



CERTIFICATION TEST REPORT

Report Number. : 12563734-E2V2

Applicant : Samsung Electronics Co., Ltd.
129 Samsung-Ro, Yeongtong-Gu,
Suwon-Si, Gyeonggi-Do, 16677, Korea

Model : SM-G970F/DS and SM-G970F

FCC ID : A3LSMG970F

EUT Description : GSM/WCDMA/LTE phone with BT, DTS/UNII a/b/g/n/ac/11ax HE
20/40/80, ANT+ and NFC

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C

Date Of Issue:
January 14, 2019

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NVLAP Lab code: 200065-0

REPORT REVISION HISTORY

| Rev. | Issue Date | Revisions | Revised By |
|------|------------|------------------------------|-------------|
| V1 | 12/19/2018 | Initial Issue | |
| V2 | 1/14/2019 | Updated Sections 5.1 and 5.3 | Steven Tran |

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Samsung Electronics Co., Ltd.
129 Samsung-Ro, Yeongtong-Gu,
Suwon-Si, Gyeonggi-Do, 16677, Korea

EUT DESCRIPTION: GSM/WCDMA/LTE phone with BT, DTS/UNII a/b/g/n/ac/11ax HE
20/40/80, ANT+ and NFC

MODEL: SM-G970F/DS and SM-G970F

SERIAL NUMBER: Conducted: R38KA0H49TL
Radiated: R38KB05BJQB

DATE TESTED: OCTOBER 30, 2018 TO DECEMBER 5, 2018

| APPLICABLE STANDARDS | |
|--------------------------|--------------|
| STANDARD | TEST RESULTS |
| CFR 47 Part 15 Subpart C | Complies |

UL Verification Services Inc. tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.

This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of the U.S. government.

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Reviewed By:



STEVEN TRAN
Project Engineer
Consumer Technology Division
UL Verification Services Inc.

2. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15, ANSI C63.10-2013, and KDB 558074 D01 15.247 Meas Guidance v05.

3. FACILITIES AND ACCREDITATION

The test sites and measurement facilities used to collect data are located at 47173 and 47266 Benicia Street, and 47658 Kato Road, Fremont, California, USA. Line conducted emissions are measured only at the 47173 address. The following table identifies which facilities were utilized for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

| 47173 Benicia Street | 47266 Benicia Street | 47658 Kato Rd |
|--|---|---|
| <input checked="" type="checkbox"/> Chamber A (ISED:2324B-1) | <input type="checkbox"/> Chamber D (ISED:22541-1) | <input type="checkbox"/> Chamber I (ISED:2324A-5) |
| <input checked="" type="checkbox"/> Chamber B (ISED:2324B-2) | <input type="checkbox"/> Chamber E (ISED:22541-2) | <input type="checkbox"/> Chamber J (ISED:2324A-6) |
| <input checked="" type="checkbox"/> Chamber C (ISED:2324B-3) | <input type="checkbox"/> Chamber F (ISED:22541-3) | <input type="checkbox"/> Chamber K (ISED:2324A-1) |
| | <input type="checkbox"/> Chamber G (ISED:22541-4) | <input type="checkbox"/> Chamber L (ISED:2324A-3) |
| | <input type="checkbox"/> Chamber H (ISED:22541-5) | |

The above test sites and facilities are covered under FCC Test Firm Registration # 208313. Chambers above are covered under Industry Canada company address and respective code

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0

4. CALIBRATION AND UNCERTAINTY

4.1. MEASURING INSTRUMENT CALIBRATION

The measuring equipment utilized to perform the tests documented in this report has been calibrated in accordance with the manufacturer's recommendations, and is traceable to recognized national standards.

4.2. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

Field Strength (dBuV/m) = Measured Voltage (dBuV) + Antenna Factor (dB/m) + Cable Loss (dB) – Preamp Gain (dB)

$$36.5 \text{ dBuV} + 18.7 \text{ dB/m} + 0.6 \text{ dB} - 26.9 \text{ dB} = 28.9 \text{ dBuV/m}$$

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

Final Voltage (dBuV) = Measured Voltage (dBuV) + Cable Loss (dB) + Limiter Factor (dB) + LISN Insertion Loss.

$$36.5 \text{ dBuV} + 0 \text{ dB} + 10.1 \text{ dB} + 0 \text{ dB} = 46.6 \text{ dBuV}$$

4.3. MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the apparatus:

| PARAMETER | UNCERTAINTY |
|---|-------------|
| Worst Case Conducted Disturbance, 9KHz to 0.15 MHz | 3.84 dB |
| Worst Case Conducted Disturbance, 0.15 to 30 MHz | 3.65 dB |
| Worst Case Radiated Disturbance, 9KHz to 30 MHz | 3.15 dB |
| Worst Case Radiated Disturbance, 30 to 1000 MHz | 5.36 dB |
| Worst Case Radiated Disturbance, 1000 to 18000 MHz | 4.32 dB |
| Worst Case Radiated Disturbance, 18000 to 26000 MHz | 4.45 dB |
| Worst Case Radiated Disturbance, 26000 to 40000 MHz | 5.24 dB |

Uncertainty figures are valid to a confidence level of 95%.

5. EQUIPMENT UNDER TEST

5.1. EUT DESCRIPTION

The EUT is a GSM/WCDMA/LTE phone with BT, DTS/UNII a/b/g/n/ac/11ax HE 20/40/80, ANT+ and NFC. The model SM-G970F was used for final testing and is representative of the test results in this report.

5.2. MAXIMUM OUTPUT POWER

The transmitter has a maximum peak conducted output power as follows:

| Frequency Range (MHz) | Mode | Output Power (dBm) | Output Power (mW) |
|-----------------------|----------------|--------------------|-------------------|
| 2402 - 2480 | Basic GFSK | 16.99 | 50.00 |
| 2402 - 2480 | Enhanced DQPSK | 12.35 | 17.18 |
| 2402 - 2480 | Enhanced 8PSK | 12.97 | 19.82 |

Note: GFSK, DQPSK, 8PSK average Power are all investigated, The GFSK & 8PSK Power are the worst case. Testing is based on these modes to showing compliance. For average power data please refer to section 4.7.

5.3. DESCRIPTION OF AVAILABLE ANTENNAS

The radio utilizes an FPCB antenna, with a maximum gain of -1.21 dBi.

5.4. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was G970F.001

5.5. WORST-CASE CONFIGURATION AND MODE

Radiated emissions below 1GHz, above 18GHz, and power line conducted emission were performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Band edge and radiated emissions between 1GHz and 18GHz were performed with the EUT set to transmit at the highest power on low, middle and high channels.

The fundamental of the EUT was investigated in three orthogonal orientations X,Y,Z, it was determined that X orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in X orientation.

Worst-case data rates as provided by the client were:

GFSK mode: DH5
8PSK mode: 3-DH5

All radios that can be transmitted simultaneously have been evaluated for radiated for all possible combinations of transmission and found to be in compliance.

5.6. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

| Support Equipment List | | | | |
|------------------------|--------------|----------|---------------|--------|
| Description | Manufacturer | Model | Serial Number | FCC ID |
| AC Adapter | Samsung | EP-TA300 | R3KB5B01S1SE3 | N/A |
| USB Data Caba | Samsung | N/A | N/A | N/A |
| Earphone | Samsung | N/A | N/A | N/A |

I/O CABLES (CONDUCTED TEST)

| I/O Cable List | | | | | | |
|----------------|---------|----------------------|----------------|-------------|------------------|----------------------|
| Cable No | Port | # of identical ports | Connector Type | Cable Type | Cable Length (m) | Remarks |
| 1 | Antenna | 1 | RF | Shielded | 0.2 | To PSA and BT Tester |
| 2 | USB | 1 | USB | Un-shielded | 1 | EUT to AC Mains |

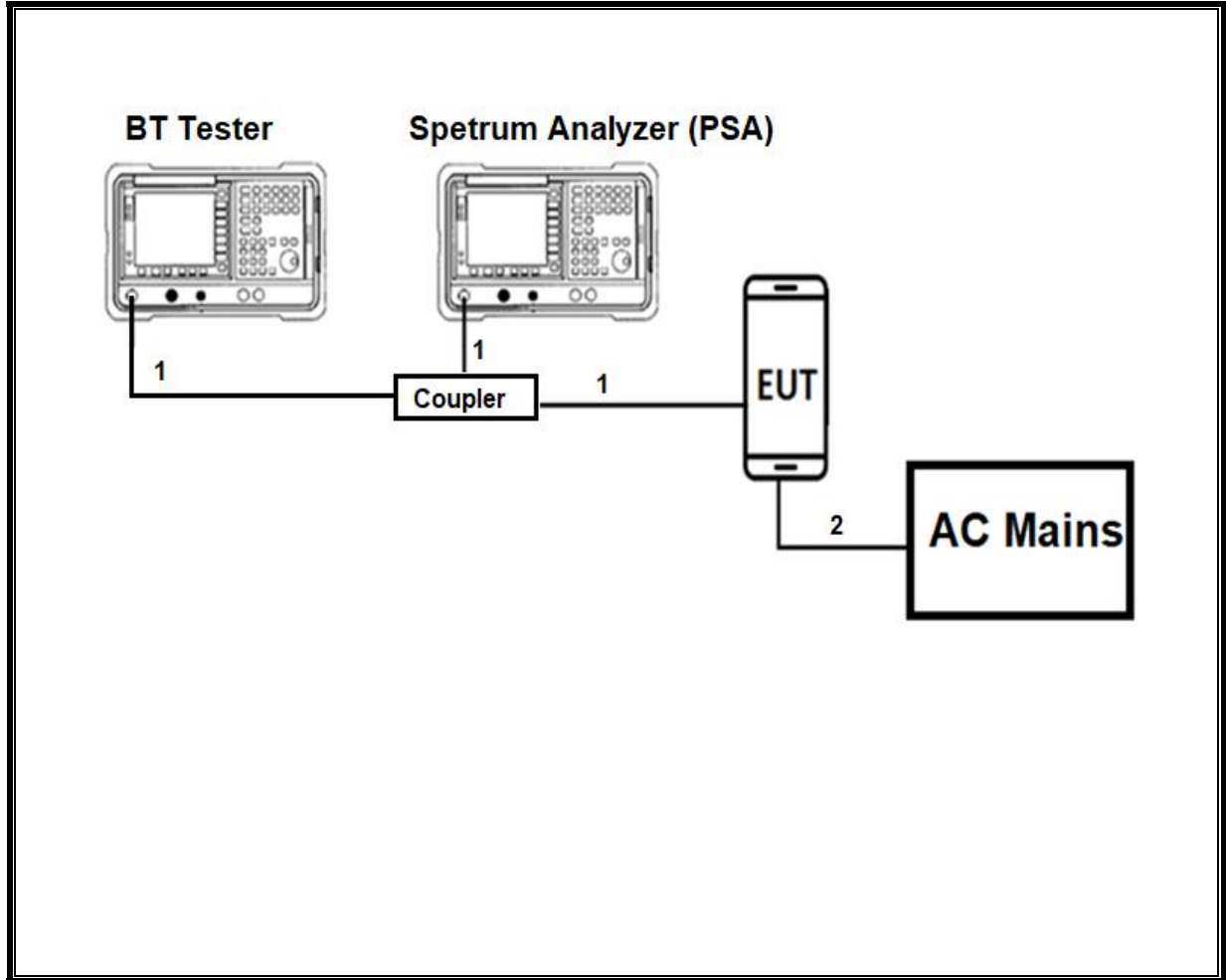
I/O CABLES (RADIATED AND CONDUCTED EMISSIONS)

| I/O Cable List | | | | | | |
|----------------|----------|----------------------|----------------|-------------|------------------|---------|
| Cable No | Port | # of identical ports | Connector Type | Cable Type | Cable Length (m) | Remarks |
| 1 | USB | 1 | USB | Shielded | 1 | N/A |
| 2 | earphone | 1 | 3.5mm | Un-shielded | 1 | N/A |

TEST SETUP

The EUT is a standalone. Test software exercised the radio card.

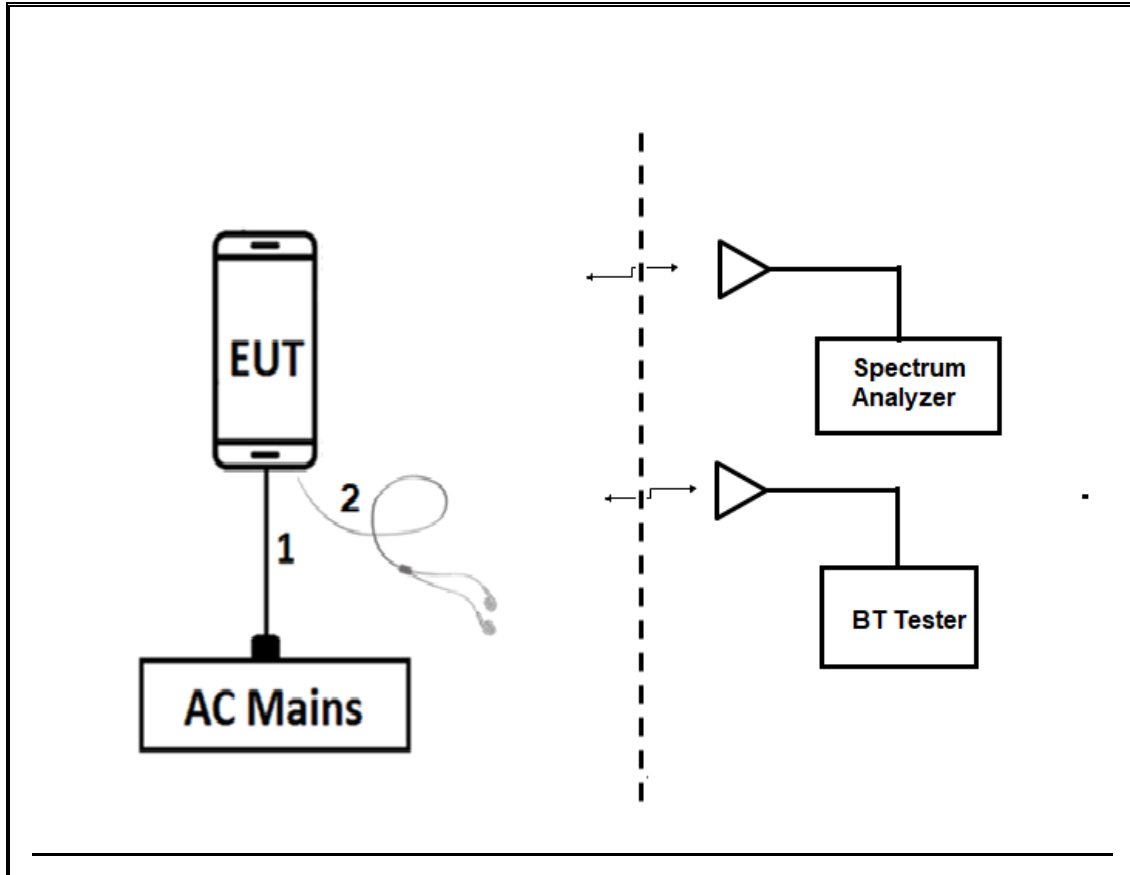
CONDUCTED TEST SETUP DIAGRAM



TEST SETUP

For conducted tests: the EUT was Stand alone. The test software exercises the radio.

RADIATED AND AC LINE CONDUCTED EMISSIONS SETUP DIAGRAM



TEST SETUP

For radiated tests: EUT has support equipment. The test software exercises the radio.

6. TEST AND MEASUREMENT EQUIPMENT

The following test and measurement equipment was utilized for the tests documented in this report:

| TEST EQUIPMENT LIST | | | | | |
|--|---------------------------------|------------------------|------------|------------|-------------|
| Description | Manufacturer | Model | ID Num | Cal Due | Last Cal |
| Amplifier, 100KHz to 1GHz,32dB | SONOMA INSTRUMENT | 310N | T300 | 12/11/2019 | 12/11/2019 |
| RF Amplifier | MITEQ | AFS42-00101800-25-S-42 | T493 | 10/13/2019 | 10/13/2018 |
| RF Amplifier, 1-18GHz | MITEQ | AFS42-00101800-25-S-42 | T1165 | 10/20/2019 | 10/20/2018 |
| Pre-Amp 1-26.5 GHz | Agilent | 8449B | T404 | 03/09/2019 | 023/09/2018 |
| Antenna, Broadband Hybrid, 30MHz to 2000MHz | Sunol Sciences Corp. | JB3 | T900 | 06/18/2019 | 06/18/2018 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T345 | 04/25/2019 | 04/25/2018 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T863 | 06/21/2019 | 06/21/2018 |
| Antenna, Horn 1-18GHz | ETS-Lindgren | 3117 | T862 | 05/24/2019 | 05/24/2018 |
| Antenna, Active Loop 9kHz-30MHz | Com-Power Corp. | AL-130R | PRE0165308 | 12/13/2018 | 12/13/2017 |
| 18 - 26.5 GHz Horn Antenna | ARA | MWH-1826/B | T477 | 06/16/2019 | 06/16/2018 |
| Power Meter, P-series single channel | Agilent (Keysight) Technologies | N1911A | T1271 | 07/26/2019 | 07/26/2018 |
| Power Sensor, P-series, 50MHz to 18GHz, Wideband | Agilent (Keysight) Technologies | N1921A | T1224 | 10/09/2019 | 10/09/2018 |
| EMI Reciever | Rohde & Schwarz | ESR | T1436 | 02/21/2019 | 02/21/2018 |
| L.I.S.N. | FCC INC. | FCC LISN 50/250 | T1310 | 06/15/2019 | 06/15/2018 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T1113 | 12/21/2018 | 12/21/2017 |
| Spectrum Analyzer | Agilent (Keysight) Technologies | E4446A | T146 | 08/13/2019 | 08/13/2018 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T1466 | 04/16/2019 | 04/16/2018 |
| Spectrum Analyzer, PXA, 3Hz to 44GHz | Agilent (Keysight) Technologies | N9030A | T1454 | 01/08/2019 | 01/08/2018 |

| Test Software List | | | |
|-----------------------|--------------|--------|-----------------------|
| Description | Manufacturer | Model | Version |
| Radiated Software | UL | UL EMC | Ver 9.5, Dec 01, 2016 |
| Antenna Port Software | UL | UL RF | Ver 9.0, Oct 31, 2018 |

7. MEASUREMENT METHODS

On Time and Duty Cycle: ANSI C63.10-2013 Section 11.6

Occupied BW (20dB): ANSI C63.10-2013 Section 6.9.2

Occupied BW (99%): ANSI C63.10-2013 Section 6.9.3

Carrier Frequency Separation: ANSI C63.10-2013 Section 7.8.2

Number of Hopping Frequencies: ANSI C63.10-2013 Section 7.8.3

Time of Occupancy (Dwell Time): ANSI C63.10-2013 Section 7.8.4

Peak Output Power: ANSI C63.10-2013 Section 7.8.5

Conducted Spurious Emissions: ANSI C63.10-2013 Section 7.8.8

Conducted Band-Edge: ANSI C63.10-2013 Section 6.10.4

Radiated Spurious Emissions 30-1000MHz: ANSI C63.10-2013 Section 6.3 and 6.5

Radiated Spurious Emissions above 1GHz: ANSI C63.10-2013 Section 6.3 and 6.6

Radiated Band-edge: ANSI C63.10-2013 Section 6.10.5

AC Power-line conducted emissions: ANSI C63.10-2013, Section 6.2.

8. ANTENNA PORT TEST RESULTS

8.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

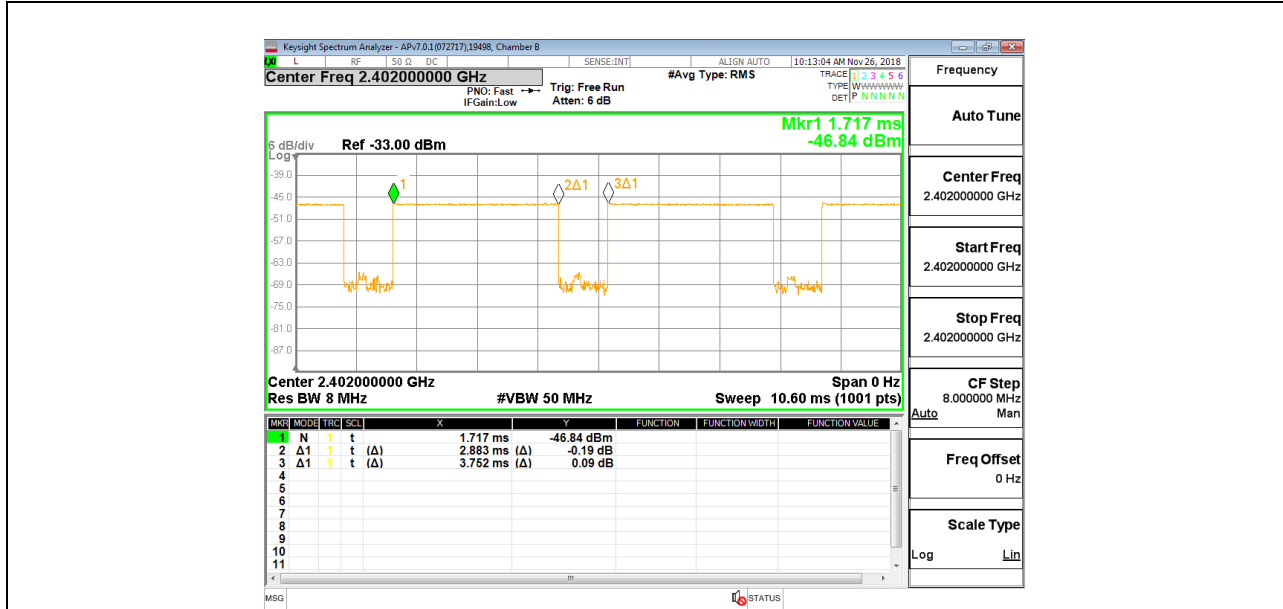
PROCEDURE

ANSI C63.10, Section 11.6 : Zero-Span Spectrum Analyzer Method.

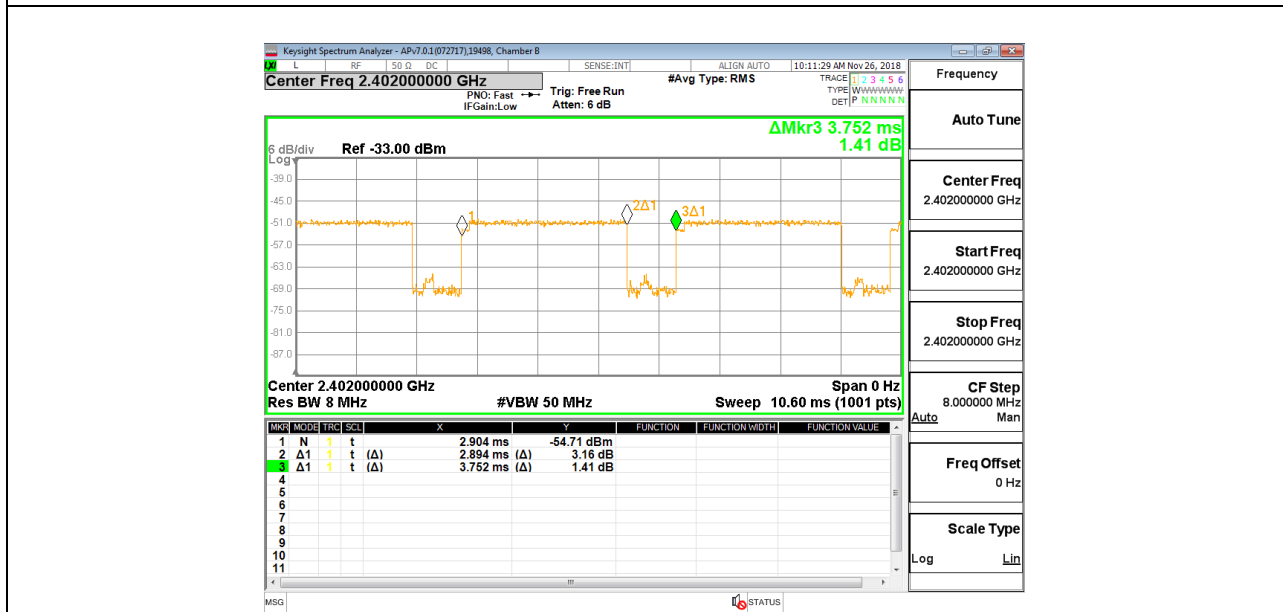
ON TIME AND DUTY CYCLE RESULTS

| Mode | ON Time B (msec) | Period (msec) | Duty Cycle x (linear) | Duty Cycle (%) | Duty Cycle Correction Factor (dB) | 1/T Minimum VBW (kHz) |
|----------------|------------------------|------------------|-----------------------------|----------------------|---|-----------------------------|
| Bluetooth GFSK | 2.883 | 3.752 | 0.768 | 76.8% | 1.14 | 0.347 |
| Bluetooth 8PSK | 2.894 | 3.749 | 0.772 | 77.2% | 1.12 | 0.346 |

DUTY CYCLE PLOTS



BLUETOOTH GFSK



BLUETOOTH 8PSK

8.2. 20 dB AND 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

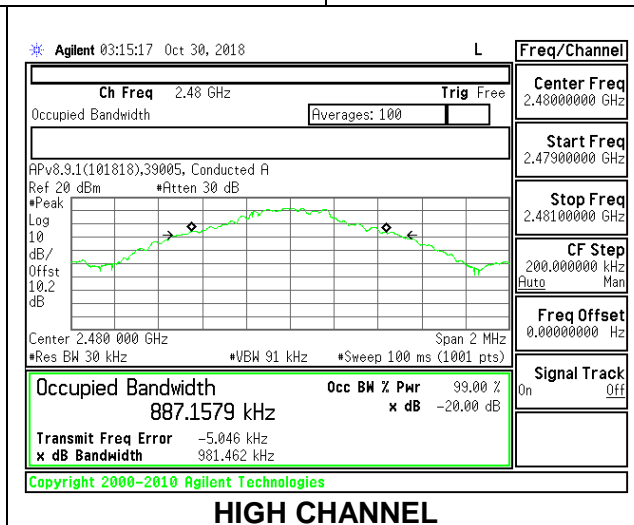
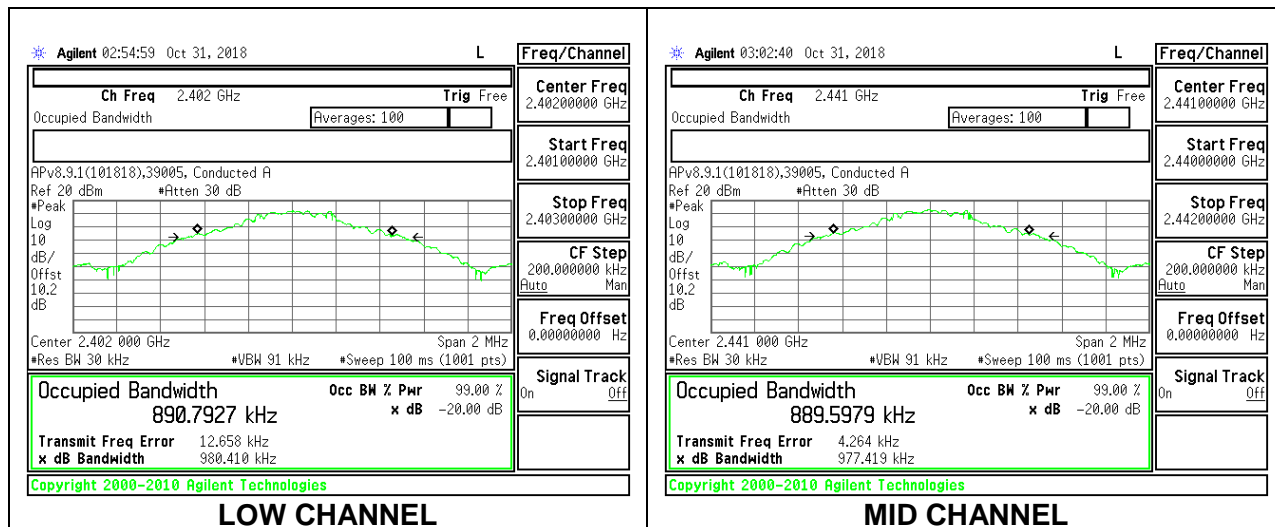
TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 20 dB bandwidth. The VBW is set to \geq RBW. The sweep time is coupled.

