

7. Maximum Output Power test

7.1 Operating environment

Temperature: 23 °C
Relative Humidity: 50 %
Atmospheric Pressure: 1022 hPa

7.2 Test setup & procedure

The test procedure was according to FCC measurement guidelines DA 00-705.

The power output per FCC §15.247(b) was measured on the EUT using a 50 ohm SMA cable connected to peak power meter via power sensor. Power was read directly and cable loss correction (2 dB) was added to the reading to obtain power at the EUT antenna terminals. The test was performed at 3 channels (lowest, middle and highest channel).

7.3 Measured data of Maximum Output Power test results

Mode	Channel	Frequency (MHz)	Output Power (dBm)		Total Power (mW)	Limit (dBm)	Margin (dB)
			(PK)	(AV)	(PK)		
GFSK	0	2402	5.71	4.73	3.72	30	-24.29
	39	2441	5.67	4.68	3.69	30	-24.33
	78	2480	5.51	4.67	3.56	30	-24.49
$\pi/4$ -DPSK	0	2402	5.54	4.75	3.58	30	-24.46
	39	2441	5.6	4.71	3.63	30	-24.40
	78	2480	5.48	4.67	3.53	30	-24.52
8-DPSK	0	2402	5.69	4.74	3.71	30	-24.31
	39	2441	5.58	4.69	3.61	30	-24.42
	78	2480	5.34	4.66	3.42	30	-24.66

8. RF Antenna Conducted Spurious test

8.1 Operating environment

Temperature: 25 °C
Relative Humidity: 58 %
Atmospheric Pressure: 1008 hPa

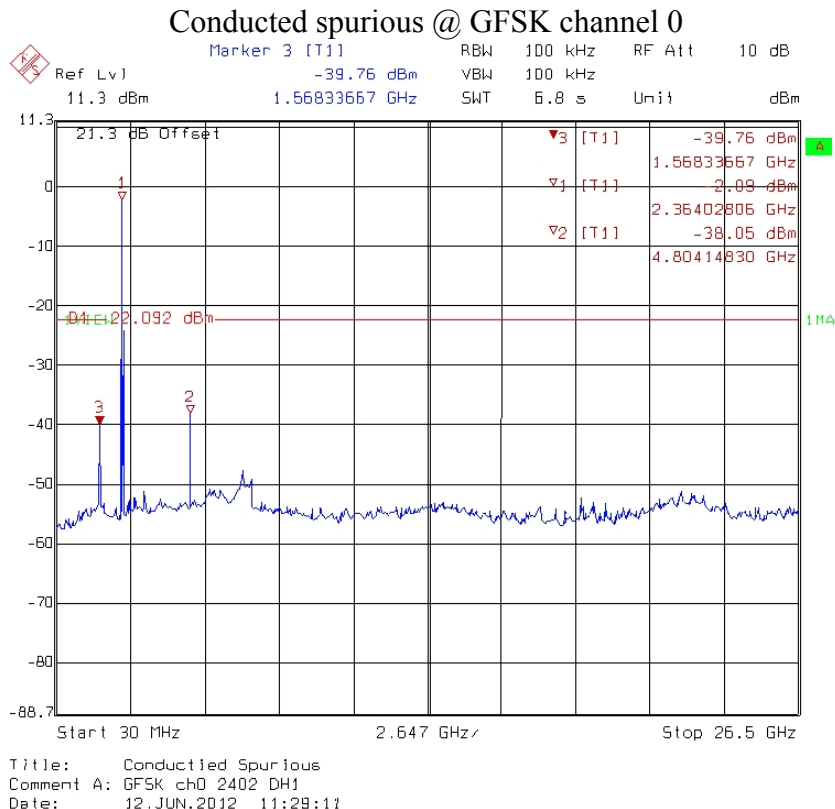
8.2 Test setup & procedure

The test procedure was according to FCC measurement guidelines DA 00-705.

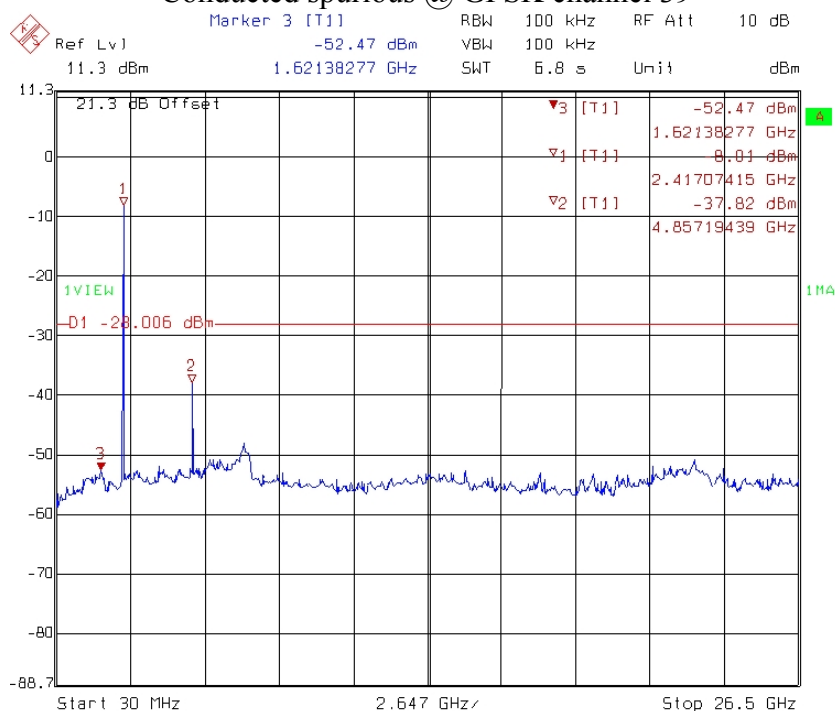
The measurements were performed from 30MHz to 25GHz RF antenna conducted per FCC 15.247 (c) was measured from the EUT antenna port using a 50ohm spectrum analyzer with the resolution bandwidth set at 100 kHz, and the video bandwidth set at 100 kHz.

Harmonics and spurious noise must be at least 20dB down from the highest emission level within the authorized band as measured with a 100 kHz RBW. The table below is the results from the highest emission for each channel within the authorized band. This table was used to determine the spurious limits for each channel.

