

TEST REPORT

Report Number: R13761452-E2

Applicant : Milwaukee Electric Tool Corp
13135 W Lisbon Road
Brookefield, WI 53005
United States

Model : 2191-20

FCC ID : P36-219120

IC : 25187-219120

EUT Description : Wireless Earbuds

Test Standard(s) : FCC 47 CFR PART 15 SUBPART C: 2022
ISED RSS-247 ISSUE 2: 2017
ISED RSS-GEN ISSUE 5 +A2: 2021

Date Of Issue:
2023-02-19

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REPORT REVISION HISTORY

Rev.	Issue Date	Revisions	Revised By
V1	2022-10-11	Initial Issue	Brian Kiewra
V2	2023-02-19	Updated model number	Niklas Haydon

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1. ATTESTATION OF TEST RESULTS

COMPANY NAME: Milwaukee Electric Tool Corp
13135 W Lisbon Road
Brookefield, WI 53005
United States

EUT DESCRIPTION: Wireless Earbuds

MODEL: 2191-20

SERIAL NUMBER: Non-serialized

SAMPLE RECEIPT DATE: 2021-04-15

DATE TESTED: 2021-07-03 to 2021-07-20

APPLICABLE STANDARDS	
STANDARD	TEST RESULTS
CFR 47 Part 15 Subpart C: 2022	Complies
ISED RSS-247 Issue 2: 2017	Complies
ISED RSS-GEN Issue 5 + A1 + A2: 2021	Complies

UL LLC 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.

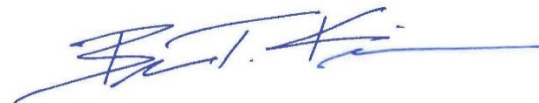
This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the U.S. government.

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For UL LLC By:



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Staff Engineer
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Prepared By:



Brian Kiewra
Project Engineer
Consumer, Medical and IT Segment
UL LLC

2. TEST RESULTS SUMMARY

FCC Clause	ISED Clause	Requirement	Result	Comment
See Comment		Duty Cycle	Reporting purposes only	Per ANSI C63.10, Section 11.6.
See Comment	RSS-GEN 6.7	20dB BW/99% OBW	Reporting purposes only	ANSI C63.10 Sections 6.9.2 and 6.9.3
15.247 (a)(1)	RSS-247 (5.1) (b)	Hopping Frequency Separation	Complies	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Number of Hopping Channels	Complies	None.
15.247 (a)(1)(iii)	RSS-247 (5.1) (d)	Average Time of Occupancy	Complies	None.
15.247 (b)(1)	RSS-247 (5.4) (b)	Output Power	Complies	None.
See Comment		Average Power	Reporting purposes only	Per ANSI C63.10, Section 11.9.2.3.2.
15.247 (d)	RSS-247 (5.5)	Conducted Spurious Emissions	Complies	None.
15.209, 15.205	RSS-GEN 8.9, 8.10	Radiated Emissions	Complies	None.
15.207	RSS-Gen 8.8	AC Mains Conducted Emissions	Complies	None.

This report contains data provided by the applicant which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.

3. TEST METHODOLOGY

The tests documented in this report were performed in accordance with FCC CFR 47 Part 2, FCC CFR 47 Part 15: 2022, ANSI C63.10-2013, KDB 558074 D01 15.247 Meas Guidance v05r02, KDB 414788 D01 Radiated Test Site v01r01, RSS-GEN Issue 5 + +A1 +A2: 2021, and RSS-247 Issue 2: 2017.

4. FACILITIES AND ACCREDITATION

UL LLC is accredited by A2LA, certification # 0751.06, for all testing performed within the scope of this report. Testing was performed at the locations noted below.

	Address	ISED CABID	ISED Company Number	FCC Registration
<input type="checkbox"/>	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
<input checked="" type="checkbox"/>	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A		27265	

5. DECISION RULES AND MEASUREMENT UNCERTAINTY

5.1. METROLOGICAL TRACEABILITY

All test and measuring equipment utilized to perform the tests documented in this report are calibrated on a regular basis, with a maximum time between calibrations of one year or the manufacturers' recommendation, whichever is less, and where applicable is traceable to recognized national standards.

5.2. DECISION RULES

The Decision Rule is based on Simple Acceptance in accordance with ISO Guide 98-4:2012 Clause 8.2. (Measurement uncertainty is not taken into account when stating conformity with a specified requirement.)

5.3. MEASUREMENT UNCERTAINTY

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

PARAMETER	UNCERTAINTY
Radio Frequency (Spectrum Analyzer)	141.2 Hz
Occupied Channel Bandwidth	1.22%
RF output power, conducted	1.3 dB (PK) 0.45 dB (AV)
Power Spectral Density, conducted	2.47 dB
Unwanted Emissions, conducted	1.94 dB
All emissions, radiated	6.01 dB
Conducted Emissions (0.150-30MHz) - LISN	3.40 dB
Temperature	0.57°C
Humidity	3.39%
DC Supply voltages	1.70%
Time	3.39%

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

5.4. SAMPLE CALCULATION

RADIATED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\text{Field Strength (dBuV/m)} = \text{Measured Voltage (dBuV)} + \text{Antenna Factor (dB/m)} + \text{Cable Loss (dB)} - \text{Preamp Gain (dB)}$$

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

MAINS CONDUCTED EMISSIONS

Where relevant, the following sample calculation is provided:

$$\text{Final Voltage (dBuV)} = \text{Measured Voltage (dBuV)} + \text{Cable Loss (dB)} + \text{Limiter Factor (dB)} + \text{LISN Insertion Loss}$$

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

6. EQUIPMENT UNDER TEST

6.1. EUT DESCRIPTION

The EUT is a pair of wireless earbuds with a Bluetooth and BLE transceiver. This report covers Bluetooth testing only.

6.2. 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	6.03	4.01
2402 - 2480	Enhanced DQPSK	7.27	5.33
2402 - 2480	Enhanced 8PSK	7.45	5.56

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 9.7.

6.1. DESCRIPTION OF AVAILABLE ANTENNAS

The antenna(s) gain and type, as provided by the manufacturer' are as follows:

The radio utilizes an FPCB antenna, with a maximum gain of 2.64dBi.

6.2. SOFTWARE AND FIRMWARE

The EUT firmware installed during testing was v1.6.2.6

The test utility software used during testing was RF_test_tool_v5.2.2.69

6.3. WORST-CASE CONFIGURATION AND MODE

The left earbud and right earbud are electrically identical, therefore one earbud was used for testing with the exception of power line conducted emissions testing. For power line conducted emissions testing the EUT was placed in its charging case.

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 Y orientation was worst-case orientation; therefore, all final radiated testing was performed with the EUT in Y orientation.

All testing performed in GFSK and 8PSK modes. 8PSK mode represents DQPSK and is considered equivalent or worst-case. Note – Power and Average Time of Occupancy were performed in DQPSK mode.

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

GFSK mode: DH5
DQPSK mode: 2-DH5
8PSK mode: 3-DH5

6.4. DESCRIPTION OF TEST SETUP

SUPPORT EQUIPMENT

Support Equipment List				
Description	Manufacturer/Brand	Model	Serial Number	FCC ID
None				

I/O CABLES

I/O Cable List						
Cable No	Port	# of identical ports	Connector Type	Cable Type	Cable Length (m)	Remarks
1	I/O	1	Micro-USB	Shielded	<3m	Used only to plug in to charging case

SETUP DIAGRAMS

Please refer to R13761452-EP1 for setup diagrams

7. TEST AND MEASUREMENT EQUIPMENT

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

Test Equipment Used - Wireless Conducted Measurement Equipment

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
Common Equipment					
Conducted Room 1					
SA0027 (PRE0126407)	Spectrum Analyzer	Keysight Technologies	N9030A	2021-06-25	2022-06-25
HI0090 (PRE0191271)	Environmental Meter	Fisher Scientific	15-077-963	2020-06-26	2021-06-26*
HI0090 (PRE0191271)	Environmental Meter	Fisher Scientific	15-077-963	2021-07-12	2022-07-12
SOFTEMI	Antenna Port Software	UL	Version 2021.05.28	NA	NA
Conducted Room 2					
SA0025 (PRE0126407)	Spectrum Analyzer	Keysight Technologies	N9030A	2021-04-01	2022-06-10
PWM003 (PRE0137345)	RF Power Meter	Keysight Technologies	N1911A	2020-08-28	2021-08-28
PWS004 (PRE0126443)	Peak and Avg Power Sensor, 50MHz to 6GHz	Keysight Technologies	E9323A	2020-08-12	2021-08-12
HI0096	Environmental Meter	Fisher Scientific	14-650-118	2020-09-23	2021-09-23
SOFTEMI	Antenna Port Software	UL	Version 2021.05.28	NA	NA

* Testing performed while in calibration

Test Equipment Used - Radiated Disturbance Emissions Test Equipment (Morrisville - South Chamber)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
	0.009-30MHz				
AT0079	Active Loop Antenna	ETS-Lindgren	6502	2020-08-20	2021-08-20
	30-1000 MHz				
AT0075	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2020-10-27	2021-10-27
AT0074	Hybrid Broadband Antenna	Sunol Sciences Corp.	JB3	2020-07-27	2021-07-27
	1-18 GHz				
AT0072	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2021-05-03	2022-05-03
AT0078	Double-Ridged Waveguide Horn Antenna, 1 to 18 GHz	ETS Lindgren	3117	2020-11-19	2021-11-19
	Gain-Loss Chains				
S-SAC01	Gain-loss string: 0.009-30MHz	Various	Various	2020-07-10	2021-07-10
S-SAC02	Gain-loss string: 25-1000MHz	Various	Various	2020-07-10	2021-07-10
S-SAC03	Gain-loss string: 1-18GHz	Various	Various	2020-07-06	2021-07-06
	Receiver & Software				
197954	Spectrum Analyzer	Rohde & Schwarz	ESW44	2021-03-30	2022-03-30
197955	Spectrum Analyzer	Rohde & Schwarz	ESW44	2021-03-10	2022-03-10
SOFTEMI	EMI Software	UL	Version 9.5 (04 Mar 2021)		
	Additional Equipment used				
s/n 200037635	Environmental Meter	Fisher Scientific	06-662-4	2020-01-22	2022-01-22
s/n 181474341	Environmental Meter	Fisher Scientific	15-077-963	2020-08-06	2021-08-06

Test Equipment Used - Line-Conducted Emissions – Voltage (Morrisville – Conducted 1)

Equipment ID	Description	Manufacturer	Model Number	Last Cal.	Next Cal.
CBL087	Coax cable, RG223, N-male to BNC-male, 20-ft.	Pasternack	PE3W06143-240	2021-04-05	2022-04-05
HI0090	Environmental Meter	Fisher Scientific	14-650-118	2020-06-26	2021-06-26
LISN003	LISN, 50-ohm/50-uH, 250uH 2-conductor, 25A	Fischer Custom Com.	FCC-LISN-50/250-25-2-01	2020-08-18	2021-08-18
75141	EMI Test Receiver 9kHz-7GHz	Rohde & Schwarz	ESCI 7	2020-08-18	2021-08-18
ATA222	Transient Limiter, 0.009-100MHz	Electro-Metrics	EM-7600	2021-04-05	2022-04-05
PS214	AC Power Source	Elgar	CW2501M (s/n 1523A02396)	NA	NA
SOFTEMI	EMI Software	UL	Version 9.5 (04 Mar 21)		
	Miscellaneous (if needed)				
CDECABLE001	ANSI C63.4 1m extension cable.	UL	Per Annex B of ANSI C63.4	2020-08-08	2021-08-08

8. 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

Band-Edge: ANSI C63.10-2013 Section 7.8.6, 6.10.4 and 6.10.5

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

AC Line Conducted Emissions: ANSI C63.10-2013 Section 6.2

9. ANTENNA PORT TEST RESULTS

9.1. ON TIME AND DUTY CYCLE

LIMITS

None; for reporting purposes only.

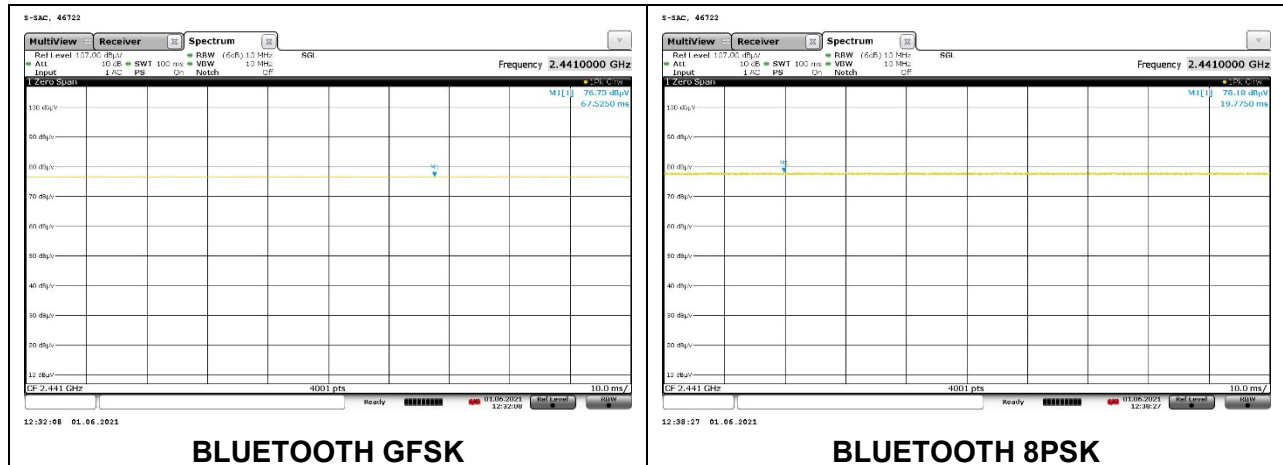
PROCEDURE

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	10.00	10.00	1.000	100.0%	0.00	0.010
Bluetooth 8PSK	10.00	10.00	1.000	100.0%	0.00	0.010

DUTY CYCLE PLOTS



9.2. 20 dB AND 99% BANDWIDTH

LIMITS

None; for reporting purposes only.

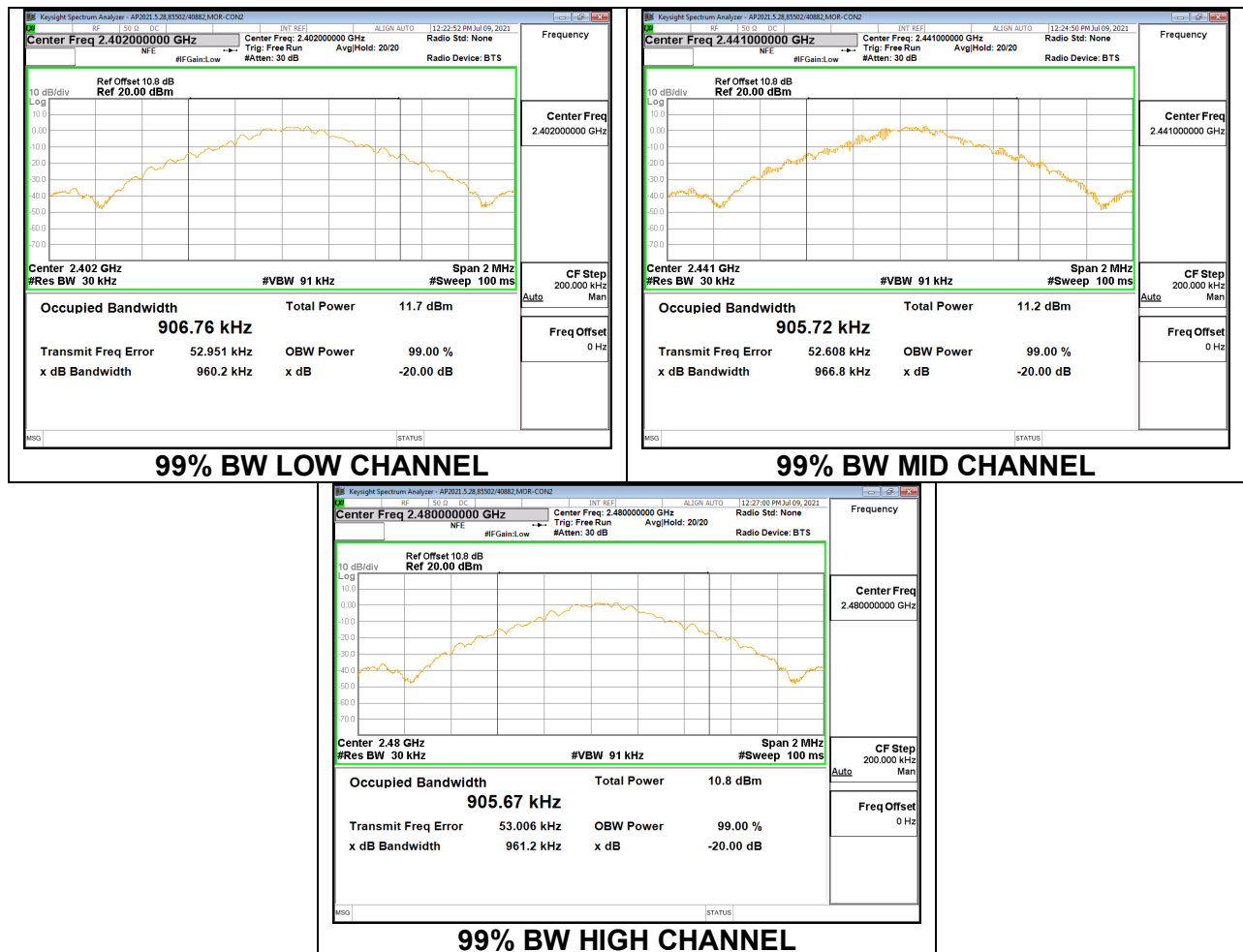
TEST PROCEDURE

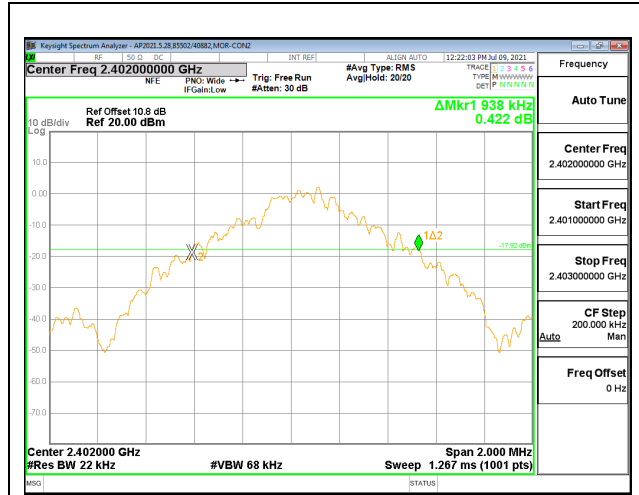
The transmitter output is connected to a spectrum analyzer. The RBW is set to $\geq 1\%$ of the 20 dB bandwidth. The VBW is set to \geq RBW. The sweep time is coupled.

RESULTS

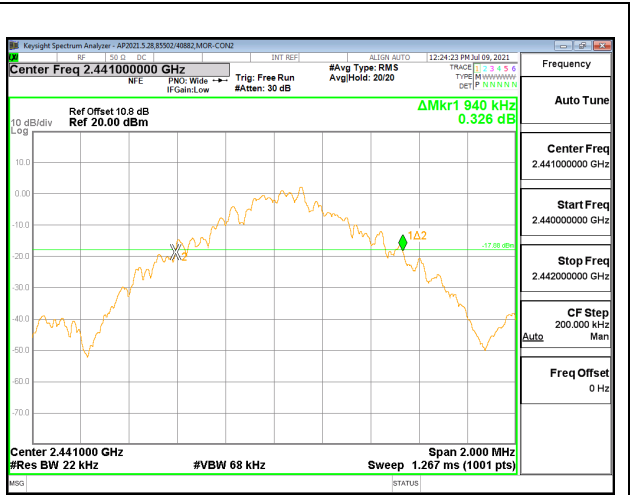
9.2.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	0.938	0.90676
Mid	2441	0.940	0.90572
High	2480	0.954	0.90567

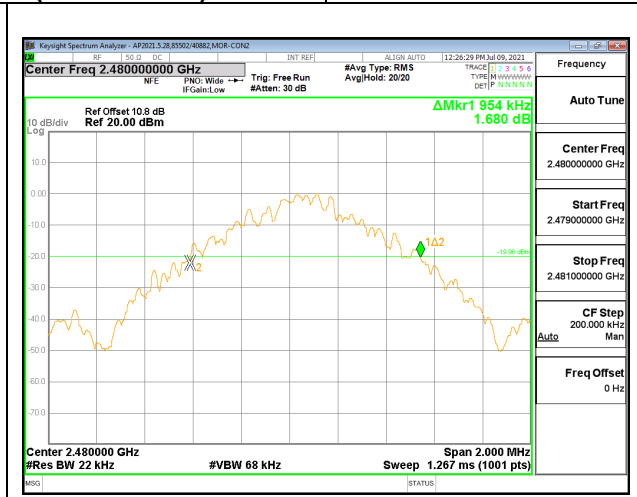




LOW CHANNEL (20 dB EBW)



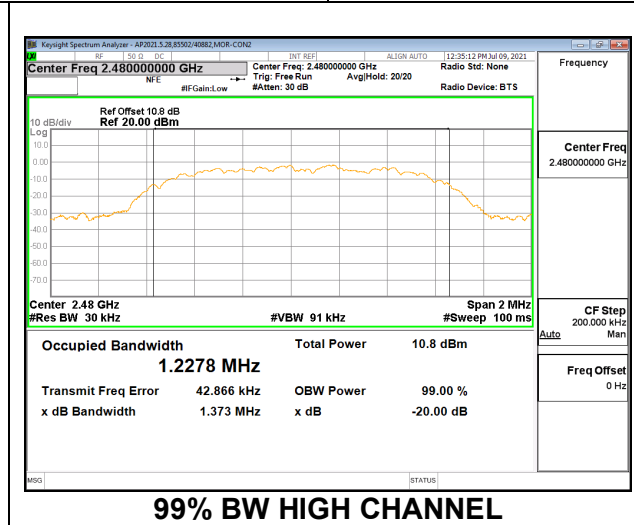
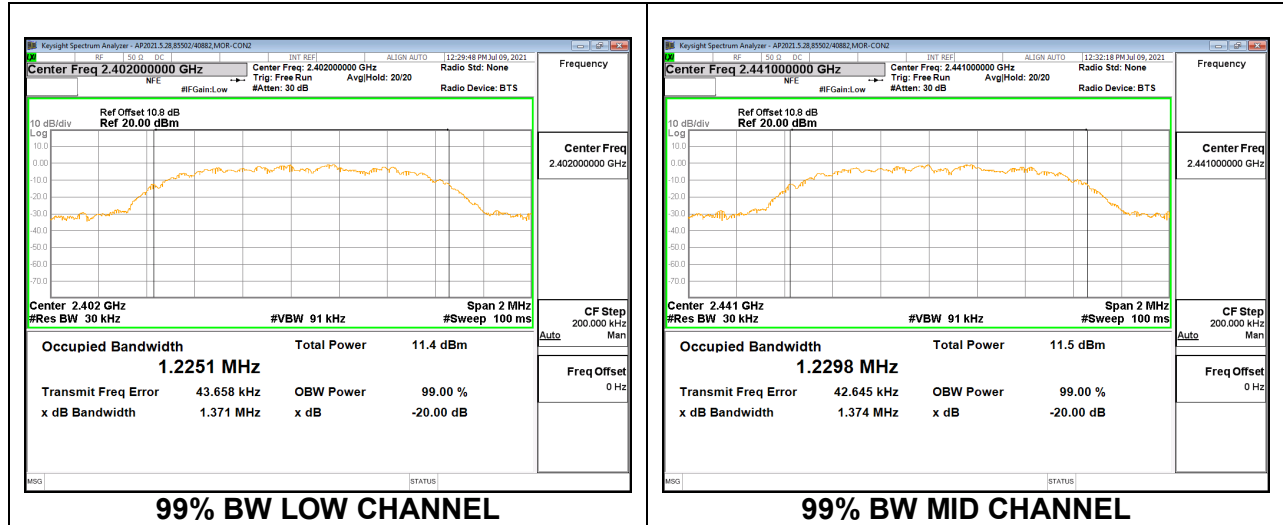
MID CHANNEL (20 dB EBW)

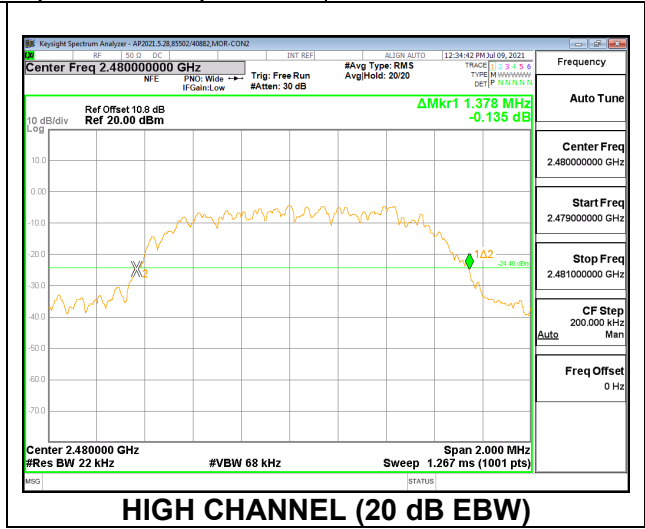
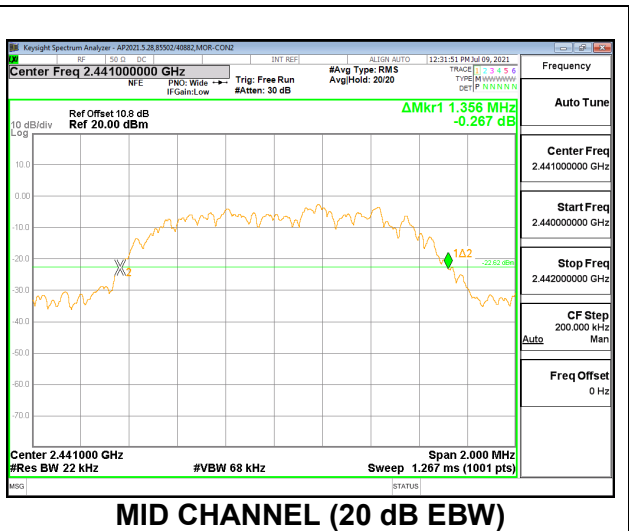
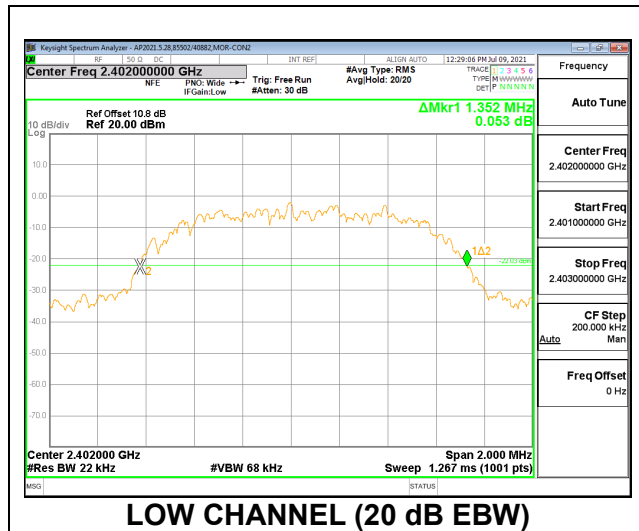


HIGH CHANNEL (20 dB EBW)

9.2.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	99% Bandwidth (MHz)
Low	2402	1.352	1.2251
Mid	2441	1.356	1.2298
High	2480	1.378	1.2278





9.3. HOPPING FREQUENCY SEPARATION

LIMITS

FCC §15.247 (a) (1)

RSS-247 (5.1) (b)

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.

