

4.7 Transmitter Radiated Emissions FCC Rule 15.247(d), 15.209, 15.205

4.7.1 Requirement

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) (see §15.205(c)).

For out of band radiated emissions (except for frequencies in restricted bands), in any 100 kHz bandwidths outside the EUT pass-band, the RF power shall be at least 20dB (peak) or 30 dB (average) below that of the maximum in-band 100 kHz emissions.

4.7.2 Procedure

Radiated emission measurements were performed from 30 MHz to 26,000 MHz. Spectrum Analyzer Resolution Bandwidth is 100 kHz or greater for frequencies 30 MHz to 1000 MHz, 1 MHz for frequencies above 1000 MHz.

The EUT is placed on a plastic turntable that is 80 cm in height. If the EUT attaches to peripherals, they are connected and operational (as typical as possible). During testing, all cables were manipulated to produce worst-case emissions. The signal is maximized through rotation. The antenna height and polarization are varied during the search for maximum signal level. The antenna height is varied from 1 to 4 meters. Radiated emissions are taken at 3 meters

Measurements made from 1 GHz to 18GHz had a 2.4-2.5GHz notch filter in place. A preamp was used from 30MHz to 26GHz.

All measurements were made with a Peak Detector and compared to QP limits for 30MHz – 1GHz and Average or Peak limits for 1GHz – 26GHz where applicable.

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels).

4.7.3 Field Strength Calculation

Field Strength Calculation

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

FS = RA + AF + CF - AG; if measurement is performed at a distance other than specified in the rule, a Distance Correction Factor (DCF) shall be added.

Where FS = Field Strength in dB(μ V/m)

RA = Receiver Amplitude (including preamplifier) in dB(μ V); AF = Antenna Factor in dB(1/m)

CF = Cable Attenuation Factor in dB; AG = Amplifier Gain in dB

Assume a receiver reading of 52.0 dB(μ V) is obtained. The antennas factor of 7.4 dB(1/m) and cable factor of 1.6 dB is added. The amplifier gain of 29 dB is subtracted, giving field strength of 32 dB(μ V/m). This value in dB(μ V/m) was converted to its corresponding level in μ V/m.

RA = 52.0 dB(μ V)

AF = 7.4 dB(1/m)

CF = 1.6 dB

AG = 29.0 dB

$$FS = 52.0 + 7.4 + 1.6 - 29.0 = 32 \text{ dB}(\mu\text{V}/\text{m}).$$

Level in μ V/m = Common Antilogarithm $[(32 \text{ dB}\mu\text{V}/\text{m})/20] = 39.8 \mu\text{V}/\text{m}$.

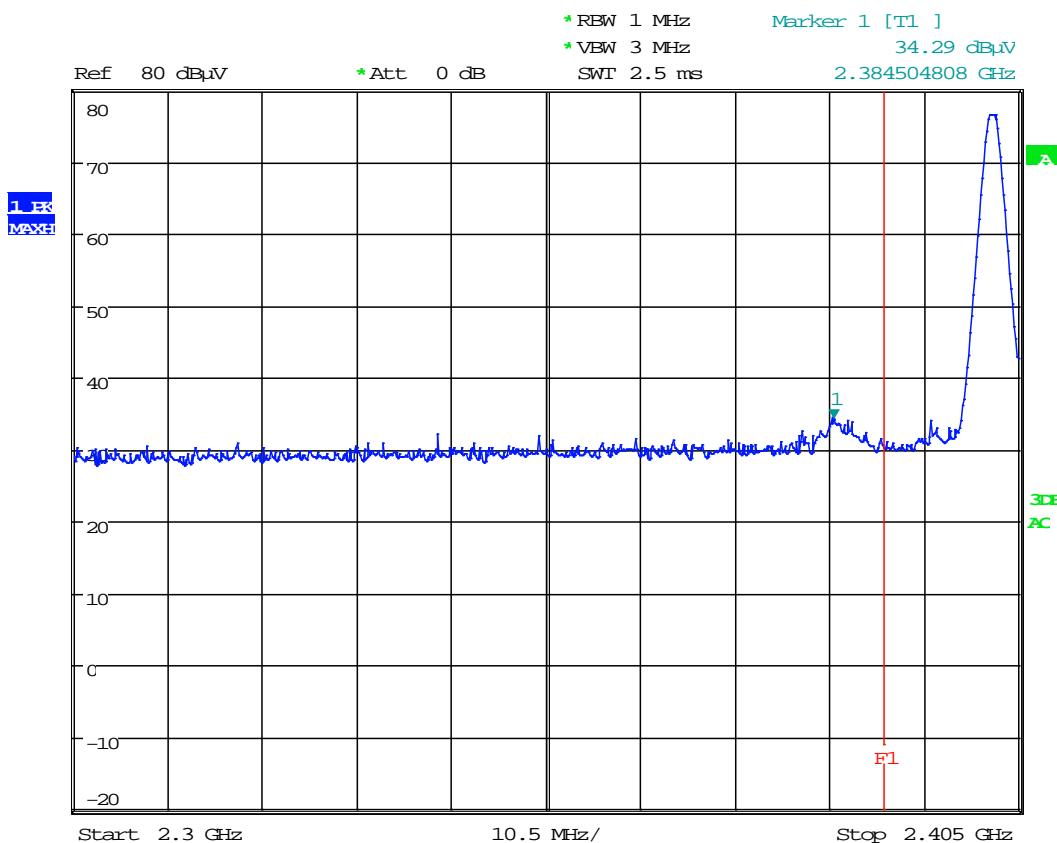
4.7.4 Test Results

The data on the following pages list the significant emission frequencies, the limit and the margin of compliance.

Radiated emission measurements were performed up to 26GHz. No other emissions were detected above the noise floor which is at least 10 dB below the limit.

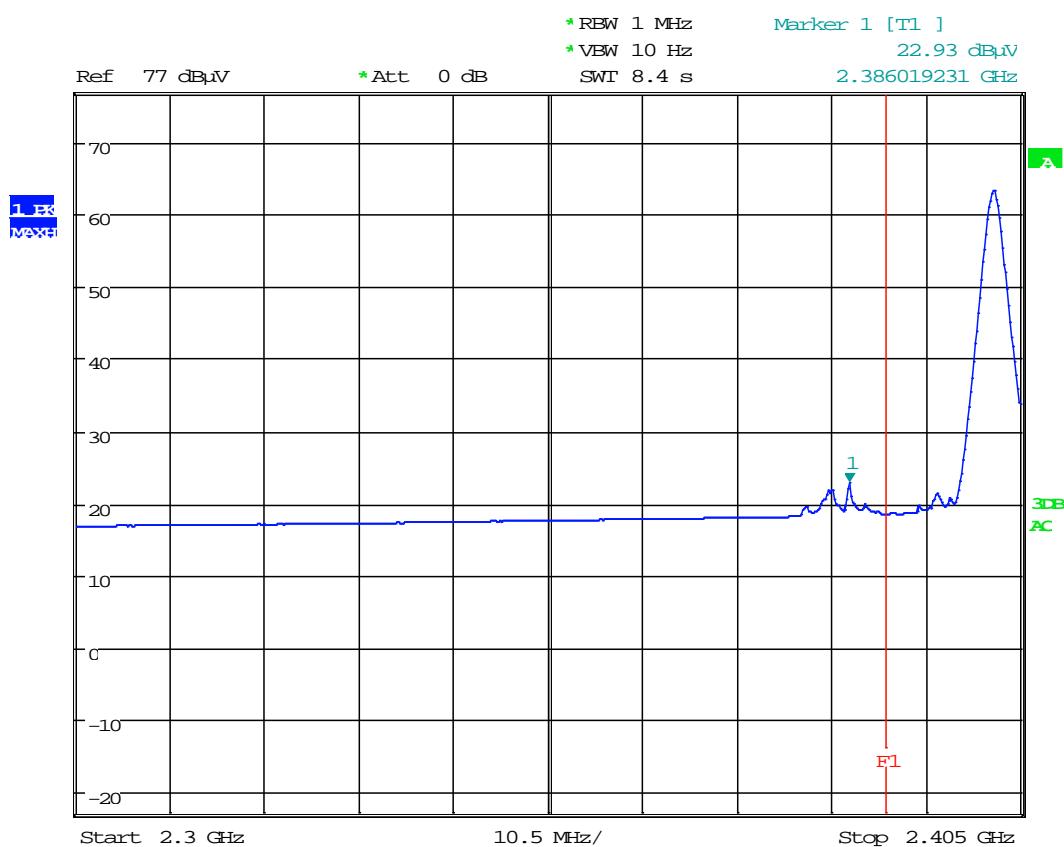
4.7.4 Test Results: 15.209/15.205 Restricted Band Emissions with Internal Antenna

GFSK Modulation for Out-of-Band Spurious Emissions at the Band Edge



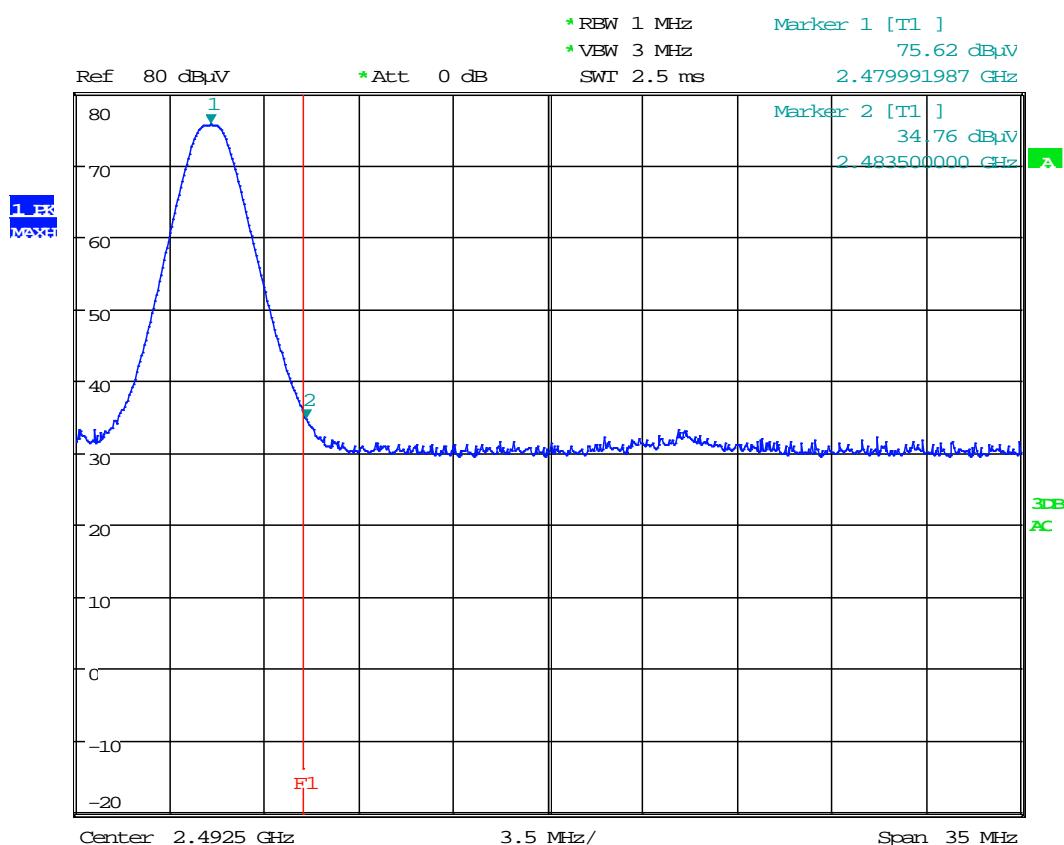
Date: 28.OCT.2015 05:55:12

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
GFSK	Peak	0	2402	32.3	29.8	62.1	74	-11.9	Pass



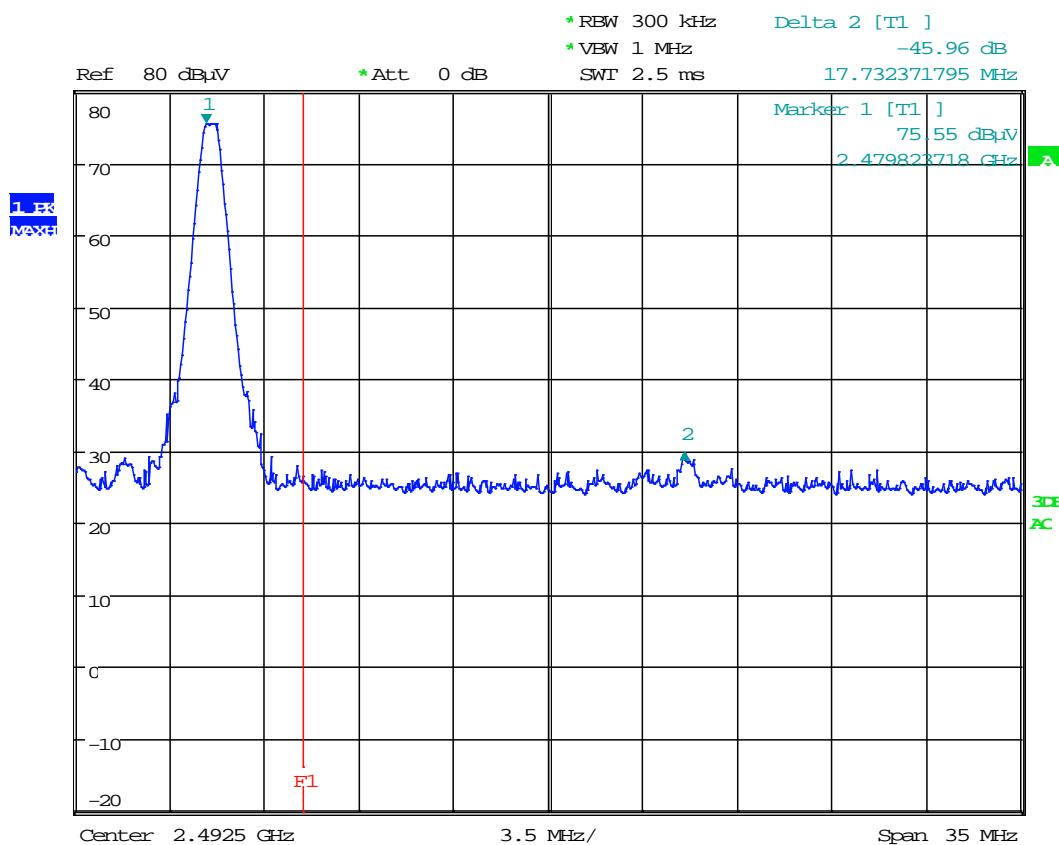
Date: 28.OCT.2015 05:52:01

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
GFSK	Avg	0	2402	22.9	29.8	52.7	54	-1.3	Pass



