

TEST REPORT

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CHINA
Report Number: SZ3240124-05690E-RF-00A
FCC ID: 2AL9B-SNG301

Test Standard (s)

FCC PART 15.247

Sample Description

Product Type: Bluetooth Headphone
Model No.: SNG301
Multiple Model(s) No.: SNG301-CAT, SNG301-UNI, SNG301-PNDA, SL-8150
Trade Mark: Singimals, Vivitar
Date Received: 2024/01/24
Report Date: 2024/03/11

Test Result:	Pass▲
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▲ In the configuration tested, the EUT complied with the standards above.

Prepared and Checked By:

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April Zhang
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Approved By:

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Jimmy Xiao
RF Supervisor

Note: The information marked # is provided by the applicant, the laboratory is not responsible for its authenticity and this information can affect the validity of the result in the test report. Customer model name, addresses, names, trademarks etc. are included.

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	SZ3240124-05690E-RF-00A	Original Report	2024/03/11

GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product	Bluetooth Headphone
Tested Model	SNG301
Multiple Model(s)	SNG301-CAT, SNG301-UNI, SNG301-PNDA, SL-8150 (The Multiple models are electrically identical with the test model except for color and decoration. Please refer to the declaration letter [#] for more detail, which was provided by manufacturer.)
Frequency Range	Bluetooth: 2402-2480MHz
Maximum Conducted Peak Output Power	4.11dBm
Modulation Technique	Bluetooth: GFSK, $\pi/4$ -DQPSK, 8DPSK
Antenna Specification [#]	-0.58dBi (provided by the applicant)
Voltage Range	DC 3.7V from battery or DC 5V from USB port
Sample serial number	2H4G-2 for Radiated Emissions Test 2H4G-1 for RF Conducted Test (Assigned by BACL, Shenzhen)
Sample/EUT Status	Good condition
Adapter Information	N/A

Objective

This test report is in accordance with Part 2-Subpart J, Part 15-Subparts A and C of the Federal Communication Commission rules.

The tests were performed in order to determine compliance with FCC Part 15, Subpart C, section 15.203, 15.205, 15.209 and 15.247 rules.

Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices.

All emissions measurement was performed at Bay Area Compliance Laboratories Corp. (Shenzhen). The radiated testing was performed at an antenna-to-EUT distance of 3 meters.

Each test item follows test standards and with no deviation.

Measurement Uncertainty

Parameter		Uncertainty
Occupied Channel Bandwidth		±5%
RF output power, conducted		0.72 dB(k=2, 95% level of confidence)
AC Power Lines Conducted Emissions	9kHz~150 kHz	3.94dB(k=2, 95% level of confidence)
	150 kHz ~30MHz	3.84dB(k=2, 95% level of confidence)
Radiated Emissions	9kHz - 30MHz	3.30dB(k=2, 95% level of confidence)
	30MHz~200MHz (Horizontal)	4.48dB(k=2, 95% level of confidence)
	30MHz~200MHz (Vertical)	4.55dB(k=2, 95% level of confidence)
	200MHz~1000MHz (Horizontal)	4.85dB(k=2, 95% level of confidence)
	200MHz~1000MHz (Vertical)	5.05dB(k=2, 95% level of confidence)
	1GHz - 6GHz	5.35dB(k=2, 95% level of confidence)
	6GHz - 18GHz	5.44dB(k=2, 95% level of confidence)
	18GHz - 40GHz	5.16dB(k=2, 95% level of confidence)
Temperature		±1°C
Humidity		±1%
Supply voltages		±0.4%

Note: The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval. Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty.

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Shenzhen) to collect test data is located on the 5F(B-West) , 6F, 7F, the 3rd Phase of Wan Li Industrial Building D, Shihua Rd, FuTian Free Trade Zone, Shenzhen, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 715558, the FCC Designation No. : CN5045.

SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in an engineering mode.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
0	2402	40	2442
1	2403	41	2443
2	2404	42	2444
...	...	...	...
...	...	...	...
36	2438	75	2477
37	2439	76	2478
38	2440	77	2479
39	2441	78	2480

EUT was tested with Channel 0, 39 and 78.

EUT Exercise Software

“FCC_assisc1.0.2.2”[#] exercise software was used and the power level is 10[#]. The software and power level was provided by the applicant.

Special Accessories

No special accessory.

Equipment Modifications

No modification was made to the EUT tested.

Support Equipment List and Details

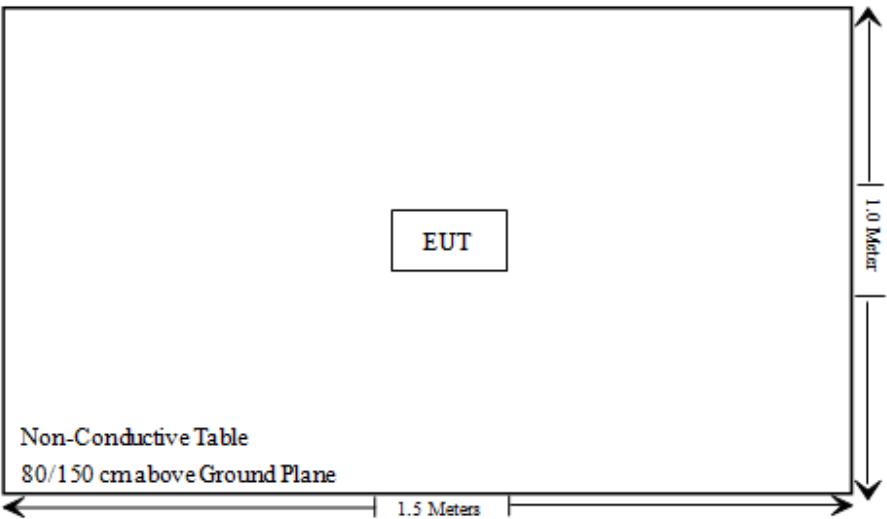
Manufacturer	Description	Model	Serial Number
/	/	/	/

External I/O Cable

Cable Description	Length (m)	From Port	To
/	/	/	/

Block Diagram of Test Setup

For Radiated Emissions:



SUMMARY OF TEST RESULTS

Rules	Description of Test	Result
FCC 15.247 (i), §1.1307 (b) & §2.1093	RF Exposure	Compliant
FCC §15.203	Antenna Requirement	Compliant
FCC §15.207(a)	AC Line Conducted Emissions	Not Applicable
FCC §15.205, §15.209, §15.247(d)	Radiated Emissions	Compliant
FCC §15.247(a)(1)	20 dB Emission Bandwidth	Compliant
FCC §15.247(a)(1)	Channel Separation Test	Compliant
FCC §15.247(a)(1)(iii)	Time of Occupancy (Dwell Time)	Compliant
FCC §15.247(a)(1)(iii)	Quantity of hopping channel Test	Compliant
FCC §15.247(b)(1)	Peak Output Power Measurement	Compliant
FCC §15.247(d)	Band edges	Compliant

Not Applicable: The device is powered by the battery when normal operation.

TEST EQUIPMENT LIST

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
Radiated Emission Test					
R&S	EMI Test Receiver	ESR3	102455	2023/02/08	2024/02/07
Sonoma instrument	Pre-amplifier	310 N	186238	2023/06/08	2024/06/07
Sunol Sciences	Broadband Antenna	JB1	A040904-1	2023/07/20	2024/07/19
ETS	Passive Loop Antenna	6512	29604	2023/07/07	2024/07/06
Unknown	Cable	Chamber Cable 1	F-03-EM236	2023/08/03	2024/08/02
Unknown	Cable	Chamber Cable 4	EC-007	2023/08/03	2024/08/02
Rohde & Schwarz	Spectrum Analyzer	FSV40	101605	2023/04/18	2024/04/17
COM-POWER	Pre-amplifier	PA-122	181919	2023/06/29	2024/06/28
A.H.System	Pre-amplifier	PAM-1840VH	190	2023/08/03	2024/08/02
Schwarzbeck	Horn Antenna	BBHA9120D(1201)	1143	2023/07/26	2024/07/25
Electro-Mechanics Co	Horn Antenna	3116	2026	2023/09/18	2026/09/17
Unknown	RF Cable	KMSE	0735	2023/10/08	2024/10/07
Unknown	RF Cable	UFA147	219661	2023/10/08	2024/10/07
Unknown	RF Cable	XH750A-N	J-10M	2023/10/08	2024/10/07
UTIFLEX	RF Cable	NO. 13	232308-001	2023/08/03	2024/08/02
MICRO-TRONICS	2.8G Passband filter	HPM50111	F-03-EM217	2023/08/03	2024/08/02
SNSD	2.4G Band Reject filter	BSF2402-2480MN-0898-001	2.4G filter	2023/08/03	2024/08/02
Audix	EMI Test software	E3	191218(V9)	NCR	NCR
RF Conducted Test					
R&S	SPECTRUM ANALYZER	FSU26	200120	2024/01/08	2025/01/07
MARCONI	10dB Attenuator	6534/3	2942	2023/07/04	2024/07/03
Micro-Tronics	RF Cable	8082135	W1113	2023/07/04	2024/07/03

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Shenzhen) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

FCC§15.247 (i), §1.1307 (b) & §2.1093 - RF EXPOSURE

Applicable Standard

According to FCC §2.1093 and §1.1307(b) , systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

- a) According to KDB 447498 D01 General RF Exposure Guidance

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW})/(\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

1. $f(\text{GHz})$ is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test Exclusion.

Measurement Result

For worst case:

Frequency (MHz)	Maximum Tune-up power [#]		Calculated Distance (mm)	Calculated Value	Threshold (1-g SAR)	SAR Test Exclusion
	(dBm)	(mW)				
2402-2480	4.5	2.82	5	0.9	3	Yes

Note#: the maximum tune up power was declared by the applicant.

Result: No Standalone SAR test is required

FCC §15.203 - ANTENNA REQUIREMENT

Applicable Standard

According to FCC § 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

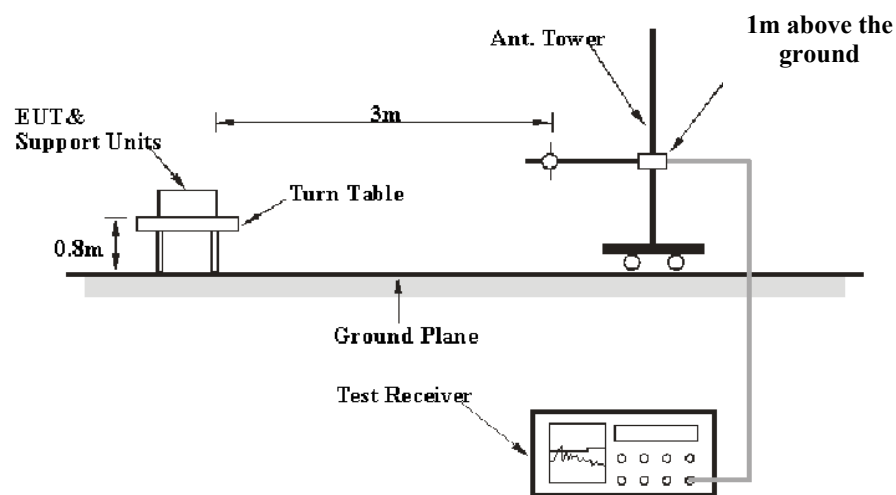
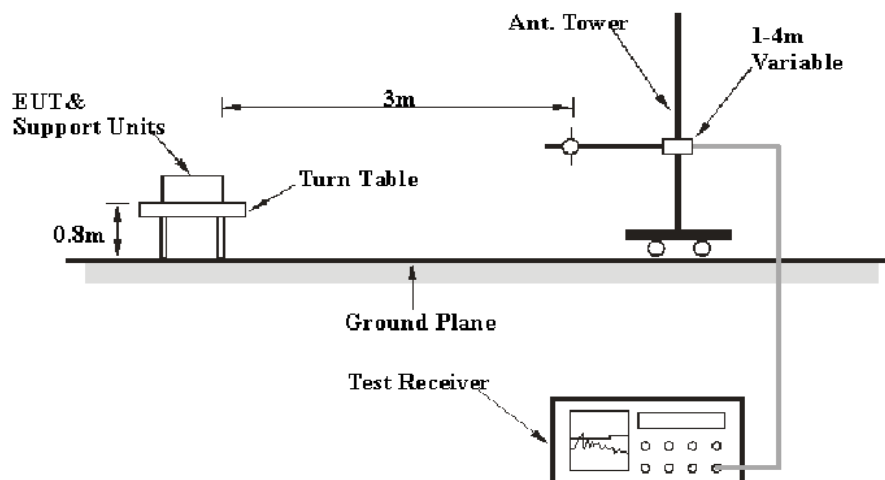
Antenna Connector Construction

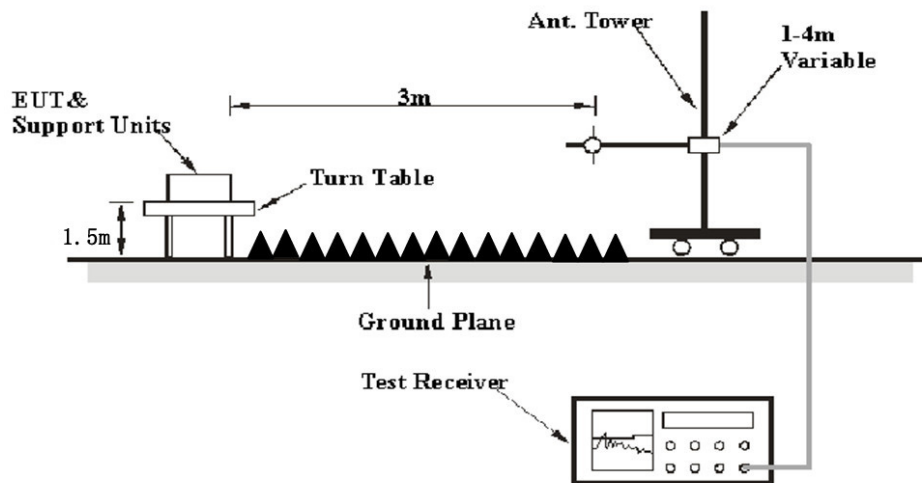
The EUT has one internal antenna arrangement, which was permanently attached, the antenna gain[#] is -0.58dBi, fulfill the requirement of this section. Please refer to the EUT photos.

Result: Compliant

FCC §15.205, §15.209 & §15.247(d) - RADIATED EMISSIONS**Applicable Standard**

FCC §15.205; §15.209; §15.247(d)

EUT Setup**9 kHz-30MHz:****30MHz-1GHz:**

Above 1GHz:

The radiated emission tests were performed in the 3 meters, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC 15.209 and FCC 15.247 limits.

EMI Test Receiver & Spectrum Analyzer Setup

The EMI test receiver & Spectrum Analyzer Setup were set with the following configurations:

Frequency Range	RBW	Video B/W	IF B/W	Measurement
9 kHz – 150 kHz	/	/	200 Hz	QP
	300 Hz	1 kHz	/	PK
150 kHz – 30 MHz	/	/	9 kHz	QP
	10 kHz	30 kHz	/	PK
30 MHz – 1000 MHz	/	/	120 kHz	QP
	100 kHz	300 kHz	/	PK
Above 1 GHz	1MHz	3 MHz	/	PK
	1MHz	10 Hz	/	AV

If the maximized peak measured value complies with under the QP/Average limit more than 6dB, then it is unnecessary to perform an QP/Average measurement.

Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All final data was recorded in Quasi-peak detection mode for frequency range of 9 kHz -1 GHz and peak and Average detection modes for frequencies above 1 GHz.

All emissions under the average limit and under the noise floor have not recorded in the report.

