

NCC Test Report

Report No.: NCC_RF_SL20021201-TRB-002_DSS

Test Model: R12

Received Date: 05/19/2020

Test Date: 05/21/2020-06/18/2020

Issued Date: 06/25/2020

Applicant: Trimble, Inc.

Address: 935 Stewart Drive, Sunnyvale, CA 94085, USA

Manufacturer: Trimble, Inc.

Address: 935 Stewart Drive, Sunnyvale, CA 94085, USA

Issued By: Bureau Veritas Consumer Products Services, Inc.

Lab Address: 775 Montague Expressway, Milpitas, CA 95035

Test Location (1): 775 Montague Expressway, Milpitas, CA 95035

**FCC Registration /
Designation Number:** 540430

ISED# / CAB identifier: 4842D



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Release Control Record

Issue No.	Description	Date Issued
NCC_RF_SL20021201-TRB-002_DSS	Original Release	06/25/2020

1 Certificate of Conformity

Product: GNSS System integrated with WiFi/BT & UHF

Brand: Trimble

Test Model: R12

Sample Status: Engineering sample

Applicant: Trimble, Inc.

Test Date: 05/21/2020-06/18/2020

Standards: LP0002: 2018

The above equipment has been tested by **Bureau Veritas Consumer Products Services, Inc., Milpitas Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : Deon, **Date:** 06/25/2020
Deon Dai / Test Engineer

Approved by : Chen Ge, **Date:** 06/25/2020
Chen Ge / Engineer Reviewer

2 Summary of Test Results

LP0002: 2018 558074 D01 DTS Meas Guidance v05r02			
LP0002: 2018 section	Test Item	Result	Remarks
2.7	Restricted Band of Operation	PASS	Meet the requirement of limit.
2.3	AC Conducted Emissions	PASS	Meet the requirement of limit.
3.10.1.6	Channel Separation	PASS	Meet the requirement of limit.
3.10.1.6	20 dB Bandwidth	PASS	Meet the requirement of limit.
3.10.1.6	Number of Hopping Channels	PASS	Meet the requirement of limit.
3.10.1.6	Time of Occupancy	PASS	Meet the requirement of limit.
3.10.1.2	Output Power	PASS	Meet the requirement of limit.
3.10.1.5	Radiated Emissions & Band Edge Measurement	PASS	Meet the requirement of limit.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
Conducted Emissions at mains ports	150kHz ~ 30MHz	3.51dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	3.73dB
Radiated Emissions above 1 GHz	1GHz ~ 6GHz	4.64dB
	6GHz ~ 18GHz	4.82dB
	18GHz ~ 40GHz	4.91dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	GNSS System integrated with WiFi/BT & UHF
Brand	Trimble
Test Model	R12
Identification No. of EUT	N/A
Status of EUT	Engineering sample
Power Supply Rating	100-240VAC, 1.2A, 50-60Hz
Modulation Type	GFSK, $\pi/4$ DQPSK, 8DPSK
Modulation Technology	FHSS
Transfer Rate	1/2/3Mbps
Operating Frequency	2402~2480MHz
Number of Channel	79
Antenna Type	SMD patch antenna
Antenna Gain	2 dBi
Antenna Connector	SMA for -00; No external connector for -60 (00: 90913-00 & 90914-00, -60: 90913-60 & 90914-60)

3.2 Description of Test Modes

79 channels are provided for BT-EDR mode:

Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (MHz)	Channel	Freq. (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		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE $\geq$ 1G	RE<1G	PLC	APCM	
-	√	√	√	√	

Where **RE $\geq$ 1G**: Radiated Emission above 1GHz **RE<1G**: Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **APCM**: Antenna Port Conducted Measurement

NOTE:

1. The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **X-plane**.
2. "-" means no effect.

Radiated Emission Test (Above 1GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
-	0 to 78	0, 39, 78	FHSS	GFSK	DH5
-	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

Radiated Emission Test (Below 1GHz):

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
-	0 to 78	78	FHSS	8DPSK	3DH5

Power Line Conducted Emission Test:

- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
- ☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
-	0 to 78	78	FHSS	8DPSK	3DH5

Antenna Port Conducted Measurement:

- ☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
- ☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).

architecture).

☒ Following channel(s) was (were) selected for the final test as listed below.

EUT CONFIGURE MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION TECHNOLOGY	MODULATION TYPE	PACKET TYPE
-	0 to 78	0, 39, 78	FHSS	GFSK	DH5
-	0 to 78	0, 39, 78	FHSS	8DPSK	3DH5

Test Condition:

APPLICABLE TO	ENVIRONMENTAL CONDITIONS	INPUT POWER	TESTED BY
RE $\geq$ 1G	25deg. C, 65%RH	120Vac, 60Hz	Deon Dai
RE<1G	25deg. C, 65%RH	120Vac, 60Hz	Deon Dai
PLC	25deg. C, 68%RH	120Vac, 60Hz	Deon Dai
APCM	21deg. C, 60%RH	120Vac, 60Hz	Deon Dai

3.4 Description of Support Units

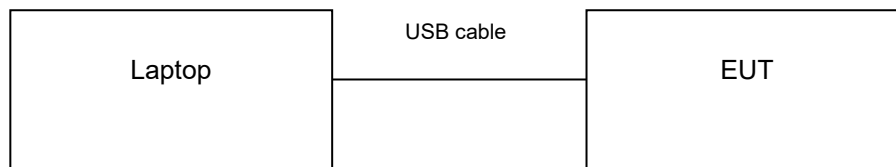
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Laptop	Lenovo	E430	MP-3B3NA	N/A	Provided by Customer
B.						
C.						
D.						
E.						
F.						
G.						

ID	Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1.	RS232 to USB	1	1	N	0	Provided by Customer

Note: The core(s) is(are) originally attached to the cable(s).

3.4.1 Configuration of System under Test



3.5 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

LP0002 :2018
KDB 558074 D01 15.247 Meas Guidance v05r02

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission Measurement

4.1.1 Limits of Radiated Emission

Radiated emissions which fall in the restricted bands must comply with the radiated emission limits specified as below table. Other emissions shall be at least 20dB below the highest level of the desired power:

Frequencies (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

NOTE:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

DESCRIPTION & MANUFACTURER	MODEL NO.	SERIAL NO.	DATE OF CALIBRATION	DUE DATE OF CALIBRATION
EMI Receiver Rohde & Schwarz	ESW 44	100179	8/30/2019	8/30/2020
Hybrid Antenna SUNAR	JB6	A111717	03/09/2020	03/09/2021
Pre-Amplifier RF Bay, Inc.	LPA-6-30	11170601	04/27/2020	04/27/2021
Horn Antenna ETS-Lindgren	3117	218554	12/20/2019	12/20/2020
Preamplifier RF-Lambda	RAMP00M50GA	17032300047	09/19/2019	09/19/2020

4.1.3 Test Procedures

For Radiated emission below 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

NOTE:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9 kHz at frequency below 30MHz.

For Radiated emission above 30MHz

- a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.
- b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.
- c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
- d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.
- e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.
- f. The test-receiver system was set to peak and average detects function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

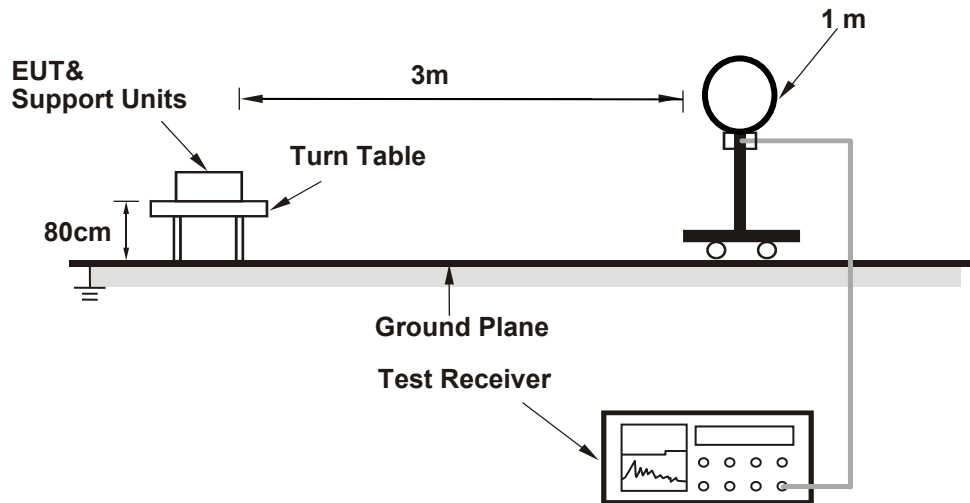
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120 kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. The resolution bandwidth of test receiver/spectrum analyzer is 1MHz and the video bandwidth is $\geq 1/T$ (Duty cycle < 98%) or 10Hz (Duty cycle $\geq 98\%$) for Average detection (AV) at frequency above 1GHz.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

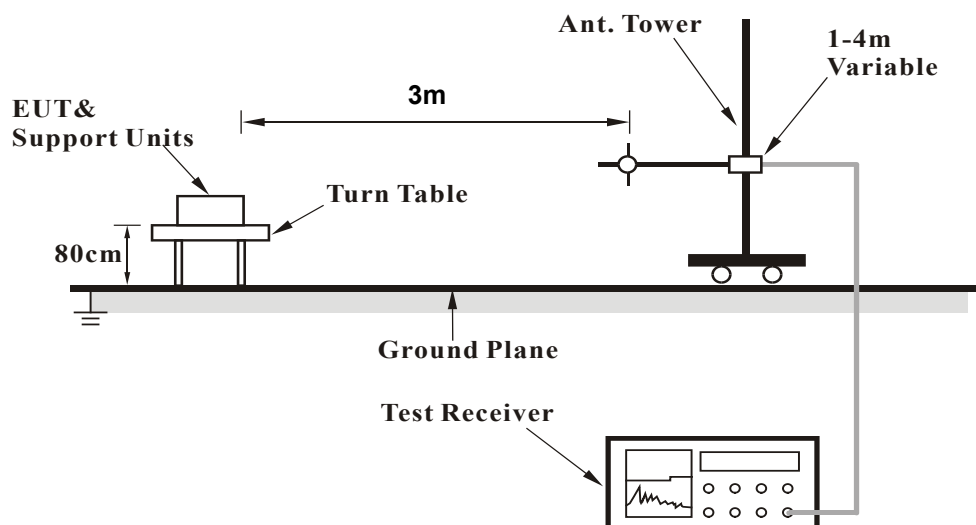
No deviation.

