Emissions
Test Report

EUT Name / PMN: CTP2019DTNA

Model No. / HVIN: CTP19TNv3

CFR 47 Part 15.247: 2023 and RSS 247 Issue 2.

Prepared for:

Daimler Truck North America LLC
4555 N. Channel Ave, PORTLAND OR 97217-3849 USA

Prepared by:

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Report/Issue Date: October 18, 2023
Revision Number 4
Report Number: FCC_IC_RF_CIXU-TNY-P23050039 CTP2_Hopping_15.247

Revisions

Revision No.	Date MM/DD/YYYY	Reason for Change	Author
1	07/05/2023	Original Release	James Ma
2	08/02/2023	Update EUT name and model number	Abhijit Patibandla
3	10/16/2023	Update Bandedge Plots	Abhijit Patibandla
4	10/18/2023	Remove LTE Information	Abhijit Patibandla

Note: Latest revision report will replace all previous reports.

Bureau Veritas Consumer Products Services, Inc.
775 Montague Expressway, Milpitas, CA 95035
Tel: (408) 526-1188

Statement of Compliance

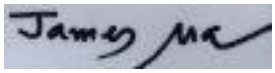
Manufacturer:	Daimler Truck North America LLC
Name of Equipment / PMN:	CTP2019DTNA
Model No's. / HVIN:	CTP19TNv3
Type of Equipment:	Integrated Device. Automotive Telematics Unit
Application of Regulations:	CFR 47 Part 15.247: 2023 and RSS 247 Issue 2.
Test Dates:	May 22, 2023 to October 10, 2023

Guidance Documents:

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v05r02,

Test Methods:

Emissions: ANSI C63.10-2013, KDB 558074 D01 DTS Measurement Guidance v05r02,

Abhijit Patibandla & James Ma

Test Engineer Date: October 18, 2023

Suresh Kondapalli

Reviewer Signatory Date: October 18, 2023

Testing Cert #2742-01 **US1109** **4842D**

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1 Executive Summary

1.1 Scope

This report is intended to document the status of conformance with the requirements of the CFR 47 Part 15.247: 2023 and RSS 247 Issue 2. based on the results of testing performed on May 22, 2023 to October 10, 2023 on the CTP2019DTNA Model CTP19TNv3 manufactured by Daimler Truck North America LLC. This report only applies to the specific samples tested under the stated test conditions. It is the responsibility of the manufacturer to assure that additional production units of this model are manufactured with identical or EMI equivalent electrical and mechanical components. This report is further intended to document changes and modifications to the EUT throughout its life cycle. All documentation will be included as a supplement.

1.2 Purpose

Testing was performed to evaluate the EMC performance of the EUT in accordance with the applicable requirements, procedures, and criteria defined in the application of regulations and application of standards listed in this report. The 2402 MHz to 2480 MHz frequency band is covered in this document.

1.3 Summary of Test Results

Table 1: Summary of Test Results

Test	Test Method ANSI C63.10	Test Parameters	Measured Value	Result
2400 MHz to 2483.5 MHz Band				
Maximum Transmitted Power	CFR47 15.247 (b1), RSS-247 Issue 2 Sect. 5.4 (b)	30 dBm	3.27 dBm	**Complied**
Occupied Bandwidth	CFR 47 15.247(a1), RSS Gen. Iss. 5 Sect. 6.7	N/A	919 kHz (20dB BW) 887 kHz (99% BW)	**Complied**
Channel Separation	CFR47 15.247 (a1), RSS-247 Issue 2 Sect. 5.1 (b)	>25 kHz	996.5 KHz	**Complied**
Number of Hopping Channels	CFR47 15.247 (a1), RSS-247 Issue 2 Sect. 5.1 (d)	>15	79 Channels	**Complied**
Average time occupancy of Channel	CFR47 15.247 (a1), RSS-247 Issue 2 Sect. 5.1 (d)	< 0.4 sec	288 ms	**Complied**
Out of Band Emission	CFR47 15.247 (d), RSS-247 Issue 2 Sect. 5.5	< -30 dBr	-32.67	**Complied**
Restricted Bands of Operation	CFR47 15.205, RSS Gen. Iss. 5 Sect. 8.10	Class B	See Plots	**Complied**
Spurious Emission in Transmitted Mode	CFR47 15.209, RSS Gen. Iss. 5 Sect. 8.9	Class B	39.6dBuV/m at 1980.019MHz with 14.4dB Margin	**Complied**
AC Power Conducted Emission	CFR47 15.207, RSS Gen. Iss. 5 Sect. 8.8	N/A		**N/A**

1.4 Special Accessories

No special accessories were necessary in order to achieve compliance.

1.5 Equipment Modifications

None.

2 Laboratory Information

2.1 Accreditations & Endorsements

2.1.1 US Federal Communications Commission

Bureau Veritas Consumer Products Services, Inc. at 775 Montague Expressway, Milpitas CA 95035 is recognized by the commission for performing testing services for the general public on a fee basis. These laboratory test facilities have been fully described in reports submitted to and accepted by the FCC (Registration No. US1109). The laboratory scope of accreditation includes: Title 47 CFR Parts 15, 18, 20, 22, 24, 25, 27, 90, 95, 95, 97 and 101. The accreditation is updated every 3 years.

2.1.2 NIST / A2LA

Bureau Veritas Consumer Products Services, Inc is accredited by the National Voluntary Laboratory Accreditation Program, which is administered under the auspices of the National Institute of Standards and Technology. The laboratory has been assessed and accredited in accordance with ISO Guide 17025:2017 and ISO 9002 (Lab Code 2742-01). The scope of laboratory accreditation includes emission and immunity testing. The accreditation is updated annually.

2.1.3 Canada

Bureau Veritas Consumer Products Services, Inc. at the 775 Montague Expressway, Milpitas, CA 95035 address is accredited by Industry Canada for performing testing services for the general public on a fee basis. This laboratory test facilities have been fully described in reports submitted to and accepted by Industry Canada (File Number 4842D). This reference number is the indication to the Industry Canada Certification Officers that the site meets the requirements of RSS 212, Issue 1 (Provisional). The accreditation is updated every 3 years.

2.1.4 Japan – VCCI

The Voluntary Control Council for Interference by Information Technology Equipment (VCCI) is a group that consists of Information Technology Equipment (ITE) manufacturers and EMC test laboratories. The purpose of the Council is to take voluntary control measures against electromagnetic interference from Information Technology Equipment, and thereby contribute to the development of a socially beneficial and responsible state of affairs in the realm of Information Technology Equipment in Japan. Bureau Veritas Consumer Products Services, Inc. at 775 Montague Expressway, Milpitas, CA 95035 has been assessed and approved in accordance with the Regulations for Voluntary Control Measures.
VCCI Registration No. for for Milpitas: A-0133

2.1.5 Acceptance by Mutual Recognition Arrangement

The United States has an established agreement with specific countries under the Asia Pacific Laboratory Accreditation Corporation (APLAC) Mutual Recognition Arrangement. Under this agreement, all Bureau Veritas Consumer Products Services, Inc. at 775 Montague Expressway, Milpitas, CA 95035 test results and test reports within the scope of the laboratory NIST / A2LA accreditation will be accepted by each member country.

2.2 Test Facilities

All of the test facilities are located at 775 Montague Expressway, Milpitas, California, 95035, USA.

2.2.1 Emission Test Facility

The Semi-Anechoic chamber and AC Line Conducted measurement facility used to collect the radiated and conducted data has been constructed in accordance with ANSI C63.7:1992. The site has been measured in accordance with and verified to comply with the theoretical normalized site attenuation requirements of ANSI C63.4-2014, at a test distance of 3 and 10 meters. The site is listed with the FCC and accredited by A2LA (Lab Code 2742-01). A report detailing this site can be obtained from Bureau Veritas Consumer Products Services, Inc.

2.3 Measurement Uncertainty

The following calculation follows the procedures as set forth in the clause 7.2.3 of ETSI TR 100 028-1 V1.4.1 (2001-12). The expression of Uncertainty in Radiated RF Testing is according to ISO/IEC 17025: 2017 and TR 100 028-1 V1.4.1 (2001-12):

Emission Measurement Uncertainty

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.51 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73 dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64 dB
	6GHz ~ 18GHz	4.82 dB
	18GHz ~ 40GHz	4.91 dB

Radio Measurement Uncertainty

Estimated Combined Standard Uncertainty Type	Uncertainty
Frequency Error Measurements	± 3.88 Hz
Carrier Power Measurements	± 0.70 dB.
Adjacent Channel Power Measurements	± 1.47 dB.
Modulation Frequency Response Measurements	± 0.46 dB.
Transmitter Conducted Emission measurements	± 2.06 dB

2.4 Calibration Traceability

All measurement instrumentation is traceable to the National Institute of Standards and Technology (NIST). Measurement method complies with ANSI/NCSL Z540-1-1994 and ISO Standard 17025:2017. Equipment calibration records are kept on file at the test facility.

3 General Information

3.1 General Description of EUT

<table>
<tr><td>Product/ PMN</td><td>CTP2019DTNA</td></tr>
<tr><td>Brand</td><td>CTP</td></tr>
<tr><td>Test Model / HVIN</td><td>CTP19TNv3</td></tr>
<tr><td>Identification No. of EUT</td><td>A6633000000
Or A6633000500</td></tr>
<tr><td>Status of EUT</td><td>Engineering sample</td></tr>
<tr><td>Power Supply Rating</td><td>12 V input is expected from vehicles. Supports 8V to 32V</td></tr>
<tr><td>Temperature Operating Range</td><td>-35C to 75C</td></tr>
<tr><td>BT/WLAN Module</td><td>
<table>
<tr><td colspan="2">Model</td><td>UGKZ7A10</td></tr>
<tr><td colspan="2">Manufacturer</td><td>ALPS</td></tr>
<tr><td rowspan="5">WiFi</td><td>Frequency</td><td>2412 to 2462MHz for 802.11b/g/n</td></tr>
<tr><td>Channel Bandwidth</td><td>20 MHz</td></tr>
<tr><td>Modulation</td><td>802.11b – BPSK, QPSK, CCK, DSSS
802.11g – BPSK, QPSK, 16/64QAM, OFDM
802.11n – HT mode MCS0-7</td></tr>
<tr><td>Data rate max</td><td>802.11b – 11Mbps
802.11g – 54Mbps
802.11n – 72.2Mbps</td></tr>
<tr><td>Output Level</td><td>802.11b – +15dBm
802.11g – +13dBm
802.11n – +11dBm</td></tr>
<tr><td rowspan="3"></td><td>Sensitivity</td><td>802.11b – -90dBm
802.11g – -74dBm
802.11n – -72dBm</td></tr>
<tr><td rowspan="2">BT</td><td>Frequency</td><td>2402 ~2480MHz</td></tr>
<tr><td>Channel Spacing</td><td>Normal mode – 1MHz
BLE mode –2MHz</td></tr>
</table>
</td></tr>
<tr><td>Antenna Information</td><td>
<table>
<tr><td>ANTENNA-CABLE, WIFI/BT, INT</td><td>A66-12157-000</td><td>2400-2485 MHz
5150-5925 MHz</td><td>30 dBm</td><td>Antenna Type: WiFi/BT
2400-2485 MHz: 4.0 dBi
5150-5925 MHz: 5.0 dBi</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Note: The above radio information is for the BT/ WLAN radio module inside CTP19TNv3.
This report is only document the classic bluetooth radio.</td></tr>
</table>

3.2 Equipment Configuration

A description of the equipment configuration is given in the Test Plan Section. The EUT was tested as called for in the test standard and was configured and operated in a manner consistent with its intended use. The EUT was connected to rated power and allowed to reach intended operating conditions. The placement of the EUT system components was guided by the test standard and selected to represent typical installation conditions.

In the case of an EUT that can operate in more than one configuration, preliminary testing was performed to determine the configuration that produced maximum radiation.

The final configuration was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.3 Operating Mode

A description of the operation mode is given in the Test Plan Section. In the case of an EUT that can operate in more than one state, preliminary testing was performed to determine the operating mode that produced maximum radiation.

The final operating mode was selected to produce the worst case radiation for emissions testing and to place the EUT in the most susceptible state for immunity testing.

3.4 Unique Antenna Connector

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of CFR47 Parts 15.211, 15.213, 15.217, 15.219, or 15.221.

3.4.1 Results

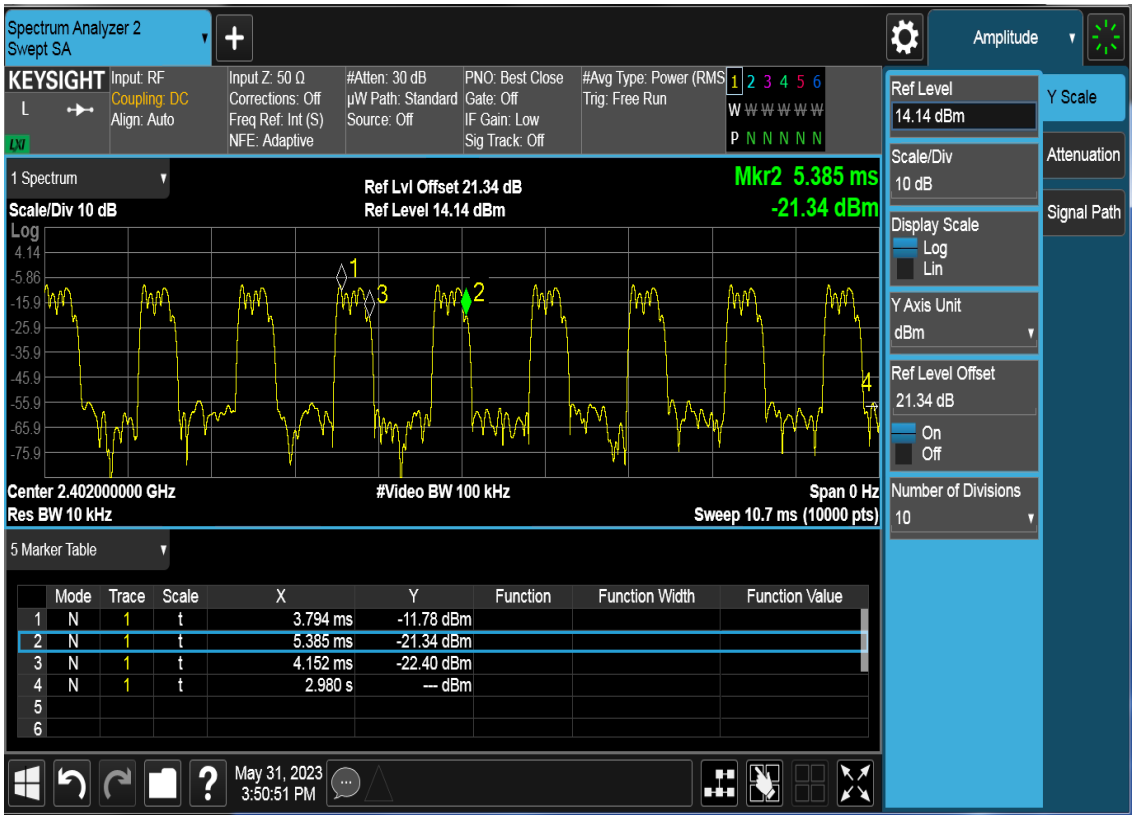
The CTP19TNv3 is a unique connector cable is used. Professional installation required.

3.5 Duty Cycle

The CTP19TNv3

3.5.1 Results

Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Factor (dB)
Classic	0.358	1.233	29	5.37
Notes: EUT was configured and measured for its duty cycle.				



Duty Cycle at 1 Mbps

4 Test Types and Results

Testing was performed in accordance with CFR 47 Part 15.247: 2023 and RSS 247 Issue 2. These test methods are listed under the laboratory's A2LA Scope of Accreditation. This test measures the levels emanating from the EUT, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices. Procedures described in ANSI C63.10:2013 standard were used.

4.1 Output Power Requirements

The maximum output power requirement is the maximum equivalent isotropic radiated power delivering at the transmitting antenna under specified conditions of measurements in the presence of modulation.

The maximum output power and harmonics shall not exceed CFR47 Part 15.247 (b):2023 and RSS 247 Issue 2 Sect. 5.4 (b).

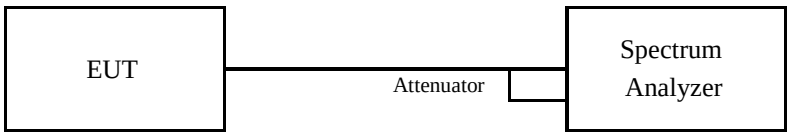
The maximum transmitted powers are

Band 2400-2483.5 MHz: 1 W

4.1.1 Test Method

The ANSI C63.10-2013 Section 7.8 and KDB 558074 D01V05r02 Section 9 conducted method was used to measure the channel power output. The preliminary investigation was performed at different data rate/ chain to determine the highest power output for each mode. The worst findings were conducted on 3 channels in each operating range per CFR47 Part 15.247(b): 2023 and RSS 247 Sect. 5.4 (b). This test was conducted on 3 channels of Engineering Sample. The worst mode result indicated below.

Test Setup:



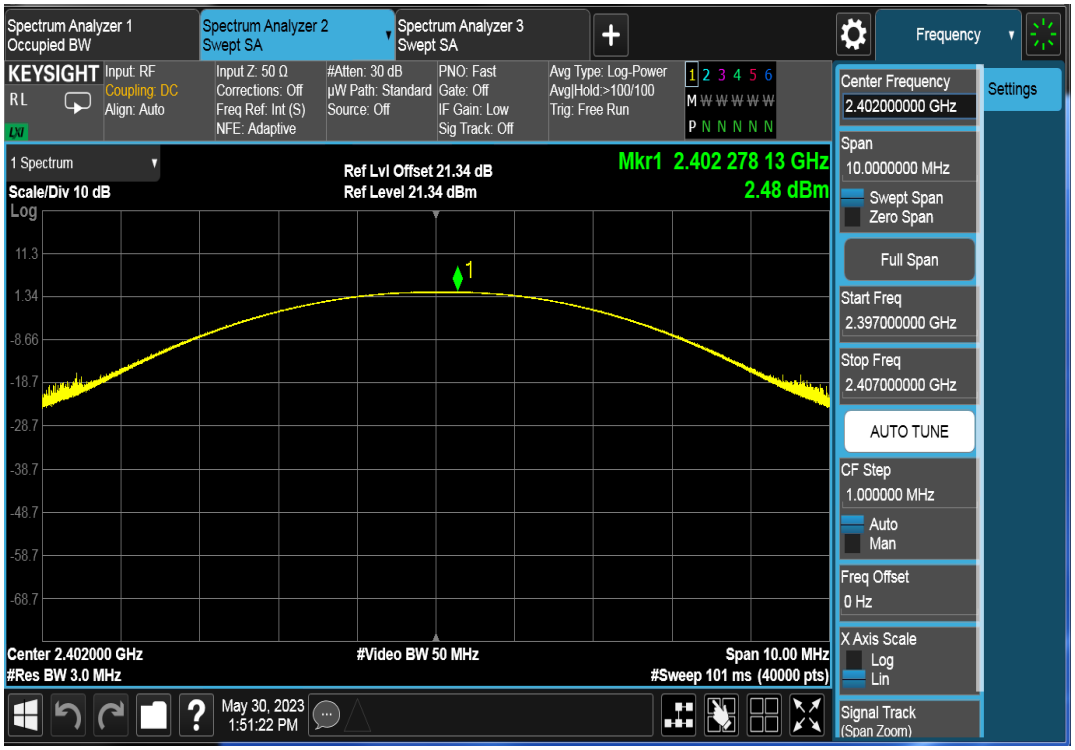
4.1.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

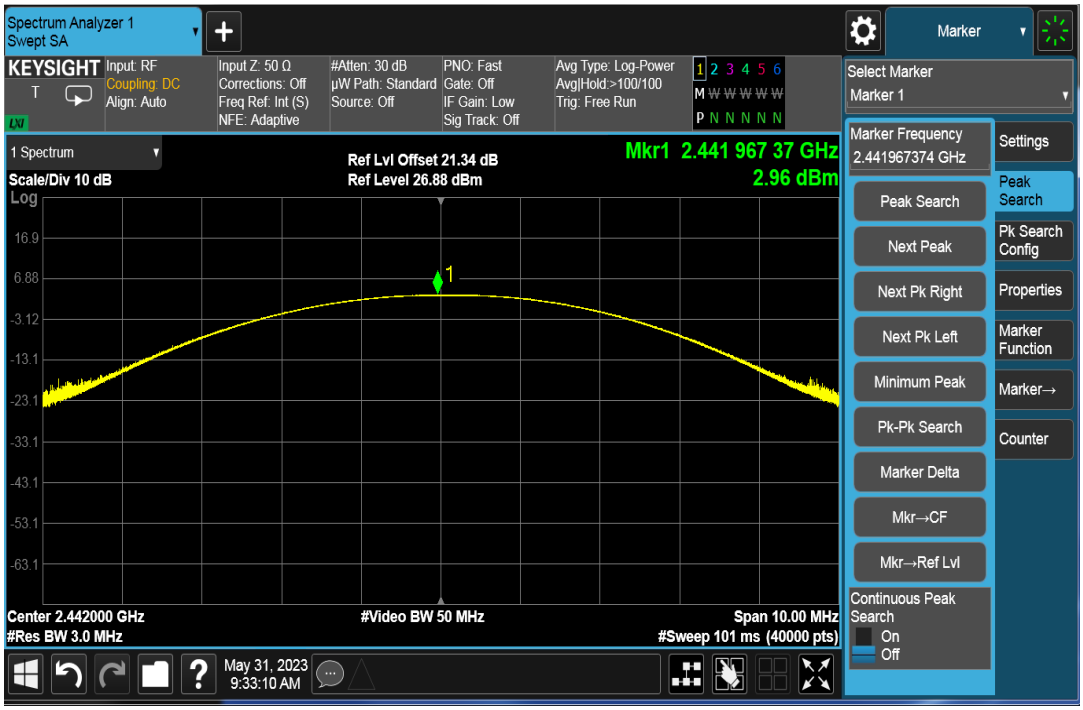
Table 2: RF Output Power at the Antenna Port – Test Results

