

FCC TEST REPORT

Test report No.: EMC- FCC- R0079
FCC ID: P7KRVM-704M
Type of equipment: RearView Monitor
Model Name: RVM-704M
Brand Name: -
Applicant: Diasonic Technology Co., Ltd.
FCC Rule Part(s): FCC Part 15 Subpart C
Section 15.203, Section 15.209
Section 15.207, Section 15.247
ANSI C63.4 2009
ANSI C63.10 2009
Frequency Range: 2 402 MHz ~ 2 480 MHz
Test result: Complied


The above equipment was tested by EMC compliance Testing Laboratory for compliance with the requirements of FCC Rules and Regulations.

The results of testing in this report apply to the product/system which was tested only. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Date of test: September 10, 2012 ~ September 14, 2012

Issued date: September 27, 2012


Tested by: _____
LEE, CHANG WON


Approved by: _____
KIM, CHANG MIN

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1. Client information

Applicant: Diasonic Technology Co., Ltd.
Address: #321-43, Suksu-dong, Manan-ku, Anyang-city,
Kyungki-do, Korea.
Telephone number: +82-31-474-0852
Facsimile number : +82-31-474-0856
Contact person: Min-Hwan Kim / rnd@diasonic.com

Manufacturer: Diasonic Technology Co., Ltd.
Address : #321-43, Suksu-dong, Manan-ku, Anyang-city,
Kyungki-do, Korea.

2. Laboratory information

Address

EMC Compliance Ltd.
480-5 Shin-dong, Yeongtong-gu, Suwon-city, Gyeonggi-do, 443-390, Korea
Telephone Number: 82 31 336 9919 Facsimile Number: 82 31 336 4767

Certificate

CBTL Testing Laboratory, KOLAS NO.: 231
FCC Filing No.: 508785
VCCI Registration No.: C-1713, R-1606, T-258

SITE MAP



3. Description of E.U.T.

3.1 Basic description

| | |
|---------------------------------|--|
| Applicant : | Diasonic Technology Co., Ltd. |
| Address of Applicant: | #321-43, Suksu-dong, Manan-ku, Anyang-city, Kyungki-do, Korea. |
| Manufacturer: | Diasonic Technology Co., Ltd. |
| Address of Manufacturer: | #321-43, Suksu-dong, Manan-ku, Anyang-city, Kyungki-do, Korea. |
| Type of equipment: | RearView Monitor |
| Basic Model: | RVM-704M |
| Brand name: | - |
| Serial number: | Proto Type |

3.2 General description

| | |
|------------------------------|---|
| Frequency Range | 2 402 MHz ~ 2 480 MHz |
| Type of Modulation | Modulation technologies: FHSS Modulation : GFSK, 8DPSK |
| Number of Channels | 79 channels |
| Type of Antenna | Integral |
| Antenna Gain | 3.5 dBi |
| Transmit Power | Under 17 dBm |
| Power supply | 24 V DC |
| Operating temperature | -20 °C ~ 55 °C |
| Dimension | 178(W) X 110(H) X 44.6(D) mm |
| Weight | 640 g |

3.3 Test frequency

| | Frequency |
|------------------|-----------|
| Low frequency | 2 402 MHz |
| Middle frequency | 2 440 MHz |
| High frequency | 2 480 MHz |

3.4 Test Voltage

| mode | Voltage |
|------------------|---------|
| Norminal voltage | DC 24 V |

4. Summary of test results

4.1 Standards & results

| Rule Reference | Parameter | Report Section | Test Result |
|--|---|----------------|-------------|
| 15.203, 15.247(b)(4) | Antenna Requirement | 5.1 | C |
| 15.247(b)(1), (4) | Maximum Peak Output Power | 5.2 | C |
| 15.247(a)(1) | Carrier Frequency Separation | 5.3 | C |
| 15.247(a)(1) | 20dB Channel Bandwidth | 5.4 | C |
| 15.247(a)(iii) 15.247(b)(1) | Number of Hopping Channel | 5.5 | C |
| 15.247(a) (iii) | Time of Occupancy(Dwell Time) | 5.6 | C |
| 15.247(d), 15.205(a), 15.209(a) | Spurious Emission, Band Edge, and Restricted bands | 5.7 | C |
| 15.247(e) | Peak Power Spectral Density | 5.8 | C |
| 15.207(a) | Conducted Emissions | 5.9 | N/A |
| 15.247(i), 1.1307(b)(1) | RF Exposure | 5.10 | C |
| Note: C=complies NC= Not complies NT=Not tested NA=Not Applicable | | | |

* The method of measurement used to test this DSS device is FCC Public Notice DA 00-705

* The general test methods used to test this device is ANSI C63.4 2003 (or 2009, or ANSI C63.10 2009)

4.2 Uncertainty

| Measurement Item | Combined Standard Uncertainty U_c | Expanded Uncertainty $U = KU_c$ (K = 2) |
|-----------------------|--|--|
| Conducted RF power | ± 0.75 dB | ± 1.3 dB |
| Radiated disturbance | +2.280dB / - 2.278 dB | +4.560dB / - 4.556 dB |
| Conducted disturbance | +1.883 dB / - 1.676 dB | +3.766dB / - 3.352 dB |

5. Test results

5.1 Antenna Requirement

5.1.1 Regulation

According to §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this Section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

And according to §15.247(b)(4), the conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.1.2 Result

-Complied

The transmitter has an integral dipole antenna. type of antenna.
The directional gain of the antenna is 3.5 dBi.

5.2 Maximum Peak Output Power

5.2.1 Regulation

According to §15.247(b)(1), for frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

According to §15.247(b)(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

5.2.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument (spectrum analyzer) using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 5 times the 20 dB bandwidth, centered on a hopping channel RBW > the 20 dB bandwidth of the emission being measured VBW \geq RBW Sweep = auto Detector function = peak Trace = max hold
5. Measure the highest amplitude appearing on spectral display and record the level to calculate results.
6. Repeat above procedures until all frequencies measured were complete.

5.2.3 Test Result

-Complied
- GFSK

| Channel | Frequency (MHz) | Result (dBm) | Limit (dBm) | Margin (dB) |
|---------|-----------------|--------------|-------------|-------------|
| Low | 2 402 | -9.55 | 30.00 | 39.55 |
| Middle | 2 440 | -10.48 | 30.00 | 40.48 |
| High | 2 480 | -11.31 | 30.00 | 41.31 |

- 8DPSK

| Channel | Frequency (MHz) | Result (dBm) | Limit (dBm) | Margin (dB) |
|---------|-----------------|--------------|-------------|-------------|
| Low | 2 402 | -11.23 | 30.00 | 41.23 |
| Middle | 2 440 | -12.33 | 30.00 | 42.33 |
| High | 2 480 | -13.23 | 30.00 | 43.23 |

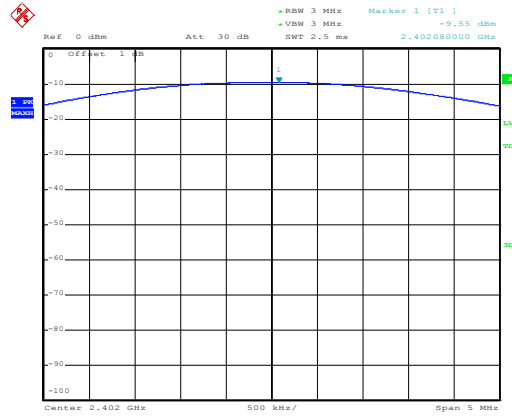
NOTE:

1. Since the directional gain of the integral antenna declared by the manufacturer ($G_{ANT} = 3.5$ dBi) does not exceed 6.0 dBi, there was no need to reduce the output power.
2. We took the insertion loss of the cable loss into consideration within the measuring instrument.

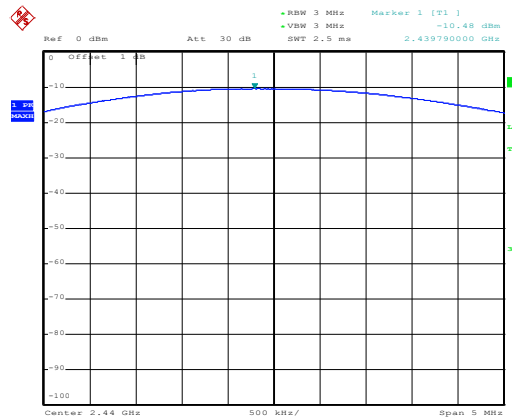
5.2.4 Test Plot

Figure 1. Plot of the Maximum Peak Output Power (Conducted)
- GFSK

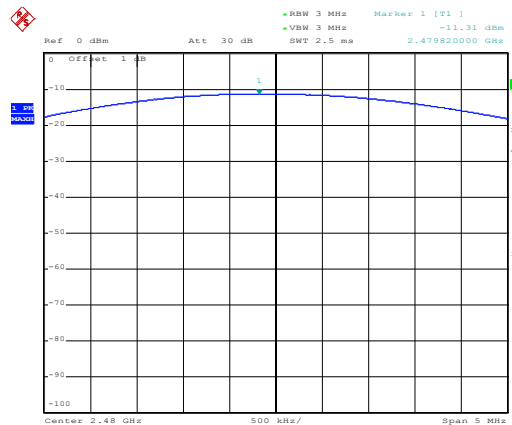
Lowest Channel
(2 402 MHz)



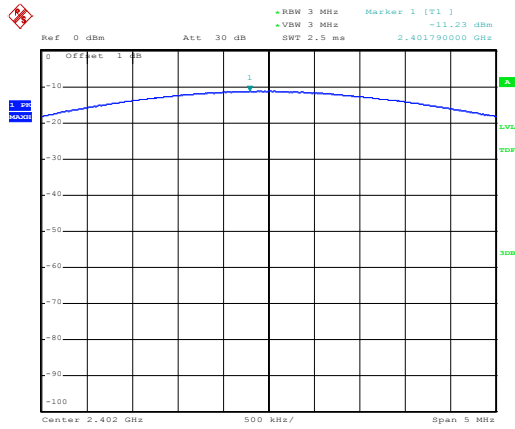
Middle Channel
(2 440 MHz)



