Novatel

REVISED TEST REPORT FOR

PwrPak7
Model: 01019717

Tested To The Following Standards:

FCC Part 15 Subpart C Section(s)

15.247
(DTS 2400-2483.5 MHz)

Report No.: 100690-2A

Date of issue: December 12, 2017

ACCREDITED
Testing Certificates:
803.01, 803.02, 803.05, 803.06

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 EMC 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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Testing the Future
CKC LABORATORIES, INC.

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ADMINISTRATIVE INFORMATION

Test Report Information

REPORT PREPARED FOR:

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Calgary AB T2E 8S5

REPRESENTATIVE: Jim Turner
Customer Reference Number: RPO0006000

REPORT PREPARED BY:

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Mariposa, CA 95338

Project Number: 100690

DATE OF EQUIPMENT RECEIPT: November 17, 2017
DATE(S) OF TESTING: November 17, 2017

Revision History

Original: Testing of the PwrPak7, Model: 01019717 to FCC Part 15 Subpart C Section(s) 15.247.
Revision A: Added modulation type power settings for 6M and MCS7 and corrected a typo for the High Channel referenced from 2472 to 2462 to the updated Summary table for section 15.247(b)(3) Output Power, with notes added underneath the table. Replaced the max power datasheet. A note was added under the Band Edge Summary table for section 15.247(d) Conducted Spurious.

Report Authorization

The test data contained in this report documents the observed testing parameters pertaining to and are relevant for only the sample equipment 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.
22116 23rd Drive S.E., Suite A
Canyon Park, Bothell, WA 98021

Software Versions

CKC Laboratories Proprietary Software	Version
EMITest Emissions	5.03.11

Site Registration & Accreditation Information

Location	NIST CB #	TAIWAN	CANADA	FCC	JAPAN
Canyon Park Bothell, WA	US0081	SL2-IN-E-1145R	3082C-1	US1022	A-0148

SUMMARY OF RESULTS

Standard / Specification: FCC Part 15 Subpart C - 15.247 (DTS)

Test Procedure	Description	Modifications	Results
15.247(a)(2)	6dB Bandwidth	NA	NP
15.247(b)(3)	Output Power	NA	Pass
15.247(e)	Power Spectral Density	NA	NP
15.247(d)	RF Conducted Emissions & Band Edge	NA	Pass
15.247(d)	Radiated Emissions & Band Edge	NA	Pass

NA = Not Applicable
NP = CKC Laboratories was not contracted to perform test.

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
None

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
PwrPak7	Novatel	01019717	NMNE17190014K

Support Equipment:

Device	Manufacturer	Model #	S/N
Laptop	Dell	Latitude E6530	NA
AC Adaptor	Dell	LA90PM130	NA
USB to Serial	SIIG	AKU3144X0129	5U-HS2012-S2

Configuration 2

Equipment Tested:

Device	Manufacturer	Model #	S/N
PwrPak7	Novatel	01019717	NMNE17190018S

Support Equipment:

Device	Manufacturer	Model #	S/N
USB to Serial	SIIG	AKU3144X0129	5U-HS2012-S2
AC Adaptor	Dell	LA90PM130	NA
Laptop	Dell	Latitude E6530	NA
Attenuator	Alan	Model 50TX82.5 BNC	NA
Amplifier	Mini-Circuits	ZHL-1217HLN-SMA	NA
Bias Tee Coupler	Mini-Circuits	ZFBT-4R2G-FT	NA
GNSS Active Antenna	Novatel	GPS-703-GGG	NA

General Product Information:

Product Information	Manufacturer-Provided Details
Equipment Type:	Stand-Alone Equipment
Type of Wideband System:	802.11 b/g/n20
Operating Frequency Range:	2412-2462MHz
Modulation Type(s):	CCK, DQPSK, PBCC, BPSK, QPSK OFDM, 16-QAM, 64-QAM
Maximum Duty Cycle:	Tested 100%
Number of TX Chains:	1
Antenna Type(s) and Gain:	Integral Trace, 2.6dBi
Beamforming Type:	NA
Antenna Connection Type:	Integral (External connector provided to facilitate testing)
Nominal Input Voltage:	13.2VDC (9V-36VDC range)
Firmware / Software used for Test:	OM7CR0301SN0007 / WifiConfigSequencer.exe

FCC Part 15 Subpart C

15.247(b)(3) Output Power

Test Data Summary - Voltage Variations					
Frequency (MHz)	**Modulation**	**$V_{Minimum}$ (dBm)**	**$V_{Nominal}$ (dBm)**	**$V_{Maximum}$ (dBm)**	**Max Deviation from $V_{Nominal}$ (dB)**
2412	11M Data Rate (PBCC/QPSK) (Worst Case)	9.4	9.4	9.4	0.0
2442	11M Data Rate (PBCC/QPSK) (Worst Case)	9.6	9.6	9.6	0.0
2462	11M Data Rate (PBCC/QPSK) (Worst Case)	10.0	10.0	10.0	0.0

Test performed using operational mode with the highest output power, representing worst case.

Parameter Definitions:

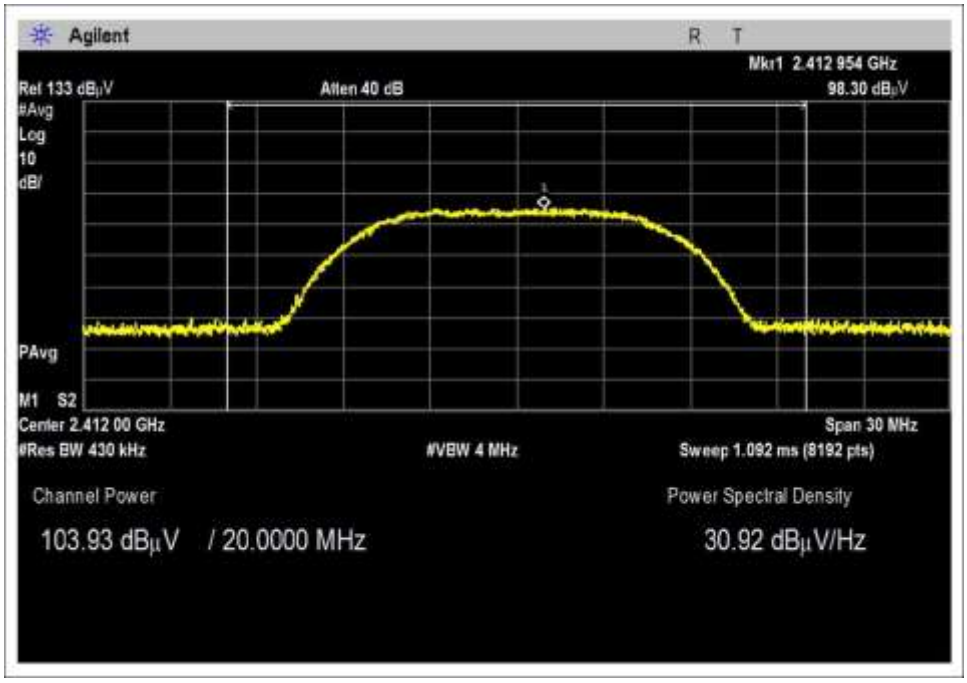
Measurements performed at input voltage according to manufacturer specification.

