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Test Report

Certification

FCC ID	2ADZ3B001
Equipment Under Test	KP003
Test Report Serial No	V036629_03
Dates of Test	June 14 and 29, 20016 July 18 and 25, 2016 August 15, 2016
Report Issue Date	August 29, 2016

Test Specifications:	**Applicant:**
FCC Part 15, Subpart C	Hidden Butler, Inc. 2185 Tracy Hall Parkway Provo, UT 84606 U.S.A

Testing
NVLAP Lab Code 100272-0

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.

Applicant	Hidden Butler, Inc.
Manufacturer	Hidden Butler, Inc.
Brand Name	TrackPIN
Model Number	KP003
FCC ID	2ADZ3B001

On this 29th day of August 2016, 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.

Norman P Hansen

Tested by: Norman P. Hansen

Test Technician

Mark M. Feil

Reviewed by: Mark M. Feil

Laboratory Coordinator

Revision History		
Revision	**Description**	**Date**
01	Original Report Release	August 29, 2016
02	Change FCC ID to 2ADZ3B001 and update section 2.2 to say "used for control in the TrackPIN enclosed area entry system."	September 8, 2016
03	Remove FHSS data for separate DTS and FHSS reports per TCB request	October 31, 2016

Table of Contents

1 Client Information

1.1 Applicant

Company Name	Hidden Butler, Inc. 2185 Tracy Hall Parkway Provo, UT 84606 U.S.A
Contact Name	Mark Hall
Title	President

1.2 Manufacturer

Company Name	Hidden Butler, Inc. 2185 Tracy Hall Parkway Provo, UT 84606 U.S.A
Contact Name	Mark Hall
Title	President

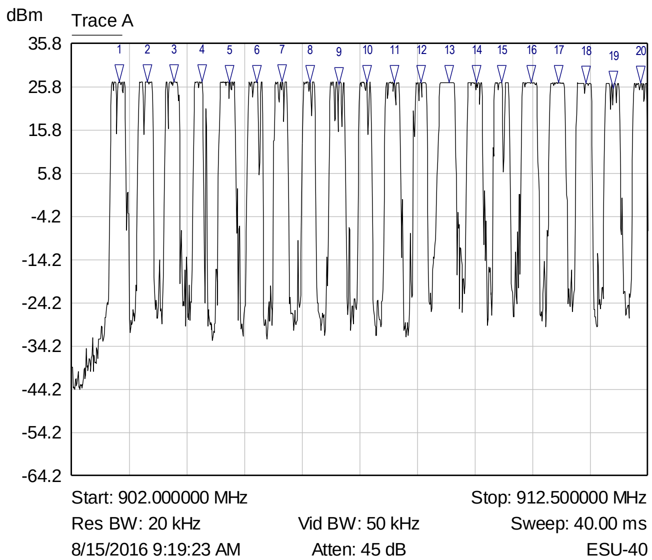
2 Equipment Under Test (EUT)

2.1 Identification of EUT

Brand Name	TrackPIN
Model Number	KP003
Hardware Version	V4.0
Serial Number	None
Dimensions (cm)	18.0 x 11.0 x 9.0

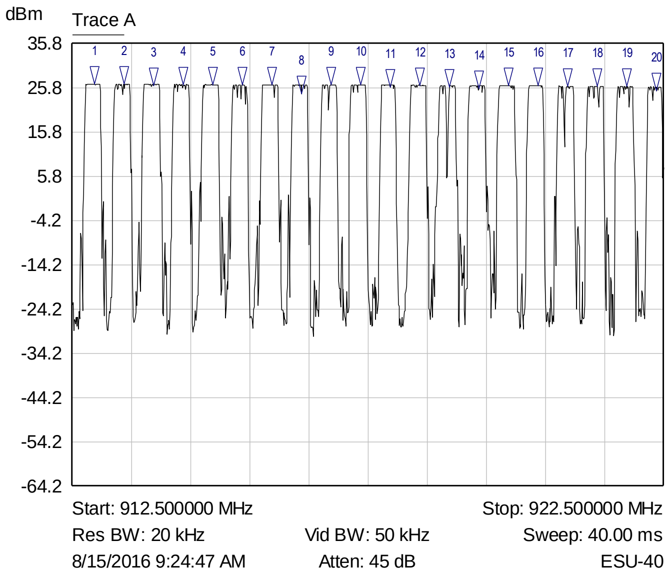
2.2 Description of EUT

The KP003 is keypad with a 902 – 928 MHz band transceiver used for control in the TrackPIN enclosed area entry system. Power is provided by 4 AA batteries. The transceiver operates using 50 channels in the 902 – 928 MHz frequency band using FHSS, DTS, or Hybrid operation. The antenna is a trace on the PCB. Plots of the channels are shown below.



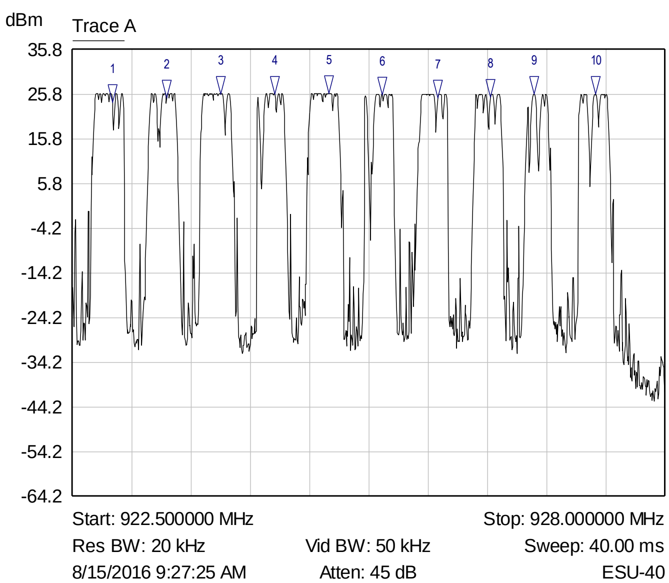
Mkr	Trace	X-Axis	Value
1	Trace A	902.871500 MHz	26.901644 dBm
2	Trace A	903.375500 MHz	26.890270 dBm
3	Trace A	903.869000 MHz	26.898317 dBm
4	Trace A	904.373000 MHz	26.925211 dBm
5	Trace A	904.877000 MHz	26.723669 dBm
6	Trace A	905.370500 MHz	26.815865 dBm
7	Trace A	905.832500 MHz	26.903566 dBm
8	Trace A	906.347000 MHz	26.828865 dBm
9	Trace A	906.872000 MHz	26.356121 dBm
10	Trace A	907.376000 MHz	26.872169 dBm
11	Trace A	907.880000 MHz	26.852697 dBm
12	Trace A	908.363000 MHz	26.811892 dBm
13	Trace A	908.877500 MHz	26.817587 dBm
14	Trace A	909.371000 MHz	26.781715 dBm
15	Trace A	909.833000 MHz	26.718191 dBm
16	Trace A	910.368500 MHz	26.735540 dBm
17	Trace A	910.872500 MHz	26.722616 dBm
18	Trace A	911.376500 MHz	26.679955 dBm
19	Trace A	911.870000 MHz	25.539040 dBm
20	Trace A	912.374000 MHz	26.631420 dBm

Graph 1: EUT Channel Plot



Mkr	Trace	X-Axis	Value
1	Trace A	912.870000 MHz	26.612617 dBm
2	Trace A	913.370000 MHz	26.590784 dBm
3	Trace A	913.870000 MHz	26.229607 dBm
4	Trace A	914.370000 MHz	26.525713 dBm
5	Trace A	914.870000 MHz	26.531010 dBm
6	Trace A	915.370000 MHz	26.516047 dBm
7	Trace A	915.870000 MHz	26.491621 dBm
8	Trace A	916.370000 MHz	24.417118 dBm
9	Trace A	916.870000 MHz	26.453691 dBm
10	Trace A	917.370000 MHz	26.384117 dBm
11	Trace A	917.870000 MHz	26.040337 dBm
12	Trace A	918.370000 MHz	26.341911 dBm
13	Trace A	918.870000 MHz	25.938259 dBm
14	Trace A	919.370000 MHz	25.590017 dBm
15	Trace A	919.870000 MHz	26.294870 dBm
16	Trace A	920.370000 MHz	26.251711 dBm
17	Trace A	920.870000 MHz	26.188444 dBm
18	Trace A	921.370000 MHz	26.136885 dBm
19	Trace A	921.870000 MHz	26.084986 dBm
20	Trace A	922.370000 MHz	25.166222 dBm

Graph 2: EUT Channel Plot



Mkr	Trace	X-Axis	Value
1	Trace A	922.868500 MHz	23.967474 dBm
2	Trace A	923.374500 MHz	25.002932 dBm
3	Trace A	923.875000 MHz	25.752474 dBm
4	Trace A	924.375500 MHz	25.841972 dBm
5	Trace A	924.876000 MHz	25.893160 dBm
6	Trace A	925.376500 MHz	25.644096 dBm
7	Trace A	925.888000 MHz	24.968328 dBm
8	Trace A	926.377500 MHz	25.198465 dBm
9	Trace A	926.784500 MHz	25.780762 dBm
10	Trace A	927.356500 MHz	25.752932 dBm

Graph 3: EUT Channel Plot

This report covers the 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 V036628.