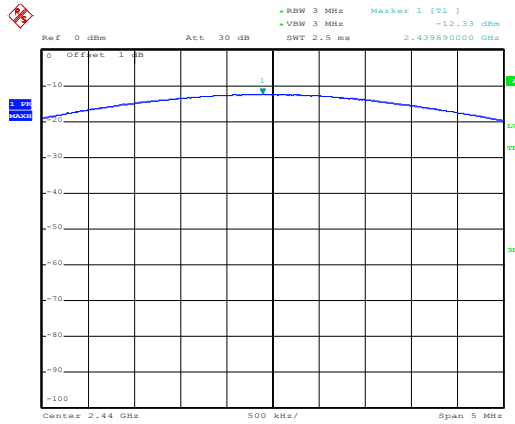
Highest Channel
(2 480 MHz)



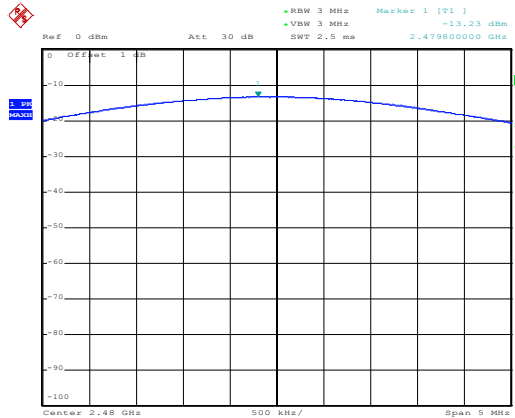
- 8DPSK
 Lowest Channel
 (2 402 MHz)



Middle Channel
 (2 440 MHz)



Highest Channel
 (2 480 MHz)



5.3 Carrier Frequency Separation

5.3.1 Regulation

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW

5.3.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface.
4. Set the spectrum analyzer as follows: Span = wide enough to capture the peaks of two adjacent channels
Resolution (or IF) Bandwidth (RBW) \geq 1% of the span Video (or Average) Bandwidth (VBW) \geq RBW Sweep = auto Detector function = peak Trace = max hold
5. Measure the separation between the peaks of the adjacent channels using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.

5.3.3 Test Result

-Complied

- GFSK

| Channel | Carrier frequency separation | Limit |
|---------|------------------------------|--|
| Low | 0.996 MHz | ≥ 25 kHz or two-thirds of the 20 dB bandwidth |
| Middle | 1.002 MHz | ≥ 25 kHz or two-thirds of the 20 dB bandwidth |
| High | 0.998 MHz | ≥ 25 kHz or two-thirds of the 20 dB bandwidth |

- 8DPSK

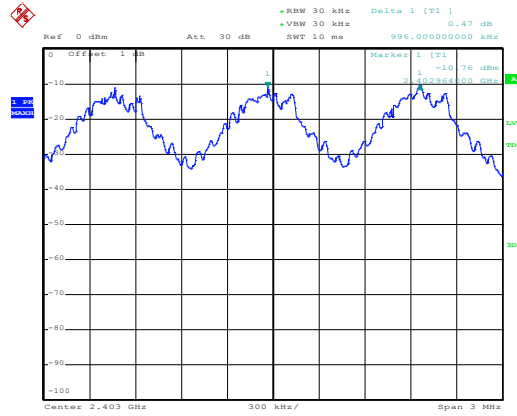
| Channel | Carrier frequency separation | Limit |
|---------|------------------------------|--|
| Low | 1.002 MHz | ≥ 25 kHz or two-thirds of the 20 dB bandwidth |
| Middle | 1.002 MHz | ≥ 25 kHz or two-thirds of the 20 dB bandwidth |
| High | 1.008 MHz | ≥ 25 kHz or two-thirds of the 20 dB bandwidth |

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

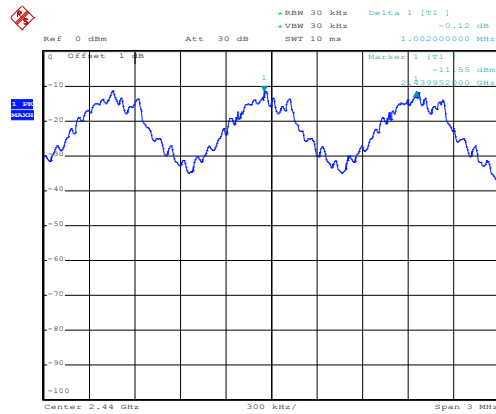
5.3.4 Test Plot

Figure 3. Plot of the Carrier Frequency Separation (Conducted)

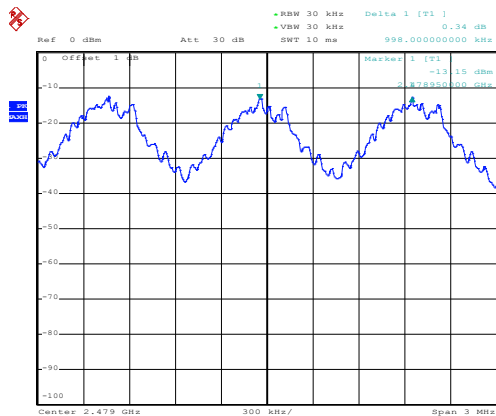
- GFSK
Lowest Channel
(2 402 MHz)



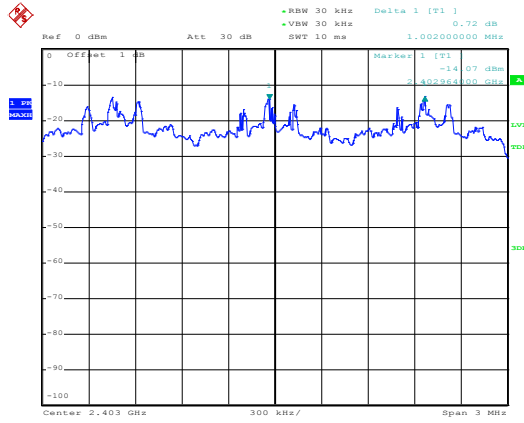
Middle Channel
(2 440 MHz)



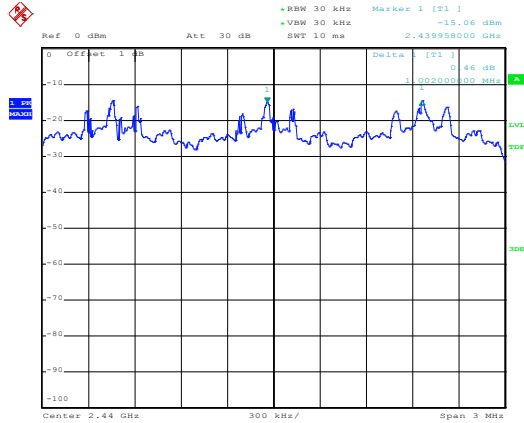
Highest Channel
(2 480 MHz)



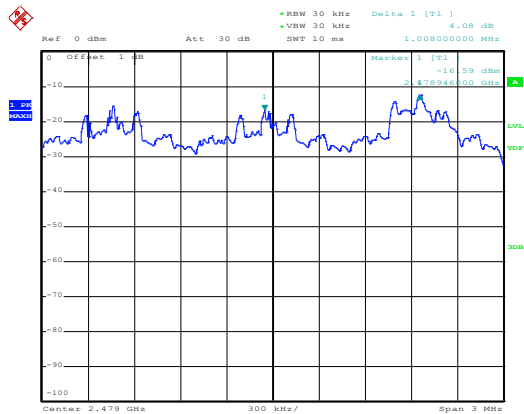
- 8DPSK
 Lowest Channel
 (2 402 MHz)



Middle Channel
 (2 440 MHz)



Highest Channel
 (2 480 MHz)



5.4 20 dB Channel Bandwidth

5.4.1 Regulation

According to §15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater. Alternatively, frequency hopping systems operating in the 2400-2483.5 MHz band may have hopping channel carrier frequencies that are separated by 25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 mW

5.4.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer as follows: Span = approximately 2 to 3 times the 20 dB bandwidth, centered on a hopping channel RBW \geq 1% of the 20 dB bandwidth VBW \geq RBW Sweep = auto Detector function = peak Trace = max hold
5. Set a reference level on it equal to the highest peak value.
6. Measure the frequency difference of two frequencies that were attenuated 20dB from the reference level. Record the frequency difference as the emission bandwidth.
7. Repeat above procedures until all frequencies measured were complete..

