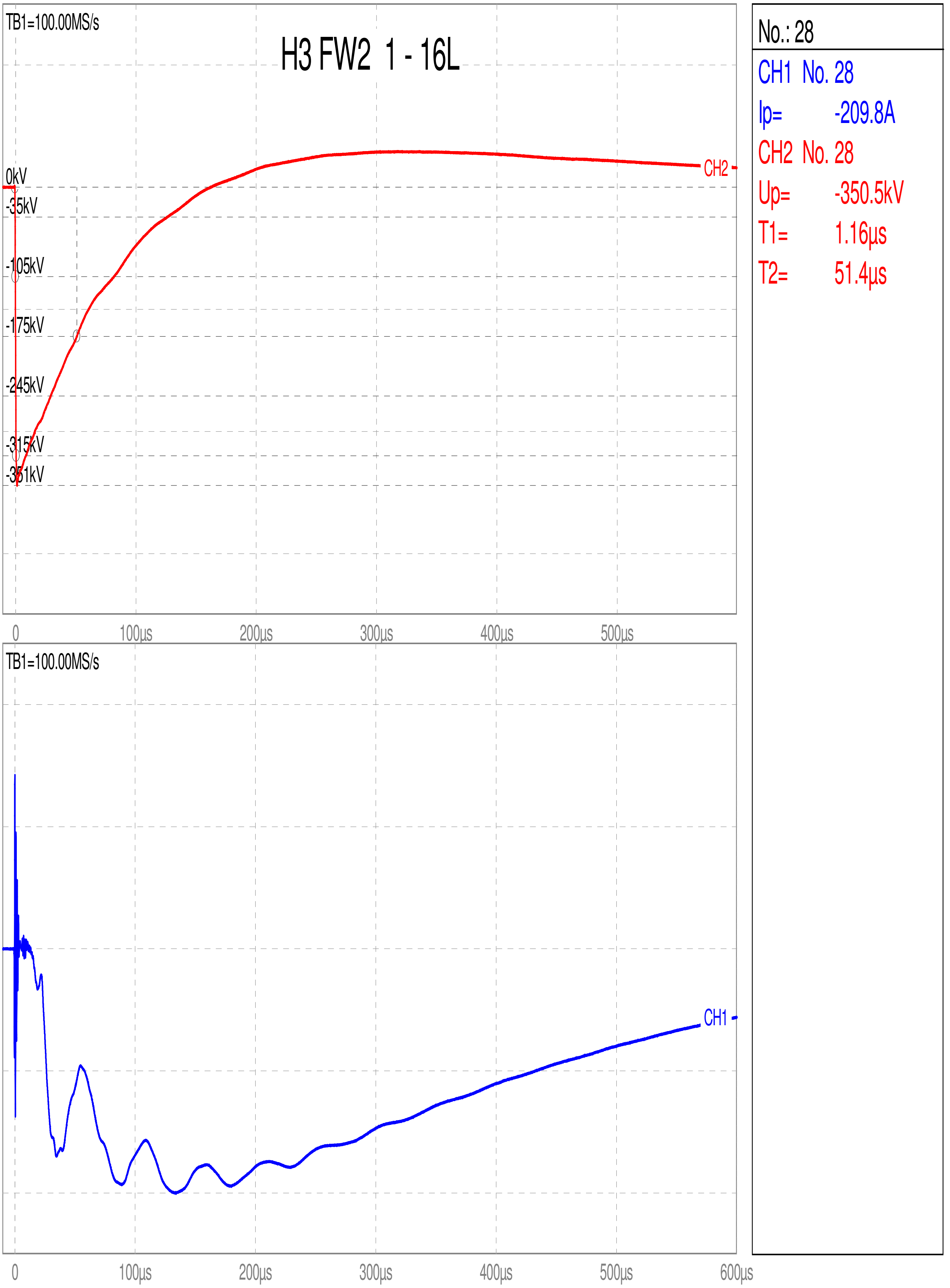
No.: 121186

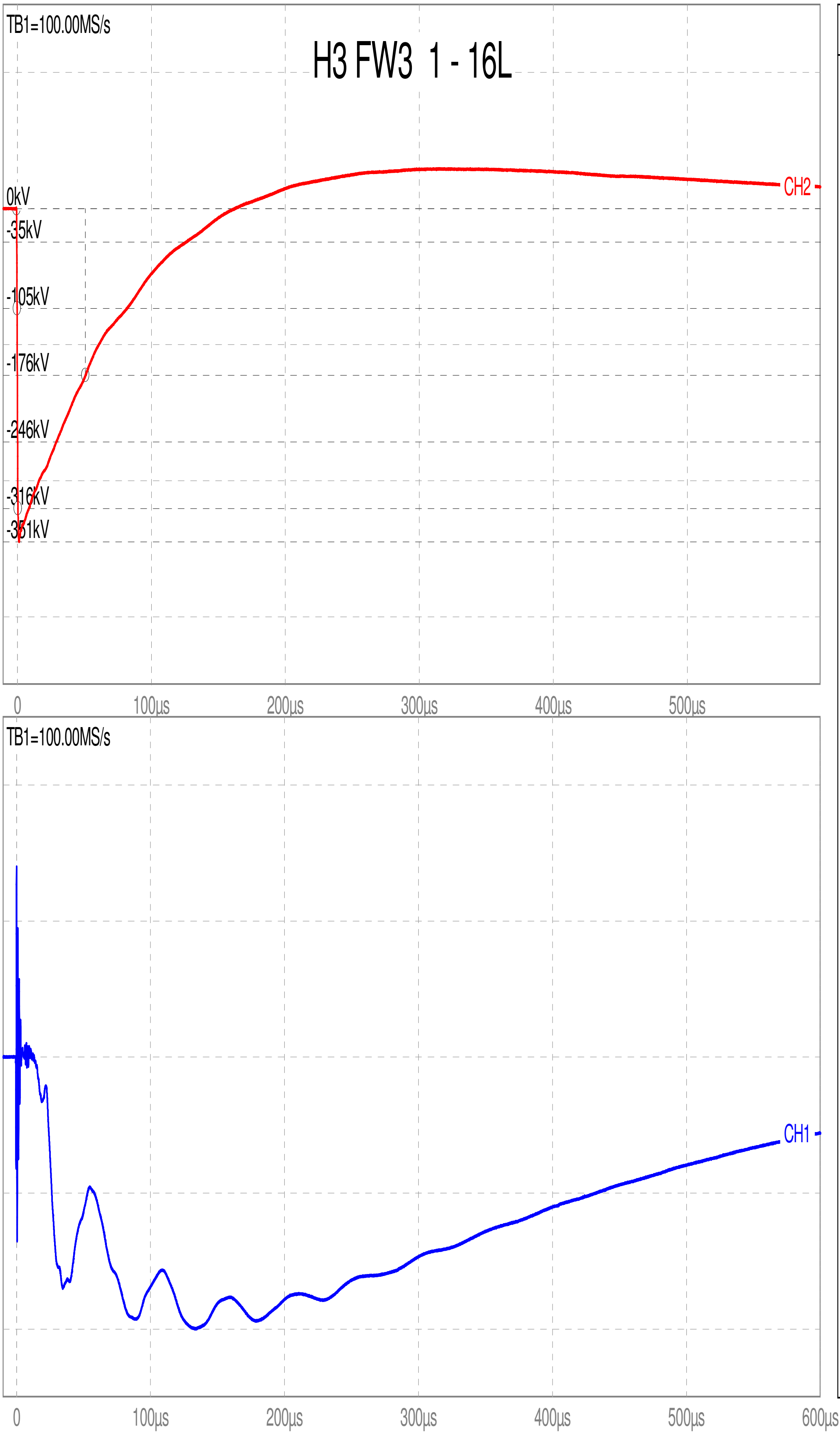
CH2 No. 121186

Up= -387.2kV

T1= 1.18µs

Tc= 4.01µs


TB1=100.00MS/s
H3 FW2 1 - 16L
0kV
-35kV
-105kV
-175kV
-245kV
-315kV
-351kV
CH2
0
100µs
200µs
300µs
400µs
500µs
TB1=100.00MS/s
CH1
0
100µs
200µs
300µs
400µs
500µs
600µs
No.: 28
CH1 No. 28
Ip= -209.8A
CH2 No. 28
Up= -350.5kV
T1= 1.16µs
T2= 51.4µs



No.: 29

CH1 No. 29

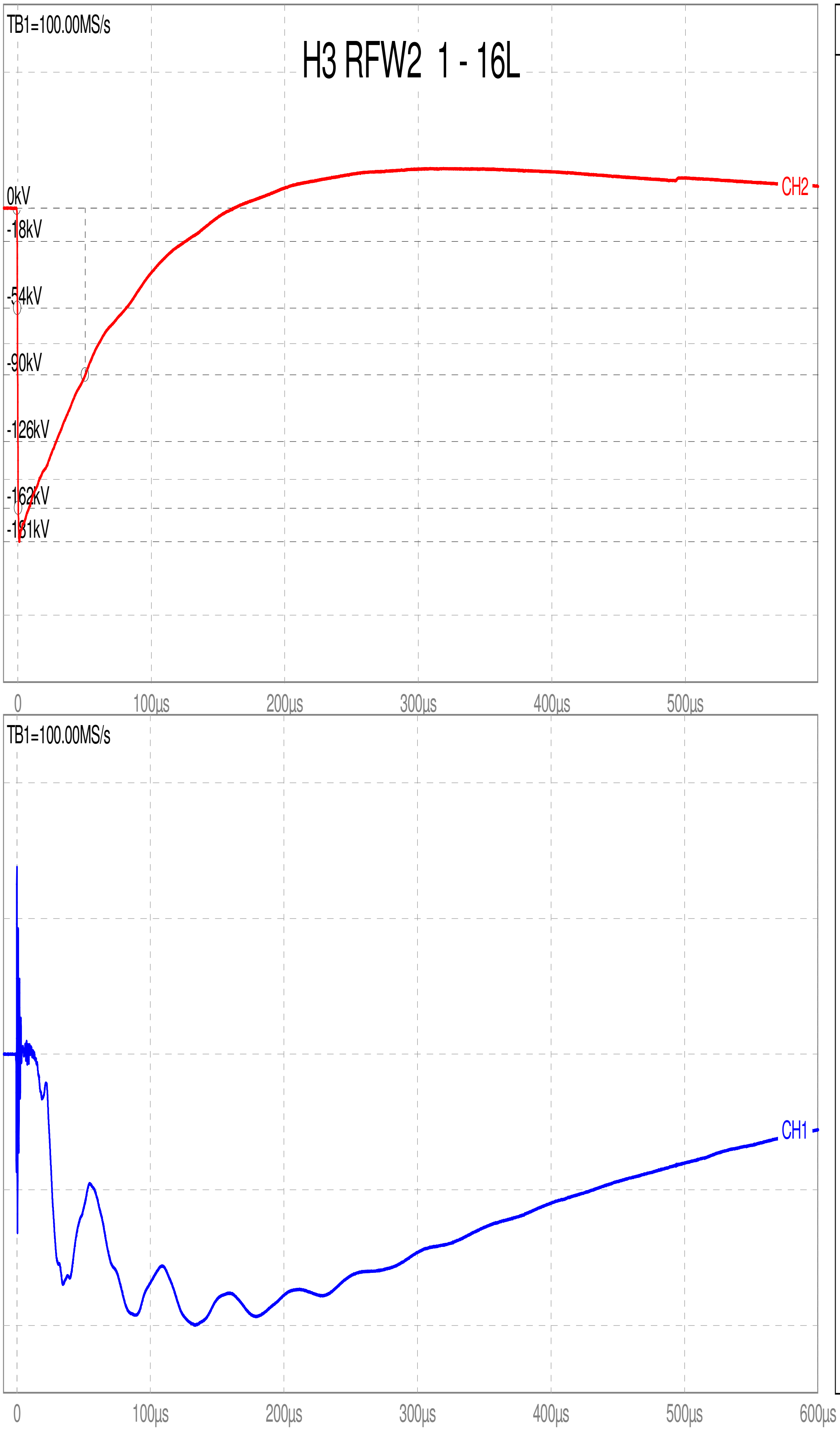
Ip= -210.4A

CH2 No. 29

Up= -351.3kV

T1= 1.16µs

T2= 51.4µs



No.: 30

CH1 No. 30

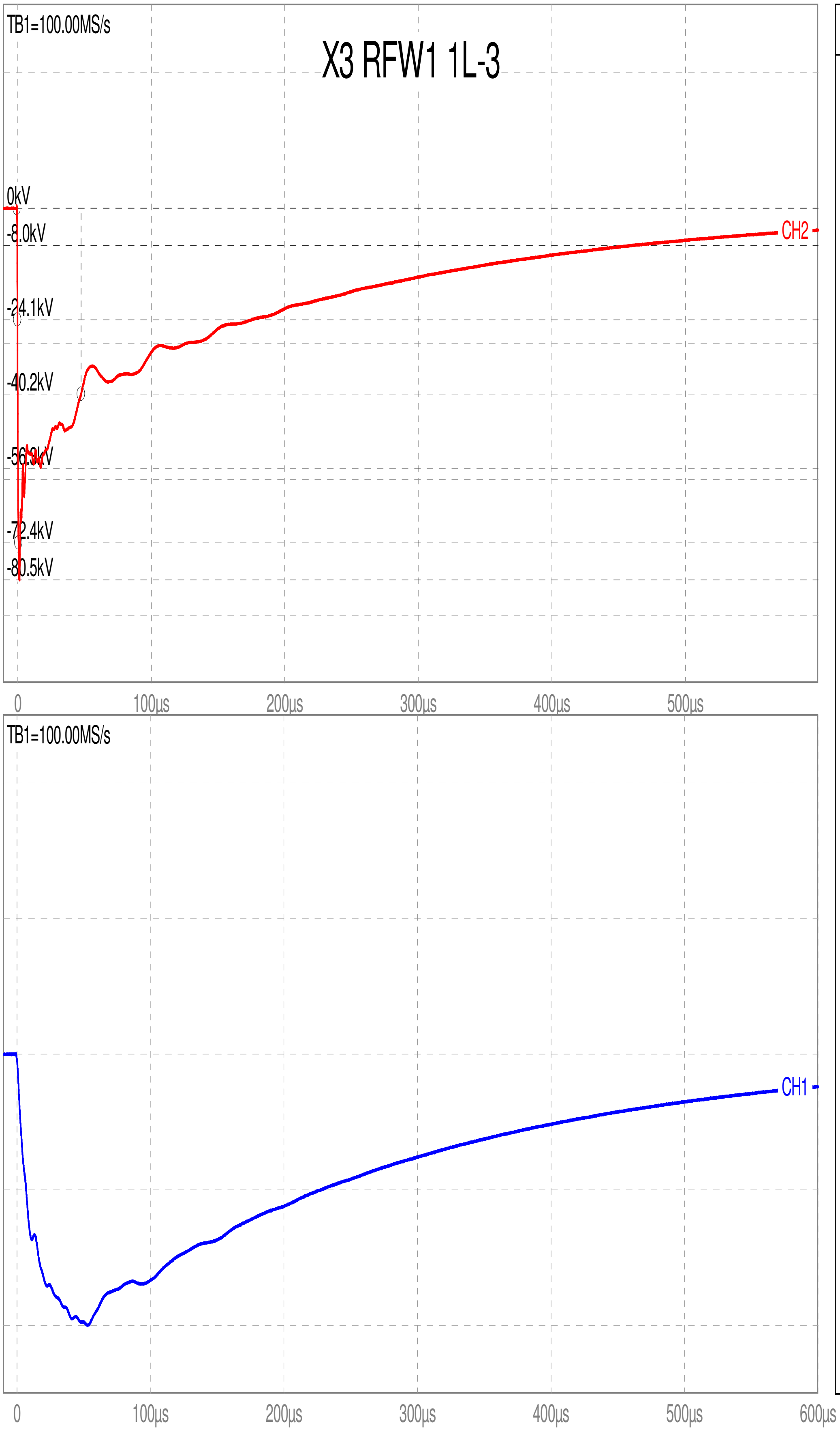
Ip= -107.8A

CH2 No. 30

Up= -180.5kV

T1= 1.16µs

T2= 51.1µs



No.: 31

CH1 No. 31

Ip= -354.6A

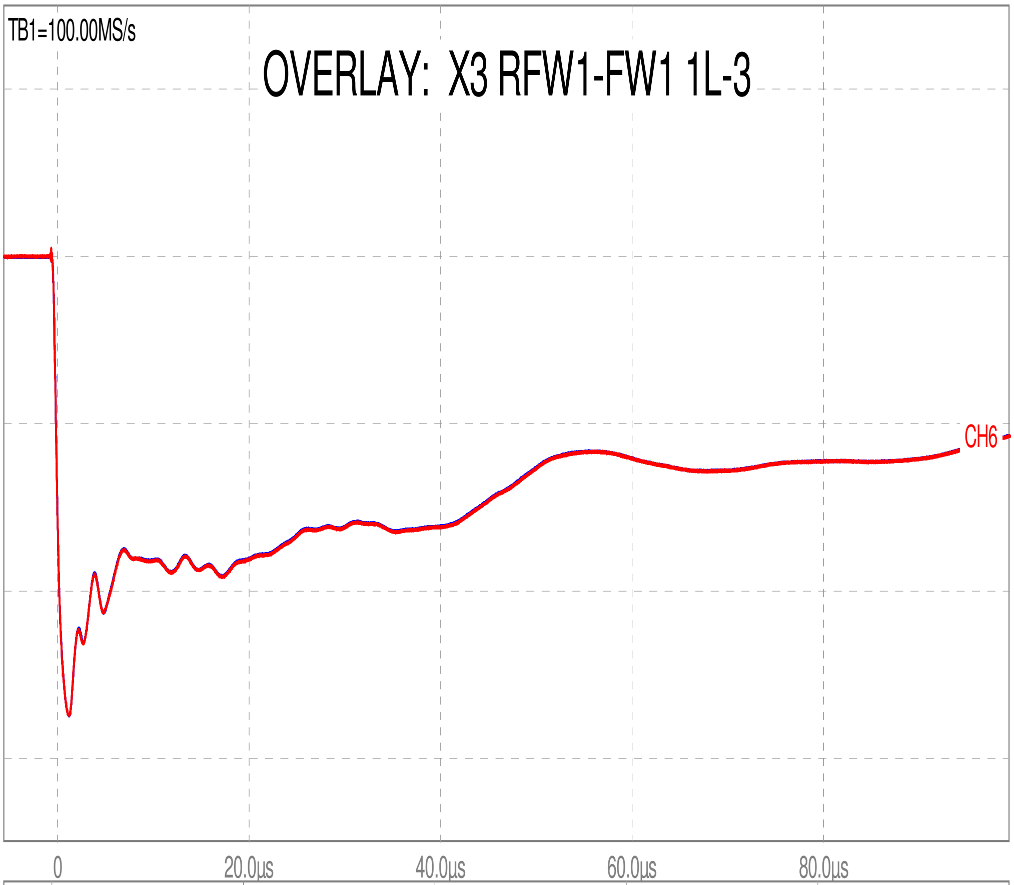
CH2 No. 31

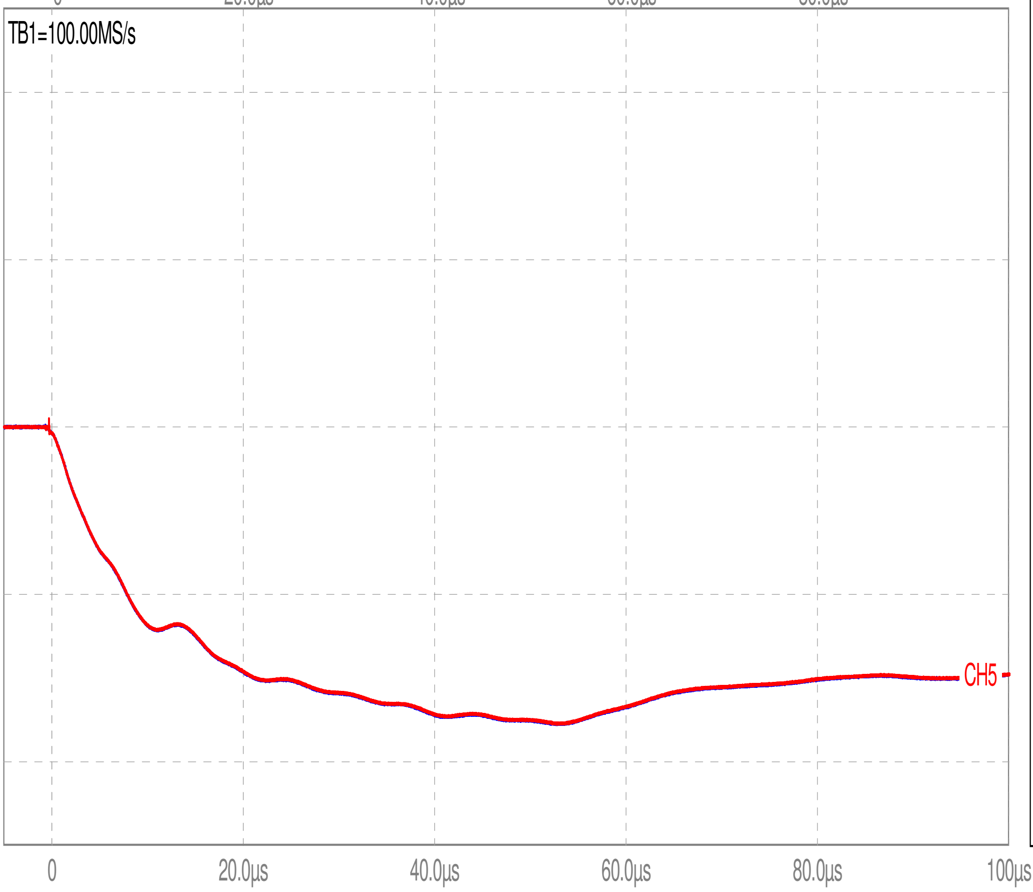
Up= -80.45kV

T1= 1.29µs

T2= 48µs

OVERLAY: X3 RFW1-FW1 1L-3





No.: 32

CH1 No. 32

Ip= -354.6A

CH2 No. 32

Up= -80.45kV

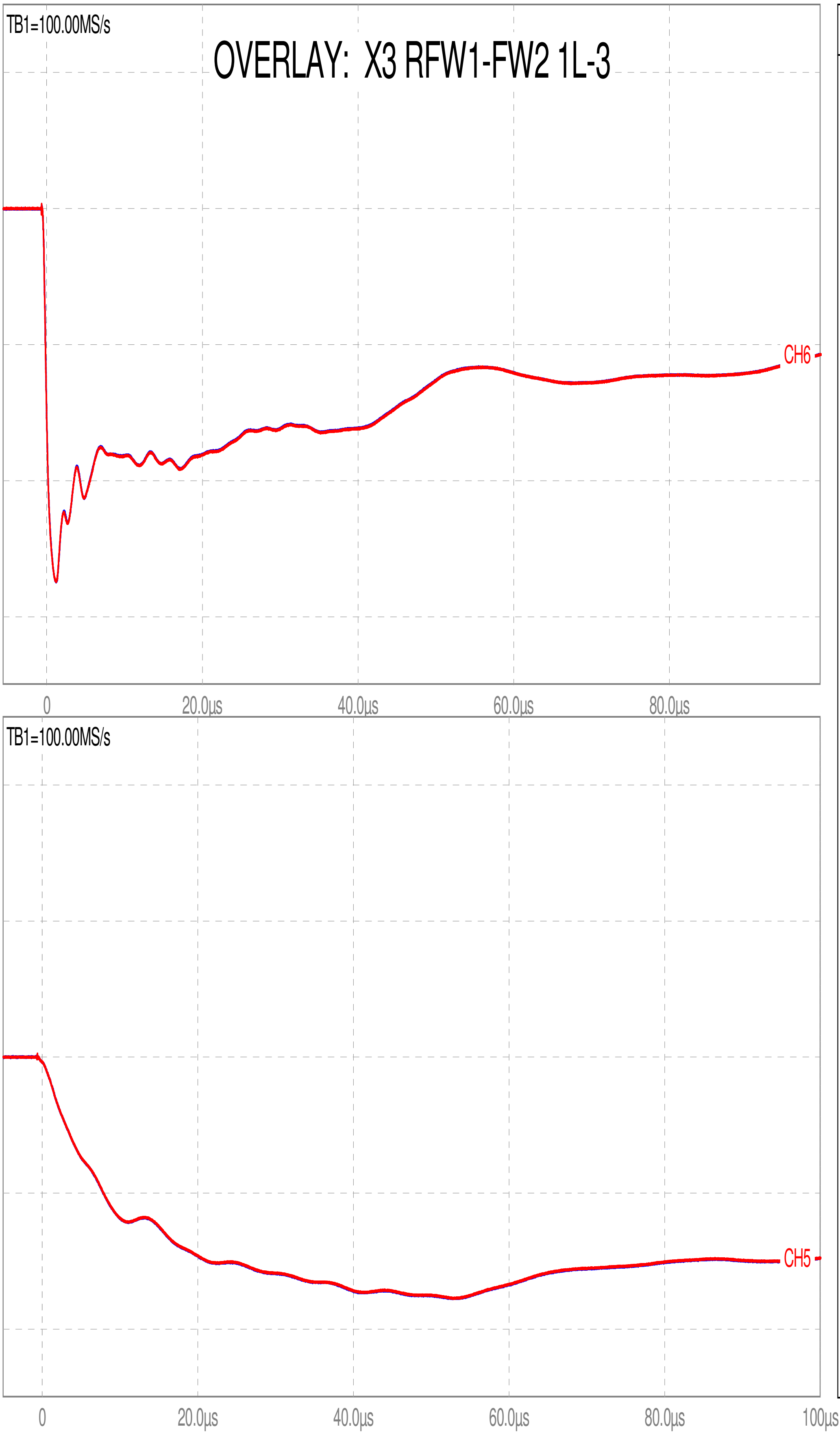
T1= 1.29µs

T2= 48µs

CH5 No. 121196

CH6 No. 121196

OVERLAY: X3 RFW1-FW2 1L-3



No.: 33

CH1 No. 33

Ip= -354.6A

CH2 No. 33

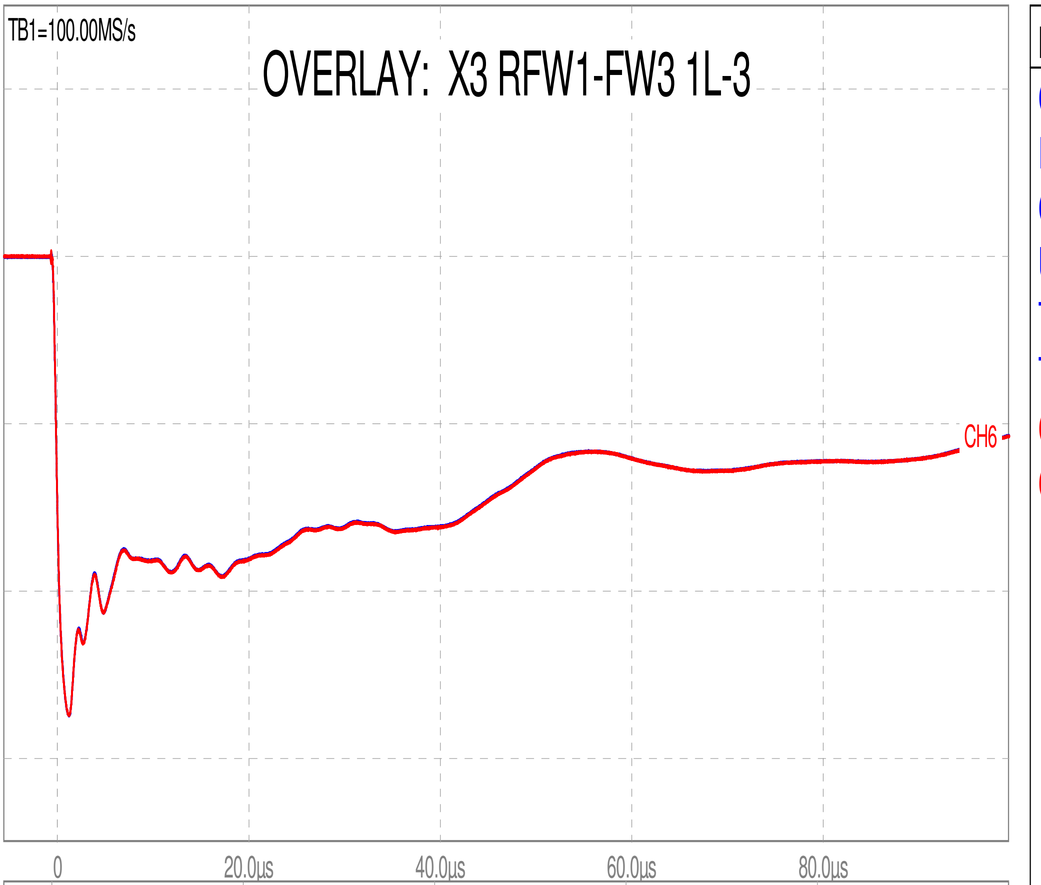
Up= -80.45kV

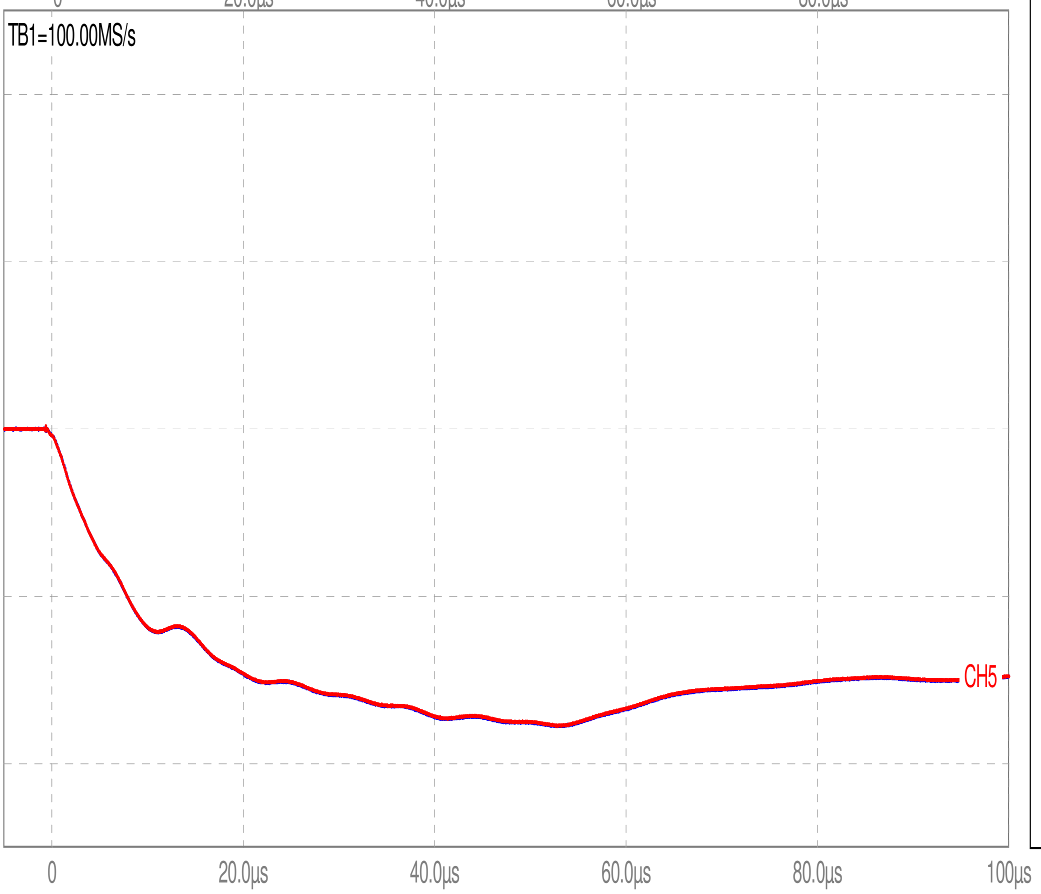
T1= 1.29µs

T2= 48µs

CH5 No. 121199

CH6 No. 121199





No.: 34

CH1 No. 34

Ip= -354.6A

CH2 No. 34

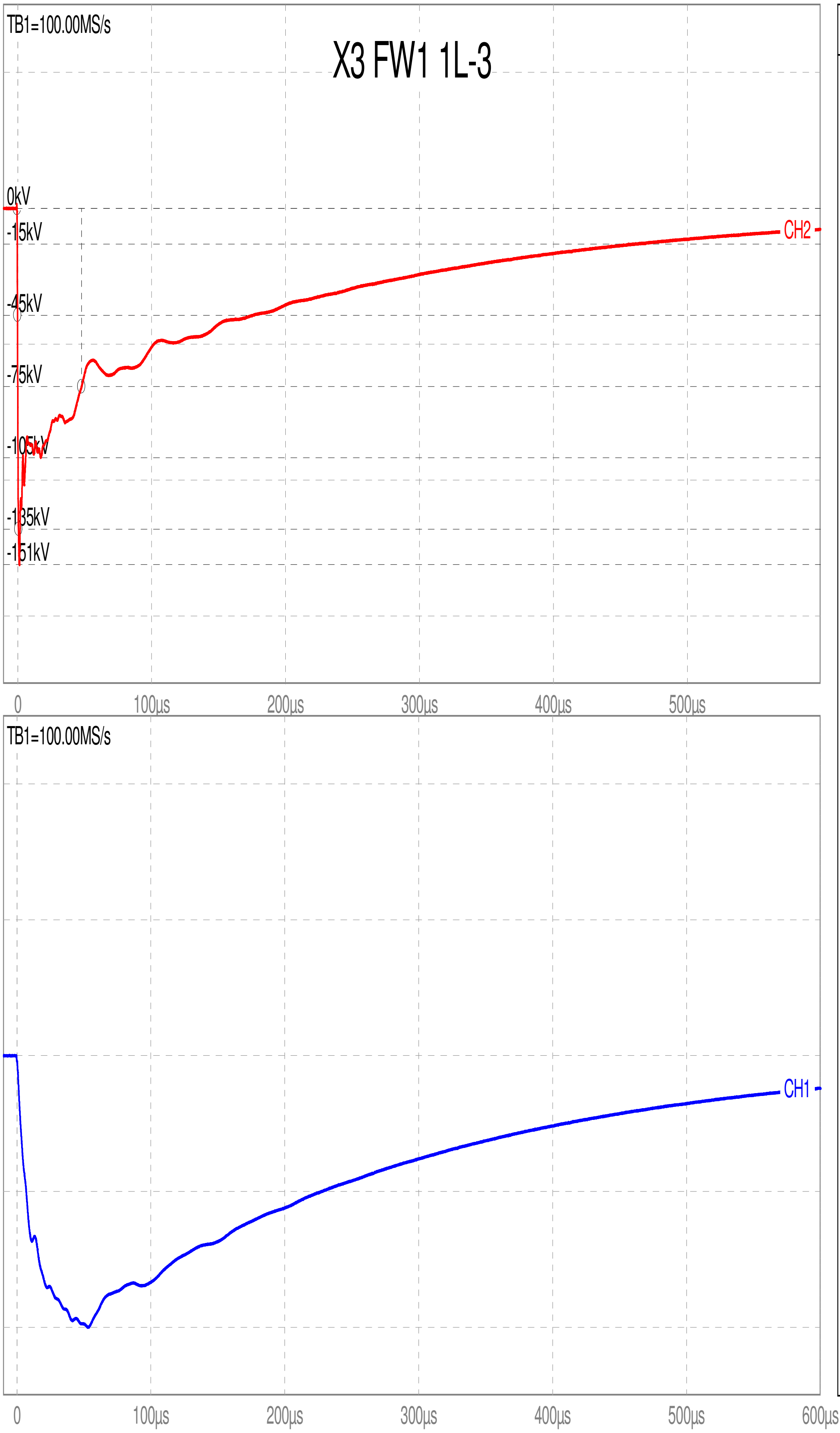
Up= -80.45kV

T1= 1.29µs

T2= 48µs

CH5 No. 121200

CH6 No. 121200



No.: 35

CH1 No. 35

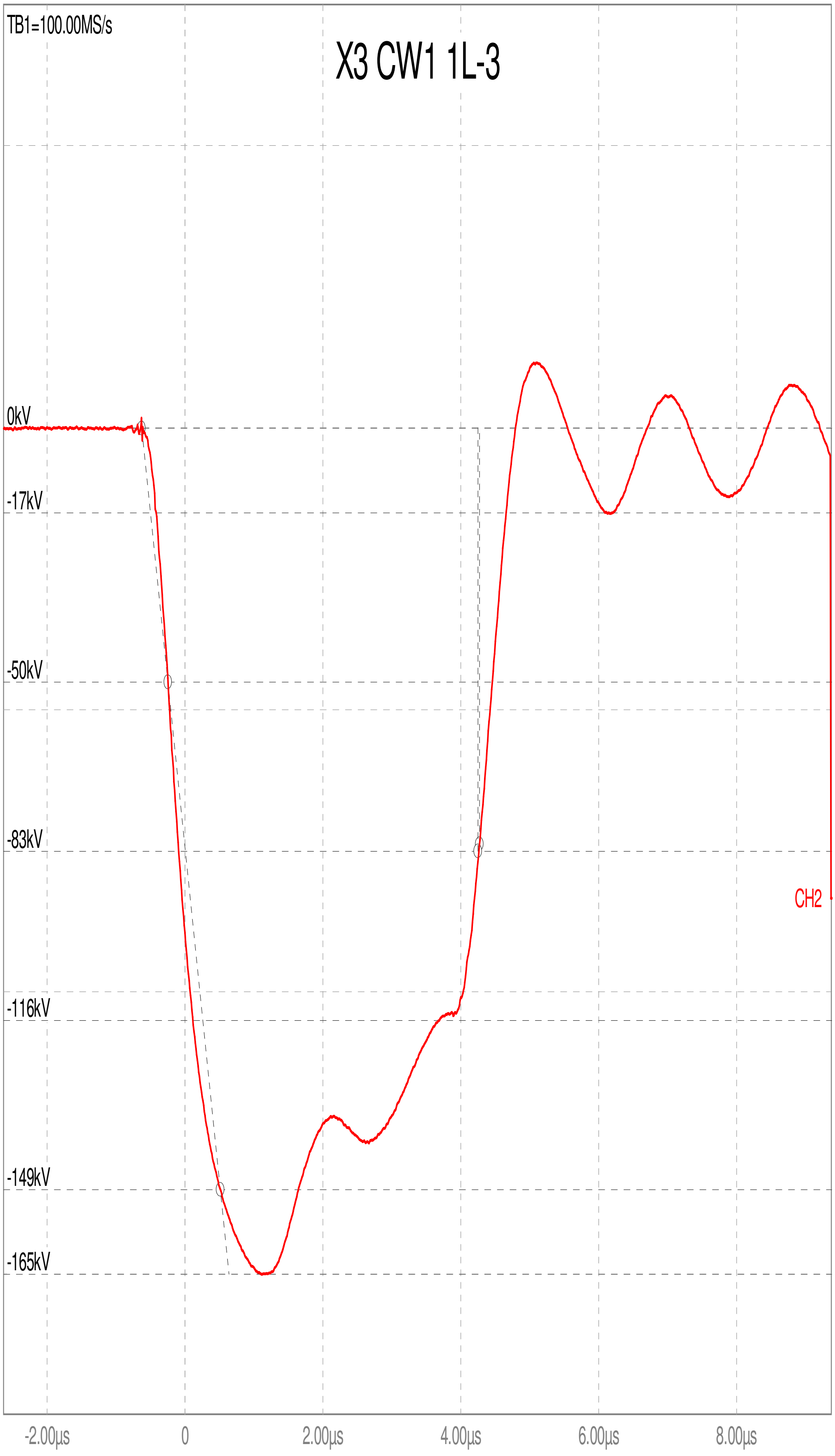
Ip= -664A

CH2 No. 35

Up= -150.5kV

T1= 1.26µs

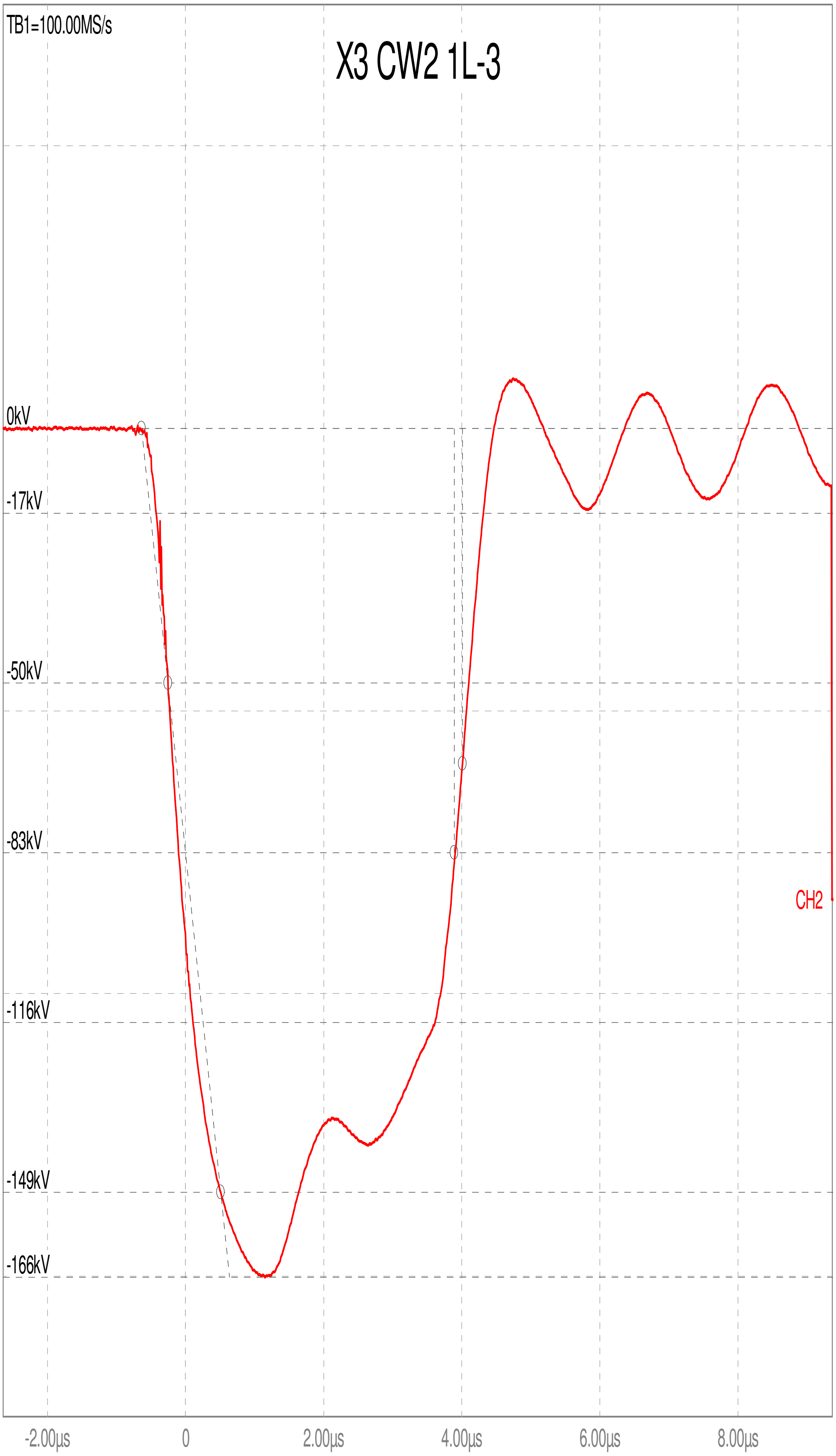
T2= 48.2µs



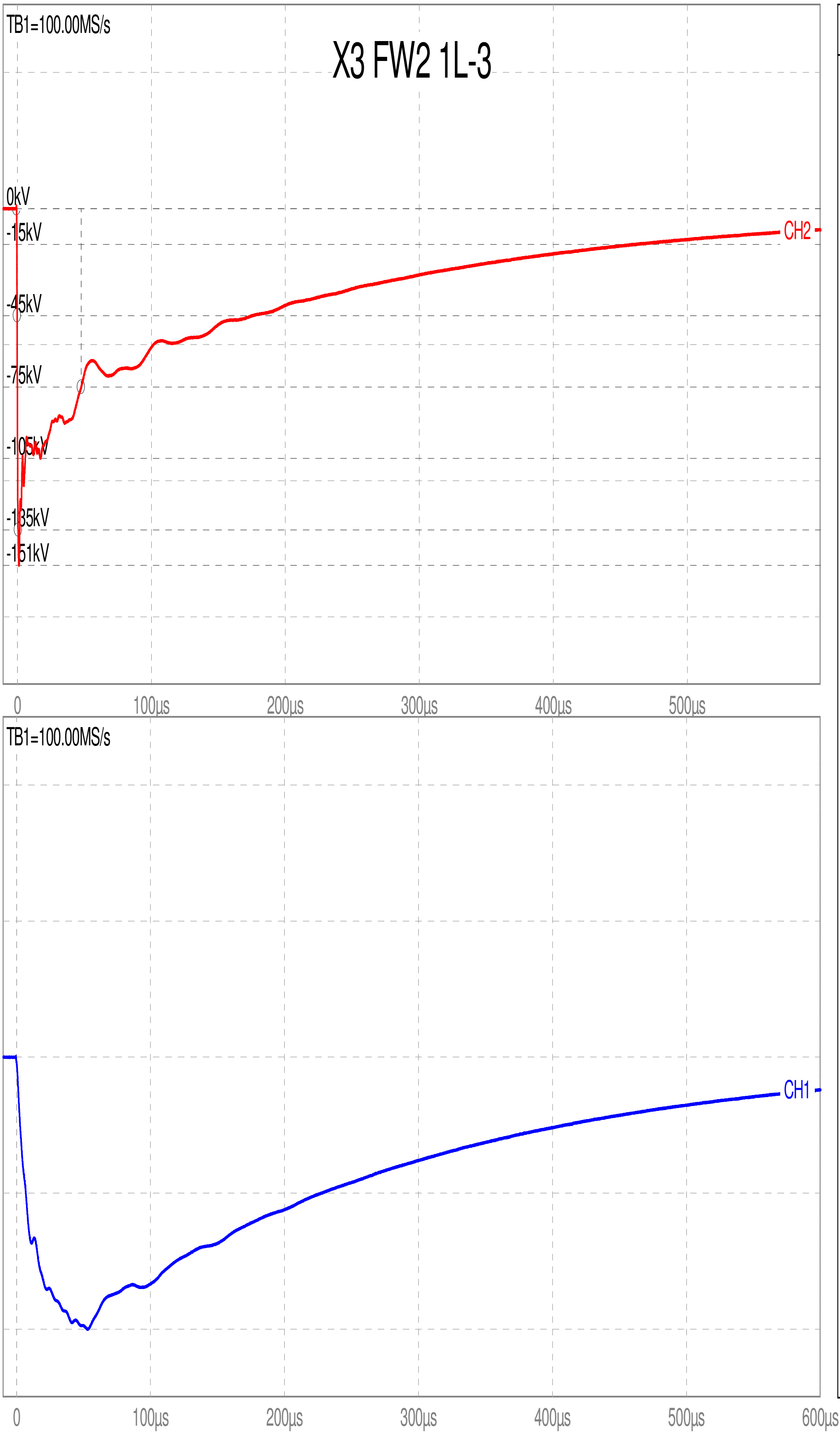
No.: 121197

CH2 No. 121197

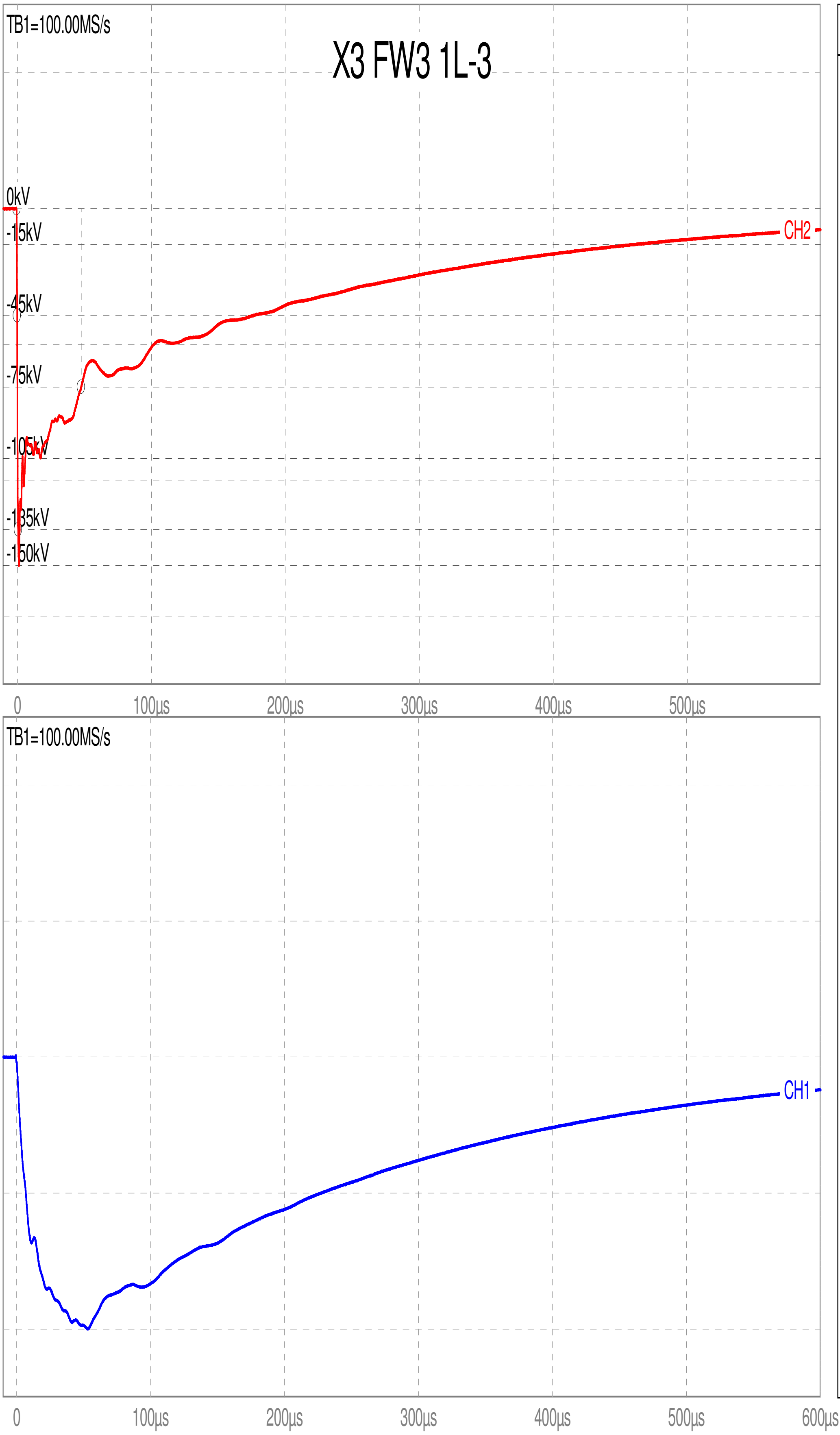
Up=	-165.3kV
T1=	1.27µs
Tc=	4.9µs
T2=	4.88µs



