LAB N° 0986 L
FCC Test Firm Registration #: 375156

TEST REPORT

This revision completely replaces previous test report no. 24-05403-1 (see §1.8)

According to following Standards

Test Methods	ANSI C63.4: 2014 -06 ANSI C63.10: 2013-06
Test specification	FCC Rules: Code of Federal Regulations (CFR) no. 47 Part 15 Subpart C Section 15.247, 15.205, 15.203, 15.207, 15.209 Test plan: Technical specification Display LEONARDO OTS2 v4.0

Maximum Peak Output Power, FCC Section 15.247 (b) (1)	**Compliant**
20dB Bandwidth & 99%, FCC Section 15.247 (a) (1)	**Compliant**
Band-edge, FCC Section 15.247(d)	**Compliant**
Number of Hopping Frequency and Dwell Time, FCC Section 15.247 (a)(1)(iii)	**Compliant**
Frequency Separation, FCC Section 15.247 (a)(1)	**Compliant**
Conducted Spurious Emissions, Section 15.247(d)	**Compliant**
Radiated Spurious Emissions, FCC Section 15.205 (a), 15.209, 15.247(d)	**Compliant**
Restricted Bands of Operation, Section 15.205	**Compliant**
Antenna Requirement/ Transmit Antenna, FCC Section 15.203	**Compliant**
AC Power Line Conducted Emissions, Section 15.207	**Not applicable** (see par. 10.0)

Applicant's name ..... :	MTA S.p.A.	
Address..... :	Viale dell'Industria, 12 - 26845 Codogno (LO) - Italy	
Manufacturer..... :	MTA S.p.A.	
Address..... :	Viale dell'Industria, 12 - 26845 Codogno (LO) - Italy	
Device Under Test ..... :	Display LEONARDO OTS2	
Date of issue..... :	01st October 2024	
Validity..... :	See section 1.2	
Author of Test report ..... :	Rudy Valent	
Engineer/s ..... :	Rudy Valent	
Technical Manager/s (+ signature) :	Enrico Not	Firmato digitalmente da: Not Enrico Firmato il 01/10/2024 11:11 Seriale Certificato: 2484967 Valido dal 29/05/2023 al 29/05/2026 InfoCamere Qualified Electronic Signature CA
Approved by (+ signature) ..... :	Stefano Petrini (Laboratory Manager)	Firmato digitalmente da: Petrini Stefano Firmato il 01/10/2024 12:05 Seriale Certificato: 2573139 Valido dal 28/06/2023 al 28/06/2026 InfoCamere Qualified Electronic Signature CA
Testing Laboratory..... :	Emilab Srl a Socio Unico	
Address..... :	Via F.lli Solari 5/A – 33020 Amaro (UD) – Italy	

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1.0 General Information

1.1 Testing Laboratory

Testing procedure and testing location:	
Testing Laboratory:	
Testing location / address.....:	Emilab Srl a Socio Unico Via F.lli Solari 5/A – 33020 Amaro (UD) – Italy Tel +39 0433 468625 Fax +39 0433 494739 Email: info.emilab@applus.com
Participants:	-

1.2 Sampling and Documentation

The samples and any specific hardware and software simulators and accessories, hereinafter called auxiliary apparatus and the related information (samples and auxiliary apparatus) was delivered by customer under his own responsibility. The results contained in this report reflect the results for this particular model and serial number tested in combination with the auxiliary apparatuses. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report. The laboratory takes no responsibility for the auxiliary equipment and for the information provided by the customer. This report shall not be reproduced, except in full, without the written approval of the Issuing testing Emilab laboratory.

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1.3 Test specifications

Test performed according to:	
Test plan	Technical specification Display LEONARDO OTS2 v4.0 Number: TP010-23 rev.1 Revision date: 07/06/2024 Author: R. Nunnari
Test specification	All compliance measurements have been carried out using the procedures described in the standard ANSI C63.4-2014, ANSI C63.10-2013, Section 15.31 of CFR47 Part 15 – Subpart A (General) FCC Rules: Code of Federal Regulations (CFR) no. 47 Part 15 Subpart C Section 15.247, 15.205, 15.207, 15.209
Test Methods / Basic Standard	ANSI C63.4: 2014-06 ANSI C63.10: 2013-06

1.4 Test scheduling and general conditions

Scheduling:	
Date of receipt of EUT ..... :	18/04/2024
Date (s) of performance of tests..... :	23/04/2024 – 23/05/2024
EUT Number ..... :	24LA00181/01 (normal product) 24LA00181/02 (EUT with external RF antenna connectors)
Environment Conditions:	If not otherwise specified: Temperature: 18-28 °C Humidity: 20-90 % Pressure: 86-106 kPa

1.5 Test case of final verdicts

The results consider the measurement uncertainty, where applicable, using the following scheme	
- test case does not apply to the test object :	N/A (Not Applicable)
- test object does meet the requirement..... :	Compliant or PASS
- test object does not meet the requirement :	Not Compliant or FAIL

1.6 Uncertainty

The reported expanded uncertainty of measurements is stated as the standard uncertainty of measurement, multiplied by the coverage factor k=2, which for a normal distribution corresponding to a coverage probability of approximately 95%.

1.7 Terms, definitions and abbreviations

With reference to IEC 60050-161

AC Alternating Current
ACK Acknowledgement
AFH Adaptive Frequency Hopping
ALSE Absorber-Lined Shielded Enclosure
AM Amplitude Modulation
AN Artificial Network
ASTM American Society for Testing & Material
AV Average Detector
BIT Burst Interval Time
BLE Bluetooth Low Energy

BT	Bluetooth
BU	Before to use
BW	Bandwidth
CCA	Clear Channel Assessment
CW	Continuous Wave
DAA	Detect And Avoid
DC	Direct Current
DFS	Dynamic Frequency Selection
DMM	Digital Multi Meter
DSSS	Direct Sequence Spread Spectrum
DUT	Device under Test
e.i.r.p.	equivalent isotropically radiated power
e.r.p.	effective radiated power
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EUT	Equipment under Test
FAR	Fully Anechoic Room
FC	Fault Condition
FFT	Fast Fourier Transform
FG	Function Generator
FHSS	Frequency Hopping Spread Spectrum
FSC	Functional Status Classification
GND	Ground
HT20 High	Throughput in a 20 MHz channel
HT40 High	Throughput in a 40 MHz channel
I/O	Input/Output
IEC	International Electrotechnical Commission
IP	International Protection
ISM	Industrial, Scientific and Medical
ISO	International Organization for Standardization
LBT	Listen Before Talk
LED	Light Emitting Diode
LIN	Local Interconnect Network
LISN	Line Impedance Simulation Network
LPDA	Logarithmic Periodic Dipole Antenna
LV	Low Voltage
MCS	Modulation Coding Scheme
MIMO	Multiple Input, Multiple Output
MS/s	Mega-Samples per second
MU	Medium Utilization
NACK	Not Acknowledged
OATS	Open Air Test Site
OC	Operating Conditions
OFDM	Orthogonal Frequency Division Multiplexing
OM	Operating Mode

OOB	Out Of Band
OVP	Overvoltage Protection
PA	Power Amplifier
PAS	Power Amplifier System
PK	Peak Detector
PLC	Programmable Logic Controller
PM	Pulse Modulation
ppm	parts per million
PPS	Pulses Per Second
PRF	Pulse Repetition Frequency
PWM	Pulse Width Modulation
RBW	Resolution Bandwidth
QP	Quasi-Peak Detector
RE	Radiated Emission
RLAN	Radio Local Area Network
RF	Radio Frequency
RMS	Root Mean Square
RT	Room Temperature
Rx	Receiver
SAC	Semi Anechoic Chamber
TEM	Transverse Electromagnetic
TL	Threshold Level
TPC	Transmit Power Control
Tx	Transmitter
VBW	Video Bandwidth
VSWR	Voltage Standing Wave Ratio
WLAN	Wireless Local Area Network

1.8 Notes related to this revision

This revision to Test Report no. **24-05403-1** was prepared after the reports received by the company's Radio-EMC certification experts, remarks received by email on September 18th, 2024, accepted and implemented on October 01st, 2024.

The following changes have been made:

- to avoid possible misunderstandings about the calibration date, especially when the month of the equipment calibration due date coincides with the month of the test, the day has also been added

Final considerations:

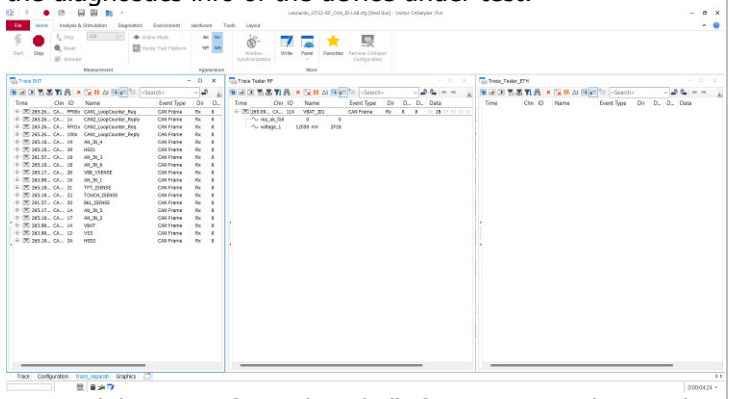
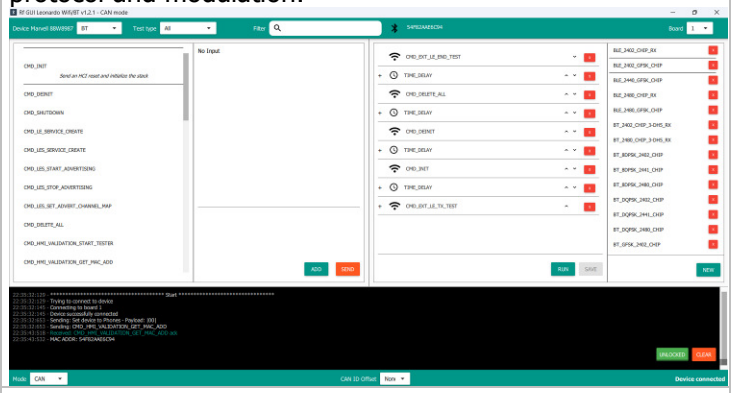
The changes made to the test report have no effect on the final judgment of the tests (Pass/Fail or Compliant/Not Compliant outcome) because they are not changes that affect the procedures and execution of the tests or the validity and compliance of the instruments used.

2.0 Device Under Test

2.1 Device description and setup information

These information are provided by the customer under his own responsibility

Description ..... :	Touch Screen Instrument Panel
Trade Mark.....:	MTA
Manufacturer .....:	MTA S.p.A.
Model/Type reference.....:	Display Leonardo OTS2
Voltage.....:	14.5 Vdc
Current.....:	/
Frequency .....:	/
Power.....:	/
Serial Number.....:	S/N: 00002, batch: 054 (24LA00181/01) S/N: 00008, batch: 054 (24LA00181/02)
Number of samples tested .....:	1+1
Internal customer EUT Number.....:	**MTA P/N:** 6100552/12
Sample stage / level.....:	Certification Phase and PV-PHASE
Hardware stage / level .....:	04.02.00.00
Software stage / level.....:	04.07.00.00
Modification stage .....:	/
Operating Mode .....:	**Mode 1:** during the tests the EUT was powered at 14.5 Vdc. At the other side of the harness are connected a Load Box, with analog loads, digital loads, CAN bus, LIN bus and cameras, and a direct connection for ethernet bus. Note: cameras are used for check video input of the EUT during immunity test, during emission test all cameras were not supplied, as required by the costumer. CAN, LIN and Ethernet connection are continuously kept active with auxiliary devices, connected with EUT trough optical fiber. Optical converters for CAN bus and LIN bus are supplied from the Laboratory, Optical converter for Ethernet bus is supplied by the costumer. Note: during radiated emissions tests, these devices are kept outside the test chamber. LIN communication is kept active with a "LIN simulator" device, set in echo mode, Ethernet communication is kept active with a counterpart device, similar to the EUT under test and CAN communication was kept active with PC software "CANalyzer" with configuration named "Leonardo_OTS2-RF_CAN_ID-LAB.cfg", where are send all

	the diagnostics info of the device under test:  RF module is configured with "Rf GUI Leonardo WiFi/BT v1.2.1 – CAN mode" software, for set type of communication (BLE, BT or WiFi), transmit channel, protocol and modulation: 
Wiring harness.....:	Harness type 1 (2500 mm)
Monitoring .....:	/
Info.....:	Auxiliary equipment provided by the applicant:

Equipment	Model	Serial Number	Manufacturer
Power Supply 230Vac to 12 Vdc/5A	SGA60E 12-P1J	-	-
WiFi Antenna (for EUT with external RF connectors)	-	-	-
WiFi Antenna (for EUT with external RF connectors)			
LIN Simulator	-	-	MTA
RF tester (BT+WiFi)	-	-	MTA
Ethernet Simulator	-	-	MTA
Harness 2500 mm	-	-	MTA
Laptop	Latitude 3540	n° MTA 1313	DELL
USB-CAN interface	VN1630 A	007113-588503	VECTOR
EUT Fixture	-	-	MTA

	Ethernet Optical Converters	TJA1101	SN545028	EMC Tools
	Ethernet Optical Converters	TJA1101	SN545027	EMC Tools

2.2 Deviation from the specified conditions

Deviation from the specified conditions: N/A

2.3 Channel list

Bluetooth

Frequency band [MHz]: 2400 – 2483.5							
Channel	**Frequency [MHz]**	**Channel**	**Frequency [MHz]**	**Channel**	**Frequency [MHz]**	**Channel**	**Frequency [MHz]**
0	2402	20	2422	40	2442	60	2462
1	2403	21	2423	41	2443	61	2463
2	2404	22	2424	42	2444	62	2464
3	2405	23	2425	43	2445	63	2465
4	2406	24	2426	44	2446	64	2466
5	2407	25	2427	45	2447	65	2467
6	2408	26	2428	46	2448	66	2468
7	2409	27	2429	47	2449	67	2469
8	2410	28	2430	48	2450	68	2470
9	2411	29	2431	49	2451	69	2471
10	2412	30	2432	50	2452	70	2472
11	2413	31	2433	51	2453	71	2473
12	2414	32	2434	52	2454	72	2474
13	2415	33	2435	53	2455	73	2475
14	2416	34	2436	54	2456	74	2476
15	2417	35	2437	55	2457	75	2477
16	2418	36	2438	56	2458	76	2478
17	2419	37	2439	57	2459	77	2479
18	2420	38	2440	58	2460	78	2480
19	2421	39	2441	59	2461	-	-

2.4 Test modes and Channel details

Bluetooth

Test Description	Channel Frequency	Modulation	Data Rate
Maximum Peak Output Power, FCC Section 15.247 (b) (1)	2402 / 2441 / 2480	GFSK π/4 DQPSK 8DPSK	1Mbps (BR) 2Mbps (EDR) 3Mbps (EDR)
Band-edge, FCC Section 15.247(d)	2402 / 2480 and Hopping	GFSK π/4 DQPSK 8DPSK	1Mbps (BR) 2Mbps (EDR) 3Mbps (EDR)
20dB Bandwidth & 99%, FCC Section 15.247 (a) (1)	2402 / 2441 / 2480	GFSK π/4 DQPSK 8DPSK	1Mbps (BR) 2Mbps (EDR) 3Mbps (EDR)
Number of Hopping Frequency and Dwell Time, FCC Section 15.247 (a)(1)(iii)	Hopping	GFSK π/4 DQPSK 8DPSK	1Mbps (BR) 2Mbps (EDR) 3Mbps (EDR)
Frequency Separation, FCC Section 15.247 (a)(1)	Hopping	GFSK π/4 DQPSK 8DPSK	1Mbps (BR) 2Mbps (EDR) 3Mbps (EDR)
Conducted Spurious Emissions, FCC Section 15.247(d)	2402 / 2441 / 2480	GFSK π/4 DQPSK 8DPSK	1Mbps (BR) 2Mbps (EDR) 3Mbps (EDR)
Radiated Spurious Emissions, FCC Section 15.205 (a), 15.209, 15.247(d)	Worst case detected during Max Peak Output Power test	-	-
Restricted Bands of Operation, Section 15.205	Worst case detected during Max Peak Output Power test	-	-
Antenna Requirement/ Transmit Antenna, FCC Section 15.203	-	-	-

3.0 Maximum Conducted Output Power – Test Conditions

Technician	Rudy Valent		
Table No.	TEST: Maximum Peak Output Power, FCC Section 15.247 (b) (1)		\
Method	ANSI C63.10: 2013-06, par. 7.8.5		\
Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C	
	Relative Humidity	Less or equal to 80 %	
Parameters recorded during the test	Laboratory Ambient Temperature	21 – 24 °C	
	Relative Humidity	34 – 45 %	
Date (s) of test execution	23/04/2024 – 02/05/2024		

Supplementary information:

- Test performed on EUT 24LA00181/02
- Conducted Test, executed at Bluetooth antenna output (50ohm, SMA) connected to the Spectrum Analyser through an attenuator (30 dB)
- EUT powered at 14.5 Vdc
- EUT Operating Mode: Mode 1
- Spectrum analyser settings setup:
  - Detector: Peak
  - RBW: 3MHz and VBW=3MHz
  - Trace mode: Max Hold
- Test executed with the following settings:
  - BR mode with modulation GFSK on channel 0, 39 and 78
  - EDR mode with modulation π/4 DQPSK on channel 0, 39 and 78
  - EDR mode with modulation 8DPSK on channel 0, 39 and 78

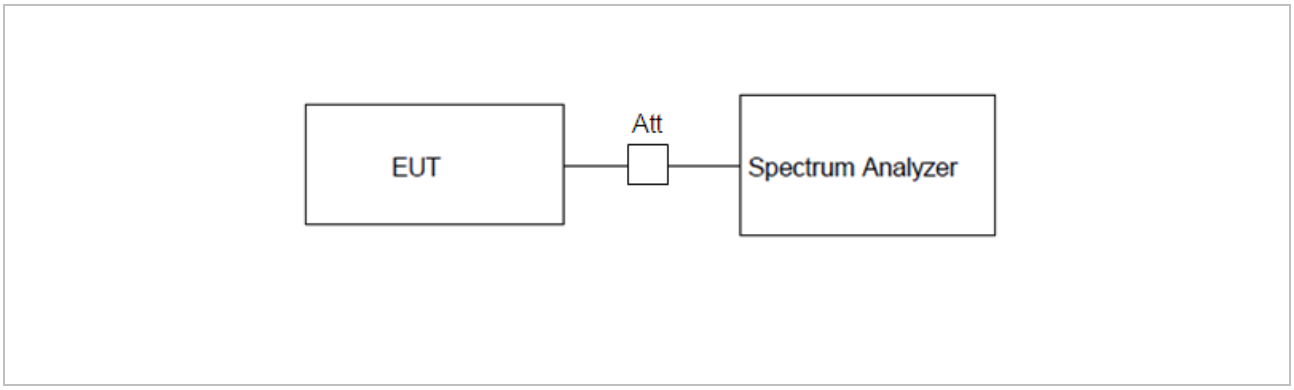
3.1 Test Equipment Used – Maximum Conducted Output Power

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL092016	EMI Receiver	ESW44	Rohde&Schwarz	23-Feb-2024	1 year
EL046111	Dual DC Power Supply	CPX400D	TTi	10-Oct-2023	1 year
EL117019	RF Cable	SLU26-35M35M-01.00M	Timesmicrowave	02-May-2023	1 year
				02-May-2024	1 year
EL082315	Attenuator 30dB	PE7087-30	-	03-May-2023	1 year
EL109018	DataLogger T/UR	HL-1D	Rotronic	29-May-2023	1 year
EL089216	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL089316	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL075814	LIN Optical converter	090	EMC TOOLS	NA	
EL075914	LIN Optical converter	090	EMC TOOLS	NA	

3.2 Auxiliary Equipment – Maximum Conducted Output Power

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL119519	Signal Generator	MG3693A	Anritsu	06-Oct-2023	1 year

3.3 Setup – Maximum Conducted Output Power



3.4 Requirements – Maximum Conducted Output Power

FCC Section 15.247

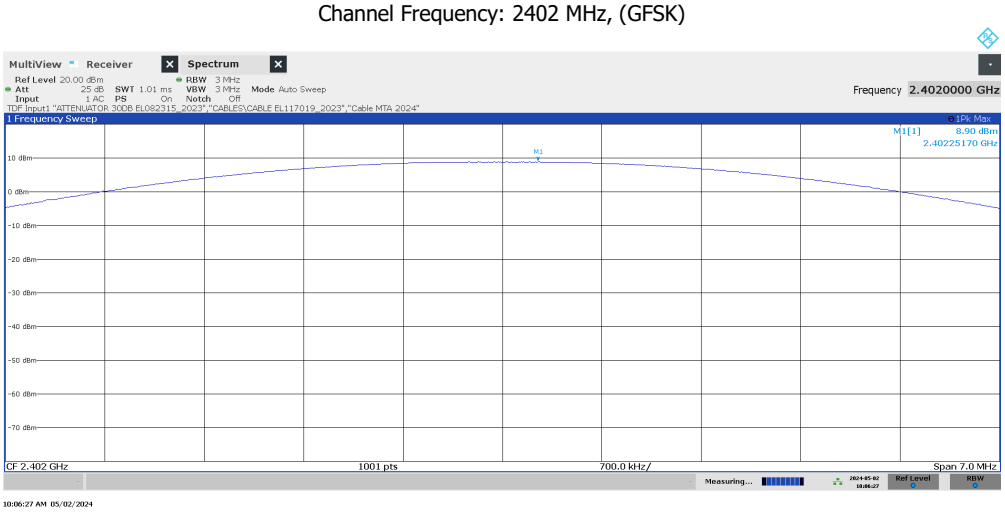
(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (3) For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

3.5 Results – Maximum Conducted Output Power

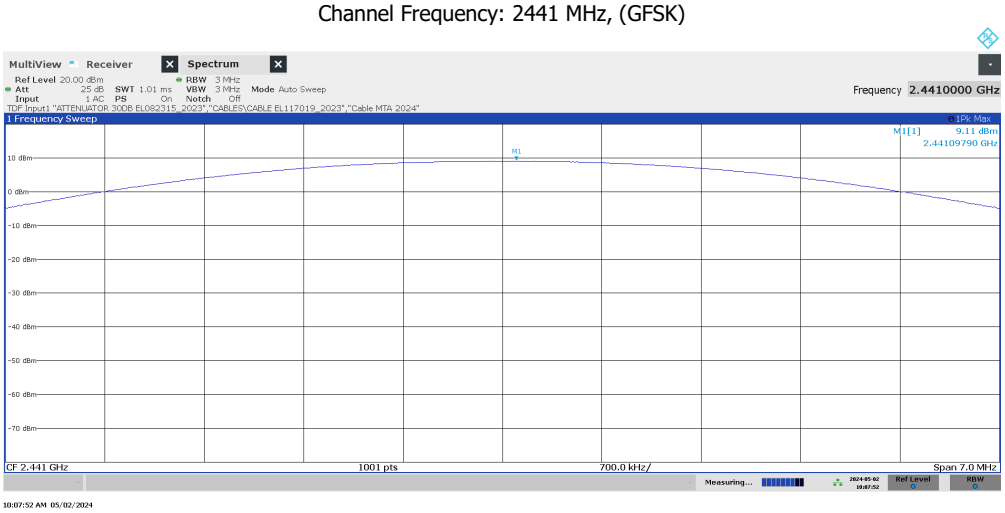
The result of the test is: **PASS**.
See the details in the charts/tables of the following paragraphs (see the worst case in bold text).

Modulation mode	Channel Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Margin (dB)
GFSK	2402.0	8.9	30.0	21.1
	2441.0	9.1	30.0	20.9
	2480.0	9.3	30.0	20.7
π/4 DQPSK	2402.0	7.9	30.0	22.1
	2441.0	8.1	30.0	21.9
	2480.0	8.4	30.0	21.6
8DPSK	2402.0	8.3	30.0	21.7
	2441.0	8.4	30.0	21.6
	2480.0	8.6	30.0	21.4

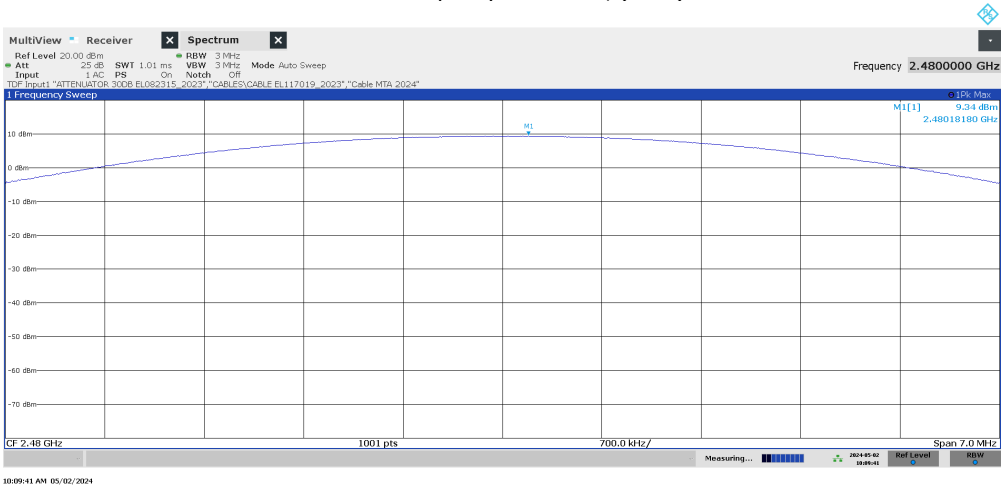
Channel Frequency: 2402 MHz, (GFSK)



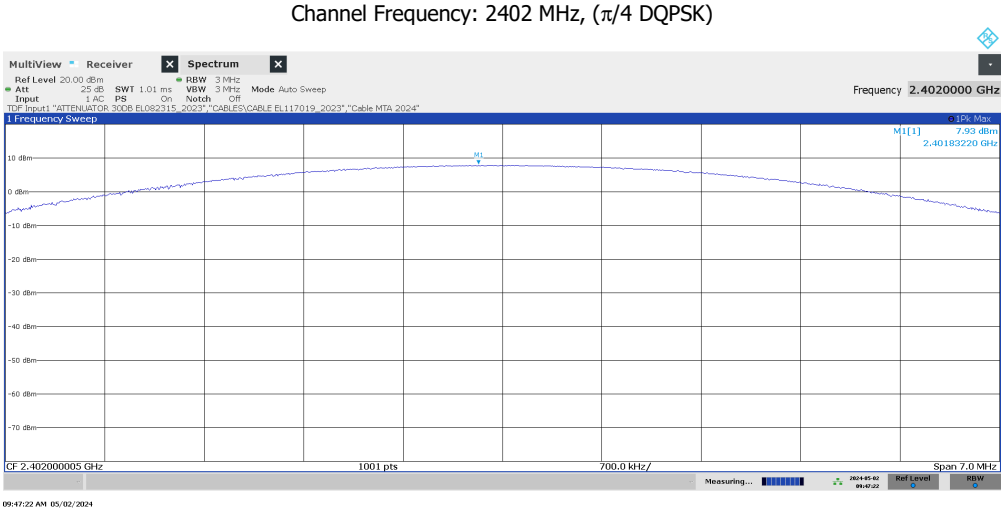
Channel Frequency: 2441 MHz, (GFSK)



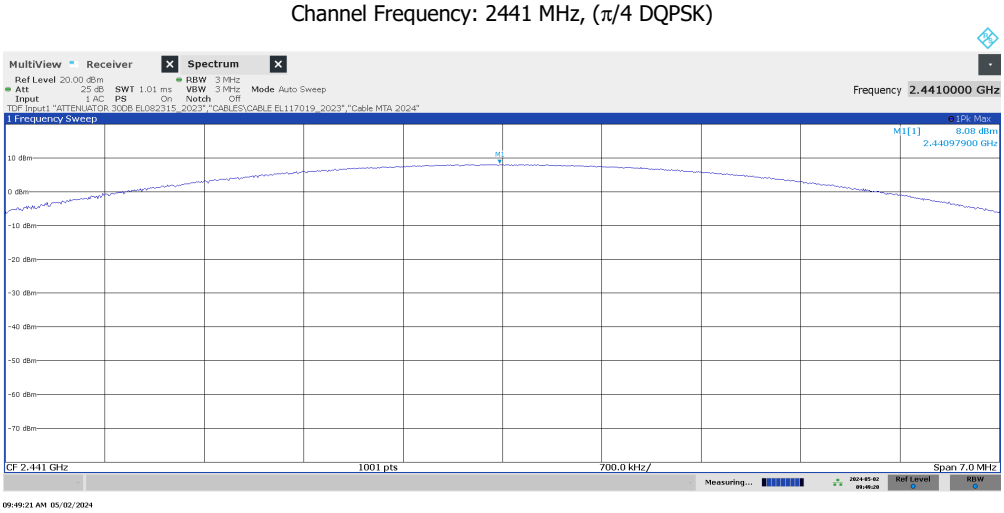
Channel Frequency: 2480 MHz, (GFSK)



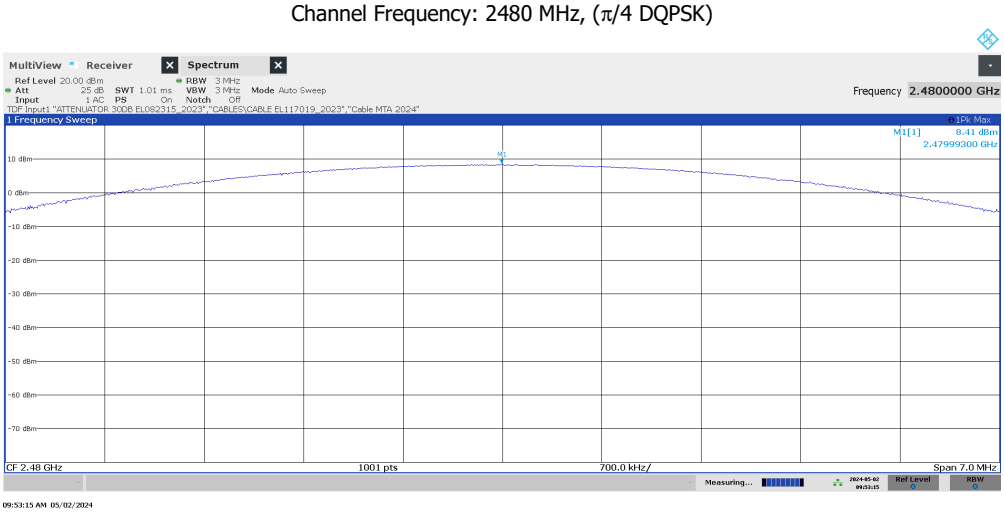
Channel Frequency: 2402 MHz, (π/4 DQPSK)



