

Test Report

FCC ID: 2APSD-IGM4

Date of issue: Apr. 12, 2021

Report Number:	MTi20081916-5E2
Sample Description:	Mortise 2+
Model(s):	IGM4
Applicant:	igloocompany Pte Ltd
Address:	67 Ayer Rajah Crescent #03-25/26 Singapore Singapore
Date of Test:	Nov. 19, 2020 to Dec. 01, 2020

Shenzhen Microtest Co., Ltd.
<http://www.mtitest.com>

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This test report is the revision of the test report MTi20082807-5E5, the original report is invalid.

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Test Result Certification

Applicant's name: igloocompany Pte Ltd

Address: 67 Ayer Rajah Crescent #03-25/26 Singapore Singapore

Manufacture's Name: SOLITY CO., LTD

Address: #103 Yangcheon Venture town 267, Sinjeong-ro, Yangcheon-gu, Seoul, Korea 08079

Product name: Mortise 2+

Trademark: igloohome

Model name: IGM4

Standards: FCC Part 15.225

Test Procedure: ANSI C63.10-2013

This device described above has been tested by Shenzhen Microtest Co., Ltd. and the test results show that the equipment under test (EUT) is in compliance with the FCC requirements. And it is applicable only to the tested sample identified in the report.

Tested by:

Danny Xu

Dec. 01, 2020

Reviewed by:

Leo Su

Apr. 12, 2021

Approved by:

Tom Xue

Apr. 12, 2021

1 General description

1.1 Feature of equipment under test (EUT)

Product name:	Mortise 2+
Model name:	IGM4
Series model:	N/A
Difference of series model:	N/A
Operating frequency:	13.56MHz
Modulation type:	ASK
Antenna Tpye:	PCB antenna
Maximum Field Strength:	53.05dBμV/m at 3 meter
Hardware Version:	Main PCB HW : M-4200_REV0.6_20200410 - Front PCB HW : F-4200_REV0.3_20200608
Software Version:	FW: M4220_VER_10_HEX-3D8659_IGM4
Power Supply:	DC 9V from battery
Serial number:	MTi20081916-5-S0001

1.2 Operation channel list

Channel	Frequency (MHz)
01	13.56

1.3 Test channel list

Channel	Frequency (MHz)
01	13.56

1.4 Ancillary equipment list

Equipment	Model	S/N	Manufacturer	Certificate type
/	/	/	/	/

1.5 Description of support units

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

Item	Equipment	Brand	Model/Type No.	Series No.	Note
/	/	/	/	/	/
/	/	/	/	/	/

Note:

(1)The support equipment was authorized by Declaration of Confirmation.

(2)For detachable type I/O cable should be specified the length in cm in 『Length』 column.

1.6 EUT operation mode

During testing, the EUT is operated in a keeping TX mode.

2 SUMMARY OF TEST RESULT

Test procedures according to the technical standards:

No.	Standard Section	Test Item	Result	Remark
1	15.203	Antenna Requirement	Pass	
2	15.207	Conducted Emission	Pass	
3	15.225(d)/15.209	Radiated Emissions	Pass	
4	15.225(a)(b)(c)/15.205	Field Strength of Fundamental Emissions	Pass	
5	15.215	20dB Bandwidth	Pass	
6	15.225(e)	Frequency Tolerance	Pass	

3 Test Facilities and Accreditations

3.1 Test laboratory

Test Laboratory	Shenzhen Microtest Co., Ltd
Location	101, No. 7, Zone 2, Xinxing Industrial Park, Fuhai Avenue, Xinhe Community, Fuhai Street, Bao' an District, Shenzhen, Guangdong, China.
FCC Registration No.:	FCC Registration No.: 448573

3.2 Environmental conditions

Temperature:	15°C~35°C
Humidity	20%~75%
Atmospheric pressure	98kPa~101kPa

3.3 Measurement uncertainty

The reported uncertainty of measurement $y \pm U$, where expended uncertainty U is based on a standard uncertainty multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95 %

