Compliance Engineering Ireland Ltd
Clonross Lane, Derrockstown, Dunshaughlin, Co. Meath
Tel: +353 1 8256722 Fax: +353 1 8256733

Project Number: 15E5407-1b

Prepared for:

Schrader Electronics

By

Compliance Engineering Ireland Ltd

Clonross Lane

Derrockstown

Dunshaughlin

Co. Meath

FCC Site Registration: 92592

Industry Canada Assigned Site Code: 8517A-2

FCC ID: MRXCRETxRx

IC: 2546A-CRETxRx

Date

24th Sept 2015

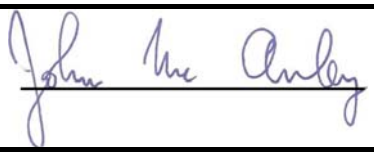
FCC EQUIPMENT AUTHORISATION

Test Report

EUT Description

Repeater for Tyre Pressure and Temperature Measurement System

Authorised :
John McAuley



TEST SUMMARY

The equipment complies with the requirements according to the following standards.

FCC Part Section(s)	Industry Canada	TEST PARAMETERS	Test Result
15.231(e) 15.35	RSS-210 A1.1.5 RSS-Gen 6.10	Duty Cycle	PASS
15.231(e) 15.209	RSS-210 A.1.1.5 RSS-210 8.9	RADIATED EMISSIONS	PASS
15.231(c)	RSS-210 A1.1.3	20dB BANDWIDTH / 99% Bandwidth	PASS
15.209	RSS-210 2.3 RSS Gen 7.1	Receive Spurious Emissions	PASS

RSS 210 Issue 8
RSS-Gen Issue 4

Exhibit A – Technical Report

Table of Contents

1.0 EUT Description

The EUT was repeater using a short range 433.909 MHz band transceiver for reporting of tyre pressure and temperature in cars/trucks.

Model:	CRETxRx
Type:	Repeater for Tyre Pressure and Temperature Measurement System
FCC ID:	MRXCRETxRx
Company:	Schrader Electronics
Contact	Mr James Kyle
Address:	11 Technology Park, Belfast Road, Antrim, Northern Ireland BT41 1QS
Phone:	+44 28 9448 3067
e-mail:	jakyle@schrader.co.uk
Test Standards:	47 CFR, Part 15.231(e)
Type of radio:	Stand-alone
Transmitter Type:	FSK
Operating Frequency Range(s):	433.909 MHz
Number of Channels:	One
Antenna:	Integral
Transmitter power configuration:	24 VDC Battery.
Operating. Temp Range:	-40° C to +85° C
Classification:	DSR
Test Methodology:	Measurements performed according to the procedures in ANSI C63.4-2014 ANSI C63.10-2013

1.1 EUT Operation

Operating Conditions during Test:
The equipment under test was operated during the measurement under the following conditions:

A sample of EUT which was programmed to operate in test mode (CW mode) was used for all tests except duty cycle and bandwidth.

The duty cycle test was performed on a sample of EUT programmed to operate at the highest duty cycle possible.

Environmental conditions
During the measurement the environmental conditions were within the listed ranges:
☒ Normal
Temperature: +15 to +35 ° C
Humidity: 20-75 %

1.2 Modifications
No modifications were required in order to pass the test specifications.

1.3 Date of Test
The tests were carried out on one sample of the EUT on 15th and 19th of January 2015.

1.4 Electromagnetic Emissions Testing
The guidelines of CISPR 16-4 were used for all uncertainty calculations, estimates and expressions thereof for EMC testing. A copy of Compliance Engineering Ireland Ltd.'s policy for EMC Measurement Uncertainty is available on request.
RF Requirements: Spurious emissions in accordance with FCC CFR 15.107, 15.109 and 15.209. Tests were carried out to the requirements of CISPR 16-4 and ANSI C63.4-2014 and C63.10-2013.

1.4.1 Measurement Uncertainty
The measurement uncertainty (with a 95% confidence level) for the conducted emissions test was ±3.5 dB.
The measurement uncertainty (with a 95% confidence level) for the radiated emissions test was ±5.3 dB (from 30 to 100 MHz), ±4.7 dB (from 100 to 300 MHz), ±3.9 dB (from 300 to 1000 MHz) and ±3.8 dB (from 1 GHz to 40 GHz).

2.0 Emissions Measurements

2.1 Conducted Emissions Measurements

Test not performed as EUT is powered from battery.

2.2 Radiated Emissions Measurements

Radiated Power measurements were made at the Compliance Engineering Ireland Ltd anechoic chamber located in Dunshaughlin, Co. Meath, Ireland to determine the radio noise radiated from the EUT. A "Description of Measurement Facilities" has been submitted to the FCC and approved pursuant to Section 2.948 of CFR 47 of the FCC rules.

2.2.1 General

Emissions below 1GHz were measured using a tri-log antenna with resolution bandwidth 100kHz at a measurement distance of 3 metres with EUT on a motorised turntable which allowed 360 degrees rotation.

Emissions above 1GHz were measured using a horn antenna with resolution bandwidth of 1MHz and video bandwidth of 10MHz at a measurement distance of 3 metres with EUT on a motorised turntable which allowed 360 degrees rotation.

2.2.2 Measurements in Transmit mode

A Radiated Emission pre-scan was performed which covered the x, y and z orientations in horizontal and vertical polarizations. In each case the emission was maximised.
The result of this pre-scan showed that the highest emission for vertical polarization was with the EUT on its side (orientation2 O2)
The EUT in a vertical orientation (orientation3 O3) gave the highest emissions for horizontal polarization.
A full scan for radiated emission was performed in orientation O2 for vertical polarization and in orientation O3 for horizontal polarization.

The radiated emissions were maximised by configuring the EUT, by rotating the EUT, and by raising and lowering the antenna from 1 to 4 metres.
Significant peaks from the EUT were then recorded to determine margin to the limits.

Tests were carried out as per Ansi C63.10 -2013

2.2.3 Measurements in Receive Mode

Exploratory radiated emissions measurements were carried out to determine the orientation that maximised the emissions.
Final radiated emissions measurements were carried out on the EUT in the orientation determined from the exploratory measurements.

For measurements, below 1GHz, the EUT was set up at a 3 metre distance from the receiving antenna, in a semi Anechoic Chamber, with the EUT running in a receive mode. The EUT was rotated 360 degrees azimuth and the search antenna height varied 1 to 4m in order to maximize the emissions.

For measurements above 1GHz, the EUT was set up at a 3 metre distance from the antenna, in a fully anechoic chamber, with the EUT running in receive mode. The EUT was rotated 360 degrees azimuth in order to maximize the emissions.

Significant peaks from the EUT were then recorded to determine margin to the limits.

Tests were carried out as per Ansi C63.4 -2014

2.3 Antenna Requirements

According to FCC 47 CFR 15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

* The antenna of this E.U.T is permanently attached.

*The E.U.T Complies with the requirement of 15.203

2.4 Test Criteria

Requirement -15.231 (c) & IC RSS-210 A1.1.3

The bandwidth of the emission shall be no wider than 0.25% of the centre frequency for devices operating above 70 MHz and below 900 MHz. For devices operating above 900 MHz. the emission shall be no wider than 0.5% of the centre frequency. Bandwidth is determined at the points 20dB down from the modulated carrier.

TEST PROCEDURE

RESULTS

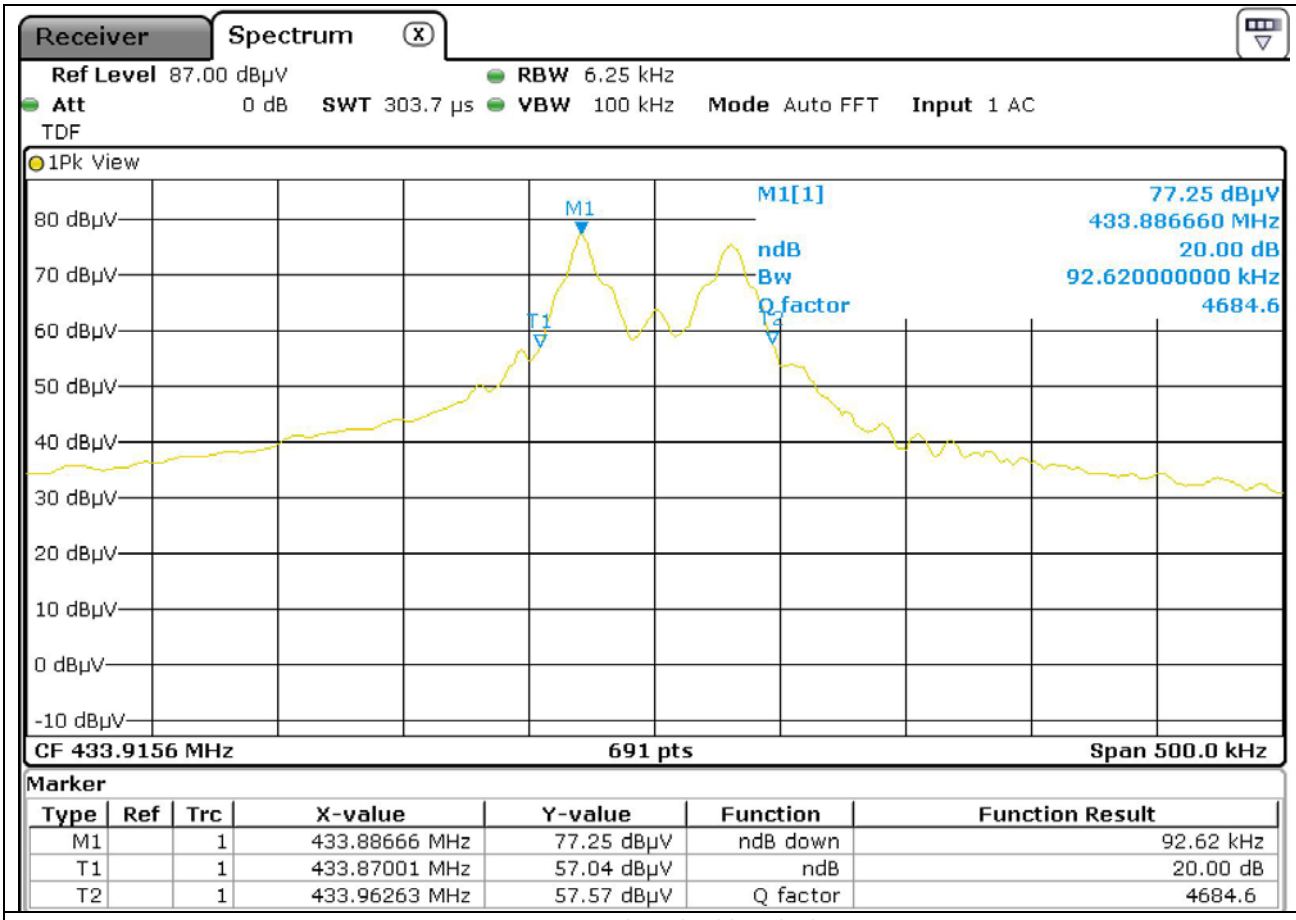


Fig 1 Occupied Bandwidth 20dB down

Operating Frequency (MHz)	20dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
433.916	92.62	1084.8	992.2	Pass