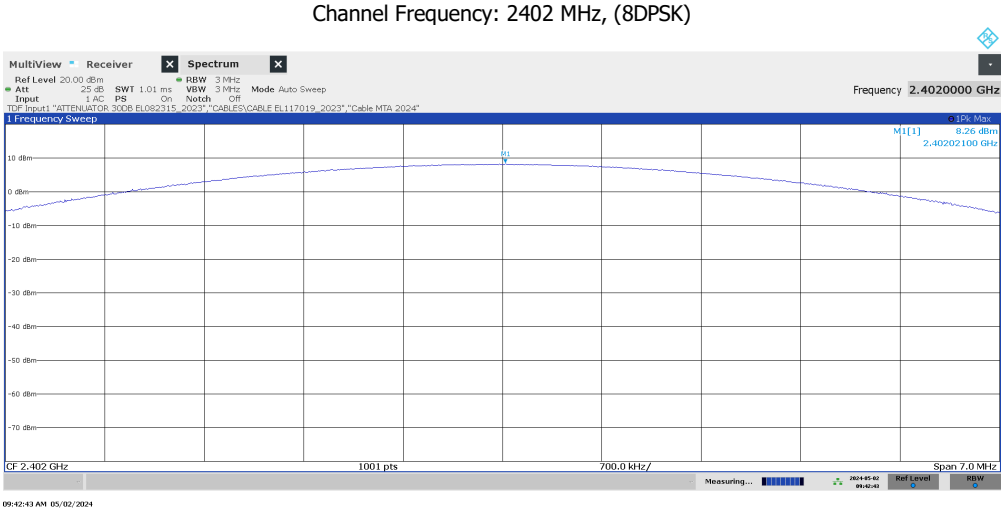
Channel Frequency: 2441 MHz, (π/4 DQPSK)



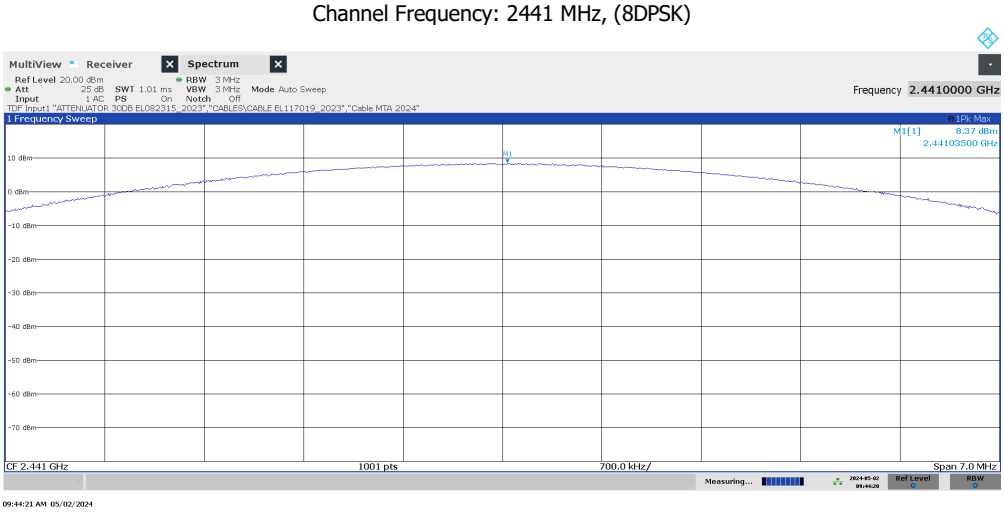
Channel Frequency: 2480 MHz, (π/4 DQPSK)



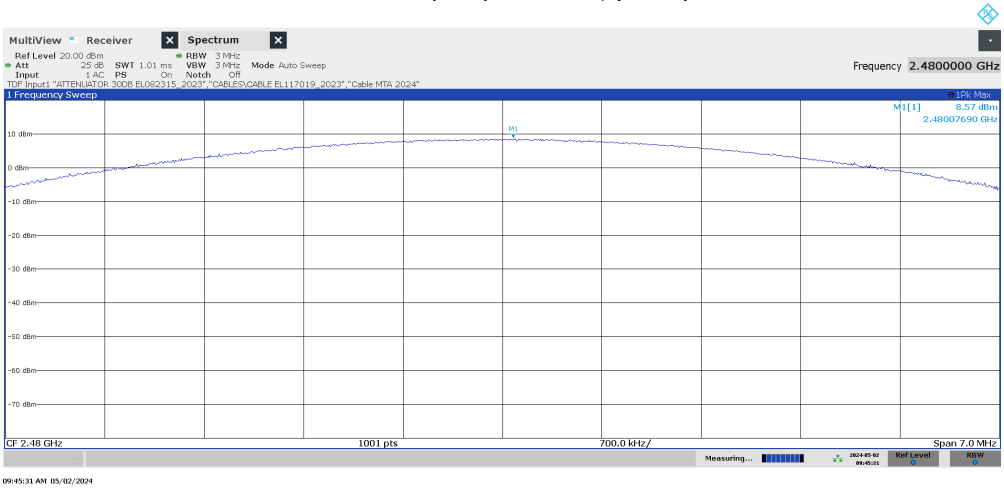
Channel Frequency: 2402 MHz, (8DPSK)



Channel Frequency: 2441 MHz, (8DPSK)



Channel Frequency: 2480 MHz, (8DPSK)



4.0 Bandwidth – Test Conditions

Technician	Rudy Valent		
Table No.	TEST: 20dB Bandwidth & 99%, FCC Section 15.247 (a) (1)		\
Method	ANSI C63.10: 2013-06, par. 6.9		\
Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C	
	Relative Humidity	Less or equal to 80 %	
Parameters recorded during the test	Laboratory Ambient Temperature	23 °C	
	Relative Humidity	50 %	
Date (s) of test execution	06/05/2024		

Supplementary information:

- Test performed on EUT 24LA00181/02
- Conducted Test, executed at Bluetooth antenna output (50ohm, SMA) connected to the Spectrum Analyser through an attenuator (30 dB)
- EUT powered at 14.5 Vdc
- EUT Operating Mode: Mode 1
- Spectrum analyser settings setup:
  - Mode: automatic spectrum analyzer tools
  - Detector: Peak
  - Trace mode: max hold (over last 10 sweeps)
  - RBW: 100 kHz and VBW=3xRBW
- Test executed with the following settings:
  - BR mode with modulation GFSK on channel 0, 39 and 78
  - EDR mode with modulation π/4 DQPSKon channel 0, 39 and 78
  - EDR mode with modulation 8DPSK on channel 0, 39 and 78

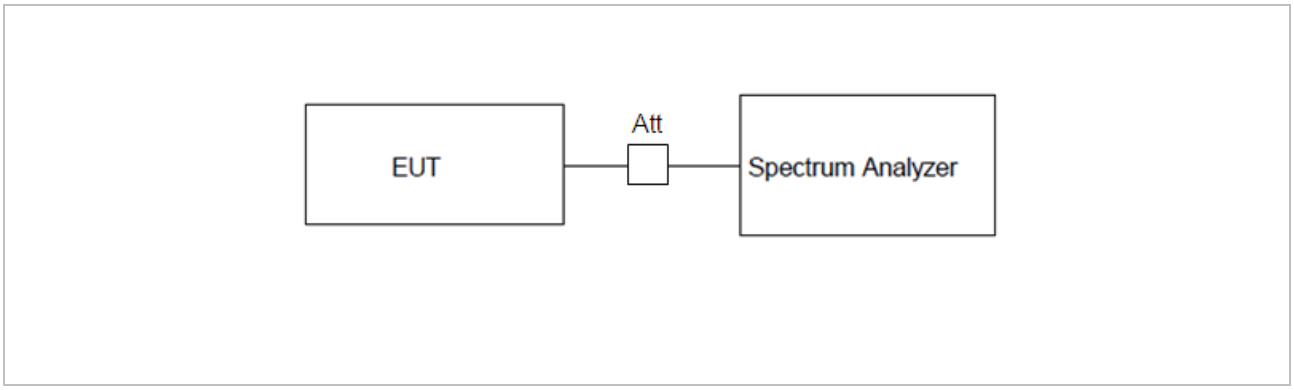
4.1 Test Equipment Used – Bandwidth

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL092016	EMI Receiver	ESW44	Rohde&Schwarz	23-Feb-2024	1 year
EL046111	Dual DC Power Supply	CPX400D	TTi	10-Oct-2023	1 year
EL117019	RF Cable	SLU26-35M35M-01.00M	Timesmicrowave	02-May-2024	1 year
EL082315	Attenuator 30dB	PE7087-30	-	02-May-2024	1 year
EL109018	DataLogger T/UR	HL-1D	Rotronic	29-May-2023	1 year
EL089216	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL089316	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL075814	LIN Optical converter	090	EMC TOOLS	NA	
EL075914	LIN Optical converter	090	EMC TOOLS	NA	

4.2 Auxiliary Equipment – Bandwidth

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL119519	Signal Generator	MG3693A	Anritsu	06-Oct-2023	1 year

4.3 Setup – Bandwidth



4.4 Requirements – Bandwidth

FCC Section 15.247

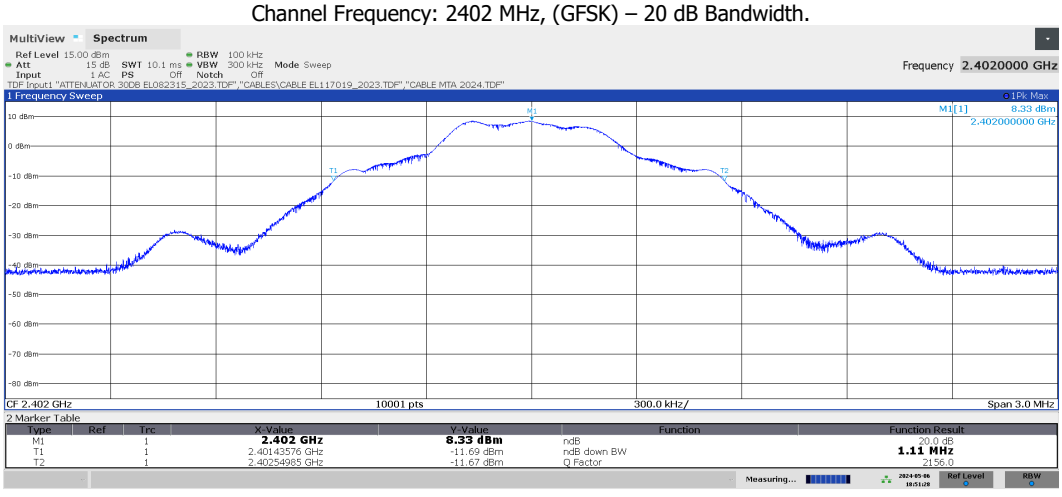
(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the

4.5 Result – Bandwidth

The 20dB bandwidth is used to verify conformity to the channel separation requirement (see par. 6.4.1.2).
See the details in the charts/tables of the following paragraphs.

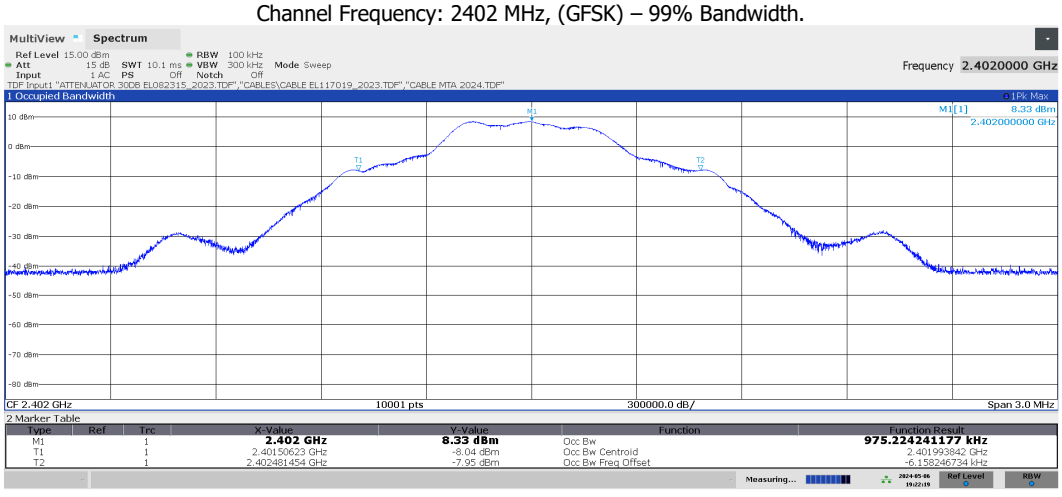
Modulation mode	Channel Frequency (MHz)	20 dB Bandwidth (MHz)	99% Bandwidth (kHz)
GFSK	2402.0	1.1	975.2
	2441.0	1.1	975.3
	2480.0	1.1	975.2
π/4 DQPSK	2402.0	1.3	1168.0
	2441.0	1.3	1169.7
	2480.0	1.3	1169.9
8DPSK	2402.0	1.4	1195.2
	2441.0	1.4	1195.9
	2480.0	1.4	1196.4

Channel Frequency: 2402 MHz, (GFSK) – 20 dB Bandwidth.



06:51:29 PM 05/06/2024

Channel Frequency: 2402 MHz, (GFSK) – 99% Bandwidth.



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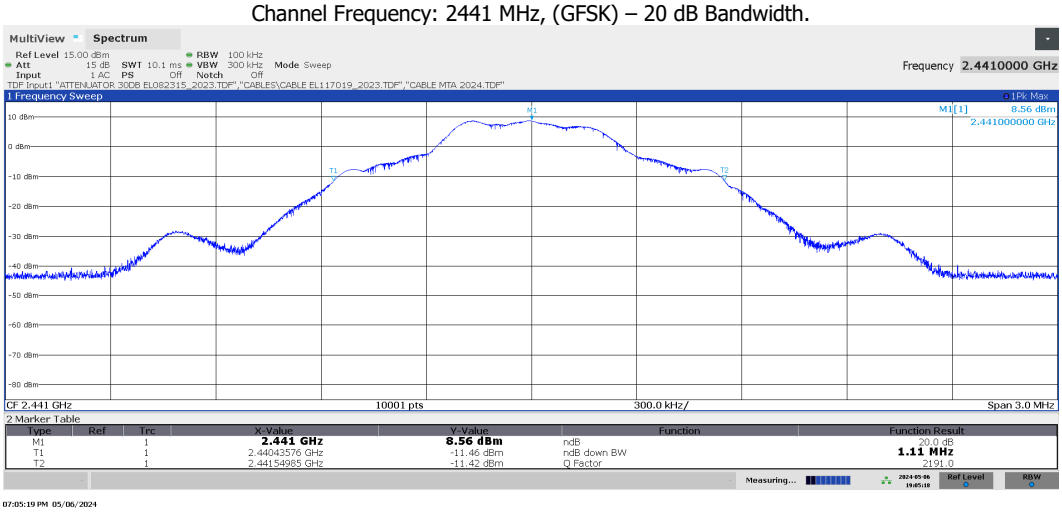
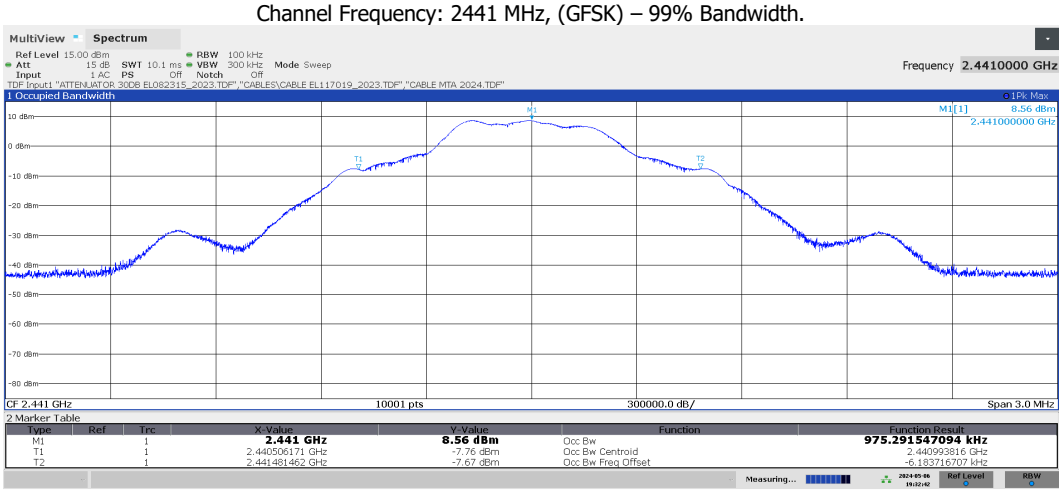
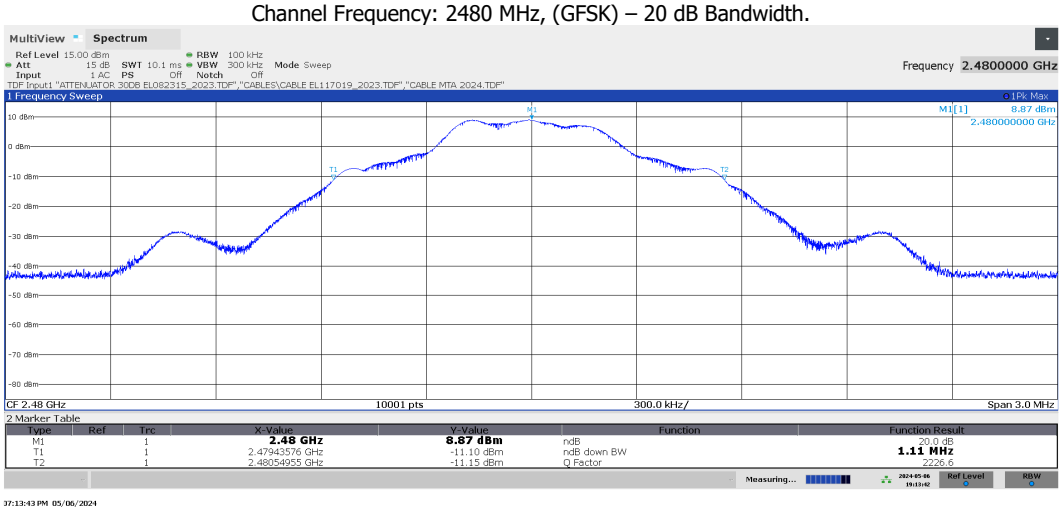
Channel Frequency: 2441 MHz, (GFSK) – 20 dB Bandwidth.



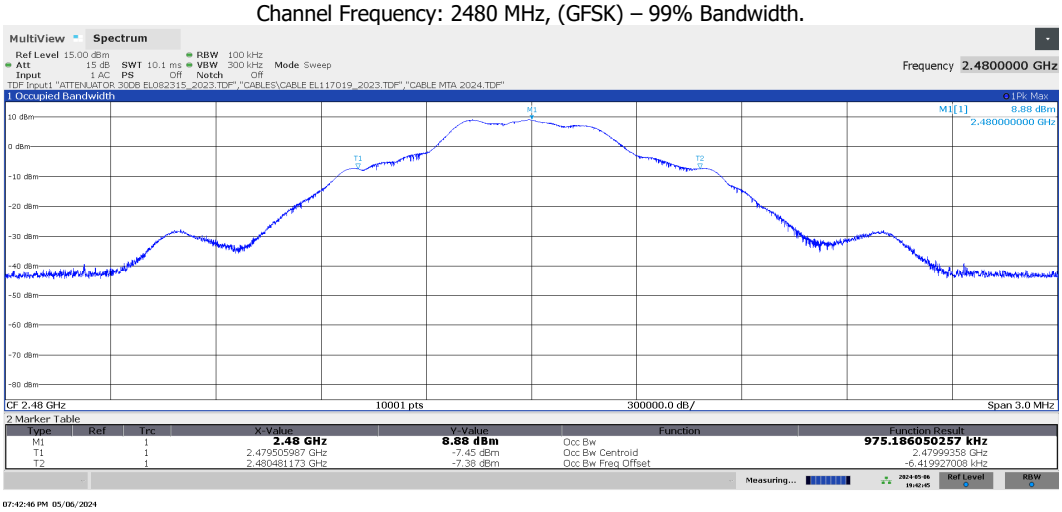
Channel Frequency: 2441 MHz, (GFSK) – 99% Bandwidth.



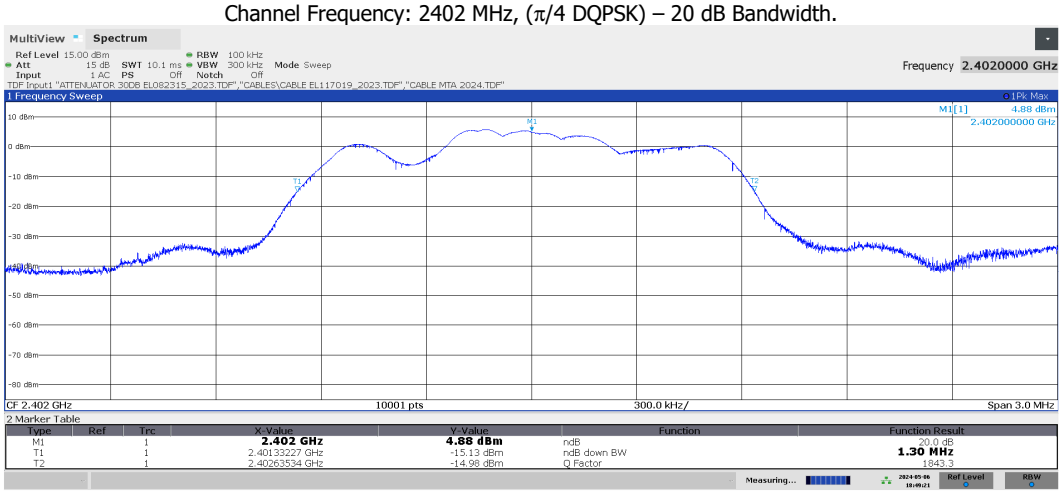
Channel Frequency: 2480 MHz, (GFSK) – 20 dB Bandwidth.



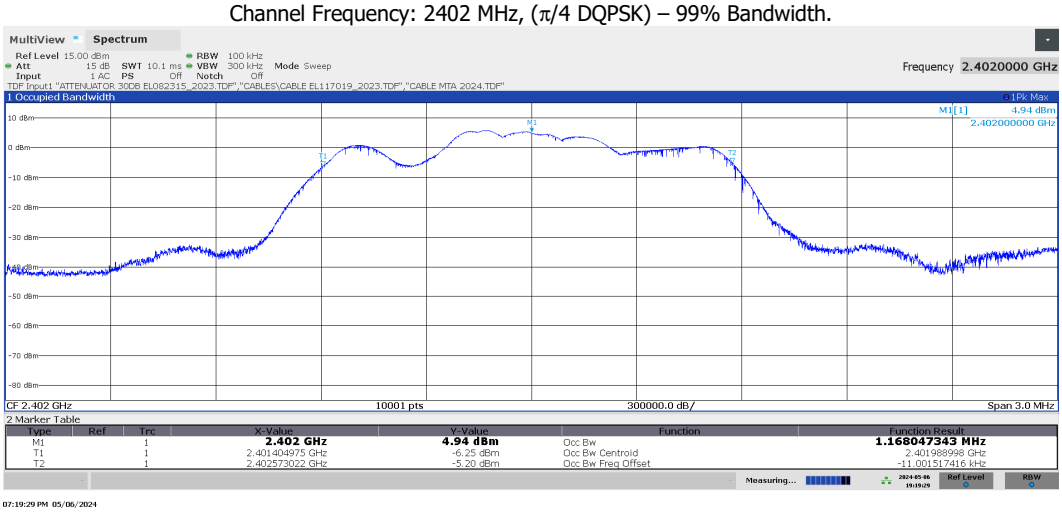
Channel Frequency: 2480 MHz, (GFSK) – 99% Bandwidth.



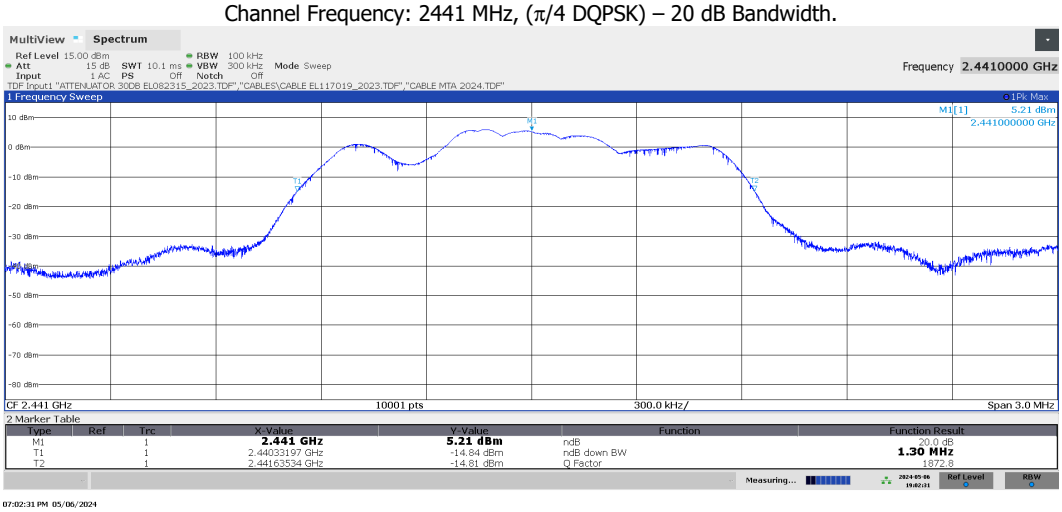
Channel Frequency: 2402 MHz, (π/4 DQPSK) – 20 dB Bandwidth.



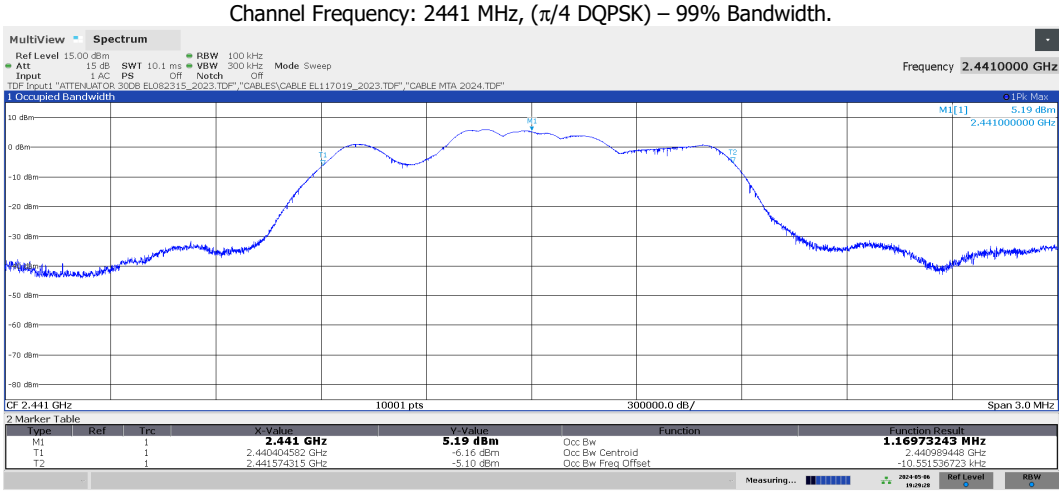
Channel Frequency: 2402 MHz, (π/4 DQPSK) – 99% Bandwidth.



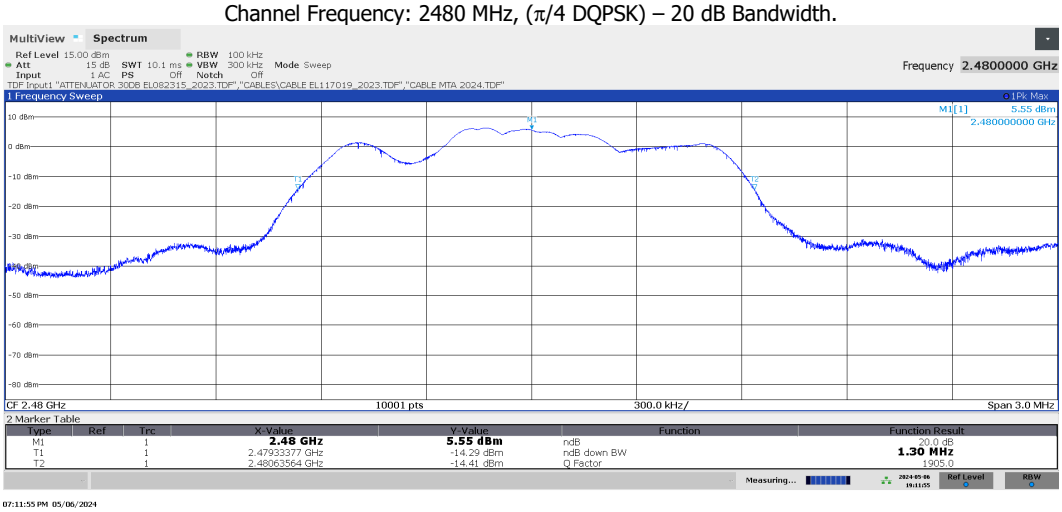
Channel Frequency: 2441 MHz, (π/4 DQPSK) – 20 dB Bandwidth.



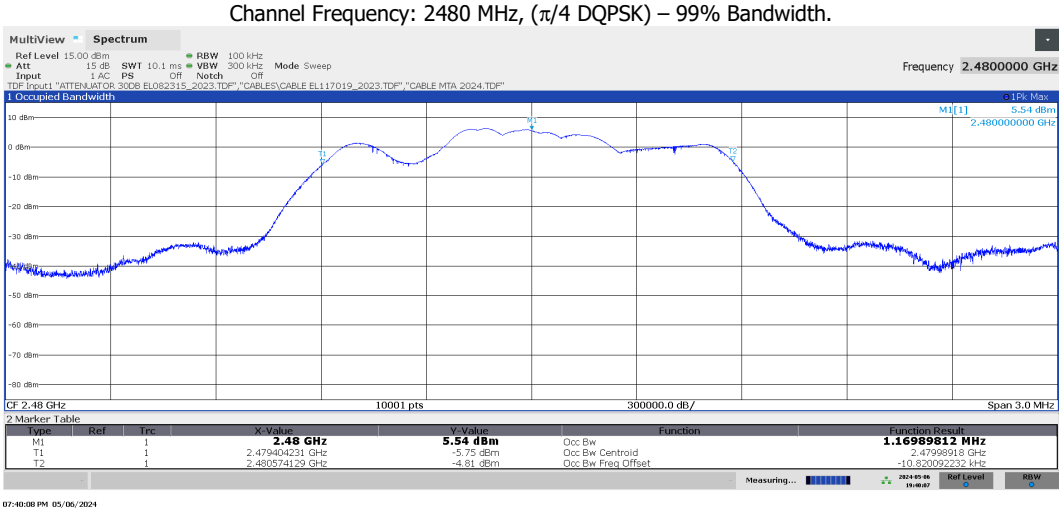
Channel Frequency: 2441 MHz, (π/4 DQPSK) – 99% Bandwidth.



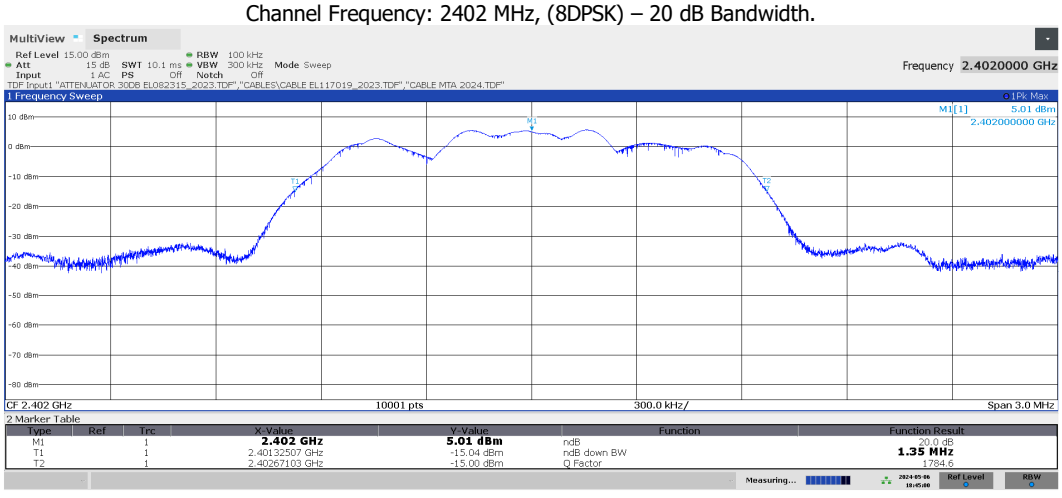
Channel Frequency: 2480 MHz, (π/4 DQPSK) – 20 dB Bandwidth.



