LTA
Laboratory for Test & Approval Co.,Ltd.

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Dates of Tests: November 23 ~ November 13, 2015
Test Report S/N: LR500111511F
Test Site : LTA CO., LTD.

CERTIFICATION OF COMPLIANCE

FCC ID **2AGMY-MSM320**

APPLICANT **MCT CO., LTD.**

Equipment Class	**:**	**Digital Transmission System (DTS)**
Manufacturing Description	**:**	**LoRa FR module**
Manufacturer	**:**	**MCT CO., LTD.**
Model name	**:**	**MSM320**
Test Device Serial No.:	**:**	**Identical prototype**
Rule Part(s)	**:**	**FCC Part 15.247 Subpart C; ANSI C-63.4-2009**
Frequency Range	**:**	**917.3 ~ 923.3 MHz**
RF power	**:**	**Max 1.51 dBm – Conducted**
Data of issue	**:**	**November 25, 2015**

This test report is issued under the authority of:

Yong-Chul Wang, Manager

The test was supervised by:

Joon-Young Jeon, Test Engineer

This test result only responds to the tested sample. It is not allowed to copy this report even partly without the allowance of the test laboratory. The report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the Federal Government.

NVLAP LAB Code.: 200723-0

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1. General information

1-1 Test Performed

Company name : LTA Co., Ltd.

Address : 243, Jubug-ri,Yangji-Myeon,Youngin-Si, Kyunggi-Do, Korea. 449-822

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Quality control in the testing laboratory is implemented as per ISO/IEC 17025 which is the "General requirements for the competents of calibration and testing laboratory".

1-2 Accredited agencies

LTA Co., Ltd. is approved to perform EMC testing by the following agencies:

Agency	Country	Accreditation No.	Validity	Reference
NVLAP	U.S.A	200723-0	2016-09-30	ECT accredited Lab.
RRA	KOREA	KR0049	-	EMC accredited Lab.
FCC	U.S.A	610755	2017-04-21	FCC filing
FCC	U.S.A	649054	2017-04-13	FCC CAB
VCCI	JAPAN	R2133(10 m), C2307	2017-06-21	VCCI registration
VCCI	JAPAN	T-2009	2016-12-23	VCCI registration
VCCI	JAPAN	G-563	UPDATING	VCCI registration
IC	CANADA	5799A-1	UPDATING	IC filing
KOLAS	KOREA	NO.551	2017-01-08	KOLAS accredited Lab.

2. Information about test item

2-1 Client & Manufacture

Company name	: MCT CO., LTD.
Address	: B-215, Garden5 Works, 52 Dhungmin-ro, Songpa-gu, Seoul, Korea(05839)
Telephone / Facsimile	: +82-2-2047-1622 / +82-2-2047-1625

2-2 Equipment Under Test (EUT)

Trade name	: MSM320
Model name	: MSM320
Serial number	: Identical prototype
Date of receipt	: November 23, 2015
EUT condition	: Pre-production, not damaged
Antenna type	: Dipole with Max Gain: 2.11 dBi
Frequency Range	: 917.3 ~ 923.3 MHz
RF output power	: Max 1.51 dBm – Conducted
Number of Channels	: 20
Power Source	: DC 3.6 V
Firmware Version	: V 1.0.0

2-3 Tested frequency

Bluetooth	LOW	MID	HIGH
Frequency (MHz)	917.3	920.3	923.3

2-4 Ancillary Equipment

Equipment	Model No.	Serial No.	Manufacturer
-	-	-	-

3. Test Report

3.1 Summary of tests

FCC Part Section(s)	Parameter	Limit	Test Condition	Status (note 1)
15.247(a)	6 dB Bandwidth	> 500 KHz	Conducted	C
15.247(b)	Transmitter Peak Output Power	< 1 Watt		C
15.247(d)	Transmitter Power Spectral Density	< 8 dBm @ 3 KHz		C
15.247(d)	Band Edge & Spurious	> 20 dBc		C
15.209	Field Strength of Harmonics	Emissions	Radiated	C
15.207	AC Conducted Emissions	Emissions	Conducted	C
15.203	Antenna requirement	–	–	C

Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable

Note 2: The data in this test report are traceable to the national or international standards.

Note 1: Antenna Requirement

→ The **MCT CO., LTD.** FCC ID: **2AGMY-MSM320** unit complies with the requirement of §15.203.

The antenna type is Dipole antenna.

Note 2: The sample was tested according to the following specification:
FCC Parts 15.247; ANSI C-63.4-2009
FCC KDB Publication No. 558074 D01 v03 r03
FCC TCB Workshop 2012, April

3.2 Technical Characteristics Test

3.2.1 6 dB Bandwidth

Procedure:

*The testing follows FCC KDB Publication No. 558074 D01 V03 R03 and TCB Workshop 2012, April.

The bandwidth at 6dB below the highest in-band spectral density was measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate frequencies.

After the trace being stable, Use the marker-to-peak function to set the marker to the peak of the emission. Use the marker-delta function to measure 6 dB down one side of the emission. Reset the marker-delta function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is the 6 dB bandwidth of the emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 1 MHz

Span = 10 MHz

VBW = 1 MHz (VBW ≥ RBW)

Sweep = auto

Trace = max hold

Detector function = peak

Measurement Data: MIMO

Mode	Frequency (MHz)	Channel No.	Test Results	
			Measured Bandwidth (MHz)	Result
Normal	917.3	1	1.52	Complies
	920.3	17	1.52	Complies
	923.3	32	1.52	Complies

- See next pages for actual measured spectrum plots.

Minimum Standard:

