TEST REPORT

Test Report No. : UL-RPT-RP-13063166-216-FCC

Applicant	:	Disruptive Technologies Research AS
Model No.	:	Sensor US with Range Extender
FCC ID	:	2ATFX-100541
Technology	:	902 – 928 MHz (DTS)
Test Standard(s)	:	FCC Parts 15.209(a) & 15.247
		For details of applied tests refer to test result summary

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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: Sercan Usta
Title: Laboratory Engineer
Date: 24 April 2020

Approved by: Ajit Phadtare
Title: Lead Test Engineer
Date: 24 April 2020

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.

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1. Customer Information

1.1.Applicant Information

Company Name:	Disruptive Technologies Research AS
Company Address:	Ytrebygdsveien 215, 5258 Blomsterdalen, Bergen, Norway
Contact Person:	Bengt Johannes Lundberg
Contact E-Mail Address:	bengt.lundberg@disruptive-technologies.com
Contact Phone No.:	+47 91633887

1.2.Manufacturer Information

Company Name:	Zollner Elektronik AG
Company Address:	Manfred-Zollner-Straße 1, 93499 Zandt, Germany
Contact Person:	Thomas Glasschröder (QA Manager)
Contact E-Mail Address:	thomas_glasschroeder@zollner.de
Contact Phone No.:	+49 9944-201-7146

2. Summary of Testing

2.1. General Information

Applied Standards

Specification Reference:	47CFR15.247
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.247
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.209
Test Firm Registration:	399704

Location

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

Date information

Order Date:	30 September 2019
EUT arrived:	09 December 2019 to 10 February 2020
Test Dates:	09 December 2019 to 23 March 2020
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(1)	☐	☐	☐	☒
Part 15.247(a)(2)	Transmitter Minimum 6 dB Bandwidth	☒	☐	☐	☐
Part 15.35(c)	Transmitter Duty Cycle	☒	☐	☐	☐
Part 15.247(e)	Transmitter Power Spectral Density	☒	☐	☐	☐
Part 15.249(a)	Transmitter Fundamental Field Strength	☒	☐	☐	☐
Part 15.247(d)/15.209(a)	Transmitter Radiated Emissions	☒	☐	☐	☐
Part 15.247(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	☒	☐	☐	☐

Note:

1. Not Applicable as EUT operates using a non-rechargeable battery power.

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 558074 D01 15.247 Meas Guidance v05r02 April 2, 2019
Title:	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating Under Section 15.247 of the FCC Rules
Reference:	KDB 414788 D01 Radiated Test Site v01r01, July 12, 2018
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:	Disruptive Technologies
Model Name or Number:	Sensor US with Range Extender
Test Sample Serial Number:	UD3 [XID: bjr0tge7gpvg00cjvapg] (Radiated sample)
Hardware Version Number:	100644
Software Version Number:	cc13xx_firmware/1.2.28
FCC ID:	2ATFX-100541

Brand Name:	Disruptive Technologies
Model Name or Number:	Sensor US with Range Extender
Test Sample Serial Number:	UD7 [XID: bjr27avbluqg00dm55e0] (Radiated sample)
Hardware Version Number:	100644
Software Version Number:	cc13xx_firmware/1.2.28
FCC ID:	2ATFX-100541

Brand Name:	Disruptive Technologies
Model Name or Number:	Sensor US with Range Extender
Test Sample Serial Number:	UD19 [XID: bjr2bf0pismg008i21d0] (Radiated sample)
Hardware Version Number:	100644
Software Version Number:	cc13xx_firmware/1.2.28
FCC ID:	2ATFX-100541

3.2. Description of EUT

The equipment under test was a combination of Wireless IoT Sensor (Sensor US) coupled wirelessly (glued on flexible PCB) to Range Extender; supporting 902-928 MHz (DTS) communications through a Cloud Connector gateway.

The Wireless IoT Sensor (Sensor US) was powered via a non-rechargeable battery.

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:	902-928 MHz (Digital Transmission System) Standard Mode	
Power Supply Requirement:	Nominal	3 V, 0.1 mA DC (Internal battery)
Type of Unit:	Transceiver	
Channel Spacing:	Fixed frequency	
Modulation:	Frequency Shift Keying (FSK)	
Data Rate (kbps):	240	
Sensor US Power Amplifier Power Settings:	+9 dBm	
Sensor US Internal integrated Antenna Gain:	-27.0 dBi	
Sensor US Internal Integrated Antenna Type:	Integrated PCB Antenna	
Sensor US Internal Integrated Antenna Details :	Model No. PN 100132-1 “DT Sensor antenna, 1st segment” and PN 100134-1 “DT Sensor antenna, 3rd segment” | Manufacturer: DISRUPTIVE TECHNOLOGIES	
Range Extender Antenna Gain:	+18.0 dBi	
Range Extender Antenna Type:	Integrated PCB Antenna	
Range Extender Antenna Details :	PN 100644 "Sensor Range Extender PCB (EU & US)" | Manufacturer: DISRUPTIVE TECHNOLOGIES	
Combined Directivity Gain: (Sensor US Internal integrated Antenna + Range Extender Antenna Gain)	+6 dBi	
Equivalent Maximum Conducted Output Power:	8.49 dBm	
Transmit Frequency Range:	903.250 MHz to 926.750 MHz	
Transmit Channels Tested:	**Channel ID**	**Channel Frequency (MHz)**
	Bottom	903.250
	Middle	915.000
	Top	926.750

3.5. Support Equipment

The following support equipment was used to exercise the EUT during testing:

A. Support Equipment (In-house)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	RJ 45 Cable	Not stated	Not stated	Not stated

B. Support Equipment (Manufacturer supplied)

Item	Description	Brand Name	Model Name or Number	Serial Number
1	Ethernet switch with power-over-ethernet (PoE) Injector	D-Link	DPE-101GI	SQ031HB003386
2	Switching Power Supply (PoE)	mimosa	POE16R-560	502-00005
3	POE/LAN Cable 5 m (M12x Coded to RJ45)	Not stated	1407473	Not stated
4	Laptop computer	Apple	MacBook Pro	C02T60V0GY25
5	Gateway with an 902-928 MHz RF-Technology, that relays communication between sensors and the cloud	Disruptive Technologies Research AS	Cloud Connector US	bjemb9tuvn3g0008o500

4. Operation and Monitoring of the EUT during Testing

4.1. Operating Modes

The EUT was tested in the following operating mode(s):
☒ Transmitting Mode - Standard Mode Fixed Channel Frequency Mode.

4.2. Configuration and Peripherals

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

EUT Configuration:

The EUT was a combination of Sensor US wirelessly coupled (glued on) with a flexible PCB Range Extender.

EUT Power Supply:

- For all radiated measurements, the EUT was powered via the non-rechargeable internal battery of the Sensor US.

Test Mode Activation:

- The customer supplied a Gateway, “Cloud Connector US”, supporting 902-928 MHz RF-Technology, from which test modes were activated wirelessly.
- This Gateway was powered via PoE injector & connected to the internet via a LAN cable.
- A wireless connection was established between this Gateway & EUT.
- The Test mode configuration files were installed on MacBook supplied by customer.
- For Standard Mode power amplifier inside the Sensor US was set to 9 dBm.
- All measurments were performed with worst case (the highest) operational duty cycle of the EUT.

Radiated Measurements:

- The EUT radiated samples with fully charged internal battery were used for 6 dB bandwidth, field strength, band edge & spurious emissions measurements.
- The EUT radiated samples transmitting with the maximum possible duty cycle in test mode of 7.22 %, were used for the mentioned measurements.
- In response to an FCC inquiry;
  - FSK modulation is not considered a 'Pulse" emission for FCC rules
  - Further details on duty cycle correction are provided during TCB workshop presentation.
  - The relevant TCB workshop presentation is “FCC Updates & Reminders | November 13,2019”
  - Slide 8 of FCC Updates & Reminders | November 13,2019 refers to FCC KDB 558074 D01 15.247 Meas Guidance v05r02 Section 11 Frequently Asked Questions**,** Question 3 & Answer 3.
  - All required criteria of the mentioned Answer 3 are satisfied by EUT.
- Therefore, in response to an FCC inquiry referencing FCC KDB 558074 D01 15.247 Meas Guidance v05r02 Section 11 Frequently Asked Questions**,** Answer 3 a) the worst case (the highest) operational duty cycle of the EUT is subtracted from the Peak reading to derive the RMS average value.
- Before starting final radiated measurements “worst case verification” with the EUT in Standing-position & Laying-position was performed by Lab. The EUT in Laying position was found to be the worst case therefore this report includes relevant results.
- Radiated spurious emissions were performed with the EUT positioned on the turn table and rotating 360 degrees while the antenna height varies from 1 to 4 m over the measurement frequency range.
- EMC32 V10.1.0 Software was used for the Radiated spurious emission measurement.

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 Minimum 6 dB Bandwidth

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	10 February 2020
Test Sample Serial Number:	UD7 [XID: bjr27avbluqg00dm55e0] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.247(a)(2)
Test Method Used:	FCC KDB 558074 Section 8.2 referencing ANSI C63.10:2013 Section 11.8.1 Option 1

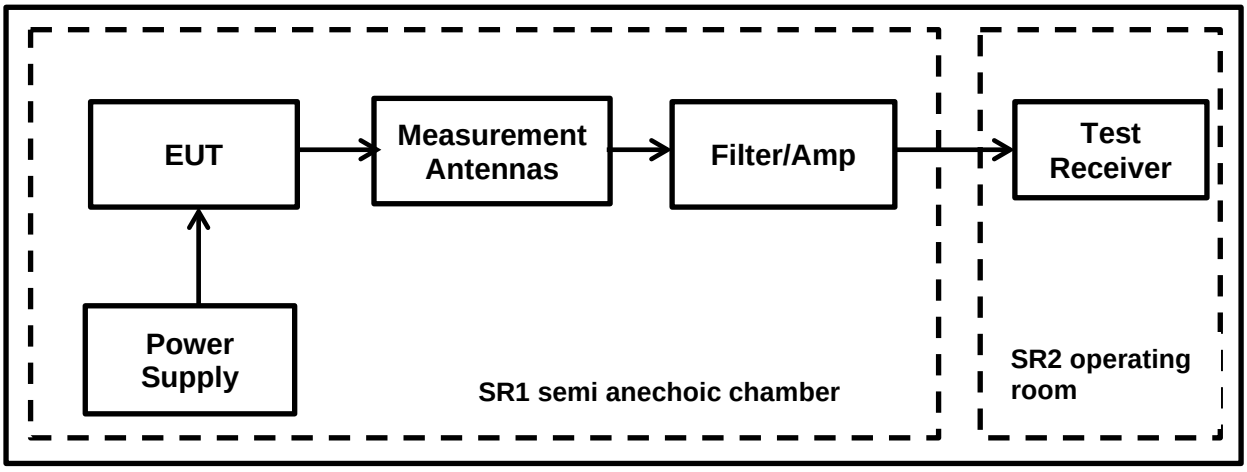
Environmental Conditions:

Temperature (°C):	22.5
Relative Humidity (%):	37

Notes:

1. 6 dB DTS bandwidth tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 8.2 referencing ANSI C63.10 Section 11.8 (11.8.1 Option 1 measurement procedure). The spectrum analyser resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The DTS bandwidth was measured at 6 dB down from the peak of the signal.
2. Measurements were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.