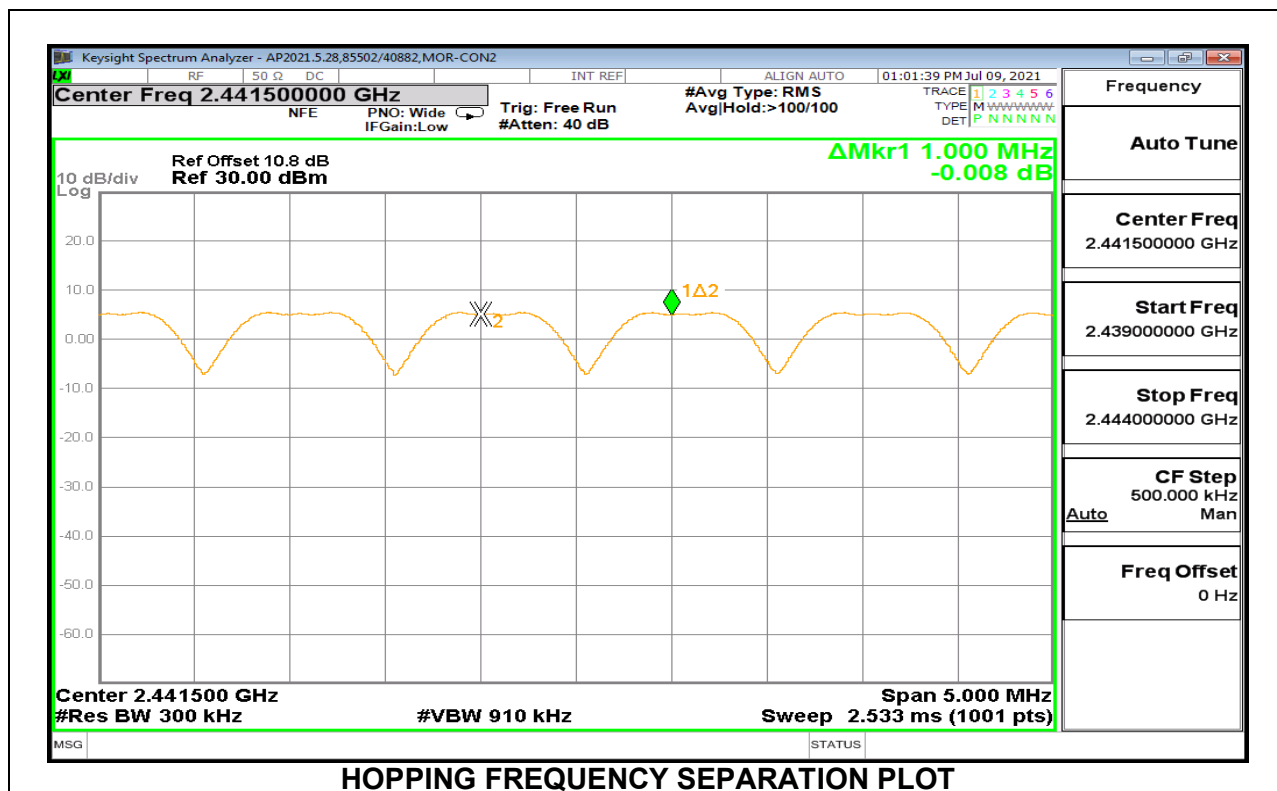
Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than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

TEST PROCEDURE

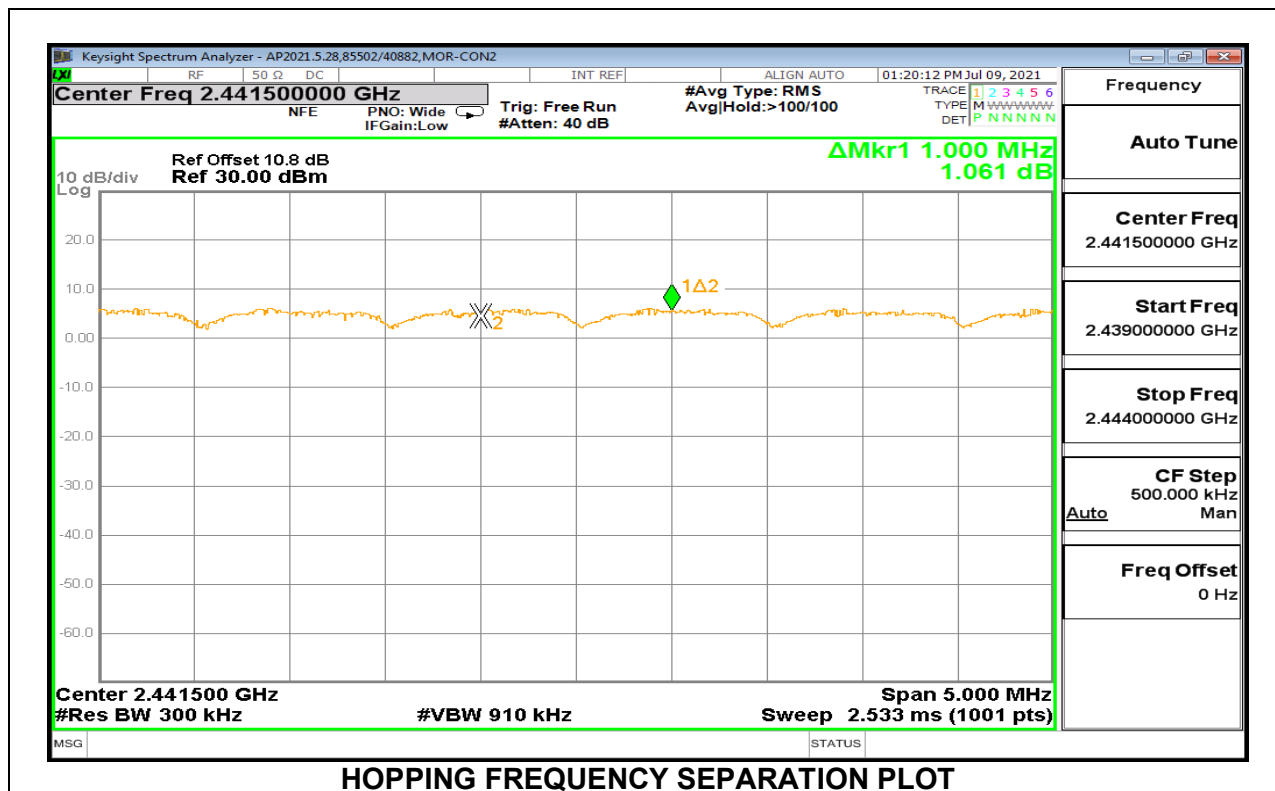
The transmitter output is connected to a spectrum analyzer. The RBW is set to 300 kHz (approx. 30% of channel spacing) and the VBW is set to $VBW \geq RBW$. The sweep time is coupled.

RESULTS

9.3.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION



9.3.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION



Note – The channel hopping separation of 1MHz is less than the 20 dB bandwidth (approx. 1.38 MHz). However, the output power is less than 125 mW and the channel separation is greater than 2/3 the 20 dB bandwidth (approx. 919 kHz).

Ch. A	Ch. B	Ch. 1 to Ch. 2 Sep.	Max. 20 dB BW	2/3 20 dB BW	Margin
(MHz)	(MHz)	(MHz)	(MHz)	(MHz)	(MHz)
2441	2442	1.000	1.378	0.919	-0.081

9.4. NUMBER OF HOPPING CHANNELS

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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

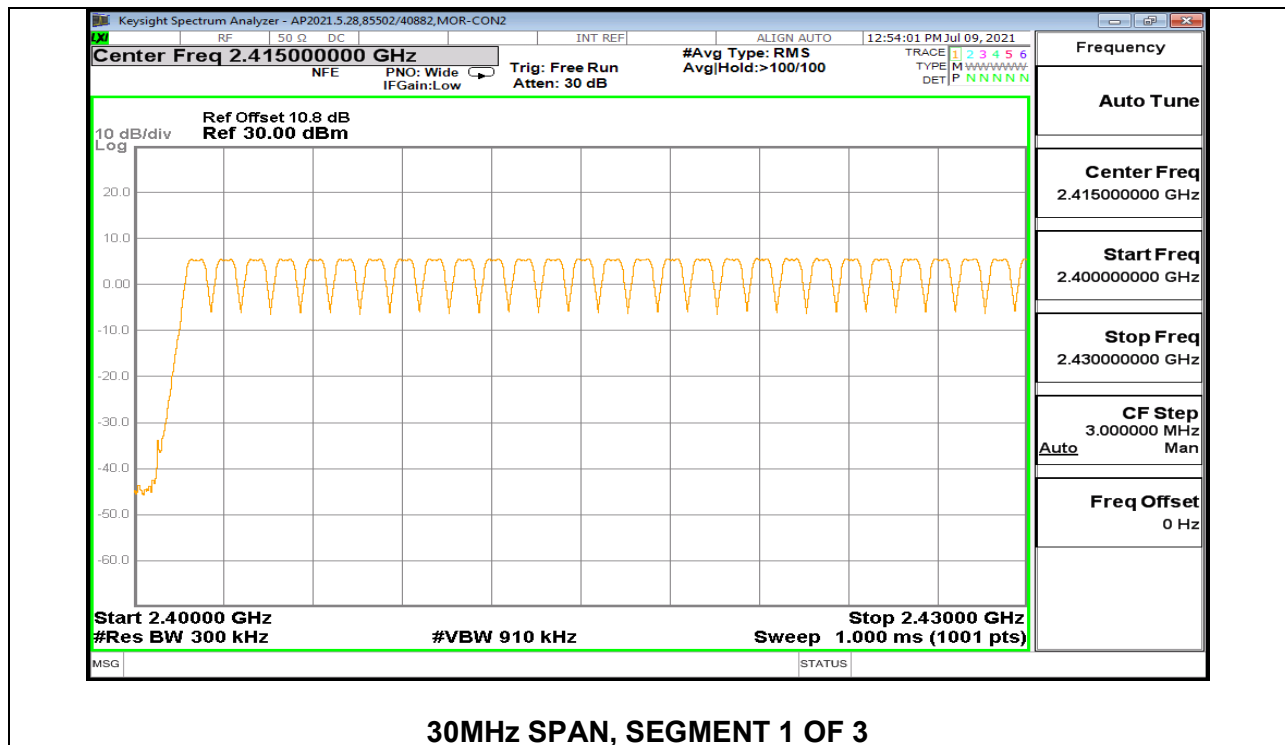
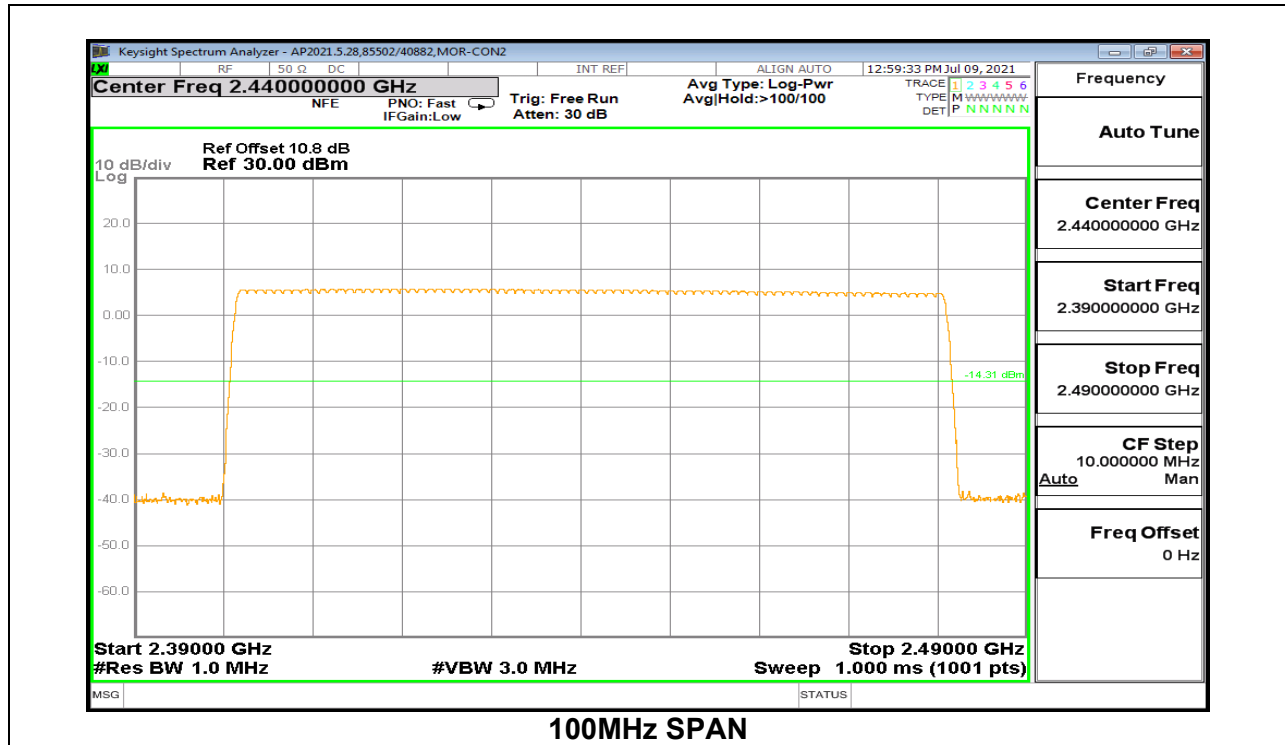
TEST PROCEDURE

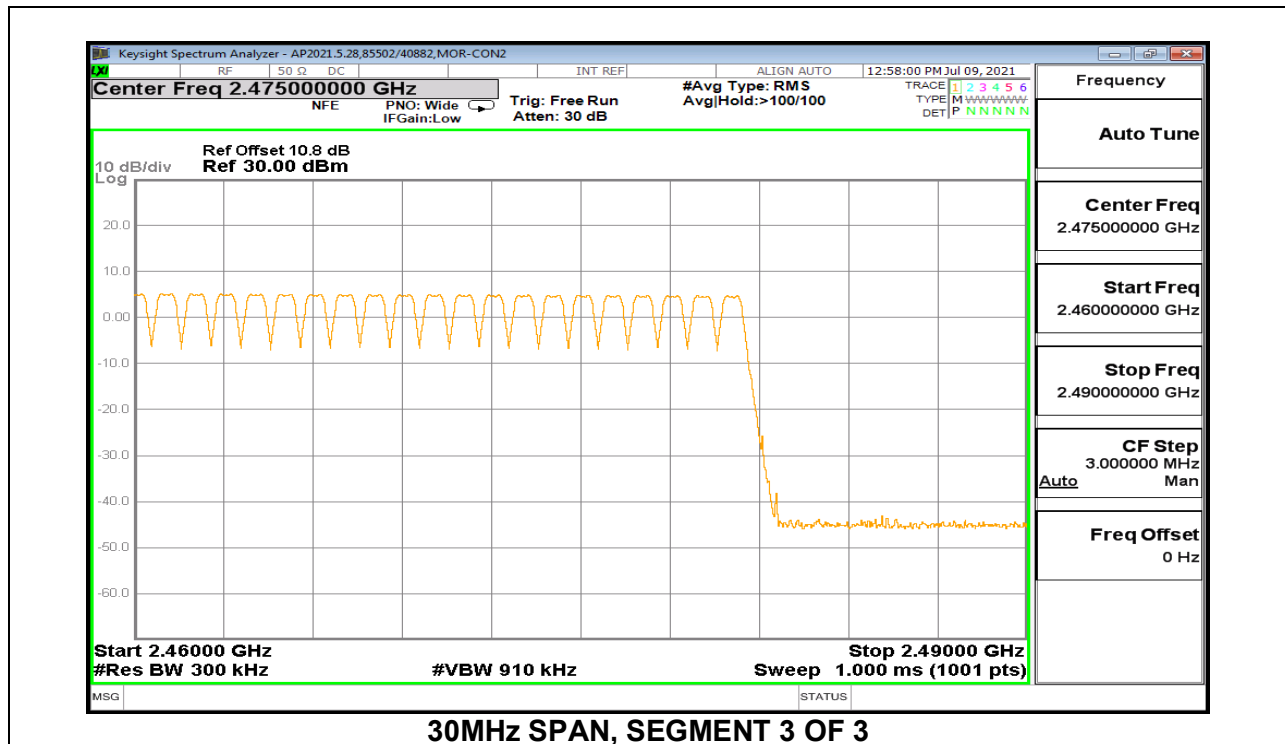
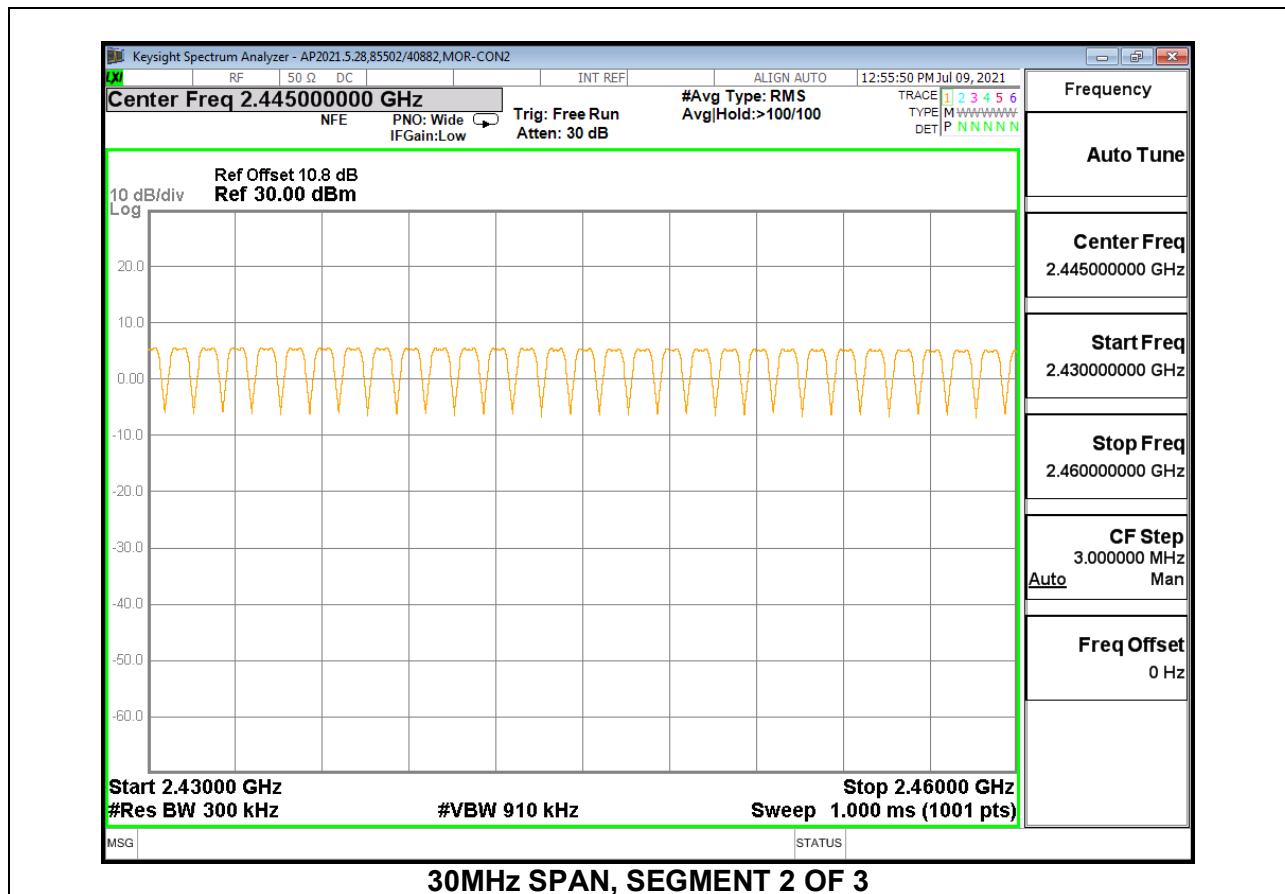
The transmitter output is connected to a spectrum analyzer. The span is set to cover the entire authorized band, in either a single sweep or in multiple contiguous sweeps. The RBW is set to a maximum of 1 % of the span. The analyzer is set to Max Hold.

