

Test report

279893-1TRFWL

Date of issue: September 23, 2015

Applicant:

Fiber-Span

Product:

Digital Narrowband Class A Signal Booster

Model:

FS71C-85

FCC ID:

Q4VFS71C-85

Specification:

FCC 47 CFR Part 90

Private land mobile radio services

Test location

Company name	Nemko Canada Inc.
Address	303 River Road
City	Ottawa
Province	Ontario
Postal code	K1V 1H2
Country	Canada
Telephone	+1 613 737 9680
Facsimile	+1 613 737 9691
Toll free	+1 800 563 6336
Website	www.nemko.com
Site number	FCC test site registration number: 176392 (3 m semi anechoic chamber)

Tested by	Kevin Rose, Wireless/EMC Specialist
Reviewed by	Andrey Adelberg, Senior Wireless/EMC Specialist
Date	September 23, 2015
Signature	

Limits of responsibility

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	Fiber-Span
Address	3434 Rt. 22W, Ste 140
City	Branchburg
Province/State	NJ
Postal/Zip code	08876
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	Not applicable
\$90.210 \$90.219(e)(4)(i)(ii)(iii)	Input Vs Output	Pass
\$90.214	Transient frequency behavior	Not applicable
\$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

3.1 Sample information

Receipt date	March 16, 2015
Nemko sample ID number	1

3.2 EUT information

Product name	Digital Narrowband Class A Signal Booster
Model	FS71C-85
Serial number	A3313-1-1, A3313-1-2

3.3 Technical information

Operating band	Uplink: 806–824 MHz and Downlink: 851–869 MHz
Modulation type	Analog FM
Power requirements	110–240 V _{AC} , 50/60 Hz
Emission designator	F3E
Gain	85 dB
Antenna information	Typical antenna information is DL unity gain Omni Antenna. UL 7 dBi Yagi with a minimum of 5 dB cable loss from the EUT.

3.4 Product description and theory of operation

The DHRU amplifies RF frequencies in both the downlink and uplink paths with duplexers that provide both downlink and uplink frequency bands on a single distributed antenna system.

3.5 EUT exercise details

The EUT used a hyperterm interface to change the channels.

3.6 EUT setup diagram

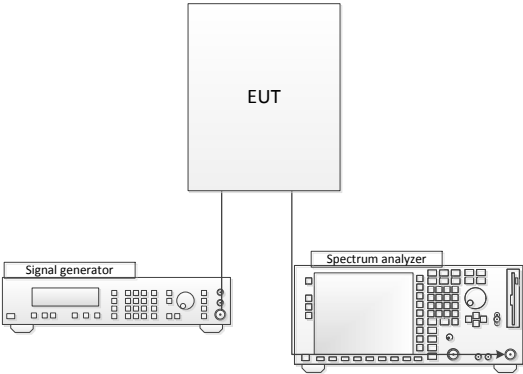


Figure 3.6-1: Setup diagram

Section 4. Engineering considerations

4.1 Modifications incorporated in the EUT

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

4.2 Technical judgment

There was no control of the AGC. The end user has no ability to turn AGC off.

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5. Test conditions

5.1 Atmospheric conditions

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

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

6.1 Uncertainty of measurement

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

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)

(s) The output power shall not exceed by more than 20 percent either the output power shown in the Radio Equipment List [available in accordance with §90.203(a)(1)] for transmitters included in this list or when not so listed, the manufacturer's rated output power for the particular transmitter specifically listed on the authorization.

8.1.2 Test summary

Test date	April 15, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	38 %

8.1.3 Observations, settings and special notes

There was no control of the AGC. The end user has no ability to turn AGC off.
Worst case limit is used. Test receiver settings:

Detector mode	Peak
Resolution bandwidth	1 MHz
Intergration 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

UL/DL	Frequency, MHz	Conducted power, dBm	Antenna Gain, dBd	Minimum Cable loss to Antenna, dB	Calculated output, dBm	ERP, dBm	ERP limit, W
UL	806.025	36.55	4.85	5.00	36.40	4.37	5.00
UL	809.025	37.04	4.85	5.00	36.89	4.89	5.00
UL	823.975	36.96	4.85	5.00	36.81	4.80	5.00
DL	851.025	37.11	-2.15	0.00	34.96	3.13	5.00
DL	854.025	37.1	-2.15	0.00	34.95	3.13	5.00
DL	868.975	37.13	-2.15	0.00	34.98	3.15	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.

Emission Mask H. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier 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 4 kHz or less: Zero dB.
- (2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 4 kHz, but no more than 8.5 kHz: At least $107 \log(f_d/4)$ dB;
- (3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 8.5 kHz, but no more than 15 kHz: At least $40.5 \log(f_d/1.16)$ dB;
- (4) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (f_d in kHz) of more than 15 kHz, but no more than 25 kHz: At least $116 \log(f_d/6.1)$ dB;
- (5) On any frequency removed from the center of the authorized bandwidth by more than 25 kHz: At least $43 + \log(P)$ dB.

Emission Mask G. For transmitters that are not equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier 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 10 kHz, but no more than 250 percent of the authorized bandwidth: At least $116 \log(f_d/6.1)$ dB, or $50 + 10 \log(P)$ dB, or 70 dB, whichever is the lesser attenuation;
- (2) 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

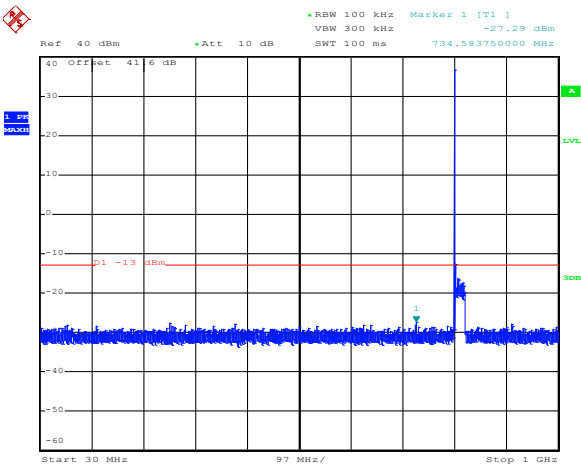
Test date	April 28, 2015	Temperature	23 °C
Test engineer	Kevin Rose	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	32 %

