Itron, Inc.

REVISED TEST REPORT TO 105379-13

Itron Cellular 500G Module
Model: 500GAC

Tested to The Following Standards:

FCC Part 15 Subpart C Section(s)

15.207 & 15.247
(HYBRID 902-928MHz)

Report No.: 105379-13A

Date of issue: August 18, 2021

Test Certificate # 803.01

This test report bears the accreditation symbol indicating that the testing performed herein meets the test and reporting requirements of ISO/IEC 17025 under the applicable scope of testing for CKC Laboratories, Inc.

We strive to create long-term, trust based relationships by providing sound, adaptive, customer first testing services. We embrace each of our customers' unique EMC challenges, not as an interruption to set processes, but rather as the reason we are in business.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

Itron, Inc.
2111 N. Molter Road
Liberty Lake, WA 99019

Representative: Jay Holcomb
Customer Reference Number: 236177

REPORT PREPARED BY:

Terri Rayle
CKC Laboratories, Inc.
5046 Sierra Pines Drive
Mariposa, CA 95338

Project Number: 105379

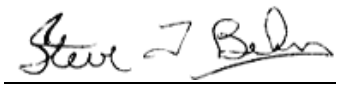
DATE OF EQUIPMENT RECEIPT: May 11, 2021
DATE(S) OF TESTING: May 11, 13, 14, 25, and 27, 2021

Revision History

Original: Testing of the Itron Cellular 500G Module, Model: 500GAC to FCC Part 15 Subpart C Section(s) 15.207 & 15.247 (HYBRID 902-928MHz)
Revision A: To add a note under the table on page 10 for the asterisk displayed. Added statement to the Conditions During Test table to clarify the orientation of the EUT during testing.

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the equipment provided by the client, tested in the agreed upon operational mode(s) and configuration(s) as identified herein. Compliance assessment remains the client's responsibility. This report may not be used to claim product endorsement by A2LA or any government agencies. This test report has been authorized for release under quality control from CKC Laboratories, Inc.



Steve Behm
Director of Quality Assurance & Engineering Services
CKC Laboratories, Inc.

Test Facility Information

Our laboratories are configured to effectively test a wide variety of product types. CKC utilizes first class test equipment, anechoic chambers, data acquisition and information services to create accurate, repeatable and affordable test results.

TEST LOCATION(S):
CKC Laboratories, Inc.
110 Olinda Place
Brea, CA 92823

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.19

Site Registration & Accreditation Information

Location	*NIST CB #	FCC	Canada	Japan
Canyon Park, Bothell, WA	US0103	US1024	3082C	A-0136
Brea, CA	US0103	US1024	3082D	A-0136
Fremont, CA	US0103	US1024	3082B	A-0136
Mariposa, CA	US0103	US1024	3082A	A-0136

*CKC's list of NIST designated countries can be found at: https://standards.gov/cabs/designations.html

SUMMARY OF RESULTS

Standard / Specification: FCC Part 15 Subpart C - 15.247 (Hybrid 902-928MHz)

Test Procedure	Description	Modifications	Results
15.247(a)(1)(i)	Occupied Bandwidth	NA	PASS
15.247(a)(1)	Carrier Separation	NA	PASS
15.247(a)(1)(i)	Number of Hopping Channels	NA	NA1
15.247(a)(1)(i)	Average Time of Occupancy	NA	NA1
15.247 (f)	Hybrid Systems Time of Occupancy	NA	NP
15.247 (f)	Hybrid Systems Power Spectral Density	NA	PASS
15.247(b)(2)	Output Power	NA	PASS
15.247(d)	RF Conducted Emissions & Band Edge	NA	PASS
15.247(d)	Radiated Emissions & Band Edge	NA	PASS
15.207	AC Conducted Emissions	NA	NA2

NA = Not Applicable
NA1 = This test is not applicable under Hybrid System requirements section 15.247 (f).
NA2 = The Manufacturer declares the EUT is battery powered.
NP = CKC Laboratories is not contacted to perform testing. See manufacturer declaration in Average Time of Occupancy section

ISO/IEC 17025 Decision Rule
The declaration of pass or fail herein is based upon assessment to the specification(s) listed above, including where applicable, assessment of measurement uncertainties. For performance related tests, equipment was monitored for specified criteria identified in that section of testing.

Modifications During Testing

This list is a summary of the modifications made to the equipment during testing.

Summary of Conditions
No modifications were made during testing.

Modifications listed above must be incorporated into all production units.

Conditions During Testing

This list is a summary of the conditions noted to the equipment during testing.

Summary of Conditions
The manufacturer declares the equipment is only installed in one orientation and was tested in that orientation.

EQUIPMENT UNDER TEST (EUT)

During testing, numerous configurations may have been utilized. The configurations listed below support compliance to the standard(s) listed in the Summary of Results section.

Configuration 1

Equipment Tested:

Device	Manufacturer	Model #	S/N
Itron Cellular 500G Module	Itron, Inc.	500GAC	CON1

Support Equipment:

Device	Manufacturer	Model #	S/N
USB to Serial Interface	Itron, Inc.	NA	NA
Laptop Computer	Dell	Latitude E6410	46TXXNI

Configuration 2

Equipment Tested:

Device	Manufacturer	Model #	S/N
Itron Cellular 500G Module	Itron, Inc.	500GAC	005

Support Equipment:

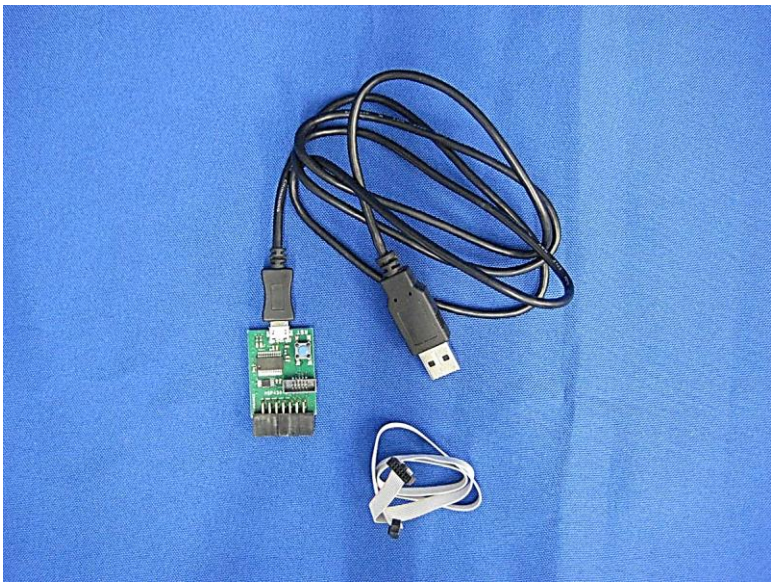
Device	Manufacturer	Model #	S/N
USB to Serial Interface	Itron, Inc.	NA	NA
Laptop Computer	Dell	Latitude E6410	46TXXNI

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	Proprietary Low power and FHSS
Operating Frequency Range:	902.4MHz to 927.6MHz (300kbps GFSK PL2)
Number of Hopping Channels:	3 to 64
Modulation Type(s):	GFSK 300kbps
Maximum Duty Cycle:	45% (GFSK)
Number of TX Chains:	1
Antenna Type(s) and Gain:	PCB Trace 0.9dBi
Beamforming Type:	NA
Antenna Connection Type:	Integral
Nominal Input Voltage:	3.6V Battery
Firmware / Software used for Test:	App Version: 0.0.33.0 CSL version: 8.1.17.0 Hardware Rev: 4

EUT Photo(s)

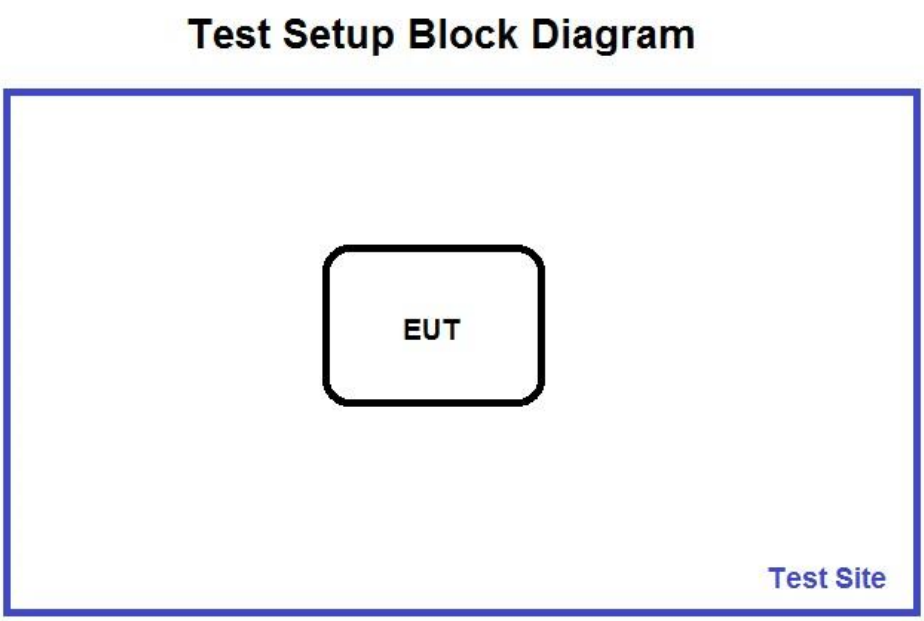
Support Equipment Photo(s)



USB to Serial Interface

Laptop and Power Supply

Block Diagram of Test Setup(s)



FCC Part 15 Subpart C

15.247(a) Transmitter Characteristics

Test Setup/Conditions			
Test Location:	Brea Lab D	Test Engineer:	S. Yamamoto
Test Method:	ANSI C63.10 (2013)	Test Date(s):	5/11/2021
Configuration:	1		
Test Setup:	The equipment under test (EUT) is connected to a laptop computer via USB to serial interface board. The laptop is running Command Line Interface (CLI) Tool. This software is used to run the scripts for setting the EUT parameters. The RF output has been configured to a coaxial cable output with sma connector. The output is connected to the spectrum analyzer using a coaxial cable and power attenuator. Frequency range of test: 902.0MHz to 928.0MHz. GFSK 300kbps Power Level 2 Low channel 902.4MHz Middle channel 915.2MHz High channel 927.6MHz Temperature: 21°C Humidity: 50% Pressure: 99kPa Site D Reference 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10-2013		

Environmental Conditions			
Temperature (ºC)	21	Relative Humidity (%):	50

Test Equipment					
Asset#	Description	Manufacturer	Model	Cal Date	Cal Due
02869	Spectrum Analyzer	Agilent	E4440A	8/3/2020	8/3/2021
03432	Attenuator	Aeroflex/Weinschel	90-30-34	10/22/2019	10/22/2021
P07656	Cable	Astrolab, Inc.	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

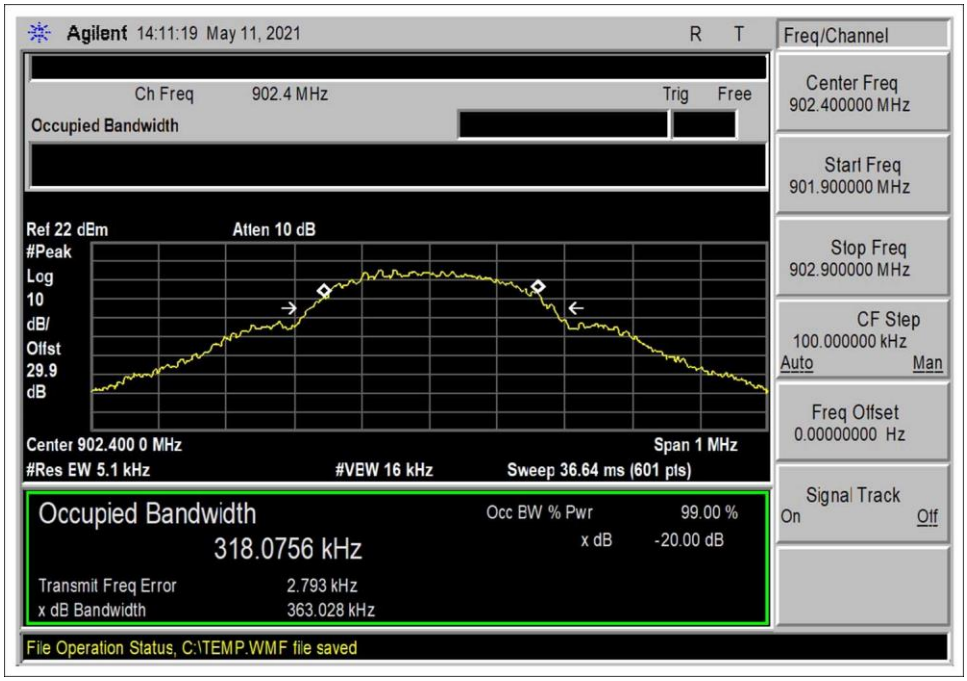
15.215(c) 20 dB Bandwidth

20dB Occupied Bandwidth

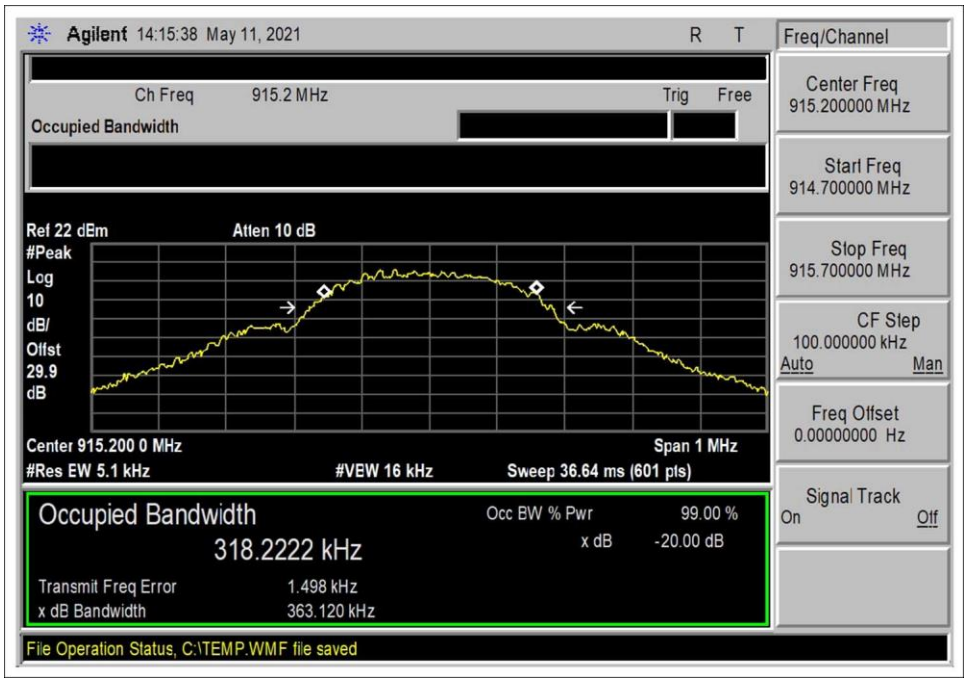
Test Data Summary					
Frequency (MHz)	**Antenna Port**	**Modulation**	**Measured (kHz)**	**Limit (kHz)**	**Results**
902.4	1	GFSK 300kbps (PL2)	363.028	*See Note	NA
915.2	1	GFSK 300kbps (PL2)	363.120		
927.6	1	GFSK 300kbps (PL2)	363.301		

*For this Hybrid mode there is no requirement to meet the FHSS or DTS bandwidth limits. See Supplemental Section of data in 15.247 (f) Hybrid Systems.

