

FCC Test Report (BT)

Report No.: FCC_IC_RF_SL19110601_PST-001_BT_Rev01

FCC ID: 2AKA8-FA470NAXAA

IC: 22098-FA470NAXAA

Test Model: FA-470_NA_01_AA

Series Model: FA-470_NA_02_AA, FA-470_NA_03_AA

Received Date: 11/18/2019

Test Date: 11/20/2019 - 11/27/2019

Issued Date: 12/26/2019

Applicant: PST ELETRONICA LTD

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Manufacturer: PST ELETRONICA LTDA

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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:** 540430/4842D



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Table of Contents

Release Control Record	4
1 Certificate of Conformity.....	5
2 Summary of Test Results	6
2.1 Measurement Uncertainty.....	6
2.2 Modification Record	6
3 General Information.....	7
3.1 General Description of EUT	7
3.2 Description of Test Modes	8
3.2.1 Test Mode Applicability and Tested Channel Detail.....	9
3.3 Description of Support Units	11
3.3.1 Configuration of System under Test	11
3.4 General Description of Applied Standards	11
4 Test Types and Results	12
4.1 Radiated Emission and Bandedge Measurement	12
4.1.1 Limits of Radiated Emission and Bandedge Measurement	12
4.1.2 Test Instruments	13
4.1.3 Deviation from Test Standard	15
4.1.4 Test Setup.....	15
4.1.5 EUT Operating Conditions.....	16
4.1.6 Test Results	17
4.2 Conducted Emission Measurement.....	27
4.2.1 Limits of Conducted Emission Measurement.....	27
4.2.2 Test Instruments	27
4.2.3 Test Procedures.....	28
4.2.4 Deviation From Test Standard	28
4.2.5 Test Setup.....	28
4.2.6 EUT Operating Condition	28
4.2.7 Test Results	28
4.3 Number of Hopping Frequency Used	29
4.3.1 Limits of Hopping Frequency Used Measurement	29
4.3.2 Test Setup.....	29
4.3.3 Test Instruments	29
4.3.4 Test Procedure	29
4.3.5 Deviation from Test Standard	29
4.3.6 Test Results	29
4.4 Dwell Time on Each Channel	32
4.4.1 Limits of Dwell Time on Each Channel Measurement.....	32
4.4.2 Test Setup.....	32
4.4.3 Test Instruments	32
4.4.4 Test Procedures.....	32
4.4.5 Deviation from Test Standard	32
4.4.6 Test Results	33
4.5 Channel Bandwidth.....	36
4.5.1 Limits of Channel Bandwidth Measurement.....	36
4.5.2 Test Setup.....	36
4.5.3 Test Instruments	36
4.5.4 Test Procedure	36
4.5.5 Deviation from Test Standard	36

4.5.6 EUT Operating Condition	36
4.5.7 Test Results	37
4.6 Hopping Channel Separation.....	38
4.6.1 Limits of Hopping Channel Separation Measurement.....	38
4.6.2 Test Setup.....	38
4.6.3 Test Instruments	38
4.6.4 Test Procedure	38
4.6.5 Deviation from Test Standard	38
4.6.6 Test Results	39
4.7 Maximum Output Power	40
4.7.1 Limits of Maximum Output Power Measurement	40
4.7.2 Test Setup.....	40
4.7.3 Test Instruments	40
4.7.4 Test Procedure	40
4.7.5 Deviation from Test Standard	40
4.7.6 EUT Operating Condition	40
4.7.7 Test Results	41
4.8 Conducted Out of Band Emission Measurement	42
4.8.1 Limits of Conducted Out of Band Emission Measurement.....	42
4.8.2 Test Instruments	42
4.8.3 Test Procedure	42
4.8.4 Deviation from Test Standard	42
4.8.5 EUT Operating Condition	42
4.8.6 Test Results	42
5 Pictures of Test Arrangements.....	47
Appendix – Information on the Testing Laboratories	48

Release Control Record

Issue No.	Description	Date Issued
FCC_RF_SL19110601_PST-001_BTEDR	Original Report	11/27/2019
FCC_IC_RF_SL19110601_PST-001_BT_Rev01	Revision 1.0	12/26/2019

1 Certificate of Conformity

Product: FleetArc Gateway

Brand: Stoneridge

Test Model: FA-470_NA_01_AA

Series Model: FA-470_NA_02_AA, FA-470_NA_03_AA

Sample Status: Engineering Sample

Applicant: PST ELETRONICA LTDA

Test Date: 11/20/2019 - 11/27/2019

Standards: 47 CFR FCC Part 15, Subpart C (Section 15.247)

RSS-247 Issue 2, February 2017

ANSI C63.10: 2013

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 :



Yao-Wei Lee / Test Engineer

Date:

12/26/2019

Approved by :



Ge Chen / Engineer Reviewer

Date:

12/26/2019

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (SECTION 15.247)				
FCC Clause	RSS Section(s)	Test Item	Result	Remarks
15.207	RSS-Gen[8.8]	AC Power Conducted Emission	N/A	EUT is powered via DC power supply.
15.247(a)(1)(iii)	RSS-Gen[8.9] RSS-247[5.5]	Number of Hopping Frequency Used	PASS	Meet the requirement of limit.
15.247(a)(1)(iii)	RSS-247[5.5]	Dwell Time on Each Channel	PASS	Meet the requirement of limit.
15.247(a)(1)	RSS-247[5.2]	1. Hopping Channel Separation 2. Spectrum Bandwidth of a Frequency Hopping Sequence Spread Spectrum System	PASS	Meet the requirement of limit.
15.247(b)	RSS-247[5.4(4)]	Maximum Peak Output Power	PASS	Meet the requirement of limit.
15.205 & 15.209 & 15.247(d)	RSS-247[5.2]	Radiated Emissions & Band Edge Measurement	PASS	Meet the requirement of limit. Minimum passing margin is -4.4dB at 907.211MHz.
15.247(d)	RSS-Gen[8.8]	Antenna Port Emission	PASS	Meet the requirement of limit.
15.203		Antenna Requirement	PASS	No antenna connector is used. PCB antenna which is permanently attached.

1. If The Frequency Hopping System operating in 2400-2483.5MHz band and the output power less than 125mW. The hopping channel carrier frequencies separated by a minimum of 25kHz or two-thirds of the 20dB bandwidth of hopping channel whichever is greater.
2. Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

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	3.856 dB
Radiated Emissions up to 1 GHz	30MHz ~ 1GHz	4.638 dB
Radiated Emissions above 1 GHz	Above 1GHz	4.580dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product Type	Automotive Fleet Tracker
Brand	Stoneridge
Test Model	FA-470_NA_01_AA
Series Model	FA-470_NA_02_AA, FA-470_NA_03_AA
Status of EUT	Engineering Sample
Power Supply Rating	9V to 32V
Modulation Type	GFSK, $\pi/4$ -DQPSK, 8DPSK
Modulation Technology	FHSS
Transfer Rate	BDR/EDR: up to 3MB/s
Operating Frequency	2402MHz ~ 2480MHz
Number of Channel	79
Output Power	0.805mW
Antenna Type	PCB Antenna
Antenna Connector	N/A

3.2 Description of Test Modes

79 channels are provided for BT-BDR/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 positions 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	39	FHSS	GFSK	DH5
-	0 to 78	39	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).
- ☒ 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	12VDC	Yao Wei Lee
RE<1G	25deg. C, 65%RH	12VDC	Yao Wei Lee
APCM	21deg. C, 60%RH	12VDC	Yao Wei Lee

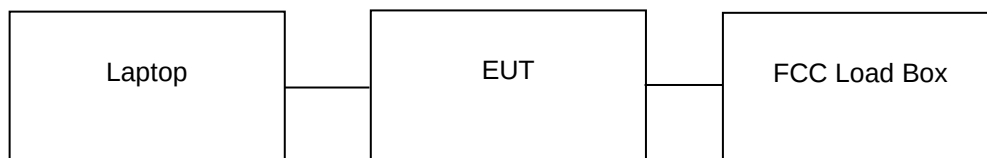
3.3 Description of Support Units

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	Dell	Latitude 3550	2MHWY32	N/A	Provided by Lab

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

3.3.1 Configuration of System under Test



Note: EUT is powered via connection to "FCC Load Box" provided by client.

3.4 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:

FCC Part 15, Subpart C (15.247)
KDB 558074 D01 15.247 Meas Guidance v05r02
ISED RSS-247
ANSI C63.10-2013

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

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

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
PXA Signal Analyzer KEYSIGHT	N9030B	MY57140584	03/05/2019	03/05/2020
Horn Antenna ETS-Lindgren	3117	218554	11/06/2019	11/06/2020
Biconilog Antenna Sunol	JB1	A030702	3/9/2018	3/9/2020
Preamplifier RF BAY INC	LPA-6-30	11170601	4/27/2019	4/27/2020

NOTE:

1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
2. The horn antenna and HP preamplifier (model: 3117) are used only for the measurement of emission frequency above 1GHz if tested.