4.1.5 Test Setup

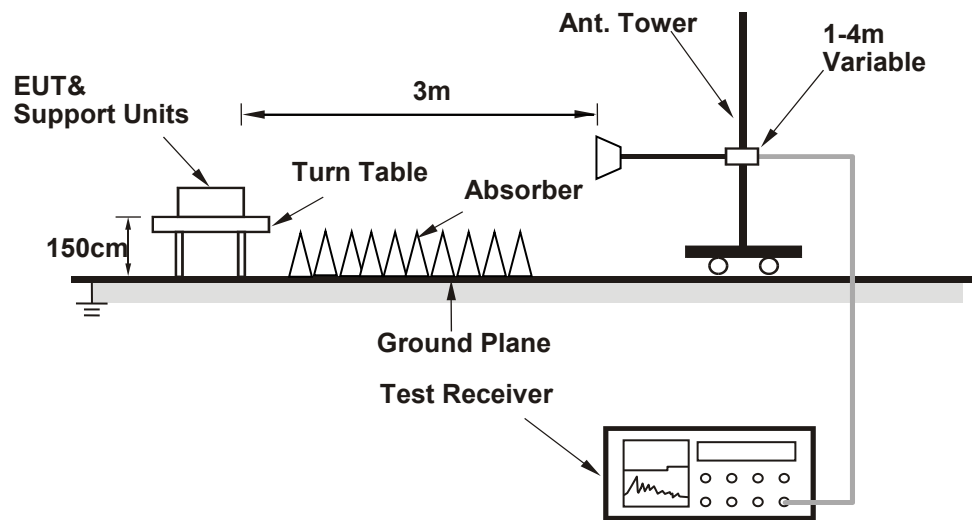
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

- Connected the EUT with the Notebook Computer which is placed on remote site.
- Controlling software has been activated to set the EUT on specific status.

4.1.7 Test Results

BELOW 1GHz WORST-CASE DATA:

BT_GFSK

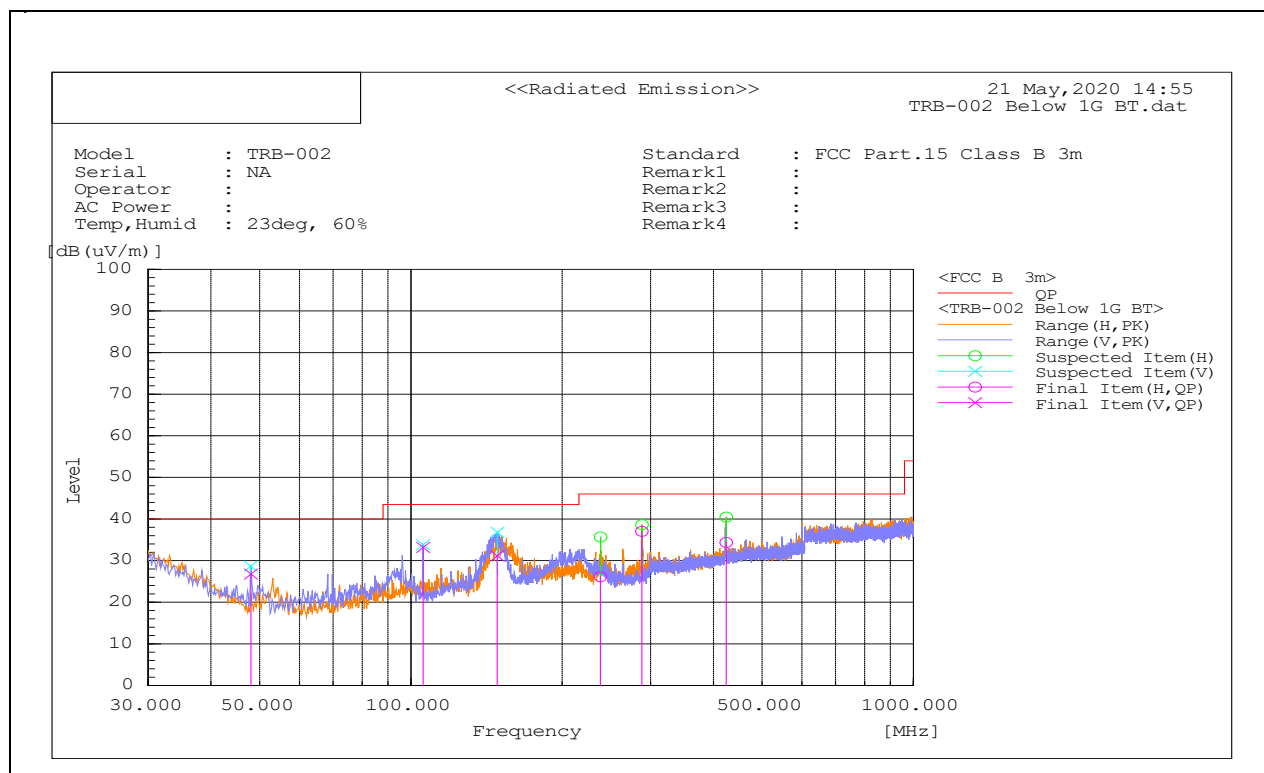
CHANNEL	Middle Channel	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	48.067	V	12.5	14.3	26.8	40	-13.2	104	46.8	Pass
2	105.765	V	16.2	17	33.2	43.5	-10.3	100	233	Pass
3	148.505	V	11.9	19.3	31.2	43.5	-12.3	100	0	Pass
4	238.344	H	7.5	18.6	26.1	46	-19.9	137	199	Pass
5	288.171	H	16	21	37	46	-9	100	141	Pass
6	424.092	H	10.6	23.8	34.4	46	-11.6	100	290	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



BT_8DPSK

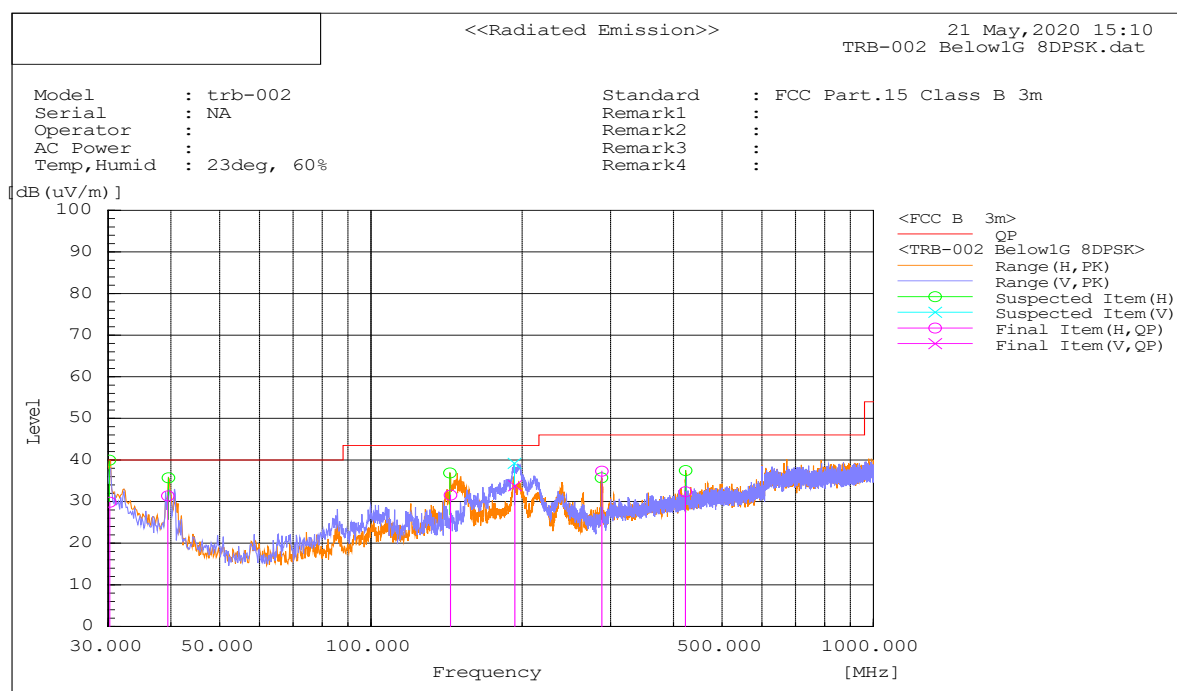
CHANNEL	Middle Channel	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading QP [dB(uV)]	Factor [dB(1/m)]	Level QP [dB(uV/m)]	Limit\QP dB(uV/m)	Margin QP [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	30.216	H	3	26.8	29.8	40	-10.2	272	223	Pass
2	39.453	H	11.4	20	31.4	40	-8.6	162	156	Pass
3	143.961	H	12.5	19	31.5	43.5	-12	314	0	Pass
4	193.393	V	15.3	18.5	33.8	43.5	-9.7	112	268	Pass
5	288.084	H	16.3	21	37.3	46	-8.7	104	233	Pass
6	422.423	H	8.6	23.8	32.4	46	-13.6	213	230	Pass

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Cable Loss (dB) + AF (dB)
2. AF (dB/m) = Antenna Factor (dB/m) – Preamplifier Gain (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Emission level – Limit value.



ABOVE 1GHz TEST DATA:

BT_GFSK

CHANNEL	Low Channel	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 26GHz		Average

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1916.849	H	42.6	65.3	-10.3	32.3	55	54	74	-21.7	-19	251	14.8	Pass
2	2002.124	V	41.9	56.5	-10	31.9	46.5	54	74	-22.1	-27.5	100	89.6	Pass
3	4803.11	H	39.1	52	-5.9	33.2	46.1	54	74	-20.8	-27.9	222	28.7	Pass

CHANNEL	Middle Channel	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 26GHz		Average

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2717.101	H	42.4	55.8	-9	33.4	46.8	54	74	-20.6	-27.2	215	351.4	Pass
2	4880.766	V	38.7	51.4	-6.1	32.6	45.3	54	74	-21.4	-28.7	237	190.9	Pass
3	10433.97	H	33.5	46.4	3.3	36.8	49.7	54	74	-17.2	-24.3	373	134	Pass

CHANNEL	High Channel	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 26GHz		Average

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m														
No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1952.413	H	42.4	59.6	-10.1	32.3	49.5	54	74	-21.7	-24.5	208	0	Pass
2	3413.638	V	39.9	52.8	-7.9	32	44.9	54	74	-22	-29.1	394	0.1	Pass
3	4959.508	V	39.1	52.3	-6	33.1	46.3	54	74	-20.9	-27.7	337	150.9	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

ABOVE 1GHz TEST DATA:

BT_8DPSK

CHANNEL	Low Channel	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 26GHz		Average

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1916.556	H	42.8	66.7	-10.3	32.5	56.4	54	74	-21.5	-17.6	258	7.2	Pass
2	4804.631	V	39.1	52.4	-5.9	33.2	46.5	54	74	-20.8	-27.5	380	0.5	Pass
3	6489.734	H	36.7	50.1	-2.2	34.5	47.9	54	74	-19.5	-26.1	294	198.9	Pass

