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Test Report

Prepared for: Solar Roadways

Model: Solar Panel

Description: Solar Panels with LEDs for Roadway

Serial Number: SR050

FCC ID: 2A2MS-SR046

IC ID: 27936-SR046

To

FCC Part 15.247 DTS

IC RSS-247 Issue 2

Date of Issue: December 3, 2021

On the behalf of the applicant:

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Attention of:

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Afzal Fazal
Project Test Engineer

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All results contained herein relate only to the sample tested.

Test Report Revision History

Revision	Date	Revised By	Reason for Revision
1.0	August 20, 2021	Afzal Fazal	Original Document
2.0	August 20, 2021	Poona Saber	<ul style="list-style-type: none"> -Edited the power data to show compliance to radiated limits -Edited naming convention on page 10 -created radiated spurious emission on page 13-17 -revised number of pages, headers for measurement uncertainty and test setup pics plus updated table of contents to match accordingly
3.0	August 22, 2021	Afzal Fazal	<ul style="list-style-type: none"> -Avg plots included for RZ spurious emissions -Corrected TE table with correct pre-amp and antenna
4.0	September 7, 2021	Afzal Fazal	<ul style="list-style-type: none"> -Updated information for software and firmware for EUT in the Additional Info section -Updated to correct procedure used for radiated emissions per C63.10:2013, sections 11.11 and 11.12 -Updated the type of DTS the EUT incorporates -Added duty cycle/pulse averaging to ensure the EUT complies (due to low duty cycle) -Updated type of modulation incorporated with bit rate and symbol rate
5.0	December 3, 2021	Afzal Fazal	Updated FCC and IC ID

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ANAB

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The tests results contained within this test report all fall within our scope of accreditation, unless noted below.

Please refer to <http://www.compliancetesting.com/labscope.html> for current scope of accreditation.



FCC Site Reg. #349717

IC Site Reg. #2044A-2

The applicant has been cautioned as to the following

15.21 - Information to User

The user's manual or instruction manual for an intentional radiator shall caution the user that changes, or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

15.27(a) - Special Accessories

Equipment marked to a consumer must be capable of complying with the necessary regulations in the configuration in which the equipment is marketed. Where special accessories, such as shielded cables and/or special connectors are required to enable an unintentional or intentional radiator to comply with the emission limits in this part, the equipment must be marketed with, i.e. shipped and sold with, those special accessories. However, in lieu of shipping or packaging the special accessories with the unintentional or intentional radiator, the responsible party may employ other methods of ensuring that the special accessories are provided to the consumer without an additional charge.

Information detailing any alternative method used to supply the special accessories for a grant of equipment authorization or retained in the verification records, as appropriate. The party responsible for the equipment, as detailed in § 2.909 of this chapter, shall ensure that these special accessories are provided with the equipment. The instruction manual for such devices shall include appropriate instructions on the first page of text concerned with the installation of the device that these special accessories must be used with the device. It is the responsibility of the user to use the needed special accessories supplied with the equipment.

Standard Test Conditions Engineering Practices

Except as noted herein, the following conditions and procedures were observed during the testing:

In accordance with ANSI C63.10-2013 and unless otherwise indicated in the specific measurement results, the ambient temperature of the actual EUT was maintained within the range of 10° to 40°C (50° to 104°F) unless the particular equipment requirements specified testing over a different temperature range. Also, unless otherwise indicated, the humidity levels were in the range of 10% to 90% relative humidity.

Measurement results, unless otherwise noted, are worst-case measurements.

Environmental Conditions		
Temperature (°C)	Humidity (%)	Pressure (mbar)
26.7	42.2	985.0

EUT Description

Model: Solar Panel

Description: Solar Panel with LEDs for Roadway

Firmware: 255.255.8.0.4.1.2.11

Software: Peer2Peer – Router Endpoint

Serial Number: SR046

Additional Information: The EUT has one power input and is powered via an external power supply. The EUT was tested to 120V, 60Hz. The EUT encompasses Zigbee technology, and is processed via a 8-bit AVR microcontroller with a low power 2.4 GHz transceiver for Zigbee and IEEE 801.15.4. The module encompasses Serial Peripheral Interface (SPI) of ATmega256RFR2, ATmega128RFR2, and ATmega64RFR2.

The SPIs have seven programmable bit rates. The RX BBP performs additional signal filtering and signal synchronization. The frequency offset of each frame is calculated by the synchronization unit and is used during the remaining receive process to correct the offset. The receiver is designed to handle frequency and symbol rate deviations up to ± 120 ppm caused by combined receiver and transmitter deviations. In Basic Operating Mode, the reception of a frame is indicated by a TRX24_RX_START interrupt. Accordingly, its end is signaled by a TRX24_RX_END interrupt. Based on the quality of the received signal a link quality indicator (LQI) is calculated and appended to the frame.

EUT Operation during Tests

The EUT was powered on and set to operate normally so testing could be done with all functions of the device active. The EUT operates on 120V, 60Hz via an external power supply. The device is controlled via a native FCC test mode available in the product firmware. A dongle was used alongside with the testing to have the software communicate with the EUT. The EUT was tested in worst-case normal operating condition with the FCC Test program continuously running. The EUT duty cycle was less than 98%, therefore a lag of data rate was present when taking the measurements.

Antenna Info:

Antenna = JTI Chip Antenna

Antenna Gain = 3.0 dBi typ. (XZ-V)

Accessories:

Qty	Description	Manufacturer	Model	S/N
1	Dongle	Solar Roadways	Thumb Drive	SR035B
1	Power Supply	Mean Well	RSP-320-7.5	001
1	Laptop	ThinkPad-Lenovo	W520	R9E2D37

Cables:

Qty	Description	Length (M)	Shielding Y/N	Shielded Hood Y/N	Ferrite Y/N
1	AC Cable	2	Y	Y	N

Modifications: none
15.203: Antenna Requirement:

- ☒ The antenna is permanently attached to the EUT
- ☐ The antenna uses a unique coupling
- ☐ The EUT must be professionally installed
- ☐ The antenna requirement does not apply

Test Results Summary

Specification	Test Name	Pass, Fail, N/A	Comments
15.247(b), RSS-247 (5.4)	Peak Output Power	Pass	
15.247(b), RSS-247 (5.4 & 5.5)	Conducted Spurious Emissions	N/A	This test was not deemed necessary as the EUT did not have an external conducted antenna port
15.247(d), RSS-247 (5.1 & 5.2) 15.209(a), RSS-Gen (6.13 & 8.9) 15.205, RSS-Gen (8.10)	Radiated Spurious Emissions	Pass	
15.247(d), RSS-247 (5.1 & 5.2) 15.209(a), RSS-Gen (6.13 & 8.9) 15.205, RSS-Gen (8.10)	Emissions At Band Edges	Pass	
15.247(a)(2), RSS-Gen (6.7), RSS-247, (5.1 & 5.2)	Occupied Bandwidth	Pass	
15.247(e), RSS-247 (5.1 & 5.2)	Transmitter Power Spectral Density	Pass	
15.207, ISED-003	A/C Powerline Conducted Emissions	Pass	
15.109, RSS-Gen 7.1	Receiver Spurious Emission Limits	Pass	
15.35(c), RSS-Gen 8.2	Pulse Averaging/Duty Cycle	Pass	

Note:

Spectrum frequency from 9MHz to 25GHz (tenth harmonic of fundamental frequency) was investigated, and no obvious emission were detected from 9KHz to 30MHz and 18GHz to 25GHz, so below final test was performed with frequency range from 30MHz to 18GHz.

Statements of conformity are reported as:

- Pass - the measured value is below the acceptance limit, *acceptance limit = test limit*.
- Fail - the measured value is above the acceptance limit, *acceptance limit = test limit*.

References	Description
CFR47, Part 15, Subpart B	Unintentional Radiators
CFR47, Part 15, Subpart C	Intentional Radiators
ANSI C63.10-2013	American National standard for testing Unlicensed Wireless Devices
ANSI C63.4-2014	Method and Measurements of Radio-Noise Emissions from low-Voltage Electrical and Electronic Equipment in the range 9kHz to 40GHz.
ISO/IEC 17025:2017	General requirements for the Competence of Testing and Calibrations Laboratories
KDB 558074 D01 v04	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating under §15.247

Duty Cycle

Engineer: Afzal Fazal

Test Date: 9/9/21

Test Procedure

The duty cycle de-rating factor used in the calculation of average radiated limits (per CFR 15.209 and 15.35(c)) is described below. This factor was calculated by first determining the worst-case scenario for system operation. With the worst-case operating scenario, the transmission duty cycle was calculated as:

3.0 mSec = ON time (figures below)

97.0 mSec = OFF time (figure below)

$(3.0 \text{ mS total time On}) / (97.0 \text{ mS total time Off}) = 0.031 \text{ Numeric Duty Cycle}$

$\text{Duty Cycle} = 20 \text{ Log } (0.031) = -30.19 \text{ dB}$

The Spectrum Analyzer was set to the following:

RBW \geq OBW

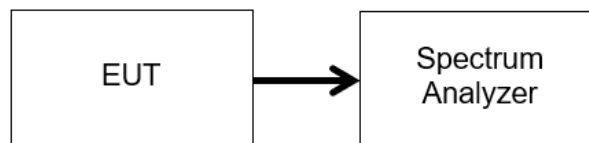
VBW \geq RBW

Span = 0 Hz

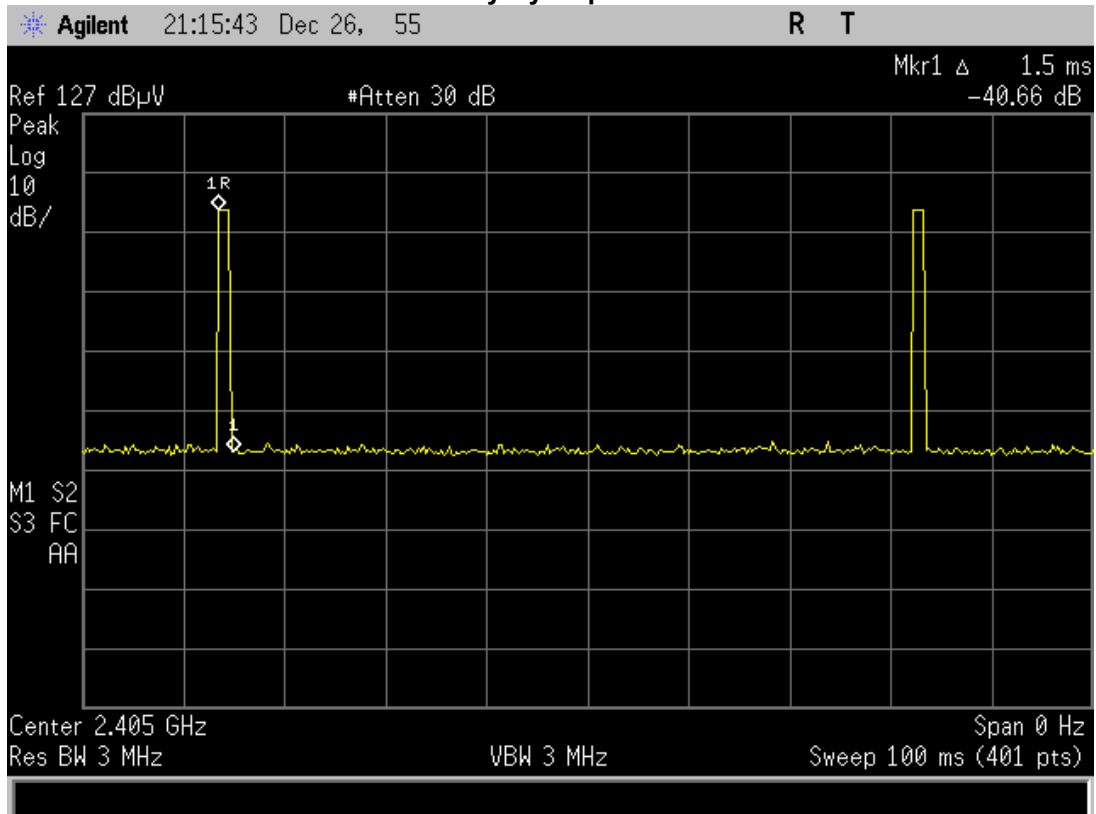
Sweep time = 100 msec

Detector = Peak

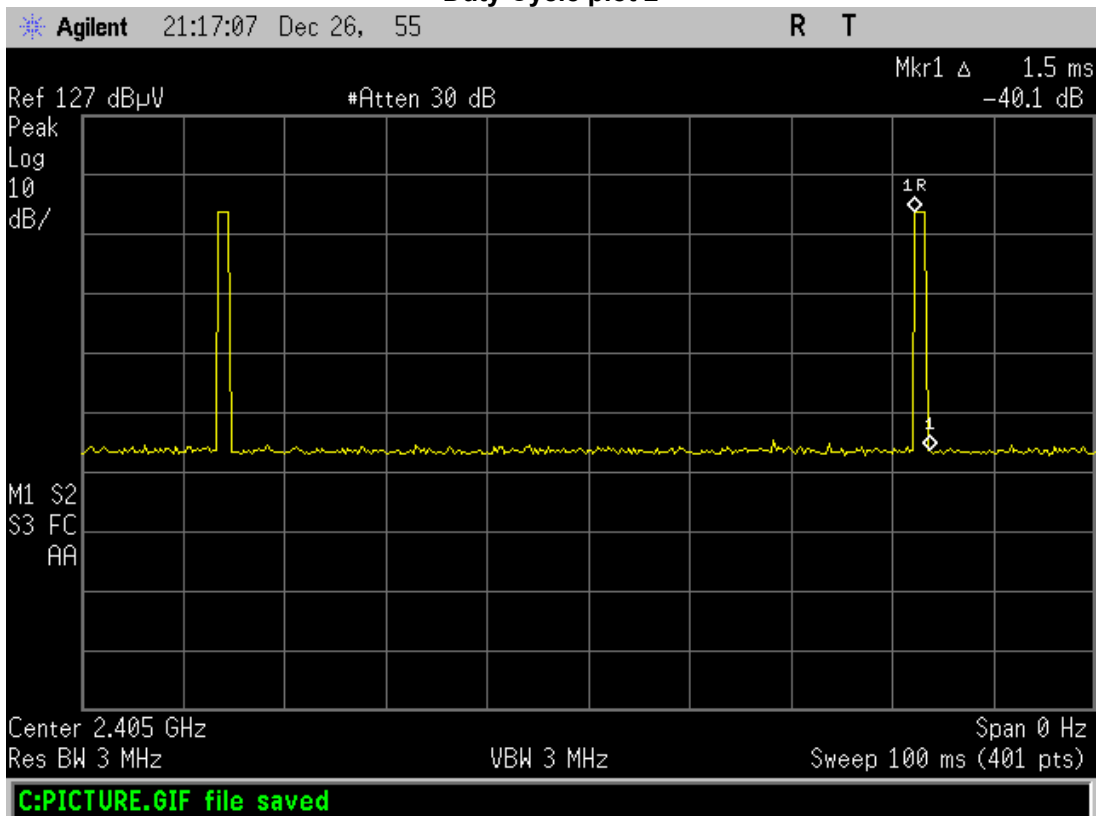
Test Setup



Duty Cycle plot 1



Duty Cycle plot 2



Peak Output Power

Engineer: Afzal Fazal

Test Date: 8/13/21

Test Procedure

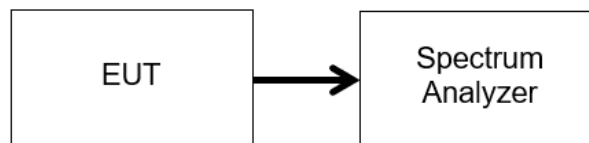
The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized. The peak readings were taken, and the result was then compared to the limit. The test was performed per section 11.9 of C63.10:2013 "Procedure for determining fundamental emission output power for DTS devices".