5.4.3 Test Result

-Complied

- GFSK

| Channel | 20dB Channel bandwidth | Limit | Carrier frequency separation |
|---------|------------------------|---|------------------------------|
| Low | 810 kHz | < thirds- two of the Carrier frequency separation | 996 kHz |
| Middle | 810 kHz | < thirds- two of the Carrier frequency separation | 1002 kHz |
| High | 810 kHz | < thirds- two of the Carrier frequency separation | 998 kHz |

- 8DPSK

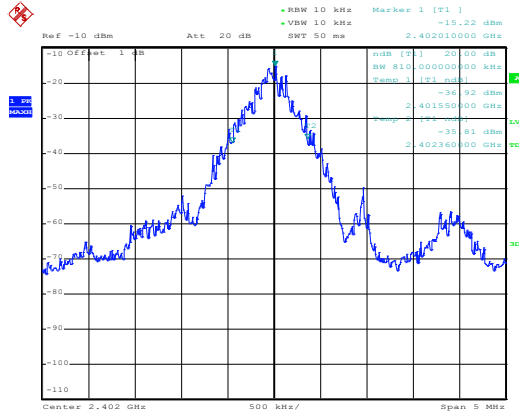
| Channel | 20dB Channel bandwidth | Limit | Carrier frequency separation |
|---------|------------------------|---|------------------------------|
| Low | 1260 kHz | < thirds- two of the Carrier frequency separation | 1002 kHz |
| Middle | 1270 kHz | < thirds- two of the Carrier frequency separation | 1002 kHz |
| High | 1270 kHz | < thirds- two of the Carrier frequency separation | 1008 kHz |

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

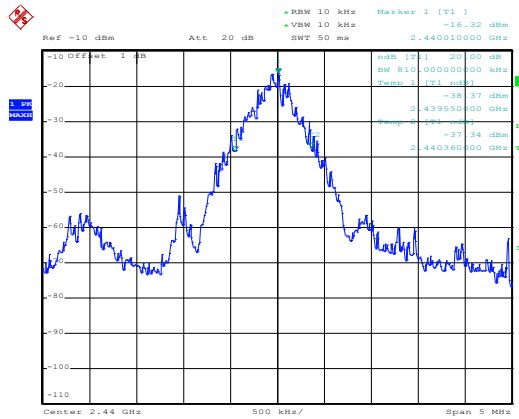
5.4.4 Test Plot

Figure 5. Plot of the 20dB Channel Bandwidth (Conducted)

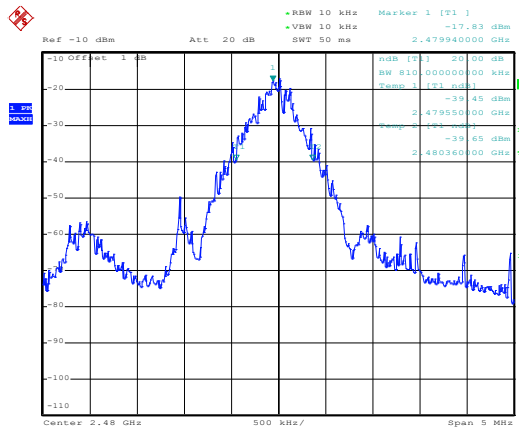
- GFSK
 Lowest Channel
 (2 402 MHz)



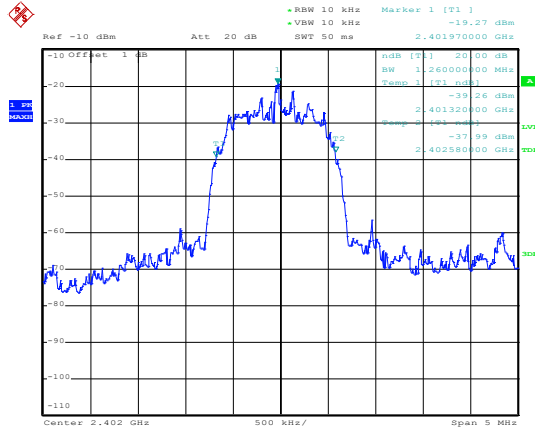
Middle Channel
 (2 440MHz)



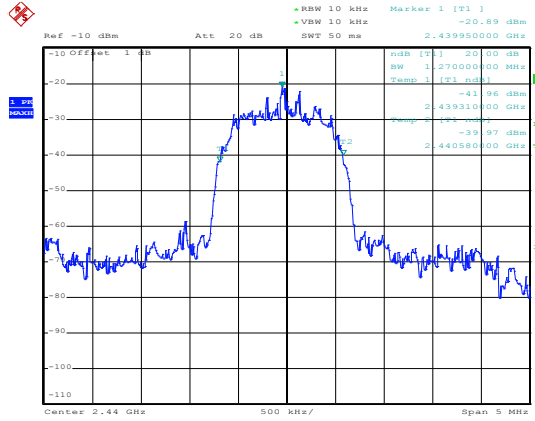
Highest Channel
 (2 480 MHz)



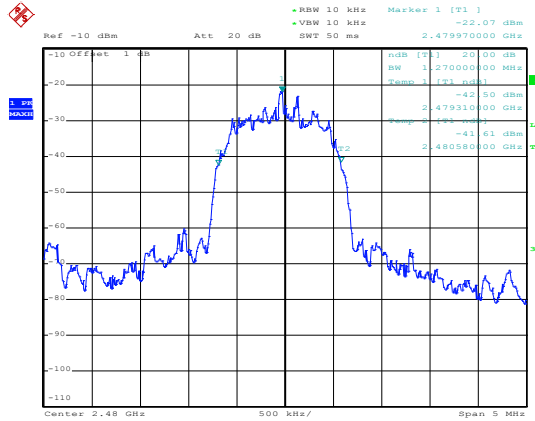
- 8DPSK
 Lowest Channel
 (2 402 MHz)



Middle Channel
 (2 440MHz)



Highest Channel
 (2 480 MHz)



5.5 Number of Hopping Channels

5.5.1 Regulation

According to §15.247(a)(1)(iii), Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used. According to §15.247(b)(1), For frequency hopping systems operating in the 2400-2483.5 MHz band employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5725-5850 MHz band: 1 watt. For all other frequency hopping systems in the 2400-2483.5 MHz band: 0.125 watts.

5.5.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set the hopping function enabled by controlling it via UART interface.
4. Set the spectrum analyzer as follows: Span = the frequency band of operation RBW \geq 1% of the span VBW \geq RBW Sweep = auto Detector function = peak Trace = max hold
5. Record the number of hopping channels.

5.5.3 Test Result

-Complied

- GFSK

| Frequency | Number of hopping channel | Limit |
|-------------------|---------------------------|-----------|
| 2 402 – 2 480 MHz | 79 | \geq 15 |

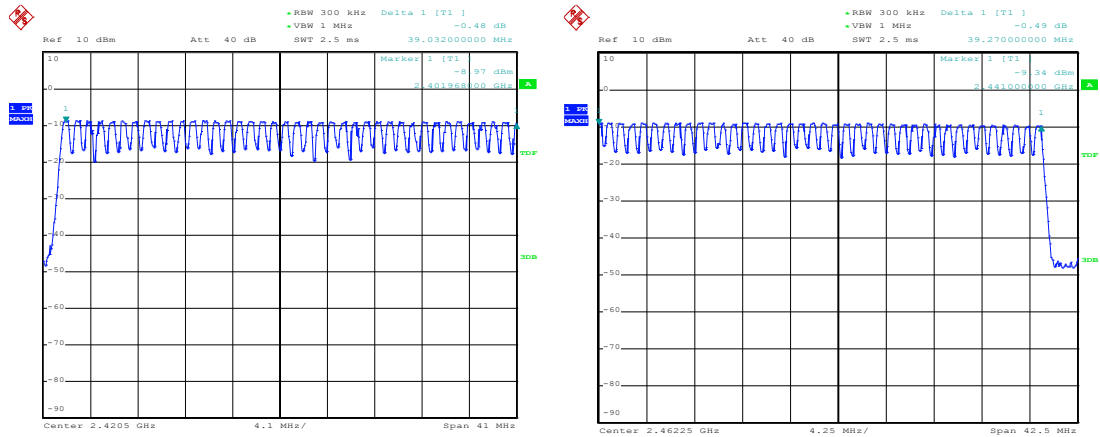
- 8DPSK

| Frequency | Number of hopping channel | Limit |
|-------------------|---------------------------|-----------|
| 2 402 – 2 480 MHz | 79 | \geq 15 |

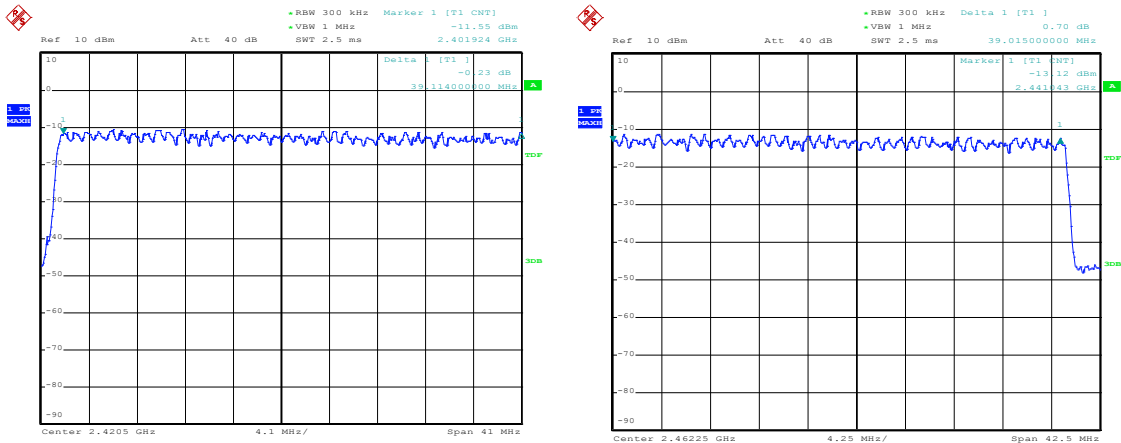
5.5.4 Test Plot

Figure 7. Plot of the Number of Hopping Channels (Conducted)

- GFSK



- 8DPSK



5.6 Time of Occupancy(Dwell Time)

5.6.1 Regulation

According to §15.247(a)(1)(iii), frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

5.6.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface.
4. Set the spectrum analyzer as follows: Span = zero span, centered on a hopping channel RBW = 1 MHz VBW \geq RBW Sweep = as necessary to capture the entire dwell time per hopping channel Detector function = peak Trace = max hold
5. Measure the dwell time using the marker-delta function.
6. Repeat above procedures until all frequencies measured were complete.
7. Repeat this test for different modes of operation (e.g., data rate, modulation format, etc.), if applicable.

