DAkkS Deutsche Akkreditierungsstelle D-PL-21375-01-03 D-PL-21375-01-04

INGENIEURBÜRO LENHARDT

Bundesnetzagentur BNetzA-CAB-21/21-21

Test Report

Test report no.: 21065799-20827-0
Date of issue: 2021-09-14

Test result: The test item **- passed -** and complies with the listed standards.

Applicant

Mitsubishi Electric Corporation Sanda Works

Manufacturer

Mitsubishi Electric Corporation

Test Item

R1LOW-R-SBM

RF-Spectrum Testing according to:

FCC 47 CFR Part 15
Radio Frequency Devices (Subpart C)

RSS-247, Issue 2 (2017-02)
Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices

RSS-Gen, Issue 5 (2018-04)
General Requirements for Compliance of Radio Apparatus

Tested by (name, function, signature)	*Karsten Geraldy* *Head of Laboratory RF*	signature
Approved by (name, function, signature)	*Andreas Bender* *Head of Laboratory*	signature

Applicant and Test item details	
Applicant	Mitsubishi Electric Corporation Sanda Works 2-3-33, Miwa, Sanda-City, Hyogo 669-1513 Japan DESIGN-A SECTION, CAR MULTIMEDIA DESIGN DEPT. Fon: +81 79 559 4813 E-Mail: Yoshinaga.Ryuji@db.MitsubishiElectric.co.jp
Manufacturer	Mitsubishi Electric Corporation 2-3-33, Miwa, Sanda-City, Hyogo 669-1513 Japan DESIGN-A SECTION, CAR MULTIMEDIA DESIGN DEPT. Fon: +81 79 559 4813 E-Mail: Yoshinaga.Ryuji@db.MitsubishiElectric.co.jp
Test item description	Automotive Display Audio
Model/Type reference	R1LOW-R-SBM
Standard specific information	
FCC ID	UJH-R1LOW-R-SBM
IC	662K-R1LOWRSB
PMN	R1LOW-R-SBM
HVIN	NR-0C-R-DV
FVIN	N/A
HMN	N/A
Frequency	2400 to 2483.5 MHz DTS band
Technology	Type of radio transmission: DSSS, OFDM Type of modulation: (D)BPSK, (D)QPSK, CCK, 16QAM, 64QAM
Number of channels	13 (20/22 MHz)
Antenna	external PCB antenna
Power supply	9 V – 16.5V, DC Battery
Temperature range	-40 °C to +75 °C

Disclaimer and Notes

The content of this rest report relates to the mentioned test sample(s) only.
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The last valid version is available at TAMSys®.

Within this test report, a ☒ point / ☐ comma is used as a decimal separator.
If otherwise, a detailed note is added adjected to its use.

IBL-Lab GmbH does not take test samples. The sample used for testing is provided by the applicant.

Decision rule: Binary Statement for Simple Acceptance Rule according ILAC-G8:09/2019

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2 GENERAL INFORMATION

2.1 Administrative details

Testing laboratory	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 Sankt Ingbert / Germany Fon: +49 6894 38938-0 Fax: +49 6894 38938-99 URL: www.ib-lenhardt.de E-Mail: info@ib-lenhardt.de
Accreditation	The testing laboratory is accredited by Deutsche Akkreditierungsstelle GmbH (DAkkS) in compliance with DIN EN ISO/IEC 17025:2018. Scope of testing and registration number: • Electronics D-PL-21375-01-01 • Electromagnetic Compatibility D-PL-21375-01-02 • Electromagnetic Compatibility and Telecommunication (FCC requirements) D-PL-21375-01-03 • Telecommunication (TC) and Electromagnetic Compatibility (EMC) for Canadian Standards D-PL-21375-01-04 • ISED Company Number 27156 • Testing Laboratory CAB Identifier DE0020 • Telekommunikation (TK) D-PL-21375-01-05 Website DAkkS: https://www.dakks.de/ The Deutsche Akkreditierungsstelle GmbH (DAkkS) is also a signatory to ILAC Mutual Recognition Arrangement
Testing location	**IBL-Lab GmbH** Heinrich-Hertz-Allee 7 66386 St. Ingbert / Germany
Date of receipt of test samples	2021-07-07
Start – End of tests	2021-07-08 – 2021-09-07

2.2 Possible test case verdicts

Test sample meets the requirements	P (PASS)
Test sample does not meet the requirements	F (FAIL)
Test case does not apply to the test sample	N/A (Not applicable)
Test case not performed	N/P (Not performed)

2.3 Observations

No additional observations other than the reported observations within this test report have been made.

2.4 Opinions and Interpretations

No appropriate opinions or interpretations according ISO/IEC 17025:2017 clause 7.8.7 are within this test report.

2.5 Revision History

-0 Initial Version

2.6 Further documents

List of further applicable documents belonging to the present test report:
- no additional documents -

3 ENVIRONMENTAL & TEST CONDITIONS

3.1 Environmental conditions

Temperature	20°C ± 5°C
Relative humidity	25-75 % r.H.
Barometric Pressure	860-1060 mbar
Power supply	230 V / 50 Hz

3.2 Normal and extreme test conditions

	minimum	nominal	maximum
Temperature	-/-	+25 °C	-/-
Relative humidity	-/-	50 % r.h.	-/-
Power supply	-/-	12.6 V DC	-/-

4 TEST STANDARDS AND REFERENCES

Test standard (accredited)	**Description**
FCC 47 CFR Part 15	Radio Frequency Devices (Subpart C)
RSS-247, Issue 2 (2017-02)	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen, Issue 5 (2018-04)	General Requirements for Compliance of Radio Apparatus

Test standard (not accredited)	**Description**
none	---

Reference	**Description**
ANSI C63.4-2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
558074 D01 15.247 Meas Guide v05r02	Guidance for compliance measurements on digital transmission systems, frequency hopping spread spectrum systems and hybrid system devices operating under section 15.247 of the FCC rules

5 EQUIPMENT UNDER TEST (EUT)

5.1 Product Description

Automotive Display Audio

*: as declared by applicant

5.2 Test Item Description

Model name*	R1LOW-R-SBM
Serial numbers R1LOW-R-SBM test samples*	radiated EUT: 61314 conducted EUT: 61313
Serial numbers R1LOW-R test samples*	radiated EUT: 60338 conducted EUT: 60337
PCB identifier*	NJ00193611
Hardware status*	NR-0C-R-DV
Software status*	Android 10

*: as declared by applicant; please see Annex A, B for EUT photographs.

5.3 Technical Data of Equipment

Operational frequency band*	2400 to 2483.5 MHz DTS band
Transmitter*	Chip QCA6574AU with 48 MHz TCXO (Module UGKZ5A3006A)
Technology*	802.11 b/g/n, DSSS, OFDM
Modulation type*	802.11 b: DBPSK, DQPSK, CCK 802.11 g: BPSK, QPSK, 16QAM, 64QAM 802.11 n: BPSK, QPSK, 16QAM, 64QAM
Data rate*	802.11 b: 1 Mbps – 11 Mbps 802.11 g: 6 Mbps – 54 Mbps 802.11 n: 6.5 Mbps – 144.4 Mbps
Number of channels*	13
Channel bandwidth*	22 MHz (b-mode) / 20 MHz (g-, n-mode)
Channel spacing*	5 MHz
Guard Interval*	802.11n: GI=800 ns, GI=400 ns
Rated RF Output Power*	802.11 b: 14 dBm; 802.11 g: 11 dBm; 802.11 n: 11 dBm
Antenna R1LOW-R-SBM model* Part name Antenna 0	external PCB antenna P68306857AA/00534042660 #0
Antenna gain R1LOW-R-SBM model *	Antenna 0: 1.85 dBi
Antenna R1LOW-R model* Part name Antenna 0	Sheet metal antenna, 2342059-2
Antenna gain R1LOW-R model*	Antenna 0: -3.55 dBi
Number of Spatial Streams*	NSS=1, NSS=2
Power supply, V_{nom}*	9 V – 16.5V, DC Battery, V_{nom}=12.6 V
Temperature range, T_{nom}*	-40 °C to +75 °C, T_{nom}=+25°C

*: as declared by applicant

Channels with **22 MHz (b-mode) / 20 MHz (g-, n-mode)** channel bandwidth:

2400 to 2483.5 DTS band channel number & center frequency													
channel	**1**	2	3	4	5	6	**7**	8	9	10	11	12	**13**
f_c / MHz	**2412**	2417	2422	2427	2432	2437	**2442**	2447	2452	2457	2462	2467	**2472**

5.4 Additional Information

Model differences	• R1LOW-R-SBM model with external antenna and disassociated display • R1LOW-R model with integrated sheet metal antenna and associated display **Applicant declares that transmitter modul and PCB are identical in both models** Conducted R1LOW-R test sample is used for following test cases: • DTS bandwidth (6 dB) • Occupied Channel Bandwidth (99%) • Peak power spectral density (PSD) • Band edge compliance (BEC), conducted • Conducted spurious emissions (CSE) Radiated R1LOW-R test sample is used for following test cases: • Radiated spurious emissions (RSE) Conducted R1LOW-R-SBM test sample is used for following test cases: • RF output power (conducted peak power) Radiated R1LOW-R-SBM test sample is used for following test cases: • Antenna gain (calculated) • Band edge compliance (BEC), radiated • Radiated spurious emissions (RSE) – worst case from R1LOW-R test sample tests
Ancillaries tested with	None
Additional equipment used for testing	Notebook with test tool

5.5 Test modes	
Mode 1, b-mode	22 MHz bandwidth, Modulation type: DBPSK 1 Mbps*
	20 MHz bandwidth, Modulation type: BPSK 6 Mbps*
Mode 3, n-HT20 mode	20 MHz bandwidth, Modulation type: BPSK 6.5 Mbps, NSS=1*
Channel	Channels used for testing are marked in bold in 20 MHz channel list (see secion 5.3)
Antennas and transmit operating mode	Equipment with 2 antennas/transmit chains (antenna 0, antenna 1); apart from conducted output power all other test cases can be performed with one antenna only (antenna 0)
Worst case configuration with respect to RF output power	Conducted RF output power has been measured with conducted test sample 60337 for following modulation types, spatial streams and data rates at low, mid, and high channel frequencies marked in bold in 20 MHz channel list (see section 5.3): – 802.11b, DBPSK, 1 Mbps, antenna 0, antenna 1, antenna 0 + 1 – 802.11b, DBPSK, 1 Mbps, antenna 0 + 1 – 802.11b, DQPSK, 2 Mbps, antenna 0 + 1 – 802.11b, CCK, 5.5 Mbps, antenna 0 + 1 – 802.11b, CCK, 11 Mbps, antenna 0 + 1 – 802.11g, BPSK, 6 Mbps, antenna 0, antenna 1, antenna 0 + 1 – 802.11g, QPSK, 12 Mbps, antenna 0 + 1 – 802.11g, 16 QAM, 24 Mbps, antenna 0 + 1 – 802.11g, 64 QAM, 24 Mbps, antenna 0 + 1 – 802.11n, BPSK, 6.5 Mbps, antenna 0 – 802.11n, QPSK, 13 Mbps, antenna 0 – 802.11n, 16 QAM, 26 Mbps, antenna 0 – 802.11n, 64 QAM, 52 Mbps, antenna 0 * From conducted RF output measurements with test sample 60337 test mode 1, 2, 3 have been selected based on measured maximum conducted output power

6 SUMMARY OF TEST RESULTS

Test specification
FCC 47 CFR Part 15 **RSS-247, Issue 2 (2017-02) / RSS-Gen, Issue 5 (2018-04)**

Clause	Requirement / Test Case	Result - Remark	Verdict
§15.247(a)(2) RSS-247,5.2 (a)	DTS bandwidth (6 dB)	KDB 558074, clause: 8.2	- PASS -
RSS Gen, 6.7	Occupied bandwidth (99%)	-/-	- PASS -
§15.247(b)(3) RSS-247, 5.4 (d)	RF output power (conducted peak power)	KDB 558074, clause: 8.3.1	- PASS -
§15.247(b)(4) RSS-247, 5.4 (d)	Antenna gain (calculated)	-/-	- PASS -
§15.247(e) RSS-247, 5.2 (b)	Peak power spectral density (PSD)	KDB 558074, clause: 8.4	- PASS -
§15.247(d) RSS-247, 5.5	Band edge compliance (BEC), conducted	KDB 558074, clause: 8.5	- PASS -
§15.247(d) RSS-247, 5.5	Band edge compliance (BEC), radiated	KDB 558074, clause: 8.7	- PASS -
§15.247(d) RSS-247, 5.5	Conducted spurious emissions (CSE)	KDB 558074 DTS clause: 8.5	- PASS -
15.247(d) / §15.209 RSS-247, 5.5 / RSS-Gen, 8.9	Radiated spurious emissions (RSE)	-/-	- PASS -
§15.207 RSS-Gen, 8.8	AC conducted emissions	EUT is battery powered	- N/A -

Comments and observations
Following pages show requirements and references of FCC Part 15.247, ANSI C63.10 and KDB 558074 only. Same tests are also applicable and valid for RSS-247, with clauses given in table above.

7 TEST RESULTS

7.1 DTS Bandwidth (6 dB)

Applicability
This requirement applies to all types of DTS equipment.

Description
The DTS Bandwidth is defined as the 6 dB bandwidth.

Limit
§15.247
(a)(2) The minimum 6 dB bandwidth shall be at least 500 kHz.

Test procedure
ANSI C63.10, 11.8
The steps are as follows:
a) Set RBW = 100 kHz.
b) Set the VBW ≥ [3 × RBW].
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.
The automatic bandwidth measurement capability of an instrument may be employed using the 6 dB bandwidth mode.

Test setup: 8.4 with conducted test sample 60337 (see 5.2)

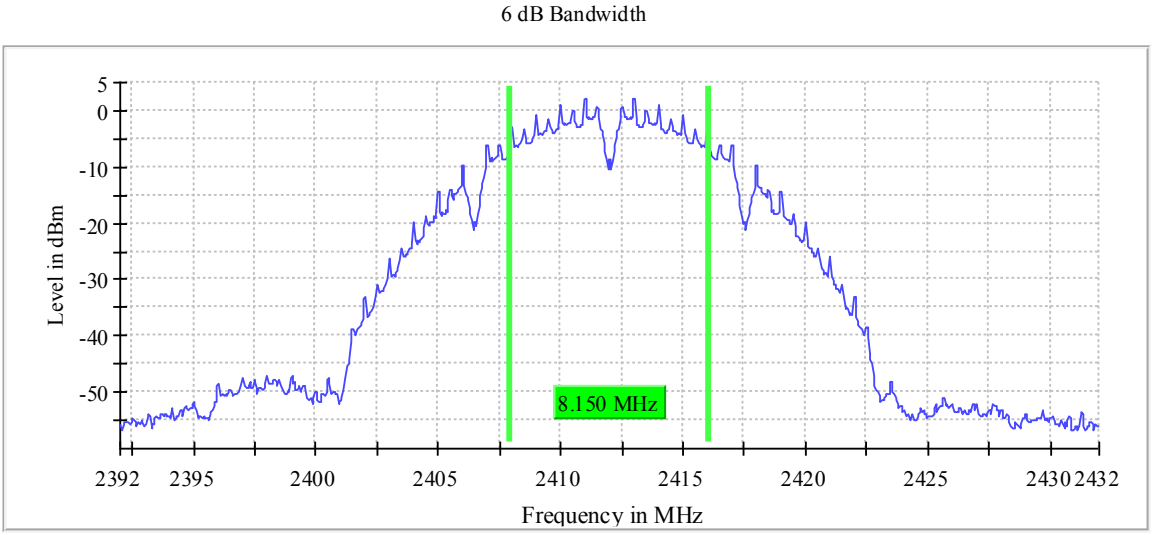
Test Results

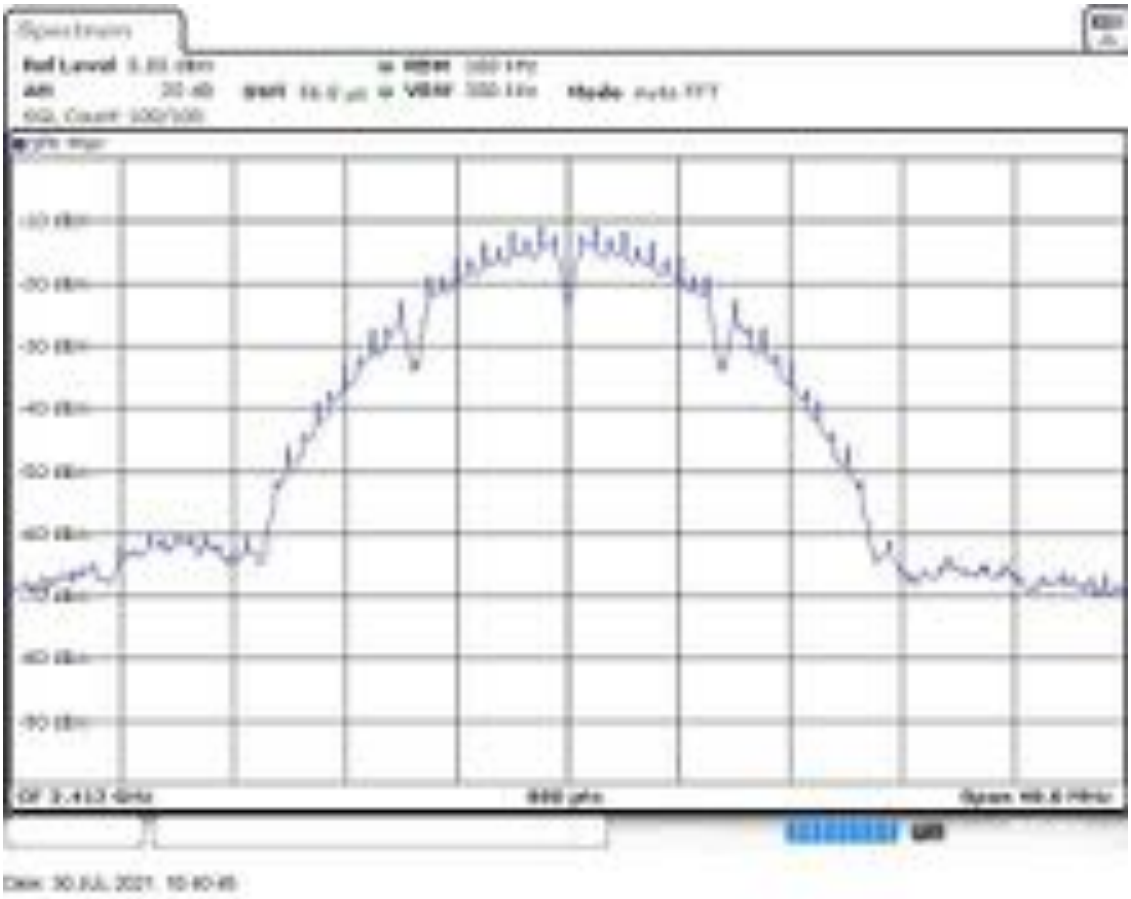
EUT Mode	DTS Bandwidth (6 dB)			Limit [MHz]
	low channel [MHz]	mid channel [MHz]	high channel [MHz]	
Mode 1	8.150	8.150	7.750	≥ 0.500
Mode 2	15.850	15.400	15.750	≥ 0.500
Mode 3	15.250	15.450	15.250	≥ 0.500

Comment:	---

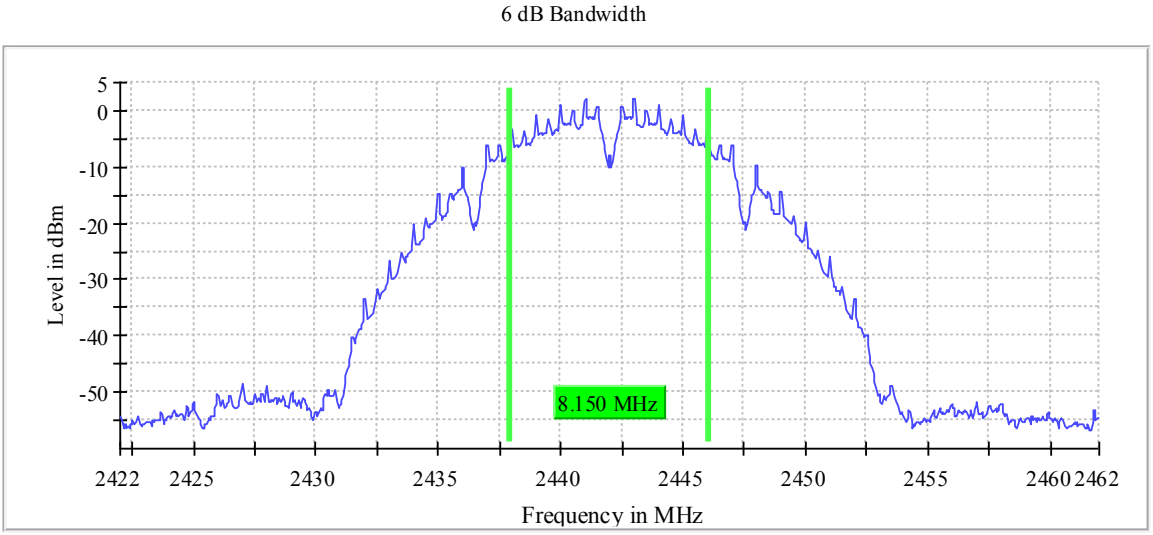
Verdict	**- PASS -**	*see next plots*

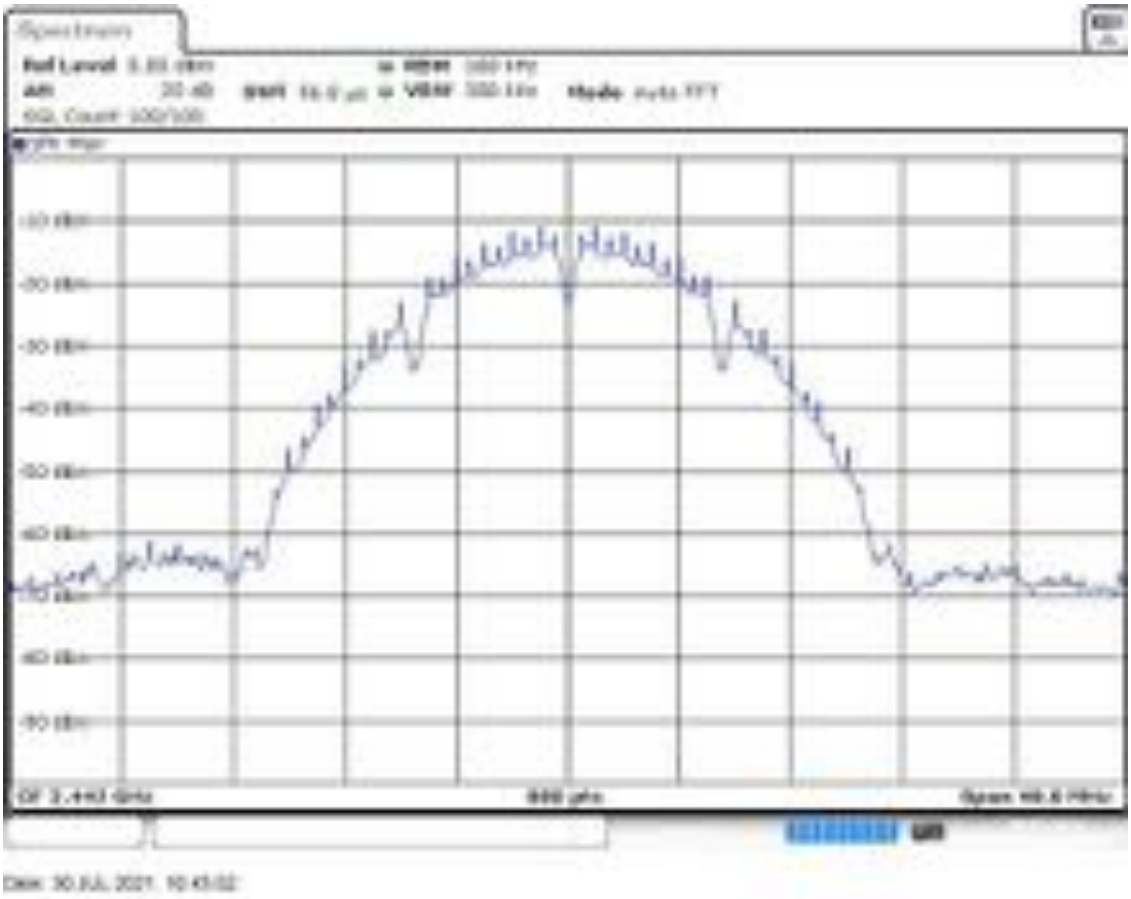
Plot 1: Mode 1, DTS Bandwidth, low channel



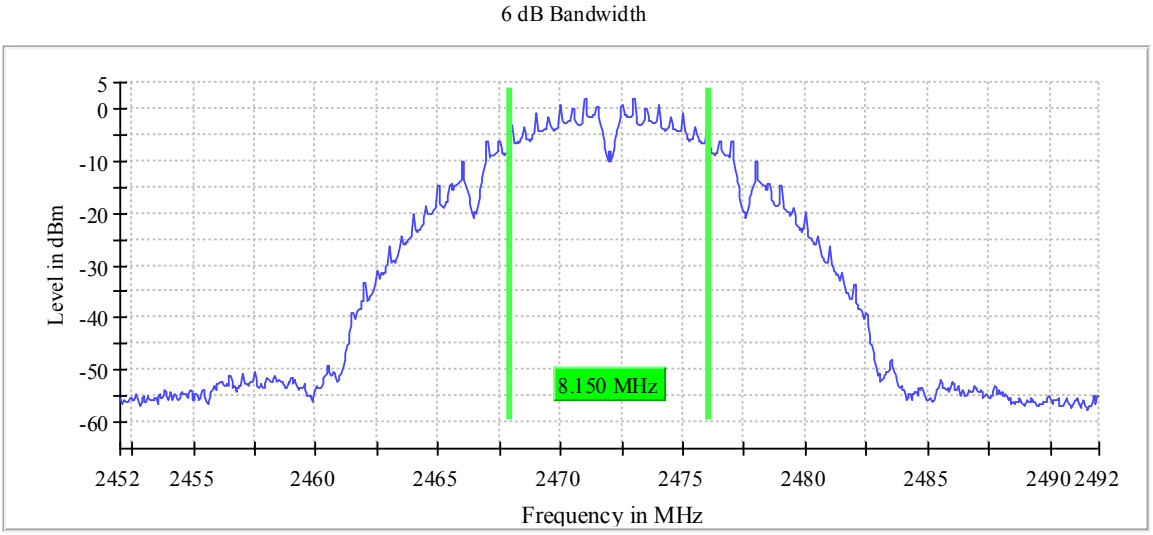


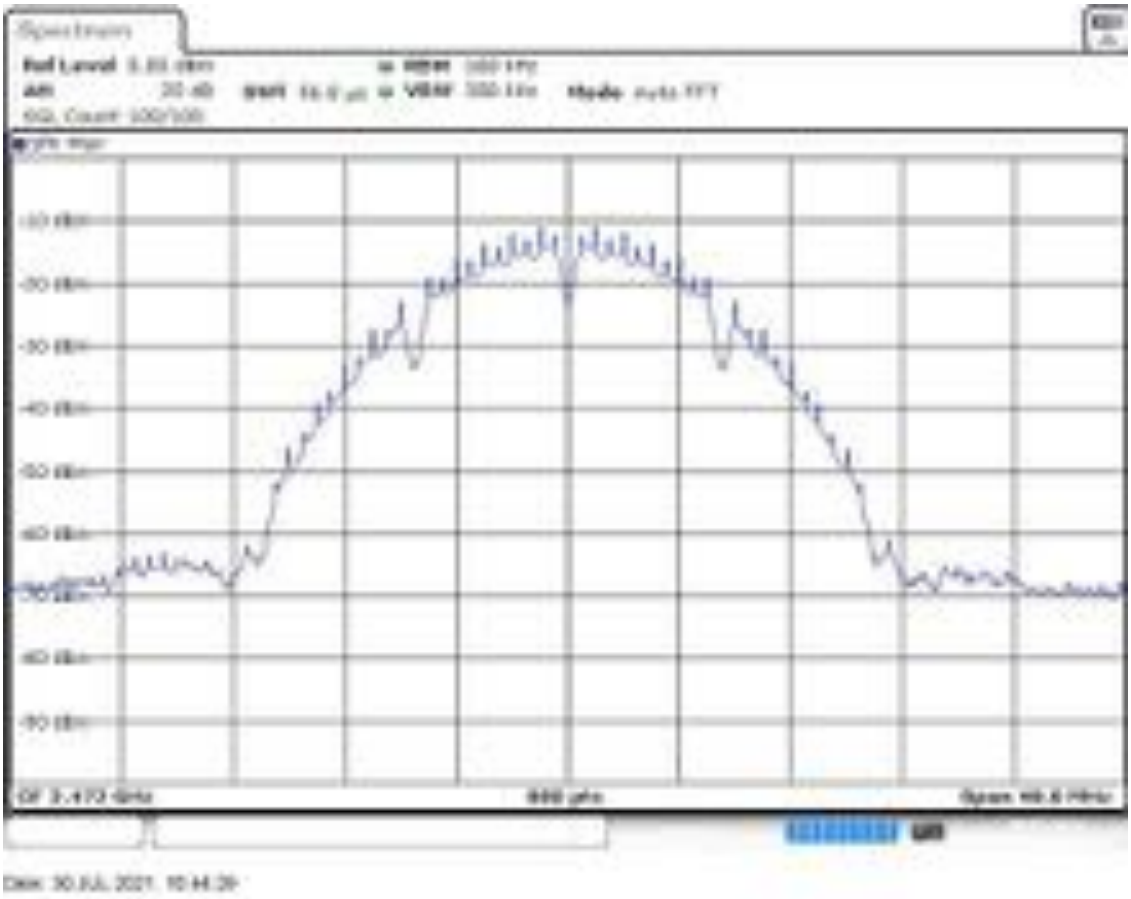
Plot 2: Mode 1, DTS Bandwidth, mid channel