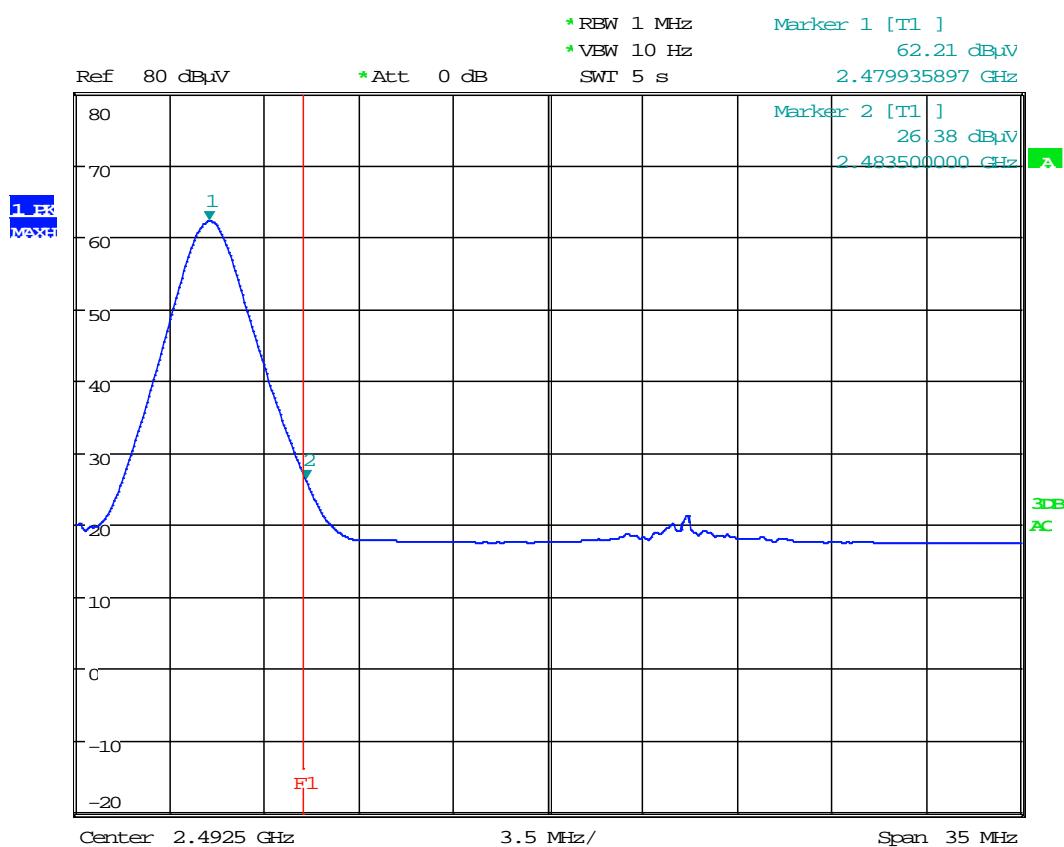
Date: 28.OCT.2015 06:41:47

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
GFSK	Peak	78	2480	34.8	29.8	64.6	74	-9.4	Pass



Date: 28.OCT.2015 06:44:32

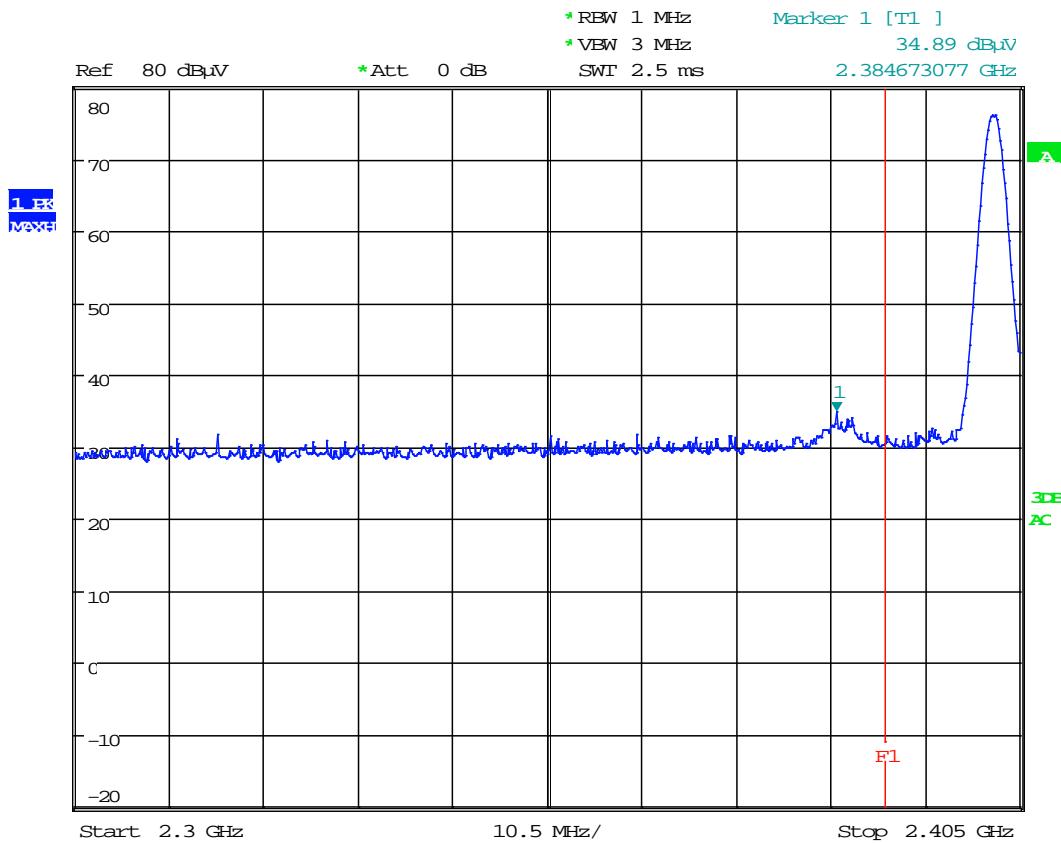
Modulation Type	Detector	EUT Channel	Frequency	Peak to Band Edge Delta
			MHz	dB(uV)
GFSK	Peak	78	2480	46.0



Date: 28.OCT.2015 06:42:44

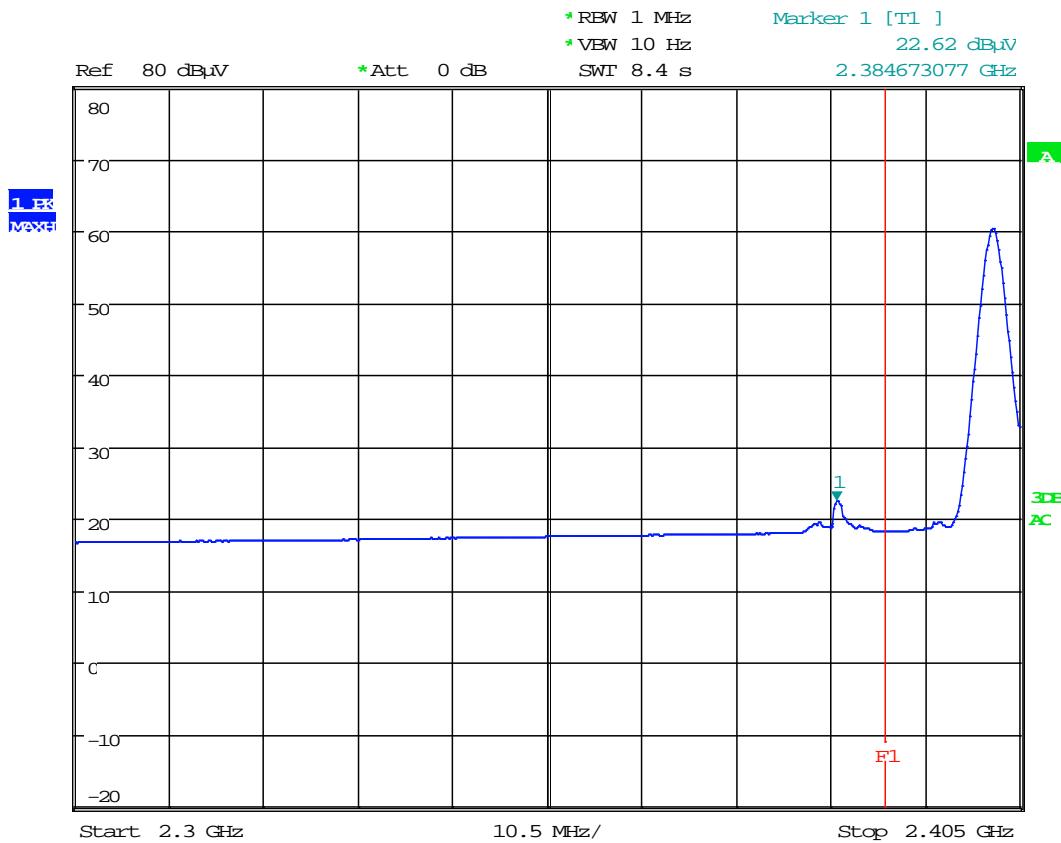
Frequency	Raw FS Amplitude at 3m	Corr. Factor	FS at 3m	Peak to Band Edge Delta	Corrected Band edge FS at 3m	Peak Limit	Margin	Results
MHz	dB(uV)	dB	dB(uV/m)	dB(uV)	dB(uV/m)	dB(uV/m)	dB(uV/m)	
2480	62.2	29.8	92.0	46.0	46	54	-8.0	Pass

$\pi/4$ -DQPSK Modulation for Out-of-Band Spurious Emissions at the Band Edge



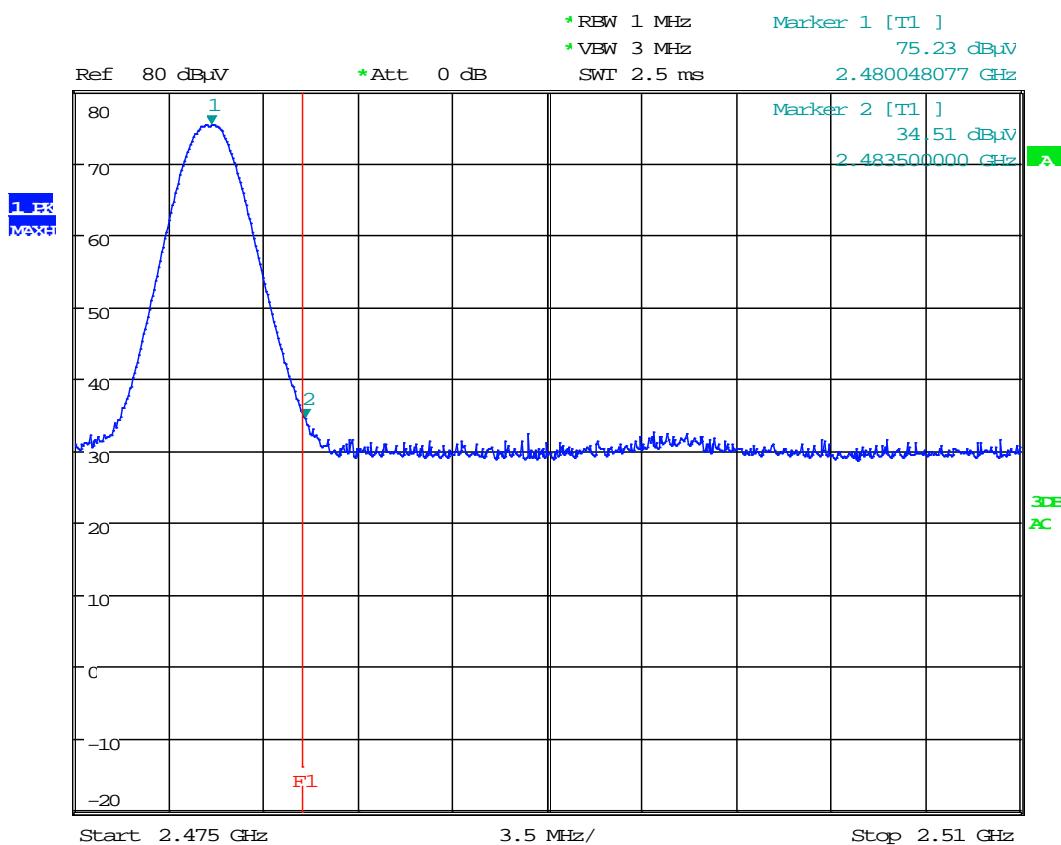
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Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
$\pi/4$ -DQPSK	Peak	0	2402	34.9	29.8	63.8	74	-10.2	Pass



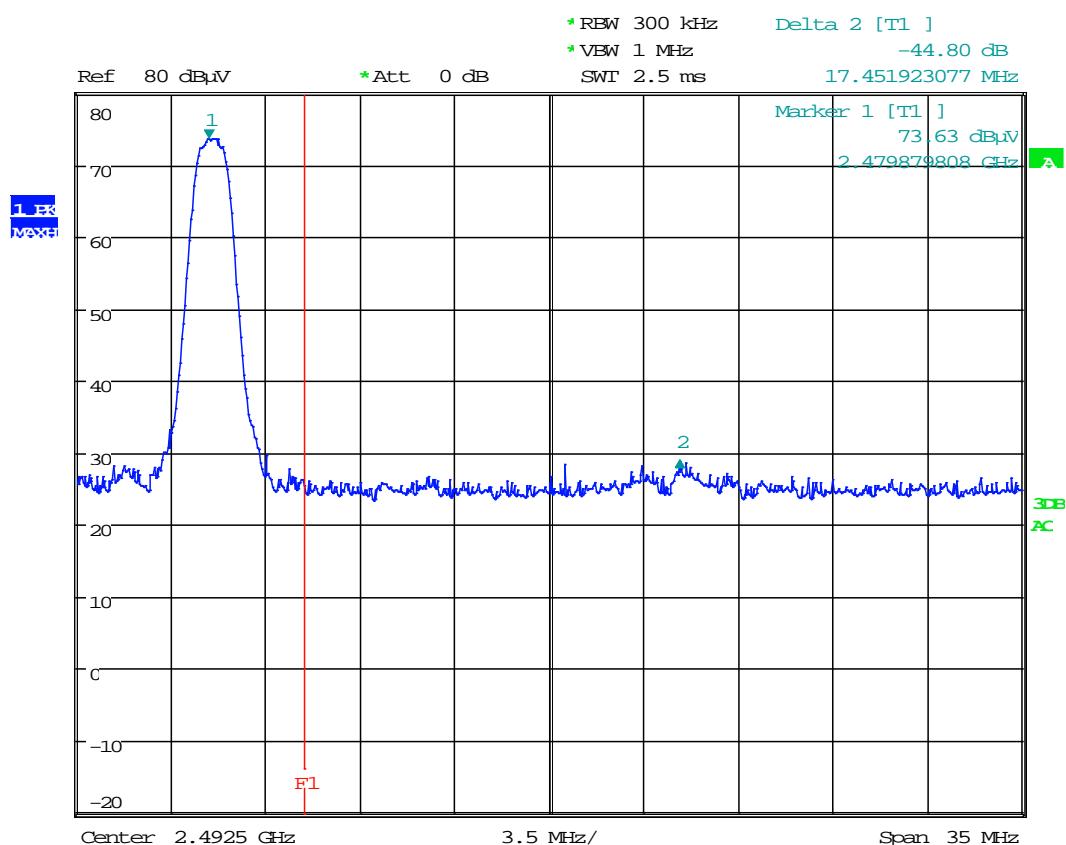
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Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
$\pi/4$ -DQPSK	Avg	0	2402	22.6	29.8	52.4	54	-1.6	Pass



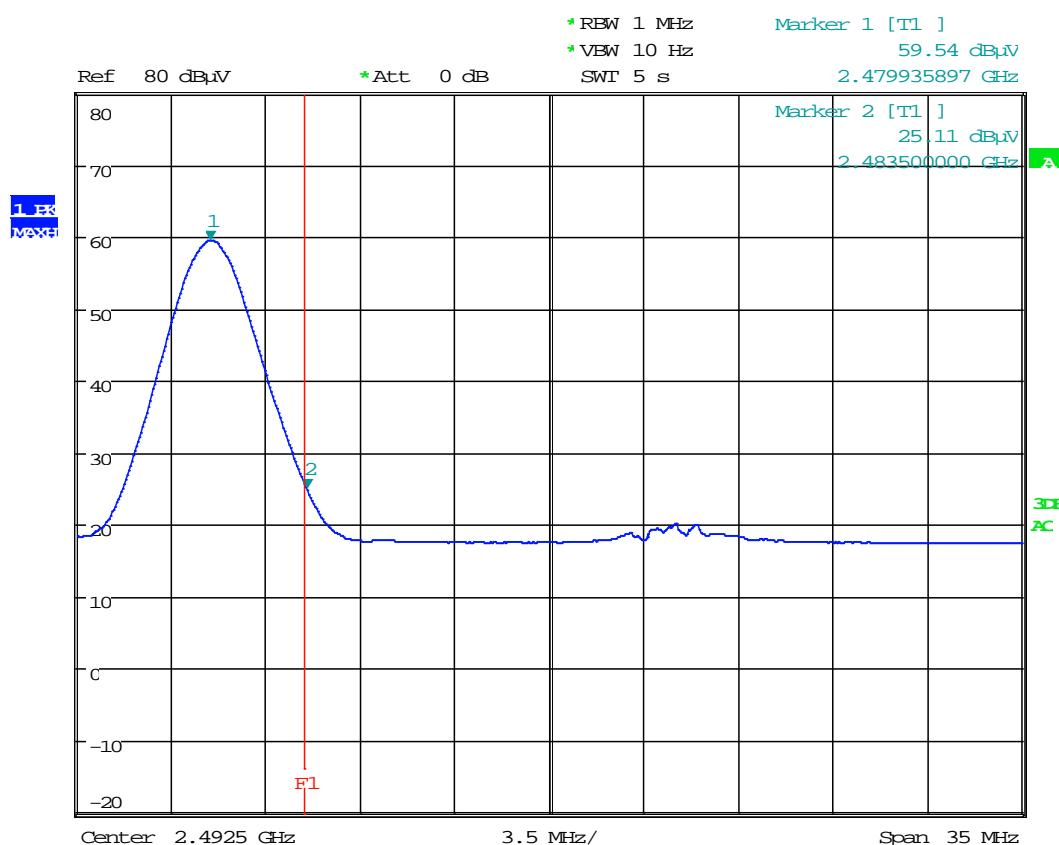
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Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
$\pi/4$ -DQPSK	Peak	78	2480	34.5	29.8	63.4	74	-10.6	Pass