8.2.3 Observations, settings and special notes

Frequencies used in the intermodulation plots, (805.975 –806.700 MHz) (823.250–825.750 MHz) (852.025 –851.500 MHz) (867.975 –868.375 MHz)

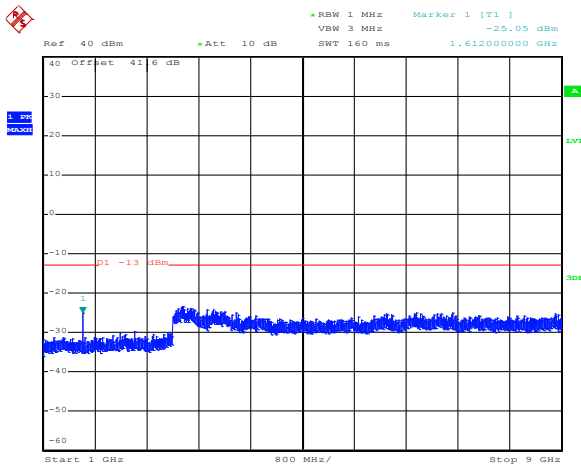
Frequency range	30 MHz to 10 th harmonic
Detector mode	Peak
Resolution bandwidth sweep	100 kHz (below 1 GHz), 1000 kHz (above 1 GHz)
Resolution bandwidth band edge	> 1 % of OBW
Video bandwidth	>RBW
Trace mode	Max Hold
Measurement time	Auto

8.2.4 Test data



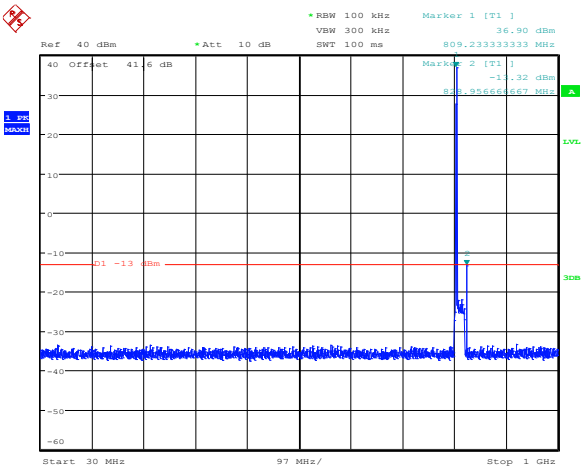
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Figure 8.2-1: 806.025 MHz Spurious 30–1000 MHz



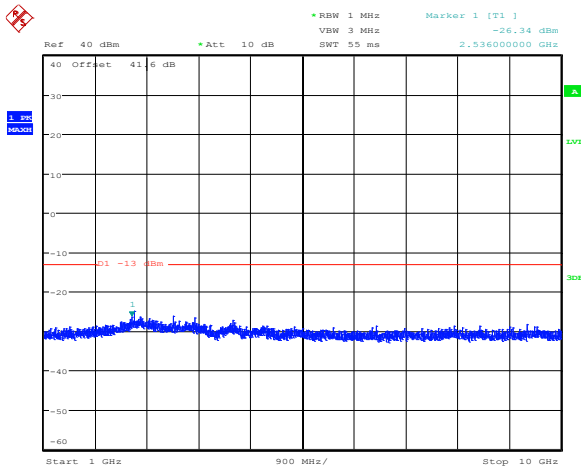
Date: 28.APR.2015 16:58:15

Figure 8.2-2: 806.025 MHz Spurious 1–9 GHz



High channel
Date: 15.APR.2015 19:06:03

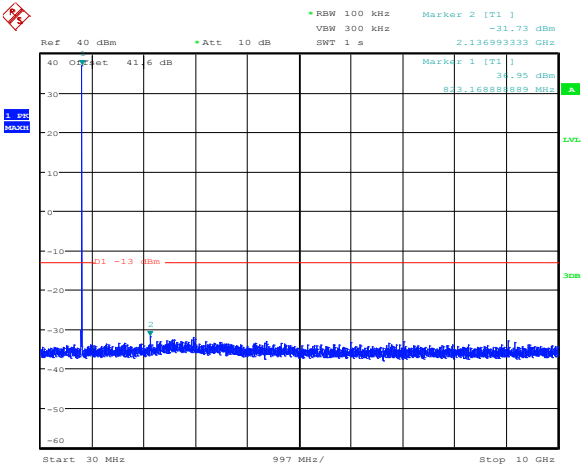
Figure 8.2-3: 809.025 MHz Spurious 30–1000 MHz



High channel
Date: 15.APR.2015 19:06:31

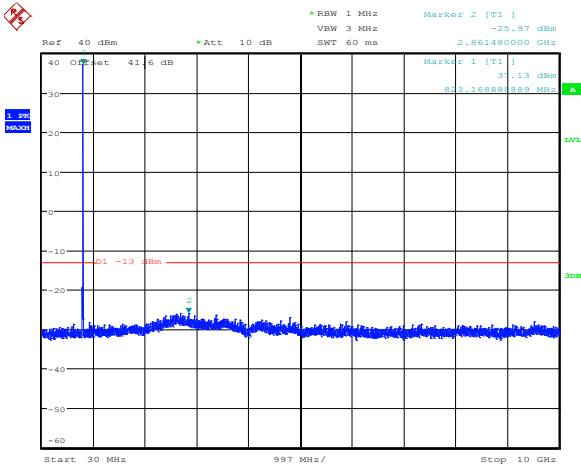
Figure 8.2-4: 809.025 MHz Spurious 1–10 GHz