Parameter	Value
$V_{Nominal}$:	13.2VDC
$V_{Minimum}$:	9VDC
$V_{Maximum}$:	36VDC

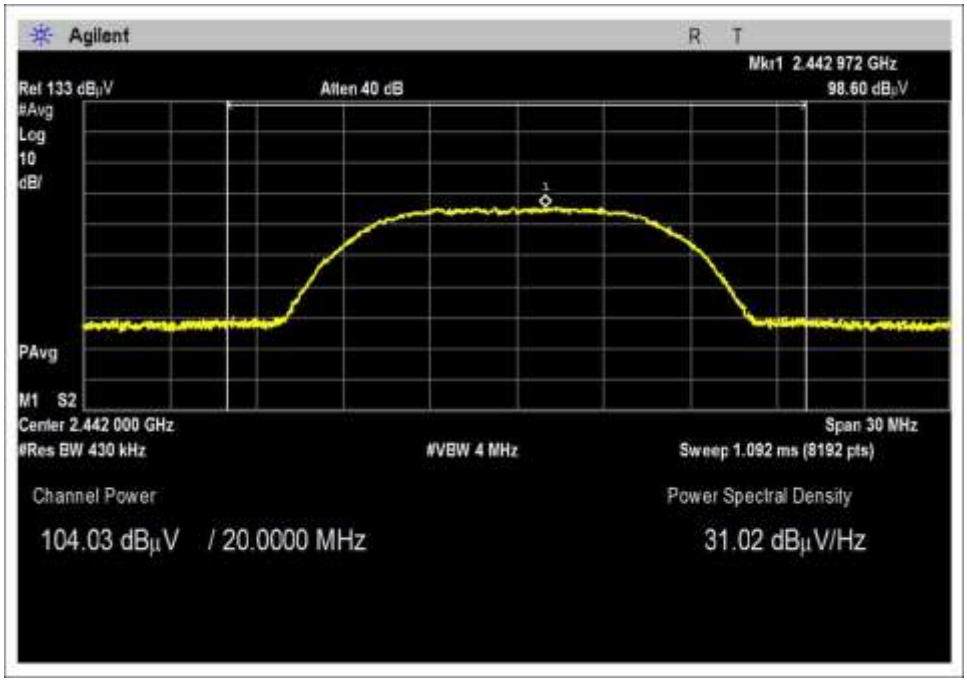
Power Output Test Data Summary - RF Conducted Measurement					
Measurement Option: AVGSA-1					
Frequency (MHz)	**Modulation**	**Ant. Type / Gain (dBi)**	**Measured (dBm)**	**Limit (dBm)**	**Results**
2412	11M Data Rate (PBCC/QPSK) (Worst Case)	Integral Trace / 2.6dBi	9.4	≤30	Pass
2442	11M Data Rate (PBCC/QPSK) (Worst Case)	Integral Trace / 2.6dBi	9.6	≤30	Pass
2462	11M Data Rate (PBCC/QPSK) (Worst Case)	Integral Trace / 2.6dBi	10.0	≤30	Pass
2412	6M (OFDM/BPSK) (Worst Case 802.11g)	Integral Trace / 2.6dBi	8.6	≤30	Pass
2442	6M (OFDM/BPSK) (Worst Case 802.11g)	Integral Trace / 2.6dBi	9.4	≤30	Pass
2462	6M (OFDM/BPSK) (Worst Case 802.11g)	Integral Trace / 2.6dBi	10.0	≤30	Pass
2412	MCS7 (64-QAM) (Worst Case 802.11n)	Integral Trace / 2.6dBi	7.8	≤30	Pass
2442	MCS7 (64-QAM) (Worst Case 802.11n)	Integral Trace / 2.6dBi	8.6	≤30	Pass
2462	MCS7 (64-QAM) (Worst Case 802.11n)	Integral Trace / 2.6dBi	9.3	≤30	Pass

Note:
Measured dBm = Measured dBuV – 107
Measured dBuV = Raw dBuV (spectrum analyzer reading) + insertion loss factors (for cable and attenuator)
See data sheet for insertion loss factors.

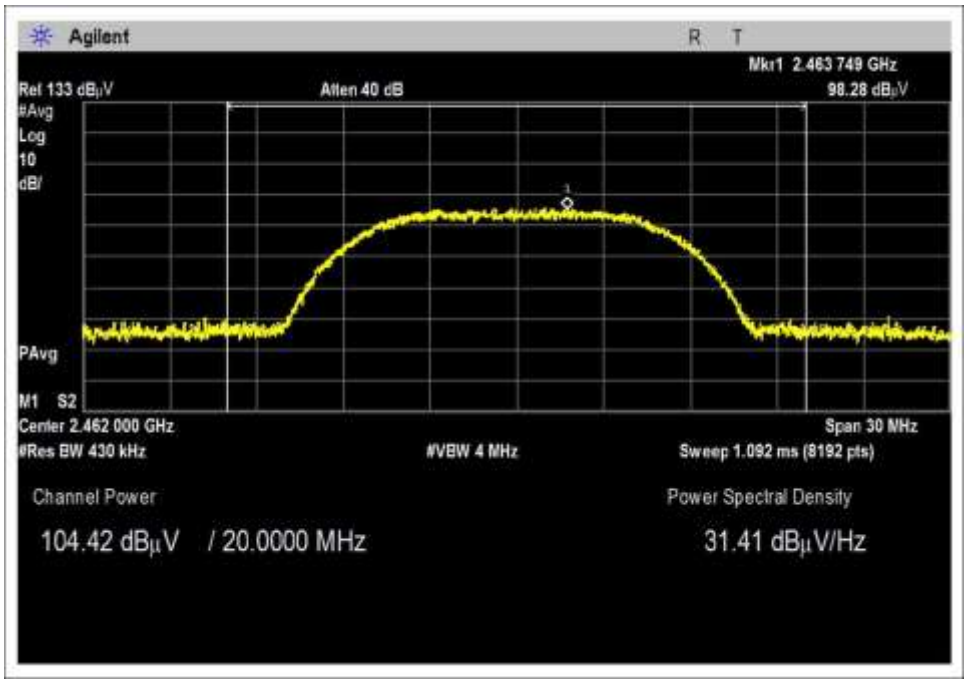
Plots



2402, 11M



2442, 11M


Agilent
R T
Mkr1 2.463 749 GHz
Ref 133 dBµV
Atten 40 dB
98.28 dBµV
#Avg
Log
10
dB/
PAvg
M1 S2
Center 2.462 000 GHz
Span 30 MHz
#Res BW 430 kHz
#VBW 4 MHz
Sweep 1.092 ms (8192 pts)
Channel Power
Power Spectral Density
104.42 dBµV / 20.0000 MHz
31.41 dBµV/Hz

2462, 11M

Test Setup / Conditions / Data

Test Location:	CKC Laboratories • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**Novatel**		
Specification:	**15.247(b) Power Output (2400-2483.5 MHz DTS)**		
Work Order #:	**100690**	Date:	11/17/2017
Test Type:	**Conducted Emissions**	Time:	09:53:41
Tested By:	Michael Atkinson	Sequence#:	1
Software:	EMITest 5.03.11		13.2VDC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Range: Fundamental
Frequency tested: 2412, 2442, 2462MHz
Firmware power setting: Max
EUT Firmware: OM7CR0301SN0007
Modulation/Data Rate: All data rates investigated, 11M data rate worst case.