RESULTS

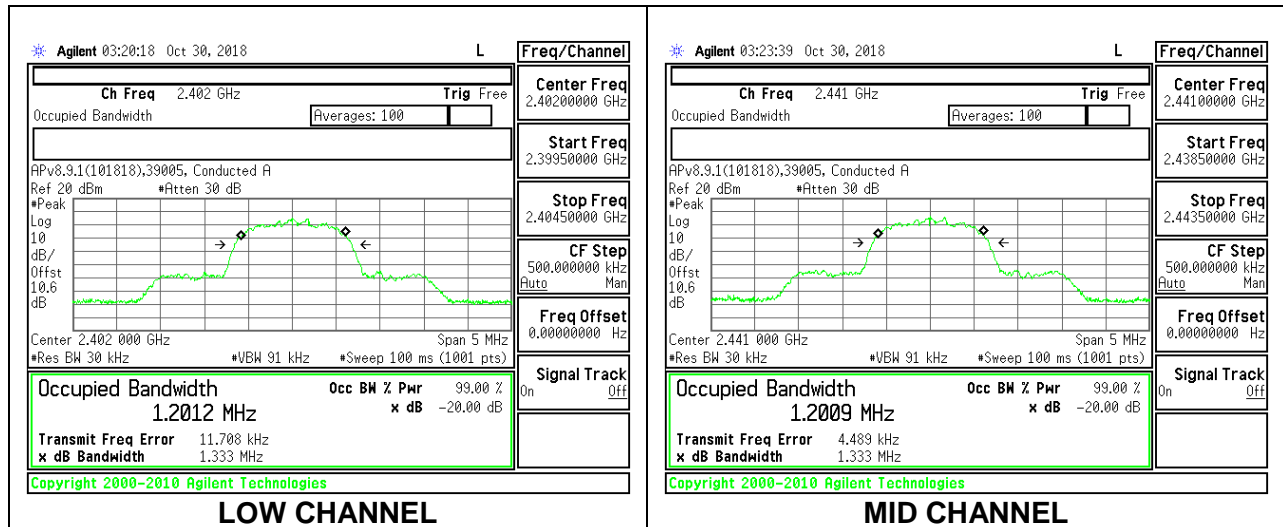
8.2.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low | 2402 | 0.9804 | 0.8908 |
| Mid | 2441 | 0.9774 | 0.8896 |
| High | 2480 | 0.9815 | 0.8872 |



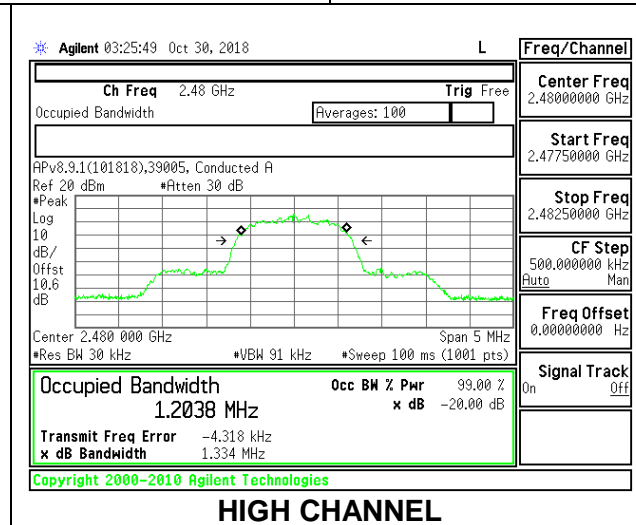
8.2.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| Channel | Frequency (MHz) | 20dB Bandwidth (MHz) | 99% Bandwidth (MHz) |
|---------|-----------------|----------------------|---------------------|
| Low | 2402 | 1.333 | 1.2012 |
| Mid | 2441 | 1.333 | 1.2009 |
| High | 2480 | 1.334 | 1.2038 |



LOW CHANNEL

MID CHANNEL



HIGH CHANNEL

8.3. HOPPING FREQUENCY SEPARATION

LIMITS

FCC §15.247 (a) (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.

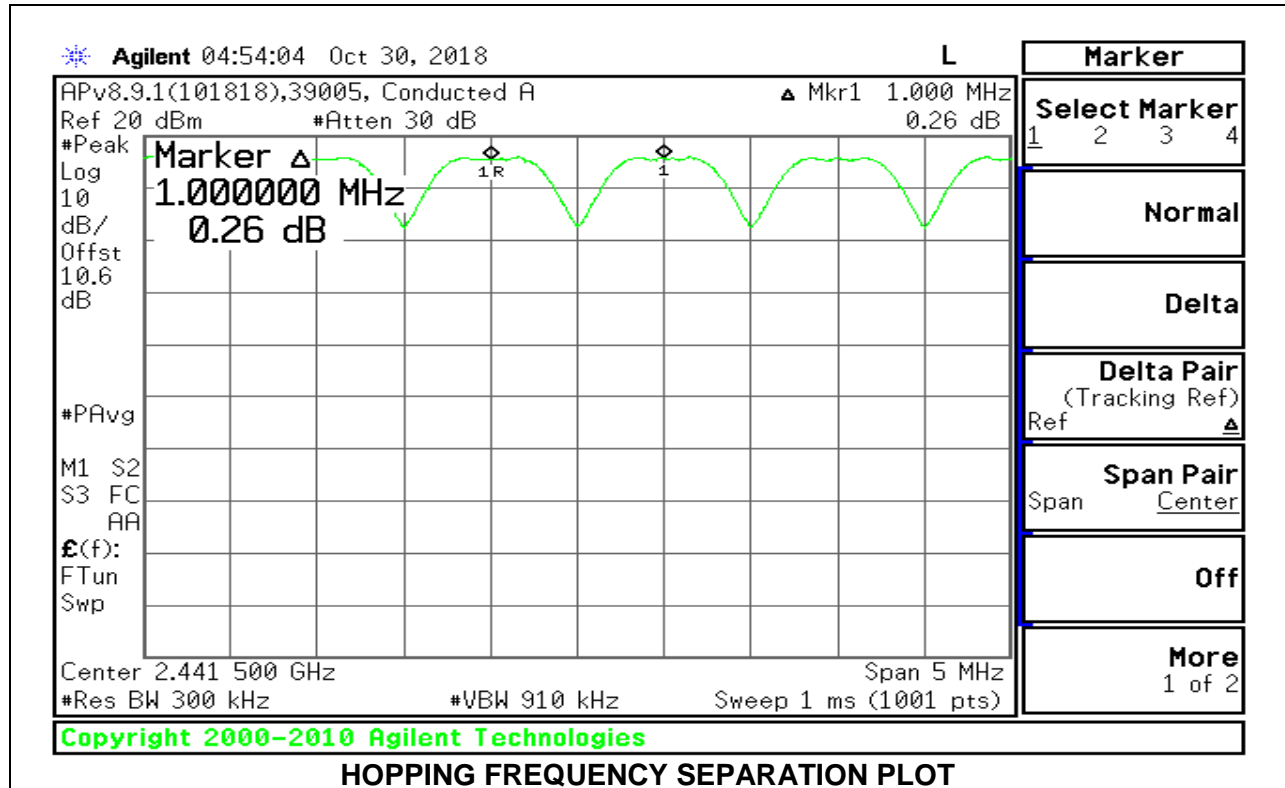
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.

TEST PROCEDURE

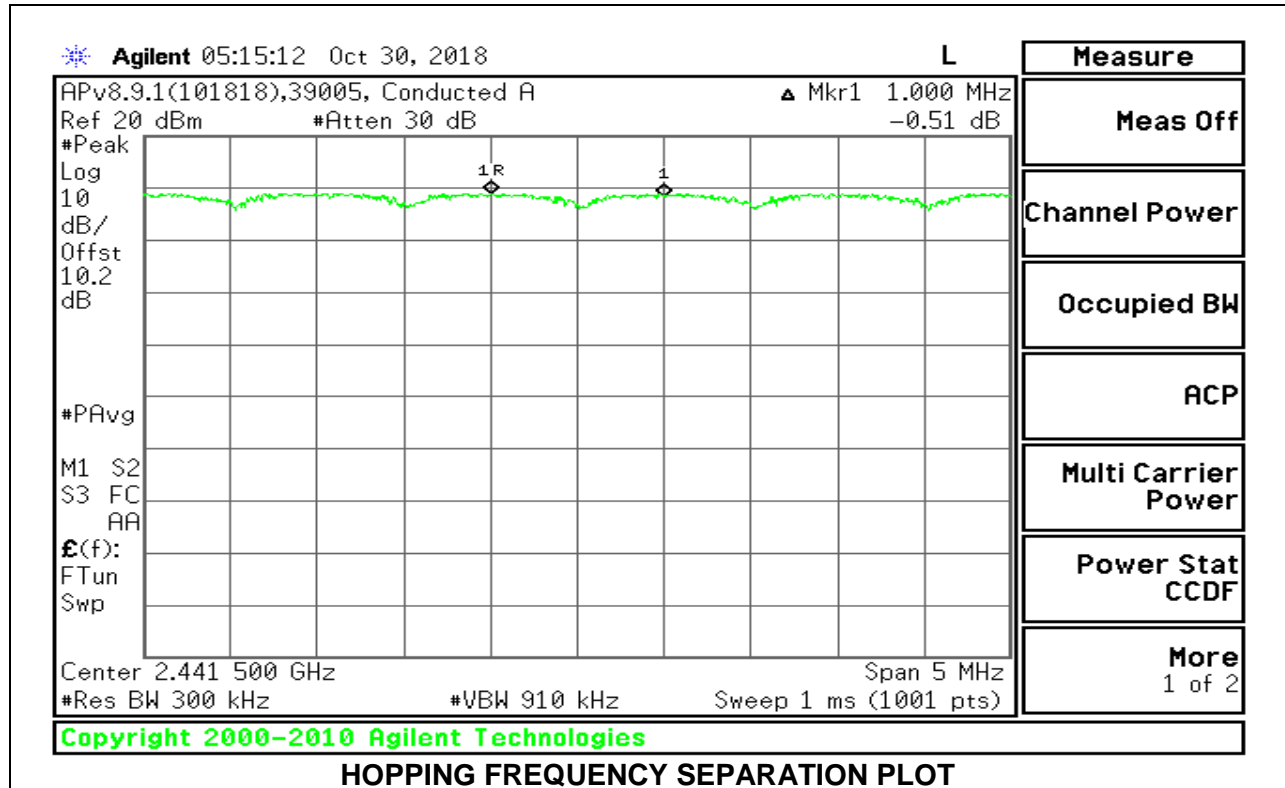
The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz and the VBW is set to 300 kHz. The sweep time is coupled.

RESULTS

8.3.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION



8.3.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION



8.4. NUMBER OF HOPPING CHANNELS

LIMITS

FCC §15.247 (a) (1) (iii)

Frequency hopping systems in the 2400 – 2483.5 MHz band shall use at least 15 non-overlapping channels.

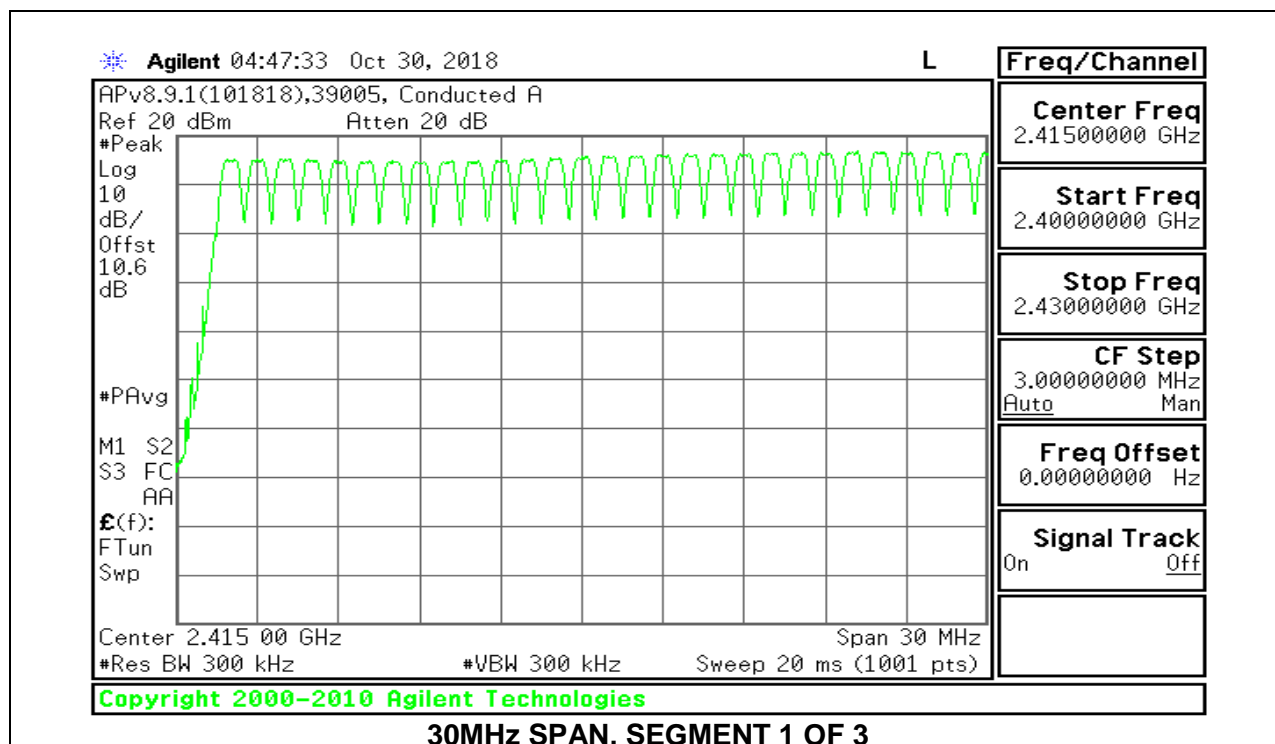
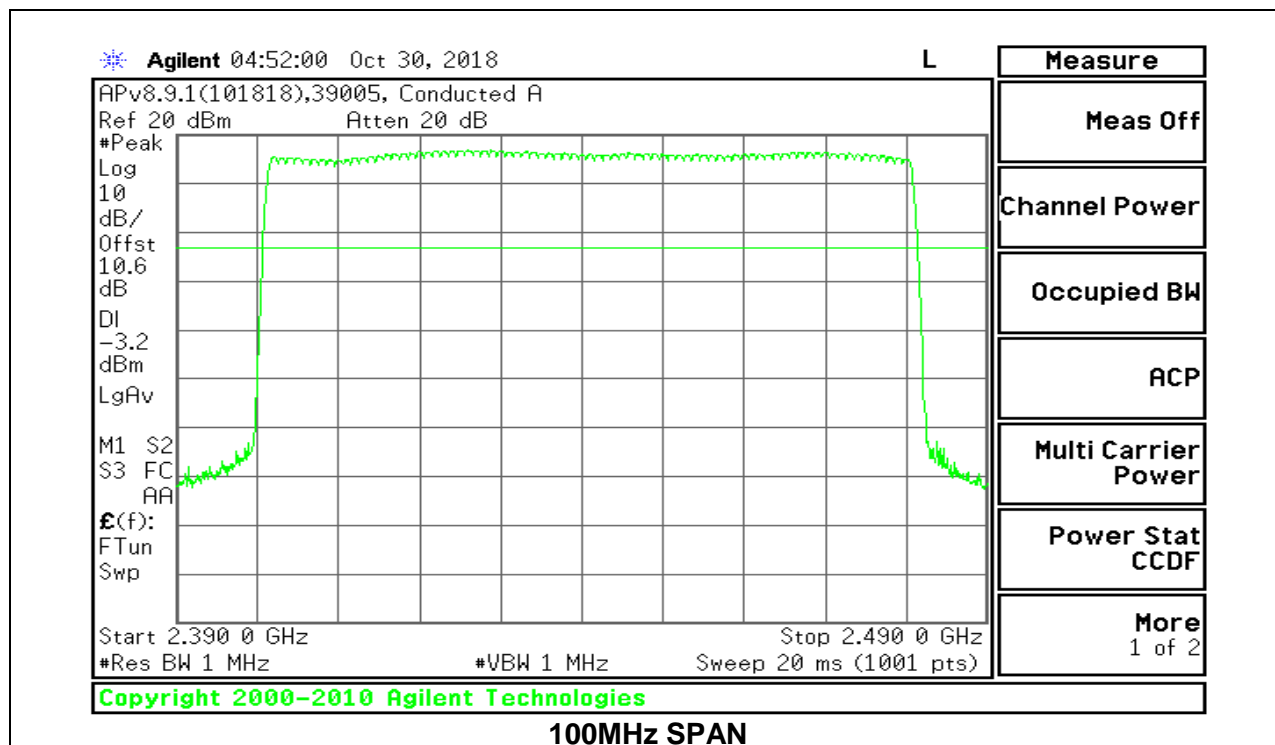
TEST PROCEDURE

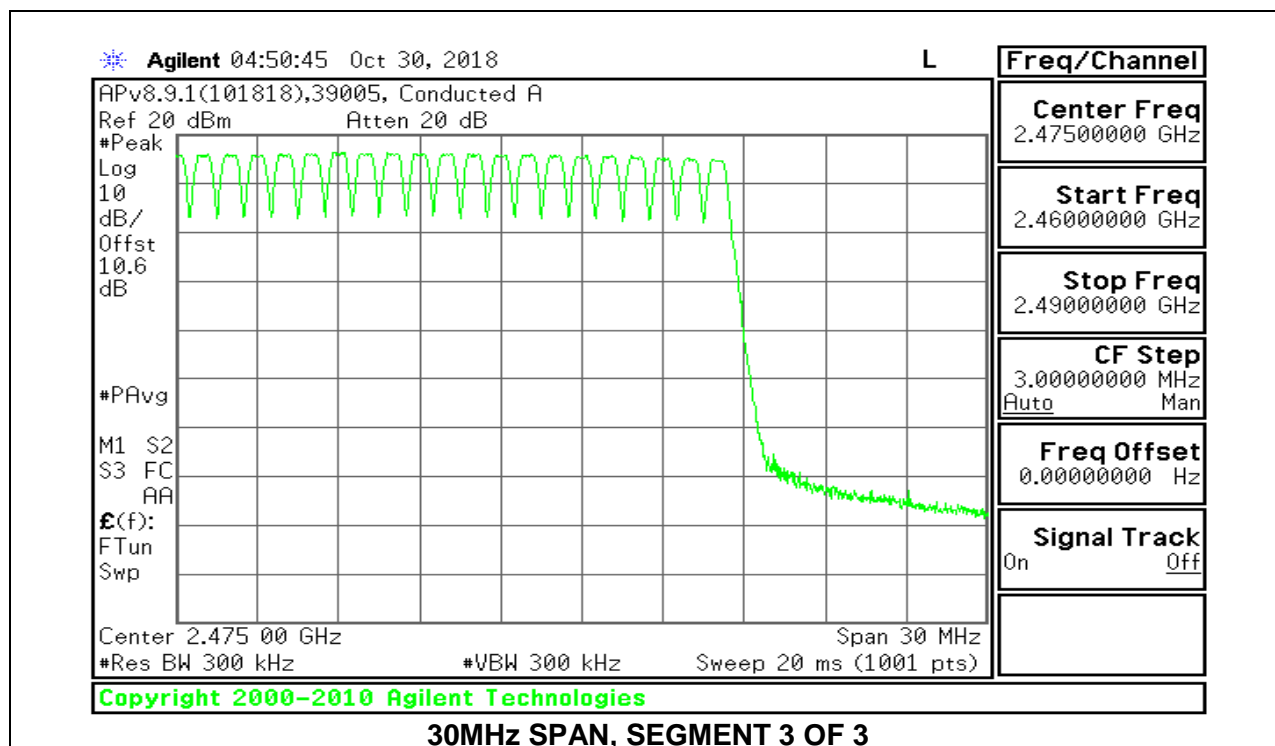
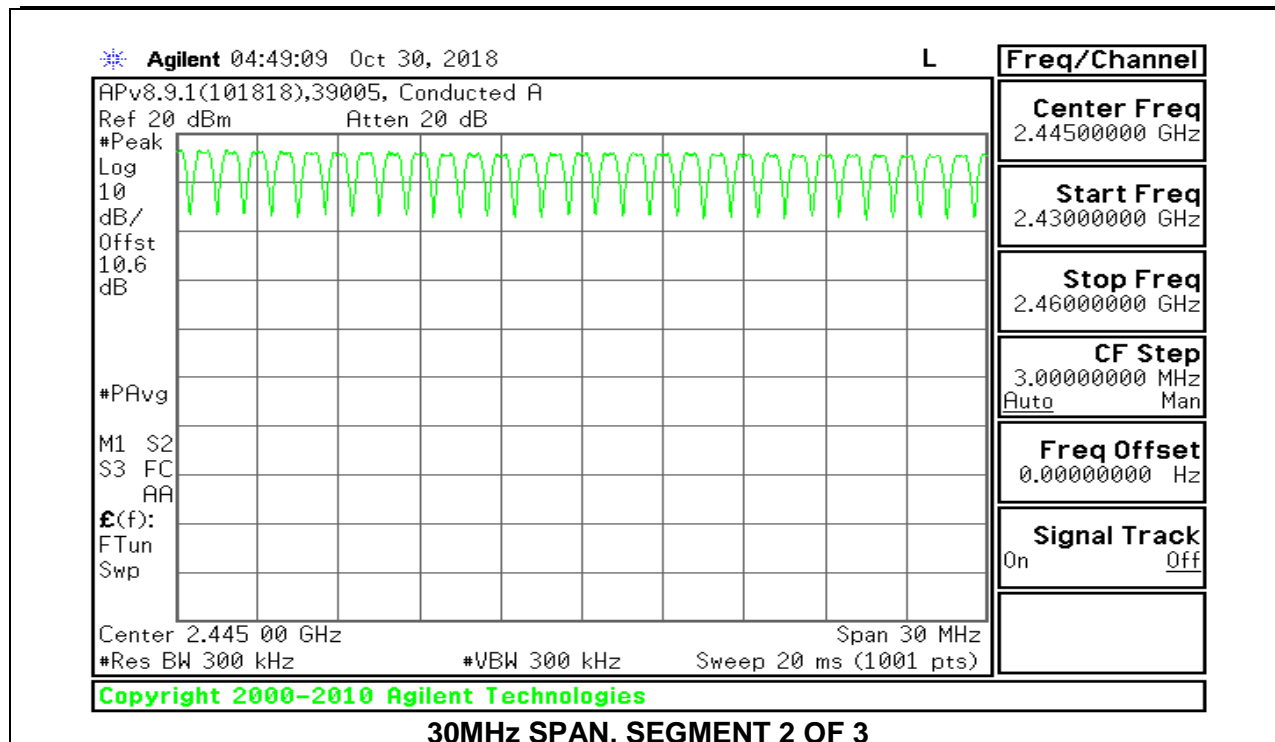
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

