TEST REPORT

Test Report No. : UL-RPT-RP-12579073-616-FCC-COLOUR5C

Applicant	:	Visteon Electronics Germany GmbH
Model No.	:	COLOUR 5C
FCC ID	:	2AA98-COLOUR5C
Technology	:	RFID – 125 kHz
Test Standard(s)	:	FCC Parts 15.205,15.209(a),15.215
		For details of applied tests refer to test result summary

1. This test report shall not be reproduced in full or partial, without the written approval of UL International Germany GmbH.
2. The results in this report apply only to the sample tested.
3. The test results in this report are traceable to the national or international standards.
4. Test Report Version 1.0
5. Result of the tested sample: **PASS**

Prepared by: Abdoufataou, Salifou
Title: Laboratory Engineer
Date: 10.April.2019

Approved by: Ajit, Phadtare
Title: Lead Test Engineer
Date: 10.April.2019

DAkkS Deutsche Akkreditierungsstelle D-PL-19381-02-00

This laboratory is accredited by DAkkS.
The tests reported herein have been performed in accordance with its' terms of accreditation.

UL INTERNATIONAL GERMANY GMBH
Hedelfinger Str. 61
70327 Stuttgart, Germany
STU.CTECHLab@ul.com

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Table of Contentss

1. Customer Information

1.1.Applicant Information

Company Name:	Visteon Electronics Germany GmbH
Company Address:	Visteonstrasse 4-10, Kerpen 50170, GERMANY
Contact Person:	Dr. Dennis Pril
Contact E-Mail Address:	+49-721-4766 1026
Contact Phone No.:	dprill@visteon.com

1.2.Manufacturer Information

Company Name:	Visteon Electronics Slovakia s.r.o,
Company Address:	Namestovo 10BB, 02901, SLOVAK REPUBLIK
Contact Person:	Dominik Belko
Contact E-Mail Address:	dbelko@visteon.com
Contact Phone No.:	+49 191 766 48 09

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.205 and 47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.205 and 15.209
Specification Reference:	47CFR15.215
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Sections 15.215
Test Firm Registration:	399704

Location

Location of Testing:	UL International Germany GmbH Hedelfinger Str. 61 70327 Stuttgart Germany

Date information

Order Date:	29 October 2018
EUT arrived:	15 January 2019
Test Dates:	16 January 2019 to 11 February 2019
EUT returned:	-/-

2.2. Summary of Test Results

Clause	Measurement	Complied	Did not comply	Not performed	Not applicable
Part 15.207	Transmitter AC Conducted Emissions	☐	☐	☐	☒
Part 15.215(c)	Transmitter 20 dB Bandwidth	☒	☐	☐	☐
Part 15.209(a)	Transmitter Fundamental Field Strength	☒	☐	☐	☐
Part 15.209(a)(c)	Transmitter Radiated Emissions	☒	☐	☐	☐

Note(s):

1. Not applicable the EUT will be powered via Car DC battery.

2.3. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
Reference:	KDB 414788 D01 Radiated Test Site v01
Title:	TEST SITES FOR RADIATED EMISSION MEASUREMENTS

2.4. Deviations from the Test Specification

For the measurements contained within this test report, there were no deviations from, additions to, or exclusions from the test specification identified above.

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	VISTEON
Model Name:	COLOUR 5C
Test Sample Serial Number:	38569228
Hardware Version Number:	PWB23707
Software Version Number:	S210 RTA
FCC ID:	2AA98-COLOUR5C

3.2. Description of EUT

The equipment under test was a VW MQBAB2020 Instrument Cluster and Immobilizer supporting RFID 125 kHz technology.

EUT was the PCB with cable and coil. To put EUT into the operation a speedometer display and push button needs to be connected to the PCB.

In order to represent end user application setup and avoid short circuits during testing a representative external plastic housing was used.

Initial checks demonstrated that the external plastic housing had no influence on the measurements and obtained test results.

3.3. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.4. Additional Information Related to Testing

Tested Technology:	RFID	
Category of Equipment:	Transceiver	
Channel Spacing:	Single channel device	
Transmit Frequency Range:	125 kHz	
Power Supply Requirement:	V_{nom}	12 V DC
	V_{min}	6 V DC
	V_{max}	V DC
Tested Temperature Range:	T_{nom}	23 °C
	T_{min}	-40 °C
	T_{max}	80 °C

3.5. Antenna Information Related to Testing

Following Antenna types were used for the EUT testing:

Antenna Reference:	Antenna 1
Antenna Designation:	Kostal Air Coil
Antenna Type:	Air Coil
Antenna Gain:	0 dBi
Part number:	Kostal: No: 10141222 | VW NO: 2Q0.953.254 (transponder coil)

Antenna Reference:	Antenna 2
Antenna Designation:	HUF
Antenna Type:	Mechanical Lock Coil NSS (BASIC) + WFS5c
Antenna Gain:	0 dBi
Part number:	VW PN: 2G0.905.855

3.6. Support Equipment

No support equipment was used to exercise the EUT during testing:

Item	Description	Brand Name	Model Name or Number	Serial Number
1	--	--	--	--
2	--	--	--	--

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):
☒ Constantly transmitting at full power with a modulated carrier.

4.2. Configuration and Peripherals

The EUT was tested in the following configuration(s):

- The EUT was powered via DC power supply 12 V DC.
- The customer provided test setup instructions 'InstructionsFor_Operating_And_Testing_MQB_ClusterAndImmobilizer_v2.docx' that were used to place the device into a continuous transmission mode.
- The EUT supports 3 test modes, which can be selected from the red selector button just below the dials and display panel.
- All tests were carried out in Continuous test mode : The RF is constantly on, without any modulation (just carrier transmission). Icon M5 (yellow triangle symbol) is lit.
- The worst case determination was done on both antenna types supplied by the customer. Antenna 1 was found to be the worst case Antenna in terms of H-field level producing maximum level. Therefore radiated spurious emissions & H-field extreme conditions measurements were only carried out with Antenna 1. For further Antenna details refer section 3.5.
- Refer to Appendix 1 of this test report for details of radiated tests on an open field test site.

5. Measurements, Examinations and Derived Results

5.1. General Comments

Measurement uncertainties are evaluated in accordance with current best practice. Our reported expanded uncertainties are based on standard uncertainties, which are multiplied by an appropriate coverage factor to provide a statistical confidence level of approximately 95%. Please refer to Section 6 *Measurement Uncertainty* for details.