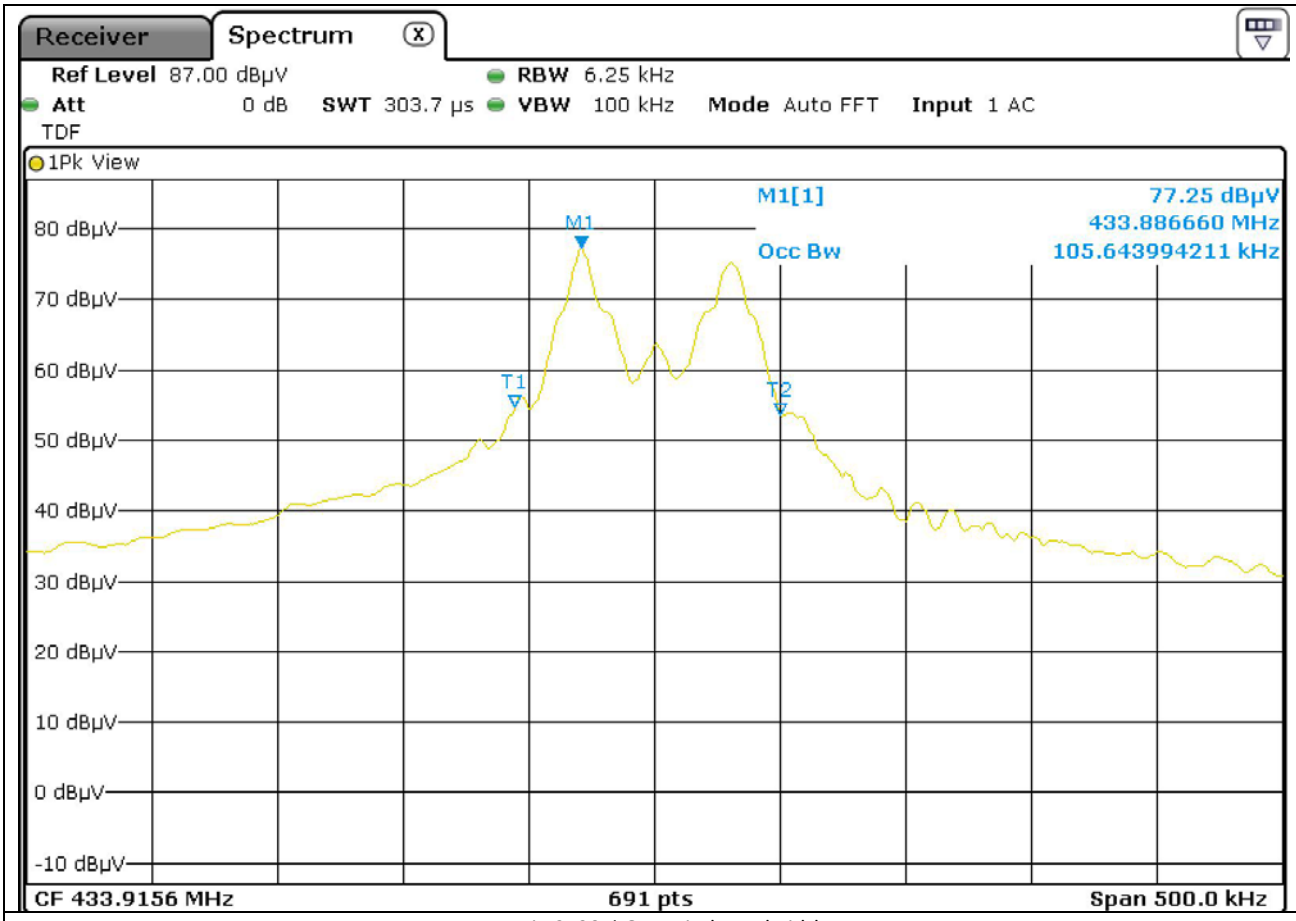


Fig 2 99% Occupied Bandwidth

Operating Frequency (MHz)	99% Bandwidth (kHz)
433.916	105.6

3.0 MAXIMUM MODULATION PERCENTAGE (M%) / Duty cycle

LIMIT

Requirement 15.35 (c) 15.231(e) IC RSS-Gen 6.10

The measurement field strength shall be determined by averaging over one complete pulse train, including blanking intervals, as long as the pulse train does not exceed 0.1 seconds. As an alternative(provided the transmitter operates for longer than 0.1 seconds) or in cases where the pulse train exceeds 0.1 seconds, the measured field strength shall be determined from the average absolute voltage during a 0.1 seconds interval during which the field strength is at its maximum value. The exact method of calculating the average field strength shall be submitted with any application for certification or shall be retained in the measurement data file for equipment subject to notification or verification.

TEST PROCEDURE

The transmitter output is connected to a spectrum analyzer or radiated field strength. The RBW is set to 100 kHz and the VBW is set to 1MHz. The sweep time is coupled and the span is set to 0 Hz. The number of pulses is measured and calculated in a 100 ms scan.

