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## Test Report

### Certification

<b>FCC ID</b>	2AAAS-FT01
<b>Equipment Under Test</b>	FT01
<b>Test Report Serial No</b>	V042765_02
<b>Dates of Test</b>	October 10, 2017 and October 25, 2017
<b>Report Issue Date</b>	October 31, 2017

<b>Test Specifications:</b>	<b>Applicant:</b>
FCC Part 15, Subpart C	Vivint, Inc. 4931 N. 300 W. Provo, UT 84604 U.S.A.



## Certification of Engineering Report

This report has been prepared by VPI Laboratories, Inc. to document compliance of the device described below with the requirements of Federal Communications Commission (FCC) Part 15, Subpart C. This report may be reproduced in full. Partial reproduction of this report may only be made with the written consent of the laboratory. The results in this report apply only to the sample tested.

<b>Applicant</b>	Vivint, Inc.
<b>Manufacturer</b>	Vivint, Inc.
<b>Brand Name</b>	Vivint
<b>Model Number</b>	FT01
<b>FCC ID</b>	2AAAS-FT01

On this 31<sup>st</sup> day of October 2017, I, individually and for VPI Laboratories, Inc., certify that the statements made in this engineering report are true, complete, and correct to the best of my knowledge, and are made in good faith.

Although NVLAP has accredited the VPI Laboratories, Inc. EMC testing facilities, this report must not be used to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the federal government.

VPI Laboratories, Inc.



Tested by: Norman P. Hansen



Reviewed by: Clay Allred

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<b>Revision History</b>		
<b>Revision</b>	<b>Description</b>	<b>Date</b>
01	Original Report Release	October 31, 2017
02	Correct Calibration Dates for Asset Number V034216	December 13, 2017

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## 1 Client Information

### 1.1 Applicant

<b>Company Name</b>	Vivint, Inc. 4931 N. 300 W. Provo, UT 84604 U.S.A.
<b>Contact Name</b>	Greg Hansen
<b>Title</b>	Regulatory Compliance Manager

### 1.2 Manufacturer

<b>Company Name</b>	Vivint, Inc. 4931 N. 300 W. Provo, UT 84604 U.S.A.
<b>Contact Name</b>	Greg Hansen
<b>Title</b>	Regulatory Compliance Manager

## 2 Equipment Under Test (EUT)

### 2.1 Identification of EUT

<b>Brand Name</b>	Vivint
<b>Model Number</b>	FT01
<b>Hardware Version</b>	Revision A
<b>Serial Number</b>	None
<b>Dimensions (cm)</b>	6.5 x 6.5 x 2.5

### 2.2 Description of EUT

The FT01 is a flood and freeze sensor used in Vivint systems to alarm if water is detected or the temperature is below a set point. The FT01 mounts flat with the moisture probes at the bottom of the unit. The FT01 is powered by 3 VDC from a CR123A battery. A 345 MHz, momentarily operated, transmitter is included in the FT01 for issuing the alarm to the system controller. A trace on the PCB is used as the antenna.

This report covers the transmitter circuitry of the devices subject to FCC Part 15, Subpart C. The circuitry of the device subject to FCC Subpart B was found to be compliant and is covered in VPI Laboratories, Inc. report V042764.

### 2.3 EUT and Support Equipment

The EUT and support equipment used during the test are listed below.

<b>Brand Name Model Number Serial Number</b>	<b>Description</b>	<b>Name of Interface Ports / Interface Cables</b>
BN: Vivint MN: FT01 (Note 1) SN: None	Moisture and Temperature Sensor with 345 MHz Transmitter	See Section 2.4

Notes: (1) EUT

### 2.4 Interface Ports on EUT

There are no interface ports on the EUT.

### 2.5 Modification Incorporated/Special Accessories on EUT

There were no modifications or special accessories required to comply with the specification.

### 2.6 Deviation from Test Standard

There were no deviations from the test specification.

### 3 Test Specification, Methods and Procedures

#### 3.1 Test Specification

<b>Title</b>	FCC PART 15, Subpart C (47 CFR 15) 15.203, 15.207, and 15.231 Periodic operation in the 40.66 – 40.70 MHz and above 70 MHz
<b>Purpose of Test</b>	The tests were performed to demonstrate initial compliance

#### 3.2 Methods & Procedures

##### 3.2.1 §15.203 Antenna Requirement

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of Sections 15.211, 15.213, 15.217, 15.219, or 15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with Section 15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this Part are not exceeded.

