



***Society of Cable  
Telecommunications  
Engineers***

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**ENGINEERING COMMITTEE  
Interface Practices Subcommittee**

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**AMERICAN NATIONAL STANDARD**

**ANSI/SCTE 81 2012**

**Surge Withstand Test Procedure**

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## 1.0 SCOPE

- 1.1 This document describes a procedure for subjecting a broadband device to surge conditions as specified in IEEE C62.41<sup>1</sup>. Ports shall be tested in compliance with IEEE C62.41 Category B3 Combination Waveform or IEEE C62.41 Category A3 Ring Waveform as specified for the Device Under Test.

## 2.0 COMPLIANCE NOTATION

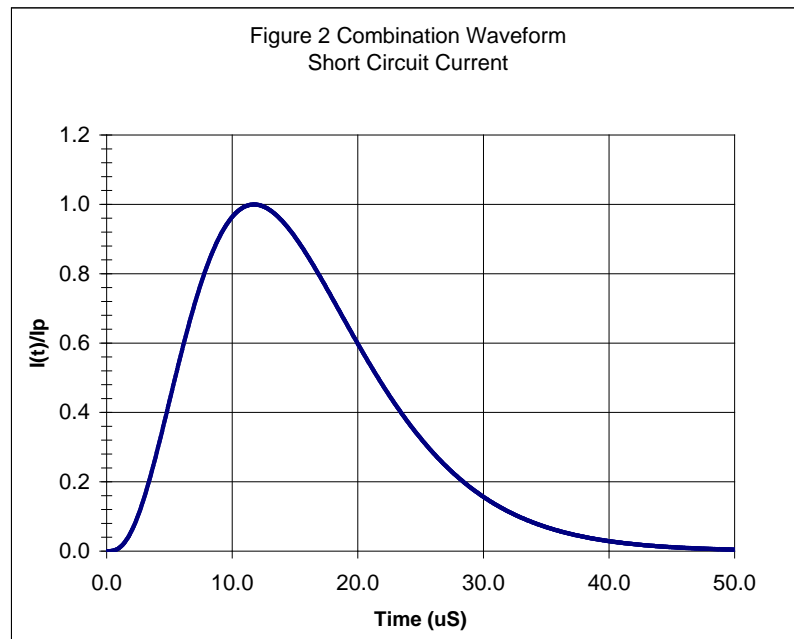
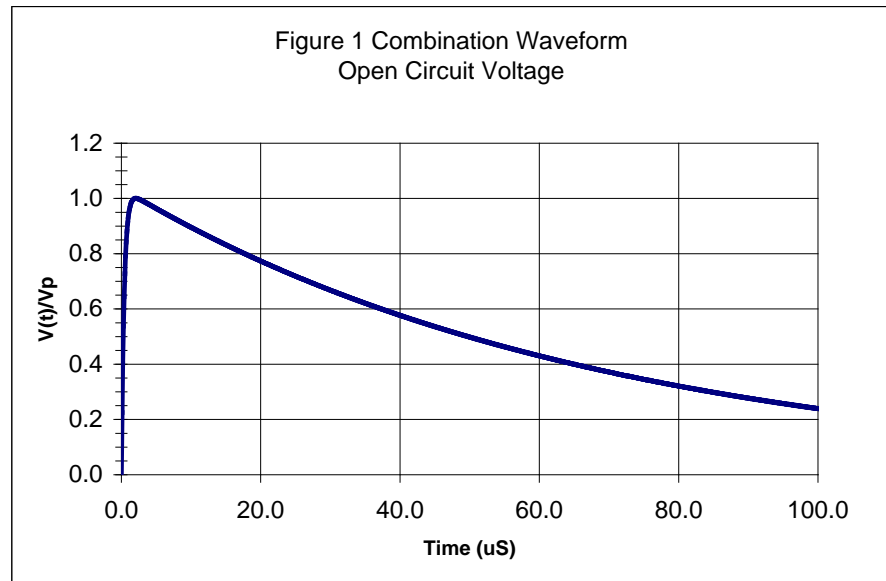
“SHALL”	This word or the adjective “REQUIRED” means that the item is an absolute requirement of this specification.
“SHALL NOT”	This phrase means that the item is an absolute prohibition of this specification.
“SHOULD”	This word or the adjective “RECOMMENDED” means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted before choosing a different course.
“SHOULD NOT”	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
“MAY”	This word or the adjective “OPTIONAL” means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

