

TEST DATA

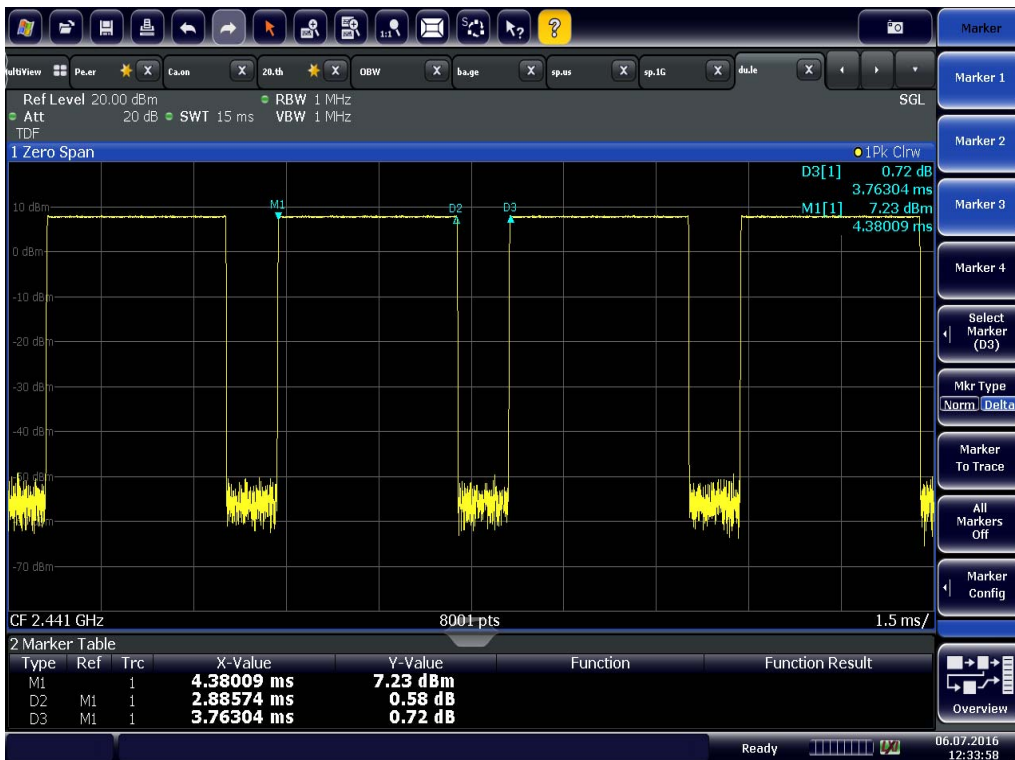
8.5 Transmitter Average Time of Occupancy

FCC §15.247(a)(1), IC RSS-247 Issue 1, 5.1(4)

Test mode : Set to Hopping mode

Result

Mode	Pulse width (ms)	*)Numbers of slots	**)Average time of Occupancy (ms)	Limit (ms)	Margin (ms)
1x/EDR	2.89	106.7	308.4	≤ 400	91.6
AFH	2.89	53.3	154.1	≤ 400	245.9



1x/EDR mode

- 1) This result was measured at DH5 mode in **1x/EDR mode**, which has longest time in one transmission burst.
- 2) Bluetooth 1x/EDR mode has a channel hopping rate of 1600 hops/s and 79 hopping channels.
- 3) The average time of occupancy in the specified 31.6 second period (79 channels x 0.4 s) is equal to pulse width x (hopping rate / 6) / 79 x (0.4 x hopping channels).
- 4) *) Numbers of slots in 31.6 sec = $(1600 / 6) / 79 \times 31.6$
- 5) **) Average time of Occupancy = $2.89 \text{ ms} \times 106.7 = 308.4 \text{ ms}$

AFH mode

- 1) This result was measured at DH5 mode in **AFH mode**, which has longest time in one transmission burst.
- 2) Bluetooth AFH mode has a channel hopping rate of 800 hops/s and 20 hopping channels.
- 3) The average time of occupancy in the specified 8 second period (20 channels x 0.4 s) is equal to pulse width x (hopping rate / 6) / 20 x (0.4 x hopping channels).
- 4) *) Numbers of slots in 20 sec = $(800 / 6) / 20 \times 8$
- 5) **) Average time of Occupancy = $2.89 \text{ ms} \times 53.33 = 154.1 \text{ ms}$

TEST DATA

8.6 Number of Hopping Channels

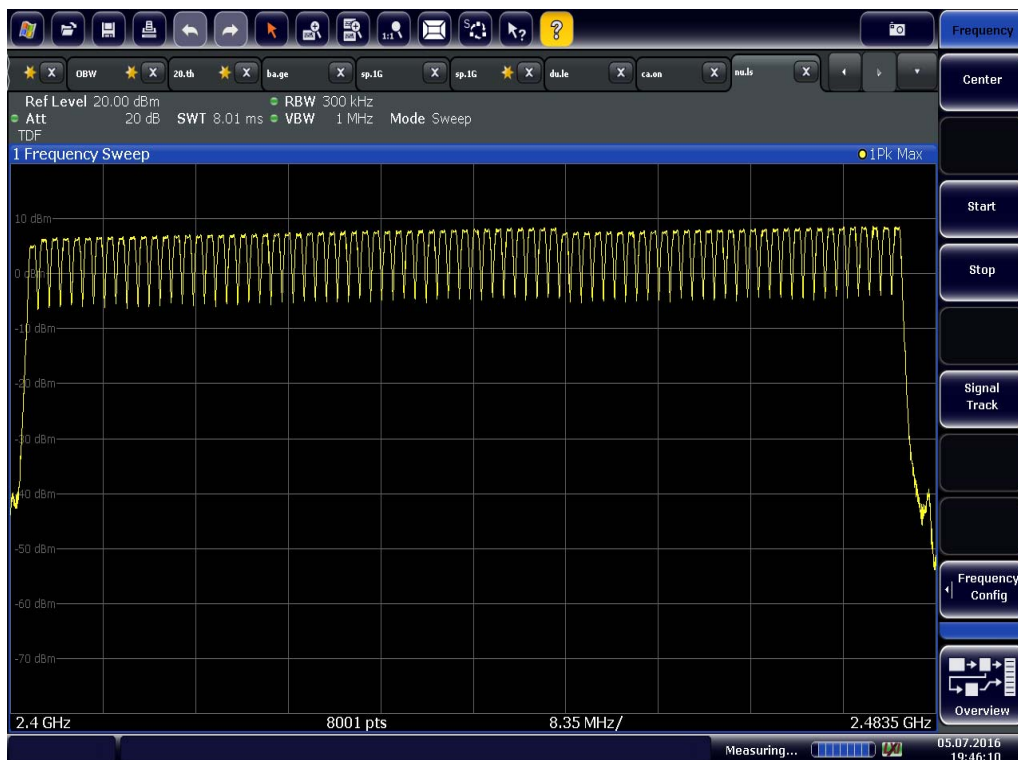
FCC §15.247(a)(1)(iii), IC RSS-247 Issue 1, 5.1(4)

Test mode : Set to Hopping mode

Result

The EUT complies with the minimum number of hopping channels when it is operating **1x/EDR mode using 79 channels** and when operating in **AFH mode using 20 channels**.

GFSK mode



TEST DATA

8.7 Peak Output Power and E.I.R.P

FCC §15.247(b)(1), IC RSS-247 Issue 1, 5.4(2)

Test Mode : Set to Lowest channel, Middle channel and Highest channel

Result

Modulation	Frequency (MHz)	Peak Power (dBm)	Limit (dBm)	E.I.R.P* (dBm)	E.I.R.P Limit (dB)	Result
GFSK	2402	5.39	30.00	5.39	36.00	Complies
GFSK	2441	8.09	30.00	8.09	36.00	Complies
GFSK	2480	8.61	30.00	8.61	36.00	Complies
$\pi/4$ DQPSK	2402	3.28	30.00	3.28	36.00	Complies
$\pi/4$ DQPSK	2441	6.61	30.00	6.61	36.00	Complies
$\pi/4$ DQPSK	2480	7.16	30.00	7.16	36.00	Complies
8DPSK	2402	3.64	30.00	3.64	36.00	Complies
8DPSK	2441	6.88	30.00	6.88	36.00	Complies
8DPSK	2480	7.46	30.00	7.46	36.00	Complies

Note:

The following formular was used for spectrum offset:

$Spectrum\ offset\ (dB) = Attenuator\ (dB) + Cable\ Loss\ (dB) + SMA\ Type\ Connector\ Loss\ (dB)$

*) E.I.R.P was calculated by following equation according to KDB412172 D01 Determining ERP and EIRP v01

$$E.I.R.P = P_T + G_T - L_C$$

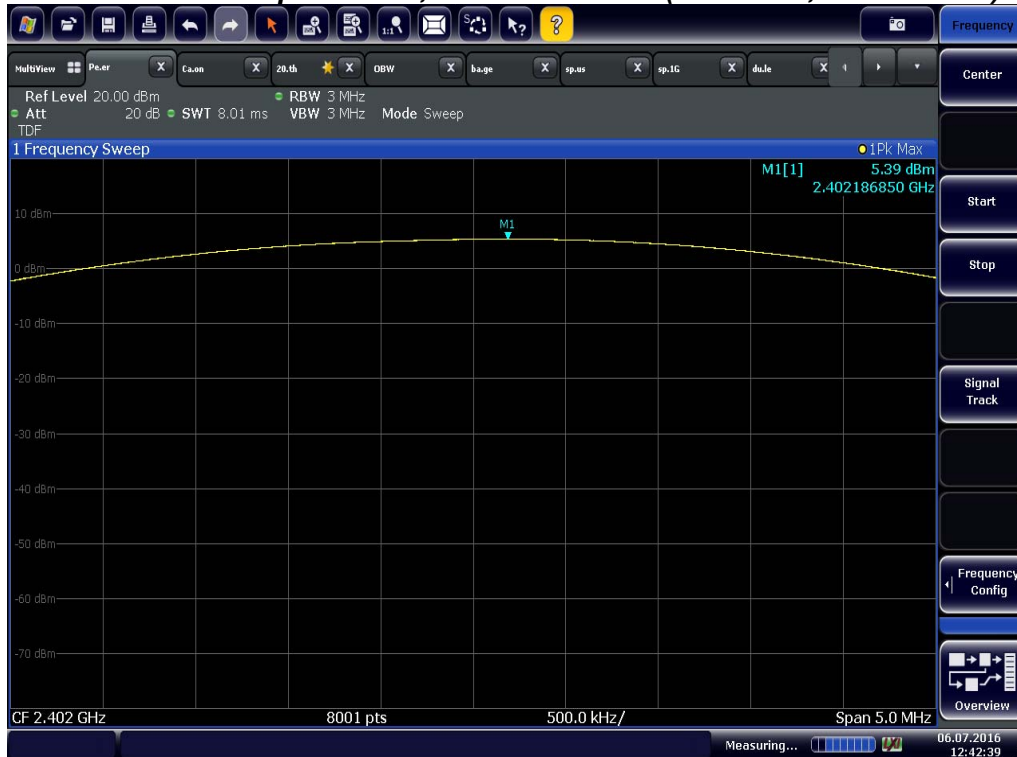
$P_T =$ Peak outputpower (dBm)

$G_T =$ Gain of the transmitting antenna in dBi, Peak antenna gain is 0 dBi.

$L_C =$ Signal attenuation in the connecting cable between the transmitter and antenna in dB. This factor of an integral antenna is negligible.

PLOT OF TEST DATA

Maximum Peak Output Power, Lowest channel (2402 MHz, GFSK mode)

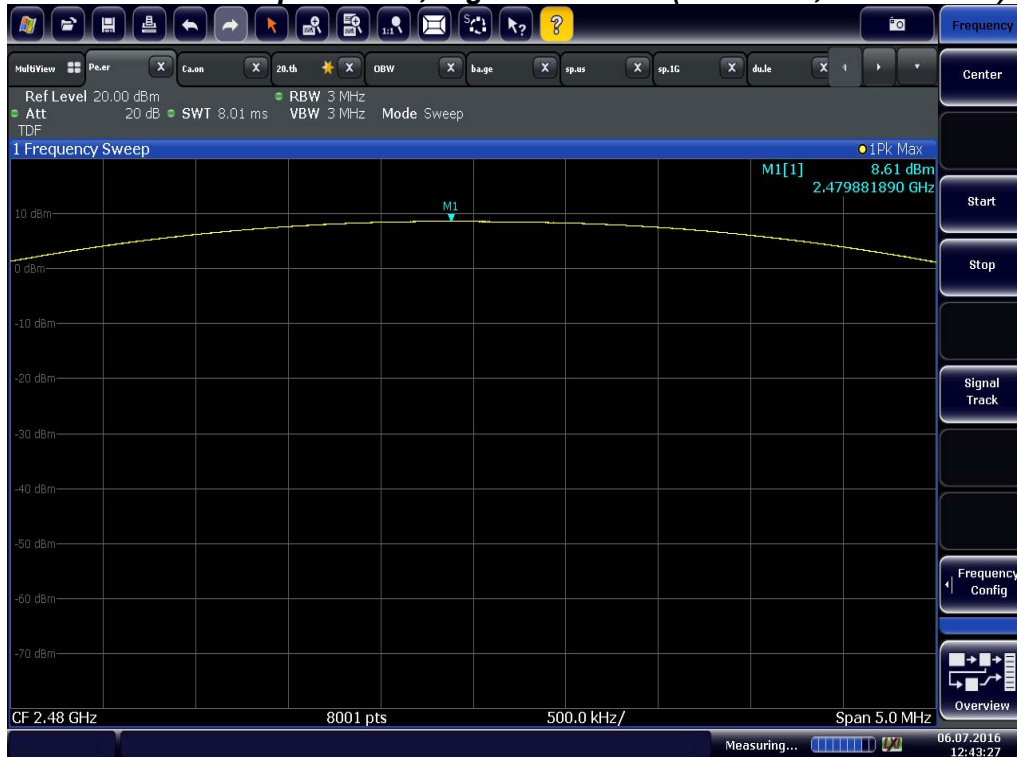


Maximum Peak Output Power, Middle channel (2441 MHz, GFSK mode)

