

# TEST RESULT SUMMARY

## FCC Part 15 Subpart C Section 15.247 Industry Canada RSS-210 Issue 8: 2010

MANUFACTURER	NovAtel Incorporated 1120 68th Ave NE Calgary AB T2E 8S5 Canada
DESCRIPTION OF EQUIPMENT	Professional Agricultural Navigation Systems
NAME OF EQUIPMENT	Smart6 & Ag-Star
MODEL NUMBER(S) TESTED	01019126 & 01019128
SERIAL NUMBER(S) TESTED	NMEA13260001P & NMEE13280005B
TEST REPORT NUMBER	NC1308070.4
TEST DATE(S)	21 August – 09 September 2013

TÜV SÜD America Inc, as an independent testing laboratory, declares that the equipment tested as specified above conforms to the applicable requirements of FCC Part 15 Subpart C Section 15.247 *"Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz"*, and Industry Canada RSS-210 Issue 8: 2010 *"License-exempt Radio Apparatus (All Frequency Bands): Category I Equipment"*.

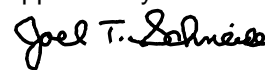
It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical characteristics. Any modifications necessary for compliance made during testing on the above mentioned date(s) must be implemented in all production units for compliance to be maintained.

Date: 02 October 2013

Tested by:



Approved by:



Location: Taylors Falls MN  
USA

Greg Jakubowski  
Senior EMC Technician

Joel T Schneider  
Senior EMC Engineer

Not Transferable

# EMC TEST REPORT

Test Report No. NC1308070.4 Date of issue: 02 October 2013

Product Description Professional Agricultural Navigation Systems

Product Name Smart6 & Ag-Star

Model No(s) Tested 01019126 & 01019128

Serial No(s) Tested NMEA13260001P & NMEE13280005B

Manufacturer NovAtel Incorporated

Address 1120 68th Ave NE  
Calgary AB T2E 8S5 Canada

Test Result ☒ **Positive** ☐ **Negative**

*TÜV SÜD America Inc reports apply only to the specific samples tested under stated test conditions. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. TÜV SÜD America Inc shall have no liability for any deductions, inferences or generalizations drawn by the client or others from TÜV SÜD America Inc issued reports.*

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*TÜV SÜD America Inc and its professional staff hold government and professional organization certifications and are members of AAMI, ACIL, AEA, ANSI, IEEE, NARTE, and VCCI.*

## REVISION RECORD

REVISION	TOTAL NUMBER OF PAGES	DATE	DESCRIPTION
	61	02 October 2013	Initial Release



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## EMC TEST REGULATIONS:

The tests were performed according to the following regulations:

- FCC Part 15 Subpart C Sections 15.247(a)(1), (b)(1), (d)
- Industry Canada RSS-210 Issue 8, sections A8.1(a), (b), (d), A8.4(2), A8.5

## ENVIRONMENTAL CONDITIONS IN THE LAB

	<u>Actual</u>
Temperature:	: 19-23°C
Atmospheric pressure	: 98-99 kPa
Relative Humidity	: 65-79%

## POWER SUPPLY UTILIZED

Power supply system : 12 VDC

## TEST EQUIPMENT

All measurement instrumentation is traceable to the National Institute of Standards and Technology and is calibrated according to internal procedure.

## SIGN EXPLANATIONS

- ☐ - not applicable
- ☒ - applicable.

## 20 dB Bandwidth

FCC 15.247(a)(1), IC RSS-210 A8.1(a)

### Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

The 20 dB bandwidth is 1.013 – 1.017 MHz

### Test location

☐ - Wild River Lab Large Test Site (Open Area Test Site)

☐ - Wild River Lab Small Test Site (Open Area Test Site)

☒ - Wild River Lab Large Test Site Tech Area

### Test equipment

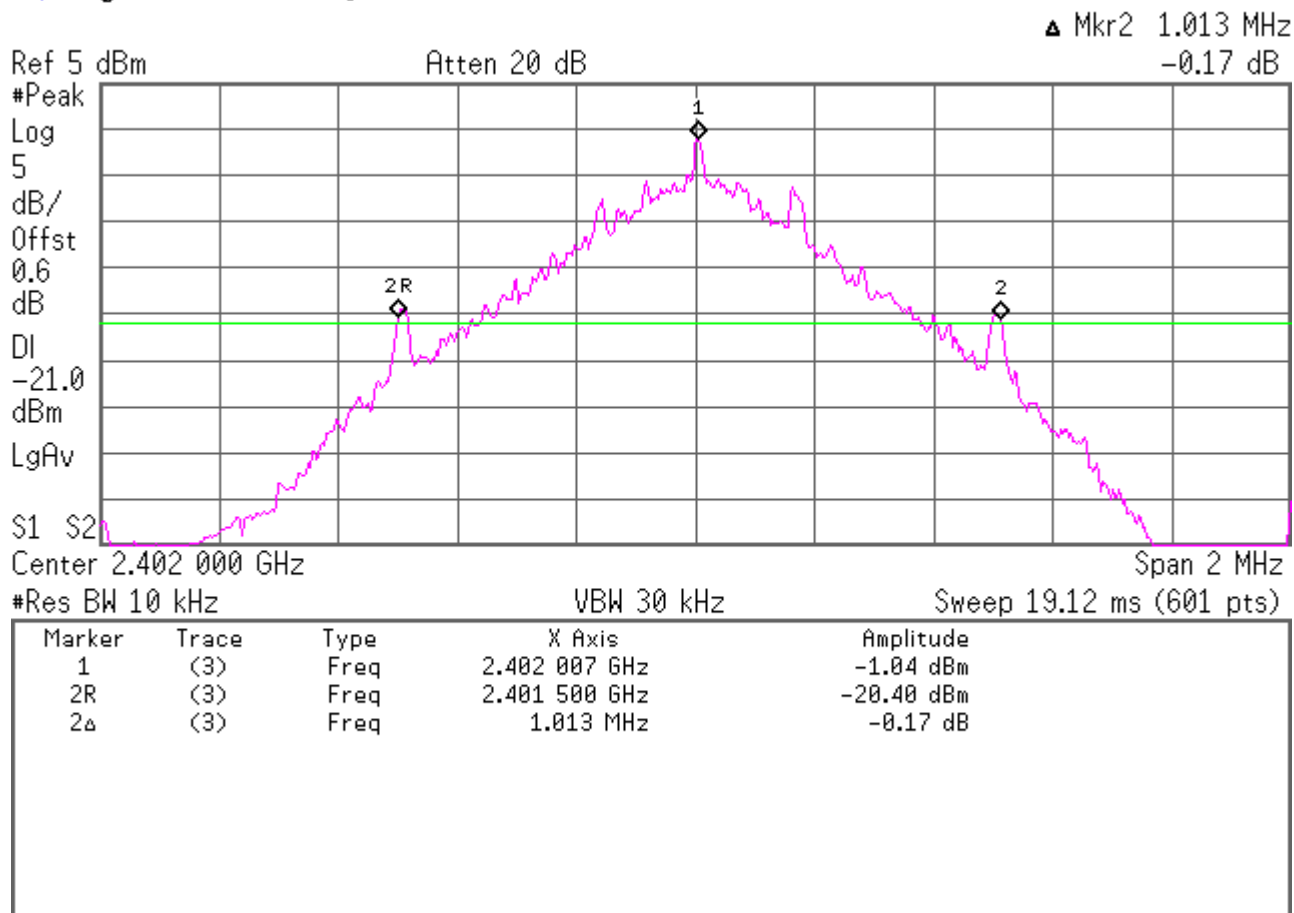
TUV ID	Model	Manufacturer	Description	Serial	Cal Due
NBLE03367	E4440A	Agilent	Spectrum Analyzer	MY42510439	20-May-14

### Test limit

Unspecified

### Test data

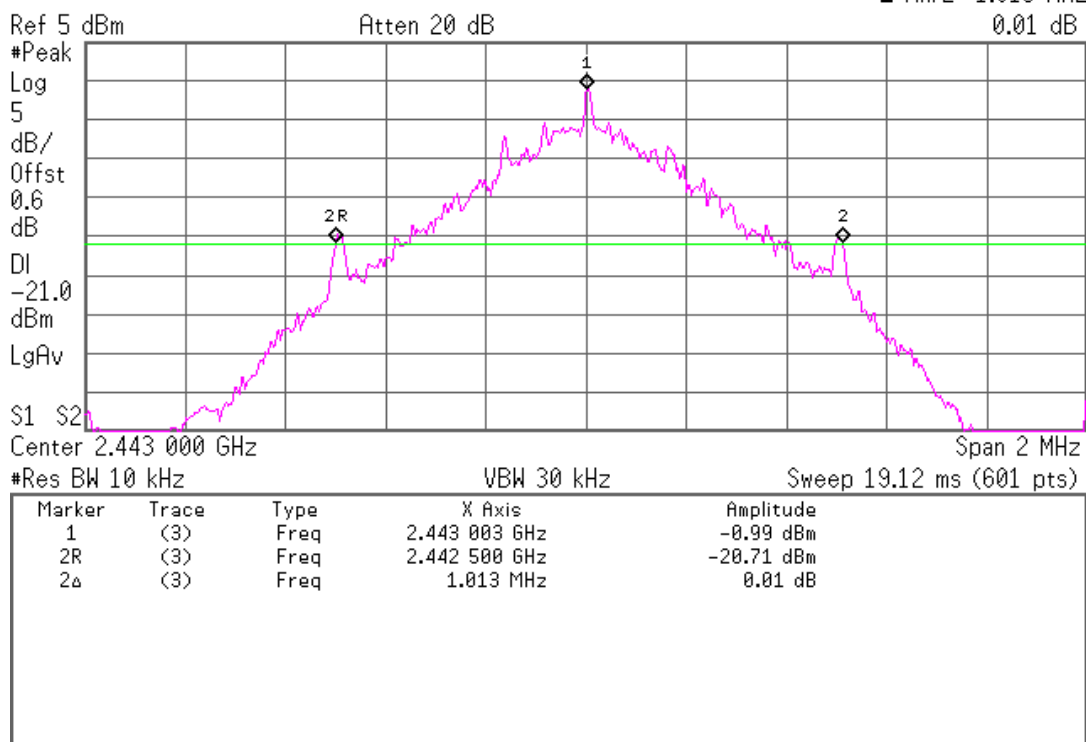
Agilent 14:55:28 Aug 23, 2013



### Mid channel

Agilent 14:52:29 Aug 23, 2013

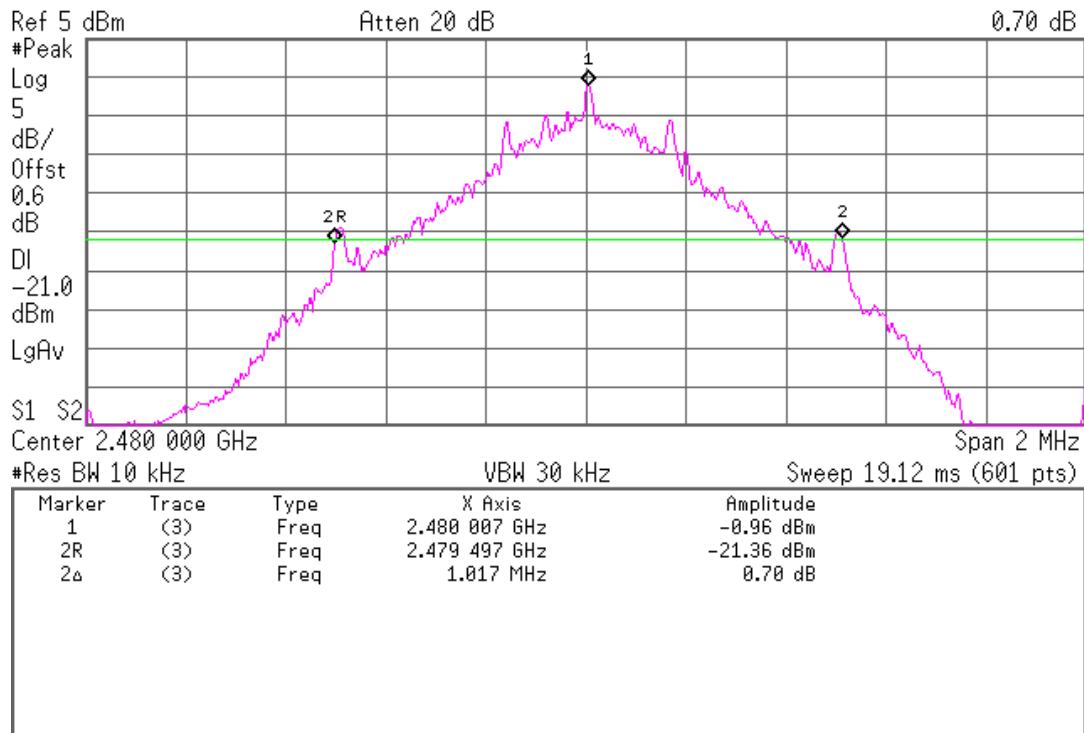
Mkr2 1.013 MHz  
0.01 dB



### High channel

Agilent 14:56:38 Aug 23, 2013

Mkr2 1.017 MHz  
0.70 dB



## Carrier frequency separation

FCC 15.247(a)(1), IC RSS-210 A8.1(b)

### Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Carrier frequency separation is 1 MHz

### Test location

☐ - Wild River Lab Large Test Site (Open Area Test Site)

☐ - Wild River Lab Small Test Site (Open Area Test Site)

☒ - Wild River Lab Large Test Site Tech Area

### Test equipment

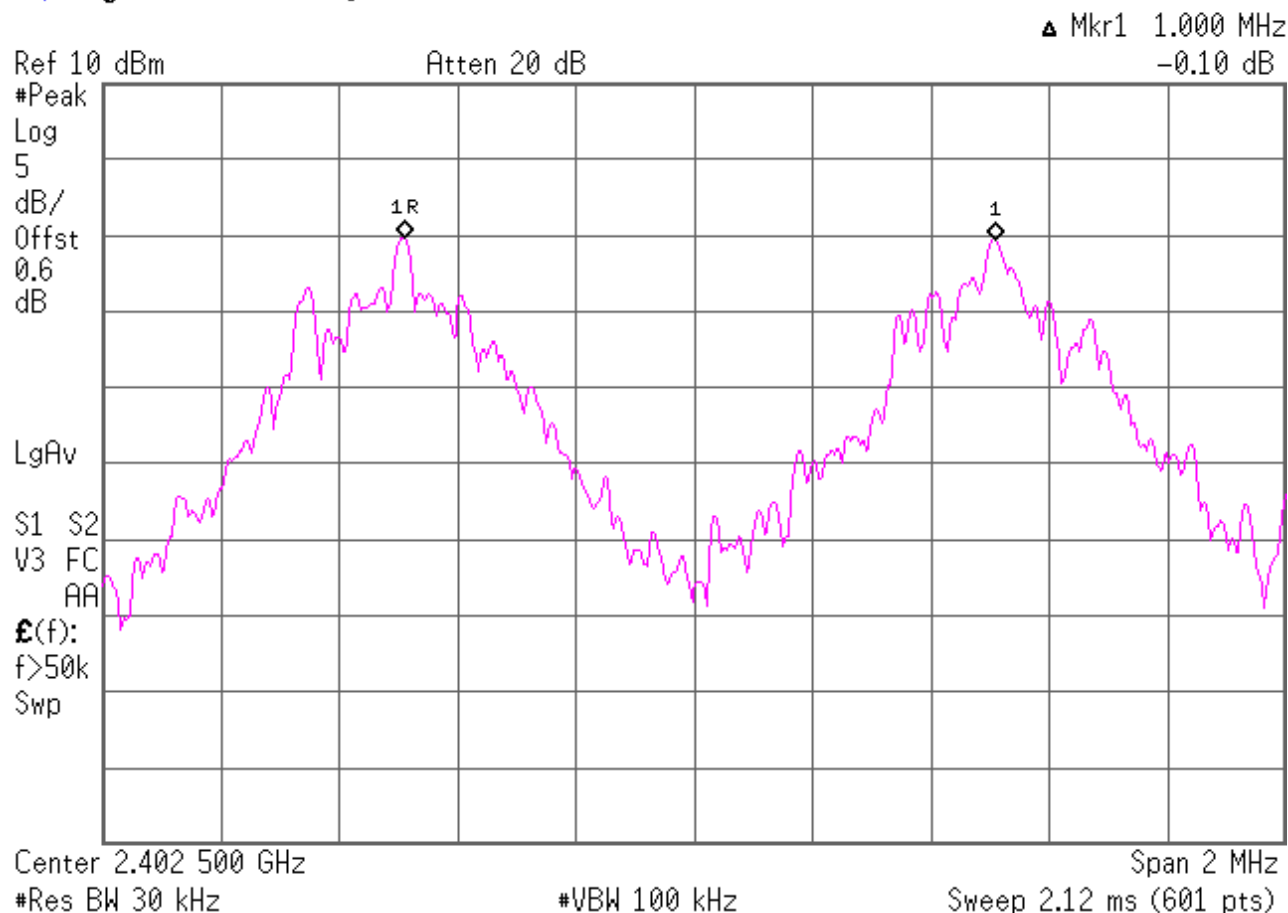
TUV ID	Model	Manufacturer	Description	Serial	Cal Due
NBLE03367	E4440A	Agilent	Spectrum Analyzer	MY42510439	20-May-14