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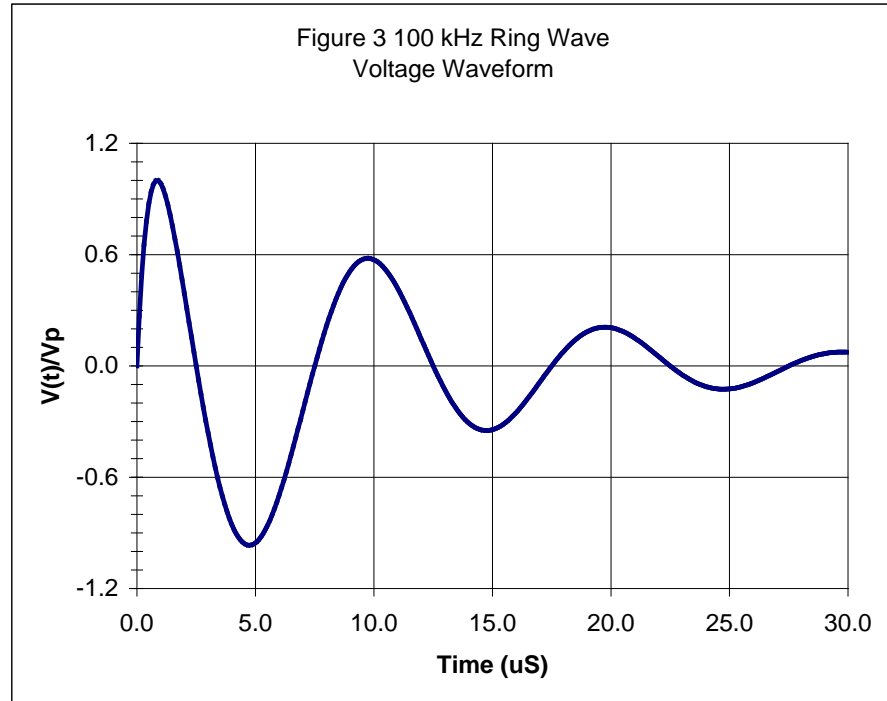
<sup>1</sup> Normative Reference - IEEE C62.41-1991 “*IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits*”

### 3.0 DEFINITIONS

- 3.1 **Combination Wave:** Specified in paragraph 9.4.2 of IEEE C62.41. The 1.2/50-8/20  $\mu\text{s}$  combination wave is defined by both an open circuit voltage waveform and a short circuit current waveform. The open circuit voltage waveform has a front time of 1.2  $\mu\text{s}$  and duration of 50  $\mu\text{s}$  (see Figure 1). The short circuit current waveform has a front time of 8  $\mu\text{s}$  and duration of 20  $\mu\text{s}$  (see Figure 2). The exact voltage and current waveforms delivered to the device under test are dependent on the generator and DUT impedance. See the IEEE practice Reference section for guidance in the selection of representative waveforms.



3.2 Ring Wave: Specified in paragraph 9.4.1 of IEEE C62.41. The 0.5  $\mu$ s-100 kHz ring wave has an initial rise time of 0.5  $\mu$ s and an oscillating frequency of 100 kHz, where the frequency is calculated from the first and third zero crossing after the initial peak (see Figure 3). See the IEEE practice Reference section for guidance in the selection of representative waveforms.