No.: 121198	
CH2 No. 121198	
Up=	-165.6kV
T1=	1.27µs
Tc=	4.65µs
T2=	4.52µs



No.: 38	
CH1 No. 38	
Ip=	-664A
CH2 No. 38	
Up=	-150.5kV
T1=	1.26µs
T2=	48.2µs



No.: 39

CH1 No. 39

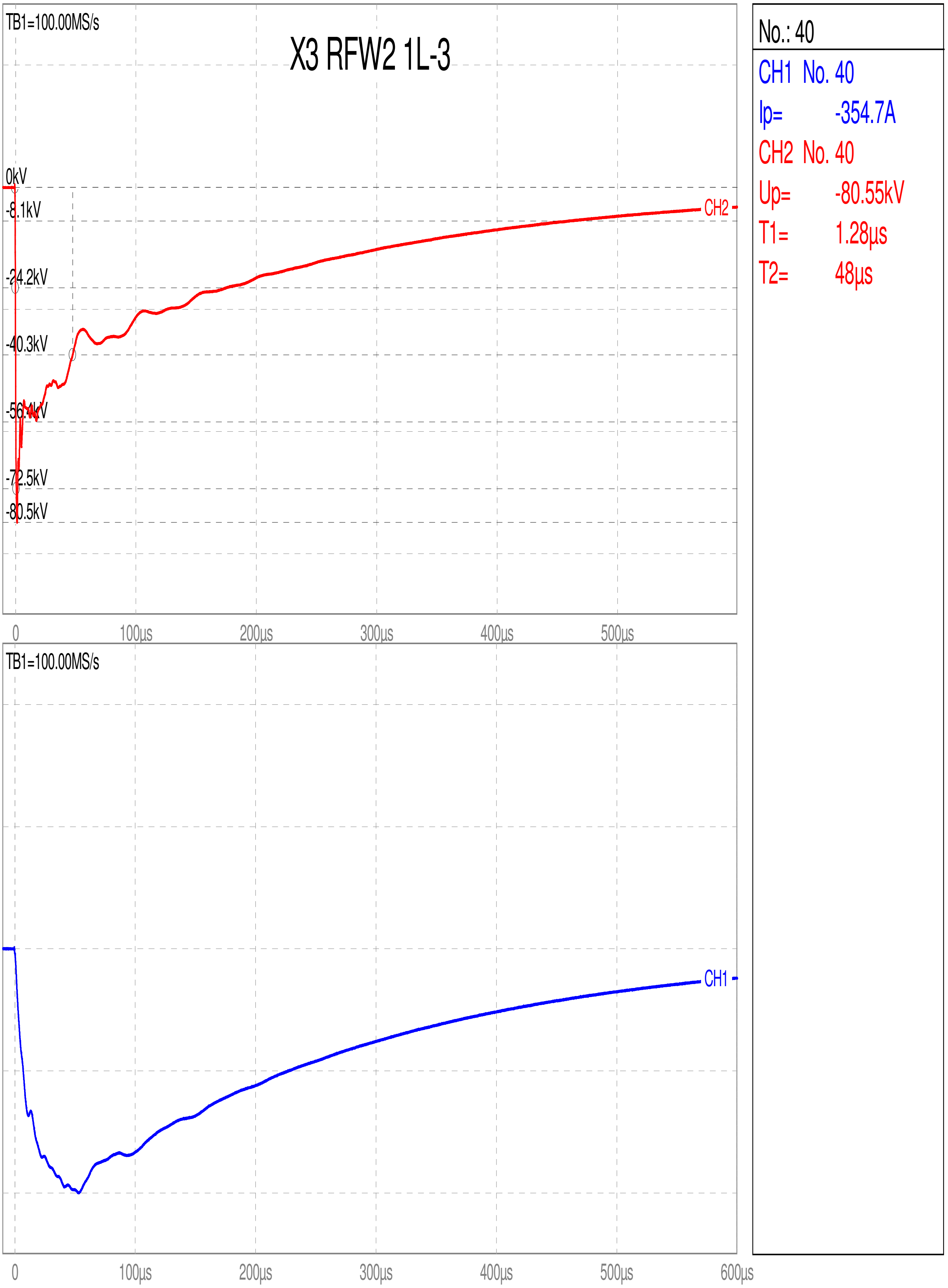
Ip= -664.7A

CH2 No. 39

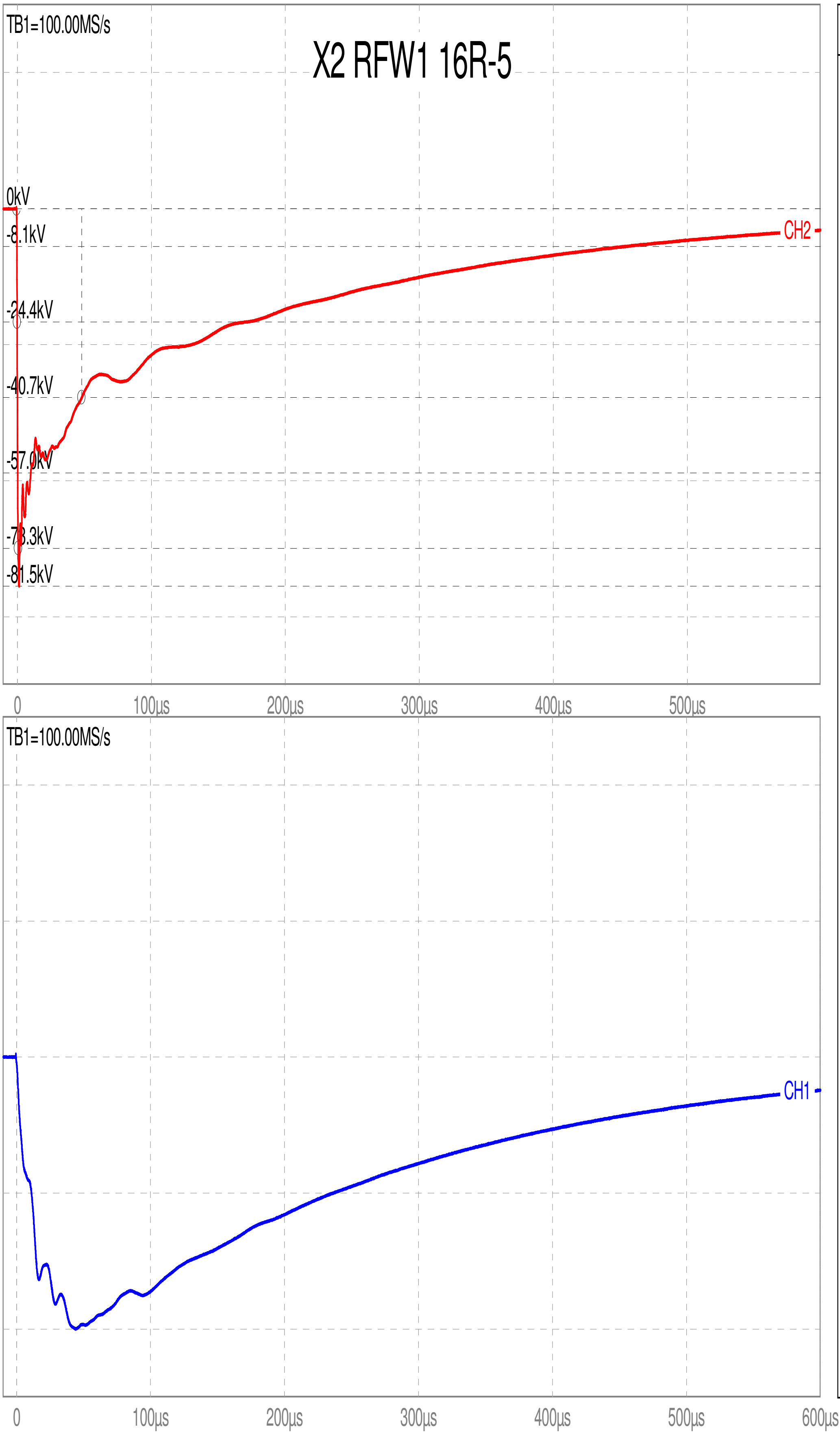
Up= -150.4kV

T1= 1.26µs

T2= 48.2µs



TB1=100.00MS/s
X3 RFW2 1L-3
0kV
-8.1kV
-24.2kV
-40.3kV
-56.4kV
-72.5kV
-80.5kV
CH2
0
100µs
200µs
300µs
400µs
500µs
TB1=100.00MS/s
CH1
0
100µs
200µs
300µs
400µs
500µs
600µs
No.: 40
CH1 No. 40
Ip= -354.7A
CH2 No. 40
Up= -80.55kV
T1= 1.28µs
T2= 48µs



No.: 41

CH1 No. 41

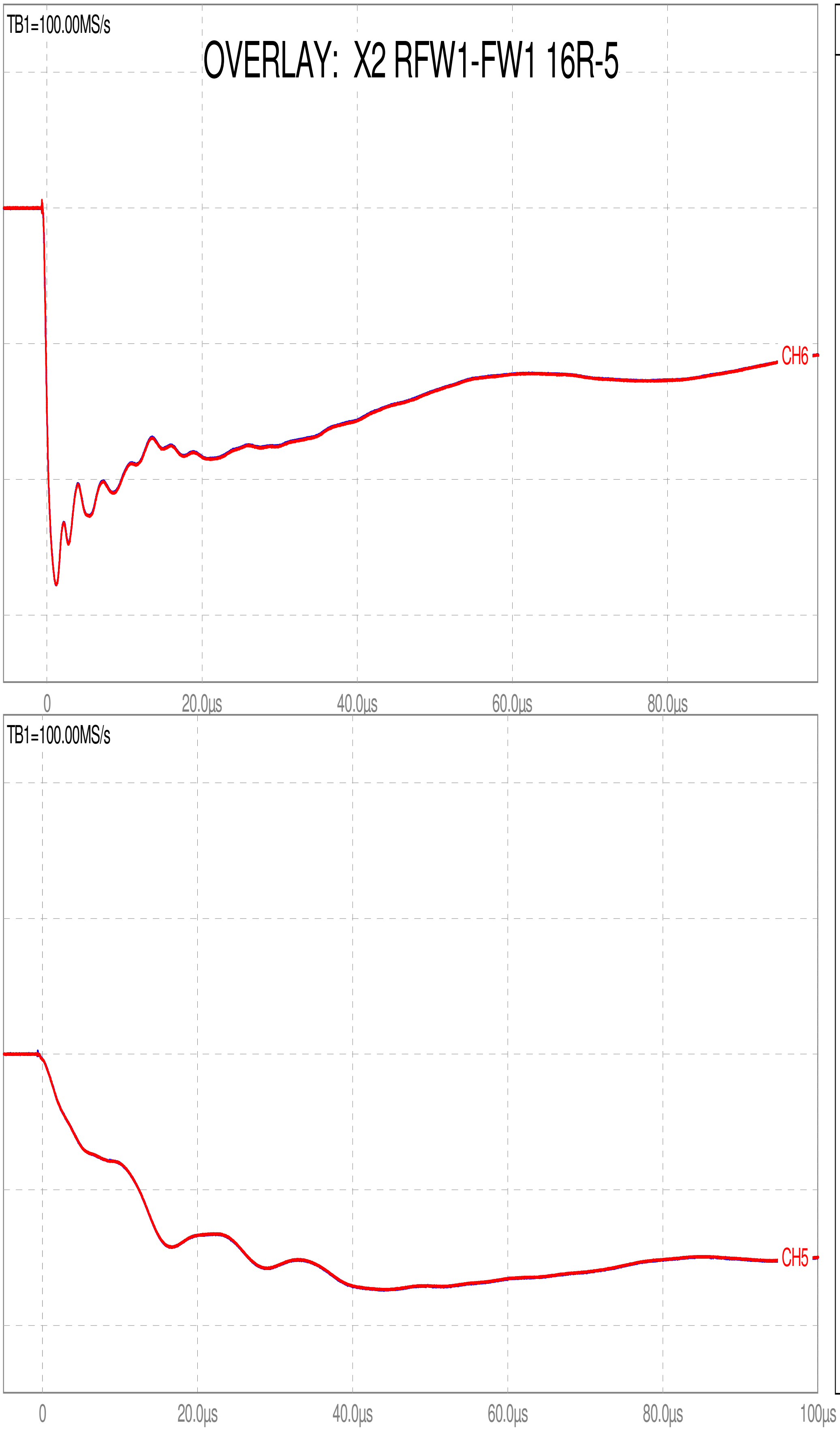
Ip= -347.3A

CH2 No. 41

Up= -81.47kV

T1= 1.32µs

T2= 48.6µs



No.: 42

CH1 No. 42

Ip= -347.3A

CH2 No. 42

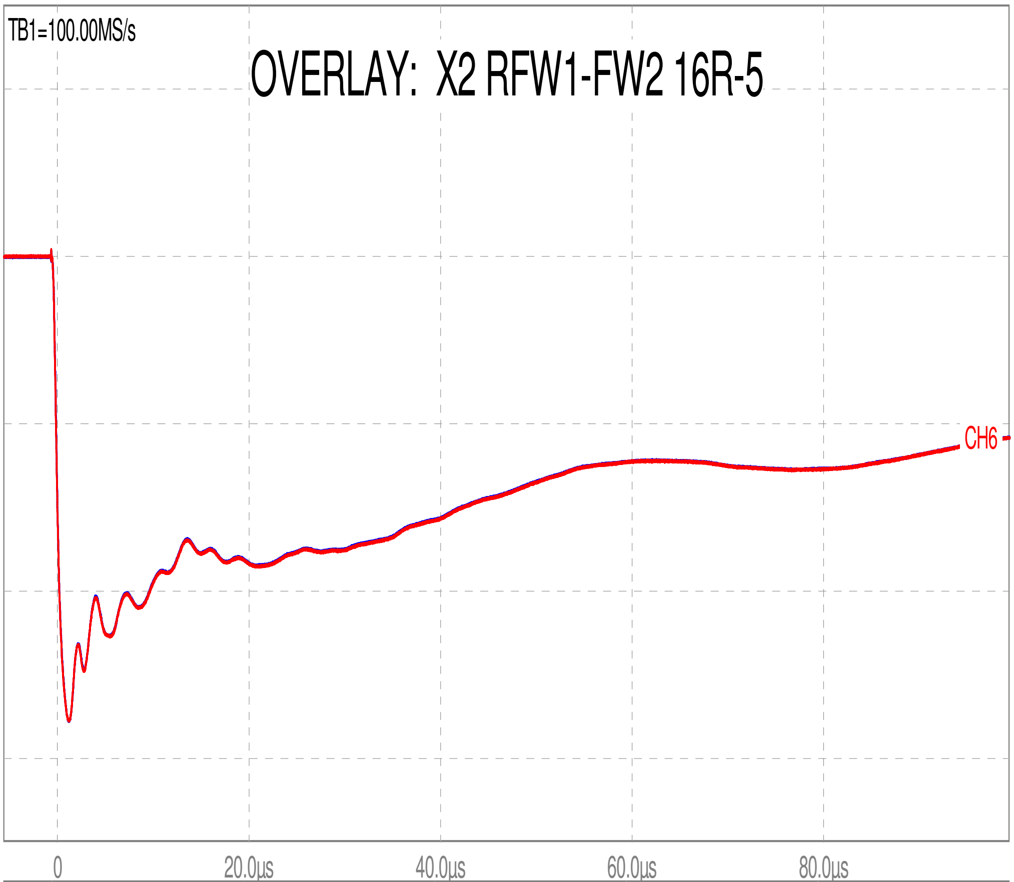
Up= -81.47kV

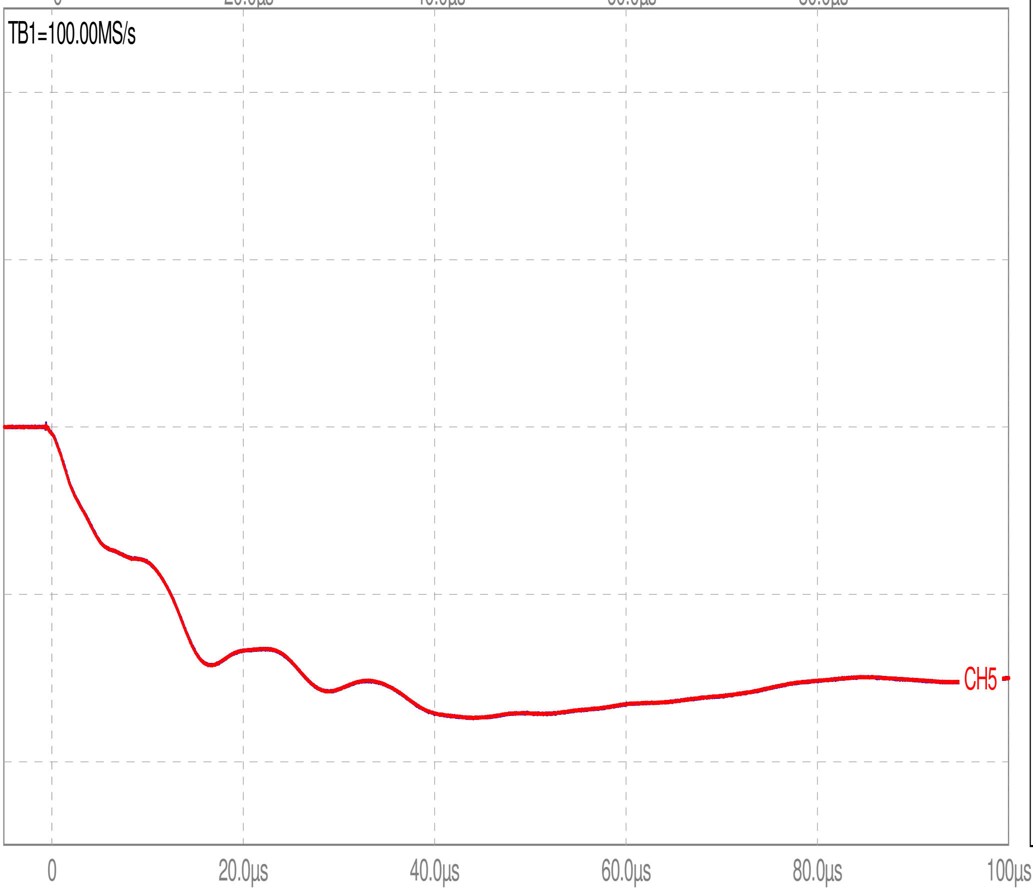
T1= 1.32µs

T2= 48.6µs

CH5 No. 121203

CH6 No. 121203





No.: 43

CH1 No. 43

Ip= -347.3A

CH2 No. 43

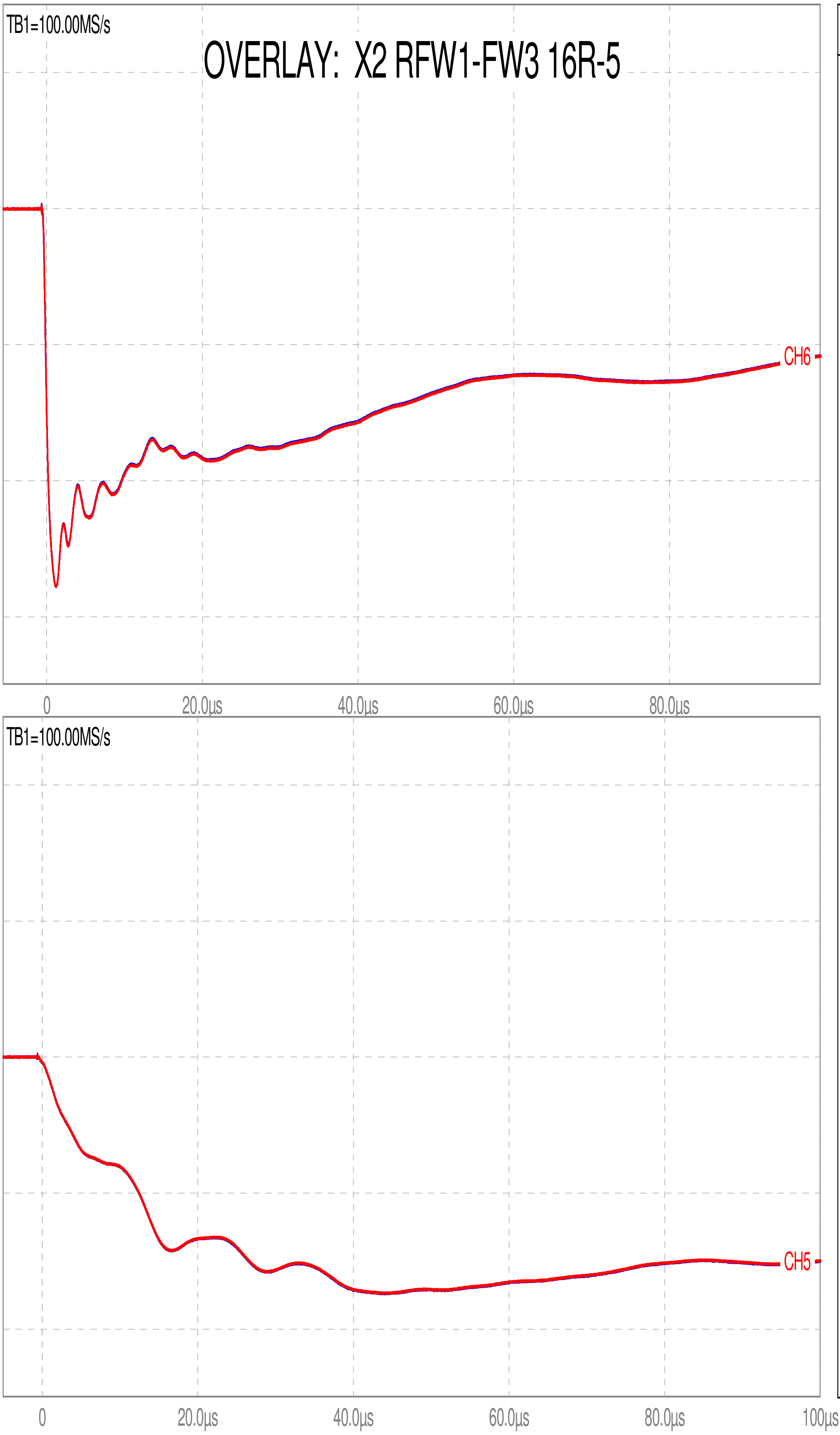
Up= -81.47kV

T1= 1.32µs

T2= 48.6µs

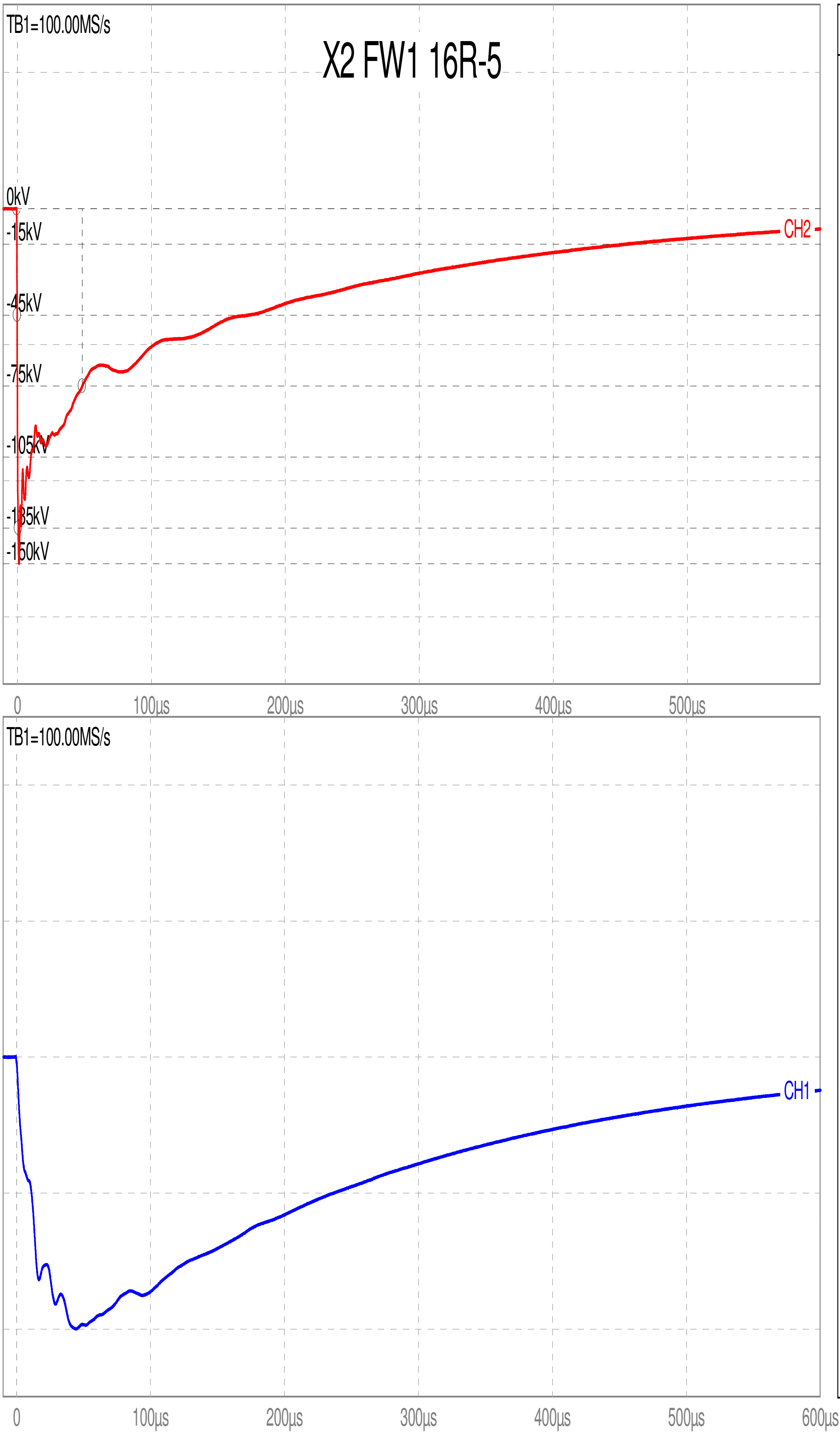
CH5 No. 121206

CH6 No. 121206



No.: 44

CH1 No. 44
Ip= -347.3A
CH2 No. 44
Up= -81.47kV
T1= 1.32µs
T2= 48.6µs
CH5 No. 121207
CH6 No. 121207



No.: 45

CH1 No. 45

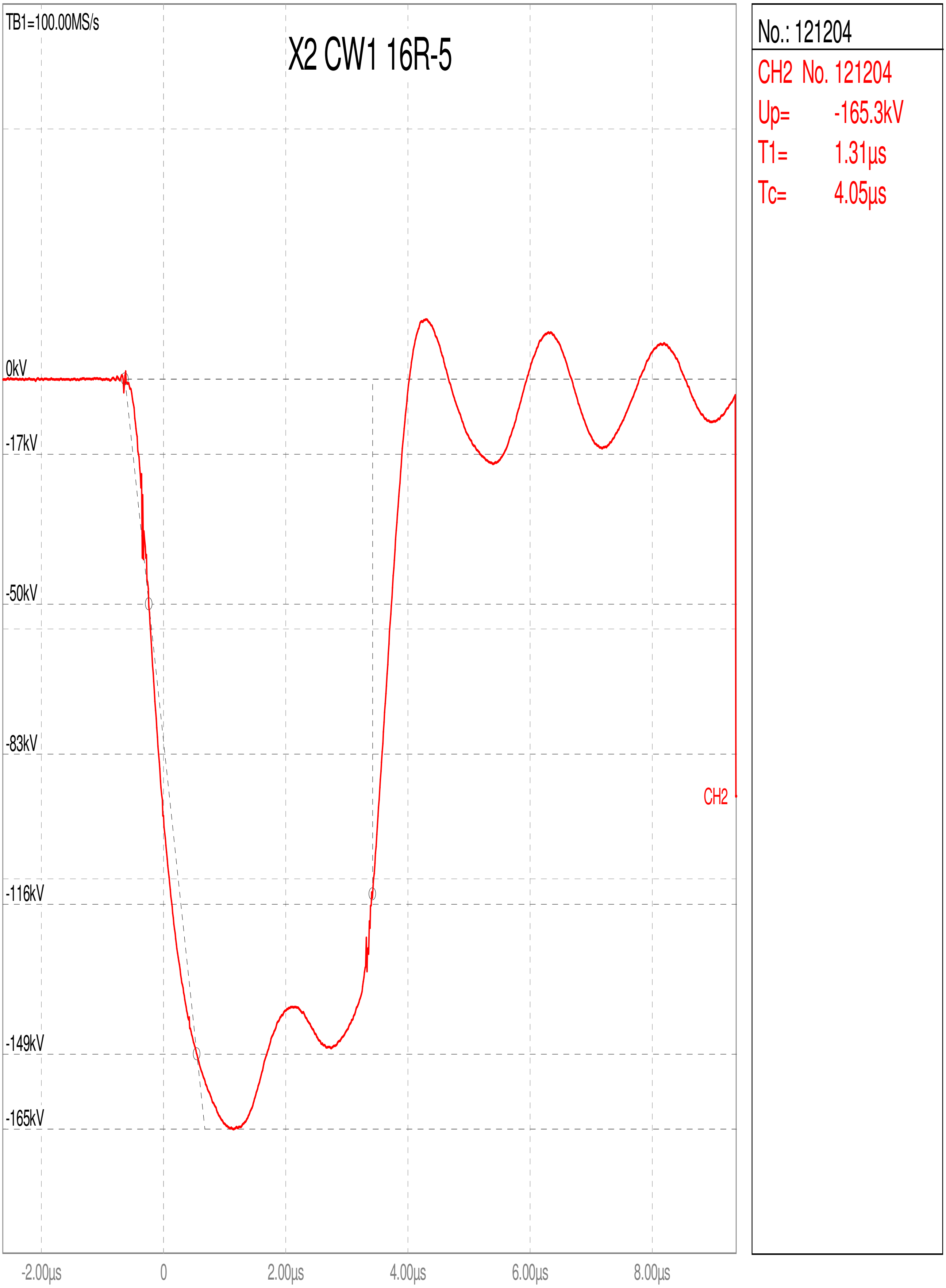
Ip= -639.5A

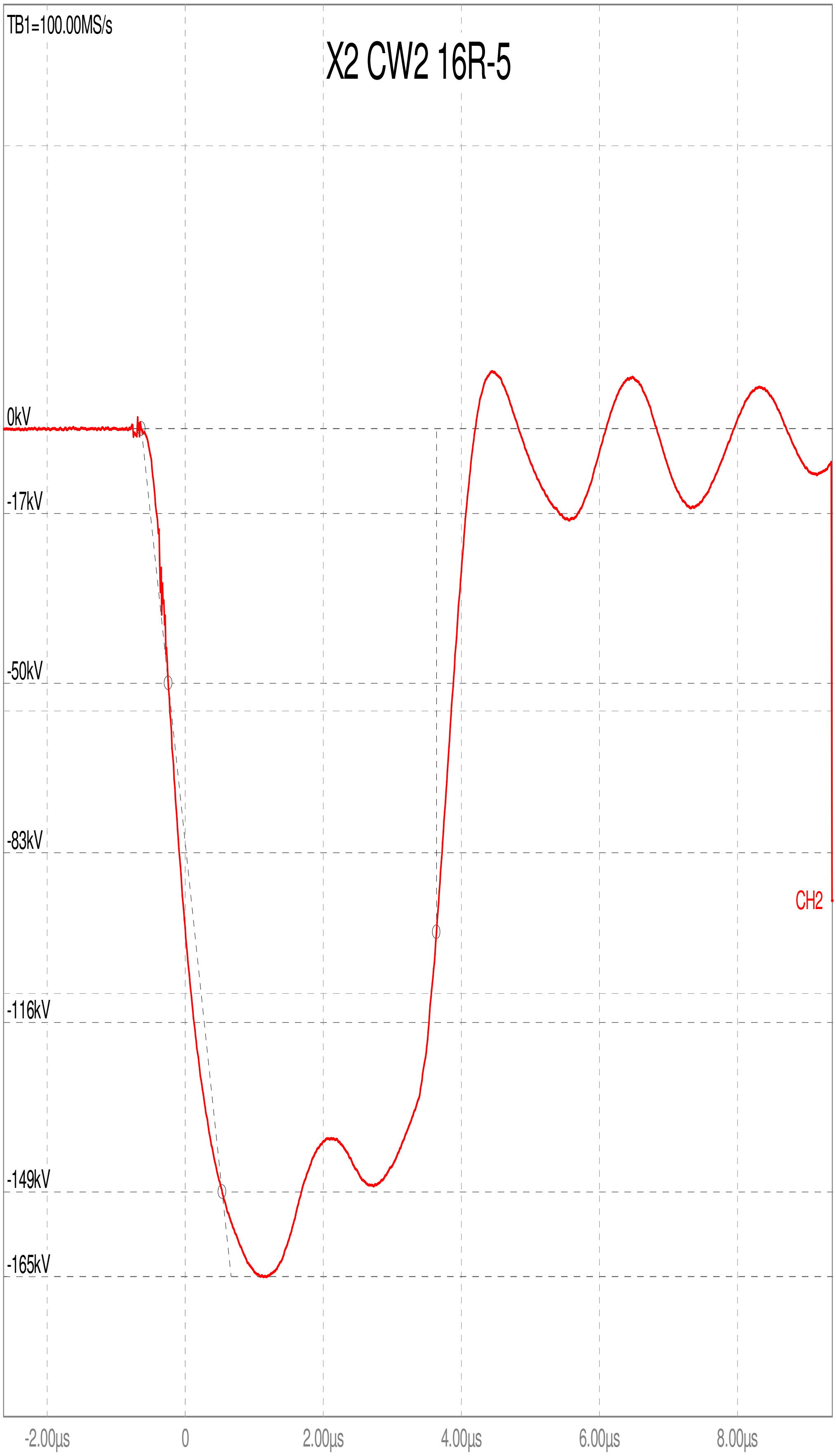
CH2 No. 45

Up= -149.7kV

T1= 1.3µs

T2= 48.9µs


TB1=100.00MS/s
X2 CW1 16R-5
0kV
-17kV
-50kV
-83kV
-116kV
-149kV
-165kV
CH2
-2.00µs
0
2.00µs
4.00µs
6.00µs
8.00µs
No.: 121204
CH2 No. 121204
Up= -165.3kV
T1= 1.31µs
Tc= 4.05µs