Factor & Over Limit/Margin Calculation

The Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain. The basic equation is as follows:

$$\text{Factor} = \text{Antenna Factor} + \text{Cable Loss} - \text{Amplifier Gain}$$

The “**Over Limit/Margin**” column of the following data tables indicates the degree of compliance with the applicable limit. For example, an Over Limit/margin of -7dB means the emission is 7dB below the limit. The equation for calculation is as follows:

$$\begin{aligned}\text{Over Limit} &= \text{Level} - \text{Limit}; \text{Margin} = \text{Corrected Amplitude} - \text{Limit} \\ \text{Level} / \text{Corrected Amplitude} &= \text{Read Level} + \text{Factor}\end{aligned}$$

Test Data

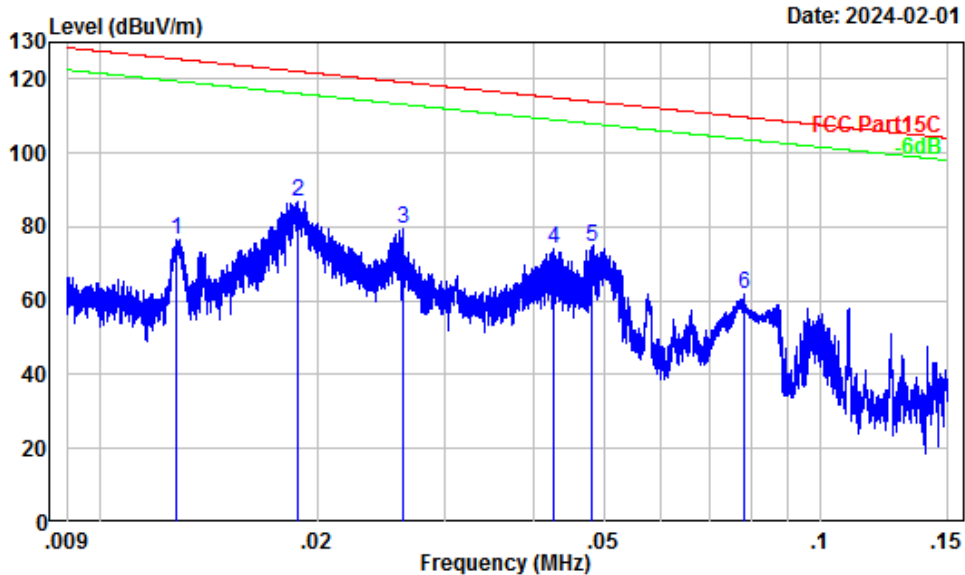
Environmental Conditions

Temperature:	23~25.1 °C
Relative Humidity:	50~55 %
ATM Pressure:	101.0 kPa

The testing was performed by Warren Huang on 2024-02-01 for below 1GHz and Tyler Wu from 2024-02-03 to 2024-03-11 for above 1GHz.

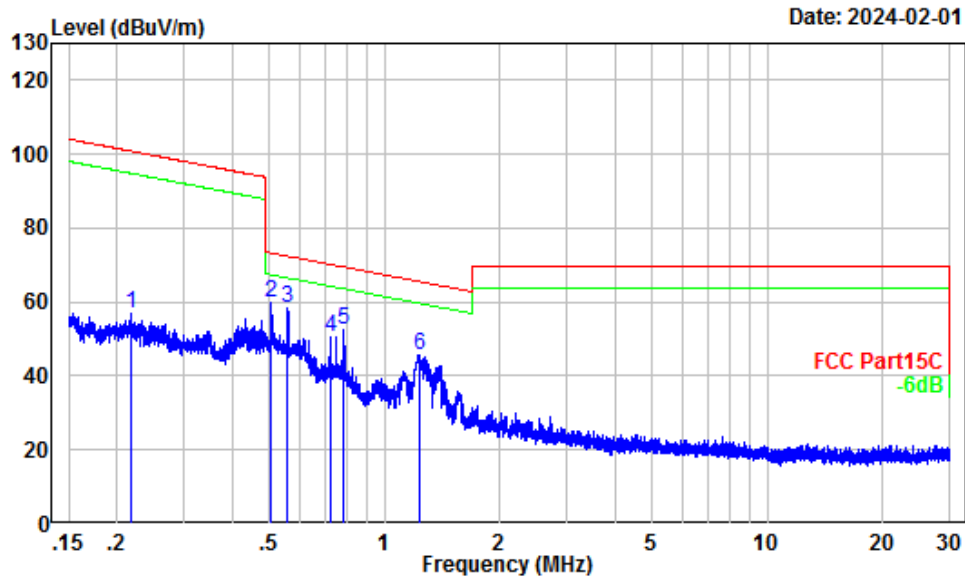
Test mode: Transmitting

Note: After pre-scan in the X, Y and Z axes of orientation, the worst case as below:

9 kHz-30MHz: (Maximum output power mode 8DPSK, Low Channel, Parallel)

Site : chamber
Condition : 3m
Project Number: SZ3240124-05690E-RF
Note : BT
Tester : Warren Huang

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	0.01	52.46	24.18	76.64	125.48	-48.84	Peak
2	0.02	50.61	36.19	86.80	122.14	-35.34	Peak
3	0.03	48.30	31.26	79.56	119.21	-39.65	Peak
4	0.04	43.25	30.83	74.08	115.00	-40.92	Peak
5	0.05	41.62	32.87	74.49	113.98	-39.49	Peak
6	0.08	37.15	24.71	61.86	109.75	-47.89	Peak

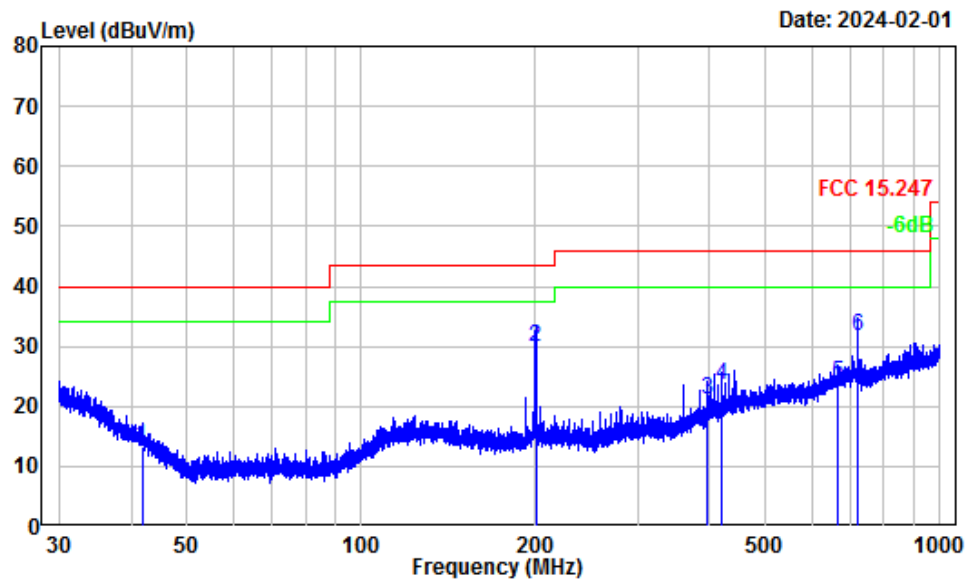


Site : chamber
 Condition : 3m
 Project Number: SZ3240124-05690E-RF
 Note : BT
 Tester : Warren Huang

	Freq	Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB	
1	0.22	28.32	28.60	56.92	100.81	-43.89	Peak
2	0.51	20.87	39.10	59.97	73.51	-13.54	Peak
3	0.56	20.21	38.19	58.40	72.64	-14.24	Peak
4	0.72	17.96	32.71	50.67	70.37	-19.70	Peak
5	0.78	17.24	35.22	52.46	69.70	-17.24	Peak
6	1.23	14.30	31.18	45.48	65.63	-20.15	Peak

30MHz-1GHz: (Maximum output power mode 8DPSK, Low Channel)

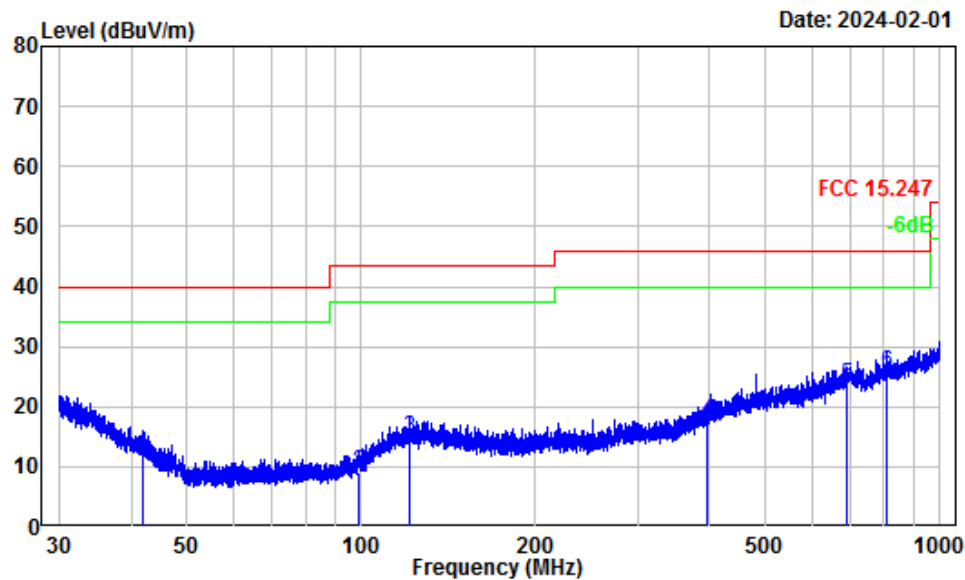
Horizontal



Site : chamber
Condition : 3m Horizontal
Project Number: SZ3240124-05690E-RF
Note : BT
Tester : Warren Huang

	Freq Factor		Read Level		Limit	Over	Remark
	MHz	dB/m	dBuV	dBuV/m	Line	Limit	
1	41.77	-11.51	24.84	13.33	40.00	-26.67	QP
2	200.16	-11.03	40.97	29.94	43.50	-13.56	QP
3	396.59	-7.53	28.53	21.00	46.00	-25.00	QP
4	420.03	-6.66	30.20	23.54	46.00	-22.46	QP
5	668.14	-2.10	26.01	23.91	46.00	-22.09	QP
6	721.09	-1.57	33.33	31.76	46.00	-14.24	QP

Vertical



Site : chamber
Condition : 3m Vertical
Project Number: SZ3240124-05690E-RF
Note : BT
Tester : Warren Huang

	Freq Factor		Read Level	Limit Level	Over Limit	Remark
	MHz	dB/m	dBuV	dBuV/m	dBuV/m	dB
1	42.03	-13.04	25.00	11.96	40.00	-28.04 QP
2	99.27	-15.39	24.49	9.10	43.50	-34.40 QP
3	120.91	-10.75	25.63	14.88	43.50	-28.62 QP
4	394.85	-7.82	25.33	17.51	46.00	-28.49 QP
5	688.96	-2.12	25.80	23.68	46.00	-22.32 QP
6	810.27	-0.54	26.32	25.78	46.00	-20.22 QP

Above 1GHz:

Frequency (MHz)	Receiver		Rx Antenna	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave	Polar (H/V)				
GFSK							
Low Channel 2402MHz							
4804.00	48.13	PK	H	2.42	50.55	74	-23.45
4804.00	37.39	Ave	H	2.42	39.81	54	-14.19
4804.00	48.65	PK	V	2.42	51.07	74	-22.93
4804.00	38.42	Ave	V	2.42	40.84	54	-13.16
Middle Channel 2441MHz							
4882.00	48.72	PK	H	2.56	51.28	74	-22.72
4882.00	37.24	Ave	H	2.56	39.8	54	-14.2
4882.00	49.15	PK	V	2.56	51.71	74	-22.29
4882.00	38.06	Ave	V	2.56	40.62	54	-13.38
High Channel 2480MHz							
4960.00	49.03	PK	H	2.68	51.71	74	-22.29
4960.00	36.58	Ave	H	2.68	39.26	54	-14.74
4960.00	49.45	PK	V	2.68	52.13	74	-21.87
4960.00	37.92	Ave	V	2.68	40.60	54	-13.40

Frequency (MHz)	Receiver		Rx Antenna	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave	Polar (H/V)				
π/4-DQPSK							
Low Channel 2402MHz							
4804.00	48.01	PK	H	2.42	50.43	74	-23.57
4804.00	36.94	Ave	H	2.42	39.36	54	-14.64
4804.00	48.52	PK	V	2.42	50.94	74	-23.06
4804.00	37.85	Ave	V	2.42	40.27	54	-13.73
Middle Channel 2441MHz							
4882.00	48.03	PK	H	2.56	50.59	74	-23.41
4882.00	36.29	Ave	H	2.56	38.85	54	-15.15
4882.00	48.61	PK	V	2.56	51.17	74	-22.83
4882.00	37.54	Ave	V	2.56	40.1	54	-13.9
High Channel 2480MHz							
4960.00	48.05	PK	H	2.68	50.73	74	-23.27
4960.00	35.81	Ave	H	2.68	38.49	54	-15.51
4960.00	48.69	PK	V	2.68	51.37	74	-22.63
4960.00	36.92	Ave	V	2.68	39.60	54	-14.40

Frequency (MHz)	Receiver		Rx Antenna	Factor (dB/m)	Corrected Amplitude (dBμV/m)	Limit (dBμV/m)	Margin (dB)
	Reading (dBμV)	PK/Ave	Polar (H/V)				
8DPSK							
Low Channel 2402MHz							
4804.00	48.12	PK	H	2.42	50.54	74	-23.46
4804.00	36.07	Ave	H	2.42	38.49	54	-15.51
4804.00	48.63	PK	V	2.42	51.05	74	-22.95
4804.00	37.99	Ave	V	2.42	40.41	54	-13.59
Middle Channel 2441MHz							
4882.00	48.09	PK	H	2.56	50.65	74	-23.35
4882.00	35.92	Ave	H	2.56	38.48	54	-15.52
4882.00	48.54	PK	V	2.56	51.1	74	-22.9
4882.00	36.83	Ave	V	2.56	39.39	54	-14.61
High Channel 2480MHz							
4960.00	48.05	PK	H	2.68	50.73	74	-23.27
4960.00	35.78	Ave	H	2.68	38.46	54	-15.54
4960.00	48.32	PK	V	2.68	51.00	74	-23.00
4960.00	36.73	Ave	V	2.68	39.41	54	-14.59

Note:

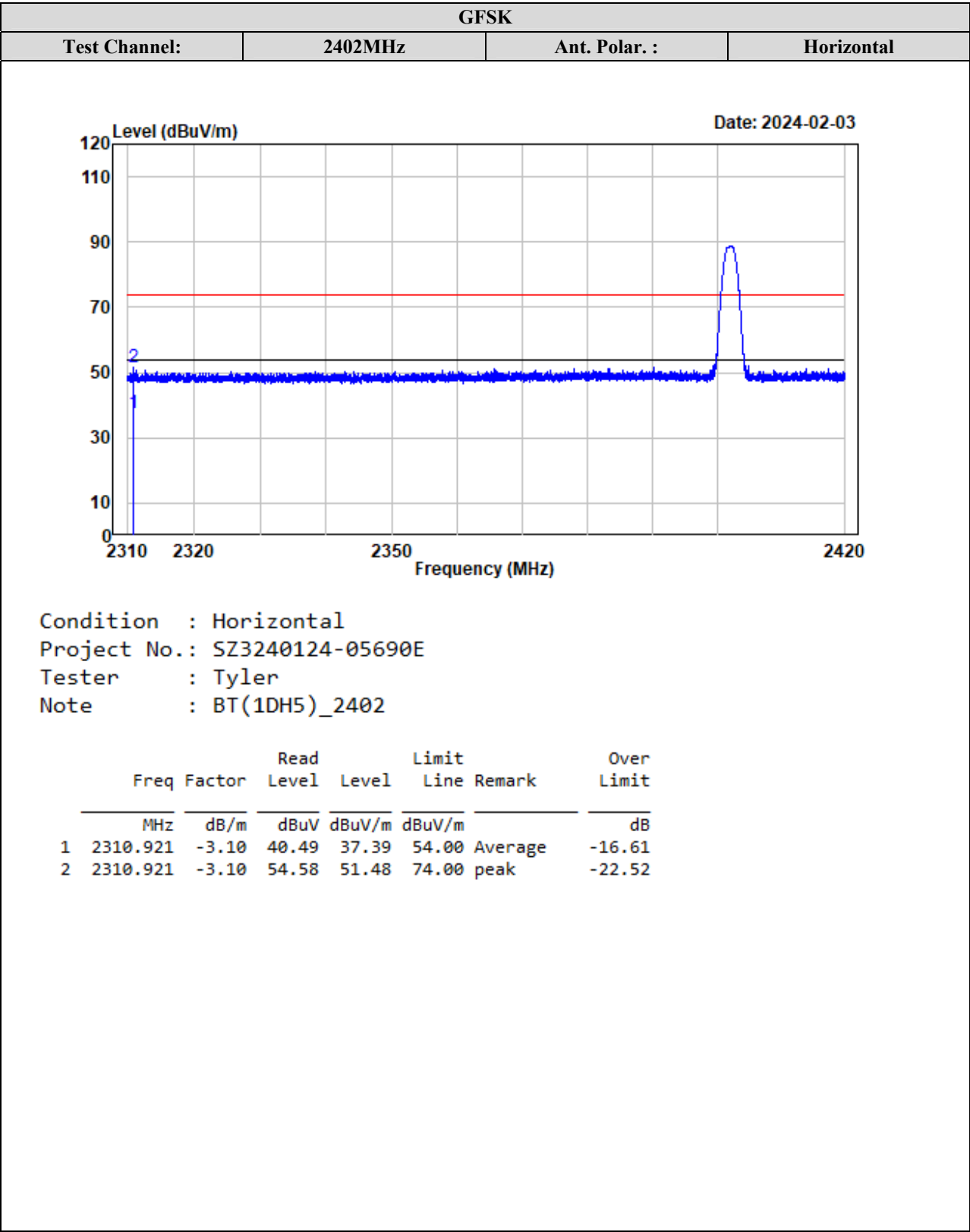
Factor = Antenna factor (RX) + Cable Loss – Amplifier Factor