- 3.3 Rise Time: The time difference between the 10% and 90% amplitude points on the leading edge of the waveform.
- 3.4 Front Time: For the voltage waveform of the combination wave, the front time is defined as  $1.67(t_{90}-t_{30})$ , where  $t_{90}$  and  $t_{30}$  are the times of the 90% and 30% amplitude points on the leading edge of the waveform. The front time of the current waveform is defined as  $1.25(t_{90}-t_{10})$ .
- 3.5 Duration: The time difference between the virtual origin and the 50% amplitude point on the tail of the waveform.
- 3.6 Virtual Origin: The time that a straight line between the 30% and 90% amplitude points intersects the I=0 line.
- 3.7 Effective Source Impedance: The ratio of peak open circuit voltage to peak short circuit current. For the Combination Wave, C62.41 Category B3, the effective source impedance is  $2 \pm 0.25 \Omega$ , and for the Ring Wave, C62.41 Category A3, the effective source impedance is  $30 \pm 0.5 \Omega$ .
- 3.8 DUT: Device Under Test.

**WARNING: High voltages are present. Only trained personnel should perform these tests. Use of safety goggles and other protective is recommended.**

## 4.0 EQUIPMENT

### 4.1 Pulse Generator

The surge generator must be capable of producing the Ring Wave as specified by C62.41 Category A3 and the Combination Wave as specified by C62.41 Category B3. (one of the following or equivalent)

- KeyTek EMCPro® PLUS
- Haefely Psurge 6.1 Surge Tester with PHV 30.2 (combination wave only). (Discontinued)
- Haefely PSURGE 8000 with PIM 110 and PIM 100 Surge Generator, and PCD 100 Coupler
- Shaffner NSG650 High Energy Surge Generator (Discontinued)
- Shaffner NSG2050 Surge Generator System

## **4.2 Coupling Filter**

This device is used to isolate the AC power to the device being subjected to the surge. This allows all the surge energy to be directed to the DUT and not absorbed by the power system. (one of the following or equivalent)

- Not required for Keytek
- Haefely FPSURGE 32.1
- Schaffner CDN 110 Surge Generator Coupling Network

## **4.3 Digital Sampling Oscilloscope**

- Tektronix TDS 2022B or equivalent

This device is normally connected to the test connectors of the surge generator to monitor device performance.

## **4.4 Alternate Waveform Monitoring Equipment**

The following test probes (or equivalent) can be used to directly monitor the surge waveforms applied to the DUT.

- Voltage Probe, Tektronix P6015A High Voltage Probe or equivalent
- Current Probe, Tektronix TCP202 or equivalent

## **4.5 Power Supply: AC or DC, as required by the DUT**



## 5.0 SET-UP

- 5.1 The test equipment shall be calibrated following the manufacturer recommendations. The test equipment shall be allowed adequate warm-up and stabilization time prior to calibration.
- 5.2 Determine all configurations to be tested unless directed otherwise. The surge shall be applied to each RF and AC/DC port, unless directed otherwise. The coupling filter shall only be used where AC power is to be present on the port to be surged.
- 5.3 All unused RF ports shall be terminated with a 75  $\Omega$ , AC de-coupled termination.
- 5.4 The surge equipment shall be connected in accordance with the selected setup of Figures 4 to 9. Alternate scope connections are shown for direct measurement at the DUT. The waveform (Ring Wave or Combination Wave) and open circuit peak voltage and short circuit peak current of the surge pulse shall be selected as required by the specifications of the DUT for the particular terminal being tested.
- 5.5 The digital sampling scope shall be used to verify the voltage and current waveforms of the surge generator prior to and after surge testing has been performed. Verify no significant current is drawn during open circuit test of cables without DUT connected at maximum test voltage.
- 5.6 The test connectors shall be inspected for arc over damage (carbon tracking) prior to and after the surge testing has been performed. If damaged, the test equipment connector shall be replaced before proceeding.
- 5.7 The coaxial jumper connecting the device under test to the test set shall be a minimum of one foot long and a maximum of two feet. The coaxial jumper can be connected to the test set with normal test lead cables.