Test Date: 05-30-2023	**Test By:** Abhijit Patibandla
Test Method: Conducted Measurements	**Power Setting:** Level 4 dBm
Antenna Type: Unique Connector Cable	**Max. Antenna Gain:** 4.0 dBi
Operating Mode: Uncorrelated	**Signal State**: Modulated
Ambient Temp.: 23 °C	**Relative Humidity:** 39%

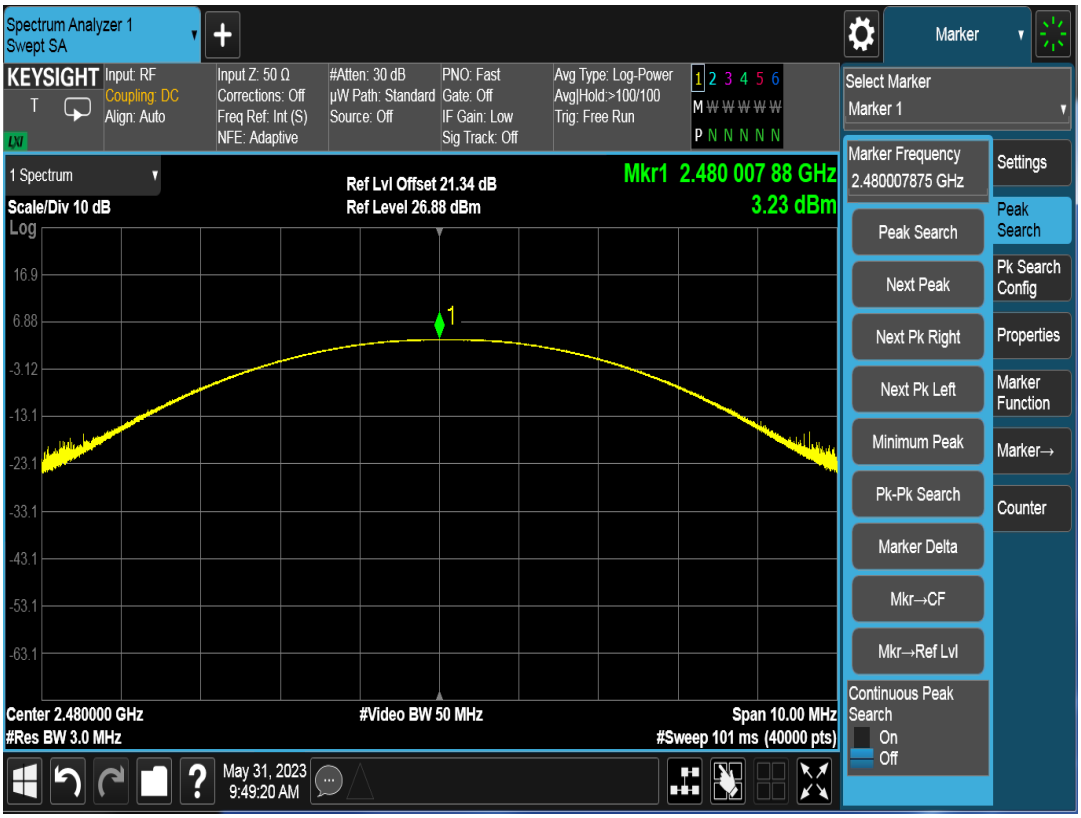
DH1				
Operating Channel	**Measured Power [dBm]**	**Limit [dBm]**	**Margin (dB)**	**Pass/Fail**
2402 MHz	2.48	30.00	-27.52	Pass
2440 MHz	2.96	30.00	-27.04	Pass
2480 MHz	3.23	30.00	-26.77	Pass



2402 MHz

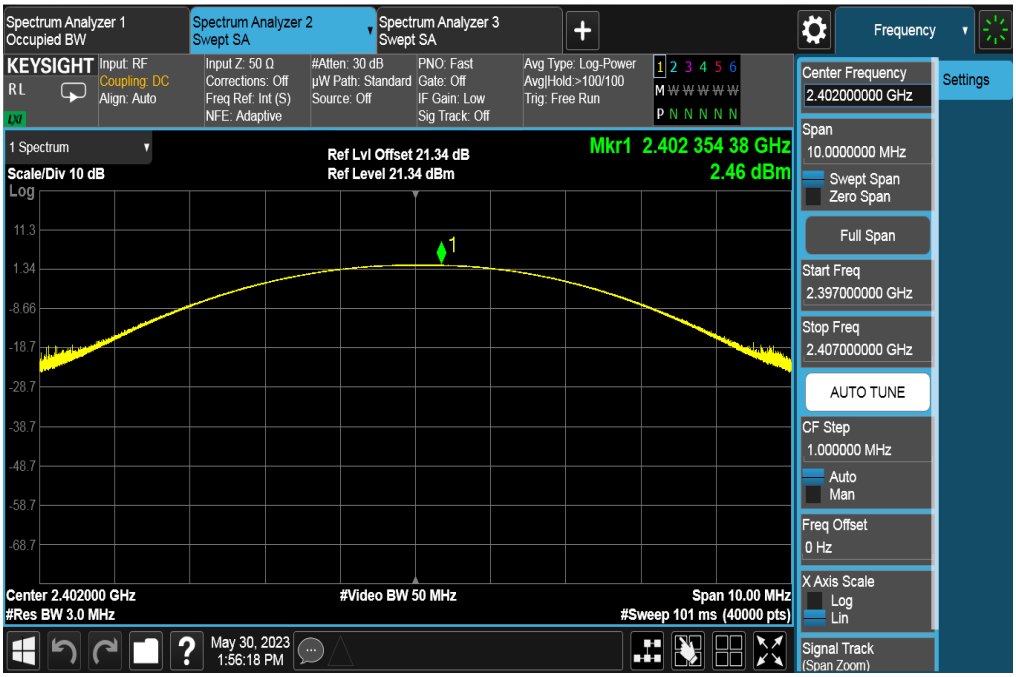


2442 MHz

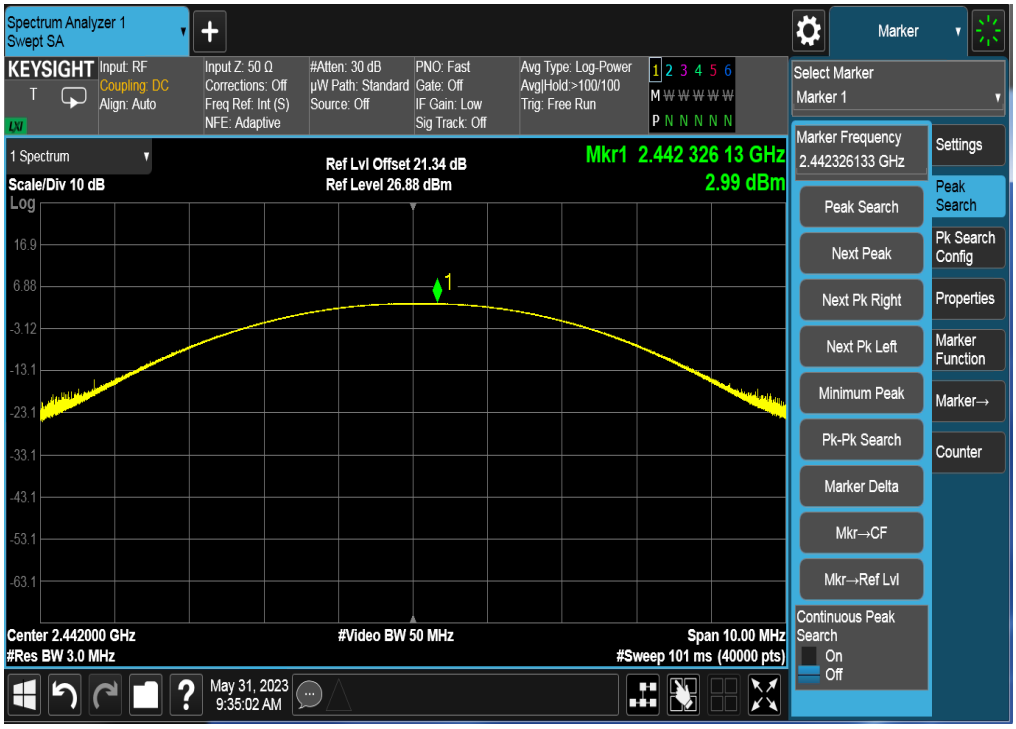

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 30 dB
µW Path: Standard
Source: Off
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Marker
Select Marker
Marker 1
1 Spectrum
Scale/Div 10 dB
Ref Lvl Offset 21.34 dB
Ref Level 26.88 dBm
Mkr1 2.480 007 88 GHz
3.23 dBm
Log
16.9
6.88
-3.12
-13.1
-23.1
-33.1
-43.1
-53.1
-63.1
Center 2.480000 GHz
#Res BW 3.0 MHz
#Video BW 50 MHz
Span 10.00 MHz
#Sweep 101 ms (40000 pts)
Marker Frequency
2.480007875 GHz
Settings
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Pk Search Config
Properties
Marker Function
Marker→
Counter
May 31, 2023
9:49:20 AM

2480 MHz

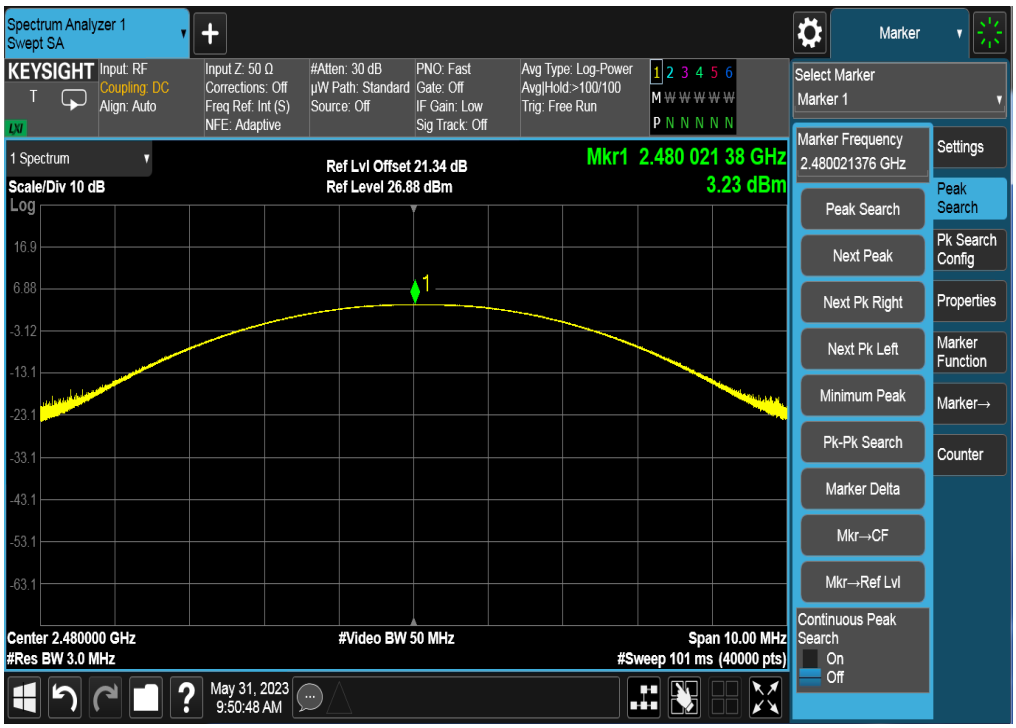
DH3				
Operating Channel	**Measured Power [dBm]**	**Limit [dBm]**	**Margin (dB)**	**Pass/Fail**
2402 MHz	2.46	30.00	-27.54	Pass
2440 MHz	2.99	30.00	-27.01	Pass
2480 MHz	3.23	30.00	-26.77	Pass



2402 MHz

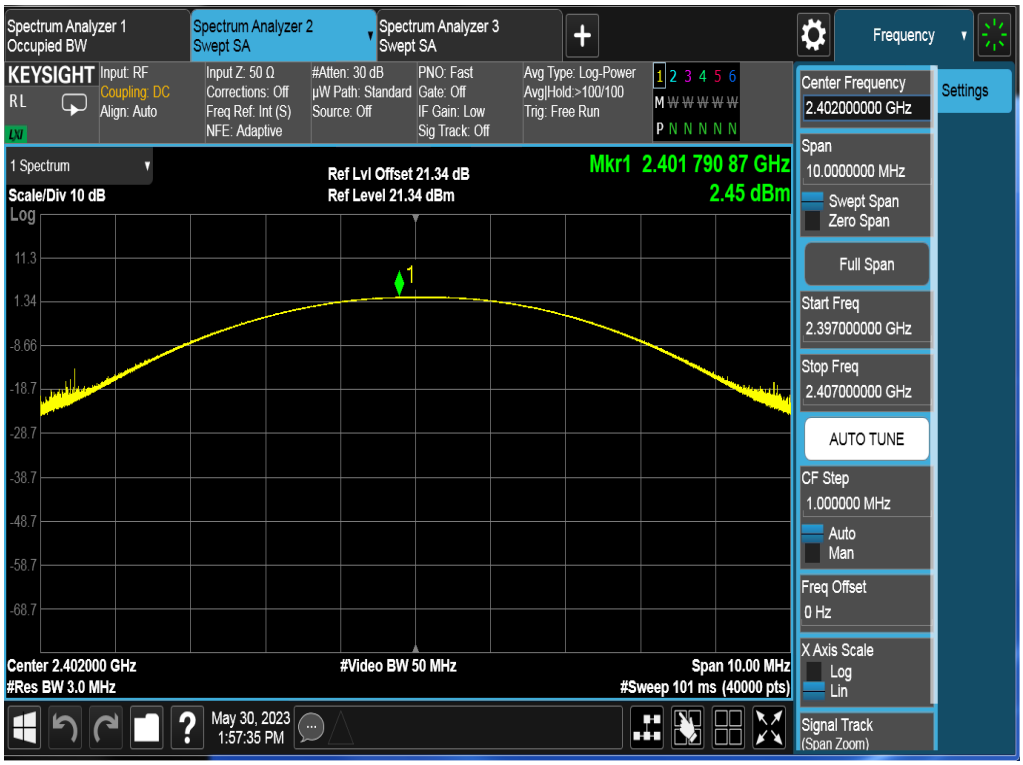


2442 MHz

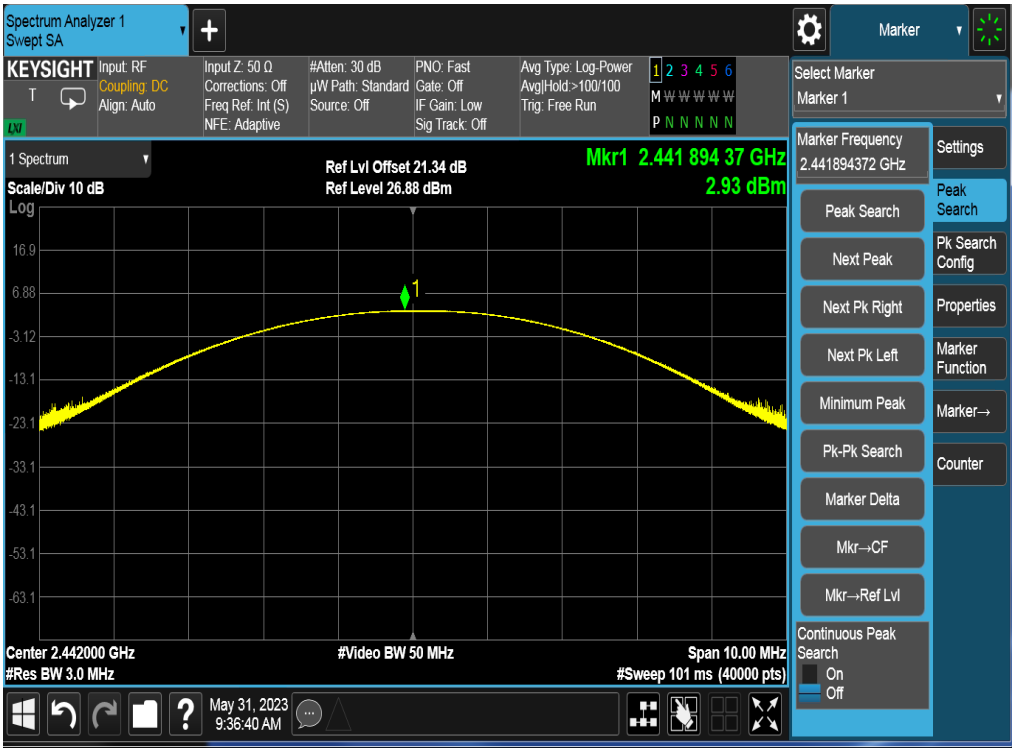


2480 MHz

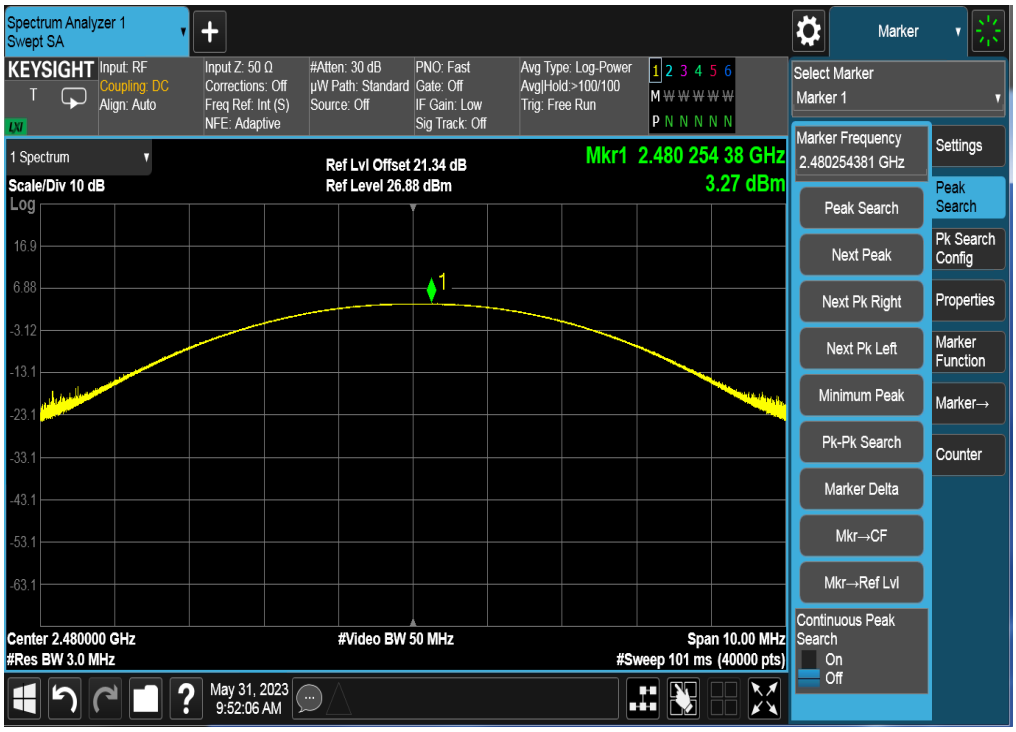
DH5				
Operating Channel	**Measured Power [dBm]**	**Limit [dBm]**	**Margin (dB)**	**Pass/Fail**
2402 MHz	2.45	30.00	-27.55	Pass
2440 MHz	2.93	30.00	-27.07	Pass
2480 MHz	3.27	30.00	-26.73	Pass



2402 MHz



2442 MHz



2480 MHz

4.2 Occupied Bandwidth

The occupied bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency.

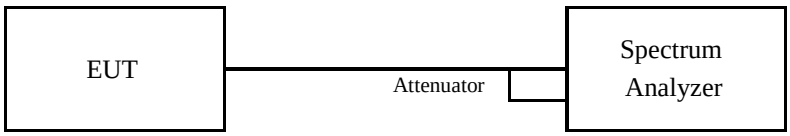
The 99% bandwidth is the bandwidth in which 99% of the transmitted power occupied.

Per Section CFR47 15.247(a1) 2023 and RSS Gen Issue 5 Sect.6.7

4.2.1 Test Method

The conducted method was used to measure the occupied bandwidth according to ANSI C63.10:2013 Section 6.9.2 and 7.8.7. The measurement was performed with modulation per CFR47 15.247(a) (1) 2023 and RSS Gen Issue 5 Sect.6.7. The preliminary investigation was performed to find the narrowest 6 dB bandwidth for each operational mode at different data rates. This worst finding was performed on 3 channels in each operating frequency range; 2400 MHz to 2483.5 MHz. This test was conducted on 3 channels in each mode of Engineering Sample. The worst sample result indicated below.

