

# TEST REPORT

of

FCC Part 15 Subpart C §15.247

FCC ID: V2R-TWE5C

Equipment Under Test : True Wireless Earbuds

Model Name : TW-E5C

Variant Model Name(s) : -

Applicant : Cresyn Co., Ltd.

Manufacturer : Cresyn Co., Ltd.

Date of Receipt : 2023.11.07

Date of Test(s) : 2023.11.10 ~ 2023.12.01

Date of Issue : 2023.12.01

In the configuration tested, the EUT complied with the standards specified above. This test report does not assure KOLAS accreditation.

- 1) The results of this test report are effective only to the items tested.
- 2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.
- 3) This test report cannot be reproduced, except in full, without prior written permission of the Company.
- 4) The data marked \* in this report was provided by the customer and may affect the validity of the test results.

We are responsible for all the information of this test report except for the data(\*) provided by the customer.

Tested by:



Dave Kim

Technical  
Manager:



Inho Park

**SGS Korea Co., Ltd. Gunpo Laboratory**



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## 1. General Information

### 1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx>.

Phone No. : +82 31 688 0901

Fax No. : +82 31 688 0921

### 1.2. Details of Applicant

Applicant : Cresyn Co., Ltd.

Address : 5 Gangnam-dearo 107-gil, Seocho-gu, Seoul, South Korea, 06524

Contact Person : Jang, Hyeon-gil

Phone No. : +82 2 2041 2730

### 1.3. Details of Manufacturer

Company : Cresyn Co., Ltd.

Address : 5 Gangnam-dearo 107-gil, Seocho-gu, Seoul, South Korea, 06524

### 1.4. Description of EUT

<b>Kind of Product</b>	True Wireless Earbuds	
<b>Model Name</b>	TW-E5C	
<b>Variant Model Names</b>	-	
<b>Serial Number</b>	Right Conducted Sample: TWE5C_1 Right Radiated Sample: TWE5C_2 Left Conducted Sample: TWE5C_3 Left Radiated Sample: TWE5C_4	
<b>Power Supply</b>	DC 3.7 V	
<b>Frequency Range</b>	2 402 MHz ~ 2 480 MHz (Bluetooth Low Energy)	
<b>Modulation Technique</b>	GFSK	
<b>Number of Channels</b>	40 channels (Bluetooth Low Energy)	
<b>Antenna Type</b>	<b>Right</b>	FPC Antenna
	<b>Left</b>	FPC Antenna
<b>Antenna Gain*</b>	<b>Right</b>	0.16 dB i
	<b>Left</b>	-0.33 dB i
<b>H/W Version</b>	1.0	
<b>S/W Version</b>	1.0	

### 1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Signal Generator	R&S	SMA100B	106887	Oct. 06, 2023	Annual	Oct. 06, 2024
Spectrum Analyzer	R&S	FSV30	103453	Oct. 31, 2023	Annual	Oct. 31, 2024
Spectrum Analyzer	R&S	FSV43	100637	Apr. 06, 2023	Annual	Apr. 06, 2024
Spectrum Analyzer	Agilent	N9020A	MY53421758	Sep. 01, 2023	Annual	Sep. 01, 2024
Attenuator	AEROFLEX / INMET	40AH2W-10	40G-1	Jun. 14, 2023	Annual	Jun. 14, 2024
High Pass Filter	Wainwright Instrument GmbH	WHKX3.0/18G-10SS	21	Jun. 01, 2023	Annual	Jun. 01, 2024
High Pass Filter	Wainwright Instrument GmbH	WHNX7.5/26.5G-6SS	11	Oct. 17, 2023	Annual	Oct. 17, 2024
Low Pass Filter	Mini-Circuits	NLP-1200+	V 8979400903-2	Feb. 09, 2023	Annual	Feb. 09, 2024
Power Sensor	R&S	NRP-Z81	100669	May 16, 2023	Annual	May 16, 2024
DC Power Supply	Agilent	U8002A	MY49030063	Jan. 20, 2023	Annual	Jan. 20, 2024
DC Power Supply	R&S	HMP2020	102133	Apr. 17, 2023	Annual	Apr. 17, 2024
Preamplifier	H.P.	8447F	2944A03909	Aug. 04, 2023	Annual	Aug. 04, 2024
Signal Conditioning Unit	R&S	SCU-18	10117	Jun. 15, 2023	Annual	Jun. 15, 2024
Preamplifier	TESTEK	TK-PA1840H	130016	Jan. 11, 2023	Annual	Jan. 11, 2024
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 21, 2023	Biennial	Aug. 21, 2025
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB 9163	01126	Feb. 09, 2023	Annual	Feb. 09, 2024
Horn Antenna	R&S	HF906	100326	Feb. 28, 2023	Annual	Feb. 28, 2024
Horn Antenna	Schwarzbeck Mess-Elektronik	BBHA 9170	BBHA9170223	Oct. 10, 2023	Annual	Oct. 10, 2024
EMI Test Receiver	R&S	ESU26	100109	Jan. 18, 2023	Annual	Jan. 18, 2024
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N.C.R.	N/A	N.C.R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/3833 0516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/3833 0516/L	N.C.R.	N/A	N.C.R.
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	N/A	N.C.R.	N/A	N.C.R.
Coaxial Cable	RFONE	MWX221-NMSNMS (4 m)	J1023142	Oct. 04, 2023	Semi-Annual	Apr. 04, 2024
Coaxial Cable	Qualwave Inc.	QA500-18-NN-10 (10 m)	22200114	Oct. 04, 2023	Semi-Annual	Apr. 04, 2024
Coaxial Cable	RFONE	PL360P-292M292M-1.5M-A	20200324002	Oct. 14, 2023	Semi-Annual	Apr. 14, 2024

### 1.6. Declaration by the Manufacturer

- The Bluetooth version of the EUT is 5.3

### 1.7. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD: FCC Part 15 Subpart C		
Section	Test Item(s)	Result
15.205(a) 15.209 15.247(d)	Transmitter Radiated Spurious Emissions and Conducted Spurious Emission	Complied
15.247(a)(2)	6 dB Bandwidth	Complied
15.247(b)(3)	Maximum Peak Conducted Output Power	Complied
15.247(e)	Power Spectral Density	Complied
15.207	AC Power Line Conducted Emission	N/A <sup>1)</sup>

**Note;**

1) The AC power line test was not performed because the EUT use battery power for operation and which do not operate from the AC power lines.

### 1.8. Test Procedure(s)

The measurement procedures described in the American National Standard of Procedure for Compliance Testing of unlicensed Wireless Devices (ANSI C63.10-2013) and the guidance provided in KDB 558074 D01 15.247 Meas Guidance v05r02 were used in the measurement of the DUT.

### 1.9. Sample Calculation

Where relevant, the following sample calculation is provided:

#### 1.9.1. Conducted Test

$$\text{Offset value (dB)} = \text{Attenuator (dB)} + \text{Cable loss (dB)}$$

#### 1.9.2. Radiation Test

$$\text{Field strength level (dB}\mu\text{V/m)} = \text{Measured level (dB}\mu\text{V)} + \text{Antenna factor (dB/m)} + \text{Cable loss (dB)} - \text{Amplifier gain (dB)} + \text{Duty factor (dB)}$$

### 1.10. Information of software for test

- Using the software of Bluetest3 (Version 3.3.17.1792) to testing of EUT.

### 1.11. Test Report Revision

Revision	Report number	Date of Issue	Description
0	F690501-RF-RTL004631	2023.12.01	Initial

### 1.12. Measurement Uncertainty

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

Parameter	Uncertainty	
Maximum Peak Conducted Output Power	0.33 dB	
Power Spectral Density	0.64 dB	
6 dB Bandwidth	0.01 MHz	
Conducted Spurious Emission	0.79 dB	
Radiated Emission, 9 kHz to 30 MHz	H	3.60 dB
	V	3.60 dB
Radiated Emission, below 1 GHz	H	4.60 dB
	V	4.90 dB
Radiated Emission, above 1 GHz	H	3.90 dB
	V	3.80 dB

All measurement uncertainty values are shown with a coverage factor of  $k=2$  to indicate a 95 % level of confidence.

### 1.13. Worst-Case Configuration and Test Mode

**Right**

Modulation	Mode	Frequency (MHz)	Packet length (Byte)	RF Output Power (dBm)
GFSK	PHY 1M	2 402	37	<b>9.36</b>
			255	8.98
	PHY 2M	2 402	37	<b>9.53</b>
			255	9.16

**Left**

Modulation	Mode	Frequency (MHz)	Packet length (Byte)	RF Output Power (dBm)
GFSK	PHY 1M	2 402	37	9.15
			255	8.90
	PHY 2M	2 402	37	9.22
			255	8.74

**Remark;**

The EUT supported PHY 1M, PHY2M.

All modes were investigated.

For PHY 1M and PHY 2M, 37 bytes is tested as worst condition.

