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TEST REPORT

Report No.: 21061501HKG-002

Mobile Technologies Inc.

Application For Certification
(Original Grant)

FCC ID: 2AA2X-15000301
IC: 24439-15000301

Transceiver (125kHz RFID Card Reader)

Prepared and Checked by:	**Approved by:**
Signed On File Wong Cheuk Ho, Herbert Lead Engineer	Digitally signed by Kenneth Wong Location: Intertek Testing Services Hong Kong Limited Wong Kwok Yeung, Kenneth Assistant Supervisor Date: 20 Aug 2021

TEST REPORT

GENERAL INFORMATION

Grantee:	Mobile Technologies Inc.
Grantee Address:	1050 NE 67th Ave., Hillsboro, Oregon, 97124, United States
Contact Person:	Audy Tse
e-mail:	audy.tse@mtigs.com
Brand Name:	MTI
Model / HVIN:	VERSA EX
PMN:	VERSA EX
Type of EUT:	Transceiver (125kHz RFID Card Reader)
Description of EUT:	Network Hub
Serial Number:	D23MT0100023
FCC ID / IC:	2AA2X-15000301 / 24439-15000301
Date of Sample Submitted:	28 Jun 2021
Date of Test:	10 Jul 2021 to 20 Jul 2021
Report No.:	21061501HKG-002
Report Date:	20 Aug 2021
Environmental Conditions:	Temperature: +10 to 40°C Humidity: 10 to 90%
Conclusion:	Test was conducted by client submitted sample. The submitted sample as received complied with the 47 CFR Part 15 / RSS-210 Issue 9 Certification.

TEST REPORT

SUMMARY OF TEST RESULT

Test Specification	Reference	Results
Radiated Emission Radiated Emission on the Bandedge	15.209 / RSS-gen	Pass
Transmitter Power Line Conducted Emissions	15.207 / RSS-gen	Pass

The equipment under test is found to be complying with the following standards:
FCC Part 15, October 1, 2020 Edition
RSS-210 Issue 10, December 2019
RSS-Gen Issue 5 + Amendment 2 (February 2021)

Note: 1. The EUT uses a permanently attached antenna which, in accordance to section 15.203, is considered sufficient to comply with the pervisions of this section.
2. Pursuant to FCC part 15 Section 15.215(c), the 20 dB bandwidth of the emission was contained within the frequency band designated (mentioned as above) which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over excepted variations in temperature and supply voltage were considered.

TEST REPORT

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TEST REPORT

1.0 GENERAL DESCRIPTION

1.1 Product Description

The Equipment Under Test (EUT) is Versa Ex. The EUT has 125kHz RFID reader and 2.4GHz Zigbee transceiver for wireless connectivity. The EUT is powered by USB port (5VDC) from AC/DC adaptor (Model: W&T-AD1824A050300U Input:100-240VAC 50/60Hz 0.8A, Output: 5V 3A). When main power is lost, the unit is powered from internal backup battery.

Antenna Type: Internal, Integral

For electronic filing, the brief circuit description is saved with filename: descri.pdf.

1.2 Related Submittal(s) Grants

This is a single application for certification of a transceiver (125kHz RFID portion).

1.3 Test Methodology

Both AC mains line-conducted and radiated emission measurements were performed according to the procedures in ANSI C63.10 (2013). All radiated measurements were performed in an 3m Chamber . Preliminary scans were performed in the 3m Chamber only to determine worst case modes. All radiated tests were performed at an antenna to EUT distance of 3 meters, unless stated otherwise in the **"Justification Section"** of this Application.

1.4 Test Facility

The radiated emission test site and antenna port conducted measurement facility used to collect the radiated data and conductive data are at Workshop No. 3, G/F., World-Wide Industrial Centre, 43-47 Shan Mei Street, Fo Tan, Sha Tin, N.T., Hong Kong SAR, China. This test facility and site measurement data have been fully placed on file with the FCC and Industry Canada No.: 2042H, Conformity Assessment Body Identifier (CABID) of test facility: HKAP01.

TEST REPORT

2.0 SYSTEM TEST CONFIGURATION

2.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in ANSI C63.10 (2013).

The EUT was powered by USB port (5VDC) from AC/DC adaptor.