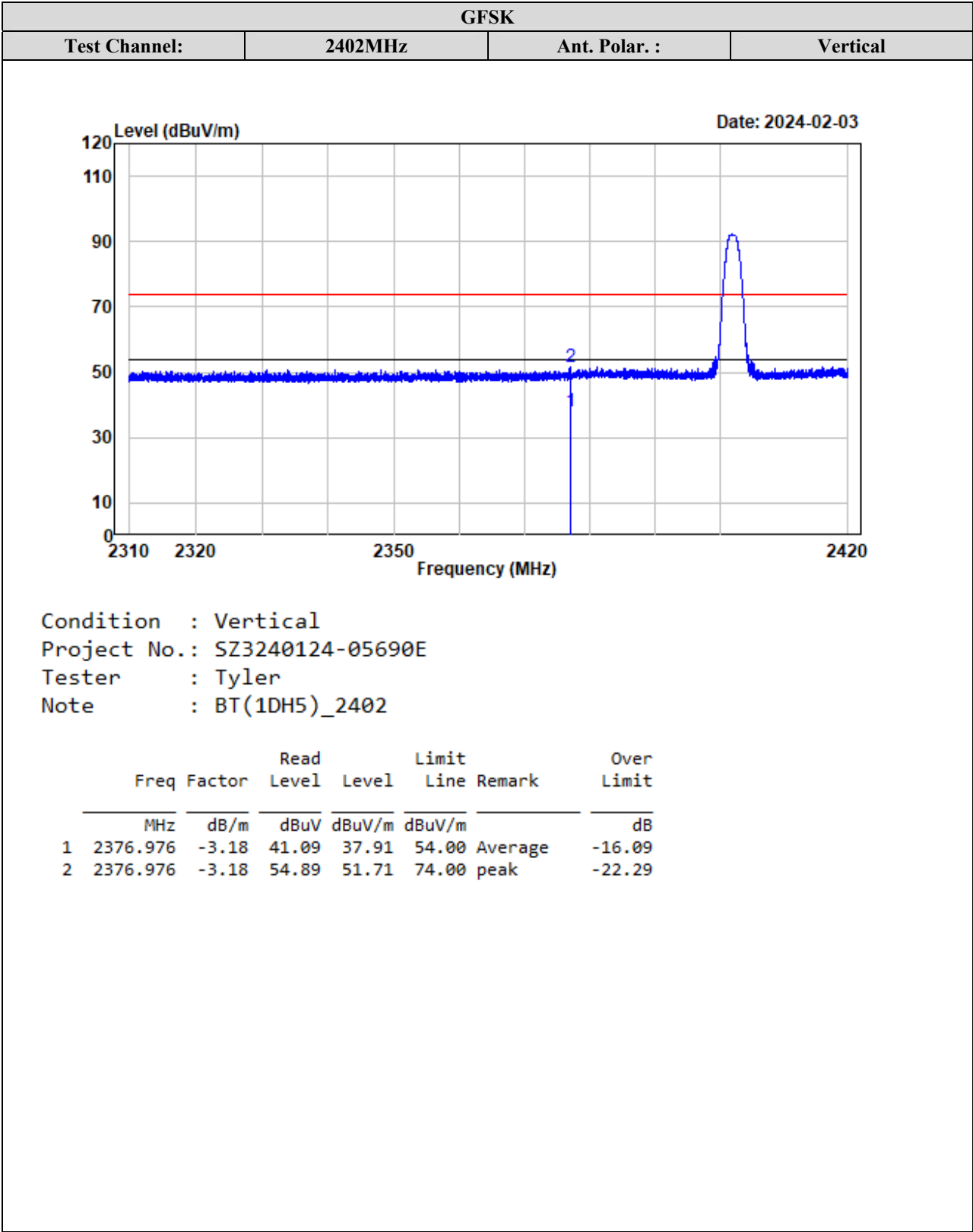
Corrected Amplitude = Factor + Reading

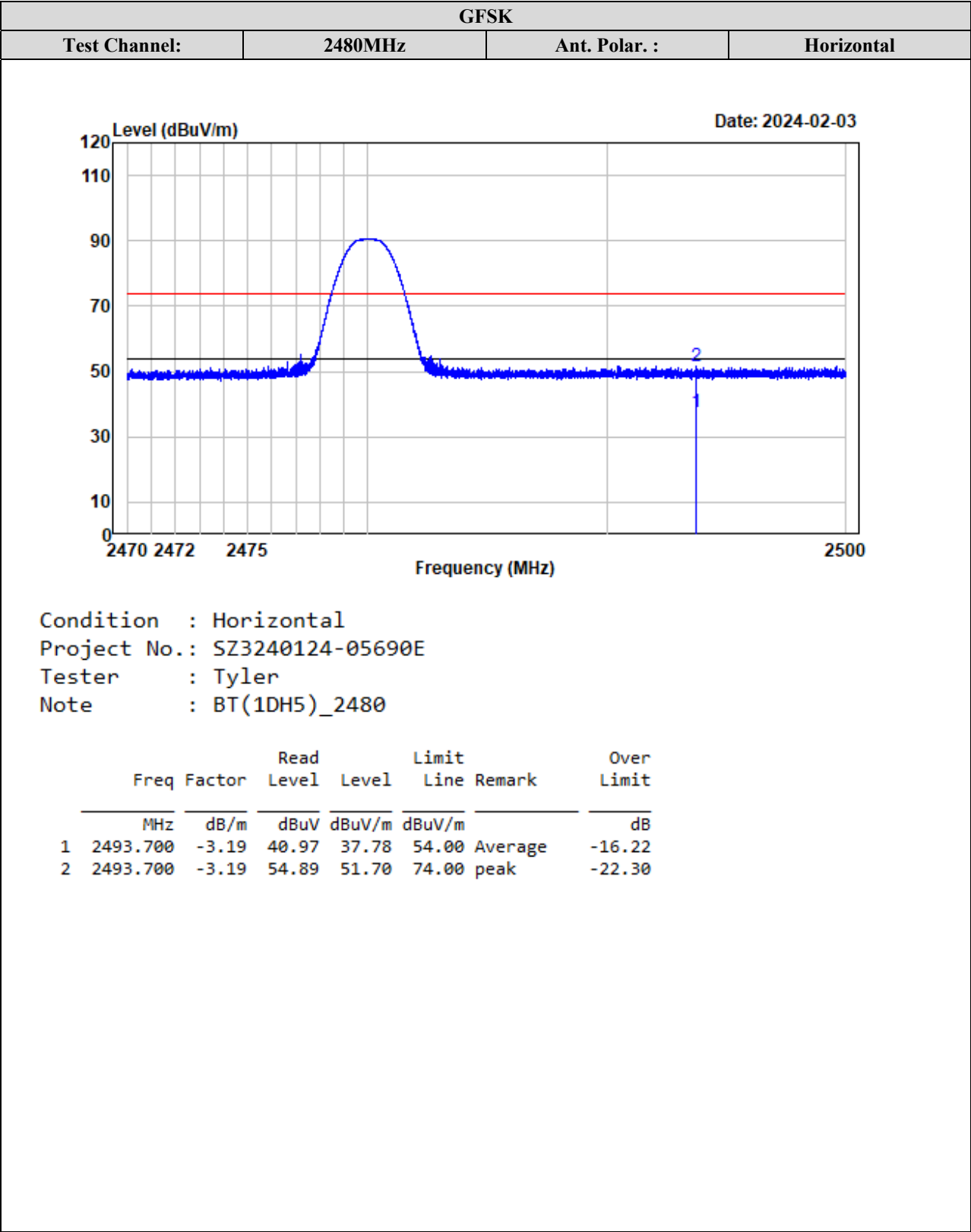
Margin = Corrected. Amplitude - Limit

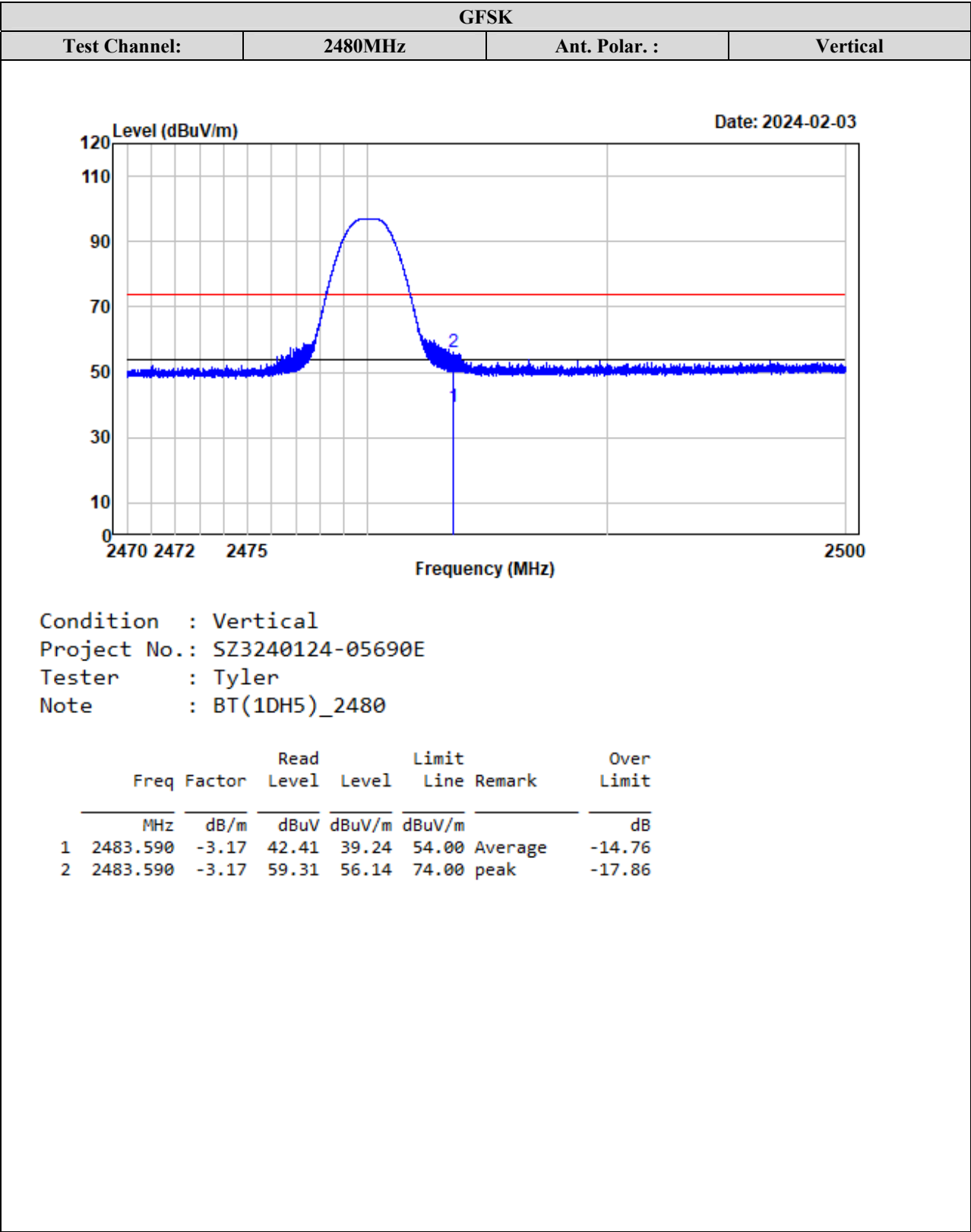
The other spurious emission which is in the noise floor level or 20dB below the limit was not recorded.

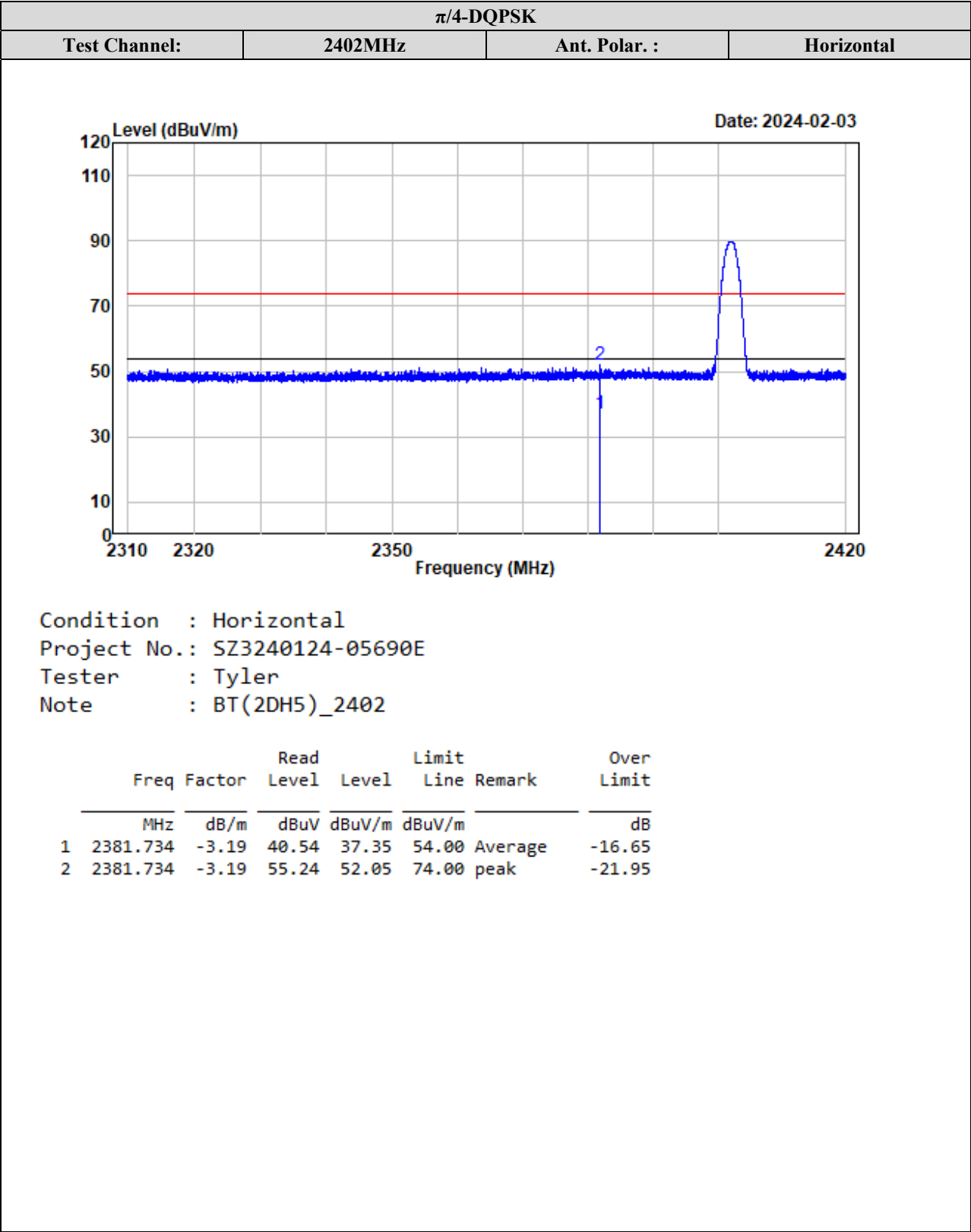
Test plots for Band Edge Measurements (Radiated):