Test Setup:



4.2.2 Results

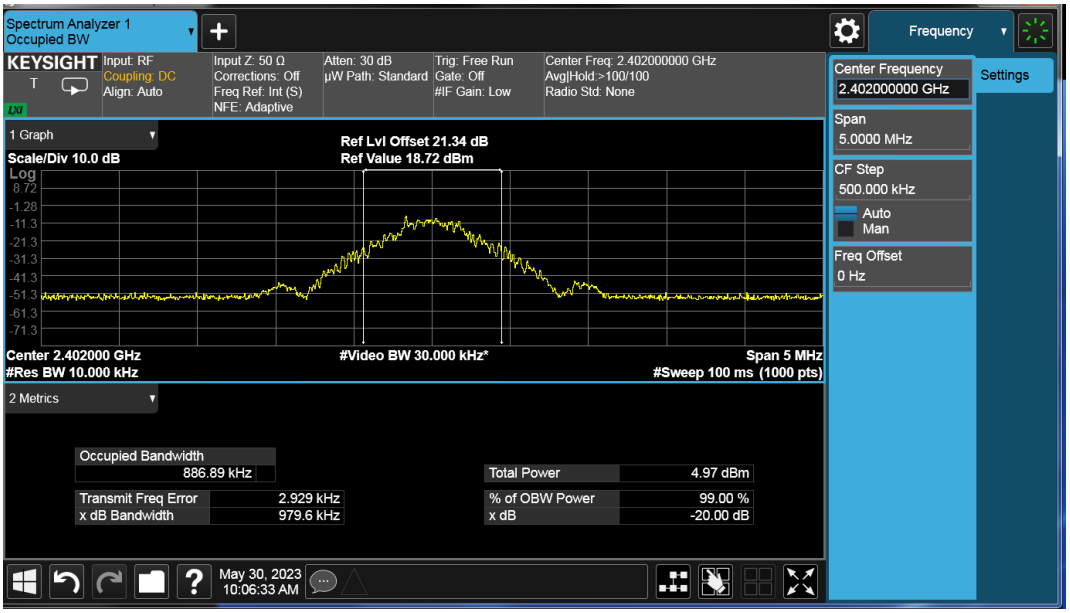
As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 3: Occupied Bandwidth – Test Results

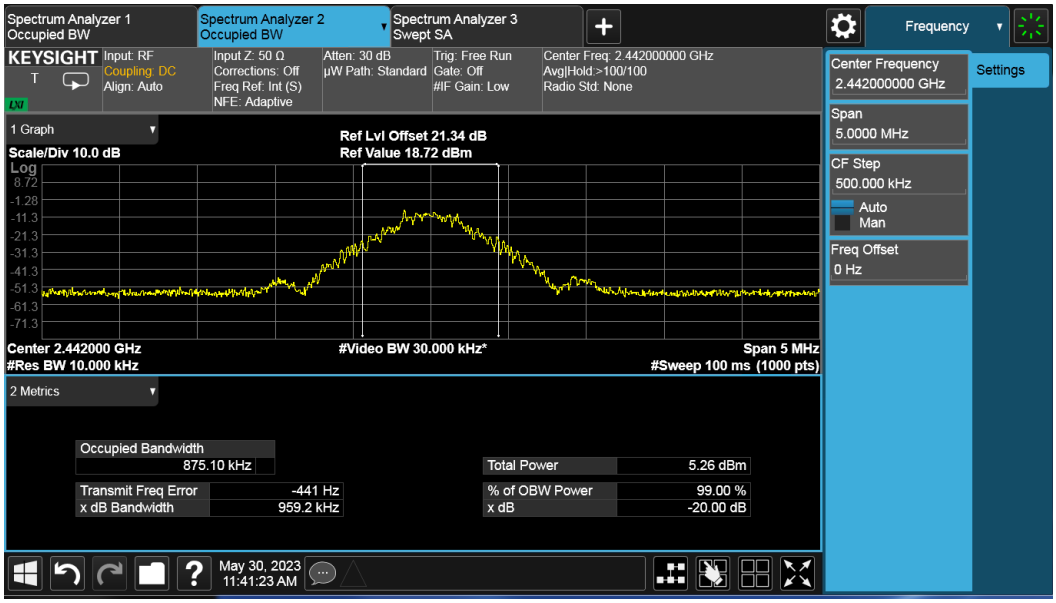
Test Date: May 30, 2023	**Test By:** Abhijit Patibandla
Test Method: Conducted Measurements	**Power Setting:** Level 4 dBm
Antenna Type: Unique Connector Cable	**Max. Antenna Gain:** 4.0 dBi
Operating Mode: Uncorrelated	**Signal State**: Modulated
Ambient Temp.: 23 °C	**Relative Humidity:** 39%

CTP2019DTNA		
DH1		
Frequency (MHz)	**20dB Bandwidth MHz**	**99% Bandwidth MHz**
2402	0.979	0.887
2442	0.959	0.875
2480	1.003	0.885
DH3		
Frequency (MHz)	**20dB Bandwidth MHz**	**99% Bandwidth MHz**
2402	0.920	0.887
2442	0.919	0.877
2480	0.921	0.884
DH5		
Frequency (MHz)	**20dB Bandwidth MHz**	**99% Bandwidth MHz**
2402	0.923	0.887
2442	0.922	0.878
2480	0.922	0.877

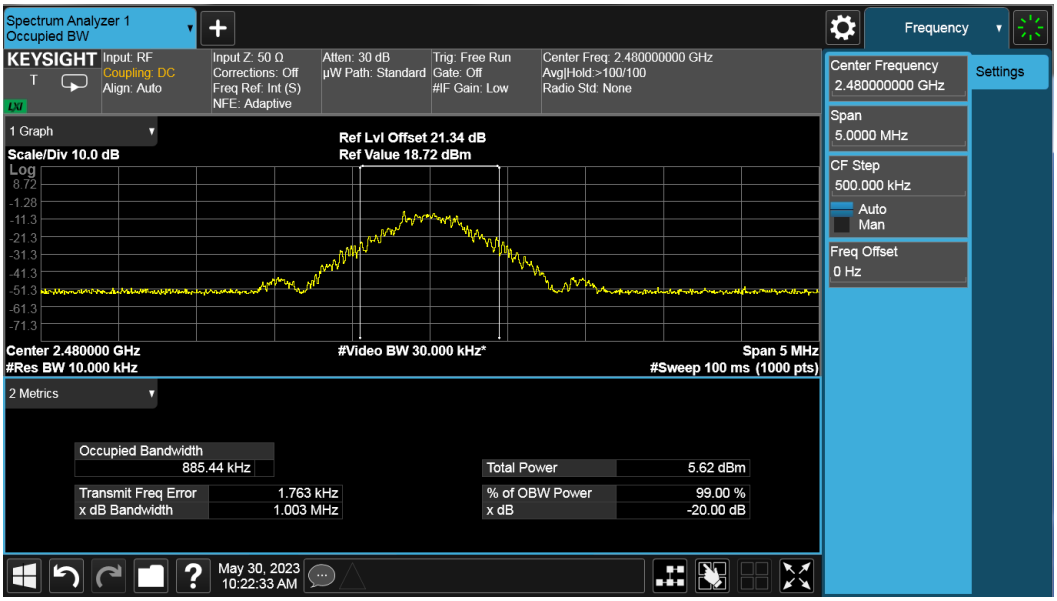
DH1



99% and 20dB Bandwidth 2402 MHz

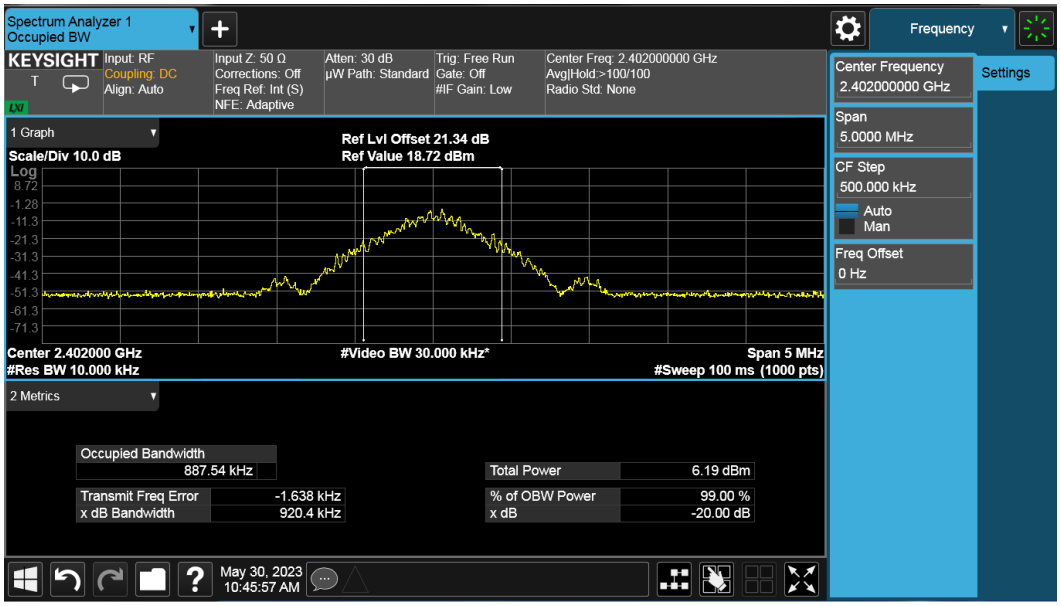


99% and 20dB Bandwidth 2442 MHz

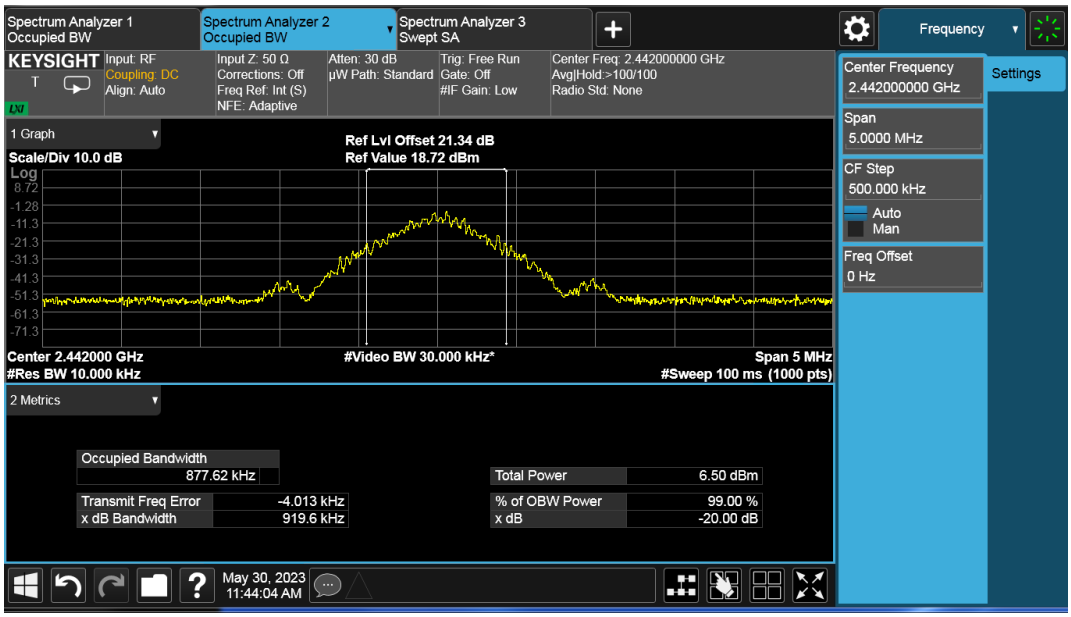


99% and 20dB Bandwidth 2480 MHz

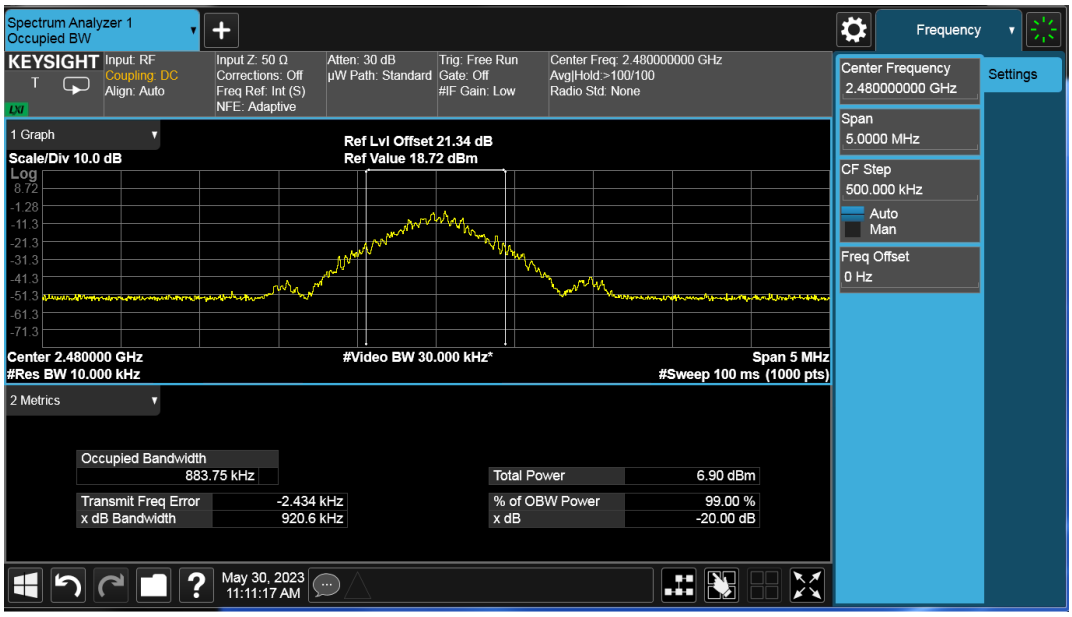
DH3



99% and 20dB Bandwidth 2402 MHz

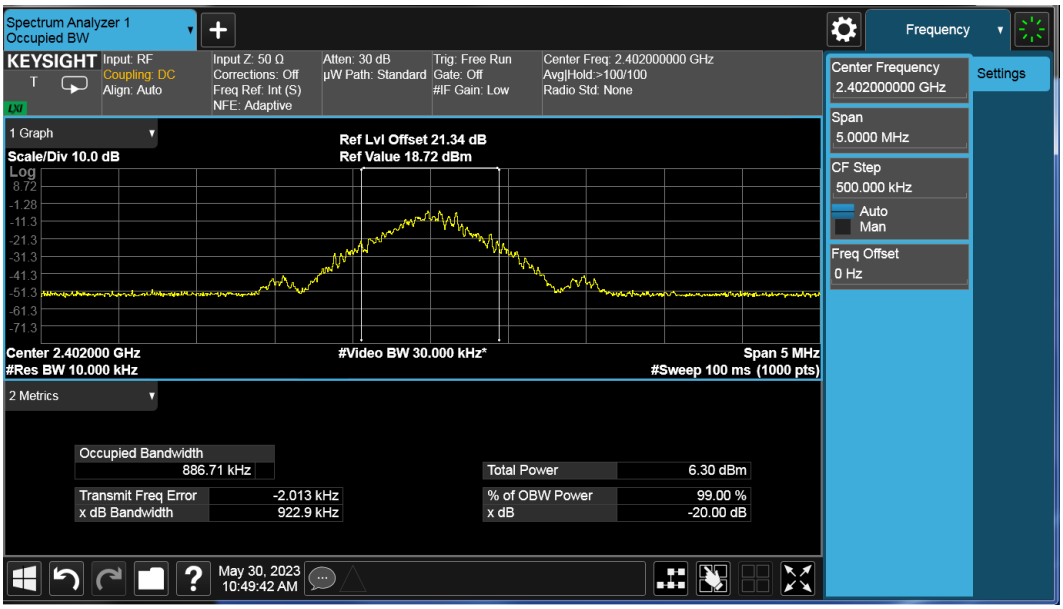


99% and 20dB Bandwidth 2442 MHz

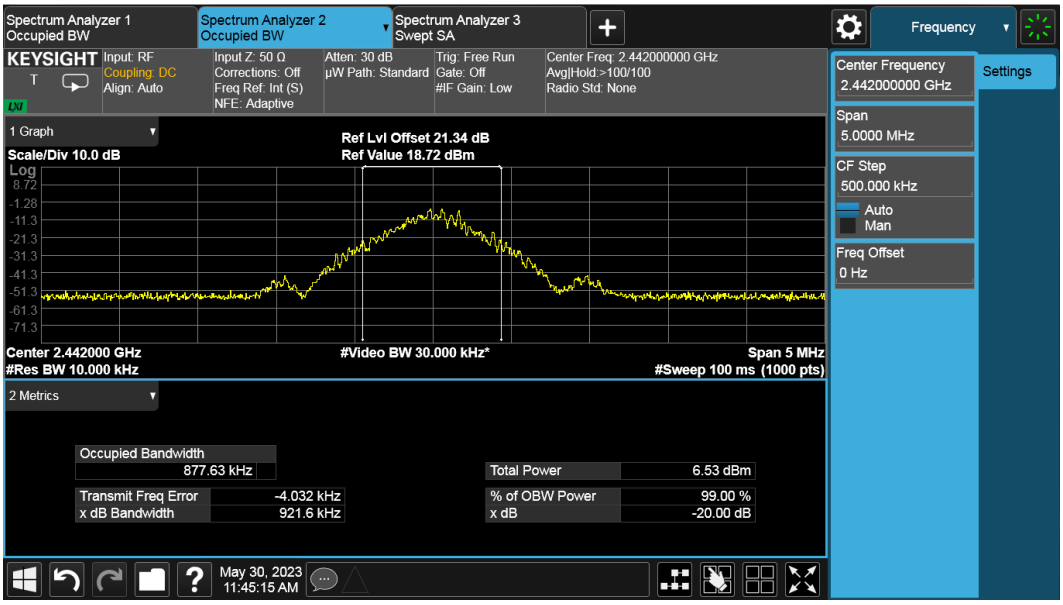


99% and 20dB Bandwidth 2480 MHz

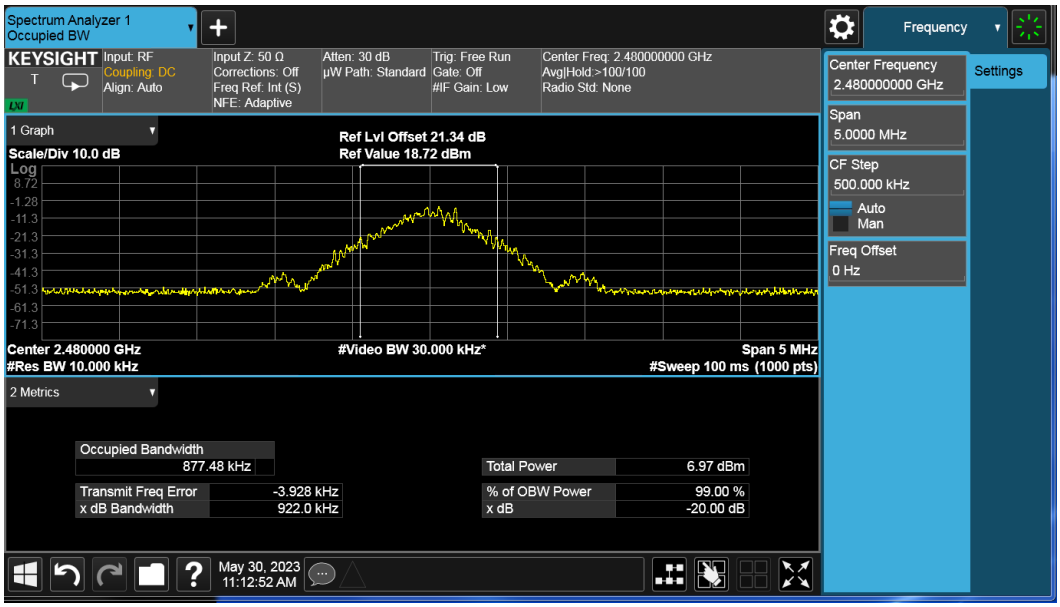
DH5



99% and 20dB Bandwidth 2402 MHz



99% and 20dB Bandwidth 2442 MHz



99% and 20dB Bandwidth 2480 MHz

4.3 Hopping Frequency Requirements

The Frequency Hopping Requirements are applicable to the equipment using Frequency Hopping Spread Spectrum (FHSS) modulation.

Per CFR47 15.247 (a1), RSS-247 Issue 2 Sect.5.1 (b) and (d), frequency hopping systems in the 2400–2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than

0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.

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

The setup was identical to RF output power measurement.

4.3.1 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

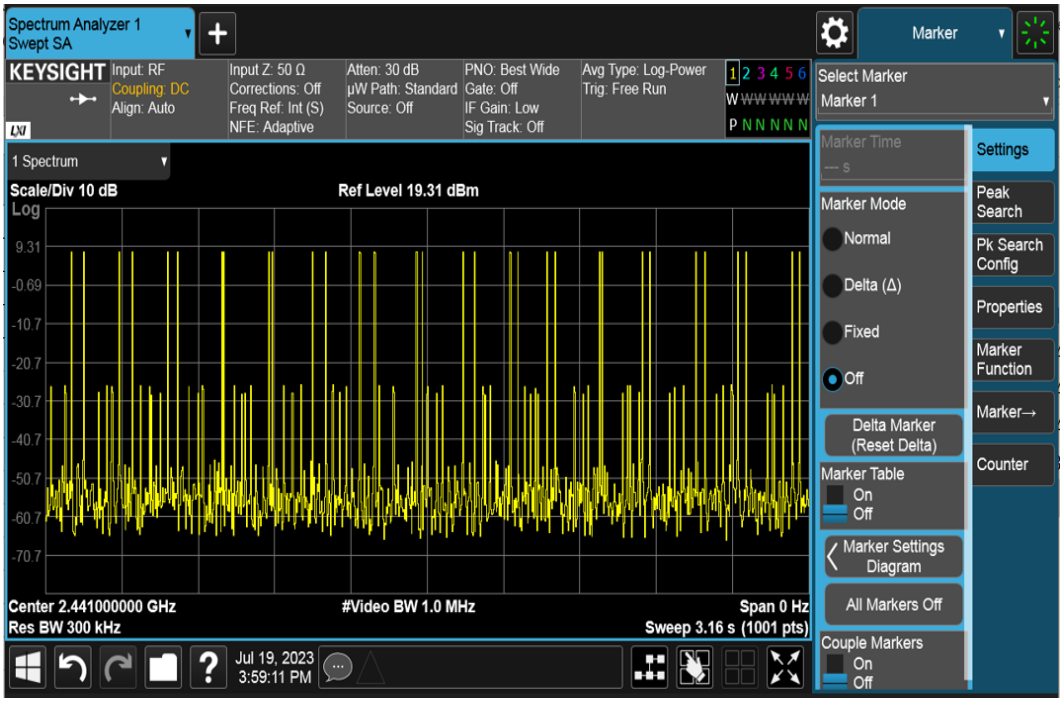
Table 4: Frequency Hopping Requirements

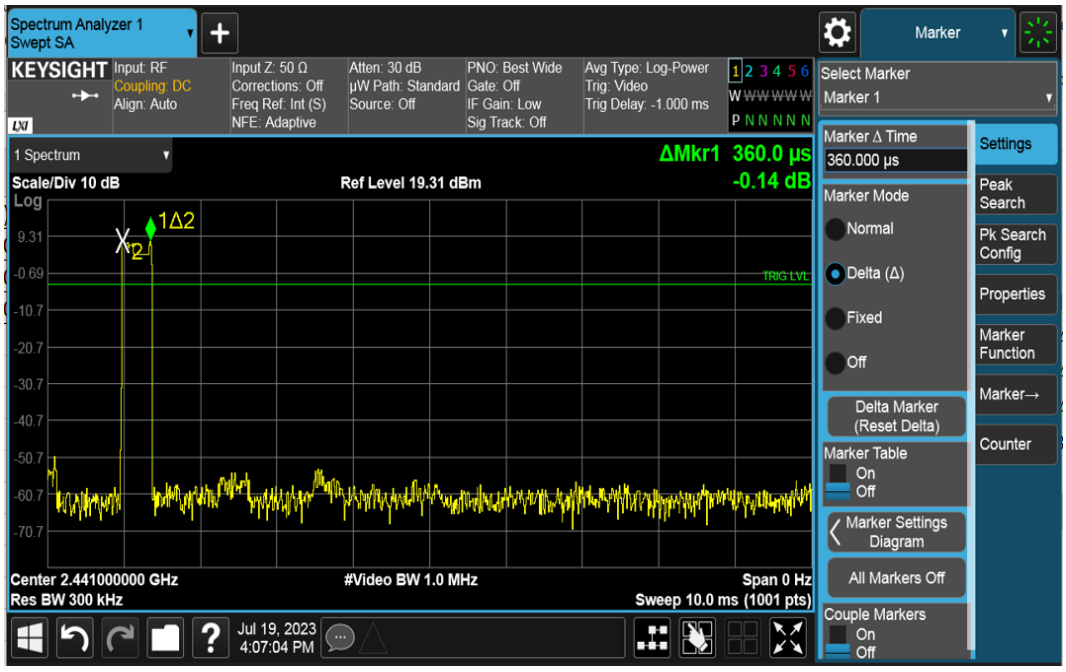
Test Date: 05-31-2023	**Test By:** Abhijit Patibandla
Test Method: Conducted Measurements	**Power Setting:** Level 4 dBm
Antenna Type: Unique Connector Cable	**Max. Antenna Gain:** 4.0 dBi
Operating Mode: Uncorrelated	**Signal State**: Modulated
Ambient Temp.: 23 °C	**Relative Humidity:** 39%

