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

TEST REPORT

This revision completely replaces previous test report no. 24-05401 (see §1.8)

According to following Standards

Test Methods	KDB Publication 865664 D02: 2015	
Test specification	FCC Rules: Code of Federal Regulations (CFR) no. 47 Part 1 Subpart I Section 1.1310 Test plan: Technical specification Display LEONARDO OTS2 v4.0	
Radiofrequency radiation exposure limits.		**Compliant**
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 11:09 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 12:01 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	FCC Rules: Code of Federal Regulations (CFR) no. 47 Part 1 Subpart I Section 1.1310
Test Methods / Basic Standard	KDB Publication 865664 D02: 2015

1.4 Test scheduling and general conditions

Scheduling:	
Date of receipt of EUT ..... :	18/04/2024
Date (s) of performance of tests..... :	27/05/2024
EUT Number ..... :	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. **24-05401** was prepared after a second check of the report 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:

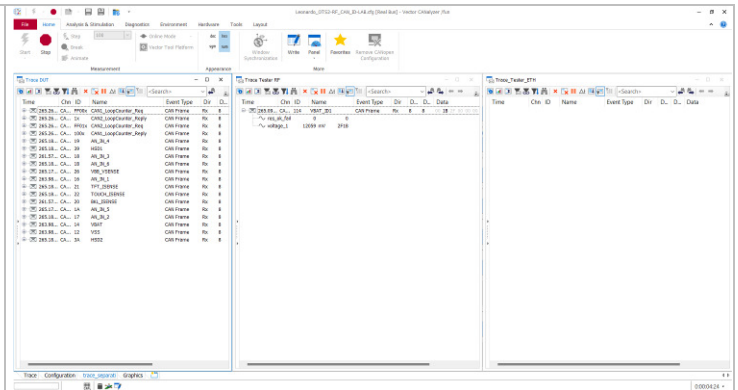
The changes made to the test report have no effect on the final judgment of the tests (Pass/Fail or Compliant/Not Compliant outcome) because they are not changes that affect the procedures and execution of the tests or the validity and compliance of the instruments used.

2.0 Device Under Test

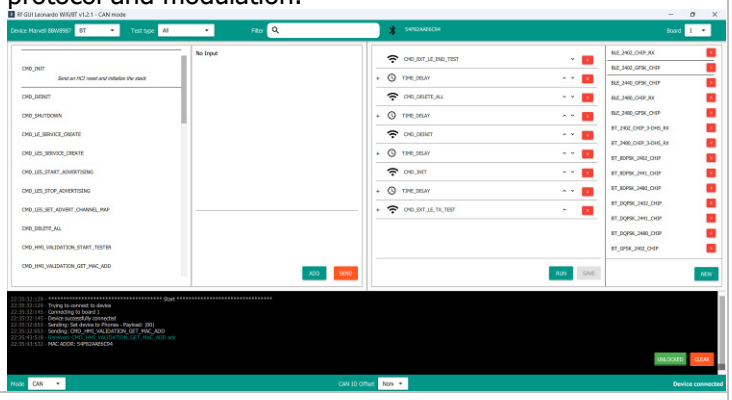
2.1 Device description and setup information

These information are provided by the customer under his own responsibility

Description ..... :	Touch Screen Instrument Panel
Trade Mark.....:	
Manufacturer .....:	MTA S.p.A.
Model/Type reference.....:	Display Leonardo OTS2
Voltage.....:	14.5 Vdc
Current.....:	-
Frequency .....:	-
Power.....:	-
Serial Number.....:	S/N: 00008, batch: 054 (24LA00181/02)
Number of samples tested .....:	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 (BT)

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	-	-

Bluetooth Low Energy (BLE)

Frequency band [MHz]: 2400 – 2483.5			
Channel	**Frequency [MHz]**	**Channel**	**Frequency [MHz]**
37	2402	18	2442
0	2404	19	2444
1	2406	20	2446
2	2408	21	2448
3	2410	22	2450
4	2412	23	2452
5	2414	24	2454
6	2416	25	2456
7	2418	26	2458
8	2420	27	2460
9	2422	28	2462
10	2424	29	2464
38	2426	30	2466
11	2428	31	2468
12	2430	32	2470
13	2432	33	2472
14	2434	34	2474
15	2436	35	2476
16	2438	36	2478
17	2440	39	2480

WiFi

Frequency band [MHz]: 2400 – 2483.5	
Channel	**Frequency [MHz]**
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462

2.4 Test modes and Channel details

Bluetooth (BT)

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)

Bluetooth Low Energy (BLE)

Test Description	Channel Frequency	Modulation	Data Rate
Maximum Peak Output Power, FCC Section 15.247 (b) (1)	2402 / 2440 / 2480	GFSK	1Mbps (BR)

WiFi

Test Description	Channel Frequency	Modulation
Maximum Peak Output Power, FCC Section 15.247 (b) (1)	CH1 / CH6 / CH11	WiFi b (22 MHz - DQPSK) / WiFi g (20 MHz - 64QUAM)

3.0 Limitation of human exposure to electromagnetic fields – 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	27/05/2024		

Supplementary information:

- Test performed on EUT 24LA00181/02
- Output Power to Antenna values are that of Channel Power measured on Bluetooth/BLE antenna output (50ohm, SMA) and WiFi (50ohm, SMA, connected to the Spectrum Analyser through an attenuator (30 dB)
- EUT Integral Antenna Gain values were taken from the documentation provided by the applicant
- Test executed with the following settings:
  - (BT) BR mode with modulation GFSK on channel 0, 39 and 78
  - (BT) EDR mode with modulation π/4 DQPSK on channel 0, 39 and 78
  - (BT) EDR mode with modulation 8DPSK on channel 0, 39 and 78
  - BLE mode with modulation GFSK on channel 37, 17 and 39.
  - WiFi b mode with modulation DQPSK (22 MHz) on channel 1, 6 and 11.
  - WiFi g mode with modulation 64QUAM (20 MHz) on channel 1, 6 and 11.
- Worst cases for each transmitter, were summed to check the maximum emission in the presence of several transmitters operating simultaneously (Note: BT and BLE transmitters cannot operate together).