6 dB Bandwidth > 500 kHz

Measurement Setup

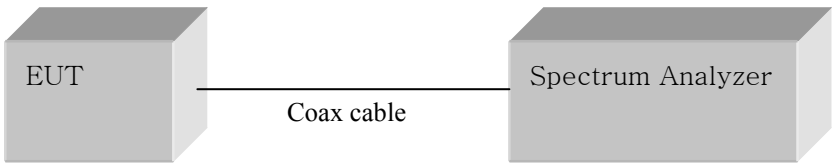
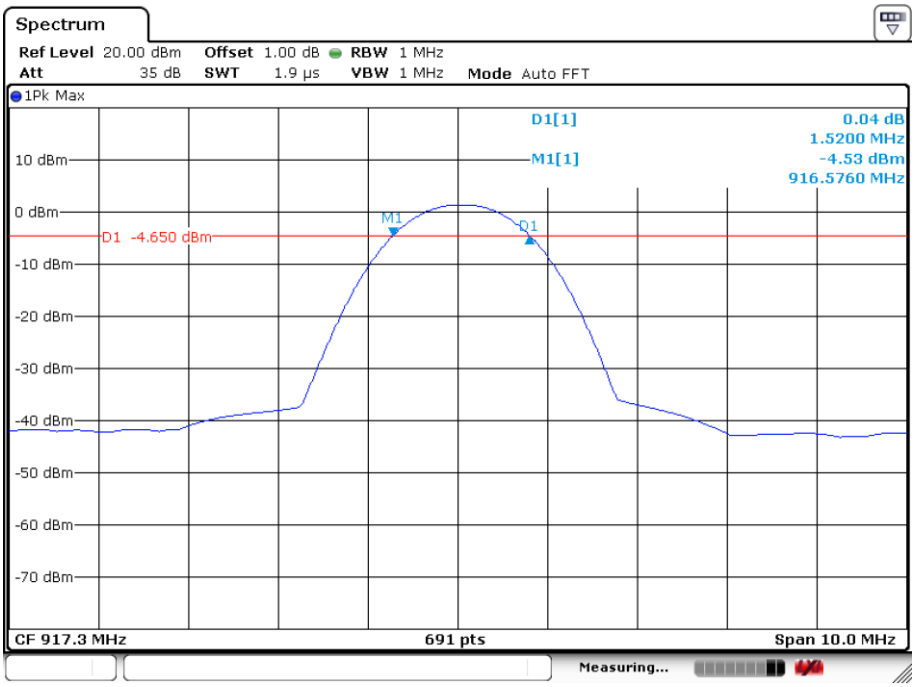
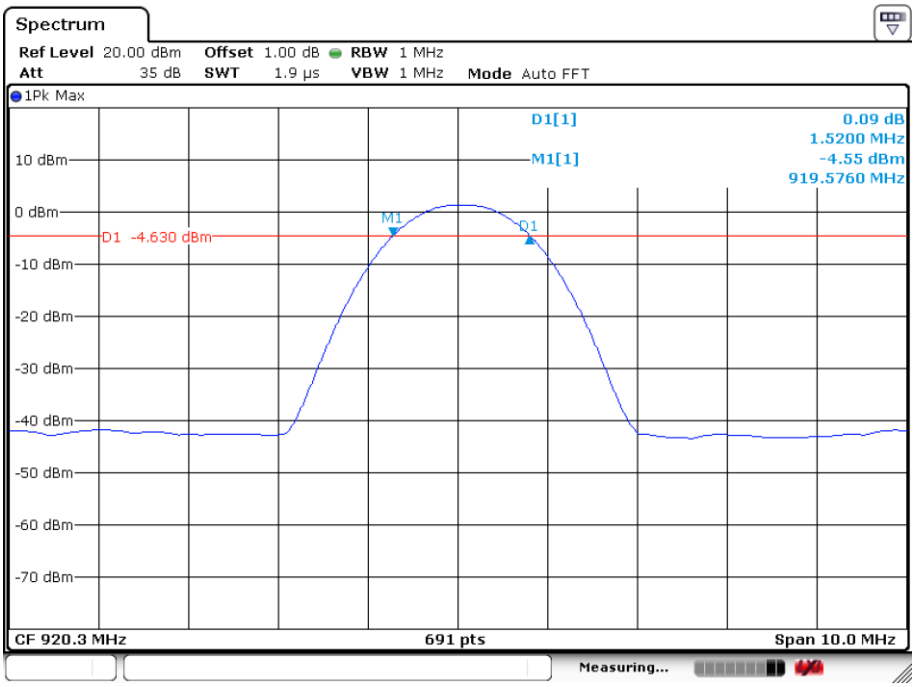


Figure 1: Measurement setup for the carrier frequency separation

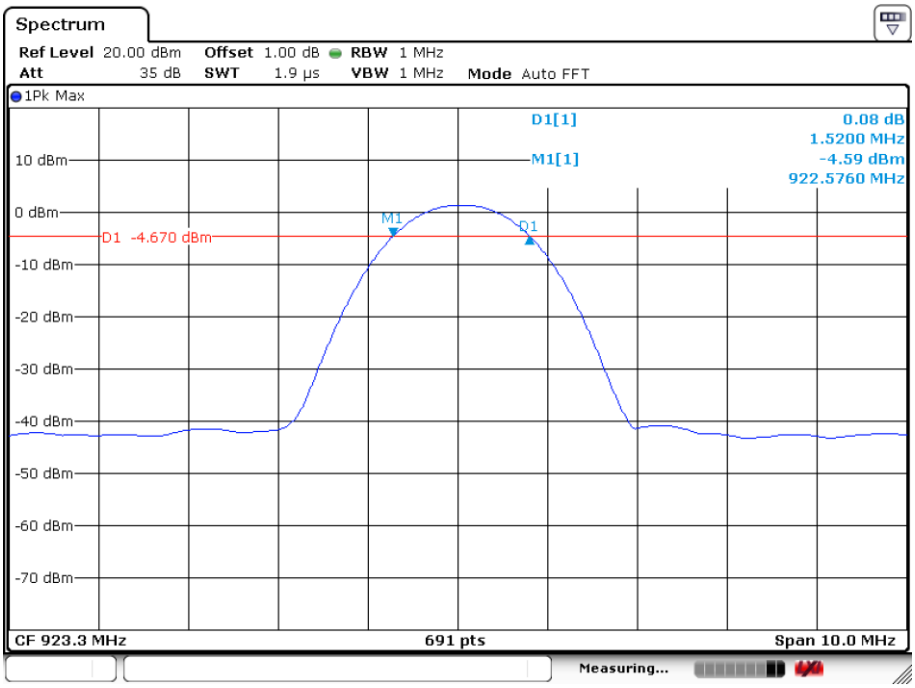
Ch1



Ch17



Ch32



3.2.2 Peak Output Power Measurement

Procedure:

*The testing follows FCC KDB Publication No. 558074 D01 V03 R03 and TCB Workshop 2012, April.