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. Both 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 9kHz 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 detect 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:

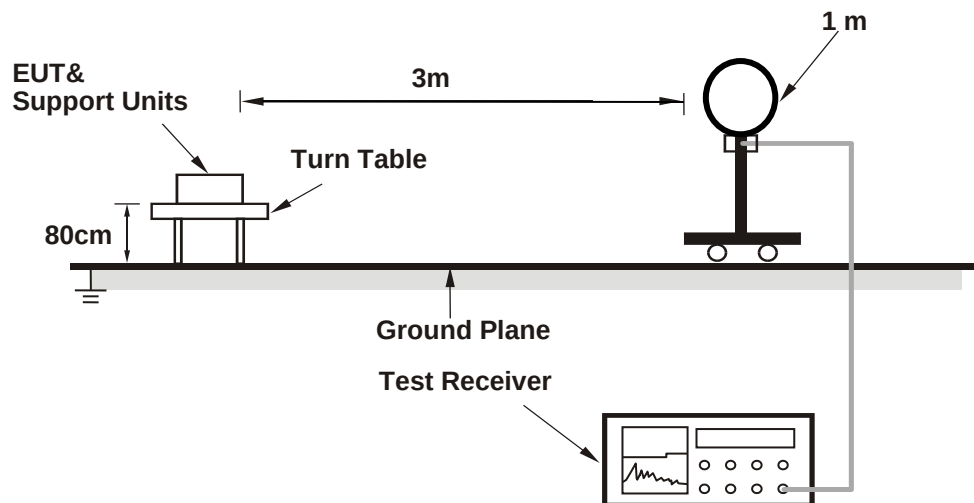
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
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.

4.1.3 Deviation from Test Standard

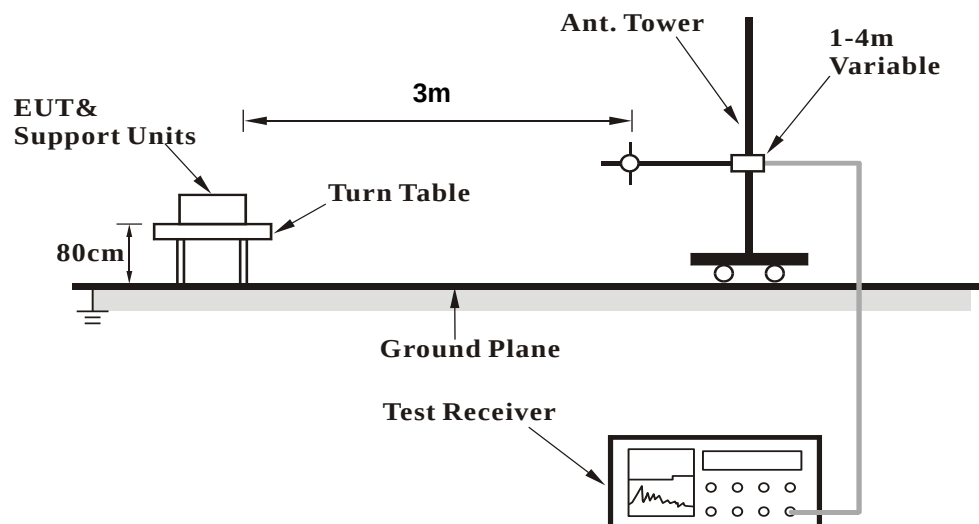
No deviation.

4.1.4 Test Setup

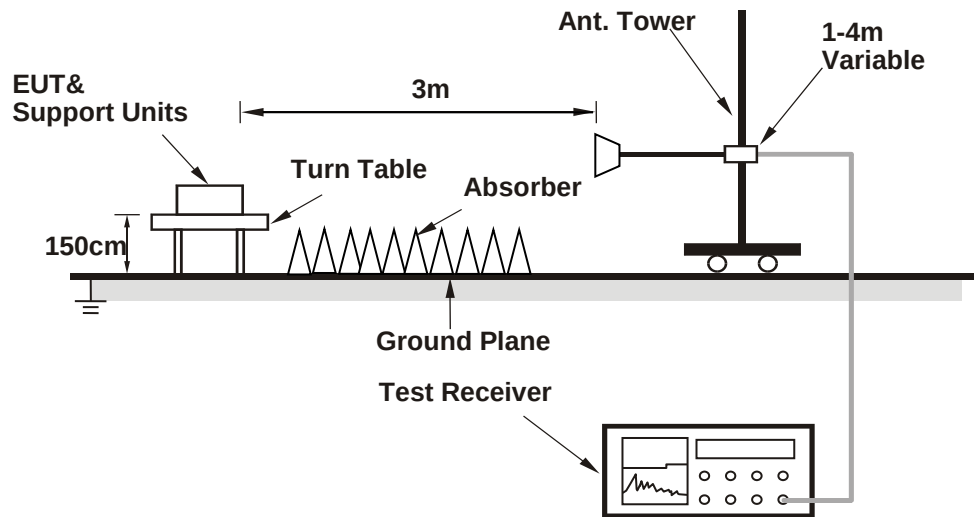
For Radiated emission below 30MHz



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).

4.1.5 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.

4.1.6 Test Results

Above 1GHz Data:

BT_GFSK

CHANNEL	TX Channel 0	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 25GHz		Average

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4804.306	H	54.6	-2.7	Average	51.9	54	2.1	223	150.4
4828.415	V	31.6	-2.7	Average	28.9	54	25.1	155	98
16896.518	H	16.2	22.6	Average	38.8	54	15.2	180	130.2
4804.306	H	59	-2.7	Peak	56.3	74	17.7	223	150.4
4828.415	V	45.3	-2.7	Peak	42.6	74	31.4	155	98
16896.518	H	29.9	22.6	Peak	52.5	74	21.5	180	130.2

REMARKS:

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

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 25GHz		Average

ANTENNA POLARITY & test distance: HORIZONTAL & Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4880.301	V	48.9	-2.6	Average	46.3	54	-7.7	248	172.9
4880.298	H	47.5	-2.6	Average	44.9	54	-9.1	100	94
7046.742	H	27.5	4.9	Average	32.4	54	-21.6	101.2	94
4880.301	V	54.3	-2.6	Peak	51.7	74	-22.3	248	172.9
4880.298	H	53.6	-2.6	Peak	51	74	-23	100	94
7046.742	H	40.2	4.9	Peak	45.1	74	-28.9	101.2	94

REMARKS:

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

CHANNEL	TX Channel 78	DETECTOR FUNCTION	Peak Average
FREQUENCY RANGE	1GHz ~ 25GHz		

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4960.294	H	46.8	-2.5	Average	44.3	54	-9.7	204.6	98.5
4960.248	V	44.6	-2.5	Average	42.1	54	-11.9	246.8	217.4
7141.615	V	26.8	4.8	Average	31.6	54	-22.4	240.2	110
4960.294	H	52.7	-2.5	Peak	50.2	74	-23.8	204.6	98.5
4960.248	V	51.4	-2.5	Peak	48.9	74	-25.1	246.8	217.4
7141.615	V	40.7	4.8	Peak	45.5	74	-28.5	240.2	110

REMARKS:

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

BT_8DPSK

CHANNEL	TX Channel 0	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 25GHz		Average

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4803.976	H	40.9	-2.7	Average	38.2	54	-15.8	101.8	17.1
4804.009	V	40.8	-2.7	Average	38.1	54	-15.9	255.7	165.4
12375.235	V	21.8	11.8	Average	33.6	54	-20.4	399.9	340.3
4803.976	H	40.9	-2.7	Peak	54.1	74	-19.9	101.8	17.1
4804.009	V	40.8	-2.7	Peak	53.8	74	-20.2	255.7	165.4
12375.235	V	21.8	11.8	Peak	47.5	74	-26.5	399.9	340.3

REMARKS:

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

CHANNEL	TX Channel 39	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 25GHz		Average

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
4861.186	V	31.6	-2.7	Average	28.9	54	-25.1	181.8	159
4881.947	H	36.8	-2.7	Average	34.2	54	-19.8	127	24.4
7051.841	V	27.6	11.8	Average	32.5	54	-21.5	195.6	65.9
4861.186	V	44.6	-2.7	Peak	41.9	74	-32.1	181.8	159
4881.947	H	52.2	-2.7	Peak	49.6	74	-24.4	127	24.4
7051.841	V	41	11.8	Peak	45.9	74	-28.1	195.6	65.9

REMARKS:

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

CHANNEL	TX Channel 78	DETECTOR FUNCTION	Peak
FREQUENCY RANGE	1GHz ~ 25GHz		Average

ANTENNA POLARITY & test distance: HORIZONTAL& Vertical at 3 m									
Frequency [MHz]	Pol	Reading [dB(uV)]	Factor [dB(1/m)]	Measurement Type	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
5003.682	H	32.2	-2.5	Average	29.7	54	-24.3	111.5	63.9
4959.968	V	34.9	-2.5	Average	32.4	54	-21.6	215.3	176.9
8280.466	H	24.5	6.7	Average	31.2	54	-22.8	346.1	122.5
5003.682	H	45.3	-2.5	Peak	42.8	74	-31.2	111.5	63.9
4959.968	V	49.7	-2.5	Peak	47.2	74	-26.8	215.3	176.9
8280.466	H	37.3	6.7	Peak	44	74	-30	346.1	122.5