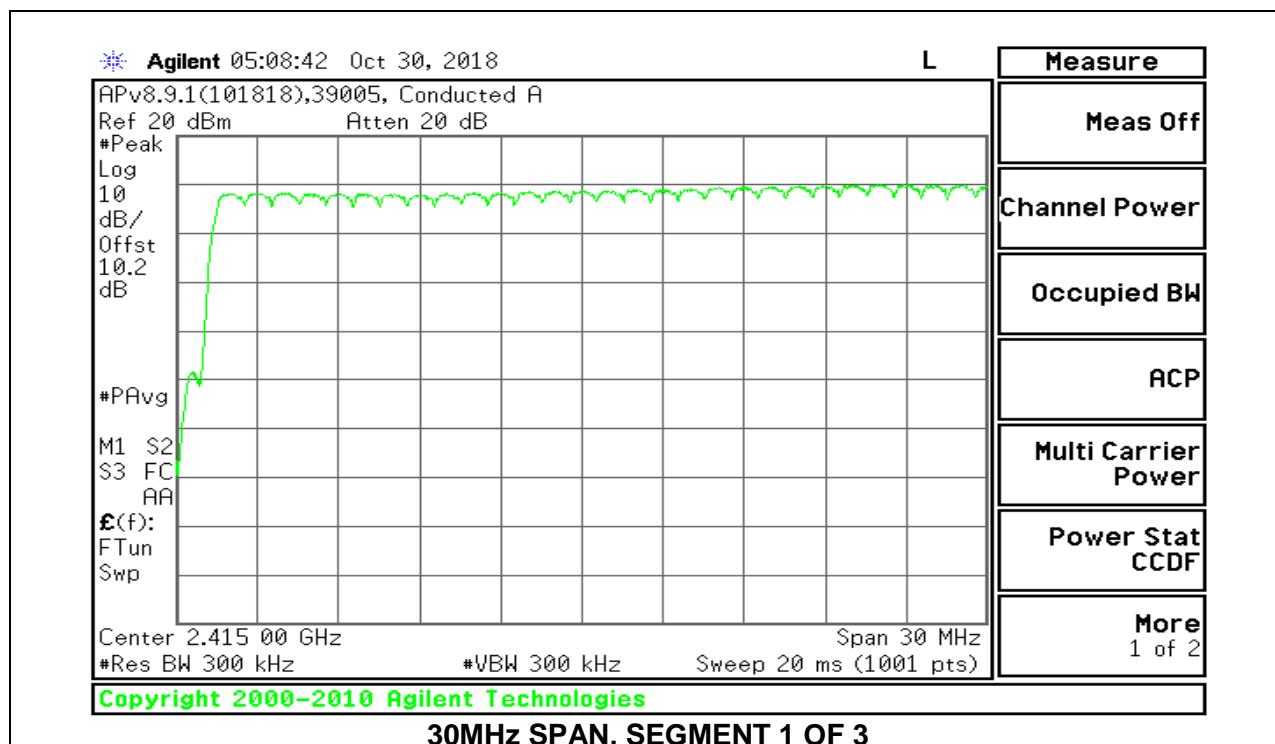
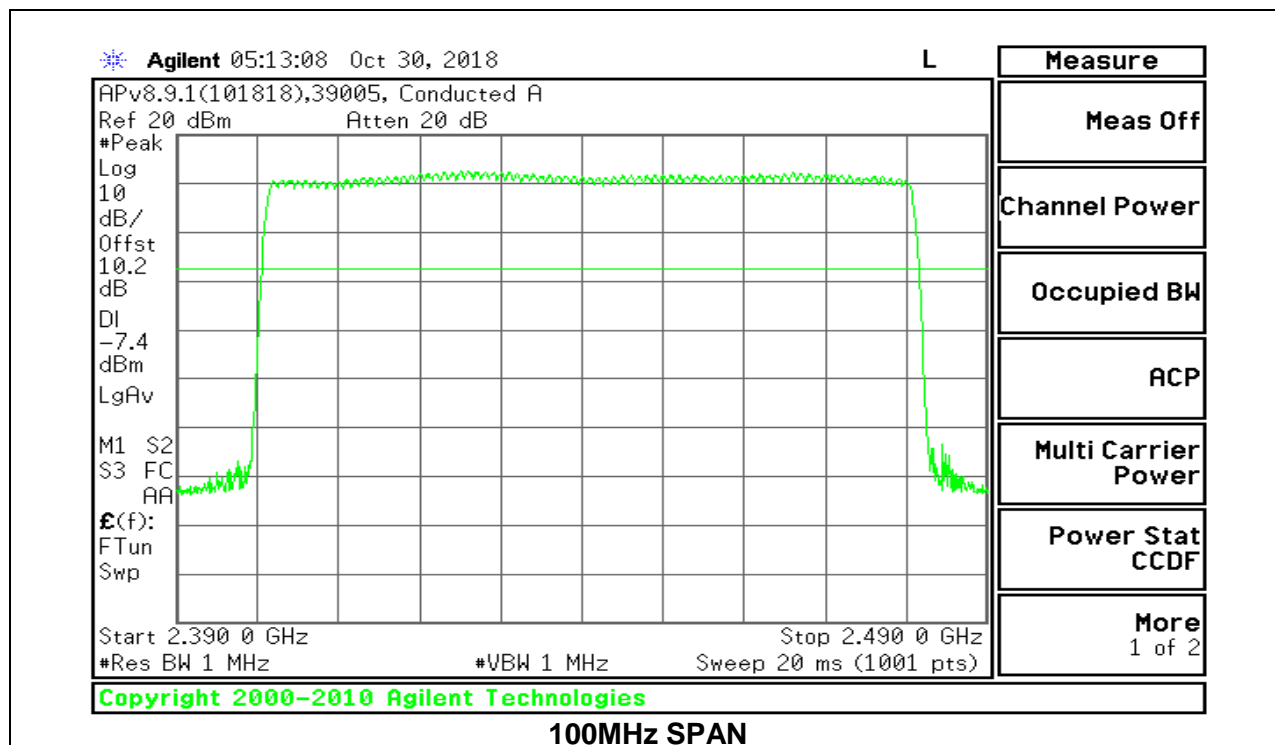
Normal Mode: 79 Channels Observed

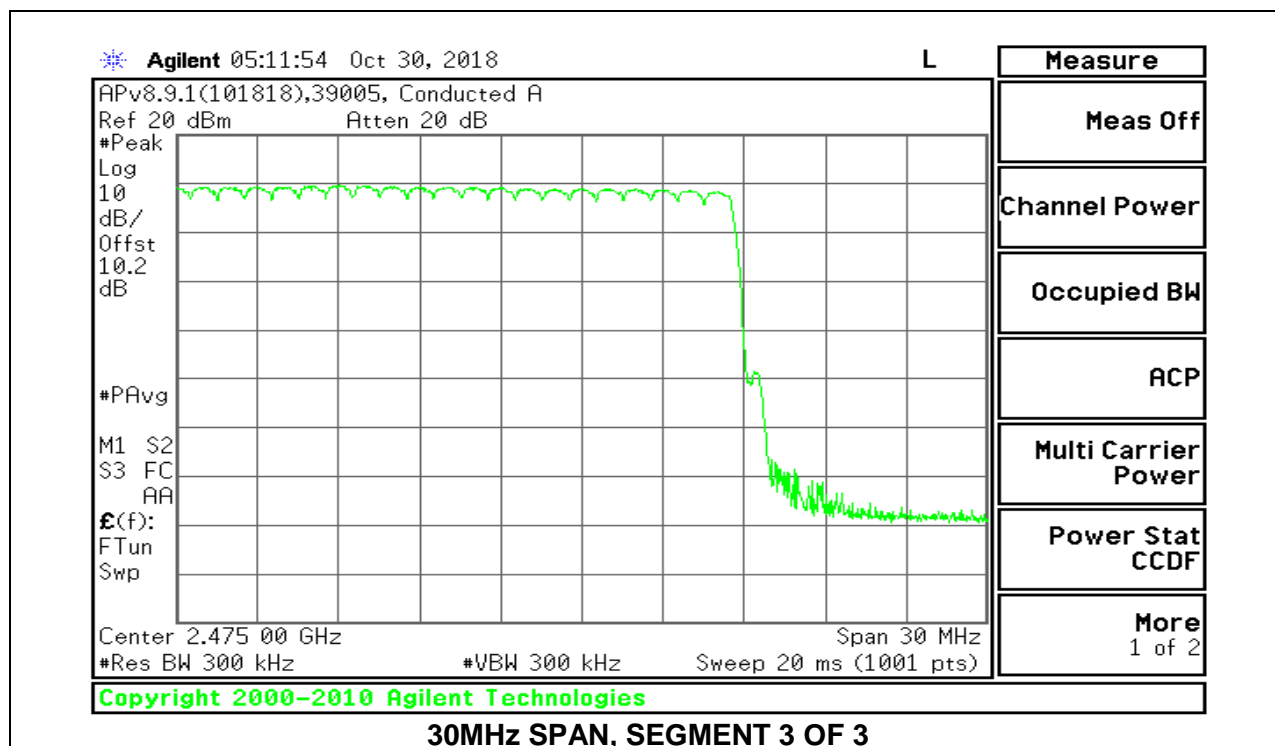
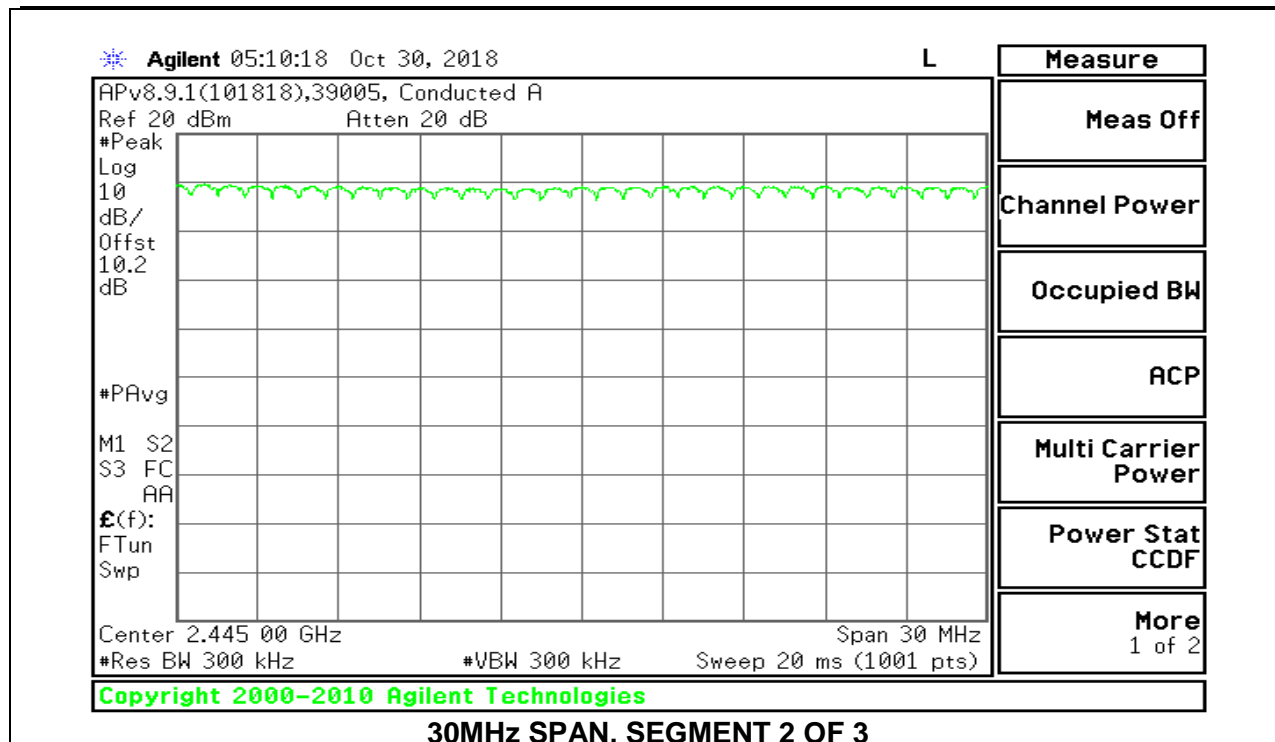
8.4.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION





8.4.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION





8.5. AVERAGE TIME OF OCCUPANCY

LIMITS

FCC §15.247 (a) (1) (iii)

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.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The span is set to 0 Hz, centered on a single, selected hopping channel. The width of a single pulse is measured in a fast scan. The number of pulses is measured in a 3.16 second scan, to enable resolution of each occurrence.

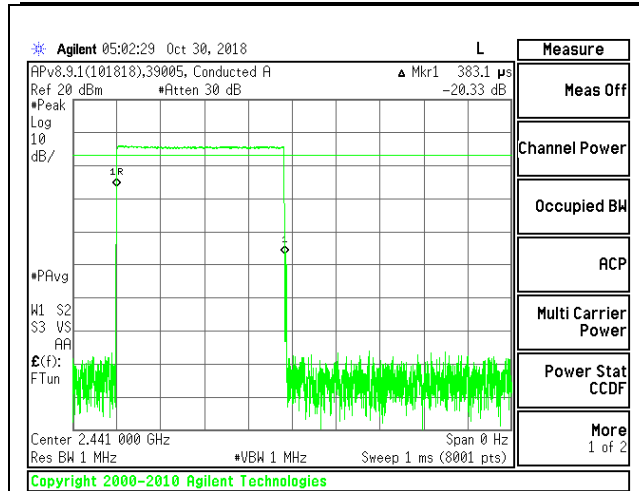
The average time of occupancy in the specified 3.16 second period (79 channels * 0.4 s) is equal to $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{ pulse width}$.

For AFH mode, the average time of occupancy in the specified 8 second period (20 channels * 0.4 seconds) is equal to $10 * (\# \text{ of pulses in } 0.8 \text{ s}) * \text{ pulse width}$.

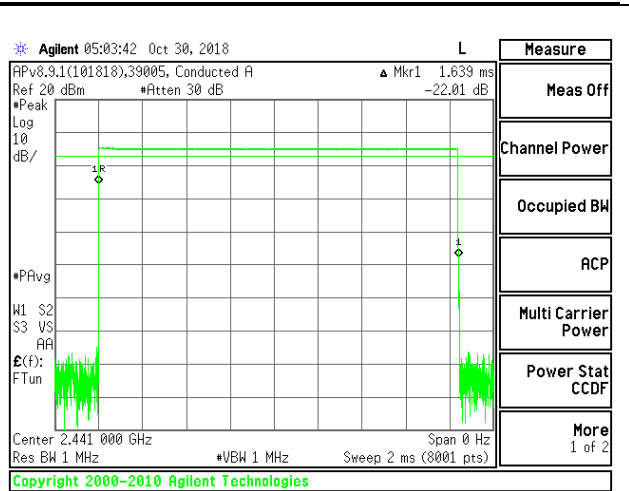
RESULTS

8.5.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

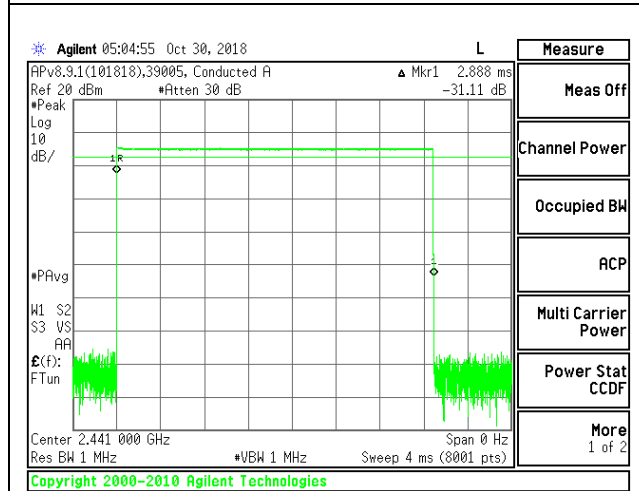
| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|-------------------------|--------------------|----------------------------------|---------------------------------|-------------|--------------|
| GFSK Normal Mode | | | | | |
| DH1 | 0.3831 | 32 | 0.1226 | 0.4 | -0.2774 |
| DH3 | 1.639 | 18 | 0.2950 | 0.4 | -0.1050 |
| DH5 | 2.888 | 9 | 0.2599 | 0.4 | -0.1401 |
| GFSK AFH Mode | | | | | |
| DH Packet | Pulse Width (sec) | Number of Pulses in 0.8 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
| 3DH1 | 0.3831 | 8 | 0.03065 | 0.4 | -0.3694 |
| 3DH3 | 1.639 | 4.5 | 0.07376 | 0.4 | -0.3262 |
| 3DH5 | 2.888 | 2.25 | 0.06498 | 0.4 | -0.3350 |



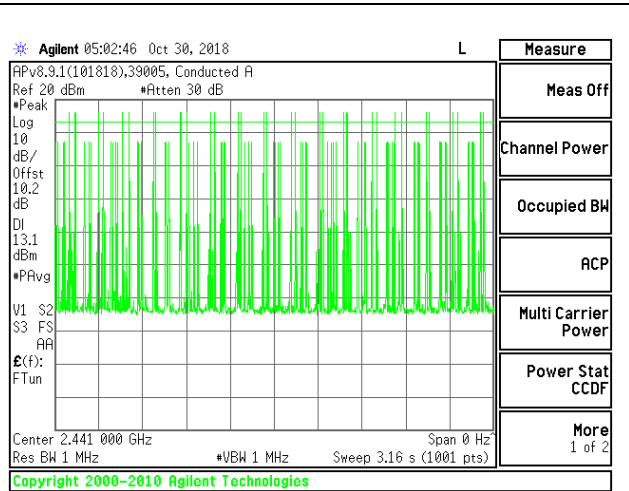
PULSE WIDTH – DH1



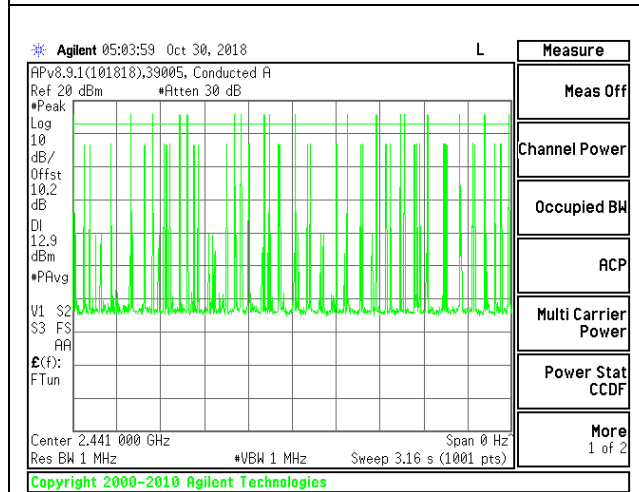
PULSE WIDTH – DH3



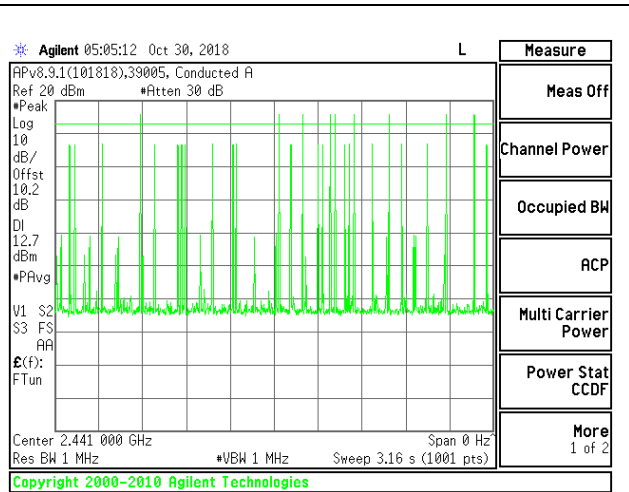
PULSE WIDTH – DH5



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH1



NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH3

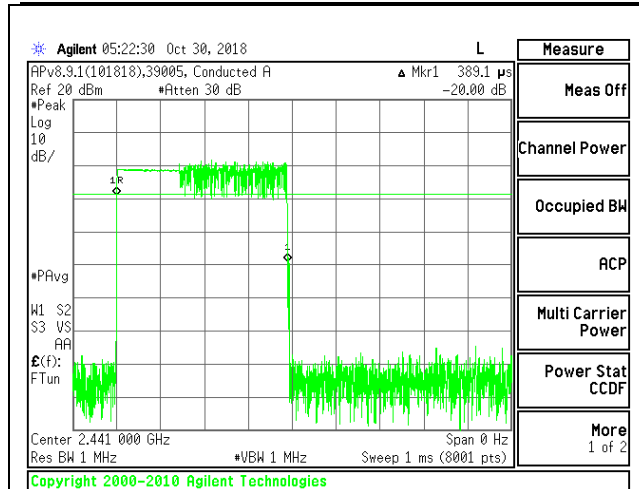


NUMBER OF PULSES IN 3.16 SECOND OBSERVATION PERIOD – DH5

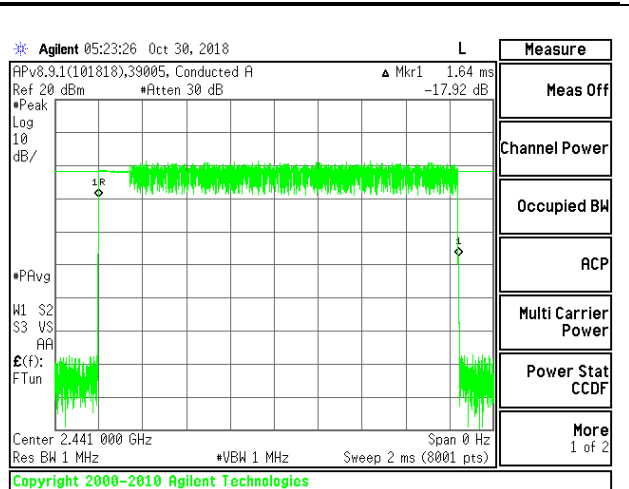
8.5.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| DH Packet | Pulse Width (msec) | Number of Pulses in 3.16 seconds | Average Time of Occupancy (sec) | Limit (sec) | Margin (sec) |
|------------------|--------------------|----------------------------------|---------------------------------|-------------|--------------|
| 8PSK Normal Mode | | | | | |
| 3DH1 | 0.3891 | 31 | 0.120621 | 0.4 | -0.27938 |
| 3DH3 | 1.64 | 12 | 0.1968 | 0.4 | -0.2032 |
| 3DH5 | 2.892 | 10 | 0.2892 | 0.4 | -0.1108 |

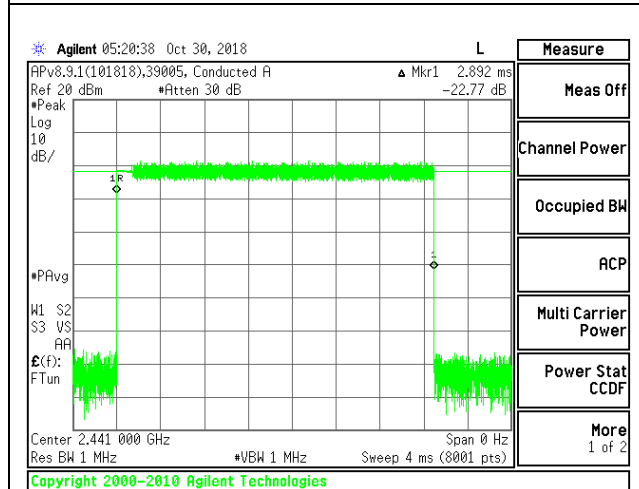
Note: for AFH(8PSK) mode, please refer to the results of AFH(GFSK) mode; the channel selection and hopping rate are the same for both EDR and Basic Rate operation, data for Basic Rate demonstrates compliance with channel occupancy when AFH is employed.