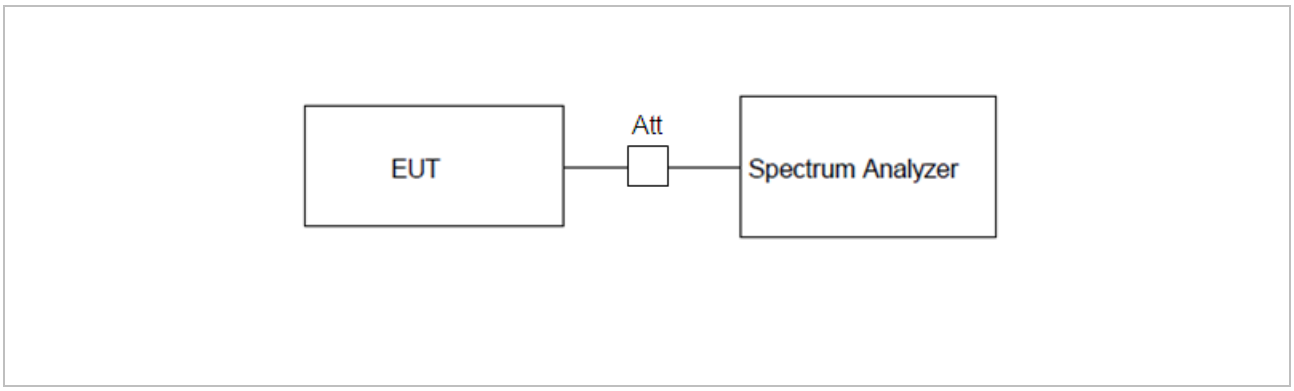
3.1 Test Equipment Used – Limitation of human exposure to electromagnetic fields

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	

3.2 Auxiliary Equipment – Limitation of human exposure to electromagnetic fields

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

3.3 Setup – Limitation of human exposure to electromagnetic fields



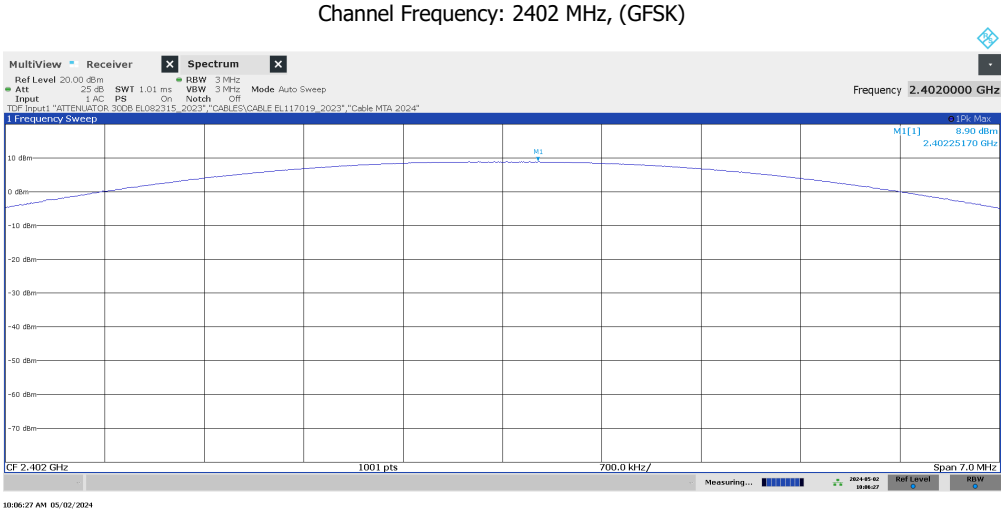
3.4 Channel Power measurement – Limitation of human exposure to electromagnetic fields

See the details in the charts/tables of the following paragraphs (see the worst case in bold text).

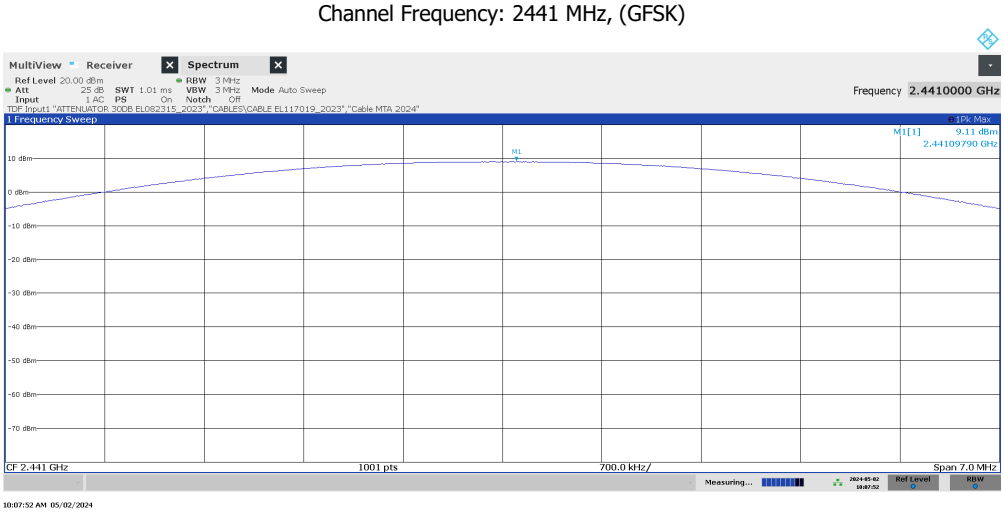
Bluetooth (BT) Transmitter

Modulation mode	Channel Frequency (MHz)	Output Power (dBm)
GFSK	2402.0	8.9
	2441.0	9.1
	2480.0	9.3
π/4 DQPSK	2402.0	7.9
	2441.0	8.1
	2480.0	8.4
8DPSK	2402.0	8.3
	2441.0	8.4
	2480.0	8.6