Average Occupancy Time/ Dwell Time

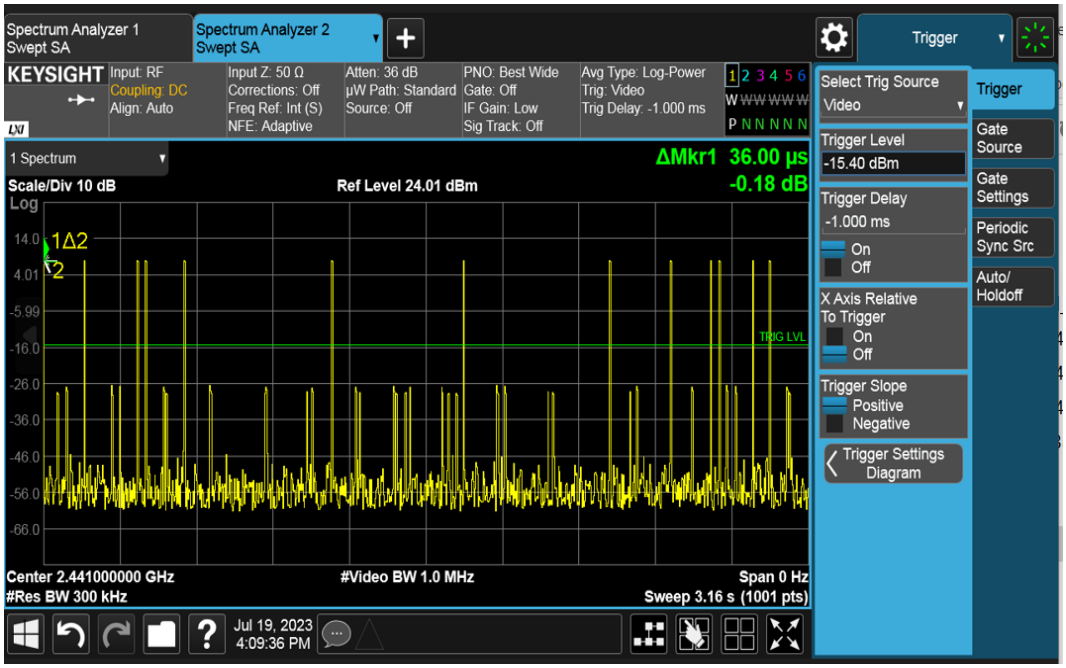
	Number of busts in 31.6s	Bust ON Time (ms)	Total Dwell Time (ms)	Dewll Time limit (ms)
DH1	310	0.36	111.6	400
DH3	130	1.63	211.9	400
DH5	100	2.88	288	400

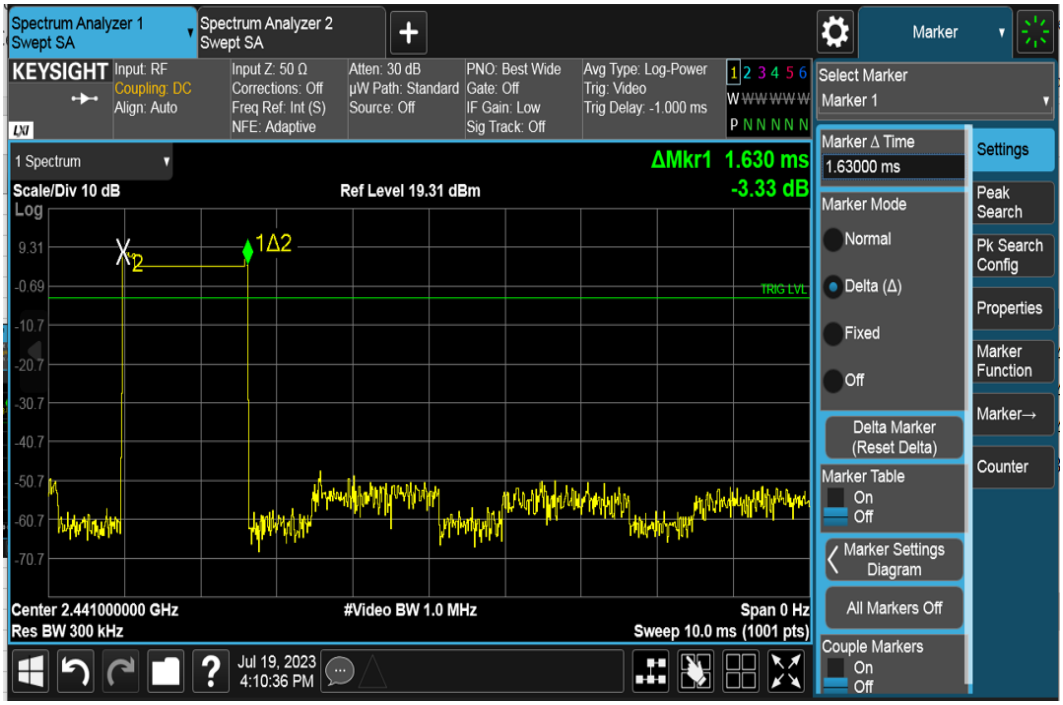
DH1


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Trig: Free Run
Marker
Select Marker
Marker 1
1 Spectrum
Scale/Div 10 dB
Ref Level 19.31 dBm
Log
9.31
-0.69
-10.7
-20.7
-30.7
-40.7
-50.7
-60.7
-70.7
Center 2.441000000 GHz
Res BW 300 kHz
#Video BW 1.0 MHz
Span 0 Hz
Sweep 3.16 s (1001 pts)
Jul 19, 2023
3:59:11 PM
Marker Time
Marker Mode
Normal
Delta (Δ)
Fixed
Off
Delta Marker (Reset Delta)
Marker Table
On
Off
Marker Settings Diagram
All Markers Off
Couple Markers
On
Off
Settings
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

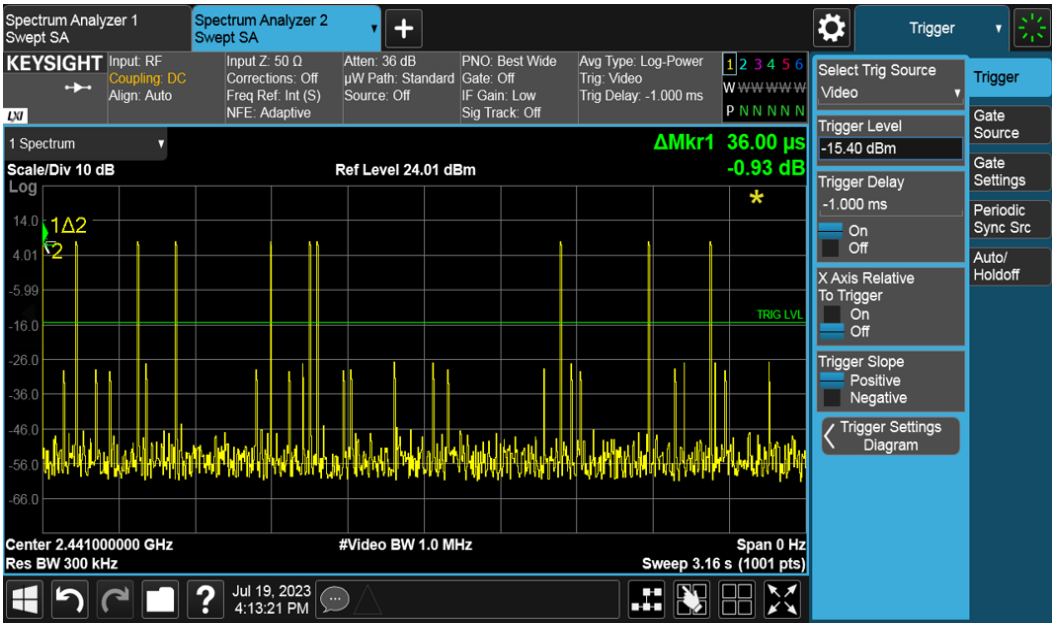

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Trig: Video
Trig Delay: -1.000 ms
Marker
Select Marker
Marker 1
1 Spectrum
ΔMkr1 360.0 µs
-0.14 dB
Scale/Div 10 dB
Ref Level 19.31 dBm
Log
9.31
-0.69
-10.7
-20.7
-30.7
-40.7
-50.7
-60.7
-70.7
1Δ2
TRIG LVL
Center 2.441000000 GHz
Res BW 300 kHz
#Video BW 1.0 MHz
Span 0 Hz
Sweep 10.0 ms (1001 pts)
Jul 19, 2023
4:07:04 PM
Marker Δ Time
360.000 µs
Marker Mode
Normal
Delta (Δ)
Fixed
Off
Delta Marker (Reset Delta)
Marker Table
On
Off
Marker Settings Diagram
All Markers Off
Couple Markers
On
Off
Settings
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

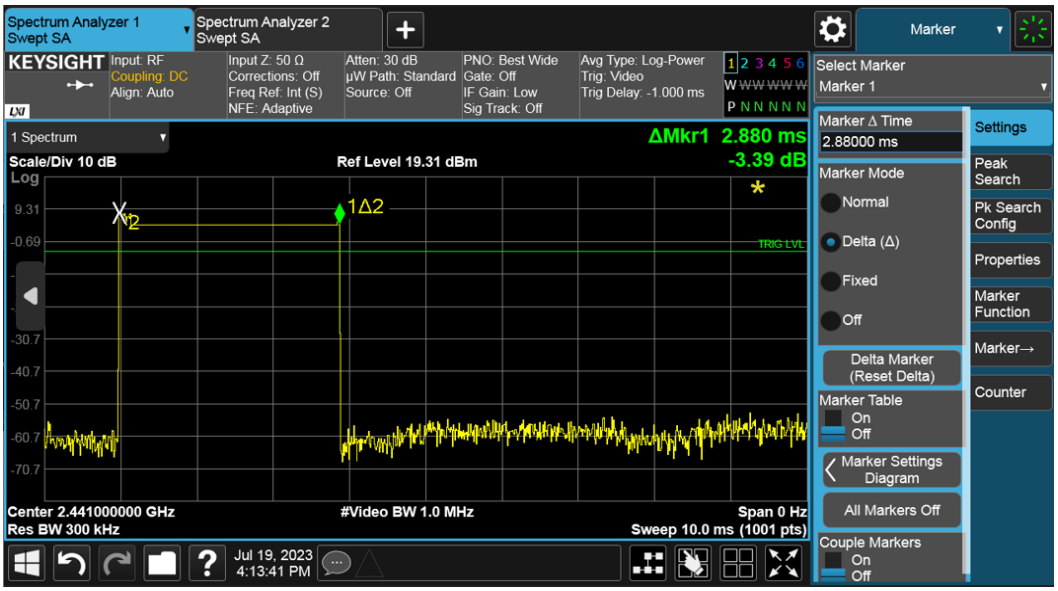
DH3


Spectrum Analyzer 1
Swept SA
Spectrum Analyzer 2
Swept SA
Trigger
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 36 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Trig: Video
Trig Delay: -1.000 ms
1 Spectrum
ΔMkr1 36.00 µs
-0.18 dB
Scale/Div 10 dB
Ref Level 24.01 dBm
Log
14.0
4.01
-5.99
-16.0
-26.0
-36.0
-46.0
-56.0
-66.0
1Δ2
TRIG LVL
Center 2.441000000 GHz
#Res BW 300 kHz
#Video BW 1.0 MHz
Span 0 Hz
Sweep 3.16 s (1001 pts)
Jul 19, 2023
4:09:36 PM
Select Trig Source
Video
Trigger Level
-15.40 dBm
Trigger Delay
-1.000 ms
On
Off
X Axis Relative
To Trigger
On
Off
Trigger Slope
Positive
Negative
Trigger Settings
Diagram
Trigger
Gate
Source
Gate
Settings
Periodic
Sync Src
Auto/
Holdoff

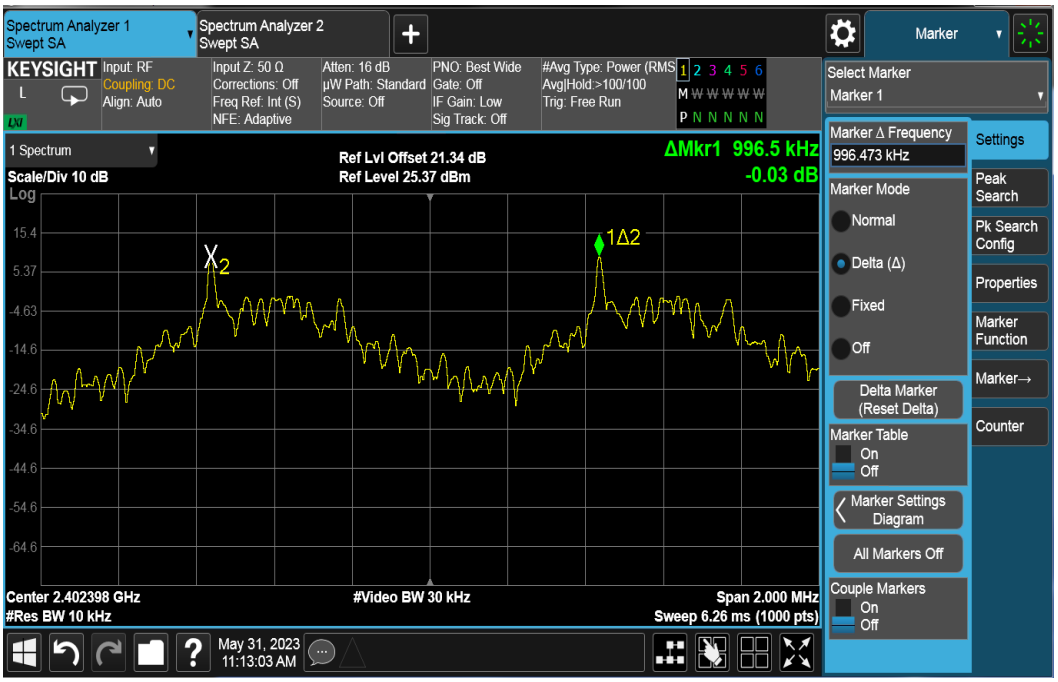

Spectrum Analyzer 1
Swept SA
Spectrum Analyzer 2
Swept SA
Marker
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Trig: Video
Trig Delay: -1.000 ms
1 Spectrum
ΔMkr1 1.630 ms
-3.33 dB
Scale/Div 10 dB
Ref Level 19.31 dBm
Log
9.31
-0.69
-10.7
-20.7
-30.7
-40.7
-50.7
-60.7
-70.7
1Δ2
TRIG LVL
Center 2.441000000 GHz
Res BW 300 kHz
#Video BW 1.0 MHz
Span 0 Hz
Sweep 10.0 ms (1001 pts)
Jul 19, 2023
4:10:36 PM
Select Marker
Marker 1
Marker Δ Time
1.63000 ms
Marker Mode
Normal
Delta (Δ)
Fixed
Off
Delta Marker
(Reset Delta)
Marker Table
On
Off
Marker Settings
Diagram
All Markers Off
Couple Markers
On
Off
Settings
Peak
Search
Pk Search
Config
Properties
Marker
Function
Marker→
Counter

DH5

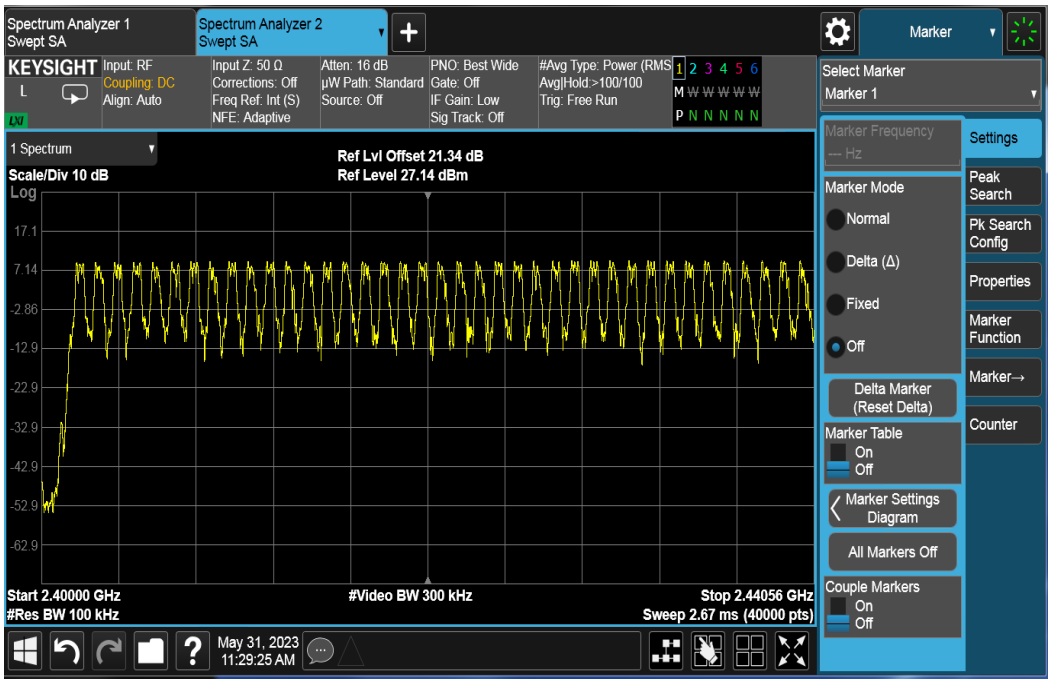

Spectrum Analyzer 1
Swept SA
Spectrum Analyzer 2
Swept SA
Trigger
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 36 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Trig: Video
Trig Delay: -1.000 ms
1 Spectrum
ΔMkr1 36.00 µs
-0.93 dB
Scale/Div 10 dB
Ref Level 24.01 dBm
Log
14.0
4.01
-5.99
-16.0
-26.0
-36.0
-46.0
-56.0
-66.0
1Δ2
2
TRIG LVL
Center 2.441000000 GHz
Res BW 300 kHz
#Video BW 1.0 MHz
Span 0 Hz
Sweep 3.16 s (1001 pts)
Jul 19, 2023
4:13:21 PM
Select Trig Source
Video
Trigger Level
-15.40 dBm
Trigger Delay
-1.000 ms
On
Off
X Axis Relative
To Trigger
On
Off
Trigger Slope
Positive
Negative
Trigger Settings
Diagram
Trigger
Gate
Source
Gate
Settings
Periodic
Sync Src
Auto/
Holdoff

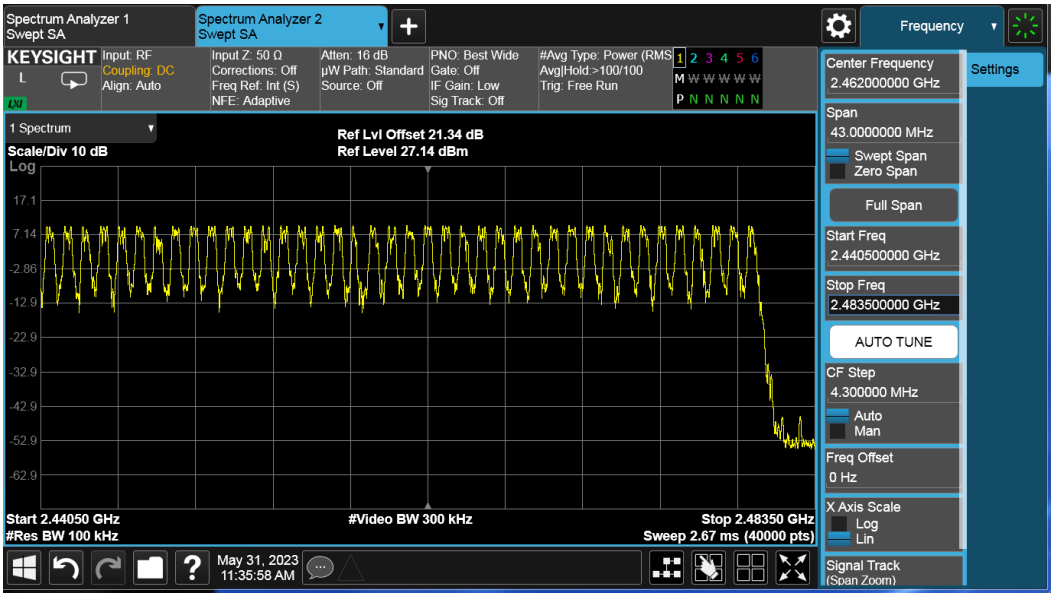

Spectrum Analyzer 1
Swept SA
Spectrum Analyzer 2
Swept SA
Marker
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corrections: Off
Freq Ref: Int (S)
NFE: Adaptive
Atten: 30 dB
µW Path: Standard
Source: Off
PNO: Best Wide
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Trig: Video
Trig Delay: -1.000 ms
1 Spectrum
ΔMkr1 2.880 ms
-3.39 dB
Scale/Div 10 dB
Ref Level 19.31 dBm
Log
9.31
-0.69
-30.7
-40.7
-50.7
-60.7
-70.7
1Δ2
2
TRIG LVL
Center 2.441000000 GHz
Res BW 300 kHz
#Video BW 1.0 MHz
Span 0 Hz
Sweep 10.0 ms (1001 pts)
Jul 19, 2023
4:13:41 PM
Select Marker
Marker 1
Marker Δ Time
2.88000 ms
Marker Mode
Normal
Delta (Δ)
Fixed
Off
Delta Marker
(Reset Delta)
Marker Table
On
Off
Marker Settings
Diagram
All Markers Off
Couple Markers
On
Off
Settings
Peak
Search
Pk Search
Config
Properties
Marker
Function
Marker→
Counter

Minimum Channel Separation/ Frequency Separation GFSK			
Operating Channel (MHz)	**Hopping Separation (kHz)**	**Two-Third of 20dB Bandwidth Limit (kHz)**	**Result**
2402	996.5	> 652.7 KHz	Pass



Frequency Separation DH1





The number of Operating Channels is 79

4.4 Out of Band Emissions

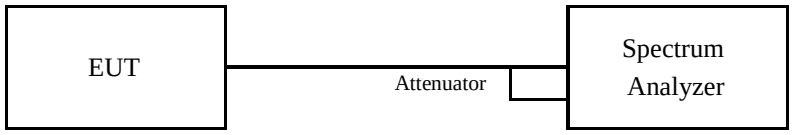
The setup was identical to RF output power measurement. Intentional radiators operating under the alternative provisions to the general emission limits, must be designed to ensure that the 20 dB or 30 dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equipment operates, is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the designated bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If the frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

Since the transmitter complies with the conducted power limits base on the use of CFR47 Part 15.247(b)(3), any frequency outside the band of 2400MHz to 2483.5MHz, the power output level must be below 20db from the in-band transmitting signal; CFR 47 Part 15.215, 15.247(d) and RSS-247 Issue 2 Sect.5.5.