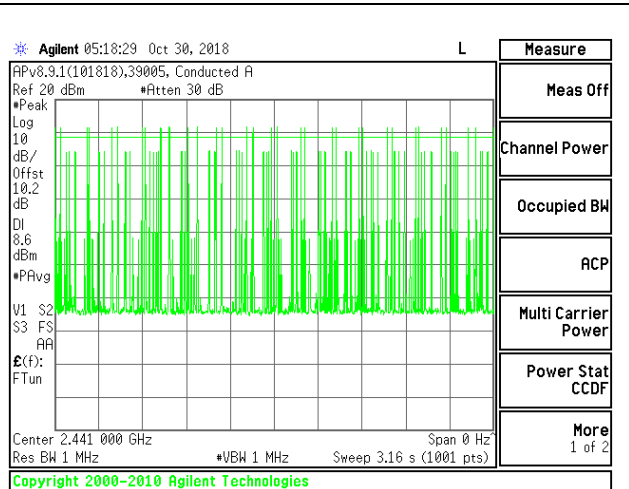
PULSE WIDTH – 3DH1



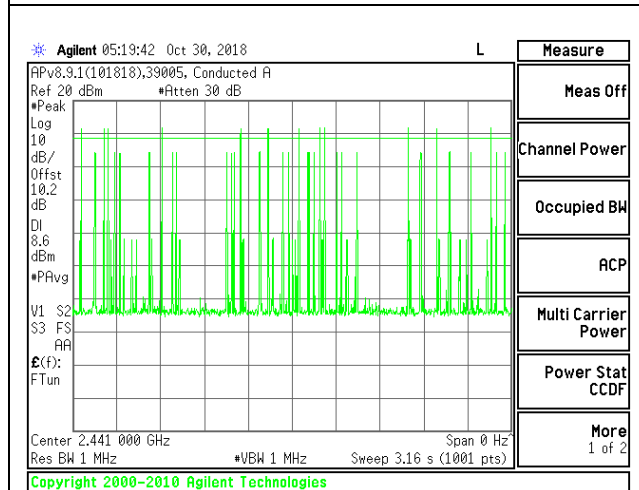
PULSE WIDTH – 3DH3



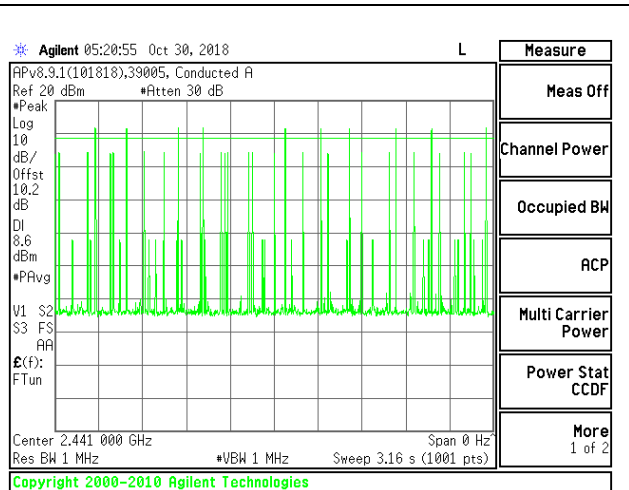
PULSE WIDTH – 3DH5



**NUMBER OF PULSES IN 3.16 SECOND
 OBSERVATION PERIOD – 3DH1**



**NUMBER OF PULSES IN 3.16 SECOND
 OBSERVATION PERIOD – 3DH3**



**NUMBER OF PULSES IN 3.16 SECOND
 OBSERVATION PERIOD – 3DH5**

8.6. OUTPUT POWER

LIMITS

§15.247 (b) (1)

The maximum antenna gain is less than 6 dBi, therefore the limit is 30 dBm. 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.

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter. The cable assembly insertion loss was entered as an offset in the power meter to allow for a gated peak reading of power.

RESULTS

8.6.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| | |
|------------|------------|
| Tested By: | 39005 RA |
| Date: | 11/20/2018 |

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low | 2402 | 16.27 | 30 | -13.73 |
| Middle | 2441 | 16.99 | 30 | -13.01 |
| High | 2480 | 16.20 | 30 | -13.8 |

8.6.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

| | |
|------------|------------|
| Tested By: | 39005 RA |
| Date: | 11/20/2018 |

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low | 2402 | 11.66 | 21 | -9.34 |
| Middle | 2441 | 12.35 | 21 | -8.65 |
| High | 2480 | 11.77 | 21 | -9.23 |

8.6.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| | |
|------------|------------|
| Tested By: | 39005 RA |
| Date: | 11/20/2018 |

| Channel | Frequency (MHz) | Output Power (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------------|-----------------------|----------------|----------------|
| Low | 2402 | 12.22 | 21 | -8.78 |
| Middle | 2441 | 12.97 | 21 | -8.03 |
| High | 2480 | 12.22 | 21 | -8.78 |

8.7. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter. The cable assembly insertion loss was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

8.7.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

| | |
|------------|------------|
| Tested By: | 39005 RA |
| Date | 11/20/2018 |

| Channel | Frequency (MHz) | Average Power (dBm) |
|---------|--------------------|------------------------|
| Low | 2402 | 15.87 |
| Middle | 2441 | 16.57 |
| High | 2480 | 15.62 |

8.7.2. BLUETOOTH BASIC DATA RATE DQPSK MODULATION

| | |
|------------|------------|
| Tested By: | 39005 RA |
| Date | 11/20/2018 |

| Channel | Frequency (MHz) | Average Power (dBm) |
|---------|--------------------|------------------------|
| Low | 2402 | 8.55 |
| Middle | 2441 | 9.25 |
| High | 2480 | 8.87 |

8.7.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

| | |
|------------|------------|
| Tested By: | 39005 RA |
| Date | 11/20/2018 |

| Channel | Frequency (MHz) | Average Power (dBm) |
|---------|--------------------|------------------------|
| Low | 2402 | 8.87 |
| Middle | 2441 | 9.29 |
| High | 2480 | 8.89 |

8.8. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

Limit = -20 dBc

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer. The resolution bandwidth is set to 100 kHz. The video bandwidth is set to 300 kHz.

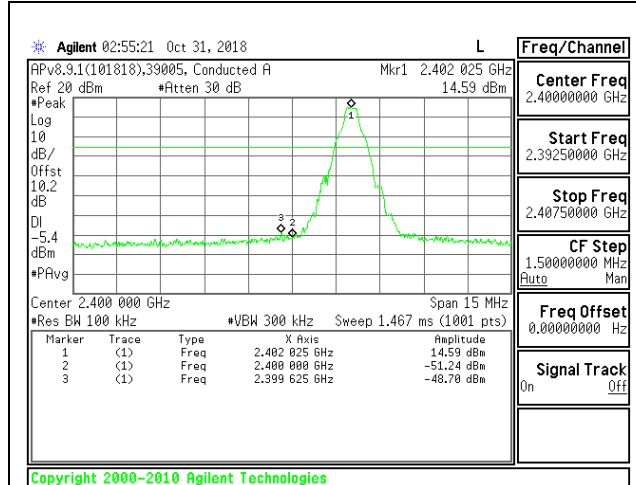
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

The bandedges at 2.4 and 2.4835 GHz are investigated with the transmitter set to the normal hopping mode.

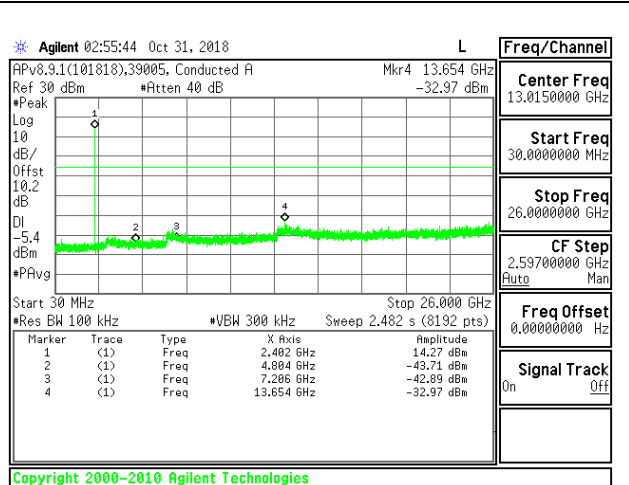
RESULTS

8.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

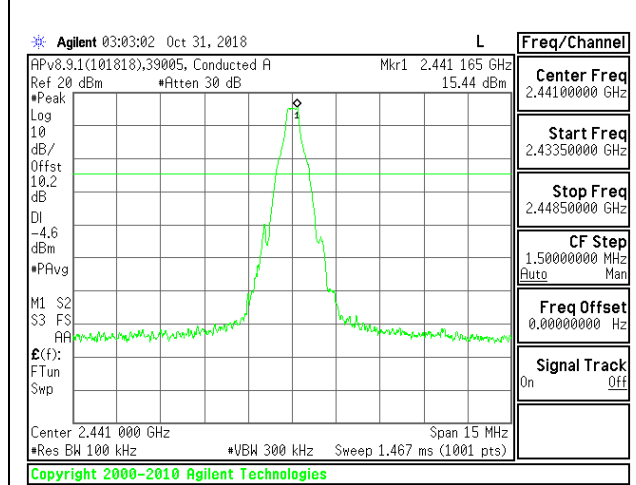
Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



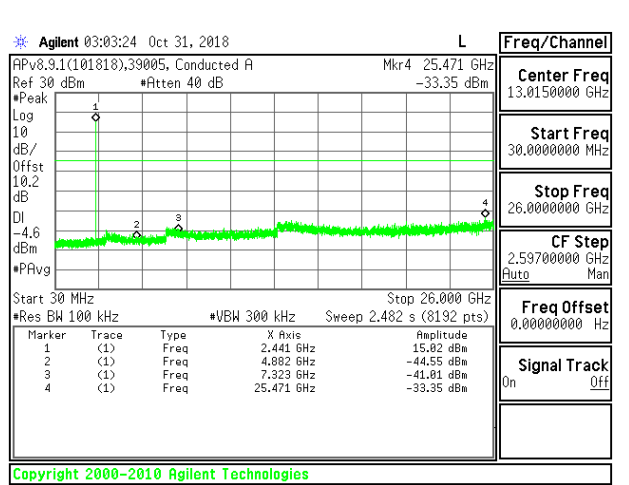
LOW CHANNEL BANDEDGE



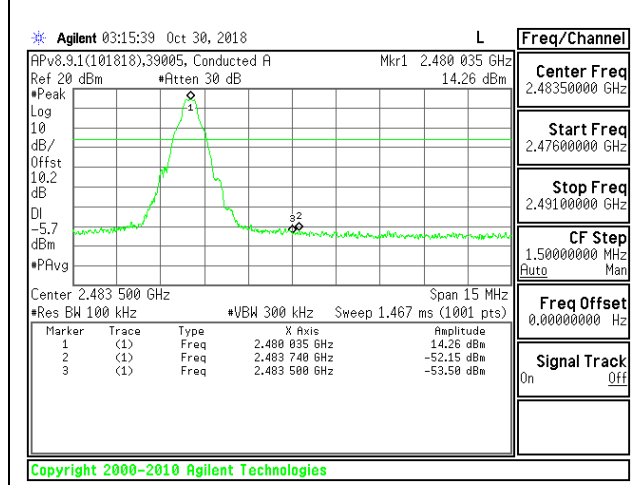
OUT-OF-BAND LOW CHANNEL



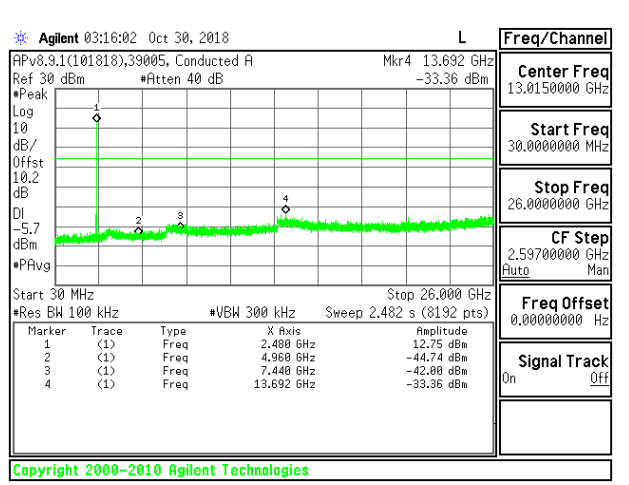
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

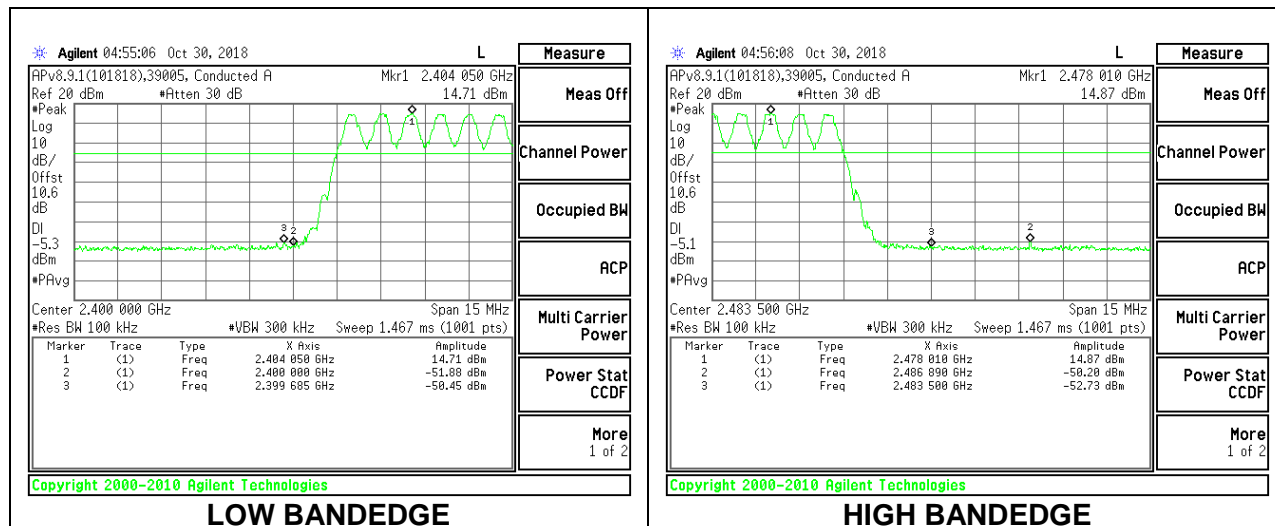


HIGH CHANNEL BANDEDGE



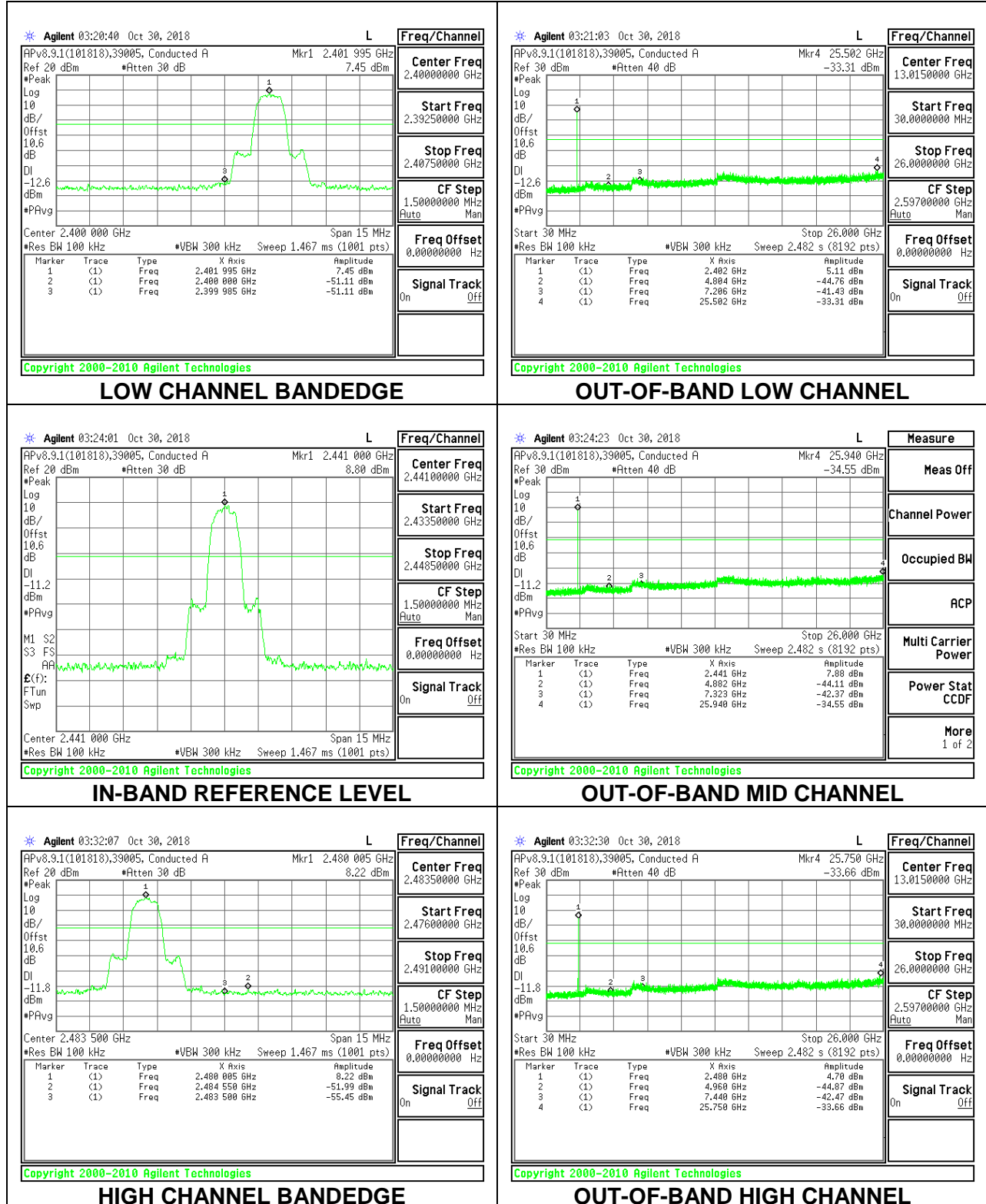
OUT-OF-BAND HIGH CHANNEL

Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

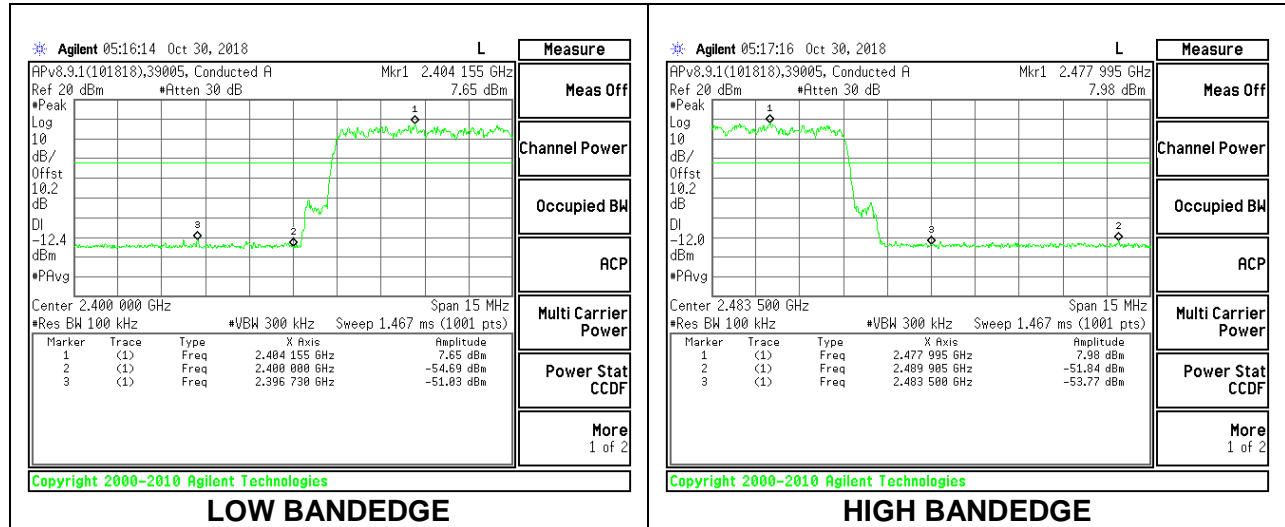


8.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



9. RADIATED TEST RESULTS

LIMITS

FCC §15.205 and §15.209

| Frequency Range (MHz) | Field Strength Limit (uV/m) at 3 m | Field Strength Limit (dBuV/m) at 3 m |
|-----------------------|------------------------------------|--------------------------------------|
| 0.009-0.490 | 2400/F(kHz) @ 300 m | - |
| 0.490-1.705 | 24000/F(kHz) @ 30 m | - |
| 1.705 - 30 | 30 @ 30m | - |
| 30 - 88 | 100 | 40 |
| 88 - 216 | 150 | 43.5 |
| 216 - 960 | 200 | 46 |
| Above 960 | 500 | 54 |

TEST PROCEDURE

The EUT is placed on a non-conducting table 80 cm above the ground plane for measurement below 1GHz; 1.5 m above the ground plane for measurement above 1GHz. The antenna to EUT distance is 3 meters. The EUT is configured in accordance with ANSI C63.10. The EUT is set to transmit in a continuous mode.

For measurements below 1 GHz the resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.

For pre-scans above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 30 KHz for peak measurements.

For measurements above 1 GHz the resolution bandwidth is set to 1 MHz, then the video bandwidth is set to 3 MHz for peak measurements and 1 MHz resolution bandwidth with 1/T (360Hz) video bandwidth with peak detector for average measurements.

The spectrum from 1 GHz to 18 GHz is investigated with the transmitter set to the lowest, middle, and highest channels in each applicable band. Below 1GHz and above 18GHz emissions, the channel with the highest output power was tested.

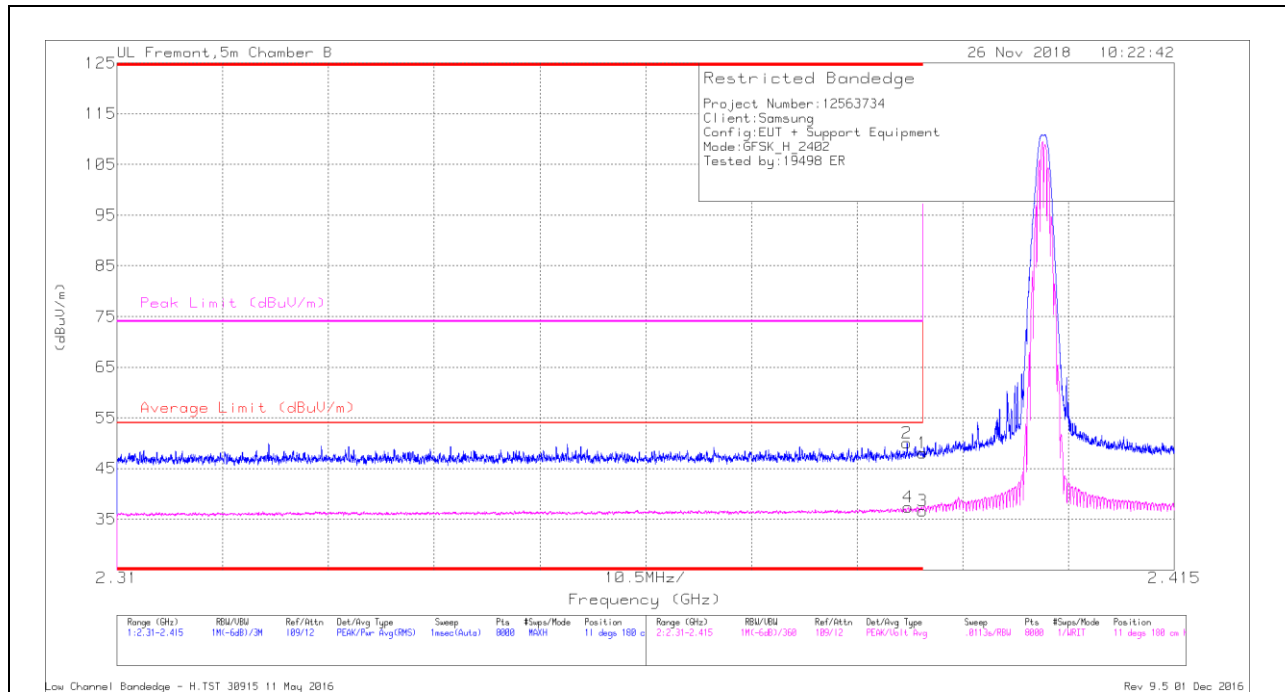
The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

