

# Test report

**282376-3TRFWL**

Date of issue: June 18, 2015

Applicant:

**Andrew Wireless Innovations Group**

Product:

**ION-E**

Model:

**UAP**

FCC ID:

**BCR-IONEUAP**

Specification:

**FCC 47 CFR Part 90**

Private Land Mobile Radio Services

#### Test location

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Company name	Nemko Canada Inc.
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City	Ottawa
Province	Ontario
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Country	Canada
Telephone	+1 613 737 9680
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Website	www.nemko.com
Site number	FCC test site registration number: 176392, IC: 2040A-4 (3 m semi anechoic chamber)

Tested by	Kevin Rose, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Date	June 18, 2015
Signature	

#### Limits of responsibility

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Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.

This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

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Section 1. Report summary

1.1 Applicant and manufacturer

Company name	Andrew Wireless Innovations Group
Address	620 N Greenfield Parkway
City	Garner
Province/State	NC
Postal/Zip code	27529
Country	USA

1.2 Test specifications

FCC 47 CFR Part 90	PRIVATE LAND MOBILE RADIO SERVICES
935210 D02 Signal Boosters Certification v02r01	Appendix D booster, amplifier, and repeater interim basic authorization procedures

1.3 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was completed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See “Summary of test results” for full details.

1.4 Exclusions

None

1.5 Test report revision history

Revision #	Details of changes made to test report
TRF	Original report issued



Section 2. Summary of test results

2.1 FCC Part 90 test results

Part	Test description	Verdict
§90.205 §90.219(e)(1)	RF Output Power	Pass
§90.210 §90.219(e)(3)	Conducted Spurious	Pass
§90.210 §90.219(e)(3)	Radiated Spurious	Pass
§90.213	Frequency stability	Pass
§90.210 §90.219(e)(4)(i)(ii)(iii)	Input vs Output	Pass
§90.214	Transient frequency behavior	Pass
§90.221	Adjacent channel power	Not applicable
§90.207	Modulation Characteristics	Pass
§90.219 (e)(2)	Noise figure	Pass

Notes: None

## Section 3. Equipment under test (EUT) details

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### 3.1 Sample information

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Receipt date	August 18, 2014
Nemko sample ID number	1

### 3.2 EUT information

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Product name	ION-E
Model	UAP
Serial number	18

### 3.3 Technical information

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Operating band	450–512 MHz
Modulation type	P25, FM
Power requirements	110 V <sub>AC</sub> , ~3 A for entire system tested
Emission designator	F1D, F3E
Gain	20 dB
Antenna information	Antenna Gain is -7.15 dBd

### 3.4 Product description and theory of operation

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The UAP amplifier is a multi-band, multi-operator remote unit configuration used in conjunction with a master unit in the ION-E optical distribution antenna system.

### 3.5 EUT exercise details

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The UAP was controlled via a Laptop interface with control software to configure the system.

3.6 EUT setup diagram

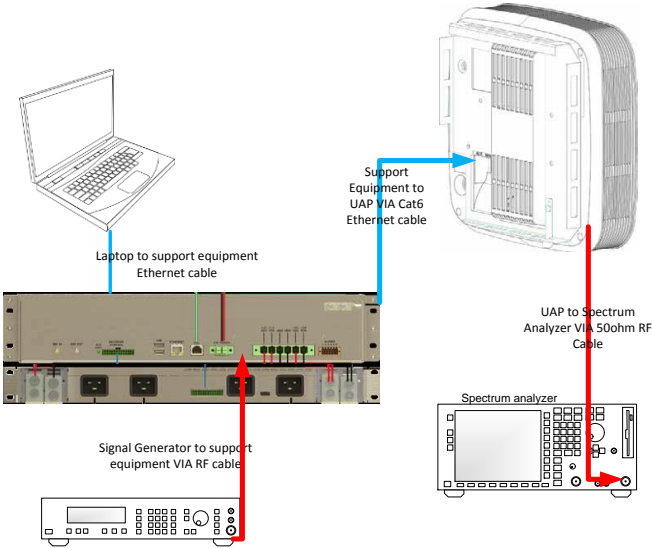


Figure 3.6-1: Setup diagram

Table 3.6-1: Support equipment

Description	Manufacturer	Model/Part number	Serial number	Rev.
Power Supply	GE	SP800XXXXXXZ0P3	14CS1227006	1
WCS rack	Commscope	WCS4	47	-



**Section 4. Engineering considerations**

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**4.1 Modifications incorporated in the EUT**

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There were no modifications performed to the EUT during this assessment.

**4.2 Technical judgment**

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None

**4.3 Deviations from laboratory tests procedures**

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No deviations were made from laboratory procedures.



# Section 5. Test conditions

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## 5.1 Atmospheric conditions

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Temperature	15–30 °C
Relative humidity	20–75 %
Air pressure	860–1060 mbar

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

## 5.2 Power supply range

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The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages  $\pm 5\%$ , for which the equipment was designed.