RESULTS

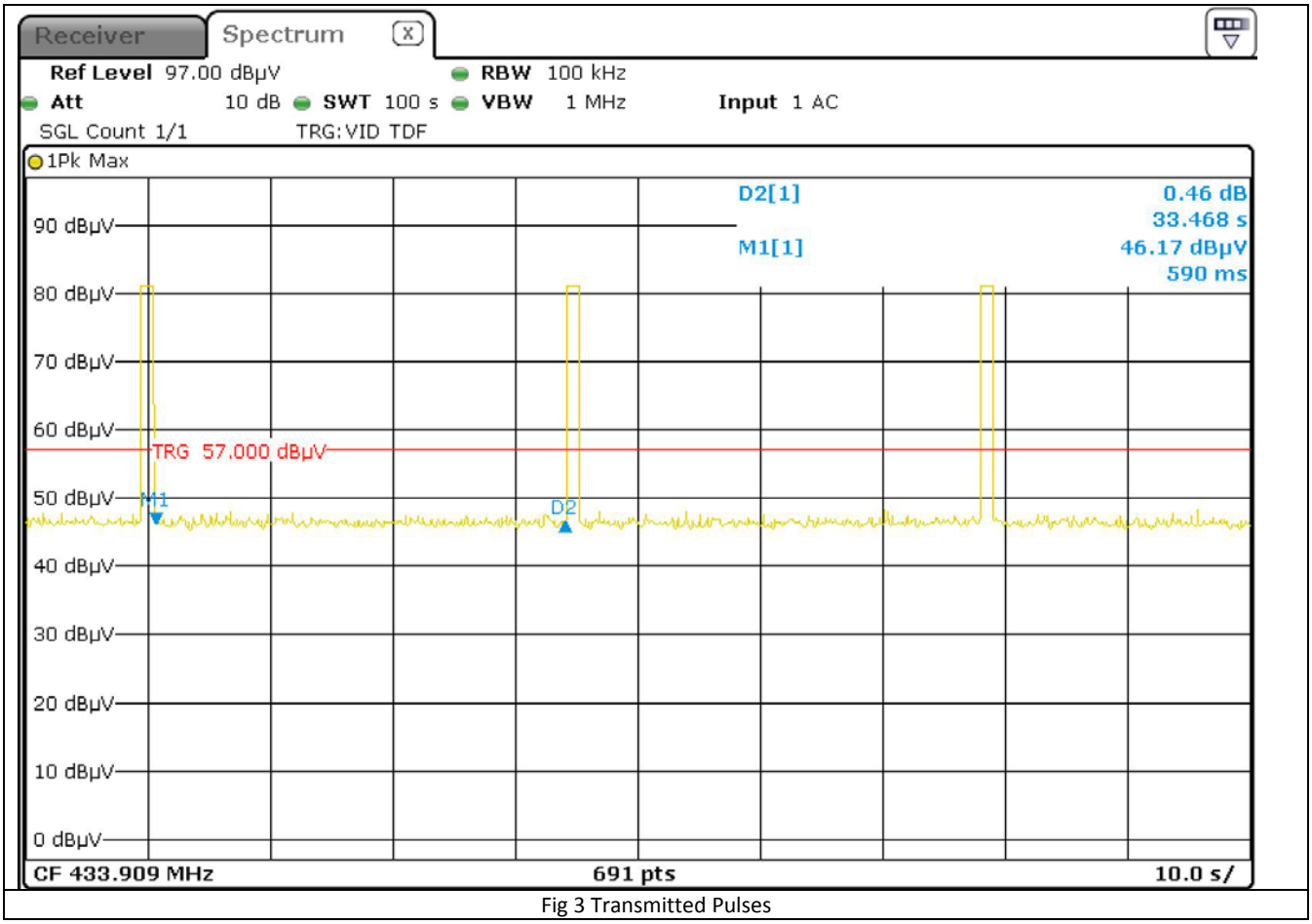


Fig 3 Transmitted Pulses

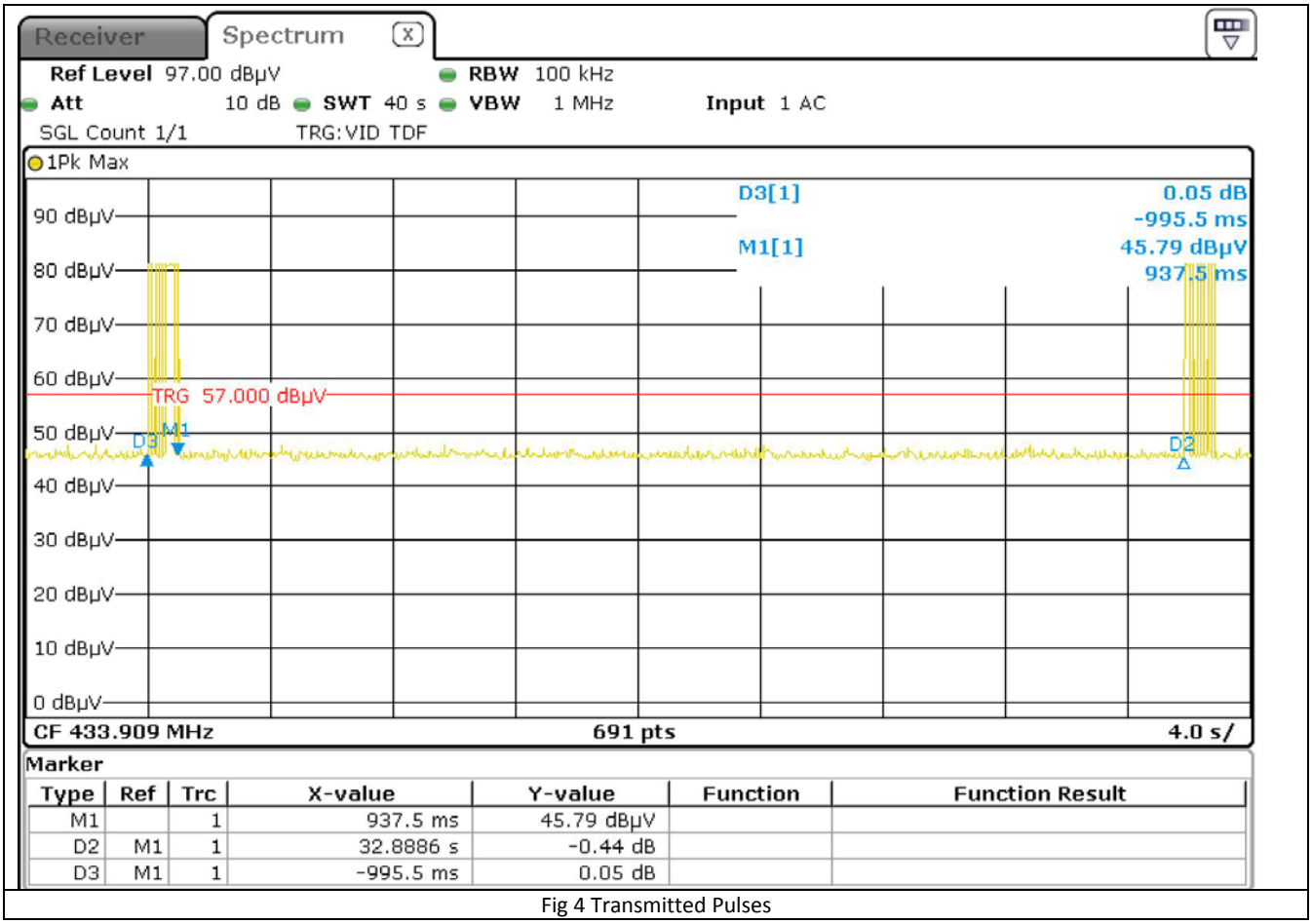


Fig 4 Transmitted Pulses

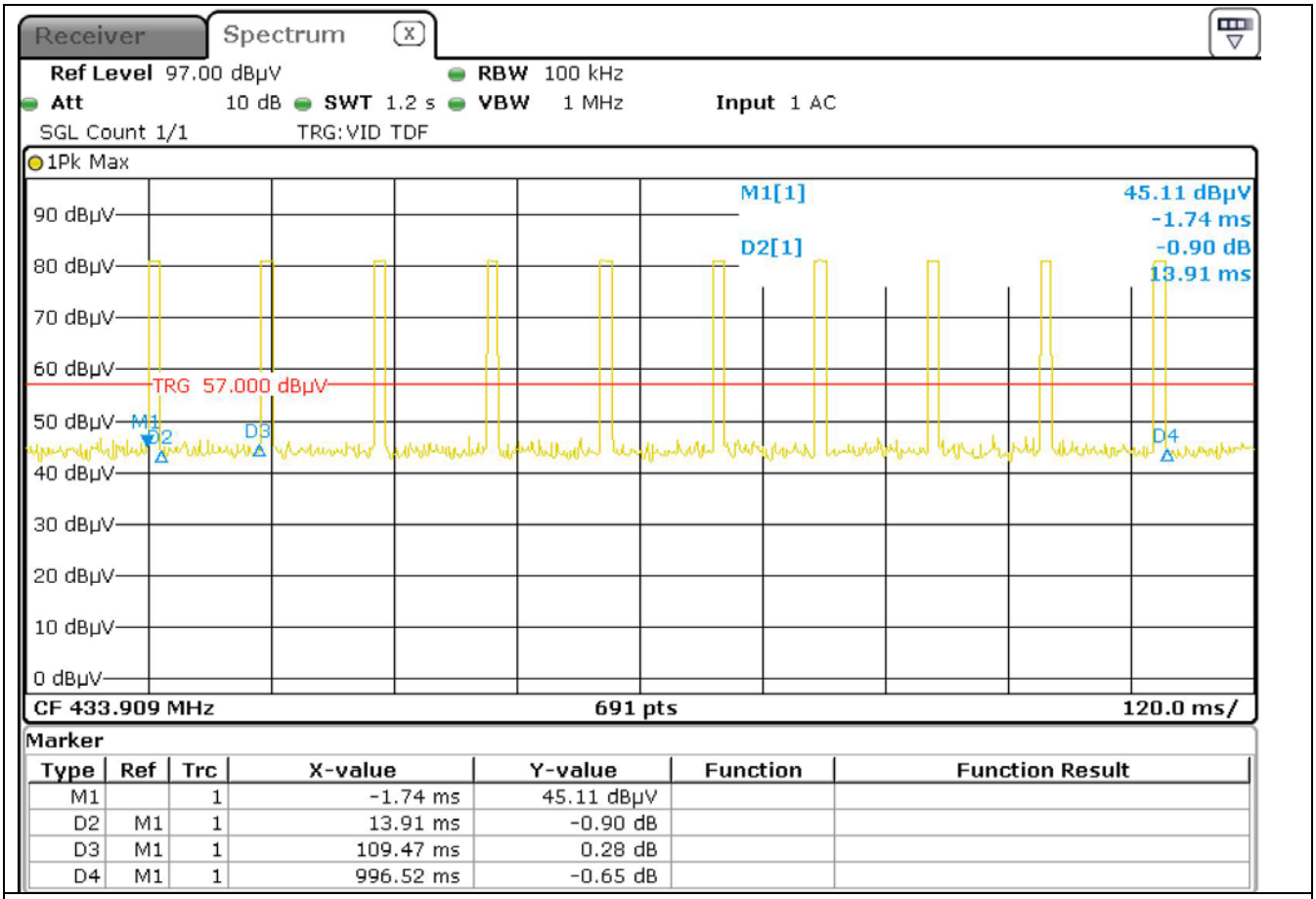


Fig 5 Transmitted Pulses

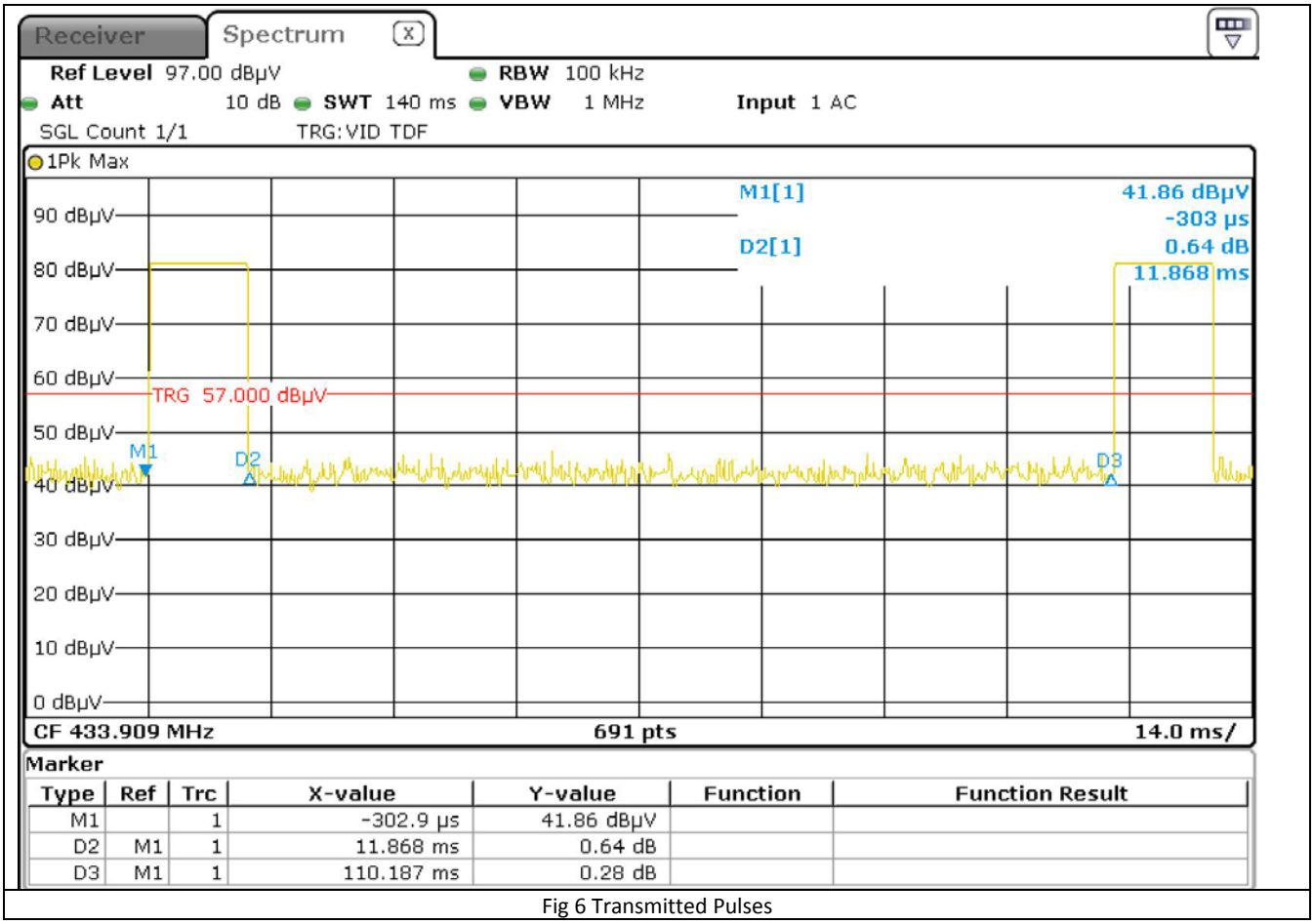


Fig 6 Transmitted Pulses

MAXIMUM MODULATION PERCENTAGE /Duty Cycle

One Period(mS)	Pulse Width (mS)	No of Pulses	Duty Cycle	Duty Cycle %	Test Result
100	**11.868**	**1**	**0.11868**	**11.9**	**Pass**

CALCULATION

Average Reading = Peak Reading dB(µV/m) +20log (Duty Cycle),
*where Duty Cycle is (No of pulses*pulse width)/100 or T*

Note correction for pulse mode operation is

20 log duty cycle (dB)
-18.5

15.231e duty cycle limits

The duration of each transmission shall not be greater than one second and the silent period between transmissions shall be at least 30 times the duration of the transmission but in no case less than 10 seconds

Result

Duration of each transmission = 995mS	Limit 1sec	Comply
Silent period between transmissions = 32.89Secs	Limit 29.85secs	Comply

4.0 Field Strength of Spurious Radiated Emissions

Test Specification: FCC 15.231(e) and RSS-210 A1.1.5

Fundamental Frequency (MHz)	Field Strength of fundamental (µV/m)	Strength of Spurious Emissions (µV/m).
40.66 ~ 40.70	22.50	225
70 ~ 130	1250	125
130 ~ 174	1250 to 3750 **	125 to 375 **
174 ~ 260	3750	375
260 ~ 470	3750 to 12500 **	375 to 1250 **
Above 470	12500	1250

**** Linear interpolations**

Interpolation Formula = 16.67 x Freq MHz - 2833.33

For operating frequency of 433.909 MHz the following limits apply (using interpolation formula above)

Fundamental Frequency	Field Strength of fundamental	Field Strength of fundamental	Field Strength of Spurious Emissions	Field Strength of Spurious Emissions
MHz	µV/m	dBµV/m	µV/m	dBµV/m
433.909	4400.263	72.9	440.026	52.9

Test Specification: FCC PART 15, SECTION 47 CFR 15.209 , RSS Gen 8.9

Frequency (MHz)	Field Strength (µV/m)	Field Strength (dBµV/m)
30-88	100	40.0
88-216	150	43.5
216-960	200	46.0
Above 960	500	54.0

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this part, e.g., Sections 15.231 and 15.241

4.1 Results for Radiated emissions Transmit mode

Test Specification: FCC 15.231(e) and RSS-210 A1.1.5

Appendix A shows the results of the scans in the anechoic chamber.
Ref Appendix C for EUT orientation