Date: 28.OCT.2015 06:33:51

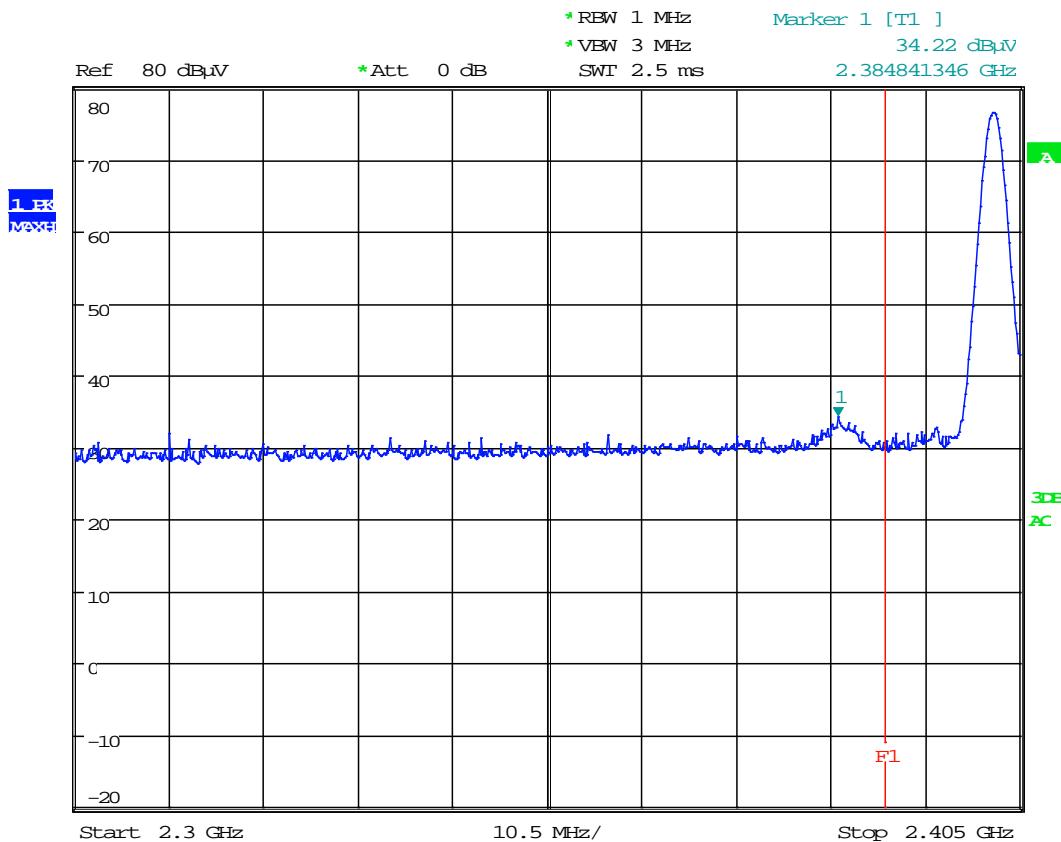
Modulation Type	Detector	EUT Channel	Frequency	Peak to Band Edge Delta
			MHz	dB(uV)
$\pi/4$ -DQPSK	Peak	78	2480	44.8



Date: 28.OCT.2015 06:32:05

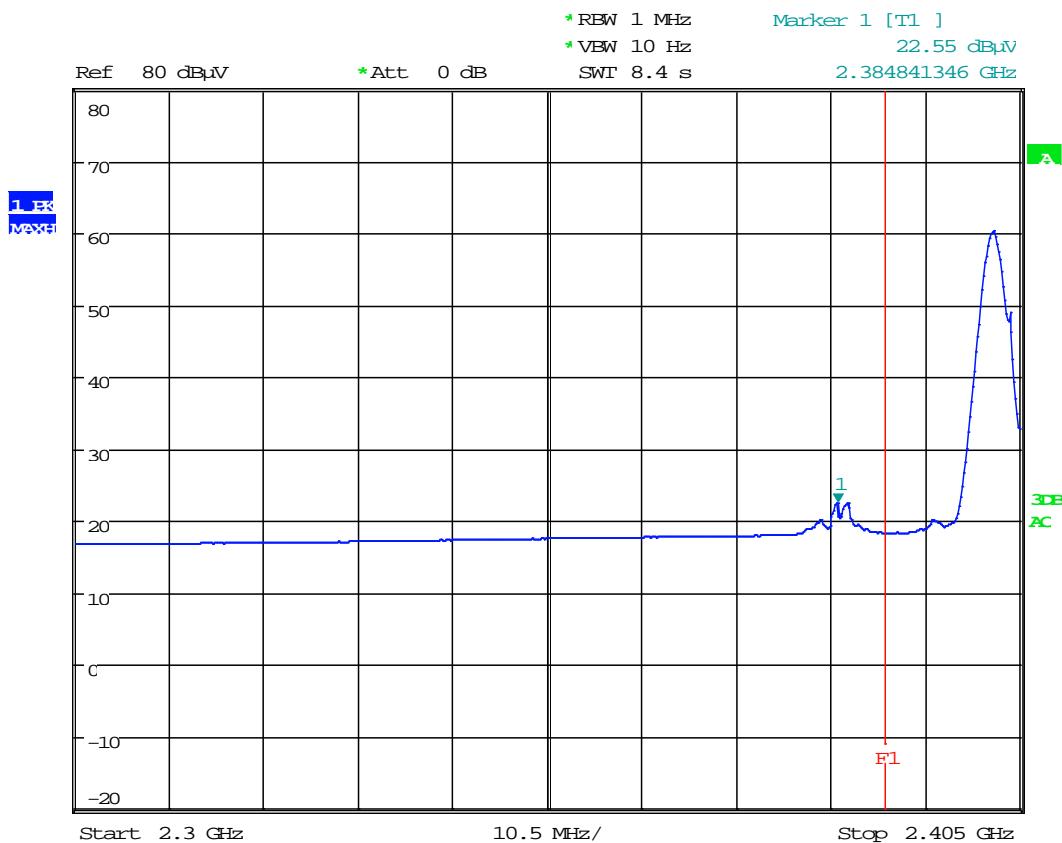
Frequency	Raw FS Amplitude at 3m	Corr. Factor	FS at 3m	Peak to Band Edge Delta	Corrected Band edge FS at 3m	Peak Limit	Margin	Results
MHz	dB(uV)	dB	dB(uV/m)	dB(uV)	dB(uV/m)	dB(uV/m)	dB(uV/m)	
2480	59.5	29.8	89.3	44.8	44.5	54	-9.5	Pass

8DPSK Modulation for Out-of-Band Spurious Emissions at the Band Edge



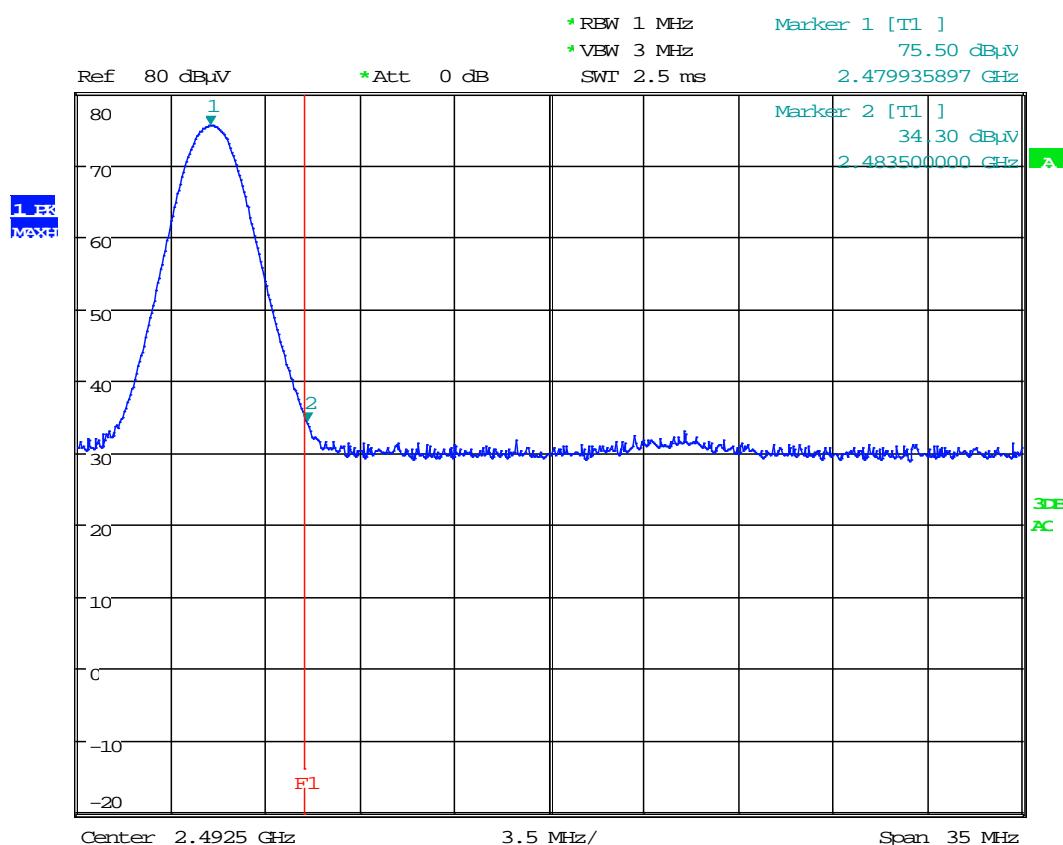
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Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)		
8DPSK	Peak	0	2402	34.2	29.8	64	74	-10.0	Pass



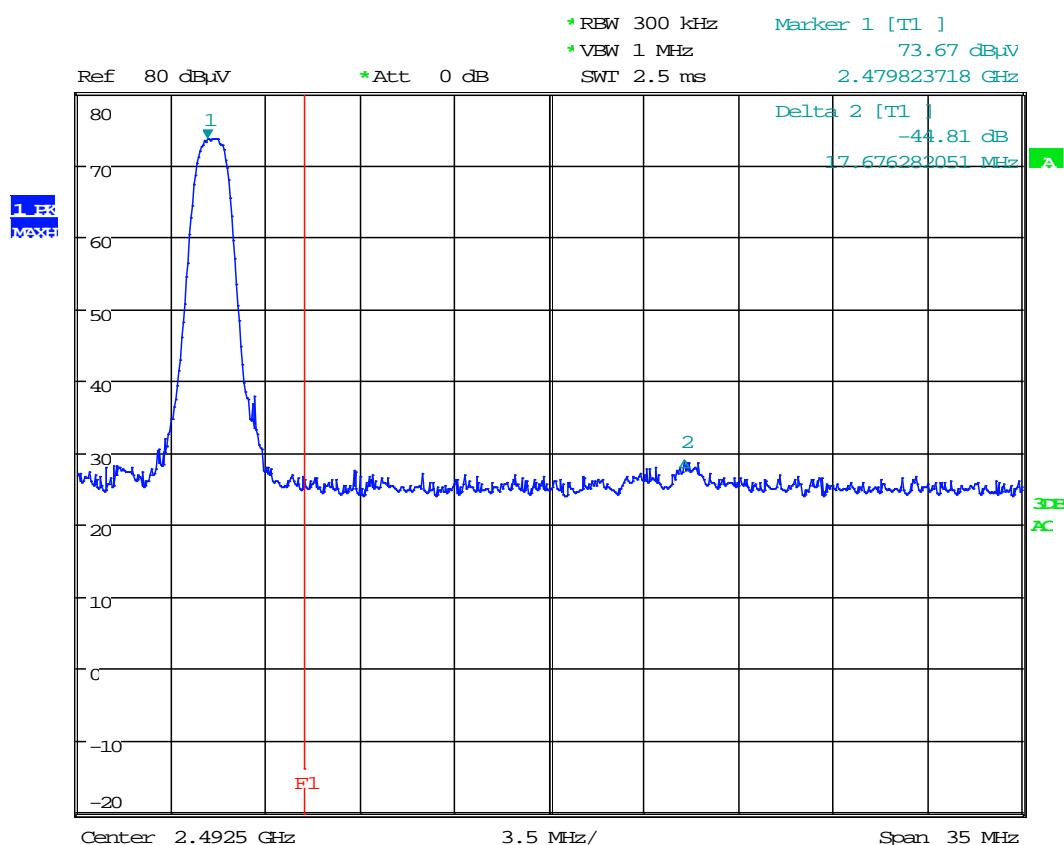
Date: 28.OCT.2015 06:00:49

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
8DPSK	Avg	0	2402	22.5	29.8	52.3	54	-1.7	Pass



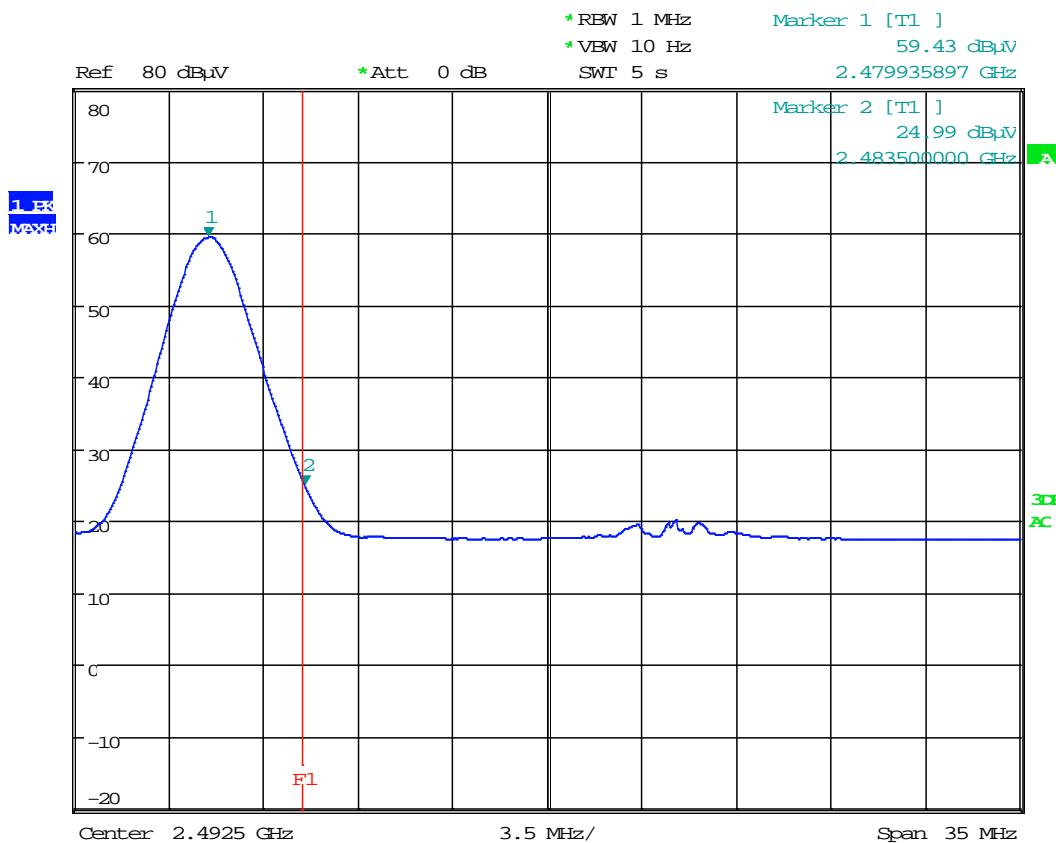
Date: 28.OCT.2015 06:36:59

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
8DPSK	Peak	78	2480	34.3	29.8	64.1	74	-9.9	Pass