RESULTS

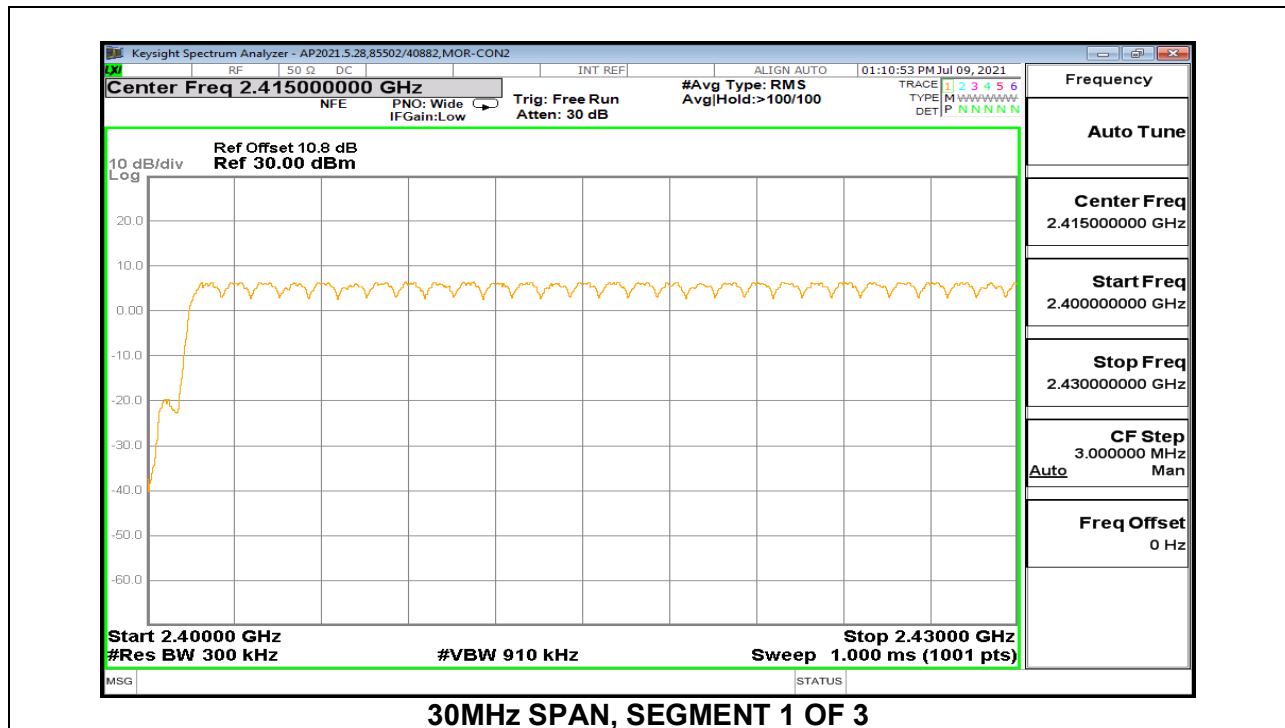
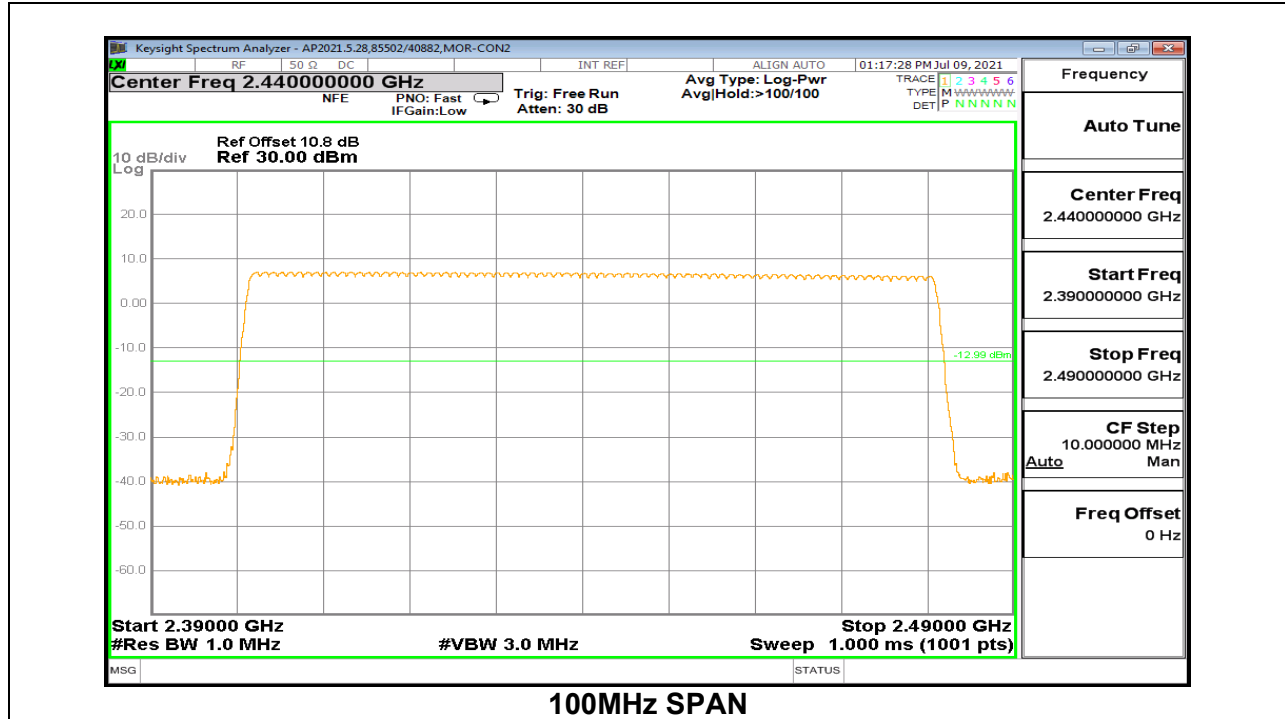
Normal Mode: All Channels Observed

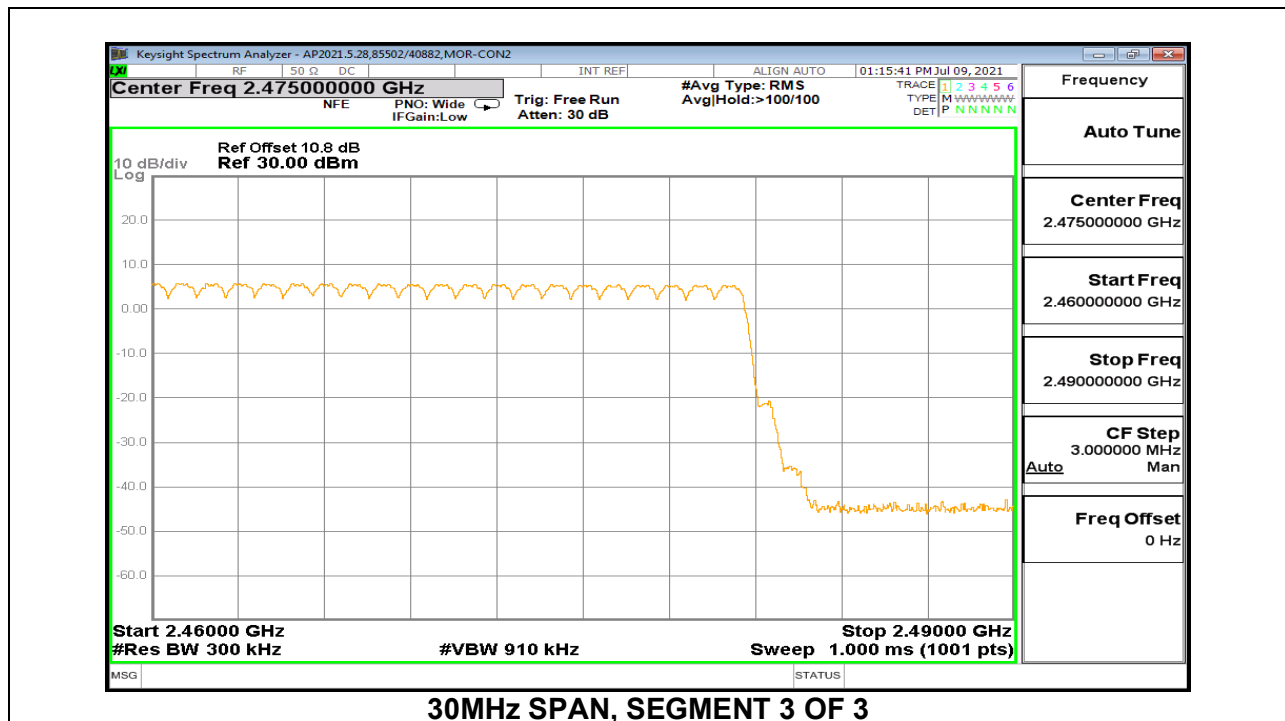
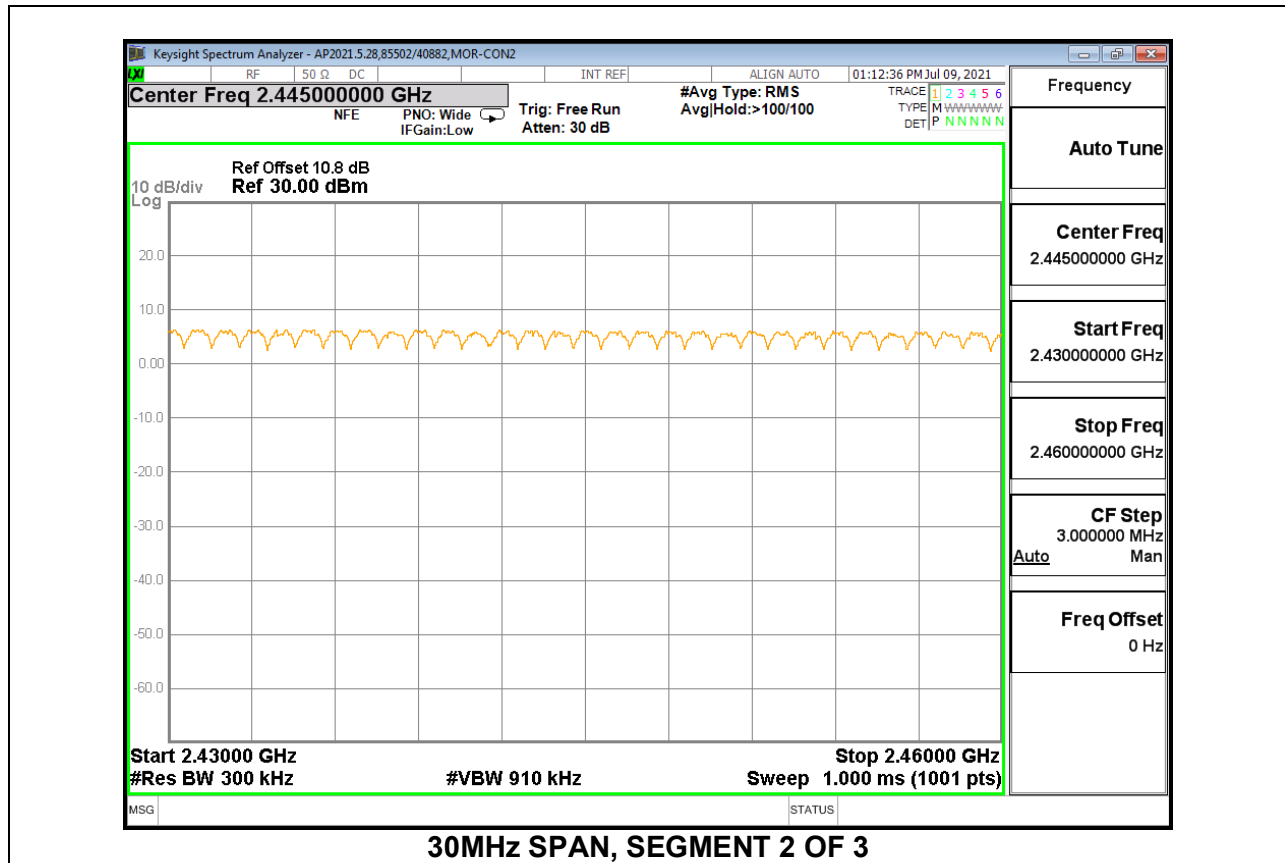
9.4.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION





9.4.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION





9.5. AVERAGE TIME OF OCCUPANCY

LIMITS

FCC §15.247 (a) (1) (iii)

RSS-247 (5.1) (d)

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.

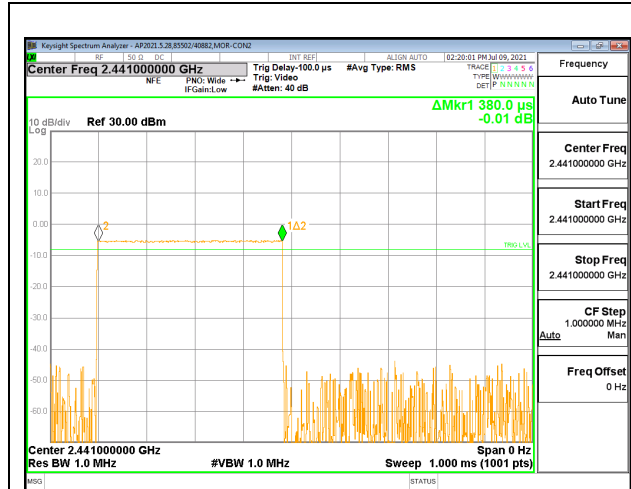
The average time of occupancy in the specified 3.16 second period (79 channels * 0.4 s) is equal to $10 * (\# \text{ of pulses in } 3.16 \text{ s}) * \text{ pulse width}$.

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

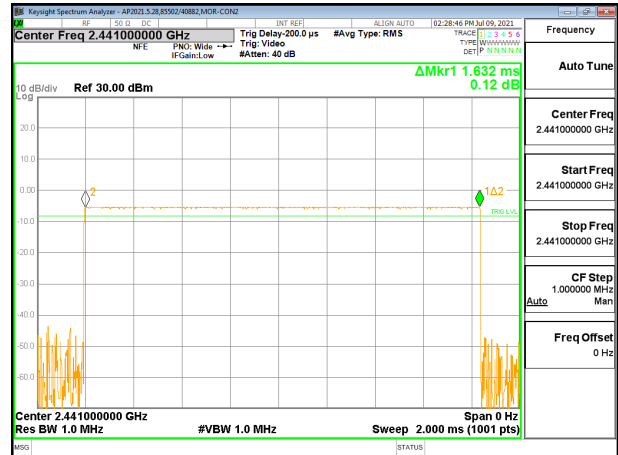
RESULTS

9.5.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

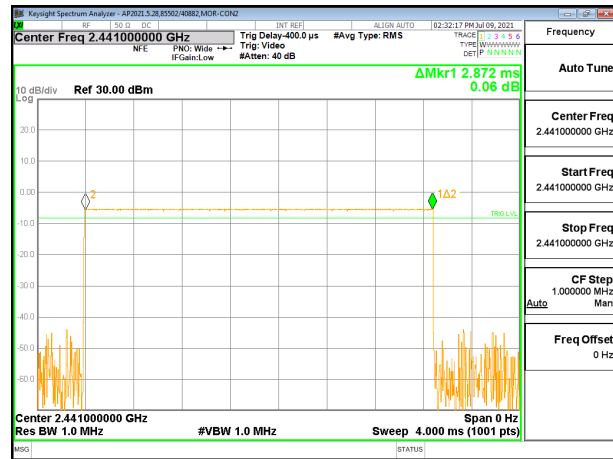
DH Packet	Pulse Width (msec)	Number of Pulses in 3.16 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
GFSK Normal Mode					
DH1	0.380	32	0.1216	0.4	-0.2784
DH3	1.632	12	0.1958	0.4	-0.2042
DH5	2.872	10	0.2872	0.4	-0.1128
GFSK AFH Mode					
DH Packet	Pulse Width (sec)	Number of Pulses in 0.8 seconds	Average Time of Occupancy (sec)	Limit (sec)	Margin (sec)
DH1	0.380	8	0.03040	0.4	-0.3696
DH3	1.632	3	0.04896	0.4	-0.3510
DH5	2.872	2.5	0.07180	0.4	-0.3282



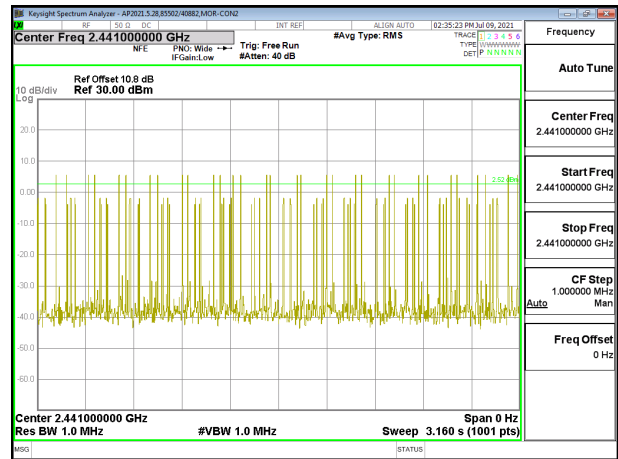
PULSE WIDTH – DH1



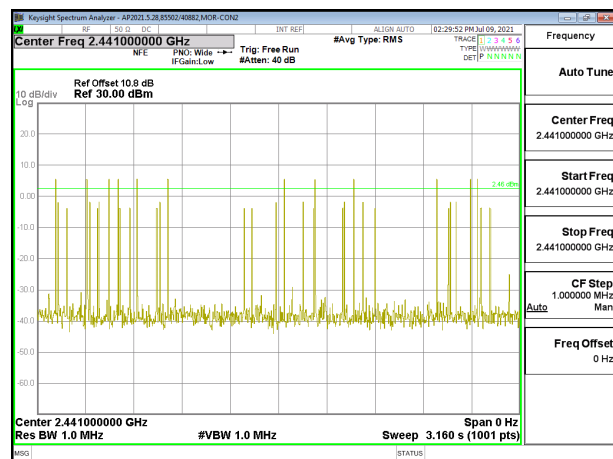
PULSE WIDTH – DH3



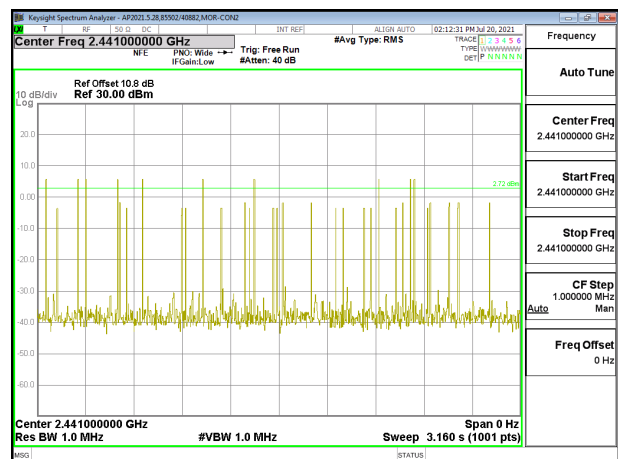
PULSE WIDTH – DH5



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



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

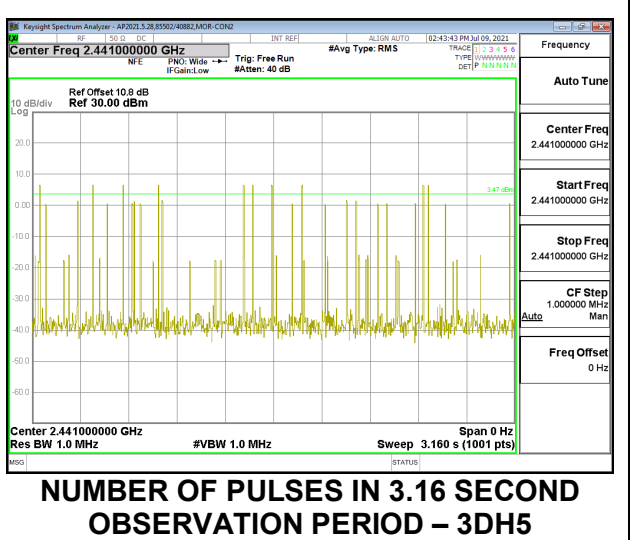
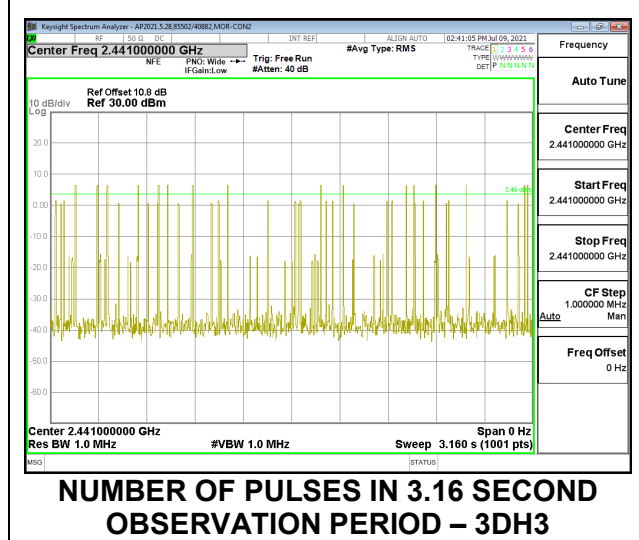
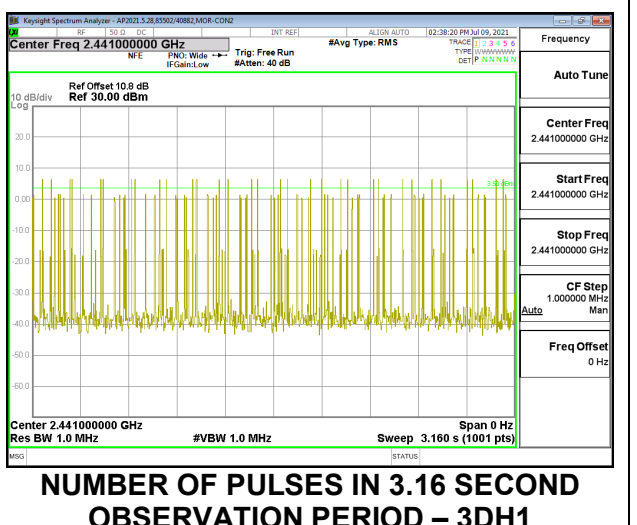
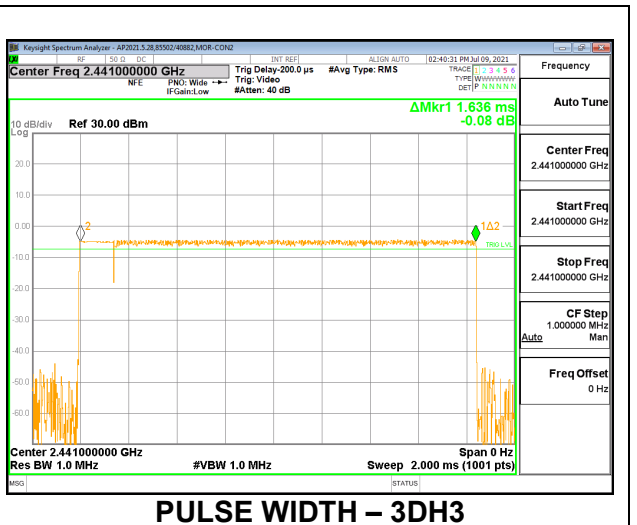
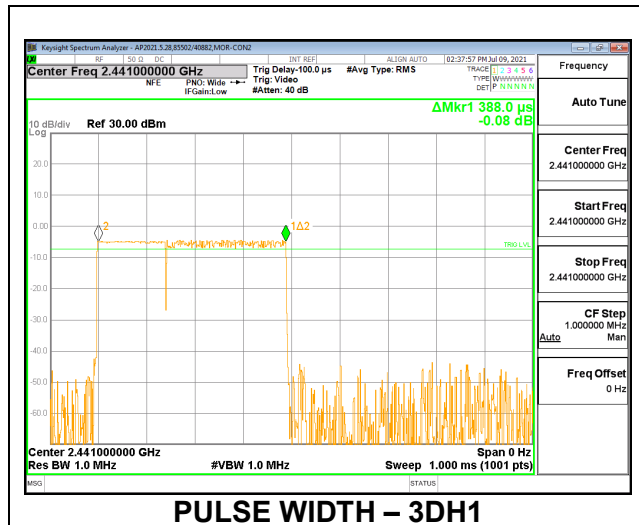


**NUMBER OF PULSES IN 3.16 SECOND
 OBSERVATION PERIOD – DH5**

9.5.2. 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	0.388	31	0.12028	0.4	-0.2797
3DH3	1.636	16	0.26176	0.4	-0.1382
3DH5	2.88	10	0.288	0.4	-0.112

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.



9.6. OUTPUT POWER

LIMITS

§15.247 (b) (1)

RSS-247 (5.4) (b)

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.

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

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 10.98 dB (including 10 dB pad and 0.98 dB cable) was entered as an offset in the power meter to allow for a peak reading of power.

RESULTS

9.6.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Tested By:	85502/40882
Date:	2021-07-09

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	6.03	30	-23.97
Middle	2441	5.55	30	-24.45
High	2480	4.60	30	-25.4

9.6.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	85502/40882
Date:	2021-07-09

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	7.27	30	-22.73
Middle	2441	6.81	30	-23.19
High	2480	6.05	30	-23.95

9.6.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	85502/40882
Date:	2021-07-09

Channel	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
Low	2402	7.45	21	-13.55
Middle	2441	7.02	21	-13.98
High	2480	6.32	21	-14.68

9.7. AVERAGE POWER

LIMITS

None; for reporting purposes only

TEST PROCEDURE

Measurements perform using a wideband gated RF power meter.

The cable assembly insertion loss of 10.98 dB (including 10 dB pad and 0.98 dB cable) was entered as an offset in the power meter to allow for a gated average reading of power.

RESULTS

9.7.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

Tested By:	85502/40882
Date	2021-07-09

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	5.86
Middle	2441	5.37
High	2480	4.41

9.7.2. BLUETOOTH ENHANCED DATA RATE DQPSK MODULATION

Tested By:	85502/40882
Date	2021-07-09

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	5.56
Middle	2441	5.15
High	2480	4.22

9.7.3. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Tested By:	85502/40882
Date	2021-07-09

Channel	Frequency (MHz)	Average Power (dBm)
Low	2402	5.55
Middle	2441	5.14
High	2480	4.23

9.8. CONDUCTED SPURIOUS EMISSIONS

LIMITS

FCC §15.247 (d)

RSS-247 5.5

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.

