SCTE · ISBE

STANDARDS

Interface Practices Subcommittee

SCTE STANDARD

SCTE 81 2018

Surge Withstand Test Procedure

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1. Introduction

1.1. Executive Summary

When evaluating broadband products for surge susceptibility to both power ports, and data ports it is useful to have a uniformed practice for this endeavor. The document seeks to outline such a practice.

1.2. Scope

This document describes a procedure for subjecting a broadband device to surge conditions as specified in IEEE C62.45. Ports shall be tested in compliance with IEEE C62.45 Category B Combination Waveform or IEEE C62.45 Category A Ring Waveform as specified for the Device Under Test.

1.3. Benefits

This procedure is intended to benefit the purchasers of products tested, by ensuring a uniformed method of evaluation.

1.4. Intended Audience

This document is intended for multiple audiences including product designers, test engineers and end users of products tested to this procedure.

1.5. Areas for Further Investigation or to be Added in Future Versions

There are no current recommendations for further investigations.

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

- No normative references are applicable.

2.2. Standards from Other Organizations

- IEEE C62.45-2002 “IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits”

2.3. Published Materials

- No normative references are applicable.

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

- IEEE C62.41.1-2002 "Guide on the Surges Environment in Low-Voltage (1000 V and Less) AC Power Circuits"
- IEEE C62.41.2-2002 "IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits"

3.1. SCTE References

- No informative references are applicable.

3.2. Standards from Other Organizations

- No informative references are applicable.

3.3. Published Materials

- No informative references are applicable.

4. Compliance Notation

shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
forbidden	This word means the value specified shall never be used.
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.
deprecated	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of this document. Implementations should avoid use of deprecated features.

5. Abbreviations and Definitions

5.1. Abbreviations

AC	alternating current
DC	direct current
DUT	device under test
IEEE	Institute of Electrical and Electronics Engineers
RF	radio frequency

SCTE	Society of Cable Telecommunication Engineers
V	volt

5.2. Definitions

Combination Wave	Specified in paragraph 9.2.2 of IEEE C62.45. The 1.2/50-8/20 μs 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 μs and duration of 50 μs (see Figure 1). The short circuit current waveform has a front time of 8 μs and duration of 20 μs (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.
Ring Wave	Specified in paragraph 9.2.1 of IEEE C62.45. The 0.5 μs-100 kHz ring wave has an initial rise time of 0.5 μs 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.
Rise Time	The time difference between the 10% and 90% amplitude points on the leading edge of the waveform.
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 $1.25(t_{90}-t_{10})$.
Duration	The time difference between the virtual origin and the 50% amplitude point on the tail of the waveform.
Virtual Origin	The time that a straight line between the 30% and 90% amplitude points intersects the V or I = 0 line.
Effective Source Impedance	The ratio of peak open circuit voltage to peak short circuit current. For the Combination Wave, C62.45 Category B, the effective source impedance is 2 ± 0.25 Ω, and for the Ring Wave, C62.45 Category A, the effective source impedance is 30 ± 0.5 Ω.

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

6. Equipment

6.1. Pulse Generator

The surge generator must be capable of producing the Ring Wave as specified by C62.45 Category A and the Combination Wave as specified by C62.45 Category B. (one of the following or equivalent)

- Thermo Scientific EMCPro® PLUS
- Haefely PSURGE 8000 with PIM 110 and PIM 100 Surge Generator, and PCD 1XX Coupling and Decoupling Network
- Teseq NSG 3060-ANSI with CDN 3061 Coupling and Decoupling Network

6.2. 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 Thermo Scientific EMCPro® PLUS
- Haefely PCD 1XX Coupling and Decoupling Network
- Teseq CDN 3061 Coupling and Decoupling Network

6.3. Digital Sampling Oscilloscope

- Tektronix TDS 2022C or equivalent

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

6.4. 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

6.5. Power Supply: AC or DC, as required by the DUT

7. Set-Up

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.
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.
3. All unused RF ports shall be terminated with a 75Ω, AC de-coupled termination.
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. 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.
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.
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.