The maximum peak output power was measured with the spectrum analyzer connected to the antenna output of the EUT. The spectrum analyzer's internal channel power integration function is used to integrate the power over a bandwidth greater than or equal to the 99% bandwidth. The EUT was operating in transmit mode at the appropriate center frequency.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 1 MHz Span = auto

VBW = 1 MHz (VBW ≥ RBW) Sweep = auto

Detector function = peak

Measurement Data: Port 1

Mode	Frequency (MHz)	Channel No.	Test Results	
			Measured Data (dBm)	Result
Normal	917.3	1	1.51	Complies
	920.3	17	1.49	Complies
	923.3	32	1.51	Complies

Minimum Standard:

Peak output power	< 1 W

Measurement Setup

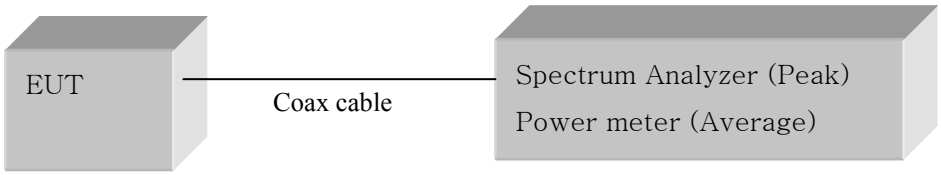
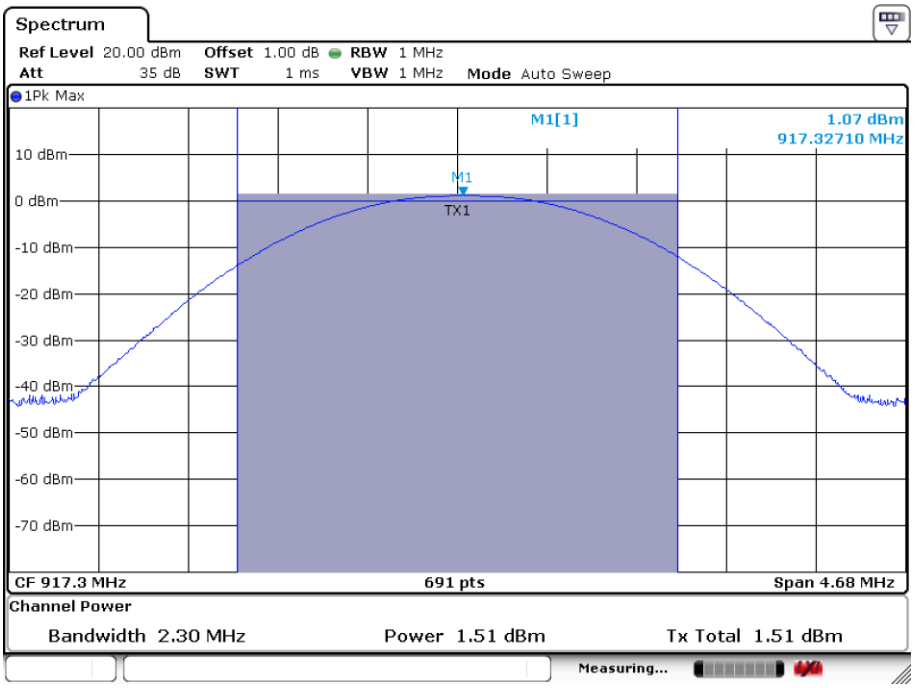
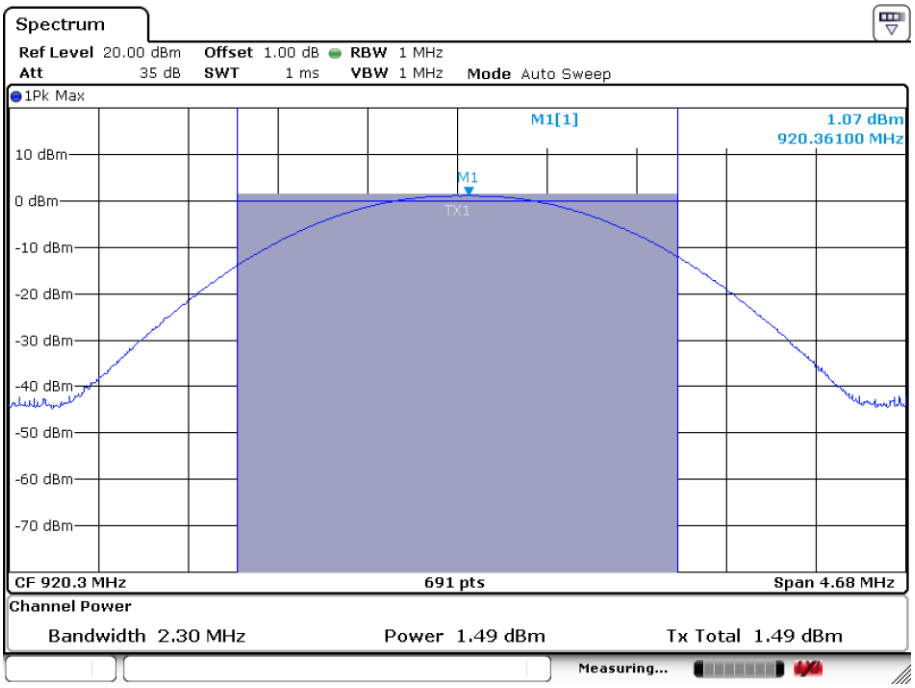