In accordance with DAkkS requirements all the measurement equipment is on a calibration schedule. All equipment was within the calibration period on the date of testing.

5.2. Test Results

5.2.1. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Segun I. Adeniji	**Test Date:**	17 January 2019
Test Sample Serial Number:	38569228		
Test Site Identification	SR 9		

FCC Reference:	Part 15.215(c)
Test Method Used:	ANSI C63.10 Section 6.9.2

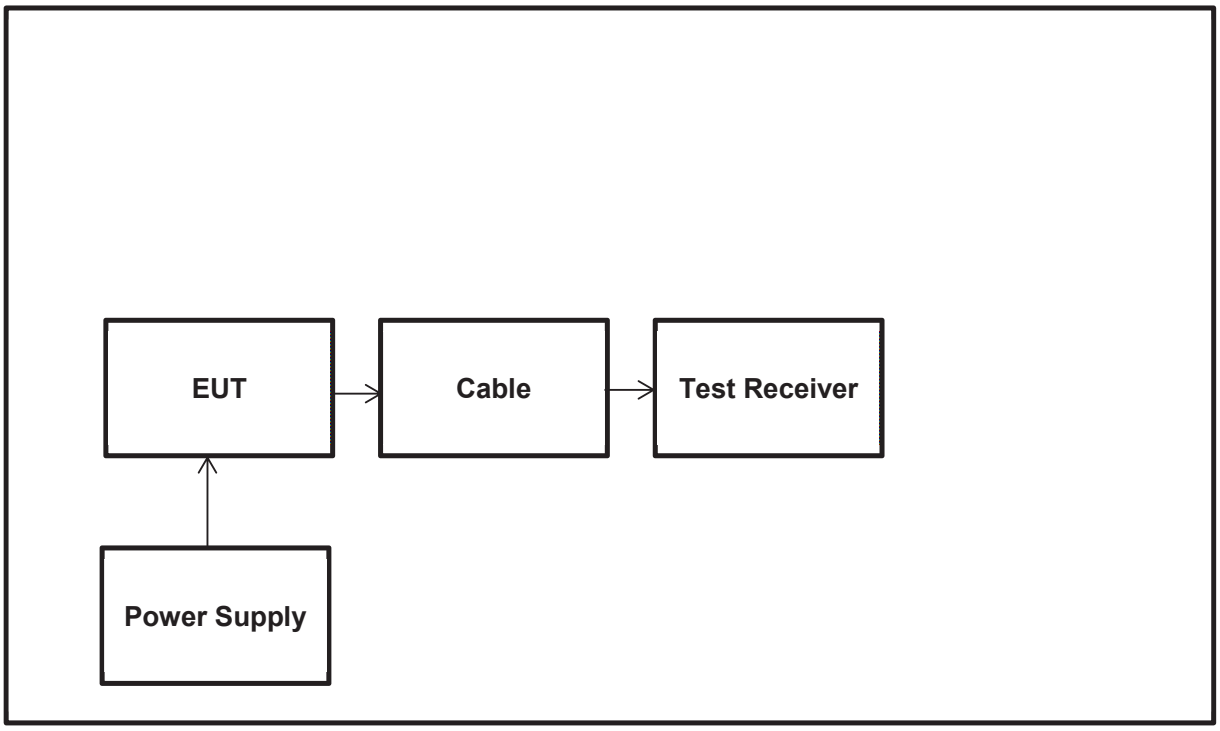
Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	28

Settings of the Instrument

RBW/VBW	1 kHz / 3 kHz
Span	10 kHz
Sweep time	Auto
Detector	Peak

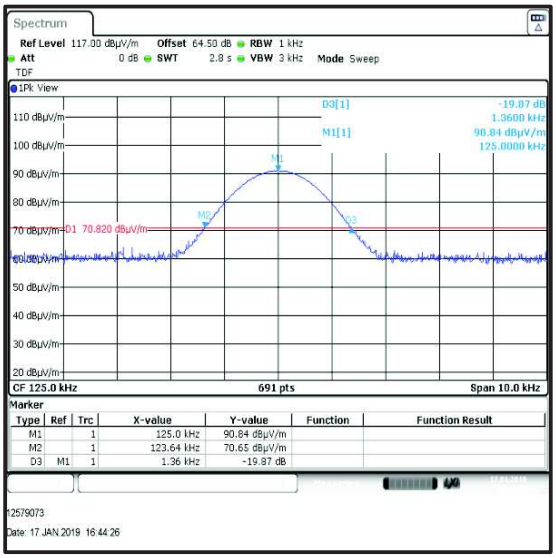
Test Setup:



Transmitter 20 dB Bandwidth (continued)

Results:

Channel	20 dB Bandwidth (kHz)
125 kHz	2.72



Single Channel

Result: Pass

5.2.2. Transmitter Fundamental Field Strength

Test Summary:

Test Engineer:	Segun I. Adeniji	**Test Date:**	16 January 2019 & 11 February 2019
Test Sample Serial Number:	38569228		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.209(d)
Test Method Used:	ANSI C63.10 Section 6.4

Environmental Conditions:

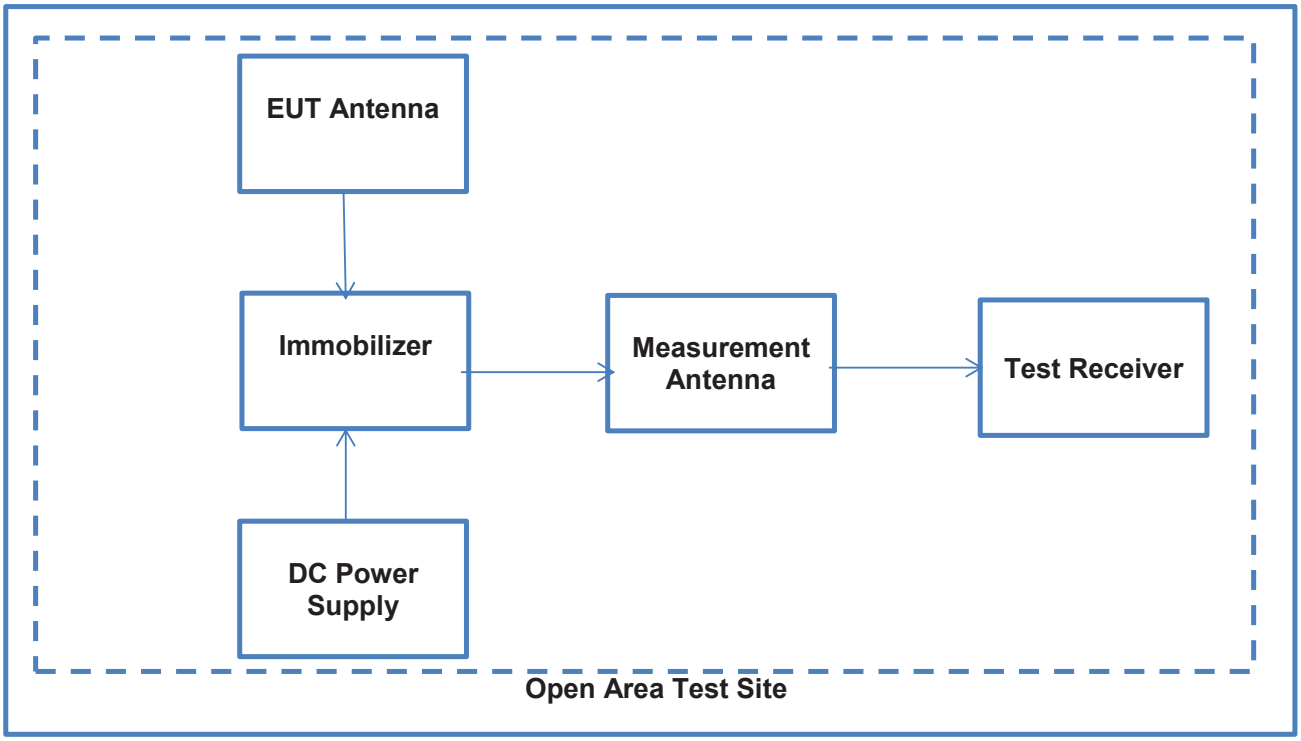
Temperature (°C):	23
Relative Humidity (%):	31

Note(s):

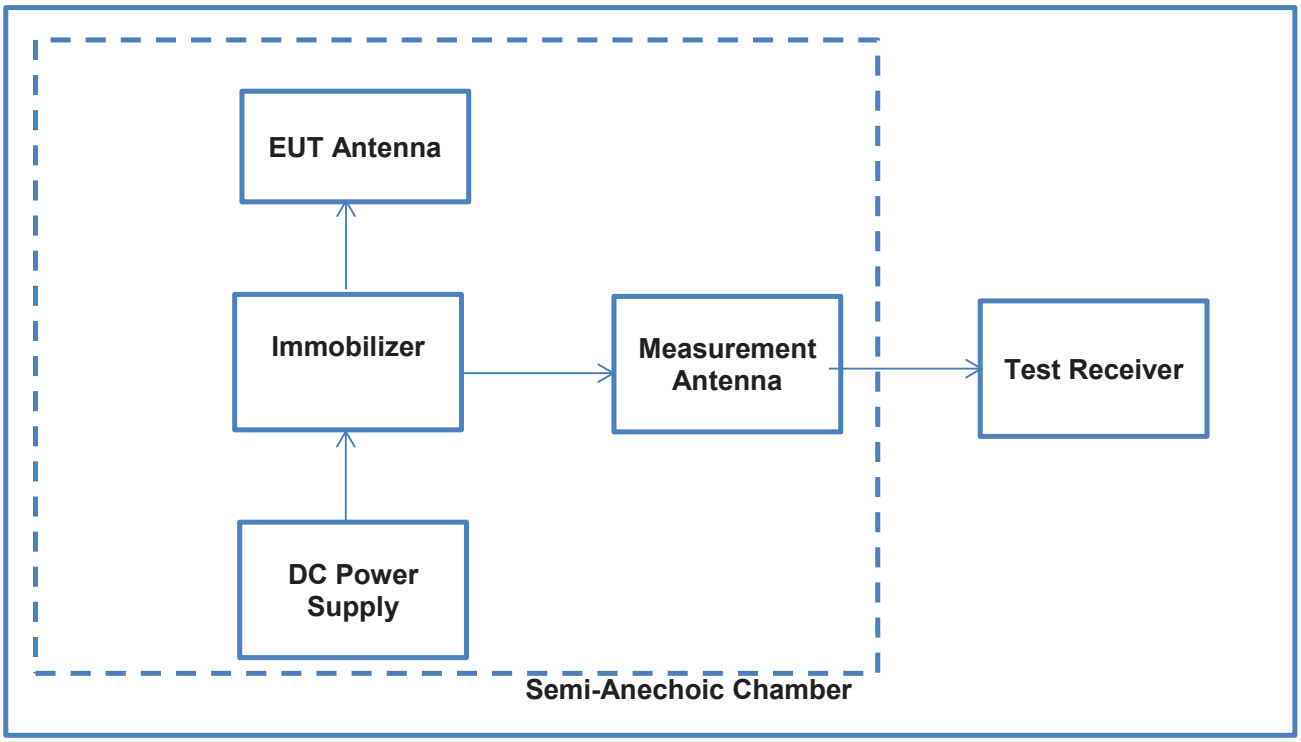
1. The limit is specified at a test distance of 300 metres. However, as specified by FCC Section 15.31 (f)(2), measurements may be performed at a closer distance and the measured level corrected to the specified measurement distance by using the square of an inverse linear distance extrapolation factor (40dB/decade).
2. In accordance with 414788 D01. Instead of an OATS a Semi Anechoic Chamber was used where evidence was shown that the behaviour is the same. A maximum deviation of 0.64 dB for 125 kHz was observed. This deviation is also taken into account to the result.
3. The measurement was done on both antenna types supplied by the customer. The Antenna details is given in section 3.5.
4. Pre-scan measurements were performed using a spectrum analyzer with a peak detector and measurement bandwidth of 200 Hz. The fundamental field strength was maximized by rotating the measurement antenna and EUT. The spectrum analyzer was then switched to test receiver mode and the final measurement on the maximized level was performed.
5. The measurement was performed at a measurement distance of 3 m where field strength of X dBuV/m was measured. This value was later extrapolated to a distance of 300 m by subtracting 80 dB from the result.
6. A transducer factor was used on the spectrum analyser during measurement. This factor includes correction between the fixed gain of the magnetic loop antenna and the calibration values. It also includes the value of the RF cable used to connect the antenna to the spectrum analyser which was incorporated into the annual calibration of the magnetic loop antenna.
7. Since the field strength level is below the quasi peak limit, hence no quasi-peak detector measurement is required.