4.1.1 Fundamental Measurements with Trilog Antenna (30MHz to 1GHz)

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
433.909	58.3	O2	Vertical	16.1	0	1.2	75.6	72.9	17.3
433.909	63.4	O3	Horizontal	16.1	0	1.2	80.7	72.9	12.2

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 18.5dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
433.909	75.6	O2	Vertical	57.1	72.9	15.8
433.909	80.7	O3	Horizontal	62.2	72.9	10.7

4.1.2 Harmonics Measurements with Trilog Antenna (30MHz to 1GHz)

Test Specification: FCC 15.231(e) and RSS-210 A1.1.5

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
MHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
867.818	15.5	O2	Vertical	22.2	0	1.4	39.1	52.9	33.8
867.818	18.7	O3	Vertical	22.2	0	1.4	42.3	52.9	30.6

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 18.5dB Duty Cycle factor)	Average Limit	Margin
MHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
867.818	39.1	O2	Vertical	20.6	52.9	32.3
867.818	42.3	O3	Vertical	23.8	52.9	29.1

Result: Pass

4.1.3 Spurious Measurements 30M -1GHz

Test Specification: FCC PART 15.209 , RSS Gen 8.9

Frequency MHz	Quasi Peak Level dBuV/m	Antenna Polarity	Antenna Factor dB	Cable loss dB	Final Field Strength Quasi Peak dBuV/m	Quasi Peak Limit dBuV/m	Margin dB
460.281	-2.9	Vertical	16.6	1.2	14.9	46.0	31.1
848.035	-2.7	Vertical	23.3	1.4	22	46.0	24.0
926.946	-2.1	Vertical	22.9	1.4	22.2	46.0	23.8
419.526	-2.3	Horizontal	16.2	1.2	15.1	46.0	30.9
851.546	-1.8	Horizontal	22.3	1.4	21.9	46.0	24.1

Duty cycle correction =20Log (duty cycle) dB

Duty Cycle correction for Average measurement of pulsed signal =Peak -18.5dB

as per ANSI C63.10-2013 Section 7.5

Result: Pass

4.1.4 Horn antenna measurements (1GHz – 4.5 GHz)

Test Specification: FCC PART 15.209 , RSS Gen 8.9

Frequency	Reading Peak	EUT Orientation	Antenna Polarity	Antenna Factor	Preamp Gain	Cable loss	Final Field Strength Peak	Average Limit	Margin for Peak v Average Limit +20dB
GHz	dBuV/m		V/H	dB	dB	dB	dBuV/m	dBuV/m	dB
1.301	54.7	O2	Vertical	23.6	39.8	3.8	42.3	52.9	30.6
1.734	57.4	O2	Vertical	24.8	39.3	2.8	45.7	52.9	27.2
2.170	54.8	O2	Vertical	28	39	3.2	47.0	52.9	25.9
1.301	61.5	O3	Horizontal	23.6	39.8	3.8	49.1	52.9	23.8
1.734	61.0	O3	Horizontal	24.8	39.3	2.8	49.3	52.9	23.6
2.170	57.7	O3	Horizontal	28	39	3.2	49.9	52.9	23.0

Frequency	Final Field Strength Peak	EUT Orientation	Antenna Polarity	Average Level (Peak plus - 18.5dB Duty Cycle factor)	Average Limit	Margin
GHz	dBuV/m		V/H	dBuV/m	dBuV/m	dB
1.301	42.3	O2	Vertical	23.8	52.9	29.1
1.734	45.7	O2	Vertical	27.1	52.9	25.8
2.170	47.0	O2	Vertical	28.5	52.9	24.4
1.301	49.1	O3	Horizontal	30.5	52.9	22.4
1.734	49.3	O3	Horizontal	30.8	52.9	22.1
2.170	49.9	O3	Horizontal	31.4	52.9	21.5

Duty cycle correction =20Log (duty cycle) dB

Duty Cycle correction for Average measurement of pulsed signal =Peak -18.5dB

as per ANSI C63.10-2013 Section 7.5

Result: Pass

4.2 Results for Radiated emissions Receive mode

Test Specification: FCC Part 15.209 , RSS-210 Section 2.3, RSS Gen Section 7.1

Frequency	Quasi peak Level	Antenna Factor	Preamp Gain	Cable Loss	Antenna Polarity	EUT Orientation	Final Field Strength Quasi Peak	Average Limit	Margin
MHz	dBuV/m	dB	dB	dB	V/H		dBuV/m	dBuV/m	dB
466.64	-2.2	16.6	0	1.2	Vertical	O2	15.6	46.0	30.4
846.96	-12.6	33.4	0	1.4	Vertical	O2	22.2	46.0	23.8
996.55	-3.4	23.6	0	2.2	Vertical	O2	22.4	54.0	31.6
456.29	-2.9	16.5	0	1.2	Horizontal	O3	14.8	46.0	31.2
886.19	-0.2	22	0	1.4	Horizontal	O3	23.2	46.0	22.8
980.43	-3.4	24.2	0	1.4	Horizontal	O3	22.2	54.0	31.8

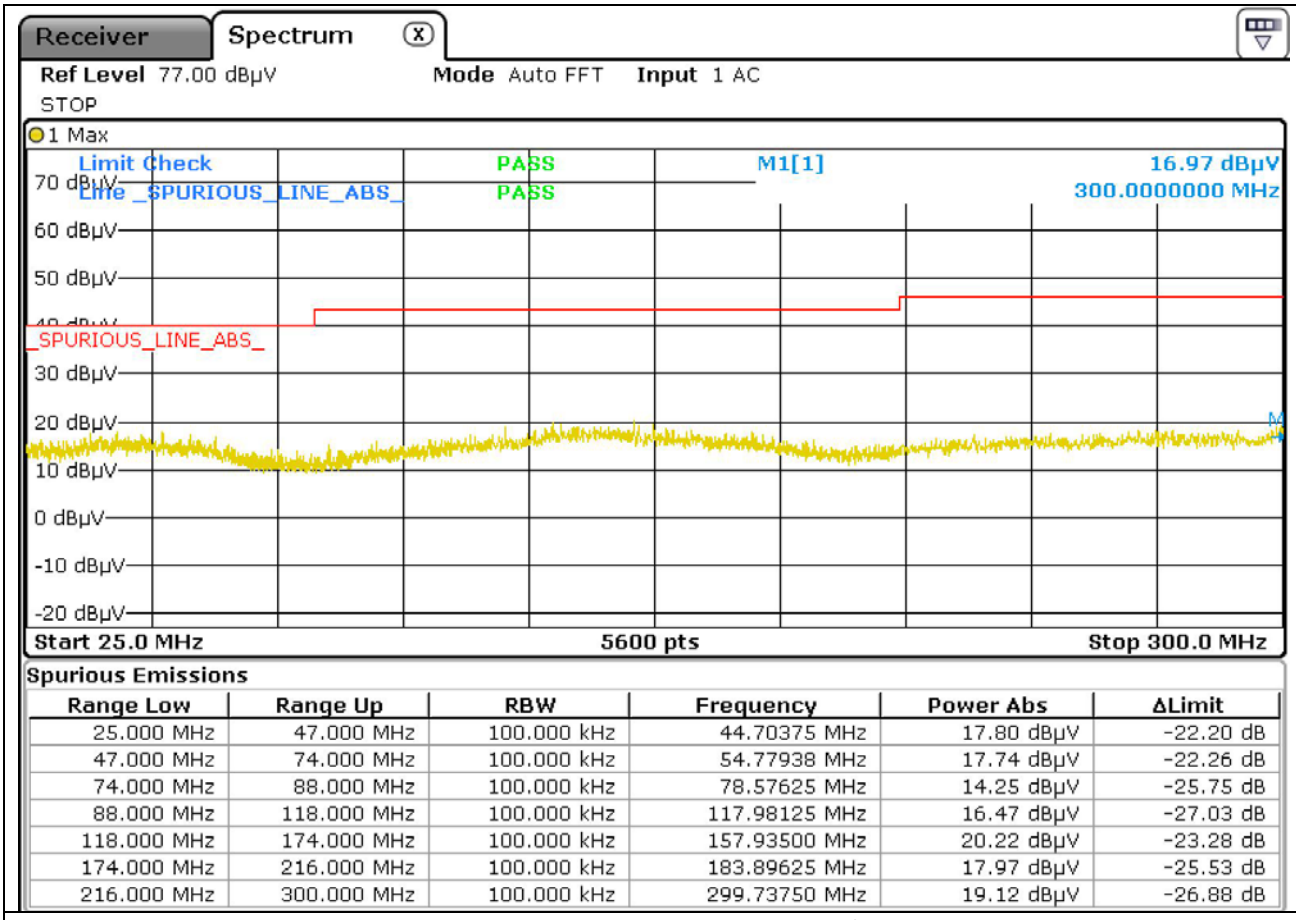
Result: Pass

5.0 List of Test Equipment

Instrument	Manufacturer.	Model	CEI Ref No.	Cal Due Date
Preamplifier	Hewlett Packard	83017A	805	19/09/2015
Spectrum Analyser	Rohde & Schwarz	FSP 40	850	14/08/2015
Spectrum Analyser/Receiver	Rohde & Schwarz	ESR	869	06/06/2017
Antenna Trilog	Schwarzbeck	VULB 9160	889	29/07/2017
Anechoic Chamber	CEI	10M	845	23/09/2015
Antenna Log Periodic	Chase	UPA6108	609	11/09/2015
Horn Antenna	EMCO	3115	655	14/11/2015