For maximizing emissions below 30 MHz, the EUT was rotated through 360°, the centre of the loop antenna was placed 1 meter above the ground, and the antenna polarization was changed. For maximizing emission at and above 30 MHz, the EUT was rotated through 360°, the antenna height was varied from 1 meter to 4 meters above the ground plane, and the antenna polarization was changed. This step by step procedure for maximizing emissions led to the data report in Exhibit 3.0.

The rear of unit shall be flushed with the rear of the table.

The equipment under test (EUT) was configured for testing in a typical fashion (as a customer would normally use it). The EUT was mounted to a plastic stand if necessary and placed on the wooden turntable, which enabled the engineer to maximize emissions through its placement in the three orthogonal axes.

For simultaneous transmission, both Zigbee and 125kHz RFID portions are also switched on when taking radiated emission for determining worst-case spurious emission.

2.2 EUT Exercising Software

There was no special software to exercise the device. Once the unit is powered up, it transmits the RF signal continuously.

2.3 Special Accessories

There are no special accessories necessary for compliance of this product.

2.4 Measurement Uncertainty

When determining of the test conclusion, the Measurement Uncertainty of test has been considered.

Uncertainty and Compliance - Unless the standard specifically states that measured values are to be extended by the measurement uncertainty in determining compliance, all compliance determinations are based on the actual measured value.

2.5 Support Equipment List and Description

An AC/DC adaptor was used to power the device.

Model: W&T-AD1824A050300U (Input:100-240VAC 50/60Hz 0.8A, Output: 5V 3A)
(Provided by Applicant)

TEST REPORT

3.0 EMISSION RESULTS

Data is included of the worst-case configuration (the configuration which resulted in the highest emission levels). A sample calculation, configuration photographs and data tables of the emissions are included.

3.1 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any), Average Factor (optional) from the measured reading. The basic equation with a sample calculation is as follows:

FS = RA + AF + CF - AG - AV

where FS = Field Strength in dBµV/m
RA = Receiver Amplitude (including preamplifier) in dBµV
CF = Cable Attenuation Factor in dB
AF = Antenna Factor in dB
AG = Amplifier Gain in dB
AV = Average Factor in dB

In the following table(s), the reading shown on the data table reflects the preamplifier gain. An example for the calculations in the following table is as follows:

FS = RR + LF

where FS = Field Strength in dBµV/m
RR = RA - AG - AV in dBµV
LF = CF + AF in dB

Assume a receiver reading of 52.0 dBµV is obtained. The antenna factor of 7.4 dB and cable factor of 1.6 dB are added. The amplifier gain of 29 dB and average factor of 5 dB are subtracted, giving a field strength of 27 dBµV/m. This value in dBµV/m was converted to its corresponding level in µV/m.

RA = 52.0 dBµV/m
AF = 7.4 dB
CF = 1.6 dB
AG = 29.0 dB
AV = 5.0 dB
FS = RR + LF
FS = 18 + 9 = 27 dBµV/m

RR = 18.0 dBµV
LF = 9.0 dB

Level in µV/m = Common Antilogarithm [(27 dBµV/m)/20] = 22.4 µV/m

TEST REPORT

3.2 Radiated Emission Configuration Photograph

The worst case in radiated emission was found at 56.078 MHz

For electronic filing, the worst-case radiated emission configuration photographs are saved with filename: radiated photos.pdf.

3.3 Radiated Emission Data

The data on the following page lists the significant emission frequencies, the limit and the margin of compliance. Numbers with a minus sign are below the limit.

Judgment: Passed by 14.2 dB

3.4 Conducted Emission Configuration Photograph

The worst case in line-conducted emission was found at 0.560 MHz

For electronic filing, the worst-case line-conducted configuration photographs are saved with filename: conducted photo.pdf.

3.5 Conducted Emission Data

For electronic filing, the graph and data table of conducted emission is saved with filename: conducted.pdf.