### Test limit

Separated by a minimum of 25 kHz or the 20 dB bandwidth of the hopping channel, whichever is greater

### Test data

Agilent 14:02:41 Aug 23, 2013





## Number of Hopping Frequencies

FCC 15.247(a)(1)(iii), IC RSS-210 A8.1(d)

### Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"  
Number of Hopping Frequencies is 79

### Test location

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☒ - Wild River Lab Large Test Site Tech Area

### Test equipment

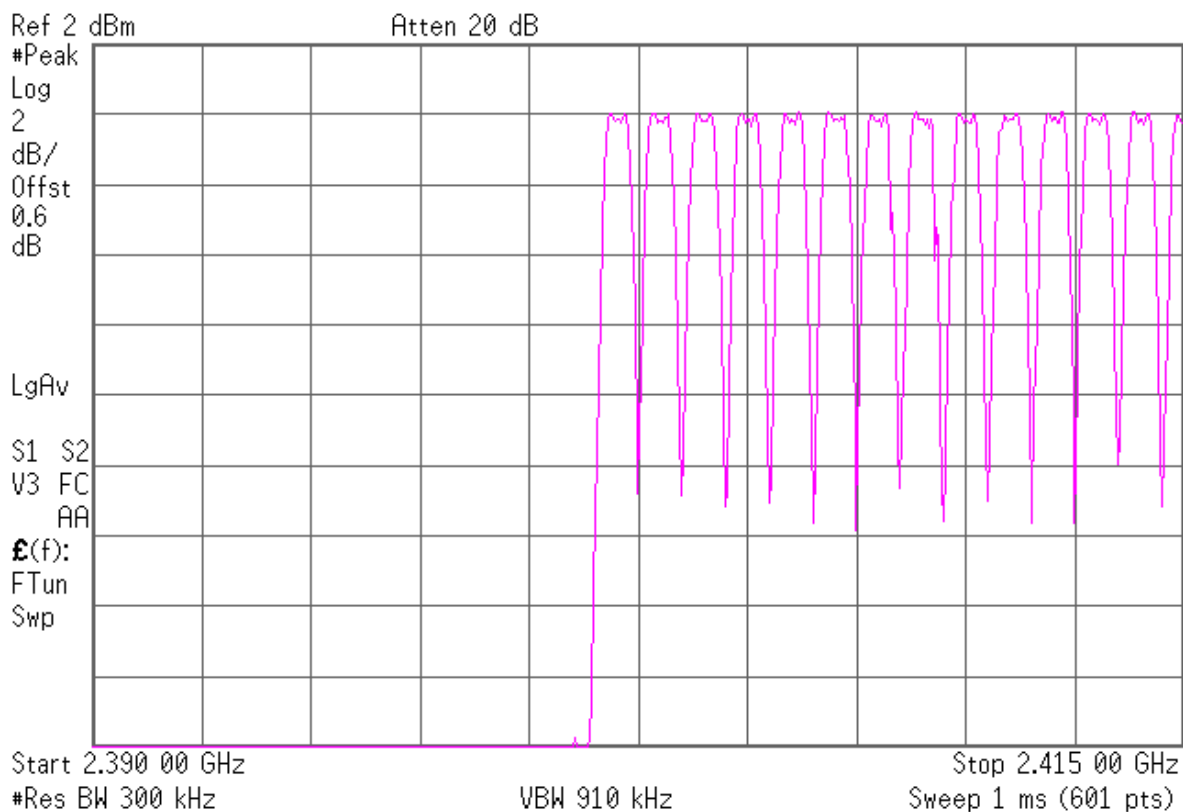
TUV ID	Model	Manufacturer	Description	Serial	Cal Due
NBLE03367	E4440A	Agilent	Spectrum Analyzer	MY42510439	20-May-14

### Test limit

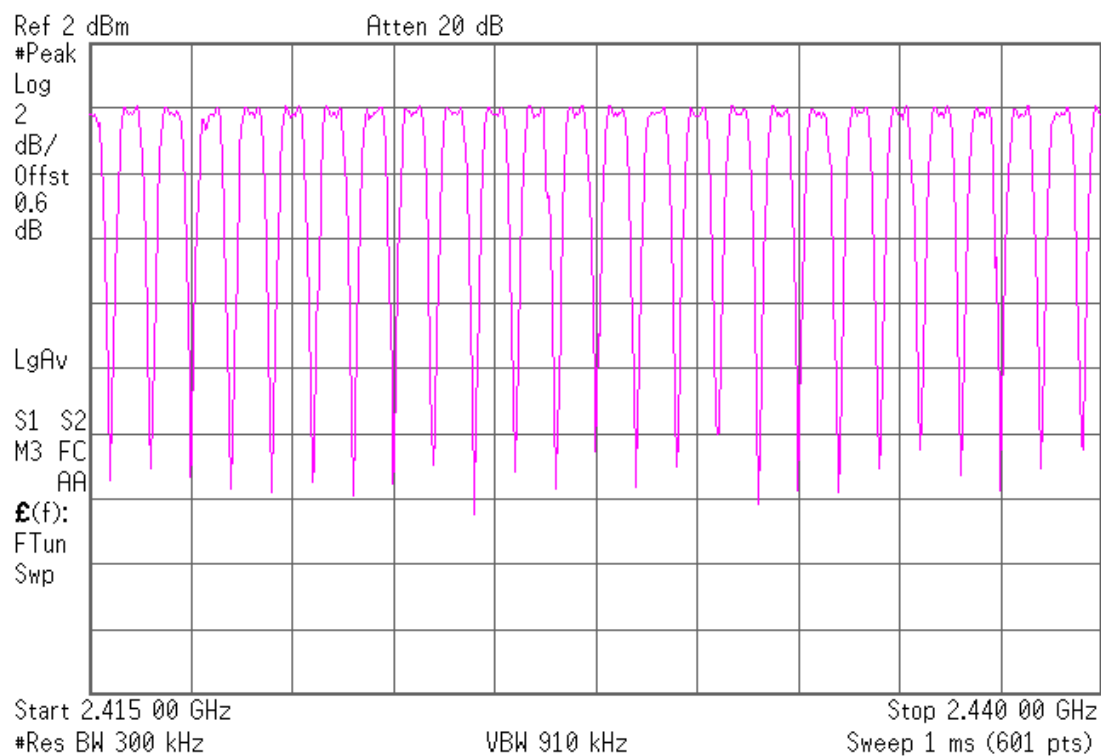
At least 15 channels

### Test data

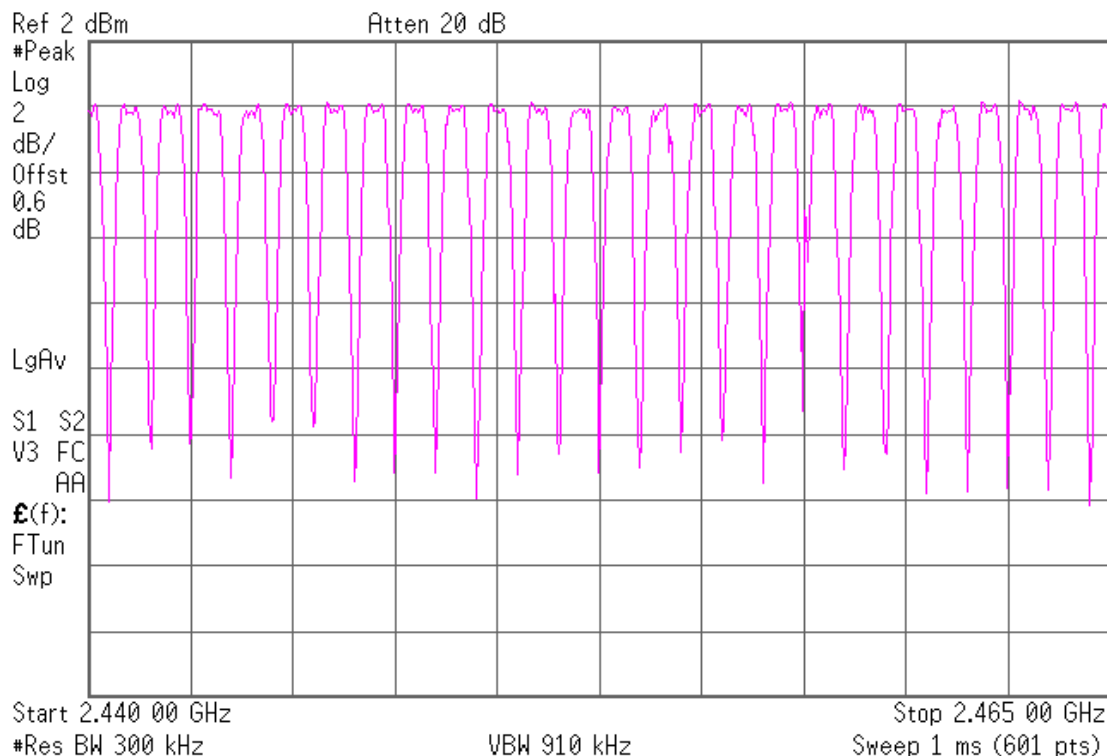
✱ Agilent 14:11:15 Aug 23, 2013



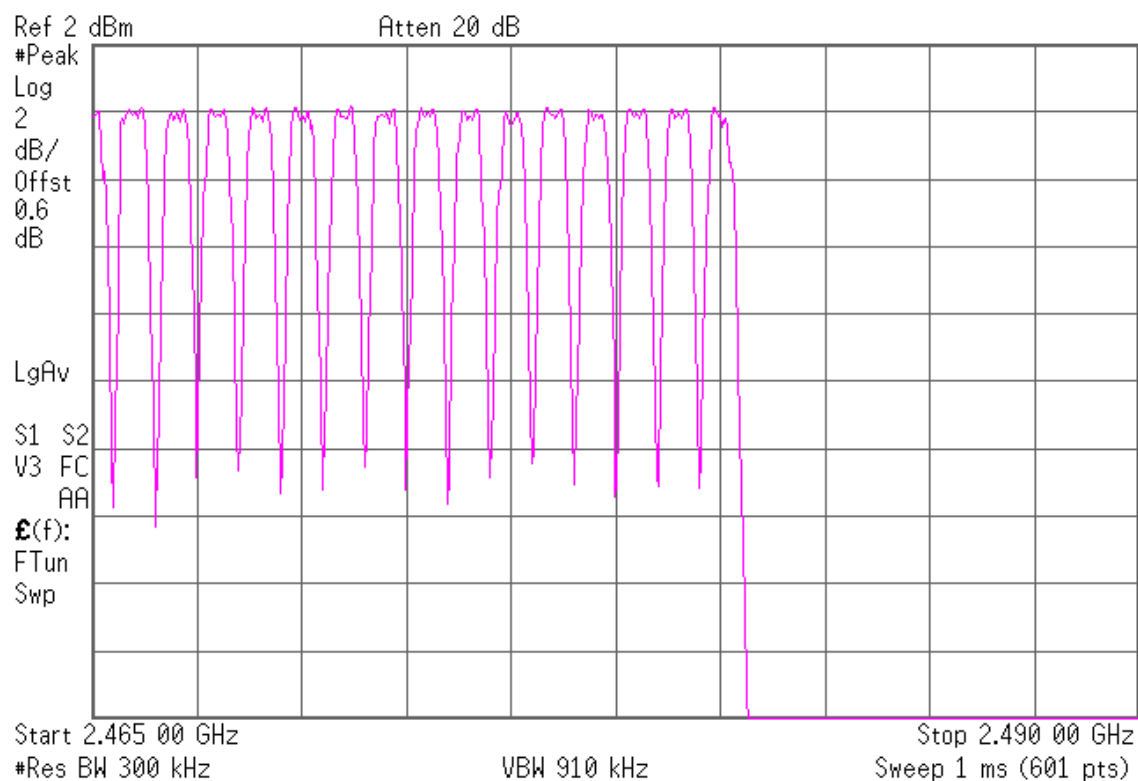
✱ Agilent 14:12:22 Aug 23, 2013



✱ Agilent 14:13:18 Aug 23, 2013



✱ **Agilent** 14:14:17 Aug 23, 2013



## Time of Occupancy

FCC 15.247(a)(1)(iii), IC RSS-210 A8.1(d)

### Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Time of occupancy should be less than 400 msec within a period of 31.6 seconds.

We've measured DH5 bluetooth to be 2.9 msec pulse width. Bluetooth info states DH5 1x/EDR has 266.67 hops/second, so # of hops per second on one channel =  $266.67/79 = 3.38$  hops/second. So # of hops over a 31.6 second period =  $3.38 \times 31.6 = 106.67$  hops/31.6 seconds. So,  $106.67 \times 2.9 \text{ msec} = 309.3 \text{ msec}$ . DH1 and DH3 are lower.

### Test location

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☒ - Wild River Lab Large Test Site Tech Area

### Test equipment

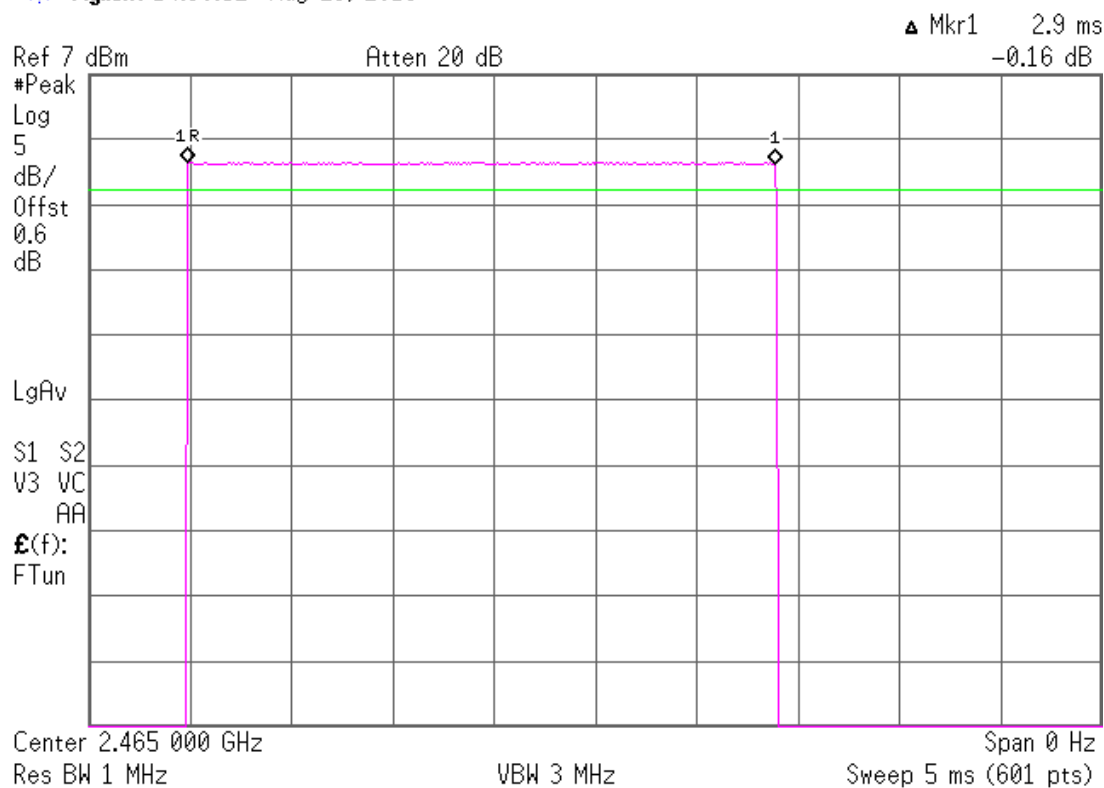
TUV ID	Model	Manufacturer	Description	Serial	Cal Due
NBLE03367	E4440A	Agilent	Spectrum Analyzer	MY42510439	20-May-14

### Test limit

The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds, multiplied by the number of hopping channels employed.