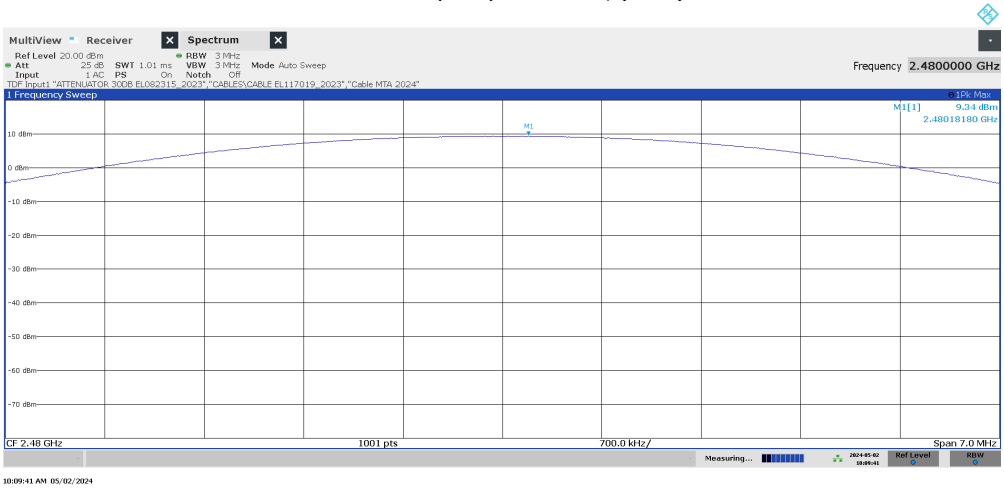
Channel Frequency: 2402 MHz, (GFSK)



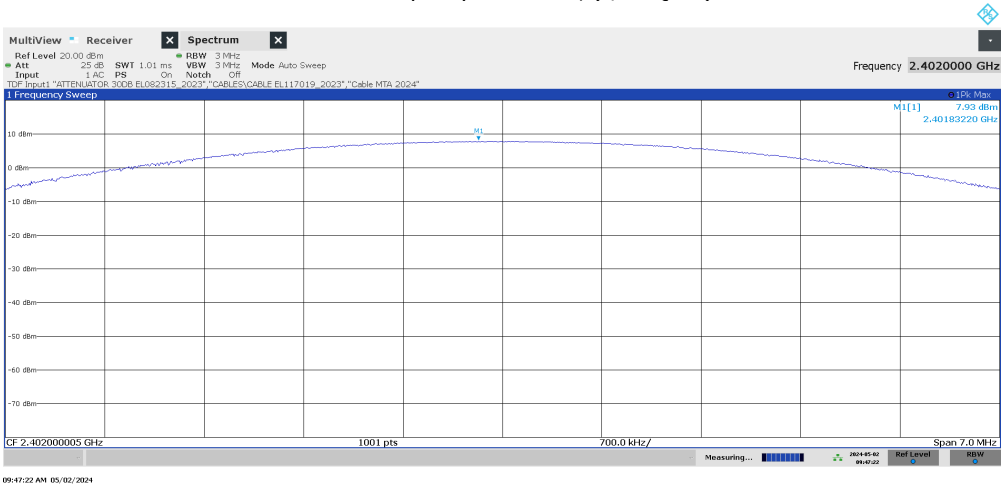
Channel Frequency: 2441 MHz, (GFSK)



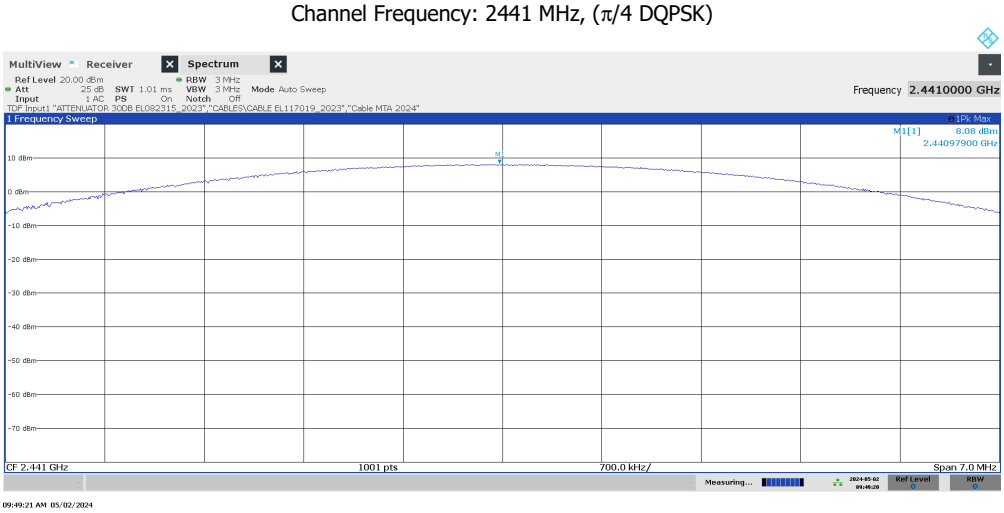
Channel Frequency: 2480 MHz, (GFSK)



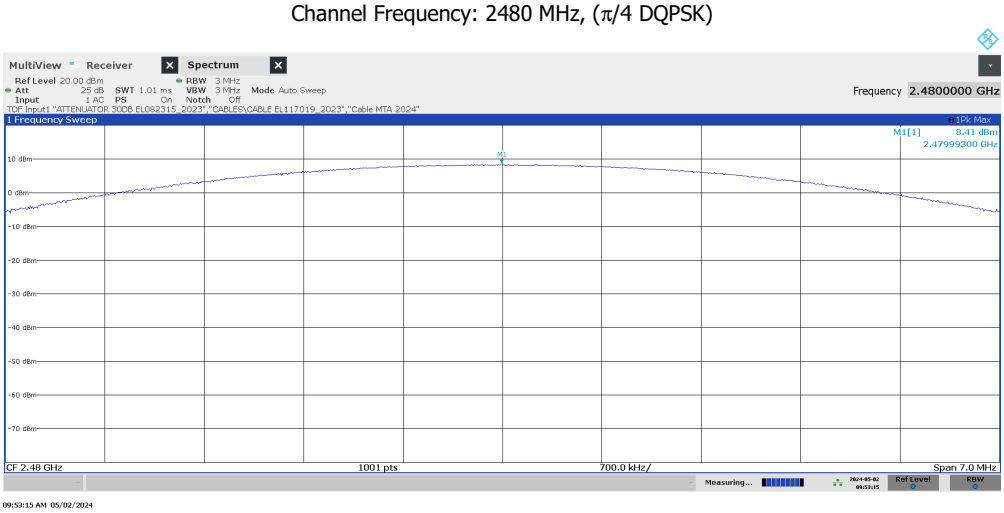
Channel Frequency: 2402 MHz, (π/4 DQPSK)