5.6.3 Test Result

-Complied

- GFSK

| Channel | Reading[ms] | Hopping rate[hop/s] | Number of Channels | Actual[s] | Limit[s] |
|---------|-------------|---------------------|--------------------|-----------|----------|
| Low | 2.903 | 4 | 79 | 0.005 | 0.40 |
| Middle | 2.903 | 4 | 79 | 0.005 | 0.40 |
| High | 2.903 | 4 | 79 | 0.005 | 0.40 |

- 8DPSK

| Channel | Reading[ms] | Hopping rate[hop/s] | Number of Channels | Actual[s] | Limit[s] |
|---------|-------------|---------------------|--------------------|-----------|----------|
| Low | 2.917 | 4 | 79 | 0.005 | 0.40 |
| Middle | 2.901 | 4 | 79 | 0.005 | 0.40 |
| High | 2.901 | 4 | 79 | 0.005 | 0.40 |

Actual = Reading × (Hopping rate / Number of channels) × Test period

Test period = 0.4 [seconds / channel] × 79 [channel] = 31.6 [seconds]

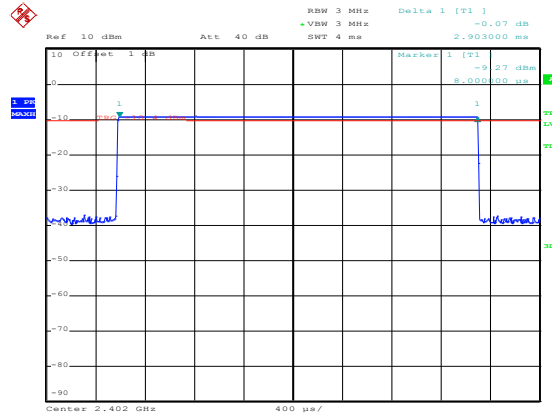
NOTE:

1. We took the insertion loss of the cable loss into consideration within the measuring instrument.

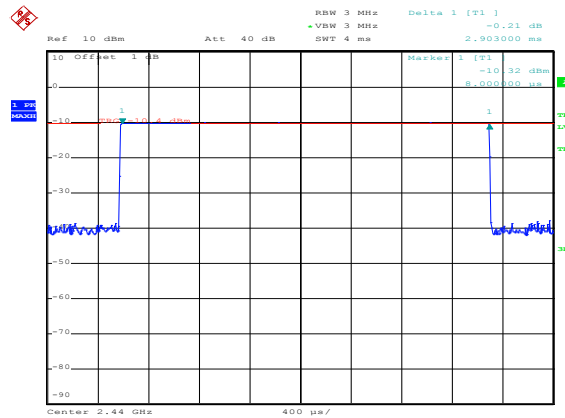
5.6.4 Test Plot

Figure 8. Plot of the Time of Occupancy (Conducted)

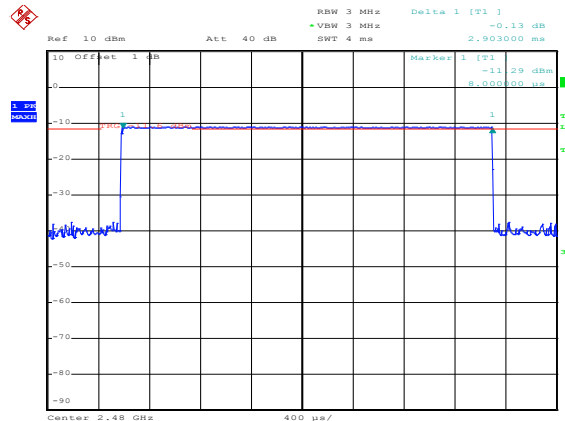
- GFSK
Lowest Channel
(2 402 MHz)



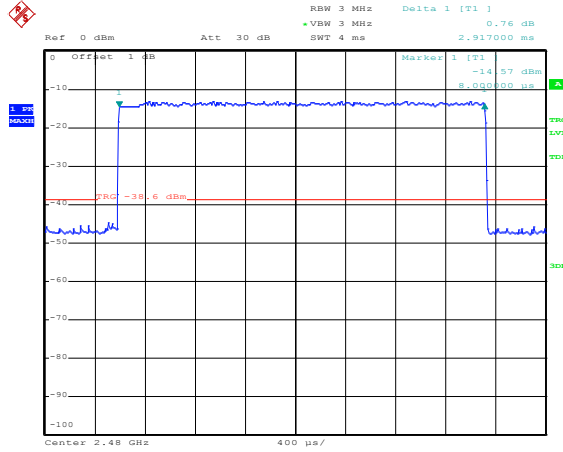
Middle Channel
(2 440 MHz)



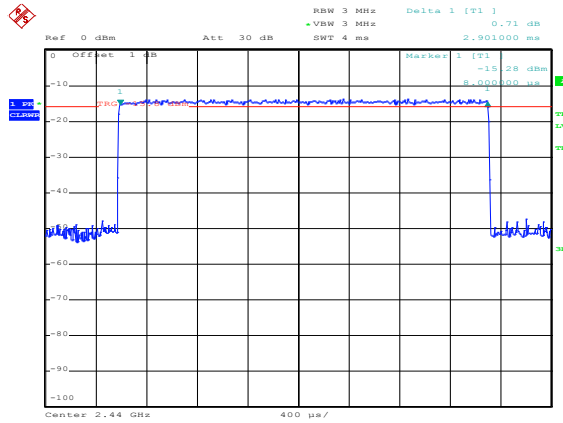
Highest Channel
(2 480 MHz)



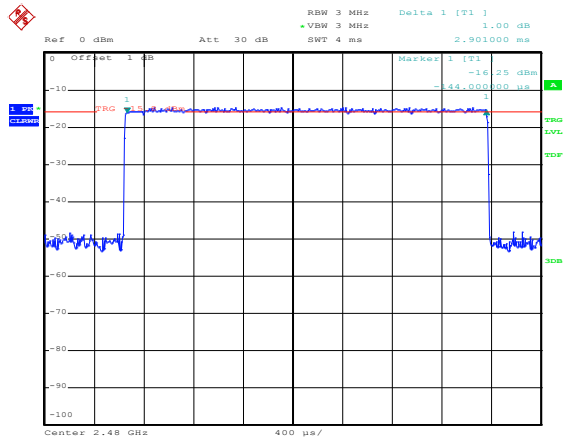
- 8DPSK
Lowest Channel
(2 402 MHz)



Middle Channel
(2 440 MHz)



Highest Channel
(2 480 MHz)



5.7 SPURIOUS EMISSION, BAND EDGE, AND RESTRICTED BANDS

5.7.1 Regulation

According to §15.247(d), 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

According to §15.209(a), for an intentional device, the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the following values:

| Frequency (MHz) | Field strength ($\mu\text{V}/\text{m}$ @ 3m) | Field strength ($\text{dB}\mu\text{V}/\text{m}$ @ 3m) |
|-----------------|---|--|
| 30–88 | 100 | 40.0 |
| 88–216 | 150 | 43.5 |
| 216–960 | 200 | 46.0 |
| Above 960 | 500 | 54.0 |

According to §15.109(a), for an unintentional device, except for Class A digital devices, the field strength of radiated emissions from unintentional radiators at a distance of 3 meters shall not exceed the above table.

** The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi-peak detector and above 1000 MHz are based on the average value of measured emissions.

5.7.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1) Band-edge Compliance of RF Conducted Emissions

2)

1. Set the spectrum analyzer as follows:

Span = wide enough to capture the peak level of the emission operating on the channel closest to the bandedge, as well as any modulation products which fall outside of the authorized band of operation

RBW \geq 1% of the span

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

2. Allow the trace to stabilize. Set the marker on the emission at the band-edge, or on the highest modulation product outside of the band, if this level is greater than that at the band-edge. Enable the marker-delta function, and then use the marker-to-peak function to move the marker to the peak of the in-band emission.

3. Now, using the same instrument settings, enable the hopping function of the EUT. Allow the trace to stabilize. Follow the same procedure listed above to determine if any spurious emissions caused by the hopping function also comply with the specified limit.

2) Spurious RF Conducted Emissions:

1. Set the spectrum analyzer as follows:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span.

RBW = 100 kHz

VBW \geq RBW

Sweep = auto

Detector function = peak

Trace = max hold

2. Allow the trace to stabilize. Set the marker on the peak of any spurious emission recorded.

a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.

5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

3) Spurious Radiated Emissions:

1. The preliminary radiated measurements were performed to determine the frequency producing the maximum emissions in an anechoic chamber at a distance of 3 meters.
2. The EUT was placed on the top of the 0.8-meter height, 1 × 1.5 meter non-metallic table. To find the maximum emission levels, the height of a measuring antenna was changed and the turntable was rotated 360°.
3. The antenna polarization was also changed from vertical to horizontal. The spectrum was scanned from 9 kHz to 30 MHz using the loop antenna, and from 30 to 1000 MHz using the TRILOG broadband antenna, and from 1000 MHz to 26500 MHz using the horn antenna.
4. To obtain the final measurement data, the EUT was arranged on a turntable situated on a 4 × 4 meter at the Open Area Test Site. The EUT was tested at a distance 3 meters.
5. Each frequency found during preliminary measurements was re-examined and investigated. The test-receiver system was set up to average, peak, and quasi-peak detector function with specified bandwidth.

5.7.3 Test Result

-complied

1. Band edge compliance of RF Conducted Emissions was shown in figure 10.
2. Band edge compliance of RF Radiated Emissions was shown in figure 11.
3. Spurious RF conducted Emissions were shown in the Figure 12.

Note: We took the insertion loss of the cable into consideration within the measuring instrument.

