TEST REPORT

Test Report No. : UL-RPT-RP13713258-1416A V2.0

Customer	:	Robert Bosch GmbH
Model No. / HMN	:	BCM3100
Contains FCC ID	:	2AWRC-BG95M2
Contains ISED Certification No.	:	IC: 26294- BG95M2
Technology	:	LTE Cat M1 & NB-IoT– Band 2
Test Standard(s)	:	FCC Parts 2.1053, 24.238(a) & 15.209(a) Innovation, Science and Economic Development Canada RSS-133 Issue 6 Section 6.5 RSS-Gen Issue 5 Section 6.13
Test Laboratory	:	UL International (UK) Ltd, Basingstoke, Hampshire, RG24 8AH, United Kingdom

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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: 18 February 2022

Checked by:

Sarah Williams
RF Operations Leader, Radio Laboratory

Company Signatory:

Ben Mercer
Lead Project Engineer, Radio Laboratory

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Customer Information

Company Name:	Robert Bosch GmbH
Address:	Bosch eBike Systems Markwiesenstraße 58 72770 Reutlingen Germany

Report Revision History

Version Number	Issue Date	Revision Details	Revised By
1.0	03/12/2021	Initial Version	Sarah Williams
2.0	18/02/22	Address TCB/FCB comments	Sarah Williams

Table of Contents

1 Attestation of Test Results

1.1 Description of EUT

The equipment under test was an e-Bike motion sensor attachment used for data communication in the event of a detected theft or accident. The EUT had GPS reception and communication capabilities over LTE Cat-M1 and NB-IoT. The EUT contains FCC / ISED Canada certified module FCC ID: 2AWRC-BG95M2 / IC: 26294-BG95M2.

1.2 General Information

Specification Reference:	47CFR24
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 24 Subpart E (Broadband PCS)
Specification Reference:	47CFR15.209
Specification Title:	Code of Federal Regulations Volume 47 (Telecommunications): Part 15 Subpart C (Intentional Radiators) - Section 15.209
Specification Reference:	RSS-Gen Issue 5 February 2021
Specification Title:	General Requirements for Compliance of Radio Apparatus
Specification Reference:	RSS-133 Issue 6, January 2018
Specification Title:	2 GHz Personal Communications Services
Site Registration:	FCC: 685609, ISEDC: 20903
FCC Lab. Designation No.:	UK2011
ISEDC CABID:	UK0001
Location of Testing:	Unit 3 Horizon, Wade Road, Kingsland Business Park, Basingstoke, Hampshire, G24 8AH, United Kingdom
Test Dates:	01 September 2021 to 01 October 2021

1.3 Summary of Test Results

FCC Reference (47CFR)	ISED Canada Reference	Measurement	Result
Part 15.209(a) / 2.1053 / 24.238(a)	RSS-Gen 6.13 / RSS-133 6.5	Transmitter Out of Band 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 International (UK) Ltd is accredited by the United Kingdom Accreditation Service (UKAS). UKAS is one of the signatories to the International Laboratory Accreditation Co-operation (ILAC) Arrangement for the mutual recognition of test reports. The tests reported herein have been performed in accordance with its terms of accreditation.

2.2 Methods and Procedures

Reference:	ANSI/TIA-603-E 2016
Title:	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
Reference:	ANSI C63.26-2015
Title:	American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services
Reference:	FCC KDB 971168 D01 v03r01, April 9, 2018
Title:	Measurement Guidance for Certification of Licensed Digital Transmitters
Reference:	Notice 2020 - DRS0023
Title:	Guidance on magnetic field strength radiated emission measurements (9 kHz - 30 MHz)

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 & Decision Rule

Overview

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 of the measurand (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.

Decision Rule

The decision rule applied is based upon the accuracy method criteria. The measurement uncertainty is met and the result is considered in conformance with the requirement criteria if the observed value is within the prescribed limit.

Measurement Uncertainty

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
Radiated Spurious Emissions	9 kHz to 30 MHz	95%	±5.32 dB
Radiated Spurious Emissions	30 MHz to 1 GHz	95%	±3.30 dB
Radiated Spurious Emissions	1 GHz to 18 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 Radiated Emissions Tests