### Test data

✱ Agilent 14:36:52 Aug 23, 2013



## Peak output power

FCC 15.247(b)(1), IC RSS-210 A8.4(2)

## Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

The maximum conducted peak output power is 1.53 dBm or 1.43 mW

## Test location

☐ - Wild River Lab Large Test Site (Open Area Test Site)

☐ - Wild River Lab Small Test Site (Open Area Test Site)

☒ - Wild River Lab Large Test Site Tech Area

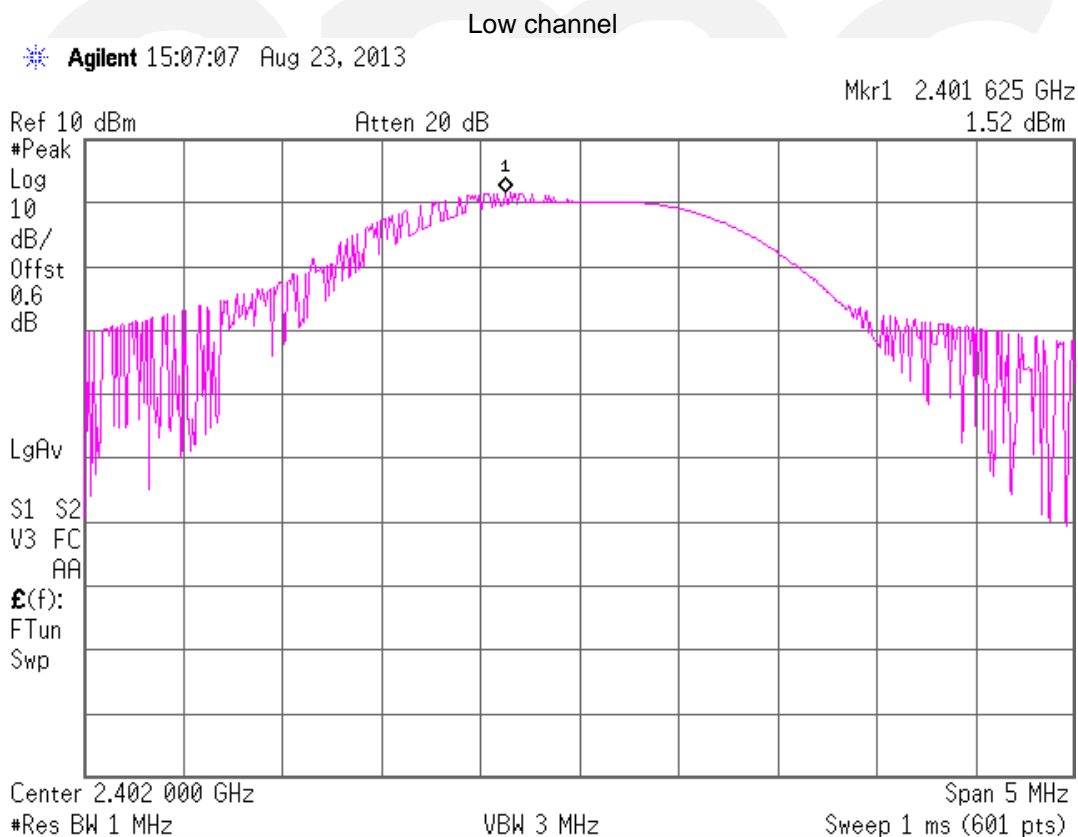
## Test equipment

TUV ID	Model	Manufacturer	Description	Serial	Cal Due
NBLE03367	E4440A	Agilent	Spectrum Analyzer	MY42510439	20-May-14

## Test limit

1 Watt

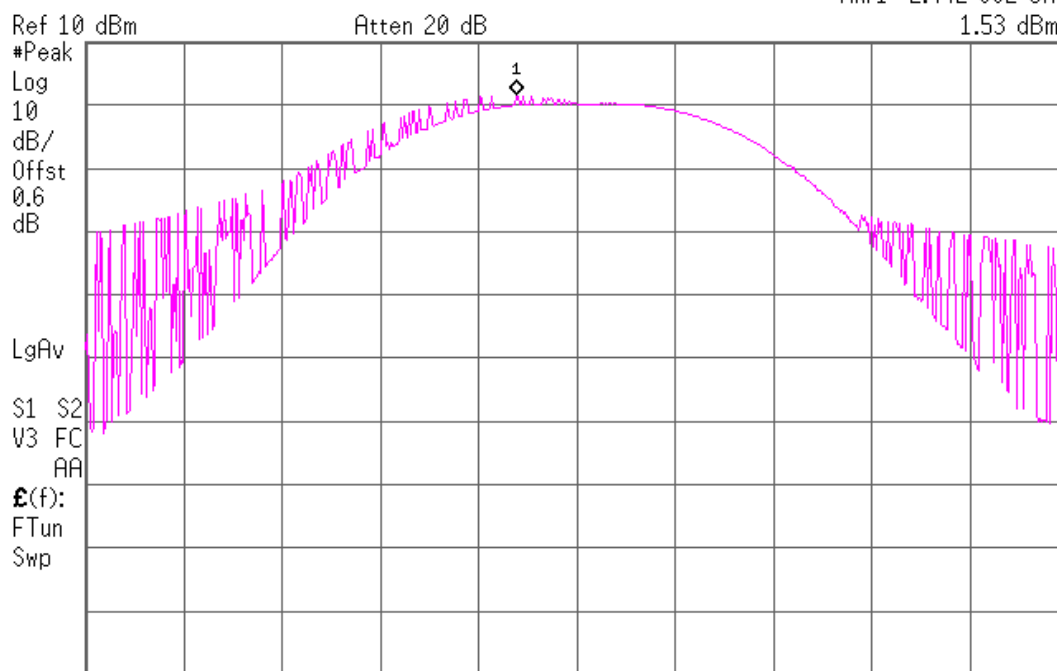
## Test data



### Mid channel

Agilent 15:06:17 Aug 23, 2013

Mkr1 2.442 692 GHz  
1.53 dBm

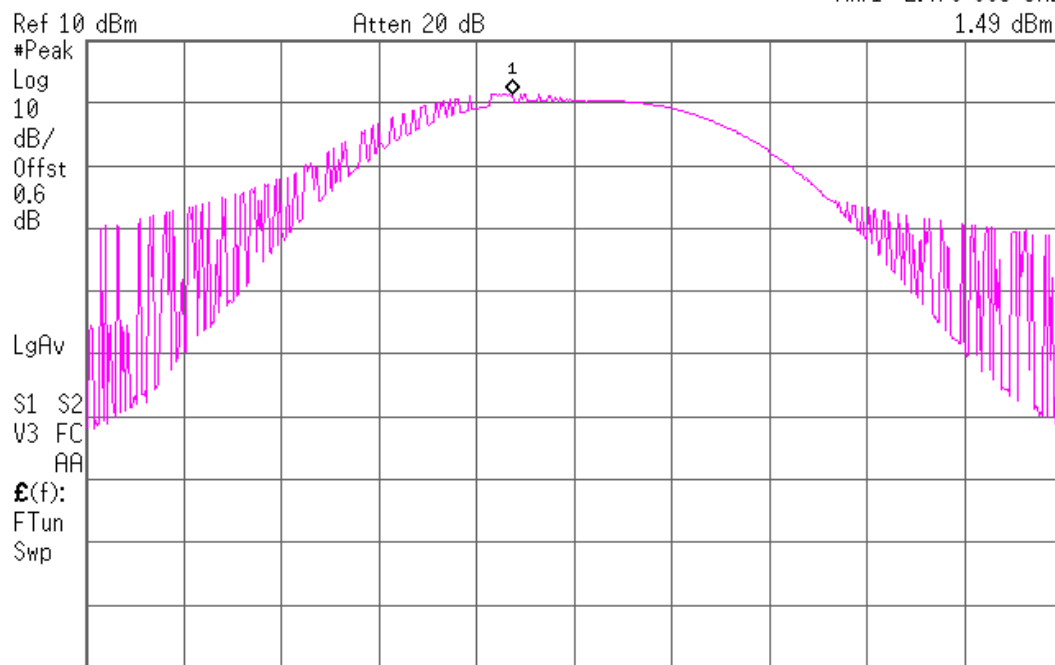


Center 2.443 000 GHz Span 5 MHz  
#Res BW 1 MHz VBW 3 MHz Sweep 1 ms (601 pts)

### High channel

Agilent 15:05:21 Aug 23, 2013

Mkr1 2.479 683 GHz  
1.49 dBm



Center 2.480 000 GHz Span 5 MHz  
#Res BW 1 MHz VBW 3 MHz Sweep 1 ms (601 pts)

## Band edge

FCC 15.247(d) RSS-210 A8.5

## Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Maximum average field strength of a bandedge emission is 40.3 dBuV/m at 3m at 2.4835 GHz

Minimum margin of compliance is 13.7 dB

Maximum peak field strength of a bandedge emission is 59.63 dBuV/m at 3m at 2.4835 GHz

Minimum margin of compliance is 14.37 dB

## Test location

☒ - Wild River Lab Large Test Site (Open Area Test Site)

☐ - Wild River Lab Small Test Site (Open Area Test Site)

☐ - Wild River Lab Large Test Site Tech Area

## Test equipment

TUV ID	Model	Manufacturer	Description	Serial	Cal Due
WRLE02075	3115	EMCO	Ridge Guide Ant. 1-18 GHz	9001-3275	12-Feb-14
WRLE10527	SL18B4020	Phase One Microwave	Preamplifier 1 – 18 GHz	0001	Code B 08-Jan-14
WRLE02689	8566B	Hewlett-Packard	Spectrum Analyzer	2416A00321	22-Apr-14
WRLE03295	85662A	Hewlett-Packard	Analyzer Display	2349A06144	22-Apr-14
NBLE02683	85650A	Hewlett-Packard	Quasi-peak Adapter	2430A00495	30-May-14

## Test limit for radiated spurious emissions in restricted bands

Frequency (GHz)	Field strength ( $\mu$ V/meter)	Field strength (dB $\mu$ V/meter)
2.39 & 2.4835	500 – AV 5000 – PK	54.0 74.0

## Test limit for spurious emissions

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.

## Test data

Agilent 15:07:07 Aug 23, 2013

Mkr1 2.401 625 GHz

1.52 dBm

Ref 10 dBm

Atten 20 dB

#Peak

Log

10

dB/

Offst

0.6

dB

LgAv

S1 S2

V3 FC

AA

$\mathcal{E}(f)$ :

FTun

Swp

Center 2.402 000 GHz

Span 5 MHz

#Res BW 1 MHz

VBW 3 MHz

Sweep 1 ms (601 pts)

**This output power plot demonstrates -20 dBc lower band edge compliance**



Model 01019126, Smart6

### Measurement summary for limit1: FCC 15.247 >1GHz 3m pk (Pk)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA1 FCC 15.247 >1GHz 3m pk
Low channel					
2.39 GHz	49.25 Pk	4.49 / 28.25 / 43.26 / 0.0	38.73	H / 1.00 / 136	-35.27
High channel					
2.4835 GHz	62.65 Pk	4.66 / 28.59 / 43.36 / 0.0	52.53	H / 1.00 / 132	-21.47

### Measurement summary for limit2: FCC 15.247 >1GHz 3m av (Av)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA2 FCC 15.247 >1GHz 3m av
Low channel					
2.39 GHz	39.66 Av	4.49 / 28.25 / 43.26 / 0.0	29.14	H / 1.00 / 136	-24.86
High channel					
2.4835 GHz	45.26 Av	4.66 / 28.59 / 43.36 / 0.0	35.14	H / 1.00 / 132	-18.86

Model 01019128, Ag-Star

### Measurement summary for limit1: FCC B >1GHz 3m pk (Pk)

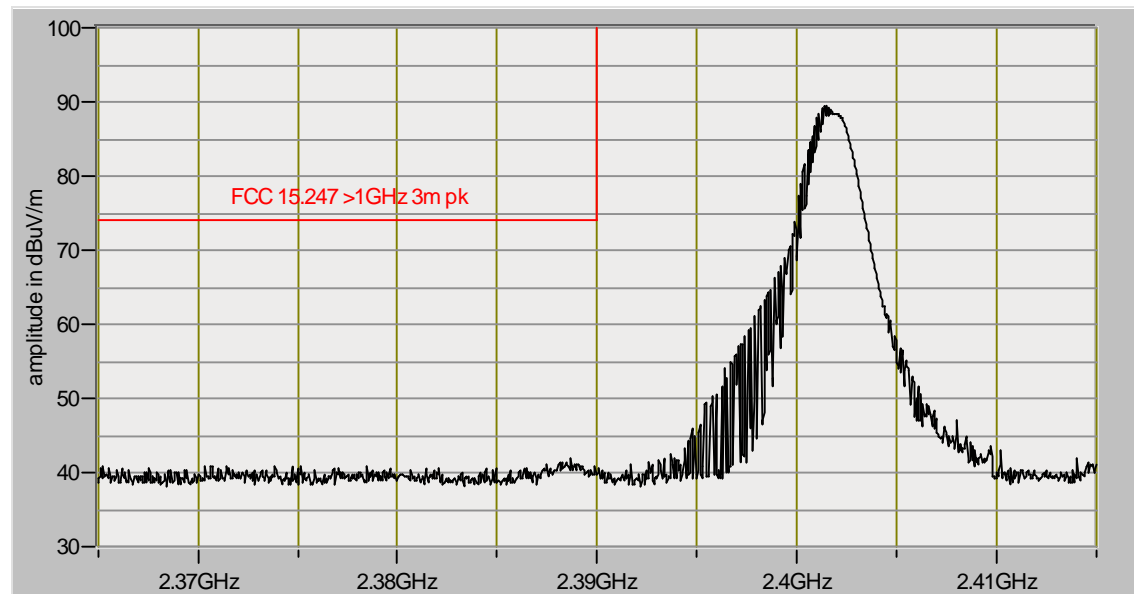
FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA1 FCC B >1GHz 3m pk
Low channel					
2.39 GHz	49.4 Pk	4.49 / 28.25 / 43.26 / 0.0	38.88	H / 1.00 / 132	-35.12
High channel					
2.4835 GHz	69.75 Pk	4.66 / 28.59 / 43.36 / 0.0	59.63	H / 1.00 / 126	-14.37

### Measurement summary for limit2: FCC B >1GHz 3m av (Av)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA2 FCC B >1GHz 3m av
Low channel					
2.39 GHz	40.01 Av	4.49 / 28.25 / 43.26 / 0.0	29.49	H / 1.00 / 132	-24.51
High channel					
2.4835 GHz	50.42 Av	4.66 / 28.59 / 43.36 / 0.0	40.3	H / 1.00 / 126	-13.7