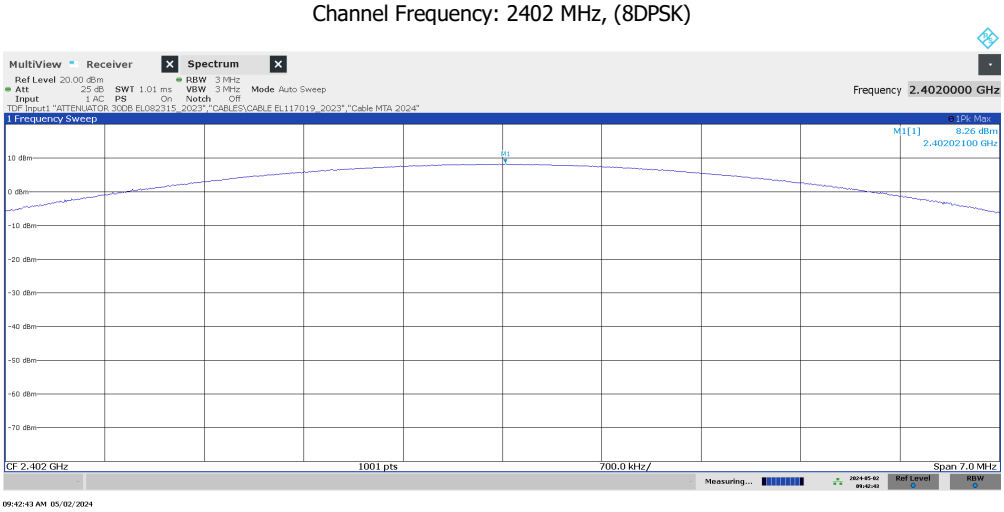
Channel Frequency: 2441 MHz, (π/4 DQPSK)



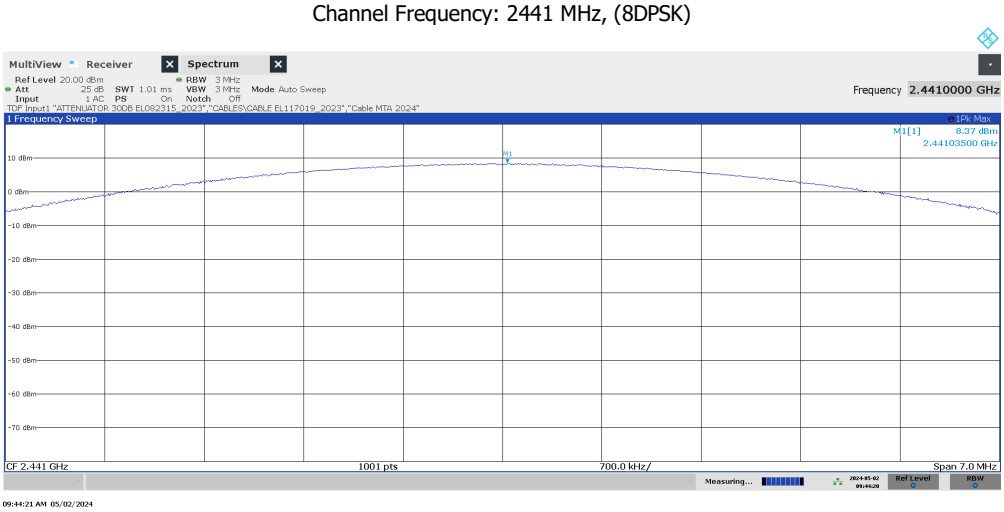
Channel Frequency: 2480 MHz, (π/4 DQPSK)



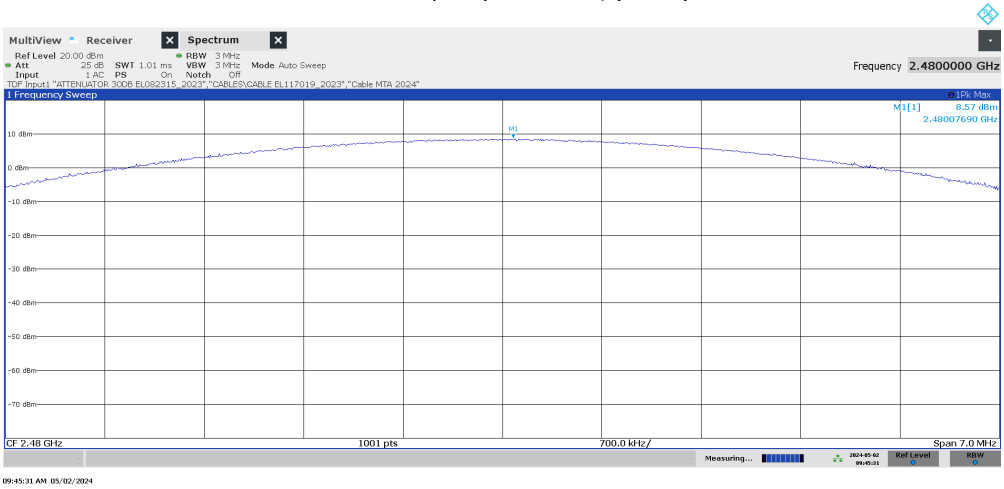
Channel Frequency: 2402 MHz, (8DPSK)



Channel Frequency: 2441 MHz, (8DPSK)