Transmitter Fundamental Field strength test setup

Open Area Test Site



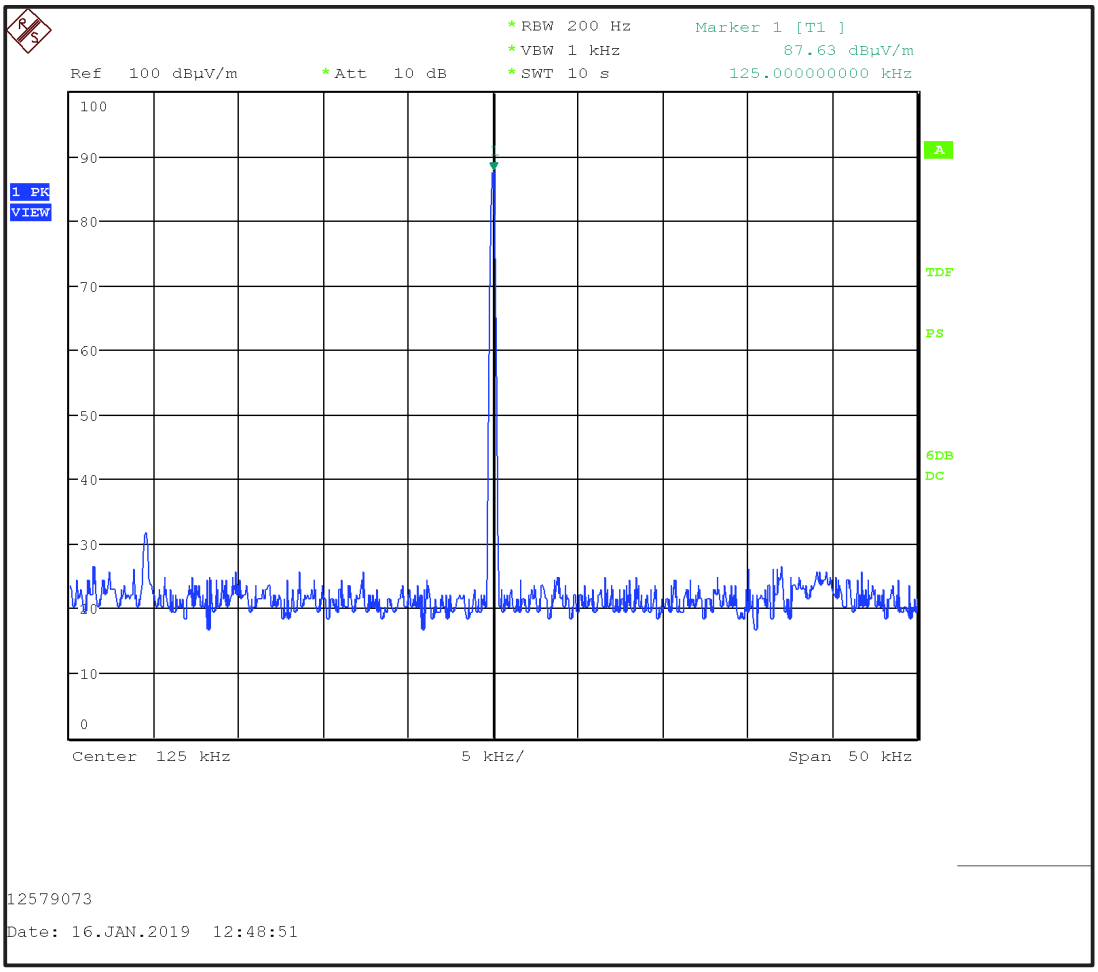
Semi Anechoic Chamber



Results: Antenna 1 / Peak

Frequency (MHz)	Measurement Antenna Polarization	Measured Level at 3 m (dBµV/m)	Extrapolated Level at 300 m (dBµV/m)	Deviation from OATS to SAC	Corrected Level at 300 m (dBµV/m) with deviation added	Limit at 300 m (dBµV/m)	Margin (dB)	Result
124.91	90° to EUT	87.63	7.63	0.64	8.27	25.7	17.43	Pass