CHANNEL	Middle Channel	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 26GHz		Average

Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1916.814	V	42.3	61.6	-10.3	32	51.3	54	74	-22	-22.7	187	95	Pass
2	2683.556	V	42.9	56.1	-9	33.9	47.1	54	74	-20.1	-26.9	308	211	Pass
3	4881.661	H	38.7	51.8	-6.1	32.6	45.7	54	74	-21.4	-28.3	387	215.7	Pass

CHANNEL	High Channel	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 26GHz		Average

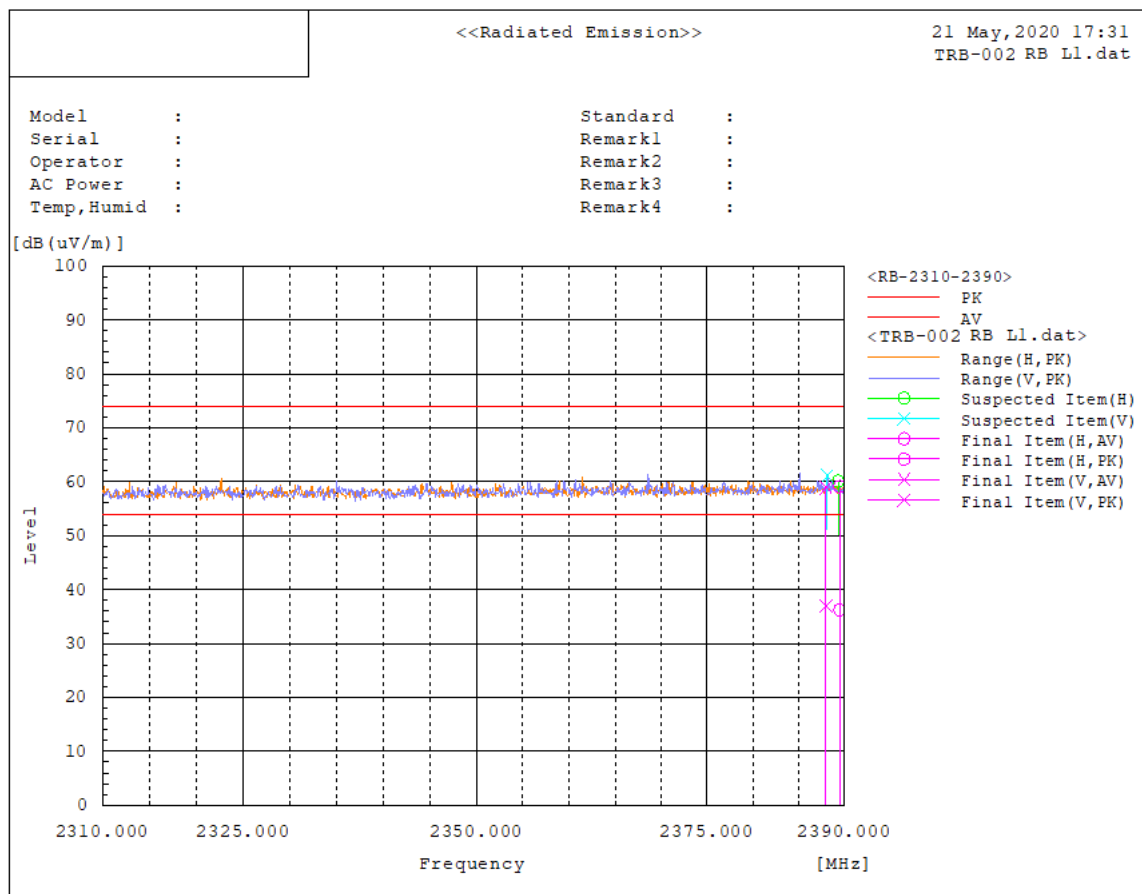
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	1916.402	H	42.4	65.5	-10.3	32.1	55.2	54	74	-21.9	-18.8	258	2	Pass
2	4960.09	H	39.1	52.1	-6	33.1	46.1	54	74	-20.9	-27.9	172	260.9	Pass
3	6287.271	H	36.8	50.7	-2.7	34.1	48	54	74	-19.9	-26	180	250.6	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

Restricted band (GFSK low channel)



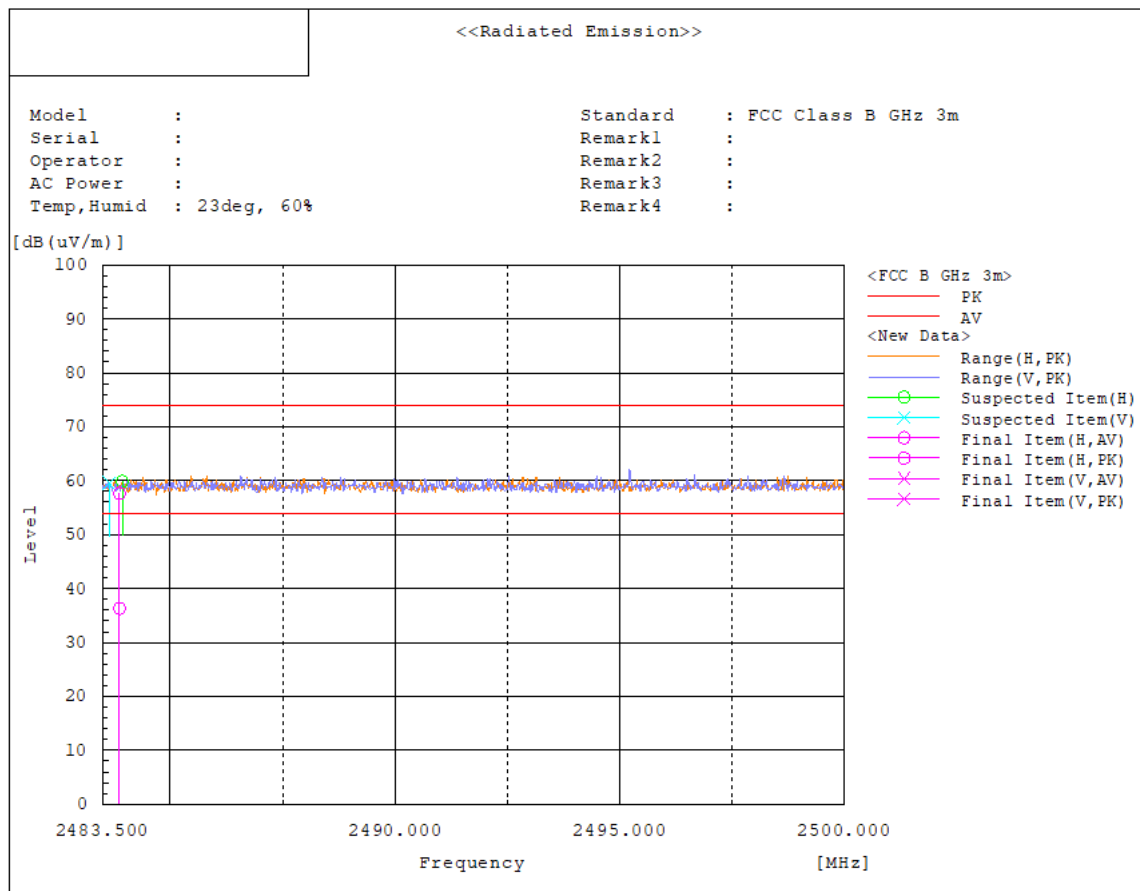
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2388.01	V	1.9	23.8	35.1	37	58.9	54	74	-17	-15.1	171	42.4	Pass
2	2389.48	H	1.1	24	35.1	36.2	59.1	54	74	-17.8	-14.9	205	0.2	Pass

REMARKS:

- Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
- Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
- Margin = Level (dBuV/m) - Limit value (dBuV/m)

Restricted band (GFSK high channel)



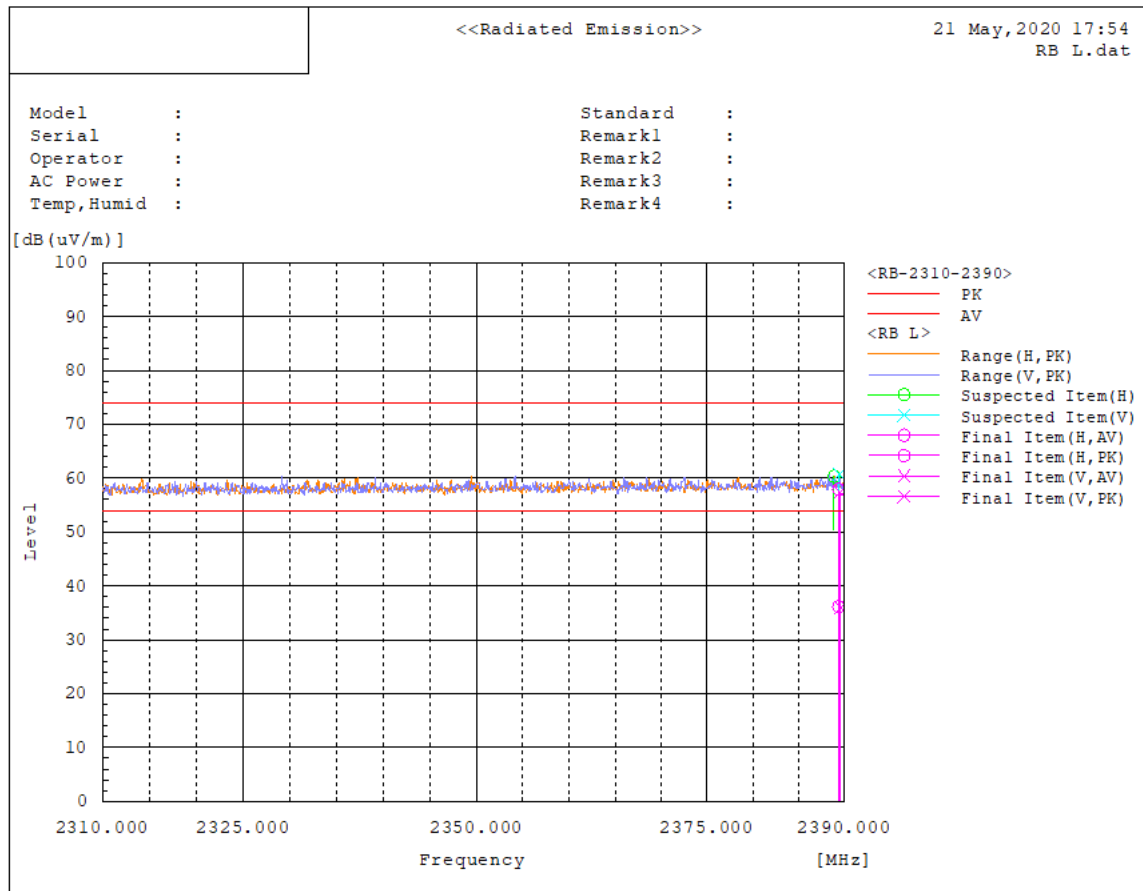
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2483.34	V	0.7	22.2	35.6	36.3	57.8	54	74	-17.7	-16.2	230	235.4	Pass
2	2483.87	H	0.7	22.1	35.6	36.3	57.7	54	74	-17.7	-16.3	179	0.1	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