Date: 28.OCT.2015 06:39:14

Modulation Type	Detector	EUT Channel	Frequency	Peak to Band Edge Delta
			MHz	dB(uV)
8DPSK	Peak	78	2480	44.8



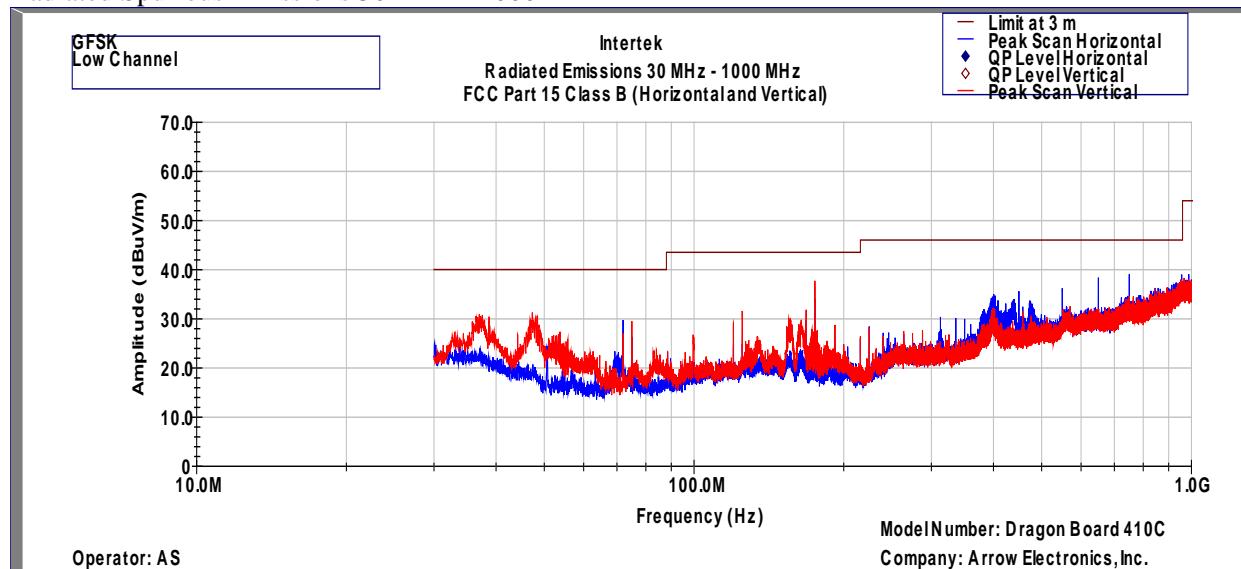
Date: 28.OCT.2015 06:37:41

Frequency	Raw FS Amplitude at 3m	Corr. Factor	FS at 3m	Peak to Band Edge Delta	Corrected Band edge FS at 3m	Peak Limit	Margin	Results
MHz	dB(uV)	dB	dB(uV/m)	dB(uV)	dB(uV/m)	dB(uV/m)	dB(uV/m)	
2480	62.2	29.8	89.2	44.8	44.4	54	-9.6	Pass

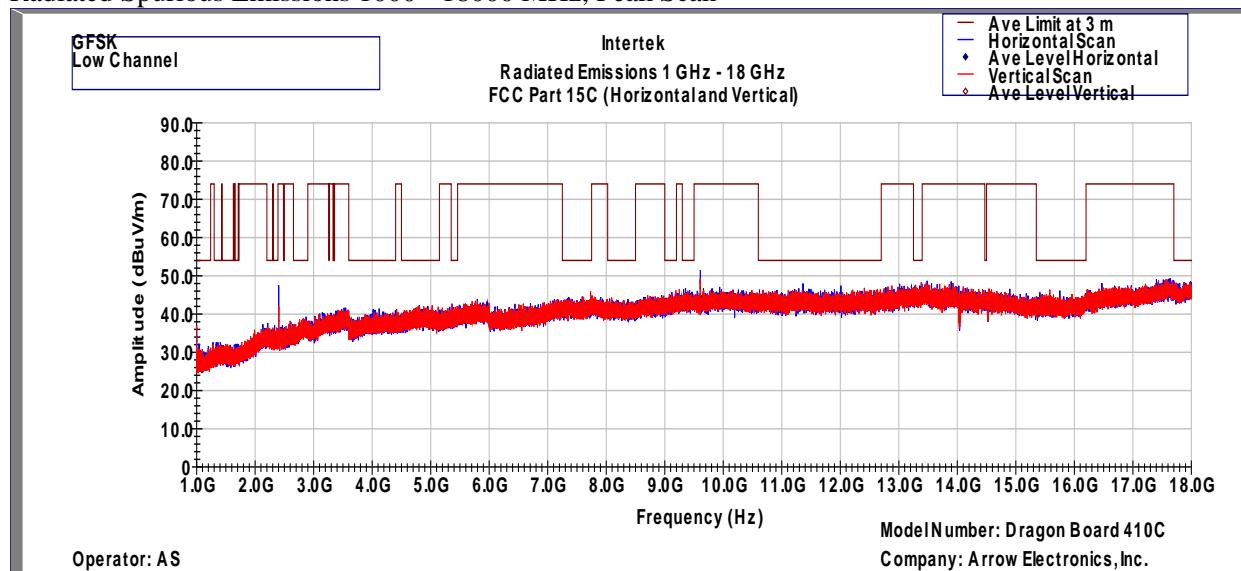
Out-of-Band Radiated Spurious Emissions GFSK

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



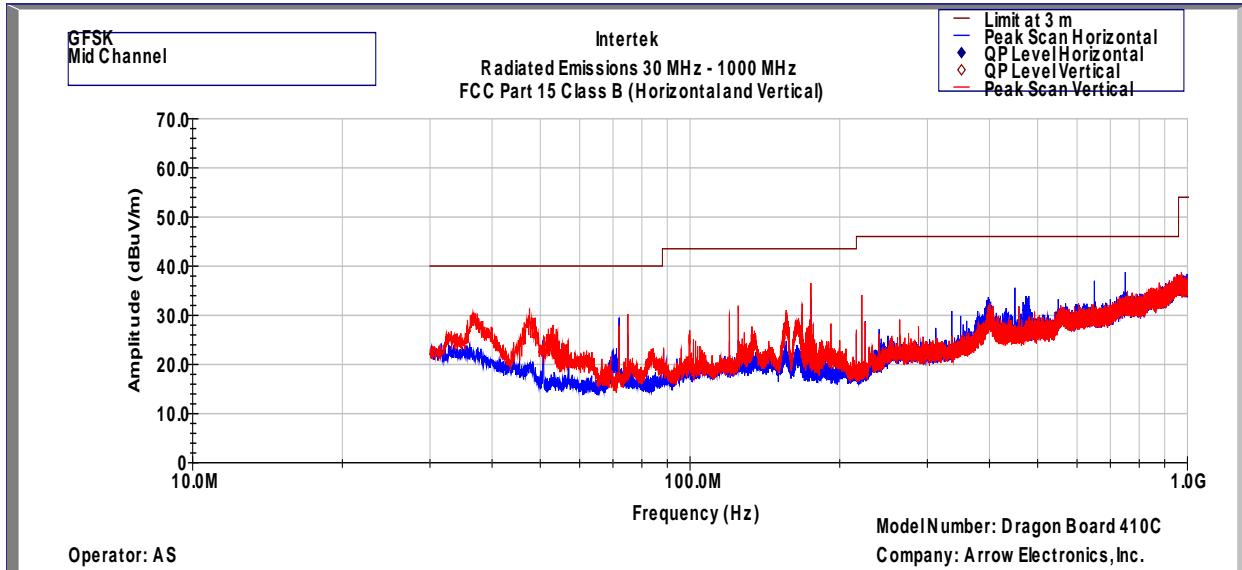
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

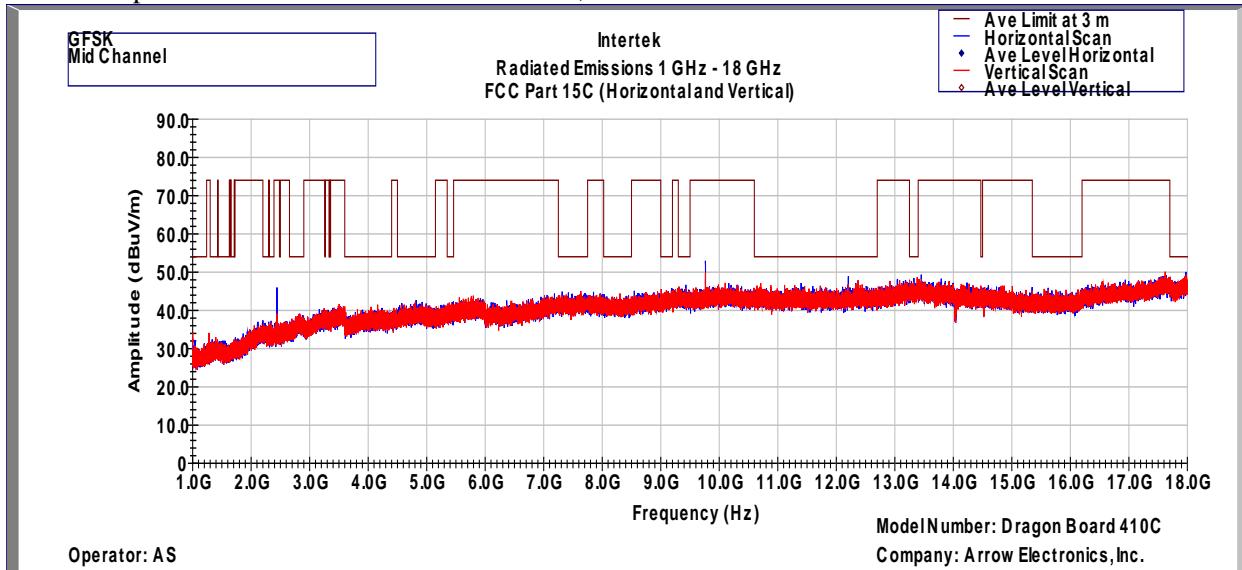
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2441MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



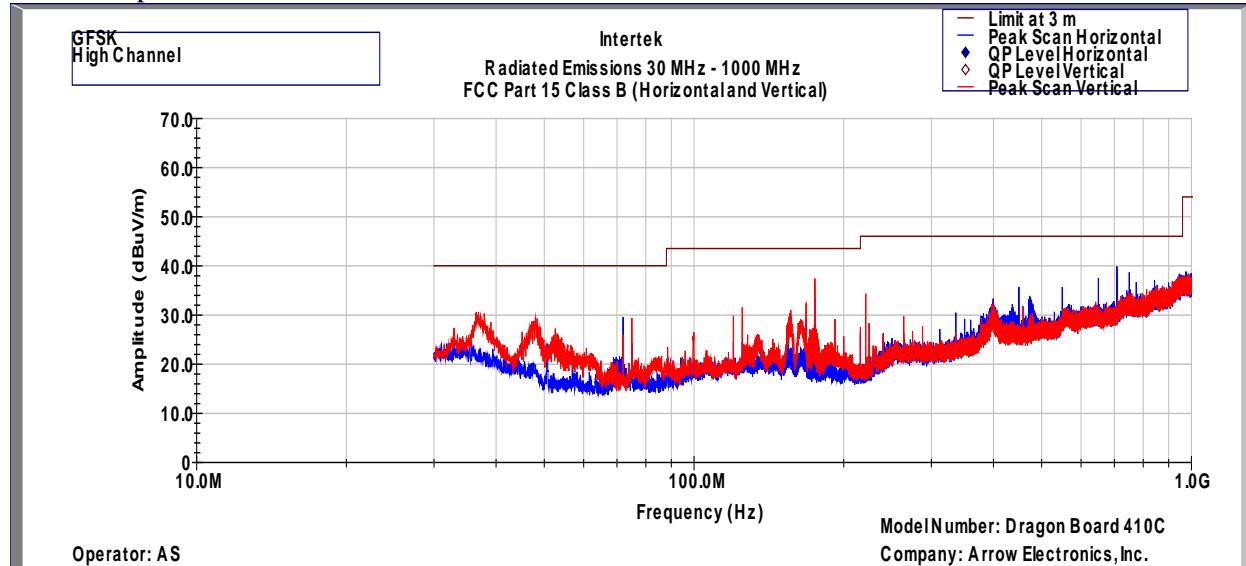
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

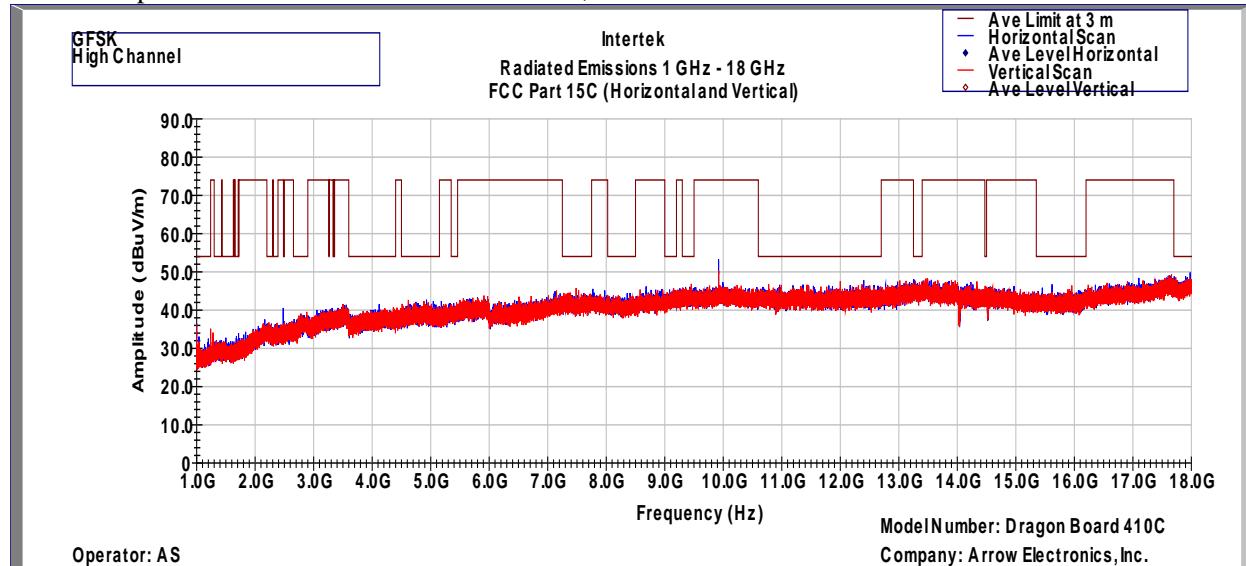
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

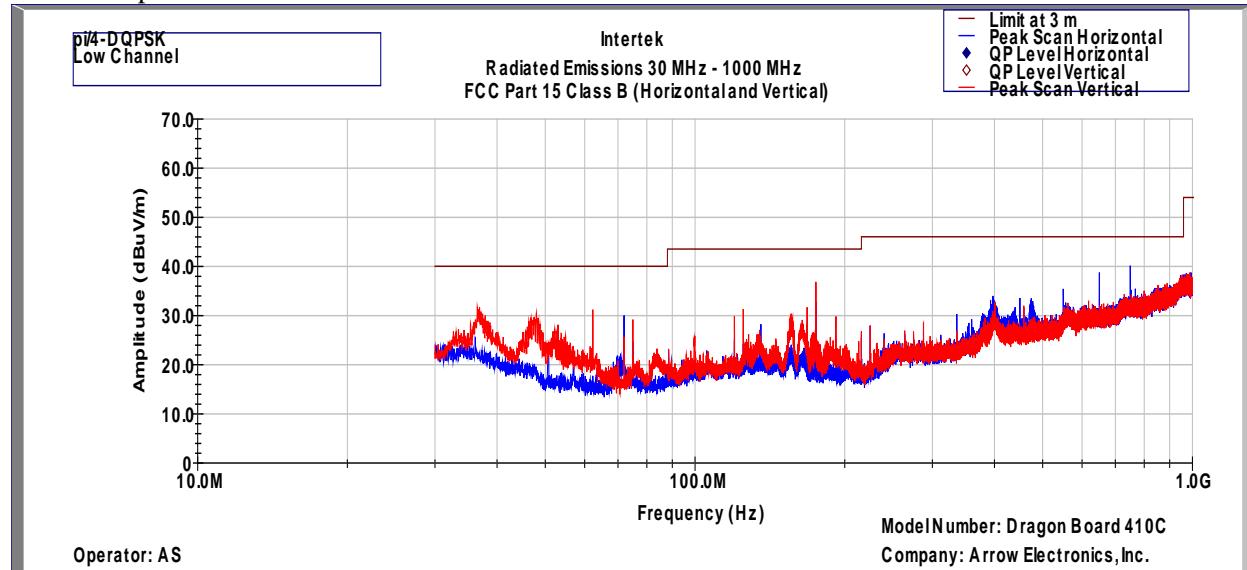
Corrected Peak Scans are under the Average Limit of 54.