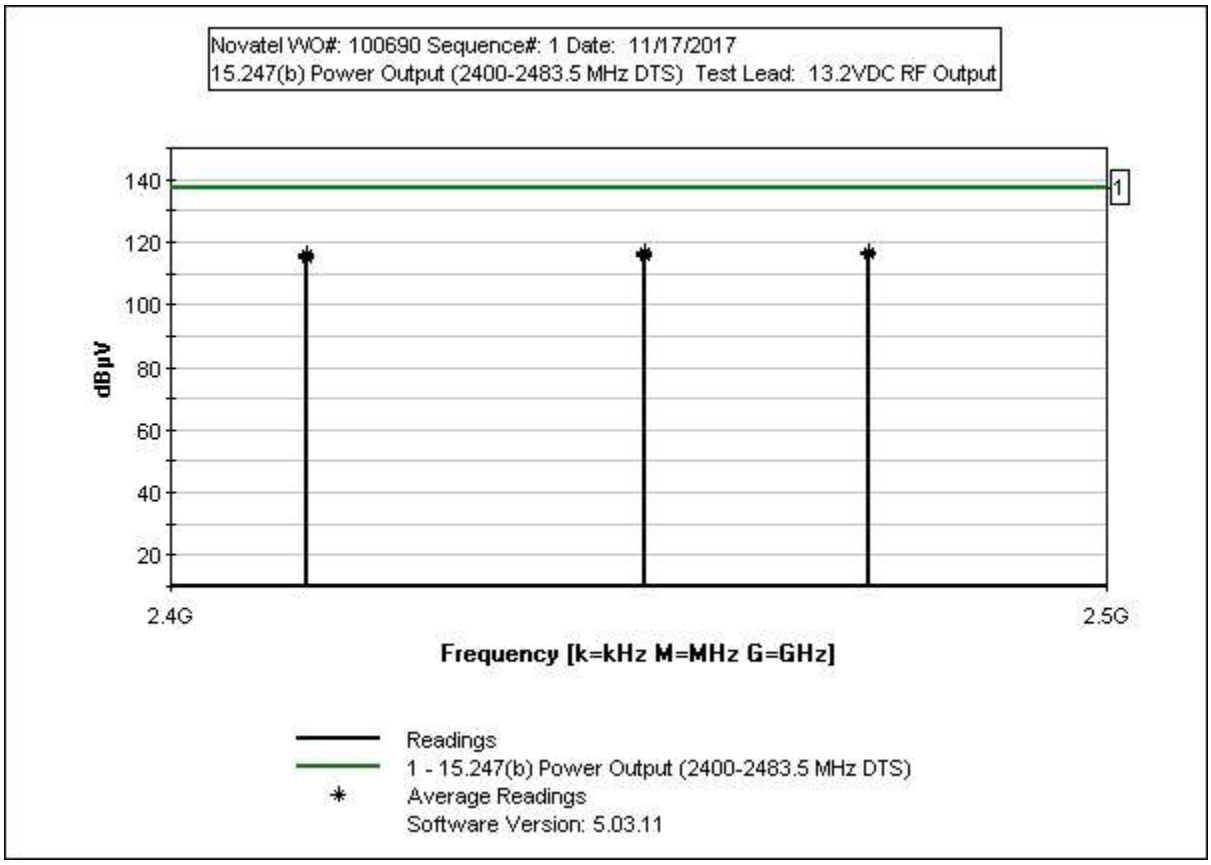
Antenna type: Integral Trace
Antenna Gain : 2.6dBi

Duty Cycle: 100%

Setup:
The EUT is DC powered through a DC power supply. The EUT is connected to a support laptop via USB directly, as well as a RS-232 cable which connected to a serial hub to the laptop.

The EUT is continuously transmitting. Low, Mid, and High channels as well as all data rates investigated, worst case data reported. The EUT was fitted with a temporary antenna port for direct conducted measurements.

Temperature (ºC): 22
Relative Humidity (%): 33
Test Location: Bothell Lab Bench
Test Method: ANSI C63.10 (2013), KDB 558074 (April 5, 2017)


Novatel WO#: 100690 Sequence#: 1 Date: 11/17/2017
15.247(b) Power Output (2400-2483.5 MHz DTS) Test Lead: 13.2VDC RF Output
140
120
100
80
60
40
20
dBµV
1
2.4G
2.5G
Frequency [k=kHz M=MHz G=GHz]
Readings
1 - 15.247(b) Power Output (2400-2483.5 MHz DTS)
Average Readings
Software Version: 5.03.11

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN02673	Spectrum Analyzer	E4446A	2/3/2017	2/3/2019
T2	ANP06241	Attenuator	54A-10	3/28/2016	3/28/2018
T3	ANP06678	Cable	32026-29801-29801-144	9/19/2016	9/19/2018

Measurement Data: Reading listed by margin. Test Lead: RF Output

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	T3 dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	2462.000M Ave	104.4	+0.0	+9.9	+2.7		+0.0	117.0	137.0 11M	-20.0	RF Ou
2	2462.000M Ave	104.4	+0.0	+9.9	+2.7		+0.0	117.0	137.0 6M	-20.0	RF Ou
3	2442.000M Ave	104.0	+0.0	+9.9	+2.7		+0.0	116.6	137.0 11M	-20.4	RF Ou
4	2412.000M Ave	103.9	+0.0	+9.9	+2.6		+0.0	116.4	137.0 11M	-20.6	RF Ou
5	2442.000M Ave	103.8	+0.0	+9.9	+2.7		+0.0	116.4	137.0 6M	-20.6	RF Ou
6	2462.000M Ave	103.7	+0.0	+9.9	+2.7		+0.0	116.3	137.0 MCS7	-20.7	RF Ou
7	2442.000M Ave	103.0	+0.0	+9.9	+2.7		+0.0	115.6	137.0 MCS7	-21.4	RF Ou
8	2412.000M Ave	103.1	+0.0	+9.9	+2.6		+0.0	115.6	137.0 6M	-21.4	RF Ou
9	2412.000M Ave	102.3	+0.0	+9.9	+2.6		+0.0	114.8	137.0 MCS7	-22.2	RF Ou

Test Setup Photo

15.247(d) RF Conducted Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**Novatel**		
Specification:	**15.247(d) Conducted Spurious Emissions**		
Work Order #:	**100690**	Date:	11/17/2017
Test Type:	**Conducted Emissions**	Time:	11:31:19
Tested By:	Michael Atkinson	Sequence#:	4
Software:	EMITest 5.03.11		13.2VDC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Range: Fundamental
Frequency tested: 2412, 2442, 2462MHz
Firmware power setting: Max
EUT Firmware: OM7CR0301SN0007
Modulation/Data Rate: All data rates investigated, worst case reported.