Model 01019126, Smart6

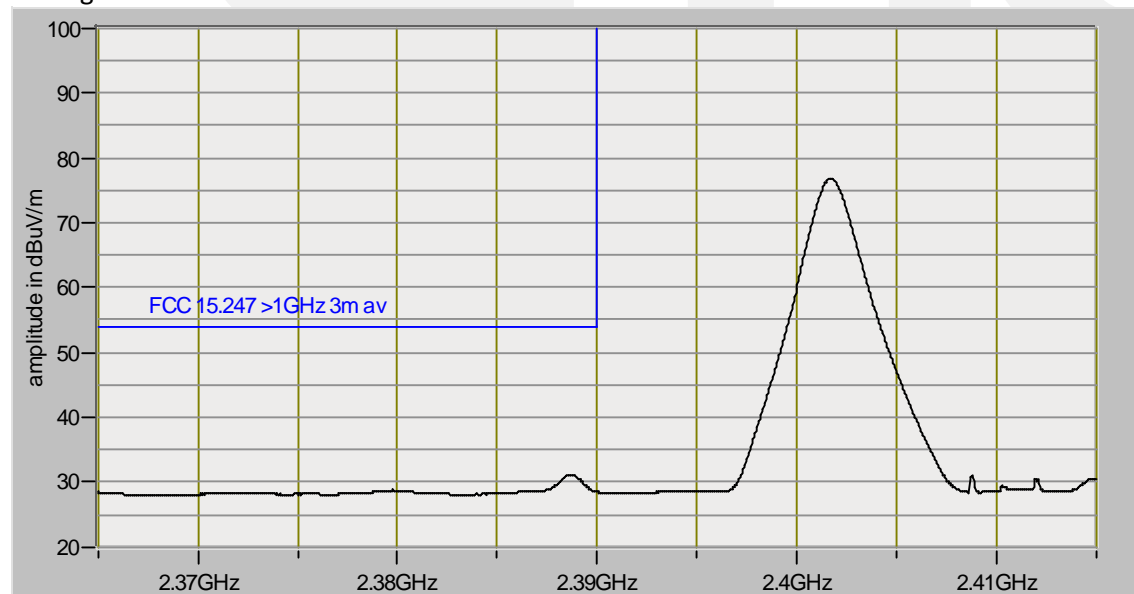
Low channel  
Peak



RBW 1MHz

VBW 3MHz

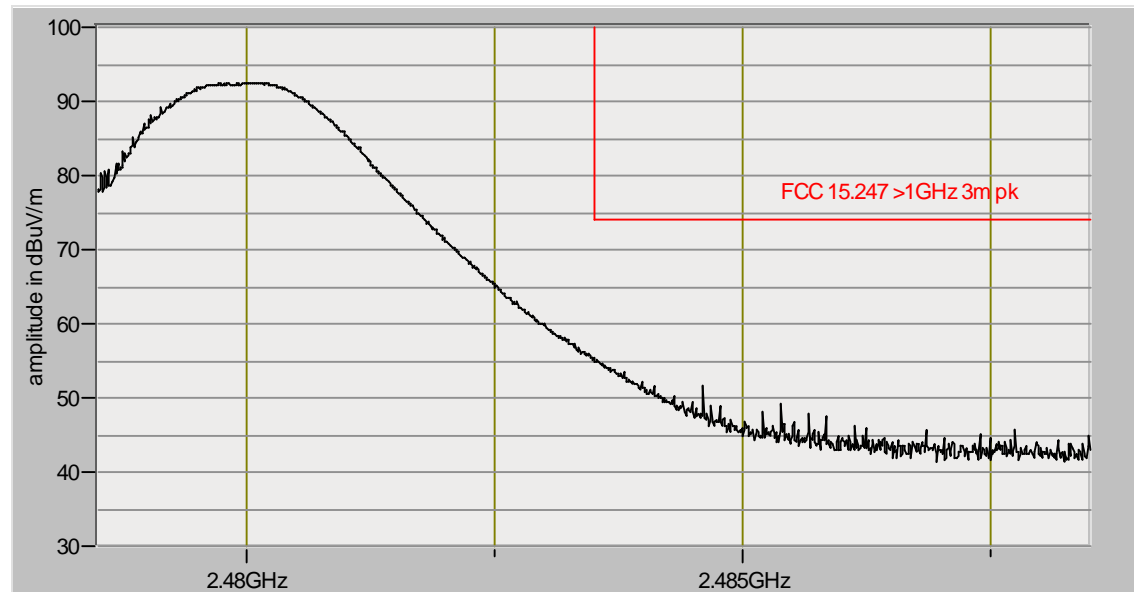
Average



RBW 1MHz

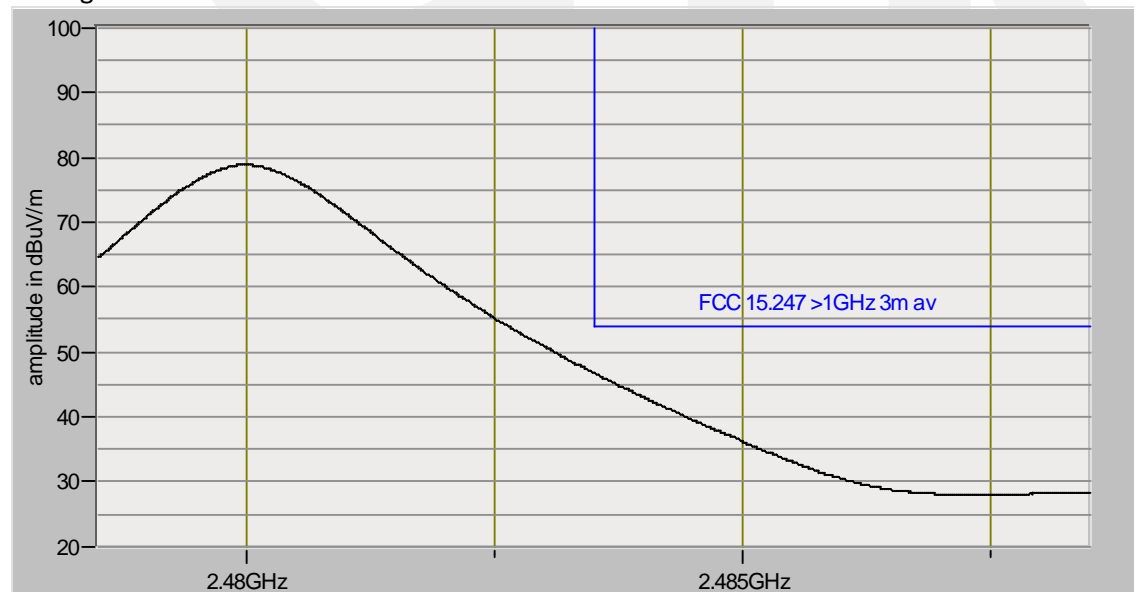
VBW 10Hz

# High channel Peak



RBW 1MHz VBW 3MHz  
This plot also demonstrates -20 dBc upper band edge compliance

## Average

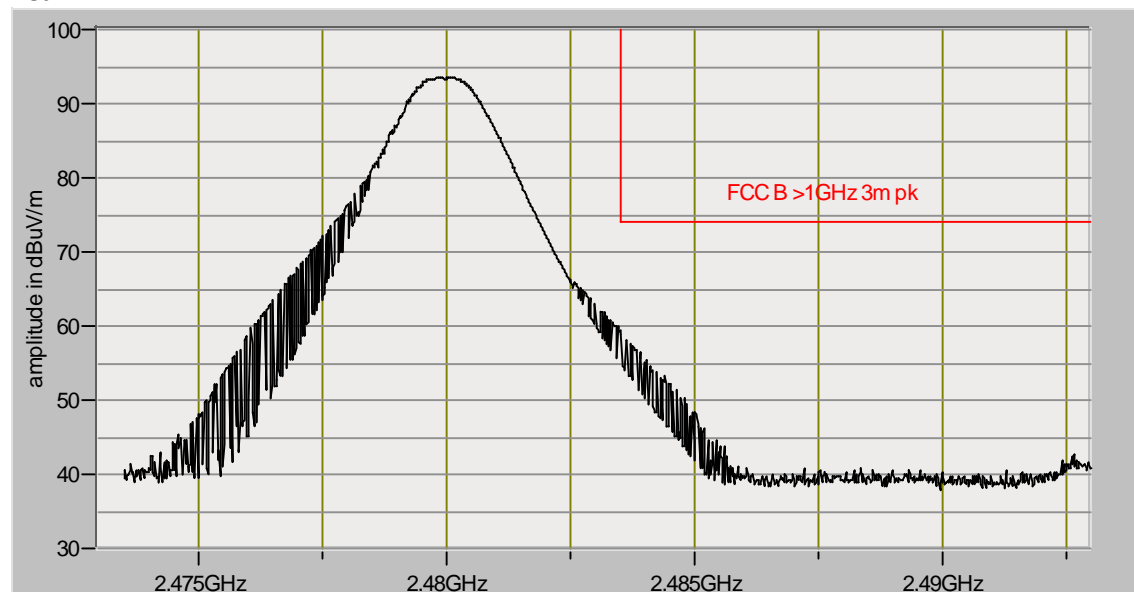


RBW 1MHz VBW 10Hz

Model 01019128, Ag-Star

High channel

Peak

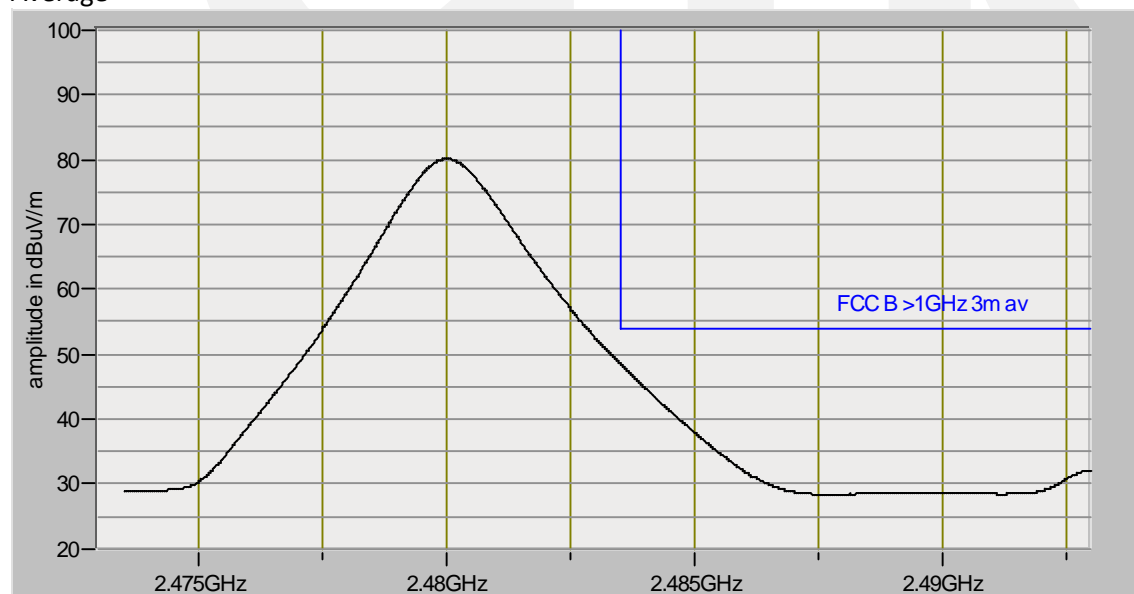


RBW 1MHz

VBW 3MHz

This plot also demonstrated -20 dBc upper band edge compliance

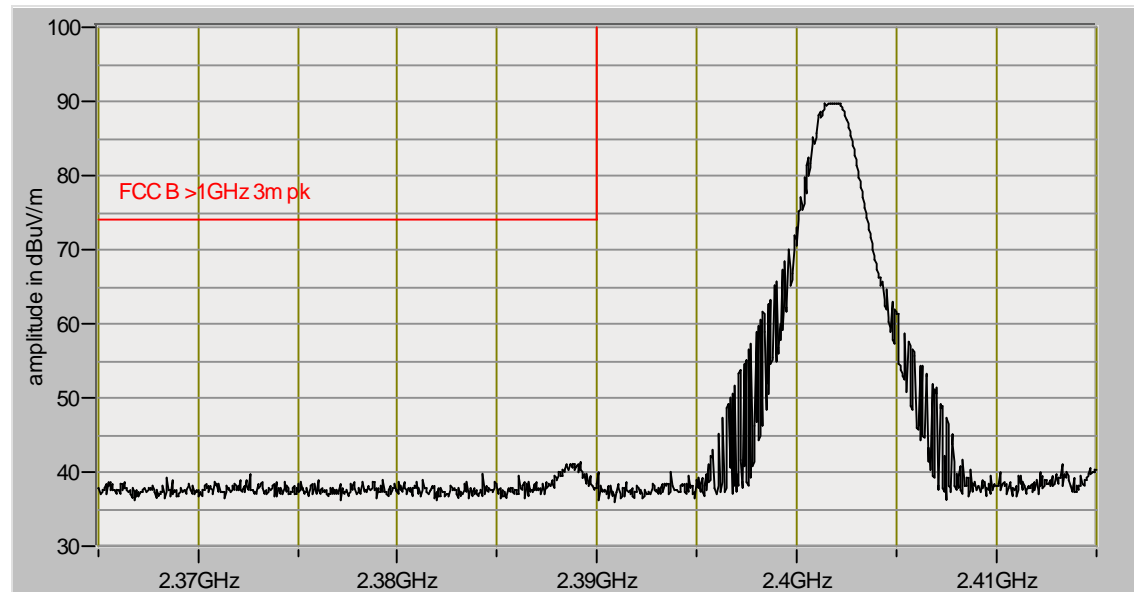
Average



RBW 1MHz

VBW 10Hz

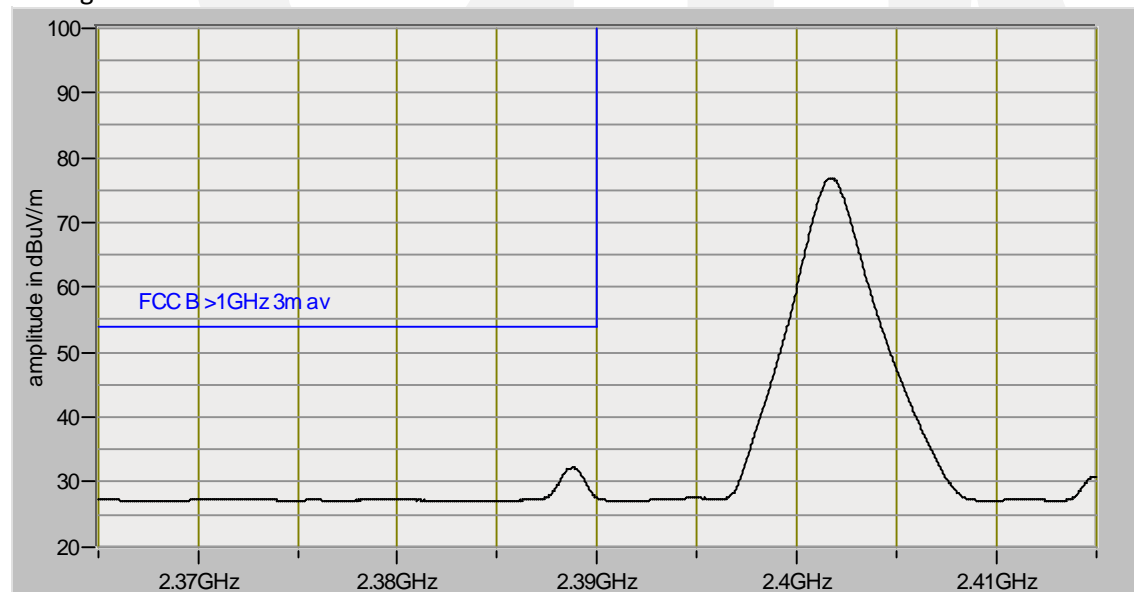
Low channel  
Peak



RBW 1MHz

VBW 3MHz

Average



RBW 1MHz

VBW 10Hz

## Spurious Emissions - Conducted

FCC 15.247(d) IC RSS-210 A8.5

### Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"  
Maximum spurious emission level relative to the -20 dBc limit is -31.58 dBm at 280 MHz, fundamental on low channel

Minimum margin of compliance is 10.59 dB

### Test location

- ☐ - Wild River Lab Large Test Site (Open Area Test Site)
- ☐ - Wild River Lab Small Test Site (Open Area Test Site)
- ☒ - Wild River Lab Large Test Site Tech Area

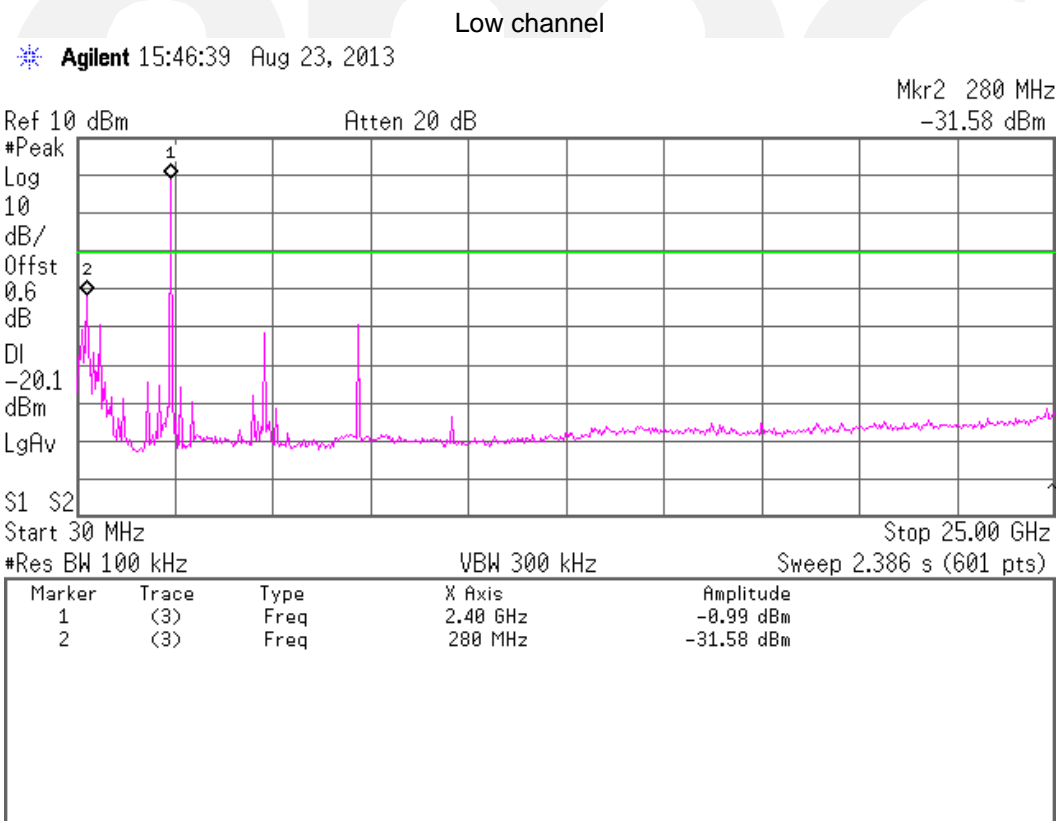
### Test equipment

TUV ID	Model	Manufacturer	Description	Serial	Cal Due
NBLE03367	E4440A	Agilent	Spectrum Analyzer	MY42510439	20-May-14