2.3 EUT and Support Equipment

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

Brand Name Model Number Serial Number	Description	Name of Interface Ports / Interface Cables
BN: TrackPIN MN: KP003 (Note 1) SN: None	Keypad	See Section 2.4

Notes: (1) EUT

2.4 Interface Ports on EUT

There are no interface ports or the EUT.

2.5 Modification Incorporated/Special Accessories on EUT

The following modifications were made to the EUT by the Client during testing to comply with the specification. This report is not complete without an accompanying signed attestation, that the product will have all of the documented modifications incorporated into the product when manufactured and placed on the market.

- When operating as a Hybrid device, the maximum power setting in firmware was set to 0x02.
- When operating as a DTS, the maximum power setting in firmware was set to 0x04.

2.6 Deviation from Test Standard

There were no deviations from the test specification.

3 Test Specification, Methods and Procedures

3.1 Test Specification

Title	FCC PART 15, Subpart C (47 CFR 15) 15.203, 15.207, and 15.247 Limits and methods of measurement of radio interference characteristics of radio frequency devices.
Purpose of Test	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 μH/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 (dBμV)	
	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.

3.2.3 §15.247 Operation within the bands 902 – 928 MHz, 2400 – 2483.5 MHz, and 5725 – 5850 MHz

a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions.

1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400 – 2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudorandomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.

   i. For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies and the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period. The maximum allowed 20 dB bandwidth of the hopping channel is 500 kHz.

   ii. Frequency hopping systems operating in the 5725-5850 MHz band shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

   iii. Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 non-overlapping channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 non-overlapping channels are used.

2) Systems using digital modulation techniques may operate in the 902 - 928 MHz, 2400 - 2483.5 MHz, and 5725 - 5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

b) The maximum peak output power of the intentional radiator shall not exceed the following:

1) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

2) For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725 – 5850 MHz bands: 1 watt. As an alternative to a peak power measurement, compliance with the Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

c) Operation with directional antenna gains greater than 6 dBi.

1) Fixed point-to-point operation:

i. Systems operating in the 2400-2483.5 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi provided the maximum peak output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6 dBi.

ii. Systems operating in the 5725-5850 MHz band that are used exclusively for fixed, point-to-point operations may employ transmitting antennas with directional gain greater than 6 dBi without any corresponding reduction in transmitter peak output power.

iii. Fixed, point-to-point operation, as used in paragraphs (b)(4)(i) and (b)(4)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

2) In addition to the provisions in paragraphs (b)(1), (b)(3), (b)(4) and (c)(1)(i) of this section, transmitters operating in the 2400-2483.5 MHz band that emit multiple directional beams, simultaneously or sequentially, for the purpose of directing signals to individual receivers or to groups of receivers provided the emissions comply with the following:

i. Different information must be transmitted to each receiver.

ii. If the transmitter employs an antenna system that emits multiple directional beams but does not emit multiple directional beams simultaneously, the total output power conducted to the array or arrays that comprise the device, i.e., the sum of the power supplied to all antennas, antenna elements, staves, etc. and summed across all carriers or frequency channels, shall not exceed the limit specified in paragraph (b)(1) or (b)(3) of this section, as applicable. However, the total conducted output power shall be reduced by 1 dB below the specified limits for each 3 dB that the directional gain of the antenna /antenna array exceeds 6 dBi. The directional antenna gain shall be computed as follows:

A. The directional gain shall be calculated as the sum of 10 log (number of array elements or staves) plus the directional gain of the element or stave having the highest gain.

B. A lower value for the directional gain than that calculated in paragraph (c)(2)(ii)(A) of this section will be accepted if sufficient evidence is presented, e.g., due to shading of the array or coherence loss in the beamforming.

iii. If a transmitter employs an antenna that operates simultaneously on multiple directional beams using the same or different frequency channels, the power supplied to each emission beam is subject to the power limit specified in paragraph (c)(2)(ii) of this section. If transmitted beams overlap, the power shall be reduced to ensure that their aggregate power does not exceed the limit specified in paragraph (c)(2)(ii) of this section. In addition, the aggregate power transmitted simultaneously on all beams shall not exceed the limit specified in paragraph (c)(2)(ii) of this section by more than 8 dB.

iv. Transmitters that emit a single directional beam shall operate under the provisions of paragraph (c)(1) of this section.

d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The digital modulation operation of the hybrid system, with the frequency hopping turned off, shall comply with the power density requirements of paragraph (d) of this section.

g) Frequency hopping spread spectrum systems are not required to employ all available hopping channels during each transmission. However, the system, consisting of both the transmitter and the receiver, must be designed to comply with all of the regulations in this section should the transmitter be presented with a continuous data (or information) stream. In addition, a system employing short transmission bursts must comply with the definition of a frequency hopping system and must distribute its transmissions over the minimum number of hopping channels specified in this section.

h) The incorporation of intelligence within a frequency hopping spread spectrum system that permits the system to recognize other users within the spectrum band so that it individually and independently chooses and adapts its hopsets to avoid hopping on occupied channels is permitted. The coordination of frequency hopping systems in any other manner for the express purpose of avoiding the simultaneous occupancy of individual hopping frequencies by multiple transmitters is not permitted.

i) Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Note: Spread spectrum systems are sharing these bands on a noninterference basis with systems supporting critical Government requirements that have been allocated the usage of these bands, secondary only to ISM equipment operated under the provisions of Part 18 of this Chapter. Many of these Government systems are airborne radiolocation systems that emit a high EIRP which can cause interference to other users. Also, investigations of the effect of spread spectrum interference to U. S. Government operations in the 902-928 MHz band may require a future decrease in the power limits allowed for spread spectrum operation.

3.3 Test Procedure

The testing was performed according to the procedures in ANSI C63.10-2013 and 47 CFR Part 15. Testing was performed at the VPI Laboratories, Inc. Wanship open area test site #2, 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, 2016.

4 Operation of EUT During Testing

4.1 Operating Environment

Power Supply	6 VDC from 4 – AA batteries

4.2 Operating Modes

The transmitter was tested while in a constant transmit mode at the upper, middle, and lower channels. Full testing to the requirements for a DTS and for an FHSS device was performed. The device was also tested to the transmit timing and PSD requirements for a Hybrid device. This report covers the DTS testing as well as the channel timing when the device operates as a hybrid device. New batteries were installed for testing.

4.3 EUT Exercise Software

The software used in testing was FCC Test V1.00. This software allowed for the EUT to transmit in the different mode required to fully test. The output power was also configurable using this software.

5 Summary of Test Results

5.1 FCC Part 15, Subpart C

5.1.1 Summary of Tests

Section	Environmental Phenomena	Frequency Range (MHz)	Result
15.203	Antenna Requirements	Structural requirement	Complied
15.207	Conducted Disturbance at Mains Ports	0.15 to 30	Not Applicable
15.247(a) FHSS	Channel Separation	902 – 928	Not Applicable
15.247(a) FHSS	20 dB Bandwidth	902 – 928	Not Applicable
15.247(a) FHSS	Time of Occupancy	902 – 928	Not Applicable
15.247 (a) DTS	6 dB Bandwidth	902 – 928	Complied
15.247(b) FHSS	Peak Output Power	902 – 928	Not Applicable
15.247(b) DTS	Average Output Power	902 – 928	Complied
15.247(d)	Antenna Conducted Spurious Emissions	0.009 – 9300	Complied
15.247(d)	Emissions in the Restricted Bands	0.009 – 9300	Complied
15.247(e) DTS	3 kHz Power Spectral Density	902 – 928	Complied
15.247(f) Hybrid	Time of Occupancy	902 – 928	Complied
15.247(f) Hybrid	3 kHz Power Spectral Density	902 – 928	Not Applicable
15.247(g)	Channel Usage	902 – 928	Complied (Note 1)
15.247(h)	Channel Intelligence/Avoidance	902 – 928	Complied (Note 1)
15.247(i)	RF Exposure	902 – 928	Complied (Note 1)
Note 1: Compliance with these requirements is shown in documents filed with the FCC at the time of Certification.			