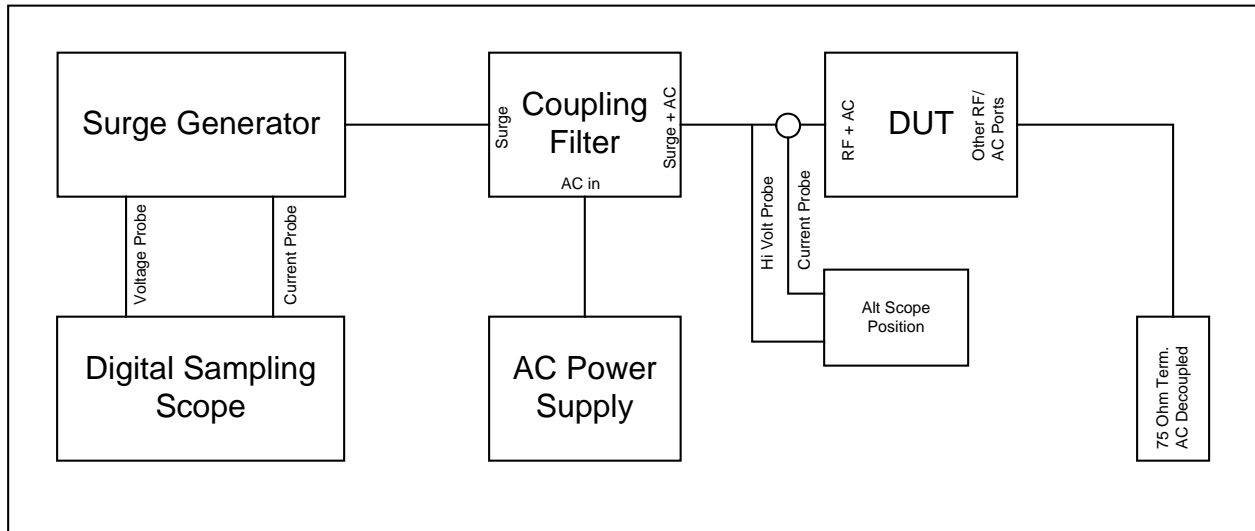
## **6.0 PROCEDURE**

- 6.1 Turn on the DUT power supply (AC or DC, as appropriate and if required) and allow the DUT to warm up for at least 15 minutes.
- 6.2 Pre-test the DUT and record any AC, DC, RF, or other characteristic required by the specification.
- 6.3 Set the peak voltage positive and adjust the phase angle if necessary.
- 6.4 Apply a sequential set of positive peak voltage ( $90^\circ$  phase angle to the line voltage) surge pulses starting at 500 V<sub>peak</sub> and rising to the maximum specified voltage in 500 V<sub>peak</sub> incremental steps to the terminal being tested. The sequence shall continue with 4 additional surge applications of the maximum specified voltage. There shall be a minimum time delay between surge pulse applications of 5 seconds. (It is recommended that the test voltage not exceed 6000 V<sub>peak</sub>.)
- 6.5 Set the peak voltage negative ( $270^\circ$  phase angle to line voltage), and repeat step 4.4.
- 6.6 Remove the DUT from the fixture, reconfigure the set-up for the next terminal to be tested, and repeat the test.
- 6.7 After all terminals have been subjected to the surge, re-test for the characteristics recorded in 4.2.