### Test limit

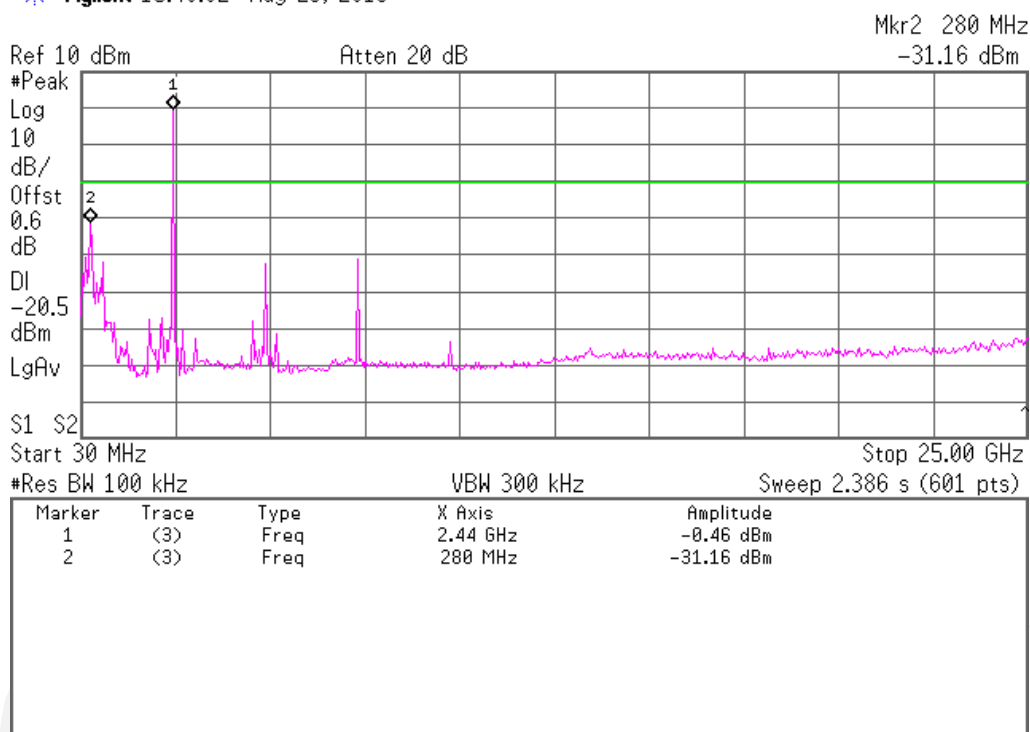
-20 dBc

### Test data



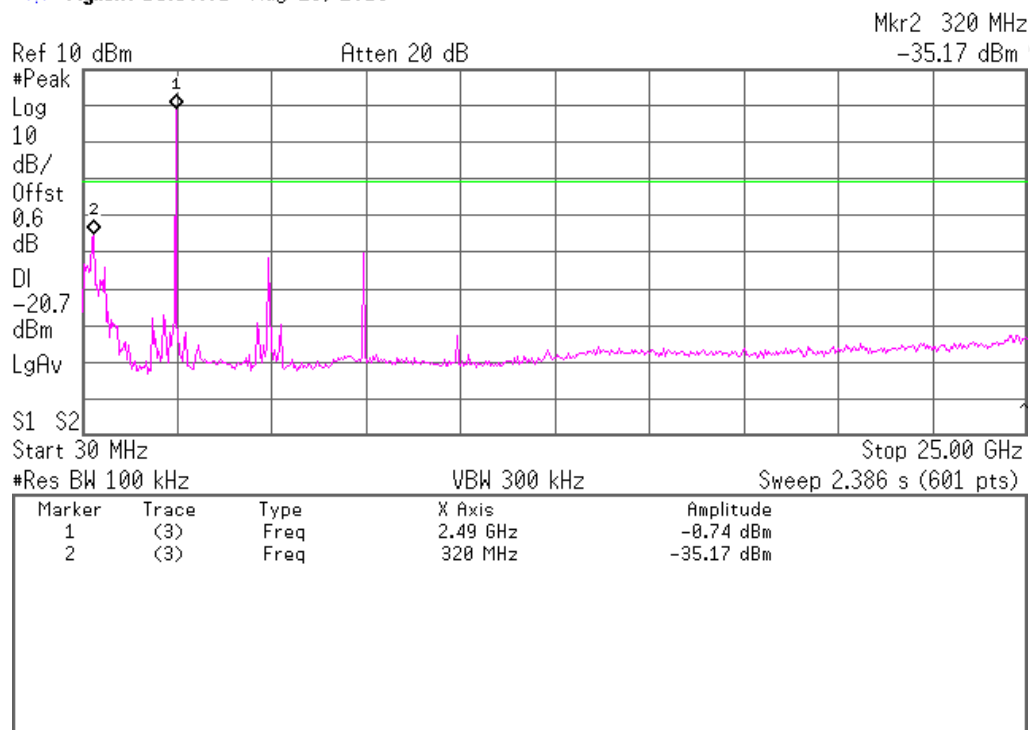
### Mid channel

Agilent 15:48:02 Aug 23, 2013



### High channel

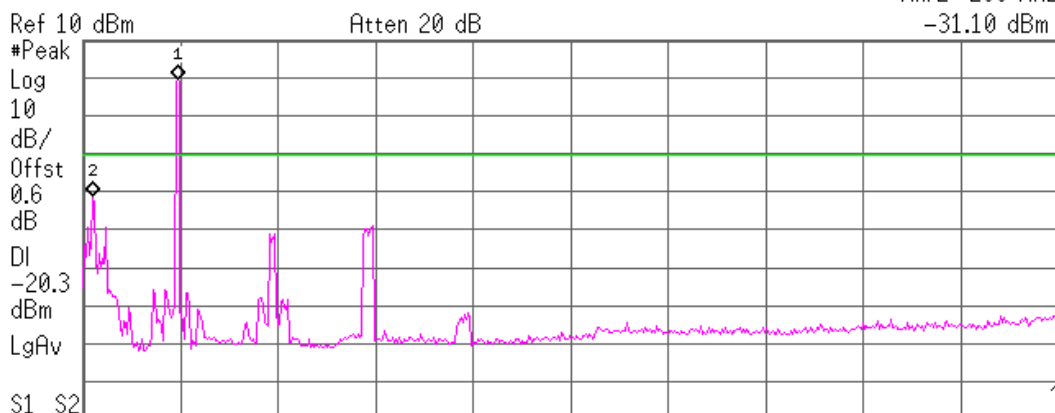
Agilent 15:50:01 Aug 23, 2013



# Hopping

Agilent 15:55:45 Aug 23, 2013

Mkr2 280 MHz  
-31.10 dBm



Start 30 MHz Stop 25.00 GHz  
#Res BW 100 kHz VBW 300 kHz Sweep 2.386 s (601 pts)

Marker	Trace	Type	X Axis	Amplitude
1	(3)	Freq	2.44 GHz	-0.26 dBm
2	(3)	Freq	280 MHz	-31.10 dBm



## Spurious Emissions - Radiated in restricted bands

FCC 15.247(d), IC RSS-210 A8.5

### Test summary

The requirements are: ☒ - MET ☐ - NOT MET

Testing per FCC DA 00-705 "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems"

Minimum margin of compliance is 5.67 dB at 7.44 GHz

### Test location

☒ - Wild River Lab Large Test Site (Open Area Test Site)

☐ - Wild River Lab Small Test Site (Open Area Test Site)

☐ - Wild River Lab Large Test Site Tech Area

### Test equipment

TUV ID	Model	Manufacturer	Description	Serial	Cal Due
WRLE02075	3115	EMCO	RidgeGuide Ant. 1-18 GHz	9001-3275	12-Feb-14
WRLE10527	SL18B4020	Phase One Microwave	Preamplifier 1 – 18 GHz	0001	Code B 08-Jan-14
WRLE03997	EWT-14-0066	EWT	2.4 GHz Notch filter	E2	Code B 08-Jan-14
WRLE02003	F550B1	Acronetics	4-8 GHz Bandpass Filter	010	Code B 08-Jan-14
WRLE03933	F551B-1	Acronetics	8-12 GHz Bandpass Filter	010	Code B 08-Jan-14
WRLE02689	8566B	Hewlett-Packard	Spectrum Analyzer	2416A00321	22-Apr-14
WRLE03295	85662A	Hewlett-Packard	Analyzer Display	2349A06144	22-Apr-14
NBLE02683	85650A	Hewlett-Packard	Quasi-peak Adapter	2430A00495	30-May-14
NBLE03367	E4440A	Agilent	Spectrum Analyzer	MY42510439	20-May-14
OWLE03996	SAS-572	A.H. Systems	STD Gain Horn	183	Code Y
WRLE03978	SL26-3010	Phase One Microwave	Amplifier 18-26.5 GHz	0005	Code B 02-Jan-14

### Test limit (in restricted bands)

Frequency (MHz)	Field strength (μV/meter)	Field strength (dBμV/meter)
30 - 88	100 – QP	40.0
88 - 216	150 – QP	43.5
216 - 960	200 – QP	46.0
960-1000	500 – QP	54.0
>1000	500 – AV	54.0
	5000 – PK	74.0

### Test data

See following pages

Model 01019126, Smart6

30-1000 MHz

### Measurement summary for limit1: FCC 15.247 <1GHz 3m (Qp)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA1 FCC 15.247 <1GHz 3m
168.03 MHz	35.95 Qp	1.15 / 8.85 / 27.43 / 0.01	18.53	V / 1.00 / 270	-24.97

1-25 GHz

### Measurement summary for limit1: FCC 15.247 >1GHz 3m pk (Pk)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA1 FCC 15.247 >1GHz 3m pk
7.44 GHz	50.35 Pk	10.0 / 36.38 / 42.83 / 1.27	55.18	V / 1.00 / 107	-18.82
7.323 GHz	49.55 Pk	9.94 / 36.21 / 42.71 / 1.21	54.2	V / 1.00 / 330	-19.8
2.484 GHz	62.65 Pk	4.66 / 28.59 / 43.36 / 0.0	52.53	H / 1.00 / 132	-21.47
4.96 GHz	49.8 Pk	7.97 / 33.12 / 43.52 / 0.47	47.84	V / 1.10 / 111	-26.16
4.882 GHz	49.15 Pk	7.86 / 32.97 / 43.6 / 1.04	47.42	V / 1.00 / 0	-26.58
4.804 GHz	50.4 Pk	7.75 / 32.86 / 43.69 / 0.0	47.33	V / 1.10 / 100	-26.67
2.39 GHz	49.25 Pk	4.49 / 28.25 / 43.26 / 0.0	38.73	H / 1.00 / 136	-35.27
1.36 GHz	48.3 Pk	3.49 / 25.3 / 40.86 / 0.12	36.36	V / 1.00 / 0	-37.64

### Measurement summary for limit2: FCC 15.247 >1GHz 3m av (Av)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA2 FCC 15.247 >1GHz 3m av
7.44 GHz	41.54 Av	10.0 / 36.38 / 42.83 / 1.27	46.37	V / 1.00 / 107	-7.63
7.323 GHz	41.61 Av	9.94 / 36.21 / 42.71 / 1.21	46.26	V / 1.00 / 330	-7.74
4.96 GHz	41.53 Av	7.97 / 33.12 / 43.52 / 0.47	39.57	V / 1.10 / 111	-14.43
4.804 GHz	42.61 Av	7.75 / 32.86 / 43.69 / 0.0	39.54	V / 1.10 / 100	-14.46
4.882 GHz	41.0 Av	7.86 / 32.97 / 43.6 / 0.45	38.68	V / 1.08 / 104	-15.32
2.484 GHz	45.26 Av	4.66 / 28.59 / 43.36 / 0.0	35.14	H / 1.00 / 132	-18.86
2.39 GHz	39.66 Av	4.49 / 28.25 / 43.26 / 0.0	29.14	H / 1.00 / 136	-24.86
1.36 GHz	39.51 Av	3.49 / 25.3 / 40.86 / 0.12	27.57	V / 1.00 / 0	-26.43

Model 01019128, Ag-Star

30-1000 MHz

### Measurement summary for limit1: FCC 15.247 <1GHz 3m (Qp)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA1 FCC 15.247 <1GHz 3m
265.452 MHz	41.51 Qp	1.5 / 12.69 / 27.22 / 0.02	28.5	V / 1.69 / 105	-17.5

1-25 GHz

### Measurement summary for limit1: FCC B >1GHz 3m pk (Pk)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA1 FCC B >1GHz 3m pk
7.323 GHz	52.0 Pk	9.94 / 36.21 / 42.71 / 1.21	56.65	V / 1.12 / 323	-17.35
7.44 GHz	50.75 Pk	10.0 / 36.38 / 42.83 / 1.27	55.57	V / 1.06 / 321	-18.43
4.882 GHz	51.05 Pk	7.86 / 32.97 / 43.6 / 1.04	49.32	V / 1.12 / 93	-24.68
4.804 GHz	51.9 Pk	7.75 / 32.86 / 43.69 / 0.43	49.26	V / 1.10 / 103	-24.74
4.96 GHz	49.95 Pk	7.97 / 33.12 / 43.52 / 0.47	47.99	V / 1.06 / 102	-26.01
2.39 GHz	49.4 Pk	4.49 / 28.25 / 43.26 / 0.0	38.88	H / 1.00 / 132	-35.12
1.537 GHz	48.55 Pk	3.65 / 25.66 / 41.58 / 0.14	36.41	V / 1.00 / 350	-37.59
1.537 GHz	48.45 Pk	3.65 / 25.66 / 41.58 / 0.14	36.31	V / 1.00 / 0	-37.69
1.546 GHz	48.15 Pk	3.65 / 25.69 / 41.65 / 0.14	35.98	V / 1.00 / 0	-38.02
2.484 GHz	69.75 Pk	4.66 / 28.59 / 43.36 / 0.0	59.63	H / 1.00 / 126	-75.37

### Measurement summary for limit2: FCC B >1GHz 3m av (Av)

FREQ	LEVEL (dBuV)	CABLE / ANT / PREAMP / ATTEN (dB)	FINAL (dBuV / m)	POL / HGT / AZ (m)(DEG)	DELTA2 FCC B >1GHz 3m av
7.44 GHz	43.51 Av	10.0 / 36.38 / 42.83 / 1.27	48.33	V / 1.06 / 321	-5.67
7.323 GHz	43.57 Av	9.94 / 36.21 / 42.71 / 1.21	48.22	V / 1.12 / 323	-5.78
4.882 GHz	43.38 Av	7.86 / 32.97 / 43.6 / 1.04	41.65	V / 1.12 / 93	-12.35
4.804 GHz	43.99 Av	7.75 / 32.86 / 43.69 / 0.43	41.35	V / 1.10 / 103	-12.65
2.484 GHz	50.42 Av	4.66 / 28.59 / 43.36 / 0.0	40.3	H / 1.00 / 126	-13.7
4.96 GHz	42.15 Av	7.97 / 33.12 / 43.52 / 0.47	40.19	V / 1.06 / 102	-13.81
2.39 GHz	40.01 Av	4.49 / 28.25 / 43.26 / 0.0	29.49	H / 1.00 / 132	-24.51
1.537 GHz	39.84 Av	3.65 / 25.66 / 41.58 / 0.14	27.7	V / 1.00 / 0	-26.3
1.537 GHz	39.83 Av	3.65 / 25.66 / 41.58 / 0.14	27.69	V / 1.00 / 350	-26.31