##### 3.2.2 §15.207 Conducted Limits

(a) Except as shown in paragraphs (b) and (c) of this section, for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50  $\mu$ H/50 ohms line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency range (MHz)	Limit (dB $\mu$ V)	
	Quasi-peak	Average
0.15 to 0.50*	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

\*Decreases with the logarithm of the frequency.

**Table 1: Limits for conducted emissions at mains ports of Class B ITE.**

(c) Measurements to demonstrate compliance with the conducted limits are not required for devices which only employ battery power for operation and which do not operate from the AC power lines or contain provisions for operation while connected to the AC power lines. Devices that include, or make provisions for, the use of battery chargers which permit operating while charging, AC adapters or battery eliminators or that connect to the AC power lines indirectly, obtaining their power through another device which is connected to the AC power lines, shall be tested to demonstrate compliance with the conducted limits.

**3.2.3 §15.231**

- a) (a) The provisions of this section are restricted to periodic operation within the band 40.66-40.70 MHz and above 70 MHz. Except as shown in paragraph (e) of this section, the intentional radiator is restricted to the transmission of a control signal such as those used with alarm systems, door openers, remote switches, etc. Continuous transmissions, voice, video and the radio control of toys are not permitted. Data is permitted to be sent with a control signal. The following conditions shall be met to comply with the provisions for this periodic operation:
  - 1) A manually operated transmitter shall employ a switch that will automatically deactivate the transmitter within not more than 5 seconds of being released.
  - 2) A transmitter activated automatically shall cease transmission within 5 seconds after activation.
  - 3) Periodic transmissions at regular predetermined intervals are not permitted. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the total transmission time does not exceed two seconds per hour.
  - 4) Intentional radiators which are employed for radio control purposes during emergencies involving fire, security, and safety of life, when activated to signal an alarm, may operate during the pendency of the alarm condition.
  - 5) Transmission of set-up information for security systems may exceed the transmission duration limits in paragraphs (a)(1) and (a)(2) of this section, provided such transmissions are under the control of a professional installer and do not exceed ten seconds after a manually operated switch is released or a transmitter is activated automatically. Such set-up information may include data.
- b) In addition to the provisions of §15.205, the field strength of emission from intentional radiators operated under this section shall not exceed the following.

<b>Fundamental frequency (MHz)</b>	<b>Field strength of fundamental (microvolts/meter)</b>	<b>Field strength of spurious emissions (microvolts/meter)</b>
40.66 - 40.70	2,250	225
70 - 130	1,250	125
130 - 174	1,250 to 3,750 **	125 to 375 **
174 - 260	3,750	375
260 - 470	3,750 to 12,500 **	375 to 1,250 **
Above 470	12,500	1,250

\*\* Linear interpolations

**Table 2: Limits for field strength of emissions from intentional radiators.**

- 1) The above field strength limits are specified at a distance of 3 meters. The tighter limits apply at the band edges.

- 2) Intentional radiators operating under the provisions of this section shall demonstrate compliance with the limits on the field strength of emissions, as shown in the above table, based on the average value of the measured emissions. As an alternative, compliance with the limits in the above table may be based on the use of measurement instrumentation with a CISPR quasi-peak detector. The specific method of measurement employed shall be specified in the application for equipment authorization. If average emission measurements are employed, the provision in §15.35 for averaging pulsed emission and for limiting peak emissions apply. Further, compliance with the provisions of §15.205 shall be demonstrated using the measurement instrumentation specified in that section.
- 3) The limits on the field strength of the spurious emission in the above table are based on the fundamental frequency of the intentional radiator. Spurious emission shall be attenuated to the average (or, alternatively, CISPR quasi-peak) limits shown in this table or to the general limits shown in §15.209, whichever limit permits a higher field strength.
- c) The bandwidth of the emission shall be no wider than 0.25% of the center frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz, the emission shall be no wider than 0.5% of the center frequency. Bandwidth is determined at the points 20 dB down from the modulated carrier.
- d) For devices operation within the frequency band 40.66-40.70 MHz, the bandwidth of the emission shall be confined within the band edges and the frequency tolerance of the carrier shall be  $\pm 0.01\%$ . This frequency tolerance shall be maintained for a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation on the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.
- e) Intentional radiators may operate at a periodic rate exceeding that specified in paragraph (a) of this section and may be employed for any type of operation, including operation prohibited in paragraph (a) of this section, provided that intentional radiator complies with the provisions of paragraphs (b) through (d) of this section except the field strength table in paragraph (b) of this section is replaced by the following.