Radiated emission below 1 GHz was performed with the EUT set to transmit at the channel with highest output power as worst-case scenario.

Radiated emission above 1 GHz was performed with the EUT set to transmit Low/Middle/High Channels as worst-case scenario.

Conducted tests were performed with the EUT set to transmit Low/Middle/High channels with highest output power.

### 1.14. Duty Cycle of EUT

Regarding to KDB 558074 D01 15.247 Meas Guidance v05r02, 6, the maximum duty cycles of all modes were investigated and set the spectrum analyzer as below;  
 Set RBW ≥ OBW if possible; otherwise, set RBW to the largest available value. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T exceeds 100.

**Right**

Test Mode	PHY 1M	PHY 2M
Duty Cycle (%)	62.90	32.26
Correction Factor (dB)	2.01	4.91

**Left**

Test Mode	PHY 1M	PHY 2M
Duty Cycle (%)	62.90	33.33
Correction Factor (dB)	2.01	4.77

**Remark;**

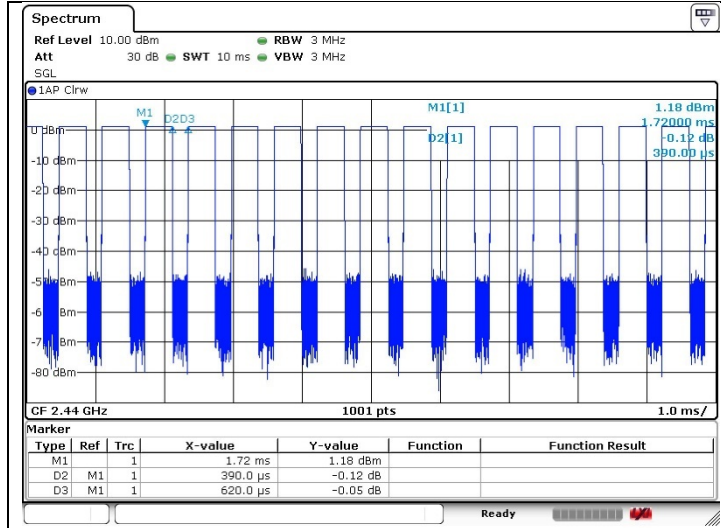
1. Duty Cycle (%) = (Tx on time / Tx on + off time) x 100
2. Correction Factor (dB) = 10 log (1 / Duty Cycle)