# Section 6. Measurement uncertainty

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## 6.1 Uncertainty of measurement

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Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of  $K = 2$  with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78

## Section 7. Test equipment

### 7.1 Test equipment list

*Table 7.1-1: Equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
3 m EMI test chamber	TDK	SAC-3	FA002047	1 year	Feb. 25/16
Flush mount turntable	Sunol	FM2022	FA002082	—	NCR
Controller	Sunol	SC104V	FA002060	—	NCR
Antenna mast	Sunol	TLT2	FA002061	—	NCR
Receiver/spectrum analyzer	Rohde & Schwarz	ESU 26	FA002043	1 year	Jan. 7/16
Spectrum analyzer	Rohde & Schwarz	FSU	FA001877	1 year	Mar. 27/16
Bilog antenna (20–3000 MHz)	Sunol	JB3	FA002108	1 year	Apr. 12/16
Horn antenna (1–18 GHz)	EMCO	3115	FA000825	1 year	Apr. 01/16
Pre-amplifier (1–18 GHz)	JCA	JCA118-503	FA002091	1 year	June 23/15
50 Ω coax cable	C.C.A.	None	FA002555	1 year	June 23/15
Signal generator	Rohde & Schwarz	SMIQ03E	FA001269	1 year	June 15/15
Signal generator	Rohde & Schwarz	SMIQ06B	FA001878	1 year	June 15/15
Noise Source	HP	346A	Rental	2 year	Mar 20/17
50 Ω coax cable	Huber + Suhner	None	FA002074	1 year	June 23/15
Temperature chamber	Thermotron	SM-16C	FA001030	1 year	NCR

Note: NCR - no calibration required

## Section 8. Testing data

### 8.1 FCC §90.205; §90.219(e)(1) RF Output Power

#### 8.1.1 Definitions and limits

Signal boosters must be deployed such that the radiated power of the each retransmitted channel, on the forward link and on the reverse link, does not exceed 5 Watts effective radiated power (ERP)

#### 8.1.2 Test summary

Test date	May 26, 2015	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1004 mbar
Verdict	Pass	Relative humidity	47 %

#### 8.1.3 Observations, settings and special notes

Worst case limit is used. Test receiver settings:

Detector mode	Peak
Resolution bandwidth	1 MHz
Integration bandwidth	>OBW
Video bandwidth	>RBW
Trace mode	Max Hold
Measurement time	Auto

#### 8.1.4 Test data

**Table 8.1-1: RF Output power results**

Modulation	Frequency, MHz	Conducted Power , dBm	Antenna Gain, dBd	ERP, W	Limit, W
Analog	475	8.08	-7.15	0.001	5.00
P25	475	8.02	-7.15	0.001	5.00

## 8.2 FCC §90.210; §90.219(e)(3) Conducted Spurious

### 8.2.1 Definitions and limits

Spurious emissions from a signal booster must not exceed  $-13$  dBm within any 100 kHz measurement bandwidth.

(c) Emission Mask C. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier output power (P) as follows:

- (1) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 5 kHz, but not more than 10 kHz: At least  $83 \log(f_d/5)$  dB;
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency ( $f_d$  in kHz) of more than 10 kHz, but not more than 250 percent of the authorized bandwidth: At least  $29 \log(f_d/11)$  dB or 50 dB, whichever is the lesser attenuation;
- (3) On any frequency removed from the center of the authorized bandwidth by more than 250 percent of the authorized bandwidth: At least  $43 + 10 \log(P)$  dB.

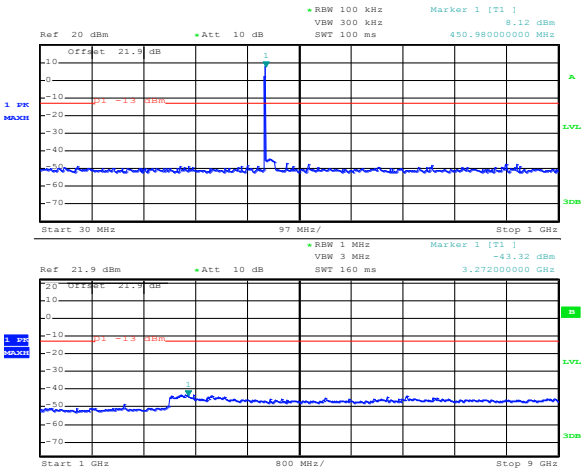
### 8.2.2 Test summary

Test date	April 28, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	32 %

### 8.2.3 Observations, settings and special notes

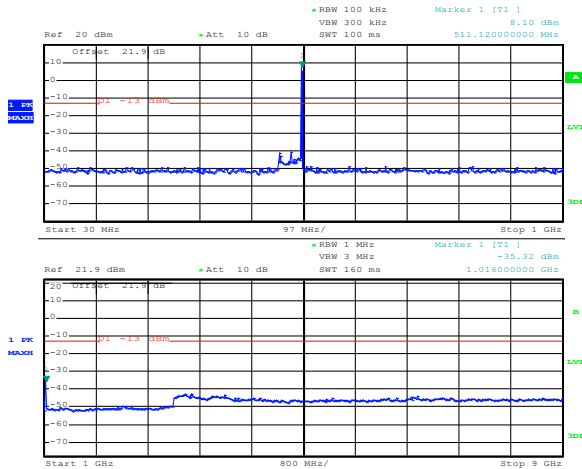
Frequency range	30 MHz to 10th harmonic
Detector mode	Peak
Resolution bandwidth sweep	100 kHz (below 1 GHz), 1000 kHz (above 1 GHz)
Resolution bandwidth band edge	> 1 % of OBW
Video bandwidth	>RBW
Trace mode	Max Hold
Measurement time	Auto