The Spectrum Analyzer was set to the following:

RBW \geq DTS Bandwidth
 VBW $\geq 3 \times$ RBW
 Span $\geq 3 \times$ RBW
 Sweep time = auto couple
 Detector = peak
 Trace Mode = max hold

The EUT was set to transmit on the lowest, middle and highest frequencies at the maximum power level. The RF output power was measured using the RBW \geq DTS bandwidth method.

Test Setup



Transmitter Peak Output Power

Tuned Frequency (MHz)	Measured Value Conducted (dBm)	Antenna gain (dBi)	Radiated power EIRP (dBm)	Specification Limit EIRP (dBm)	Result
2405	6.47	3	9.47	36 dBm	Pass
2425	-10.70	3	-7.70	36 dBm	Pass
2480	6.36	3	9.36	36 dBm	Pass

Restricted band Radiated Spurious Emissions

Engineer: Afzal Fazal

Test Date: 7/6/21

Test Procedure Radiated Spurious Emissions: 30 – 1000 MHz

The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized. The test was performed per section 11.12 of C63.10:2013 "Radiated emission measurements in restricted frequency bands" and compared to limits of 15.205.

All emissions from 30 MHz to 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

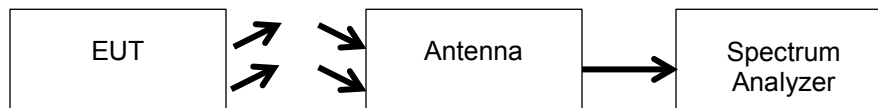
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 120 KHz

VBW = 300 KHz

Detector – Quasi Peak

Test Setup



Radiated Spurious Emissions Test Data: 30 MHz – 1000 MHz Antenna = Chip Antenna

Frequency (MHz)	Measured Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Polarity (H or V)
56.76	30.05	40	-9.95	V
92.350	36.98	43.5	-6.52	V
105.380	35.74	43.5	-7.76	V
135.270	31.04	43.5	-12.46	V
795.170	30.59	46	-15.41	H
839.830	30.21	46	-15.79	H

Test Procedure for Radiated Spurious Emissions above 1 GHz

The EUT was tested in a semi anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Spurious Emissions. The antenna, band reject filter, amplifier and cable correction factors were input into the spectrum analyzer before recording the Measured Level to ensure accurate readings. The spectrum for each tuned frequency was examined to the 10th harmonic. The test was performed per section 11.12 of C63.10:2013 "Radiated emission measurements in restricted frequency bands" and compared to limits of 15.205.

All emissions above 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

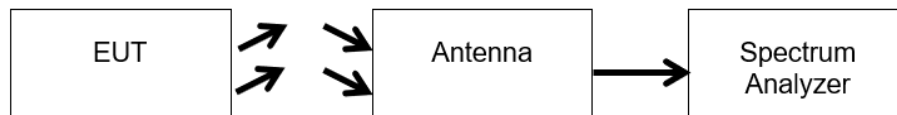
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 1 MHz

VBW = 3 MHz

Detector – Average

Test Setup



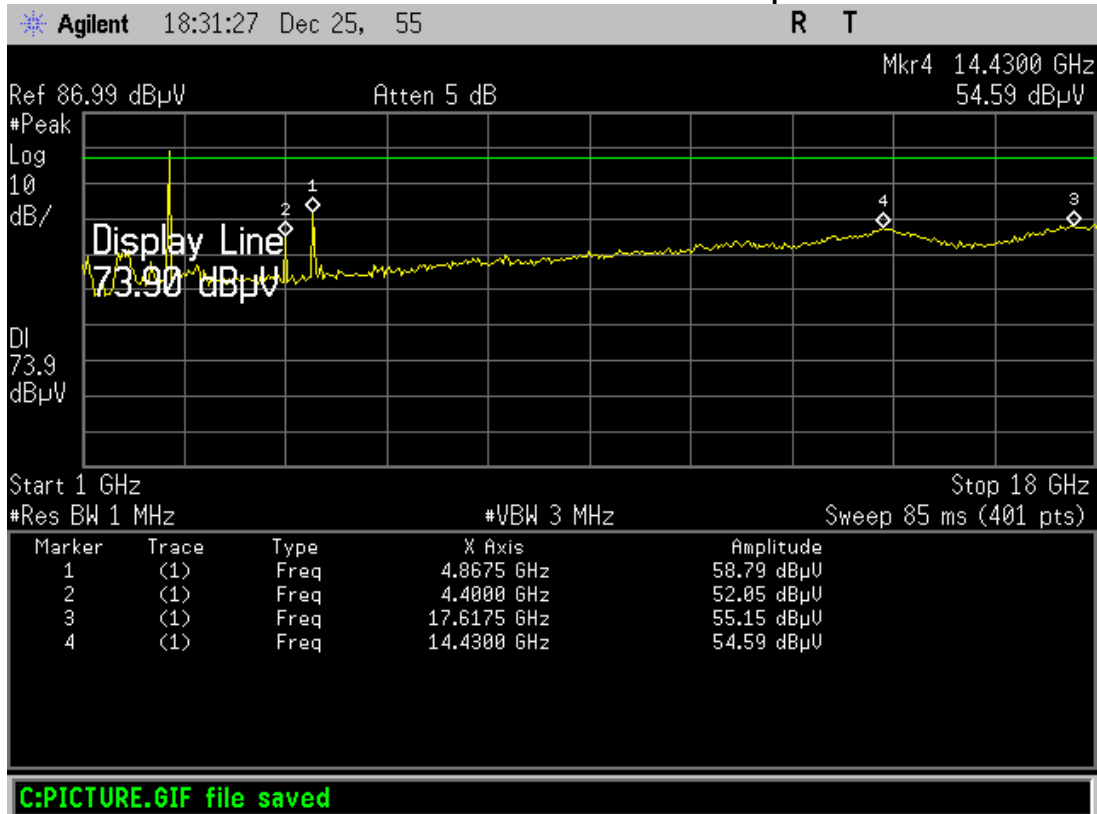
Detector Settings	RBW (MHz)	VBW (MHz)	Span
Peak	1	3	As Necessary
Average	1	3	As Necessary

Radiated Spurious Emissions

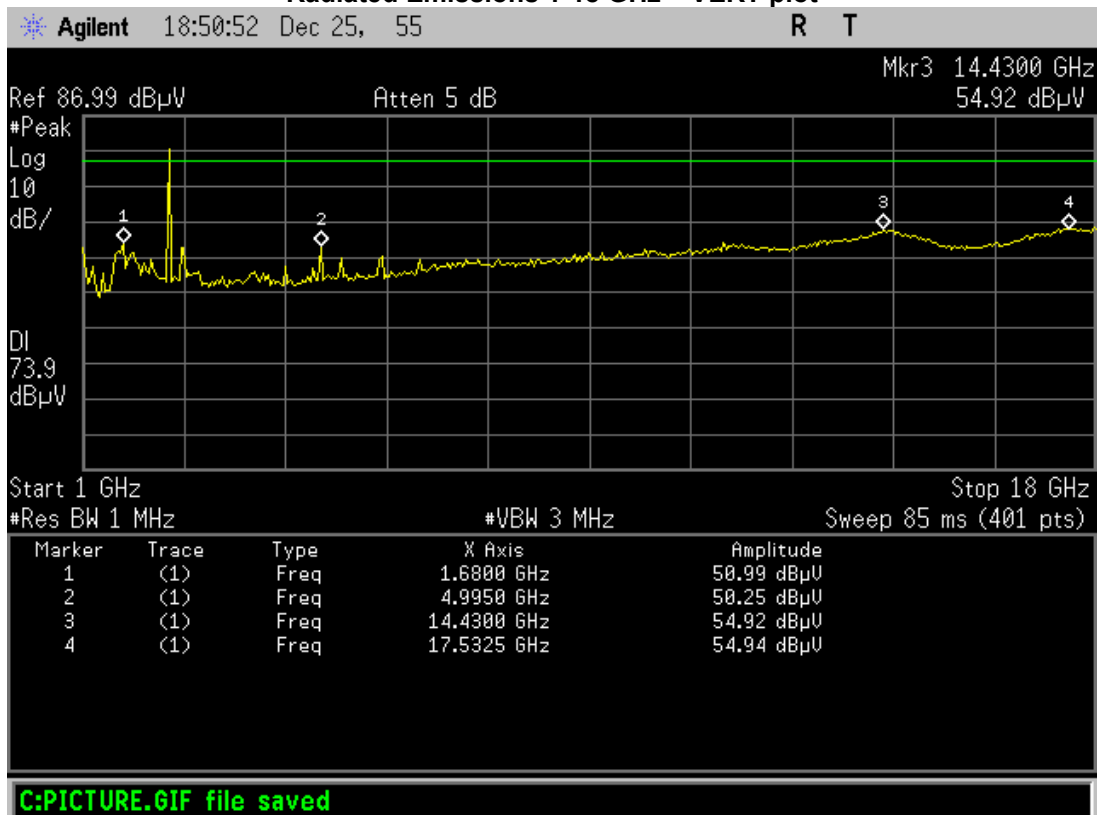
1-18 GHz

Tuned Frequency (MHz)	Emission Frequency (MHz)	Peak Measured Value (dBuV/m)	Peak Limit (dBuV/m)	Average Measured Value (dBuV/m)	Average Limit (dBuV/m)	Result
1680	1680	50.99	74.0	38.47	54.0	Pass
4400	4400	52.05	74.0	38.03	54.0	Pass
4867.500	4867.500	58.79	74.0	39.57	54.0	Pass
4995.000	4995.000	50.25	74.0	39.33	54.0	Pass
14430.000	14430.000	54.92	74.0	46.82	54.0	Pass
17532.500	17532.500	54.94	74.0	46.78	54.0	Pass
17617.500	17617.500	55.15	74.0	47.22	54.0	Pass

Radiated Emissions 1-18 GHz – HORZ plot



Radiated Emissions 1-18 GHz – VERT plot



Radiated Spurious Emissions

Engineer: Afzal Fazal

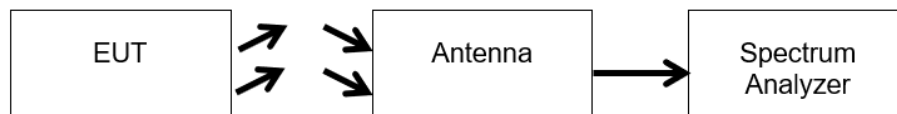
Test Date: 7/6/21

Test Procedure

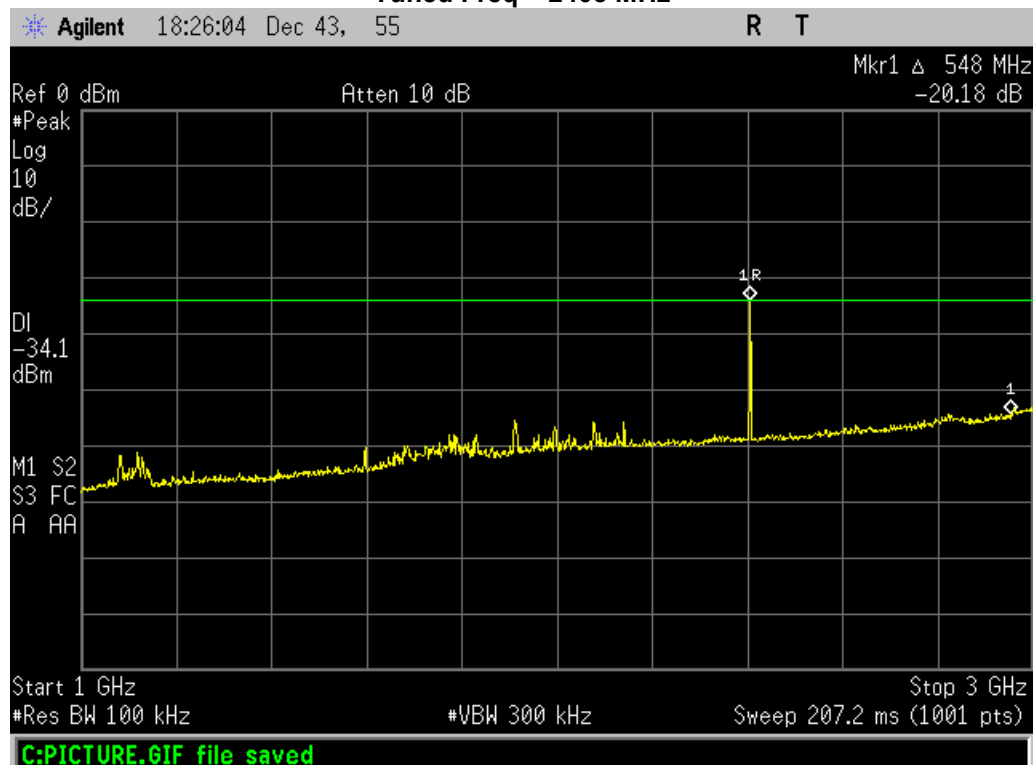
The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized.