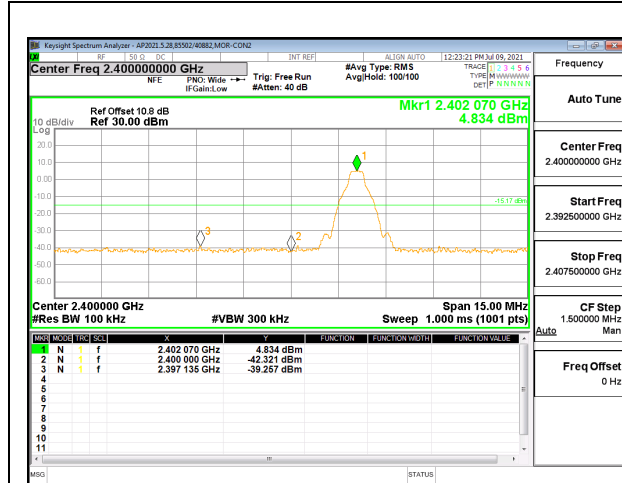
The spectrum from 30 MHz to 26 GHz is investigated with the transmitter set to the lowest, middle, and highest channels.

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

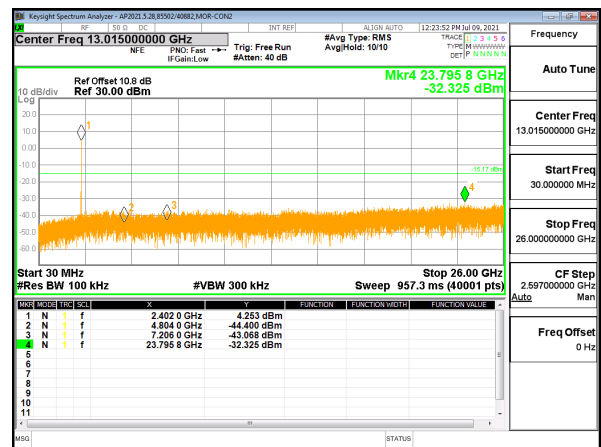
RESULTS

9.8.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

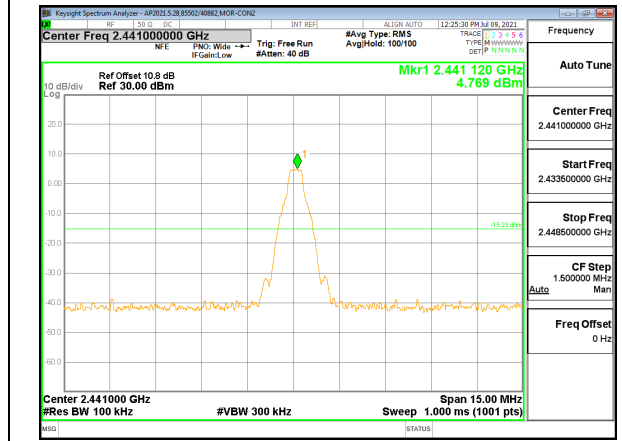
Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



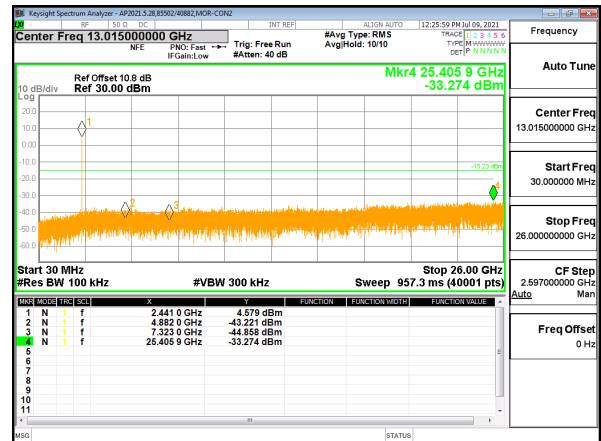
LOW CHANNEL BANDEDGE



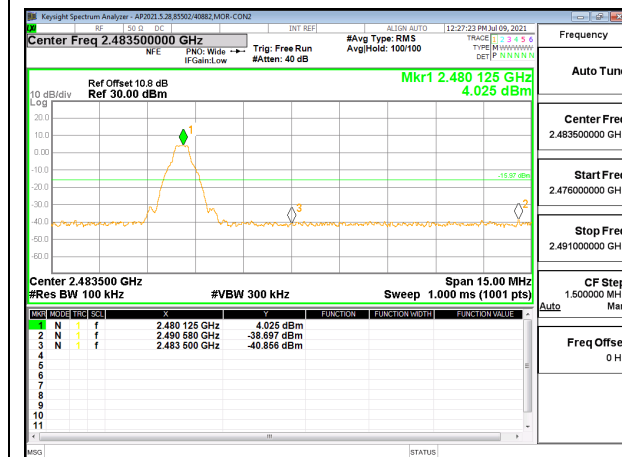
OUT-OF-BAND LOW CHANNEL



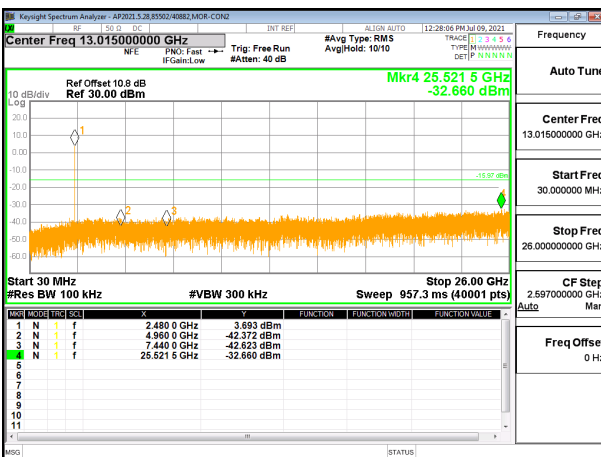
IN-BAND REFERENCE LEVEL



OUT-OF-BAND MID CHANNEL

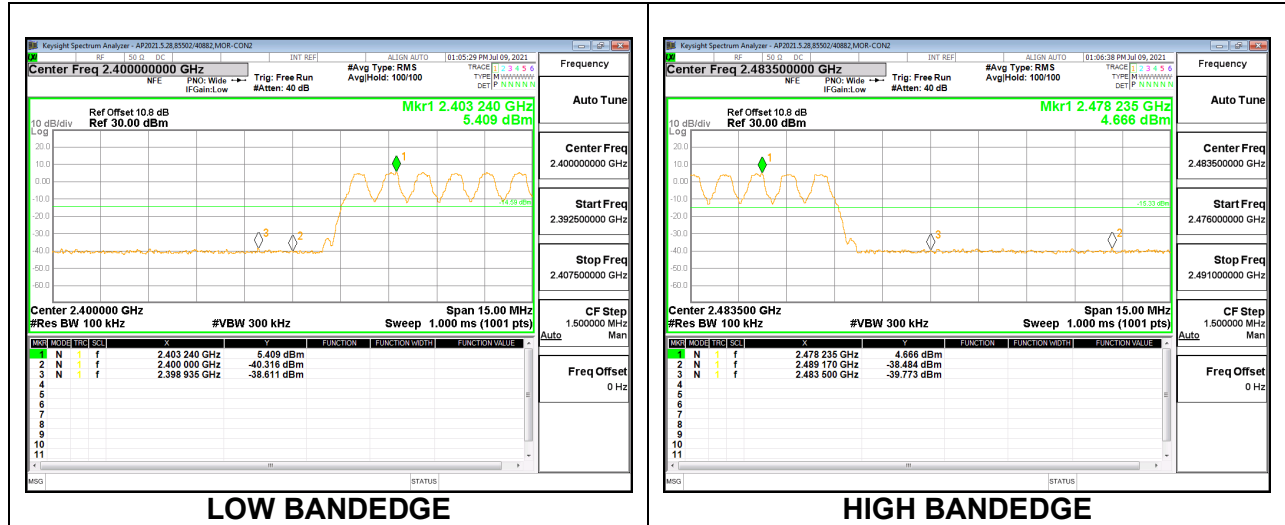


HIGH CHANNEL BANDEDGE



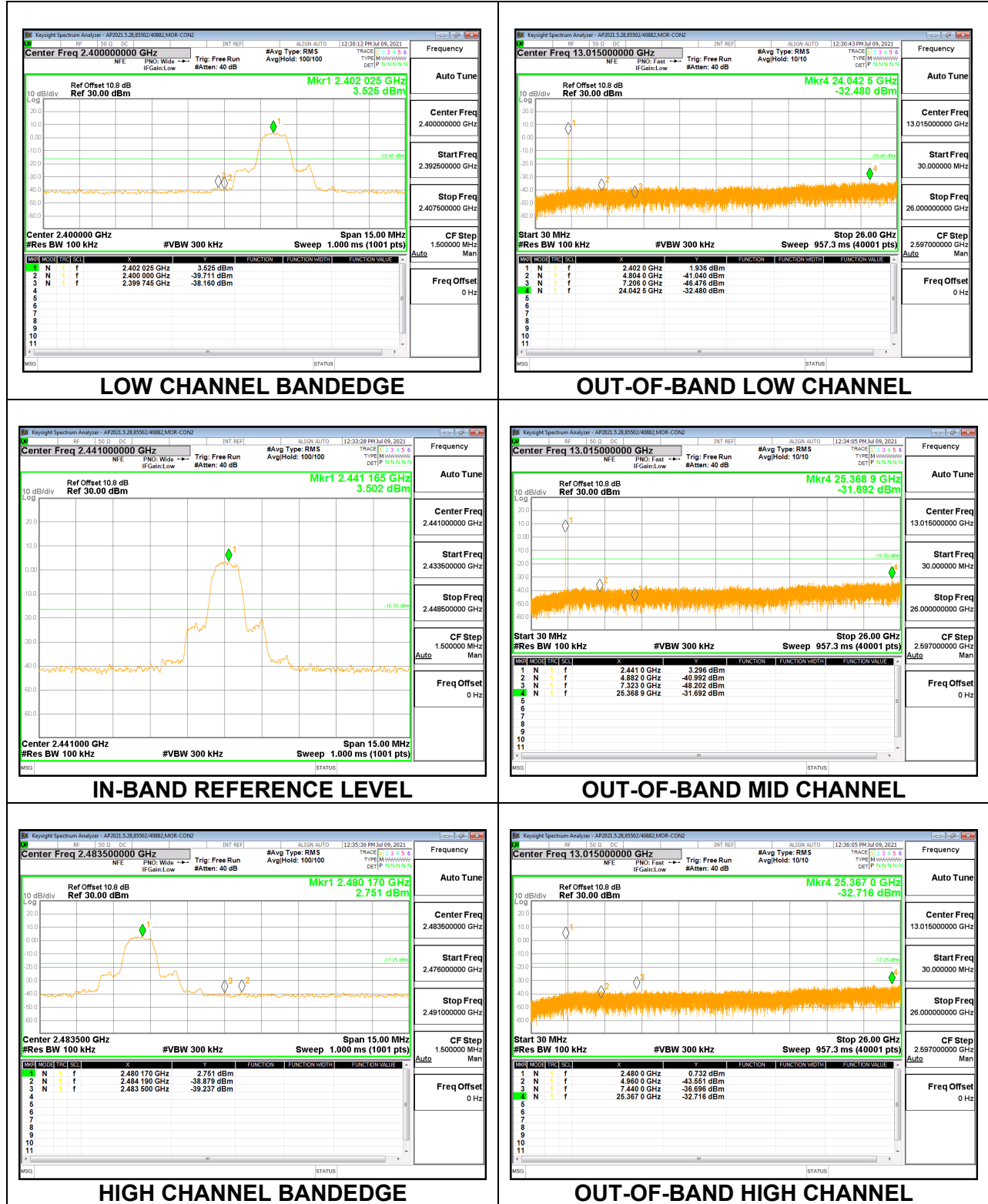
OUT-OF-BAND HIGH CHANNEL

Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON

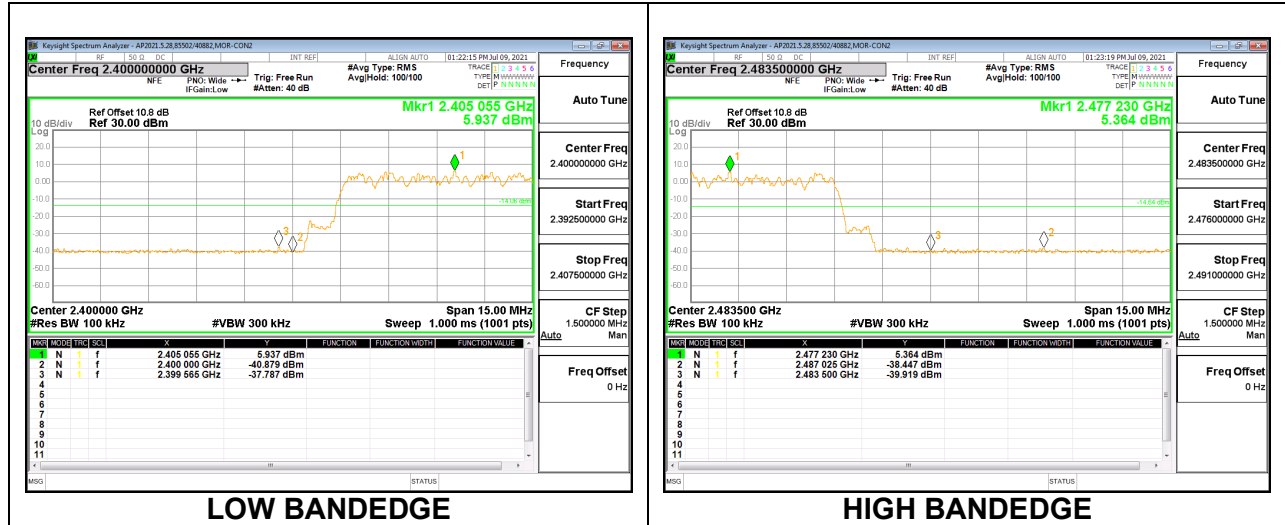


9.8.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

Antenna 1 SPURIOUS EMISSIONS, NON-HOPPING



Antenna 1 SPURIOUS BANDEDGE EMISSIONS WITH HOPPING ON



10. 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

RSS-GEN, Section 8.9 and 8.10.

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	-

Frequency Range (MHz)	Field Strength Limit (uV/m) at 3 m	Field Strength Limit (dBuV/m) at 3 m
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 in the 30-1000MHz range, 9kHz for peak and/or quasi-peak detection measurements in the 0.15-30MHz range and 200Hz for peak and/or quasi-peak detection measurements in the 9 to 150kHz range. Peak detection is used unless otherwise noted as quasi-peak or average (9-90kHz and 110-490kHz).

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 final measurements above 1 GHz the resolution bandwidth is set to 1 MHz; the video bandwidth is set to 3 MHz for peak measurements and 1 MHz resolution bandwidth with 1/T 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.

3D antenna use - For below 30MHz testing, investigation was done on three antenna orientations (parallel, perpendicular, and ground-parallel).

The limits in CFR 47, Part 15, Subpart C, paragraph 15.209(a), are identical to those in RSS-Gen section 8.9, Table 6, since the measurements are performed in terms of magnetic field strength and converted to electric field strength levels (as reported in the table), using the free space impedance of 377 Ohms. For example the measurement at frequency X kHz resulted in a level of Y dBuV/m, which is equivalent to $Y - 51.5 = Z$ dBuA/m, which has the same margin, W dB, to the corresponding RSS-Gen Table 6 limit as it has to 15.209(a) limit.

Base on FCC 15.31 (f) (2): measurements may be performed at a distance closer than that specified in the regulations; however, an attempt should be made to avoid making measurements in the near field.

KDB 414788 Open Field Site(OFS) and Chamber Correlation Justification

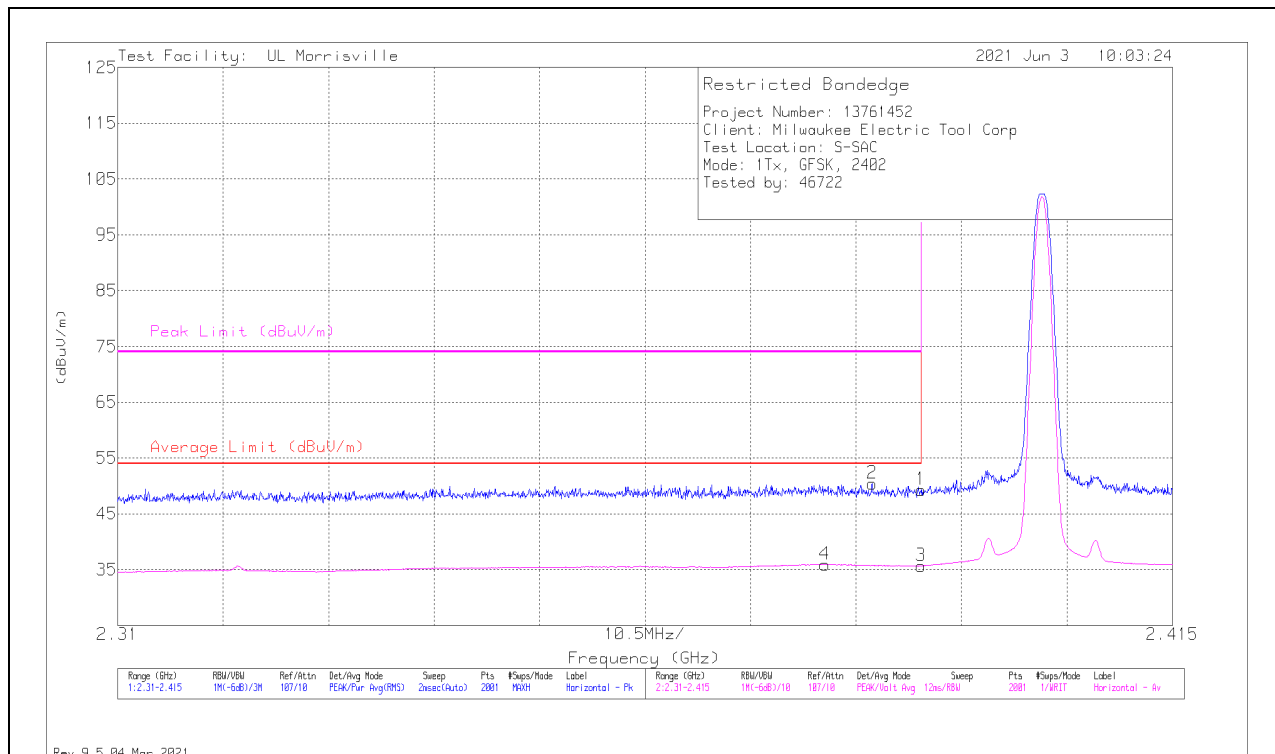
OFS and chamber correlation testing had been performed and chamber measured test result is the worst case test result.

10.1. TRANSMITTER ABOVE 1 GHz

10.1.1. BLUETOOTH BASIC DATA RATE GFSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.38996	41.6	Pk	31.9	-24.2	49.3	-	-	74	-24.7	133	117	H
2	* ** 2.38513	42.46	Pk	32.2	-24.3	50.36	-	-	74	-23.64	133	117	H
3	* ** 2.38996	27.94	VA1T	31.9	-24.2	35.64	54	-18.36	-	-	133	117	H
4	* ** 2.3804	27.73	VA1T	32.5	-24.3	35.93	54	-18.07	-	-	133	117	H

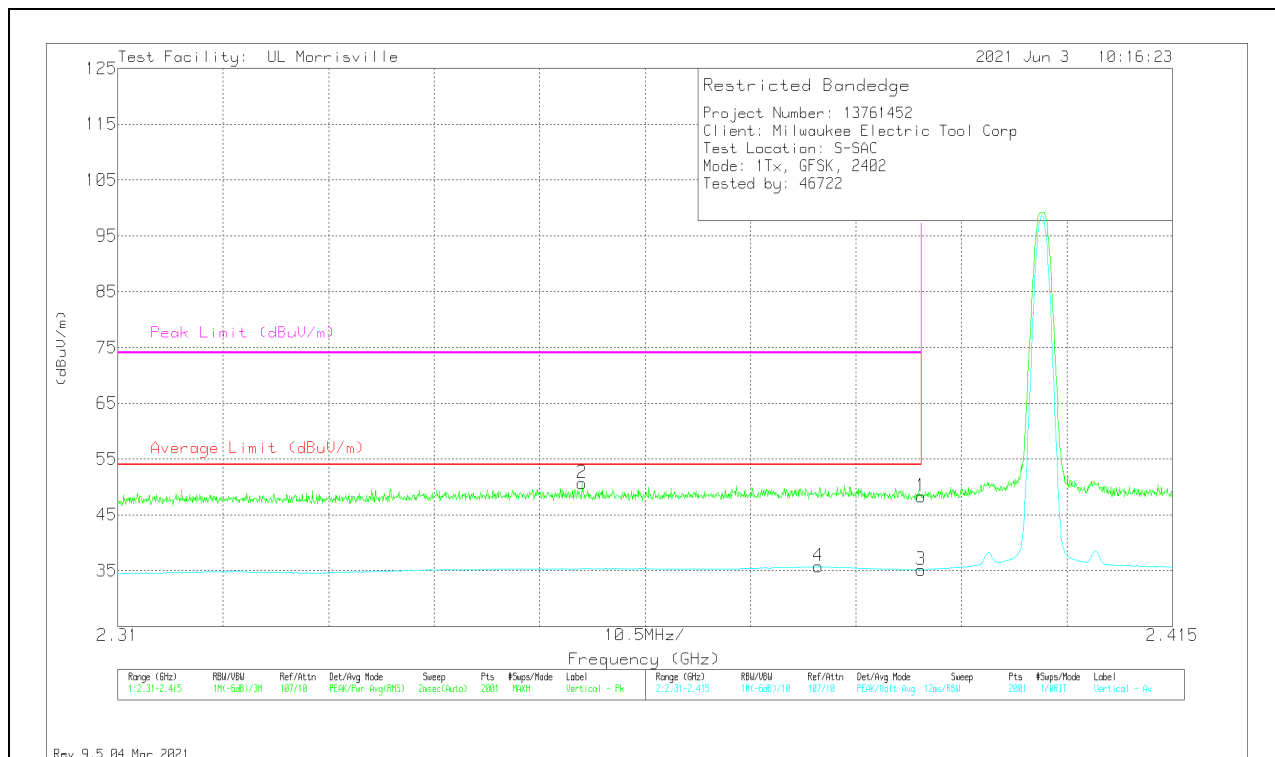
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

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

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.38996	40.64	Pk	31.9	-24.2	48.34	-	-	74	-25.66	161	101	V
2	* ** 2.35625	42.72	Pk	32.2	-24.3	50.62	-	-	74	-23.38	161	101	V
3	* ** 2.38996	27.46	VA1T	31.9	-24.2	35.16	54	-18.84	-	-	161	101	V
4	* ** 2.37972	27.52	VA1T	32.5	-24.3	35.72	54	-18.28	-	-	161	101	V

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

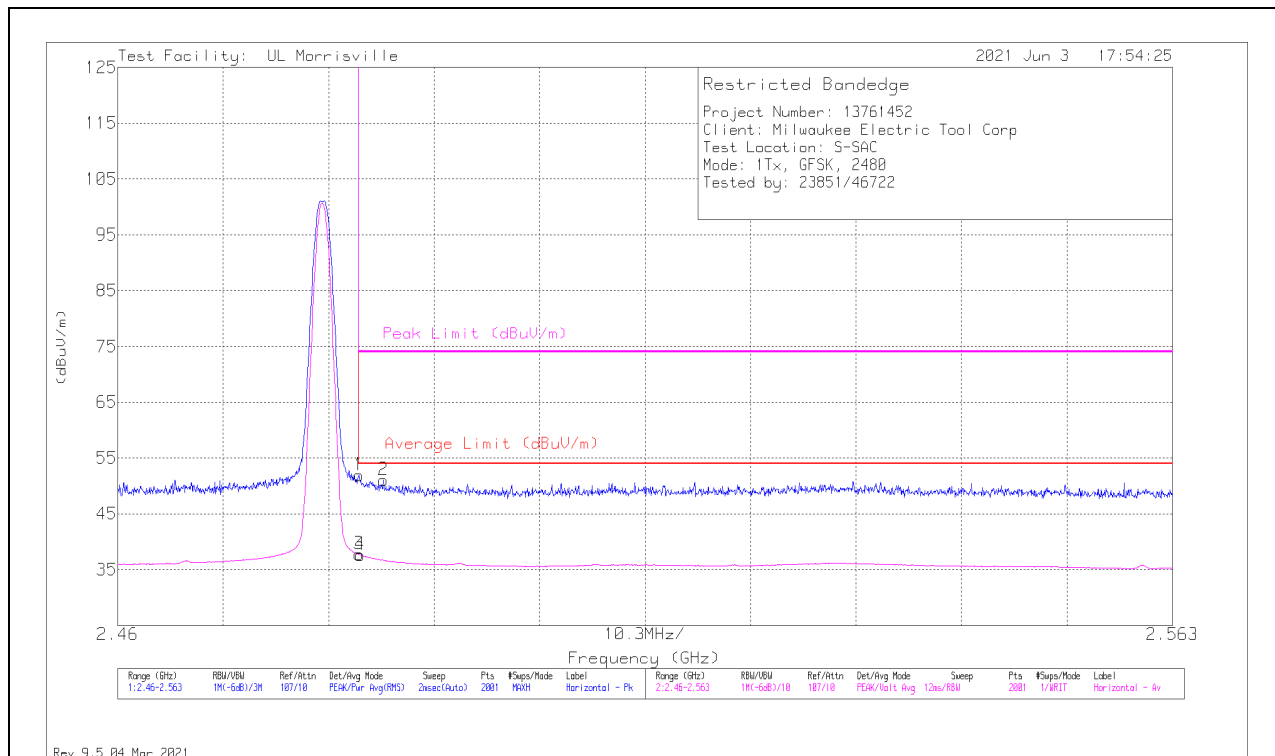
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