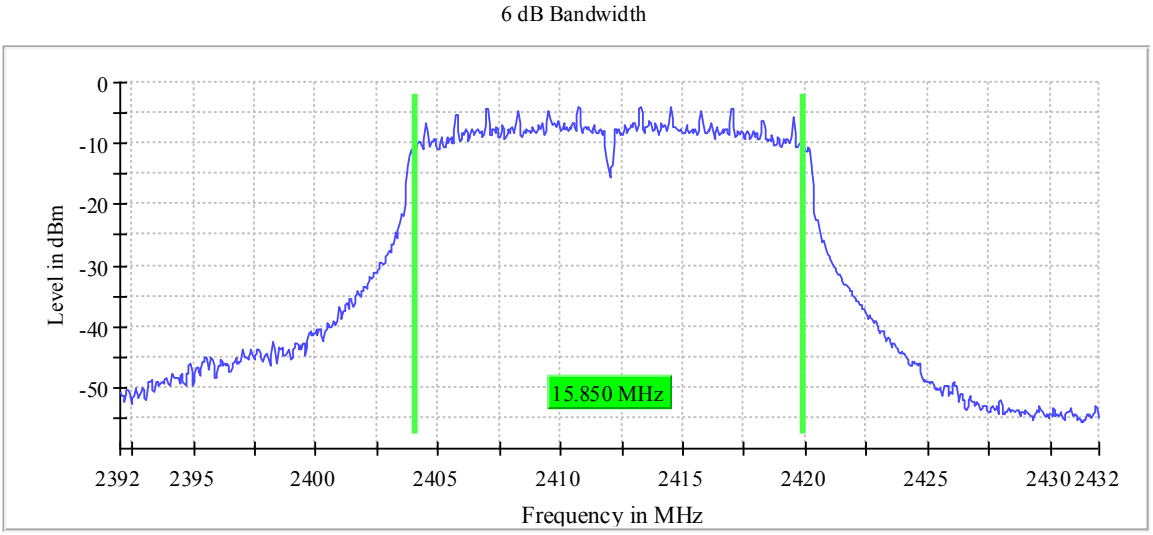


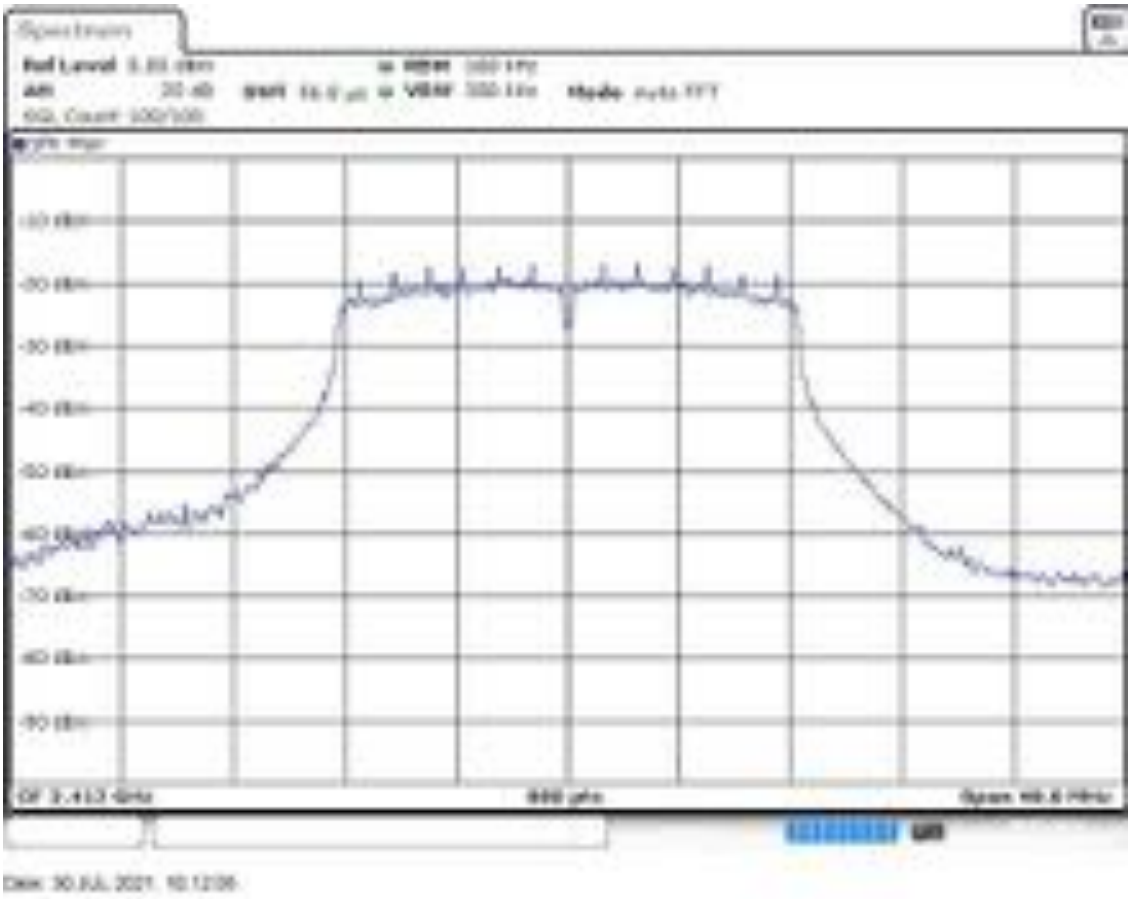
Plot 3: Mode 1, DTS Bandwidth, high channel



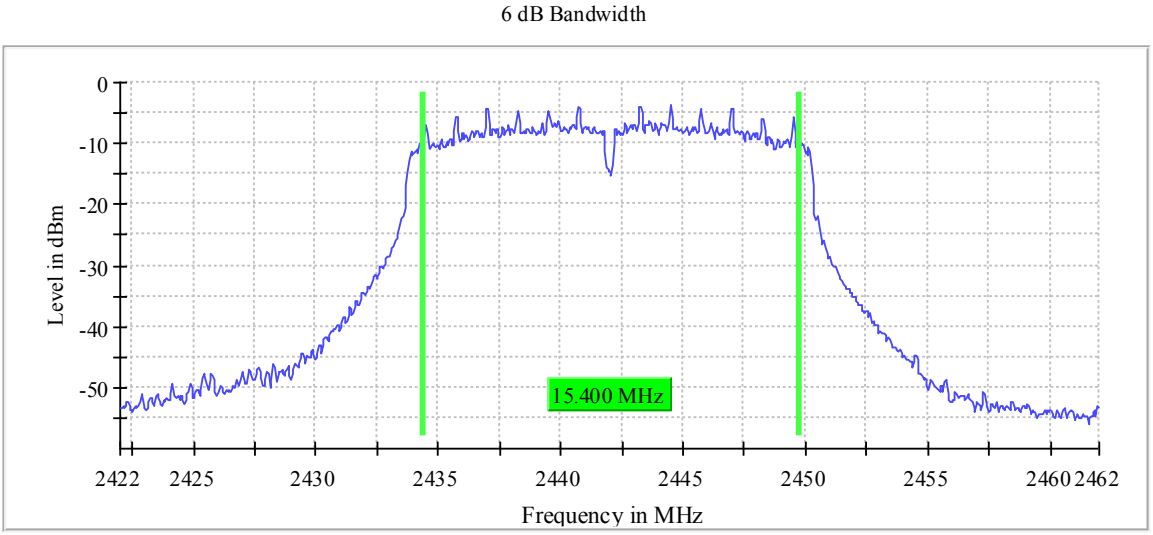


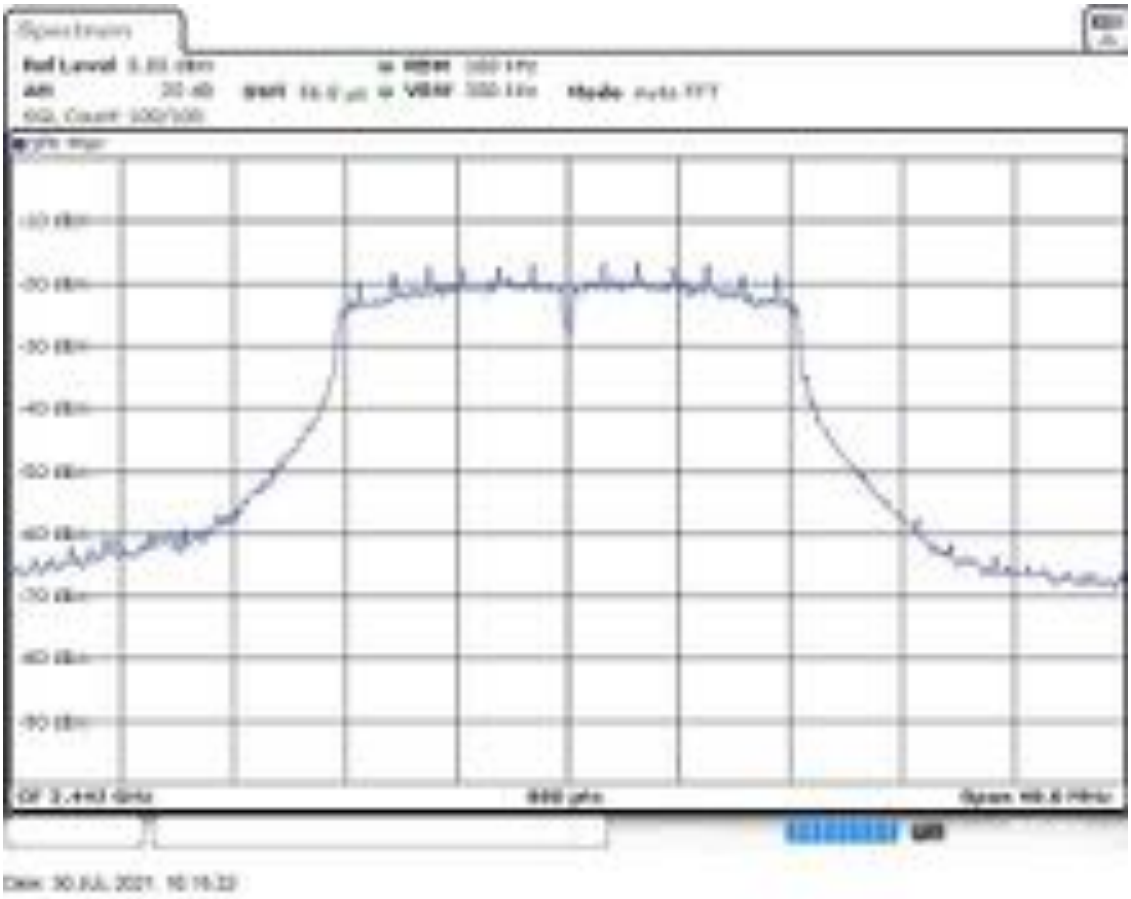
Plot 4: Mode 2, DTS Bandwidth, low channel



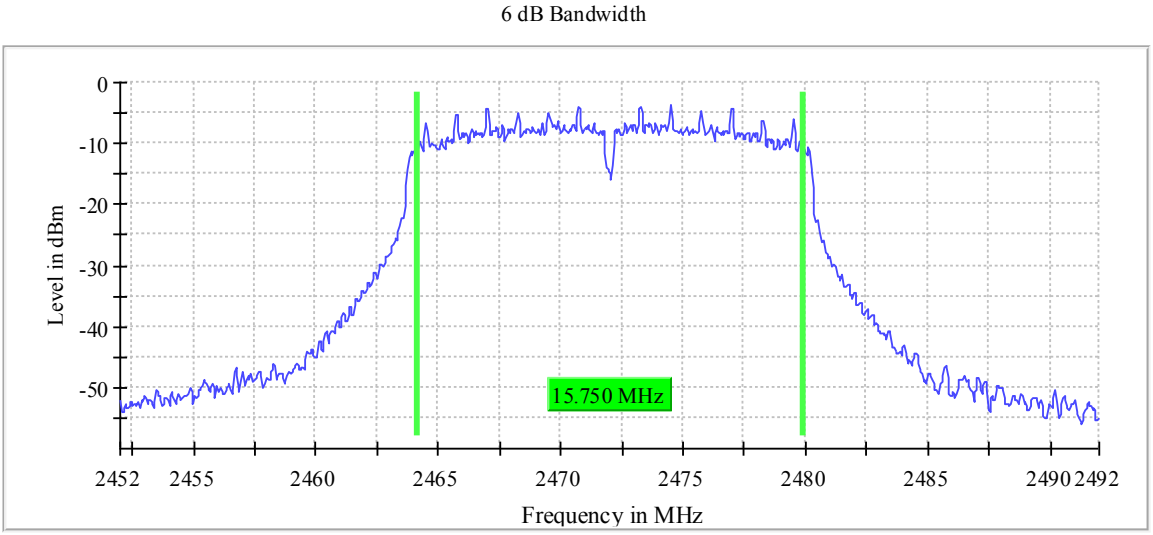


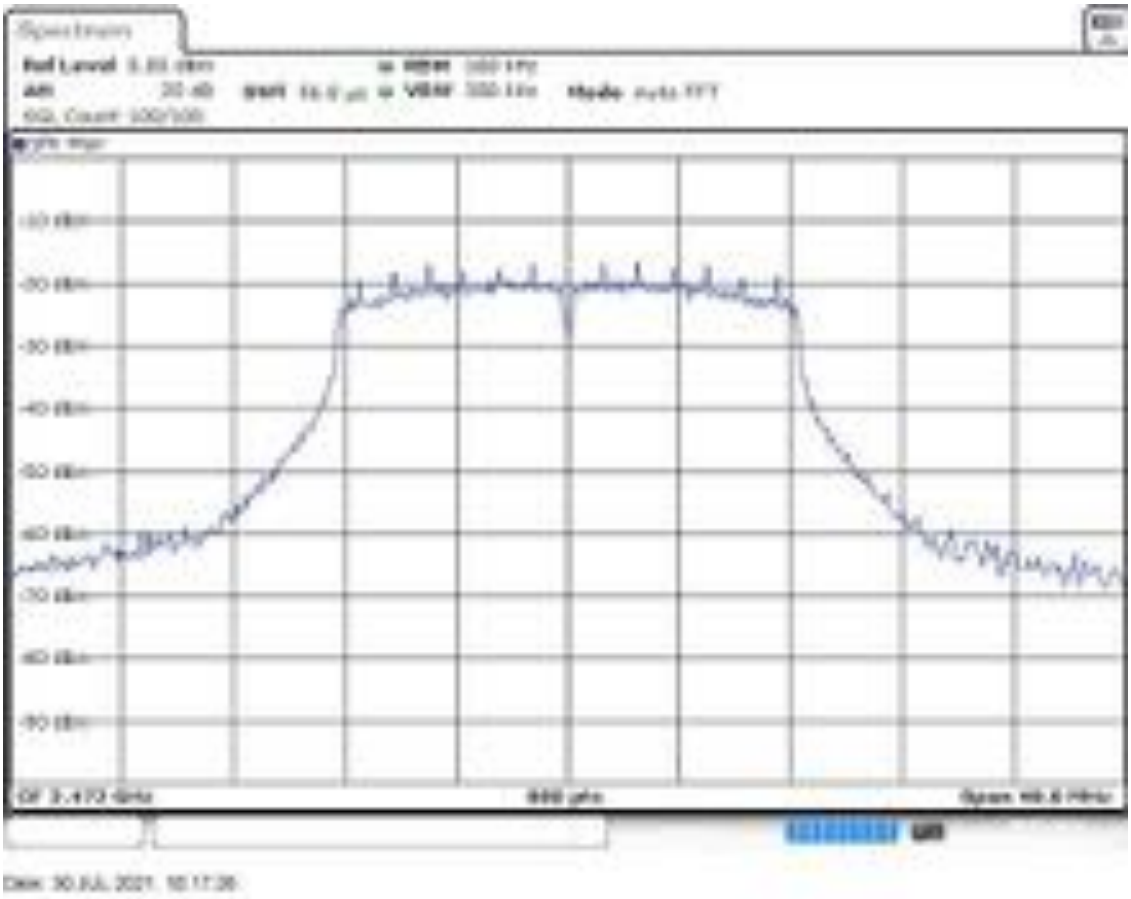
Plot 5: Mode 2, DTS Bandwidth, mid channel



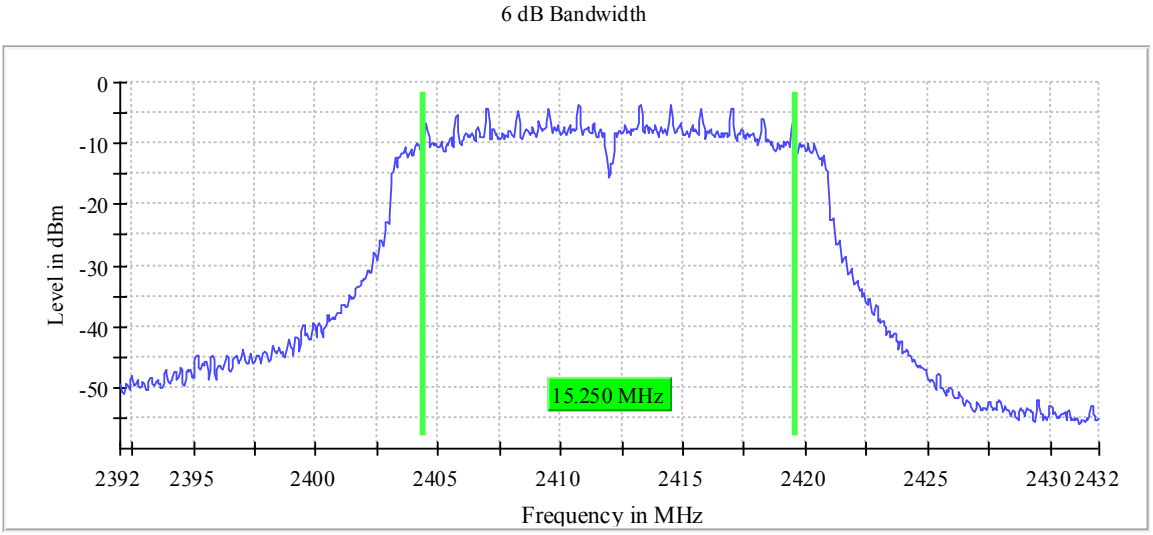


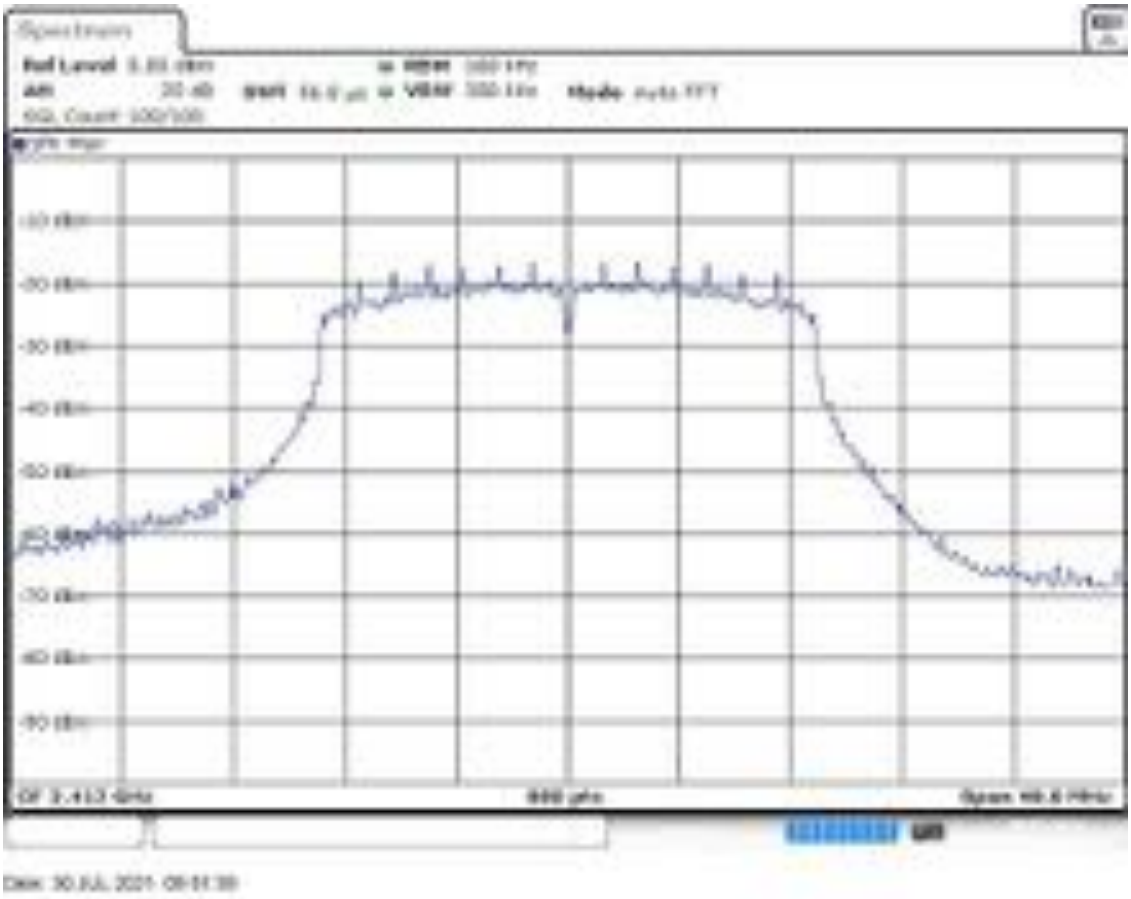
Plot 6: Mode 2, DTS Bandwidth, high channel



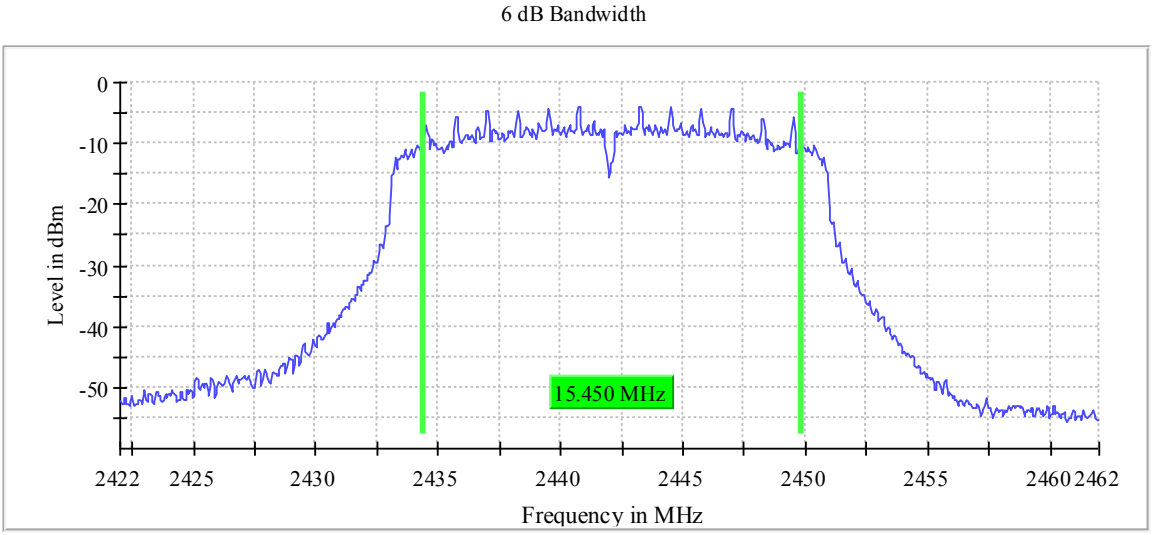


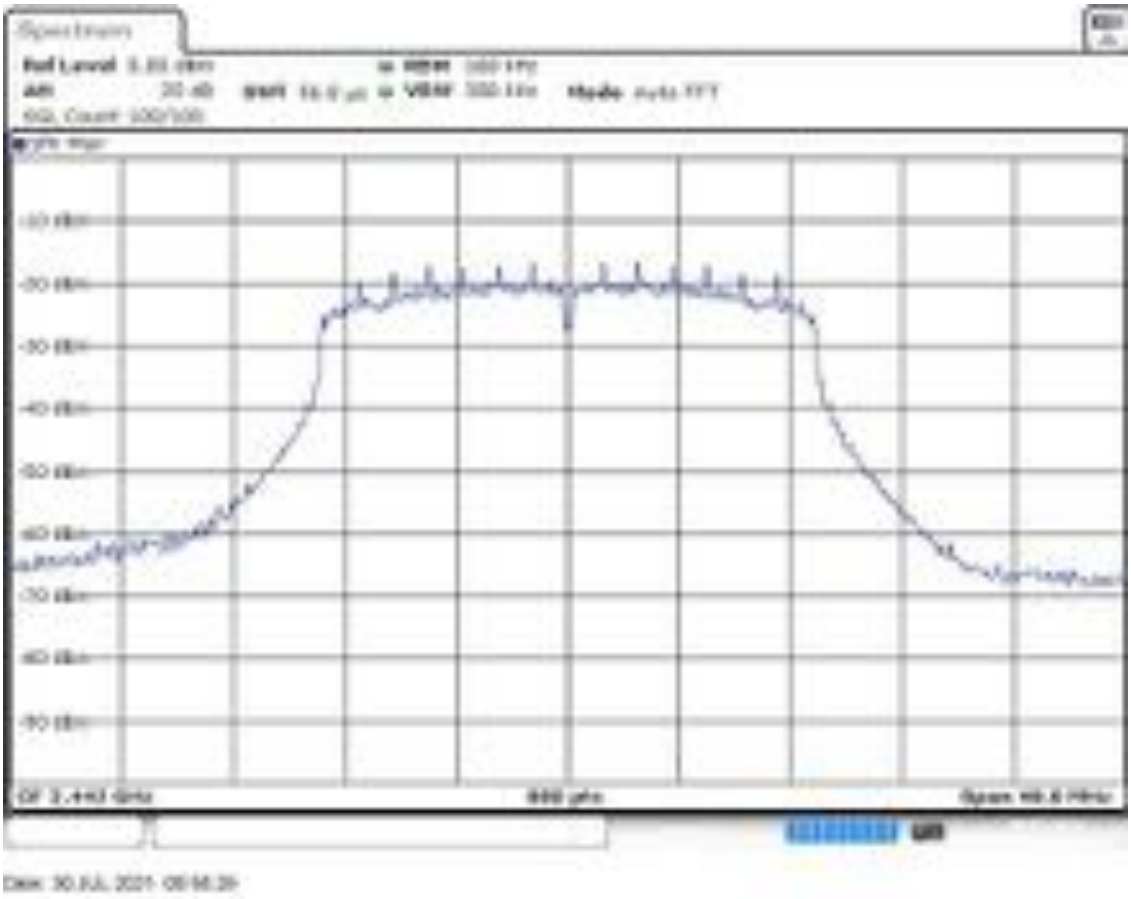
Plot 7: Mode 3, DTS Bandwidth, low channel



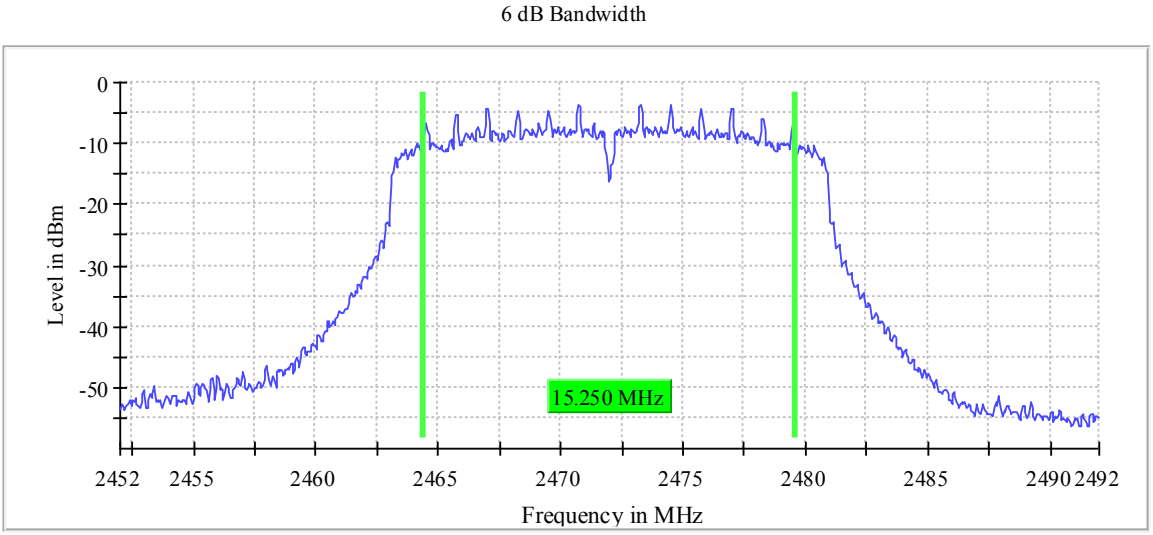


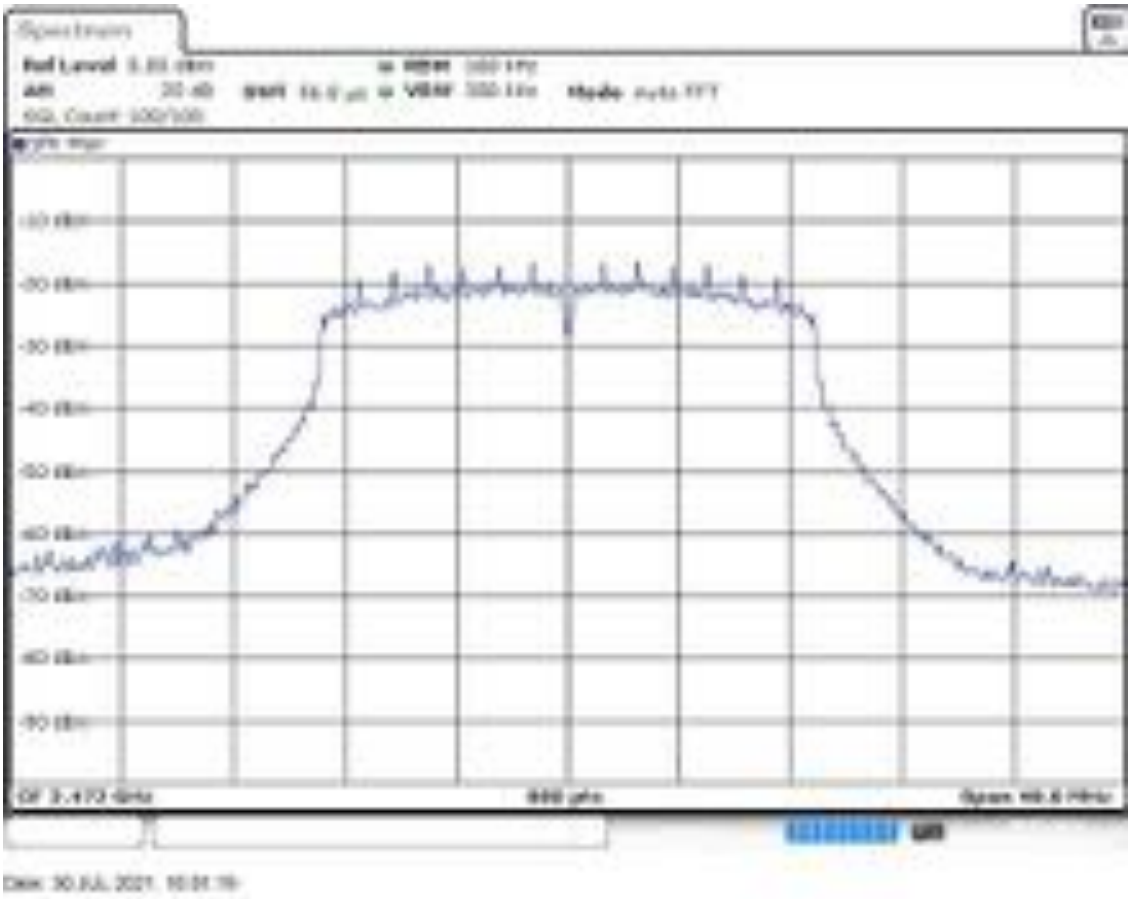
Plot 8: Mode 3, DTS Bandwidth, mid channel





Plot 9: Mode 3, DTS Bandwidth, high channel





7.2 Occupied Bandwidth (99% OBW)

Applicability
This requirement applies to all types of DTS equipment.

Description
The Occupied Channel Bandwidth is the bandwidth that contains 99 % of the power of the signal (RSS-Gen).

Limit
No limit defined.