Judgment: Pass by 23.3 dB

TEST REPORT

CONDUCTED EMISSION

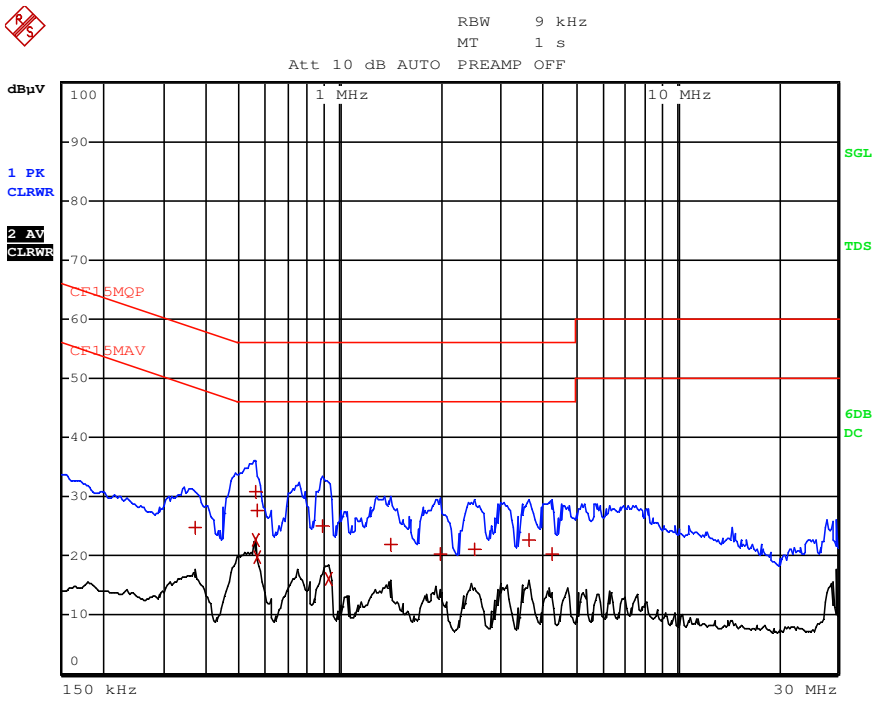
Model: VERSA EX
Date of Test: 13 Jul 2021
Worst-Case Operating Mode: 125kHz RFID Reader + Zigbee Operating

EDIT PEAK LIST (Final Measurement Results)

Trace1: CF15MQP
Trace2: CF15MAV
Trace3: ---

	TRACE	FREQUENCY	LEVEL dBµV		DELTA LIMIT dB
1	Quasi Peak	370.5 kHz	24.83	L1	-33.65
1	Quasi Peak	559.5 kHz	30.71	L1	-25.28
2	CISPR Average	559.5 kHz	22.73	L1	-23.26
1	Quasi Peak	568.5 kHz	27.79	L1	-28.20
2	CISPR Average	568.5 kHz	19.72	L1	-26.27
1	Quasi Peak	883.5 kHz	25.01	L1	-30.98
2	CISPR Average	924 kHz	16.19	L1	-29.81
1	Quasi Peak	1.4145 MHz	21.90	L1	-34.09
1	Quasi Peak	1.9995 MHz	20.23	L1	-35.76
1	Quasi Peak	2.5125 MHz	21.14	L1	-34.85
1	Quasi Peak	3.6285 MHz	22.81	L1	-33.18
1	Quasi Peak	4.2495 MHz	20.22	L1	-35.77

TEST REPORT



Note: Measurement Uncertainty is ±4.2dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSIONS

Model: VERSA EX
Date of Test: 13 Jul 2021
Worst-Case Operating Mode: Transmitting (125kHz RFID Card Reader)

Table 1
Pursuant to FCC Part 15 Section 15.209

9-90kHz and 110-490kHz (Average data)

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Distance Factor (dB)	Calculated at 300m (dBµV/m)	Limit at 300m (dBµV/m)	Margin (dB)
O	0.025	38.0	0	11.8	49.8	80.0	-30.2	39.6	-69.8
O	0.125	45.2	0	11.7	56.9	80.0	-23.1	25.7	-48.8
O	0.174	36.9	0	11.6	48.5	80.0	-31.5	22.8	-54.3
O	0.250	39.9	0	11.6	51.5	80.0	-28.5	19.6	-48.1

490kHz-30MHz: (Quasi-Peak data)