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

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.48354	43.49	Pk	32.5	-24.1	51.89	-	-	74	-22.11	125	129	H
2	* ** 2.48596	42.65	Pk	32.5	-24.1	51.05	-	-	74	-22.95	125	129	H
3	* ** 2.48354	29.31	VA1T	32.5	-24.1	37.71	54	-16.29	-	-	125	129	H
4	* ** 2.48369	29.22	VA1T	32.5	-24.1	37.62	54	-16.38	-	-	125	129	H

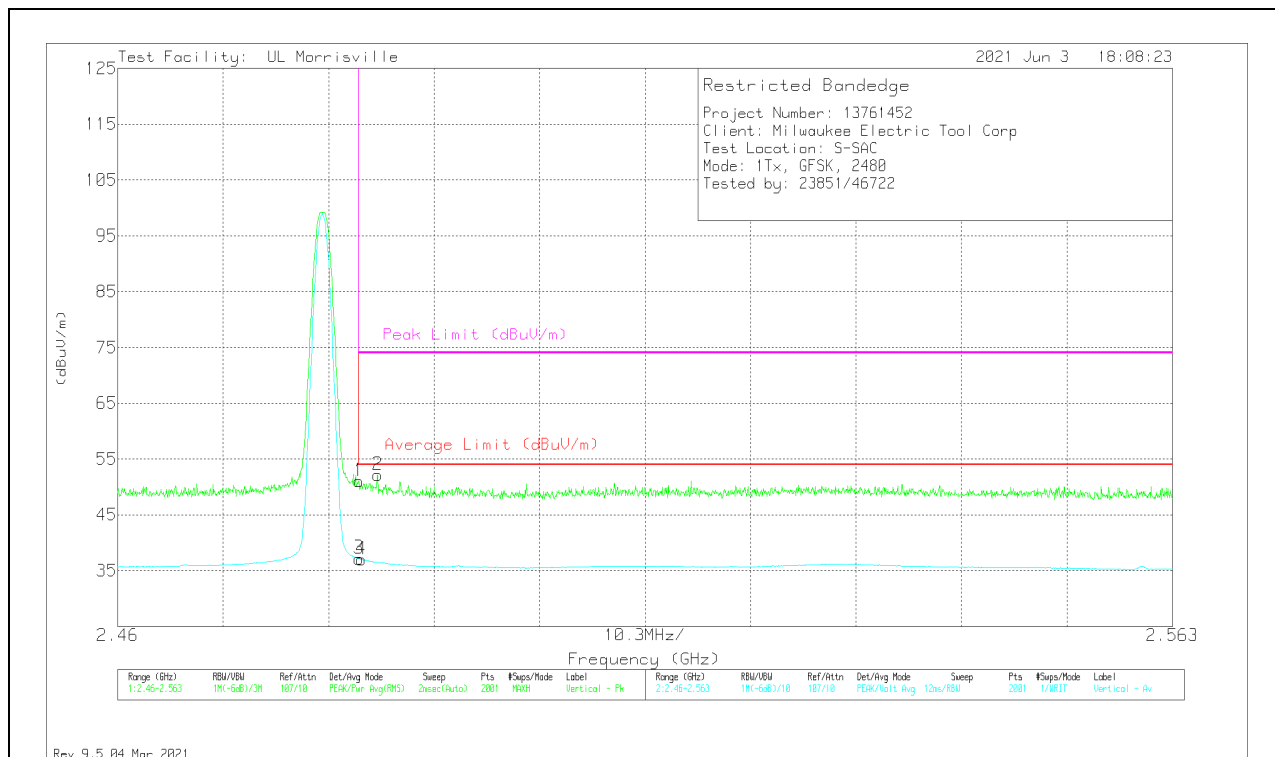
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

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

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.48354	42.68	Pk	32.5	-24.1	51.08	-	-	74	-22.92	167	125	V
2	* ** 2.48539	43.76	Pk	32.5	-24.1	52.16	-	-	74	-21.84	167	125	V
3	* ** 2.48354	28.79	VA1T	32.5	-24.1	37.19	54	-16.81	-	-	167	125	V
4	* ** 2.48379	28.65	VA1T	32.5	-24.1	37.05	54	-16.95	-	-	167	125	V

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

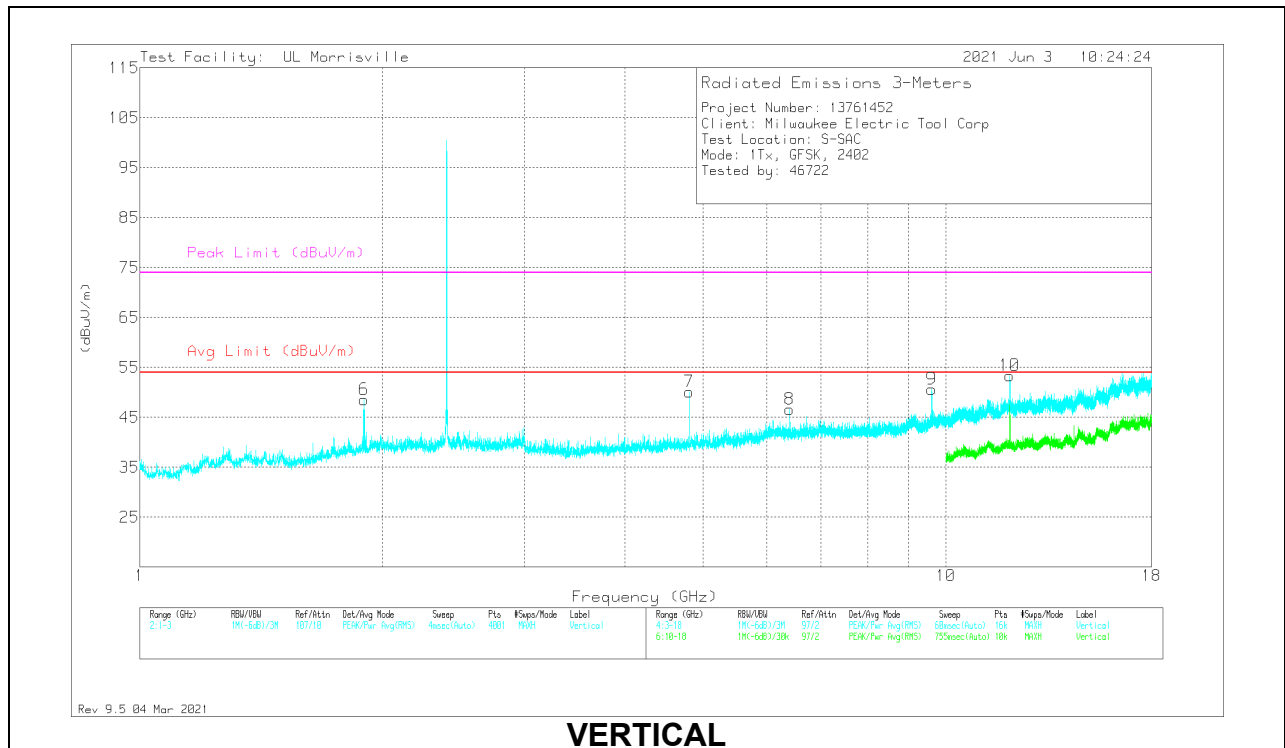
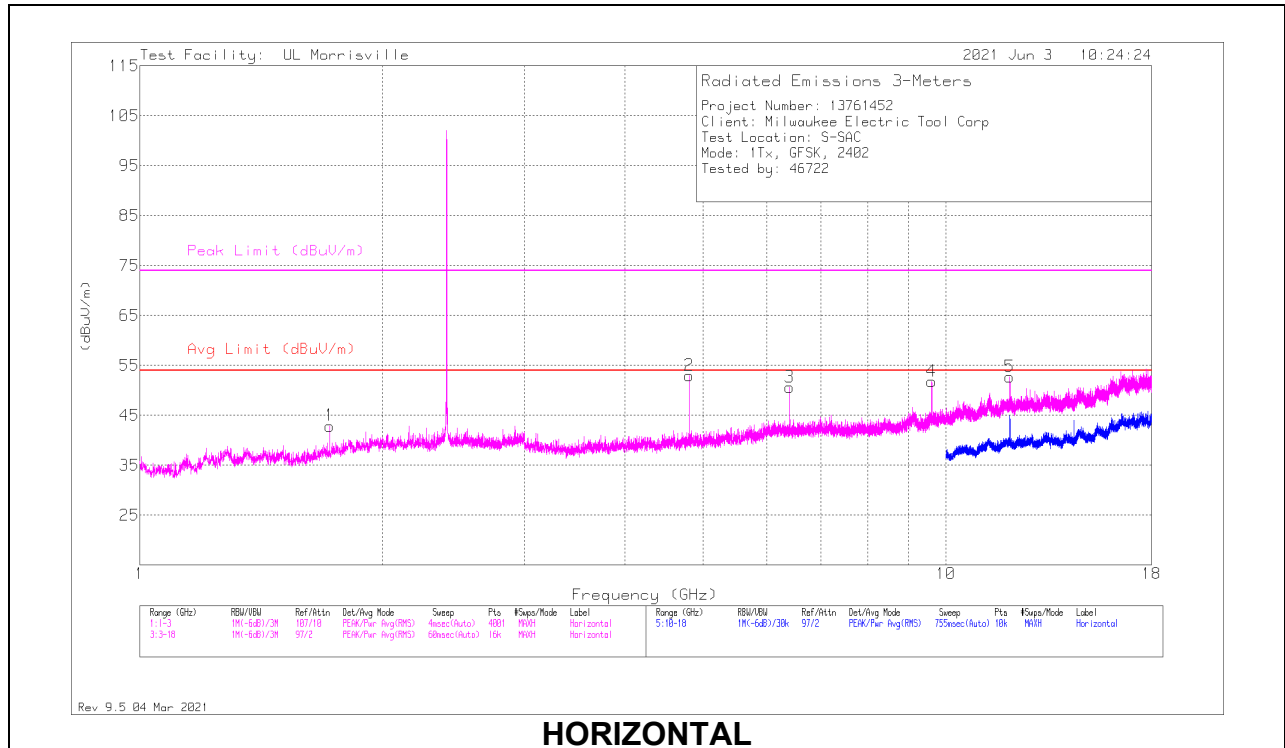
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

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

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	*** 1.71897	35.29	PK2	29.3	-22.1	42.49	-	-	74	-31.51	351	315	H
	*** 1.72218	18.37	VA1T	29.4	-22.1	25.67	54	-28.33	-	-	351	315	H
6	** 1.89696	21.72	PK2	30.9	-22.3	30.32	-	-	74	-43.68	10	102	V
	** 1.89725	18.76	VA1T	30.9	-22.3	27.36	54	-26.64	-	-	10	102	V
2	*** 4.80429	40.8	PK2	34.1	-30.9	44	-	-	74	-30	185	132	H
	*** 4.80397	48.02	VA1T	34.1	-30.9	51.22	54	-2.78	-	-	185	132	H
5	*** 12.01081	34.62	PK2	38.7	-24.1	49.22	-	-	74	-24.78	161	110	H
	*** 12.01055	27.91	VA1T	38.7	-24.1	42.51	54	-11.49	-	-	161	110	H
7	*** 4.80402	47	PK2	34.1	-30.9	50.2	-	-	74	-23.8	209	300	V
	*** 4.80397	45.87	VA1T	34.1	-30.9	49.07	54	-4.93	-	-	209	300	V
10	*** 12.01066	33.34	PK2	38.7	-24.1	47.94	-	-	74	-26.06	154	101	V
	*** 12.01049	30.24	VA1T	38.7	-24.1	44.84	54	-9.16	-	-	154	101	V
3	6.405	43.61	Pk	35.5	-28.5	50.61	-	-	-	-	0-360	101	H
8	6.405	39.64	Pk	35.5	-28.5	46.64	-	-	-	-	0-360	101	V
4	9.6075	41.21	Pk	36.9	-26.3	51.81	-	-	-	-	0-360	101	H
9	9.6075	40.07	Pk	36.9	-26.3	50.67	-	-	-	-	0-360	101	V

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

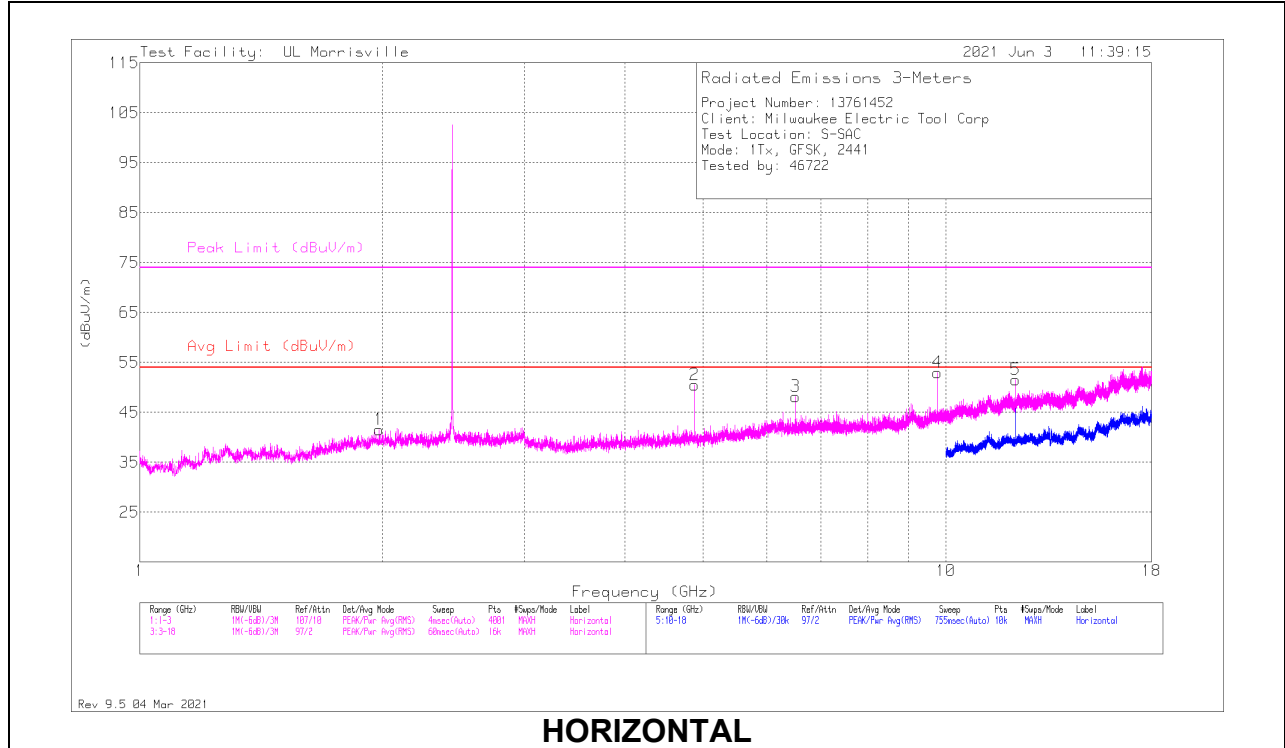
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

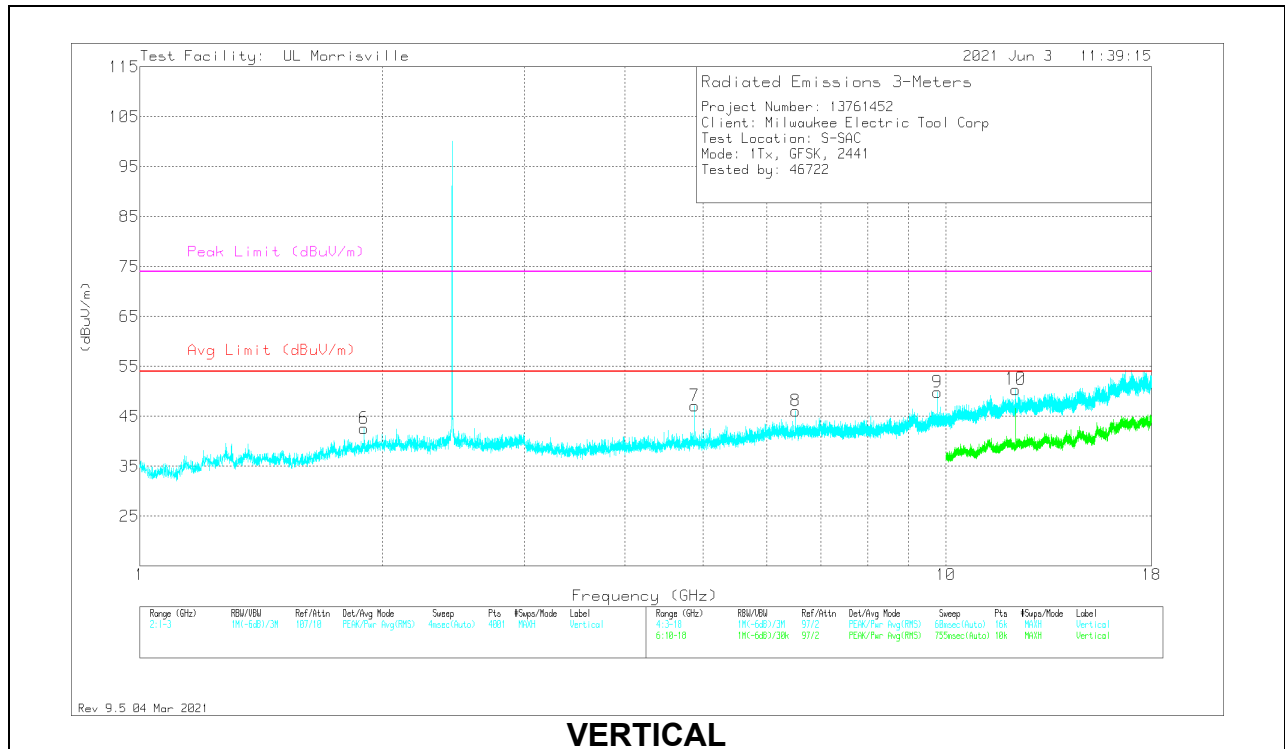
PK2 - Maximum Peak

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	AT0072 (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	** 1.98343	20.3	PK2	31	-22.5	28.8	-	-	74	-45.2	26	281	H
	** 1.98096	18.53	VA1T	30.9	-22.5	26.93	54	-27.07	-	-	26	281	H
6	** 1.8973	17.71	PK2	30.9	-22.3	26.31	-	-	74	-47.69	74	333	V
	** 1.89629	18.36	VA1T	30.9	-22.3	26.96	54	-27.04	-	-	74	333	V
2	** 4.88197	44.49	PK2	34.2	-30.8	47.89	-	-	74	-26.11	4	107	H
	** 4.88197	45.76	VA1T	34.2	-30.8	49.16	54	-4.84	-	-	4	107	H
5	** 12.20568	37.66	PK2	38.8	-24.3	52.16	-	-	74	-21.84	133	101	H
	** 12.20555	30.09	VA1T	38.8	-24.3	44.59	54	-9.41	-	-	133	101	H
7	** 4.88236	43.04	PK2	34.2	-30.8	46.44	-	-	74	-27.56	104	155	V
	** 4.88198	42.43	VA1T	34.2	-30.8	45.83	54	-8.17	-	-	104	155	V
10	** 12.20587	33.78	PK2	38.8	-24.3	48.28	-	-	74	-25.72	110	112	V
	** 12.20557	29.3	VA1T	38.8	-24.3	43.8	54	-10.2	-	-	110	112	V
3	6.50906	41.95	Pk	35.6	-29.4	48.15	-	-	-	-	0-360	101	H
8	6.50906	39.89	Pk	35.6	-29.4	46.09	-	-	-	-	0-360	101	V
4	9.76406	41.87	Pk	36.9	-25.8	52.97	-	-	-	-	0-360	101	H
9	9.76406	38.73	Pk	36.9	-25.8	49.83	-	-	-	-	0-360	101	V

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

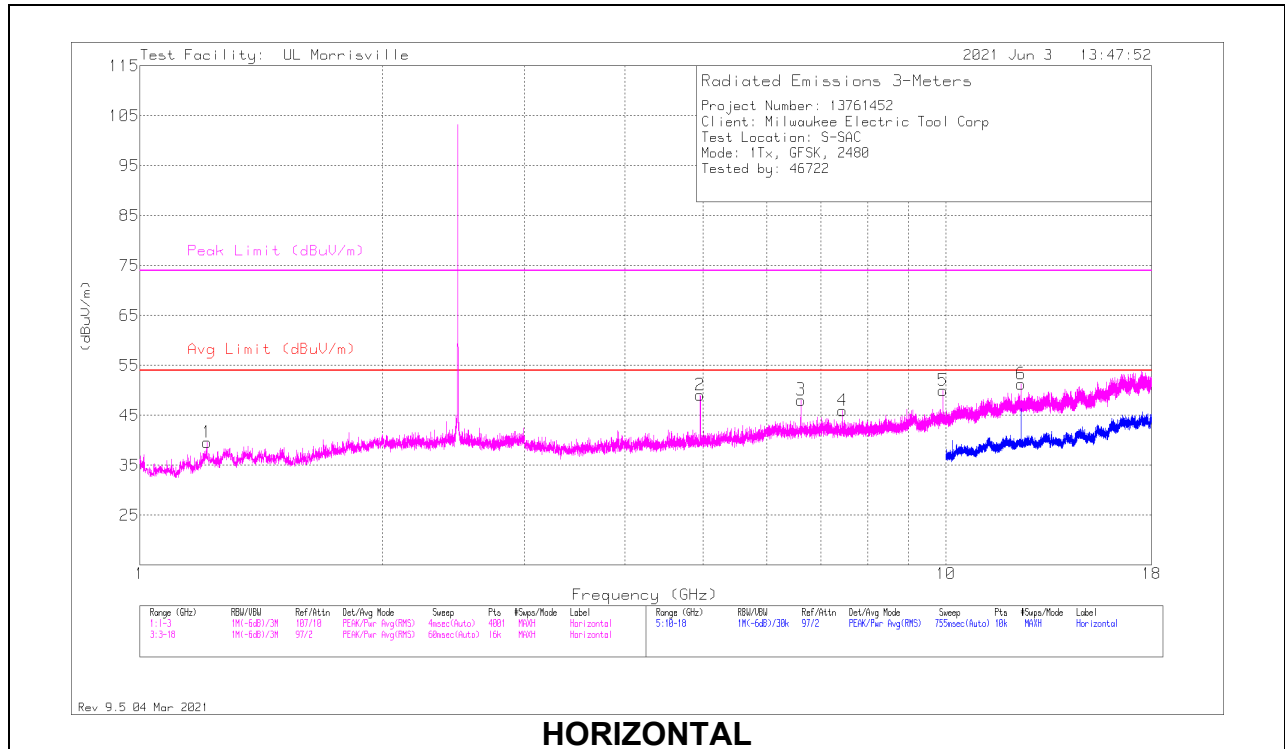
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