Test procedure
ANSI C63.10, 6.9.3
The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.
The following procedure shall be used for measuring 99% power bandwidth:
a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
d) Step a) through step c) might require iteration to adjust within the specified range.
e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Test setup: 8.4 with conducted test sample 60337 (see 5.2)

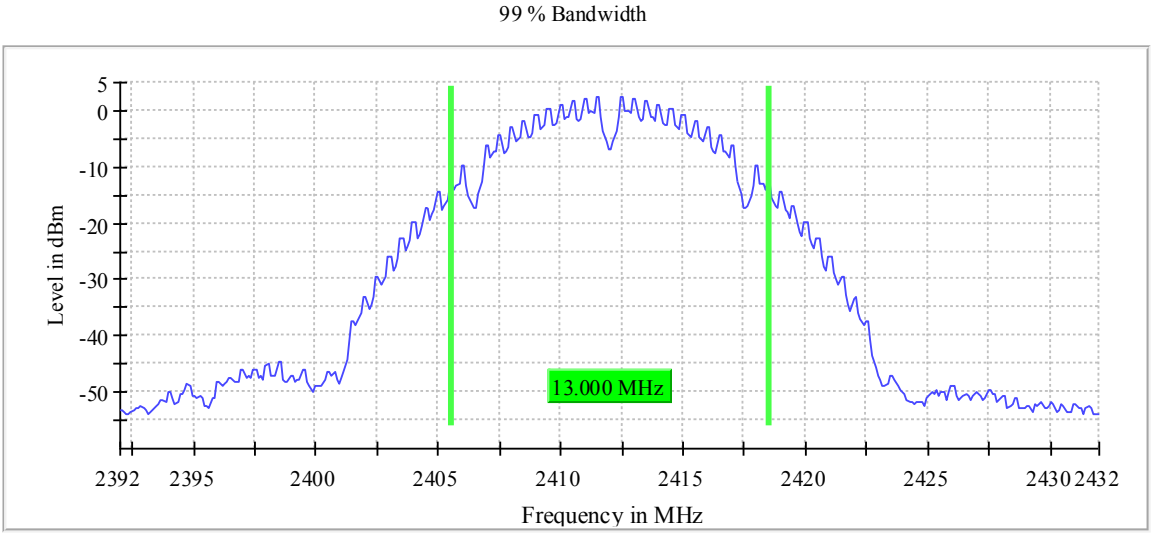
Test Results

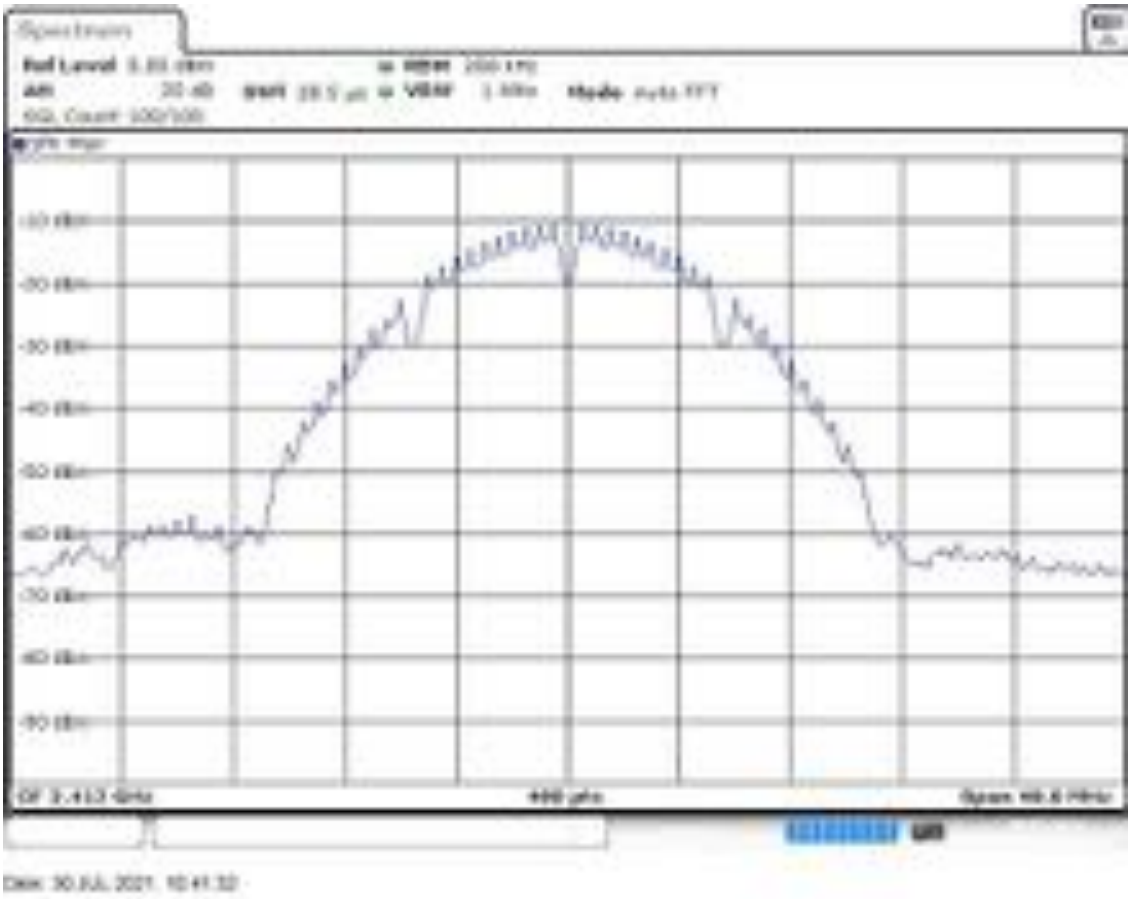
EUT Mode	Occupied Bandwidth (99%)		
	low channel [MHz]	mid channel [MHz]	high channel [MHz]
Mode 1	13.000	13.000	13.000
Mode 2	16.300	16.300	16.300
Mode 3	17.500	17.500	17.500

Comment:	---

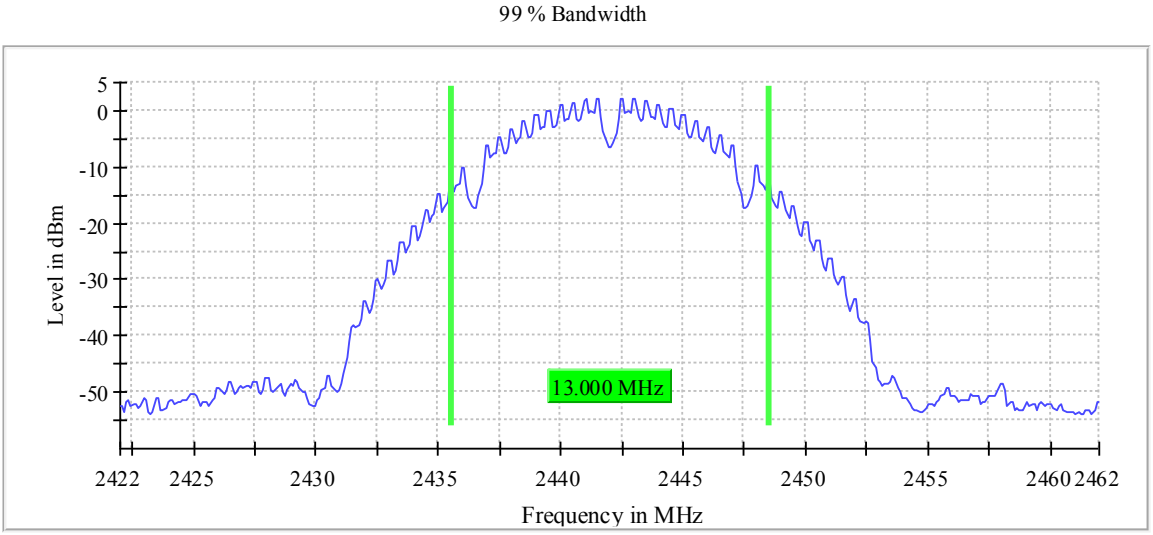
Verdict	- PASS -	*see next plots*

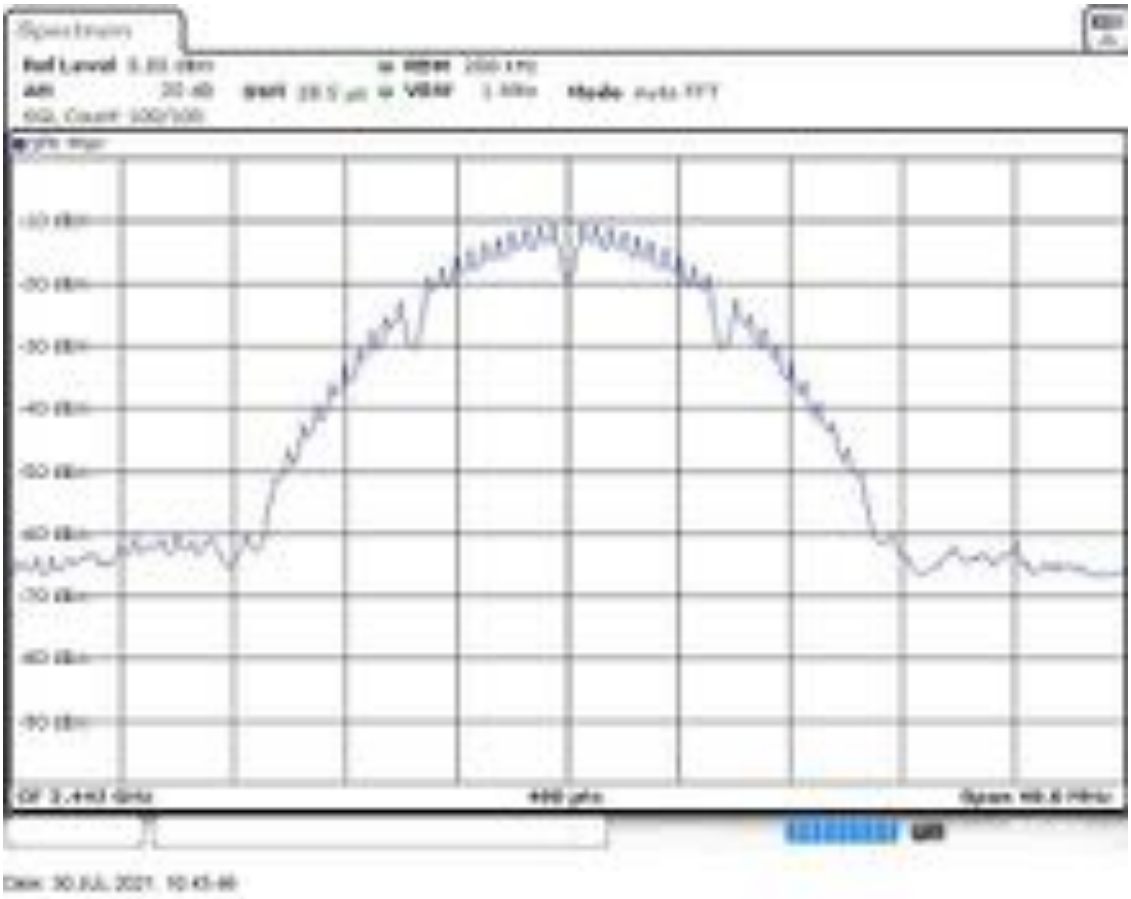
Plot 10: Mode 1, 99% Occupied Bandwidth, low channel



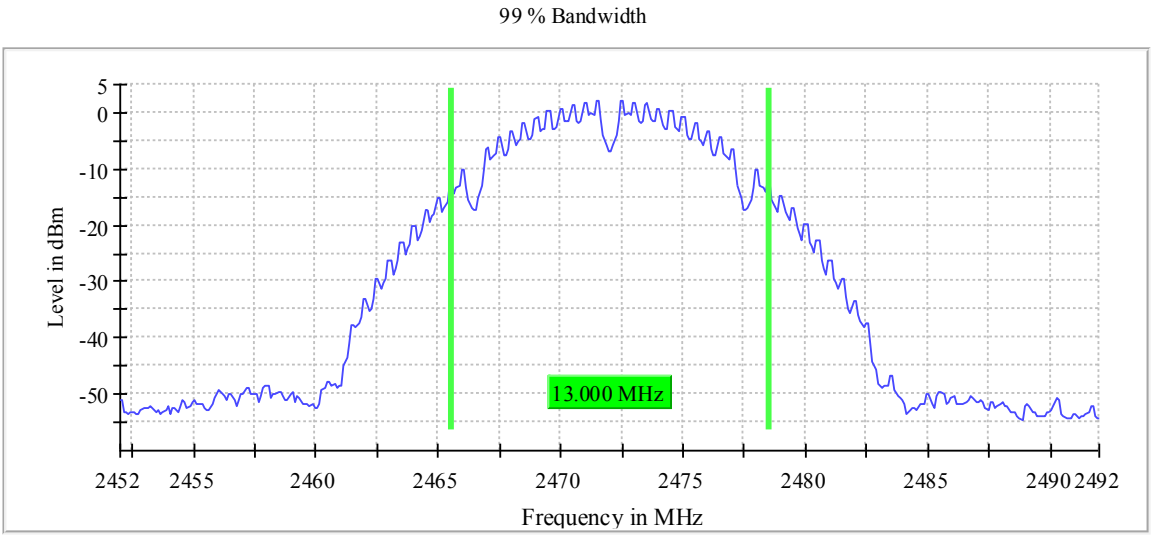


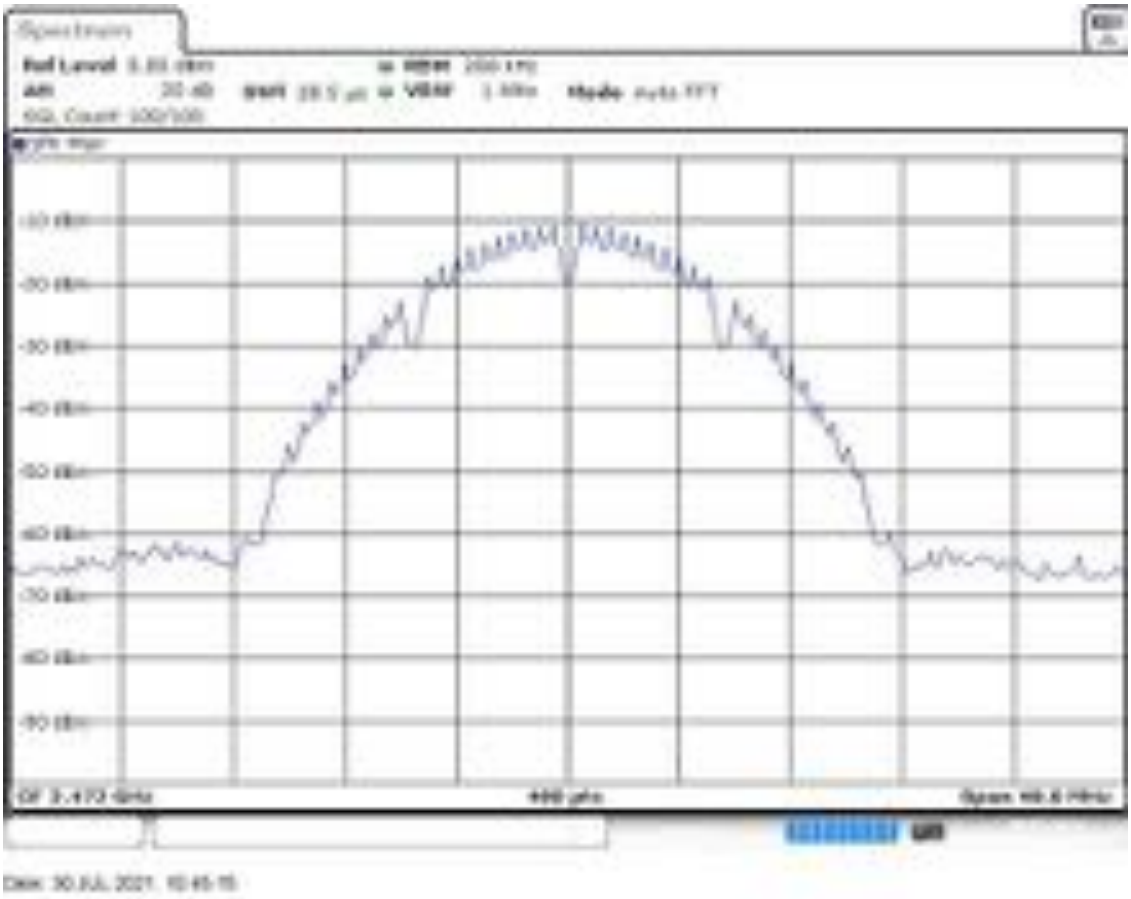
Plot 11: Mode 1, 99% Occupied Bandwidth, mid channel



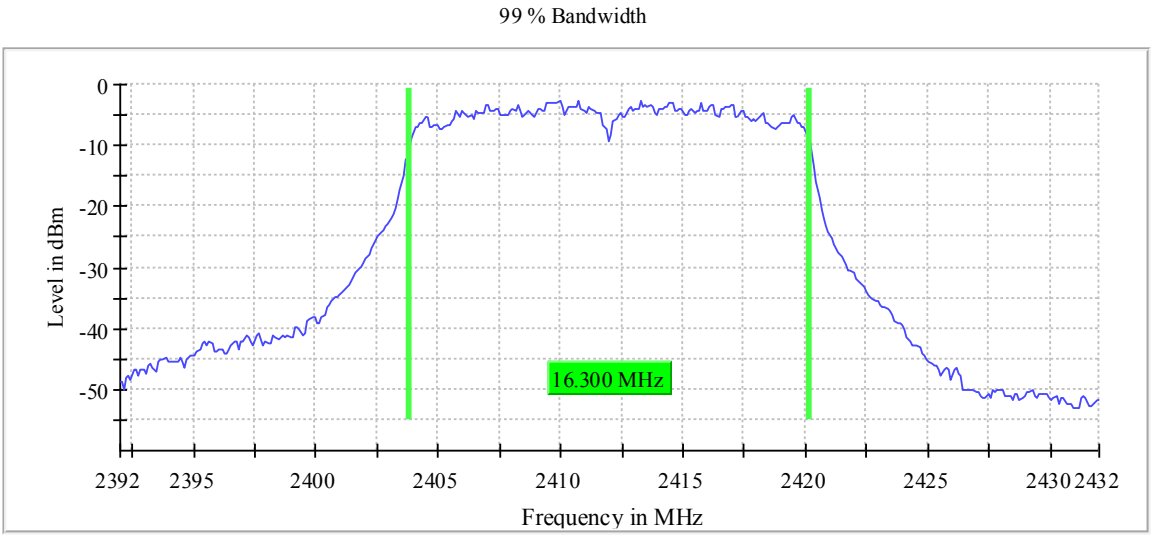


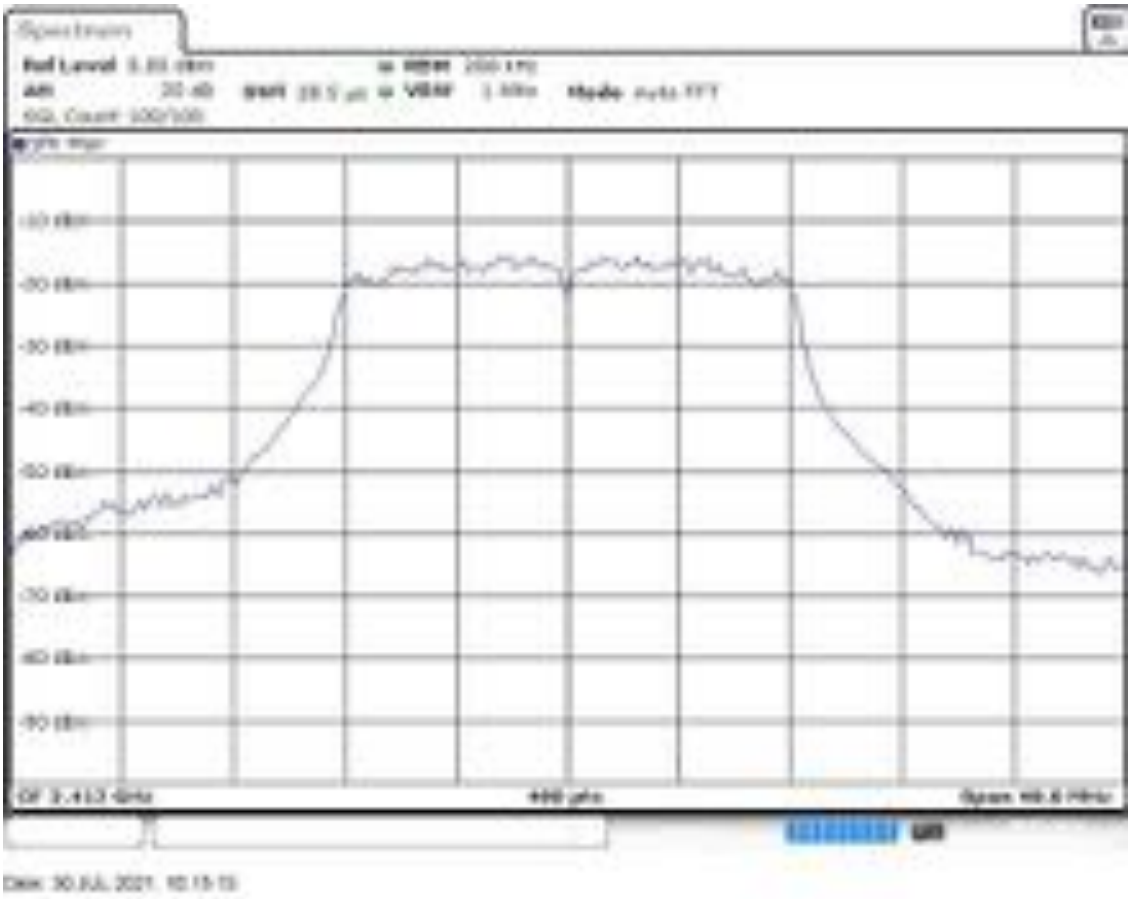
Plot 12: Mode 1, 99% Occupied Bandwidth, high channel



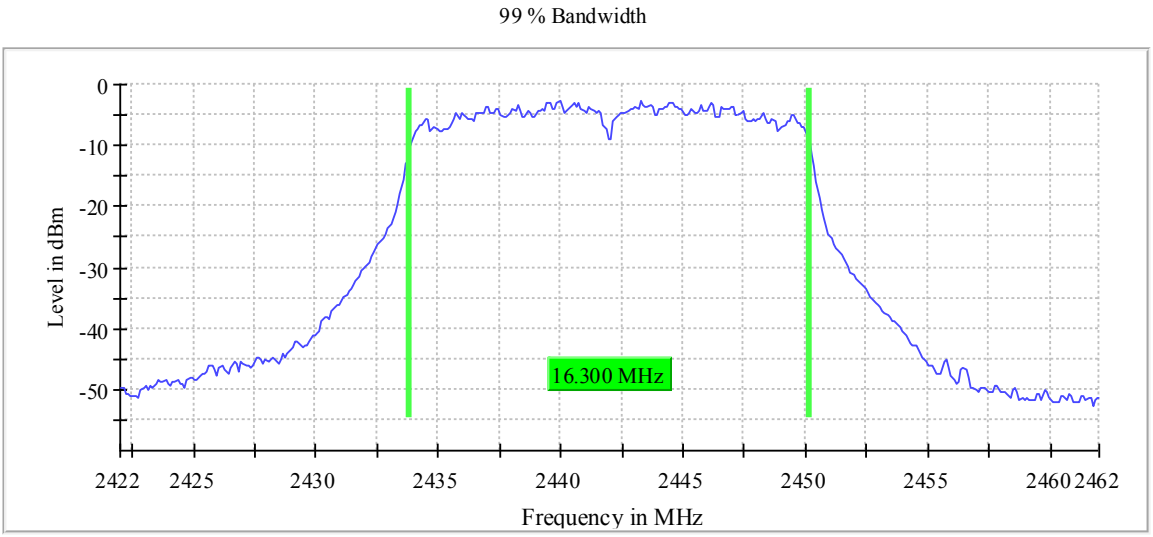


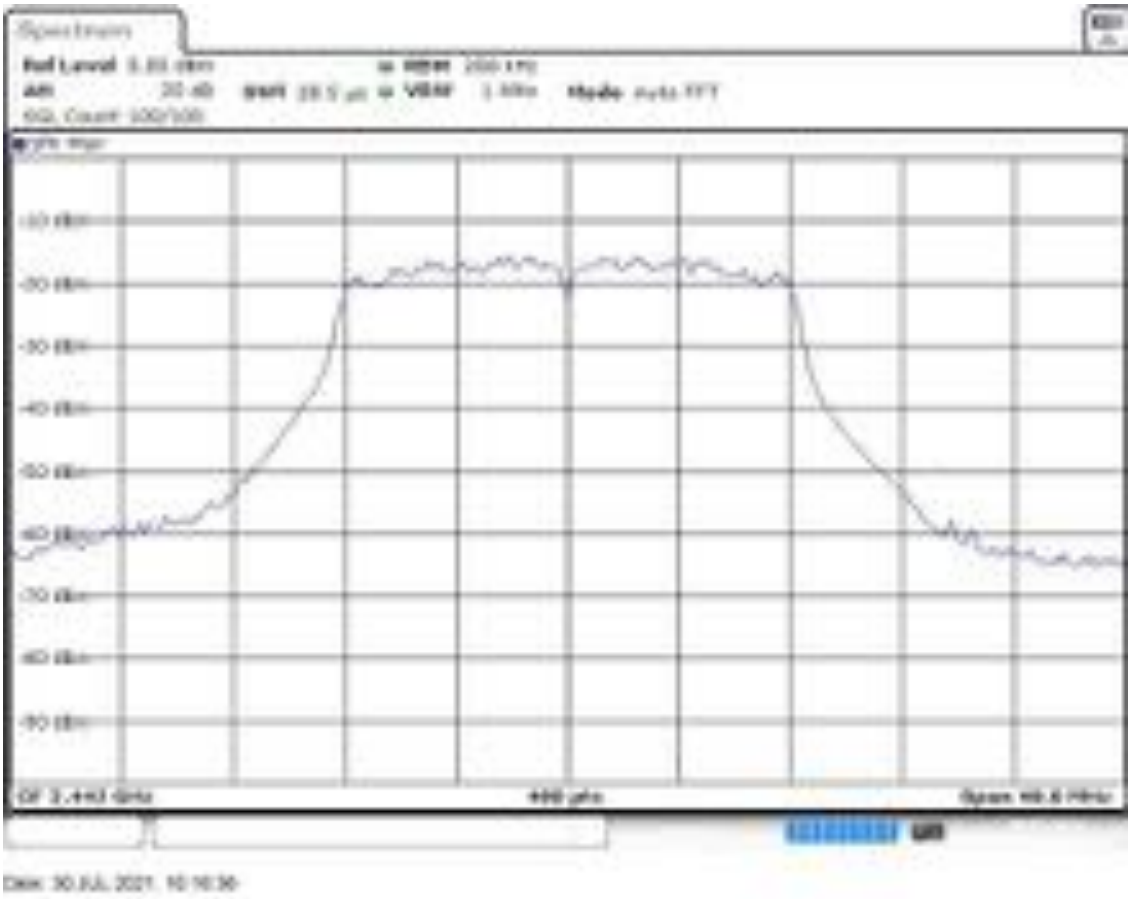
Plot 13: Mode 2, 99% Occupied Bandwidth, low channel



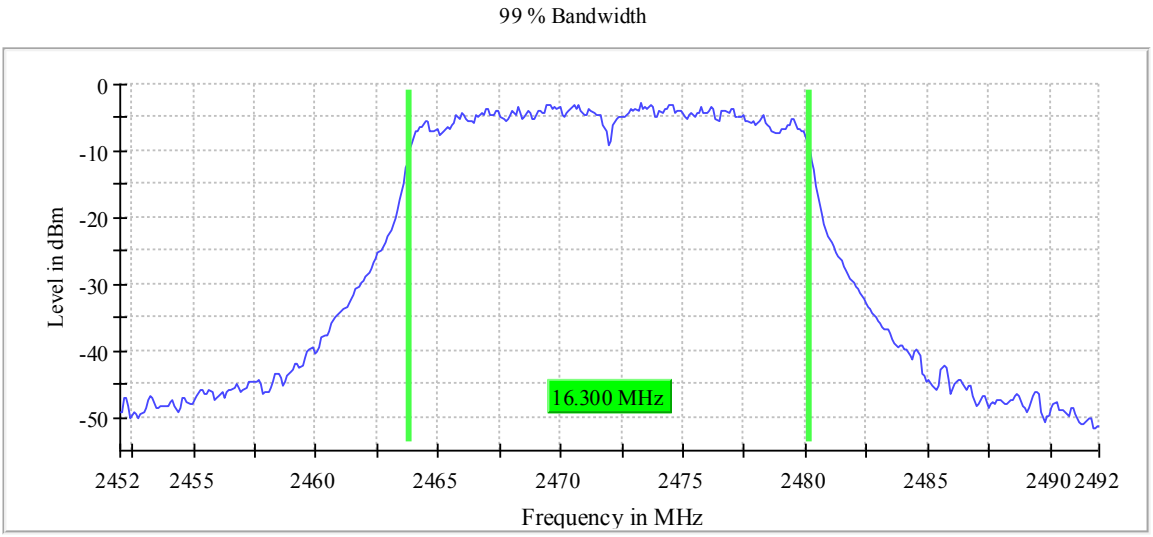


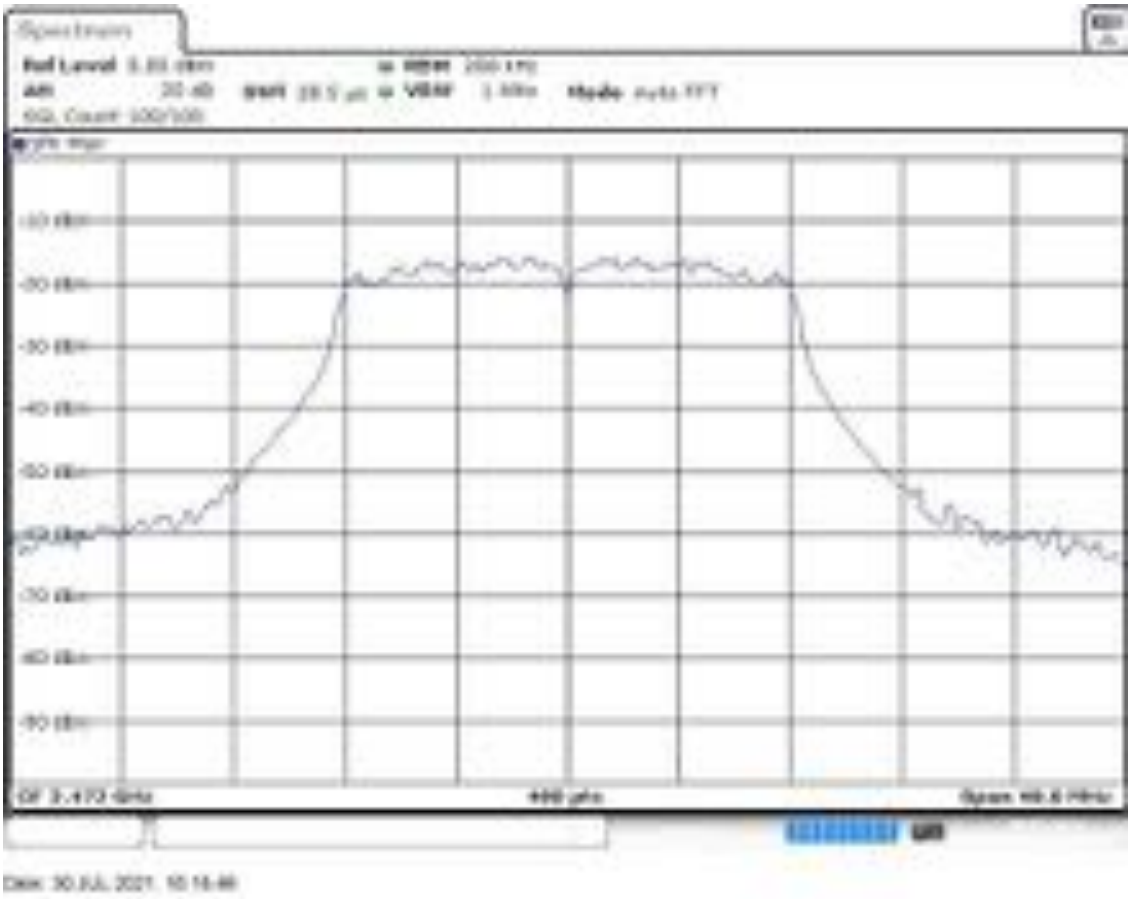
Plot 14: Mode 2, 99% Occupied Bandwidth, mid channel