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. The test was performed per section 11.11 of C63.10:2013 "Emissions in nonrestricted frequency bands" and compared to limits of 15.209.

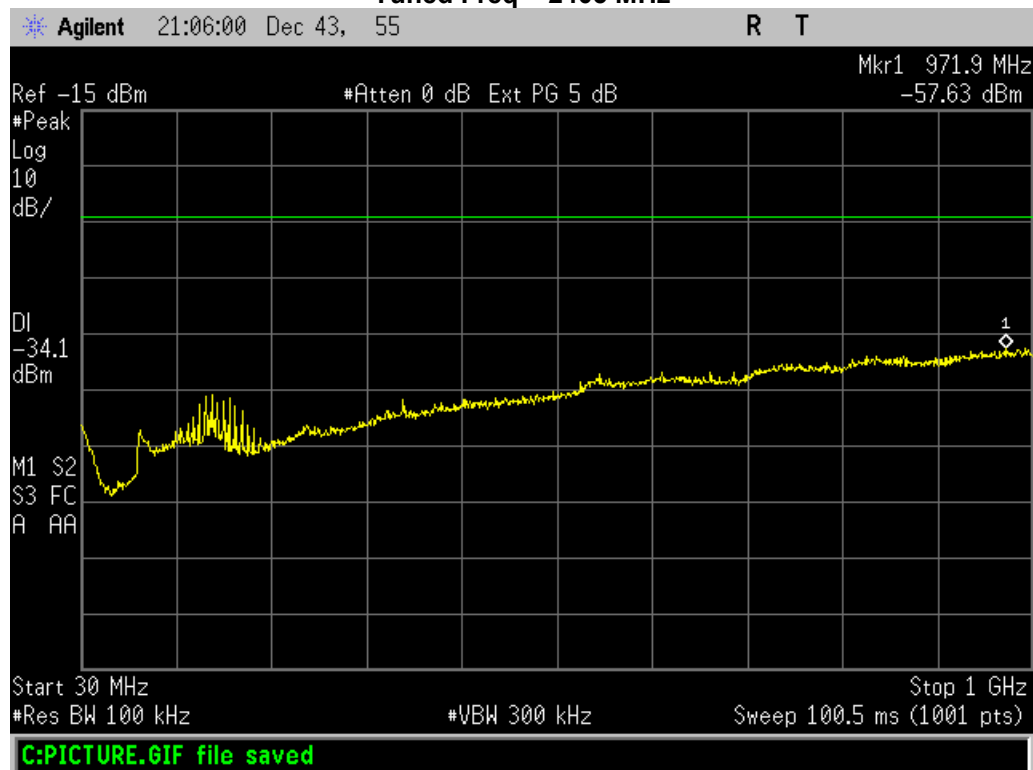
Test Setup



Spurious emissions 1-3 GHz Tuned Freq = 2405 MHz



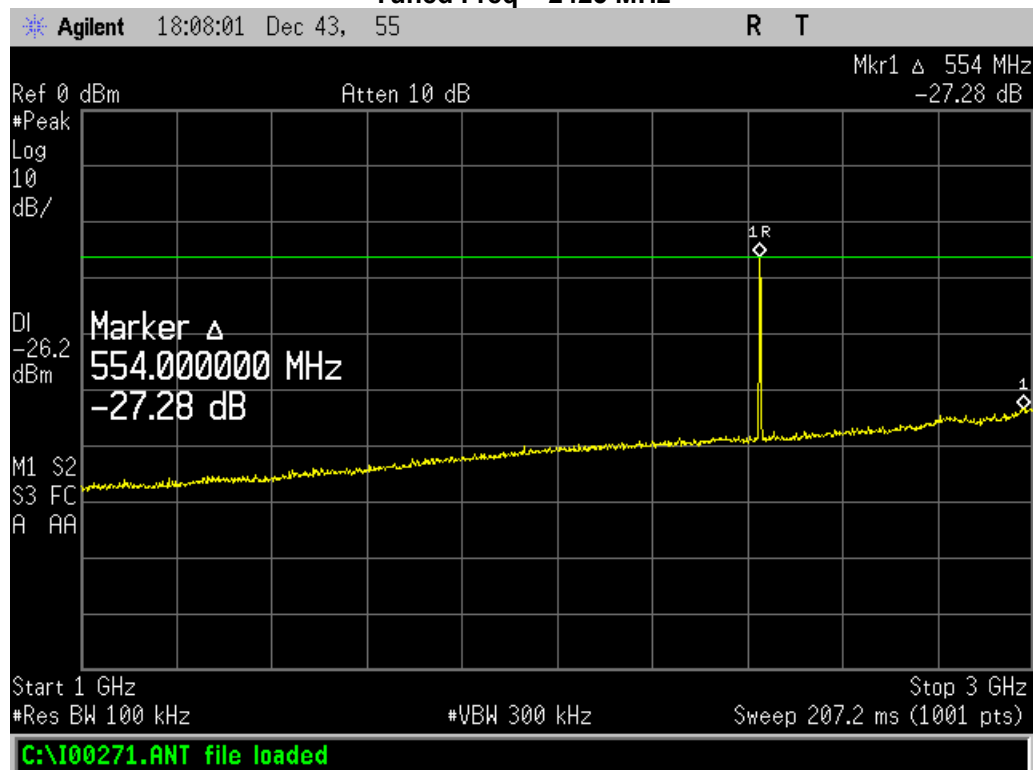
Spurious emissions 30-1000 MHz Tuned Freq = 2405 MHz



Spurious emissions 3-18 GHz Tuned Freq = 2405 MHz



Spurious emissions 1-3 GHz Tuned Freq = 2425 MHz



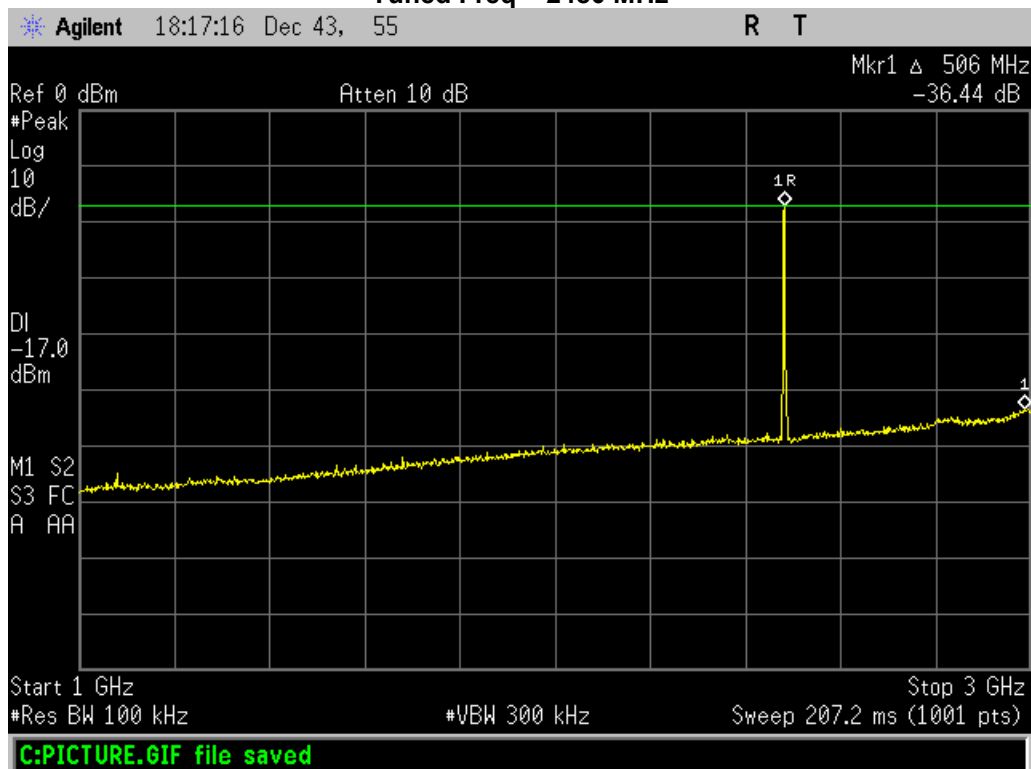
Spurious emissions 30-1000 MHz Tuned Freq = 2425 MHz



Spurious emissions 3-18 GHz Tuned Freq = 2425 MHz



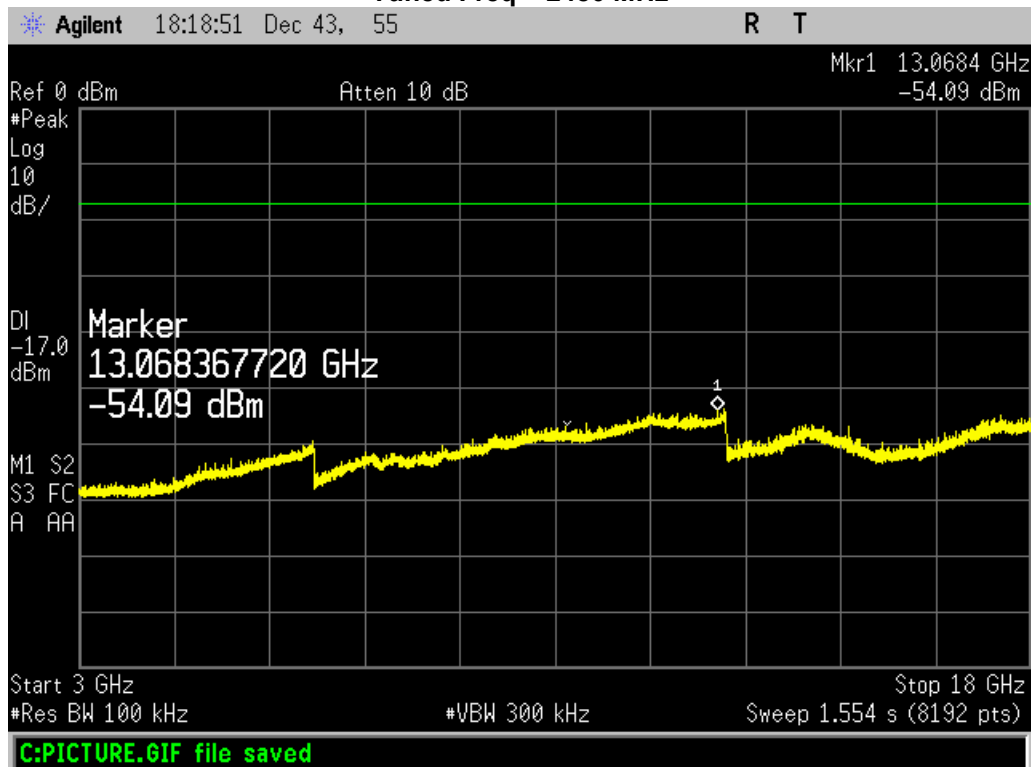
Spurious emissions 1-3 GHz Tuned Freq = 2480 MHz



Spurious emissions 30-1000 MHz Tuned Freq = 2480 MHz



Spurious emissions 3-18 GHz Tuned Freq = 2480 MHz



Emissions at Band Edges

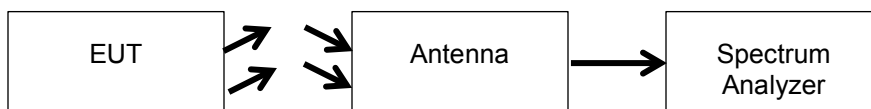
Engineer: Afzal Fazal

Test Date: 7/30 – 8/16 - 2021

Test Procedure

The EUT was tested in a semi-anechoic chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for band edge and restricted band for both peak and average measurements. The cable and antenna correction factors were input into the analyzer as a reference level offset to ensure accurate readings. The test was performed per section 11.13 of C63.10:2013 “Procedure for determining Band-edge measurements for DTS devices”.

Band Edge Test Setup

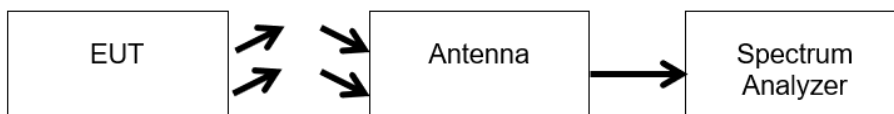


Band Edge Emissions Summary

Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Value (dBc)	Detector	Limit (dBc)	Result
2405	2400	40.82	Peak	-20 dBc	Pass
2480	2483.5	37.45	Peak	-20 dBc	Pass

Note: All spurious emissions on all 3 channels were also at least -20 dBc from the highest applicable limit of the tuned frequency.