No.	Item	Uncertainty
1	Conducted Emission Test	$\pm 1.38\text{dB}$
2	RF power, conducted	$\pm 0.16\text{dB}$
3	Spurious emissions, conducted	$\pm 0.21\text{dB}$
4	All emissions, radiated(<1G)	$\pm 4.68\text{dB}$
5	All emissions, radiated(>1G)	$\pm 4.89\text{dB}$
6	Temperature	$\pm 0.5^\circ\text{C}$
7	Humidity	$\pm 2\%$

3.4 Test software

Software Name	Manufacturer	Model	Version
RF Test System	Shenzhen JS tonscond co., ltd	JS1120-3	2.5.77.0418

4 List of test equipment

Equipment No.	Equipment Name	Manufacturer	Model	Serial No.	Calibration date	Due date
MTI-E043	EMI Test Receiver	Rohde&schwarz	ESCI7	101166	2020/06/04	2021/06/03
MTI-E044	TRILOG Broadband Antenna	schwarzbeck	VULB 9163	9163-1338	2020/06/05	2021/06/04
MTI-E047	Amplifier	Hewlett-Packard	8447F	3113A06150	2020/06/04	2021/06/03
MTI-E089	ESG Vector Signal Generator	Agilent	N5182A	MY49060455	2020/06/03	2021/06/02
MTI-E058	ESG Series Analog Signal Generator	Agilent	E4421B	GB40051240	2020/07/03	2021/07/04
MTI-E062	PXA Signal Analyzer	Agilent	N9030A	MY51350296	2020/06/04	2021/06/03
MTI-E078	Synthesized Sweeper	Agilent	83752A	3610A01957	2020/06/04	2021/06/03
MTI-E079	DC Power Supply	Agilent	E3632A	MY40027695	2020/06/04	2021/06/03
MTI-E045	Double Ridged Broadband Horn Antenna	schwarzbeck	BBHA 9120D	9120D-2278	2020/06/05	2021/06/04
MTI-E021	EMI Test Receiver	Rohde&schwarz	ESCS30	100210	2020/06/04	2021/06/03
MTI-E022	Pulse Limiter	Schwarzbeck	VSTD 9561-F	00679	2020/06/03	2021/06/02
MTI-E023	Artificial mains network	Schwarzbeck	NSLK 8127	NSLK 8127 #841	2020/06/04	2021/06/03
MTI-E046	Active Loop Antenna	Schwarzbeck	FMZB 1519B	00044	2020/06/05	2021/06/04
MTI-E048	Amplifier	Agilent	8449B	3008A02400	2020/07/03	2021/07/04
MTI-E072	Thermometer Clock Humidity Monitor	-	HTC-1	/	2020/06/07	2021/06/06
Note: the calibration interval of the above test instruments is 12 months and the calibrations are traceable to international system unit (SI).						



5 Test Result

5.1 Antenna requirement

5.1.1 Standard requirement

15.203 requirement: For intentional device, according to 15.203: an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device

5.1.2 EUT Antenna

The antenna is an integrated antenna, which was permanently affixed to the device and un-replaced, complies with 15.203. In addition, the maximum antenna gain is 0dBi.