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 uses a trace on the PCB as the antenna, has a maximum gain of 3.17 dBi, and is not user replaceable.

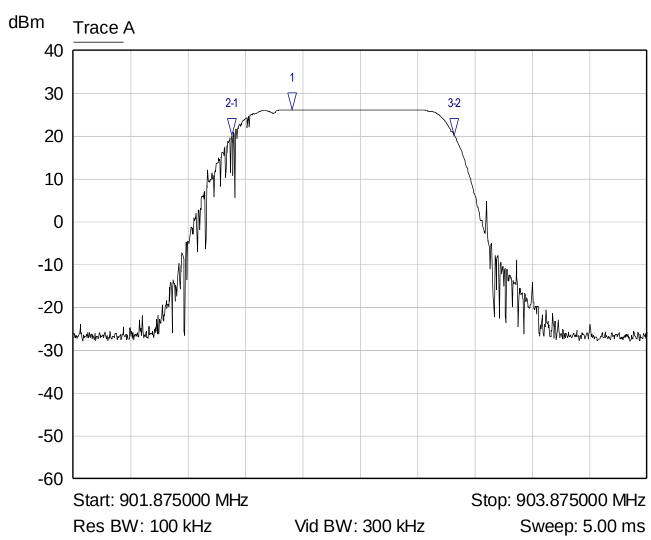
Result

The EUT complied with the specification.

6.2.2 §15.247(a) 6 dB Bandwidth – DTS

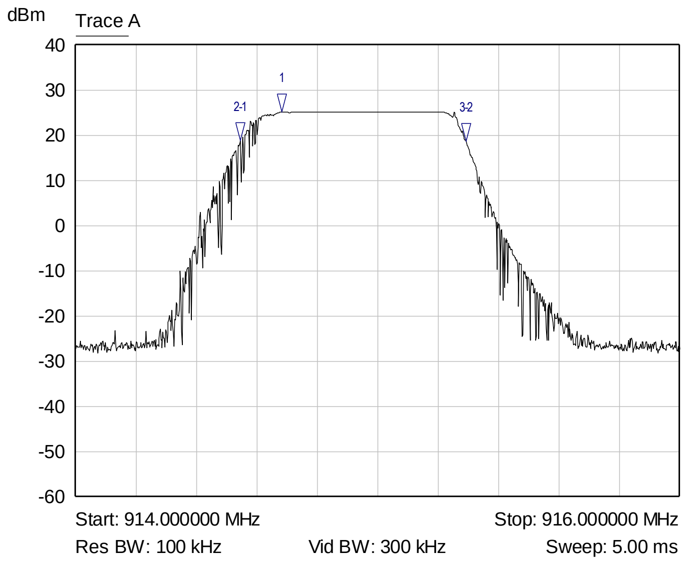
A DTS system must use a minimum 500 kHz 6 dB bandwidth. The plots below show the 6 dB emission bandwidth when operating as a DTS system.

Frequency (MHz)	Emissions 6 dB bandwidth (kHz)
902.875	776
915.000	748
927.375	786



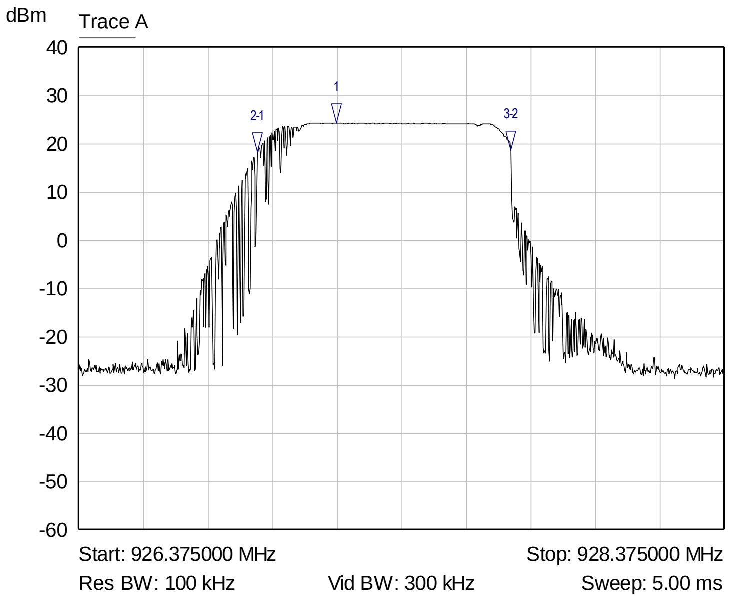
Mkr	Trace	X-Axis	Value	Notes
1	Trace A	902.637000 MHz	26.210000 dBm	
2-1	Trace A	-210.000000 kHz	-6.077000 dB	
3-2	Trace A	776.000000 kHz	-0.014000 dB	

Graph 4: Lowest Channel 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	914.682000 MHz	25.203000 dBm	
2-1 ▽	Trace A	-138.000000 kHz	-6.360000 dB	
3-2 ▽	Trace A	748.000000 kHz	-0.205000 dB	

Graph 5: Middle Channel 6 dB Bandwidth



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	927.173000 MHz	24.310000 dBm	
2-1 ▽	Trace A	-246.000000 kHz	-5.979000 dB	
3-2 ▽	Trace A	786.000000 kHz	0.253000 dB	

Graph 6: Highest Channel 6 dB Bandwidth

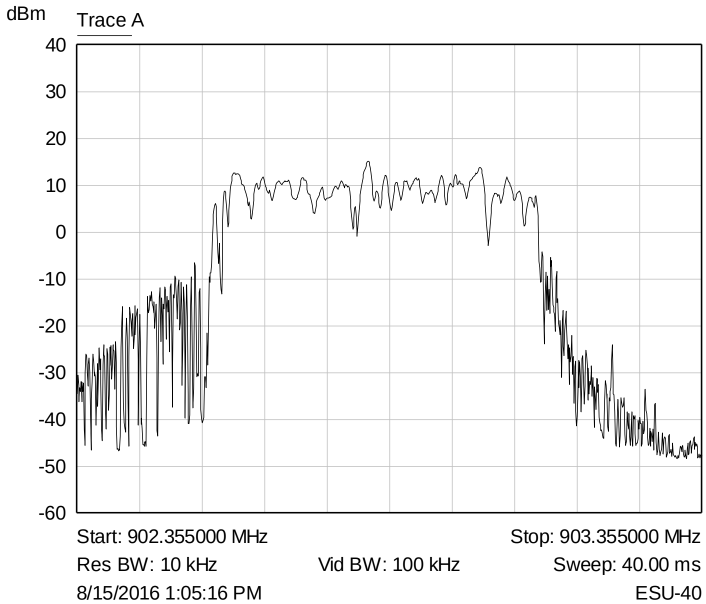
Result

The EUT complies with the specification as the 6 dB bandwidth is greater than 500 kHz.

6.2.3 §15.247(b) Average Output Power

The antenna used with the EUT has a gain of 3.17 dBi. The limit for this device is 30 dBm or 1 Watt. Plots are shown below and the results of this testing are summarized in the table.

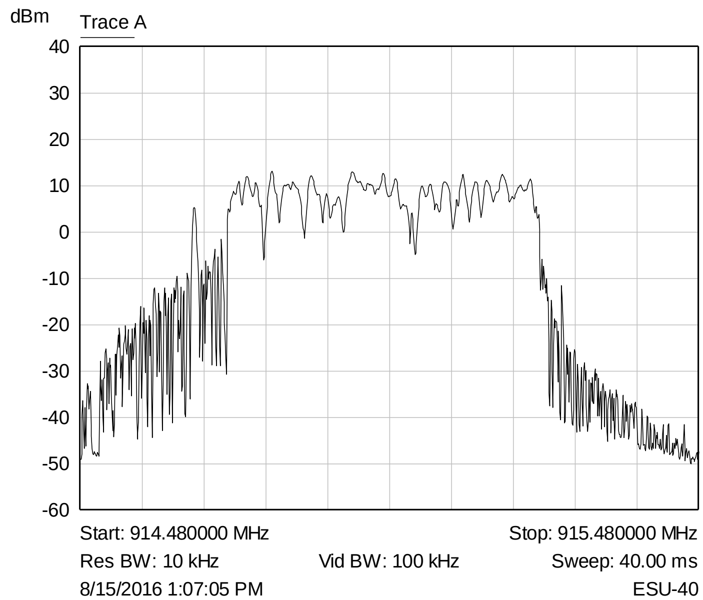
Frequency (MHz)	Measurement (dBm)	Peak Output Power (mW)
902.875	26.17	414.00
915.000	25.45	350.75
927.375	24.69	294.44