Asset No.	Instrument	Manufacturer	Type No.	Serial No.	Date Calibration Due	Cal. Interval (Months)
M2003	Thermohygrometer	Testo	608-H1	45046641	10 Dec 2021	12
K0017	3m RSE Chamber	Rainford	N/A	N/A	21 Oct 2021	12
M1874	Test Receiver	Rohde & Schwarz	ESU26	100553	19 May 2022	12
A2951	Pre-Amplifier	Com-Power	PAM-103	441141	25 Jan 2022	12
A2863	Pre-Amplifier	Agilent	8449B	3008A02100	21 Oct 2021	12
A3142	Pre-Amplifier	Schwarzbeck	BBV 9718B	00020	21 Oct 2021	12
A2896	Pre-Amplifier	Schwarzbeck	BBV 9721	9721-023	16 Feb 2022	12
A3161	Antenna	Teseq	CBL6111D	50859	04 May 2022	12
A2889	Antenna	Schwarzbeck	BBHA 9120 B	BBHA 9120B653	23 Oct 2021	12
A2890	Antenna	Schwarzbeck	HWRD 750	014	26 Oct 2021	12
A2895	Antenna	Schwarzbeck	BBHA 9170	9170-728	16 Feb 2022	12
A2916	Attenuator	AtlanTecRF	AN18W5-10	832827#1	01 Feb 2022	12
A2918	Attenuator	AtlanTecRF	AN18W5-20	832828#1	01 Feb 2022	12
A3036	Low Pass Filter	AtlanTecRF	AFL-02000	15062902848	01 Feb 2022	12
A2914	High Pass Filter	AtlanTecRF	AFH-03000	2155	01 Feb 2022	12
A2947	High Pass Filter	AtlanTecRF	AFH-07000	1601900001	01 Feb 2022	12
A2908	High Pass Filter	Wainwright Instruments	WHJE5-920-1000-4000-60EE	3	01 Feb 2022	12
K0001	3m RSE Chamber	Rainford EMC	N/A	N/A	06 Sep 2022	12
M2040	Thermohygrometer	Testo	608-H1	45124934	10 Dec 2021	12
M2044	Test Receiver	Rohde & Schwarz	ESU26	100122	29 Apr 2022	12
A3154	Pre-Amplifier	Com-Power	PAM-103	18020012	24 Aug 2022	12
A553	Antenna	Chase	CBL6111A	1593	15 Mar 2022	12
A3083	Low Pass Filter	AtlanTecRF	AFL-01000	18010900076	03 Feb 2022	12
A3198	Magnetic Loop Antenna	ETS-Lindgren	6502	00221887	12 Aug 2022	12

3 Equipment Under Test (EUT)

3.1 Identification of Equipment Under Test (EUT)

Brand Name:	BCM3100
Model Name or Number / HMN:	BCM3100
Test Sample Serial Number:	14026-0022-01-368-00-000 *(Radiated sample #1)*
Hardware Part Number:	EB13 100 00B
Hardware Version Number:	7.0.0
Software Version Number:	0.13.1-pi21-07-4
Firmware Version:	BG95M2LAR02A04
Contains FCC ID:	2AWRC-BG95M2
Contains ISED Canada Certification Number:	IC: 26294-BG95M2

Brand Name:	BCM3100
Model Name or Number / HMN:	BCM3100
Test Sample Serial Number:	14026-0033-01-368-00-000 *(Radiated sample #2)*
Hardware Part Number:	EB13 100 00B
Hardware Version Number:	7.0.0
Software Version Number:	0.13.1-pi21-07-4
Firmware Version:	BG95M2LAR02A04
Contains FCC ID:	2AWRC-BG95M2
Contains ISED Canada Certification Number:	IC: 26294-BG95M2

3.2 Modifications Incorporated in the EUT

No modifications were applied to the EUT during testing.

3.3 Additional Information Related to Testing

Technology Tested:	LTE Cat M1- Band 2		
Type of Equipment:	Transceiver		
Channel Bandwidth:	3 MHz		
Modulation:	QPSK		
Power Supply Requirement(s):	13.5 VDC		
Transmit Frequency Range:	1850 MHz to 1910 MHz		
Transmit Channels Tested:	**Channel ID**	**N_{ul}**	**Frequency of Uplink (MHz)**
	Bottom	18615	1851.5
	Middle	18900	1880.0
	Top	19185	1908.5

Technology Tested:	NB-IOT - Band 2		
Type of Equipment:	Transceiver		
Channel Bandwidth:	200 kHz		
Modulation:	π/2-BPSK		
Power Supply Requirement(s):	13.5 VDC		
Transmit Frequency Range:	1850 MHz to 1910 MHz		
Transmit Channels Tested:	**Channel ID**	**N_{ul}**	**Frequency of Uplink (MHz)**
	Bottom	18625	1850.2
	Middle	18900	1880.0
	Top	19175	1909.8

3.4 Description of Available Antennas

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

Frequency Range (MHz)	Antenna Gain (dBi)
1850 to 1910	0.9

3.5 Description of Test Setup

Support Equipment

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

Description:	Laptop Computer
Brand Name:	Dynabook
Model Name or Number:	Satellite Pro C40-H-10D
Serial Number:	31227951H

Description:	Radio Communication Analyser
Brand Name:	Anritsu
Model Name or Number:	MT8821C
Serial Number:	6262287694

Description:	DC Power Supply
Brand Name:	Tenma
Model Name or Number:	72-10480
Serial Number:	08250099280

Description:	CAN opto converter 1
Brand Name:	Peak System
Model Name or Number:	IPEH-002026
Serial Number:	01254#2

Description:	CAN opto converter 2
Brand Name:	Peak System
Model Name or Number:	IPEH-002026
Serial Number:	01256#1

Description:	AC to DC Power Adapter 1
Brand Name:	Mascot
Model Name or Number:	9581
Serial Number:	3319R2

Description:	AC to DC Power Adapter 2
Brand Name:	BSY
Model Name or Number:	BSY065T1902103 D
Serial Number:	G71C000MG410 /2012043370

Support Equipment (continued)

Description:	CAN-FD to USB Dongle 1
Brand Name:	Peak System
Model Name or Number:	IPEH-004022
Serial Number:	025569

Description:	CAN-FD to USB Dongle 2
Brand Name:	Peak System
Model Name or Number:	IPEH-004022
Serial Number:	025564

Description:	BRC Simulator
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	Fibre Optics Cable. Quantity 1. Length 10 m.
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Description:	HMI Cables. Quantity 2. Lengths 0.3 m & 1.5 m.
Brand Name:	Not marked or stated
Model Name or Number:	Not marked or stated
Serial Number:	Not marked or stated

Operating Modes

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

- Transmitting at maximum power on bottom, middle or top channel as required.
- Worst-case modes were determined and tested as:
    - Band 2 -:NB-IoT: π/2-BPSK / 1 tone / 15 kHz / Offset 11.
    - Band 2 -:LTE Cat M1: QPSK / NB 0 / 1 RB / Offset 0.