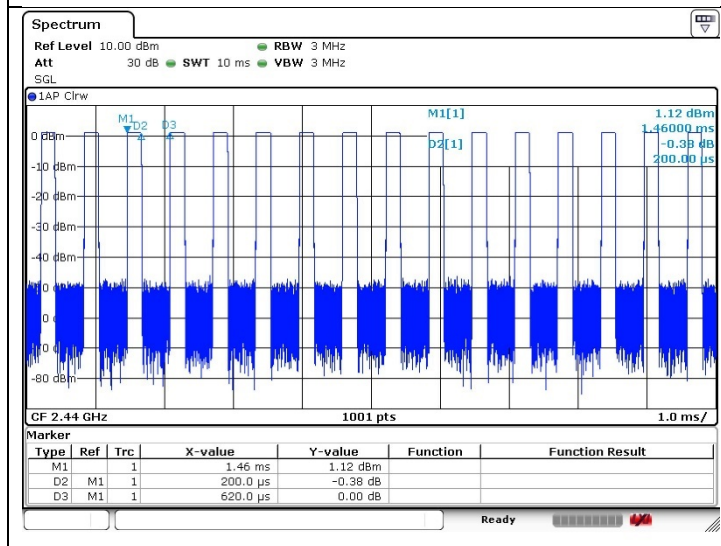
- Test plot

Right

PHY 1M

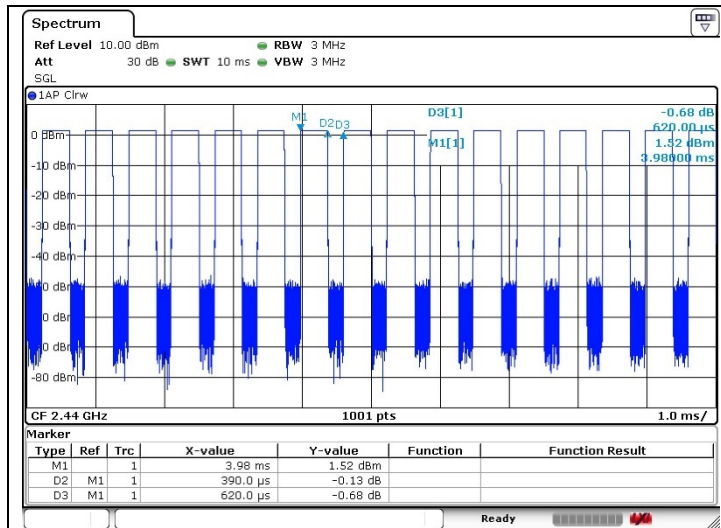


PHY 2M

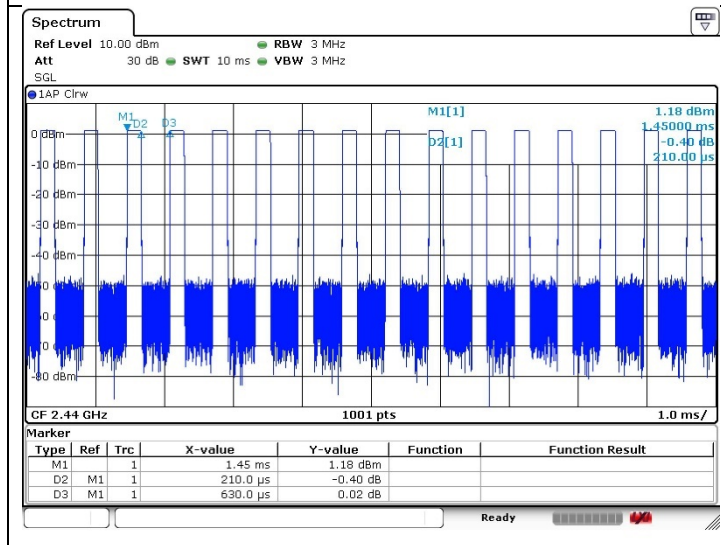


Left

PHY 1M



PHY 2M

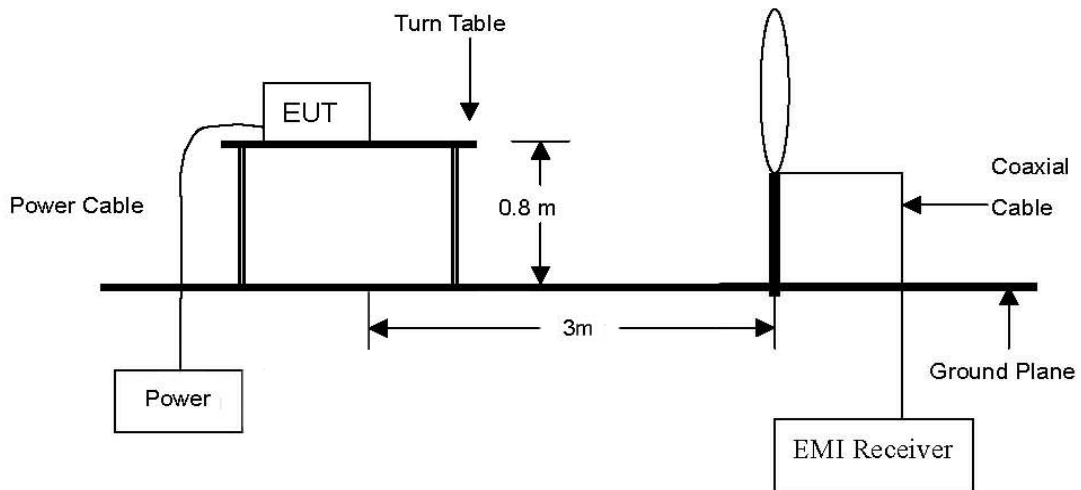


## 2. Transmitter Radiated Spurious Emissions and Conducted Spurious Emission

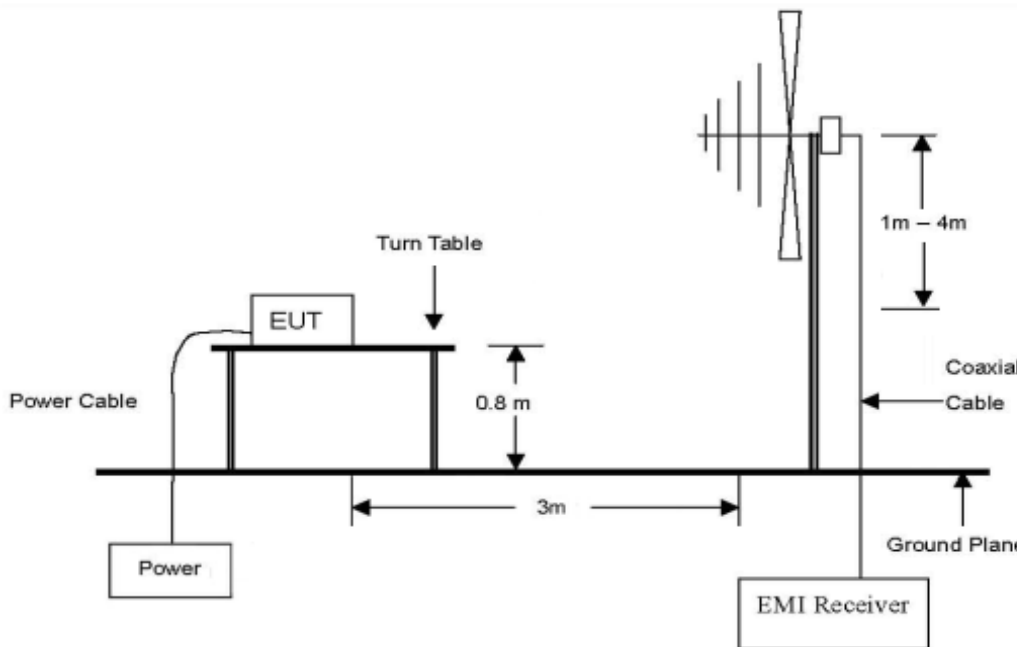
### 2.1. Test Setup

#### 2.1.1. Transmitter Radiated Spurious Emissions

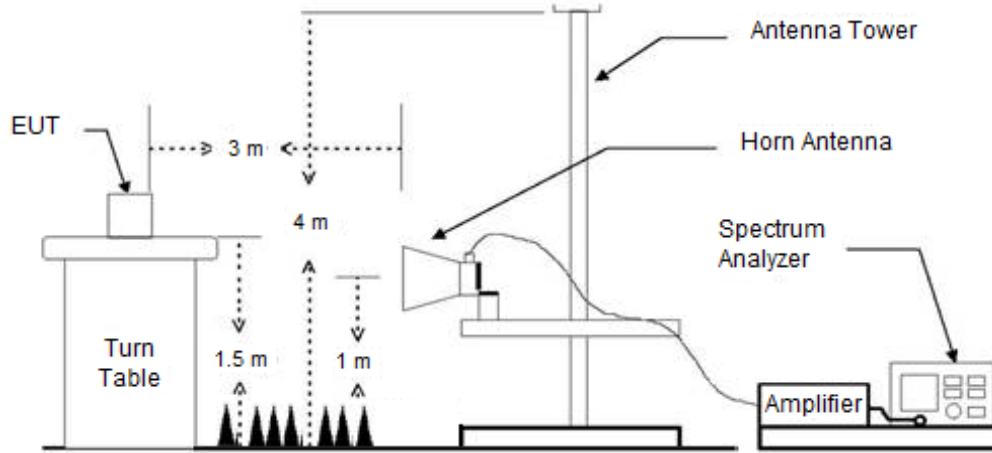
The diagram below shows the test setup that is utilized to make the measurements for emission from 9 kHz to 30 MHz emissions.



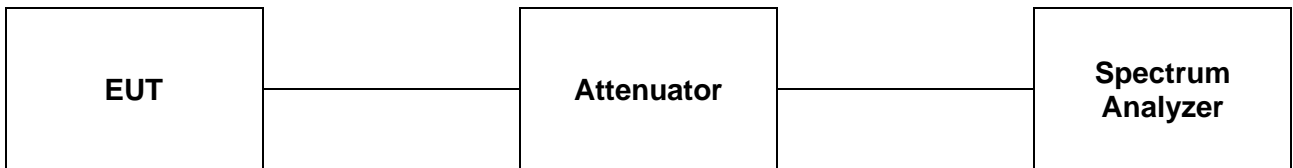
The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz Emissions.



The diagram below shows the test setup that is utilized to make the measurements for emission. The spurious emissions were investigated from 1 GHz to the 10<sup>th</sup> harmonic of the highest fundamental frequency or 40 GHz, whichever is lower.



**2.1.2. Conducted Spurious Emission**



## 2.2. Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emission which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

According to §15.209(a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength ( $\mu\text{V}/\text{m}$ )	Measurement Distance (Meters)
0.009-0.490	2 400/F(kHz)	300
0.490-1.705	24 000/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

\*\* Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., §§15.231 and 15.241.

## 2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates in section 11.11 & 11.12 of ANSI C63.10-2013

### 2.3.1. Test Procedures for emission below 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
2. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
3. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.

### 2.3.2. Test Procedures for emission from above 30 MHz

1. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site below 1 GHz and 1.5 meters above the ground at a 3 meter anechoic chamber test site above 1 GHz. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. For measurements below 1 GHz resolution bandwidth is set to 100 kHz for peak detection measurements or 120 kHz for quasi-peak detection measurements. Peak detection is used unless otherwise noted as quasi-peak.
6. For measurements Above 1 GHz resolution bandwidth is set to 1 MHz, the video bandwidth is set to 3 MHz for peak measurements and as applicable for average measurements.

**2.3.3. Test Procedures for Radiated Spurious Emissions**

1. Unwanted Emissions into Non-Restricted Frequency Bands

- The Reference Level Measurement refer to section 11.11.2

Set analyzer center frequency to DTS channel center frequency, SPAN  $\geq 1.5$  times the DTS bandwidth, the RBW = 100 kHz and VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

- Unwanted Emissions Level Measurement refer to section 11.11.3

Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 kHz and VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold.

2. Unwanted Emissions into Restricted Frequency Bands

- Peak Power measurement procedure refer to section 11.12.2.4

Set RBW = as specified in Table 9, VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = auto, Trace = Max hold.

**Table 9 – RBW as a function of frequency**

Frequency	RBW
9 kHz to 150 kHz	200 Hz to 300 Hz
0.15 MHz to 30 MHz	9 kHz to 10 kHz
30 MHz to 1 000 MHz	100 kHz to 120 kHz
$> 1\ 000$ MHz	1 MHz

If the peak – detected amplitude can be shown to comply with the average limit, then it is not necessary to perform a separate average measurement.

- Average Power measurements procedure refer to section 11.12.2.5.2

The EUT shall be configured to operate at the maximum achievable duty cycle.

Measure the duty cycle D of the transmitter output signal as described in section 11.6.

Set RBW = 1 MHz, VBW  $\geq 3 \times$  RBW, Detector = RMS, if span / (# of points in sweep)  $\leq$  (RBW/2).

Satisfying this condition may require increasing the number of points in the sweep or reducing the span. If this condition cannot be satisfied then the detector mode shall be set to peak.

Averaging type = power (i.e., RMS).

As an alternative the detector and averaging type may be set for linear voltage averaging.

Some instruments require linear display mode in order to use linear voltage averaging. Log or dB averaging shall not be used. Sweep time = auto, Perform a trace average of at least 100 traces.

A correction factor shall be added to the measurement results prior to comparing to the emission limit in order to compute the emission level that would have been measured had the test been performed at 100 percent duty cycle. The correction factor is computed as follows:

- 1) If power averaging (rms) mode was used in step f), then the applicable correction factor is  $[10 \log (1 / D)]$ , where D is the duty cycle.
- 2) If a specific emission is demonstrated to be continuous ( $D \geq 98\%$ ) rather than turning ON and OFF with the transmit cycle, then no duty cycled correction is required for that emission.

3. Definition of DUT Axis.

The radiation test of the EUT was investigated in three orthogonal orientations X, Y, and Z described in the test setup photo. All radiated testing of EUT was performed with worst case asix.

### 2.3.4. Test Procedures for Conducted Spurious Emissions

Per the guidance of ANSI C63.10-2013, section 11.11.1 & 11.11.2 & 11.11.3, the reference level for out of band emissions is established from the plots of this section since the band edge emissions are measured with a RBW of 100 kHz. This reference level is then used as the limit in subsequent plots for out of band spurious emissions shown in section 2.4.3. The limit for out of band spurious emission at the band edge is 20 dB below the fundamental emission level measured in a 100 kHz bandwidth.

#### 1. Conducted Emissions at Band Edge

- The Measurement refer to section 11.11.3

Set the center frequency and span to encompass frequency range to be measured, the RBW = 100 kHz and VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = Auto couple, Trace mode = Max hold, The trace was allowed to stabilize.

#### 2. Conducted Spurious Emissions

- The Measurement refer to section 11.11.3

Start frequency was set to 9 kHz and stop frequency was set to 25 GHz (separated into two plots per channel), RBW = 1 MHz, VBW  $\geq 3 \times$  RBW, Detector = Peak, Sweep time = Auto couple, Trace = Max hold, The trace was allowed to stabilize.

#### 3. TDF function

- For plots showing conducted spurious emissions from 9 kHz to 25 GHz, all path loss of wide frequency range was investigated and compensated to spectrum analyzer as TDF function.  
So, the reading values shown in plots were final result.