5.2 Conducted emission

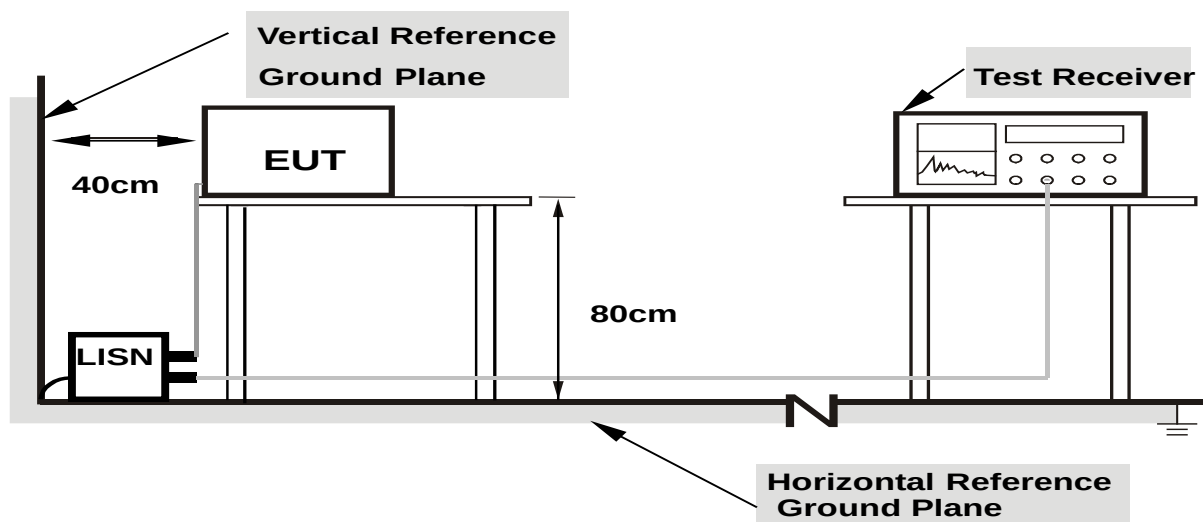
5.2.1 Limits

FREQUENCY (MHz)	Class B (dBuV)	
	Quasi-peak	Average
0.15 -0.5	66 - 56 *	56 - 46 *
0.50 -5.0	56.00	46.00
5.0 -30.0	60.00	50.00

Note

- (1)The tighter limit applies at the band edges.
- (2)The limit of " * " marked band means the limitation decreases linearly with the logarithm of the frequency in the range.

5.2.2 Test setup



Note: 1.Support units were connected to second LISN.

2.Both of LISNs (AMN) are 80 cm from EUT and at least 80 from other units and other metal planes

5.2.3 Test procedure

a. EUT Operating Conditions

The EUT was configured for testing in a typical fashion (as a customer would normally use it). The EUT has been programmed to continuously transmit during test. This operating condition was tested and used to collect the included data.

b. The following table is the setting of the receiver

Receiver Parameters	Setting
Attenuation	10 dB
Start Frequency	0.15 MHz
Stop Frequency	30 MHz
IF Bandwidth	9 kHz

- c. The EUT was placed 0.8 meters from the horizontal ground plane with EUT being connected to the power mains through a line impedance stabilization network (LISN). All other support equipments powered from additional LISN(s). The LISN provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.
- d. Interconnecting cables that hang closer than 40 cm to the ground plane shall be folded back and forth in the center forming a bundle 30 to 40 cm long.
- e. I/O cables that are not connected to a peripheral shall be bundled in the center. The end of the cable may be terminated, if required, using the correct terminating impedance. The overall length shall not exceed 1 m.
- f. LISN at least 80 cm from nearest part of EUT chassis.

For the actual test configuration, please refer to the related Item –EUT Test Photos.



5.2.4 Test results

Note: Not applicate. Because the product is battery powered, so this item not applicate.



5.3 Radiated Emissions

5.3.1 Limit

According to FCC section 15.209 (a), except as provided elsewhere in this subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength ($\mu\text{V/m}$)
0.009 - 0.490	2400/F(kHz)
0.490 - 1.705	24000/F(kHz)
1.705 - 30.0	30
30 - 88	100
88 - 216	150
216 - 960	200
Above 960	500

Note1: For Above 1000 MHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.

Note2: For above 1000 MHz, limit field strength of harmonics: 54dBuV/m@3m (AV) and 74dBuV/m@3m (Peak).

5.3.2 Test Procedure

The measurement frequency range is from 9 kHz to the 10th harmonic of the fundamental frequency. The Turn Table is actuated to turn from 0° to 360°, and both horizontal and vertical polarizations of the Test Antenna are used to find the maximum radiated power. Mid channels on all channel bandwidth verified. Only the worst RB size/offset presented. The power of the EUT transmitting frequency should be ignored.

