



TEST REPORT

Test Report No. : UL-RPT-RP13150589-416A V2.0

Manufacturer : Buddi Limited
Model No : Smart Tag 4
FCC ID : ZDLST4
Test Standard(s) : FCC Parts 15.209(a) & 15.249

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2. The results in this report apply only to the sample(s) tested.
3. The sample tested is in compliance with the above standard(s).
4. The test results in this report are traceable to the national or international standards.
5. Version 2.0 supersedes all previous versions.

Date of Issue: 11 March 2020

Checked by:

Ian Watch
Senior Engineer, Radio Laboratory

Company Signatory:

Sarah Williams
Senior Test Engineer, Radio Laboratory
UL VS LTD



UL VS LTD

Unit 1-3 Horizon, Kingsland Business Park, Wade Road, Basingstoke, Hampshire, RG24 8AH, UK
Telephone: +44 (0)1256 312000
Facsimile: +44 (0)1256 312001

Customer Information

Company Name:	Buddi Limited
Address:	Talbot House 17 Church Street Rickmansworth Hertfordshire WD3 1DE United Kingdom

Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	20/02/2020	Initial Version	Ian Watch
2.0	11/03/2020	Changed model name and description of EUT as requested by the TCB	Ian Watch

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1. Attestation of Test Results







1.1. Description of EUT

The Equipment Under Test was an Electronic Monitoring (EM) device using the 902 MHz to 928 MHz band.

1.2. General Information

Specification Reference:	47CFR15.249
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Section 15.249
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) – Sections 15.209
Site Registration:	621311
Location of Testing:	UL VS LTD, Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom
Test Dates:	03 February 2020 to 04 February 2020

1.3. Summary of Test Results

FCC Reference (47CFR)	Measurement	Result
Part 15.249(a)	Transmitter Fundamental Field Strength	
Part 2.1049	Transmitter 20 dB Bandwidth	
Part 15.249(a)(d)(e)/15.209(a)	Transmitter Radiated Emissions	
Part 15.249(d)/15.209(a)	Transmitter Band Edge Radiated Emissions	
Key to Results		
 = Complied  = Did not comply		

1.4. 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.

2. Summary of Testing

2.1. Facilities and Accreditation

The test site and measurement facilities used to collect data are located at Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, RG24 8AH, United Kingdom. The following table identifies which facilities were utilised for radiated emission measurements documented in this report. Specific facilities are also identified in the test results sections.

Site 1	X
Site 2	-
Site 17	X

UL VS LTD is accredited by UKAS. The tests reported herein have been performed in accordance with its terms of accreditation.

2.2. Methods and Procedures

Reference:	ANSI C63.10-2013
Title:	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.3. Calibration and Uncertainty

Measuring Instrument Calibration

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

Measurement Uncertainty

No measurement or test can ever be perfect and the imperfections give rise to error of measurement in the results. Consequently the result of a measurement is only an approximation to the value measured (the specific quantity subject to measurement) and is only complete when accompanied by a statement of the uncertainty of the approximation.

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	Range	Confidence Level (%)	Calculated Uncertainty
Fundamental Field Strength	902 MHz to 928 MHz	95%	±3.30 dB
20 dB Bandwidth	902 MHz to 928 MHz	95%	±4.92 %
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±4.39 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 9.3 GHz	95%	±2.94 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.

2.4. Test and Measurement Equipment

Test Equipment Used for Transmitter Fundamental Field Strength / 20 dB Bandwidth Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	07 Jan 2021	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
A3154	Pre Amplifier	Com Power	PAM-103	18020012	04 Oct 2020	12
A553	Antenna	Chase	CBL6111A	1593	14 Oct 2020	12
A3112	Attenuator	AtlanTecRF	AN18-06	219706#2	14 Oct 2020	12
A2523	Attenuator	AtlanTecRF	AN18W5-10	832827#1	04 Mar 2020	12