### 8.2.4 Test data



Date: 26.MAY.2015 20:05:52

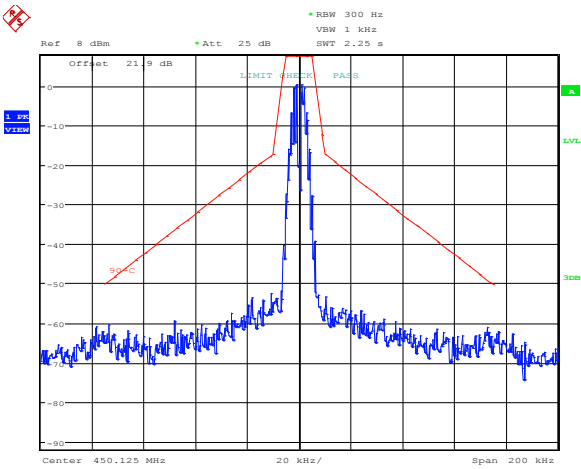
Figure 8.2-1: 30MHz to 9 GHz Analog



Date: 26.MAY.2015 20:08:33

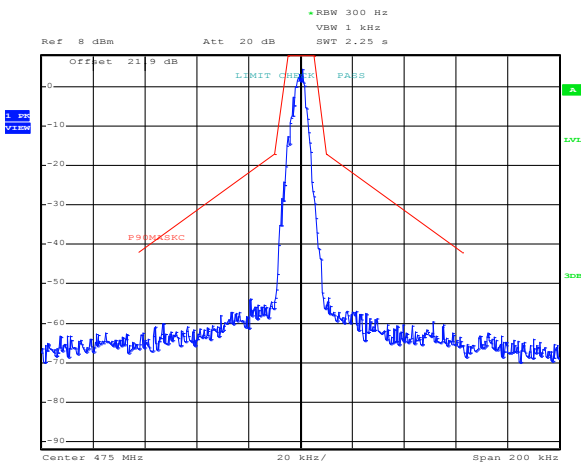
Figure 8.2-2: 30MHz to 9 GHz P25

8.2.4 Test data continued



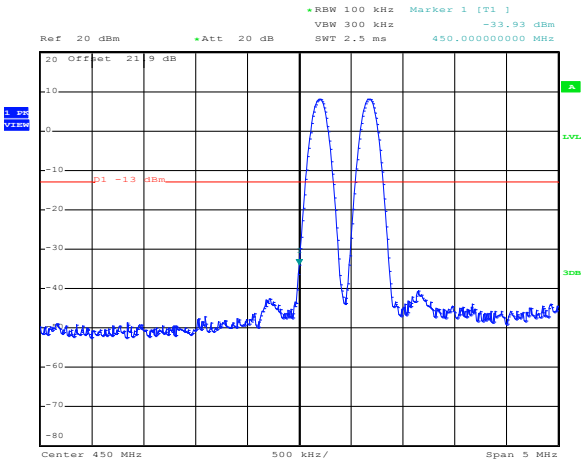
High channel  
Date: 29.APR.2015 20:58:30