All Spurious Emission tests were performed in X, Y, Z axis direction. And only the worst axis test condition was recorded in this test report.

Use the following spectrum analyzer settings:

Span = wide enough to fully capture the emission being measured

RBW = 1 MHz for $f \geq 1$ GHz, 100 kHz for $f < 1$ GHz

VBW $\geq$ RBW

Sweep = auto

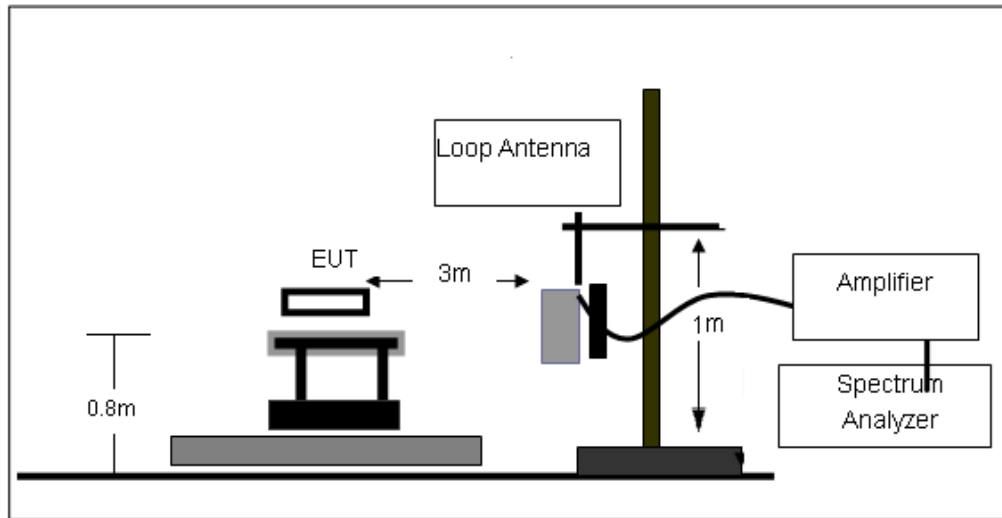
Detector function = peak

Trace = max hold

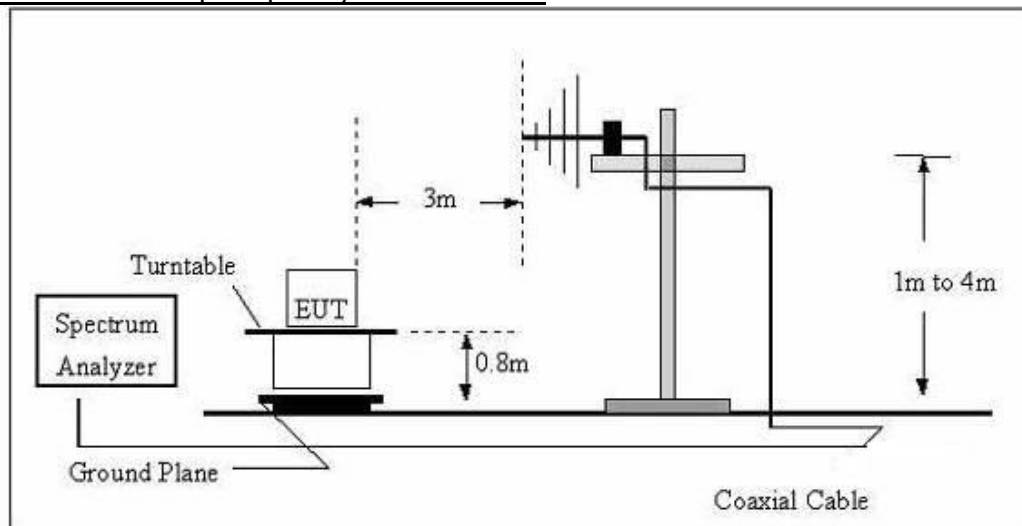


5.3.3 Test Setup

