

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Applicant: Sony Mobile Communications INC.

EUT Description: Mobile Phone

FCC ID: PY7-04605A

Report Number: ZR/2018/A001103

FCC Rule Part: §15.247, Cat: DSS

Issue Date: 2018/12/14

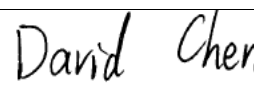
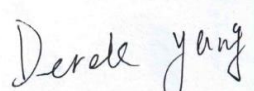
Date of Test: 2018/10/19 to 2018/11/14

Date of EUT Received: 2018/10/18

We hereby certify that:

The above equipment was tested by SGS Shenzhen Ltd. Electronics & Communication Laboratory. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Authorized for issue by:		
Tested By		2018/12/14
	(Mike Hu) /Project Engineer	Date
Checked By		2018/12/14
	(David Chen) /Reviewer	Date
Approved By		2018/12/14
	(Derek Yang) Wireless Laboratory Manager	Date

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Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
--	Rev.00	Initial creation of document	All	2018/11/28	--
--	Rev.01	Removed the BT version Description	Page 4	2018/12/14	--

The difference between PY7-04605A and PY7-50241M is shown in the below table:

		PY7-04605A (Updated approval)	PY7-50241M (Full approval)
Licensed Frequency	LTE	1,2,3,5,7,8,28,38,39,40,41M	1,2,3,5,7,8,20,38
	UMTS	the same	the same
	GSM	the same	the same
	IC	the same	the same
	Antenna	the same	the same
Unlicensed Frequency	Bluetooth	The same	The same
	2.4G Wi-Fi	the same	the same
	5G Wi-Fi	the same	the same
	IC	the same	the same
	Antenna	the same	the same
Hardware	Ram / Rom	the same	the same
	Camera	The same	the same
	PCB	the same	the same
	USB Port	the same	the same
Appearance	Dimension	the same	the same
Accessory	Battery	the same	the same
	External Charger	the same	the same
	USB cable	the same	the same
other	SIM card	Double	Double

Considering to the difference, all data were copied from the original report (Report No.: ZR/2018/9002703)

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1 GENERAL INFORMATION

1.1 Product description

General:

EUT Description:	Mobile Phone
Trade Mark:	Sony
Power Supply:	Lithium-ion battery:3.85V or charge by USB
Operation Frequency:	2402MHz~2480MHz $f_c = 2402 \text{ MHz} + N * 1 \text{ MHz}$, where: - f_c = "Operating Frequency" in MHz, - N = "Channel Number" with the range from 0 to 78.
Modulation Technique:	Frequency Hopping Spread Spectrum(FHSS)
Modulation Type:	GFSK, $\pi/4$ DQPSK, 8DPSK
Number of Channel:	79
Hopping Channel Type:	Adaptive Frequency Hopping systems
Sample Type:	☒ Portable Device, ☐ Module
Antenna Type:	☐ External, ☒ Integrated
Antenna Gain:	-2.79dBi

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1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

KDB 558074 D01 v05 DSS Meas. Guidance

ANSI C63.10:2013

Note: All test items have been performed and record as per the above standards.

1.3 Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

- **CNAS (No. CNAS L2929)**

CNAS has accredited SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab to ISO/IEC 17025:2005 General Requirements for the Competence of Testing and Calibration Laboratories (CNAS-CL01 Accreditation Criteria for the Competence of Testing and Calibration Laboratories) for the competence in the field of testing.

- **A2LA (Certificate No. 3816.01)**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory is accredited by the American Association for Laboratory Accreditation(A2LA). Certificate No. 3816.01.

- **VCCI**

The 3m Fully-anechoic chamber for above 1GHz, 10m Semi-anechoic chamber for below 1GHz, Shielded Room for Mains Port Conducted Interference Measurement and Telecommunication Port Conducted Interference Measurement of SGS-CSTC Standards Technical Services Co., Ltd. have been registered in accordance with the Regulations for Voluntary Control Measures with Registration No.: G-20026, R-14188, C-12383 and T-11153 respectively.

- **FCC –Designation Number: CN1178**

SGS-CSTC Standards Technical Services Co., Ltd., Shenzhen EMC Laboratory has been recognized as an accredited testing laboratory.

Designation Number: CN1178. Test Firm Registration Number: 406779.

- **Industry Canada (IC)**

Two 3m Semi-anechoic chambers and the 10m Semi-anechoic chamber of SGS-CSTC Standards Technical Services Co., Ltd. Shenzhen Branch EMC Lab have been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 4620C-1, 4620C-2, 4620C-3.

1.4 Special Accessories

AC Charger, USB cable and Earphone are used while the test is conducted and there is no other accessory attached. This is the worst case condition.

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1.5 Equipment Modifications

There was no modification incorporated into the EUT.

1.6 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m*9m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

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2 SYSTEM TEST CONFIGURATION

2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz,. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. 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.

2.3.2 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3 Radiated Emissions

The EUT is placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

2.4 Measurement Results Explanation Example

For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

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2.5 Configuration of Tested System

Fig. 2-1 Conducted Emission Configuration

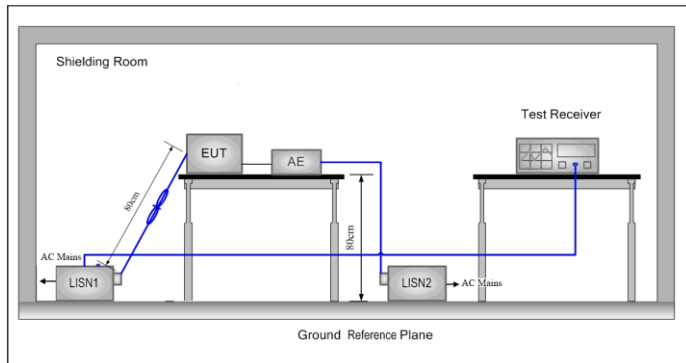


Fig. 2-2 Conducted Test Configuration(RF)

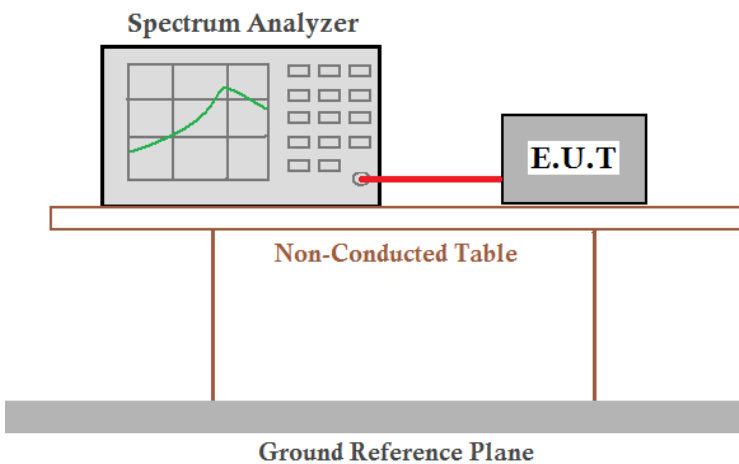


Fig. 2-3 Conducted power Configuration

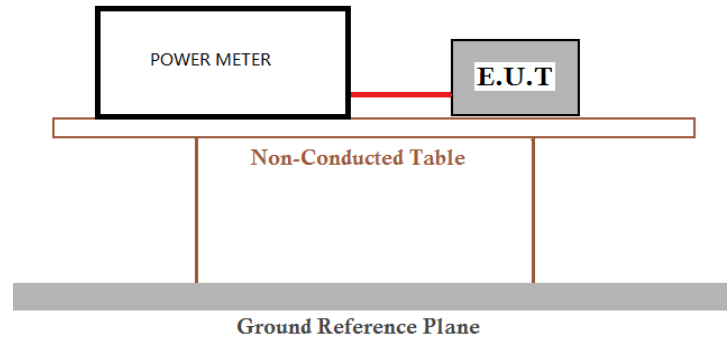
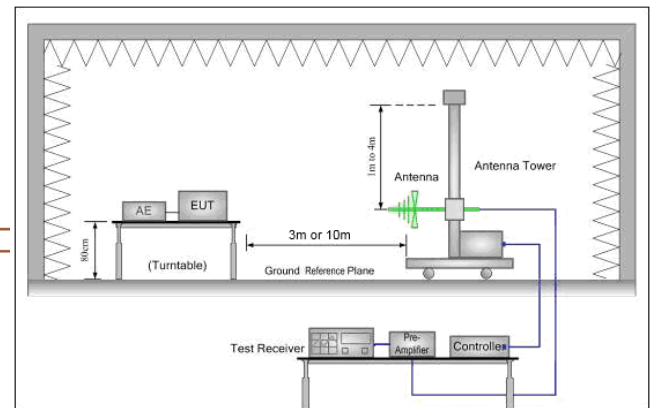
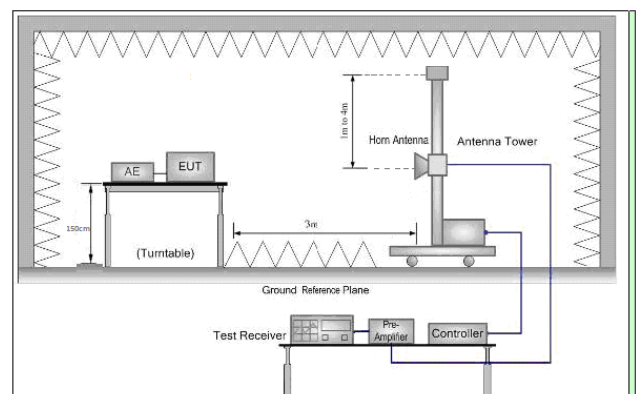


Fig. 2-4 Radiated Emission Configuration



30MHz to 1GHz



Above 1 GHz

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	Compliant
§15.247(b)(1)	Conducted Output Power	Compliant
§15.247(a)(1)	20dB & 99% Emission Bandwidth	Compliant
§15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(a)(1)	Frequency Separation	Compliant
§15.247(a)(1)(iii)	Number of hopping frequency	Compliant
§15.247(a)(1)(iii)	Time of Occupancy	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

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4 DESCRIPTION OF TEST MODES

4.1 Operated in 2400 ~ 2483.5MHz Band

79 channels are provided for Bluetooth

channel	FREQUENCY	channel	FREQUENCY	channel	FREQUENCY	channel	FREQUENCY
1	2402 MHz	21	2422 MHz	41	2442 MHz	71	2462 MHz
2	2403 MHz	22	2423 MHz	42	2443 MHz	72	2463 MHz
3	2404 MHz	23	2424 MHz	43	2444 MHz	73	2464 MHz
4	2405 MHz	24	2425 MHz	44	2445 MHz	74	2465 MHz
5	2406 MHz	25	2426 MHz	45	2446 MHz	75	2466 MHz
6	2407 MHz	26	2427 MHz	46	2447 MHz	76	2467 MHz
7	2408 MHz	27	2428 MHz	47	2448 MHz	77	2468 MHz
8	2409 MHz	28	2429 MHz	48	2449 MHz	78	2469 MHz
9	2410 MHz	29	2430 MHz	49	2450 MHz	79	2470 MHz
10	2411 MHz	30	2431 MHz	50	2451 MHz	70	2471 MHz
11	2412 MHz	31	2432 MHz	51	2452 MHz	71	2472 MHz
12	2413 MHz	32	2433 MHz	52	2453 MHz	72	2473 MHz
13	2414 MHz	33	2434 MHz	53	2454 MHz	73	2474 MHz
14	2415 MHz	34	2435 MHz	54	2455 MHz	74	2475 MHz
15	2416 MHz	35	2436 MHz	55	2456 MHz	75	2476 MHz
16	2417 MHz	36	2437 MHz	56	2457 MHz	76	2477 MHz
17	2418 MHz	37	2438 MHz	57	2458 MHz	77	2478 MHz
18	2419 MHz	38	2439 MHz	58	2459 MHz	78	2479 MHz
19	2420 MHz	39	2440 MHz	59	2460 MHz	79	2480 MHz
20	2421 MHz	40	2441 MHz	60	2461 MHz		

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4.2 The Worst Test Modes and Channel Details

- 1 The EUT has been tested under operating condition.
- 2 Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.
- 3 Investigation has been done on all the possible configurations for searching the worst case.

4.2.1 RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5
RADIATED EMISSION TEST (ABOVE 1 GHz)				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK	DH5

4.2.2 ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST				
Peak Output Power, 20dB Band Width				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	PACKET TYPE
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, $\pi/4$ -DQPSK, 8-DPSK	DH5
Band Edge				
Bluetooth	2402 to 2480	2402, 2480	GFSK, $\pi/4$ -DQPSK, 8-DPSK	DH5
Frequency Separation				
Bluetooth	2402 to 2480	2441	GFSK, $\pi/4$ -DQPSK, 8-DPSK	DH5
Number of hopping frequency				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, $\pi/4$ -DQPSK, 8-DPSK	DH5
Time of Occupancy (Dwell time)				
Bluetooth	2402 to 2480	2402, 2441, 2480	GFSK, $\pi/4$ -DQPSK, 8-DPSK	DH1/DH3/DH5 2DH1/2DH3/2DH5 3DH1/3DH3/3DH5

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5 MEASUREMENT UNCERTAINTY

No.	Item	Measurement Uncertainty
1	Total RF power, conducted	$\pm 0.75\text{dB}$
2	RF power density, conducted	$\pm 2.84\text{dB}$
3	Spurious emissions, conducted	$\pm 0.75\text{dB}$
4	Radiated Spurious emission test	$\pm 4.5\text{dB}$ (30MHz-1GHz)
		$\pm 4.8\text{dB}$ (1GHz-25GHz)
5	Conduct emission test	$\pm 3.12\text{ dB}$ (9KHz- 30MHz)
6	Temperature test	$\pm 1^{\circ}\text{C}$
7	Humidity test	$\pm 3\%$
8	DC and low frequency voltages	$\pm 0.5\%$

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of $k=2$.

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6 CONDUCTED EMISSION TEST

6.1 Standard Applicable

Frequency within 150 kHz to 30MHz shall not exceed the limit table as below.

Frequency range MHz	Limits dB(uV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50

Note

- The lower limit shall apply at the transition frequencies
- The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.

6.2 Measurement Equipment Used

Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Duedate
				(yyyy-mm-dd)	(yyyy-mm-dd)
Shielding Room	ZhongYu Electron	GB-88	SEM001-06	2017/5/10	2020/5/9
LISN	Rohde & Schwarz	ENV216	SEM007-01	2018/9/2	2019/9/2
LISN	ETS-LINDGREN	Feb-16	SEM007-02	2018/4/2	2019/4/1
Measurement Software	AUDIX	e3 V5.4.1221d	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM024-01	2018/7/12	2019/7/11
2 Line ISN	Fischer Custom Communications Inc.	FCC-TLISN-T2-02	EMC0122	2018/2/14	2019/2/13
EMI Test Receiver	Rohde & Schwarz	ESCI	SEM004-02	2018/4/2	2019/4/1

NOTE: N/A refers to Not Calibrated Required.

6.3 EUT Setup

- The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI 63.10:2013.
- The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
- The LISN was connected with 120Vac/60Hz power source.

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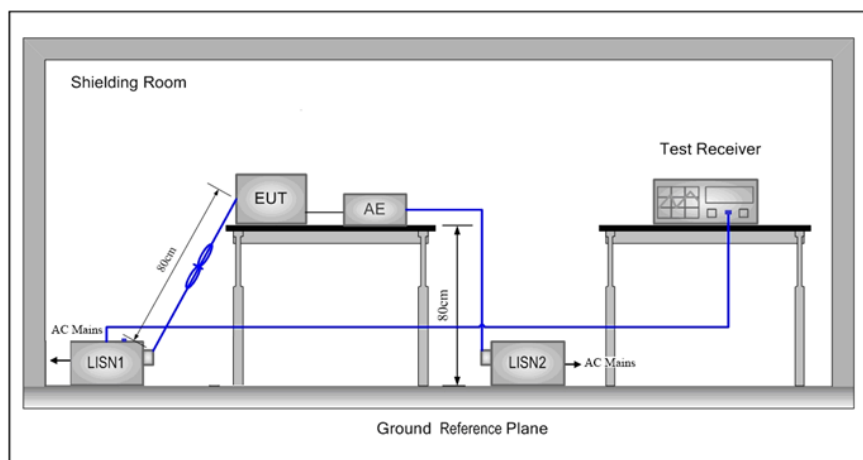
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6.4 Test SET-UP (Block Diagram of Configuration)



6.5 Measurement Procedure

1. The EUT was placed on a table which is 0.8m above ground plan.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Repeat above procedures until all frequency measured were complete.