4. Measured value of the Field strength of spurious Emissions (Radiated)

- **GFSK**
Low channel (2 402 MHz)

| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. [V/H] | Reading [dB(μV)] | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|--|--------------------------------|---------------|---------------------|----------------|----------------------|---------------------|----------------|
| Quasi-Peak DATA. Emissions below 30 MHz | | | | | | | |
| 24.012 | 9 | V | 26.9 | -20.7 | 6.2 | 49.5 | 43.3 |
| Quasi-Peak DATA. Emissions below 1GHz | | | | | | | |
| 31.673 | 120 | V | 34.3 | -15.8 | 18.5 | 40.0 | 21.5 |
| 38.063 | 120 | V | 31.1 | -15.1 | 16.0 | 40.0 | 24.0 |
| 384.759 | 120 | H | 49.2 | -9.5 | 39.7 | 46.0 | 6.3 |
| 769.508 | 120 | V | 42.8 | -1.0 | 41.8 | 46.0 | 4.2 |
| Peak DATA. Emissions above 1GHz | | | | | | | |
| NOT Detected | | | | | | | |
| Average DATA. Emissions above 1GHz | | | | | | | |
| NOT Detected | | | | | | | |

* Test Distance: 3m
 Spec Distance: 30m
 Reading value = reading + Distance correction factor(-20 dB) = 26.9dB

Middle channel (2 440 MHz)

| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. [V/H] | Reading [dB(μV)] | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|--|--------------------------------|---------------|---------------------|----------------|----------------------|---------------------|----------------|
| Quasi-Peak DATA. Emissions below 30 MHz | | | | | | | |
| 24.005 | 9 | V | 27.0 | -20.7 | 6.3 | 49.5 | 43.2 |
| | | | | | | | |
| Quasi-Peak DATA. Emissions below 1GHz | | | | | | | |
| 31.661 | 120 | V | 34.0 | -15.8 | 18.2 | 40.0 | 21.8 |
| 38.063 | 120 | V | 32.0 | -15.1 | 16.9 | 40.0 | 23.1 |
| 384.778 | 120 | H | 49.6 | -9.5 | 40.1 | 46.0 | 5.9 |
| 769.412 | 120 | V | 41.7 | -1.0 | 40.7 | 46.0 | 5.3 |
| | | | | | | | |
| Peak DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Average DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

* Test Distance: 3m
Spec Distance: 30m
Reading value = reading + Distance correction factor(-20 dB) = 27.0 dB

High channel (2 480 MHz)

| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. [V/H] | Reading [dB(μV)] | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|--|--------------------------------|---------------|---------------------|----------------|----------------------|---------------------|----------------|
| Quasi-Peak DATA. Emissions below 30 MHz | | | | | | | |
| 24.007 | 9 | V | 26.1 | -20.7 | 5.4 | 49.5 | 44.1 |
| | | | | | | | |
| Quasi-Peak DATA. Emissions below 1GHz | | | | | | | |
| 31.485 | 120 | V | 33.5 | -15.8 | 17.7 | 40.0 | 22.3 |
| 38.235 | 120 | V | 31.3 | -15.1 | 16.2 | 40.0 | 23.8 |
| 384.762 | 120 | H | 51.0 | -9.5 | 41.5 | 46.0 | 4.5 |
| 769.559 | 120 | V | 40.7 | -1.0 | 39.7 | 46.0 | 6.3 |
| | | | | | | | |
| Peak DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Average DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

* Test Distance: 3m
Spec Distance: 30m
Reading value = reading + Distance correction factor(-20 dB) = 26.1 dB

- 8DPSK

Low channel (2 402 MHz)

| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. [V/H] | Reading [dB(μV)] | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|--|--------------------------------|---------------|---------------------|----------------|----------------------|---------------------|----------------|
| Quasi-Peak DATA. Emissions below 30 MHz | | | | | | | |
| 24.015 | 9 | V | 27.3 | -20.7 | 6.6 | 49.5 | 42.9 |
| | | | | | | | |
| Quasi-Peak DATA. Emissions below 1GHz | | | | | | | |
| 30.576 | 120 | V | 35.3 | -15.9 | 19.4 | 40.0 | 20.6 |
| 37.449 | 120 | V | 31.6 | -15.2 | 16.4 | 40.0 | 23.6 |
| 384.757 | 120 | H | 48.7 | -9.5 | 39.2 | 46.0 | 6.8 |
| 769.598 | 120 | V | 42.7 | -1.0 | 41.7 | 46.0 | 4.3 |
| 897.645 | 120 | H | 37.9 | 1.4 | 39.3 | 46.0 | 6.7 |
| | | | | | | | |
| Peak DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Average DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

* Test Distance: 3m
 Spec Distance: 30m
 Reading value = reading + Distance correction factor(-20 dB) = 27.3 dB

Middle channel (2 440 MHz)

| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. [V/H] | Reading [dB(μV)] | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|--|--------------------------------|---------------|---------------------|----------------|----------------------|---------------------|----------------|
| Quasi-Peak DATA. Emissions below 30 MHz | | | | | | | |
| 24.015 | 9 | V | 27.1 | -20.7 | 6.4 | 49.5 | 43.1 |
| | | | | | | | |
| Quasi-Peak DATA. Emissions below 1GHz | | | | | | | |
| 30.576 | 120 | V | 34.7 | -15.9 | 18.8 | 40.0 | 21.2 |
| 37.449 | 120 | V | 31.2 | -15.2 | 16.0 | 40.0 | 24.0 |
| 384.757 | 120 | H | 48.9 | -9.5 | 39.4 | 46.0 | 6.6 |
| 769.629 | 120 | V | 41.9 | -1.0 | 40.9 | 46.0 | 5.1 |
| 897.743 | 120 | H | 38.3 | 1.4 | 39.7 | 46.0 | 6.3 |
| | | | | | | | |
| Peak DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Average DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

* Test Distance: 3m
Spec Distance: 30m
Reading value = reading + Distance correction factor(-20 dB) = 27.1 dB

High channel (2 480 MHz)

| Frequency [MHz] | Receiver Bandwidth [kHz] | Pol. [V/H] | Reading [dB(μV)] | Factor [dB] | Result [dB(μV/m)] | Limit [dB(μV/m)] | Margin [dB] |
|--|--------------------------------|---------------|---------------------|----------------|----------------------|---------------------|----------------|
| Quasi-Peak DATA. Emissions below 30 MHz | | | | | | | |
| 24.009 | 9 | V | 26.7 | -20.7 | 6.0 | 49.5 | 43.5 |
| | | | | | | | |
| Quasi-Peak DATA. Emissions below 1GHz | | | | | | | |
| 30.576 | 120 | V | 36.1 | -15.9 | 20.2 | 40.0 | 19.8 |
| 37.449 | 120 | V | 31.7 | -15.2 | 16.5 | 40.0 | 23.5 |
| 384.757 | 120 | H | 49.1 | -9.5 | 39.6 | 46.0 | 6.4 |
| 769.504 | 120 | V | 42.3 | -1.0 | 41.3 | 46.0 | 4.7 |
| 897.765 | 120 | H | 38.7 | 1.4 | 40.1 | 46.0 | 5.9 |
| | | | | | | | |
| Peak DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Average DATA. Emissions above 1GHz | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

* Test Distance: 3m
Spec Distance: 30m
Reading value = reading + Distance correction factor(-20 dB) = 26.7 dB

Factor(dB) = ANT Factor+ Amp Gain + Cable Loss

Margin (dB) = Limit - Result

[Result = Reading – Factor]

1. H = Horizontal, V = Vertical Polarization

2. ATT = Attenuation (10dB pad and/or Insertion Loss of HPF), AF/CL = Antenna Factor and Cable Loss

* The spurious emission at the frequency does not fall in the restricted bands.

** The measured result is within the test standard limit by a margin less than the measurement uncertainty; it is therefore not possible to state compliance based on the 95 % level of confidence. However, the result indicates that compliance is more probable than non-compliance.

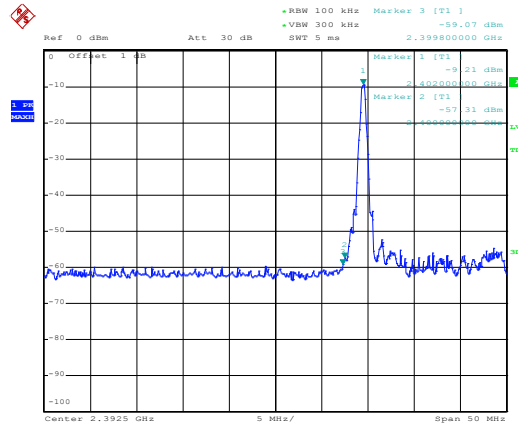
NOTE: All emissions not reported were more than 20 dB below the specified limit or in the noise floor.

5.7.4 Test Plot

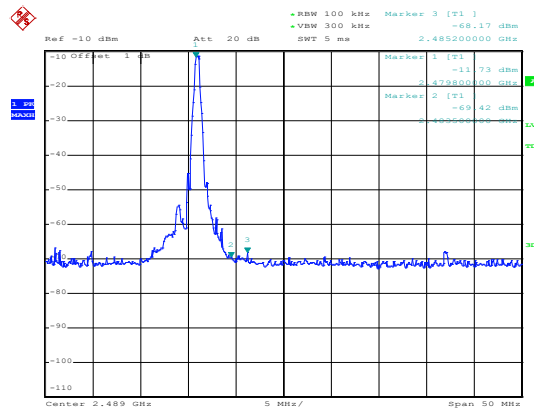
Figure 10. Plot of the Band Edge (Conducted)

- GFSK

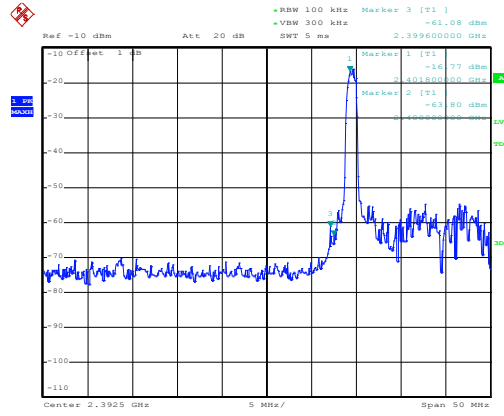
Lowest Channel
(2 402 MHz)



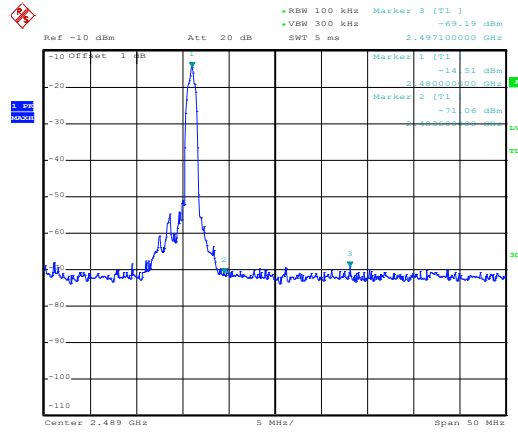
Highest Channel
(2 480 MHz)