Trace A

Measurement Parameter	Value
Channel power	26.170652 dBm

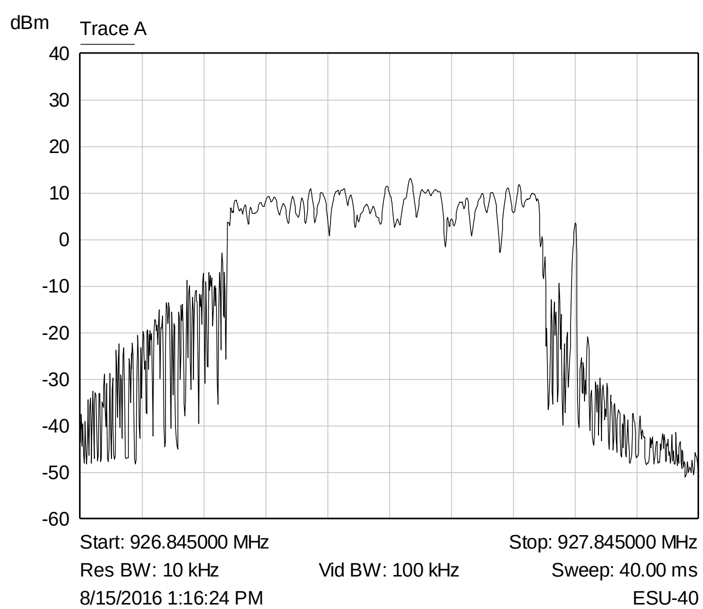
Graph 7: Lowest Channel Average Power Output Power



Trace A

Measurement Parameter	Value
Channel power	25.448742 dBm

Graph 8: Middle Channel Average Power Output Power



Trace A

Measurement Parameter	Value
Channel power	24.685271 dBm

Graph 9: Highest Channel Average Power Output Power

Result

In the configuration tested, the RF Average output power was less than 1 Watt; therefore, the EUT complied with the requirements of the specification.

6.2.4 §15.247(d) Conducted Spurious Emissions

The frequency range from the lowest frequency generated or used in the device to the tenth harmonic of the highest fundamental frequency was investigated to measure any antenna-conducted emissions. The tables show the measurement data from spurious emissions noted across the frequency range when transmitting at the lowest frequency, middle frequency, and upper frequency. Shown is a plot showing the channels of the operating band remaining in the specified band of 902 – 928 MHz.

The highest emissions seen are reported below. Average power measurement usage in order to demonstrate compliance specifies that the emissions will be attenuated a minimum of 30 dB below the highest level measured within the authorized band using a 100 kHz RBW. The highest power measured was 26.2 dBm; therefore, the criteria is 26.2 – 30 = -3.8 dBm.

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)	Margin (dB)
1805.75	-39.1	-3.8	-35.3
2708.63	-41.8	-3.8	-38.0
3611.50	-40.6	-3.8	-36.8
4514.37	-41.5	-3.8	-37.7
5417.25	-40.9	-3.8	-37.1
6320.12	-42.7	-3.8	-38.9
7223.00	-41.1	-3.8	-37.3
8125.87	-40.8	-3.8	-37.0
9028.75	-39.8	-3.8	-36.0

Table 2: Transmitting on the Lowest Channel

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)	Margin (dB)
1830.00	-38.9	-3.8	-35.1
2745.00	-40.7	-3.8	-36.9
3660.00	-41.5	-3.8	-37.7
4575.00	-41.8	-3.8	-38.0
5490.00	-40.6	-3.8	-36.8
6405.00	-41.2	-3.8	-37.4
7320.00	-41.8	-3.8	-38.0
8235.00	39.9	-3.8	43.7
9150.00	-40.2	-3.8	-36.4

Table 3: Transmitting on the Middle Channel

Frequency (MHz)	Corrected Level (dBm)	Criteria (dBm)	Margin (dB)
1854.75	-38.6	-3.8	-34.8
2782.13	-40.9	-3.8	-37.1
3709.50	-42.0	-3.8	-38.2
4636.88	-41.6	-3.8	-37.8
5564.25	-40.8	-3.8	-37.0
6491.63	-41.8	-3.8	-38.0
7419.00	-41.3	-3.8	-37.5
8346.38	-40.6	-3.8	-36.8
9273.75	-42.1	-3.8	-38.3

Table 4: Transmitting on the Highest Channel

Result

Conducted spurious emissions were attenuated 30 dB or more from the fundamental; therefore, the EUT complies with the specification.

6.2.5 Radiated Spurious Emissions in the Restricted Bands of §15.205

The frequency range from the lowest frequency generated or used in the device to the tenth harmonic of the highest fundamental emission was investigated to measure any radiated emissions in the restricted bands. The following tables show measurements of any emission that fell into the restricted bands of §15.205. The tables show the worst-case emission measured from the EUT in any operational mode. The noise floor was a minimum of 6 dB below the limit. The emissions in the restricted bands must meet the limits specified in

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBµV)	Correction Factor (dB)	Field Strength (dBµV/m)	Limit (dBµV/m)	Margin (dB)
2708.6	Peak	Vertical	10.1	33.6	43.7	74.0	-30.3
2708.6	Average	Vertical	5.8	33.6	39.4	54.0	-14.6
2708.6	Peak	Horizontal	14.7	33.6	48.3	74.0	-25.7
2708.6	Average	Horizontal	11.8	33.6	45.4	54.0	-8.6
3611.5	Peak	Vertical	14.4	36.7	51.1	74.0	-22.9
3611.5	Average	Vertical	9.4	36.7	46.1	54.0	-7.9
3611.5	Peak	Horizontal	15.3	36.7	52.0	74.0	-22.0
3611.5	Average	Horizontal	10.9	36.7	47.6	54.0	-6.4
4514.4	Peak	Vertical	9.8	38.3	48.1	74.0	-25.9
4514.4	Average	Vertical	2.8	38.3	41.1	54.0	-12.9

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4514.4	Peak	Horizontal	11.3	38.3	49.6	74.0	-24.4
4514.4	Average	Horizontal	5.0	38.3	43.3	54.0	-10.7
5417.2	Peak	Vertical	4.0	40.4	44.4	74.0	-29.6
5417.2	Average	Vertical	-1.7	40.4	38.7	54.0	-15.3
5417.2	Peak	Horizontal	3.6	40.4	44.0	74.0	-30.0
5417.2	Average	Horizontal	-2.3	40.4	38.1	54.0	-15.9
7223.0	Peak	Vertical	4.6	43.6	48.2	74.0	-25.8
7223.0	Average	Vertical	-0.9	43.6	42.7	54.0	-11.3
7223.0	Peak	Horizontal	7.7	43.6	51.3	74.0	-22.7
7223.0	Average	Horizontal	-2.9	43.6	40.7	54.0	-13.3
8125.8	Peak	Vertical	5.3	45.3	50.6	74.0	-23.4
8125.8	Average	Vertical	-7.2	45.3	38.1	54.0	-15.9
8125.8	Peak	Horizontal	7.4	45.3	52.7	74.0	-21.3
8125.8	Average	Horizontal	-4.1	45.3	41.2	54.0	-12.8
9028.8	Peak	Vertical	2.5	46.8	49.3	74.0	-24.7
9028.8	Average	Vertical	-8.5	46.8	38.3	54.0	-15.7
9028.8	Peak	Horizontal	5.0	46.8	51.8	74.0	-22.2
9028.8	Average	Horizontal	-7.1	46.8	39.7	54.0	-14.3

Table 5: Transmitting at the Lowest Frequency

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2745.0	Peak	Vertical	10.4	33.7	44.1	74.0	-29.9
2745.0	Average	Vertical	4.9	33.7	38.6	54.0	-15.4
2745.0	Peak	Horizontal	14.0	33.7	47.7	74.0	-26.3
2745.0	Average	Horizontal	10.0	33.7	43.7	54.0	-10.3
3660.0	Peak	Vertical	8.2	36.8	45.0	74.0	-29.0
3660.0	Average	Vertical	1.0	36.8	37.8	54.0	-16.2
3660.0	Peak	Horizontal	7.4	36.8	44.2	74.0	-29.8
3660.0	Average	Horizontal	-0.3	36.8	36.5	54.0	-17.5
4575.0	Peak	Vertical	12.2	38.5	50.7	74.0	-23.3
4575.0	Average	Vertical	6.1	38.5	44.6	54.0	-9.4
4575.0	Peak	Horizontal	12.3	38.5	50.8	74.0	-23.2