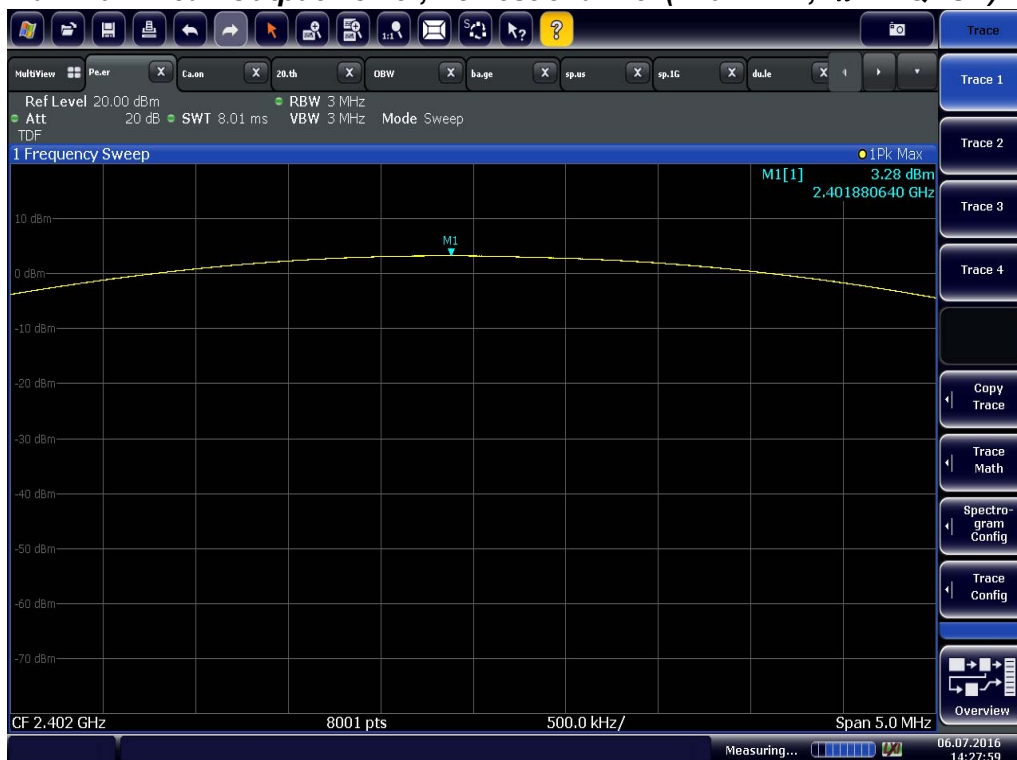


PLOT OF TEST DATA

Maximum Peak Output Power, Highest channel (2480 MHz, GFSK mode)

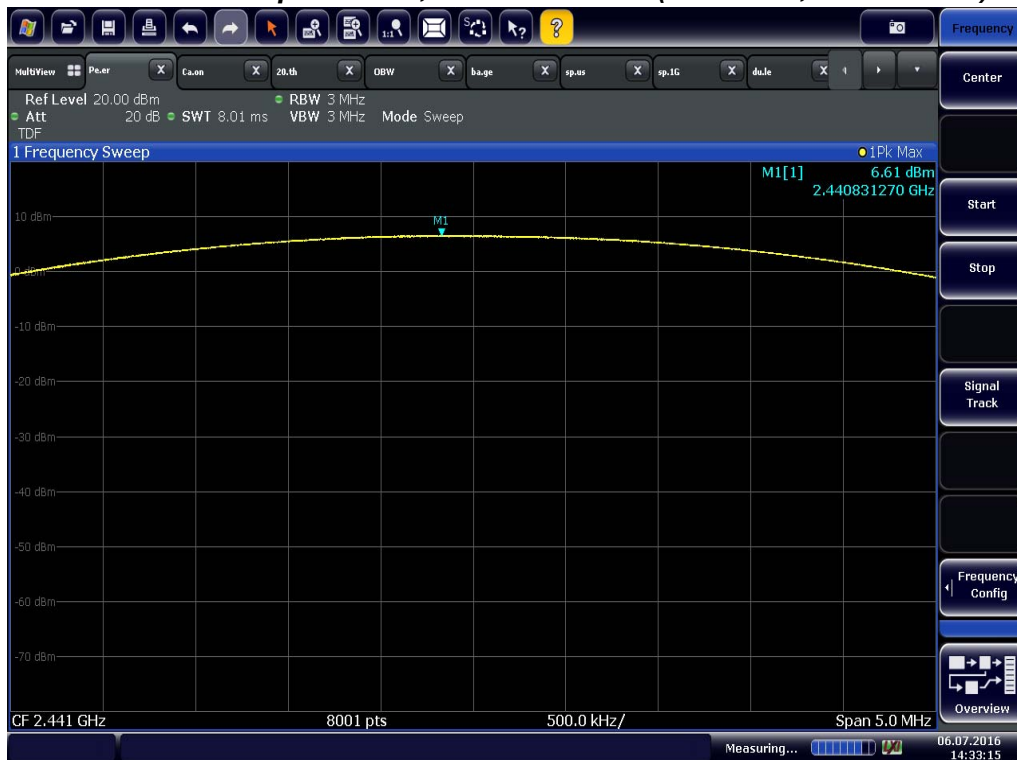


Maximum Peak Output Power, Lowest channel (2402 MHz, $\pi/4$ QPSK)



PLOT OF TEST DATA

Maximum Peak Output Power, Middle channel (2441 MHz, $\pi/4$ DQPSK)



Maximum Peak Output Power, Highest channel (2480 MHz, $\pi/4$ DQPSK)



PLOT OF TEST DATA

Maximum Peak Output Power, Lowest channel (2402 MHz, 8DPSK)

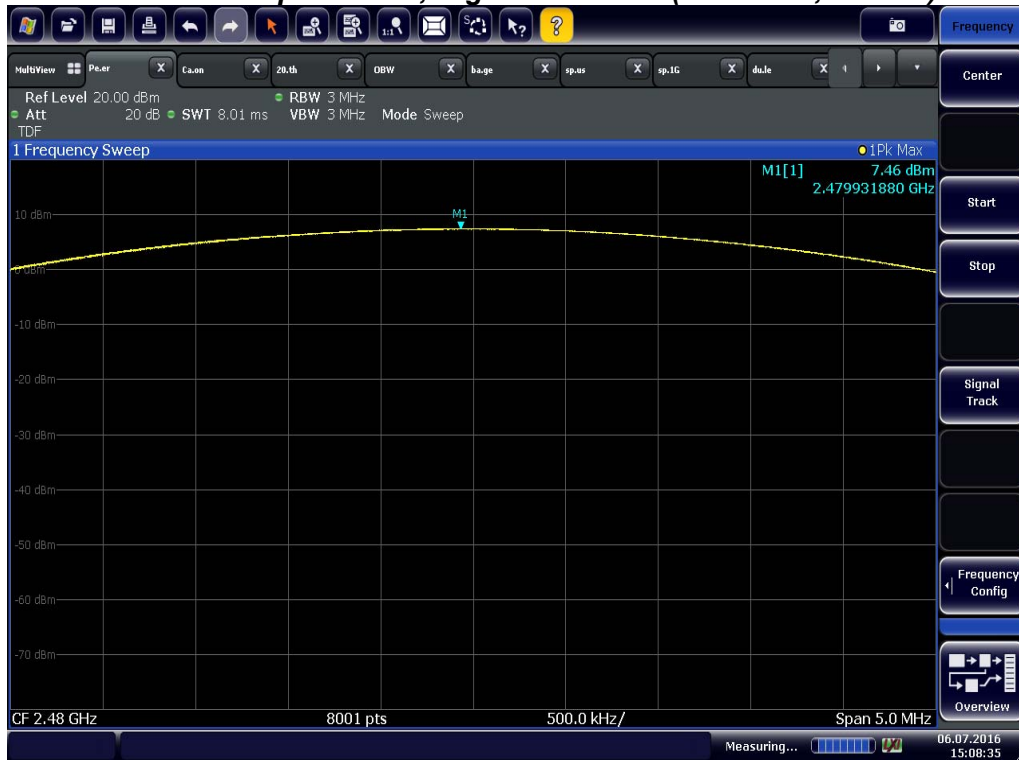


Maximum Peak Output Power, Middle channel (2441 MHz, 8DPSK)



PLOT OF TEST DATA

Maximum Peak Output Power, Highest channel (2480 MHz, 8DPSK)



TEST DATA

8.8 Conducted Spurious Emission

FCC §15.247(d), IC RSS-247 Issue 1, 5.5

Test Mode : Set to Lowest channel, Middle channel and Highest channel

Result

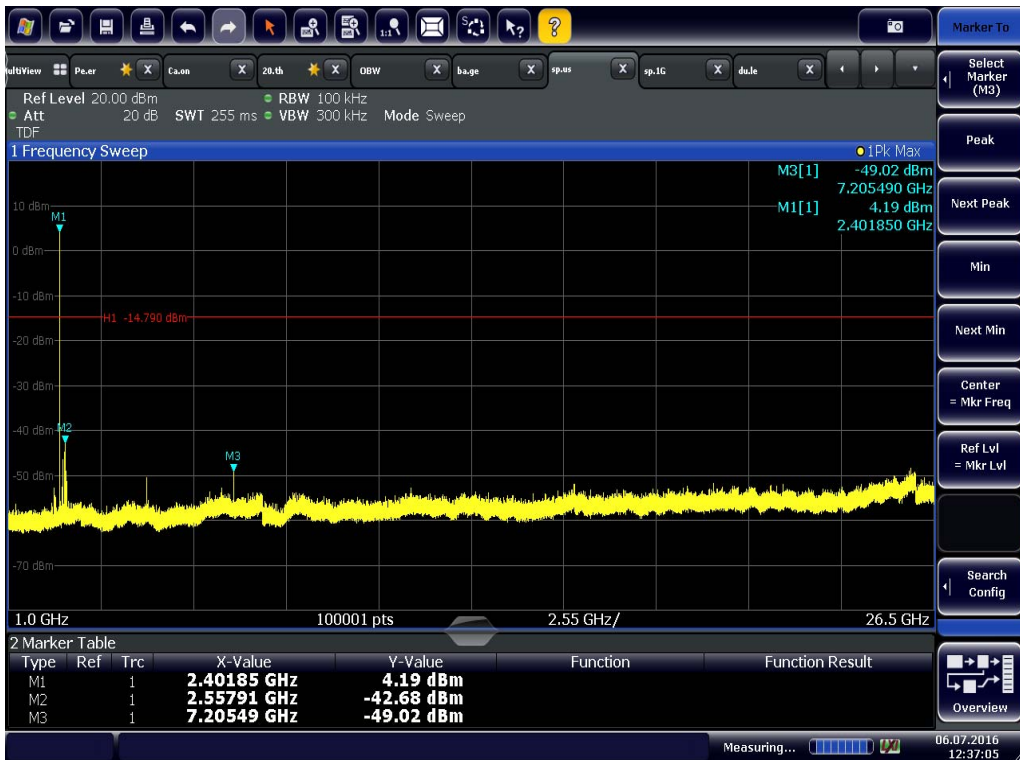
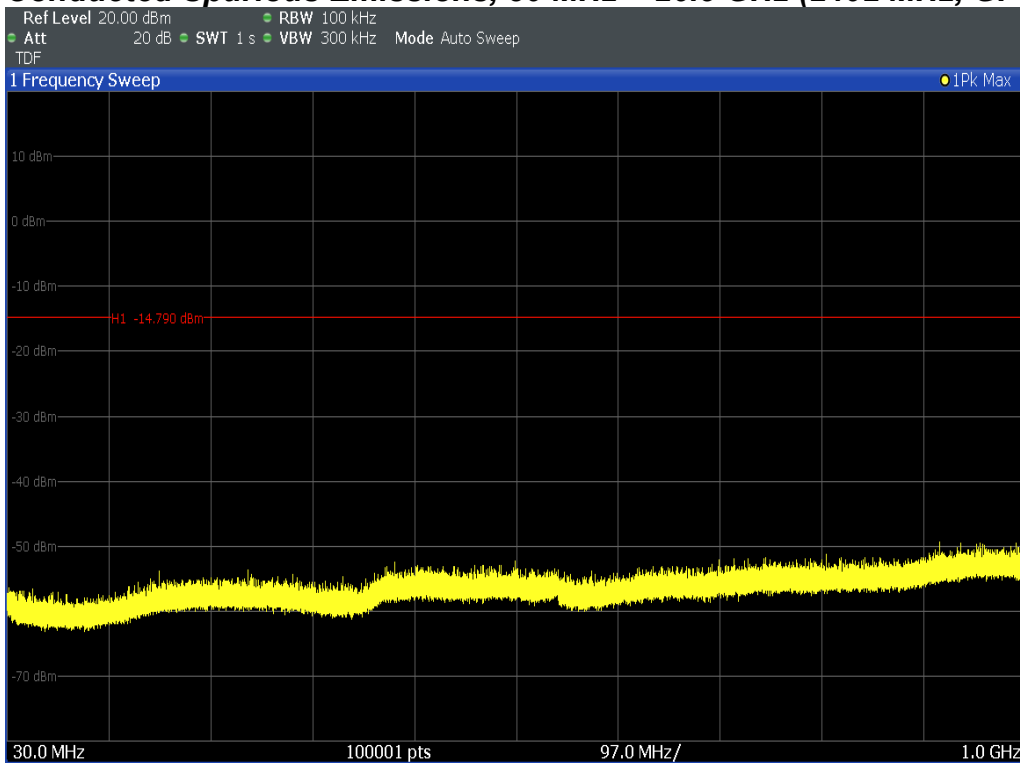
Modulation Mode	Frequency (MHz)	Result	Limit (dBc)
GFSK	2402	More than 20 dBc	20
GFSK	2441	More than 20 dBc	20
GFSK	2480	More than 20 dBc	20
$\pi/4$ DQPSK	2402	More than 20 dBc	20
$\pi/4$ DQPSK	2441	More than 20 dBc	20
$\pi/4$ DQPSK	2480	More than 20 dBc	20
8DPSK	2402	More than 20 dBc	20
8DPSK	2441	More than 20 dBc	20
8DPSK	2480	More than 20 dBc	20

Note:

The cable and attenuator loss from 30 MHz to 26.5 GHz was reflected in spectrum analyzer with correction factor for the spurious emissions test.

