Test Report

C9124AXD-A/-B

Cisco Catalyst C9124AX Series 802.11ax Access Point 2.4GHz BLE Radio

FCC ID: LDK-HTIAK2282 IC: 2461N-HTIAK2282

2400-2483.5 MHz

Against the following Specifications:

CFR47 Part 15.247 RSS-247 RSS-Gen



Cisco Systems 170 West Tasman Drive San Jose, CA 95134

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This report replaces any previously entered test report under EDCS – 21606814. This test report has been electronically authorized and archived using the CISCO Engineering Document Control system. Test Report Template EDCS# 11644121.

SECTION 1: OVI	ERVIEW	3
SECTION 2: ASS	ESSMENT INFORMATION	4
2.2 DATE OF TES	TING	6
	JE DATE	
	Assessed (EUT)	
	IPTION	
SECTION 3: RES	SULT SUMMARY	8
3.1 RESULTS SU	MMARY TABLE	8
SECTION 4: SAM	IPLE DETAILS	11
APPENDIX A: EI	MISSION TEST RESULTS	12
	ST SETUP DIAGRAM	
	Е	
	WIDTH (6DB BANDWIDTH)	
	Bandwidth Conducted Output Power	
	CTRAL DENSITY	
	D SPURIOUS EMISSIONS	
A.7 CONDUCTEI	DRECEIVER SPURIOUS EMISSIONS	40
	D BANDEDGE (RESTRICTED BAND)	
A.9 CONDUCTEI	D BANDEDGE (NON-RESTRICTED BAND)	49
APPENDIX B: E	MISSION TEST RESULTS	52
	SION SETUP DIAGRAM-BELOW 1G	
	PURIOUS EMISSIONS	
	PURIOUS EMISSIONS	
	Emissions 30MHz to 1GHz Cted Emissions	
APPENDIX C:	LIST OF TEST EQUIPMENT USED TO PERFORM THE TEST	
APPENDIX D:	ABBREVIATION KEY AND DEFINITIONS	
APPENDIX E:	PHOTOGRAPHS OF TEST SETUPS	59
APPENDIX F:	SOFTWARE USED TO PERFORM TESTING	59
APPENDIX G:	TEST PROCEDURES	59
APPENDIX H:	SCOPE OF ACCREDITATION (A2LA CERTIFICATE NUMBER 1178-01)	59
APPENDIX I:	TEST ASSESSMENT PLAN	59
APPENDIX J:	WORST CASE JUSTIFICATION	59

Section 1: Overview

The samples were assessed against the tests under the requirements of the following specifications:

Emission

CFR47 Part 15.247 RSS-247 Issue 2: Feb 2017 RSS-Gen Issue 5: Apr 2018

Section 2: Assessment Information

2.1 General

This report contains an assessment of an apparatus against Electromagnetic Compatibility Standards based upon tests carried out on the samples submitted. The testing was performed by and for the use of Cisco systems Inc:

With regard to this assessment, the following points should be noted:

- The results contained in this report relate only to the items tested and were obtained in the period between the date of the initial assessment and the date of issue of the report. Manufactured products will not necessarily give identical results due to production and measurement tolerances.
- b) The apparatus was set up and exercised using the configuration and modes of operation defined in this report only.
- c) Where relevant, the apparatus was only assessed using the susceptibility criteria defined in this report and the Test Assessment Plan (TAP).
- d) All testing was performed under the following environmental conditions:

 Temperature
 15°C to 35°C (54°F to 95°F)

 Atmospheric Pressure
 860mbar to 1060mbar (25.4" to 31.3")

 Humidity
 10% to 75*%

*[Where applicable] For ESD testing the humidity limits used were 30% to 60% and for EFT/B tests the humidity limits used were 25% to 75%.

 All AC testing was performed at one or more of the following supply voltages: 110V 60 Hz (+/-20%)

Units of Measurement

The units of measurements defined in the appendices are reported in specific terms, which are test dependent. Where radiated measurements are concerned these are defined at a particular distance. Basic voltage measurements are defined in units of [dBuV]

As an example, the basic calculation for all measurements is as follows:

Emission level [dBuV] = Indicated voltage level [dBuV] + Cable Loss [dB] + Other correction factors [dB] The combinations of correction factors are dependent upon the exact test configurations [see test equipment lists for further details] and may include:-

Antenna Factors, Pre Amplifier Gain, LISN Loss, Pulse Limiter Loss and Filter Insertion Loss.

Note: to convert the results from dBuV/m to uV/m use the following formula:-

Level in uV/m = Common Antilogarithm [(X dBuV/m)/20] = Y uV/m

Measurement Uncertainty Values

voltage and power measurements	± 2 dB
conducted EIRP measurements	± 1.4 dB
radiated measurements	± 3.2 dB
frequency measurements	± 2.4 10-7
temperature measurements	± 0.54°
humidity measurements	± 2.3%
DC and low frequency measurements	± 2.5%

Where relevant measurement uncertainty levels have been estimated for tests performed on the apparatus. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

Radiated emissions (expanded uncertainty, confidence interval 95%)

30 MHz - 300 MHz	+/- 3.8 dB
300 MHz - 1000 MHz	+/- 4.3 dB
1 GHz - 10 GHz	+/- 4.0 dB
10 GHz - 18GHz	+/- 8.2 dB
18GHz - 26.5GHz	+/- 4.1 dB
26.5GHz - 40GHz	+/- 3.9 dB

Conducted emissions (expanded uncertainty, confidence interval 95%)

+/- 0.38 dB

A product is considered to comply with a requirement if the nominal measured value is below the limit line. The product is considered to not be in compliance in case the nominal measured value is above the limit line.

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2.2 Date of testing 29-MAR-2021 through 30-MAR-2021

2.3 Report Issue Date

31-MAR-2021

Cisco uses an electronic system to issue, store and control the revision of test reports. This system is called the Engineering Document Control System (EDCS). The actual report issue date is embedded into the original file on EDCS. Any copies of this report, either electronic or paper, that are not on EDCS must be considered uncontrolled.

2.4 Testing facilities

This assessment was performed by:

Testing Laboratory

Cisco Systems, Inc. 125 West Tasman Drive (Building P) San Jose, CA 95134 USA

Headquarters

Cisco Systems, Inc., 170 West Tasman Drive San Jose, CA 95134, USA

Registration Numbers for Industry Canada

Cisco System Site	Address	Site Identifier
Building P, 10m Chamber	125 West Tasman Dr	Company #: 2461N-2
	San Jose, CA 95134	
Building P, 5m Chamber	125 West Tasman Dr	Company #: 2461N-1
	San Jose, CA 95134	
Building 7, 5m Chamber	425 E. Tasman Drive	Company #: 2461N-3
	San Jose, California 95134	

Test Engineers

Said Abdelwafi, Julian Land

2.5 Equipment Assessed (EUT) C9124AXI

2.6 EUT Description

The Cisco Catalyst 9124AX Series outdoor access points are next-generation Wi-Fi 6 access points encased in a rugged and robust design that service providers and enterprises can easily deploy.

The radio supports the following modes of operation. The modes are further defined in the radio Theory of Operation. The modes included in this report represent the worst-case data for all modes.

BLE 5.1

The following antennas are supported by this product series. Please note, the antenna information has been provided by the customer (the Cisco business unit). The data included in this report represent the worst-case data for all antennas.

Frequency	Antenna Name		Antenna	a Gain
2.4GHz & 5GHz (Wi-Fi)	Antenna 1	TX/RX: internal	9dBi@2.4GHz	9dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 2	TX/RX: internal	9dBi@2.4GHz	9dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 3	TX/RX: internal	9dBi@2.4GHz	9dBi@5GHz
2.4GHz & 5GHz (Wi-Fi)	Antenna 4	TX/RX: internal	9dBi@2.4GHz	9dBi@5GHz
BLE	Antenna T	TX/RX: internal	4dE	Bi
2.4GHz & 5GHz (Aux)	Antenna A	TX/RX: internal	9dBi@2.4GHz	9dBi@5GHz
2.4GHz & 5GHz (Aux)	Antenna B	RX: internal	9dBi@2.4GHz	9dBi@5GHz

Ithaca (Internal Antenna) Model C9124AXD-x

Section 3: Result Summary

3.1 Results Summary Table

Conducted emissions

Basic Standard	Technical Requirements / Details	Result
FCC 15.247 RSS-247	6dB Bandwidth Systems using digital modulation techniques may operate in the 2400- 2483.5MHz band. The minimum 6dB bandwidth shall be at least 500 kHz	
FCC 15.247 RSS-247	 99% & 26 dB Bandwidth: The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW. 	Pass
	The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.	
FCC 15.247 RSS-247	Output Power: 15.247 The maximum conducted output power of the intentional radiator for systems using digital modulation in the 2400-2483.5 MHz band shall not exceed 1 Watt (30dBm). If transmitting antennas of directional gain greater than 6 dBi are used, the maximum conducted output power shall be reduced by the amount in dB that the directional gain of the antenna exceeds 6 dBi.	Pass
	RSS-247 For DTSs employing digital modulation techniques operating in the band 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. Except as provided in Section 5.4(e), the e.i.r.p. shall not exceed 4 W.	
FCC 15.247 RSS-247	Power Spectral Density 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.	Pass
FCC 15.247 RSS-247	Conducted Spurious Emissions / Band-Edge: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.	Pass
FCC 15.247 RSS-247 FCC 15.205 RSS-Gen	Restricted band: Unwanted emissions falling within the restricted bands, as defined in FCC 15.205 (a) and RSS-Gen 8.10 must also comply with the radiated emission limits specified in FCC 15.209 (a) and RSS-Gen 8.9	Pass

Basic Standard	Technical Requirements / Details		
FCC 15.209 RSS-Gen	1		
RSS-Gen	 RX Spurious Emissions: RSS-Gen 8.9 Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission. RSS-Gen 8.10 Restricted Bands Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and (c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen. 		
AC conducted Emissions: Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table in these sections. The more stringent limit applies at the frequency range boundaries.		Not covered by the scope of this test report	

Section 4: Sample Details

Note: Each sample was evaluated to ensure that its condition was suitable to be used as a test sample prior to the commencement of testing.