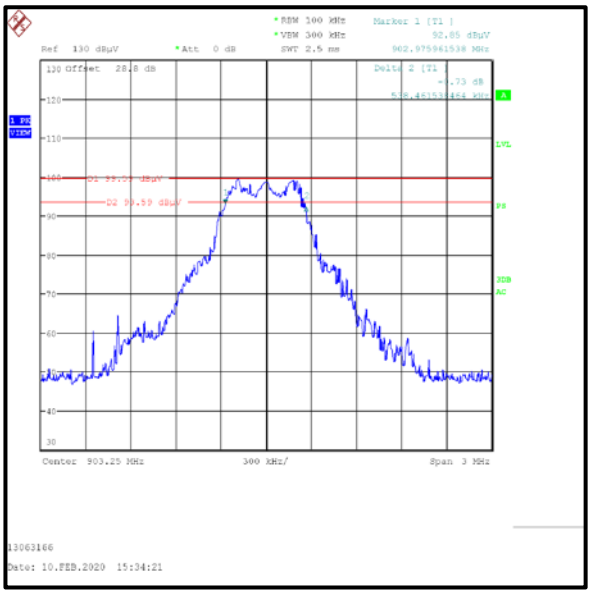
Test setup:



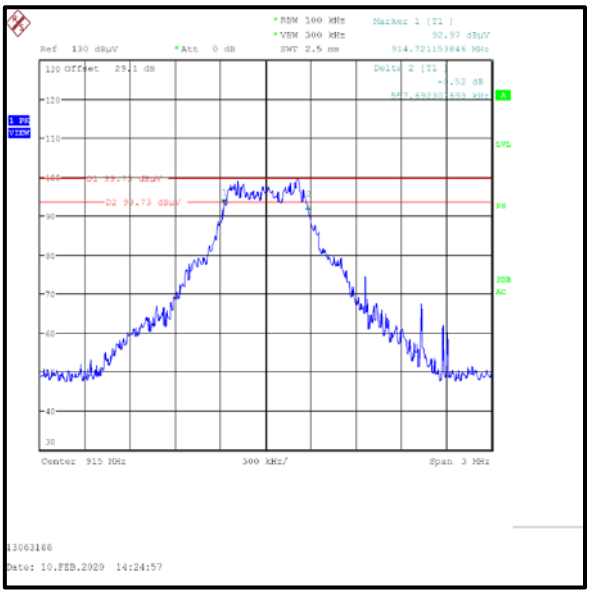
Transmitter Minimum 6 dB Bandwidth (continued)

Results:

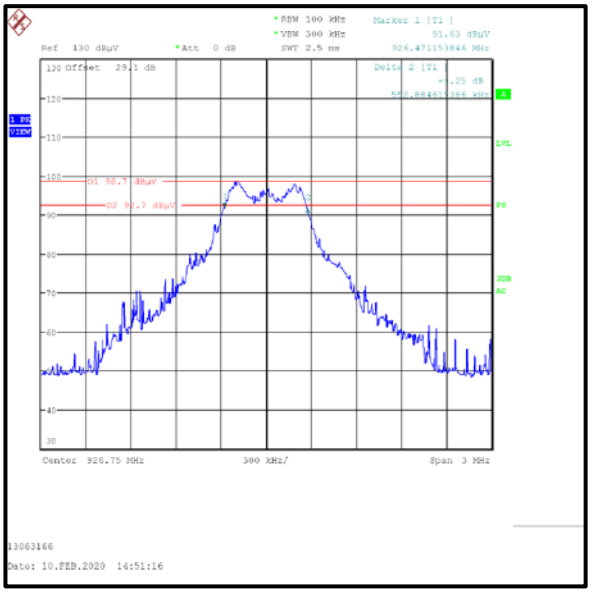
Channel	6 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)	Result
Bottom	538.462	≥500	38.462	Complied
Middle	557.692	≥500	57.692	Complied
Top	552.885	≥500	52.885	Complied



Bottom Channel



Middle Channel



Top Channel

Result: Pass

5.2.2.Transmitter Duty Cycle

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	10 February 2020
Test Sample Serial Number:	UD7 [XID: bjr27avbluqg00dm55e0] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.35(c)
Test Method Used:	FCC KDB 558074 Section 6.0

Environmental Conditions:

Temperature (°C):	22.5
Relative Humidity (%):	37

Note(s):

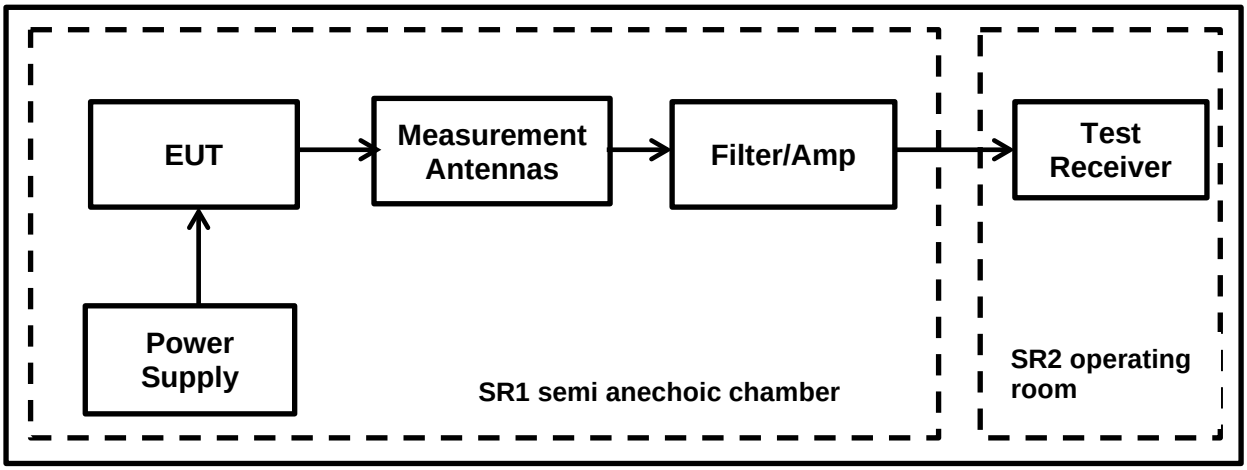
1. In order to assist with the determination of the average level of fundamental and spurious emissions field strength, measurements were made of duty cycle to determine the transmission duration and the silent period time of the transmitter. The transmitter duty cycle was measured using a spectrum analyser in the time domain and calculated by using the following calculation:

   Duty Cycle (%) = 100 X [On Time (T_{ON})] / [Period(T_{ON}+ T_{OFF}) or 100ms whichever is the lesser]

   Duty Cycle Correction Factor= 10 log 1 / [On Time (T_{ON})] / [Period(T_{ON}+ T_{OFF}) or 100ms whichever is the lesser]

2. Measurements were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
3. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
4. The measurements were performed with the maximum possible duty cycle in test mode of the EUT.
5. The measured values of duty cycle & duty cycle correction factor are based on the maximum transmission time in any 100 msec period.

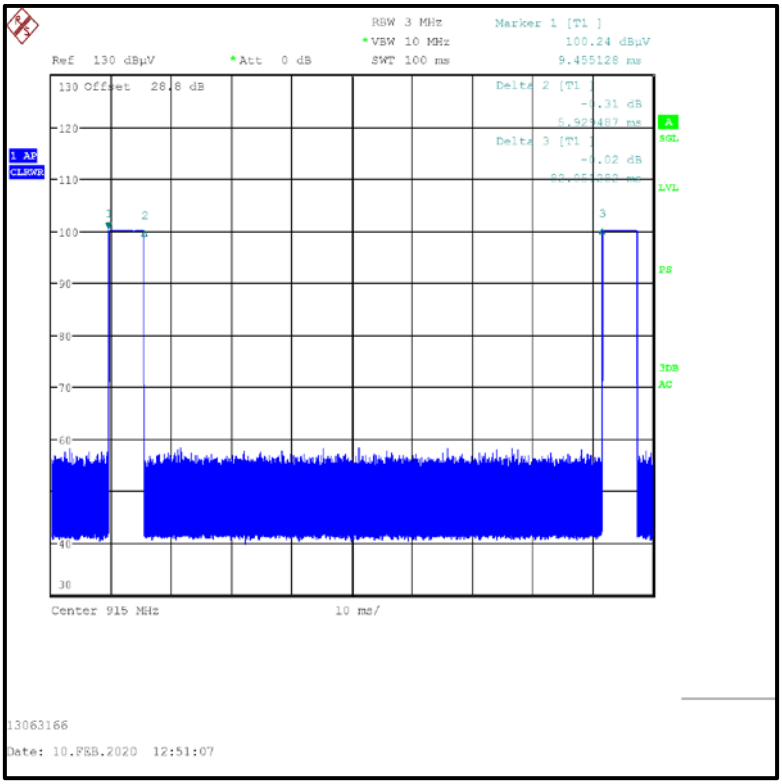
Test setup:



Transmitter Duty Cycle (continued)

Results: Standard Mode / Test Mode Maximum Possible Duty Cycle

Pulse On Time (T_{ON}) (ms)	Pulse Period (T_{ON} +T_{OFF}) (ms)	Test Mode Maximum Possible Duty Cycle (%)	Test Mode Maximum Possible Duty Cycle Correction Factor (dB)
5.929	82.051	7.22	11.41



5.2.3. Transmitter Power Spectral Density

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	10 February 2020 & 23 March 2020
Test Sample Serial Number:	UD7 [XID: bjr27avbluqg00dm55e0] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.247(e)
Test Method Used:	FCC KDB 558074 Sections 8.4 referencing ANSI C63.10 Sections 11.10.2

Environmental Conditions:

Temperature (°C):	22.5
Relative Humidity (%):	37

Note(s):

1. Final measurements were performed using the above configurations on the bottom, middle and top channels.
2. The EUT was transmitting at 7.22 % duty cycle and testing was performed in accordance with KDB 558074 8.4 referencing ANSI C63.10 Section 11.10.2 Method PKPSD (peak PSD). The signal analyser resolution bandwidth was set to 3 kHz and video bandwidth 10 kHz. A peak detector was used, sweep time was set to auto and the trace was allowed to fully stabilize. A marker was placed at the highest peak of the measured signal and was recorded.
3. Measurements were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
4. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
5. The measured field strength values in dBµV/m @ 3m were converted to equivalent EIRP power values in dBm by subtracting 95.2; in accordance with FCC KDB 558074 Section 3 & ANSI C63.10:2013, Annex G.2.
6. Following formula (Working in dB units,) was used