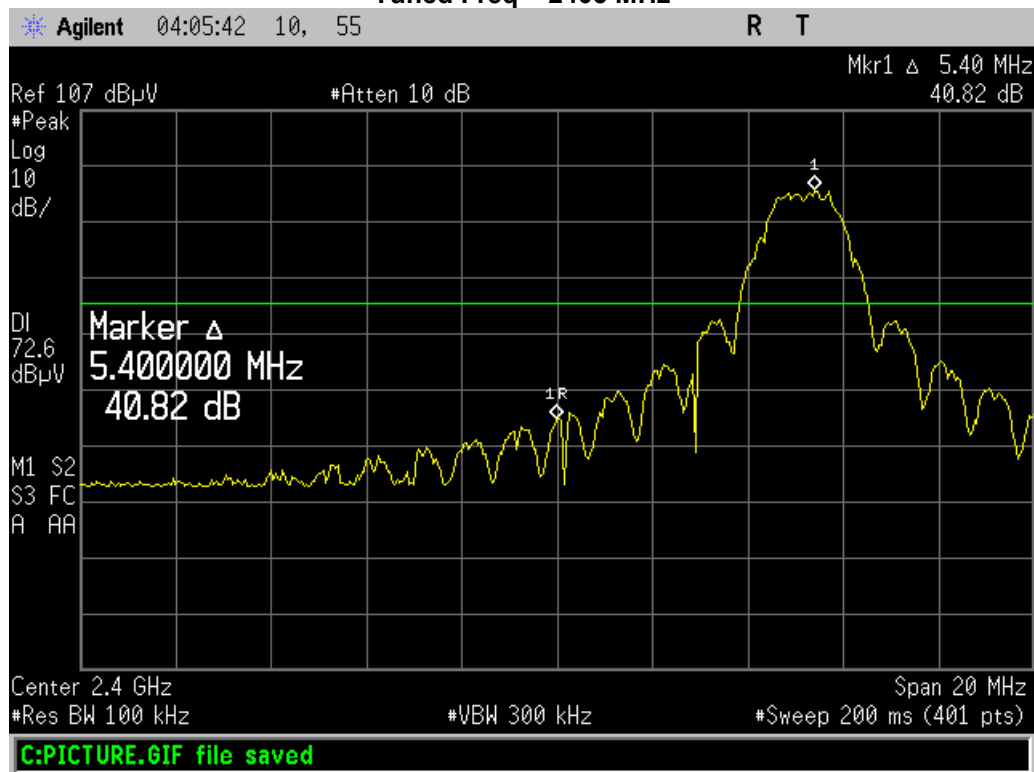
Restricted Band Test Setup



Restricted Band Emissions Summary

Restricted Band (MHz)	Tuned Frequency (MHz)	Emission Frequency (MHz)	Measured Value (dBuV/m)	Detector	Limit (dBuV/m)	Result
2310 – 2390	2405	2362.40	46.93	Peak	74	Pass
2310 – 2390	2405	2390.00	37.46	Average	54	Pass
2483.5 - 2500	2480	2483.50	60.68	Peak	74	Pass
2483.5 - 2500	2480	2483.88	50.58	Average	54	Pass

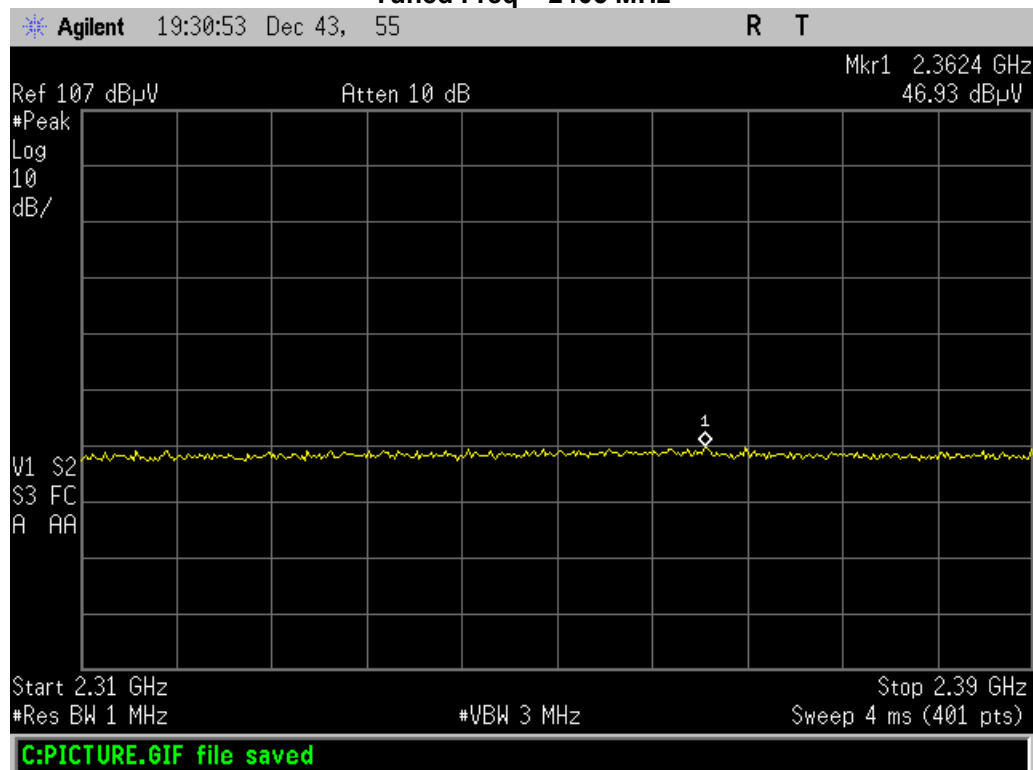
Band Edge 2400 MHz Tuned Freq = 2405 MHz



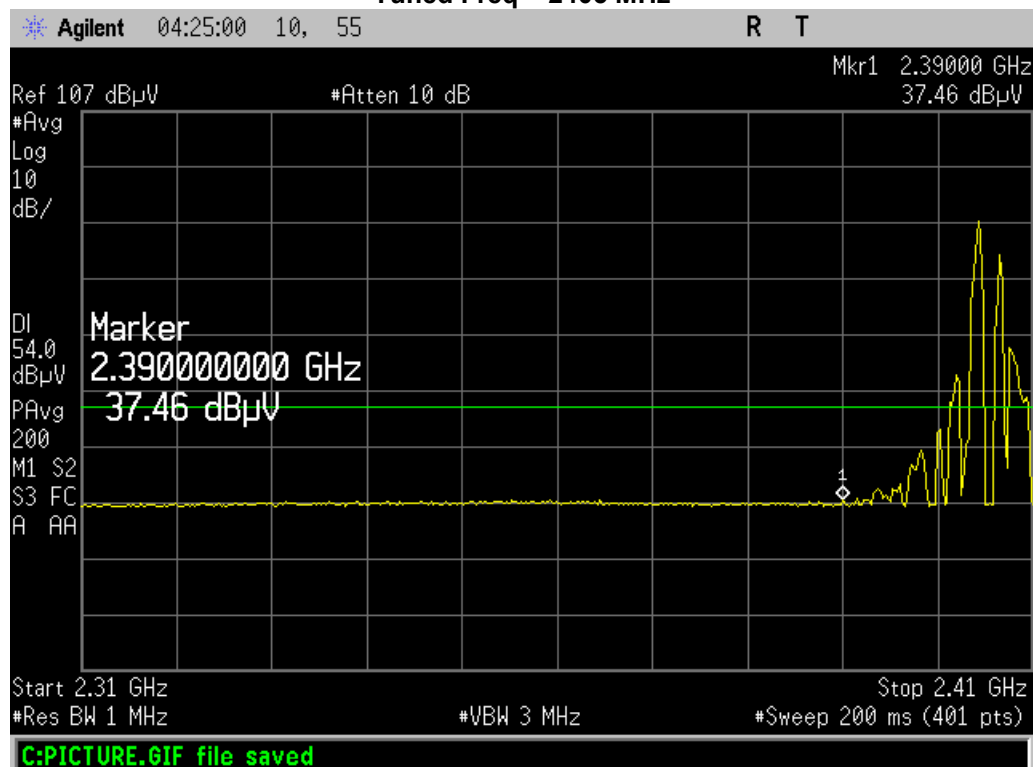
Band Edge 2483.5 MHz Tuned Freq = 2480 MHz



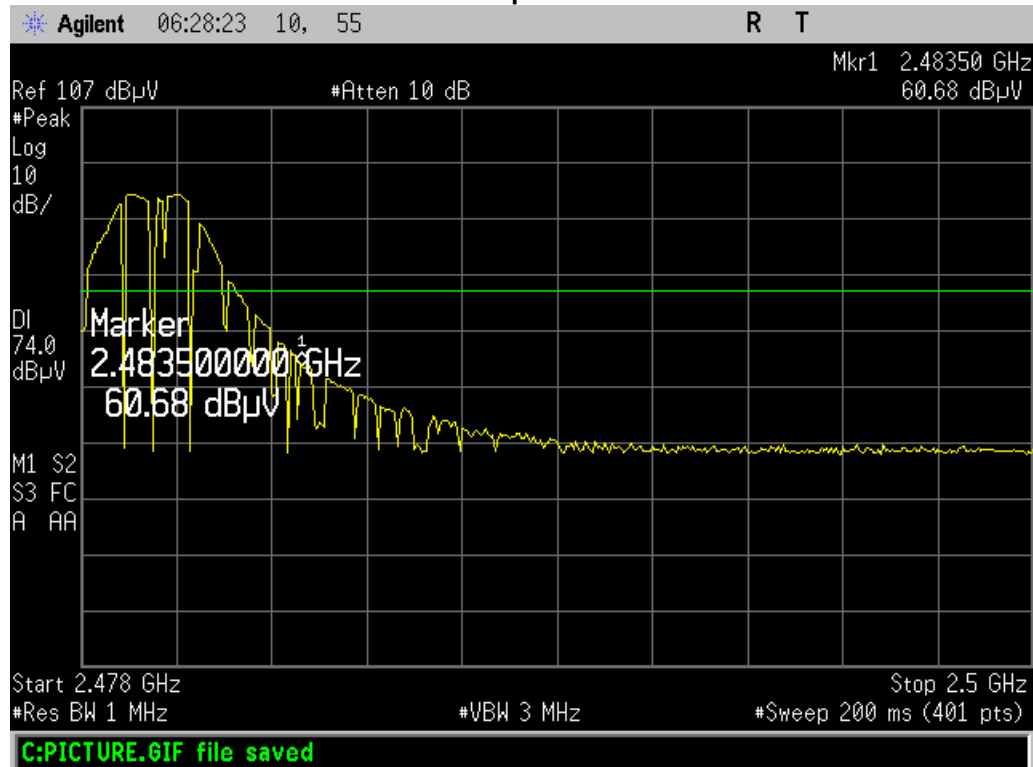
Restricted Band 2310 – 2390 MHz – Peak Tuned Freq = 2405 MHz



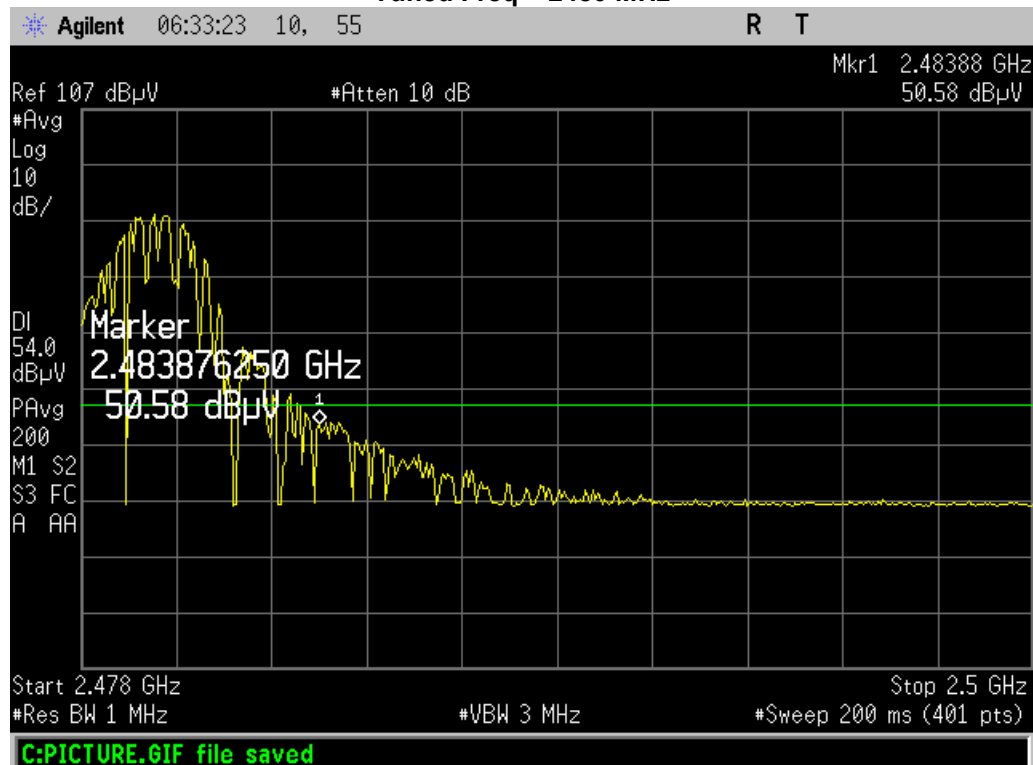
Restricted Band 2310 – 2390 MHz – Avg Tuned Freq = 2405 MHz



Restricted Band 2483.5 – 2500 MHz – Peak Tuned Freq = 2480 MHz



Restricted Band 2483.5 – 2500 MHz – Avg Tuned Freq = 2480 MHz



Occupied Bandwidth

Engineer: Afzal Fazal

Test Date: 8/13/21

Test Procedure

The EUT was connected directly to a spectrum analyzer. The Span was set wide enough to capture the entire transmit spectrum and the resolution bandwidth was set to at least 1% of the span. The analyzer was set to max hold and when the entire spectrum was captured the 6dB and 99% bandwidths were measured to verify the bandwidth met the specification. The 6dB bandwidth test was performed per section 11.8 of C63.10:2013 "Procedure for determining DTS Bandwidth for DTS devices". The 99% bandwidth test was performed per section 6.9 of C63.10:2013 "Standard test methods for measuring Occupied Bandwidth".