4.1 Sample Details

Sample No.	Equipment Details	Manufacturer	Hardware Rev.	Serial Number
S01	C9124AXI-A (used in Rack 8)	Foxconn (for Cisco)	074-125082-01	FOC24523WZG

4.2 System Details

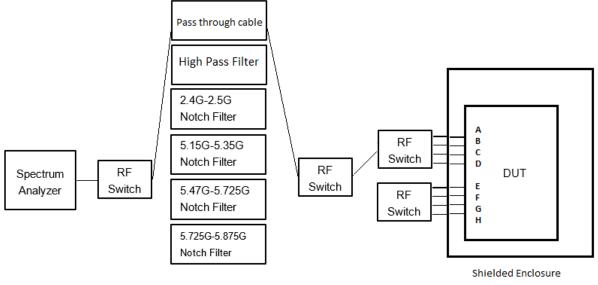
System #	Description	Samples
1	EUT (used in Rack 8)	S01

4.3 Mode of Operation Details

Mode#	Description	Comments
1	Continuous Transmit	AP Running Image: 8.8.1.10
	Testing using Rack 8	Cisco AP Software, (ap1g6a), [sjc-ads-
		9175:/nobackup/rahulsi6/ithaca/c175_throttle/router]
		Compiled Wed Feb 17 19:47:58 PST 2021

Appendix A: Emission Test Results

Conducted Test Setup Diagram



8-port radio shown here Some radios will fewer transmit paths

A.1 Duty Cycle

Duty Cycle Test Requirement

From KDB 558074, Section 6

6.0 Duty cycle, transmission duration and maximum power control level

Preferably, all measurements of maximum conducted (average) output power will be performed with the EUT transmitting continuously (*i.e.*, with a duty cycle of greater than or equal to 98%). When continuous operation cannot be realized, then the use of sweep triggering/signal gating techniques can be utilized to ensure that measurements are made only during transmissions at the maximum power control level. ...

When continuous transmission cannot be achieved and sweep triggering/signal gating cannot be implemented, alternate procedures are provided that can be used to measure the average power; however, they will require an additional measurement of the transmitter duty cycle. Within this guidance document, the duty cycle refers to the fraction of time over which the transmitter is on and is transmitting at its maximum power control level. The duty cycle is considered to be constant if variations are less than ± 2 percent, otherwise the duty cycle is considered to be non-constant.

Duty Cycle Test Method

From KDB 558074, Section 6:

The zero-span mode on a spectrum analyzer or EMI receiver if the response time and spacing between bins on the sweep are sufficient to permit accurate measurements of the on and off times of the transmitted signal. Set the center frequency of the instrument to the center frequency of the transmission. Set RBW \geq OBW if possible; otherwise, set RBW to the largest available value. Set VBW \geq RBW. Set detector = peak or average. The zero-span measurement method shall not be used unless both RBW and VBW are > 50/T and the number of sweep points across duration T

exceeds 100. (For example, if VBW and/or RBW are limited to 3 MHz, then the zero-span method of measuring duty cycle shall not be used if $T \le 16.7$ microseconds.)

Duty Cycle Test Information

Tested By :	Date of testing:
Said Abdelwafi, Julian Land Test Result : PASS	29-MAR-2021 through 30-MAR-2021

Test Equipment

See Appendix C for list of test equipment

Duty Cycle Data Table

Duty Cycle table and screen captures are shown below for power/psd modes.

Frequency (MHz)	Mode	Data Rate (Mbps)	Duty Cycle Correction Factor (dB)
2402	GFSK 125kbps – 2Mbps	1	0

Data Screenshots

2402 MHz: GFSK, 1 Mbps

Spect Swept	rum Anal t SA	yzer 1	•	+									Frequency	₩
KEY RL	SIGHT ++-	Input: F Couplin Align: A	ng: DC	Input Ζ: 50 Ω Corrections: On Freq Ref: Int (S) NFE: Full	#Atten: 16 dB μW Path: Star	ndard G IF	'NO: Fast Sate: Off F Gain: Low Sig Track: Of		Avg Type: Lo Avg Hold: 1/1 Trig: Free Ru		1 2 3 4 5 6 A \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	2.40	er Frequency 2000000 GHz	Settings
1 Spe	ctrum / Div 10 d	18	T		Ref Level 15.	00 dBp	n				11.00 ms .680 dBm	L	000000 Hz	
Log 5.00						4				'			Swept Span Zero Span	
-5.00 -15.0													Full Span	
-25.0 -35.0 -45.0												Start 2.402	Freq 2000000 GHz	
-55.0 -65.0												Stop 2.402	Freq 2000000 GHz	
	er 2.4020		GHz		#Video BW 1	00 kHz	2				Span 0 Hz		AUTO TUNE	
	W 3.0 M	Hz	v						Swe	ep 22.0 r	ns (1001 pts)	CF S1 3.000	ep 0000 MHz	
	Mode	Trace	Scale		Y		unction	Fun	ction Width	Func	tion Value		Nuto Van	
1 2 3	N N N	1 1 1	t t t	11.00 ms 11.00 ms 11.00 ms	1.680 dB 1.680 dB 1.680 dB	m m						Freq 0 Hz	Offset	
4 5 6	N	1	t	11.00 ms	1.680 dB	m							s Scale _og _in	

A.2 DTS Bandwidth (6dB Bandwidth)

DTS Bandwidth Test Requirement

For the FCC 15.247 (2)

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

For Industry Canada: RSS-247 5.2 (a)

5.2 Digital transmission systems

DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz: a) The minimum 6 dB bandwidth shall be 500 kHz.

DTS Bandwidth/ 6dB Bandwidth Test Procedure

Ref. KDB 558074 D01 DTS Meas Guidance v05r02, Section 8.2

ANSI C63.10: 2013, Clause 11.8.2 Option 2

6 BW Test Procedure

1. Set the radio in the continuous transmitting mode.

- 2. Allow the trace to stabilize.
- 3. Setting the x-dB bandwidth mode to -6dB within the measurement set up function.
- 4. Select the automatic OBW measurement function of an instrument to perform bandwidth measurement.

5. Capture graphs and record pertinent measurement data.

Ref. KDB 558074 D01 DTS Meas Guidance v05r02, Section 8.2

ANSI C63.10: 2013, Clause 11.8.2 Option 2

6 BW Test parameters

11.8 DTS bandwidth

One of the following procedures may be used to determine the modulated DTS bandwidth.

11.8.1 Option 1

The steps for the first option are as follows:

- a) Set RBW = 100 kHz.
- b) Set the $VBW \ge [3 \times RBW]$.
- c) Detector = peak.
- d) Trace mode = max hold.
- e) Sweep = auto couple.
- f) Allow the trace to stabilize.
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

11.8.2 Option 2

The automatic bandwidth measurement capability of an instrument may be employed using the X dB bandwidth mode with X set to 6 dB, if the functionality described in 11.8.1 (i.e., RBW = 100 kHz, VBW \geq 3 × RBW, and peak detector with maximum hold) is implemented by the instrumentation function. When using this capability, care shall be taken so that the bandwidth measurement is not influenced by any intermediate power nulls in the fundamental emission that might be \geq 6 dB.

Tested By :	Date of testing:
Said Abdelwafi, Julian Land	29-MAR-2021 through 30-MAR-2021
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

DTS BW Table

Frequency (MHz)	Mode	Data Rate (Mbps)	6dB BW (MHz)	Limit (kHz)	Margin (MHz)
2402	GFSK 125kbps – 2Mbps	1	0.6741	>500	0.1741
2426	GFSK 125kbps – 2Mbps	1	0.6833	>500	0.1833
2480	GFSK 125kbps – 2Mbps	1	0.6873	>500	0.1873

Data Screenshots

2402 MHz: GFSK, 1 Mbps



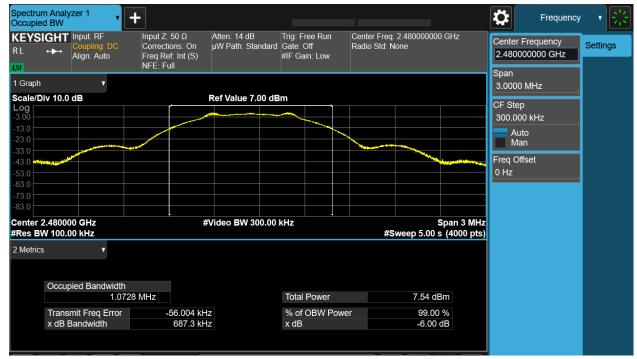
Antenna A

2426 MHz: GFSK, 1 Mbps



Antenna A

2480 MHz: GFSK, 1 Mbps



A.3 Occupied Bandwidth

Occupied Bandwidth Test Requirement

The 99% occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. There is no limit for 99% OBW.

The 26 dB emission is the width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 26 dB relative to the maximum level measured in the fundamental emission.