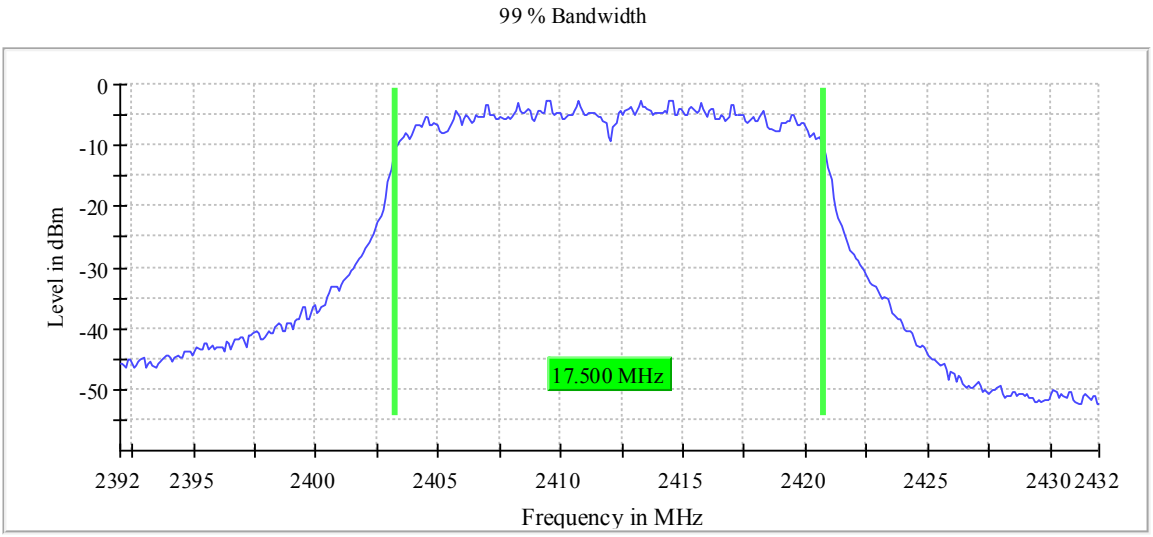


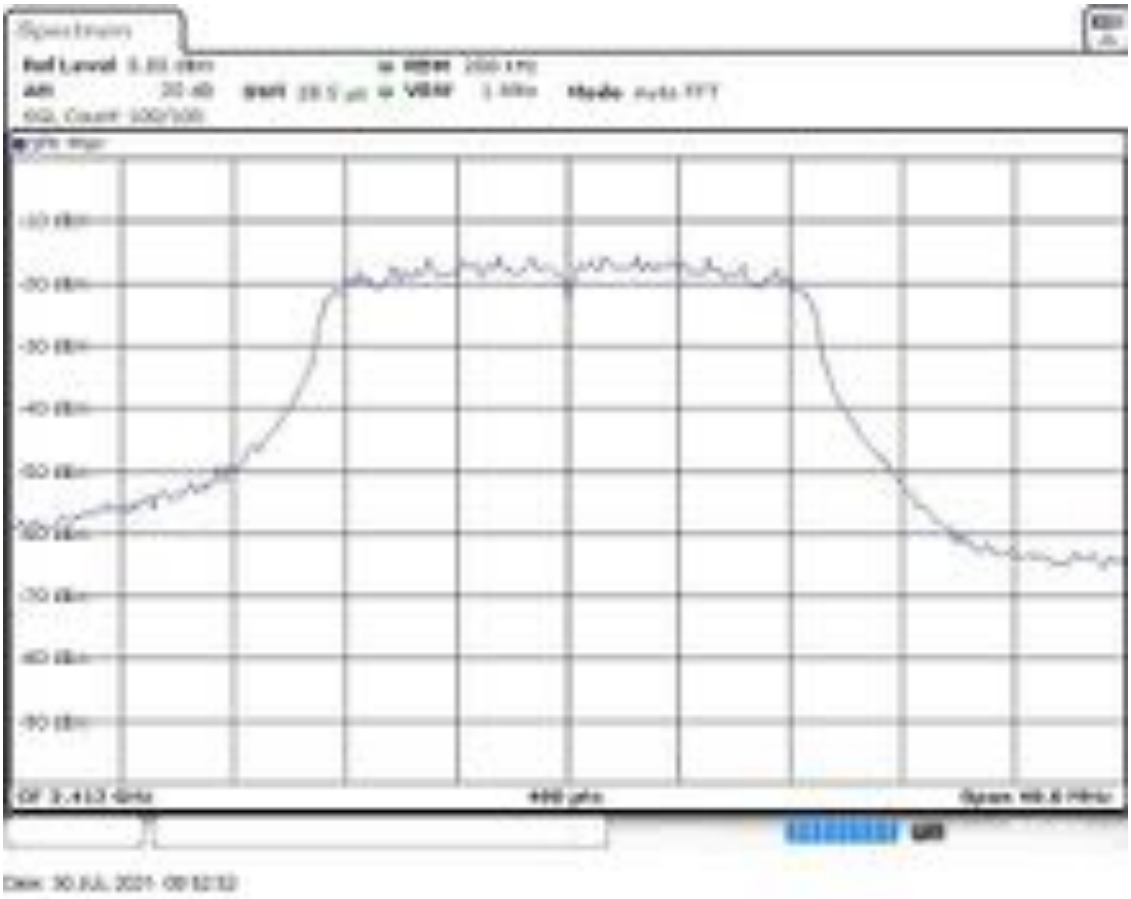
Plot 15: Mode 2, 99% Occupied Bandwidth, high channel



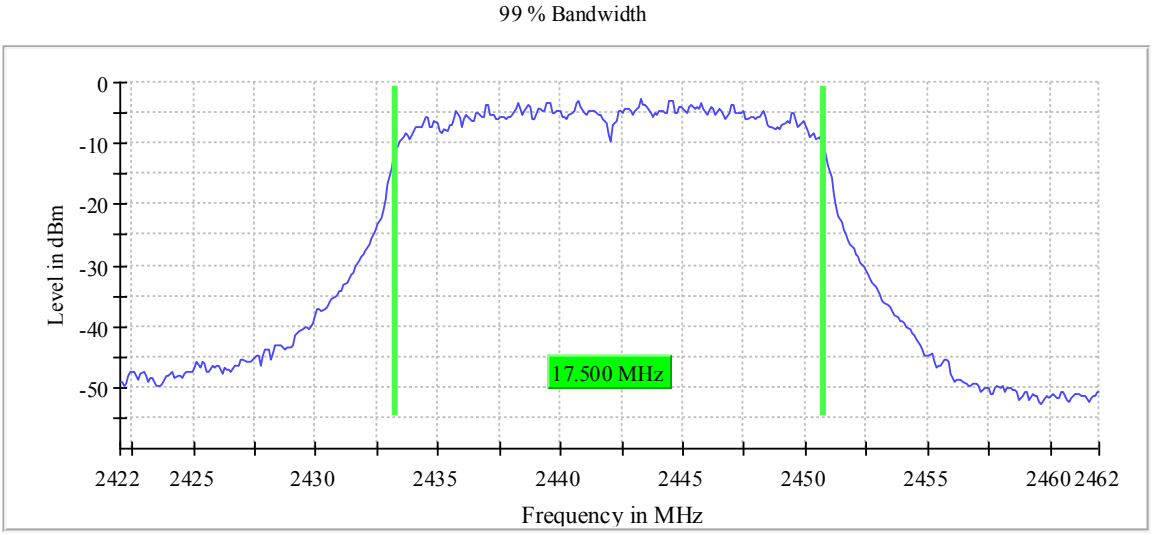


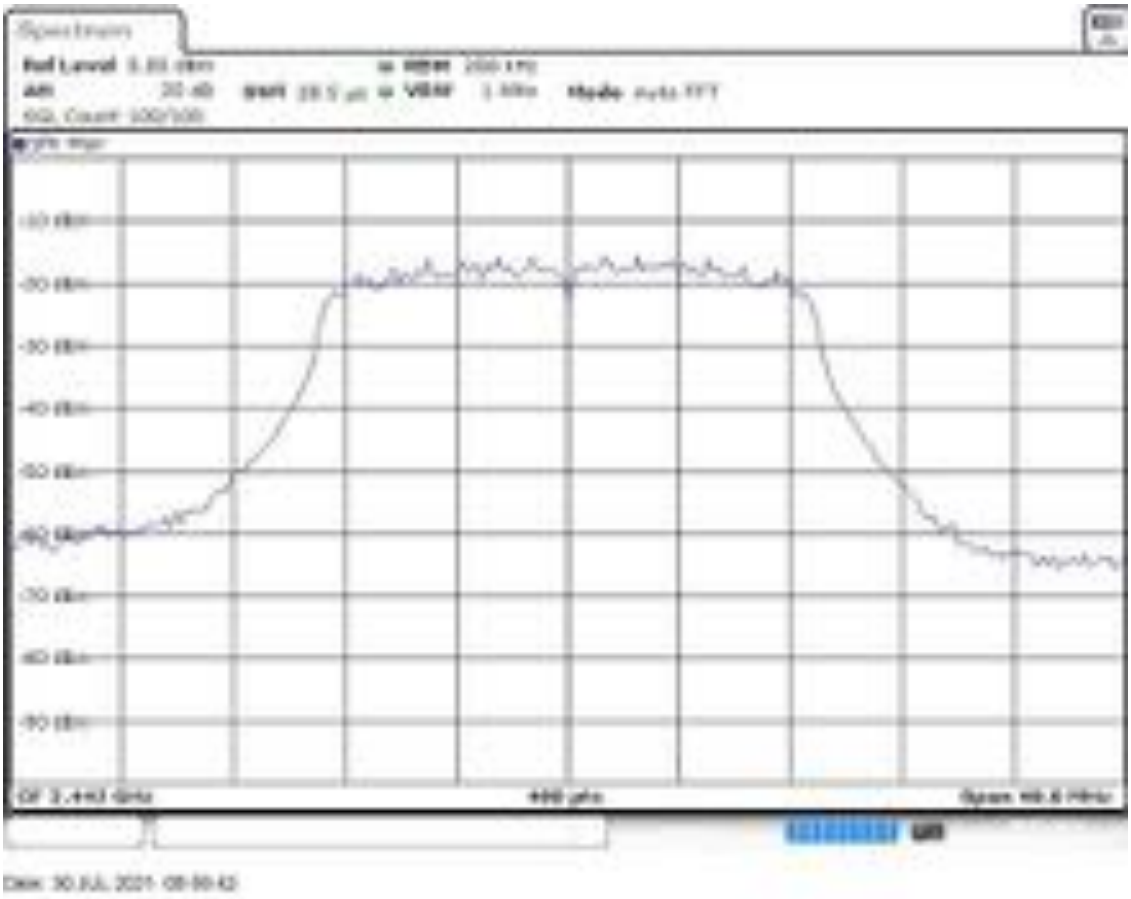
Plot 16: Mode 3, 99% Occupied Bandwidth, low channel



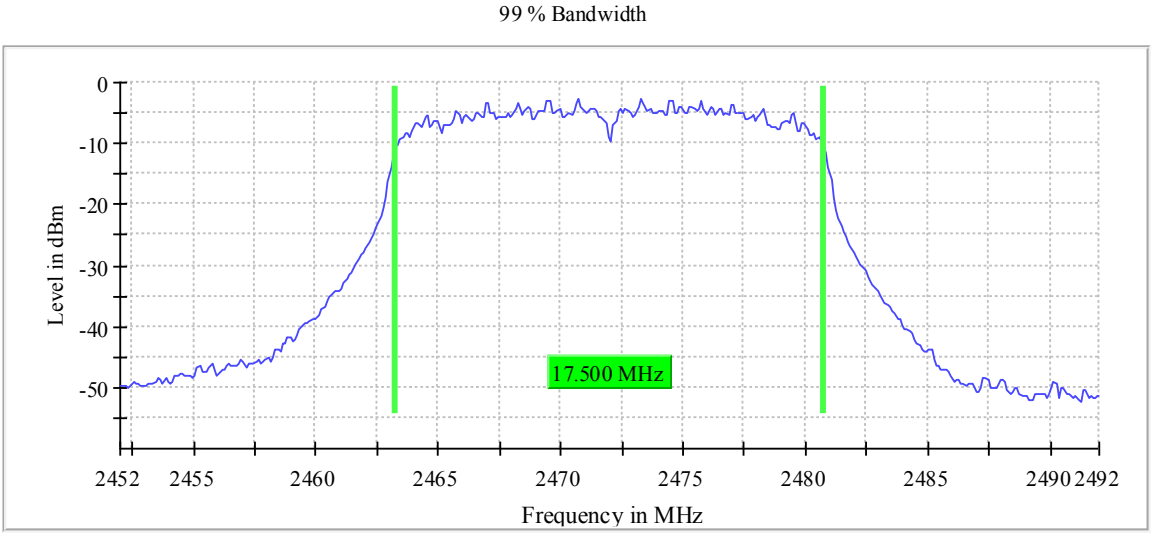


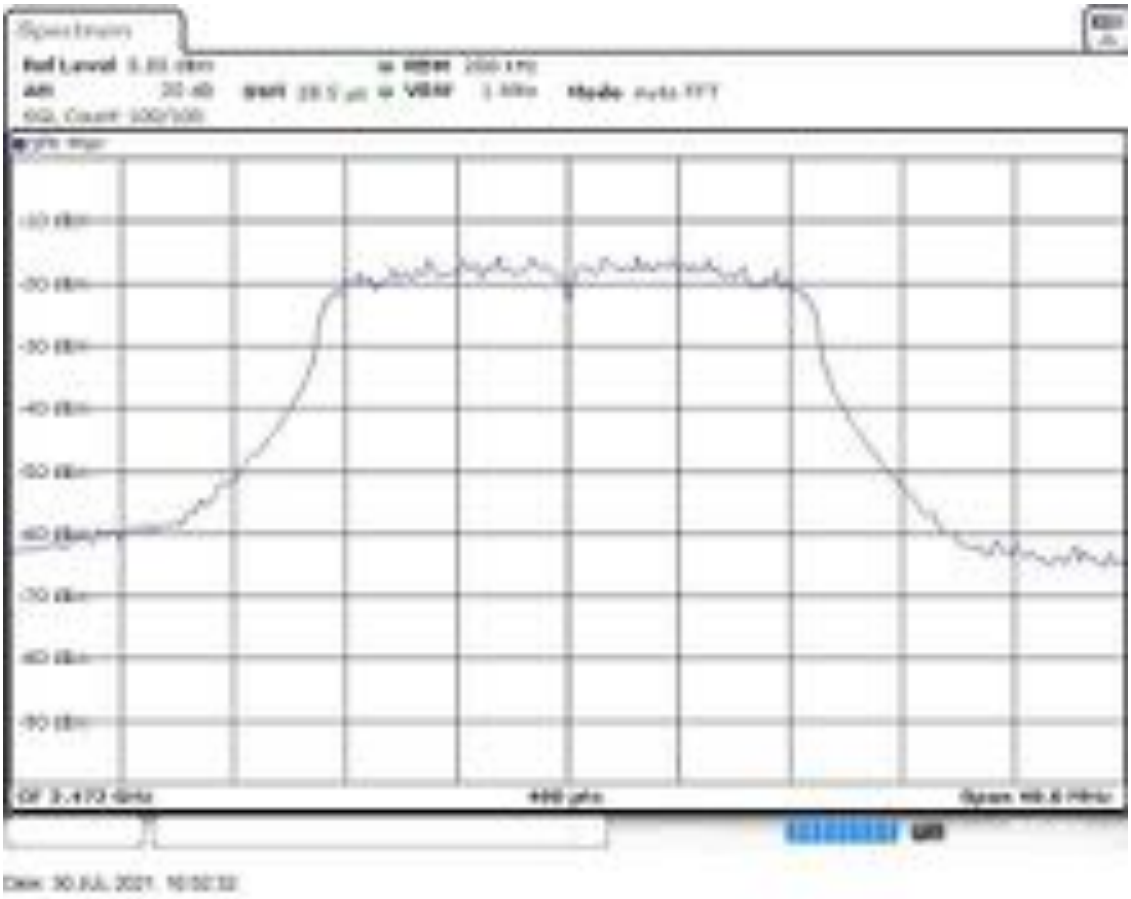
Plot 17: Mode 3, 99% Occupied Bandwidth, mid channel





Plot 18: Mode 3, 99% Occupied Bandwidth, high channel





7.3 RF Output Power (Conducted Peak Power)

Applicability
This requirement applies to all types of DTS equipment.

Description
The RF Output Power is defined as the conducted peak output power.

Limit
§15.247
(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:
(3) For systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the *maximum conducted output power* is the highest total transmit power occurring in any mode.
(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

Test procedure
KDB 558074 D01.

ANSI C63.10, 11.9.2.3.2
Method AVGPM-G is a measurement using a gated RF average power meter.
Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Because the measurement is made only during the ON time of the transmitter, no duty cycle correction factor is required.
Gate triggering can be implemented in such a way that the sweep of the instrument is only active during the burst period of the device. Any Gate triggering shall be performed on the full power portion of the pulses and care must be taken to ensure that static portions of the pulse are not included in the measurement (ensuring that the trace is averaged over the entire symbol range). All Gate triggered measurements shall be accompanied by a Gate setup plot in the test report.

Test setup: 8.4 with conducted test sample 61313 (see 5.2)

Test Results				
EUT Mode	**RF Output Power**			**Limit Max [dBm]**
	low channel [dBm]	**mid channel [dBm]**	**high channel [dBm]**	
Mode 1, b-mode	10.7	10.3	10.5	30
Mode 2, g-mode	8.1	7.7	8.0	30
Mode 3, n-mode	7.9	7.5	7.8	30

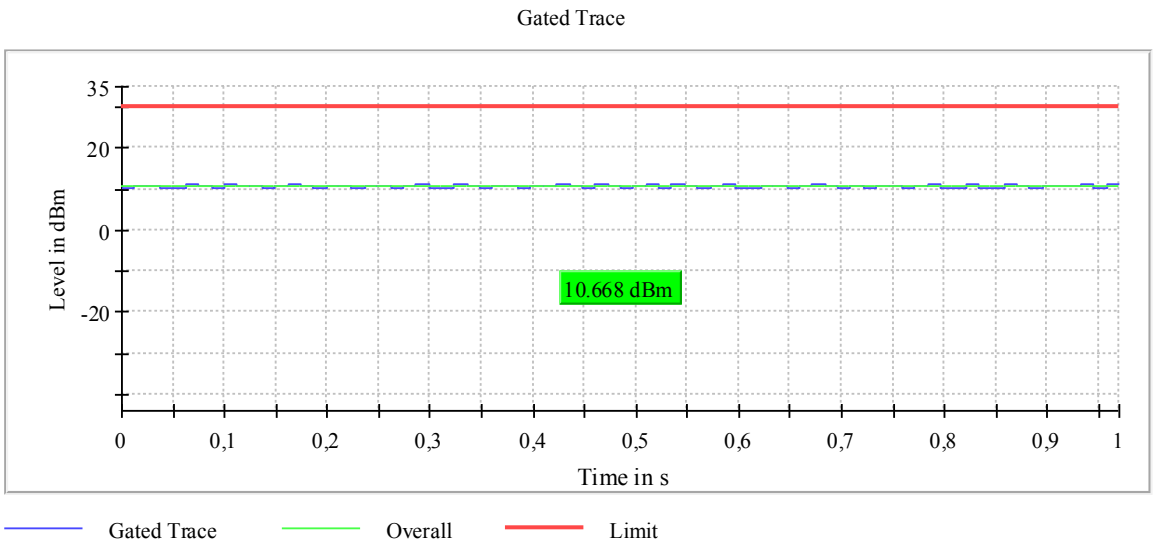
Comment:	---

Verdict	**- PASS -**	*see next plots*

Plot 19: Mode 1, AVGPM-G Gated Average Power Measurement, low channel

Result

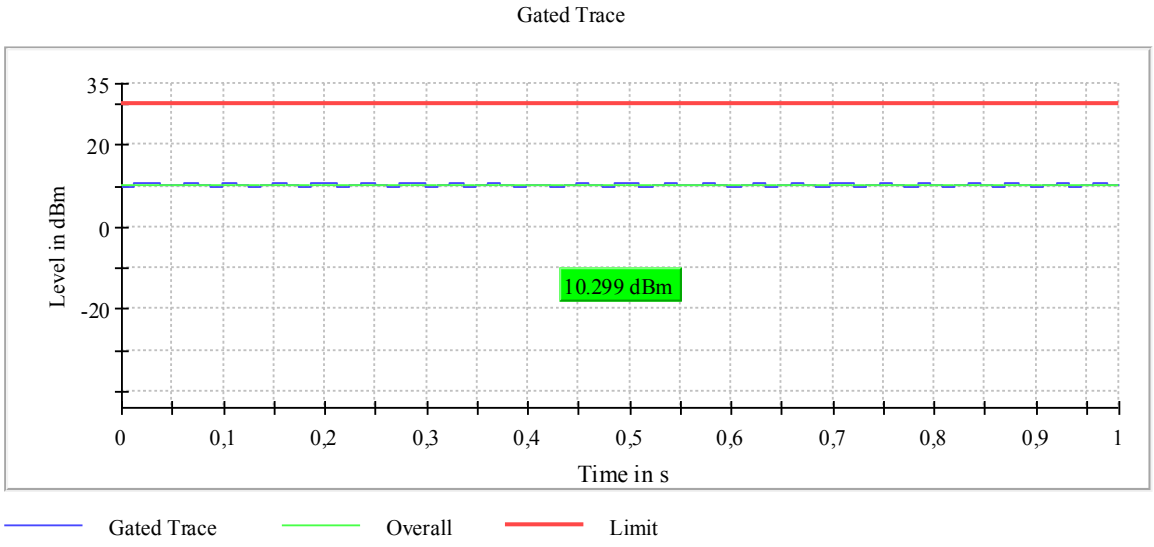
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2412.000000	10.7	30.0	10.7	98.151	PASS



Plot 20: Mode 1, AVGPM-G Gated Average Power Measurement, mid channel

Result

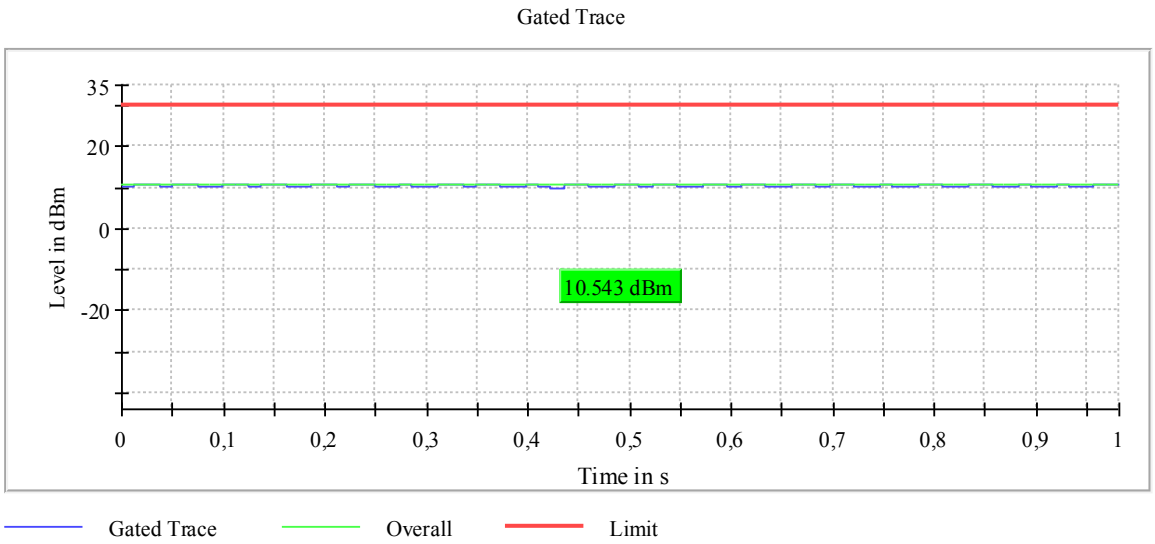
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2442.000000	10.3	30.0	10.3	99.025	PASS



Plot 21: Mode 1, AVGPM-G Gated Average Power Measurement, high channel

Result

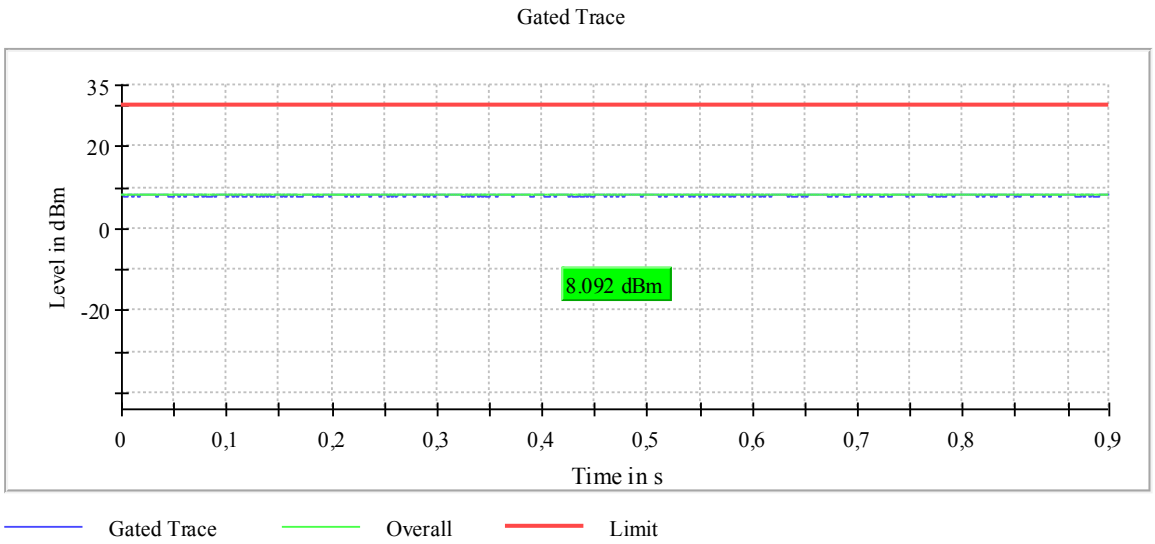
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2472.000000	10.5	30.0	10.5	98.982	PASS



Plot 22: Mode 2, AVGPM-G Gated Average Power Measurement, low channel

Result

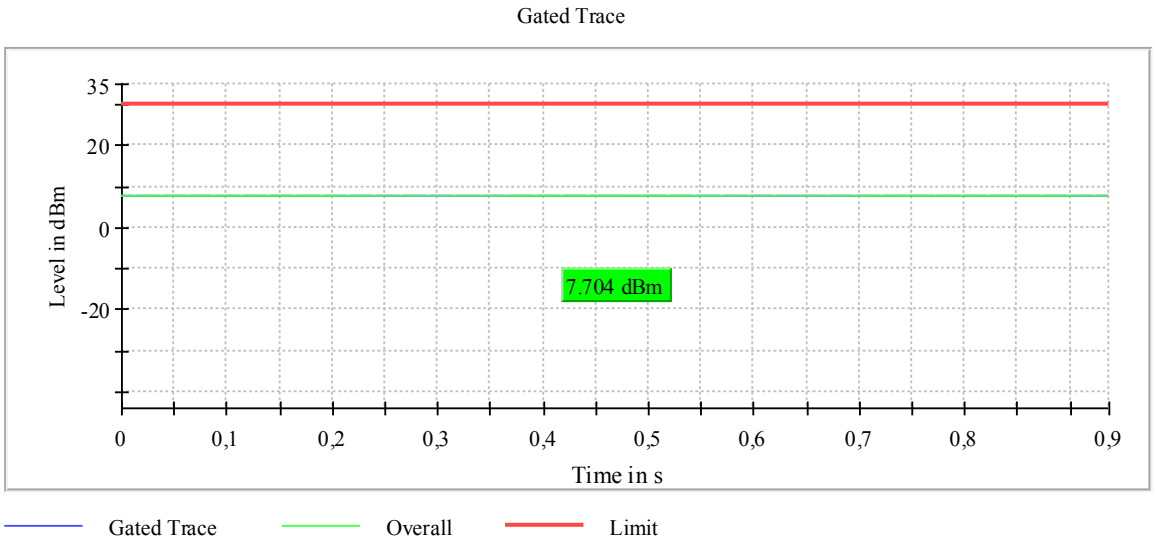
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2412.000000	8.1	30.0	8.1	94.048	PASS



Plot 23: Mode 2, AVGPM-G Gated Average Power Measurement, mid channel

Result

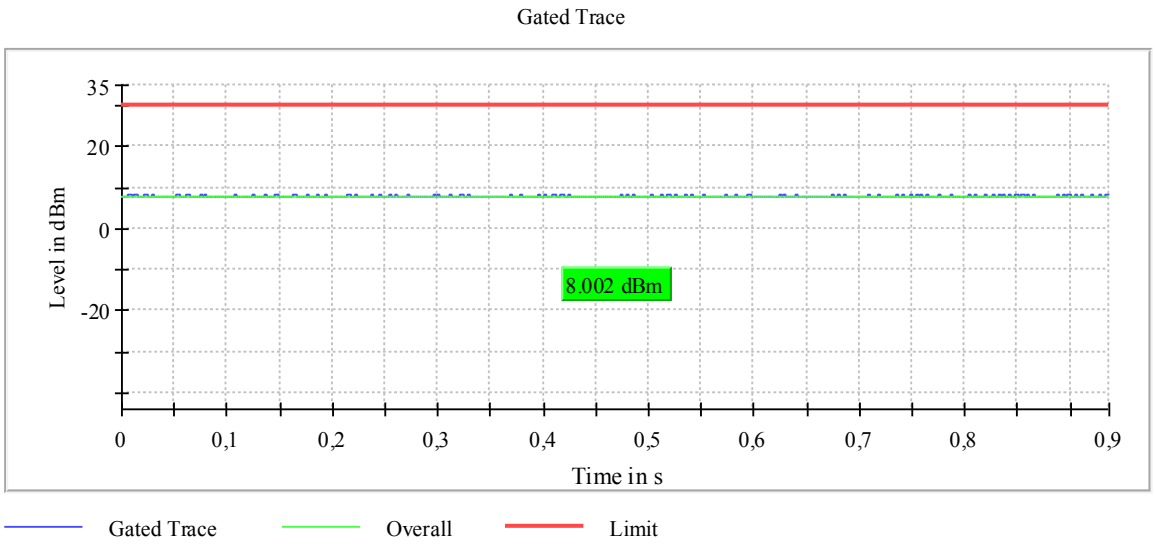
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2442.000000	7.7	30.0	7.7	94.095	PASS