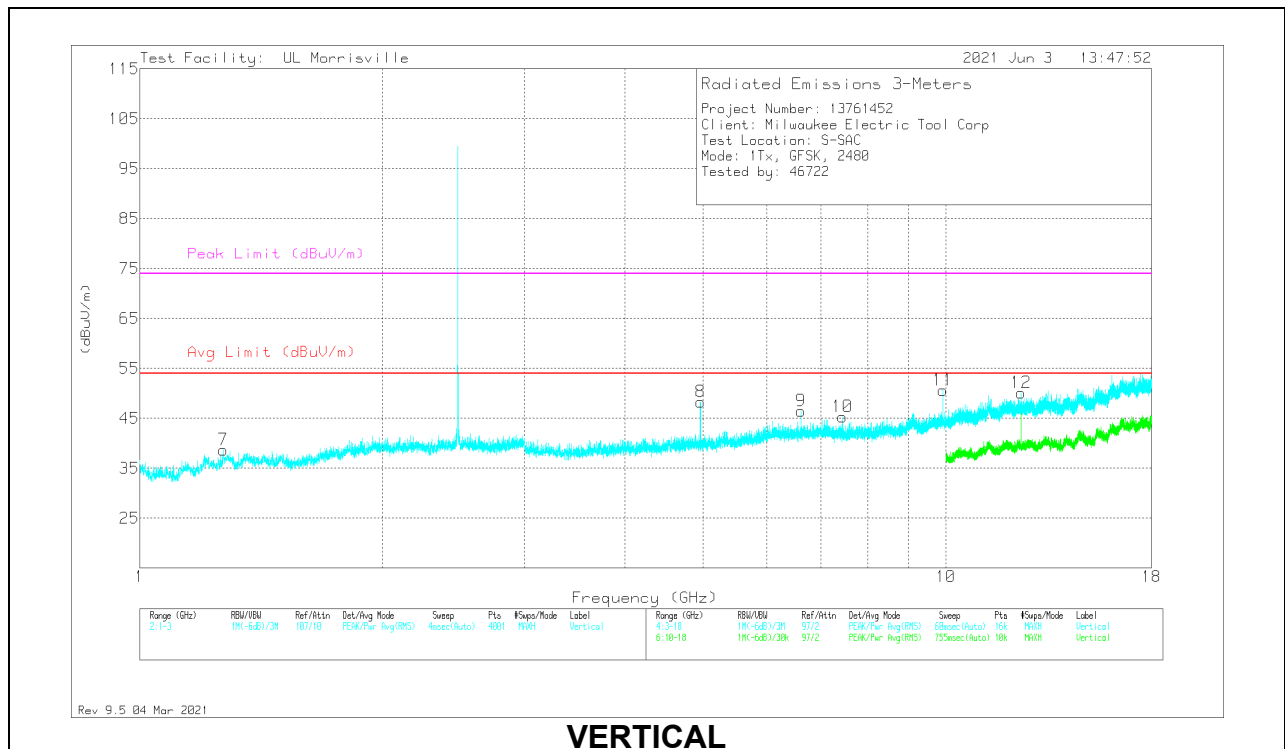
PK2 - Maximum Peak

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	AT0072 (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	*** 1.21152	26.23	PK2	29	-23.6	31.63	-	-	74	-42.37	70	120	H
	*** 1.21238	19.34	VA1T	28.9	-23.6	24.64	54	-29.36	-	-	70	120	H
7	* 1.26905	24.48	PK2	29.7	-23.2	30.98	-	-	74	-43.02	218	102	V
	* 1.27123	18.37	VA1T	29.7	-23.2	24.87	54	-29.13	-	-	218	102	V
2	*** 4.9596	42.89	PK2	34	-31	45.89	-	-	74	-28.11	13	125	H
	*** 4.95998	42.73	VA1T	34	-31	45.73	54	-8.27	-	-	13	125	H
4	*** 7.44043	33.11	PK2	35.6	-27.7	41.01	-	-	74	-32.99	312	101	H
	*** 7.43997	31.08	VA1T	35.6	-27.7	38.98	54	-15.02	-	-	312	101	H
6	*** 12.40107	34.02	PK2	38.8	-24.4	48.42	-	-	74	-25.58	168	102	H
	*** 12.40055	28.52	VA1T	38.8	-24.4	42.92	54	-11.08	-	-	168	102	H
8	*** 4.95971	42.61	PK2	34	-31	45.61	-	-	74	-28.39	149	103	V
	*** 4.95997	39.6	VA1T	34	-31	42.6	54	-11.4	-	-	149	103	V
10	*** 7.43983	22.69	PK2	35.6	-27.7	30.59	-	-	74	-43.41	243	195	V
	*** 7.43971	22.52	VA1T	35.6	-27.7	30.42	54	-23.58	-	-	243	195	V
12	*** 12.39896	22.83	PK2	38.8	-24.3	37.33	-	-	74	-36.67	171	135	V
	*** 12.40056	24.08	VA1T	38.8	-24.4	38.48	54	-15.52	-	-	171	135	V
3	6.61313	40.3	Pk	35.8	-28	48.1	-	-	-	-	0-360	101	H
9	6.61313	38.7	Pk	35.8	-28	46.5	-	-	-	-	0-360	101	V
11	9.91969	39.57	Pk	36.9	-25.8	50.67	-	-	-	-	0-360	101	V
5	9.92063	38.87	Pk	36.9	-25.8	49.97	-	-	-	-	0-360	101	H

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

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

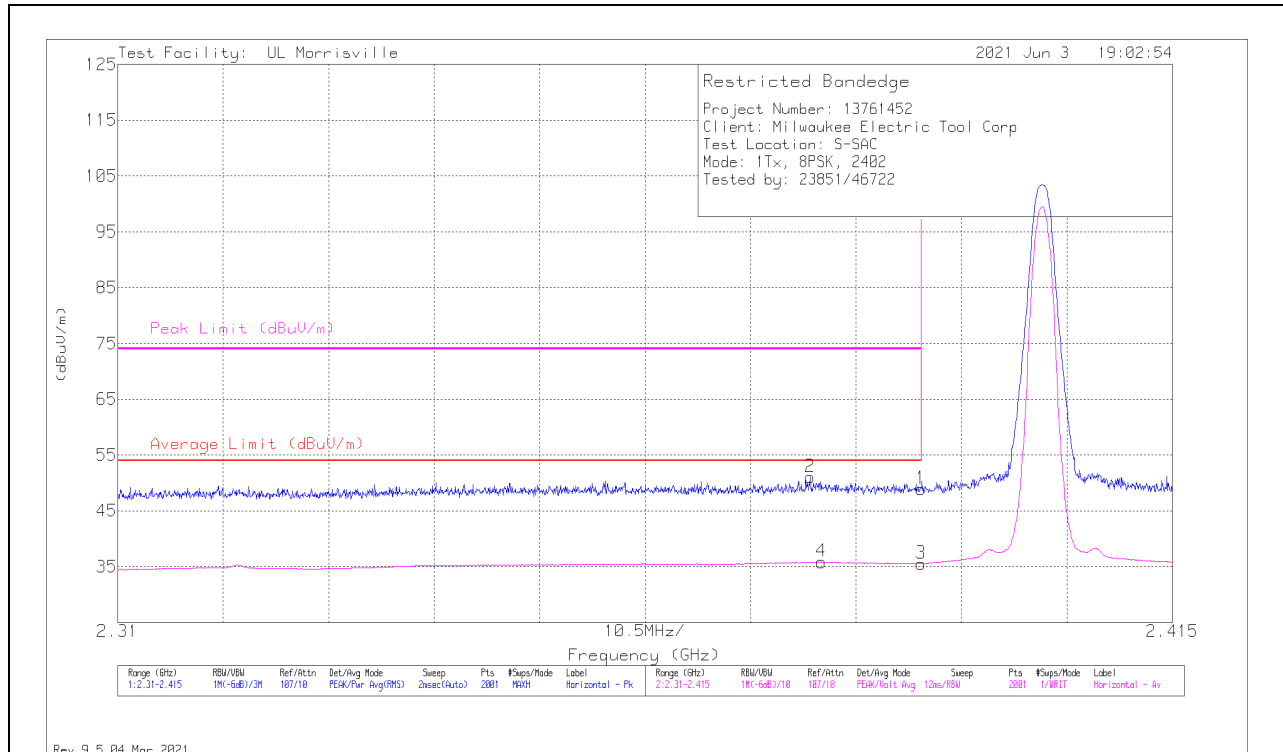
PK2 - Maximum Peak

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

10.1.2. BLUETOOTH ENHANCED DATA RATE 8PSK MODULATION

BANDEDGE (LOW CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.38996	41.19	Pk	31.9	-24.2	48.89	-	-	74	-25.11	296	119	H
2	* ** 2.37893	42.86	Pk	32.5	-24.3	51.06	-	-	74	-22.94	296	119	H
3	* ** 2.38996	27.79	VA1T	31.9	-24.2	35.49	54	-18.51	-	-	296	119	H
4	* ** 2.38009	27.63	VA1T	32.5	-24.3	35.83	54	-18.17	-	-	296	119	H

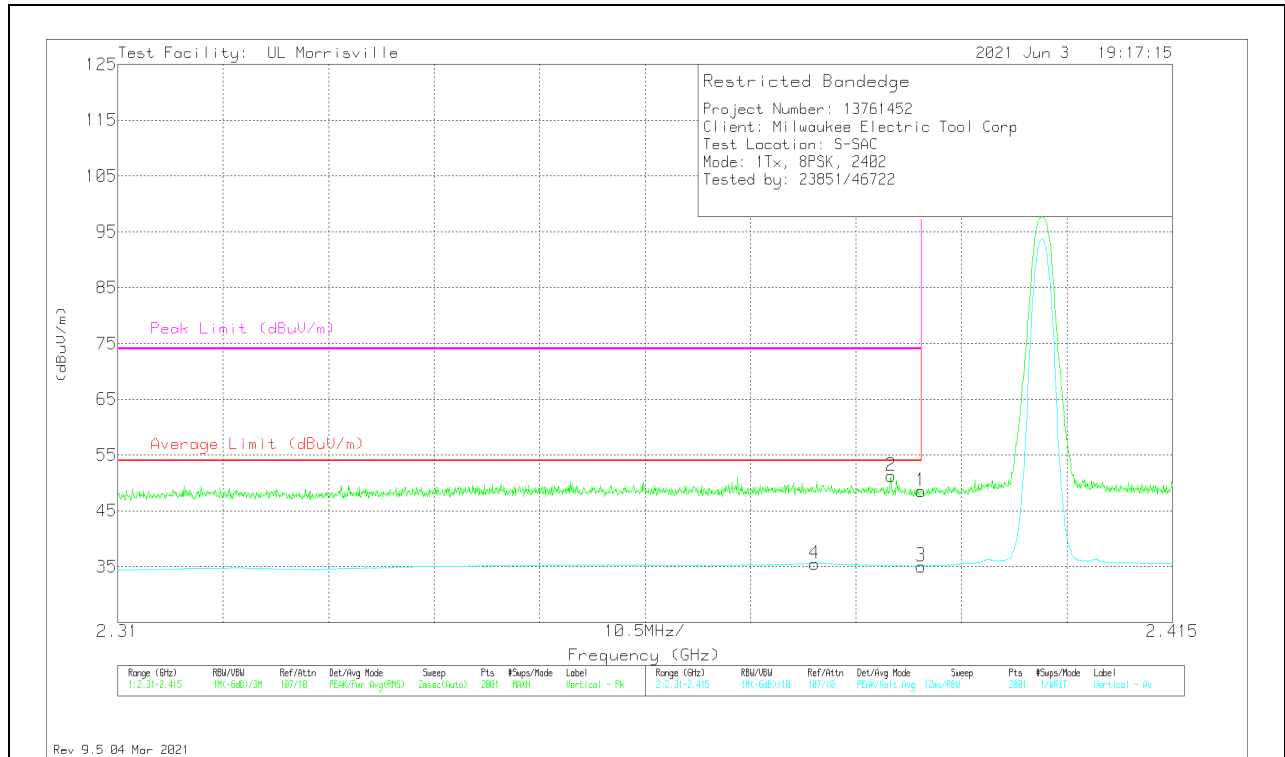
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

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

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.38996	40.85	Pk	31.9	-24.2	48.55	-	-	74	-25.45	334	101	V
2	* ** 2.38697	43.43	Pk	32.1	-24.3	51.23	-	-	74	-22.77	334	101	V
3	* ** 2.38996	27.38	VA1T	31.9	-24.2	35.08	54	-18.92	-	-	334	101	V
4	* ** 2.37935	27.37	VA1T	32.5	-24.3	35.57	54	-18.43	-	-	334	101	V

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

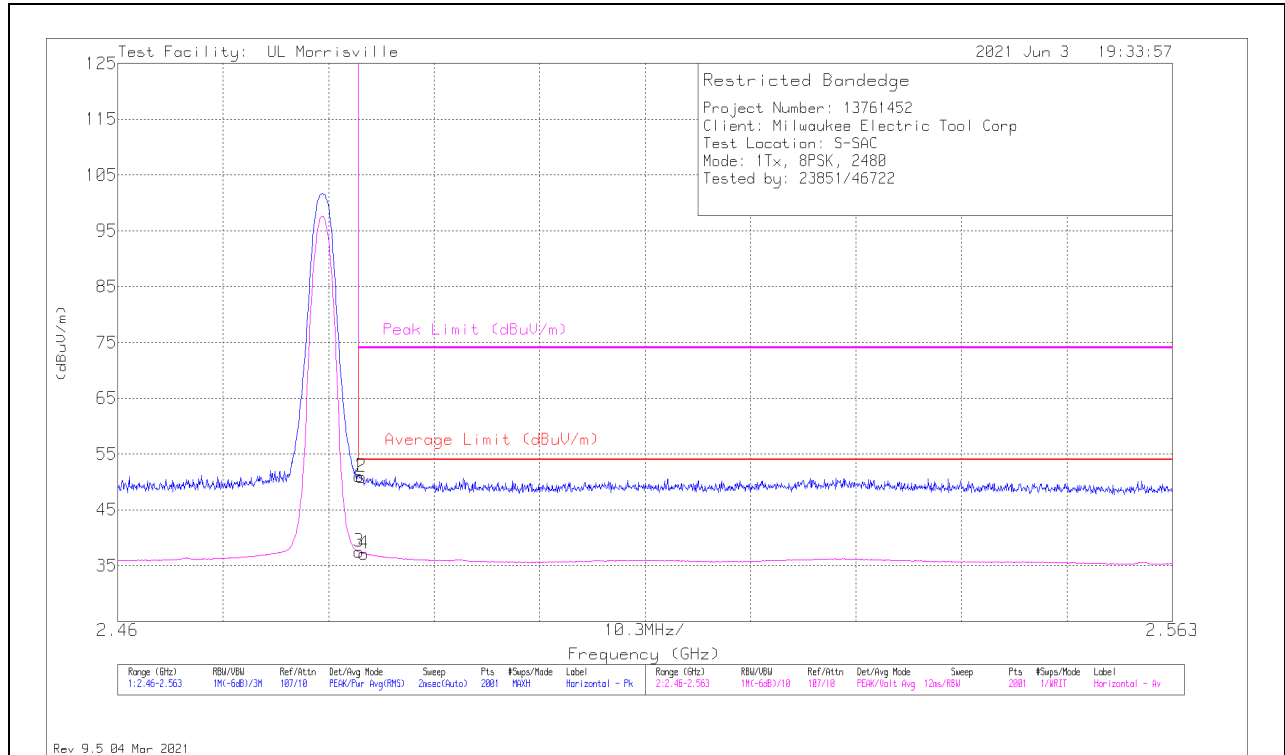
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

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

BANDEDGE (HIGH CHANNEL)

HORIZONTAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.48354	42.58	Pk	32.5	-24.1	50.98	-	-	74	-23.02	82	104	H
2	* ** 2.48379	42.54	Pk	32.5	-24.1	50.94	-	-	74	-23.06	82	104	H
3	* ** 2.48354	29.05	VA1T	32.5	-24.1	37.45	54	-16.55	-	-	82	104	H
4	* ** 2.48405	28.77	VA1T	32.5	-24.1	37.17	54	-16.83	-	-	82	104	H

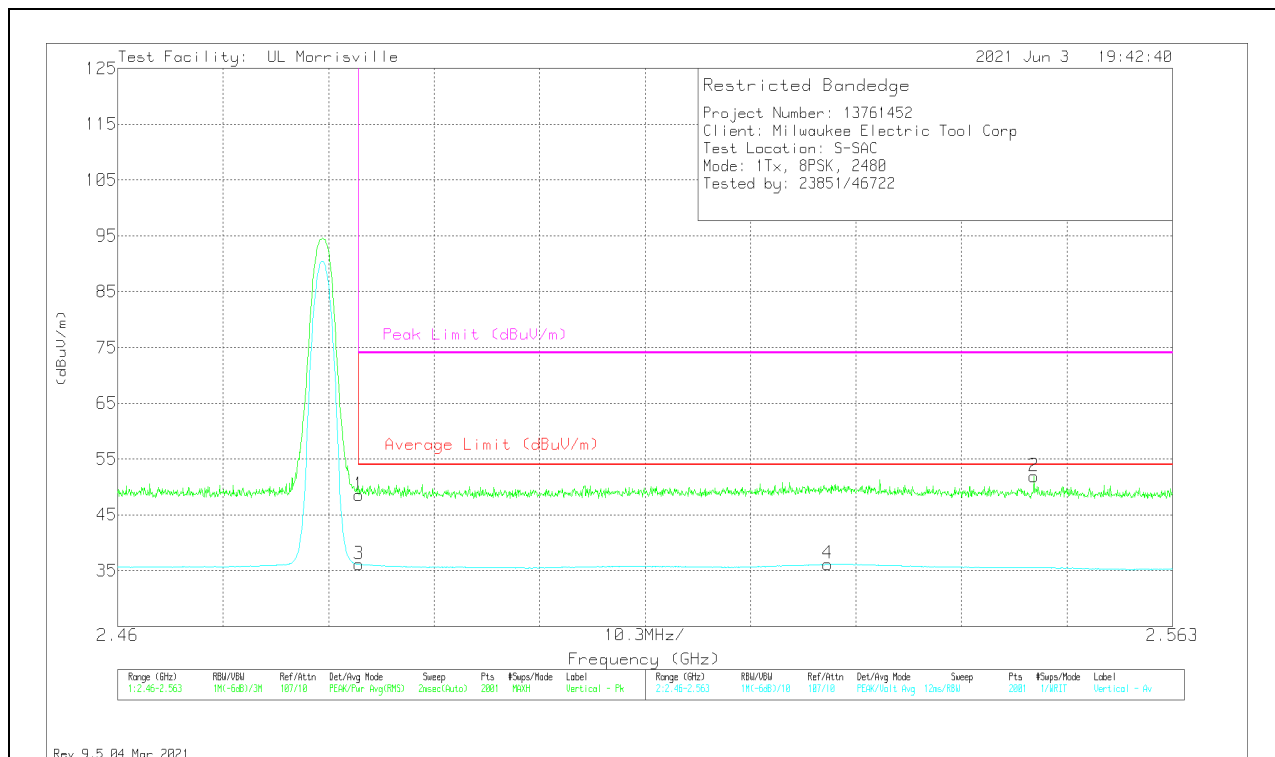
* - indicates frequency in CFR47 Pt 15 / IC RSS-Restricted Band

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

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

VERTICAL RESULT



Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.48354	40.21	Pk	32.5	-24.1	48.61	-	-	74	-25.39	256	105	V
2	** 2.54946	43.49	Pk	32.5	-24.1	51.89	-	-	74	-22.11	256	105	V
3	* ** 2.48354	27.71	VA1T	32.5	-24.1	36.11	54	-17.89	-	-	256	105	V
4	** 2.52932	27.2	VA1T	33.1	-24.1	36.2	54	-17.8	-	-	256	105	V

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

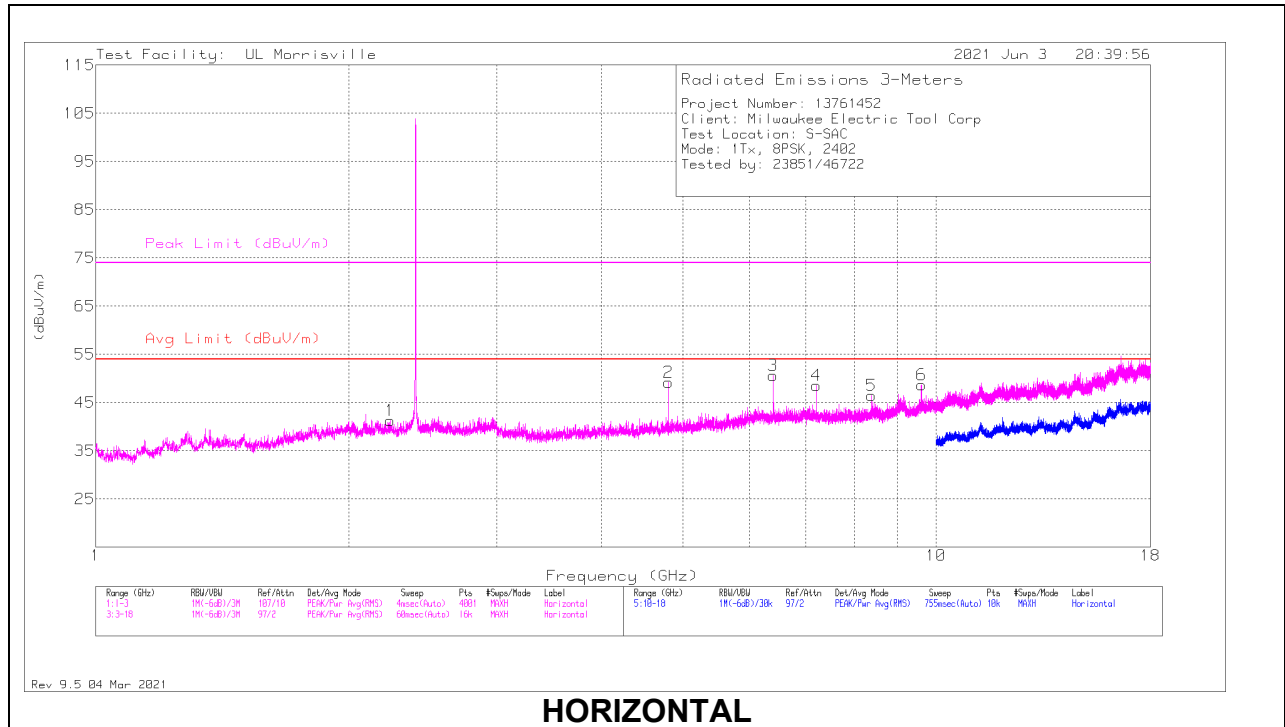
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

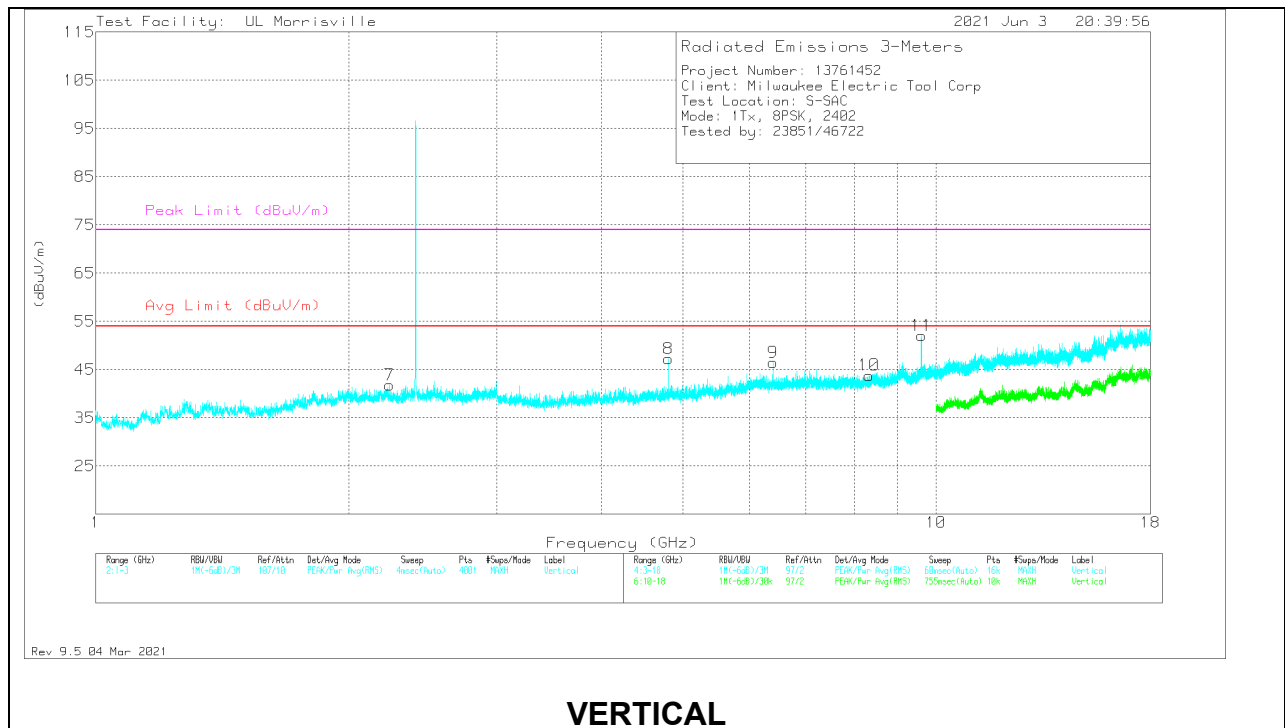
VA1T - FHSS: Linear Voltage Average VB=1/Ton where: Ton is transmit duration