9.1. TRANSMITTER ABOVE 1 GHz

9.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Trace Markers

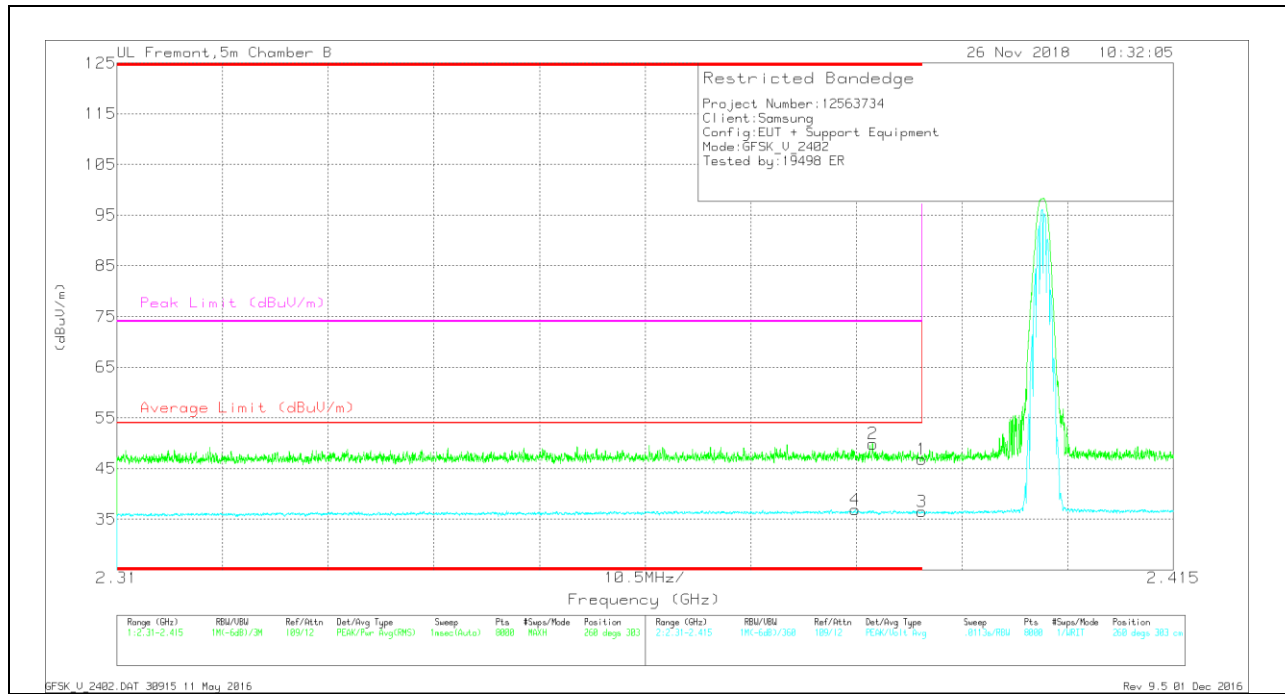
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.39 | 36.46 | Pk | 32.3 | -20.7 | 48.06 | - | - | 74 | -25.94 | 11 | 180 | H |
| 2 | * 2.388 | 38.46 | Pk | 32.3 | -20.7 | 50.06 | - | - | 74 | -23.94 | 11 | 180 | H |
| 3 | * 2.39 | 25.09 | VA1T | 32.3 | -20.7 | 36.69 | 54 | -17.31 | - | - | 11 | 180 | H |
| 4 | * 2.389 | 25.81 | VA1T | 32.3 | -20.7 | 37.41 | 54 | -16.59 | - | - | 11 | 180 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average $V_B=1/T_{on}$ where: T_{on} is transmit duration

VERTICAL RESULT



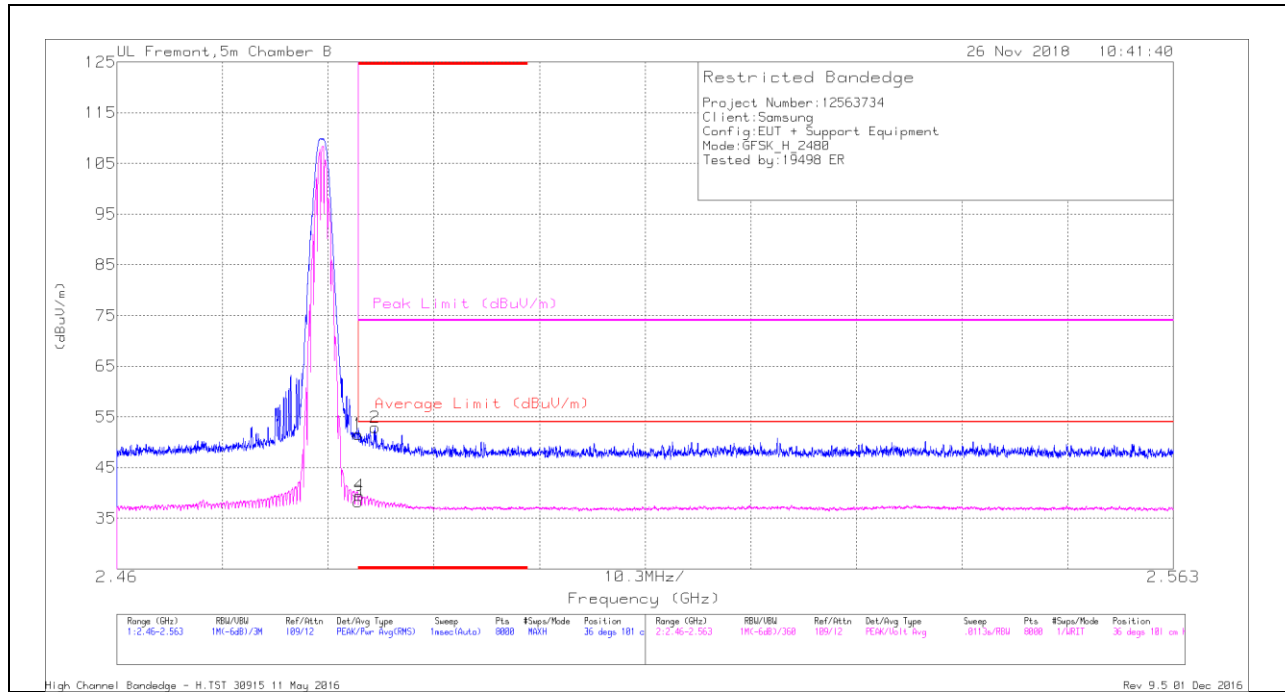
Trace Markers

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cb/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 4 | * 2.383 | 25.24 | VA1T | 32.3 | -20.7 | 36.84 | 54 | -17.16 | - | - | 260 | 303 | V |
| 2 | * 2.385 | 38.26 | Pk | 32.3 | -20.7 | 49.86 | - | - | 74 | -24.14 | 260 | 303 | V |
| 1 | * 2.39 | 35.2 | Pk | 32.3 | -20.7 | 46.8 | - | - | 74 | -27.2 | 260 | 303 | V |
| 3 | * 2.39 | 24.94 | VA1T | 32.3 | -20.7 | 36.54 | 54 | -17.46 | - | - | 260 | 303 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band
 Pk - Peak detector
 VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Trace Markers

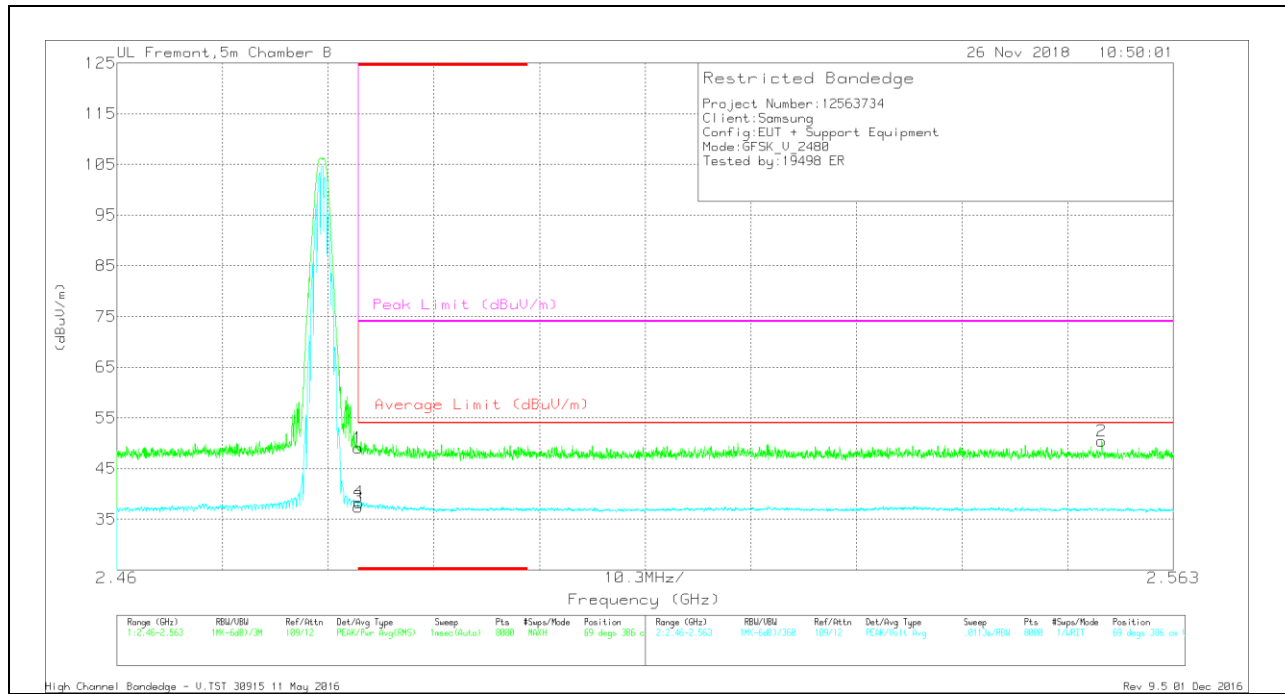
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.484 | 39.29 | Pk | 32.6 | -20.3 | 51.59 | - | - | 74 | -22.41 | 36 | 101 | H |
| 3 | * 2.484 | 26 | VA1T | 32.6 | -20.3 | 38.3 | 54 | -15.7 | - | - | 36 | 101 | H |
| 4 | * 2.484 | 27.2 | VA1T | 32.6 | -20.3 | 39.5 | 54 | -14.5 | - | - | 36 | 101 | H |
| 2 | * 2.485 | 40.67 | Pk | 32.6 | -20.4 | 52.87 | - | - | 74 | -21.13 | 36 | 101 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

VERTICAL RESULT



Trace Markers

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cb/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.484 | 36.72 | Pk | 32.6 | -20.3 | 49.02 | - | - | 74 | -24.98 | 69 | 386 | V |
| 3 | * 2.484 | 25.11 | VA1T | 32.6 | -20.3 | 37.41 | 54 | -16.59 | - | - | 69 | 386 | V |
| 4 | * 2.484 | 26.01 | VA1T | 32.6 | -20.3 | 38.31 | 54 | -15.69 | - | - | 69 | 386 | V |
| 2 | 2.556 | 38.19 | Pk | 32.7 | -20.5 | 50.39 | - | - | 74 | -23.61 | 69 | 386 | V |

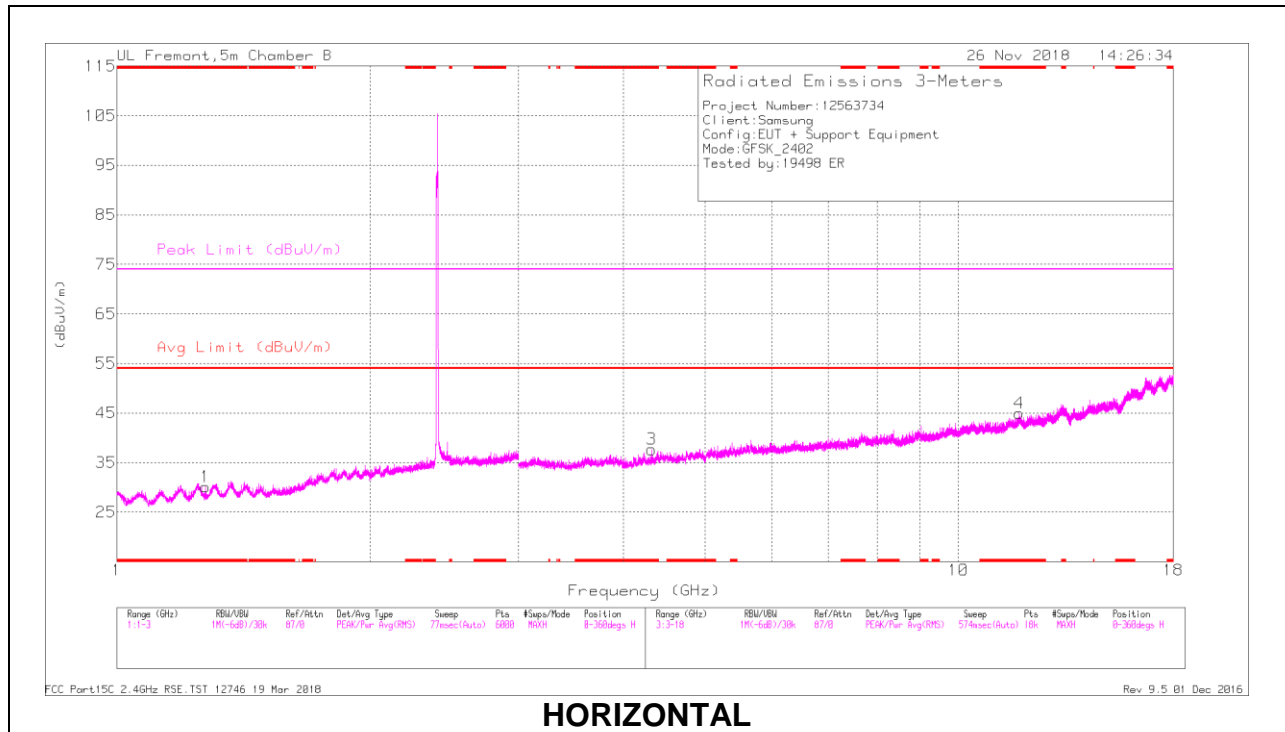
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

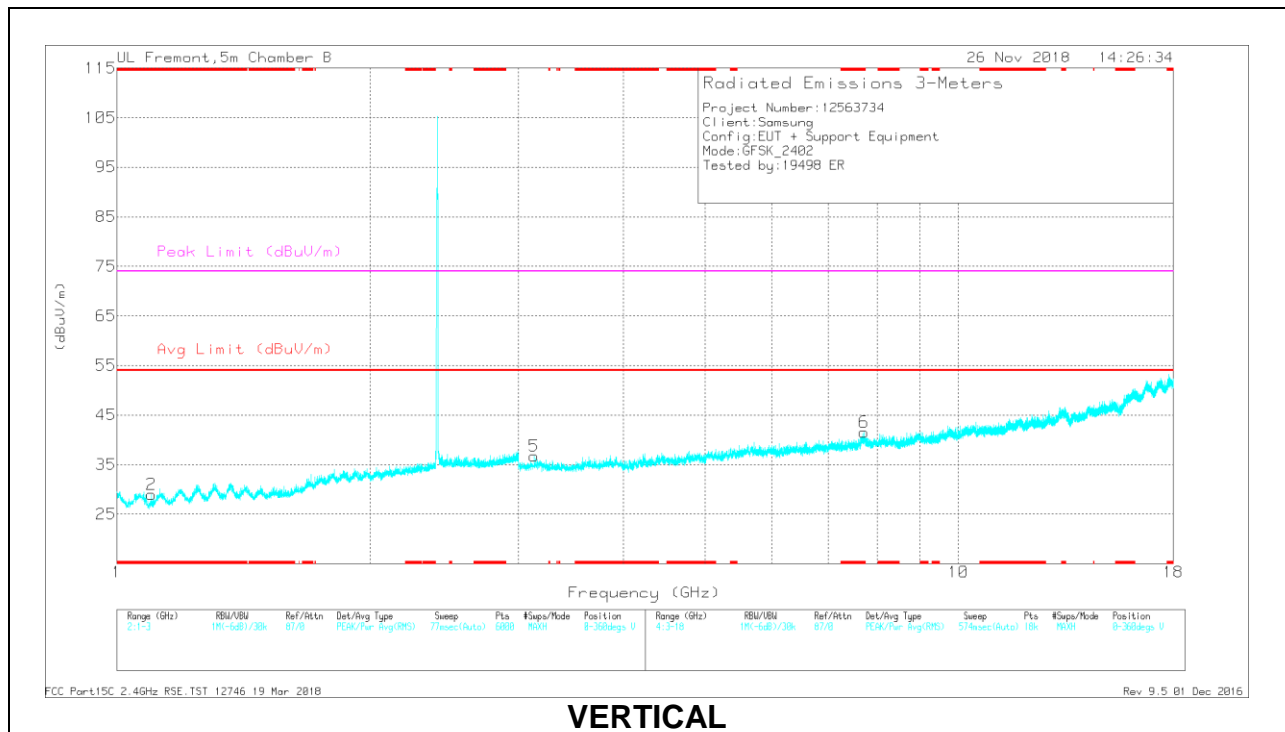
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

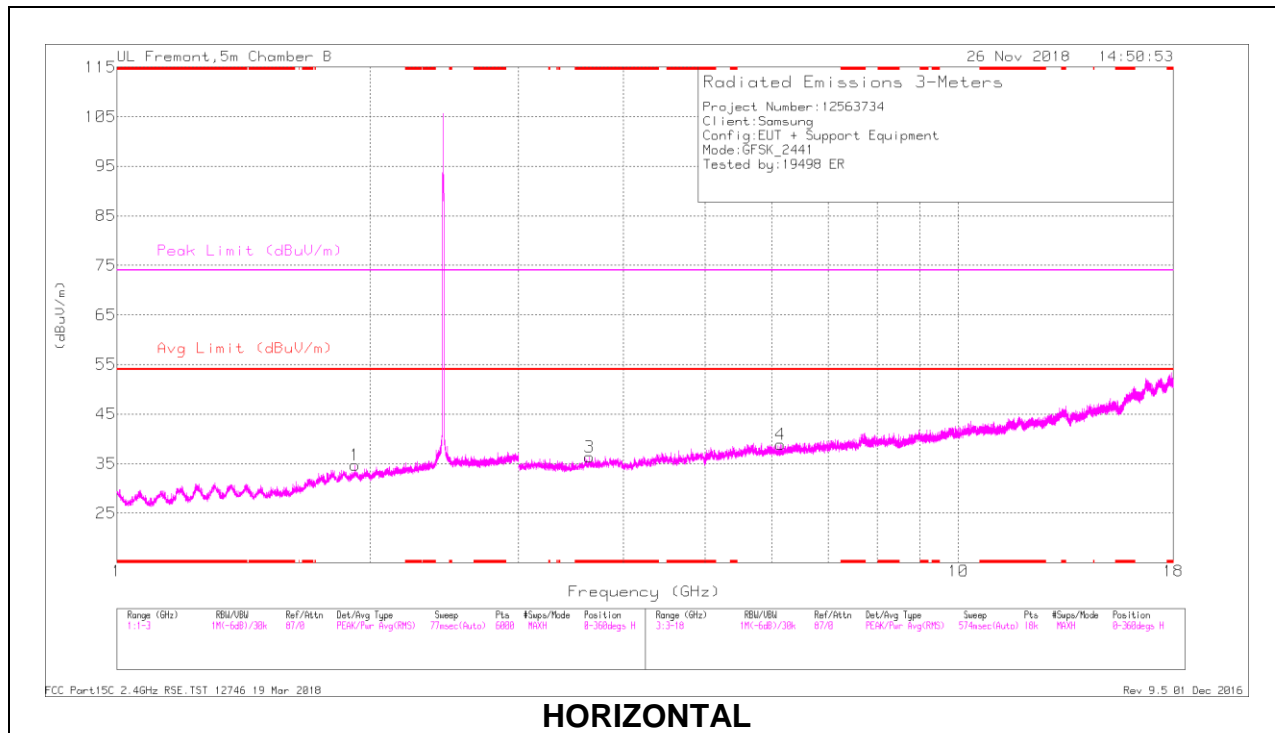
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|--------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 1.274 | 27.04 | PKFH | 28.4 | -21.7 | 33.74 | - | - | 74 | -40.26 | 302 | 120 | H |
| | * 1.275 | 15.9 | VA1T | 28.4 | -21.7 | 22.6 | 54 | -31.4 | - | - | 302 | 120 | H |
| 2 | * 1.101 | 28.19 | PKFH | 27.2 | -22.5 | 32.89 | - | - | 74 | -41.11 | 229 | 105 | V |
| | * 1.098 | 16.72 | VA1T | 27.2 | -22.6 | 21.32 | 54 | -32.68 | - | - | 229 | 105 | V |
| 3 | * 4.315 | 38.27 | PKFH | 33.7 | -30.9 | 41.07 | - | - | 74 | -32.93 | 146 | 145 | H |
| | * 4.318 | 27.35 | VA1T | 33.7 | -30.9 | 30.15 | 54 | -23.85 | - | - | 146 | 145 | H |
| 4 | * 11.8 | 31.56 | PKFH | 39.2 | -21.4 | 49.36 | - | - | 74 | -24.64 | 73 | 218 | H |
| | * 11.8 | 20.44 | VA1T | 39.2 | -21.3 | 38.34 | 54 | -15.66 | - | - | 73 | 218 | H |
| 6 | * 7.721 | 34.82 | PKFH | 36.5 | -25.4 | 45.92 | - | - | 74 | -28.08 | 324 | 394 | V |
| | * 7.72 | 23.56 | VA1T | 36.5 | -25.4 | 34.66 | 54 | -19.34 | - | - | 324 | 394 | V |
| 5 | 3.131 | 27.07 | VA1T | 33.2 | -30.4 | 29.87 | - | - | - | - | 154 | 187 | V |
| | 3.134 | 38.51 | PKFH | 33.2 | -30.4 | 41.31 | - | - | - | - | 154 | 187 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

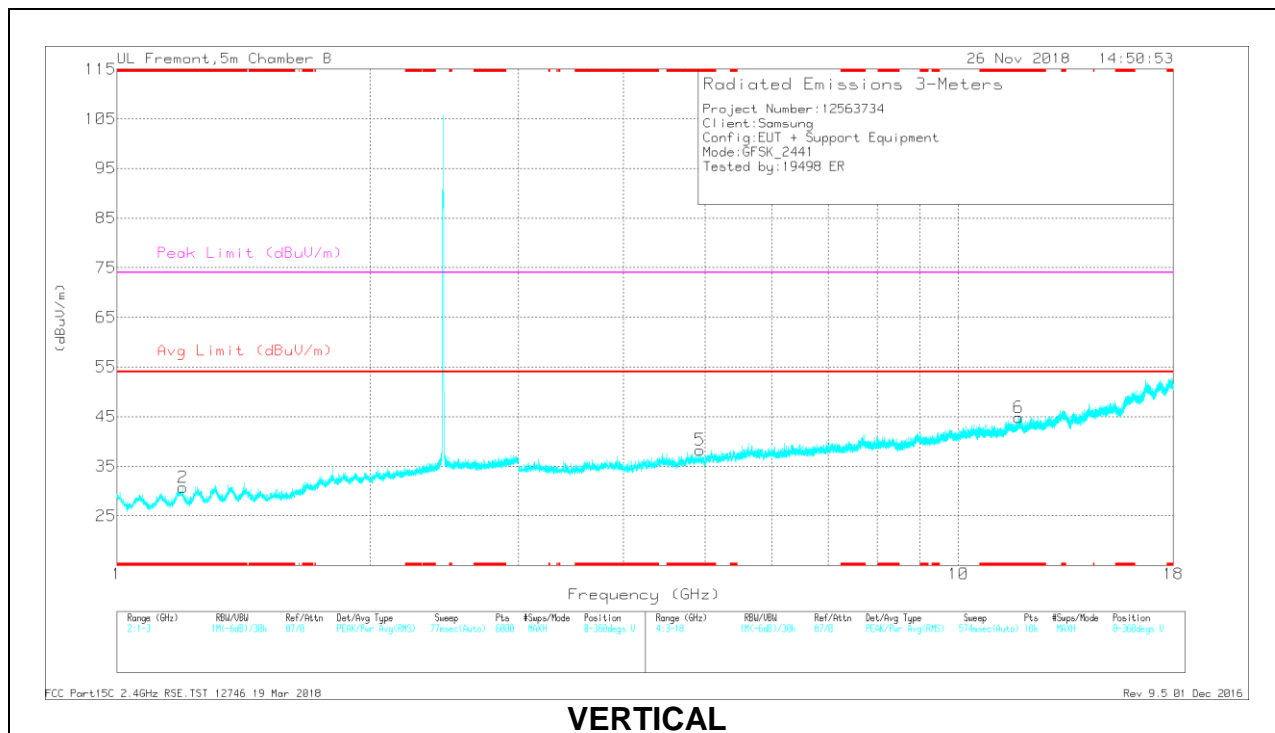
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