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
4575.0	Average	Horizontal	5.7	38.5	44.2	54.0	-9.8
5490.0	Peak	Vertical	2.7	40.6	43.3	74.0	-30.7
5490.0	Average	Vertical	-4.7	40.6	35.9	54.0	-18.1
5490.0	Peak	Horizontal	3.5	40.6	44.1	74.0	-29.9
5490.0	Average	Horizontal	-4.2	40.6	36.4	54.0	-17.6
7320.0	Peak	Vertical	2.8	43.9	46.7	74.0	-27.3
7320.0	Average	Vertical	-9.1	43.9	34.8	54.0	-19.2
7320.0	Peak	Horizontal	5.0	43.9	48.9	74.0	-25.1
7320.0	Average	Horizontal	-6.3	43.9	37.6	54.0	-16.4
8235.0	Peak	Vertical	3.7	45.5	49.2	74.0	-24.8
8235.0	Average	Vertical	-5.6	45.5	39.9	54.0	-14.1
8235.0	Peak	Horizontal	4.3	45.5	49.8	74.0	-24.2
8235.0	Average	Horizontal	-7.6	45.5	37.9	54.0	-16.1
9150.0	Peak	Vertical	4.7	46.9	51.6	74.0	-22.4
9150.0	Average	Vertical	-8.1	46.9	38.8	54.0	-15.2
9150.0	Peak	Horizontal	4.3	46.9	51.2	74.0	-22.8
9150.0	Average	Horizontal	-7.9	46.9	39.0	54.0	-15.0

Table 6: Transmitting at the Middle Frequency

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2782.1	Peak	Vertical	12.4	33.9	46.3	74.0	-27.7
2782.1	Average	Vertical	8.3	33.9	42.2	54.0	-11.8
2782.1	Peak	Horizontal	12.4	33.9	46.3	74.0	-27.7
2782.1	Average	Horizontal	7.1	33.9	41.0	54.0	-13.0
3709.5	Peak	Vertical	10.4	37.0	47.4	74.0	-26.6
3709.5	Average	Vertical	4.1	37.0	41.1	54.0	-12.9
3709.5	Peak	Horizontal	8.6	37.0	45.6	74.0	-28.4
3709.5	Average	Horizontal	1.8	37.0	38.8	54.0	-15.2
4638.9	Peak	Vertical	9.6	38.6	48.2	74.0	-25.8
4638.9	Average	Vertical	3.8	38.6	42.4	54.0	-11.6
4638.9	Peak	Horizontal	7.8	38.6	46.4	74.0	-27.6
4638.9	Average	Horizontal	0.9	38.6	39.5	54.0	-14.5

Frequency (MHz)	Detector	Antenna Polarity	Receiver Reading (dBμV)	Correction Factor (dB)	Field Strength (dBμV/m)	Limit (dBμV/m)	Margin (dB)
5564.3	Peak	Vertical	7.8	40.7	48.5	74.0	-25.5
5564.3	Average	Vertical	0.2	40.7	40.9	54.0	-13.1
5564.3	Peak	Horizontal	8.2	40.7	48.9	74.0	-25.1
5564.3	Average	Horizontal	0.5	40.7	41.2	54.0	-12.8
7419.0	Peak	Vertical	5.2	44.2	49.4	74.0	-24.6
7419.0	Average	Vertical	-5.0	44.2	39.2	54.0	-14.8
7419.0	Peak	Horizontal	7.4	44.2	51.6	74.0	-22.4
7419.0	Average	Horizontal	-2.8	44.2	41.4	54.0	-12.6
8346.4	Peak	Vertical	3.1	45.7	48.8	74.0	-25.2
8346.4	Average	Vertical	-6.9	45.7	38.8	54.0	-15.2
8346.4	Peak	Horizontal	1.8	45.7	47.5	74.0	-26.5
8346.4	Average	Horizontal	-6.9	45.7	38.8	54.0	-15.2
9273.8	Peak	Vertical	1.3	47.0	48.3	74.0	-25.7
9273.8	Average	Vertical	-9.5	47.0	37.5	54.0	-16.5
9273.8	Peak	Horizontal	2.3	47.0	49.3	74.0	-24.7
9273.8	Average	Horizontal	-9.4	47.0	37.6	54.0	-16.4

Table 7: Transmitting at the Highest Frequency

No other emissions were seen in the restricted bands.

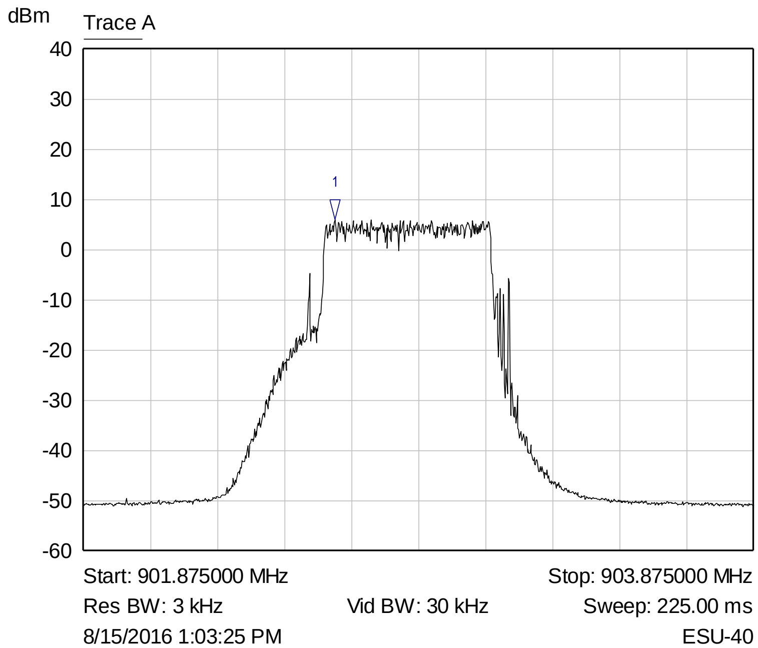
Result

The radiated spurious emissions in the restricted bands met the limits specified in §15.209; therefore, the EUT complies with the specification.

6.2.6 §15.247(e) Maximum Power Spectral Density

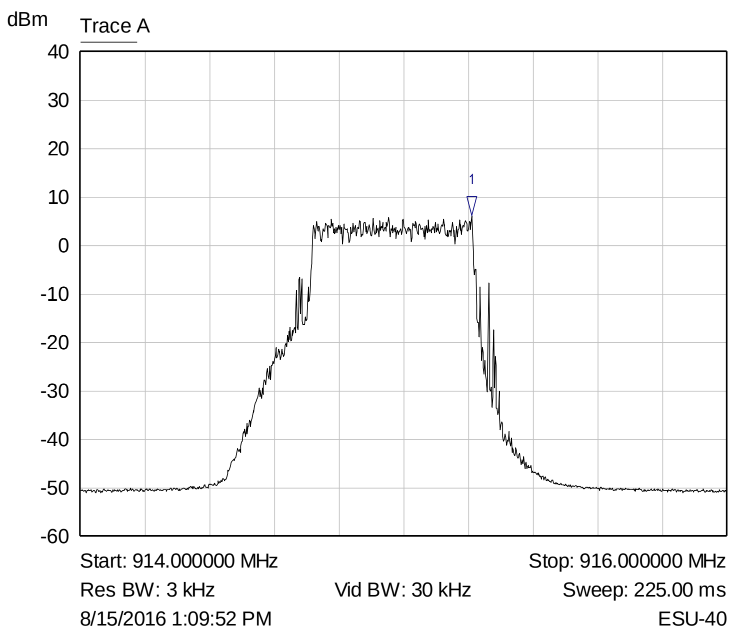
When operating as a DTS device, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. Since the average output power was used, spectral density must be measured using average. Results of this testing are summarized.