8.2.4 Test data continued



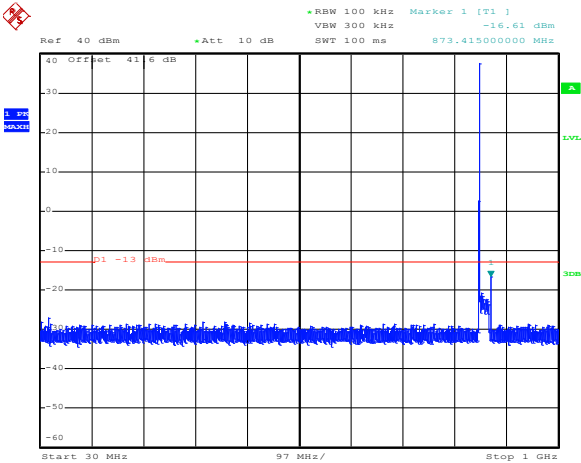
High channel
Date: 15.APR.2015 15:13:47

Figure 8.2-5: 823.975 MHz Spurious 30 MHz –10 GHz



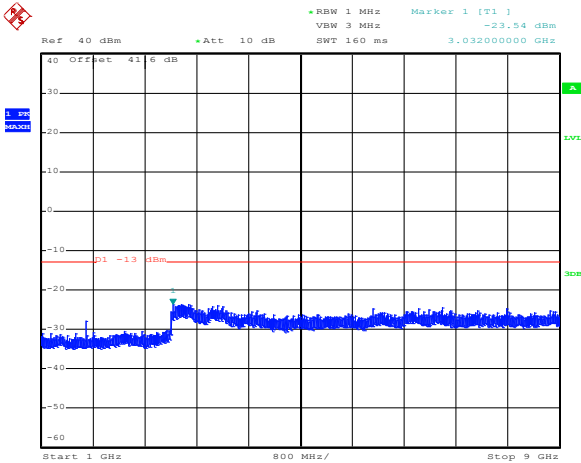
High channel
Date: 15.APR.2015 15:14:40

Figure 8.2-6: 823.975 MHz Spurious 30 MHz –10 GHz



Date: 28.APR.2015 13:53:08

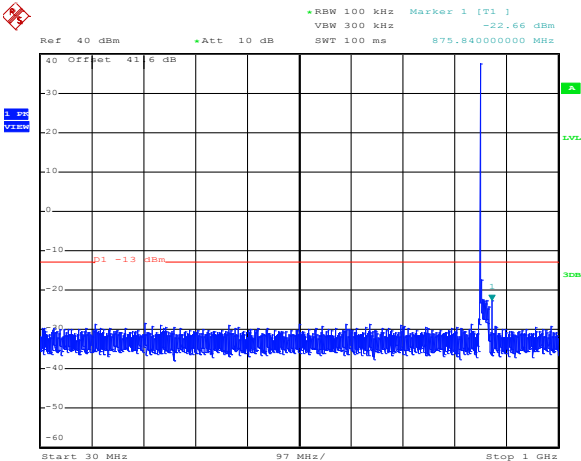
Figure 8.2-7: 851.025 MHz Spurious 30–1000 MHz



Date: 28.APR.2015 13:54:16

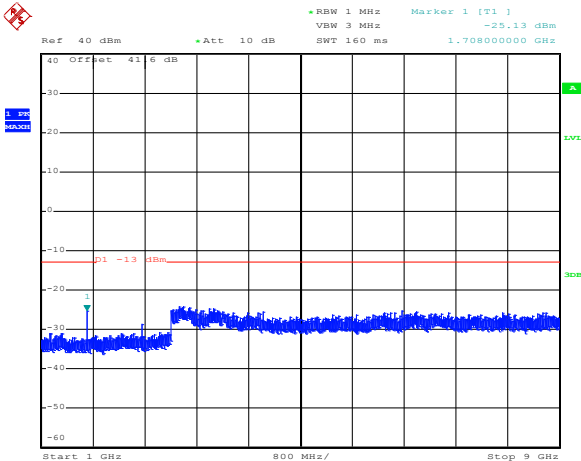
Figure 8.2-8: 851.025 MHz Spurious 1–9 GHz