6.6 Measurement Result

Note: Refer to next page for measurement data and plots.

Note2: The * reveals the worst-case results that closet to the limit

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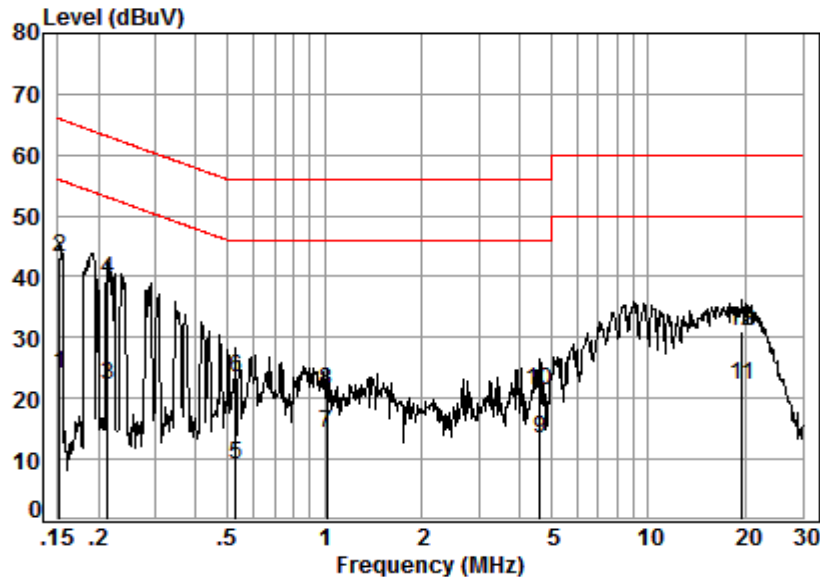
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AC POWER LINE CONDUCTED EMISSION TEST DATA: L



Site : Shielding Room

Condition: Neutral

Job No. : 90027

Test mode: b

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.15	0.01	9.63	14.35	23.99	55.91	-31.92	Average
2	0.15	0.01	9.63	33.57	43.21	65.91	-22.70	QP
3	0.21	0.02	9.64	12.55	22.21	53.05	-30.84	Average
4	0.21	0.02	9.64	29.80	39.46	63.05	-23.59	QP
5	0.53	0.06	9.64	-0.50	9.20	46.00	-36.80	Average
6	0.53	0.06	9.64	13.74	23.44	56.00	-32.56	QP
7	1.02	0.09	9.71	4.47	14.27	46.00	-31.73	Average
8	1.02	0.09	9.71	11.36	21.16	56.00	-34.84	QP
9	4.62	0.17	9.70	3.63	13.50	46.00	-32.50	Average
10	4.62	0.17	9.70	11.50	21.37	56.00	-34.63	QP
11	19.53	0.24	10.12	11.86	22.22	50.00	-27.78	Average
12	19.53	0.24	10.12	20.70	31.06	60.00	-28.94	QP

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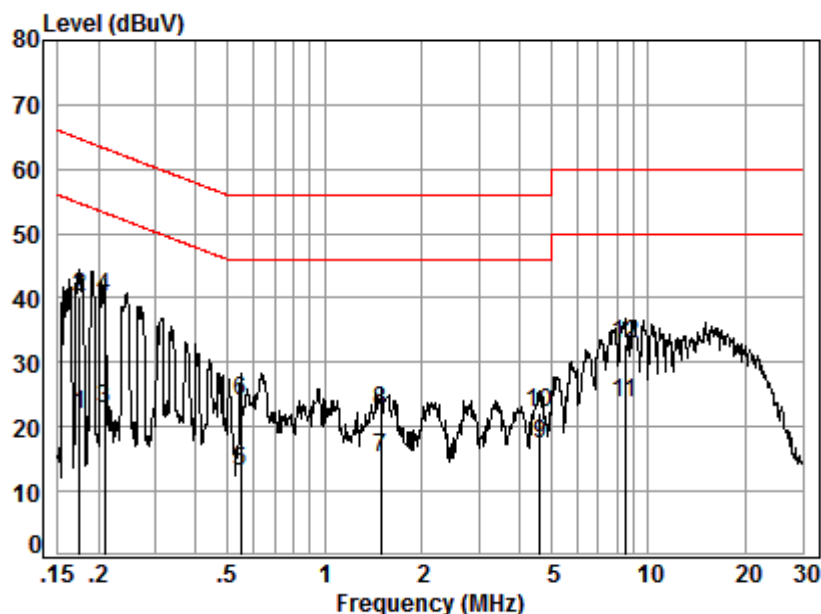
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AC POWER LINE CONDUCTED EMISSION TEST DATA: N



Site : Shielding Room

Condition: Line

Job No. : 90027

Test mode: b

	Freq	Cable Loss	LISN Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB	dBuV	dBuV	dBuV	dB	
1	0.17	0.02	9.66	12.31	21.99	54.72	-32.73	Average
2	0.17	0.02	9.66	30.47	40.15	64.72	-24.57	QP
3	0.21	0.02	9.66	13.07	22.75	53.23	-30.48	Average
4	0.21	0.02	9.66	30.44	40.12	63.23	-23.11	QP
5	0.55	0.06	9.67	3.29	13.02	46.00	-32.98	Average
6	0.55	0.06	9.67	14.18	23.91	56.00	-32.09	QP
7	1.50	0.13	9.73	5.48	15.34	46.00	-30.66	Average
8	1.50	0.13	9.73	12.58	22.44	56.00	-33.56	QP
9	4.62	0.17	9.73	7.35	17.25	46.00	-28.75	Average
10	4.62	0.17	9.73	12.30	22.20	56.00	-33.80	QP
11	8.50	0.17	9.82	13.72	23.71	50.00	-26.29	Average
12	8.50	0.17	9.82	22.75	32.74	60.00	-27.26	QP

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7 CONDUCTED OUTPUT POWER MEASUREMENT

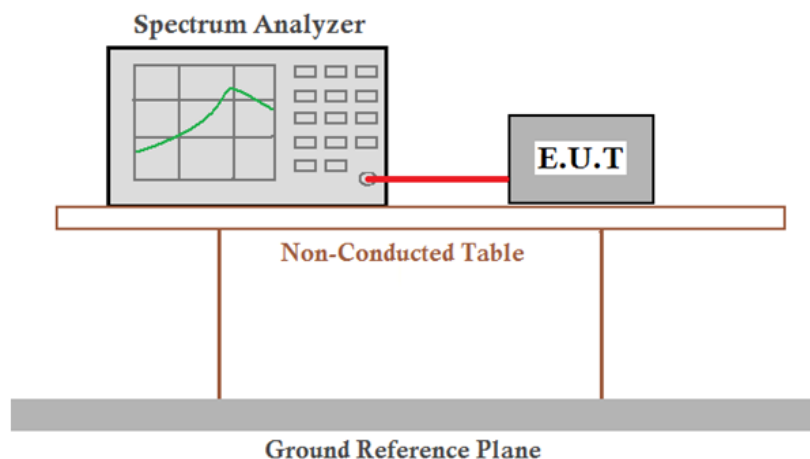
7.1 Standard Applicable

For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 hopping channels, The Limit: 1Watt. For all other frequency hopping systems in the 2400 – 2483.5MHz band: The Limit: 0.125 Watts. The power limit for 1Mbps is 1watt, and 2Mbps, 3Mbps and AFH mode are 0.125 watts.

7.2 Measurement Equipment Used

Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Duedate
				(yyyy-mm-dd)	(yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	2018/9/15	2019/9/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2018/3/13	2019/3/12
Coaxial Cable	SGS	N/A	SEM031-01	2018/7/13	2019/7/12
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018/9/2	2019/9/2
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2018/11/27	2019/11/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018/9/2	2019/9/2

7.3 Test Set-up:



7.4 Measurement Procedure:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows FCC Public Notice DA 00-705 Measurement Guidelines.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter or spectrum. (Max Hold, Detector = Peak, RBW >=20dB bandwidth)

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4. Record the max. reading.
5. Repeat above procedures until all default test channel is completed.

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7.5 Measurement Result

7.5.1 Measurement Data of Average power

GFSK mode		
Test channel	Average Output Power (dBm)	Result
Lowest	9.41	Report purpose only
Middle	8.95	Report purpose only
Highest	6.89	Report purpose only
$\pi/4$ DQPSK mode		
Test channel	Average Output Power (dBm)	Result
Lowest	6.57	Report purpose only
Middle	6.01	Report purpose only
Highest	3.59	Report purpose only
8DPSK mode		
Test channel	Average Output Power (dBm)	Result
Lowest	6.53	Report purpose only
Middle	6.07	Report purpose only
Highest	3.58	Report purpose only

7.5.2 Measurement Data of Peak power

GFSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	11.25	20.97	Pass
Middle	10.92	20.97	Pass
Highest	9.04	20.97	Pass
$\pi/4$ DQPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	10.56	20.97	Pass
Middle	10.23	20.97	Pass
Highest	8.50	20.97	Pass
8DPSK mode			
Test channel	Peak Output Power (dBm)	Limit (dBm)	Result
Lowest	10.54	20.97	Pass
Middle	10.19	20.97	Pass
Highest	8.49	20.97	Pass

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8 20DB & 99% EMISSION BANDWIDTH MEASUREMENT

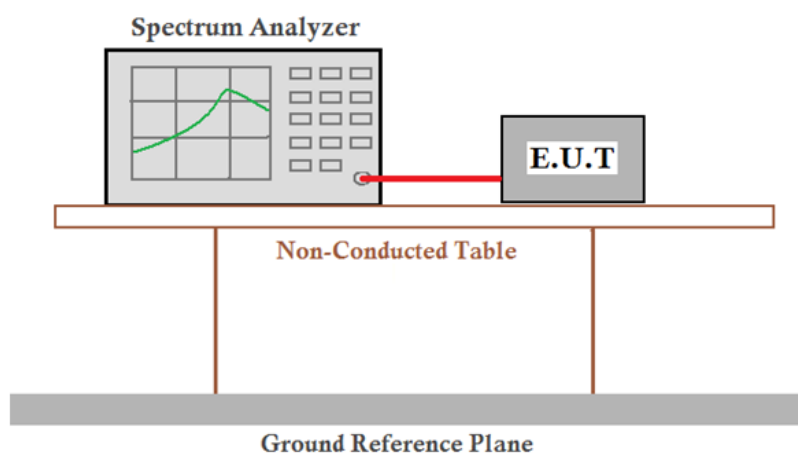
8.1 Standard Applicable

For frequency hopping systems operating in the 2400 MHz-2483.5 MHz no limit for 20dB bandwidth.

8.2 Measurement Equipment Used

Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Duedate
				(yyyy-mm-dd)	(yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	2018/9/15	2019/9/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2018/3/13	2019/3/12
Coaxial Cable	SGS	N/A	SEM031-01	2018/7/13	2019/7/12
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018/9/2	2019/9/2
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2018/11/27	2019/11/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018/9/2	2019/9/2

8.3 Test Set-up



8.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set the spectrum analyzer as RBW=10 kHz (1 % of 20 dB Bandwidth.), VBW = 30 kHz, Span= 3MHz, Sweep=auto, Detector = Peak, and Max hold for 20dB Bandwidth test.
5. Mark the peak frequency and -20dB (upper and lower) frequency

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6. Repeat above procedures until all test default channel is completed

NOTE: For the plot of bandwidth measurement, the marker of the 20dB BW is arrow-mark

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8.5 Measurement Result

Mode	Test Channel	Occupied Bandwidth (KHz)	20dB Emission Bandwidth (KHz)	Result
GFSK	Lowest	764.2	815.2	Pass
	Middle	761.2	815.2	Pass
	Highest	755.2	815.2	Pass
$\pi/4$ DQPSK	Lowest	1150.8	1264.7	Pass
	Middle	1147.9	1261.7	Pass
	Highest	1141.9	1252.7	Pass
8DPSK	Lowest	1150.8	1216.8	Pass
	Middle	1153.8	1213.8	Pass
	Highest	1141.9	1213.8	Pass

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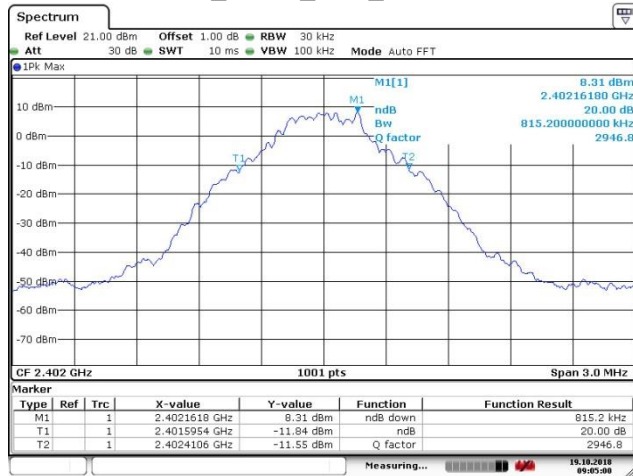
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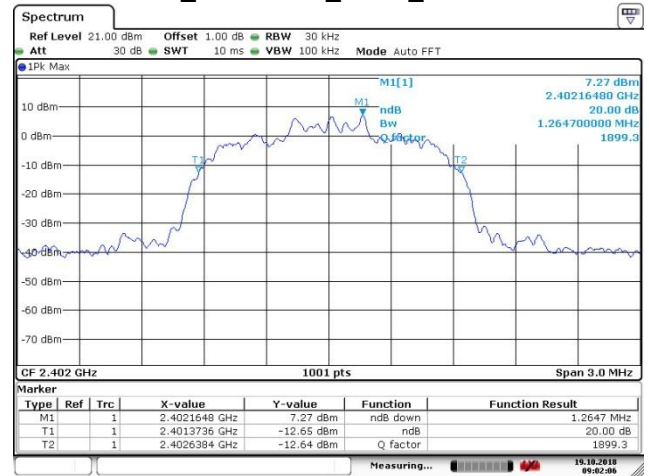
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20dB_GFSK_DH5_2402MHz



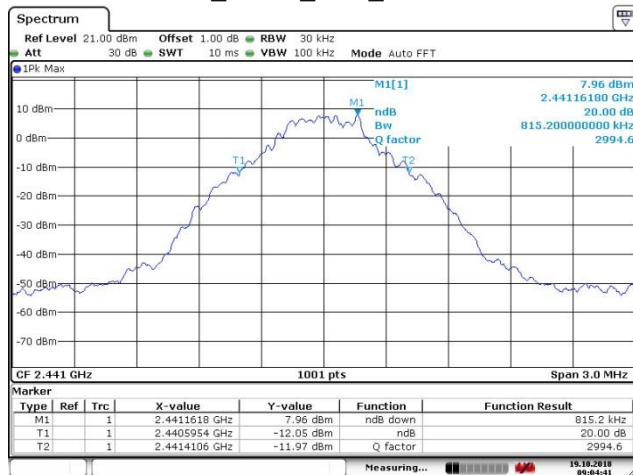
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20dB_π4DQPSK_2DH5_2402MHz



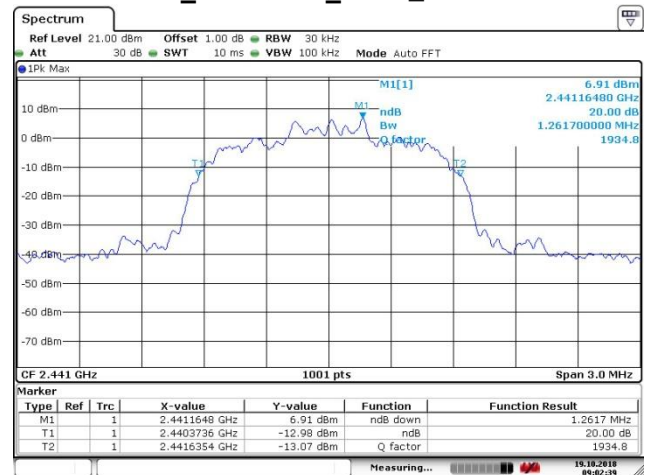
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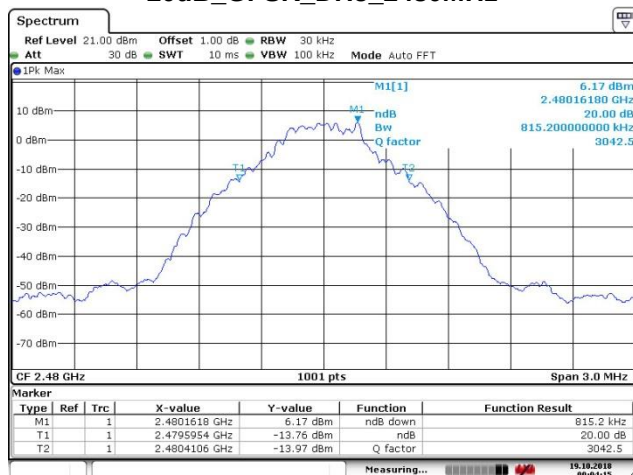
Date: 19.OCT.2018 09:04:41