Occupied Bandwidth Test Method

Ref. ANSI C63.10: 2013

Occupied Bandwidth

Test Procedure

- 1. Set the radio in the continuous transmitting mode.
- 2. Allow the trace to stabilize.
- 3. Setting the x-dB bandwidth mode to -26dB & OBW to 99% within the measurement set up function.
- 4. Select the automatic OBW measurement function of an instrument to perform bandwidth measurement.
- 5. Capture graphs and record pertinent measurement data.

Ref. ANSI C63.10: 2013 section 6.9.3

Occupied Bandwidth

Test parameters

6.9.3 Occupied bandwidth—power bandwidth (99%) measurement procedure

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

- a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.
- b) The nominal IF filter bandwidth (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.
- c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [10 log (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.5.2.
- d) Step a) through step c) might require iteration to adjust within the specified range.
- e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max hold mode (until the trace stabilizes) shall be used.
- f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.
- g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.
- h) The occupied bandwidth shall be reported by providing plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

Tested By :	Date of testing:
Said Abdelwafi, Julian Land	29-MAR-2021 through 30-MAR-2021
Test Result : PASS	· · ·

Test Equipment

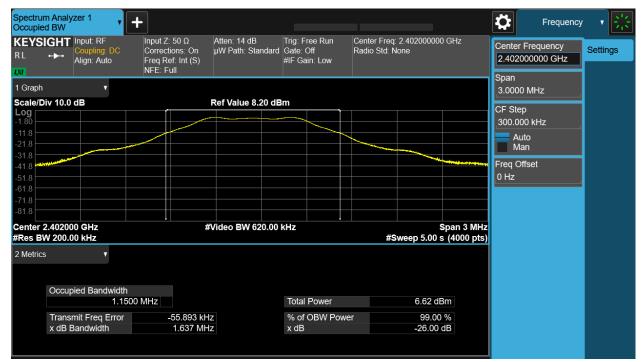
See Appendix C for list of test equipment

Occupied Bandwidth

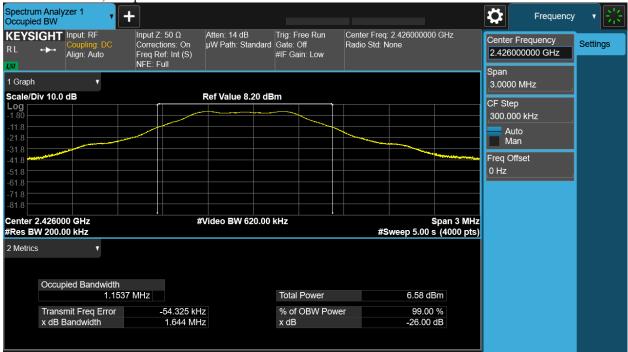
Frequency (MHz)	Mode	Data Rate (Mbps)	26dB BW (MHz)	99% BW (MHz)
2402	GFSK 125kbps – 2Mbps	1	1.637	1.150
2426	GFSK 125kbps – 2Mbps	1	1.644	1.154
2480	GFSK 125kbps – 2Mbps	1	1.664	1.164

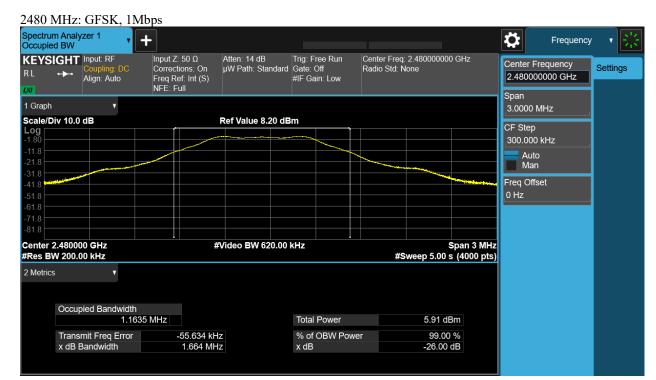
Data Screenshots

2402 MHz: GFSK, 1Mbps



2426 MHz: GFSK, 1Mbps







A.4 Maximum Conducted Output Power

Maximum Conducted Output Power Test Requirement

FCC, 15.247

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following: (3) For systems using digital modulation in the 902-928 MHz, **2400-2483.5 MHz**, and 5725-5850 MHz bands: **1 Watt**. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(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.

Industry Canada, RSS-247:

5.4 Transmitter output power and equivalent isotropically radiated power (e.i.r.p.) requirements d) For DTSs employing digital modulation techniques operating in the bands 902-928 MHz and 2400-2483.5 MHz, the maximum peak conducted output power shall not exceed 1W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

The maximum supported antenna gain is 4dBi. The peak correlated gain for each mode is listed in the table below.

Maximum Conducted Output Power Test Method

Ref. KDB 558074 D01 DTS Meas Guidance v05r02

ANSI C63.10: 2013

Maximum Conducted Output power

Test Procedure

1. Set the radio in the continuous transmitting mode at full power

Compute power by integrating the spectrum across the EBW (or alternatively entire 99% OBW) of the signal using the instrument's band power measurement function. The integration shall be performed using the spectrum analyzer band-power measurement function with band limits set equal to the EBW or the OBW band edges.
 Capture graphs and record pertinent measurement data.

Ref. 558074 D01 DTS Meas Guidance v05r02, 8.3.2.2 Measurement using a spectrum analyzer (SA)

ANSI C63.10: 2013, section 11.9.2.2.4 Method AVGSA-2

Maximum Conducted Output power Test parameters

11.9.2.2	11.9.2.2.4 Method AVGSA-2									
	VGSA-2 uses trace averaging across ON and OFF times of the EUT transmissions, followed by e correction. The procedure for this method is as follows:									
a)	Measure the duty cycle D of the transmitter output signal as described in 11.6.									
b)	Set span to at least 1.5 times the OBW.									
c)	Set RBW = 1% to 5% of the OBW, not to exceed 1 MHz.									
d)	Set $VBW \ge [3 \times RBW]$.									
e)	Number of points in sweep $\geq [2 \times \text{span} / \text{RBW}]$. (This gives bin-to-bin spacing $\leq \text{RBW} / 2$, so that narrowband signals are not lost between frequency bins.)									
f)	Sweep time = auto.									
g)	Detector = RMS (i.e., power averaging), if available. Otherwise, use the sample detector mode.									
h)	Do not use sweep triggering. Allow the sweep to "free run."									
i)	Trace average at least 100 traces in power averaging (rms) mode; however, the number of traces to be averaged shall be increased above 100 as needed such that the average accurately represents the true average over the ON and OFF periods of the transmitter.									
j)	Compute power by integrating the spectrum across the OBW of the signal using the instrument's band power measurement function with band limits set equal to the OBW band edges. If the instrument does not have a band power function, then sum the spectrum levels (in power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.									
k)	Add [10 log $(1 / D)$], where D is the duty cycle, to the measured power to compute the average power during the actual transmission times (because the measurement represents an average over both the ON and OFF times of the transmission). For example, add [10 log $(1/0.25)$] = 6 dB if the duty cycle is 25%.									

The "measure-and-sum technique" is used for measuring in-band transmit power of a device. In the measure-andsum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units. (See ANSI C63.10 section 14.3 for Guidance)

Tested By :	Date of testing:
Said Abdelwafi, Julian Land	29-MAR-2021 through 30-MAR-2021
Test Result : PASS	·

Test Equipment

See Appendix C for list of test equipment

Note: Limit is modified to ensure complying with both conducted power limit of 30dBm and eirp limit of 36 dBm

Maximum Output Power

Frequency 2402 MHz

Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Max Power (dBm)	Duty Cycle (dB)	Total Tx Channel Power (dBm)	Limit (dBm)	Margin (dB)
GFSK, 1 Mbps	1	4	0.61	0	0.61	30	29.39

Frequency 2426 MHz

Mode		Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Max Power (dBm)	Duty Cycle (dB)	Total Tx Channel Power (dBm)	Limit (dBm)	Margin (dB)
GFSK, 1	Mbps	1	4	0.60	0	0.60	30	29.40

Frequency 2480 MHz

		Antenna Gain	er		Channel Power		
Mode	Tx Paths	Correlated (dBi)	Tx 1 Max Power (dBm)	Duty Cycle (dB)	Total Tx (dBm)	Limit (dBm)	Margin (dB)
GFSK, 1 Mbps	1	4	-0.09	0	-0.09	30	30.09

Data Screenshots

Spectrum Analyzer 1 Channel Power	+					*	Frequency	/ · 🐺
KEYSIGHT Input: RF Coupling: DC Align: Auto	Input Ζ: 50 Ω Corrections: On Freq Ref: Int (S) NFE: Full	Atten: 14 dB µW Path: Standard #PNO: Fast	Trig: Free Run Gate: Off #IF Gain: Low	Center Freq: 2.4020000 Avg Hold: 100/100 Radio Std: None	00 GHz		equency 0000 GHz	Settings
1 Graph v Scale/Div 10.0 dB		Ref Value 11.00 d	Bm	Mkr1 2.401939 1.	244 GHz 318 dBm	Span 3.0000 M CF Step	1Hz	
9.00 19.0		••1 				300.000 Auto Man		
29.0						Freq Offs 0 Hz	et	
49.0 59.0 69.0								
79.0		/ideo BW 3.0000	MHz		Span 3 MHz			
Res BW 1.0000 MHz 2 Metrics				Sweep 20.7 ms				
Total Channel Power	0.61 dBm / 1.15 M	Hz						
Total Power Spectral Densit	-59.99 dBm/	Hz						