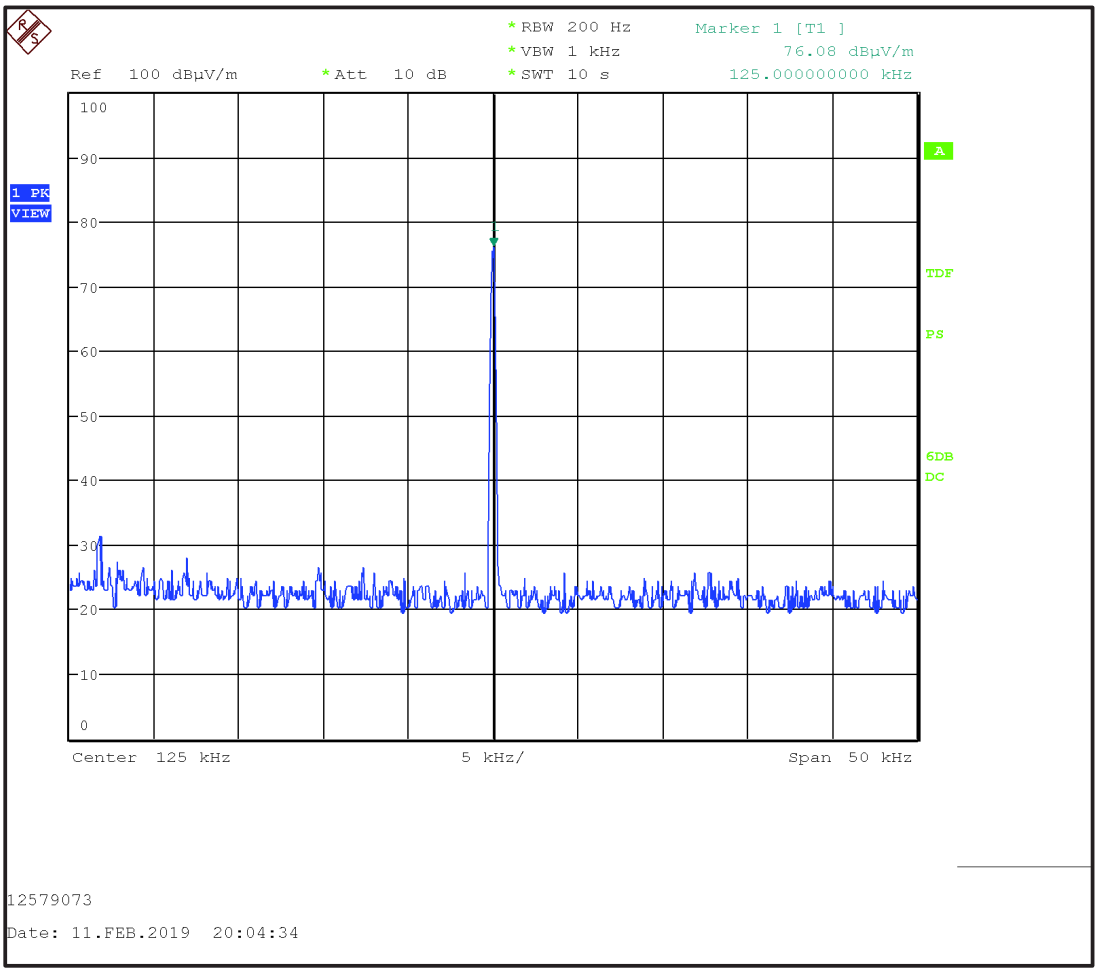
Result: Pass



Results: Antenna 2 / Peak

Frequency (MHz)	Measurement Antenna Polarization	Measured Level at 3 m (dBµV/m)	Extrapolated Level at 300 m (dBµV/m)	Deviation from OATS to SAC	Corrected Level at 300 m (dBµV/m) with deviation added	Limit at 300 m (dBµV/m)	Margin (dB)	Result
124.91	0° to EUT	76.08	-3.92	0.64	-3.28	25.7	22.42	Pass

Result: Pass



5.2.2 Transmitter Radiated Spurious Emissions

Test Summary:

Test Engineer:	Segun I. Adeniji	**Test Date:**	16 January 2019
Test Sample Serial Number:	38569228		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3, 6.4 and 6.5
Frequency Range:	9 kHz to 1000 MHz

Environmental Conditions:

Temperature (°C):	23
Relative Humidity (%):	31

Settings of the Instrument

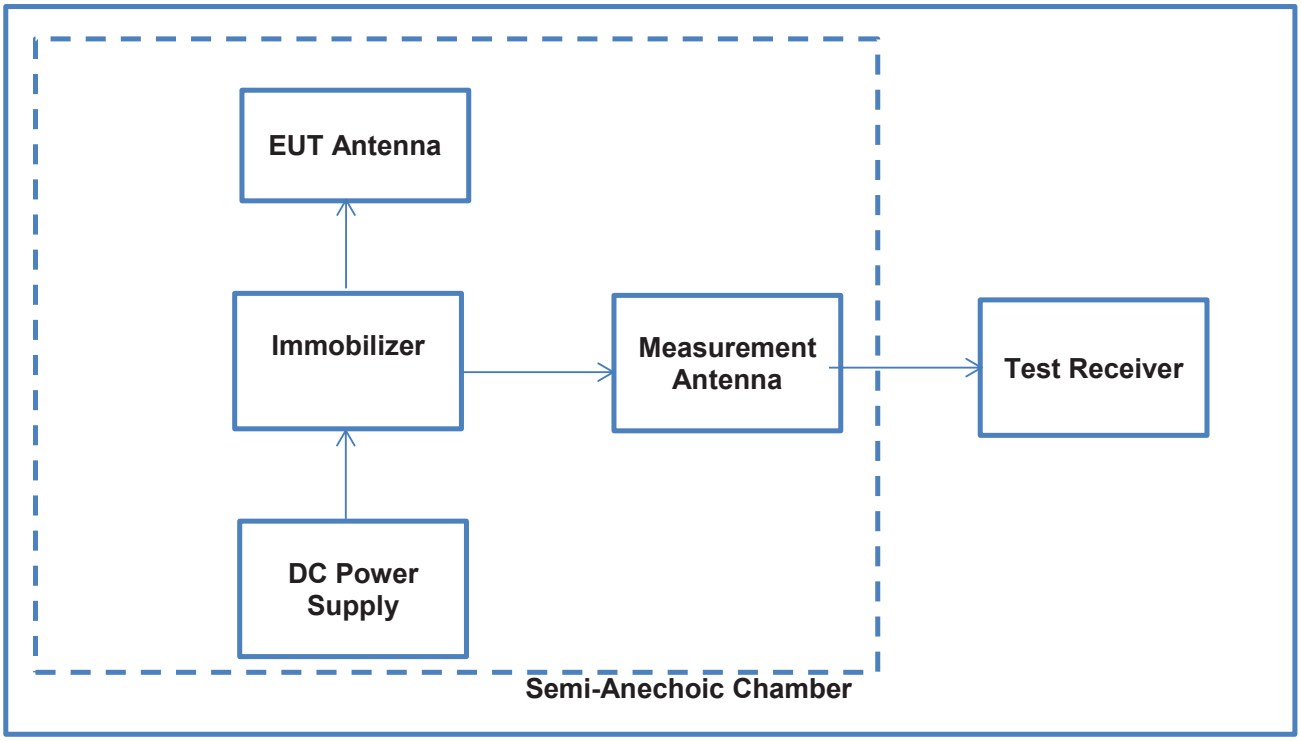
Frequency Range	RBW	VBW	Detector
9 kHz-150 kHz	300 Hz	1 kHz	Peak Detector
150 kHz-30 MHz	10 kHz	30 kHz	Peak Detector
30 MHz-1 GHz	100 kHz	300 kHz	Peak Detector

Note(s):