20dB_π4DQPSK_2DH5_2441MHz



Date: 19.OCT.2018 09:02:39

20dB_GFSK_DH5_2480MHz



Date: 19.OCT.2018 09:04:15

20dB_π4DQPSK_2DH5_2480MHz



Date: 19.OCT.2018 09:03:02

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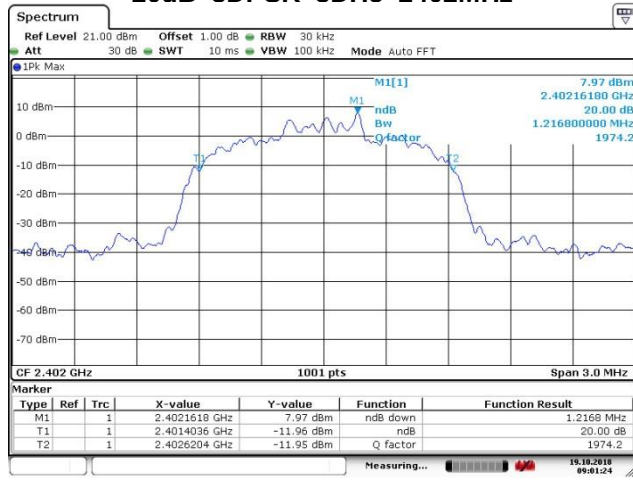
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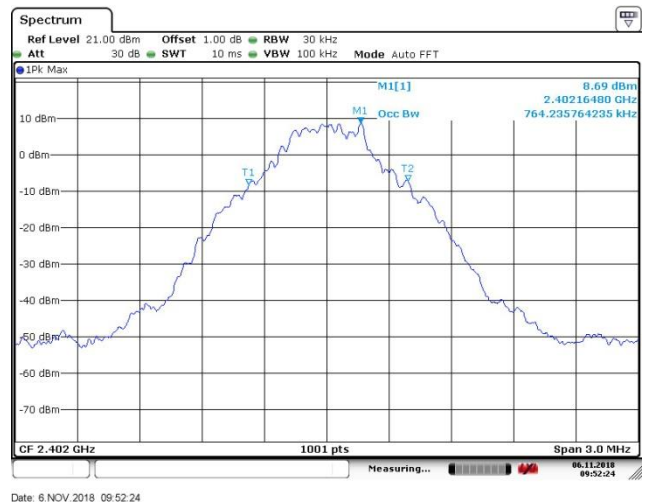
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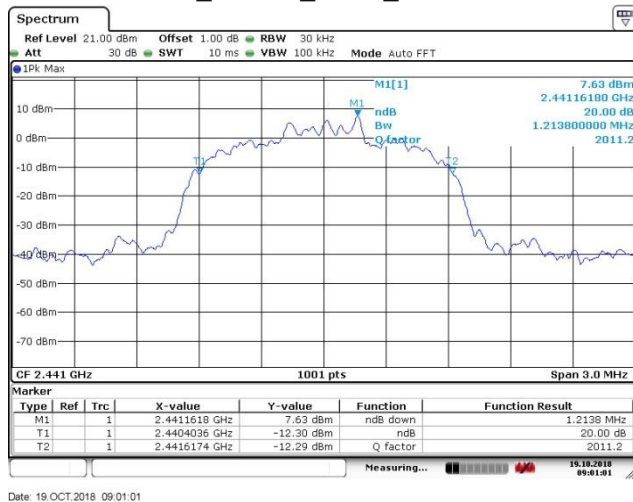
20dB 8DPSK 3DH5 2402MHz



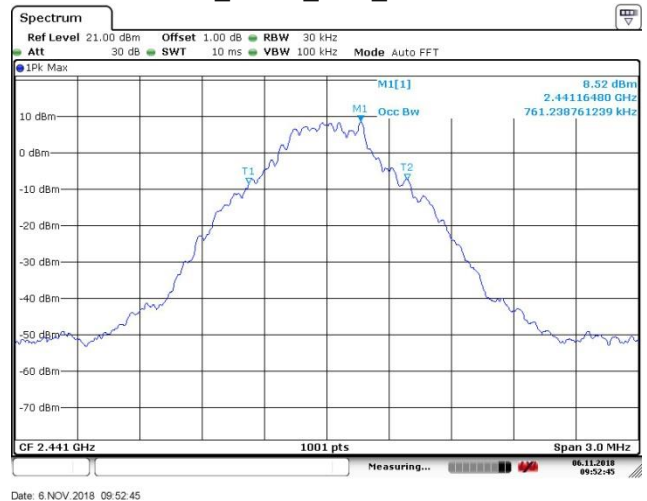
OBW_GFSK_DH5_2402MH



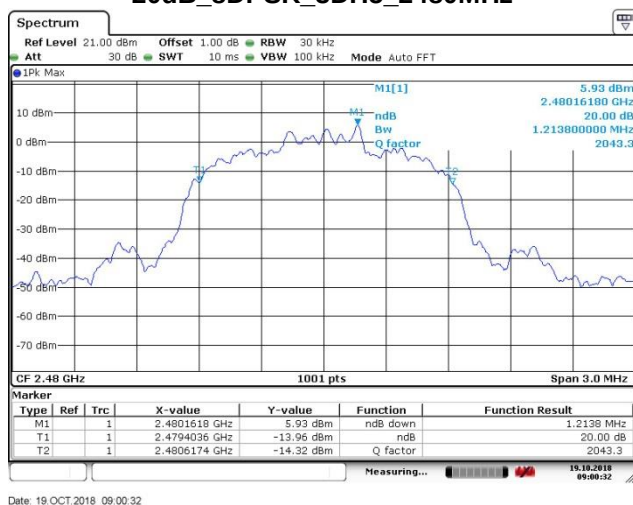
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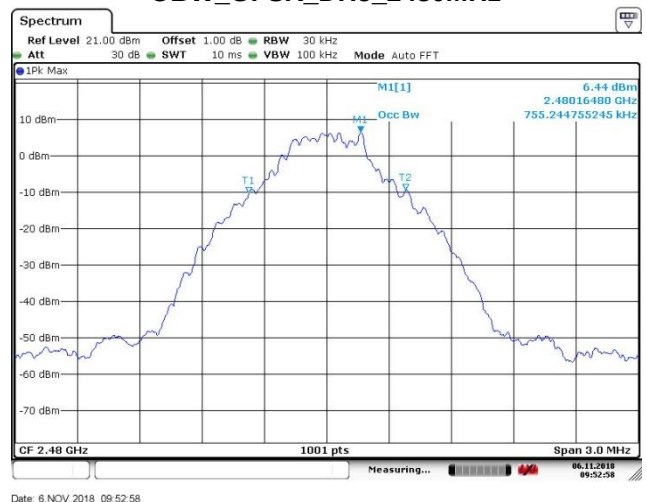
OBW_GFSK_DH5_2441MH



20dB_8DPSK_3DH5_2480MHz



OBW_GFSK_DH5_2480MH



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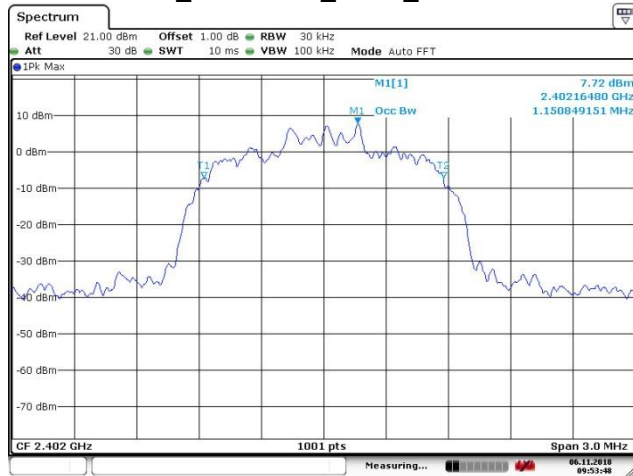
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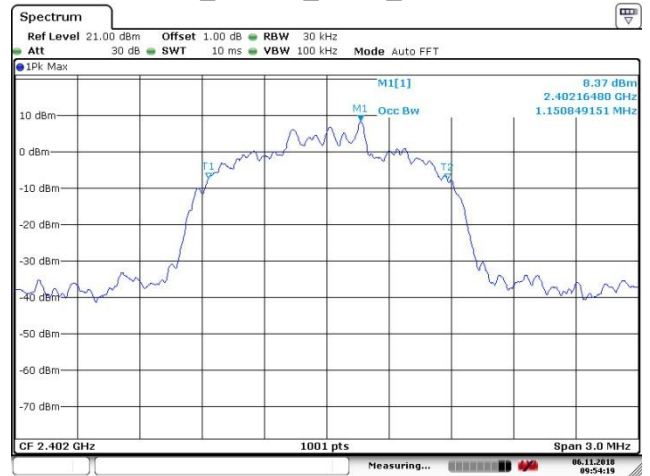
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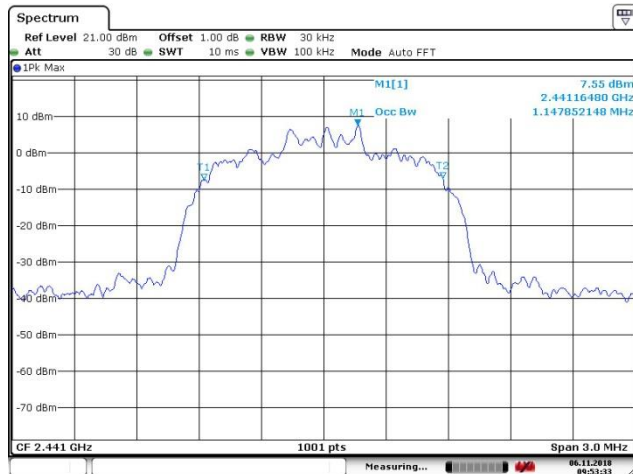
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OBW_8DPSK_3DH5_2402MHz



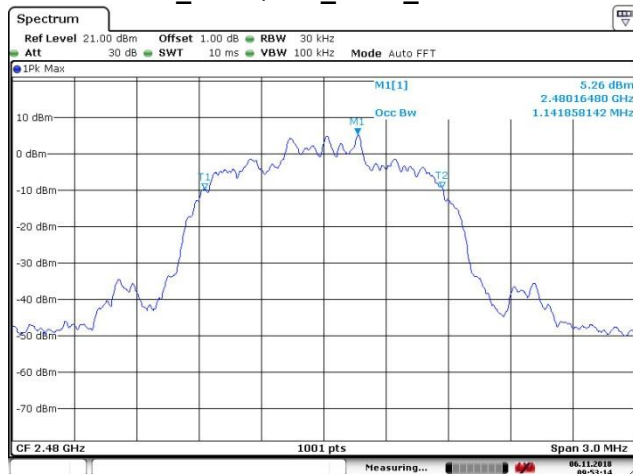
OBW_π4DQPSK_2DH5_2441MHz



OBW_8DPSK_3DH5_2441MHz



OBW_π4DQPSK_2DH5_2480MHz



OBW_8DPSK_3DH5_2480MHz



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9 CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT

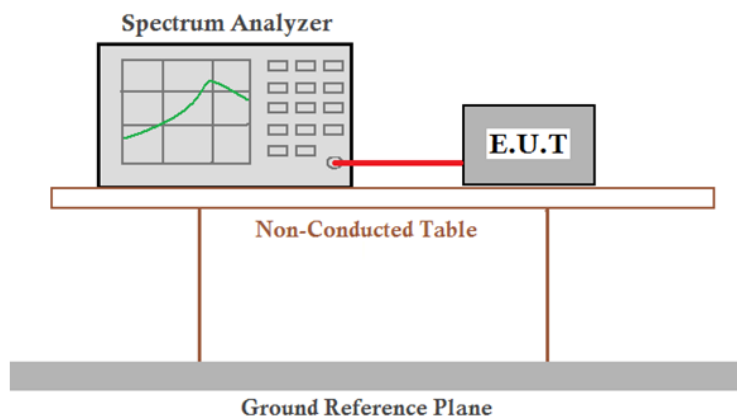
9.1 Standard Applicable

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. 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).

9.2 Measurement Equipment Used

Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Duedate
				(yyyy-mm-dd)	(yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	2018/9/15	2019/9/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2018/3/13	2019/3/12
Coaxial Cable	SGS	N/A	SEM031-01	2018/7/13	2019/7/12
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018/9/2	2019/9/2
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2018/11/27	2019/11/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018/9/2	2019/9/2

9.3 Test SET-UP



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9.4 Measurement Procedure

9.4.1 Conducted Band Edge:

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Sweep = auto
6. Mark peak and record the max level.
7. Repeat above procedures until all frequency measured were complete.

9.4.2 Conducted Spurious Emission:

1. To connect Antenna Port of EUT to Spectrum.
2. The testing follows ANSI C63.10:2013.
3. Set RBW = 100 kHz & VBW = 300 kHz, Detector =Peak, Sweep = Auto
4. Allow trace to fully stabilize.
5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
6. Repeat above procedures until all default test channel measured were complete.

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

9.5 Measurement Result

See next page for test plots.

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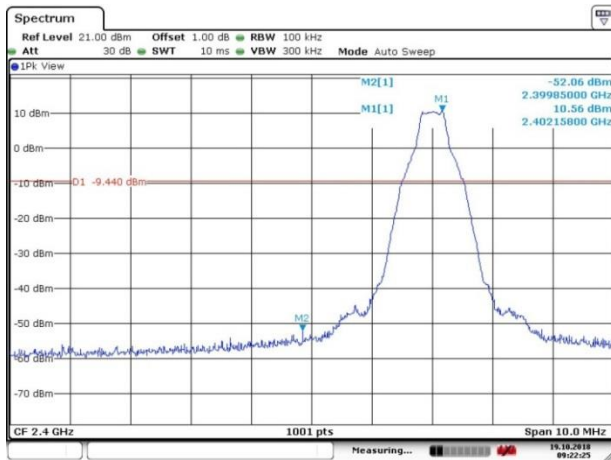
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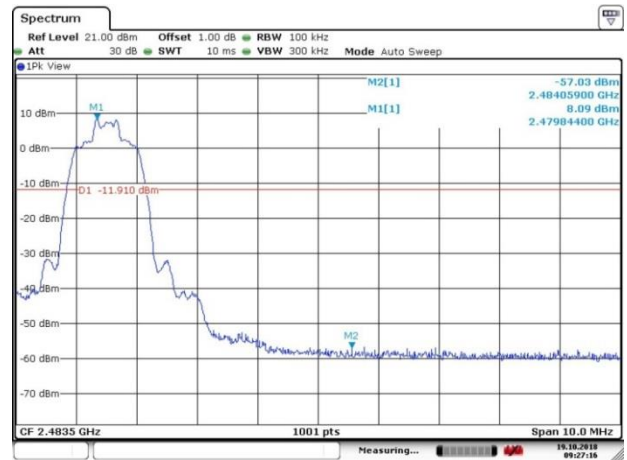
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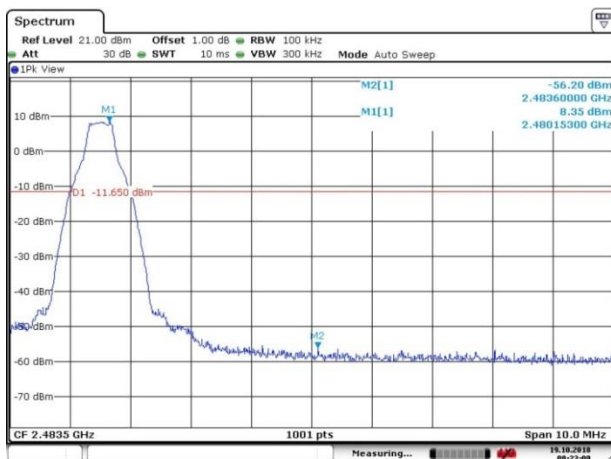
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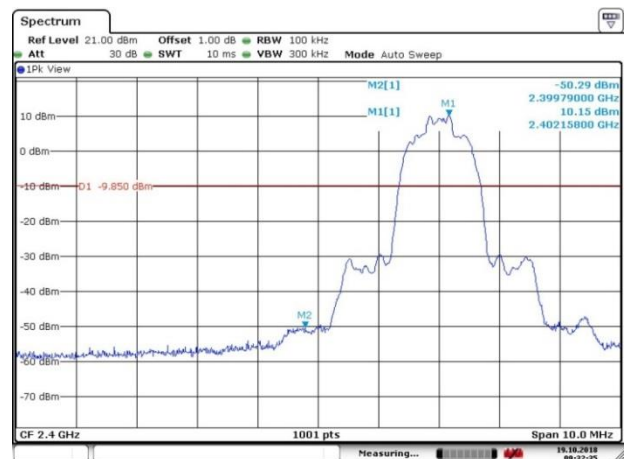
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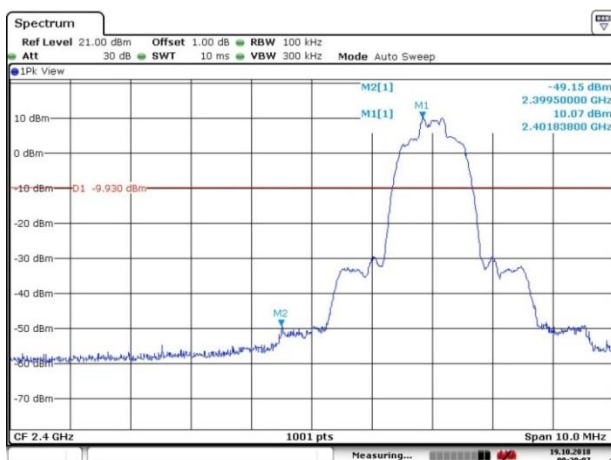
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Band Edge_8DPSK_3DH5_2480MHz