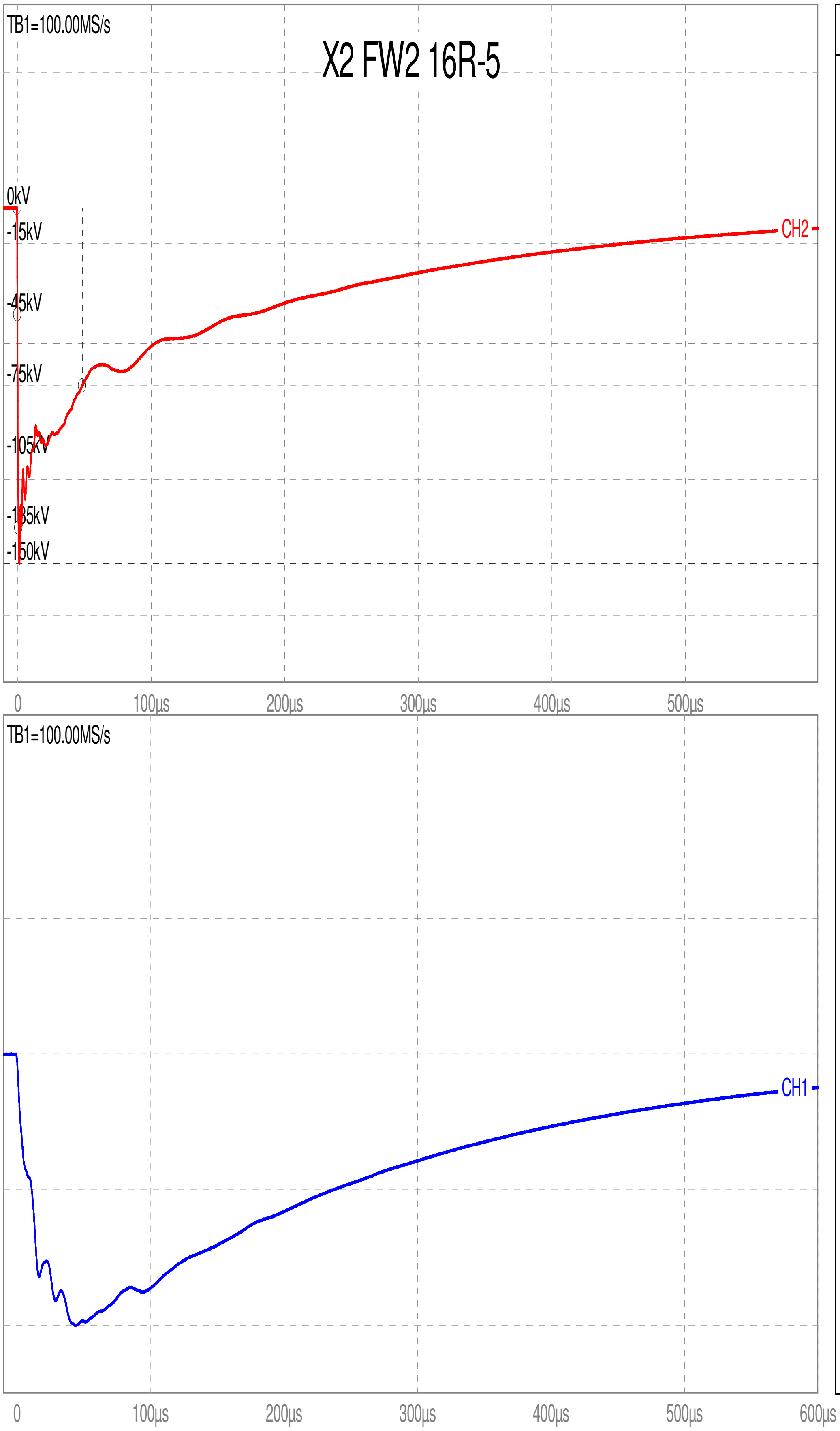
No.: 121205

CH2 No. 121205

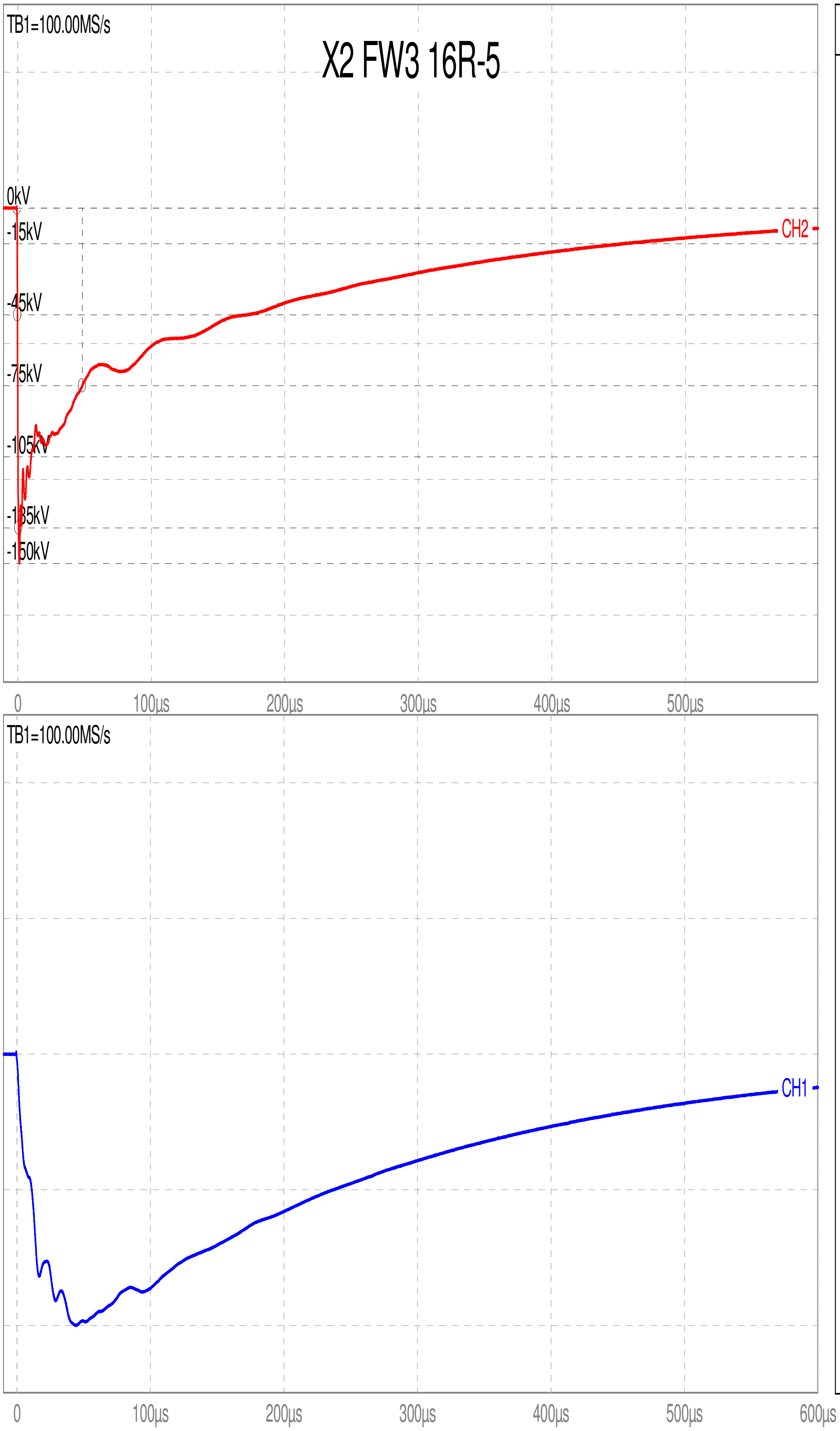
Up= -165.2kV

T1= 1.3µs

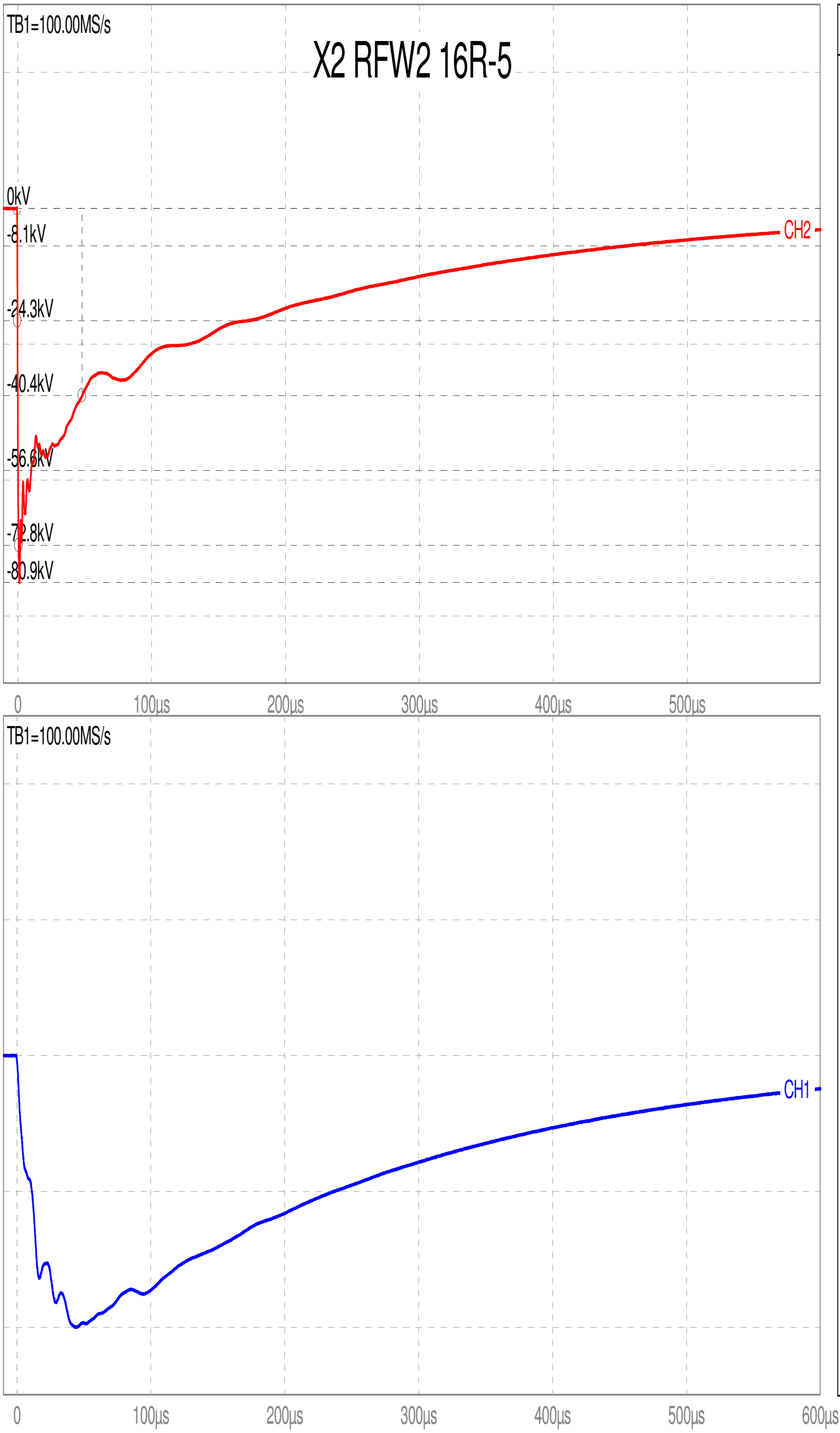
Tc= 4.27µs



No.: 48	
CH1 No. 48	
Ip=	-641.6A
CH2 No. 48	
Up=	-150.3kV
T1=	1.3µs
T2=	48.9µs



No.: 49	
CH1 No. 49	
Ip=	-641.8A
CH2 No. 49	
Up=	-150.3kV
T1=	1.3µs
T2=	48.9µs



No.: 50

CH1 No. 50

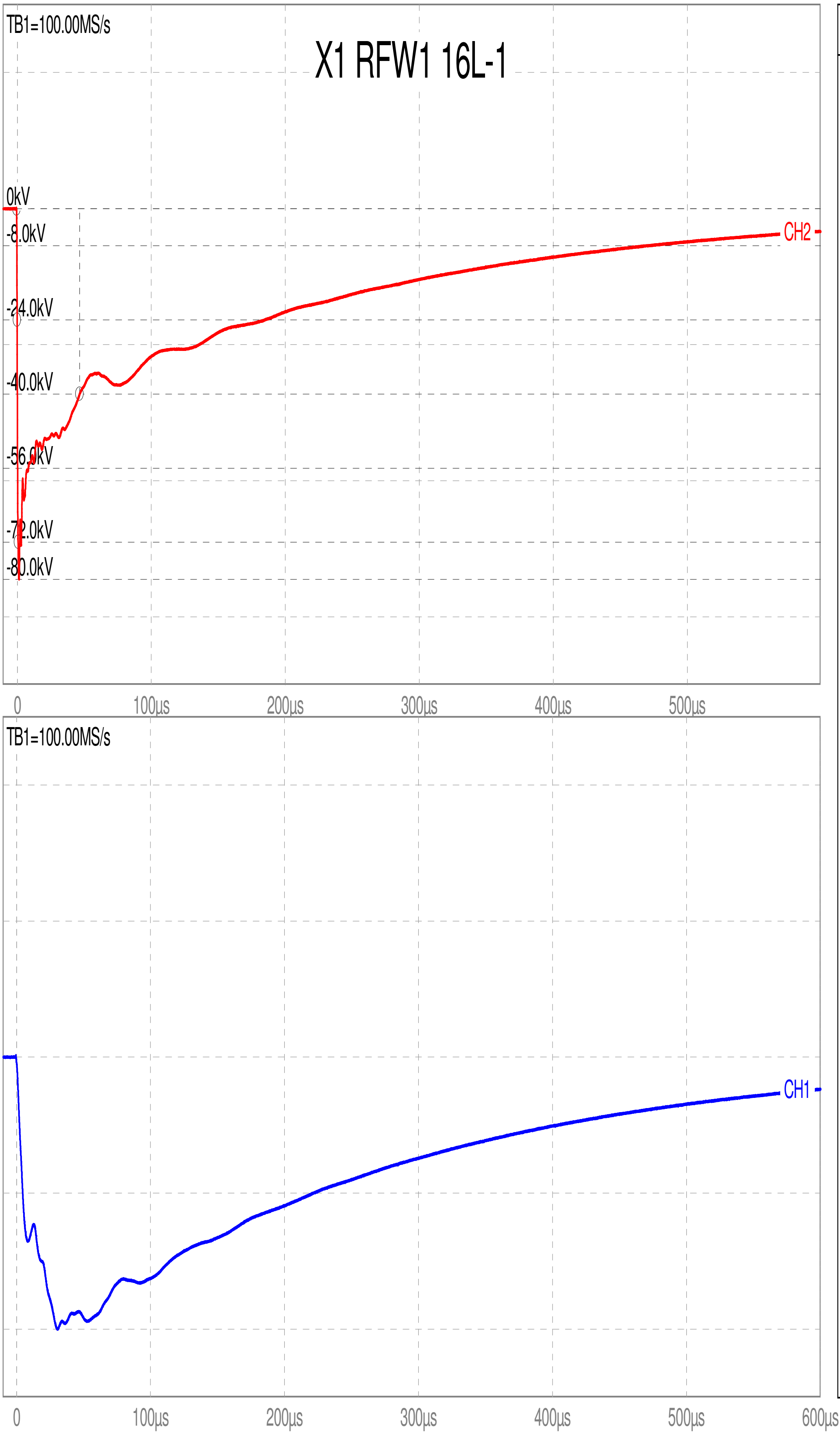
Ip= -344.9A

CH2 No. 50

Up= -80.89kV

T1= 1.32µs

T2= 48.6µs



No.: 51

CH1 No. 51

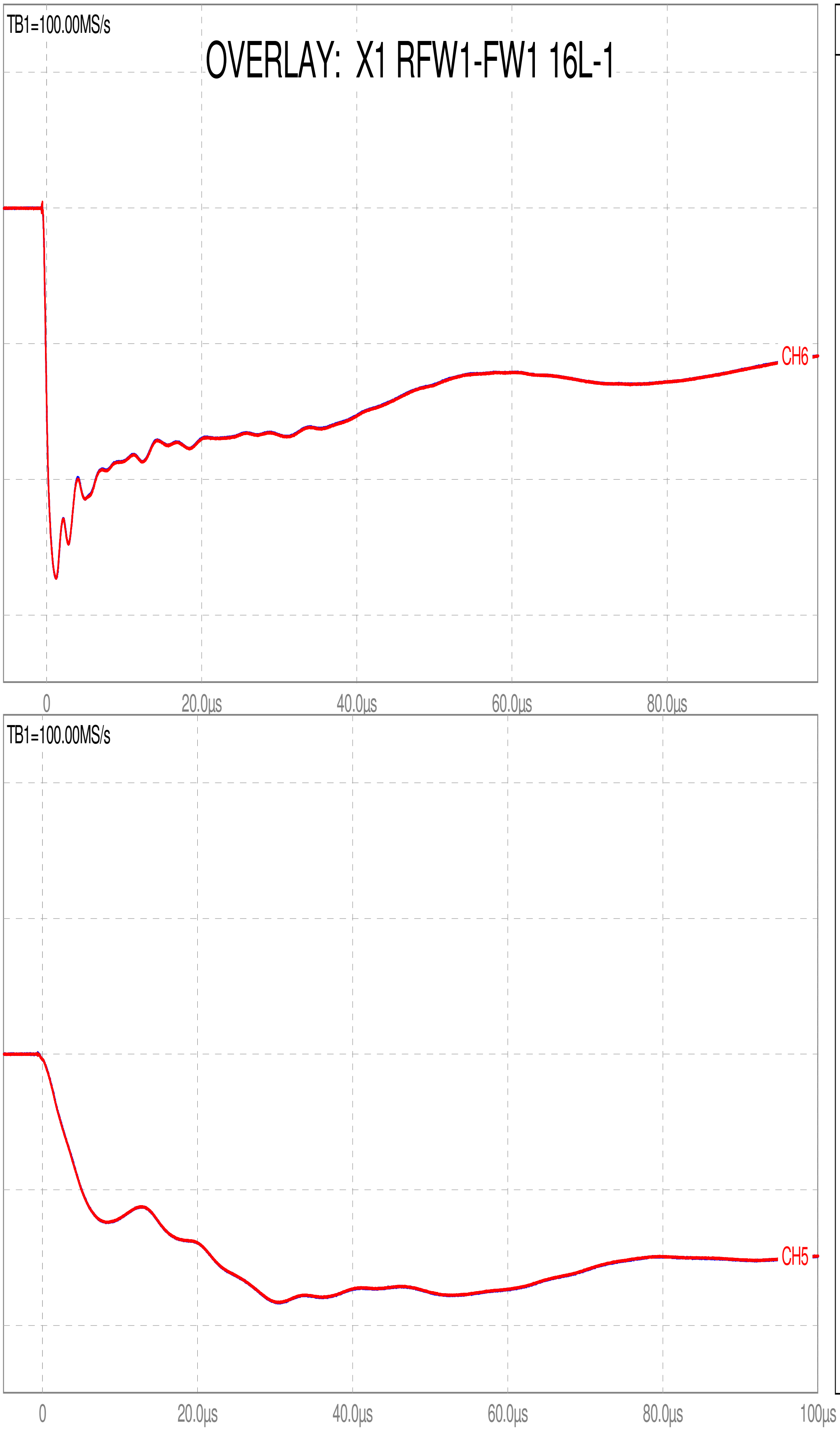
Ip= -365.9A

CH2 No. 51

Up= -80.01kV

T1= 1.26µs

T2= 47µs



No.: 52

CH1 No. 52

Ip= -365.9A

CH2 No. 52

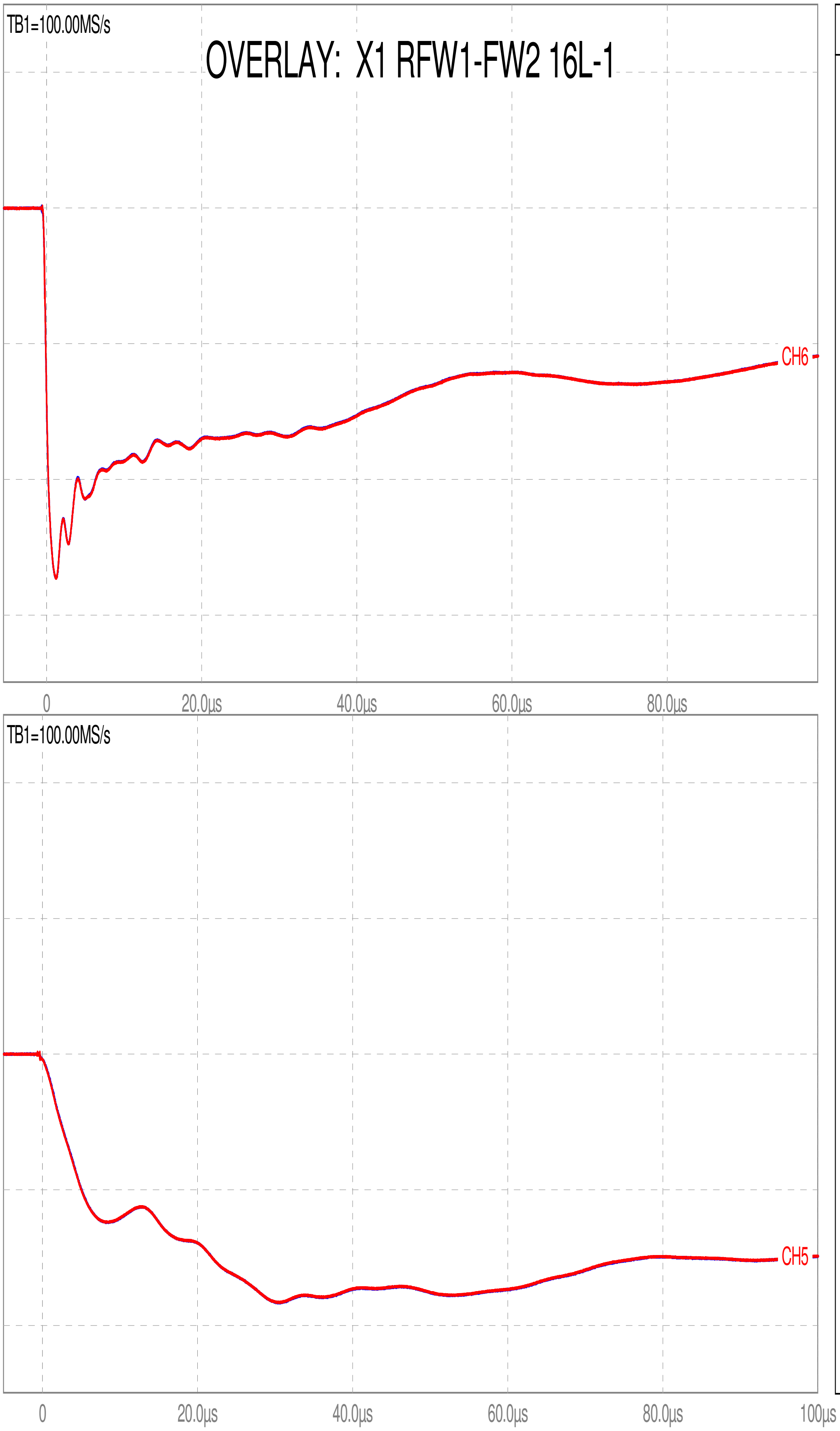
Up= -80.01kV

T1= 1.26µs

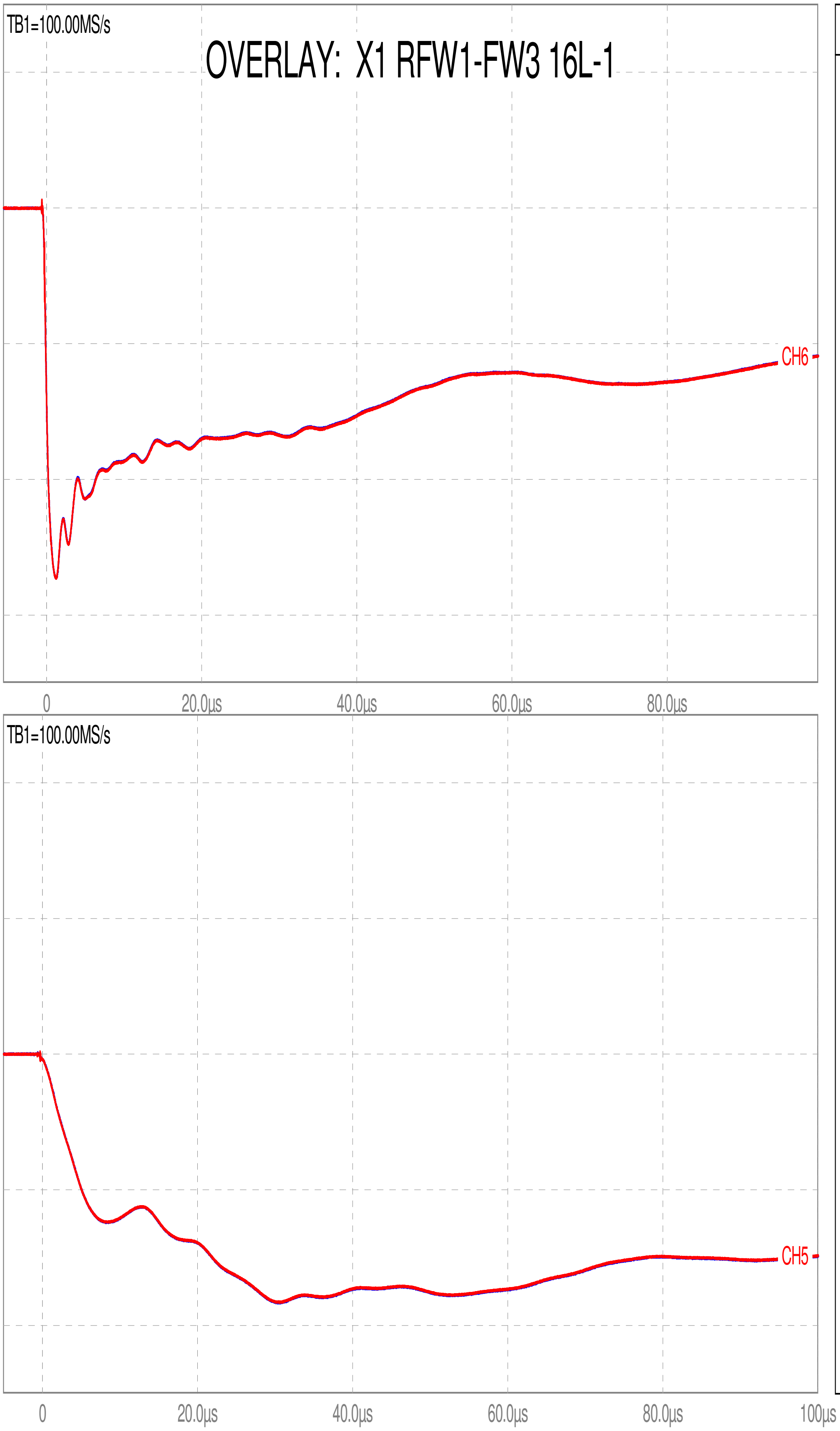
T2= 47µs

CH5 No. 121211

CH6 No. 121211



No.: 53
CH1 No. 53
Ip= -365.9A
CH2 No. 53
Up= -80.01kV
T1= 1.26µs
T2= 47µs
CH5 No. 121214
CH6 No. 121214



No.: 54

CH1 No. 54

Ip= -365.9A

CH2 No. 54

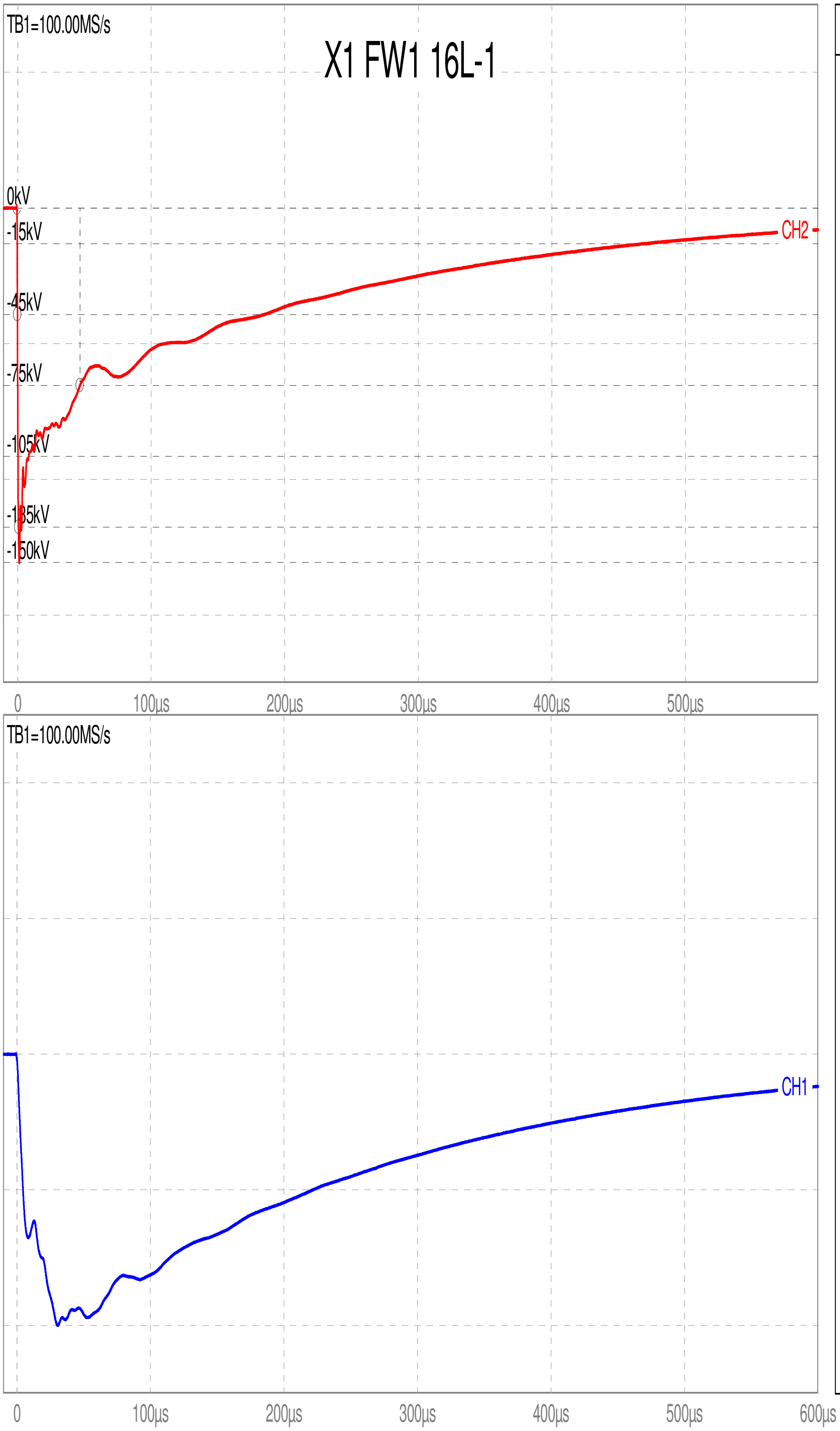
Up= -80.01kV

T1= 1.26µs

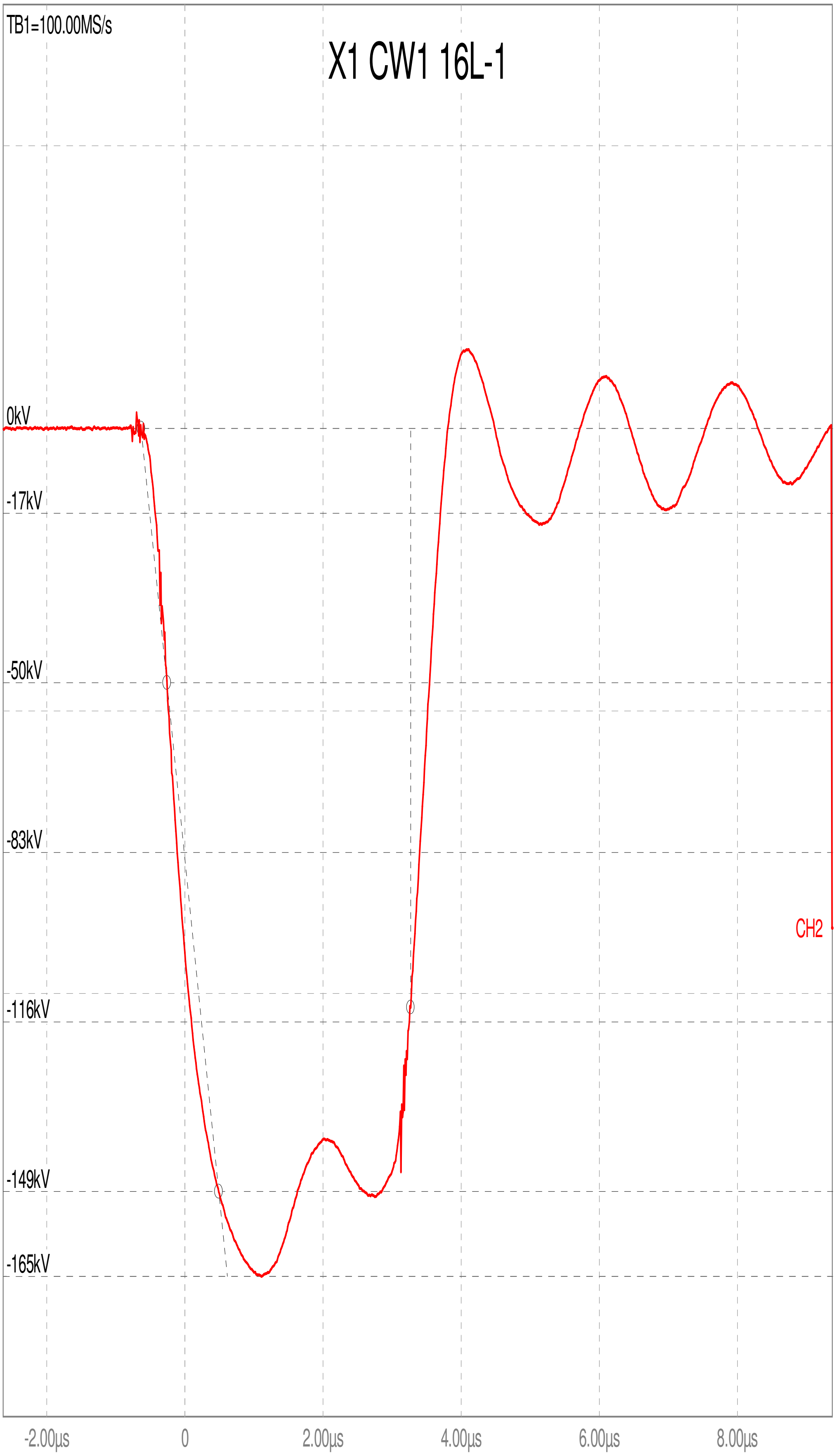
T2= 47µs

CH5 No. 121215

CH6 No. 121215



No.: 55	
CH1 No. 55	
Ip=	-685.4A
CH2 No. 55	
Up=	-149.9kV
T1=	1.25µs
T2=	47.2µs



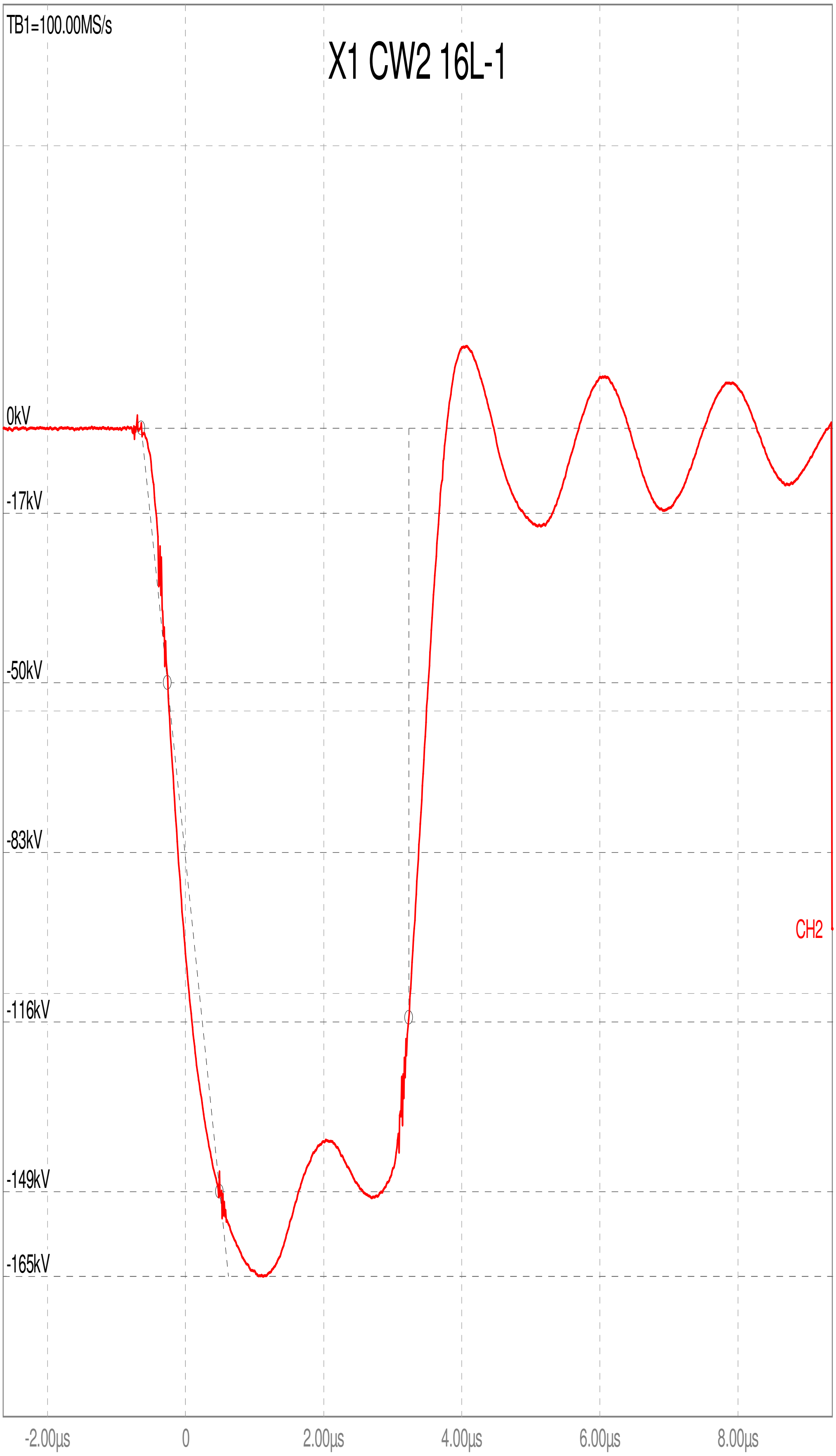
No.: 121212

CH2 No. 121212

Up= -165.4kV

T1= 1.25µs

Tc= 3.9µs



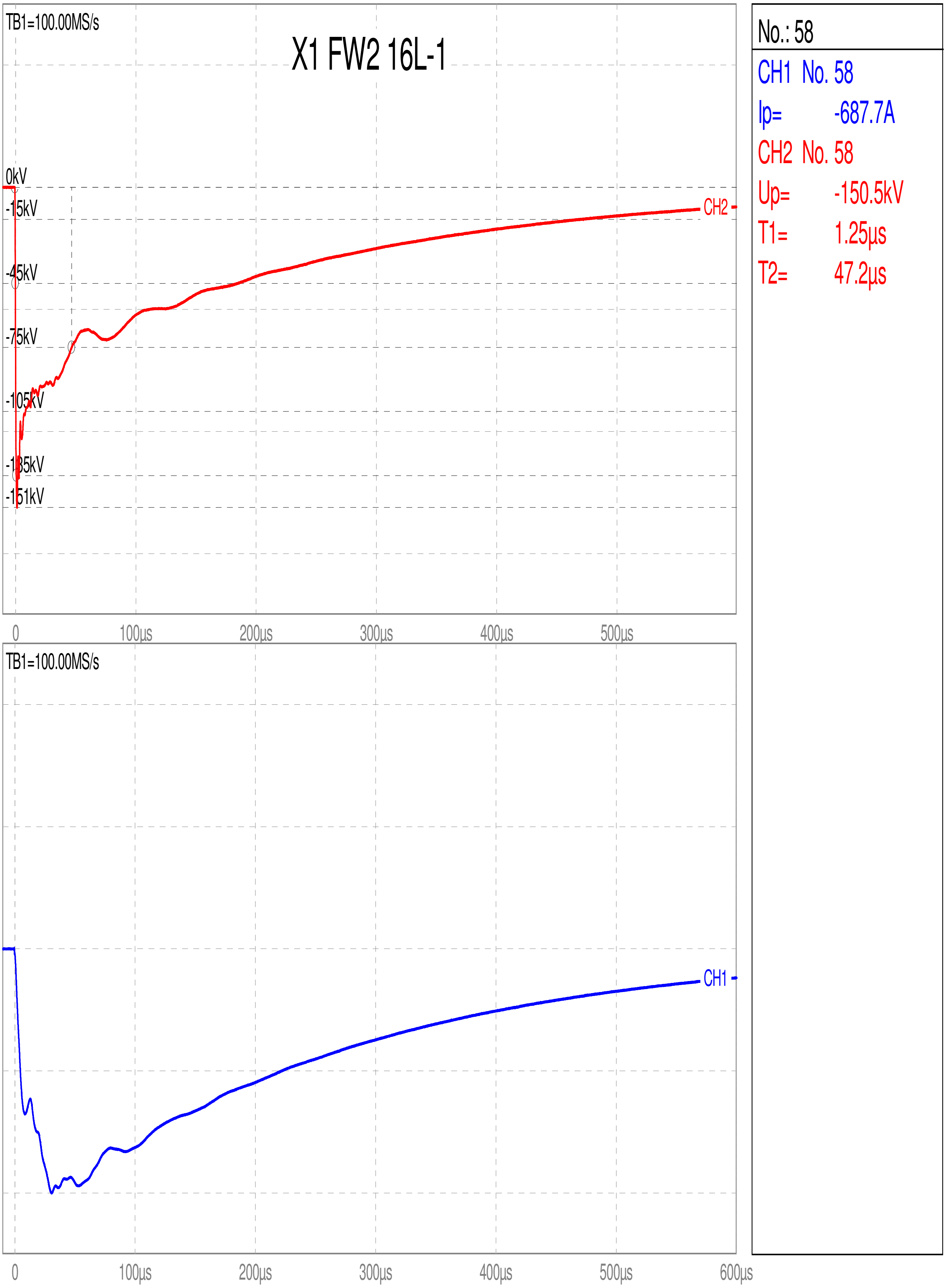
No.: 121213

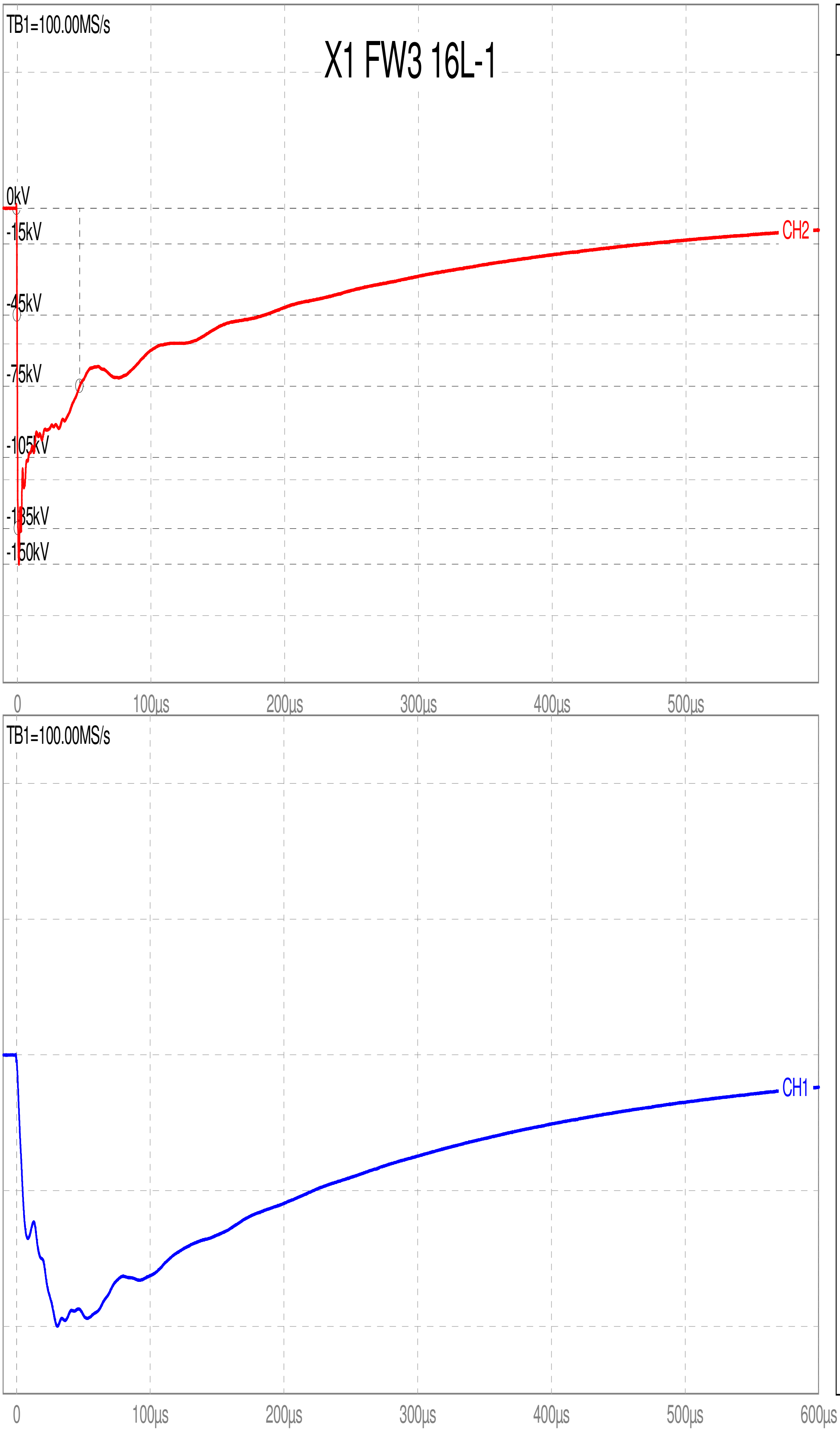
CH2 No. 121213

Up= -165.2kV

T1= 1.26µs

Tc= 3.87µs


TB1=100.00MS/s
X1 FW2 16L-1
0kV
-15kV
-45kV
-75kV
-105kV
-135kV
-151kV
CH2
0
100µs
200µs
300µs
400µs
500µs
TB1=100.00MS/s
CH1
0
100µs
200µs
300µs
400µs
500µs
600µs
No.: 58
CH1 No. 58
Ip= -687.7A
CH2 No. 58
Up= -150.5kV
T1= 1.25µs
T2= 47.2µs



No.: 59

CH1 No. 59

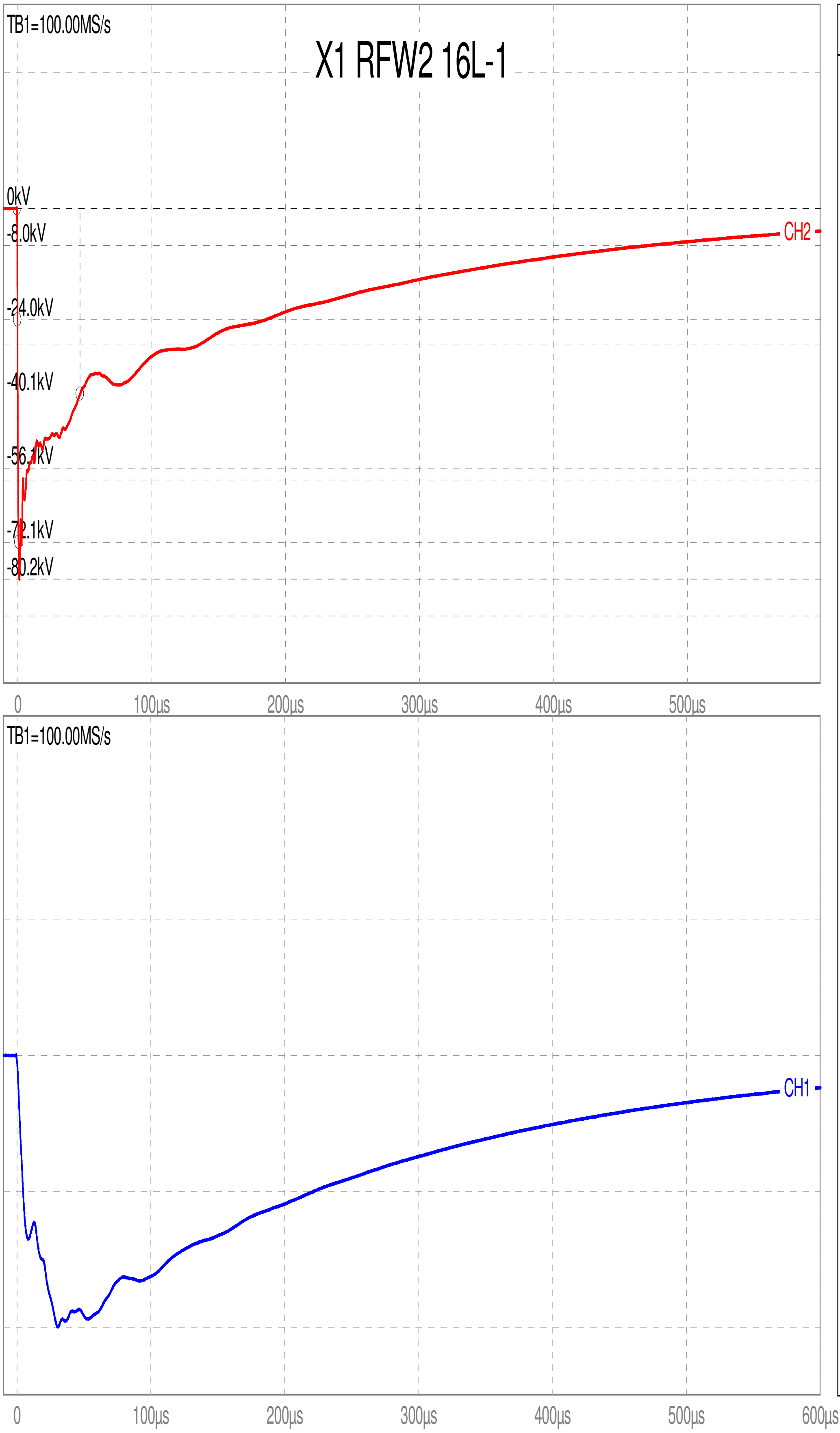
Ip= -687.7A

CH2 No. 59

Up= -150.4kV

T1= 1.24µs

T2= 47.2µs



No.: 60

CH1 No. 60

Ip= -366.3A

CH2 No. 60

Up= -80.16kV

T1= 1.26µs

T2= 47.1µs

Induced Test

3 BUSHING RADIO INTERFERENCE VOLTAGE AND PARTIAL DISCHARGE MEASUREMENT
INDUCED TEST USING NEMA BUSHING CAPACITANCE TAP METHOD
CORONA LEVEL IN MICROVOLTS(uV) AND PICOCOULOMBS(pC), MOTOR GENERATOR FREQUENCY IS 180 Hz

RATED HIGH VOLTAGE SYSTEM VOLTAGE = 67.65 kV
HIGH VOLTAGE TAP VOLTAGE = 70.95 kV
INPUT SUPPLY VOLTAGE = 7.16 kV Line to Ground

INPUT HERE
HIGH VOLTAGE ENHANCED TEST LEVEL 1.76 x 70.95 = 124.71 kV L-L

INPUT SUPPLY VOLTAGE LEVEL 1.76 x 7.16 = 12.58 kV L-G

Protection Circuit
44 volts

300
60
30
↓
73 %OF PT 60 V RANGE

PT=	1 :1	V L-G	HV V L-G
CT=	1 :1	ENH= 12583.5	5.96
		1 HOUR= 11010.6	5.22
		125%= 8948.9	4.24
		100%= 7159.1	3.39

DETC Position	1
LTC Position	16L

INPUT HERE
HIGH VOLTAGE ONE HOUR TEST LEVEL 1.54 x 70.95 = 109.12 kV L-L

INPUT SUPPLY VOLTAGE LEVEL 1.54 x 7.16 = 11.01 kV L-G

DURATION OF TEST ONE HOUR

% of Max HV Tap Voltage	A Phase		B Phase		C Phase		Time (Min.)
	(pC)	(uV)	(pC)	(uV)	(pC)	(uV)	
0	8	9	9	11	8	9	
100	11	10	13	11	12	10	
125	13	11	15	12	14	11	
154	15	12	17	13	16	12	
176	17	14	19	15	18	14	
154	16	13	18	14	17	13	0
154	16	13	17	14	16	12	5
154	16	13	17	14	16	12	10
154	15	13	17	14	16	12	15
154	15	12	17	13	16	12	20
154	15	12	16	13	16	12	25
154	15	12	16	13	15	12	30
154	14	12	16	13	15	11	35
154	14	12	15	12	15	11	40
154	14	11	15	12	15	11	45
154	14	11	14	12	14	11	50
154	13	11	14	11	14	10	55
154	13	11	14	11	14	10	60
125	12	10	13	10	13	9	
100	11	9	13	9	12	8	
0	9	8	10	9	9	8	

DURATION OF TEST IS 7200 CYCLES, HV TAP

EQUIPMENT DSE # CELL 2 PACIFIC

MR.: 5119
TESTED BY: CD/CT/SS
DATE: 9/17/2020

E5119_X2

Report Source **TwoWindingTransformer**

Session Test Date 9/17/2020 9:44:22 PM

Nameplate - Two-winding Transformer

Company	Delta Star Inc.	**Serial Number**	E5119
Location	DSE	**Special ID**	E5119
Division	TEST	**Circuit Designation**	
Manufacturer		**Configuration**	Y-Y
Year Manufactured		**Tank Type**	Select Tank Type
Mfr Location		**Coolant**	Select Coolant
Phases	Three	**Class**	
Oil Volume	*	**BIL**	*
Weight	*		
kV	*, *	**VA Rating**	*, *, *, *, Undefined