<b>Fundamental frequency (MHz)</b>	<b>Field strength of fundamental (microvolts/meter)</b>	<b>Field strength of spurious emissions (microvolts/meter)</b>
40.66 - 40.70	1,000	100
70 - 130	500	50
130 - 174	500 to 1,500 **	50 to 150 **
174 - 260	1,500	150
260 - 470	1,500 to 5,000 **	150 to 500 **
Above 470	5,000	500

\*\* Linear interpolations

**Table 3: Limits for field strength of emissions from intentional radiators.**

In addition, devices operated under the provisions of this paragraph shall be provided with a means for automatically limiting operation so that the duration of each transmission shall not be greater than one

second and the silent periods between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds.

### **3.3 Test Procedure**

The conducted disturbance at mains ports and radiated disturbance testing was performed according to the procedures in ANSI C63.10:2013. Testing was performed at VPI Laboratories, Inc. Wanship Upper Open Area Test Site, located at 29145 Old Lincoln Highway, Wanship, UT. VPI Laboratories, Inc. is accredited by National Voluntary Laboratory Accreditation Program (NVLAP); NVLAP Lab Code: 100272-0, which is effective until September 30, 2018. VPI Laboratories, Inc. carries FCC Accreditation Designation Number US5263.

## 4 Operation of EUT During Testing

### 4.1 Operating Environment

Power Supply	3 VDC from CR123A Battery
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### 4.2 Operating Modes

The transmitter was tested while in a constant transmit mode. A new battery was installed for testing.

### 4.3 EUT Exercise Software

Vivint Water Leak Sensor firmware version Ver. 1.7 was used to exercise the EUT.

## 5 Summary of Test Results

### 5.1 FCC Part 15, Subpart C

#### 5.1.1 Summary of Tests

Part 15, Subpart C Reference	Test Performed	Frequency Range (MHz)	Result
15.203	Antenna Requirement	N/A	Complied
15.207	Emissions at the AC Mains	0.15 – 30	Not Applicable
15.231 (a)	Periodic Operation	345	Complied
15.231 (b)	Radiated Emissions	0.009 – 3450	Complied
15.231 (c)	Bandwidth	345	Complied
15.231 (d)	Frequency Stability	40.66 – 40.70	Not Applicable
15.231 (e)	Radiated Emissions	0.009 – 3450	Not Applicable

### 5.2 Result

In the configuration tested, the EUT complied with the requirements of the specification.

## 6 Measurements, Examinations and Derived Results

### 6.1 General Comments

This section contains the test results only. Details of the test methods used and a list of the test equipment used during the measurements can be found in Section 7 of this report.

### 6.2 Test Results

#### 6.2.1 §15.203 Antenna Requirements

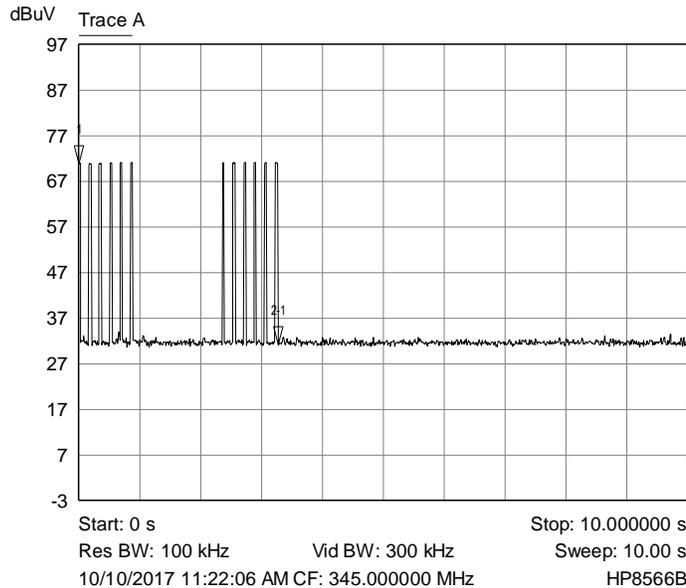
The EUT used a trace on the PCB for an antenna.