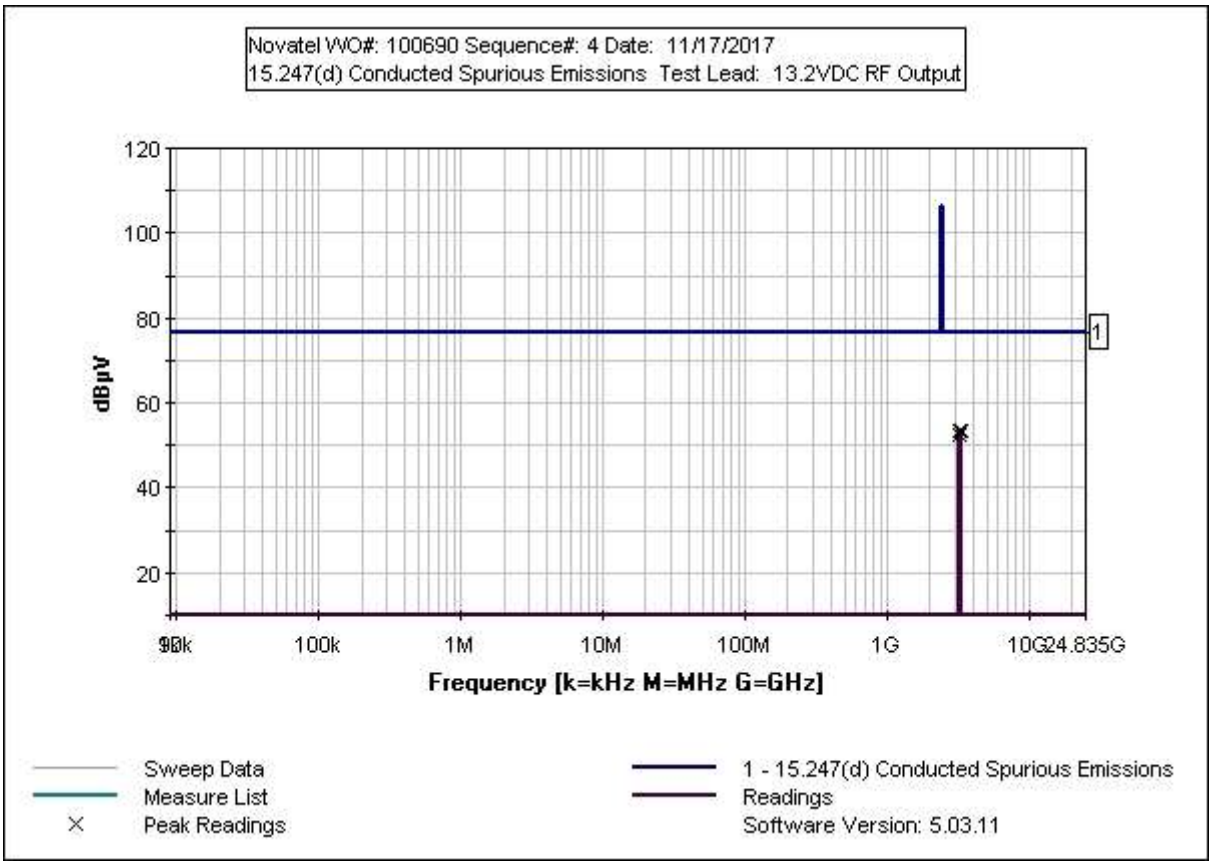
Antenna type: Integral Trace
Antenna Gain : 2.6dBi

Duty Cycle: 100%

Setup:
The EUT is DC powered through a DC power supply. The EUT is connected to a support laptop via USB directly, as well as a RS-232 cable which connected to a serial hub to the laptop.

The EUT is continuously transmitting. Low, Mid, and High channels as well as all data rates investigated, worst case data reported. The EUT was fitted with a temporary antenna port for direct conducted measurements.

Temperature (ºC): 22
Relative Humidity (%): 33
Test Location: Bothell Lab Bench
Test Method: ANSI C63.10 (2013), KDB 558074 (April 5, 2017)



Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02673	Spectrum Analyzer	E4446A	2/3/2017	2/3/2019
T1	ANP06241	Attenuator	54A-10	3/28/2016	3/28/2018
T2	ANP06678	Cable	32026-29801-29801-144	9/19/2016	9/19/2018

Measurement Data: Reading listed by margin. Test Lead: RF Output

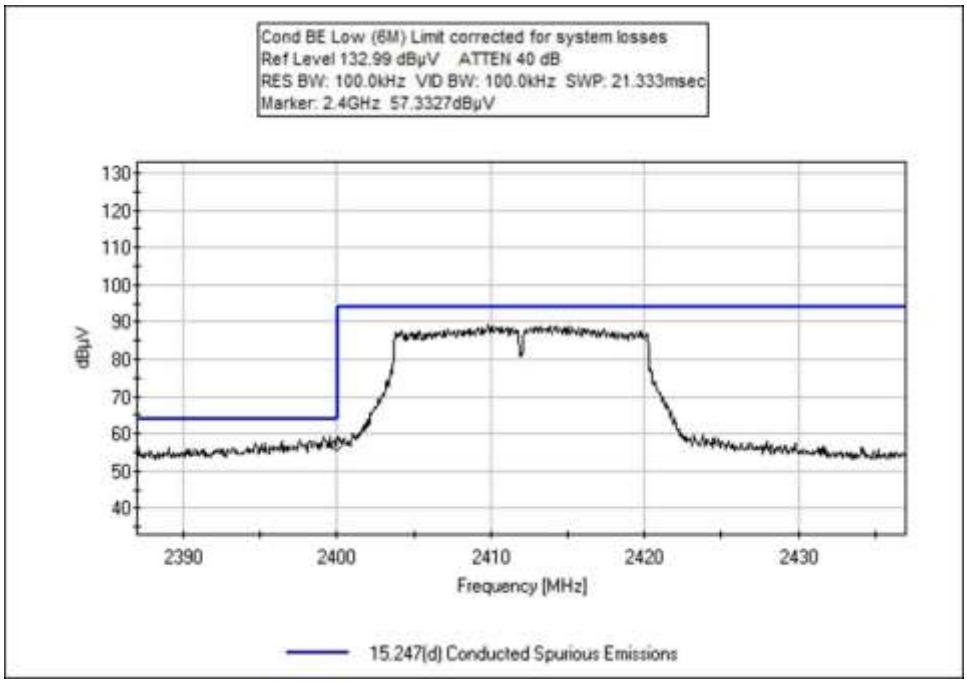
#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	3288.000M	40.7	+9.7	+3.1			+0.0	53.5	76.5	-23.0	RF Ou
2	3214.000M	40.5	+9.7	+3.1			+0.0	53.3	76.5	-23.2	RF Ou
3	3263.000M	39.6	+9.7	+3.1			+0.0	52.4	76.5	-24.1	RF Ou