Test-setup photo(s):  
Radiated measurements

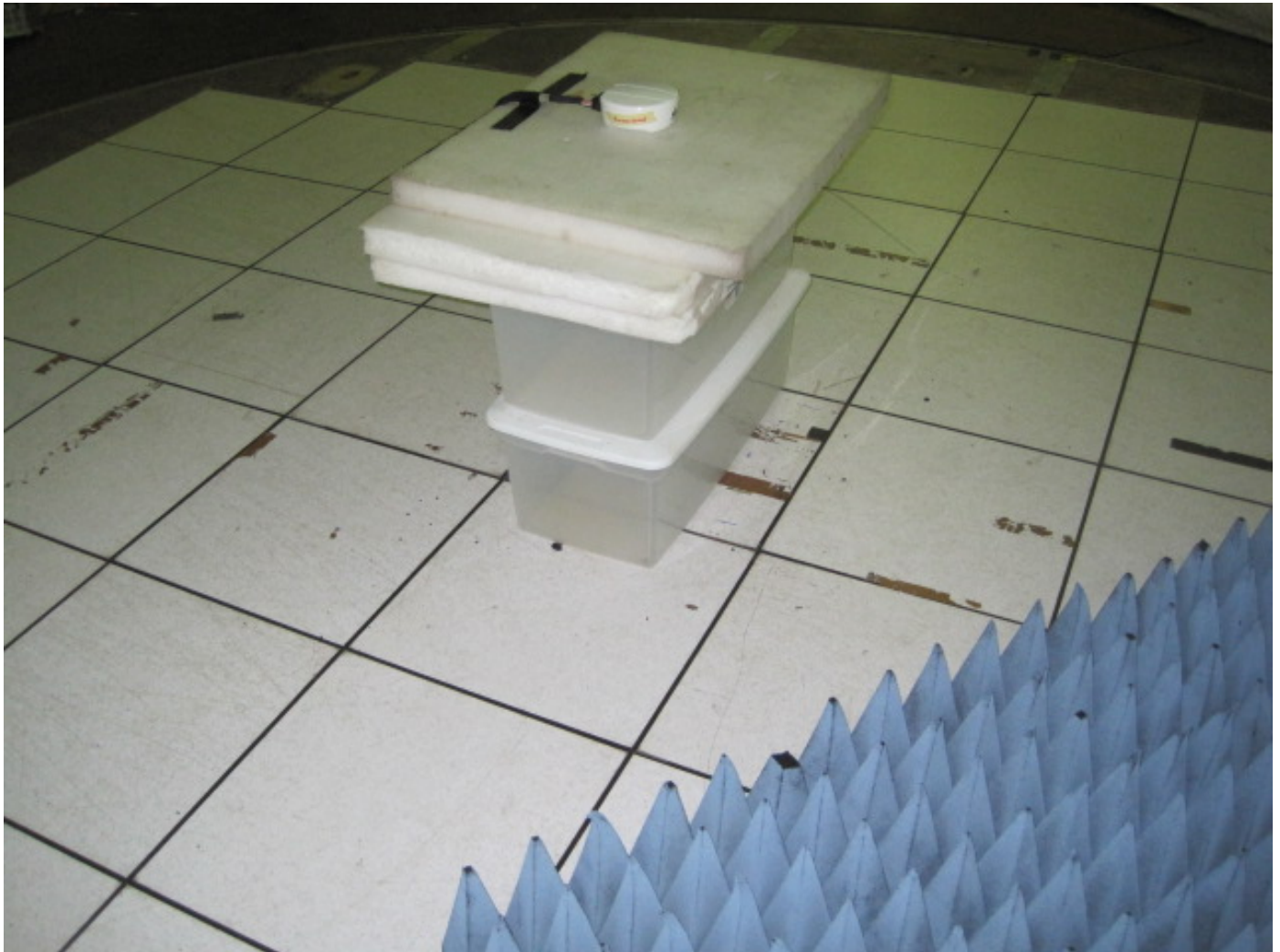


Test-setup photo(s):  
Radiated measurements

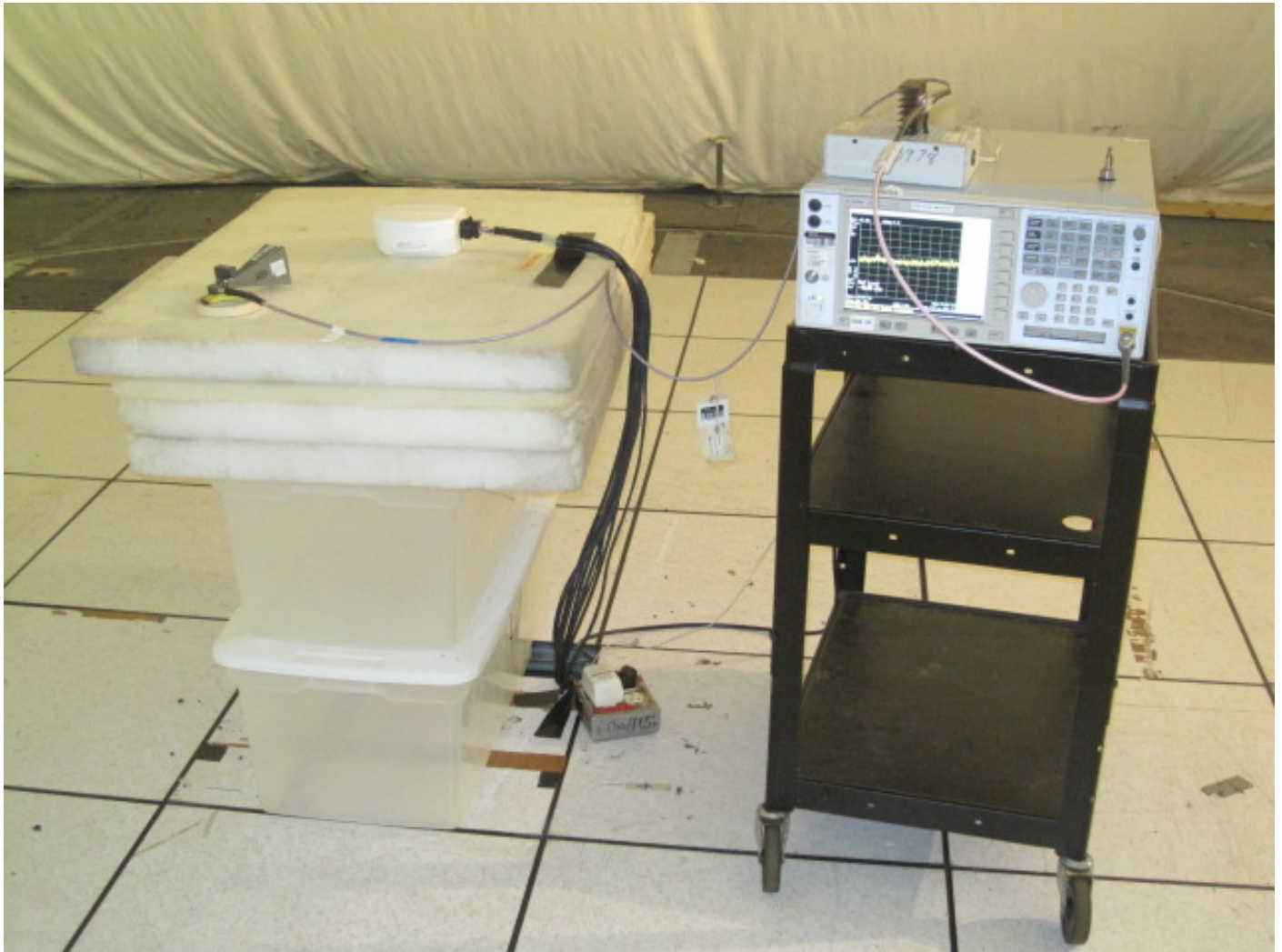




Test-setup photo(s):  
Radiated measurements



Test-setup photo(s):  
Radiated measurements



**Equipment Under Test (EUT) Test Operation Mode:**

**The device under test was operated under the following conditions during emissions testing:**

- ☐ - Standby
- ☐ - Test program (H - Pattern)
- ☐ - Test program (color bar)
- ☐ - Test program (customer specific)
- ☐ - Practice operation
- ☐ - Normal Operating Mode
- ☒ - Fundamental set on low, mid & high channels. Continuous on. Maximum power

**Configuration of the device under test:**

- ☒ - See Constructional Data Form and Block Diagram in Appendix A
- ☐ - See Product Information Form in Appendix B



## GENERAL REMARKS:

None

### Modifications required to pass:

- ☒ None
- ☐ As indicated on the data sheet(s)

### Test Specification Deviations: Additions to or Exclusions from:

- ☒ None
- ☐ As indicated in the Test Plan

## SUMMARY:

The requirements according to the technical regulations are

- ☒ - met and the equipment under test does fulfill the general approval requirements.
- ☐ - **not** met and the equipment under test does **not** fulfill the general approval requirements.

EUT Received Date:	<u>21 August 2013</u>
Condition of EUT:	<u>Normal</u>
Testing Start Date:	<u>21 August 2013</u>
Testing End Date:	<u>09 September 2013</u>

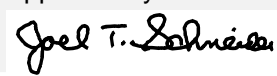
## TÜV SÜD AMERICA INC

Tested by:



Greg Jakubowski  
Senior EMC Technician

Approved by:



Joel T Schneider  
Senior EMC Engineer

## Appendix A

### Constructional Data Form





## REGULATORY TEST PLAN

### SMART 6 and AG-STAR

D18385

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# REVISION HISTORY

REV	ECO	DATE	DESCRIPTION	TITLE	NAME
0A		June 07, 2013	Initial Draft	HW Verification Technologist	A. Gimenez
0B		June 07, 2013	Second Draft	HW Verification Technologist	A. Gimenez
0C		June 14 2013	Added Test configurations for BT, Added emissions of conducted disturbances, magnetic field immunity, test voltages, conducted limits, CISPR22 emissions and CIRPS12/ CISPR25 Broadband electromagnetic emissions radiated from ESA's test exemptions. Re-arranged format. Added SW configuration and Bluetooth pass/fail criteria.	HW Verification Technologist	A. Gimenez
0D		June 15, 2013	Changed OEM638 to OEM615	HW Verification Technologist	A. Gimenez
0E		July 11, 2013	Edits and reformat following July 4 meeting. Note, I did not make suggested changes to Test Configurations and Test Setups at this time.		J. Davis
0F		July 15 2013	Eliminated Test Configurations, and modified Test Setups.	HW Verification Technologist	A. Gimenez
1	130403	July 15 2013	Release	HW Verification Technologist	A. Gimenez

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## 1 PURPOSE

The purpose of this document is to present a set of regulatory test cases that will be conducted for the Smart6 / Ag-Star Smart Antennas. The characteristic of the tests and guidance are described in order to support the correct application of the test cases and a quote for the tests listed in this document.

The intent of the plan is to illustrate all the requirements necessary to allow the Smart 6 and AG-STAR Antenna to carry the CE Mark; meet the requirements of Industry Canada; and FCC CFR Title 47, Part 15, Subpart B and Subpart C.

## 2 SCOPE

The SMART 6 antenna and AG-STAR smart antenna and their packaging shall be CE Marked (and CB scheme for safety) under the RTT&E Directive (1999/5/EC) and EMC Directive (2004/108/EC). The products fall under ITE Equipment and Radio Equipment classifications. The CE mark will also cover RoHS Recast Directive (2011/65/EC).

Smart6 and AG-STAR are equipped with Bluetooth® capability. The design incorporates the National Semiconductor LMX9830.

- National Semiconductor LMX9830
- Compliant with the Bluetooth 2.0 Core Specification
- Qualified Design ID (PRD 2.0): B012364

The Smart6 / Ag-Star operating voltage range is from 8 to 36 VDC.

The Immunity requirements of ETSI EN 301 489-1 (called up by RTT&E Directive) can be partially covered by the tests used to illustrate compliance with EN55024, but also include ISO7637 Conducted Transient Immunity on the DC supply lines.

For the radio equipment general requirements (ETSI EN301 489-1), the Smart6 / Ag-Star shall be classified as mobile equipment (e.g.: vehicular use). This ties in with EN 50498 and with EMC Directive for Vehicles (2004/104/EC), see ETSI EN 301 489-1, appendix B, and 2004/104/EC, 3.2.9.

Note that 2004/104/EC requirements are very similar to EMC for machinery standards called up by the EMC Directive (2004/108/EC):

- ISO 14982 (Agricultural and Forestry machinery)

Compliance with Industry Canada requirements (RSS-GEN, RSS-210, ICES-003) are demonstrated with the test cases used to illustrate compliance with EN301 489-1, EN55022 and FCC CFR Title 47, Part 15 Subparts B and C, ETSI EN 300 328 and ETSI EN 301 489-17.

Test cases to illustrate compliance are conducted at NovAtel and at an accredited external test lab.

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Test cases to illustrate compliance with the R&TTE Directive and the EMC Directive are to be conducted on both of the following products(unless otherwise noted):

- 01019126 Smart 6 Antenna-Bluetooth/Tilt
- 01019128 AG-STAR Antenna-Bluetooth

Note that the Smart6 has the following variants which will not be tested separately:

- 01019120 Smart6- Bluetooth
- 01019124 Smart6 –Tilt
- 01019123 Smart6 (no radio or tilt options)

### 3 REFERENCE DOCUMENTS

D13250	ISO7367 Pass/Fail Interpretation
D18176	SysRD – SMART 6/AG-STAR Phase 2
D18365	Smart6/AG-STAR HW Verification Plan
D18382	Smart6/AG_STAR Environmental Test Plan
D17240	Smart6-L Regulatory Test Plan
D17958	Smart6-L HDAT Report
D17959	Smart6-L TCF
D17640	Smart6-L Safety Compliance Plan
D17239	Smart6-L HW Verification Plan
D17961	Smart6-L Safety Report
D17958	Smart6-L HDAT Report

### 4 DELIVERABLES

- a. Soft Copy of Emissions scans (Generated by test facility)
- b. Compliance Reports (Generated by test facility)
- c. Formal Test Record Documents (Generated by NovAtel)
- d. Technical Construction File (Generated by NovAtel)
- e. Declaration of Conformity (Generated by NovAtel)
- f. RoHS BOM Analysis (Generated by NovAtel)

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## 5 TEST CASE EXEMPTIONS

Base Standard	Test Basis / Description	Exemption
EN55022	CISPR22 Conducted Emissions	Product is not intended for connection to a DC mains network.
ETSI EN 301 489-1	Conducted Emissions	ETSI EN 301 489-1, 8.3 requires Class B emission performance. ACB provided guidance that <i>Class A</i> emission performance <i>is acceptable</i> , provided the product is not used in a Class B environment (residential, commercial). Given that the product use case is mobile in a vehicle, it will not be in a Class B environment.
EN55024	EN61000-4-8 Magnetic Field Immunity	The Smart6 / Ag-Star are installed in locations that would not be influenced by power frequency magnetic fields generated by power frequency currents in conductors, leakage of transformers in substations, power plants.
EN55024	EN61000-4-6 Conducted RF Immunity	<u>AC Power Port</u> Product is not sold with a AC/DC Adapter
EN 55024	EN 61000-4-5 Surge Immunity (DC port only)	Also note that ETSI EN 301 489-1 (9.8) has no surge immunity requirement for mobile applications. No long outdoor cables.
2004/104/EC ETSI 301-489-1	CISPR 12 / CISPR 25 Broadband electromagnetic emissions radiated from ESA's	Radio equipment and many types of its associated ancillary equipment do not generate broadband emission in the meaning of this definition 2.1.5 in annex I of Directive 2004/104/EC [23]. No type approval test is deemed necessary
ISO 7637-2	Emissions of Conducted Disturbances	The Smart6 / Ag-Star contain active electronic devices. (e.g.: op-amp circuits, switching power supplies, microprocessor based) Exemptions for devices that are not switched, contain no switches, or do not include inductive loads.
ETSI EN 301 489-17	Test Voltages	12V and 24V testing is required by the standard, but 24V testing will not be performed. It is not being performed because the Bluetooth module's power supply is not expected to be effected by operation of the Smart6 / Ag-Star at either end of their 8-36VDC input voltage range. The Bluetooth module's power is provided by a LDO regulator which outputs 2.85VDC +/-3%.
FCC Part 15, Subpart C Section 15.207	Conducted Limits	The Smart6 / Ag-Star do not have provision for a direct connection to the public utility ac power lines.

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Base Standard	Test Basis / Description	Exemption
2004/104/EC	ISO 10605 ESD	For vehicles fitted with tires, the vehicle body can be considered to be an electrically isolated structure. Electrostatic forces in relation to the external environment only can occur at the moment that the occupant enters or exits the stationary vehicle. <b>Note:</b> ISO 10605 is required by ISO 14982, but can be waived due to similarity of protection and filtering circuitry with that of Smart Ag which was tested to ISO 10605.
Radio immunity tests	Standby mode	<b>No tests will be required to demonstrate immunity compliance with Bluetooth radio in Standby</b> – Standby mode was covered by Smart Ag Enhancements and Smart-MR10 programs. An assessment was conducted based on minimal changes made to the circuitry ‘in front of’ the Bluetooth radio – power protection and filtering, I/O protection and filtering.