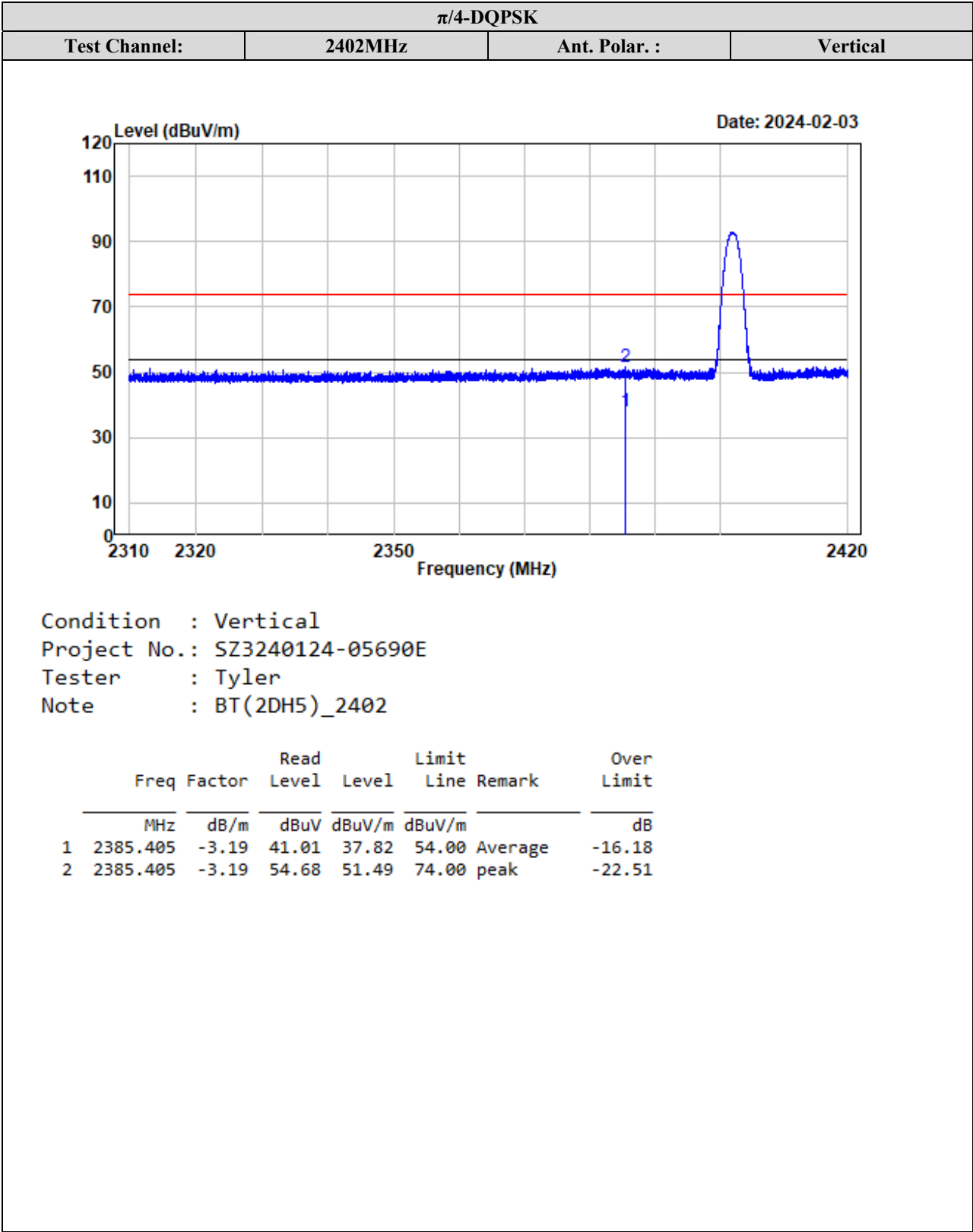


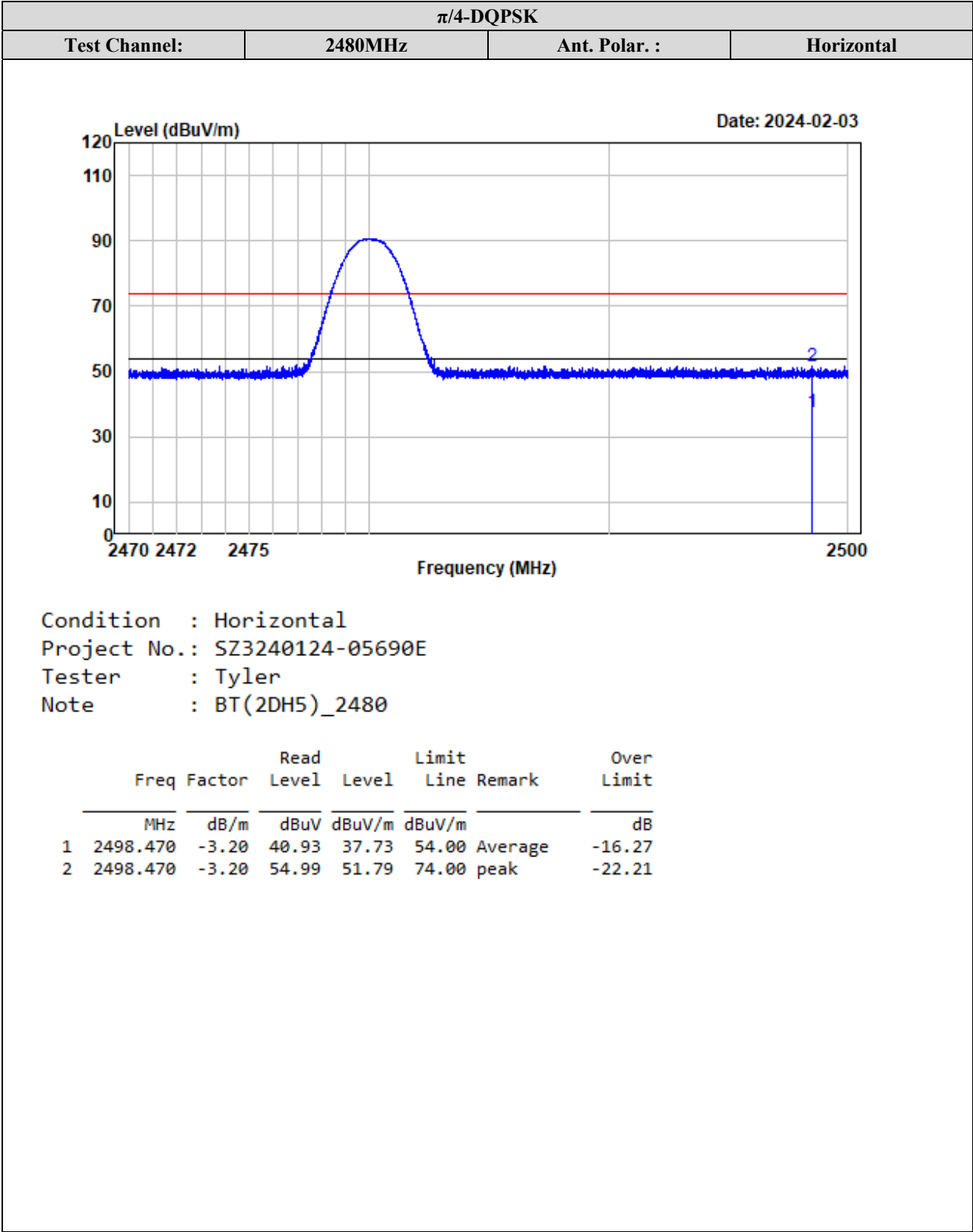


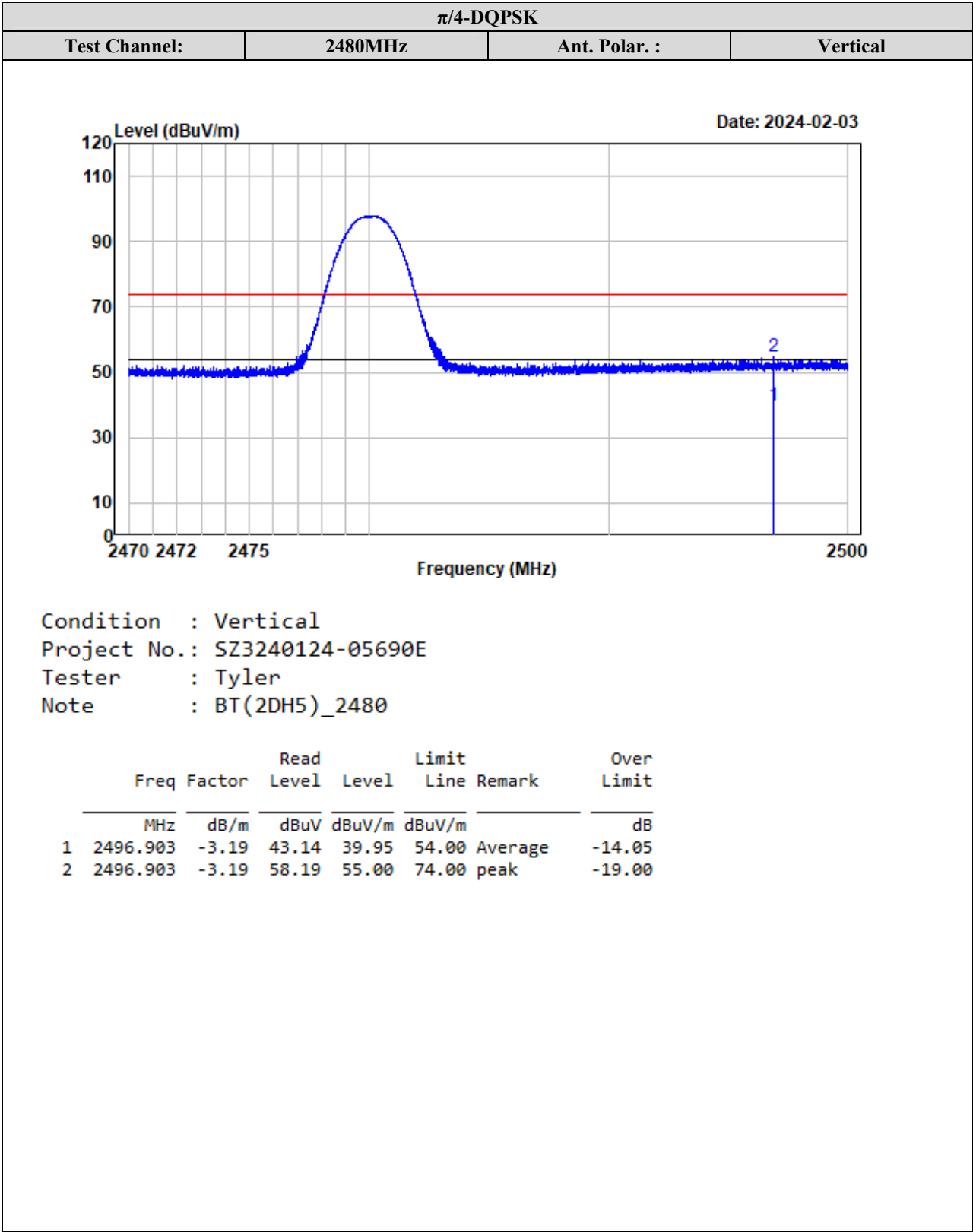


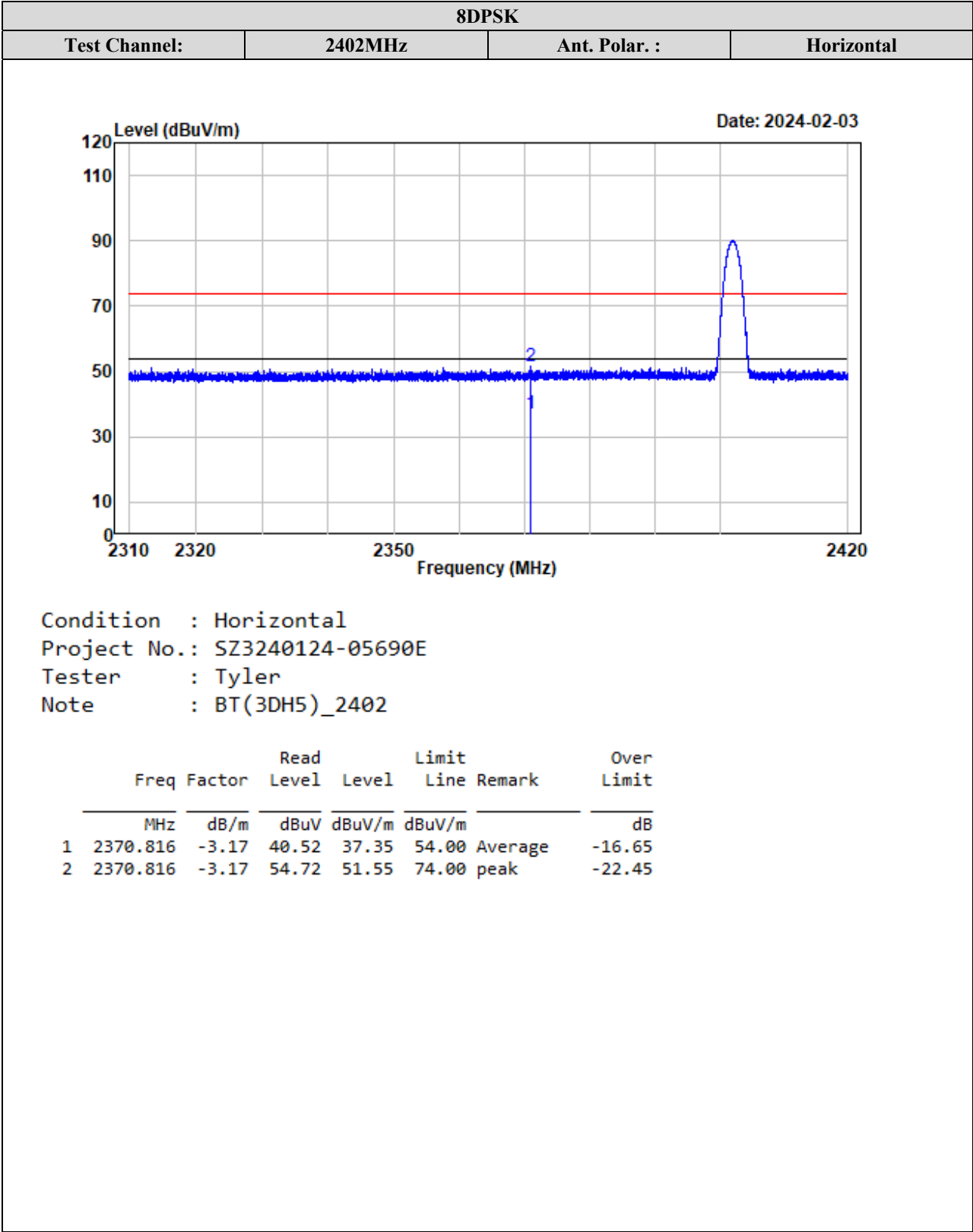


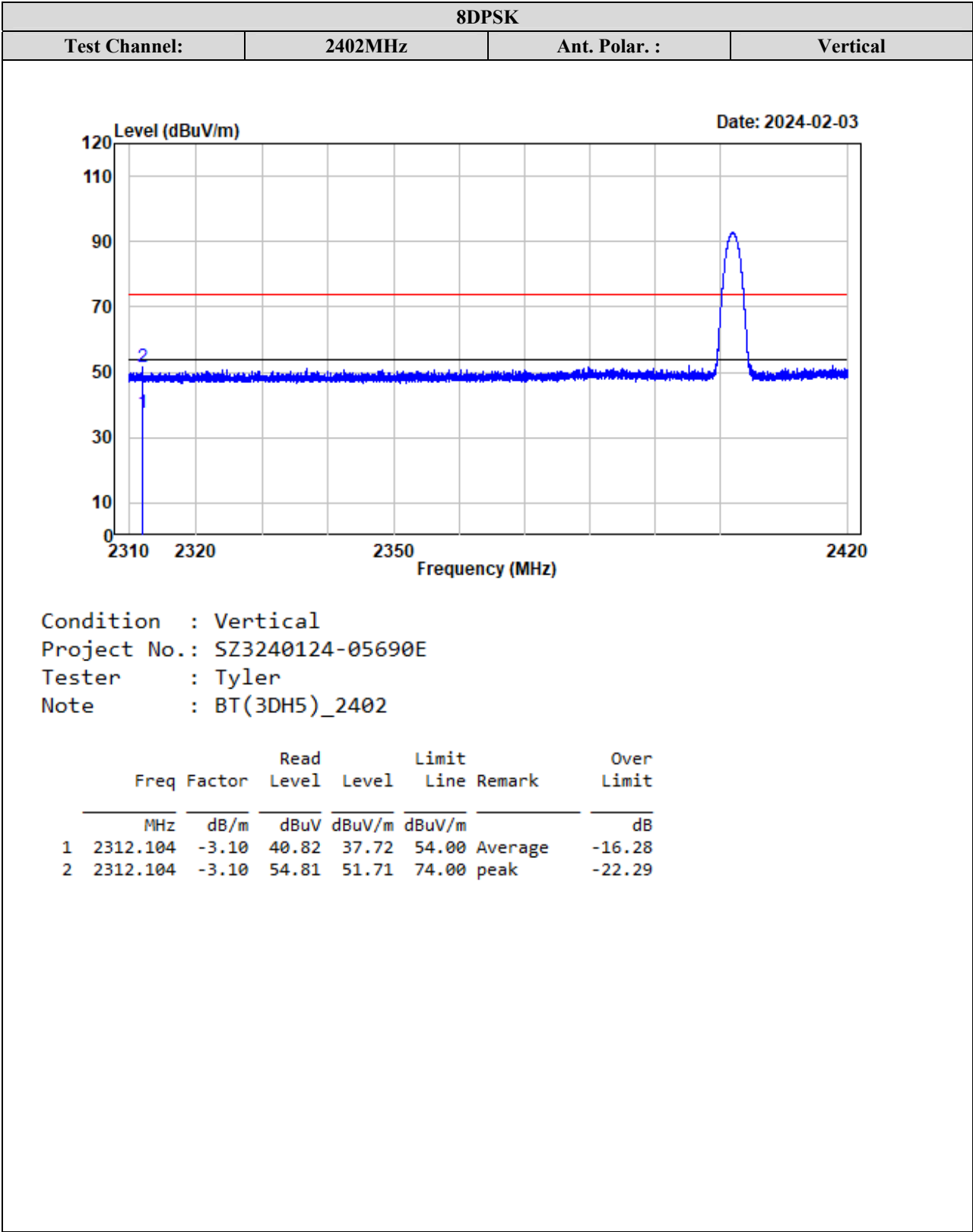


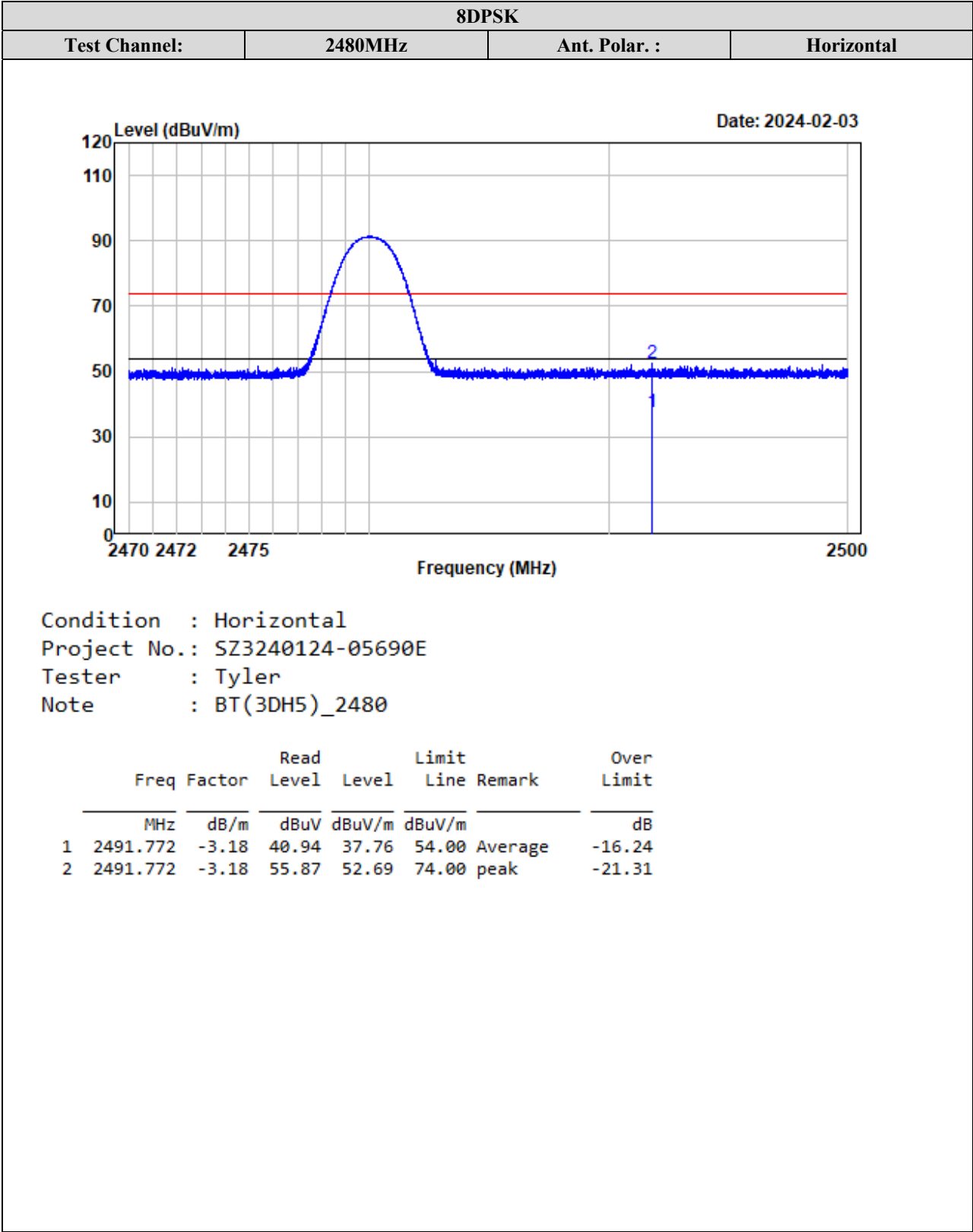


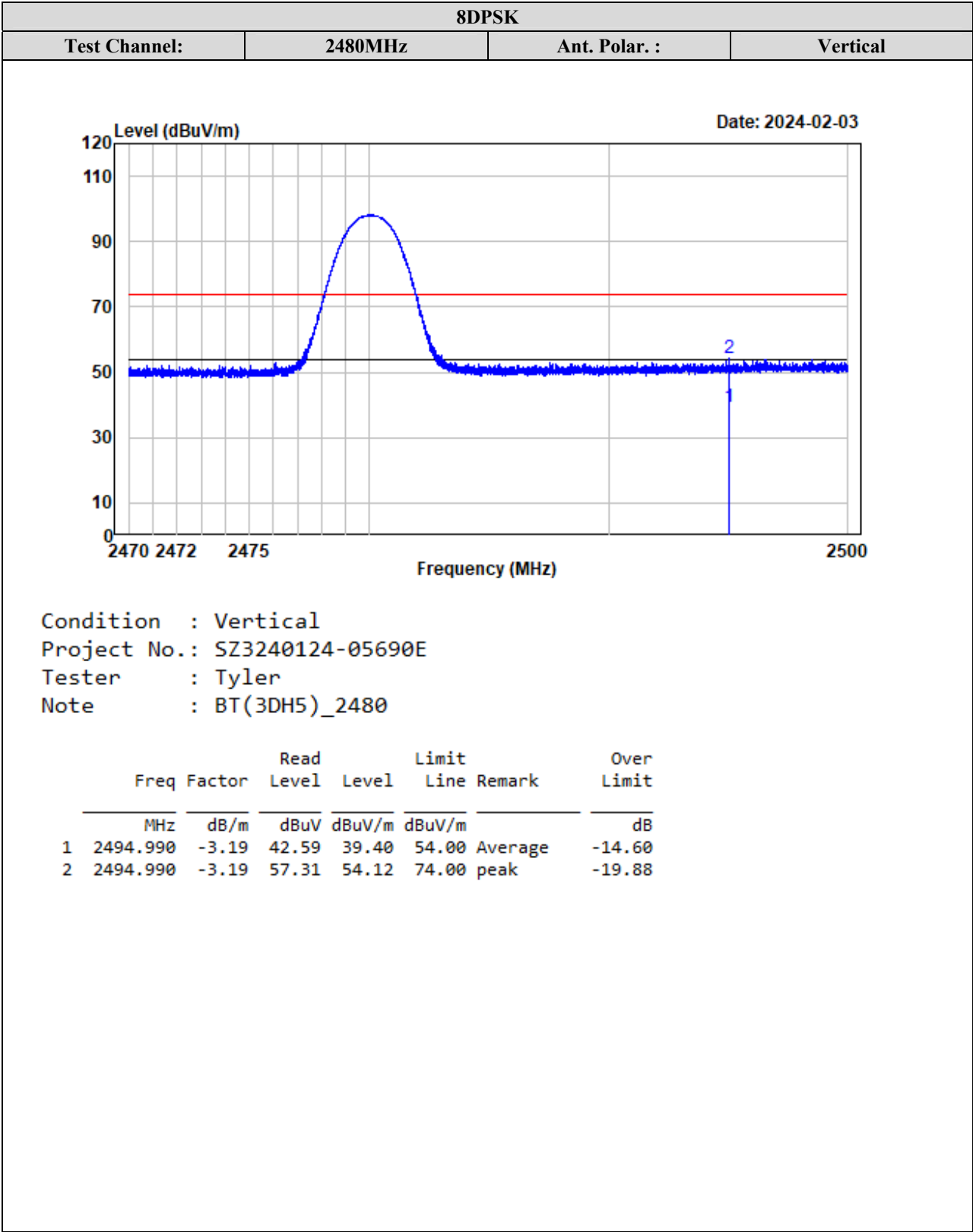




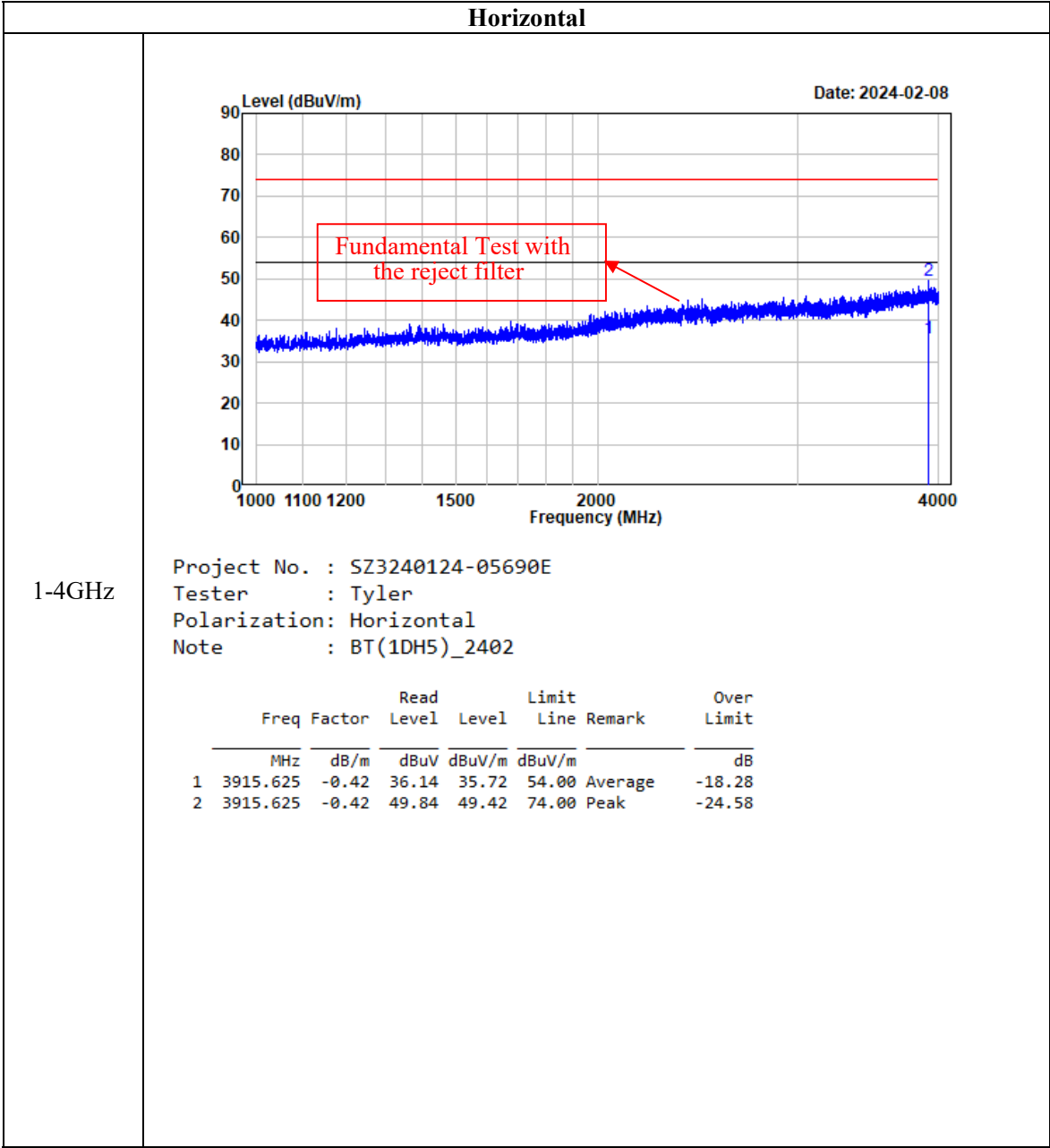


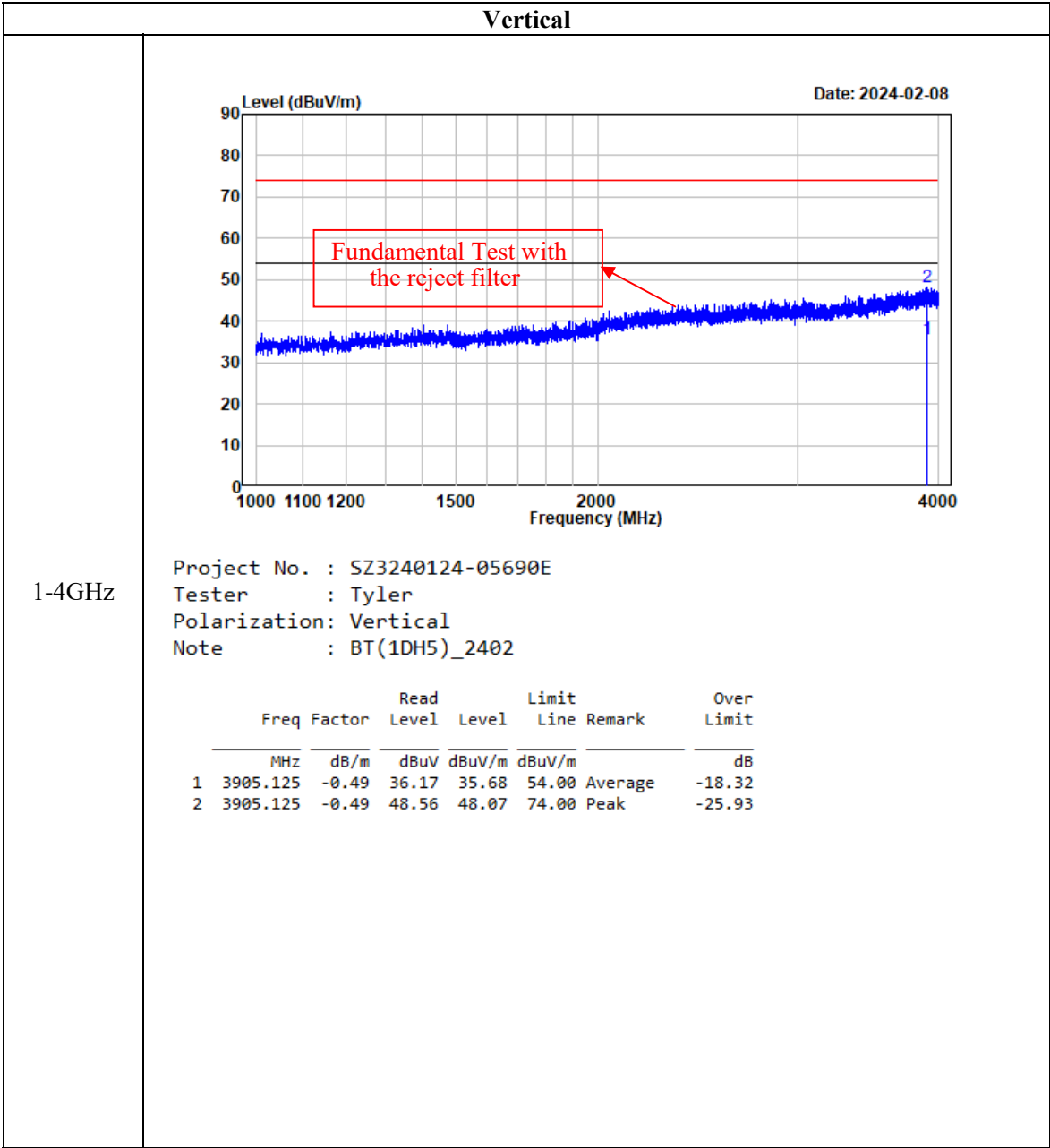


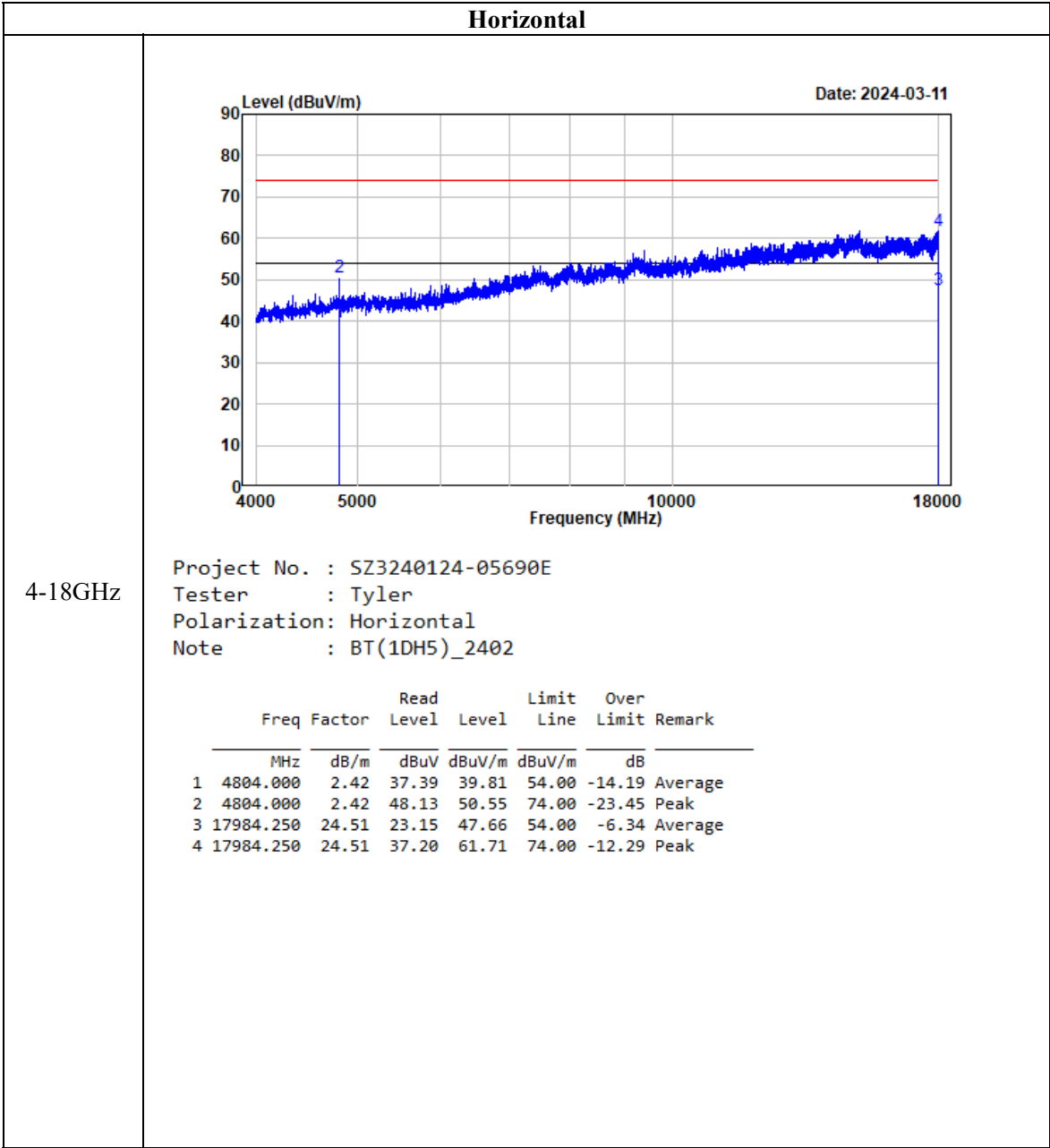


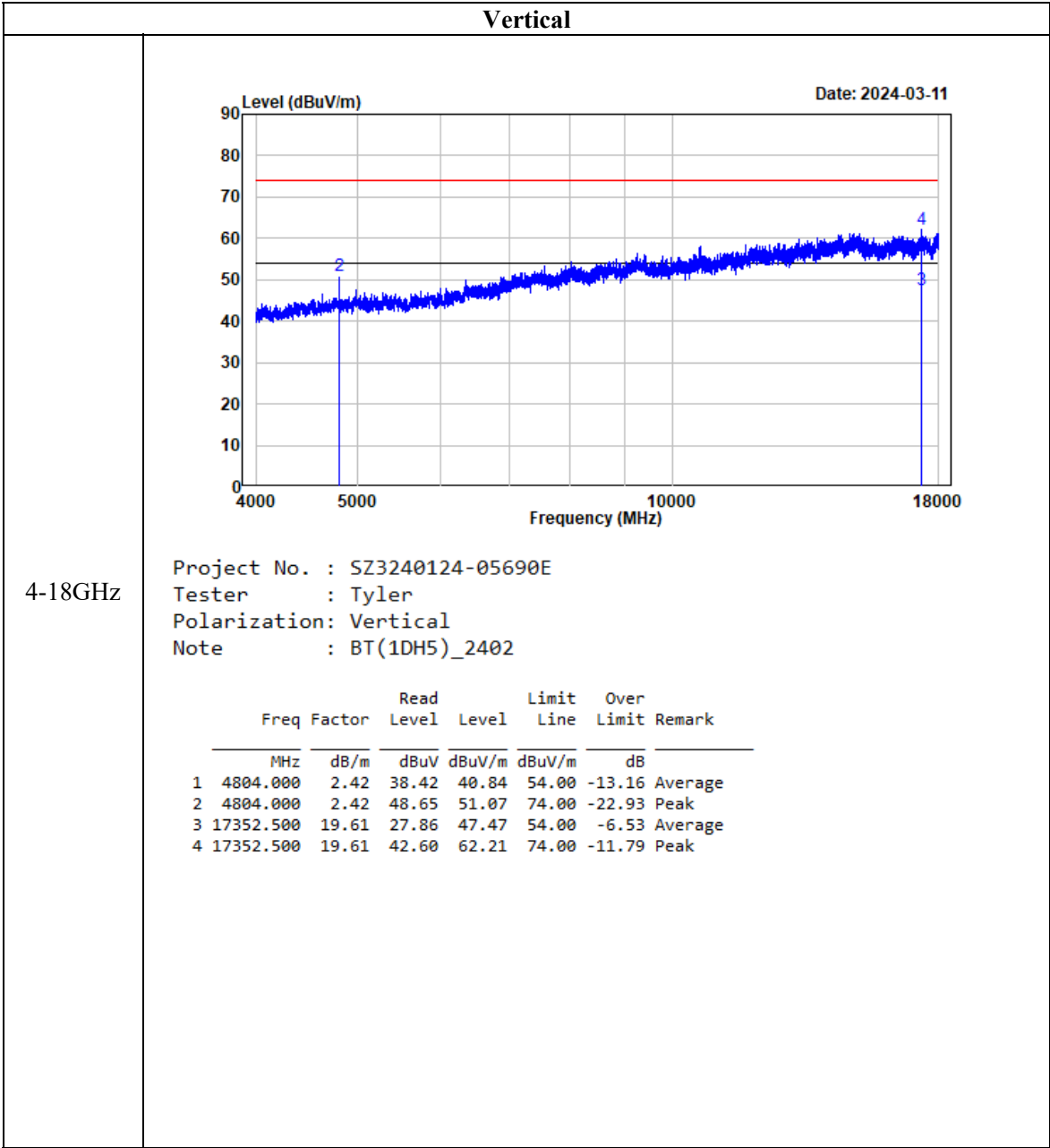


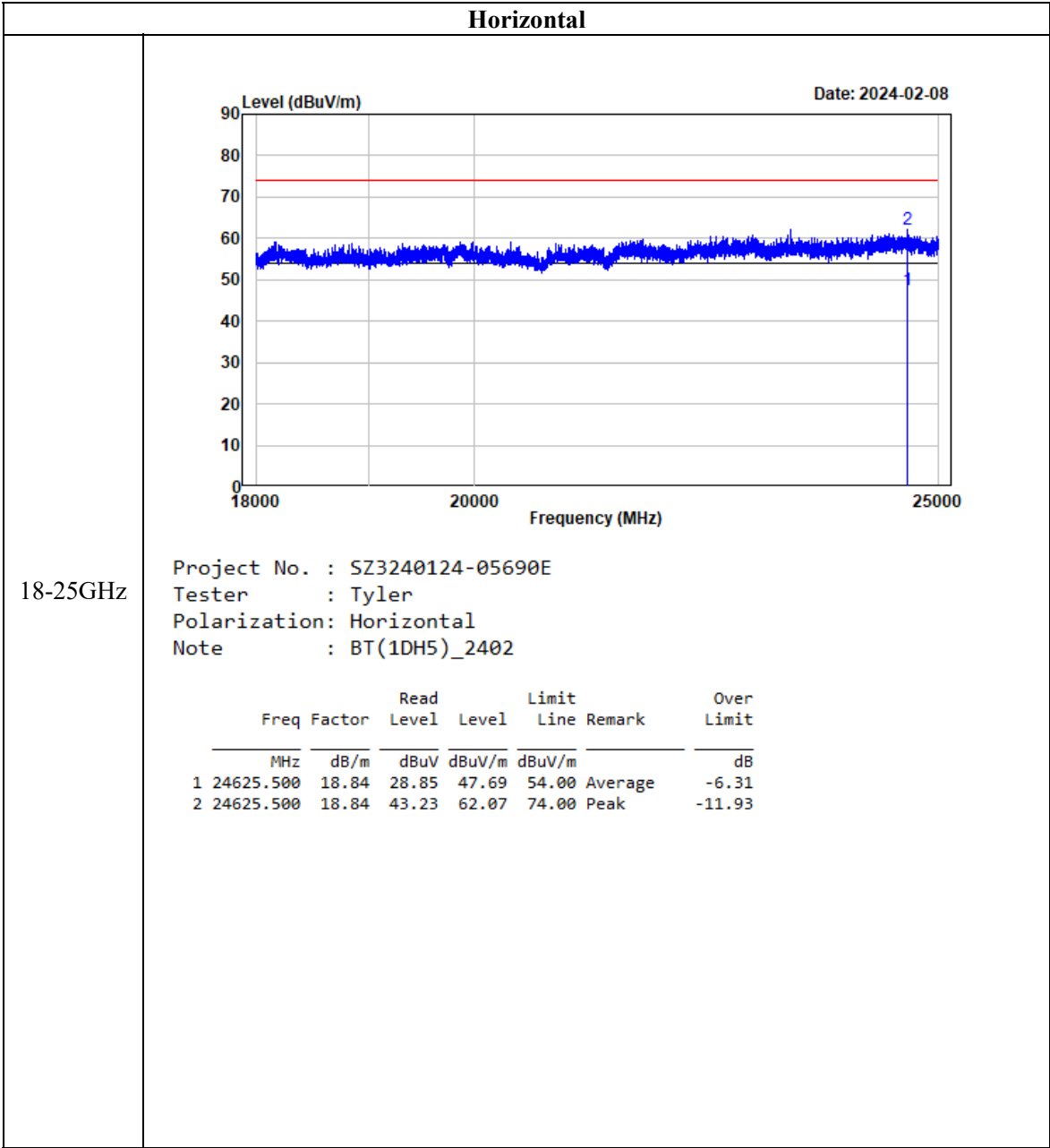
Listed with the worst harmonic margin test plot:

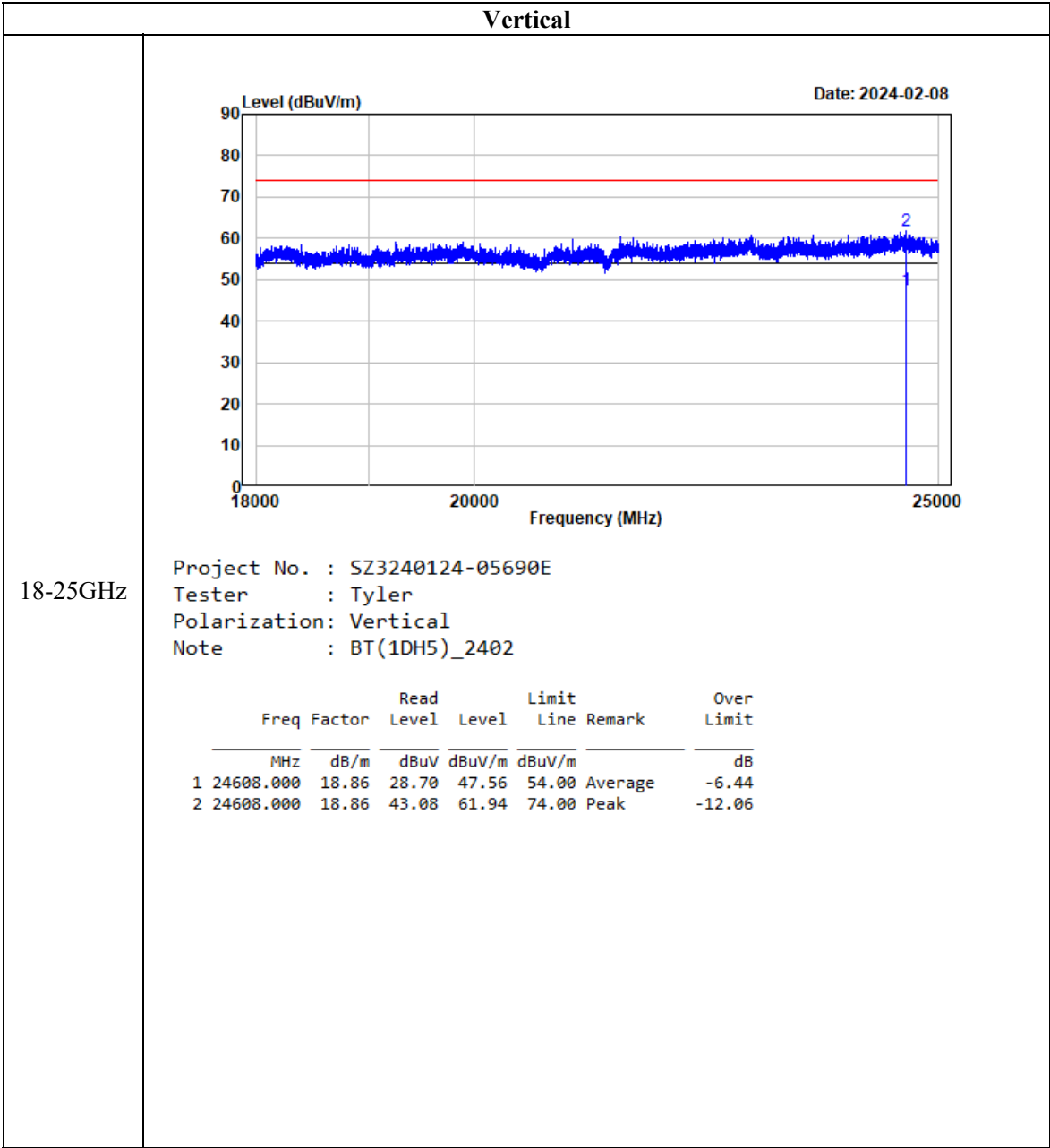












FCC §15.247(a) (1) - CHANNEL SEPARATION TEST

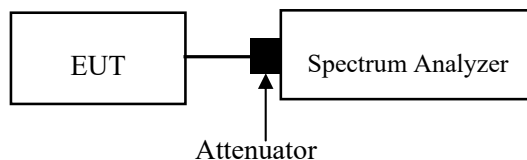