Restricted band (8DPSK low channel)



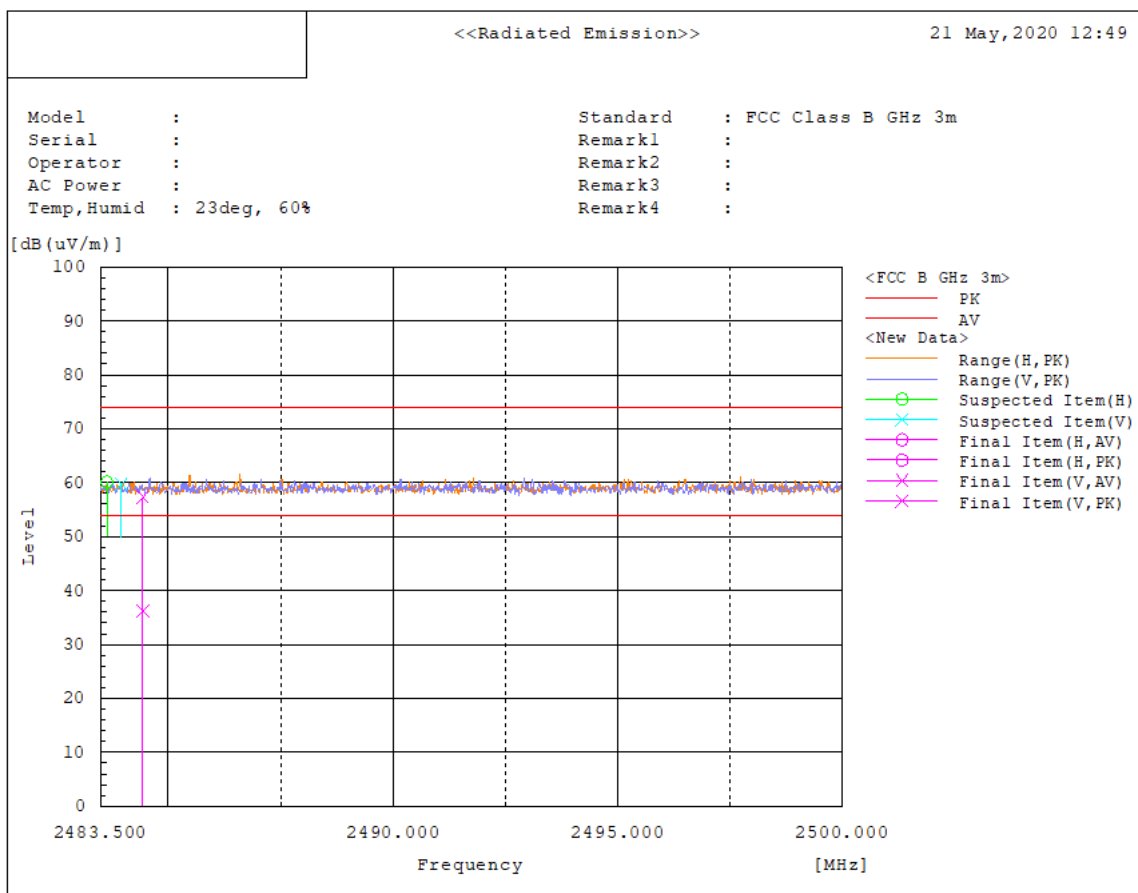
Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2389.36	H	1	22.8	35.1	36.1	57.9	54	74	-17.9	-16.1	357	0.1	Pass
2	2389.56	V	0.9	22.3	35.1	36	57.4	54	74	-18	-16.6	154	359.2	Pass

REMARKS:

- Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
- Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
- Margin = Level (dBuV/m) - Limit value (dBuV/m)

Restricted band (8DPSK high channel)



Antenna Polarity & Test Distance: Vertical and Horizontal at 3m

No.	Frequency (MHz)	Polarization (H/V)	Reading AV [dB(uV)]	Reading PK [dB(uV)]	Factor [dB(1/m)]	Level AV [dB(uV/m)]	Level PK [dB(uV/m)]	Limit AV [dB(uV/m)]	Limit PK [dB(uV/m)]	Margin AV [dB]	Margin PK [dB]	Height (cm)	Angle (Deg)	Pass/Fail
1	2483.29	H	0.9	22.4	35.6	36.5	58	54	74	-17.5	-16	332	149	Pass
2	2484.45	V	0.7	21.7	35.6	36.3	57.3	54	74	-17.7	-16.7	162	315	Pass

REMARKS:

1. Level (dBuV) = Reading (dBuV) + Factor (dB(1/m)).
2. Factor (dB(1/m)) = Antenna Factor(AF) (dB(1/m)) + Cable Loss (dB) –Preamplifier Gain (dB)
3. Margin = Level (dBuV/m) - Limit value (dBuV/m)

4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.

2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Date Of Calibration	Due Date Of Calibration
EMI Test Receiver ROHDE & SCHWARZ	ESIB 40	100179	11/01/2019	11/01/2020
Transient Limiter ELECTRO-METRICS	EM-7600-5	106	12/31/2019	12/31/2020
LISN EMCO	3816/2NM	214372	01/14/2020	01/14/2021

4.2.3 Test Procedures

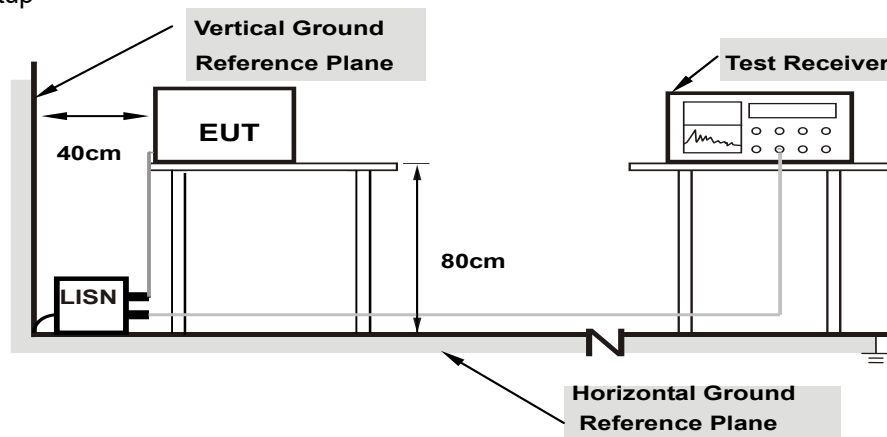
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
- Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
- The frequency range from 150 kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9 kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Conditions

Same as 4.1.6.

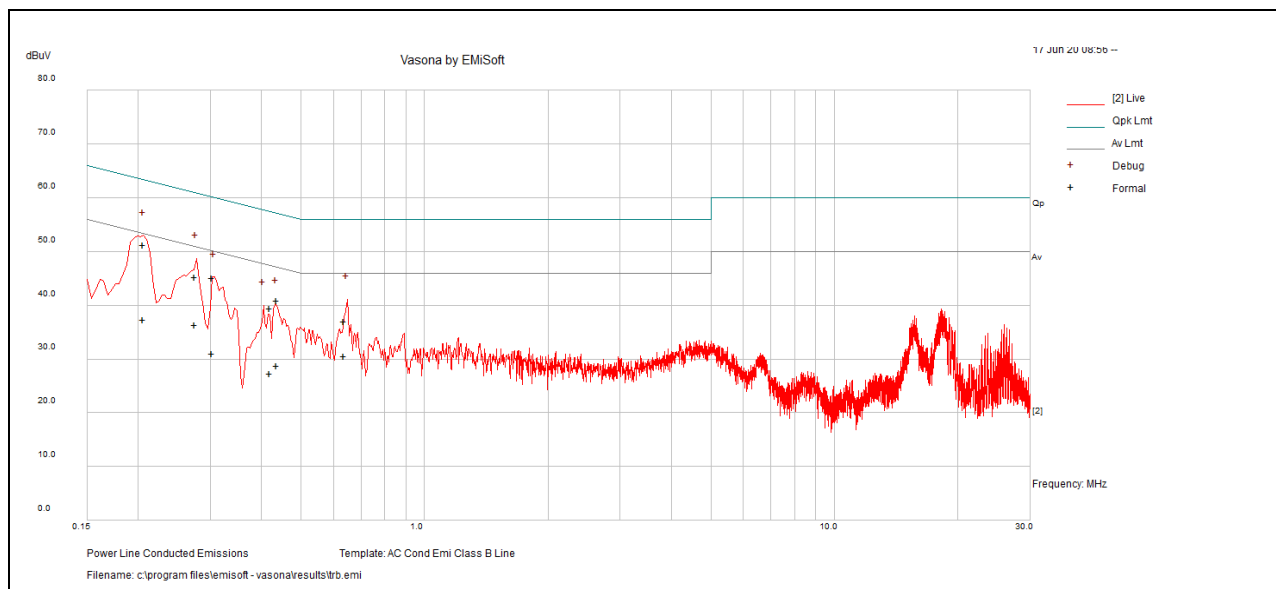
4.2.7 Test Results

Phase	Line (L)	Detector Function	Quasi-Peak / Average
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No	Freq. [MHz]	Raw (dBuV)	Cale Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	0.206	41.79	9.38	0.04	51.21	Quasi Peak	Live	63.35	-12.14	Pass
2	0.276	35.85	9.44	0.04	45.32	Quasi Peak	Live	60.94	-15.62	Pass
3	0.304	35.63	9.44	0.04	45.11	Quasi Peak	Live	60.14	-15.03	Pass
4	0.638	27.54	9.46	0.04	37.04	Quasi Peak	Live	56	-18.96	Pass
5	0.437	31.41	9.45	0.04	40.9	Quasi Peak	Live	57.11	-16.21	Pass
6	0.421	29.97	9.45	0.04	39.45	Quasi Peak	Live	57.43	-17.98	Pass
7	0.206	27.99	9.38	0.04	37.41	Average	Live	53.35	-15.94	Pass
8	0.276	26.97	9.44	0.04	36.44	Average	Live	50.94	-14.5	Pass
9	0.304	21.5	9.44	0.04	30.98	Average	Live	50.14	-19.17	Pass
10	0.638	21	9.46	0.04	30.5	Average	Live	46	-15.5	Pass
11	0.437	19.26	9.45	0.04	28.75	Average	Live	47.11	-18.37	Pass
12	0.421	17.85	9.45	0.04	27.34	Average	Live	47.43	-20.09	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level - Limit value
3. Emission Level = Correction Factor + Raw Value + Factors Value.