Configuration and Peripherals

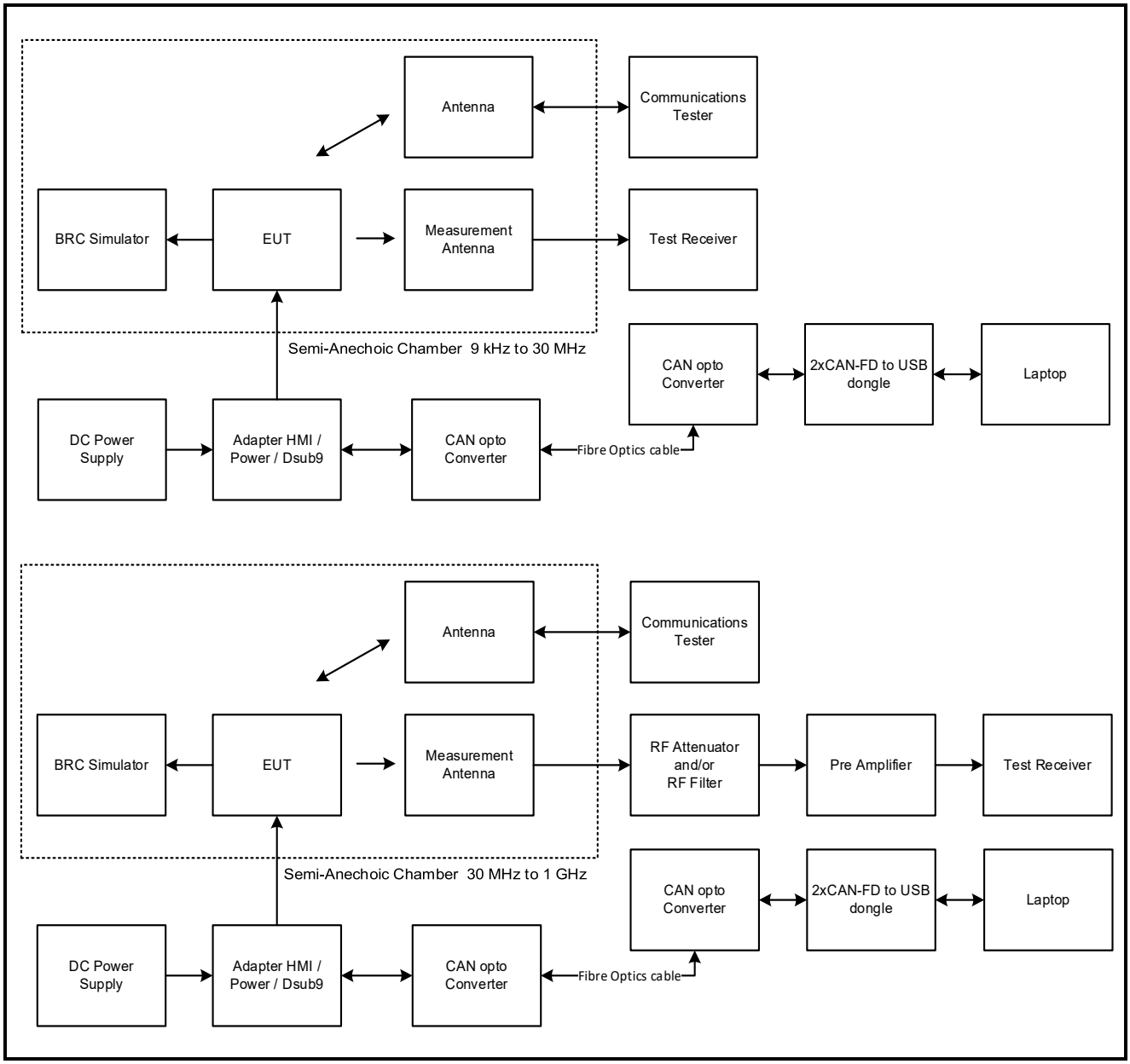
The EUT was tested in the following configuration(s):

- The EUT was placed into a non-ui mode by using the BCM PC Tool for Certification application installed on a customer supplied laptop PC. Instructions were provided by the customer to enable the baseband and radio (BCM3100 Certification Instructions_20210709.docx). This enabled the EUT to connect via a radiated link with the Anritsu LTE system simulator operating in transceiver mode. The Anritsu LTE simulator was used to configure the EUT operating mode.
- The EUT was placed in three orthogonal orientations X, Y and Z to determine the worst case orientation for radiated spurious emissions. This was determined to be the Y position. All pre-scans and final measurements were performed in this orientation.
- The EUT was powered from a DC Power Supply.