Test Equipment Used for Transmitter Radiated Emissions Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	07 Jan 2021	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
A3154	Pre Amplifier	Com Power	PAM-103	18020012	04 Oct 2020	12
A3198	Magnetic Loop Antenna	ETS-Lindgren	6502	00221887	27 Mar 2020	12
A553	Antenna	Chase	CBL6111A	1593	14 Oct 2020	12
A3112	Attenuator	AtlanTecRF	AN18-06	219706#2	14 Oct 2020	12
M2003	Thermohygrometer	Testo	608-H1	45046641	07 Jan 2021	12
K0017	3m RSE Chamber	Rainford EMC	N/A	N/A	01 Aug 2020	12
M1630	Test Receiver	Rohde & Schwarz	ESU40	100233	12 Nov 2020	12
A2948	Pre Amplifier	Com Power	PAM-118A	551087	08 Aug 2020	12
A3142	Pre Amplifier	Schwarzbeck	BBV 9718 B	00020	08 Aug 2020	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120 B 653	08 Aug 2020	12
A2890	Antenna	Schwarzbeck	HWRD750	014	08 Aug 2020	12
A2908	High Pass Filter	Wainwright Instruments	WHJE5-920-1000-4000-60EE	3	20 Feb 2020	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	20 Feb 2020	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	20 Feb 2020	12

Test and Measurement Equipment (continued)**Test Equipment Used for Transmitter Band Edge Radiated Emissions Tests**

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2040	Thermohygrometer	Testo	608-H1	45124934	07 Jan 2021	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	16 Oct 2020	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	01 Apr 2020	12
A3154	Pre Amplifier	Com Power	PAM-103	18020012	04 Oct 2020	12
A553	Antenna	Chase	CBL6111A	1593	14 Oct 2020	12
A3112	Attenuator	AtlanTecRF	AN18-06	219706#2	14 Oct 2020	12
A2937	Attenuator	AtlanTecRF	AN18W5-06	208147#1	04 Mar 2020	12

3. Equipment Under Test (EUT)

3.1. Identification of Equipment Under Test (EUT)

Brand Name:	Smart Tag 4
Model Name or Number:	Smart Tag 4
Test Sample Serial Number:	STS00021
Hardware Version:	V11.5
Firmware Version:	1.11.34
FCC ID:	ZDLST4

3.2. Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.3. Additional Information Related to Testing

Tested Technology:	Short Range Device		
Power Supply Requirement:	Nominal	3.7 VDC from internal battery	
Type of Unit:	Transceiver		
Channel Spacing:	500 kHz		
Modulation:	GFSK		
Data Rate (bit/s):	38400		
Transmit Frequency Range:	914.5 MHz to 921.0 MHz		
Transmit Channels Tested:	Channel ID	Channel Number	Channel Frequency (MHz)
	Bottom	0	914.5
	Middle	6	917.5
	Top	13	921.0

3.4. Description of Available Antennas

The radio utilizes an integrated antenna, with the following maximum gain:

Frequency Range (MHz)	Antenna Gain (dBi)
902 to 928	0.4

3.5. Description of Test Setup

Support Equipment

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

Description:	Strap which fits around the subject's ankle and then clicks in either end to the Smart Tag device
Brand Name:	Buddi
Model Name or Number:	Smart Tag Strap
Serial Number:	Not marked or stated

Description:	Switching Power Adaptor (modified by customer)
Brand Name:	Stontronics Ltd
Model Name or Number:	DSA-15P-12 UK
Serial Number:	Not marked or stated

Operating Modes

The EUT was tested in the following operating mode(s):

- Transmitting at maximum power with modulated carrier on bottom, middle and top channels as required.