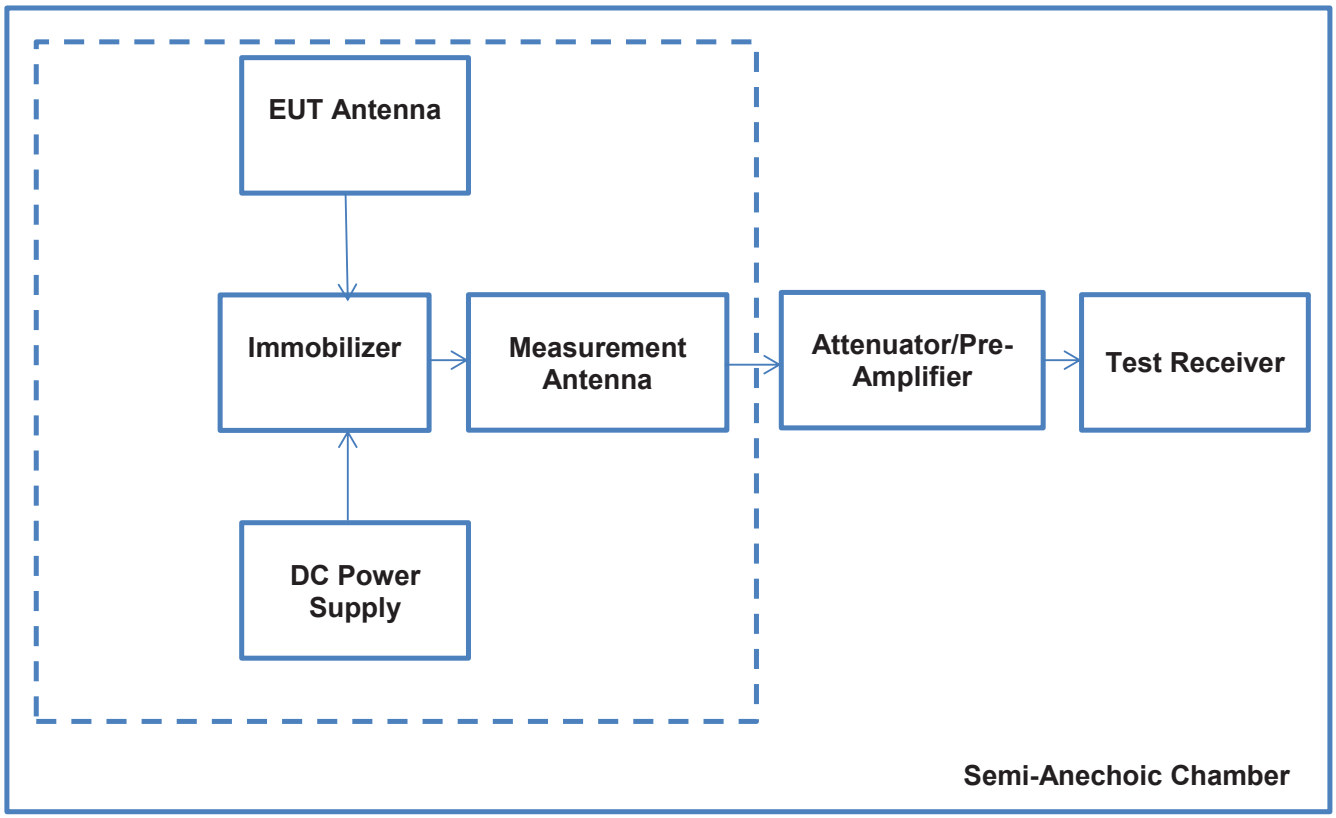
1. In accordance with FCC KDB 414788, an alternative test site may be used for the measurement. Therefore the result from the semi-anechoic chamber tests is shown in this section of the test report.
2. The emissions from 9kHz to 1 GHz were recorded. Markers were placed on the peaks of the pre-scan plots and the worst case emissions were noted.
3. All other emissions were greater than 20 dB below the applicable limit, below the noise floor of the measurement system or ambient.
4. Measurements were performed in a semi-anechoic chamber at a distance of 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Between 30 MHz and 1 GHz, maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
5. A transducer factor was used on the spectrum analyser during open field tests. This factor includes correction between the fixed gain of the magnetic loop antenna and the calibration values. It also includes the value of the RF cable used to connect the antenna to the spectrum analyser which was incorporated into the annual calibration of the magnetic loop antenna.
6. The emission shown at approximately 125 kHz is the fundamental emission. The worst case emissions were presented in the result table.
7. Since the field strength level is below the quasi peak limit, hence no quasi-peak detector measurement is required.
8. The worst case determination was done on both antenna types supplied by the customer. Antenna 1 was found to be the worst case Antenna in terms of H-field level producing maximum level. Therefore radiated spurious emissions measurements were only carried out with Antenna 1. For further Antenna details refer section 3.5.
9. The measurement was performed at a measurement distance of 3 m where field strength of X dBuV/m was measured.
    - 9 kHz- 490 kHz: measured level extrapolated to a distance of 300 m by subtracting 80 dB from the result.

- 490kHz-1705 kHz: measured level extrapolated to a distance of 30 m by subtracting 40 dB from the result.

Transmitter Radiated Spurious Emission test setup (Measurement below 30 MHz)



Transmitter Radiated Spurious Emission test setup (Measurement above 30 MHz)



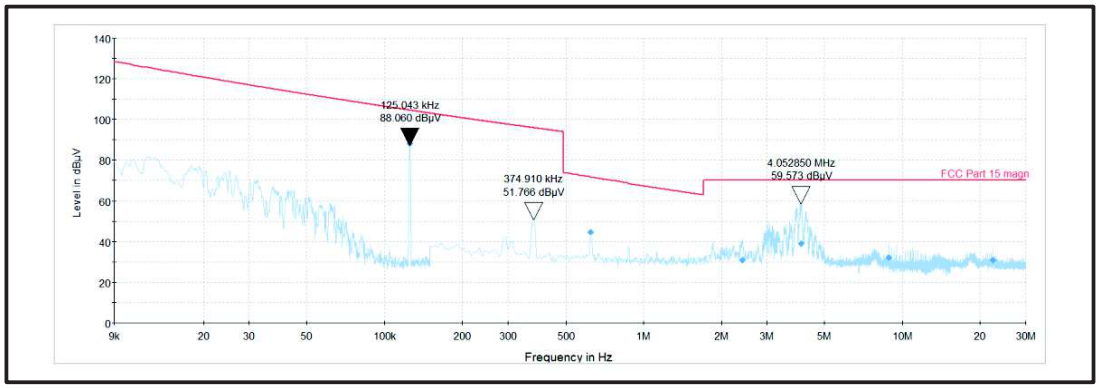
Results: Antenna 1 / Peak Detector

Frequency (MHz)	Antenna Polarization	Extrapolated Levels (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
0.374	Vertical	-28.23	16.15	44.38	Pass
4.053	Vertical	19.57	29.54	9.97	Pass
66.49	Vertical	29.24	40.00	10.76	Pass
400.0	Vertical	36.96	46.00	9.04	Pass