8. Procedure

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.
2. Pre-test the DUT and record any AC, DC, RF, or other characteristic required by the specification.
3. Set the peak voltage positive and adjust the phase angle if necessary.
4. For AC power connection only
    a. Apply a sequential set of positive peak voltage (90° phase angle to the line voltage) surge pulses starting at 500 Vpeak and rising to the maximum specified voltage in 500 Vpeak 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 Vpeak.)
    b. Set the peak voltage negative (270° phase angle to line voltage), and repeat step 8.4.
5. For all other ports
    a. Apply a sequential set of positive peak voltage surge pulses starting at 500 Vpeak and rising to the maximum specified voltage in 500 Vpeak 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 Vpeak.)
    b. Set the peak voltage negative, and repeat step 8.5
6. Remove the DUT from the fixture, reconfigure the set-up for the next terminal to be tested, and repeat the test.
7. After all terminals have been subjected to the surge, re-test for the characteristics recorded in 8.2.

9. Recording Results

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

A typical test report format can be found as Addendum 11

10. Figures

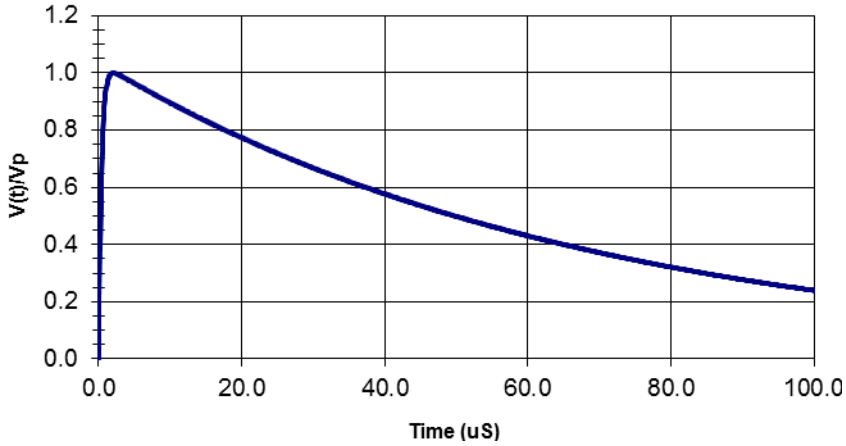

Figure 1 - Combination Waveform Open Circuit Voltage

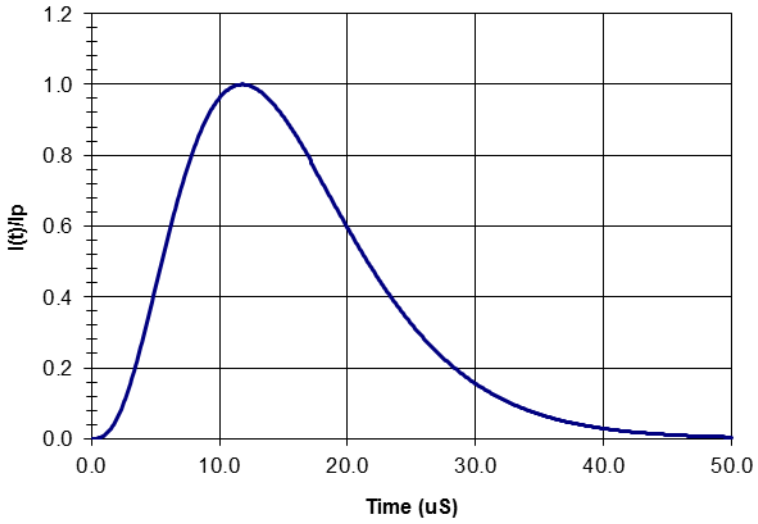

Figure 2 - Combination Waveform Short Circuit Current