Figure 2: Measurement setup for the carrier frequency separation

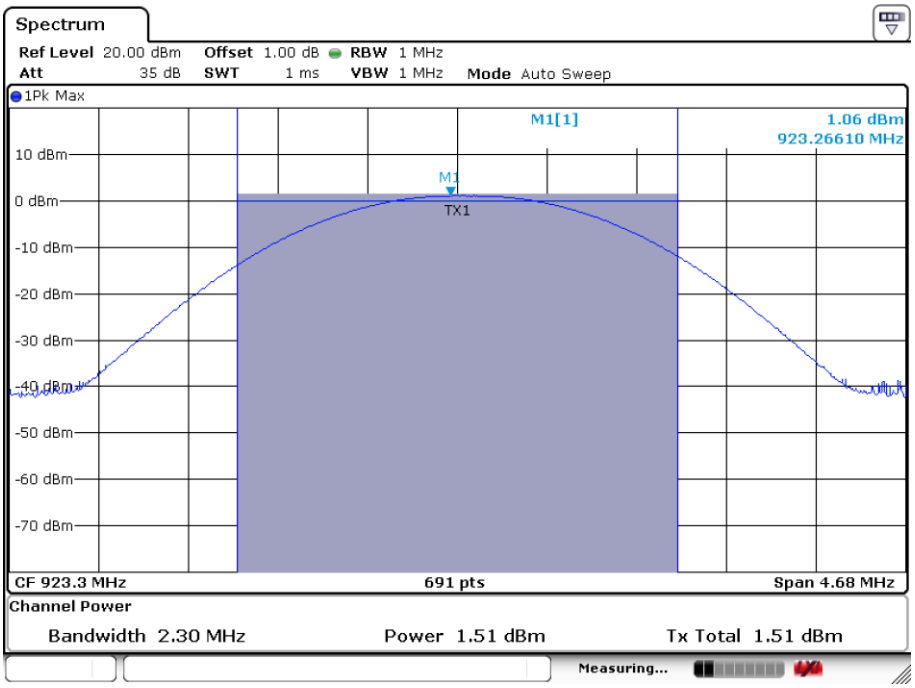
CH1



CH17



CH32


Spectrum
Ref Level 20.00 dBm Offset 1.00 dB RBW 1 MHz
Att 35 dB SWT 1 ms VBW 1 MHz Mode Auto Sweep
1Pk Max
M1[1]
1.06 dBm
923.26610 MHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
TX1
CF 923.3 MHz
691 pts
Span 4.68 MHz
Channel Power
Bandwidth 2.30 MHz
Power 1.51 dBm
Tx Total 1.51 dBm
Measuring...

3.2.3 Power Spectral Density

Procedure:

*The testing follows FCC KDB Publication No. 558074 D01 V03 R03 and TCB Workshop 2012, April.

The peak power density is measured with a spectrum analyzer connected to the antenna terminal while the EUT is operating in transmission mode at the appropriate frequencies.

The spectrum analyzer is set to:

RBW = 3 kHz — Span = 300 kHz

VBW = 3 kHz — Sweep = 100 sec

Detector function = peak — Trace = max hold

Measurement Data: Port 1

Mode	Frequency (MHz)	Channel No.	Test Results	
			dBm/3kHz	Result
Normal	917.3	1	-1.57	Complies
	920.3	17	-1.57	Complies
	923.3	32	-1.58	Complies

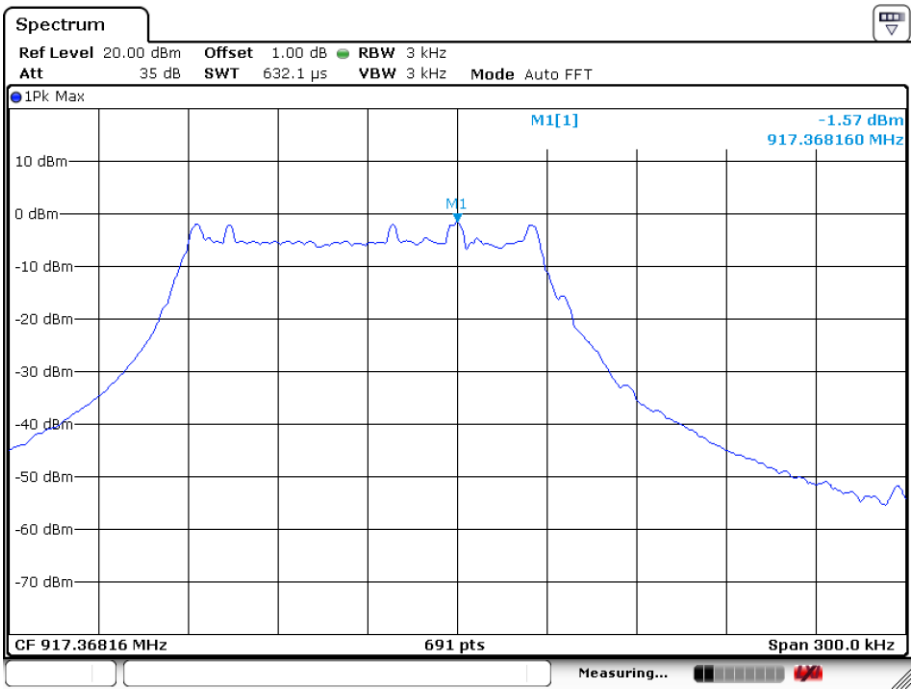
Minimum Standard:

Power Spectral Density	< 8dBm @ 3kHz BW

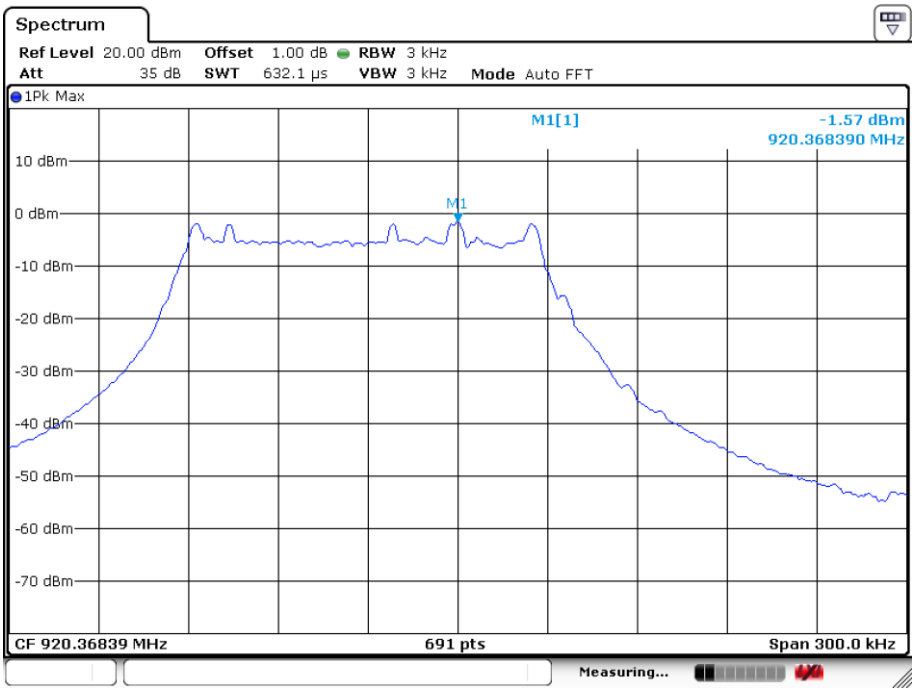
Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