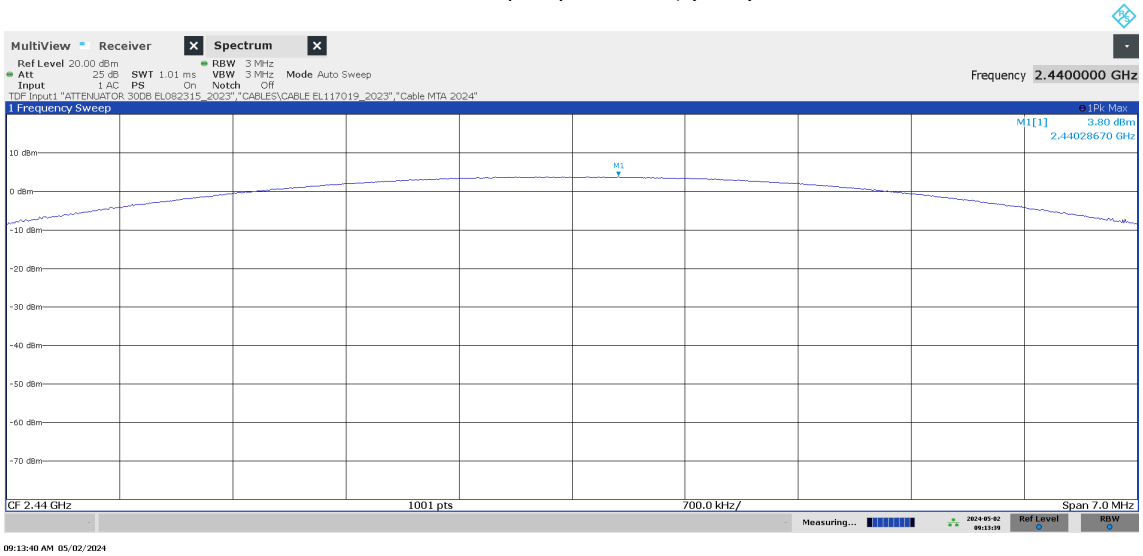
Channel Frequency: 2480 MHz, (8DPSK)



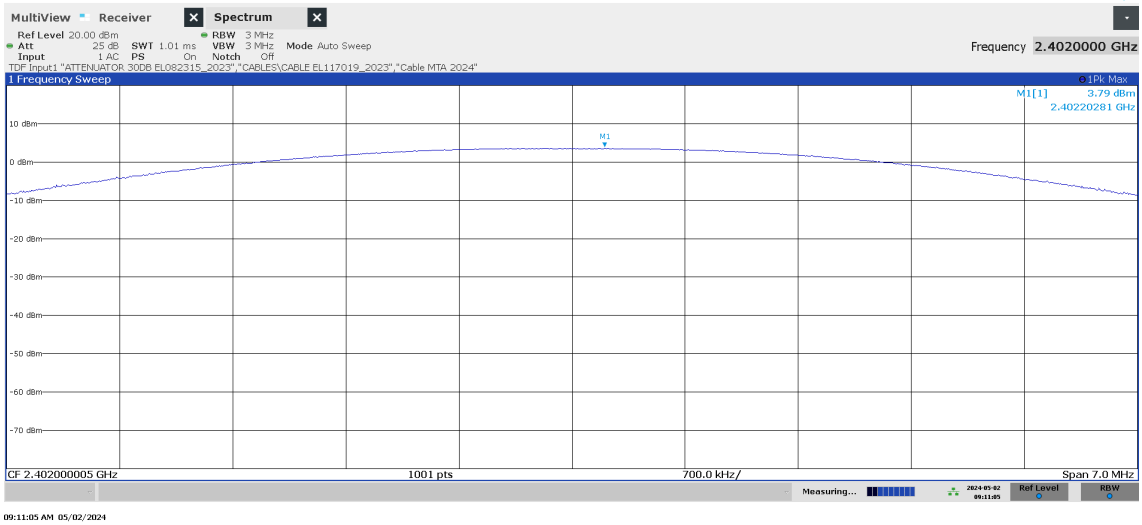
Bluetooth Low Energy (BLE) Transmitter

Modulation mode	Channel Frequency (MHz)	Output Power (dBm)
GFSK	2402,0	3.8
	2440,0	3.8
	2480,0	4.0

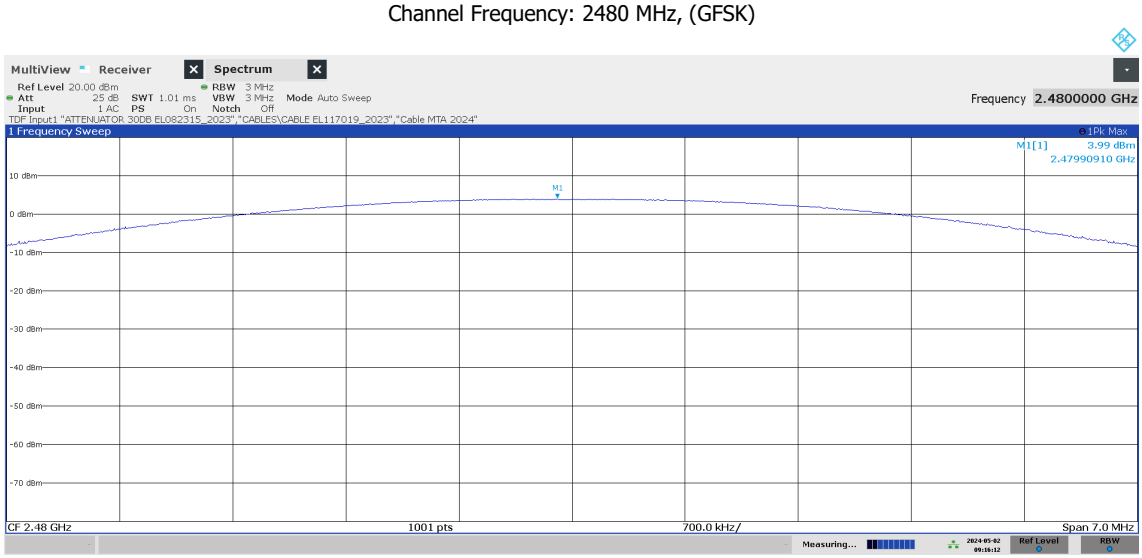
Channel Frequency: 2402 MHz, (GFSK)



Channel Frequency: 2440 MHz, (GFSK)