8.2.4 Test data continued



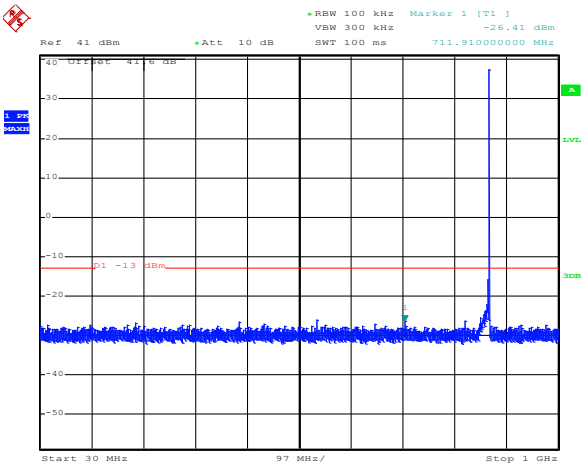
Date: 28.APR.2015 14:46:50

Figure 8.2-9: 854.025 MHz Spurious 30–1000 MHz



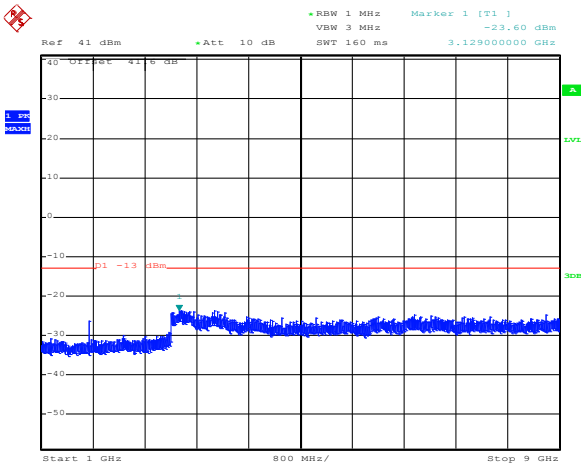
Date: 28.APR.2015 14:48:09

Figure 8.2-10: 854.025 MHz Spurious 1–9 GHz



Date: 28.APR.2015 18:28:32

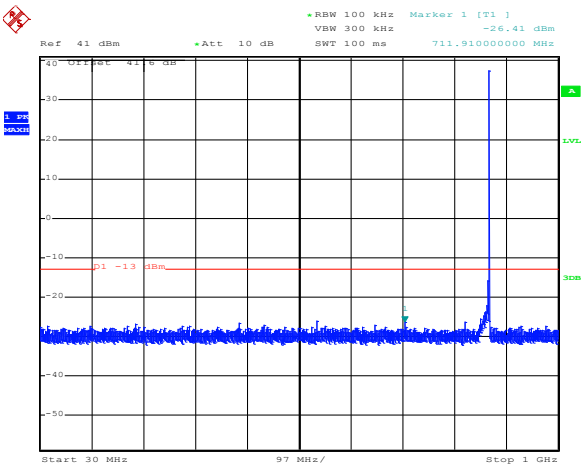
Figure 8.2-11: 868.975 MHz Spurious 30–1000 MHz



Date: 28.APR.2015 18:29:15

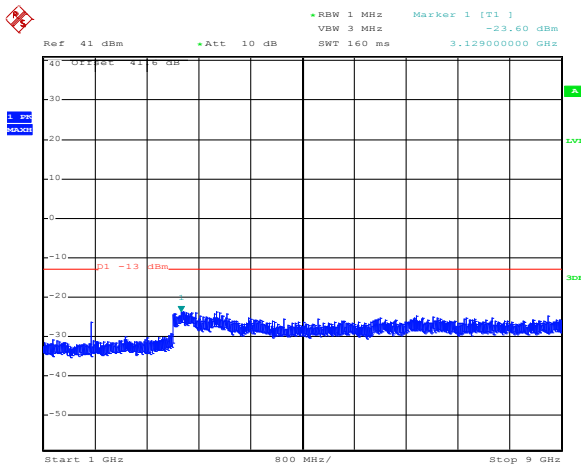
Figure 8.2-12: 868.975 MHz Spurious 1–9 GHz

8.2.4 Test data continued



Date: 28.APR.2015 18:28:32

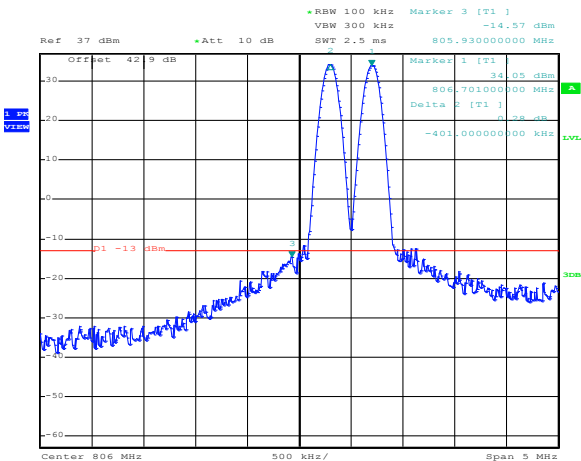
Figure 8.2-13: 851.025 MHz Spurious 30–1000 MHz



Date: 28.APR.2015 18:29:15

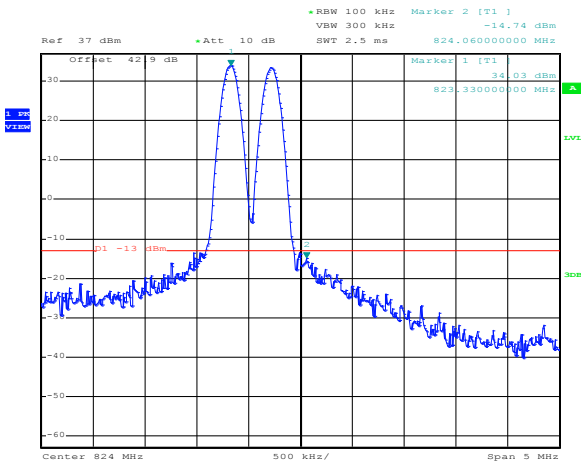
Figure 8.2-14: 851.025 MHz Spurious 1–9 GHz