Administration

Test Date	9/17/2020	**Test Time:**	9:44 PM	**Weather**	Indoors
Air Temperature	23°C	**Apparatus Temperature**	28°C	**Humidity**	54 %
Tester	tj/jy	**Work Order**		**Date Last Tested**	
Verified		**Test Set Type**		**Date Retested**	
Verification Date		**Set Top Serial #**		**Reason**	
Last Sheet #		**Set Bottom Serial #**		**Travel Time**	
Purchase Order		**Ins. Book #**		**Duration**	
Copies		**Sheet #**		**Crew Size**	3

Bushing Nameplate

Designation	Serial #	Manufacturer	Type	C1 %PF	C1 Cap	C2 %PF	C2 Cap	Rated kV	Amps
H1	20203697	ABB (ASEA-Brown Boveri)	O+C II	0.32	250	0.11	469	69	*
H2	20203698	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.12	465	69	*
H3	20203700	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.13	465	69	*
X0	20203715	ABB (ASEA-Brown Boveri)	O+C	0.24	499	0.16	261	25	*
X1	20203737	ABB (ASEA-Brown Boveri)	O+C	0.25	507	0.15	260	25	*
X2	20203713	ABB (ASEA-Brown Boveri)	O+C	0.24	500	0.14	261	25	*
X3	20203736	ABB (ASEA-Brown Boveri)	O+C	0.25	506	0.14	261	25	*

Bushing Additional Details -H1

Designation H1 **Voltage** High **Serial #** 20203697

Catalog #		**Amps**	*	**BIL**	*	**Tap**	
Class		**Year**		**Drawing**			
Style		**Other**		**S.O. Number**			

Physical Dimensions

Creep Distance	*	**Overall Length**	*	**Inner Seal Dia.**	*	**Eff. Gnd Sleeve**	*
Total Weight	*	**Recess Depth**	*	**Outer Seal Dia.**	*	**Slot Size**	*
Units							

Flange Dimensions

To Bottom	*	**# Bolts**	*	**Max. Diameters**		**Draw Lead**	
To Top	*	**Bolt Size**	*	**Below Flange**	*	**Tube ID**	*
		Circle Diameter	*	**Above Flange**	*	**To Pin**	*

Overall Tests

	Insulation	Test kV	mA	Watts	% PF Corr.	Corr Fctr	Cap (pF)	FRANK™	Manual
1	CH+CHL	9.999	39.785	0.836	0.202	0.962	10554.100		
2	CH	9.998	7.723	0.228	0.284	0.962	2048.580		
3	CHL(UST)	10.005	32.067	1.094	0.328	0.962	8506.245		
4	CHL	0	32.062	0.607	0.182	0.962	8505.520		
5	CL+CHL	9.997	73.779	1.597	0.208	0.962	19571.650		
6	CL	9.997	41.732	0.990	0.228	0.962	11069.950		
7	CHL(UST)	9.997	32.056	0.622	0.187	0.962	8502.940		
8	CHL	0	32.047	0.607	0.182	0.962	8501.700		

LSR	mA: 39.785/39.785, 1/1	Watts: 0.836/0.836, 1/1	Cap (pF): 10554.100/10554.100, 1/1
LSR	mA: 7.723/7.723, 1/1	Watts: 0.228/0.228, 1/1	Cap (pF): 2048.580/2048.580, 1/1
LSR	mA: 32.067/32.067, 1/1	Watts: 1.094/1.094, 1/1	Cap (pF): 8506.245/8506.245, 1/1
LSR	mA: 32.062/32.062, 1/1	Watts: 0.607/0.607, 1/1	Cap (pF): 8505.520/8505.520, 1/1
LSR	mA: 73.779/73.779, 1/1	Watts: 1.597/1.597, 1/1	Cap (pF): 19571.650/19571.650, 1/1
LSR	mA: 41.732/41.732, 1/1	Watts: 0.990/0.990, 1/1	Cap (pF): 11069.950/11069.950, 1/1
LSR	mA: 32.056/32.056, 1/1	Watts: 0.622/0.622, 1/1	Cap (pF): 8502.940/8502.940, 1/1
LSR	mA: 32.047/32.047, 1/1	Watts: 0.607/0.607, 1/1	Cap (pF): 8501.700/8501.700, 1/1

Core Ground Test

Voltage	*	**Resistance**	*

Insulation Resistance

			Core Ground Test	
Manufacturer			*	
Serial #			*	
Connections	**Volts**	**T1 (Mohms)**	**T2 (Mohms)**	**PI**
Hi to Lo/Earth	*	*	*	*
Hi to Earth Guard Lo	*	*	*	*
Lo to Hi/Earth	*	*	*	*
Lo to Earth Guard Hi	*	*	*	*
Hi to Lo Guard Earth	*	*	*	*
Core to Earth	*	*	*	*

Exciting Current Tests

Leakage Reactance Tests (3-Phase Equivalent) [H-L]

		Test Results								Ratings	
DETC/LTC	Phase	Voltage	Current	Watts	PF meas	Ind.	Res. (Ohms)	Imp. (Ohms)	Reac. (Ohms)	FRANK™	Manual
3/N	Phase A	97.357 V	2.047 A	6.828 W	3.426	0.126 H	1.63	47.569	47.541	Unrated	Unrated
3/N	Phase B	95.112 V	2.024 A	6.676 W	3.467	0.125 H	1.629	47.004	46.976	Unrated	Unrated
3/N	Phase C	96.269 V	2.062 A	7.438 W	3.747	0.124 H	1.749	46.699	46.666	Unrated	Unrated

		% Impedance			% Reactance			
DETC/LTC	Phase	% Imped.	Benchmark	Delta Bench.	% Reac.	Benchmark	Delta Bench.	D Average (%)
3/N		8.643	8.63	0.154	8.638	8.63	0.091	

Leakage Reactance Tests (Per Phase) [H-L]

		Test Results								Ratings	
DETC/LTC	Phase	Voltage	Current	Watts	PF meas	Ind.	Res. (Ohms)	Imp. (Ohms)	Reac. (Ohms)	FRANK™	Manual
3/N	Phase A	96.21 V	2.061 A	7.477 W	3.772	0.124 H	1.761	46.7	46.667	Unrated	Unrated
3/N	Phase B	95.141 V	2 A	6.503 W	3.417	0.126 H	1.625	47.578	47.55	Unrated	Unrated
3/N	Phase C	95.097 V	2.024 A	6.521 W	3.388	0.125 H	1.592	46.991	46.964	Unrated	Unrated

		% Impedance			% Reactance			
DETC/LTC	Phase	% Imped.	Benchmark	Delta Bench.	% Reac.	Benchmark	Delta Bench.	D Average (%)
3/N	Phase A	17.143	8.63	98.645	17.131	8.63	98.504	0.835
3/N	Phase B	17.465	8.63	102.379	17.455	8.63	102.261	1.040
3/N	Phase C	17.25	8.63	99.885	17.24	8.63	99.771	0.205

Note	HV&LV 1/3
Note	HV&LV 2/1
Note	HV&LV 3/2

Report Source **TwoWindingTransformer**

Session Test Date 9/17/2020 3:55:00 PM

Nameplate - Two-winding Transformer

Company	Delta Star Inc.	**Serial Number**	E5119
Location	DSE	**Special ID**	E5119
Division	TEST	**Circuit Designation**	
Manufacturer		**Configuration**	Y-Y
Year Manufactured		**Tank Type**	Select Tank Type
Mfr Location		**Coolant**	Select Coolant
Phases	Three	**Class**	
Oil Volume	*	**BIL**	*
Weight	*		
kV	*, *	**VA Rating**	*, *, *, *, Undefined

Administration

Test Date	9/17/2020	**Test Time:**	3:55 PM	**Weather**	
Air Temperature	*	**Apparatus Temperature**	*	**Humidity**	*
Tester	JB/JY	**Work Order**		**Date Last Tested**	
Verified		**Test Set Type**		**Date Retested**	
Verification Date		**Set Top Serial #**		**Reason**	
Last Sheet #		**Set Bottom Serial #**		**Travel Time**	
Purchase Order		**Ins. Book #**		**Duration**	
Copies		**Sheet #**		**Crew Size**	3

Bushing Nameplate

Designation	Serial #	Manufacturer	Type	C1 %PF	C1 Cap	C2 %PF	C2 Cap	Rated kV	Amps
H1	20203697	ABB (ASEA-Brown Boveri)	O+C II	0.32	250	0.11	469	69	*
H2	20203698	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.12	465	69	*
H3	20203700	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.13	465	69	*
X0	20203715	ABB (ASEA-Brown Boveri)	O+C	0.24	499	0.16	261	25	*
X1	20203737	ABB (ASEA-Brown Boveri)	O+C	0.25	507	0.15	260	25	*
X2	20203713	ABB (ASEA-Brown Boveri)	O+C	0.24	500	0.14	261	25	*
X3	20203736	ABB (ASEA-Brown Boveri)	O+C	0.25	506	0.14	261	25	*

Bushing Additional Details -H1

Designation H1 **Voltage** High **Serial #** 20203697

Catalog #		**Amps**	*	**BIL**	*	**Tap**	
Class		**Year**		**Drawing**			
Style		**Other**		**S.O. Number**			

Physical Dimensions

Creep Distance	*	**Overall Length**	*	**Inner Seal Dia.**	*	**Eff. Gnd Sleeve**	*
Total Weight	*	**Recess Depth**	*	**Outer Seal Dia.**	*	**Slot Size**	*
Units							

Flange Dimensions

To Bottom	*	**# Bolts**	*	**Max. Diameters**		**Draw Lead**	
To Top	*	**Bolt Size**	*	**Below Flange**	*	**Tube ID**	*
		Circle Diameter	*	**Above Flange**	*	**To Pin**	*

DETC	3	3	*
DETC	3	3	*
DETC	3	3	*
DETC	3	3	*
DETC	3	3	*
DETC	3	3	*
DETC	3	3	*
On-line (LTC)			*

			H1 H3			H2 H1			H3 H2				
DETC	**LTC**	**Test kV**	**mA**	**Watts**	**X**	**mA**	**Watts**	**X**	**mA**	**Watts**	**X**	**FRANK™**	**Manual**
3	16L	8	28.245	175.377	L	14.585	86.722	L	13.783	85.492	L		
3	15L	8	191.279	206.591	L	177.944	109.563	L	175.863	108.988	L		
3	14L	8	28.252	175.281	L	14.607	86.659	L	13.787	85.319	L		
3	13L	8	67.028	183.145	L	54.308	92.296	L	53.063	91.148	L		
3	12L	8	28.286	175.128	L	14.617	86.626	L	13.796	85.256	L		
3	11L	8	67.064	183.065	L	54.282	92.267	L	53.077	91.093	L		
3	10L	8	28.307	175.077	L	14.626	86.612	L	13.802	85.218	L		
3	9L	8	191.803	205.532	L	178.451	108.892	L	176.347	108.313	L		
3	8L	8	28.325	175.042	L	14.636	86.598	L	13.809	85.200	L		
3	7L	8	67.123	182.960	L	54.349	92.187	L	53.102	91.065	L		
3	6L	8	28.334	174.991	L	14.641	86.585	L	13.816	85.190	L		
3	5L	8	67.130	182.834	L	54.372	92.158	L	53.130	91.016	L		
3	4L	8	28.346	174.966	L	14.647	86.582	L	13.821	85.181	L		
3	3L	8	191.704	205.157	L	178.575	108.651	L	176.342	108.166	L		
3	2L	8	28.355	174.928	L	14.656	86.606	L	13.828	85.165	L		
3	1L	8	67.136	182.769	L	54.362	92.168	L	53.114	91.000	L		
1	N	10	24.952	157.039	L	13.069	78.085	L	12.147	76.770	L		
2	N	10	26.026	164.282	L	13.554	81.735	L	12.636	80.368	L		
3	N	10	27.061	171.561	L	14.010	85.384	L	13.067	83.910	L		
4	N	10	28.260	179.893	L	14.571	89.588	L	13.625	88.092	L		
5	N	10	29.538	188.915	L	15.146	94.149	L	14.223	92.630	L		
3	1R	8	66.982	183.365	L	54.253	92.457	L	52.832	91.115	L		
3	2R	8	28.294	175.275	L	14.627	86.722	L	13.654	85.126	L		
3	3R	8	191.357	206.049	L	178.040	109.435	L	175.732	108.785	L		
3	4R	8	28.316	175.170	L	14.643	86.673	L	13.669	85.069	L		
3	5R	8	67.087	183.064	L	54.330	92.283	L	52.912	90.957	L		
3	6R	8	28.328	175.106	L	14.652	86.645	L	13.678	85.044	L		
3	7R	8	67.110	183.053	L	54.327	92.282	L	52.939	90.951	L		
3	8R	8	28.336	175.062	L	14.659	86.635	L	13.688	85.044	L		
3	9R	8	191.733	205.438	L	178.494	108.883	L	176.246	108.278	L		
3	10R	8	28.354	175.046	L	14.669	86.616	L	13.697	85.031	L		
3	11R	8	67.168	182.984	L	54.384	92.211	L	52.982	90.933	L		
3	12R	8	28.365	175.038	L	14.675	86.614	L	13.703	85.018	L		
3	13R	8	67.184	182.902	L	54.408	92.190	L	52.991	90.839	L		
3	14R	8	28.368	175.003	L	14.680	86.611	L	13.707	85.015	L		
3	15R	8	191.851	205.264	L	178.518	108.699	L	176.245	108.052	L		
3	16R	8	28.384	175.003	L	14.690	86.653	L	13.716	85.012	L		

Report Source **TwoWindingTransformer**

Session Test Date 9/15/2020 7:29:41 PM

Nameplate - Two-winding Transformer

Company	Delta Star Inc.	**Serial Number**	E5119
Location	DSE	**Special ID**	E5119
Division	TEST	**Circuit Designation**	
Manufacturer		**Configuration**	Y-Y
Year Manufactured		**Tank Type**	Select Tank Type
Mfr Location		**Coolant**	Select Coolant
Phases	Three	**Class**	
Oil Volume	*	**BIL**	*
Weight	*		
kV	*, *	**VA Rating**	*, *, *, *, Undefined

Administration

Test Date	9/15/2020	**Test Time:**	7:29 PM	**Weather**	Indoors
Air Temperature	24°C	**Apparatus Temperature**	34°C	**Humidity**	49 %
Tester	tj/jy	**Work Order**		**Date Last Tested**	
Verified		**Test Set Type**		**Date Retested**	
Verification Date		**Set Top Serial #**		**Reason**	
Last Sheet #		**Set Bottom Serial #**		**Travel Time**	
Purchase Order		**Ins. Book #**		**Duration**	
Copies		**Sheet #**		**Crew Size**	3

Bushing Nameplate

Designation	Serial #	Manufacturer	Type	C1 %PF	C1 Cap	C2 %PF	C2 Cap	Rated kV	Amps
H1	20203697	ABB (ASEA-Brown Boveri)	O+C II	0.32	250	0.11	469	69	*
H2	20203698	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.12	465	69	*
H3	20203700	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.13	465	69	*
X0	20203715	ABB (ASEA-Brown Boveri)	O+C	0.24	499	0.16	261	25	*
X1	20203737	ABB (ASEA-Brown Boveri)	O+C	0.25	507	0.15	260	25	*
X2	20203713	ABB (ASEA-Brown Boveri)	O+C	0.24	500	0.14	261	25	*
X3	20203736	ABB (ASEA-Brown Boveri)	O+C	0.25	506	0.14	261	25	*

Bushing Additional Details -H1

Designation H1 | **Voltage** High | **Serial #** 20203697

Catalog #		**Amps**	*	**BIL**	*	**Tap**	
Class		**Year**		**Drawing**			
Style		**Other**		**S.O. Number**			

Physical Dimensions

Creep Distance	*	**Overall Length**	*	**Inner Seal Dia.**	*	**Eff. Gnd Sleeve**	*
Total Weight	*	**Recess Depth**	*	**Outer Seal Dia.**	*	**Slot Size**	*
Units							

Flange Dimensions

To Bottom	*	**# Bolts**	*	**Max. Diameters**		**Draw Lead**	
To Top	*	**Bolt Size**	*	**Below Flange**	*	**Tube ID**	*
		Circle Diameter	*	**Above Flange**	*	**To Pin**	*

Overall Tests

	Insulation	Test kV	mA	Watts	% PF Corr.	Corr Fctr	Cap (pF)	FRANK™	Manual
1	CH+CHL	9.998	39.776	0.827	0.193	0.929	10550.500		
2	CH	9.999	7.725	0.237	0.286	0.929	2049.165		
3	CHL(UST)	9.999	32.049	0.584	0.169	0.929	8501.545		
4	CHL	0	32.050	0.589	0.171	0.929	8501.335		
5	CL+CHL	9.998	73.809	1.621	0.204	0.929	19578.800		
6	CL	9.999	41.754	1.049	0.233	0.929	11075.200		
7	CHL(UST)	9.998	32.056	0.602	0.175	0.929	8503.265		
8	CHL	0	32.056	0.572	0.166	0.929	8503.600		

LSR	mA: 39.776/39.776, 1/1	Watts: 0.827/0.827, 1/1	Cap (pF): 10550.500/10550.500, 1/1
LSR	mA: 7.725/7.725, 1/1	Watts: 0.237/0.237, 1/1	Cap (pF): 2049.165/2049.165, 1/1
LSR	mA: 32.049/32.049, 1/1	Watts: 0.584/0.584, 1/1	Cap (pF): 8501.545/8501.545, 1/1
LSR	mA: 32.050/32.050, 1/1	Watts: 0.589/0.589, 1/1	Cap (pF): 8501.335/8501.335, 1/1
LSR	mA: 73.809/73.809, 1/1	Watts: 1.621/1.621, 1/1	Cap (pF): 19578.800/19578.800, 1/1
LSR	mA: 41.754/41.754, 1/1	Watts: 1.049/1.049, 1/1	Cap (pF): 11075.200/11075.200, 1/1
LSR	mA: 32.056/32.056, 1/1	Watts: 0.602/0.602, 1/1	Cap (pF): 8503.265/8503.265, 1/1
LSR	mA: 32.056/32.056, 1/1	Watts: 0.572/0.572, 1/1	Cap (pF): 8503.600/8503.600, 1/1

Bushing C1

ID	Serial #	NP %PF	NP Cap	Test kV	mA	Watts	% PF Corr.	Corr Fctr	Cap(pF)	FRANK™	Manual
H1	20203697	0.32	250	9.999	0.937	0.026	0.292	1.042	248.624		
H2	20203698	0.33	250	10.000	0.938	0.027	0.298	1.042	248.797		
H3	20203700	0.33	250	9.999	0.940	0.027	0.299	1.042	249.451		
X0	20203715	0.24	499	10.000	1.883	0.039	0.218	1.042	499.394		
X1	20203737	0.25	507	10.000	1.920	0.042	0.230	1.042	509.428		
X2	20203713	0.24	500	10.000	1.892	0.041	0.225	1.042	501.848		
X3	20203736	0.25	506	10.000	1.908	0.042	0.231	1.042	506.187		

LSR	mA: 0.937/0.937, 1/1	Watts: 0.026/0.026, 1/1	Cap (pF): 248.624/248.624, 1/1
LSR	mA: 0.938/0.938, 1/1	Watts: 0.027/0.027, 1/1	Cap (pF): 248.797/248.797, 1/1
LSR	mA: 0.940/0.940, 1/1	Watts: 0.027/0.027, 1/1	Cap (pF): 249.451/249.451, 1/1
LSR	mA: 1.883/1.883, 1/1	Watts: 0.039/0.039, 1/1	Cap (pF): 499.394/499.394, 1/1
LSR	mA: 1.920/1.920, 1/1	Watts: 0.042/0.042, 1/1	Cap (pF): 509.428/509.428, 1/1
LSR	mA: 1.892/1.892, 1/1	Watts: 0.041/0.041, 1/1	Cap (pF): 501.848/501.848, 1/1
LSR	mA: 1.908/1.908, 1/1	Watts: 0.042/0.042, 1/1	Cap (pF): 506.187/506.187, 1/1

Bushing C2

ID	Serial #	NP %PF	NP Cap	Test kV	mA	Watts	% PF Corr.	Corr Fctr	Cap(pF)	FRANK™	Manual
H1	20203697	0.11	469	0.499	1.760	0.036	0.203	1	466.862		
H2	20203698	0.12	465	0.499	1.748	0.032	0.183	1	463.736		
H3	20203700	0.13	465	0.499	1.735	0.036	0.209	1	460.240		
X0	20203715	0.16	261	0.499	0.972	0.019	0.195	1	257.911		
X1	20203737	0.15	260	0.499	0.968	0.024	0.244	1	256.762		
X2	20203713	0.14	261	0.499	0.971	0.016	0.162	1	257.694		
X3	20203736	0.14	261	0.499	0.976	0.015	0.158	1	258.924		

LSR	mA: 1.760/1.760, 1/1	Watts: 0.036/0.036, 1/1	Cap (pF): 466.862/466.862, 1/1
LSR	mA: 1.748/1.748, 1/1	Watts: 0.032/0.032, 1/1	Cap (pF): 463.736/463.736, 1/1
LSR	mA: 1.735/1.735, 1/1	Watts: 0.036/0.036, 1/1	Cap (pF): 460.240/460.240, 1/1
LSR	mA: 0.972/0.972, 1/1	Watts: 0.019/0.019, 1/1	Cap (pF): 257.911/257.911, 1/1
LSR	mA: 0.968/0.968, 1/1	Watts: 0.024/0.024, 1/1	Cap (pF): 256.762/256.762, 1/1
LSR	mA: 0.971/0.971, 1/1	Watts: 0.016/0.016, 1/1	Cap (pF): 257.694/257.694, 1/1
LSR	mA: 0.976/0.976, 1/1	Watts: 0.015/0.015, 1/1	Cap (pF): 258.924/258.924, 1/1

Core Ground Test

Voltage	*	**Resistance**	*

Insulation Resistance

			Core Ground Test	
Manufacturer			*	
Serial #			*	
Connections	**Volts**	**T1 (Mohms)**	**T2 (Mohms)**	**PI**
Hi to Lo/Earth	*	*	*	*
Hi to Earth Guard Lo	*	*	*	*
Lo to Hi/Earth	*	*	*	*
Lo to Earth Guard Hi	*	*	*	*
Hi to Lo Guard Earth	*	*	*	*
Core to Earth	*	*	*	*

Report Source **TwoWindingTransformer**

Session Test Date 9/8/2020 10:49:08 PM

Nameplate - Two-winding Transformer

Company	Delta Star Inc.	**Serial Number**	E5119
Location	DSE	**Special ID**	E5119
Division	TEST	**Circuit Designation**	
Manufacturer		**Configuration**	Y-Y
Year Manufactured		**Tank Type**	Select Tank Type
Mfr Location		**Coolant**	Select Coolant
Phases	Three	**Class**	
Oil Volume	*	**BIL**	*
Weight	*		
kV	*, *	**VA Rating**	*, *, *, *, Undefined

Administration

Test Date	9/8/2020	**Test Time:**	10:49 PM	**Weather**	
Air Temperature	*	**Apparatus Temperature**	*	**Humidity**	*
Tester	JY/TJ	**Work Order**		**Date Last Tested**	
Verified		**Test Set Type**		**Date Retested**	
Verification Date		**Set Top Serial #**		**Reason**	
Last Sheet #		**Set Bottom Serial #**		**Travel Time**	
Purchase Order		**Ins. Book #**		**Duration**	
Copies		**Sheet #**		**Crew Size**	3

Report Source **TwoWindingTransformer**

Session Test Date 9/3/2020 8:59:29 PM

Nameplate - Two-winding Transformer

Company	Delta Star Inc.	**Serial Number**	E5119
Location	DSE	**Special ID**	E5119
Division	TEST	**Circuit Designation**	
Manufacturer		**Configuration**	Y-Y
Year Manufactured		**Tank Type**	Select Tank Type
Mfr Location		**Coolant**	Select Coolant
Phases	Three	**Class**	
Oil Volume	*	**BIL**	*
Weight	*		
kV	*, *	**VA Rating**	*, *, *, *, Undefined

Administration

Test Date	9/3/2020	**Test Time:**	8:59 PM	**Weather**	
Air Temperature	*	**Apparatus Temperature**	*	**Humidity**	*
Tester	JB/JY	**Work Order**		**Date Last Tested**	
Verified		**Test Set Type**		**Date Retested**	
Verification Date		**Set Top Serial #**		**Reason**	
Last Sheet #		**Set Bottom Serial #**		**Travel Time**	
Purchase Order		**Ins. Book #**		**Duration**	
Copies		**Sheet #**		**Crew Size**	3

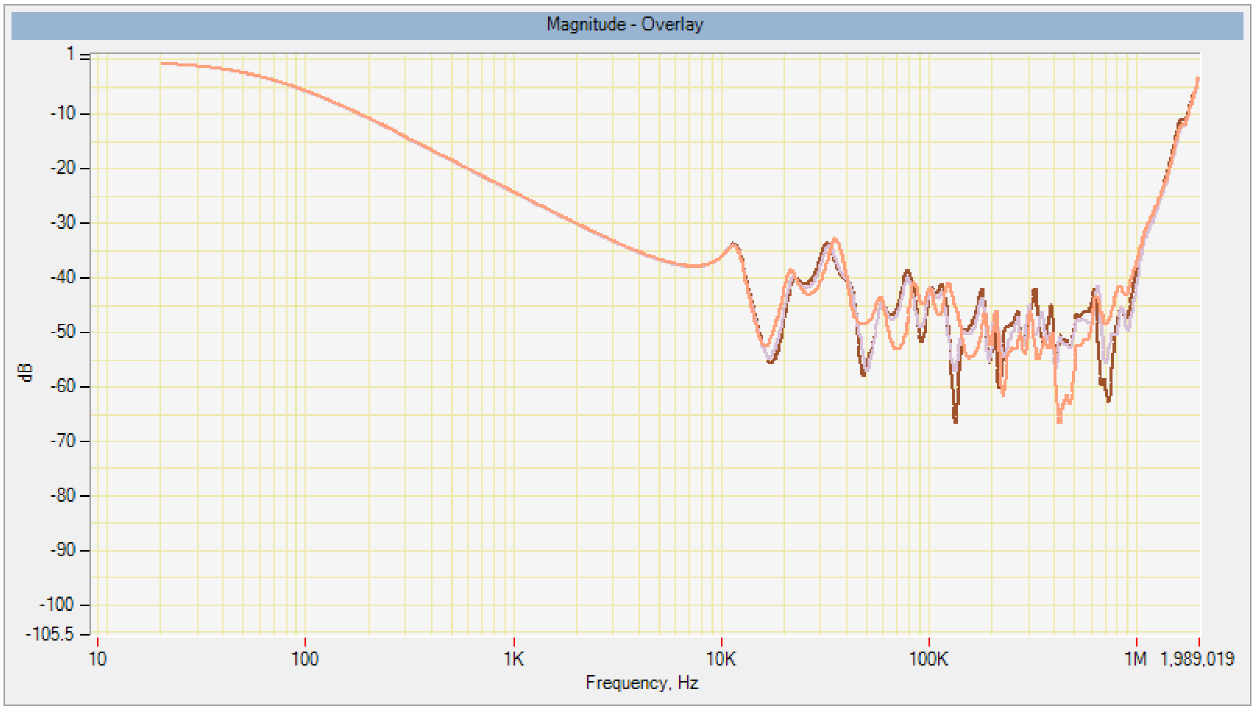
Bushing Nameplate

Designation	Serial #	Manufacturer	Type	C1 %PF	C1 Cap	C2 %PF	C2 Cap	Rated kV	Amps
H1	1	ABB (ASEA-Brown Boveri)	O+C II	0.32	250	0.11	469	69	*
H2	2	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.12	465	69	*
H3	3	ABB (ASEA-Brown Boveri)	O+C II	0.33	250	0.13	465	69	*

H1-H3_2020-09-17_20-31-42 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 8:31:42 PM
LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8

H2-H1_2020-09-17_20-36-27 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 8:36:27 PM
LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8

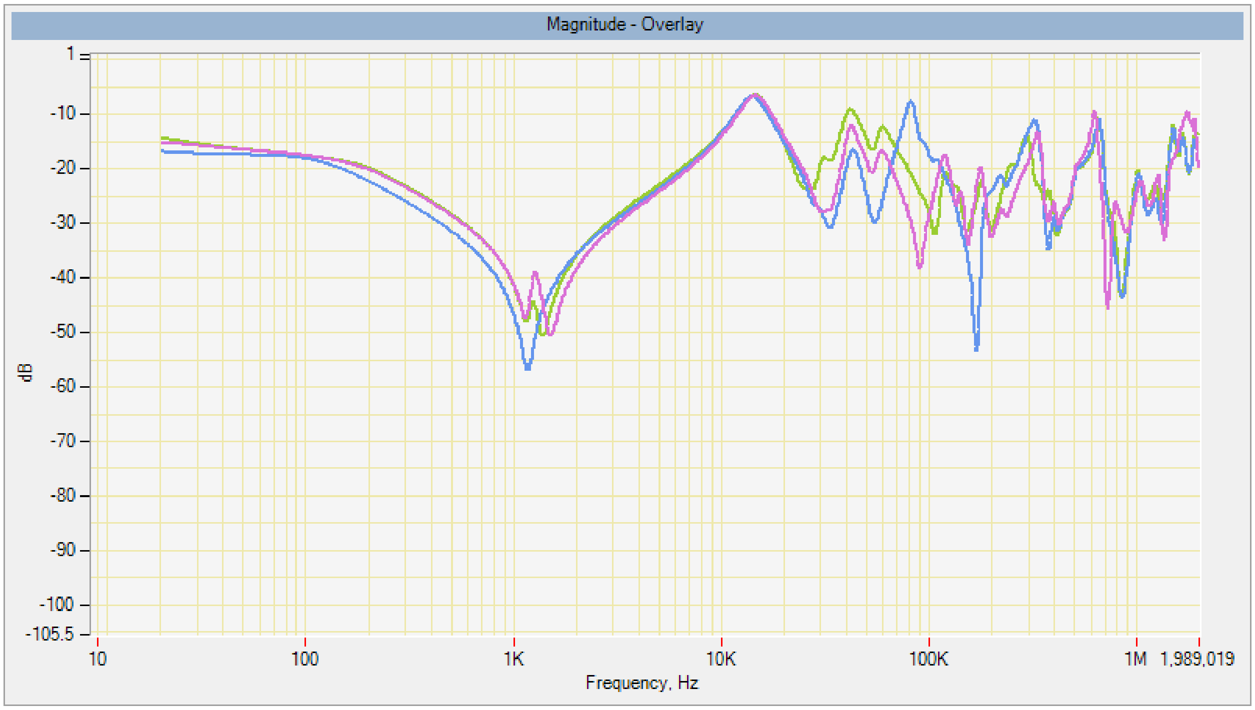
H3-H2_2020-09-17_20-45-51 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 8:45:51 PM
LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8



H3-H2_2020-09-17_20-54-08 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 8:54:08 PM LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8

H2-H1_2020-09-17_20-59-08 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 8:59:08 PM LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8

H1-H3_2020-09-17_21-03-59 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 9:03:59 PM LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8



X1-X0_2020-09-17_21-16-44 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 9:16:44 PM LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8

X2-X0_2020-09-17_21-21-56 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 9:21:56 PM LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8

X3-X0_2020-09-17_21-34-13 - Manufacturer: Delta-StarSerial Number: E5119Date: 9/17/2020 9:34:13 PM LTC: 16RDETC: 3MVA Maximum: 33KV: 67.65/13.8

No Load Sound Test @ 100%

Measuring Position	ONAN Sound dB(A)		ONAF Sound dB(A)			
	1/3 Height	2/3 Height	1/3 Height	2/3 Height		
1	57.5	61.8	59.7	59.5		
2	56.7	58.8	57.9	57.9		
3	60.4	55.4	56.5	57.6		
4	58.2	57.6	56.8	58.2		
5	60.3	60.3	59.3	59.0		
6	58.1	56.4	59.2	59.0		
7	55.7	59.9	60.3	59.0		
8	58.3	58.1	59.3	60.8		
9	59.1	59.8	61.0	59.4		
10	58.9	57.2	59.2	59.7		
11	57.6	55.5	59.5	58.3		
12	59.8	60.3	62.0	60.5		
13	60.1	60.5	61.1	60.6		
14	58.6	58.5	62.1	60.4		
15	61.4	56.1	60.3	60.2		
16	57.3	55.6	60.2	58.6		
17	56.2	57.7	59.3	59.0		
18	58.0	58.4	60.9	61.3		
19	57.9	55.9	59.5	60.2		
20	63.6	59.1	59.9	59.3		
21	60.8	58.6	60.0	59.3		
22			57.9	57.9		
23			59.8	59.1		
24			60.8	60.8		
25			59.5	58.7		
26			56.5	55.7		
27			58.7	58.0		
28			57.6	57.4		
29			57.3	58.3		
30			59.1	58.4		
31			59.0	58.8		
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
Subtotal	59.2	58.5	59.6	59.2		
Average	58.9		59.4			
Amb. Correction	1.6		1.6			
Wall Correction	1.7		2.3			
Field Correction	1.0		0.0			

MR	5119
A or C Test	A
VOLTAGE %	100
TESTED BY	JB
DATE	9/17/2020
CELL NUMBER	2
NLTC POS.	3
LTC POS.	15L
VOLTAGE (V)	12510
CURRENT (A)	10.88

Measuring Position	**Ambient Sound Level**	
	1/3 Height	2/3 Height
BEFORE TEST		
5	54.1	55.4
11	54.7	54.9
16	55.3	55.1
21	55.5	56.0
Subtotal	54.9	55.4
Average	55.2	
AFTER TEST		
5	54.9	55.6
11	54.3	54.5
16	55.5	55.0
21	55.7	54.7
Subtotal	55.1	55.0
Average	55.1	
Total Avg	55.1	

Wall Sound Reflection Correction	
A (meters)	679.3
α	0.2
S_V (meters)	3396.5
ONAN Contour	
S (meters)	79.1
h (inchs)	118.7
l_m (meters)	21
K	**1.7**
ONAF Contour	
S (meters)	116.8
h (inchs)	118.7
l_m (meters)	31
K	**2.3**

A WEIGHTED NO LOAD SOUND LEVEL		
Cooling Method	Measured Sound Level dB(A)	Guaranteed Sound Level dB(A)
ONAN	54.6	62
ONAF	55.5	64

A WEIGHTED NO LOAD SOUND POWER	
Cooling Method	Sound Power Calc. dB(A)
ONAN	73.6
ONAF	74.5

No Load Sound Test @ 100%

Measuring Position			ONAFONAF Sound dB(A)		ONAF3 Sound dB(A)	
			1/3 Height	2/3 Height	1/3 Height	2/3 Height
1			59.7	59.6	60.4	60.2
2			58.2	58.7	59.0	58.9
3			56.6	57.3	57.9	58.7
4			58.2	57.8	59.0	59.1
5			59.4	59.6	60.9	59.9
6			59.6	60.1	60.9	60.0
7			59.6	60.3	61.6	61.1
8			61.2	61.3	62.6	62.3
9			61.2	60.9	62.2	62.0
10			62.0	61.6	62.6	61.9
11			61.2	60.5	62.5	62.3
12			60.5	60.6	62.1	63.7
13			60.8	61.4	62.2	64.6
14			61.9	63.0	63.4	62.9
15			62.0	61.7	63.3	62.6
16			62.5	61.5	63.6	61.5
17			59.9	59.9	61.8	62.3
18			62.5	60.8	63.1	62.9
19			61.1	61.4	62.5	62.9
20			61.2	61.6	63.4	62.5
21			62.4	61.4	63.0	62.4
22			61.1	60.9	63.7	60.7
23			58.9	59.5	62.6	59.8
24			60.5	60.2	60.1	60.5
25			60.8	60.3	60.7	59.8
26			59.8	59.2	61.3	58.2
27			57.7	57.1	58.3	58.6
28			59.8	58.1	60.3	57.9
29			57.2	58.2	57.8	58.9
30			60.6	58.7	60.6	59.8
31			59.5	59.2	60.1	59.3
32						
33						
34						
35						
36						
37						
38						
39						
40						
41						
42						
43						
44						
45						
46						
47						
48						
49						
50						
Subtotal			60.5	60.3	61.7	61.3
Average			60.4		61.5	
Amb. Correction			1.3		1.0	
Wall Correction			2.3		2.3	
Field Correction			0.0		0.0	

MR	5119
A or C Test	A
VOLTAGE %	100
TESTED BY	JB
DATE	9/17/2020
CELL NUMBER	2
NLTC POS.	3
LTC POS.	N
VOLTAGE (V)	13800
CURRENT (A)	0.65

Measuring Position	**Ambient Sound Level**	
	1/3 Height	2/3 Height
BEFORE TEST		
5	54.1	55.4
11	54.7	54.9
16	55.3	55.1
21	55.5	56.0
Subtotal	54.9	55.4
Average	55.2	
AFTER TEST		
5	54.9	55.6
11	54.3	54.5
16	55.5	55.0
21	55.7	54.7
Subtotal	55.1	55.0
Average	55.1	
Total Avg	55.1	

Wall Sound Reflection Correction	
A (meters)	679.3
α	0.2
S_V (meters)	3396.5
ONAN Contour	
S (meters)	79.1
h (inchs)	118.7
l_m (meters)	21
K	**1.7**
ONAFONAF Contour	
S (meters)	116.8
h (inchs)	118.7
l_m (meters)	31
K	**2.3**

A WEIGHTED NO LOAD SOUND LEVEL		
Cooling Method	Measured Sound Level dB(A)	Guaranteed Sound Level dB(A)
ONAFONAF	56.8	64
ONAF3	58.2	65

A WEIGHTED NO LOAD SOUND POWER	
Cooling Method	Sound Power Calc. dB(A)
ONAFONAF	#NUM!
ONAF3	#NUM!

Octave Sound Level Test ONAN @ 100%

MR	5119
VOLTAGE %	100
COOLING CONDITION	ONAN
TESTED BY	JB
DATE	9/19/2020

Frequency	31.5 Hz		63 Hz		125 Hz		250 Hz		500 Hz		1000 Hz		2000 Hz		4000 Hz		8000 Hz	
Microphone Position	Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels	
	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	51.1	51.1	59.9	61.7	68.8	75.4	51.6	63.6	50.5	56.3	43.3	42.7	40.1	40.0	36.9	37.5	26.3	26.7
2	51.9	50.6	56.6	55.2	68.9	71.7	48.6	55.3	50.1	51.1	44.0	44.0	39.5	40.3	37.2	37.3	26.4	27.1
3	50.2	47.9	59.3	54.0	74.9	59.0	51.8	56.3	49.4	44.9	43.1	43.2	39.9	39.5	37.5	38.3	27.9	28.4
4	50.8	51.3	61.2	52.4	70.1	68.9	57.9	53.2	45.9	44.7	43.3	43.5	40.1	40.0	38.9	38.5	26.7	28.1
5	51.2	55.9	53.4	56.2	70.4	74.5	55.4	60.7	46.9	45.5	42.7	43.8	39.6	39.6	37.3	37.8	27.5	26.9
6	49.2	54.2	53.9	53.2	69.0	63.5	59.9	48.8	46.2	44.2	43.5	43.4	39.4	40.7	38.3	37.8	26.3	26.5
7	49.3	54.3	54.4	52.2	56.0	73.3	49.0	60.1	47.2	45.5	43.7	43.5	39.5	40.0	38.1	38.5	25.9	26.2
8	51.7	55.0	57.2	52.7	70.5	70.2	57.3	56.5	44.0	48.1	44.9	43.6	40.1	40.5	37.1	38.7	26.5	27.0
9	52.8	53.7	56.9	56.2	71.8	65.2	61.4	66.0	46.6	47.4	44.6	42.7	39.9	39.7	38.5	38.4	26.3	26.9
10	49.9	49.8	58.1	56.5	72.5	66.2	55.3	59.5	46.7	47.0	43.7	43.8	40.0	40.8	38.4	37.8	26.9	27.2
11	49.5	50.2	58.7	55.9	64.7	58.4	55.8	51.6	44.7	47.8	43.4	44.4	40.5	39.6	37.3	38.3	26.5	27.4
12	50.5	53.8	58.2	55.4	71.6	72.3	62.7	62.1	49.8	47.6	44.4	43.7	39.8	39.8	37.3	36.6	24.9	25.5
13	52.4	52.7	57.9	54.1	73.0	68.5	55.8	61.9	49.6	47.1	43.7	43.6	40.1	40.7	36.7	37.3	25.6	26.7
14	54.1	54.9	56.8	52.8	67.2	61.7	53.5	61.1	44.4	48.5	44.4	43.4	40.5	40.2	37.2	36.1	25.7	25.5
15	52.1	57.3	64.2	62.2	69.3	57.7	63.9	56.5	44.1	47.6	44.0	44.9	40.6	40.2	36.0	36.8	26.5	26.3
16	52.2	52.9	56.4	57.5	65.6	56.1	57.8	55.3	48.2	48.7	43.4	43.7	40.1	39.6	36.3	37.4	24.9	25.4
17	54.8	53.7	60.0	59.9	49.7	57.0	60.3	59.8	48.8	53.6	43.2	43.0	40.0	38.7	36.1	36.5	25.0	25.2
18	51.7	56.8	61.8	58.4	69.2	71.1	48.9	55.5	47.6	50.0	43.1	43.4	39.7	39.4	35.7	35.6	25.3	25.2
19	52.9	53.5	57.0	55.0	69.5	64.2	55.9	52.4	50.7	47.5	44.0	42.9	39.6	39.0	37.4	36.3	25.5	25.3
20	52.6	54.5	59.5	57.5	77.3	71.3	63.4	52.1	48.7	48.5	43.2	42.9	39.4	39.8	36.6	36.9	25.7	26.6
21	51.8	53.8	60.0	57.3	74.3	70.8	62.5	55.3	55.2	47.2	44.7	42.7	39.3	38.8	36.8	36.7	26.2	26.3
Subtotal	51.8	53.8	58.9	57.0	71.1	69.7	58.8	59.4	48.8	49.2	43.8	43.5	39.9	39.9	37.3	37.5	26.2	26.6
Average SL	52.9		58.1		70.5		59.1		49.0		43.6		39.9		37.4		26.4	
Corrected. SL	52.1		44.1		70.4		58.7		45.9		35.4		33.3		18.5		19.6	

Microphone Position 31.5 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.76	55.21
11	53.44	52.18
16	58.09	54.42
21	53.97	57.01
Subtotal	55.5	55.0
Average SL	55.3	
AFTER TEST		
5	57.89	56.91
11	53.44	51.6
16	55.4	55.98
21	56.51	55.78
Subtotal	56.1	55.5
Average SL	55.8	
Total Avg SL	55.5	

Microphone Position 250 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	46.37	49.49
11	49.98	45.65
16	46.53	50.44
21	50.35	48.7
Subtotal	48.7	48.9
Average SL	48.8	
AFTER TEST		
5	50.61	50.69
11	49.99	44.54
16	46.39	48.95
21	49.38	46.47
Subtotal	49.4	48.3
Average SL	48.8	
Total Avg SL	48.8	

Microphone Position 2000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	40.56	40.87
11	40.7	40.96
16	41.27	41.18
21	40.45	41.59
Subtotal	40.8	41.2
Average SL	41.0	
AFTER TEST		
5	40.88	40.06
11	40.6	40.55
16	40.66	40.69
21	40.59	40.34
Subtotal	40.7	40.4
Average SL	40.6	
Total Avg SL	40.8	

Microphone Position 63 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	59.79	58.03
11	54.95	51.95
16	57.98	55.35
21	61.81	55.73
Subtotal	59.3	55.8
Average SL	57.9	
AFTER TEST		
5	58.51	58.78
11	59.98	55.45
16	54.74	55.08
21	63.21	54.08
Subtotal	60.1	56.2
Average SL	58.6	
Total Avg SL	58.3	

Microphone Position 500 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	45.28	46.34
11	45.31	46.17
16	47.87	45.43
21	45.93	46.13
Subtotal	46.2	46.0
Average SL	46.1	
AFTER TEST		
5	46.39	47.77
11	44.61	45.49
16	46.84	46.05
21	45.71	45.67
Subtotal	46.0	46.3
Average SL	46.2	
Total Avg SL	46.1	

Microphone Position 4000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	35.85	36.52
11	37.99	37.72
16	36.94	38.86
21	37.25	36.99
Subtotal	37.1	37.6
Average SL	37.4	
AFTER TEST		
5	35.76	36.21
11	37.9	37.86
16	37.95	39.18
21	36.63	37.7
Subtotal	37.2	37.9
Average SL	37.5	
Total Avg SL	37.4	

Microphone Position 125 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.41	51.47
11	51.03	53.88
16	51.16	52.61
21	59.42	56.35
Subtotal	55.5	54.0
Average SL	54.8	
AFTER TEST		
5	51.75	52.82
11	51.7	50.04
16	51.73	52.79
21	60.14	48.44
Subtotal	55.7	51.4
Average SL	54.0	
Total Avg SL	54.4	

Microphone Position 1000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	42.91	43.74
11	43.39	44.03
16	44.66	45.25
21	45.41	44.4
Subtotal	44.2	44.4
Average SL	44.3	
AFTER TEST		
5	44.53	43.63
11	43.8	43.58
16	44.52	45.25
21	43.92	44.02
Subtotal	44.2	44.2
Average SL	44.2	
Total Avg SL	44.2	

Microphone Position 8000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	25.41	26.1
11	28.04	28.39
16	26.9	28.03
21	25.93	27.72
Subtotal	26.7	27.6
Average SL	27.2	
AFTER TEST		
5	25.42	26.49
11	28.44	28.38
16	27.47	27.31
21	26.14	27.55
Subtotal	27.0	27.5
Average SL	27.3	
Total Avg SL	27.2	