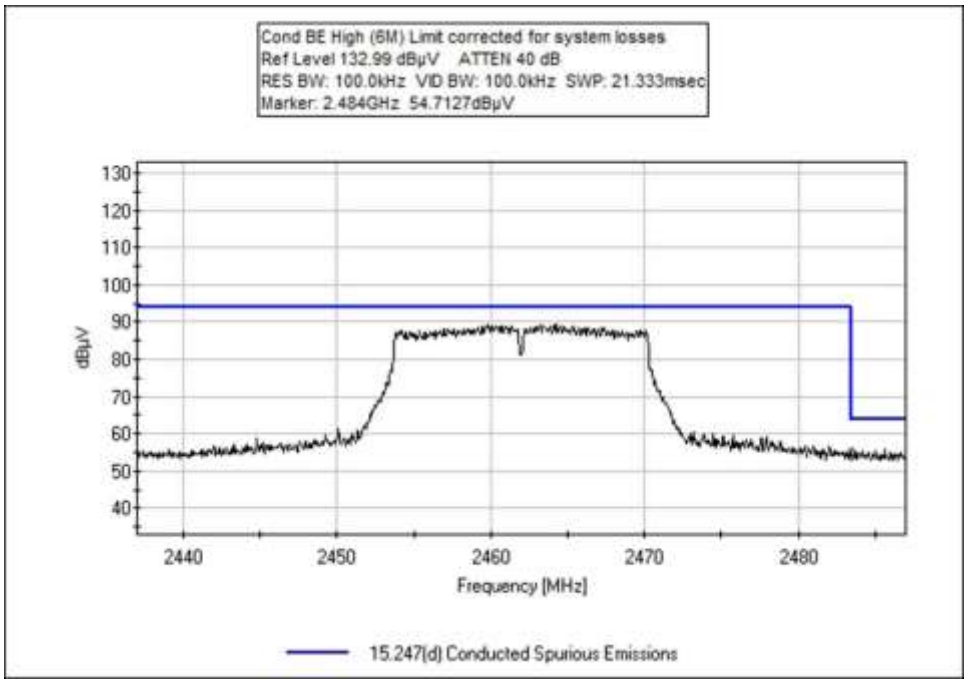
Band Edge

Band Edge Summary				
Limit applied: Max Power/100kHz - 30dB (When average power limit is applied).				
Frequency (MHz)	**Modulation**	**Measured (dBm)**	**Limit (dBm)**	**Results**
2400.0	6M Data Rate (OFDM/BPSK) (Worst Case)	-37.2	< -30.5	Pass
2483.5	6M Data Rate (OFDM/BPSK) (Worst Case)	-40.2	< -30.5	Pass

Note: The limit is derived 30dB down from the worst case fundamental using 100kHz RBW to measure the fundamental.

Band Edge Plots





Test Setup / Conditions / Data

Test Location:	CKC Laboratories • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**Novatel**		
Specification:	**15.247(d) Conducted Spurious Emissions**		
Work Order #:	**100690**	Date:	11/17/2017
Test Type:	**Conducted Emissions**	Time:	11:16:41
Tested By:	Michael Atkinson	Sequence#:	3
Software:	EMITest 5.03.11		13.2VDC

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Range: Fundamental
Frequency tested: 2412, 2462MHz
Firmware power setting: Max
EUT Firmware: OM7CR0301SN0007
Modulation/Data Rate: All data rates investigated, worst case reported.

Antenna type: Integral Trace
Antenna Gain: 2.6dBi

Duty Cycle: 100%

Setup:
The EUT is DC powered through a DC power supply. The EUT is connected to a support laptop via USB directly, as well as a RS-232 cable which connected to a serial hub to the laptop.

The EUT is continuously transmitting. Low and High channels as well as all data rates investigated, worst case data reported. The EUT was fitted with a temporary antenna port for direct conducted measurements.

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
	AN02673	Spectrum Analyzer	E4446A	2/3/2017	2/3/2019
T1	ANP06241	Attenuator	54A-10	3/28/2016	3/28/2018
T2	ANP06678	Cable	32026-29801-29801-144	9/19/2016	9/19/2018

Measurement Data: Reading listed by margin. Test Lead: RF Output

#	Freq MHz	Rdng dBµV	T1 dB	T2 dB	dB	dB	Dist Table	Corr dBµV	Spec dBµV	Margin dB	Polar Ant
1	2400.000M	57.3	+9.9	+2.6			+0.0	69.8	76.5 6M	-6.7	RF Ou
2	2483.500M	54.2	+9.9	+2.7			+0.0	66.8	76.5 6M	-9.7	RF Ou

Test Setup Photo

15.247(d) Radiated Emissions & Band Edge

Test Setup / Conditions / Data

Test Location:	CKC Laboratories • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**Novatel**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions**		
Work Order #:	**100690**	Date:	11/17/2017
Test Type:	**Maximized Emissions**	Time:	14:28:37
Tested By:	Steven Pittsford	Sequence#:	5
Software:	EMITest 5.03.11		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 2			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 2			

Test Conditions / Notes:

Frequency Range: 1-13GHz
Frequency tested: 2412, 2442, 2462MHz
Firmware power setting: 10
EUT Firmware: OM7CR0301SN0007
Modulation/Data Rate: All data rates investigated, only worst case data reported

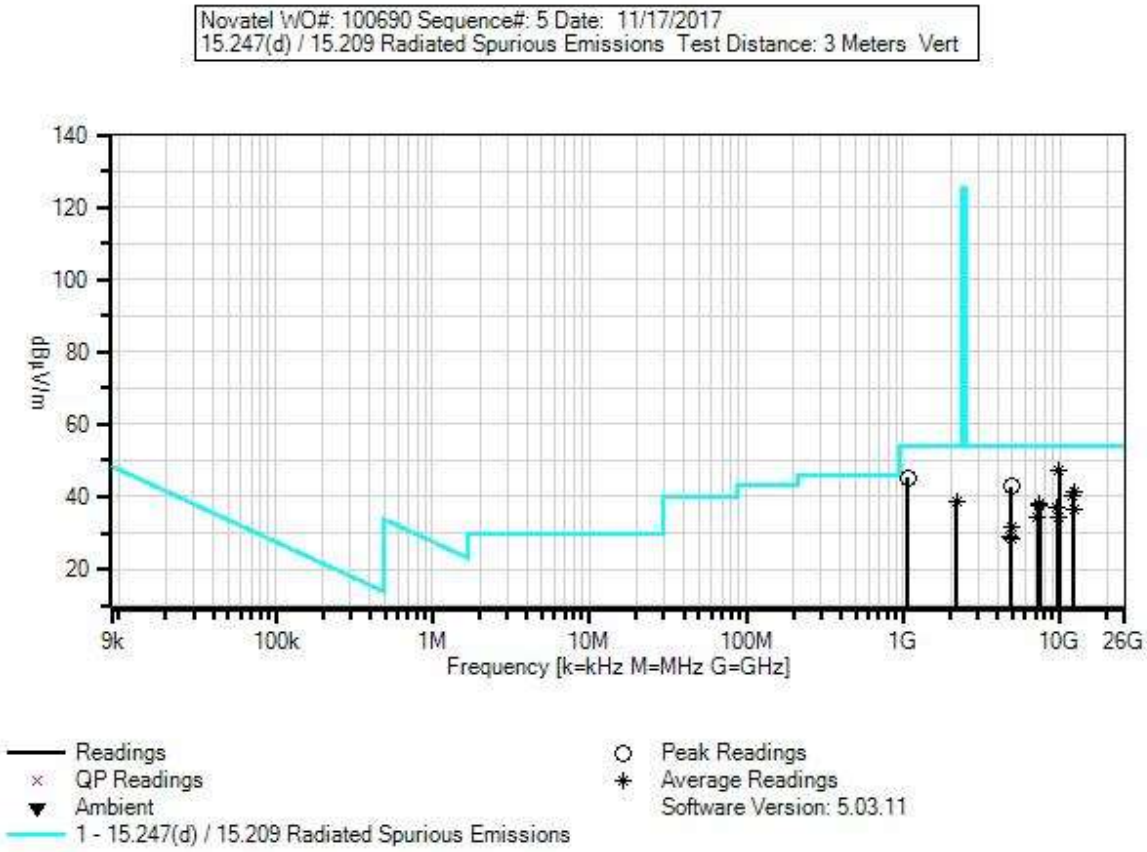
Antenna type: Integral Trace
Antenna Gain: 2.6dBi

Duty Cycle: 100%

Setup:
The EUT is DC powered through a battery. The EUT is connected to an external GNSS active antenna which is located remotely with an open view of the sky. The active antenna is powered by a Bias Tee coupler and the signal strength is tuned with an amplifier and output DC power supply. The Bias Tee coupler is powered by a dual output power supply. The EUT is connected to a support laptop via 1 USB port. The 26Pin IO contained 1 x CAN Interface and 3 x RS-232 ports. The RS-232 ports which were connected to a serial to USB 2 port hub which is then connected to the laptop.