8.2.4 Test data continued



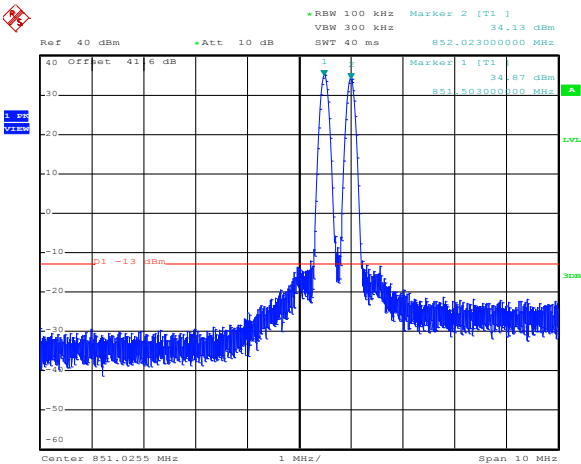
Date: 20.MAY.2015 15:06:20

Figure 8.2-15: 806 MHz Intermodulation



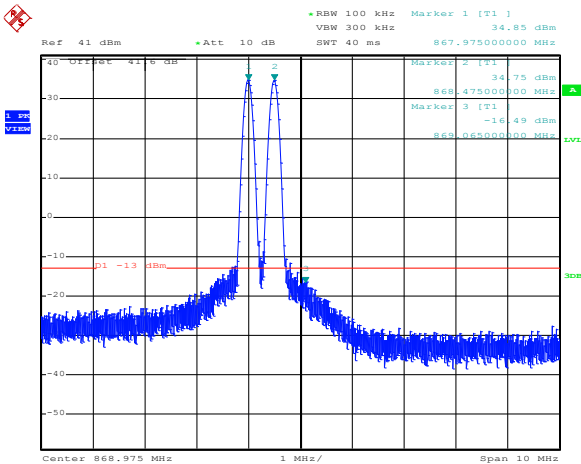
Date: 20.MAY.2015 15:11:31

Figure 8.2-16: 824 MHz Intermodulation



Date: 28.APR.2015 14:10:00

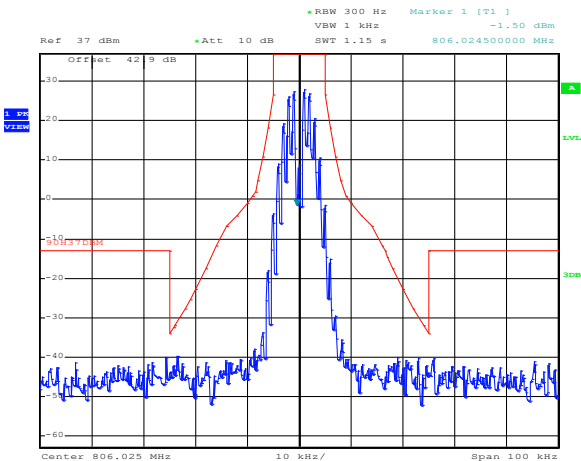
Figure 8.2-17: 851 MHz Intermodulation



Date: 28.APR.2015 18:34:17

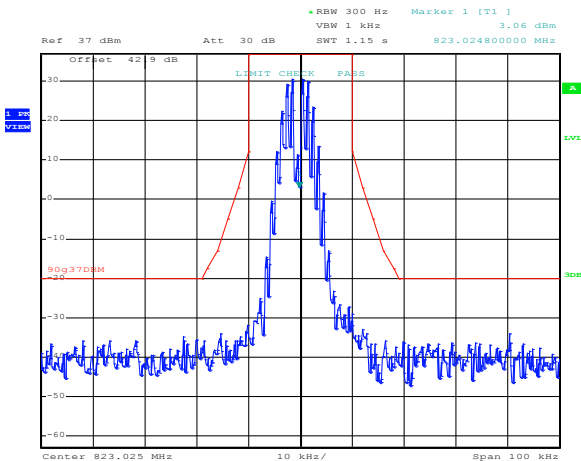
Figure 8.2-18: 869 MHz Intermodulation

8.2.4 Test data continued



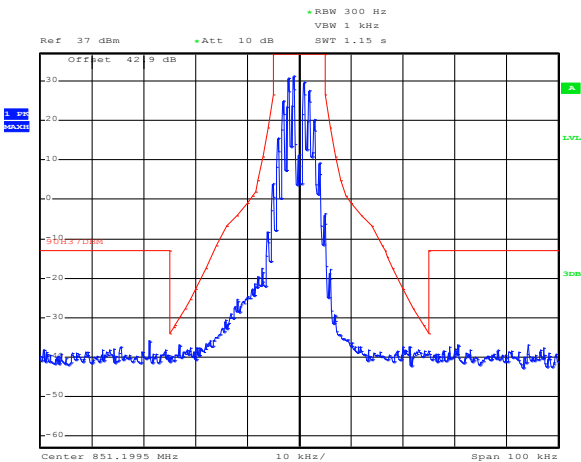
Date: 20.MAY.2015 14:59:29

Figure 8.2-19: 806.025 MHz Mask H



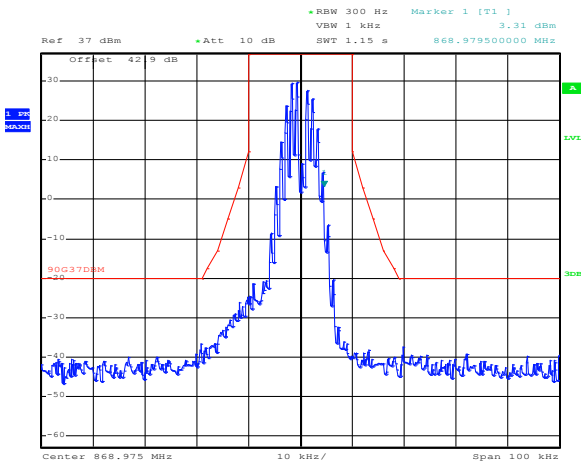
Date: 12.MAY.2015 14:19:15

Figure 8.2-20: 823.975 MHz Mask G



Date: 20.MAY.2015 18:05:08

Figure 8.2-21: 851.025 MHz Mask H



Date: 20.MAY.2015 18:07:56

Figure 8.2-22: 868.975 MHz Mask G

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

8.3.1 Definitions and limits

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

8.3.2 Test summary

Test date	April 28, 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 th 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 §90.210; §90.219(e)(4)(i)(ii)(iii) Input vs Output

8.4.1 Definitions and limits

(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)

8.4.2 Test summary

Test date	April 29, 2015	Temperature	22 °C
Test engineer	Kevin Rose	Air pressure	1003 mbar
Verdict	Pass	Relative humidity	46 %

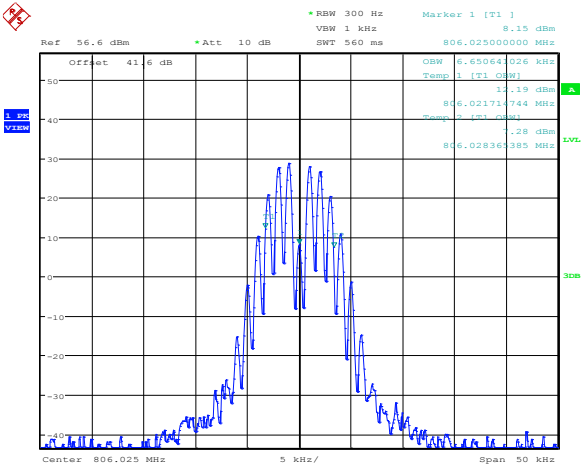
8.4.3 Observations, settings and special notes

There was no control of the AGC. The end user has no ability to turn AGC off.