## 6 REGULATORY TEST CASES

### 6.1 Emissions Test Cases -- Unintentional Radiators

The unintentional radiator emission tests address the requirements of:

- FCC Part 15, subpart B
- Industry Canada RSS-Gen, ICES-003
- RTTE Directive 1999/5/EC -- ETSI EN 301 489-1, EN 55022
- EMC Directive 2004/108/EC – adds ISO 14982 (EMC for Agricultural and Forestry Machinery)
- EMC Directive for Vehicles 2004/104/EC

#### 6.1.1 Radiated Emissions, EN55022:2006, ETSI EN 301 489-1 (8.2), ICES-003, Issue 5 **(External Test)**

ITE EN 55022; IC ICES-003; ETSI EN 301 489-1 (8.2)	Test Basis	Frequency Range (MHz)	Class B Limits
Paragraph 6	CISPR 22	30 – 230	30 dB(μV/m) Quasi-peak
		230 – 1000	37 dB(μV/m) Quasi-peak
		1000 - 3000	70 (dBuV/m) Peak 50 dB(uV/m) Average
		3000 - 6000	74 (dBuV/m) Peak 54 dB(uV/m) Average

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### 6.1.2 Radiated Emissions FCC Part 15 Subpart B

(External Test)

FCC Part 15 Subpart B	Test Basis	Frequency Range (MHz)	Class B Limits
Section 15.109	ANSI C63.4	30 – 88	29 dB(μV/m) Quasi-peak
		88 - 216	33 dB(μV/m) Quasi-peak
		216 - 960	36 dB(μV/m) Quasi-peak
		960 - 1000	44 dB(μV/m) Quasi-peak
		1000 – <b>25000</b>	74 dB(μV/m) Peak 54 dB(μV/m) Average

**Notes:**

- Measurement distance of 10m below 1 GHz, 3m above 1GHz
- The highest frequency intentionally generated for both variants is 4.8 to 4.96 GHz (LMX9830VCO)
- Test unintentional radiated emission for both products from 30 MHz to 25GHz (5 x 4.8GHz)

### 6.1.3 Conducted Emissions ETSI EN301 489-1 (8.3)

(Internal Test)

ETSI EN 301 489-1 Section 8.3	Test Basis	Frequency Range (MHz)	Class B Limit	
			(QP) dBuV	(Avg) dBuV
DC Power Input Port DC Power Output Port	CISPR 22; CISPR 25 LISN	0.15 to 0.5	66 to 56	56 to 46
		0.5 to 5	56	46
		5 to 30	60	50

**Notes:**

- Test Method and limits according to CISPR 22. Use a CISPR25 LISN connected to the DC Power Source.
- Performed with the UUT at 12VDC and 24VDC
- Limit decreases linearly with the logarithm of the frequency in the range from 150 kHz to 500 KHz.

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#### 6.1.4 Radiated Emissions – ESAs Mounted on Agricultural Machinery or Vehicle (External Test)

EMC Directive for Vehicles – 2004/104/EC; EMC Directive 2004/108/EC --Agriculture and Forestry Machinery – ISO 14982			
Test Description	Basic Standard	Frequency Range	Limits for quasi-peak detector
Broadband electromagnetic emissions radiated from ESA's <i>Test Case Exemption</i>	CISPR 12 / CISPR 25	30 MHz - 75 MHz	62dB(uV/m) to 52dB(uV/m)
		75 MHz - 400 MHz	52dB(uV/m) to 63dB(uV/m)
		400MHz – 1GHz	63dB(uV/m)
Narrowband electromagnetic emissions radiated from ESA's	CISPR 12 / CISPR 25	30 MHz - 75 MHz	52dB(uV/m) to 42dB(uV/m)
		75 MHz - 400 MHz	42dB(uV/m) to 53dB(uV/m)
		400MHz – 1GHz	53dB(uV/m)

- UUT is powered at 12VDC and 24VDC for all test cases.
- Average detector for Narrowband (limit changes logarithmically with changing frequency)
- Limits in ISO 14982 requires 2dB pass margin, resulting in same limit as in 2004/104/EC.

## 6.2 Immunity Test Cases -- Unintentional Radiators

The unintentional radiator immunity tests address the requirements of:

- RTTE Directive 1999/5/EC -- ETSI EN 301 489-1, EN 55024
- EMC Directive 2004/108/EC – adds ISO 14982 (EMC for Agricultural and Forestry Machinery)
- EMC Directive for Vehicles 2004/104/EC
- Bluetooth communications must be established for all immunity test setups.

### 6.2.1 Electrostatic Discharge (Internal Test)

Specification	Test Basis	Port	Level	Performance
EN55024:2010  ETSI EN 301 489-1 Section 9.3 ( <u>not required</u> for mobile product)	EN61000-4-2	Enclosure port	Contact Discharge +/- 4 KV Air Discharge +/- 8 KV	Criterion B

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## 6.2.2 Radiated Immunity

(External Test)

Specification	Test Basis	Port	Limits	Performance
EN55024:2010 ETSI EN 301 489-1 Section 9.2	EN61000-4-3	Enclosure port	80 to 1000 MHz - 3 V/m 1400 to 2000 MHz - 3 V/m 2000 MHz to 2700 MHz - 1 V/m 80 % AM (1KHz)	Criterion A

## 6.2.3 Electrical Fast Transients (only on 01019126)

(Internal Test)

Specification	Test Basis	Port	Level	Performance
EN55024:2010 ETSI EN 301 489-1 Section 9.4 ( <u>not required</u> for mobile product)	EN61000-4-4	DC Power Port	0.5kV(peak) 5/50 Tr/Th nS - 5 KHz Repetition Frequency	Criterion B
		Signal Port	0.5kV(peak) 5/50 Tr/Th nS - 5 KHz Repetition Frequency <i>Test applied to all lines simultaneously to earth (ground)</i>	

## 6.2.4 Surge Immunity

Optional

test, no formal requirement

(Internal Test)

Specification	Test Basis	Port	Level	Performance
EN55024:2010 (may be tested internally)	EN61000-4-5	DC Power Port (test case exemption)	0.5 kVp - Line to Ground, 1,2/50 (8/20) Tr/Th uS	Criterion B
		Signal Port	1 kVp - Line to Ground, 1,2/50 (8/20) Tr/Th uS	

## 6.2.5 Conducted RF Immunity (only on 01019126)

(External Test)

Specification	Test Basis	Port	Frequency Range	Performance
EN55024:2010 ETSI EN 301 489-1 Section 9.5	EN61000-4-6	DC Power Port Signal Port	0.15 MHz – 80 MHz - 3V - 80% AM 1 KHz	Criterion A

### Notes:

- Data processing (computation), data conversion, storage or transfer shall be performed and the results of processing shall be compared with results in normal operation.

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## 6.2.6 Immunity of ESAs on Vehicles/Ag Equipment to Electromagnetic Radiation (External Test)

UUT is powered at 12VDC and 24VDC.

Specification	Test Case	Frequency Range	Limits	Functional Status
2004/104/EC Paragraph 6.7	ISO 11452-4 (BCI)	20MHz - 200MHz	60mA	A
	ISO 11452-2 (ALSE)	200MHz – 2.0GHz	30V/m	A

## 6.2.7 Immunity of ESAs on Vehicles/Ag Equipment to ISO 7637-2 Pulses Conducted onto Supply Lines

UUT is powered at 12VDC and 24VDC.

## 6.3 Conducted Transient Immunity (Supply Lines) (only on 01019126) (Internal Test)

Specification	ISO-7637-2 Clause	Transient Type	Test Pulse	Test Level III (12V System)	Test Level III (24V System)	Functional Status
ETSI EN 301 489-1 Section 9.6  2004/104/EC Paragraph 6.8	5.6.1	Inductive Load Switching	Pulse 1	-75V	-450V	C Survival Only
	5.6.2		Pulse 2a	+37V	+37V	B
			Pulse 2b	+10V	+20V	C Survival Only
2004/108/EC (ISO 14982)	5.6.3	Mutual Coupling	Pulse 3a	-112V	-150V	A
			Pulse 3b	+75V	+150V	A

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Specification	ISO-7637-2 Clause	Transient Type	Test Pulse	Test Level III (12V System)	Test Level III (24V System)	Functional Status
	5.6.4	Cranking	Pulse 4	-6V	-12V	A

**Notes:**

- Immunity of Electronic Sub-Assemblies (ESAs): Product is not related to any immunity related functions.
- Refer to NovAtel document D13250 – ISO7637 Pass/Fail Interpretation

**Notes:**

- Immunity of Electronic Sub-Assemblies (ESAs): Product is not related to any immunity related functions.
- Refer to NovAtel document D13250 – ISO7637 Pass/Fail Interpretation

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## 6.4 Intentional Radiator Requirements – R&TTE Directive

### 6.4.1 FCC Part 15, Subpart C – Unlicensed band

Description	FCC Part 15, Subpart C Rule Part	Industry Canada Requirement
Carrier Frequency Separation	15.207 (a)(1)	RSS 210 Issue 7, A8-1(b)
Number of Hopping Frequencies	15.247 (a)(1)(iii)	RSS 210 Issue 7, A8-1(d)
Time of Occupancy	15.247 (a)(1)(iii)	RSS 210 Issue 7, A8-1(d)
20 dB Bandwidth	15.247 (a)(1)	RSS 210 Issue 7, A8-1
99% Power bandwidth	N/A	RSS-Gen Issue 2, 4.6.1
Pseudorandom Frequency Hopping Sequence	15.247 (a)(1)	RSS 210 Issue 7, A8-1
Equal Hopping Frequency Use	15.247 (a)(1)	RSS 210 Issue 7, A8-1
Peak Output Power	15.247 (a)(1)	RSS 210 Issue 7, A8-4(2)
Duty Cycle	15.35 (c)	RSS-Gen Issue 2, 4.5
Conducted Spurious Emissions	15.247 (d)	RSS 210 Issue 7, A8.5
Conducted Spurious Emissions Band Edge	15.247 (d)	RSS 210 Issue 7, A8.5
Radiated Spurious Emissions Band Edge	15.247, 15.205	RSS 210 Issue 7, 2.6, A8.5
Radiated Spurious Emissions (Tx and Rx)	15.247, 15.205	RSS 210 Issue 7, 2.7, A8.5 RSS Gen Issue 2, 7.2.3

The highest frequency **intentionally** generated (Bluetooth) in the Smart6 and AG-Star enclosures is **2483 MHz**. For an intentional radiator, the test frequency must go up to **10x the highest frequency** intentionally generated within the product (FCC Part 15, para 15.33 [1]). For Bluetooth this means the test goes out to 25 GHz.

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## 6.4.2 INDUSTRY CANADA -- IC RSS-GEN, Issue 2; RSS 210, Issue 7

Compliance with Industry Canada requirements are demonstrated with the test cases used to illustrate compliance with EN 301 489-1, EN 301 489-17, EN 300-328, and FCC CFR Title 47, Part 15, Subpart C.

The lifting strategy (i.e. Family or single) is to be finalized with the lab/ TCB.

No additional tests are required to demonstrate compliance.

Description	FCC Part 15, Subpart C Rule Part	Industry Canada Requirement
Carrier Frequency Separation	15.207 (a)(1)	RSS 210 Issue 7, A8-1(b)
Number of Hopping Frequencies	15.247 (a)(1)(iii)	RSS 210 Issue 7, A8-1(d)
Time of Occupancy	15.247 (a)(1)(iii)	RSS 210 Issue 7, A8-1(d)
20 dB Bandwidth	15.247 (a)(1)	RSS 210 Issue 7, A8-1
99% Power bandwidth	N/A	RSS-Gen Issue 2, 4.6.1
Pseudorandom Frequency Hopping Sequence	15.247 (a)(1)	RSS 210 Issue 7, A8-1
Equal Hopping Frequency Use	15.247 (a)(1)	RSS 210 Issue 7, A8-1
Peak Output Power	15.247 (a)(1)	RSS 210 Issue 7, A8-4(2)
Duty Cycle	15.35 (c)	RSS-Gen Issue 2, 4.5
Conducted Spurious Emissions	15.247 (d)	RSS 210 Issue 7, A8.5
Conducted Spurious Emissions Band Edge	15.247 (d)	RSS 210 Issue 7, A8.5
Radiated Spurious Emissions Band Edge	15.247, 15.205	RSS 210 Issue 7, 2.6, A8.5
Radiated Spurious Emissions (Tx and Rx)	15.247, 15.205	RSS 210 Issue ,7 2.7, A8.5 RSS Gen Issue 2, 7.2.3

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### 6.4.3 ETSI EN 301 489-1: Common Technical Requirements (Intentional Radiators) (External Test)

Essential requirements and test specifications relevant to the presumption of conformity under Article 3.1(b) of the R&TTE Directive, and Part 1 of the multi-part EN 301 489 series covering EMC.

Compliance with the immunity requirements of EN 301 489-1 (Bluetooth Operating) are achieved with the test cases used to illustrate compliance with EN 55024.

***No additional tests will be required to demonstrate immunity compliance with Bluetooth radio in Standby*** – Standby mode was covered by Smart Ag Enhancements and Smart-MR10 programs. Minimal changes were made to circuitry ‘in front of’ the Bluetooth radio – power protection and filtering, I/O protection and filtering.

Specification	Test Cases with Bluetooth Radio Active
Section 8.2 – Radiated Emissions	Compliance in accordance with ETSI EN 300 328 5.75 & 5.76
Section 8.3 – Conducted emissions DC power input / output ports	Conducted emissions --DC power input port (Test Method according to CISPR 22. Use a CISPR25 LISN connected to the DC Power Source) <i>Performed with the UUT at 12VDC and 24VDC</i>
Section 9.2 – RF Electromagnetic Field	Compliance in accordance with EN 55024 (EN 61000-4-3)
Section 9.3 – Electrostatic discharges	Compliance in accordance with EN 55024 (EN 61000-4-2)
Section 9.4 – Fast transients common mode	Compliance in accordance with EN 55024 (EN 61000-4-4)
Section 9.5 – Radio frequency common mode	Compliance in accordance with EN 55024 (EN 61000-4-6)
Section 9.6 – Transients and surges in the vehicular environment	Compliance in accordance with ISO 7637-2
Section B.2.1 – Broadband emissions generated by the ESA ( <i>Test Case Exemption</i> )	Compliance in accordance with Directive 2004/104/EC
Section B.2.2 - Narrowband emissions generated by the ESA	Compliance in accordance with Directive 2004/104/EC
Section B.2.3 – Immunity of the ESA to transient disturbances conducted along the supply lines	Compliance in accordance with Directive 2004/104/EC
Section B.2.4 – Conducted disturbances caused by the ESA. ( <i>Test Case Exemption</i> )	Compliance in accordance with Directive 2004/104/EC

- UUT is powered at 12VDC for all test cases, except...
- Test cases to support the requirements of ISO-7637 require additional testing at 24V.
- ESA used in a mobile environment (tractor, vehicle)

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#### 6.4.4 ETSI EN 300 328: Data Transmission Equipment Operating in the 2.4 GHz ISM Band (Intentional Radiators) (External Test)

Essential requirements and test specifications relevant to the presumption of conformity under Article 3.2 of the R&TTE Directive.

No additional tests are required to illustrate compliance.

Specification	Description
Section 5.7.2	Equivalent Isotropic Radiated Power
Section 5.7.3	Maximum E.I.R.P. Spectral Density
Section 5.7.4	Frequency Range
Ref Clause No. 4.3.4.1	Dwell Time
Ref Clause No. 4.3.4.2	Hopping Channel
Ref Clause No. 4.3.4.3	Hopping Sequence
Section 5.7.5 Note 1	Transmitter Spurious Emissions (30 MHz to 12.75 GHz)
Section 5.7.6 Note 1	Receiver Spurious Emissions (30 MHz to 12.75 GHz)

**Note 1:** When the Bluetooth module is placed in continuous transmit or receive mode fixed on one channel during testing, there is a 4.8 GHz to 4.96 GHz spurious emission dependant on the assigned channel.

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#### 6.4.5 ETSI EN 301 489-17: Specific conditions for Broadband Data Transmission Systems (Intentional Radiators)

Essential requirements and test specifications relevant to the presumption of conformity under Article 3.1(b) of the R&TTE Directive and Part 17 of the multi-part EN 301 489 series covering EMC.

Compliance with the requirements of EN 301 489-17 are achieved with the test cases used to illustrate compliance with EN 301 489-1.

No additional tests are required to illustrate compliance.

Specification	Description
Section 8.2 – Radiated Emissions	Compliance in accordance with ESI EN 300 328 5.75 & 5.76
Section 8.3 – DC power input / output ports	Compliance in accordance with ETSI EN 301 489-1
Section 9.2 – RF Electromagnetic Field	Compliance in accordance with ETSI EN 301 489-1
Section 9.3 – Electrostatic discharges	Compliance in accordance with ETSI EN 301 489-1
Section 9.4 – Fast transients common mode	Compliance in accordance with ETSI EN 301 489-1
Section 9.5 – Radio frequency common mode	Compliance in accordance with ETSI EN 301 489-1
Section 9.6 – Transients and surges in the vehicular environment	Compliance in accordance with ETSI EN 301 489-1
Section 9.8 – Surges, line to line and line to ground	Compliance in accordance with ETSI EN 301 489-1
Section B.2.1 – Broadband emissions generated by the ESA ( <i>Test Case Exemption</i> )	Compliance in accordance with ETSI EN 301 489-1
Section B.2.2 - Narrowband emissions generated by the ESA	Compliance in accordance with ETSI EN 301 489-1
Section B.2.3 – Immunity of the ESA to transient disturbances conducted along the supply lines	Compliance in accordance with ETSI EN 301 489-1
Section B.2.4 – Conducted disturbances caused by the ESA. ( <i>Test Case Exemption</i> )	Compliance in accordance with ETSI EN 301 489-1

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## 7 IMMUNITY TEST PASS / FAIL CRITERIA

### 7.1 EN 55024 / ETSI EN 301 489-1 / ISO 11452-2 / ISO 11452-4

#### ***Performance Criterion A:***

The UUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed below a performance level **specified by the manufacturer** when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance.