4.4.1 Test Method

The conducted method in ANSI C63.10-2013 was used to measure the out-of-band emission requirement. The measurement was performed with modulation per CFR47 15.247 (d) 2023 and *RSS-247 Issue 2 Sect.5.5*. This test was conducted on 3 channels of Engineering Sample. The worst sample result indicated below.

Test Setup:



4.4.2 Results

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 4: Out of Band Emissions – Test Results

Test Date: 10-10-2023	**Test By:** Abhijit Patibandla
Test Method: Conducted Measurements	**Power Setting:** Level 4 dBm
Antenna Type: Unique Connector Cable	**Max. Antenna Gain:** 4.0 dBi
Operating Mode: Uncorrelated	**Signal State**: Modulated
Ambient Temp.: 23 °C	**Relative Humidity:** 39%

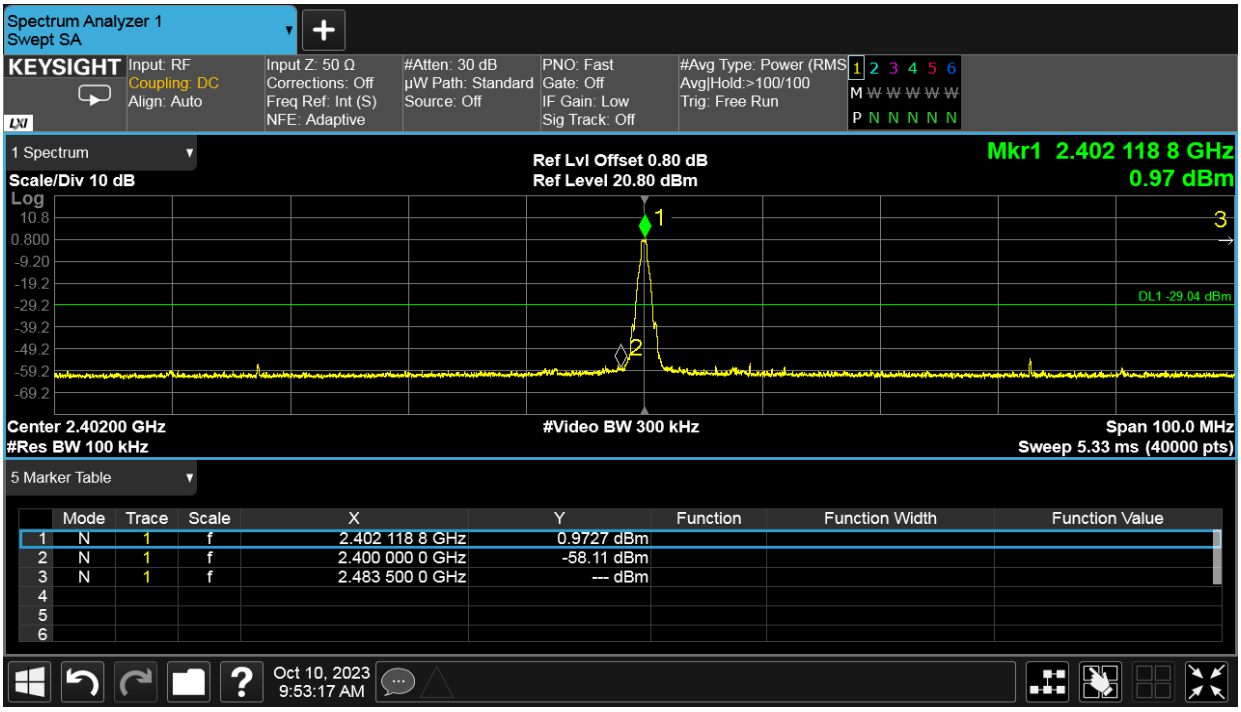
Out of Band Results for CTP2019DTNA			
Frequency (MHz)	**Out of Band Level (dBm)**	**20 dBc Level (dBm)**	**Margin (dB)**
2402	-51.97	-19.04	-32.93
2442	-51.41	-18.74	-32.67
2480	-52.46	-18.34	-34.12

Note: dBc is defined as the level below the main carrier.

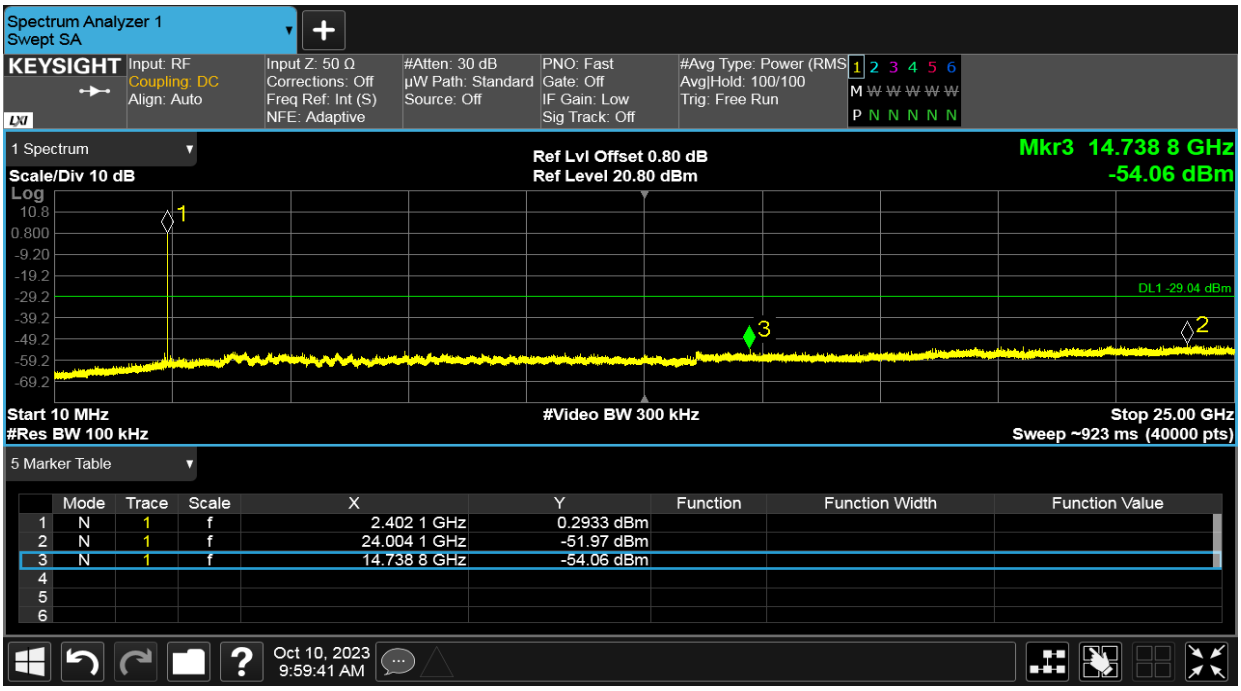
The band-edge level must be lower than the 20 dBc level.

The maximum out of band emission on each individual output is at least 20 dB below the maximum in-band PSD on that output.

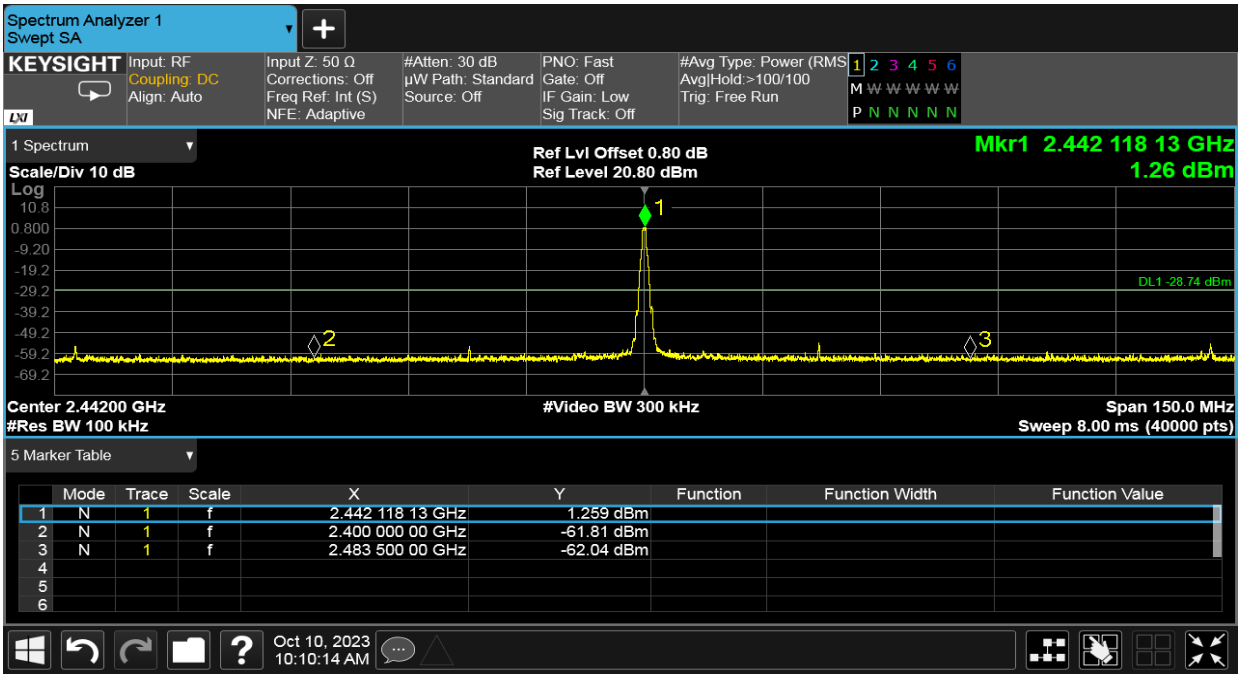
(*) The band-edge is compared to the highest -20 dBc level of the test mode.
For the band edge measurements in a hopping mode per ANSI C63.10 Sect. 7.8.6, the plots on page 35 demonstrate that both 2400 MHz and 2483.5 MHz edges are more than 20 dB below the in-band signal.



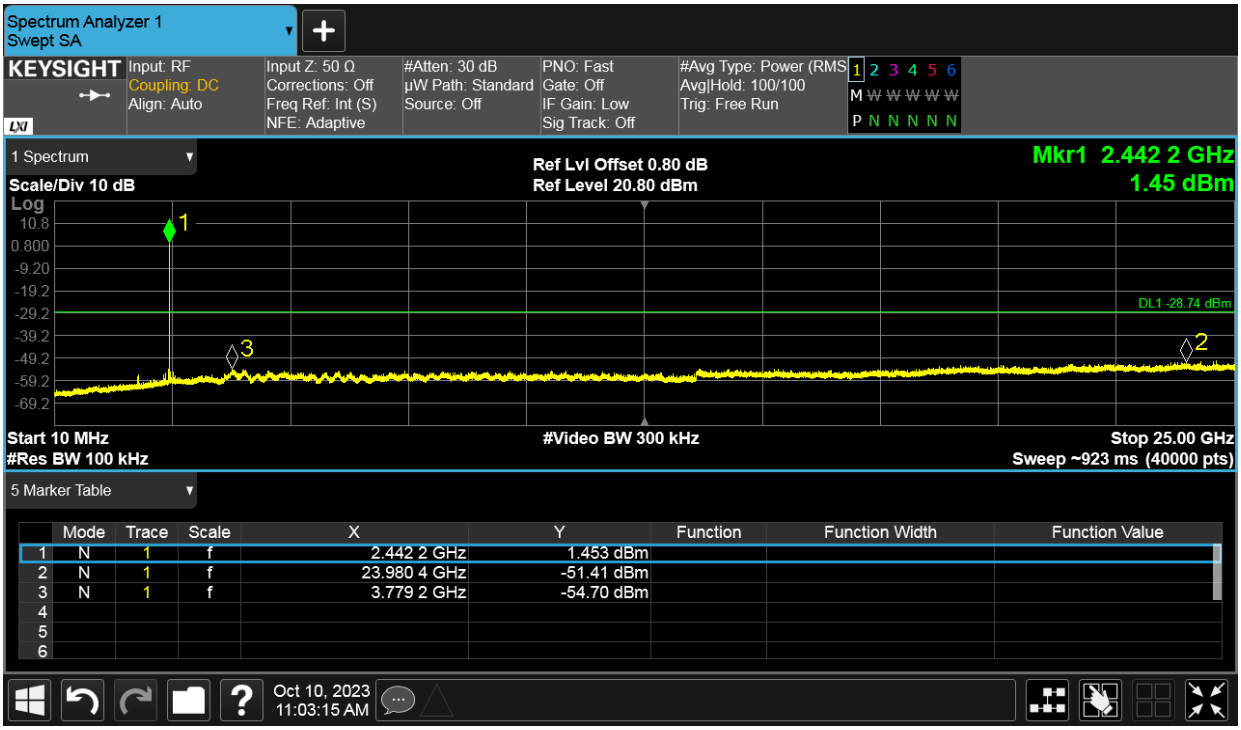
Conducted Band Edge – 2402 MHz



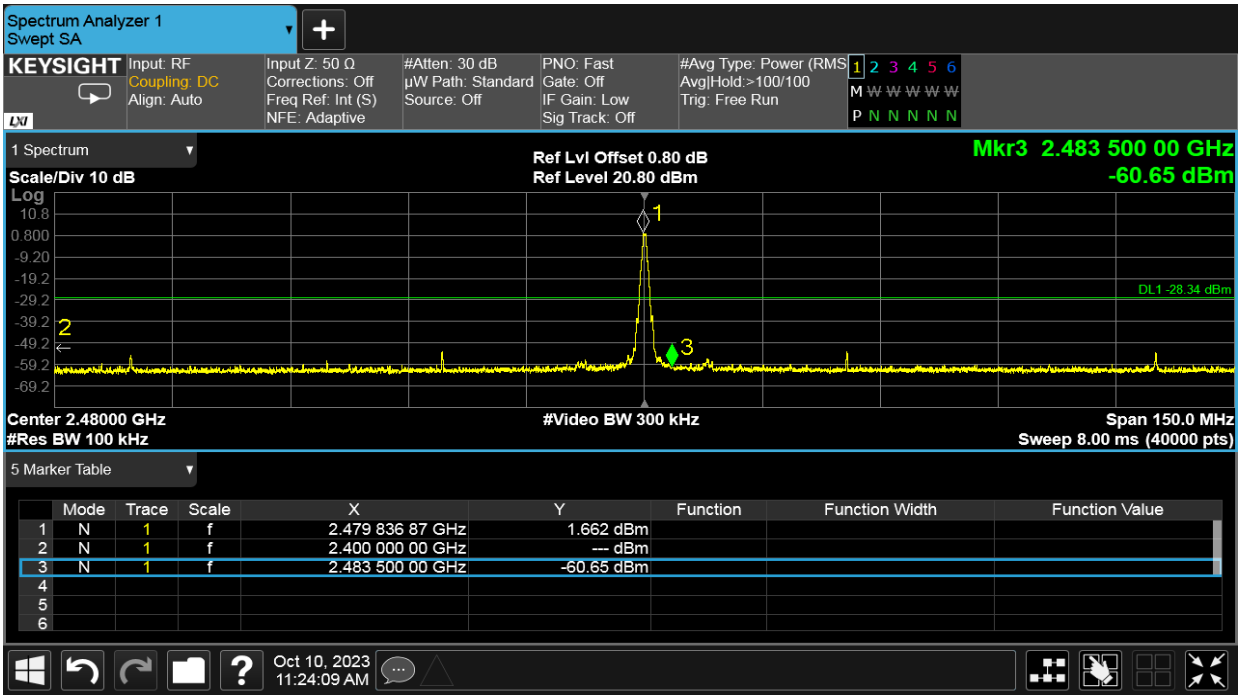
Out of Band Emission - 2402 MHz



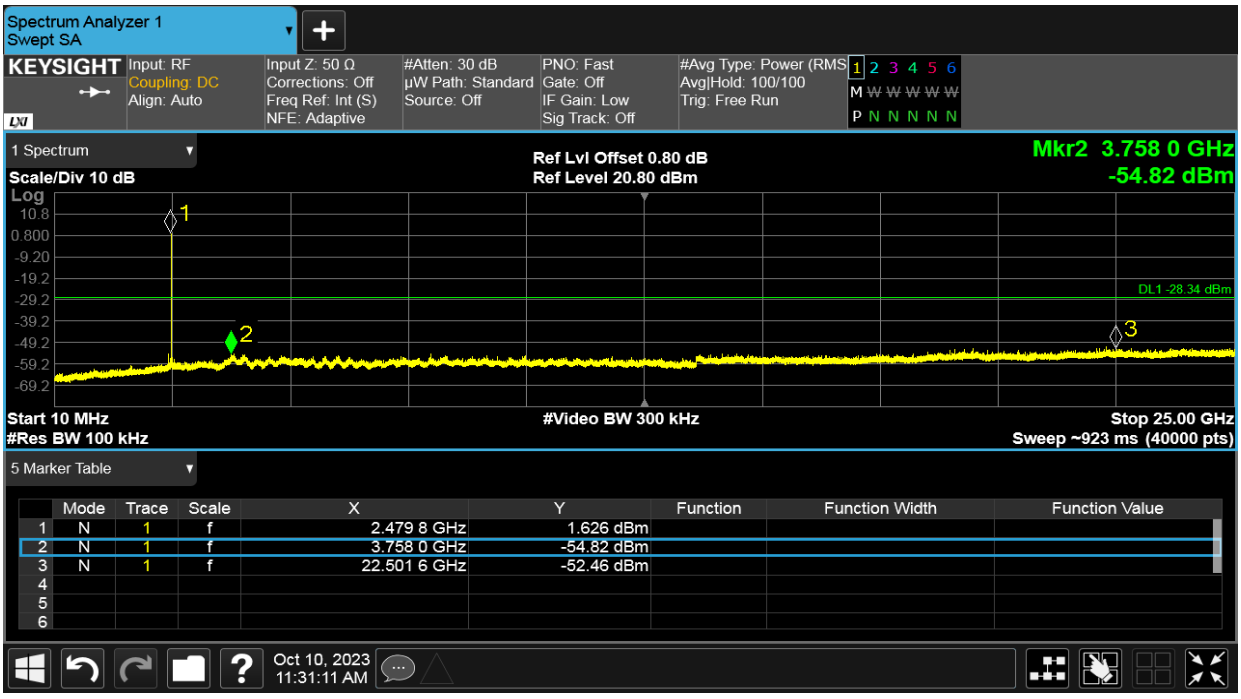
Conducted Band Edge – 2442 MHz



Out of Band Emission - 2442 MHz



Conducted Band Edge – 2480 MHz



Out of Band Emission - 2480 MHz

4.5 Transmit Spurious Emissions

Transmitter spurious emissions are emissions outside the frequency range of the equipment when the equipment is in transmit mode; per requirement of CFR47 15.205, 15.209, 15.247(d), RSS-Gen Sect. 8.9.

4.5.1 Test Methodology

4.5.1.1 Preliminary Test

A test program that controls instrumentation and data logging was used to automate the preliminary RF emission test procedure. The frequency range of interest was divided into sub-ranges to yield a frequency resolution of approximately 120 kHz and provide a reading at each frequency for no more than 12° of turntable rotation. For each frequency sub-range the turntable was rotated 360° while peak emission data was recorded and plotted over the frequency range of interest in horizontal and vertical antenna polarization's.

Preliminary emission profile testing was performed inside the anechoic chamber. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the floor. The EUT was positioned as shown in the setup photographs. The receiving antenna was placed at a distance of 3m at a fixed height of 1m. Measurement equipment was located outside of the chamber. A video camera was placed inside the chamber to view the EUT.

Pres-scans were performed to determine the worst case configuration for data rate.

4.5.1.2 Final Test

For each frequency measured, the peak emission was maximized by manipulating the receiving antenna from 1 to 4 meters above the ground plane and placing it at the position that produced the maximum signal strength reading. The turntable was then rotated through 360° while observing the peak signal and placing the EUT at the position that produced maximum radiation. The six highest emissions relative to the limit were measured unless such emissions were more than 20 dB below the limit. If less than six emissions are within 20 dB of the limit, than the noise level of the receiver is measured at frequencies where emissions are expected. Multiples of all oscillator and microprocessor frequencies were also checked.

Final testing was performed on an NSA compliant test site. The EUT was placed on a 1.0m x 1.5m non-conductive table 80cm (<1 GHz) and 150cm (>1 GHz) above the ground plane. The placement of EUT and cables were the same as for preliminary testing and is shown in the setup photographs.