Radiated emission test-up frequency below 30MHz



Radiated emission test-up frequency 30MHz~1GHz

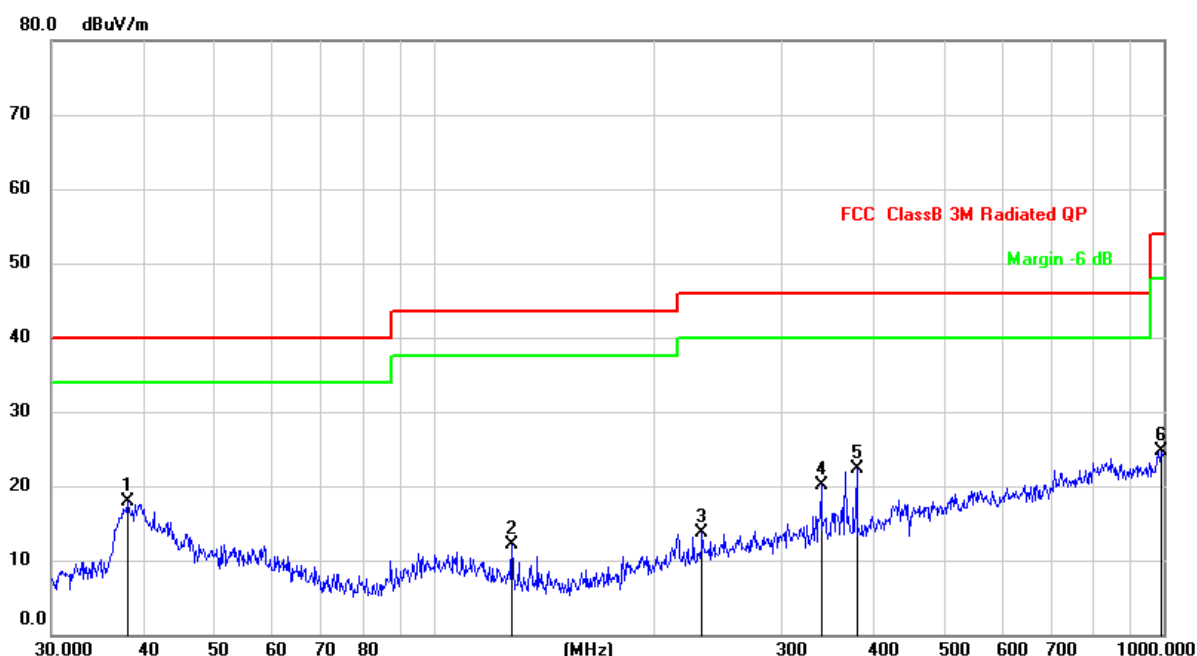


5.3.4 Test Result9 kHz-30MHz

No.	Freq.	Level	Factor	Measurement	Limit	Margin
	MHz	dBuV	dBuV/m	dBuV/m	dBuV/m	dB
1	0.0311	22.73	20.47	43.20	117.62	-74.42
2	0.0677	20.44	20.44	40.88	110.9	-70.02
3	0.11	25.58	20.40	45.98	106.7	-60.72
4	1.2034	18.61	20.21	38.82	66.02	-27.20
5	1.464	14.78	20.26	35.04	64.32	-29.28
6	1.7437	11.27	20.22	31.49	69.5	-38.01