Result: Pass

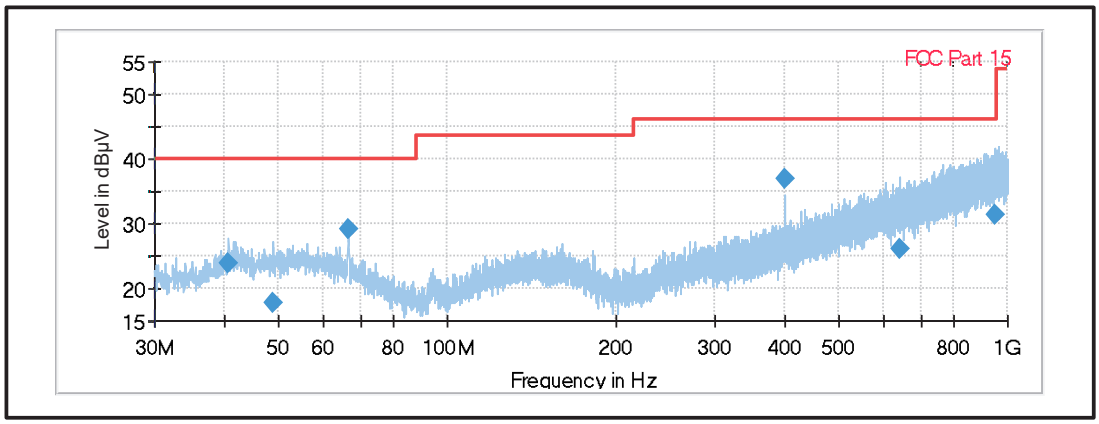
Transmitter Radiated Spurious Emissions (continued)

Plot: Transmitter Radiated Spurious Emissions (9kHz-30 MHz) @ 3m/ Antenna 1



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Plot: Transmitter Radiated Spurious Emissions (30 MHz-1000 MHz) @ 3m / Antenna 1



Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

6. Measurement Uncertainty

The expression of uncertainty of a measurement result allows realistic comparison of results with reference values and limits given in specifications and standards.

The uncertainty of the result may need to be taken into account when interpreting the measurement results.

The reported expanded uncertainties below are based on a standard uncertainty multiplied by an appropriate coverage factor such that a confidence level of approximately 95% is maintained. For the purposes of this document “approximately” is interpreted as meaning “effectively” or “for most practical purposes”.

Measurement Type	Confidence Level (%)	Calculated Uncertainty
Transmitter Fundamental Field Strength	95%	±3.10 dB
Radiated Spurious Emissions	95%	±3.10 dB
20 dB Bandwidth	95%	±0.87 %

The methods used to calculate the above uncertainties are in line with those recommended within the various measurement specifications. Where measurement specifications do not include guidelines for the evaluation of measurement uncertainty the published guidance of the appropriate accreditation body is followed.

7. Used equipment

Test site: SR 1/2

ID	Manufacturer	Type	Model	Serial No.	Calibration Date	Cal. Cycle
1	Rohde & Schwarz	Antenna, Loop	HFH2-Z2	831247/012	8/5/2016	36
383	Rohde & Schwarz	Antenna, Rod	HFH2-Z1	890151/11	7/14/2017	24
424	EMCO	Antenna, Horn	EMCO 3116	00046537	7/28/2016	24
460	Deisl	Turntable	DT 4250 S		n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	8/8/2016	36
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	7/20/2016	36
587	Maturo	antenna mast, tilting	TAM 4.0-E	011/7180311	n/a	n/a
588	Maturo	Controller	NCD	029/7180311	n/a	n/a
591	Rohde & Schwarz	Receiver	ESU 40	100244/040	7/12/2018	12
608	Rohde & Schwarz	Switch Matrix	OSP 120	101227	4/8/2014	60
628	Maturo	Antenna mast	CAM 4.0-P	224/19590716	n/a	n/a
629	Maturo	Kippeinrichtung	KE 2.5-R-M	MAT002	n/a	n/a

Test site: SR 9

ID	Manufacturer	Type	Model	Serial No.	Calibration Date	Cal. Cycle
625	Schwarzbeck	Antenna, H-field	HFSL 7101	109	Verification - only relative measurements	n/a
637	Rohde & Schwarz	Spectrum Analyzer	FSV40	101587	7/11/2018	12
195	SPS	Power Supply	TOE8842-24	51455	Verified by Multimeter	12
216	Agilent	Multimeter	34401A	US36017458	7/11/2017	24
378	ESPEC/ Thermotec	Climatic Chamber	PL-1FT	5100869	8/9/2016	36

8. Open-Area-Test Site comparison

GPS coordinates
48.765746, 9.250684

Test Setup

The following listed equipment was used for the measurement:

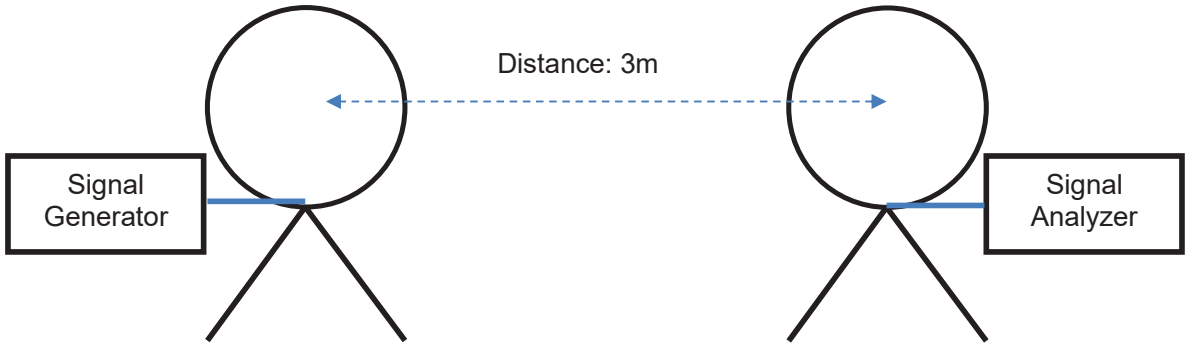
Manufacturer	Type	Model	Frequency Range
Rohde & Schwarz	Receiver, EMI Test	SML03	9 kHz – 30 MHz
Rohde & Schwarz	Receiver, EMI Test	ESIB7	20 Hz – 7 GHz
Rohde & Schwarz	Antenna, Loop	HFH2-Z2	1 kHz – 30 MHz
ETS LINDGREN	Antenna, Loop	6512	1 kHz – 30 MHz
Huber and Suhner	RF Cable	-	-
Elspec	BNC Cable	-	-

The transmit signal to the ETS Lindgren loop antenna is supplied by the SML signal generator.