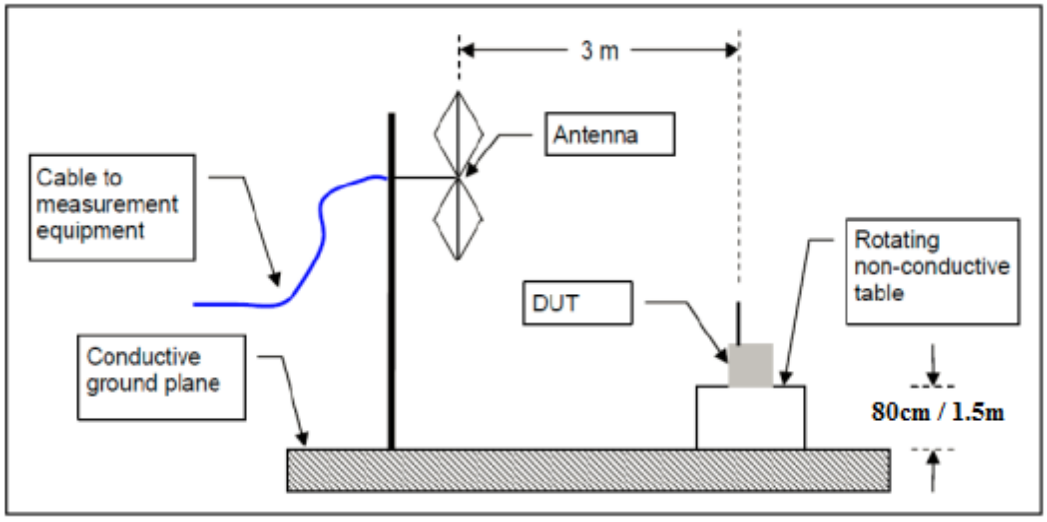
The final scans performed on the worst axis, Y-Axis up, for three operating channels in each operating mode;

2402 MHz, 2442 MHz, and 2480 MHz in the DH1 and DH5; worst case.

4.5.1.3 Deviations

None.

Test Setup:



4.5.2 Transmitter Spurious Emission Limit

The spurious emissions of the transmitter shall not exceed the values in CFR47 Part 15.205, 15.209: 2021 and RSS Gen Sect. 8.10: 2019.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490.....	2400/F(kHz)	300
0.490-1.705.....	24000/F(kHz)	30
1.705-30.0.....	30	30
30-88.....	100 **	3
88-216.....	150 **	3
216-960.....	200 **	3
Above 960.....	500	3

All harmonics and spurious emission which are outside of the restricted band shall be 20dB below the in-band emission.

4.5.3 Test Results

The final measurement data was taken under the worst case operating modes, configurations, and/or cable positions. It also reflects the results including any modifications and/or special accessories listed in Sections 1.4 and test plan.

As originally tested, the EUT was found to be compliant to the requirements of the test standard(s).

Table 5: Transmit Spurious Emissions at Band-Edge Requirements (**DH1)**

Test Date: May 29, 2023	**Test By: James Ma**
Test Method: Radiated Measurements	**Power Setting:** Level 4 dBm
Antenna Type: Unique Connector Cable	**Max. Antenna Gain:** 4.0 dBi
Operating Mode: Uncorrelated	**Signal State**: Modulated
Ambient Temp.: 23 °C	**Relative Humidity:** 44%

Band-Edge Results for DH1

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Pol (H/V)	Reading AV (dBuV/m)	Reading PK (dBuV/m)	Factor (dB)	Level AV (dBuV/m)	Level PK dB(uV/m)	Limit AV (dBuV/m)	Limit PK (dBuV/m)	Margin AV (dB)	Margin PK (dB)	Hght (cm)	Angle (Deg)	Pass/ Fail
1	2390	H	-2.0	11.7	36.5	34.5	48.2	54	74	-19.5	-25.8	110	19.1	Pass
2	2390	V	-2.0	12.0	36.5	34.5	48.5	54	74	-19.5	-25.5	101	0.1	Pass
3	2402	V	46.1	56.7	36.5	82.6	93.2	54	74			101	251.7	N/A*
4	2402	H	50.8	61.4	36.5	87.3	97.9	54	74			145	312.1	N/A*
5	2480	V	48.6	59.3	36.8	85.4	96.1	54	74			101	189	N/A*
6	2480	H	50.1	60.7	36.8	86.9	97.5	54	74			112	345	N/A*
7	2483.5	H	-1.4	13.2	36.8	35.4	50.0	54	74	-18.6	-24.0	100	162.3	Pass
8	2483.5	V	-1.5	12.6	36.8	35.3	49.4	54	74	-18.7	-24.6	101	184.8	Pass

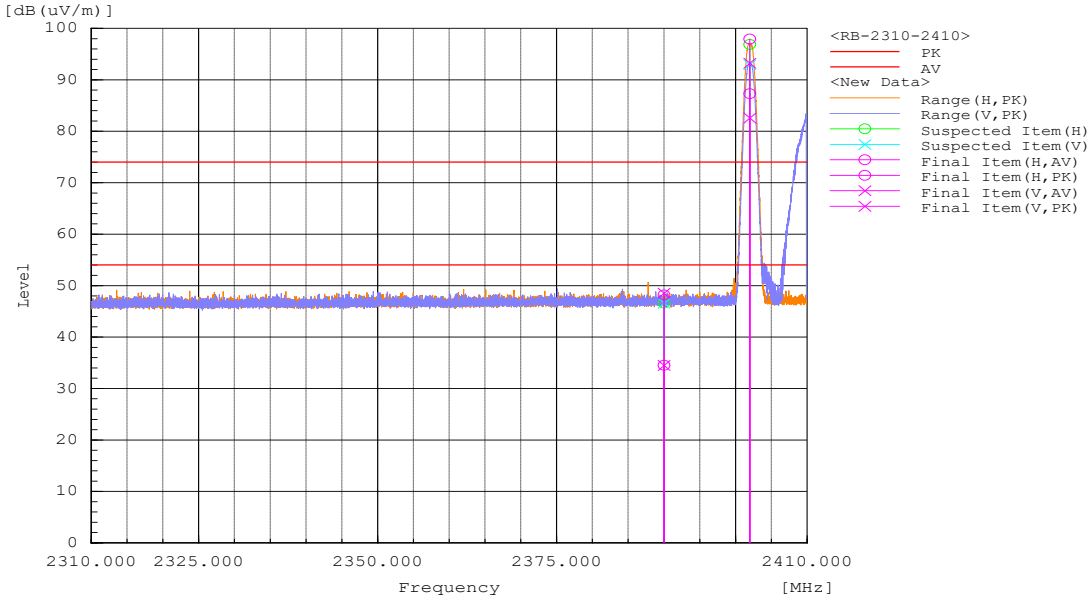
Note: The emissions were measured at the adjacent restricted band of the fundamental signal.
All the band-edge measurements met the restricted band requirements of CFR47 15.205
Band-edge measurement plots use a wider span than 2 MHz to evaluate additional spectrum bands for in-band leakage and spurious emission.

(*) Fundamental/ Inband emission.

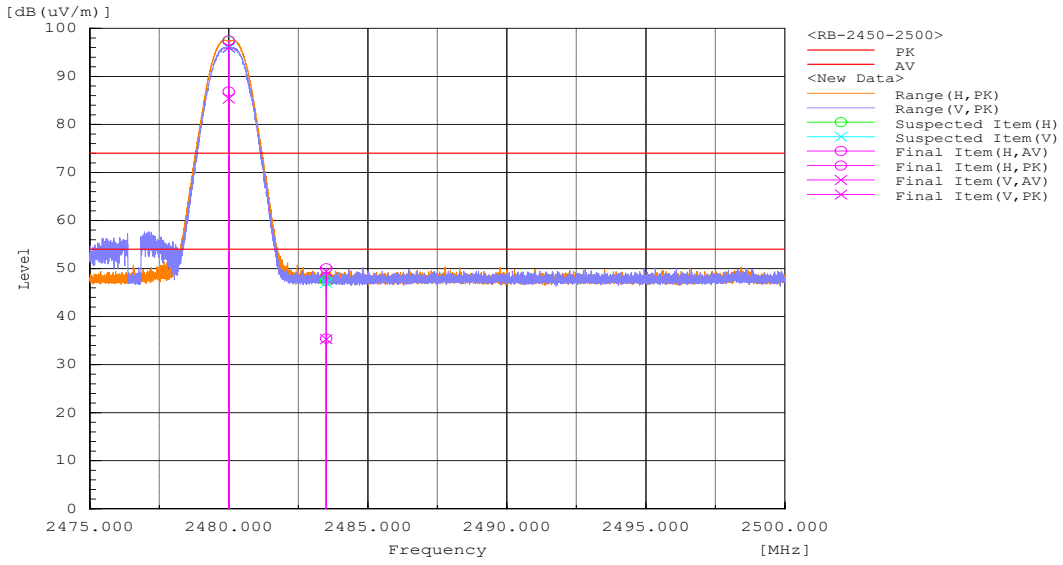
Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)

AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).

Margin value = Emission level – Limit value.



Band-edge - 2402 MHz

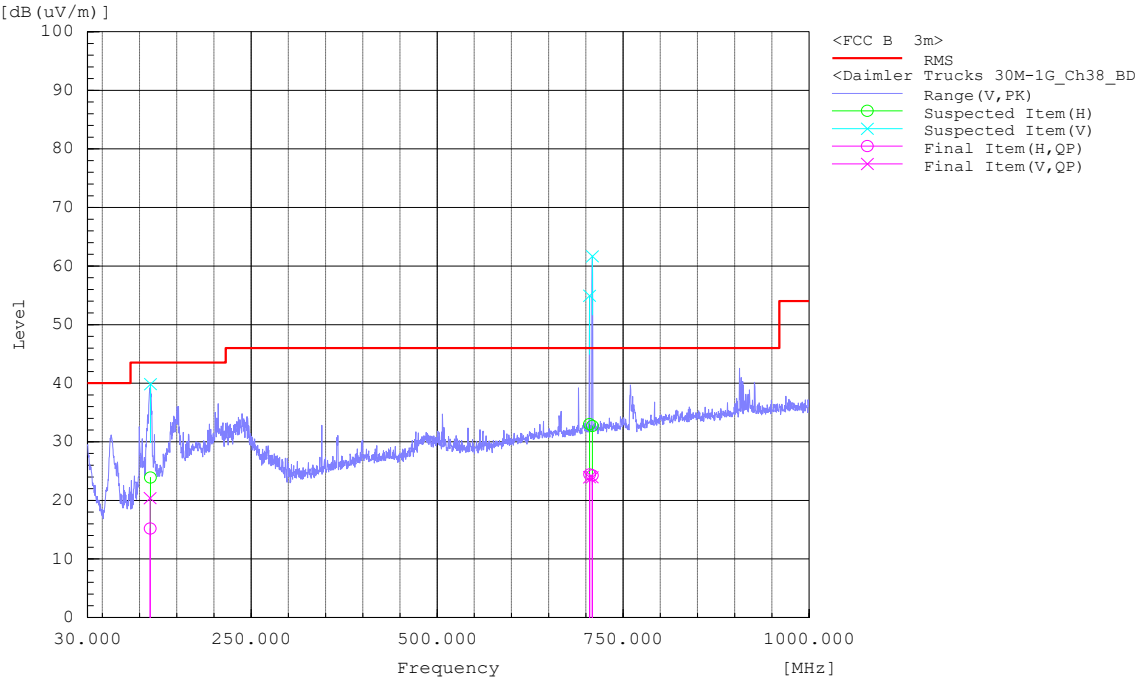


Band-edge – 2480 MHz

Radiated Emissions			
EUT Name	CTP2019DTNA	**Date**	05/29/2023
EUT Model	CTP19TNv3	**Temp / Hum in**	23°C / 40% RH
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	EUT on Vertical Position	**Line AC / Freq**	N/A
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	120 kHz/ 300 kHz
Dist/Ant Used	3m / JB6	**Performed by**	James Ma

Frequency [MHz]	Pol V/H	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
114.202	V	-2.3	22.7	20.4	43.5	-23.1	119.4	168.5
114.258	H	-7.4	22.6	15.2	43.5	-28.3	197.1	319.5
705.163	H	-9.3	33.7	24.4	46.0	-21.6	383.0	11.6
704.818	V	-9.3	33.3	24.0	46.0	-22.0	152.7	55.5
708.401	V	-9.3	33.3	24.0	46.0	-22.0	399.2	357.8
708.594	H	-9.3	33.6	24.3	46.0	-21.7	128.5	197.6

DH1 (30 M- 1GHz)

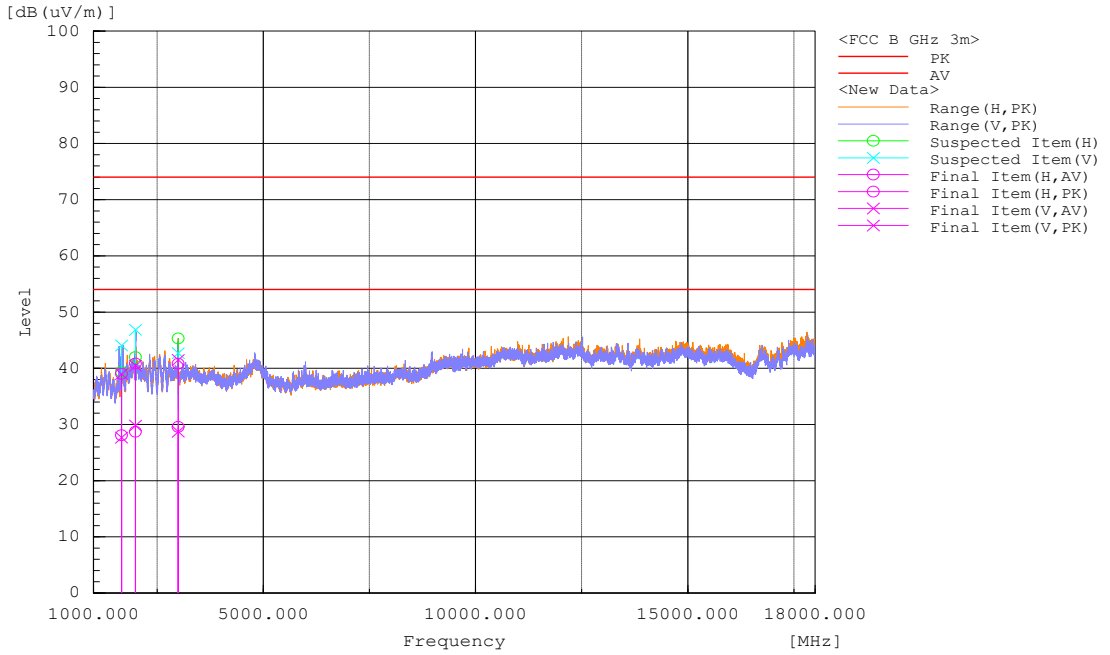


Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 3.51 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Note: The worst case emission was observed on Channel 2442 MHz.

Radiated Emissions			
EUT Name	CTP2019DTNA	**Date**	05/29/2023
EUT Model	CTP19TNv3	**Temp / Hum in**	23°C / 40% RH
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	EUT on Vertical Position	**Line AC / Freq**	N/A
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz / 3 MHz
Dist/Ant Used	3m / 3117	**Performed by**	James Ma

Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
1660.615	H	42.2	53.1	-14.1	28.1	39.0	54	74	-25.9	-35.0
1661.805	V	41.8	53.1	-14.1	27.7	39.0	54	74	-26.3	-35.0
1989.689	V	41.5	52.2	-11.7	29.8	40.5	54	74	-24.2	-33.5
1989.847	H	40.4	52.5	-11.7	28.7	40.8	54	74	-25.3	-33.2
2996.152	H	40.6	51.8	-11.0	29.6	40.8	54	74	-24.4	-33.2
2997.812	V	39.7	52.5	-11.0	28.7	41.5	54	74	-25.3	-32.5

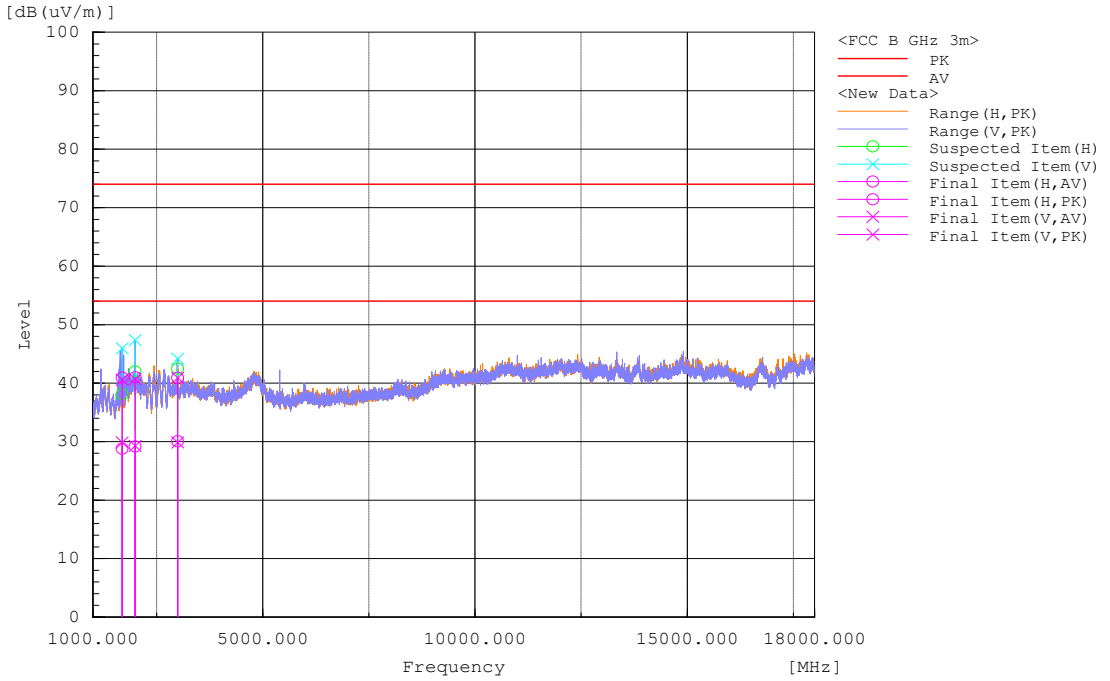
Transmitted Data at 2402 MHz (**DH1 1-18 GHz)**



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2442 MHz (**DH1 1-18 GHz)**

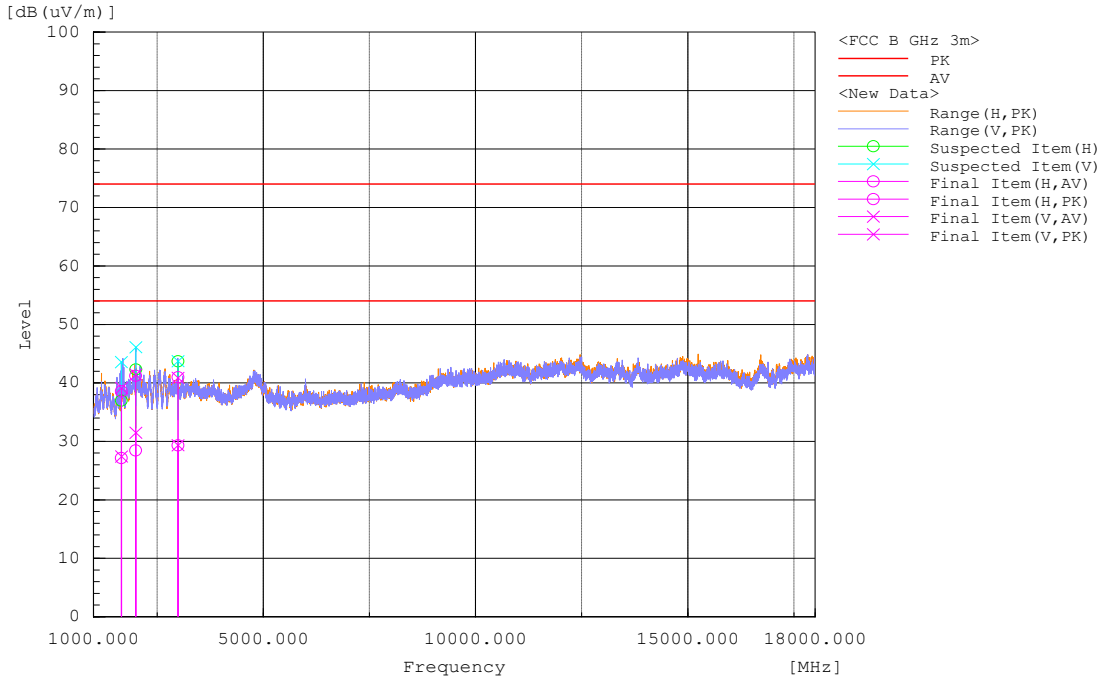
Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
1688.361	V	43.6	54.3	-13.7	29.9	40.6	54	74	-24.1	-33.4
1688.384	H	42.5	54.6	-13.7	28.8	40.9	54	74	-25.2	-33.1
1992.131	H	40.9	52.7	-11.7	29.2	41.0	54	74	-24.8	-33.0
1993.735	V	41.0	52.4	-11.7	29.3	40.7	54	74	-24.7	-33.3
2994.474	V	40.9	51.9	-11.0	29.9	40.9	54	74	-24.1	-33.1
2994.393	H	41.1	51.9	-11.0	30.1	40.9	54	74	-23.9	-33.1



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2480 MHz (**DH1 1-18 GHz)**

Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
1658.471	H	41.2	52.7	-14.1	27.1	38.6	54	74	-26.9	-35.4
1659.057	V	41.5	53.2	-14.1	27.4	39.1	54	74	-26.6	-34.9
1996.367	V	43.2	53.1	-11.7	31.5	41.4	54	74	-22.5	-32.6
1995.302	H	40.1	52.9	-11.7	28.4	41.2	54	74	-25.6	-32.8
2992.918	H	40.3	52.0	-11.0	29.3	41.0	54	74	-24.7	-33.0
2992.454	V	40.4	51.9	-11.0	29.4	40.9	54	74	-24.6	-33.1