Antenna A

2426 MHz: GFSK 1 Mbps

Spectru Channe	m Analy. I Power	zer 1	+									Frequency	▼ ∺
KEYS RL		Input: RF Coupling: DC Align: Auto	Input Z: Correctio Freq Ref NFE: Fu	ons: On f: Int (S)	Atten: 14 dB µW Path: Star #PNO: Fast	ndard Gate	Free Run ∷ Off ∋ain: Low	Center Fre Avg Hold: Radio Std:		0 GHz		Frequency 000000 GHz	Settings
1 Graph) Div 10.0	۲		P	ef Value 11.	00 dBm		Mkr1	2.425966	547 GHz 272 dBm	3.000		
Log 1.00 -9.00 -19.0					••••••••••••••••••••••••••••••••••••••	1					CF Ste 300.00 Au	00 kHz ito	
-29.0 -39.0 -49.0											Freq O 0 Hz	ffset	
-59.0 -69.0 -79.0													
Center : #Res B				#V	ideo BW 3.0	000 MHz		Sv	veep 20.7 ms	Span 3 MHz (10000 pts)			
2 Metrics													
		el Power Spectral Densit		n / 1.15 MH).02 dBm/H									



2480 MHz: GFSK 1 Mbps



A.5 Power Spectral Density

Power Spectral Density Test Requirement

15.247 (e) / RSS-247 5.2 (b)

5.2 Digital transmission systems

DTSs include systems that employ digital modulation techniques resulting in spectral characteristics similar to direct sequence systems. The following applies to the bands 902-928 MHz and 2400-2483.5 MHz:

b) The transmitter power spectral density conducted from the transmitter 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 section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

Power Spectral Density Test Method

Ref. KDB 558074 D01 DTS Meas Guidance v05r02

	ANSI	C63.10	: 2013
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Power Spectral Density
Test Procedure
1. Set the radio in the continuous transmitting mode at full power
2.Configure Spectrum analyzer as per test parameters below and Peak search marker
3. Capture graphs and record pertinent measurement data.

Ref. KDB 558074 D01 DTS Meas Guidance v05r02, section 8.4 DTS maximum power spectral density level in the fundamental emission

ANSI C63.10: 2013, section 11.10.5 Average PSD

Power Spectral Density

Test parameters

11.10.5 Method AVGPSD-2

Method AVGPSD-2 uses trace averaging across ON and OFF times of the EUT transmissions, followed by duty cycle correction.

The following procedure is applicable when the EUT cannot be configured to transmit continuously (i.e., D < 98%), when sweep triggering/signal gating cannot be used to measure only when the EUT is transmitting at its maximum power control level, and when the transmission duty cycle is constant (i.e., duty cycle variations are less than ±2%):

- a) Measure the duty cycle (D) of the transmitter output signal as described in 11.6.
- b) Set instrument center frequency to DTS channel center frequency.
- c) Set span to at least 1.5 times the OBW.
- d) Set RBW to: $3 \text{ kHz} \le \text{RBW} \le 100 \text{ kHz}.$
- e) Set $VBW \ge [3 \times RBW]$.
- f) Detector = power averaging (rms) or sample detector (when rms not available).
- g) Ensure that the number of measurement points in the sweep $\geq [2 \times \text{span} / \text{RBW}]$.
- h) Sweep time = auto couple.
- i) Do not use sweep triggering; allow sweep to "free run."
- j) Employ trace averaging (rms) mode over a minimum of 100 traces.
- k) Use the peak marker function to determine the maximum amplitude level.
- l) Add [10 log (1 / D)], where D is the duty cycle measured in step a), to the measured PSD to compute the average PSD during the actual transmission time.
- m) If measured value exceeds requirement specified by regulatory agency, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).

The "Measure and add 10 $\log(N)$ dB technique", where N is the number of outputs, is used for measuring in-band Power Spectral Density. (See ANSI C63.10 section 14.3.2.3)

Tested By :	Date of testing:
Said Abdelwafi, Julian Land	29-MAR-2021 through 30-MAR-2021
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

Power Spectral Density

Frequency 2402 MHz

Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 PSD (dBm/MHz)	Duty Cycle (dB)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
GFSK, 1 Mbps	1	4	-14.26	0	-14.26	8	22.26

Frequency 2426 MHz

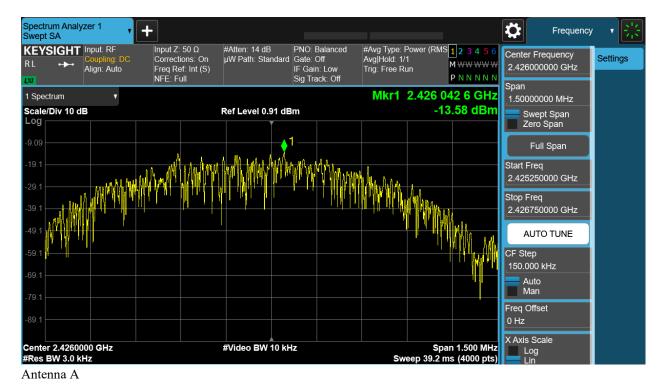
Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1_PSD (dBm/MHz)	Duty Cycle (dB)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
GFSK, 1Mbps	1	4	-13.58	0	-13.58	8	21.58

Frequency 2480 MHz

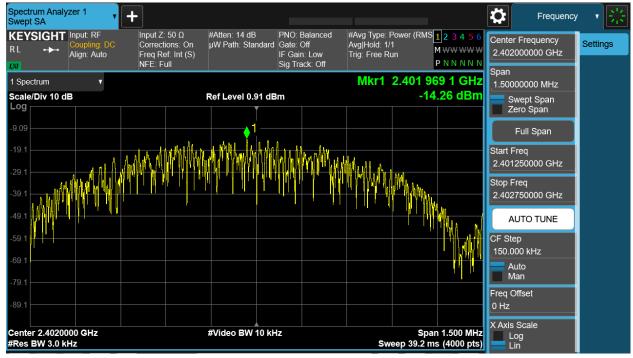
Mode		Tx Paths	Correlated Antenna Gain (dBi)	Tx 1_PSD (dBm/MHz)	Duty Cycle (dB)	Total PSD (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
GFSK, 1	Mbps	1	4	-15.78	0	-15.78	8	23.78

Data Screenshots

2426 MHz: GFSK, 1 Mbps

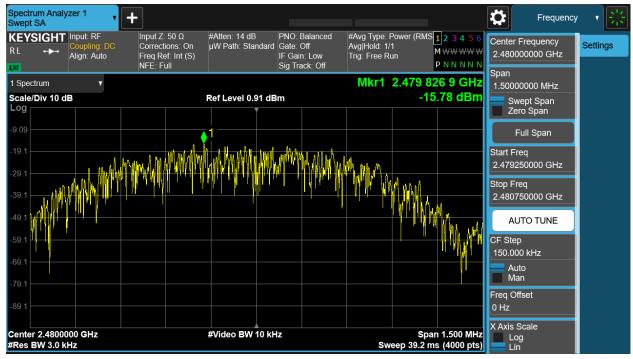


2402 MHz: GFSK, 1 Mbps





2480 MHz: Non HT20, 6 to 54 Mbps



A.6 Conducted Spurious Emissions

Conducted Spurious Emissions Test Requirement

15.205 / RSS-Gen

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a) and RSS-GEN section 8.10, must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)) and RSS-Gen section 8.9

RSS-Gen 8.9 Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

RSS-Gen 8.10 (b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and (c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Use formula below to substitute conducted measurements in place of radiated measurements

E[dBµV/m] = EIRP[dBm] - 20 log(d[meters]) + 104.77, where E = field strength and d = 3 meter

1) Average Plot, Limit= -41.25 dBm eirp

2) Peak plot, Limit = -21.25 dBm eirp

Conducted Spurious Emissions Test Method

Ref. KDB 558074 D01 DTS Meas Guidance v05r02

ANSI C63.10: 2013

Conducted Spurious Emissions

Test Procedure

1. Connect the antenna port(s) to the spectrum analyzer input.

2. Place the radio in continuous transmit mode

3. Configure Spectrum analyzer as per test parameters below (be sure to enter all losses between the transmitter output and the spectrum analyzer).

4. Use the peak marker function to determine the maximum spurs amplitude level.

5. The "measure-and-sum technique" is used for measuring in-band transmit power of a device. In the measure-and-sum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units. The worst case output is recorded. (see ANSI C63.10 2013 section 14.3.2.2)

6. Capture graphs and record pertinent measurement data.

Ref. KDB 558074 D01 DTS Meas Guidance v05r02, section 8.1 c) 3, section 8.6 DTS emissions in restricted frequency bands

ANSI C63.10: 2013 section 11.12.2.4 (Peak) & 11.12.2.5.2 (Average)

Conducted Spurious Emissions Test parameters	
Peak	Average
Span = 30 MHz to 26.5 GHz / 26.5 GHz to 40 GHz	Span = 30 MHz to 26.5 GHz / 26.5 GHz to 40 GHz
RBW = 1 MHz	RBW = 1 MHz
$VBW \ge 3 MHz$	$VBW \ge 3 MHz$
Sweep = Auto	Sweep = Auto

Detector = Peak	Detector = RMS
Trace = Max Hold.	Power Averaging

ANSI C63.10: 2013 section 11.12.2.2 c) add the max antenna gain + ground reflection factor (4.7 dB for frequencies between 30 MHz and 1000 MHz, and 0 dB for frequencies > 1000 MHz).