Test Setup Diagrams

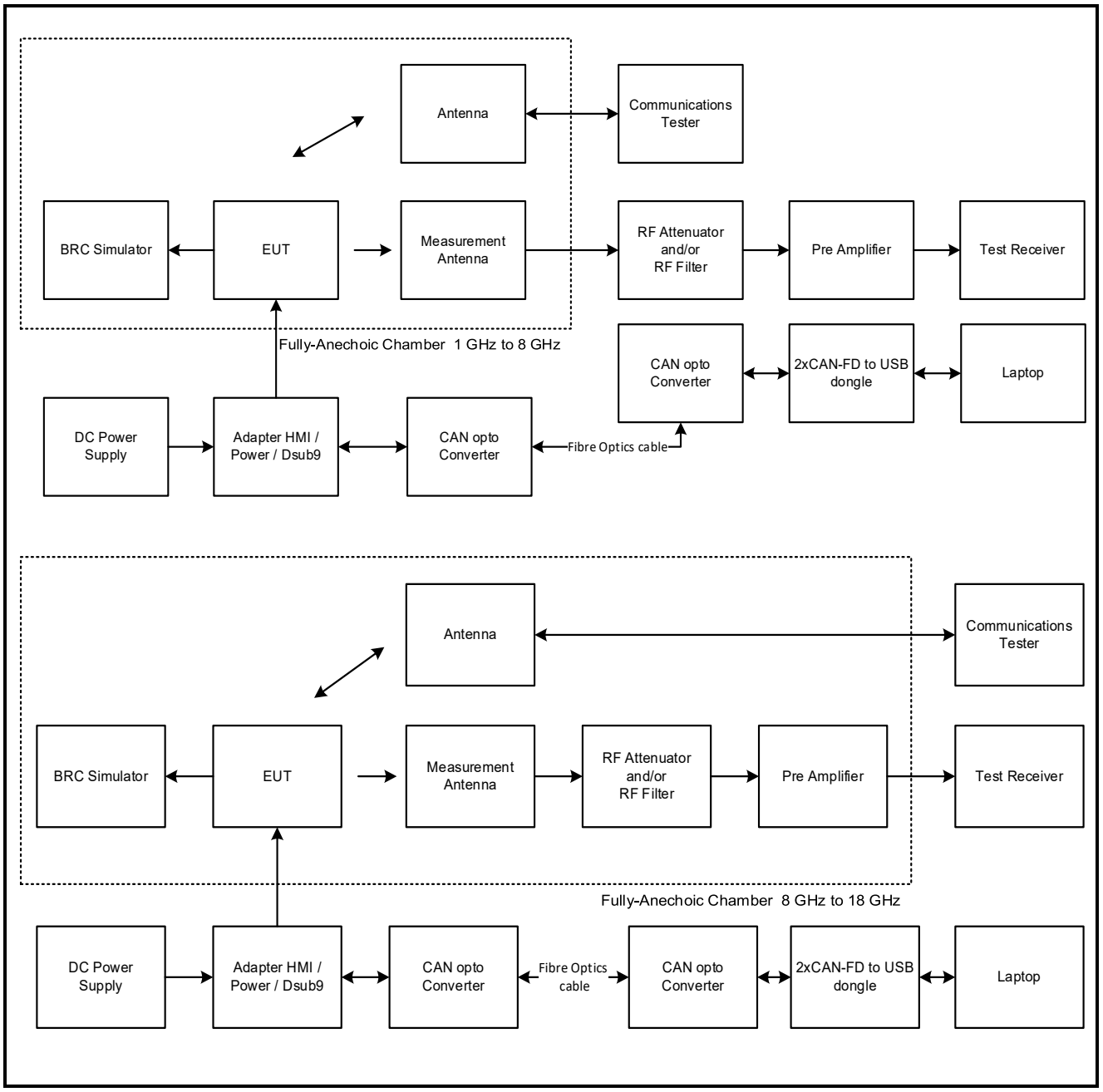
Radiated Tests:

Test Setup for Transmitter Radiated Emissions



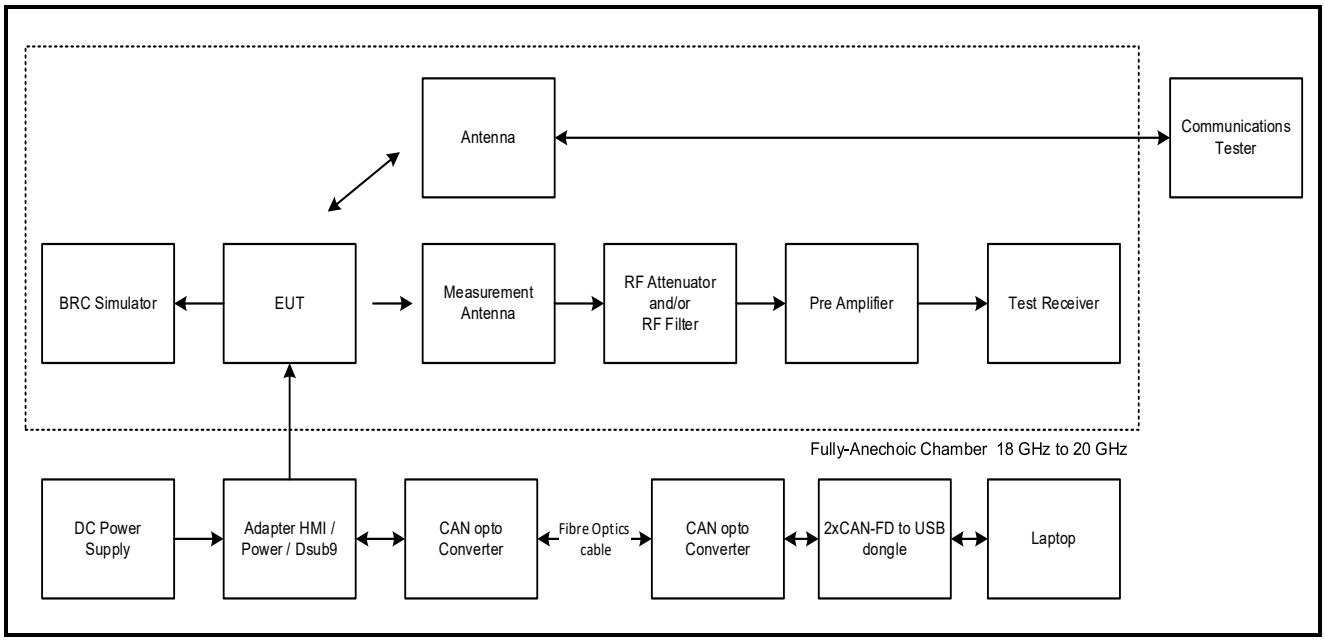
Test Setup Diagrams (continued)