Applicable Standard

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.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.2

1. Set the EUT in transmitting mode, maxhold the channel.
2. Set the adjacent channel of the EUT and maxhold another trace.
3. Measure the channel separation.



Test Data

Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	40 %
ATM Pressure:	101.0 kPa

The testing was performed by Cheeb Huang on 2024-02-02.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Test Frequency (MHz)	Channel Separation (MHz)	Limits (MHz)
BDR Mode (GFSK)	2402	0.993	0.704
	2441	0.999	0.716
	2480	0.999	0.718
EDR Mode ($\pi/4$ -DQPSK)	2402	0.999	0.898
	2441	1.005	0.900
	2480	0.999	0.904
EDR Mode (8DPSK)	2402	0.999	0.868
	2441	1.002	0.866
	2480	1.002	0.868

Note: Limits = $(2/3) * 20\text{dB}$ bandwidth

Low Channel



ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 01:43:41

ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 01:44:17

*REM 30 kHz Delta 2 (T1) -0.01 dB
 *VEM 100 kHz
 Ref 25 dBm *Att 30 dB SWT 15 ms 999.000000000 kHz

Offset 11 dB Markers 1 (T1) 2
 2.40218000 GHz 2.40218000 GHz
 2.40218000 GHz

1 dB View

Center 2.4025 GHz 300 kHz/ Span 3 MHz



Ref 25 dBm • Att 30 dB SWT 15 ms 1.005000000 MHz

Offset 11 dB Markers 1 [T1] 2.4418000 GHz

Center 2.4415 GHz 300 kHz/ Span 3 MHz

PM VIEW LVL

Ref 25 dBm Att 30 dB SWT 15 ms 999.000000000 kHz

Offset 11 dB Marked 1 [T1]