Octave Sound Level Test ONAF @ 100%

MR	5119	TESTED BY	JB
VOLTAGE %	100	DATE	9/19/2020
COOLING CONDITION	ONAF		

Frequency	31.5 Hz		63 Hz		125 Hz		250 Hz		500 Hz		1000 Hz		2000 Hz		4000 Hz		8000 Hz	
Microphone	Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels	
Position	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	53.4	54.5	57.8	57.1	72.6	72.6	60.5	57.0	50.2	52.6	44.4	45.1	39.5	41.4	36.3	37.4	26.2	26.4
2	55.1	54.7	58.2	57.4	64.2	68.7	61.0	55.8	47.3	50.3	44.2	44.6	39.5	40.5	37.5	36.3	27.0	27.0
3	55.2	52.8	60.2	52.5	58.0	68.8	59.1	50.5	48.8	49.6	44.3	44.8	40.0	40.1	36.9	37.7	26.9	27.5
4	51.9	52.6	55.3	51.1	64.0	65.6	56.5	54.2	50.4	48.3	44.2	44.8	40.2	40.7	37.9	37.3	28.0	27.9
5	54.1	53.5	56.6	51.4	70.6	70.2	53.0	55.2	48.3	51.7	44.5	44.4	40.3	40.8	38.1	38.6	28.4	27.9
6	53.3	54.1	54.7	55.4	71.9	70.1	47.1	59.7	51.0	49.1	47.0	45.1	40.6	40.8	39.6	38.8	28.7	29.0
7	54.9	52.5	52.9	55.1	72.9	70.5	55.4	56.1	49.9	49.3	47.2	46.1	41.9	42.0	38.9	38.0	29.9	29.0
8	54.7	54.4	51.1	53.1	69.0	72.3	55.0	59.6	51.8	51.0	47.3	47.7	42.1	42.5	38.6	38.4	30.0	29.7
9	53.6	54.1	54.2	52.3	73.5	67.5	60.3	56.2	53.8	51.7	47.3	48.1	42.0	42.4	37.8	39.3	30.2	30.1
10	56.2	56.6	54.5	52.7	64.7	67.1	55.5	55.7	53.6	50.5	46.5	47.0	41.5	41.9	38.2	38.3	29.2	28.8
11	57.5	53.7	54.2	55.4	67.0	63.1	53.0	53.9	54.7	52.8	46.5	47.0	41.6	41.9	37.9	37.9	28.5	29.3
12	57.7	56.7	56.0	53.4	73.1	71.2	57.4	56.3	56.8	52.6	47.4	47.6	41.4	41.5	38.3	39.2	27.5	28.4
13	57.2	57.6	57.5	50.6	72.3	71.9	58.9	58.0	55.3	53.4	46.6	46.7	41.1	41.4	37.7	39.2	27.6	27.9
14	56.5	56.8	55.3	53.3	75.0	70.3	60.2	56.4	52.3	53.6	46.5	46.0	41.4	41.8	38.9	38.8	27.5	28.1
15	51.4	52.7	58.8	55.4	67.2	70.0	63.2	58.2	53.2	53.3	47.1	46.5	41.3	42.0	38.0	39.3	26.9	27.5
16	53.6	54.1	60.1	54.2	68.9	61.3	61.9	54.6	51.6	53.3	46.9	46.4	41.5	40.7	37.9	37.1	28.7	27.0
17	56.4	55.5	60.5	57.1	68.4	67.1	57.0	56.6	52.0	51.8	47.4	46.9	42.1	41.8	38.2	38.2	29.7	29.3
18	55.6	57.2	61.6	58.3	66.2	66.5	62.6	66.9	51.8	51.8	47.9	48.0	42.4	42.3	39.6	38.9	29.6	30.2
19	55.1	55.9	60.6	57.5	57.3	63.9	57.8	61.6	51.7	51.6	48.0	48.6	42.9	43.2	38.6	38.6	30.1	30.4
20	61.6	57.8	56.7	55.3	62.1	66.3	53.4	52.6	50.4	51.9	48.0	47.8	42.9	42.8	39.2	39.4	30.5	30.0
21	58.0	58.7	51.0	49.6	67.6	67.1	58.9	54.5	51.8	50.4	46.5	47.1	42.3	41.9	38.4	38.2	28.9	28.3
22	55.5	57.2	53.6	58.6	63.3	55.0	54.4	53.6	50.4	49.5	46.4	46.1	41.7	41.6	37.2	37.6	28.1	28.2
23	56.1	56.1	55.8	55.4	72.3	67.1	59.5	59.7	51.1	50.3	45.6	45.1	41.3	41.2	37.3	37.9	26.7	27.1
24	51.6	52.0	57.1	57.5	74.9	74.1	57.9	58.0	48.6	49.8	45.1	44.8	40.9	39.8	36.7	37.1	26.2	26.3
25	55.4	52.1	58.0	57.6	72.3	69.6	60.4	59.4	50.9	51.1	44.6	44.5	40.4	39.2	37.6	36.3	26.7	26.2
26	55.4	55.0	58.5	58.9	63.6	56.8	51.1	52.5	51.0	47.7	44.9	44.7	40.9	39.4	36.8	36.9	26.1	26.3
27	56.7	57.2	55.2	56.2	72.5	69.9	51.2	52.3	48.9	49.1	44.4	45.4	39.8	40.1	36.4	37.2	26.1	26.3
28	56.6	57.2	55.2	54.2	64.3	63.3	56.8	54.8	48.7	49.3	44.2	44.7	39.8	40.9	35.7	37.1	26.1	26.3
29	54.6	56.7	53.4	55.2	66.5	71.6	55.0	50.2	48.4	49.6	44.8	44.9	40.4	40.2	36.2	36.8	26.4	26.7
30	55.7	54.0	54.1	56.8	71.8	71.3	51.4	50.2	50.0	50.1	44.1	44.8	40.3	40.9	36.2	37.4	26.2	26.8
31	55.7	57.0	54.5	57.3	71.7	72.2	57.8	48.8	51.6	50.2	44.2	44.5	40.1	40.4	37.2	36.6	26.3	27.1
Subtotal	55.9	55.6	57.1	55.7	70.3	69.4	58.3	57.7	51.7	51.2	46.1	46.2	41.2	41.3	37.8	38.0	28.1	28.2
Average SL	55.7		56.4		69.9		58.0		51.5		46.2		41.3		37.9		28.2	
Corrected. SL	42.2		53.6		69.8		57.4		49.9		41.7		31.7		28.3		21.0	

Microphone Position 31.5 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.76	55.21
11	53.44	52.18
16	58.09	54.42
21	53.97	57.01
Subtotal	55.5	55.0
Average SL	55.3	
AFTER TEST		
5	57.89	56.91
11	53.44	51.6
16	55.4	55.98
21	56.51	55.78
Subtotal	56.1	55.5
Average SL	55.8	
Total Avg SL	55.5	

Microphone Position 250 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	46.37	49.49
11	49.98	45.65
16	46.53	50.44
21	50.35	48.7
Subtotal	48.7	48.9
Average SL	48.8	
AFTER TEST		
5	50.61	50.69
11	49.99	44.54
16	46.39	48.95
21	49.38	46.47
Subtotal	49.4	48.3
Average SL	48.8	
Total Avg SL	48.8	

Microphone Position 2000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	40.56	40.87
11	40.7	40.96
16	41.27	41.18
21	40.45	41.59
Subtotal	40.8	41.2
Average SL	41.0	
AFTER TEST		
5	40.88	40.06
11	40.6	40.55
16	40.66	40.69
21	40.59	40.34
Subtotal	40.7	40.4
Average SL	40.6	
Total Avg SL	40.8	

Microphone Position 63 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	59.79	58.03
11	54.95	51.95
16	57.98	55.35
21	61.81	55.73
Subtotal	59.3	55.8
Average SL	57.9	
AFTER TEST		
5	58.51	58.78
11	59.98	55.45
16	54.74	55.08
21	63.21	54.08
Subtotal	60.1	56.2
Average SL	58.6	
Total Avg SL	58.3	

Microphone Position 500 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	45.28	46.34
11	45.31	46.17
16	47.87	45.43
21	45.93	46.13
Subtotal	46.2	46.0
Average SL	46.1	
AFTER TEST		
5	46.39	47.77
11	44.61	45.49
16	46.84	46.05
21	45.71	45.67
Subtotal	46.0	46.3
Average SL	46.2	
Total Avg SL	46.1	

Microphone Position 4000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	35.85	36.52
11	37.99	37.72
16	36.94	38.86
21	37.25	36.99
Subtotal	37.1	37.6
Average SL	37.4	
AFTER TEST		
5	35.76	36.21
11	37.9	37.86
16	37.95	39.18
21	36.63	37.7
Subtotal	37.2	37.9
Average SL	37.5	
Total Avg SL	37.4	

Microphone Position 125 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.41	51.47
11	51.03	53.88
16	51.16	52.61
21	59.42	56.35
Subtotal	55.5	54.0
Average SL	54.8	
AFTER TEST		
5	51.75	52.82
11	51.7	50.04
16	51.73	52.79
21	60.14	48.44
Subtotal	55.7	51.4
Average SL	54.0	
Total Avg SL	54.4	

Microphone Position 1000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	42.91	43.74
11	43.39	44.03
16	44.66	45.25
21	45.41	44.4
Subtotal	44.2	44.4
Average SL	44.3	
AFTER TEST		
5	44.53	43.63
11	43.8	43.58
16	44.52	45.25
21	43.92	44.02
Subtotal	44.2	44.2
Average SL	44.2	
Total Avg SL	44.2	

Microphone Position 8000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	25.41	26.1
11	28.04	28.39
16	26.9	28.03
21	25.93	27.72
Subtotal	26.7	27.6
Average SL	27.2	
AFTER TEST		
5	25.42	26.49
11	28.44	28.38
16	27.47	27.31
21	26.14	27.55
Subtotal	27.0	27.5
Average SL	27.3	
Total Avg SL	27.2	

Octave Sound Level Test ONAFONAF @ 100%

MR	5119
VOLTAGE %	100
COOLING CONDITION	ONAF
TESTED BY	JB
DATE	9/19/2020

Frequency	31.5 Hz		63 Hz		125 Hz		250 Hz		500 Hz		1000 Hz		2000 Hz		4000 Hz		8000 Hz	
Microphone Position	Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels	
	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	55.9	56.8	58.2	58.2	72.7	72.4	59.0	55.2	51.4	52.2	45.1	45.4	40.7	41.3	36.9	36.7	26.4	27.4
2	53.9	54.1	55.1	56.6	59.8	65.1	60.6	59.6	49.3	48.8	44.5	45.7	40.0	40.6	37.2	36.5	27.1	27.5
3	54.9	55.4	55.4	52.6	61.0	64.0	50.7	50.7	50.2	51.3	46.0	45.8	41.5	41.5	36.9	37.9	27.8	28.1
4	55.2	52.3	58.6	56.4	65.2	62.4	55.2	52.1	51.0	51.3	46.8	46.5	41.1	41.9	38.0	38.4	29.3	29.0
5	55.7	50.9	56.1	56.1	70.1	70.3	50.3	49.2	49.5	51.1	46.3	47.2	41.5	41.5	38.3	38.1	29.4	29.3
6	53.3	53.2	59.1	54.6	71.0	71.1	49.4	49.3	51.5	51.8	46.7	47.8	42.4	42.2	38.5	38.7	29.9	30.2
7	53.3	58.4	55.6	53.1	68.8	70.6	51.4	52.1	51.3	52.9	48.2	48.5	42.7	43.1	39.2	39.2	30.4	30.9
8	56.6	56.0	53.8	52.2	72.4	72.7	57.9	56.8	52.5	52.0	49.5	49.8	43.8	44.0	40.1	39.0	31.9	31.6
9	52.9	56.3	53.8	52.2	68.9	68.5	57.7	57.3	53.7	52.4	49.7	49.9	44.3	44.6	40.1	40.3	32.5	32.3
10	55.7	55.4	56.0	53.2	71.9	69.7	58.4	60.6	54.4	52.7	49.8	49.1	43.9	43.9	39.7	40.8	31.5	31.7
11	56.6	58.1	58.0	53.0	64.0	63.3	61.5	56.2	56.1	54.5	48.4	48.9	43.3	43.2	38.8	39.2	30.7	31.3
12	54.2	54.4	54.3	56.2	62.5	67.4	54.9	56.9	55.2	55.3	48.6	48.2	42.9	43.2	39.4	39.8	30.0	30.5
13	58.2	58.0	54.7	53.6	65.6	72.2	55.0	57.6	56.0	54.8	48.4	49.0	42.1	42.9	40.1	38.8	29.6	29.3
14	57.7	59.2	51.6	52.9	69.1	71.7	57.5	62.7	57.3	55.6	48.8	49.1	42.9	42.5	38.5	38.8	29.2	29.1
15	56.5	59.7	55.5	54.2	68.9	70.4	57.6	56.1	56.7	55.8	48.9	48.9	42.3	42.3	38.4	39.5	28.9	28.4
16	56.0	55.6	55.6	56.8	74.0	69.8	59.5	58.3	56.2	55.2	49.4	48.3	42.6	42.7	37.9	39.5	28.6	28.9
17	56.7	55.3	56.3	54.8	57.2	58.9	58.2	58.1	54.1	54.5	48.3	47.2	42.9	42.3	38.3	37.8	28.7	29.2
18	55.8	58.2	60.5	58.7	69.1	68.3	65.6	58.7	55.1	53.1	49.3	49.4	43.3	43.6	39.1	40.2	30.6	31.4
19	59.6	57.6	62.5	60.7	68.0	68.3	57.1	58.3	53.3	53.5	49.7	50.6	44.4	44.1	39.9	40.3	32.1	32.0
20	60.8	57.8	61.5	58.0	59.5	62.5	57.1	62.6	54.2	53.5	49.9	51.1	45.1	45.0	40.2	39.6	32.6	32.9
21	57.6	60.0	59.4	53.9	62.5	64.9	51.1	52.3	52.6	53.8	50.1	50.2	44.6	44.8	39.9	40.4	32.7	32.3
22	58.7	59.8	52.9	51.9	67.8	67.7	61.8	57.4	51.2	53.4	48.2	49.2	43.8	43.4	39.0	39.3	30.9	30.0
23	59.9	54.2	60.0	55.7	61.3	51.4	56.1	55.5	52.4	52.2	47.3	47.7	42.4	42.4	38.2	38.4	29.6	28.7
24	54.0	53.2	57.8	53.2	72.9	67.9	59.7	58.5	51.3	51.6	46.2	45.9	41.0	41.6	36.0	38.7	27.3	28.0
25	50.5	51.3	56.6	56.3	75.0	73.1	57.2	52.7	50.6	50.2	45.1	45.9	41.1	41.3	36.6	37.9	26.3	27.2
26	57.7	52.9	57.3	58.1	72.7	70.9	59.3	56.8	49.0	49.7	45.8	44.8	40.3	41.2	37.3	37.1	26.8	27.4
27	55.8	58.1	57.6	57.6	67.3	64.5	54.5	49.7	50.6	50.0	45.8	45.4	40.6	40.5	36.2	36.3	27.2	26.8
28	55.1	56.1	56.2	55.1	74.0	70.0	52.3	53.9	48.8	48.2	45.2	45.0	41.2	40.5	36.6	36.6	26.4	26.1
29	56.4	55.2	57.9	53.1	65.7	64.5	52.9	57.6	49.7	48.4	45.4	45.1	40.9	41.3	36.9	37.1	26.9	26.8
30	56.0	55.7	55.2	57.6	72.9	71.5	57.3	50.9	51.7	52.2	45.5	44.7	41.2	40.8	37.2	36.4	26.9	26.3
31	55.7	54.1	57.3	55.2	71.4	71.8	56.7	55.0	50.1	49.3	45.0	44.5	40.8	40.5	36.9	37.3	26.8	26.8
Subtotal	56.5	56.6	57.5	55.8	69.9	69.3	58.1	57.2	53.2	52.8	47.8	48.0	42.5	42.6	38.5	38.7	29.7	29.7
Average SL	56.6		56.7		69.6		57.6		53.0		47.9		42.6		38.6		29.7	
Corrected. SL	49.7		52.9		69.5		57.0		52.0		45.5		37.9		32.3		26.1	

Microphone Position 31.5 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.76	55.21
11	53.44	52.18
16	58.09	54.42
21	53.97	57.01
Subtotal	55.5	55.0
Average SL	55.3	
AFTER TEST		
5	57.89	56.91
11	53.44	51.6
16	55.4	55.98
21	56.51	55.78
Subtotal	56.1	55.5
Average SL	55.8	
Total Avg SL	55.5	

Microphone Position 250 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	46.37	49.49
11	49.98	45.65
16	46.53	50.44
21	50.35	48.7
Subtotal	48.7	48.9
Average SL	48.8	
AFTER TEST		
5	50.61	50.69
11	49.99	44.54
16	46.39	48.95
21	49.38	46.47
Subtotal	49.4	48.3
Average SL	48.8	
Total Avg SL	48.8	

Microphone Position 2000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	40.56	40.87
11	40.7	40.96
16	41.27	41.18
21	40.45	41.59
Subtotal	40.8	41.2
Average SL	41.0	
AFTER TEST		
5	40.88	40.06
11	40.6	40.55
16	40.66	40.69
21	40.59	40.34
Subtotal	40.7	40.4
Average SL	40.6	
Total Avg SL	40.8	

Microphone Position 63 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	59.79	58.03
11	54.95	51.95
16	57.98	55.35
21	61.81	55.73
Subtotal	59.3	55.8
Average SL	57.9	
AFTER TEST		
5	58.51	58.78
11	59.98	55.45
16	54.74	55.08
21	63.21	54.08
Subtotal	60.1	56.2
Average SL	58.6	
Total Avg SL	58.3	

Microphone Position 500 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	45.28	46.34
11	45.31	46.17
16	47.87	45.43
21	45.93	46.13
Subtotal	46.2	46.0
Average SL	46.1	
AFTER TEST		
5	46.39	47.77
11	44.61	45.49
16	46.84	46.05
21	45.71	45.67
Subtotal	46.0	46.3
Average SL	46.2	
Total Avg SL	46.1	

Microphone Position 4000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	35.85	36.52
11	37.99	37.72
16	36.94	38.86
21	37.25	36.99
Subtotal	37.1	37.6
Average SL	37.4	
AFTER TEST		
5	35.76	36.21
11	37.9	37.86
16	37.95	39.18
21	36.63	37.7
Subtotal	37.2	37.9
Average SL	37.5	
Total Avg SL	37.4	

Microphone Position 125 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.41	51.47
11	51.03	53.88
16	51.16	52.61
21	59.42	56.35
Subtotal	55.5	54.0
Average SL	54.8	
AFTER TEST		
5	51.75	52.82
11	51.7	50.04
16	51.73	52.79
21	60.14	48.44
Subtotal	55.7	51.4
Average SL	54.0	
Total Avg SL	54.4	

Microphone Position 1000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	42.91	43.74
11	43.39	44.03
16	44.66	45.25
21	45.41	44.4
Subtotal	44.2	44.4
Average SL	44.3	
AFTER TEST		
5	44.53	43.63
11	43.8	43.58
16	44.52	45.25
21	43.92	44.02
Subtotal	44.2	44.2
Average SL	44.2	
Total Avg SL	44.2	

Microphone Position 8000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	25.41	26.1
11	28.04	28.39
16	26.9	28.03
21	25.93	27.72
Subtotal	26.7	27.6
Average SL	27.2	
AFTER TEST		
5	25.42	26.49
11	28.44	28.38
16	27.47	27.31
21	26.14	27.55
Subtotal	27.0	27.5
Average SL	27.3	
Total Avg SL	27.2	

Octave Sound Level Test ONAF3 @ 100%

MR	5119
VOLTAGE %	100
COOLING CONDITION	NA2
TESTED BY	JB
DATE	9/19/2020

Frequency	31.5 Hz		63 Hz		125 Hz		250 Hz		500 Hz		1000 Hz		2000 Hz		4000 Hz		8000 Hz	
Microphone	Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels		Decibels	
Position	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height	1/3 Height	2/3 Height
1	55.6	52.8	57.8	57.3	73.2	72.9	60.8	57.2	51.5	52.9	45.9	46.7	40.4	41.1	37.0	36.8	27.0	27.6
2	57.0	54.0	56.4	59.9	58.8	68.4	60.8	59.2	48.4	49.6	45.7	46.4	41.5	41.4	36.9	37.2	27.5	28.1
3	54.9	52.3	56.4	54.4	60.6	66.1	51.3	55.7	51.8	52.0	47.2	46.8	41.5	42.3	37.3	38.9	28.1	29.0
4	56.9	54.9	56.4	57.5	63.8	59.8	58.6	59.9	52.4	52.6	47.6	47.2	41.7	43.2	37.9	38.4	30.0	29.5
5	53.6	50.0	57.3	56.8	70.6	69.1	54.3	58.1	52.6	50.6	47.4	48.2	42.7	42.7	39.5	39.4	30.3	30.6
6	57.5	53.5	57.8	56.5	71.3	67.5	53.7	54.5	53.7	52.0	49.2	49.5	43.1	43.4	39.6	39.2	31.3	31.5
7	55.7	54.4	55.9	54.6	70.9	70.7	52.9	55.4	54.9	52.8	50.3	50.0	44.4	44.4	40.5	40.2	32.5	31.8
8	54.3	55.5	54.6	54.9	72.0	71.9	55.4	52.7	54.3	54.0	51.7	50.8	45.4	45.0	40.4	40.5	33.3	32.9
9	54.4	55.4	55.6	56.2	69.4	69.7	56.6	59.6	54.3	54.4	51.7	51.1	44.9	45.2	40.8	40.7	33.3	32.9
10	53.5	52.5	56.2	54.2	73.7	64.3	55.1	54.3	56.3	56.0	51.2	50.9	44.9	44.0	40.3	40.3	33.4	32.4
11	51.5	57.0	57.5	55.8	65.1	66.3	63.0	58.0	57.8	57.1	50.4	50.2	44.0	43.7	39.9	40.3	32.0	31.1
12	55.8	55.3	57.9	53.8	62.1	73.7	59.4	59.9	58.0	56.8	50.0	50.0	43.9	43.6	39.4	39.3	31.1	31.0
13	54.8	55.2	55.8	56.6	66.4	73.4	57.4	65.7	57.2	57.9	50.0	50.1	43.9	43.3	39.9	39.6	30.2	30.0
14	65.3	63.5	58.5	57.5	70.7	70.9	58.9	59.0	58.7	56.5	50.1	49.2	43.5	43.5	39.5	39.6	30.0	30.3
15	63.2	57.2	60.5	56.8	70.0	70.0	59.6	60.0	58.2	55.1	49.6	50.3	43.6	43.4	38.7	41.1	29.7	30.8
16	58.3	57.8	55.9	58.4	73.8	61.6	63.0	58.2	55.9	56.2	49.9	49.9	43.6	43.7	39.0	39.4	30.1	30.7
17	58.0	52.3	57.4	58.2	63.3	67.2	59.7	56.9	56.2	56.1	50.2	50.9	43.7	44.8	39.4	40.7	30.5	33.1
18	55.2	59.4	60.5	58.8	69.0	69.0	65.8	62.0	55.6	55.3	50.0	52.0	44.7	46.3	40.2	41.5	32.8	34.0
19	56.1	60.5	61.8	59.6	68.3	65.0	56.5	60.4	56.0	56.2	52.0	53.0	46.2	46.5	41.4	40.9	34.4	34.2
20	57.4	60.5	62.0	55.5	67.2	63.3	63.2	55.7	56.3	54.6	52.3	52.2	46.2	46.5	42.1	40.7	34.3	33.6
21	55.2	59.7	62.0	51.3	60.7	66.7	61.3	58.4	56.3	54.8	52.3	50.8	46.4	44.7	41.6	39.8	34.3	31.0
22	62.1	60.0	60.4	54.7	63.0	55.1	54.8	55.4	55.2	51.8	52.5	49.6	46.2	42.5	41.3	38.9	34.4	29.8
23	61.5	57.5	53.8	56.3	68.0	66.5	61.2	57.0	54.7	51.9	50.2	47.2	44.9	42.3	40.5	38.2	32.6	28.5
24	58.8	56.4	58.7	55.3	59.6	72.9	56.1	53.9	55.0	51.2	49.1	46.9	44.1	41.9	39.3	37.7	31.4	27.5
25	56.6	54.7	58.8	59.4	73.0	71.9	59.3	56.6	50.9	51.0	47.4	46.4	42.1	41.8	38.0	37.0	28.5	27.9
26	54.4	55.7	59.3	57.2	74.6	64.6	58.8	54.6	51.1	51.3	46.5	46.4	42.2	42.0	38.1	38.0	27.6	27.9
27	54.4	57.9	55.0	55.5	67.0	68.1	54.1	52.3	51.2	50.0	46.6	46.8	42.0	41.4	37.6	37.1	27.8	27.2
28	52.9	55.7	58.6	55.7	74.0	63.0	53.1	56.0	50.3	49.8	45.7	46.1	41.6	41.3	36.7	36.9	26.9	27.1
29	53.7	57.1	55.5	53.2	66.5	69.9	54.3	55.1	50.6	49.9	45.6	45.5	41.4	40.9	36.5	36.8	27.2	26.7
30	50.9	54.6	56.4	54.1	73.0	72.4	55.9	54.4	53.2	52.0	45.9	44.9	41.3	41.5	36.7	36.7	27.6	27.7
31	56.7	54.9	56.4	56.8	72.3	72.3	61.3	53.8	52.0	49.4	45.8	46.3	41.2	41.3	37.1	36.1	27.5	27.7
Subtotal	57.8	57.1	58.2	56.6	70.1	69.5	59.4	58.2	55.0	54.0	49.6	49.3	43.8	43.5	39.4	39.2	31.3	30.7
Average SL	57.5		57.5		69.8		58.8		54.5		49.5		43.7		39.3		31.0	
Corrected. SL	53.0		50.2		69.7		58.4		53.8		47.9		40.5		34.8		28.6	

Microphone Position 31.5 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.76	55.21
11	53.44	52.18
16	58.09	54.42
21	53.97	57.01
Subtotal	55.5	55.0
Average SL	55.3	
AFTER TEST		
5	57.89	56.91
11	53.44	51.6
16	55.4	55.98
21	56.51	55.78
Subtotal	56.1	55.5
Average SL	55.8	
Total Avg SL	55.5	

Microphone Position 250 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	46.37	49.49
11	49.98	45.65
16	46.53	50.44
21	50.35	48.7
Subtotal	48.7	48.9
Average SL	48.8	
AFTER TEST		
5	50.61	50.69
11	49.99	44.54
16	46.39	48.95
21	49.38	46.47
Subtotal	49.4	48.3
Average SL	48.8	
Total Avg SL	48.8	

Microphone Position 2000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	40.56	40.87
11	40.7	40.96
16	41.27	41.18
21	40.45	41.59
Subtotal	40.8	41.2
Average SL	41.0	
AFTER TEST		
5	40.88	40.06
11	40.6	40.55
16	40.66	40.69
21	40.59	40.34
Subtotal	40.7	40.4
Average SL	40.6	
Total Avg SL	40.8	

Microphone Position 63 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	59.79	58.03
11	54.95	51.95
16	57.98	55.35
21	61.81	55.73
Subtotal	59.3	55.8
Average SL	57.9	
AFTER TEST		
5	58.51	58.78
11	59.98	55.45
16	54.74	55.08
21	63.21	54.08
Subtotal	60.1	56.2
Average SL	58.6	
Total Avg SL	58.3	

Microphone Position 500 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	45.28	46.34
11	45.31	46.17
16	47.87	45.43
21	45.93	46.13
Subtotal	46.2	46.0
Average SL	46.1	
AFTER TEST		
5	46.39	47.77
11	44.61	45.49
16	46.84	46.05
21	45.71	45.67
Subtotal	46.0	46.3
Average SL	46.2	
Total Avg SL	46.1	

Microphone Position 4000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	35.85	36.52
11	37.99	37.72
16	36.94	38.86
21	37.25	36.99
Subtotal	37.1	37.6
Average SL	37.4	
AFTER TEST		
5	35.76	36.21
11	37.9	37.86
16	37.95	39.18
21	36.63	37.7
Subtotal	37.2	37.9
Average SL	37.5	
Total Avg SL	37.4	

Microphone Position 125 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	54.41	51.47
11	51.03	53.88
16	51.16	52.61
21	59.42	56.35
Subtotal	55.5	54.0
Average SL	54.8	
AFTER TEST		
5	51.75	52.82
11	51.7	50.04
16	51.73	52.79
21	60.14	48.44
Subtotal	55.7	51.4
Average SL	54.0	
Total Avg SL	54.4	

Microphone Position 1000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	42.91	43.74
11	43.39	44.03
16	44.66	45.25
21	45.41	44.4
Subtotal	44.2	44.4
Average SL	44.3	
AFTER TEST		
5	44.53	43.63
11	43.8	43.58
16	44.52	45.25
21	43.92	44.02
Subtotal	44.2	44.2
Average SL	44.2	
Total Avg SL	44.2	

Microphone Position 8000 Hz	AMBIENT SOUND LEVEL 1/3 Height	2/3 Height
BEFORE TEST		
5	25.41	26.1
11	28.04	28.39
16	26.9	28.03
21	25.93	27.72
Subtotal	26.7	27.6
Average SL	27.2	
AFTER TEST		
5	25.42	26.49
11	28.44	28.38
16	27.47	27.31
21	26.14	27.55
Subtotal	27.0	27.5
Average SL	27.3	
Total Avg SL	27.2	

DELTA STAR, INC.

E5119

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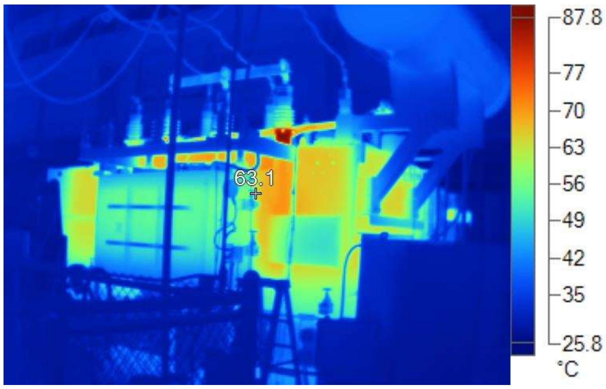

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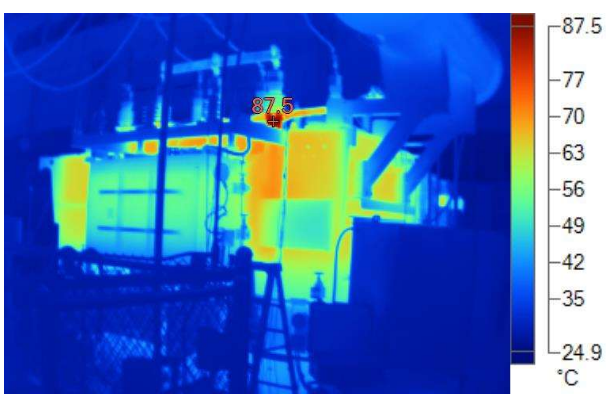

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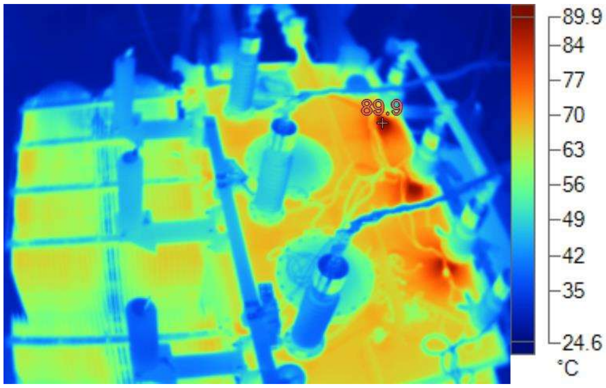

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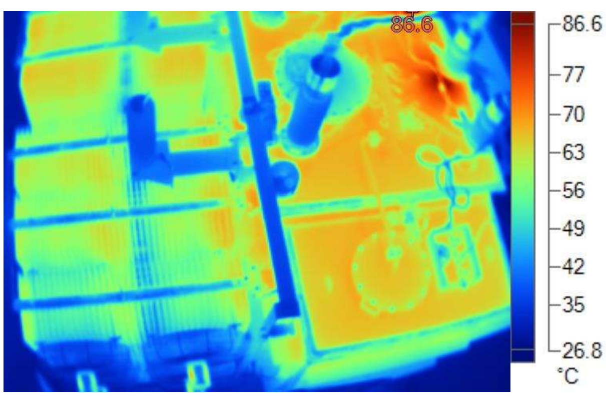

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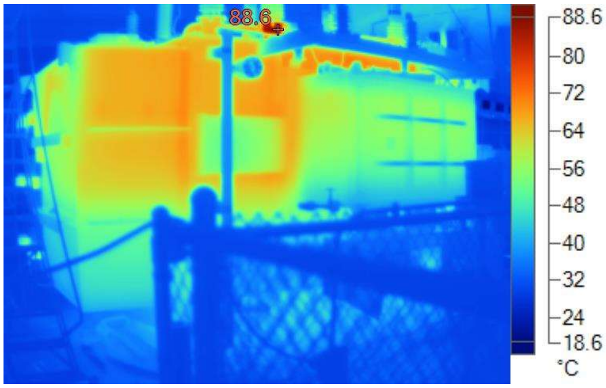

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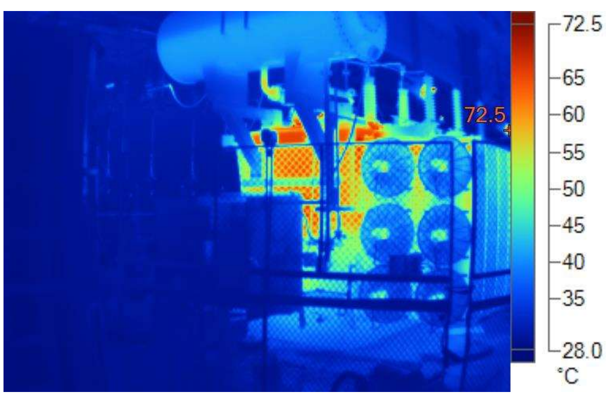

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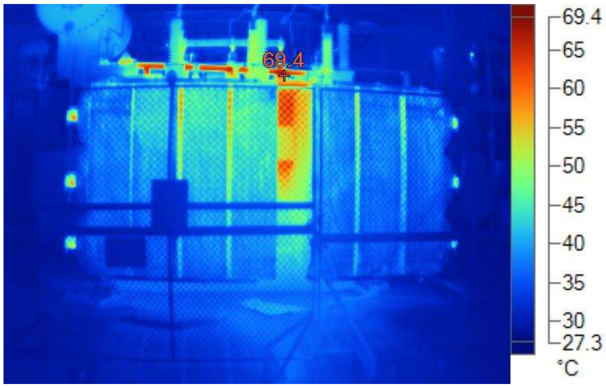

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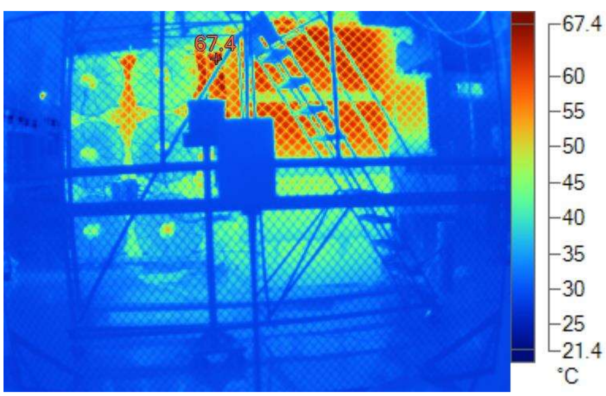

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HEAT RUN RESULTS

MR	5119	TESTED BY	JB/TJ/JY	CELL #	
MVA	33.00	DATE	9/16/2020	PHASE	A

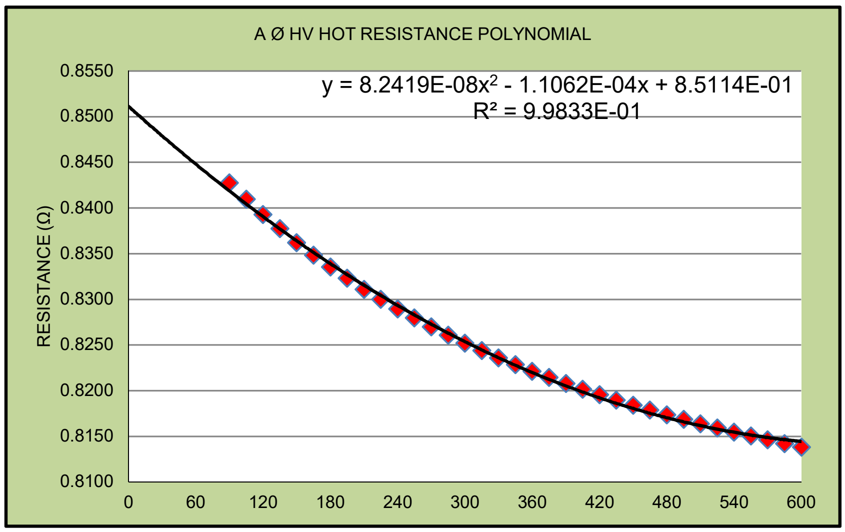
A PHASE RESISTANCE			USE DATA	
TIME (S)	HV (Ω)	LV (Ω)	HV	LV
0			N	N
15			N	N
30			N	N
45			N	N
60			N	N
75			N	N
90	0.842760	0.015669	Y	Y
105	0.840974	0.015632	Y	Y
120	0.839292	0.015596	Y	Y
135	0.837721	0.015562	Y	Y
150	0.836213	0.015530	Y	Y
165	0.834834	0.015501	Y	Y
180	0.833533	0.015473	Y	Y
195	0.832291	0.015447	Y	Y
210	0.831097	0.015421	Y	Y
225	0.829993	0.015398	Y	Y
240	0.828940	0.015376	Y	Y
255	0.827950	0.015354	Y	Y
270	0.826980	0.015334	Y	Y
285	0.826071	0.015315	Y	Y
300	0.825212	0.015297	Y	Y
315	0.824383	0.015280	Y	Y
330	0.823589	0.015263	Y	Y
345	0.822841	0.015247	Y	Y
360	0.822123	0.015232	Y	Y
375	0.821447	0.015217	Y	Y
390	0.820778	0.015203	Y	Y
405	0.820154	0.015189	Y	Y
420	0.819545	0.015176	Y	Y
435	0.818967	0.015164	Y	Y
450	0.818403	0.015151	Y	Y
465	0.817870	0.015140	Y	Y
480	0.817351	0.015128	Y	Y
495	0.816856	0.015117	Y	Y
510	0.816369	0.015106	Y	Y
525	0.815919	0.015096	Y	Y
540	0.815457	0.015086	Y	Y
555	0.815027	0.015076	Y	Y
570	0.814607	0.015066	Y	Y
585	0.814194	0.015057	Y	Y
600	0.813800	0.015048	Y	Y

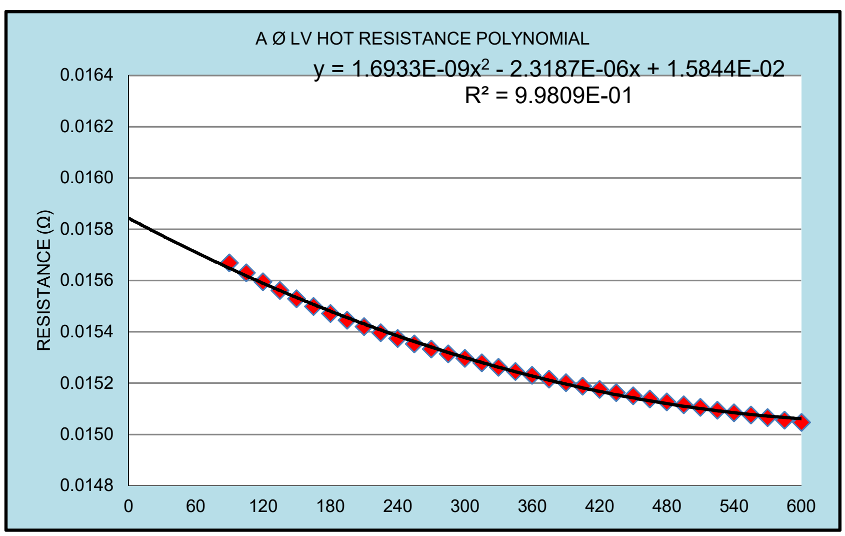
TEMP. MEASUREMENTS	
TOP OIL TEMP AT CUT BACK	77.46
TOP RAD TEMP AT CUT BACK	77.46
BOT RAD TEMP AT CUT BACK	51.04
AMBIENT TEMP AT CUT BACK	26.43
TOP OIL TEMP AT SHUT-DOWN	77.05
TOP RAD TEMP AT SHUT-DOWN	77.05
BOT RAD TEMP AT SHUT-DOWN	50.60
AMBIENT TEMP AT SHUT-DOWN	26.60

TEMP. CALCULATIONS AT CUTBACK		
	Measured	Corrected
AVG. OIL RISE	37.82	37.63
TOP OIL RISE	51.04	50.78
BOT OIL RISE	24.61	24.49

TEMP. CALCULATIONS AT SHUT-DOWN	
AVG. OIL RISE	37.22
TOP OIL RISE	50.45

	A Ø HV	A Ø LV
COLD RESISTANCE TEMP	24.9	24.9
COLD RESISTANCE	0.706000	0.013024
HOT RESISTANCE	0.851136	0.015844
TEMP RISE FOR WINDING	51.6	54.5
CORRECTED WINDING GRADIENT	14.2	16.9
CORRECTED TOP OIL RISE	50.8	50.8
CORRECTED WINDING RISE	51.8	54.6
WINDING AND OIL GUARANTEE	65	65
HOT SPOT MULTIPLIER	1.030	1.160
CORRECTED HOT SPOT	65.4	70.4
HOT SPOT GUARANTEE	80	80





Required & Actual Losses and Current		
	Required	**Actual**
Total Losses (kW)	277.68	279.23
Total Current (A)	305.64	308.08
Rated Losses (kW)	260.57	262.29
Rated Current (A)	296.08	299.26

Measured Values	
Top Oil Rise	**51.04**
HV Winding Gradient	**14.40**
LV Winding Gradient	**17.24**
HV Winding Rise	**52.23**
LV Winding Rise	**55.06**
HV Hot Spot	**65.87**
LV Hot Spot	**71.03**

Correction Factors	
"m" Winding ONAF	0.8
Corrected HV AWR per Gradient	51.79
Corrected LV AWR per Gradient	54.58
"n" Oil ONAF	0.9

HEAT RUN RESULTS

MR	5119	TESTED BY	JB/TJ/JY	CELL #	
MVA	33.00	DATE	9/16/2020	PHASE	B

B PHASE RESISTANCE			USE DATA	
TIME (S)	HV (Ω)	LV (Ω)	HV	LV
0			N	N
15			N	N
30			N	N
45			N	N
60			N	N
75	0.840993	0.015611	N	N
90	0.839068	0.015571	Y	Y
105	0.837293	0.015534	Y	Y
120	0.835631	0.015499	Y	Y
135	0.834071	0.015467	Y	Y
150	0.832580	0.015435	Y	Y
165	0.831200	0.015406	Y	Y
180	0.829896	0.015379	Y	Y
195	0.828669	0.015353	Y	Y
210	0.827483	0.015328	Y	Y
225	0.826391	0.015305	Y	Y
240	0.825352	0.015283	Y	Y
255	0.824366	0.015262	Y	Y
270	0.823410	0.015242	Y	Y
285	0.822525	0.015222	Y	Y
300	0.821671	0.015204	Y	Y
315	0.820861	0.015187	Y	Y
330	0.820070	0.015170	Y	Y
345	0.819334	0.015154	Y	Y
360	0.818628	0.015139	Y	Y
375	0.817948	0.015124	Y	Y
390	0.817286	0.015110	Y	Y
405	0.816660	0.015096	Y	Y
420	0.816065	0.015083	Y	Y
435	0.815490	0.015071	Y	Y
450	0.814928	0.015058	Y	Y
465	0.814391	0.015047	Y	Y
480	0.813881	0.015035	Y	Y
495	0.813378	0.015024	Y	Y
510	0.812896	0.015013	Y	Y
525	0.812432	0.015003	Y	Y
540	0.811988	0.014993	Y	Y
555	0.811554	0.014983	Y	Y
570	0.811131	0.014974	Y	Y
585	0.810733	0.014965	Y	Y
600	0.810338	0.014956	Y	Y

TEMP. MEASUREMENTS	
TOP OIL TEMP AT CUT BACK	77.46
TOP RAD TEMP AT CUT BACK	77.46
BOT RAD TEMP AT CUT BACK	51.04
AMBIENT TEMP AT CUT BACK	26.43
TOP OIL TEMP AT SHUT-DOWN	76.09
TOP RAD TEMP AT SHUT-DOWN	76.09
BOT RAD TEMP AT SHUT-DOWN	49.40
AMBIENT TEMP AT SHUT-DOWN	26.77

TEMP. CALCULATIONS AT CUTBACK		
	Measured	Corrected
AVG. OIL RISE	37.82	37.63
TOP OIL RISE	51.04	50.78
BOT OIL RISE	24.61	24.49

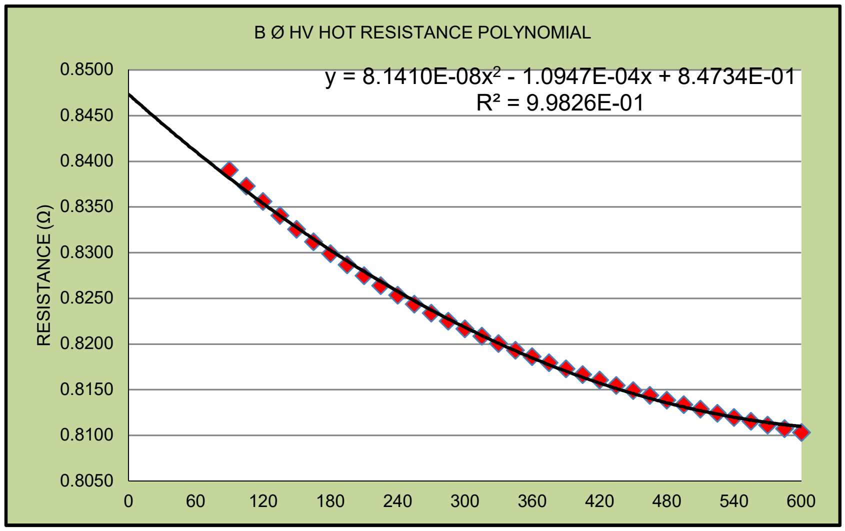
TEMP. CALCULATIONS AT SHUT-DOWN	
AVG. OIL RISE	35.98
TOP OIL RISE	49.32

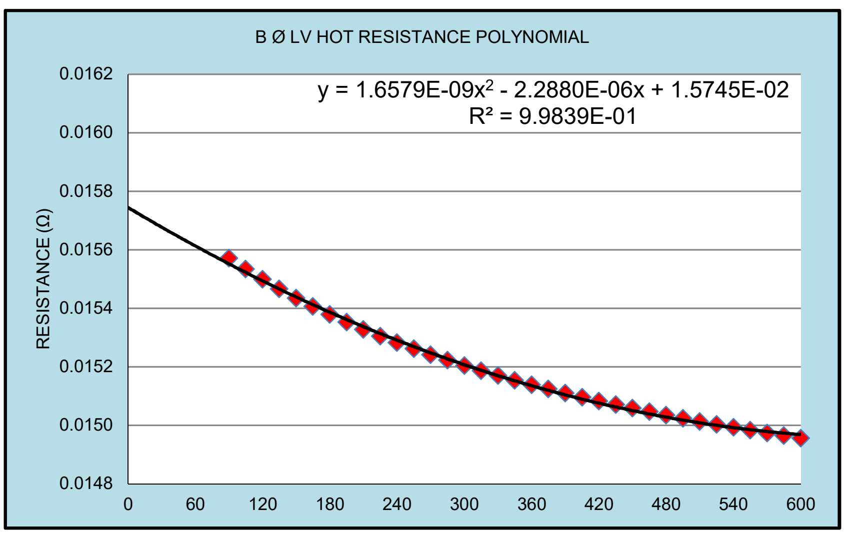
	B Ø HV	B Ø LV
COLD RESISTANCE TEMP	24.9	24.9
COLD RESISTANCE	0.705450	0.012993
HOT RESISTANCE	0.847341	0.015745
TEMP RISE FOR WINDING	50.3	53.1
CORRECTED WINDING GRADIENT	14.2	17.0
CORRECTED TOP OIL RISE	50.8	50.8
CORRECTED WINDING RISE	51.8	54.6
WINDING AND OIL GUARANTEE	65	65
HOT SPOT MULTIPLIER	1.030	1.160
CORRECTED HOT SPOT	65.4	70.4
HOT SPOT GUARANTEE	80	80