8.3 Measured data of the highest RF Antenna Conducted Spurious test result

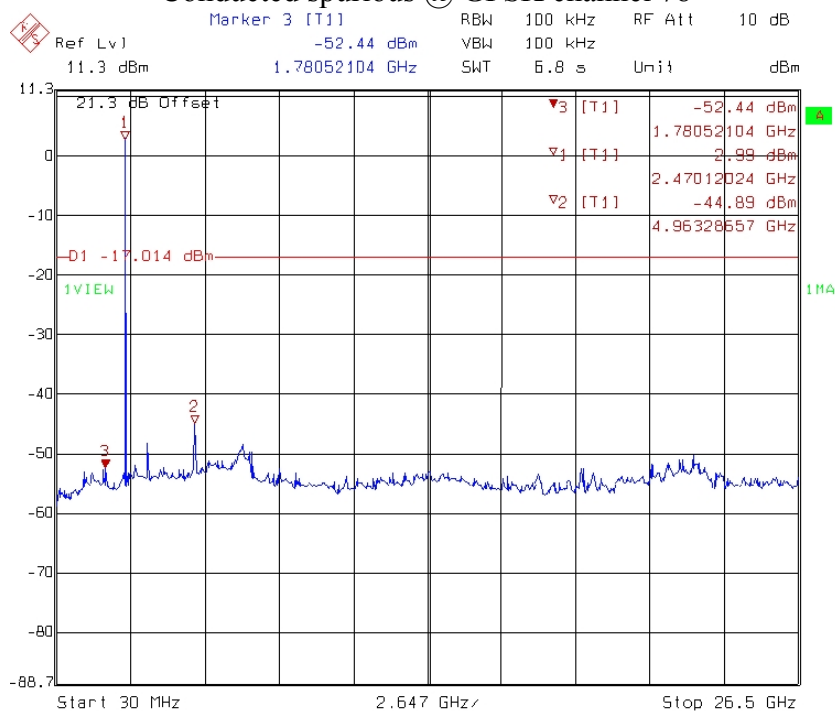


Conducted spurious @ GFSK channel 39



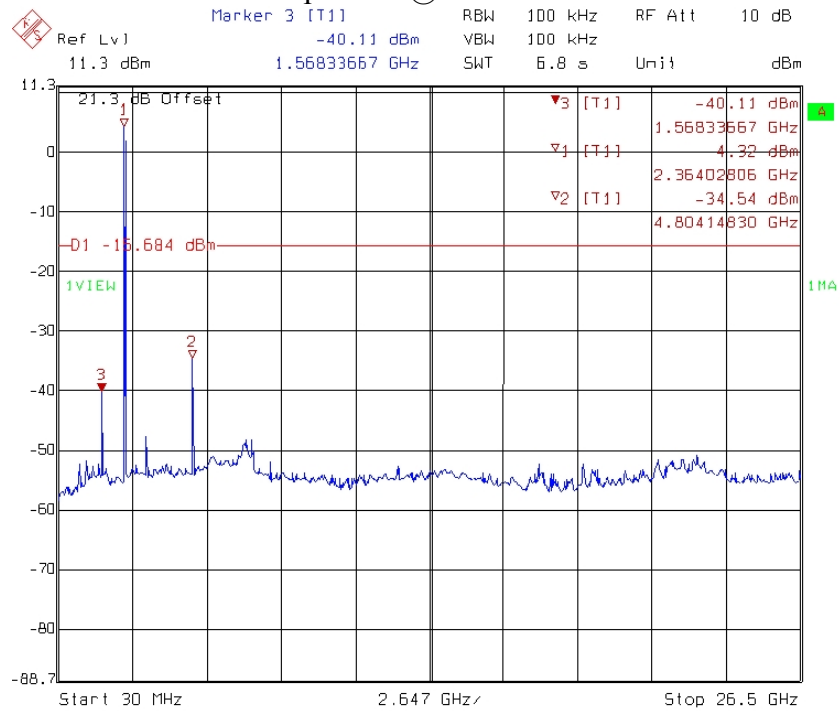
Title: Conducted Spurious
Comment A: GFSK ch39 2441 DH1
Date: 12 JUN 2012 11:53:05

Conducted spurious @ GFSK channel 78



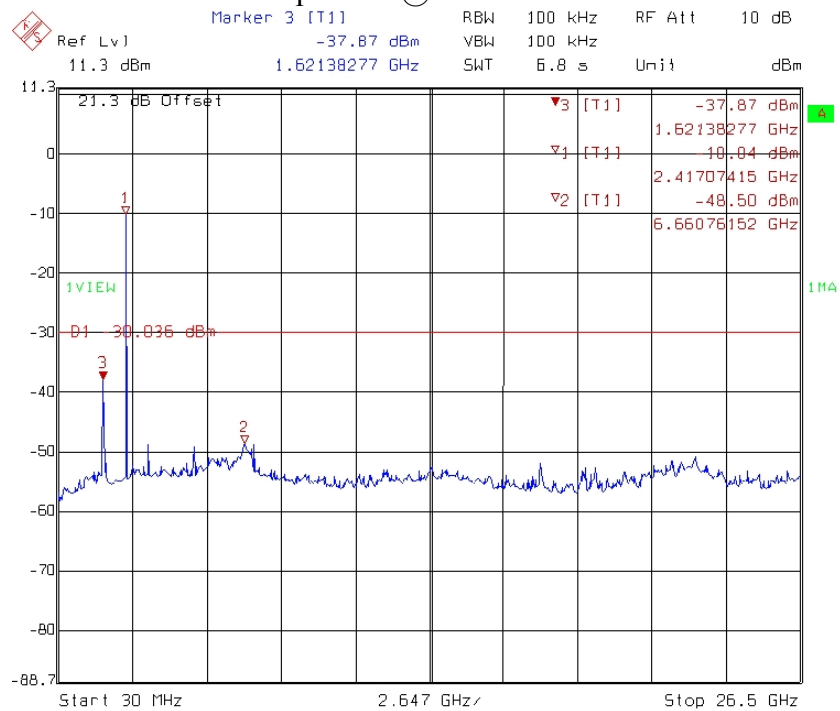
Title: Conducted Spurious
Comment A: GFSK ch78 2480 DH1
Date: 12 JUN 2012 12:00:32

Conducted spurious @ $\pi/4$ -DPSK channel 0



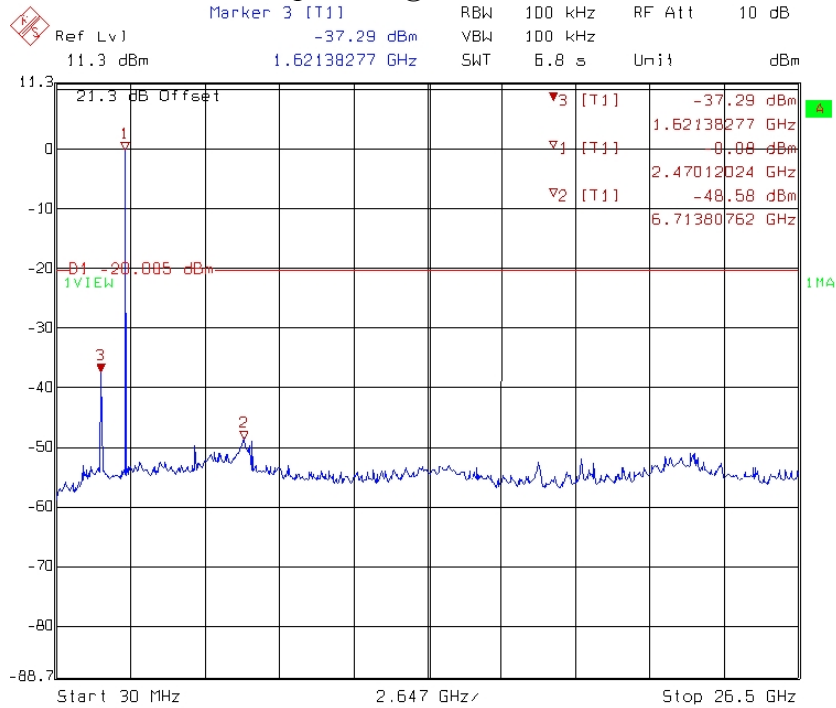
Title: Conducted Spurious
Comment A: pi/4-QPSK ch0 2402 DH1
Date: 13.JUN.2012 15:25:24