Configuration and Peripherals

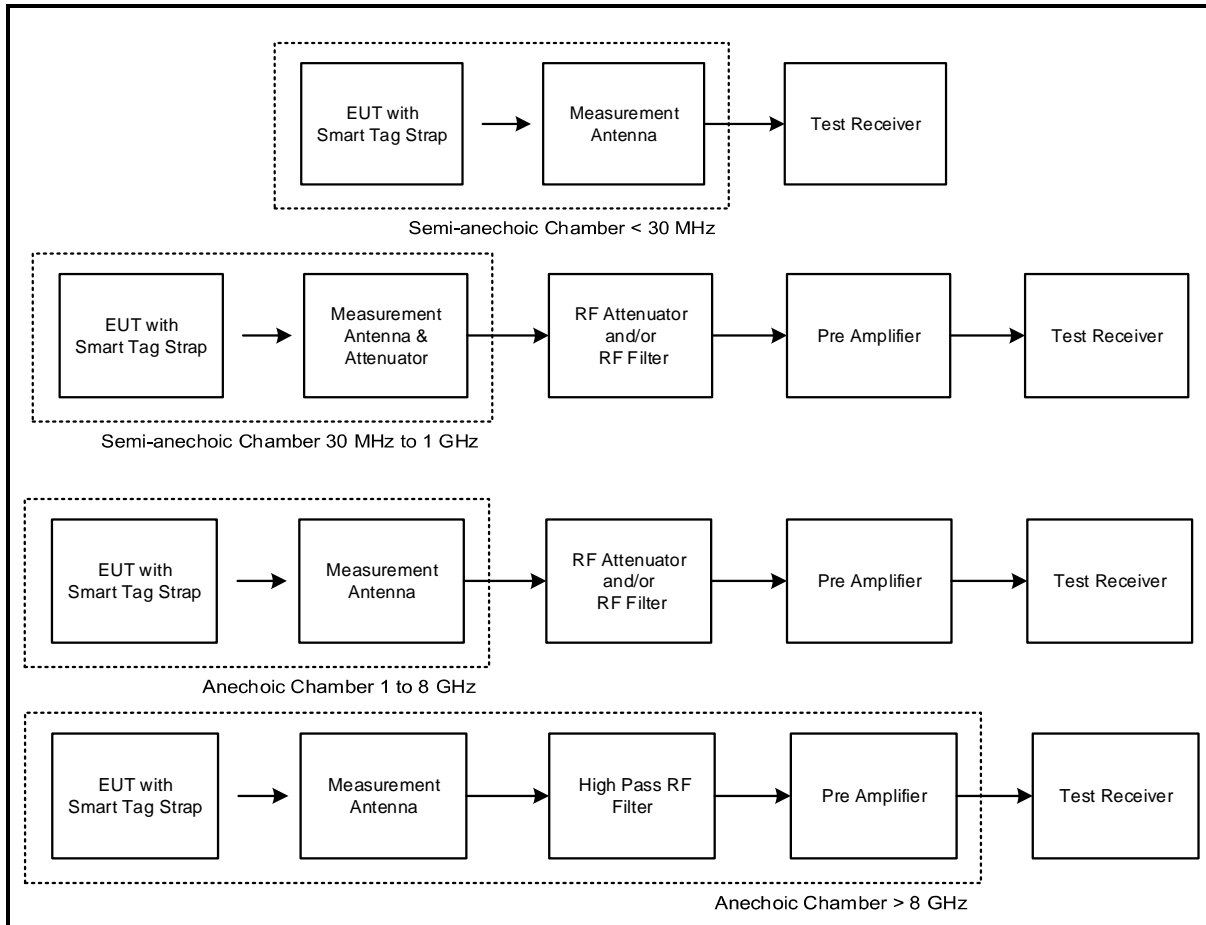
The EUT was tested in the following configuration(s):

- The customer had pre-loaded test software/firmware to the EUT prior to testing. Test mode was enabled following the instructions in 'SmartTAG v11.x 3G+WIFI - FCC ISM Radio Certification Test Guide.pdf', Issue Date: 17th October 2019. A modified Switching Power Adaptor was provided by the customer for test mode purposes only. This allowed selection of test mode parameters via a button in accordance with the provided instructions.
- The customer declared the commercial version of the EUT cannot transmit while powered from a mains supply via the Switching Power Adaptor.
- Transmitter radiated spurious emissions tests were performed with the ankle strap fitted to the EUT and powered from the internal batteries.
- All radiated tests were performed with the EUT placed in the worst case orientation/position for the applicable test.

Test Setup Diagrams

Radiated Tests:

Test Setup for Transmitter Radiated Emissions



4. Radiated Test Results

4.1. Transmitter Fundamental Field Strength

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	03 February 2020
Test Sample Serial Number:	STS00021		

FCC Reference:	Part 15.249(a)
Test Method Used:	ANSI C63.10 Section 6.5

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	40

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. Measurements were performed in a semi-anechoic chamber (Asset Number K0001) 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. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
3. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.
4. Final measurements were performed on the marker frequencies and results entered into the table below. The test receiver resolution bandwidth was set to 120 kHz, using a CISPR quasi-peak detector.