Polari-zation	Frequency (MHz)	Reading (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Distance Factor (-dB)	Calculated at 30m (dBµV/m)	Limit at 30m (dBµV/m)	Margin (dB)
O	0.524	34.9	0	11.6	46.5	40.0	6.5	33.2	-26.7
O	1.034	28.3	0	11.5	39.8	40.0	-0.2	29.5	-29.7

NOTES:
1. Quasi-Peak Detector Data unless otherwise stated. Average Detector Data for 9-90kHz and 110-490kHz.
2. All measurements were made at 3 meters.
3. Negative sign in the column shows value below limit.
4. Loop antenna is used for the emissions below 30MHz.
5. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

RADIATED EMISSIONS

Model: VERSA EX
Date of Test: 13 Jul 2021
Worst-Case Operating Mode: Transmitting (125kHz RFID Card Reader)

Table 2
Pursuant to RSS-Gen Requirement

9-90kHz and 110-490kHz (Average data)

Frequency (MHz)	Reading Level (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m From loop antenna (dBµV/m)	Conversion Factor (dBΩ)	Distance Factor for 300m (dB)	Calculated at 300m from loop antenna (dBµA/m)	Limit at 300m (dBµA/m)	Margin (dB)
0.025	38.0	0.0	11.8	49.8	51.5	80.0	-81.7	-11.9	-69.8
0.125	45.2	0.0	11.7	56.9	51.5	80.0	-74.6	-25.9	-48.7
0.174	36.9	0.0	11.6	48.5	51.5	80.0	-83.0	-28.7	-54.3
0.250	39.9	0.0	11.6	51.5	51.5	80.0	-80.0	-31.9	-48.1

490kHz-30MHz: (Quasi-Peak data)

Frequency (MHz)	Reading Level (dBµV)	Pre-Amp Gain (dB)	Antenna Factor (dB/m)	Net at 3m From loop antenna (dBµV/m)	Conversion Factor (dBΩ)	Distance Factor for 30m (dB)	Calculated at 30m from loop antenna (dBµA/m)	Limit at 30m (dBµA/m)	Margin (dB)
0.524	34.9	0.0	11.6	46.5	51.5	40.0	-45.0	-18.3	-26.7
1.034	28.3	0.0	11.5	39.8	51.5	40.0	-51.7	-24.2	-27.5

NOTES:
1. Quasi-Peak Detector Data unless otherwise stated. Average Detector Data for 9-90kHz and 110-490kHz.
2. All measurements were made at 3 meters.
3. Negative sign in the column shows value below limit.
4. Loop antenna is used for the emissions below 30MHz.
5. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

Model: VERSA EX
Date of Test: 13 Jul 2021
Worst-Case Operating Mode: 125kHz RFID Reader + Zigbee Operating

Table 3
Pursuant to FCC Part 15 Section 15.209 / RSS-Gen Requirement

Polarization	Frequency (MHz)	Reading (dBµV)	Pre-amp (dB)	Antenna Factor (dB)	Net at 3m (dBµV/m)	Limit at 3m (dBµV/m)	Margin (dB)
V	56.078	30.8	16	11.0	25.8	40.0	-14.2
V	71.802	33.2	16	7.0	24.2	40.0	-15.8
H	119.088	24.8	16	14.0	22.8	43.5	-20.7
V	124.815	26.5	16	14.0	24.5	43.5	-19.0
V	141.512	26.2	16	14.0	24.2	43.5	-19.3
V	218.782	22.6	16	17.0	23.6	46.0	-22.4

NOTES:
1. Quasi-Peak Detector Data unless otherwise stated.
2. All measurements were made at 3 meters.
3. Negative sign in the column shows value below limit.
4. Loop antenna is used for the emissions below 30MHz.
5. Measurement Uncertainty is ±5.3dB at a level of confidence of 95%.

TEST REPORT

4.0 EQUIPMENT PHOTOGRAPHS

For electronic filing, the photographs are saved with filename: external photos.pdf and internal photos.pdf.

5.0 PRODUCT LABELLING

For electronics filing, the FCC ID label artwork and the label location are saved with filename: label.pdf.

6.0 TECHNICAL SPECIFICATIONS

For electronic filing, the block diagram and schematic of the tested EUT are saved with filename: block.pdf and circuit.pdf respectively.