Results	Complies
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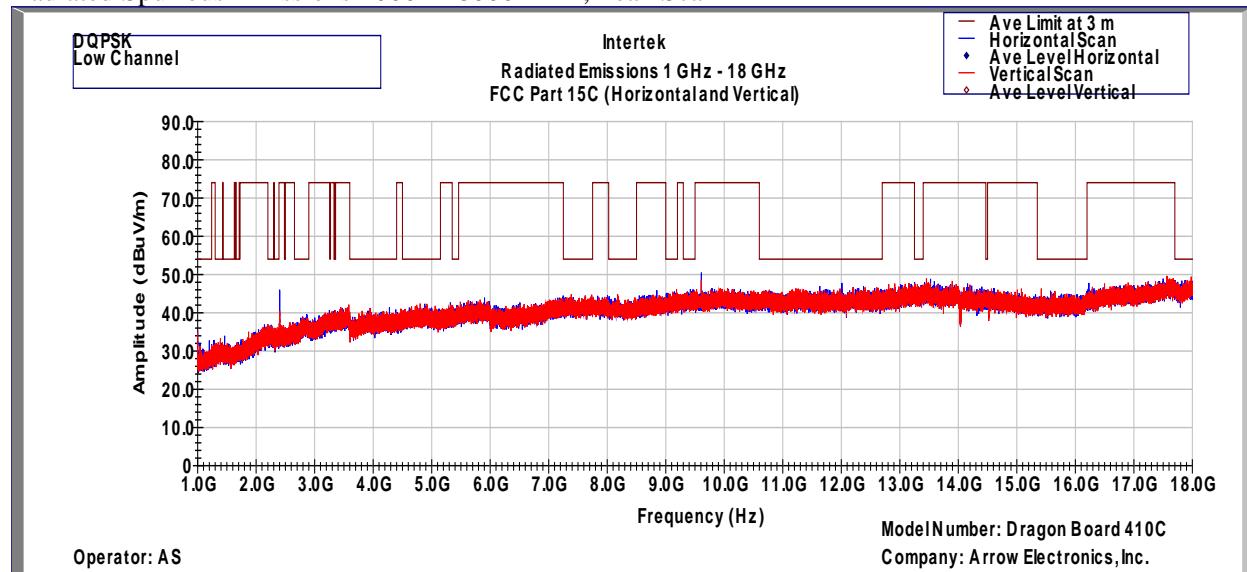
Out-of-Band Radiated Spurious Emissions $\pi/4$ -DQPSK

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



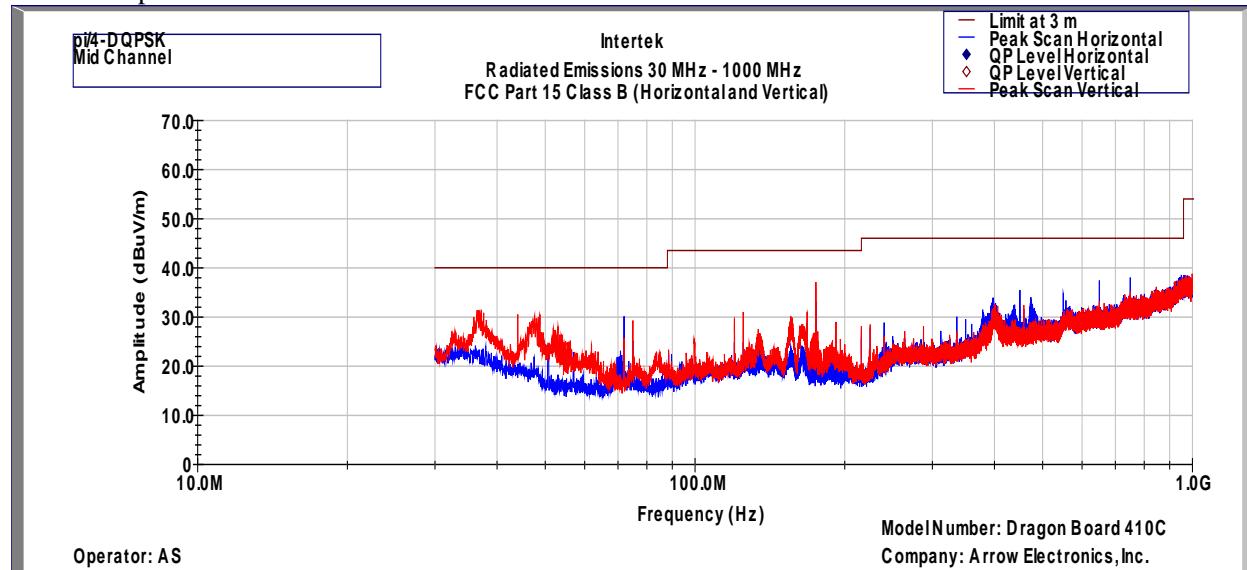
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

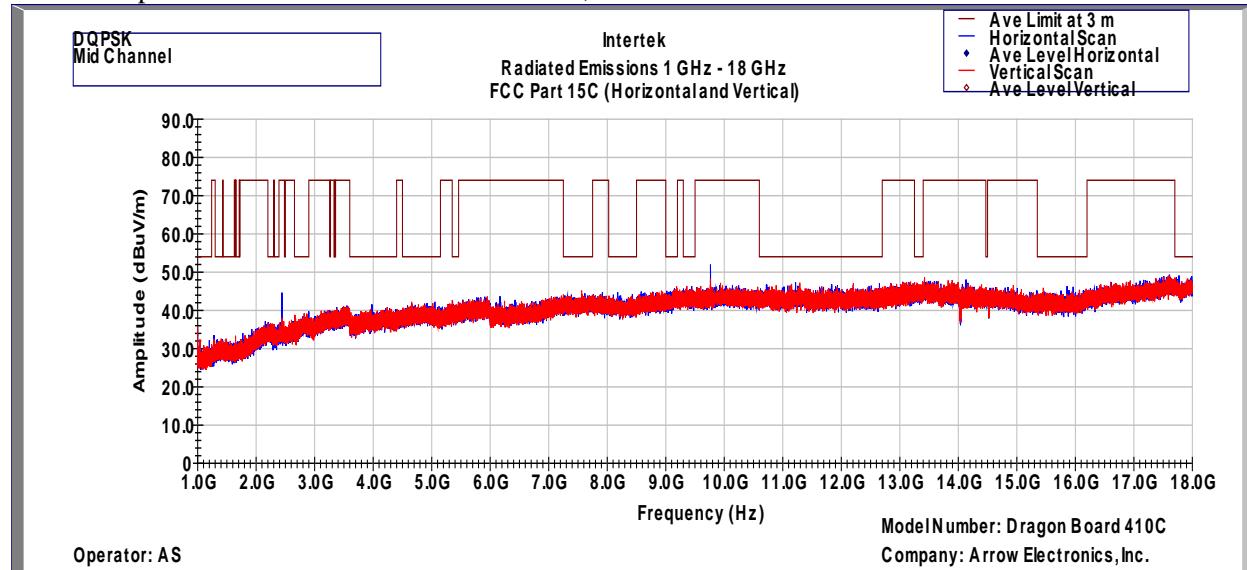
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2441MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



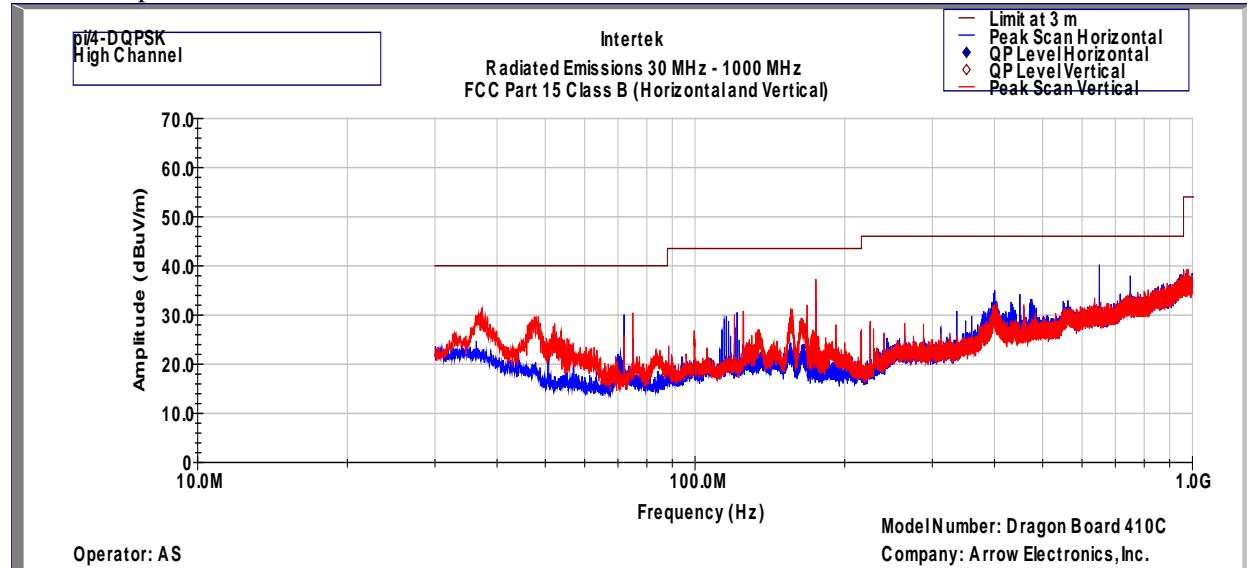
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

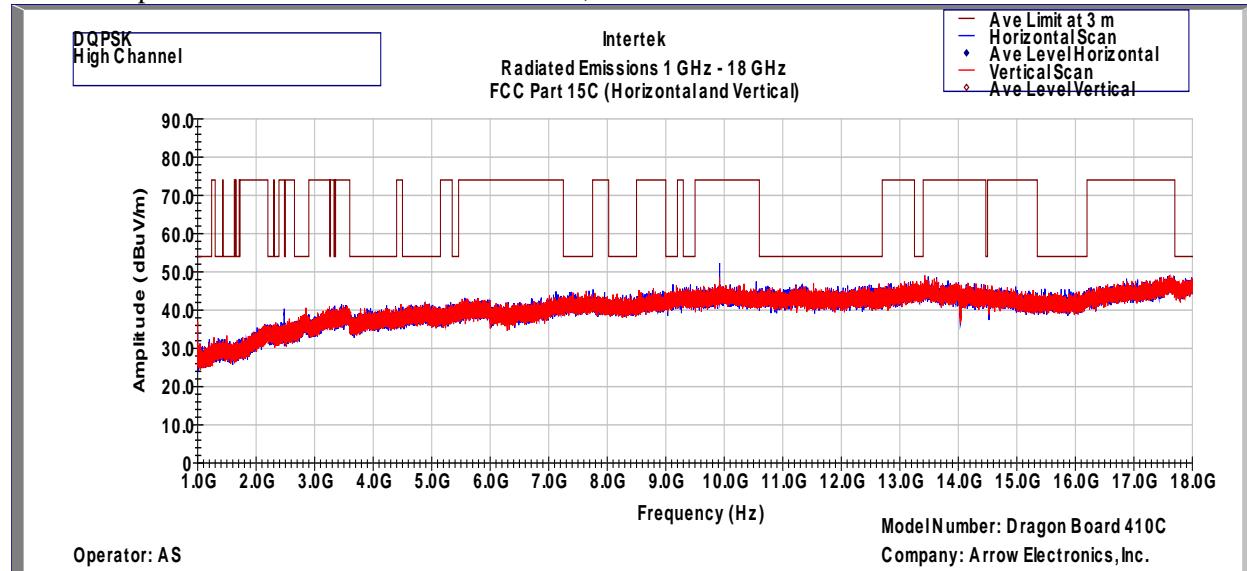
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

Corrected Peak Scans are under the Average Limit of 54.

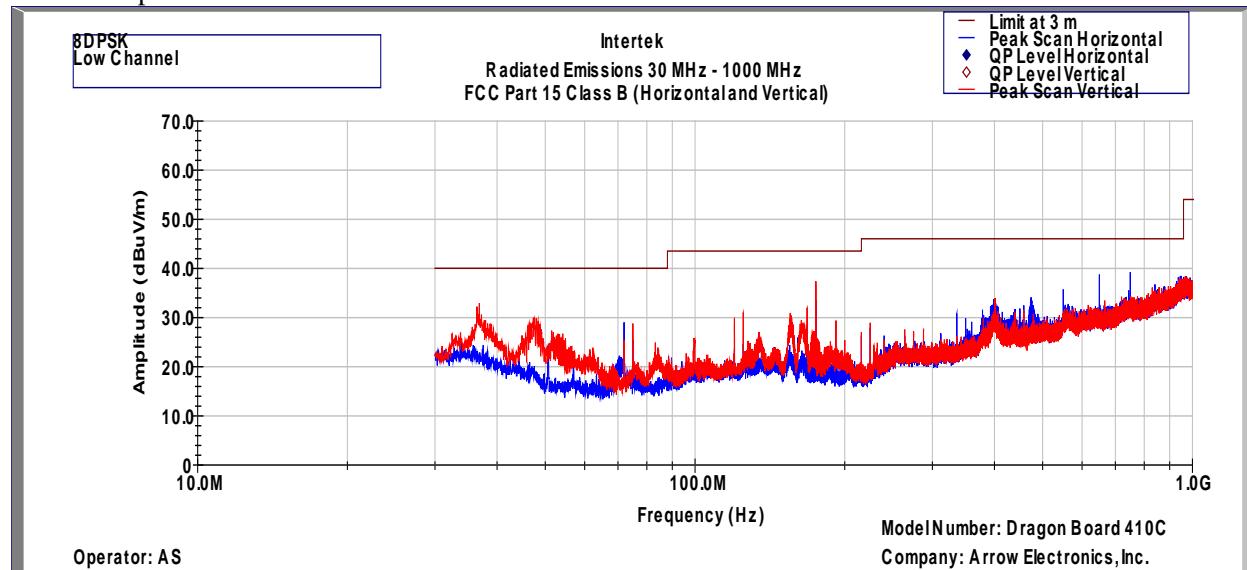
Results

Complies

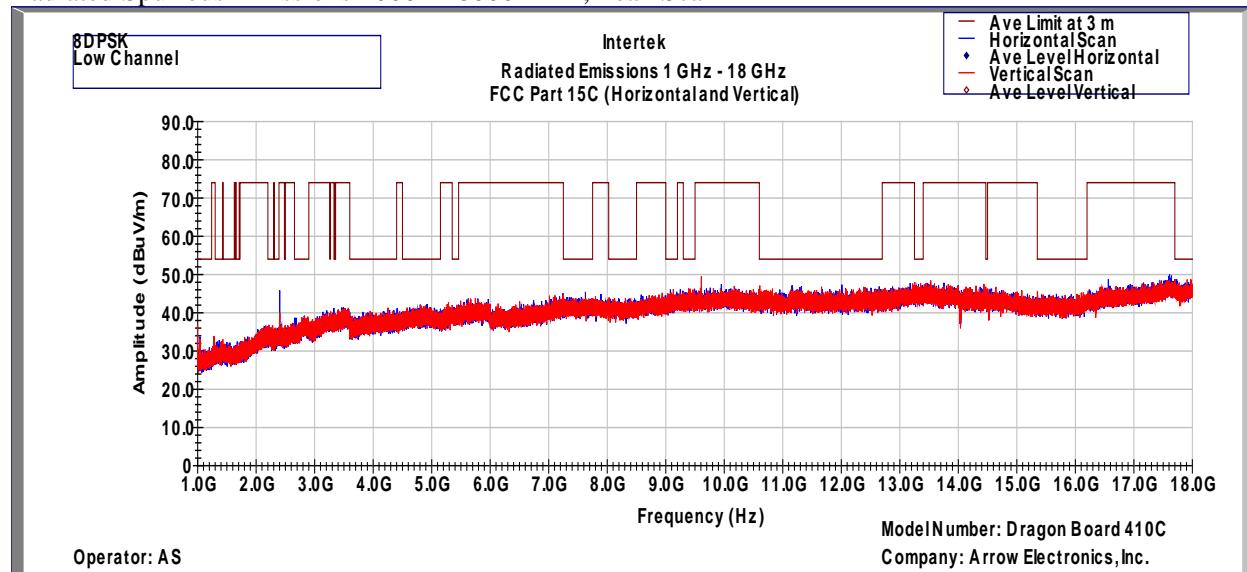
Out-of-Band Radiated Spurious Emissions 8DPSK