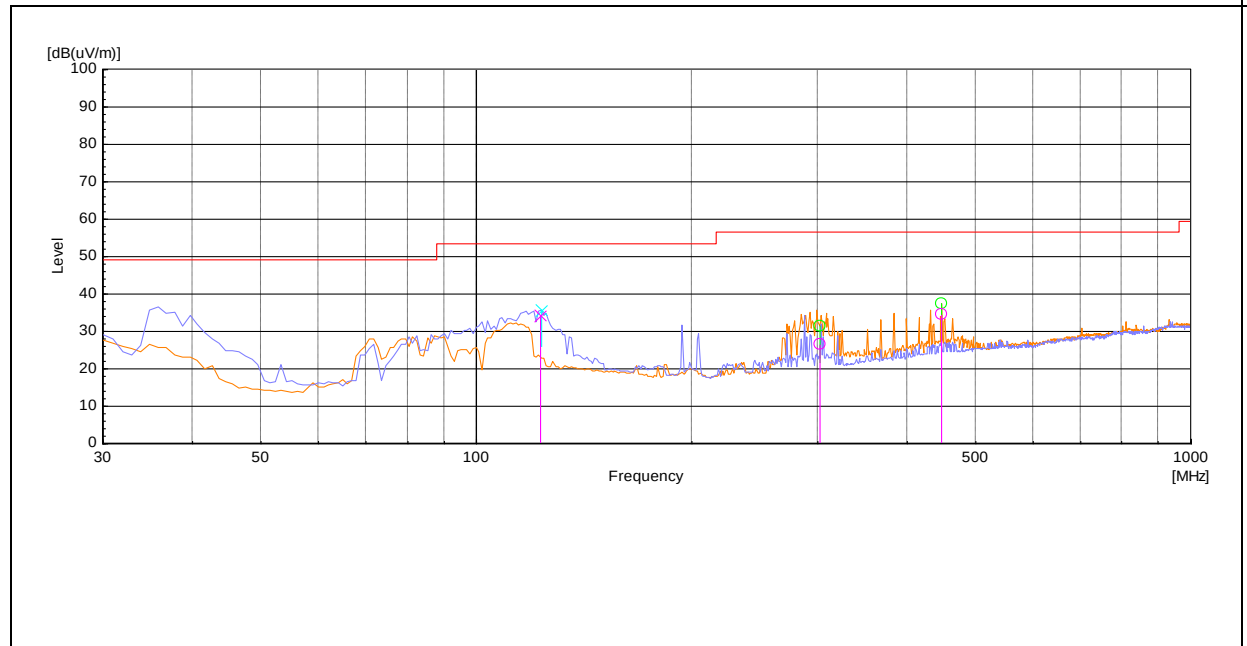
REMARKS:

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

Below 1GHz Data:

BT_GFSK

CHANNEL	TX Channel 19	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		



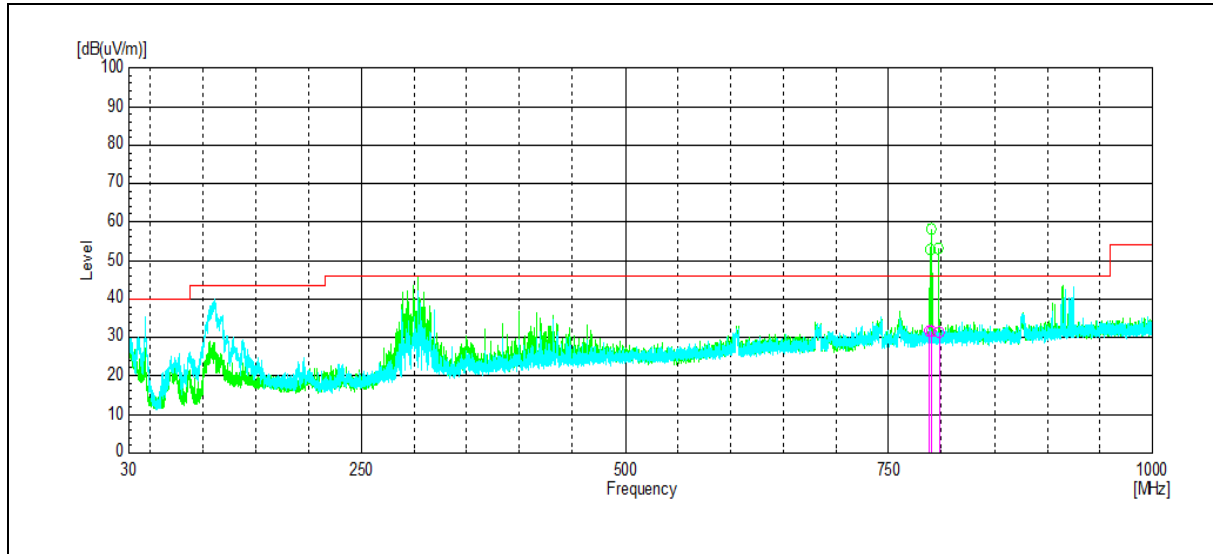
REMARKS:

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

ANTENNA POLARITY & Test Distance: Horizontal & Vertical at 3m								
Frequency [MHz]	Pol	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]
123.052	V	5.4	14.5	19.9	34.4	53.5	19.1	120
302.125	H	13.1	6.7	19.8	26.5	56.5	30	100
447.996	H	12.7	11	23.7	34.7	56.5	21.8	202

BT_8DPSK

CHANNEL	TX Channel 19	DETECTOR FUNCTION	Quasi Peak
FREQUENCY RANGE	30MHz – 1GHz		



REMARKS:

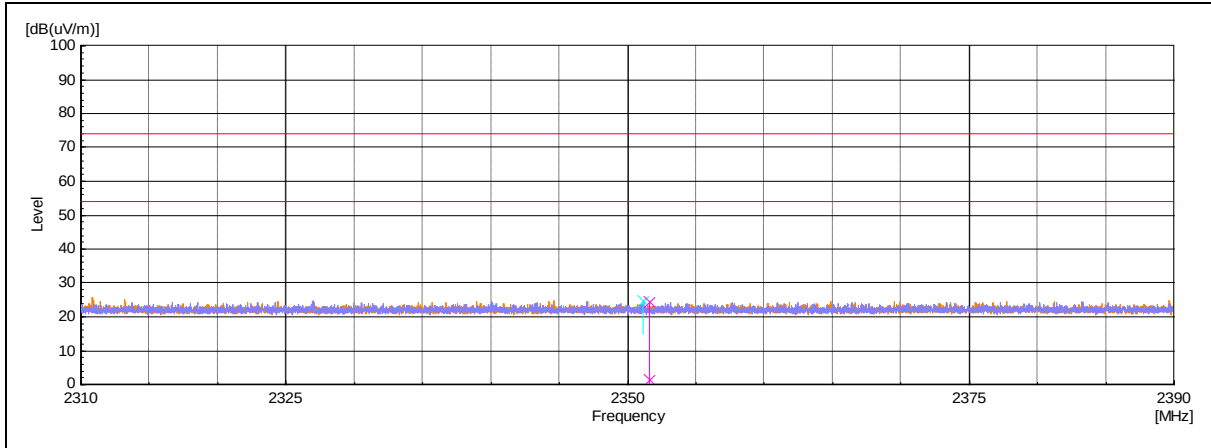
1. Emission level (dBuV/m) = Reading QP (dBuV) + Factor (dB)
2. Factor (dB) = Antenna Factor (dB) – Cable Loss (dB).
3. The emission levels of other frequencies were less than 20dB margin against the limit.
4. Margin value = Limit Value – Emission level (dBuV/m)

ANTENNA POLARITY & Test Distance: Horizontal & Vertical at 3m								
Frequency [MHz]	Pol	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]
907.211	V	11.2	30.4	41.6	46	-4.4	306.2	210.2
909.496	V	1.9	30.4	32.3	46	-13.7	245.7	274.2
914.089	V	2	30.5	32.5	46	-13.5	367.5	254.2

RESTRICTED BAND

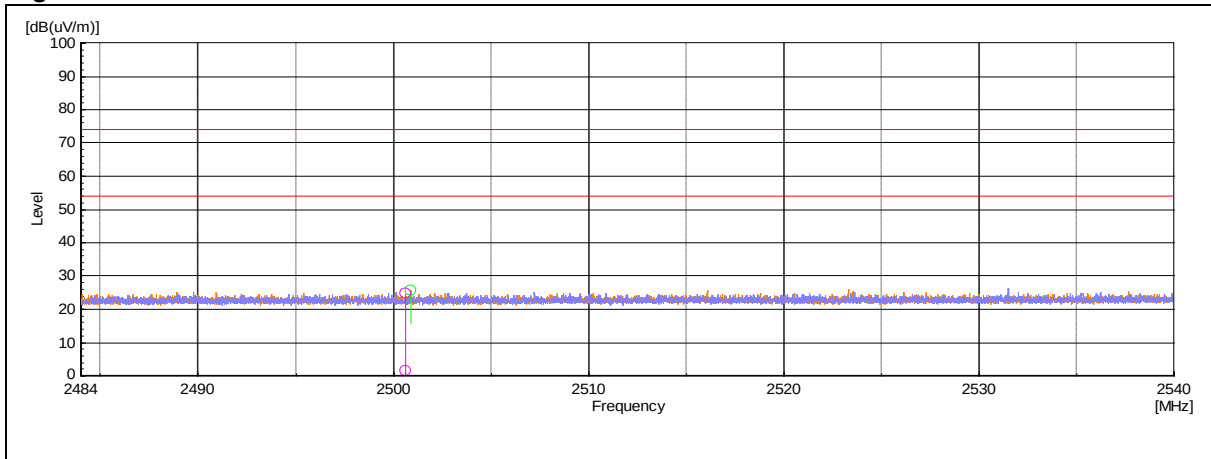
BT_GFSK

Low Channel



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2351.623	V	11.5	Average	-10	1.5	54	-52.5	138.8	330.3
2351.623	V	34.4	Peak	-10	24.4	74	-49.6	138.8	330.3