Frequency (MHz)	3 kHz Power Spectral Density (dBm)
902.875	6.00
915.000	6.16
927.375	4.68



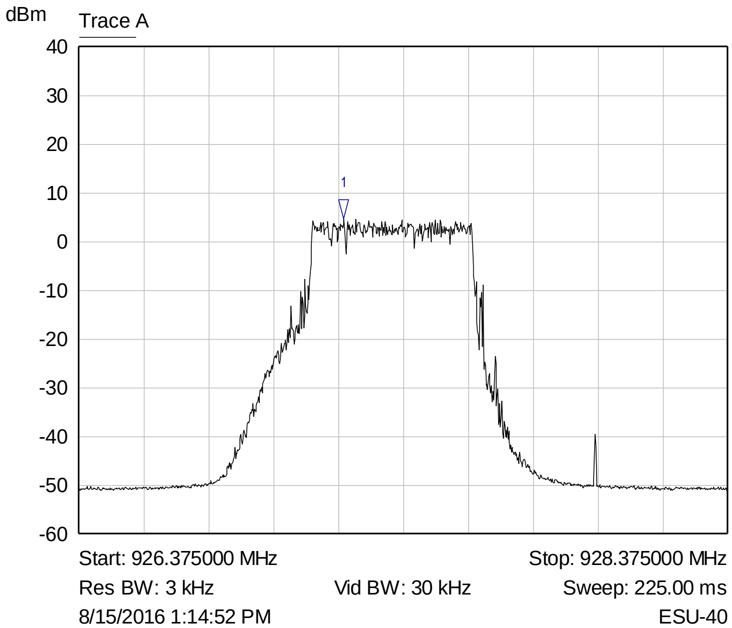
Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	902.625000 MHz	6.002326 dBm	

Graph 10: Lower Channel Spectral Density



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	915.210000 MHz	6.159004 dBm	

Graph 11: Middle Channel Spectral Density



Mkr	Trace	X-Axis	Value	Notes
1 ▽	Trace A	927.191000 MHz	4.676520 dBm	

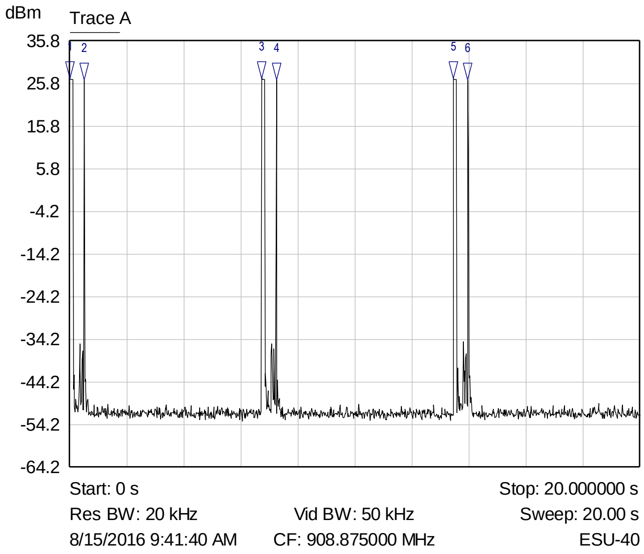
Graph 12: Highest Channel Spectral Density

Result

The 3 kHz power spectral density was 6.16 dBm, less than the limit of 8 dBm; therefore, the EUT complies with the specification.

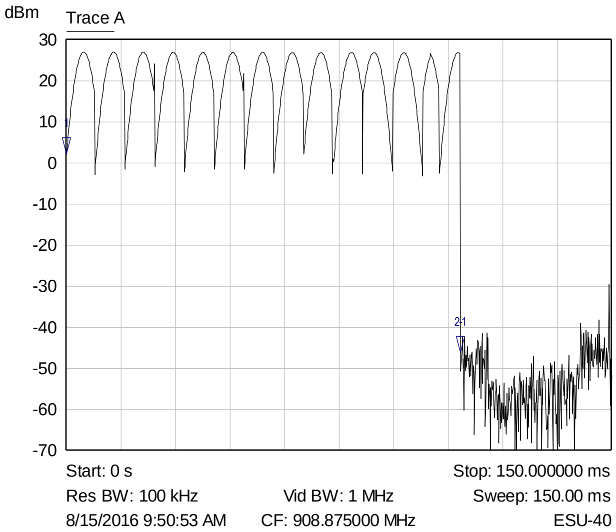
6.2.7 §15.247(f) Hybrid Operation – Time of Occupancy

The EUT shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping feequencies employed multiplied by 0.4. The EUT uses 50 hopping channels. The EUT must have a dwell time of less than 0.4 seconds in 20 seconds (0.4 x 50 = 20 seconds). Plots and calculations are shown below.



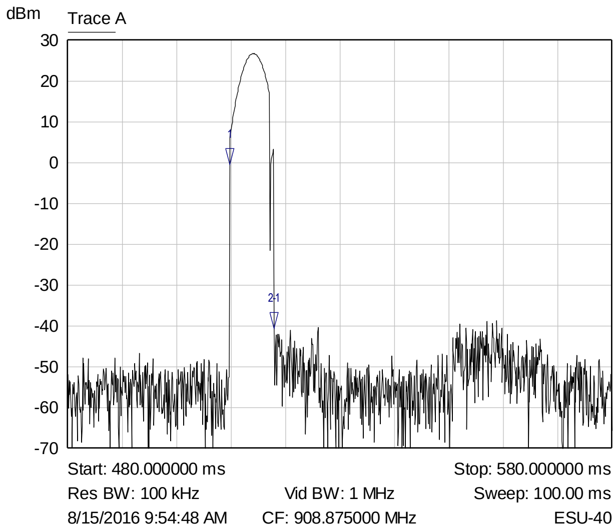
Mkr	Trace	X-Axis	Value
1 ▽	Trace A	0 s	26.901037 dBm
2 ▽	Trace A	500.000000 ms	26.652733 dBm
3 ▽	Trace A	6.720000 s	26.901850 dBm
4 ▽	Trace A	7.240000 s	26.660881 dBm
5 ▽	Trace A	13.460000 s	26.926062 dBm
6 ▽	Trace A	13.960000 s	26.669474 dBm

Graph 13: Channel Hits in 20 Seconds



Mkr	Trace	X-Axis	Value
1 ▽	Trace A	0 s	2.169917 dBm
2-1 ▽	Trace A	108.300000 ms	-48.369200 dB

Graph 14: Timing Plot Duration of the Wide Transmissions Shown in Graph 24



Mkr	Trace	X-Axis	Value
1 ∇	Trace A	509.700000 ms	-0.425687 dBm
2-1 ∇	Trace A	8.200000 ms	-40.260657 dB

Graph 15: Timing Plot Duration of the Narrow Transmissions Shown in Graph 24

From the plots, the EUT transmits up to 6 times per second in 20 seconds. There are 3 transmissions with a 108.3 ms duration and 3 transmissions with an 8.2 ms duration. The total on time in 20 seconds on one channel is 233 ms ((108.3 x 3) + (8.2 x 3) = 349.5 ms).

Result

The EUT complies with the specification as the EUT transmits on an individual channel for a maximum of 349.5 milliseconds in 20 seconds, less than the 0.4 seconds allowed by the specification.

7 Test Procedures and Test Equipment

7.1 Conducted Emissions at Mains Ports

The conducted emissions at mains and telecommunications ports from the EUT were measured using a spectrum analyzer with a quasi-peak adapter for peak, quasi-peak and average readings. The quasi-peak adapter uses a bandwidth of 9 kHz, with the spectrum analyzer's resolution bandwidth set at 100 kHz, for readings in the 150 kHz to 30 MHz frequency ranges.

The conducted emissions at mains ports measurements are performed in a screen room using a (50 Ω/50 μH) Line Impedance Stabilization Network (LISN).

Where mains flexible power cords are longer than 1 m, the excess cable is folded back and forth as far as possible so as to form a bundle not exceeding 0.4 m in length.

Where the EUT is a collection of devices with each device having its own power cord, the point of connection for the LISN is determined from the following rules:

- Each power cord, which is terminated in a mains supply plug, shall be tested separately.
- Power cords, which are not specified by the manufacturer to be connected via a host unit, shall be tested separately.
- Power cords which are specified by the manufacturer to be connected via a host unit or other power supplying equipment shall be connected to that host unit and the power cords of that host unit connected to the LISN and tested.
- Where a special connection is specified, the necessary hardware to effect the connection is supplied by the manufacturer for the testing purpose.
- When testing equipment with multiple mains cords, those cords not under test are connected to an artificial mains network (AMN) different than the AMN used for the mains cord under test.

For testing, desktop EUT are placed on a non-conducting table at least 0.8 meters from the metallic floor and placed 40 cm from the vertical coupling plane (copper plating in the wall behind EUT table). Floor standing equipment is placed directly on the earth grounded floor.

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer	Hewlett Packard	8566B	V034141	03/28/2016	03/28/2017
Quasi-Peak Detector	Hewlett Packard	85650A	V033345	03/03/2016	03/03/2017
LISN	VPI Labs	LISN-COMM-50	V034042	02/26/2016	02/26/2017
Conductance Cable Wanship Site #2	VPI Labs	Cable J	V034832	01/11/2016	01/11/2017
Transient Limiter	Hewlett Packard	11947A	V033591	01/11/2016	01/11/2017
Test Software (AC)	VPI Labs	Revision 01	V035674	N/A	N/A

Table 8: List of equipment used for conducted emissions testing at mains ports.

All the equipment listed above 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.