Test Setup for Transmitter Radiated Emissions (continued)



Test Setup Diagrams (continued)

Test Setup for Transmitter Radiated Emissions (continued)



4 Radiated Test Results

4.1 Transmitter Out of Band Radiated Emissions – NB-IoT

Test Summary:

Test Engineers:	John Ferdinand & Jose Bayona	**Test Dates:**	01 September 2021 to 01 October 2021
Test Sample Serial Numbers:	14026-0022-01-368-00-000 & 14026-0033-01-368-00-000		

FCC Reference:	Parts 2.1053, 15.209(a) & 24.238(a)
ISED Canada Reference:	RSS-Gen 6.13 / RSS-133 6.5
Test Method Used:	KDB 971168 Section 6 referencing ANSI C63.26 Section 5.7
Frequency Range	9 kHz to 20 GHz

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	45 to 49

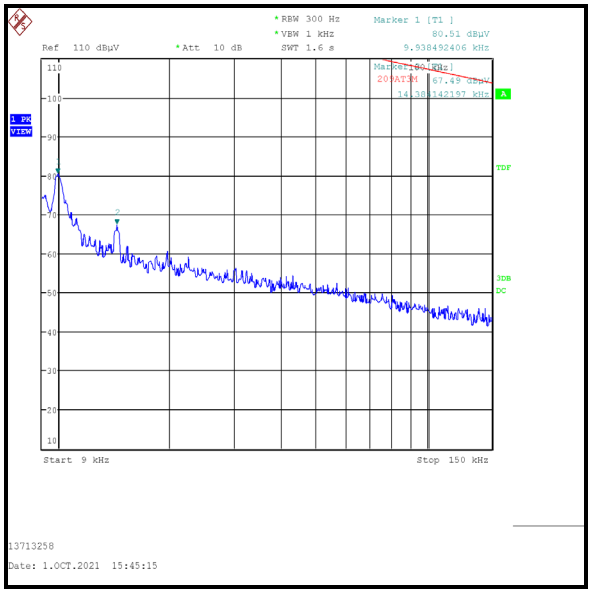
Note(s):

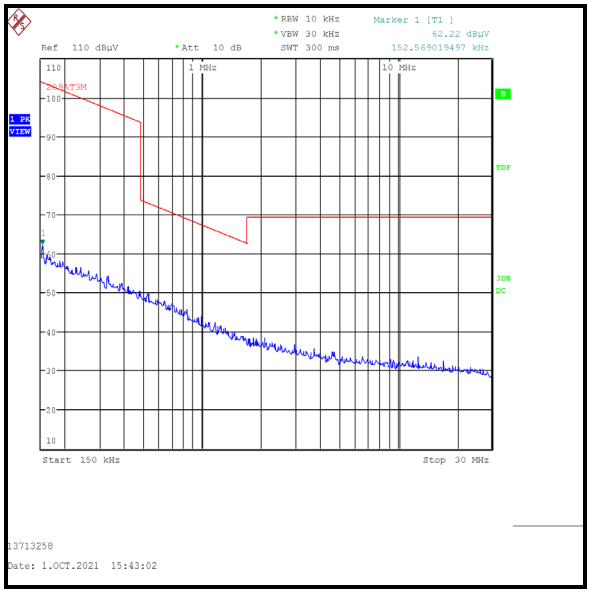
1. The emission seen on the 1 GHz to 3 GHz plot at approximately 1880 MHz is the EUT carrier.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
3. FCC: Measurements below 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 ANSI C63.10 clause 6.4.3; measurements may be performed at a closer distance and the measured level extrapolated to the specified measurement distance using the method described in clause 6.4.4.2.
4. ISEDC: 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, as allowed by ANSI C63.10 clause 5.2; an alternative test site that can demonstrate equivalence to an open area test site may be used for measurements below 30 MHz. Therefore, measurements were performed in a semi-anechoic chamber. The correlation data between semi-anechoic chamber and an open field test site is available upon request.
5. Measurements from 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.
6. 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. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

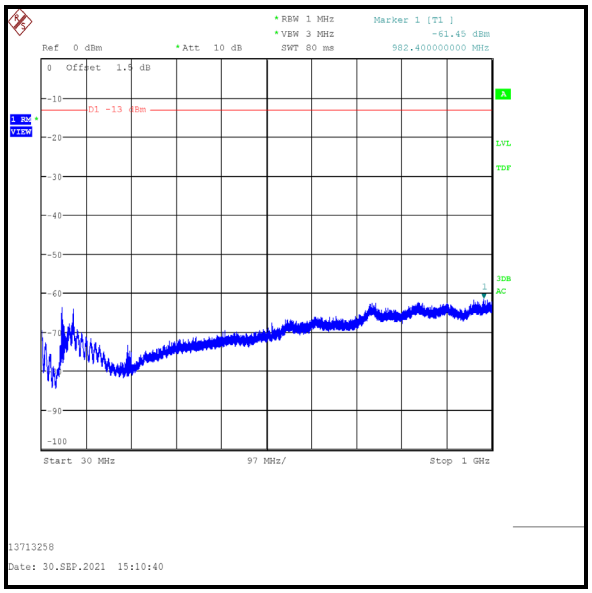
Transmitter Out of Band Radiated Emissions – NB-IoT (continued)