Center 2.4795 GHz 300 kHz/ Span 3 MHz

Delta 2 [T1] 0.00 dB

VBW 100 kHz

2.47918000 GHz

0 dBm

10 dBm

20 dBm

30 dBm

40 dBm

50 dBm

60 dBm

70 dBm

80 dBm

90 dBm

100 dBm

110 dBm

120 dBm

130 dBm

140 dBm

150 dBm

160 dBm

170 dBm

180 dBm

190 dBm

200 dBm

210 dBm

220 dBm

230 dBm

240 dBm

250 dBm

260 dBm

270 dBm

280 dBm

290 dBm

300 dBm

310 dBm

320 dBm

330 dBm

340 dBm

350 dBm

360 dBm

370 dBm

380 dBm

390 dBm

400 dBm

410 dBm

420 dBm

430 dBm

440 dBm

450 dBm

460 dBm

470 dBm

480 dBm

490 dBm

500 dBm

510 dBm

520 dBm

530 dBm

540 dBm

550 dBm

560 dBm

570 dBm

580 dBm

590 dBm

600 dBm

610 dBm

620 dBm

630 dBm

640 dBm

650 dBm

660 dBm

670 dBm

680 dBm

690 dBm

700 dBm

710 dBm

720 dBm

730 dBm

740 dBm

750 dBm

760 dBm

770 dBm

780 dBm

790 dBm

800 dBm

810 dBm

820 dBm

830 dBm

840 dBm

850 dBm

860 dBm

870 dBm

880 dBm

890 dBm

900 dBm

910 dBm

920 dBm

930 dBm

940 dBm

950 dBm

960 dBm

970 dBm

980 dBm

990 dBm

1000 dBm

1010 dBm

1020 dBm

1030 dBm

1040 dBm

1050 dBm

1060 dBm

1070 dBm

1080 dBm

1090 dBm

1100 dBm

1110 dBm

1120 dBm

1130 dBm

1140 dBm

1150 dBm

1160 dBm

1170 dBm

1180 dBm

1190 dBm

1200 dBm

1210 dBm

1220 dBm

1230 dBm

1240 dBm

1250 dBm

1260 dBm

1270 dBm

1280 dBm

1290 dBm

1300 dBm

1310 dBm

1320 dBm

1330 dBm

1340 dBm

1350 dBm

1360 dBm

1370 dBm

1380 dBm

1390 dBm

1400 dBm

1410 dBm

1420 dBm

1430 dBm

1440 dBm

1450 dBm

1460 dBm

1470 dBm

1480 dBm

1490 dBm

1500 dBm

1510 dBm

1520 dBm

1530 dBm

1540 dBm

1550 dBm

1560 dBm

1570 dBm

1580 dBm

1590 dBm

1600 dBm

1610 dBm

1620 dBm

1630 dBm

1640 dBm

1650 dBm

1660 dBm

1670 dBm

1680 dBm

1690 dBm

1700 dBm

1710 dBm

1720 dBm

1730 dBm

1740 dBm

1750 dBm

1760 dBm

1770 dBm

1780 dBm

1790 dBm

1800 dBm

1810 dBm

1820 dBm

1830 dBm

1840 dBm

1850 dBm

1860 dBm

1870 dBm

1880 dBm

1890 dBm

1900 dBm

1910 dBm

1920 dBm

1930 dBm

1940 dBm

1950 dBm

1960 dBm

1970 dBm

1980 dBm

1990 dBm

2000 dBm

2010 dBm

2020 dBm

2030 dBm

2040 dBm

2050 dBm

2060 dBm

2070 dBm

2080 dBm

2090 dBm

2100 dBm

2110 dBm

2120 dBm

2130 dBm

2140 dBm

2150 dBm

2160 dBm

2170 dBm

2180 dBm

2190 dBm

2200 dBm

2210 dBm

2220 dBm

2230 dBm

2240 dBm

2250 dBm

2260 dBm

2270 dBm

2280 dBm

2290 dBm

2300 dBm

2310 dBm

2320 dBm

2330 dBm

2340 dBm

2350 dBm

2360 dBm

2370 dBm

2380 dBm

2390 dBm

2400 dBm

2410 dBm

2420 dBm

2430 dBm

2440 dBm

2450 dBm

2460 dBm

2470 dBm

2480 dBm

2490 dBm

2500 dBm

2510 dBm

2520 dBm

2530 dBm

2540 dBm

2550 dBm

2560 dBm

2570 dBm

2580 dBm

2590 dBm

2600 dBm

2610 dBm

2620 dBm

2630 dBm

2640 dBm

2650 dBm

2660 dBm

2670 dBm

2680 dBm

2690 dBm

2700 dBm

2710 dBm

2720 dBm

2730 dBm

2740 dBm

2750 dBm

2760 dBm

2770 dBm

2780 dBm

2790 dBm

2800 dBm

2810 dBm

2820 dBm

2830 dBm

2840 dBm

2850 dBm

2860 dBm

2870 dBm

2880 dBm

2890 dBm

2900 dBm

2910 dBm

2920 dBm

2930 dBm

2940 dBm

2950 dBm

2960 dBm

2970 dBm

2980 dBm

2990 dBm

3000 dBm

3010 dBm

3020 dBm

3030 dBm

3040 dBm

3050 dBm

3060 dBm

3070 dBm

3080 dBm

3090 dBm

3100 dBm

3110 dBm

3120 dBm

3130 dBm

3140 dBm

3150 dBm

3160 dBm

3170 dBm

3180 dBm

3190 dBm

3200 dBm

3210 dBm

3220 dBm

3230 dBm

3240 dBm

3250 dBm

3260 dBm

3270 dBm

3280 dBm

3290 dBm

3300 dBm

3310 dBm

3320 dBm

3330 dBm

*BW 30 kHz Delta 2 (T1) 0.03 dB
 *VM 100 kHz
 Ref 25 dBm *Att 30 dB SWT 15 ms 999.000000000 kHz

Offset 11 dB Mark4= 1 (T1) 1.00 dBm
 2.40185000 GHz

10 dB View

Center 2.4025 GHz 300 kHz/ Span 3 MHz

Ref 25 dBm Att 30 dB SMT 15 ms 1.002000000 MHz

Offset 11 dB Marker 1 [F1] 1.002000000 MHz

2.440850000 GHz

1 2

Center 2.4415 GHz Span 3 MHz 300 kHz/



Ref 25 dBm Att 30 dB SWT 15 ms Delta 2 [71] 0.01 dB 1.002000000 MHz

Offset 11 dB Marker 1 [71] 2.4795000 GHz 1.002000000 MHz

1 2

Center 2.4795 GHz 300 kHz/ Span 3 MHz

FCC §15.247(a) (1) - 20 dB EMISSION BANDWIDTH

Applicable Standard

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.

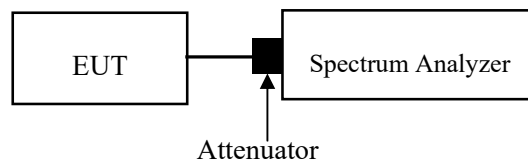
Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.7 & Clause 6.9.2

The following conditions shall be observed for measuring the occupied bandwidth and 20 dB bandwidth:

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the spectrum analyzer shall be set large enough to capture all products of the modulation process, including the emission skirts, around the carrier frequency, but small enough to avoid having other emissions (e.g. on adjacent channels) within the span.
- The detector of the spectrum analyzer shall be set to “Sample”. However, a peak, or peak hold, may be used in place of the sampling detector since this usually produces a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold (or “Max Hold”) may be necessary to determine the occupied / 20 dB bandwidth if the device is not transmitting continuously.

The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the actual occupied / 20 dB bandwidth and video bandwidth (VBW) shall be approximately three times RBW, unless otherwise specified by the applicable requirement.



Test Data

Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	40 %
ATM Pressure:	101.0 kPa

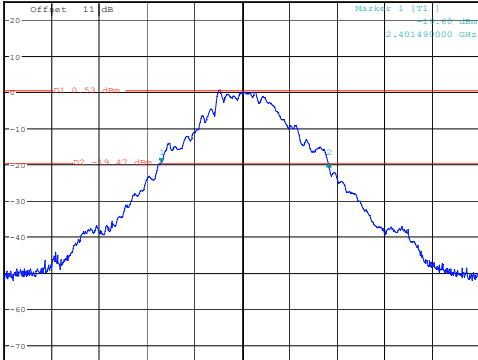
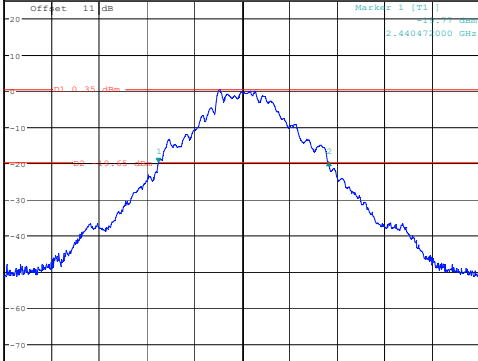
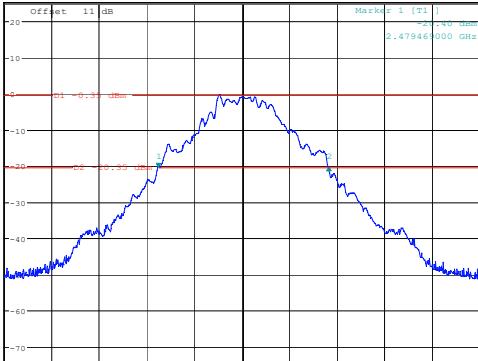
The testing was performed by Cheeb Huang on 2024-02-02.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Test Channel	Test Frequency (MHz)	20 dB Bandwidth (MHz)
BDR Mode (GFSK)	Lowest	2402	1.056
	Middle	2441	1.074
	Highest	2480	1.077
EDR Mode ($\pi/4$ -DQPSK)	Lowest	2402	1.347
	Middle	2441	1.350
	Highest	2480	1.356
EDR Mode (8DPSK)	Lowest	2402	1.302
	Middle	2441	1.299
	Highest	2480	1.302

20 dB Bandwidth

Low Channel	BDR Mode (GFSK) Ref: 25 dBm Att: 30 dB RBW: 30 kHz VBW: 100 kHz SMT: 1 s Delta 2 [T1]: -0.24 dB 1.056000000 MHz  Center: 2.402 GHz 300 kHz/ Span: 3 MHz ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang Date: 2.FEB.2024 01:09:01
Middle Channel	Ref: 25 dBm Att: 30 dB RBW: 30 kHz VBW: 100 kHz SMT: 1 s Delta 2 [T1]: -0.13 dB 1.074000000 MHz  Center: 2.441 GHz 300 kHz/ Span: 3 MHz ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang Date: 2.FEB.2024 01:24:19
High Channel	Ref: 25 dBm Att: 30 dB RBW: 30 kHz VBW: 100 kHz SMT: 1 s Delta 2 [T1]: -0.06 dB 1.077000000 MHz  Center: 2.48 GHz 300 kHz/ Span: 3 MHz ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang Date: 2.FEB.2024 01:36:33

Low Channel



Ref 25 dBm Att 30 dB BW 30 kHz VM 100 kHz SW 1 s Delta 2 [T1] 0.20 dB 1.299000000 MHz

Offset 11 dB

Marker 1 [T1]

01 0.00 dB

02 -19.71 dB

Center 2.441 GHz 300 kHz/ Span 3 MHz

ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 01:34:31

The screenshot displays a Spectrum Analyzer interface. At the top left, there is a red square icon with a white cross. The main display area shows a blue trace representing the signal spectrum. The horizontal axis is labeled "Center 2.48 GHz" and "Span 3 MHz". The vertical axis is labeled "dBm" and ranges from -70 to +20. A red horizontal line is drawn across the plot at approximately -10 dBm. Two green horizontal lines are also visible, one at approximately -25 dBm and another at approximately -35 dBm. The signal trace starts at approximately -40 dBm at the center frequency, rises to a peak of about -10 dBm, and then falls back down to approximately -40 dBm. The right side of the plot shows a grid with labels "Delta 2 [F1] 0.40 dB" and "1.302000000 MHz".

ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 01:40:51

FCC §15.247(a) (1) (iii) - QUANTITY OF HOPPING CHANNEL TEST

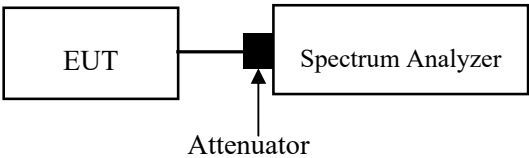
Applicable Standard

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.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.3

- 1. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- 2. Set the EUT in hopping mode from first channel to last.
- 3. By using the max-hold function record the quantity of the channel.



Test Data

Environmental Conditions

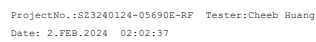
Temperature:	24.2 °C
Relative Humidity:	40 %
ATM Pressure:	101.0 kPa

The testing was performed by Cheeb Huang on 2024-02-02.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Frequency Range (MHz)	Number of Hopping Channel	Limits
GFSK	2400-2483.5	79	≥15
π/4-DQPSK	2400-2483.5	79	≥15
8DPSK	2400-2483.5	79	≥15

GFSK

Ref 25 dBm Att 30 dB SMT 10 ms Delta 2 [T1] -1.36 dB 77.82200000 GHz

Offset 11 dB Marker 1 [T1]

Start 2.4 GHz Stop 2.4835 GHz

8.35 MHz/

1.99 V/div

1 2

0 dBm

2.40217000 GHz

30 dB

ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 02:14:18

Ref 25 dBm Att 30 dB BW 100 kHz VM 300 kHz Delta 2 [T1] -1.59 dB SWT 10 ms 78.07250000 MHz

Offet 11 dB Mark 1 [T1] 2.40183000 GHz

Start 2.4 GHz 8.35 MHz/ Stop 2.4835 GHz

ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 02:25:00

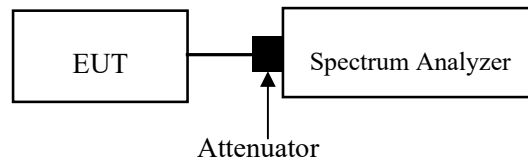
FCC §15.247(a) (1) (iii) - TIME OF OCCUPANCY (DWEELL TIME)**Applicable Standard**

Frequency hopping systems in the 2400-2483.5 MHz 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.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.4

2. The EUT was worked in channel hopping.
3. Set the RBW to: 1MHz.
4. Set the VBW $\geq 3 \times$ RBW.
5. Set the span to 0Hz.
6. Detector = peak.
7. Sweep time = auto couple.
8. Trace mode = max hold.
9. Allow trace to fully stabilize.
10. Recorded the time of single pulses

**Test Data****Environmental Conditions**

Temperature:	24.2 °C
Relative Humidity:	40 %
ATM Pressure:	101.0 kPa

The testing was performed by Cheeb Huang on 2024-02-02.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Packet Type	Test Frequency (MHz)	Pulse width (ms)	Result (s)	Limit (s)
BDR Mode (GFSK)	DH1	2441	0.377	0.121	0.400
	DH3	2441	1.635	0.262	0.400
	DH5	2441	2.900	0.309	0.400
EDR Mode ($\pi/4$ -DQPSK)	2DH1	2441	0.387	0.124	0.400
	2DH3	2441	1.641	0.263	0.400
	2DH5	2441	2.905	0.310	0.400
EDR Mode (8DPSK)	3DH1	2441	0.388	0.124	0.400
	3DH3	2441	1.641	0.263	0.400
	3DH5	2441	2.905	0.310	0.400

Note:

DH1:Dwell time=Pulse time (ms) $\times$ (1600/2/79) $\times$ 31.6 s

DH3:Dwell time=Pulse time (ms) $\times$ (1600/4/79) $\times$ 31.6 s

DH5:Dwell time=Pulse time (ms) $\times$ (1600/6/79) $\times$ 31.6 s

Version 1.0 (2023/10/07)

Version 1.0 (2023/10/07)

FCC §15.247(b) (1) - PEAK OUTPUT POWER MEASUREMENT

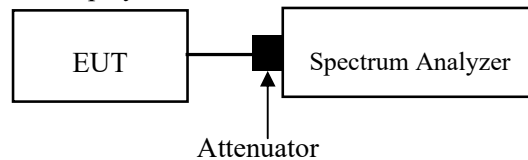
Applicable Standard

According to §15.247(b) (1), 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. And for all other frequency hopping systems in the 2400–2483.5 MHz band: 0.125 watts.

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.5

1. Place the EUT on a bench and set in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to one test equipment.
3. Add a correction factor to the display.



Test Data

Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	40 %
ATM Pressure:	101.0 kPa

The testing was performed by Cheeb Huang on 2024-02-02.

EUT operation mode: Transmitting

Test Result: Compliant.

Test Modes	Test Frequency (MHz)	Peak Conducted Output Power (dBm)	Limits (dBm)
BDR Mode (GFSK)	2402	3.51	21
	2441	3.25	21
	2480	2.65	21
EDR Mode ($\pi/4$ -DQPSK)	2402	3.80	21
	2441	3.72	21
	2480	3.16	21
EDR Mode (8DPSK)	2402	4.11	21
	2441	3.95	21
	2480	3.45	21

FCC §15.247(d) - BAND EDGES TESTING

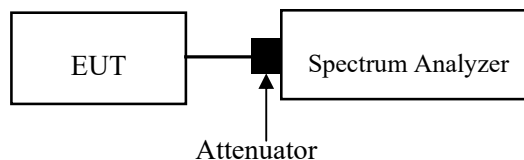
Applicable Standard

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

Test Procedure

Test Method: ANSI C63.10-2013 Clause 7.8.6 & Clause 6.10

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Remove the antenna from the EUT and then connect to a low loss RF cable from the antenna port to a EMI test receiver, then turn on the EUT and make it operate in transmitting mode. Then set it to Low Channel and High Channel within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW of spectrum analyzer to 100 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.