Conducted spurious @ $\pi/4$ -DPSK channel 39



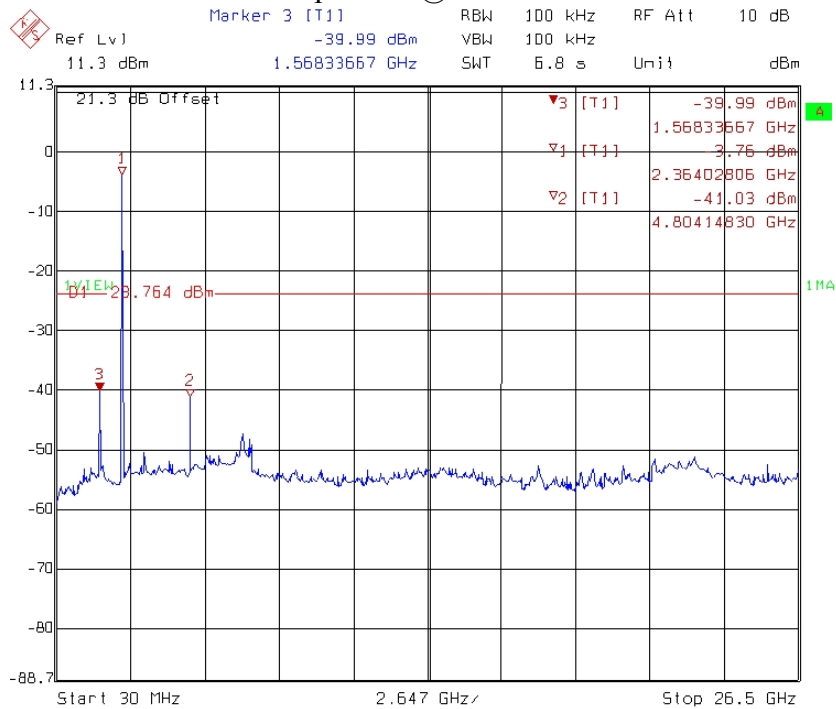
Title: Conducted Spurious
Comment A: pi/4-QPSK ch39 2441 DH1
Date: 13.JUN.2012 15:41:33

Conducted spurious @ $\pi/4$ -DPSK channel 78



Title: Conducted Spurious
Comment A: pi/4-QPSK ch78 2480 DH1
Date: 13.JUN.2012 16:05:09

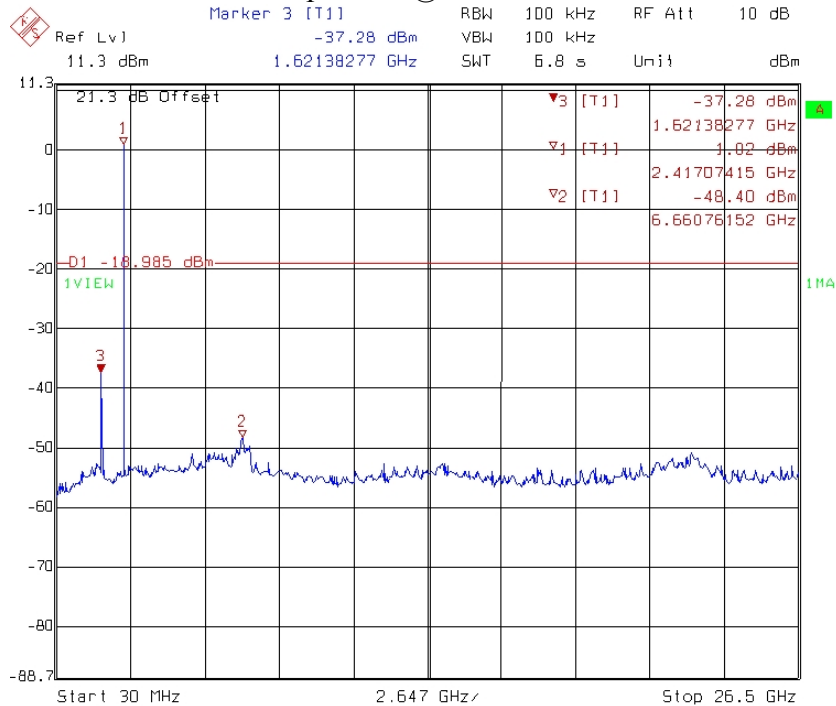
Conducted spurious @ 8-DPSK channel 0



Title: Conducted Spurious
Comment A: 8DPSK ch0 2402 DH1
Date: 13.JUN.2012 16:10:57

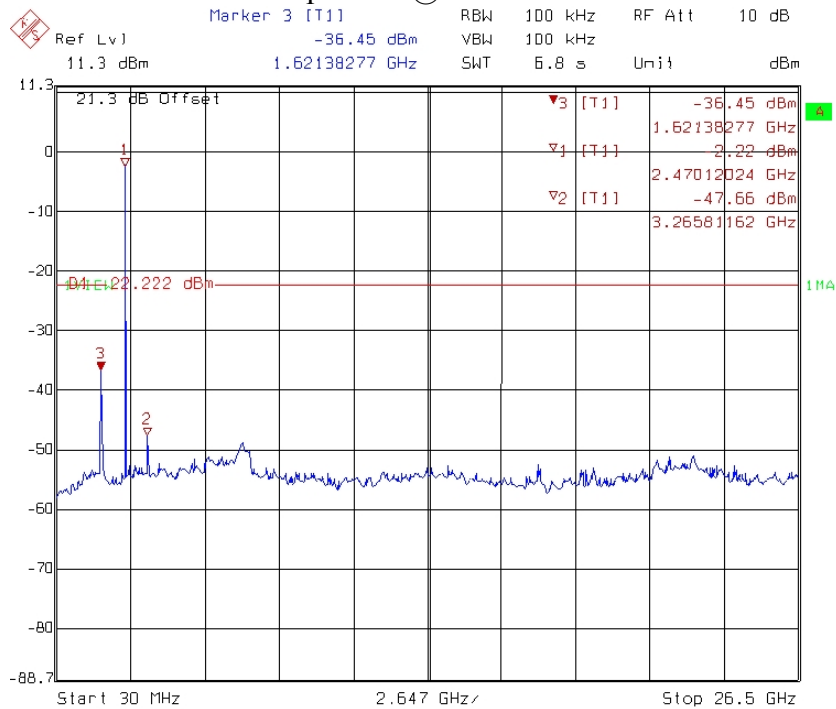


Conducted spurious @ 8-DPSK channel 39



Title: Conducted Spurious
Comment A: 8DPSK ch39 2441 DH1
Date: 13.JUN.2012 16:20:09

Conducted spurious @ 8-DPSK channel 78



Title: Conducted Spurious
Comment A: 8DPSK ch78 2480 DH1
Date: 13.JUN.2012 16:25:58