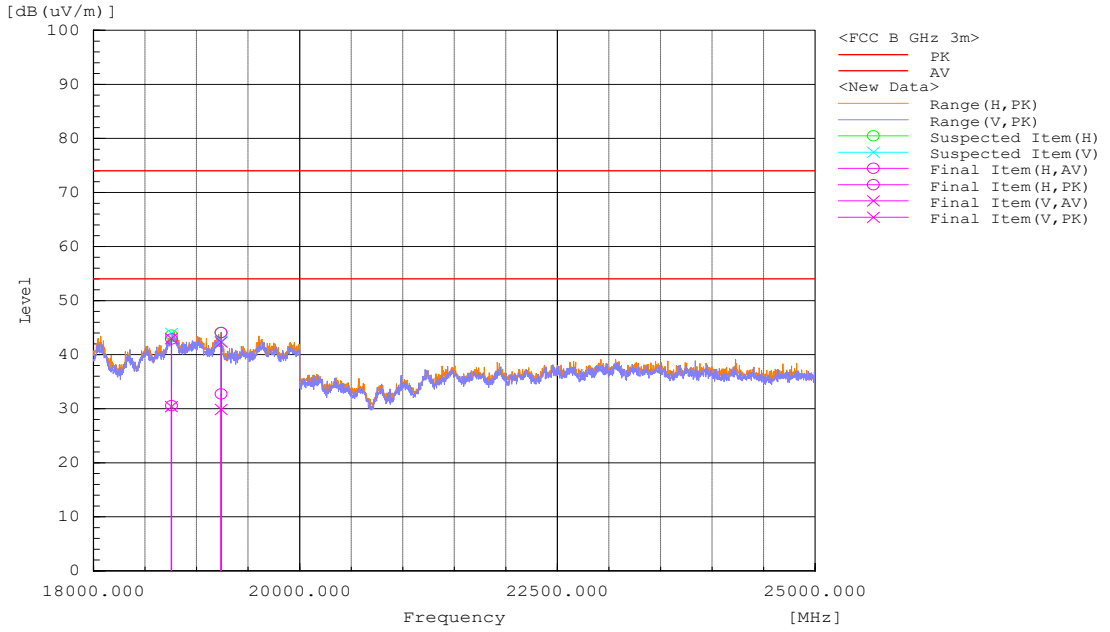


Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Radiated Emissions			
EUT Name	CTP2019DTNA	**Date**	05/29/2023
EUT Model	CTP19TNv3	**Temp / Hum in**	23°C / 40% RH
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	EUT on Vertical Position	**Line AC / Freq**	N/A
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz / 3 MHz
Dist/Ant Used	3m / SAS-574	**Performed by**	James Ma

Transmitted Data at 2402 MHz (**DH1 18-25 GHz)**

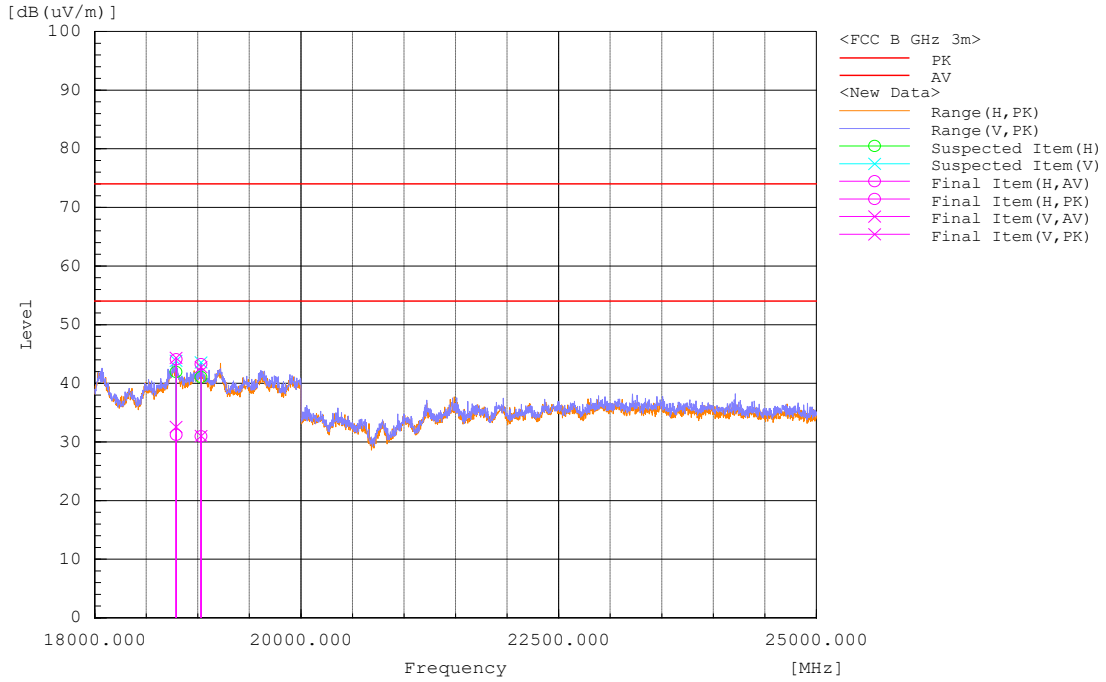
Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
18755.812	V	15.7	28.3	14.7	30.4	43.0	54	74	-23.6	-31.0
18757.094	H	15.9	28.3	14.6	30.5	42.9	54	74	-23.5	-31.1
19238.566	H	19.0	30.4	13.7	32.7	44.1	54	74	-21.3	-29.9
19237.556	V	16.1	28.5	13.8	29.9	42.3	54	74	-24.1	-31.7



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2442 MHz (**DH1 18-25 GHz)**

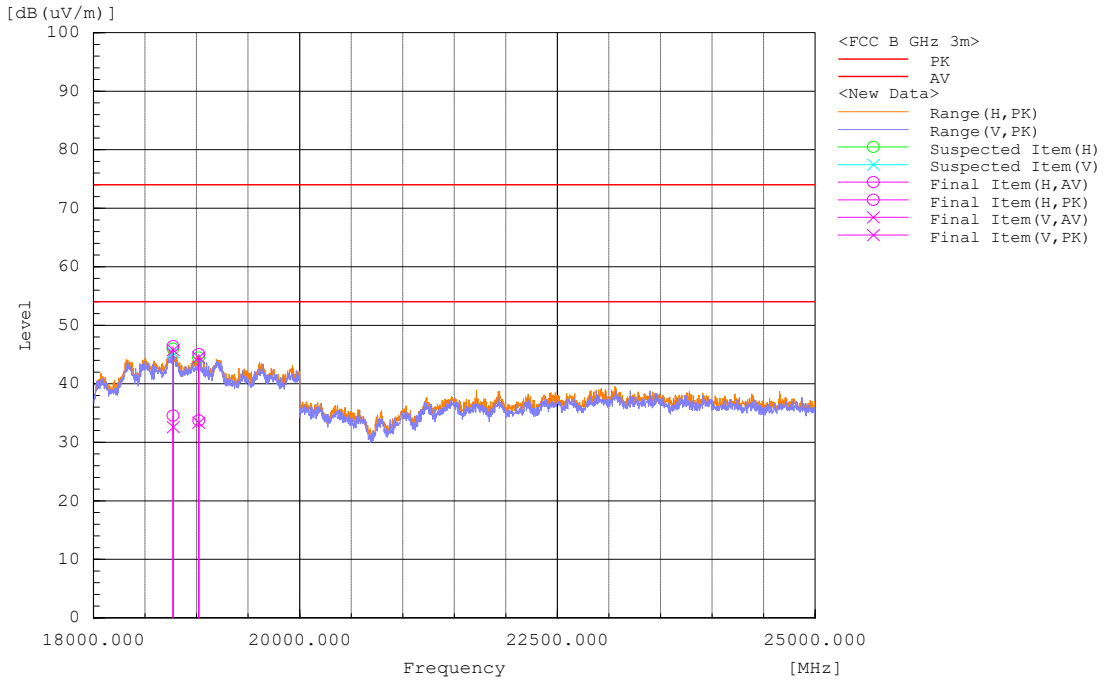
Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
18789.36	V	18.0	29.7	14.6	32.6	44.3	54	74	-21.4	-29.7
18789.614	H	16.6	29.5	14.6	31.2	44.1	54	74	-22.8	-29.9
19030.368	H	17.0	29.3	14.0	31.0	43.3	54	74	-23.0	-30.7
19031.33	V	17.1	28.9	13.9	31.0	42.8	54	74	-23.0	-31.2



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2480 MHz (**DH1 18-25 GHz)**

Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
18772.512	H	19.8	31.7	14.7	34.5	46.4	54	74	-19.5	-27.6
18774.066	V	17.9	31.1	14.7	32.6	45.8	54	74	-21.4	-28.2
19020.528	V	18.9	30.1	14.4	33.3	44.5	54	74	-20.7	-29.5
19021.022	H	19.3	30.7	14.4	33.7	45.1	54	74	-20.3	-28.9



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Table 6: Transmit Spurious Emissions at Band-Edge Requirements **(DH5)**

Test Date: May 29, 2023	**Test By: James Ma**
Test Method: Radiated Measurements	**Power Setting:** Level 4 dBm
Antenna Type: Unique Connector Cable	**Max. Antenna Gain:** 4.0 dBi
Operating Mode: Uncorrelated	**Signal State**: Modulated
Ambient Temp.: 23 °C	**Relative Humidity:** 44%

Band-Edge Results for DH3

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Pol (H/V)	Reading AV (dBuV/m)	Reading PK (dBuV/m)	Factor (dB)	Level AV (dBuV/m)	Level PK dB(uV/m)	Limit AV (dBuV/m)	Limit PK (dBuV/m)	Margin AV (dB)	Margin PK (dB)	Hght (cm)	Angle (Deg)	Pass/ Fail
1	2390	H	-1.7	12.6	36.5	34.8	49.1	54	74	-19.2	-24.9	182	301.4	Pass
2	2390	V	-1.9	12.1	36.5	34.6	48.6	54	74	-19.4	-25.4	200	237.6	Pass
3	2402	V	56.5	62.5	36.5	93.0	99.0	54	74			100	226.7	N/A*
4	2402	H	57.4	63.4	36.5	93.9	99.9	54	74			104	101.4	N/A*
5	2480	V	55.6	61.6	36.8	92.4	98.4	54	74			104	225.8	N/A*
6	2480	H	54.3	60.3	36.8	91.1	97.1	54	74			130	184.1	N/A*
7	2483.5	V	-1.2	13.3	36.8	35.6	50.1	54	74	-18.4	-23.9	156	354.1	Pass
8	2483.5	H	-0.6	14.2	36.8	36.2	51.0	54	74	-17.8	-23.0	170	195.3	Pass

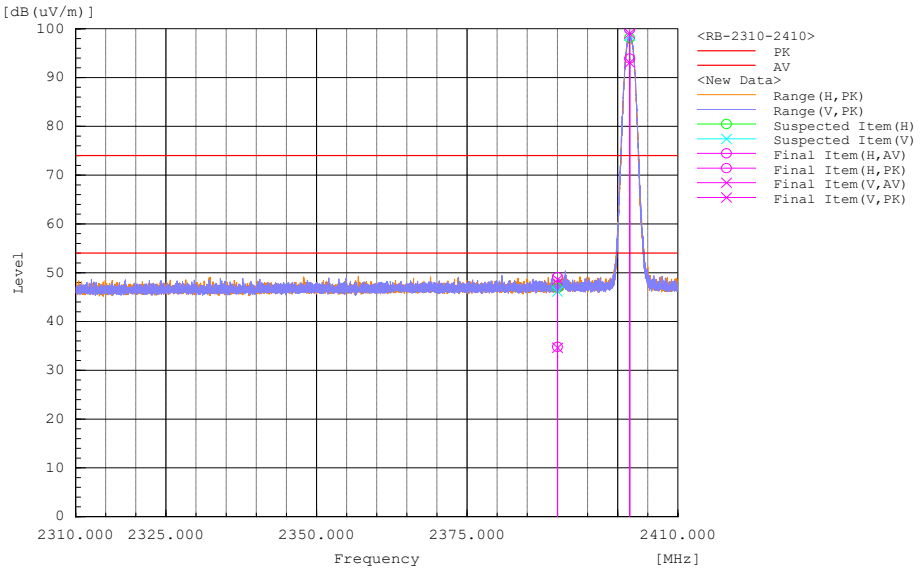
Note: The emissions were measured at the adjacent restricted band of the fundamental signal.
All the band-edge measurements met the restricted band requirements of CFR47 15.205
Band-edge measurement plots use a wider span than 2 MHz to evaluate additional spectrum bands for in-band leakage and spurious emission.

(*) Fundamental/ Inband emission.

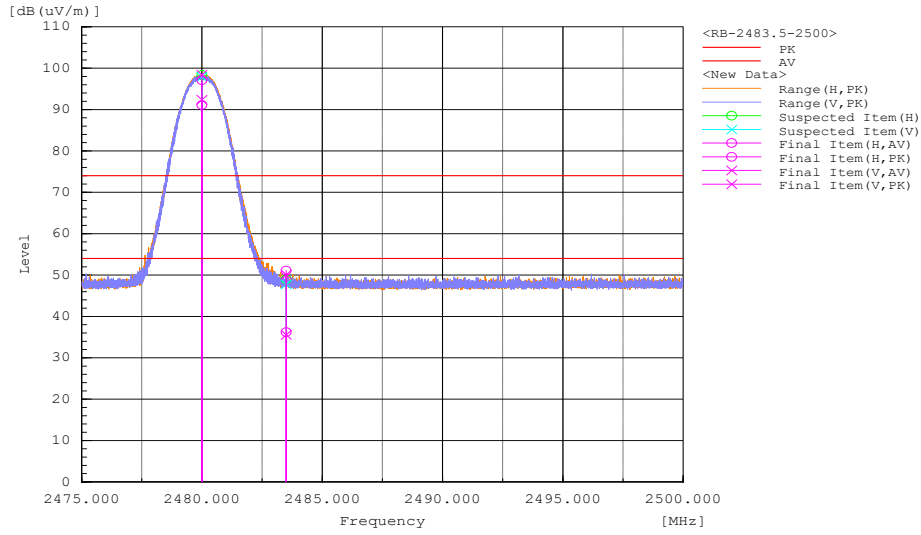
Emission level (dBuV/m) = Reading Value (dBuV) + Factor (dB)

AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).

Margin value = Emission level – Limit value.



Band-edge - 2402 MHz

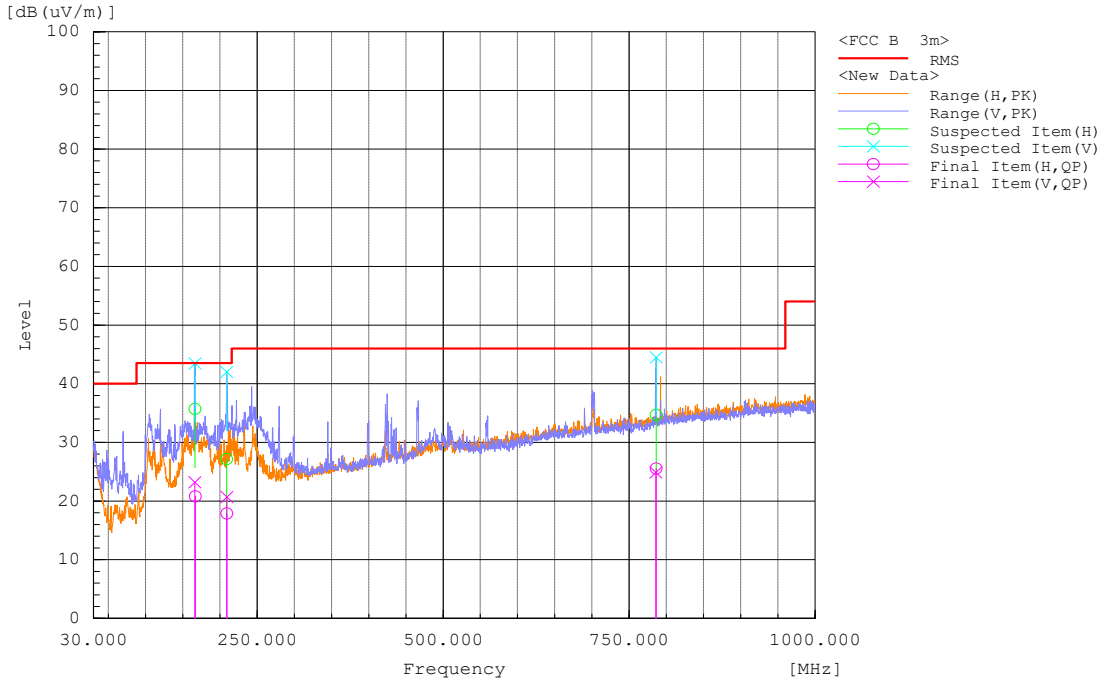


Band-edge-2480 MHz

Radiated Emissions			
EUT Name	CTP2019DTNA	**Date**	05/29/2023
EUT Model	CTP19TNv3	**Temp / Hum in**	23°C / 40% RH
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	EUT on Vertical Position	**Line AC / Freq**	N/A
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	120 kHz/ 300 kHz
Dist/Ant Used	3m / JB6	**Performed by**	James Ma

DH5 (30 M- 1GHz)

Frequency [MHz]	Pol V/H	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
166.235	V	0.5	22.7	23.2	43.5	-20.3	109.9	129.2
166.978	H	-1.6	22.4	20.8	43.5	-22.7	179.0	262.4
209.347	H	-3.4	21.3	17.9	43.5	-25.6	165.7	229.2
209.373	V	-0.8	21.5	20.7	43.5	-22.8	110.6	266.6
785.964	V	-9.2	34.1	24.9	46	-21.1	347.3	358.4
786.301	H	-9.2	34.7	25.5	46	-20.5	222.7	218.5

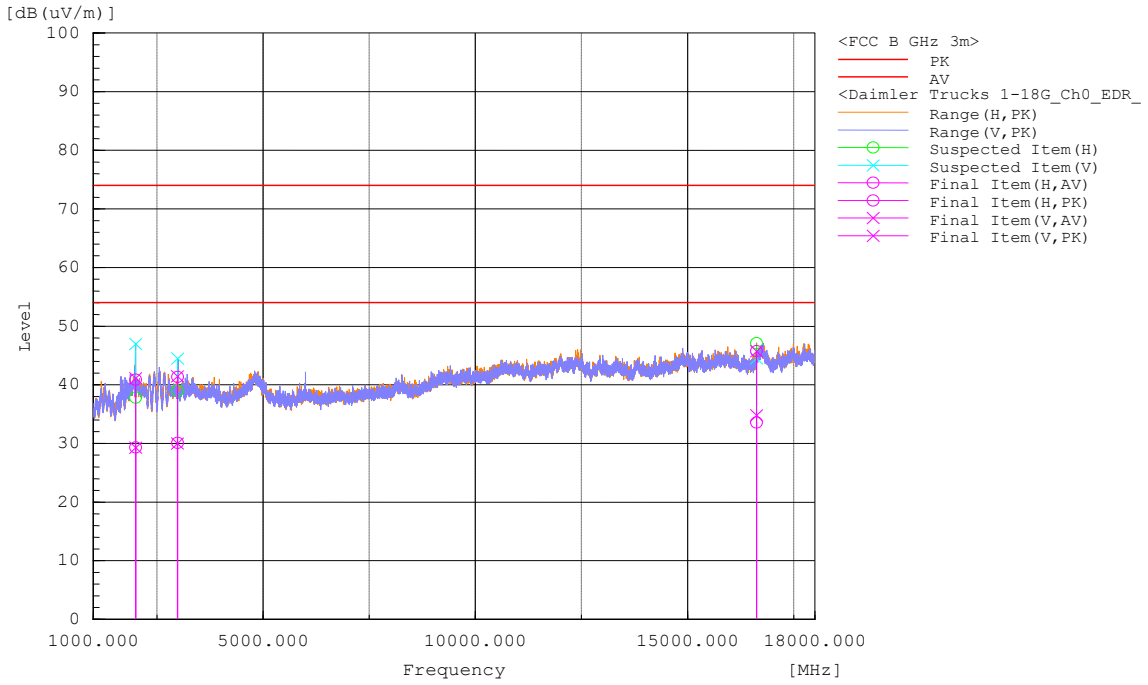


Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 3.51 dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Note: The worst case emission was observed on Channel 2442 MHz.