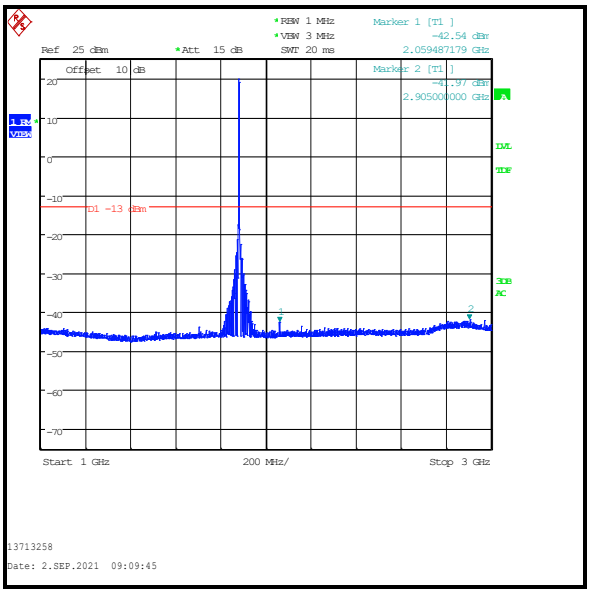
Results: Middle Channel

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
2059.487	-42.5	-13.0	29.5	Complied
3760.000	-51.7	-13.0	38.7	Complied

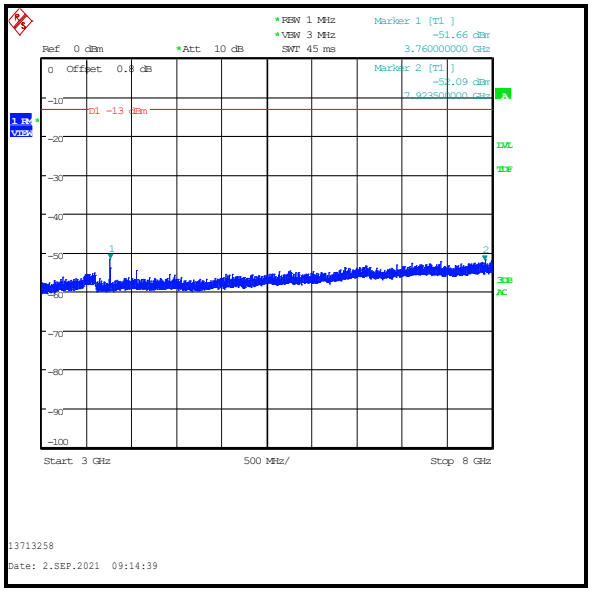


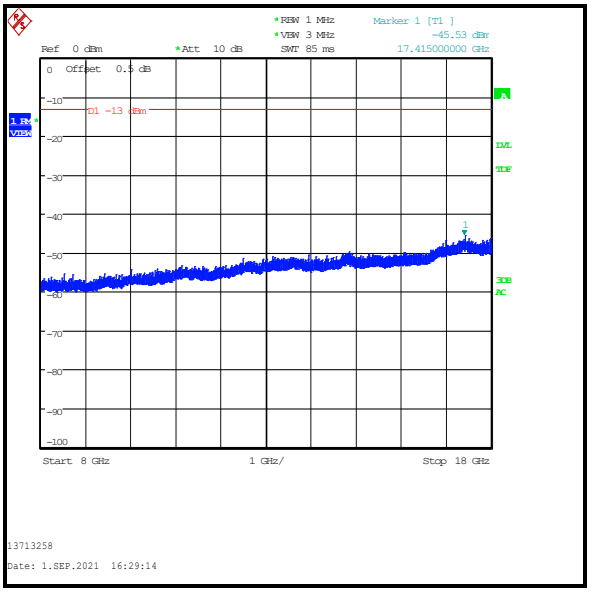


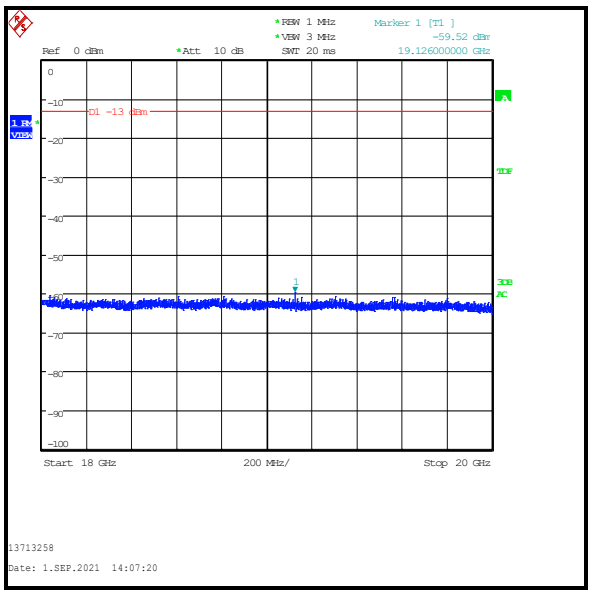




Transmitter Out of Band Radiated Emissions – NB-IoT (continued)