The Spectrum Analyzer was set to the following for 6 dB DTS BW:

RBW = 100 kHz

VBW $\geq 3 \times$ RBW

Peak Detector

Trace mode = max hold

Sweep = auto couple

Span = 1.5 x EBW

The Spectrum Analyzer was set to the following for OBW:

RBW = 30 kHz

VBW $\geq 3 \times$ RBW

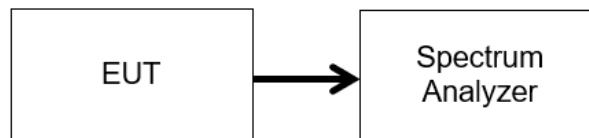
Peak Detector

Trace mode = max hold

Sweep = auto couple

Span = 1.5 x EBW

Test Setup



6 dB Occupied Bandwidth Summary

Frequency (MHz)	Measured Bandwidth (MHz)	Specification Limit (kHz)	Result
2405	1.570	≥ 500	Pass
2425	1.550	≥ 500	Pass
2480	1.568	≥ 500	Pass

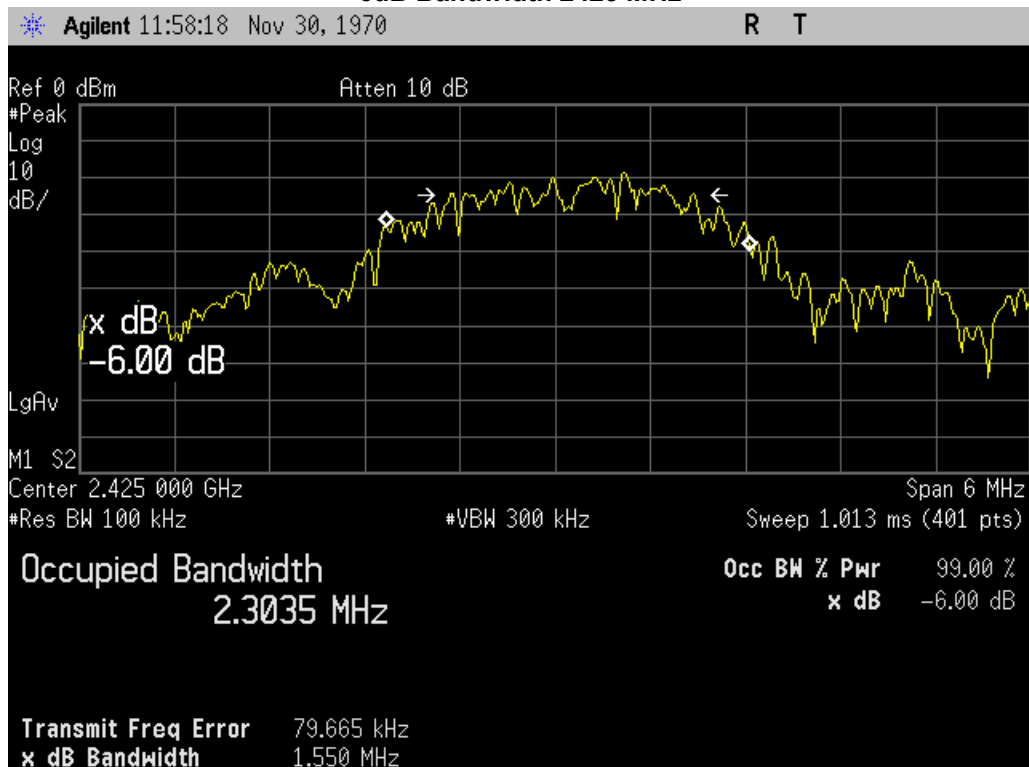
99% Bandwidth Summary

Frequency (MHz)	Measured Bandwidth (MHz)	Result
2405	2.389	Pass
2425	2.411	Pass
2480	2.413	Pass

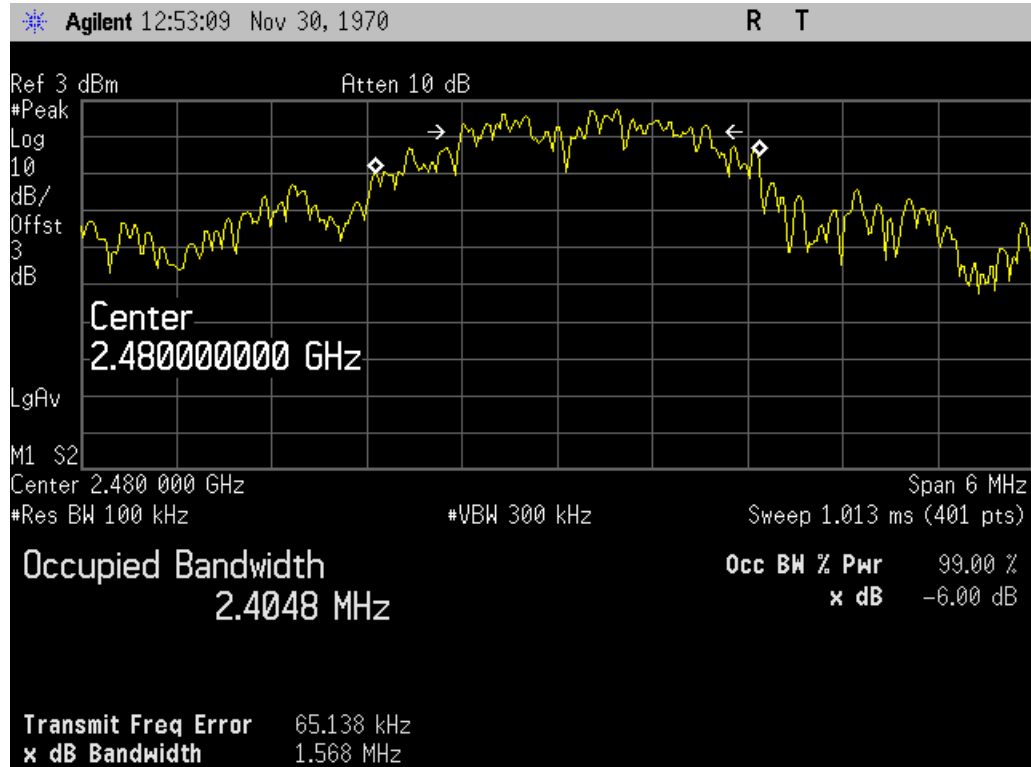
6dB Bandwidth 2405 MHz



6dB Bandwidth 2425 MHz



6dB Bandwidth 2480 MHz



99% Bandwidth 2405 MHz



99% Bandwidth 2425 MHz



99% Bandwidth 2480 MHz



Transmitter Power Spectral Density (PSD)

Engineer: Afzal Fazal

Test Date: 8/13/21

Test Procedure

The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the TX signal levels were maximized. The test was performed per section 11.10 of C63.10:2013 "Procedure for determining PSD for DTS devices".

The Spectrum Analyzer was set to the following:

DTS channel center frequency

Span 1.5 x DTS bandwidth

RBW = 3 kHz ≤ RBW ≤ 100 kHz

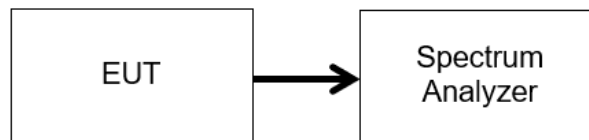
VBW ≥ 3 x RBW

Peak Detector

Sweep time = auto couple

Trace mode = max hold

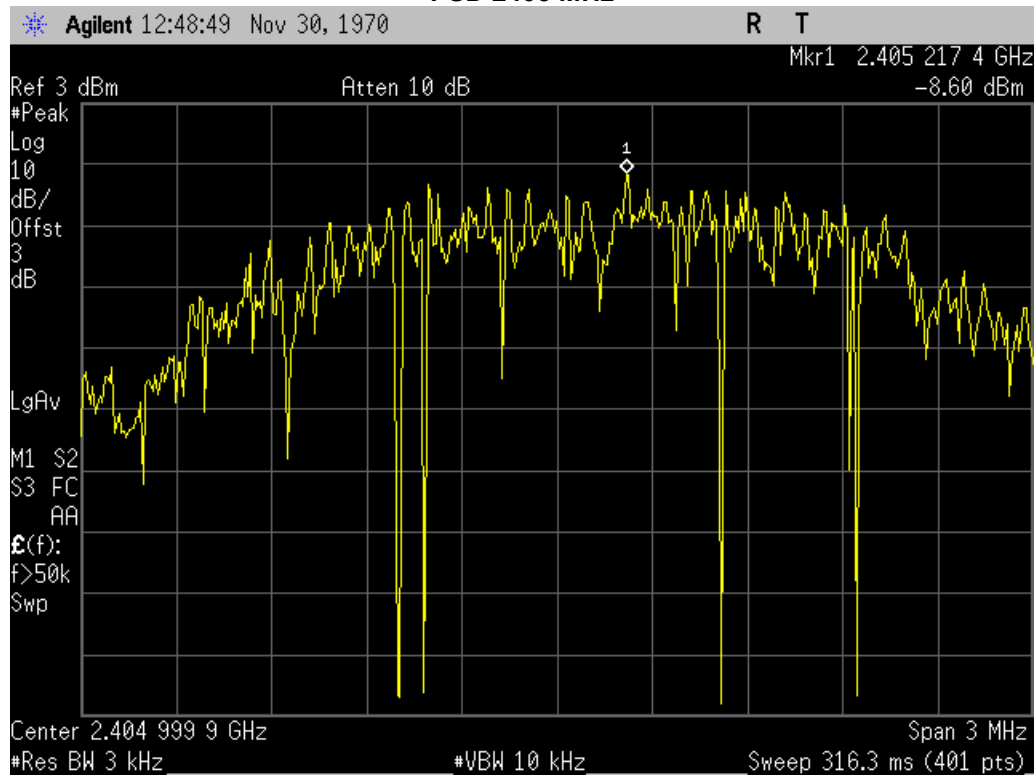
Test Setup



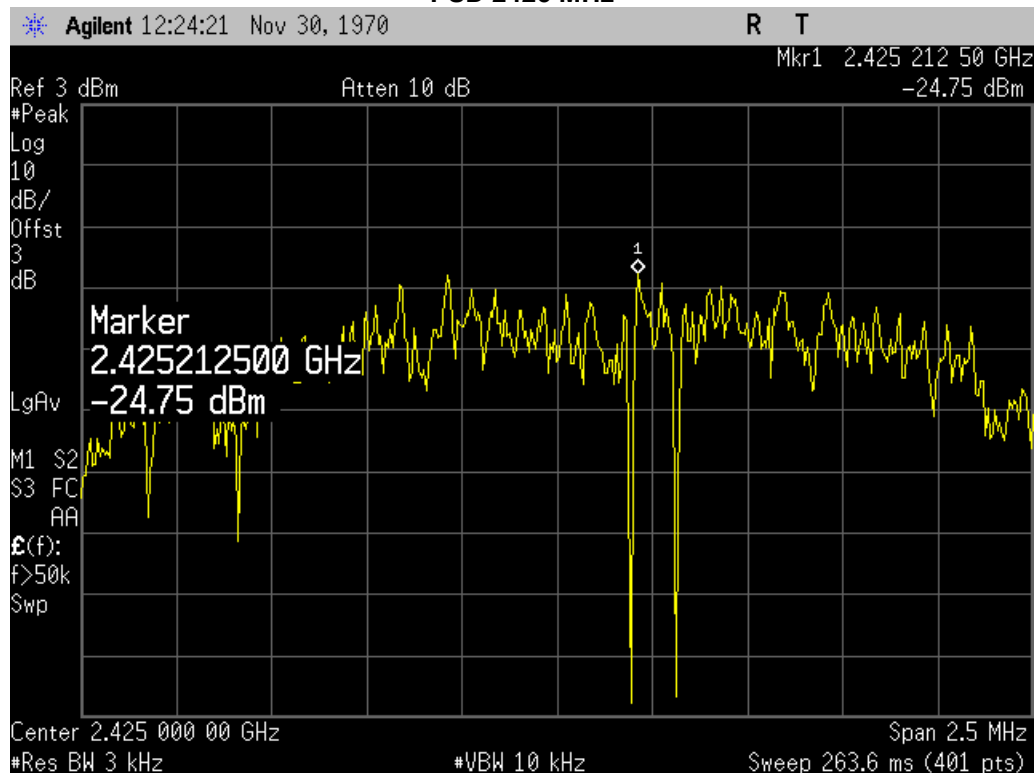
PSD Summary

Frequency (MHz)	Measured Data (dBm)	Specification Limit (dBm)	Result
2405	-8.60	8	Pass
2425	-24.75	8	Pass
2480	-7.09	8	Pass