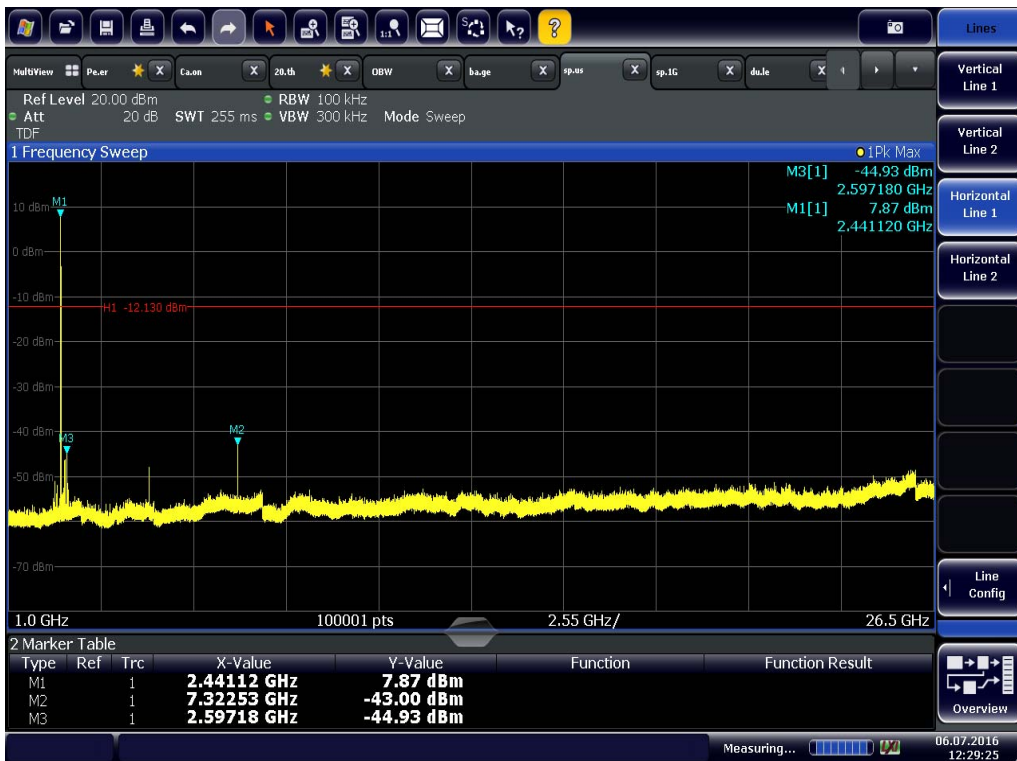
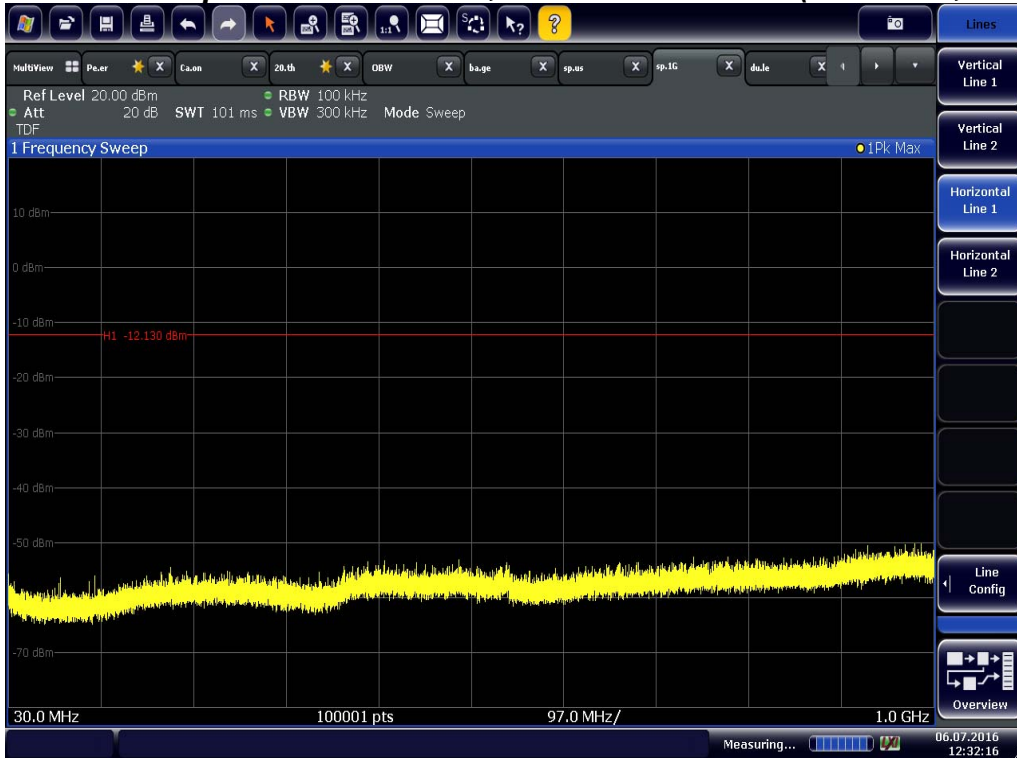
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz (2402 MHz, GFSK Mode)



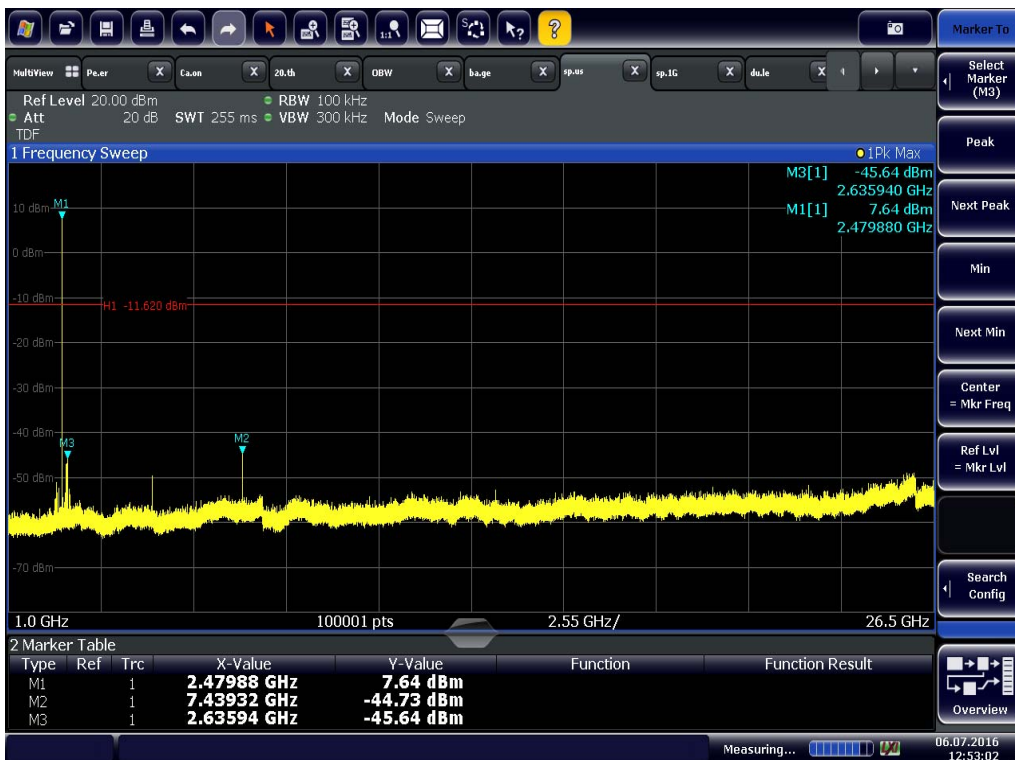
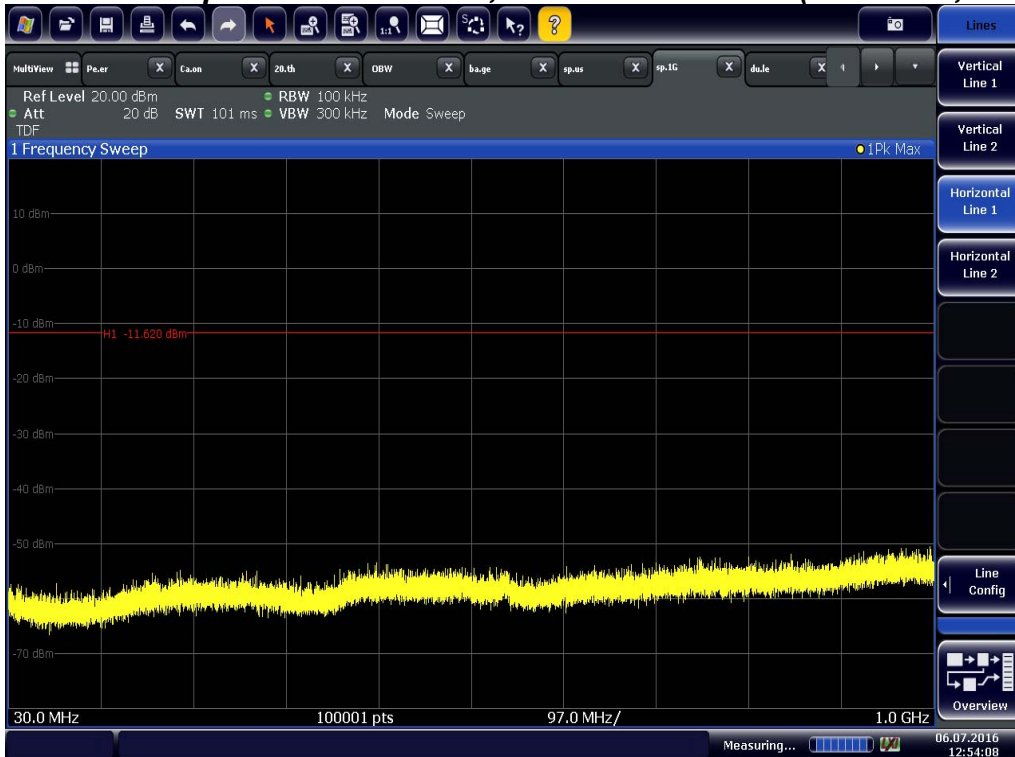
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz (2441 MHz, GFSK Mode)



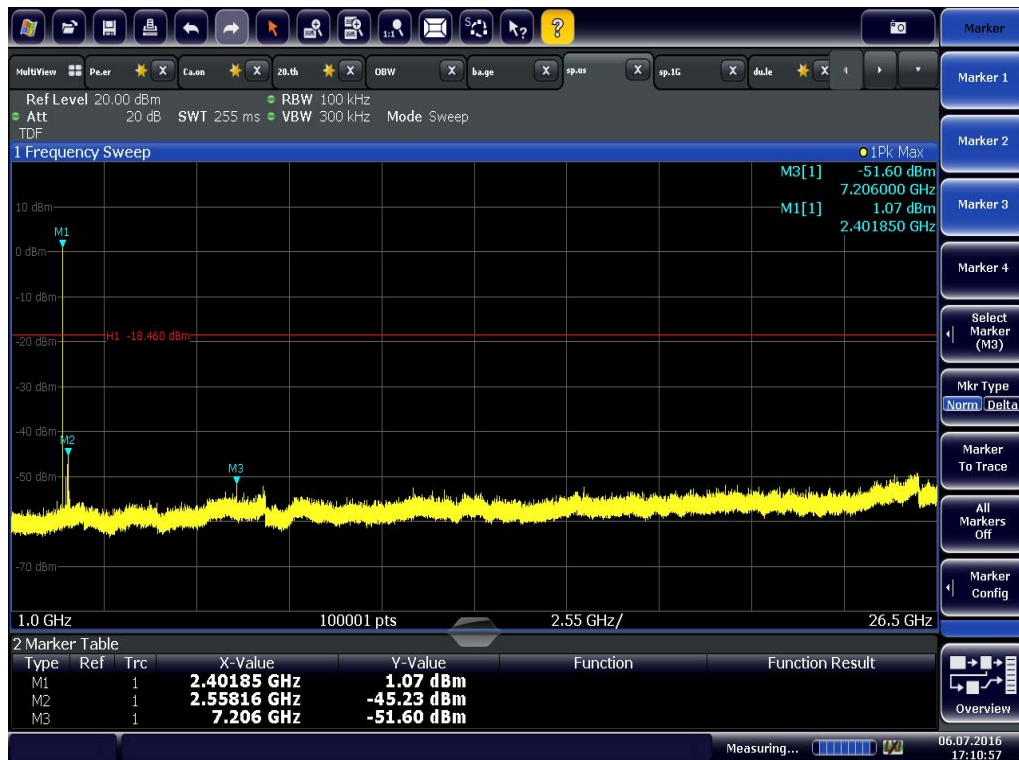
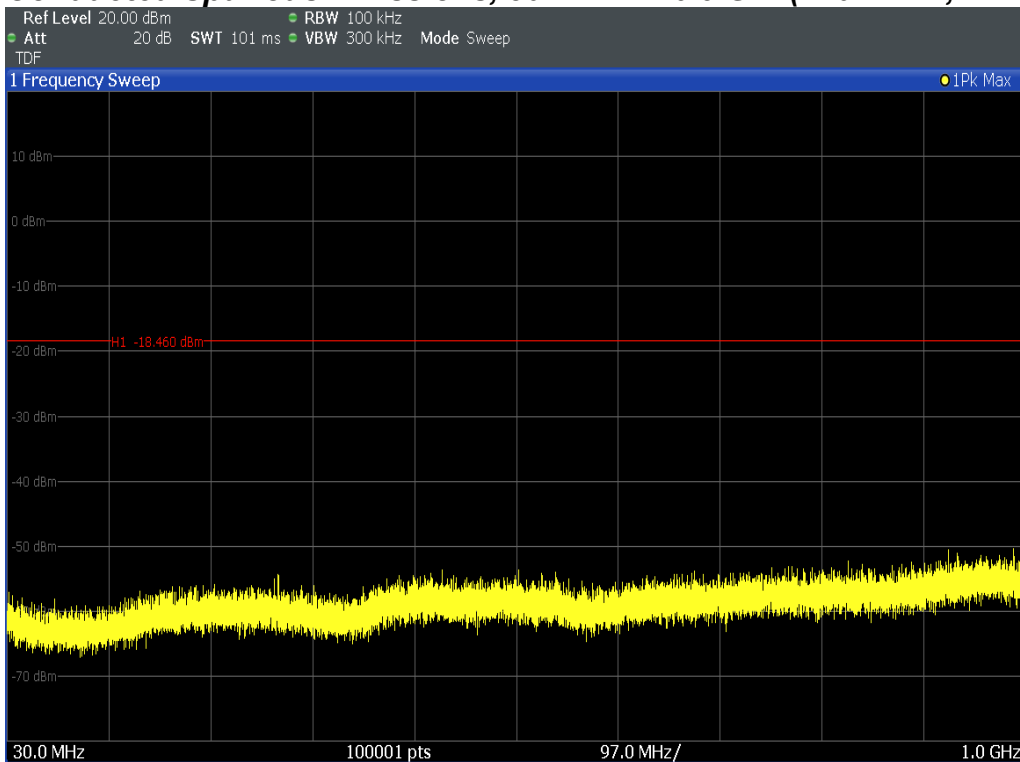
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz (2480 MHz, GFSK Mode)