- 8DPSK
Lowest Channel
(2 402 MHz)



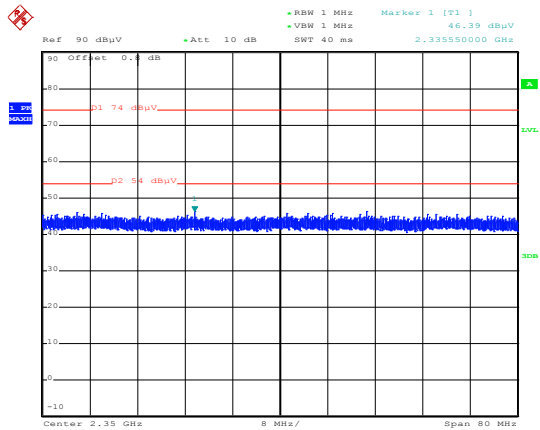
Highest Channel
(2 480 MHz)



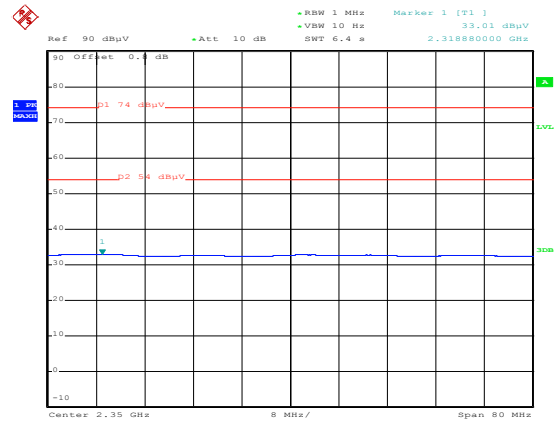
5.7.4 Test Plot (Continue)

Figure 11. Plot of the Band Edge (Radiated) - GFSK

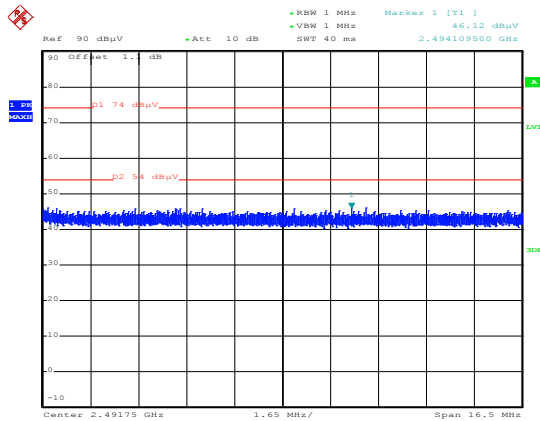
Lowest Channel(2 402 MHz): PEAK



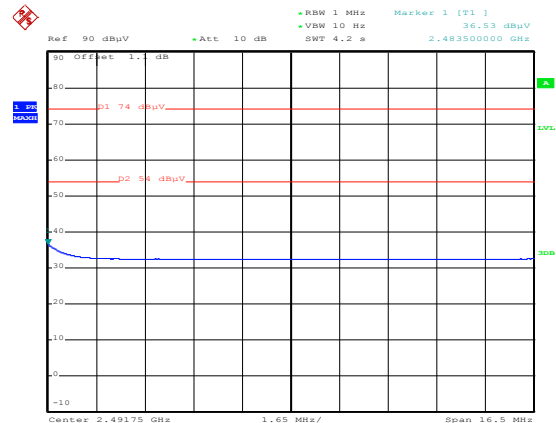
Lowest Channel(2 402 MHz): AVERAGE



Highest Channel(2480 MHz): PEAK

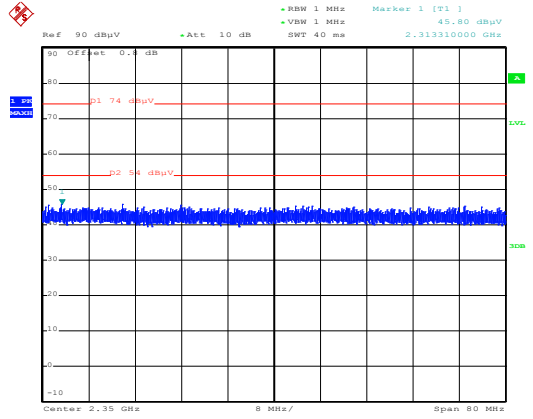


Highest Channel(2480 MHz): AVERAGE

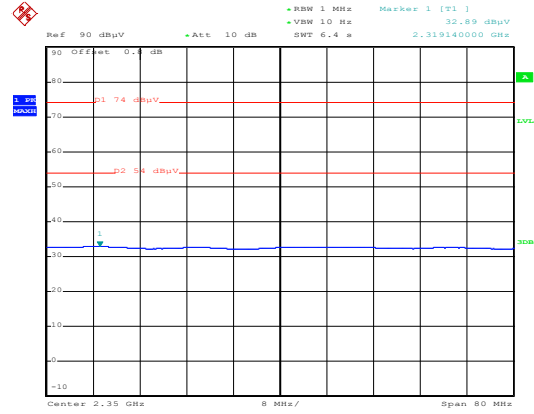


- 8DPSK

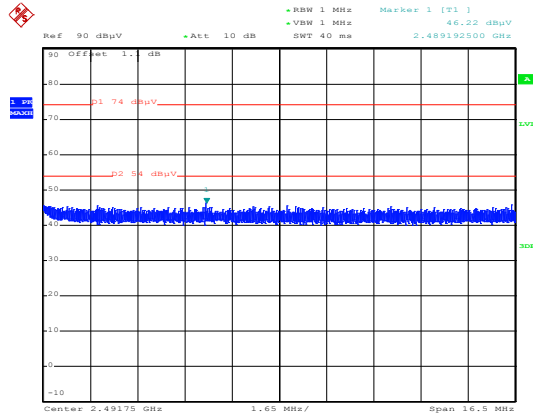
Lowest Channel(2 402 MHz): PEAK



Lowest Channel(2 402 MHz): AVERAGE



Highest Channel(2480 MHz): PEAK



Highest Channel(2480 MHz): AVERAGE

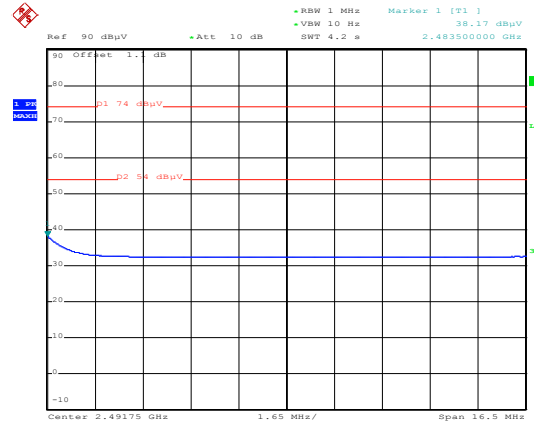
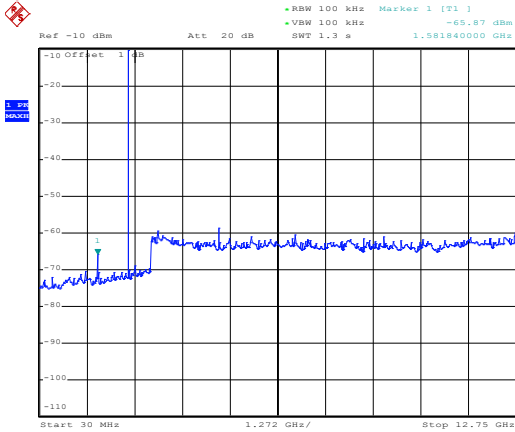
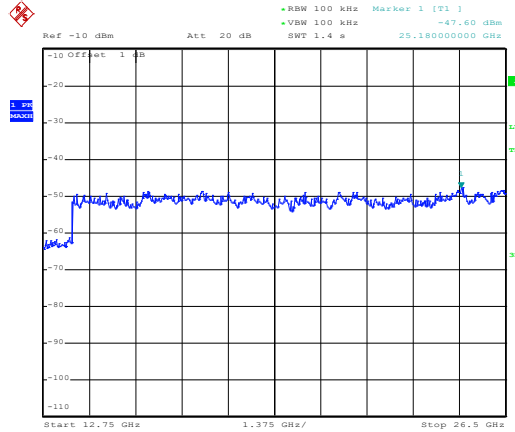


Figure 12. Plot of the Spurious RF conducted emissions - GFSK

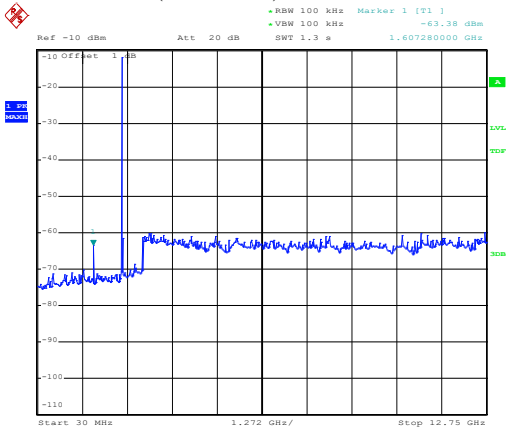
Lowest Channel(2 402 MHz):30MHz~12.75GHz