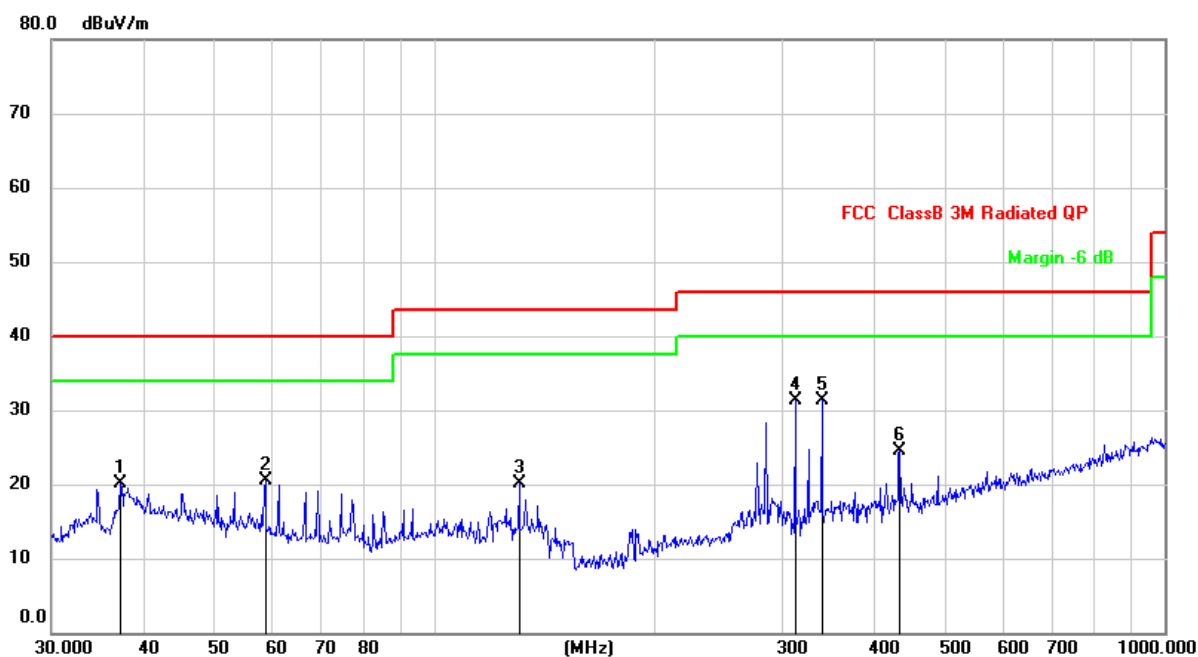
30MHz – 1GHz

EUT :	Mortise 2+	Model Name :	IGM4
Pressure:	1010 hPa	Phase:	H
Test Mode :	NFC	Test Voltage :	DC 9V from battery



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over	
		MHz	dBuV	dBuV/m	dBuV/m	dBuV/m	dB	Detector
1	*	38.0782	32.40	-14.53	17.87	40.00	-22.13	QP
2		128.1126	28.99	-16.81	12.18	43.50	-31.32	QP
3		233.3486	26.33	-12.64	13.69	46.00	-32.31	QP
4		339.5887	30.02	-9.85	20.17	46.00	-25.83	QP
5		379.9141	31.66	-9.28	22.38	46.00	-23.62	QP
6		993.0113	22.96	1.70	24.66	54.00	-29.34	QP

EUT :	Mortise 2+	Model Name :	IGM4
Pressure:	1010 hPa	Phase:	V
Test Mode :	NFC	Test Voltage :	DC 9V from battery



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	
		MHz	dBuV	dBuV/m	dBuV/m	dBuV/m	dB	Detector
1		37.2854	34.86	-14.71	20.15	40.00	-19.85	QP
2		58.8185	34.97	-14.51	20.46	40.00	-19.54	QP
3		130.8369	37.10	-17.05	20.05	43.50	-23.45	QP
4	*	312.1792	41.60	-10.27	31.33	46.00	-14.67	QP
5		339.5887	41.09	-9.85	31.24	46.00	-14.76	QP
6		434.0649	32.84	-8.32	24.52	46.00	-21.48	QP



5.4 Field Strength of Fundamental Emissions

5.4.1 Limits:

According to FCC section 15.225, for <30 MHz, Radiated emissions were measured according to ANSI C63.4. The EUT was set to transmit at the highest output power. The EUT was set 10 meter away from the measuring antenna. The loop antenna was positioned 1 meter above the ground from the center of the loop. The measuring bandwidth was set to 10 KHz. (Note: During testing the receive antenna was rotated about its axis to maximize the emission from the EUT)