Test Results: 15.209 Radiated Spurious Emissions Low Channel, Tx at 2402MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



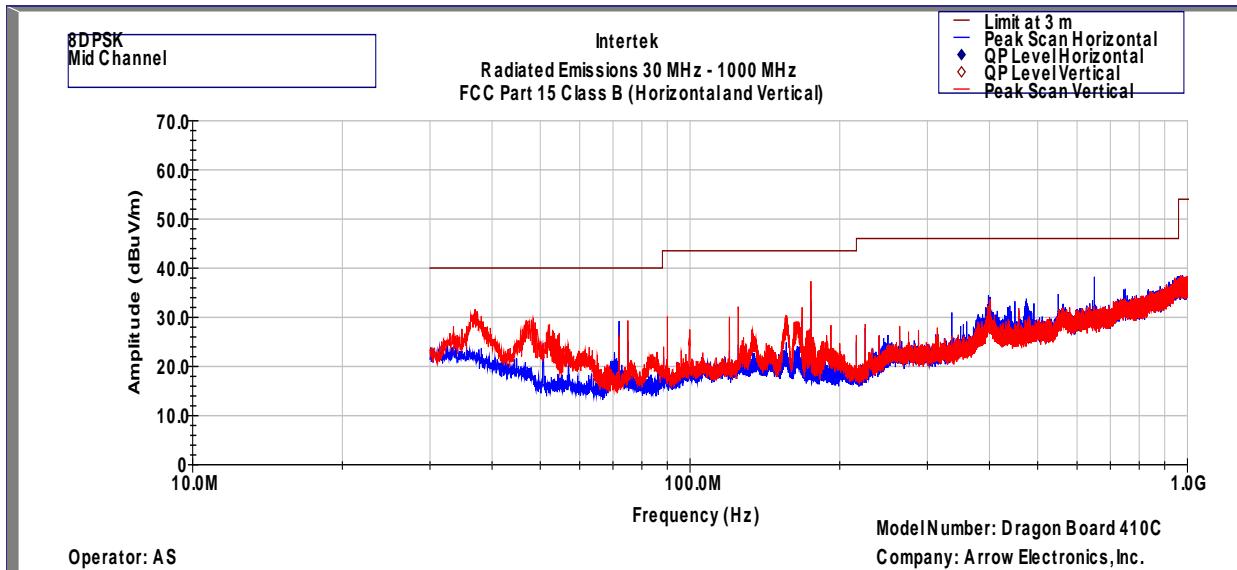
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

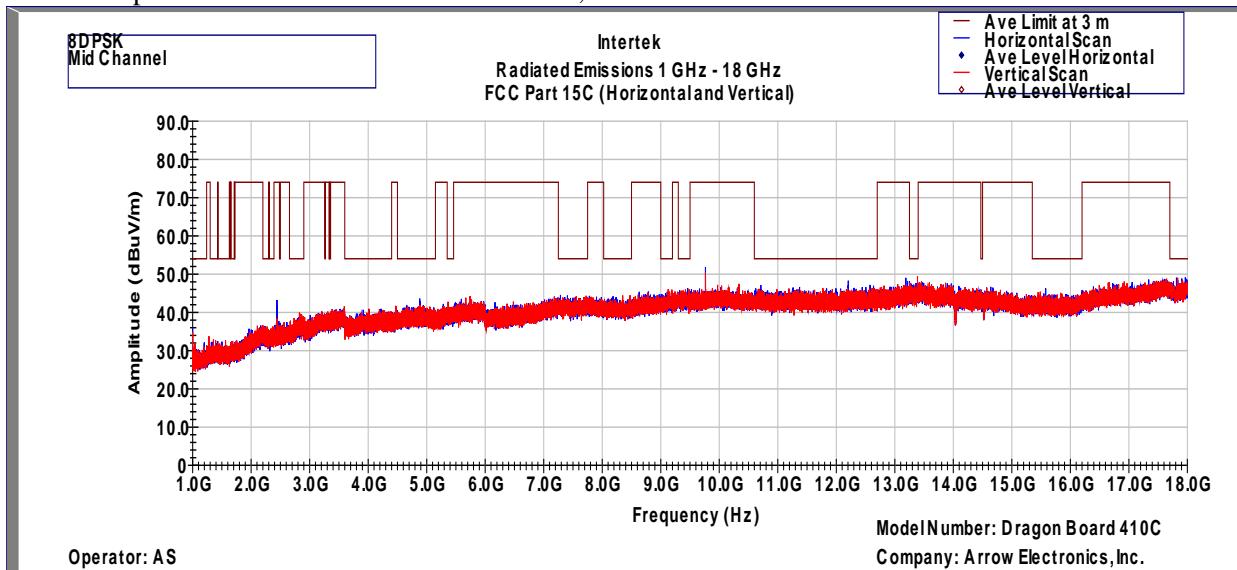
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions Mid Channel, Tx at 2441MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



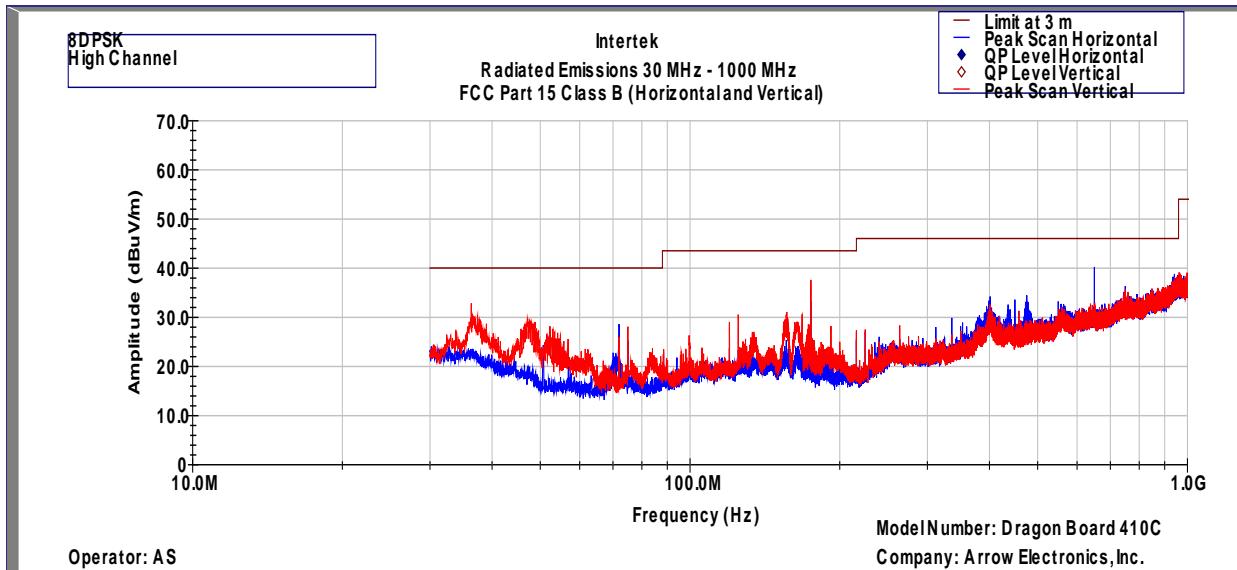
Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

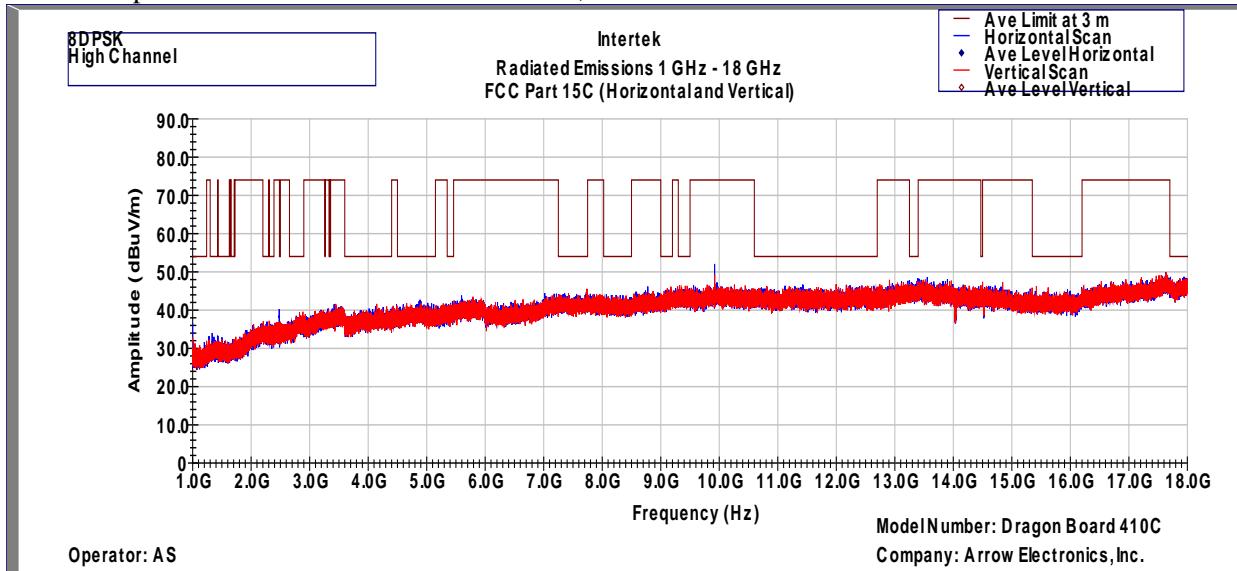
Corrected Peak Scans are under the Average Limit of 54.

Test Results: 15.209 Radiated Spurious Emissions High Channel, Tx at 2480MHz

Radiated Spurious Emissions 30 MHz - 1000 MHz



Radiated Spurious Emissions 1000 - 18000 MHz, Peak Scan



Note: Radiated emission measurements were performed up to 25GHz. No Emissions were identified when scanned from 18-25 GHz

Note: FS@3m = RA + AF + CF - Preamp, (Peak)

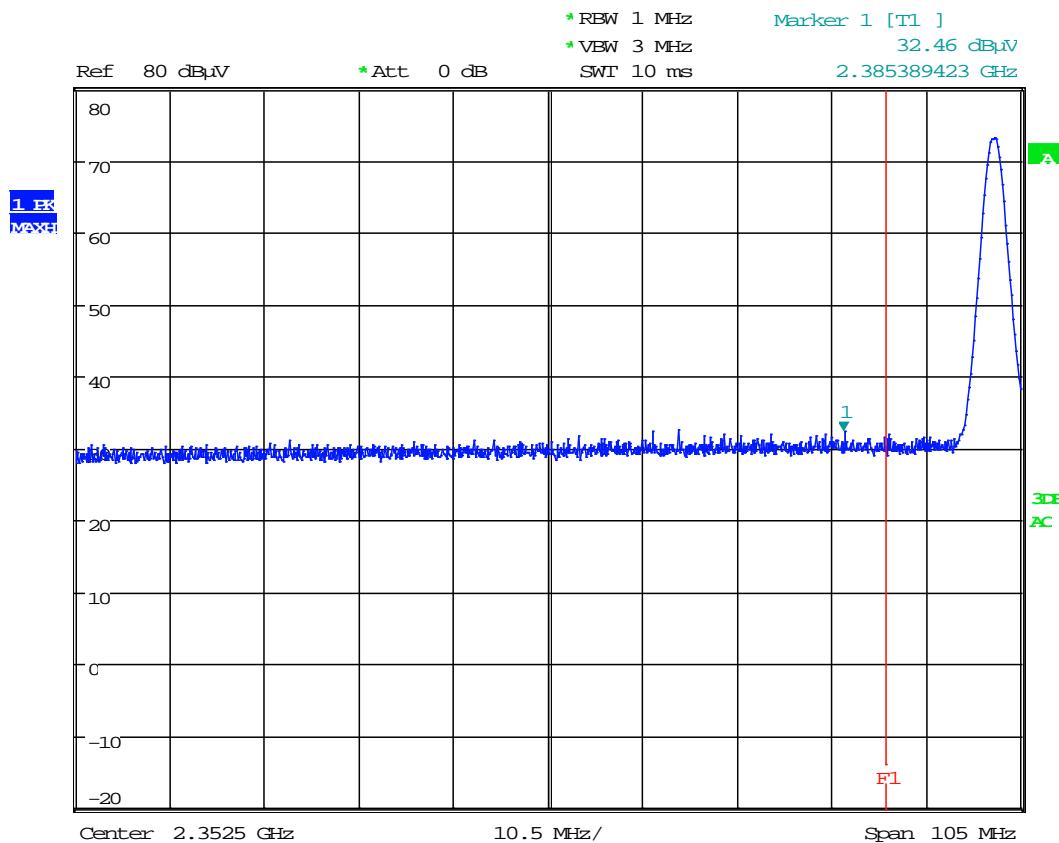
Corrected Peak Scans are under the Average Limit of 54.