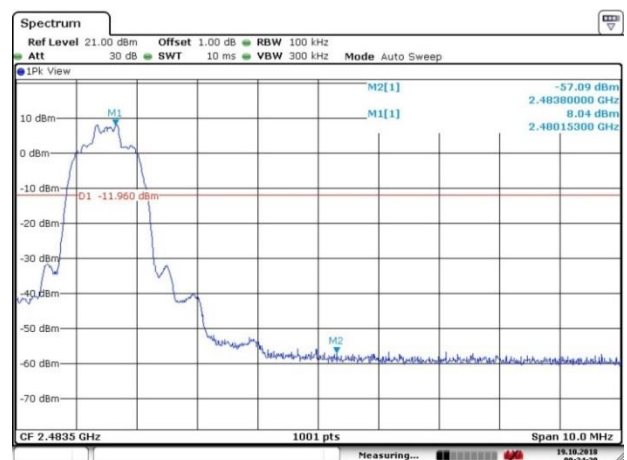
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Band Edge_π4DQPSK_2DH5_2402MHz



Date: 19.OCT.2018 09:29:07

Band Edge_8DPSK_3DH5_2480MHz



Date: 19.OCT.2018 09:34:40

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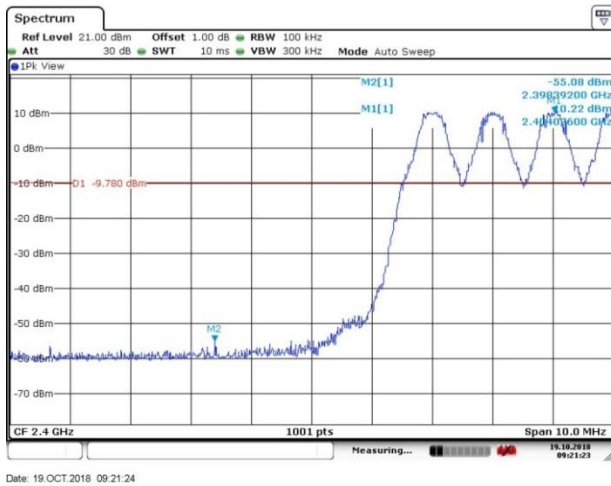
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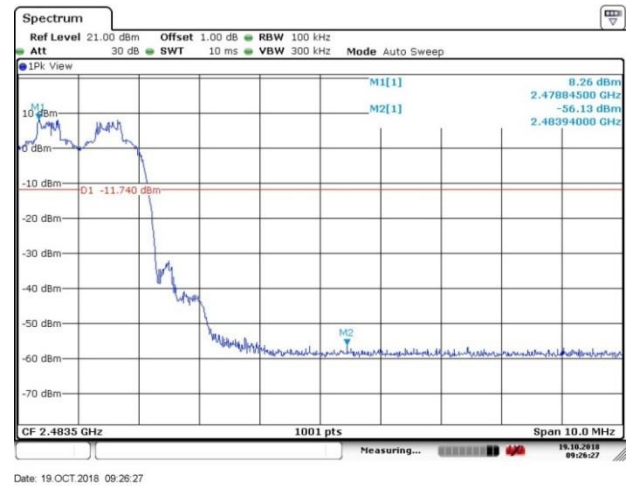
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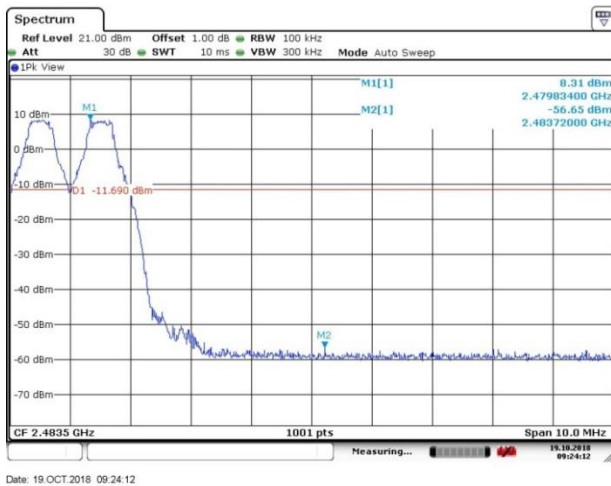
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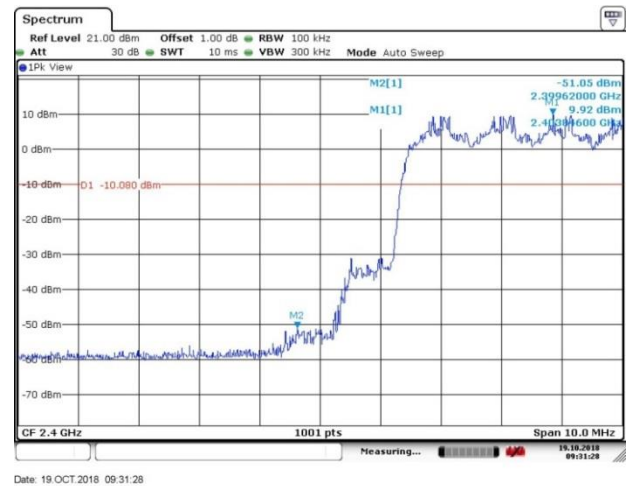
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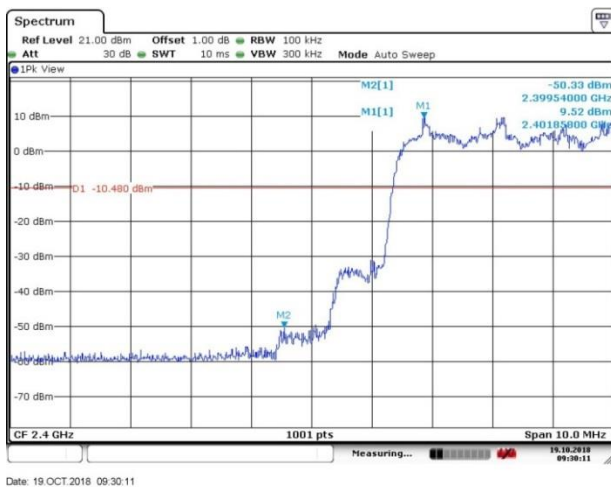
Hopping Band Edge_GFSK_DH5_2480MHz



Hopping Band Edge_8DPSK_3DH5_2402MHz



Hopping Band Edge_π4DQPSK_2DH5_2402MHz



Hopping Band Edge_8DPSK_3DH5_2480MHz



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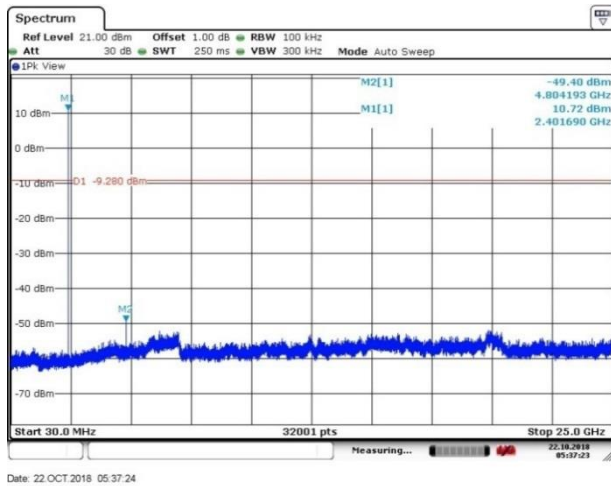
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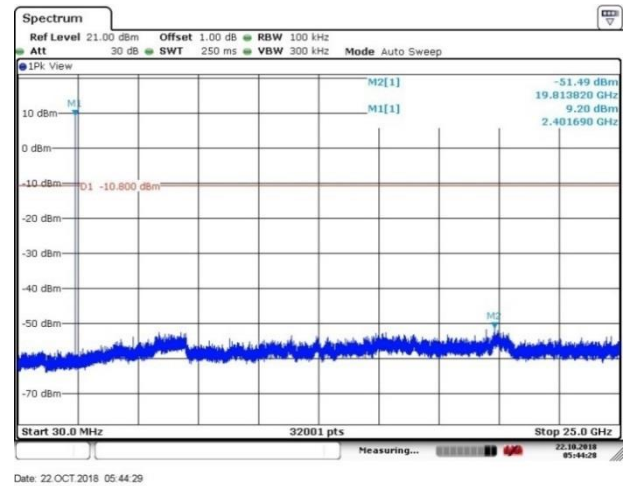
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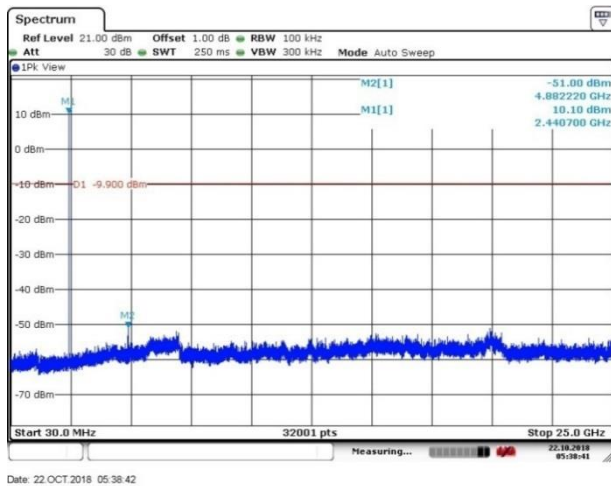
Conducted emission_GFSK_DH5_low Ch



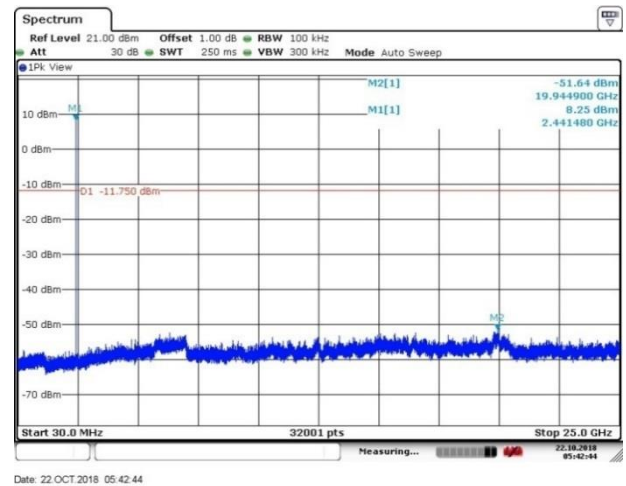
Conducted emission_π4DQPSK_2DH5_low Ch



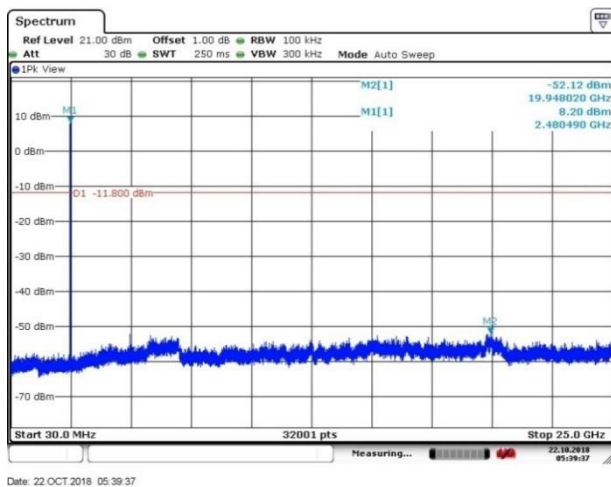
Conducted emission_GFSK_DH5_mid Ch



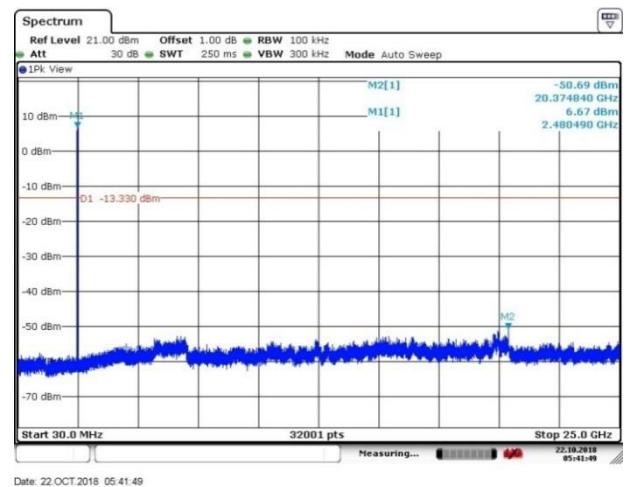
Conducted emission_π4DQPSK_2DH5_mid Ch



Conducted emission_GFSK_DH5_high Ch



Conducted emission_π4DQPSK_2DH5_high Ch



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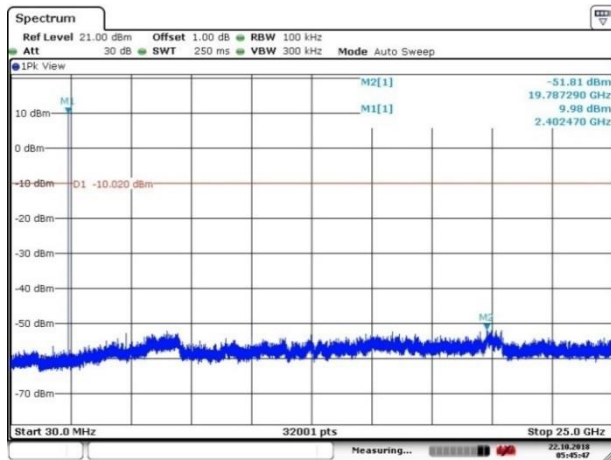
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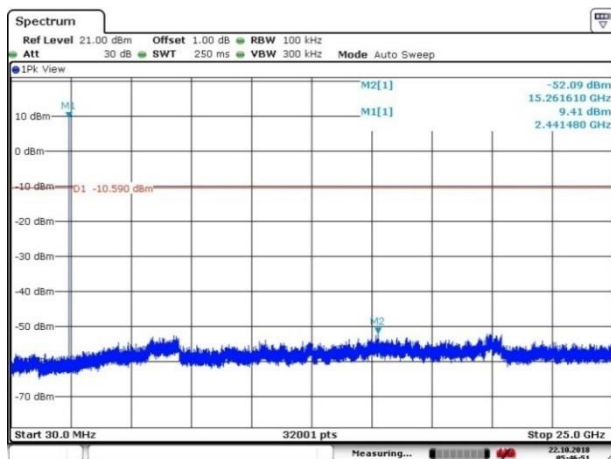
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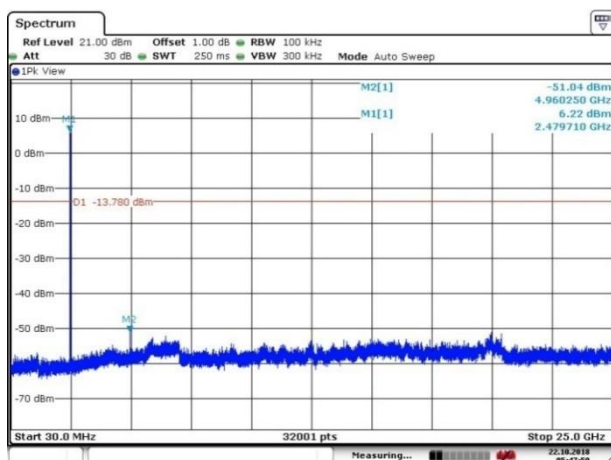
Conducted emission_8DPSK_3DH5_low Ch



Conducted emission_8DPSK_3DH5_mid Ch



Conducted emission_8DPSK_3DH5_high Ch



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10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

10.1 Standard Applicable

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. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 limit as below.