#### Result

The EUT complied with the specification

#### 6.2.2 §15.231 (a)

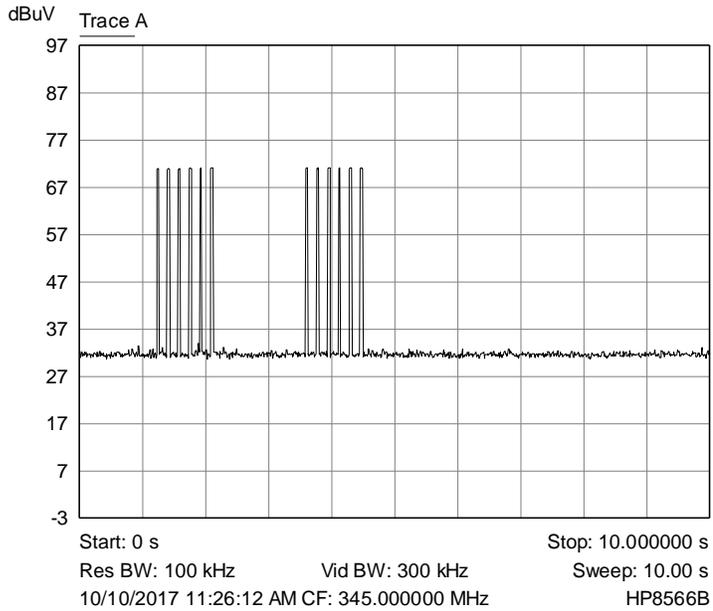
- 1) The EUT is not manually activated.
- 2) The EUT is automatically activated. If moisture is detected or is the temperature drops below the set point, the EUT will transmit 2 series of 6 pulse trains. The transmissions then cease. A plot of the transmission is shown below to demonstrate that the emission ceases within 5 second of activation.



Mkr	Trace	X-Axis	Value	Notes
1 ▾	Trace A	0 s	70.9000 dBuV	
2:1 ▾	Trace A	3.270000 s	-39.7000 dB	

**Graph 1: Plot Showing EUT Ceases Transmission Within 5 Seconds of Automatic Activation**

- 3) The EUT does not transmit at regular predetermined intervals. The EUT does use transmissions to verify system integrity and function. This transmission happens once in a random period of time between 60 and 70 minutes. The plot below shows the system integrity emission. Calculations are made to show compliance with a total allowed transmission time of 2 seconds per hour.



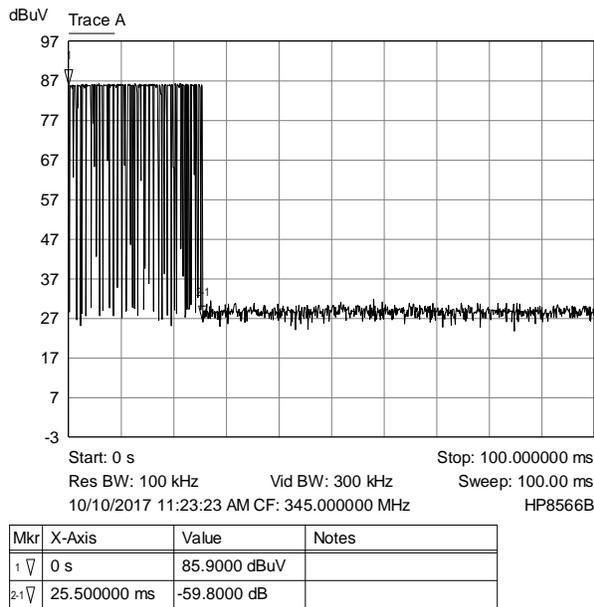
**Graph 2: Plot Showing EUT System Integrity Transmission**

The 2 sets of pulse trains are identical and are the same length as the pulse trains used when alarming. The On time for one pulse train is 25.5 ms. The EUT used Manchester encoding that has a duty cycle of 50%. There are 12 pulse trains.

$25.5 \text{ ms} \times 12 \text{ pulse trains} \times 0.5 \text{ duty cycle} = 153 \text{ ms per hour maximum}$

- 4) The EUT may be used during an emergency that involves fire and safety of life.
- 5) The EUT does require set up information transmissions (pairing). The setup transmission must end within 10 seconds of a manually activated switch being released. The setup transmission consists of 2 sets of 4 pulse trains. The setup button was pressed and released. The plot is shown below.





**Graph 4: 100 ms Plot of Pulse Train**

**Average factor calculation**

The plot above shows the pulse train is 25.5 ms in duration. The Average Factor will be calculated using 100 ms as specified in FCC §15.35(c). The pulsed transmission is 25.5 ms and has a duty cycle of 50%.