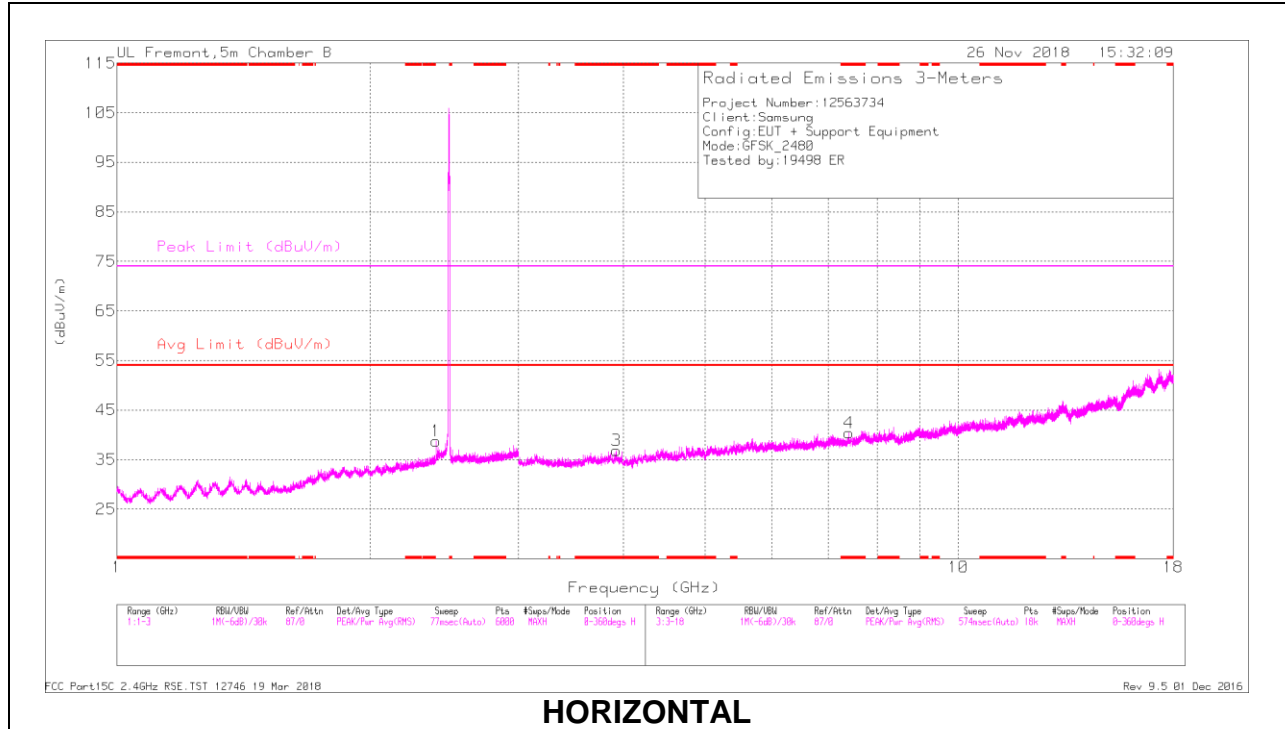
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|--------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 2 | * 1.196 | 29.44 | PKFH | 28.2 | -22.2 | 35.44 | - | - | 74 | -38.56 | 141 | 189 | V |
| | * 1.196 | 17.63 | VA1T | 28.2 | -22.2 | 23.63 | 54 | -30.37 | - | - | 141 | 189 | V |
| 3 | * 3.647 | 38.25 | PKFH | 33.3 | -30.3 | 41.25 | - | - | 74 | -32.75 | 212 | 235 | H |
| | * 3.646 | 26.78 | VA1T | 33.3 | -30.2 | 29.88 | 54 | -24.12 | - | - | 212 | 235 | H |
| 5 | * 4.929 | 39.07 | PKFH | 34.4 | -30 | 43.47 | - | - | 74 | -30.53 | 103 | 176 | V |
| | * 4.927 | 26.73 | VA1T | 34.4 | -30 | 31.13 | 54 | -22.87 | - | - | 103 | 176 | V |
| 6 | * 11.789 | 30.61 | PKFH | 39.1 | -21.4 | 48.31 | - | - | 74 | -25.69 | 286 | 179 | V |
| | * 11.791 | 20.25 | VA1T | 39.1 | -21.4 | 37.95 | 54 | -16.05 | - | - | 286 | 179 | V |
| 1 | 1.919 | 17.02 | VA1T | 31 | -20.6 | 27.42 | - | - | - | - | 244 | 152 | H |
| | 1.92 | 28.24 | PKFH | 31 | -20.6 | 38.64 | - | - | - | - | 244 | 152 | H |
| 4 | 6.146 | 36.32 | PKFH | 35.5 | -28.9 | 42.92 | - | - | - | - | 44 | 210 | H |
| | 6.147 | 25.47 | VA1T | 35.5 | -28.8 | 32.17 | - | - | - | - | 44 | 210 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

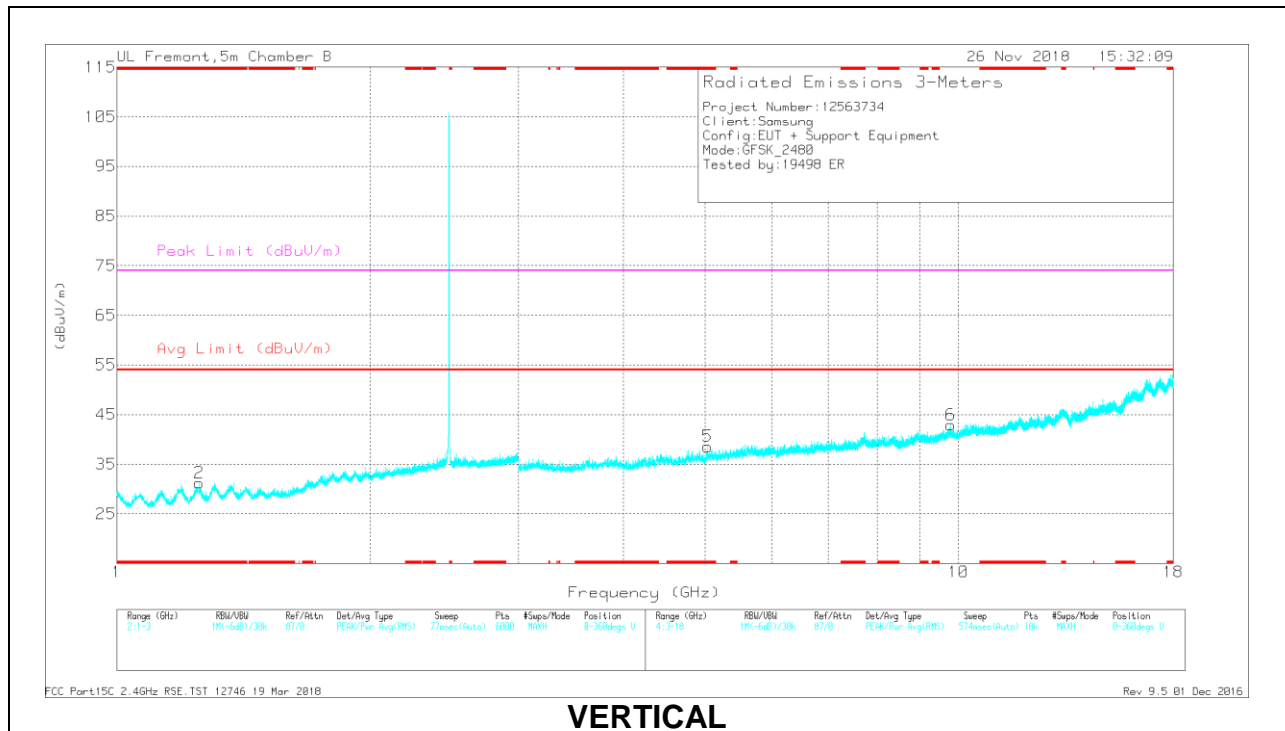
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|--------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 2 | * 1.254 | 28.77 | PKFH | 28.3 | -21.9 | 35.17 | - | - | 74 | -38.83 | 248 | 153 | V |
| | * 1.252 | 17.68 | VA1T | 28.3 | -22.1 | 23.88 | 54 | -30.12 | - | - | 248 | 153 | V |
| 3 | * 3.921 | 37.82 | PKFH | 33.4 | -29.5 | 41.72 | - | - | 74 | -32.28 | 193 | 234 | H |
| | * 3.918 | 26.51 | VA1T | 33.4 | -29.4 | 30.51 | 54 | -23.49 | - | - | 193 | 234 | H |
| 4 | * 7.406 | 34.61 | PKFH | 36.2 | -26.3 | 44.51 | - | - | 74 | -29.49 | 130 | 191 | H |
| | * 7.406 | 23.75 | VA1T | 36.2 | -26.3 | 33.65 | 54 | -20.35 | - | - | 130 | 191 | H |
| 5 | * 5.034 | 35.19 | PKFH | 34.6 | -28.8 | 40.99 | - | - | 74 | -33.01 | 66 | 171 | V |
| | * 5.034 | 25.1 | VA1T | 34.6 | -28.8 | 30.9 | 54 | -23.1 | - | - | 66 | 171 | V |
| 1 | 2.394 | 29.7 | PKFH | 32.4 | -20.8 | 41.3 | - | - | - | - | 329 | 107 | H |
| | 2.394 | 20.4 | VA1T | 32.4 | -20.8 | 32 | - | - | - | - | 329 | 107 | H |
| 6 | 9.796 | 32.75 | PKFH | 37.3 | -22.9 | 47.15 | - | - | - | - | 199 | 211 | V |
| | 9.796 | 21.62 | VA1T | 37.3 | -22.9 | 36.02 | - | - | - | - | 199 | 211 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

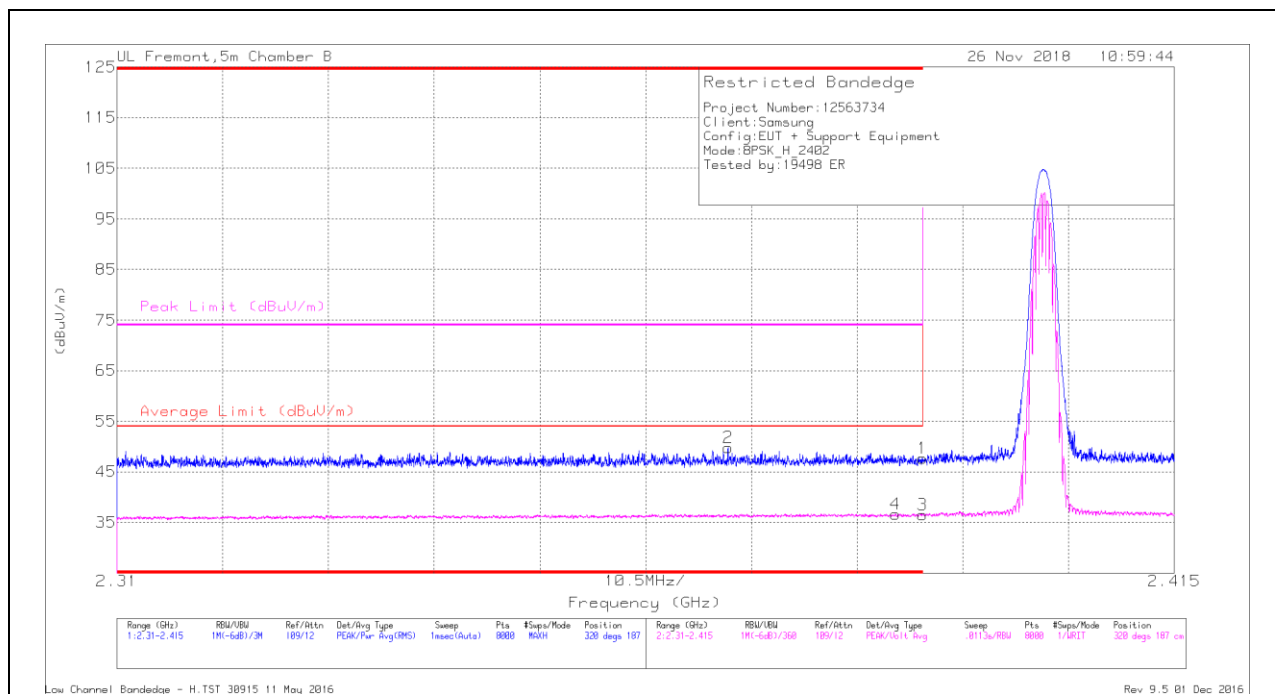
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

9.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Trace Markers

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 2 | * 2.371 | 38.14 | Pk | 32.3 | -20.7 | 49.74 | - | - | 74 | -24.26 | 320 | 187 | H |
| 4 | * 2.387 | 25.09 | VA1T | 32.3 | -20.7 | 36.69 | 54 | -17.31 | - | - | 320 | 187 | H |
| 1 | * 2.39 | 36.07 | Pk | 32.3 | -20.7 | 47.67 | - | - | 74 | -26.33 | 320 | 187 | H |
| 3 | * 2.39 | 24.93 | VA1T | 32.3 | -20.7 | 36.53 | 54 | -17.47 | - | - | 320 | 187 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average $V_B=1/T_{on}$ where: T_{on} is transmit duration

VERTICAL RESULT



Trace Markers

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cb/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 2 | * 2.312 | 38.03 | Pk | 32 | -20.6 | 49.43 | - | - | 74 | -24.57 | 198 | 152 | V |
| 4 | * 2.379 | 25.16 | VA1T | 32.3 | -20.7 | 36.76 | 54 | -17.24 | - | - | 198 | 151 | V |
| 1 | * 2.39 | 35.98 | Pk | 32.3 | -20.7 | 47.58 | - | - | 74 | -26.42 | 198 | 152 | V |
| 3 | * 2.39 | 24.85 | VA1T | 32.3 | -20.7 | 36.45 | 54 | -17.55 | - | - | 198 | 151 | V |

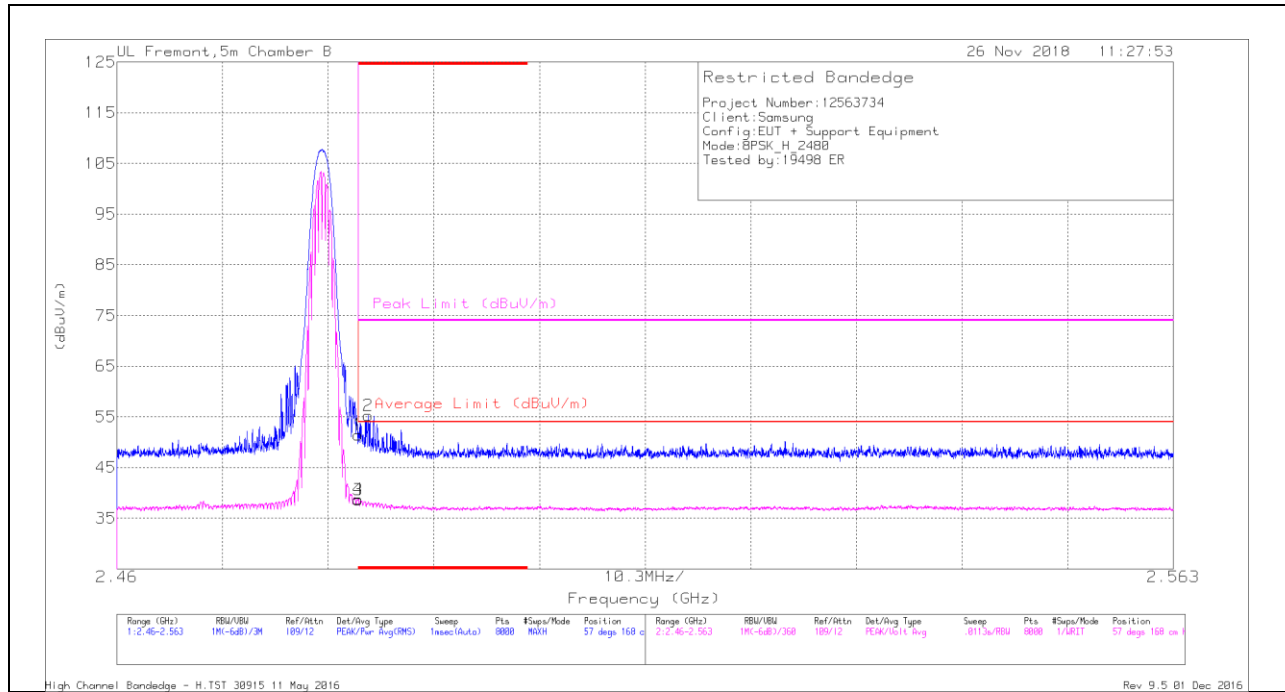
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Trace Markers

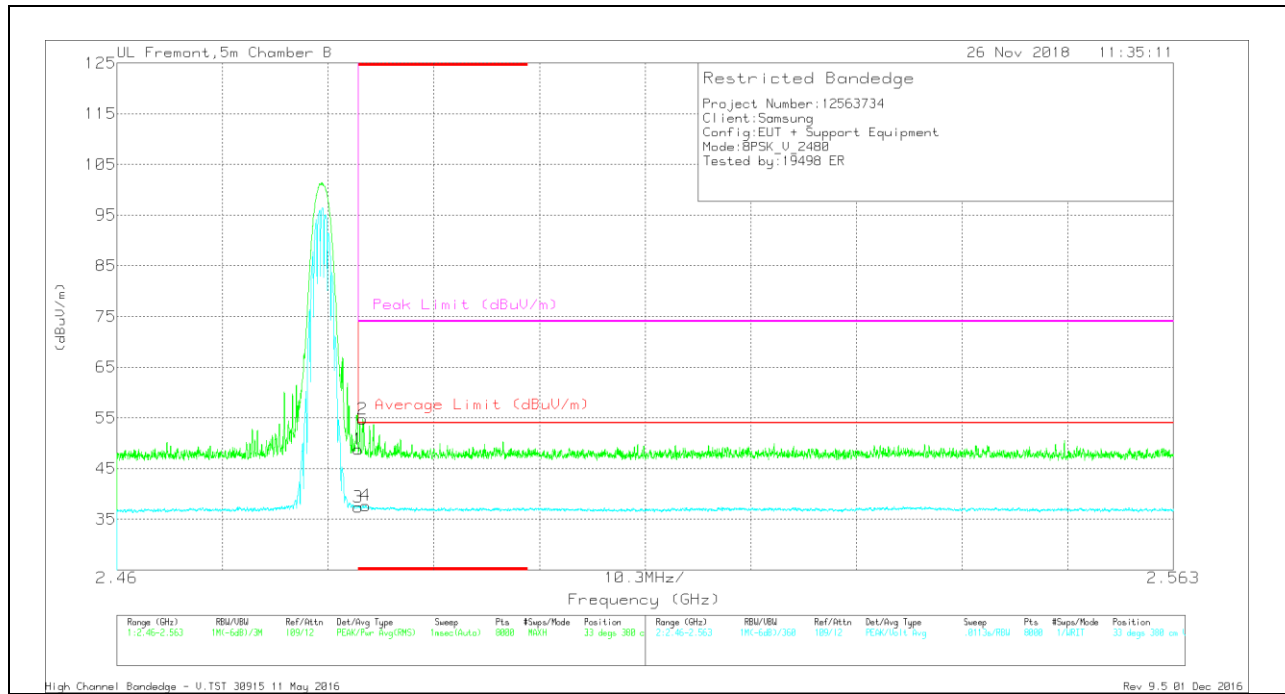
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.484 | 39.17 | Pk | 32.6 | -20.3 | 51.47 | - | - | 74 | -22.53 | 57 | 168 | H |
| 3 | * 2.484 | 26.27 | VA1T | 32.6 | -20.3 | 38.57 | 54 | -15.43 | - | - | 57 | 168 | H |
| 4 | * 2.484 | 26.49 | VA1T | 32.6 | -20.3 | 38.79 | 54 | -15.21 | - | - | 57 | 168 | H |
| 2 | * 2.485 | 43.05 | Pk | 32.6 | -20.4 | 55.25 | - | - | 74 | -18.75 | 57 | 168 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

VERTICAL RESULT



Trace Markers

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cb/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Average Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|-----------------------|----------------------------|------------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.484 | 36.46 | Pk | 32.6 | -20.3 | 48.76 | - | - | 74 | -25.24 | 33 | 380 | V |
| 2 | * 2.484 | 42.6 | Pk | 32.6 | -20.4 | 54.8 | - | - | 74 | -19.2 | 33 | 380 | V |
| 3 | * 2.484 | 25.03 | VA1T | 32.6 | -20.3 | 37.33 | 54 | -16.67 | - | - | 33 | 380 | V |
| 4 | * 2.484 | 25.49 | VA1T | 32.6 | -20.4 | 37.69 | 54 | -16.31 | - | - | 33 | 380 | V |

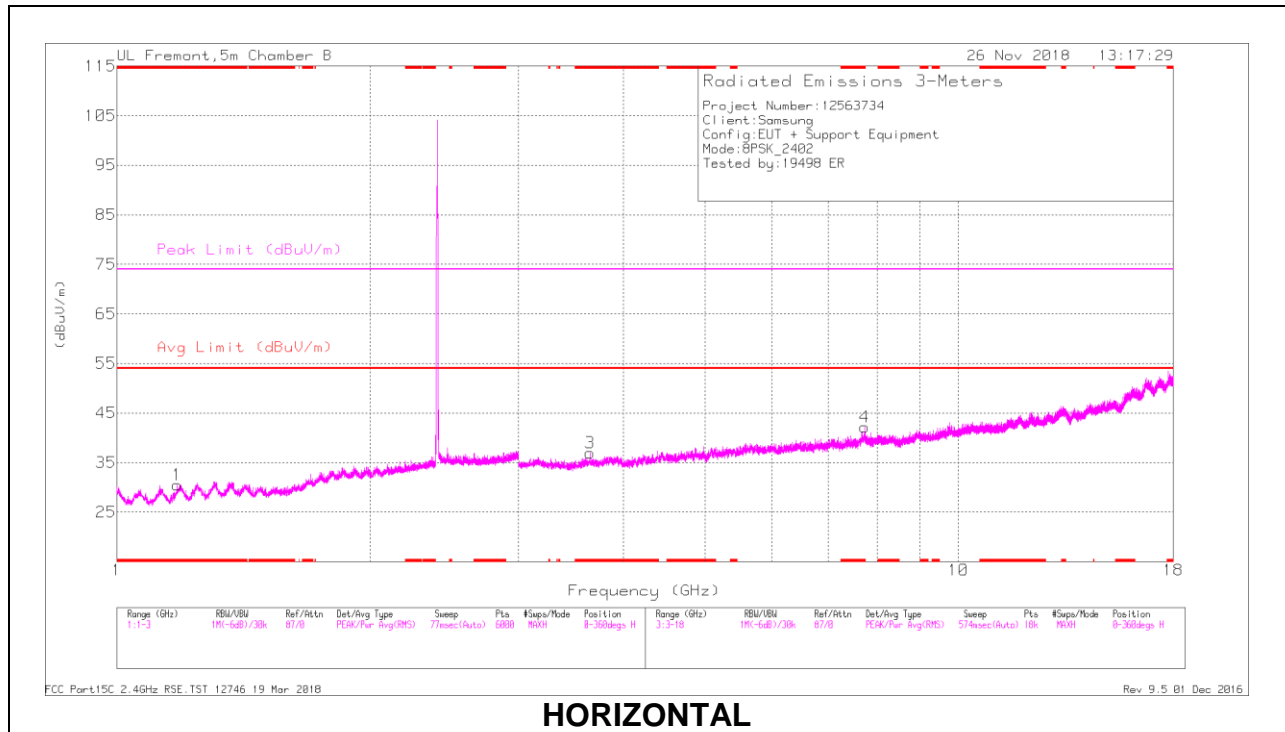
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

Pk - Peak detector

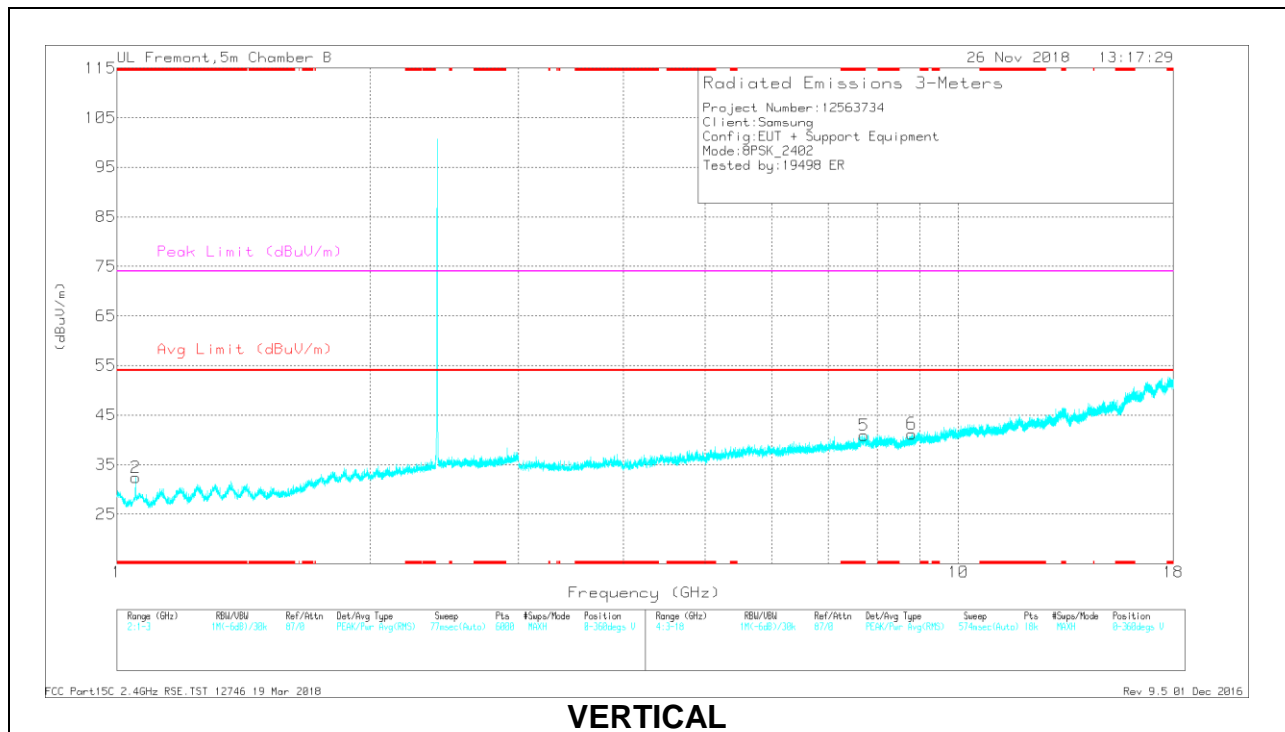
VA1T - FHSS: Linear Voltage Average $VB=1/Ton$ where: Ton is transmit duration