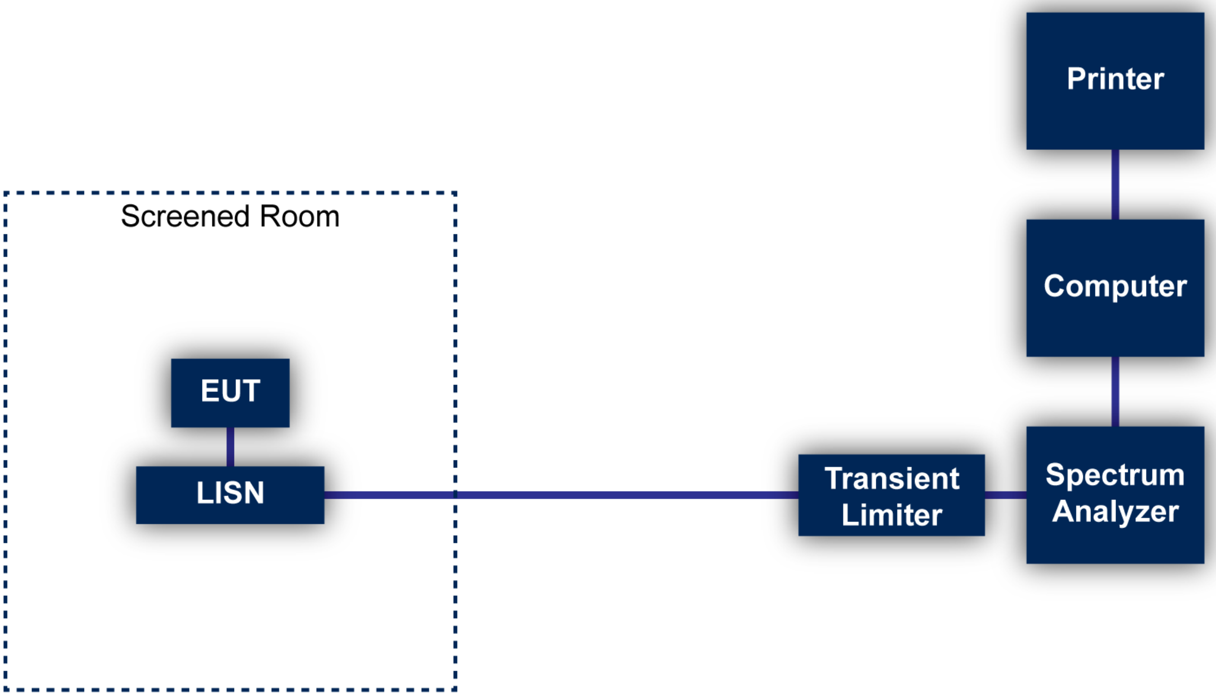


Figure 1: Conducted Emissions Test

7.2 Direct Connection at the Antenna Port Test

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Spectrum Analyzer/Receiver	Rohde & Schwarz	ESU40	V033119	06/17/2016	06/17/2017
6 dB Attenuator	Pasternack	PE7004-6	V033645	01/15/2016	01/15/2017
20 dB Attenuator	Fairview	SA18N10W-20	V034159	01/15/2016	01/15/2017
Low Loss Cable	N/A	N/A	V034173	01/15/2016	01/15/2017

An independent calibration laboratory or VPI Laboratories, Inc. personnel calibrates all the equipment listed above 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.

7.2.1 Test Configuration Block Diagram

Figure 2: Direct Connection at the Antenna Port Test

7.3 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	06/17/2016	06/17/2017
Spectrum Analyzer	Hewlett Packard	8566B	V034141	03/28/2016	03/28/2017

Type of Equipment	Manufacturer	Model Number	Asset Number	Date of Last Calibration	Due Date of Calibration
Quasi-Peak Detector	Hewlett Packard	85650A	V033345	03/03/2016	03/03/2017
Loop Antenna	EMCO	6502	V034216	10/01/2014	10/01/2016
Biconilog Antenna	EMCO	3142E-PA	V035736	06/24/2016	06/24/2017
Double Ridged Guide Antenna	EMCO	3115	V033469	02/09/2016	02/09/2018
High Frequency Amplifier	Miteq	AFS4-001018000-35-10P-4	V033997	01/15/2016	01/15/2017
900 MHz High Pass Filter	Micro-Tronics	HPM50108-03	V034185	01/15/2016	01/15/2017
6' High Frequency Cable	Microcoax	UFB197C-0-0720-000000	V033638	01/11/2016	01/11/2017
20' High Frequency Cable	Microcoax	UFB197C-1-3120-000000	V033979	01/15/2016	01/15/2017
3 Meter Radiated Emissions Cable Wanship Site #2	Microcoax	UFB205A-0-4700-000000	V033639	01/11/2016	01/11/2017
Pre/Power-Amplifier	Hewlett Packard	8447F	V034218	09/18/2015	09/18/2016
Test Software (FCC)	VPI Labs	Revision 01	V035673	N/A	N/A

Table 9: List of equipment used for radiated emissions testing.

All the equipment listed above 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.

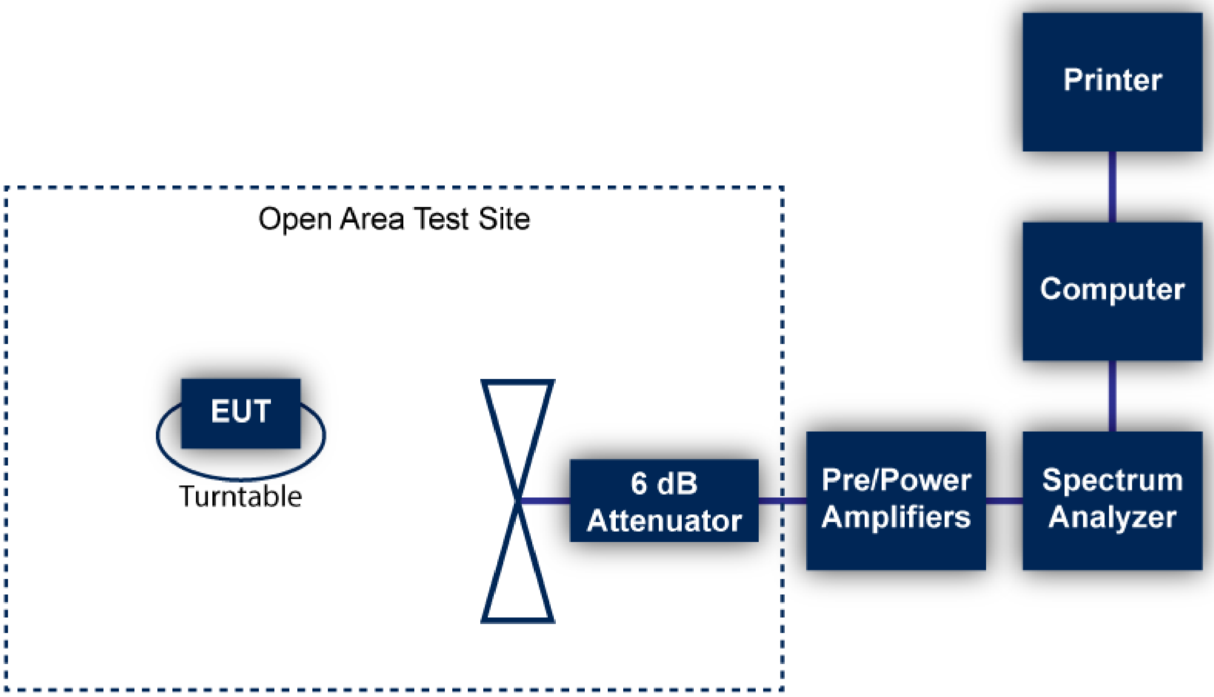


Figure 3: Radiated Emissions Test

7.4 Measurement Uncertainty

Test	Uncertainty (±dB)	Confidence (%)
Conducted Emissions	2.8	95
Radiated Emission (9 kHz to 30 MHz)	3.3	95
Radiated Emissions (30 MHz to 1 GHz)	3.4	95
Radiated Emissions (1 GHz to 18 GHz)	5.0	95