Required & Actual Losses and Current		
	Required	**Actual**
Total Losses (kW)	277.68	279.23
Total Current (A)	305.64	308.08
Rated Losses (kW)	260.57	258.75
Rated Current (A)	296.08	297.56

Measured Values	
Top Oil Rise	**51.04**
HV Winding Gradient	**14.33**
LV Winding Gradient	**17.09**
HV Winding Rise	**52.15**
LV Winding Rise	**54.91**
HV Hot Spot	**65.79**
LV Hot Spot	**70.86**

Correction Factors	
"m" Winding ONAF	0.8
Corrected HV AWR per Gradient	51.84
Corrected LV AWR per Gradient	54.59
"n" Oil ONAF	0.9





HEAT RUN RESULTS

MR	5119	TESTED BY	JB/TJ/JY	CELL #	
MVA	33.00	DATE	9/16/2020	PHASE	C

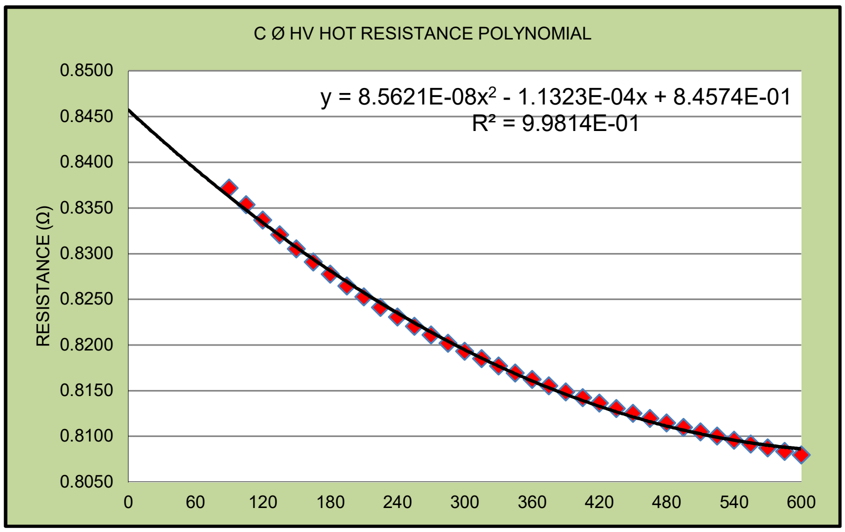
C PHASE RESISTANCE			USE DATA	
TIME (S)	HV (Ω)	LV (Ω)	HV	LV
0			N	N
15			N	N
30			N	N
45			N	N
60			N	N
75			N	N
90	0.837191	0.015788	Y	Y
105	0.835369	0.015748	Y	Y
120	0.833657	0.015710	Y	Y
135	0.832048	0.015675	Y	Y
150	0.830507	0.015642	Y	Y
165	0.829081	0.015611	Y	Y
180	0.827736	0.015582	Y	Y
195	0.826471	0.015554	Y	Y
210	0.825254	0.015527	Y	Y
225	0.824123	0.015502	Y	Y
240	0.823061	0.015479	Y	Y
255	0.822054	0.015456	Y	Y
270	0.821080	0.015435	Y	Y
285	0.820173	0.015415	Y	Y
300	0.819312	0.015395	Y	Y
315	0.818490	0.015377	Y	Y
330	0.817685	0.015359	Y	Y
345	0.816942	0.015342	Y	Y
360	0.816223	0.015326	Y	Y
375	0.815536	0.015311	Y	Y
390	0.814870	0.015296	Y	Y
405	0.814248	0.015281	Y	Y
420	0.813643	0.015268	Y	Y
435	0.813055	0.015254	Y	Y
450	0.812503	0.015241	Y	Y
465	0.811972	0.015229	Y	Y
480	0.811461	0.015217	Y	Y
495	0.810969	0.015205	Y	Y
510	0.810487	0.015194	Y	Y
525	0.810026	0.015183	Y	Y
540	0.809589	0.015172	Y	Y
555	0.809149	0.015161	Y	Y
570	0.808745	0.015151	Y	Y
585	0.808345	0.015141	Y	Y
600	0.807957	0.015132	Y	Y

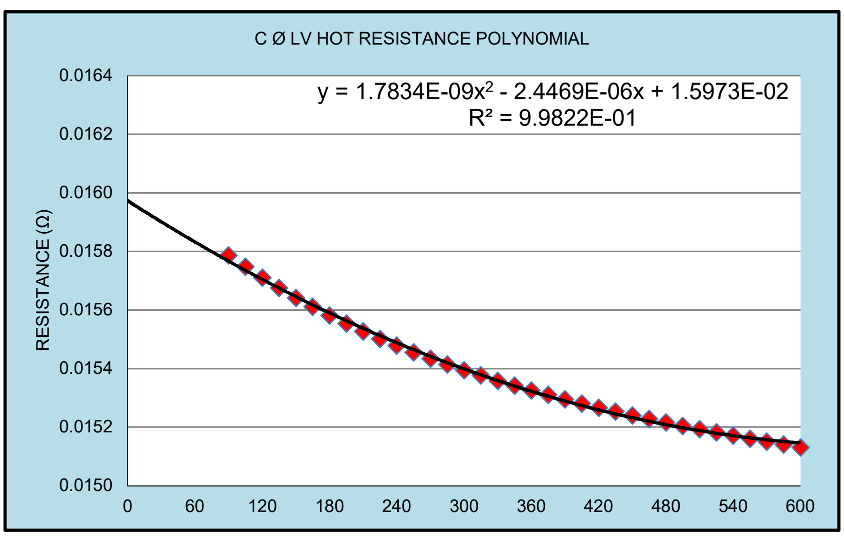
TEMP. MEASUREMENTS	
TOP OIL TEMP AT CUT BACK	77.46
TOP RAD TEMP AT CUT BACK	77.46
BOT RAD TEMP AT CUT BACK	51.04
AMBIENT TEMP AT CUT BACK	26.43
TOP OIL TEMP AT SHUT-DOWN	74.42
TOP RAD TEMP AT SHUT-DOWN	74.42
BOT RAD TEMP AT SHUT-DOWN	48.48
AMBIENT TEMP AT SHUT-DOWN	26.85

TEMP. CALCULATIONS AT CUTBACK		
	Measured	Corrected
AVG. OIL RISE	37.82	37.63
TOP OIL RISE	51.04	50.78
BOT OIL RISE	24.61	24.49

TEMP. CALCULATIONS AT SHUT-DOWN	
AVG. OIL RISE	34.60
TOP OIL RISE	47.57

	C Ø HV	C Ø LV
COLD RESISTANCE TEMP	24.9	24.9
COLD RESISTANCE	0.704750	0.013125
HOT RESISTANCE	0.845737	0.015973
TEMP RISE FOR WINDING	49.9	54.3
CORRECTED WINDING GRADIENT	15.2	19.5
CORRECTED TOP OIL RISE	50.8	50.8
CORRECTED WINDING RISE	52.8	57.1
WINDING AND OIL GUARANTEE	65	65
HOT SPOT MULTIPLIER	1.030	1.160
CORRECTED HOT SPOT	66.4	73.4
HOT SPOT GUARANTEE	80	80





Required & Actual Losses and Current		
	Required	**Actual**
Total Losses (kW)	277.68	279.23
Total Current (A)	305.64	308.08
Rated Losses (kW)	260.57	259.6
Rated Current (A)	296.08	298.2

Measured Values	
Top Oil Rise	**51.04**
HV Winding Gradient	**15.34**
LV Winding Gradient	**19.73**
HV Winding Rise	**53.17**
LV Winding Rise	**57.55**
HV Hot Spot	**66.84**
LV Hot Spot	**73.92**

Correction Factors	
"m" Winding ONAF	0.8
Corrected HV AWR per Gradient	52.80
Corrected LV AWR per Gradient	57.14
"n" Oil ONAF	0.9

HEAT RUN

MR	5119	Load Loss ONAN	66.99	kW	Rated Current	150.73
MVA ONAN	16.8	Load Loss ONAF	260.57	kW	Rated Current	296.08
MVA ONAF	33.0	Load Loss 75%	145.68	kW	Rated Current	222.06
MVA 75% ONAF	24.8	Load Loss 125%	409.33	kW	Rated Current	370.10
MVA 125% ONAF	41.3	No Load Loss	17.11	kW		
HV Tap	5	Total Losses (TL) ONAN	84.10	kW	TL Current	168.8833
LV Tap	15L	Total Losses (TL) ONAF	277.676	kW	TL Current	305.64184
PT 1:	1	Total Losses (TL) 75%	162.791	kW	TL Current	234.7338
CT 1:	1	Total Losses (TL) 125%	426.439	kW	TL Current	377.750929

	Line #	Amps	kW
ONAN CB	84	175.4	86.1
ONAN AØ SD	TYPE	TYPE	TYPE
ONAN BØ SD	TYPE	TYPE	TYPE
ONAN CØ SD	85	150.4	62.7
ONAF CB	33	308.1	279.2
ONAF AØ SD	34	299.3	262.3
ONAF BØ SD	45	297.6	258.8
ONAF CØ SD	58	298.2	259.6

	Line #	Amps	kW
75% CB	TYPE	TYPE	TYPE
75% SD	TYPE	TYPE	TYPE
125% CB	TYPE	TYPE	TYPE
125% SD	TYPE	TYPE	TYPE

Hottest Phase

	CHANNEL	1	2	3	4	5	6	7	8	9	10											
Scan	Time	Amb	Amb	Amb	Amb	T Rad	T Rad	B Rad	B Rad	T Oil	T Oil	Avg Amb	Avg T Rad	Avg B Rad	Avg T Oil	T.O.R.		Title	Amps	kW		
11	9/16/2020 09:00:31:245	23.1	24.1	23.3	24.0	26.8	26.9	22.0	23.1	26.8	26.9	23.6	26.9	22.6	26.9	3.2	#VALUE!	ST FA	323.5	278.5		
17	9/16/2020 09:30:31:269	22.9	24.0	24.3	23.9	41.9	42.2	25.7	26.6	41.9	42.2	23.8	42.1	26.2	42.1	18.3	15.1					
23	9/16/2020 10:00:31:264	22.7	23.9	24.8	23.9	51.6	52.0	31.4	33.0	51.6	52.0	23.8	51.8	32.2	51.8	28.0	9.7		312.7	277.2		
29	9/16/2020 10:30:31:247	22.5	23.8	24.6	23.9	58.2	58.5	35.3	37.3	58.2	58.5	23.7	58.4	36.3	58.4	34.7	6.7					
35	9/16/2020 11:00:31:263	22.6	23.9	25.5	24.1	62.8	63.1	38.5	41.1	62.8	63.1	24.0	62.9	39.8	62.9	38.9	4.2			277.6		
41	9/16/2020 11:30:31:247	22.6	23.9	25.6	24.3	66.1	66.3	40.8	43.6	66.1	66.3	24.1	66.2	42.2	66.2	42.1	3.2					
47	9/16/2020 12:00:31:273	22.7	24.0	25.9	24.5	68.5	68.6	42.8	45.4	68.5	68.6	24.3	68.6	44.1	68.6	44.3	2.3		310.1	278.7		
53	9/16/2020 12:30:31:277	22.9	24.2	26.1	24.8	70.5	70.6	44.1	47.1	70.5	70.6	24.5	70.6	45.6	70.6	46.1	1.7				1.6	
59	9/16/2020 13:00:31:259	23.1	24.4	26.4	25.0	72.0	72.1	45.0	48.1	72.0	72.1	24.7	72.1	46.5	72.1	47.3	1.2				1.2	
65	9/16/2020 13:30:31:239	23.4	24.6	26.7	25.2	73.2	73.1	45.9	49.1	73.2	73.1	25.0	73.2	47.5	73.2	48.2	0.8				0.8	48.1
71	9/16/2020 14:00:31:234	23.6	24.8	27.0	25.5	74.2	74.1	46.9	49.8	74.2	74.1	25.2	74.1	48.4	74.1	48.9	0.7				0.6	48.7
77	9/16/2020 14:30:31:235	23.8	25.1	26.6	25.6	74.7	74.6	47.1	50.2	74.7	74.6	25.3	74.7	48.6	74.7	49.4	0.5		309.1	379.1	0.4	49.1
83	9/16/2020 15:00:31:244	24.0	25.2	26.4	25.6	75.4	75.4	47.2	50.4	75.4	75.4	25.3	75.4	48.8	75.4	50.1	0.7	51.3	308.9	279.4		
89	9/16/2020 15:30:31:259	24.1	25.4	27.1	25.7	75.7	75.7	48.0	50.8	75.7	75.7	25.6	75.7	49.4	75.7	50.1	0.0					
95	9/16/2020 16:00:31:234	24.5	25.7	27.7	25.9	76.2	76.2	48.9	51.4	76.2	76.2	26.0	76.2	50.2	76.2	50.2	0.1		307.1	277.1		
101	9/16/2020 16:30:31:235	24.8	26.0	27.4	26.2	76.7	76.7	48.9	52.3	76.7	76.7	26.1	76.7	50.6	76.7	50.6	0.4					
	9/16/2020 17:00:31:243	25.1	26.3	27.3	26.4	77.1	77.0	49.5	52.1	77.1	77.0	26.3	77.1	50.8	77.1	50.8	0.2			278.7		
113	9/16/2020 17:30:31:251	25.4	26.5	26.6	26.6	77.4	77.3	49.9	52.3	77.4	77.3	26.3	77.3	51.1	77.3	51.0	0.3					
119	9/16/2020 18:00:31:240	25.6	26.7	26.8	26.7	77.6	77.4	49.7	52.3	77.6	77.4	26.4	77.5	51.0	77.5	51.0	0.0	CB FA	308.1	279.2		
15	9/16/2020 18:30:15:295	25.8	26.9	26.9	26.8	77.1	77.0	49.3	51.9	77.1	77.0	26.6	77.0	50.6	77.0	50.4	-0.6					
45	9/16/2020 19:00:15:320	25.9	27.1	27.0	26.8	76.6	76.5	48.5	51.8	76.6	76.5	26.7	76.6	50.2	76.6	49.8	-1.2	SD FA A	299.3	262.3		
46	9/16/2020 19:01:15:314	25.8	27.1	27.1	26.8	76.7	76.4	48.5	51.9	76.7	76.4	26.7	76.5	50.2	76.5	49.8	0.0					
47	9/16/2020 19:02:15:292	25.8	27.2	27.1	26.8	76.6	76.5	49.4	51.7	76.6	76.5	26.7	76.5	50.6	76.5	49.8	0.0					
48	9/16/2020 19:03:15:305	25.8	27.2	27.1	26.9	76.6	76.5	49.8	51.3	76.6	76.5	26.7	76.5	50.6	76.5	49.8	0.0					
49	9/16/2020 19:04:15:294	25.8	27.2	27.1	26.8	76.5	76.4	49.9	50.9	76.5	76.4	26.7	76.5	50.4	76.5	49.7	-0.1					
50	9/16/2020 19:05:15:320	25.8	27.1	27.1	26.8	76.5	76.4	49.8	50.6	76.5	76.4	26.7	76.5	50.2	76.5	49.7	0.0					
51	9/16/2020 19:06:15:297	25.8	27.2	27.1	26.8	76.4	76.4	49.7	50.2	76.4	76.4	26.7	76.4	50.0	76.4	49.7	-0.1					
52	9/16/2020 19:07:15:324	25.8	27.1	27.1	26.8	76.1	76.2	49.5	50.0	76.1	76.2	26.7	76.2	49.8	76.2	49.4	-0.2					
53	9/16/2020 19:08:15:303	25.8	27.1	27.1	26.8	76.4	76.3	49.3	49.8	76.4	76.3	26.7	76.3	49.6	76.3	49.6	0.2					
54	9/16/2020 19:09:15:283	25.8	27.1	27.1	26.8	76.3	76.3	49.3	49.6	76.3	76.3	26.7	76.3	49.4	76.3	49.6	0.0					
55	9/16/2020 19:10:15:322	25.9	27.2	27.1	26.9	76.2	76.0	49.3	49.5	76.2	76.0	26.8	76.1	49.4	76.1	49.3	-0.3					
56	9/16/2020 19:11:15:303	25.9	27.2	27.1	26.9	76.2	76.2	49.3	49.5	76.2	76.2	26.8	76.2	49.4	76.2	49.4	0.1					
75	9/16/2020 19:30:15:303	25.9	27.2	27.1	26.8	74.8	74.6	47.1	50.3	74.8	74.6	26.7	74.7	48.7	74.7	48.0	-1.4					
105	9/16/2020 20:00:15:316	25.9	27.4	27.2	26.8	74.6	74.5	48.0	50.6	74.6	74.5	26.8	74.6	49.3	74.6	47.7	-1.7	SD FA B	297.6	258.8		
106	9/16/2020 20:01:15:306	25.9	27.3	27.1	26.8	74.6	74.6	48.4	50.9	74.6	74.6	26.8	74.6	49.6	74.6	47.8	0.1					
107	9/16/2020 20:02:15:294	25.9	27.3	27.2	26.8	74.6	74.5	49.2	50.6	74.6	74.5	26.8	74.6	49.9	74.6	47.8	0.0					
108	9/16/2020 20:03:15:283	26.0	27.4	27.2	26.8	74.6	74.6	49.3	50.4	74.6	74.6	26.8	74.6	49.9	74.6	47.8	0.0					
109	9/16/2020 20:04:15:297	26.0	27.4	27.2	26.8	74.6	74.6	49.2	50.1	74.6	74.6	26.8	74.6	49.6	74.6	47.7	0.0					
110	9/16/2020 20:05:15:284	26.0	27.4	27.2	26.8	74.5	74.5	49.2	49.7	74.5	74.5	26.8	74.5	49.4	74.5	47.7	-0.1					
111	9/16/2020 20:06:15:316	26.0	27.4	27.2	26.8	74.6	74.6	48.9	49.4	74.6	74.6	26.8	74.6	49.1	74.6	47.7	0.0					
112	9/16/2020 20:07:15:292	26.0	27.4	27.2	26.8	74.3	74.5	48.7	49.2	74.3	74.5	26.9	74.4	48.9	74.4	47.6	-0.2					
113	9/16/2020 20:08:15:321	26.0	27.4	27.2	26.8	74.5	74.4	48.5	48.9	74.5	74.4	26.8	74.5	48.7	74.5	47.6	0.1					
114	9/16/2020 20:09:15:311	26.0	27.4	27.2	26.8	74.4	74.5	48.4	48.8	74.4	74.5	26.8	74.4	48.6	74.4	47.6	0.0					
115	9/16/2020 20:10:15:293	26.0	27.4	27.2	26.9	74.4	74.4	48.3	48.6	74.4	74.4	26.9	74.4	48.5	74.4	47.6	0.0					
116	9/16/2020 20:11:15:317	26.0	27.4	27.2	26.8	74.1	74.4	48.2	48.5	74.1	74.4	26.9	74.2	48.3	74.2	47.4	-0.2					
135	9/16/2020 20:30:15:283	26.0	27.4	27.1	26.8	73.0	72.8	47.2	50.1	73.0	72.8	26.8	72.9	48.6	72.9	46.1	-1.3					
165	9/16/2020 21:00:15:285	26.2	27.6	27.3	26.9	74.1	74.0	47.7	50.3	74.1	74.0	27.0	74.1	49.0	74.1	47.1	-0.3	SD FA C	298.2	259.6		
166	9/16/2020 21:01:15:302	26.2	27.6	27.3	26.9	74.1	74.0	48.7	50.6	74.1	74.0	27.0	74.1	49.6	74.1	47.1	0.0					
167	9/16/2020 21:02:15:283	26.2	27.6	27.3	26.9	74.1	74.0	49.3	50.1	74.1	74.0	27.0	74.1	49.7	74.1	47.1	0.0					
168	9/16/2020 21:03:15:322	26.2	27.6	27.3	26.9	74.1	74.0	48.9	50.0	74.1	74.0	27.0	74.1	49.5	74.1	47.1	0.0					
169	9/16/2020 21:04:15:307	26.2	27.6	27.3	26.9	74.0	74.0	48.8	49.7	74.0	74.0	27.0	74.0	49.3	74.0	47.0	0.0					
170	9/16/2020 21:05:15:305	26.2	27.6	27.3	26.9	74.0	74.1	48.8	49.3	74.0	74.1	27.0	74.1	49.1	74.1	47.1	0.0					
171	9/16/2020 21:06:15:316	26.2	27.6	27.3	26.9	74.0	74.0	48.5	49.0	74.0	74.0	27.0	74.0	48.8	74.0	47.0	0.0					
172	9/16/2020 21:07:15:304	26.2	27.6	27.3	26.9	74.1	73.6	48.1	48.8	74.1	73.6	27.0	73.9	48.5	73.9	46.9	-0.2					
173	9/16/2020 21:08:15:320	26.2	27.6	27.3	26.9	74.0	74.0	48.0	48.6	74.0	74.0	27.0	74.0	48.3	74.0	47.0	0.1					
174	9/16/2020 21:09:15:291	26.2	27.6	27.3	26.9	73.9	73.9	48.0	48.4	73.9	73.9	27.0	73.9	48.2	73.9	46.9	-0.1					
175	9/16/2020 21:10:15:327	26.2	27.6	27.3	26.9	73.8	73.9	47.9	48.2	73.8	73.9	27.0	73.9	48.1	73.9	46.9	-0.1					
176	9/16/2020 21:11:15:296	26.2	27.6	27.3	26.9	73.8	73.8	47.9	48.1	73.8	73.8	27.0	73.8	48.0	73.8	46.8	-0.1					
185	9/16/2020 21:20:15:291	26.2	27.6	27.3	26.9	73.2	73.3	46.1	48.8	73.2	73.3	27.0	73.3	47.4	73.3	46.2	-0.5	ST OA	175.5	85.4		
195	9/16/2020 21:30:15:289	26.2	27.6	27.3	26.9	72.2	71.9	42.9	44.8	72.2	71.9	27.0	72.1	43.8	72.1	45.1	-1.2					
225	9/16/2020 22:00:15:322	26.3	27.7	27.3	26.8	67.3	67.2	40.9	40.6	67.3	67.2	27.0	67.3	40.7	67.3	40.2	-4.8					
285	9/16/2020 23:00:15:299	26.3	27.8	27.2	26.8	63.6	63.5	45.6	45.9	63.6	63.5	27.0	63.6	45.8	63.6	36.6	-3.7					
345	9/17/2020 00:00:15:317	26.2	27.7	27.0	26.7	63.2	63.2	46.3	46.3	63.2	63.2	26.9	63.2	46.3	63.2	36.3	-0.2					
405	9/17/2020 01:00:15:307	26.1	27.6	26.9	26.6	63.4	63.4	46.5	46.5	63.4	63.4	26.8	63.4	46.5	63.4	36.6	0.3					
465	9/17/2020 02:00:15:287	26.0	27.5	26.7	26.5	63.3	63.2	46.2	46.6	63.3	63.2	26.7	63.3	46.4	63.3	36.6	0.0					
525	9/17/2020 03:00:15:283	25.9	27.4	26.6	26.4	63.1	63.2	46.2	46.6	63.1	63.2	26.6	63.2	46.4	63.2	36.6	0.0					
585	9/17/2020 04:00:15:319	25.9	27.4	26.5	26.3	63.0	62.8	46.2	46.6	63.0	62.8	26.5	62.9	46.4	62.9	36.4	-0.2					
645	9/17/2020 05:00:15:283	25.8	27.3	26.5	26.3	63.1	63.0	46.4	46.5	63.1	63.0	26.5	63.1	46.4	63.1	36.6	0.2					
705	9/17/2020 06:00:15:283	25.8	27.3	26.4	26.2	62.9	62.9	46.2	46.5	62.9	62.9	26.4	62.9	46.4	62.9	36.5	-0.1					
765	9/17/2020 07:00:15:307	25.6	27.2	26.3	26.1	62.8	62.8	46.3	46.5	62.8	62.8	26.3	62.8	46.4	62.8	36.5	0.0	CB OA	175.4	86.1		
825	9/17/2020 08:00:15:284	25.5	27.1	26.2	25.9	61.2	61.2	44.5	44.8	61.2	61.2	26.2	61.2	44.7	61.2	35.1	-1.5	SD OA C	150.4	62.7		
826	9/17/2020 08:01:15:310	25.5	27.1	26.1	26.0	61.3	61.4	44.5	44.8	61.3	61.4	26.2	61.3	44.7	61.3	35.2	0.1					
827	9/17/2020 08:02:15:295	25.5	27.1	26.1	26.0	61.2	61.2	44.4	44.9	61.2	61.2	26.2	61.2	44.7	61.2	35.0	-0.1					
828	9/17/2020 08:03:15:285	25.5	27.1	26.0	26.1	61.2	61.2	44.4	44.9	61.2	61.2	26.2	61.2	44.7	61.2	35.0	0.0					
829	9/17/2020 08:04:15:321	25.5	27.1	25.8	26.2	61.2	61.1	44.3	44.8	61.2	61.1	26.1	61.1	44.6	61.1	35.0	-0.1					
830	9/17/2020 08:05:15:294	25.5	27.1	25.8	26.3	61.1	61.2	44.3	44.7	61.1	61.2	26.2	61.1	44.5	61.1	35.0	0.0					
831	9/17/2020 08:06:15:315	25.5	27.1	25.8	26.2	61.0	61.0	44.2	44.6	61.0	61.0	26.1	61.0	44.4	61.0	34.9	-0.1					
832	9/17/2020 08:07:15:284	25.5	27.1	25.9	26.2	61.1	61.0	44.0	44.6	61.1	61.0	26.2	61.0	44.3	61.0	34.9	0.0					
833	9/17/2020 08:08:15:307	25.5	27.1	25.9	26.3	61.0	61.0	44.0	44.5	61.0	61.0	26.2	61.0	44.2	61.0	34.8	0.0					
834	9/17/2020 08:09:15:289	25.7	27.1	25.9	26.3	61.0	60.9	43.8	44.4	61.0	60.9	26.2	61.0	44.1	61.0	34.7	-0.1					
835	9/17/2020 08:10:15:315	25.6	27.1	25.9	26.3	60.9	60.9	43.7	44.3	60.9	60.9	26.2	60.9	44.0	60.9	34.7	0.0					
																0.0						

HEAT RUN RESULTS

MR	5119	TESTED BY	JB/TJ/JY	CELL #	
MVA	16.80	DATE	9/16/2020	PHASE	C

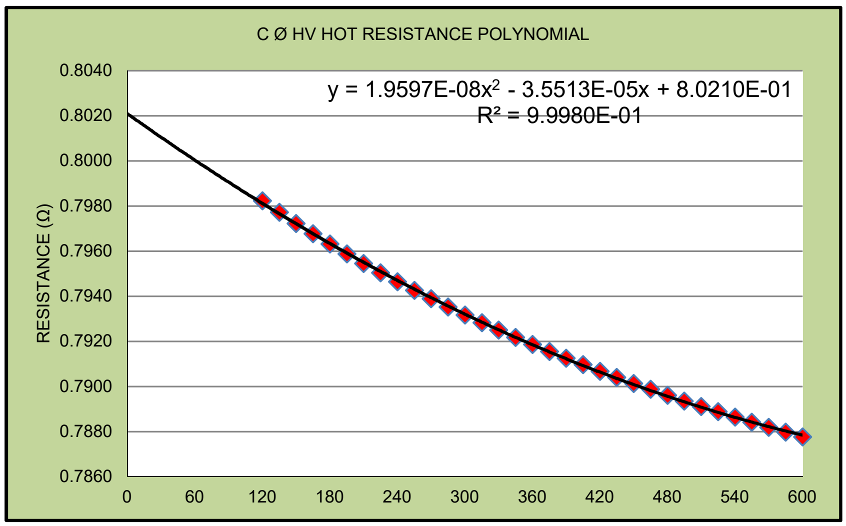
C PHASE RESISTANCE			USE DATA	
TIME (S)	HV (Ω)	LV (Ω)	HV	LV
0			N	N
15			N	N
30			N	N
45			N	N
60			N	N
75			N	N
90			N	N
105			N	N
120	0.798229	0.014925	Y	Y
135	0.797722	0.014913	Y	Y
150	0.797233	0.014903	Y	Y
165	0.796772	0.014893	Y	Y
180	0.796317	0.014883	Y	Y
195	0.795882	0.014873	Y	Y
210	0.795450	0.014864	Y	Y
225	0.795045	0.014855	Y	Y
240	0.794646	0.014846	Y	Y
255	0.794260	0.014838	Y	Y
270	0.793886	0.014829	Y	Y
285	0.793526	0.014822	Y	Y
300	0.793172	0.014814	Y	Y
315	0.792826	0.014806	Y	Y
330	0.792496	0.014799	Y	Y
345	0.792171	0.014791	Y	Y
360	0.791859	0.014784	Y	Y
375	0.791552	0.014778	Y	Y
390	0.791250	0.014771	Y	Y
405	0.790964	0.014764	Y	Y
420	0.790677	0.014758	Y	Y
435	0.790404	0.014752	Y	Y
450	0.790128	0.014746	Y	Y
465	0.789870	0.014740	Y	Y
480	0.789612	0.014734	Y	Y
495	0.789358	0.014728	Y	Y
510	0.789111	0.014722	Y	Y
525	0.788878	0.014717	Y	Y
540	0.788638	0.014712	Y	Y
555	0.788418	0.014706	Y	Y
570	0.788190	0.014701	Y	Y
585	0.787970	0.014696	Y	Y
600	0.787761	0.014691	Y	Y

TEMP. MEASUREMENTS	
TOP OIL TEMP AT CUT BACK	62.80
TOP RAD TEMP AT CUT BACK	62.80
BOT RAD TEMP AT CUT BACK	46.41
AMBIENT TEMP AT CUT BACK	26.28
TOP OIL TEMP AT SHUT-DOWN	61.24
TOP RAD TEMP AT SHUT-DOWN	61.24
BOT RAD TEMP AT SHUT-DOWN	44.66
AMBIENT TEMP AT SHUT-DOWN	26.18

TEMP. CALCULATIONS AT CUTBACK		
	Measured	Corrected
AVG. OIL RISE	28.32	27.80
TOP OIL RISE	36.51	35.84
BOT OIL RISE	20.13	19.75

TEMP. CALCULATIONS AT SHUT-DOWN	
AVG. OIL RISE	26.77
TOP OIL RISE	35.06

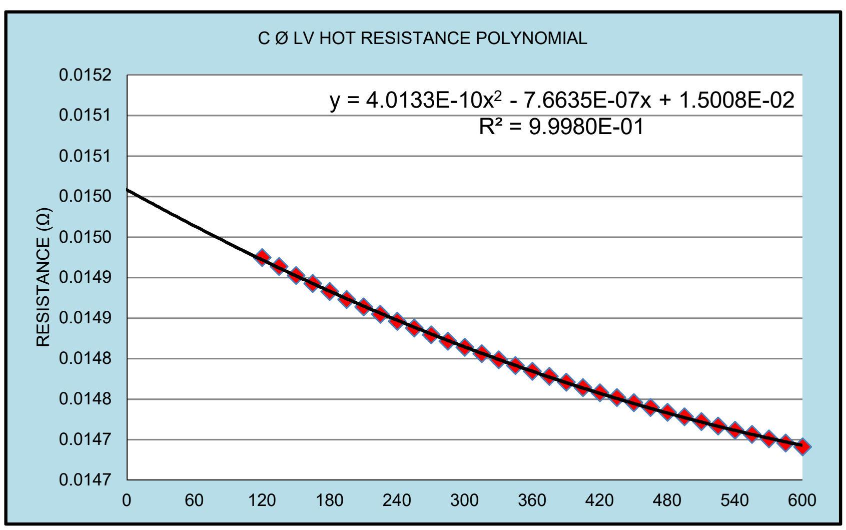
	C Ø HV	C Ø LV
COLD RESISTANCE TEMP	24.9	24.9
COLD RESISTANCE	0.704750	0.013125
HOT RESISTANCE	0.802096	0.015008
TEMP RISE FOR WINDING	34.5	35.9
CORRECTED WINDING GRADIENT	7.8	9.2
CORRECTED TOP OIL RISE	35.8	35.8
CORRECTED WINDING RISE	35.6	37.0
WINDING AND OIL GUARANTEE	65	65
HOT SPOT MULTIPLIER	1.030	1.160
CORRECTED HOT SPOT	43.9	46.5
HOT SPOT GUARANTEE	80	80



Required & Actual Losses and Current		
	Required	Actual
Total Losses (kW)	84.10	86.081
Total Current (A)	168.88	175.41
Rated Losses (kW)	66.99	62.671
Rated Current (A)	150.73	150.42

Measured Values	
Top Oil Rise	36.51
HV Winding Gradient	7.78
LV Winding Gradient	9.17
HV Winding Rise	36.10
LV Winding Rise	37.49
HV Hot Spot	44.53
LV Hot Spot	47.15

Correction Factors	
"m" Winding ONAN	0.8
Corrected HV AWR per Gradient	35.60
Corrected LV AWR per Gradient	36.99
"n" Oil ONAN	0.8



DELTA STAR COLD RESISTANCE

Tap Position	5 / 15L
Current Range [A]	20
Time to Stabilization [s]	120

A Phase

Winding	Resistance (Ω)	Bushing	Polarity
HV	0.7060000	H1	+
		H2	-
LV	0.0130240	X1	+
		X0	-
TV			+
			-

B Phase

Winding	Resistance (Ω)	Bushing	Polarity
HV	0.7054500	H2	+
		H3	-
LV	0.0129930	X2	+
		X0	-
TV			+
			-

C Phase

Winding	Resistance (Ω)	Bushing	Polarity
HV	0.7047500	H3	+
		H1	-
LV	0.0131250	X3	+
		X0	-
TV			+
			-

Top Oil Temperature [C]	25.8
Top Rad Temperature [C]	25.2
Bot Rad Temperature [C]	23.4
Resistance Temperature [C]	24.9

MR:	5119
Resistance Bridge ID No:	391234 RAYTECH LOANER
Tested By:	CT/SS/MVB
Date:	9/16/2020

No Load Losses

CELL NUMBER	1			TESTED BY	DATE	PA LOSSES BEFORE VAPOR PHASE	2.63
MR	5119	CT RATIO	1	BEFORE IMPULSE CT	09/16/20	PA LOSSES AT NO LOAD	3.47
REF. TEMPERATURE (°C)	20	PT RATIO	1	AFTER IMPULSE AM	09/17/20	% DIFFERENCE	0.32

RATED TAP VALUES	DESIGN	GUAR.	MEAS. BEFORE	MEAS./GUAR.	PASS/FAIL	MEAS. AFTER	MEAS./GUAR.	% CHANGE	PASS/FAIL
XCITATION CURRENT 100% (%	**0.14**	**0.40**	**0.09**	-76.76%	PASS	**0.09**	-76.77%	-0.05%	PASS
NO LOAD LOSS (kW)	**14.87**	**15.00**	**13.64**	-9.10%	PASS	**13.69**	-8.73%	0.41%	PASS

TEST NUMBER	1	2	3	4	5	6	7	8	9	10
TARGET VOLTAGE (V)	**13800**	**12420**	**15180**	**12510**	**12400**	**15090**	**15180**	**13800**	**12420**	**15180**
TEST TEMPERATURE (°C)	25	25	25	25	25	25	25	32	32	32
DETC POSITION	3	3	3	3	3	3	3	3	3	3
LTC POSITION	N	N	N	15L	16L	15R	16R	N	N	N
PERCENT OF RATED VOLTAGE	100	90	110	100	100	100	100	100	90	110
BEFORE/AFTER IMPULSE	BEFORE	BEFORE	BEFORE	BEFORE	BEFORE	BEFORE	BEFORE	AFTER	AFTER	AFTER
MEASUREMENTS										
AVERAGE VOLTAGE A L-L (V)	13825	12456	15245	12502	12400	15140	15200	13830	12450	15262
AVERAGE VOLTAGE B L-L (V)	13822	12431	15250	12472	12362	15124	15209	13825	12419	15244
AVERAGE VOLTAGE C L-L (V)	13791	12443	15203	12477	12371	15132	15214	13800	12384	15196
MEASURED AVERAGE RMS VOLTAGE (V)	13800	12427	15213	12459	12353	15106	15182	13803	12407	15212
CURRENT PHASE A (A)	0.7333	0.6478	0.9630	10.8660	0.8393	9.1283	0.7108	0.7324	0.6385	0.9630
CURRENT PHASE B (A)	0.4880	0.4238	0.6868	10.6990	0.5666	9.0053	0.5140	0.4877	0.4147	0.6862
CURRENT PHASE C (A)	0.7388	0.6352	1.0009	11.0720	0.8281	9.3076	0.7118	0.7391	0.6259	0.9983
AVERAGE CURRENT (A)	0.6534	0.5689	0.8836	10.8790	0.7447	9.1471	0.6456	0.6530	0.5597	0.8825
WATTS A PHASE (W)	5550	4503	7230	7118	5603	7075	5506	5543	4434	7232
WATTS B PHASE (W)	3364	2710	4283	4510	3470	4680	3641	3363	2688	4295
WATTS C PHASE (W)	4665	3715	5931	5391	4659	5556	4755	4664	3633	5923
THREE PHASE LOSSES (W)	**13579**	**10928**	**17444**	**17018**	**13732**	**17311**	**13901**	**13570**	**10755**	**17450**
CORRECTED TOTAL LOSSES (W) ---- RMS/AVG	**13591**	**10943**	**17466**	**17052**	**13759**	**17341**	**13925**	**13585**	**10765**	**17475**
DESIGN AND CORRECTED LOSSES										
DISTORTION CORRECTED LOSSES (kW)	13.591	10.943	17.466	17.052	13.759	17.341	13.925	13.585	10.765	17.475
TEST VOLTAGE (kV)	13.800	12.420	15.180	12.510	12.400	15.090	15.180	13.800	12.420	15.180
MEASURED AVG. TEST VOLTAGE (kV)	13.813	12.443	15.233	12.484	12.378	15.132	15.208	13.818	12.418	15.234
RATED ONAN CURRENT (A)	703	703	703	775	782	643	639	703	703	703
POWER FACTOR	0.869	0.891	0.747	0.073	0.861	0.073	0.818	0.869	0.895	0.748
MEASURED VALUES										
EXCITATION CURRENT (%)	**0.093**	**0.081**	**0.126**	**1.403**	**0.095**	**1.423**	**0.101**	**0.093**	**0.080**	**0.126**
CORRECTED NO LOAD LOSS (kW)	**13.64**	**10.98**	**17.52**	**17.11**	**13.80**	**17.40**	**13.97**	**13.69**	**10.85**	**17.61**

Load Losses OA

TYPE TR or ATR	TR-2

TR-2 = 2 WINDING TRANSFORMER
TR-3 = 3 WINDING TRANSFORMER
ATR = AUTOTRANSFORMER

TYPE WINDING CONFIGURATION		
WINDING	TR	ATR
HV	Y	Y
LV	Y	Y

RATED TAP VALUES	DESIGN	GUAR.	MEASURED	% DIFF	PASS/FAIL
LOAD LOSS [kW]	59.85	58.70	57.54	-1.98%	PASS
IMPEDANCE [%]	9.10	9.00	8.63	-4.15%	PASS

CT RATIO	1	MR	5119	COEFFICIENT HV	1.5	TESTED BY	CT/SS
		CELL NUMBER	1	COEFFICIENT LV	3	DATE	09/16/20

	UNITS	136.71	139.96	143.38	146.96	150.73	136.71	143.38	150.73	136.71	143.38	150.73	150.73	150.73	150.73	150.73
TEST		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
MVA		16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
DETC POSITION		1	2	3	4	5	1	3	5	1	3	5	5	5	5	5
PRIMARY TAP VOLTAGE	[kV]	70.95	69.3	67.65	66	64.35	70.95	67.65	64.35	70.95	67.65	64.35	64.35	64.35	64.35	64.35
PRIMARY LINE AMPS	[A]	136.71	139.96	143.38	146.96	150.73	136.71	143.38	150.73	136.71	143.38	150.73	150.73	150.73	150.73	150.73
LTC TAP POSITION		N	N	N	N	N	16R	16R	16R	16L	16L	16L	1L	8L	14L	15L
SECONDARY TAP VOLTAGE	[kV]	13.8	13.8	13.8	13.8	13.8	15.18	15.18	15.18	12.4	12.4	12.4	13.71	13.11	12.6	12.51
SECONDARY LINE AMPS	[A]	702.86	702.86	702.86	702.86	702.86	638.96	638.96	638.96	782.22	782.22	782.22	707.48	739.85	769.80	775.34
MEASUREMENTS																
VOLTMETER READING A L-L	[kV]	5.894	5.864	5.861	5.822	5.792	5.916	5.868	5.826	5.876	5.823	5.768	5.794	5.792	5.779	5.776
VOLTMETER READING B L-L	[kV]	5.863	5.828	5.825	5.791	5.759	5.880	5.834	5.795	5.842	5.784	5.731	5.759	5.755	5.745	5.738
VOLTMETER READING C L-L	[kV]	5.869	5.838	5.835	5.789	5.766	5.885	5.841	5.799	5.846	5.787	5.734	5.761	5.757	5.744	5.743
AMMETER READING A	[A]	133.060	138.350	143.570	148.180	152.760	128.710	138.220	147.440	136.420	146.920	156.940	152.710	153.680	155.660	156.350
AMMETER READING B	[A]	131.790	137.170	142.240	146.720	151.290	127.550	137.060	146.000	135.060	145.440	155.250	151.270	152.200	154.060	154.730
AMMETER READING C	[A]	134.080	139.430	144.660	149.140	153.900	129.580	139.100	148.220	137.610	148.150	157.840	153.580	154.620	156.560	157.350
WATTS A	[kW]	11.884	12.047	12.346	12.613	12.961	10.049	10.467	11.143	15.574	16.150	16.824	13.250	14.516	15.946	16.424
WATTS B	[kW]	18.567	19.392	20.179	20.929	21.700	17.482	18.954	20.463	21.519	23.256	24.947	22.049	23.396	24.437	24.725
WATTS C	[kW]	16.184	16.890	17.378	17.741	18.093	15.114	16.175	16.895	19.176	20.444	21.201	18.370	19.470	20.580	20.944
SUM WATTMETER READING	[kW]	46.635	48.329	49.903	51.283	52.754	42.645	45.596	48.501	56.269	59.850	62.972	53.669	57.382	60.963	62.093
TEMPERATURES																
REFERENCE TEMPERATURE	[°C]	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
TEST TEMPERATURE	[°C]	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
RESISTANCE TEMPERATURE	[°C]	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
RESISTANCE																
PRI. RES.@ TEST TEMP (L-L or L-G) **L-L**	[Ω]	0.791933	0.773317	0.756067	0.737233	0.718550	0.791933	0.756067	0.718550	0.791933	0.756067	0.718550	0.718550	0.718550	0.718550	0.718550
SEC. RES.@ TEST TEMP (L-L or L-G) **L-G**	[Ω]	0.012202	0.012202	0.012202	0.012202	0.012202	0.013466	0.013466	0.013466	0.013473	0.013473	0.013473	0.012255	0.012885	0.013275	0.013265
CALCULATIONS AT TEST TEMPERATURE																
PRI. I^2R. @ TEST TEMP	[W]	21847	22362	22942	23504	24098	21847	22942	24098	21847	22942	24098	24098	24098	24098	24098
SEC. I^2R. @ TEST TEMP	[W]	17796	17796	17796	17796	17796	16231	16231	16231	24337	24337	24337	18109	20823	23224	23542
TOTAL I^2R. @ TEST TEMP	[W]	39644	40158	40739	41300	41894	38079	39174	40329	46184	47279	48435	42206	44920	47322	47639
LOAD LOSS. @ TEST TEMP	[W]	49289	49487	49825	50557	51435	48182	49128	50841	56554	57063	58283	52417	55330	57334	57862
STRAY LOSS. @ TEST TEMP	[W]	9646	9329	9086	9257	9541	10104	9955	10512	10370	9784	9848	10210	10409	10013	10223
CALCULATIONS AT REFERENCE TEMPERATURE																
PRI. I^2R @ REF. TEMP	[W]	26899	27532	28247	28938	29669	26899	28247	29669	26899	28247	29669	29669	29669	29669	29669
SEC. I^2R. @ REF. TEMP.	[W]	21911	21911	21911	21911	21911	19984	19984	19984	29964	29964	29964	22296	25637	28594	28985
TOTAL I^2R. @ REF. TEMP.	[W]	48810	49443	50158	50849	51581	46883	48231	49654	56863	58211	59633	51965	55307	58263	58654
LOAD LOSS @ REF.TEMP.	[W]	56644	57020	57538	58368	59330	55089	56317	58192	65285	66158	67632	60258	63761	66396	66957
STRAY LOSS. @ REF.TEMP.	[W]	7834	7577	7380	7519	7750	8206	8085	8538	8423	7946	7999	8293	8455	8132	8303
PRI. IMPEDANCE VOLTAGE	[V]	6040	5913	5836	5759	5699	6265	6070	5945	5869	5661	5526	5704	5664	5582	5553
MEASURED VALUES																
LOAD LOSS	[kW]	56.64	57.02	57.54	58.37	59.33	55.09	56.32	58.19	65.29	66.16	67.63	60.26	63.76	66.40	66.96
% IMPEDANCE	[%]	8.51	8.53	8.63	8.73	8.86	8.83	8.97	9.24	8.27	8.37	8.59	8.86	8.80	8.67	8.63