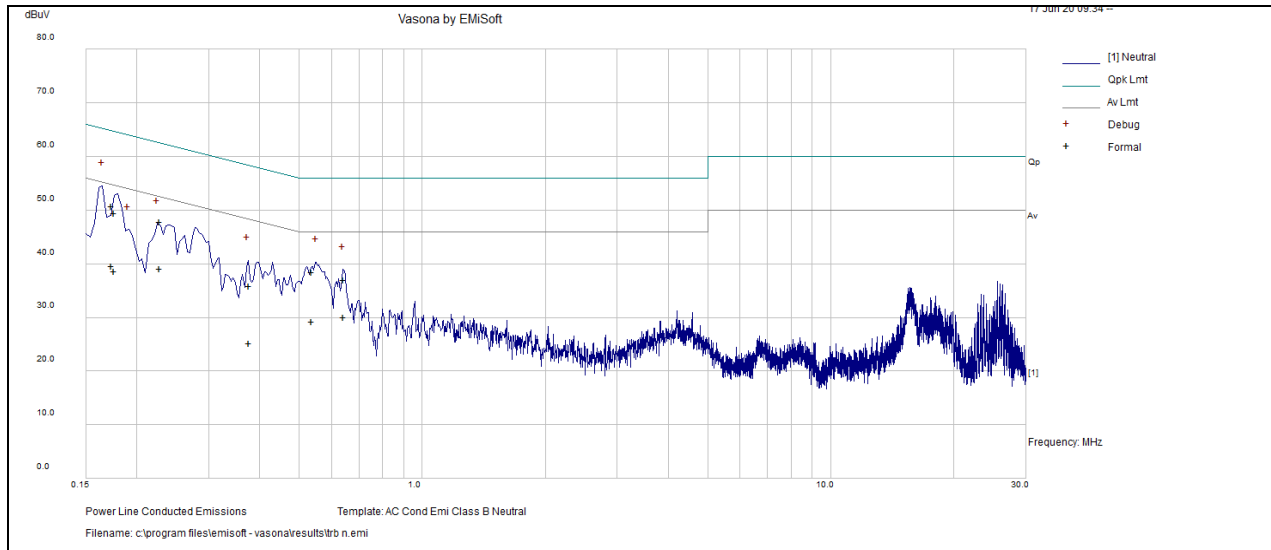


Phase	Neutral (N)	Detector Function	Quasi-Peak / Average
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No	Freq. [MHz]	Raw (dBuV)	Cale Loss (dB)	Factors (dB)	Level (dBuV)	Measurement Type	Line	Limit (dBuV)	Margin (dB)	Pass /Fail
1	0.174	41.35	9.33	0.03	50.72	Quasi Peak	Neutral	64.75	-14.03	Pass
2	0.229	38.38	9.41	0.03	47.82	Quasi Peak	Neutral	62.5	-14.68	Pass
3	0.539	28.97	9.45	0.03	38.45	Quasi Peak	Neutral	56	-17.55	Pass
4	0.642	27.49	9.46	0.03	36.98	Quasi Peak	Neutral	56	-19.02	Pass
5	0.176	40.18	9.34	0.03	49.55	Quasi Peak	Neutral	64.66	-15.11	Pass
6	0.378	26.39	9.44	0.03	35.87	Quasi Peak	Neutral	58.32	-22.45	Pass
7	0.174	30.32	9.33	0.03	39.69	Average	Neutral	54.75	-15.06	Pass
8	0.229	29.62	9.41	0.03	39.06	Average	Neutral	52.5	-13.44	Pass
9	0.539	19.79	9.45	0.03	29.28	Average	Neutral	46	-16.72	Pass
10	0.642	20.64	9.46	0.03	30.13	Average	Neutral	46	-15.87	Pass
11	0.176	29.26	9.34	0.03	38.63	Average	Neutral	54.66	-16.03	Pass
12	0.378	15.83	9.44	0.03	25.3	Average	Neutral	48.32	-23.02	Pass

REMARKS:

1. The emission levels of other frequencies were very low against the limit.
2. Margin value = Emission level - Limit value
3. Emission Level = Correction Factor + Raw Value + Factors Value.

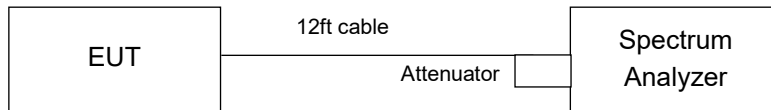


4.3 Channel Bandwidth

4.3.1 Limits of Channel Bandwidth Measurement

For frequency hopping system operating in the 2400-2483.5MHz, If the 20dB bandwidth of hopping channel is greater than 25kHz, two-thirds 20dB bandwidth of hopping channel shall be a minimum limit for the hopping channel separation.

4.3.2 Test Setup



4.3.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.4 Test Procedure

- Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
- Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
- Repeat above procedures until all frequencies measured were complete.

4.3.5 Deviation from Test Standard

No deviation.

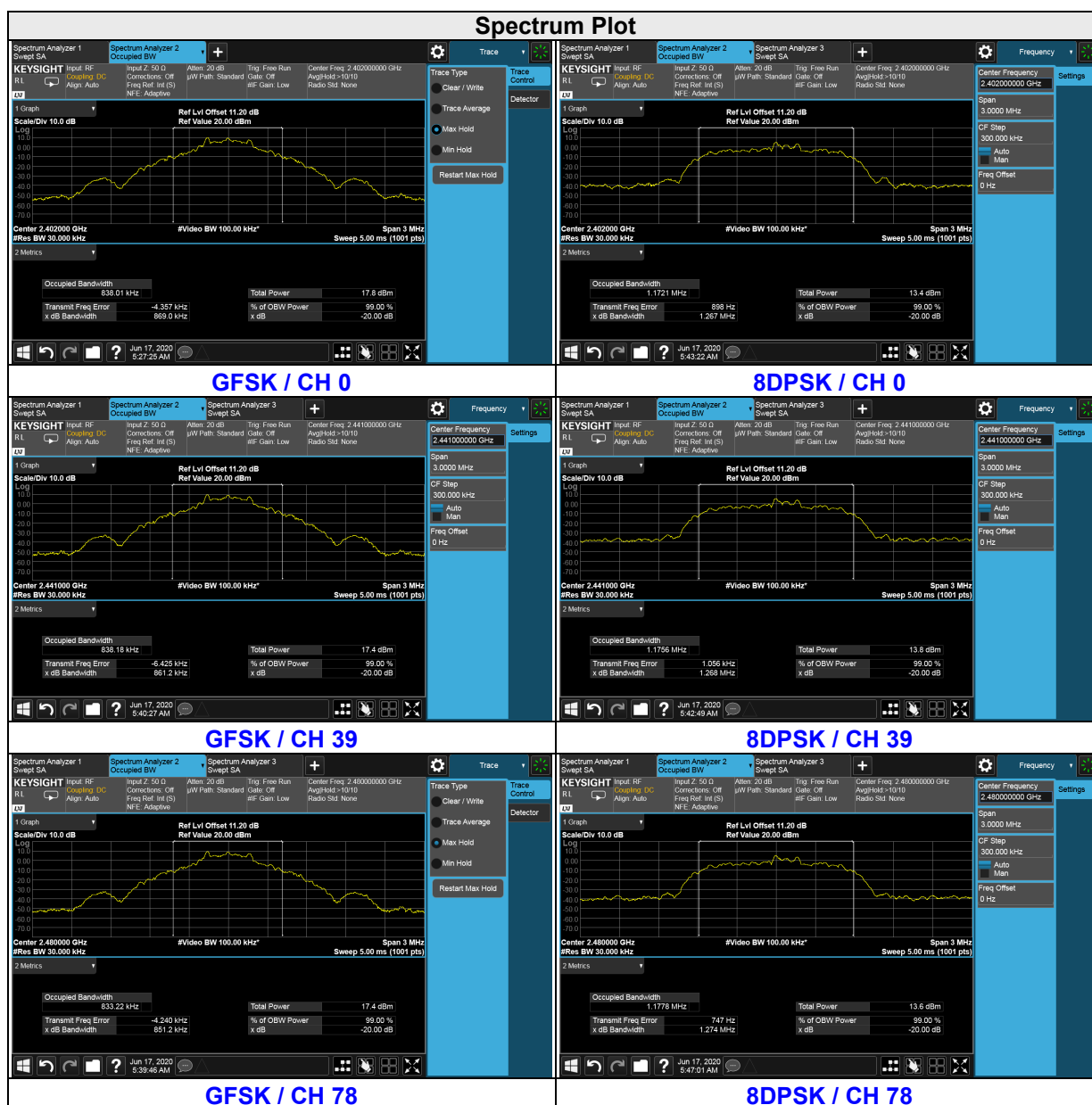
4.3.6 EUT Operating Condition

The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.3.7 Test Results

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	
		GFSK	8DPSK
0	2402	0.869	1.267
39	2441	0.861	1.268
78	2480	0.851	1.274

Test Plots

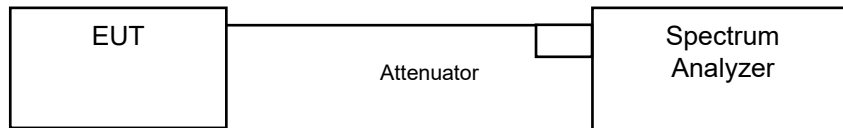


4.4 Hopping Channel Separation

4.4.1 Limits of Hopping Channel Separation Measurement

At least 25kHz or 20dB hopping channel bandwidth (whichever is greater).

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test Procedure

Measurement Procedure REF

- a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
- c. By using the MaxHold function record the separation of two adjacent channels.
- d. Measure the frequency difference of these two adjacent channels by SA MARK function. And then plot the result on SA screen.
- e. Repeat above procedures until all frequencies measured were complete.