7.0 INSTRUCTION MANUAL

For electronic filing, a preliminary copy of the Instruction Manual is saved with filename: manual.pdf.

This manual will be provided to the end-user with each unit sold/leased in the United States.

TEST REPORT

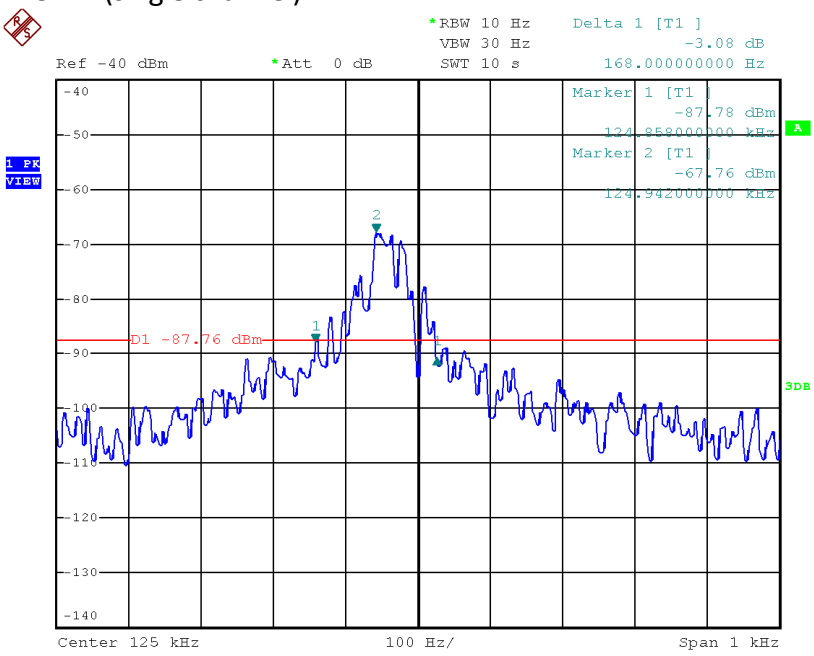
8.0 MISCELLANEOUS INFORMATION

The miscellaneous information includes details of the test procedure and measured bandwidth / calculation of factor such as pulse desensitization and averaging factor (calculation and timing diagram).

8.1 Measured Bandwidth

Pursuant to FCC Part 15 Section 15.215(c), the 20dB bandwidth of the emission was contained within the frequency band designed (mentioned as above) which the EUT operated. The effects, if any, from frequency sweeping, frequency hopping, other modulation techniques and frequency stability over expected variations in temperature and supply voltage were considered.

125kHz (single channel)



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8.2 Discussion of Pulse Desensitization

Pulse desensitivity is not applicable for this device. Since the transmitter transmits the RF signal continuously.

8.3 Calculation of Average Factor

The average factor is not applicable for this device as the transmitted signal is a continuously signal.

TEST REPORT

8.4 Emissions Test Procedures

The following is a description of the test procedure used by Intertek Testing Services Hong Kong Ltd. in the measurements of transmitter operating under the Part 15, Subpart C rules.

The transmitting equipment under test (EUT) is placed on a wooden turntable which is four feet in diameter and approximately 0.8m in height above the ground plane for emission measurement at or below 1GHz and 1.5m in height above the ground plane for emission measurement above 1GHz. During the radiated emissions test, the turntable is rotated and any cables leaving the EUT are manipulated to find the configuration resulting in maximum emissions. The EUT is adjusted through all three orthogonal axis to obtain maximum emission levels. The antenna height and polarization are also varied during the testing to search for maximum signal levels. The height of the antenna is varied from one to four meters.

Detector function for radiated emissions is in peak mode. Average readings, when required, are taken by measuring the duty cycle of the equipment under test and subtracting the corresponding amount in dB from the measured peak readings. A detailed description for the calculation of the average factor can be found in Exhibit 8.3.

The frequency range scanned is from the lowest radio frequency signal generated in the device which is greater than 9 kHz to the tenth harmonic of the highest fundamental frequency or 40 GHz, whichever is lower. For line conducted emissions, the range scanned is 150 kHz to 30 MHz.