## 2.4. Test Results

Ambient temperature : (23 ± 1) °C  
 Relative humidity : 47 % R.H.

### 2.4.1. Radiated Spurious Emission below 1 000 MHz

The frequency spectrum from 9 kHz to 1 000 MHz was investigated. All reading values are peak values.

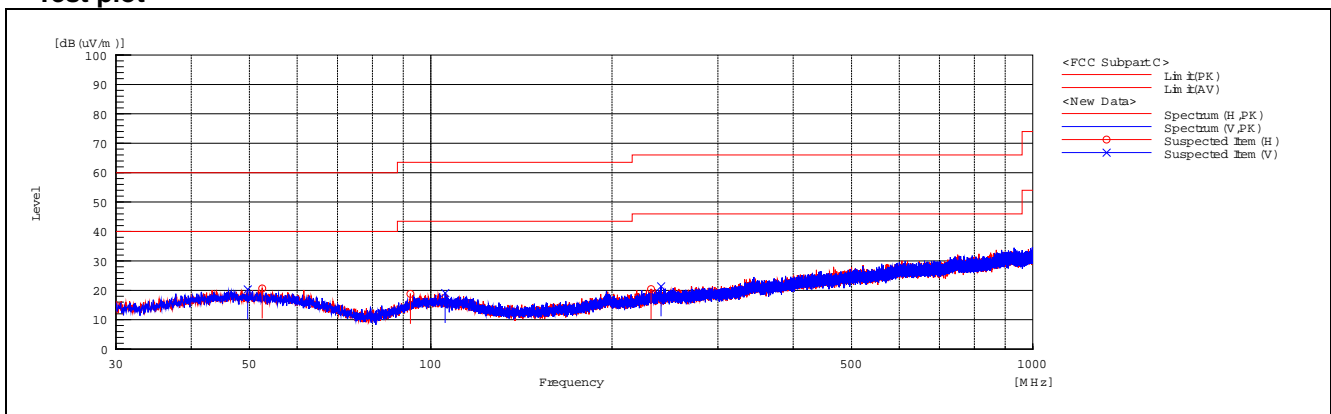
**Right**

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
49.64	28.50	Peak	V	19.64	-27.85	20.29	40.00	19.71
52.47	29.00	Peak	H	19.45	-27.83	20.62	40.00	19.38
Above 100.00	Not Detected	-	-	-	-	-	-	-

**Remark;**

- Spurious emissions for all channels were investigated and almost the same below 1 GHz.
- Reported spurious emissions are in **PHY 1M / 37 bytes / Low channel** as worst case among other channels.
- Radiated spurious emission measurement as below.  
 (Actual = Reading + AF + AMP + CL)
- According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.
- Test from 30 MHz to 1 000 MHz was performed using the software of EP5RE(V5.3.70) from TOYO.

**- Test plot**

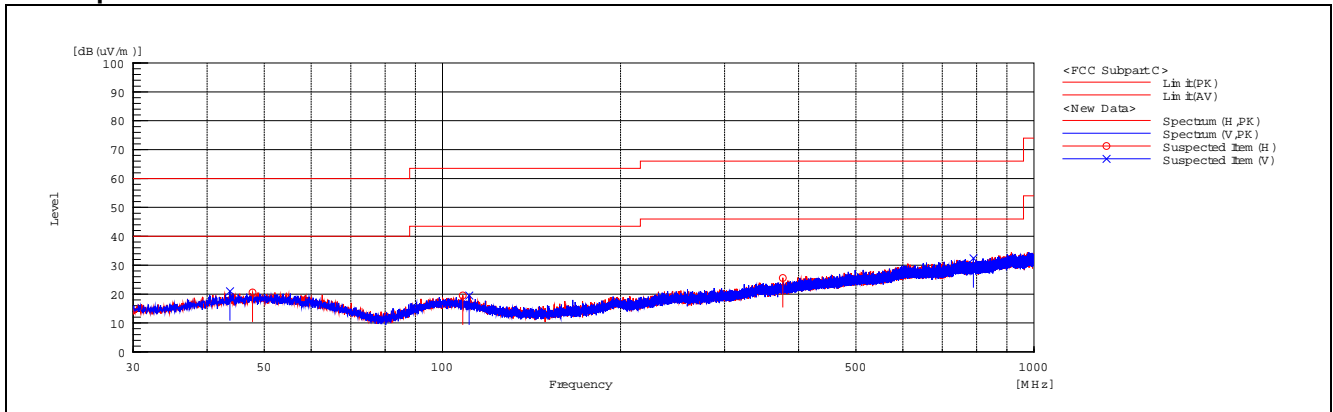


Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
43.74	29.70	Peak	V	19.25	-27.91	21.04	40.00	18.96
47.74	28.80	Peak	H	19.67	-27.87	20.60	40.00	19.40
789.83	30.80	Peak	V	26.60	-24.99	32.41	46.00	13.59
Above 100.00	Not Detected	-	-	-	-	-	-	-

**Remark;**

- Spurious emissions for all channels were investigated and almost the same below 1 GHz.
- Reported spurious emissions are in **PHY 2M / 37 bytes / Low channel** as worst case among other channels.
- Radiated spurious emission measurement as below.  
(Actual = Reading + AF + AMP + CL)
- According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.
- Test from 30 MHz to 1 000 MHz was performed using the software of EP5RE(V5.3.70) from TOYO.

**- Test plot**



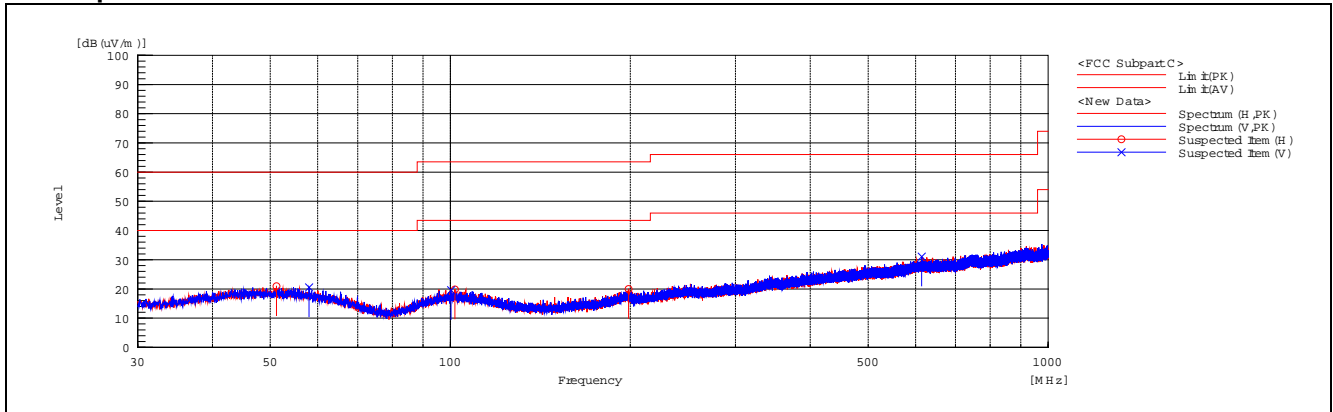
**Left**

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
51.18	29.10	Peak	H	19.66	-27.84	20.92	40.00	19.08
58.05	29.50	Peak	V	18.79	-27.78	20.51	40.00	19.49
614.26	31.30	Peak	V	25.20	-25.40	31.10	46.00	14.90
Above 700.00	Not Detected	-	-	-	-	-	-	-

**Remark;**

- Spurious emissions for all channels were investigated and almost the same below 1 GHz.
- Reported spurious emissions are in **PHY 1M / 37 bytes / Low channel** as worst case among other channels.
- Radiated spurious emission measurement as below.  
 (Actual = Reading + AF + AMP + CL)
- According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.
- Test from 30 MHz to 1 000 MHz was performed using the software of EP5RE(V5.3.70) from TOYO.