   EIRP Power Spectral Density [dBm/3 kHz] = Measured Power Spectral Density [dBµV/m/3kHz] + 20log(d [m]) -104.77 (at d=3 m)

   EIRP Power Spectral Density [dBm/3 kHz] = Measured Power Spectral Density [dBµV/m/3kHz] - 95.2

   Where, d: measurement distance

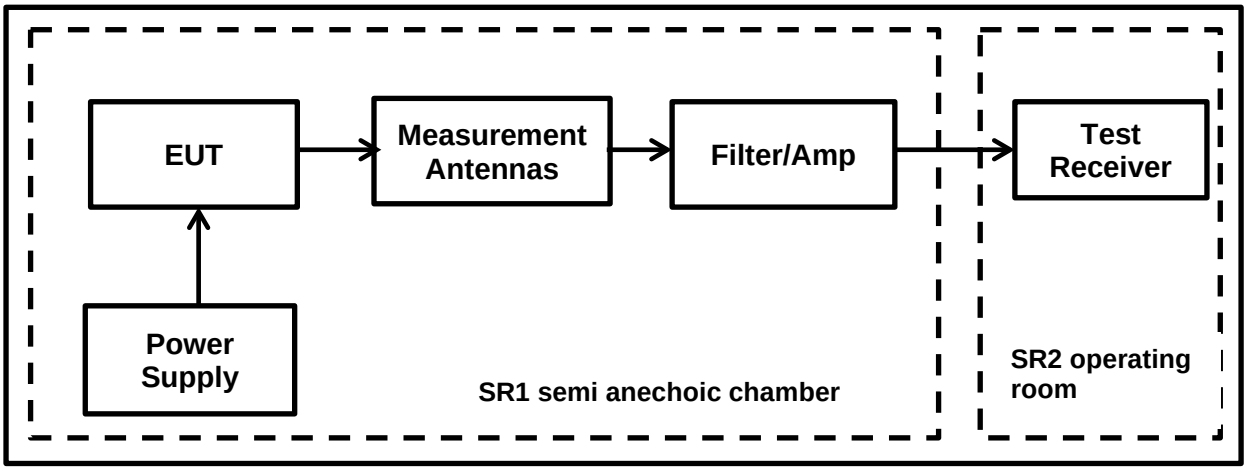
7. Due to the directivity of the combined antennas (Sensor US Internal integrated Antenna & Range Extender Antenna Gain) an additional gain of + 6 dBi is included.
8. The declared antenna gain in dBi plus directivity of the combined antennas were then subtracted from radiated power spectral density values in dBm to obtain the equivalent conducted power spectral density values in dBm.

   Equivalent Conducted Power Spectral Density [dBm] = EIRP Power Spectral Density [dBm] - Sensor US Internal integrated Antenna Gain [dBi] - Range Extender Antenna Gain [dBi] - Directivity Gain [dBi]

   Equivalent Conducted Power Spectral Density [dBm] = EIRP Power Spectral Density [dBm] - (-27.0 [dBi]) - 18.0 [dBi] - 6.0 [dBi]

Transmitter Power Spectral Density (continued)

Test setup:



Transmitter Power Spectral Density (continued)

Results: Standard Mode

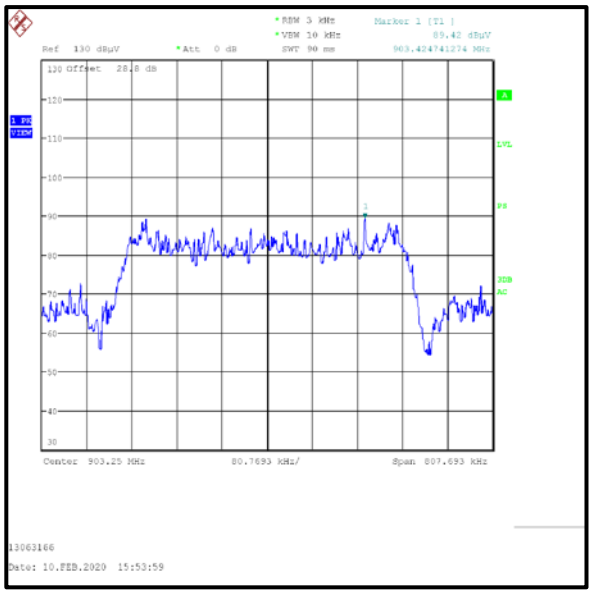
Channel	Measured Power Spectral Density (dBµV/m /3 kHz)	dBµV/m to dBm conversion factor @ 3m (dB)	EIRP Power Spectral Density (dBm/3 kHz)
Bottom	89.42	-95.2	-5.78
Middle	90.39	-95.2	-4.81
Top	88.36	-95.2	-6.84

Channel	EIRP Power Spectral Density (dBm/3 kHz)	Sensor US Declared Antenna Gain (dBi)	Range Extender Declared Antenna Gain (dBi)	Directivity Gain (dBi)	Conducted Power Spectral Density (dBm/3 kHz)	Conducted Power Spectral Density (dBm/3 kHz)	Margin (dB)	Result
Bottom	-5.78	-27.0	+18.0	+6.0	-2.78	8.0	10.78	Complied
Middle	-4.81	-27.0	+18.0	+6.0	-1.81	8.0	9.81	Complied
Top	-6.84	-27.0	+18.0	+6.0	-3.84	8.0	11.84	Complied

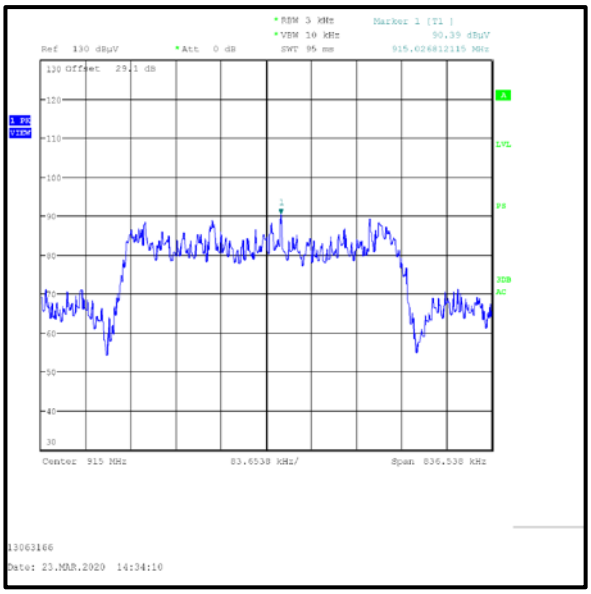
Result: Pass

Transmitter Power Spectral Density (continued)

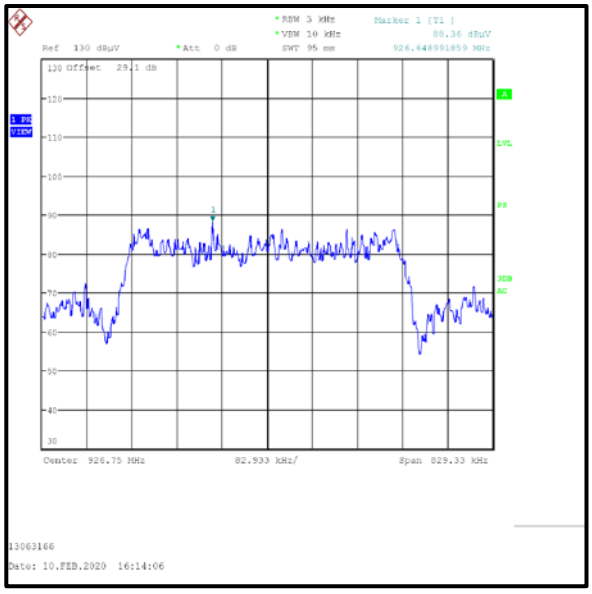
Results: Standard Mode



Bottom Channel



Middle Channel



Top Channel

Result: Pass

5.2.4. Transmitter Maximum Peak Output Power

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	10 February 2020
Test Sample Serial Number:	UD7 [XID: bjr27avbluqg00dm55e0] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.247(b)(3)
Test Method Used:	FCC KDB 558074 Section 8.3.1.1 referencing ANSI C63.10 Section 11.9.1.1

Environmental Conditions:

Temperature (°C):	22.5
Relative Humidity (%):	37

Notes:

1. Measurements were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. Tests were performed using a spectrum analyser in accordance with FCC KDB 558074 Section 8.3.1.1 with the RBW ≥ DTS bandwidth referencing ANSI C63.10 Section 11.9.1.1.
4. The signal analyser resolution bandwidth was set to 1 MHz and video bandwidth of 3 MHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The span was set to 3 MHz. A marker was placed at the peak of the signal and the results recorded in the table below.
5. The measurement was made with highest possible duty cycle.
6. The measured field strength values in dBµV/m @ 3m were converted to equivalent EIRP power values in dBm by subtracting 95.2; in accordance with FCC KDB 558074 Section 3 & ANSI C63.10:2013, Annex G.2.
7. Following formula (Working in dB units,) was used

   EIRP[dBm] = E[dBµV/m]+ 20log(d [m]) -104.77

   at d=3 m

   EIRP[dBm] = E[dBµV/m] - 95.2

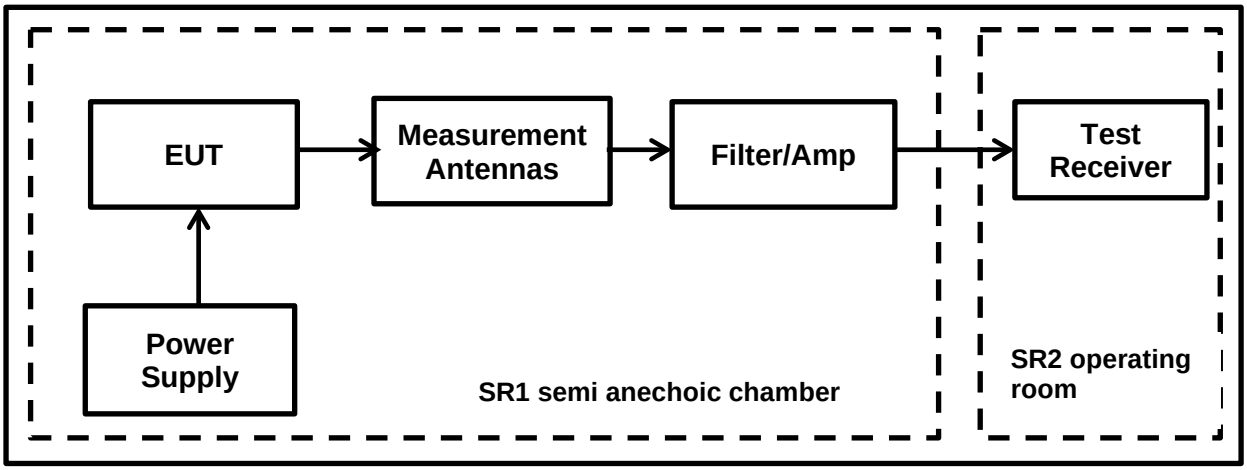
   Where, E: field strength | d: measurement distance | EIRP: equivalent isotropically radiated power
8. Due to the directivity of the combined antennas (Sensor US Internal integrated Antenna & Range Extender Antenna Gain) an additional gain of + 6 dBi is included.
9. The declared antenna gain in dBi plus directivity of the combined antennas were then subtracted from EIRP power values in dBm to obtain the equivalent conducted power values in dBm.