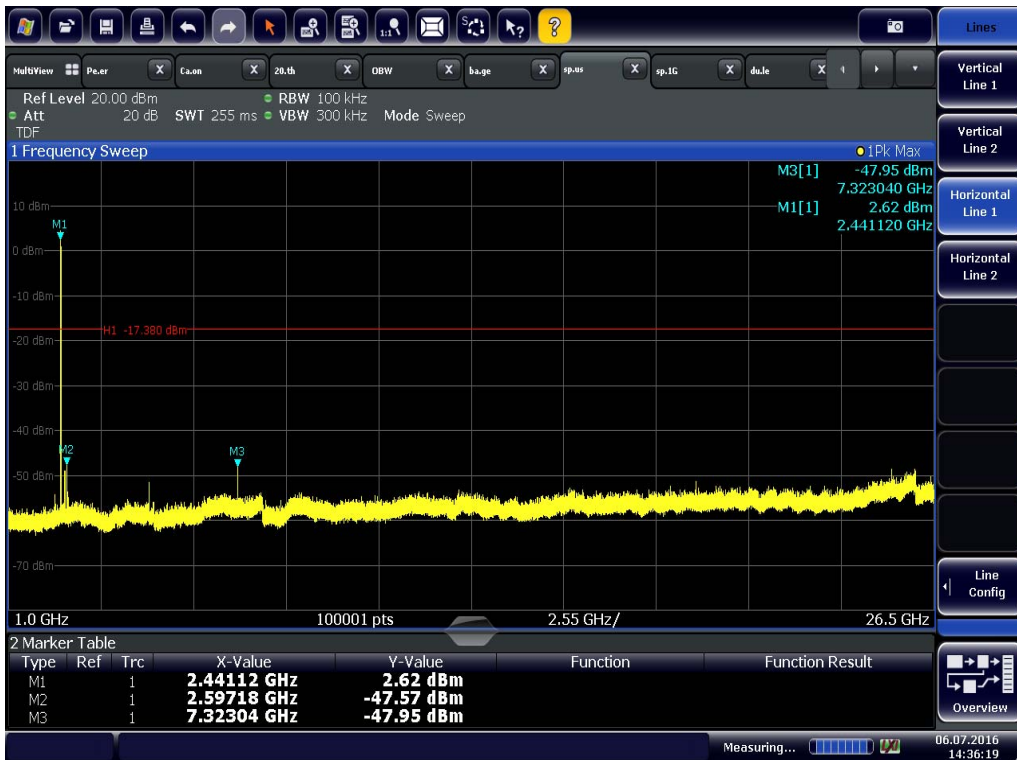
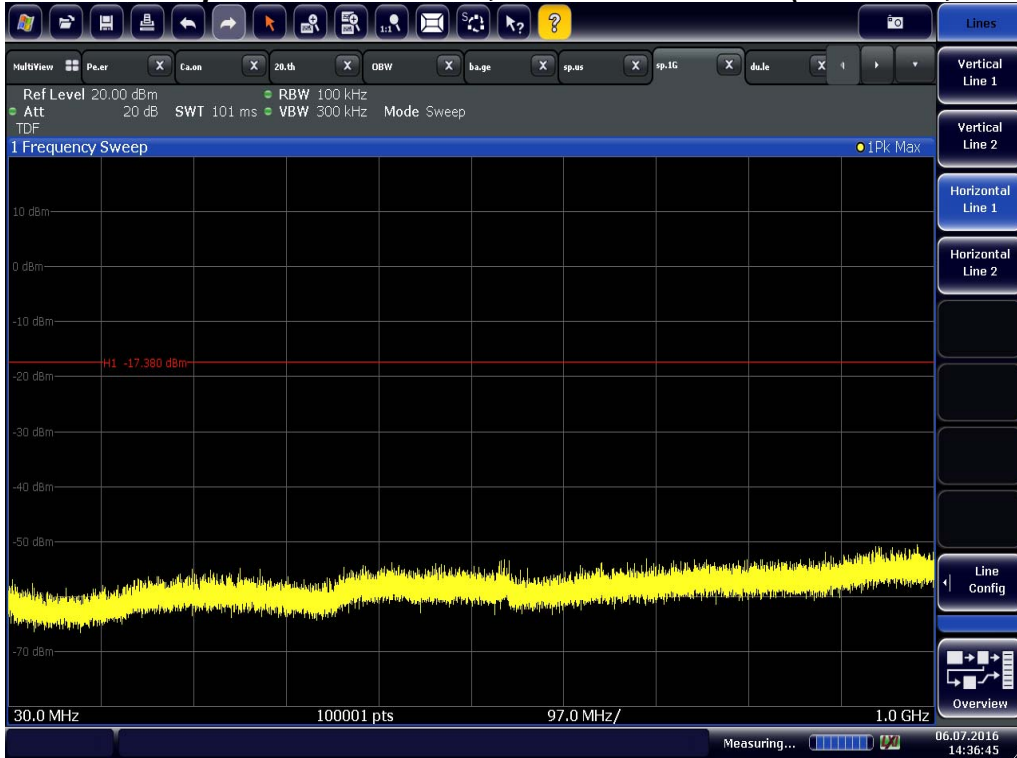
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz(2402 MHz, $\pi/4$ DQPSK Mode)



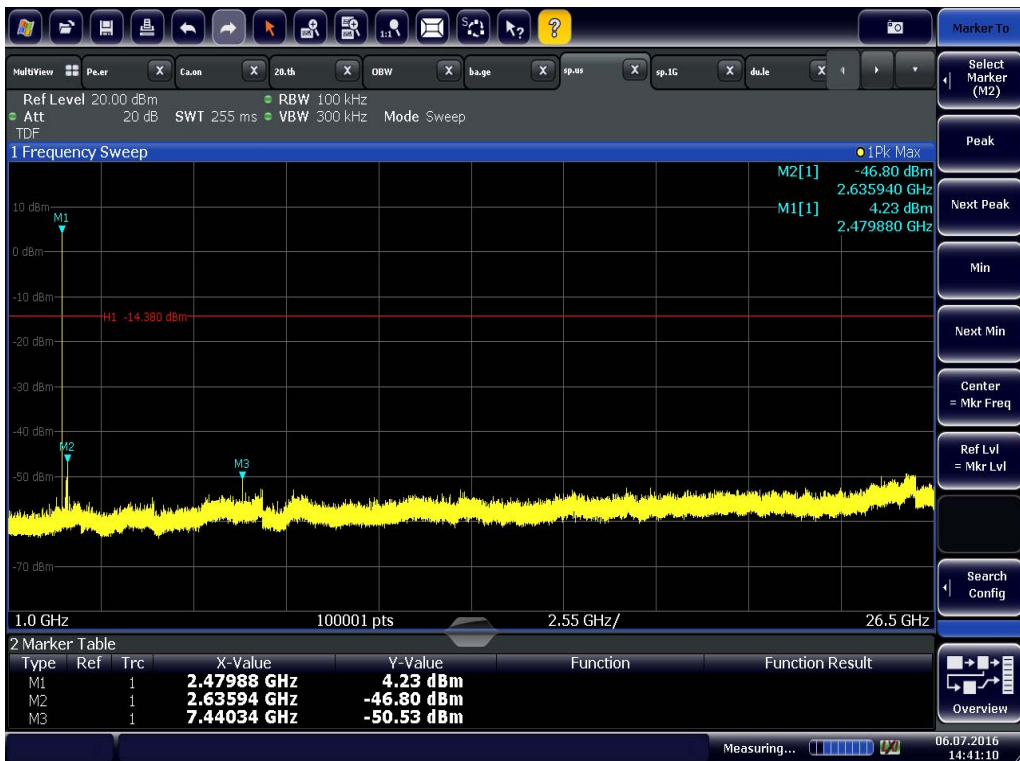
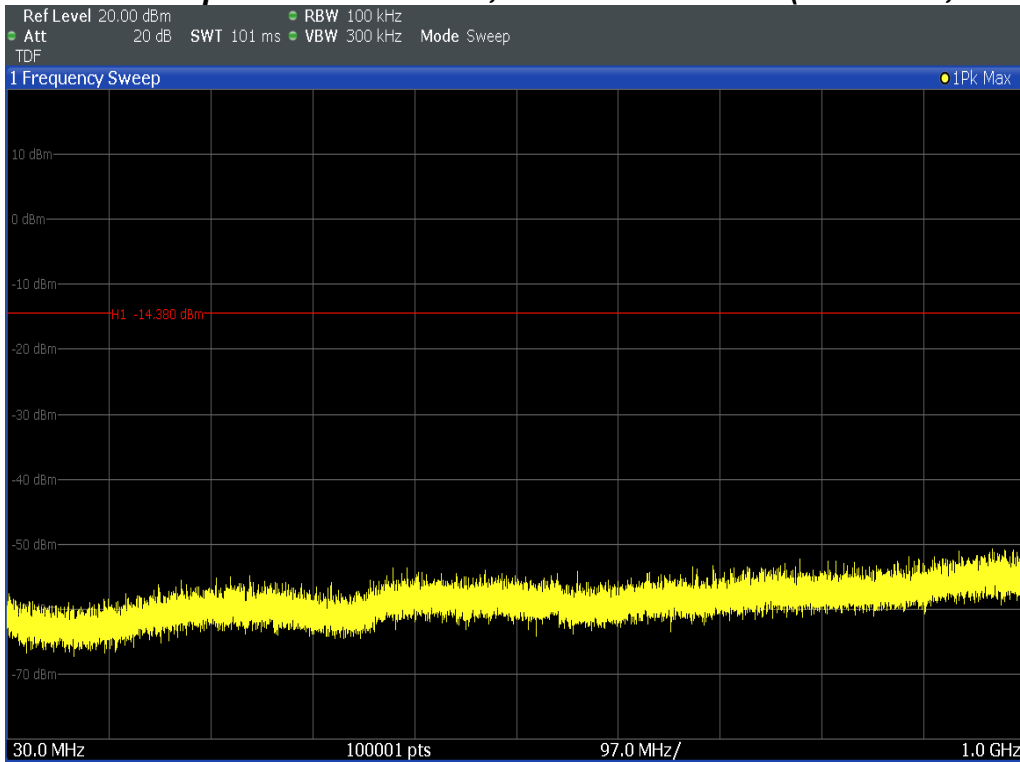
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz (2441 MHz, $\pi/4$ DQPSK Mode)



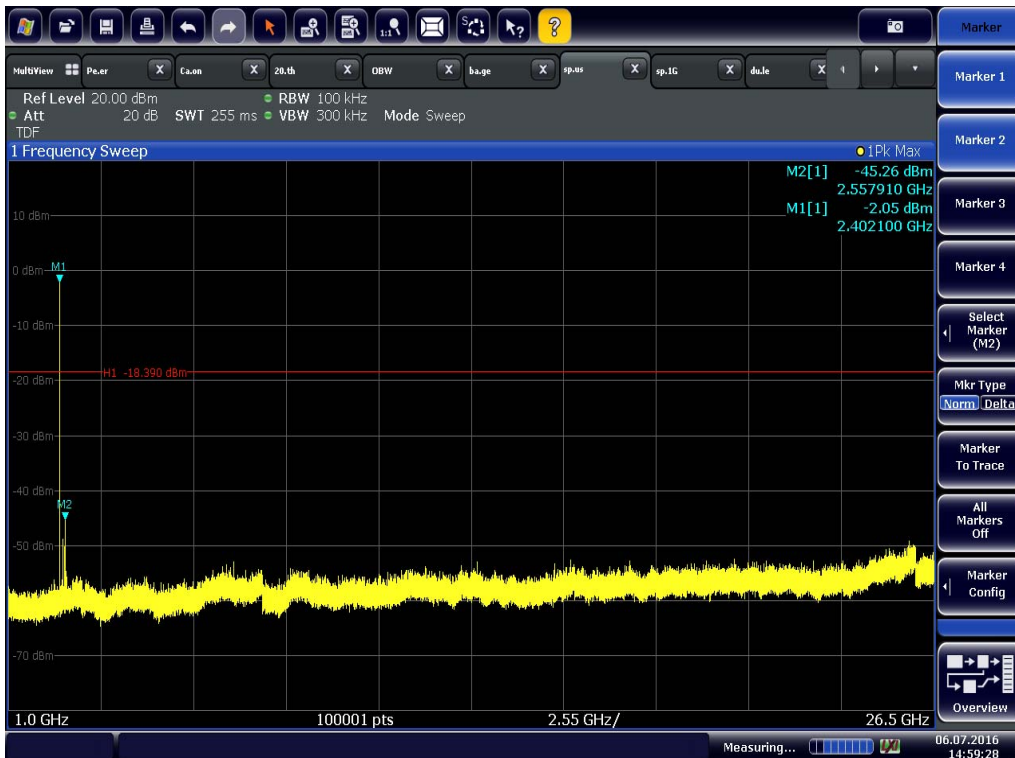
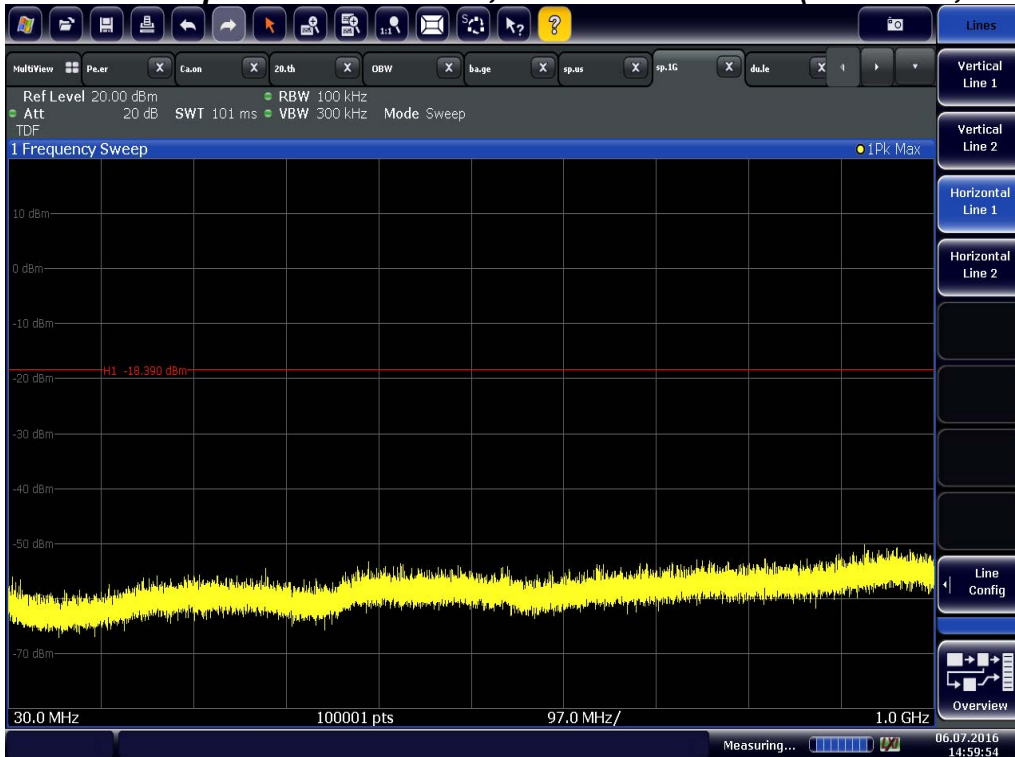
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz(2480 MHz, $\pi/4$ DQPSK Mode)