Tested By :	Date of testing:
Said Abdelwafi, Julian Land	29-MAR-2021 through 30-MAR-2021
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

Conducted Spurs Average Upper

Spect Swep	rum Anal t SA	yzer 1	Ţ	+								Frequency	· • 🛞
RL	SIGHT	Input: F Couplin Align: A	ng: DC	Input Ζ: 50 Ω Corrections: On Freq Ref: Int (S) NFE: Full	#Atten: 0 dΒ μW Path: Standar	PNO: Fas d Gate: Off IF Gain: H Sig Track:	ligh	#Avg Type: Po Avg Hold: 125 Trig: Free Run	AWW	456 ₩₩₩ NNN	Center Fr 19.00000 Span	equency 00000 GHz	Settings
1 Spe	ctrum		T					M	(r4 24.838	GHz	_14.0000(000 GHz	
Scale Log -20.0	/Div 10 (B			Ref Level -10.00	dBm			-81.503	dBm		pt Span Span	
-20.0 -30.0 -40.0											Fu	ll Span	
-50.0 -60.0											Start Free 12.0000	1 00000 GHz	
-70.0 -80.0 -90.0		nn	~~~~~	m pic the hard a sugar wat	en e	مر مر المر مر	مررجعومهما		harren har	s.m.	Stop Fred 26.0000	l 00000 GHz	
	12.000 G BW 1.0 I				#Video BW 3.0 N	1Hz*		Swoor	Stop 26.00 2725.1 ms (10		AUT CF Step	O TUNE	
	ker Table	VINZ	v					Sweet	J23.1 IIIS (10	orpisj		0000 GHz	
	Mode	Trace	Scale	Х	Y	Function	Fun	nction Width	Function Va	lue	Auto Man		
1	N	1	f	2.402 GHz 4.804 GHz	dBm dBm						Freq Offs	et	
3	N	1	f	7.206 GHz	dBm						0 Hz		
4 5 6	N			24.838 GHz	-81.50 dBm						X Axis Sc Log Lin	ale	
	5	6		? Mar 30, 2021 2:31:44 PM	\mathbb{D}_{2}					\mathbf{X}	Signal Tra (Span Zoo		

Conducted Spurs Peak Upper

Spec Swep	rum Anal t SA	yzer 1	•	+								Frequency	- 1 🐺
KE) RL	′SIGH1 ·≁·	Input: F Couplir Align: A	ng: DC	Input Z: 50 Ω Corrections: On Freq Ref: Int (S) NFE: Full	#Atten: 0 dB μW Path: Standar	PNO: Fa rd Gate: O IF Gain: Sig Trac	ff High	#Avg Type: F Avg Hold: 12 Trig: Free Ru	:5/125 JN	1 2 3 4 5 6 M WW WW W P N N N N N		er Frequency 00000000 GHz	Settings
1 Spe	ctrum		•					N	lkr4 25.	930 GHz		000000 GHz	
Scale Log	e/Div 10	dB		F	Ref Level -10.00	dBm			-59	.67 dBm		Swept Span Zero Span	
-30.0 -40.0												Full Span	
-40.0 -50.0 -60.0 -70.0	\ -4			Japate / 16/14/19 / 16/14/14/14/14/14/14/14/14/14/14/14/14/14/	y	م المراد مراد المراد م		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	Nerretter My Nor	mon al all and and	Start 12.0	Freq 00000000 GHz	
-80.0 -90.0	an sin an an	and a state of the	anda - o th <mark>a</mark> ak								Stop 26.0	Freq 00000000 GHz	
	12.000 Q BW 1.0				#Video BW 3.0 I	MHz		Swo		26.000 GHz s (1001 pts)			
	ker Table	11/2	V					Jine	ep 23.111	3 (1001 pt3)		0000000 GHz	
	Mode	Trace	Scale	X	Y	Functio	n Fur	nction Width	Functi	on Value $_$		Auto Man	
1	N N	1	f	12.000 GHz 12.000 GHz	-72.45 dBm -72.45 dBm						Freq	Offset	
3		1	f	12.000 GHz	-72.45 dBm						0 Hz		
4 5 6		1	f	25.930 GHz	-59.67 dBm							s Scale ₋og ∟in	
H	5	6		Mar 30, 2021 2:33:34 PM	D 🔼							l Track Zoom)	

Conducted Spurs Average

Frequency 2402 MHz

Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)	Duty Cycle (dB)	Total Conducted Spur (dBm)	Limit (dB)	Margin (dB)
GFSK, 1 Mbps	1	4	-61.3	0	-57.3	-41.25	16.1

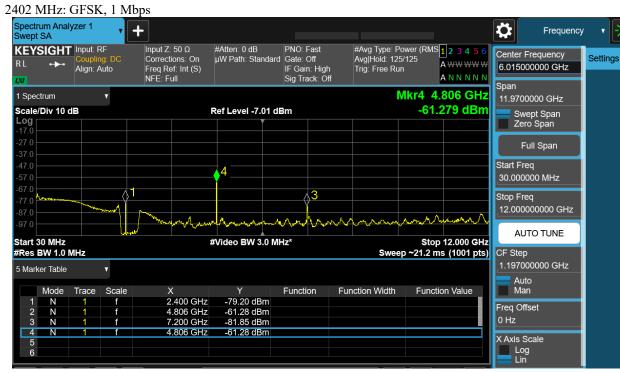
Frequency 2426 MHz

Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)	Duty Cycle (dB)	Total Conducted Spur (dBm)	Limit (dB)	Margin (dB)
GFSK, 1 Mbps	1	4	-71.8	0	-67.8	-41.25	26.6

Frequency 2480 MHz

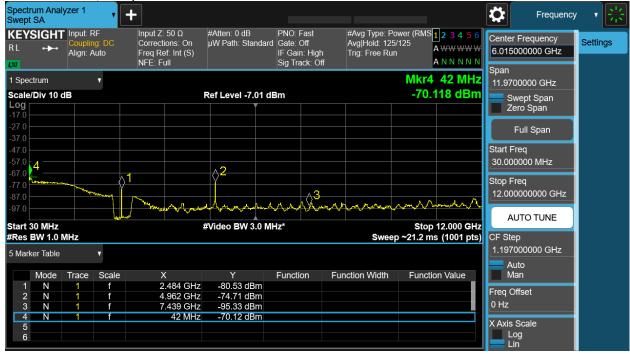
Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)	Duty Cycle (dB)	Total Conducted Spur (dBm)	Limit (dB)	Margin (dB)
Mode	Tx	Col (dB	Tx (dB	Dui (dB	Tot (dB	Lin (dB	Ma (dB
GFSK, 1 Mbps	1	4	-70.1	0	-66.1	-41.25	24.9

Data Screenshots

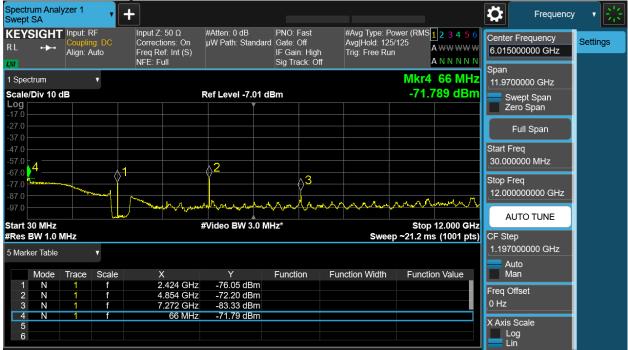


Antenna A

2480 MHz: GFSK, 1 Mbps



2426 MHz: GFSK, 1 Mbps



Conducted Spurs Peak

Frequency 2402 MHz

	1	1	1	1			
	Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)	Duty Cycle (dB)	Total Conducted Spur (dBm)	Limit (dB)	Margin (dB)
Mode	Тx	ŬÐ	Tx (dF	D D	P L J	Li (d	ББ
GFSK, 1 Mbps	1	4	-50.3	0	-46.3	-21.25	25.05

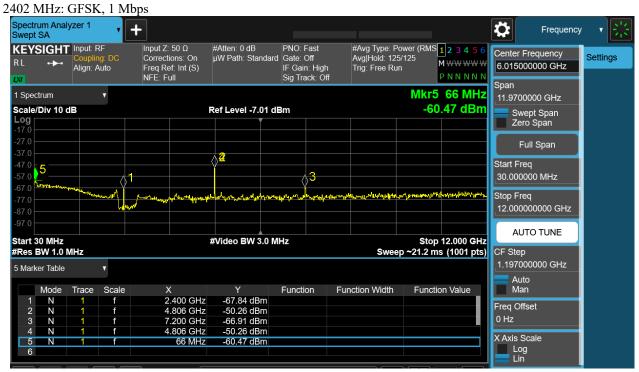
Frequency 2426 MHz

Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)	Duty Cycle (dB)	Total Conducted Spur (dBm)	Limit (dB)	Margin (dB)
GFSK, 1 Mbps	1	4	-60.4	0	-56.4	-21.25	35.15

Frequency 2480 MHz

Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Spur Power (dBm)	Duty Cycle (dB)	Total Conducted Spur (dBm)	Limit (dB)	Margin (dB)
GFSK, 1 Mbps	1	4	-62.3	0	-58.3	-21.25	37.05