Figure 8.2-3: Analog Mask C



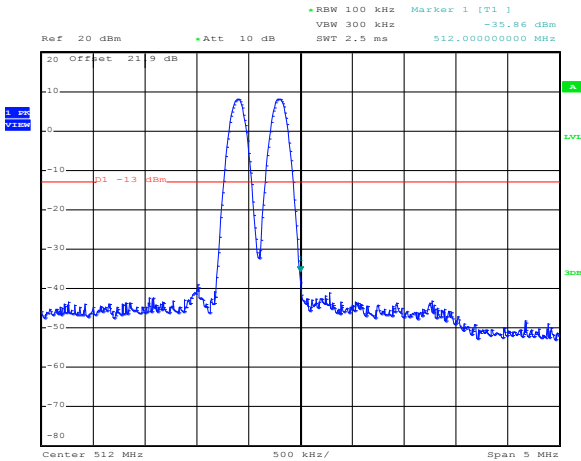
Date: 25.MAY.2015 19:09:08

Figure 8.2-4: P25 Mask C



Date: 26.MAY.2015 20:04:59

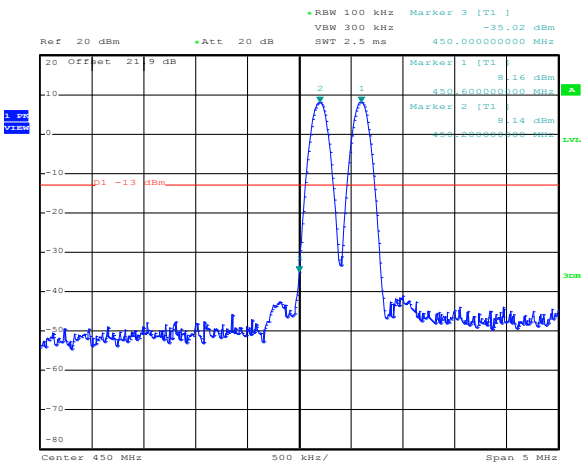
Figure 8.2-5: Analog Intermodulation



Date: 26.MAY.2015 20:10:16

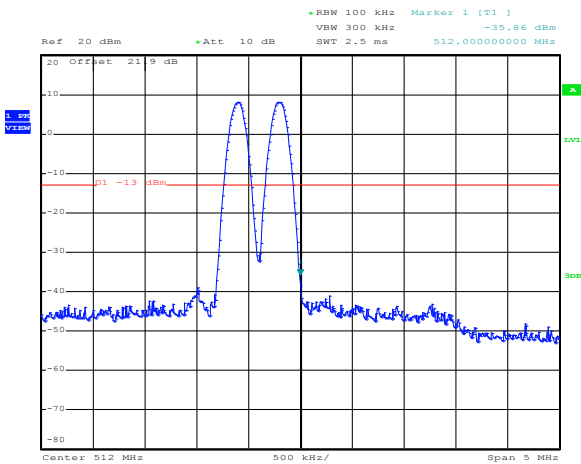
Figure 8.2-6: Analog Intermodulation

8.2.4 Test data continued



Date: 26.MAY.2015 20:02:56

Figure 8.2-7: P25 Intermodulation



Date: 26.MAY.2015 20:10:33

Figure 8.2-8: P25 Intermodulation



## 8.3 FCC §90.210(c)(3); §90.219(e)(3) Radiated Spurious

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### 8.3.1 Definitions and limits

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Spurious emissions from a signal booster must not exceed –13 dBm within any 100 kHz measurement bandwidth.

### 8.3.2 Test summary

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Test date	May 3, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1005 mbar
Verdict	Pass	Relative humidity	35 %

### 8.3.3 Observations, settings and special notes

---

Low, Mid, and High channels were investigated.

**No emissions were detected within 20 dB of the –13 dBm limit.**

Receiver settings were:

Frequency range	30 MHz to 10 <sup>th</sup> harmonic
Detector mode	Peak
Resolution bandwidth	100 kHz (below 1 GHz), 1 MHz (above 1 GHz)
Video bandwidth	>RBW
Trace mode	Max Hold

## 8.4 FCC §90.213 Frequency stability

### 8.4.1 Definitions and limits

Frequency range (MHz)	Fixed and base stations, PPM	Mobile stations Over 2 W output power, PPM	Mobile stations 2 W or less output power, PPM
421-512	<sup>7 11 14</sup> 2.5	<sup>8</sup> 5	85

<sup>7</sup>In the 421-512 MHz band, fixed and base stations with a 12.5 kHz channel bandwidth must have a frequency stability of 1.5 ppm. Fixed and base stations with a 6.25 kHz channel bandwidth must have a frequency stability of 0.5 ppm.

<sup>8</sup>In the 421-512 MHz band, mobile stations designed to operate with a 12.5 kHz channel bandwidth must have a frequency stability of 2.5 ppm. Mobile stations designed to operate with a 6.25 kHz channel bandwidth must have a frequency stability of 1.0 ppm.

<sup>11</sup>Paging transmitters operating on paging-only frequencies must operate with frequency stability of 5 ppm in the 150-174 MHz band and 2.5 ppm in the 421-512 MHz band.

<sup>14</sup>Control stations may operate with the frequency tolerance specified for associated mobile frequencies

### 8.4.2 Test summary

Test date	April 23, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	36 %

### 8.4.3 Observations, settings and special notes

Assessed to remain within assigned band. Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	20 Hz
Video bandwidth	RBW × 3
Trace mode	Max Hold

### 8.4.4 Test data

**Table 8.4-1: Frequency Stability result**

Test conditions	Frequency, MHz	Offset, Hz
+50 °C, Nominal	459.997983	0
+40 °C, Nominal	459.997983	0
+30 °C, Nominal	459.997983	0
+20 °C, +15 %	459.997983	0
+20 °C, Nominal	459.997983	Reference
+20 °C, -15 %	459.997983	0
+10 °C, Nominal	459.997983	0
0 °C, Nominal	459.997983	0
-10 °C, Nominal	459.997983	0
-20 °C, Nominal	459.997983	0
-30 °C, Nominal	459.997983	0

## 8.5 FCC §90.214 Transient frequency behavior

### 8.5.1 Definitions and limits

Transmitters designed to operate in the 150-174 MHz and 421-512 MHz frequency bands must maintain transient frequencies within the maximum frequency difference limits during the time intervals indicated:

Time intervals <sup>1 2</sup>	Maximum
frequency difference <sup>3</sup>	All equipment
150 to 174 MHz	421 to 512 MHz
Transient Frequency Behavior for Equipment Designed to Operate on 25 kHz Channels	
t <sub>14</sub>	±25.0 kHz 5.0 ms 10.0 ms
t <sub>2</sub>	±12.5 kHz 20.0 ms 25.0 ms
t <sub>34</sub>	±25.0 kHz 5.0 ms 10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 12.5 kHz Channels	
t <sub>14</sub>	±12.5 kHz 5.0 ms 10.0 ms
t <sub>2</sub>	±6.25 kHz 20.0 ms 25.0 ms
t <sub>34</sub>	±12.5 kHz 5.0 ms 10.0 ms
Transient Frequency Behavior for Equipment Designed to Operate on 6.25 kHz Channels	
t <sub>14</sub>	±6.25 kHz 5.0 ms 10.0 ms
t <sub>2</sub>	±3.125 kHz 20.0 ms 25.0 ms
t <sub>34</sub>	±6.25 kHz 5.0 ms 10.0 ms

t<sub>on</sub> is the instant when a 1 kHz test signal is completely suppressed, including any capture time due to phasing.

t<sub>1</sub> is the time period immediately following t<sub>on</sub>.

t<sub>2</sub> is the time period immediately following t<sub>1</sub>.

t<sub>3</sub> is the time period from the instant when the transmitter is turned off until t<sub>off</sub>.

t<sub>off</sub> is the instant when the 1 kHz test signal starts to rise.

<sup>2</sup> During the time from the end of t<sub>2</sub> to the beginning of t<sub>3</sub>, the frequency difference must not exceed the limits specified in §90.213.

<sup>3</sup> Difference between the actual transmitter frequency and the assigned transmitter frequency.

<sup>4</sup> If the transmitter carrier output power rating is 6 watts or less, the frequency difference during this time period may exceed the maximum frequency difference for this time period.

### 8.5.2 Test summary

Test date	April 15, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

### 8.5.3 Observations, settings and special notes

Assessed to remain within assigned band. Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	20 Hz
Video bandwidth	RBW × 3
Trace mode	Max Hold