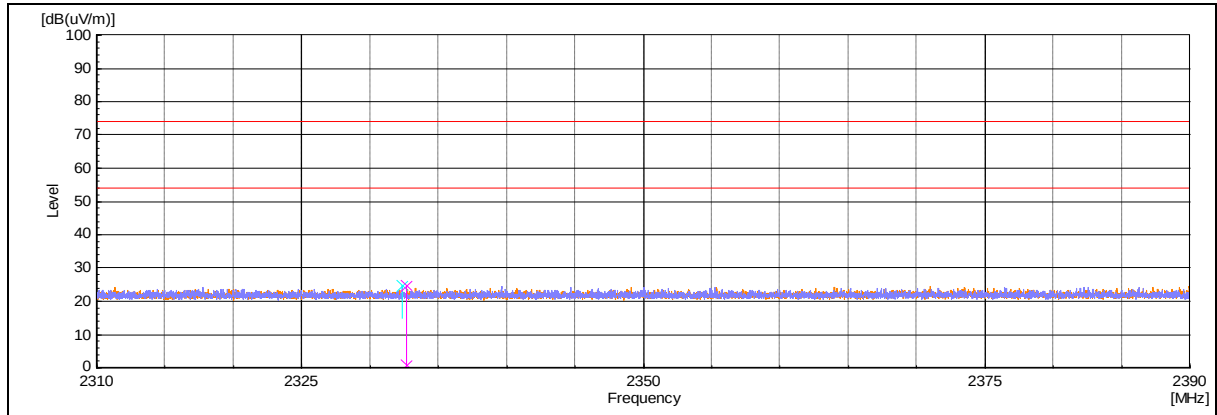
High Channel



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2500.608	H	11	Average	-9.5	1.5	54	-52.5	205.7	7
2500.608	H	34.1	Peak	-9.5	24.4	74	-49.6	205.7	7

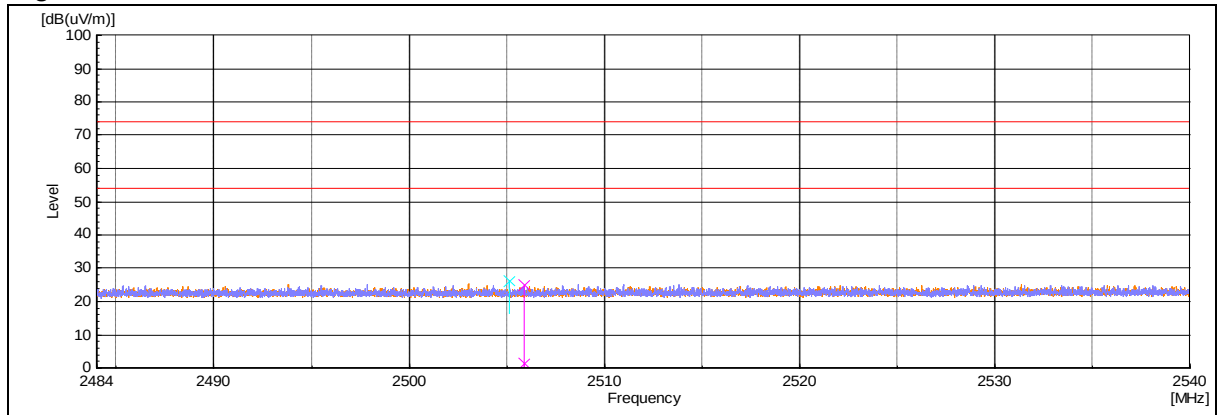
BT_8DPSK

Low Channel



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2332.656	V	10.8	Average	-10	0.8	54	-53.2	376.2	48.9
2332.656	V	34.8	Peak	-10	24.8	74	-49.2	376.2	48.9

High Channel



Frequency [MHz]	Pol	Reading [dB(uV)]	Measurement Type	Factor [dB(1/m)]	Level [dB(uV/m)]	Limit [dB(uV/m)]	Margin [dB]	Height [cm]	Angle [deg]
2505.878	V	11	Average	-9.5	1.5	54	-52.5	399.8	226.1
2505.878	V	34.5	Peak	-9.5	25	74	-49	399.8	226.1

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	08/28/2018	11/28/2019
Transient Limiter ELECTRO-METRICS	EM-7600-5	106	12/31/2018	12/31/2019
LISN EMCO	3816/2NM	214372	01/10/2019	01/10/2020

4.2.3 Test Procedures

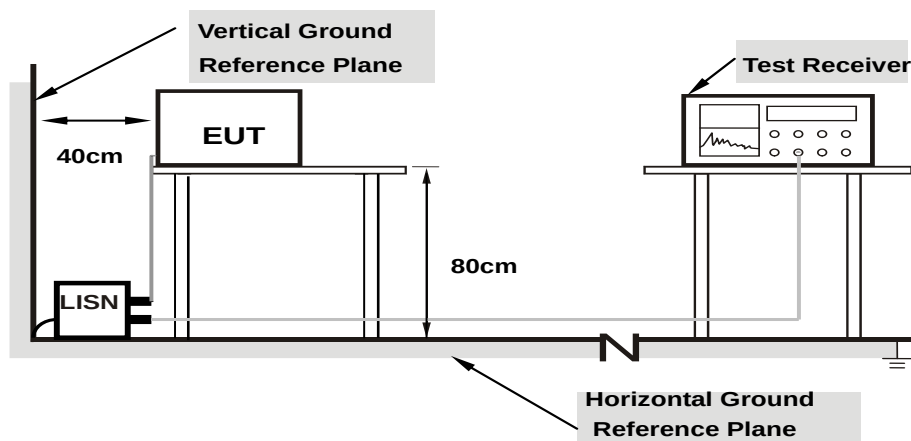
- The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance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

NOTE: The resolution bandwidth and video bandwidth of test receiver is 9kHz 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 Condition

Same as 4.1.6.

4.2.7 Test Results

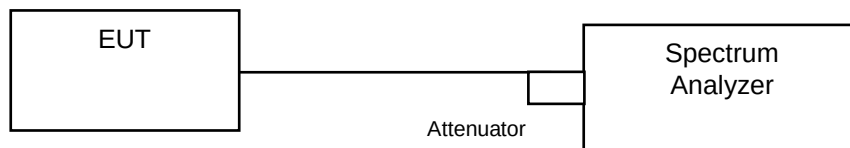
Tests not applicable because EUT is powered by DC power supply

4.3 Number of Hopping Frequency Used

4.3.1 Limits of Hopping Frequency Used Measurement

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

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

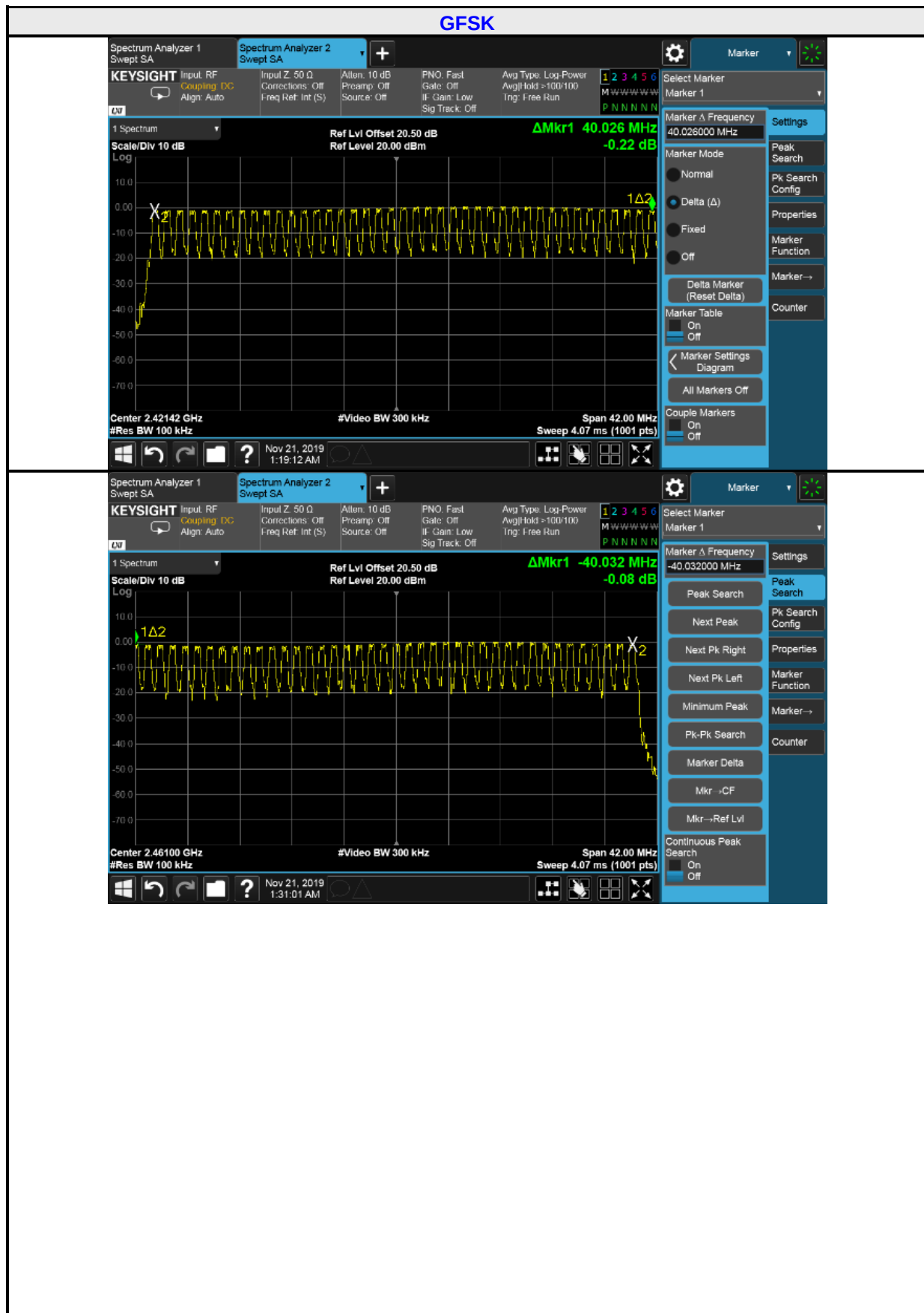
- a. Check the calibration of the measuring instrument (SA) using either an internal calibrator or a known signal from an external generator.
- b. Turn on the EUT and connect its antenna terminal to measurement via a low loss cable. Then set it to any one measured frequency within its operating range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