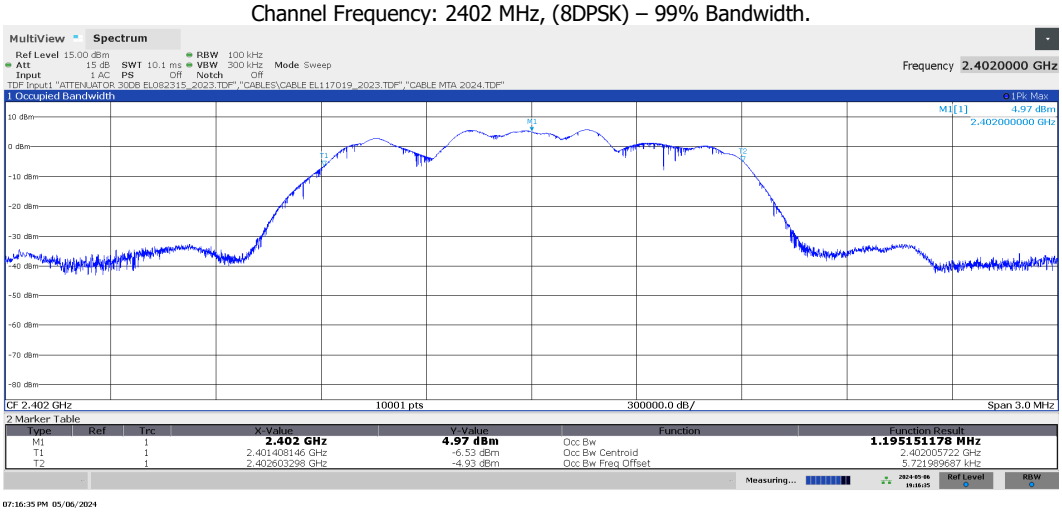
Channel Frequency: 2480 MHz, (π/4 DQPSK) – 99% Bandwidth.



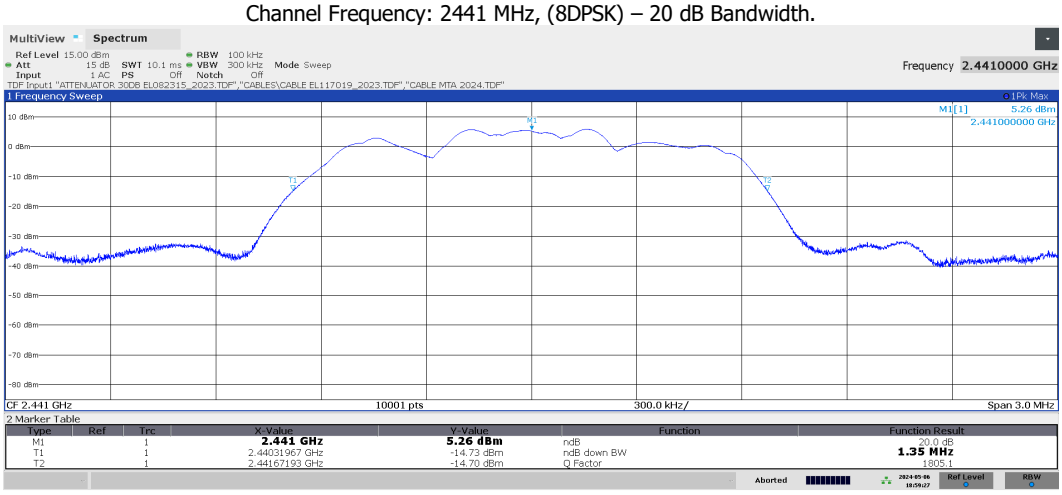
Channel Frequency: 2402 MHz, (8DPSK) – 20 dB Bandwidth.



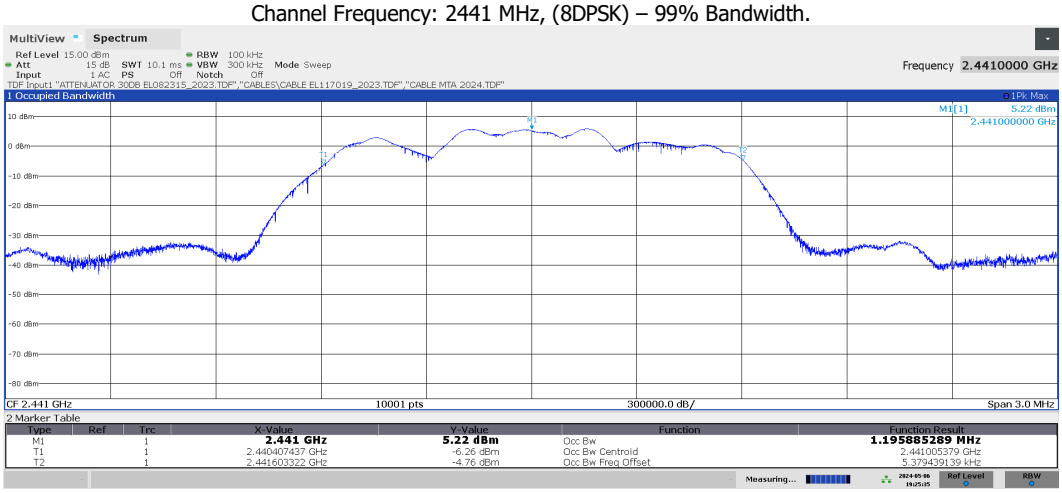
Channel Frequency: 2402 MHz, (8DPSK) – 99% Bandwidth.



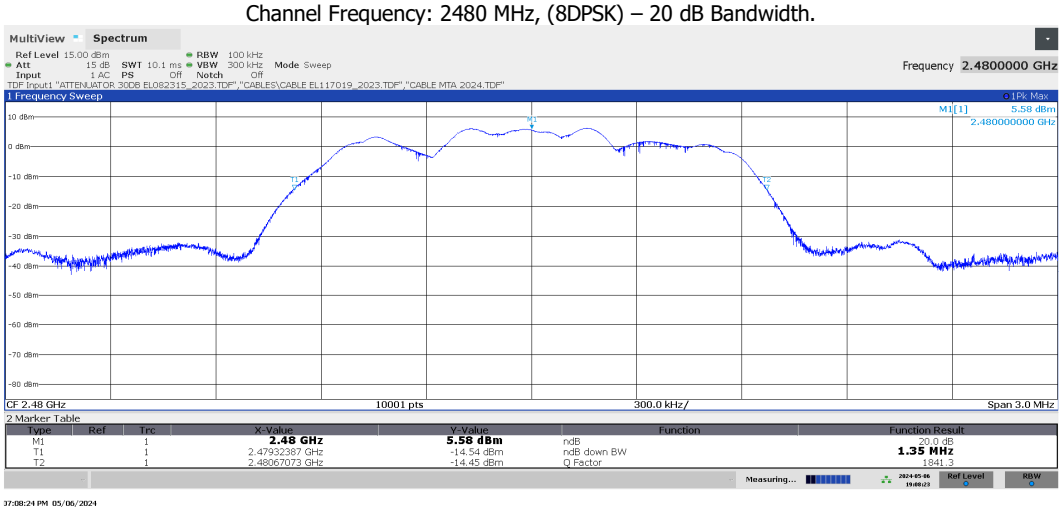
Channel Frequency: 2441 MHz, (8DPSK) – 20 dB Bandwidth.



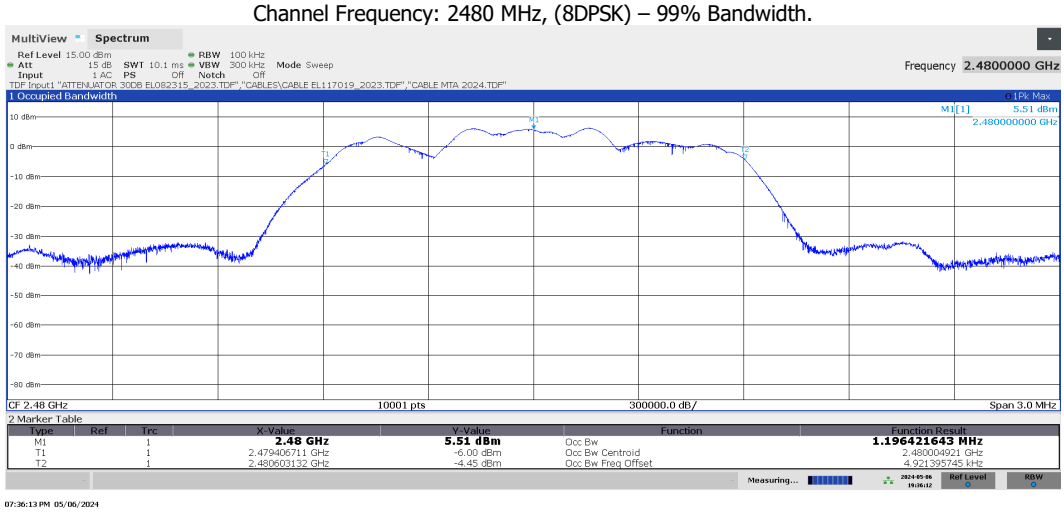
Channel Frequency: 2441 MHz, (8DPSK) – 99% Bandwidth.



Channel Frequency: 2480 MHz, (8DPSK) – 20 dB Bandwidth.



Channel Frequency: 2480 MHz, (8DPSK) – 99% Bandwidth.



5.0 Band-edge Compliance – Test Conditions

Technician	Rudy Valent		
Table No.	TEST: Band-edge, FCC Section 15.247(d)		\
Method	ANSI C63.10: 2013-06, par. 6.10.4		\
Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C	
	Relative Humidity	Less or equal to 80 %	
Parameters recorded during the test	Laboratory Ambient Temperature	22 – 23 °C	
	Relative Humidity	52 – 50 %	
Date (s) of test execution	06/05/2024 – 07/05/2024		

Supplementary information:

- Test performed on EUT 24LA00181/02;
- Conducted Test, executed at Bluetooth antenna output (50ohm, SMA) connected to the Spectrum Analyser through an attenuator (30 dB);
- EUT powered at 14.5 Vdc;
- EUT Operating Mode: Mode 1;
- Spectrum analyser settings setup:
  - Detector: Peak,
  - RBW: 100 kHz and VBW=300 kHz
  - Trace mode: Max Hold (over last 100 sweeps),
- Test executed with the following settings:
  - BR mode with modulation GFSK on channel 0 and 78
  - EDR mode with modulation π/4 DQPSKon channel 0 and 78
  - EDR mode with modulation 8DPSK on channel 0 and 78
  - BR mode with modulation GFSK in Hopping Mode
  - EDR mode with modulation π/4 DQPSK in Hopping Mode
  - EDR mode with modulation 8DPSK in Hopping Mode

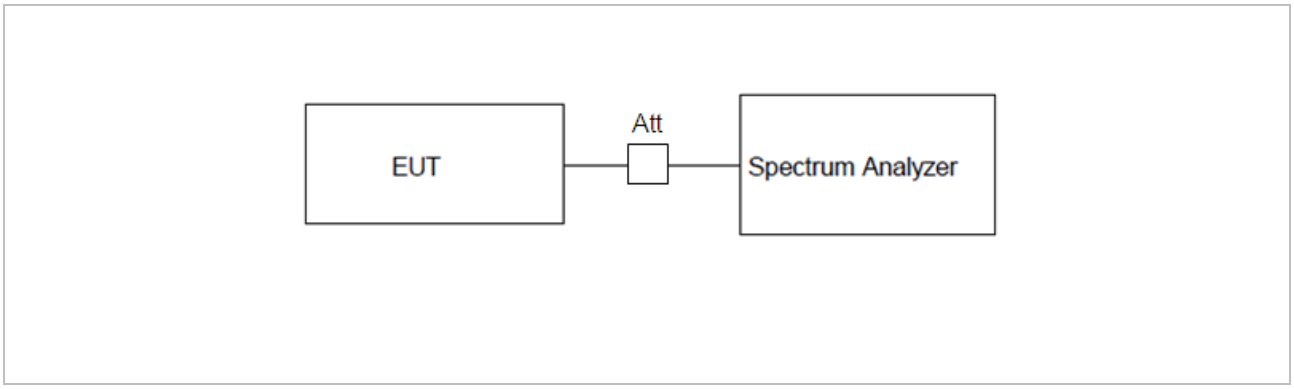
5.1 Test Equipment Used – Band-edge Compliance

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL092016	EMI Receiver	ESW44	Rohde&Schwarz	23-Feb-2024	1 year
EL046111	Dual DC Power Supply	CPX400D	TTi	10-Oct-2023	1 year
EL117019	RF Cable	SLU26-35M35M-01.00M	Timesmicrowave	02-May-2024	1 year
EL082315	Attenuator 30dB	PE7087-30	-	02-May-2024	1 year
EL109018	DataLogger T/UR	HL-1D	Rotronic	29-May-2023	1 year
EL089216	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL089316	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL075814	LIN Optical converter	090	EMC TOOLS	NA	
EL075914	LIN Optical converter	090	EMC TOOLS	NA	

5.2 Auxiliary Equipment – Band-edge Compliance

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL119519	Signal Generator	MG3693A	Anritsu	06-Oct-2023	1 year

5.3 Setup – Band-edge Compliance



5.4 Requirements – Band-edge Compliance

FCC Section 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)).

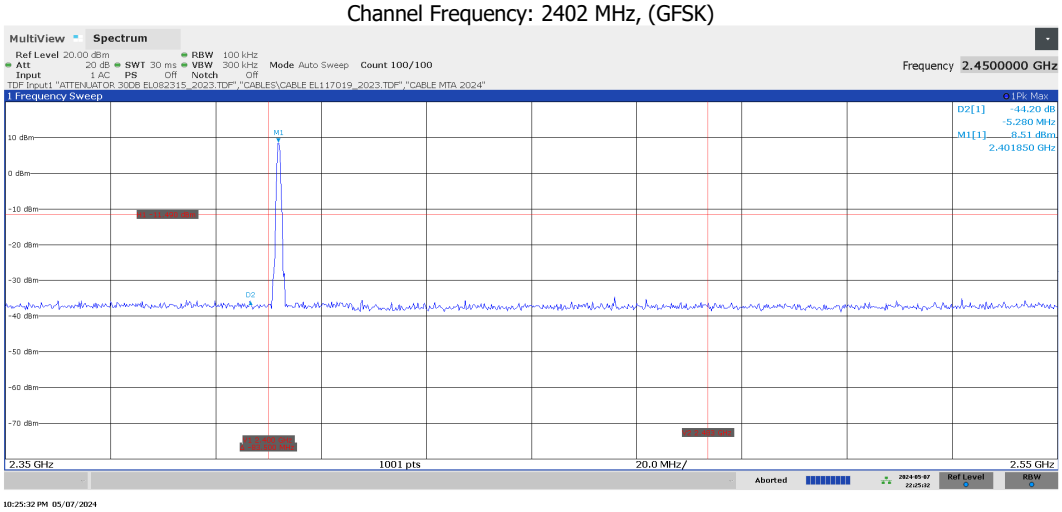
5.5 Results – Band-edge Compliance

The amplitude of spurious emissions is lower than 20 dBc, thus the result of the test is: **PASS**.
See the details in the charts/tables of the following paragraphs (see the worst case in bold text).

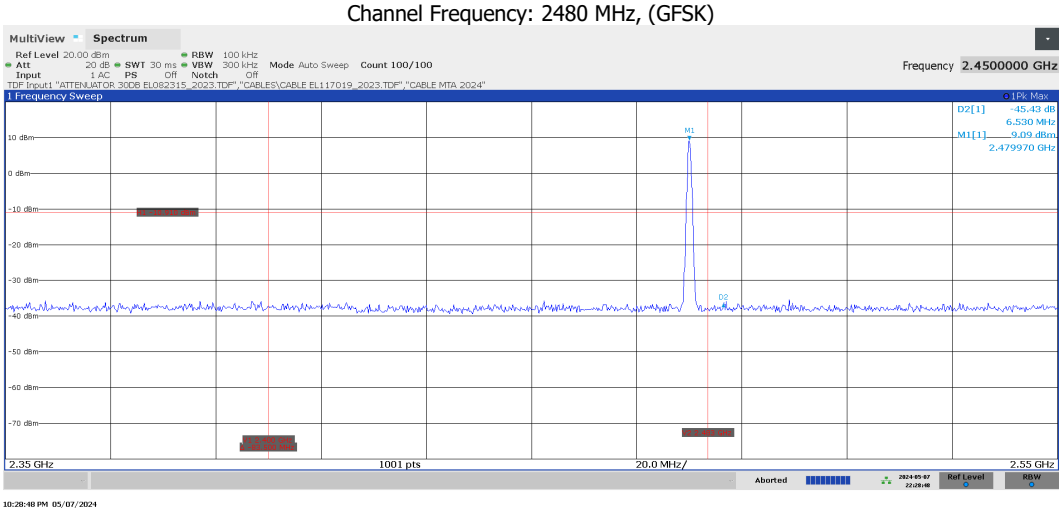
Hopping OFF

Modulation mode	Max Signal Frequency (MHz)	Max Signal (dBm)	Frequency of Max OOB signal (MHz)	Difference (dBc)	Limit (dBc)
GFSK	2401.9	8.5	2396.6	44.2	20.0
	2480.0	9.1	2486.5	45.4	20.0
π/4 DQPSK	2401.9	5.5	2399.8	42.0	20.0
	2479.8	6.4	2485.7	43.4	20.0
8DPSK	2401.9	5.5	2398.7	41.6	20.0
	2479.8	5.6	2485.1	42.13	20.0

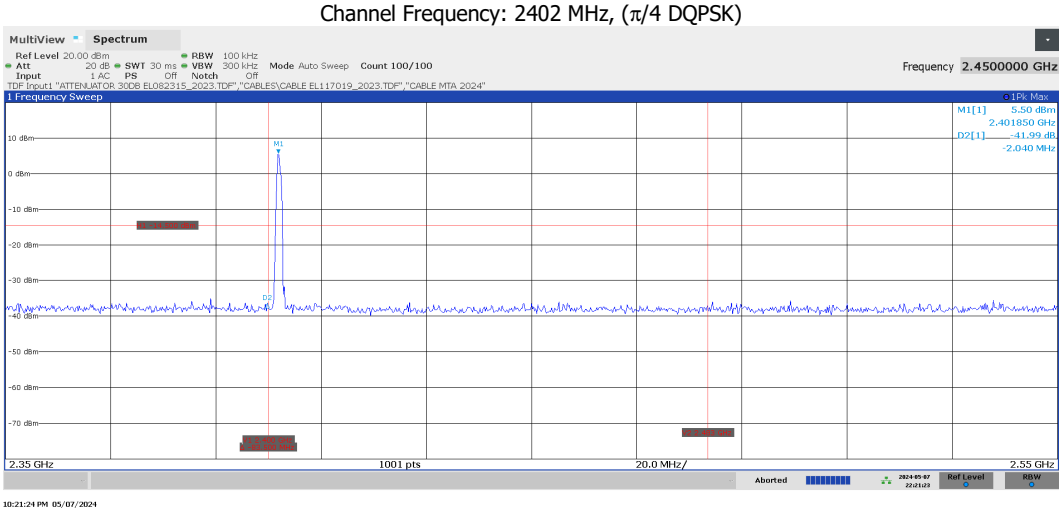
Channel Frequency: 2402 MHz, (GFSK)



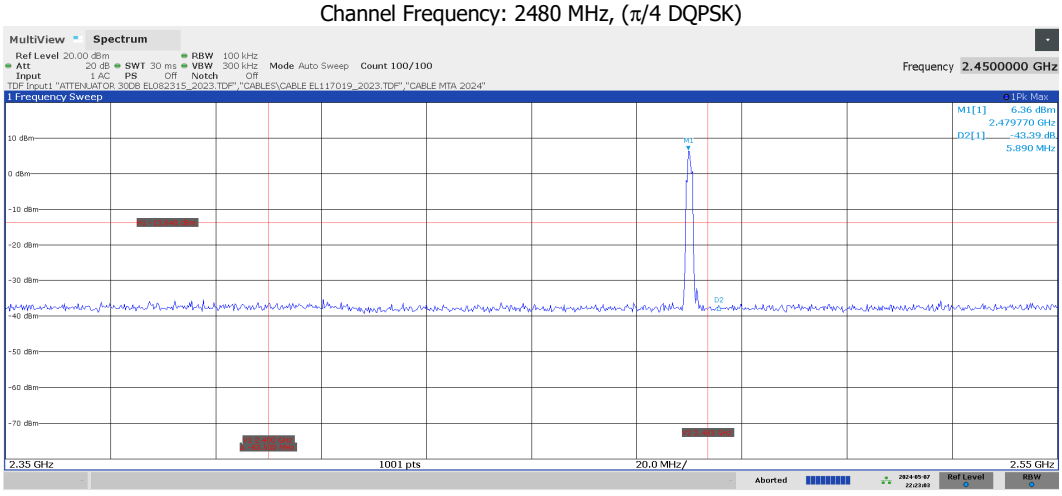
Channel Frequency: 2480 MHz, (GFSK)



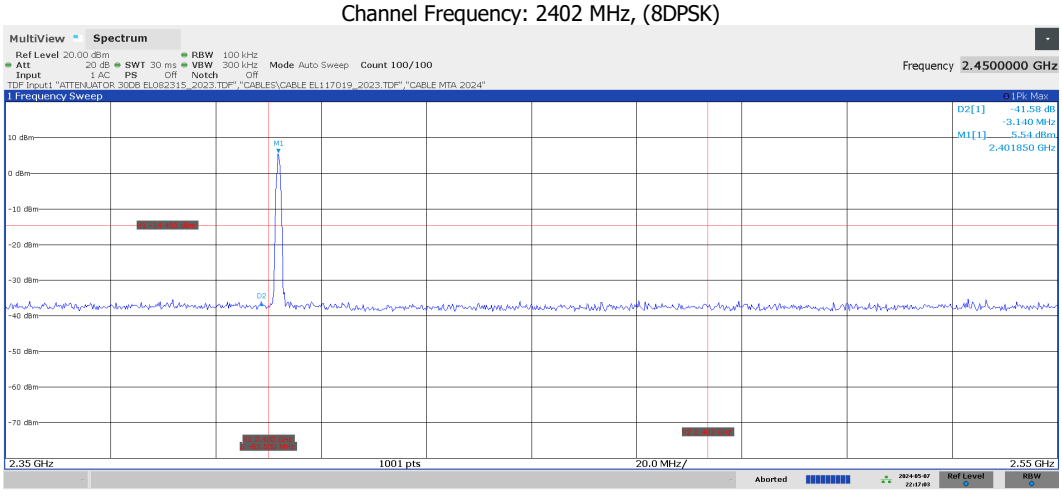
Channel Frequency: 2402 MHz, (π/4 DQPSK)



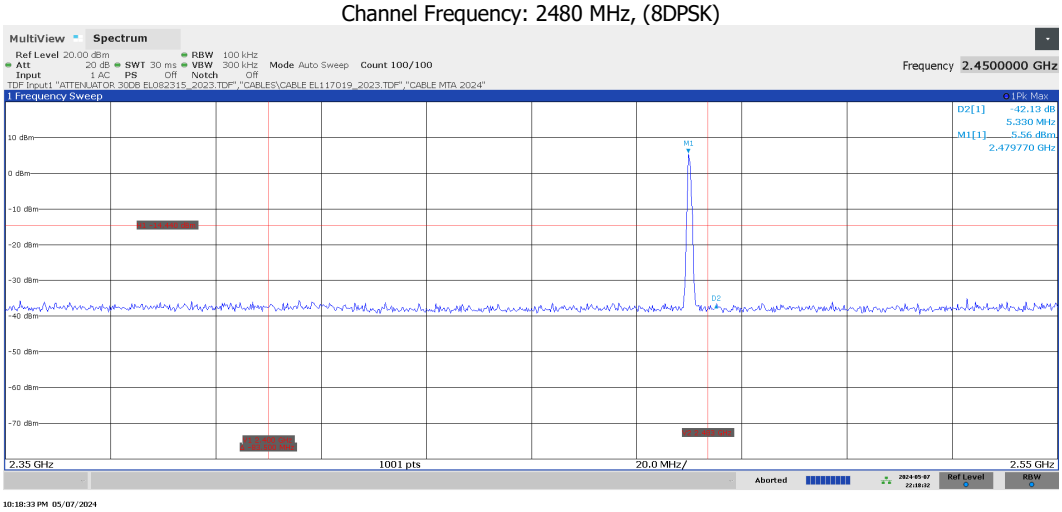
Channel Frequency: 2480 MHz, (π/4 DQPSK)



Channel Frequency: 2402 MHz, (8DPSK)



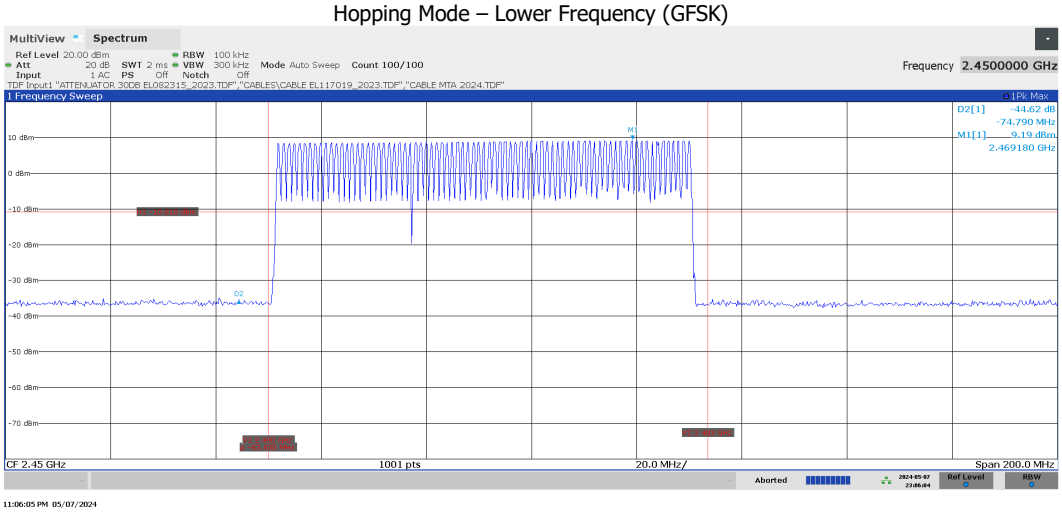
Channel Frequency: 2480 MHz, (8DPSK)



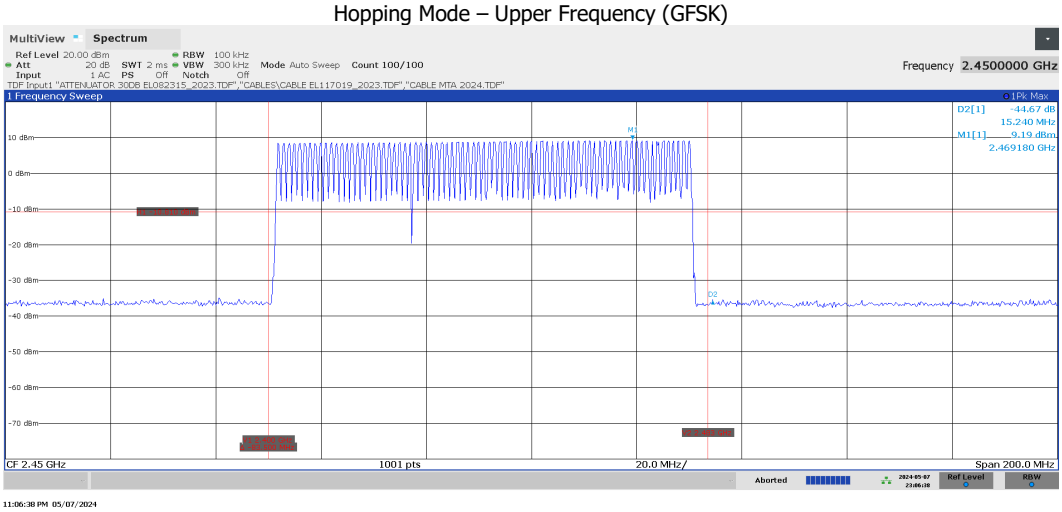
Hopping ON

Modulation mode	Max Signal Frequency (MHz)	Max Signal (dBm)	Frequency of Max OOB signal (MHz)	Difference (dBc)	Limit (dBc)
GFSK	2469.2	9.2	2394.4	44.6	20.0
			2484.4	44.7	20.0
π/4 DQPSK	2468.8	6.4	2395.9	43.7	20.0
			2518.3	41.4	20.0
8DPSK	2477.2	6.2	2384.7	40.6	20.0
			2486.8	42.5	20.0

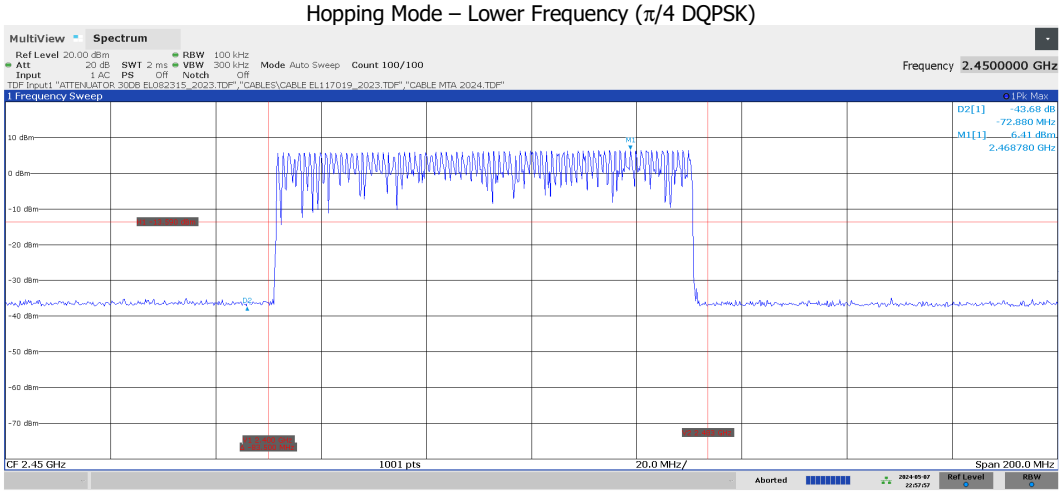
Hopping Mode – Lower Frequency (GFSK)