9. Radiated Emission test

9.1 Operating environment

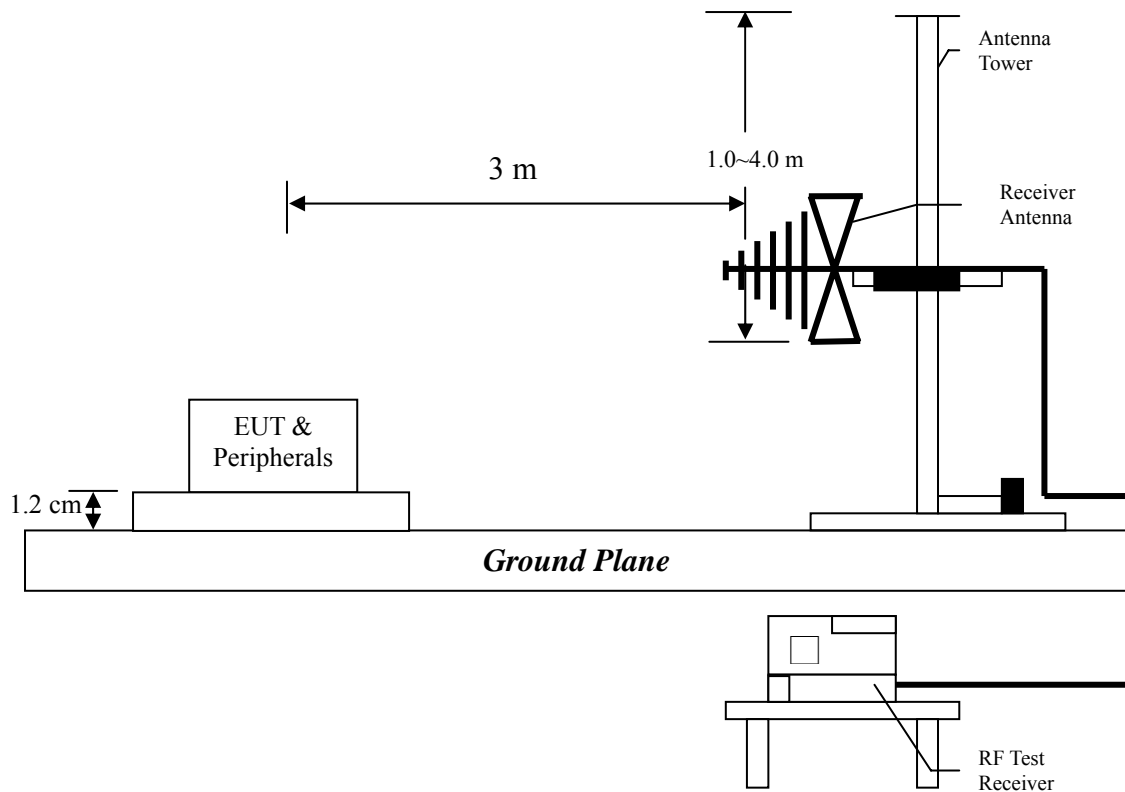
Temperature: 23 °C
Relative Humidity: 53 %
Atmospheric Pressure: 1008 hPa

9.2 Test setup & procedure

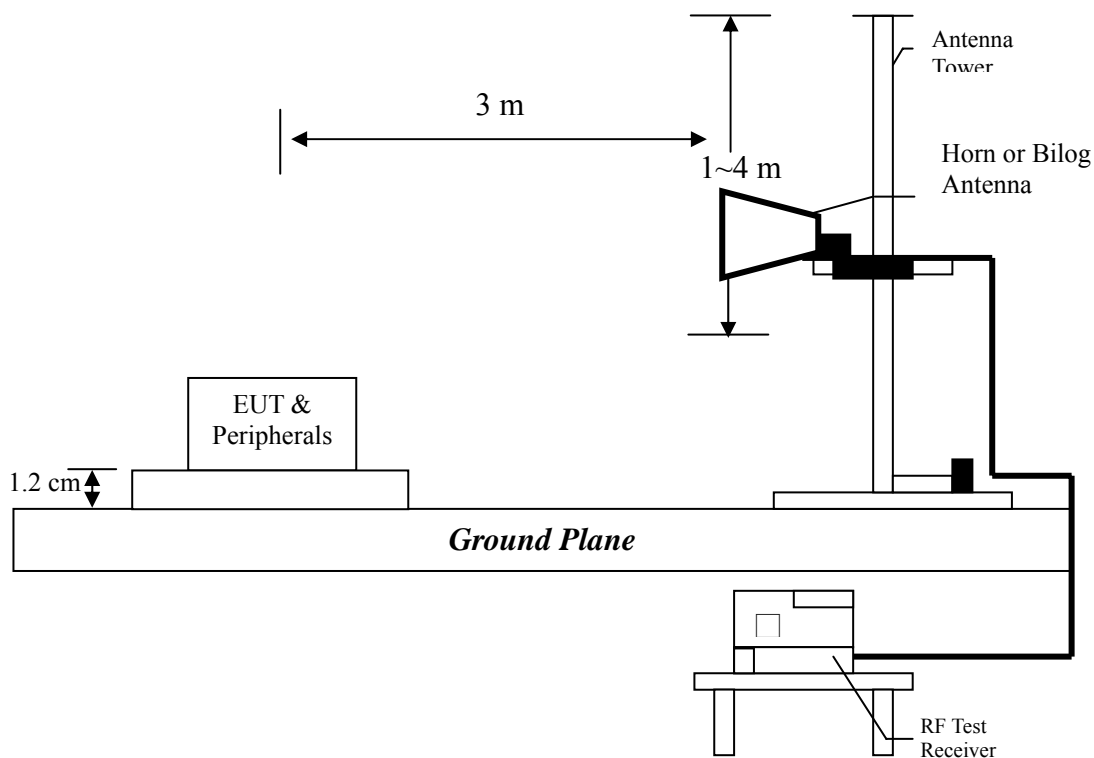
The test procedure was according to FCC measurement guidelines DA 00-705 and ANSI C63.4/2003.

The Diagram below shows the test setup, which is utilized to make these measurements.

The frequency spectrum from 30MHz to 1000MHz was investigated.



The frequency spectrum from over 1GHz was investigated.



The signal is maximized through rotation and placement in the three orthogonal axes.

Radiated emission measurements were performed from 30 MHz to 25 GHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1 GHz, 1MHz – for frequencies above 1 GHz.

The EUT for testing is arranged on a fiberglass turntable. If some peripherals apply to the EUT, the peripherals will be connected to EUT and the whole system. During the test, all cables were arranged to produce worst-case emissions. The signal is maximized through rotation. The height of antenna and polarization is changing constantly for exploring for maximum signal level. The height of antenna can be up to 4 meters and down to 1 meter.

The measurement for radiated emission will be done at the distance of three meters unless the signal level is too low to measure at that distance. In the case of the reading under noise floor, a pre-amplifier is used and/or the test is conducted at a closer distance. And then all readings are extrapolated back to the equivalent 3 meter reading using inverse scaling with distance.

The EUT configuration please refer to the “Spurious set-up photo.pdf”.

9.3 Emission limits

The spurious Emission shall test through the 10th harmonic. 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).

Frequency (MHz)	Limits (dBμV/m@3m)
30-88	40
88-216	43.5
216-960	46
Above 960	54

Remark:

1. In the above table, the tighter limit applies at the band edges.
2. Distance refers to the distance in meters between the measuring instrument antenna and the closed point of any part of the device or system

Measurement uncertainty was calculated in accordance with TR 100 028-1.