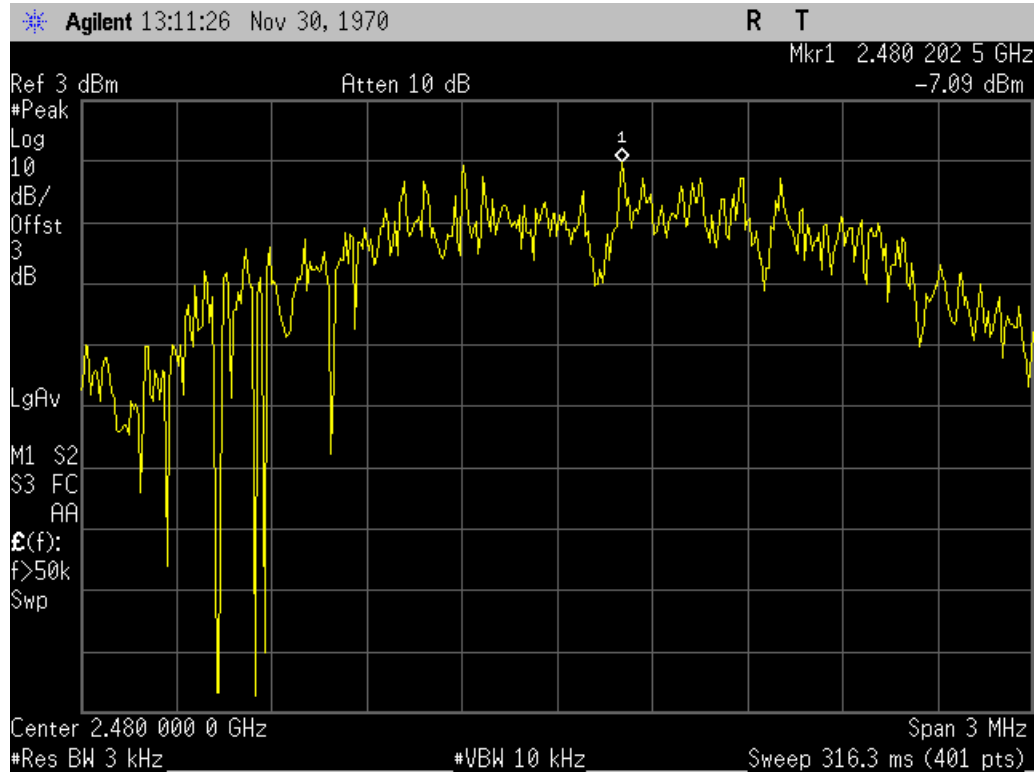
PSD 2405 MHz



PSD 2425 MHz



PSD 2480 MHz



A/C Powerline Conducted Emission

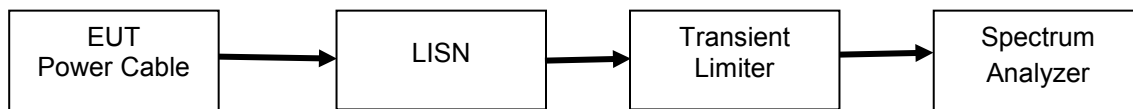
Engineer: Afzal Fazal

Test Date: 6/30/2021

Test Procedure

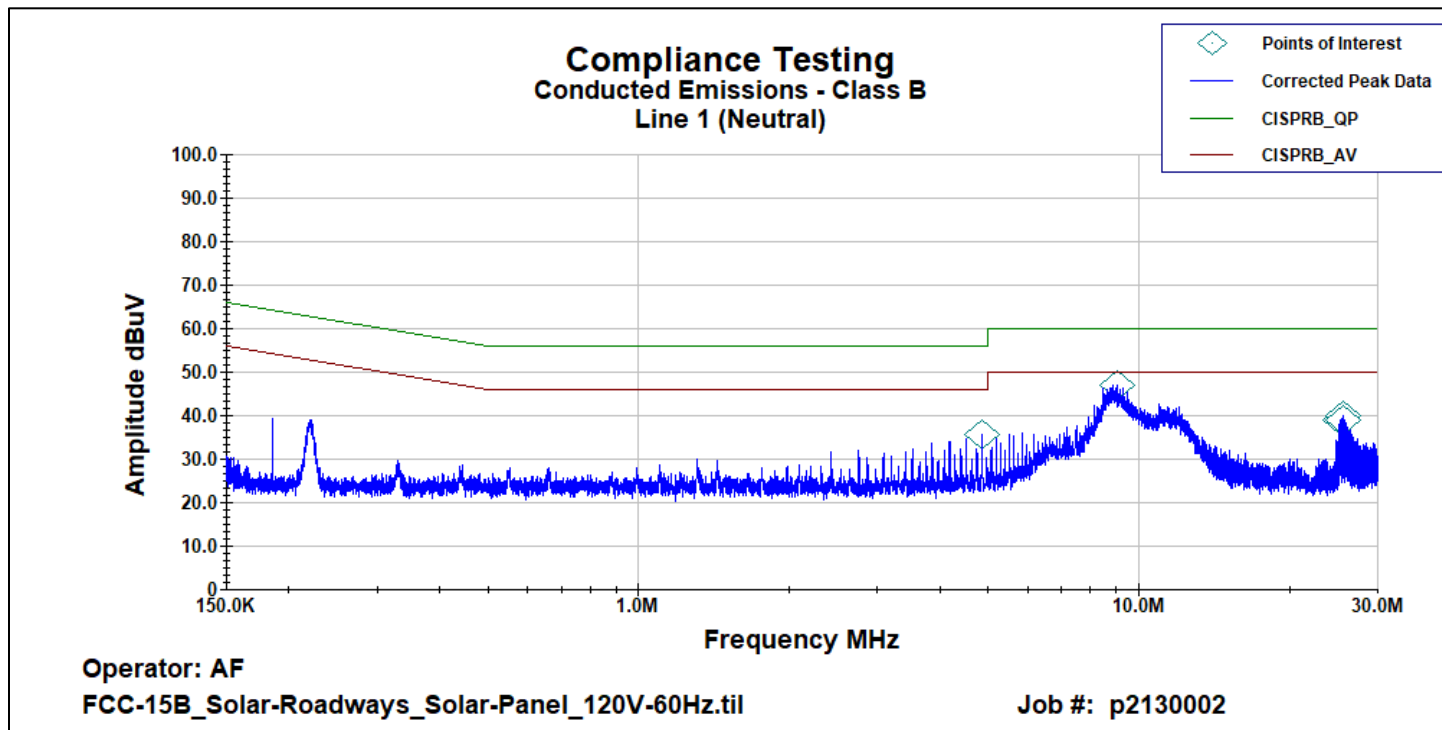
The EUT power cable was connected to a LISN and the monitored output of the LISN was connected to a transient limiter, which then connected directly to a spectrum analyzer. The conducted emissions from 150 kHz to 30 MHz were measured and compared to the specification limits. The test was performed per section 6.2 of C63.10:2013 “Standard test method for ac power-line conducted emissions from unlicensed wireless devices”.

Test Setup

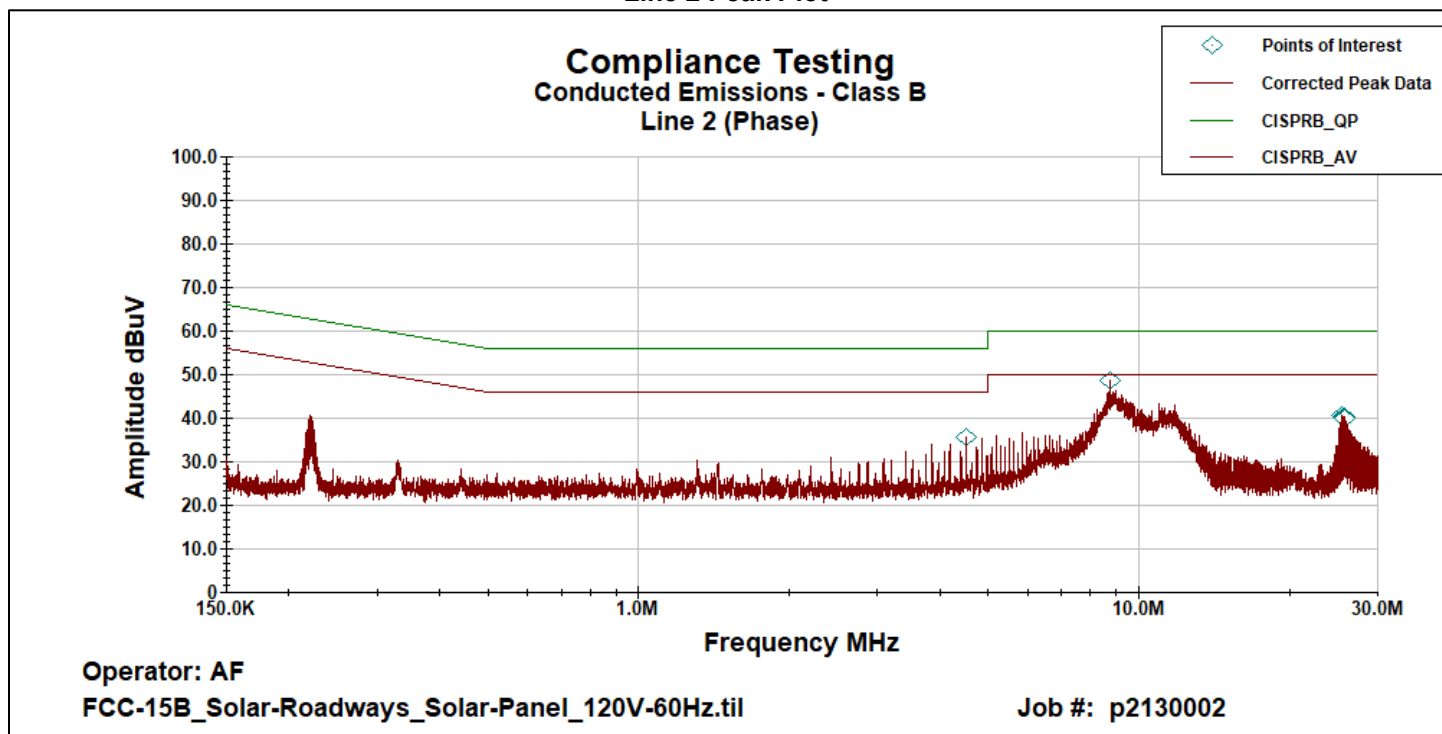


Conducted Emission Test Results

Line 1 Peak Plot



Line 2 Peak Plot



Line 1 Neutral Avg Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
4.847MHz	17.21	0.08	0.1	10.2	27.59	46	-18.41
9.0293MHz	25.69	0.05	0.15	10.2	36.093	50	-13.907
25.333MHz	13.16	-0.2	0.23	10.4	23.597	50	-26.403
25.439MHz	9.48	-0.2	0.23	10.4	19.911	50	-30.089
25.554MHz	11.29	-0.2	0.23	10.4	21.719	50	-28.281
25.662MHz	10.06	-0.2	0.233	10.4	20.493	50	-29.507

Line 2 Phase Avg Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	Avg Margin (dB)
4.5166MHz	14.54	0.05	0.096	10.2	24.885	46	-21.115
8.7497MHz	25.22	0.02	0.143	10.2	35.574	50	-14.426
25.449MHz	9.3	-0.31	0.23	10.4	19.624	50	-30.376
25.566MHz	11.19	-0.31	0.23	10.4	21.505	50	-28.495
25.695MHz	20.06	-0.31	0.235	10.4	30.381	50	-19.619
25.754MHz	7.78	-0.32	0.238	10.4	18.106	50	-31.894

Line 1 Neutral QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
4.847MHz	23.41	0.08	0.1	10.2	33.79	56	-22.21
9.0293MHz	31.25	0.05	0.15	10.2	41.65	60	-18.35
25.333MHz	26.74	-0.197	0.23	10.4	37.173	60	-22.827
25.439MHz	25.29	-0.199	0.23	10.4	35.721	60	-24.279
25.554MHz	24.99	-0.201	0.23	10.4	35.419	60	-24.581
25.662MHz	25.19	-0.203	0.233	10.4	35.62	60	-24.38

Line 2 Phase QP Detector

Frequency	Measured Value (dBuV)	LISN Correction Factor (dB)	Cable Loss (dB)	Transient Limiter (dB)	Final Data (dBuV)	Limit (dBuV)	QP Margin (dB)
4.847MHz	17.21	0.08	0.1	10.2	27.59	46	-18.41
9.0293MHz	25.69	0.05	0.15	10.2	36.093	50	-13.907
25.333MHz	13.16	-0.2	0.23	10.4	23.597	50	-26.403
25.439MHz	9.48	-0.2	0.23	10.4	19.911	50	-30.089
25.554MHz	11.29	-0.2	0.23	10.4	21.719	50	-28.281
25.662MHz	10.06	-0.2	0.233	10.4	20.493	50	-29.507

Receiver Spurious Emissions

Engineer: Afzal Fazal

Test Date: 7/18/2021

Test Procedure

The EUT was tested in a semi-anechoic test chamber set 3m from the receiving antenna. A spectrum analyzer was used to verify that the EUT met the requirements for Radiated Emissions. The EUT was tested by rotating it 360° with the antennas in both the vertical and horizontal orientation and was raised from 1 to 4 meters to ensure the RX signal levels were maximized. The test was performed per section 11.11 of C63.10:2013 "Emissions in nonrestricted frequency bands" and compared to limits of 15.209.

All emissions from 30 MHz to 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 120 KHz

VBW = 300 KHz

Detector – Quasi Peak

All emissions above 1 GHz were examined.

Measured Level includes antenna and receiver cable correction factors.

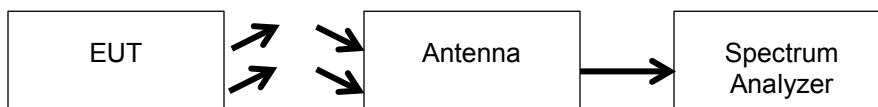
Correction factors were input into the spectrum analyzer before recording "Measured Level".