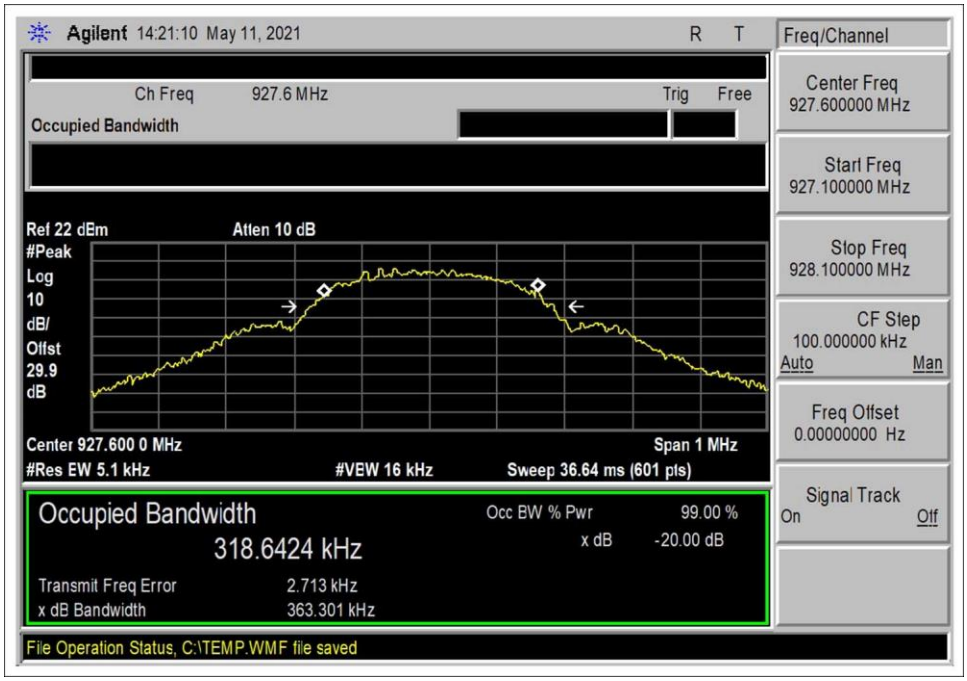
Plot(s)



Low Channel



Middle Channel

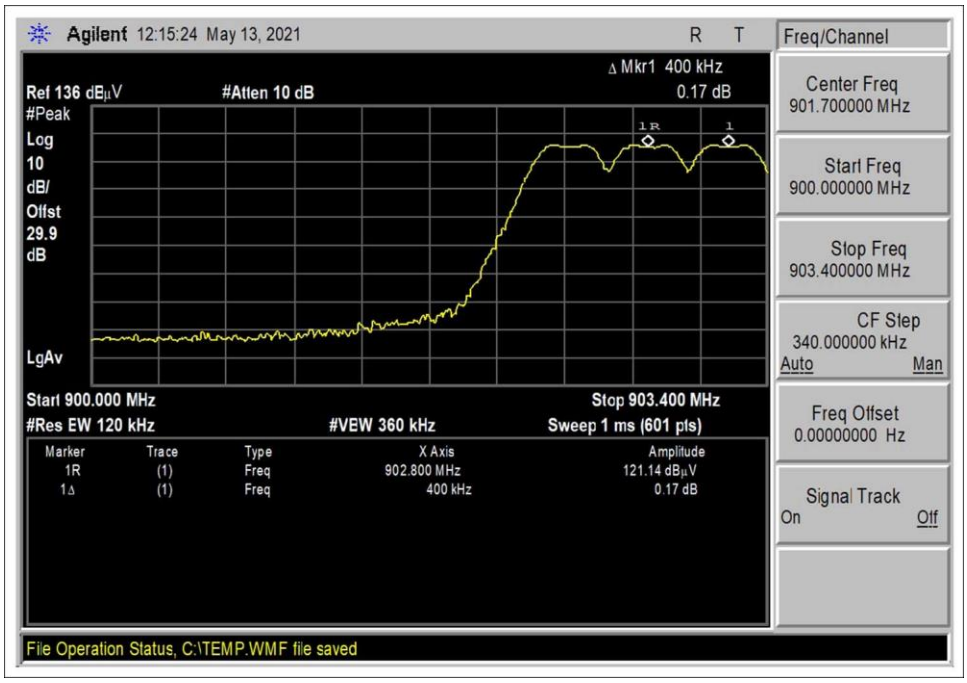


High Channel

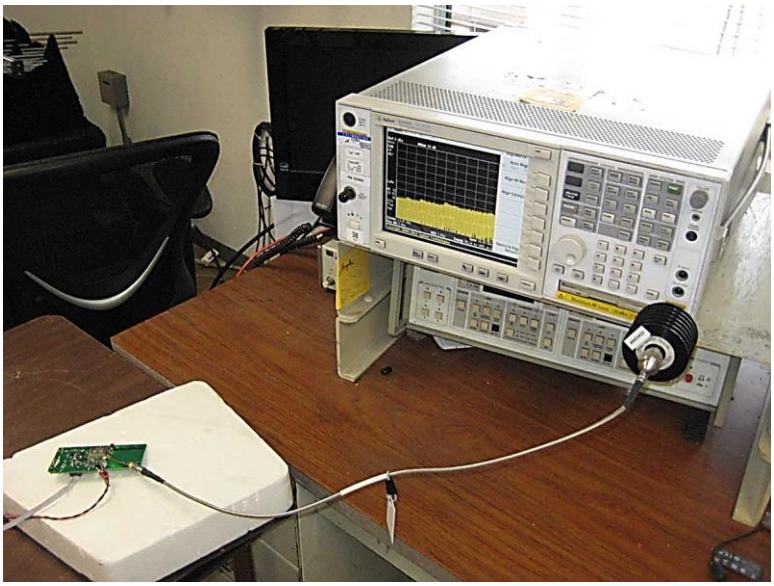
15.247(a)(1) Carrier Separation

Test Data Summary				
Limit applied: 20dB bandwidth of the hopping channel.				
Antenna Port	**Operational Mode**	**Measured (kHz)**	**Limit (kHz)**	**Results**
1	GFSK 300kbps (PL2)	400	363.301	Pass

Plot(s)



Test Setup Photo(s)



15.247 (f) Hybrid Systems Time of Occupancy

The Manufacturer declares CKC laboratories was not contracted to perform the testing due to the required equipment and firmware to exercise the EUT's multiple pseudo-random hopping sequences was not available and that the complexity of the different modulations and modes depend on the device to be in a fully operating network environment.

Therefore, the manufacturer declares the following:

"With the multiple modulations, modes and hop tables, the mode with the worst-case Time of Occupancy to demonstrate 400mS compliance is 399mS in 20 seconds, since this modulation is less than 250kHz Occupied Band Width. Each session of multiple short transmissions takes place on channels out of a minimum of 50 channels in a pseudorandom sequence. The algorithm that determines the pseudo-random hop sequence ensures all active channels are used equally on the average.

Additionally, the manufacturer declares the following: Since the 300kbps power level 2 modulation is a hybrid both DTS and DSS, we comply with the channel occupancy requirement of 400mS in 1.2 seconds (minimum of 3 channels x 400mS = 1.2 seconds).

Itron employs hopping patterns based on pseudo-random sequence generators or pseudo-random hop tables.

The firmware uses the channels in the prescribed pseudo random order; therefore, it maintains equal channel usage.

The system has receiver channel bandwidths that match the transmitter's modulation bandwidth that is enabled.

With the transmitter and receiver in synchronization within the network, transmitters switch frequencies in synchronization with the receiver.

When the transmitter needs to send a continuous or long data stream, total time of the packet transmissions is monitored to comply with dwell time requirement of 400ms in the appropriate 10s or 20s window depending on the modulation/mode enabled.

This device does not employ any hopping avoidance techniques.

15.247 (f) Hybrid Systems Power Spectral Density

Test Setup / Conditions / Data

Test Location:	CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112		
Customer:	**Itron, Inc.**		
Specification:	**15.247(f) Power Spectral Density**		
Work Order #:	**105379**	Date:	5/13/2021
Test Type:	**Conducted Emissions**	Time:	10:12:55
Tested By:	S. Yamamoto	Sequence#:	10
Software:	EMITest 5.03.19		3.6Vdc

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is connected to a laptop computer via USB to serial interface board. The laptop is running Command Line Interface (CLI) Tool. This software is used to run the scripts for setting the EUT parameters.

The RF output has been configured to a coaxial cable output with sma connector. The output is connected to the spectrum analyzer using a coaxial cable and power attenuator.

Frequency range of test: 902.4MHz to 927.6MHz.
Low Channel 902.4MHz
Middle Channel 915.2MHz
High Channel 927.6MHz

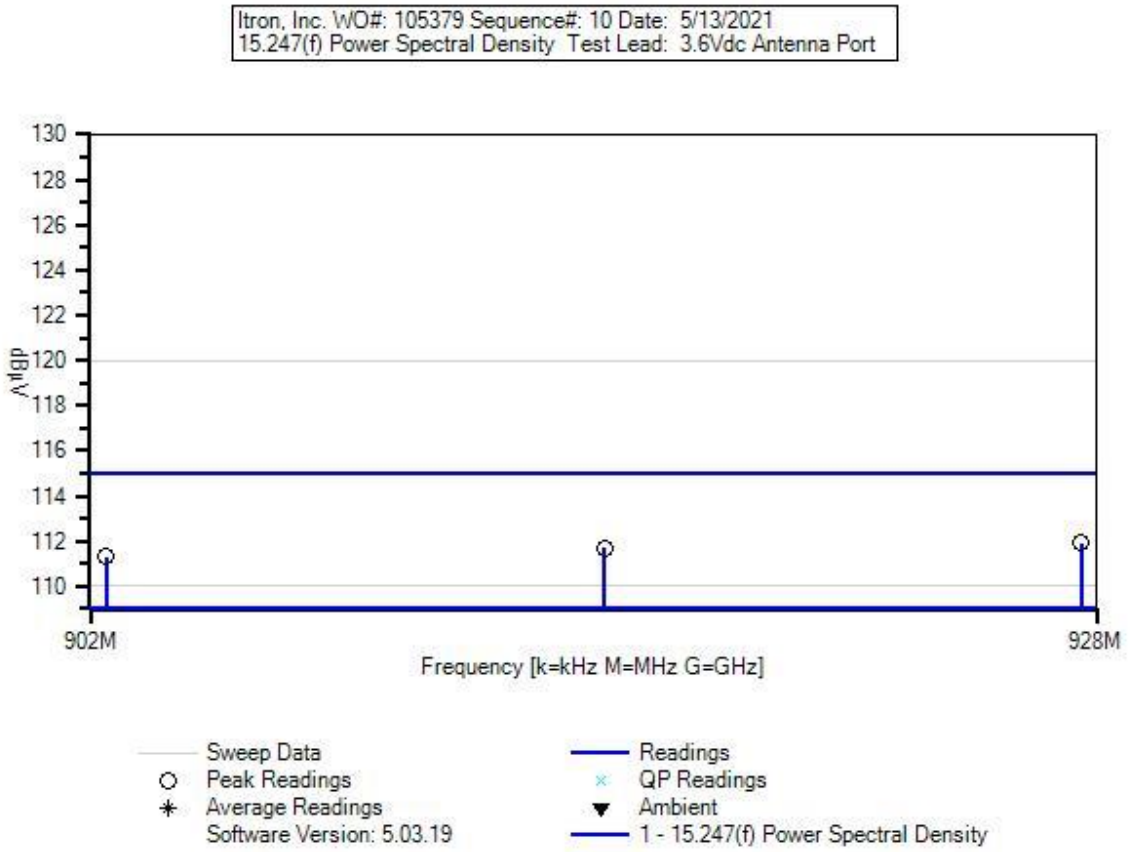
RBW=3kHz, VBW=10kHz

Output level 2 300kbps

Test Environment Conditions:
Temperature: 20°C
Humidity: 53%
Pressure: 99kPa

Site D

Reference 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10-2013



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T3	ANP07656	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Measurement Data: Reading listed by margin. Test Lead: Antenna Port