Plot 24: Mode 2, AVGPM-G Gated Average Power Measurement, high channel

Result

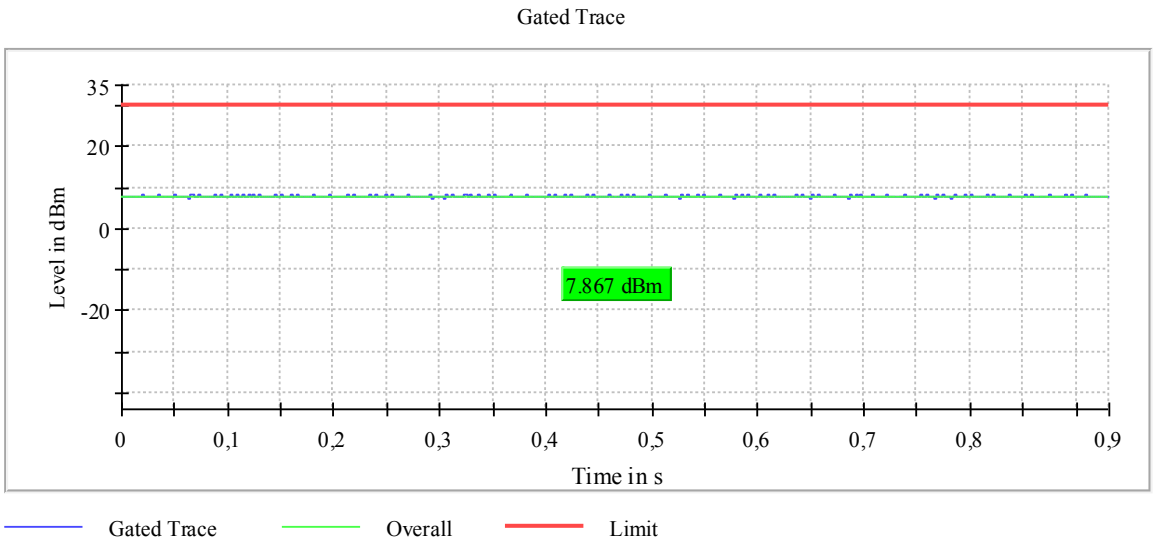
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2472.000000	8.0	30.0	8.0	94.071	PASS



Plot 25: Mode 3, AVGPM-G Gated Average Power Measurement, low channel

Result

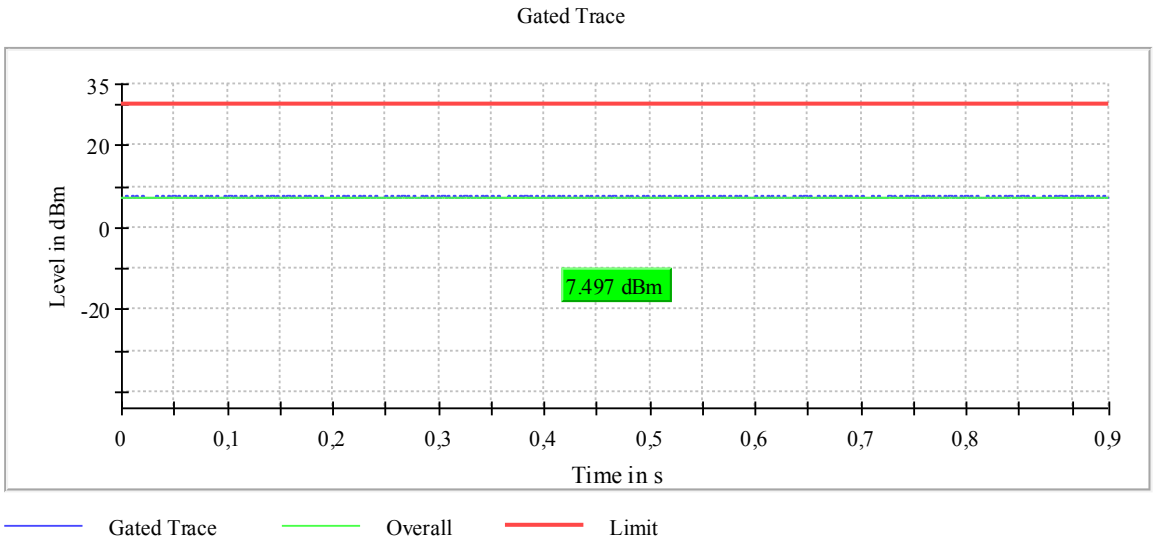
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2412.000000	7.9	30.0	7.9	93.415	PASS



Plot 26: Mode 3, AVGPM-G Gated Average Power Measurement, mid channel

Result

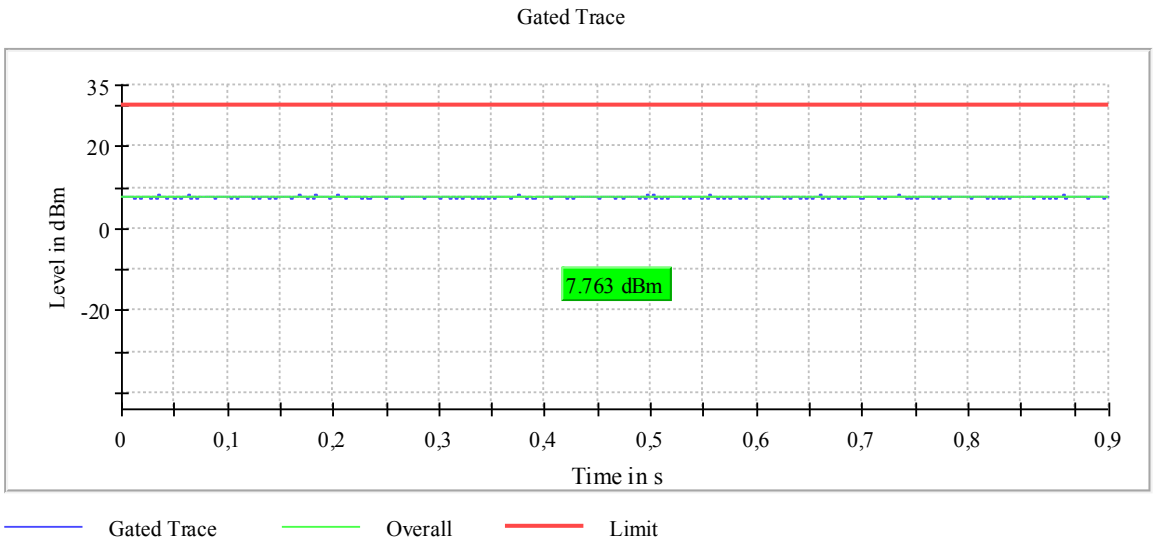
DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2442.000000	7.5	30.0	7.5	93.672	PASS



Plot 27: Mode 3, AVGPM-G Gated Average Power Measurement, high channel

Result

DUT Frequency (MHz)	Gated RMS (dBm)	Limit Max (dBm)	Gated EIRP (dBm)	DutyCycle (%)	Result
2472.000000	7.8	30.0	7.8	93.644	PASS



7.4 Antenna Gain (calculated)

Applicability
This requirement applies to all types of DTS equipment.

Description
The antenna gain is defined as the difference between radiated peak power (Peak EIRP) substracted by the conducted peak power of the module, given in dBi.

Limit
§15.247
(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi.

Test setup: 8.2 with radiated sample (see 5.2), 8.4 with conducted sample (see 5.2)

Test Results

Mode 1	low channel	mid channel	high channel	Max Limit
Radiated power [dBm]	9.4	9.8	11.2	36
Conducted power [dBm]	10.7	10.3	10.5	30
Calculated antenna agin [dBi]	-1.3	-0.5	0.7	6

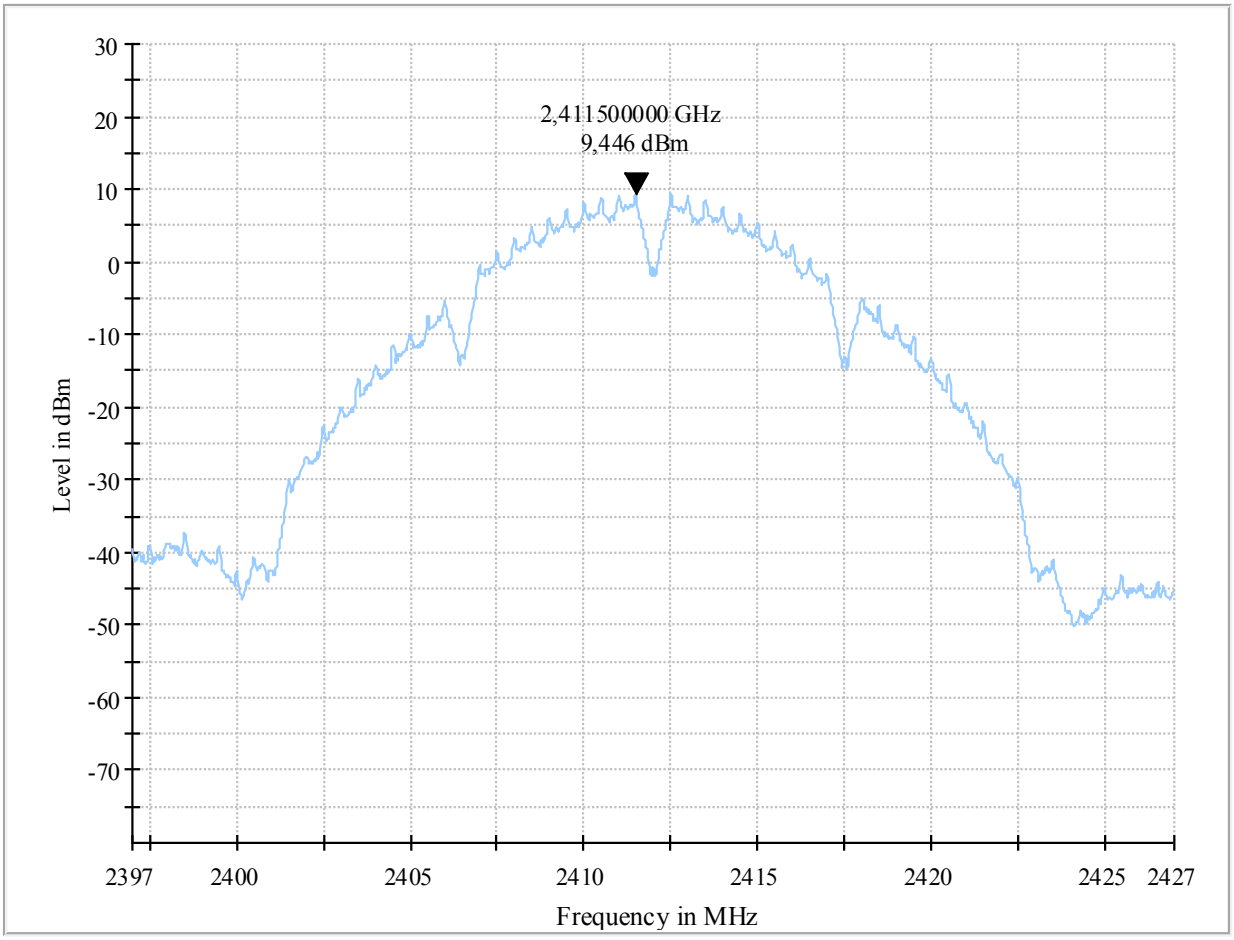
Comment:	---

Verdict	- PASS -	*see next plots**

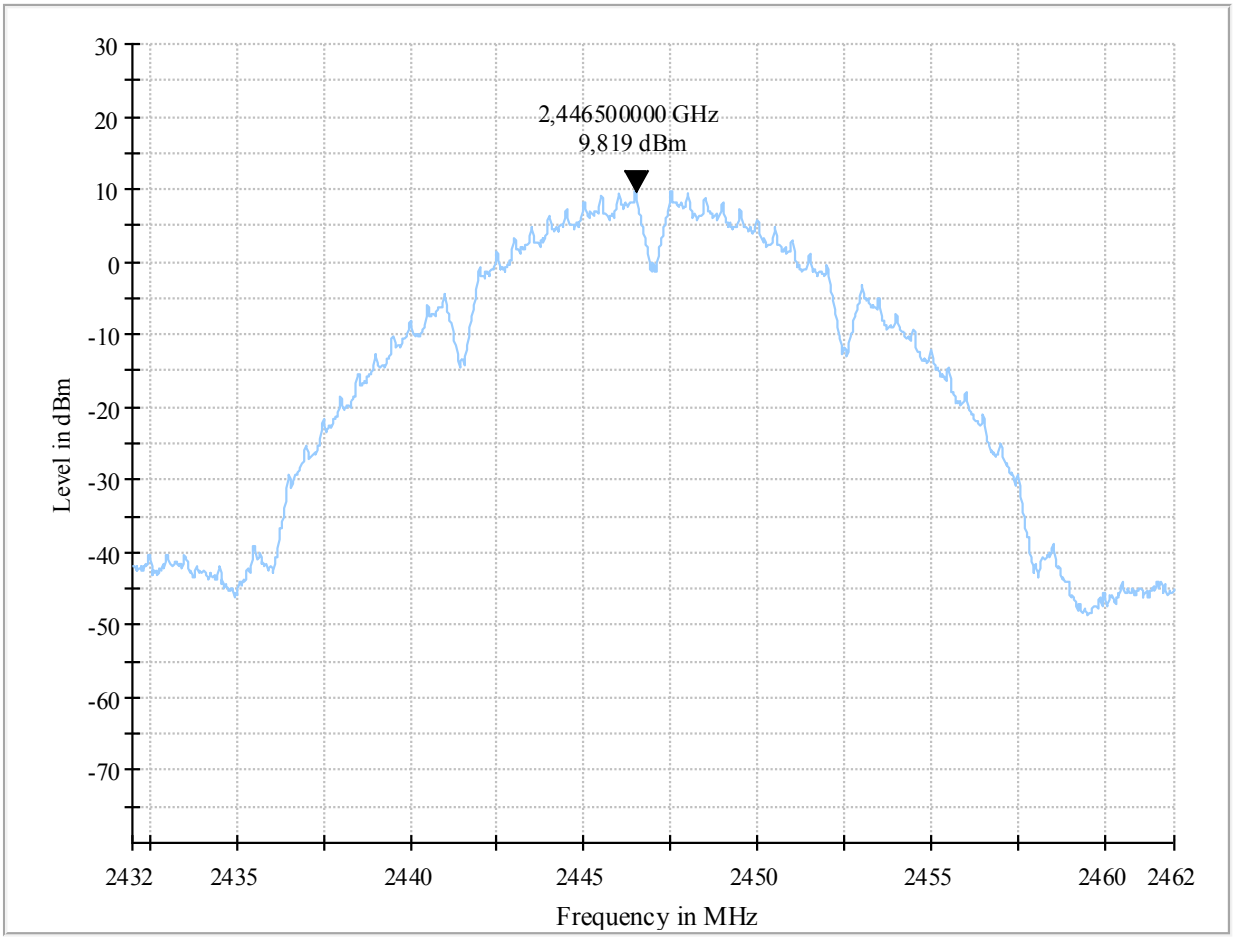
*description of line and marker for all radiated Peak Power measurements:

positive Peak (Max Hold) trace during pre-scan
Max Peak value
final Quasi Peak value

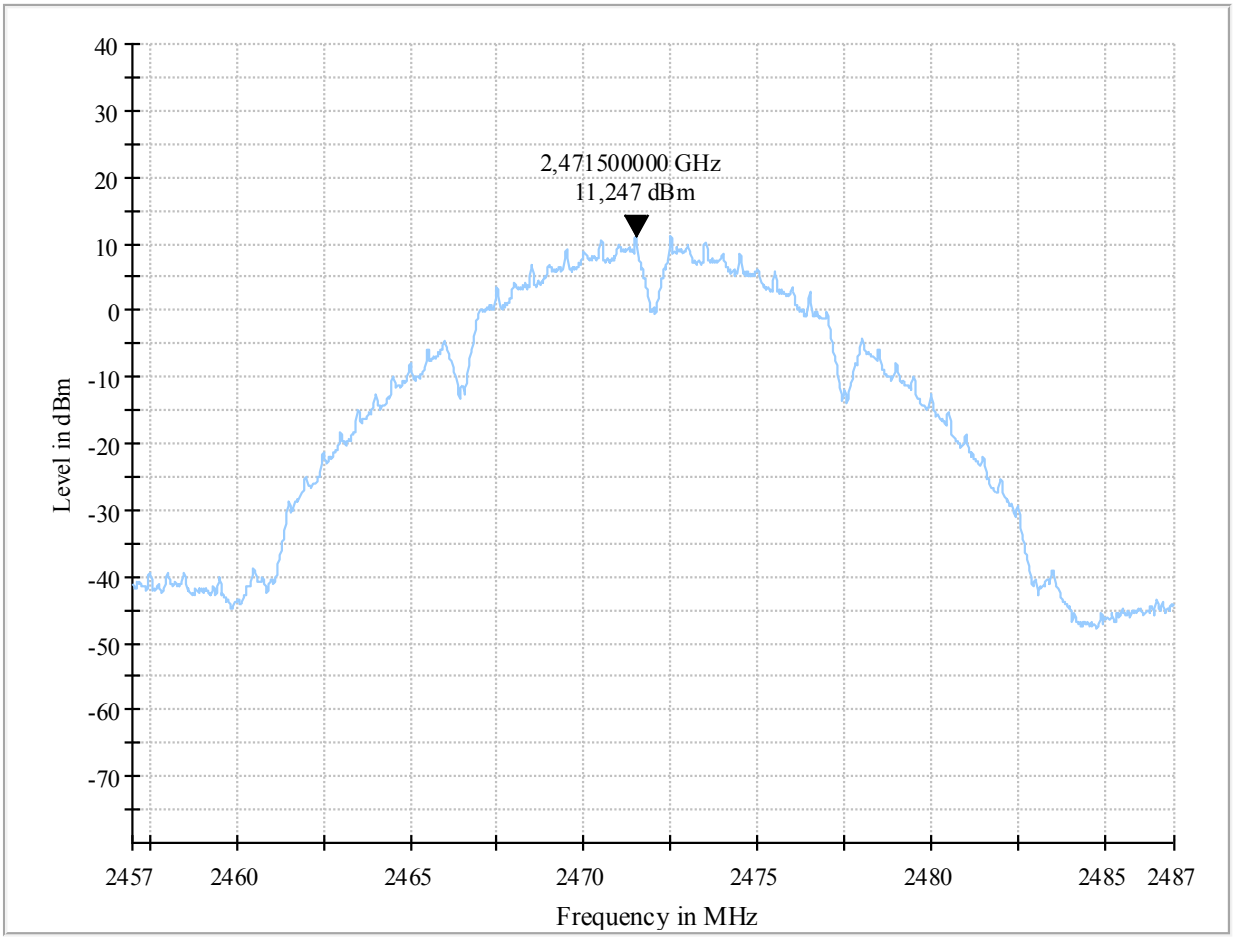
Plot 28: Mode 1, Peak EIRP, low channel, 2412 MHz



Plot 29: Mode 1, Peak EIRP, mid channel, 2447 MHz



Plot 30: Mode 1, Peak EIRP, high channel, 2472 MHz



7.5 Peak Power Spectral Density (PSD)

Applicability
This requirement applies to all types of DTS equipment.

Description
The Power Spectral Density (PSD) is defined as the conducted peak power spectral density in a 3 kHz bandwidth during any time of continuous transmission.

Limits
§15.247
(e) For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

Test procedure
ANSI C63.10, 11.10.2
The following procedure shall be used if maximum peak conducted output power was used to determine compliance, and it is optional if the maximum conducted (average) output power was used to determine compliance:
a) Set analyzer center frequency to DTS channel center frequency.
b) Set the span to 1.5 times the DTS bandwidth.
c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum amplitude level within the RBW.
j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat.

Test setup: 8.4 with conducted test sample 60337 (see 5.2)

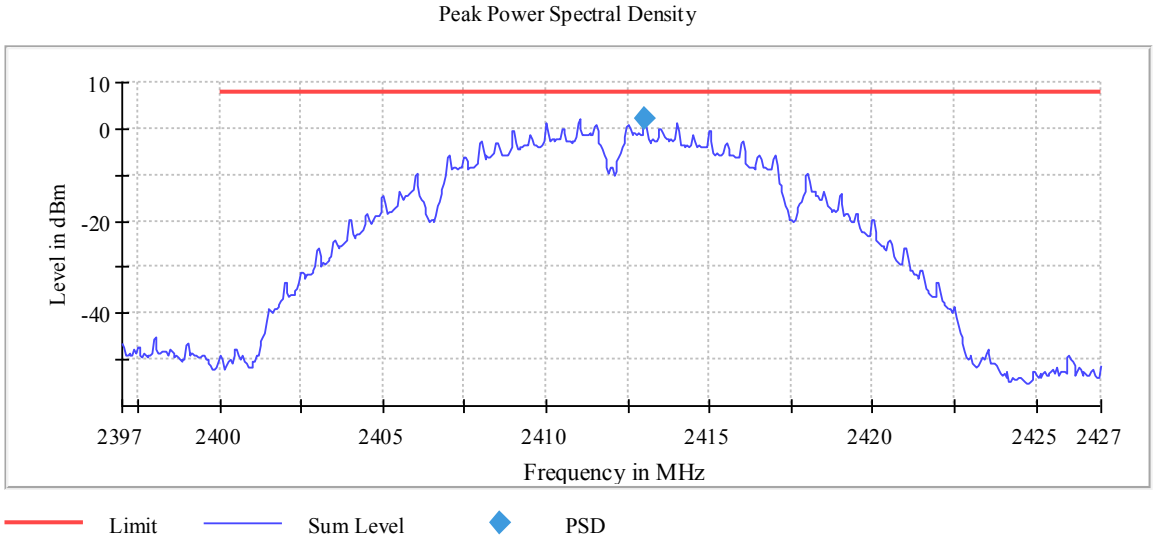
Test Results

EUT Mode	Peak Power Spectral Density [dBm / 3 kHz]			Limit [dBm / 3 kHz]
	low channel	mid channel	high channel	
Mode 1	2.1	2.1	1.9	8

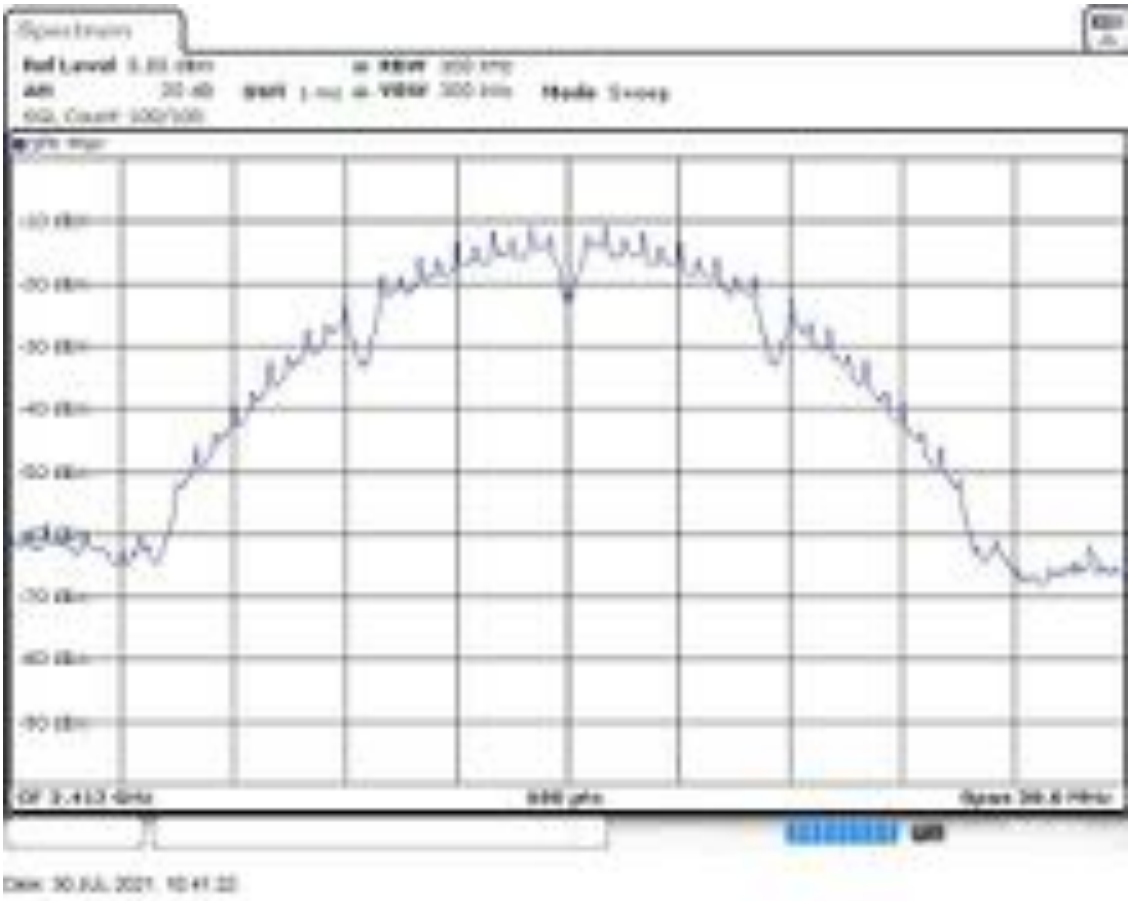
Comment:	---

Verdict	- PASS -	*see next plots*

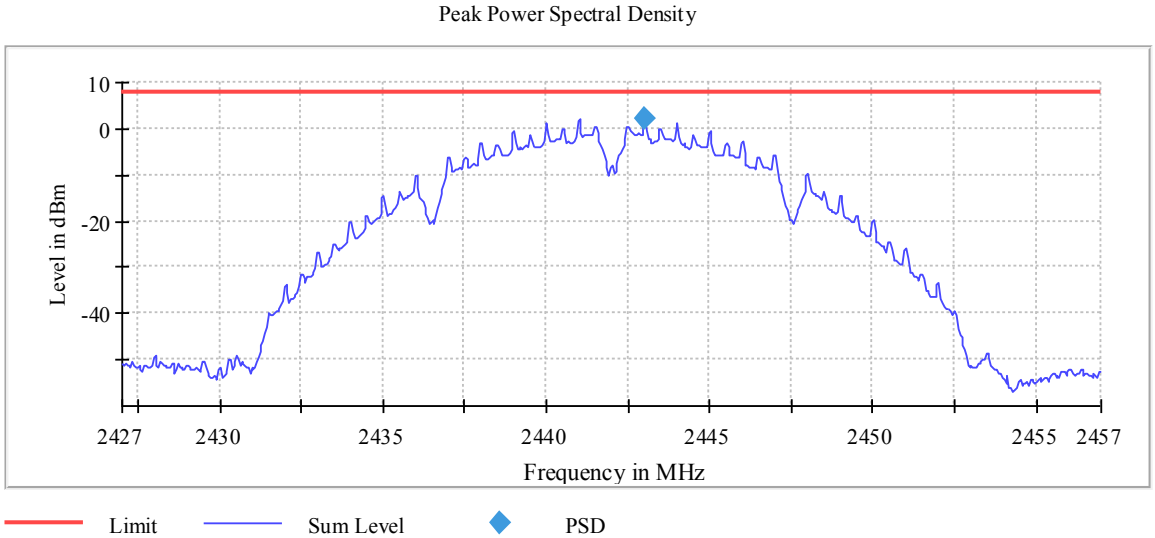
Plot 31: Mode 1, Peak PSD, low channel



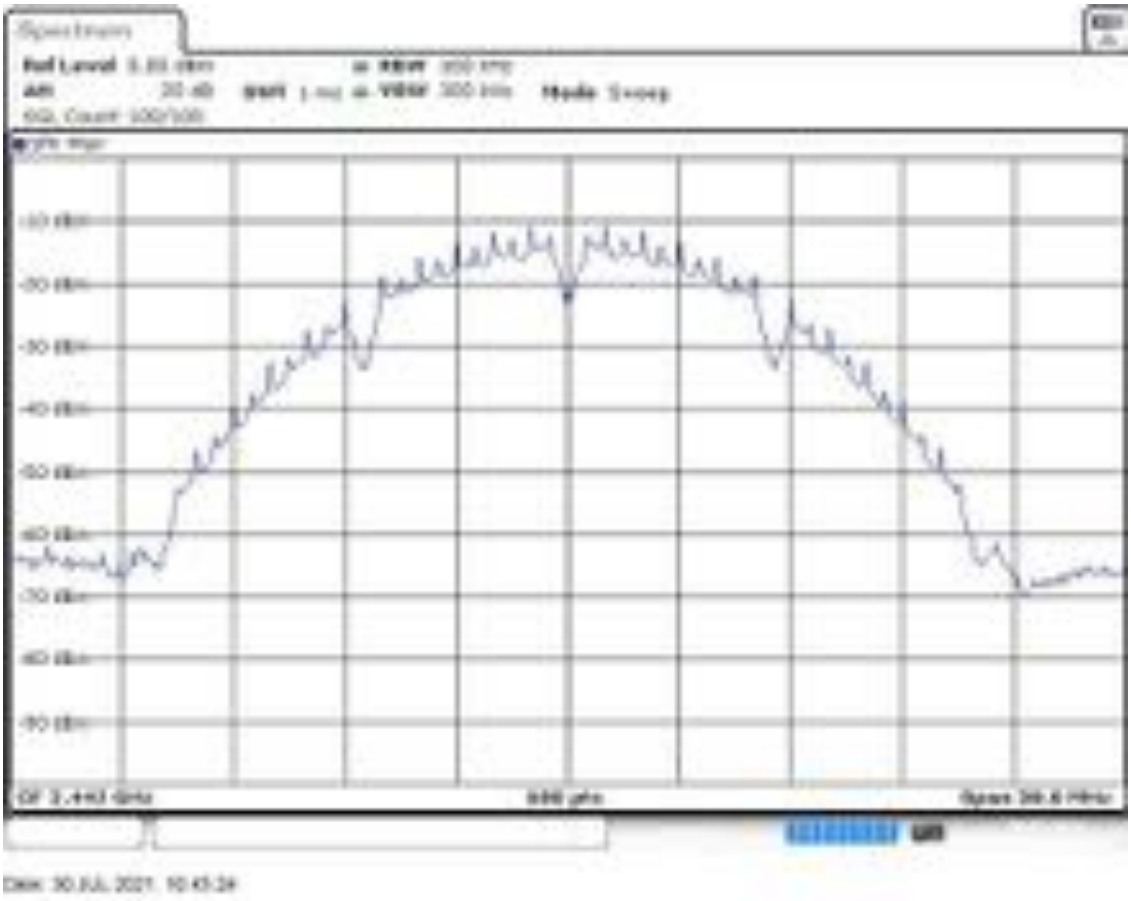
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2412.000000	2413.025000	2.110	8.0	PASS