Appendix A
Additional Test Results

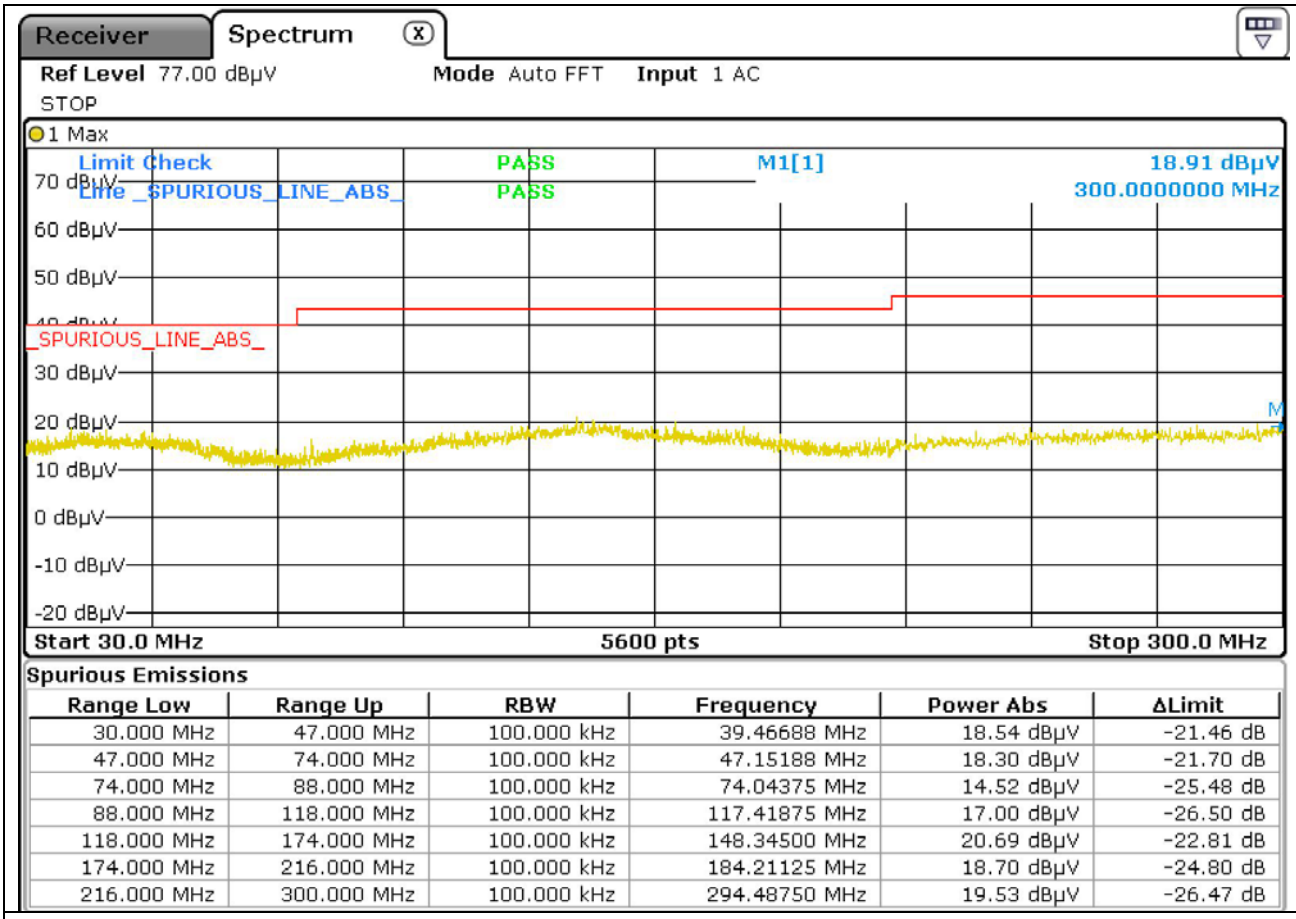
Transmitter Spurious Emissions



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
25.000 MHz	47.000 MHz	100.000 kHz	44.70375 MHz	17.80 dBµV	-22.20 dB
47.000 MHz	74.000 MHz	100.000 kHz	54.77938 MHz	17.74 dBµV	-22.26 dB
74.000 MHz	88.000 MHz	100.000 kHz	78.57625 MHz	14.25 dBµV	-25.75 dB
88.000 MHz	118.000 MHz	100.000 kHz	117.98125 MHz	16.47 dBµV	-27.03 dB
118.000 MHz	174.000 MHz	100.000 kHz	157.93500 MHz	20.22 dBµV	-23.28 dB
174.000 MHz	216.000 MHz	100.000 kHz	183.89625 MHz	17.97 dBµV	-25.53 dB
216.000 MHz	300.000 MHz	100.000 kHz	299.73750 MHz	19.12 dBµV	-26.88 dB

Fig A1 Scan 30MHz – 300MHz Vertical



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	47.000 MHz	100.000 kHz	39.46688 MHz	18.54 dBµV	-21.46 dB
47.000 MHz	74.000 MHz	100.000 kHz	47.15188 MHz	18.30 dBµV	-21.70 dB
74.000 MHz	88.000 MHz	100.000 kHz	74.04375 MHz	14.52 dBµV	-25.48 dB
88.000 MHz	118.000 MHz	100.000 kHz	117.41875 MHz	17.00 dBµV	-26.50 dB
118.000 MHz	174.000 MHz	100.000 kHz	148.34500 MHz	20.69 dBµV	-22.81 dB
174.000 MHz	216.000 MHz	100.000 kHz	184.21125 MHz	18.70 dBµV	-24.80 dB
216.000 MHz	300.000 MHz	100.000 kHz	294.48750 MHz	19.53 dBµV	-26.47 dB