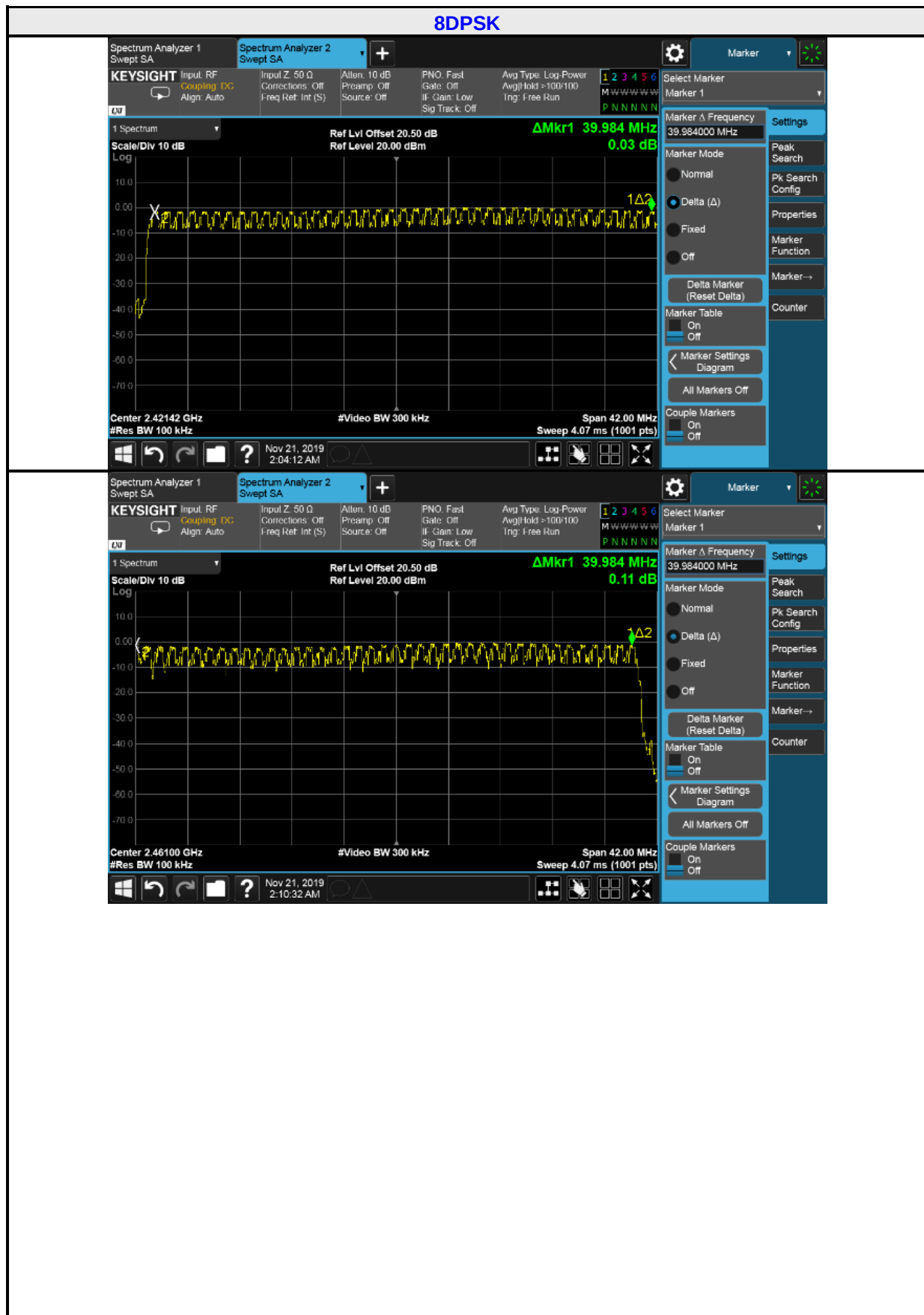
4.3.5 Deviation from Test Standard

No deviation.

4.3.6 Test Results

There are 79 hopping frequencies in the hopping mode. Please refer to next page for the test result. On the plots, it shows that the hopping frequencies are equally spaced.



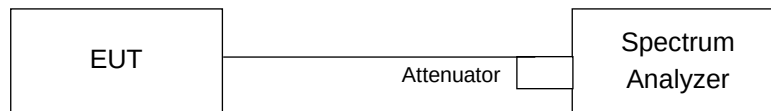


4.4 Dwell Time on Each Channel

4.4.1 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.

4.4.2 Test Setup



4.4.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.4.4 Test 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 to 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.

4.4.5 Deviation from Test Standard

No deviation.

4.4.6 Test Results

GFSK

Mode	Number of Hopping 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				
DH1	79	31.6	3.16	32	320	0.366	117.12	400	PASS
DH3	79	31.6	3.16	19	190	0.143	27.17	400	PASS
DH5	79	31.6	3.16	10	100	0.144	14.40	400	PASS

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

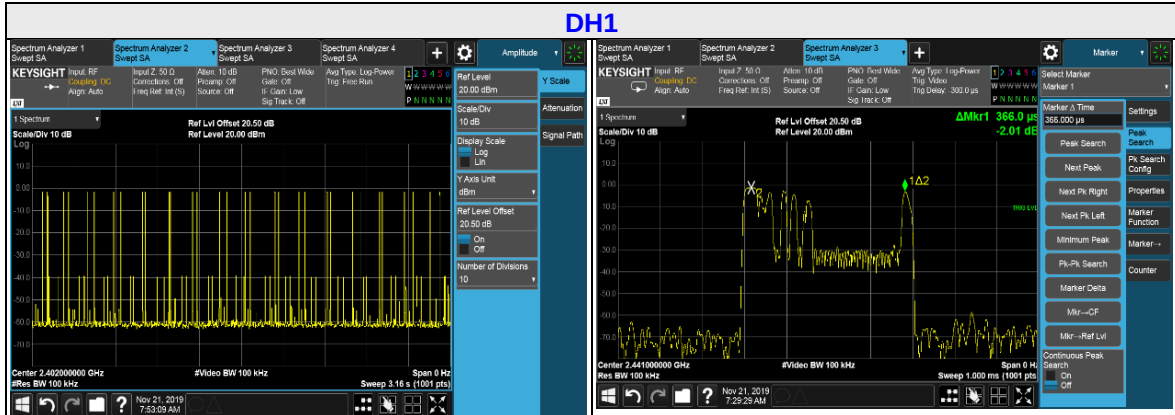
8DPSK

Mode	Number of Hopping 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				
3DH1	79	31.6	3.16	32	320	0.424	135.68	400	PASS
3DH3	79	31.6	3.16	15	150	0.186	27.90	400	PASS
3DH5	79	31.6	3.16	13	130	0.186	24.18	400	PASS