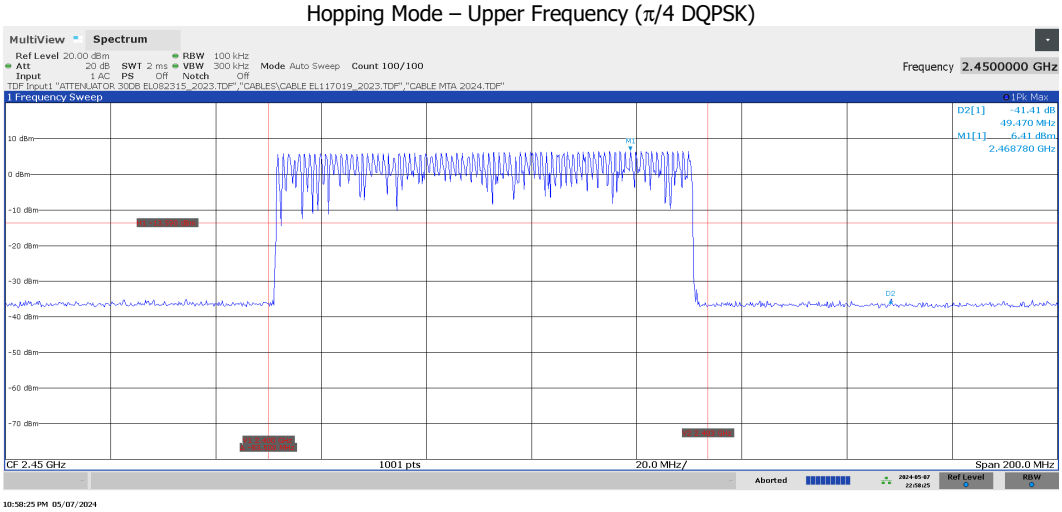
Hopping Mode – Upper Frequency (GFSK)



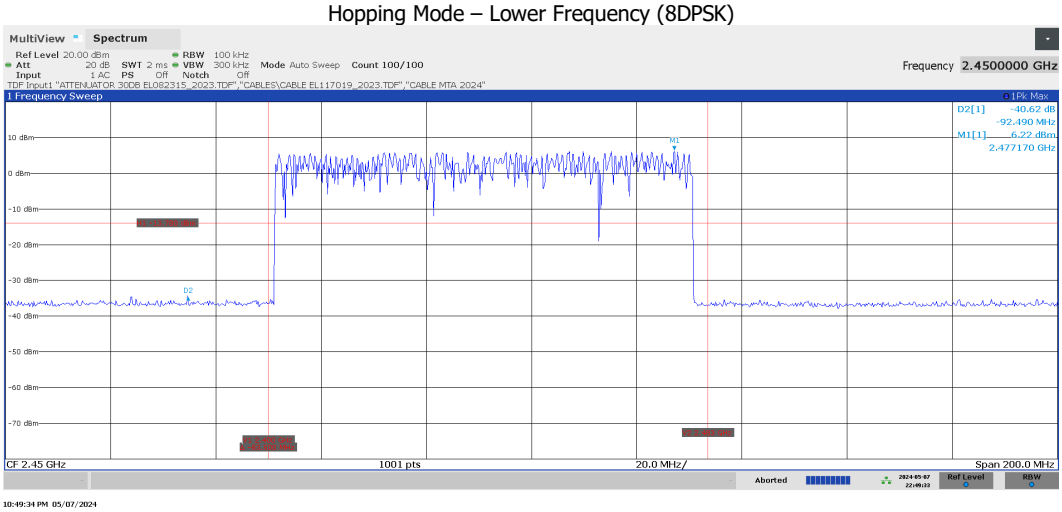
Hopping Mode – Lower Frequency (π/4 DQPSK)



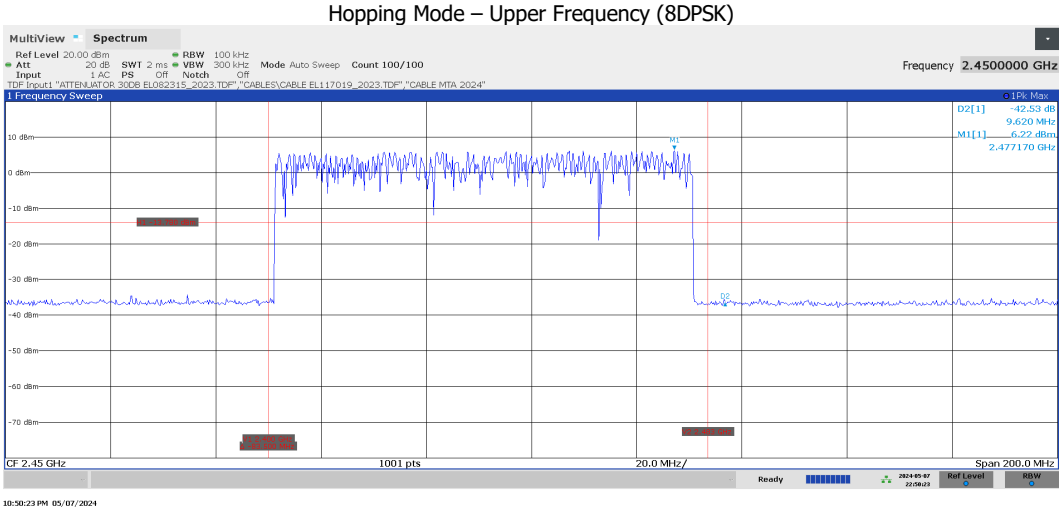
Hopping Mode – Upper Frequency (π/4 DQPSK)



Hopping Mode – Lower Frequency (8DPSK)



Hopping Mode – Upper Frequency (8DPSK)



6.0 Hopping Verifications – Test Conditions

Technician	Rudy Valent	
Table No.	TEST: Number of Hopping Frequency and Dwell Time, FCC Section 15.247 (a)(1)(iii) Frequency Separation, FCC Section 15.247 (a)(1)	\
Method	ANSI C63.10: 2013-06, par. 7.8.2, 7.8.3 and 7.8.4	\

Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C
	Relative Humidity	Less or equal to 80 %
Parameters recorded during the test	Laboratory Ambient Temperature	23 – 24 °C
	Relative Humidity	45 – 50 %
Date (s) of test execution	08/05/2024 – 09/05/2024	

Supplementary information:

- Test performed on EUT 24LA00181/02;
- Conducted Test, executed at Bluetooth antenna output (50ohm, SMA) connected to the Spectrum Analyser through an attenuator (30 dB);
- EUT powered at 14.5 Vdc;
- EUT Operating Mode: Mode 1;
- Spectrum analyser settings setup:
  - Detector: Peak
  - RBW: 100 kHz and VBW=300 kHz
  - Trace mode: Max Hold (over 100 sweeps)
- Test executed with the following settings:
  - BR mode with modulation GFSK, Hopping with DH1, DH3 and DH5 packet types;
  - EDR mode with modulation π/4 DQPSK, Hopping with DH1, DH3 and DH5 packet types;
  - EDR mode with modulation 8DPSK, Hopping with DH1, DH3 and DH5 packet types;

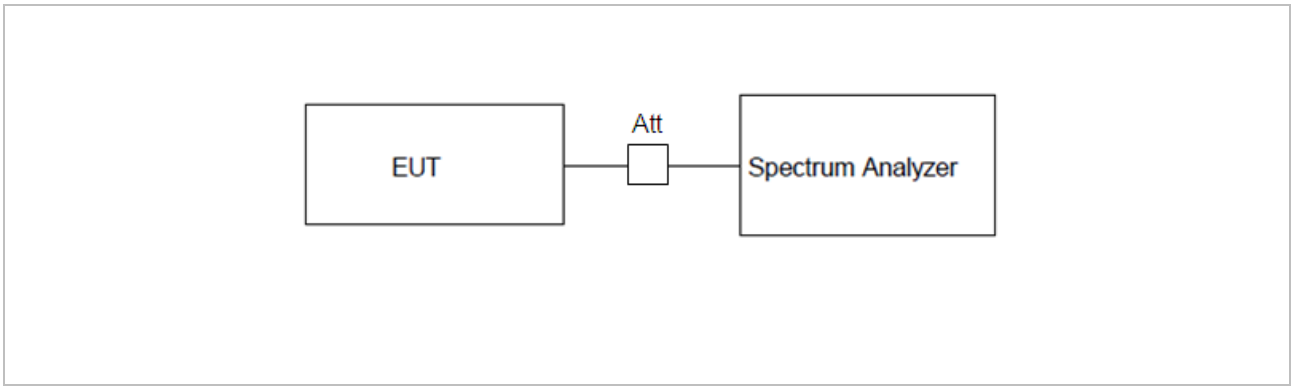
6.1 Test Equipment Used – Hopping Verifications

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL092016	EMI Receiver	ESW44	Rohde&Schwarz	23-Feb-2024	1 year
EL046111	Dual DC Power Supply	CPX400D	TTi	10-Oct-2023	1 year
EL117019	RF Cable	SLU26-35M35M-01.00M	Timesmicrowave	02-May-2024	1 year
EL119019	RF Cable	SKBL-2M-LOW	Mini-Circuits	07-Nov-2023	1 year
EL082315	Attenuator 30dB	PE7087-30	-	02-May-2024	1 year
EL109018	DataLogger T/UR	HL-1D	Rotronic	29-May-2023	1 year
EL089216	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL089316	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL075814	LIN Optical converter	090	EMC TOOLS	NA	
EL075914	LIN Optical converter	090	EMC TOOLS	NA	

6.2 Auxiliary Equipment – Hopping Verifications

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL119519	Signal Generator	MG3693A	Anritsu	06-Oct-2023	1 year

6.3 Setup – Hopping Verifications



6.4 Requirements – Hopping Verifications

FCC Section 15.247

(a) Operation under the provisions of this Section is limited to frequency hopping and digitally modulated intentional radiators that comply with the following provisions:
(1) Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW. The system shall hop to channel frequencies that are selected at the system hopping rate from a pseudo randomly ordered list of hopping frequencies. Each frequency must be used equally on the average by each transmitter. The system receivers shall have input bandwidths that match the hopping channel bandwidths of their corresponding transmitters and shall shift frequencies in synchronization with the transmitted signals.
(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

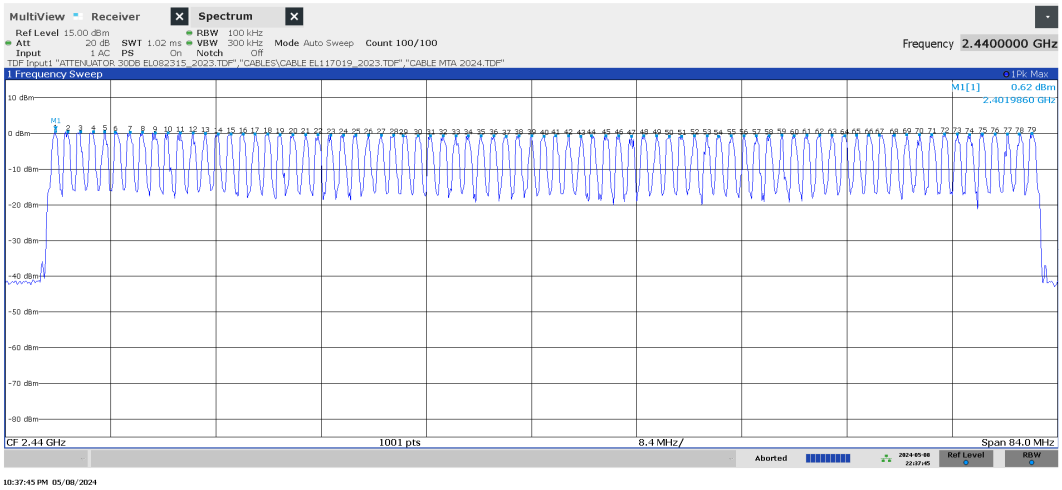
6.5 Results – Hopping Verifications

6.5.1 Number of Hopping Channels – Hopping Verifications

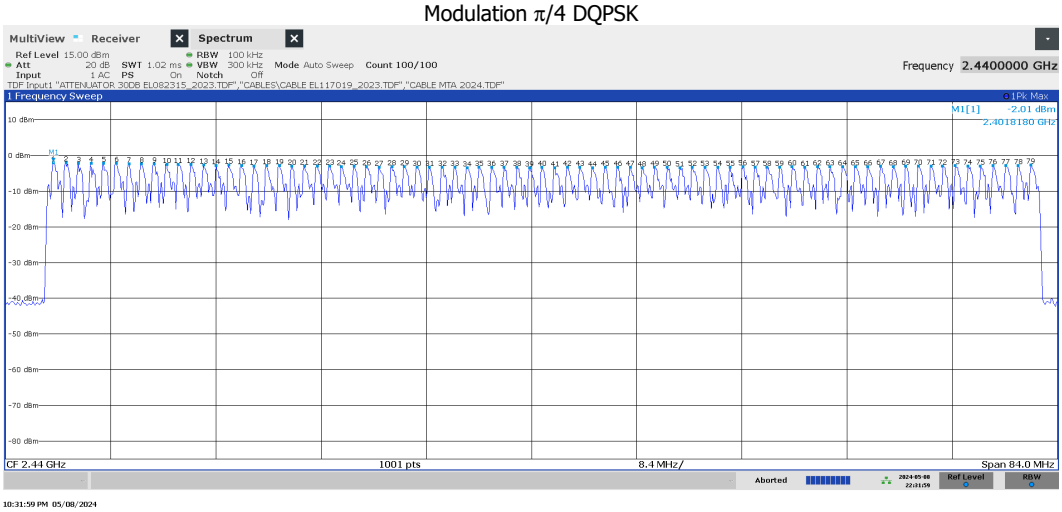
Section 15.247 (a)(1)(iii) Frequency hopping systems in the 2400 - 2483.5 MHz band shall use at least 15 channels.
The result of the test is: **PASS**.
See the details in the charts/tables of the following paragraphs (see the worst case in bold text).

Modulation mode	Number of channels	Limit
GFSK	79	≥ 15
π/4 DQPSK	79	≥ 15
8DPSK	79	≥ 15

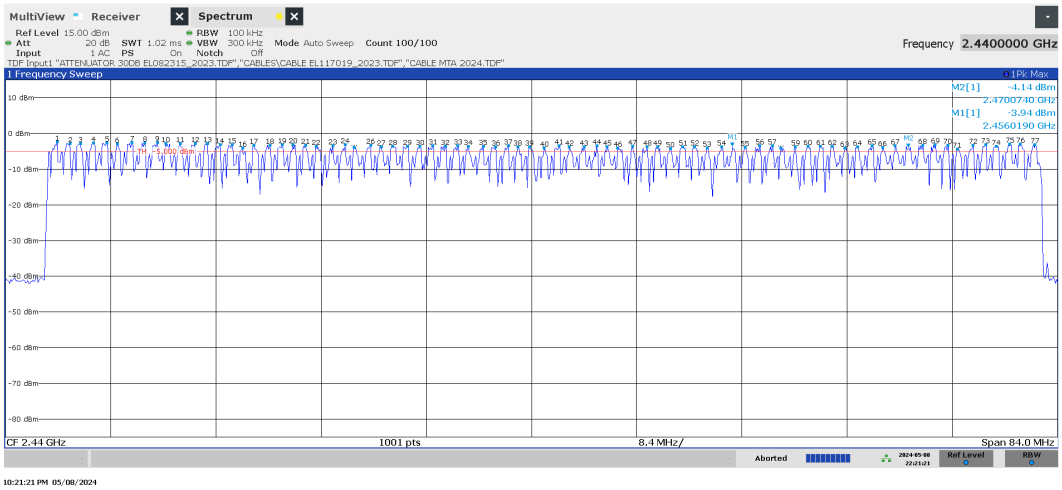
Modulation GFSK



Modulation π/4 DQPSK



Modulation 8DPSK



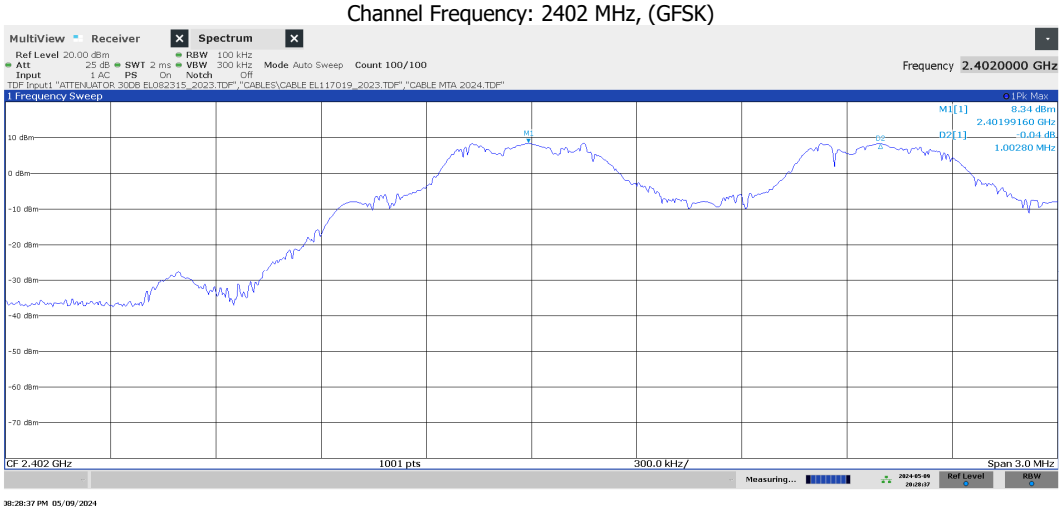
6.5.2 Channels Separation – Hopping Verifications

Section 15.247 (a) (1) Frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW.
The result of the test is: **PASS**.
See the details in the charts/tables of the following paragraphs (see the worst case in bold text).

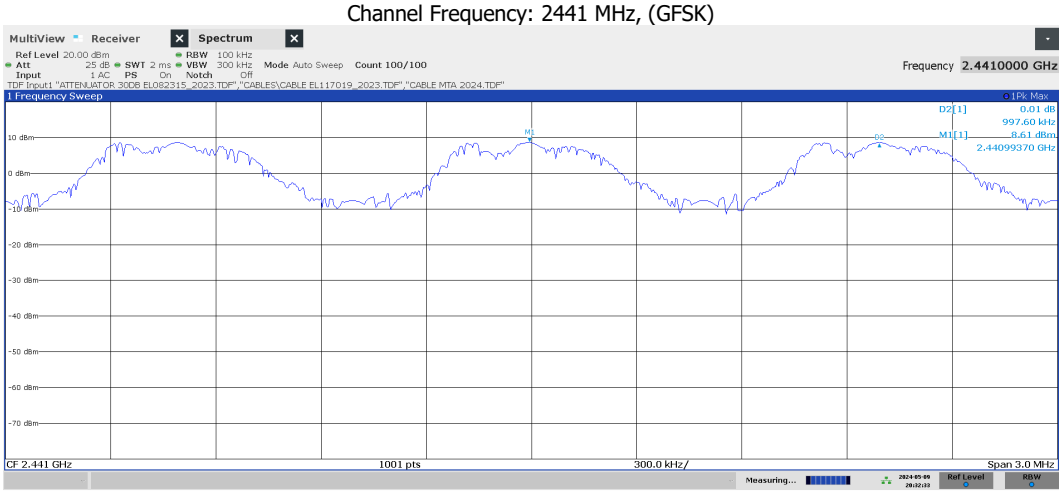
Modulation mode	Channel Frequency (MHz)	Measured Channel Separation (kHz)	Measured 20 dB Bandwidth (MHz)	Applicable Minimum Limit (kHz)
GFSK	2402.0	1002.8	1.1	370.0
	2441.0	997.6	1.1	370.0
	2480.0	998.9	1.1	370.0
π/4 DQPSK	2402.0	996.3	1.3	433.3
	2441.0	1015.6	1.3	433.3
	2480.0	1007.9	1.3	433.3
8DPSK	2402.0	999.3	1.4	450.0
	2441.0	1002.3	1.4	450.0
	2480.0	1012.4	1.4	450.0

(*) Measures were collected at paragraph 4.4.1

Channel Frequency: 2402 MHz, (GFSK)

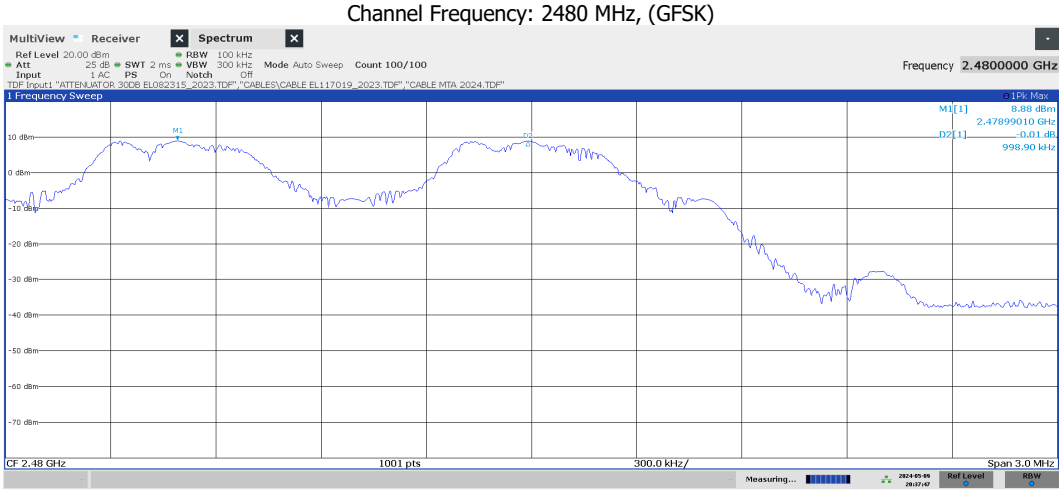


Channel Frequency: 2441 MHz, (GFSK)



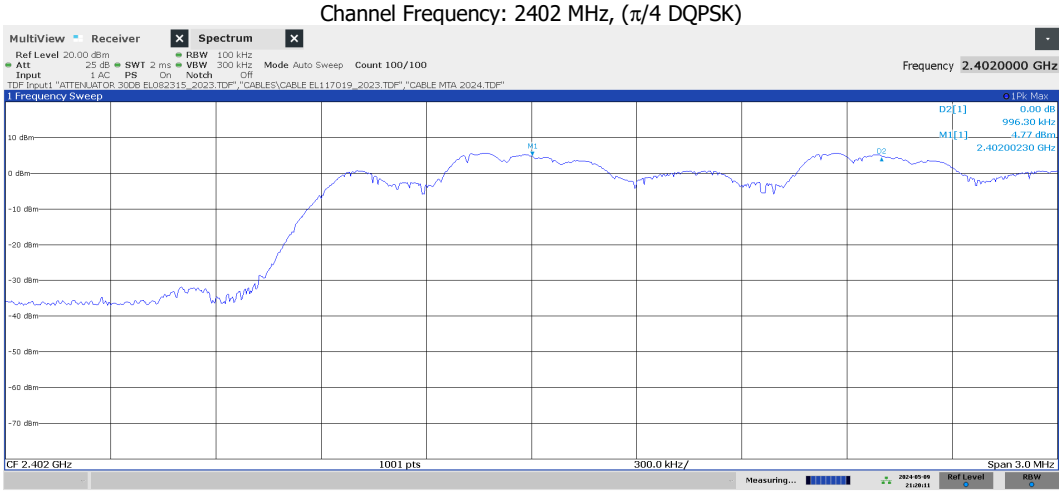
08:32:34 PM 05/09/2024

Channel Frequency: 2480 MHz, (GFSK)



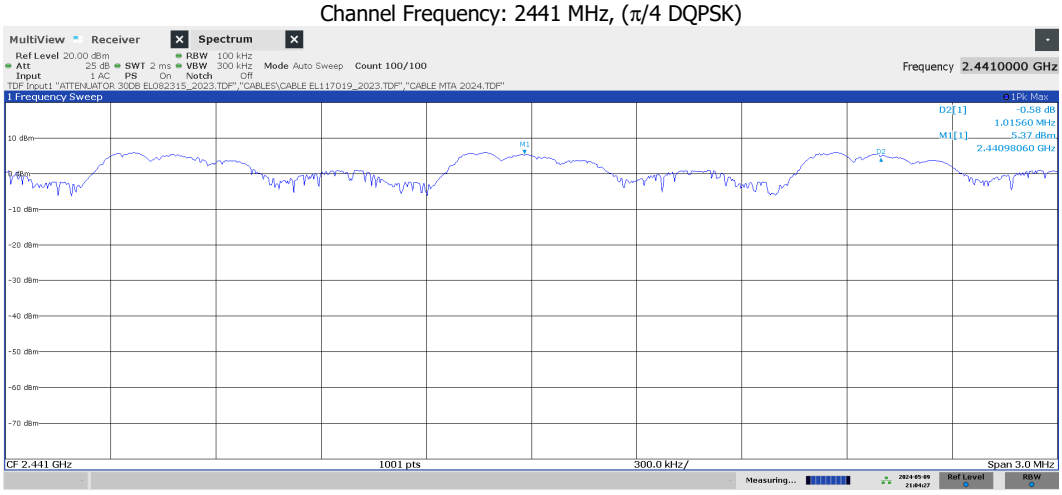
08:37:48 PM 05/09/2024

Channel Frequency: 2402 MHz, (π/4 DQPSK)



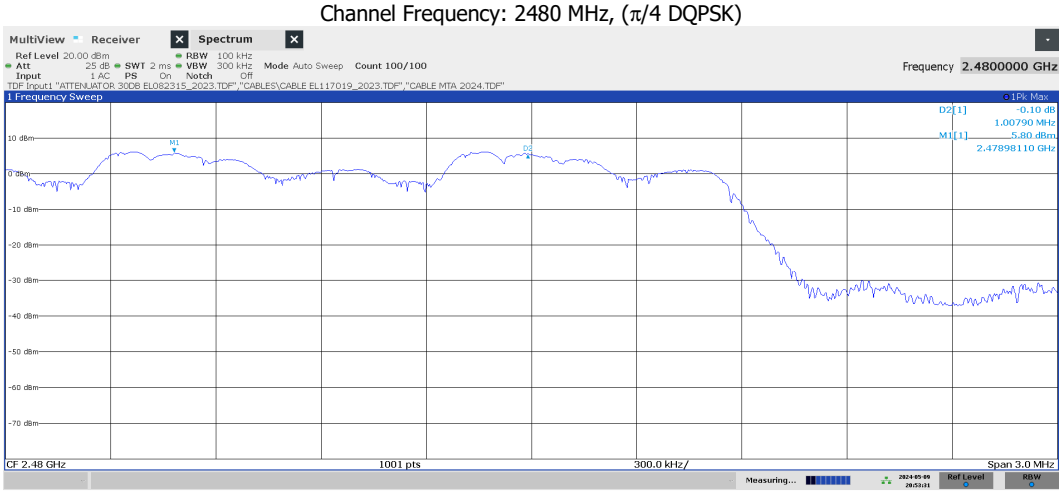
09:20:12 PM 05/09/2024

Channel Frequency: 2441 MHz, (π/4 DQPSK)



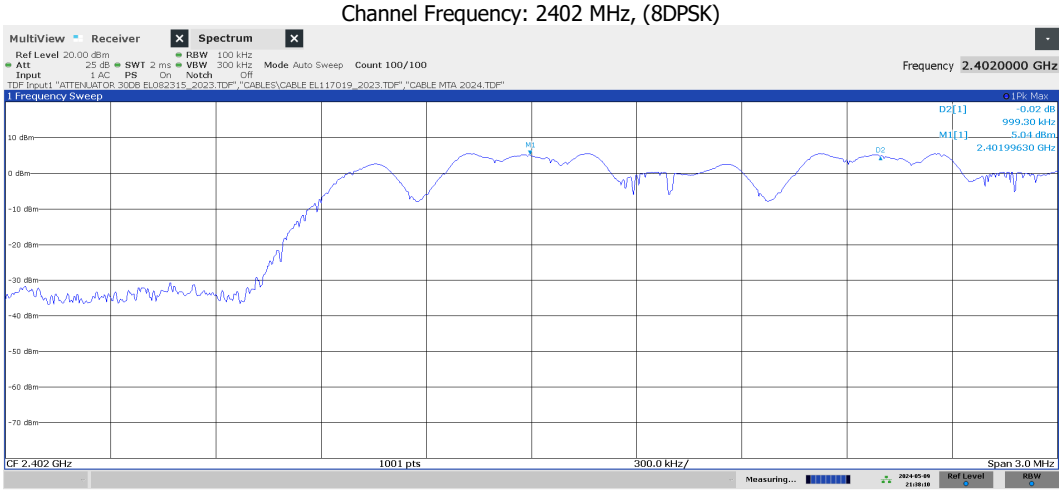
09:04:28 PM 05/09/2024

Channel Frequency: 2480 MHz, (π/4 DQPSK)



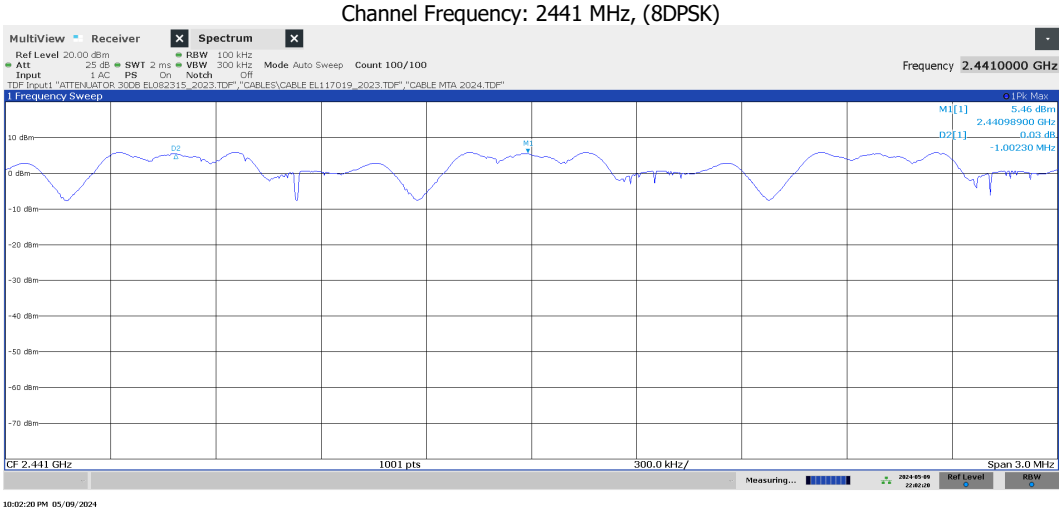
08:53:31 PM 05/09/2024

Channel Frequency: 2402 MHz, (8DPSK)



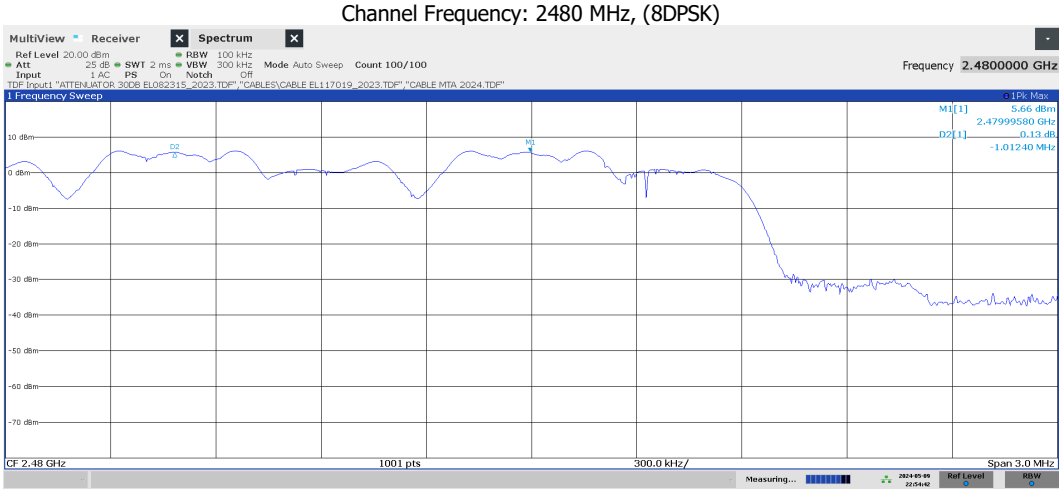
09:38:11 PM 05/09/2024

Channel Frequency: 2441 MHz, (8DPSK)



10:02:20 PM 05/09/2024

Channel Frequency: 2480 MHz, (8DPSK)



10:54:43 PM 05/09/2024

6.5.3 Dwell Time – Hopping Verifications

Section 15.247 (a)(1)(iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed.
The result of the test is: **PASS**.
See the details in the charts/tables of the following paragraphs (see the worst case in bold text).