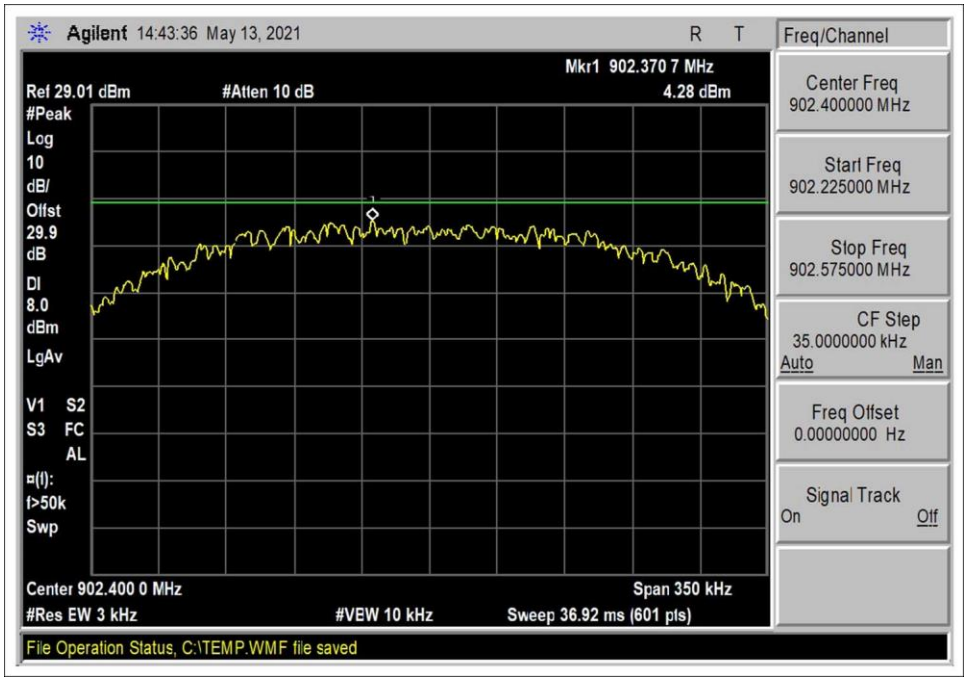
#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	927.600M	82.0	+0.0	+29.6	+0.3		+0.0	111.9	115.0	-3.1	Anten
2	915.200M	81.8	+0.0	+29.6	+0.3		+0.0	111.7	115.0	-3.3	Anten
3	902.400M	81.4	+0.0	+29.6	+0.3		+0.0	111.3	115.0	-3.7	Anten

15.247 (f) Power Spectral Density

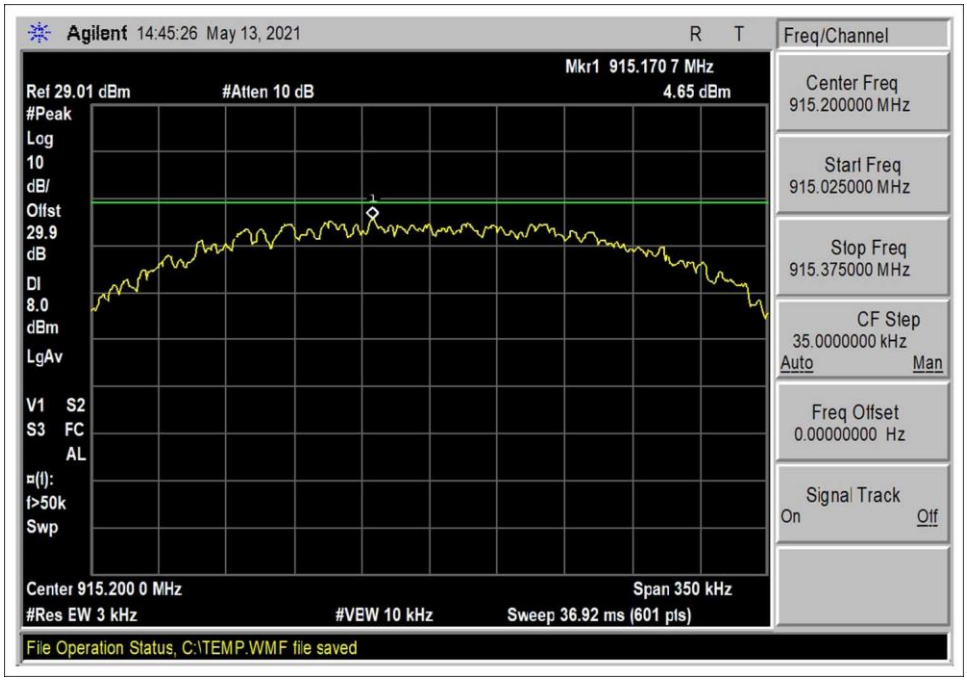
Power Spectral Density

Test Data Summary - RF Conducted Measurement				
Measurement Method: PKPSD				
Frequency (MHz)	**Modulation**	**Measured (dBm/3kHz)**	**Limit (dBm/3kHz)**	**Results**
902.4	GFSK 300kbps (PL2)	4.28	≤8	Pass
915.2	GFSK 300kbps (PL2)	4.65	≤8	Pass
927.6	GFSK 300kbps (PL2)	4.91	≤8	Pass

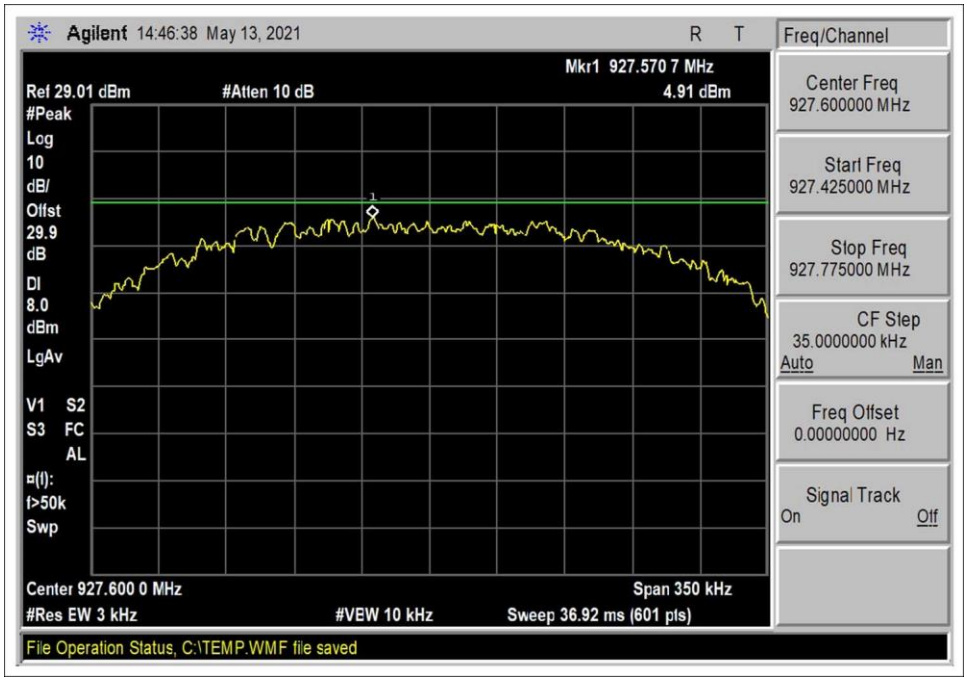
Plots



Low Channel

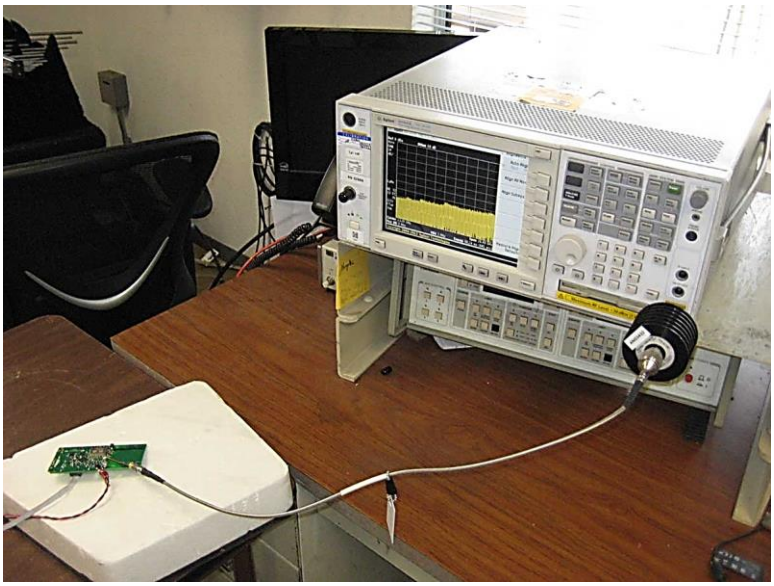


Middle Channel



High Channel

Test Setup Photo(s)



15.247(b)(2) Output Power

Test Setup / Conditions / Data

Test Location:	CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112		
Customer:	**Itron, Inc.**		
Specification:	**15.247(b) Power Output (902-928 MHz DTS)**		
Work Order #:	**105379**	Date:	5/11/2021
Test Type:	**Conducted Emissions**	Time:	11:46:59
Tested By:	S. Yamamoto	Sequence#:	4
Software:	EMITest 5.03.19		3.6Vdc

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is connected to a laptop computer via USB to serial interface board. The laptop is running Command Line Interface (CLI) Tool. This software is used to run the scripts for setting the EUT parameters.

The RF output has been configured to a coaxial cable output with sma connector. The output is connected to the spectrum analyzer using a coaxial cable and power attenuator.

Frequency range of test: 902.4MHz to 927.6MHz.
Low Channel 902.4MHz
Middle Channel 915.2MHz
High Channel 927.6MHz

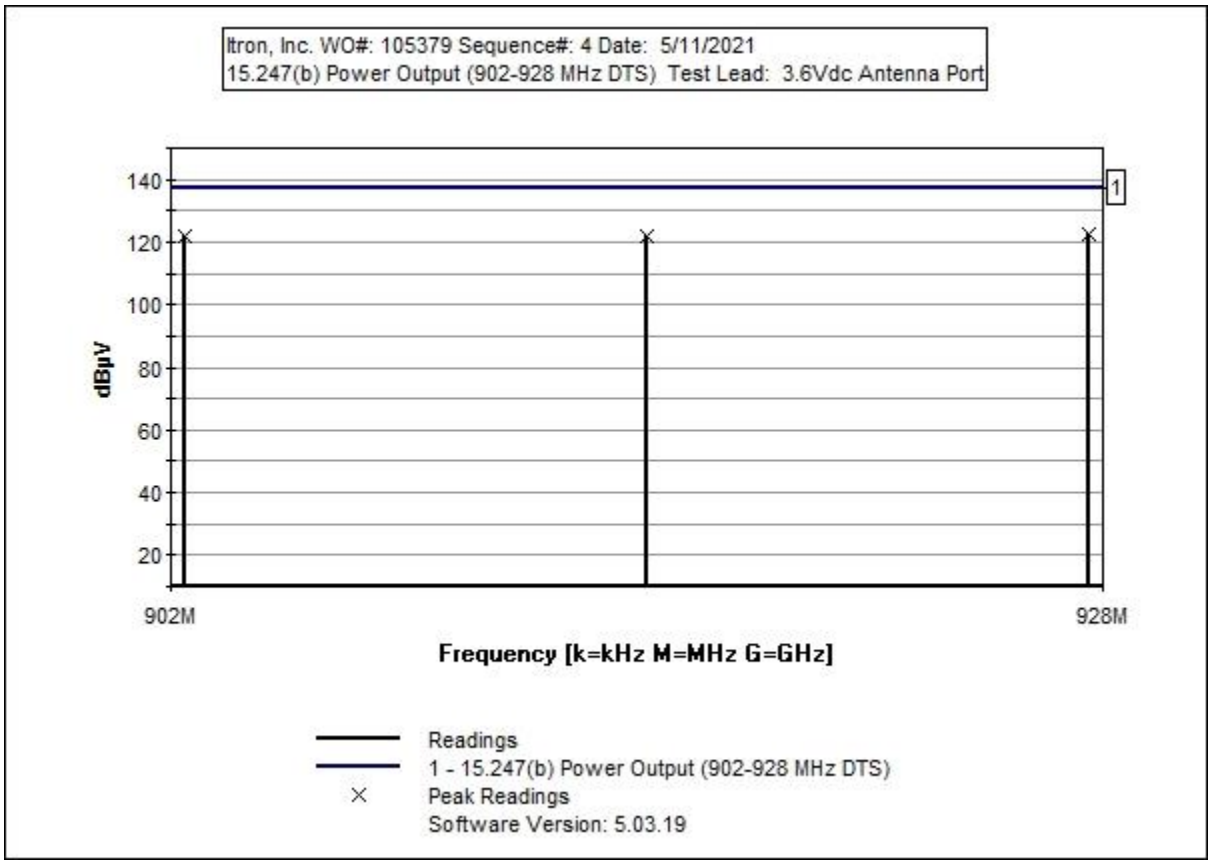
RBW=560kHz, VBW=1.8MHz

Output level 2 300kbps

Test Environment Conditions:
Temperature: 21°C
Humidity: 50%
Pressure: 99kPa

Site D

Reference 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10-2013



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T3	ANP07656	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Measurement Data: Reading listed by margin. Test Lead: Antenna Port

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	927.600M	92.4	+0.0	+29.6	+0.3		+0.0	122.3	137.0	-14.7	Anten
2	915.200M	92.1	+0.0	+29.6	+0.3		+0.0	122.0	137.0	-15.0	Anten
3	902.400M	91.7	+0.0	+29.6	+0.3		+0.0	121.6	137.0	-15.4	Anten

Parameter Definitions:

Measurements performed at input voltage according to manufacturer specification.

Parameter	Value
$V_{Nominal}$:	3.6Vdc
$V_{Minimum}$:	NA
$V_{Maximum}$:	NA

Test Data Summary - Voltage Variations

This equipment is battery powered. Power output tests were performed using a power supply simulating a brand new battery.