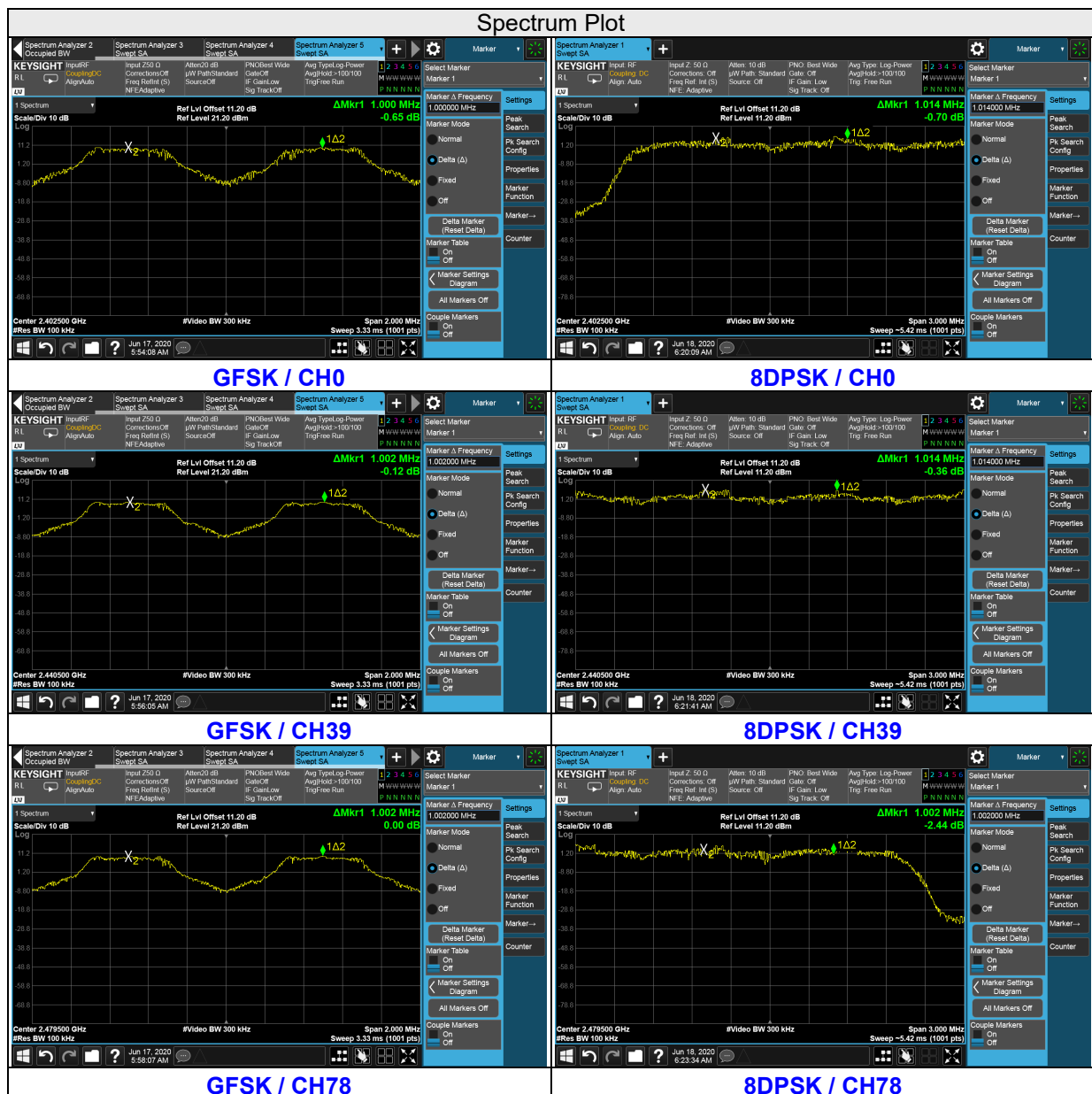
4.4.5 Deviation from Test Standard

No deviation.

4.4.6 Test Results

Channel	Frequency (MHz)	Adjacent Channel Separation (MHz)		20dB Bandwidth (MHz)		Minimum Limit (MHz)		Pass / Fail
		GFSK	8DPSK	GFSK	8DPSK	GFSK	8DPSK	
0	2402	1.000	1.014	0.869	1.267	0.579	0.845	Pass
39	2441	1.002	1.014	0.861	1.268	0.574	0.845	Pass
78	2480	1.002	1.002	0.851	1.274	0.567	0.849	Pass

NOTE: The minimum limit is two-third 20dB bandwidth.

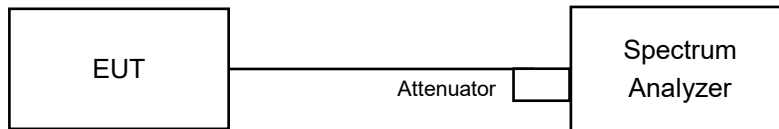


4.5 Conducted Output Power Measurement

4.5.1 Limits of Conducted Output Power Measurement

The Maximum Output Power Measurement is 1W.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test Procedures

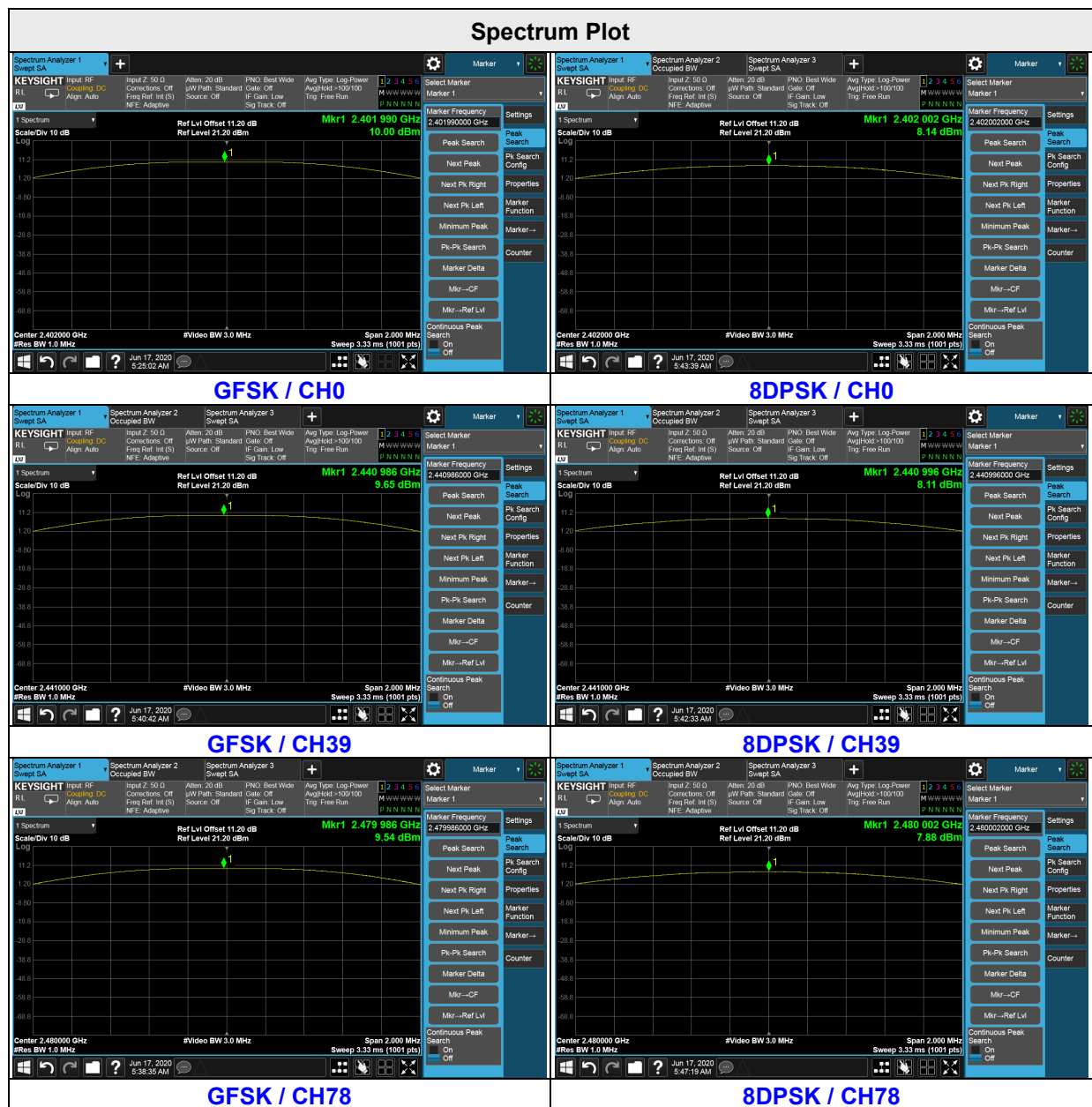
- a. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
- b. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range. Set a reference level on the measuring instrument equal to the highest peak value.
- c. The center frequency of the spectrum analyzer is set to the fundamental frequency and using 3MHz RBW and 10 MHz VBW.
- d. Measure the captured power within the band and recording the plot.
- e. Repeat above procedures until all frequencies required were complete.

4.5.5 Deviation from Test Standard

No deviation.

4.5.6 Test Results

Channel	Frequency (MHZ)	Output Power (dBm)		Output Power (mW)		Power Limit (mW)	Pass / Fail
		GFSK	8DPSK	GFSK	8DPSK		
0	2402	10.00	8.14	10.00	9.11	1000	Pass
39	2441	9.65	8.11	9.85	9.09	1000	Pass
78	2480	9.54	7.88	9.80	8.97	1000	Pass

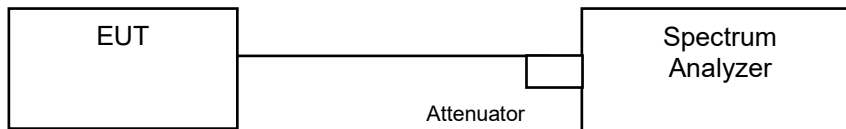


4.6 Number of Hopping Frequency Used

4.6.1 Limits of Hopping Frequency Used Measurement

At least 15 channels frequencies, and should be equally spaced.