Results: Bottom Channel / Quasi-Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
914.5	Horizontal	88.5	94.0	5.5	Complied

Results: Middle Channel / Quasi-Peak

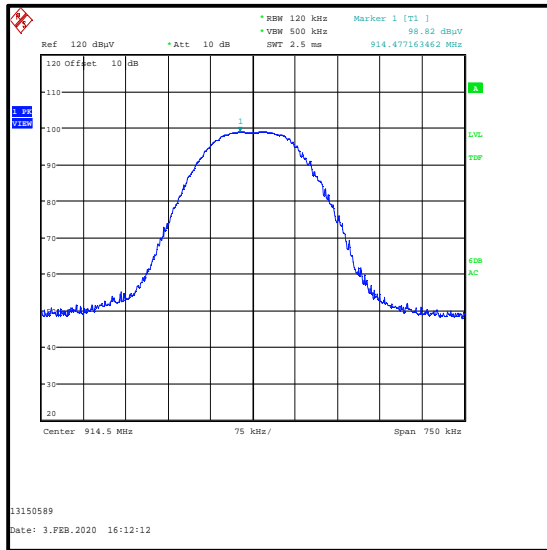
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
917.5	Horizontal	88.4	94.0	5.6	Complied

Results: Top Channel / Quasi-Peak

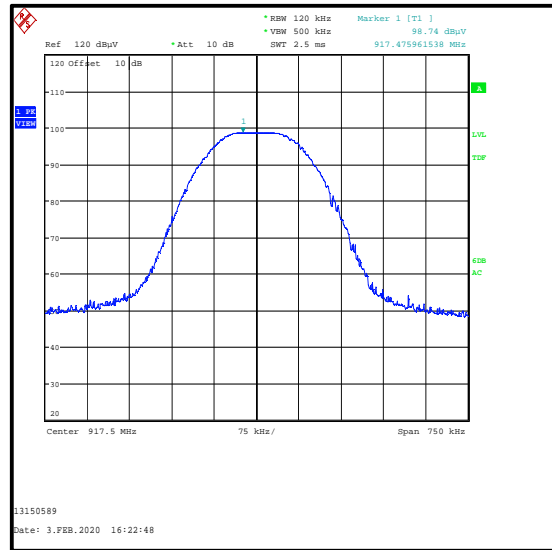
Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
921.0	Horizontal	88.2	94.0	5.8	Complied

Transmitter Fundamental Field Strength (continued)

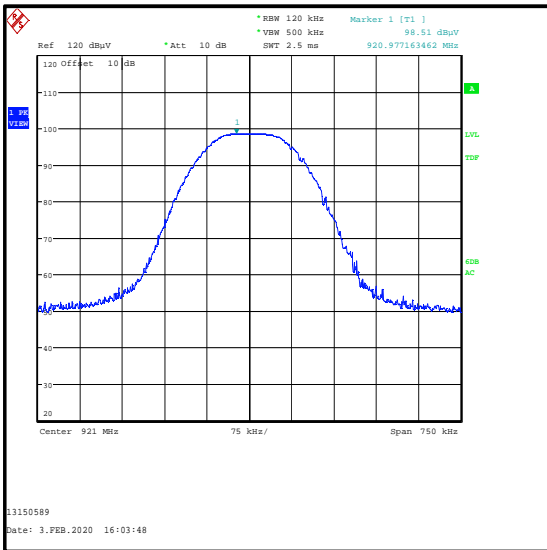
Results:



Bottom Channel



Middle Channel



Top Channel

4.2. Transmitter 20 dB Bandwidth

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	03 February 2020
Test Sample Serial Number:	STS00021		

FCC Reference:	Part 2.1049
Test Method Used:	ANSI C63.10 Section 6.9.2

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	40

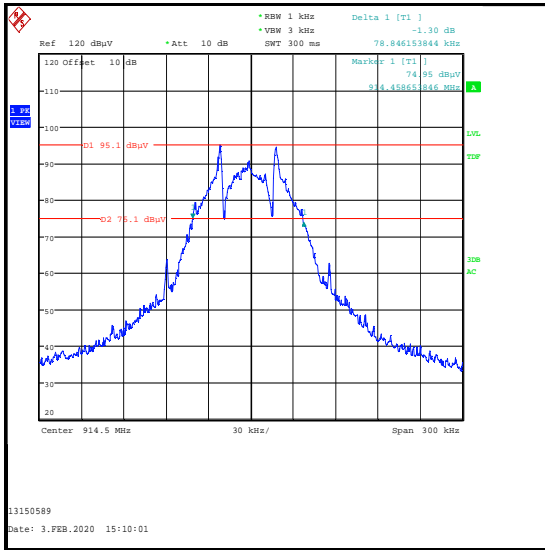
Note(s):

1. The test receiver resolution bandwidth was set to 1 kHz and video bandwidth 3 kHz. A peak detector was used, sweep time was set to auto and the trace mode was Max Hold. The span was set to 300 kHz.