And according to §15.33(a) (1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	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 (dBμV/m) = 20 log Emission level (dBμV/m)

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10.2 Measurement Equipment Used

RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Due date
				(yyyy-mm-dd)	(yyyy-mm-dd)
3m Semi-Anechoic Chamber	ETS-LINDGREN	N/A	SEM001-01	2017/8/5	2020/8/4
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM025-01	2018/7/12	2019/7/11
MXE EMI Receiver (20Hz-8.4GHz)	Agilent Technologies	N9038A	SEM004-05	2018/9/2	2019/9/2
BiConiLog Antenna (26-3000MHz)	ETS-LINDGREN	3142C	SEM003-01	2017/6/27	2020/6/26
Pre-amplifier (0.1-1.3GHz)	Agilent Technologies	8447D	SEM005-01	2018/4/2	2019/4/1

RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. Date	Cal. Due date
				(yyyy-mm-dd)	(yyyy-mm-dd)
10m Semi-Anechoic Chamber	SAEMC	FSAC1018	SEM001-03	2018/3/31	2021/3/30
EMI Test Receiver (9k-7GHz)	Rohde & Schwarz	ESR	SEM004-03	2018/4/2	2019/4/1
Trilog-Broadband Antenna(25M-2GHz)	Schwarzbeck	VULB9168	SEM003-18	2016/6/29	2019/6/28
Pre-amplifier (9k-1GHz)	Sonoma	310N	SEM005-03	2018/4/13	2019/4/12
Loop Antenna (9kHz-30MHz)	ETS-Lindgren	6502	SEM003-08	2017/8/22	2020/8/21
Measurement Software	AUDIX	e3 V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM029-01	2018/7/12	2019/7/11

RE in Chamber					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Due date
				(yyyy-mm-dd)	(yyyy-mm-dd)
3m Semi-Anechoic Chamber	AUDIX	N/A	SEM001-02	2018/3/13	2021/3/12
Measurement Software	AUDIX	e3V8.2014-6-27	N/A	N/A	N/A
Coaxial Cable	SGS	N/A	SEM026-01	2018/7/12	2019/7/11
EXA Signal Analyzer (10Hz-26.5GHz)	Agilent Technologies Inc	N9010A	SEM004-09	2018/4/13	2019/4/12
BiConiLog Antenna (26-3000MHz)	ETS-Lindgren	3142C	SEM003-01	2017/6/27	2020/6/26
Horn Antenna (0.8-18GHz)	Rohde & Schwarz	HF907	SEM003-07	2018/4/13	2021/4/12
Pre-amplifier(0.1-1.3GHz)	HP	8447D	SEM005-02	2018/9/2	2019/9/2
Low Noise Amplifier(100MHz-18GHz)	Black Diamond Series	BDLNA-0118-352810	SEM005-05	2018/9/27	2019/9/27
Pre-amplifier(18-26GHz)	Rohde & Schwarz	CH14-H052	SEM005-17	2018/4/2	2019/4/1

NOTE: N/A refers to Not Calibrated Required.

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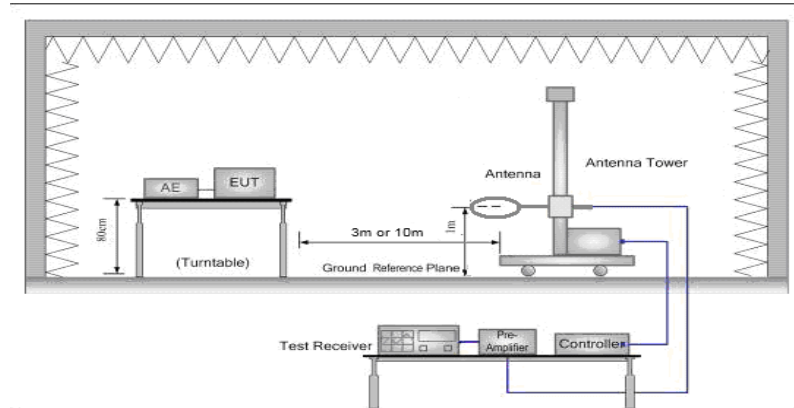
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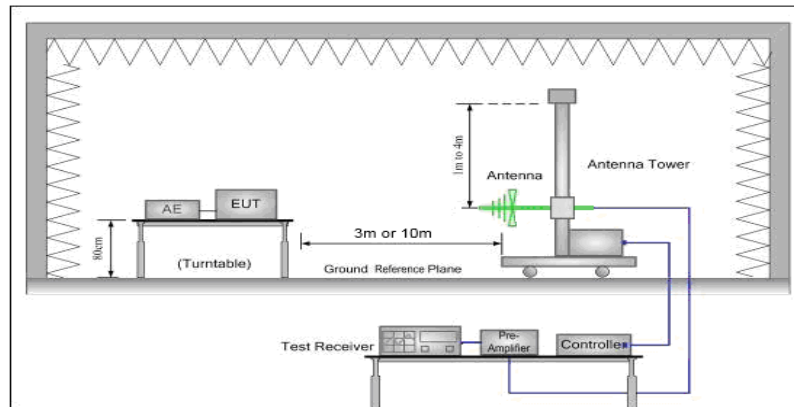
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10.3 Test SET-UP

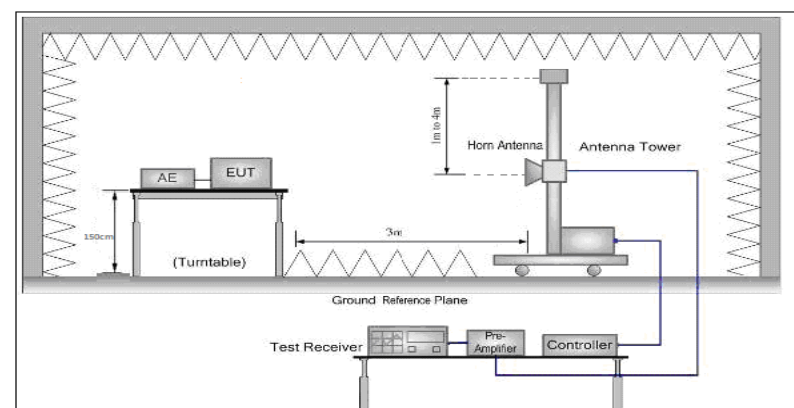
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



(B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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10.4 Measurement Procedure

10.4.1 Radiated Emission

1. The testing follows the Measurement Procedure of ANSI C63.10:2013.
2. The EUT was placed on a turn table with 0.8m for frequency < 1GHz and 1.5m for frequency > 1GHz above ground plan.
3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.
9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
11. Repeat above procedures until all default test channel measured were complete.

10.4.2 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

$$FS = RA + AF + CL - AG$$

Where	FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
	RA = Reading Amplitude	AG = Amplifier Gain
	AF = Antenna Factor	

The limit of the emission level is expressed in dBuV/m, which converts $20 \cdot \log(\mu V/m)$

Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

10.5 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

10.6 Measurement Result

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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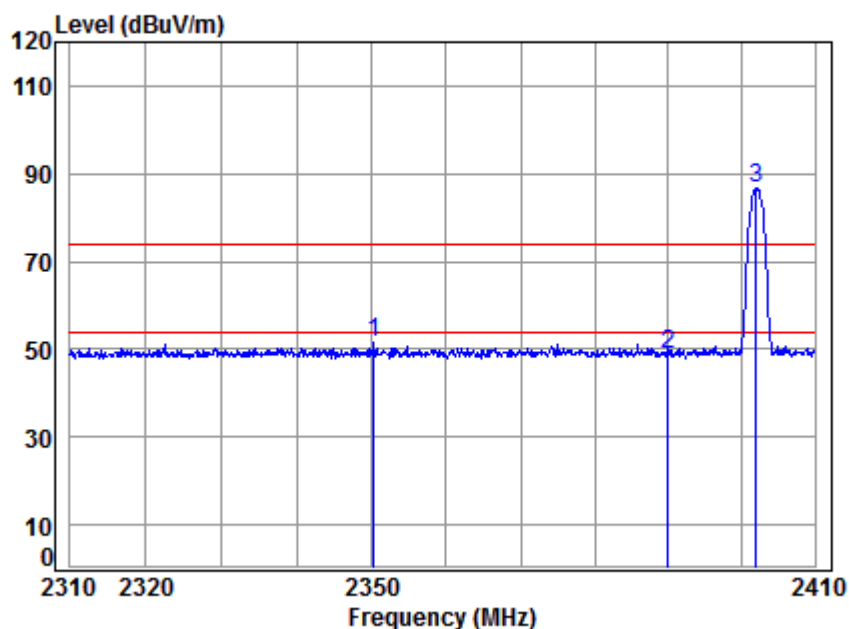
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10.6.1 Radiated Band Edge Measurement Result:

10.6.1.1 Worst Case Mode (GFSK(DH5)) _Lowest Channel_ Peak _Vertical



Site : chamber
Condition: 3m VERTICAL
Job No : 90027
Mode : 2402 Band edge
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	2350.289	5.42	28.45	41.86	59.58	51.59	74.00	-22.41	peak
2	2390.000	5.47	28.52	41.87	56.82	48.94	74.00	-25.06	peak
3 *	2402.000	5.49	28.54	41.88	94.47	86.62	74.00	12.62	peak

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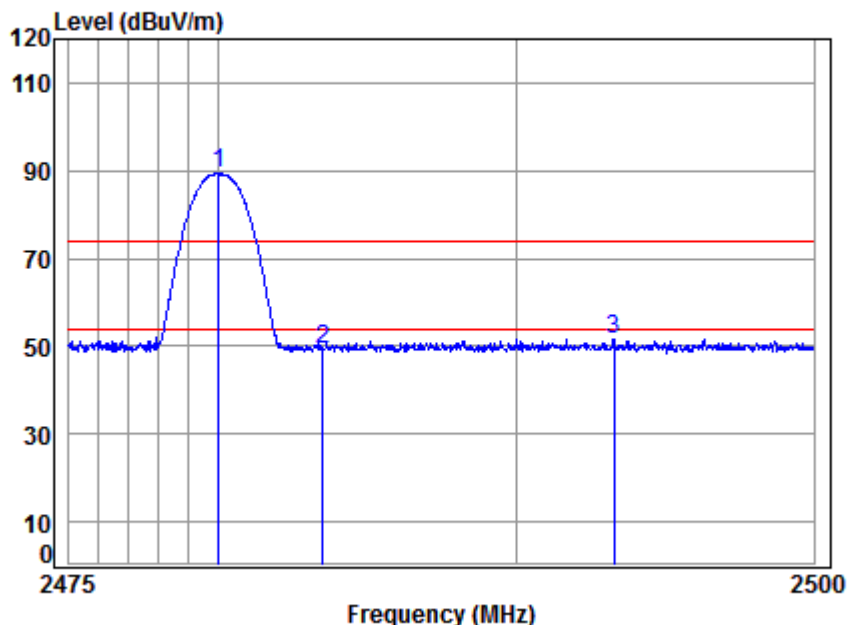
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10.6.1.2 Worst Case Mode (GFSK(DH5)) _Highest Channel_ Peak _Vertical



Site : chamber

Condition: 3m VERTICAL

Job No : 90027

Mode : 2480 Band edge

Note : BT

		Cable	Ant	Preamp	Read	Limit	Over	
	Freq	Loss	Factor	Factor	Level	Level	Line	Limit Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1 *	2480.000	5.59	28.67	41.91	96.99	89.34	74.00	15.34 peak
2	2483.500	5.60	28.67	41.91	56.91	49.27	74.00	-24.73 peak
3	2493.275	5.61	28.69	41.91	59.37	51.76	74.00	-22.24 peak

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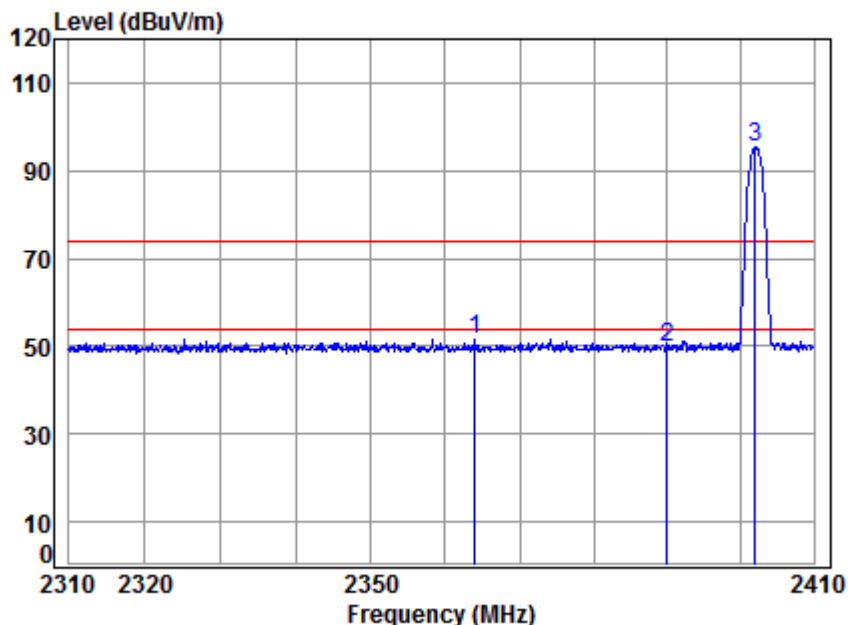
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10.6.1.3 Worst Case Mode (GFSK(DH5)) _Lowest Channel_ Peak _Horizontal



Site : chamber

Condition: 3m HORIZONTAL

Job No : 90027

Mode : 2402 Band edge

Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	2363.974	5.44	28.47	41.86	59.67	51.72	74.00	-22.28	peak
2	2390.000	5.47	28.52	41.87	57.53	49.65	74.00	-24.35	peak
3 *	2402.000	5.49	28.54	41.88	103.13	95.28	74.00	21.28	peak

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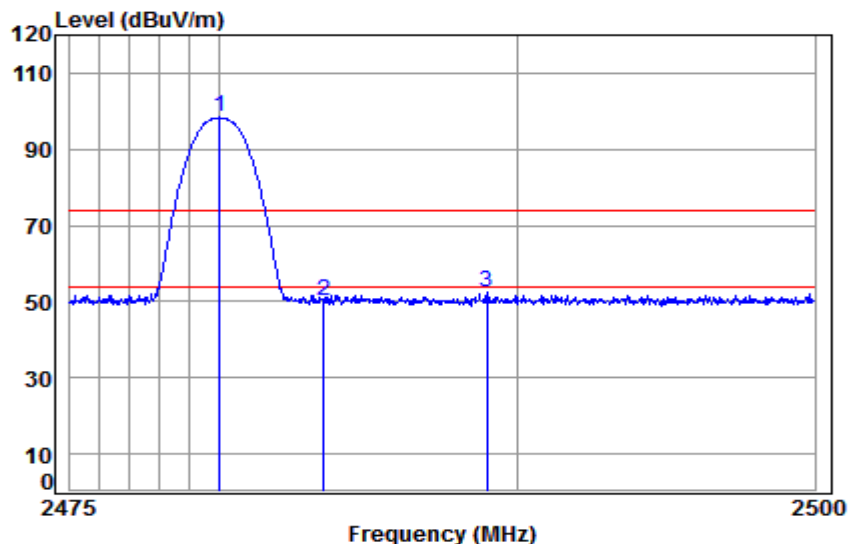
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10.6.1.4 Worst Case Mode (GFSK(DH5)) _Highest Channel_ Peak _ Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No : 90027
Mode : 2480 Band edge
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1 *	2480.000	5.59	28.67	41.91	105.98	98.33	74.00	24.33	peak
2	2483.500	5.60	28.67	41.91	57.73	50.09	74.00	-23.91	peak
3	2488.969	5.61	28.68	41.91	59.89	52.27	74.00	-21.73	peak

Remark:

The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level = Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

All Modes have been tested, but only the worst case data displayed in this report.