The Average Factor is calculated by the equation:

Average Factor = 20 log (on time/pulse train time)

Pulse train time = 100 ms

On time = 12.75 ms (25.5 ms at 50% duty cycle)

Average Factor = 20 log (12.75 / 100) = -17.9 dB

**Radiated Interference Measurements – (Vertical Polarity)**

Frequency (MHz)	Detector	Receiver Reading (dBµV)	Average Factor (dB)	Correction Factor (dB/m)	Field Strength (dBµV/m)	Limit (dBµV/m)	Delta (dB)
345.0*	Peak	52.9	-17.9	24.5	59.5	77.3	-17.8
690.0	Peak	16.3	-17.9	33.4	31.8	57.3	-25.5
1035.0**	Peak	6.1	-17.9	26.7	14.9	54.0	-39.1
1380.0**	Peak	15.4	-17.9	28.0	25.5	54.0	-28.5
1725.0	Peak	24.4	-17.9	29.8	36.3	57.3	-21.0
2070.0	Peak	27.3	-17.9	31.6	41.0	57.3	-16.3
2415.0	Peak	26.1	-17.9	32.7	40.9	57.3	-16.4

Frequency (MHz)	Detector	Receiver Reading (dB $\mu$ V)	Average Factor (dB)	Correction Factor (dB/m)	Field Strength (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Delta (dB)
2760.0**	Peak	36.4	-17.9	34.2	52.7	54.0	-1.3
3105.0	Peak	26.4	-17.9	35.6	44.1	57.3	-13.2
3450.0	Peak	17.3	-17.9	36.6	36.0	57.3	-21.3
* Fundamental Emission							
** Emission in the restricted bands of operation							

**Radiated Interference Measurements – (Horizontal Polarity)**

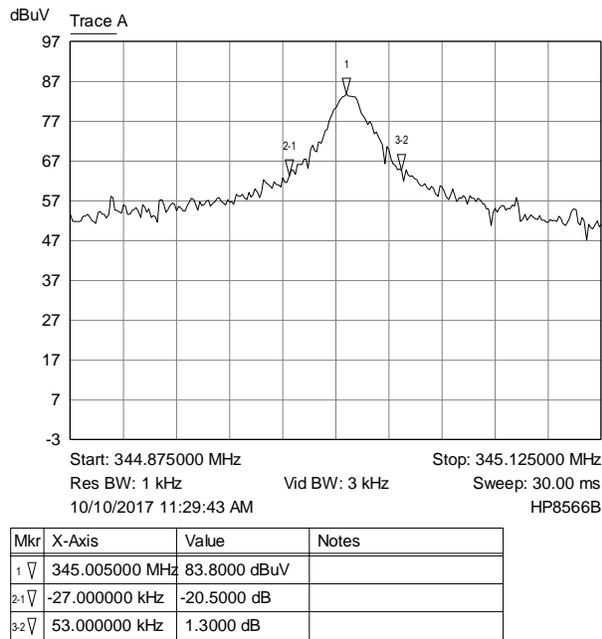
Frequency (MHz)	Detector	Receiver Reading (dB $\mu$ V)	Average Factor (dB)	Correction Factor (dB/m)	Field Strength (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Delta (dB)
345.0*	Peak	69.1	-17.9	24.5	75.7	77.3	-1.6
690.0	Peak	13.7	-17.9	33.4	29.2	57.3	-28.1
1035.0**	Peak	5.7	-17.9	26.7	14.5	54.0	-39.5
1380.0**	Peak	19.0	-17.9	28.0	29.1	54.0	-24.9
1725.0	Peak	32.9	-17.9	29.8	44.8	57.3	-12.5
2070.0	Peak	37.2	-17.9	31.6	50.9	57.3	-6.4
2415.0	Peak	30.2	-17.9	32.7	45.0	57.3	-12.3
2760.0**	Peak	34.8	-17.9	34.2	51.1	54.0	-2.9
3105.0	Peak	32.7	-17.9	35.6	50.4	57.3	-6.9
3450.0	Peak	21.8	-17.9	36.6	40.5	57.3	-16.8
* Fundamental Emission							
** Emission in the restricted bands of operation							

**Result**

The EUT complied with the requirements of this section.