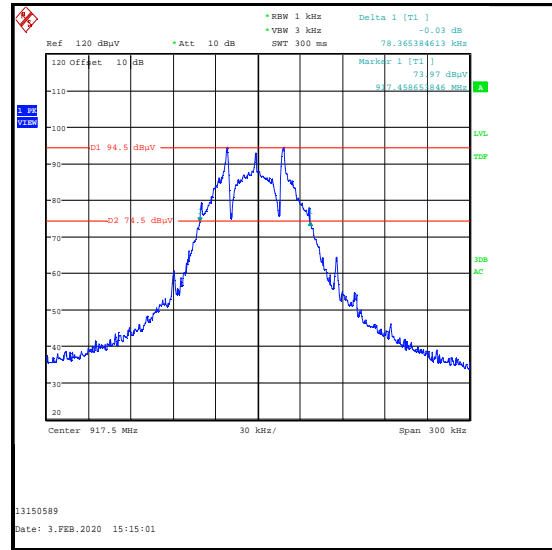
Results:

Channel	20 dB Bandwidth (kHz)
Bottom	78.846
Middle	78.365
Top	78.846

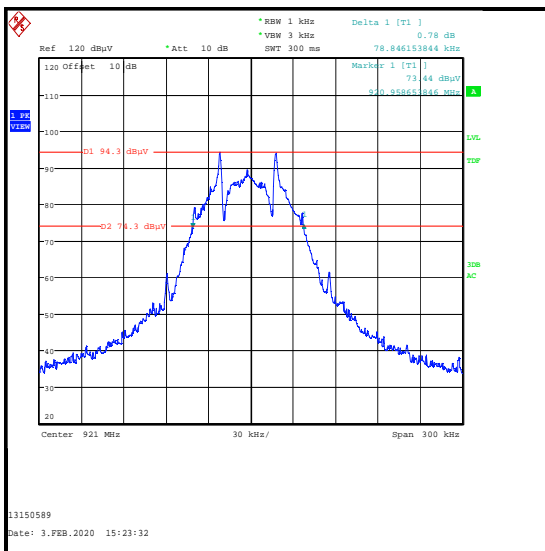
Transmitter 20 dB Bandwidth (continued)



Bottom Channel



Middle Channel



Top Channel

4.3. Transmitter Radiated Emissions <1 GHz

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	03 February 2020
Test Sample Serial Number:	STS00021		

FCC Reference:	Parts 15.249(a)(d)(e) & 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):	22
Relative Humidity (%):	40