Parameter	Uncertainty
Radiated Emission	±5.056 dB



9.4 Radiated spurious emission test data

9.4.1 Measurement results: frequencies equal to or less than 1 GHz

The test was performed on EUT under GFSK, $\pi/4$ -DPSK and 8-DPSK mode. The worst case occurred at $\pi/4$ -DPSK Channel 78.

EUT : TS112W
Worst Case : $\pi/4$ -DPSK at Channel 78

Antenna Polariz. (V/H)	Freq. (MHz)	Receiver Detector	Corr. Factor (dB/m)	Reading (dBuV)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
V	247.28	QP	12.22	30.49	42.70	46.00	-3.30
V	365.62	QP	15.06	24.05	39.11	46.00	-6.89
V	400.54	QP	16.47	24.53	41.00	46.00	-5.00
V	474.26	QP	17.68	21.31	38.99	46.00	-7.01
V	516.94	QP	18.56	23.08	41.63	46.00	-4.37
V	827.34	QP	23.62	19.96	43.58	46.00	-2.42
H	315.18	QP	14.32	24.20	38.51	46.00	-7.49
H	400.54	QP	16.81	17.84	34.65	46.00	-11.35
H	563.50	QP	19.72	11.35	31.07	46.00	-14.93
H	631.40	QP	21.55	10.44	31.98	46.00	-14.02
H	743.92	QP	22.95	9.59	32.54	46.00	-13.46
H	827.34	QP	24.04	20.17	44.20	46.00	-1.80

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor

9.4.2 Measurement results: frequency above 1GHz

EUT : TS112W
Test Condition : GFSK at channel 0

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3180	PK	V	33.8	36.24	45.50	-	47.94	54	-6.06
4804	PK	V	35.1	38.54	54.23	-	57.67	74	-16.33
4804	AV	V	35.1	38.54	23.48	-30.75	26.92	54	-27.08
3180	PK	H	33.8	36.24	41.39	-	43.83	54	-10.17
4804	PK	H	35.1	38.54	48.35	-	51.79	54	-2.21
7206	PK	H	33.0	44.6	34.35	-	45.95	54	-8.05

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

EUT : TS112W
Test Condition : GFSK at channel 39

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3240	PK	V	33.8	36.24	43.39	-	45.83	54	-8.17
4882	PK	V	35.1	38.54	50.52	-	53.96	54	-0.04
3240	PK	H	33.8	36.24	42.36	-	44.80	54	-9.20
4882	PK	H	35.1	38.54	46.36	-	49.80	54	-4.20

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

EUT : TS112W
Test Condition : GFSK at channel 78

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3300	PK	V	33.8	36.24	46.73	-	49.17	54	-4.83
4960	PK	V	35.1	38.54	47.81	-	51.25	54	-2.75
3300	PK	H	33.8	36.24	43.02	-	45.46	54	-8.54
4960	PK	H	35.1	38.54	41.14	-	44.58	54	-9.42

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

EUT : TS112W
Test Condition : $\pi/4$ -DPSK at channel 0

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3180	PK	V	33.8	36.24	44.26	-	46.70	54	-7.30
4804	PK	V	35.1	38.54	52.33	-	55.77	74	-18.23
4804	AV	V	35.1	38.54	21.60	-30.73	25.04	54	-28.96
7206	PK	V	33.0	44.60	35.42	-	47.02	54	-6.98
3180	PK	H	33.8	36.24	42.23	-	44.67	54	-9.33
4804	PK	H	35.1	38.54	50.57	-	54.01	74	-19.99
4804	AV	H	35.1	38.54	19.84	-30.73	23.28	54	-30.72

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

EUT : TS112W
Test Condition : $\pi/4$ -DPSK at channel 39

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3240	PK	V	33.8	36.24	44.19	-	46.63	54	-7.37
4882	PK	V	35.1	38.54	49.98	-	53.42	54	-0.58
3240	PK	H	33.8	36.24	41.24	-	43.68	54	-10.32
4882	PK	H	35.1	38.54	48.86	-	52.30	54	-1.70

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

EUT : TS112W
Test Condition : $\pi/4$ -DPSK at channel 78

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3300	PK	V	33.8	36.24	48.78	-	51.22	54	-2.78
4960	PK	V	35.1	38.54	45.51	-	48.95	54	-5.05
3300	PK	H	33.8	36.24	43.09	-	45.53	54	-8.47
4960	PK	H	35.1	38.54	44.52	-	47.96	54	-6.04

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.



EUT : TS112W
Test Condition : 8-DPSK at channel 0

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3180	PK	V	33.8	36.24	43.06	-	45.50	54	-8.50
4804	PK	V	35.1	38.54	52.49	-	55.93	74	-18.07
4804	AV	V	35.1	38.54	21.79	-30.70	25.23	54	-28.77
3180	PK	H	33.8	36.24	42.14	-	44.58	54	-9.42
4804	PK	H	35.1	38.54	50.58	-	54.02	74	-19.98
4804	AV	H	35.1	38.54	19.88	-30.70	23.32	54	-30.68

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

EUT : TS112W
Test Condition : 8-DPSK at channel 39

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamplifier Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3240	PK	V	33.8	36.24	43.65	-	46.09	54	-7.91
4882	PK	V	35.1	38.54	51.50	-	54.94	74	-19.06
4882	AV	V	35.1	38.54	20.80	-30.70	24.24	54	-29.76
3240	PK	H	33.8	36.24	41.96	-	44.40	54	-9.60
4882	PK	H	35.1	38.54	50.54	-	53.98	54	-0.02

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.



EUT : TS112W
Test Condition : 8-DPSK at channel 78

Frequency (MHz)	Spectrum Analyzer Detector	Antenna Polariz. (H/V)	Preamp Gain (dB)	Correction Factor (dB/m)	Reading (dBuV)	Average Factor (dB)	Corrected Level (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
3300	PK	V	33.8	36.24	48.81	-	51.25	54	-2.75
4960	PK	V	35.1	38.54	48.99	-	52.43	54	-1.57
3300	PK	H	33.8	36.24	43.35	-	45.79	54	-8.21
4960	PK	H	35.1	38.54	44.11	-	47.55	54	-6.45

Remark:

1. Corr. Factor = Antenna Factor + Cable Loss
2. Corrected Level = Reading + Corr. Factor + Duty Cycle Correction Factor
3. The frequency measured ranges from 1GHz to 25GHz.
4. Duty Cycle Correction Factor: Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

10. Emission on the band edge §FCC 15.247(d)

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum 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.

10.1 Test setup & procedure

Please refer to the clause 9.2 of this report.