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

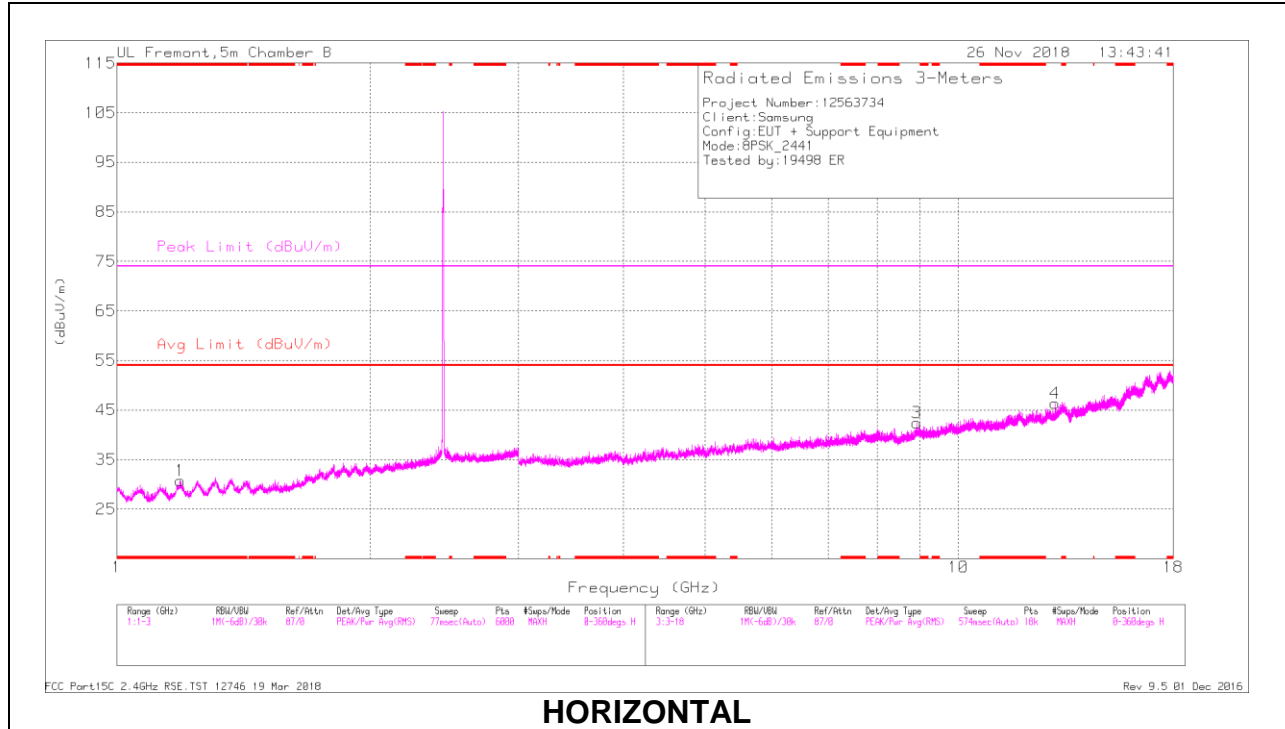
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|--------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 1.178 | 28.34 | PKFH | 28 | -22.3 | 34.04 | - | - | 74 | -39.96 | 198 | 137 | H |
| | * 1.179 | 17.78 | VA1T | 28 | -22.2 | 23.58 | 54 | -30.42 | - | - | 198 | 137 | H |
| 2 | * 1.054 | 29.04 | PKFH | 27.4 | -22.9 | 33.54 | - | - | 74 | -40.46 | 102 | 225 | V |
| | * 1.052 | 18.05 | VA1T | 27.5 | -22.8 | 22.75 | 54 | -31.25 | - | - | 102 | 225 | V |
| 5 | * 7.73 | 35.02 | PKFH | 36.5 | -25.2 | 46.32 | - | - | 74 | -27.68 | 257 | 173 | H |
| | * 7.724 | 23.52 | VA1T | 36.5 | -25.5 | 34.52 | 54 | -19.48 | - | - | 257 | 173 | H |
| 3 | * 3.649 | 37.81 | PKFH | 33.3 | -30.4 | 40.71 | - | - | 74 | -33.29 | 40 | 154 | H |
| | * 3.654 | 27.34 | VA1T | 33.3 | -30.5 | 30.14 | 54 | -23.86 | - | - | 40 | 154 | H |
| 4 | * 7.727 | 34.72 | PKFH | 36.5 | -25.5 | 45.72 | - | - | 74 | -28.28 | 129 | 122 | V |
| | * 7.726 | 23.44 | VA1T | 36.5 | -25.5 | 34.44 | 54 | -19.56 | - | - | 129 | 122 | V |
| 6 | 8.805 | 34.72 | PKFH | 36.6 | -25.5 | 45.82 | - | - | - | - | 243 | 209 | V |
| | 8.807 | 23 | VA1T | 36.6 | -25.5 | 34.1 | - | - | - | - | 243 | 209 | V |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

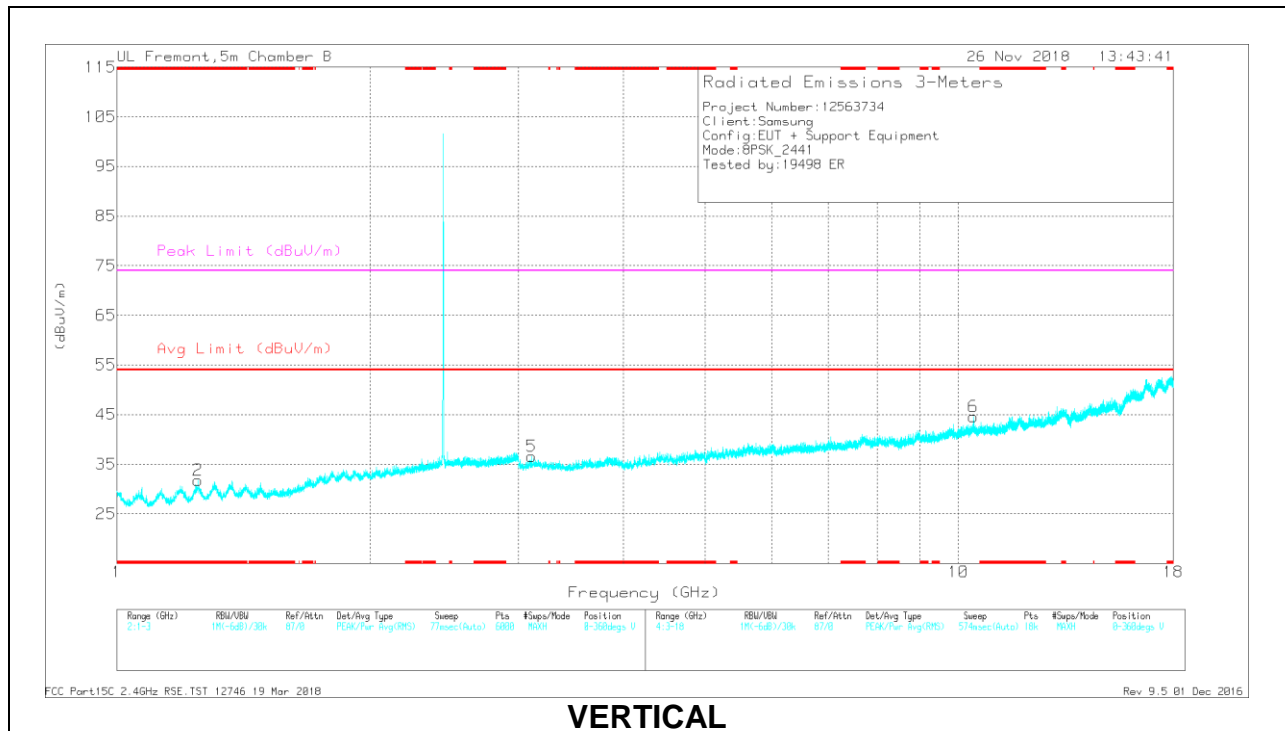
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

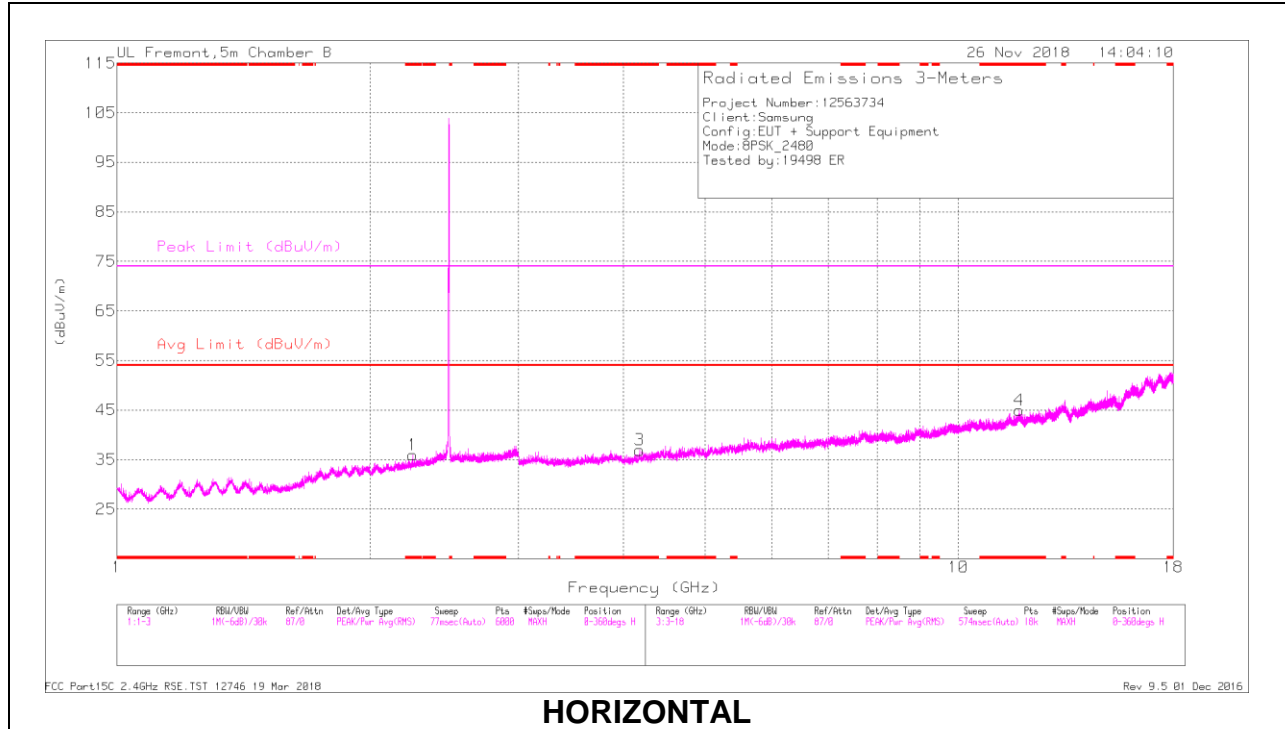
| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|--------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 1.191 | 30.44 | PKFH | 28.1 | -22.1 | 36.44 | - | - | 74 | -37.56 | 295 | 127 | H |
| | * 1.191 | 18.1 | VA1T | 28.1 | -22.1 | 24.1 | 54 | -29.9 | - | - | 295 | 127 | H |
| 2 | * 1.246 | 28.89 | PKFH | 28.3 | -22 | 35.19 | - | - | 74 | -38.81 | 239 | 161 | V |
| | * 1.246 | 18.16 | VA1T | 28.3 | -22 | 24.46 | 54 | -29.54 | - | - | 239 | 161 | V |
| 5 | 3.113 | 38.24 | PKFH | 33.3 | -30.8 | 40.74 | - | - | - | - | 152 | 182 | V |
| | 3.114 | 27.12 | VA1T | 33.3 | -30.8 | 29.62 | - | - | - | - | 152 | 182 | V |
| 3 | 8.922 | 22.17 | VA1T | 36.8 | -24 | 34.97 | - | - | - | - | 140 | 141 | H |
| | 8.923 | 33.65 | PKFH | 36.8 | -24 | 46.45 | - | - | - | - | 140 | 141 | H |
| 6 | 10.418 | 32.64 | PKFH | 37.9 | -22.2 | 48.34 | - | - | - | - | 103 | 153 | V |
| | 10.42 | 20.97 | VA1T | 37.9 | -22.2 | 36.67 | - | - | - | - | 103 | 153 | V |
| 4 | 13.032 | 30.45 | PKFH | 39.6 | -21.1 | 48.95 | - | - | - | - | 74 | 247 | H |
| | 13.034 | 20.01 | VA1T | 39.6 | -21.1 | 38.51 | - | - | - | - | 74 | 247 | H |

* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

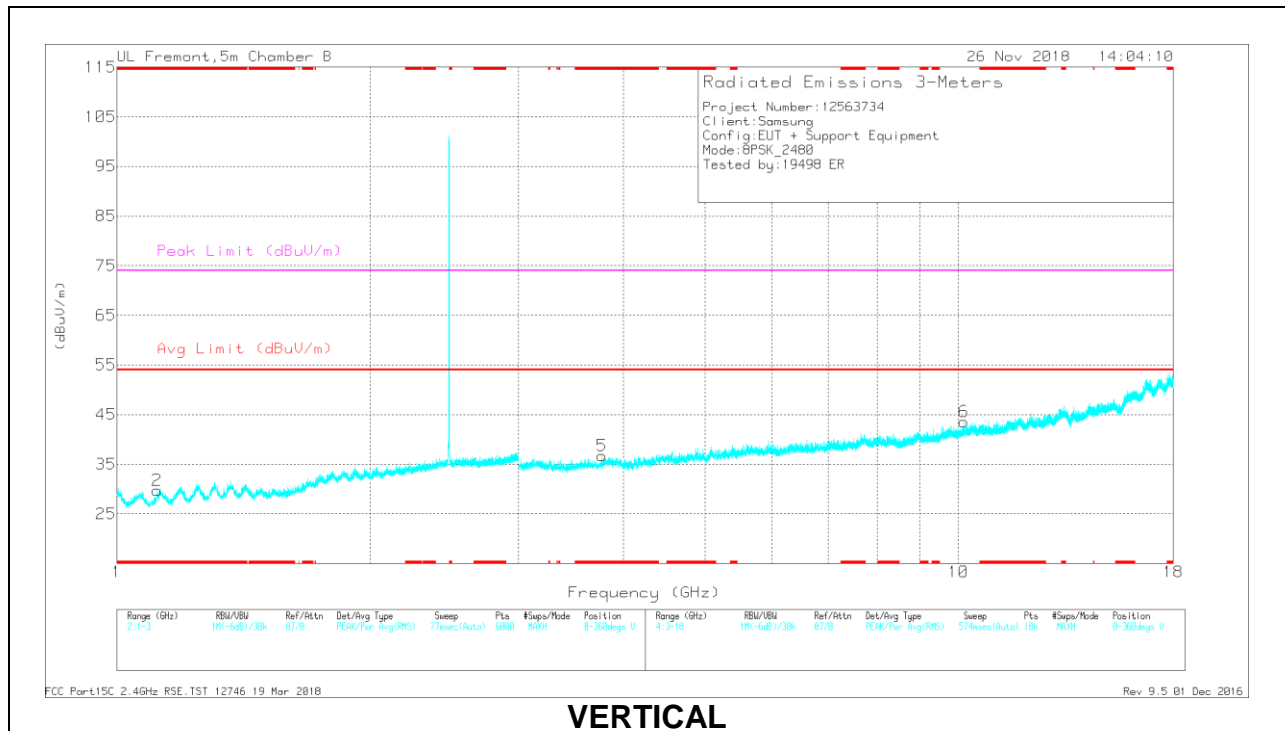
PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | AF T863 (dB/m) | Amp/Cbl/Filtr/Pad (dB) | Corrected Reading (dBuV/m) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|------|----------------|------------------------|----------------------------|--------------------|-------------|---------------------|----------------|----------------|-------------|----------|
| 1 | * 2.244 | 27.89 | PKFH | 31.7 | -20.7 | 38.89 | - | - | 74 | -35.11 | 65 | 114 | H |
| | * 2.246 | 16.6 | VA1T | 31.7 | -20.7 | 27.6 | 54 | -26.4 | - | - | 65 | 114 | H |
| 2 | * 1.117 | 29.36 | PKFH | 27.4 | -22.4 | 34.36 | - | - | 74 | -39.64 | 136 | 174 | V |
| | * 1.117 | 17.6 | VA1T | 27.4 | -22.4 | 22.6 | 54 | -31.4 | - | - | 136 | 174 | V |
| 3 | * 4.175 | 36.87 | PKFH | 33.6 | -29.6 | 40.87 | - | - | 74 | -33.13 | 221 | 141 | H |
| | * 4.175 | 26.23 | VA1T | 33.6 | -29.6 | 30.23 | 54 | -23.77 | - | - | 221 | 141 | H |
| 4 | * 11.817 | 31.08 | PKFH | 39.1 | -21.2 | 48.98 | - | - | 74 | -25.02 | 166 | 222 | H |
| | * 11.816 | 20.32 | VA1T | 39.1 | -21.2 | 38.22 | 54 | -15.78 | - | - | 166 | 222 | H |
| 5 | * 3.768 | 38.53 | PKFH | 33.4 | -30.8 | 41.13 | - | - | 74 | -32.87 | 290 | 274 | V |
| | * 3.769 | 27.36 | VA1T | 33.4 | -30.8 | 29.96 | 54 | -24.04 | - | - | 290 | 274 | V |
| 6 | 10.152 | 32.69 | PKFH | 37.8 | -23.5 | 46.99 | - | - | - | - | 323 | 134 | V |
| | 10.155 | 21.66 | VA1T | 37.8 | -23.5 | 35.96 | - | - | - | - | 323 | 134 | V |

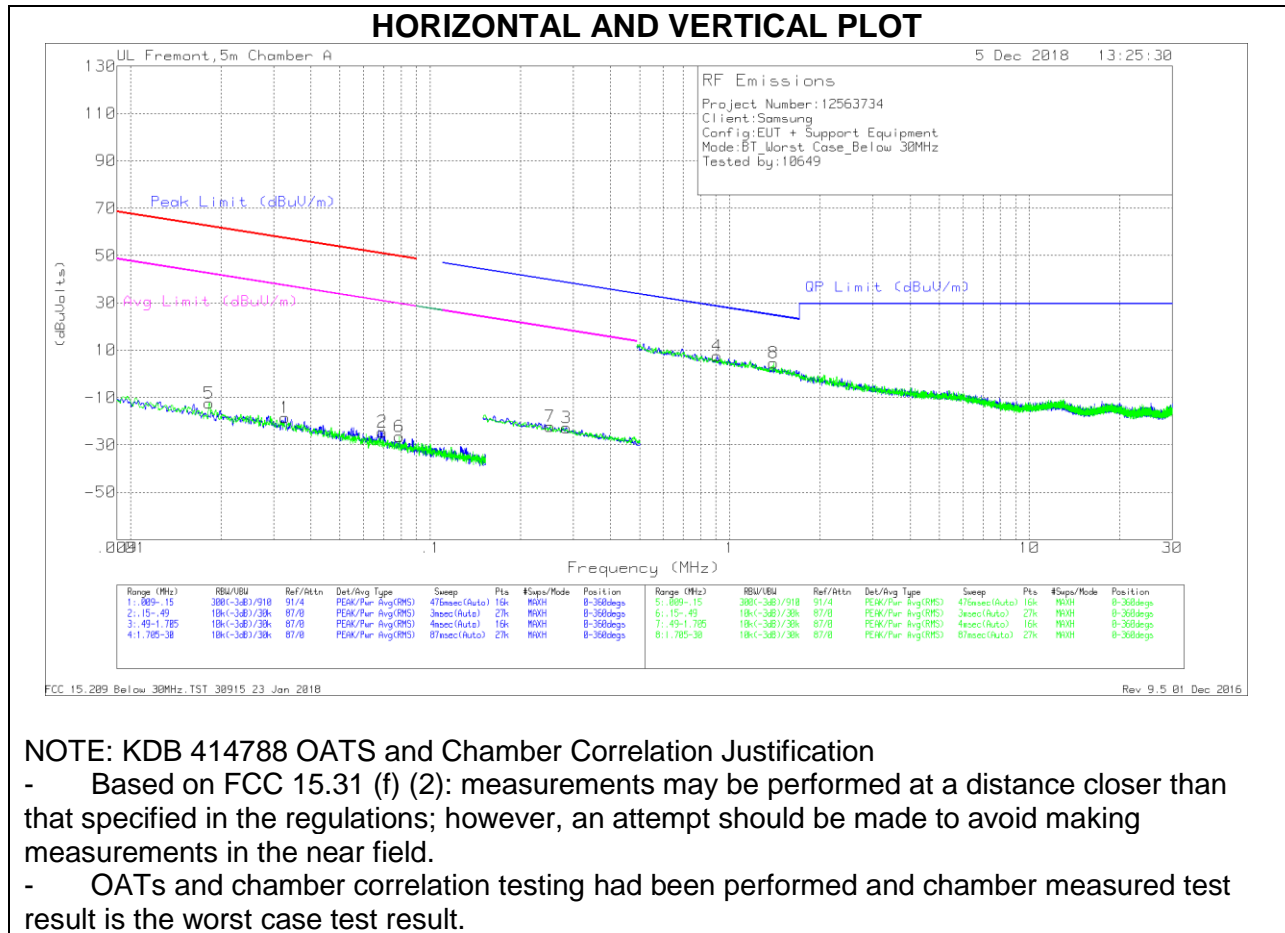
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

PKFH - FHSS: RB=100k/1MHz VB=3 x RB, Peak

VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

9.2. Worst Case Below 30 MHz

SPURIOUS EMISSIONS 9 kHz TO 30 MHz (WORST-CASE CONFIGURATION)



Below 30 MHz Data

Trace Markers

Trace Markers

| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | Loop Antenna (dB/m) | Cables (dB) | Dist Corr 300m | Corrected Reading (dBuVolts) | Peak Limit (dBuV/m) | Margin (dB) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | Margin (dB) | Avg Limit (dBuV/m) | Margin (dB) | Azimuth (Degs) |
|--------|-----------------|----------------------|-----|---------------------|-------------|----------------|------------------------------|---------------------|-------------|--------------------|-------------|---------------------|-------------|--------------------|-------------|----------------|
| 5 | .01831 | 53.11 | Pk | 14.6 | 0 | -80 | -12.29 | 62.33 | -74.62 | 42.33 | -54.62 | - | - | - | - | 0-360 |
| 1 | .03285 | 46.41 | Pk | 15.2 | 0 | -80 | -18.39 | 57.25 | -75.64 | 37.25 | -55.64 | - | - | - | - | 0-360 |
| 2 | .06916 | 41.42 | Pk | 14.1 | 0 | -80 | -24.48 | 50.79 | -75.27 | 30.79 | -55.27 | - | - | - | - | 0-360 |
| 6 | .07885 | 39.43 | Pk | 14.1 | 0 | -80 | -26.47 | 49.65 | -76.12 | 29.65 | -56.12 | - | - | - | - | 0-360 |
| 7 | .25145 | 44.07 | Pk | 13.7 | .1 | -80 | -22.13 | - | - | - | - | 39.61 | -61.74 | 19.61 | -41.74 | 0-360 |
| 3 | .28495 | 43.42 | Pk | 13.7 | .1 | -80 | -22.78 | - | - | - | - | 38.52 | -61.3 | 18.52 | -41.3 | 0-360 |