**- Test plot**

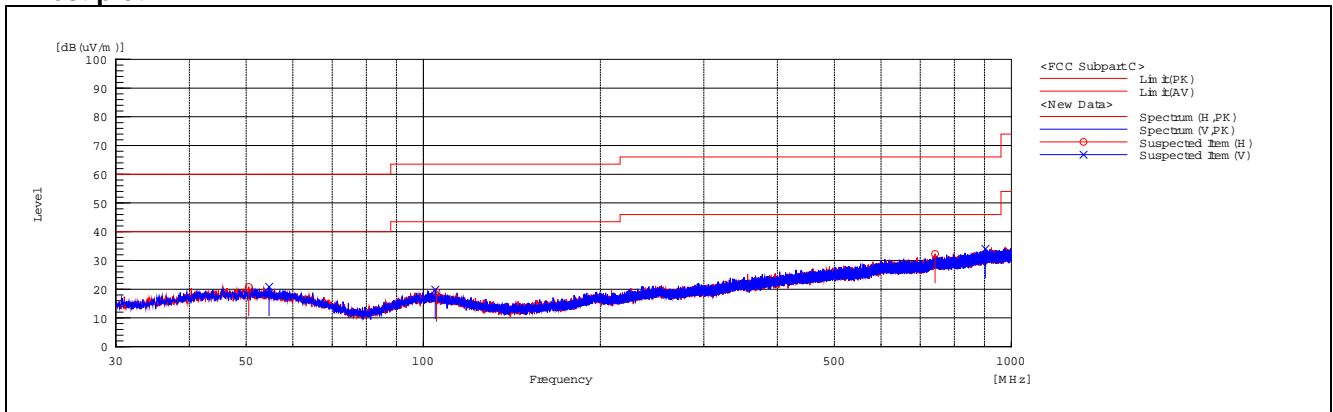


Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
50.49	29.00	Peak	H	19.65	-27.85	20.80	40.00	19.20
54.65	29.30	Peak	V	19.27	-27.81	20.76	40.00	19.24
741.50	30.70	Peak	H	26.60	-25.01	32.29	46.00	13.71
902.80	30.90	Peak	V	27.84	-24.70	34.04	46.00	11.96

**Remark;**

- Spurious emissions for all channels were investigated and almost the same below 1 GHz.
- Reported spurious emissions are in **PHY 2M / 37 bytes / Low channel** as worst case among other channels.
- Radiated spurious emission measurement as below.  
(Actual = Reading + AF + AMP + CL)
- According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.
- Test from 30 MHz to 1 000 MHz was performed using the software of EP5RE(V5.3.70) from TOYO.

**- Test plot**



### 2.4.2. Radiated Spurious Emission above 1 000 MHz

The frequency spectrum above 1 000 MHz was investigated. All reading values are peak and average values.

Right

Test mode: PHY 1M

Low Channel (2 402 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 310.00	15.72	Peak	H	28.04	6.65	-	50.41	74.00	23.59
*2 310.00	4.68	Average	H	28.04	6.65	2.01	41.38	54.00	12.62
*2 346.89	17.38	Peak	H	28.19	6.89	-	52.46	74.00	21.54
*2 369.99	6.15	Average	H	28.24	8.40	2.01	<b>44.80</b>	54.00	9.20
*2 390.00	15.69	Peak	H	28.28	7.55	-	51.52	74.00	22.48
*2 390.00	4.98	Average	H	28.28	7.55	2.01	42.82	54.00	11.18

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 804.47	42.34	Peak	V	32.72	-34.20	-	40.86	74.00	33.14
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Middle Channel (2 440 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 880.03	41.57	Peak	V	33.08	-33.87	-	40.78	74.00	33.22
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

High Channel (2 480 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 483.50	20.98	Peak	H	28.27	7.69	-	56.94	74.00	17.06
*2 483.50	6.29	Average	H	28.27	7.69	2.01	44.26	54.00	9.74
*2 483.82	21.54	Peak	H	28.27	7.67	-	57.48	74.00	16.52
*2 491.35	6.48	Average	H	28.28	7.22	2.01	43.99	54.00	10.01
*2 500.00	17.27	Peak	H	28.30	6.71	-	52.28	74.00	21.72
*2 500.00	5.64	Average	H	28.30	6.71	2.01	42.66	54.00	11.34

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 960.29	38.61	Peak	V	33.20	-34.51	-	37.30	74.00	36.70
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-

**Test mode: PHY 2M**

Low Channel (2 402 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 310.00	14.78	Peak	H	28.04	6.65	-	49.47	74.00	24.53
*2 310.00	5.27	Average	H	28.04	6.65	4.91	44.87	54.00	9.13
*2 336.96	17.49	Peak	H	28.15	7.07	-	52.71	74.00	21.29
*2 314.08	5.96	Average	H	28.06	6.83	4.91	45.76	54.00	8.24
*2 390.00	15.78	Peak	H	28.28	7.55	-	51.61	74.00	22.39
*2 390.00	5.12	Average	H	28.28	7.55	4.91	45.86	54.00	8.14

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 804.94	41.62	Peak	V	32.72	-34.20	-	40.14	74.00	33.86
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Middle Channel (2 440 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 879.13	40.78	Peak	V	33.07	-33.86	-	39.99	74.00	34.01
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

High Channel (2 480 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 483.50	21.45	Peak	H	28.27	7.69	-	57.41	74.00	16.59
*2 483.50	8.36	Average	H	28.27	7.69	4.91	<b>49.23</b>	54.00	4.77
*2 483.54	21.68	Peak	H	28.27	7.69	-	57.64	74.00	16.36
*2 483.54	7.67	Average	H	28.27	7.69	4.91	48.54	54.00	5.46
*2 500.00	15.30	Peak	H	28.30	6.71	-	50.31	74.00	23.69
*2 500.00	6.40	Average	H	28.30	6.71	4.91	46.32	54.00	7.68

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 961.01	38.32	Peak	V	33.20	-34.55	-	36.97	74.00	37.03
Above 5 000.00	Not detected	-	-	-	-	-	-	-	-



Left

Test mode: PHY 1M

Low Channel (2 402 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 310.00	14.84	Peak	H	28.04	6.65	-	49.53	74.00	24.47
*2 310.00	5.51	Average	H	28.04	6.65	2.01	42.21	54.00	11.79
*2 375.57	17.39	Peak	H	28.25	8.74	-	54.38	74.00	19.62
*2 350.82	6.14	Average	H	28.20	6.89	2.01	43.24	54.00	10.76
*2 390.00	17.41	Peak	H	28.28	7.55	-	53.24	74.00	20.76
*2 390.00	5.41	Average	H	28.28	7.55	2.01	43.25	54.00	10.75

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 803.18	41.18	Peak	H	32.71	-34.21	-	39.68	74.00	34.32
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Middle Channel (2 440 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 880.33	40.85	Peak	H	33.08	-33.88	-	40.05	74.00	33.95
*7 319.08	39.35	Peak	V	36.14	-32.28	-	43.21	74.00	30.79
Above 7 400.00	Not detected	-	-	-	-	-	-	-	-

High Channel (2 480 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 483.50	17.43	Peak	H	28.27	7.69	-	53.39	74.00	20.61
*2 483.50	6.01	Average	H	28.27	7.69	2.01	43.98	54.00	10.02
*2 484.84	18.27	Peak	H	28.27	7.61	-	54.15	74.00	19.85
*2 484.60	6.63	Average	H	28.27	7.62	2.01	<b>44.53</b>	54.00	9.47
*2 500.00	15.88	Peak	H	28.30	6.71	-	50.89	74.00	23.11
*2 500.00	6.12	Average	H	28.30	6.71	2.01	43.14	54.00	10.86

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*7 440.74	39.06	Peak	V	36.20	-32.45	-	42.81	74.00	31.19
Above 7 500.00	Not detected	-	-	-	-	-	-	-	-

**Test mode: PHY 2M**

Low Channel (2 402 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 310.00	14.38	Peak	H	28.04	6.65	-	49.07	74.00	24.93
*2 310.00	5.70	Average	H	28.04	6.65	4.77	45.16	54.00	8.84
*2 372.75	17.63	Peak	H	28.25	8.61	-	54.49	74.00	19.51
*2 372.20	6.27	Average	H	28.24	8.57	4.77	47.85	54.00	6.15
*2 390.00	14.72	Peak	H	28.28	7.55	-	50.55	74.00	23.45
*2 390.00	5.68	Average	H	28.28	7.55	4.77	46.28	54.00	7.72

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*4 804.92	42.55	Peak	H	32.72	-34.20	-	41.07	74.00	32.93
Above 4 900.00	Not detected	-	-	-	-	-	-	-	-

Middle Channel (2 440 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
Above 1 000.00	Not detected	-	-	-	-	-	-	-	-

High Channel (2 480 MHz)

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*2 483.50	20.19	Peak	H	28.27	7.69	-	56.15	74.00	17.85
*2 483.50	7.64	Average	H	28.27	7.69	4.77	48.37	54.00	5.63
*2 483.54	19.71	Peak	H	28.27	7.69	-	55.67	74.00	18.33
*2 483.54	7.65	Average	H	28.27	7.69	4.77	<b>48.38</b>	54.00	5.62
*2 500.00	16.84	Peak	H	28.30	6.71	-	51.85	74.00	22.15
*2 500.00	5.73	Average	H	28.30	6.71	4.77	45.51	54.00	8.49

Radiated Emissions			Ant.	Correction Factors			Total	Limit	
Frequency (MHz)	Reading (dB $\mu$ V)	Detect Mode	Pol.	AF (dB/m)	AMP+CL (dB)	DF (dB)	Actual (dB $\mu$ V/m)	Limit (dB $\mu$ V/m)	Margin (dB)
*7 440.91	37.46	Peak	V	36.20	-32.44	-	41.22	74.00	32.78
Above 7 500.00	Not detected	-	-	-	-	-	-	-	-