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10.6.2 Radiated Spurious Emission Measurement Result:

10.6.2.1 Radiated Emission below 1GHz

The test was performed at a 10m test site. According to below formulate and the test data at 10m test distance,

$$L_3 / L_{10} = D_{10} / D_3$$

Remark:

L₃: Level @ 3m distance. Unit: uV/m;

L₁₀: Level @ 10m distance. Unit: uV/m;

D₃: 3m distance. Unit: m

D₁₀: 10m distance. Unit: m

The level at 3m test distance is below:

Frequency (MHz)	Level @ 10m (dBuV/m)	Level @ 10m (uV/m)	Level @ 3m (uV/m)	Level @ 3m (dBuV/m)	Limit @ 3m (dBuV/m)	Over Limit (dB)	Ant. Polarization
47.49	14.7	5.43	18.11	25.16	40.00	-14.84	V
166.07	14.65	5.40	18.00	25.11	40.00	-14.89	V
276.12	13.73	4.86	16.19	24.19	43.50	-19.31	V
452.72	18.1	8.04	26.78	28.56	46.00	-17.44	V
638.37	23.61	15.15	50.51	34.07	46.00	-11.93	V
815.97	25.25	18.30	61.01	35.71	46.00	-10.29	V
40.7	13.57	4.77	15.90	24.03	40.00	-15.97	H
154.82	15.22	5.77	19.23	25.68	40.00	-14.32	H
322.19	14.85	5.53	18.42	25.31	43.50	-18.19	H
504.71	19.28	9.20	30.68	29.74	46.00	-16.26	H
654.23	23.15	14.37	47.90	33.61	46.00	-12.39	H
919.29	26.39	20.87	69.56	36.85	46.00	-9.15	H

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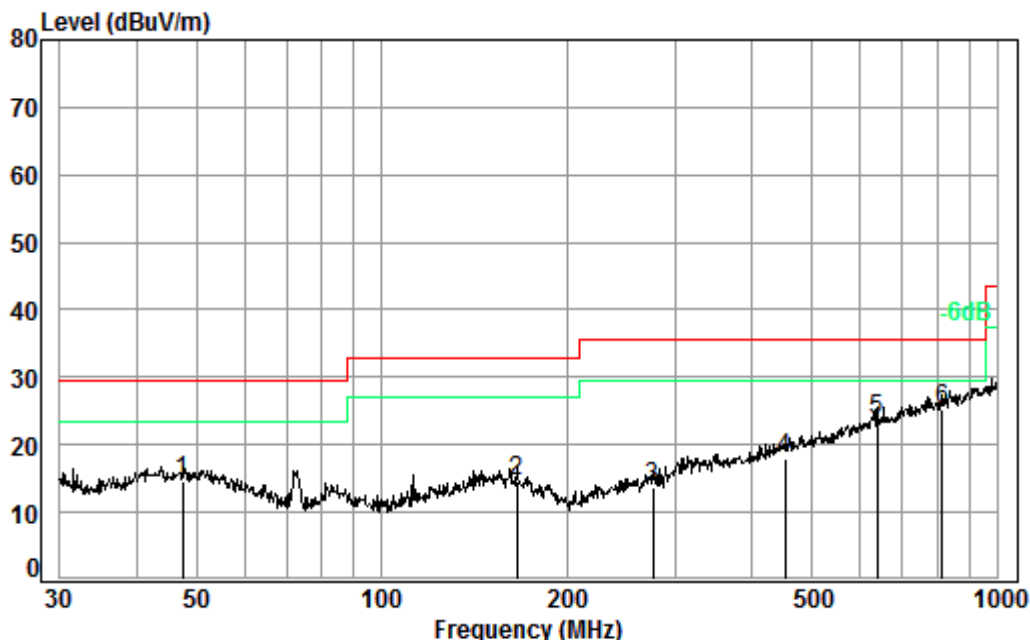
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10.6.2.1.1 Charge + Transmitting, Vertical



Condition: 10m VERTICAL

Job No. : 90027

Test Mode: b

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	47.49	6.89	12.84	32.45	27.42	14.70	29.50	-14.80
2	166.07	7.50	12.79	32.42	26.78	14.65	33.00	-18.35
3	276.12	7.93	12.04	32.37	26.13	13.73	35.60	-21.87
4	452.72	8.47	16.21	32.35	25.77	18.10	35.60	-17.50
5	638.37	8.96	19.39	32.35	27.61	23.61	35.60	-11.99
6 pp	815.97	9.32	21.35	32.06	26.64	25.25	35.60	-10.35

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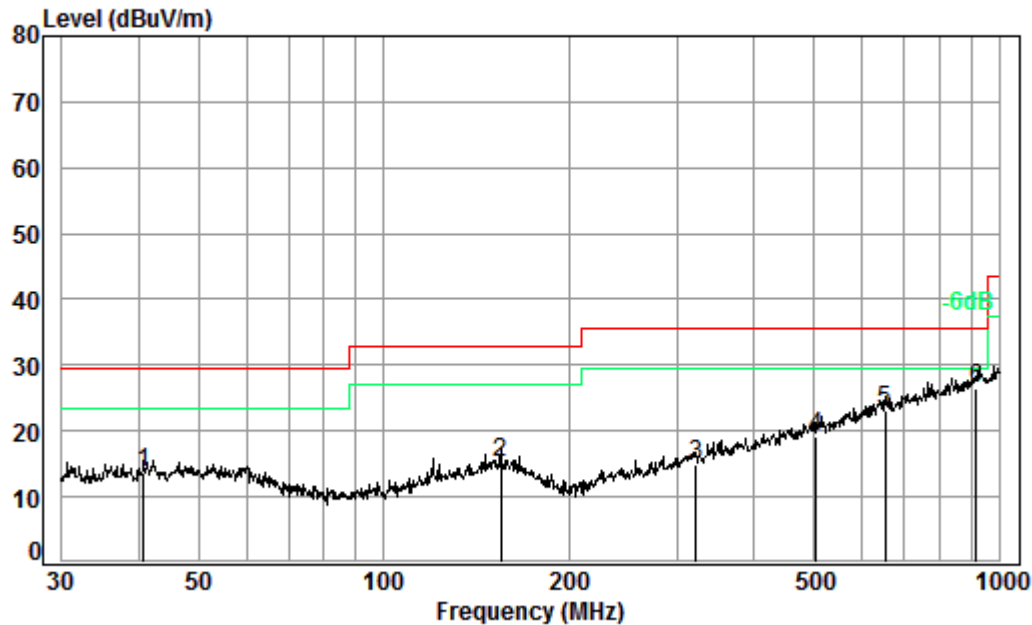
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10.6.2.1.2 Charge + Transmitting, Horizontal



Condition: 10m HORIZONTAL

Job No. : 90027

Test Mode: b

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB
1	40.70	6.83	13.26	32.46	25.94	13.57	29.50	-15.93
2	154.82	7.46	13.40	32.43	26.79	15.22	33.00	-17.78
3	322.19	8.08	13.29	32.36	25.84	14.85	35.60	-20.75
4	504.71	8.61	16.88	32.35	26.14	19.28	35.60	-16.32
5	654.23	8.99	19.59	32.34	26.91	23.15	35.60	-12.45
6 pp	919.29	9.51	22.48	31.42	25.82	26.39	35.60	-9.21

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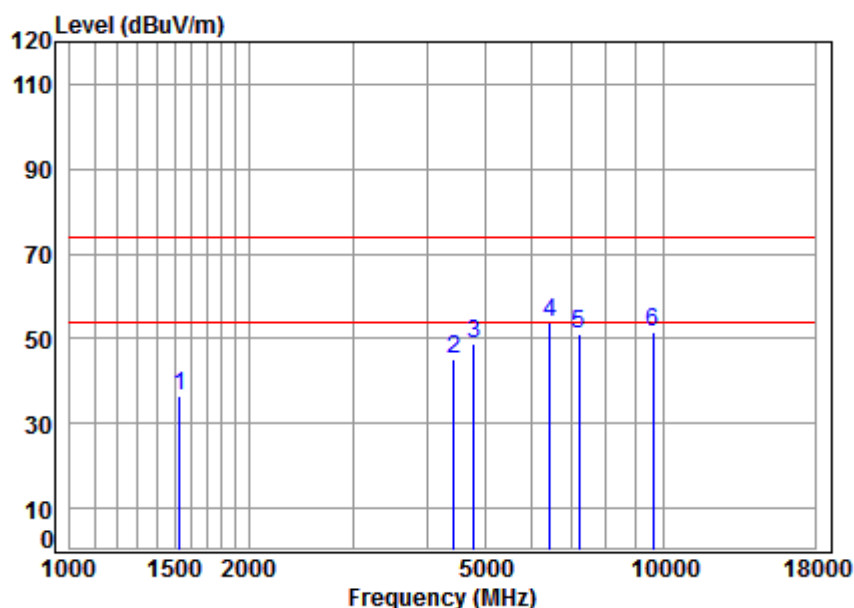
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10.6.3 Transmitter Emission above 1GHz

10.6.3.1 GFSK(DH5) _Lowest Channel_ Peak _Vertical



Site : chamber
Condition: 3m VERTICAL
Job No : 90027
Mode : 2402 TX RSE
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1529.414	5.44	25.94	41.43	46.34	36.29	74.00	-37.71	peak
2	4443.453	7.50	33.50	42.41	46.68	45.27	74.00	-28.73	peak
3	4804.000	7.89	33.97	42.47	49.26	48.65	74.00	-25.35	peak
4	6451.353	11.45	35.55	41.25	48.10	53.85	74.00	-20.15	peak
5	7206.000	10.08	36.07	40.71	45.77	51.21	74.00	-22.79	peak
6	9608.000	10.75	37.67	37.74	40.91	51.59	74.00	-22.41	peak

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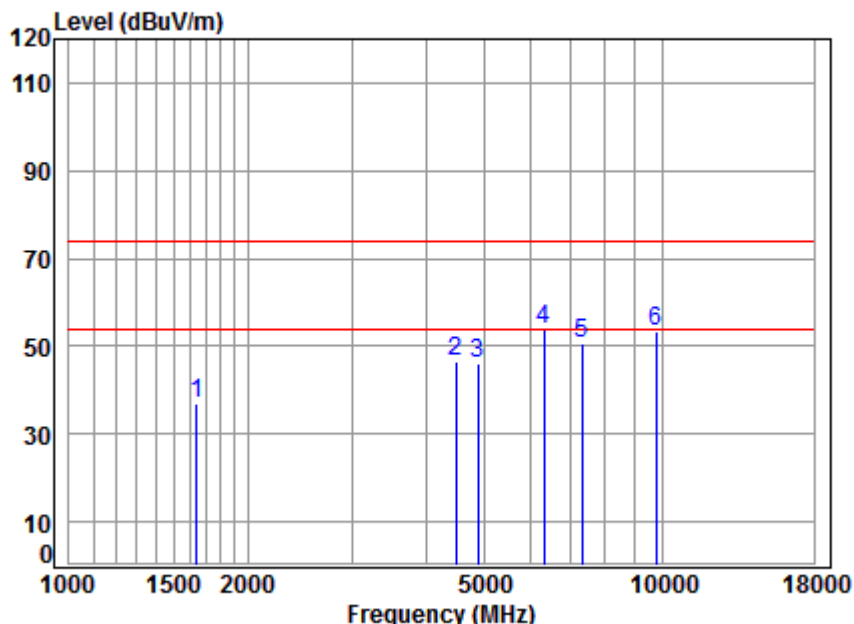
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10.6.3.2 GFSK(DH5) _Middle Channel_ Peak _Vertical



Site : chamber
Condition: 3m VERTICAL
Job No : 90027
Mode : 2441 TX RSE
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1644.019	5.30	26.44	41.50	46.88	37.12	74.00	-36.88	peak
2	4482.150	7.54	33.57	42.41	47.78	46.48	74.00	-27.52	peak
3	4882.000	7.97	34.06	42.48	46.43	45.98	74.00	-28.02	peak
4	6322.136	11.20	35.43	41.35	48.54	53.82	74.00	-20.18	peak
5	7323.000	10.05	36.16	40.63	44.84	50.42	74.00	-23.58	peak
6	9764.000	10.82	37.76	37.52	42.17	53.23	74.00	-20.77	peak

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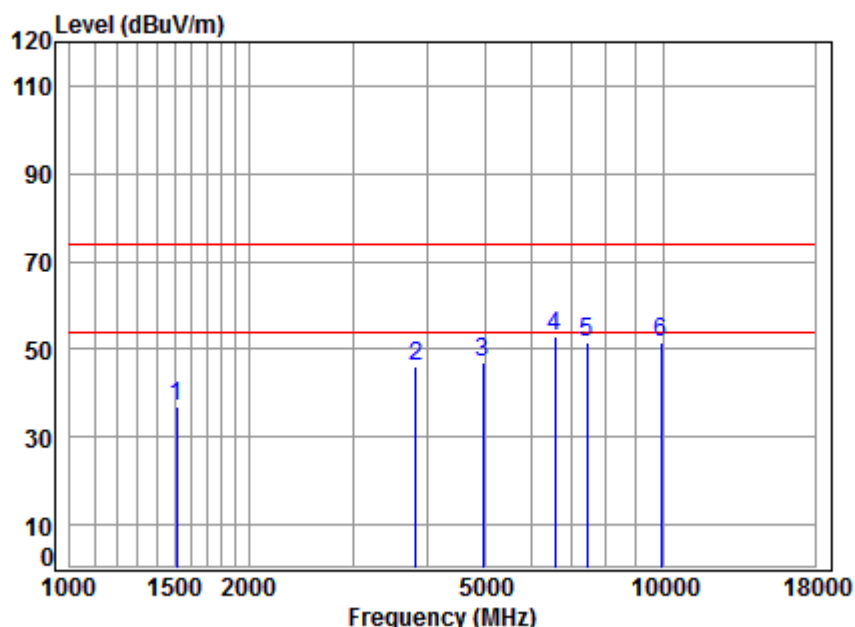
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10.6.3.3 GFSK(DH5) _Highest Channel_ Peak _Vertical



Site : chamber
Condition: 3m VERTICAL
Job No : 90027
Mode : 2480 TX RSE
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1511.833	5.46	25.85	41.41	47.03	36.93	74.00	-37.07	peak
2	3834.438	6.82	32.38	42.29	49.11	46.02	74.00	-27.98	peak
3	4960.000	8.05	34.15	42.49	47.33	47.04	74.00	-26.96	peak
4	6564.209	11.35	35.64	41.17	47.26	53.08	74.00	-20.92	peak
5	7440.000	10.02	36.25	40.56	45.68	51.39	74.00	-22.61	peak
6	9920.000	10.90	37.85	37.31	40.30	51.74	74.00	-22.26	peak