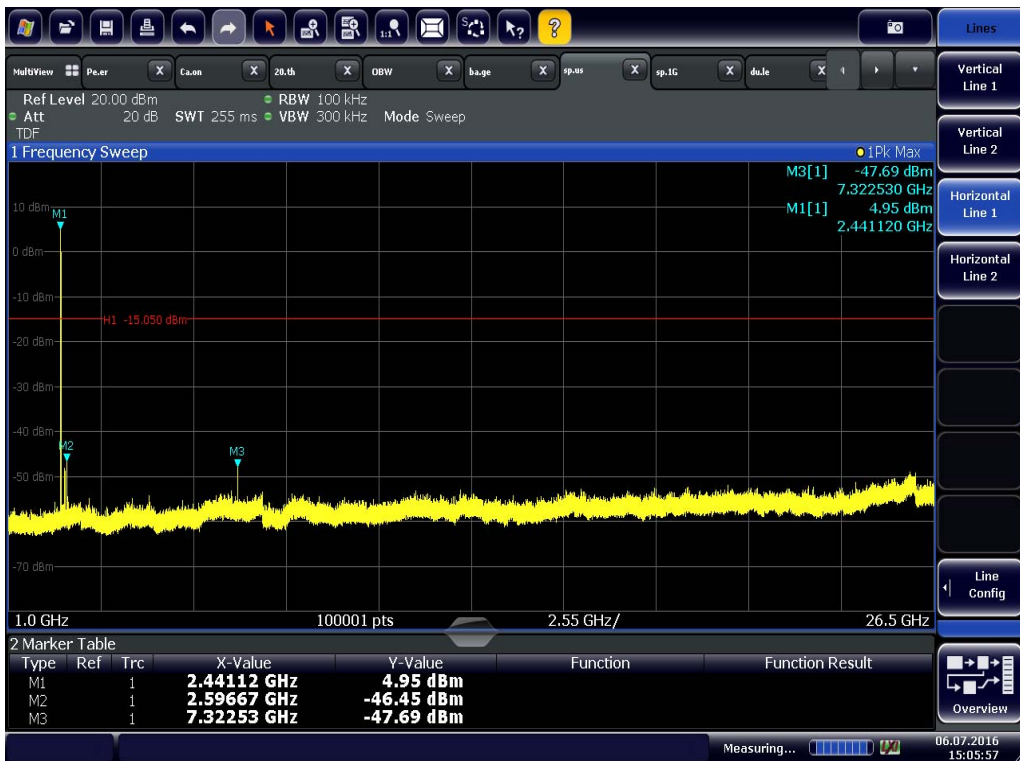
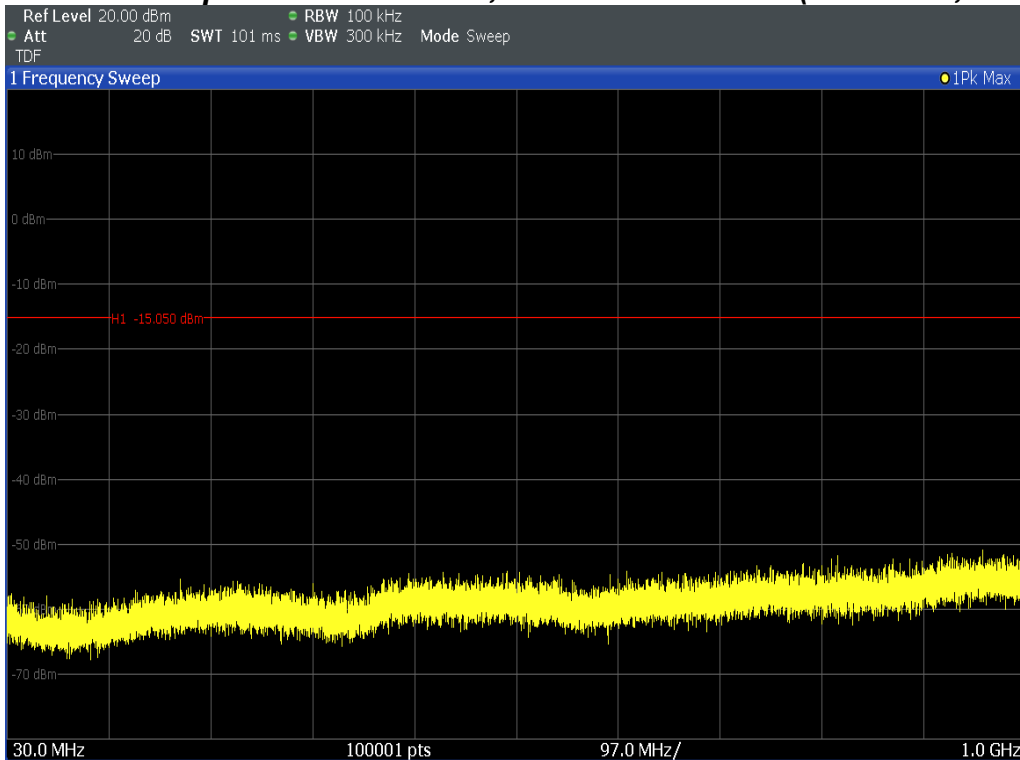
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz (2402 MHz, 8DPSK Mode)



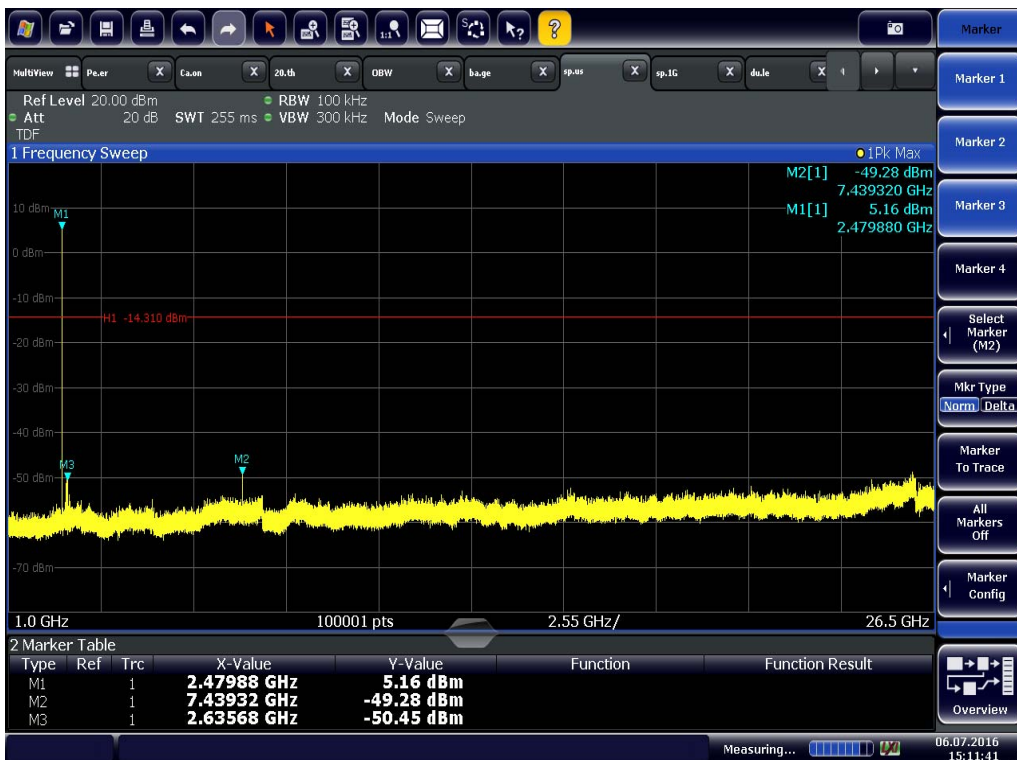
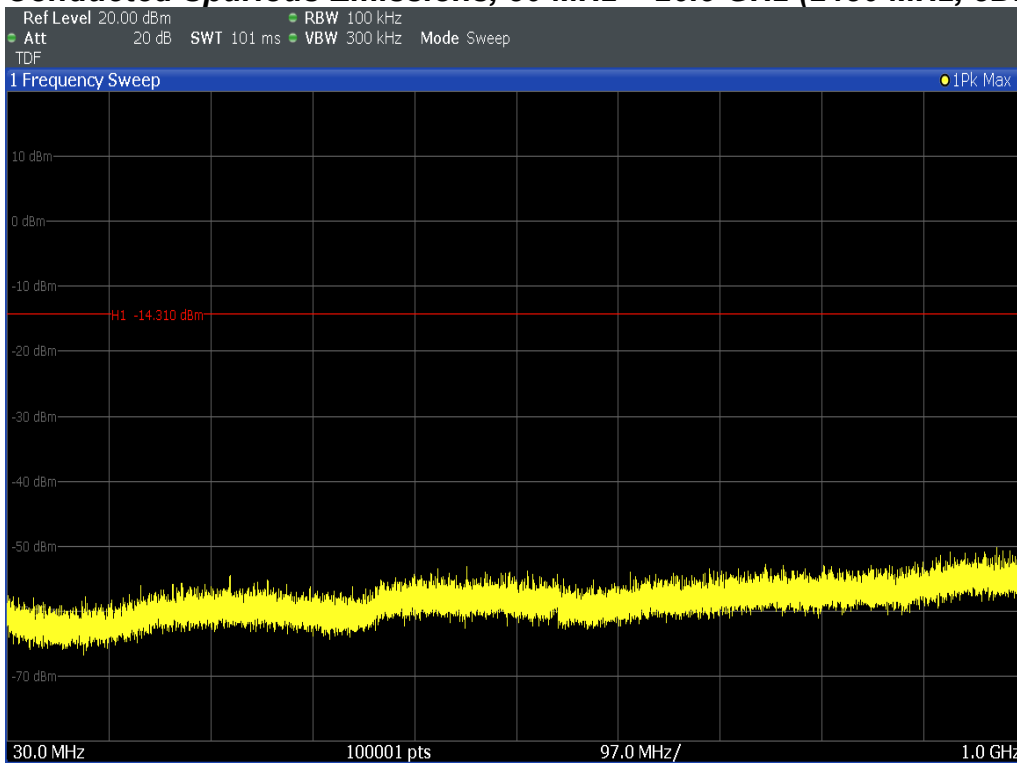
PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz (2441 MHz, 8DPSK Mode)



PLOT OF TEST DATA

Conducted Spurious Emissions, 30 MHz ~ 26.5 GHz (2480 MHz, 8DPSK Mode)



PLOT OF TEST DATA

Band Edge Lowest Channel (2402 MHz, GFSK, Non-hopping mode)



Band Edge Lowest Channel (2402 MHz, GFSK, Hopping mode)



PLOT OF TEST DATA

Band Edge Highest Channel (2480 MHz, GFSK, Non-hopping mode)

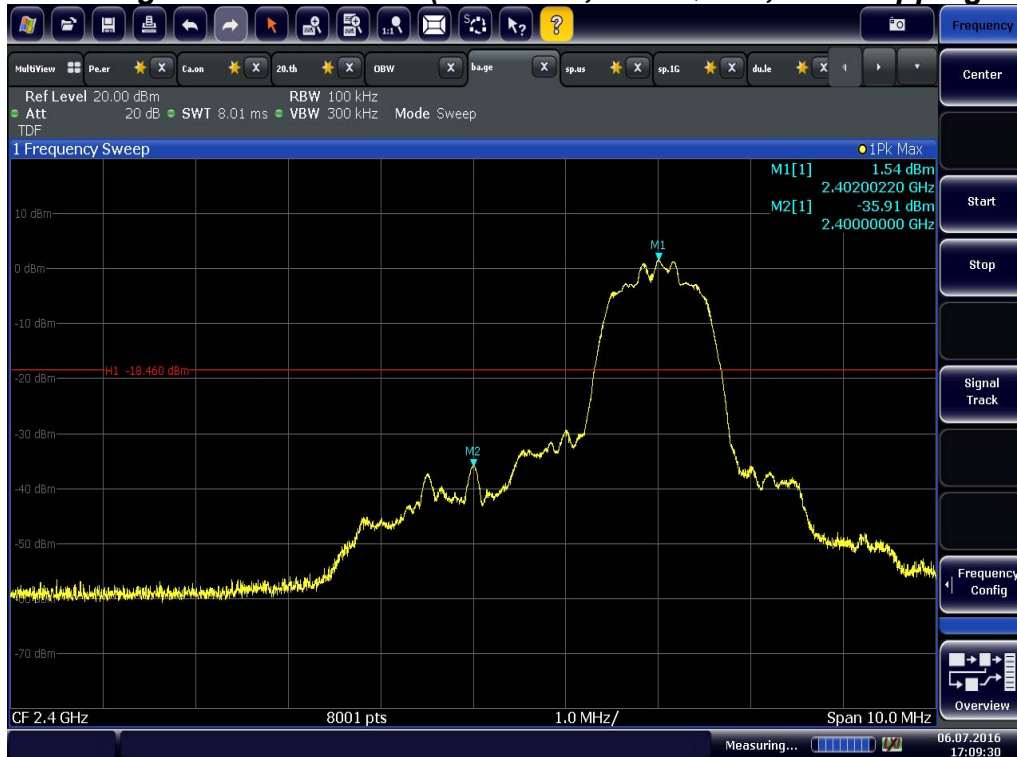


Band Edge Highest Channel (2480 MHz, GFSK, Hopping mode)