R + Xj	[%]	0.34 + 8.51j	0.34 + 8.53j	0.34 + 8.62j	0.35 + 8.72j	0.35 + 8.85j	0.33 + 8.82j	0.34 + 8.97j	0.35 + 9.23j	0.39 + 8.26j	0.39 + 8.36j	0.40 + 8.58j	0.36 + 8.86j	0.38 + 8.79j	0.40 + 8.67j	0.40 + 8.62j
R	[%]	0.33716781	0.33940522	0.34248717	0.34742653	0.35315515	0.32791253	0.33521757	0.34637987	0.3886039	0.39379536	0.4025715	0.35867839	0.37953088	0.39521183	0.3985562
X	[%]	8.50687257	8.52563902	8.61953855	8.71948602	8.84989384	8.82355775	8.96638344	9.2324331	8.26335383	8.35935736	8.57800791	8.85599747	8.79350033	8.66584112	8.62017334

Load Losses FA

TYPE TR or ATR	TR-2

TR-2 = 2 WINDING TRANSFORMER
TR-3 = 3 WINDING TRANSFORMER
ATR = AUTOTRANSFORMER

TYPE WINDING CONFIGURATION		
WINDING	**TR**	**ATR**
HV	**Y**	**Y**
LV	**Y**	**Y**

RATED TAP VALUES	DESIGN	GUAR.	MEASURED	% DIFF	PASS/FAIL
LOAD LOSS [kW]				#DIV/0!	NO DATA
IMPEDANCE [%]				#DIV/0!	NO DATA

CT RATIO: 1
MR: 5119
CELL NUMBER: 1
COEFFICIENT HV: **1.5**
COEFFICIENT LV: **3**
TESTED BY: CT/SS
DATE: 9/16/2020

	UNITS	**268.54**	**274.93**	**281.63**	**288.68**	**296.08**	**268.54**	**281.63**	**296.08**	**268.54**	**281.63**	**296.08**	**296.08**
TEST		16	17	18	19	20	21	22	23	24	25	26	27
MVA		33	33	33	33	33	33	33	33	33	33	33	33
DETC TAP POSITION		**1**	**2**	**3**	**4**	**5**	**1**	**3**	**5**	**1**	**3**	**5**	**5**
PRIMARY TAP VOLTAGE	[kV]	70.95	69.3	67.65	66	64.35	70.95	67.65	64.35	70.95	67.65	64.35	64.35
PRIMARY LINE AMPS	[A]	268.54	274.93	281.63	288.68	296.08	268.54	281.63	296.08	268.54	281.63	296.08	296.08
LTC POSITION		**N**	**N**	**N**	**N**	**N**	**16R**	**16R**	**16R**	**16L**	**16L**	**16L**	**1L**
SECONDARY TAP VOLTAGE	[kV]	13.8	13.8	13.8	13.8	13.8	15.18	15.18	15.18	12.4	12.4	12.4	13.71
SECONDARY LINE AMPS	[A]	1380.62	1380.62	1380.62	1380.62	1380.62	1255.11	1255.11	1255.11	1536.50	1536.50	1536.50	1389.68
MEASUREMENTS													
VOLTMETER READING A L-L	[kV]	5.894	5.864	5.861	5.822	5.792	5.916	5.868	5.826	5.876	5.823	5.768	5.794
VOLTMETER READING B L-L	[kV]	5.863	5.828	5.825	5.791	5.759	5.880	5.834	5.795	5.842	5.784	5.731	5.759
VOLTMETER READING C L-L	[kV]	5.869	5.838	5.835	5.789	5.766	5.885	5.841	5.799	5.846	5.787	5.734	5.761
AMMETER READING A	[A]	133.060	138.350	143.570	148.180	152.760	128.710	138.220	147.440	136.420	146.920	156.940	152.710
AMMETER READING B	[A]	131.790	137.170	142.240	146.720	151.290	127.550	137.060	146.000	135.060	145.440	155.250	151.270
AMMETER READING C	[A]	134.080	139.430	144.660	149.140	153.900	129.580	139.100	148.220	137.610	148.150	157.840	153.580
WATTS A	[kW]	11.884	12.047	12.346	12.613	12.961	10.049	10.467	11.143	15.574	16.150	16.824	13.250
WATTS B	[kW]	18.567	19.392	20.179	20.929	21.700	17.482	18.954	20.463	21.519	23.256	24.947	22.049
WATTS C	[kW]	16.184	16.890	17.378	17.741	18.093	15.114	16.175	16.895	19.176	20.444	21.201	18.370
SUM WATTMETER READING	[kW]	**46.635**	**48.329**	**49.903**	**51.283**	**52.754**	**42.645**	**45.596**	**48.501**	**56.269**	**59.850**	**62.972**	**53.669**
TEMPERATURES													
REFERENCE TEMPERATURE	[°C]	85	85	85	85	85	85	85	85	85	85	85	85
TEST TEMPERATURE	[°C]	25	25	25	25	25	25	25	25	25	25	25	25
RESISTANCE TEMPERATURE	[°C]	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2	29.2
RESISTANCE													
PRI. RES.@ TEST TEMP (L-L or L-G) **L-L**	[Ω]	0.791933	0.773317	0.756067	0.737233	0.718550	0.791933	0.756067	0.718550	0.791933	0.756067	0.718550	0.718550
SEC. RES.@ TEST TEMP (L-L or L-G) **L-G**	[Ω]	0.012202	0.012202	0.012202	0.012202	0.012202	0.013466	0.013466	0.013466	0.013473	0.013473	0.013473	0.012255
CALCULATIONS AT TEST TEMPERATURE													
PRI. I^2R. @ TEST TEMP	[W]	84296	86281	88522	90686	92979	84296	88522	92979	84296	88522	92979	92979
SEC. I^2R. @ TEST TEMP	[W]	68666	68666	68666	68666	68666	62627	62627	62627	93902	93902	93902	69870
TOTAL I^2R. @ TEST TEMP	[W]	152962	154947	157187	159352	161645	146923	151149	155606	178199	182424	186881	162849
LOAD LOSS. @ TEST TEMP	[W]	190179	190941	192245	195070	198459	185908	189558	196167	218211	220174	224879	202246
STRAY LOSS. @ TEST TEMP	[W]	37217	35994	35057	35718	36815	38985	38410	40561	40012	37750	37997	39396
CALCULATIONS AT REFERENCE TEMPERATURE													
PRI. I^2R @ REF. TEMP	[W]	103787	106231	108989	111654	114477	103787	108989	114477	103787	108989	114477	114477
SEC. I^2R. @ REF. TEMP.	[W]	84542	84542	84542	84542	84542	77107	77107	77107	115614	115614	115614	86025
TOTAL I^2R. @ REF. TEMP.	[W]	188329	190773	193531	196197	199019	180894	186096	191584	219401	224603	230091	200503
LOAD LOSS @ REF.TEMP.	[W]	218557	220007	222005	225207	228920	212558	217293	224528	251899	255264	260953	232500
STRAY LOSS. @ REF.TEMP.	[W]	30228	29235	28474	29010	29901	31664	31197	32944	32498	30661	30862	31998
PRI. IMPEDANCE VOLTAGE	[V]	11865	11615	11463	11313	11195	12306	11923	11678	11529	11121	10855	11203
MEASURED VALUES													
LOAD LOSS	[kW]	218.56	220.01	222.01	225.21	228.92	212.56	217.29	224.53	251.90	255.26	260.95	232.50
% IMPEDANCE	[%]	16.72	16.76	16.94	17.14	17.40	17.34	17.62	18.15	16.25	16.44	16.87	17.41

R + Xj	[%]	0.66 + 16.71	0.67 + 16.75	0.67 + 16.93	0.68 + 17.13	0.69 + 17.38j	0.64 + 17.33	0.66 + 17.61j	0.68 + 18.14	0.76 + 16.23j	0.77 + 16.42	0.79 + 16.85	0.70 + 17.40
R	[%]	0.66229391	0.66668882	0.67274265	0.682445	0.69369761	0.6441139	0.658463084	0.68038904	0.76332909	0.77352659	0.79076546	0.70454684
X	[%]	16.7099283	16.7467909	16.9312364	17.127562	17.38372	17.3319884	17.6125389	18.1351365	16.2315879	16.4201662	16.8496584	17.3957093

TYPE TR or ATR	TR-2

TR-2 = 2 WINDING TRANSFORMER
TR-3 = 3 WINDING TRANSFORMER
ATR = AUTOTRANSFORMER

		UNITS	**296.08**	**296.08**	**222.06**	**296.08**	**370.10**
TEST			28	29	30	31	32
MVA			33	33	24.75	33	41.25
DETC TAP POSITION			**5**	**5**	**5**	**5**	**5**
PRIMARY TAP VOLTAGE		[kV]	64.35	64.35	64.35	64.35	64.35
PRIMARY LINE AMPS		[A]	296.08	296.08	222.06	296.08	370.10
LTC POSITION			**8L**	**14L**	**15L**	**15L**	**15L**
SECONDARY TAP VOLTAGE		[kV]	13.11	12.6	12.51	12.51	12.51
SECONDARY LINE AMPS		[A]	1453.28	1512.11	1142.24	1522.99	1903.73
VOLTMETER READING A L-L		[kV]	5.792	5.779	8.321	10.991	13.724
VOLTMETER READING B L-L		[kV]	5.755	5.745	8.269	10.916	13.667
VOLTMETER READING C L-L		[kV]	5.757	5.744	8.267	10.912	13.674
AMMETER READING A		[A]	153.680	155.660	225.290	297.270	371.610
AMMETER READING B		[A]	152.200	154.060	222.920	294.420	367.700
AMMETER READING C		[A]	154.620	156.560	226.620	298.940	374.830
WATTS A		[kW]	14.516	15.946	34.143	60.021	94.920
WATTS B		[kW]	23.396	24.437	51.539	90.437	142.150
WATTS C		[kW]	19.470	20.580	43.643	76.602	121.210
SUM WATTMETER READING		[kW]	**57.382**	**60.963**	**129.325**	**227.060**	**358.280**
REFERENCE TEMPERATURE		[°C]	85	85	85	85	85
TEST TEMPERATURE		[°C]	25	25	25	25	25
RESISTANCE TEMPERATURE		[°C]	29.2	29.2	29.2	29.2	29.2
PRI. RES.@ TEST TEMP (L-L or L-G)	**L-L**	[Ω]	0.718550	0.718550	0.718550	0.718550	0.718550
SEC. RES.@ TEST TEMP (L-L or L-G)	**L-G**	[Ω]	0.012885	0.013275	0.013265	0.013265	0.013265
PRI. I^2R. @ TEST TEMP		[W]	92979	92979	52301	92979	145280
SEC. I^2R. @ TEST TEMP		[W]	80343	89608	51094	90834	141928
TOTAL I^2R. @ TEST TEMP		[W]	173322	182587	103395	183813	287208
LOAD LOSS. @ TEST TEMP		[W]	213486	221220	126028	225839	355807
STRAY LOSS. @ TEST TEMP		[W]	40164	38633	22634	42026	68600
PRI. I^2R @ REF. TEMP		[W]	114477	114477	64393	114477	178870
SEC. I^2R. @ REF. TEMP.		[W]	98919	110327	62908	111836	174744
TOTAL I^2R. @ REF. TEMP.		[W]	213396	224804	127301	226313	353614
LOAD LOSS @ REF.TEMP.		[W]	246017	256182	145684	260446	409331
STRAY LOSS. @ REF.TEMP.		[W]	32621	31378	18383	34134	55717
PRI. IMPEDANCE VOLTAGE		[V]	11125	10965	8179	10910	13641
LOAD LOSS		[kW]	246.02	256.18	145.68	260.45	409.33
% IMPEDANCE		[%]	17.29	17.04	12.71	16.95	21.20
R + Xj		[%]	0.75 + 17.27j	0.78 + 17.02j	0.59 + 12.70j	0.79 + 16.94j	0.99 + 21.17j
R		[%]	0.74550709	0.77630895	0.5886231	0.78923174	0.99231825
X		[%]	17.2729471	17.0221879	12.6968758	16.9360913	21.1749271

Zero Sequence Impedance

MR 5119 TESTER JB DATE 9/17/2020

WINDING CONFIGURATION	HV-LV
MEAS. OR CALC. POS. IMPEDANCE [%]	**8.63**
MEAS. ZERO SEQ. IMPEDANCE [%]	**0.00**
POSITIVE/ZERO IMPEDANCE [%]	**0.00%**

TEST NUMBER	**1**	**2**	**3**	**4**	**5**
DETC POSITION	1	3	5	1	3
LTC POSITION	N	N	N	16R	16R
FEED	X123-GND	X123-GND	X123-GND	X123-GND	X123-GND
FLOAT	-	-	-	-	-
GROUND	H,,	H,,	H,,	H,,	H,,
MEASUREMENTS					
TEST TEMPERATURE (° C)	35	35	35	35	35
TEST VOLTAGE (V)	24.67	29.66	29.66	33.06	33.07
TEST AMPS (A)	89.387	107.24	107.18	106.55	106.62
TEST WATTS (W)	281.29	408.73	408.89	476.08	475.46
RATED VALUES					
RATED VOLTAGE LINE-NEUTRAL (V)	7967	7967	7967	8764	8764
RATED AMPS (A)	703	703	703	639	639
BASE MVA PRIMARY/SECONDARY	17	17	17	17	17
CALCULATIONS					
ZERO SEQUENCE IMPEDANCE	7.30	7.32	7.32	6.79	6.78
ZERO SEQUENCE IMPEDANCE (R+jX)	0.932+7.244j	0.941+7.259j	0.942+7.263j	0.917+6.724j	0.915+6.722j

6	7	8	9
5	1	3	5
16R	16L	16L	16L
X123-GND	X123-GND	X123-GND	X123-GND
-	-	-	-
H,,	H,,	H,,	H,,
35	35	35	35
33.12	22.41	22.41	22.4
106.54	89.807	89.782	89.744
477.55	246.26	246.37	246.32
8764	7159	7159	7159
639	782	782	782
17	17	17	17
6.80	8.18	8.18	8.18
0.920+6.737j	1.001+8.118j	1.002+8.120j	1.002+8.120j

Percent Regulation & Efficiencies

MVA	16.8	
Fe Loss	13.691	
Cu Loss	57.538	
% Z	8.626	
% LOAD	Efficiencies	
100	99.58	
75	99.64	
50	99.67	
25	99.59	
112	99.546	
% PF	Regulation	
100	0.71	
90	4.34	
80	5.66	
70	6.55	

MR: 5119

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TEST REPORT
01-7383306-636300-00

Delta Star Inc	**Serial#:** E5119 BEFORE ALL BEFORE FA HR	**Mfr:** DELTA STAR	**Control#:** 7383306
3550 MAYFLOWER DR	**Location:**	**kV:** 67.65	**Order#:** 636300
	Equipment: TRANSFORMER	**kVA:** 33000	**Account:** 146
LYNCHBURG, VA 24501 US	**Compartment:** MAIN(BOTTOM)	**Year Mf'd:** 2020	**Received:** 09/17/2020
ATTN: SCOT HAMRICK	**Breathing:** SEAL	**Syringe ID:** 3001511	**Reported:** 09/18/2020
PO#: 57-44-063	**Bank:** **Phase:** 3	**Bottle ID:**	
Project ID: E5119	**Fluid:** MIN	**Sampled By:** AMA	
Customer ID: BEFORE ALL BEFORE FA HR			

	Lab Control Number:	7383306
	Date Sampled:	09/16/2020
	Order Number:	636300
	Oil Temp:	26
Dissolved Gas Analysis (DGA)	**Hydrogen (H2) (µL/L):**	<2
ASTM	**Methane (CH4) (µL/L):**	<1
D-3612[1]	**Ethane (C2H6) (µL/L):**	<1
	Ethylene (C2H4) (µL/L):	<1
	Acetylene (C2H2) (µL/L):	<1
	Carbon Monoxide (CO) (µL/L):	3
	Carbon Dioxide (CO2) (µL/L):	75
	Nitrogen (N2) (µL/L):	28741
	Oxygen (O2) (µL/L):	3870
	Total Dissolved Gas (TDG) (µL/L):	32689
	Total Dissolved Combustible Gas (TDCG) (µL/L):	3
	Equivalent TCG (%):	0.0071
DGA Diagnostics	**DGA Keys Gas / Interpretive Method:** (most recent sample)	Hydrogen within condition 1 limits (100 µL/L). Methane within condition 1 limits (120 µL/L). Ethane within condition 1 limits (65 µL/L). Ethylene within condition 1 limits (50 µL/L). Acetylene within condition 1 limits (1 µL/L). Carbon Monoxide within condition 1 limits (350 µL/L). Carbon Dioxide within condition 1 limits (2500 µL/L). TDCG within condition 1 limits (720 µL/L).
	DGA TDCG Rate Interpretive Method: (two most recent sample)	No previous sample available.
	DGA Cellulose (Paper) Insulation:	CO2/CO Ratio is only applicable when CO2 greater than 5000 and CO greater than 500.
	Weidmann DGA Condition Code:	NORMAL
	Weidmann Recommended Action:	Continue normal operation. Resample for testing within one year.
Comment:		
General Oil Quality (GOQ)		
ASTM D-1533[1]	**Moisture in Oil (mg/kg):**	6
	Water Saturation (%):	7
GOQ Diagnostics PER IEEE C57.106-2015 (most recent sample)	**Moisture in Oil:**	Acceptable for new transformer oil (20 mg/kg max).
Comment:		

Notations: 1. Analysis is ISO/IEC 17025:2017 accredited, ANAB Accredited Certificate Number L2303.02 2. This test is conducted by a subcontracted laboratory. 3. Subcontracted laboratory has received ISO Standard 17025 accreditation for this test. 5. This test is conducted by Weidmann Laboratory other than Primary Lab. 6. Weidmann Laboratory has received ISO Standard 17025 accreditation for this test. 7. Imported Sample: WEIDMANN Electrical Technology accepts no responsibility for these results; accreditation status does not apply to these results. 8. Imported Equipment 10. mg/kg , µg/g, µg/mL, µL/L = ppm, µg/L = ppb, mN/m = dynes/cm, mm²/s = cSt

Delta Star Inc	**Serial#:**	E5119 BEFORE ALL BEFORE FA HR	**Mfr:**	DELTA STAR	**Control#:**	7383306
3550 MAYFLOWER DR	**Location:**		**kV:**	67.65	**Order#:**	636300
	Equipment:	TRANSFORMER	**kVA:**	33000	**Account:**	146
LYNCHBURG, VA 24501 US	**Compartment:**	MAIN(BOTTOM)	**Year Mf'd:**	2020	**Received:**	09/17/2020
ATTN: SCOT HAMRICK	**Breathing:**	SEAL	**Syringe ID:**	3001511	**Reported:**	09/18/2020
PO#: 57-44-063	**Bank:**	**Phase:** 3	**Bottle ID:**			
Project ID: E5119	**Fluid:**	MIN	**Sampled By:**	AMA		
Customer ID: BEFORE ALL BEFORE FA HR						

Lab Control Number:	7383306
Date Sampled:	09/16/2020
Order Number:	636300
Oil Temp:	26

End of Test Report

Authorized By: [signature]

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Notations: 1. Analysis is ISO/IEC 17025:2017 accredited, ANAB Accredited Certificate Number L2303.02 2. This test is conducted by a subcontracted laboratory. 3. Subcontracted laboratory has received ISO Standard 17025 accreditation for this test. 5. This test is conducted by Weidmann Laboratory other than Primary Lab. 6. Weidmann Laboratory has received ISO Standard 17025 accreditation for this test. 7. Imported Sample: WEIDMANN Electrical Technology accepts no responsibility for these results; accreditation status does not apply to these results. 8. Imported Equipment 10. mg/kg , µg/g, µg/mL, µL/L = ppm, µg/L = ppb, mN/m = dynes/cm, mm²/s = cSt

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TEST REPORT
01-7383307-636300-00

Delta Star Inc	**Serial#:** E5119 BEFORE ALL B4 FA HR LTC	**Mfr:** DELTA STAR	**Control#:** 7383307
3550 MAYFLOWER DR	**Location:**	**kV:** 67.65	**Order#:** 636300
	Equipment: LTC - NEUTRAL END	**kVA:**	**Account:** 146
LYNCHBURG, VA 24501 US	**Compartment:** COMMON	**Year Mf'd:** 2020	**Received:** 09/17/2020
ATTN: SCOT HAMRICK	**Breathing:** SEALED	**Syringe ID:** 53006935	**Reported:** 09/18/2020
PO#: 57-44-063	**Bank:** **Phase:** 3	**Bottle ID:**	
Project ID: E5119	**Fluid:** MIN	**Sampled By:** AMA	
Customer ID: BEFORE ALL B4 FA HR LTC			

	Lab Control Number:	7383307
	Date Sampled:	09/16/2020
	Order Number:	636300
	Oil Temp:	26
Dissolved Gas Analysis (DGA)	**Hydrogen (H2) (µL/L):**	<2
ASTM	**Methane (CH4) (µL/L):**	<1
D-3612[1]	**Ethane (C2H6) (µL/L):**	<1
	Ethylene (C2H4) (µL/L):	<1
	Acetylene (C2H2) (µL/L):	<1
	Carbon Monoxide (CO) (µL/L):	1
	Carbon Dioxide (CO2) (µL/L):	89
	Nitrogen (N2) (µL/L):	21748
	Oxygen (O2) (µL/L):	8697
	Total Dissolved Gas (TDG) (µL/L):	30535
	Total Dissolved Combustible Gas (TDCG) (µL/L):	1
	Equivalent TCG (%):	0.0027
DGA Diagnostics	**Ratio Analysis:**	Heating to arcing gas ratios within normal limits.
Comment:		
General Oil Quality (GOQ)		
ASTM D-1533[1] **Moisture in Oil**	**(mg/kg):**	6
Water Saturation	**(%):**	7
GOQ Diagnostics PER IEEE C57.106-2015 (most recent sample)	**Moisture in Oil:**	Acceptable for new equipment (20 mg/kg max).
Comment:		

End of Test Report

Authorized By: [signature]

ERIC MCANANY
CHEMIST

Notations: 1. Analysis is ISO/IEC 17025:2017 accredited, ANAB Accredited Certificate Number L2303.02 2. This test is conducted by a subcontracted laboratory. 3. Subcontracted laboratory has received ISO Standard 17025 accreditation for this test. 5. This test is conducted by Weidmann Laboratory other than Primary Lab. 6. Weidmann Laboratory has received ISO Standard 17025 accreditation for this test. 7. Imported Sample: WEIDMANN Electrical Technology accepts no responsibility for these results; accreditation status does not apply to these results. 8. Imported Equipment 10. mg/kg , µg/g, µg/mL, µL/L = ppm, µg/L = ppb, mN/m = dynes/cm, mm²/s = cSt

MANUFACTURER: PAUWELS TRAFO BELGIUM

LOAD TAP CHANGING TRANSFORMER

NP 692

LILCO NP 692
PURCHASE ORDER No: 133501
SERIAL No: 94.4.2955
TYPE : OIF 28/140
STANDARD : ANSI C57
KVA RATING

CLASS	H-WINDING 66000 VOLTS	X-WINDING 13800 VOLTS	Y-WINDING 11660 VOLTS	TEMPERATURE RISE °C
OA	16800	16800	5880	65
1st FA	22400	22400	7840	65
2nd FA	28000	28000	9800	65
OA	(LOSS OF ONE RADIATOR) 15.5 MVA			
2nd FA	(LOSS OF TWO FANS) 25.5 MVA			

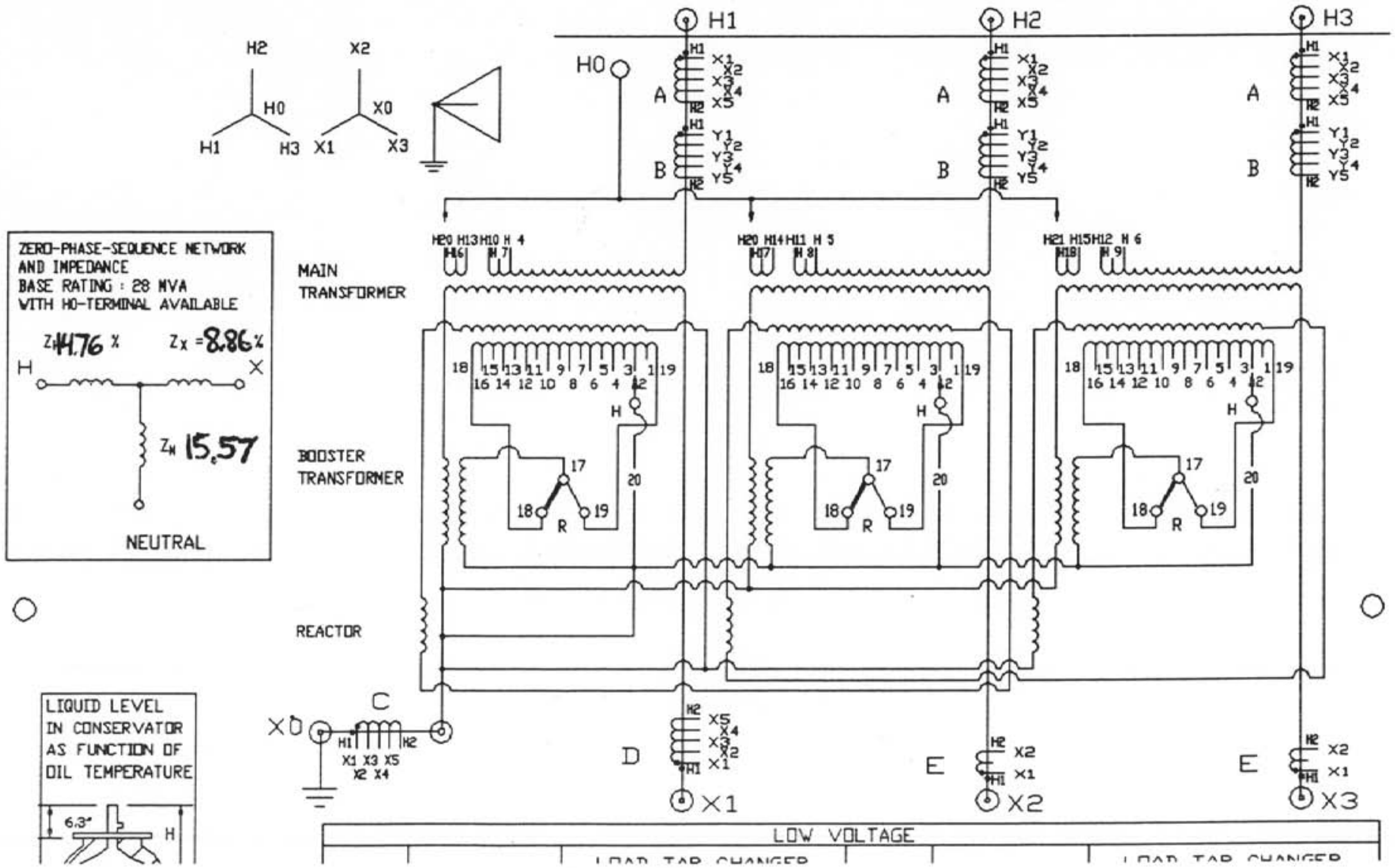
LOAD TAP CHANGER TYPE ON LV : ABB-UZFRT 200/500
DE-ENERGISED TAP CHANGER TYPE ON HV : ASP-F II HI - 60 kV - 315 A
TRANSITION RESISTORS OF THE ON LOAD TAP CHANGER : 2x1.1 Ohm/PHASE

YEAR OF MANUFACTURE : NOV.1994
FREQUENCY / PHASES : 60Hz / 3PHASE

	WINDINGS	BUSHINGS
BIL HV	350	350
BIL LV	110	150
BIL TERTIARY	110	

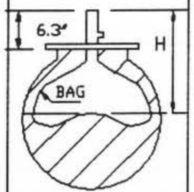
SERVICE : CONTINUOUS
INSULATION LIQUID (LESS THAN 1PPM PCB) ASTM D3487-81 TYPE EXXON UNIVOLT N61

SOUND LEVEL : 62 dB(A) AT 1 Ft OA
65 dB(A) AT 6 Ft 2nd FA
IMPEDANCE 15.07% AT 66/13.8 kV AND 28 MVA
NUMBER OF CORE GROUNDS : 3



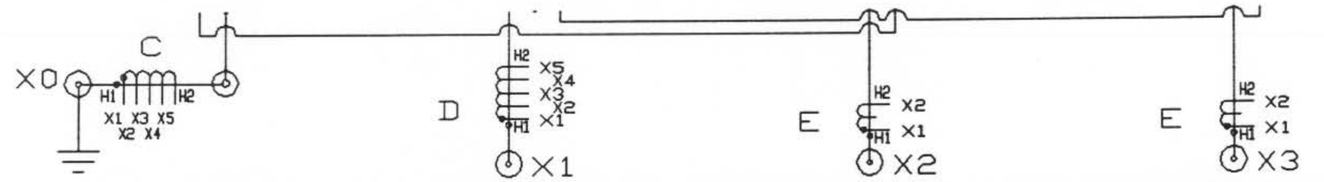
NP692

LIQUID LEVEL IN CONSERVATOR AS FUNCTION OF OIL TEMPERATURE



TEMP.°C	H IN INCH
-20 °C	41.73
-10 °C	39.76
0 °C	37.79
10 °C	35.43
20 °C	33.85
30 °C	31.49
40 °C	29.92
50 °C	27.95
60 °C	25.98
70 °C	24.40
80 °C	22.04
90 °C	19.68
100 °C	17.32
110 °C	14.96
120 °C	12.59

CT LOCATION	CURRENT RATIO
E : X2-X3	1200:5A 1.2 B 0.9



LOW VOLTAGE

VOLTS	AMPS AT 65°C RISE AND 2ndFA CLASS	LOAD TAP CHANGER POS	R CONNECTS AT DIRECTION RAISE	R CONNECTS AT DIRECTION LOWER	H CONNECTS	VOLTS	AMPS AT 65°C RISE AND 2ndFA CLASS	LOAD TAP CHANGER POS	R CONNECTS AT DIRECTION RAISE	R CONNECTS AT DIRECTION LOWER	H CONNECTS
15180	1065	16R	17-19		16-20	13800	1170	N		17-18	17-20
15090	1070	15R	17-19		15-20	13710	1170	1L		17-18	16-20
15010	1075	14R	17-19		14-20	13630	1170	2L		17-18	15-20
14920	1085	13R	17-19		13-20	13540	1170	3L		17-18	14-20
14840	1090	12R	17-19		12-20	13460	1170	4L		17-18	13-20
14750	1095	11R	17-19		11-20	13370	1170	5L		17-18	12-20
14660	1105	10R	17-19		10-20	13280	1170	6L		17-18	11-20
14580	1110	9R	17-19		9-20	13200	1170	7L		17-18	10-20
14490	1115	8R	17-19		8-20	13110	1170	8L		17-18	9-20
14400	1120	7R	17-19		7-20	13020	1170	9L		17-18	8-20
14320	1130	6R	17-19		6-20	12940	1170	10L		17-18	7-20
14230	1135	5R	17-19		5-20	12850	1170	11L		17-18	6-20
14150	1145	4R	17-19		4-20	12770	1170	12L		17-18	5-20
14060	1150	3R	17-19		3-20	12680	1170	13L		17-18	4-20
13970	1155	2R	17-19		2-20	12590	1170	14L		17-18	3-20
13890	1165	1R	17-19		1-20	12510	1170	15L		17-18	2-20
13800	1170	NA	17-19		17-20	12420	1170	16L		17-18	1-20

APPROXIMATE MASSES + VOLUMES		
CORE + COILS (UNTANKING PART)	34900 KG	76940 LBS
TANK + FITTINGS	8550 KG	18850 LBS
LIQUID 4745 GALLONS	15450 KG	34060 LBS
TOTAL MASS	58900 KG	129850 LBS

HIGH VOLTAGE TAPCHANGER FOR DE-ENERGIZED OPERATION

VOLTS	AMPS AT 28 MVA	POS	CONNECTION		
69300	233	1	H10-H13	H11-H14	H12-H15
67650	239	2	H13-H 7	H14-H 8	H15-H 9
66000	245	3	H 7-H16	H 8-H17	H 9-H18
64350	251	4	H16-H 4	H17-H 5	H18-H 6
62700	258	5	H 4-H19	H 5-H20	H 6-H21

CT LOCATION	CURRENT RATIO	TAP	CURRENT RATIO	TAP	CT LOCATION	CURRENT RATIO	TAP	CURRENT RATIO	TAP
A : H1-H2-H3	50:5	X2-X3	300:5	X2-X4	C : X0	300:5	X3-X4	1200:5	X1-X3
MR: 600:5A	100:5	X1-X2	400:5	X1-X4	MR: 2000:5A	400:5	X1-X2	1500:5	X1-X4
C400	150:5	X1-X3	450:5	X3-X5	C800	500:5	X4-X5	1600:5	X2-X5
	200:5	X4-X5	500:5	X2-X5		800:5	X2-X3	2000:5	X1-X5
	250:5	X3-X4	600:5	X1-X5		1100:5	X2-X4		
B : H1-H2-H3	300:5	Y3-Y4	1200:5	Y1-Y3	D : X1	300:5	X3-X4	1200:5	X1-X3
MR: 2000:5A	400:5	Y1-Y2	1500:5	Y1-Y4	MR: 2000:5A	400:5	X1-X2	1500:5	X1-X4
C800	500:5	Y4-Y5	1600:5	Y2-Y5	0.3B1.8	500:5	X4-X5	1600:5	X2-X5
	800:5	Y2-Y3	2000:5	Y1-Y5		800:5	X2-X3	2000:5	X1-X5
	1100:5	Y2-Y4				1100:5	X2-X4		

LDC

NOTES:
- INSTALLATION & OPERATING INSTRUCTIONS SEE TRANSFORMER INSTRUCTION MANUAL
- CONDUCTOR MATERIAL : COPPER
- MAIN TANK IS DESIGNED FOR 100KPa VACUUM FILLING (14.5 PSI)
- RADIATORS AND CONSERVATOR ARE DESIGNED FOR 100 KPo VACUUM FILLING (14.5 PSI)
- ALLOWABLE SHORT CIRCUIT APPARENT POWER OF THE SYSTEM : 9800 MVA

1677/9442955/A+B

NP692

PAUWELS TRAFO BELGIUM

TR 1-7.02 TRANSFORMER TEST REPORT

Manufacturer's Name : PAUWELS TRAFO   Mfr'sREF Nr. : 9442955   Type : OIF 28/140
Purchaser : LONG ISLAND L.C.NEW YORK   Purch.orderNr. : 133501
Date of test : 09.11.94
Cooling class : OA/1stFA/2ndFA   Phase : 3   Hertz : 60   Insulating Fluid: Mineral oil type II
Winding H: (V) 66000 conn.: WYE   X: (V) 13800 conn.: WYE   Y: (V) 11661.4 conn.: DELTA
16.8/22.4/28 MVA   16.8/22.4/28 MVA   5.88/7.84/9.8 MVA
Taps H: DTC:5   X: LTC:33   Y: N.A.

RESISTANCE. EXCITING CURRENT. LOSSES AND IMPEDANCE-Based on normal rating unless otherwise stated. Losses and regulation are based on Wattmeter measurements. Resistances are given between phases.

	Resistance in ohm at 21 oC between phases			At 100 % Voltage		Load losses and Impedance at 85 oC					
				Exciting current	No load losses	V to V		6600 V to 13800 V		V to V	
	H	X	Y	in %	in Watt	MVA	% IMP.	28 MVA	% IMP.	MVA	% IMP.
Guar.	N.A.	N.A.	N.A.	0.15	16500			142 KW	15		
Meas.	0.5022	0.0241	N.A.	0.0796	15899			140	15.07		

TEMPERATURE RISE TYPE TEST : is determined from TEST RESULTS TR. NR.9442669

Cool-mode	MVA-base	Temp. RiseGuar. {oC}	Oil rise above ambient: Losses Dissipat	Top {oC}	Aver. {oC}	Energized Winding	Tap-kV	Amps	Shorted Winding	Tap-kV	Amps	Rise by Resistance oC: H	X	Y	Hot Spot oC Gar.: HV	LV
O.A.	16.8	65	66.326	41.1	38.2	H	62.7	154.7	X	13.8	702.9	45	46.2	N.A.	60	61.2
2ndFA	28	65	156.42	50.1	37.6	H	62.7	257.8	X	13.8	1171.4	50.3	49.3	N.A.	65.3	64.3

(Average winding rise above ambient temperature: Energized Winding, Shorted Winding, Rise by Resistance)

% Regulation full load at tap 3N   Efficiency at tap ap 3N
at p.f. 1 : 1.62 %   at p.f. 1 at 50% load : 99.6 %   at p. f. 0.8 : 99.5 %
at p.f. 0.8 : 10.1 %   at 100% load : 99.4 %   : 99.3 %
at 125% load : 99.3 %   : 99.2 %

ZERO SEQUENCE IMPEDANCE
input at H : X open Y open : 47.19 ohms/ph   input at X:H open 1.66 ohms/ph
H : X shorted Y open : 31.79 ohms/ph   X:H shorted 1.13 ohms/ph
H : X shorted Y shorted: N.A. ohms/ph   H : X shorted Y shorted: N.A. ohms/ph

NOISE PRESSURE LEVEL

Coolmode	Measured	Guaranteed
O.A.	58.91 dB(A)	62 dB(A)
2ndFA	61.93 dB(A)	65 dB(A)
	dB(A)	dB(A)

Auxiliary losses in Watts 1550   Fans measured : 12   Guaranteed :

VOLTAGE RATIO : measured at all taps and are within the allowable 0.5% range.
Angular displacement and winding connections : OK as per order specifications

DIELECTRIC TESTS - If Impulse Tests are required, see seperate Transformer Impulse Test Report

Applied Potential Tests
Voltage applied between each winding and all other windings connected to core and ground.
Testfrequency : 60 Hz

	Voltage Tap of Tested Winding	Test Voltage Applied	Duration of Test
H :	66 kV	140 kV	60 sec
X :	13.8 kV	34 kV	60 sec
Y :	11.6 kV	34 kV	60 sec

Induced Potential Tests   winding   Energized winding X (13800)
One hour level : N.A. kV (r.m.s., phase to ground)   with N.A. V for one hour and
Enhancem. level : N.A. kV (r.m.s., phase to ground)   2XUN V for 1 min (enhancement level) TESTFR. 125 HZ
Testfrequency : N.A. Hz

R.I.V. MEASUREMENT - If required see seperate R.I.V. Test Report
Electrical and mechanical tests on L.T.C. have been done with nominal current and voltage.
Oil leakage and pressure test has been done with 5 P.S.I. during 24 hours.
Auxiliary wiring has been tested with 2.5 kV during 1 minute(s).(except electronical equipment)

INSULATION RESISTANCE with megger 5000 V DC		H-grnd	20000 Mohm	X-grnd	20000 Mohm	Y-grnd	N.A. Mohm
Core-grnd :	10000 Mohm	H-X	20000 Mohm	H-Y	N.A. Mohm	X-Y	N.A. Mohm

REMARKS : I hereby certify this is a true report based on factory tests made in accordance with the Transformer Test code C57.12.90 current edition of the A.N.S.I., and that the Transformer withstood the above insulation tests.

Signed VAN CLEMEN   Date 14.11.94   Approved by VAN DEN BOSCH R.

N.A. = NOT APPLICABLE   Transformer Quality Assurance and Testing Dept.

VT-KZ-105/02

KE[illegible]ING

Q.C. DEPT.
F. VAN CLEMEN
Date : 15/11/94

VRT Power TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	ROUTINE TEST REPORT	Test Report No.: 2683 Page : 1 Type : 13784 Serial No. : 17047-2

RATING DATA

Purchaser: PSEG

Order No. : 5000019096

Date of test : 07.11.2019

Specification: SP.04.02.002-L
Object : Three phase power transformer
Rated Power [MVA] : 16.8/22.4/28.0/33.0
Temperature rise : 65°C
Rated Voltage [kV] : 67.65/13.8 (6.418D) Regulation: H.V ± 2x2.44%, L.V. ± 16x0.625%
Rated Current [A]: 143.4/ 702.9 - 16.8 MVA 239.0/1171.0 - 28.0 MVA
191.2/ 937.1 - 22.4 MVA 281.6/1381.6 - 33.0 MVA
Cooling class : ONAN/ONAF/ONAF/ONAF
Frequency [Hz]: 60
Polarity and angular displacement: Y - Yn connection, 0°

Guaranteed and measured value:

	Guaranteed	Measured
No load losses (Unom,16.8MVA)	Po [kW] : 15.0	Po [kW] : 14.0
Exciting current (Unom,based on 16.8MVA)	Io [%] : -	Io [%] : 0.19
No load losses (1.1Unom)	Po [kW] : -	Po [kW] : 21.2
Exciting current (1.1Unom)	Io [%] : -	Io [%] : 0.78
Load losses (based on 33MVA and 85°C)	Pcu [kW] : 160.0	Pcu [kW] : 160.3
Total losses (based on 33MVA and 85°C)	Ptot [kW] : 175.0	Ptot [kW] : 174.3
Impedance between 67.65 / 13.80Kv (based on 16.8MVA and 85°C)	uk [%] : 9.0	uk [%] : 9.07

We hereby certify that this is a true report based on factory test made in accordance to IEEE C57.12.00-2015, IEEE C57.12.90-2015 and specification No. SP.04.02.002-L, that the transformer withstood successfully all tests stated in this test report.

Date : 07.11.2019	Approved by: ______________ Shenkerman Mark	Tested by: ______________ Ashtar Avidan

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**TEST REPORT**	Test Report No.: 2683 Page : 2 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000	Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60	Rated current [A]: 281.6/1381.6

Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**NAME PLATE**	Test Report No.: 2683 Page : 3 Type : 13784 Serial No. : 13976/3

Rated power [kVA]: 33000 Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60 Rated current [A]: 281.6/1381.6

VRT POWER

THREE PHASE TRANSFORMER

TYPE 13784 SERIAL NO. 17047/2 NAMEPLATE NO. 949

MONTH JULY YEAR 2019 FREQUENCY 60 Hz

16800/22400/28000/33000 KVA CLASS ONAN/ONAF/ONAF/ONAF 65 C TEMPERATURE RISE

67650Y-13800GrdY/7967 (6418D)

INSULATION LEVELS

HIGH VOLTAGE 350KV BIL
LOW VOLTAGE 110KV BIL
TERTIARY 110KV BIL

COOLING CLASS	RATED POWER	RATED CURRENT, A	
		HV	LV
ONAN	16800	143.4	703
ONAF	22400	191.2	937
ONAF	28000	239.0	1171
ONAF	33000	281.6	1381

WEIGHTS:

CORE AND COILS	67200 lb.
TANK AND FITTINGS	41580 lb.
OIL (4660gal)	35010 lb.
TOTAL	143790 lb.
UNTANKING	74000 lb.
SHIPPING	93500 lb.

MAXIMUM SOUND PRESSURE LEVEL

RATING, KVA	16800	28000	33000
SOUND LEVEL, DBA	60.9	62.3	63.0

LTC ABB TYPE UZFRN 200/600

LOAD TAP CHANGER		RATING	LV WITH DETC ON POS.3	
POS.	CONNECTION	kVA	VOLTS	AMPERES
16R	17-19 16-20	33000	15180	1255
15R	15-20		15094	1262
14R	14-20		15008	1270
13R	13-20		14921	1277
12R	12-20		14835	1284
11R	11-20		14749	1292
10R	10-20		14663	1299
9R	9-20		14576	1307
8R	8-20		14490	1315
7R	7-20		14404	1323
6R	6-20		14318	1331
5R	5-20		14231	1339
4R	4-20		14145	1347
3R	3-20		14059	1355
2R	2-20		13973	1364
1R	1-20		13886	1372
N	17-20		13800	
NA				
1L	17-18 16-20	32803	13714	1381
2L	15-20	32596	13628	
3L	14-20	32390	13541	
4L	13-20	32184	13455	
5L	12-20	31978	13369	
6L	11-20	31771	13283	
7L	10-20	31565	13196	
8L	9-20	31359	13110	
9L	8-20	31152	13024	
10L	7-20	30946	12938	
11L	6-20	30740	12851	
12L	5-20	30533	12765	
13L	4-20	30327	12679	
14L	3-20	30121	12593	
15L	2-20	29914	12506	
16L	1-20	29708	12420	

OIL QUANTITIES

MAIN TANK	4061 gal
RADIATORS	310 gal
TAP CHANGER	106 gal
CONSERVATOR AT 25°C	183 gal
TO BE REMOVED (FROM MAIN TANK) UP TO THE CORE	270 gal
TOTAL AT 25°C	4660 gal

IMPEDANCES,%

AT 16800KVA, DETC ON POS.3

POS. LTC	16R	N	16L
POSITIVE SEQUENCE HV-LV	9.34	9.07	8.94
ZERO SEQUENCE FROM LV SIDE	9.81	10.62	11.00

BUSHING CURRENT TRANSFORMER MULTI RATIO
CT-1 ACC.CLASS C-800, RTF-2

CURRENT RATIO	TAP	CURRENT RATIO	TAP
150:5	X3-X4	750:5	X2-X4
250:5	X4-X5	1000:5	X2-X5
400:5	X3-X5	1100:5	X1-X3
500:5	X1-X2	1250:5	X1-X4
600:5	X2-X3	1500:5	X1-X5

BUSHING CURRENT TRANSFORMER, MULTI RATIO
CT-2, CT4A ACC. CLASS C-800, RTF-2
CT-4N ACC. CLASS C-400, RTF-2

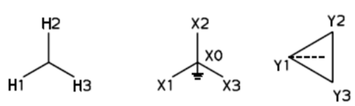
CURRENT RATIO	TAP	CURRENT RATIO	TAP
300:5	X3-X4	1200:5	X1-X3
400:5	X1-X2	1500:5	X1-X4
500:5	X4-X5	1600:5	X2-X5
800:5	X2-X3	2000:5	X1-X5
1100:5	X2-X4		

DE-ENERGIZED TAP CHANGER		HV WITH LTC ON POS. N	
POS.	CONNECTS	VOLTS	AMPERES AT 33000 KVA
1	6-5	70950	268.5
2	5-7	69300	274.9
3	7-4	67650	281.6
4	4-8	66000	288.7
5	8-3	64350	296.1

CAUTION!