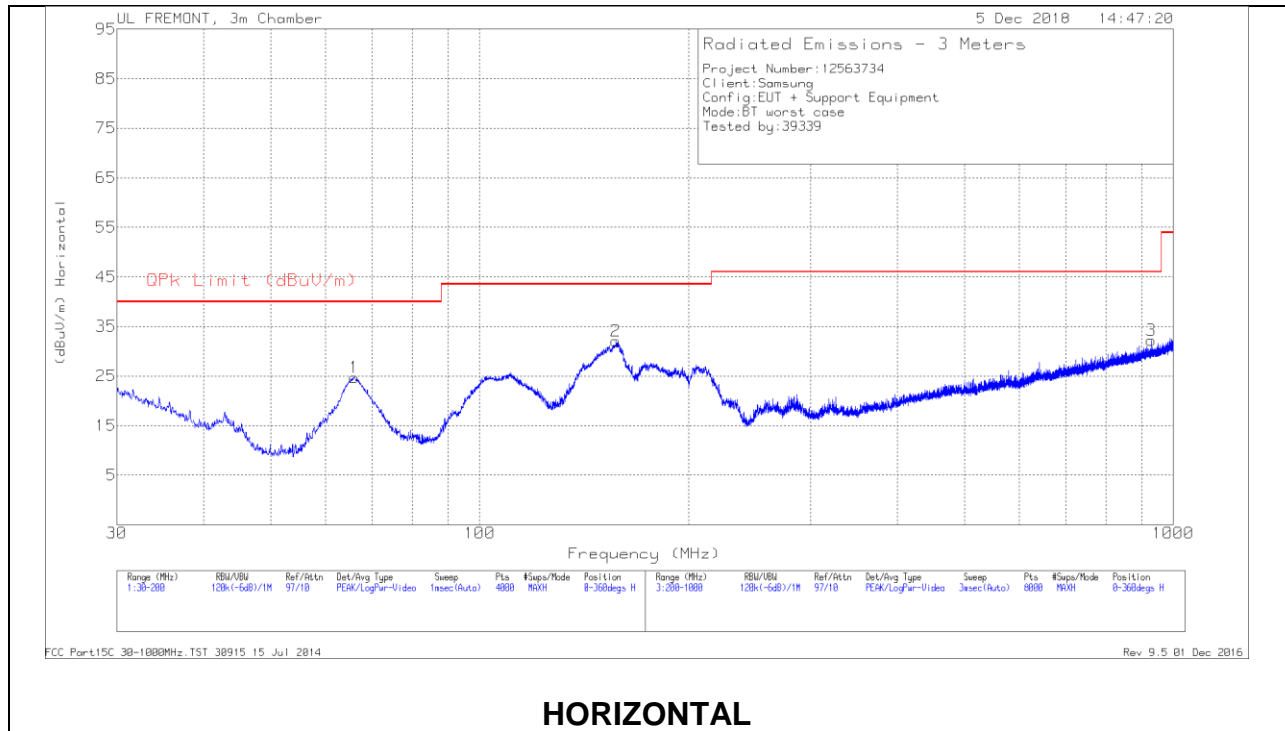
Pk - Peak detector

| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | Loop Antenna (dB/m) | Cables (dB) | Dist Corr 30m | Corrected Reading (dBuVolts) | QP Limit (dBuV/m) | Margin (dB) | Azimuth (Degs) |
|--------|-----------------|----------------------|-----|---------------------|-------------|---------------|------------------------------|-------------------|-------------|----------------|
| 4 | .9069 | 33.34 | Pk | 14 | .1 | -40 | 7.44 | 28.47 | -21.03 | 0-360 |
| 8 | 1.39976 | 30.12 | Pk | 14.2 | .2 | -40 | 4.52 | 24.71 | -20.19 | 0-360 |

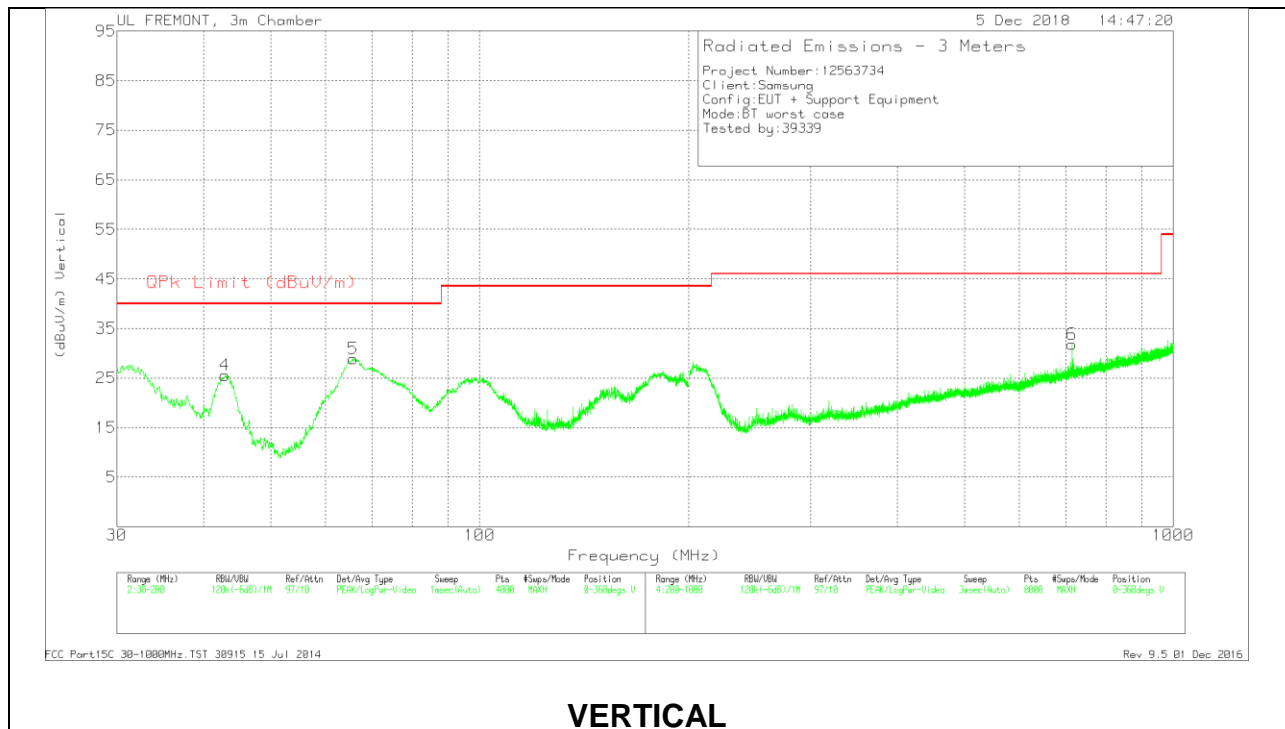
Pk - Peak detector

9.3. Worst Case Below 1 GHz

SPURIOUS EMISSIONS 30 TO 1000 MHz (WORST-CASE CONFIGURATION)



HORIZONTAL



VERTICAL

Below 1GHz Data

Trace Markers

| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | AF T900 (dB/m) | Amp/Cbl (dB/m) | Corrected Reading (dBuV/m) | QPk Limit (dBuV/m) | Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|--------|-----------------|----------------------|-----|----------------|----------------|----------------------------|--------------------|-------------|----------------|-------------|----------|
| 4 | 42.9659 | 40.64 | Pk | 15.8 | -30.9 | 25.54 | 40 | -14.46 | 0-360 | 100 | V |
| 5 | 65.7305 | 47.52 | Pk | 12 | -30.6 | 28.92 | 40 | -11.08 | 0-360 | 100 | V |
| 1 | 65.9643 | 43.3 | Pk | 12 | -30.6 | 24.7 | 40 | -15.3 | 0-360 | 400 | H |
| 2 | 157.1504 | 45.49 | Pk | 16.3 | -29.7 | 32.09 | 43.52 | -11.43 | 0-360 | 200 | H |
| 6 | 714.8669 | 34.54 | Pk | 24.4 | -27.1 | 31.84 | 46.02 | -14.18 | 0-360 | 100 | V |
| 3 | 929.7949 | 30.85 | Pk | 26.7 | -25.4 | 32.15 | 46.02 | -13.87 | 0-360 | 300 | H |

Pk - Peak detector

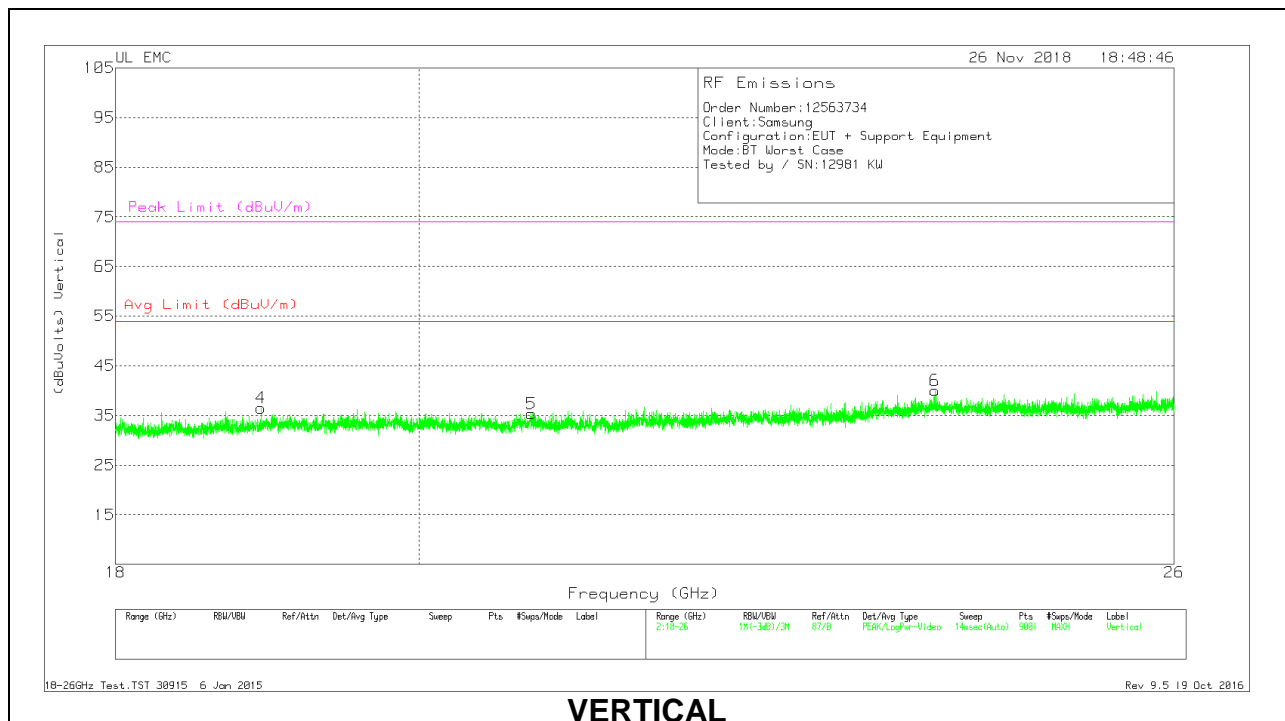
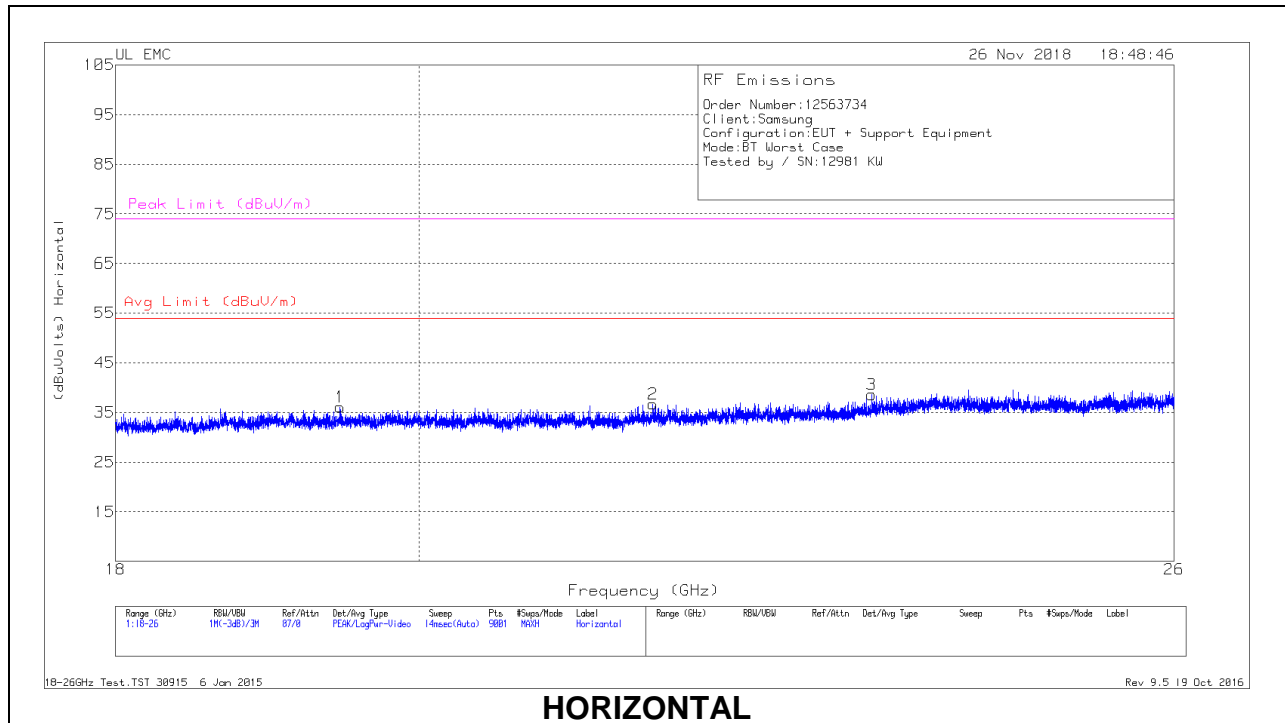
Radiated Emissions

| Frequency (MHz) | Meter Reading (dBuV) | Det | AF T900 (dB/m) | Amp/Cbl (dB/m) | Corrected Reading (dBuV/m) | QPk Limit (dBuV/m) | Margin (dB) | Azimuth (Degs) | Height (cm) | Polarity |
|-----------------|----------------------|-----|----------------|----------------|----------------------------|--------------------|-------------|----------------|-------------|----------|
| 65.8961 | 44.95 | Qp | 12 | -30.6 | 26.35 | 40 | -13.65 | 261 | 112 | V |

Qp - Quasi-Peak detector

9.4. Worst Case 18-26 GHz

SPURIOUS EMISSIONS 18-26 GHz (WORST-CASE CONFIGURATION)



18 – 26GHz DATA

| Marker | Frequency (GHz) | Meter Reading (dBuV) | Det | T447 AF (dB/m) | Amp/Cbl (dB) | Dist Corr (dB) | Corrected Reading (dBuVolts) | Avg Limit (dBuV/m) | Margin (dB) | Peak Limit (dBuV/m) | PK Margin (dB) |
|--------|-----------------|----------------------|-----|----------------|--------------|----------------|------------------------------|--------------------|-------------|---------------------|----------------|
| 1 | 19.46 | 37.35 | Pk | 32.8 | -24.6 | -9.5 | 36.05 | 54 | -17.95 | 74 | -37.95 |
| 2 | 21.692 | 37.68 | Pk | 33.1 | -24.6 | -9.5 | 36.68 | 54 | -17.32 | 74 | -37.32 |
| 3 | 23.406 | 38.6 | Pk | 33.9 | -24.4 | -9.5 | 38.6 | 54 | -15.4 | 74 | -35.4 |
| 4 | 18.932 | 38.79 | Pk | 32.5 | -25.3 | -9.5 | 36.49 | 54 | -17.51 | 74 | -37.51 |
| 5 | 20.795 | 36.84 | Pk | 33 | -25 | -9.5 | 35.34 | 54 | -18.66 | 74 | -38.66 |
| 6 | 23.926 | 39.2 | Pk | 34.3 | -24 | -9.5 | 40 | 54 | -14 | 74 | -34 |

Pk - Peak detector

10. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

| Frequency of Emission (MHz) | Conducted Limit (dBuV) | |
|-----------------------------|------------------------|-----------|
| | Quasi-peak | Average |
| 0.15-0.5 | 66 to 56* | 56 to 46* |
| 0.5-5 | 56 | 46 |
| 5-30 | 60 | 50 |

*Decreases with the logarithm of the frequency.

TEST PROCEDURE

The EUT is placed on a non-conducting table 40 cm from the vertical ground plane and 80 cm above the horizontal ground plane. The EUT is configured in accordance with ANSI C63.10.

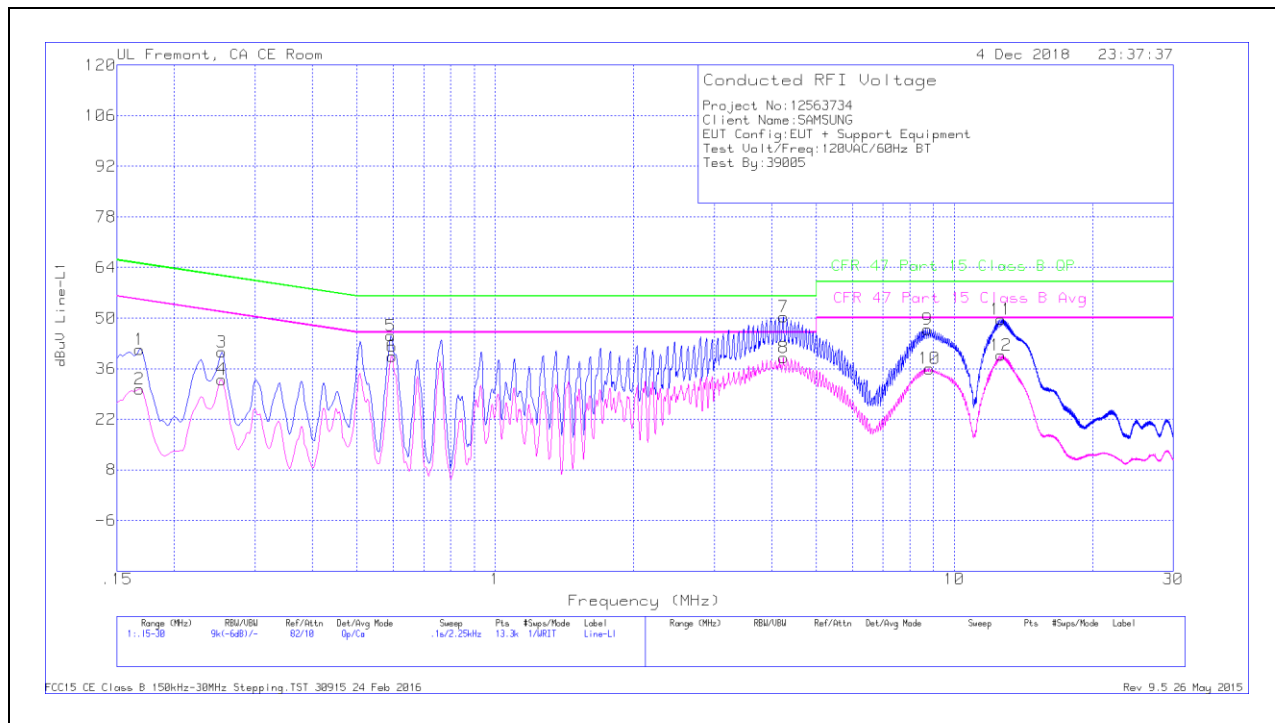
The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

Line conducted data is recorded for both NEUTRAL and HOT lines.

RESULTS

10.1.1. AC Power Line Norm

LINE 1 RESULTS

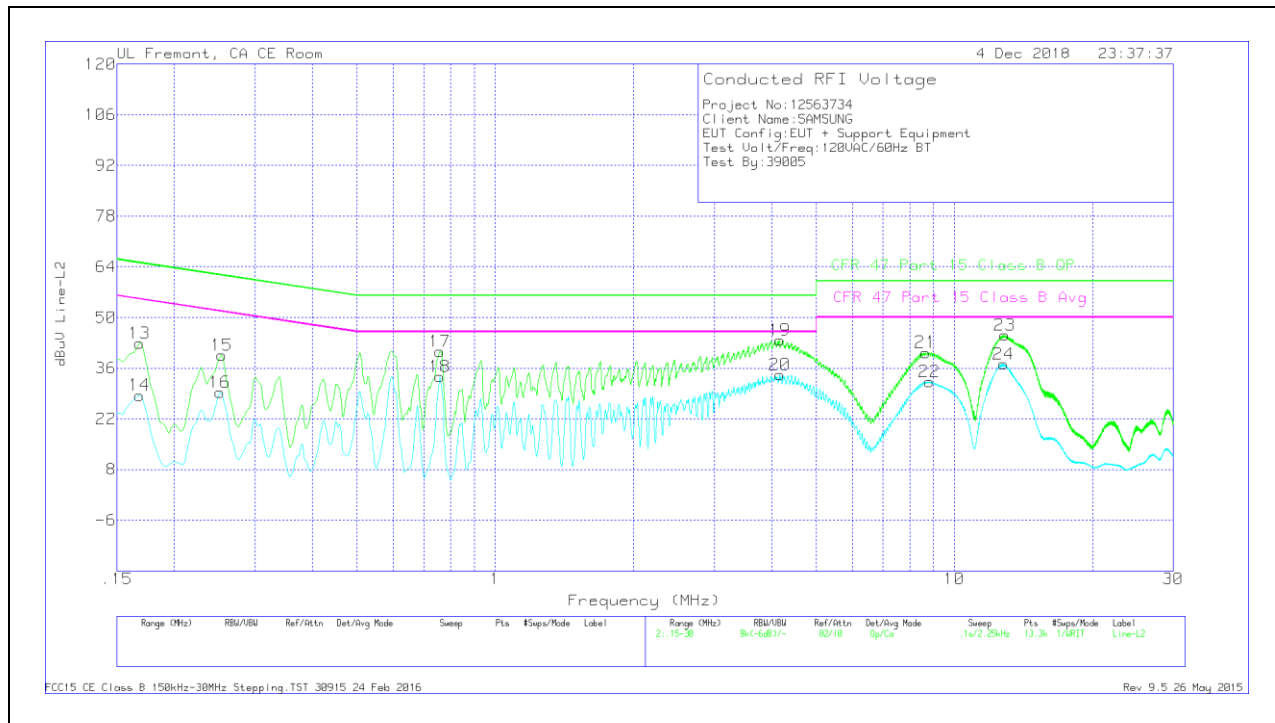


| Range 1: Line-L1 .15 - 30MHz | | | | | | | | | | | |
|------------------------------|-----------------|----------------------|-----|---------|-----------------|--------------|------------------------|---------------------------|----------------|----------------------------|-----------------------|
| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | LISN L1 | LC Cables C1&C3 | Limiter (dB) | Corrected Reading dBuV | CFR 47 Part 15 Class B QP | QP Margin (dB) | CFR 47 Part 15 Class B Avg | Av(CISPR) Margin (dB) |
| 1 | .168 | 31.08 | Qp | .1 | 0 | 10.1 | 41.28 | 65.06 | -23.78 | - | - |
| 2 | .168 | 20.18 | Ca | .1 | 0 | 10.1 | 30.38 | - | - | 55.06 | -24.68 |
| 3 | .2535 | 30.46 | Qp | 0 | 0 | 10.1 | 40.56 | 61.64 | -21.08 | - | - |
| 4 | .2535 | 22.95 | Ca | 0 | 0 | 10.1 | 33.05 | - | - | 51.64 | -18.59 |
| 5 | .59325 | 35.04 | Qp | 0 | 0 | 10.1 | 45.14 | 56 | -10.86 | - | - |
| 6 | .5955 | 29.34 | Ca | 0 | 0 | 10.1 | 39.44 | - | - | 46 | -6.56 |
| 7 | 4.24275 | 40.13 | Qp | 0 | .1 | 10.1 | 50.33 | 56 | -5.67 | - | - |
| 8 | 4.24275 | 28.81 | Ca | 0 | .1 | 10.1 | 39.01 | - | - | 46 | -6.99 |
| 9 | 8.74275 | 36.44 | Qp | 0 | .2 | 10.2 | 46.84 | 60 | -13.16 | - | - |
| 10 | 8.826 | 25.61 | Ca | 0 | .2 | 10.2 | 36.01 | - | - | 50 | -13.99 |
| 11 | 12.642 | 39.16 | Qp | .1 | .2 | 10.2 | 49.66 | 60 | -10.34 | - | - |
| 12 | 12.64875 | 29.24 | Ca | .1 | .2 | 10.2 | 39.74 | - | - | 50 | -10.26 |

Qp - Quasi-Peak detector

Ca - CISPR average detection

LINE 2 RESULTS



| Range 2: Line-L2 .15 - 30MHz | | | | | | | | | | | |
|------------------------------|-----------------|----------------------|-----|---------|-----------------|--------------|------------------------|---------------------------|----------------|----------------------------|-----------------------|
| Marker | Frequency (MHz) | Meter Reading (dBuV) | Det | LISN L2 | LC Cables C2&C3 | Limiter (dB) | Corrected Reading dBuV | CFR 47 Part 15 Class B QP | QP Margin (dB) | CFR 47 Part 15 Class B Avg | Av(CISPR) Margin (dB) |
| 13 | .168 | 32.64 | Qp | .1 | 0 | 10.1 | 42.84 | 65.06 | -22.22 | - | - |
| 14 | .168 | 18.33 | Ca | .1 | 0 | 10.1 | 28.53 | - | - | 55.06 | -26.53 |
| 15 | .2535 | 29.48 | Qp | 0 | 0 | 10.1 | 39.58 | 61.64 | -22.06 | - | - |
| 16 | .25125 | 19.15 | Ca | 0 | 0 | 10.1 | 29.25 | - | - | 51.72 | -22.47 |
| 17 | .7575 | 30.58 | Qp | 0 | 0 | 10.1 | 40.68 | 56 | -15.32 | - | - |
| 18 | .7575 | 23.54 | Ca | 0 | 0 | 10.1 | 33.64 | - | - | 46 | -12.36 |
| 19 | 4.16625 | 33.55 | Qp | 0 | .1 | 10.1 | 43.75 | 56 | -12.25 | - | - |
| 20 | 4.164 | 23.92 | Ca | 0 | .1 | 10.1 | 34.12 | - | - | 46 | -11.88 |
| 21 | 8.6685 | 29.95 | Qp | 0 | .2 | 10.2 | 40.35 | 60 | -19.65 | - | - |
| 22 | 8.8215 | 21.88 | Ca | 0 | .2 | 10.2 | 32.28 | - | - | 50 | -17.72 |
| 23 | 12.8895 | 34.56 | Qp | .1 | .2 | 10.2 | 45.06 | 60 | -14.94 | - | - |
| 24 | 12.8085 | 26.64 | Ca | .1 | .2 | 10.2 | 37.14 | - | - | 50 | -12.86 |

Qp - Quasi-Peak detector

Ca - CISPR average detection