Fig A2 Scan 30MHz – 300MHz Horizontal

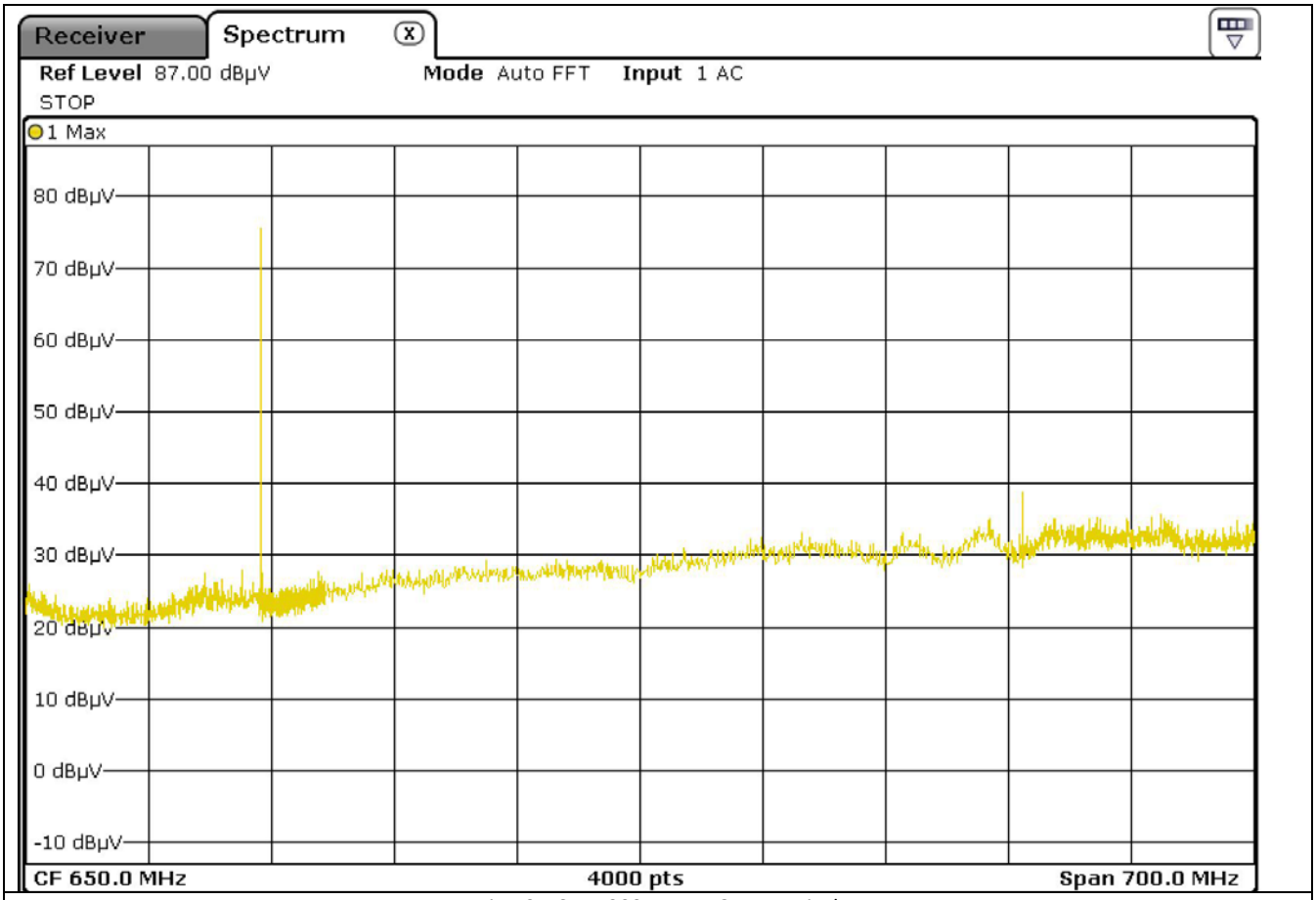


Fig A3 Scan 300MHz - 1GHz Vertical

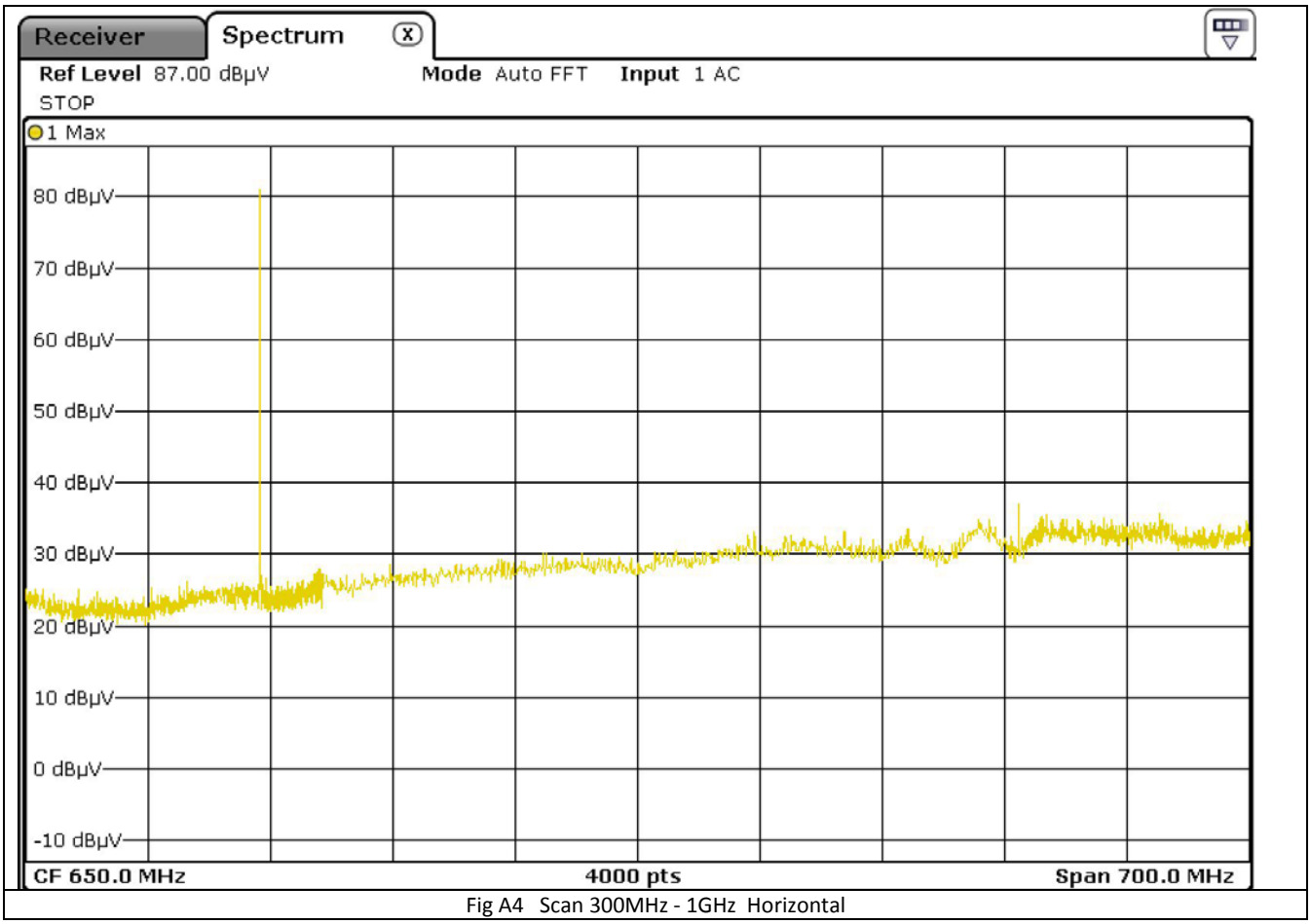


Fig A4 Scan 300MHz - 1GHz Horizontal

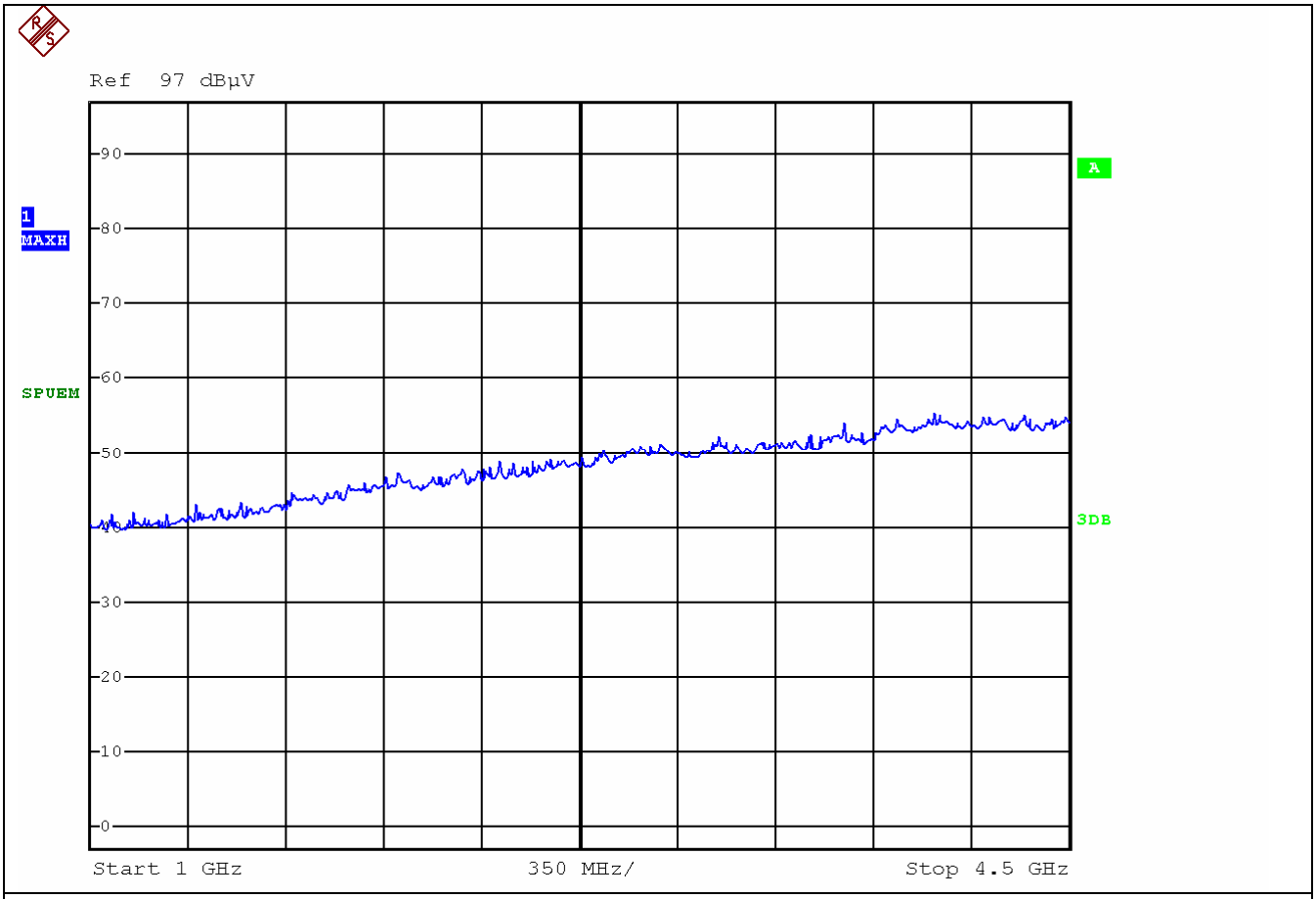


Fig A5 Scan 1GHz – 4.5GHz Vertical l

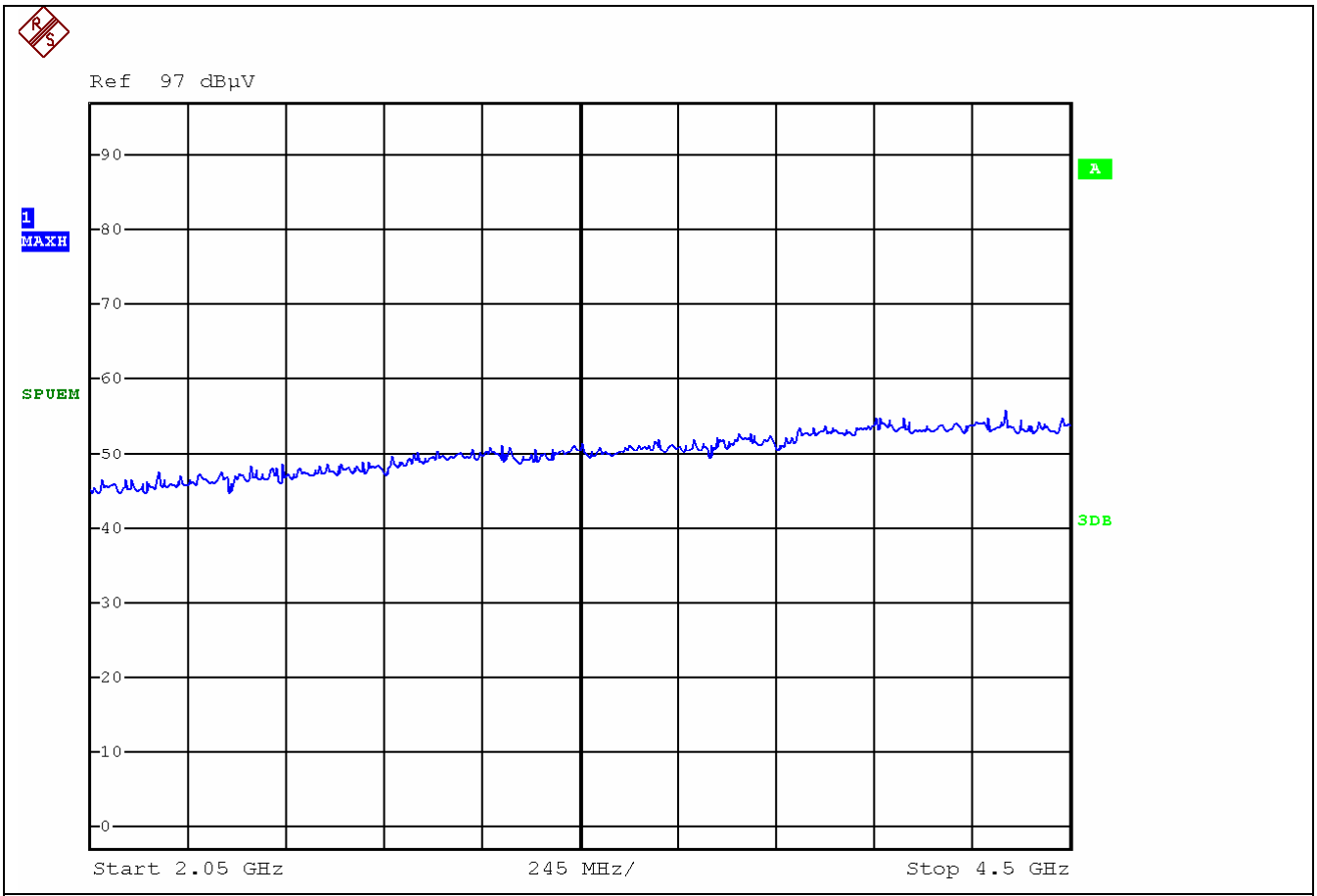
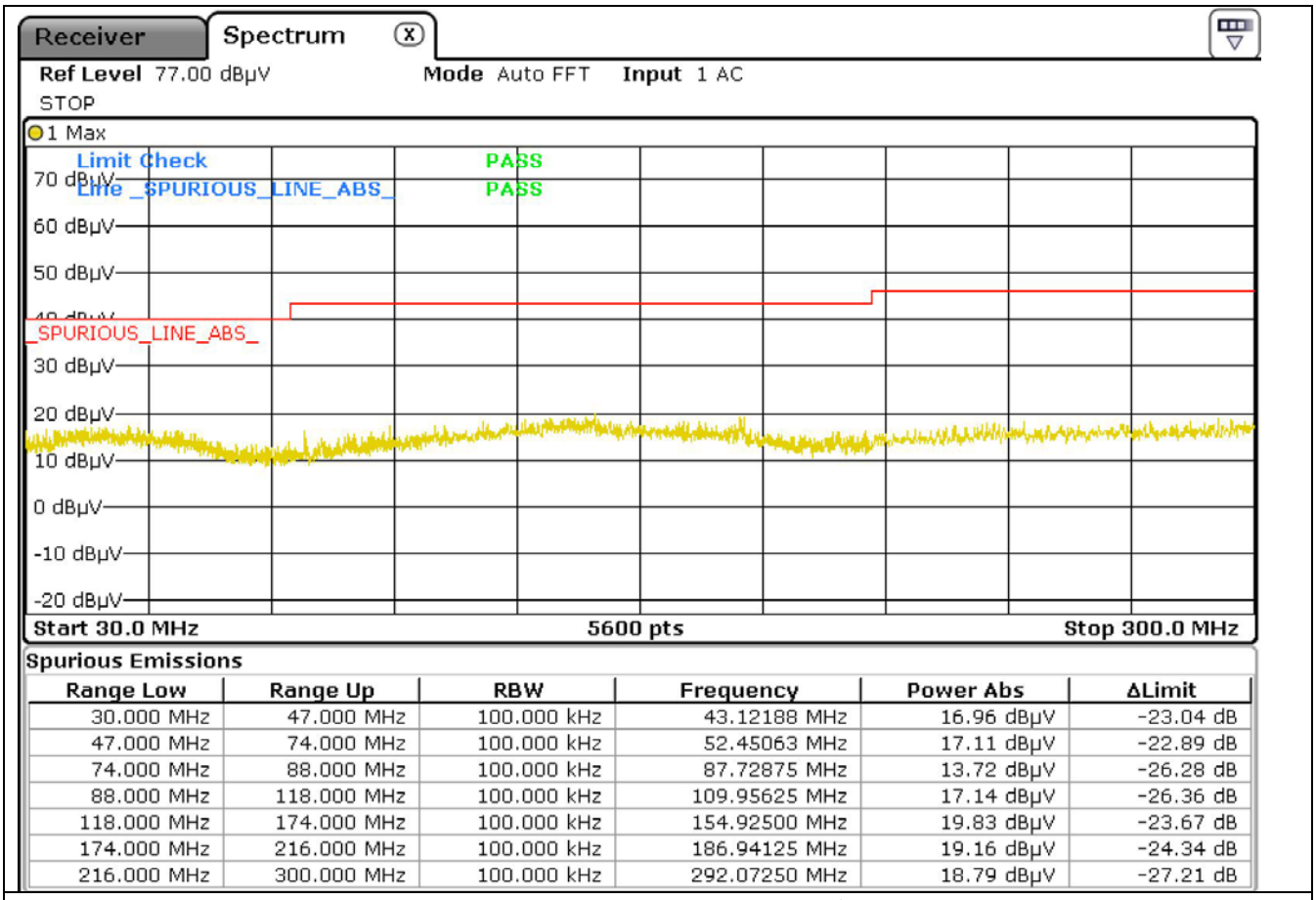