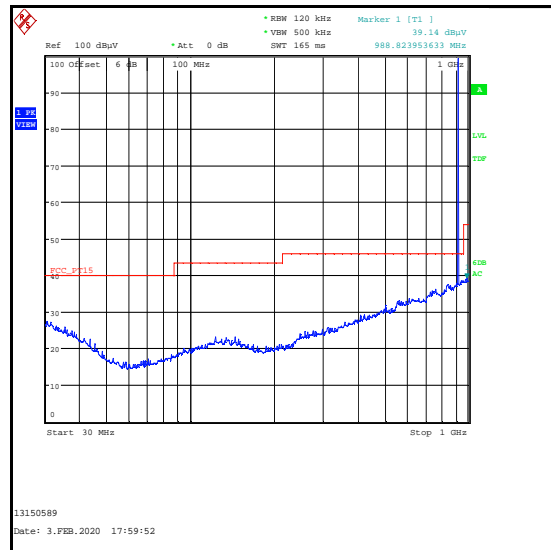
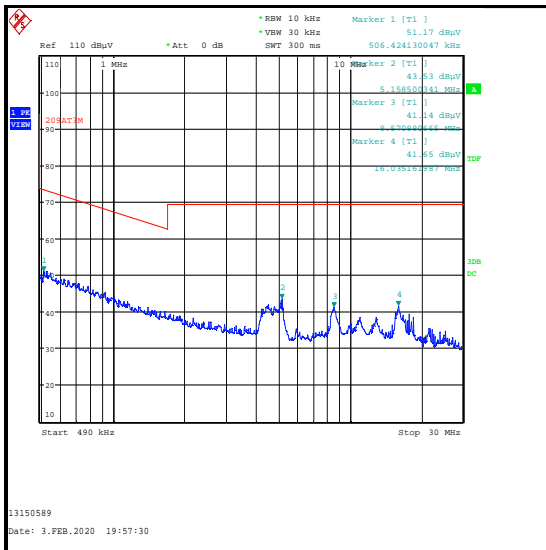
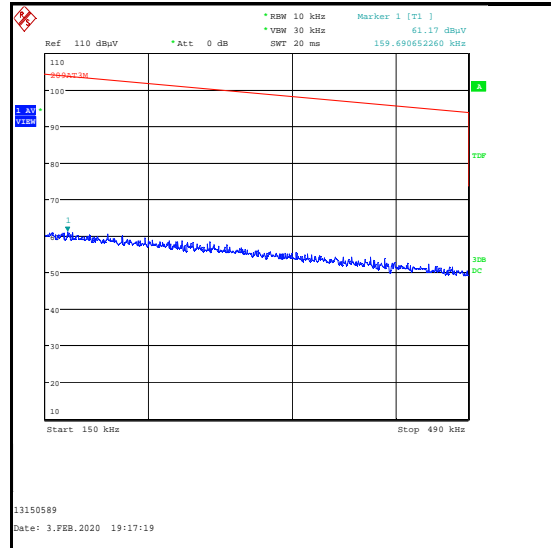
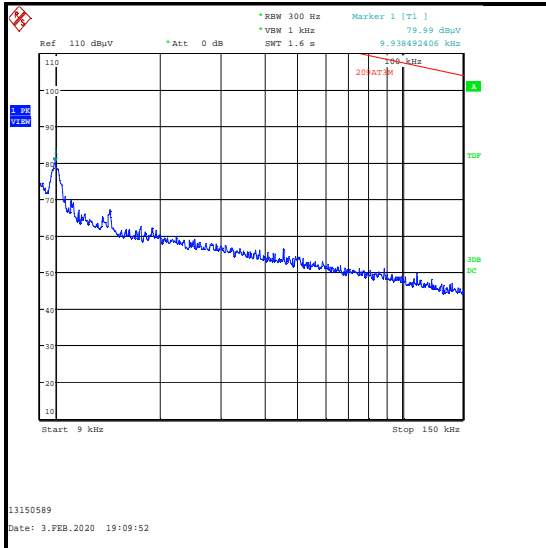
Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. The preliminary scans showed similar emission levels below 1 GHz, for each channel of operation. Therefore final radiated emissions measurements were performed with the EUT set to the middle channel only.
3. All emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system. Therefore the highest peak noise floor reading of the measuring receiver was recorded in the table below.
4. The emission shown on the 30 MHz to 1 GHz plot is the EUT fundamental at approximately 917 MHz.
5. Pre-scan were performed against Part 15.209 general radiated emissions limits.
6. Measurements below 30 MHz were performed in a semi-anechoic chamber (Asset Number K0001) at 3 metres. The EUT was placed at a height of 80 cm above the reference ground plane in the centre of the chamber turntable. The limit was extrapolated to 3 metres in accordance with ANSI C63.10 Section 6.4.4.2. Correlation data between the semi-anechoic chamber and an open-field test site is available upon request.
7. There are ambient emissions between 4 MHz to 30 MHz on the pre-scan plot for 490 kHz to 30 MHz performed in semi-anechoic chamber. A background scan between 490 kHz to 30 MHz is stored on the UL VS LTD IT server and is available for inspection upon request.
8. Measurements between 30 MHz to 1 GHz were performed in a semi-anechoic chamber (Asset Number K0001) 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. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.
9. Pre-scans were performed and markers placed on the highest measured levels. The test receiver was configured as follows: During 9 kHz to 150 kHz tests, the resolution bandwidth was set to 300 Hz and video bandwidth 1 kHz. A peak detector was used and trace mode was Max Hold. For 150 kHz to 490 kHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. An average detector was used and trace mode was Max Hold. For 490 kHz to 30 MHz, the resolution bandwidth was set to 10 kHz and video bandwidth 30 kHz. A peak detector was used and trace mode was Max Hold. For 30 MHz to 1 GHz, the resolution bandwidth was set to 120 kHz and video bandwidth 500 kHz. A peak detector was used, sweep time was set to auto and trace mode was Max Hold.