EUT is continuously transmitting. Low, Mid, and High channels as well as all data rates investigated, worst case data reported. Horizontal and Vertical antenna polarities investigated, only worst case reported. The EUT is fully exercised with communication and data transfer between the EUT and support laptop. Below 1GHz, the EUT is on the test table 80cm high. Above 1GHz, The EUT is on the test table 150cm high connected to the internal trace antenna.

Temperature (ºC): 22
Relative Humidity (%): 33
Test Location: Bothell Lab C3
Test Method: ANSI C63.10 (2013), KDB 558074 (April 5, 2017)


Novatel WO#: 100690 Sequence#: 5 Date: 11/17/2017
15.247(d) / 15.209 Radiated Spurious Emissions Test Distance: 3 Meters Vert
140
120
100
80
60
40
20
dBµV/m
9k
100k
1M
10M
100M
1G
10G
26G
Frequency [k=kHz M=MHz G=GHz]
Readings
QP Readings
Ambient
1 - 15.247(d) / 15.209 Radiated Spurious Emissions
Peak Readings
Average Readings
Software Version: 5.03.11

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03540	Preamp	83017A	5/2/2017	5/2/2019
T2	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	7/21/2017	7/21/2019
T3	ANP06515	Cable	Heliax	1/21/2016	1/21/2018
T4	ANP06540	Cable	Heliax	10/30/2017	10/30/2019
T5	ANP06934	Cable	32026-29801-29801-18	3/11/2016	3/11/2018
T6	AN02673	Spectrum Analyzer	E4446A	2/3/2017	2/3/2019
T7	AN03116	High Pass Filter	11SH10-00313	1/16/2017	1/16/2019
T8	ANP06936	Attenuator	54A-10	1/18/2016	1/18/2018

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

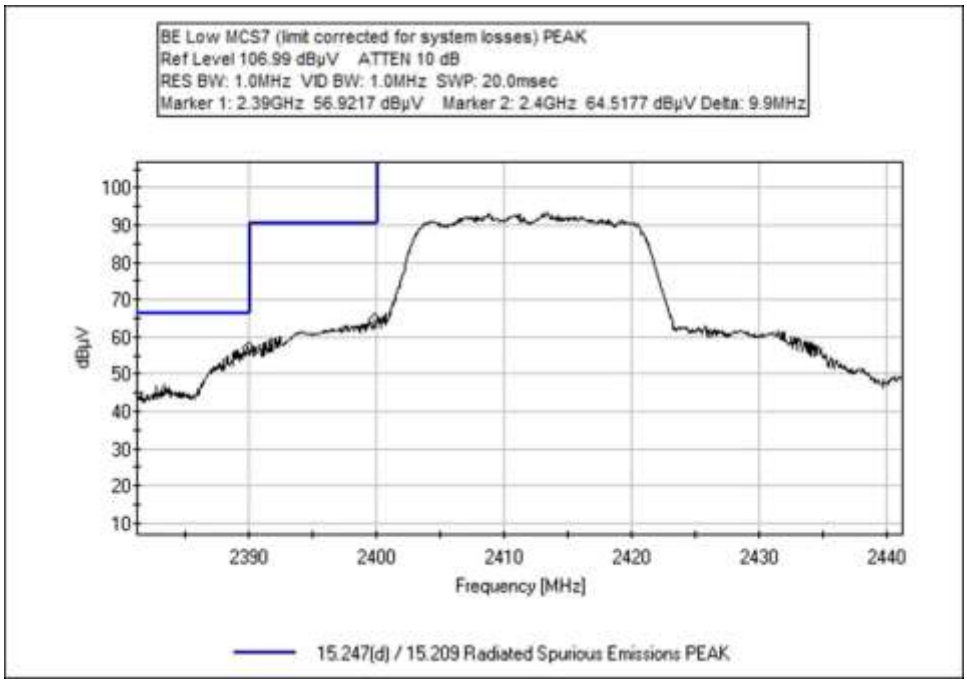
#	Freq	Rdng	T1 T5	T2 T6	T3 T7	T4 T8	Dist	Corr	Spec	Margin	Polar
	MHz	dBµV	dB	dB	dB	dB	Table	dBµV/m	dBµV/m	dB	Ant
1	9847.895M Ave	35.5	-33.6 +0.7	+37.7 +0.0	+6.0 +0.6	+0.4 +0.0	+0.0 360	47.3	54.0 High	-6.7	Horiz 136
^	9847.895M	36.7	-33.6 +0.7	+37.7 +0.0	+6.0 +0.6	+0.4 +0.0	+0.0 131	48.5	54.0 High	-5.5	Horiz 143
3	1069.000M	45.2	-36.5 +0.3	+24.1 +0.0	+1.8 +0.0	+0.4 +10.0	+0.0 345	45.3	54.0	-8.7	Vert 136
4	4924.400M	37.6	-33.2 +0.5	+32.5 +0.0	+4.0 +1.0	+0.5 +0.0	+0.0 360	42.9	54.0 High	-11.1	Vert 149
5	12309.895 M Ave	26.7	-34.1 +0.8	+39.3 +0.0	+6.6 +1.0	+1.0 +0.0	+0.0	41.3	54.0 High	-12.7	Horiz 136
6	12060.000 M Ave	26.4	-34.2 +0.8	+39.1 +0.0	+6.4 +0.7	+1.0 +0.0	+0.0	40.2	54.0 Low	-13.8	Vert 161
^	12060.000 M	28.8	-34.2 +0.8	+39.1 +0.0	+6.4 +0.7	+1.0 +0.0	+0.0	42.6	54.0 Low	-11.4	Vert 161
8	2189.500M Ave	31.2	-34.1 +0.3	+28.2 +0.0	+2.5 +0.0	+0.4 +10.0	+0.0 194	38.5	54.0	-15.5	Vert 99
^	2189.500M	42.9	-34.1 +0.3	+28.2 +0.0	+2.5 +0.0	+0.4 +10.0	+0.0 360	50.2	54.0	-3.8	Vert 136
10	7384.850M Ave	27.7	-34.3 +0.6	+36.7 +0.0	+5.4 +0.9	+1.0 +0.0	+0.0 1	38.0	54.0 High	-16.0	Horiz 136
^	7384.850M	38.4	-34.3 +0.6	+36.7 +0.0	+5.4 +0.9	+1.0 +0.0	+0.0 233	48.7	54.0 High	-5.3	Horiz 143
12	7326.000M Ave	27.6	-34.1 +0.6	+36.5 +0.0	+5.3 +0.9	+0.9 +0.0	+0.0	37.7	54.0 Mid	-16.3	Vert 149
^	7326.000M	38.2	-34.1 +0.6	+36.5 +0.0	+5.3 +0.9	+0.9 +0.0	+0.0	48.3	54.0 Mid	-5.7	Vert 149
14	9648.000M Ave	25.0	-33.6 +0.7	+37.5 +0.0	+5.8 +0.9	+0.7 +0.0	+0.0 84	37.0	54.0 Low	-17.0	Vert 168
^	9648.000M	31.3	-33.6 +0.7	+37.5 +0.0	+5.8 +0.9	+0.7 +0.0	+0.0 84	43.3	54.0 Low	-10.7	Vert 168