HARMONICS AND SPURIOUS EMISSIONS

LOW CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.2415	32.74	Pk	31.8	-23.3	41.24	54	-12.76	74	-32.76	0-360	101	H
7	* ** 2.236	33.29	Pk	31.8	-23.3	41.79	54	-12.21	74	-32.21	0-360	101	V
2	* ** 4.80386	43.37	PK2	34.1	-30.9	46.57	-	-	74	-27.43	349	101	H
	* ** 4.804	40.61	V1TV	34.1	-30.9	43.81	54	-10.19	-	-	349	101	H
5	* ** 8.38031	37.92	Pk	35.8	-27.2	46.52	54	-7.48	74	-27.48	0-360	199	H
8	* ** 4.80375	44	Pk	34.1	-30.9	47.2	54	-6.8	74	-26.8	0-360	101	V
10	* ** 8.32313	35.32	Pk	35.9	-27.4	43.82	54	-10.18	74	-30.18	0-360	199	V
3	6.405	43.61	Pk	35.5	-28.5	50.61	-	-	-	-	0-360	101	H
9	6.405	39.49	Pk	35.5	-28.5	46.49	-	-	-	-	0-360	101	V
4	7.20656	40.62	Pk	35.8	-27.9	48.52	-	-	-	-	0-360	101	H
6	9.60844	38.09	Pk	36.9	-26.3	48.69	-	-	-	-	0-360	101	H
11	9.60844	41.49	Pk	36.9	-26.3	52.09	-	-	-	-	0-360	101	V

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

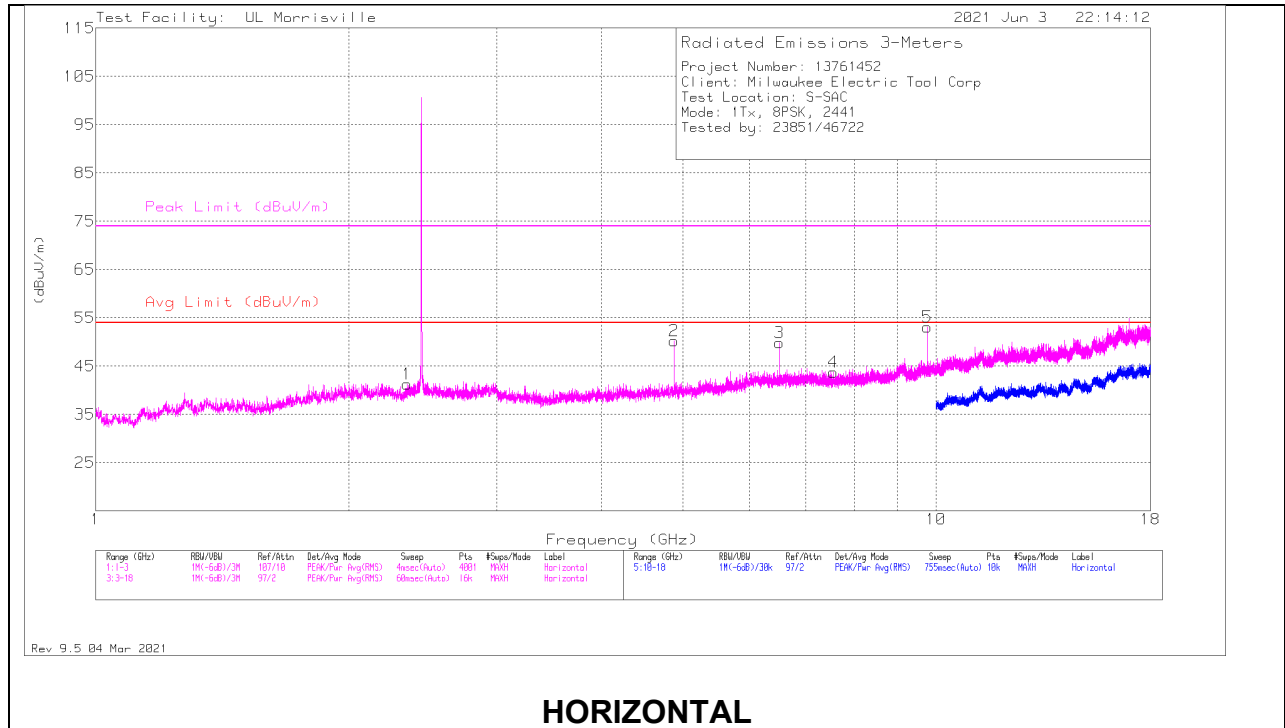
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

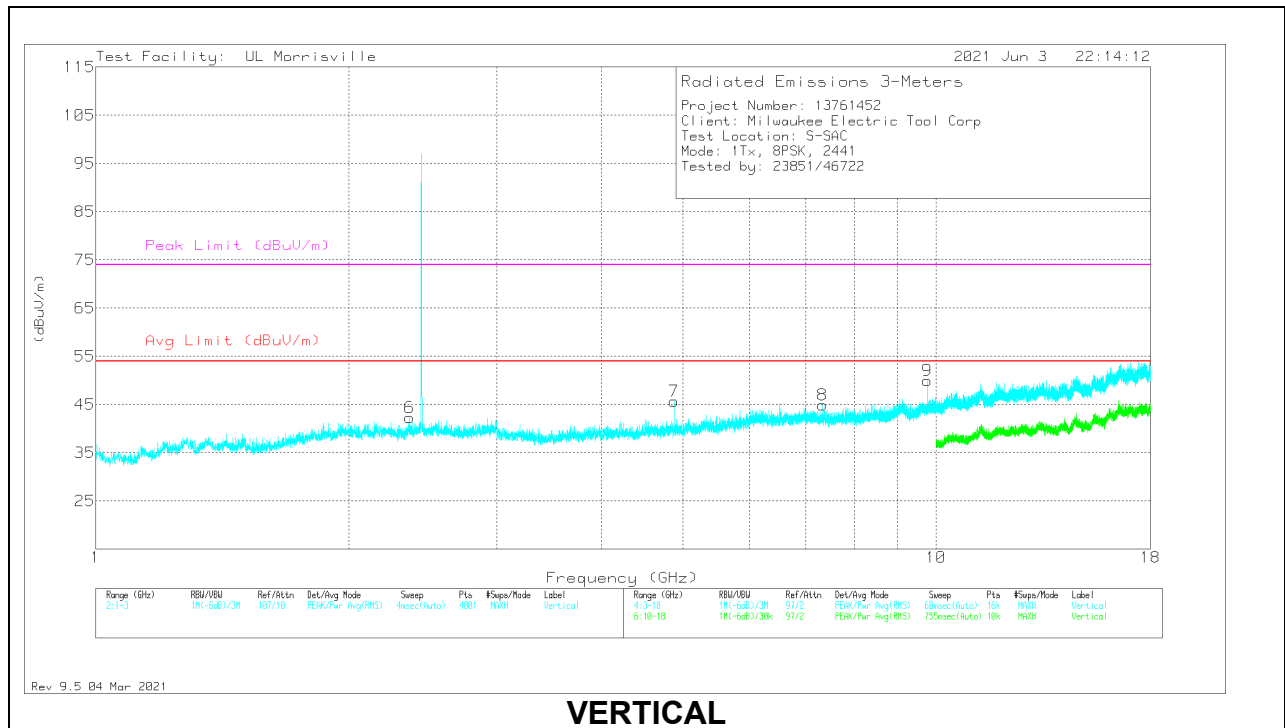
PK2 - Maximum Peak

V1TV - VB=1/Ton, Linear Voltage Average where: Ton is packet duration

MID CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	* ** 2.3465	33.12	Pk	32.1	-23.9	41.32	54	-12.68	74	-32.68	0-360	101	H
6	* ** 2.364	34.04	Pk	32.2	-23.9	42.34	54	-11.66	74	-31.66	0-360	199	V
2	* ** 4.88206	49.27	PK2	34.2	-30.8	52.67	-	-	74	-21.33	196	150	H
	* ** 4.88197	40.77	V1TV	34.2	-30.8	44.17	54	-9.83	-	-	196	150	H
4	* ** 7.54969	35.88	Pk	35.7	-27.8	43.78	54	-10.22	74	-30.22	0-360	101	H
7	* ** 4.88156	42.29	Pk	34.2	-30.8	45.69	54	-8.31	74	-28.31	0-360	200	V
8	* ** 7.32844	36.68	Pk	35.7	-27.4	44.98	54	-9.02	74	-29.02	0-360	101	V
3	6.50906	43.71	Pk	35.6	-29.4	49.91	-	-	-	-	0-360	101	H
5	9.76406	41.96	Pk	36.9	-25.8	53.06	-	-	-	-	0-360	101	H
9	9.76406	38.93	Pk	36.9	-25.8	50.03	-	-	-	-	0-360	101	V

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

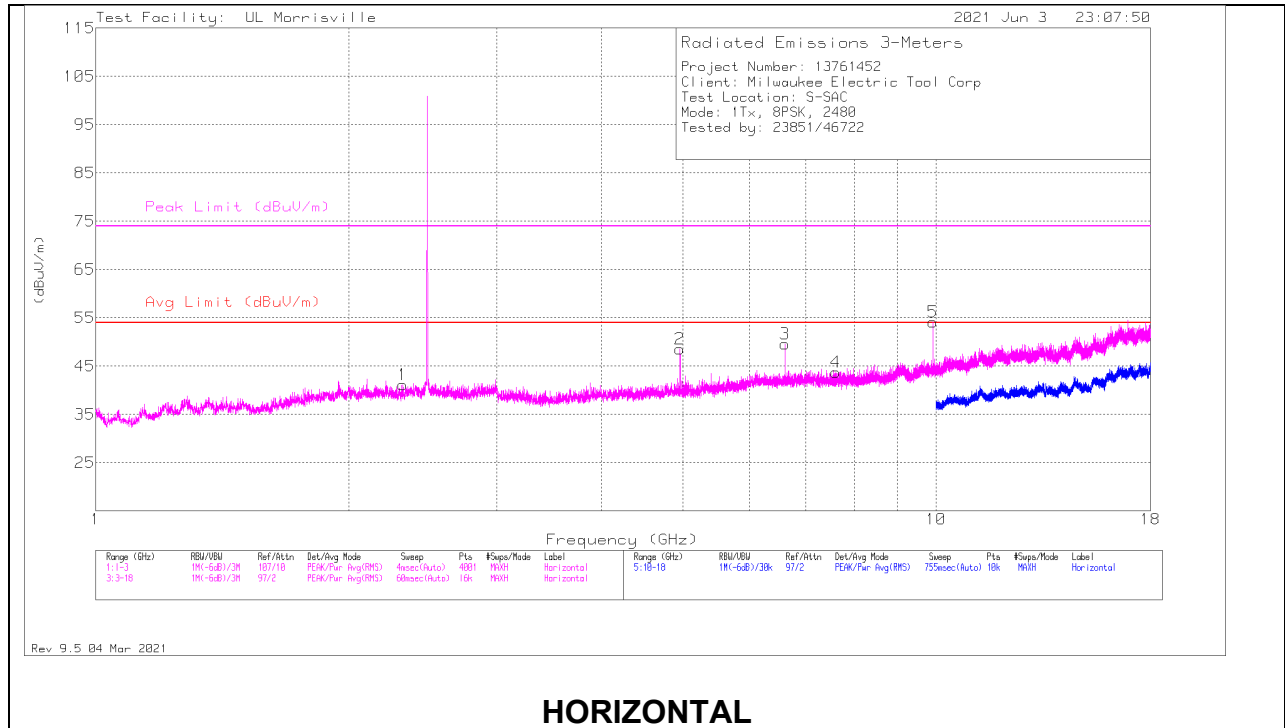
** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

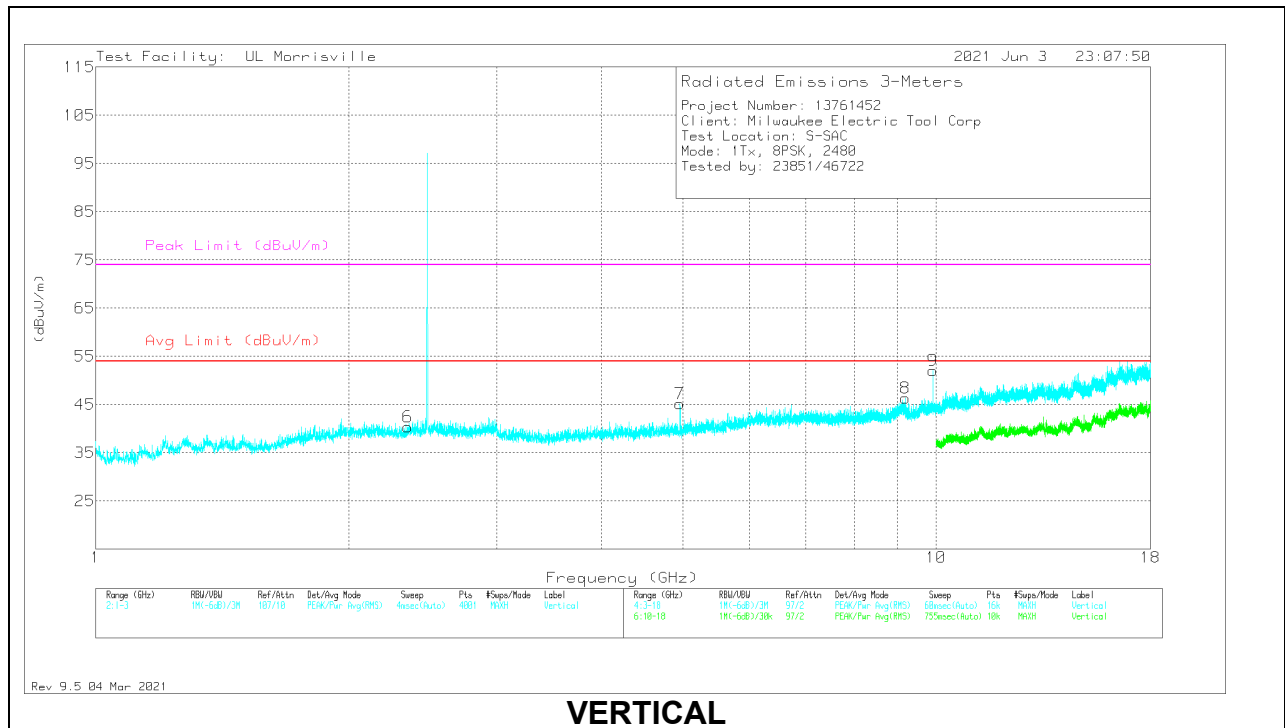
PK2 - Maximum Peak

V1TV - VB=1/Ton, Linear Voltage Average where: Ton is packet duration

HIGH CHANNEL RESULTS



HORIZONTAL



VERTICAL

RADIATED EMISSIONS

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0072 (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	*** 2.318	33.2	Pk	31.7	-23.7	41.2	54	-12.8	74	-32.8	0-360	200	H
6	** 2.3535	32.01	Pk	32.2	-23.8	40.41	54	-13.59	74	-33.59	0-360	200	V
2	*** 4.95996	46.92	PK2	34	-31	49.92	-	-	74	-24.08	201	112	H
	*** 4.95996	37.61	V1TV	34	-31	40.61	54	-13.39	-	-	201	112	H
4	** 7.59938	35.72	Pk	35.6	-27.6	43.72	54	-10.28	74	-30.28	0-360	200	H
7	*** 4.95938	42.23	Pk	34	-31	45.23	54	-8.77	74	-28.77	0-360	101	V
8	*** 9.19031	36.23	Pk	36.3	-26.2	46.33	54	-7.67	74	-27.67	0-360	101	V
3	6.61313	41.84	Pk	35.8	-28	49.64	-	-	-	-	0-360	101	H
5	9.91969	43.07	Pk	36.9	-25.8	54.17	-	-	-	-	0-360	101	H
9	9.91969	40.95	Pk	36.9	-25.8	52.05	-	-	-	-	0-360	101	V

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

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

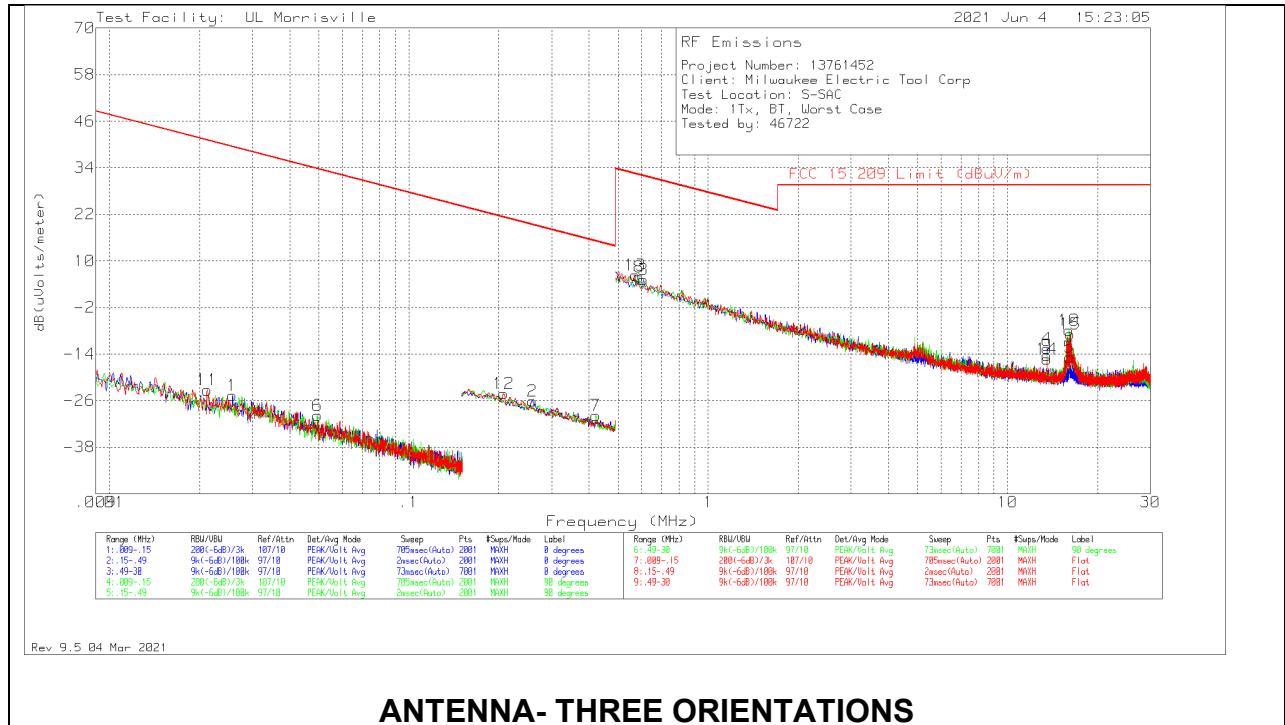
PK2 - Maximum Peak

V1TV - VB=1/Ton, Linear Voltage Average where: Ton is packet duration

10.2. WORST CASE BELOW 30MHZ

Note: All measurements were made at a test distance of 3 m. The measured data was extrapolated from the test distance (3m) to the specification distance (300 m from 9-490 kHz and 30 m from 490 kHz – 30 MHz) to clearly show the relative levels of fundamental and spurious emissions and demonstrate compliance with the requirement that the level of any spurious emissions be below the level of the intentionally transmitted signal. The extrapolation factor for the limits were $40 \cdot \log(\text{test distance} / \text{specification distance})$.

E-FIELD SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)

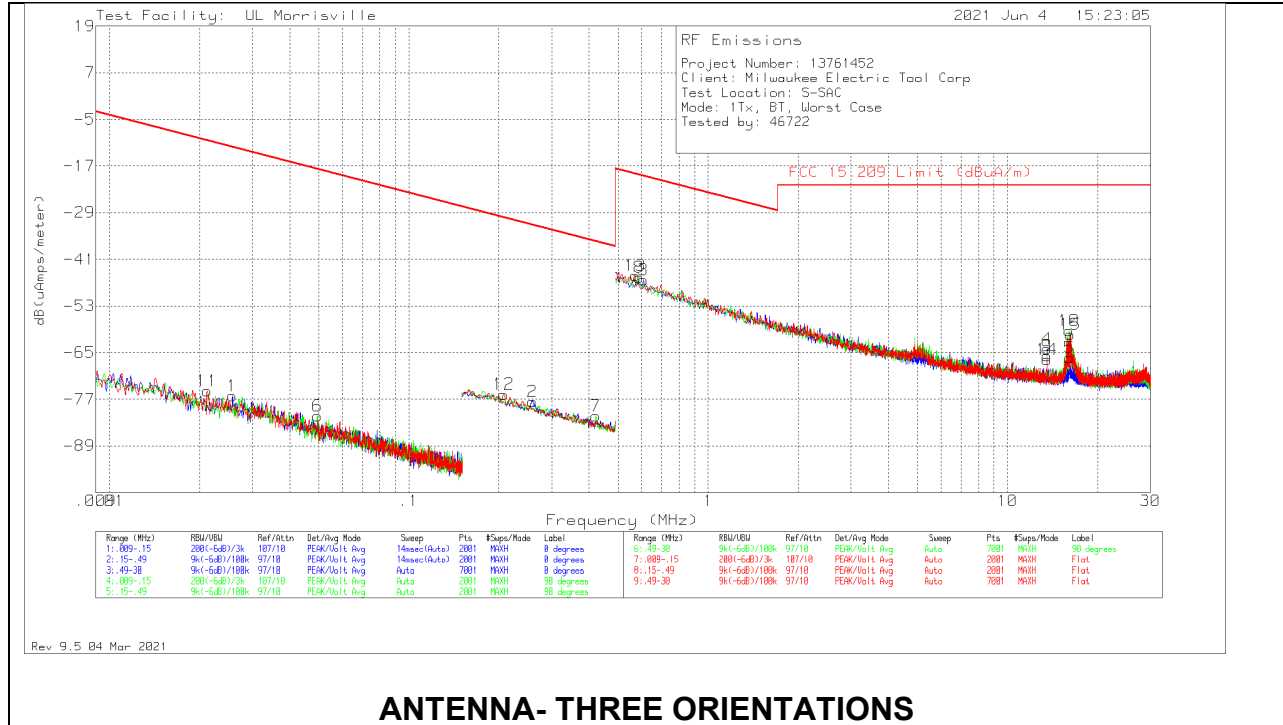


Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 (dB/m)	Cbl (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uVolts/meter)	FCC 15.209 QP/AVG Limit (dBuV/m)	FCC 15.209 Pk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Antenna Face
1	.02576	41.7	Pk	13.5	.1	-80	-24.7	39.39	59.39	-64.09	0-360	On
2	.25931	43.15	Pk	10.7	.1	-80	-26.05	19.33	39.33	-45.38	0-360	On
3	.60805	34.17	Pk	10.8	.2	-40	5.17	31.93	-	-26.76	0-360	On
4	13.5596	16.31	Pk	10.4	.7	-40	-12.59	29.54	-	-42.13	0-360	On
5	16.13136	14.04	Pk	10.3	.8	-40	-14.86	29.54	-	-44.4	0-360	On
6	.04947	38.6	Pk	11.5	.1	-80	-29.8	33.72	53.72	-63.52	0-360	Off
7	.42115	39.42	Pk	10.6	.1	-80	-29.88	15.12	35.12	-45	0-360	Off
8	.58697	34.88	Pk	10.8	.1	-40	5.78	32.23	-	-26.45	0-360	Off
9	13.5596	14.52	Pk	10.4	.7	-40	-14.38	29.54	-	-43.92	0-360	Off
10	16.00066	21.03	Pk	10.3	.8	-40	-7.87	29.54	-	-37.41	0-360	Off
11	.02121	42.91	Pk	13.7	.1	-80	-23.29	41.07	61.07	-64.36	0-360	Flat
12	.20712	44.85	Pk	10.8	.1	-80	-24.25	21.28	41.28	-45.53	0-360	Flat
13	.5701	35.46	Pk	10.8	.1	-40	6.36	32.48	-	-26.12	0-360	Flat
14	13.5596	13.61	Pk	10.4	.7	-40	-15.29	29.54	-	-44.83	0-360	Flat
15	16.18617	20.11	Pk	10.3	.8	-40	-8.79	29.54	-	-38.33	0-360	Flat

Pk - Peak detector

H-FIELD SPURIOUS EMISSIONS BELOW 30 MHz (WORST-CASE CONFIGURATION)



