



## Application: Cable Testing with Very Low Frequency AC

### Application Description

A **VLF Withstand test** is a go/no-go or pass/fail overvoltage stress test, or proof test. Can the object hold the test voltage or is it defective and will fail? **VLF AC Hipots** are needed when AC voltage testing high capacitance loads, like cables and rotating machinery. The **lower the frequency, the lower the AC charging current** each half cycle. At 0.1 Hz it takes 600x less current and power to charge a cable than at 60 Hz; 3000x less when 0.02 Hz is used. That's why VLF technology is needed and used worldwide. IEEE, IEC, & other standards exist to define the test.

To perform an AC Withstand test, the test voltage is applied for a predetermined length of time, usually from 30 – 60 minutes. The test voltage is 2 – 3 times the normal operating voltage, or  $2 U_o - 3 U_o$ . If a defect exists within the insulation of the test object that is severe enough to trigger partial discharge, it normally fails within the test time. Minor defects that are not triggered into PD and areas of good insulation are unaffected by the test. That is the purpose of the withstand/proof test. Find out if the insulation and the accessories are sound, especially following the installation of the cable system.

For testing medium and high voltage solid dielectric cable, the **IEEE Standard 400.2-2013** defines VLF testing. This standard was first published in 2002 but updated in 2013. It includes the definition and standards for VLF Withstand testing and includes test guidelines for **VLF Tangent Delta** testing.



**Capacitive Charging Current:  $A = 2\pi fCV$**

**$f$  = frequency (Hz),  $C$  = Capacitance (F),  $V$  = Voltage (V)**

### Product Designs & Specifications

**VLF Hipots** are available from **28 kVac peak to 200 kVac peak**. The voltage ratings are set around the **Acceptance Test** voltages of common cable sizes, like those for 15 kV, 25 kV, 35 kV, 69 kV, etc. The **capacitance ratings** are determined by the maximum  $\mu F$  rating that can be achieved at 0.1 Hz while still maintaining reasonably sized and priced products but still able to test typical cable lengths, with the exception of windfarm cables that can be unusually and atypically long. The **frequency output ratings** range from **0.1 Hz. down to 0.01 Hz**. The lower the frequency the higher the capacitance, or longer the cable, can be tested. Large rotating machinery can also be tested with VLF technology, per **IEEE433-2009**. VLF models with sinusoidal outputs are usually preferred, required in many cases, although a cosine-rectangular waveform is suitable for withstand testing.

### HVI Product Solutions

The **VLF Series** from HVI is the original, patented, oil insulated, analog designed VLF. Models available are 0 - 30 kV, 44 kV, 50 kV, 62 kV, 65 kV, 90 kV, 120 kV & 200 kV, measured in peak voltage with a sinusoidal output. Most are variable from 0.10 Hz to 0.01 Hz. The load ratings are from 0.4  $\mu F$  to 50  $\mu F$  depending on the model. **TD & PD Diagnostic** accessories available.

The **VLF E Series** of solid state computer controlled designs are available in two models, **0 - 34 kV and 0 - 65 kV**, peak voltage with a sinusoidal output. These models also offer DC output, Sheath testing, and other features. Both offer 0.1 Hz. - 0.01 Hz frequency output able to test 1  $\mu F$  @ 0.10 Hz up to 10  $\mu F$  at 0.01 Hz. E-Link Software is included.

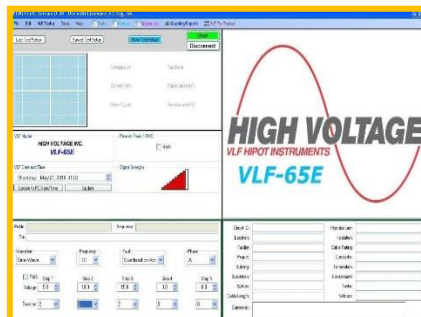


**VLF Series – Oil Insulated w/Analog Controls**  
Models: 30 kVac – 200 kVac, up to 50  $\mu F$

**E Series - Solid State**  
0-35 kVac & 0-65 kVac



**Tan Delta Module**  
0-65 kVac @ 0.1 Hz.



**E-Link Software** for extensive wireless programming, control, data logging, and test reporting is provided with **E Series** models. Also valuable for Tan Delta diagnostics.