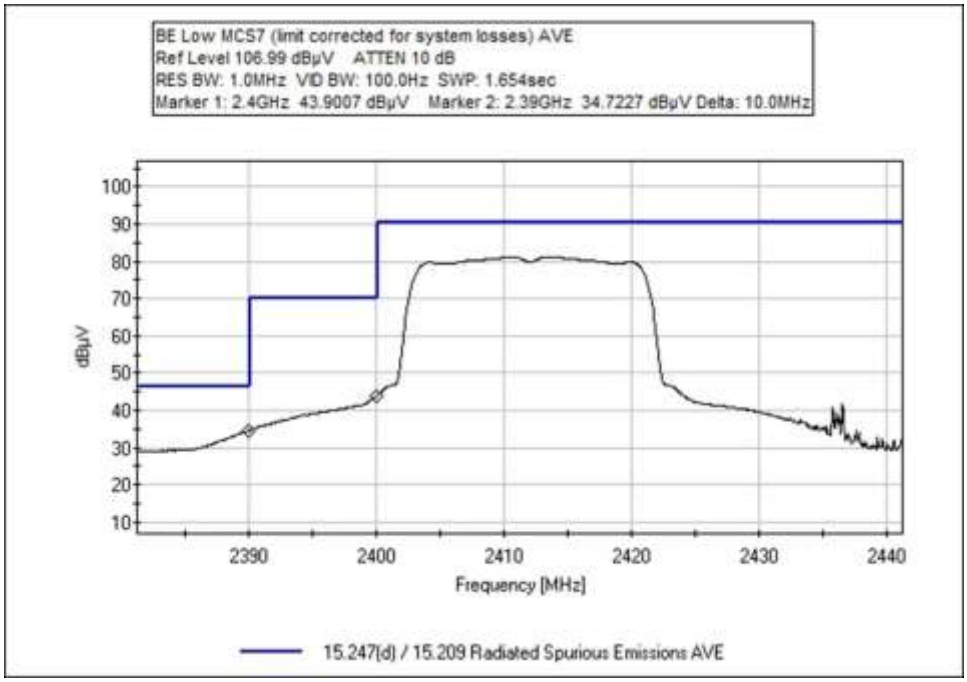
16	12210.000	21.8	-34.1	+39.3	+6.6	+1.0	+0.0	36.3	54.0	-17.7	Vert
	M		+0.8	+0.0	+0.9	+0.0					
	Ave						138		Mid		149
^	12210.000	36.3	-34.1	+39.3	+6.6	+1.0	+0.0	50.8	54.0	-3.2	Vert
	M		+0.8	+0.0	+0.9	+0.0					
									Mid		149
18	9768.000M	22.5	-33.6	+37.6	+5.9	+0.5	+0.0	34.2	54.0	-19.8	Vert
	Ave		+0.7	+0.0	+0.6	+0.0	315		Mid		149
^	9768.000M	38.2	-33.6	+37.6	+5.9	+0.5	+0.0	49.9	54.0	-4.1	Vert
			+0.7	+0.0	+0.6	+0.0	313		Mid		149
20	7236.000M	24.1	-33.9	+36.3	+5.3	+0.8	+0.0	34.2	54.0	-19.8	Horiz
	Ave		+0.6	+0.0	+1.0	+0.0	360		Low		129
^	7236.000M	30.7	-33.9	+36.3	+5.3	+0.8	+0.0	40.8	54.0	-13.2	Horiz
			+0.6	+0.0	+1.0	+0.0	360		Low		129
22	4924.400M	26.4	-33.2	+32.5	+4.0	+0.5	+0.0	31.7	54.0	-22.3	Horiz
	Ave		+0.5	+0.0	+1.0	+0.0	360		High		112
23	4824.000M	23.9	-33.2	+32.4	+4.0	+0.5	+0.0	29.1	54.0	-24.9	Horiz
	Ave		+0.5	+0.0	+1.0	+0.0			Low		129
^	4824.000M	30.7	-33.2	+32.4	+4.0	+0.5	+0.0	35.9	54.0	-18.1	Horiz
			+0.5	+0.0	+1.0	+0.0			Low		129
25	4884.000M	23.1	-33.2	+32.4	+4.0	+0.5	+0.0	28.3	54.0	-25.7	Vert
	Ave		+0.5	+0.0	+1.0	+0.0	353		Mid		137
^	4884.000M	36.5	-33.2	+32.4	+4.0	+0.5	+0.0	41.7	54.0	-12.3	Vert
			+0.5	+0.0	+1.0	+0.0	360		Mid		137