PLOT OF TEST DATA

Band Edge Lowest Channel(2402 MHz, $\pi/4$ DQPSK, Non-hopping mode)

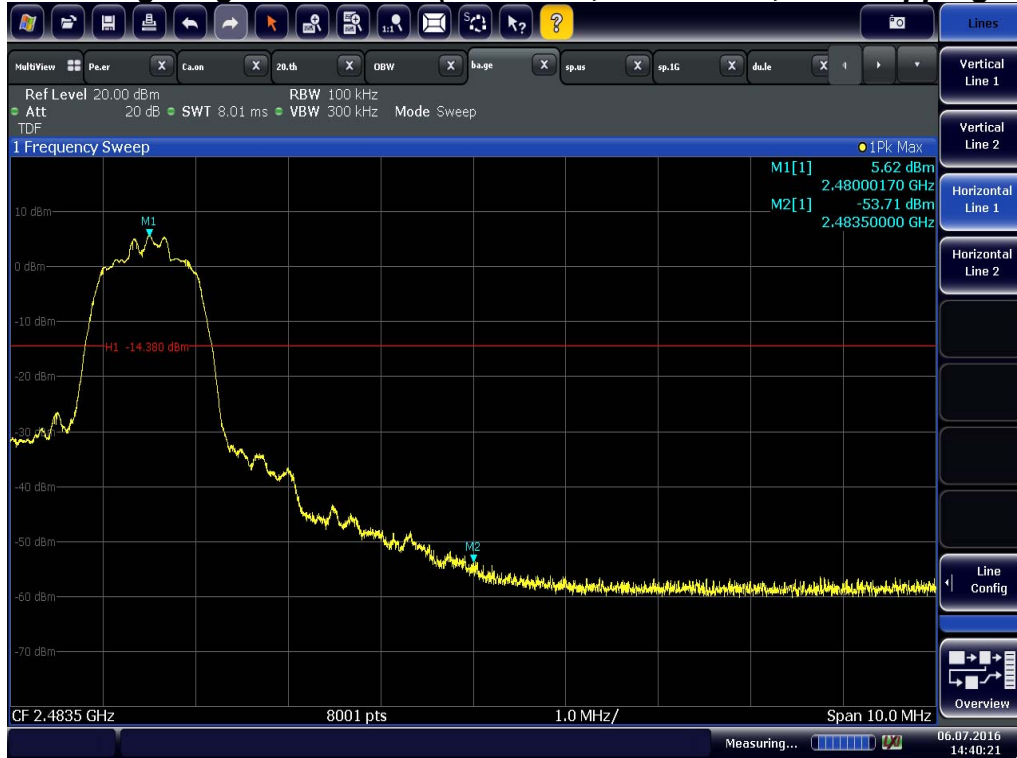


Band Edge Lowest Channel(2402 MHz, $\pi/4$ DQPSK, Hopping mode)



PLOT OF TEST DATA

Band Edge Highest Channel(2480 MHz, $\pi/4$ DQPSK, Non-hopping mode)



Band Edge Highest Channel(2480 MHz, $\pi/4$ DQPSK, Hopping mode)



PLOT OF TEST DATA

Band Edge Lowest Channel(2402 MHz, 8DPSK, Non-hopping mode)



Band Edge Lowest Channel(2402 MHz, 8DPSK, Hopping mode)

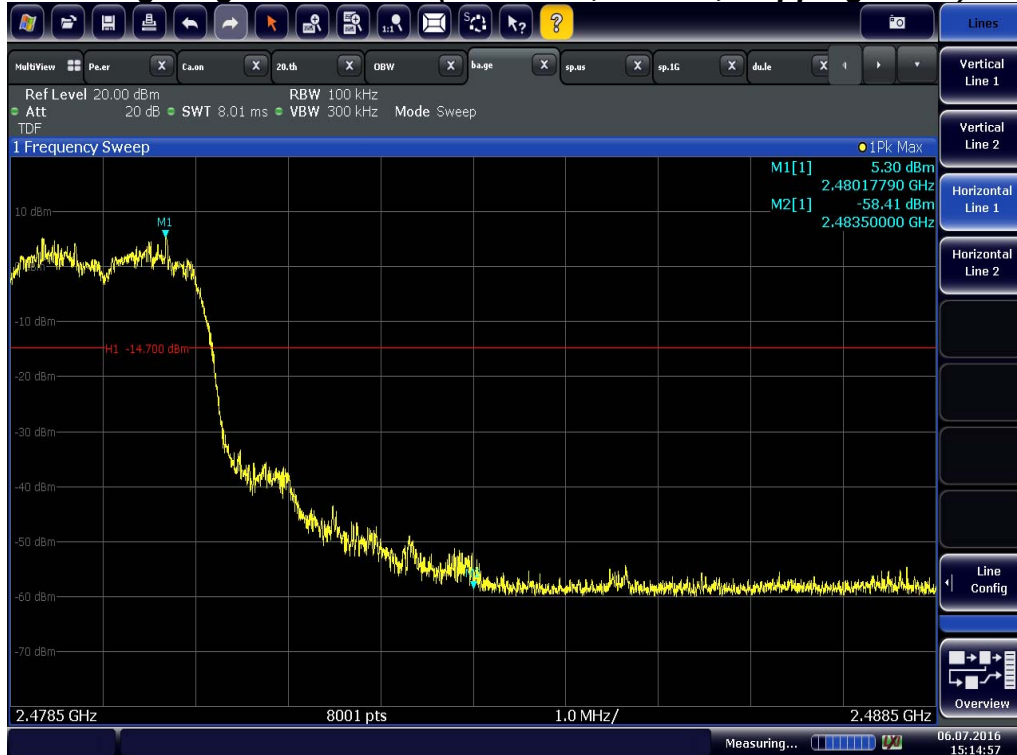


PLOT OF TEST DATA

Band Edge Highest Channel(2480 MHz, 8DPSK, Non-hopping mode)



Band Edge Highest Channel(2480 MHz, 8DPSK, Hopping mode)



TEST DATA

8.9 Radiated Spurious Emission

FCC §15.247(d), IC RSS-247 Issue 1, 5.5

Test Mode : Set to Lowest channel, Middle channel and Highest channel

Result

Lowest Channel

Frequency (MHz)	Reading (dB μ V)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4803.93	45.1	V	peak	9.4	54.5	74.0	19.5
4804.01	35.9	V	average	9.4	45.3	54.0	8.7
7205.68	44.3	V	peak	16.3	60.6	74.0	13.4
7206.02	33.1	V	average	16.3	49.4	54.0	4.6

Middle Channel

Frequency (MHz)	Reading (dB μ V)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4881.99	45.7	V	peak	9.7	55.4	74.0	18.6
4881.98	38.8	V	average	9.7	48.5	54.0	5.5
7322.22	44.1	H	peak	16.8	60.9	74.0	13.1
7323.06	33.8	V	average	16.8	50.6	54.0	3.4

Highest Channel

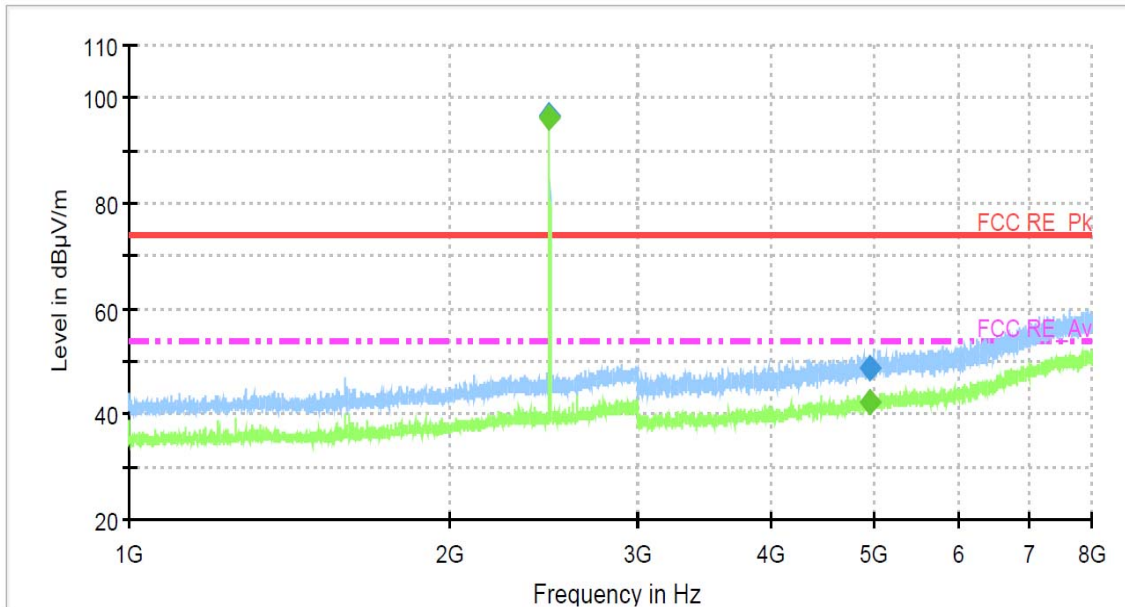
Frequency (MHz)	Reading (dB μ V)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
4960.53	47.6	V	peak	10.0	57.6	74.0	16.4
4959.99	42.2	V	average	9.9	29.6***	54.0	24.4
7440.33	44.4	V	peak	17.0	61.4	74.0	12.6
7440.14	33.8	V	average	17.0	28.3***	54.0	25.7

Notes:

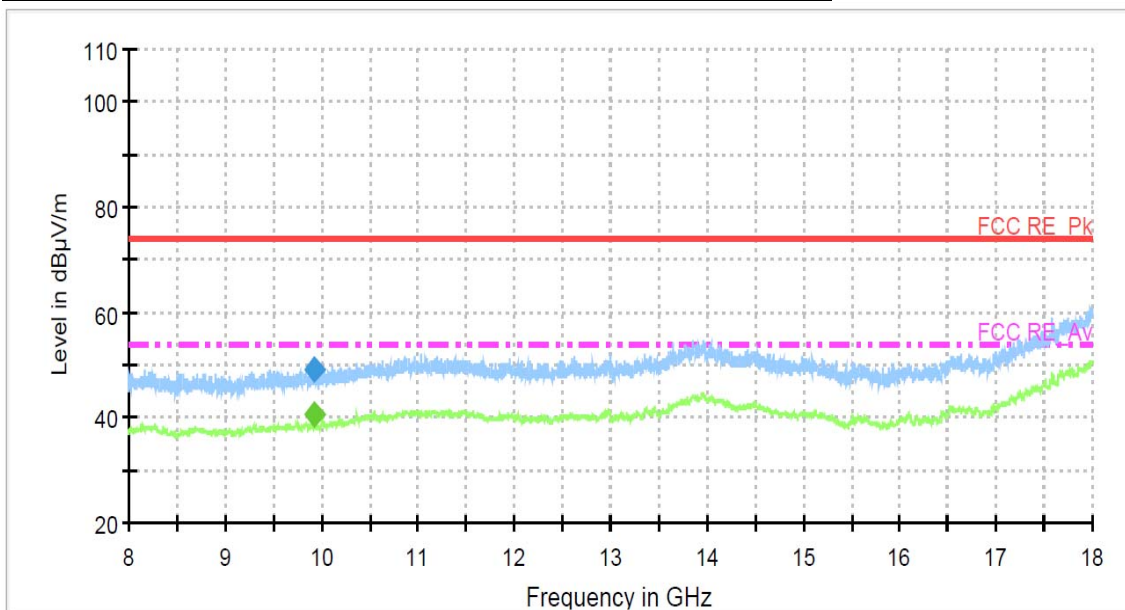
1. *Pol. H = Horizontal V = Vertical
2. **AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
3. Other spurious was under 20 dB below Fundamental.
4. *** Duty Cycle Correction Factor Calculation (Worst case : AFH mode)
 - Channel hop rate = 800 hops/second
 - Adjusted channel hop rate for DH5 mode = 133.33 hops/second
 - Time per channel hop = $1/133.33$ hops/second = 7.50 ms
 - Time to cycle through all channels = 7.50×20 channels = 150 ms
 - Number of times transmitter hits on one channel = $100 \text{ ms} / 150 \text{ ms} = 1 \text{ time(s)}$
 - Worst case dwell time = 7.50 ms
 - Duty cycle correction factor = $20\log_{10}(7.50\text{ms}/100\text{ms}) = -22.5 \text{ dB}$
5. GFSK modulation mode was the worst condition.
6. The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization. The worst data was recorded.
7. Peak emissions were measured using RBW = 1 MHz, VBW = 3 MHz, Detector = Peak.
8. Average emissions were measured using RBW = 1 MHz, VBW = 1 kHz, Detector = Peak.
9. The spectrum was measured from 9 kHz to 10th harmonic and the worst-case emissions were reported. No significant emissions were found beyond the 3rd harmonic for this device.