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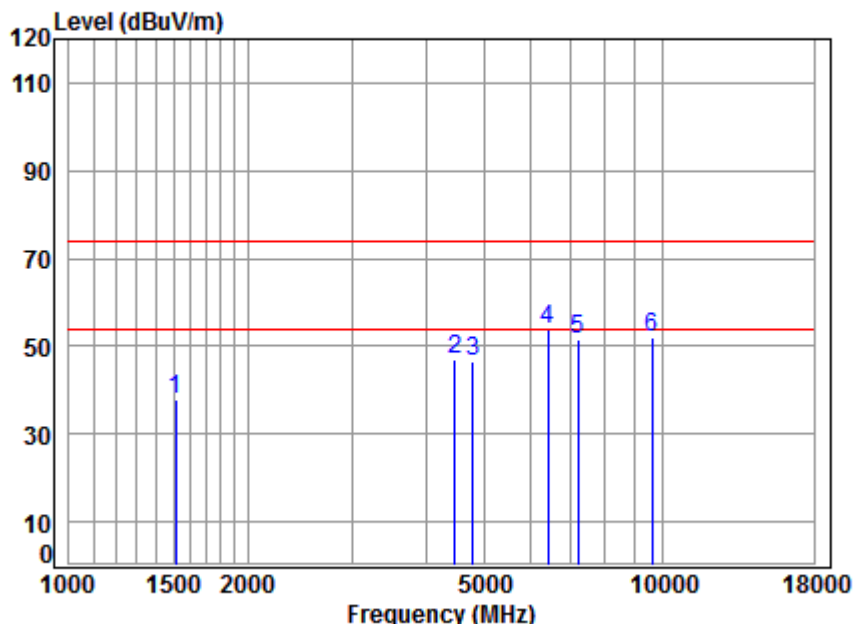
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10.6.3.4 GFSK(DH5) _Lowest Channel_ Peak _Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No : 90027
Mode : 2402 TX RSE
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1511.833	5.46	25.85	41.41	48.15	38.05	74.00	-35.95	peak
2	4469.214	7.53	33.55	42.41	48.53	47.20	74.00	-26.80	peak
3	4804.000	7.89	33.97	42.47	47.18	46.57	74.00	-27.43	peak
4	6414.167	11.38	35.52	41.28	48.14	53.76	74.00	-20.24	peak
5	7206.000	10.08	36.07	40.71	46.18	51.62	74.00	-22.38	peak
6	9608.000	10.75	37.67	37.74	41.26	51.94	74.00	-22.06	peak

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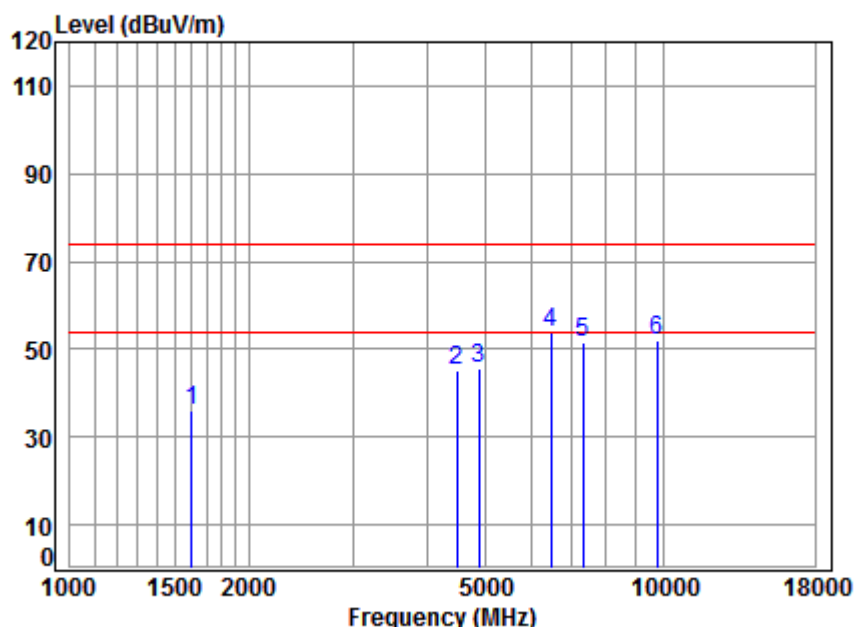
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10.6.3.5 GFSK(DH5) _Middle Channel_ Peak _ Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No : 90027
Mode : 2441 TX RSE
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1601.804	5.35	26.26	41.47	46.07	36.21	74.00	-37.79	peak
2	4482.150	7.54	33.57	42.41	46.26	44.96	74.00	-29.04	peak
3	4882.000	7.97	34.06	42.48	45.93	45.48	74.00	-28.52	peak
4	6470.026	11.48	35.57	41.24	47.94	53.75	74.00	-20.25	peak
5	7323.000	10.05	36.16	40.63	46.17	51.75	74.00	-22.25	peak
6	9764.000	10.82	37.76	37.52	40.95	52.01	74.00	-21.99	peak

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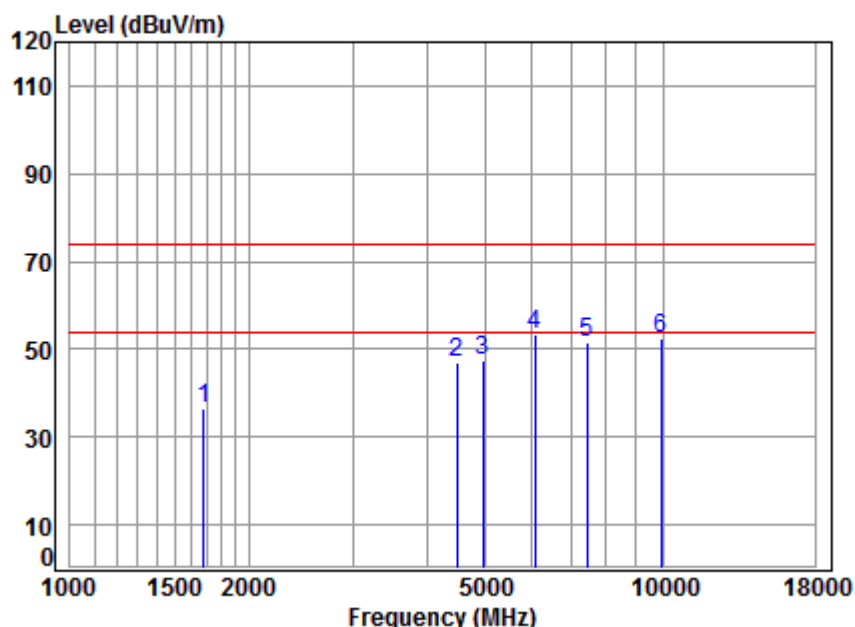
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10.6.3.6 GFSK(DH5) _Highest Channel_ Peak _ Horizontal



Site : chamber
Condition: 3m HORIZONTAL
Job No : 90027
Mode : 2480 TX RSE
Note : BT

	Freq	Cable Loss	Ant Factor	Preamp Factor	Read Level	Level	Limit Line	Over Limit	Remark
	MHz	dB	dB/m	dB	dBuV	dBuV/m	dBuV/m	dB	
1	1682.477	5.25	26.60	41.52	46.18	36.51	74.00	-37.49	peak
2	4482.150	7.54	33.57	42.41	48.08	46.78	74.00	-27.22	peak
3	4960.000	8.05	34.15	42.49	47.95	47.66	74.00	-26.34	peak
4	6071.417	10.71	35.17	41.55	49.03	53.36	74.00	-20.64	peak
5	7440.000	10.02	36.25	40.56	45.93	51.64	74.00	-22.36	peak
6	9920.000	10.90	37.85	37.31	41.01	52.45	74.00	-21.55	peak

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Remark:

1) The field strength is calculated by adding the Antenna Factor, Cable Factor & Preamplifier. The basic equation with a sample calculation is as follows:

Final Test Level = Receiver Reading + Antenna Factor + Cable Factor – Preamplifier Factor

2) Scan from 9kHz to 25GHz, the disturbance between 9KHz to 30MHz and 18GHz to 25GHz was very low, and the above harmonics were the highest point could be found when testing, The amplitude of spurious emissions from the radiator which are attenuated more than 20dB below the limit need not be reported.

3) As shown in this section, for frequencies above 1GHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation. So, only the peak measurements were shown in the report.

4) All Modes have been tested, but only the worst case data displayed in this report.

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11 FREQUENCY SEPARATION

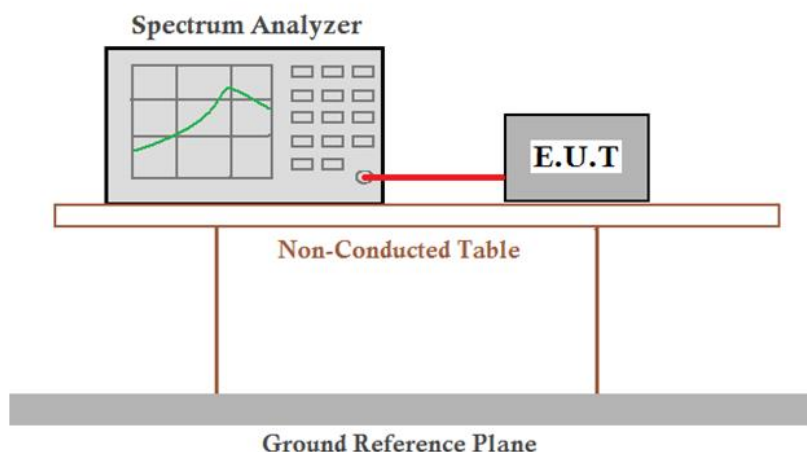
11.1 Standard Applicable

Frequency hopping systems shall have hopping channel carrier frequencies separated by minimum of 25 kHz or the $2/3 \times 20\text{dB}$ bandwidth of the hopping channel, whichever is greater.

11.2 Measurement Equipment Used

RF conducted test					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Duedate
				(yyyy-mm-dd)	(yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	2018/9/15	2019/9/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2018/3/13	2019/3/12
Coaxial Cable	SGS	N/A	SEM031-01	2018/7/13	2019/7/12
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018/9/2	2019/9/2
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2018/11/27	2019/11/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018/9/2	2019/9/2

11.3 Test Set-up



11.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = middle of hopping channel.
5. Set the spectrum analyzer as RBW=30 kHz, VBW=100 kHz, Adjust Span to 3MHz, Sweep = auto.
6. Max hold. Mark 2 Peaks of hopping channel and record the 2 peaks frequency.

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11.5 Measurement Result

GFSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Middle	1001	543.5	Pass
$\pi/4$ DQPSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Middle	1001	835.1	Pass
8DPSK mode			
Test channel	Carrier Frequencies Separation (kHz)	Limit (kHz)	Result
Middle	1001	809.2	Pass

Mode	20dB bandwidth (kHz) (worse case)	Limit (kHz) (Carrier Frequencies Separation)
GFSK	815.2	543.5
$\pi/4$ DQPSK	1252.7	835.1
8DPSK	1213.8	809.2

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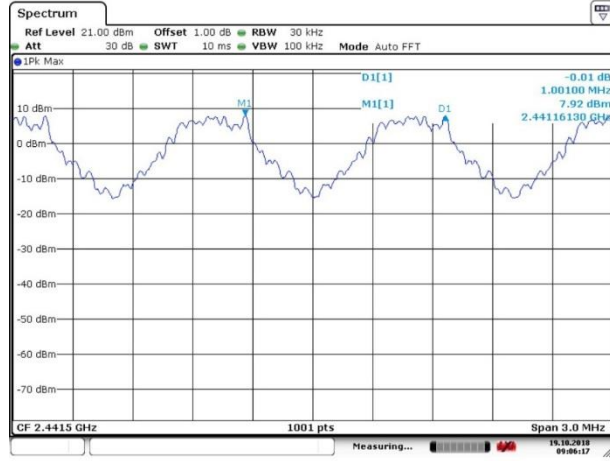
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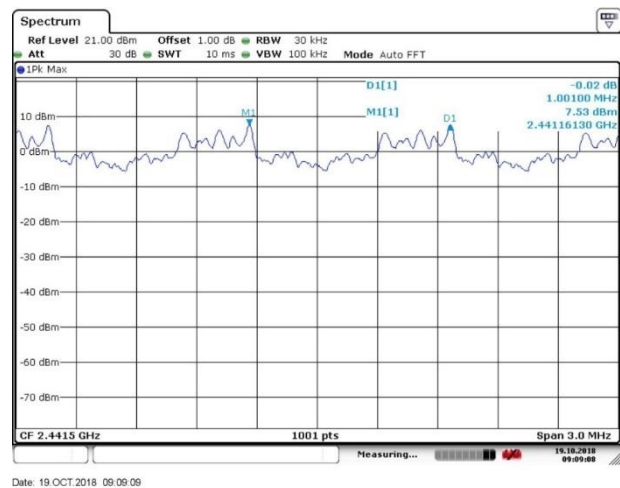
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11.6 Frequency Separation Test Data

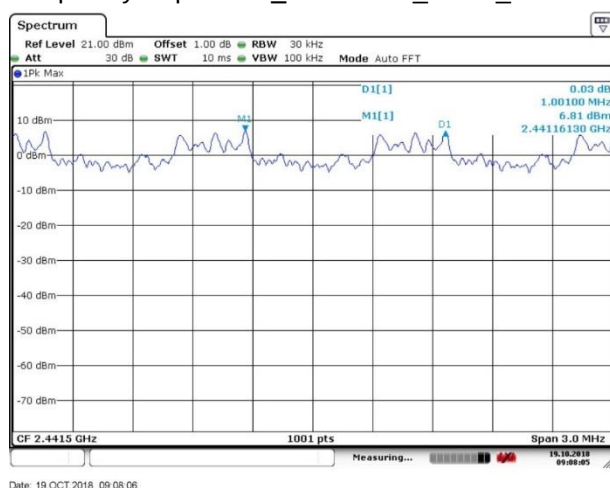
Frequency Separation_GFSK_DH5_Mid Ch



Frequency Separation_8DPSK_3DH5_Mid Ch



Frequency Separation_π4DQPSK_2DH5_Mid Ch



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12 NUMBER OF HOPPING FREQUENCY

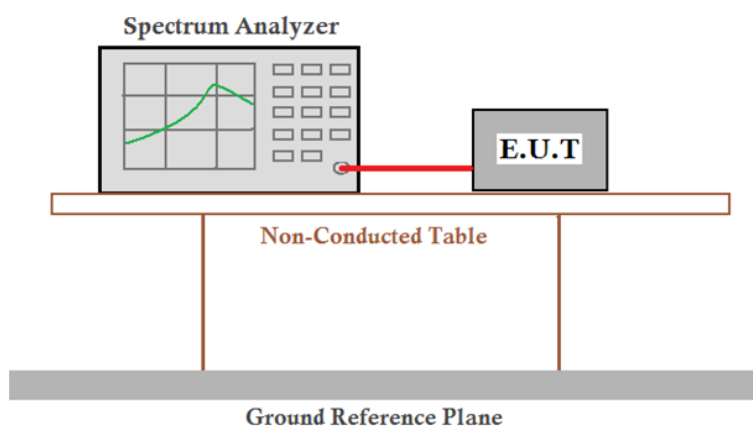
12.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5 MHz bands shall use at least 15 hopping frequencies.

12.2 Measurement Equipment Used

RF conducted test					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Duedate
				(yyyy-mm-dd)	(yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	2018/9/15	2019/9/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2018/3/13	2019/3/12
Coaxial Cable	SGS	N/A	SEM031-01	2018/7/13	2019/7/12
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018/9/2	2019/9/2
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2018/11/27	2019/11/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018/9/2	2019/9/2

12.3 Test Set-up



12.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C63.10:2013.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set spectrum analyzer Start=2400MHz, Stop = 2483.5MHz, Sweep = auto.
5. Set the spectrum analyzer as RBW=100kHz, VBW=300MHz., Detector = Peak
6. Max hold, view and count how many channel in the band.