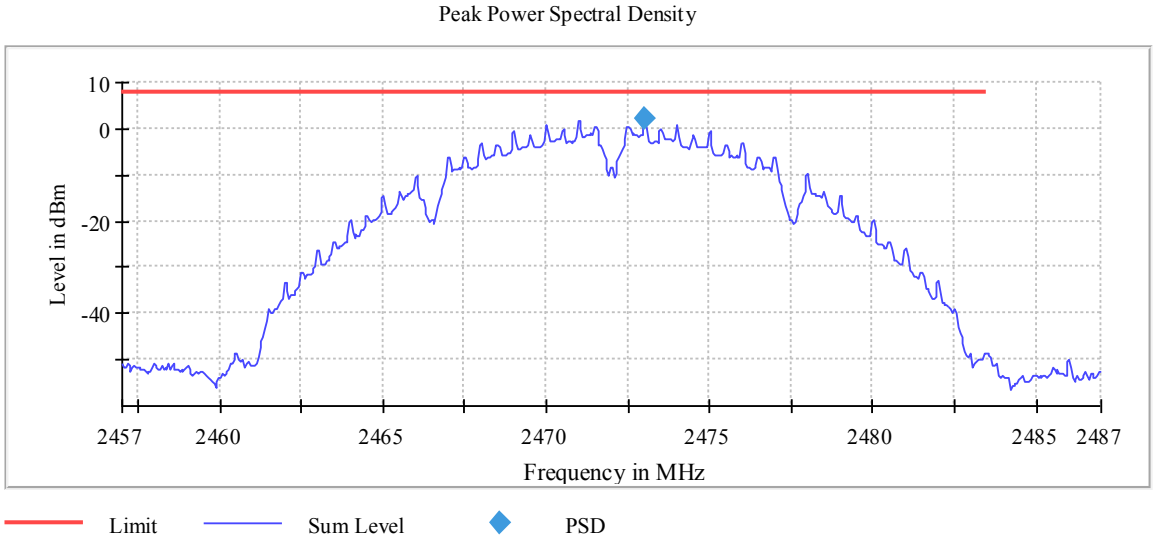
Plot 32: Mode 1, Peak PSD, mid channel



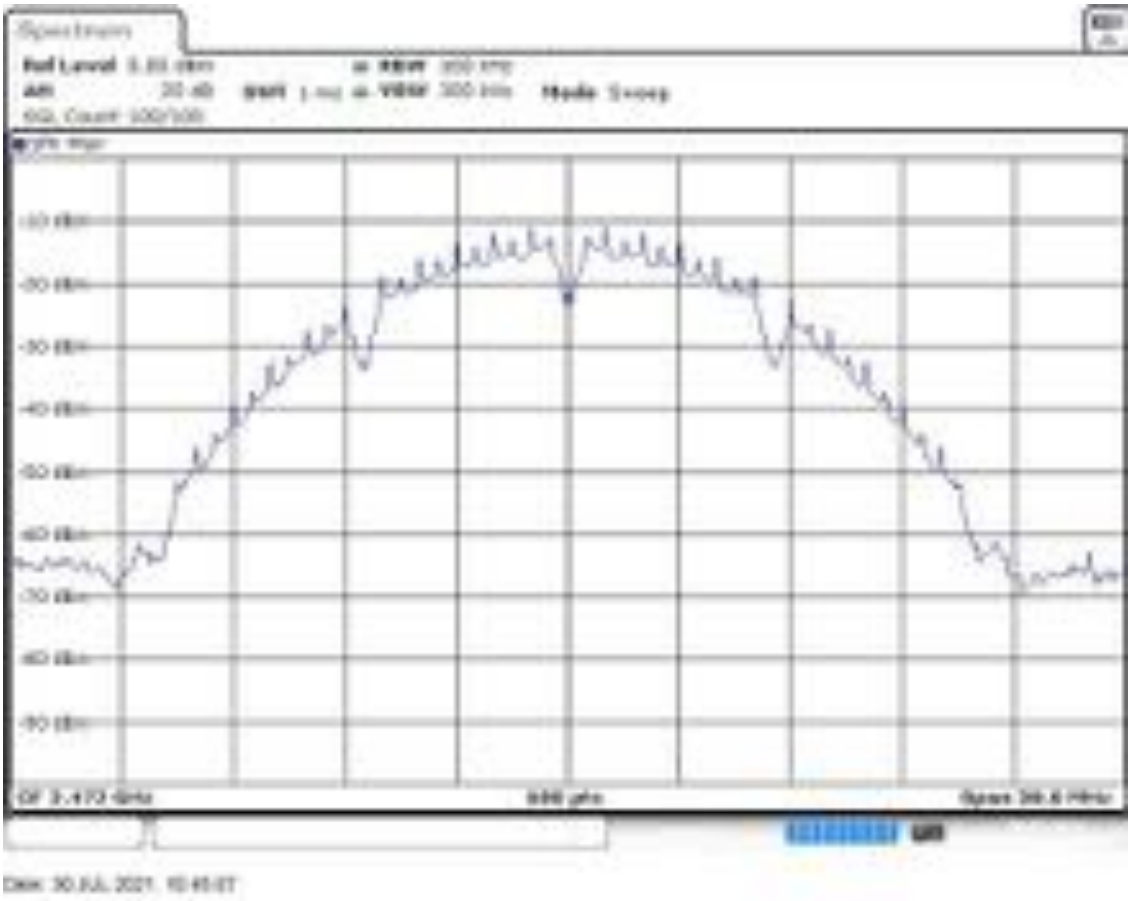
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2442.000000	2443.025000	2.052	8.0	PASS



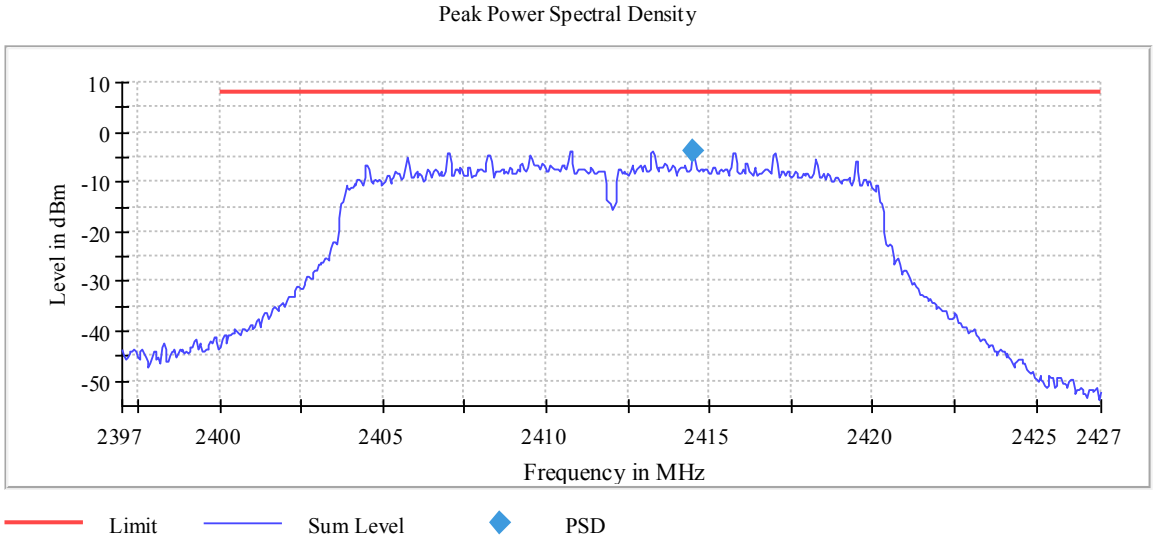
Plot 33: Mode 1, Peak PSD, high channel



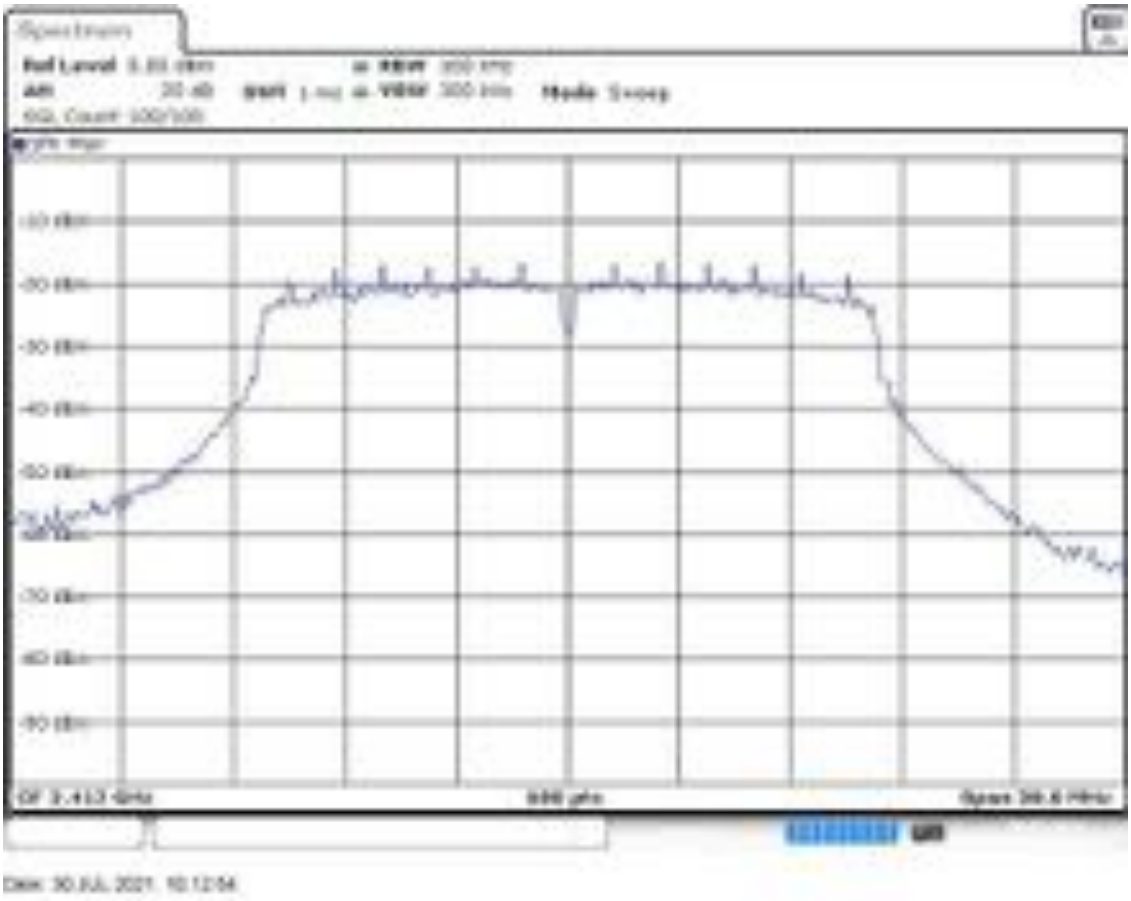
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2472.000000	2473.025000	1.910	8.0	PASS



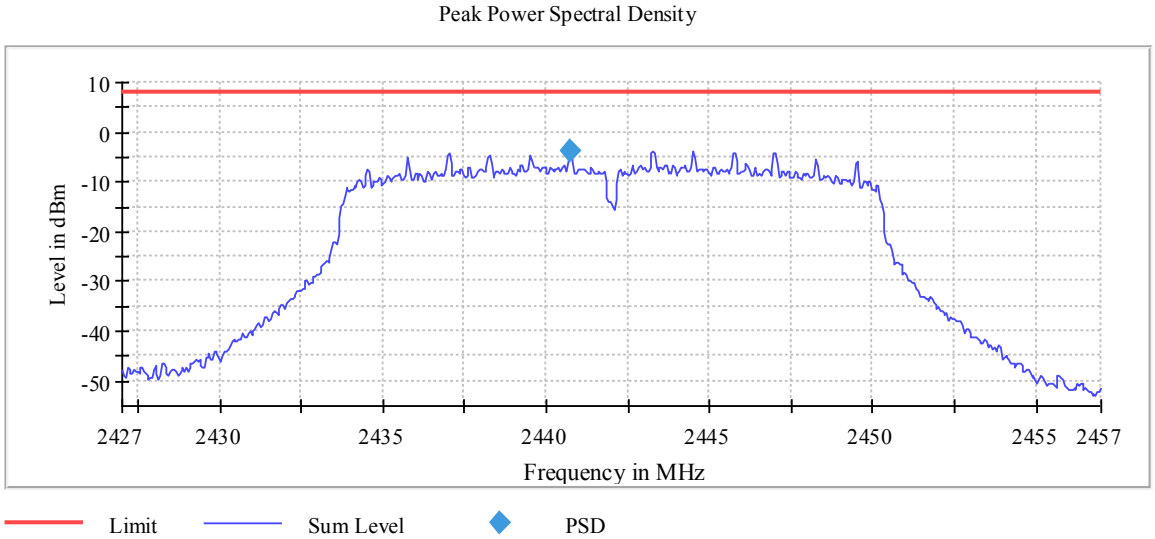
Plot 34: Mode 2, Peak PSD, low channel



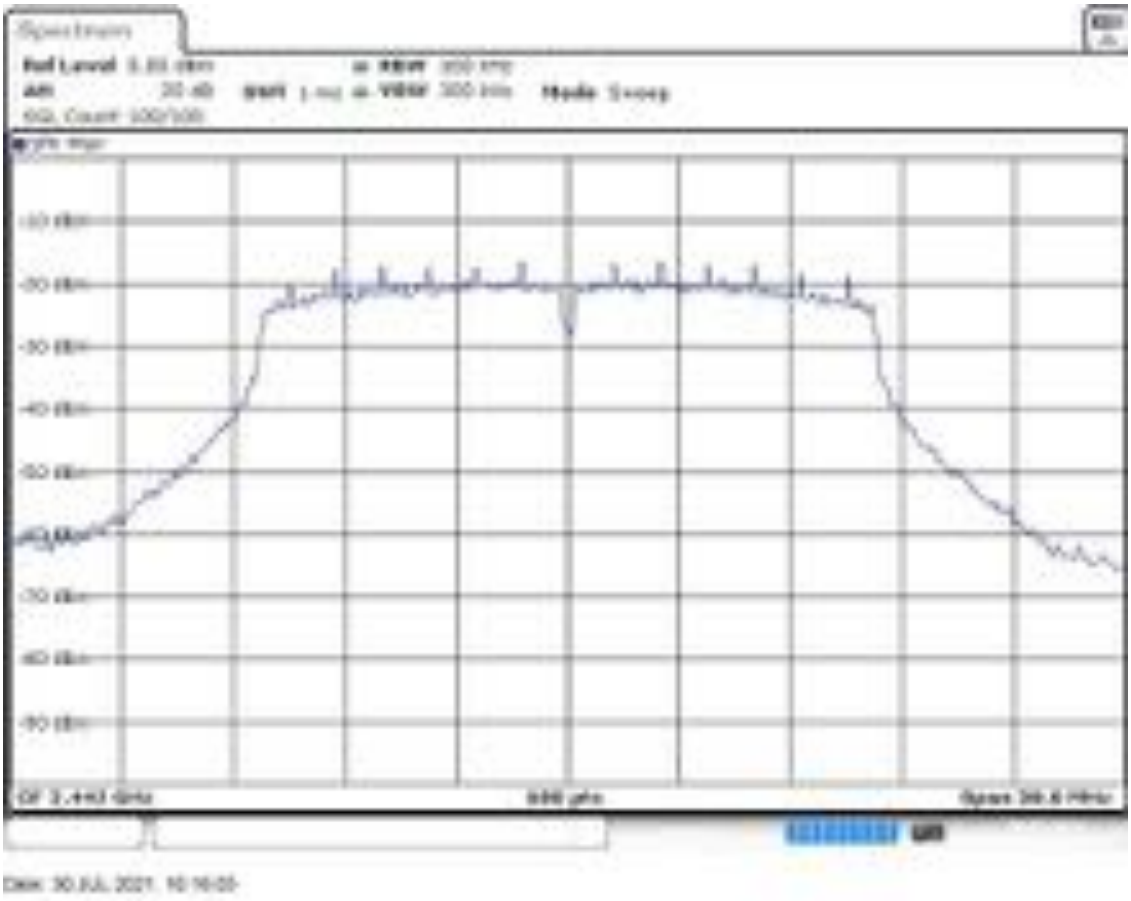
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2412.000000	2414.525000	-3.740	8.0	PASS



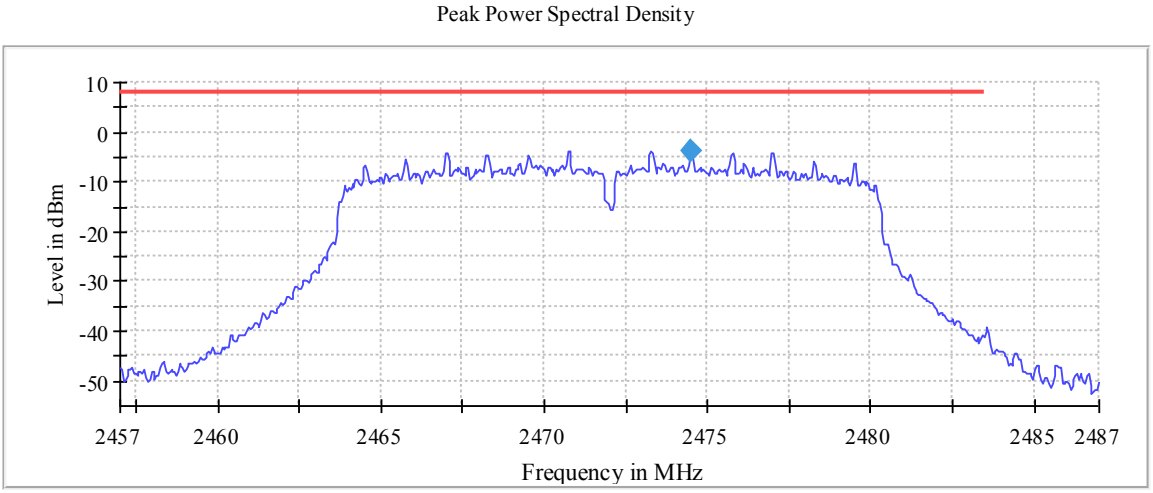
Plot 35: Mode 2, Peak PSD, mid channel



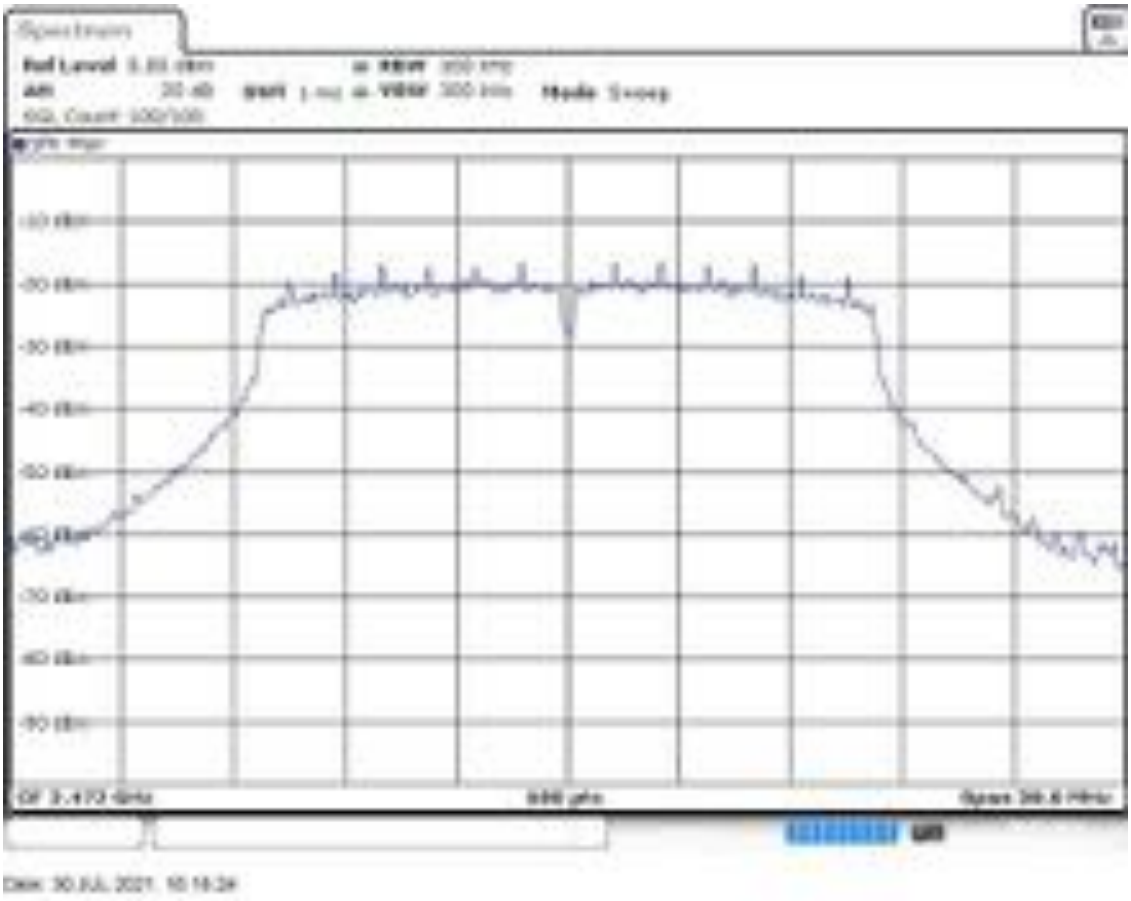
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2442.000000	2440.725000	-3.683	8.0	PASS



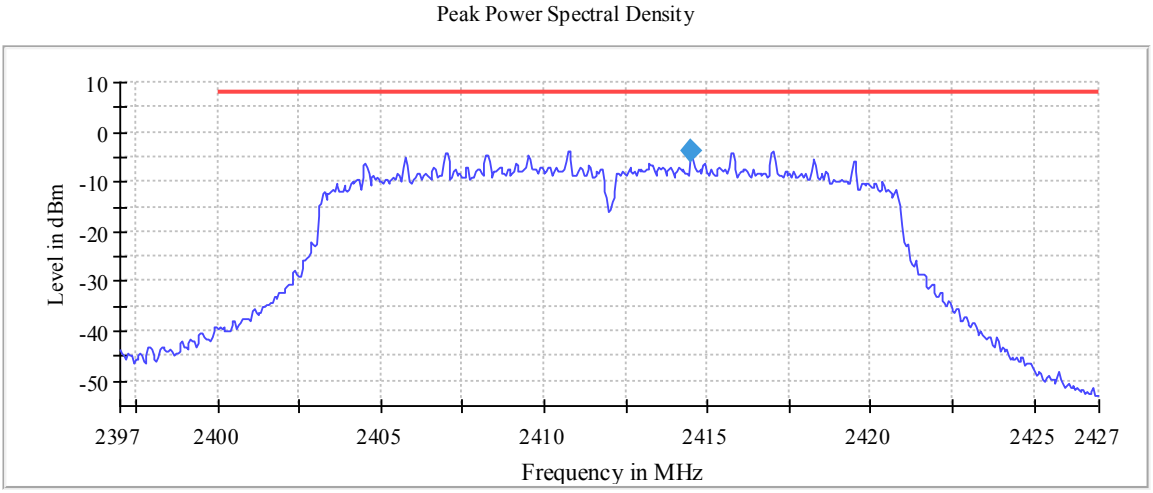
Plot 36: Mode 2, Peak PSD, high channel



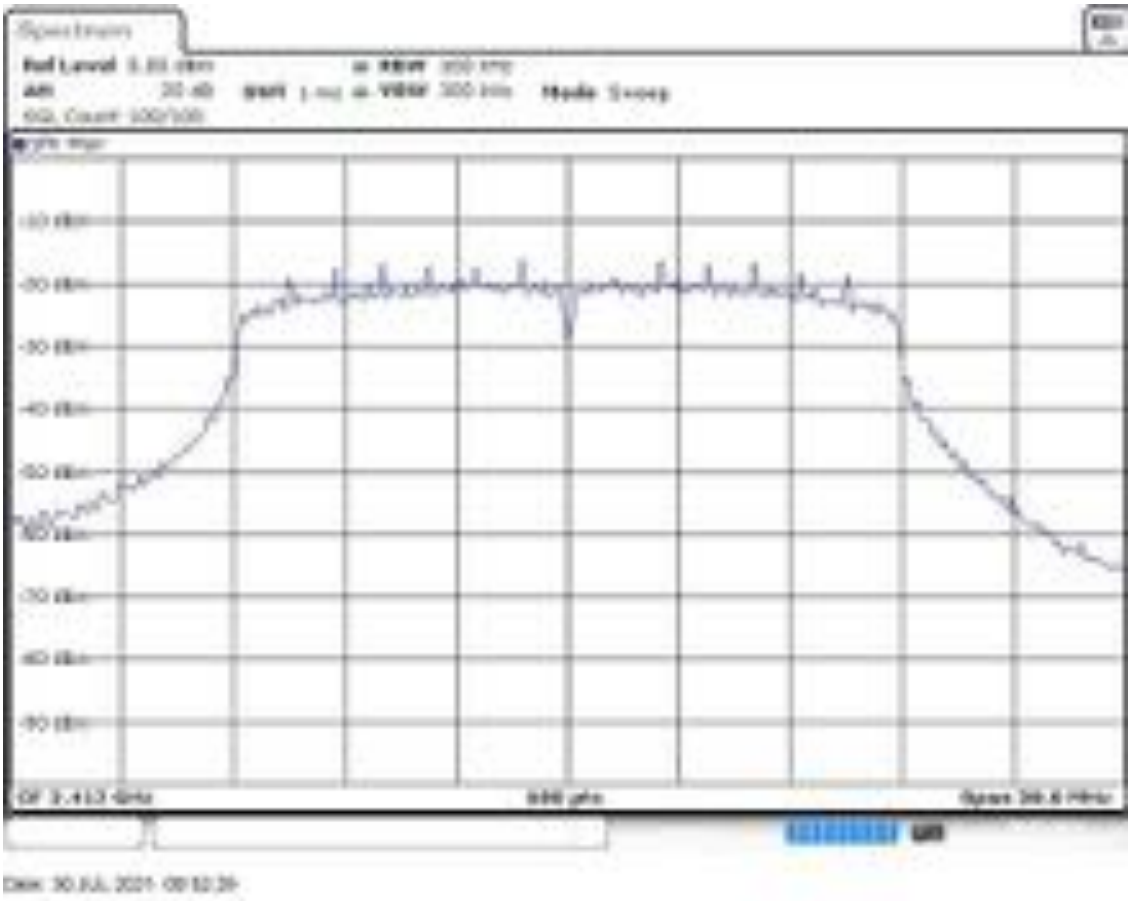
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2472.000000	2474.525000	-3.665	8.0	PASS



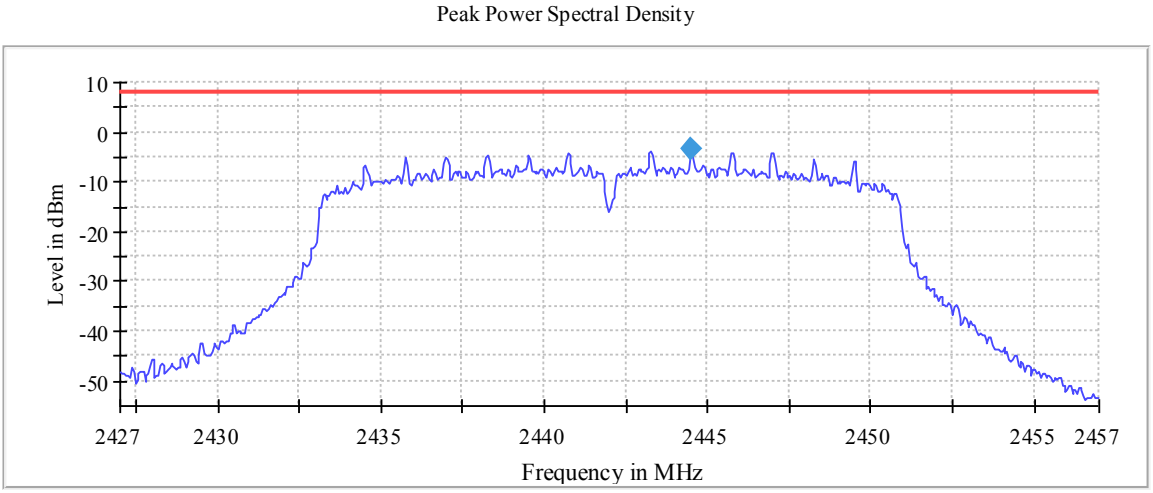
Plot 37: Mode 3, Peak PSD, low channel



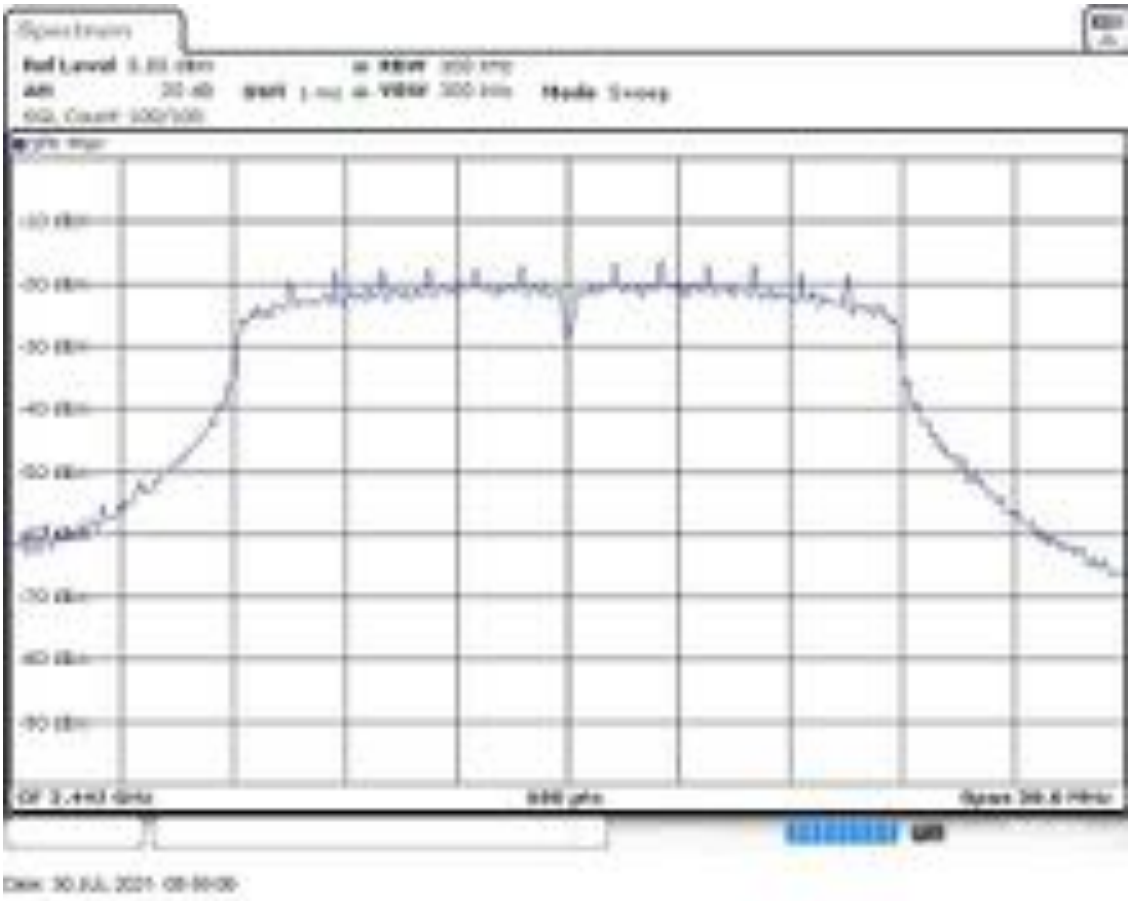
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2412.000000	2414.525000	-3.611	8.0	PASS