   Equivalent Conducted Power [dBm] = EIRP[dBm] - Sensor US Internal integrated Antenna Gain [dBi] - Range Extender Antenna Gain [dBi] - Directivity Gain [dBi]

   Equivalent Conducted Power [dBm] = EIRP [dBm] - (-27.0 [dBi]) - 18.0 [dBi] - 6.0 [dBi]

Transmitter Maximum Peak Output Power (continued)

Test setup:



Transmitter Maximum Peak Output Power (continued)

Results: Standard Mode

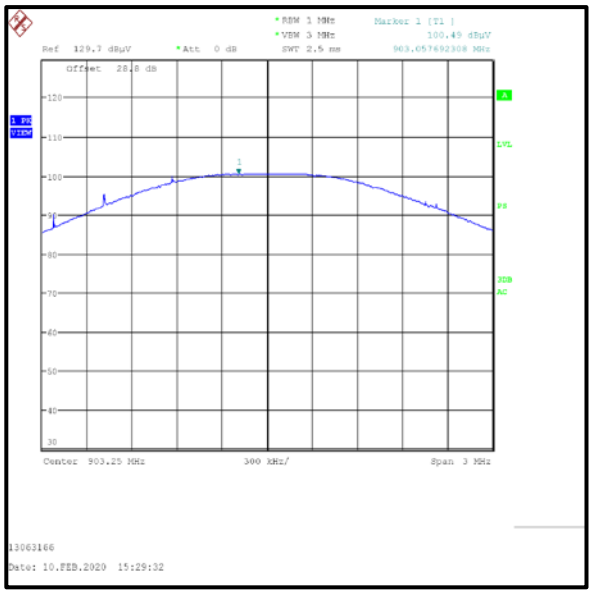
Channel	Radiated Field Strength @3m (dBµV/m)	dBµV/m to dBm Conversion factor@3m	EIRP (dBm)	De Facto EIRP Limit (dBm)	Margin (dB)	Result
Bottom	100.49	-95.2	5.29	36.0	30.71	Complied
Middle	100.69	-95.2	5.49	36.0	30.51	Complied
Top	99.23	-95.2	4.03	36.0	31.97	Complied

Channel	EIRP (dBm)	Sensor US Declared Antenna Gain (dBi)	Range Extender Declared Antenna Gain (dBi)	Directivity Gain (dBi)	Equivalent Conducted Power (dBm)	Conducted Peak Power Limit (dBm)	Margin (dB)	Result
Bottom	5.29	-27.0	+18.0	+6.0	8.29	30.0	21.71	Complied
Middle	5.49	-27.0	+18.0	+6.0	8.49	30.0	21.51	Complied
Top	4.03	-27.0	+18.0	+6.0	7.03	30.0	22.97	Complied

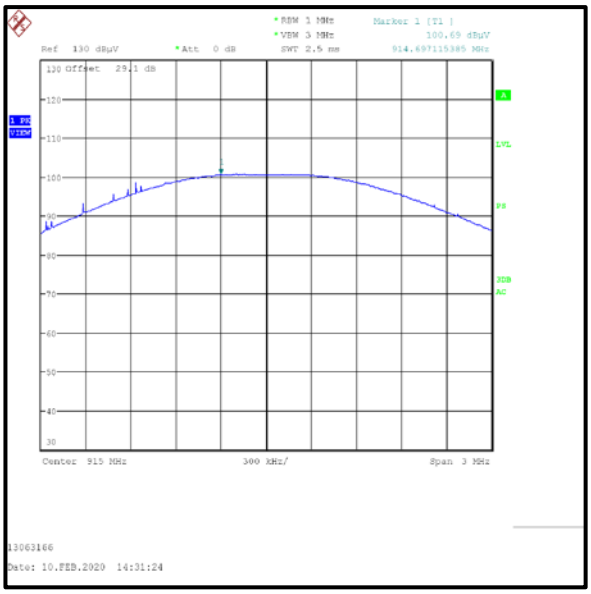
Result: Pass

Transmitter Maximum Peak Output Power (continued)

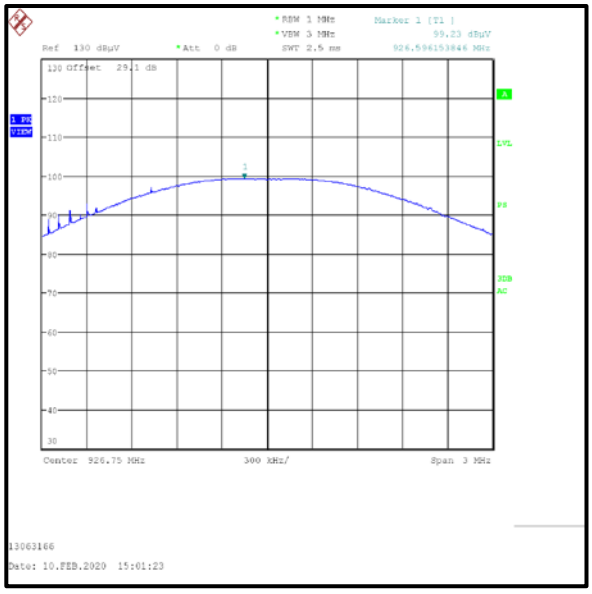
Plots:



Bottom Channel



Middle Channel



Top Channel

Result: Pass

5.2.5. Transmitter Radiated Emissions

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	09 December 2019
Test Sample Serial Number:	UD3 [XID: bjr0tge7gpvg00cjvapg] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.4
Frequency Range	9 kHz to 30 MHz

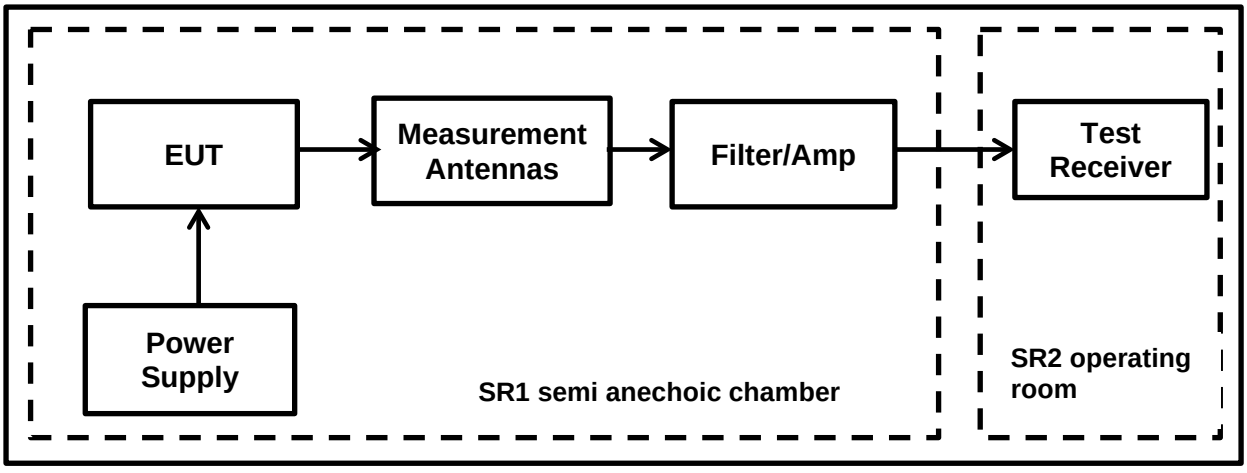
Environmental Conditions:

Temperature (°C):	20.5
Relative Humidity (%):	39

Note(s):

1. In accordance with FCC KDB 414788, an alternative test site may be used for the measurement below 30 MHz (The OATS / SAC comparison data is available upon request). Therefore the result from the semi-anechoic chamber tests is shown in this section of the test report.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. The preliminary scans showed similar emission levels below 30 MHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
4. Measurements below 30 MHz were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable.
5. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
6. Final measurements were performed on the marker frequencies and the results entered into the table below. The test receiver resolution bandwidth was set to 9 kHz, using a peak detector and span big enough to see the whole emission.

Test setup:

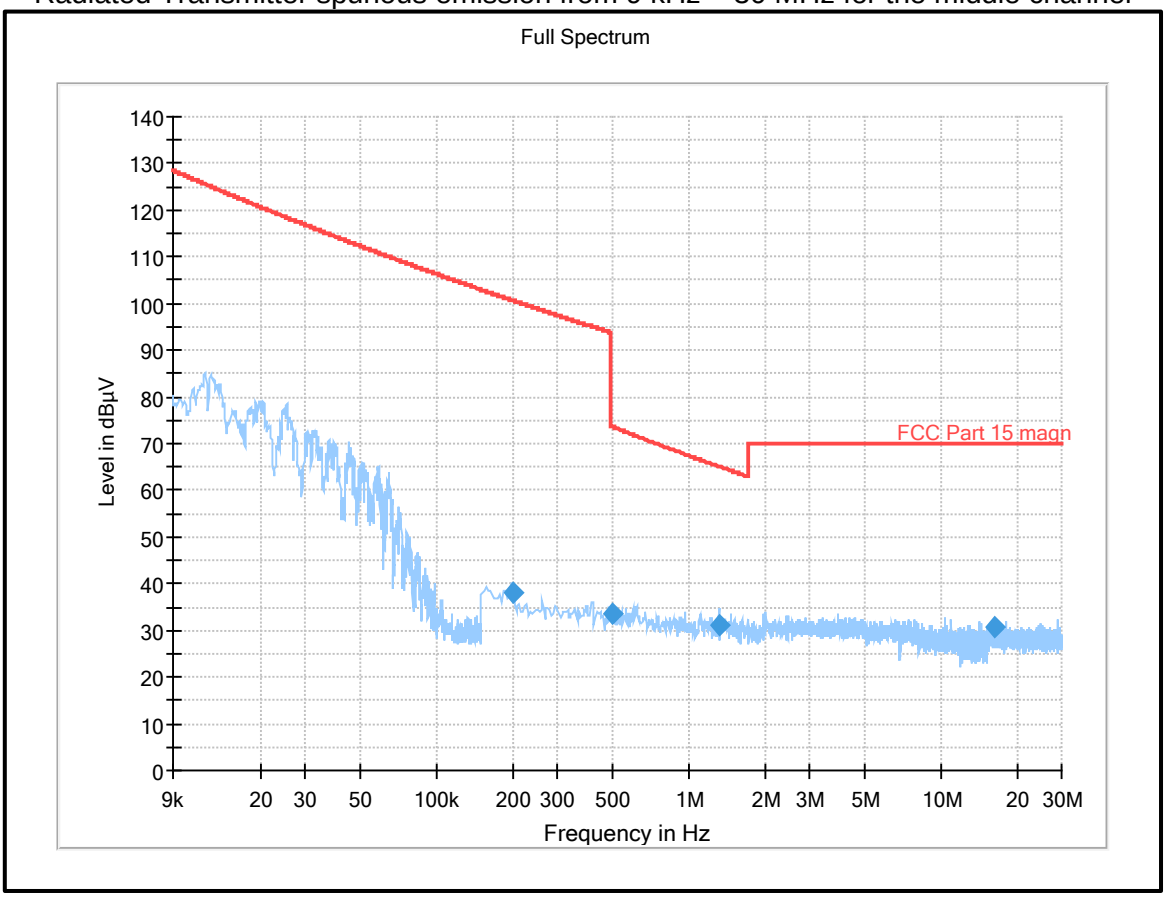


Transmitter Radiated Emissions (continued)

Results: Standard Mode / Middle Channel

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
0.20	Horizontal	37.94	100.67	62.73	Complied
0.50	Horizontal	33.68	73.66	39.98	Complied
1.31	Horizontal	31.31	65.09	33.78	Complied
16.20	Vertical	30.50	70.00	39.50	Complied

Radiated Transmitter spurious emission from 9 kHz – 30 MHz for the middle channel



Note: This plot is a pre-scan and for indication purposes only. For final measurements, see accompanying table.

Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	09 December 2019
Test Sample Serial Number:	UD3 [XID: bjr0tge7gpvg00cjvapg] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.5
Frequency Range	30 MHz to 1000 MHz

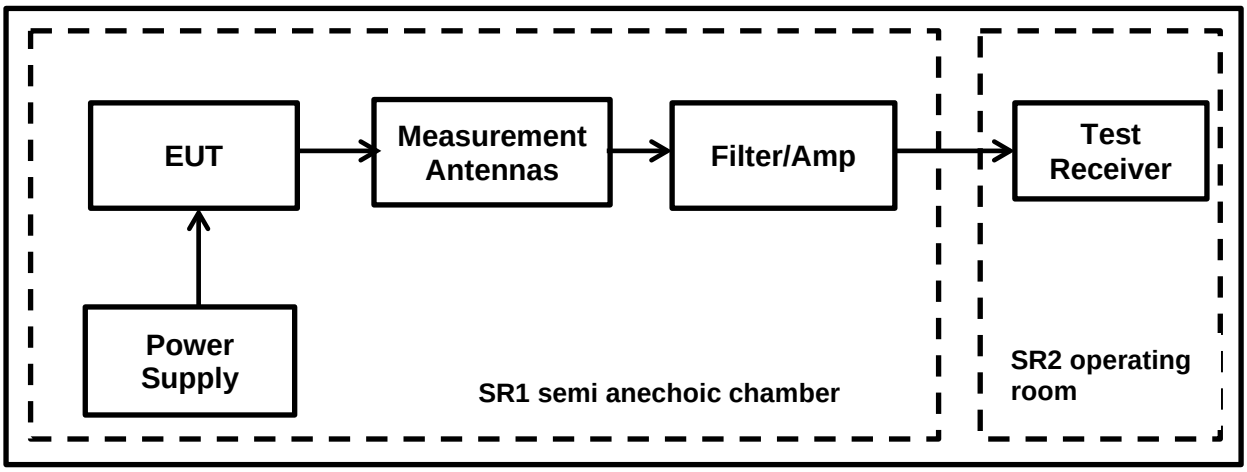
Environmental Conditions:

Temperature (°C):	20.5
Relative Humidity (%):	39

Note(s):

1. The emissions shown at frequencies between approximately 903 to 927 MHz on the 30 MHz to 1 GHz plots are the EUT fundamental for the given channel.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. Measurements below 1 GHz were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) at a distance of 3 meters. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
4. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
5. The results entered into the table below.

Test setup:



Transmitter Radiated Emissions (continued)

Results: Standard Mode / Bottom Channel

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
200.01	Vertical	21.24	43.50	22.26	Complied

Results: Standard Mode / Middle Channel

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
200.01	Vertical	21.10	43.50	22.40	Complied

Results: Standard Mode / Top Channel

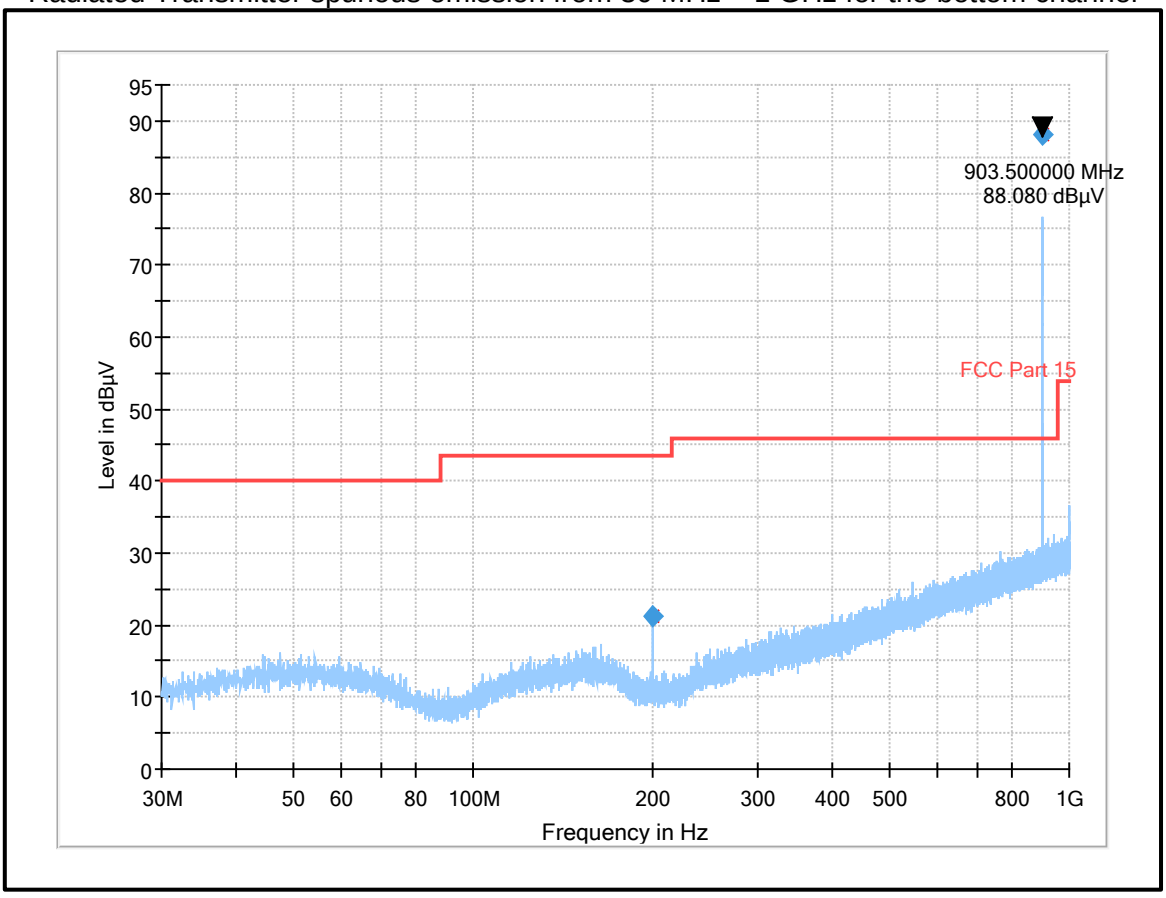
Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Result
200.01	Vertical	21.38	43.50	22.12	Complied

Result: Pass

Transmitter Radiated Emissions (continued)

Standard Mode

Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the bottom channel



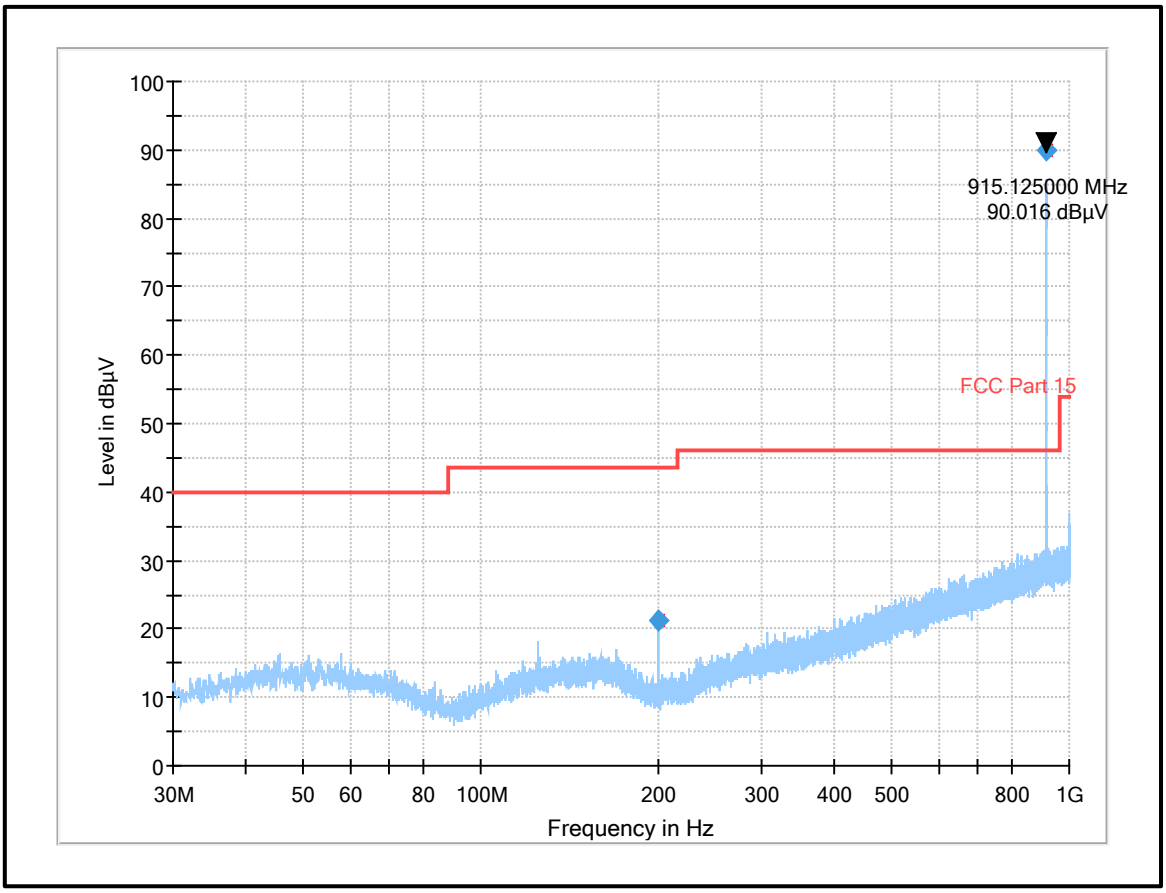
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Result: Pass