Transmitter Radiated Emissions (continued)

Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Result
988.824	Horizontal	39.1	54.0	14.9	Complied



4.4. Transmitter Radiated Emissions >1 GHz

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	04 February 2020
Test Sample Serial Number:	STS00021		

FCC Reference:	Parts 15.249(a)(d)(e) & 15.209(a)
Test Method Used:	ANSI C63.10 Sections 6.3 and 6.6
Frequency Range	1 GHz to 9.3 GHz

Environmental Conditions:

Temperature (°C):	25
Relative Humidity (%):	33

Note(s):

1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. Pre-scans were performed against Part 15.209 general radiated emissions limit
3. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
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. Pre-scans above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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 above 1 GHz were performed in a fully anechoic chamber (Asset Number K0017) 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.
6. Pre-scans were performed and markers placed on the highest measured levels. The test receiver resolution bandwidth was set to 1 MHz and video bandwidth 3 MHz, with the sweep time set to auto. Peak and average measurements were performed with their respective detectors during the pre-scan measurements.

Transmitter Radiated Emissions (continued)**Results: Peak / Bottom Channel**

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2743.610	Vertical	47.9	54.0*	6.1	Complied
3658.030	Vertical	47.4	54.0*	6.6	Complied
4572.478	Vertical	47.8	54.0*	6.2	Complied

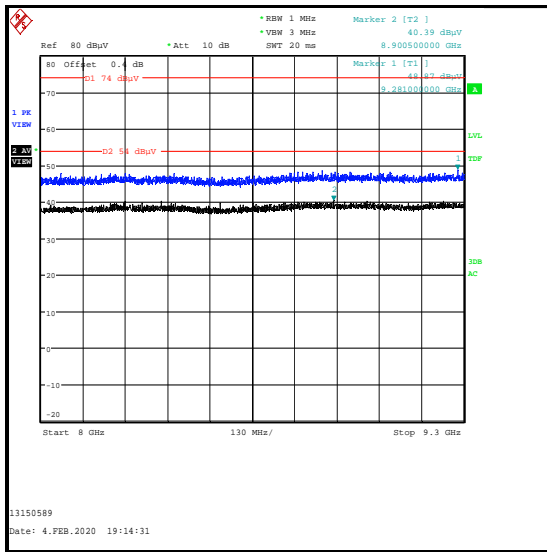
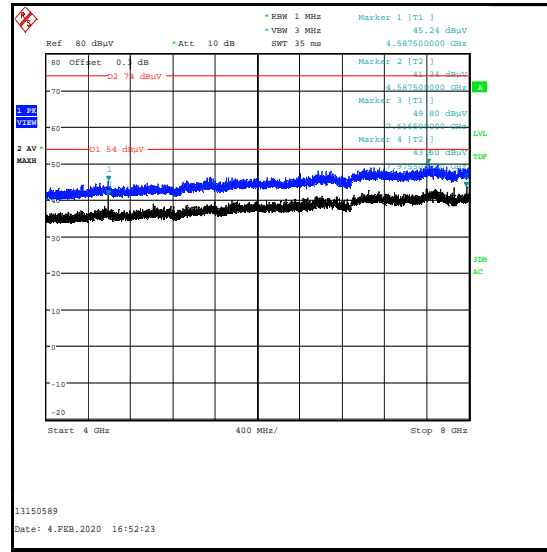
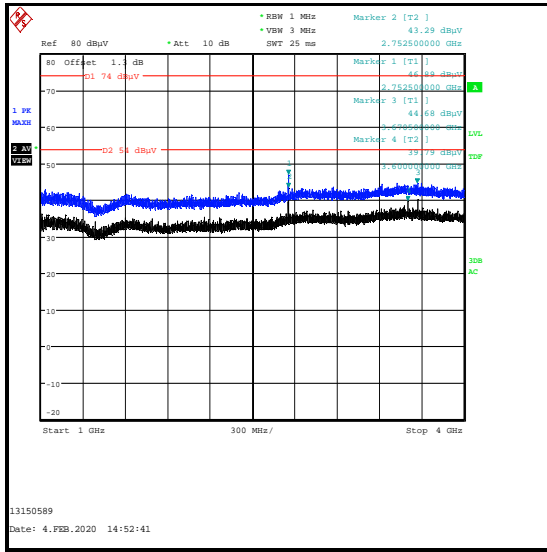
Results: Peak / Middle Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2752.545	Vertical	47.7	54.0*	6.3	Complied
3670.090	Vertical	47.3	54.0*	6.7	Complied
4587.470	Vertical	47.8	54.0*	6.2	Complied

Results: Peak / Top Channel

Frequency (MHz)	Antenna Polarity	Peak Level (dB μ V/m)	Average Limit (dB μ V/m)	Margin (dB)	Result
2762.785	Vertical	48.2	54.0*	5.8	Complied
3684.165	Vertical	46.5	54.0*	7.5	Complied
4604.545	Vertical	47.6	54.0*	6.4	Complied

Transmitter Radiated Emissions (continued)



Note: The above plots are pre-scans and for indication purposes only. For final measurements, see accompanying tables.