PLOTS OF EMISSIONS

Worst Case : 2480 MHz GFSK modulation : 1 GHz to 8 GHz

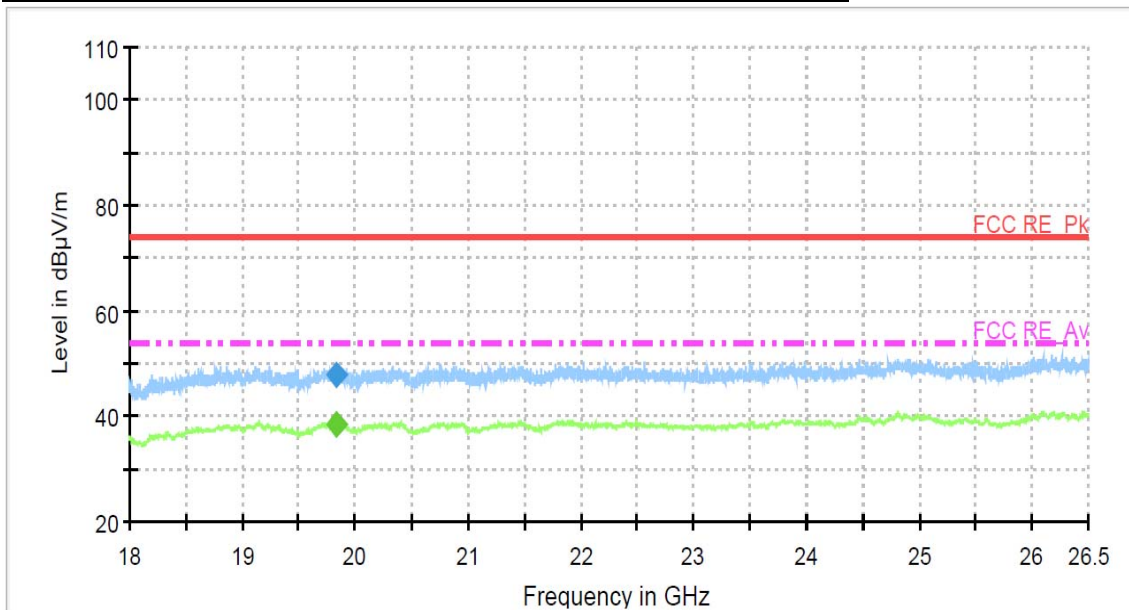


Worst Case : 2480 MHz GFSK modulation : 8 GHz to 18 GHz

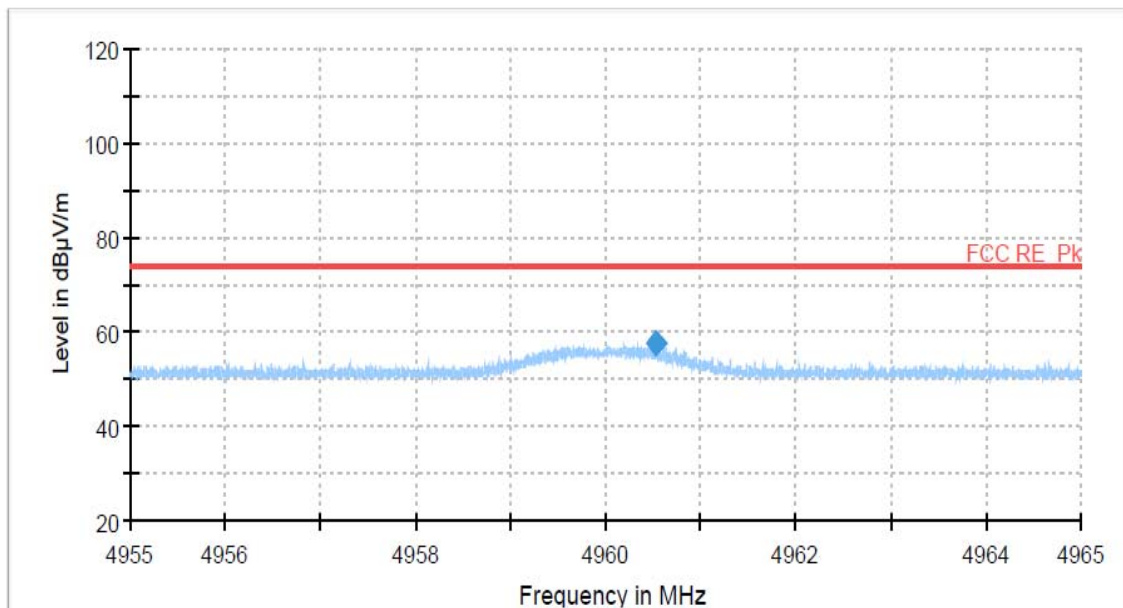


PLOTS OF EMISSIONS

Worst Case : 2480 MHz GFSK modulation : 18 GHz to 26 GHz

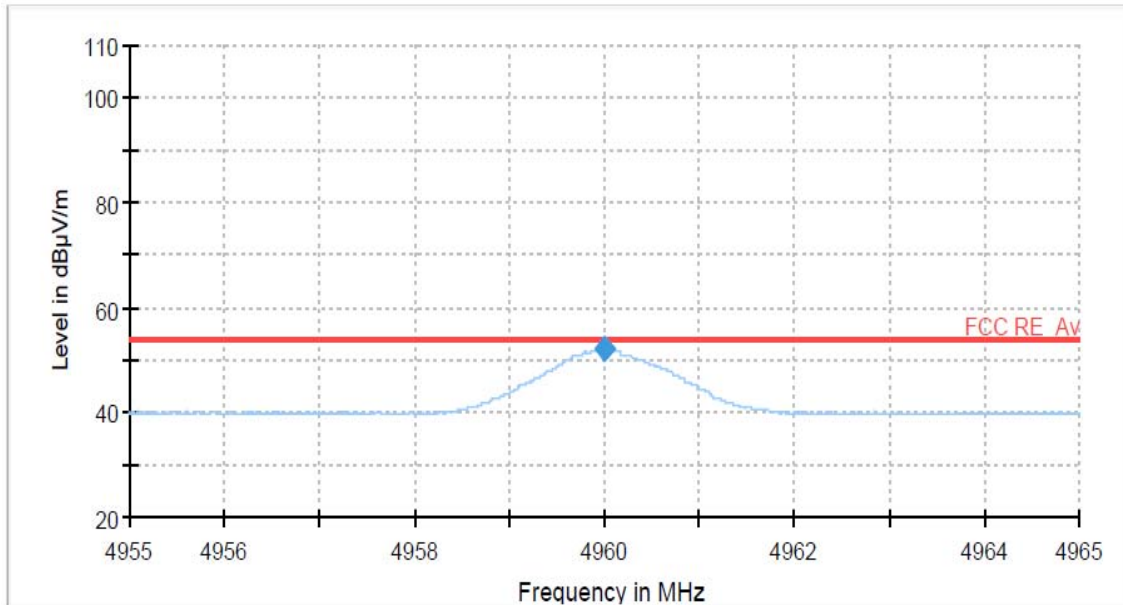


Worst Case : 2480 MHz GFSK modulation : 2nd Harmonic Pk

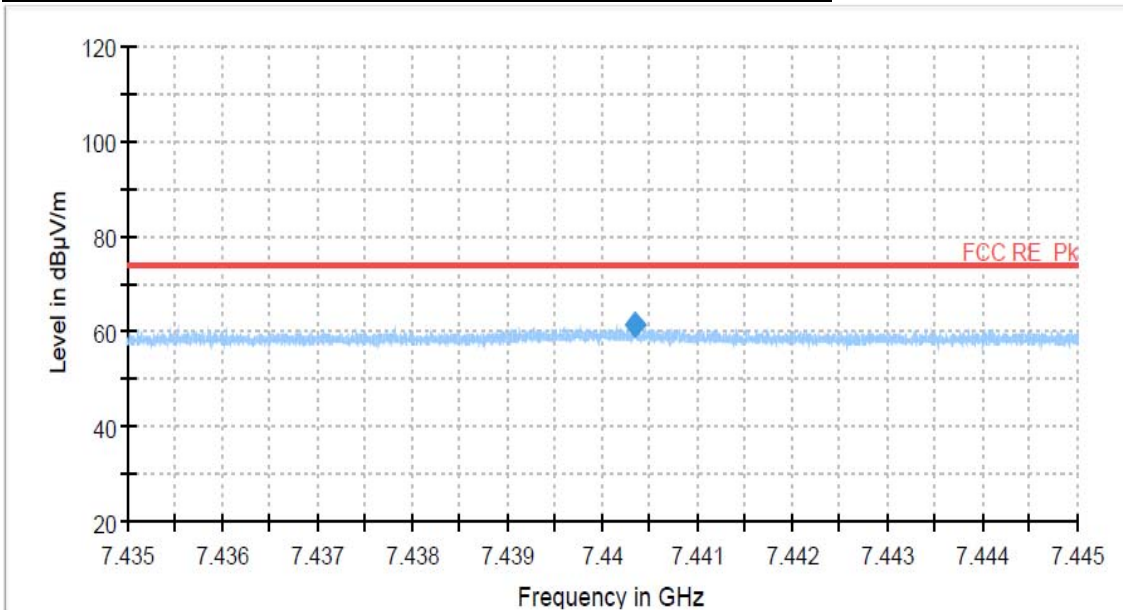


PLOTS OF EMISSIONS

Worst Case : 2480 MHz GFSK modulation : 2nd Harmonic Av

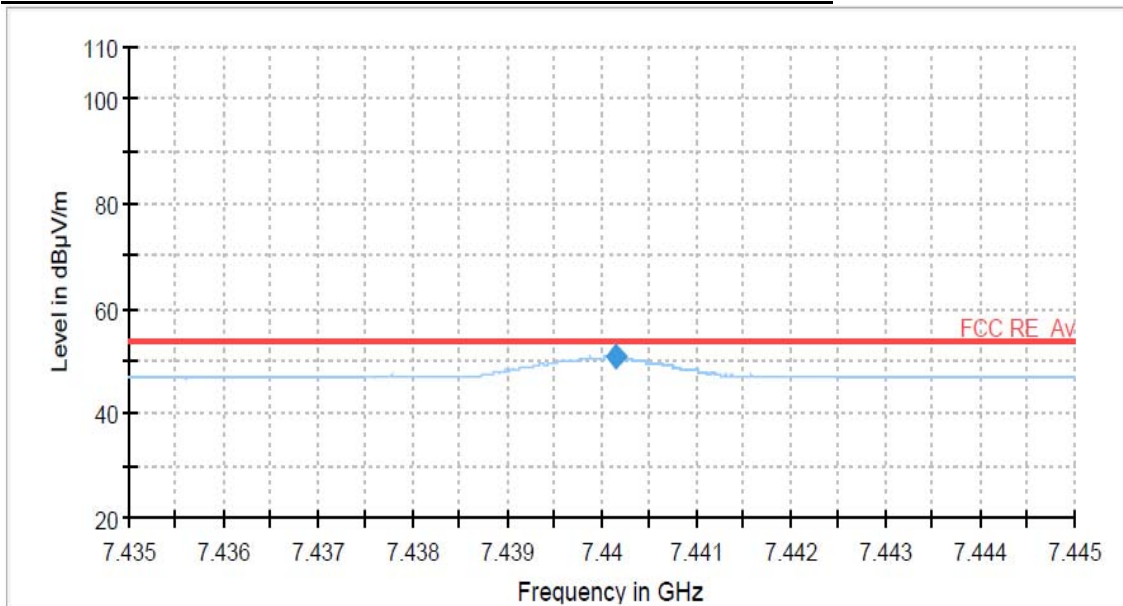


Worst Case : 2480 MHz GFSK modulation : 3rd Harmonic Pk



PLOTS OF EMISSIONS

Worst Case : 2480 MHz GFSK modulation : 3rd Harmonic Av



TEST DATA

8.10 Radiated Bandedge

FCC §15.247(d), IC RSS-247 Issue 1, 5.5

Test Mode : Set to Lowest channel, Highest channel

Result

Lowest and Highest Channels

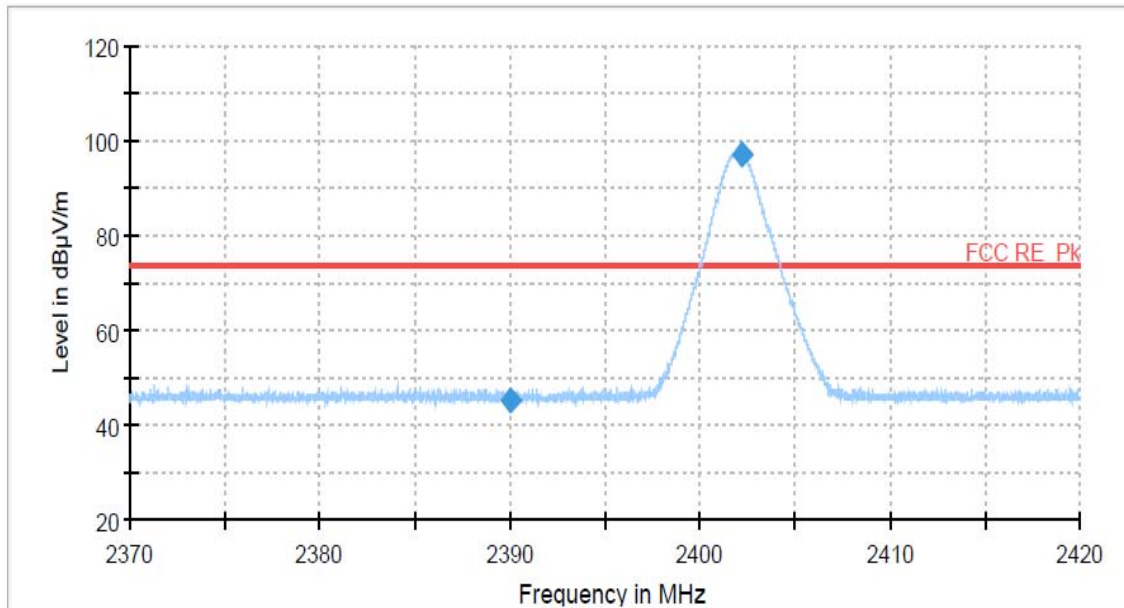
Frequency (MHz)	Reading (dBμV)	Pol* (H/V)	mode	AF+CL+Amp (dB)**	Result (dBμV/m)	Limit (dBμV/m)	Margin (dB)
2390.00	44.7	H	peak	0.4	45.1	74.0	28.9
2390.00	34.3	H	average	0.4	34.7	54.0	19.3
2483.50	54.7	H	peak	0.8	55.5	74.0	18.5
2483.50	52.9	H	average	0.8	31.2***	54.0	22.8

Note:

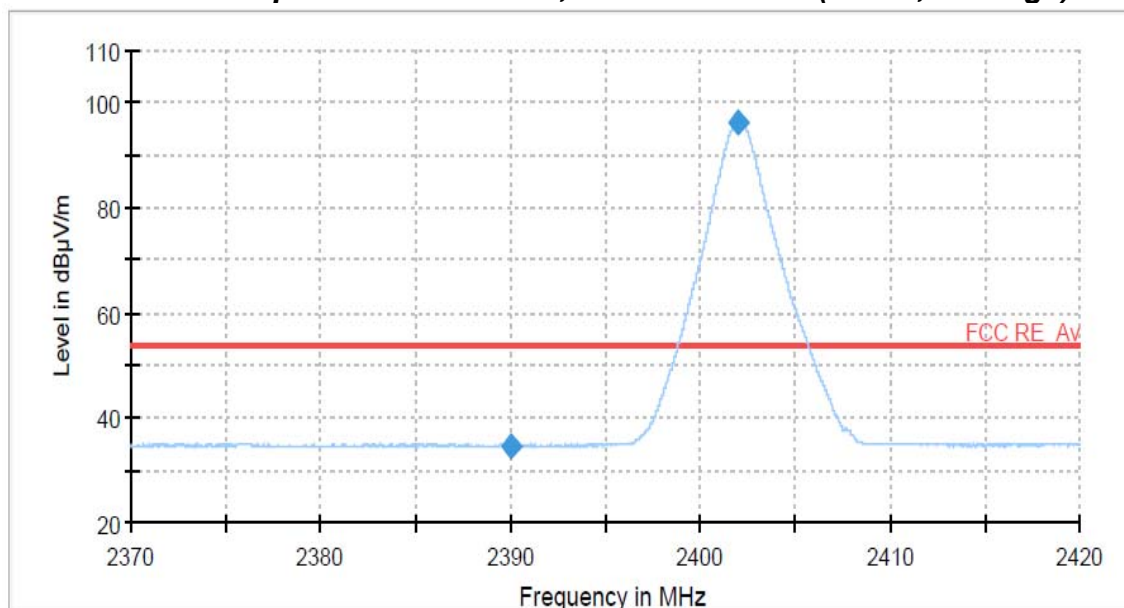
1. *Pol. H = Horizontal V = Vertical
2. **AF + CL + Amp. = Antenna Factor + Cable Loss + Amplifier.
3. Other spurious was under 20 dB below Fundamental.
4. *** Duty Cycle Correction Factor Calculation (Worst case : AFH mode)
 - Channel hop rate = 800 hops/second
 - Adjusted channel hop rate for DH5 mode = 133.33 hops/second
 - Time per channel hop = 1/133.33 hops/second = 7.50 ms
 - Time to cycle through all channels = 7.50 x 20 channels = 150 ms
 - Number of times transmitter hits on one channel = 100 ms / 150 ms = 1 time(s)
 - Worst case dwell time = 7.50 ms
 - Duty cycle correction factor = $20\log_{10}(7.50\text{ms}/100\text{ms}) = -22.5 \text{ dB}$
5. GFSK modulation mode was the worst condition.
6. The radiated emissions testing were made by rotating EUT through three orthogonal axes and rotating the receive antenna with horizontal, Vertical polarization. The worst data was recorded.
7. Peak emissions were measured using RBW = 1 MHz, VBW = 3 MHz, Detector = Peak.
8. Average emissions were measured using RBW = 1 MHz, VBW = 1kHz, Detector = Peak

PLOT OF TEST DATA

Restricted Band Spurious Emissions, Lowest channel(GFSK, Peak)

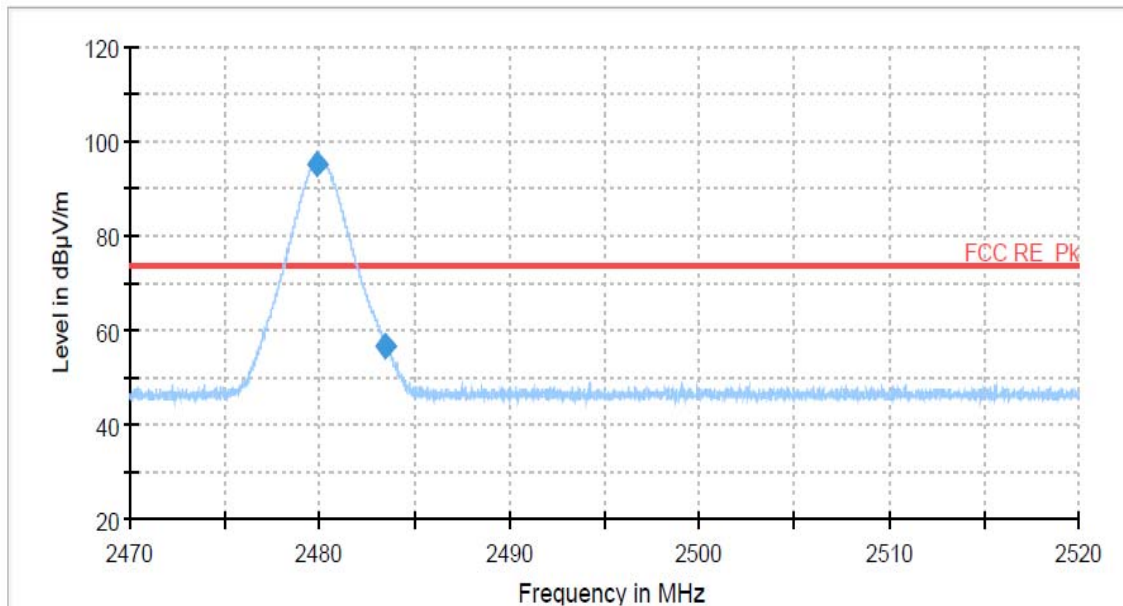


Restricted Band Spurious Emissions, Lowest channel(GFSK, Average)

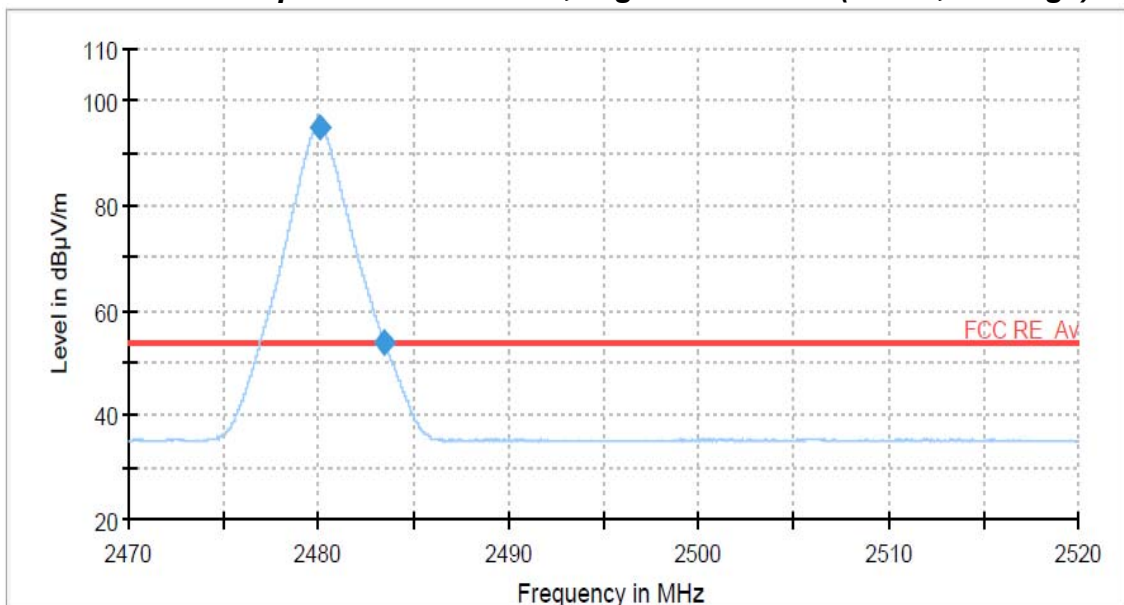


PLOT OF TEST DATA

Restricted Band Spurious Emissions, Highest channel (GFSK, Peak)



Restricted Band Spurious Emissions, Highest channel (GFSK, Average)***



9. TEST EQUIPMENT

No.	Instrument	Manufacturer	Model	Serial No.	Calibration Date	Calibration Interval
1	*Test Receiver	R & S	ESU 40	100202	Apr. 04 2016	1 year
2	*Test Receiver	R & S	ESCS30	100302	Oct. 06 2015	1 year
3	*Attenuator	PASTERNAK	PE7395-10	1441	Jan. 19 2016	1 year
4	*Attenuator	FAIRVIEW	SA3N5W-06	N/A	Apr. 04 2016	1 year
5	*Attenuator	FAIRVIEW	SA3N5W-10	N/A	Apr. 04 2016	1 year
6	Attenuator	WEINSCHEL	56-10	58765	Oct. 02 2015	1 year
7	*Amplifier	R & S	SCU 01	10030	Apr. 04 2016	1 year
8	*Amplifier	R & S	SCU18	10065	Apr. 04 2016	1 year
9	*Amplifier	R & S	SCU26	10011	Jul. 15 2016	1 year
10	Amplifier	R & S	SCU40	10008	Jul. 15 2016	1 year
11	*Pre Amplifier	HP	8449B	3008A00107	Jan. 07 2016	1 year
12	*Spectrum Analyzer	R & S	FSW43	100732	Apr. 05 2016	1 year
13	Spectrum Analyzer	Agilent	N9020A	MY51110087	Oct. 15 2015	1 year
14	*Spectrum Analyzer	R&S	FSP40	100361	Jul. 15 2016	1 year
15	*Loop Antenna	R & S	HFH2-Z2	100279	Feb. 22 2016	2 year
16	*Horn Antenna	SCHWARZBECK	BBHA9120D	9120D-508	Feb. 09 2015	2 year
17	*Horn Antenna	Q-par Angus	QSH20S20	8179	Apr. 30 2015	2 year
18	Horn Antenna	Q-par Angus	QSH22K20	8180	Apr. 30 2015	2 year
19	*Trilog-Broadband Antenna	SCHWARZBECK	VULB 9163	9163-423	Nov. 04 2015	2 year
20	*LISN	R & S	ESH3-Z5	833874/006	Oct. 06 2015	1 year
21	*Controller	INNCO	CO2000-G	CO2000/562/23890210/L	N/A	N/A
22	*Turn Table	INNCO	DT3000-3T	N/A	N/A	N/A
23	*Antenna Mast	INNCO	MA4000-EP	N/A	N/A	N/A
24	*Open Switch And Control Unit	R & S	OSP-120	100015	N/A	N/A
25	*Anechoic Chamber	Seo-Young EMC	N/A	N/A	N/A	N/A
26	*Position Controller	INNCO	CO2000	12480406/L	N/A	N/A
27	*Turn Table	INNCO	DS1200S	N/A	N/A	N/A
28	*Antenna Mast	INNCO	MA4000	N/A	N/A	N/A
29	*Anechoic Chamber	Seo-Young EMC	N/A	N/A	N/A	N/A
30	Shielded Room	Seo-Young EMC	N/A	N/A	N/A	N/A
31	*Open Switch And Control Unit	R & S	OSP-120	100081	N/A	N/A

*) Test equipment used during the test

10. ACCURACY OF MEASUREMENT

The Measurement Uncertainties stated were calculated in accordance with the requirements of measurement uncertainty contained in CISPR 16-4-2 with the confidence level of 95%

1. Conducted Uncertainty Calculation

Source of Uncertainty	X_i	Uncertainty of X_i		Coverage factor k	$u(X_i)$ (dB)	C_i	$C_i u(X_i)$ (dB)
		Value (dB)	Probability Distribution				
Receiver reading	RI	± 0.1	normal 1	1.000	0.1	1	0.1
Attenuation AMN-Receiver	LC	± 0.08	normal 2	2.000	0.04	1	0.04
AMN Voltage division factor	LAMN	± 0.8	normal 2	2.000	0.4	1	0.4
Sine wave voltage	dVSW	± 2.00	normal 2	2.000	1.00	1	1.00
Pulse amplitude response	dVPA	± 1.50	rectangular	1.732	0.87	1	0.87
Pulse repetition rate response	dVPR	± 1.50	rectangular	1.732	0.87	1	0.87
Noise floor proximity	dVNF	± 0.00	-	-	0.00	1	0.00
AMN Impedance	dZ	± 1.80	triangular	2.449	0.73	1	0.73
Ⓐ Mismatch	M	+ 0.70	U-Shaped	1.414	0.49	1	0.49
Ⓑ Mismatch	M	- 0.80	U-Shaped	1.414	- 0.56	1	- 0.56
Measurement System Repeatability	RS	0.05	normal 1	1.000	0.05	1	0.05
Remark	Ⓐ: AMN-Receiver Mismatch : + Ⓑ: AMN-Receiver Mismatch : -						
Combined Standard Uncertainty	Normal			± 1.88			
Expanded Uncertainty U	Normal ($k = 2$)			± 3.76			

2. Radiation Uncertainty Calculation

Source of Uncertainty	X_i	Uncertainty of X_i		Coverage factor k	$u(X_i)$ (dB)	C_i	$C_i u(X_i)$ (dB)
		Value (dB)	Probability Distribution				
Measurement System Repeatability	RI	0.34	normal 1	1.00	0.34	1	0.34
Receiver reading	dVsw	± 0.02	normal 2	2.00	0.01	1	0.01
Sine wave voltage	dVpa	± 0.17	normal 2	2.00	0.09	1	0.09
Pulse amplitude response	dVpr	± 0.92	normal 2	2.00	0.46	1	0.46
Pulse repetition rate response	dVnf	± 0.35	normal 2	2.00	0.18	1	0.18
Noise floor proximity	AF	± 0.50	normal 2	2.00	0.25	1	0.25
Antenna Factor Calibration	CL	± 2.00	rectangular	$\sqrt{3}$	1.15	1	1.15
Cable Loss	AD	± 1.00	normal 2	2.00	0.50	1	0.50
Antenna Directivity	AH	± 0.00	rectangular	$\sqrt{3}$	0.00	1	0.00
Antenna Factor Height Dependence	AP	± 2.00	rectangular	$\sqrt{3}$	1.15	1	1.15
Antenna Phase Centre Variation	AI	± 0.20	rectangular	$\sqrt{3}$	0.12	1	0.12
Antenna Factor Frequency Interpolation	SI	± 0.25	rectangular	$\sqrt{3}$	0.14	1	0.14
Site Imperfections	DV	± 4.00	triangular	$\sqrt{6}$	1.63	1	1.63
Measurement Distance Variation	Dbal	± 0.60	rectangular	$\sqrt{3}$	0.35	1	0.35
Antenna Balance	DCross	± 0.90	rectangular	$\sqrt{3}$	0.52	1	0.52
Cross Polarisation	M	± 0.00	rectangular	$\sqrt{3}$	0.00	1	0.18
Mismatch	M	+ 0.98 - 1.11	U-Shaped	$\sqrt{2}$	0.74	1	0.74
EUT Volume Diameter	M	0.33	normal 1	1.00	0.33	1	0.11
Remark							
Combined Standard Uncertainty	Normal						
Expanded Uncertainty U	Normal ($k = 2$)						