4.6.2 Test Setup



4.6.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

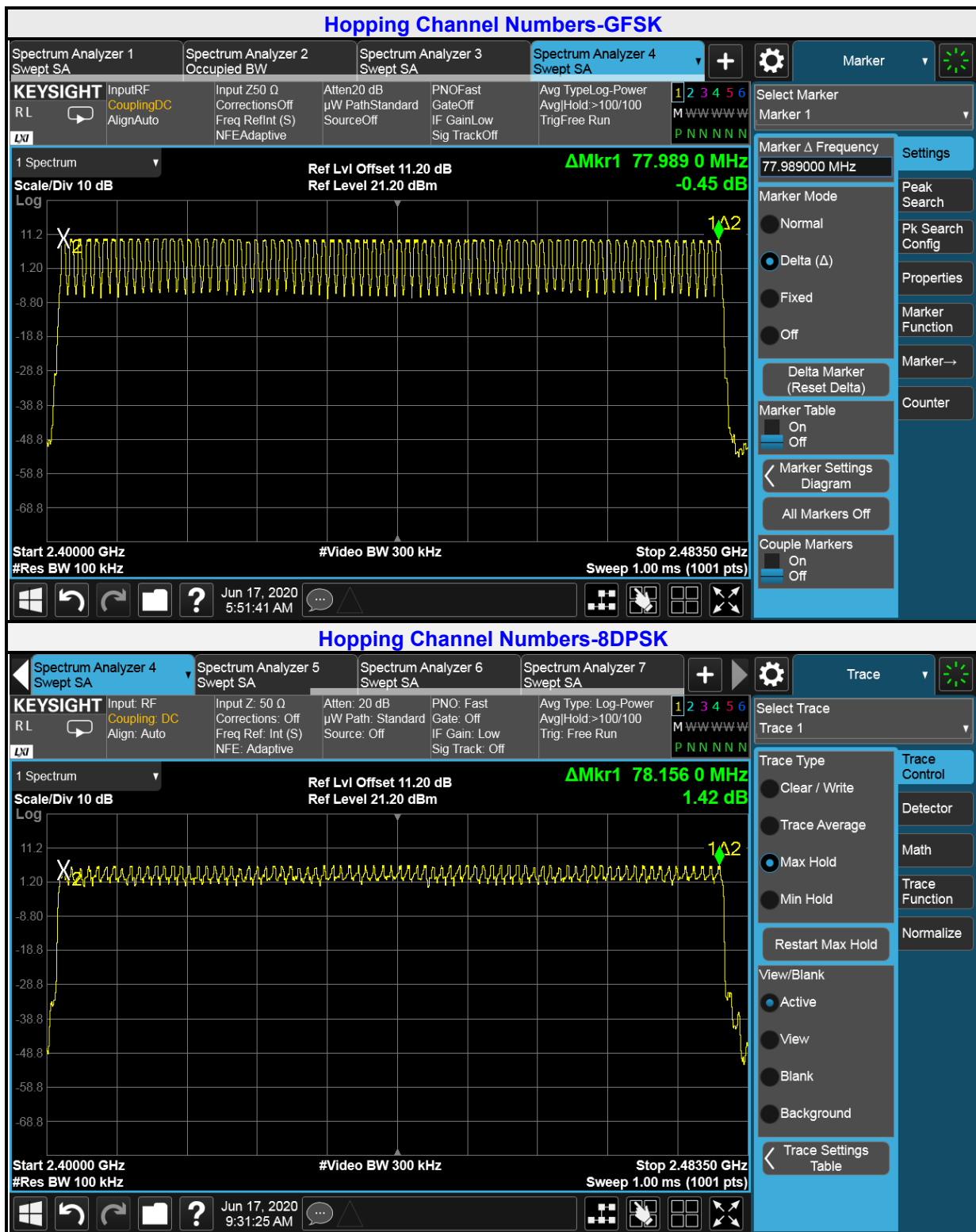
4.6.4 Test Procedure

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Set the SA on MaxHold Mode, and then keep the EUT in hopping mode. Record all the signals from each channel until each one has been recorded.
- Set the SA on View mode and then plot the result on SA screen.
- Repeat above procedures until all frequencies measured were complete.

4.6.5 Deviation from Test Standard

No deviation.

4.6.6 Test Results

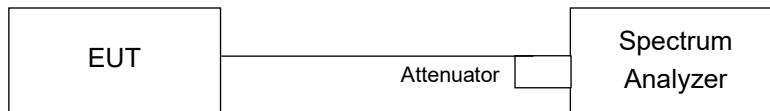


4.7 Dwell Time on Each Channel

4.7.1 Limits of Dwell Time on Each Channel Measurement

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.

4.7.2 Test Setup



4.7.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.7.4 Test Procedures

- Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range and make sure the instrument is operated in its linear range.
- Adjust the center frequency of SA on any frequency be measured and set SA to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
- Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
- Repeat above procedures until all different time-slot modes have been completed.

4.7.5 Deviation from Test Standard

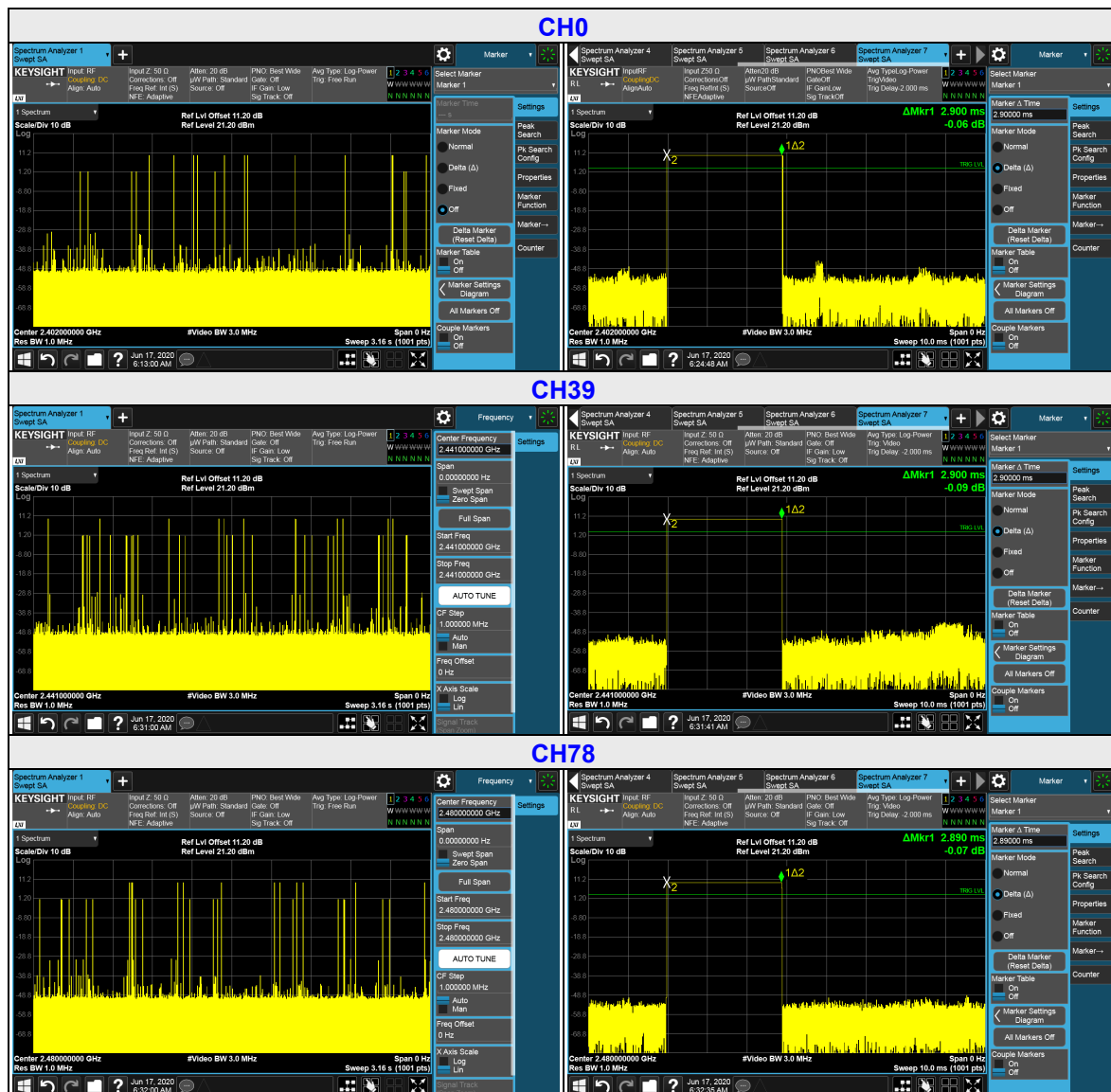
No deviation.

4.7.6 Test Results

GFSK

Mode	Channel	Number of transmission in a period(channel number * 0.4 sec)				Length of transmission time (msec)	Result (msec)	Limit (msec)	PASS/ FAIL
		Period (sec)	Sweep time (sec)	Times in a sweep	Times in a period				
DH5	0	31.6	3.16	11	110	2.90	319	400	PASS
DH5	39	31.6	3.16	11	110	2.90	319	400	PASS
DH5	78	31.6	3.16	11	110	2.89	317.9	400	PASS

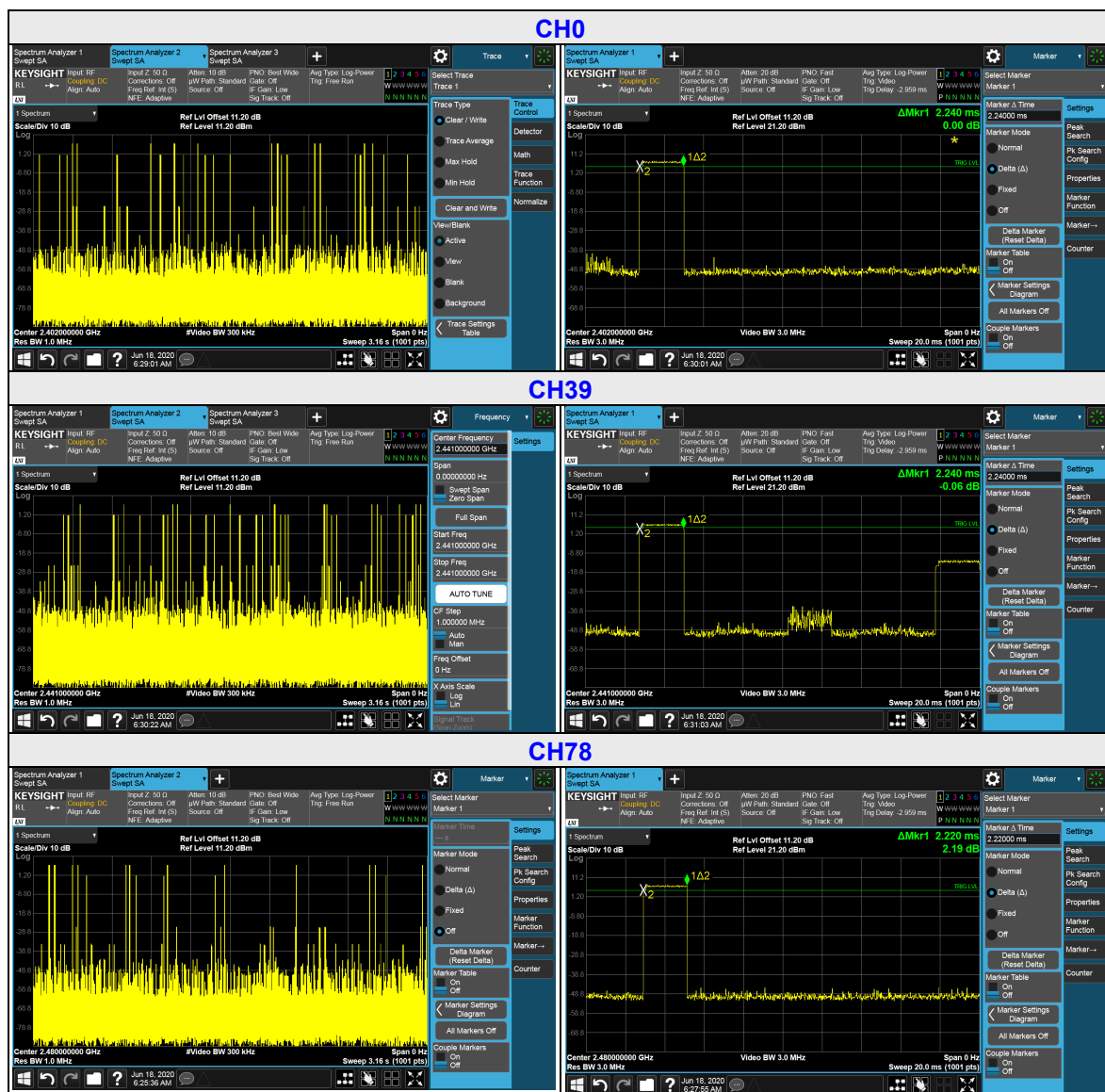
NOTE: Test plots of the transmitting time slot are shown below.