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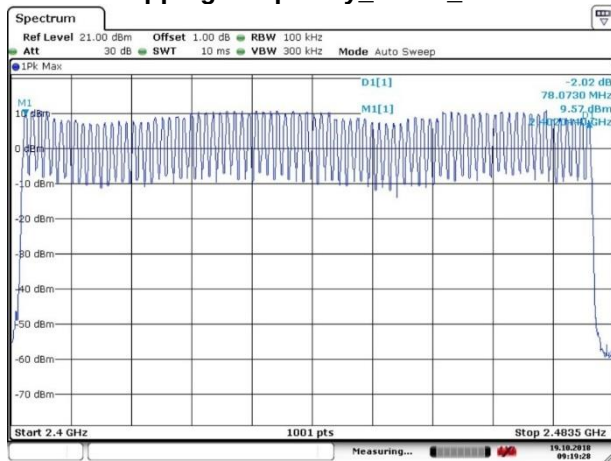
12.5 Measurement Result

12.5.1 Tabular Data of Total Channel Number

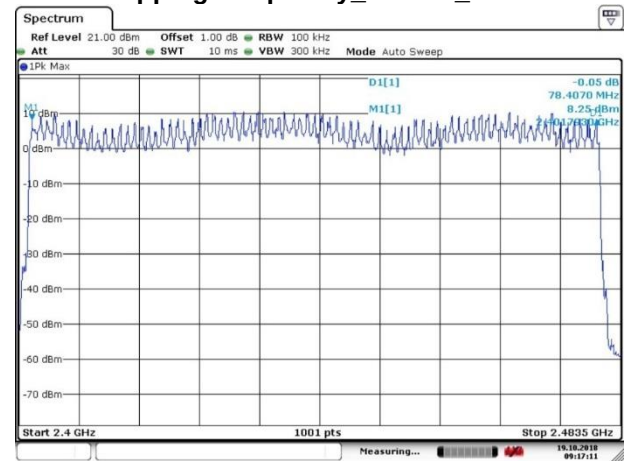
Mode	Hopping channel numbers	Limit
GFSK	79	≥15
$\pi/4$ DQPSK	79	≥15
8DPSK	79	≥15

12.5.2 Channel Number

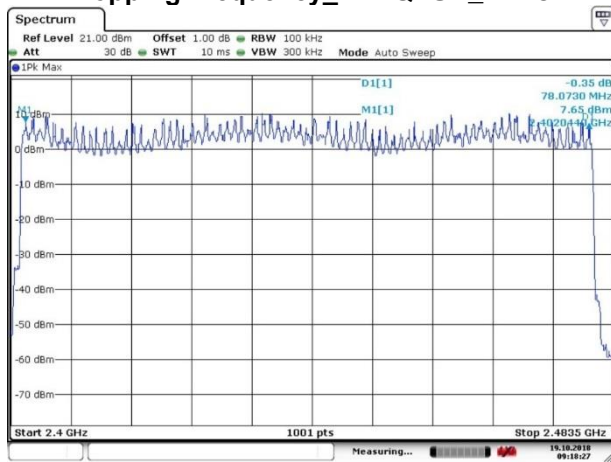
Hopping Frequency_GFSK_DH5



Hopping Frequency_8DPSK_3DH5



Hopping Frequency_π4DQPSK_2DH5



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13 TIME OF OCCUPANCY (DWELL TIME)

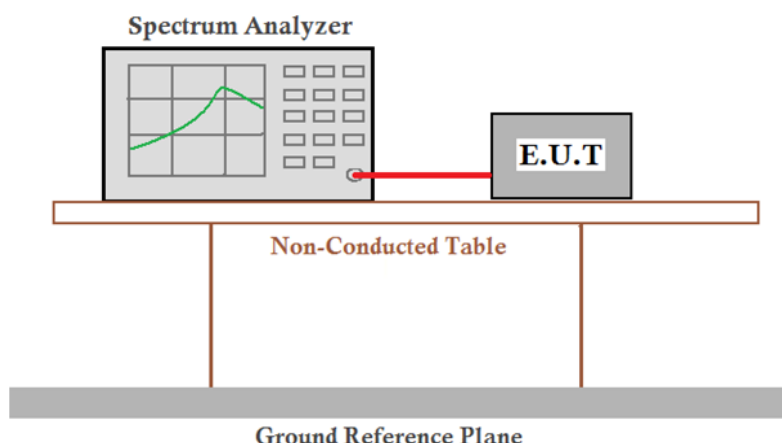
13.1 Standard Applicable

Frequency hopping systems operating in the 2400MHz-2483.5MHz. The average time of occupancy on any frequency shall not greater than 0.4 s within period of 0.4 seconds multiplied by the number of hopping channel employed.

13.2 Measurement Equipment Used

RF conducted test					
Test Equipment	Manufacturer	Model No.	Inventory No.	Cal. date	Cal.Duedate
				(yyyy-mm-dd)	(yyyy-mm-dd)
DC Power Supply	Agilent Technologies Inc	66311B	W009-09	2018/9/15	2019/9/15
Signal Analyzer	Rohde & Schwarz	FSV	W025-05	2018/3/13	2019/3/12
Coaxial Cable	SGS	N/A	SEM031-01	2018/7/13	2019/7/12
Attenuator	Weinschel Associates	WA41	SEM021-09	N/A	N/A
Signal Generator	KEYSIGHT	N5173B	SEM006-05	2018/9/2	2019/9/2
Temperature Chamber	GIANT FORCE	ICT-150-40-CP-AR	W027-03	2018/11/27	2019/11/27
Power Meter	Rohde & Schwarz	NRVS	SEM014-02	2018/9/2	2019/9/2

13.3 Test Set-up



13.4 Measurement Procedure

1. Place the EUT on the table and set it in transmitting mode.
2. The testing follows ANSI C6310:2015.
3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
4. Set center frequency of spectrum analyzer = operating frequency.
5. Set the spectrum analyzer as RBW and VBW=1MHz, Span = 0Hz , Detector = Peak, Adjust Sweep = 0.7~5ms.
6. Repeat above procedures until all frequency of the interest measured were complete.

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13.5 Result of the Measurement

Operation Modes	On time (ms) on one channel
DH1	0.390
DH3	1.658
DH5	2.908
2-DH1	0.399
2-DH3	1.661
2-DH5	2.908
3-DH1	0.398
3-DH3	1.658
3-DH5	2.923

Bluetooth Time of Occupancy Calculation

Typically, Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s, since 1x/EDR modes use 5 transmit and 1 receive slot, for a total of 6 slots, the Bluetooth transmitter is actually hopping at a rate of $1600/6=266.67$ hops/slot

$400\text{ms} \times 79 \text{ Channel} = 31.6 \text{ s}$ (Time of Occupancy Limit)

Worst case BT has 266.67 hops/second (for 1x/EDR modes with 3-DH5 operation)

$266.67 \text{ hops/second} / 79 \text{ channels} = 3.38 \text{ hops/second}$ (# of hops/second on one channel)

$3.38 \text{ hops/second/channel} \times 31.6 \text{ seconds} = 106.67 \text{ hops}$ (#hops over a 31.6 second period)

$106.67 \text{ hops} \times 2.923 \text{ ms/channel} = 311.80 \text{ ms}$ (worst case dwell time for one channel in 1x/EDR modes)

With AFH, the number of channels is reduced to a minimum of 20 channels and the channel hopping rate is reduced by 50% to 800hops/s, AFH mode also uses 6 slots so the Bluetooth transmitter hops at a rate of $800/6=133.3$ hops/s/slot

$400\text{ms} \times 20 \text{ Channel} = 8 \text{ s}$ (Time of Occupancy Limit)

Worst case BT has 133.3 hops/second/slot (for AFH mode with 3-DH5 operation)

$133.3 \text{ hops/second} / 20 \text{ channels} = 6.67 \text{ hops/second}$ (#hops/second on one channel)

$6.67 \text{ hops/second} \times 8 \text{ seconds} = 53.34 \text{ hops}$ (#hops over a 8 seconds period)

$53.34 \text{ hops} \times 2.923 \text{ ms/channel} = 155.91 \text{ ms}$ (worst case dwell time for one channel in AFH mode)

13.6 Measurement Result

Note: Refer to next page for plots.

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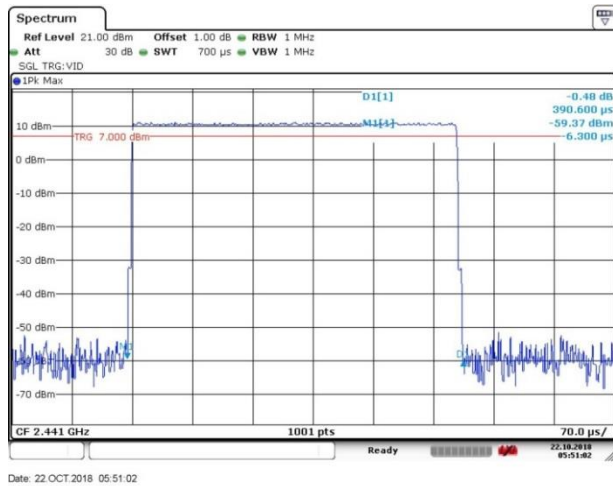
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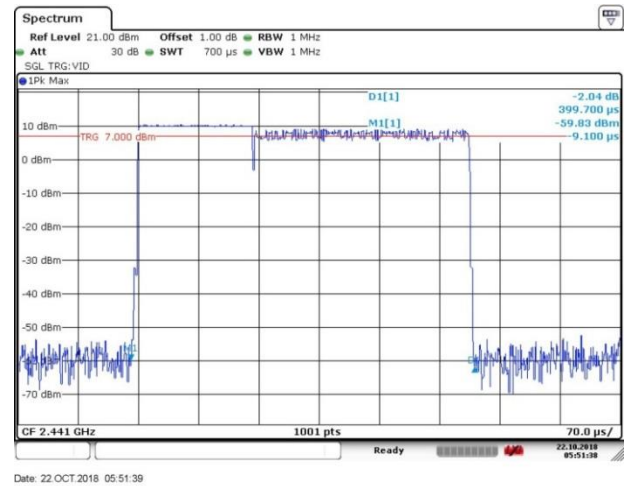
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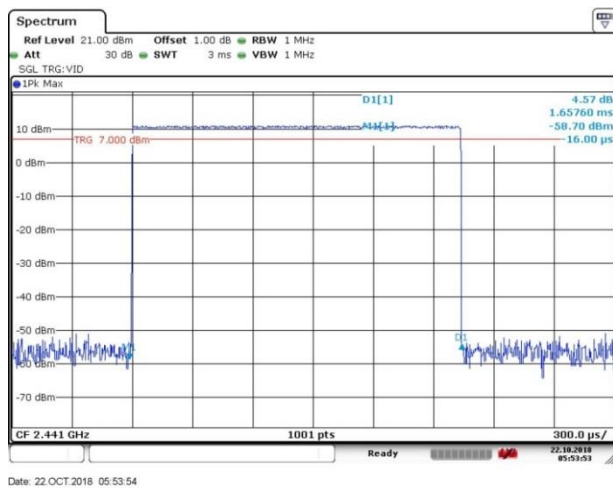
Dwell Time_DH1



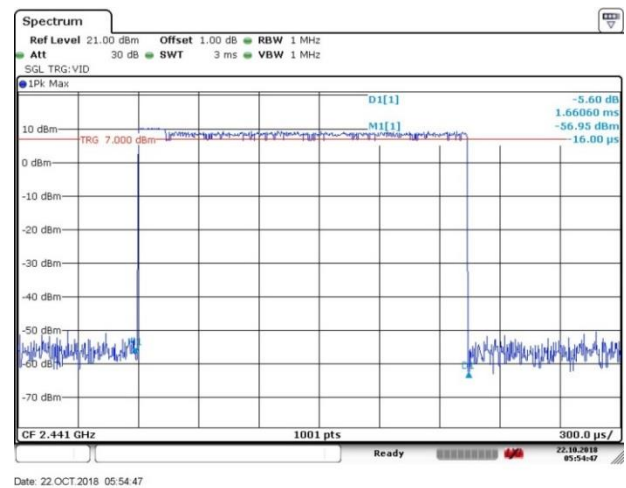
Dwell Time_2DH1



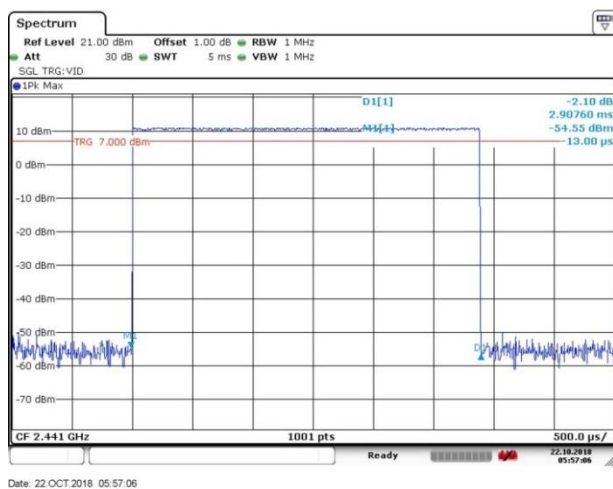
Dwell Time_DH3



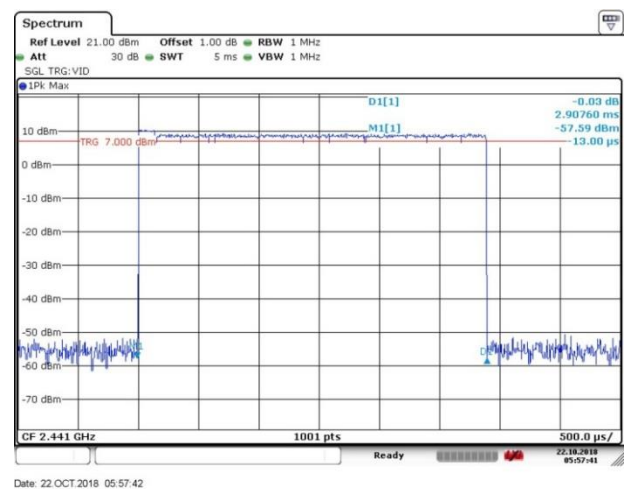
Dwell Time_2DH3



Dwell Time_DH5



Dwell Time_2DH5



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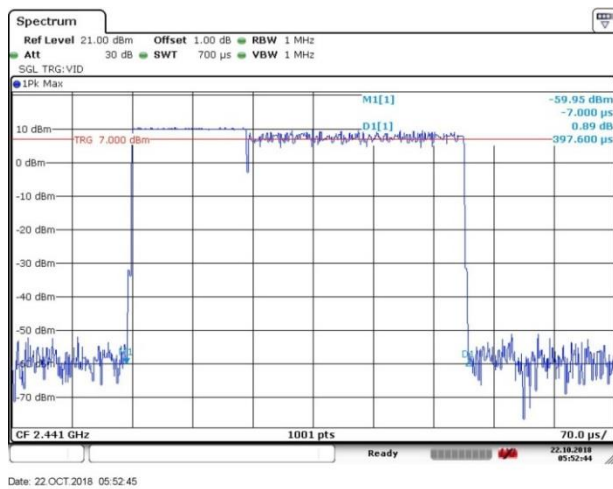
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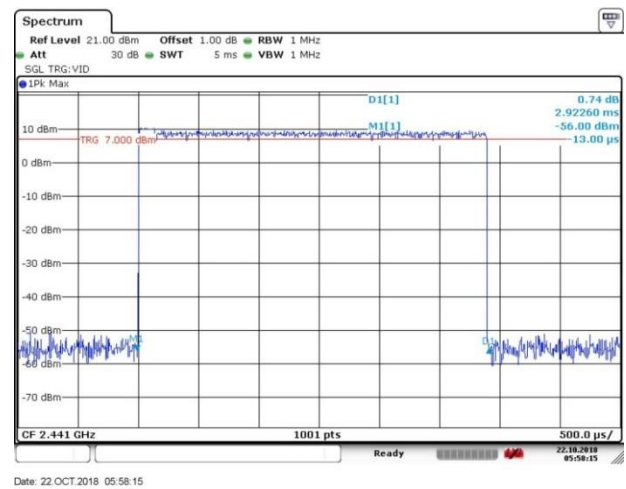
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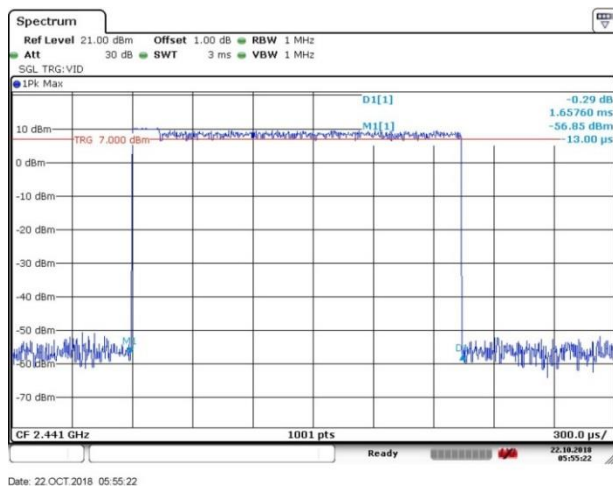
Dwell Time_3DH1



Dwell Time_3DH5



Dwell Time_3DH3



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14 ANTENNA REQUIREMENT

14.1 Standard Applicable

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

14.2 Antenna Connected Construction

The antenna is designed as permanently attached and no consideration of replacement. Please see EUT photo for details.

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15 PHOTOGRAPHS - EUT TEST SETUP DETAILS

Refer to Appendix A - Photographs of EUT Test Setup Details for ZR/2018/A0011.

~ End of Report ~

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