1. BEFORE INSTALLING OR OPERATING READ CAREFULLY THE INSTRUCTION BOOK
2. MAIN TANK PRESSURE WITHSTAND:
   - POSITIVE: 10 PSI;
   - NEGATIVE: FULL VACUUM.
3. CONSERVATOR CAN NOT WITHSTAND FULL VACUUM.
4. TRANSFORMER IS FILLED WITH ASTM D3487 TYPE II INHIBITED MINERAL OIL. OIL CONTAINS NO DETECTABLE PCB AT THE TIME OF THE MANUFACTURING.
5. THE DE-ENERGIZED TAP CHANGER MUST NOT BE OPERATED WHEN THE TRANSFORMER IS ENERGIZED.
6. CONDUCTOR MATERIAL OF WINDINGS IS COPPER.
7. TERTIARY IS RATED FOR 5.88/ 7.84/9.8/11.55MVA - (ONAN/ONAF/ONAF/ONAF)
8. MAX.CURRENT SEEN BY LTC IS 232.5AMPS.
9. CORE DESIGN IS 3-LEGGED CORE.

PHASE RELATION



PROJECT : PSEG Long Island

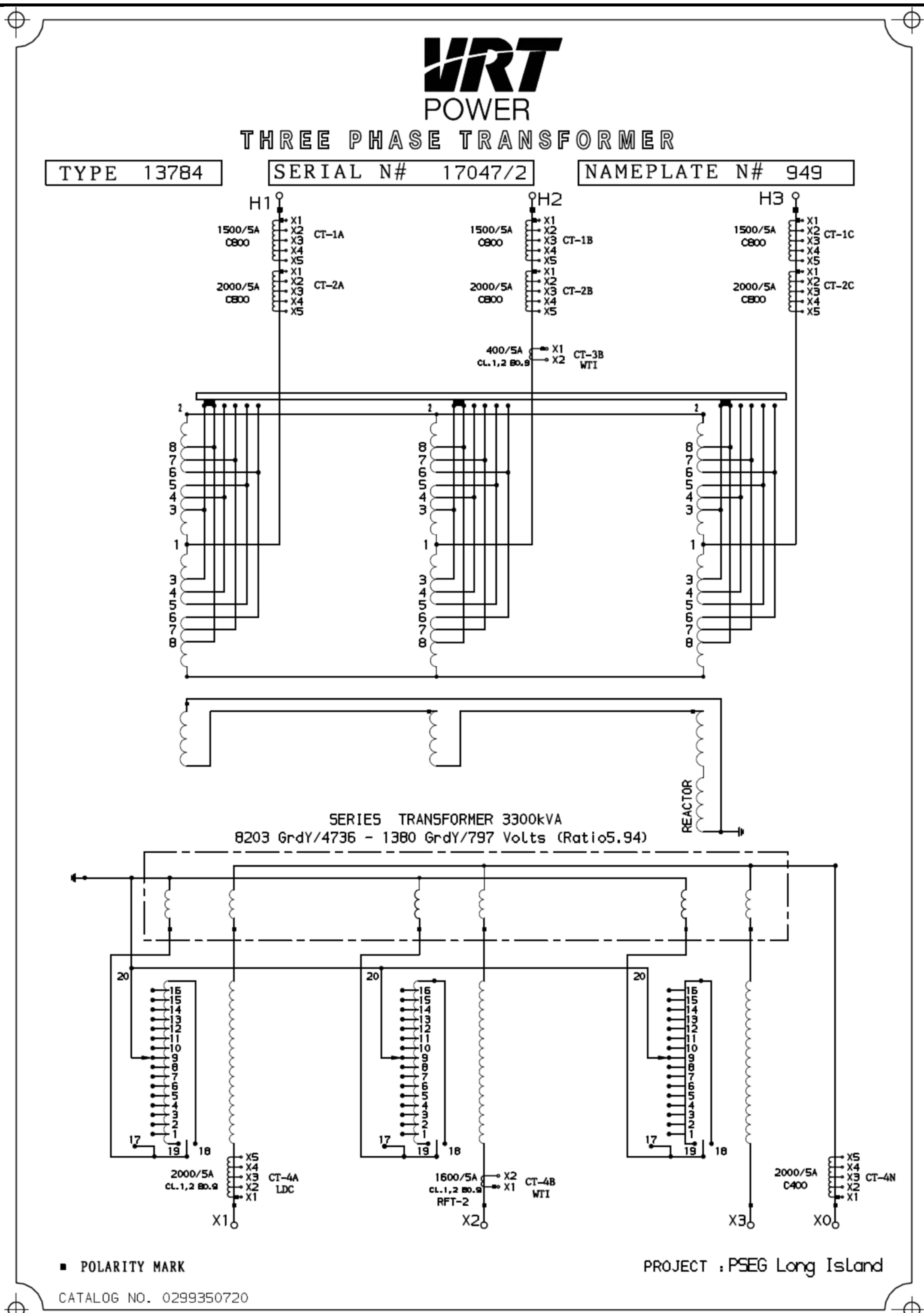
CATALOG No.0299350719

MANUFACTURED IN RAMAT HASHARON, ISRAEL

Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**NAME PLATE**	Test Report No.: 2683 Page : 4 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000 Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60 Rated current [A]: 281.6/1381.6



Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**RATIO AND POLARITY TEST**	Test Report No.: 2683 Page : 5 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000	Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60	Rated current [A]: 281.6/1381.6

Measured values

On-Load Tap Changer position	High voltage [kV]	Low Voltage [kV]	Calculated ratio	Measured deviation [%] H1-H2/X1-X2 [%]	H2-H3/X2-X3	H3-H1/X3-X1
16R	67.65	15.180	4.457	+0.12	+0.07	+0.09
15R		15.094	4.482	+0.11	+0.08	+0.10
14R		15.008	4.508	+0.07	+0.04	+0.06
13R		14.921	4.534	+0.06	+0.03	+0.04
12R		14.835	4.560	+0.04	+0.02	+0.03
11R		14.749	4.587	+0.04	+0.02	+0.03
10R		14.663	4.614	+0.04	+0.02	+0.04
9R		14.576	4.641	+0.03	+0.01	+0.02
8R		14.490	4.669	+0.02	+0.01	+0.01
7R		14.404	4.697	+0.02	±0.00	+0.01
6R		14.318	4.725	+0.01	+0.01	+0.01
5R		14.231	4.754	±0.00	-0.01	±0.00
4R		14.145	4.783	-0.01	-0.01	±0.00
3R		14.059	4.812	±0.00	-0.01	±0.00
2R		13.973	4.842	-0.01	-0.01	±0.00
1R		13.886	4.872	-0.02	-0.02	-0.01
N		13.800	4.902	-0.02	-0.03	-0.01
1L		13.714	4.933	-0.03	-0.03	-0.02
2L		13.628	4.964	-0.02	-0.02	-0.01
3L		13.541	4.996	-0.02	-0.03	-0.02
4L		13.455	5.028	-0.01	-0.02	-0.01
5L		13.369	5.060	-0.02	-0.02	-0.01
6L		13.283	5.093	±0.00	-0.02	-0.01
7L		13.196	5.127	-0.01	-0.02	-0.01
8L		13.110	5.160	-0.01	-0.02	-0.01
9L		13.024	5.194	-0.01	-0.02	-0.01
10L		12.938	5.229	±0.00	-0.02	-0.01
11L		12.851	5.264	-0.01	-0.02	-0.01
12L		12.765	5.300	±0.00	-0.02	±0.00
13L		12.679	5.336	+0.01	-0.01	±0.00
14L		12.593	5.372	+0.01	-0.01	±0.00
15L		12.506	5.409	+0.01	-0.02	±0.00
16L		12.420	5.447	+0.02	-0.01	±0.00

The angular displacement between High Voltage (H.V.) and Low Voltage (L.V.) was checked with ratiometer bridge: Y - Y , connection 0° (polarity – Normal).

Off-Load Tap Changer position	High voltage [kV]	Low Voltage [kV]	Calculated ratio	Measured deviation [%] H1-H2/X1-X2 [%]	H2-H3/X2-X3	H3-H1/X3-X1
1	70.950	13.800	5.141	+0.02	+0.01	+0.03
2	69.300		5.022	±0.00	-0.01	±0.00
3	67.650		4.902	-0.02	-0.03	-0.01
4	66.000		4.783	-0.03	-0.04	-0.03
5	64.350		4.663	-0.06	-0.07	-0.06

Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**RESISTANCE MEASUREMENT**	Test Report No.: 2683 Page : 6 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000	Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60	Rated current [A]: 281.6/1381.6

Measured resistance in mOhm at 29.2°C

Off-Load Tap Changer Position	H1-H2	H2-H3	H3-H1
1	479.5	480.5	479.6
2	466.2	467.3	466.3
3	453.0	454.2	453.1
4	439.8	441.0	439.9
5	426.8	427.8	426.8

On-Load Tap Changer Position	X1-X0	X2-X0	X3-X0
-	8.88	8.77	8.70

On-Load Tap Changer Position	X1-X2	X2-X3	X3-X1
-	17.399	17.298	17.397

Preliminary Test - Regulation winding and series transformer were not connected ; in mOhm and t=27.0°C

Regulation Winding			
On-Load Tap Changer Position	Phase X1	Phase X2	Phase X3
16R	56.49	56.10	56.68
N	1.49	1.23	1.09
16L	56.62	56.19	57.17
Series Transformer (Booster)			
(20 - 17)	38.26	37.87	37.64

Date : 07.11.2019

VRT Power TRANSFORMER PLANT HIGH VOLTAGE LABORATORY	LOAD LOSSES AND IMPEDANCES	Test Report No.: 2683 Page : 7 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000
Frequency [Hz]: 60
Guaranteed Pk [kW] : 160.0 (based on 33MVA)
Measured Pk [kW] : 160.3 (based on 33MVA)

Rated Voltage [kV]: 67.65 / 13.8
Rated current [A]: 281.6/1381.6
Guaranteed u_K[%]: 9.00 (based on 16.8MVA)
Measured u_K[%]: 9.07 (based on 16.8MVA)

Measured values

Supply and measured on H.V. side		Frequency :60Hz		L.V. side short-circuited		t= 29.2°C	
Off-Circuit Tap Changer position	On-Load Tap Changer position	Measured Terminal	Phase Voltage U[kV]	Average Voltage U [kV]	Phase Current I[A]	Average Current I [A]	Losses P[kW]
3	16R	H1	7.178	7.188	282.5	282.4	140.8
		H2	7.212		281.5		
		H3	7.174		283.3		
3	N	H1	7.053	7.064	286.0	285.9	147.1
		H2	7.092		284.8		
		H3	7.048		286.9		
3	16L	H1	6.079	6.089	250.0	249.9	134.2
		H2	6.115		248.9		
		H3	6.073		250.9		
1	16R	H1	7.534	7.545	269.3	269.2	138.6
		H2	7.570		268.2		
		H3	7.531		270.1		
1	N	H1	7.242	7.254	266.7	266.6	138.1
		H2	7.282		265.6		
		H3	7.238		267.6		
1	16L	H1	6.772	6.783	253.1	253.0	149.1
		H2	6.812		251.8		
		H3	6.766		254.0		
2	N	H1	7.346	7.358	284.0	283.9	149.7
		H2	7.387		282.8		
		H3	7.342		284.9		
4	N	H1	6.735	6.745	286.1	286.0	142.6
		H2	6.772		285.0		
		H3	6.730		287.0		

Calculated values at rated current

	Load losses in kW at 29.2 °C			Load losses in kW and u_k in % at 85°C, 33MVA			
Tap pos.	P_{cu}	P_{add}	P_k	P_{cu}	P_{add}	P_k	U_k /16.8MVA
3 – 16R	107.6	32.4	140.0	130.4	26.8	157.1	9.34
3 – N	109.9	32.8	142.8	133.2	27.1	160.3	9.07
3 – 16L	108.7	29.4	138.0	131.6	24.2	155.9	8.94
1 – 16R	105.6	32.4	137.9	127.9	26.7	154.6	9.36
1 – N	107.9	32.2	140.1	130.7	26.6	127.3	9.08
1 – 16L	107.0	29.1	136.1	129.6	24.0	153.7	8.95
2 – N	108.9	31.5	140.4	131.9	26.0	157.9	9.07
4 – N	111.0	34.2	145.3	134.5	28.3	162.8	9.10

Date : 07.11.2019

Rated power [kVA]: 33000
Frequency [Hz]: 60
Guaranteed Pk [kW] : 160.0 (based on 33MVA)
Measured Pk [kW] : 160.3(based on 33MVA)

Rated Voltage [kV]: 67.65 / 13.8
Rated current [A]: 281.6/1381.6
Guaranteed u_K[%]: 9.00 (based on 16.8MVA)
Measured u_K[%]: 9.07 (based on 16.8MVA)

Measured values

Supply and measured on H.V. side Frequency :60Hz L.V. side short-circuited t= 29.2°C

Off-Circuit Tap Changer position	On-Load Tap Changer position	Measured Terminal	Phase Voltage U[kV]	Average Voltage U [kV]	Phase Current I[A]	Average Current I [A]	Losses P[kW]
5	16R	H1	6.868	6.878	296.6	296.5	146.2
		H2	6.902		295.6		
		H3	6.864		297.4		
5	N	H1	6.703	6.714	298.1	298.1	150.0
		H2	6.741		297.1		
		H3	6.699		299.1		
5	1L	H1	5.894	5.903	262.4	262.3	118.8
		H2	5.927		261.4		
		H3	5.889		263.1		
5	8L	H1	5.869	5.878	263.3	263.2	128.4
		H2	5.903		262.3		
		H3	5.864		264.1		
5	14L	H1	5.804	5.814	261.7	261.6	135.1
		H2	5.840		260.6		
		H3	5.799		262.5		
5	15L	H1	5.778	5.788	260.9	260.8	135.7
		H2	5.814		259.8		
		H3	5.773		261.7		
5	16L	H1	5.829	5.838	263.1	263.0	139.5
		H2	5.864		262.0		
		H3	5.823		263.9		

Calculated values at rated current

	Load losses in kW at 29.2 °C			Load losses in kW and u_k in % at 85°C, 33MVA			
Tap pos.	P_{cu}	P_{add}	P_k	P_{cu}	P_{add}	P_k	U_k /16.8MVA
5 –16R	109.8	36.0	145.8	133.1	29.7	162.7	9.41
5 – N	112.2	35.8	148.0	135.9	29.6	165.5	9.14
5 – 1L	112.1	37.4	149.5	135.9	30.8	166.7	9.13
5 – 8L	111.2	35.4	146.6	134.7	29.2	164.0	9.06
5 – 14L	110.6	33.5	144.1	134.1	27.6	161.7	9.02
5 – 15L	110.5	33.1	143.6	133.9	27.3	161.2	9.01
5 – 16L	110.5	32.8	143.2	133.8	27.0	160.9	9.01

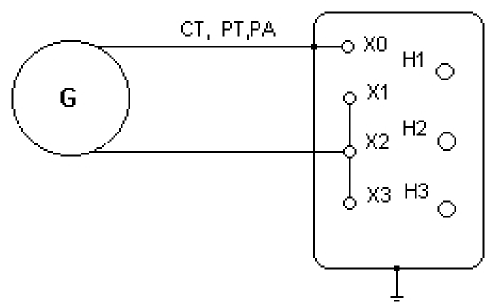
Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**ZERO-PHASE SEQUENCE IMPEDANCE VOLTAGE**	Test Report No.: 2683 Page : 9 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000	Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60	Rated current [A]: 281.6/1381.6
	Measured Z_0 [%]: 10.62 (based on 16.8MVA)

Zero sequence impedance, at 16.8MVA;

Supply and measured on L.V. side; Frequency :60Hz				
TP- HV	TP- LV	U[V]	I[A]	Z_0[%.]
3	N	187.1	466.5	10.62
3	16R	217.2	484.3	9.81
3	16L	166.5	494.7	11.00
1	N	201.1	502.3	10.60
1	16R	219.1	488.7	9.81
1	16L	165.2	490.8	11.00
5	N	202.8	506.8	10.59
5	16R	227.4	507.5	9.80
5	16L	166.6	495.1	10.99



Date : 07.11.2019

Rated power [kVA]: 33000
Frequency [Hz]: 60
Guaranteed Po (Unom) [kW]: 15.0
Measured Po (Unom) [kW]: 14.04
Rated Voltage [kV]: 67.65 / 13.8
Rated current [A]: 281.6/1381.6
Guaranteed Io (Unom, on 16.8MVA) [%]: -
Measured Io (Unom, on 16.8MVA) [%]: 0.19

NO-LOAD LOSSES AND EXCITING CURRENT

L.V. side fed. On-Load Tap Changer on position – N, 16L, 16R. H.V. side, open.
The test voltage was reading with a voltmeter responsive to mean value of voltage (U' – phase voltage).
Another reading of the voltage was from a true R.M.S. voltmeter (U).
Voltage, current and losses were measured on L.V. side of the tested transformer. Test frequency 60Hz

Before LI test
Tap position 3/N

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.00xUnom	7.962	7.969	1.433	1.063	1.454	1.316	13.99
0.8xUnom	6.402	6.400	0.693	0.475	0.694	0.620	8.29
0.9xUnom	7.179	7.178	0.903	0.639	0.914	0.818	10.67
0.95xUnom	7.571	7.573	1.088	0.786	1.103	0.992	12.15
1.05xUnom	8.353	8.376	2.268	1.741	2.294	2.101	16.59
1.10xUnom	8.768	8.859	5.815	4.844	5.846	5.501	21.23

Tap position 3/16R

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.00xUnom	8.796	8.808	1.917	1.471	1.962	1.783	21.49
0.8xUnom	6.898	6.896	0.842	0.581	0.840	0.754	11.65
0.9xUnom	7.882	7.881	1.111	0.807	1.141	1.019	15.76
0.95xUnom	8.256	8.258	1.308	0.975	1.349	1.210	17.75
1.05xUnom	9.216	9.254	3.368	2.621	3.384	3.124	25.75
1.1xUnom	9.636	9.771	8.910	7.445	8.868	8.407	32.13

Tap position 3/16L

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.0xUnom	7.207	7.224	2.339	1.813	2.462	2.204	21.52

After LI test
Tap position 3/N

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.00xUnom	7.976	7.984	1.474	1.098	1.497	1.356	14.04

Tap position 3/16R

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.00xUnom	8.784	8.797	1.958	1.534	2.075	1.855	21.38

Tap position 3/16L

	U'[kV]	U[kV]	I_{X1}[A]	I_{X2}[A]	I_{X3}[A]	I_m[A]	P_O[kW]
1.0xUnom	7.170	7.185	2.263	1.749	2.382	2.131	21.10

Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**NO-LOAD LOSSES** **AND EXCITING CURRENT**	Test Report No.: 2683 Page : 11 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000
Frequency [Hz]: 60
Guaranteed Po (Unom) [kW]: 15.0
Measured Po (Unom) [kW]: 14.04

Rated Voltage [kV]: 67.65 / 13.8
Rated current [A]: 281.6/1381.6
Guaranteed Io (Unom, on 33MVA) [%]: -
Measured Io (Unom, on 33MVA) [%]: 0.19

HARMONICS OF THE NO-LOAD CURRENT

The harmonics of the no-load current were measured at the nominal voltage (Tap pos. 3/N). The magnitude of the harmonics is expressed as a percentage of the fundamental component. The frequency was 60 cycles.

Order	I_{X1}=1.518A,H01	I_{X2}=1.122A,H01	I_{X3}=1.558A,H01
1	100.00	100.00	100.00
2	0.499	0.658	0.885
3	15.439	21.243	9.745
4	0.374	0.461	0.647
5	27.587	28.353	25.894
6	0.233	0.362	0.519
7	14.725	15.161	13.719
8	0.138	0.180	0.247
9	1.576	2.770	1.724
10	0.041	0.128	0.117
11	4.144	4.779	4.384
12	0.023	0.057	0.068
13	2.167	2.177	2.019
14	0.001	0.027	0.037
15	0.230	0.301	0.149

Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**EXCITATION CURRENT TEST**	Test Report No.: 2576 Page : 12 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000	Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60	Rated current [A]: 281.6/1381.6

Single Phase Excitation Test

The test was done after core demagnetization (at the end of No-Load Losses Test).

DETC	LTC	Test kV	H1 to H2; H3,X0-grnd		H2 to H3; H1,X0-grnd		H3 to H1; H2,X0-grnd	
			mA	Watts	mA	Watts	mA	Watts
1	N	10	12.922	73.775	14.443	78.216	25.878	147.734
2	N	10	13.383	76.996	14.972	81.603	26.897	154.232
3	N	10	13.905	80.568	15.529	85.347	27.975	161.178
4	N	10	14.448	84.419	16.138	89.348	29.089	168.561
5	N	10	14.996	88.509	16.762	93.509	30.287	176.695
3	16R	10	18.942	119.092	21.544	127.228	39.644	240.570
3	15R	10	18.420	114.744	20.953	122.600	38.436	231.866
3	14R	10	17.931	110.701	20.300	117.953	37.235	223.443
3	13R	10	17.440	106.793	19.710	113.729	36.113	215.609
3	12R	10	16.978	103.149	19.176	109.887	35.007	208.021
3	11R	10	16.530	99.704	18.646	106.192	34.031	201.247
3	10R	10	16.117	96.568	18.162	102.835	33.096	194.868
3	9R	10	15.735	93.709	17.710	99.745	32.165	188.703
3	8R	10	15.370	91.066	17.283	96.884	31.388	183.472
3	7R	10	15.062	88.827	16.909	94.384	30.659	178.672
3	6R	10	14.774	86.808	16.556	92.092	29.999	174.374
3	5R	10	14.499	84.966	16.281	90.269	29.436	170.729
3	4R	10	14.280	83.499	16.014	88.573	28.909	167.445
3	3R	10	14.093	82.283	15.816	87.322	28.511	164.971
3	2R	10	13.970	81.474	15.646	86.293	28.209	163.148
3	1R	10	13.850	80.818	15.520	85.579	27.923	161.626
3	N	10	13.903	80.598	15.544	85.308	27.898	160.886
3	1L	10	13.926	80.769	15.576	85.623	28.037	161.666
3	2L	10	14.010	81.340	15.694	86.335	28.208	162.784
3	3L	10	14.153	82.306	15.844	87.303	28.560	164.935
3	4L	10	14.322	83.503	16.046	88.626	28.949	167.465
3	5L	10	14.521	84.942	16.293	90.257	29.465	170.787
3	6L	10	14.775	86.757	16.600	92.284	29.994	174.373
3	7L	10	15.051	88.791	16.902	94.371	30.658	178.768
3	8L	10	15.367	91.142	17.266	96.873	31.373	183.607
3	9L	10	15.722	93.806	17.684	99.728	32.124	188.799
3	10L	10	16.081	96.625	18.135	102.856	33.030	194.920
3	11L	10	16.466	99.703	18.601	106.157	33.959	201.371
3	12L	10	16.907	103.184	19.120	109.839	34.926	208.203
3	13L	10	17.340	106.793	19.643	113.643	36.007	215.756
3	14L	10	17.807	110.694	20.216	117.829	37.126	223.685
3	15L	10	18.308	114.894	20.821	122.305	38.299	232.096
3	16L	10	18.797	119.352	21.443	127.000	39.532	241.117

Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**DIELECTRIC TESTS**	Test Report No.: 2683 Page : 13 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000 Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60 Rated current [A]: 281.6/1381.6

Insulation resistance tests, in GOhm Megohmeter 5kVDC t=30.3°C

	Time [minutes]										
Connexion	1	2	3	4	5	6	7	8	9	10	K
HV/LV,T to guard	25.1	39.0	48.0	55.9	62.6	68.1	72.5	75.7	77.8	78.7	3.1
HV/T,LV to guard	6.58	8.42	8.84	9.29	9.81	10.1	11.4	11.7	12.1	12.7	1.9
LV/T,HV to guard	7.63	8.74	10.9	13.7	14.2	15.1	16.2	17.0	17.9	18.6	2.4
Core1 toTank,1kVDC	10.1										
Core2 toTank,1kVDC	1.73										

Applied voltage test Time [s] : 60

H.V. [kV] : 140 L.V. [kV] : 34 The transformer withstood the test

Lightning impulse test - pages 23 - 58
The Transformer withstood the test

Insulation power - factor test
Test was made with guard circuit.

Applied Voltage [kV]	Cx [pF]	PF [%]	Connection diagram
10	9918.2	0.18	H.V. to L.V. winding and ground
10	2874.8	0.20	H.V. to ground, and guard on L.V. winding
10	7035.8	0.17	H.V. to L.V. winding
10	25327.6	0.20	L.V. to H.V. winding and ground
10	7042.3	0.17	L.V. to H.V. winding
10	18385.4	0.21	L.V. to tank, H.V. winding to guard

Oil temperature 21.7°C Temperature correction factor K= 1.04; $tg\ \delta_{20°C} = tg\ \delta/k$

Date : 07.11.2019

VRT Power **TRANSFORMER PLANT** **HIGH VOLTAGE LABORATORY**	**DIELECTRIC TESTS** **INDUCED POTENTIAL TEST**	Test Report No.: 2576 Page : 14 Type : 13784 Serial No. : 17047-2

Rated power [kVA]: 33000	Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60	Rated current [A]: 281.6/1381.6

Bushing Insulators capacity
Test was made with guard circuit using DOBLE M4000 Insulation Analyzer

Capacity	Applied Voltage [kV]	Cx [pF]	Power-Factor [%]	Serial number
C1H1	10	250.5	0.28	19181329
C2H1	2	480.7	0.27	
C1H2	10	236.9	0.22	19181288
C2H2	2	473.6	0.18	
C1H3	10	236.8	0.22	19181280
C2H3	2	475.8	0.20	
C1X1	10	540.2	0.28	19181628
C2X1	2	262.5	0.35	
C1X2	10	541.2	0.27	19181621
C2X2	2	263.2	0.21	
C1X3	10	542.5	0.28	19181632
C2X3	2	260.1	0.21	
C1X0	10	543.2	0.29	19181627
C2X0	2	262.0	0.22	

Partial discharge measurement

LV side was fed, HV side was opened. HV side was measured.
Test frequency -225Hz. X0 terminal was grounded. Tap position 1-16R
The phase voltage was raised to 62kV for 5minutes. After that the phase voltage was raised to the enhancement level 70kV and held for 32sec. Then the voltage was reduced to the one hour level (62kV) and held for one hour.
During this period, partial discharge measurements were made on each HV terminals.

Radio -Influence Voltage (RIV) and Partial Discharge Measurement [pC / μV]

Terminal	t [min]	1	1	5	32sec	0	5	10
	Uph [kV] (HV)	0	30	62	70	62	62	62
H1		8/4	6/4	6/4	-	7/3	6/4	8/4
H2		2/3	2/3	2/3	-	2/3	4/6	5/6
H3		5/3	5/3	5/3	-	5/3	4/6	5/6

Terminal	t [min]	15	20	25	30	35	40	45	50
	Uph [kV]	62	62	62	62	62	62	62	62
H1		7/4	6/4	6/4	6/4	7/4	6/4	6/5	6/5
H2		2/4	2/4	2/4	2/4	2/5	2/5	2/5	2/5
H3		5/4	5/4	4/4	5/4	5/4	4/4	4/5	5/5

Terminal	t [min]	55	60	1	1				
	Uph [kV]	62	62	30	0				
H1		7/6	6/6	6/6	7/5				
H2		2/6	2/6	2/6	2/5				
H3		4/6	5/6	5/6	5/5				

The transformer withstood the test.

Date : 07.11.2019

Rated power [kVA]: 33000	Rated Voltage [kV]: 67.65 / 13.8
Frequency [Hz]: 60	Rated current [A]: 281.6/1381.6

On-Load Tap Changer Test

The tests were performed with the tap changer fully assembled on the transformer, at final assembled condition on the transformer, filled with oil.

8 complete operating cycles with the transformer not energized, at 100% rated auxiliary supply voltage.

1 complete operating cycles with the transformer not energized, at 85% rated auxiliary supply voltage.

1 complete operating cycles with at 100% rated auxiliary supply voltage, with the transformer energized at rated voltage and frequency, at no-load.

1 tap changer operation at 100% rated auxiliary supply voltage, with ±16 steps on higher and lower side of principal tapping, with 100% rated current of the transformer, with L.V. winding short circuited.

10 tap changer operations at 100% rated auxiliary supply voltage, with ±2 steps on higher and lower side of principal tapping, with 100% rated current of the transformer, with L.V. winding short circuited.

Oil Test

- Breakdown voltage - 71.6 kV
- Dissipation factor

  at 90°C - 0.204%
- Water content - 5.6 ppm

Date : 07.11.2019

REPORT OF SOUND LEVEL MEASUREMENT

Manufacturer: VonRoll   Place of measurement: VonRoll   Date: 06.30.2019

Details of transformer:

Serial No. 17047-2 33MVA   Voltage ratio 67.65/13.8kV

Connection Y / Yn - 0°

Details of measuring instrument:

Details of measuring instrument:

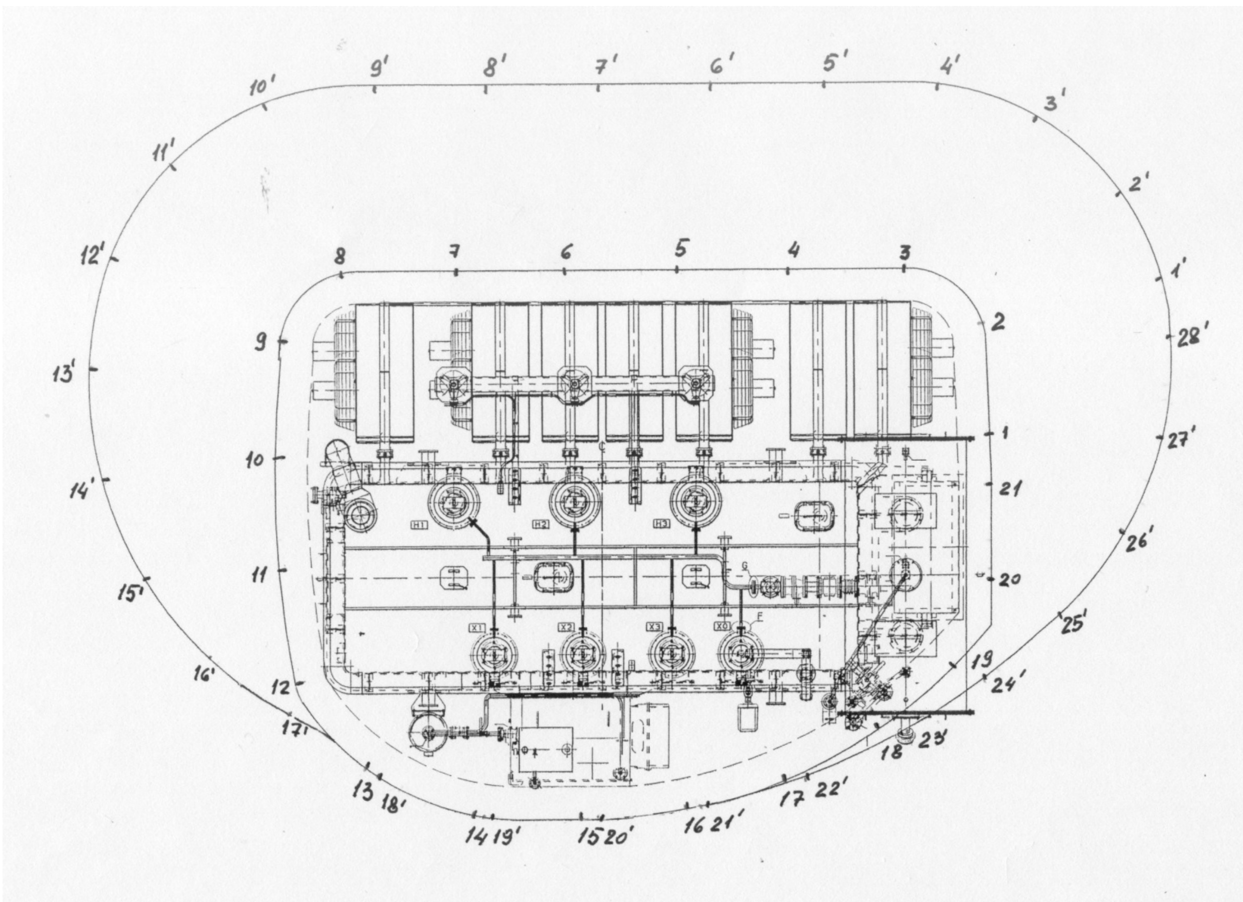
Bruel & Kjaer Type 2250-L; Microphone Bruel & Kjaer Type 4950

Calibration date of instrument and microphone: 06.30.2019

Test condition:

The transformer was fed from L.V. side, tap position 5/16L, excitation voltage Un=12.42kV

Frequency 60Hz, H.V. side on tap position 5



Plan of transformer, indicating measuring positions

Height of microphones above ground 1/3 and 2/3 of the tank height (H)

Measuring distance from principal radiating surface: for ONAN - 0.3m, for ONAF -2m,

Date : 07.11.2019

16.8MVA ONAN 100%Un

Plan position	Noise of the equipment [dB]		Background noise [dB]	Corrected noise of the equipment [dB]	
	H/3	2H/3	H/2	H/3	2H/3
1	62.2	61.2	53.8	61.4	60.2
2	59.8	63.6	53.8	58.5	63.2
3	62.5	60.8	53.8	61.9	59.8
4	61.6	60.2	53.8	60.8	58.9
5	59.6	59.9	53.9	58.3	58.6
6	59.2	59.4	53.9	57.6	58.1
7	60.3	60.5	53.9	59.0	59.5
8	61.7	61.7	53.9	60.9	60.9
9	60.5	62.0	54.4	59.2	61.2
10	62.4	60.9	54.4	61.6	59.9
11	62.8	62.6	54.4	62.0	61.8
12	62.7	63.1	54.4	61.9	62.5
13	62.3	63.2	54.4	61.5	62.6
14	64.3	63.9	54.4	63.9	63.5
15	63.7	63.2	54.4	63.1	62.6
16	63.7	63.3	54.5	63.1	62.7
17	62.2	62.5	54.5	61.4	61.7
18	62.9	62.6	54.5	62.1	61.8
19	63.8	60.7	54.5	63.2	59.4
20	63.5	62.1	54.5	62.9	61.3
21	61.7	62.2	54.5	60.7	61.4
Energy average LpA				**61.4**	

Guaranteed value A – weight sound pressure level LpA = 62dB

Date : 07.11.2019

33 MVA ONAF 100%Un, 8 fans in operation

Plan position	Noise of the equipment [dB]		Background noise [dB]	Corrected noise of the equipment [dB]	
	H/3	2H/3	H/2	H/3	2H/3
1'	62.7	63.0	53.8	62.1	62.4
2'	63.1	61.8	53.8	62.5	61.0
3'	62.3	61.4	53.8	61.7	60.6
4'	62.4	60.5	53.8	61.8	59.5
5'	62.0	60.6	53.8	61.2	59.6
6'	63.1	62.6	53.8	62.5	62.0
7'	62.9	61.8	53.9	62.3	61.0
8'	62.6	63.0	53.9	62.0	62.4
9'	61.8	62.8	53.9	61.0	62.2
10'	62.7	62.1	53.9	62.1	61.3
11'	63.4	62.4	53.9	63.0	61.8
12'	61.9	61.8	53.9	61.1	61.0
13'	63.0	62.5	53.0	63.0	62.1
14'	65.7	64.4	53.0	65.7	64.4
15'	63.3	65.4	53.0	63.3	65.4
16'	66.1	64.0	53.0	66.1	64.0
17'	66.6	65.6	53.0	66.6	65.6
18'	65.2	62.4	53.0	65.2	61.8
19'	63.1	63.5	53.0	63.1	63.5
20'	63.7	64.7	53.0	63.7	64.7
21'	63.9	64.2	52.2	63.9	64.2
22'	62.3	62.2	52.2	62.3	62.2
23'	61.1	63.9	52.2	60.5	63.9
24'	65.0	63.5	52.2	65.0	63.5
25'	66.3	60.0	52.2	66.3	59.2
26'	65.3	61.0	52.2	65.3	60.4
27'	63.9	61.7	52.2	63.9	61.3
28'	64.0	62.4	52.2	64.0	62.4
Energy average LpA				**63.1**	

Guaranteed value A – weight sound pressure level LpA = 65dB

Date : 07.11.2019

Octave Band Analysis

16.8MVA ONAN 100%Un

Microphone location (i)	Measured transformer sound pressure level (dB)									
	Octave frequency (Hz)									
	31.5	63	125	250	500	1000	2000	4000	8000	10000
1 H/3	13.4	27.0	38.9	44.9	57.7	48.5	41.1	34.8	21.8	18.6
2	16.2	26.6	38.6	43.5	53.7	52.5	42.0	35.1	23.1	19.5
3	21.5	28.6	38.9	54.4	57.1	46.1	42.2	36.5	23.5	18.5
4	20.7	31.5	42.2	50.8	54.8	49.7	43.3	37.0	25.0	18.9
5	22.5	31.3	44.5	45.9	48.0	48.9	43.1	36.0	22.6	20.3
6	22.0	29.3	42.9	45.6	47.6	46.3	44.8	36.8	24.0	21.2
7	21.6	30.3	38.2	47.7	52.5	48.6	42.4	37.0	24.5	21.4
8	17.4	29.8	38.3	55.7	55.4	49.0	42.6	37.5	23.6	18.3
9	16.6	27.0	38.5	46.6	54.9	48.3	42.1	37.8	25.1	17.8
10	18.3	29.0	43.4	48.8	54.7	48.5	43.6	37.7	24.8	18.4
11	20.2	28.6	45.3	55.3	49.2	47.7	42.6	36.6	23.4	20.5
12	21.8	27.3	38.3	51.7	52.7	53.6	42.1	36.6	24.1	20.8
13	19.2	26.3	41.4	52.3	55.7	48.8	42.3	37.0	23.4	18.6
14	18.0	30.0	44.1	44.4	57.3	51.5	42.9	37.3	25.6	21.3
15	17.2	28.3	46.8	52.5	60.1	53.2	42.0	36.3	23.4	18.6
16	21.3	28.1	45.8	55.2	57.9	52.4	43.1	37.0	22.7	16.6
17	22.1	29.3	46.7	53.8	54.3	51.7	42.0	35.6	21.9	16.8
18	19.2	29.0	44.6	51.2	54.8	50.6	42.3	35.2	20.7	16.3
19	17.8	26.8	38.6	50.8	60.8	52.0	41.7	34.2	20.2	15.7
20	17.2	27.0	40.0	53.9	60.7	54.4	49.1	46.4	31.1	24.2
21	14.0	26.7	38.0	48.9	55.4	53.6	41.3	34.6	23.5	16.7
2H/3										
1	16.2	27.0	40.5	47.8	58.3	49.9	42.1	38.3	25.9	19.3
2	18.0	26.7	37.3	49.6	63.1	49.9	40.9	35.3	23.2	17.1
3	19.4	27.8	37.7	50.8	57.3	51.8	42.1	36.9	27.1	26.1
4	23.1	28.3	39.2	48.3	50.8	47.8	42.7	37.1	23.6	20.3
5	25.2	29.6	42.7	47.2	55.2	49.0	43.6	36.5	25.6	25.5
6	26.7	32.9	42.1	45.9	52.4	47.4	46.9	37.6	27.3	26.4
7	24.7	30.3	40.3	50.0	51.6	51.0	43.5	37.3	24.3	18.2
8	26.8	31.5	40.5	51.3	53.3	49.9	45.8	37.9	25.5	19.6
9	17.6	28.4	38.3	48.6	53.3	48.9	43.4	37.4	24.2	20.7
10	22.1	31.0	41.9	49.8	53.2	52.4	43.5	37.5	25.0	21.4
11	20.5	31.7	41.3	50.7	58.2	51.8	43.6	38.5	25.9	21.2
12	18.7	29.5	39.9	44.1	55.3	50.5	42.7	36.8	23.8	18.4
13	20.0	28.6	40.0	45.1	56.5	52.0	46.5	37.9	26.2	19.3
14	17.8	29.2	39.8	46.6	58.7	53.7	43.2	36.9	24.8	18.0
15	20.6	28.0	43.6	46.7	57.8	48.2	45.9	36.5	23.7	18.4
16	23.2	30.5	42.7	49.9	63.3	52.3	42.8	35.4	21.7	17.3
17	22.3	30.3	44.2	49.7	54.7	52.4	42.5	35.7	22.5	18.5
18	21.1	28.3	44.5	49.0	56.6	53.0	42.2	34.7	21.4	15.4
19	18.3	28.8	39.6	47.3	54.6	52.2	46.6	35.7	23.1	16.9
20	13.8	28.2	37.4	44.0	62.0	52.9	44.1	34.6	21.1	16.5
21	13.6	29.0	40.8	46.5	61.1	50.8	42.5	34.1	21.3	16.8

Date : 07.11.2019

Octave Band Analysis

33 MVA ONAF 100%Un, 8 fans in operating

Microphone location (i)	Measured transformer sound pressure level (dB)									
	Octave frequency (Hz)									
	31.5	63	125	250	500	1000	2000	4000	8000	10000
H/3										
1'	15.7	28.7	43.4	47.2	57.1	51.7	48.0	41.3	32.2	28.0
2'	16.8	28.0	41.4	46.0	59.7	49.4	45.0	39.0	27.8	23.5
3'	18.5	28.5	42.6	50.6	57.2	50.3	45.8	40.2	29.3	26.1
4'	19.4	28.1	43.1	54.9	55.2	49.2	44.7	38.4	27.4	23.6
5'	21.2	27.7	42.7	49.7	52.2	50.0	45.1	40.1	28.2	24.5
6'	21.3	26.9	43.2	50.8	56.8	51.3	44.7	37.8	26.4	23.1
7'	21.3	27.7	43.4	52.2	52.6	49.0	45.0	38.6	26.5	21.7
8'	18.6	29.0	43.3	50.8	56.3	50.6	44.5	39.5	27.9	23.9
9'	19.8	28.0	45.8	52.9	51.7	50.4	45.1	39.2	27.4	24.0
10'	19.9	29.1	43.9	54.9	51.4	52.0	44.9	41.7	38.0	36.2
11'	18.5	29.8	41.1	51.2	58.9	51.3	45.7	40.7	28.1	24.5
12'	19.1	28.8	41.6	48.4	53.8	50.5	45.6	39.7	28.3	24.0
13'	21.0	26.5	41.9	47.0	50.8	51.6	46.5	40.5	28.4	23.8
14'	17.9	27.5	41.6	51.5	58.4	50.3	45.2	40.6	27.3	23.4
15'	19.4	29.6	43.1	54.8	55.4	52.3	45.3	38.9	26.7	22.5
16'	20.6	29.8	43.3	57.5	56.4	52.3	45.9	40.3	24.5	20.6
17'	21.2	29.5	40.3	49.5	52.6	50.5	45.3	40.3	30.6	26.3
18'	17.8	27.6	44.3	50.0	56.7	52.9	42.7	36.0	21.4	15.5
19'	18.9	27.1	45.6	47.8	50.9	53.9	43.1	37.6	23.5	17.7
20'	19.1	27.4	47.2	50.2	60.8	50.3	42.7	34.7	20.4	15.6
21'	22.2	28.7	44.7	53.4	60.8	53.9	42.9	35.6	20.9	15.8
22'	21.2	32.0	47.6	56.1	48.4	48.2	42.1	34.4	21.2	16.3
23'	21.0	28.7	46.7	52.9	48.8	54.4	42.8	33.4	18.9	13.6
24'	21.2	29.1	44.2	49.3	53.3	56.6	41.8	33.7	20.2	16.1
25'	17.3	29.7	43.3	53.5	63.8	51.9	42.1	34.0	21.2	17.6
26'	16.5	28.3	41.1	52.0	61.2	52.8	43.7	35.8	23.5	20.0
27'	15.6	28.3	43.9	49.5	60.1	53.7	44.9	38.0	26.6	22.3
28'	16.9	28.0	42.3	47.4	57.3	54.8	50.5	45.4	35.9	28.3

Date : 07.11.2019

Octave Band Analysis

33 MVA ONAF 100%Un, 8fans in operating

Microphone location (i)	Measured transformer sound pressure level (dB)									
	Octave frequency (Hz)									
	31.5	63	125	250	500	1000	2000	4000	8000	10000
2H/3										
1'	19.6	28.2	41.2	49.8	54.7	53.0	47.8	43.0	32.1	27.2
2'	20.1	31.2	40.6	51.3	55.9	50.8	44.4	38.0	27.6	23.7
3'	18.3	26.8	43.0	48.2	55.8	49.9	45.0	37.7	27.0	23.2
4'	16.9	26.8	42.7	50.7	51.7	49.4	44.3	37.5	27.0	23.1
5'	20.8	26.5	42.6	49.2	52.0	50.9	44.7	38.2	27.9	23.9
6'	23.3	26.5	43.0	50.3	51.6	51.1	54.0	38.7	27.7	23.9
7'	24.0	27.6	42.7	52.3	54.0	51.9	46.5	38.6	27.2	22.4
8'	22.1	28.6	43.6	51.4	55.9	50.7	47.4	38.7	27.6	23.2
9'	19.5	28.4	45.8	53.6	53.4	51.7	47.8	38.9	27.9	23.7
10'	19.6	29.4	43.3	52.9	50.9	50.8	46.8	40.6	29.3	25.3
11'	22.2	29.6	40.3	48.0	53.2	52.0	46.5	40.0	29.2	25.1
12'	17.1	27.9	40.7	52.4	51.9	52.7	46.2	39.8	30.0	26.1
13'	19.3	27.7	42.0	48.9	51.1	50.9	48.8	44.1	32.5	26.8
14'	23.8	29.7	43.7	52.3	51.9	52.0	47.7	40.2	29.5	25.4
15'	21.2	30.2	44.2	46.0	53.7	53.9	45.2	38.4	27.8	24.1
16'	22.2	30.1	40.3	54.0	55.6	48.5	46.6	38.0	26.0	20.9
17'	19.1	29.8	42.7	45.1	55.4	50.1	44.1	38.5	27.1	22.3
18'	18.5	28.9	41.2	44.8	55.3	53.5	43.1	36.9	24.0	18.5
19'	18.3	31.1	41.4	45.9	54.3	52.4	44.8	39.4	27.3	21.3
20'	20.3	27.5	43.0	48.2	60.3	47.7	42.5	36.2	23.2	17.3
21'	20.6	28.1	43.2	46.1	56.7	49.5	44.1	35.9	23.6	18.2
22'	21.8	28.0	45.2	44.6	56.5	49.9	42.6	35.4	22.3	16.8
23'	20.7	29.1	47.3	49.0	55.9	53.6	42.3	35.1	22.1	16.8
24'	18.7	27.7	46.7	44.2	60.4	52.4	42.1	35.8	24.8	21.2
25'	15.6	28.4	41.5	50.6	53.7	49.2	42.4	35.7	24.6	19.8
26'	13.9	29.0	43.0	47.3	54.0	53.8	43.4	36.9	26.3	21.8
27'	17.8	27.8	44.4	47.4	55.3	51.5	45.3	38.4	28.1	24.5
28'	15.4	28.8	39.4	48.5	57.6	52.1	45.6	38.5	28.3	24.6

Date : 07.11.2019