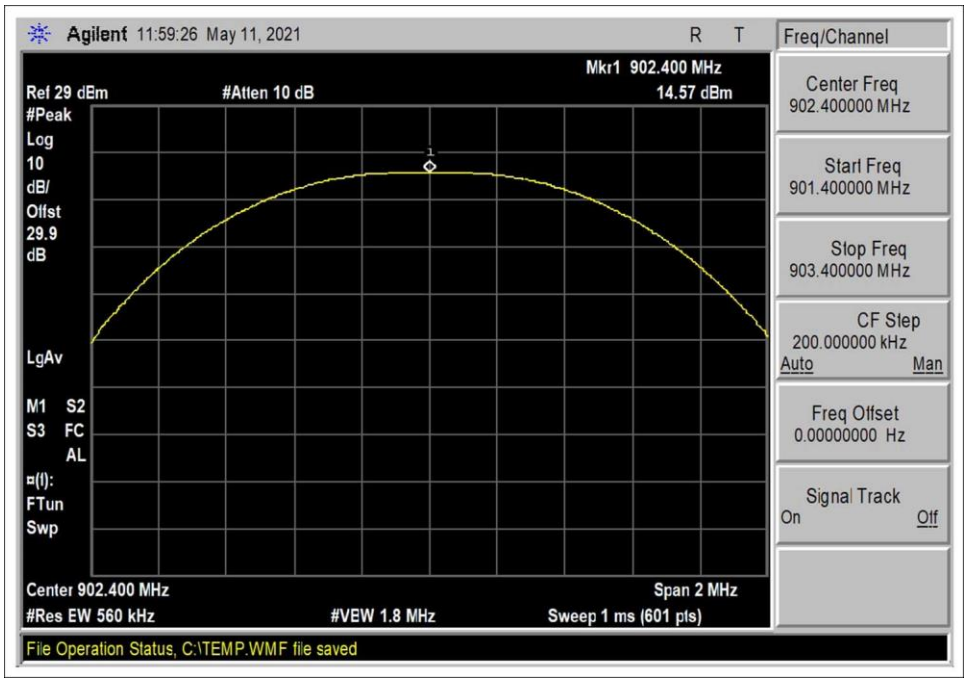
Test Data Summary - RF Conducted Measurement

$Limit = 30dBm\ Conducted/36dBm\ EIRP$

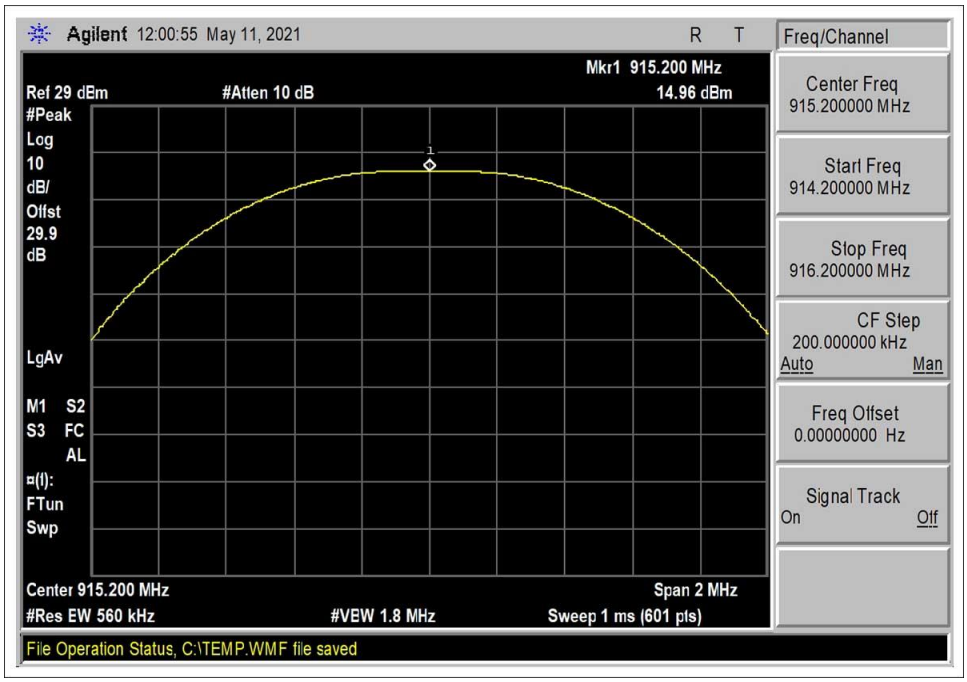
Frequency (MHz)	Modulation	Ant. Type / Gain (dBi)	Measured (dBm)	Limit (dBm)	Results
902.4	GFSK 300kbps (PL2)	PCB Trace / 0.9	14.57	≤ 30	Pass
915.2	GFSK 300kbps (PL2)	PCB Trace / 0.9	14.96	≤ 30	Pass
927.6	GFSK 300kbps (PL2)	PCB Trace / 0.9	15.30	≤ 30	Pass

*For this Hybrid Mode there is no minimum number of hopping channels required for the 1 Watt (30dBm) limit.

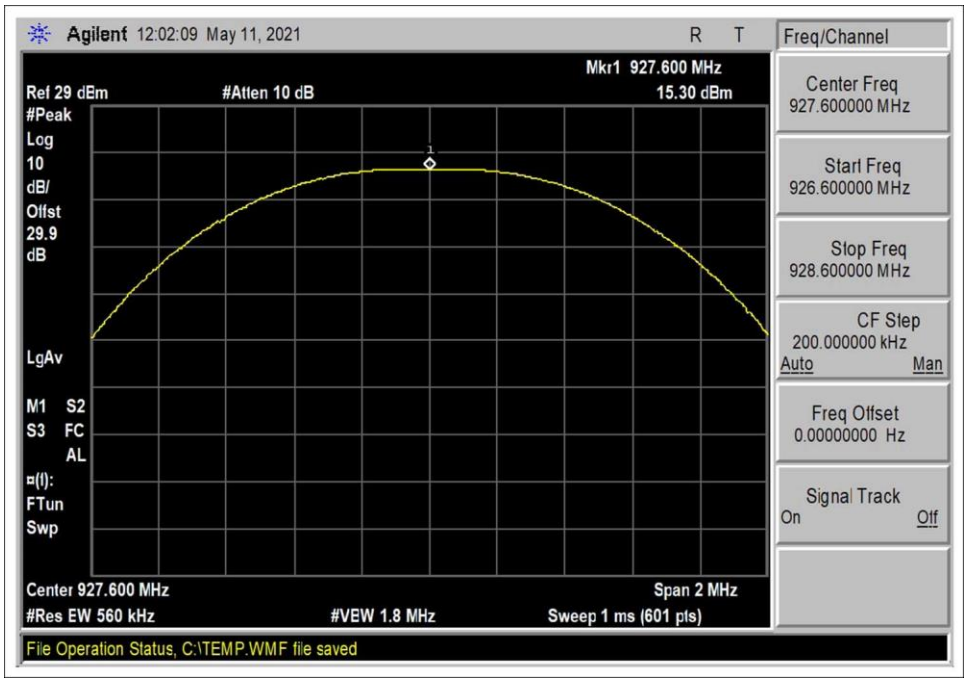
Plots



Low Channel

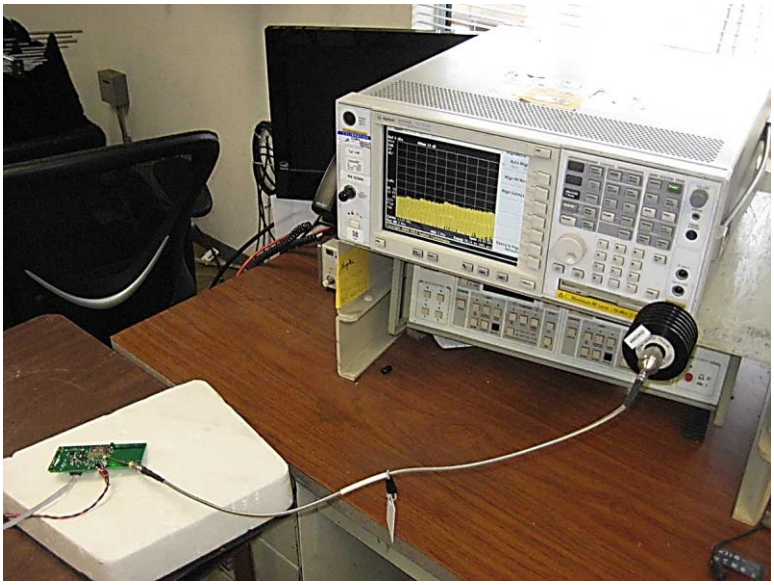


Middle Channel



High Channel

Test Setup Photo(s)



15.247(d) RF Conducted Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112		
Customer:	**Itron, Inc.**		
Specification:	**15.247(d) Conducted Spurious Emissions**		
Work Order #:	**105379**	Date:	5/14/2021
Test Type:	**Conducted Emissions**	Time:	08:16:07
Tested By:	S. Yamamoto	Sequence#:	14
Software:	EMITest 5.03.19		3.6Vdc

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is connected to a laptop computer via USB to serial interface board. The laptop is running Command Line Interface (CLI) Tool. This software is used to run the scripts for setting the EUT parameters.

The RF output has been configured to a coaxial cable output with sma connector. The output is connected to the spectrum analyzer using a coaxial cable and power attenuator.

Frequency range of test: 9kHz to 9.28GHz.

Test Channels
Low Channel 902.4MHz
Middle Channel 915.2MHz
High Channel 927.6MHz

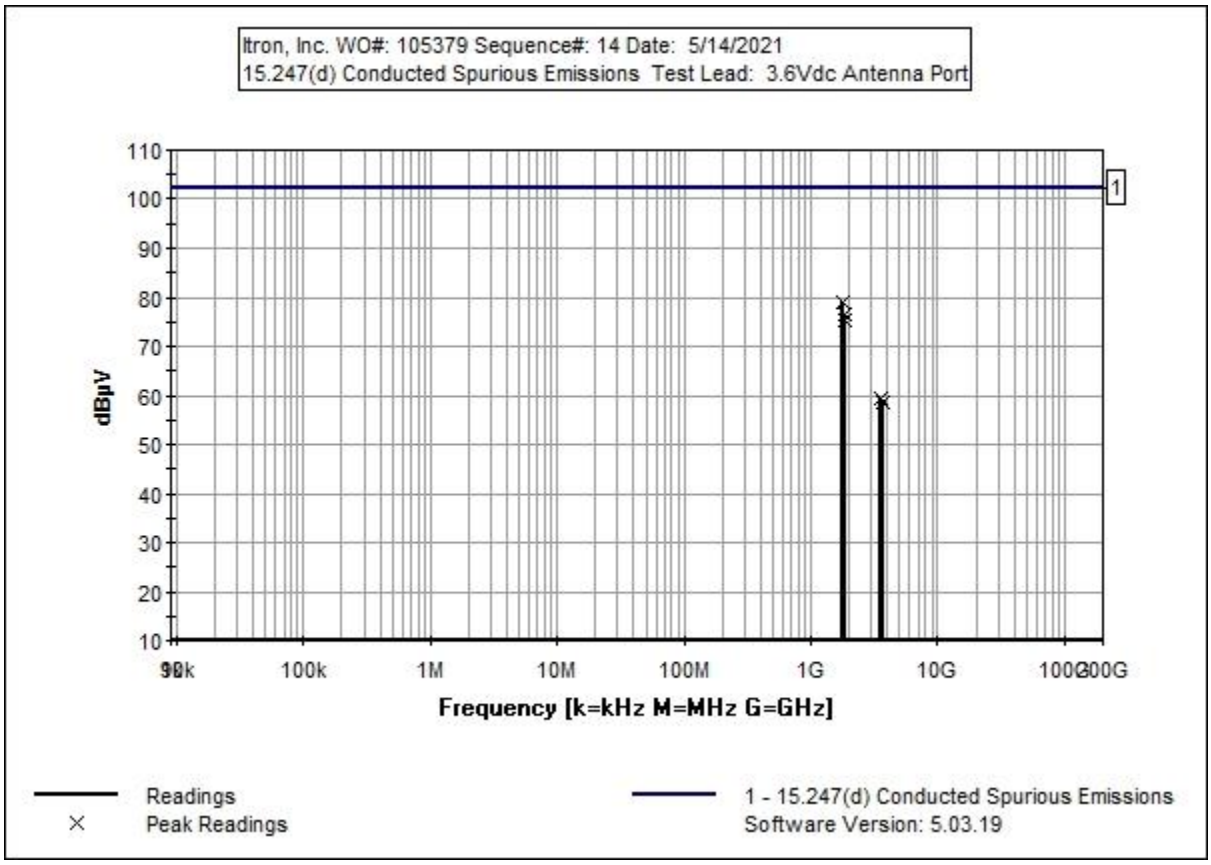
RBW=100kHz, VBW=300kHz

Output level 2 300kbps

Test Environment Conditions:
Temperature: 20°C
Humidity: 53%
Pressure: 99kPa

Site D

Reference 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10-2013



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T1	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T2	ANP07656	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