8.5.4 Test data

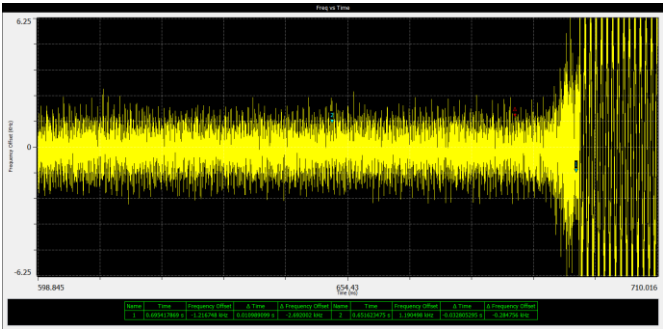


Figure 8.5-1: 6 Start

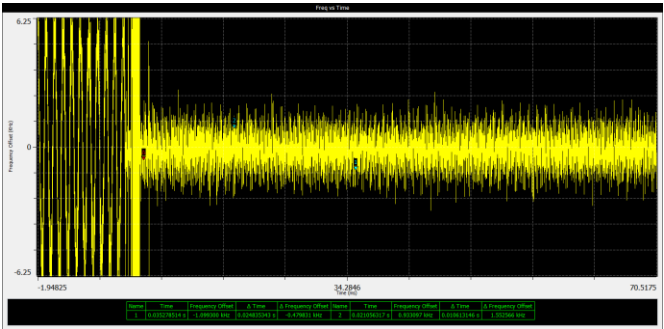


Figure 8.5-2: 6 Stop

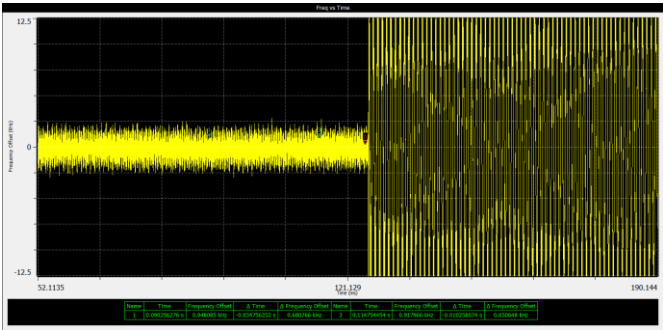


Figure 8.5-3: 12 Start

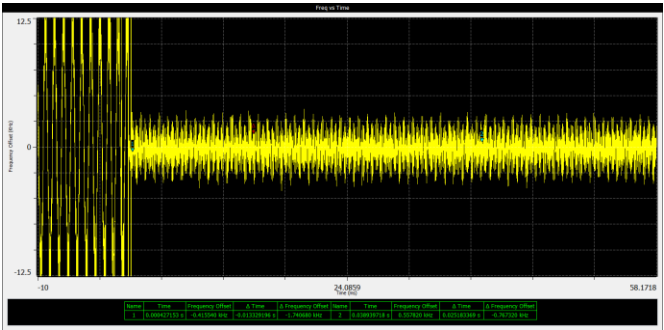


Figure 8.5-4: 12 Stop

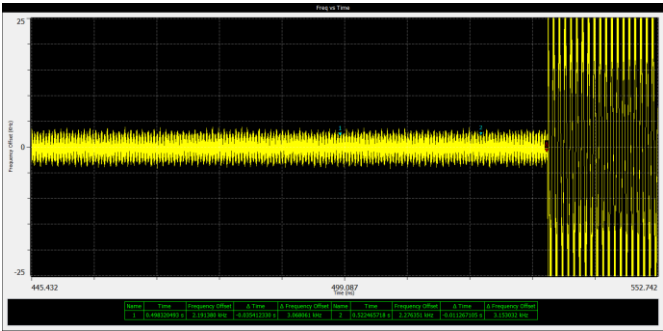


Figure 8.5-5: 25 Start

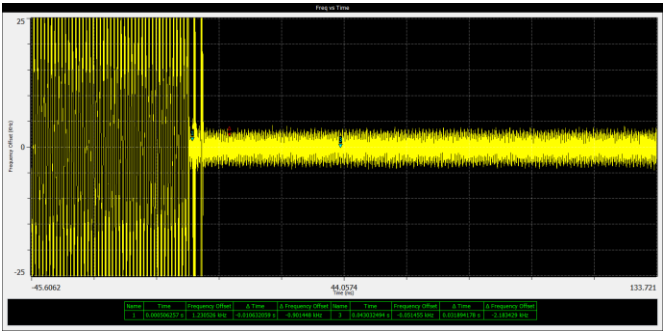


Figure 8.5-6: 25 Stop

## 8.6 FCC §90.210; §90.219(e)(4)(i)(ii)(iii) Input vs Output

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### 8.6.1 Definitions and limits

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(4) A signal booster must be designed such that all signals that it retransmits meet the following requirements:

(i) The signals are retransmitted on the same channels as received. Minor departures from the exact provider or reference frequencies of the input signals are allowed, provided that the retransmitted signals meet the requirements of §90.213.

(ii) There is no change in the occupied bandwidth of the retransmitted signals.

(iii) The retransmitted signals continue to meet the unwanted emissions limits of §90.210 applicable to the corresponding received signals (assuming that these received signals meet the applicable unwanted emissions limits by a reasonable margin)

### 8.6.2 Test summary

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Test date	May 25, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

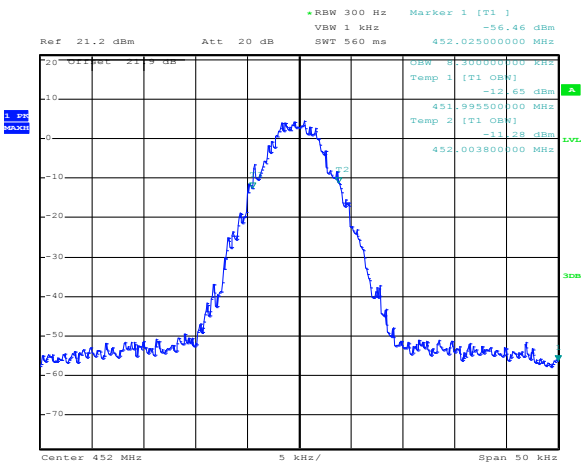
### 8.6.3 Observations, settings and special notes

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Spectrum analyzer settings:

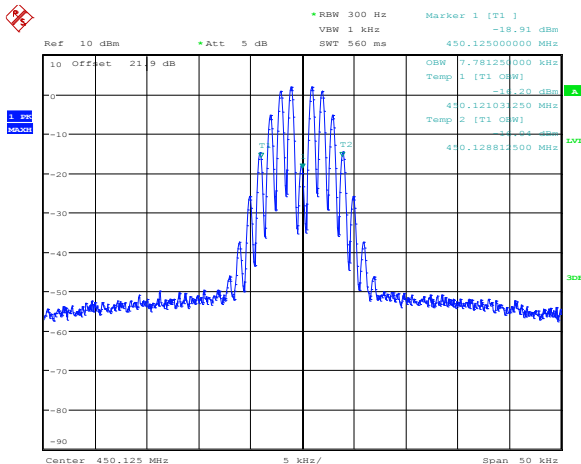
Detector mode	Peak
Resolution bandwidth	≥1 % of OBW
Video bandwidth	≥ RBW
Trace mode	Max Hold