Spectrum analyzer settings:

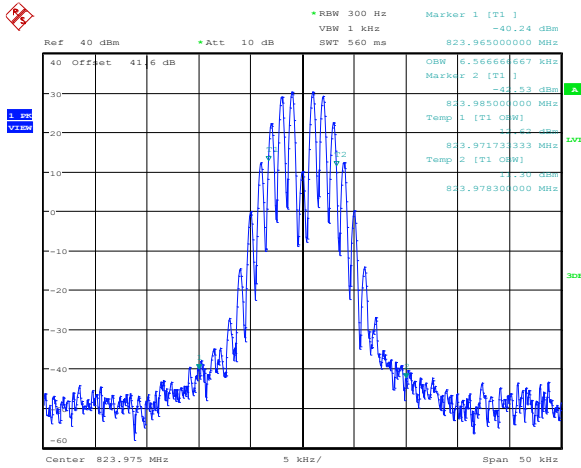
Detector mode	Peak
Resolution bandwidth	≥1 % of OBW
Video bandwidth	≥ RBW
Trace mode	Max Hold

8.4.4 Test data



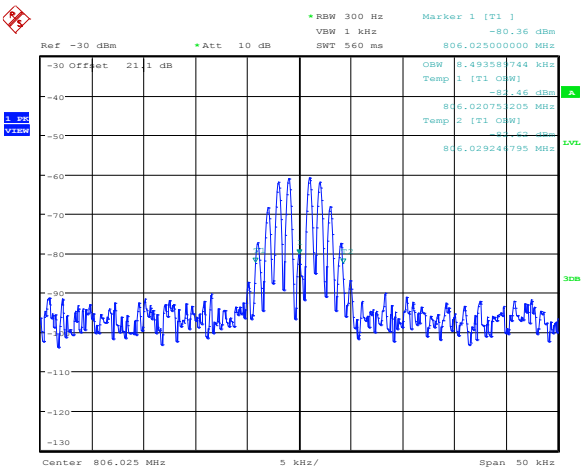
High channel
Date: 15.APR.2015 17:52:28

Figure 8.4-1: 806.025 MHz output



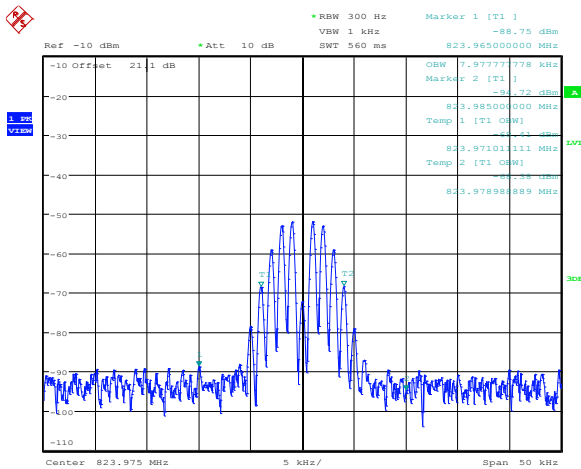
High channel
Date: 15.APR.2015 15:21:18

Figure 8.4-2: 823.975 MHz output



High channel
Date: 15.APR.2015 17:54:03

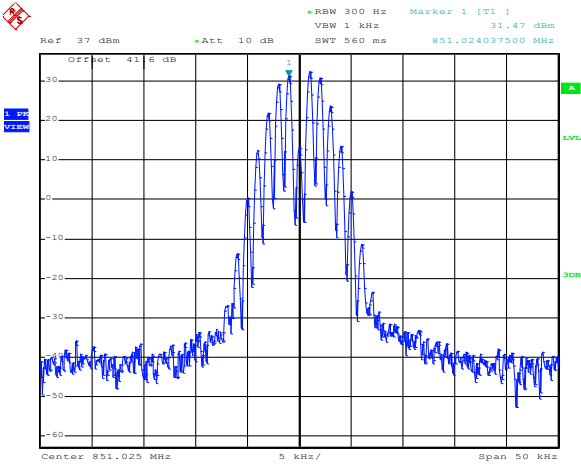
Figure 8.4-3: 806.025 MHz input



High channel
Date: 15.APR.2015 15:23:21

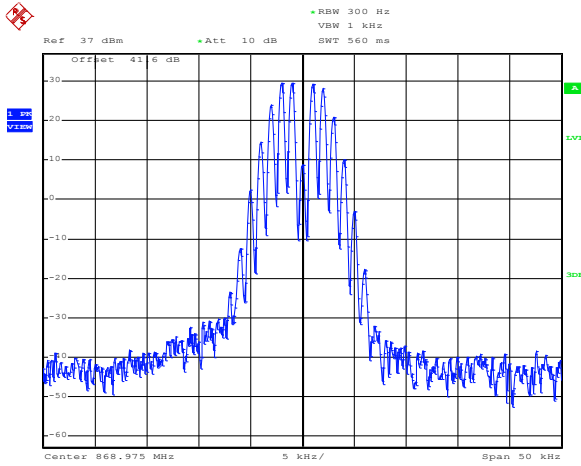
Figure 8.4-4: 823.975 MHz input

8.4.4 Test data continued



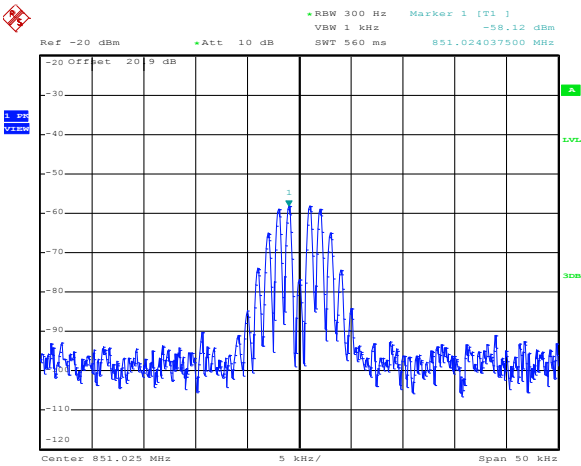
Date: 28.APR.2015 14:38:09

Figure 8.4-5: 851.025 MHz output



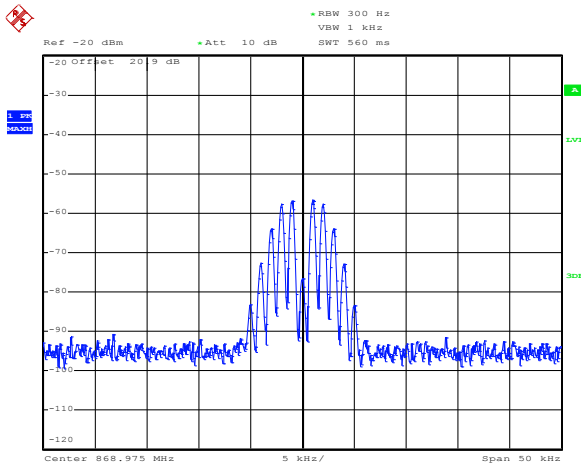
Date: 28.APR.2015 18:39:48

Figure 8.4-6: 868.975 MHz output



Date: 28.APR.2015 14:39:31

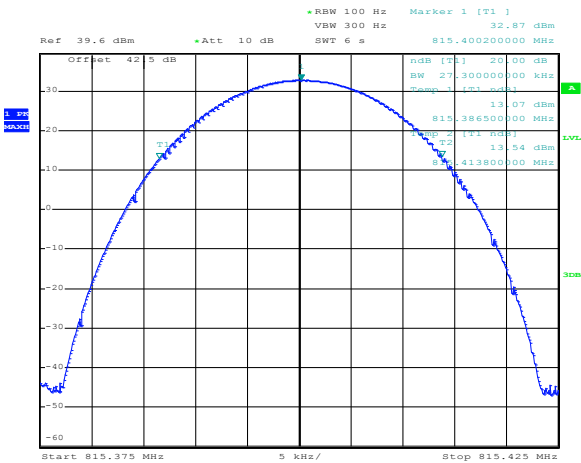
Figure 8.4-7: 851.025 MHz input



Date: 28.APR.2015 18:40:53

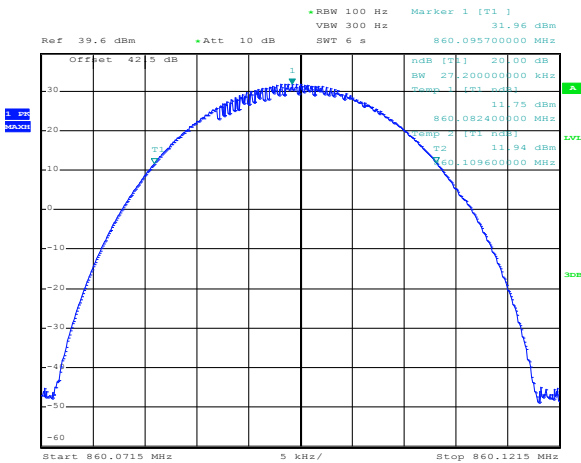