10.2 Test Result

GFSK Mode					
Channel	Measurement Freq. Band (MHz)	Detector	The Max. Field Strength in Restrict Band (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
0 (lowest)	2310-2390	PK	57.17	74	-16.83
		AV	26.42	54	-27.58
78 (highest)	2483.5-2500	PK	67.67	74	-6.33
		AV	36.92	54	-17.08

Remark: Duty Cycle Correction Factor = -30.75 dB

Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

$\pi/4$ -DPSK Mode					
Channel	Measurement Freq. Band (MHz)	Detector	The Max. Field Strength in Restrict Band (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
0 (lowest)	2310-2390	PK	57.02	74	-16.98
		AV	26.29	54	-27.71
78 (highest)	2483.5-2500	PK	67.50	74	-6.50
		AV	36.77	54	-17.23

Remark: Duty Cycle Correction Factor = -30.73 dB

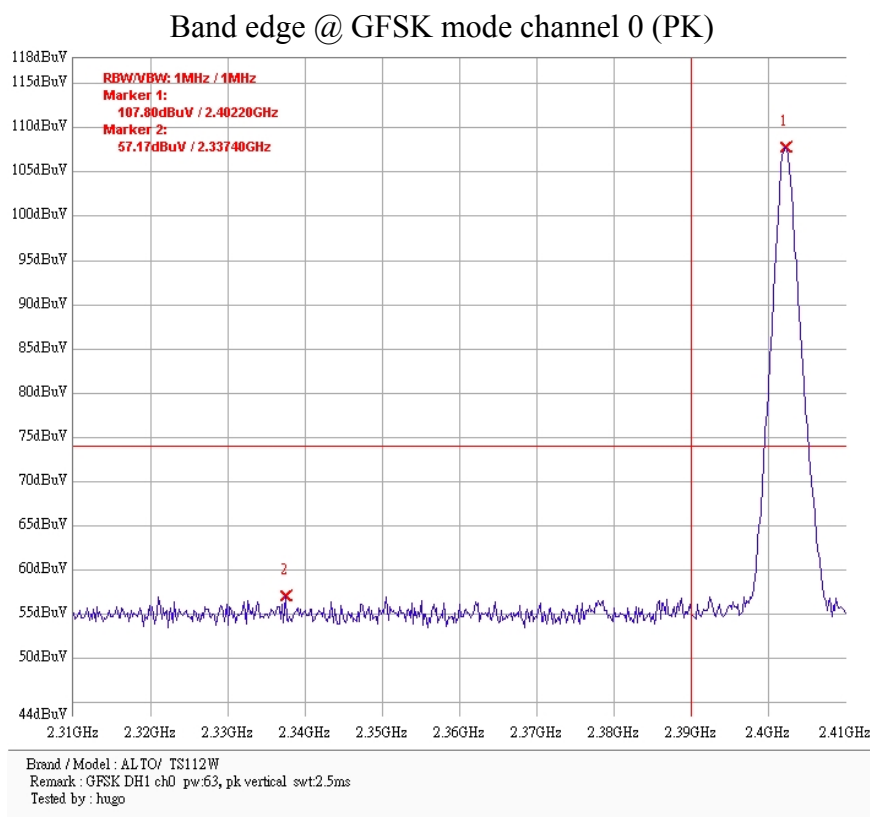
Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

8-DPSK Mode					
Channel	Measurement Freq. Band (MHz)	Detector	The Max. Field Strength in Restrict Band (dBuV/m)	Limit @ 3 m (dBuV/m)	Margin (dB)
0 (lowest)	2310-2390	PK	57.13	74	-16.87
		AV	26.43	54	-27.57
78 (highest)	2483.5-2500	PK	67.62	74	-6.38
		AV	36.92	54	-17.08

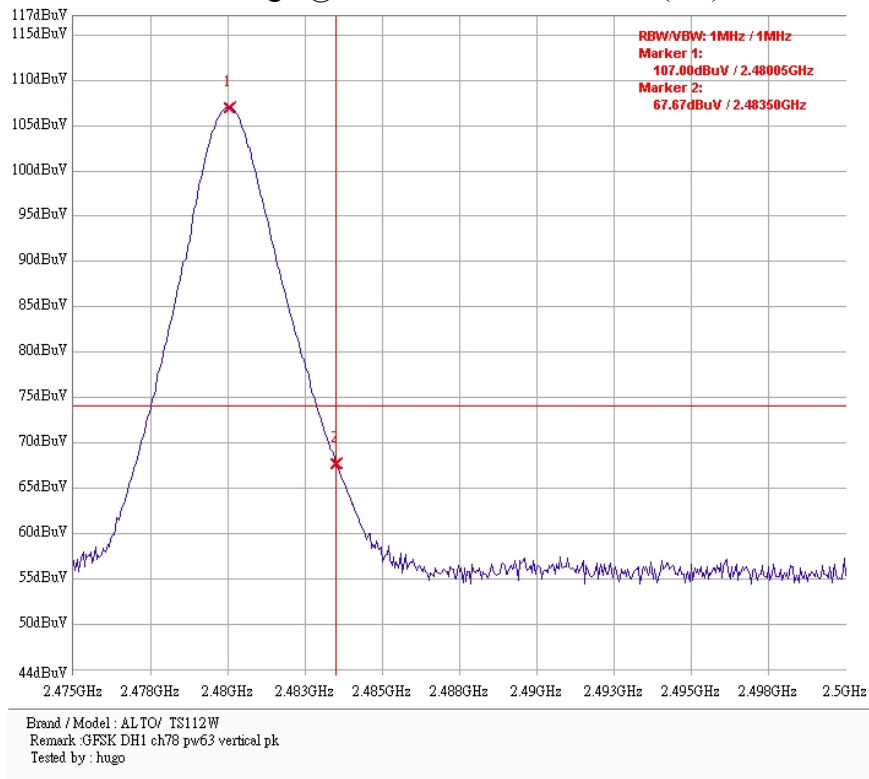
Remark: Duty Cycle Correction Factor = -30.70 dB

Please refer Time of Occupancy (dwell time) test in clause 6 of this report.

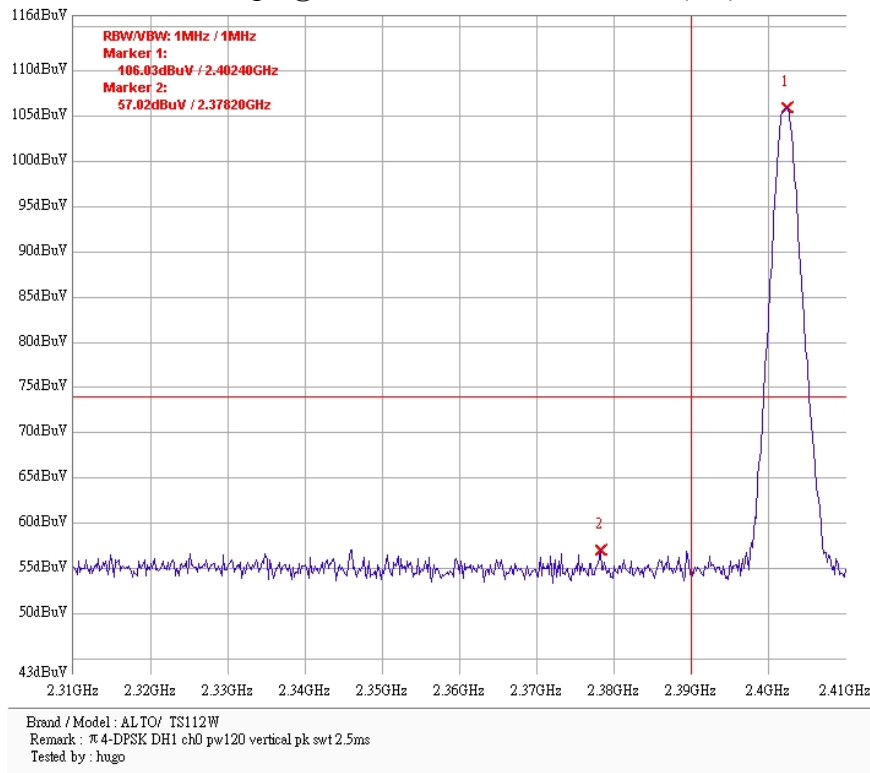
Please see the plot below.