Transmitter Radiated Emissions (continued)

Standard Mode

Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the middle channel



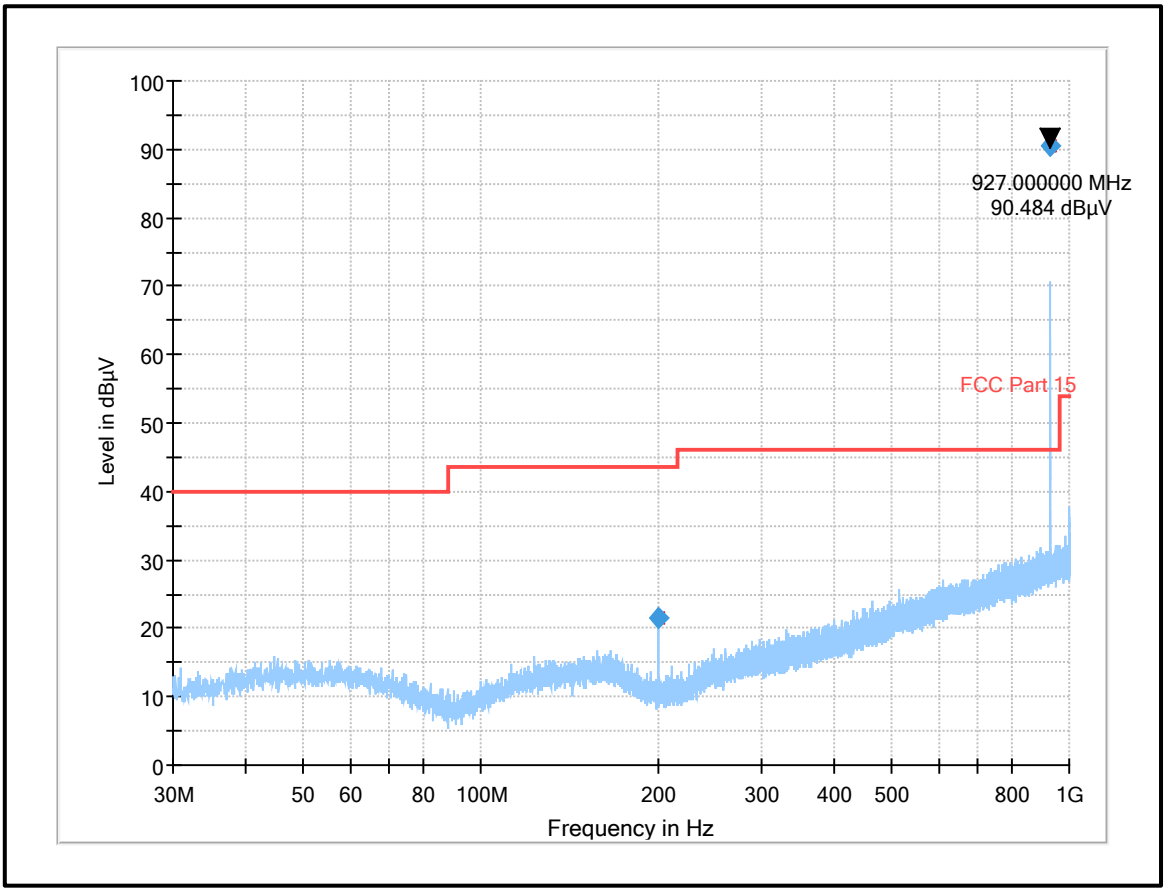
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table.

Result: Pass

Transmitter Radiated Emissions (continued)

Standard Mode

Plot: Radiated Transmitter spurious emission from 30 MHz – 1 GHz for the top channel



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

Result: Pass

Transmitter Radiated Emissions (continued)

Test Summary:

Test Engineer:	Sercan Usta	**Test Dates:**	09 December 2019 & 12 February 2020
Test Samples Serial Number:	UD3 [XID: bjr0tge7gpvg00cjvapg] (Radiated sample) & UD19 [XID: bjr2bf0pismg008i21d0] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Parts 15.247(d) & 15.209(a)
Test Method Used:	FCC KDB 558074 Sections 8.5 & 8.6 referencing ANSI C63.10 Sections 11.11 and 11.12 ANSI C63.10:2013 Sections 6.3 and 6.6
Frequency Range	1 GHz to 10 GHz

Environmental Conditions:

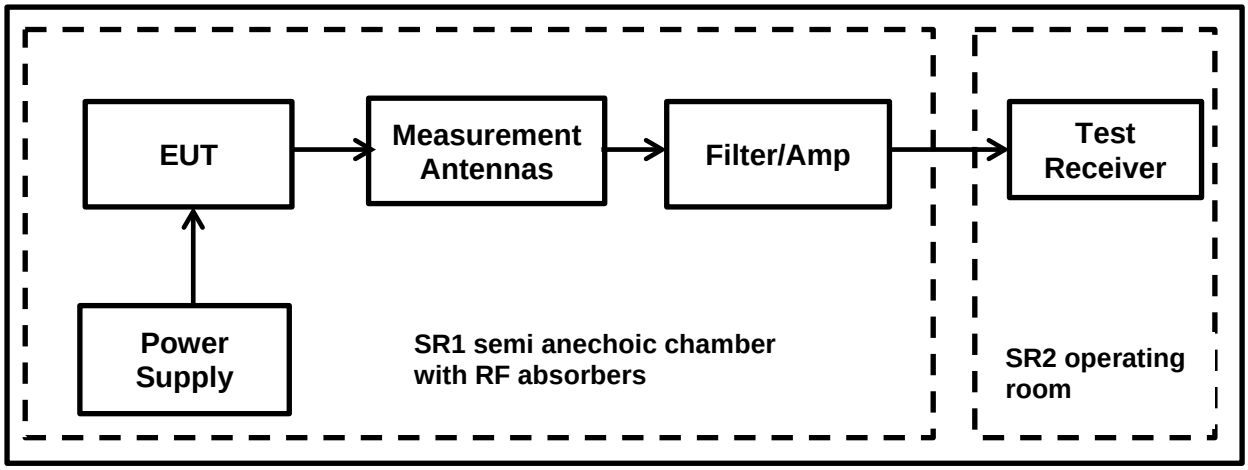
Temperature (°C):	20.5 & 21.6
Relative Humidity (%):	39 & 34

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss. All detected spurious emissions were recorded as shown in the tables below.
2. Pre-scans above 1 GHz were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) with absorbers on the ground at a distance of 3 meters. The EUT was placed at a height of 1.5 meters above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 meters above the test chamber floor, in line with the EUT. Final measurements above 1 GHz were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) with absorbers on the ground at a distance of 3 meters. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 meter to 4 meters.
3. Pre-scans were performed and a marker placed on the highest measured level of the appropriate plot. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz. The sweep time was set to auto.
4. In accordance with ANSI C63.10 Section 6.6.4.3 (Note 1), if the peak measured value complies with the average limit, it is unnecessary to perform an average measurement.
5. The EUT was transmitting continuously with a duty cycle of 7.22%.
6. In response to an FCC inquiry;
   - FSK modulation is not considered a 'Pulse" emission for FCC rules
   - Further details on duty cycle correction are provided during TCB workshop presentation.
   - The relevant TCB workshop presentation is “FCC Updates & Reminders | November 13,2019”
   - Slide 8 of FCC Updates & Reminders | November 13,2019 refers to FCC KDB 558074 D01 15.247 Meas Guidance v05r02 Section 11 Frequently Asked Questions**,** Question 3 & Answer 3.
   - All required criteria of the mentioned Answer 3 are satisfied by EUT.
7. Therefore, in response to an FCC inquiry referencing FCC KDB 558074 D01 15.247 Meas Guidance v05r02 Section 11 Frequently Asked Questions**,** Answer 3 a) the worst case (the highest) operational duty cycle of the EUT is subtracted from the Peak reading to derive the RMS average value.

Transmitter Radiated Emissions (continued)

Test Setup:



Transmitter Radiated Emissions (continued)

Results: Standard Mode / Peak Detector/ Bottom Channel / Non Restricted Band

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	- 20dBc Limit (dBµV/m)	Margin (dB)	Result
1806.325	Horizontal	43.68	78.19	34.51	Complied
3588.175	Vertical	47.57	78.19	30.62	Complied
5740.000	Horizontal	53.04	78.19	25.15	Complied

Results: Standard Mode / Peak Detector/ Bottom Channel / Restricted Band

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
4765.500	Horizontal	51.19	54.00	2.81	Complied
Refer Note 4					

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Result
2710.550	Horizontal	57.47	74.00	16.53	Complied

Results: Standard Mode / Derived RMS values / Bottom Channel / Restricted Band

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Duty Cycle Correction (dB)	Derived RMS Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2710.550	Horizontal	57.47	11.41	46.06	54.00	7.94	Complied
Refer Note 7							

Result: Pass

Results: Standard Mode / Peak Detector/ Middle Channel / Restricted Band

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
2745.550	Vertical	51.64	54.00	2.36	Complied
3867.000	Vertical	48.22	54.00	5.78	Complied
4858.000	Vertical	51.41	54.00	2.59	Complied
Refer Note 4					

Result: Pass

Transmitter Radiated Emissions (continued)

Results: Standard Mode / Peak Detector/ Top Channel / Non Restricted Band

Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
3113.000	Vertical	46.06	78.55	32.49	Complied
3441.166	Horizontal	47.40	78.55	31.15	Complied
5838.000	Vertical	52.67	78.55	25.88	Complied