Figure 8.4-8: 868.975 MHz input

8.4.4 Test data continued



Date: 25.JUN.2015 14:33:28

Figure 8.4-9: UL Filter response



Date: 25.JUN.2015 12:54:33

Figure 8.4-10: DL Filter response

8.5 FCC §90.219 (e)(2) Noise figure

8.5.1 Definitions and limits

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

8.5.2 Test summary

Test date	June 25, 2015	Temperature	24 °C
Test engineer	Kevin Rose	Air pressure	1007 mbar
Verdict	Pass	Relative humidity	43 %

8.5.3 Observations, settings and special notes

Assessed to remain within assigned band. Spectrum analyzer settings:

Detector mode	RMS
Resolution bandwidth	100 kHz
Video bandwidth	RBW × 3
Trace mode	Average

8.5.4 Test data

Table 8.5-1: Noise figure result

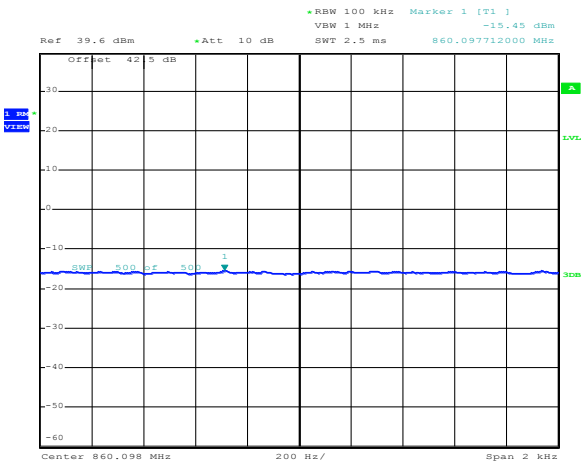
UL/DL	Noise Source OFF, dBm	Noise Source ON, dBm	ENR, dB	NF Result, dB	Limit, ±dB	Margin, dB
UL	-19.51	-17.07	5.04	6.63	9	2.37
DL	-15.45	-13.18	5.04	6.42	9	2.58

$$\text{Noise Figure (NF)} = 10 \times \log_{10} \left(10^{(\text{ENR} / 10)} / 10^{(Y / 10)} - 1 \right)$$