TEST REPORT

8.4 Emissions Test Procedures (cont'd)

The EUT is warmed up for 15 minutes prior to the test.

AC power to the unit is varied from 85% to 115% nominal and variation in the fundamental emission field strength is recorded. If battery powered, a new, fully charged battery is used.

Conducted measurements were made as described in ANSI C63.10 (2013).

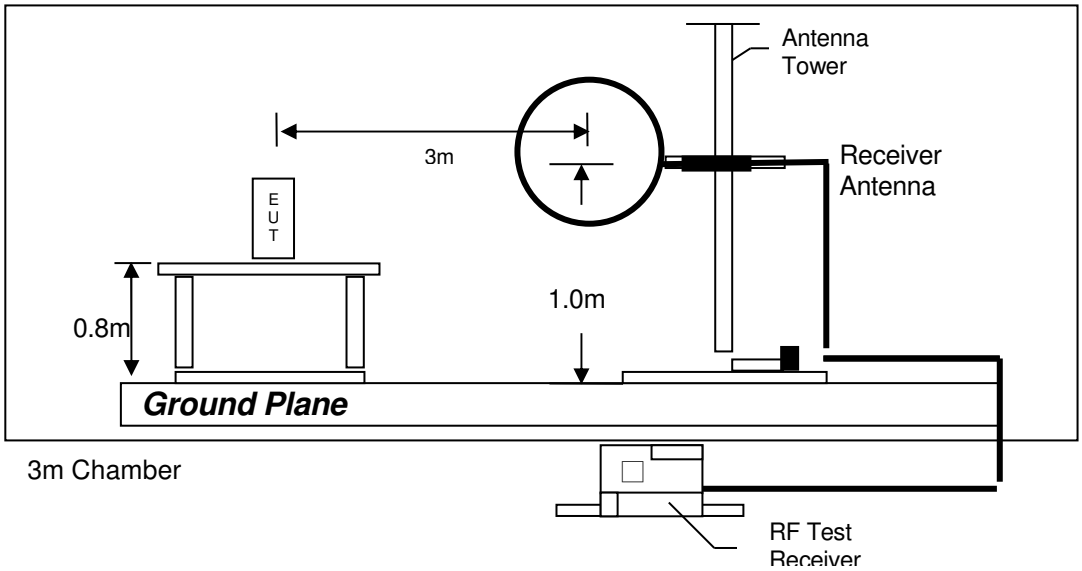
The IF bandwidth used for measurement of radiated signal strength was 100 kHz or greater when frequency is below 1000 MHz. Where pulsed transmissions of short enough pulse duration warrant, a greater bandwidth is selected according to the recommendations of Hewlett Packard Application Note 150-2. A discussion of whether pulse desensitivity is applicable to this unit is included in this report (See Exhibit 8.1). Above 1000 MHz, a resolution bandwidth of 3 MHz is used.

Transmitter measurements are normally conducted at a measurement distance of three meters. However, to assure low enough noise floor in the forbidden bands and above 1 GHz, signals are acquired at a distance of one meter or less. All measurements are extrapolated to three meters using inverse scaling, unless otherwise reported. Measurements taken at a closer distance are so marked.