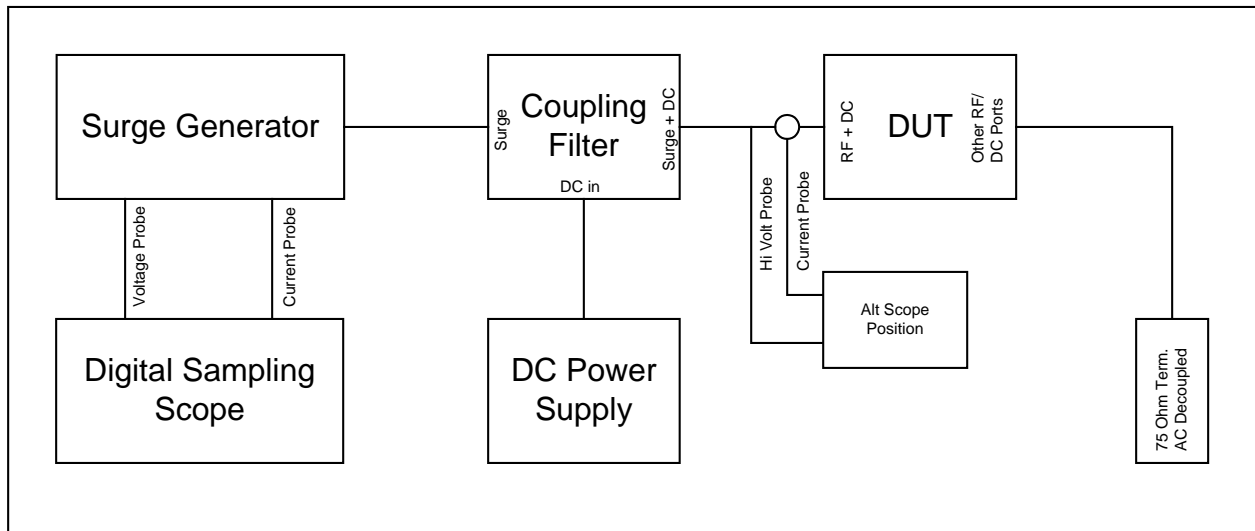
## **7.0 RECORDING RESULTS**

- 7.1 Although the exact form of the recorded data will vary, results should include as a minimum:
  - Device tested
  - Date of test
  - Type of test performed
  - Identity of device tested
  - Identity of test equipment
  - Identity of person performing the test
  - Record of RF/power data prior to test
  - Record of RF/power data after test
  - Indication of pass/fail status of device tested
- 7.2 A typical test report format can be found as Addendum II