Data Screenshots

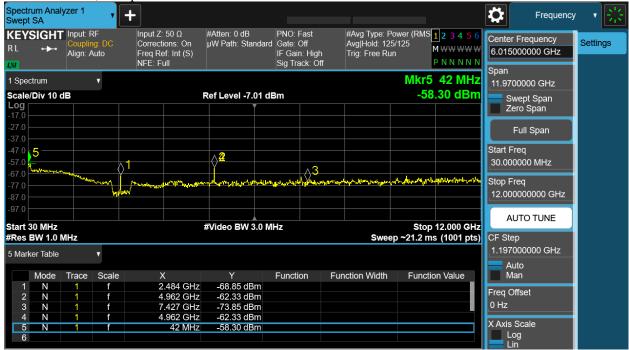


Antenna A

2426 MHz: GFSK, 1 Mbps

EYSIGHT Input: Coupl Align:	RF Input Z: 50 Ω ing: DC Corrections: 0		DNIO: E4	// A T		Frequency	
Aign.		On µW Path: Standa	PNO: Fast ard Gate: Off IF Gain: High	#Avg Type: Pow Avg Hold: 125/12 Trig: Free Run	er (RMS <mark>123456</mark> 25 MWWWW	Center Frequency S 6.015000000 GHz	etting
	NFE: Full	(3)	Sig Track: Off	Thy. Flee Rull	PNNNN		
pectrum	•	'			Mkr5 78 MHz	Span 11.9700000 GHz	
le/Div 10 dB		Ref Level -7.01	dBm		-60.57 dBm	Swept Span	
		Ţ.				Zero Span	
0						Full Span	
5	1	<mark>2</mark>	<u>3</u>			Start Freq 30.000000 MHz	
0	mound have a hope	un and the second s	nayon providential	Lind teen why grand the production of the	where we are a second and the second s	Stop Freq 12.000000000 GHz	
0		#Video BW 3.0	MHz		Stop 12.000 GHz	AUTO TUNE	
s BW 1.0 MHz				Sweep -	~21.2 ms (1001 pts)		
	v					1.197000000 GHz	
arker lable						Auto	
arker lable		Y	Function F	unction Width	Function Value	Man	
Mode Trace							
Mode Trace	f 2.424					Fred Offset	
Mode Trace 1 N 1 2 N 1	f 2.424 f 4.854	GHz -60.41 dBm				Freq Offset	
1 N 1 2 N 1 3 N 1	f 2.424 f 4.854 f 7.272	GHz -60.41 dBm GHz -68.15 dBm				Freq Offset 0 Hz	
Mode Trace 1 N 1 2 N 1	f 2.424 f 4.854 f 7.272 f 4.854	GHz -60.41 dBm GHz -68.15 dBm					

2480 MHz: GFSK, 1 Mbps

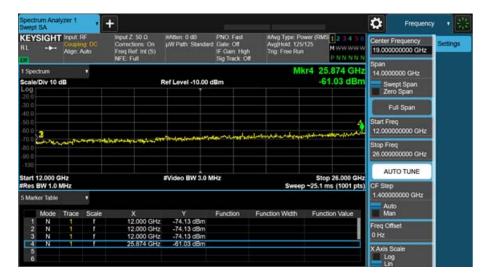


A.7 Conducted Receiver Spurious Emissions

ů + ot SA KEYSIGHT Center Frequency 19.000000000 GHz Avg(Hold, 1a Trig: Free R RL AWWWWW -Alian Au Sain: High Track: Off Mkr4 25.916 GH 1 Spectrum -82.586 dBr Ref Level -10.00 dBm Scale/Div 10 dB Swept Span Zero Span Start Freq 12.000000000 GHz Stop Freq 26.00000000 GHz 2 AUTO TUNE #Video BW 3.0 MHz* Stop 26.000 GHz Sweep ~25.1 ms (1001 pts) art 12.000 GHz Res BW 1.0 MHz F Step .400000000 GHz Auto Man X 2.402 GHz 4.804 GHz 7.206 GHz Function Function Width Function Value Mode Trace Scale Freq Offse 0 Hz N X Axis Sca

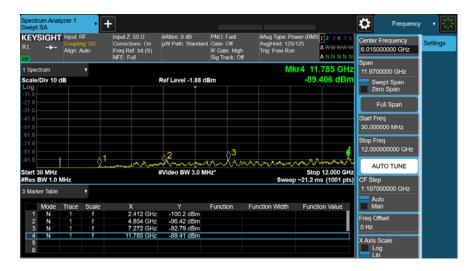
Conducted Receiver Spurs Average Upper

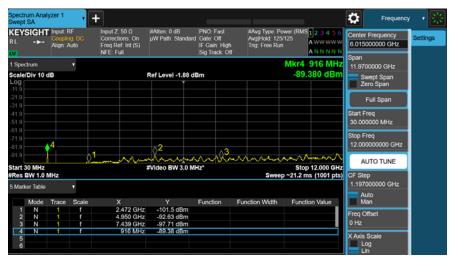
Conducted Receiver Spurs Peak Upper



Conducted Receiver Spurs Average

Spectru Swept :	um Anal SA	yzer 1	•	+						💭 Fr	requency 🔹 🛃
KEYS RL	Sight ++-	Input: F Couplin Align: A	ng: DC	Input Z: 50 Ω Corrections: On Freq Ref: Int (S) NFE: Full	rections: On µW Path: Standard Gate: q Ref: Int (S) IF Ga		Avg Hok h Trig:Fre	1: 125/125	IS <mark>123456</mark> A ******* A N N N N N	Center Freque 6.015000000	
1 Spect Scale/I	trum Div 10 d	B	•		Ref Level -1.88 c	lBm			916 MHz 9.309 dBm	Swept Sp	an
11.9 - 21.9 - 31.9 -										Zero Spar Full Spa	
41.9 51.9										Start Freq 30.000000 Mi	Hz
61.9 71.9 81.9		4			.2	3				Stop Freq 12.00000000	0 GHz
91.9	0 MHz		Q.	- marker Mark	#Video BW 3.0 N	m	mm		12.000 GHz	Αυτο τυ	INE
Res E	W 1.0 I	MHz					5		ms (1001 pts)	CF Step 1.197000000	CH4
	ar Table	_					_	_		Auto	UIL .
	Mode	Trace	Scale	X	Y	Function	Function W	ath Fun	ction Value	Man	
2	N	1	f	2.400 GHz 4.794 GHz	-101.9 dBm -97.33 dBm					Freq Offset	
3	N			4.794 GHZ 7.212 GHz	-97.53 dBm				_	0 Hz	
4	N	÷		916 MHz	-89.31 dBm						
5 6										X Axis Scale Log Lin	

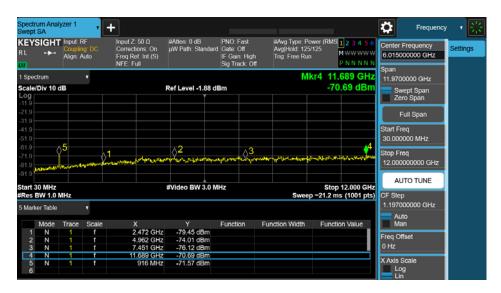




Conducted Receiver Spurs Peak

Spect Swept	rum Ana t SA	yzer 1	•	+					Frequency	· •] #
KEY RL	'SIGH1 -+-	Input F Couplin Align: /	ng: DC	Input Z: 50 Ω Corrections: On Freq Ref: Int (S) NFE: Full	#Atten: 0 dB µW Path: Standard	PNO: Fast Gate: Off F Gain: High Sig Track: Off	#Avg Type: Po Avg Hold: 125 Trig: Free Run		Center Frequency 6.015000000 GHz	Settings
1 Spe	ctrum e/Div 10	dB	T		Ref Level -1.88 d	Bm	M	kr4 11.808 GHz -71.62 dBm	Span 11.9700000 GHz Swept Span Zero Span	
-21.9 -31.9									Full Span	
-41.9 -51.9 -61.9		5						A	Start Freq 30.000000 MHz	
-71.9 -81.9 -91.9		al-gologentije	www.A	manna	L Also arrest areas	3 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	anny fir mar he what	an a	Stop Freq 12.000000000 GHz	
Start	30 MHz				#Video BW 3.0 M	Hz		Stop 12.000 GHz	AUTO TUNE	
	BW 1.0 ker Table	MHz	•				Sweep	o ~21.2 ms (1001 pts)	CF Step 1.197000000 GHz	
	Mode	Trace	Scale	Х	Y	Function F	unction Width	Function Value	Man	
1	N	1	f	2.400 GHz	-80.96 dBm				Erra Official	
2	N	1	f	4.806 GHz	-74.39 dBm				Freq Offset	
3		1	f	7.200 GHz	-74.13 dBm				0 Hz	
4		1	f	11.808 GHz	-71.62 dBm				X Axis Scale	
5 6		1	1	904 MHz	-71.20 dBm				Log	

Spectr Swept	um Anai SA	yzer 1	•	+						Frequency	- 7 🛞
KEY: RL	SIGH1	Input F Couplin Align: A	ng: DC	Input Z: 50 Ω Corrections: On Freq Ref: Int (S) NFE: Full	#Atten: 0 dB µW Path: Standar	n: 0 dB PNO: Fast #Awg Type: Power (RMS] 2 3 4 5 6 ath: Standard Gate: Off Awg Hold: 125/125 M WWW W Sig Track: Off Pinn NN N			equency 0000 GHz	Settings	
1 Spec Scale/ Log	trum Div 10 (1B	•		Ref Level -1.88 c			kr4 11.342 GHz -70.70 dBm	Swep	00 GHz ot Span Span	
-11.9 -21.9 -31.9										l Span	
-41.9 -51.9		5							Start Free 30.00000		
-61.9 -71.9 -81.9	town the second	o wyman	مىسىر	1	2 Marian	tur and the	alymore washing	ahyynyn yn an yn	Stop Freq 12.00000	00000 GHz	
Start 3	30 MHz				#Video BW 3.0 M	ИНz		Stop 12.000 GHz		O TUNE	
#Res l	BW 1.0	MHZ					Swee	p ~21.2 ms (1001 pts)			
5 Mark	er Table		•						1.197000 Auto	0000 GHz	
	Mode	Trace	Scale	X	Y	Function	Function Width	Function Value	Man		
1	N	1	f	2.424 GHz					Freq Offs	ot	
2	N	1	1	4.842 GHz					0 Hz		
3	N			7.284 GHz 11.342 GHz					0112		
4 5 6	N	1	f	916 MHz	-70.93 dBm				X Axis Sc Log Lin	ale	



A.8 Conducted Bandedge (Restricted Band)

Conducted Band Edge Test Requirement

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 §15.209(a) is not required. 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) (see §15.205(c)).