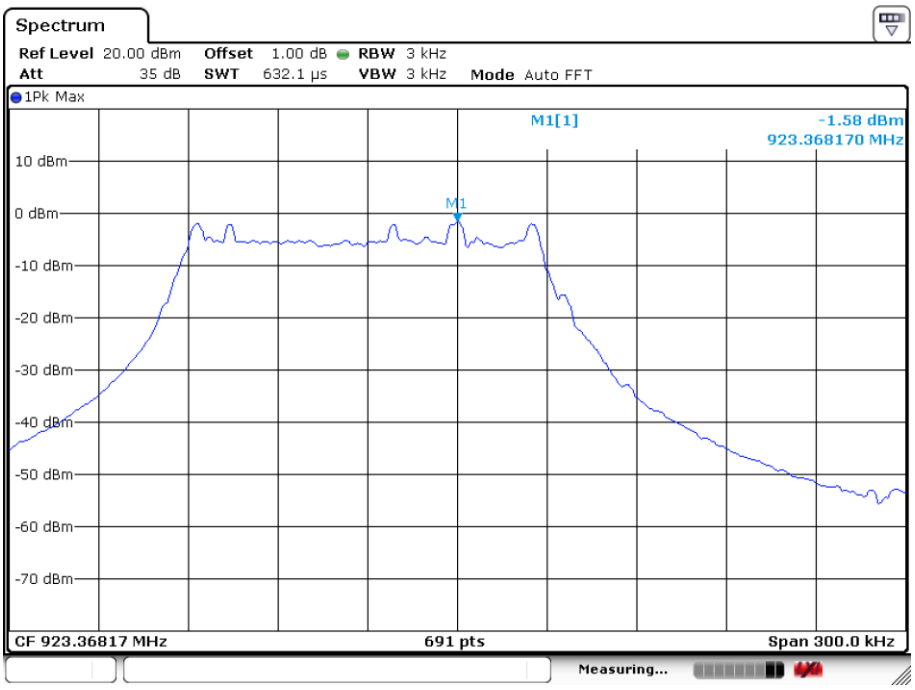
CH1



CH17



CH32


Spectrum
Ref Level 20.00 dBm Offset 1.00 dB RBW 3 kHz
Att 35 dB SWT 632.1 µs VBW 3 kHz Mode Auto FFT
1Pk Max
M1[1]
-1.58 dBm
923.368170 MHz
10 dBm
0 dBm
-10 dBm
-20 dBm
-30 dBm
-40 dBm
-50 dBm
-60 dBm
-70 dBm
M1
CF 923.36817 MHz
691 pts
Span 300.0 kHz
Measuring...

3.2.4 Band Edge

Procedure:

*The testing follows FCC KDB Publication No. 558074 D01 V03 R03 and TCB Workshop 2012, April.

The bandwidth at 20dB down from the highest inband spectral density is measured with a spectrum analyzer connected to the antenna terminal, while EUT is operating in transmission mode at the appropriate frequencies.

After the trace being stable, Use the marker-to-peak function to measure 20 dB down both sides of the intentional emission.

The spectrum analyzer is set to:

Center frequency = the highest, middle and the lowest channels

RBW = 100 kHz	VBW = 100 kHz
Span = 2 MHz ~ 5 MHz	Detector function = peak
Trace = max hold	Sweep = auto

Measurement Data: Complies

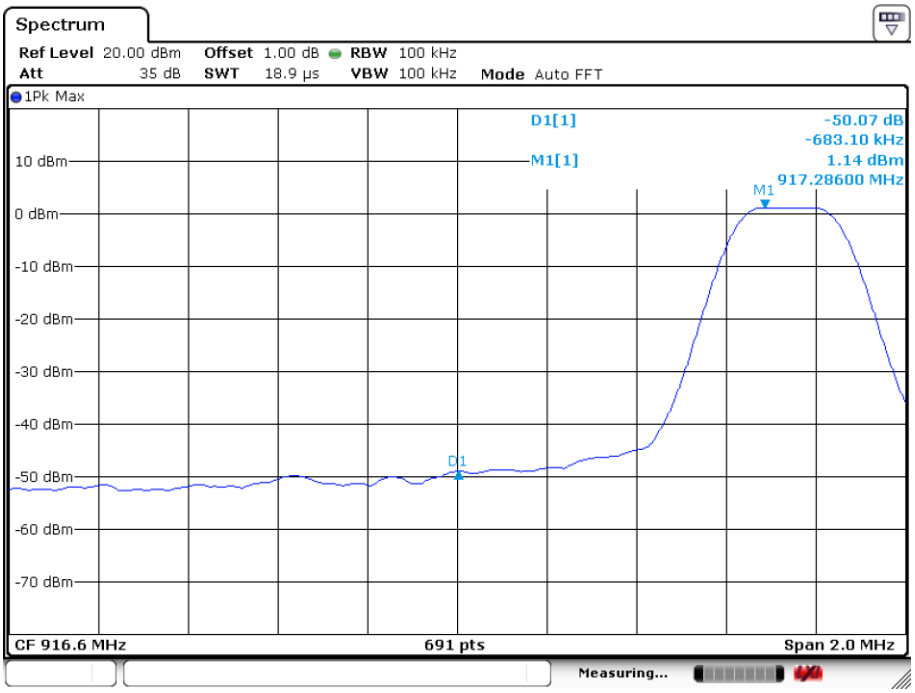
- All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest inband spectral density. Therefore the applying equipment meets the requirement.
- See next pages for actual measured spectrum plots.

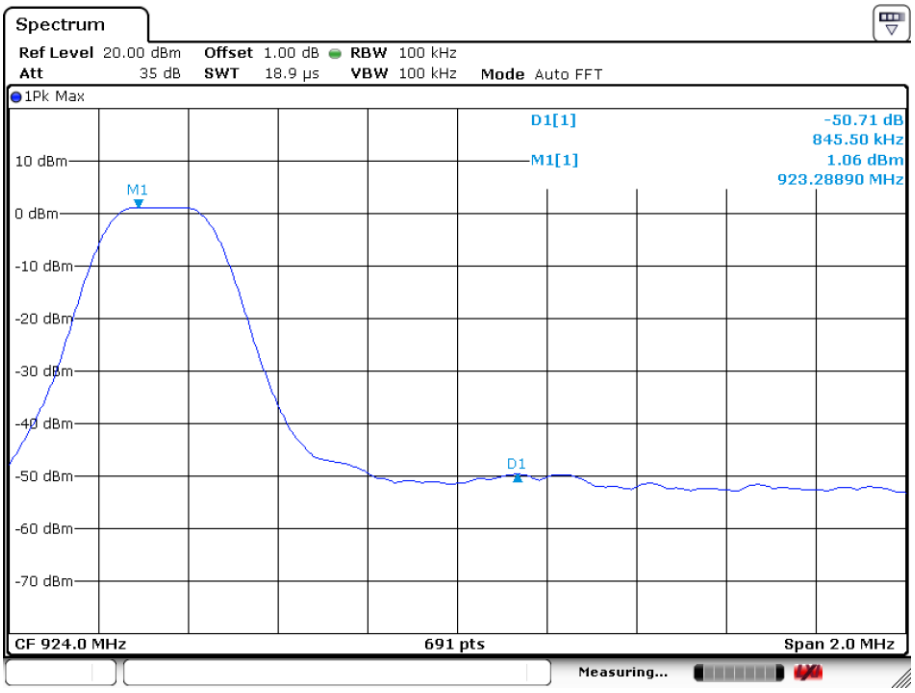
Minimum Standard:	> 20 dBc

Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

Normal Band Edge : Conducted Measurements





3.3.5 Conducted Spurious Emissions

Procedure:

The test follows FCC KDB Publication No. 558074 D01 V03 R03 The conducted spurious emissions were measured with a spectrum analyzer connected to the antenna terminal, while EUT had its hopping function disabled at the highest, middle and the lowest available channels..