8.6.4 Test data



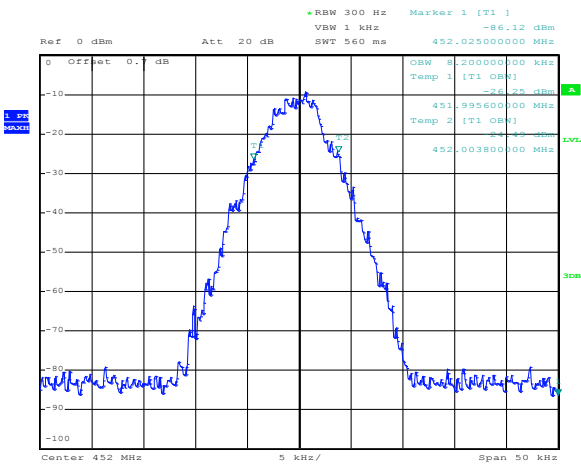
Date: 25.MAY.2015 20:07:29

Figure 8.6-1: P25 output



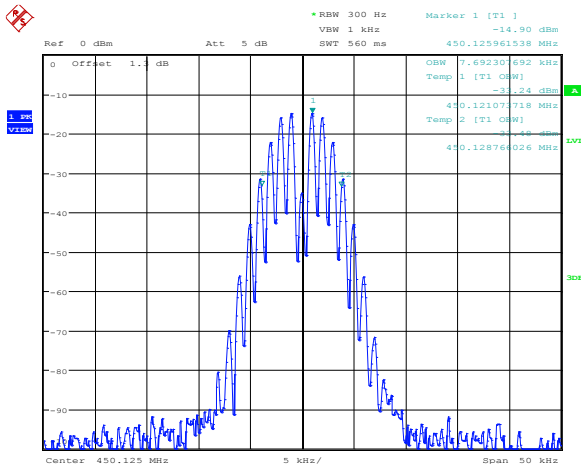
High channel  
Date: 29.APR.2015 20:23:55

Figure 8.6-2: Analog output



Date: 25.MAY.2015 20:06:25

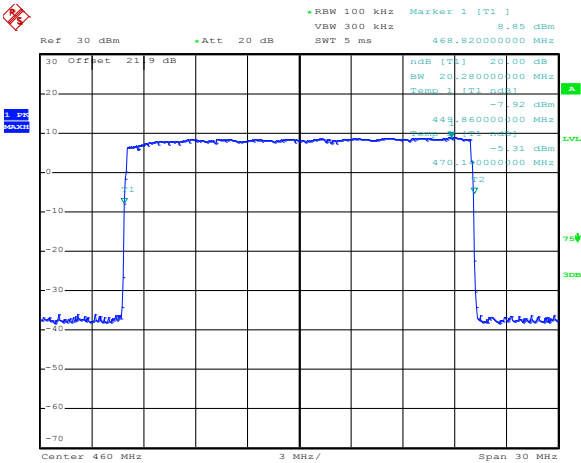
Figure 8.6-3: P25 input



High channel  
Date: 29.APR.2015 20:26:16

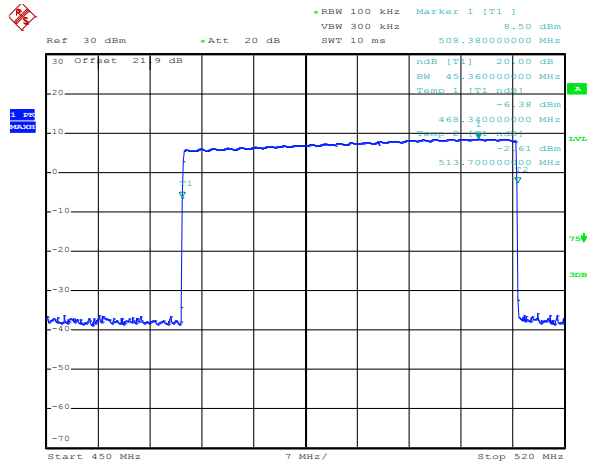
Figure 8.6-4: Analog input

8.6.4 Test data continued



Date: 29.APR.2015 14:14:24

Figure 8.6-5: Filter response



Date: 29.APR.2015 14:18:06

Figure 8.6-6: Filter response

## 8.7 FCC §90.219 (e)(2) Noise figure

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### 8.7.1 Definitions and limits

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T The noise figure of a signal booster must not exceed 9 dB in either direction.

### 8.7.2 Test summary

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Test date	May 3, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

### 8.7.3 Observations, settings and special notes

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Assessed to remain within assigned band. Spectrum analyzer settings:

Detector mode	Peak
Resolution bandwidth	1 MHz
Video bandwidth	RBW × 3
Trace mode	Average