The distance of the transmit and receive Antenna was 3m. No other distances can be achieved in SR1 so 10m and 30m distances are not possible. Due to this no comparison is possible.

The Results are valid for equipment which is not larger as the loop antenna which represents in the comparison the EUT.
If an EUT is bigger measurements on an OATS are needed.

The measurement was performed on the lowest frequency 9 kHz and was increased by 10 kHz Steps up to 100 kHz. Then the step size was 100 kHz up to 1000 kHz. From 1 MHz up to the last frequency of 30 MHz the step size was 1 MHz. The HFH2-Z2 loop antenna placed at 80 cm height was used as the receive antenna. The intercepted RF signal from this antenna was measured with the ESIB7 Test Receiver and the values were recorded accordingly.



Numeric values

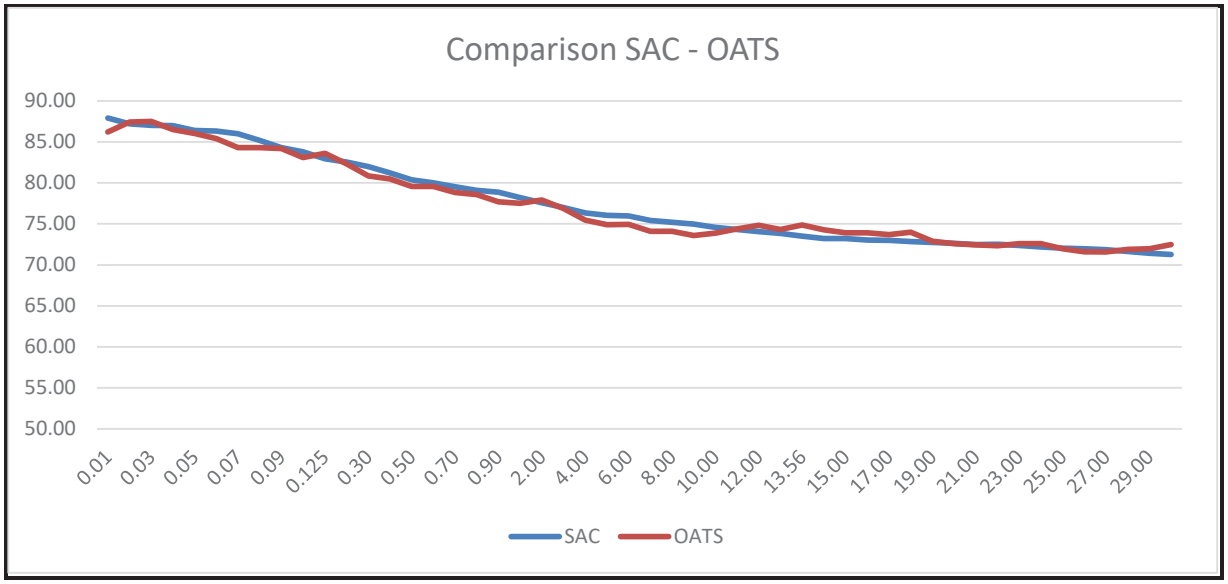
Frequency (MHz)	**0.01**	**0.02**	**0.03**	**0.04**	**0.05**	**0.06**	**0.07**	**0.08**	**0.09**	**0.10**	**0.125**	**0.20**
SR1 Measured power (dBµV)	87.91	87.22	87.01	86.98	86.40	86.32	85.98	85.20	84.30	83.80	82.96	82.55
OATS Measured power (dBµV)	86.22	87.42	87.50	86.49	86.01	85.39	84.32	84.29	84.20	83.10	83.60	82.32
Delta (dB)	-1.69	0.20	0.49	-0.49	-0.39	-0.93	-1.66	-0.91	-0.10	-0.70	0.64	-0.23

Frequency (MHz)	**0.30**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**1.00**	**2.00**	**3.00**	**4.00**	**5.00**
SR1 Measured power (dBµV)	81.98	81.23	80.39	80.00	79.53	79.10	78.87	78.20	77.60	77.01	76.32	76.04
OATS Measured power (dBµV)	80.84	80.49	79.58	79.58	78.85	78.59	77.69	77.50	77.91	76.90	75.45	74.90
Delta (dB)	-1.14	-0.74	-0.81	-0.42	-0.68	-0.51	-1.18	-0.70	0.31	-0.11	-0.87	-1.14

Frequency (MHz)	**6.00**	**7.00**	**8.00**	**9.00**	**10.00**	**11.00**	**12.00**	**13.00**	**13.56**	**14.00**	**15.00**	**16.00**
SR1 Measured power (dBµV)	75.98	75.43	75.20	74.97	74.59	74.32	74.05	73.83	73.50	73.22	73.20	73.05
OATS Measured power (dBµV)	74.94	74.09	74.11	73.58	73.87	74.38	74.84	74.31	74.88	74.29	73.90	73.93
Delta (dB)	-1.04	-1.34	-1.09	-1.39	-0.72	0.06	0.79	0.48	1.38	1.07	0.70	0.88

Frequency (MHz)	**17.00**	**18.00**	**19.00**	**20.00**	**21.00**	**22.00**	**23.00**	**24.00**	**25.00**	**26.00**	**27.00**	**28.00**	**29.00**	**30.00**
SR1 Measured power (dBµV)	73.00	72.86	72.74	72.64	72.50	72.52	72.39	72.20	72.04	71.97	71.86	71.64	71.41	71.27
OATS Measured power (dBµV)	73.70	73.98	72.90	72.60	72.45	72.34	72.59	72.59	71.97	71.59	71.58	71.88	71.98	72.49
Delta (dB)	0.70	1.12	0.16	-0.04	-0.05	-0.18	0.20	0.39	-0.07	-0.38	-0.28	0.24	0.57	1.22

Graph



Conclusion: Maximum difference is 1.69 dB @ 9 kHz

9. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	-	-	Initial Version

END OF REPORT