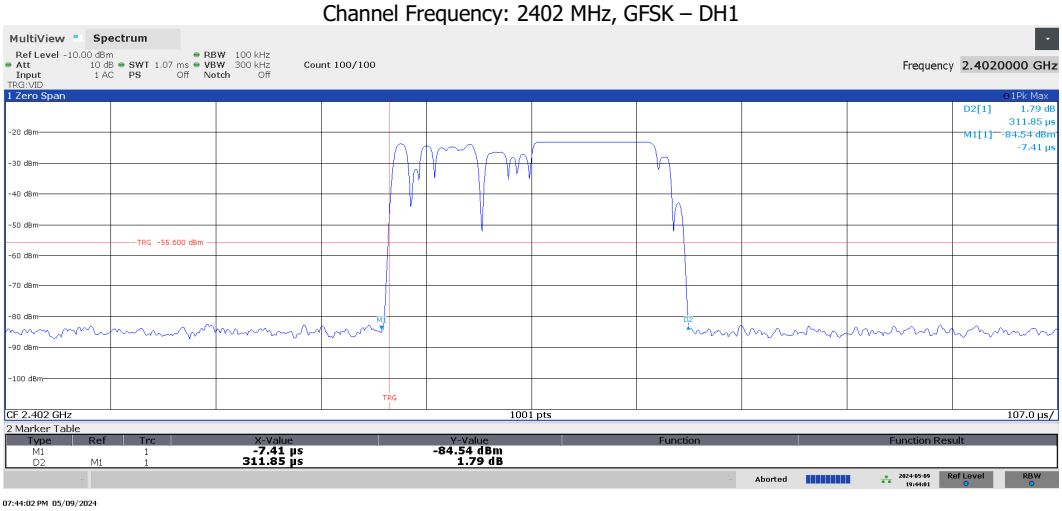
Modulation mode	Channel Frequency (MHz)	[LTT] Lenght of Transmission Time (us)	[N] Number of Transmissions in a 31.6s interval (*) (79Hopp Ch*0.4)	[LTT x N] Occupancy Time (ms)	Occupancy Time Limit (ms)
GFSK – DH1	2402.0	311.9	320.0	99.8	400
GFSK – DH3	2402.0	319.7	160.0	51.2	400
GFSK – DH5	2402.0	320.4	106.6	34.2	400
π/4 DQPSK – DH1	2402.0	254.6	320.0	81.5	400
π/4 DQPSK – DH3	2402.0	254.6	160.0	40.7	400
π/4 DQPSK – DH5	2402.0	254.0	106.6	27.1	400
8DPSK – DH1	2402.0	228.2	320.0	73.0	400
8DPSK – DH3	2402.0	228.5	160.0	36.6	400
8DPSK – DH5	2402.0	228.5	106.6	24.4	400

The DH1 packet can cover a single time slot. A maximum length packet has duration of 1 time slot. The hopping rate is 1600 hops/second so the maximum dwell time is 1/1600 seconds, or 0.625ms. DH1 Packet permit maximum 1600/79/2=10.12 hops per second in each channel (1 time slot Tx, 1 time slot Rx). So, the dwell time is the time duration of the pulse time 10.12x31.6=320 within 31.6 seconds.

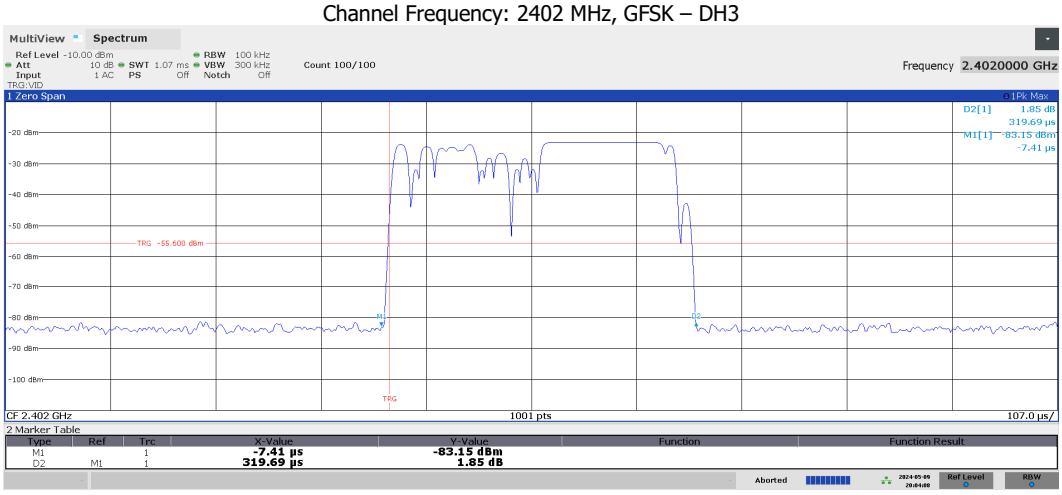
The DH3 packet can cover up to 3 time slots. A maximum length packet has duration of 3 time slot. The hopping rate is 1600 hops/second so the maximum dwell time is 3/1600 seconds, or 1.875ms. DH3 Packet permit maximum 1600/79/4=5.06 hops per second in each channel (3 time slot Tx, 1 time slot Rx). So, the dwell time is the time duration of the pulse time 5.06x31.6=160 within 31.6 seconds.

The DH5 packet can cover up to 5 time slots. Operate DH5 at maximum dwell time and maximum duty cycle. A maximum length packet has duration of 5 time slot. The hopping rate is 1600 hops/second so the maximum dwell time is 5/1600 seconds, or 3.125ms. DH5 Packet permit maximum 1600/79/6=3.37 hops per second in each channel (5 time slot Tx, 1 time slot Rx). So, the dwell time is the time duration of the pulse time 3.37x31.6=106.6 within 31.6 seconds.

Channel Frequency: 2402 MHz, GFSK – DH1



Channel Frequency: 2402 MHz, GFSK – DH3



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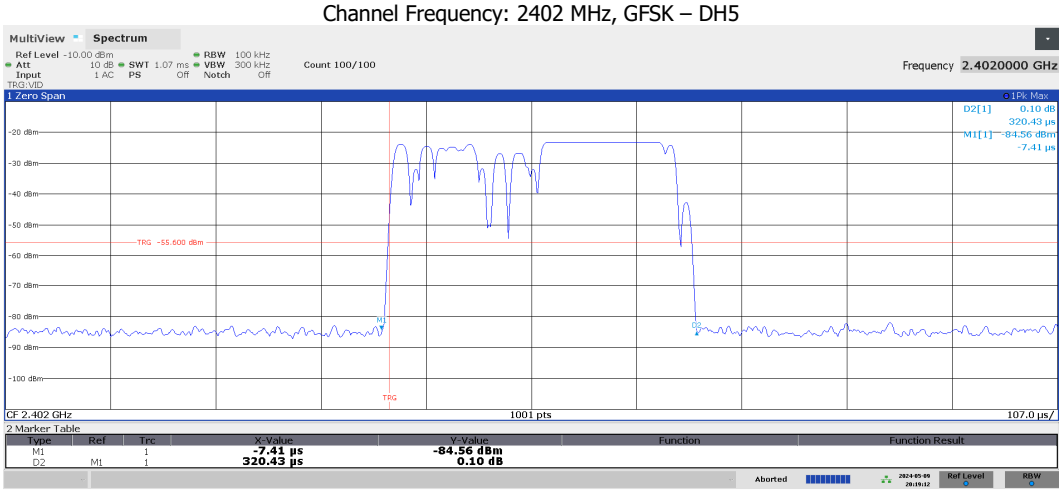
Channel Frequency: 2402 MHz, GFSK – DH5



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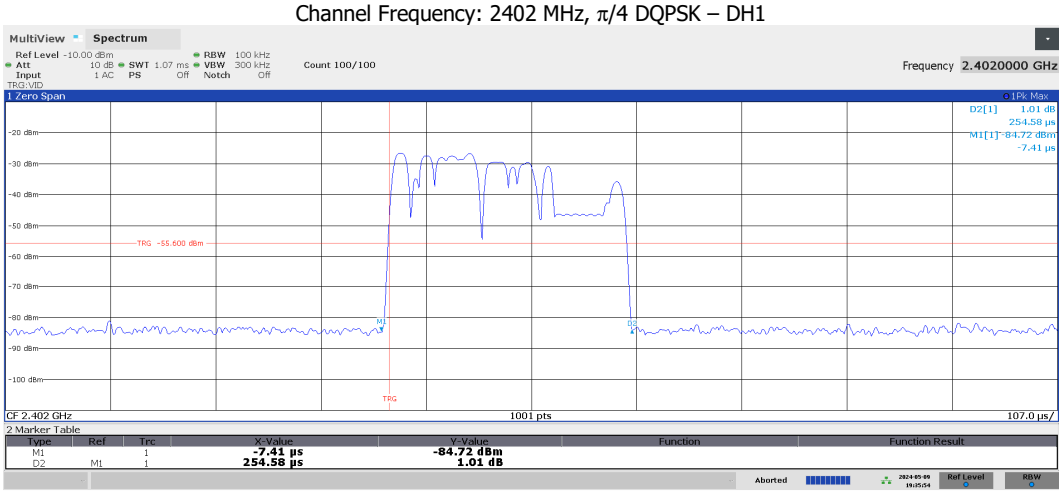
Channel Frequency: 2402 MHz, π/4 DQPSK – DH1



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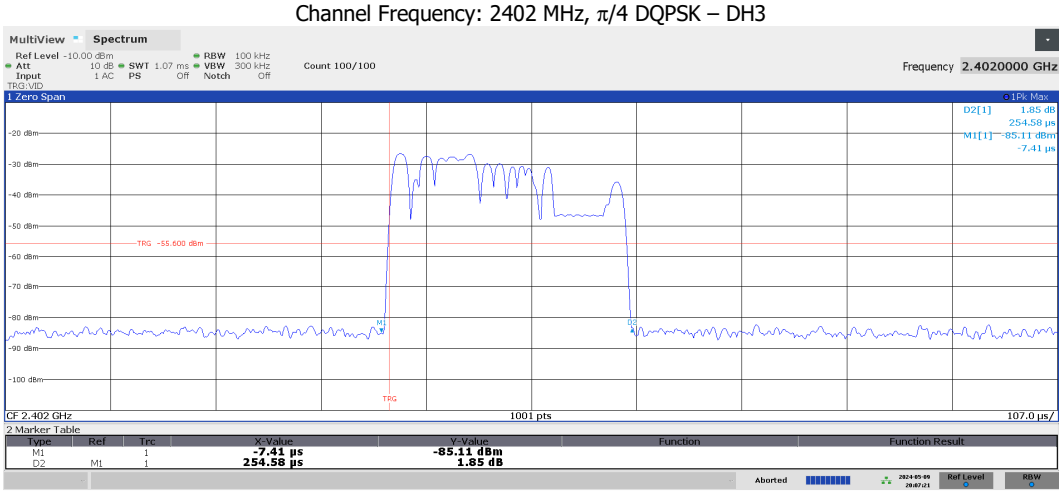
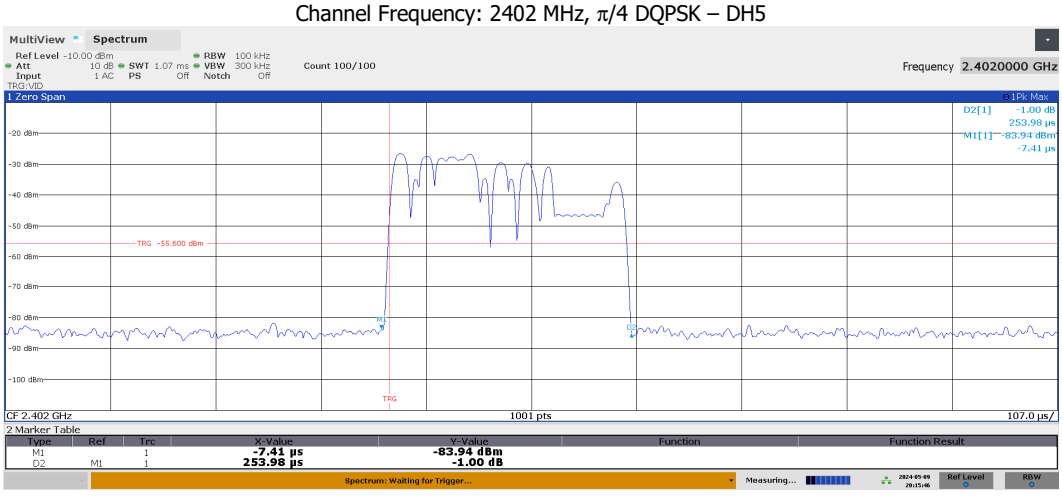
Channel Frequency: 2402 MHz, π/4 DQPSK – DH3



08:07:22 PM 05/09/2024

Channel Frequency: 2402 MHz, π/4 DQPSK – DH5



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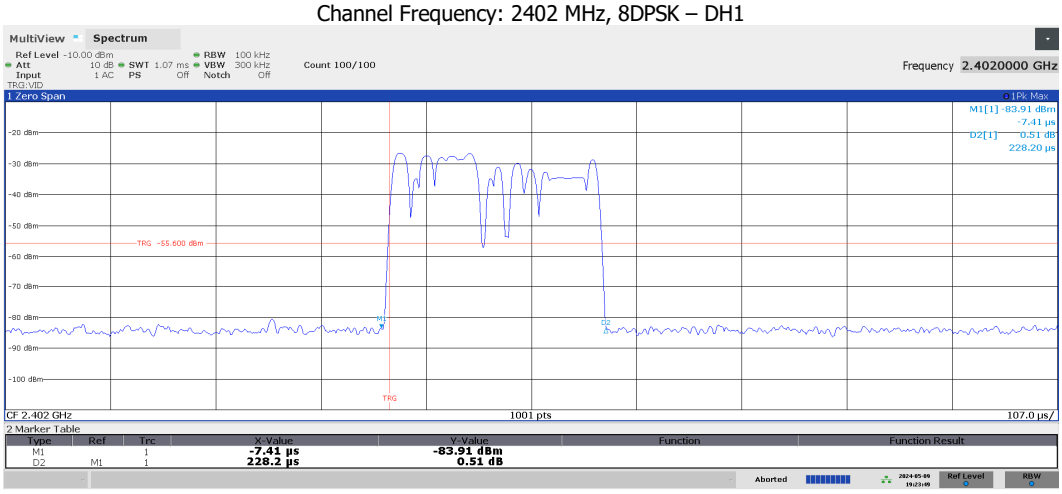
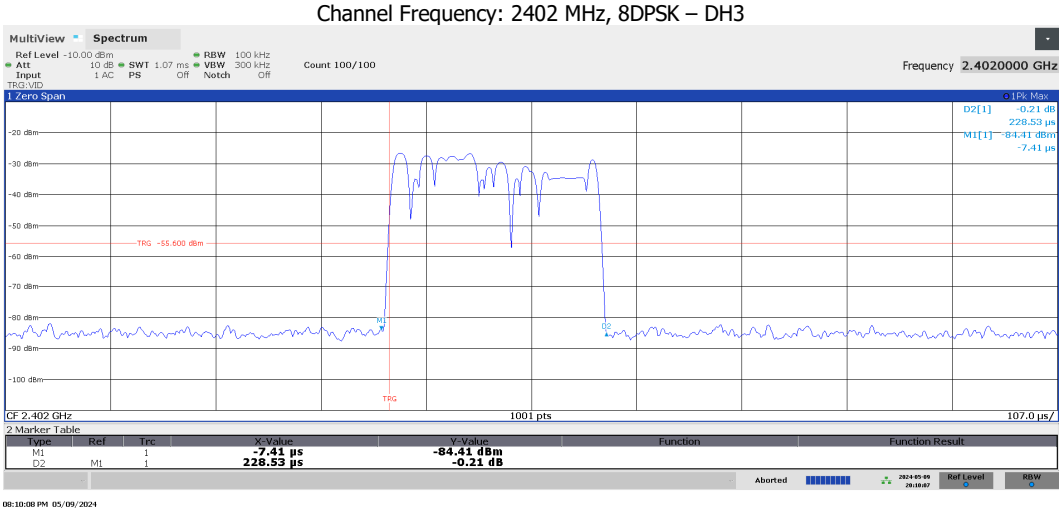
Channel Frequency: 2402 MHz, 8DPSK – DH1

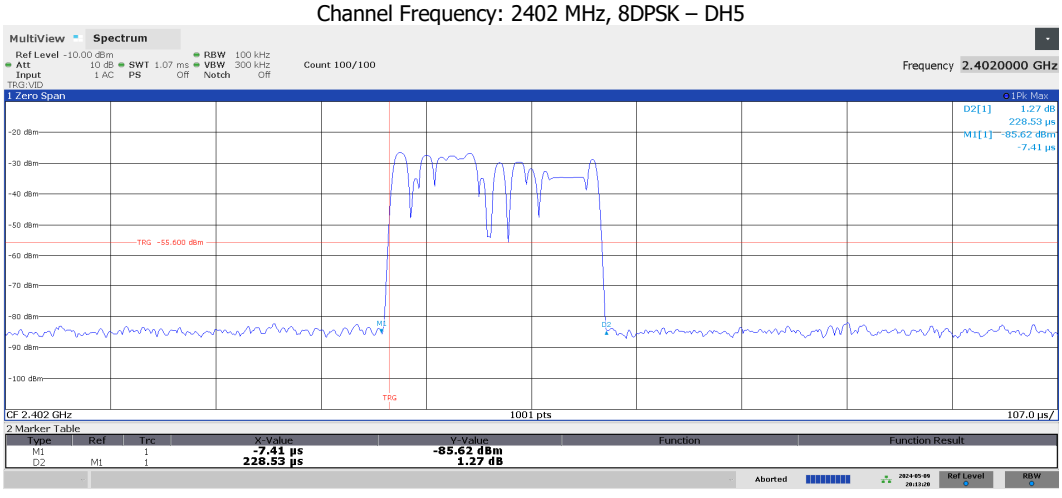


07:23:50 PM 05/09/2024

Channel Frequency: 2402 MHz, 8DPSK – DH3



Channel Frequency: 2402 MHz, 8DPSK – DH5



7.0 Conducted Spurious Emissions – Test Conditions

Technician	Rudy Valent		
Table No.	TEST: Conducted Spurious Emissions, Section 15.247 (d)		\
Method	ANSI C63.10: 2013-06, par. 7.8.8		\
Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C	
	Relative Humidity	Less or equal to 80 %	
Parameters recorded during the test	Laboratory Ambient Temperature	23 °C	
	Relative Humidity	46 %	
Date (s) of test execution	14/05/2024		

Supplementary information:

- Test performed on EUT 24LA00181/02;
- Conducted Test, executed at Bluetooth antenna output (50ohm, SMA) connected to the Spectrum Analyser through an attenuator (30 dB);
- EUT powered at 14.5 Vdc;
- EUT Operating Mode: Mode 1;
- Spectrum analyser settings setup:
  - Detector: Peak
  - RBW: 100 kHz and VBW=300 kHz
  - Trace mode: Max Hold (over last 20 sweeps)
- Frequency range of the measurements: up to 26GHz.
- Test aim is to verify that in any 100 kHz bandwidth outside the frequency band in which the digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator is at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power.
- Test executed with the following settings:
  - BR mode with modulation GFSK on channel 0, 39 and 78
  - EDR mode with modulation $\pi/4$ DQPSKon channel 0, 39 and 78
  - EDR mode with modulation 8DPSK on channel 0, 39 and 78

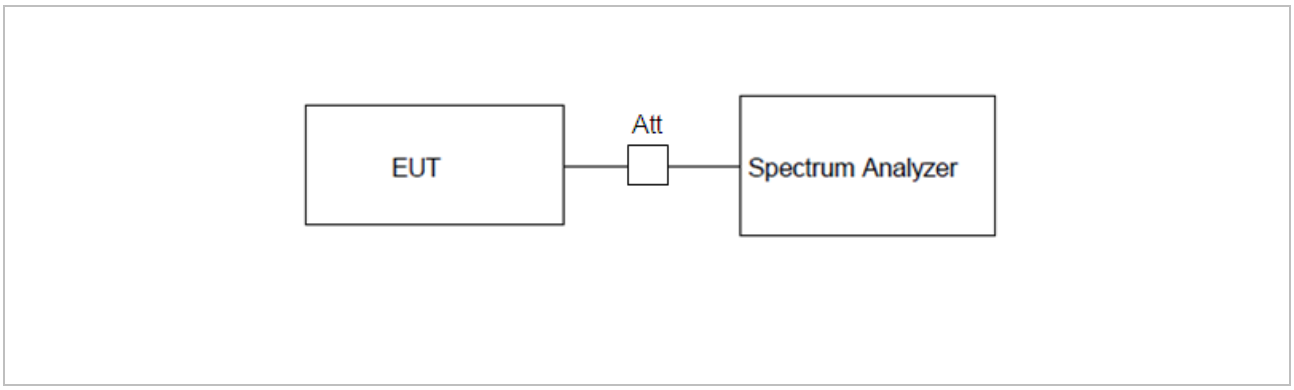
7.1 Test Equipment Used – Conducted Spurious Emissions

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL092016	EMI Receiver	ESW44	Rohde&Schwarz	23-Feb-2024	1 year
EL046111	Dual DC Power Supply	CPX400D	TTi	10-Oct-2023	1 year
EL119019	RF Cable	SKBL-2M-LOW	Mini-Circuits	07-Nov-2023	1 year
EL082315	Attenuator 30dB	PE7087-30	-	02-May-2024	1 year
EL109018	DataLogger T/UR	HL-1D	Rotronic	29-May-2023	1 year
EL089216	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL089316	HS-CAN Optical converter	050	EMC TOOLS	NA	
EL075814	LIN Optical converter	090	EMC TOOLS	NA	
EL075914	LIN Optical converter	090	EMC TOOLS	NA	

7.2 Auxiliary Equipment – Maximum Conducted Output Power

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL119519	Signal Generator	MG3693A	Anritsu	06-Oct-2023	1 year

7.3 Setup – Conducted Spurious Emissions



7.4 Requirements – Conducted Spurious Emissions

FCC Section 15.247

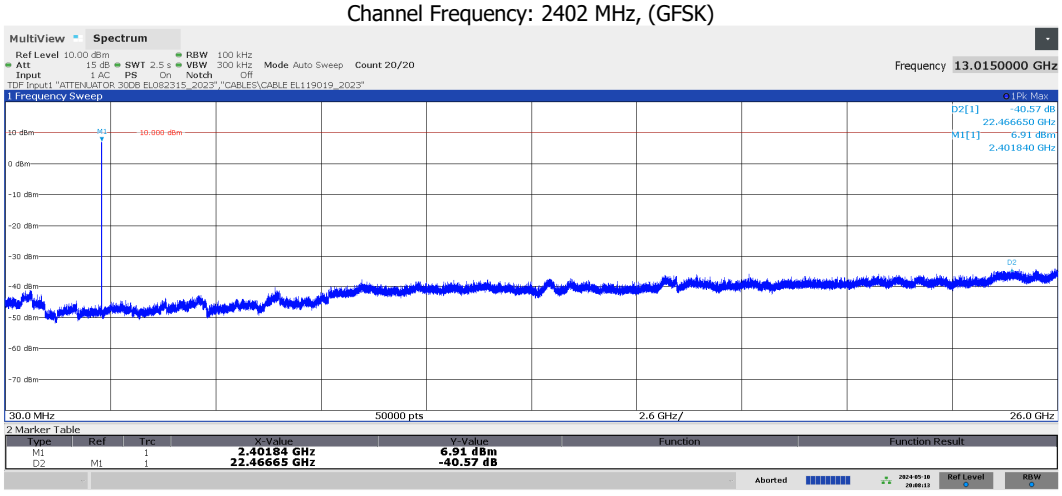
(d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains 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)).

7.5 Results – Conducted Spurious Emissions

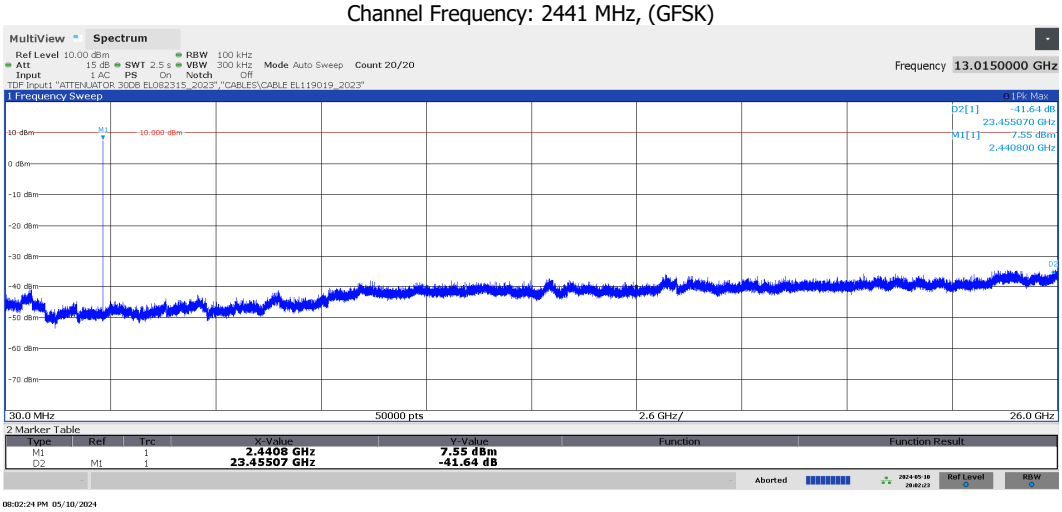
The amplitude of spurious emissions is lower than 20 dBc, thus the result of the test is: **PASS**.
See the details in the charts/tables of the following paragraphs (see the worst case in bold text).

Modulation mode	Max Signal Frequency (MHz)	Max Signal (dBm)	Frequency of Max OOB signal (MHz)	Difference (dBc)	Limit (dBc)
GFSK	2401.8	6.9	24868.5	40.6	20.0
	2440.8	7.6	25895.9	41.6	20.0
	2479.8	8.9	25964.4	41.6	20.0
π/4 DQPSK	2401.8	3.6	24889.8	37.5	20.0
	2440.8	5.1	2357503.8	39.0	20.0
	2479.8	4.0	24487.8	38.2	20.0
8DPSK	2401.8	3.7	25957.7	37.4	20.0
	2440.8	5.1	25981.6	38.8	20.0
	2480.3	3.2	25956.1	36.7	20.0

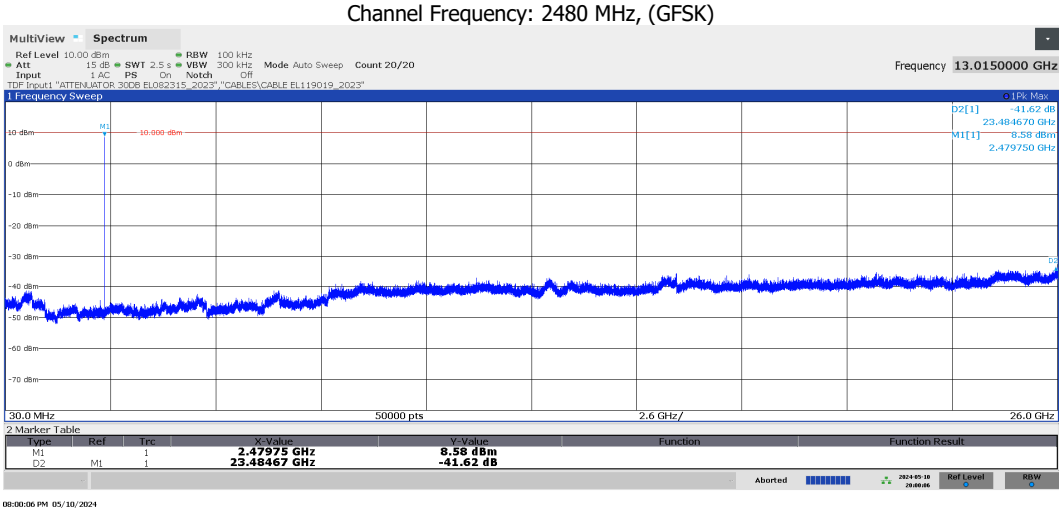
Channel Frequency: 2402 MHz, (GFSK)



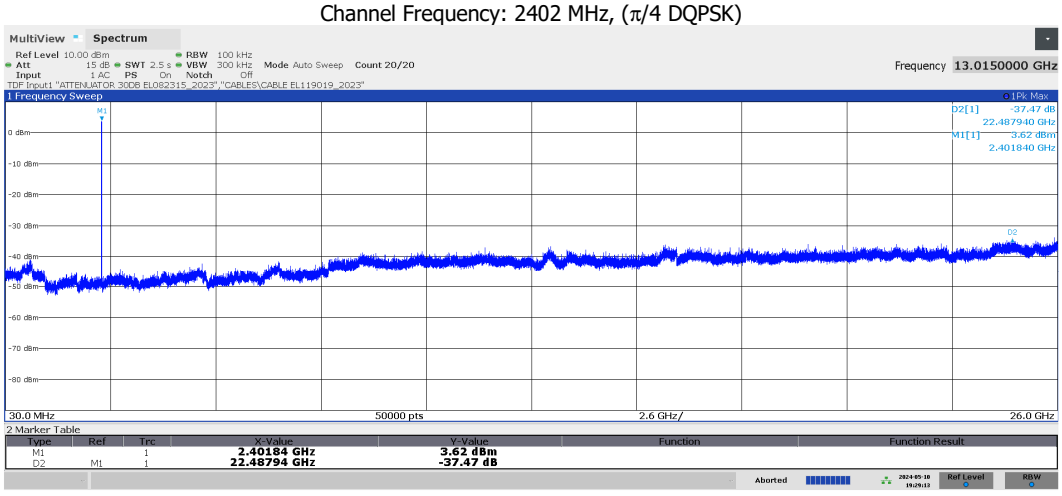
Channel Frequency: 2441 MHz, (GFSK)



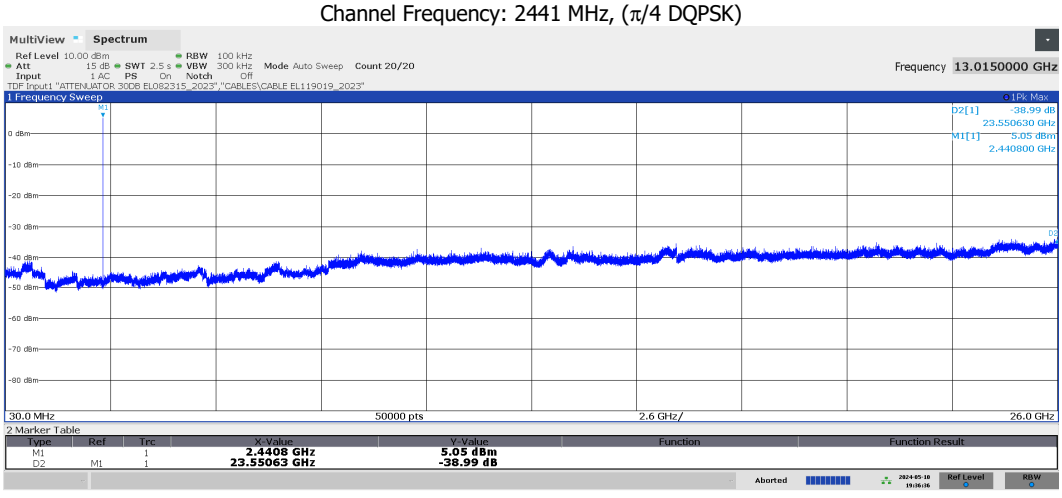
Channel Frequency: 2480 MHz, (GFSK)