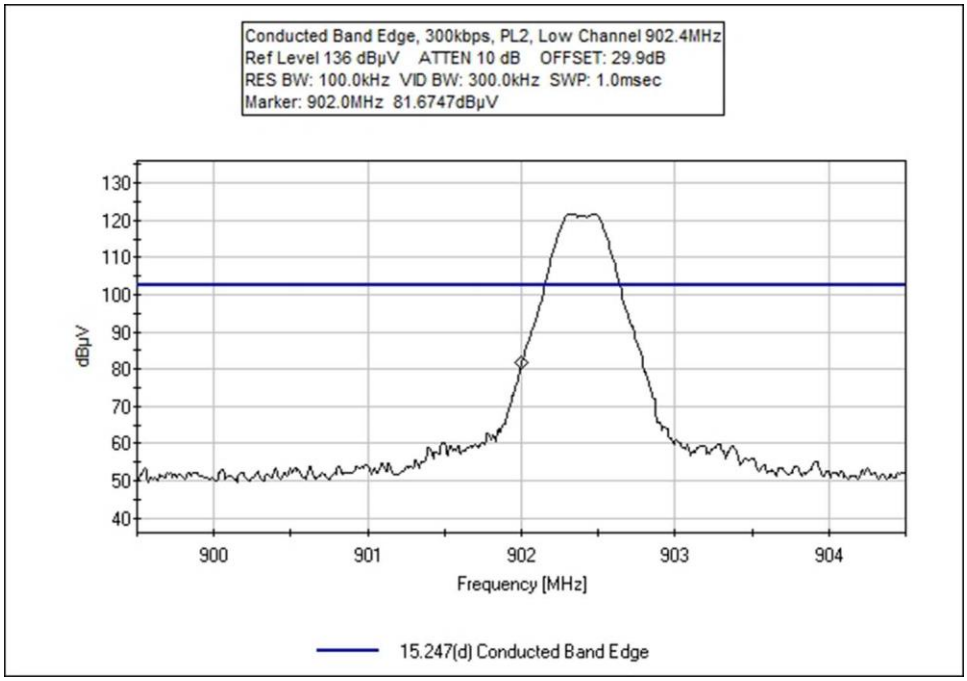
Measurement Data: Reading listed by margin. Test Lead: Antenna Port

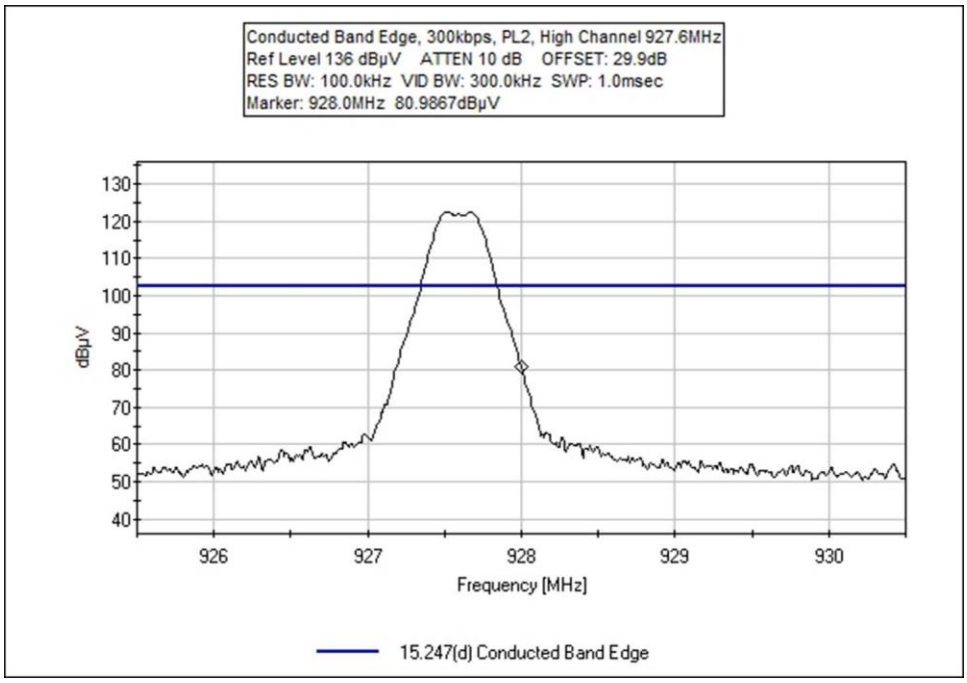
#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	1804.640M	48.9	+29.6	+0.4			+0.0	78.9	102.4	-23.5	Anten
2	1830.253M	46.6	+29.6	+0.4			+0.0	76.6	102.4	-25.8	Anten
3	1855.052M	45.5	+29.6	+0.4			+0.0	75.5	102.4	-26.9	Anten
4	3609.317M	29.0	+29.7	+0.6			+0.0	59.3	102.4	-43.1	Anten
5	3710.710M	28.3	+29.8	+0.5			+0.0	58.6	102.4	-43.8	Anten
6	3661.093M	28.3	+29.8	+0.5			+0.0	58.6	102.4	-43.8	Anten

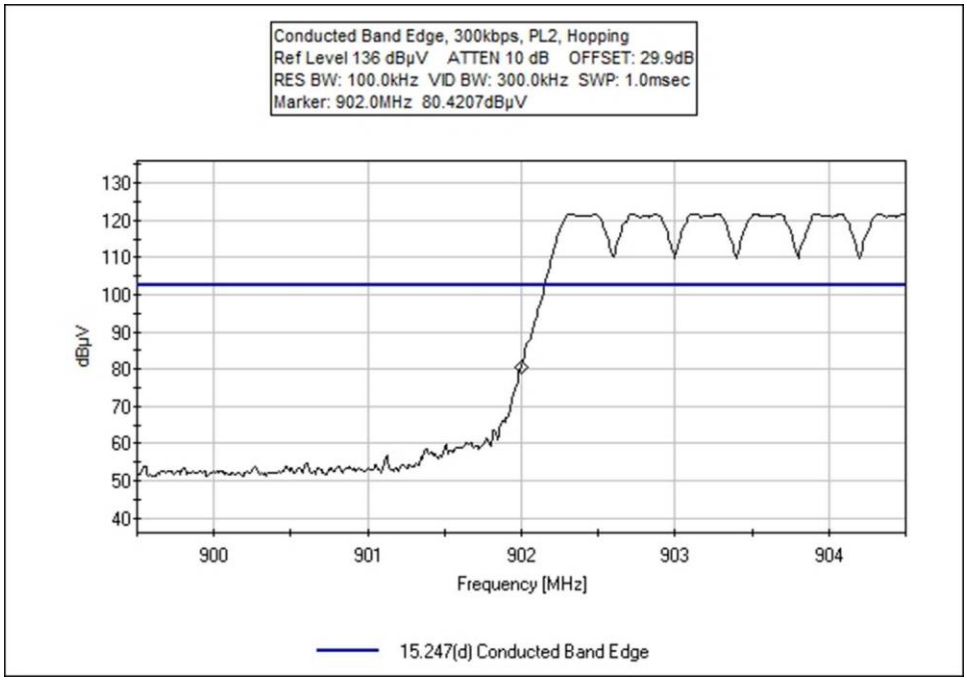
Band Edge

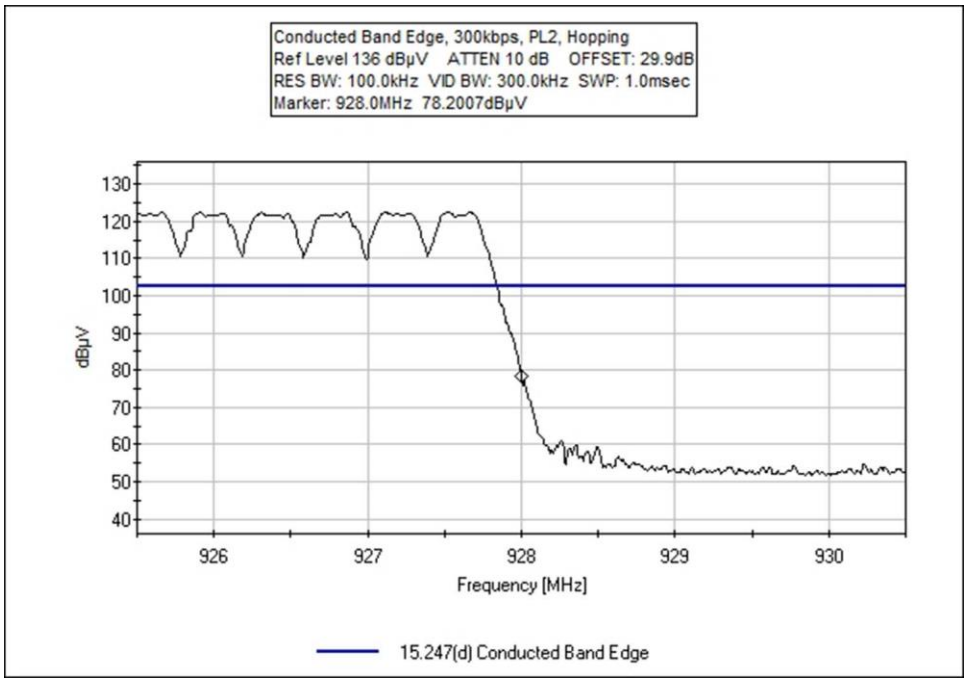
Band Edge Summary				
Limit applied: Max Power/100kHz - 20dB.				
Frequency (MHz)	**Modulation**	**Measured (dBm)**	**Limit (dBm)**	**Results**
902	GFSK 300kbps (PL2) (Single Channel)	-25.4	-4.7	Pass
928		-26.1	-4.7	Pass
902	GFSK 300kbps (PL2) (Hopping)	-26.7	-4.7	Pass
928		-28.9	-4.7	Pass

Band Edge Plots




Conducted Band Edge, 300kbps, PL2, High Channel 927.6MHz
Ref Level 136 dBµV ATTEN 10 dB OFFSET: 29.9dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 1.0msec
Marker: 928.0MHz 80.9867dBµV
dBµV
130
120
110
100
90
80
70
60
50
40
926
927
928
929
930
Frequency [MHz]
15.247(d) Conducted Band Edge


Conducted Band Edge, 300kbps, PL2, Hopping
Ref Level 136 dBµV ATTEN 10 dB OFFSET: 29.9dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 1.0msec
Marker: 902.0MHz 80.4207dBµV
dBµV
130
120
110
100
90
80
70
60
50
40
900
901
902
903
904
Frequency [MHz]
15.247(d) Conducted Band Edge


Conducted Band Edge, 300kbps, PL2, Hopping
Ref Level 136 dBµV ATTEN 10 dB OFFSET: 29.9dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 1.0msec
Marker: 928.0MHz 78.2007dBµV
130
120
110
100
90
80
70
60
50
40
dBµV
926
927
928
929
930
Frequency [MHz]
15.247(d) Conducted Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories Inc. • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112		
Customer:	**Itron, Inc.**		
Specification:	**15.247(d) Conducted Band Edge**		
Work Order #:	**105379**	Date:	5/13/2021
Test Type:	**Conducted Emissions**	Time:	10:12:55
Tested By:	S. Yamamoto	Sequence#:	9
Software:	EMITest 5.03.19		3.6Vdc

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

The equipment under test (EUT) is connected to a laptop computer via USB to serial interface board. The laptop is running Command Line Interface (CLI) Tool. This software is used to run the scripts for setting the EUT parameters.

The RF output has been configured to a coaxial cable output with sma connector. The output is connected to the spectrum analyzer using a coaxial cable and power attenuator.

Frequency range of test: 899MHz to 931MHz.
Low Channel 902.4MHz
High Channel 927.6MHz
Hopping

RBW=100kHz, VBW=300kHz

Output level 2 300kbps

Test Environment Conditions:
Temperature: 20°C
Humidity: 53%
Pressure: 99kPa

Site D

Reference 558074 D01 15.247 Meas Guidance v05r02 and ANSI C63.10-2013

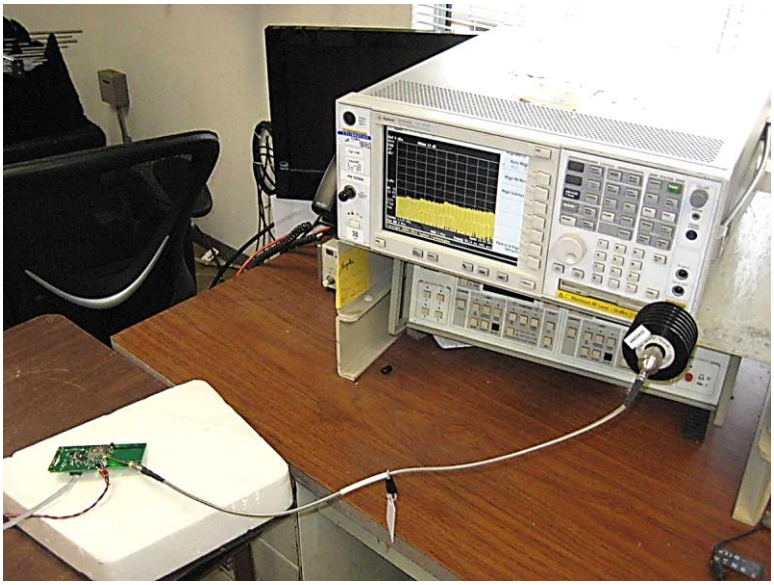
Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	AN03432	Attenuator	90-30-34	10/22/2019	10/22/2021
T3	ANP07656	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022

Measurement Data: Reading listed by margin. Test Lead: Antenna Port

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	902.000M	51.8	+0.0	+29.6	+0.3		+0.0	81.7	102.4 Single	-20.7	Anten
2	928.000M	51.1	+0.0	+29.6	+0.3		+0.0	81.0	102.4 Single	-21.4	Anten
3	902.000M	50.5	+0.0	+29.6	+0.3		+0.0	80.4	102.4 Hopping	-22.0	Anten
4	928.000M	48.3	+0.0	+29.6	+0.3		+0.0	78.2	102.4 Hopping	-24.2	Anten

Test Setup Photo(s)



15.247(d) Radiated Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories Inc • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112		
Customer:	**Itron, Inc.**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**105379**	Date:	5/25/2021
Test Type:	**Maximized Emissions**	Time:	15:10:09
Tested By:	S. Yamamoto	Sequence#:	21
Software:	EMITest 5.03.19		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 2			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 2			

Test Conditions / Notes:

The equipment under test (EUT) is connected to a laptop computer via USB to serial interface board. The laptop is running Command Line Interface (CLI) Tool. This software is used to run the scripts for setting the EUT parameters.

Once the parameters have been set, the support equipment is removed from the EUT.