After the trace being stable, set the marker on the peak of any spurious emission recorded.

The spectrum analyzer is set to:

Span = wide enough to capture the peak level of the in-band emission and all spurious emissions

RBW = 100 kHz Sweep = auto

VBW = 100 kHz Detector function = peak

Trace = max hold

Measurement Data: Complies

- All conducted emission in any 100 kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest inband spectral density. Therefore the applying equipment meets the requirement.
- See next pages for actual measured spectrum plots.

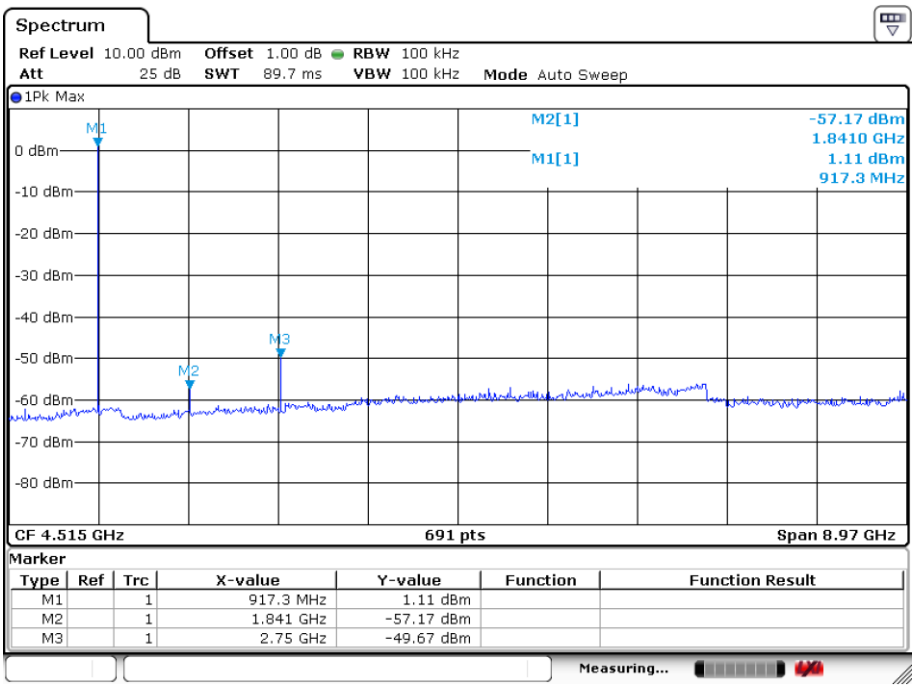
Minimum Standard:	> 20 dBc

Measurement Setup

Same as the Chapter 3.2.1 (Figure 1)