Fig A6 Scan 1GHz – 4.5GHz Horizontal

Appendix B
Additional Test Results

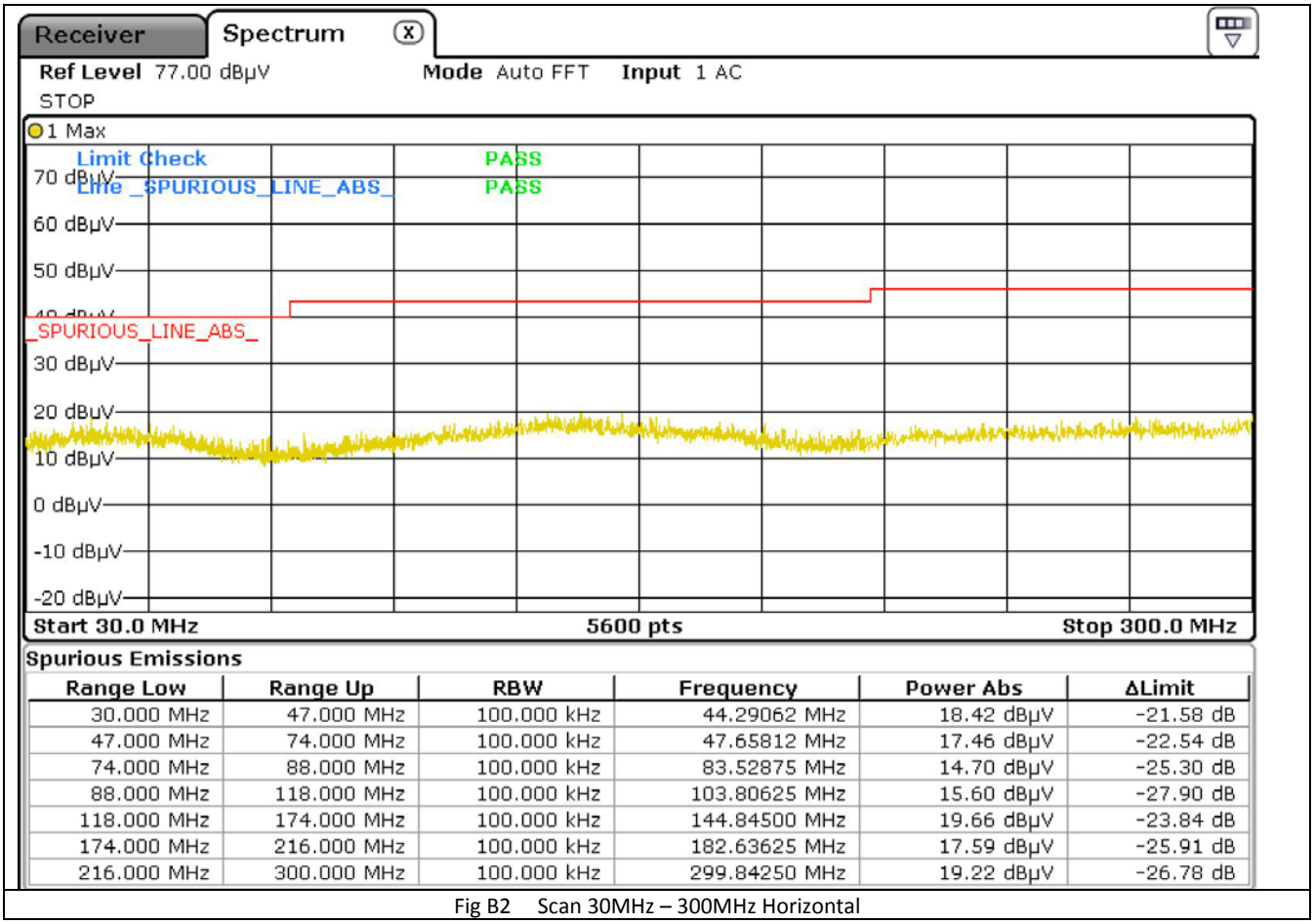
Receiver Spurious Emissions



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	47.000 MHz	100.000 kHz	43.12188 MHz	16.96 dBµV	-23.04 dB
47.000 MHz	74.000 MHz	100.000 kHz	52.45063 MHz	17.11 dBµV	-22.89 dB
74.000 MHz	88.000 MHz	100.000 kHz	87.72875 MHz	13.72 dBµV	-26.28 dB
88.000 MHz	118.000 MHz	100.000 kHz	109.95625 MHz	17.14 dBµV	-26.36 dB
118.000 MHz	174.000 MHz	100.000 kHz	154.92500 MHz	19.83 dBµV	-23.67 dB
174.000 MHz	216.000 MHz	100.000 kHz	186.94125 MHz	19.16 dBµV	-24.34 dB
216.000 MHz	300.000 MHz	100.000 kHz	292.07250 MHz	18.79 dBµV	-27.21 dB

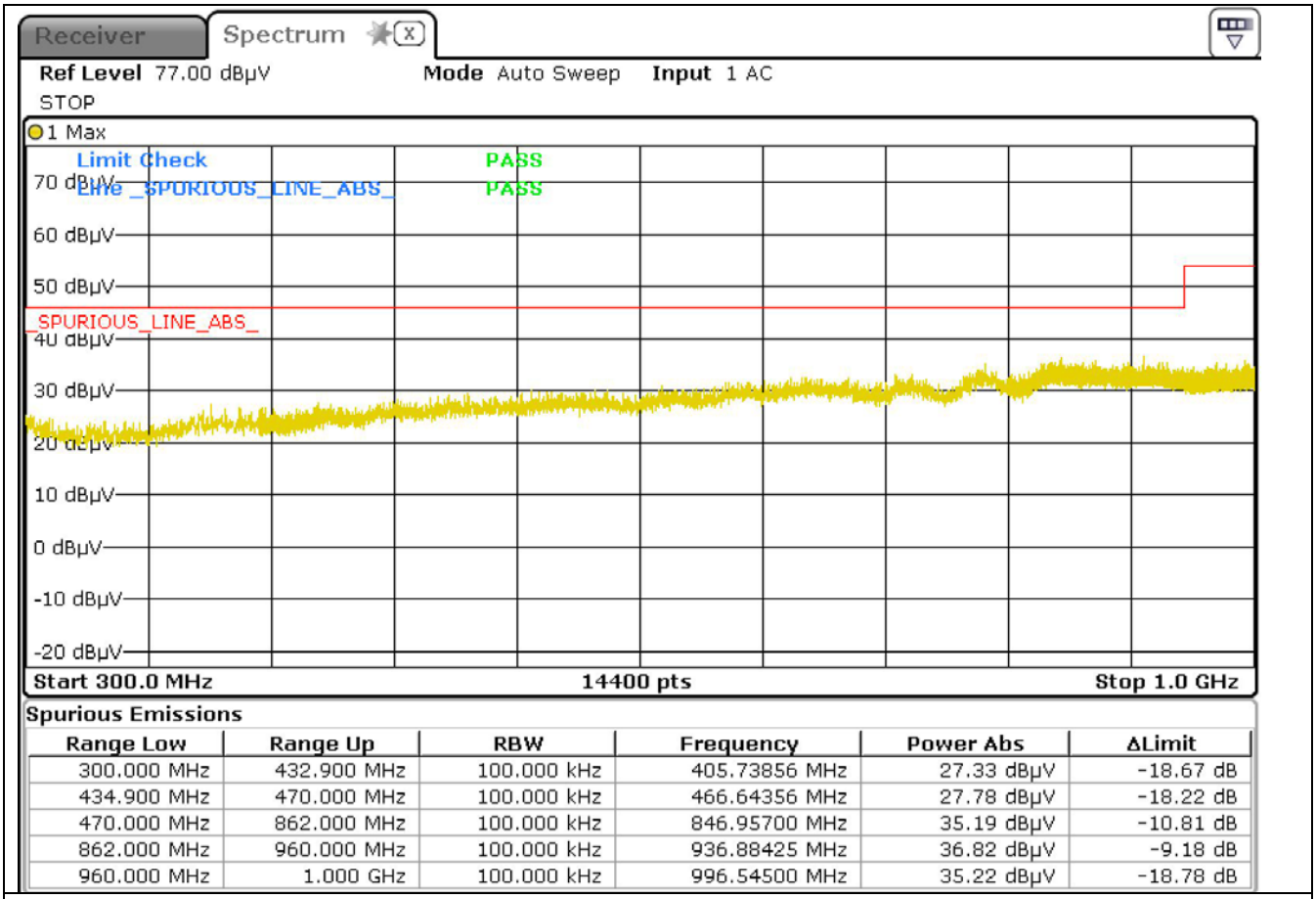
Fig B1 Scan 30MHz – 300MHz Vertical



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
30.000 MHz	47.000 MHz	100.000 kHz	44.29062 MHz	18.42 dBµV	-21.58 dB
47.000 MHz	74.000 MHz	100.000 kHz	47.65812 MHz	17.46 dBµV	-22.54 dB
74.000 MHz	88.000 MHz	100.000 kHz	83.52875 MHz	14.70 dBµV	-25.30 dB
88.000 MHz	118.000 MHz	100.000 kHz	103.80625 MHz	15.60 dBµV	-27.90 dB
118.000 MHz	174.000 MHz	100.000 kHz	144.84500 MHz	19.66 dBµV	-23.84 dB
174.000 MHz	216.000 MHz	100.000 kHz	182.63625 MHz	17.59 dBµV	-25.91 dB
216.000 MHz	300.000 MHz	100.000 kHz	299.84250 MHz	19.22 dBµV	-26.78 dB