Frequency range of test: 9kHz to 9.28GHz.

Test Channels:
Low channel 902.4MHz
Middle channel 915.2MHz
High channel 927.6MHz

RBW=1MHz, VBW=3MHz

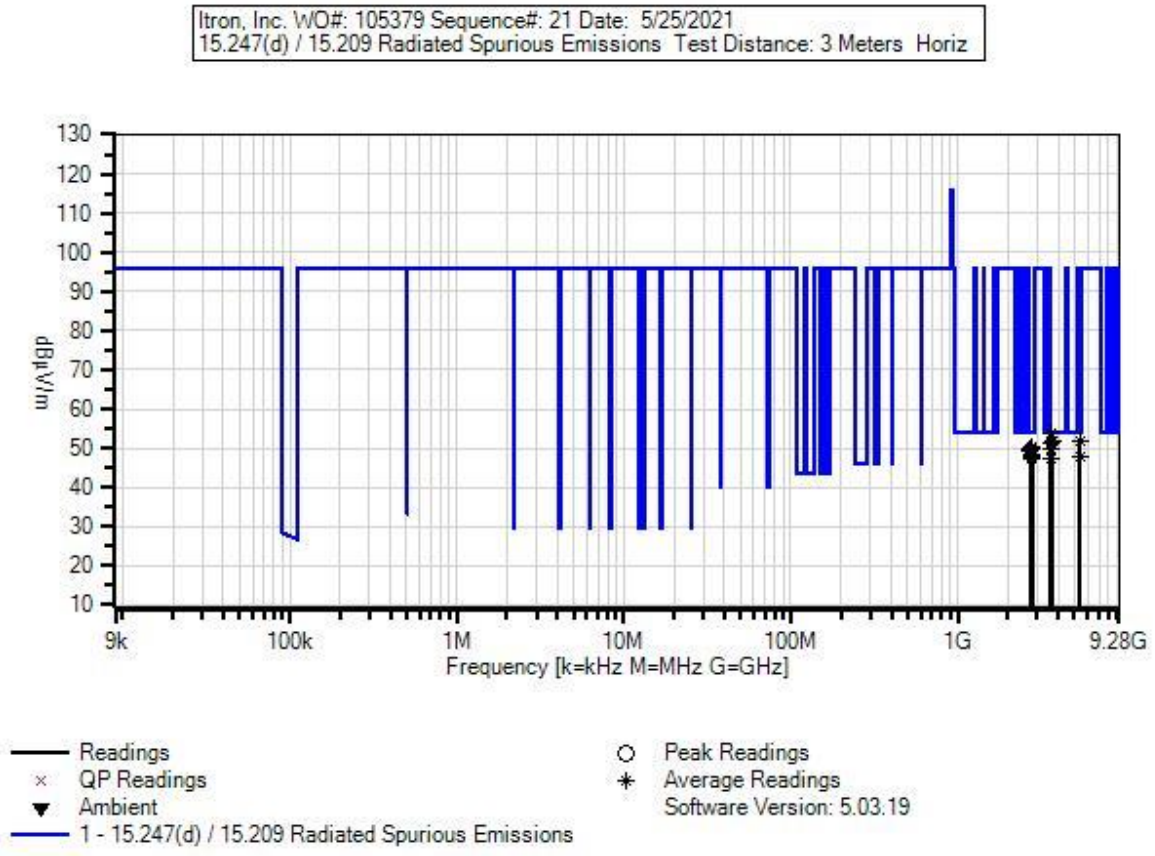
Output level 2 300kbps

The manufacturer declares the worst case duty cycle is 45ms per 100ms. The duty cycle correction factor is 20log(45/100)=-6.94dB. The average reading in the restricted bands is calculated from the peak reading with the duty cycle correction factor.

Test Environment Conditions:
Temperature: 23°C
Relative Humidity: 43%
Pressure: 99kPa

Site D

The EUT is powered from a new 3.6V lithium battery
Test Method: ANSI C63.10-2013



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	ANP04382	Cable	LDF-50	5/15/2020	5/15/2022
T3	ANP07138	Cable	ANDL1-PNMNM-60	3/30/2021	3/30/2023
T4	AN00787	Preamp	83017A	5/31/2019	5/31/2021
T5	ANP07657	Cable	32022-29094K-29094K-24TC	7/30/2020	7/30/2022
T6	AN03169	High Pass Filter	HM1155-11SS	5/10/2021	5/10/2023
T7	AN01646	Horn Antenna	3115	3/17/2020	3/17/2022
	AN00010	Preamp	8447D	1/2/2020	1/2/2022
	AN01994	Biconilog Antenna	CBL6111C	4/14/2020	4/14/2022
	ANP05283	Attenuator	ATT-0218-06-NNN-02	3/26/2020	3/26/2022
	ANP05569	Cable-Amplitude +15C to +45C (dB)	RG-214/U	12/14/2020	12/14/2022
	ANP06978	Cable	Sucoflex 104A	3/26/2020	3/26/2022
	AN00314	Loop Antenna	6502	4/13/2020	4/13/2022

Measurement Data: Reading listed by margin. Test Distance: 3 Meters

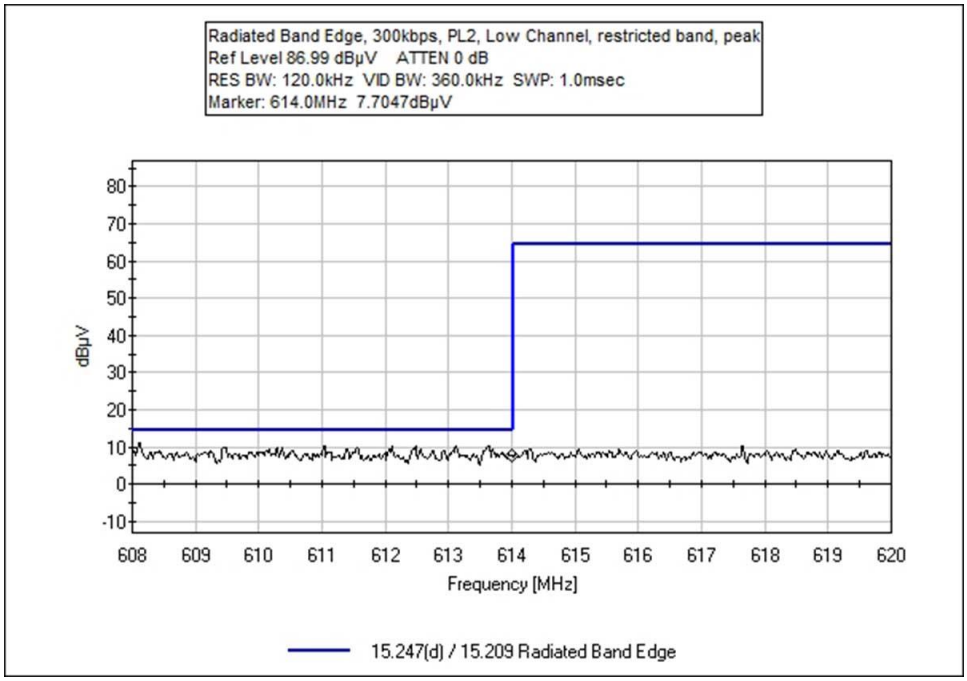
#	Freq	Rdng	T1 T5	T2 T6	T3 T7	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	3609.298M	48.7	+0.0	+7.3	+4.9	-40.0	+0.0	54.0	54.0	+0.0	Horiz
	Ave		+0.6	+0.4	+32.1						
^	3609.298M	55.6	+0.0	+7.3	+4.9	-40.0	+0.0	60.9	54.0	+6.9	Horiz
			+0.6	+0.4	+32.1						
3	5414.841M	41.5	+0.0	+8.9	+6.1	-39.7	+0.0	52.0	54.0	-2.0	Horiz
	Ave		+0.8	+0.2	+34.2						
^	5414.841M	48.4	+0.0	+8.9	+6.1	-39.7	+0.0	58.9	54.0	+4.9	Horiz
			+0.8	+0.2	+34.2						
5	3710.092M	45.6	+0.0	+7.4	+5.1	-39.9	+0.0	51.9	54.0	-2.1	Horiz
	Ave		+0.6	+0.4	+32.7						
^	3710.092M	52.5	+0.0	+7.4	+5.1	-39.9	+0.0	58.8	54.0	+4.8	Horiz
			+0.6	+0.4	+32.7						
7	3710.696M	45.4	+0.0	+7.4	+5.1	-39.9	+0.0	51.7	54.0	-2.3	Horiz
	Ave		+0.6	+0.4	+32.7						
^	3710.696M	52.3	+0.0	+7.4	+5.1	-39.9	+0.0	58.6	54.0	+4.6	Horiz
			+0.6	+0.4	+32.7						
9	3660.497M	45.3	+0.0	+7.4	+5.0	-40.0	+0.0	51.1	54.0	-2.9	Horiz
	Ave		+0.6	+0.4	+32.4						
^	3660.497M	52.2	+0.0	+7.4	+5.0	-40.0	+0.0	58.0	54.0	+4.0	Horiz
			+0.6	+0.4	+32.4						
11	2745.377M	50.1	+0.0	+6.0	+4.2	-40.0	+0.0	50.4	54.0	-3.6	Horiz
	Ave		+0.5	+0.3	+29.3						
^	2745.377M	57.0	+0.0	+6.0	+4.2	-40.0	+0.0	57.3	54.0	+3.3	Horiz
			+0.5	+0.3	+29.3						
13	3661.098M	44.0	+0.0	+7.4	+5.0	-40.0	+0.0	49.8	54.0	-4.2	Vert
	Ave		+0.6	+0.4	+32.4						
^	3661.098M	50.9	+0.0	+7.4	+5.0	-40.0	+0.0	56.7	54.0	+2.7	Vert
			+0.6	+0.4	+32.4						
15	2706.974M	49.5	+0.0	+6.0	+4.2	-40.0	+0.0	49.6	54.0	-4.4	Vert
	Ave		+0.5	+0.3	+29.1						
^	2706.974M	56.4	+0.0	+6.0	+4.2	-40.0	+0.0	56.5	54.0	+2.5	Vert
			+0.5	+0.3	+29.1						
17	2745.364M	49.3	+0.0	+6.0	+4.2	-40.0	+0.0	49.6	54.0	-4.4	Vert
	Ave		+0.5	+0.3	+29.3						
^	2745.364M	56.2	+0.0	+6.0	+4.2	-40.0	+0.0	56.5	54.0	+2.5	Vert
			+0.5	+0.3	+29.3						
19	2706.974M	49.2	+0.0	+6.0	+4.2	-40.0	+0.0	49.3	54.0	-4.7	Horiz
	Ave		+0.5	+0.3	+29.1						
^	2706.974M	56.1	+0.0	+6.0	+4.2	-40.0	+0.0	56.2	54.0	+2.2	Horiz
			+0.5	+0.3	+29.1						
21	2783.015M	47.5	+0.0	+6.1	+4.3	-40.0	+0.0	48.2	54.0	-5.8	Horiz
	Ave		+0.5	+0.3	+29.5						
22	2783.030M	47.2	+0.0	+6.1	+4.3	-40.0	+0.0	47.9	54.0	-6.1	Horiz
	Ave		+0.5	+0.3	+29.5						

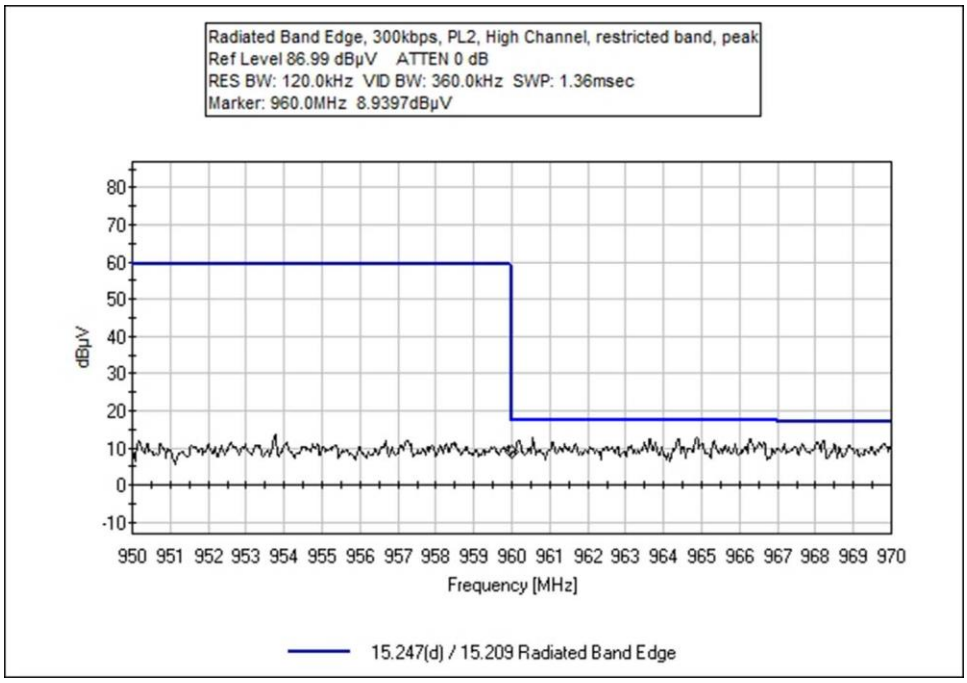
23	5414.857M	37.4	+0.0	+8.9	+6.1	-39.7	+0.0	47.9	54.0	-6.1	Vert
	Ave		+0.8	+0.2	+34.2						
^	5414.857M	44.3	+0.0	+8.9	+6.1	-39.7	+0.0	54.8	54.0	+0.8	Vert
			+0.8	+0.2	+34.2						
25	2783.030M	46.6	+0.0	+6.1	+4.3	-40.0	+0.0	47.3	54.0	-6.7	Horiz
	Ave		+0.5	+0.3	+29.5						
^	2783.015M	54.4	+0.0	+6.1	+4.3	-40.0	+0.0	55.1	54.0	+1.1	Horiz
			+0.5	+0.3	+29.5						
^	2783.030M	54.1	+0.0	+6.1	+4.3	-40.0	+0.0	54.8	54.0	+0.8	Horiz
			+0.5	+0.3	+29.5						
^	2783.030M	53.5	+0.0	+6.1	+4.3	-40.0	+0.0	54.2	54.0	+0.2	Horiz
			+0.5	+0.3	+29.5						
29	3609.274M	41.8	+0.0	+7.3	+4.9	-40.0	+0.0	47.1	54.0	-6.9	Vert
	Ave		+0.6	+0.4	+32.1						
^	3609.274M	48.7	+0.0	+7.3	+4.9	-40.0	+0.0	54.0	54.0	+0.0	Vert
			+0.6	+0.4	+32.1						