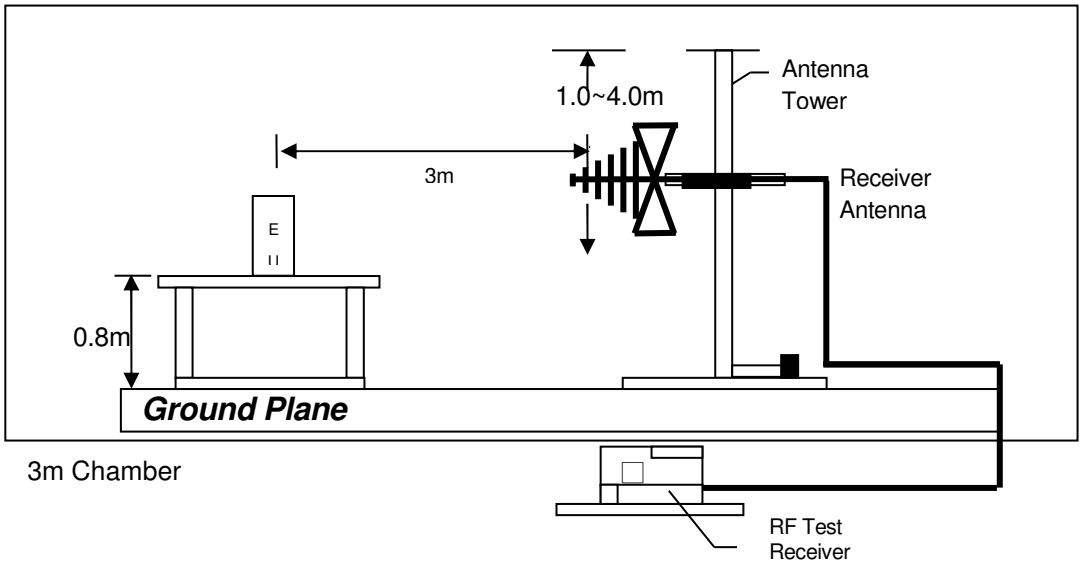
TEST REPORT

8.4.1 Radiated Emission Test Setup

The figure below shows the test setup, which is utilized to make these measurements.



Test setup of radiated emissions 9kHz to 30MHz



Test setup of radiated emissions 30MHz to 1GHz

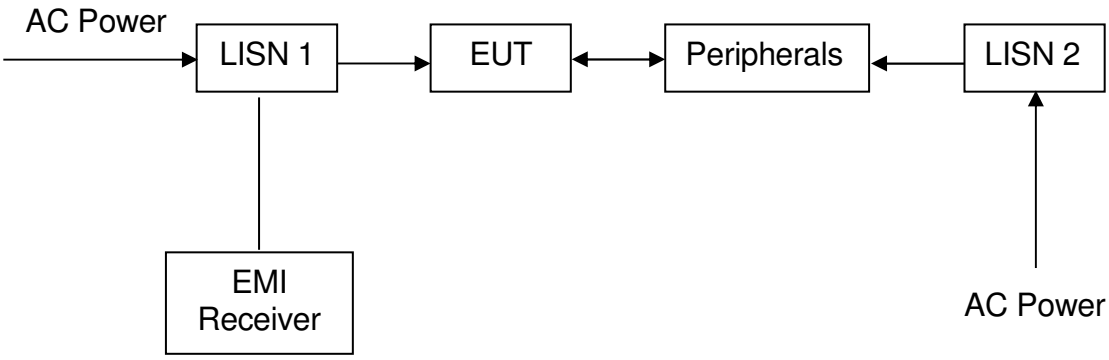
TEST REPORT

8.4.2 Conducted Emission Test Procedures

For tabletop equipment, the EUT along with its peripherals were placed on a 1.0m(W)×1.5m(L) and 0.8m in height wooden table. For floor-standing equipment, the EUT and all cables were insulated, if required, from the ground plane by up to 12 mm of insulating material. The EUT was adjusted to maintain a 0.4 meter space from a vertical reference plane. The EUT was connected to power mains through a line impedance stabilization network (LISN), which provided 50 ohm coupling impedance for measuring instrument and the chassis ground was bounded to the horizontal ground plane of shielded room. The excess power cable between the EUT and the LISN was bundled.

All connecting cables of EUT and peripherals were moved to find the maximum emission.