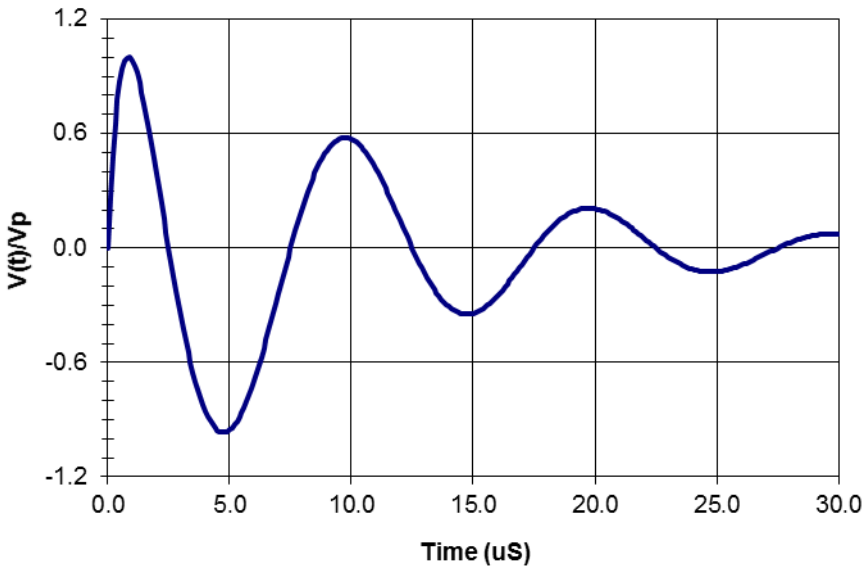

Figure 3 - 100 kHz Ring Wave Voltage Waveform

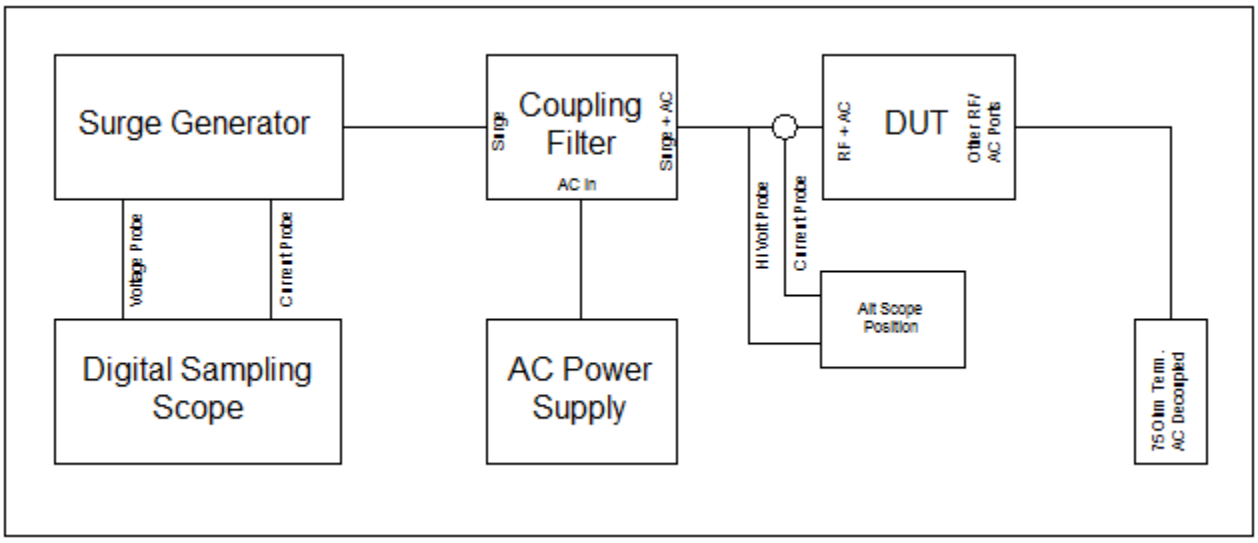

Figure 4 - Combined RF and AC Port

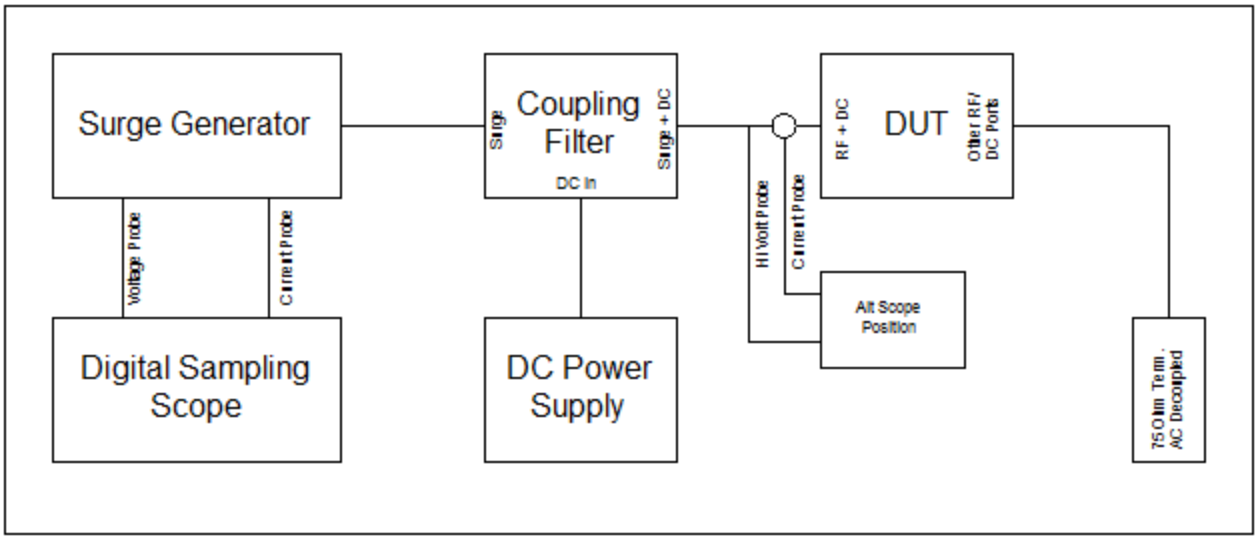

Figure 5 - Combined RF and DC Port

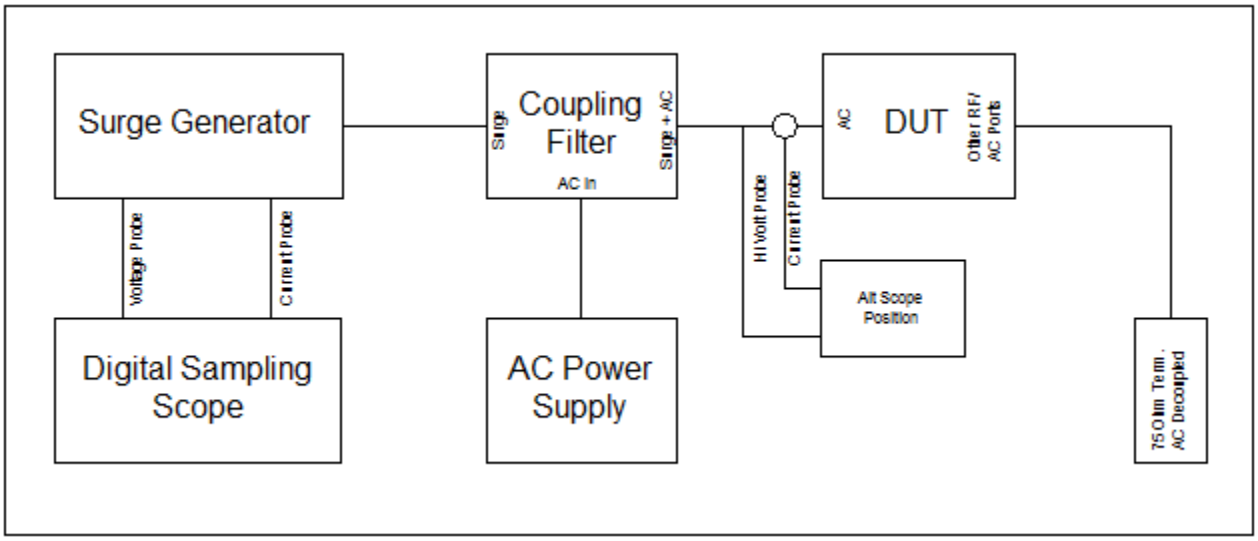

Figure 6 - AC Port

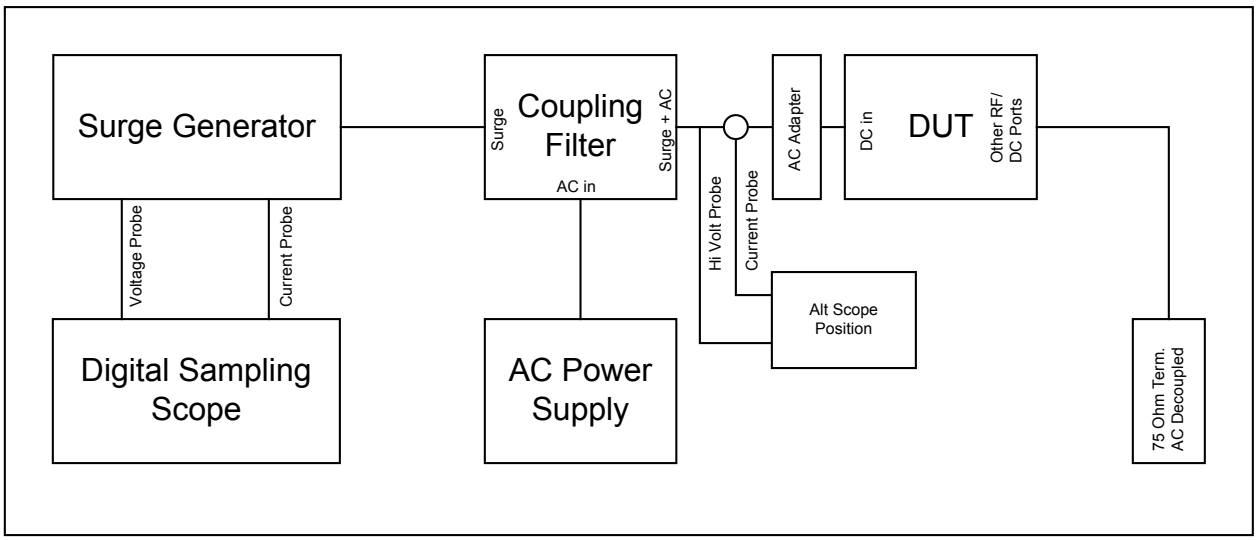

Figure 7 - AC Adapter

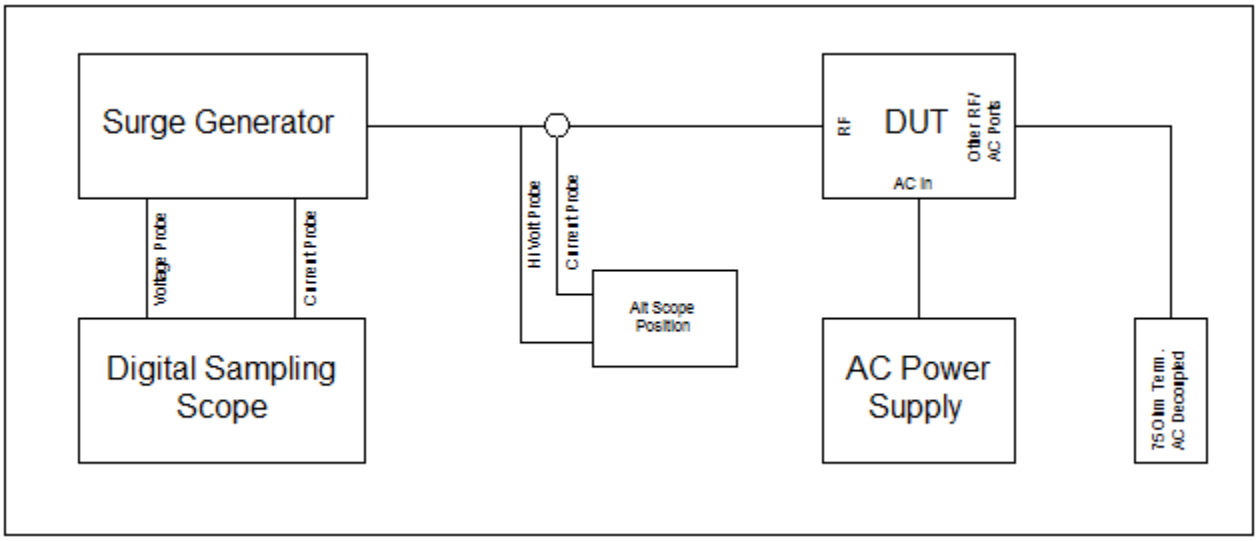

Figure 8 - RF Port – AC Power

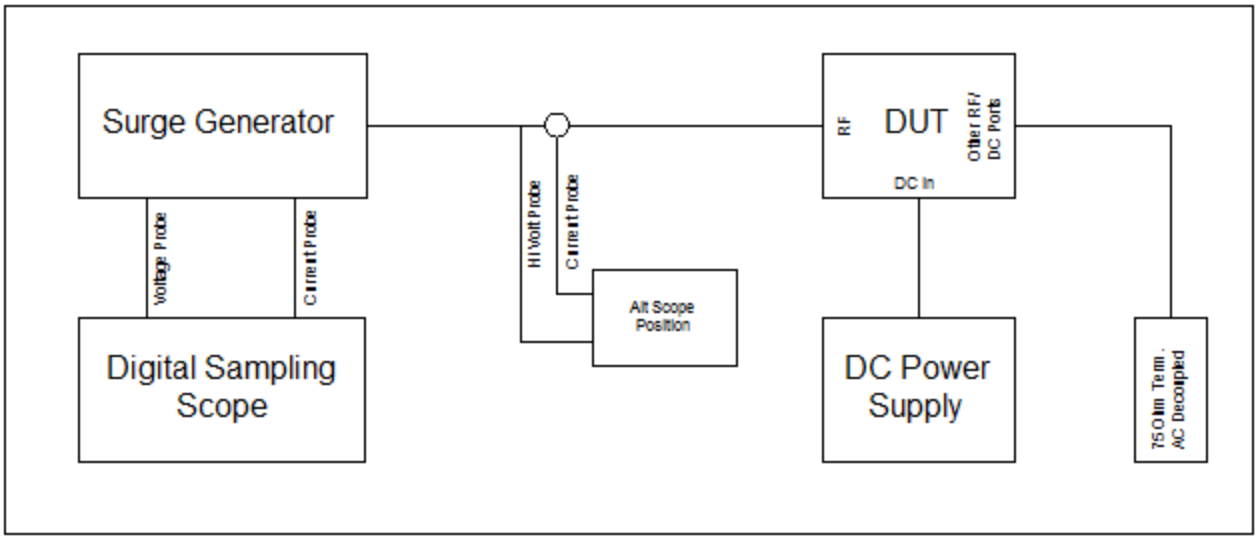

Figure 9 - RF Port – DC Power

11. Test Measurement – Report Format

Device Under Test			
Device Type:		**Manufacturer:**	
Model Number:		**Serial Number:**	

Test Parameters	
Test Type:	
Open Circuit: Max Voltage	
Short Circuit: Max Current	
Step Voltage	
Minimum Voltage	
Maximum Voltage	

Parameters Measured Prior to Test	

Parameters Measured After Test	

Test Equipment				
Device	**Manufacturer**	**Model Number**	**Serial Number**	**Last Cal Date**

Tested By	**Date of Test**	**Pass / Fail**