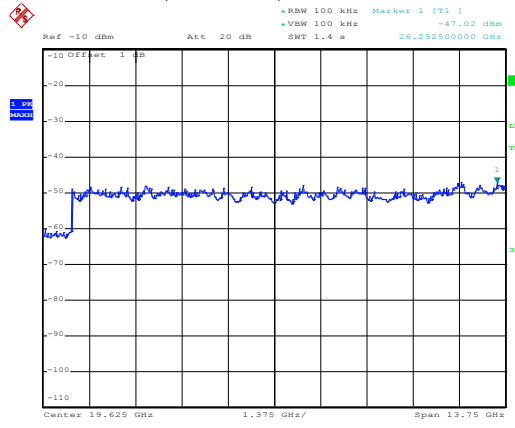
Lowest Channel(2 402 MHz):12.75~26.5GHz



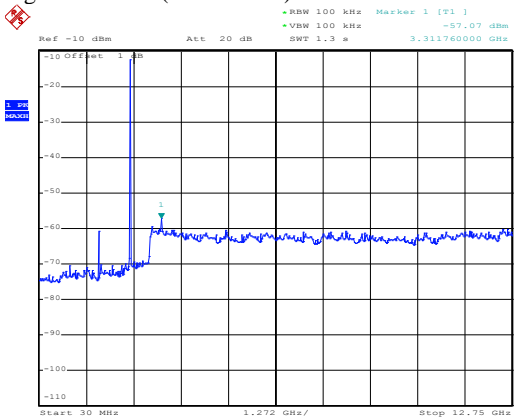
Middle Channel(2 440 MHz):30MHz~12.75GHz



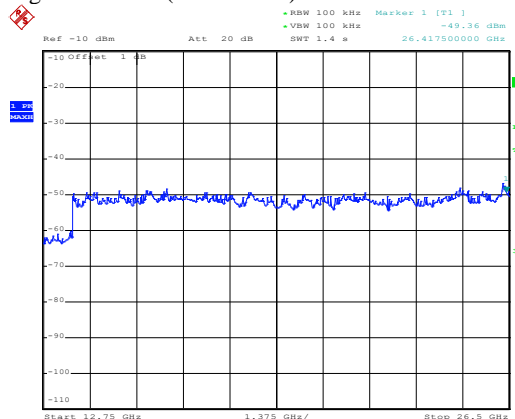
Middle Channel(2 440 MHz):12.75~26.5GHz



Highest Channel(2 480 MHz):30MHz~12.75GHz

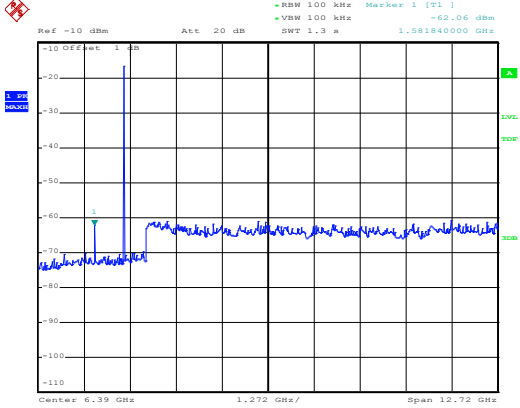


Highest Channel(2 480 MHz):12.75~26.5GHz

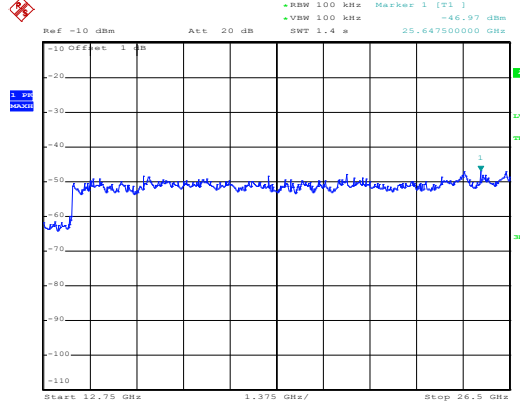


- 8DPSK

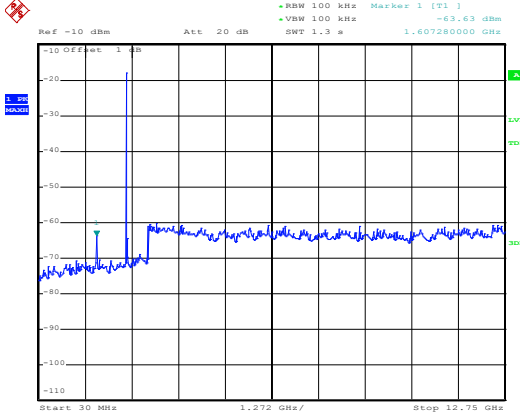
Lowest Channel(2 402 MHz):30MHz~12.75GHz



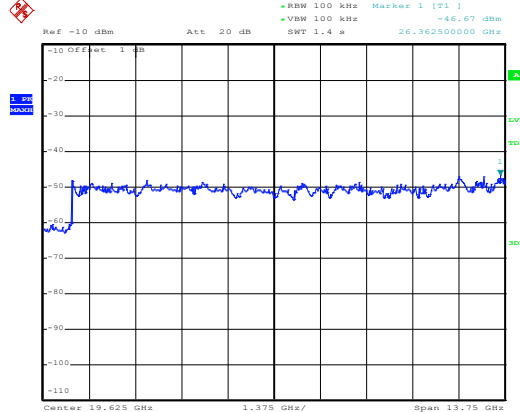
Lowest Channel(2 402 MHz):12.75~26.5GHz



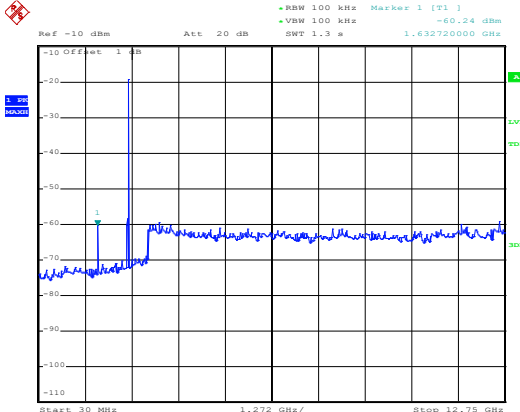
Middle Channel(2 440 MHz):30MHz~12.75GHz



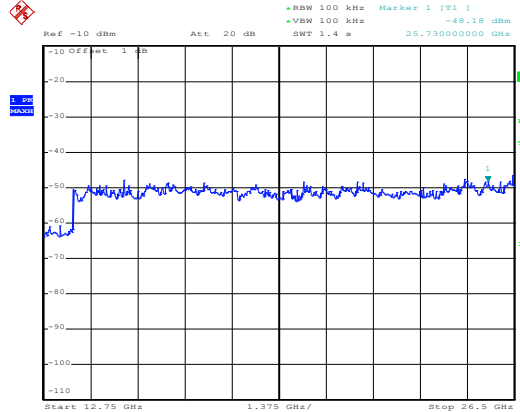
Middle Channel(2 440 MHz):12.75~26.5GHz



Highest Channel(2 480 MHz):30MHz~12.75GHz



Highest Channel(2 480 MHz):12.75~26.5GHz



5.8 Peak Power Spectral Density

5.8.1 Regulation

According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

5.8.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Connect the antenna port of the EUT to RF input on the spectrum analyzer via a low loss cable and attenuator.
3. Turn on the EUT and set it to any one measured frequency within its operating range by controlling it via UART interface and make sure the spectrum analyzer is operated in its linear range.
4. Set the spectrum analyzer to MAX HOLD mode with RBW = 3kHz.
5. Measure the highest amplitude appearing on spectral display and record the level to calculate results.
6. Repeat above procedures until all frequencies measured were complete.

5.8.3 Test Result

-Complied

- GFSK

| Channel | Actual (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------|-------------|-------------|
| Low | -20.96 | 8.00 | 28.96 |
| Middle | -21.95 | 8.00 | 29.95 |
| High | -22.72 | 8.00 | 30.72 |

- 8DPSK

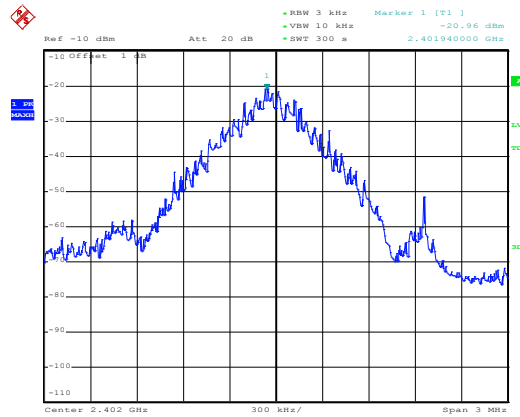
| Channel | Actual (dBm) | Limit (dBm) | Margin (dB) |
|---------|--------------|-------------|-------------|
| Low | -24.81 | 8.00 | 32.81 |
| Middle | -26.17 | 8.00 | 34.17 |
| High | -26.91 | 8.00 | 34.91 |

NOTE: We took the insertion loss of the cable loss into consideration within the measuring instrument.