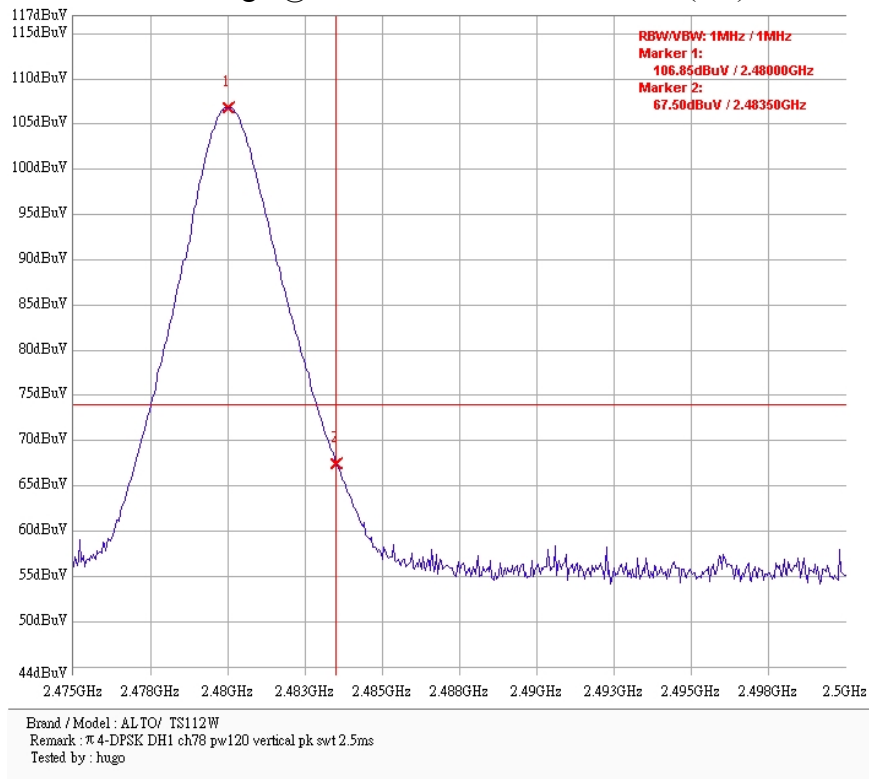
Band edge @ GFSK mode channel 78 (PK)



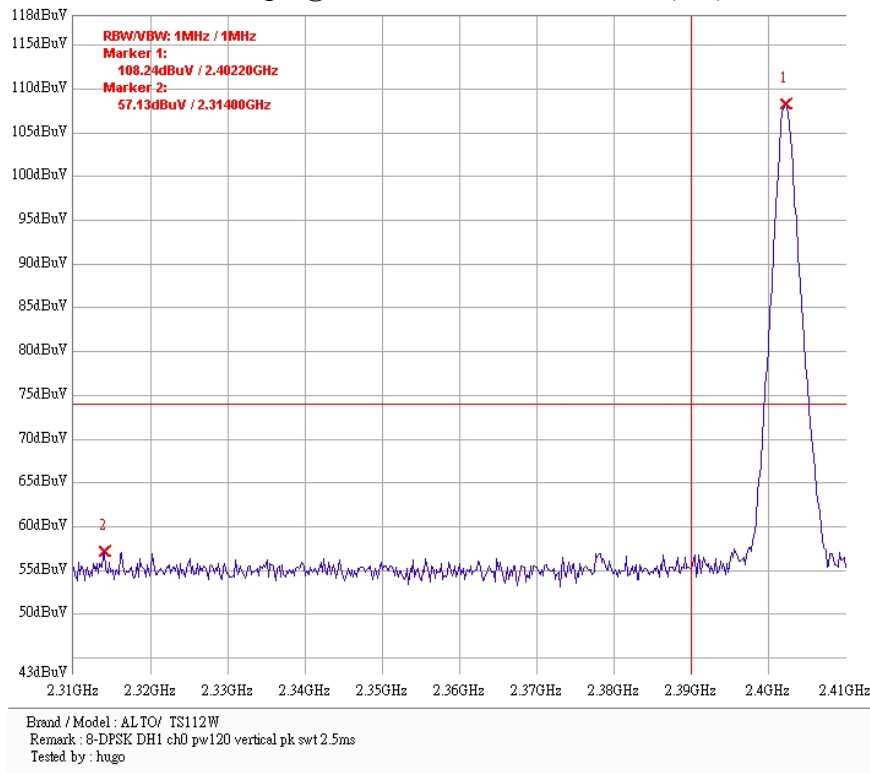
Band edge @ $\pi/4$ -DPSK mode channel 0 (PK)



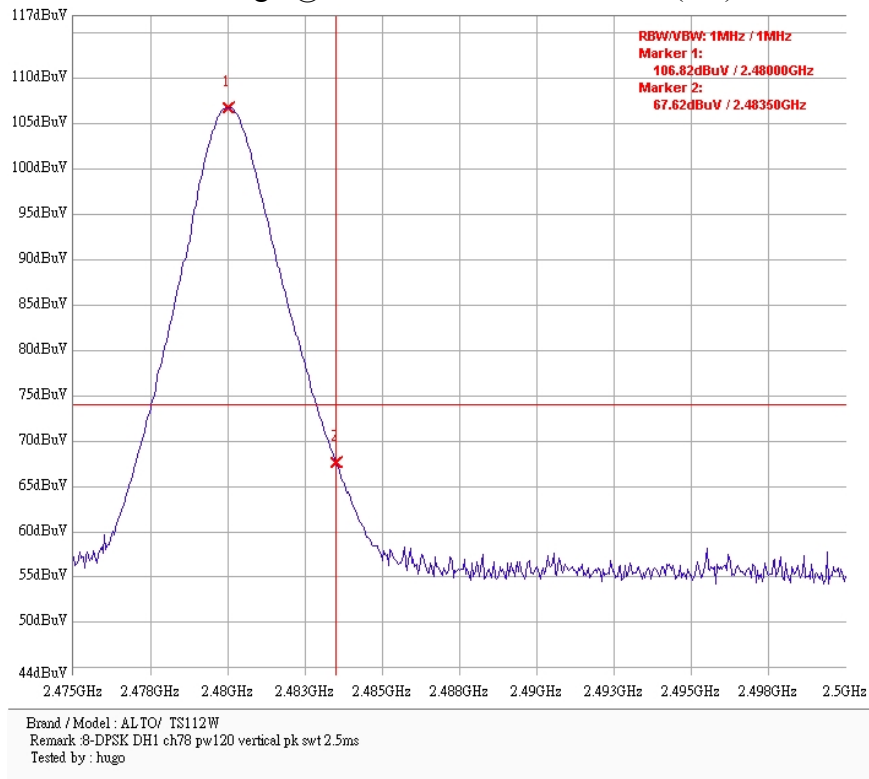
Band edge @ $\pi/4$ -DPSK mode channel 78 (PK)



Band edge @ 8-DPSK mode channel 0 (PK)