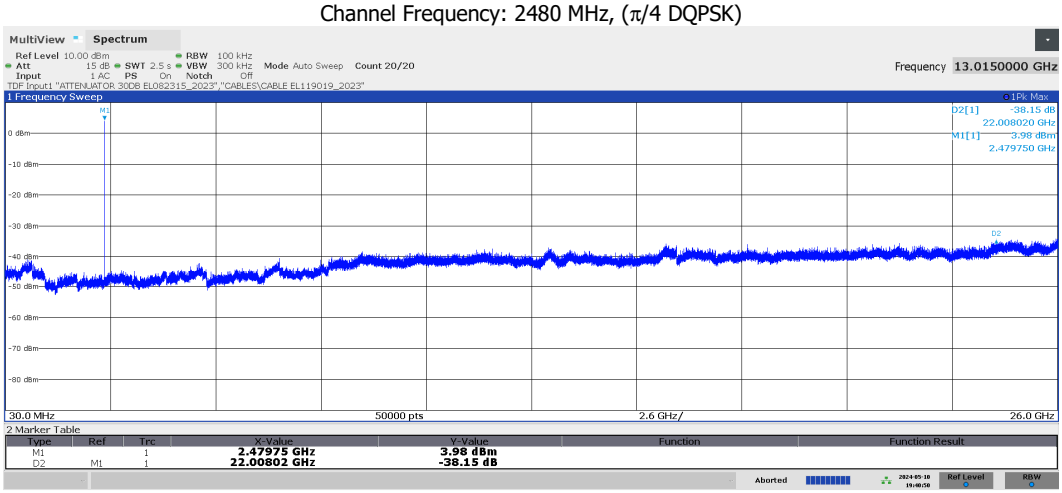
Channel Frequency: 2402 MHz, (π/4 DQPSK)



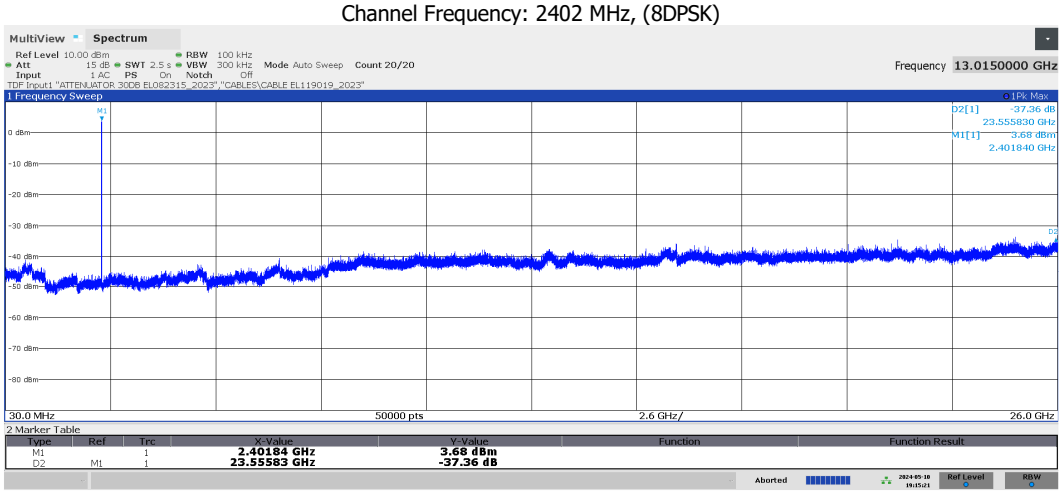
Channel Frequency: 2441 MHz, (π/4 DQPSK)



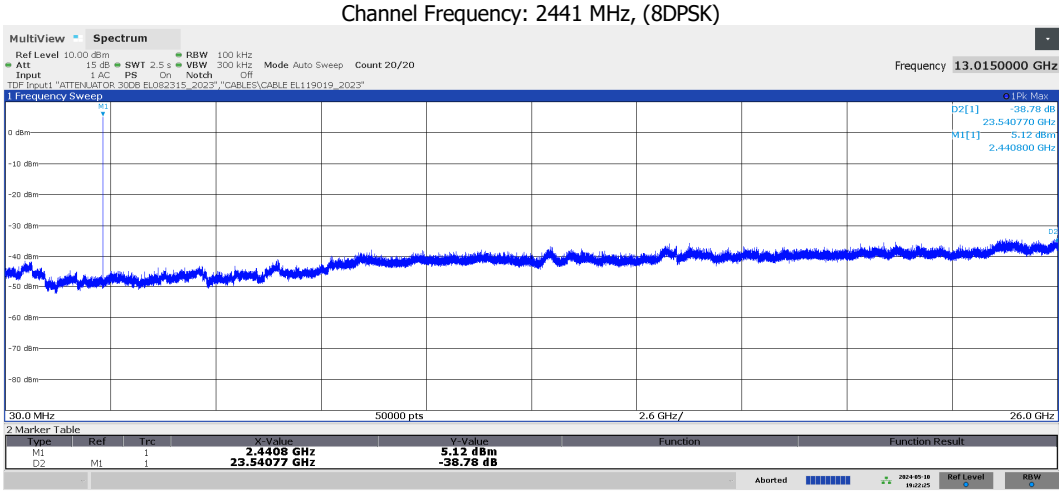
Channel Frequency: 2480 MHz, (π/4 DQPSK)



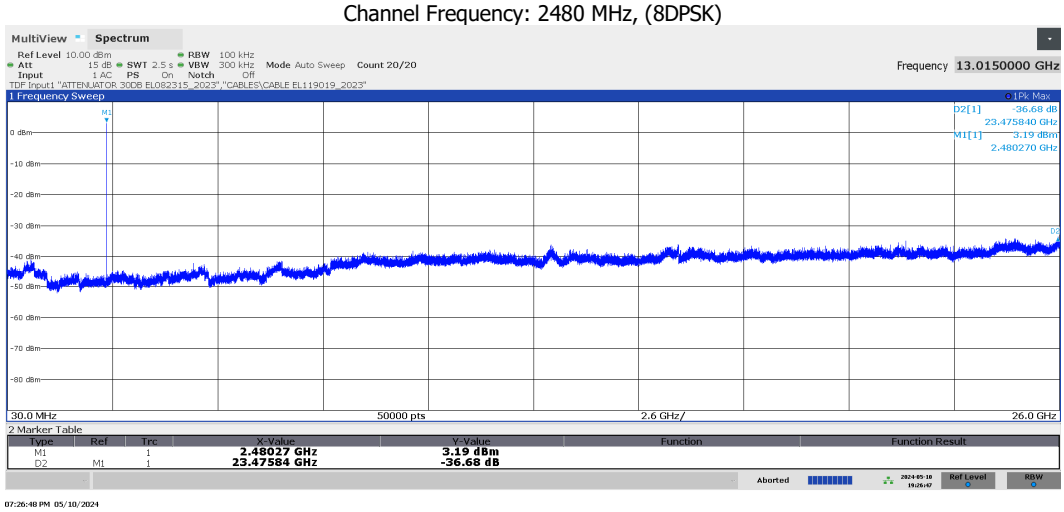
Channel Frequency: 2402 MHz, (8DPSK)



Channel Frequency: 2441 MHz, (8DPSK)



Channel Frequency: 2480 MHz, (8DPSK)



8.0 Spurious Radiated Emissions and Restricted Bands of Operation – Test Conditions

Technician	Rudy Valent		
Table No.	TEST: Spurious Radiated Emissions and Restricted Bands of Operation, Section 15.205 (a), 15.209, 15.247(d)		\
Method	ANSI C63.10: 2013-06, par. 6.3		\
Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C	
	Relative Humidity	Less or equal to 80 %	
Parameters recorded during the test	Laboratory Ambient Temperature	22 – 23 °C	
	Relative Humidity	52 – 60 %	
Date (s) of test execution	14/05/2024 – 23/05/2024		

Supplementary information:

- Test performed on EUT 24LA00181/01 in operating Mode 1, powered at 14.5 Vdc.
- Frequency range: 9kHz to 25GHz (tenth harmonic of the highest frequency used in the EUT), see FCC section 15.33 (a) (1);
- Test site: Semi-anechoic chamber for measures from 9 kHz to 1 GHz and Full-anechoic chamber for measures from 1 GHz to 25 GHz;
- The EUT was placed on turn-platform on a support at 0.8m above the ground plane for measures from 9 kHz to 1GHz and on a support at 1.5m above the ground plane for measures from 1 GHz to 25 GHz;
- The EUT was placed at 3m apart from the receiving antenna;
- The turn-platform is rotated from 0° to 360° degrees to determine the position of maximum emission level, the antenna height is changed from 1m to 4m to find the highest emission;
- The receiving antenna was positioned in vertical and horizontal polarization and from 1 GHz to 25 GHz aim the EUT (source of emission) by the use of the Accessory for azimuth antenna control, as required at section 8.3.2.2 of ANSI C63.4: 2014;
- The preliminary measurements were made with the detector set to Peak within an IF bandwidth of 200 Hz from 9 kHz to 150kHz, of 9 kHz from 150 kHz to 30 MHz, of 120 kHz from 30 MHz to 1 GHz and with the detector set to Average within an IF bandwidth of 1 MHz from 1 GHz to 25 GHz;
- Antennas used during measurements:
  - Loop antenna from 9 kHz to 30 MHz
  - Bilog antenna from 30 MHz to 1 GHz
  - Horn antenna ETS 3117 from 1 GHz to 18 GHz;
  - Horn antenna AMTP-62-20-C-SF from 18 GHz to 25 GHz;
- The final measurements of the peaks were made with the RBW and detector set to:
  - 200 Hz/Quasi-Peak from 90 kHz to 150 kHz (CISPR-Average from 9 kHz to 90 kHz);
  - 9 kHz/Quasi-Peak from 150 kHz to 30 MHz (CISPR-Average from 110 kHz to 490 kHz);
  - 120 kHz/Quasi-Peak from 30 MHz to 1 GHz;
  - 1 MHz /CISPR-Average from 1 GHz to 25 GHz;
- The measurements with Quasi-Peak and CISPR-Average detector were performed only for the six highest EUT emissions, excluding peaks lower than 20 dB from the limit;
- FCC Limits: Sections 15.209 (a) of 47 CFR Part 15

  Remark: In accordance with part 15.31 (f) (2) of FCC, when performing measurements at a closer distance than specified, the results shall be extrapolated to the specified distance by either making measurements at a minimum of two distances on at least one radial to determine the proper extrapolation factor or by using the square of an inverse linear distance extrapolation factor (40 dB/decade).

The applied formula for limits at 3 meter is:
Extrapolation (dB) = 40log (300meter / 3meter) = +80 dB
Extrapolation (dB) = 40log (30meter / 3meter) = +40 dB

- "Restricted Bands of Operation" Test executed with the following settings:
  - BR mode with modulation GFSK on channel 0, 39 and 78
  - EDR mode with modulation π/4 DQPSKon channel 0, 39 and 78
  - EDR mode with modulation 8DPSK on channel 0, 39 and 78
- "Spurious Radiated Emissions" Test executed with the following settings:
  - BR mode with modulation GFSK on channel 78.

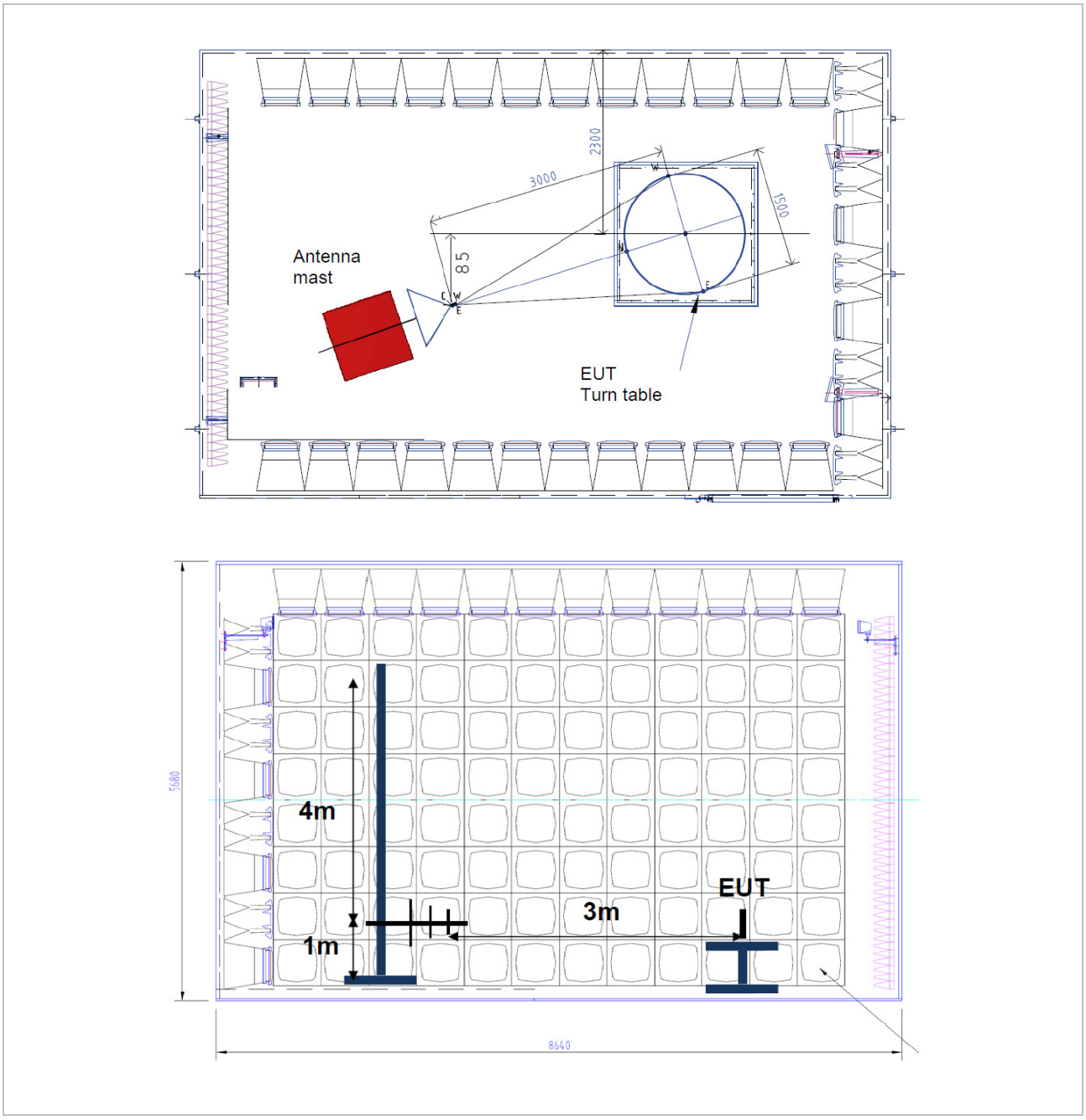
8.1 Test Equipment Used – Spurious Radiated Emissions and Restricted Bands of Operation

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL092016	EMI Receiver	ESW44	Rohde&Schwarz	23-Feb-2024	1 year
EL109018	DataLogger T/UR	HL-1D	Rotronic	29-May-2023	1 year
EL104518	Dual DC Power Supply	CPX400D	TTi	02-Feb-2024	1 year
EL102917	RF Cable	SLULL18-NMNM	TimesMicrowave	10-Aug-2023	1 year
EL140320	RF Cable	SLULL18	Timesmicrowave	07-Aug-2023	1 year
EL095517	RF Cable	SFT-205-PUR	Timesmicrowave	04-Oct-2023	1 year
EL119119	RF Cable	SFT-205-PUR	Timesmicrowave	04-Oct-2023	1 year
EL005298	Attenuator 6dB	8491A-06	Hewlett/Packard	19-Feb-2024	1 year
EL081815	High Pass Filter	VHF-7150+	Mini-Circuits	10-Jan-2024	1 year
EL091316	Pre-amplifier RF	JS32-00104000-58-5P-R	Narda -Miteq	08-Nov-2023	1 year
EL080715	Loop Antenna ETS	6502	ETS-Lindgren	10-Jul-2023	1 year
EL004098	Bilog Antenna	Bilog CBL6111C	Chase	20-Oct-2021 18-Oct-2023 (Verification)	3 years 1 year
EL084815	Horn Antenna	3117	ETS-Lindgren	27-Aug-2021 19-Jan-2024 (Verification)	3 years 1 year
EL063813	Horn Antenna	AMTP-42-20_C-SF	Spin electronics	22-Sep-2022	3 years
EL055612	Semi-anechoic chamber	FACT 03 150 STD	ETS-Lindgren	NA	
EL058412	Antenna Mast	2175	ETS-Lindgren	NA	
EL057212	Multi-Device Controller	2090	ETS-Lindgren	NA	
EL075814	LIN Optical Converter	090	EMC TOOLS	NA	
EL075914	LIN Optical Converter	090	EMC TOOLS	NA	
EL089216	HS CAN Optical Converter	050	EMC TOOLS	NA	
EL089316	HS CAN Optical Converter	050	EMC TOOLS	NA	

8.2 Auxiliary Equipment – Spurious Radiated Emissions and Restricted Bands of Operation

Id. Number	Equipment	Model	Manufacturer	Calibration date	Interval
EL093416	Comb Generator Step 1_5MHz	CG-515	COM-POWER	NA	
EL119519	Signal generator	MG3693A	Anritsu	06-Oct-2023	1 year
EL060612	RF Cable	SKBL-2M-LOW	Mini-Circuits	07-Nov-2023	1 year
EL031309	Horn Antenna	JXTXLB-20245	A-INFOMW	19-Jan-2024	1 year

8.3 Setup – Spurious Radiated Emissions and Restricted Bands of Operation



8.4 Requirements – Conducted Spurious Emissions

FCC Section 15.205

(a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Frequency (MHz)
…
2310.0 – 2390.0
2483.5 - 2500.0
…

FCC Section 5.209

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

**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.

(b) In the emission table above, the tighter limit applies at the band edges.
(c) The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the level of the fundamental emission. For intentional radiators which operate under the provisions of other sections within this part and which are required to reduce their unwanted emissions to the limits specified in this table, the limits in this table are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.
(d) The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

FCC Section 5.247

(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)).

8.5 Results – Spurious Radiated Emissions and Restricted Bands of Operation

The result of the test is: **PASS**.
See the details in the charts/tables of the following paragraphs.
Level of maximum spurious detected:

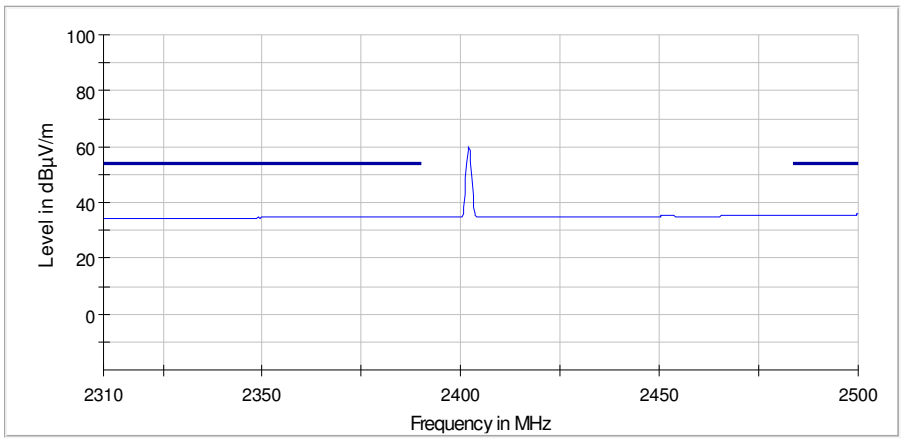
Frequency (MHz)	Quasi-Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Azimuth (deg)	Cables (dB)	Attenuator (dB)	Antenna Correction (dB/m)	Instrument Reading: Quasi-Peak (dBµV)	Result
31.260000	34.6	40.0	-5.4	138.0	311.0	0.8	5.9	18.3	9.6	Pass

Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Azimuth (deg)	Cables (dB)	Antenna Correction (dB/m)	Instrument Reading: Average (dBµV)	Result
1932.250000	37.1	54.0	-16.9	251.0	146.0	5.2	31.1	0.8	Pass

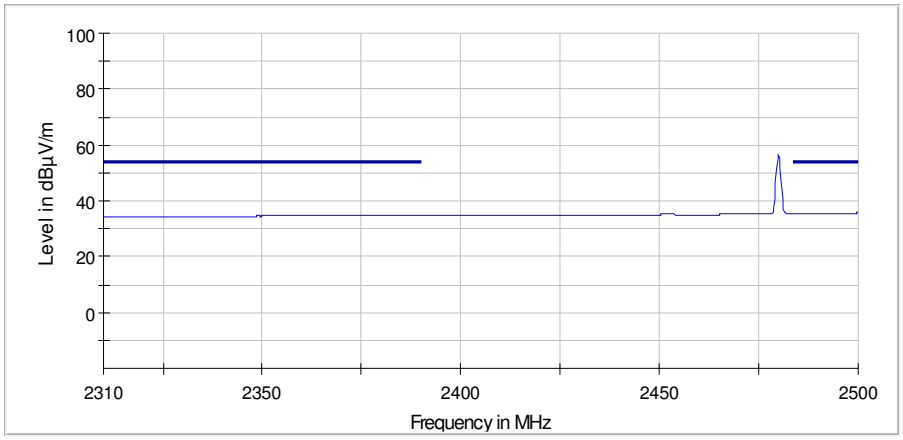
8.5.1 Restricted Bands of Operation – Spurious Radiated Emissions and Restricted Bands of Operation

Radiated emissions measured from 2.31GHz to 2.5GHz. Average detector with IF=1MHz. FCC section 15.209 Average Limit.

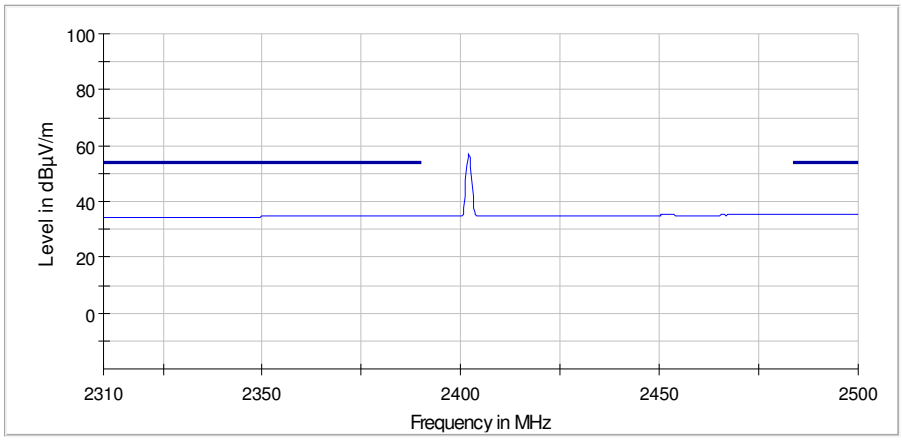
Channel Frequency: 2402 MHz, (GFSK)



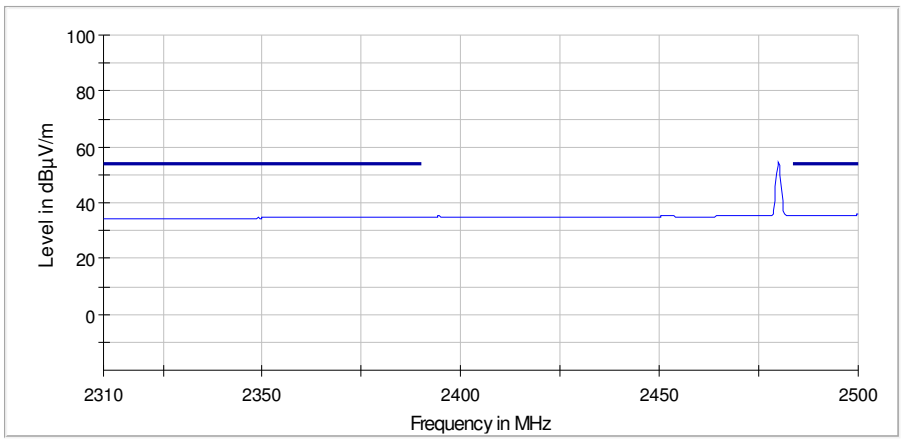
Channel Frequency: 2480 MHz, (GFSK)



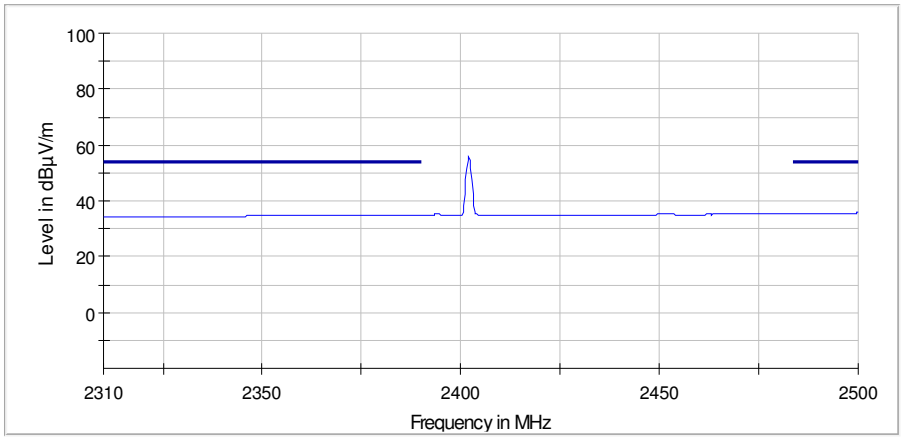
Channel Frequency: 2402 MHz, (π/4 DQPSK)



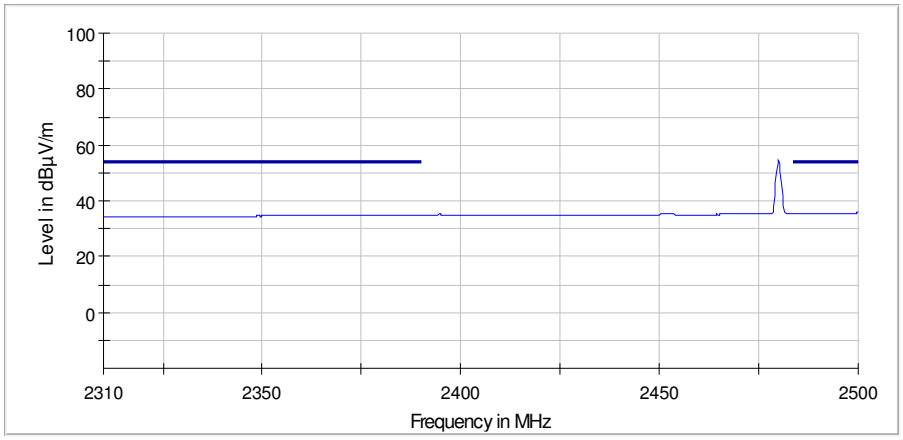
Channel Frequency: 2480 MHz, (π/4 DQPSK)



Channel Frequency: 2402 MHz, (8DPSK)



Channel Frequency: 2480 MHz, (8DPSK)



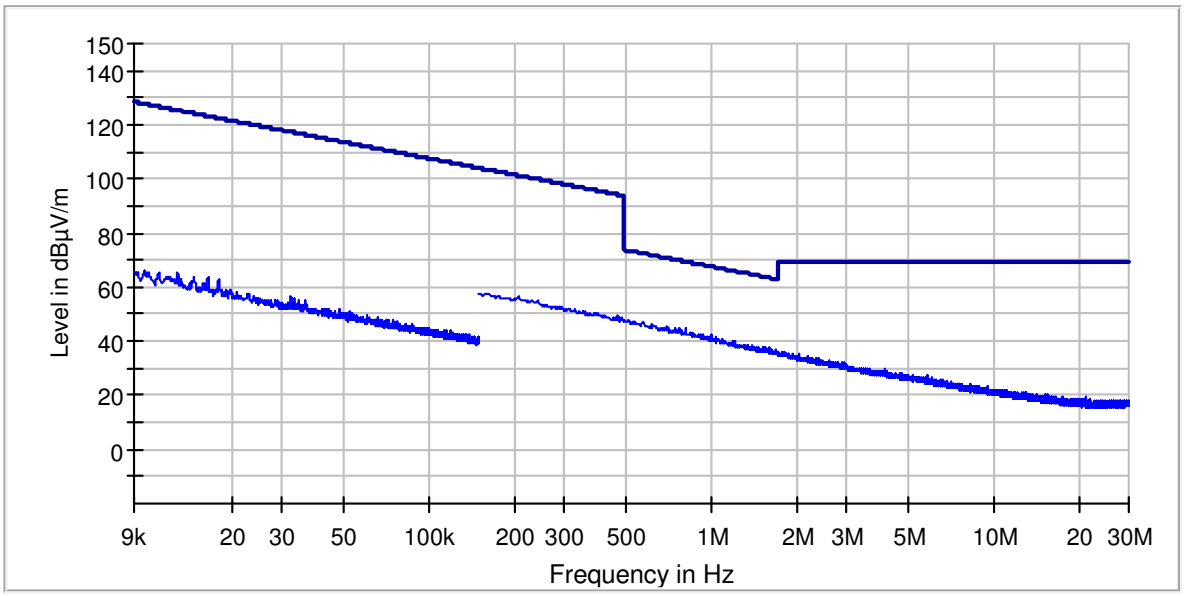
8.5.2 Spurious Radiated Emissions – Spurious Radiated Emissions and Restricted Bands of Operation

Measures from 9 kHz to 30 MHz

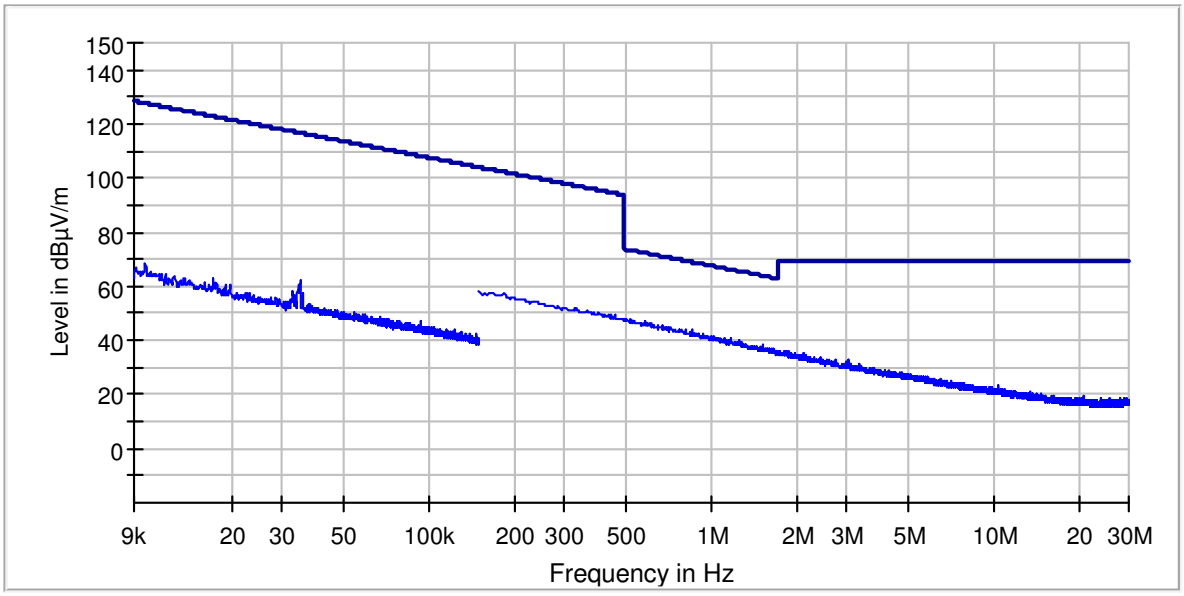
Noise Floor Measurements

Noise floor was measure with auxiliary equipment (load box and optical converters) switched ON and EUT disconnected.