RBW = 1 MHz

VBW = 3 MHz

Detector – Average

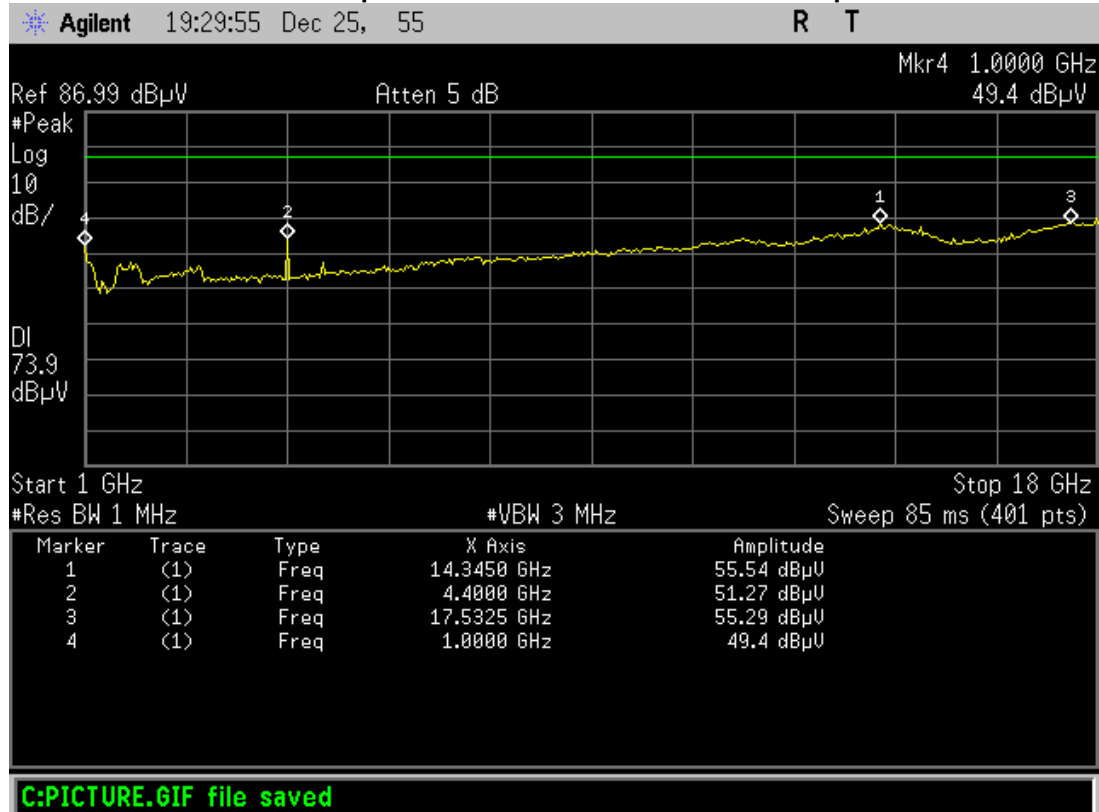
Test Setup



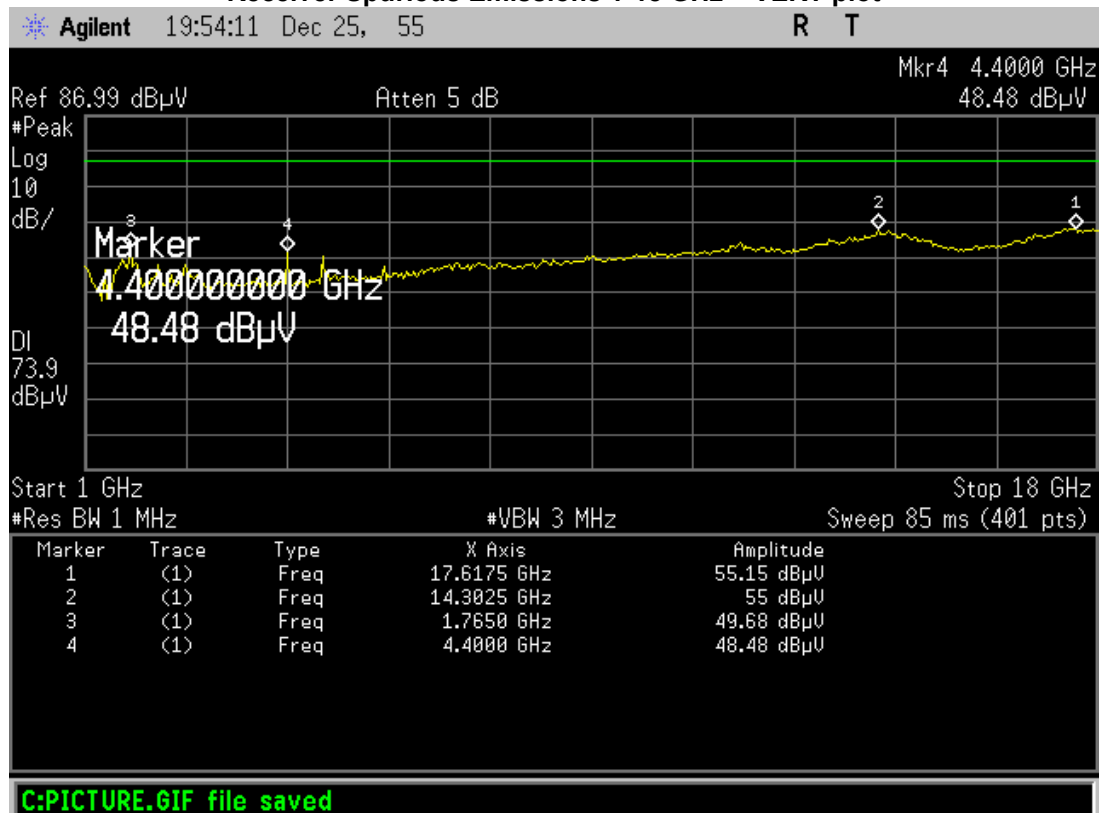
Receiver Spurious Emissions 30 MHz – 1 GHz

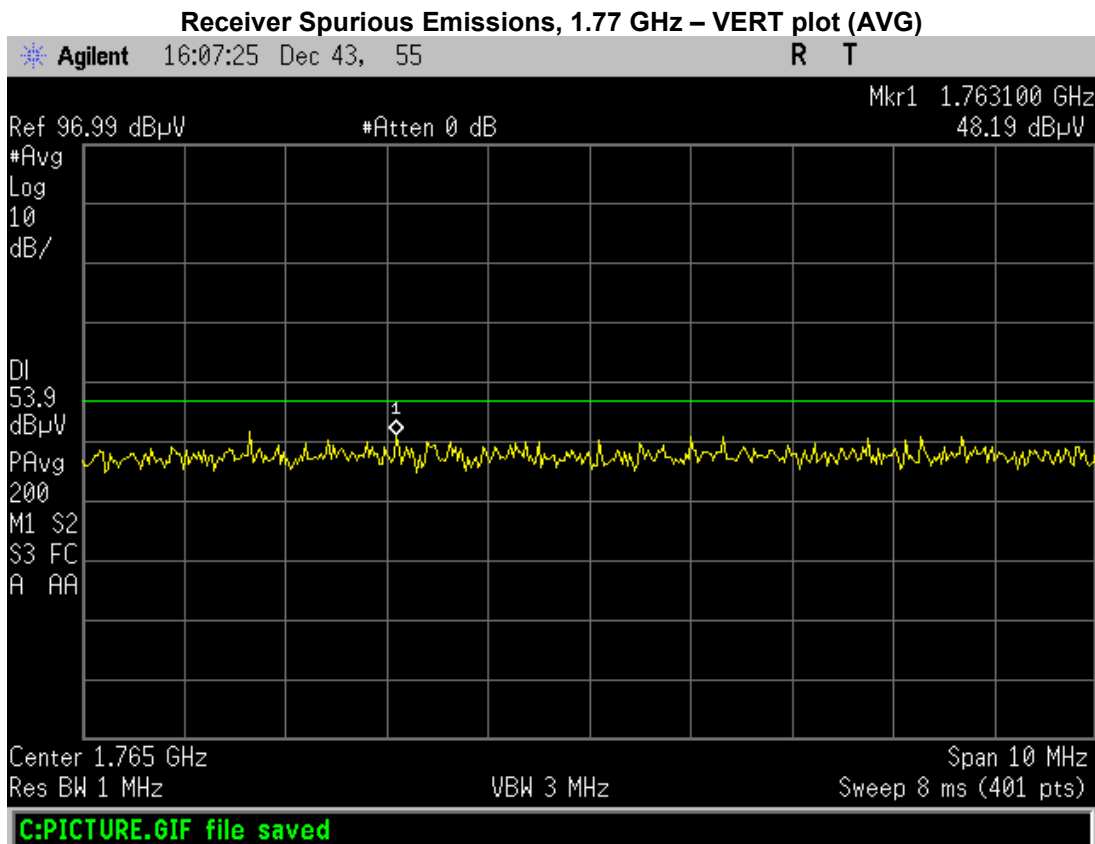
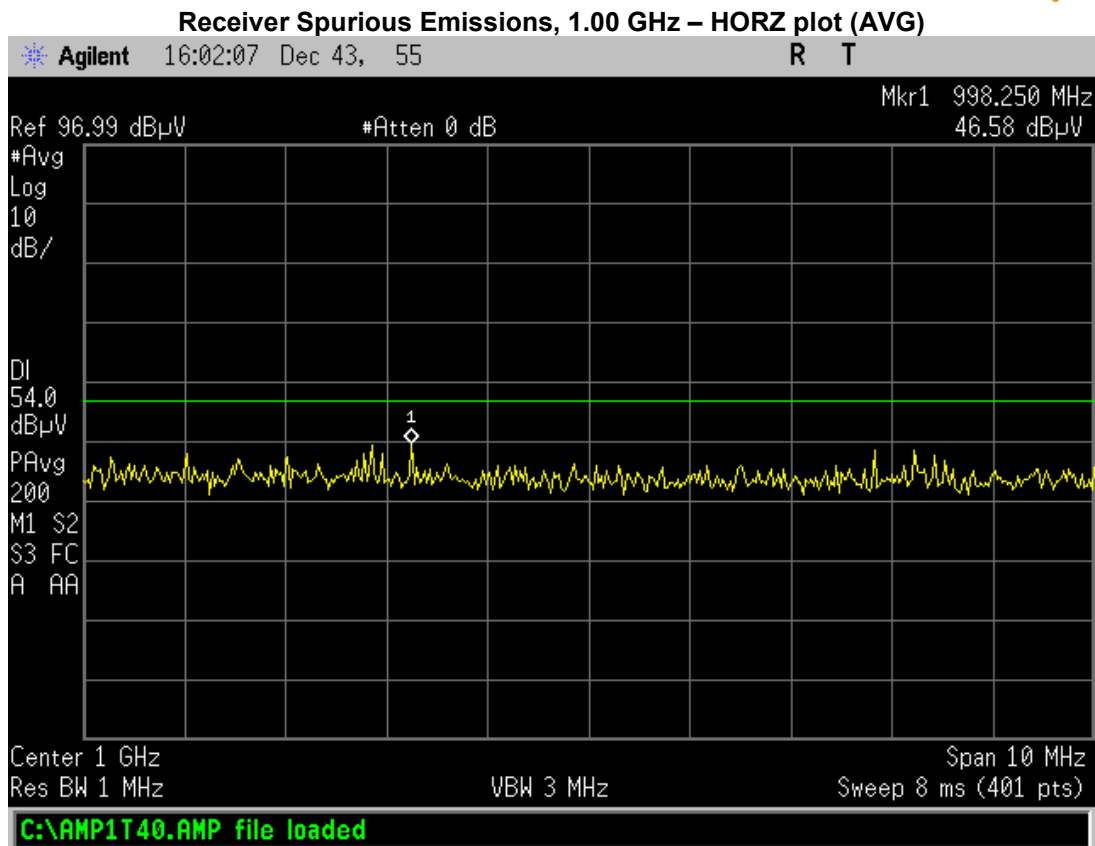
Emission Frequency (MHz)	Measured Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Antenna Polarity (V/H)	Turntable Position (deg)	Detector (QP,PK,Avg)
56.52	31.54	40	-8.46	110	V	270	QP
84.860	30.56	40	-9.44	110	V	0	QP
93.340	35.86	43.5	-7.64	110	V	140	QP
106.300	35.09	43.5	-8.41	110	V	0	QP
118.610	28.34	43.5	-15.16	110	V	0	QP
138.240	34.33	43.5	-9.17	110	V	0	QP