Results: Standard Mode / Peak Detector/ Top Channel / Non Restricted Band

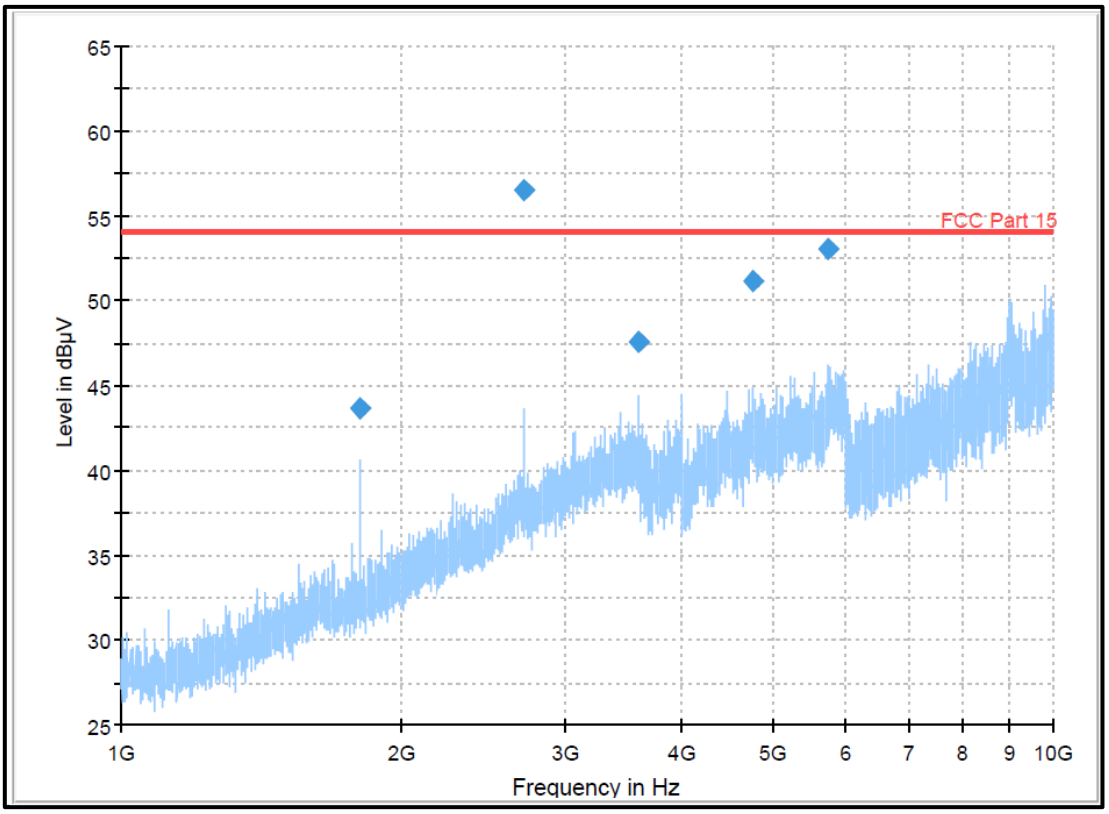
Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	Average Limit (dBµV/m)	Margin (dB)	Result
4723.000	Horizontal	50.10	54.00	3.90	Complied
Refer Note 4					

Result: Pass

Transmitter Radiated Emissions (continued)

Standard Mode

Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the bottom channel



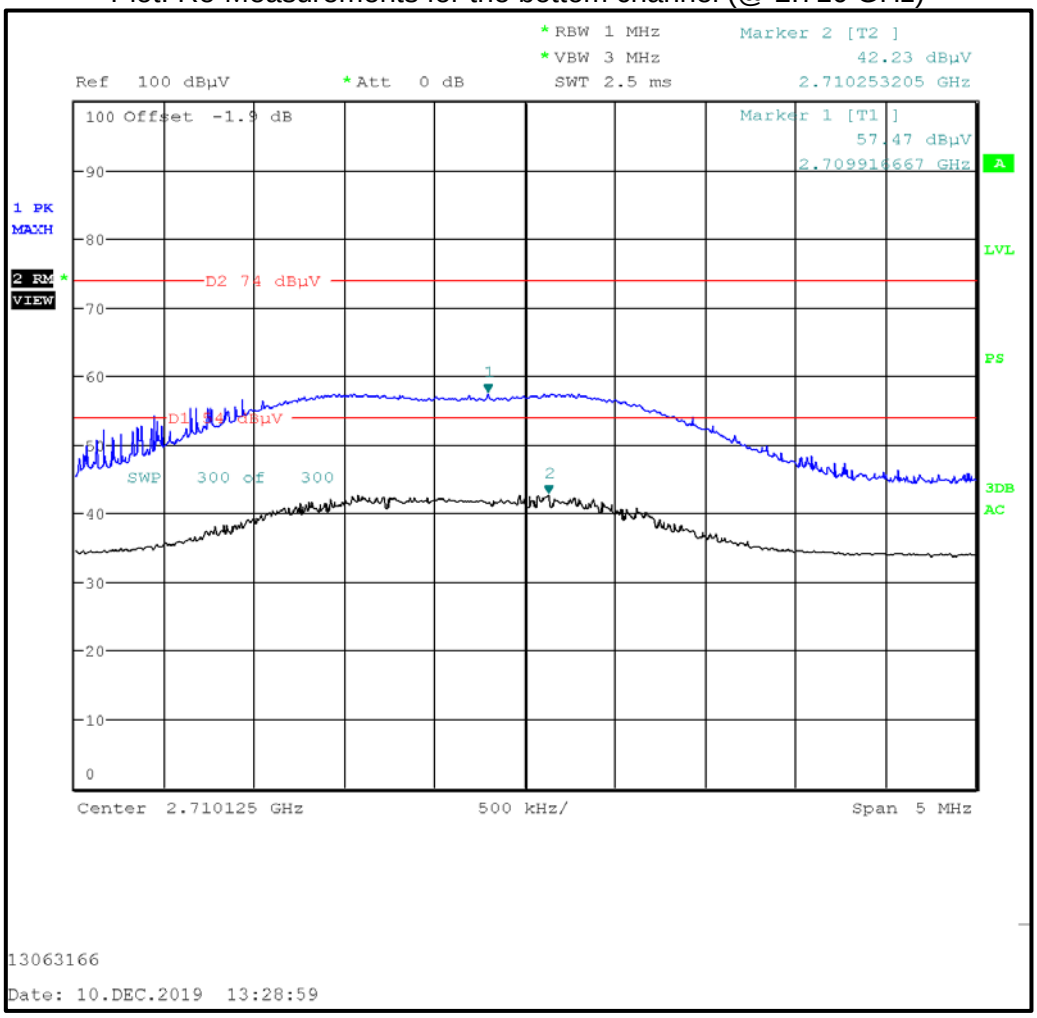
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table

Result: Pass

Transmitter Radiated Emissions (continued)

Standard Mode

Plot: Re-Measurements for the bottom channel (@ 2.710 GHz)

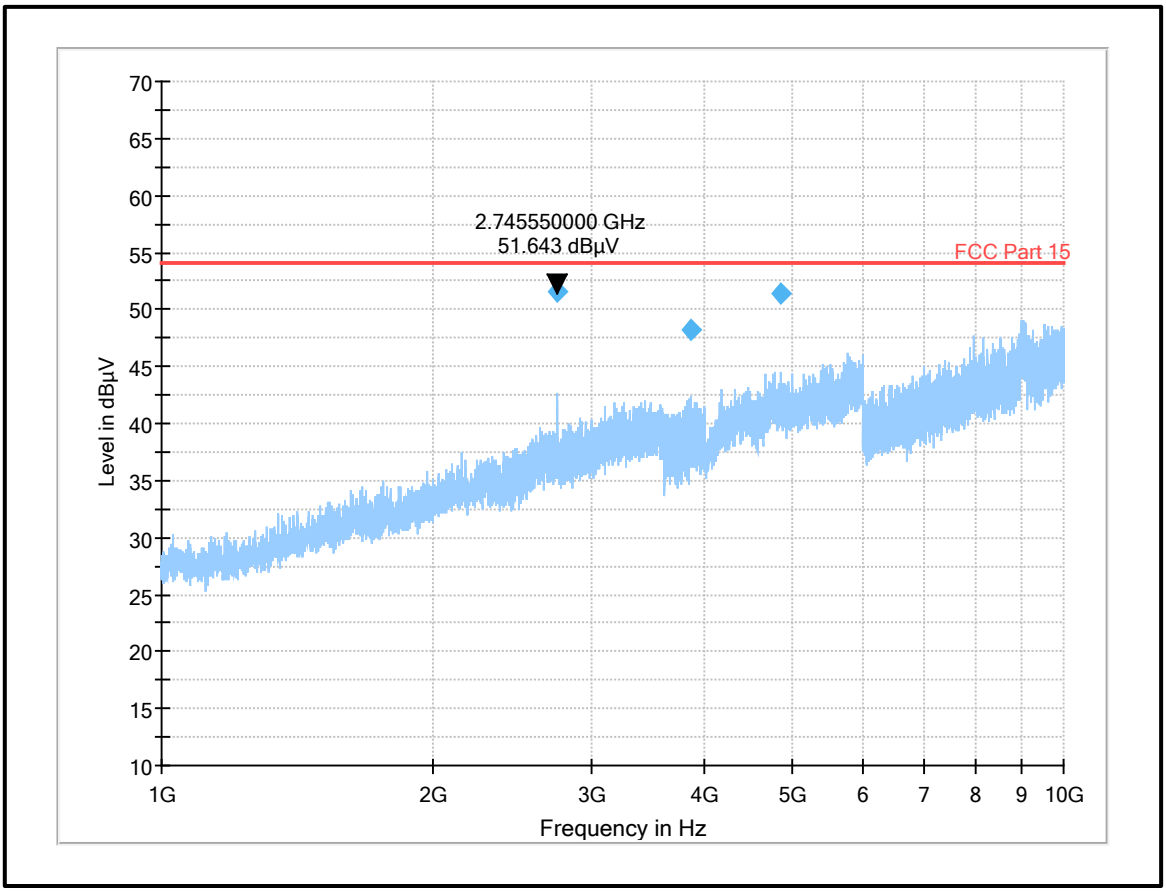


Result: Pass

Transmitter Radiated Emissions (continued)