**Remarks;**

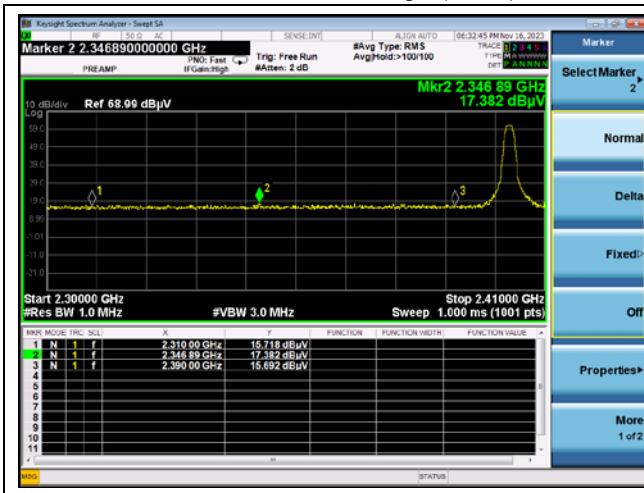
1. “\*” means the restricted band.
2. Measuring frequencies from 1 GHz to the 10<sup>th</sup> harmonic of highest fundamental frequency.
3. Radiated emissions measured in frequency above 1 000 MHz were made with an instrument using peak/average detector mode.
4. Actual = Reading + AF + CL + (DF) or Reading + AF + AMP + CL + (DF).
5. According to § 15.31(o), emission levels are not reported much lower than the limits by over 20 dB.
6. The maximized peak measured value complies with the average limit, to perform an average measurement is unnecessary.
7. AF = Antenna Factor, CL = Cable Loss, DF = Duty Correction Factor.

- Test plots

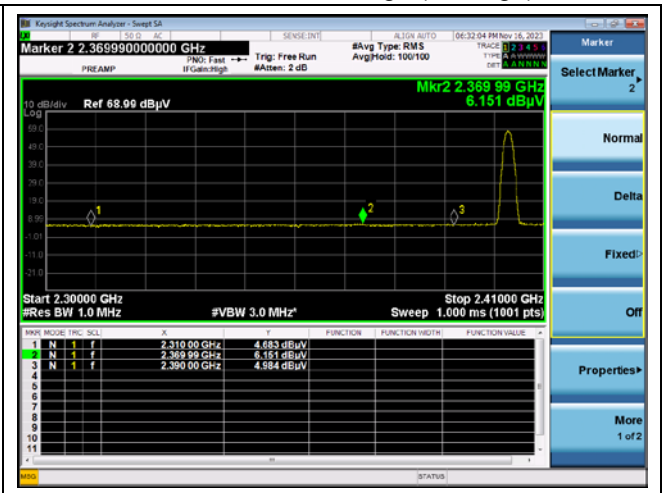
Right

Test mode: PHY 1M

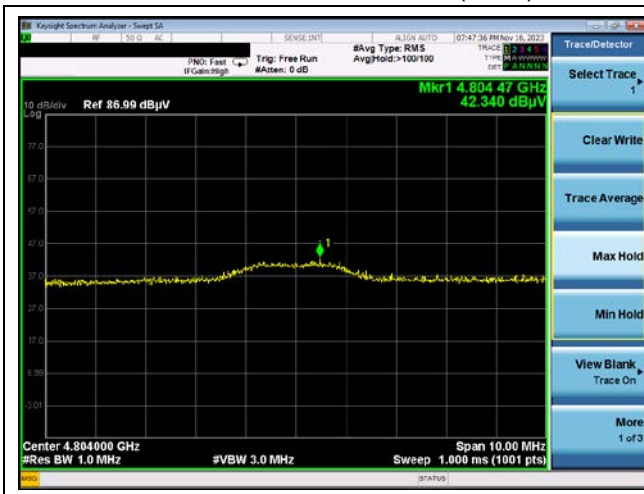
Low channel band edge (Peak)



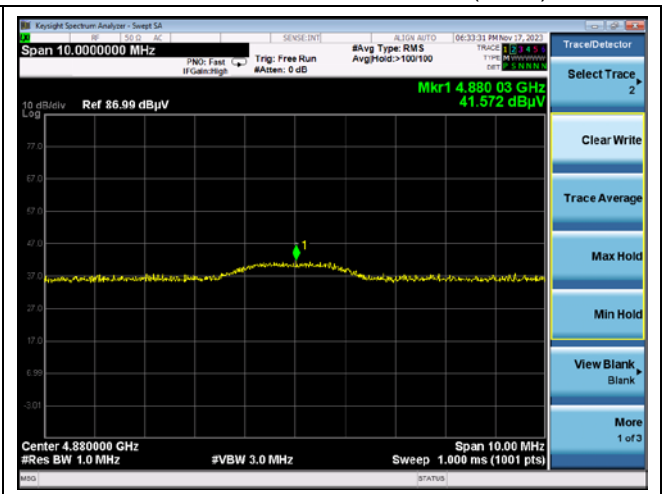
Low channel band edge (Average)



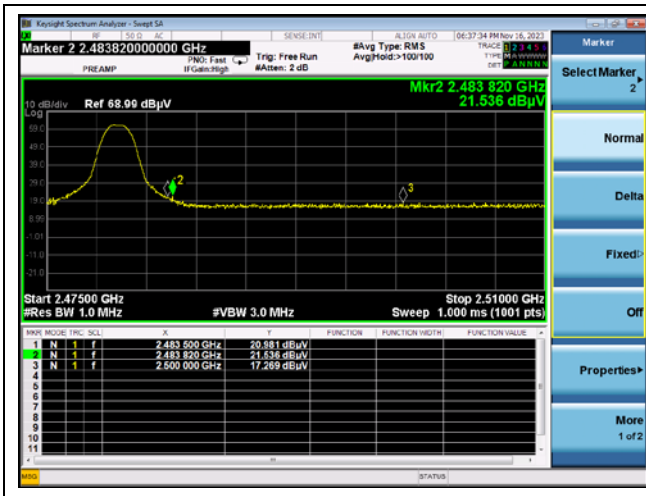
Low Channel 2<sup>nd</sup> Harmonic (Peak)



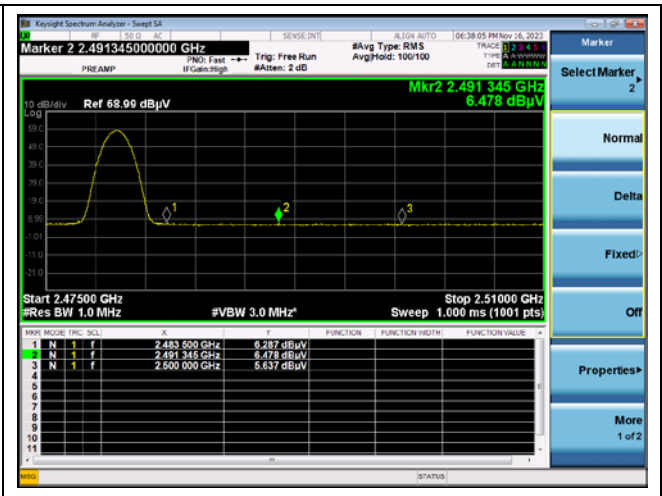
Middle Channel 2<sup>nd</sup> Harmonic (Peak)



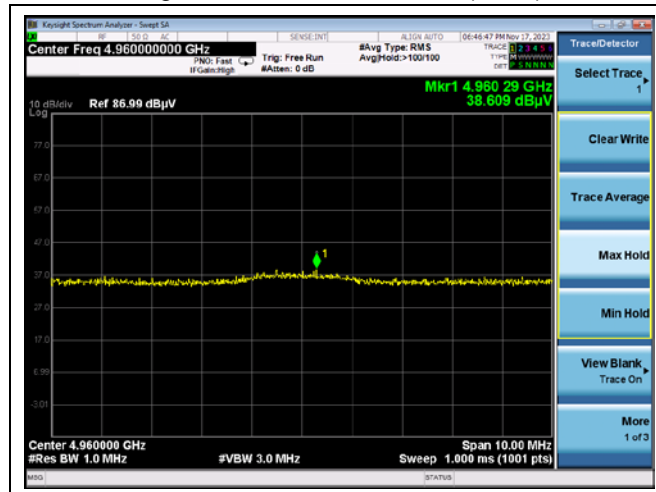
High channel band edge (Peak)



High channel band edge (Average)