4.2 Transmitter Out of Band Radiated Emissions – LTE Cat M1

Test Summary:

Test Engineers:	John Ferdinand & Jose Bayona	**Test Dates:**	01 September 2021 to 01 October 2021
Test Sample Serial Numbers:	14026-0022-01-368-00-000 & 14026-0033-01-368-00-000		

FCC Reference:	Parts 2.1053, 15.209(a) & 24.238(a)
ISED Canada Reference:	RSS-Gen 6.13 / RSS-133 6.5
Test Method Used:	KDB 971168 Section 6 referencing ANSI C63.26 Section 5.7
Frequency Range	9 kHz to 20 GHz

Environmental Conditions:

Temperature (°C):	23 to 24
Relative Humidity (%):	45 to 49

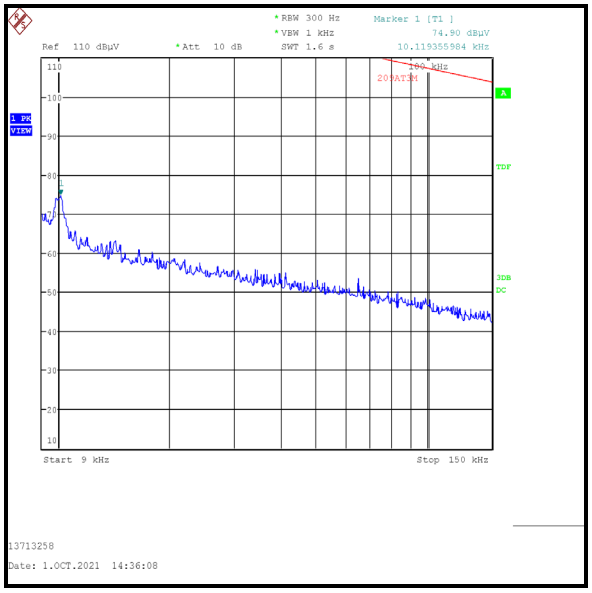
Note(s):

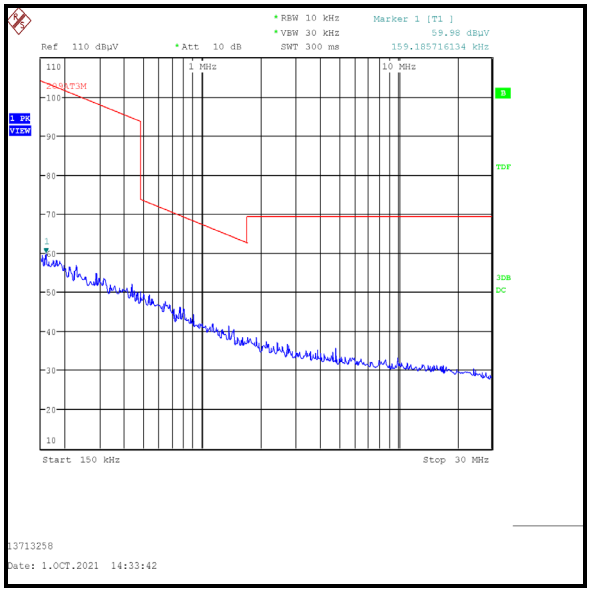
1. The emission seen on the 1 GHz to 3 GHz plot at approximately 1880 MHz is the EUT carrier.
2. All other emissions shown on the pre-scans were investigated and found to be ambient, or > 20 dB below the appropriate limit or below the noise floor of the measurement system.
3. FCC: Measurements below 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 ANSI C63.10 clause 6.4.3; measurements may be performed at a closer distance and the measured level extrapolated to the specified measurement distance using the method described in clause 6.4.4.2.
4. ISEDC: 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, as allowed by ANSI C63.10 clause 5.2; an alternative test site that can demonstrate equivalence to an open area test site may be used for measurements below 30 MHz. Therefore, measurements were performed in a semi-anechoic chamber. The correlation data between semi-anechoic chamber and an open field test site is available upon request.
5. Measurements from 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.
6. 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. Maximum emission levels were determined by height searching the measurement antenna over the range 1 metre to 4 metres.

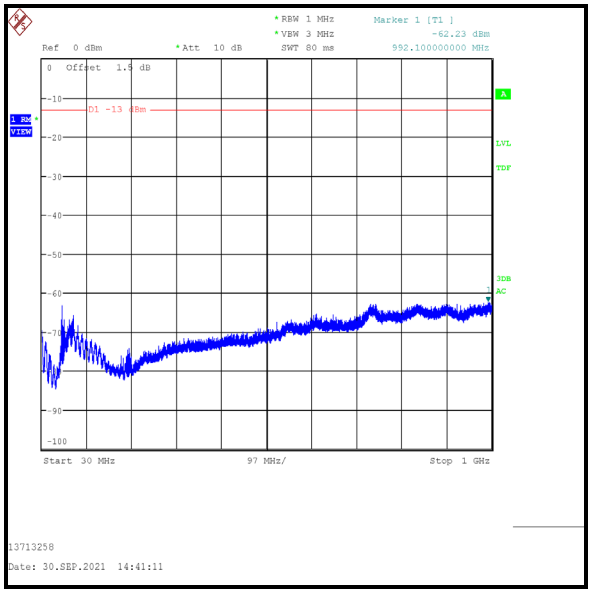
Transmitter Out of Band Radiated Emissions – LTE Cat M1 (continued)