Standard Mode

Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the middle channel



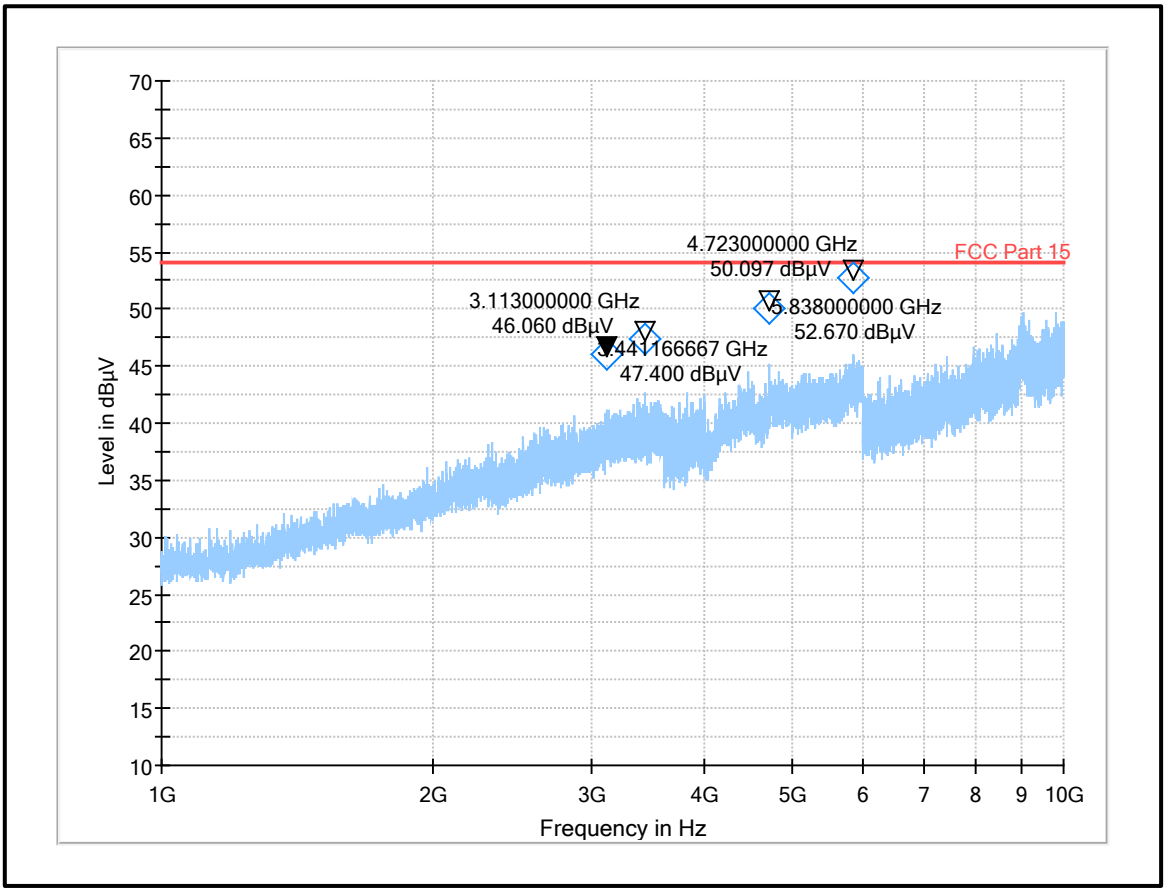
Note: These plots are pre-scans and for indication purposes only. For final measurements, see accompanying table

Result: Pass

Transmitter Radiated Emissions (continued)

Standard Mode

Plot: Radiated Transmitter spurious emission from 1 GHz – 10 GHz for the top channel



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

Result: Pass

5.2.6. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Sercan Usta	**Test Date:**	09 December 2019
Test Sample Serial Number:	UD3 [XID: bjr0tge7gpvg00cjvapg] (Radiated sample)		
Test Site Identification	SR 1/2		

FCC Reference:	Part 15.247(d)
Test Method Used:	FCC KDB 558074 Sections 8.7 referencing ANSI C63.10:2013 Section 6.10.4, 6.10.5 & Section 11.11, 11.2 ,11.13

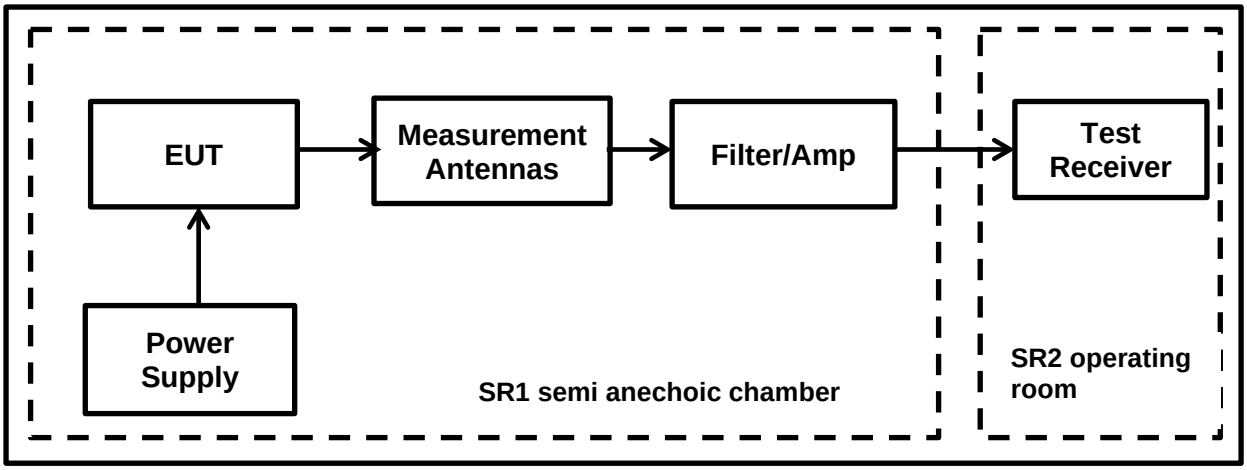
Environmental Conditions:

Temperature (°C):	20.5
Relative Humidity (%):	39

Note(s):

1. The tests were performed in a semi anechoic chamber SR1/ 2 (Asset Number 1603665) with RF absorbers at a distance of 3 metres. The EUT was placed at a height of 1.5 metres above the test chamber floor in the centre of the chamber turntable. All measurement antennas were placed at a fixed height of 1.5 metres above the test chamber floor, in line with the EUT. Final measurements were performed in a semi-anechoic chamber SR1/ 2 (Asset Number 1603665) with RF absorbers at a distance of 3 metres. The EUT was placed at a height of 1.5 m above the reference ground plane in the centre of the chamber turntable. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
2. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
3. In accordance with FCC KDB 558074 Section 8.7; as both band edges are adjacent to non-restricted bands, only -20 dBc peak measurements are required.
4. The test receiver resolution bandwidth was set to 100 kHz and video bandwidth 300 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold. The test receiver was left to sweep for a sufficient length of time in order to maximise the carrier level and out-of-band emissions. A marker and corresponding reference level line were placed on the peak of the carrier. Marker frequencies and levels were recorded.

Test setup:



Transmitter Band Edge Radiated Emissions (Continued)

Results: Standard Mode / Lower Band Edge / Peak

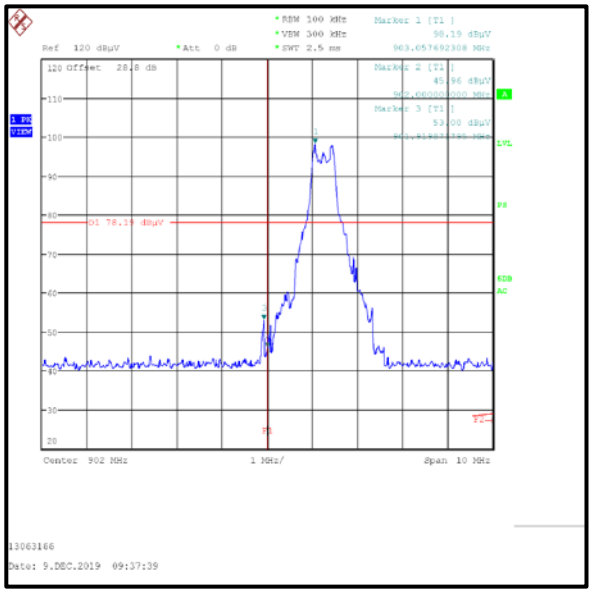
Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
901.919	Horizontal	53.00	78.19	25.19	Complied
902.000	Horizontal	45.96	78.19	32.23	Complied

Results: Standard Mode / Upper Band Edge / Peak

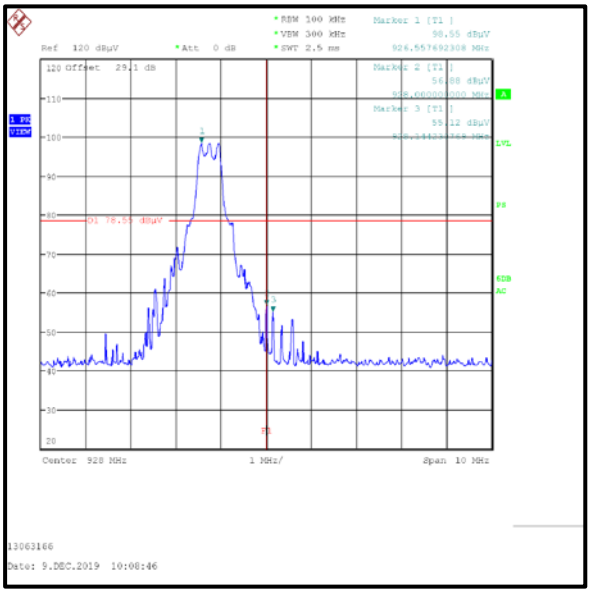
Frequency (MHz)	Antenna Polarization	Peak Level (dBµV/m)	-20 dBc Limit (dBµV/m)	Margin (dB)	Result
928.000	Horizontal	56.88	78.55	21.67	Complied
928.144	Horizontal	55.12	78.55	23.43	Complied

Result: Pass

Plots: Standard Mode



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement

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
Minimum 6 dB Bandwidth	95%	±0.87 %
Transmitter Duty Cycle	95%	±3.4%
Power Spectral Density	95%	±0.59 dB
Conducted Maximum Peak Output Power	95%	±0.59 dB
Radiated Spurious Emissions	95%	±3.10 dB
Band Edge Radiated Emissions	95%	±3.10 dB

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	Calibration Date	Cal. Cycle (months)
1	Rohde & Schwarz	Antenna, Loop	HFH2-Z2	831247/012	7/11/2019	36
377	BONN Elektronik	Amplifier, Low Noise Pre	BLMA 0118-1A	025294B	7/10/2019	12
423	Bonn Elektronik	Amplifier, Low Noise Pre	BLMA 1840-1A	55929	7/16/2019	12
460	Deisl	Turntable	DT 4250 S	n/a	n/a	n/a
465	Schwarzbeck	Antenna, Trilog Broadband	VULB 9168	9168-240	3/20/2019	24
496	Rohde & Schwarz	Antenna, log. - periodical	HL050	100297	2/19/2019	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	7/9/2019	12
608	Rohde & Schwarz	Switch Matrix	OSP 120	101227	lab verification	n/a
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
-/-	Testo	Thermo-Hygrometer	608-H1	01	lab verification	n/a

8. Report Revision History

Version Number	Revision Details		
	Page No(s)	Clause	Details
1.0	43	-	Initial Version

--- END OF REPORT ---