8.4.3 Conducted Emission Test Setup



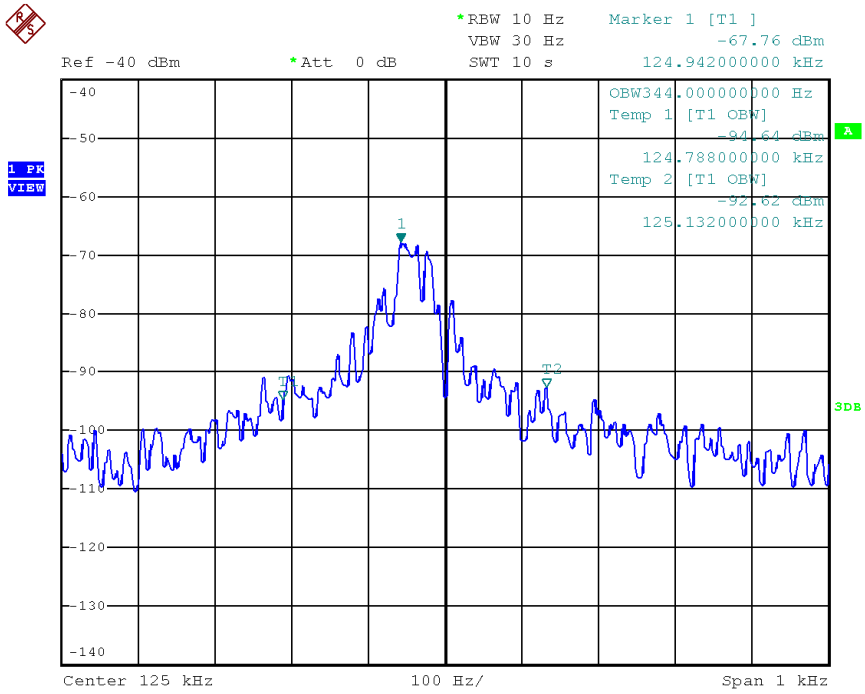
TEST REPORT

8.5 Occupied Bandwidth

Occupied Bandwidth Results:

Channel Frequency	Occupied Bandwidth (kHz)
125kHz	0.344

The worst case is shown as below



TEST REPORT

9.0 CONFIDENTIALITY REQUEST

For electronic filing, a preliminary copy of the confidentiality request is saved with filename: request.pdf.

10.0 EQUIPMENT LIST

1) Radiated Emissions Test

Equipment	EMI Test Receiver (9kHz to 26.5GHz)	Spectrum Analyzer	Biconical Antenna (20MHz to 200MHz)
Registration No.	EW-3156	EW-2466	EW-2512
Manufacturer	ROHDESCHWARZ	ROHDESCHWARZ	EMCO
Model No.	ESR26	FSP30	3104C
Calibration Date	January 25, 2021	September 05, 2020	June 03, 2020
Calibration Due Date	January 25, 2022	September 05, 2021	December 03, 2021

Equipment	Log Periodic Antenna	Double Ridged Guide Antenna	RF Cable 14m (1GHz to 26.5GHz)
Registration No.	EW-0447	EW-1133	EW-2781
Manufacturer	EMCO	EMCO	GREATBILLION
Model No.	3146	3115	SMA m/SHF5MPU /SMA m ra14m,26G
Calibration Date	September 25, 2019	June 03, 2021	November 24, 2020
Calibration Due Date	September 25, 2021	June 03, 2022	November 24, 2021

Equipment	RF Preamplifier (9kHz to 6000MHz)	Active Loop H-field (9kHz to 30MHz)	14m Double Shield RF Cable (20MHz to 6GHz)
Registration No.	EW-3006b	EW-2313	EW-2074
Manufacturer	SCHWARZBECK	ELECTROMETRI	RADIALL
Model No.	BBV9718	EM-6876	N(m)-RG142-BNC(m) L=14M
Calibration Date	November 25, 2019	December 17, 2019	August 29, 2020
Calibration Due Date	September 25, 2021	September 17, 2021	August 29, 2021

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2) Conducted Emissions Test

Equipment	RF Cable 240cm (RG142) (9kHz to 30MHz)	Artificial Mains Network	EMI Test Receiver
Registration No.	EW-2454	EW-2501	EW-2500
Manufacturer	RADIALL	ROHDESCHWARZ	ROHDESCHWARZ
Model No.	Bnc m st / 142 / bnc mra 240cm	ENV-216	ESCI
Calibration Date	November 10, 2020	September 11, 2020	March 29, 2021
Calibration Due Date	November 10, 2021	September 11, 2021	March 29, 2022

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3) Bandedge/Bandwidth Measurement

Equipment	5m RF Cable (40GHz)	Spectrum Analyzer
Registration No.	EW-2701	EW-2466
Manufacturer	RADIALL	ROHDESCHWARZ
Model No.	sma m-m 5m 40G	FSP30
Calibration Date	November 24, 2020	September 05, 2020
Calibration Due Date	November 24, 2021	September 05, 2021

END OF TEST REPORT