4.5. Transmitter Band Edge Radiated Emissions

Test Summary:

Test Engineer:	Andrew Edwards	Test Date:	03 February 2020
Test Sample Serial Number:	STS00021		

FCC Reference:	Parts 15.249(d) & 15.209
Test Method Used:	ANSI C63.10 Sections 6.3, 6.5 and 6.10
Frequency Range	1 GHz to 9.3 GHz

Environmental Conditions:

Temperature (°C):	22
Relative Humidity (%):	40

Note(s):

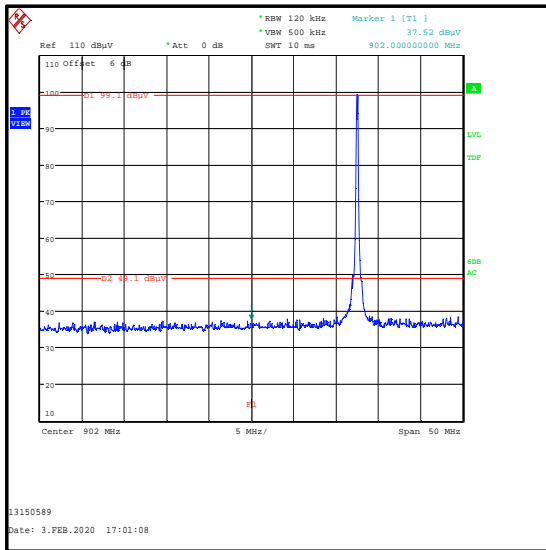
1. The final measured value, for the given emission, in the table below incorporates the calibrated antenna factor and cable loss.
2. In accordance with FCC part 15.249(d), all emissions outside of the specified frequency band shall be attenuated by at least 50 dBc or the general radiated emission limits in 15.209 whichever has less attenuation.
3. As both band edges are adjacent to non-restricted bands, only peak measurements are required. In accordance with ANSI C63.10 Section 6.10.4, was followed: the test receiver resolution bandwidth was set to 120 kHz and video bandwidth 500 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 and an out-of-band limit line was placed 50 dB below the peak level. Markers were placed on the band edge spot frequencies. Additional markers were placed on the highest emission levels outside the band edges (where a higher level emission was present). Marker frequencies and levels were recorded.

Transmitter Band Edge Radiated Emissions (continued)

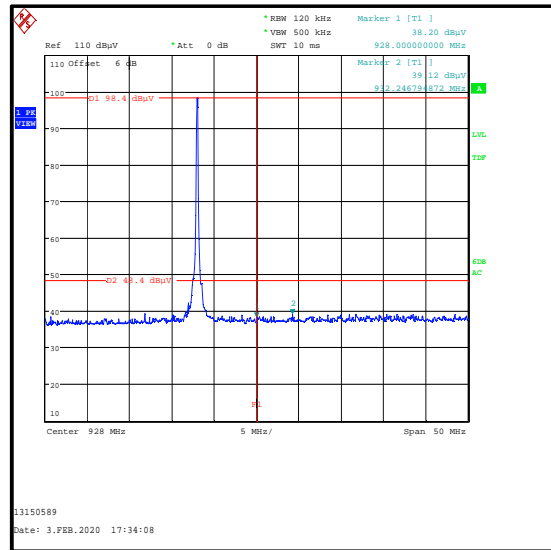
Results: Peak

Frequency (MHz)	Antenna Polarity	Level (dB μ V/m)	-50 dBc Limit (dB μ V/m)	Margin (dB)	Result
902	Horizontal	37.5	49.1	11.6	Complied
928	Horizontal	38.2	48.4	10.2	Complied
928.247	Horizontal	39.1	48.4	9.3	Complied

Results:



Lower Band Edge Peak Measurement



Upper Band Edge Peak Measurement

--- END OF REPORT ---