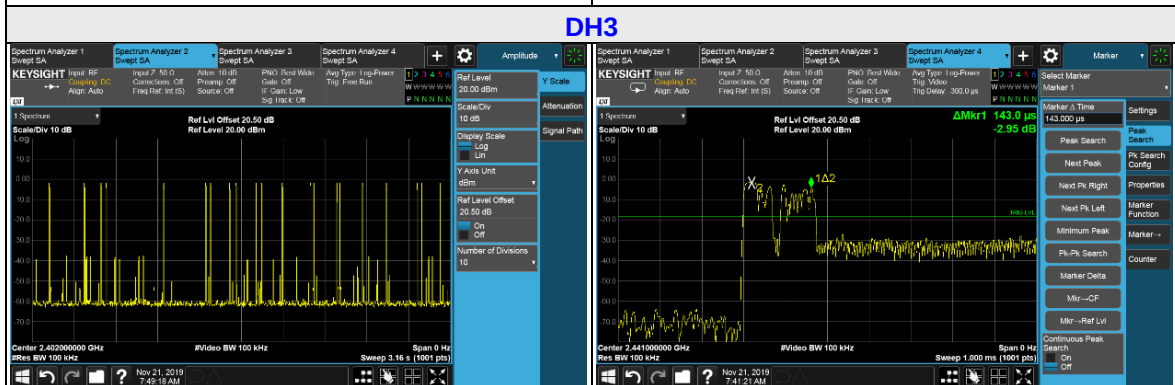
NOTE: Test plots of the transmitting time slot are shown on next page

GFSK

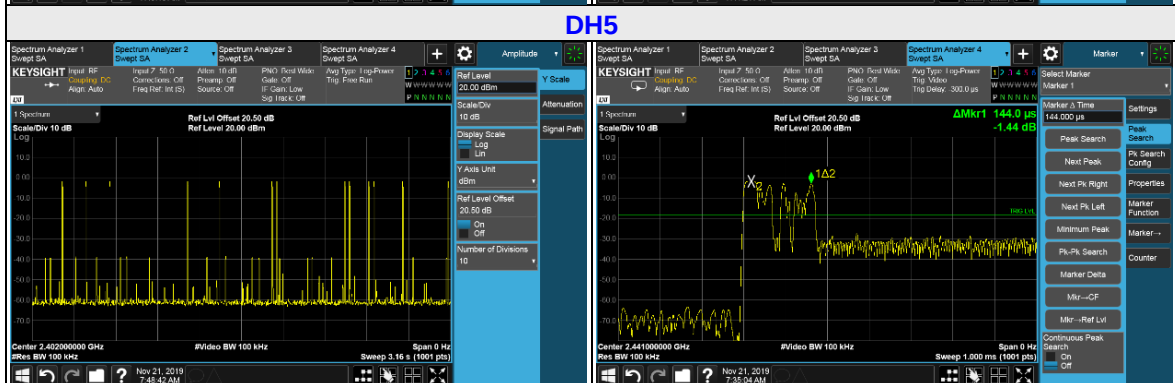
DH1



DH3



DH5



8DPSK

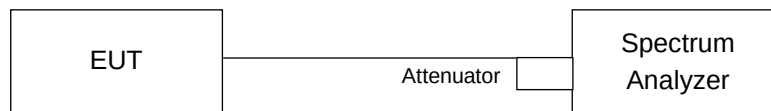


4.5 Channel Bandwidth

4.5.1 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.

4.5.2 Test Setup



4.5.3 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.5.4 Test 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.

4.5.5 Deviation from Test Standard

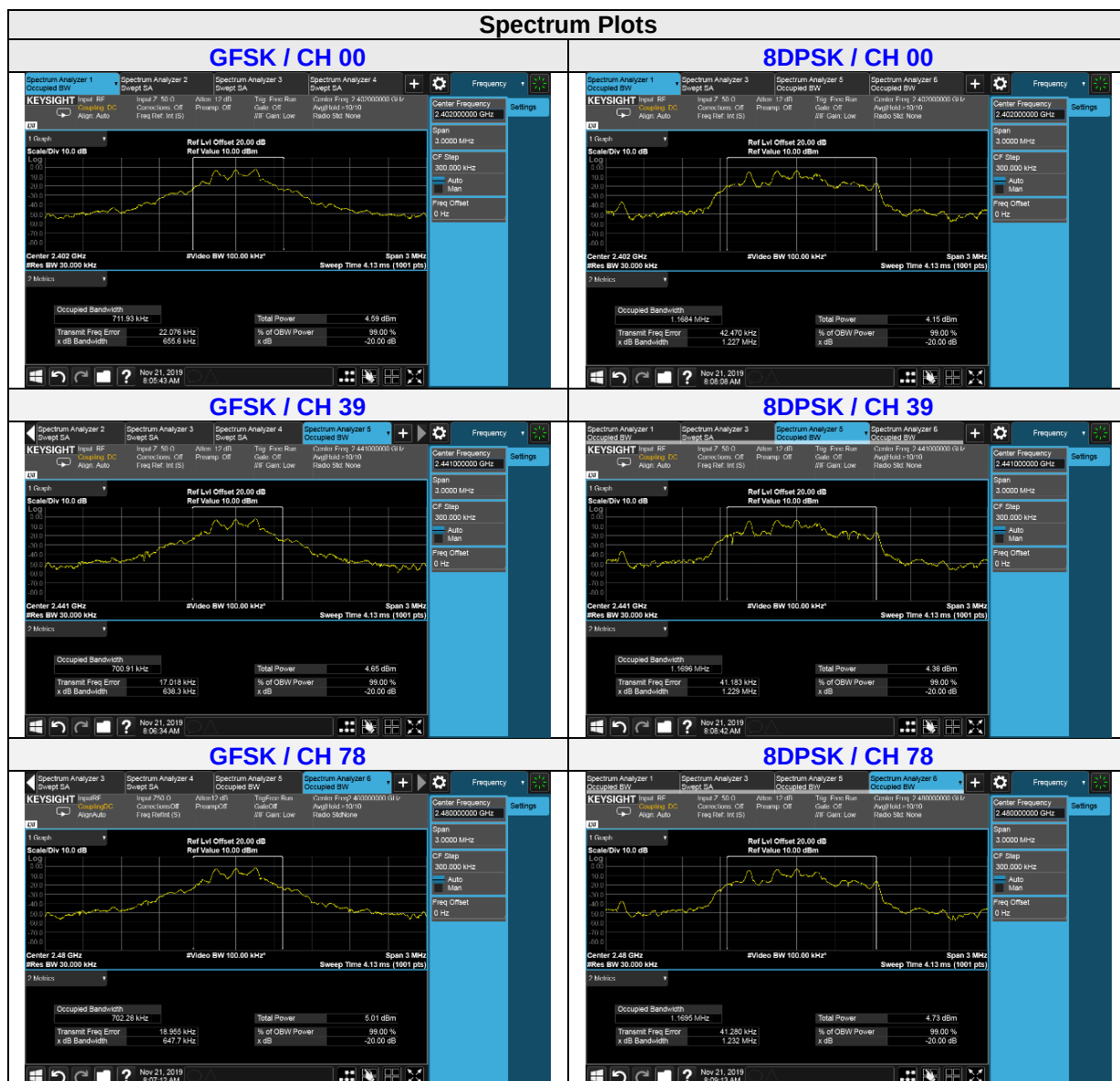
No deviation.

4.5.6 EUT Operating Condition

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

4.5.7 Test Results

Channel	Frequency (MHz)	20dB Bandwidth (MHz)	
		GFSK	8DPSK
0	2402	0.711	1.168
39	2441	0.700	1.169
78	2480	0.702	1.169

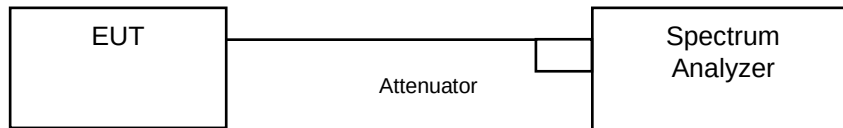


4.6 Hopping Channel Separation

4.6.1 Limits of Hopping Channel Separation Measurement

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

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

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.