RSS-247

5.5 Unwanted emissions

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced 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 that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

15.205 / RSS-Gen

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), and RSS-Gen 8.10 must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)) and RSS-Gen 8.9.

Conducted Bandedge Test Method

Ref. KDB 558074 D01 DTS Meas Guidance v05r02

|--|

Conducted Band edge

Test Procedure

1. Connect the antenna port(s) to the spectrum analyzer input.

2. Place the radio in continuous transmit mode. Use the procedures in KDB 558074 D01 DTS Meas Guidance v04 to substitute conducted measurements in place of radiated measurements.

3. Configure Spectrum analyzer as per test parameters below (be sure to enter all losses between the transmitter output and the spectrum analyzer).

4. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance.

Also measure any emissions in the restricted bands.

5. The "measure-and-sum technique" is used for measuring in-band transmit power of a device. In the measure-and-sum approach, the conducted emission level is measured at each antenna port. The measured results at the various antenna ports are then summed mathematically to determine the total emission level from the device. Summing is performed in linear power units. The worst case output is recorded.

6. Place a marker at the end of the restricted band closest to the transmit frequency to show compliance.

Also measure any emissions in the restricted bands

7. Capture graphs and record pertinent measurement data.

Ref. KDB 558074 D01 DTS Meas Guidance v05r02, section 8.1 c) 3, section 8.6 DTS emissions in restricted frequency bands

Conducted Spurious Emissions	
Test parameters	
Peak	Average
RBW = 1 MHz	RBW = 1 MHz
$VBW \ge 3 MHz$	$VBW \ge 3 MHz$
Sweep = Auto	Sweep = Auto
Detector = Peak	Detector = RMS
Trace = Max Hold.	Power Averaging

ANSI C63.10: 2013 section 11.12.2.4 (Peak) & 11.12.2.5.2 (Average)

Tested By :	Date of testing:
Said Abdelwafi, Julian Land	29-MAR-2021 through 30-MAR-2021
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

Restricted Band

Conducted Bandedge Average Table

Frequency 2402 MHz

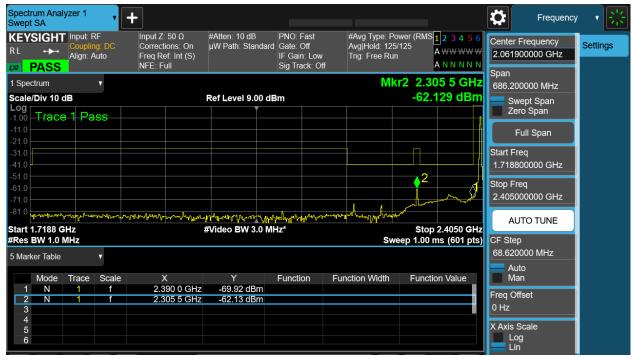
		5			2		
Mode	Tx Paths	Correlated Antenna Gain (dBi)	Tx 1 Bandedge Level (dBm)	Duty Cycle (dB)	Total Tx Bandedge Level (dBm)	Limit (dB)	Margin (dB)
GFSK, 1 Mbps	1	4	-62.1	0	-58.1	-41.25	16.9

Frequency 2480 MHz

	Paths	Correlated Antenna Gain (dBi)	Bandedge Level ()	Cycle	Total Tx Bandedge Level (dBm)		in
Mode	Tx Pa	Corre (dBi)	Tx 1 B (dBm)	Duty (dB)	Total T (dBm)	Limit (dB)	Margin (dB)
GFSK, 1 Mbps	1	4	-60.9	0	-56.9	-41.25	15.7

Data Screenshots

2402 MHz: GFSK, 1 Mbps



Antenna A

2480 MHz: GFSK, 1 Mbps

Spectrum Analyzer 1 Swept SA	+			\$	Frequency	· ~ 尝
KEYSIGHT Input: RF R L Imput: RF Align: Auto	Freq Ref: Int (S)	IF Gain: Low	Trig: Free Run	Serie	ter Frequency 72500000 GHz	Settings
1 Spectrum v	NFE: Full Ref Level 9.00 c	Sig Track: Off	Mkr2 2.575	3 GHz Spar	.000000 MHz	
Log -1.00 Trace 1 Pass -11.0					Swept Span Zero Span Full Span	
-21.0 -31.0 -41.0					Freq 78000000 GHz	
-51.0 1 -61.0 -71.0					Freq 67000000 GHz	
Start 2.4780 GHz	Միչթ ^{եղե} սութերեն, աներություն, աներություն, աներություն, աներություն, աներություն, աներություն, աներություն, աներո #Video BW 3.0 M	լուրյին որություններություններու հայուներու հայուներություններու հայուներու հայուներու հայուներու հայուներու հ Արեւերություններու հայուներու հայուներու հայուներու հայուներու հայուներու հայուներու հայուներու հայուներու հայու	Stop 3.2	2670 GHz	AUTO TUNE	
#Res BW 1.0 MHz 5 Marker Table			Sweep 1.00 ms	78.9	step 900000 MHz Auto	
ModeTraceScal1N1f2N1f3	e X Y 2.483 5 GHz -60.92 dBm 2.575 3 GHz -62.31 dBm	Function Fu	nction Width Function Y	Value	Man Offset	
4 5 6				X Ax	is Scale Log Lin	

Conducted Bandedge Peak Table

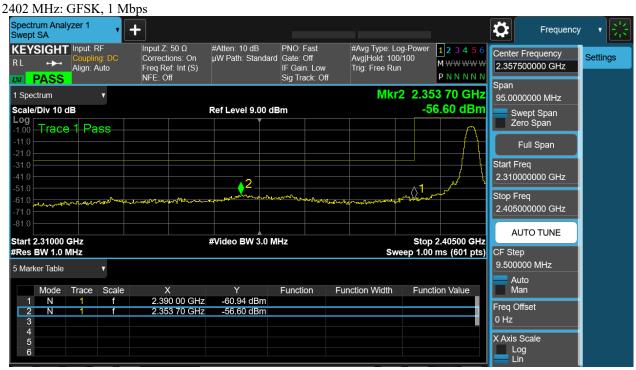
Frequend	v 2402	MHz
ricyucity	.y 4404	TATT

Mada	x Paths	Correlated Antenna Gain (dBi)	Tx 1 Bandedge Level (dBm)	Total Tx Bandedge Level (dBm)	imit IB)	Margin (dB)
Mode	Tx Pa	Corre (dBi)	Tx 1 (dBm	Fotal (dBm	Limit (dB)	Marg (dB)
GFSK, 1 Mbps	1	4	-56.6	-52.6	-21.25	31.35

Frequency 2480 MHz

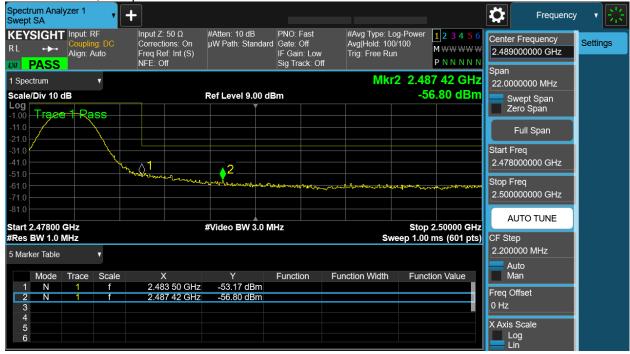
		enna Gain	Level	dge Level		
	IS	Antenna	Bandedge Level)	Total Tx Bandedge Level (dBm)		
Mode	Tx Paths	Correlated (dBi)	Tx 1 B (dBm)	Total T (dBm)	Limit (dB)	Margin (dB)
GFSK, 1 Mbps	1	4	-53.2	-49.2	-21.25	27.95

Data Screenshots



Antenna A

2480 MHz: GFSK, 1 Mbps



A.9 Conducted Bandedge (Non-Restricted Band)

Emissions in non-restricted frequency bands - Test Requirement

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 §15.209(a) is not required. 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) (see §15.205(c)).

RSS-Gen 8.9 Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 and Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

RSS-Gen 8.10 (b) Unwanted emissions that fall into restricted bands of Table 6 shall comply with the limits specified in RSS-Gen; and (c) Unwanted emissions that do not fall within the restricted frequency bands of Table 6 shall comply either with the limits specified in the applicable RSS or with those specified in this RSS-Gen.

Emissions in non-restricted frequency bands - Test Method

Ref. KDB 558074 D01 DTS Meas Guidance v05r02

Emissions in non-restricted frequency bands - Conducted

Test Procedure

1. Connect the antenna port(s) to the spectrum analyzer input.

2. Place the radio in continuous transmit mode

3. Configure Spectrum analyzer as per test parameters below (be sure to enter all losses between the transmitter output and the spectrum analyzer).