There was no detected Restricted bands and Radiated suprious emission below 30MHz. The 30m limit was converted to 3m Limit using square factor(x) as it was found by measurements as follows;
3 m Limit(dBuV/m) = $20\log(X) + 40\log(30/3) = 20\log(15848) + 40\log(30/3) = 124\text{dBuV}$

Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

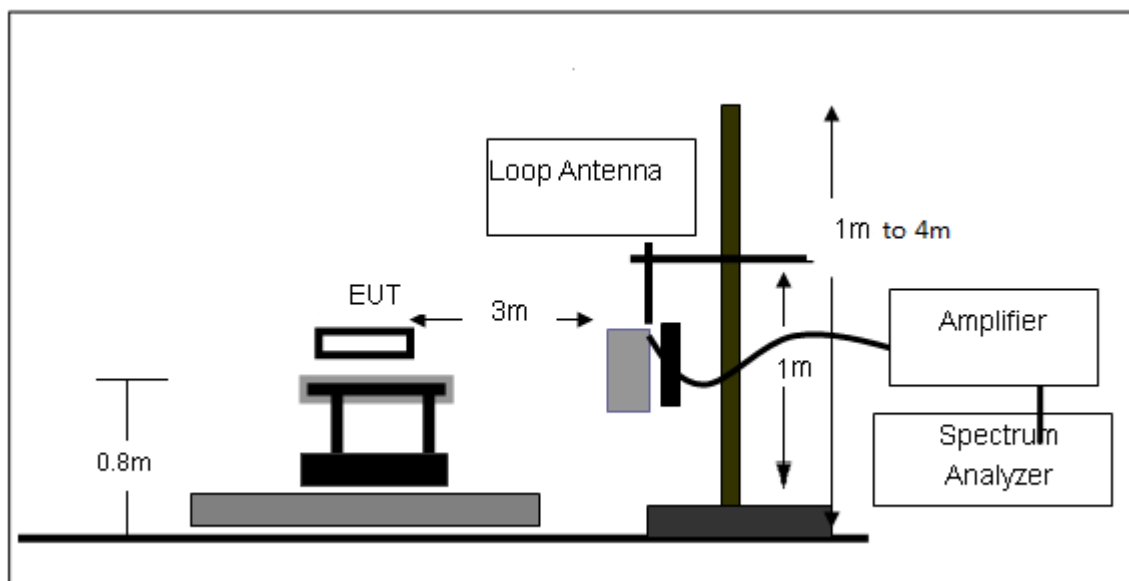
Frequency range (MHz)	Field Strength@30m		Field Strength@3m
	$\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$	$\text{dB}\mu\text{V/m}$
Below 13.110	30	29.5	69.5
13.110 ~ 13.410	106	40.5	80.5
13.410 ~ 13.553	334	50.5	90.5
13.553 ~13.567	15.848	84	124
13.567 ~ 13.710	334	50.5	90.5
13.710 ~14.010	106	40.5	80.5
Above 14.010	30	29.5	69.5

Note:

1. Field Strength ($\text{dB}\mu\text{V/m}$) = $20 \cdot \log[\text{Field Strength } (\mu\text{V/m})]$.
2. In the emission tables above, the tighter limit applies at the band edges.

5.4.2 Test Setup:

Radiated emission test-up frequency below 30MHz



5.4.3 Test Procedures

As the radiation test, set the RBW=10kHz VBW=30kHz, observed the outside band of 13.110 MHz to 14.010 MHz, than mark the higher-level emission for comparing with the FCC rules.