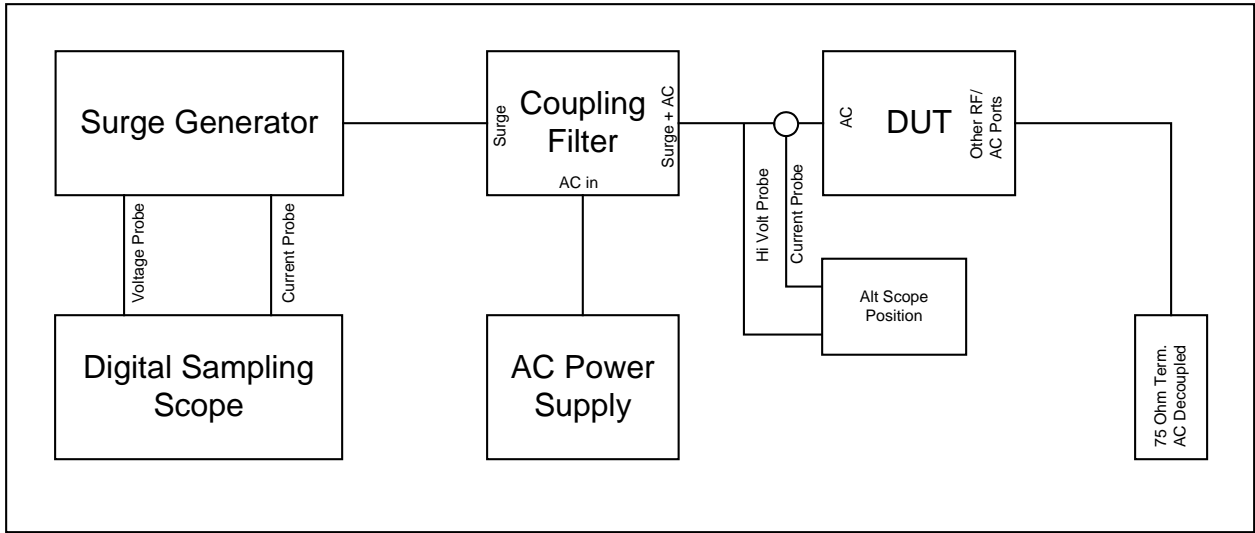
## 8.0 FIGURES



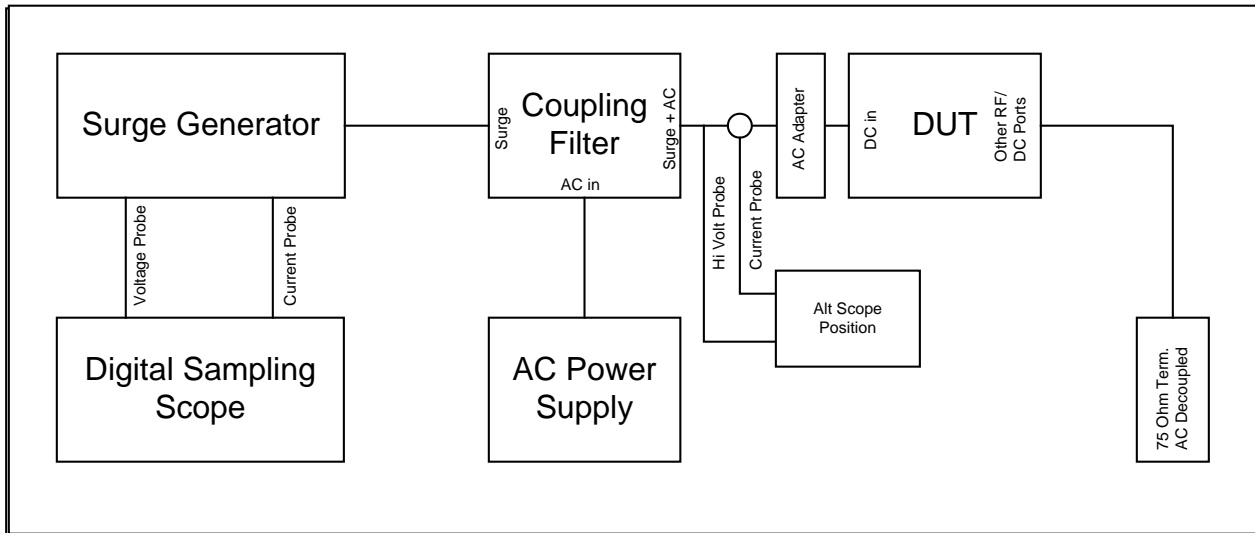
**Figure 1 – Combined RF and AC Port**



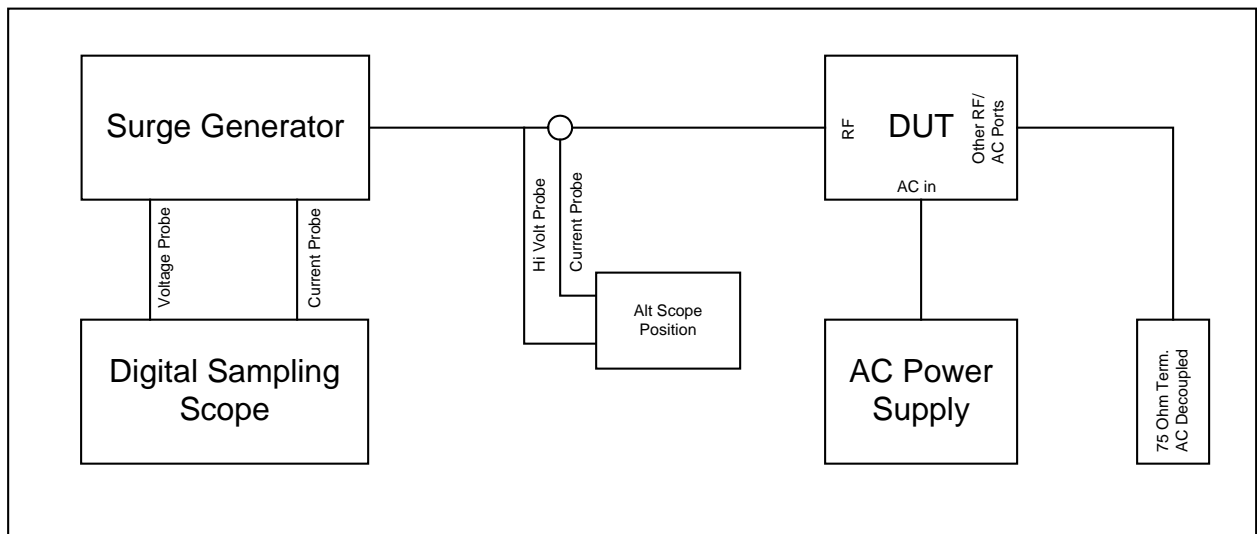
**Figure 2 – Combined RF and DC Port**



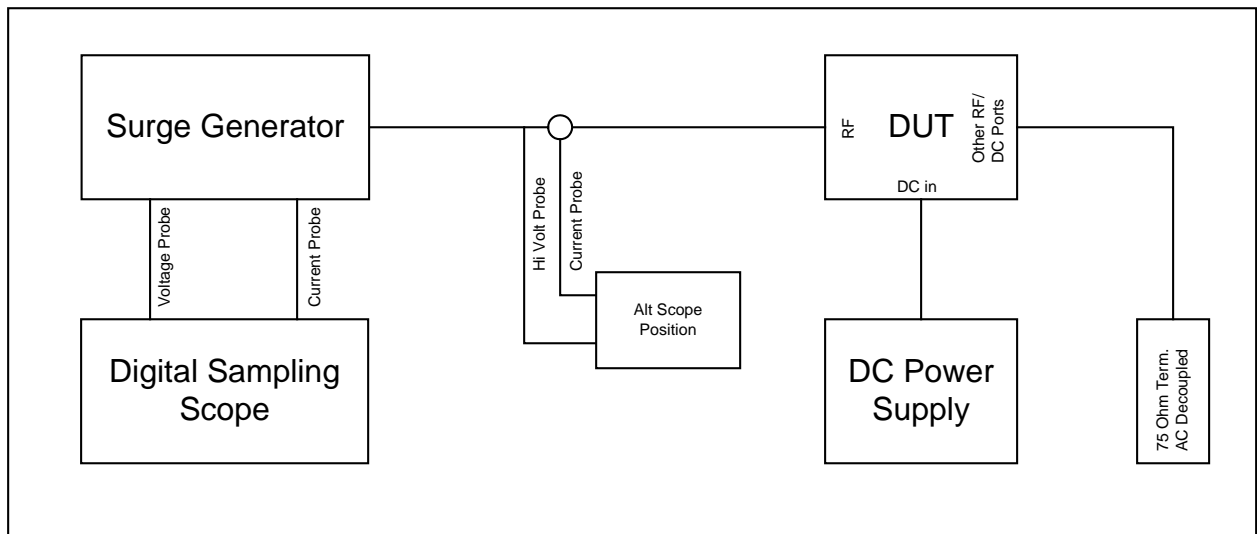
**Figure 3 – AC Port**



**Figure 4 – AC Adapter**



**Figure 5 – RF Port – AC Power**



**Figure 6 – RF Port – DC Power**

**9.0 TEST MEASUREMENT – REPORT FORMAT**

<b><i>Device Under Test</i></b>			
<b>Device Type:</b>		<b>Manufacturer:</b>	
<b>Model Number:</b>		<b>Serial Number:</b>	

<b><i>Test Parameters</i></b>	
Test Type:	
Open Circuit: Max Voltage	
Short Circuit: Max Current	
Step Voltage	
Minimum Voltage	
Maximum Voltage	

<b><i>Parameters Measured Prior to Test</i></b>	

<b><i>Parameters Measured After Test</i></b>	

<b><i>Test Equipment</i></b>				
<b>Device</b>	<b>Manufacturer</b>	<b>Model Number</b>	<b>Serial Number</b>	<b>Last Cal Date</b>

<b>Tested By</b>	<b>Date of Test</b>	<b>Pass / Fail</b>