Radiated Emissions			
EUT Name	CTP2019DTNA	**Date**	05/29/2023
EUT Model	CTP19TNv3	**Temp / Hum in**	23°C / 40% RH
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	EUT on Vertical Position	**Line AC / Freq**	N/A
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz / 3 MHz
Dist/Ant Used	3m / 3117	**Performed by**	James Ma

Transmitted Data at 2402 MHz **(DH5 _ 1-18 GHz)**

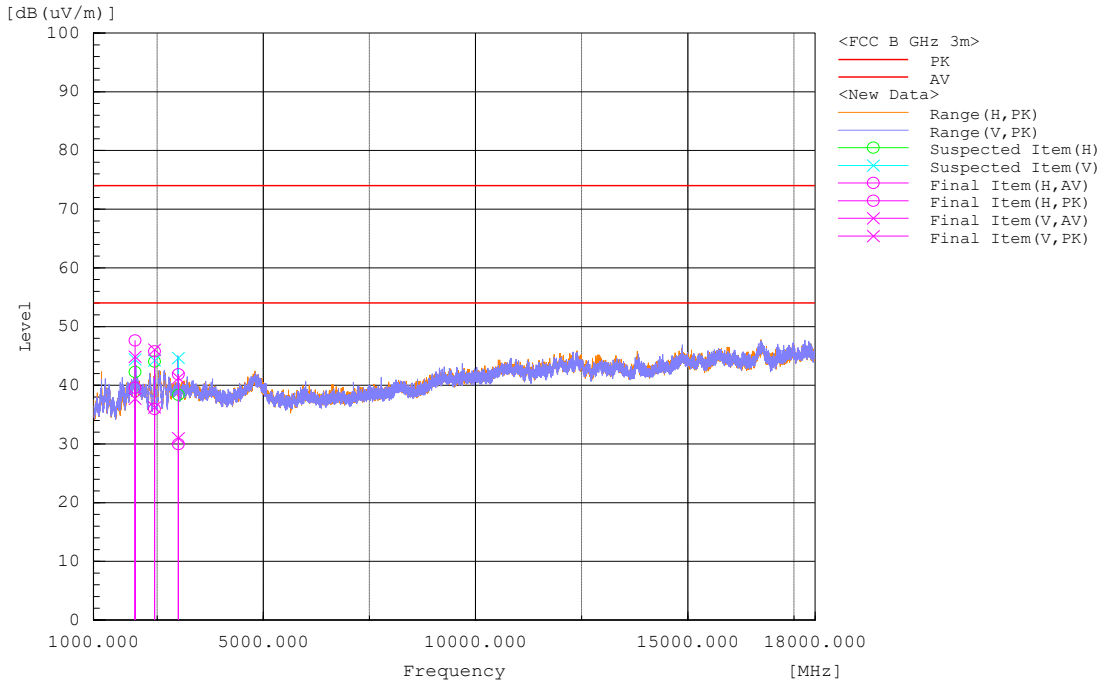
Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
1998.946	V	41.0	52.8	-11.7	29.3	41.1	54	74	-24.7	-32.9
1998.72	H	41.0	52.6	-11.7	29.3	40.9	54	74	-24.7	-33.1
2985.702	H	41.1	52.3	-11.0	30.1	41.3	54	74	-23.9	-32.7
2984.223	V	41.0	52.5	-11.0	30.0	41.5	54	74	-24.0	-32.5
16622.795	V	32.2	43.2	2.6	34.8	45.8	54	74	-19.2	-28.2
16622.935	H	31.0	43.1	2.6	33.6	45.7	54	74	-20.4	-28.3



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2442 MHz (**DH5 _ 1-18 GHz)**

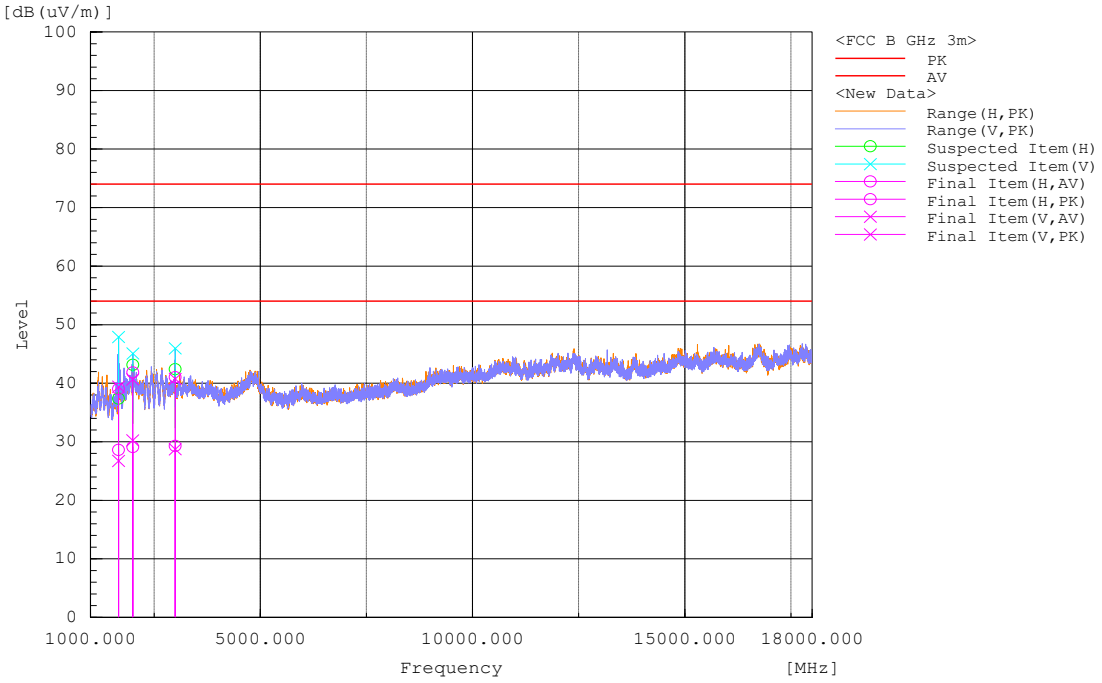
Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
1980.019	H	51.3	59.3	-11.7	39.6	47.6	54	74	-14.4	-26.4
1980.068	V	49.4	56.6	-11.7	37.7	44.9	54	74	-16.3	-29.1
2440.001	V	47.7	57.6	-11.5	36.2	46.1	54	74	-17.8	-27.9
2440.063	H	47.5	57.3	-11.5	36.0	45.8	54	74	-18.0	-28.2
2999.04	V	42.0	52.3	-11.0	31.0	41.3	54	74	-23.0	-32.7
2998.385	H	41.0	52.9	-11.0	30.0	41.9	54	74	-24.0	-32.1



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2480 MHz (**DH5 _1-18 GHz)**

Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
1662.887	H	42.7	53.1	-14.1	28.6	39.0	54	74	-25.4	-35.0
1662.437	V	40.8	53.5	-14.1	26.7	39.4	54	74	-27.3	-34.6
1995.535	V	41.9	52.4	-11.7	30.2	40.7	54	74	-23.8	-33.3
1996.119	H	40.8	53.5	-11.7	29.1	41.8	54	74	-24.9	-32.2
2996.037	H	40.3	52.0	-11.0	29.3	41.0	54	74	-24.7	-33.0
2996.7	V	39.7	51.7	-11.0	28.7	40.7	54	74	-25.3	-33.3

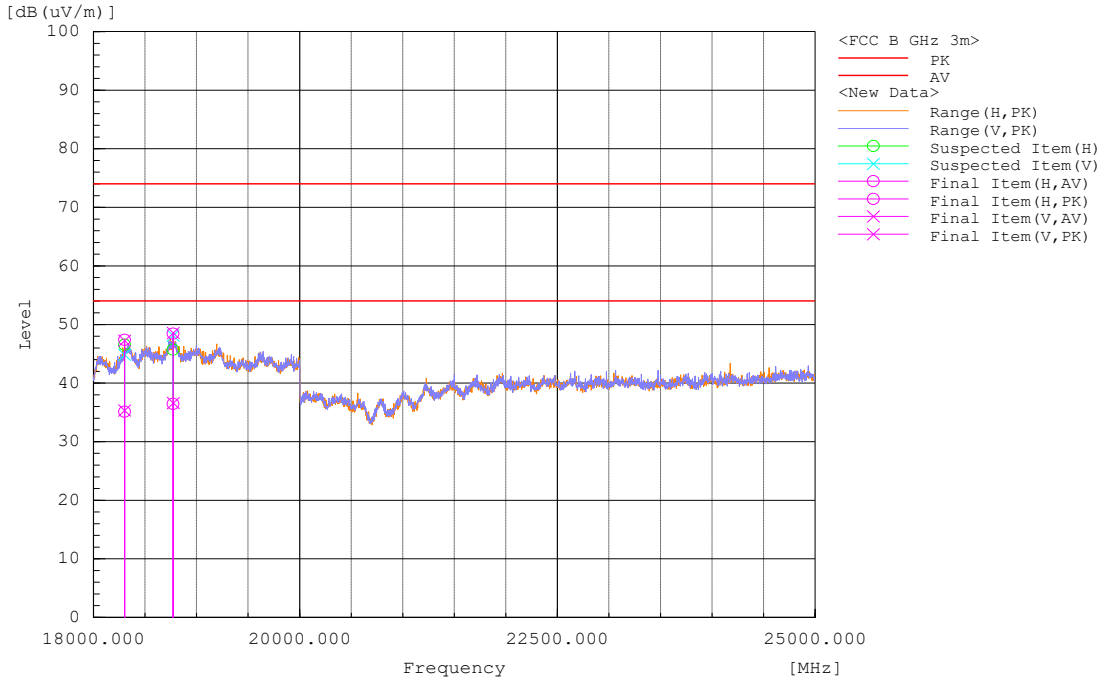


Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Radiated Emissions			
EUT Name	CTP2019DTNA	**Date**	05/29/2023
EUT Model	CTP19TNv3	**Temp / Hum in**	23°C / 40% RH
EUT Serial	N/A	**Temp / Hum out**	N/A
EUT Config.	EUT on Vertical Position	**Line AC / Freq**	N/A
Standard	CFR47 Part 15 Subpart C	**RBW / VBW**	1 MHz / 3 MHz
Dist/Ant Used	3m / SAS-574	**Performed by**	James Ma

Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
18301.658	H	19.8	32.1	15.3	35.1	47.4	54	74	-18.9	-26.6
18300.808	V	20.1	31.9	15.2	35.3	47.2	54	74	-18.7	-26.8
18773.502	V	21.9	33.9	14.7	36.6	48.6	54	74	-17.4	-25.4
18772.032	H	21.7	33.7	14.7	36.4	48.4	54	74	-17.6	-25.6

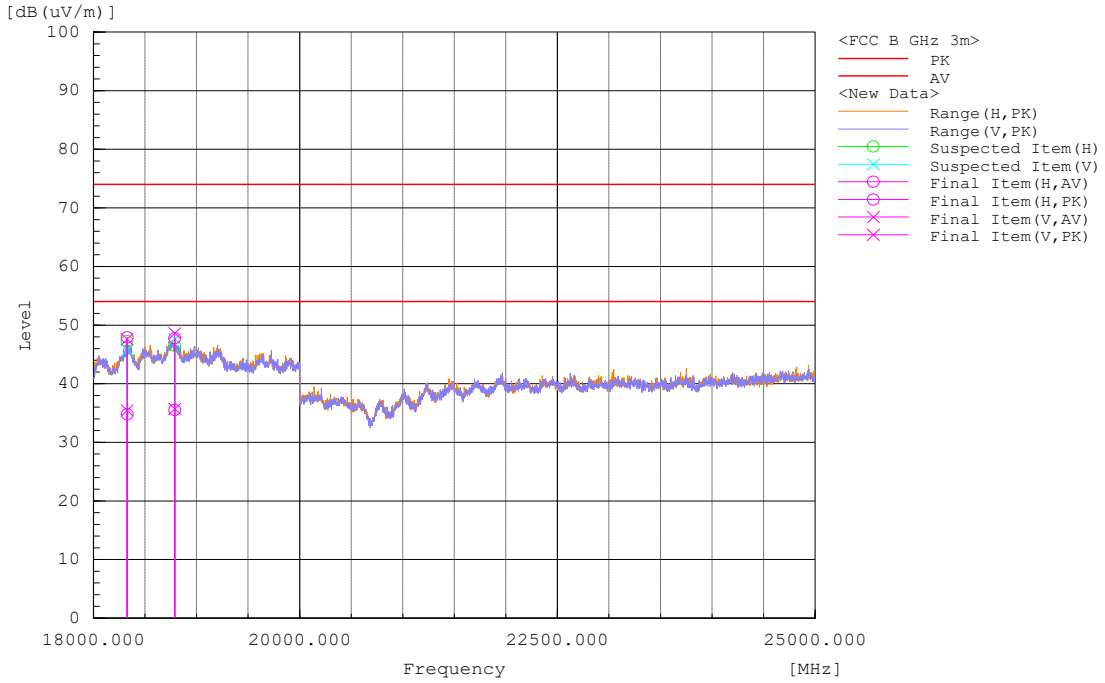
Transmitted Data at 2402 MHz **(DH5_18 - 25 GHz)**



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2442 MHz **(DH5_18 - 25 GHz)**

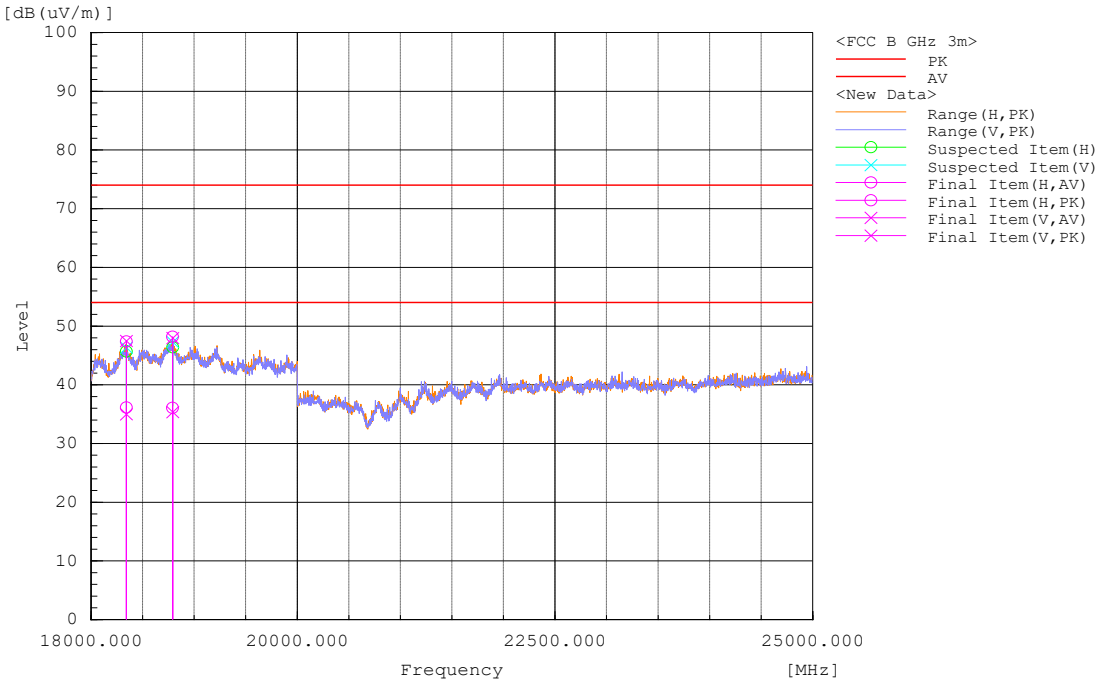
Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
18326.69	H	19.4	32.5	15.4	34.8	47.9	54	74	-19.2	-26.1
18325.57	V	20.0	32.2	15.4	35.4	47.6	54	74	-18.6	-26.4
18788.836	V	21.1	34.0	14.6	35.7	48.6	54	74	-18.3	-25.4
18788.652	H	20.9	33.2	14.6	35.5	47.8	54	74	-18.5	-26.2



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

Transmitted Data at 2480 MHz **(DH5_18 - 25 GHz)**

Frequency [MHz]	Pol V/H	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit\AV [dB(uV/m)]	Limit\PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]
18342.04	V	19.8	32.3	15.2	35.0	47.5	54	74	-19.0	-26.5
18341.642	H	20.9	32.2	15.2	36.1	47.4	54	74	-17.9	-26.6
18790.986	H	21.6	33.7	14.5	36.1	48.2	54	74	-17.9	-25.8
18791.996	V	20.8	33.4	14.6	35.4	48.0	54	74	-18.6	-26.0



Spec Margin = Level - Limit, Level = Raw+ Cbl+ CF ± Uncertainty CF= Amp Gain + ANT Factor
Combined Standard Uncertainty $u_c(y)$ = ± 4.91dB Expanded Uncertainty $U = ku_c(y)$ k = 2 for 95% confidence
Notes: All emissions passed the spurious emission limit. (*) Non-restricted band emission

4.5.4 Sample Calculation

The field strength is calculated by subtracting the Amplifier Gain and adding the Cable Loss and Antenna Correction Factor to the measured reading. The basic equation is as follows:

Field Strength (dBμV/m) = FIM - AMP + CBL + ACF

Where: FIM = Field Intensity Meter (dBμV)

AMP = Amplifier Gain (dB)

CBL = Cable Loss (dB)

ACF = Antenna Correction Factor (dB/m)

$$\mu V/m = 10^{\frac{dB\mu V/m}{20}}$$

4.6 AC Conducted Emissions

Testing was performed in accordance with ANSI C63.10: 2013. These test methods are listed under the laboratory's A2LA Scope of Accreditation.

This test measures the levels emanating from the EUT's AC input port, thus evaluating the potential for the EUT to cause radio frequency interference to other electronic devices.

The AC conducted emissions of equipment under test shall not exceed the values in CFR47 Part 15.207: 2023 and RSS Gen Issue 5 Sect. 8.8.

4.6.1 Test Methodology

A test program that controls instrumentation and data logging was used to automate the AC Power Line Conducted emission test procedure. The frequency range of interest was divided into sub-ranges such as to yield a frequency resolution of 9 kHz. Each phase and neutral of the AC power line were measured with respect to ground. Measurements were performed using a set of 50μH / 50Ω LISNs.

Testing is performed in Conducted Emission Station. The setup photographs clearly identify which site was used. The vertical ground plane used in the semi-anechoic chamber is a 2m x 2m solid aluminum frame and panel, and it is bonded to the horizontal ground plane.

In the case of tabletop equipment, the EUT is placed on a 1.0m x 1.5m non-conductive table 80cm above the ground plane and 40cm from a vertical ground reference plane. The rear of the EUT was positioned flush with the backside of the table and directly over the LISNs. The power and I/O cables were routed over the edge of the table and bundled approximately 40cm from the ground plane. Support equipment was powered from a separate LISN.

4.6.1.1 Deviations

There were no deviations from this test methodology.

4.6.2 Test Results

N/A (EUT IS NOT CONNECTED AC POWER LINE).

5 Test Equipment List

5.1 Equipment List

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Receiver Rohde and Schwarz	ESW44	1328.4100K-101662-MH	09/20/2022	09/20/2024
PXA Signal Analyzer KEYSIGHT	N9030B	MY57140374	07/20/2022	07/20/2024
Biconilog Antenna Sunol	JB6	A111717	09/22/2022	09/22/2024
Horn Antenna ETS-Lindgren	3117	218554	08/11/2022	08/11/2024
The EMC Shop	PA18G-HA	001337	12/20/2022	12/20/2024
DRG Horn Antenna	SAS574	579	09/22/2022	09/22/2024
The EMC Shop	PA40G	17610-01	07/08/2022	07/08/2024

Test software used: Toyo Corporation: Radiated Emission EP7/RE Ver 8.0.1 30

6 EMC Test Plan

6.1 Introduction

This section provides a description of the Equipment Under Test (EUT), configurations, operating conditions, and performance acceptance criteria. It is an overview of information provided by the manufacturer so that the test laboratory may perform the requested testing.

6.2 Customer

Table 7: Customer Information

Company Name	Daimler Truck North America LLC
Address	4555 N. Channel Ave,
City, State, Zip	PORTLAND OR 97217-3849 USA
Country	USA

6.3 Equipment Under Test (EUT)

Table 8: General Description of EUT

<table>
<tr><td>Product/ PMN</td><td>CTP2019DTNA</td></tr>
<tr><td>Brand</td><td>CTP</td></tr>
<tr><td>Test Model / HVIN</td><td>CTP19TNv3</td></tr>
<tr><td>Identification No. of EUT</td><td>A6633000000
Or A6633000500</td></tr>
<tr><td>Status of EUT</td><td>Engineering sample</td></tr>
<tr><td>Power Supply Rating</td><td>12 V input is expected from vehicles. Supports 8V to 32V</td></tr>
<tr><td>Temperature Operating Range</td><td>-35C to 75C</td></tr>
<tr><td>BT/WLAN Module</td><td>
<table>
<tr><td colspan="2">Model</td><td>UGKZ7A10</td></tr>
<tr><td colspan="2">Manufacturer</td><td>ALPS</td></tr>
<tr><td rowspan="5">WiFi</td><td>Frequency</td><td>2412 to 2462MHz for 802.11b/g/n</td></tr>
<tr><td>Channel Bandwidth</td><td>20 MHz</td></tr>
<tr><td>Modulation</td><td>802.11b – BPSK, QPSK, CCK, DSSS
802.11g – BPSK, QPSK, 16/64QAM, OFDM
802.11n – HT mode MCS0-7</td></tr>
<tr><td>Data rate max</td><td>802.11b – 11Mbps
802.11g – 54Mbps
802.11n – 72.2Mbps</td></tr>
<tr><td>Output Level</td><td>802.11b – +15dBm
802.11g – +13dBm
802.11n – +11dBm</td></tr>
<tr><td rowspan="2">BT</td><td>Sensitivity</td><td>802.11b – -90dBm
802.11g – -74dBm
802.11n – -72dBm</td></tr>
<tr><td>Frequency</td><td>2402 ~2480MHz</td></tr>
<tr><td></td><td>Channel Spacing</td><td>Normal mode – 1MHz
BLE mode –2MHz</td></tr>
</table>
</td></tr>
<tr><td>Antenna Information</td><td>
<table>
<tr><td>ANTENNA-CABLE, WIFI/BT, INT</td><td>A66-12157-000</td><td>2400-2485 MHz
5150-5925 MHz</td><td>30 dBm</td><td>Antenna Type: WiFi/BT
2400-2485 MHz: 4.0 dBi
5150-5925 MHz: 5.0 dBi</td></tr>
</table>
</td></tr>
<tr><td colspan="2">Note: The above radio information is for the BT/ WLAN radio module inside CTP19TNv3.
This report is only document the classic bluetooth radio.</td></tr>
</table>

Table 9: Interface Specifications

Interface Type	Cabled with what type of cable?	Is the cable shielded?	Maximum potential length of the cable?	Metallic (M), Coax (C), Fiber (F), or Not Applicable?
USB	Terminated	☒ Yes	☒ Metric:0.6 m	☒ M

Table 10: Supported Equipment

Equipment	Manufacturer	Model	Serial	Used for
Laptop	Lenovo	T430	PB-8HBRR	Set test mode

Table 11: Final Test Mode for 2402 MHz to 2480 MHz Band

Test	CTP19TNv3
Output Power	2402, 2442, 2480 MHz @ DH1, DH3, DH5
Occupied Bandwidth	2402, 2442, 2480 MHz @ DH1, DH3, DH5
Out-of-Band (-30 dBr)	2402, 2442, 2480 MHz @ DH1
Band-Edge (Radiated)	2402, 2480 MHz @ DH1, DH5
Transmitted Spurious Emission (Radiated)	2402, 2442, 2480 MHz @ DH1, DH5
AC Conducted Emission	N/A
Note: EUT transmits at 29% duty cycle in 1 Mbps mode. As per the client 2DH1, 2DH3, 2DH5, 3DH1, 3DH3, 3DH5 are not supported on the device.	

6.4 Test Specifications

Table 12: Test Specifications

Emissions and Immunity	
Rules & Regulations / Standards	**Requirement**
CFR 47 Part 15.247: 2023	All
RSS 247 Issue 2, 2017	All

END OF REPORT