**6.2.4 §15.231 (c) Bandwidth**

The bandwidth of the emission must not be wider than 0.25% of the center frequency. The center frequency is 345 MHz, therefore the bandwidth must not be wider than 862.5 kHz. The FT01 bandwidth was 53.0 kHz. See spectrum analyzer plot below.



**Graph 5: Bandwidth Plot.**

**Result**

The EUT complied with the requirements of this section.

### 6.3 Sample Field Strength Calculation

The field strength is calculated by adding the *Correction Factor* (*Antenna Factor* + *Cable Factor*), to the measured level from the receiver. The receiver amplitude reading is compensated for any amplifier gain. The basic equation with a sample calculation is shown below:

$$\text{Receiver Amplitude Reading} = \text{Receiver Reading} - \text{Amplifier Gain}$$

$$\text{Correction Factor} = \text{Antenna Factor} + \text{Cable Factor}$$

$$\text{Field Strength} = \text{Receiver Amplitude Reading} + \text{Correction Factor} + \text{Averaging Factor}$$

#### Example

Assuming a *Receiver Reading* of 42.5 dB $\mu$ V is obtained from the receiver, the *Amplifier Gain* is 26.5 dB, the *Antenna Factor* is 4.5 dB, the *Cable Factor* is 4.0 dB, and the *Averaging Factor* is -6.0. The *Field Strength* is calculated by subtracting the *Amplifier Gain* and adding the *Correction Factor* and *Averaging Factor*, giving a *Field Strength* of 18.5 dB $\mu$ V/m.

$$\text{Receiver Amplitude Reading} = 42.5 - 26.5 = 16.0 \text{ dB}\mu\text{V/m}$$

$$\text{Correction Factor} = 4.5 + 4.0 = 8.5 \text{ dB}$$

$$\text{Averaging Factor} = -6.0$$

$$\text{Field Strength} = 16.0 + 8.5 + (-6.0) = 18.5 \text{ dB}\mu\text{V/m}$$

## 7 Test Procedures and Test Equipment

### 7.1 Radiated Emissions

The radiated emissions from the EUT were measured using a spectrum analyzer with a quasi-peak adapter for peak and quasi-peak readings.

A preamplifier with a fixed gain of 26 dB and a power amplifier with a fixed gain of 22 dB were used to increase the sensitivity of the measuring instrumentation. The quasi-peak adapter uses a bandwidth of 120 kHz, with the spectrum analyzer's resolution bandwidth set at 1 MHz, for readings in the 30 to 1000 MHz frequency ranges. For frequencies below 30 MHz, a 9 kHz resolution bandwidth was used.

A loop antenna was used to measure frequencies below 30 MHz. A biconilog antenna was used to measure the frequency range of 30 to 1000 MHz, at a distance of 10 meters from the EUT. The readings obtained by these antennas are correlated to the levels obtained with a tuned dipole antenna by adding antenna factors. A double-ridged guide antenna was used to measure the emissions at frequencies above 1000 MHz at a distance of 3 and/or 1 meter from the EUT.

The configuration of the EUT was varied to find the maximum radiated emission. The EUT was connected to the peripherals listed in Section 2.3 via the interconnecting cables listed in Section 2.4. A technician manually manipulated these interconnecting cables to obtain worst-case radiated emissions. The EUT was rotated 360 degrees, and the antenna height was varied from 1 to 4 meters to find the maximum radiated emission. Where there were multiple interface ports all of the same type, cables are either placed on all of the ports or cables added to these ports until the emissions do not increase by more than 2 dB.