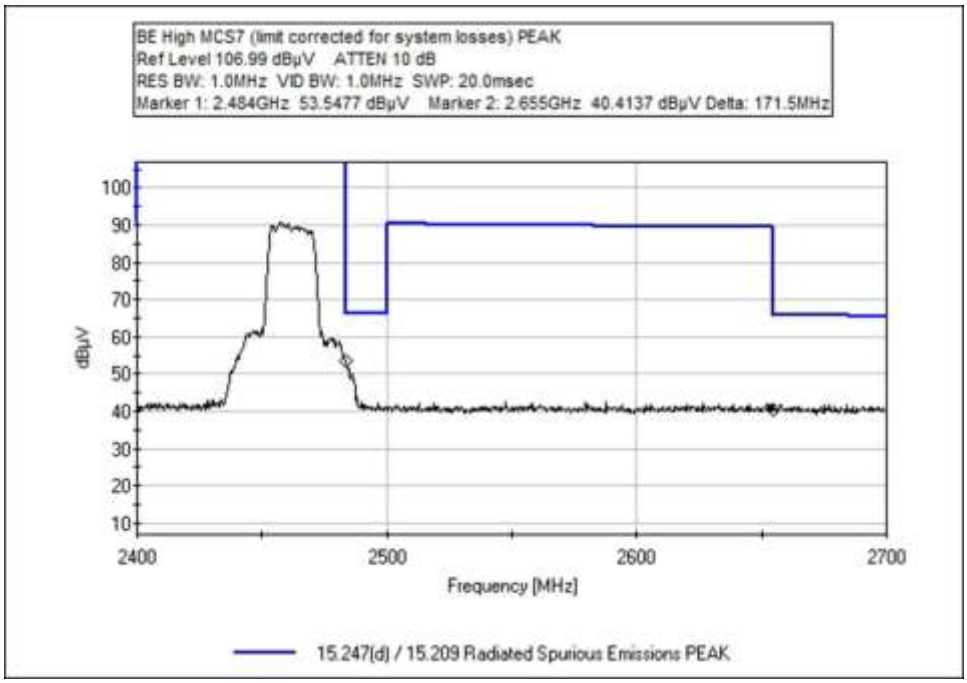
Band Edge

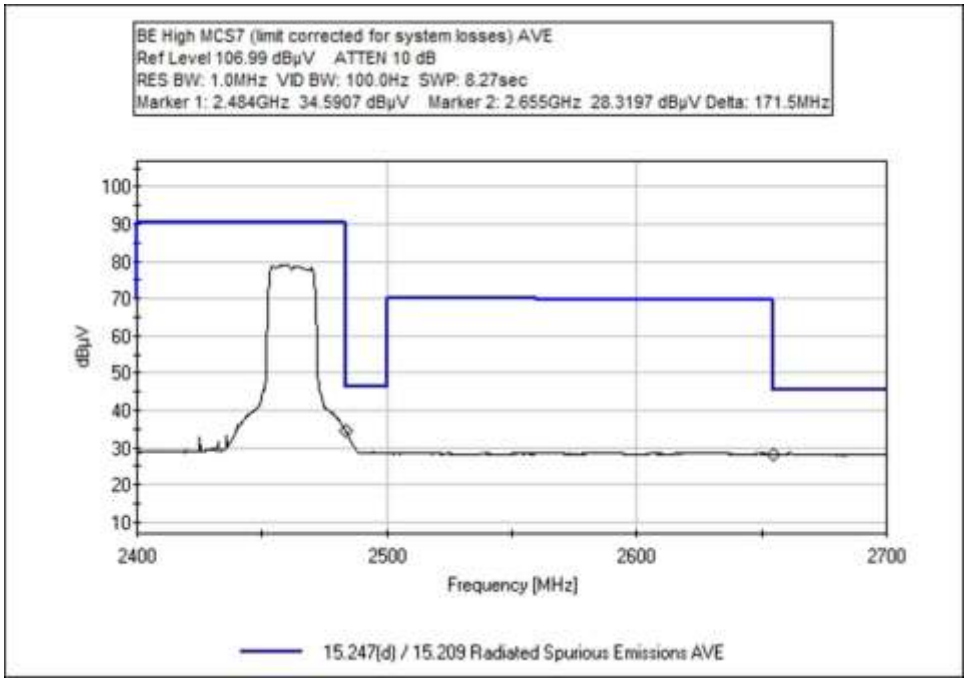
Band Edge Summary					
Frequency (MHz)	**Modulation**	**Ant. Type**	**Field Strength (dBuV/m @3m)**	**Limit (dBuV/m @3m)**	**Results**
2390.0 (PEAK)	MCS7 Data Rate - 64-QAM (Worst Case)	Integral Trace	64.4	97.8	Pass
2390.0 (AVG)	MCS7 Data Rate - 64-QAM (Worst Case)	Integral Trace	43.9	77.8	Pass
2400.0 (PEAK)	MCS7 Data Rate - 64-QAM (Worst Case)	Integral Trace	71.6	74	Pass
2400.0 (AVG)	MCS7 Data Rate - 64-QAM (Worst Case)	Integral Trace	34.7	54	Pass
2483.5 (PEAK)	MCS7 Data Rate - 64-QAM (Worst Case)	Integral Trace	61	74	Pass
2483.5 (AVG)	MCS7 Data Rate - 64-QAM (Worst Case)	Integral Trace	42.1	54	Pass

Band Edge Plots






BE High MCS7 (limit corrected for system losses) PEAK
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 1.0MHz SWP: 20.0msec
Marker 1: 2.484GHz 53.5477 dBµV Marker 2: 2.655GHz 40.4137 dBµV Delta: 171.5MHz
dBµV
100
90
80
70
60
50
40
30
20
10
2400
2500
2600
2700
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions PEAK


BE High MCS7 (limit corrected for system losses) AVE
Ref Level 106.99 dBµV ATTEN 10 dB
RES BW: 1.0MHz VID BW: 100.0Hz SWP: 8.27sec
Marker 1: 2.484GHz 34.5907 dBµV Marker 2: 2.655GHz 28.3197 dBµV Delta: 171.5MHz
dBµV
100
90
80
70
60
50
40
30
20
10
2400
2500
2600
2700
Frequency [MHz]
15.247(d) / 15.209 Radiated Spurious Emissions AVE

Test Setup / Conditions / Data

Test Location:	CKC Laboratories • 22116 23rd Drive SE, Suite A • Bothell, WA 98021 • 1-800-500-4EMC (4362)		
Customer:	**Novatel**		
Specification:	**15.247(d) / 15.209 Radiated Spurious Emissions AVE**		
Work Order #:	**100690**	Date:	11/17/2017
Test Type:	**Maximized Emissions**	Time:	15:13:19
Tested By:	Steven Pittsford	Sequence#:	6
Software:	EMITest 5.03.11		

Equipment Tested:

Device	Manufacturer	Model #	S/N
Configuration 1			

Support Equipment:

Device	Manufacturer	Model #	S/N
Configuration 1			

Test Conditions / Notes:

Frequency Range: 2.38-2.7GHz
Frequency tested: 2412, 2462MHz
Firmware power setting: 10
EUT Firmware: OM7CR0301SN0007
Modulation/Data Rate: All data rates investigated, only worst case data reported

Antenna type: Integral Trace
Antenna Gain: 2.6dBi

Duty Cycle: 100%

Setup:
The EUT is DC powered through a battery. The EUT is connected to an external GNSS active antenna which is located remotely with an open view of the sky. The active antenna is powered by a Bias Tee coupler and the signal strength is tuned with an amplifier and output DC power supply. The Bias Tee coupler is powered by a dual output power supply. The EUT is connected to a support laptop via 1 USB port. The 26Pin IO contained 1 x CAN Interface and 3 x RS-232 ports. The RS-232 ports which were connected to a serial to USB 2 port hub which is then connected to the laptop.

EUT is continuously transmitting. Low, Mid, and High channels as well as all data rates investigated, worst case data reported. Horizontal and Vertical antenna polarities investigated, only worst case reported. The EUT is fully exercised with communication and data transfer between the EUT and support laptop. Below 1GHz, the EUT is on the test table 80cm high. Above 1GHz, The EUT is on the test table 150cm high connected to the internal trace antenna.

Test Equipment:

ID	Asset #	Description	Model	Calibration Date	Cal Due Date
T1	AN03540	Preamp	83017A	5/2/2017	5/2/2019
T2	AN01467	Horn Antenna-ANSI C63.5 Calibration	3115	7/21/2017	7/21/2019
T3	ANP06515	Cable	Heliax	1/21/2016	1/21/2018
T4	ANP06540	Cable	Heliax	10/30/2017	10/30/2019
T5	ANP06934	Cable	32026-29801-29801-18	3/11/2016	3/11/2018
T6	AN02673	Spectrum Analyzer	E4446A	2/3/2017	2/3/2019
	AN03116	High Pass Filter	11SH10-00313	1/16/2017	1/16/2019
T7	ANP06936	Attenuator	54A-10	1/18/2016	1/18/2018

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

#	Freq MHz	Rdng dBµV	T1 T5 dB	T2 T6 dB	T3 T7 dB	T4 dB	Dist Table	Corr dBµV/m	Spec dBµV/m	Margin dB	Polar Ant
1	2390.000M Ave	34.7	-34.0 +0.4	+28.1 +0.0	+2.6 +10.0	+0.4	+0.0 201	42.2	54.0	-11.8	Vert 171
^	2389.920M	56.9	-34.0 +0.4	+28.1 +0.0	+2.6 +10.0	+0.4	+0.0 201	64.4	74.0	-9.6	Vert 171
3	2483.500M Ave	34.6	-34.0 +0.4	+28.1 +0.0	+2.6 +10.0	+0.4	+0.0 201	42.1	54.0	-11.9	Vert 171
^	2483.500M	53.5	-34.0 +0.4	+28.1 +0.0	+2.6 +10.0	+0.4	+0.0 194	61.0	74.0	-13.0	Vert 171
5	2399.880M	64.1	-34.0 +0.4	+28.1 +0.0	+2.6 +10.0	+0.4	+0.0 201	71.6	97.8	-26.2	Vert 171
6	2400.000M Ave	43.9	-34.0 +0.4	+28.1 +0.0	+2.6 +10.0	+0.4	+0.0 201	51.4	77.8	-26.4	Vert 171

Test Setup Photo

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.