Results

Complies

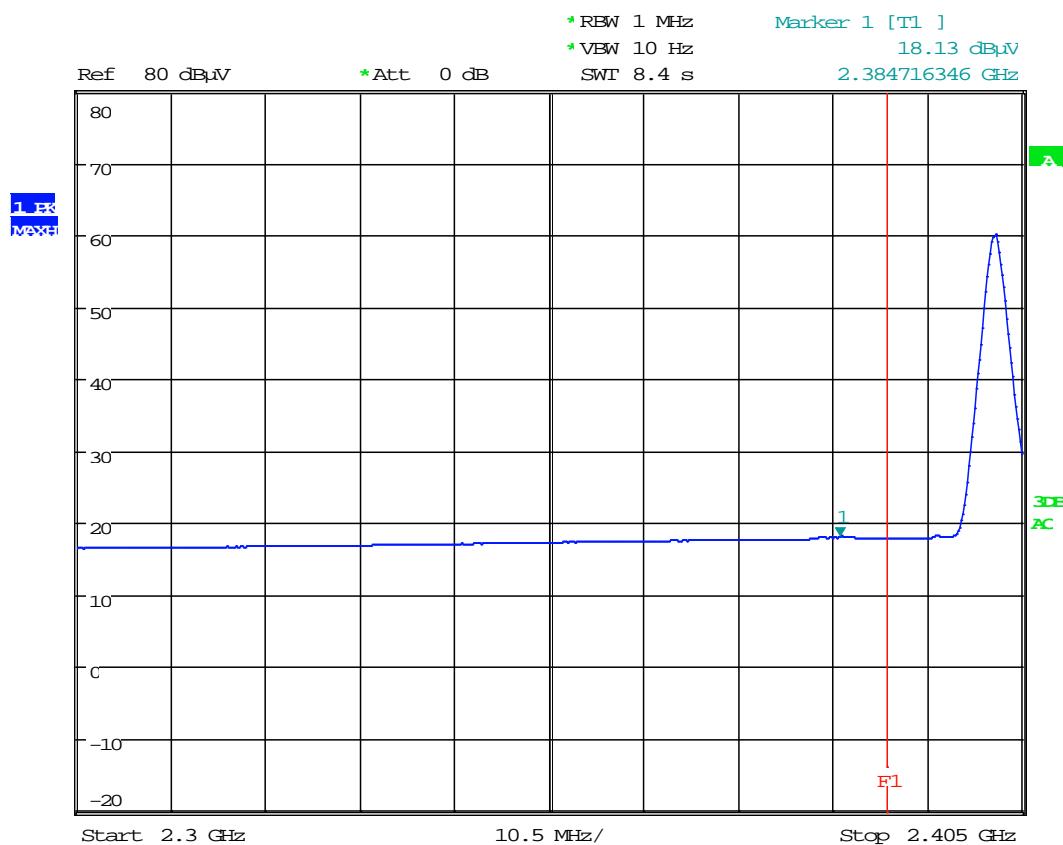
Test Results: 15.209/15.205 Restricted Band Emissions with External Antenna

GFSK Modulation for Out-of-Band Spurious Emissions at the Band Edge



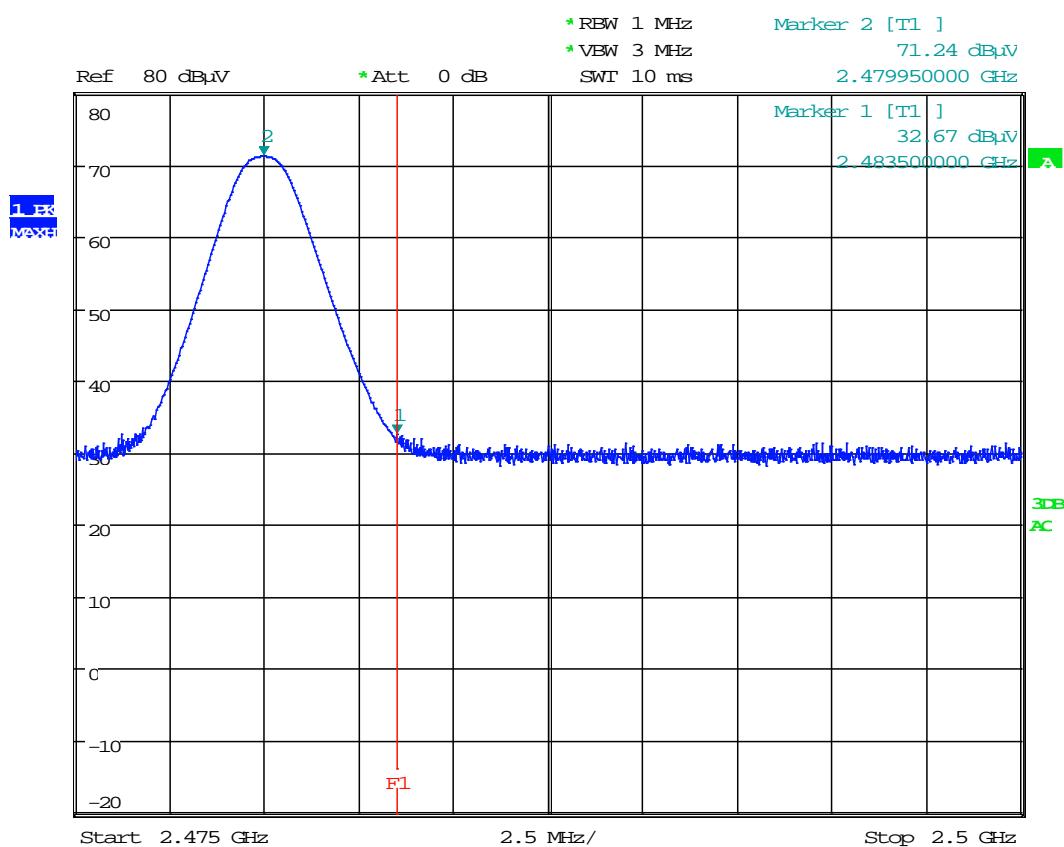
Date: 8.OCT.2015 06:34:07

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
GFSK	Peak	0	2402	32.5	29.8	62.3	74	-11.7	Pass



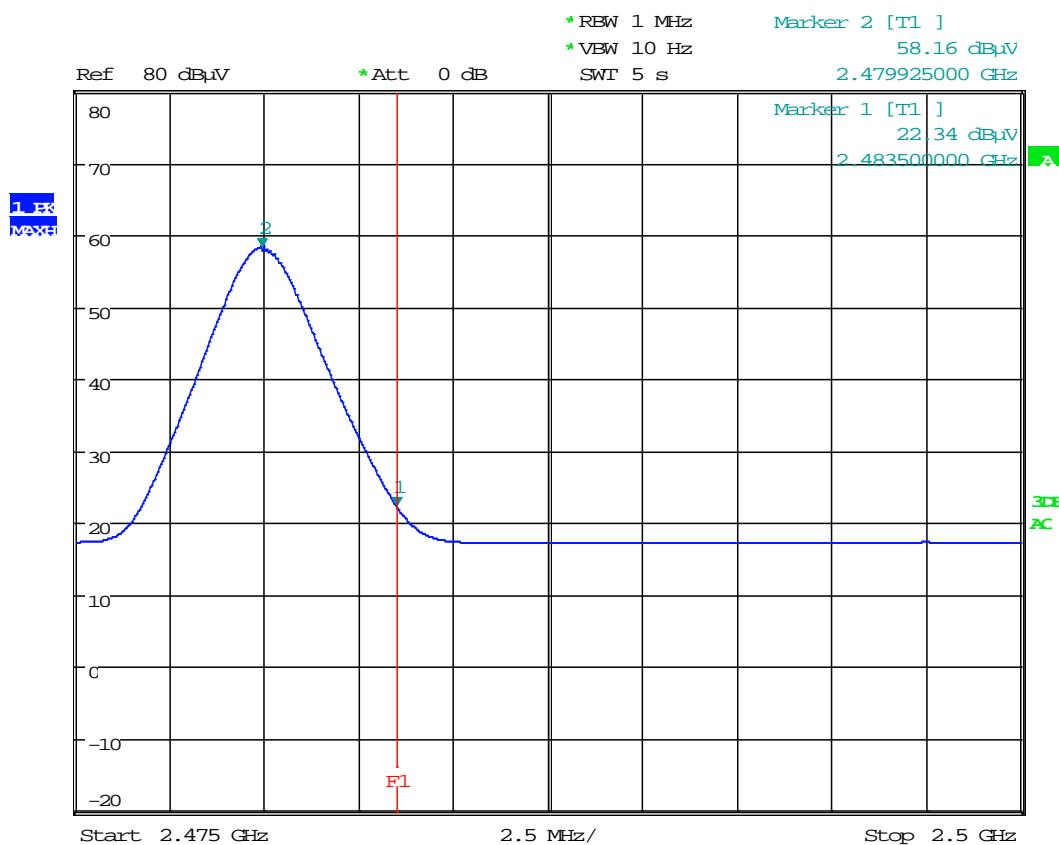
Date: 8.OCT.2015 06:35:27

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
GFSK	Avg	0	2402	18.1	29.8	47.9	54	-6.1	Pass



Date: 8.OCT.2015 07:22:32

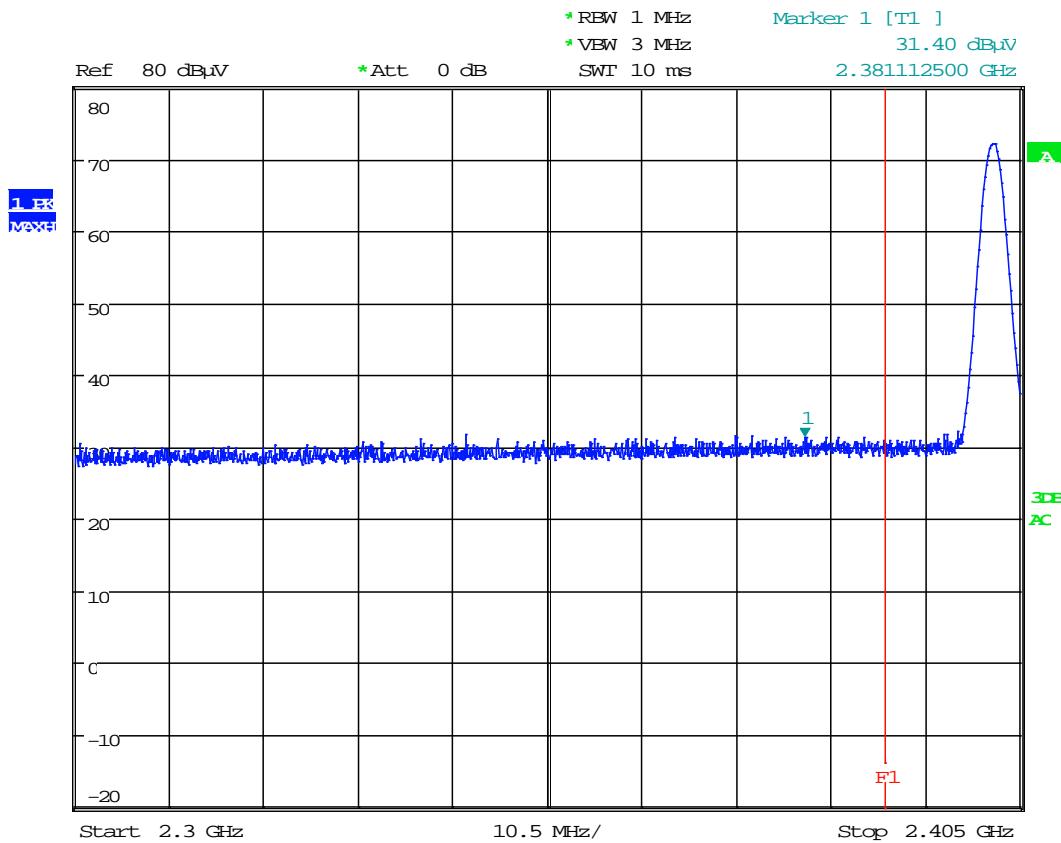
Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
GFSK	Peak	78	2480	32.7	29.8	62.5	74	-11.5	Pass



Date: 8.OCT.2015 07:19:22

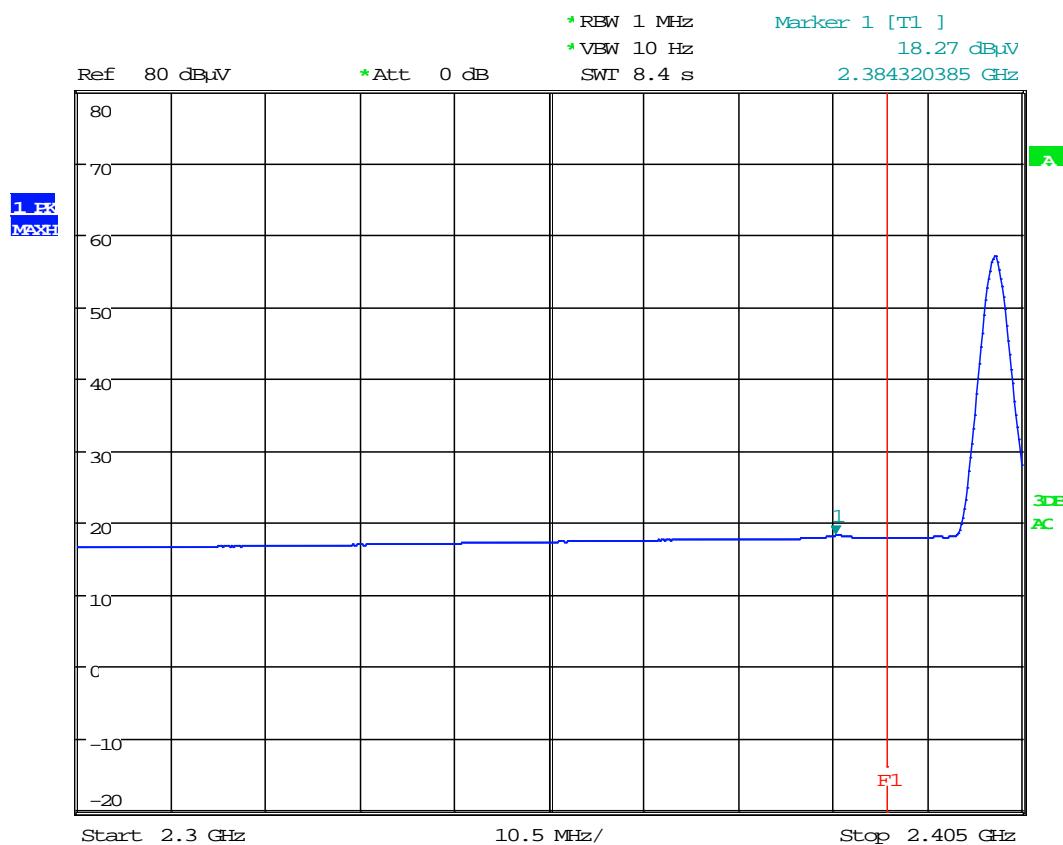
Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
GFSK	Avg	78	2480	22.3	29.8	52.1	54	-1.9	Pass

$\pi/4$ -DQPSK Modulation for Out-of-Band Spurious Emissions at the Band Edge



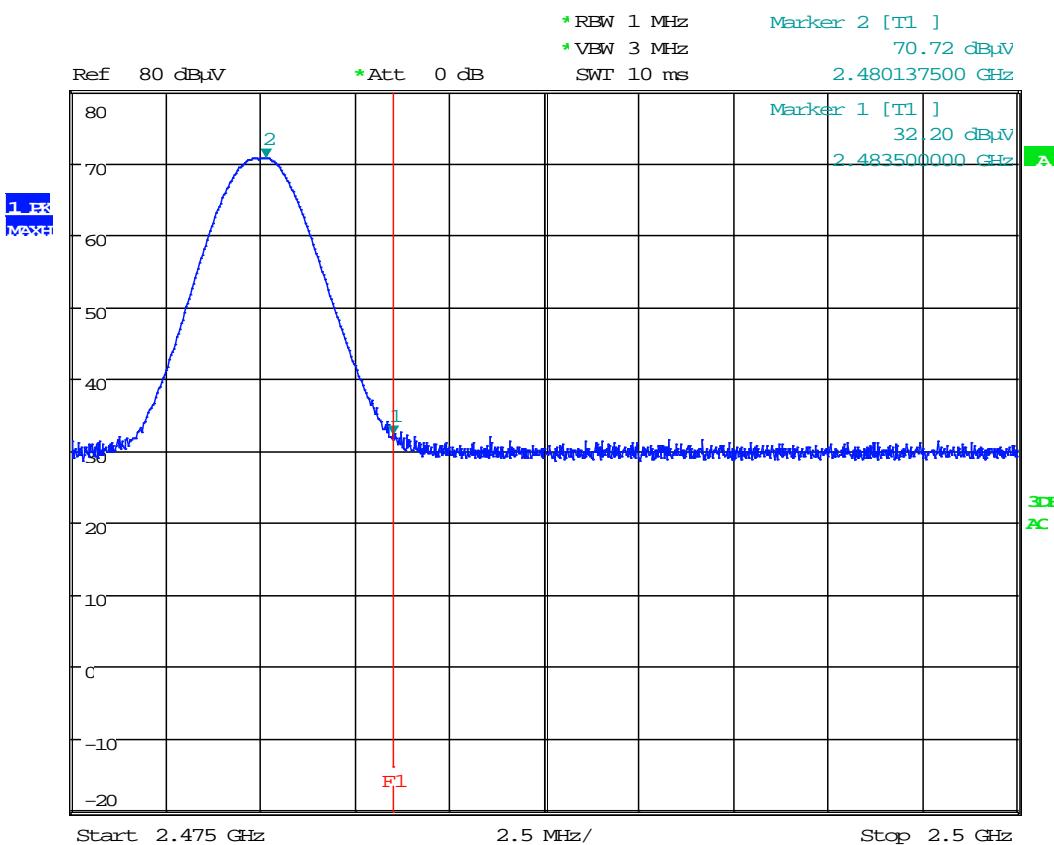
Date: 8.OCT.2015 06:42:47

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
$\pi/4$ -DQPSK	Peak	0	2402	31.4	29.8	61.2	74	-12.8	Pass