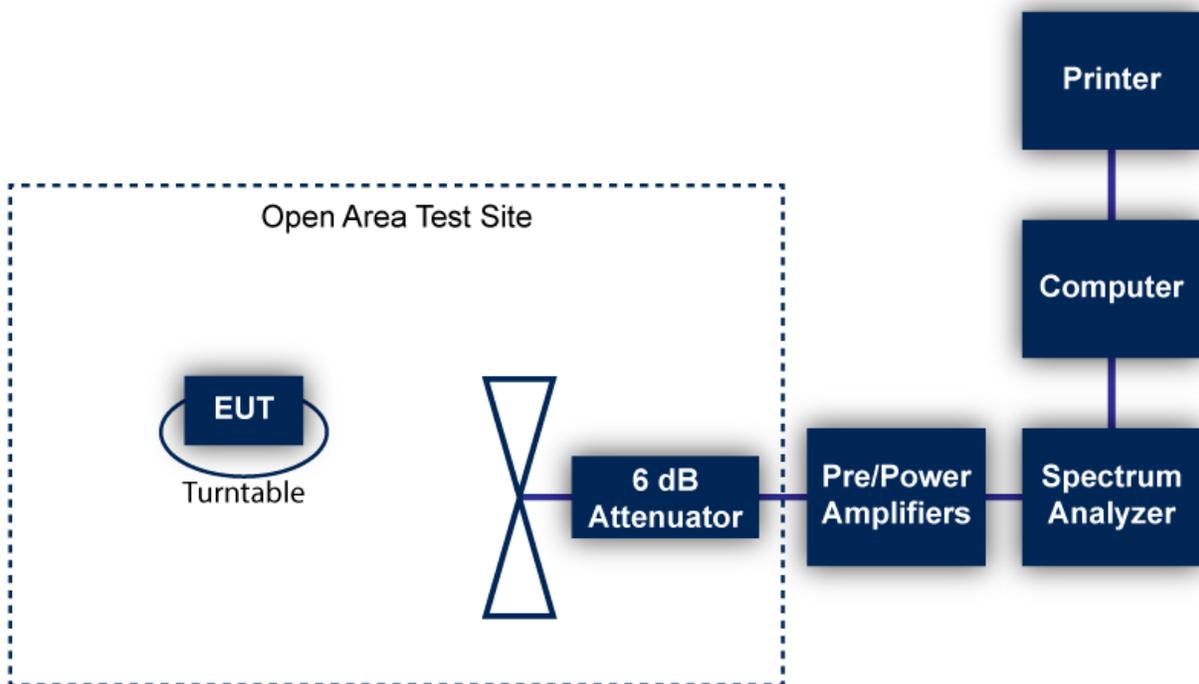
Desktop EUT are measured on a non-conducting table 0.8 meters above the ground plane. For frequencies above 1000 MHz, the EUT is placed on a table 1.5 meters above the ground plane. The table is placed on a turntable, which is level with the ground plane. For equipment normally placed on floors, the equipment shall be placed directly on the turntable.

For radiated emissions testing that is performed at distances closer than the specified distance; an inverse proportionality factor of 20 dB per decade is used to normalize the measured data for determining compliance.

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer/Receiver	Rohde & Schwarz	ESU40	V033119	06/06/2017	06/06/2018
Spectrum Analyzer	Hewlett Packard	8566B	V034141	02/15/2017	02/15/2018
Quasi-Peak Detector	Hewlett Packard	85650A	V039474	03/16/2017	03/16/2018
Loop Antenna	EMCO	6502	V034216	01/25/2017	01/25/2019
Biconilog Antenna	EMCO	3142E-PA	V035736	06/24/2016	06/24/2018
Double Ridged Guide Antenna	EMCO	3115	V033469	02/09/2016	02/09/2018
High Frequency Amplifier	Miteq	AFS4-001018000-35-10P-4	V033997	01/09/2017	01/09/2018
6' High Frequency Cable	Microcoax	UFB197C-0-0720-000000	V033638	01/09/2017	01/09/2018

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
20' High Frequency Cable	Microcoax	UFB197C-1-3120-000000	V033979	01/09/2017	01/09/2018
3 Meter Radiated Emissions Cable Wanship Upper Site	Microcoax	UFB205A-0-4700-000000	V033639	01/09/2017	01/09/2018
Test Software (FCC)	VPI Labs	Revision 01	V035673	N/A	N/A

**Table 4: List of equipment used for radiated emissions testing.**



**Figure 1: Radiated Emissions Test**

## 7.2 Equipment Calibration

All applicable equipment is calibrated using either an independent calibration laboratory or VPI Laboratories, Inc. personnel at intervals defined in ANSI C63.4:2014 following outlined calibration procedures. All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Supporting documentation relative to tractability is on file and is available for examination upon request.

## 7.3 Measurement Uncertainty

Test	Uncertainty ( $\pm$ dB)	Confidence (%)
Radiated Emission (9 kHz to 30 MHz)	3.3	95
Radiated Emissions (30 MHz to 1 GHz)	3.4	95

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<b>Test</b>	<b>Uncertainty (<math>\pm</math>dB)</b>	<b>Confidence (%)</b>
Radiated Emissions (1 GHz to 18 GHz)	5.0	95

## 8 Photographs

Photographs are requested to be held confidential and are included in documents filed for certification.

**--- End of Report ---**