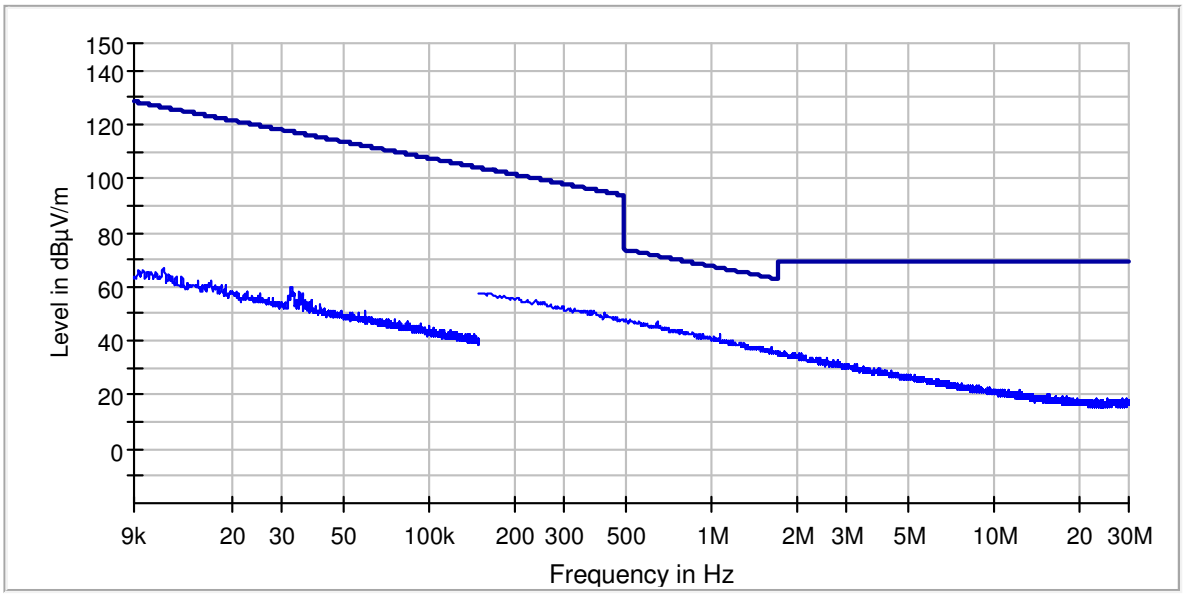
Noise floor measured from 9 kHz to 30 MHz. Peak detector with IF=200 Hz from 9 kHz to 150 kHz and IF=9 kHz from 150 kHz to 30 MHz. Q-Peak/Average limit. Measuring antenna on X axis.



Noise floor measured from 9 kHz to 30 MHz. Peak detector with IF=200 Hz from 9 kHz to 150 kHz and IF=9 kHz from 150 kHz to 30 MHz. Q-Peak/Average limit. Measuring antenna on Y axis.

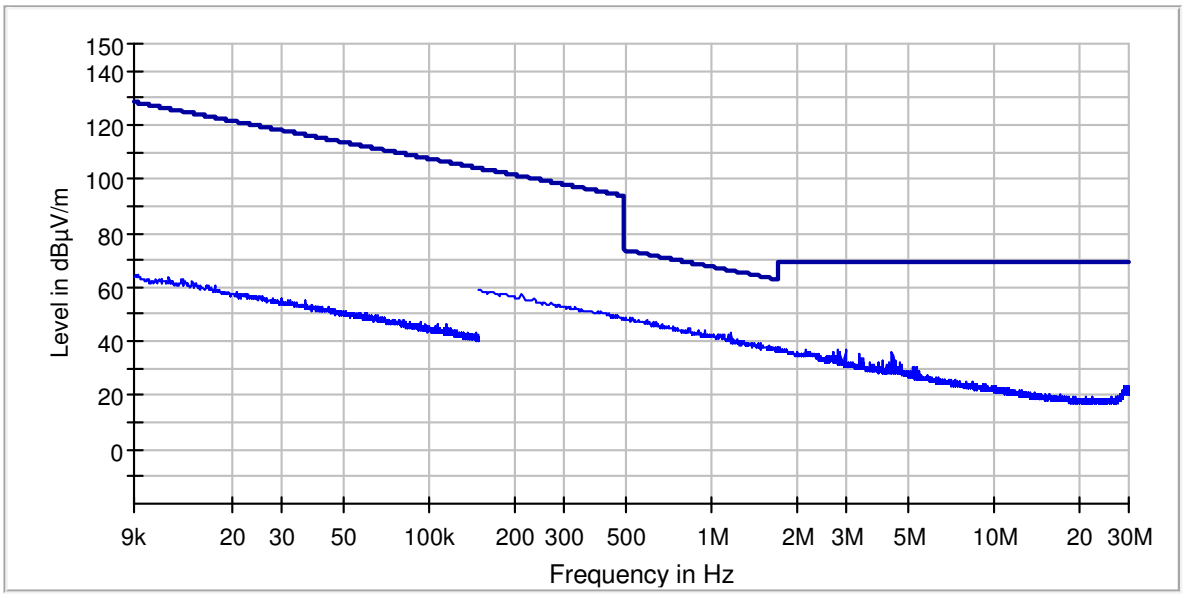


Noise floor measured from 9 kHz to 30 MHz. Peak detector with IF=200 Hz from 9 kHz to 150 kHz and IF=9 kHz from 150 kHz to 30 MHz. Q-Peak/Average limit. Measuring antenna on Z axis.

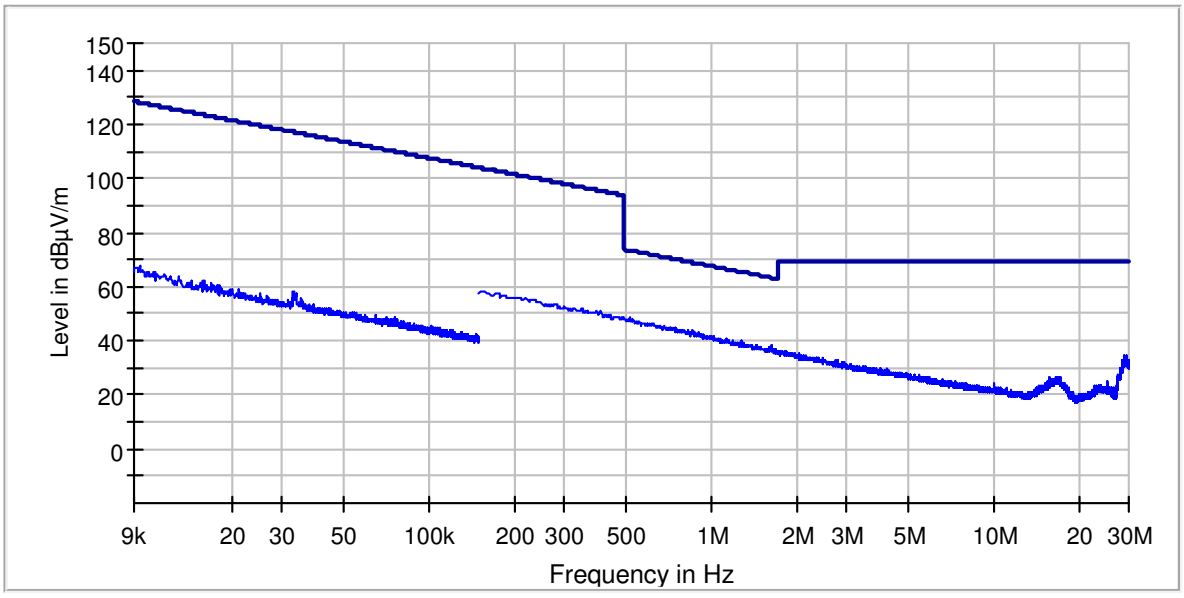


EUT Measurements

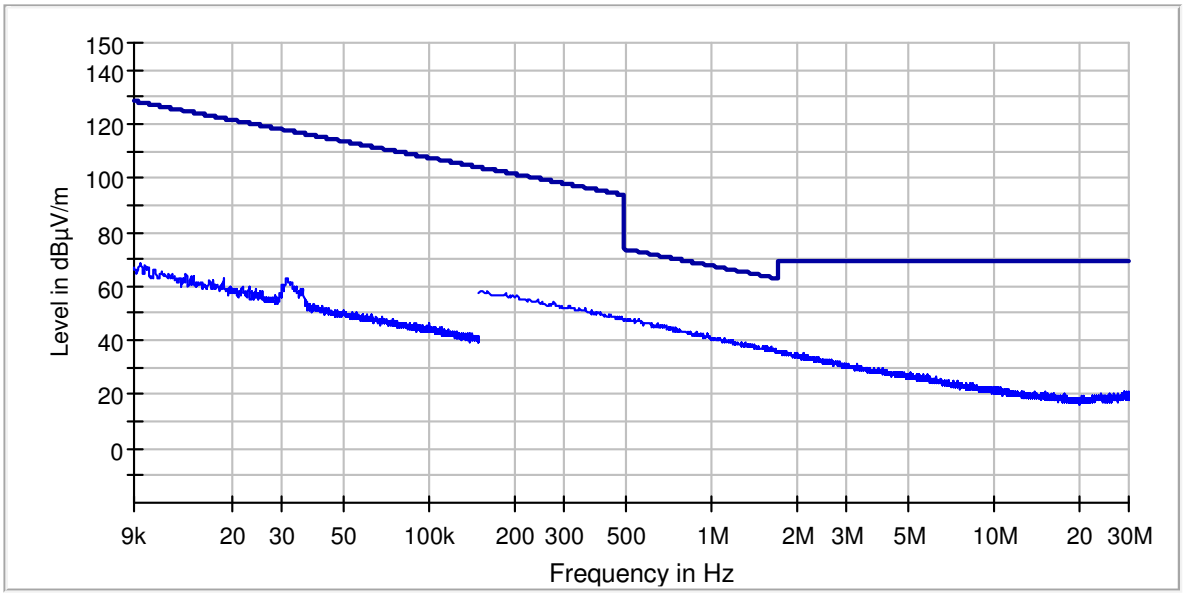
EUT emissions measured from 9 kHz to 30 MHz. Peak detector with IF=200 Hz from 9 kHz to 150 kHz and IF=9 kHz from 150 kHz to 30 MHz. Q-Peak/Average limit. Measuring antenna on X axis.



EUT emissions measured from 9 kHz to 30 MHz. Peak detector with IF=200 Hz from 9 kHz to 150 kHz and IF=9 kHz from 150 kHz to 30 MHz. Q-Peak/Average limit. Measuring antenna on Y axis.



EUT emissions measured from 9 kHz to 30 MHz. Peak detector with IF=200 Hz from 9 kHz to 150 kHz and IF=9 kHz from 150 kHz to 30 MHz. Q-Peak/Average limit. Measuring antenna on Z axis.

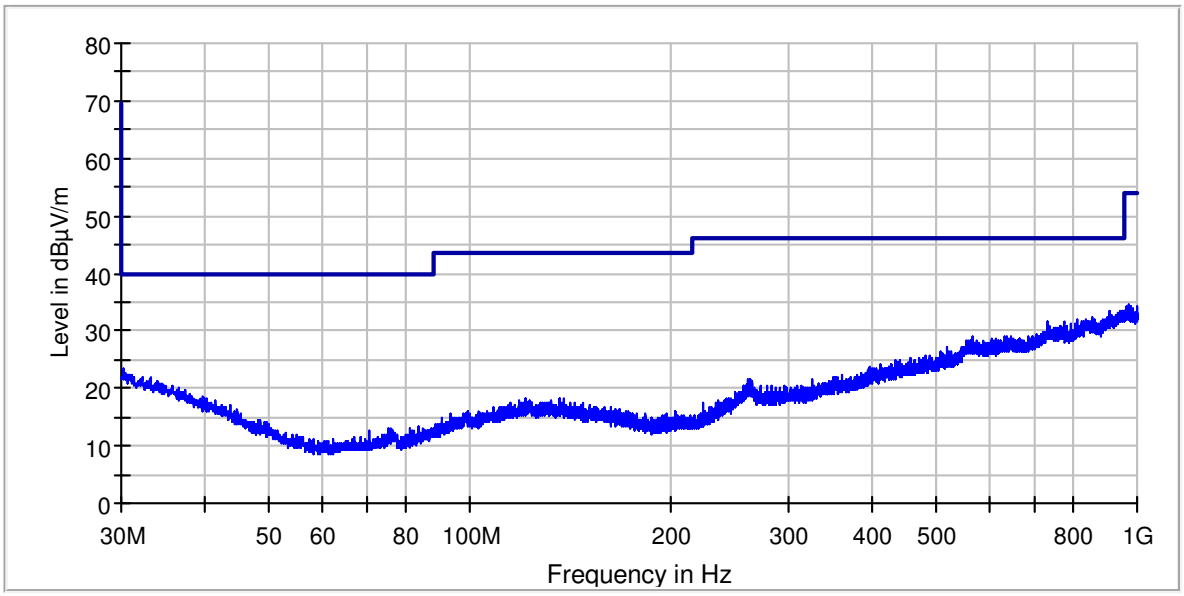


Measures from 30 MHz to 1 GHz

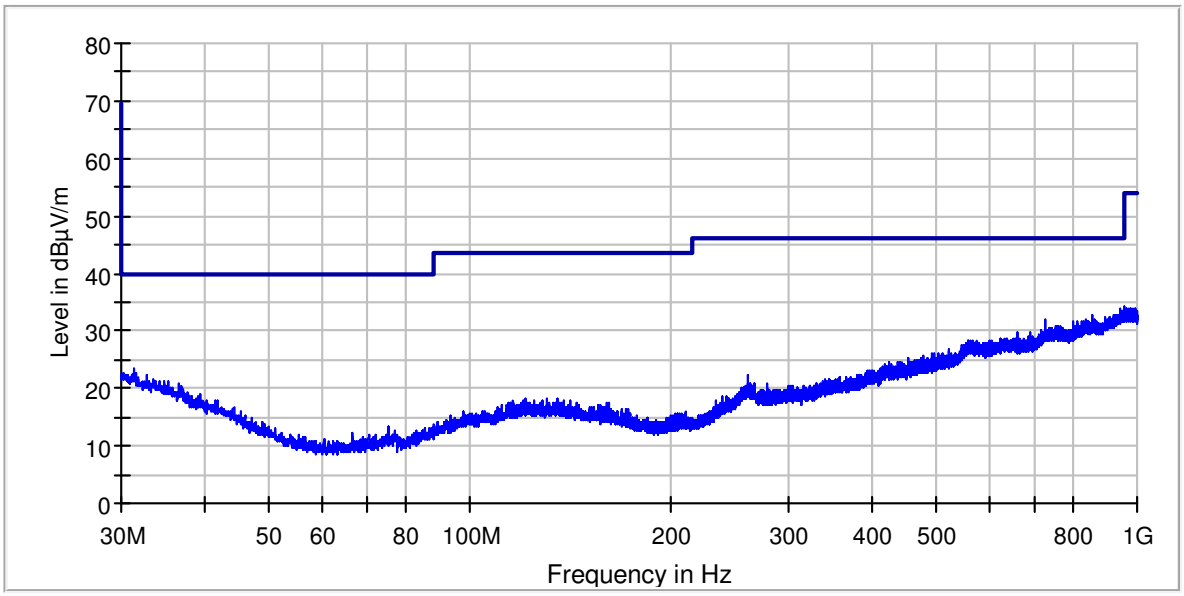
Noise Floor Measurements

Noise floor was measure with auxiliary equipment (load box and optical converters) switched ON and EUT disconnected.

Noise floor measured from 30 MHz to 1 GHz: Peak detector with IF 120 kHz. FCC section 15.209 Quasi-Peak Limit. Vertical polarization.

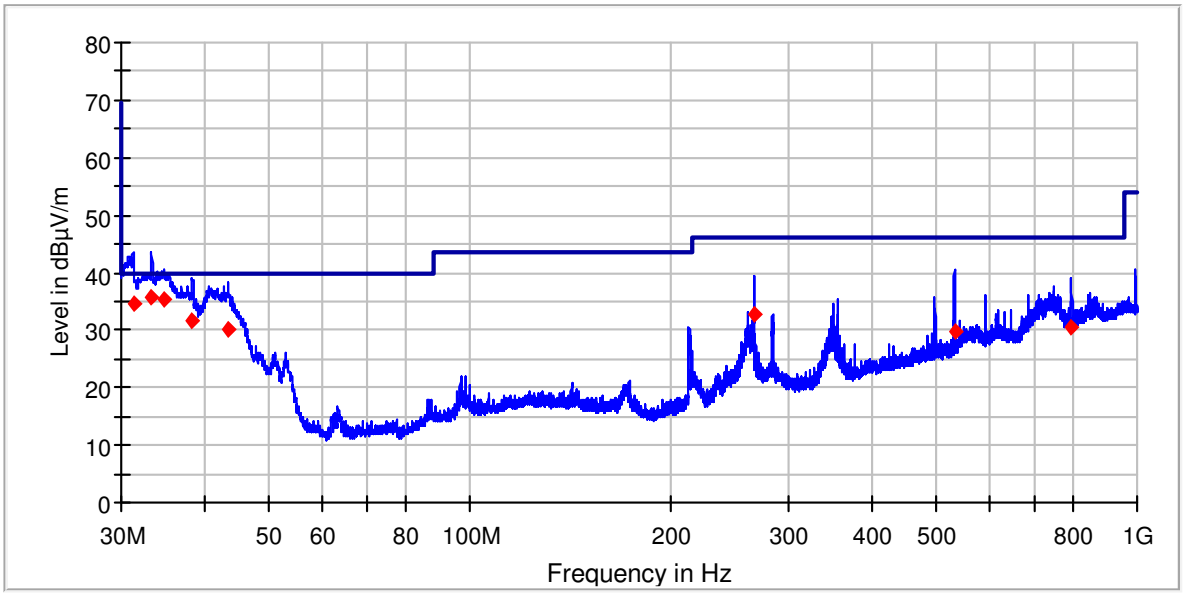


Noise floor measured from 30 MHz to 1 GHz: Peak detector with IF 120 kHz. FCC section 15.209 Quasi-Peak Limit. Horizontal polarization.



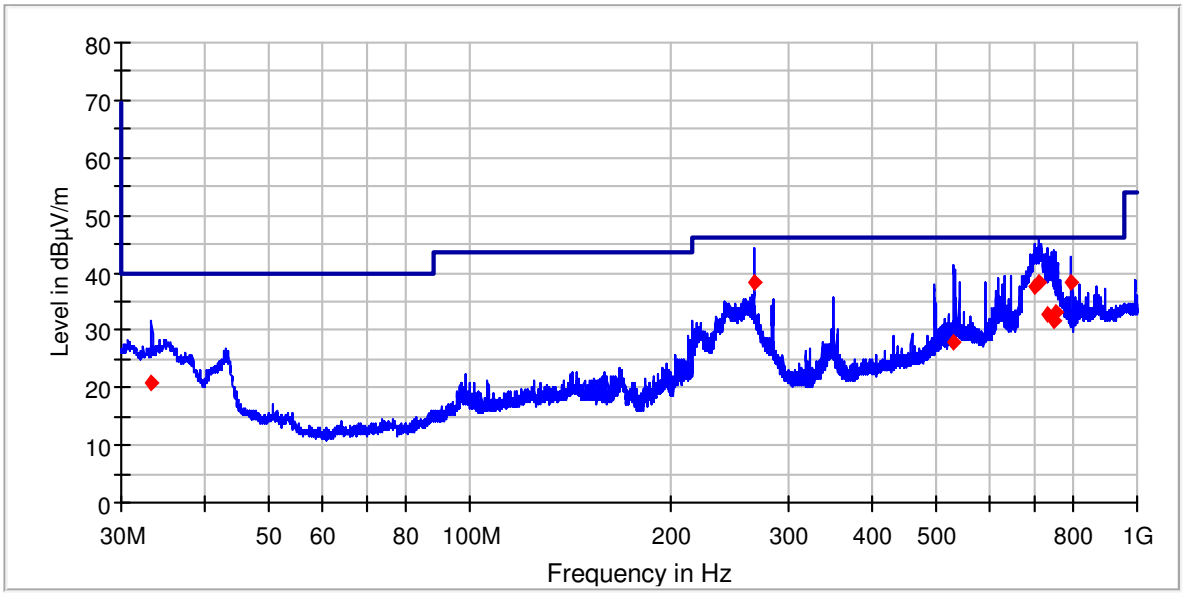
EUT Measurements

EUT emissions measured from 30 MHz to 1 GHz: Peak detector with IF 120 kHz. FCC section 15.209 Quasi-Peak Limit. Vertical polarization.



Frequency (MHz)	Quasi-Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Azimuth (deg)	Cables (dB)	Attenuator (dB)	Antenna Correction (dB/m)	Instrument Reading: Quasi-Peak (dBµV)	Result
31.260000	34.6	40.0	-5.4	138.0	311.0	0.8	5.9	18.3	9.6	Pass
33.330000	35.8	40.0	-4.2	142.0	52.0	0.8	5.9	17.3	11.8	Pass
34.770000	35.4	40.0	-4.6	103.0	126.0	0.8	5.9	16.8	11.9	Pass
38.370000	31.5	40.0	-8.5	107.0	239.0	0.8	5.9	14.8	10.0	Pass
43.410000	30.1	40.0	-9.9	150.0	210.0	0.9	5.9	12.2	11.1	Pass
266.010000	32.8	46.0	-13.2	200.0	187.0	2.2	5.9	13.9	10.8	Pass
532.050000	29.8	46.0	-16.2	106.0	133.0	3.1	5.9	18.4	2.4	Pass
798.060000	30.6	46.0	-15.4	123.0	338.0	3.7	5.9	21.7	-0.7	Pass

EUT emissions measured from 30 MHz to 1 GHz: Peak detector with IF 120 kHz. FCC section 15.209 Quasi-Peak Limit. Horizontal polarization.

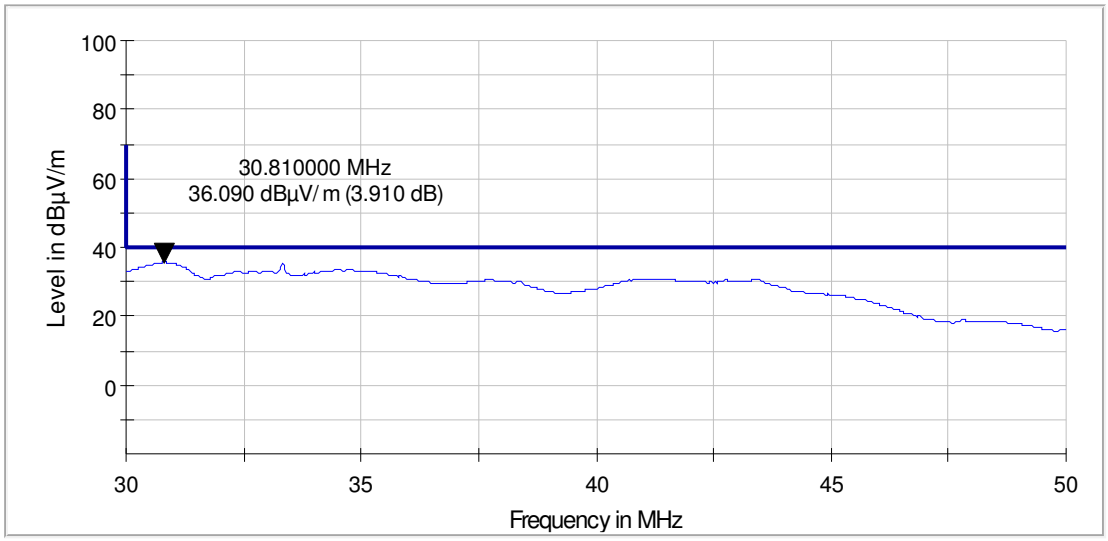


Frequency (MHz)	Quasi-Peak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Azimuth (deg)	Cables (dB)	Attenuator (dB)	Antenna Correction (dB/m)	Instrument Reading: Quasi-Peak (dBµV)	Result
33.330000	20.9	40.0	-19.1	200.0	152.0	0.8	5.9	17.3	-3.1	Pass
266.010000	38.4	46.0	-7.6	103.0	350.0	2.2	5.9	13.9	16.4	Pass
531.630000	27.9	46.0	-18.1	150.0	344.0	3.1	5.9	18.3	0.6	Pass
702.000000	37.4	46.0	-8.6	113.0	336.0	3.7	5.9	20.7	7.1	Pass
714.540000	38.3	46.0	-7.7	100.0	324.0	3.7	5.9	21.1	7.6	Pass
732.030000	32.8	46.0	-13.2	108.0	313.0	3.7	5.9	22.0	1.2	Pass
750.030000	31.5	46.0	-14.6	150.0	321.0	3.7	5.9	22.0	-0.1	Pass
754.500000	33.0	46.0	-13.1	159.0	53.0	3.7	5.9	22.0	1.4	Pass
798.000000	38.3	46.0	-7.7	100.0	311.0	3.7	5.9	21.7	7.0	Pass

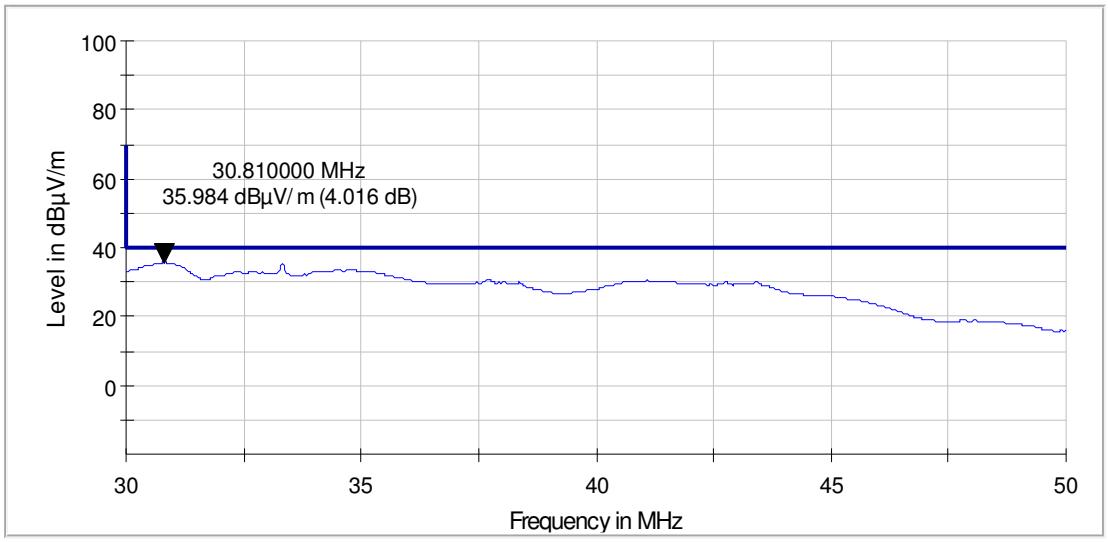
Additional measurements in bands where the emission measured with the peak detector exceeds the limit on a broader band.

Note: Cables and auxiliary instruments of the setup were moved to get worse emission condition**.**

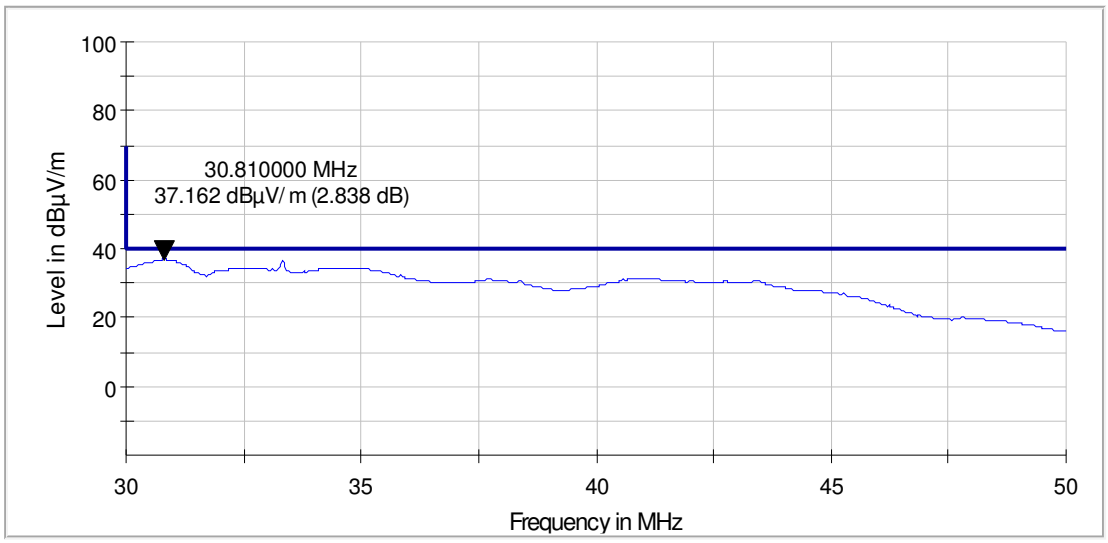
EUT emissions measured from 30 MHz to 50 MHz: Quasi-Peak detector with IF 120 kHz. FCC section 15.209 Quasi-Peak Limit. Vertical polarization, antenna high at 138 cm and EUT azimuth at 311 degrees.



EUT emissions measured from 30 MHz to 50 MHz: Quasi-Peak detector with IF 120 kHz. FCC section 15.209 Quasi-Peak Limit. Vertical polarization, antenna high at 142 cm and EUT azimuth at 52 degrees.



EUT emissions measured from 30 MHz to 50 MHz: Quasi-Peak detector with IF 120 kHz. FCC section 15.209 Quasi-Peak Limit. Vertical polarization, antenna high at 103 cm and EUT azimuth at 126 degrees.