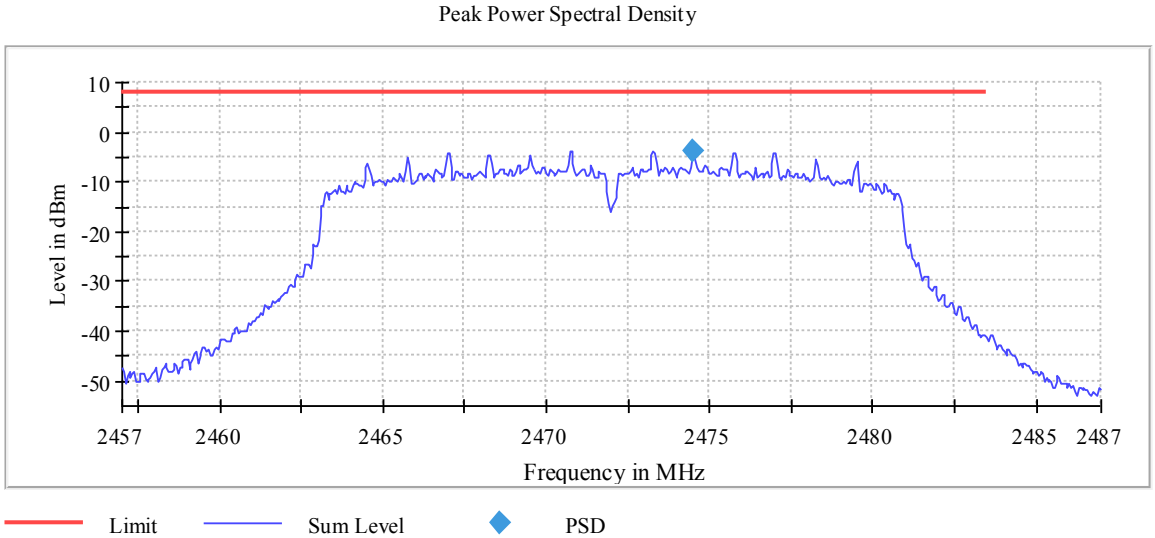
Plot 38: Mode 3, Peak PSD, mid channel



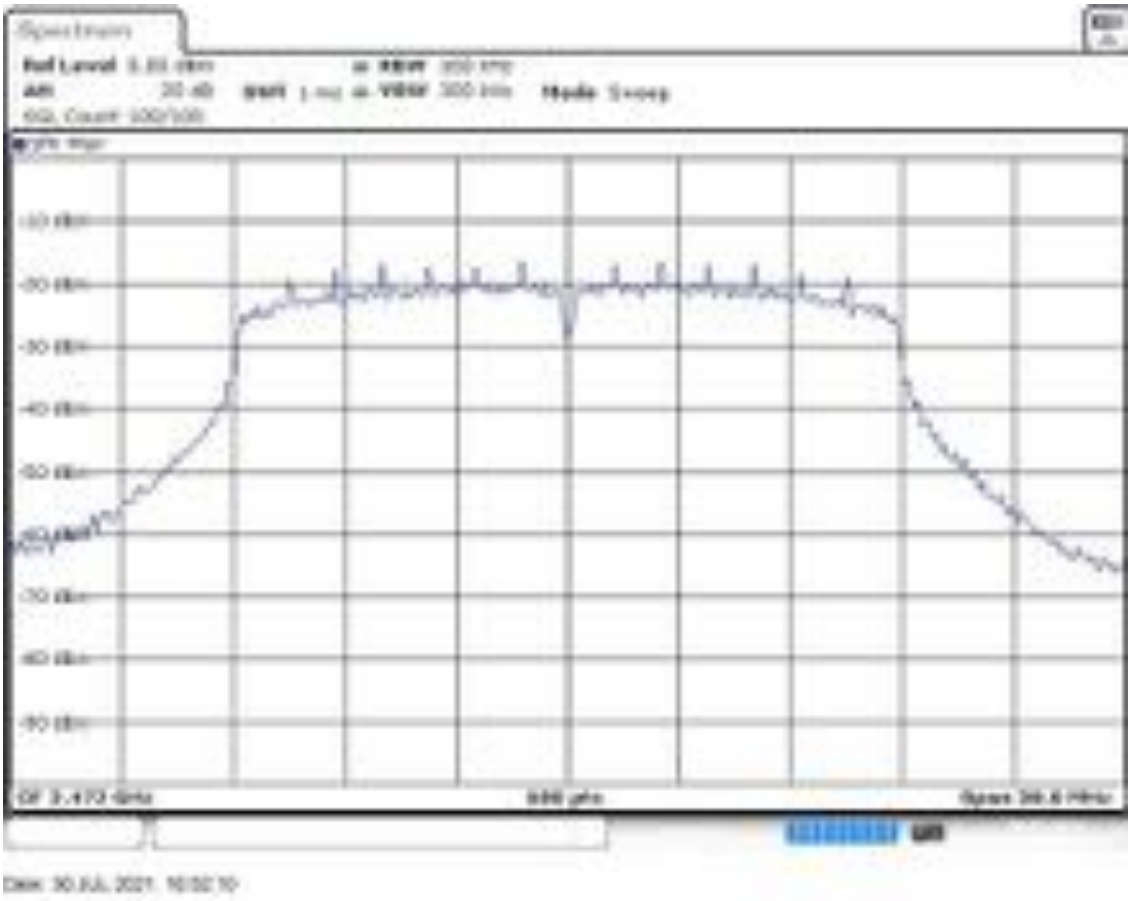
DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2442.000000	2444.525000	-3.608	8.0	PASS



Plot 39: Mode 3, Peak PSD, high channel



DUT Frequency (MHz)	Frequency (MHz)	PSD (dBm)	Limit Max (dBm)	Result
2472.000000	2474.525000	-3.650	8.0	PASS



7.6 Band Edge Compliance (BEC), conducted

Applicability
This requirement applies to all types of DTS equipment.

Description
Emissions within a restricted band and within 2 MHz of an authorized band edge may be measured using either the marker-delta method (ANSI C63.10, 6.10.6) or the integration method (ANSI C63.20, 11.13.3), provided that the DTS bandwidth (or EBW) edge falls within 2 MHz of the band edge. Otherwise, all unwanted emissions measurements shall be performed using the standard methods.

Limits
§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. Attenuation below the general limits specified in §15.209(a) is not required.

Test procedure
ANSI C63.10, 11.11
Reference level measurement:
Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.
Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

Emission level measurement:
Establish an emission level by using the following procedure:
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements as specified (≥ 20 dBc).

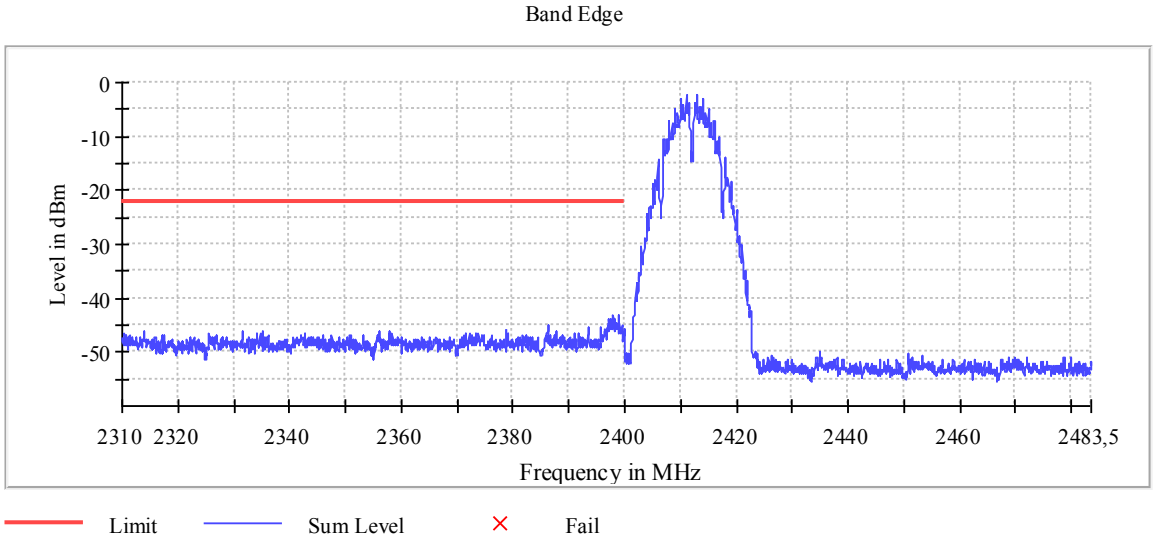
The marker-delta method, as described in ANSI C63.10, 6.10.6 can be used to perform measurements of the radiated unwanted emissions level at the band-edges provided that the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

Test setup: 8.4 with conducted test sample 60337 (see 5.2)			
Test results			
BEC	**low channel [dBc]**	**high channel [dBc]**	**Limit [dBc]**
Mode 1	> 40	> 40	≥ 20
Mode 2	> 35	> 33	≥ 20
Mode 3	> 30	> 30	≥ 20

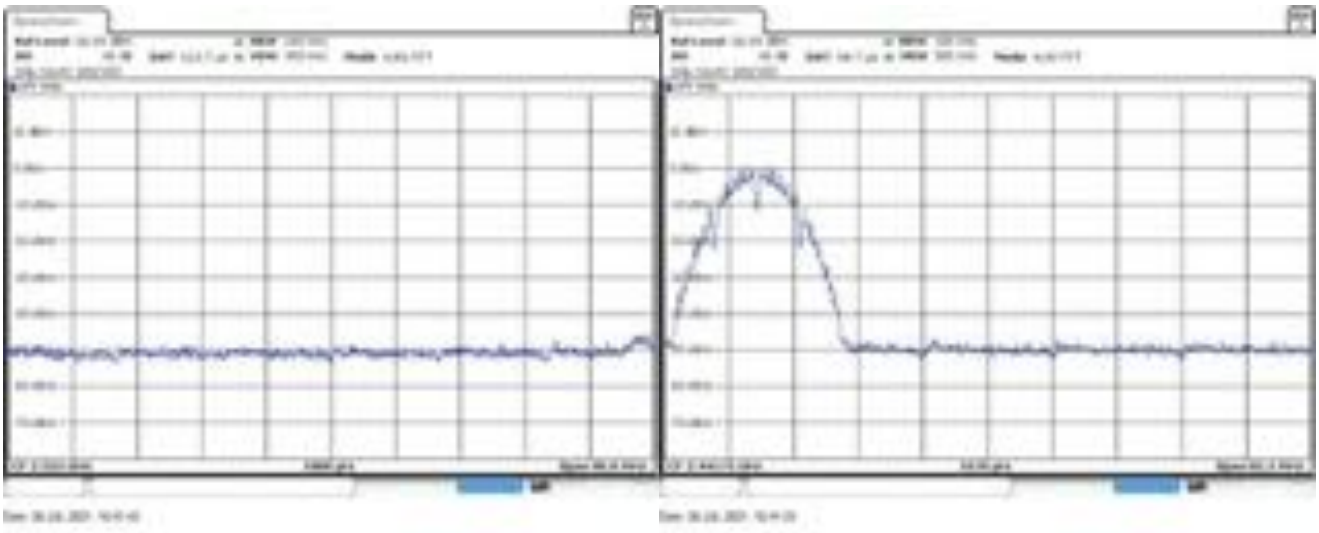
Comment:	---

Verdict	**- PASS -**	*see next plots*

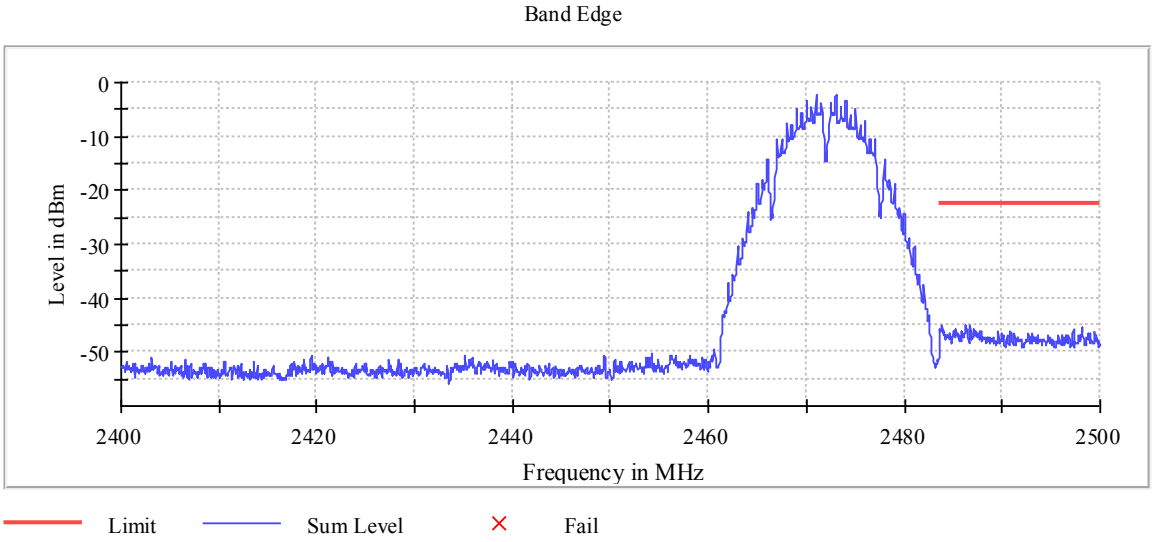
Plot 40: Mode 1, BEC, low channel



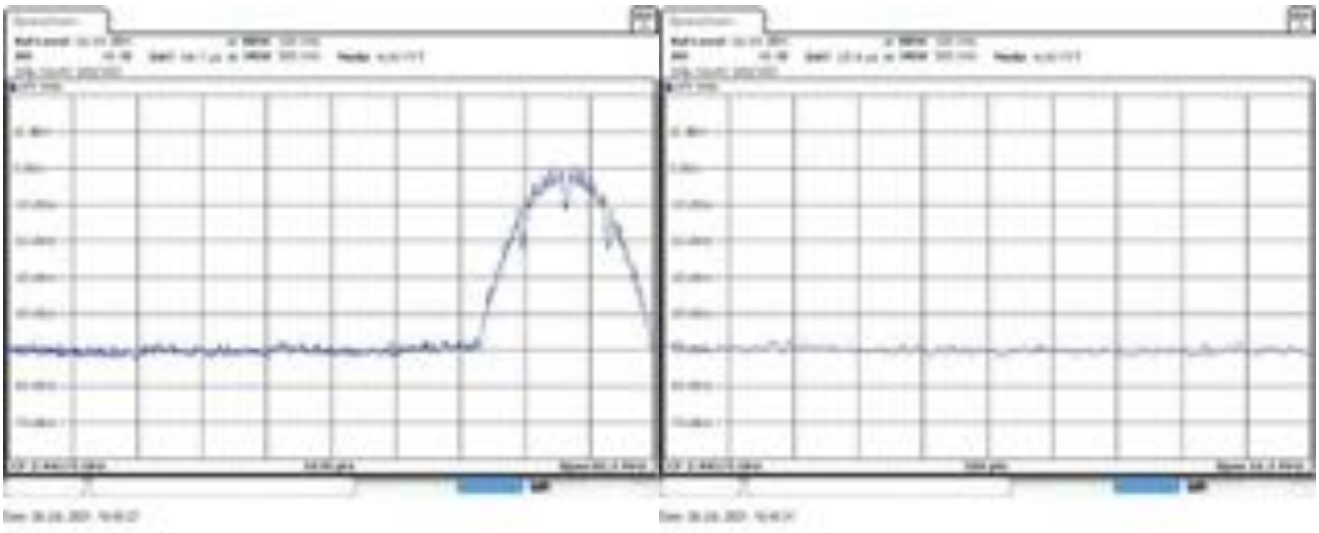
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.025000	-43.0	20.8	-22.2	PASS
2397.975000	-43.3	21.1	-22.2	PASS
2398.975000	-43.4	21.2	-22.2	PASS
2397.475000	-43.9	21.7	-22.2	PASS
2398.175000	-44.0	21.9	-22.2	PASS
2397.175000	-44.1	21.9	-22.2	PASS
2398.025000	-44.1	21.9	-22.2	PASS
2397.275000	-44.1	21.9	-22.2	PASS
2397.525000	-44.2	22.0	-22.2	PASS
2397.225000	-44.2	22.0	-22.2	PASS
2399.075000	-44.2	22.0	-22.2	PASS
2398.225000	-44.2	22.0	-22.2	PASS
2397.925000	-44.2	22.1	-22.2	PASS
2397.325000	-44.3	22.1	-22.2	PASS
2397.625000	-44.4	22.3	-22.2	PASS



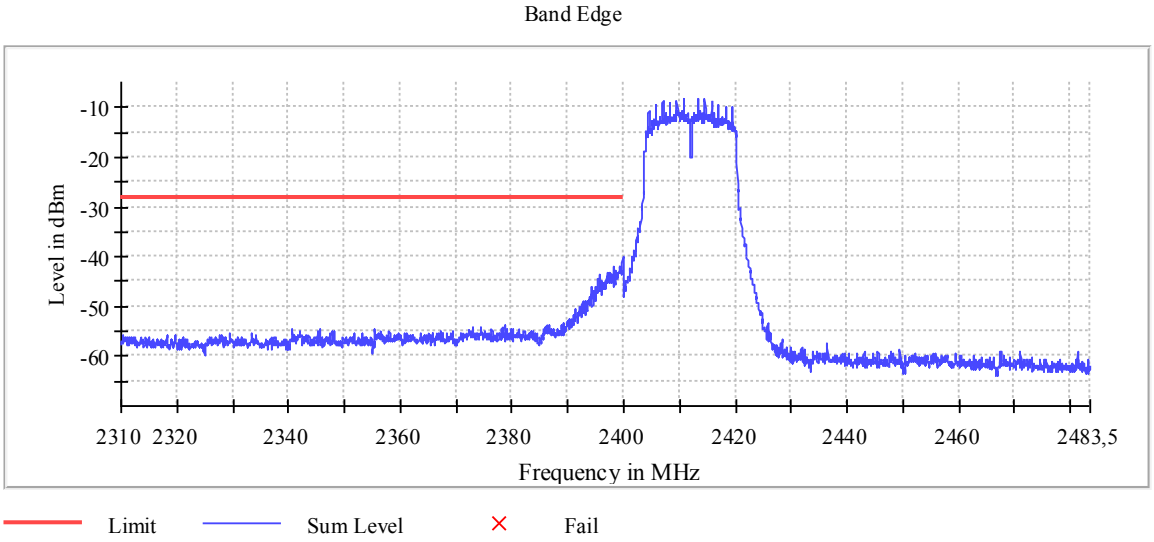
Plot 41: Mode 1, BEC, high channel



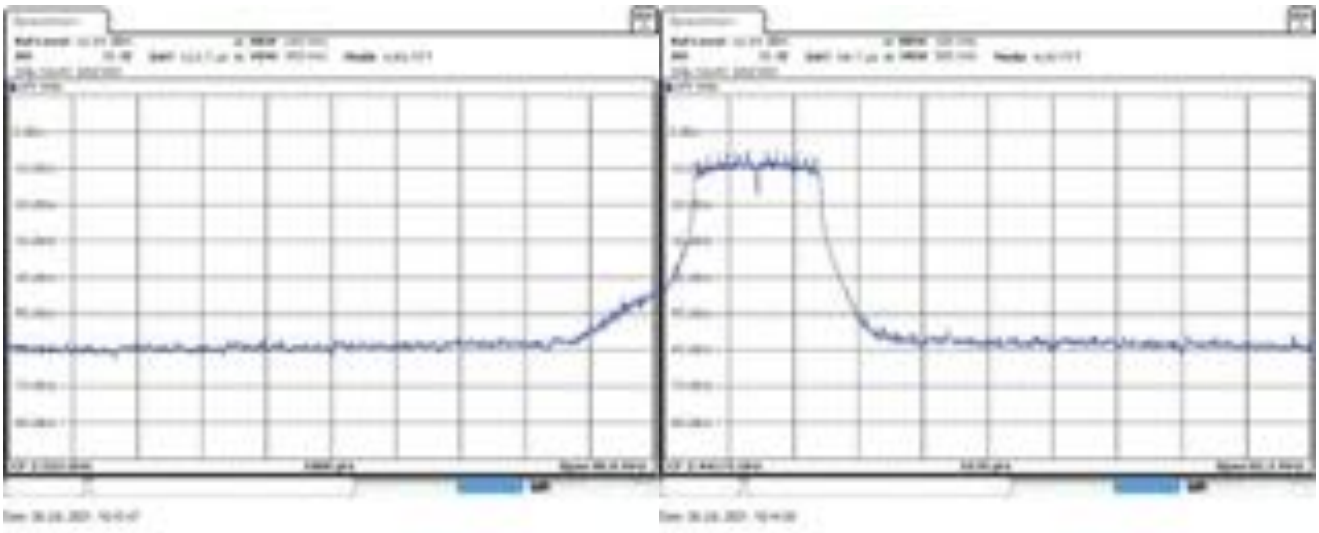
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2486.675000	-45.0	22.6	-22.3	PASS
2486.275000	-45.0	22.7	-22.3	PASS
2486.225000	-45.1	22.7	-22.3	PASS
2486.725000	-45.1	22.8	-22.3	PASS
2483.875000	-45.2	22.8	-22.3	PASS
2498.125000	-45.5	23.2	-22.3	PASS
2483.825000	-45.6	23.3	-22.3	PASS
2486.375000	-45.7	23.3	-22.3	PASS
2487.075000	-45.7	23.4	-22.3	PASS
2497.275000	-45.7	23.4	-22.3	PASS
2486.425000	-45.7	23.4	-22.3	PASS
2483.525000	-45.9	23.5	-22.3	PASS
2485.225000	-45.9	23.6	-22.3	PASS
2486.325000	-46.0	23.6	-22.3	PASS
2483.725000	-46.0	23.7	-22.3	PASS



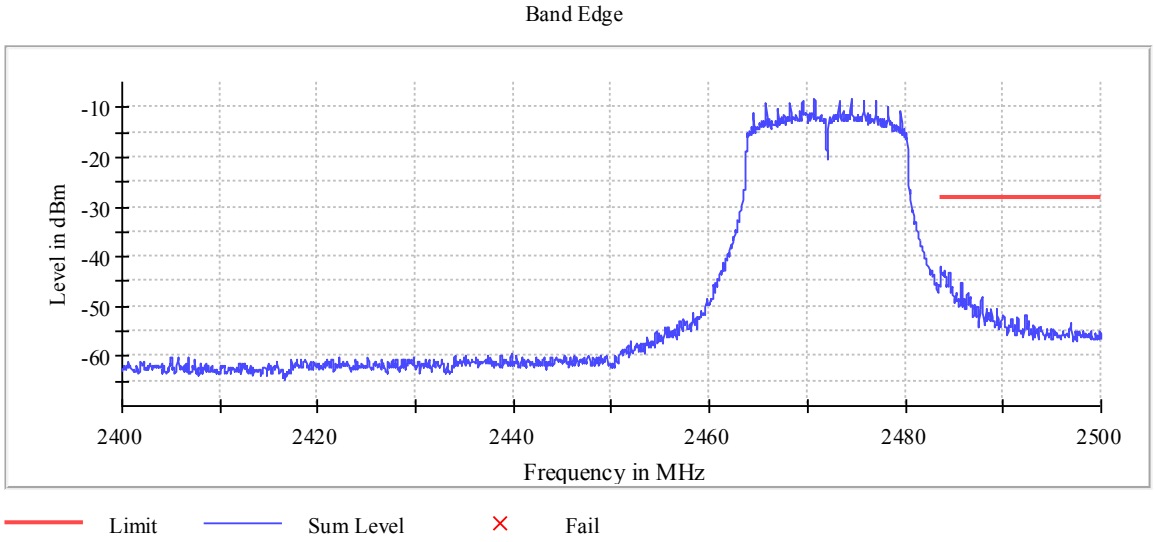
Plot 42: Mode 2, BEC, low channel



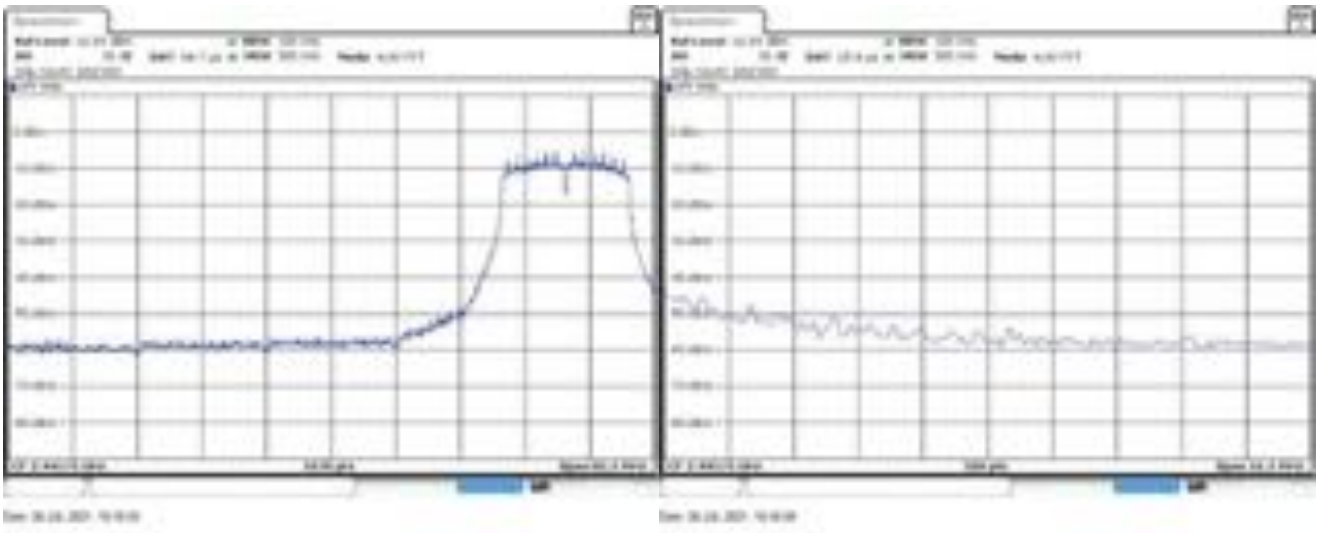
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.875000	-40.0	11.9	-28.2	PASS
2399.825000	-40.1	11.9	-28.2	PASS
2399.925000	-40.7	12.5	-28.2	PASS
2399.775000	-41.0	12.9	-28.2	PASS
2399.725000	-41.1	12.9	-28.2	PASS
2399.675000	-41.8	13.6	-28.2	PASS
2398.275000	-41.8	13.7	-28.2	PASS
2399.375000	-41.9	13.7	-28.2	PASS
2398.225000	-42.1	14.0	-28.2	PASS
2399.225000	-42.1	14.0	-28.2	PASS
2399.275000	-42.2	14.0	-28.2	PASS
2399.175000	-42.3	14.2	-28.2	PASS
2399.425000	-42.5	14.3	-28.2	PASS
2399.975000	-42.6	14.4	-28.2	PASS
2398.625000	-42.6	14.4	-28.2	PASS



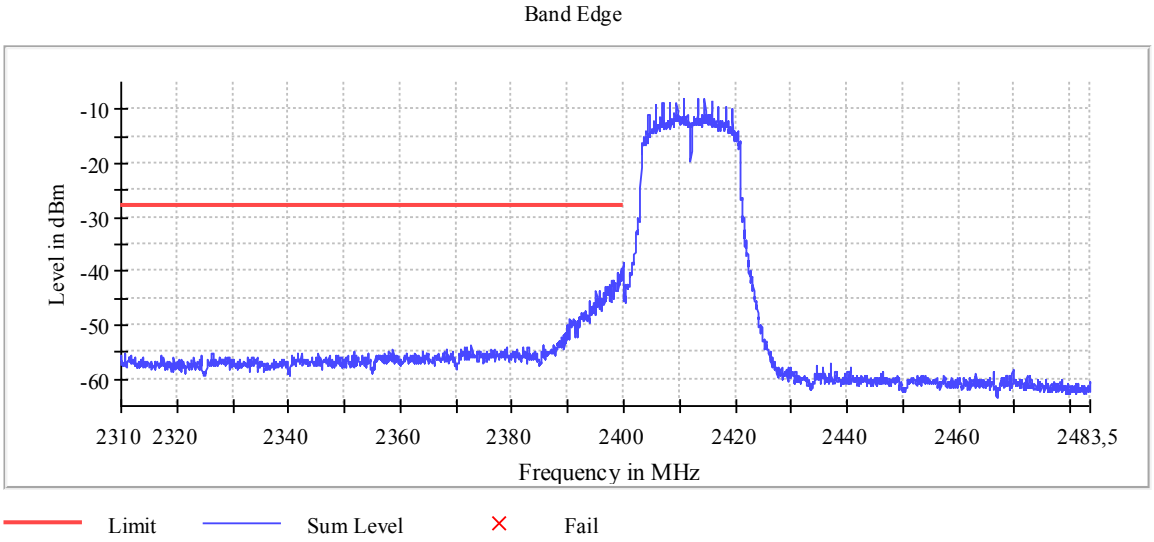
Plot 43: Mode 2, BEC, high channel



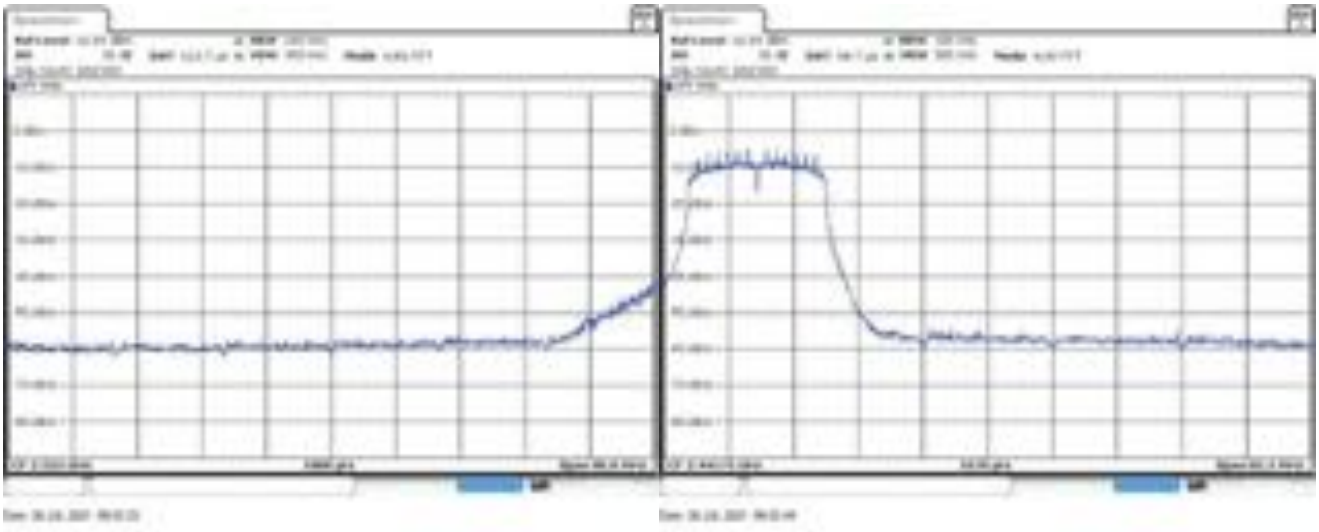
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.575000	-42.0	13.7	-28.3	PASS
2483.625000	-42.2	14.0	-28.3	PASS
2483.525000	-42.4	14.1	-28.3	PASS
2484.025000	-42.8	14.6	-28.3	PASS
2483.975000	-43.0	14.7	-28.3	PASS
2484.525000	-43.2	14.9	-28.3	PASS
2483.675000	-43.2	14.9	-28.3	PASS
2483.875000	-43.2	14.9	-28.3	PASS
2484.475000	-43.2	14.9	-28.3	PASS
2483.725000	-43.3	15.1	-28.3	PASS
2483.825000	-43.4	15.1	-28.3	PASS
2484.575000	-43.5	15.2	-28.3	PASS
2484.425000	-43.6	15.4	-28.3	PASS
2483.775000	-43.6	15.4	-28.3	PASS
2484.075000	-43.8	15.5	-28.3	PASS