Receiver Spurious Emissions 1-18 GHz – HORZ plot

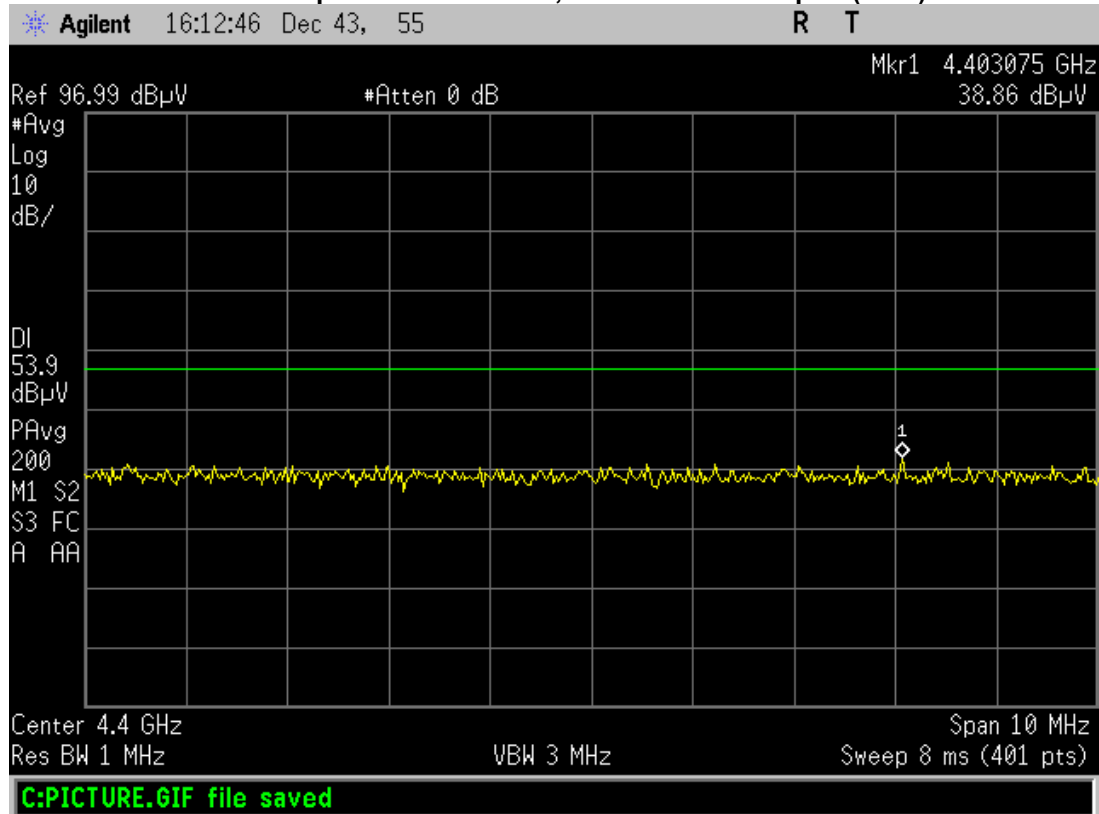


Receiver Spurious Emissions 1-18 GHz – VERT plot

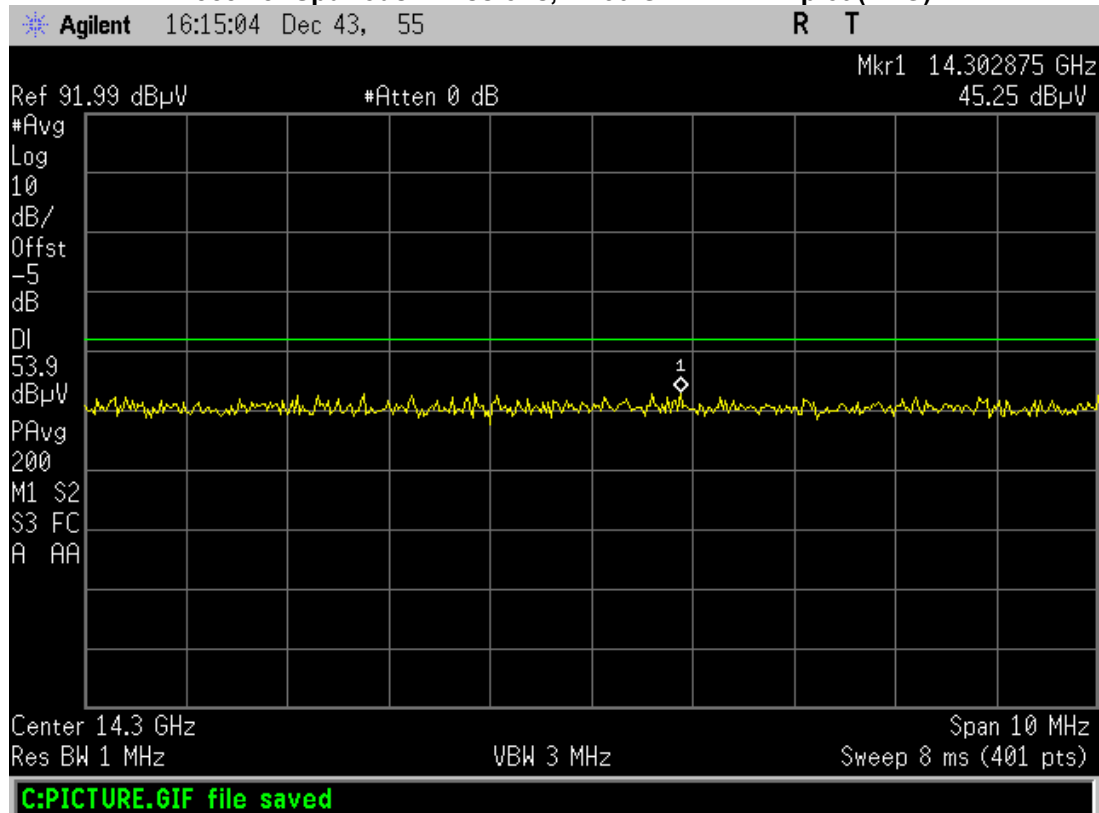




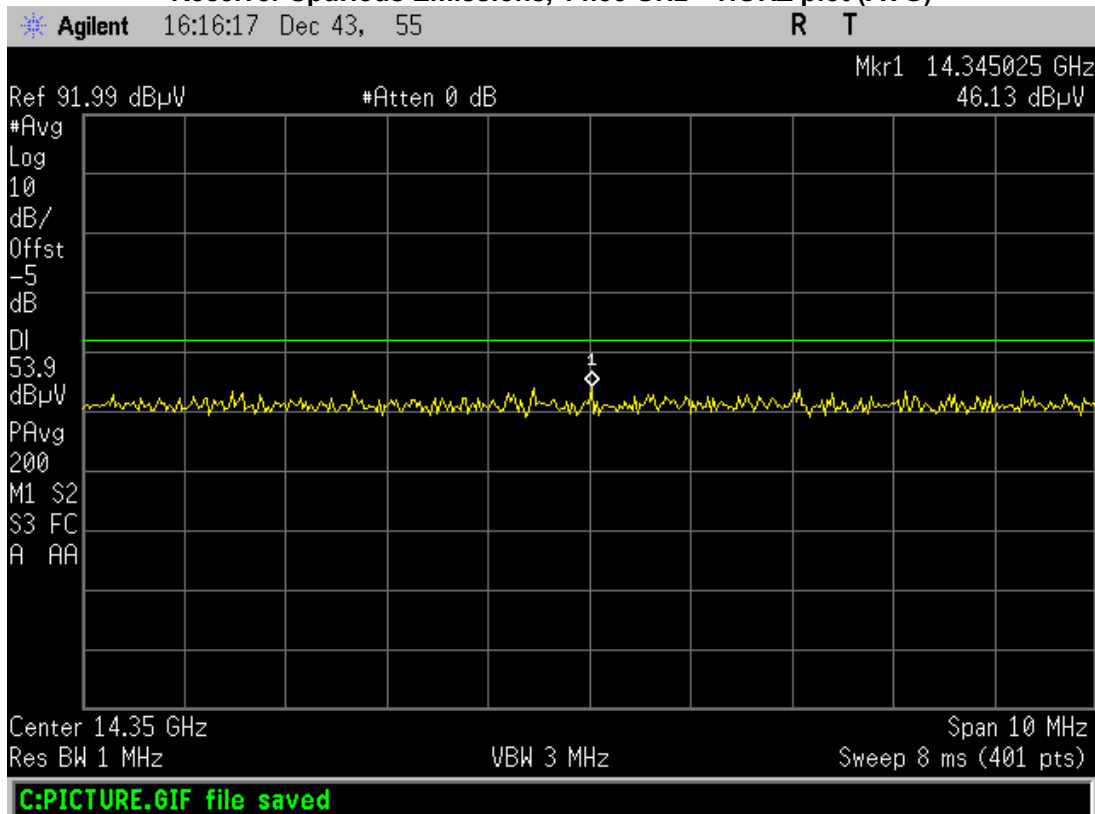
Receiver Spurious Emissions, 4.40 GHz – HORZ plot (AVG)



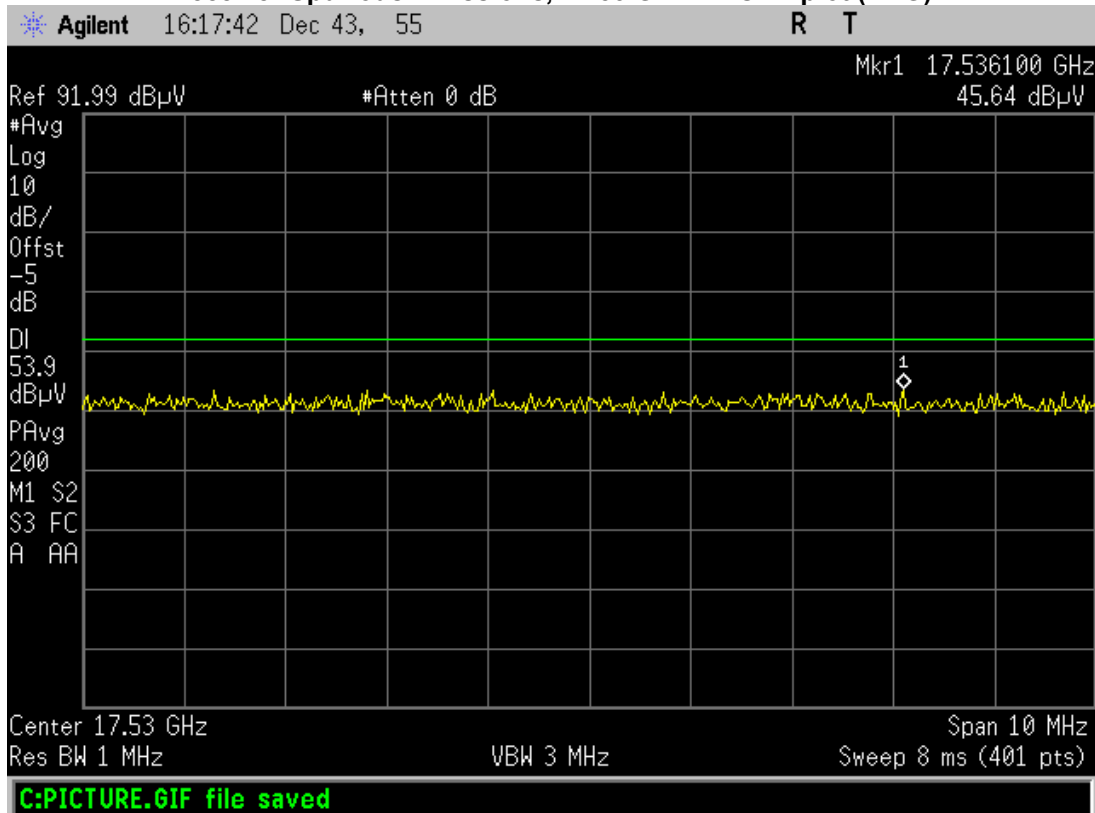
Receiver Spurious Emissions, 14.30 GHz – VERT plot (AVG)



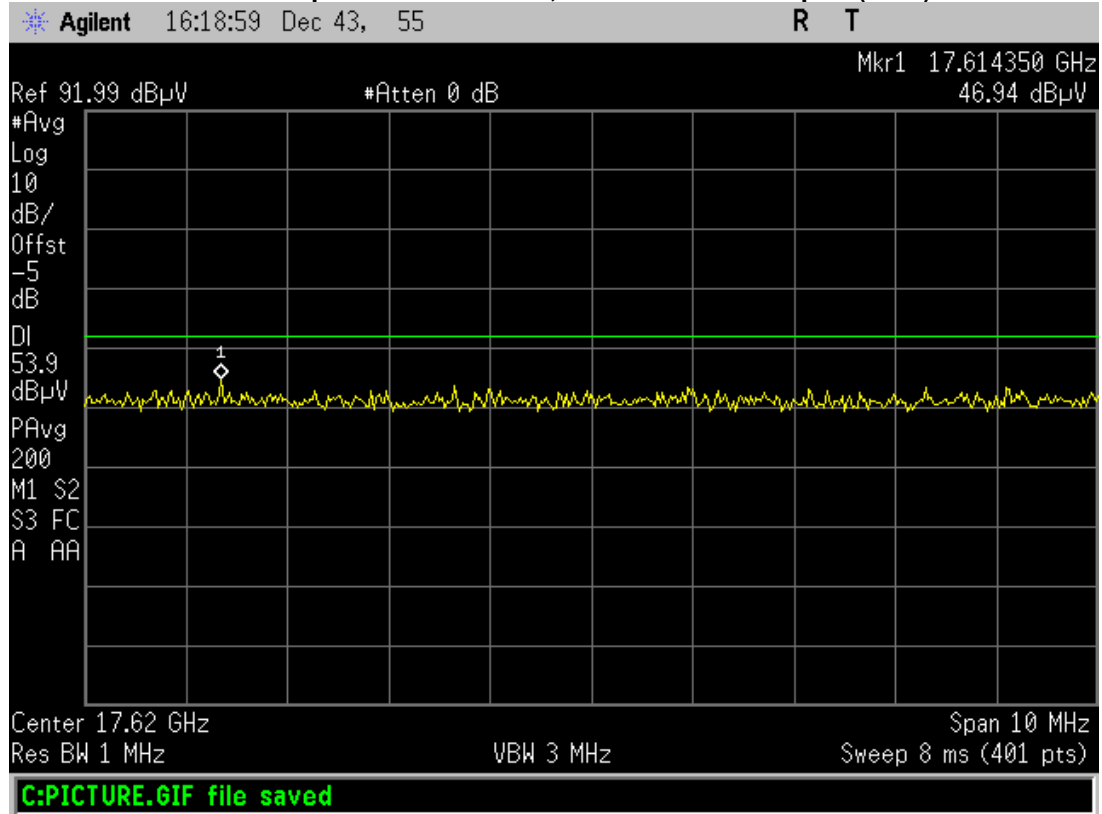
Receiver Spurious Emissions, 14.35 GHz – HORZ plot (AVG)



Receiver Spurious Emissions, 17.53 GHz – HORZ plot (AVG)



Receiver Spurious Emissions, 17.62 GHz – VERT plot (AVG)



Test Equipment Utilized

Description	Manufacturer	Model #	CT Asset #	Last Cal Date	Cal Due Date
EMI Receiver	Hewlett Packard	85462A	i00033	6/9/21	6/9/22
Horn Antenna (18-40GHz)	EMCO	3116	i00085	2/22/21	2/22/23
Horn Antenna	ARA	DRG-118/A	i00271	8/3/20	8/3/22
Transient Limiter	Com-Power	LIT-153	i00123	Verified on: 6/30/21	
Bi-Log antenna	Chase	CBL6111C	i00267	8/28/20	8/28/22
Humidity / Temp Meter	Newport	IBTHX-W-5	i00282	8/28/20	8/28/21
Voltmeter	Fluke	87-iii	i00319	5/18/21	5/18/22
Spectrum Analyzer	Agilent	E4407B	i00331	12/28/20	12/28/21
EMI Analyzer	Agilent	E7405A	i00379	12/29/20	12/29/21
3 Meter Semi-Anechoic Chamber	Panashield	3 Meter Semi-Anechoic Chamber	i00428	7/17/20	7/17/21
LISN	COM-Power	LI-125A	i00446	5/24/21	5/24/23
LISN	COM-Power	LI-125A	i00448	5/24/21	5/24/23
PSA Spectrum Analyzer	Agilent	E4445A	i00471	12/23/20	12/23/21
Preamplifier	Eravant	S BB-0115034018-2F2F-E3	i00591	Verified on: 6/6/21	

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

Measurement Uncertainty

Measurement Uncertainty (U_{lab}) for Compliance Testing is listed in the table below.

Measurement	U_{lab}
Radio Frequency	$\pm 3.3 \times 10^{-8}$
RF Power, conducted	± 1.5 dB
RF Power Density, conducted	± 1.0 dB
Conducted Emissions	± 1.8 dB
Radiated Emissions	± 4.5 dB
Temperature	± 1.5 deg C
Humidity	± 4.3 %
DC voltage	± 0.20 VDC
AC Voltage	± 1.2 VAC

The reported expanded uncertainty $\pm U_{lab}(\text{dB})$ has been estimated at a 95% confidence level ($k=2$)

U_{lab} is less than or equal to U_{ETSI} therefore

- Compliance is deemed to occur if no measured disturbance exceeds the disturbance limit
- Non-Compliance is deemed to occur if any measured disturbance exceeds the disturbance limit

In addition to the above listed equipment standard RF connectors and cables were utilized in the testing of the described equipment. Prior to testing these components were tested to verify proper operation.

END OF TEST REPORT