4. Use the marker function to determine the maximum spurs amplitude level.

5. Capture graphs and record pertinent measurement data.

Ref. KDB 558074 D01 DTS Meas Guidance v05r02 section, 8.5 DTS emissions in non-restricted frequency bands, 8.7 DTS band-edge measurements

ANSI C63.10: 2013 section 11.11.2, 11.11.3

Emissions in non-restricted frequency bands - Conducted				
Test parameters				
 11.11.2 Reference Level measurement Establish a reference level by using the following procedure: a) Set instrument center frequency to DTS channel center frequency. b) Set the span to ≥ 1.5 x DTS bandwidth. c) Set the RBW = 100 kHz. d) Set the VBW ≥ 3 x RBW. e) Detector = peak. f) Sweep time = auto couple. g) Trace mode = max hold. h) Allow trace to fully stabilize. 	 11.11.3 Emission Level Measurement a) Set the center frequency and span to encompass frequency range to be measured. b) Set the RBW = 100 kHz. c) Set the VBW ≥ 3 x RBW. d) Detector = peak. e) Sweep time = auto couple. f) Trace mode = max hold. g) Allow trace to fully stabilize. h) Use the peak marker function to determine 			
i) Use the peak marker function to determine the maximum PSD level.	the maximum amplitude level.			

Tested By :	Date of testing:
Said Abdelwafi, Julian Land	29-MAR-2021 through 30-MAR-2021
Test Result : PASS	

Test Equipment

See Appendix C for list of test equipment

Non-Restricted Band

Frequency 2402 MHz

	9	ed Bandedge Delta		Se	
Mode	Data Rate (Mbps)	Conducted Bandedge Delta (dB)	Limit (dBc)	Duty Cycle (dB)	Margin (dB)
GFSK, 1 Mbps	1	49.1	>30	0	19.1

Frequency 2480 MHz

	ate	Conducted Bandedge Delta (dB)		ycle	
Mode	Data Rate (Mbps)		Limit (dBc)	Duty Cycle (dB)	Margin (dB)
GFSK, 1 Mbps	1	61.7	>30	0	31.7

Data Screenshots



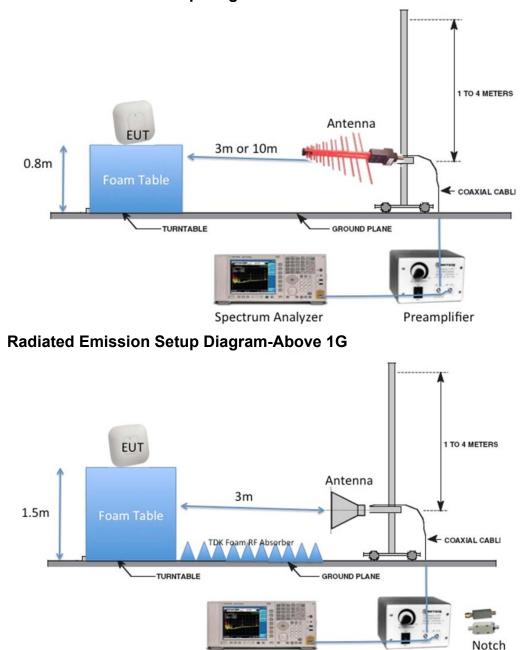
Antenna A

2480 MHz: GFSK, 1 Mbps



Appendix B: Emission Test Results

Testing Laboratory: Cisco Systems, Inc., 125 West Tasman Drive, San Jose, CA 95134, USA



Radiated Emission Setup Diagram-Below 1G

Spectrum Analyzer Preamplifier

Filters

B.1 Radiated Spurious Emissions

15.205 / RSS-Gen / LP0002:3.10.1(5)/2.8:

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a) and RSS-Gen 8.10, must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)) and RSS-Gen 8.9.

Not covered by the scope of this test report

B.2 Receiver Spurious Emissions

RSS-GEN:

Receivers are required to comply with the limits of spurious emissions as set out in this section. Receiver emission measurements are to be performed as per the normative test method referenced in section 3.

Radiated emissions which fall in the restricted bands, as defined in RSS-Gen section 8.10, must also comply with the radiated emission limits specified in RSS-Gen section 8.9.

For emissions at frequencies below 1 GHz, measurements shall be performed using a CISPR quasi-peak detector and the related measurement bandwidth. At frequencies above 1 GHz, measurements shall be performed using a linear average detector with a minimum resolution bandwidth of 1 MHz.

Not covered by the scope of this test report

B.3 Radiated Emissions 30MHz to 1GHz

15.205 / 15.209 / RSS-Gen

Radiated emissions which fall in the restricted bands, as defined in Section 15.205(a) and RSS-GEN section 8.10, must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)) and RSS-Gen section 8.9.

Not covered by the scope of this test report

B.4 AC Conducted Emissions

FCC 15.207 (a) & RSS-Gen 8.8

Except when the requirements applicable to a given device state otherwise, for any radio apparatus equipped to operate from the public utility AC power supply, either directly or indirectly (such as with a battery charger), the radio frequency voltage of emissions conducted back onto the AC power lines in the frequency range of 0.15 MHz to 30 MHz shall not exceed the limits shown in the table in these sections. The more stringent limit applies at the frequency range boundaries.

Equip#	Manufacturer/ Model	Description	Last Cal	Next Due	Test Item	
	Test Equipment used for conducted tests – Rack 8					
58720	Cisco/Automation Test Insertion Loss	Rack 8	Verify Before Use	Verify Before Use	A.1-A.6	
58198	Keysight (Agilent/HP) / N9030B-550 OPT LNP EP0	PXA Signal Analyzer, 2Hz-50GHz with Options LNP and EP0	28-Jul-20	28-Jul-21	A.1-A.6	
58205	NATIONAL INSTRUMENTS / PXIe-1062Q	CHASSIS	Cal Not Required	Cal Not Required	A.1-A.6	
58206	NATIONAL INSTRUMENTS / PXIe-8840	Up to 2.6 GHz Quad- Core PXI Express Controller	Cal Not Required	Cal Not Required	A.1-A.6	
58208	NATIONAL INSTRUMENTS / PXI-2796	40 GHz Dual 6x1 Multiplexer (SP6T)	Verify Before Use	Verify Before Use	A.1-A.6	
58210	NATIONAL INSTRUMENTS / PXI-2796	40 GHz Dual 6x1 Multiplexer (SP6T)	Verify Before Use	Verify Before Use	A.1-A.6	
58211	NATIONAL INSTRUMENTS / PXI-2799	Switch 1x1	Verify Before Use	Verify Before Use	A.1-A.6	
56327	PASTERNACK/ PE5019-1	Torque Wrench	14-May-20	14-May-21	A.1-A.6	
58256*	COMET/ T7611-4	WEB SENSOR FOR REMOTE THERMOMETER HYGROMETER	3-Feb-21	3-Feb-22	A.1-A.6	

Appendix C: List of Test Equipment Used to perform the test

Appendix D: Abbreviation Key and Definitions

Abbreviation	Description	Abbreviation	Description
EMC	Electro Magnetic Compatibility	°F	Degrees Fahrenheit
EMI	Electro Magnetic Interference	°C	Degrees Celsius
EUT	Equipment Under Test	Temp	Temperature
ITE	Information Technology Equipment	S/N	Serial Number
TAP	Test Assessment Schedule	Qty	Quantity
ESD	Electro Static Discharge	emf	Electromotive force
EFT	Electric Fast Transient	RMS	Root mean square
EDCS	Engineering Document Control System	Qp	Quasi Peak
Config	Configuration	Av	Average
CIS#	Cisco Number (unique identification number for Cisco test equipment)	Pk	Peak
Cal	Calibration	kHz	Kilohertz (1x10 ³)
EN	European Norm	MHz	MegaHertz (1x10 ⁶)
IEC	International Electro technical Commission	GHz	Gigahertz (1x10 ⁹)
CISPR	International Special Committee on Radio Interference	Н	Horizontal
CDN	Coupling/Decoupling Network	V	Vertical
LISN	Line Impedance Stabilization Network	dB	decibel
PE	Protective Earth	V	Volt
GND	Ground	kV	Kilovolt (1x10 ³)
L1	Line 1	μV	Microvolt (1x10 ⁻⁶)
L2	Line2	А	Amp
L3	Line 3	μA	Micro Amp (1x10 ⁻⁶)
DC	Direct Current	mS	Milli Second (1x10 ⁻³)
RAW	Uncorrected measurement value, as indicated by the measuring device	μS	Micro Second (1x10 ⁻⁶)
RF	Radio Frequency	μS	Micro Second (1x10 ⁻⁶)
SLCE	Signal Line Conducted Emissions	m	Meter
Meas dist	Measurement distance	Spec dist	Specification distance
N/A or NA	Not Applicable	SL	Signal Line (or Telecom Line)
Р	Power Line	L	Live Line
Ν	Neutral Line	R	Return
S	Supply	AC	Alternating Current

The following table defines abbreviations used within this test report.

Appendix E: Photographs of Test Setups

EUT Photos have been omitted from this test report. Photos can be found in the supplementary exhibit included in the submission and EDCS# 21541319.

Appendix F: Software Used to Perform Testing

Cisco Internal LabView Radio Test Automation Software:

- RF Automation Main versions: 224
- RF Domain Report Generation version 3

Appendix G:Test Procedures

Measurements were made in accordance with

- KDB 558074 D01 DTS Meas Guidance v05r02
- KDB 662911 MIMO
- ANSI C63.4 2014 Unintentional Radiators
- ANSI C63.10 2013 Intentional Radiators

Test procedures are summarized below

FCC 2.4GHz Test Procedures	EDCS # 1445042
FCC 2.4GHz RSE Test Procedures	EDCS # 1480386

Appendix H: Scope of Accreditation (A2LA certificate number 1178-01)

The scope of accreditation of Cisco Systems, Inc. can be found on the A2LA web page at:

http://www.a2la.org/scopepdf/1178-01.pdf

Appendix I: Test Assessment Plan

Compliance Test Plan (Excel) EDCS# 21468206 Target Power Tables EDCS# 19774156

Appendix J: Worst Case Justification

N/A