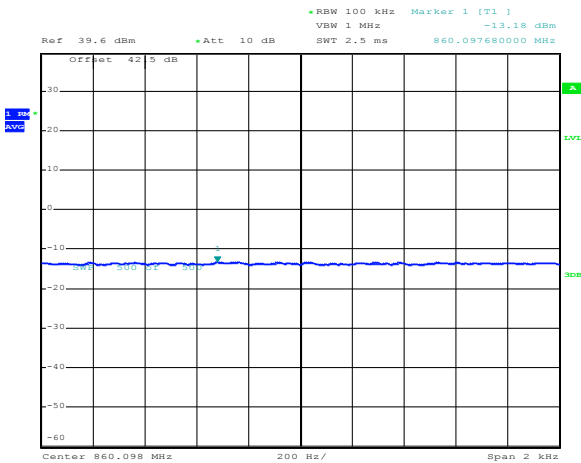
Y = Noise Source OFF – Noise Source ON

ENR= Noise level above Thermal noise

8.5.4 Test data continued



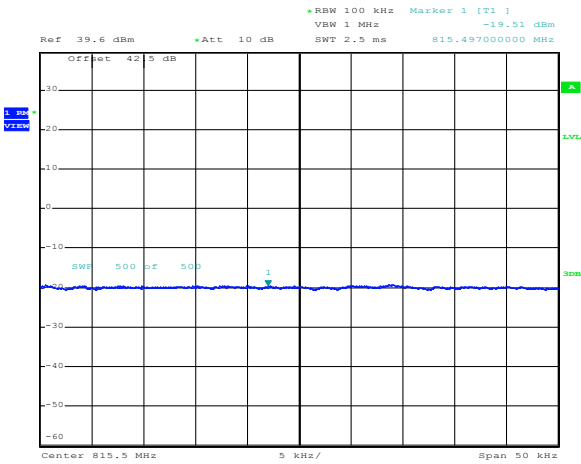
Date: 25.JUN.2015 11:31:51



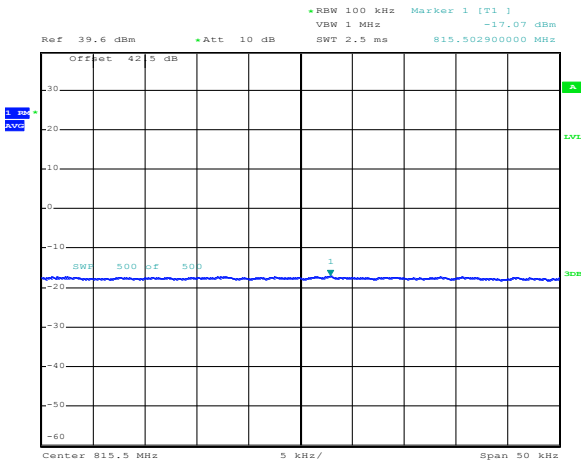
Date: 25.JUN.2015 11:32:12

Figure 8.5-1: DL Noise source off

Figure 8.5-2: DL Noise source on



Date: 25.JUN.2015 11:29:15



Date: 25.JUN.2015 11:29:46

Figure 8.5-3: UL Noise source off

Figure 8.5-4: UL Noise source on

Section 9. Setup Photos

9.1 Set-up



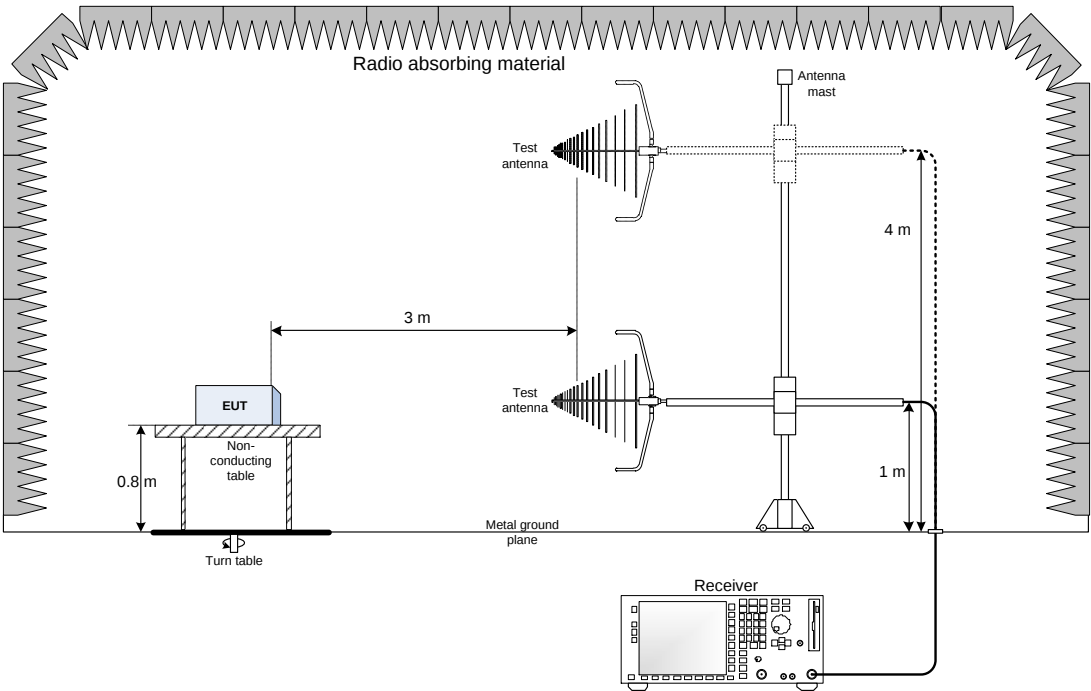
Figure 9.1-1: Radiated setup photo



Figure 9.1-2: Radiated setup photo

Section 10. Block diagrams of test set-ups

10.1 Radiated emissions set-up



10.2 Noise figure set-up