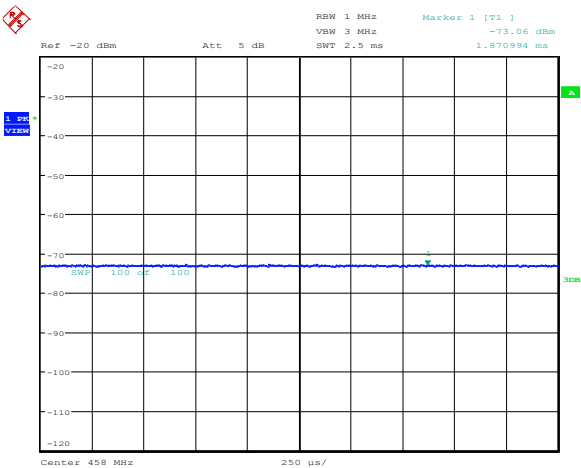


8.7.4 Test data

Table 8.7-1: Noise figure result

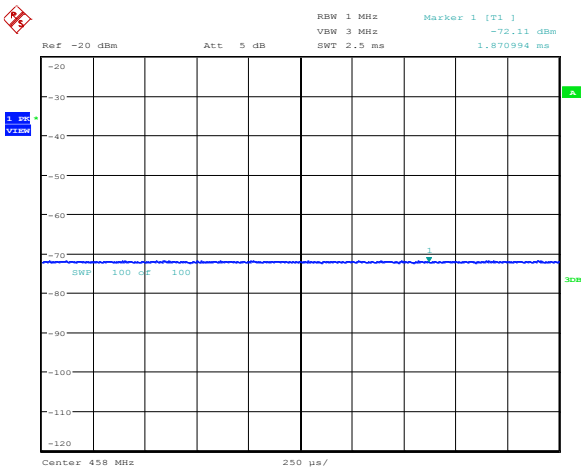
Noise Source OFF, dBm	Noise Source ON, dBm	ENR, dB	NF Result, dB	Limit, dB	Margin, dB
-73.06	-72.11	5.04	4.73	9.00	4.27

Noise Figure (NF) =  $10 \cdot \log_{10} (10^{(ENR/10)} / 10^{(Y/10)} - 1)$   
Y= Noise Source OFF - Noise Source ON  
ENR= Noise level above Thermal noise



High channel  
Date: 3.MAY.2015 14:12:55

Figure 8.7-1: 5 Noise off



High channel  
Date: 3.MAY.2015 14:13:35

Figure 8.7-2: Noise on

## Section 9. Setup Photos

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### 9.1 Set-up

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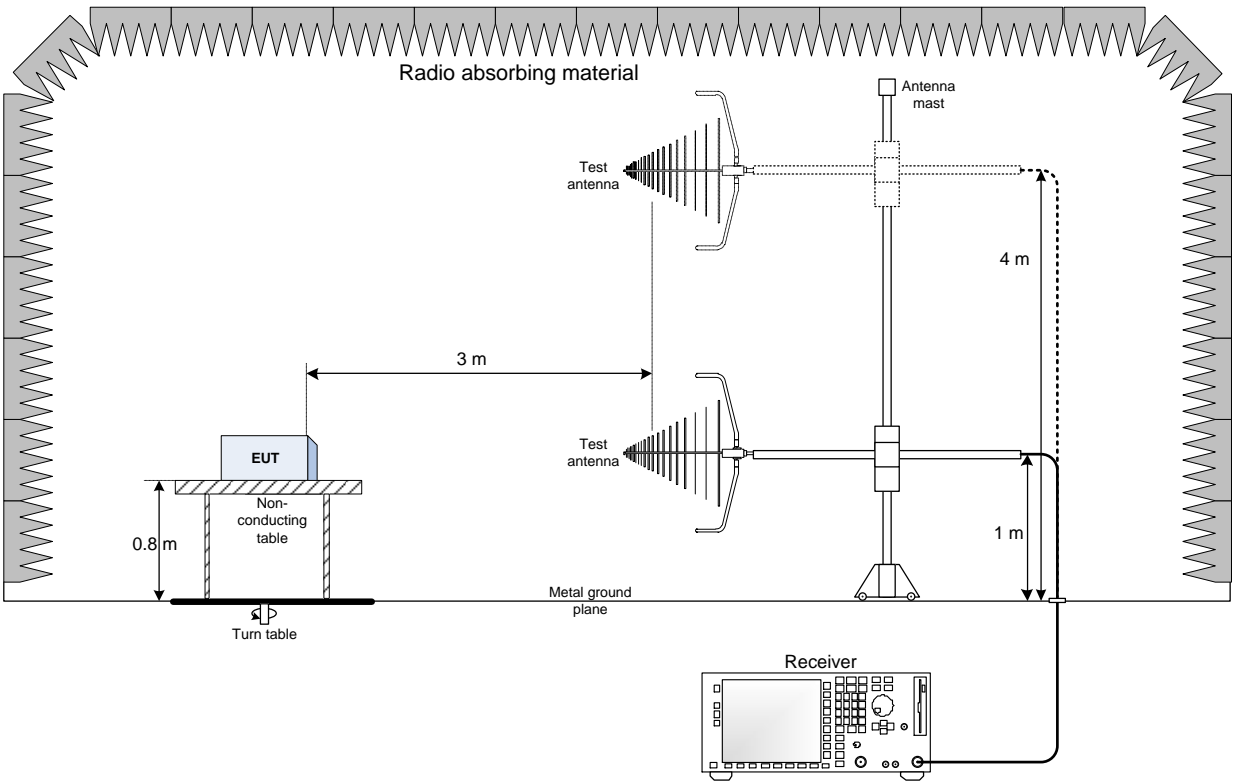
*Figure 9.1-1: Radiated setup photo*



*Figure 9.1-2: Conducted setup photo*

# Section 10. Block diagrams of test set-ups

## 10.1 Radiated emissions set-up



## 10.2 Noise figure set-up