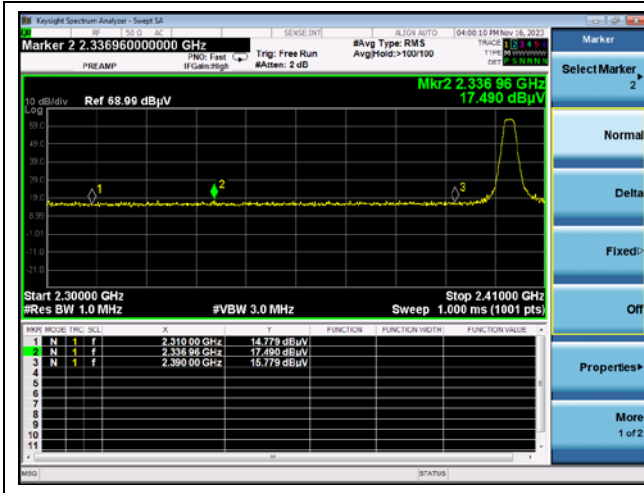


High Channel 2<sup>nd</sup> Harmonic (Peak)

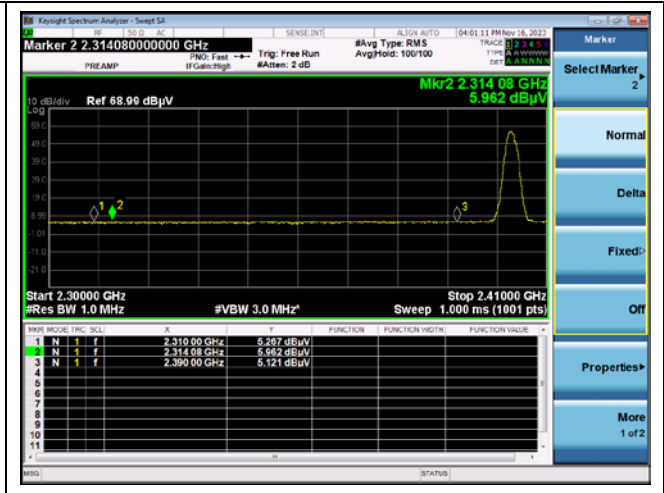


**Test mode: PHY 2M**

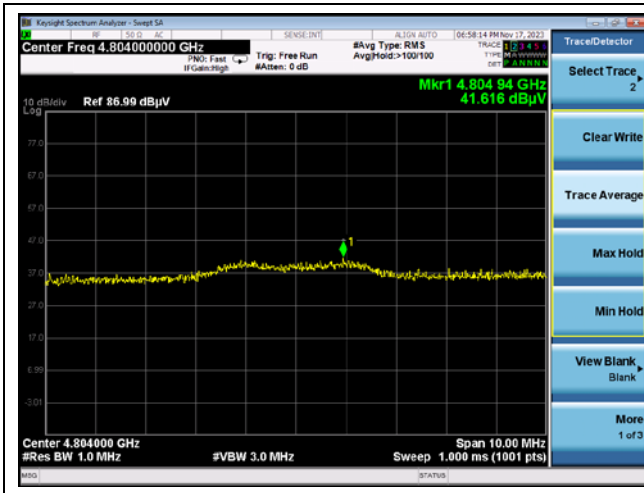
Low channel band edge (Peak)



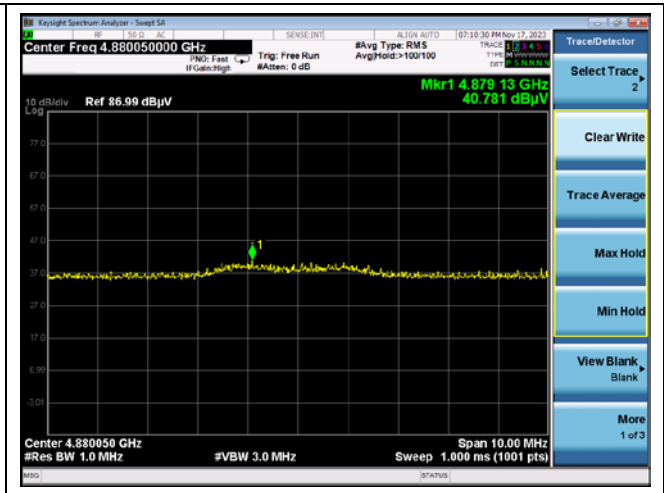
Low channel band edge (Average)



Low Channel 2<sup>nd</sup> Harmonic (Peak)



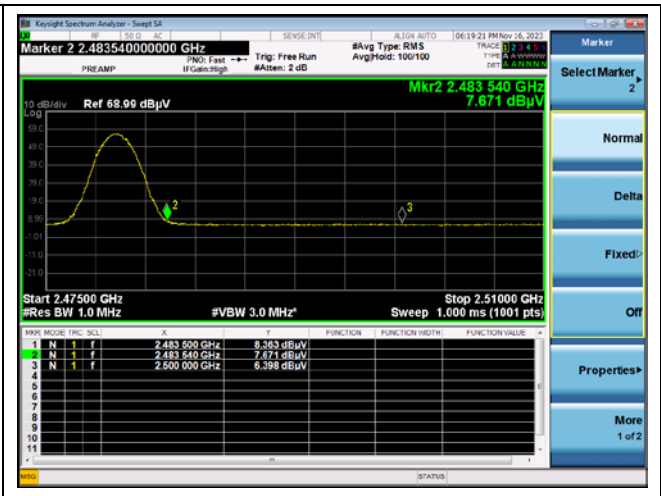
Middle Channel 2<sup>nd</sup> Harmonic (Peak)



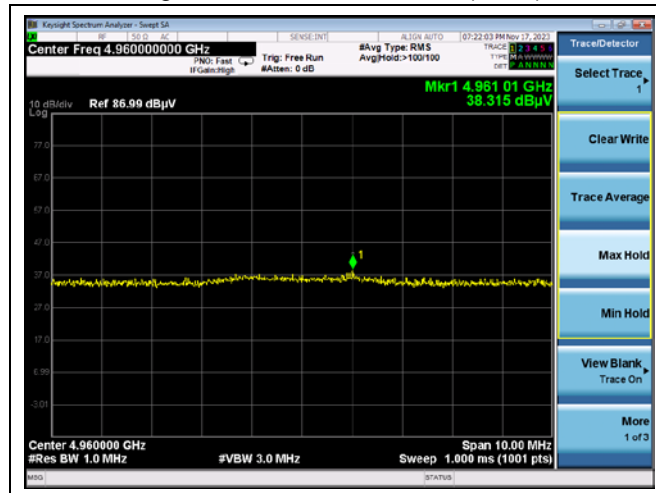
High channel band edge (Peak)



High channel band edge (Average)



High Channel 2<sup>nd</sup> Harmonic (Peak)

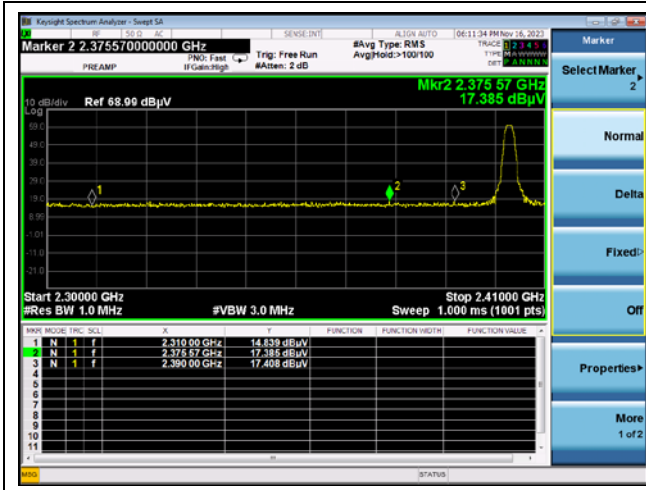




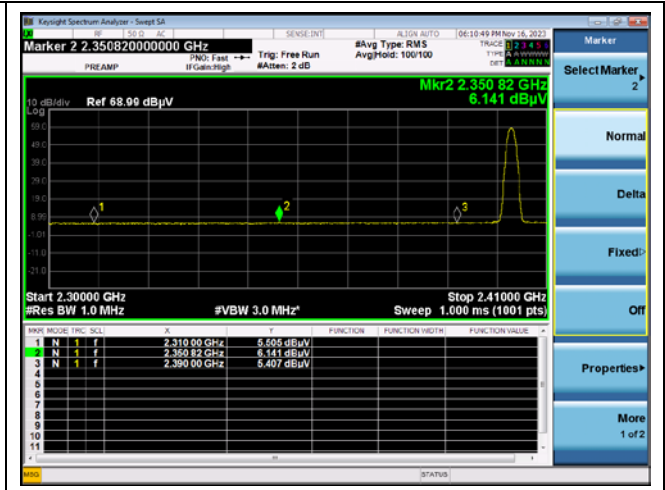
Left

Test mode: PHY 1M

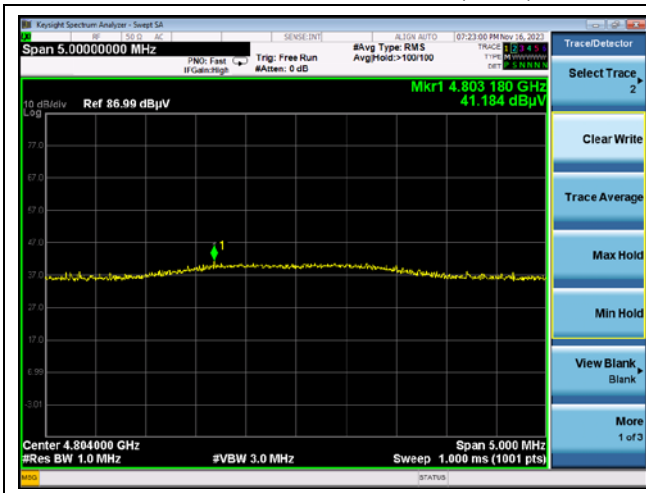
Low channel band edge (Peak)