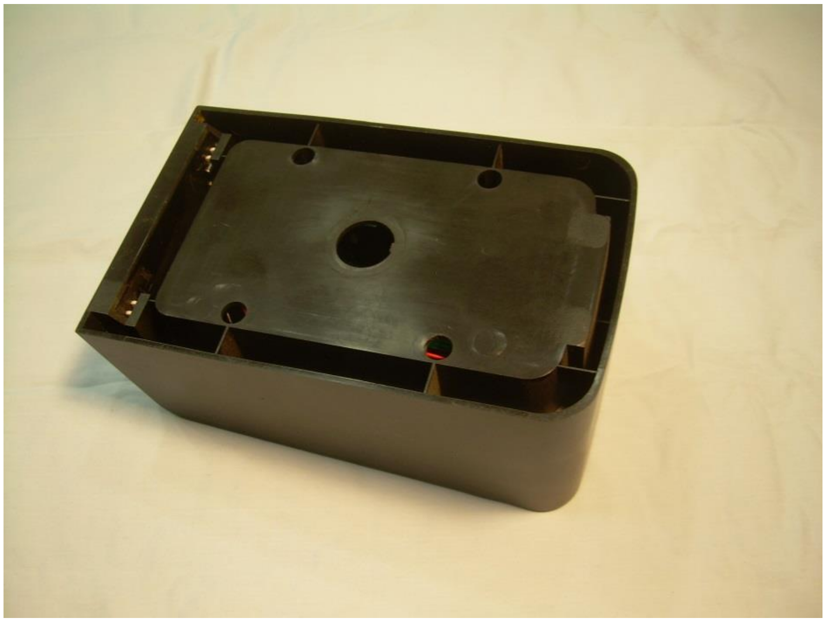
8 Photographs

Photograph 1: Front View Radiated Emissions Worst-Case Configuration – Emissions Below 1000 MHz

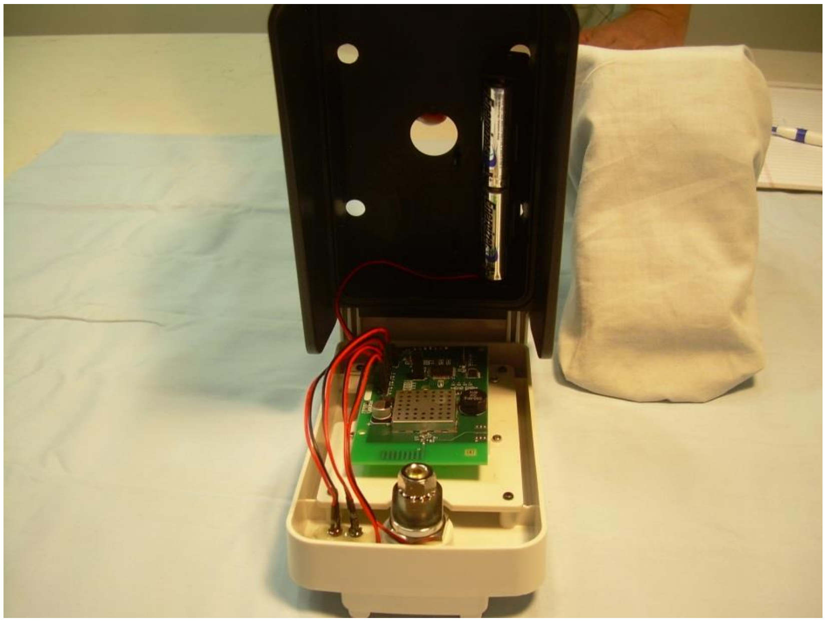
Photograph 2: Back View Radiated Emissions Worst-Case Configuration – Emissions Below 1000 MHz

Photograph 3: Front View Radiated Emissions Worst-Case Configuration – Emissions Above 1000 MHz

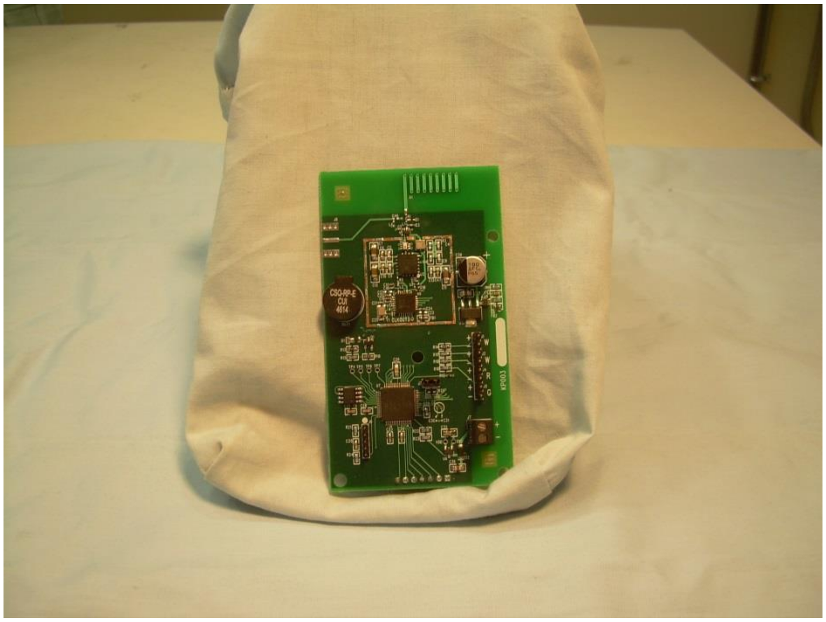
Photograph 4 - Front View of the KP003



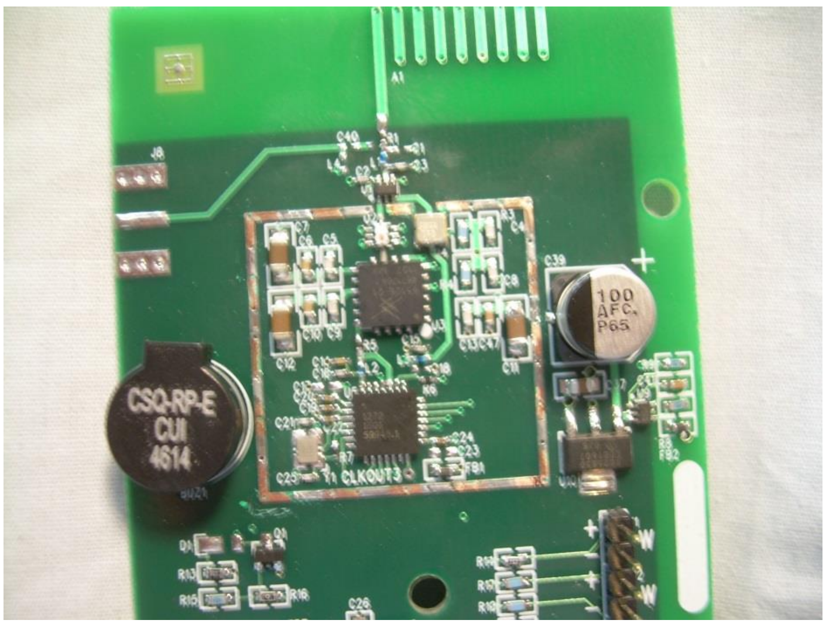
Photograph 5 - Back View Of the KP003



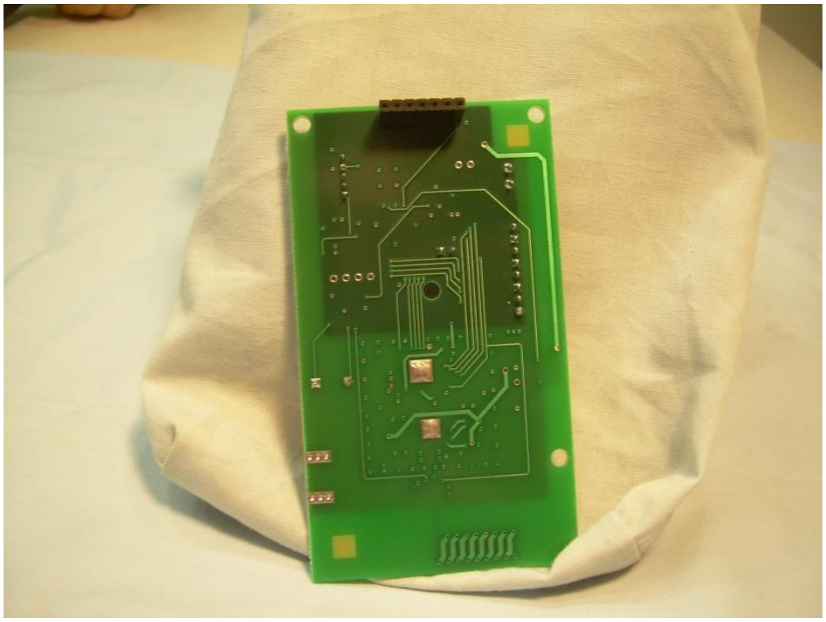
Photograph 6 – View of the KP003 with the Housing Open



Photograph 7 – View of the Component Side of the PCB with RF Shield Removed



Photograph 8 – View of the Circuitry Under the RF Shield



Photograph 9 – View of the Trace Side of the PCB

--- End of Report ---