4.6.5 Deviation from Test Standard

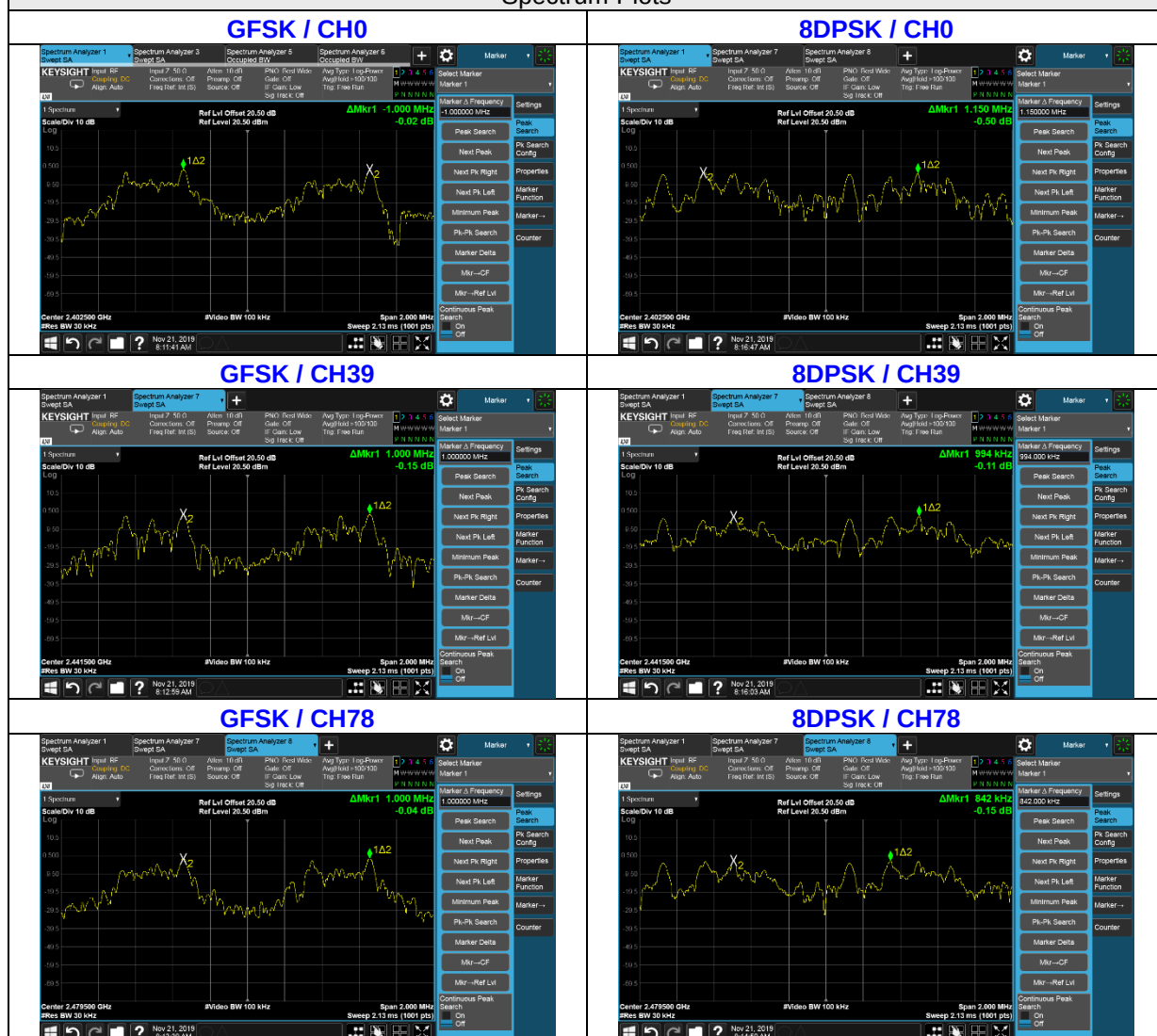
No deviation.

4.6.6 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	1.150	0.711	1.168	0.474	0.779	Pass
39	2441	1.000	0.994	0.700	1.169	0.469	0.779	Pass
78	2480	1.000	0.842	0.702	1.169	0.468	0.779	Pass

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

Spectrum Plots

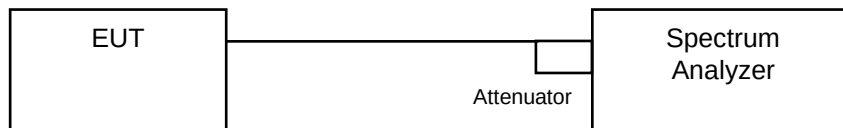


4.7 Maximum Output Power

4.7.1 Limits of Maximum Output Power Measurement

The Maximum Output Power Measurement is 1W.

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 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.
- The center frequency of the spectrum analyzer is set to the fundamental frequency and using 3MHz RBW and 10 MHz VBW.
- Measure the captured power within the band and recording the plot.
- Repeat above procedures until all frequencies required were complete.

4.7.5 Deviation from Test Standard

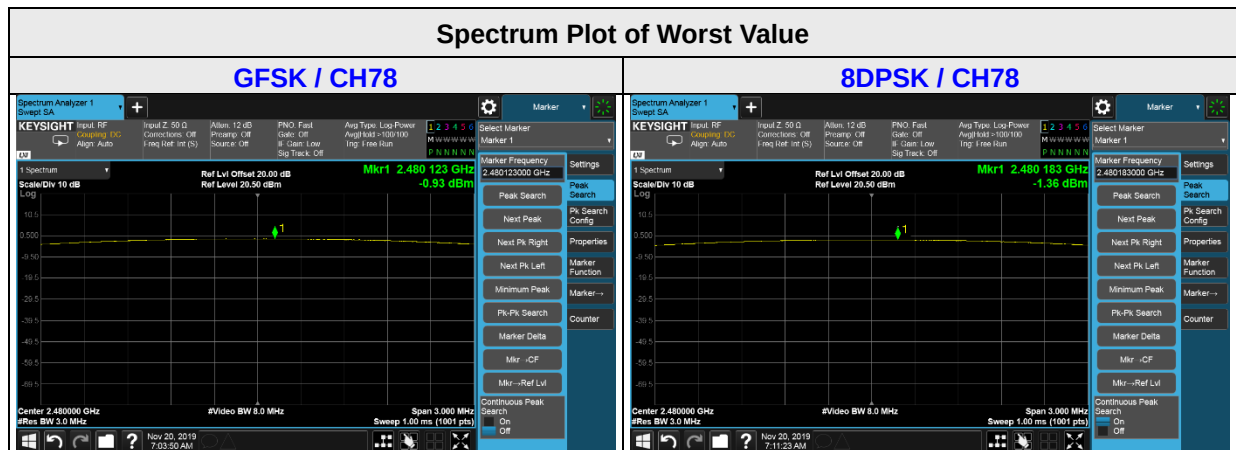
No deviation.

4.7.6 EUT Operating Condition

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

4.7.7 Test Results

Channel	Frequency (MHZ)	Output Power (mW)		Output Power (dBm)		Power Limit (W)	Pass / Fail
		GFSK	8DPSK	GFSK	8DPSK		
0	2402	0.745	0.697	-1.28	-1.57	1	Pass
39	2441	0.787	0.690	-1.04	-1.61	1	Pass
78	2480	0.805	0.731	-0.94	-1.36	1	Pass



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 loss 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

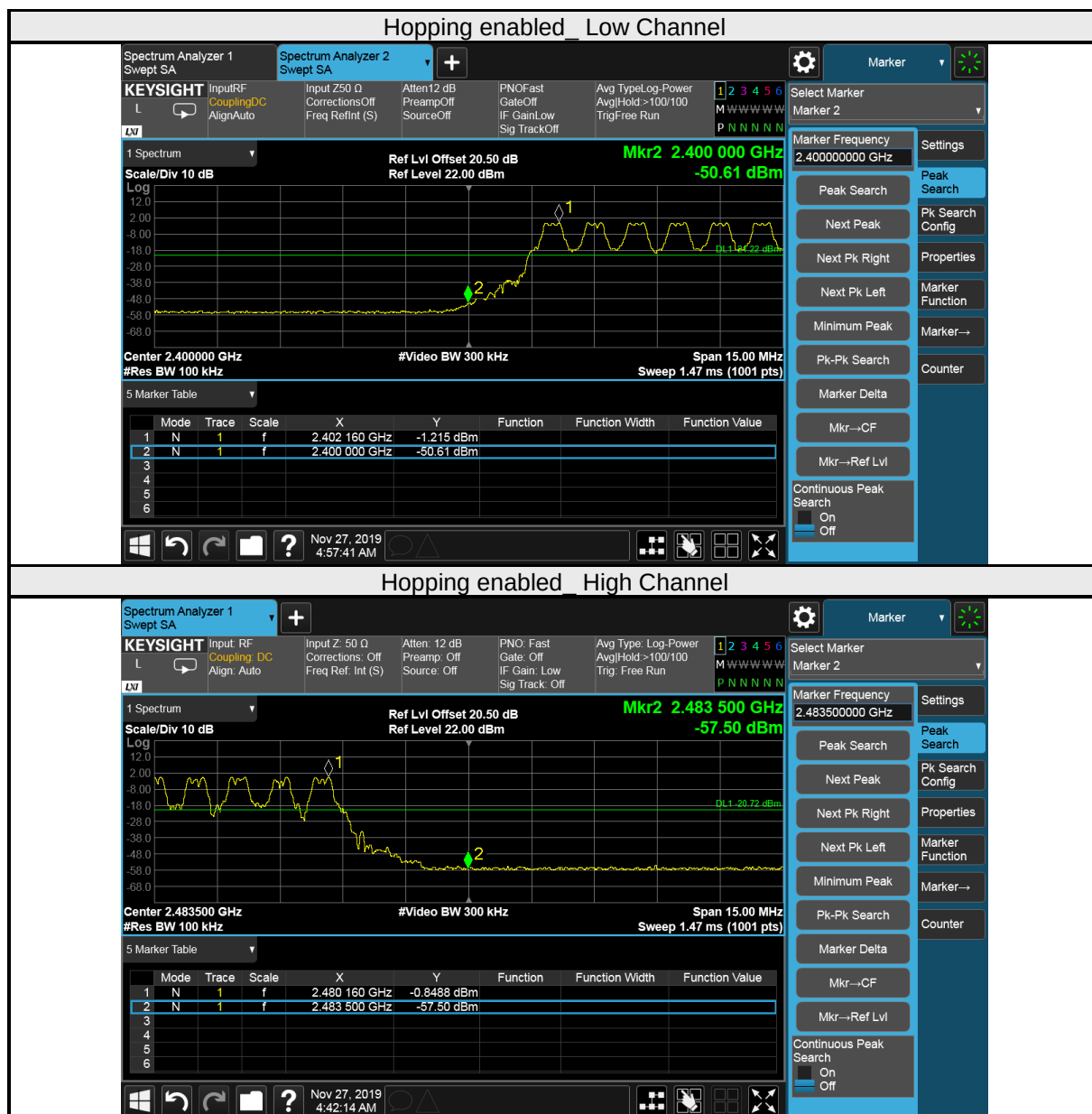
The software provided by client enabled the EUT to transmit and receive data at lowest, middle and highest channel frequencies individually.