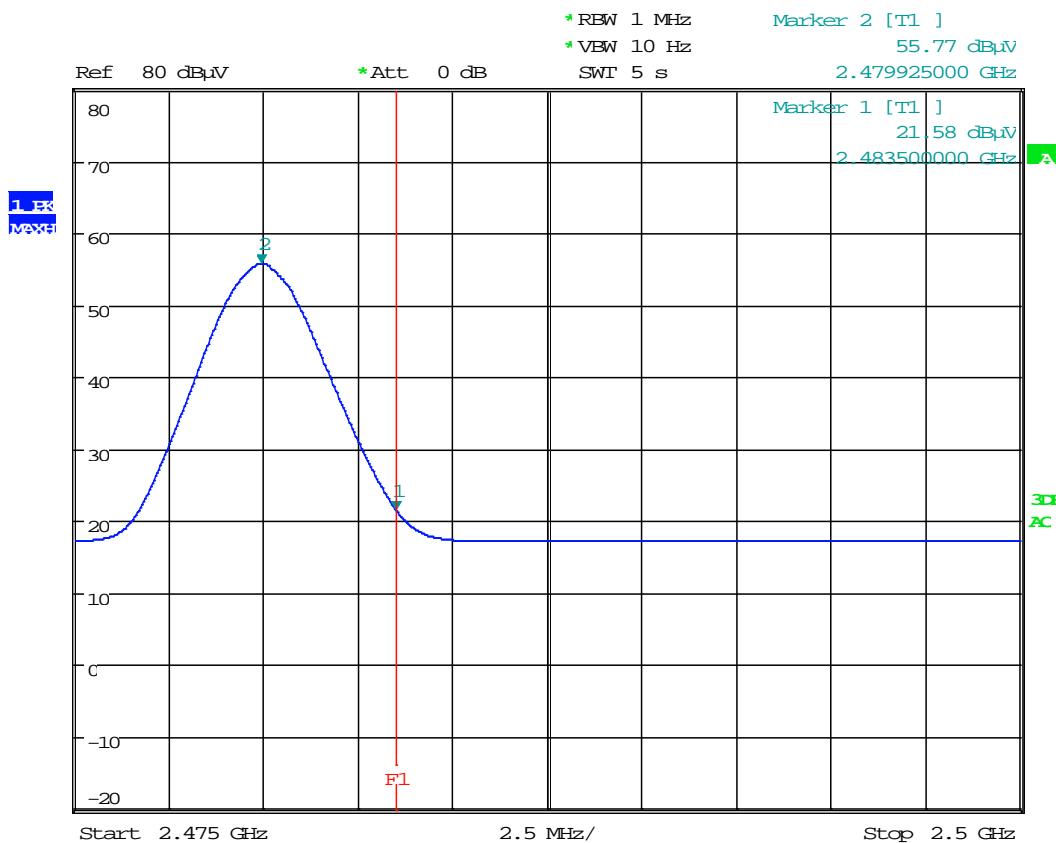
Date: 8.OCT.2015 06:41:00

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
$\pi/4$ -DQPSK	Avg	0	2402	18.3	29.8	48.1	54	-5.9	Pass



Date: 8.OCT.2015 07:15:31

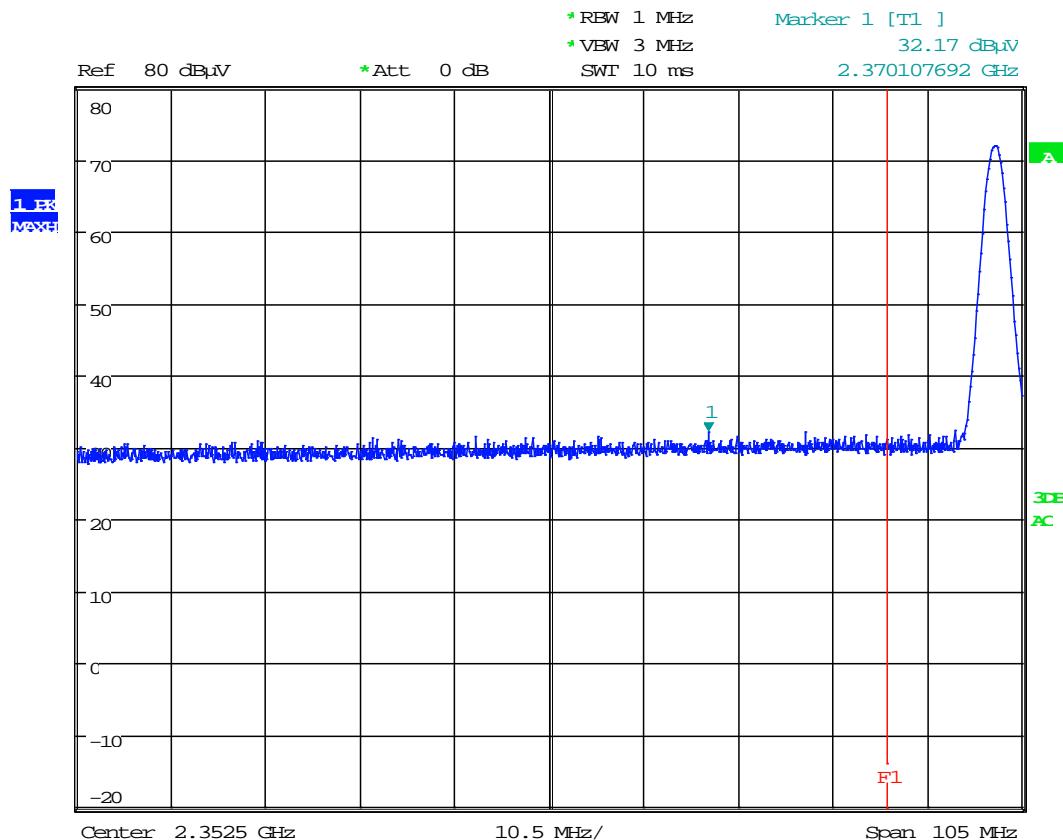
Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
$\pi/4$ -DQPSK	Peak	78	2480	32.2	29.8	62.0	74	-12.0	Pass



Date: 8.OCT.2015 07:16:24

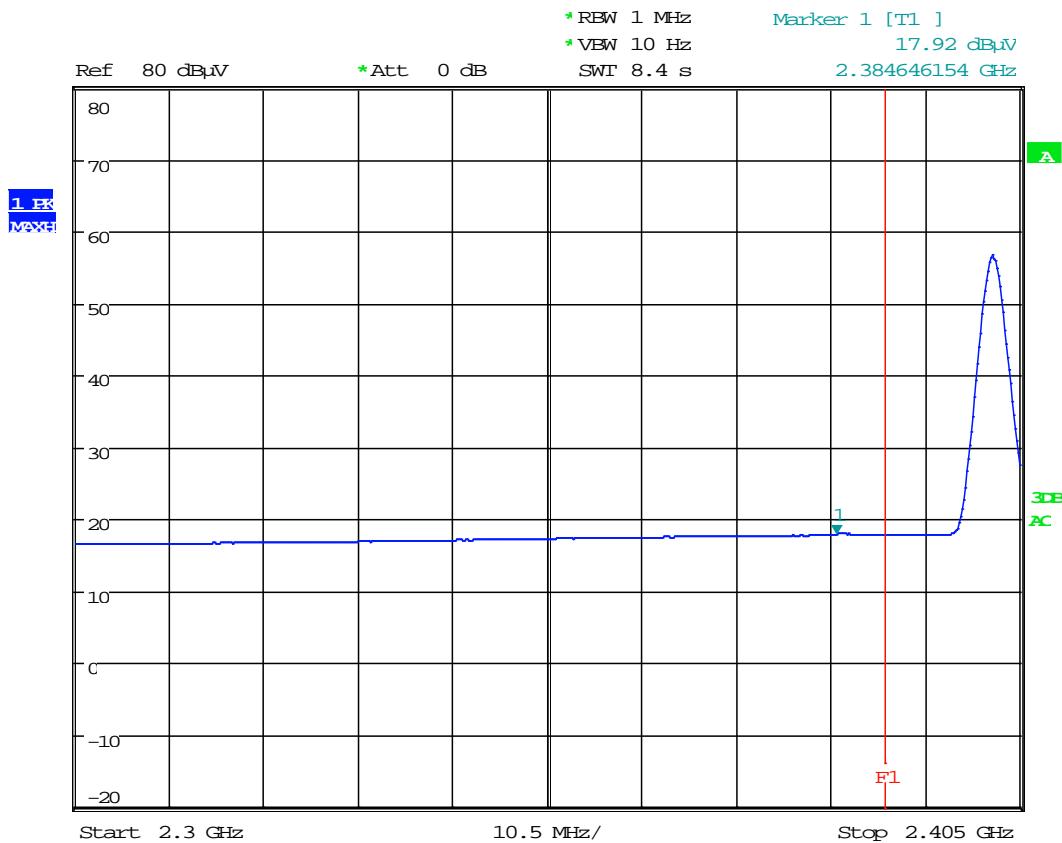
Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
$\pi/4$ -DQPSK	Avg	78	2480	21.6	29.8	51.4	54	-2.6	Pass

8DPSK Modulation for Out-of-Band Spurious Emissions at the Band Edge



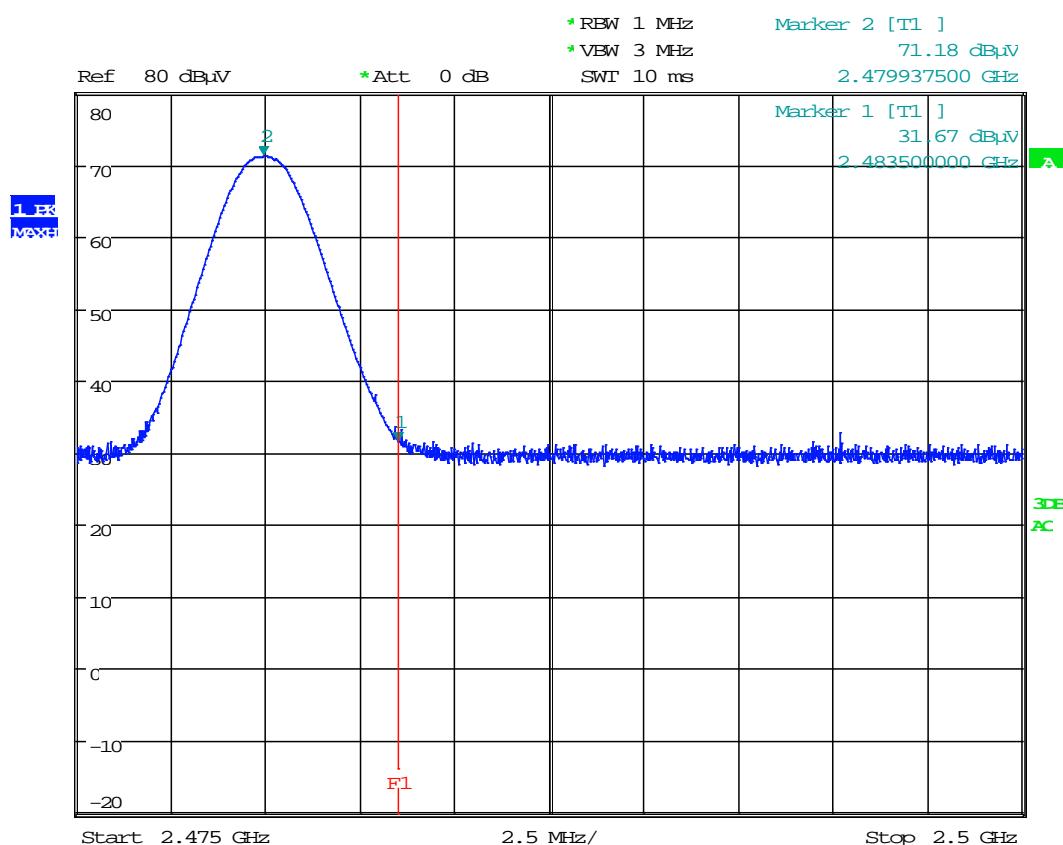
Date: 8.OCT.2015 06:45:31

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
8DPSK	Peak	0	2402	32.2	29.8	62.0	74	-12.0	Pass



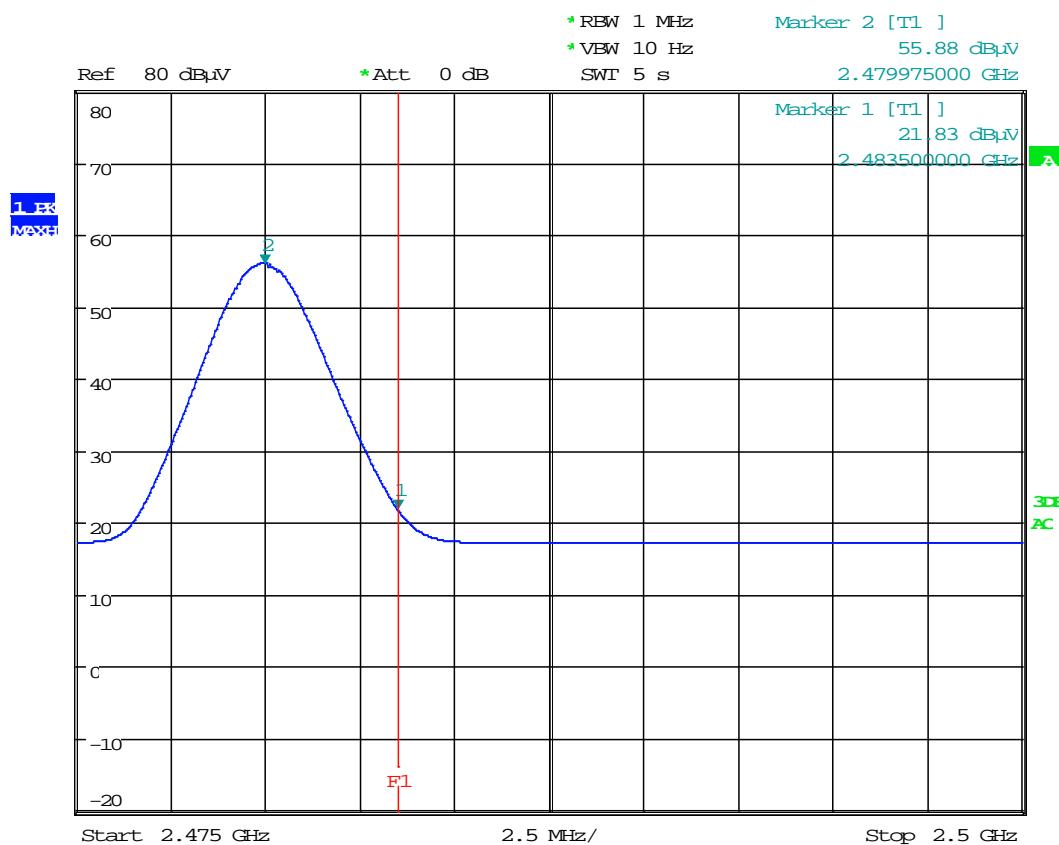
Date: 8.OCT.2015 06:46:32

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
8DPSK	Avg	0	2402	17.9	29.8	47.7	54	-6.3	Pass



Date: 8.OCT.2015 07:12:45

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
8DPSK	Peak	78	2480	31.7	29.8	61.5	74	-12.5	Pass



Date: 8.OCT.2015 07:10:39

Modulation Type	Detector	EUT Channel	Frequency	Raw Amplitude at 3m	Corr. Factor	FS at 3m	Peak Limit	Margin	Results
			MHz	dB(uV)	dB	dB(uV/m)	dB(uV/m)	dB(uV/m)	
8DPSK	Avg	78	2480	21.8	29.8	51.6	54	-2.4	Pass