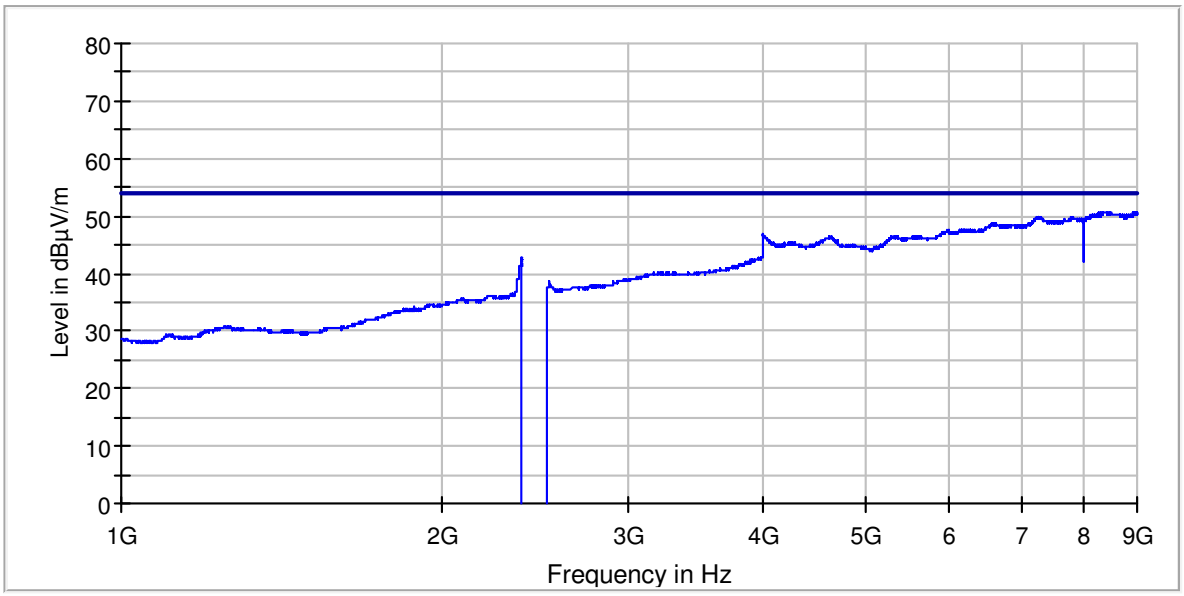


Measures from 1 GHz to 9 GHz

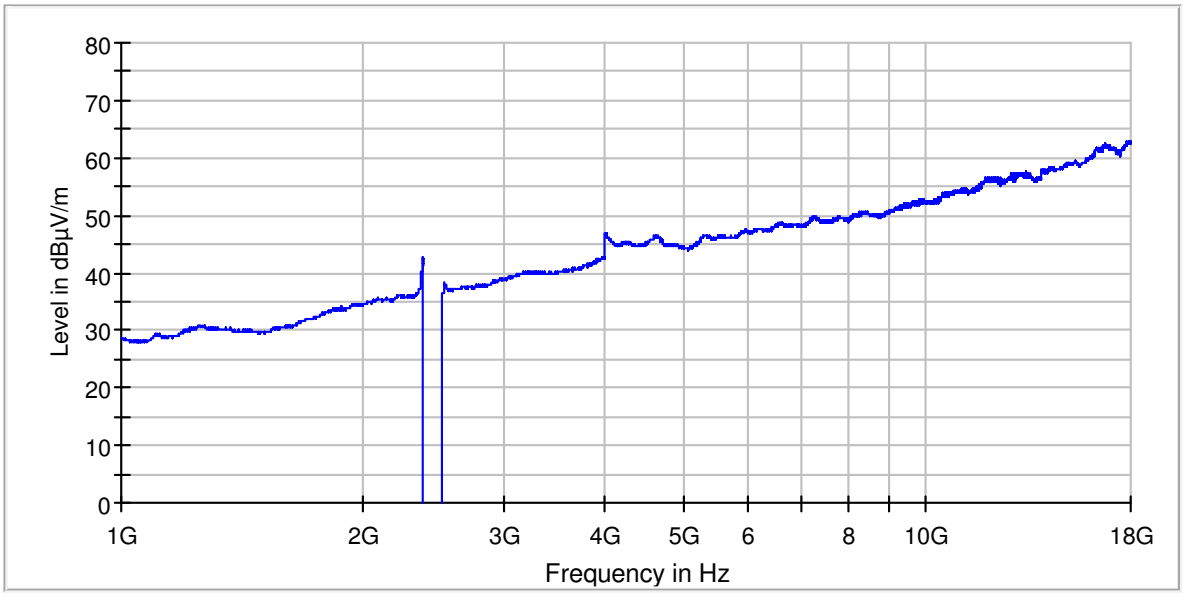
Noise Floor Measurements

Noise floor was measure with auxiliary equipment (load box and optical converters) switched ON and EUT disconnected.

Noise floor measured from 1 GHz to 9 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Vertical polarization.

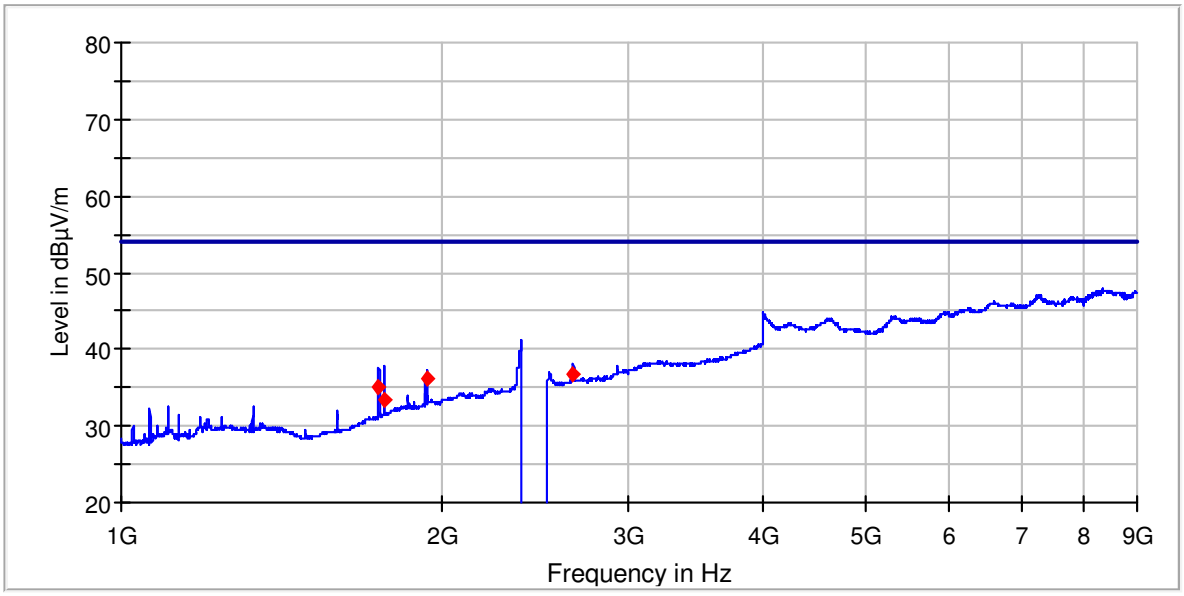


Noise floor measured from 1 GHz to 9 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Horizontal polarization.



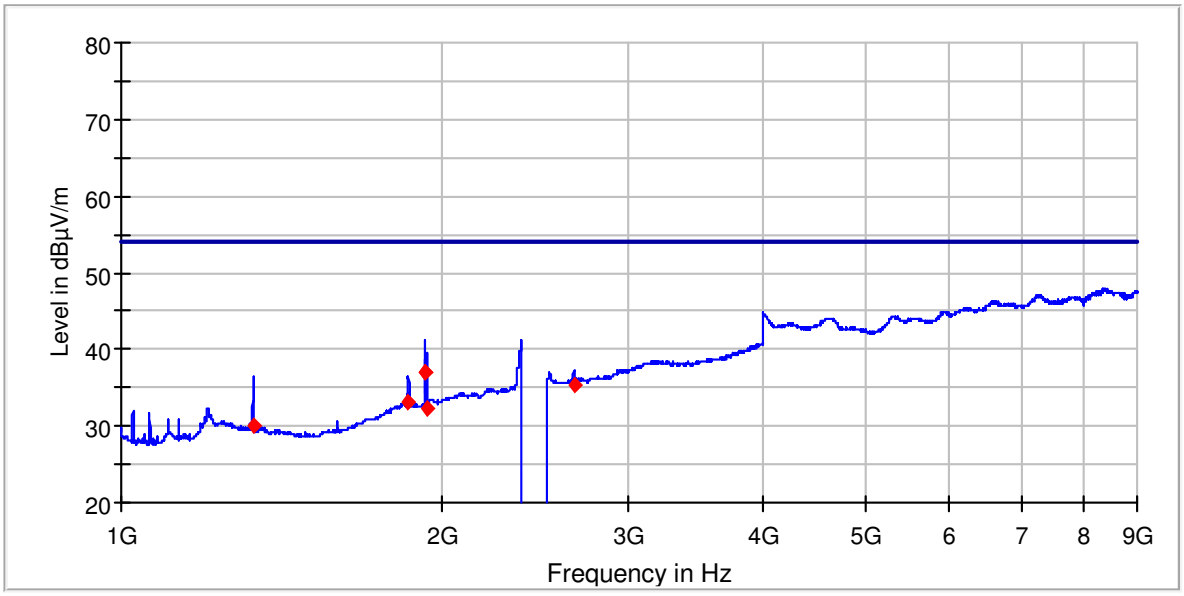
EUT Measurements

EUT emissions measured from 1 GHz to 9 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Vertical polarization.



Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Azimuth (deg)	Cables (dB)	Antenna Correction (dB/m)	Instrument Reading: Average (dBµV)	Result
1746.000000	35.2	54.0	-18.8	352.0	354.0	4.9	29.4	0.9	Pass
1764.000000	33.5	54.0	-20.5	400.0	123.0	4.9	29.5	-0.9	Pass
1939.250000	36.1	54.0	-17.9	376.0	0.0	5.2	31.1	-0.2	Pass
2660.000000	36.7	54.0	-17.3	174.0	29.0	6.0	32.3	-1.7	Pass

EUT emissions measured from 1 GHz to 9 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Horizontal polarization.



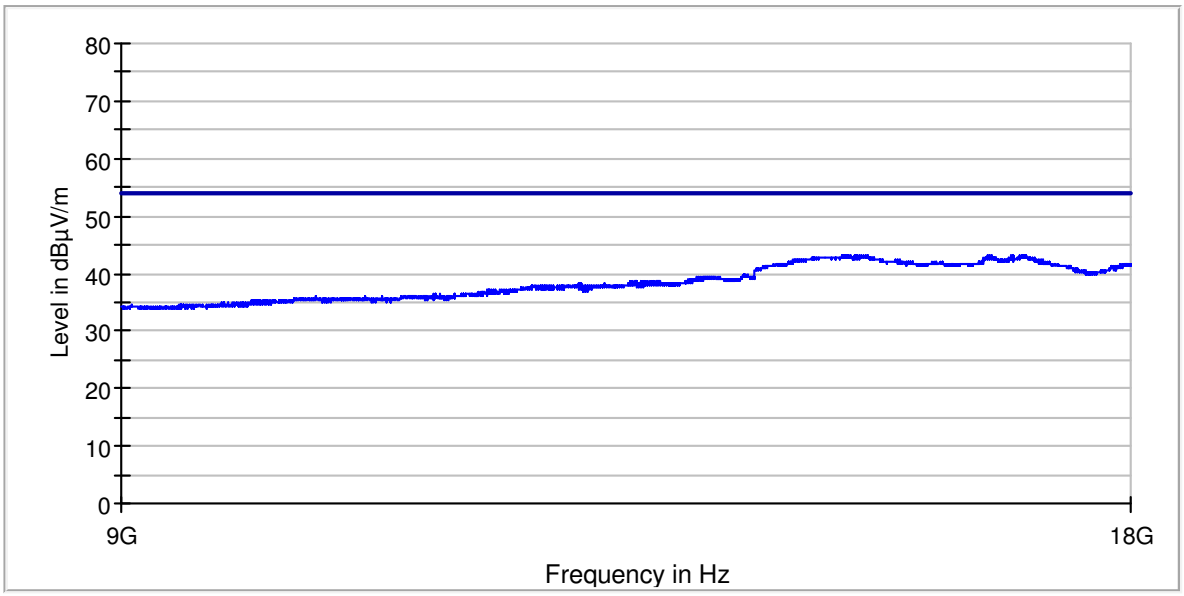
Frequency (MHz)	Average (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Height (cm)	Azimuth (deg)	Cables (dB)	Antenna Correction (dB/m)	Instrument Reading: Average (dBµV)	Result
1330.250000	30.1	54.0	-23.8	145.0	319.0	4.4	28.6	-2.8	Pass
1862.000000	33.0	54.0	-20.9	209.0	308.0	5.1	30.7	-2.8	Pass
1926.250000	37.0	54.0	-17.0	240.0	78.0	5.2	30.9	0.8	Pass
1932.250000	37.1	54.0	-16.9	251.0	146.0	5.2	31.1	0.8	Pass
1939.000000	32.4	54.0	-21.6	240.0	193.0	5.2	31.1	-3.9	Pass
2660.250000	35.5	54.0	-18.5	348.0	295.0	6.0	32.3	-2.9	Pass

Measures from 9 GHz to 18 GHz

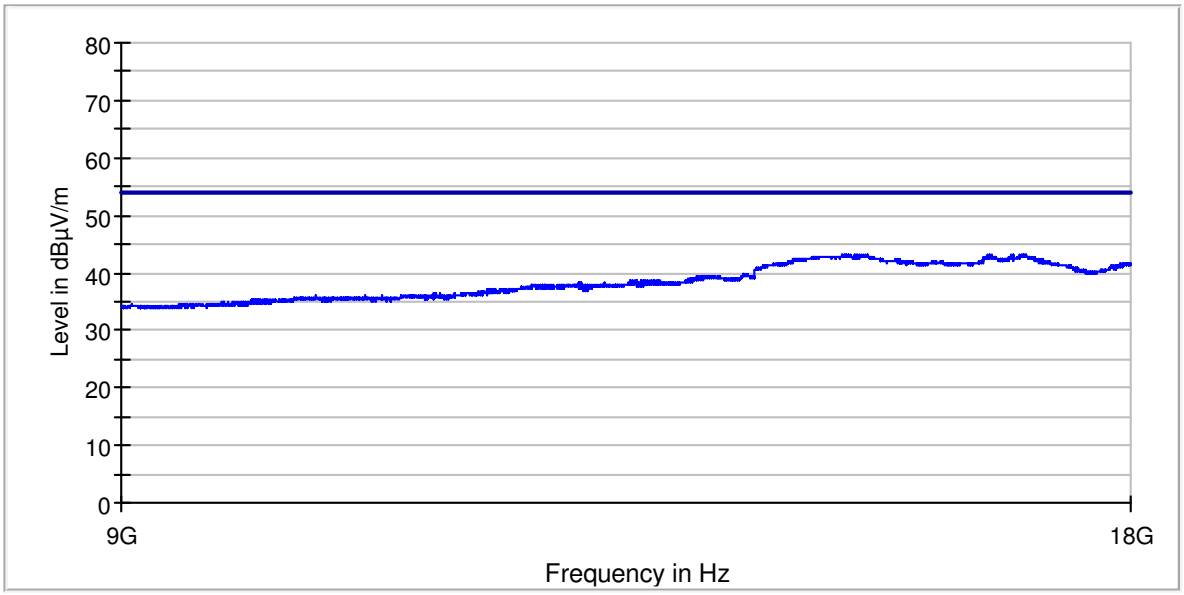
Noise Floor Measurements

Noise floor was measure with auxiliary equipment (load box and optical converters) switched ON and EUT disconnected.

Noise floor measured from 9 GHz to 18 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Vertical polarization.

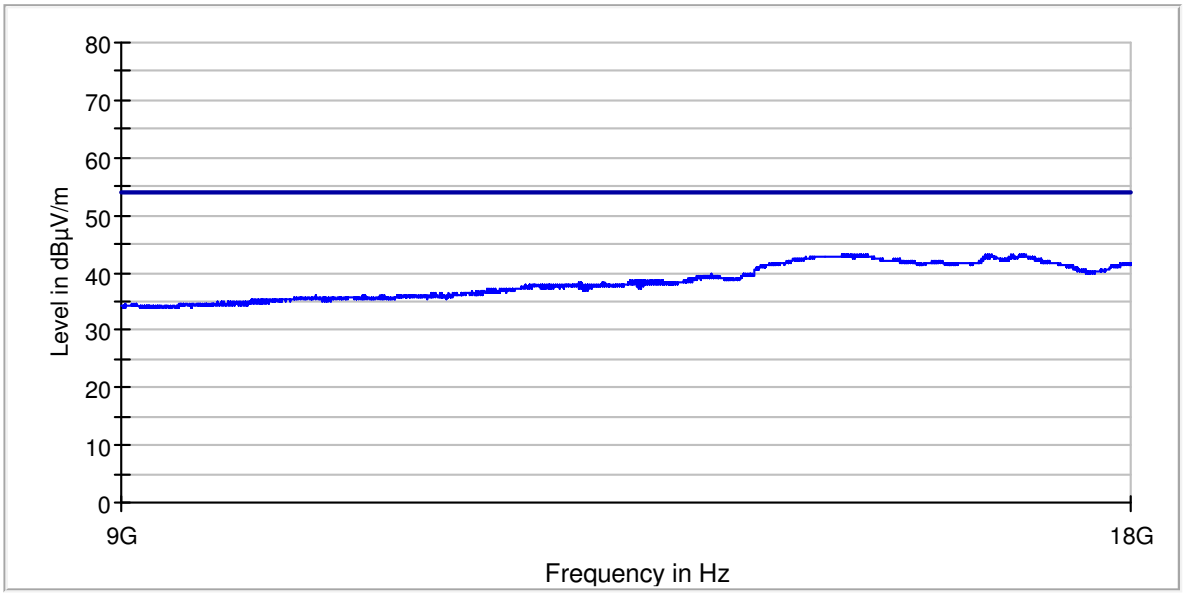


Noise floor measured from 9 GHz to 18 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Horizontal polarization.

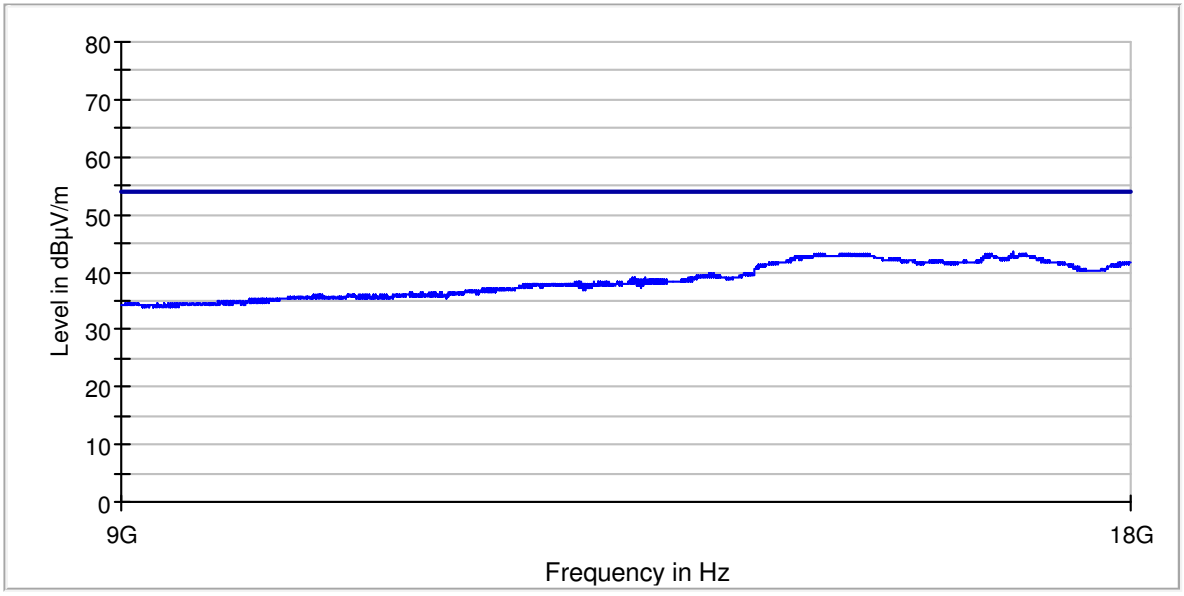


EUT Measurements

EUT emissions measured from 9 GHz to 18 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Vertical polarization.



EUT emissions measured from 9 GHz to 18 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Horizontal polarization.

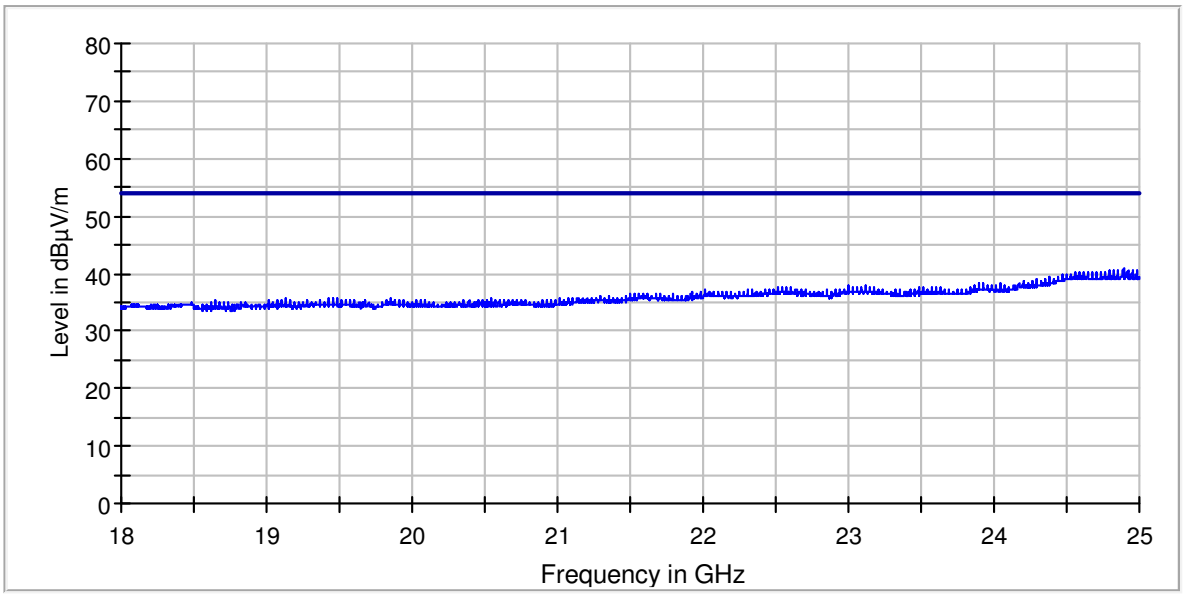


Measures from 18 GHz to 26 GHz

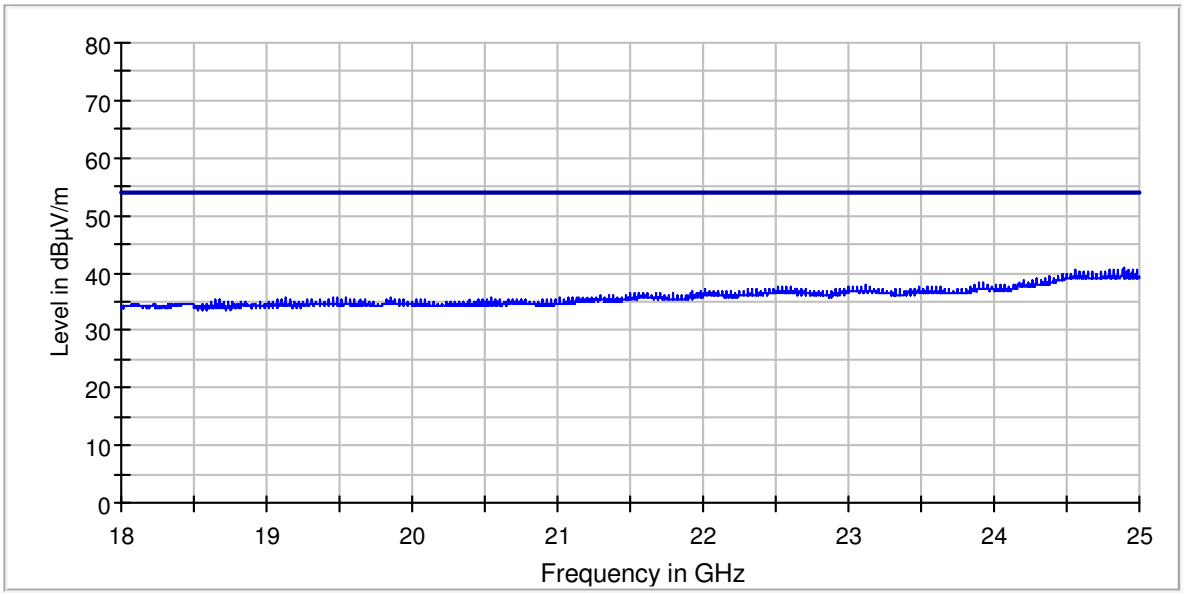
Noise Floor Measurements

Noise floor was measure with auxiliary equipment (load box and optical converters) switched ON and EUT disconnected.

Noise floor measured from 18 GHz to 26 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Vertical polarization.

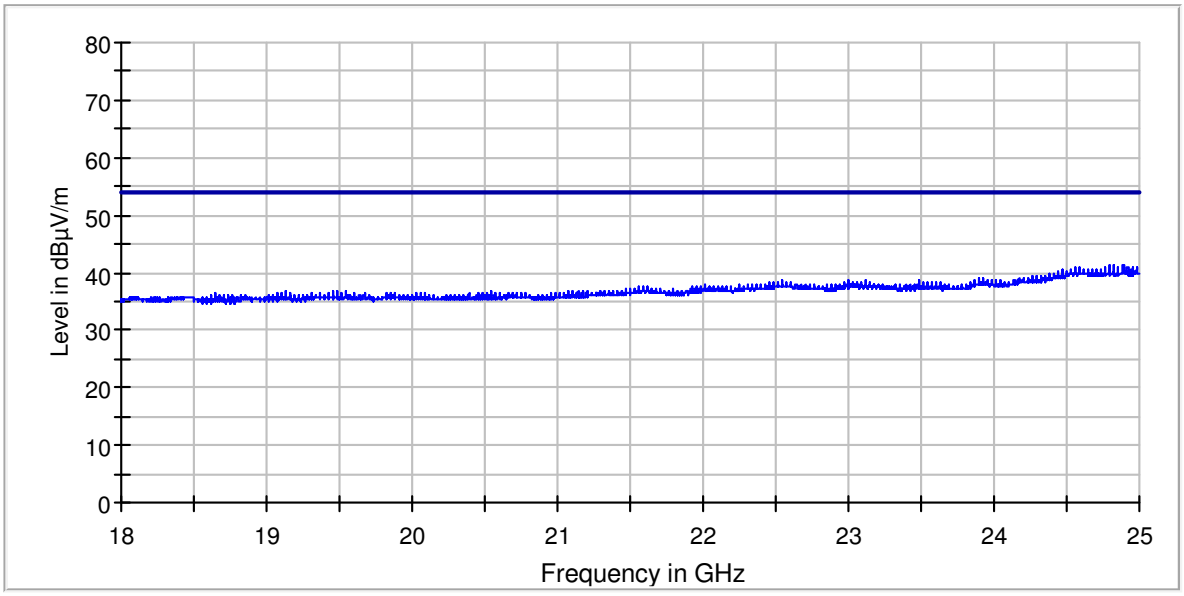


Noise floor measured from 18 GHz to 26 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Horizontal polarization.

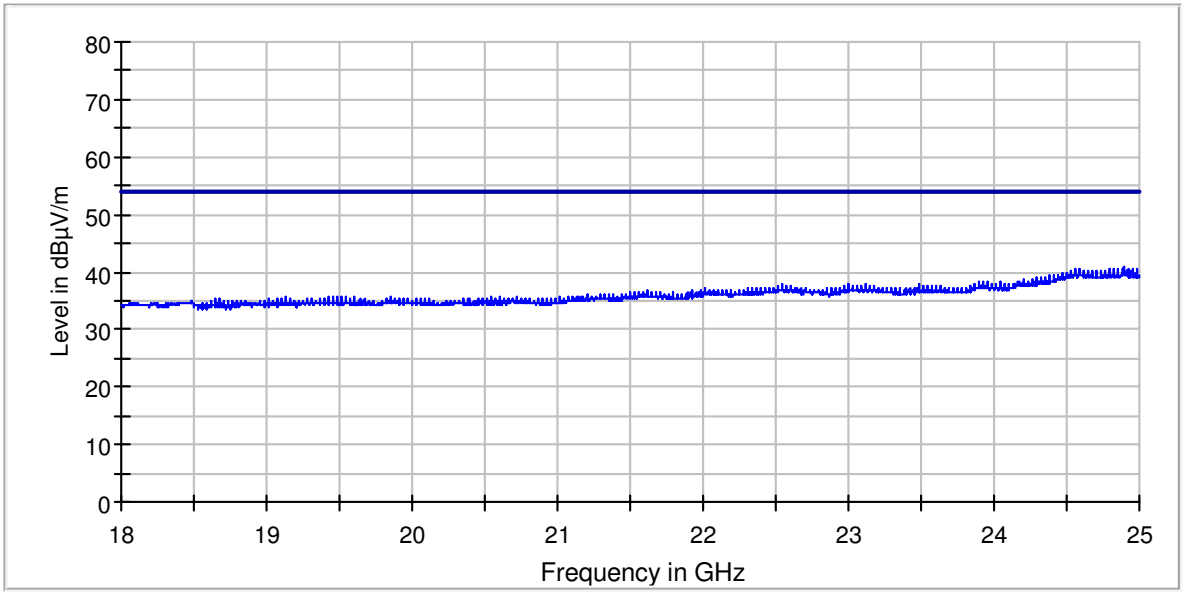


EUT Measurements

EUT emissions measured from 18 GHz to 26 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Vertical polarization.



EUT emissions measured from 18 GHz to 26 GHz: Average detector with IF 1 MHz. FCC section 15.209 Average Limit. Horizontal polarization.



9.0 Antenna requirement – Test Conditions

Technician	Rudy Valent		
Table No.	TEST: Antenna Requirement, Section 15.203		\
Method	/		\
Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C	
	Relative Humidity	Less or equal to 80 %	
Parameters recorded during the test	Laboratory Ambient Temperature	/	
	Relative Humidity	/	
Date (s) of test execution	/		
Supplementary information: since this product has permanent integrated antennas (see par. 1.7 - Config.1 of the applicable cited Test Plan), then it fulfills the requirement of this section.			

10.0 Conducted emission – Test Conditions

Technician	/		
Table No.	TEST: AC Power Line Conducted Emissions, Section 15.207		\
Method	/		\
Parameters required prior to the test	Laboratory Ambient Temperature	18 to 28 °C	
	Relative Humidity	Less or equal to 80 %	
Parameters recorded during the test	Laboratory Ambient Temperature	/	
	Relative Humidity	/	
Date (s) of test execution	/		
Supplementary information: this test is not applicable since the EUT is battery powered.			

Annex 1 – Uncertainty

A1.1 Measurement of Environmental parameters

Temperature: ±1°C

RH: ±4%

A1.2 Radio test

Conducted output power: **±2.4 dB**

Conducted adjacent channel power: **± 2.2 dB**

Conducted Bandwidth: **± 12 kHz (Span=3 MHz, RBW=100 kHz, 10001 pti)**

Conducted spurious emission: **± 3.7 dB**

A1.3 Radiated Spurious Emissions: FCC

From 9 kHz to 30 MHz using Loop antenna

Field intensity: **± 4.1 dB**

From 30 MHz to 200 MHz using Bilog antenna

Field intensity: **± 5.5 dB**

From 200 MHz to 1000 MHz using Bilog antenna

Field intensity: **± 4.4 dB**

From 1 GHz to 18 GHz using Horn antenna[1]

Field intensity: **± 5.7 dB**

From 18 GHz to 26 GHz using Horn antenna

Field intensity: **± 6.1 dB**

**********END OF TEST REPORT**********