4.8.6 Test Results

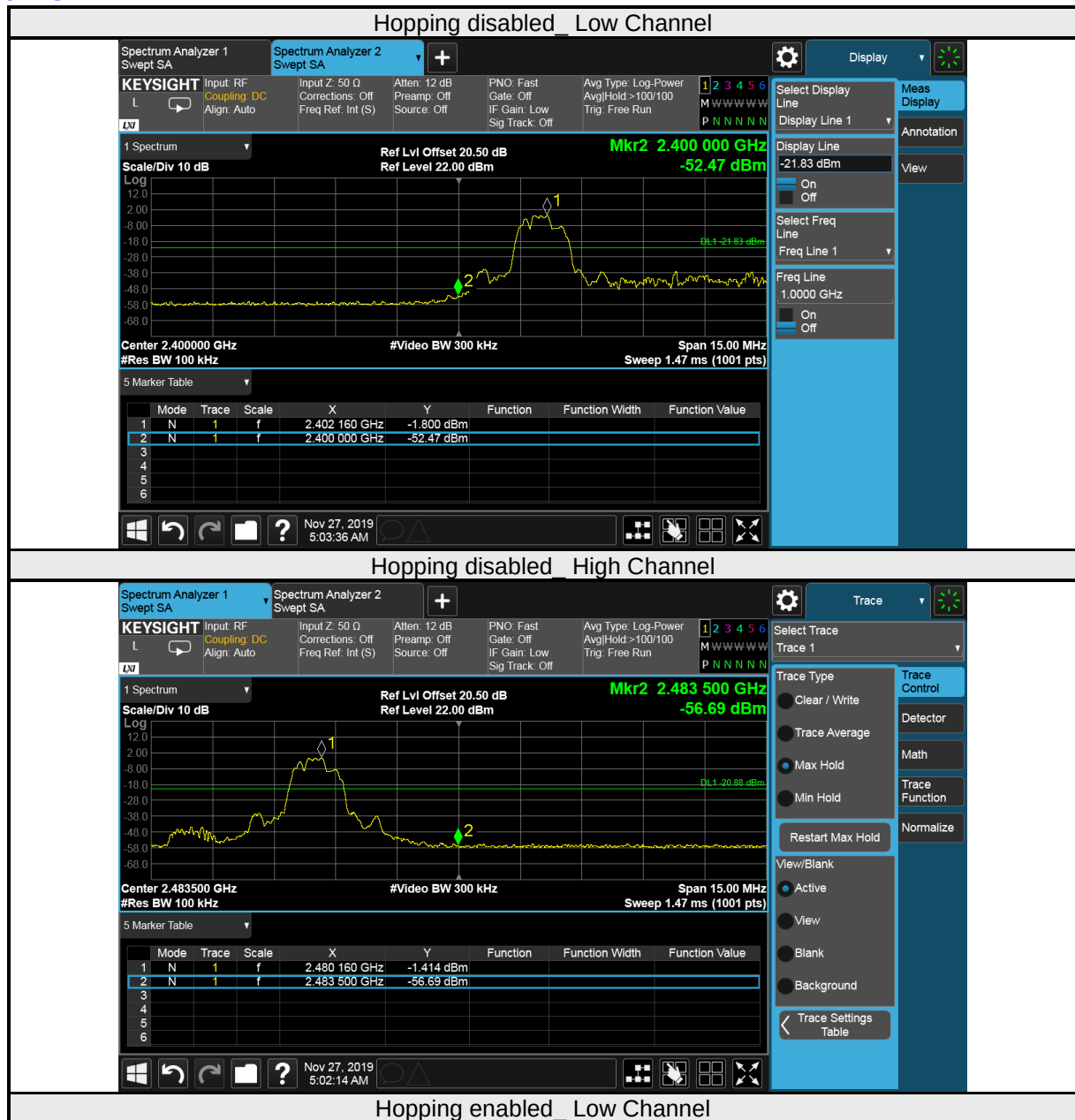
The spectrum plots are attached on the following images. D1 line indicates the highest level, D2 line indicates the 20dB offset below D1. It shows compliance with the requirement.

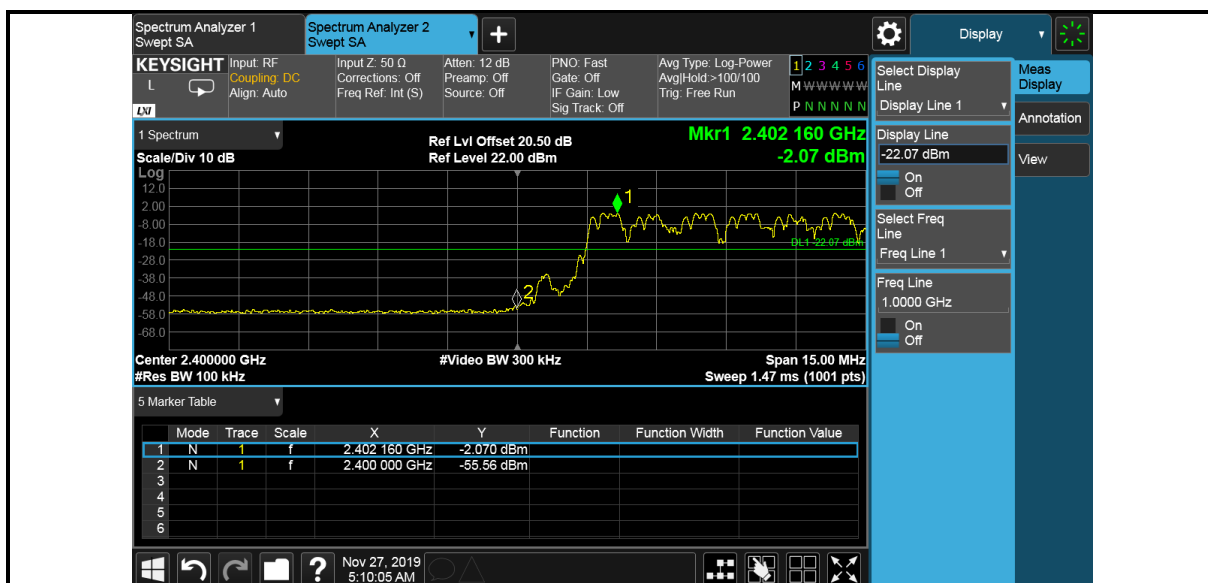
GFSK



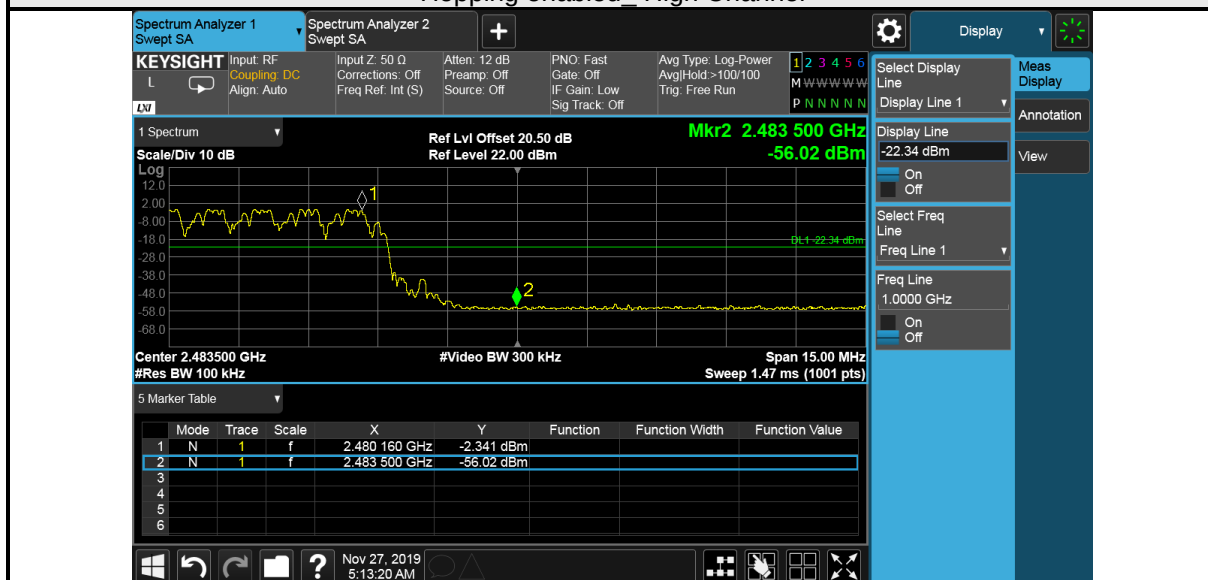


8DPSK





Hopping enabled High Channel



5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

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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Email: sales.eaw@us.bureauveritas.com

Web Site: www.cpsusa-bureauveritas.com

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

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