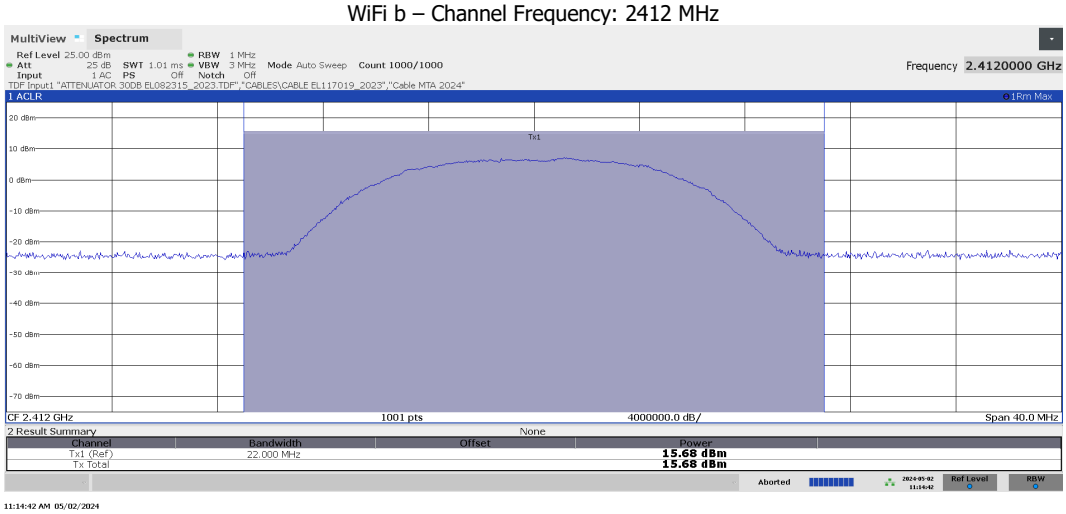
Channel Frequency: 2480 MHz, (GFSK)



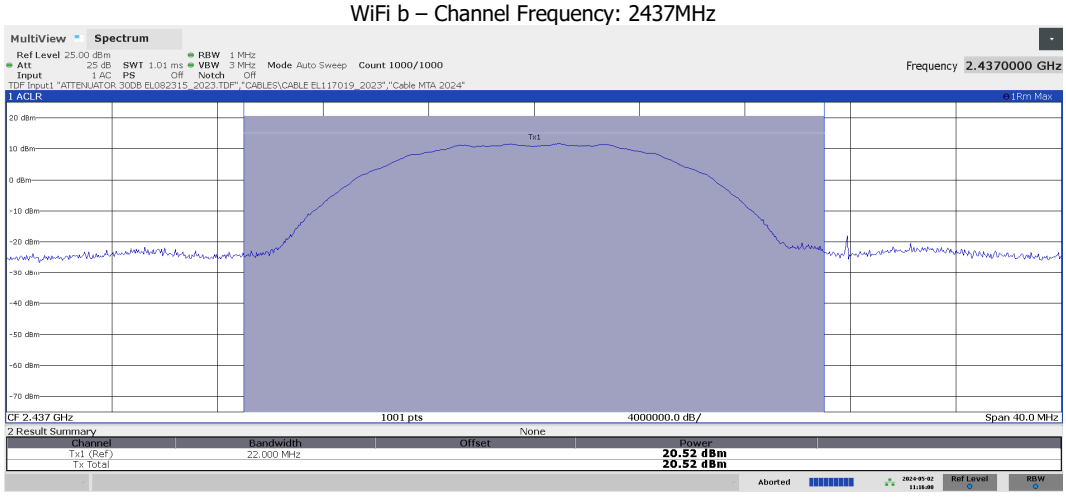
WiFi Transmitter

Modulation mode	Channel Frequency (MHz)	Output Power (dBm)
WiFi b	2412.0	15.7
	2437.0	20.5
	2462.0	12.7
WiFi g	2412.0	25.7
	2437.0	26.3
	2462.0	26.3