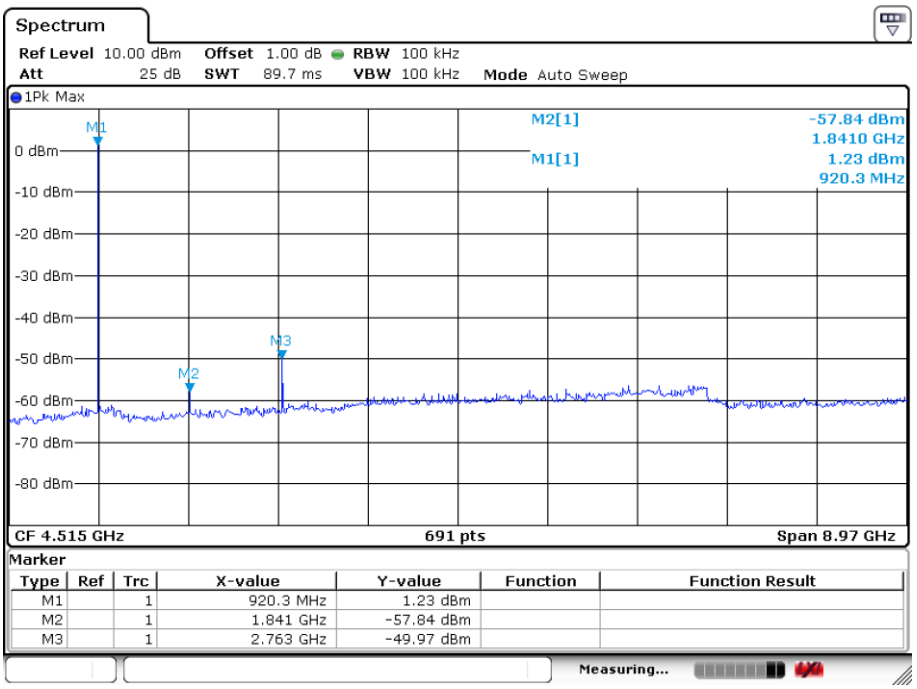
CH1

Frequency Range = 30 MHz ~ 10th harmonic



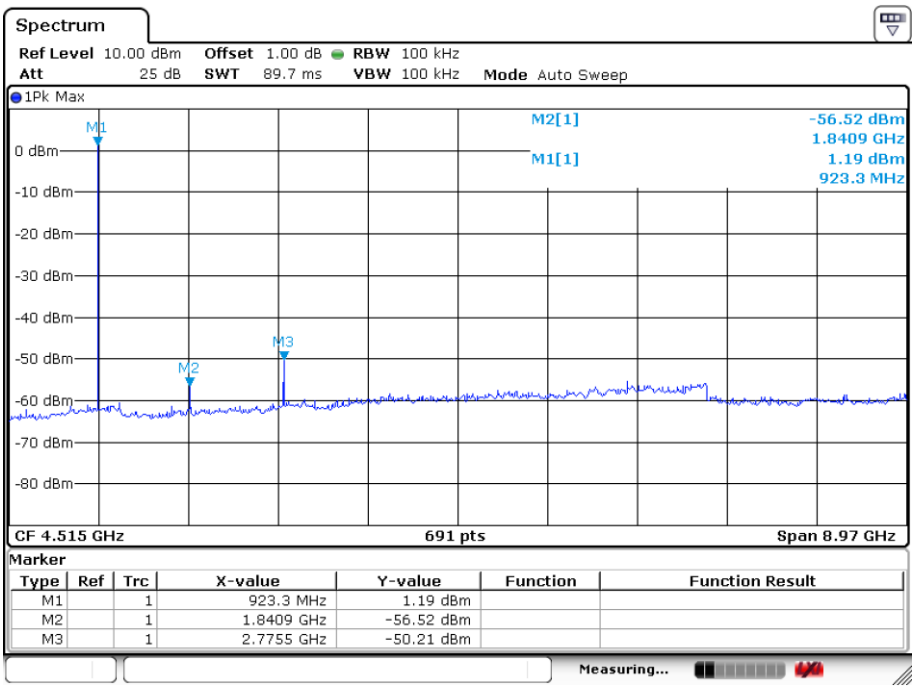
CH17

Frequency Range = 30 MHz ~ 10th harmonic



CH32

Frequency Range = 30 MHz ~ 10th harmonic



3.3.8 Radiated Spurious Emissions

Procedure:

Radiated emissions from the EUT were measured according to the dictates of DA00-705. The EUT was placed on a 0.8m high wooden table inside a shielded enclosure. An antenna was placed near the EUT and measurements of frequencies and amplitudes of field strengths were recorded for reference during final measurements. For final radiated testing, measurements were performed in OATS. Measurements were performed with the EUT oriented in 3 orthogonal axis and rotated 360 degrees to determine worst-case orientation for maximum emissions.

(a) In the frequency range of 9kHz to 30 MHz, magnetic field is measured with Loop Test Antenna. The Test Antenna is positioned with its plane vertical at 3m distance from the EUT. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.

(b) In the frequency range above 30MHz, Bi-Log Test Antenna (30MHz to 1GHz) and Horn Test Antenna (above 1GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emission levels at both horizontal and vertical polarizations should be tested.

The spectrum analyzer is set to:

Center frequency = the worst channel

Frequency Range = 9 kHz ~ 10th harmonic.

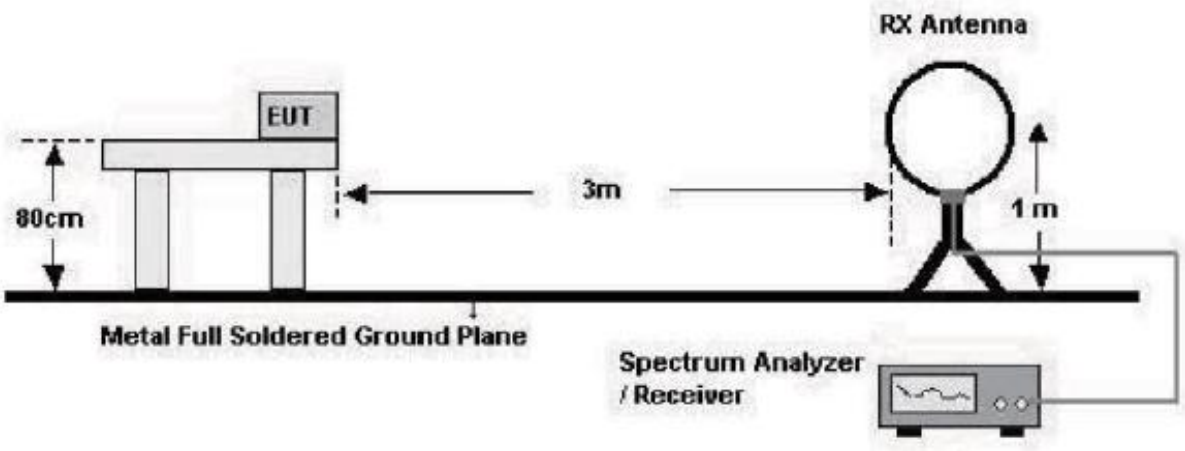
RBW = 120 kHz (30MHz ~ 1 GHz) VBW ≥ RBW

= 1 MHz (1 GHz ~ 10th harmonic)

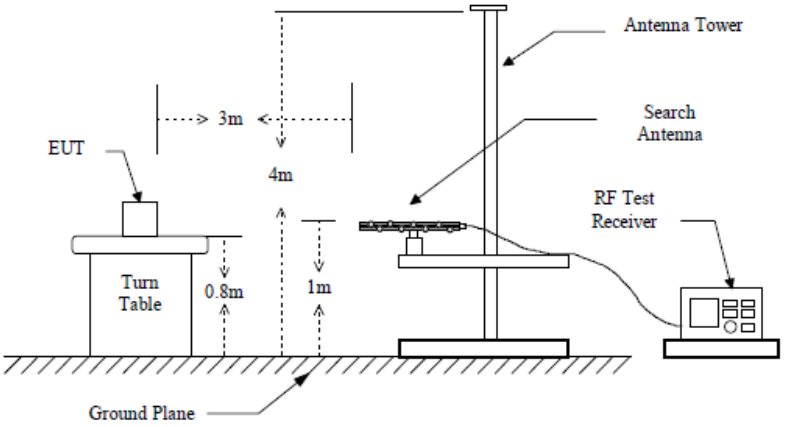
Span = 100 MHz Detector function = peak

Trace = max hold Sweep = auto

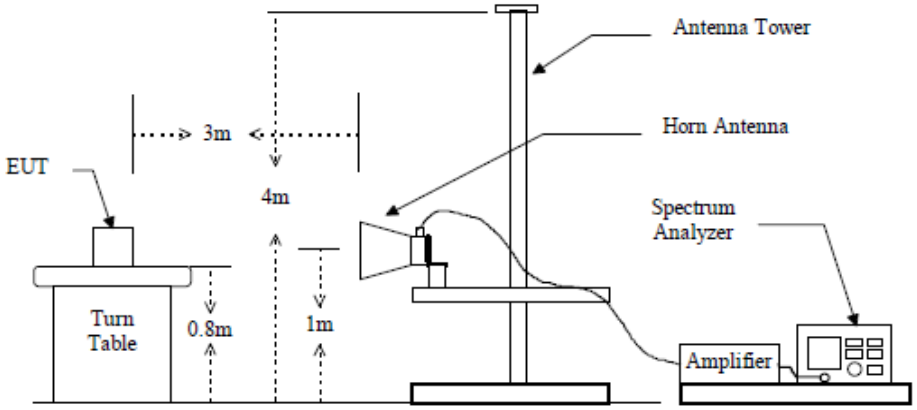
below 30MHz



below 1GHz (30MHz to 1GHz)



above 1GHz



Measurement Data: **Complies**

- See next pages for actual measured data.
- No other emissions were detected at a level greater than 20dB below limit include from 9KHz to 30MHz.