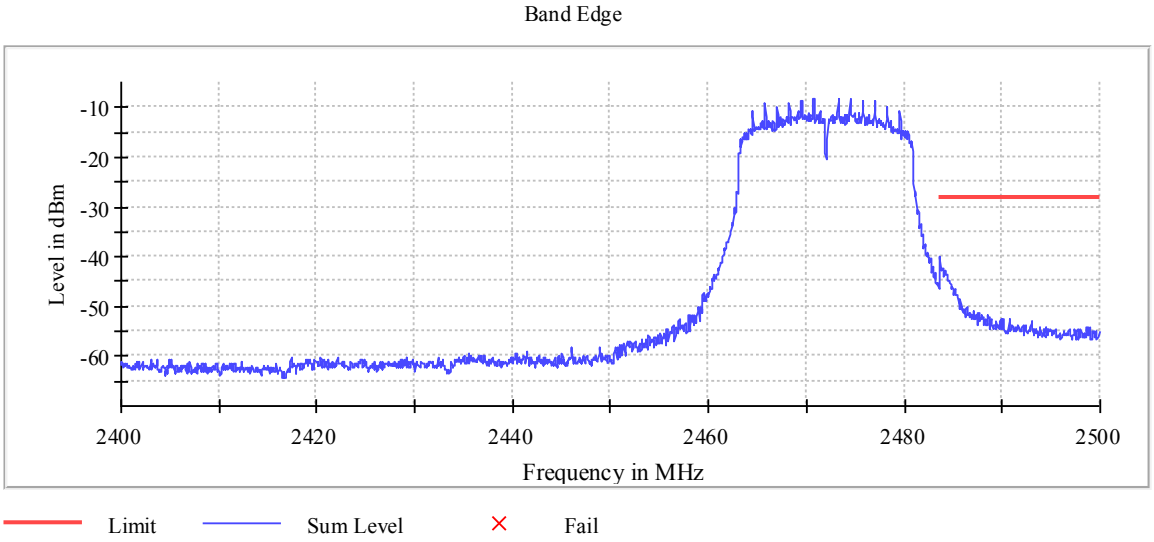
Plot 44: Mode 3, BEC, low channel



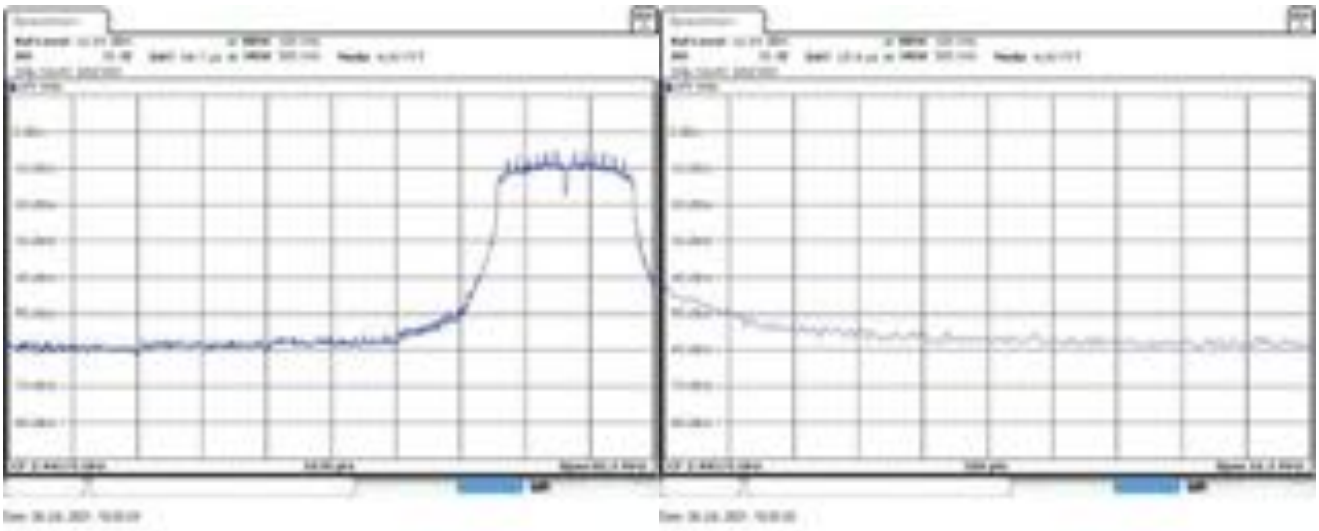
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2399.925000	-38.3	10.3	-27.9	PASS
2399.875000	-38.5	10.6	-27.9	PASS
2399.975000	-38.8	10.8	-27.9	PASS
2399.825000	-38.8	10.9	-27.9	PASS
2399.525000	-39.4	11.5	-27.9	PASS
2399.475000	-39.4	11.5	-27.9	PASS
2398.925000	-40.3	12.4	-27.9	PASS
2398.875000	-40.4	12.5	-27.9	PASS
2399.225000	-40.5	12.6	-27.9	PASS
2399.775000	-40.7	12.7	-27.9	PASS
2399.575000	-40.8	12.9	-27.9	PASS
2399.625000	-41.0	13.0	-27.9	PASS
2399.275000	-41.0	13.0	-27.9	PASS
2399.675000	-41.1	13.1	-27.9	PASS
2399.175000	-41.1	13.2	-27.9	PASS



Plot 45: Mode 3, BEC, high channel



Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)	Result
2483.625000	-39.8	11.6	-28.2	PASS
2483.675000	-40.2	12.1	-28.2	PASS
2483.575000	-40.3	12.2	-28.2	PASS
2483.525000	-41.7	13.5	-28.2	PASS
2483.875000	-42.5	14.3	-28.2	PASS
2483.925000	-42.5	14.3	-28.2	PASS
2483.775000	-42.6	14.4	-28.2	PASS
2483.725000	-42.6	14.5	-28.2	PASS
2483.825000	-42.7	14.5	-28.2	PASS
2484.175000	-43.0	14.8	-28.2	PASS
2484.125000	-43.0	14.9	-28.2	PASS
2483.975000	-43.3	15.2	-28.2	PASS
2484.225000	-43.5	15.3	-28.2	PASS
2484.325000	-43.6	15.4	-28.2	PASS
2484.375000	-43.7	15.5	-28.2	PASS



7.7 Band Edge Compliance (BEC), radiated

Applicability
This requirement applies to all types of DTS equipment.

Description
Emissions within a restricted band and within 2 MHz of an authorized band edge may be measured using either the marker-delta method (ANSI C63.10, 6.10.6) or the integration method (ANSI C63.20, 11.13.3), provided that the DTS bandwidth (or EBW) edge falls within 2 MHz of the band edge. Otherwise, all unwanted emissions measurements shall be performed using the standard methods.

Limits
§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 emissions 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)).

Test procedure
The marker-delta method as described in ANSI C63.10, 6.10.6 or the integration methode as described in ANSI C63.10, 11.13.3 can be used to perform measurements of the unwanted emissions level at the band edges.

Test setup: 8.2 with radiated test sample 61314 (see 5.2)

Test results

BEC	low channel AVG / Peak [dµV/m @3m]	high channel AVG / Peak [dµV/m @3m]	Limit AVG / Peak [dµV/m @3m]
Mode 1	≤ 45 / ≤ 56	≤ 45 / ≤ 56	≤ 54 AVG / ≤ 74 PK
Mode 2	≤ 52 / ≤ 70	≤ 52 / ≤ 70	≤ 54 AVG / ≤ 74 PK
Mode 3	≤ 52 / ≤ 70	≤ 52 / ≤ 70	≤ 54 AVG / ≤ 74 PK

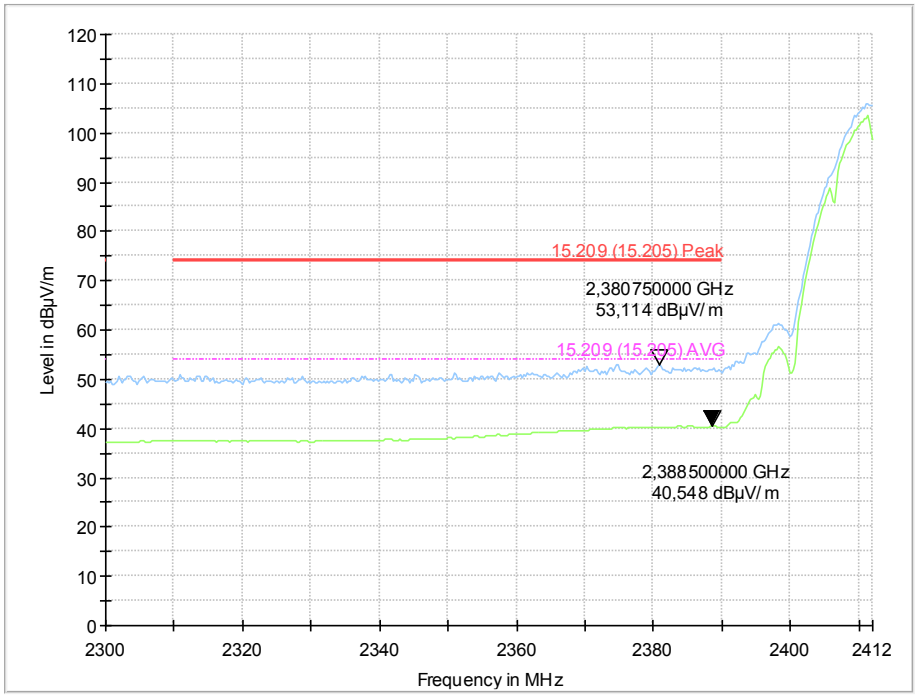
Comment:	---

Verdict	- FAIL -	*see next plots**

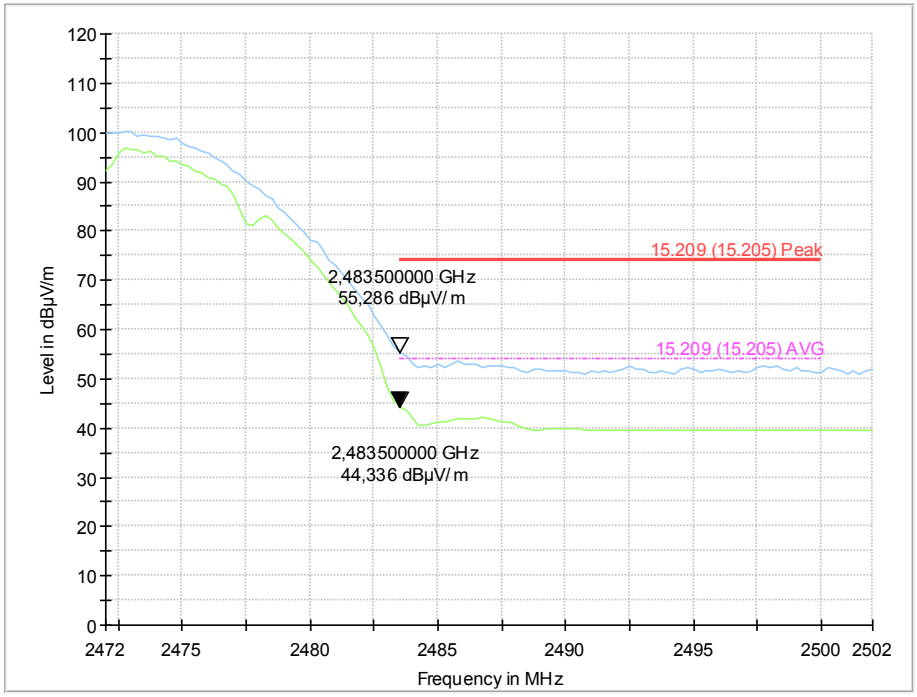
* description of traces for radiated Bend Edge Compliance (BEC) measurements:

positive Peak (Max Hold) trace
average Peak (Max Hold) trace

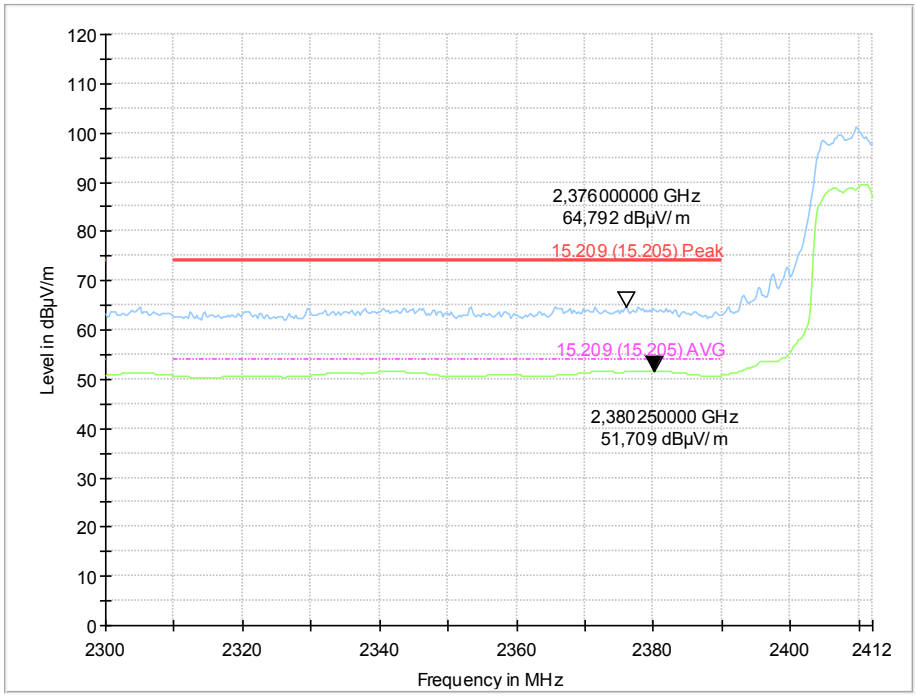
Plot 46: Mode 1, BEC, low channel 2412 MHz



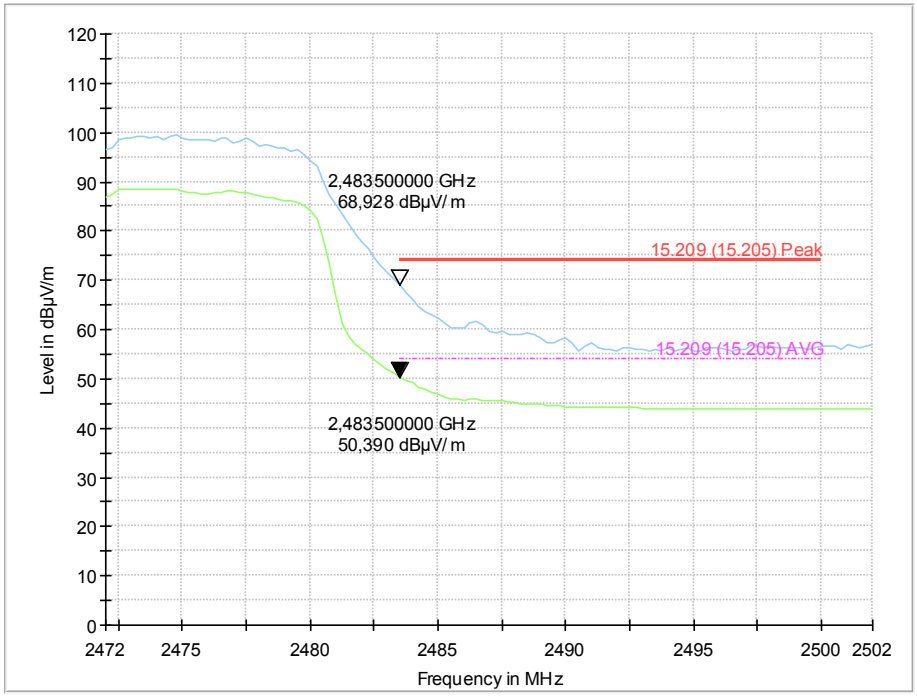
Plot 47: Mode 1, BEC, high channel, 2472 MHz



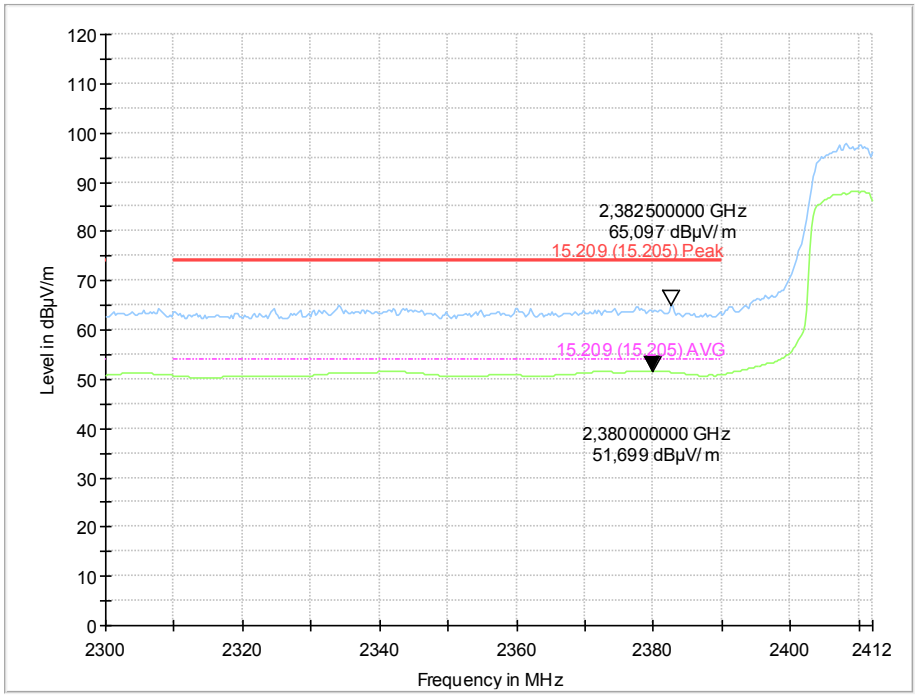
Plot 48: Mode 2, BEC, low channel, 2412 MHz



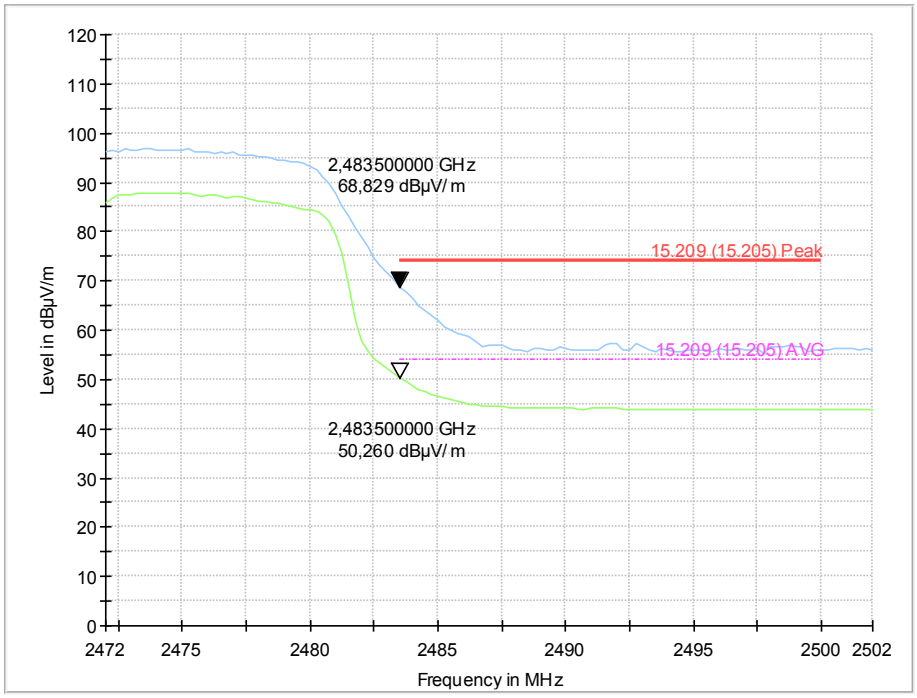
Plot 49: Mode 2, BEC, high channel, 2472 MHz



Plot 50: Mode 3, BEC, low channel, 2412 MHz



Plot 51: Mode 3, BEC, high channel, 2472 MHz



7.8 Conducted Spurious Emissions (CSE)

Applicability
This requirement applies to all types of DTS equipment.

Description
Spurious emission / unwanted emissions are emission on a frequency or frequencies which are outside the authorized band and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products.

Limits
§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. Attenuation below the general limits specified in §15.209(a) is not required.

Test procedure
ANSI C63.10, 11.11
Reference level measurement:
Establish a reference level by using the following procedure:
a) Set instrument center frequency to DTS channel center frequency.
b) Set the span to ≥ 1.5 times the DTS bandwidth.
c) Set the RBW = 100 kHz.
d) Set the VBW ≥ [3 × RBW].
e) Detector = peak.
f) Sweep time = auto couple.
g) Trace mode = max hold.
h) Allow trace to fully stabilize.
i) Use the peak marker function to determine the maximum PSD level.
Note that the channel found to contain the maximum PSD level can be used to establish the reference level.

Emission level measurement:
Establish an emission level by using the following procedure:
a) Set the center frequency and span to encompass frequency range to be measured.
b) Set the RBW = 100 kHz.
c) Set the VBW ≥ [3 × RBW].
d) Detector = peak.
e) Sweep time = auto couple.
f) Trace mode = max hold.
g) Allow trace to fully stabilize.
h) Use the peak marker function to determine the maximum amplitude level.
Ensure that the amplitude of all unwanted emissions outside of the authorized frequency band (excluding restricted frequency bands) is attenuated by at least the minimum requirements as specified (≥ 20 dBc).

The marker-delta method, as described in ANSI C63.10, 6.10.6 can be used to perform measurements of the radiated unwanted emissions level at the band-edges provided that the 99 % OBW of the fundamental emission is within 2 MHz of the authorized band edge.

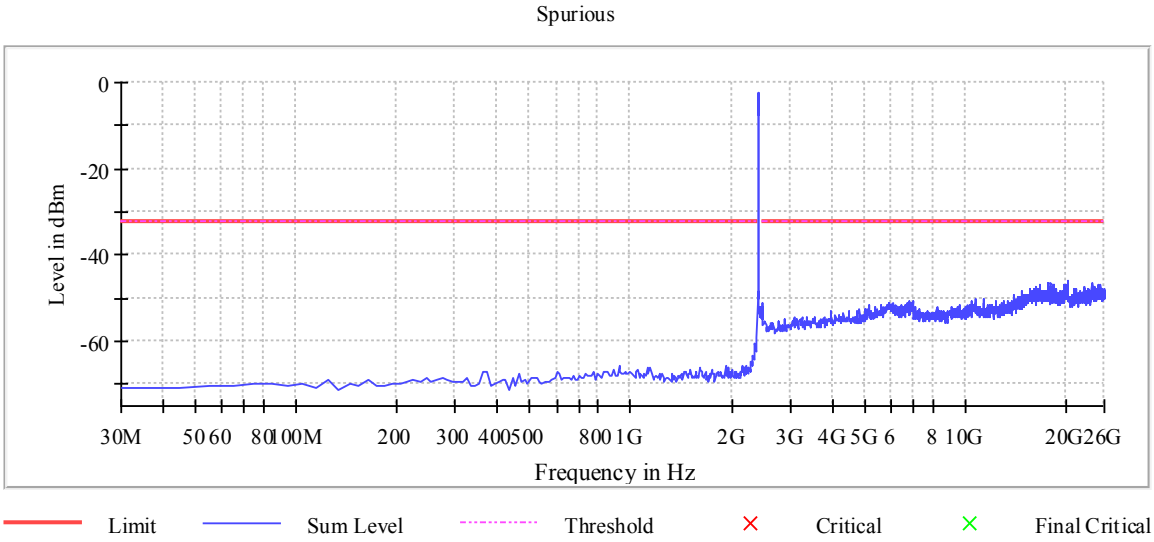
Test setup: 8.4 with conducted test sample 60337 (see 5.2)					
Test results					
EUT Mode / Channel	**Frequency [MHz]**	**Peak/RMS Detector**	**Level [dBm]**	**Limit [dBm]**	**Verdict**
Mode 1 / low channel	see next plots	MaxPeak	see next plots*	see next plots	- passed -
Mode 1 / high channel	see next plots	MaxPeak	see next plots*	see next plots	- passed -
Mode 2 / low channel	see next plots	MaxPeak	see next plots*	see next plots	- passed -
Mode 2 / high channel	see next plots	MaxPeak	see next plots*	see next plots	- passed -
Mode 3 / low channel	see next plots	MaxPeak	see next plots*	see next plots	- passed -
Mode 3 / high channel	see next plots	MaxPeak	see next plots	see next plots	- passed -

* all detected peaks are more thean 6 dB below the limit

Comment:	---

Verdict	**- PASS -**	*see next plots*

Plot 52: Mode 1, CSE, low channel, 30 MHz – 26000 MHz



Pre Measurements

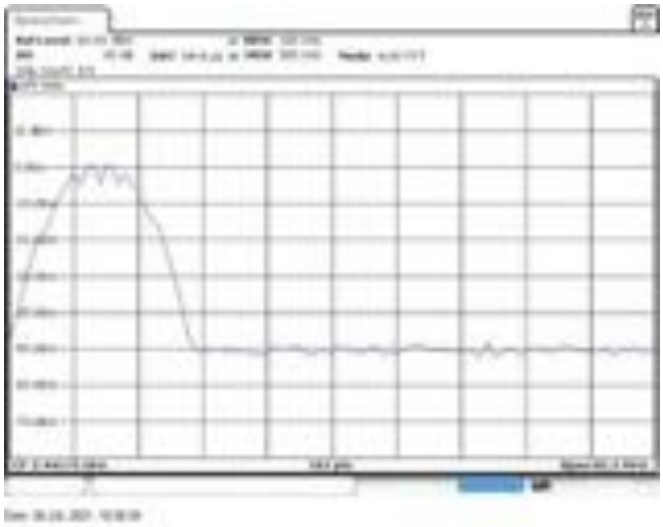
Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
20388.221526	-46.0	13.8	-32.2
17699.764875	-46.3	14.1	-32.2
23766.282299	-46.3	14.2	-32.2
18019.581279	-46.4	14.2	-32.2
20398.215788	-46.5	14.3	-32.2
16690.344348	-46.7	14.5	-32.2
24975.588079	-46.7	14.6	-32.2
18009.587017	-46.7	14.6	-32.2
18379.374734	-46.8	14.6	-32.2
19798.560030	-46.8	14.7	-32.2
18359.386209	-46.9	14.8	-32.2
25355.370059	-47.0	14.9	-32.2
23846.236400	-47.0	14.9	-32.2
18029.575542	-47.1	14.9	-32.2
20018.433808	-47.1	14.9	-32.2

Measurement Settings

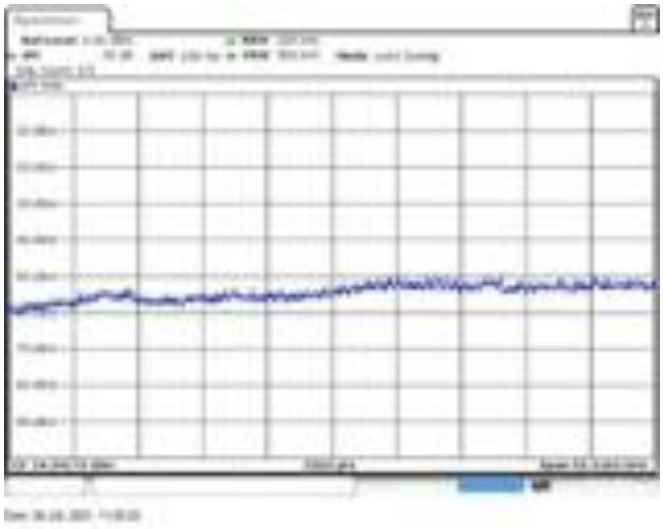
Start Frequency (MHz)	Stop Frequency (MHz)	Pre Measurement	Final Measurement
30.000000	2400.000000	1	1
2400.000000	2483.500000	1	1
2483.500000	26000.000000	1	1

Plot 53: Mode 1, CSE, low channel, 30 MHz – 2400 MHz

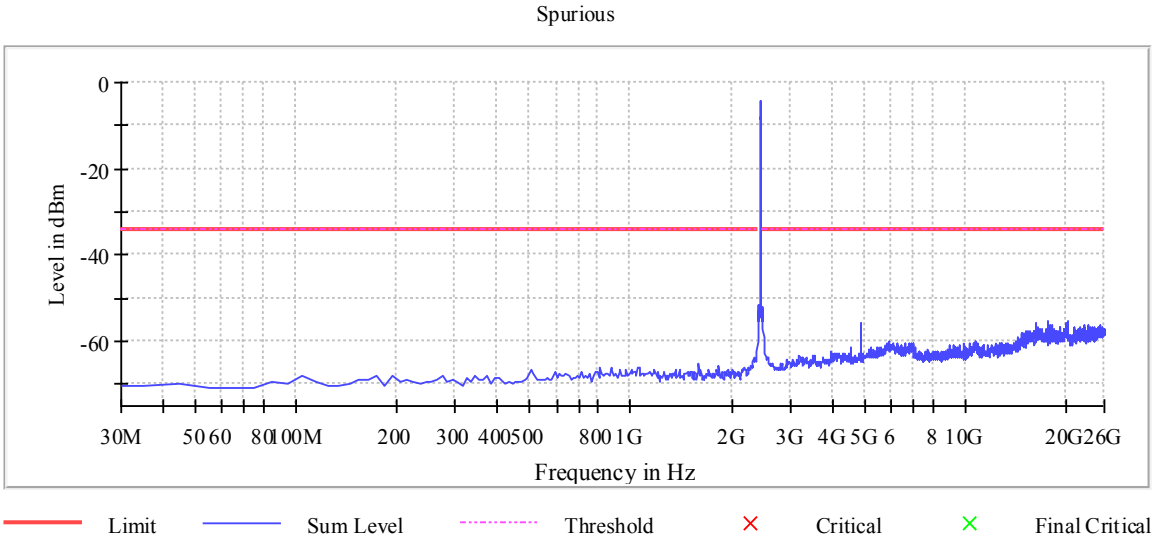
Plot 54: Mode 1, CSE, low channel, 2400 MHz – 2483.5 MHz



Plot 55: Mode 1, CSE, low channel, 2483.5 MHz – 26000 MHz



Plot 56: Mode 1, CSE, mid channel, 30 MHz – 26000 MHz



Pre Measurements

Frequency (MHz)	Level (dBm)	Margin (dB)	Limit (dBm)
17719.753400	-55.4	21.3	-34.1
20398.215788	-55.4	21.3	-34.1
4887.120166	-55.8	21.7	-34.1
20388.221526	-55.8	21.7	-34.1
20008.439545	-55.8	21.7	-34.1
16240.602529	-55.8	21.8	-34.1
17729.747663	-56.0	21.9	-34.1
22507.005206	-56.1	22.0	-34.1
25385.352847	-56.2	22.2	-34.1
23126.649490	-56.3	22.3	-34.1
17999.592754	-56.3	22.3	-34.1
17749.736188	-56.4	22.3	-34.1
16280.579579	-56.4	22.3	-34.1
18039.569805	-56.4	22.4	-34.1
21117.802699	-56.6	22.5	-34.1

Measurement Settings

Start Frequency (MHz)	Stop Frequency (MHz)	Pre Measurement	Final Measurement
30.000000	2400.000000	1	1
2400.000000	2483.500000	1	1
2483.500000	26000.000000	1	1