8DPSK

Mode	Channel	Number of transmission in a period(channel number * 0.4 sec)				Length of transmission time (msec)	Result (msec)	Limit (msec)	PASS/ FAIL
		Period (sec)	Sweep time (sec)	Times in a sweep	Times in a period				
DH5	0	31.6	3.16	11	110	2.24	246.4	400	PASS
DH5	39	31.6	3.16	13	130	2.24	291.2	400	PASS
DH5	78	31.6	3.16	12	120	2.22	266.4	400	PASS

NOTE: Test plots of the transmitting time slot are shown on below.



4.8 Conducted Out of Band Emission Measurement

4.8.1 Limits of Conducted Out of Band Emission Measurement

Below -20dB of the highest emission level of operating band (in 100kHz Resolution Bandwidth).

4.8.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.8.3 Test Procedure

The transmitter output was connected to the spectrum analyzer via a low lose cable. Set both RBW and VBW of spectrum analyzer to 100 kHz and 300 kHz with suitable frequency span including 100 MHz bandwidth from band edge. The band edges was measured and recorded.

4.8.4 Deviation from Test Standard

No deviation.

4.8.5 EUT Operating Condition

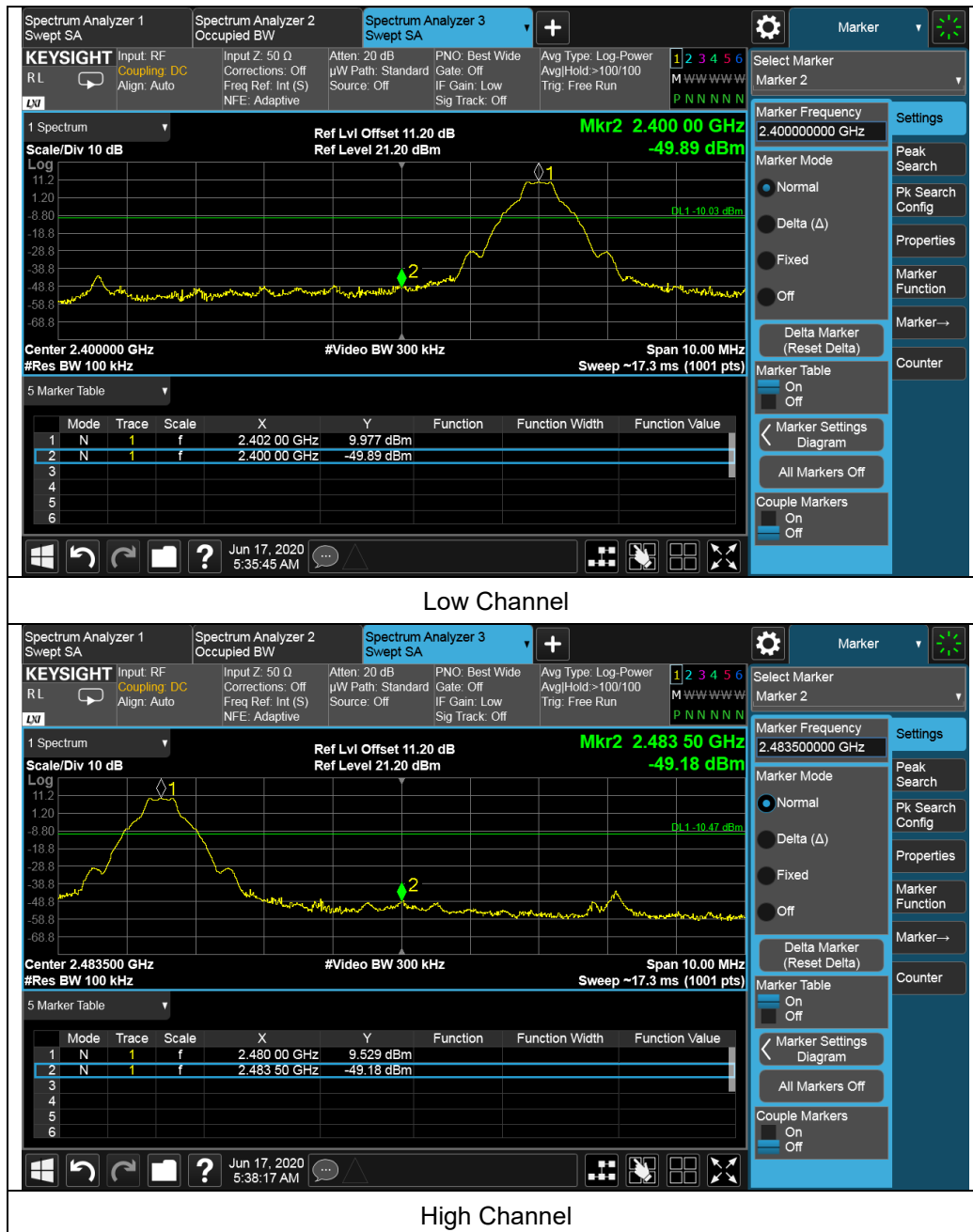
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.8.6 Test Results

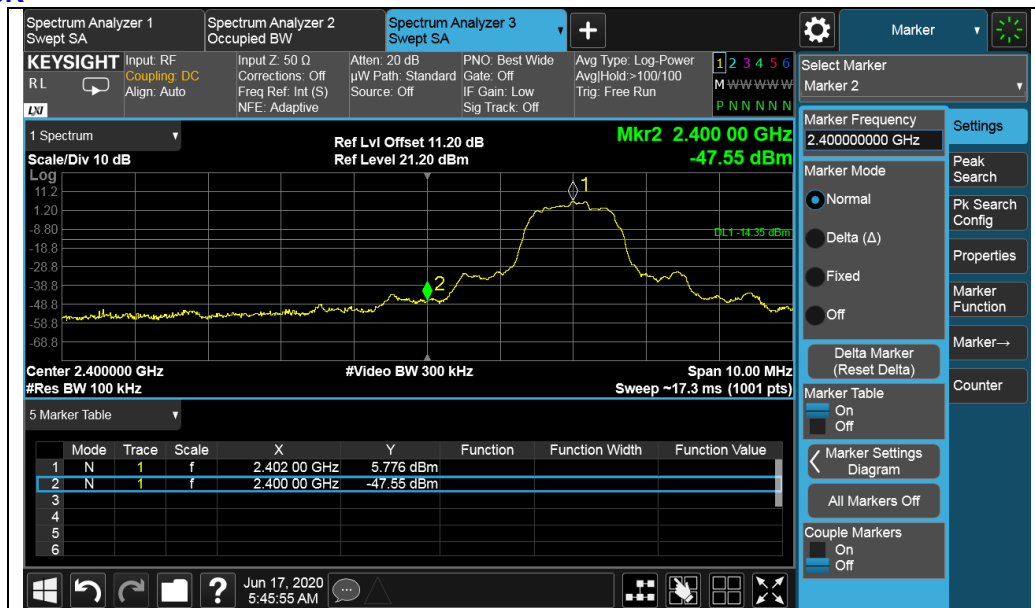
The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

4.8.7 Test Results

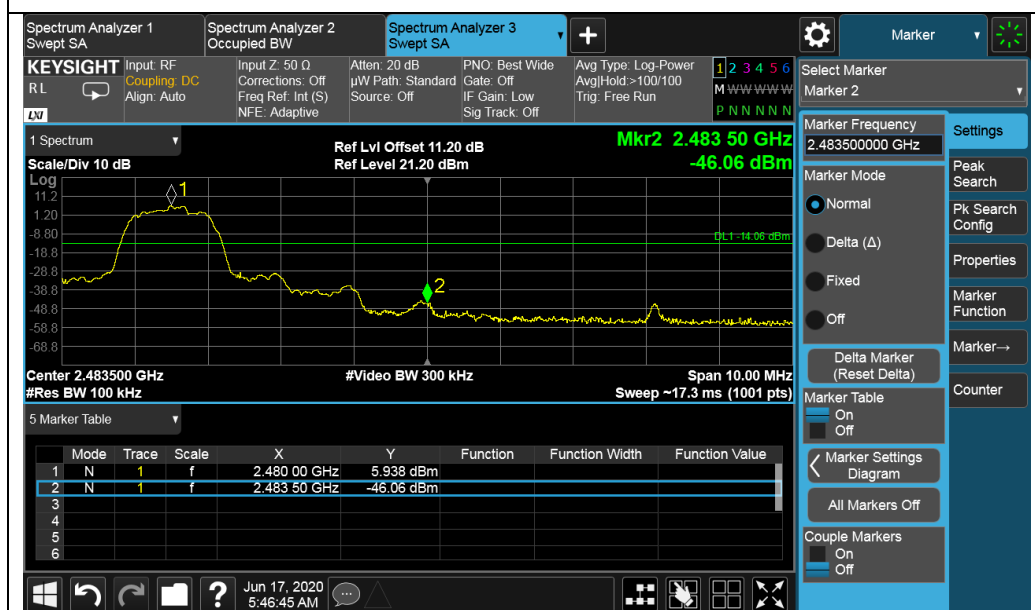
BT_GFSK



BT_8DPSK



Low Channel



High Channel

Appendix – Information on the Testing Laboratories

Bureau Veritas is a global leader in testing, inspection and certification (TIC) services. We help businesses improve safety, sustainability and productivity; and our clients include the majority of leading brands in retail, manufacturing and other industries. With a presence in every major country around the world, our quality assurance and compliance solutions are vital in helping our customers enhance product quality and concept-to-consumer journeys. We also assist with increasing speed to market, profitability and brand equity throughout the supply chain. Bureau Veritas is a leading wireless/IoT testing, inspection, audit and certification provider, with a global network of test laboratories to support the IoT industry in areas of connectivity, security, interoperability as well as quality, health & safety, and environmental/chemical requirements.

If you have any comments, please feel free to contact us at the following:

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The address and road map of all our labs can be found in our web site also.

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