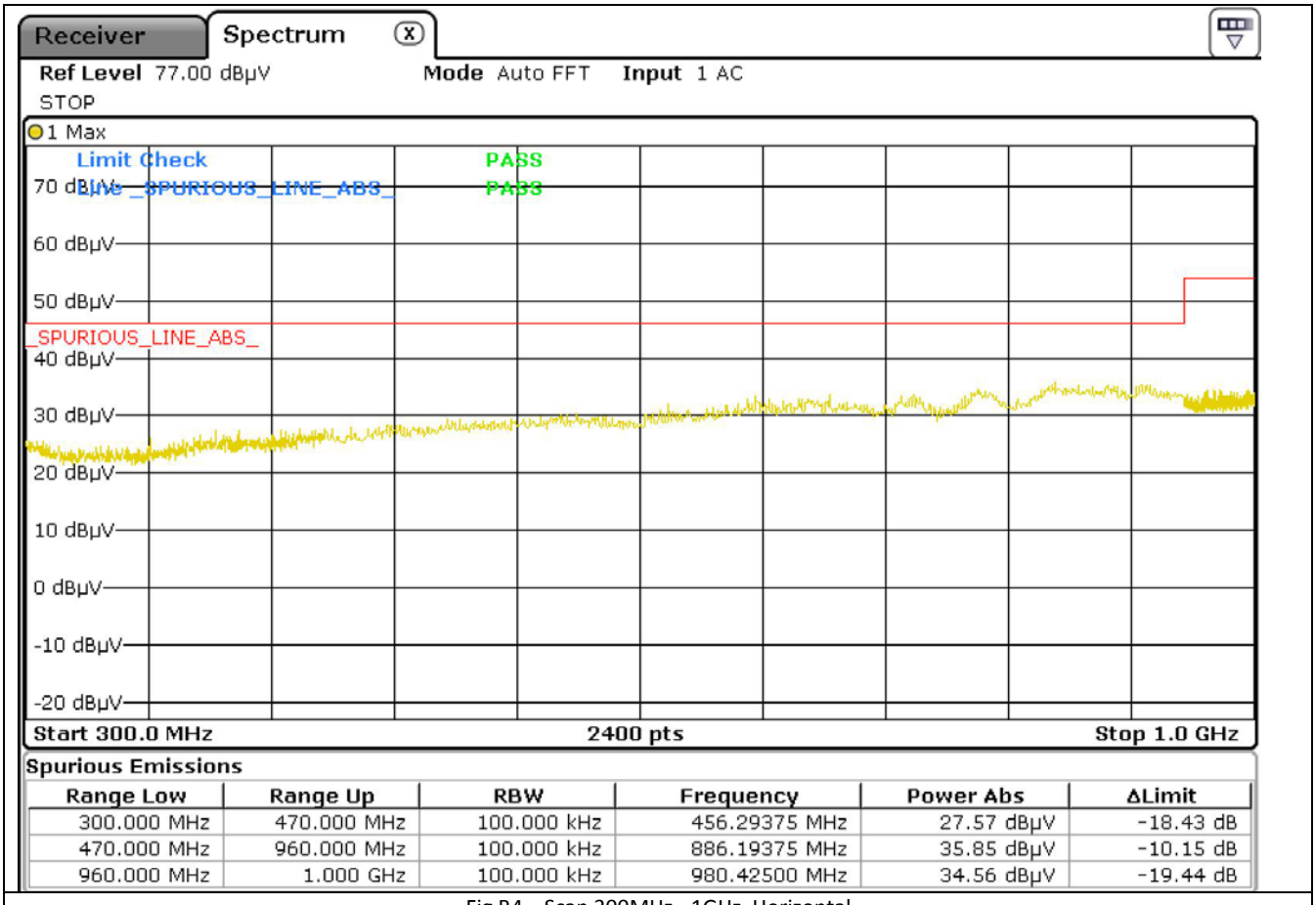
Fig B2 Scan 30MHz – 300MHz Horizontal



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
300.000 MHz	432.900 MHz	100.000 kHz	405.73856 MHz	27.33 dBµV	-18.67 dB
434.900 MHz	470.000 MHz	100.000 kHz	466.64356 MHz	27.78 dBµV	-18.22 dB
470.000 MHz	862.000 MHz	100.000 kHz	846.95700 MHz	35.19 dBµV	-10.81 dB
862.000 MHz	960.000 MHz	100.000 kHz	936.88425 MHz	36.82 dBµV	-9.18 dB
960.000 MHz	1.000 GHz	100.000 kHz	996.54500 MHz	35.22 dBµV	-18.78 dB

Fig B3 Scan 300MHz - 1GHz Vertical



Spurious Emissions

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
300.000 MHz	470.000 MHz	100.000 kHz	456.29375 MHz	27.57 dBµV	-18.43 dB
470.000 MHz	960.000 MHz	100.000 kHz	886.19375 MHz	35.85 dBµV	-10.15 dB
960.000 MHz	1.000 GHz	100.000 kHz	980.42500 MHz	34.56 dBµV	-19.44 dB

Fig B4 Scan 300MHz - 1GHz Horizontal

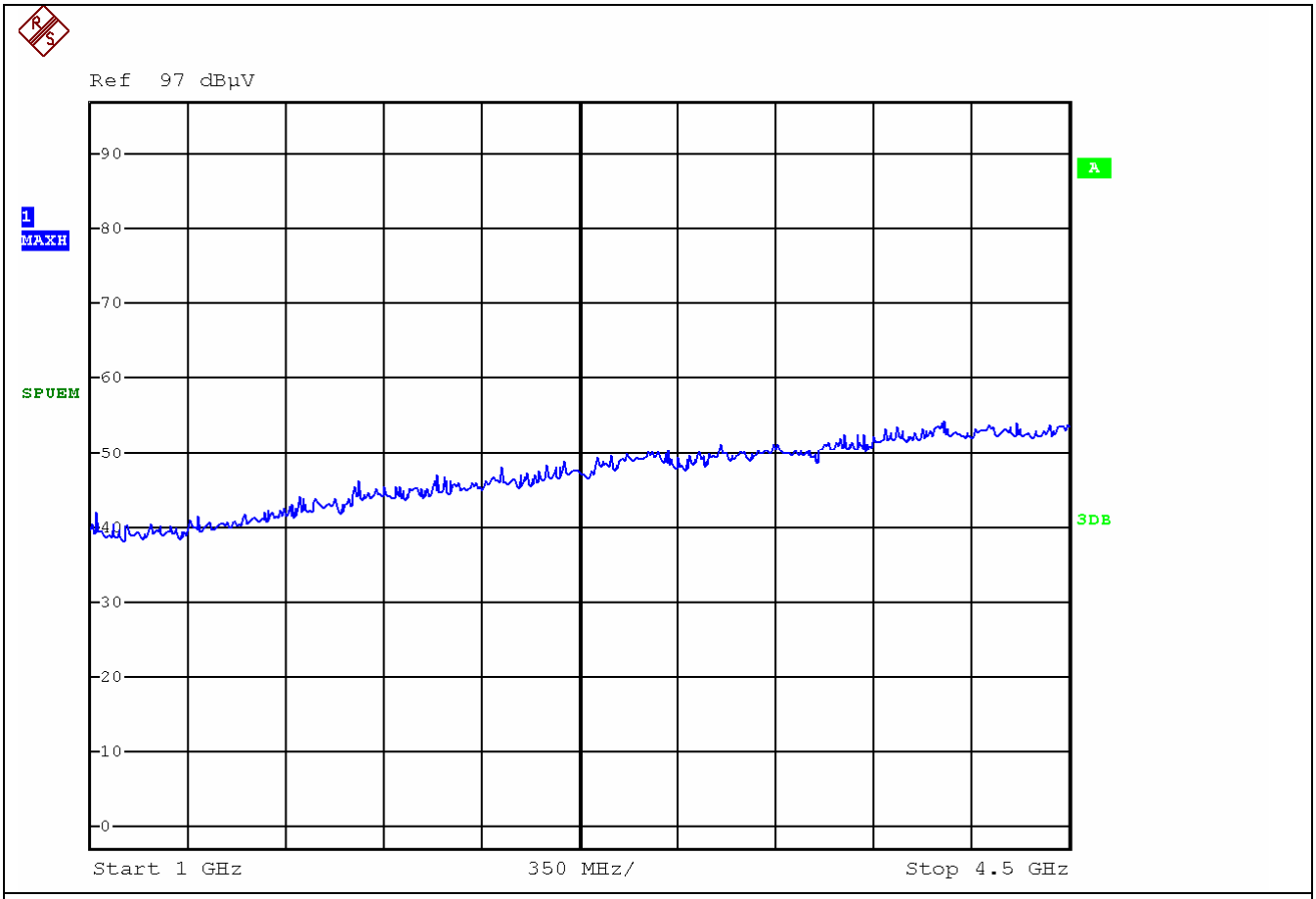


Fig B5 Scan 1GHz – 4.5GHz Vertical

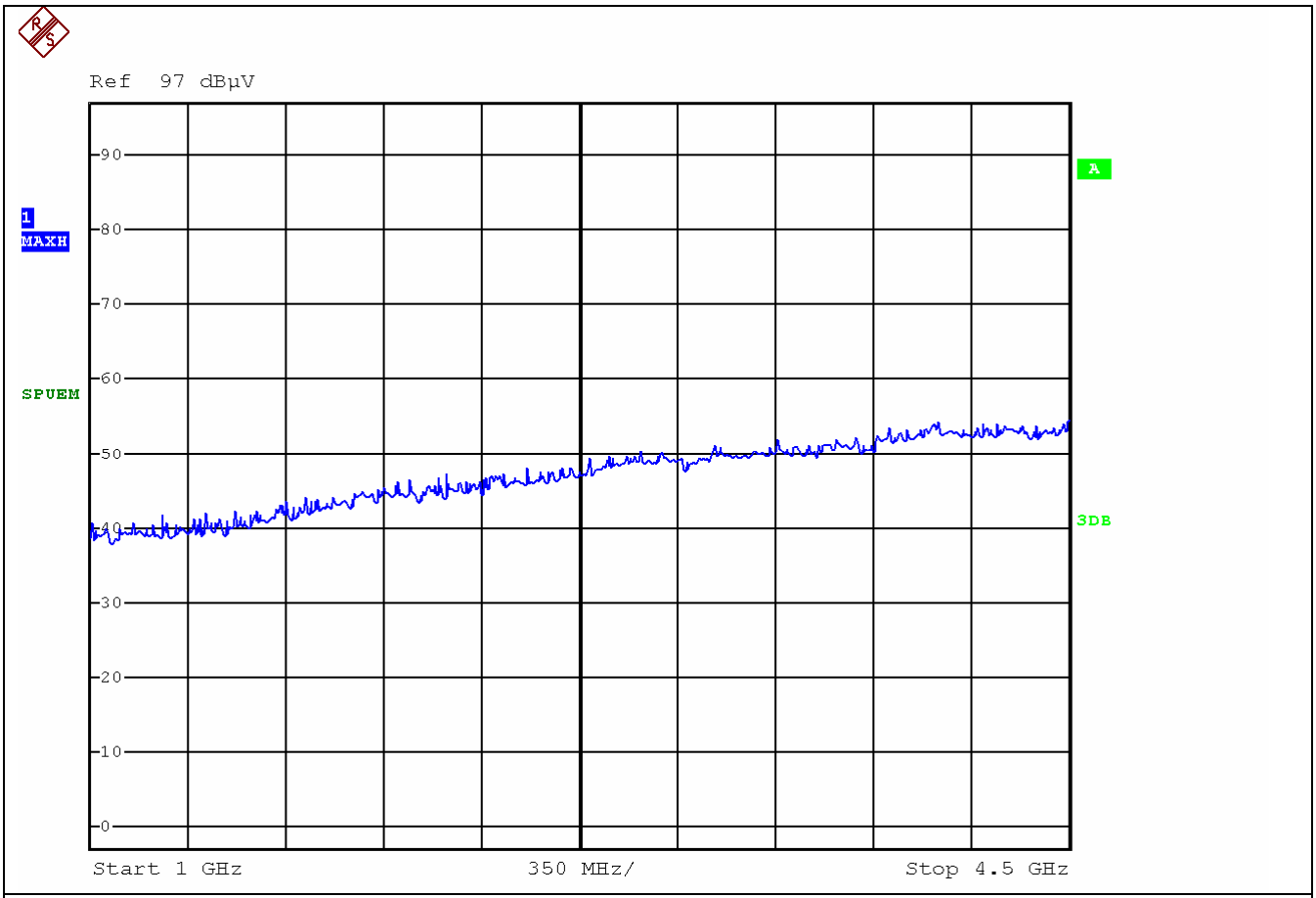


Fig B6 Scan 1GHz – 4.5GHz Horizontal

Appendix C

		
Fig C1 EUT orientation “O1”	Fig C2 EUT orientation “O2”	Fig C3 EUT orientation “O3”

End of Report