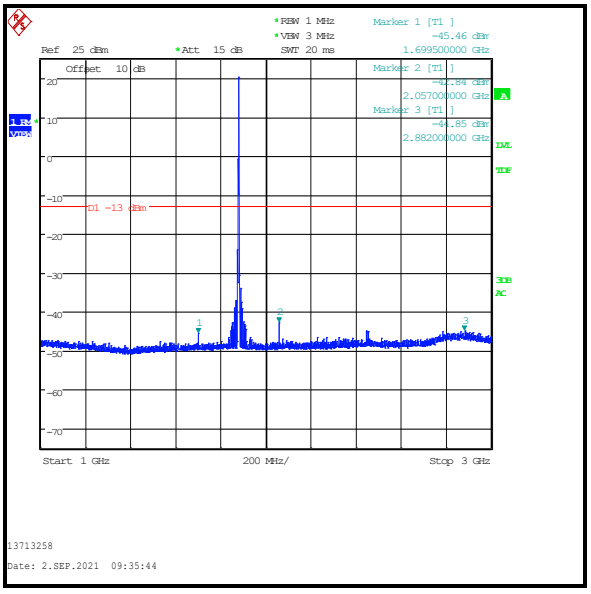
Results: Middle Channel

Frequency (MHz)	Peak Level (dBm)	Limit (dBm)	Margin (dB)	Result
1699.500	-45.5	-13.0	32.5	Complied
2057.000	-42.8	-13.0	29.8	Complied
3756.000	-49.4	-13.0	36.4	Complied

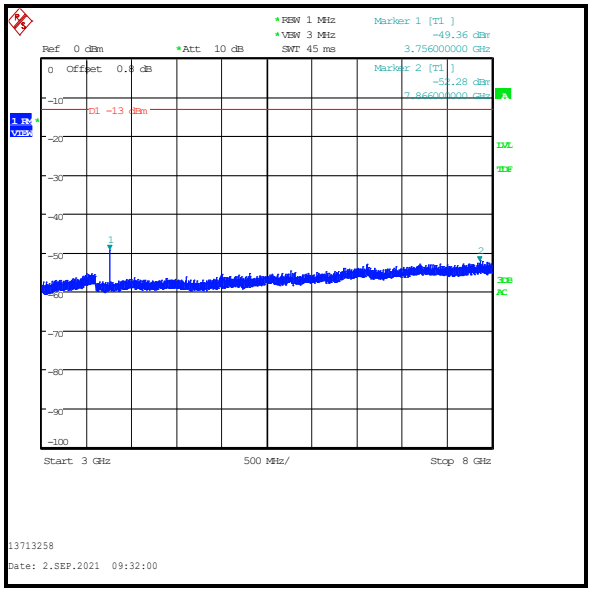


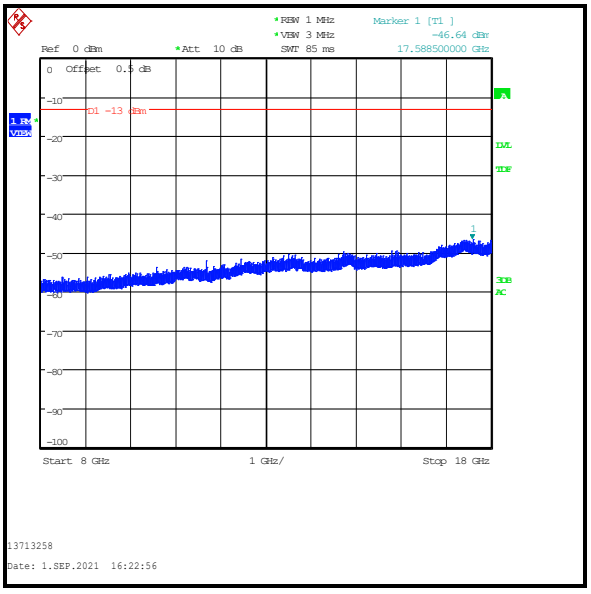


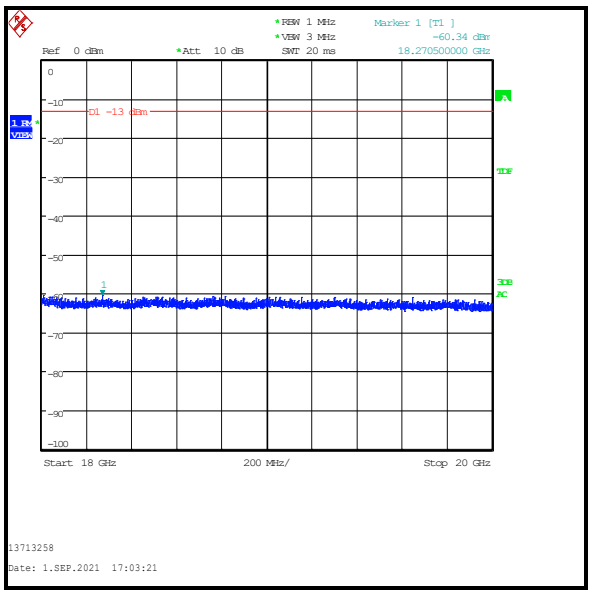




Transmitter Out of Band Radiated Emissions – LTE Cat M1 / Band 4 (continued)







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