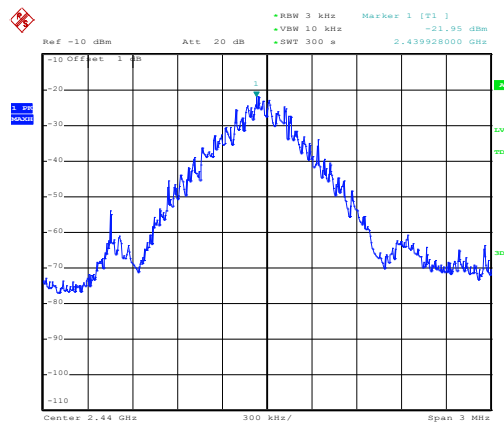
5.8.4 Test Plot

Figure 16. Plot of the Peak Power Spectral Density (Conducted)
- GFSK

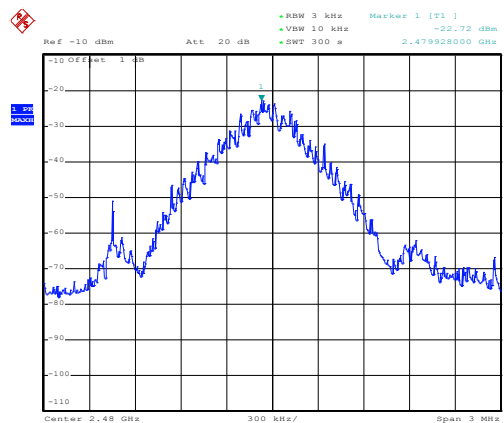
Lowest Channel
(2 402 MHz)



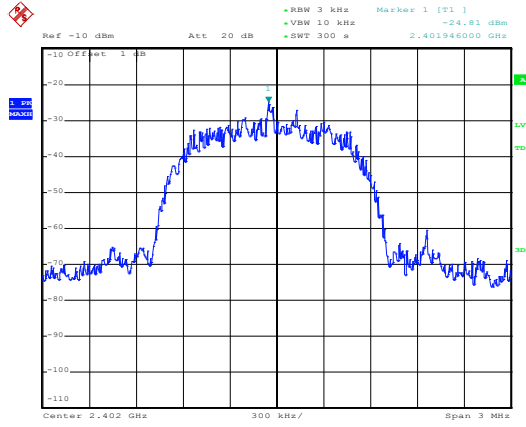
Middle Channel
(2 440 MHz)



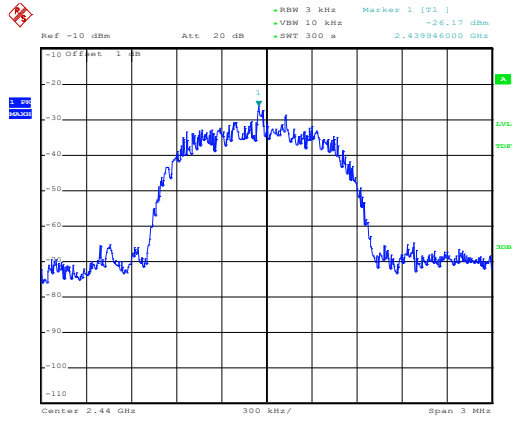
Highest Channel
(2 480 MHz)



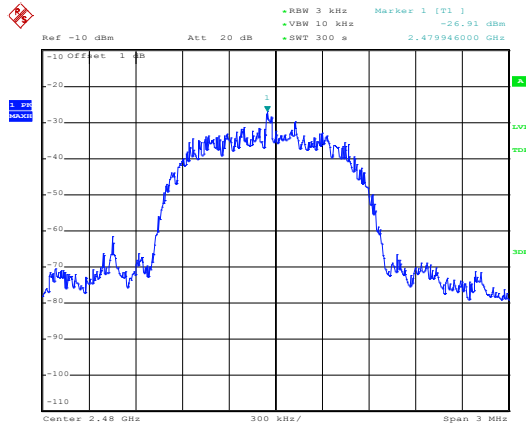
- 8DPSK
Lowest Channel
(2 402 MHz)



Middle Channel
(2 440 MHz)



Highest Channel
(2 480 MHz)



5.9 Conducted Emission(N/A)

5.9.1 Regulation

According to §15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50µH/50Ω line impedance stabilization network (LISN). Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

| Frequency of emission (MHz) | Conducted limit (dBµV) | |
|-----------------------------|------------------------|------------|
| | Qausi-peak | Average |
| 0.15 – 0.5 | 66 to 56 * | 56 to 46 * |
| 0.5 – 5 | 56 | 46 |
| 5 – 30 | 60 | 50 |

* Decreases with the logarithm of the frequency.

According to §15.107(a), for unintentional device, except for Class A digital devices, line conducted emission limits are the same as the above table.

5.9.2 Measurement Procedure

The method of measurement used to test this DSS device is FCC Public Notice DA 00-705.

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50Ω/50µH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
5. The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

5.9.3 Test Result(N/A)

-Complied

| Frequency [MHz] | Correction Factor | | Line | Quasi-peak | | | | Average | | | |
|-----------------|-------------------|-------|------|--------------|----------------|---------------|-------------|--------------|----------------|---------------|-------------|
| | LISN | Cable | | Limit [dBuV] | Reading [dBuV] | Result [dBuV] | Margin [dB] | Limit [dBuV] | Reading [dBuV] | Result [dBuV] | Margin [dB] |
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5.10 RF Exposure

5.10.1 Regulation

According to §15.247(i), systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines. See § 1.1307(b)(1) of this Chapter.

Limits for Maximum Permissible Exposure: RF exposure is calculated.

| Frequency Range | Electric Field Strength [V/m] | Magnetic Field Strength [A/m] | Power Density [mW/cm ²] | Averaging Time [minute] |
|---|-------------------------------|-------------------------------|-------------------------------------|-------------------------|
| Limits for General Population / Uncontrolled Exposure | | | | |
| 0.3 ~ 1.34 | 614 | 1.63 | *(100) | 30 |
| 1.34 ~ 30 | 824 / f | 2.19/f | *(180/f ²) | 30 |
| 30 ~ 300 | 27.5 | 0.073 | 0.2 | 30 |
| 300 ~ 1500 | / | / | f/1500 | 30 |
| 1500 ~ 15000 | / | / | 1.0 | 30 |

f=frequency in MHz, * = plane-wave equivalent power density

MPE (Maximum Permissible Exposure) Prediction

Predication of MPE limit at a given distance: Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = PG/4\pi R^2 \quad (\Rightarrow R = \sqrt{PG/4\pi S})$$

S=power density [mW/cm²]

P=Power input to antenna [mW]

G=Power gain of the antenna in the direction of interest relative to an isotropic radiator

R= distance to the center of radiation of the antenna [cm]

| | |
|--|--|
| EUT: Maximum peak output power = 0.111[mW](= -9.55 dBm) Antenna gain=2.239(= 3.5 [dBi]) | |
| 100 mW, at 20 cm from an antenna 6[dBi] | $S = PG/4\pi R^2 = 100 \times 3.98 / (4 \times \pi \times 400) = 0.0792 \text{ [mW/cm}^2] < 1.0 \text{ [mW/cm}^2]$ |
| 0.111 mW, at 20 cm from an antenna 2.239 [dBi] | $S = PG/4\pi R^2 = 0.000049 \text{ [mW/cm}^2] < 1.0 \text{ [mW/cm}^2]$ |
| 0.111 mW, at 2.5 cm from an antenna 2.239 [dBi] | $S = PG/4\pi R^2 = 0.003164 \text{ [mW/cm}^2] < 1.0 \text{ [mW/cm}^2]$ |

5.10.2 RF Exposure Compliance Issue

The information should be included in the user's manual:

This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter. A minimum separation distance of 20 cm must be maintained between the antenna and the person for this appliance to satisfy the RF exposure requirements.

6. Test equipment used for test

| | Description | Manufacture | Model No. | Serial No. | Next Cal Date. |
|-------------------------------------|-------------------------|-------------|-----------|------------|----------------|
| <input type="checkbox"/> | Temp & humidity chamber | taekwang | TK-04 | TK001 | 12.12.10 |
| <input type="checkbox"/> | Temp & humidity chamber | taekwang | TK-500 | TK002 | 13.09.03 |
| <input type="checkbox"/> | Power Meter | Agilent | E4416A | GB41292365 | 12.10.26 |
| <input type="checkbox"/> | Frequency Counter | HP | 53150A | US39250565 | 13.09.04 |
| <input type="checkbox"/> | Spectrum Analyzer | Agilent | E4407B | US39010142 | 12.10.26 |
| <input checked="" type="checkbox"/> | Spectrum Analyzer | R & S | FSP40 | 100209 | 12.10.26 |
| <input checked="" type="checkbox"/> | Signal Generator | R & S | SMR40 | 100007 | 13.06.27 |
| <input type="checkbox"/> | Modulation Analyzer | HP | 8901B | 3538A05527 | 12.10.26 |
| <input type="checkbox"/> | Audio Analyzer | HP | 8903B | 3729A19213 | 12.10.28 |
| <input type="checkbox"/> | AC Power Supply | KIKUSUI | PCR2000W | GB001619 | 12.10.25 |
| <input checked="" type="checkbox"/> | DC Power Supply | Tektronix | PS2520G | TW50517 | 13.02.06 |
| <input type="checkbox"/> | DC Power Supply | Tektronix | PS2521G | TW53135 | 12.10.25 |
| <input type="checkbox"/> | Dummy Load | BIRD | 8141 | 7560 | 13.09.09 |
| <input type="checkbox"/> | Dummy Load | BIRD | 8401-025 | 799 | 13.09.09 |
| <input checked="" type="checkbox"/> | EMI Test Receiver | R&S | ESCI | 100001 | 13.07.10 |
| <input type="checkbox"/> | Attenuator | HP | 8494A | 2631A09825 | 12.10.26 |
| <input type="checkbox"/> | Attenuator | HP | 8496A | 3308A16640 | 12.10.26 |
| <input type="checkbox"/> | Attenuator | R&S | RBS1000 | D67079 | 12.10.26 |
| <input type="checkbox"/> | Power sensor | Agilent | E9321A | US40390422 | 12.10.26 |
| <input checked="" type="checkbox"/> | LOOP Antenna | EMCO | EMCO6502 | 9205-2745 | 13.05.23 |
| <input checked="" type="checkbox"/> | BILOG Antenna | Schwarzbeck | VULB 9168 | 375 | 13.09.21 |
| <input checked="" type="checkbox"/> | HORN Antenna | ETS | 3115 | 00062589 | 13.11.21 |
| <input checked="" type="checkbox"/> | HORN Antenna | ETS | 3116 | 00086632 | 13.11.15 |
| <input type="checkbox"/> | Power Divider | Weinschel | 1580-1 | NX375 | 12.10.26 |
| <input type="checkbox"/> | Power Divider | Weinschel | 1580-1 | NX380 | 13.09.10 |
| <input type="checkbox"/> | Power Divider | Weinschel | 1594 | 671 | 13.09.09 |
| <input type="checkbox"/> | Test Receiver | R&S | ESHS30 | 828765/009 | 12.10.28 |
| <input type="checkbox"/> | LISN | R&S | ENV216 | 101358 | 12.10.26 |
| <input type="checkbox"/> | LISN | PMM | L2-16A | 0000J10705 | - |