Test Data

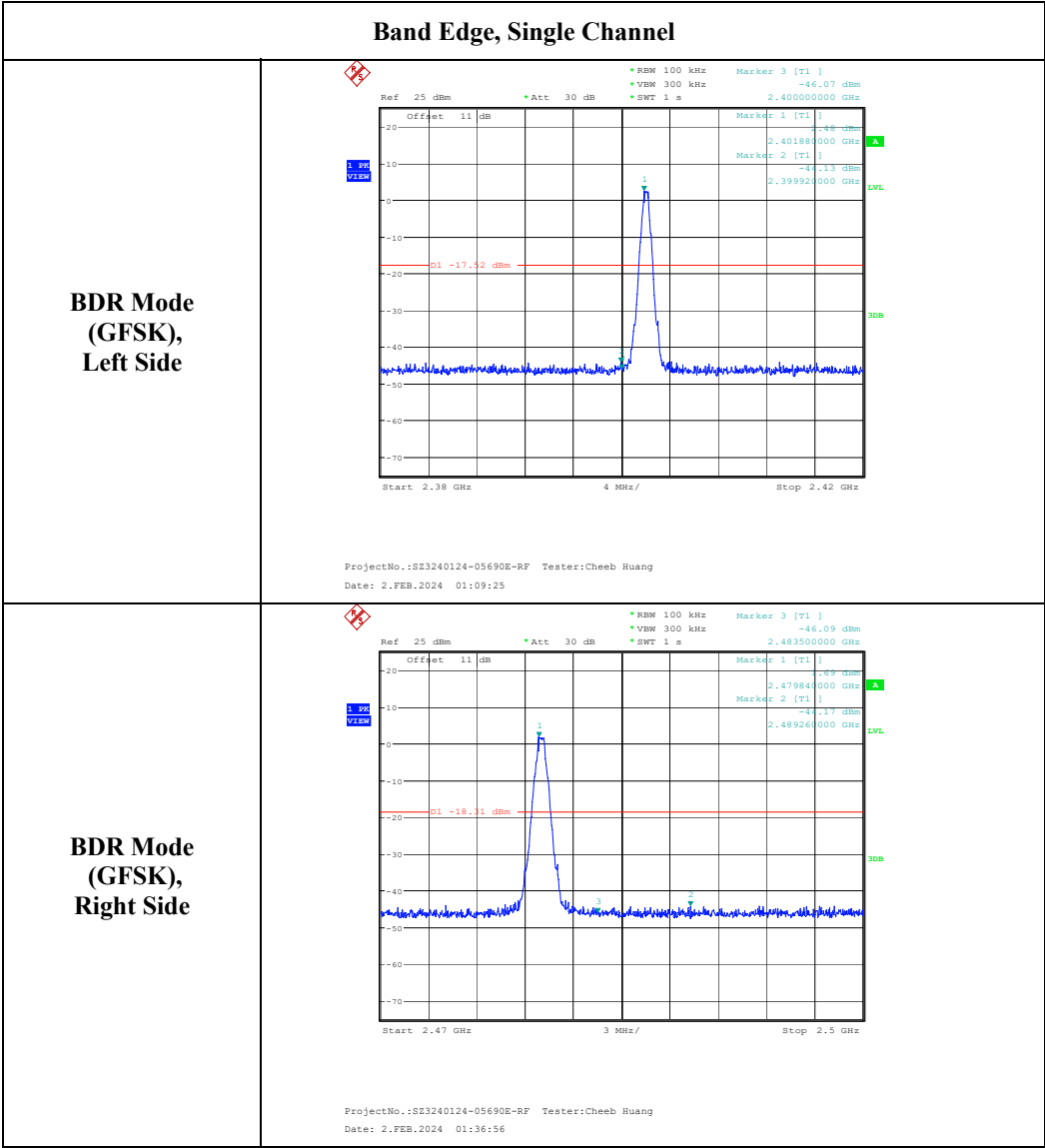
Environmental Conditions

Temperature:	24.2 °C
Relative Humidity:	40 %
ATM Pressure:	101.0 kPa

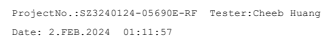
The testing was performed by Cheeb Huang on 2024-02-02.

EUT operation mode: Transmitting

Test Result: Compliant.

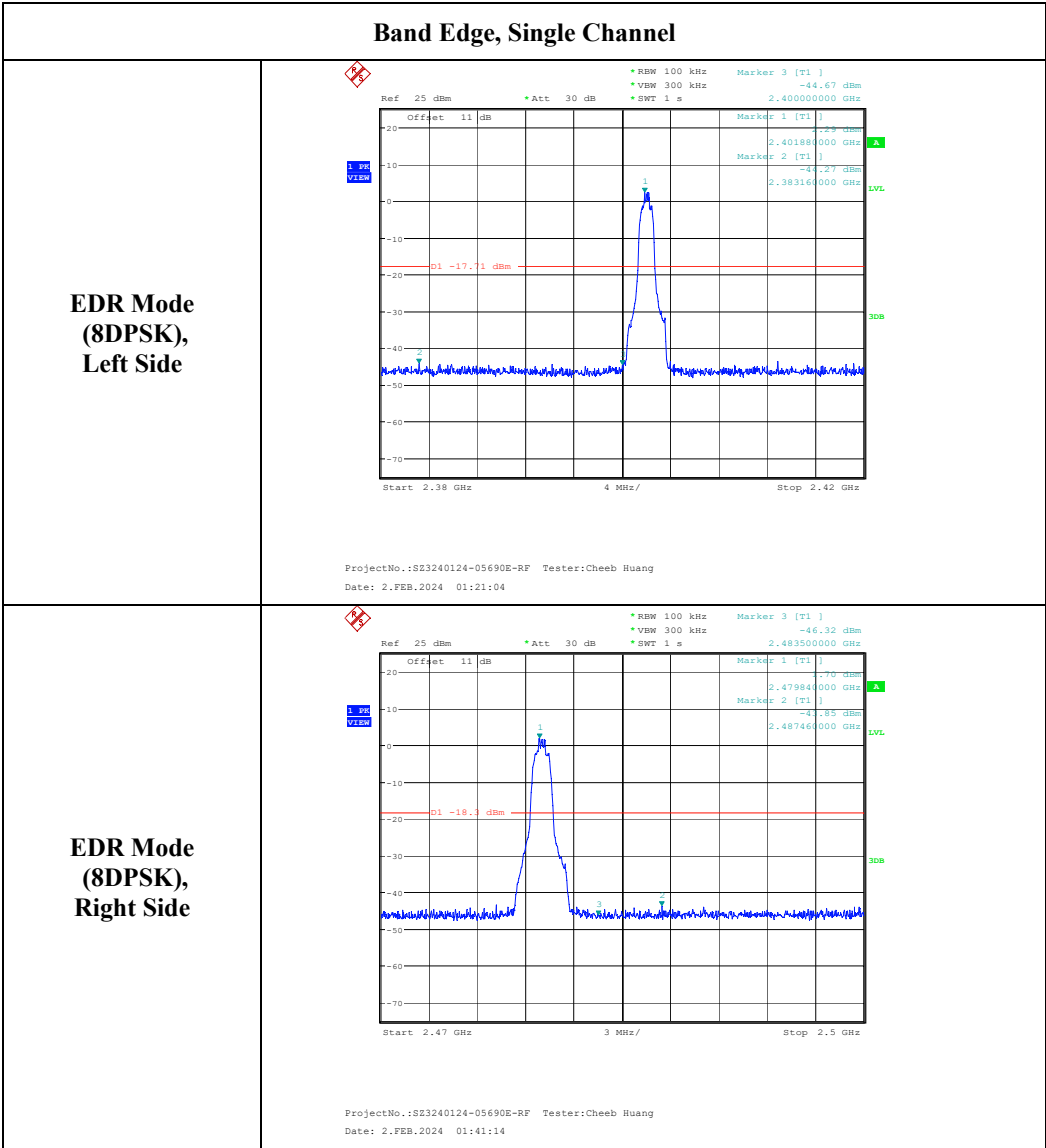


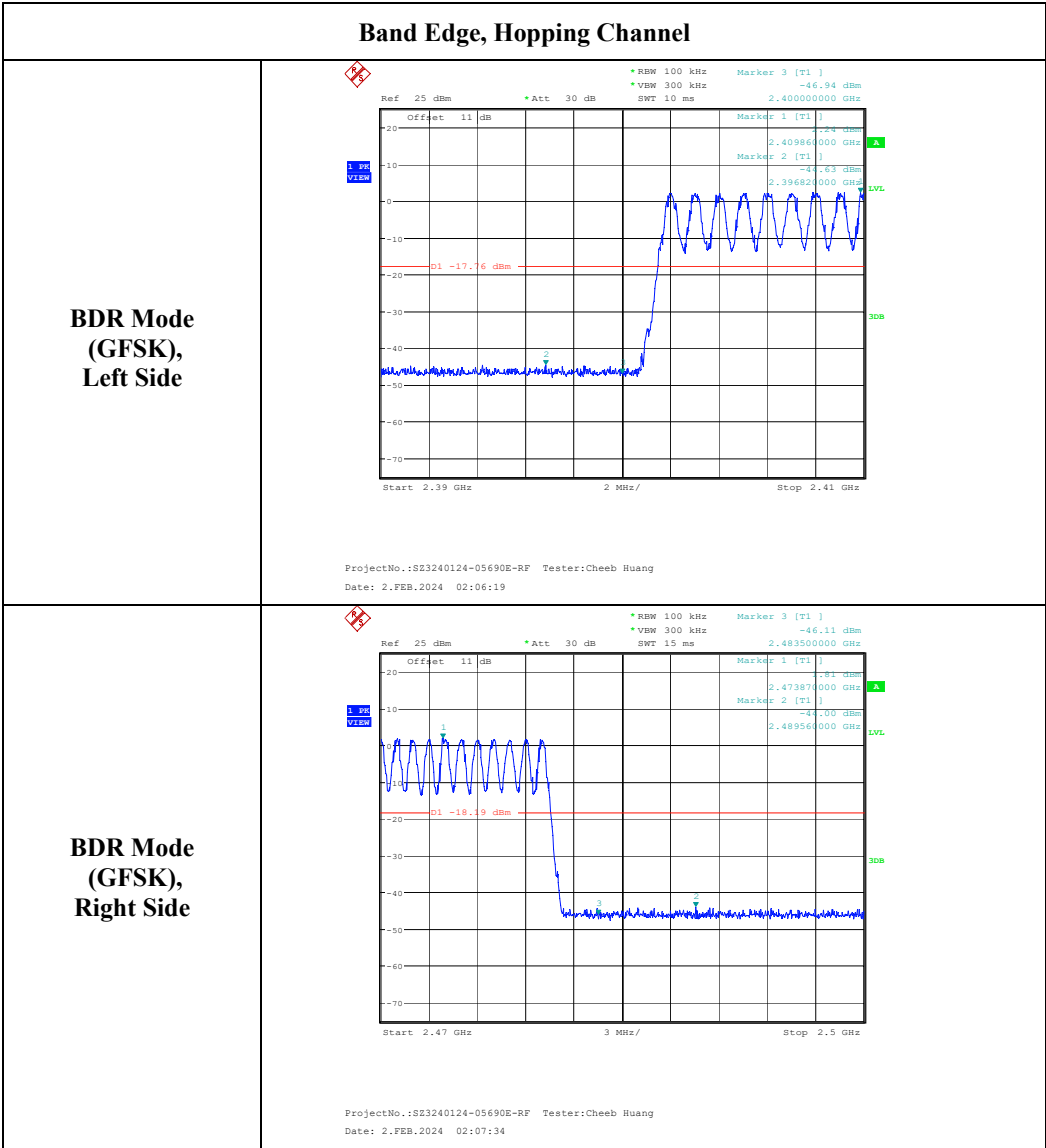
**EDR Mode
($\pi/4$ -DQPSK),
Left Side**

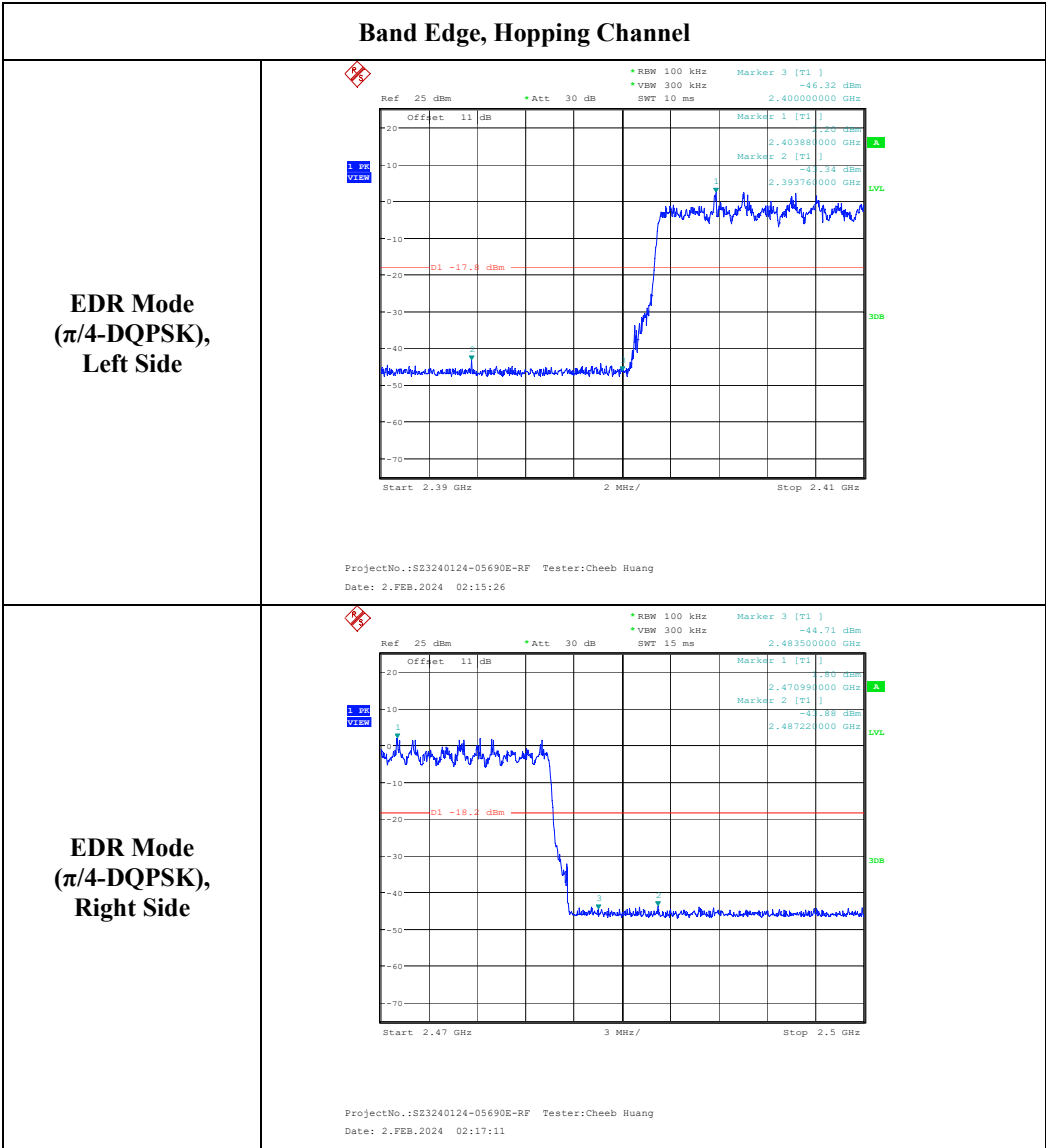


**EDR Mode
($\pi/4$ -DQPSK),
Right Side**









*BW 100 kHz
 *VBW 300 kHz
 Ref 25 dBm
 Att 30 dB
 SWT 10 ms

Marker 3 [T1]
 -46.31 dBm
 2.400000000 GHz

Offset 11 dB
 Marker 1 [T1]
 -66.00 dBm
 2.408000000 GHz
 Marker 2 [T1]
 -41.40 dBm
 2.391660000 GHz

DI -18.34 dBm

Start 2.39 GHz
 2 MHz/
 Stop 2.41 GHz

ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 02:25:41

Ref 25 dBm * Att 30 dB

* BW 100 kHz -45.25 dB
* VBW 300 kHz
SWT 15 ms 2.483500000 GHz

Marker 3 [T1]
-45.25 dB
2.473840000 GHz

Marker 1 [T1]
-9.97 dB
2.473840000 GHz
Marker 2 [T1]
-41.36 dB
2.493520000 GHz

1 dB View

D1 -18.03 dBm

Start 2.47 GHz 3 MHz/ Stop 2.5 GHz

ProjectNo.:SZ3240124-05690E-RF Tester:Cheeb Huang
Date: 2.FEB.2024 02:28:22

EUT PHOTOGRAPHS

Please refer to the attachment SZ3240124-05690E-RF External photo and SZ3240124-05690E-RF Internal photo.

TEST SETUP PHOTOGRAPHS

Please refer to the attachment SZ3240124-05690E-RF Test Setup photo.

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