Band edge @ 8-DPSK mode channel 78 (PK)

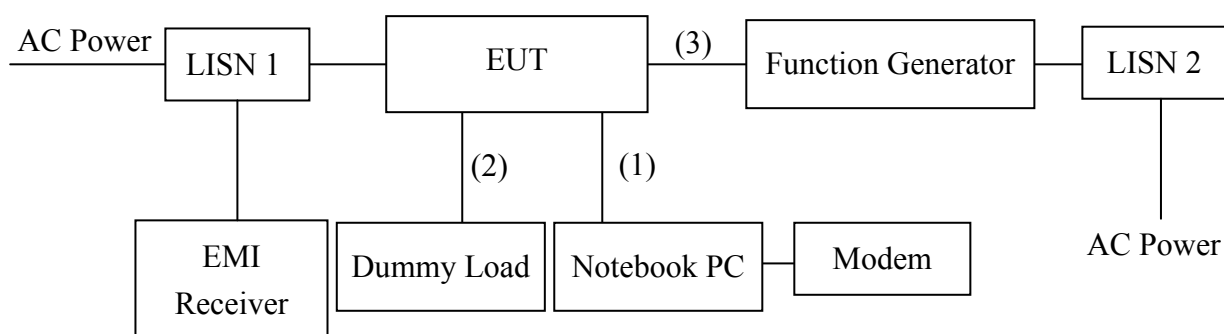


11. Power Line Conducted Emission test §FCC 15.207

11.1 Operating environment

Temperature:	25	°C
Relative Humidity:	60	%
Atmospheric Pressure	1008	hPa

11.2 Test setup & procedure



- (1) LPT SPI Cable 1 meter
- (2) Shielded Cable with XLR connector 0.4 meter × 1
- (3) Shielded Cable with XLR connector 6 meter × 2

The test procedure was according to ANSI C63.4/2003.

The EUT are connected to the main power through a line impedance stabilization network (LISN). This provides a 50 ohm/50uH coupling impedance for the measuring equipment. The peripheral devices are also connected to the main power through a LISN that provides a 50 ohm/50uH coupling impedance with 50 ohm termination.

Both sides (Line and Neutral) of AC line are checked for maximum conducted interference. In order to find the maximum emission, the relative positions of equipment and all of the interface cables must be changed according to ANSI C63.4/2003 on conducted measurement. The bandwidth of the field strength meter (R & S Test Receiver ESCS 30) is set at 9 kHz.

The EUT configuration please refer to the “Conducted set-up photo.pdf”.

11.3 Emission limit

Freq. (MHz)	Conducted Limit (dBuV)	
	Q.P.	Ave.
0.15~0.50	66 – 56*	56 – 46*
0.50~5.00	56	46
5.00~30.0	60	50

*Decreases with the logarithm of the frequency.

11.4 Uncertainty of Conducted Emission

Expanded uncertainty ($k=2$) of conducted emission measurement is ± 2.786 dB.

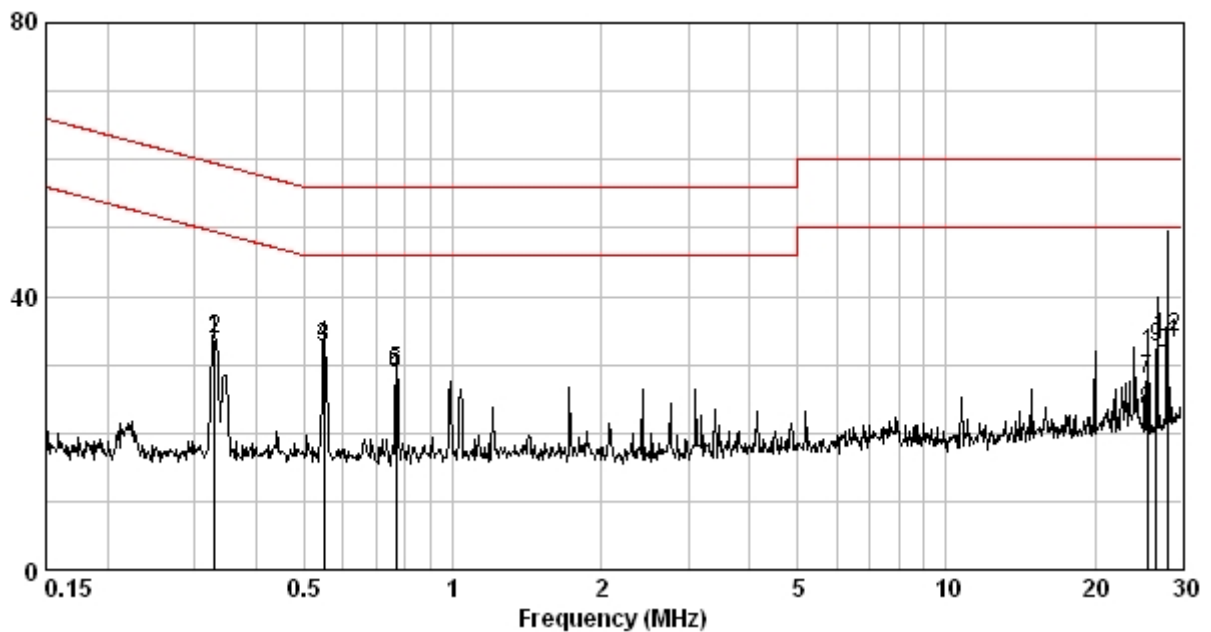
11.5 Power Line Conducted Emission test data

Phase: Line
Model No.: TS112W
Operating mode: Normal operating mode

Frequency (MHz)	Corr. Factor (dB)	Level Qp (dBuV)	Limit Qp (dBuV)	Level Av (dBuV)	Limit Av (dBuV)	Margin (dB)	
						Qp	Av
0.329	0.21	33.72	59.46	33.84	49.46	-25.74	-15.62
0.549	0.25	32.59	56.00	32.70	46.00	-23.41	-13.30
0.769	0.28	28.96	56.00	28.64	46.00	-27.04	-17.36
25.551	2.19	27.76	60.00	23.12	50.00	-32.24	-26.88
26.587	2.21	32.39	60.00	31.57	50.00	-27.61	-18.43
27.970	2.22	34.08	60.00	33.20	50.00	-25.92	-16.80

Remark:

1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)



Phase: Neutral
Model No.: TS112W
Operating mode: Normal operating mode

Frequency (MHz)	Corr. Factor (dB)	Level Qp (dBuV)	Limit Qp (dBuV)	Level Av (dBuV)	Limit Av (dBuV)	Margin (dB)	
						Qp	Av
0.329	0.22	37.44	59.47	37.69	49.47	-22.03	-11.78
0.549	0.26	32.82	56.00	32.92	46.00	-23.18	-13.08
0.767	0.29	28.01	56.00	27.43	46.00	-27.99	-18.57
2.418	0.45	28.91	56.00	28.29	46.00	-27.09	-17.71
23.967	1.82	33.91	60.00	33.81	50.00	-26.09	-16.19
26.585	1.87	26.95	60.00	25.11	50.00	-33.05	-24.89

Remark:

1. Corr. Factor (dB) = LISN Factor (dB) + Cable Loss (dB)
2. Margin (dB) = Level (dBuV) – Limit (dBuV)

