

VLF & Tan Delta Testing



Hardware Requirements

Very Low Frequency (VLF) testing is performed to verify a cables AC voltage withstand capability. It is simply a pass/fail AC stress test using an instrument with a 0.1 Hz (or lower) output frequency rather than 50/60 Hz. The lower the frequency, the lower the power required to test high capacitance loads such as long cables. If a cable can not hold 2 – 3 times normal voltage, find out during a controlled outage, locate the defect and make the repair or replacement, avoiding an in-service failure.

A Tan Delta test is a diagnostic test that indicates the degree of cable insulation degradation. Rather than using only a VLF instrument to perform a go/no-go proof test, the Tan Delta, used in conjunction with a VLF hipot, permits the user to grade the deterioration level of many cables in order to prioritize replacement, rejuvenation, or to determine what additional tests may be useful.

To perform Tangent Delta (or Loss Angle/Dissipation Factor) testing on medium voltage power cable, a sine wave producing (like all HVI models) Very Low Frequency AC hipot and a Tan Delta instrument are needed. The VLF applies the test voltage to the cable while the Tan Delta instrument measures and analyzes the current and voltage waveforms and calculates the Tan Delta number. A user can connect a computer to the Tan Delta controller to export the data.

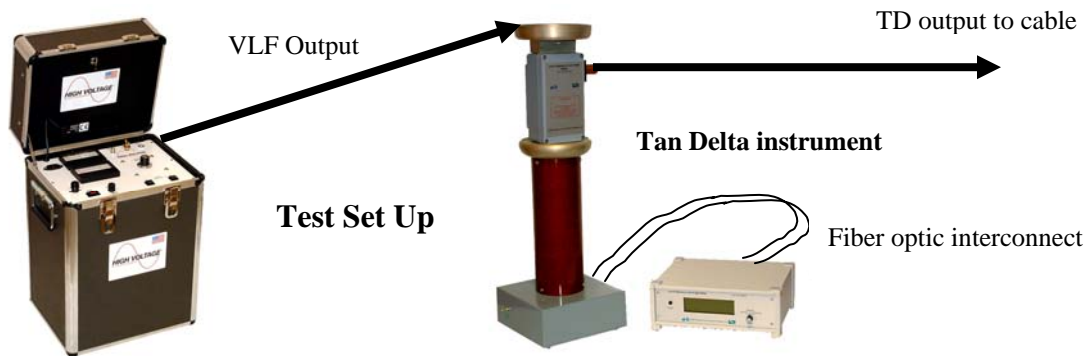
The Tan Delta instrument offered by HVI is capable of measuring up to 60 kVac peak. Since it is recommended that Tan Delta testing not be performed above 2Vo (twice the normal voltage) to avoid the possibility of a cable failure, the 60 kV rating of the instrument is capable of testing cables rated up to 35 kV. VLF hipoting, for the purpose of performing an AC stress test to verify a cable’s withstand capability, is performed up to 3Vo. Hence, it is necessary to select a VLF model capable of testing to higher voltages than when it is used solely as a voltage source for Tan Delta.

Below is the table from the IEEE400.2 Standard for VLF hipoting. Selecting the VLF model based on this chart will ensure that enough proof test, or hipot, voltage is available from the instrument, which will be more than sufficient for the lower voltage requirements of a Tan Delta test.

Table 5: VLF Test Voltage for Sinusoidal Waveform (see Note 1)

Cable Rating phase to phase	Installation (see Note 2) phase to ground	Acceptance (see Note 2) phase to ground	Maintenance (see Note 3) phase to ground
rms voltage in kV	rms or (peak voltage)	rms or (peak voltage)	rms or (peak voltage)
5	9 (13)	10 (14)	7 (10)
8	11 (16)	13 (18)	10 (14)
15	18 (25)	20 (28)	16 (22)
25	27 (38)	31 (44)	23 (33)
35	39 (55)	44 (62)	33 (47)

Below are the typical High Voltage, Inc. VLF models available that are used with the Tan Delta instrument. HVI offers many higher voltage and higher uF rated models that are not shown. The uF ratings shown are for the 0.1 Hz output setting of the VLF hipots. Most models can reduce their frequency to greatly increase the length of cables that can be tested. However, TD testing is usually performed at 0.1 Hz. **When selecting a VLF for TD testing, make sure the uF rating at 0.1Hz is high.** For example, the VLF-4022CM can test up to 1.1 uF at 0.1 Hz, 5.5 uF at 0.02Hz. All the frequencies offered by the HVI VLF products, from 0.1 Hz to 0.01Hz, are permitted under the IEEE400.2 standard. Refer to the HVI VLF brochure for more details.



Model Selection Summary

- VLF Testing: VLF’s output voltage must be high enough to test the highest voltage rated cables per IEEE400.2
- VLF Testing: VLF’s uF rating must be high enough to hipot the highest capacitance cables expected
- TD Testing: VLF’s uF rating at 0.1 Hz must be high enough to TD test the highest capacitance cables expected

For further information on the theory behind Tan Delta and VLF, testing procedures, application notes, standards, case studies, and other topics relative to cable testing, please visit the High Voltage, Inc. website or call HVI, as we are the leader in VLF technology. With our many VLF models, including our unique VLF Thumper combination, fault locators, and all other types of hipots, HVI can do more to help your cable and substation testing applications than any other.