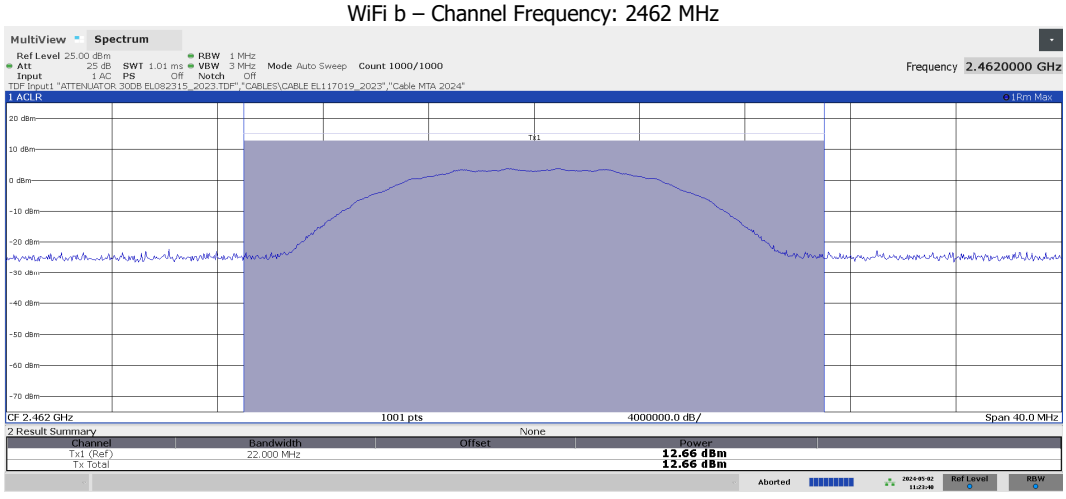
WiFi b – Channel Frequency: 2412 MHz



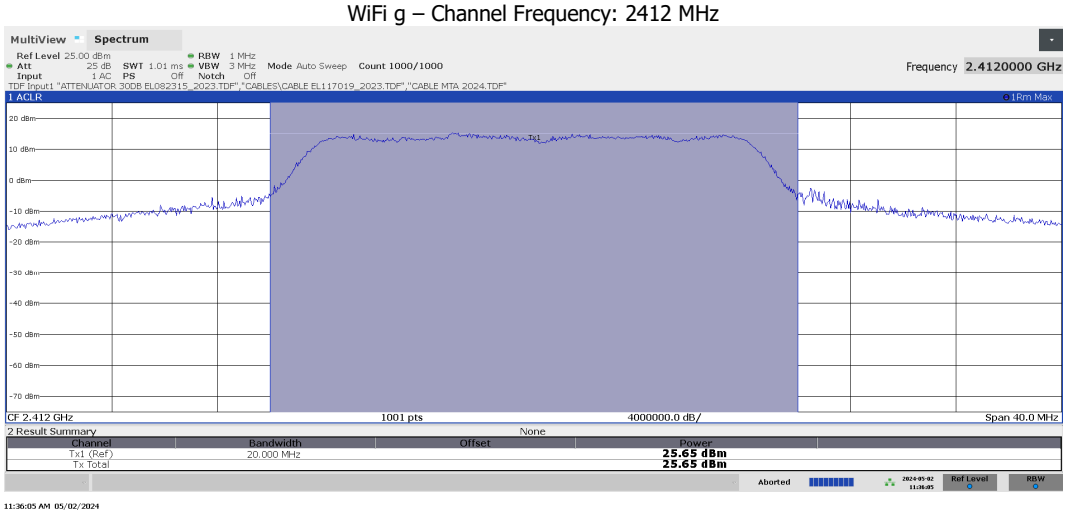
WiFi b – Channel Frequency: 2437MHz



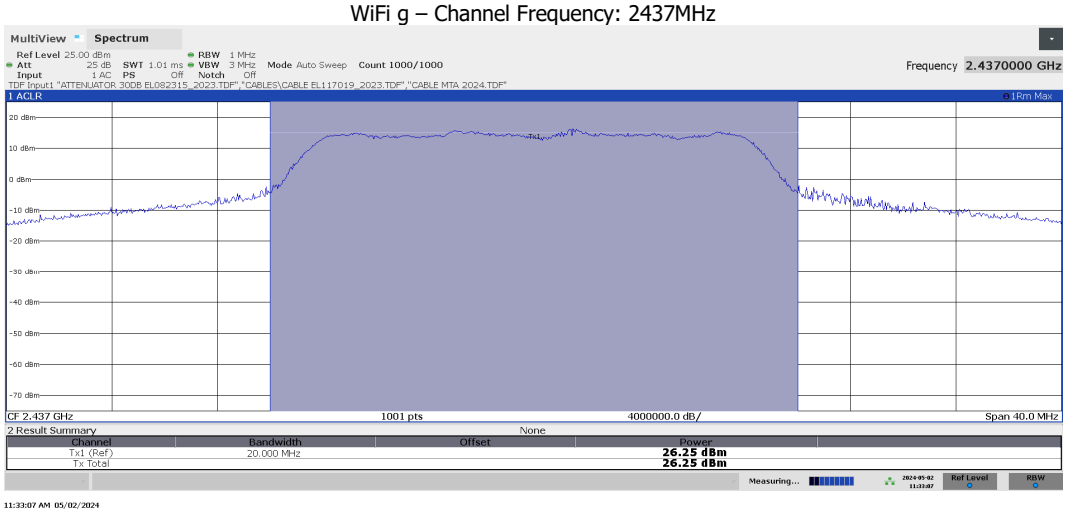
WiFi b – Channel Frequency: 2462 MHz



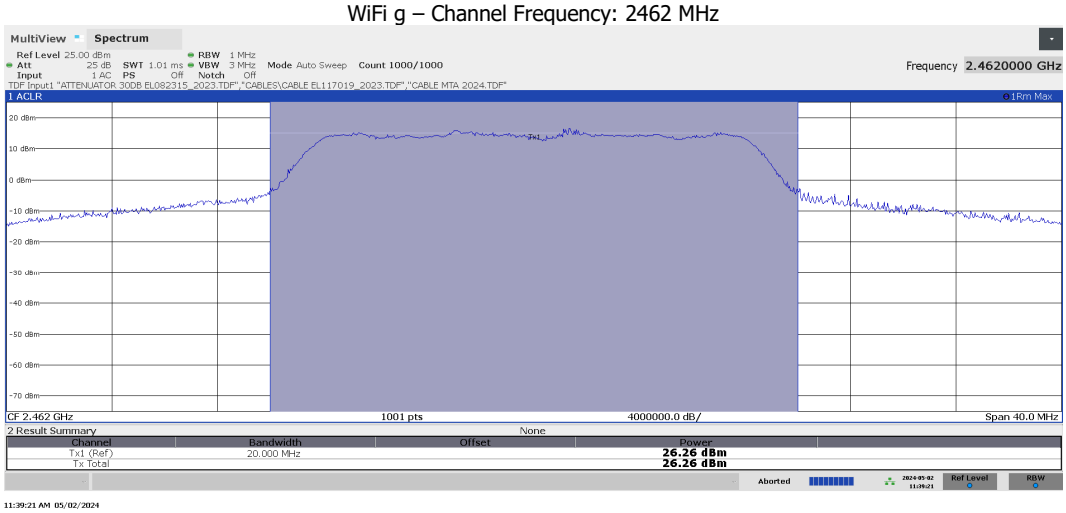
WiFi g – Channel Frequency: 2412 MHz



WiFi g – Channel Frequency: 2437MHz



WiFi g – Channel Frequency: 2462 MHz



3.5 Results – Limitation of human exposure to electromagnetic fields

BLE													
Modulation	**Channel Freq. (MHz)**	**Estimeted Tune-up Tolerance (dB)**	**Output Power to Antenna (dBm)**	**Output Power to Antenna + tolerance (dBm)**	**Output Power to Antenna (mW)**	**Integral Antenna Gain (dBi)**	**distance at evaluation point (m)**	**Duty cycle (%)**	**(Seq) Power Density (mW/cm²)**	**(Seq lim) Power Density Limit (mW/cm²)**	**Difference from limit (mW/cm²)**	**Result (Pass/Fail)**	**Seq/Seq lim**
GFSK	2402	0	3,8	3,8	2,4	2,0	0,2	100,0	0,0	1,0	-0,999	Pass	0,0008
	2440	0	3,8	3,8	2,4	2,0	0,2	100,0	0,0	1,0	-0,999	Pass	0,0008
	2480	0	4,0	4,0	2,5	2,0	0,2	100,0	0,0	1,0	-0,999	Pass	**0,0008**
BT													
Modulation	**Channel Freq. (MHz)**	**Estimeted Tune-up Tolerance (dB)**	**Output Power to Antenna (dBm)**	**Output Power to Antenna + tolerance (dBm)**	**Output Power to Antenna (mW)**	**Integral Antenna Gain (dBi)**	**distance at evaluation point (m)**	**Duty cycle (%)**	**(Seq) Power Density (mW/cm²)**	**(Seq lim) Power Density Limit (mW/cm²)**	**Difference from limit (mW/cm²)**	**Result (Pass/Fail)**	**Seq/Seq lim**
GFSK	2402	0	8,9	8,9	7,8	2,0	0,2	100,00	0,002	1,000	-0,998	Pass	0,0024
	2441	0	9,1	9,1	8,1	2,0	0,2	100,00	0,003	1,000	-0,997	Pass	0,0026
	2480	0	9,3	9,3	8,5	2,0	0,2	100,00	0,003	1,000	-0,997	Pass	0,0027
π/4 DQPSK	2402	0	7,9	7,9	6,2	2,0	0,2	100,00	0,002	1,000	-0,998	Pass	0,0019
	2441	0	8,1	8,1	6,5	2,0	0,2	100,00	0,002	1,000	-0,998	Pass	0,0020