If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended.

#### **NovAtel's Acceptable Performance for Functional Status A:**

- During the test, the UUT tracking ability may be affected. When the interfering signal or a harmonic of the interfering signal falls within the receiver passband(s), the UUT may experience C/No degradation or loss of code lock in the presence of the interfering signal, and shall re-establish normal C/No or code lock without user intervention when the interfering frequency moves outside the receiver passband(s). Frequencies at which **in-band** degradation occurs are within RF exclusion bands of the receiver, as described in ETSI EN 301 489-1(4.3). C/No degradation and loss of code lock are considered narrowband responses and according to 301 489-1 (4.4 and 9.2.2), can be disregarded from the test.
- For interfering signals outside the receiver passband(s) (L1, L2 and Glonass), C/No degradation up to 6dB below nominal is acceptable performance provided the C/No returns to nominal when the interfering frequency is changed or removed. Loss of code lock, loss of position and a need for operator intervention are **not** acceptable.
- Momentary loss of communications (CAN, RS-232, Bluetooth) during immunity is allowed, provided the communication self recovers. If Bluetooth communication is lost, the Bluetooth radio must self-recover to a mode where it is ready and able to be paired.

#### ***Performance Criterion B:***

After the test, the UUT shall continue to operate as intended without operator intervention. No degradation of performance or loss of function is allowed, after the application of the phenomena below a performance level specified by the manufacturer when the equipment is used as intended. The performance level may be replaced by a permissible loss of performance.

During the test, degradation of performance is allowed. However, no change of state or stored data is allowed to persist after the test.

If the minimum performance level or the permissible performance loss is not specified by the manufacturer, than either of these may be derived from the product description and documentation, and by what the user may reasonably expect from the equipment if used as intended.

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## 7.2 ISO 7637

Functional Status derived from D13250 – Smart-Ag ISO 7637 Pass / Fail Interpretation

- **Function Status A:** The UUT shall operate as intended without operator intervention.
- **Function Status B:** The UUT shall operate as intended without operator intervention. However, one or more of functions of UUT can go beyond specified tolerance.
- **Function Status C:** The UUT shall return automatically to normal operation after exposure disturbances are removed (automatic reset allowed).
- Momentary loss of communications (CAN, RS-232, Bluetooth) during immunity is allowed, provided the communication self recovers. If Bluetooth communication is lost, the Bluetooth radio must self-recover to a mode where it is ready and able to be paired.

ISO 7637:2004			
Pulse	Applicable	Pass/Fail (Functional Status)	Comments
1	No, but survival after exposure is required	C	<p>This negative transient occurs when the supply is disconnected (ignition switch opened) from inductive loads (blower motor, power windows) with the UUT still connected in parallel with the inductance.</p> <p>There is no expectation that the UUT will continue to operate after the ignition switch is opened, while the supply is held at or below 0Volts for 200 msec.</p> <p><b>Survival is required.</b></p>
2a	Yes	B	<b>Required</b>
2b	No, but survival after exposure is required.	C	<p>This transient pulse occurs when motors act as generators after the ignition switch is turned off.</p> <p>The UUT is not expected to operate when the vehicle is not running.</p> <p><b>Survival is required.</b></p>
3a	Yes	A	<b>Required</b>
3b	Yes	A	<b>Required</b>
4	Yes	A	Required to operate during engine cranking.

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8 TEST SETUPS

8.1 Radiated Immunity / ALSE

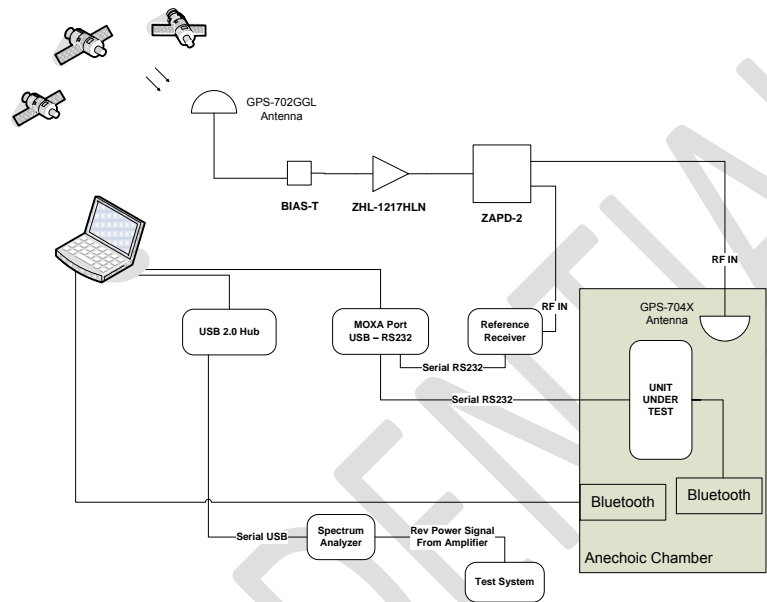


Figure 1: Test Configuration: Radiated Immunity & ISO11452-2 (ALSE)

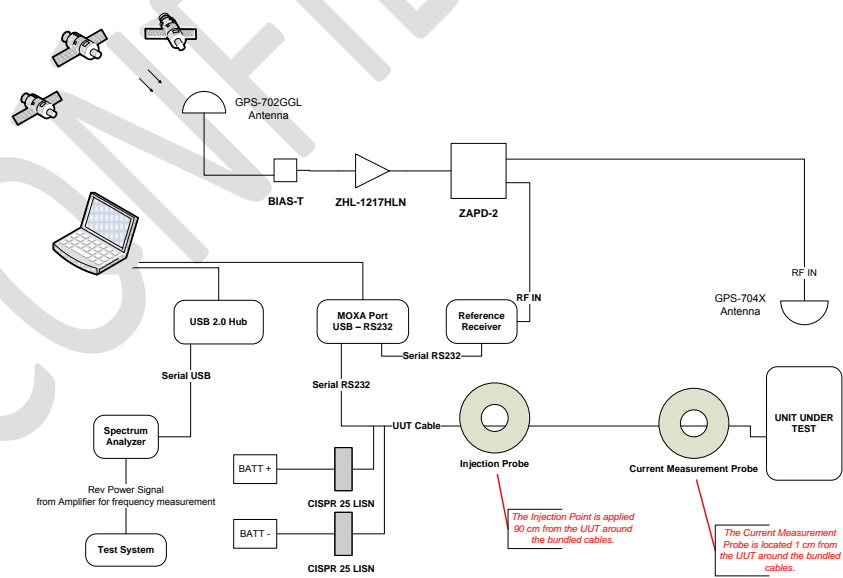


Figure 2: Test Configuration: 11452-4 Bulk Current Injection (Closed Loop Method)

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8.2 Emissions

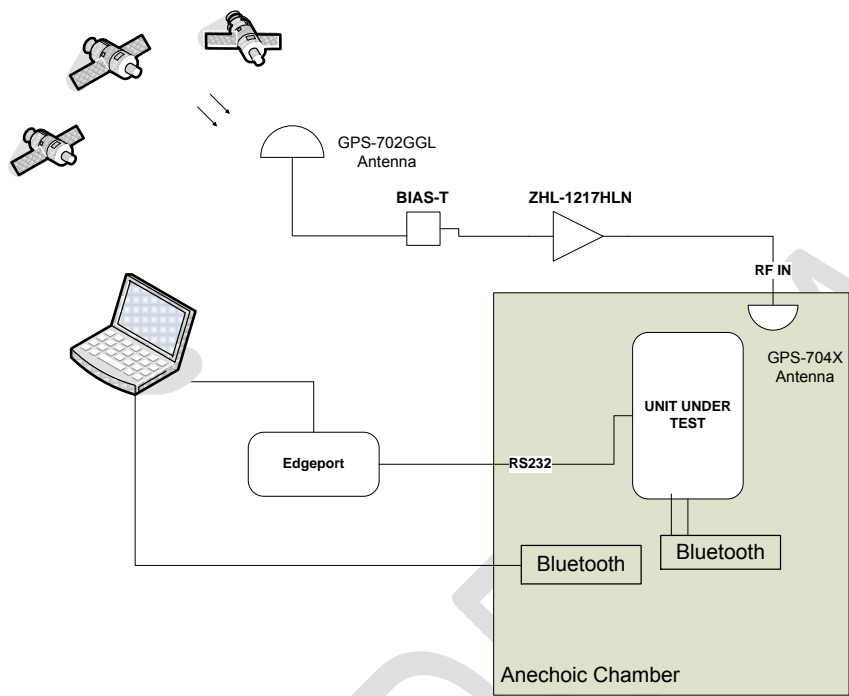


Figure 3: Test Configuration: Radiated Emissions Measurements

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## 9 SMART 6 PRODUCT DISCRIPTION

The Smart 6 Antenna is a smart antenna that includes an interface card, OEM615 and a GPS/GLONASS antenna. It is sealed by the rubber gasket on connector, adhesive label over LEDs and a permanently glued enclosure.



The System is comprised of:

- An interface card
- OEM615
- Bluetooth radio and internal antenna
- Internal GNSS antenna

The following communications are supported:

- RS232 (COM 1, 2, 3) [No flow control]
- CAN (J1939)
- PPS
- Mark-In
- Bluetooth
- Emulated Radar

Power:

- DC Input Voltage: +8 VDC to +36VDC.
- Power Consumption: 2.8 Watts (max) at 12 VDC

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Operating temperature range: -40°C to +75°C

## 9.1 Cable Listing

Part Number	Description	Port	Shield	Length
01018999	Smart AG Cable	Bundle Cable	Non-Shielded	5 meters

## 9.2 UUT Frequencies

Module	Signal Name	Frequency
OEM615	Crystal Oscillator	32.768 KHz
OEM615	VCTCXO	20 MHz
OEM615	I2C Clock; FFT Clock	40 MHz
OEM615	B Clock	100 MHz
OEM615	SD Clock	133 MHz
OEM615	VARF (Clock from Minos to uP)	25 MHz
OEM615	U1002 Switching Frequency	2.25 MHz
OEM615	U1008 Switching Frequency	5 MHz
OEM615	GPS L1 + GLONASS L1 RF Passband	1565 – 1610 MHz
OEM615	GPS L2 + GLONASS L2 RF Passband	1217 – 1254 MHz
OEM615	GPS L1 IF	134.42 MHz (20 MHz BW)
OEM615	GLONASS L1 IF	160.5MHz (17 MHz BW)
OEM615	GPS L2 / GLONASS L2 IF	124.5MHz (34 MHz BW)
OEM615	GPS L1 LO	1441 MHz
OEM615	RF VCO	1619 – 1649 MHz
OEM615	GPS VCO	1355 MHz
Interface Card	Bluetooth operating freq	2.402 GHz to 2.480 GHz
Interface Card	Bluetooth VCO	2.40 to 2.48 GHz
Interface Card	Bluetooth VCO origin, test mode only – gets downconverted to supply Bluetooth VCO	4.8 to 4.96 GHz
Interface Card	Bluetooth Crystal	13 MHz
Interface Card	Switching Power Supply	180 kHz and 220 kHz

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## 10 AG-STAR PRODUCT DESCRIPTION

### 10.1 Physical Description

The AG-STAR Antenna is a smart antenna that includes an interface card, OEMSTAR and a GPS L1/GLONASS L1 antenna. It is sealed by the rubber gasket on connector, adhesive label over LEDs and a permanently glued enclosure.



The System is comprised of:

- An interface card
- OEMSTAR
- Bluetooth radio and internal antenna
- Internal GNSS antenna

The following communications are supported:

- RS232 (COM 1, 2) [No flow control]
- CAN (J1939)
- PPS
- Mark-In
- Bluetooth
- Emulated Radar

Power:

- DC Input Voltage: +8 VDC to +36VDC.

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- Power Consumption: 2.8 Watts (max) at 12 VDC

Operating temperature range: -40°C to +75°C

## 10.2 Cable Listing

Part Number	Description	Port	Shield	Length
01018999	Smart AG Cable	Bundle Cable	Non-Shielded	5 meters

## 10.3 UUT Frequencies

Module	Component	Frequency Band [Hz]
OEMSTAR	VCTCXO	20.000 MHz
OEMSTAR	Crystal (ECX-31A)	32.768 kHz
OEMSTAR	Crystal (ABM9)	12.000 MHz
OEMSTAR	Maxim LO	GPS 1570.5 MHz
OEMSTAR	Maxim IF	GPS 4.92 MHz
OEMSTAR	Maxim LO	Glo 1603.406114
OEMSTAR	USB Clock	480 MHz
OEMSTAR	Power (switch node)	2 MHz fixed
OEMSTAR	PCK (MINOS6LX ASIC internal CPU clock)	200 MHz
OEMSTAR	SDDRCLK / SDDRCLKN (Memory Bus Clock for LP-DDR RAM)	100 MHz
OEMSTAR	GPS LO	1570.5 MHz
OEMSTAR	GPS IF-BW	2.5 MHz (double-sided)
OEMSTAR	GPS IF Freq	4.92 MHz
OEMSTAR	GLONASS LO	1603.406 MHz
OEMSTAR	GLONASS IF BW	18 MHz, double-sided
OEMSTAR	GLONASS IF Freq	0 Hz
OEMSTAR	GLONASS Channel Freq	K = 13; 6186.636 Hz
OEMSTAR	GLONASS Channel Freq	K = 7; -5624.864 Hz
Interface Card	Bluetooth operating freq	2.402 GHz to 2.480 GHz

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Module	Component	Frequency Band [Hz]
Interface Card	Bluetooth VCO	2.40 to 2.48 GHz
Interface Card	Bluetooth VCO origin, test mode only – gets downconverted to supply Bluetooth VCO	4.8 to 4.96 GHz
Interface Card	Bluetooth Crystal	13 MHz
Interface Card	Switching power supply	180 kHz and 220 kHz

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## Appendix B

### Measurement Protocol



## MEASUREMENT PROTOCOL

### GENERAL INFORMATION

#### Test Methodology

Emission testing is performed according to the procedures in ANSI C63.4-2009 and FCC KDB Publication DA 00-705.

#### Measurement Uncertainty

The test system for radiated emissions is defined as the antenna, the pre-amplifier, the spectrum analyzer and the coaxial cable. The test system has a measurement uncertainty of  $\pm 4.8$  dB. The equipment comprising the test systems is calibrated on an annual basis.

#### Justification

The Equipment Under Test (EUT) is configured in a typical user arrangement in accordance with the manufacturer's instructions. A cable is connected to each available port and either terminated with a peripheral into its characteristic impedance or left unterminated. When appropriate, the cables are manually manipulated with respect to each other to obtain maximum emissions from the unit.

#### Conducted Emissions

Final measurement levels are determined by connecting the antenna port of the DUT to a spectrum analyzer input via coaxial adapters, high frequency coax, and attenuators as necessary. The loss created by the interconnect apparatus is offset by settings within the analyzer. Specific analyzer settings are determined by the procedures throughout this report.

#### Radiated Emissions

The spectrum analyzer uses a quasi-peak detector for frequencies up to and including 1 GHz. For measurements above 1 GHz, peak and average detectors are used. The bandwidths used are equal to or greater than 100 Hz from 9 kHz to 150 kHz, 9 kHz from 150 kHz to 30 MHz, 100 kHz from 30 MHz to 1000 MHz, and 1 MHz from 1 GHz to 40 GHz. Video bandwidths are at least three times greater than the IF bandwidth. Average measurements above 1 GHz are also achieved using a peak detector with 1 MHz RBW and 10 Hz VBW.

The final level, in dB $\mu$ V/m, equals the reading from the spectrum analyzer (Level dB $\mu$ V), adding the antenna correction factor and cable loss factor (Factor dB) to it, and subtracting the preamp gain (and duty cycle correction factor, if applicable). This result then has the limit subtracted from it to provide the Delta, which gives the tabular data as shown in the data. Intentional radiators are rotated through 3 orthogonal axes to determine the test position yielding the maximum emission levels.

Example:

FREQ (MHz)	LEVEL (dB $\mu$ V)	CABLE/ANT/PREAMP (dB) (dB/m) (dB)	FINAL (dB $\mu$ V/m)	POL/HGT/AZ (m) (deg)	DELTA1
60.80	42.5Qp +	1.2 + 10.9 - 25.5 =	29.1	V 1.0 0.0	-10.9

#### Test Equipment

All measurement instrumentation is traceable to the National Institute of Standards and Technology and is calibrated according to internal procedure.