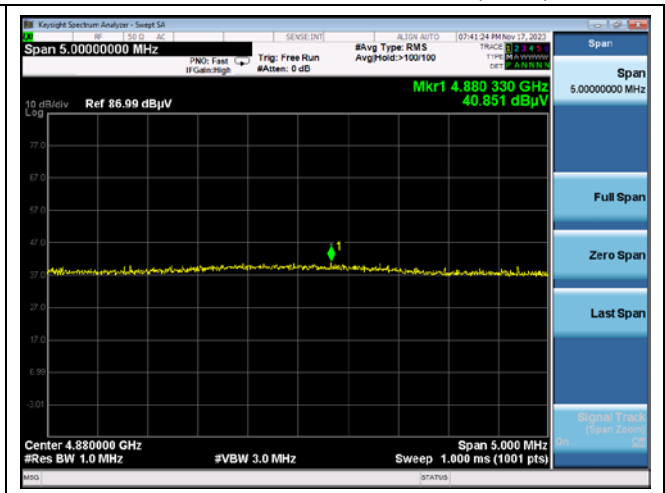
Low channel band edge (Average)



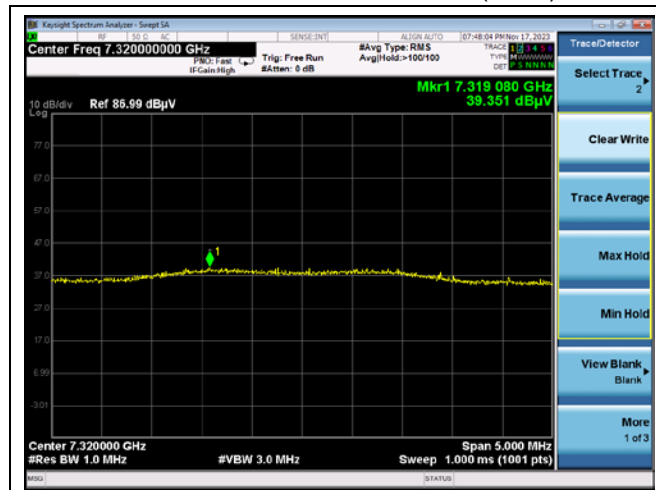
Low Channel 2<sup>nd</sup> Harmonic (Peak)



Middle Channel 2<sup>nd</sup> Harmonic (Peak)



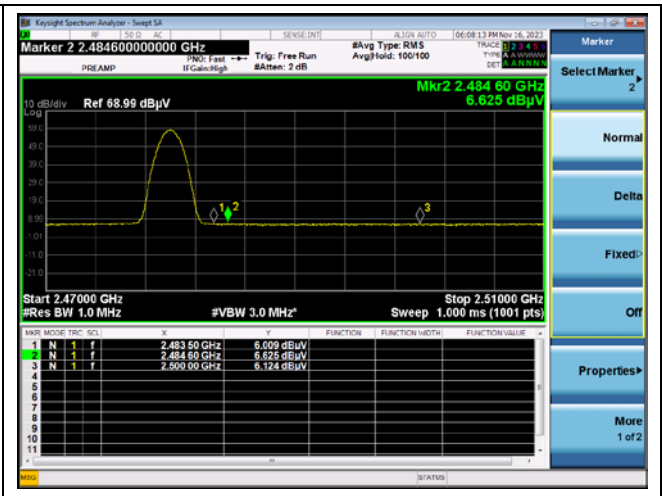
Middle Channel 3<sup>rd</sup> Harmonic (Peak)



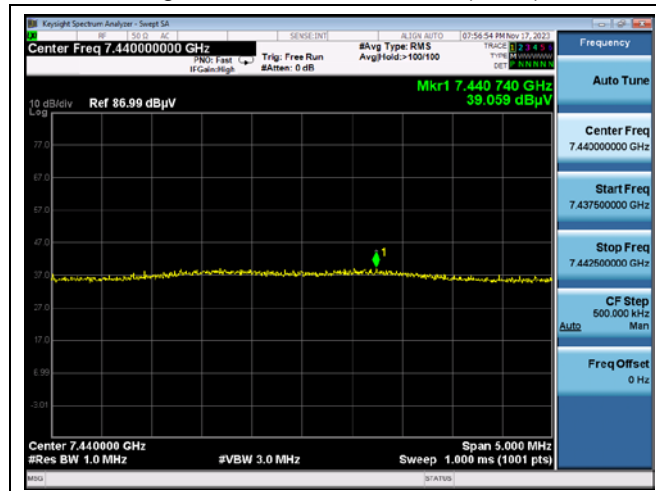
High channel band edge (Peak)



High channel band edge (Average)

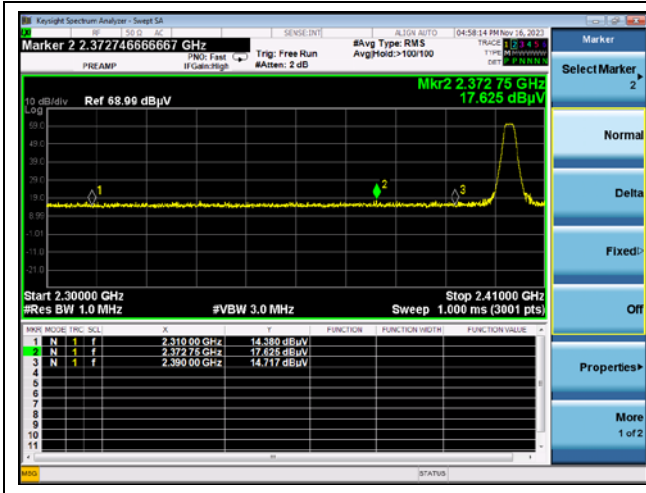


High Channel 3<sup>rd</sup> Harmonic (Peak)

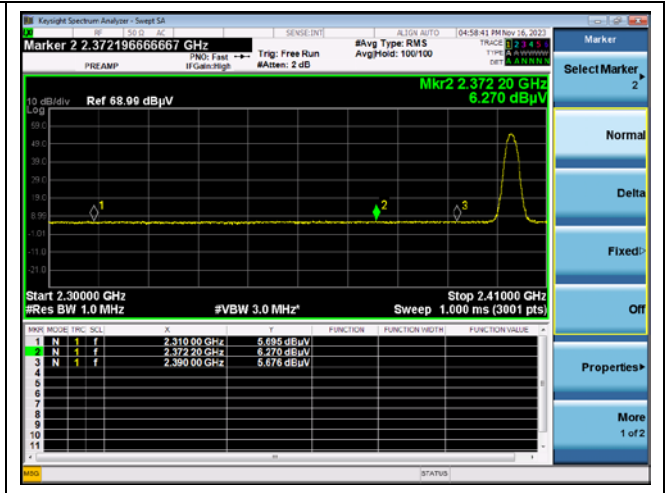


Test mode: PHY 2M

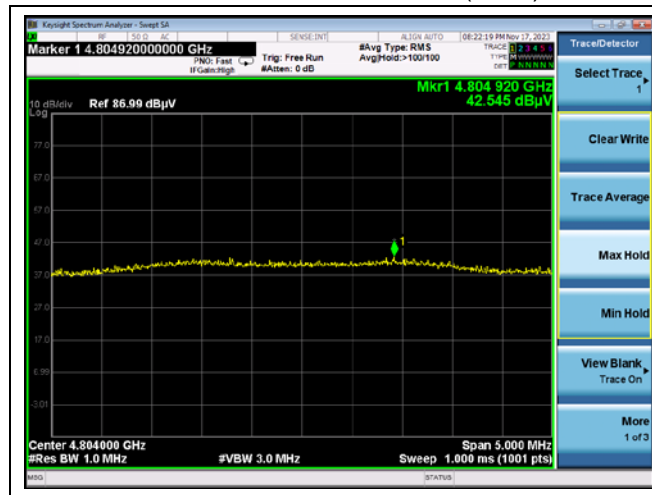
Low channel band edge (Peak)



Low channel band edge (Average)



Low Channel 2<sup>nd</sup> Harmonic (Peak)



High channel band edge (Peak)



High channel band edge (Average)