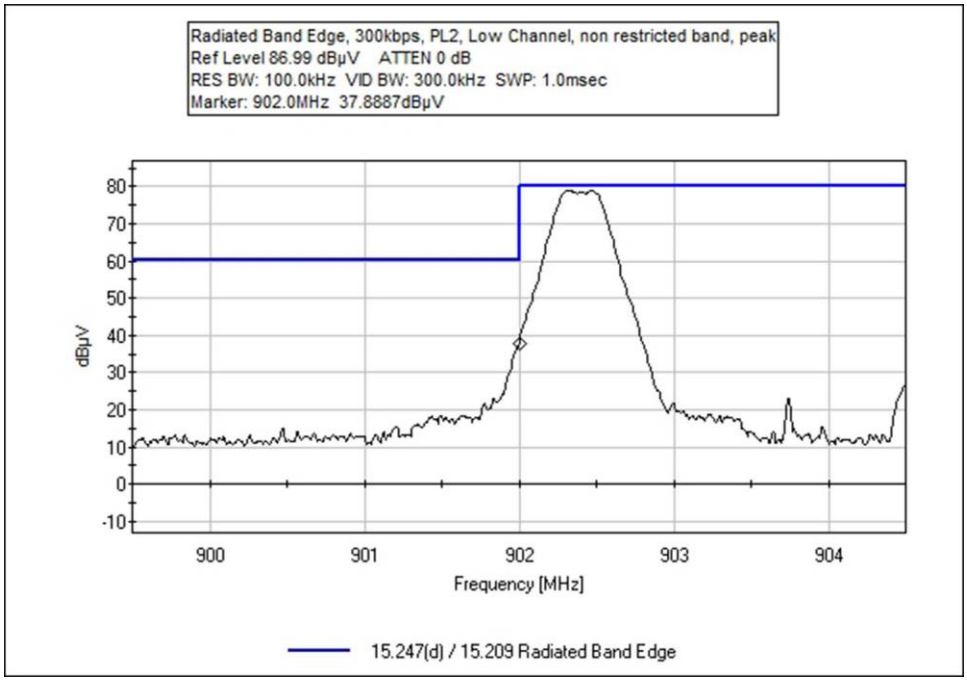
Band Edge

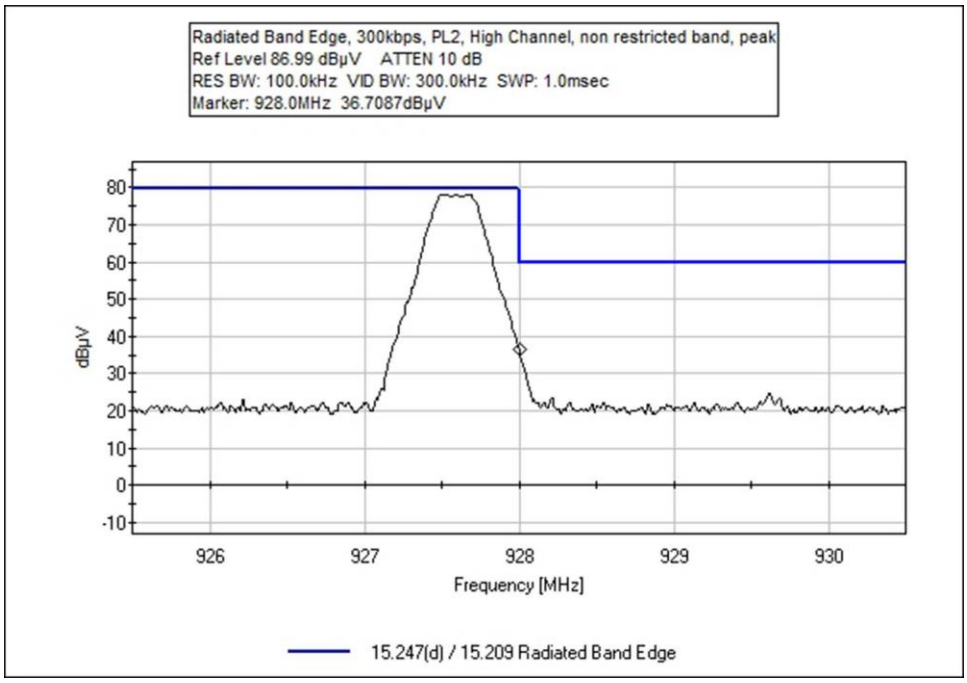
Band Edge Summary					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Field Strength (dBuV/m @3m)**	**Limit (dBuV/m @3m)**	**Results**
614	GFSK 300kbps (PL2) Single Channel	PCB Trace	39	<46	Pass
902			73.6	<96	Pass
928			72.9	<96	Pass
960			45.6	<54	Pass
614	GFSK 300kbps (PL2) Hopping	PCB Trace	39.6	<46	Pass
902			74.1	<96	Pass
928			73.0	<96	Pass
960			46.9	<54	Pass

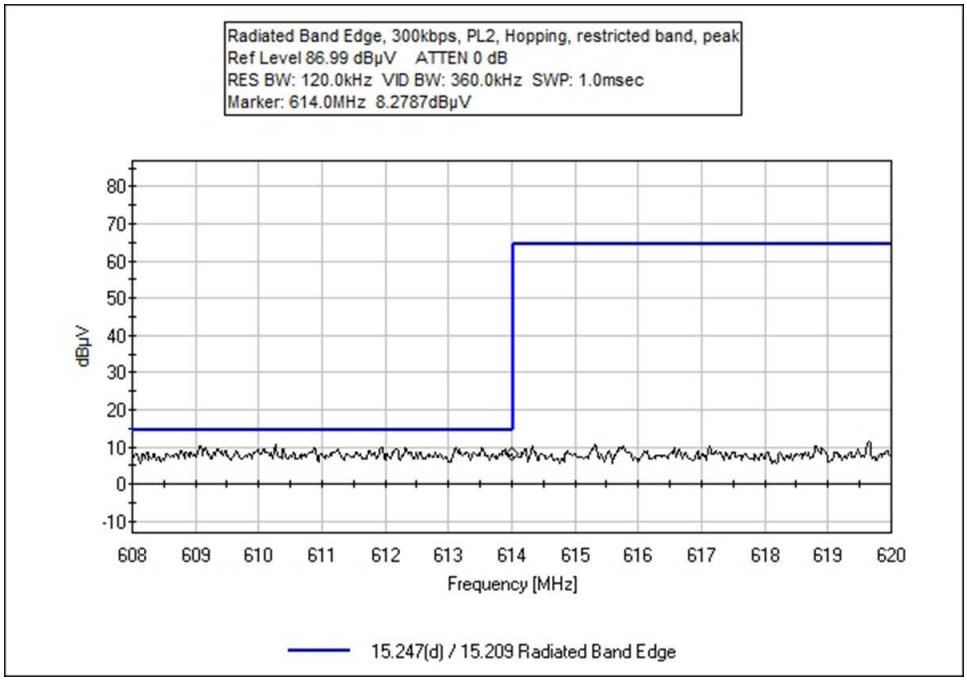
Band Edge Plots

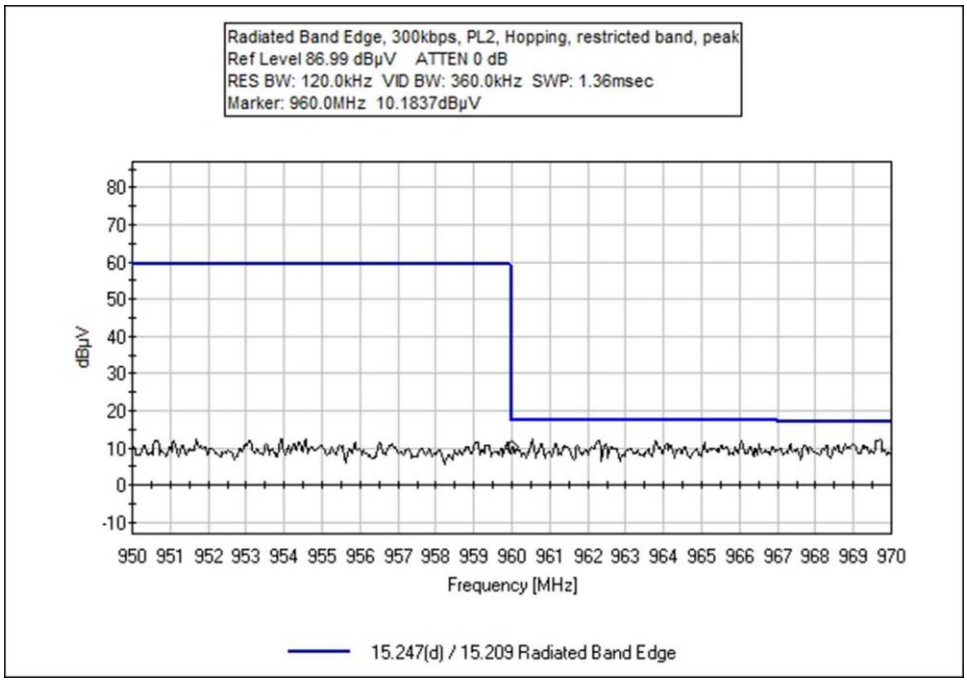


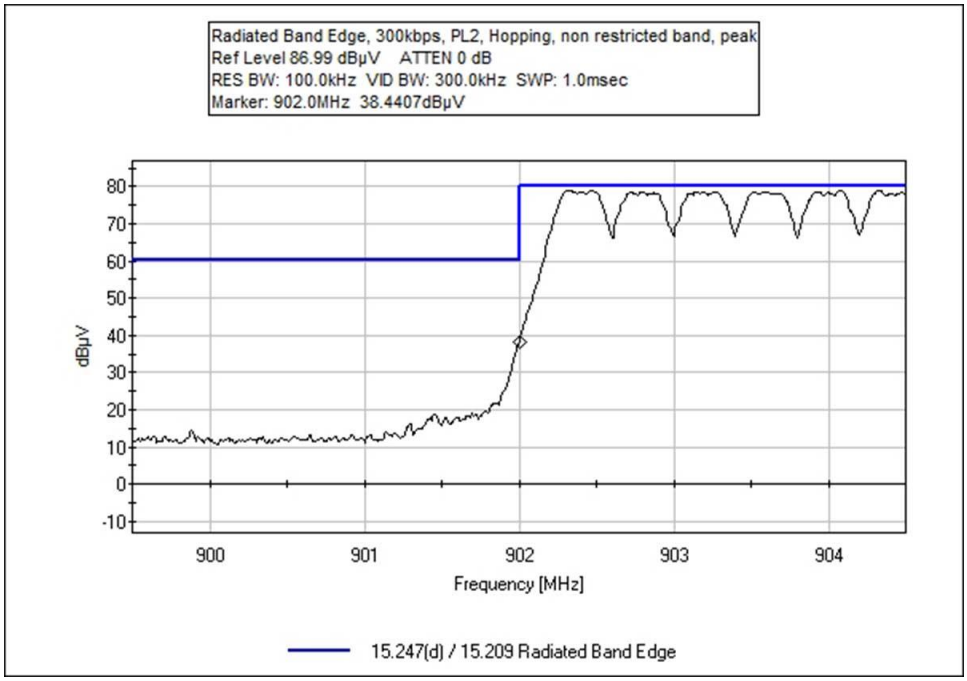

Radiated Band Edge, 300kbps, PL2, High Channel, restricted band, peak
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 1.36msec
Marker: 960.0MHz 8.9397dBµV
dBµV
80
70
60
50
40
30
20
10
0
-10
950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970
Frequency [MHz]
15.247(d) / 15.209 Radiated Band Edge

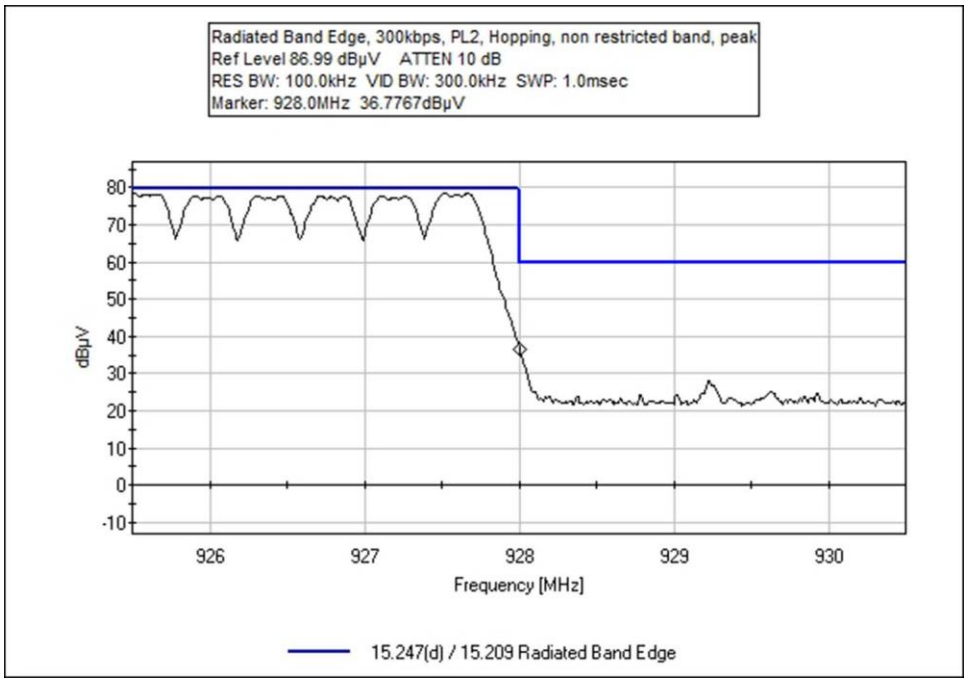

Radiated Band Edge, 300kbps, PL2, Low Channel, non restricted band, peak
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 1.0msec
Marker: 902.0MHz 37.8887dBµV
dBµV
80
70
60
50
40
30
20
10
0
-10
900
901
902
903
904
Frequency [MHz]
15.247(d) / 15.209 Radiated Band Edge