5.4.4 Test Result

Maximum Field Strength:

13.553 MHz – 13.567 MHz					
Frequency (MHz)	Level dBuV	Factor dBuV/m	Result @3m (dBμV/m)	Limit @3m dBuV/m	Margin dB
13.56	32.6277	20.42	53.0477	124	-70.9523

13.410 MHz – 13.553 MHz and 13.567 MHz – 13.710 MHz					
Frequency (MHz)	Level dBuV	Factor dBuV/m	Result @3m (dBμV/m)	Limit @3m dBuV/m	Margin dB
13.52	24.62525	20.42	45.04525	90.5	-45.4548
13.63	26.8201	20.42	47.2401	90.5	-43.2599

13.110 MHz – 13.410 MHz and 13.710 MHz – 14.010 MHz					
Frequency (MHz)	Level dBuV	Factor dBuV/m	Result @3m (dBμV/m)	Limit @3m dBuV/m	Margin dB
13.36	23.52402	20.42	43.94402	80.5	-36.556
13.95	24.04844	20.42	44.46844	80.5	-36.0316

5.5 20dB bandwidth

5.5.1 Limit

Operation within the band 13.110 MHz to 14.010 MHz

5.5.2 Requirement

Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§15.217 through 15.257 and in subpart E of this part, must be designed to ensure that 20dB bandwidth of the emission, or whatever bandwidth may otherwise be specified in the specific rule section under which the equip compliance with the 20dB attenuation specification may base on measurement at the intentional radiator's antenna output terminal unless the intentional radiator uses a permanently attached antenna, in which case compliance shall be. Demonstrated by measuring the radiated emissions.

5.5.3 Test Procedure

The 20dB bandwidth is measured with a spectrum analyzer connected via a receiver antenna placed near the EUT while the EUT is operating in transmission mode.

Use the following spectrum analyzer settings:

Span = approximately 2 to 3 times the 20 dB bandwidth

RBW $\geq$ 1% of the 20 dB bandwidth

VBW $\geq$ RBW

Sweep = auto

Detector function = peak

Trace = max hold



EUT :	Mortise 2+	Model Name :	IGM4
Pressure :	1012 hPa	Test Voltage :	DC 9V from battery
Test Mode :	TX Mode		

Frequency (MHz)	20dB Bandwidth (kHz)
13.56	8.139

The screenshot displays the Agilent Spectrum Analyzer interface for an Occupied Bandwidth (BW) measurement. The main display shows a signal trace with a peak at 13.56 MHz. The y-axis is labeled '10 dB/div' and 'Log', with a reference level of 'Ref 20.00 dBm'. The x-axis represents frequency.

Key parameters displayed on the right side of the interface:

- Frequency:** 13.560000 MHz
- Center Freq:** 13.560000 MHz
- CF Step:** 2.000 kHz
- Freq Offset:** 0 Hz
- Occupied Bandwidth:** 7.684 kHz
- Total Power:** 8.95 dBm
- Transmit Freq Error:** 79 Hz
- OBW Power:** 99.00 %
- x dB Bandwidth:** 8.139 kHz
- x dB:** -20.00 dB

Additional settings visible include: Center Freq: 13.560000 MHz, Trig: Free Run, Avg/Hold: > 10/10, Radio Std: None, Radio Device: BTS, #IF Gain: Low, #Atten: 40 dB, #Res BW: 3 kHz, #VBW: 10 kHz, Span: 20 kHz, Sweep: 2.733 ms.

5.6 Frequency stability

5.6.1 Limit

The frequency tolerance of the carrier signal shall be maintained within $\pm 0.01\%$ of the operating frequency over a temperature variation of -20 degrees to $+ 50$ degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

5.6.2 Test Procedure

1. The test is performed in a Temperature Chamber.

5.6.3 Test result

Voltage (Vdc)	Temp. (°C)	Frequency (MHz)	Deviation (%)	Limit (%)
9.0	-20	13.5601147	0.001%	+/-0.01%
9.0	-10	13.56032179	0.002%	
9.0	0	13.56032821	0.002%	
9.0	10	13.56017626	0.001%	
9.0	20	13.56027518	0.002%	
9.0	30	13.5608416	0.006%	
9.0	40	13.56014472	0.001%	
9.0	50	13.56066757	0.005%	
7.65	20	13.56030407	0.002%	
10.35	20	13.56034717	0.003%	



Photographs of the Test Setup

Radiated emission





Photographs of the EUT

See the APPENDIX 1: EUT PHOTO in the report No.: MTi20081916-5E1-1.

----END OF REPORT----