	2480	0	8,4	8,4	6,9	2,0	0,2	100,00	0,002	1,000	-0,998	Pass	0,0022
8DPSK	2402	0	8,3	8,3	6,8	2,0	0,2	100,00	0,002	1,000	-0,998	Pass	0,0021
	2441	0	8,4	8,4	6,9	2,0	0,2	100,00	0,002	1,000	-0,998	Pass	0,0022
	2480	0	8,6	8,6	7,2	2,0	0,2	100,00	0,002	1,000	-0,998	Pass	**0,0023**
WiFi													

Modulation	Channel Freq. (MHz)	Estimeted Tune-up Tolerance (dB)	Output Power to Antenna (dBm)	Output Power to Antenna + tolerance (dBm)	Output Power to Antenna (mW)	Integral Antenna Gain (dBi)	distance at evaluation point (m)	Duty cycle (%)	(Seq) Power Density (mW/cm²)	(Seq lim) Power Density Limit (mW/cm²)	Difference from limit (mW/cm²)	Result (Pass/Fail)	Seq/Seq lim
WiFi b	2412	0	15,7	15,7	37,2	2,0	0,2	100,00	0,012	1,000	-0,988	Pass	0,0117
	2437	0	20,5	20,5	112,2	2,0	0,2	100,00	0,035	1,000	-0,965	Pass	0,0354
	2462	0	12,7	12,7	18,6	2,0	0,2	100,00	0,006	1,000	-0,994	Pass	0,0059
WiFi g	2412	0	25,7	25,7	371,5	2,0	0,2	100,00	0,117	1,000	-0,883	Pass	0,1171
	2437	0	26,3	26,3	426,6	2,0	0,2	100,00	0,135	1,000	-0,865	Pass	0,1345
	2462	0	26,3	26,3	426,6	2,0	0,2	100,00	0,135	1,000	-0,865	Pass	0,1345

MPE limit compliance calculation for co-location with both BLE and WiFi transmitters actives at the same time

(Seq1 /Seq lim1) + (Seq2 /Seq lim2)	Result (Pass/Fail)
0,1353	Pass

MPE limit compliance calculation for co-location with both BT and WiFi transmitters actives at the same time

$(Seq_1 / Seq_{lim1}) + (Seq_2 / Seq_{lim2})$ shall be < 1

(Seq1 /Seq lim1) + (Seq2 /Seq lim2)	Result (Pass/Fail)
0,1368	Pass

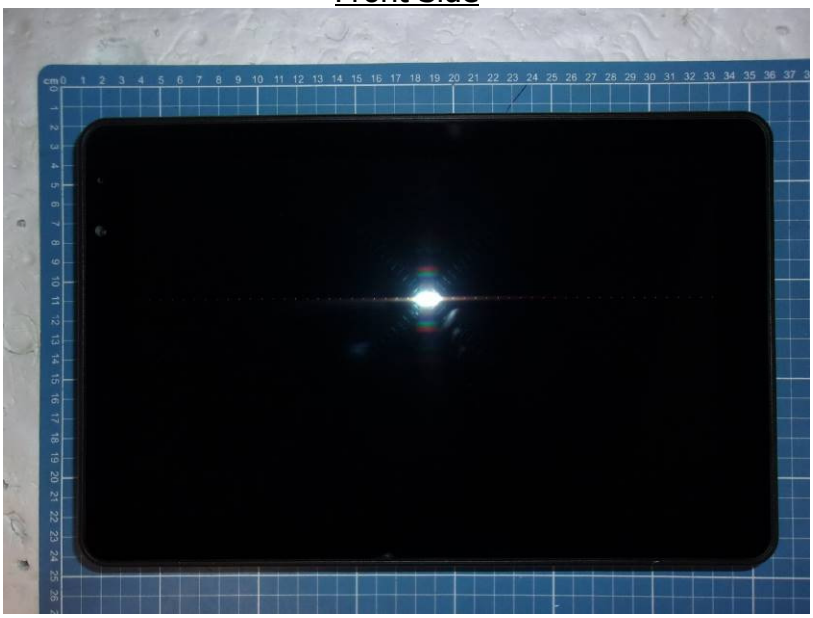
Formula "Power Density":

$$Seq\ (mW/cm^2) = \frac{Output\ Power\ (mW) \times Antenna\ Gain}{4 \times \pi \times Distance\ (cm)2} \times Duty\ Cycle$$

Annex 1 – Additional EUT detail pictures

Pictures of sample modified with external antennas

Front Side



Rear Side

EUT Details

Connectors

Label

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