Radiated Band Edge, 300kbps, PL2, High Channel, non restricted band, peak
Ref Level 86.99 dBµV ATTEN 10 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 1.0msec
Marker: 928.0MHz 36.7087dBµV
dBµV
80
70
60
50
40
30
20
10
0
-10
926
927
928
929
930
Frequency [MHz]
15.247(d) / 15.209 Radiated Band Edge


Radiated Band Edge, 300kbps, PL2, Hopping, restricted band, peak
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 1.0msec
Marker: 614.0MHz 8.2787dBµV
dBµV
80
70
60
50
40
30
20
10
0
-10
608
609
610
611
612
613
614
615
616
617
618
619
620
Frequency [MHz]
15.247(d) / 15.209 Radiated Band Edge


Radiated Band Edge, 300kbps, PL2, Hopping, restricted band, peak
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 120.0kHz VID BW: 360.0kHz SWP: 1.36msec
Marker: 960.0MHz 10.1837dBµV
dBµV
80
70
60
50
40
30
20
10
0
-10
950 951 952 953 954 955 956 957 958 959 960 961 962 963 964 965 966 967 968 969 970
Frequency [MHz]
15.247(d) / 15.209 Radiated Band Edge


Radiated Band Edge, 300kbps, PL2, Hopping, non restricted band, peak
Ref Level 86.99 dBµV ATTEN 0 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 1.0msec
Marker: 902.0MHz 38.4407dBµV
dBµV
80
70
60
50
40
30
20
10
0
-10
900
901
902
903
904
Frequency [MHz]
15.247(d) / 15.209 Radiated Band Edge


Radiated Band Edge, 300kbps, PL2, Hopping, non restricted band, peak
Ref Level 86.99 dBµV ATTEN 10 dB
RES BW: 100.0kHz VID BW: 300.0kHz SWP: 1.0msec
Marker: 928.0MHz 36.7767dBµV
80
70
60
50
40
30
20
10
0
-10
dBµV
926
927
928
929
930
Frequency [MHz]
15.247(d) / 15.209 Radiated Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories Inc • 110 N Olinda Pl • Brea CA 92823 • 714-993-6112		
Customer:	**Itron, Inc.**		
Specification:	**15.247(d) / 15.209 Radiated Band Edge**		
Work Order #:	**105379**	Date:	5/27/2021
Test Type:	**Maximized Emissions**	Time:	10:28:49
Tested By:	S. Yamamoto	Sequence#:	28
Software:	EMITest 5.03.19		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 2			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 2			

Test Conditions / Notes:

The equipment under test (EUT) is connected to a laptop computer via USB to serial interface board. The laptop is running Command Line Interface (CLI) Tool. This software is used to run the scripts for setting the EUT parameters.

Once the parameters have been set, the support equipment is removed from the EUT.

Frequency range of test: 608MHz to 970MHz.

Test Channels:
Low channel 902.4MHz
High channel 927.6MHz

RBW=100kHz, VBW=300kHz non restr band
RBW=120kHz, VBW=360kHz restr band

Output level 2 300kbps

Test Environment Conditions:
Temperature: 20°C
Relative Humidity: 52%
Pressure: 99kPa

Site D

The EUT is powered from a new 3.6V lithium battery

Test Method: ANSI C63.10-2013

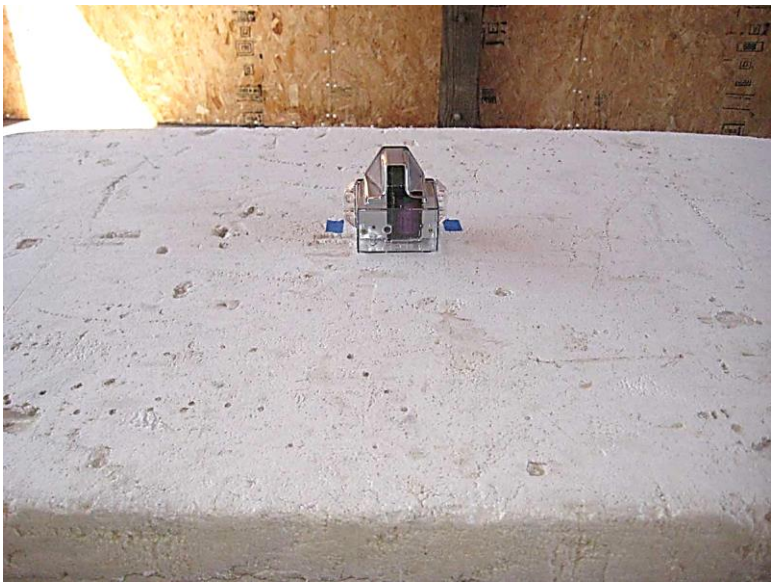
Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02869	Spectrum Analyzer	E4440A	8/3/2020	8/3/2021
T2	ANP04382	Cable	LDF-50	5/15/2020	5/15/2022
T3	ANP05569	Cable-Amplitude +15C to +45C (dB)	RG-214/U	12/14/2020	12/14/2022
T4	ANP05283	Attenuator	ATT-0218-06-NNN-02	3/26/2020	3/26/2022
T5	AN01994	Biconilog Antenna	CBL6111C	4/14/2020	4/14/2022

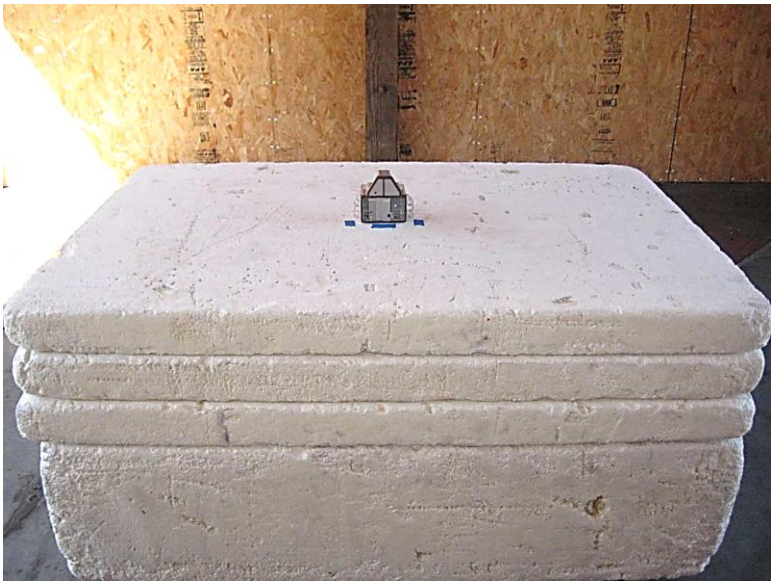
Measurement Data: Reading listed by margin. Test Distance: 3 Meters

#	Freq	Rdng	T1 T5	T2	T3	T4	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	614.000M	8.3	+0.0 +19.9	+2.8	+2.8	+5.8	+0.0	39.6	46.0 300kbps, PL2 Hopping	-6.4	Vert
2	614.000M	7.7	+0.0 +19.9	+2.8	+2.8	+5.8	+0.0	39.0	46.0 300kbps, PL2 Single	-7.0	Vert
3	960.000M	10.2	+0.0 +23.6	+3.5	+3.7	+5.9	+0.0	46.9	54.0 300kbps, PL2 Hopping	-7.1	Vert
4	960.000M	8.9	+0.0 +23.6	+3.5	+3.7	+5.9	+0.0	45.6	54.0 300kbps, PL2 Single	-8.4	Vert
5	902.000M	38.4	+0.0 +22.9	+3.4	+3.5	+5.9	+0.0	74.1	96.0 300kbps, PL2 Hopping	-21.9	Vert
6	902.000M	37.9	+0.0 +22.9	+3.4	+3.5	+5.9	+0.0	73.6	96.0 300kbps, PL2 Single	-22.4	Vert
7	928.000M	36.8	+0.0 +23.2	+3.5	+3.6	+5.9	+0.0	73.0	96.0 300kbps, PL2 Hopping	-23.0	Vert
8	928.000M	36.7	+0.0 +23.2	+3.5	+3.6	+5.9	+0.0	72.9	96.0 300kbps, PL2 Single	-23.1	Vert

Test Setup Photo(s)



Below 1GHz, Front View



Below 1GHz, Back View

Above 1GHz

SUPPLEMENTAL INFORMATION

Measurement Uncertainty

Uncertainty Value	Parameter
4.73 dB	Radiated Emissions
3.34 dB	Mains Conducted Emissions
3.30 dB	Disturbance Power

Uncertainties reported are worst case for all CKC Laboratories' sites and represent expanded uncertainties expressed at approximately the 95% confidence level using a coverage factor of k=2. Compliance is deemed to occur provided measurements are below the specified limits.

Emissions Test Details

TESTING PARAMETERS

Unless otherwise indicated, the following configuration parameters are used for equipment setup: The cables were routed consistent with the typical application by varying the configuration of the test sample. Interface cables were connected to the available ports of the test unit. The effect of varying the position of the cables was investigated to find the configuration that produced maximum emissions. Cables were of the type and length specified in the individual requirements. The length of cable that produced maximum emissions was selected.

The equipment under test (EUT) was set up in a manner that represented its normal use, as shown in the setup photographs. Any special conditions required for the EUT to operate normally are identified in the comments that accompany the emissions tables.

The emissions data was taken with a spectrum analyzer or receiver. Incorporating the applicable correction factors for distance, antenna, cable loss and amplifier gain, the data was reduced as shown in the table below. The corrected data was then compared to the applicable emission limits. Preliminary and final measurements were taken in order to ensure that all emissions from the EUT were found and maximized.

CORRECTION FACTORS

The basic spectrum analyzer reading was converted using correction factors as shown in the highest emissions readings in the tables. For radiated emissions in dBµV/m, the spectrum analyzer reading in dBµV was corrected by using the following formula. This reading was then compared to the applicable specification limit. Individual measurements were compared with the displayed limit value in the margin column. The margin was calculated based on subtracting the limit value from the corrected measurement value; a positive margin represents a measurement exceeding the limit, while a negative margin represents a measurement less than the limit.

SAMPLE CALCULATIONS		
	Meter reading	(dBµV)
+	Antenna Factor	(dB/m)
+	Cable Loss	(dB)
-	Distance Correction	(dB)
-	Preamplifier Gain	(dB)
=	Corrected Reading	(dBµV/m)

TEST INSTRUMENTATION AND ANALYZER SETTINGS

The test instrumentation and equipment listed were used to collect the emissions data. A spectrum analyzer or receiver was used for all measurements. Unless otherwise specified, the following table shows the measuring equipment bandwidth settings that were used in designated frequency bands. For testing emissions, an appropriate reference level and a vertical scale size of 10 dB per division were used.

MEASURING EQUIPMENT BANDWIDTH SETTINGS PER FREQUENCY RANGE			
TEST	BEGINNING FREQUENCY	ENDING FREQUENCY	BANDWIDTH SETTING
CONDUCTED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	9 kHz	150 kHz	200 Hz
RADIATED EMISSIONS	150 kHz	30 MHz	9 kHz
RADIATED EMISSIONS	30 MHz	1000 MHz	120 kHz
RADIATED EMISSIONS	1000 MHz	>1 GHz	1 MHz

SPECTRUM ANALYZER/RECEIVER DETECTOR FUNCTIONS

The notes that accompany the measurements contained in the emissions tables indicate the type of detector function used to obtain the given readings. Unless otherwise noted, all readings were made in the "positive peak" detector mode. Whenever a "quasi-peak" or "average" reading was recorded, the measurement was annotated with a "QP" or an "Ave" on the appropriate rows of the data sheets. In cases where quasi-peak or average limits were employed and data exists for multiple measurement types for the same frequency then the peak measurement was retained in the report for reference, however the numbering for the affected row was removed and an arrow or caret ("^") was placed in the far left-hand column indicating that the row above takes precedence for comparison to the limit. The following paragraphs describe in more detail the detector functions and when they were used to obtain the emissions data.

Peak

In this mode, the spectrum analyzer or receiver recorded all emissions at their peak value as the frequency band selected was scanned. By combining this function with another feature called "peak hold," the measurement device had the ability to measure intermittent or low duty cycle transient emission peak levels. In this mode the measuring device made a slow scan across the frequency band selected and measured the peak emission value found at each frequency across the band.

Quasi-Peak

Quasi-peak measurements were taken using the quasi-peak detector when the true peak values exceeded or were within 2 dB of a quasi-peak specification limit. Additional QP measurements may have been taken at the discretion of the operator.

Average

Average measurements were taken using the average detector when the true peak values exceeded or were within 2 dB of an average specification limit. Additional average measurements may have been taken at the discretion of the operator. If the specification or test procedure requires trace averaging, then the averaging was performed using 100 samples or as required by the specification. All other average measurements are performed using video bandwidth averaging. To make these measurements, the test engineer reduces the video bandwidth on the measuring device until the modulation of the signal is filtered out. At this point the measuring device is set into the linear mode and the scan time is reduced.