ANTENNA- THREE ORIENTATIONS

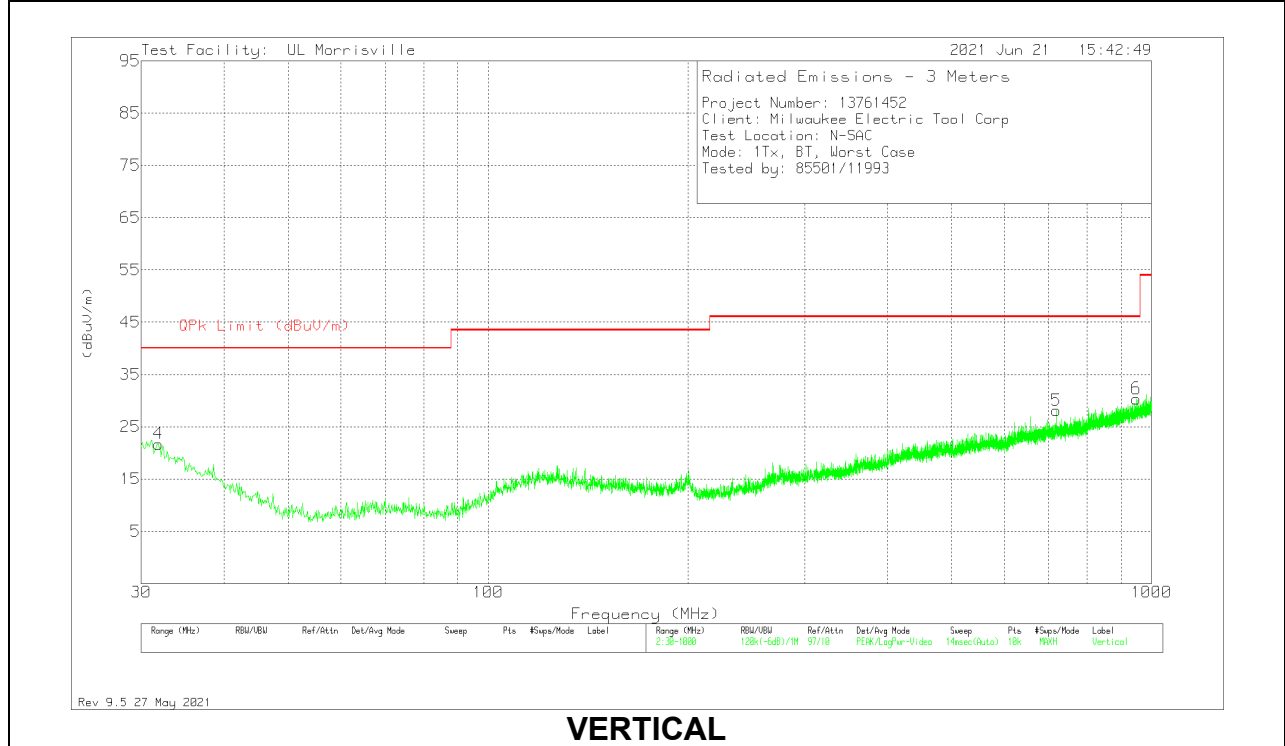
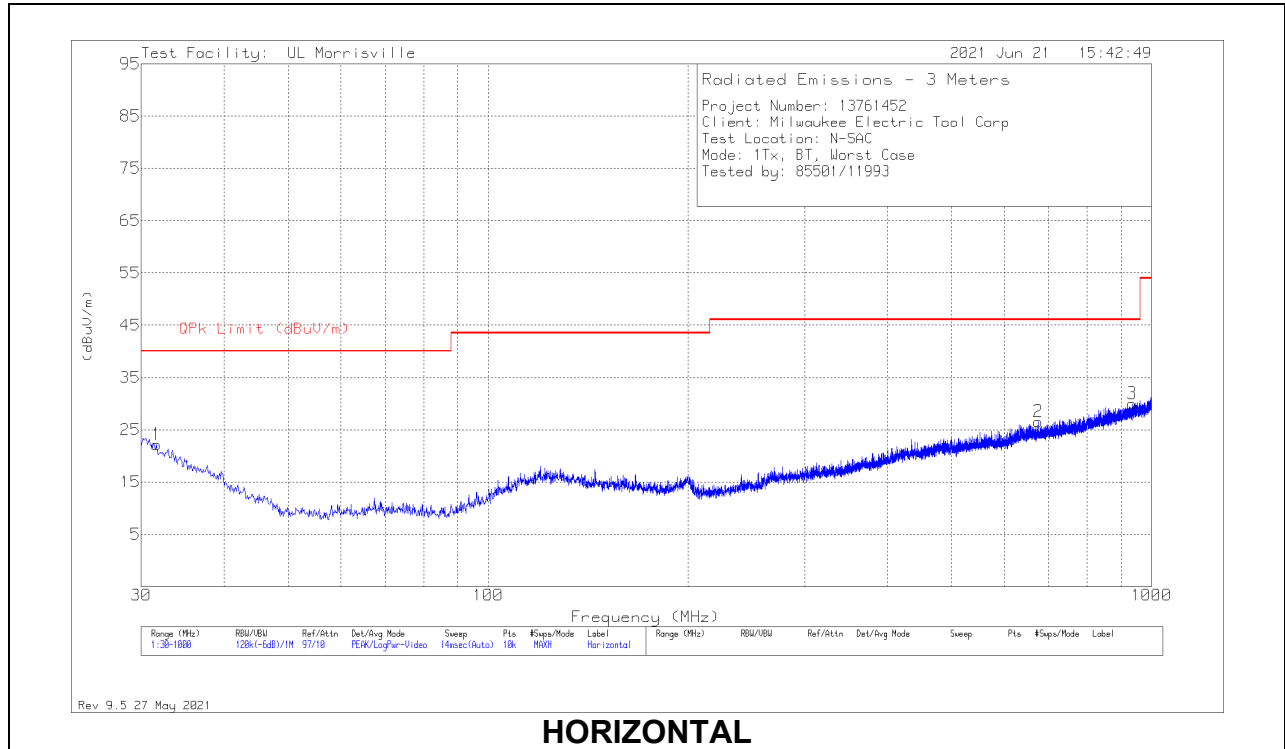
Below 30MHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0079 (dB/m)	Cbl (dB)	Dist. Corr. Factor (dB)	Corrected Reading dB(uAmps/meter)	RSS-GEN QP/Avg Limit (dBuA/m)	RSS-GEN Limit (dBuA/m)	Margin (dB)	Azimuth (Degs)	Antenna Face
1	.02576	41.7	Pk	-38	.1	-80	-76.2	-12.11	7.89	-64.09	0-360	On
2	.25931	43.15	Pk	-40.8	.1	-80	-77.55	-32.17	-12.17	-45.38	0-360	On
3	.60805	34.17	Pk	-40.7	.2	-40	-46.33	-19.57	-	-26.76	0-360	On
4	13.5596	16.31	Pk	-41.1	.7	-40	-64.09	-21.96	-	-42.13	0-360	On
5	16.13136	14.04	Pk	-41.2	.8	-40	-66.36	-21.96	-	-44.4	0-360	On
6	.04947	38.6	Pk	-40	.1	-80	-81.3	-17.78	2.22	-63.52	0-360	Off
7	.42115	39.42	Pk	-40.9	.1	-80	-81.38	-36.38	-16.38	-45	0-360	Off
8	.58697	34.88	Pk	-40.7	.1	-40	-45.72	-19.27	-	-26.45	0-360	Off
9	13.5596	14.52	Pk	-41.1	.7	-40	-65.88	-21.96	-	-43.92	0-360	Off
10	16.00066	21.03	Pk	-41.2	.8	-40	-59.37	-21.96	-	-37.41	0-360	Off
11	.02121	42.91	Pk	-37.8	.1	-80	-74.79	-10.43	9.57	-64.36	0-360	Flat
12	.20712	44.85	Pk	-40.7	.1	-80	-75.75	-30.22	-10.22	-45.53	0-360	Flat
13	.5701	35.46	Pk	-40.7	.1	-40	-45.14	-19.02	-	-26.12	0-360	Flat
14	13.5596	13.61	Pk	-41.1	.7	-40	-66.79	-21.96	-	-44.83	0-360	Flat
15	16.18617	20.11	Pk	-41.2	.8	-40	-60.29	-21.96	-	-38.33	0-360	Flat

Pk - Peak detector

10.3. WORST CASE BELOW 1 GHZ

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



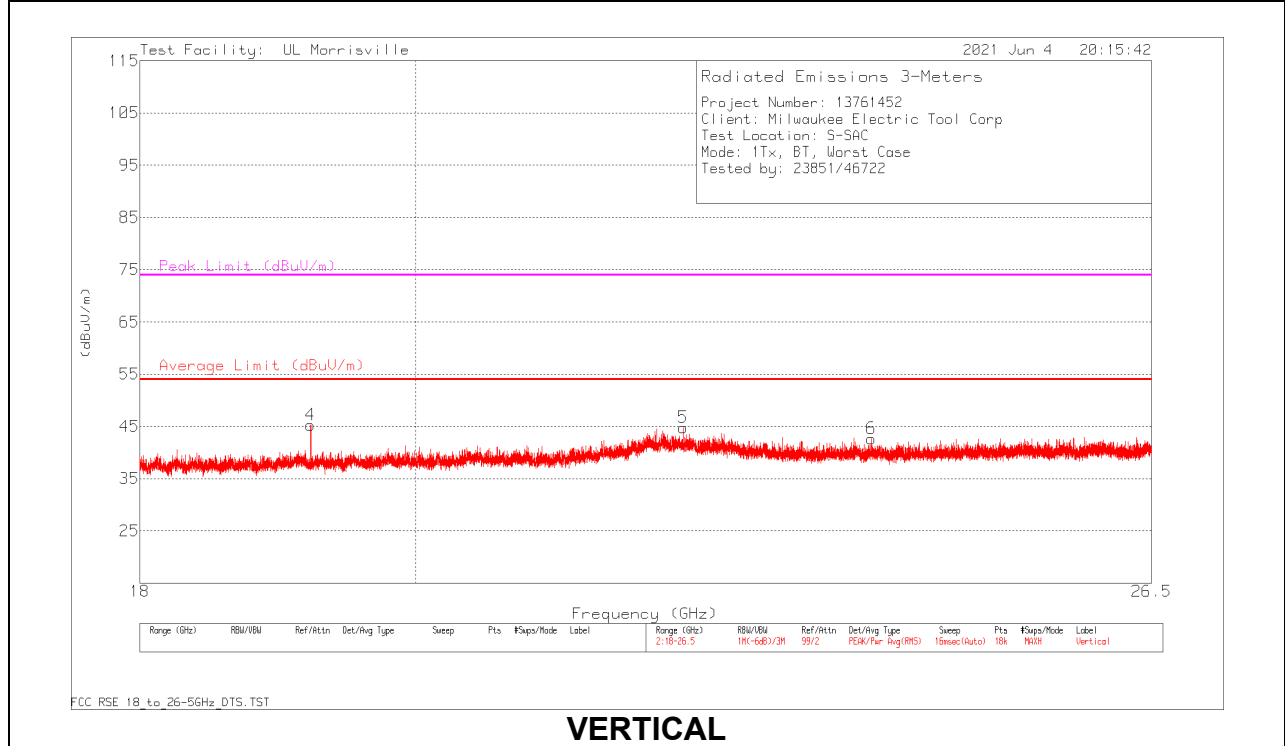
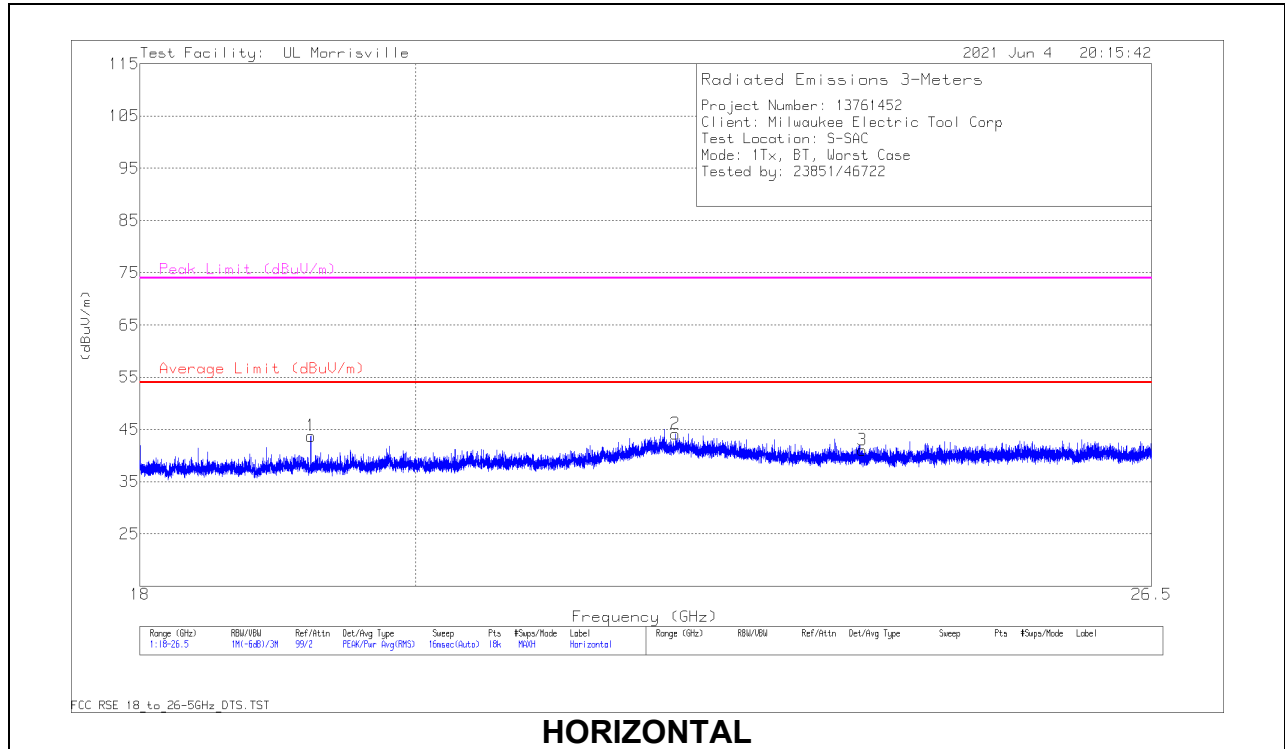
Below 1GHz Data

Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	AT0074 (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	QPk Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
5	** 719.185	27.69	Pk	26.6	-26.2	28.09	46.02	-17.93	0-360	101	V
6	** 948.396	25.45	Pk	29.1	-24.2	30.35	46.02	-15.67	0-360	101	V
1	31.649	27.75	Pk	25.8	-31.4	22.15	40	-17.85	0-360	300	H
4	31.843	27.51	Pk	25.6	-31.4	21.71	40	-18.29	0-360	101	V
2	674.856	27.15	Pk	25.8	-26.4	26.55	46.02	-19.47	0-360	200	H
3	935.107	25.67	Pk	28.7	-24.4	29.97	46.02	-16.05	0-360	200	H

Pk - Peak detector

10.4. WORST CASE 18-26 GHZ

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



18 – 26GHz DATA

Marker	Frequency (GHz)	Meter Reading (dBuV)	Det	AT0063 AF (dB/m)	Amp/Cbl (dB)	Corrected Reading (dBuV/m)	Average Limit (dBuV/m)	Margin (dB)	Peak Limit (dBuV/m)	Margin (dB)	Azimuth (Degs)	Height (cm)	Polarity
1	* ** 19.21604	49.61	Pk	33.4	-39.3	43.71	54	-10.29	74	-30.29	0-360	101	H
2	* ** 22.09156	46.61	Pk	36.8	-39.3	44.11	54	-9.89	74	-29.89	0-360	199	H
3	* ** 23.72553	44.93	Pk	34.9	-38.8	41.03	54	-12.97	74	-32.97	0-360	299	H
4	* ** 19.21557	51.15	Pk	33.4	-39.3	45.25	54	-8.75	74	-28.75	0-360	101	V
5	* ** 22.15625	47.41	Pk	36.7	-39.3	44.81	54	-9.19	74	-29.19	0-360	200	V
6	* ** 23.81101	46.2	Pk	34.8	-38.4	42.6	54	-11.4	74	-31.4	0-360	200	V

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

** - indicates frequency in Taiwan NCC LP0002 Restricted Band

Pk - Peak detector

11. AC POWER LINE CONDUCTED EMISSIONS

LIMITS

FCC §15.207 (a)

RSS-Gen 8.8

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 C63.4.

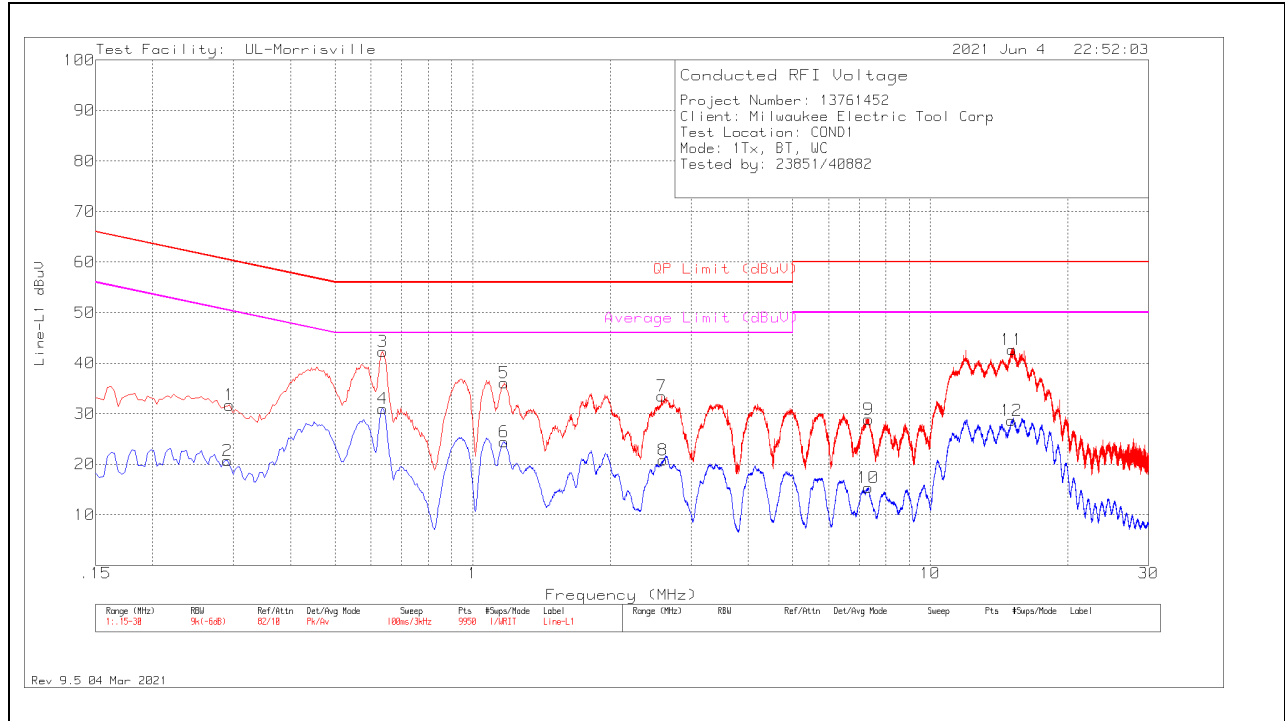
The receiver is set to a resolution bandwidth of 9 kHz. Peak detection is used unless otherwise noted as quasi-peak or average.

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

RESULTS

11.1. AC Power Line Host

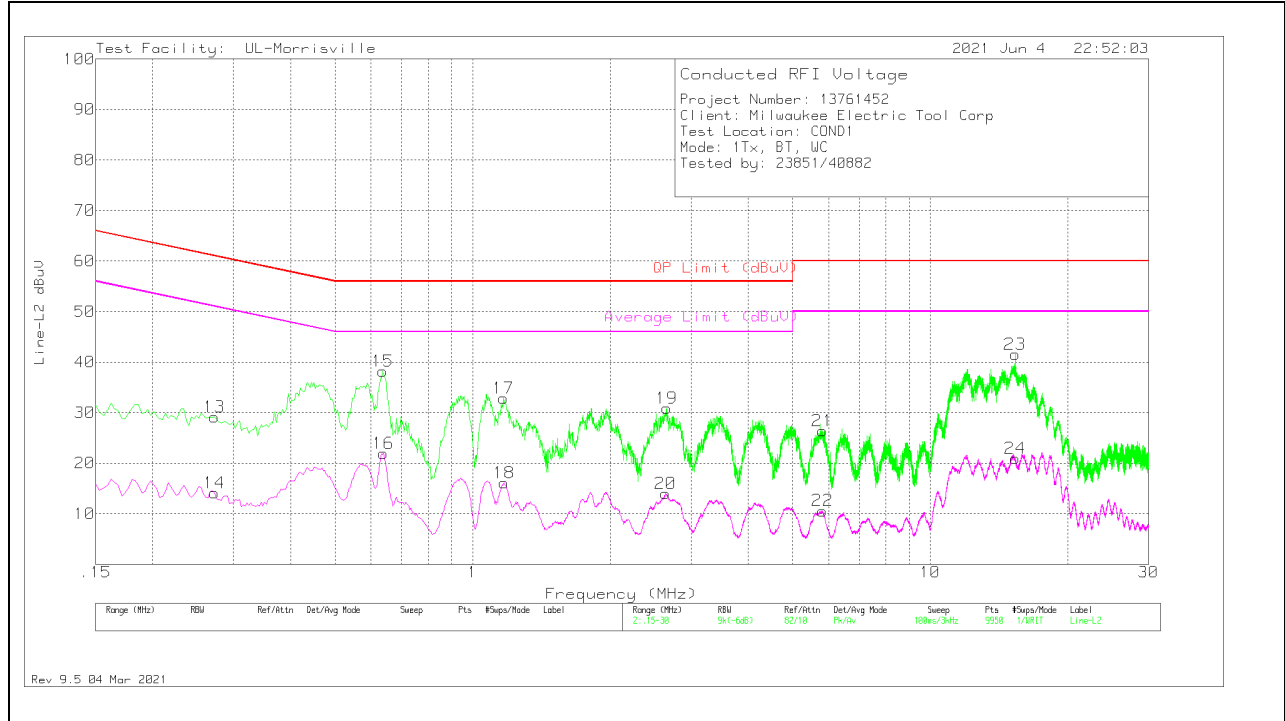
LINE 1 RESULTS



Range 1: Line-L1 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
2	.291	10.77	Av	.1	9.8	20.67	-	-	50.5	-29.83
1	.294	21.79	Pk	.1	9.8	31.69	60.41	-28.72	-	-
3	.636	32.47	Pk	0	9.8	42.27	56	-13.73	-	-
4	.636	21.22	Av	0	9.8	31.02	-	-	46	-14.98
5	1.173	26.24	Pk	0	9.8	36.04	56	-19.96	-	-
6	1.173	14.59	Av	0	9.8	24.39	-	-	46	-21.61
7	2.589	23.73	Pk	0	9.8	33.53	56	-22.47	-	-
8	2.61	11	Av	0	9.8	20.8	-	-	46	-25.2
10	7.32	5.25	Av	.1	10	15.35	-	-	50	-34.65
9	7.332	18.83	Pk	.1	10	28.93	60	-31.07	-	-
12	15.072	18.46	Av	.1	10.1	28.66	-	-	50	-21.34
11	15.078	32.47	Pk	.1	10.1	42.67	60	-17.33	-	-

Pk - Peak detector
 Av - Average detection

LINE 2 RESULTS



Range 2: Line-L2 .15 - 30MHz										
Marker	Frequency (MHz)	Meter Reading (dBuV)	Det	LISN VCF (dB)	Cbl/Limiter (dB)	Corrected Reading dBuV	QP Limit (dBuV)	Margin (dB)	Average Limit (dBuV)	Margin (dB)
13	.273	19.22	Pk	.1	9.8	29.12	61.03	-31.91	-	-
14	.273	4.22	Av	.1	9.8	14.12	-	-	51.03	-36.91
15	.636	28.41	Pk	0	9.8	38.21	56	-17.79	-	-
16	.639	12.16	Av	0	9.8	21.96	-	-	46	-24.04
17	1.167	23.09	Pk	0	9.8	32.89	56	-23.11	-	-
18	1.17	6.3	Av	0	9.8	16.1	-	-	46	-29.9
20	2.6415	4.2	Av	0	9.8	14	-	-	46	-32
19	2.658	21.09	Pk	0	9.8	30.89	56	-25.11	-	-
21	5.811	16.43	Pk	.1	9.9	26.43	60	-33.57	-	-
22	5.814	.58	Av	.1	9.9	10.58	-	-	50	-39.42
23	15.318	31.33	Pk	.1	10.1	41.53	60	-18.47	-	-
24	15.333	10.72	Av	.1	10.1	20.92	-	-	50	-29.08

Pk - Peak detector
 Av - Average detection

12. SETUP PHOTOS

Please refer to R13761452-EP1 for setup photos

END OF TEST REPORT