Minimum Standard: FCC Part 15.209(a)

Frequency (MHz)	Limit (uV/m) @ 3m
0.009 ~ 0.490	2400/F(kHz) **(@ 300m)**
0.490 ~ 1.705	24000/F(kHz) **(@ 30m)**
1.705 ~ 30	30**(@ 30m)**
30 ~ 88	100 **
88 ~ 216	150 **
216 ~ 960	200 **
Above 960	500

** Except as provided in 15.209(g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88MHz, 174-216MHz or 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g. 15.231 and 15.241.

Measurement Data :

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor		Limits [dBuV/m] AV/Peak		Result [dBuV/m] AV/Peak		Margin [dB] AV / Peak	
				Antenna	Amp.Gain+Cable						
2431	27.4	41.4	V	24.8	25.4	54.0	74.0	26.8	40.8	27.2	33.2
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor		Limits [dBuV/m] AV/Peak		Result [dBuV/m] AV/Peak		Margin [dB] AV / Peak	
				Antenna	Amp.Gain+Cable						
2431	30.2	41.1	V	24.8	25.4	54.0	74.0	29.6	40.5	24.4	33.5
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

Frequency [MHz]	Reading [dBuV/m] AV / Peak		Pol.	Correction Factor		Limits [dBuV/m] AV/Peak		Result [dBuV/m] AV/Peak		Margin [dB] AV / Peak	
				Antenna	Amp.Gain+Cable						
2436	30.1	42.2	V	24.8	25.4	54.0	74.0	29.5	41.6	24.5	32.4
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-

- No other emissions were detected at a level greater than 20dB below limit.

Radiated Emissions

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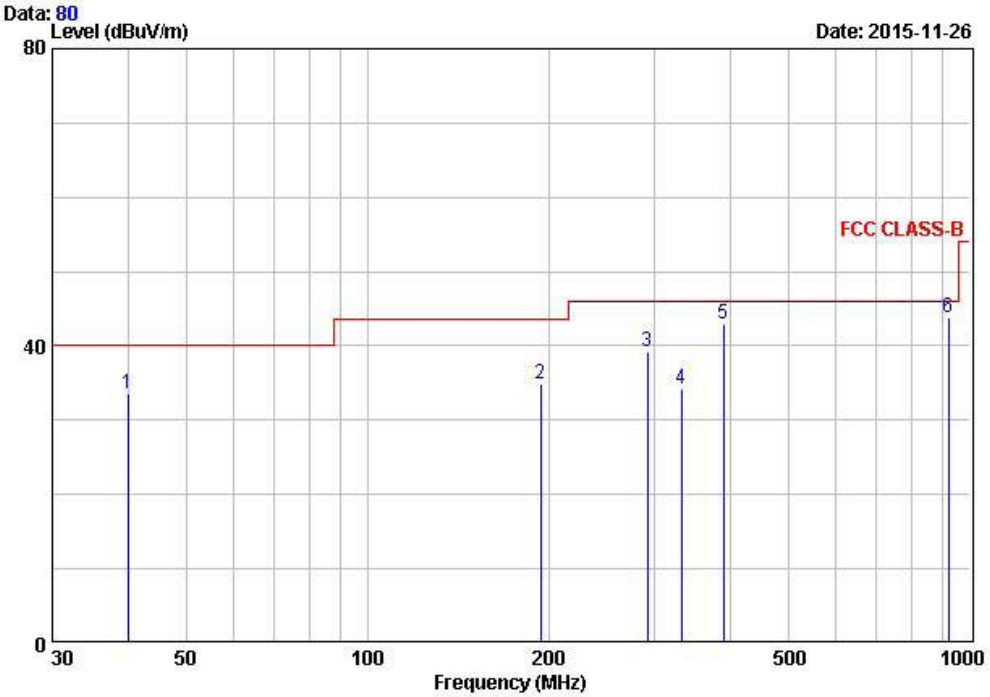
Tel :+82-31-3236008,9
Fax:+82-31-3236010

EUT/Model No.: MSM320 TEST MODE: RFID mode

Temp Humi : 15 / 33 Tested by: Y00 B C



	Freq	Reading	C.F	Result	Limit QP	Margin	Height	Angle	Polarity
	MHz	dBuV/m	dB/m	dBuV/m	dBuV/m	dB	cm	deg	
1	40.11	51.20	-17.59	33.61	40.00	6.39	100	131	VERTICAL
2	194.15	51.60	-16.81	34.79	43.50	8.71	171	219	HORIZONTAL
3	292.02	52.10	-12.95	39.15	46.00	6.85	222	324	HORIZONTAL
4	332.52	46.20	-11.91	34.29	46.00	11.71	228	293	HORIZONTAL
5	390.31	53.20	-10.31	42.89	46.00	3.11	333	335	HORIZONTAL
6	920.12	41.40	2.50	43.90	46.00	2.10	167	91	HORIZONTAL

Remarks: C.F (Correction Factor) = Antenna factor + Cable loss - Preamp gain

3.3.9 AC Conducted Emissions

Procedure:

AC power line conducted emissions from the EUT were measured according to the dictates of ANSI C63.4:2003. The conducted emissions are measured in the shielded room with a spectrum analyzer in peak hold. While the measurement, EUT had its hopping function disabled at the middle channels in line with Section 15.31(m). Emissions closest to the limit are measured in the quasi-peak mode (QP) with the tuned receiver using a bandwidth of 9 kHz. The emissions are maximized further by cable manipulation and Exerciser operation. The highest emissions relative to the limit are listed.

Measurement Data: Complies

- Refer to the next page.
- No other emissions were detected at a level greater than 20dB below limit
- It gave the worse case emissions

Minimum Standard: FCC Part 15.207(a)/EN 55022

Frequency Range (MHz)	Conducted Limit (dBuV)	
	Quasi-Peak	Average
0.15 ~ 0.5	66 to 56 *	56 to 46 *
0.5 ~ 5	56	46
5 ~ 30	60	50

* Note: The limits will decrease with the frequency logarithmically within 0.15MHz to 0.5MHz

Conducted Emissions -LINE

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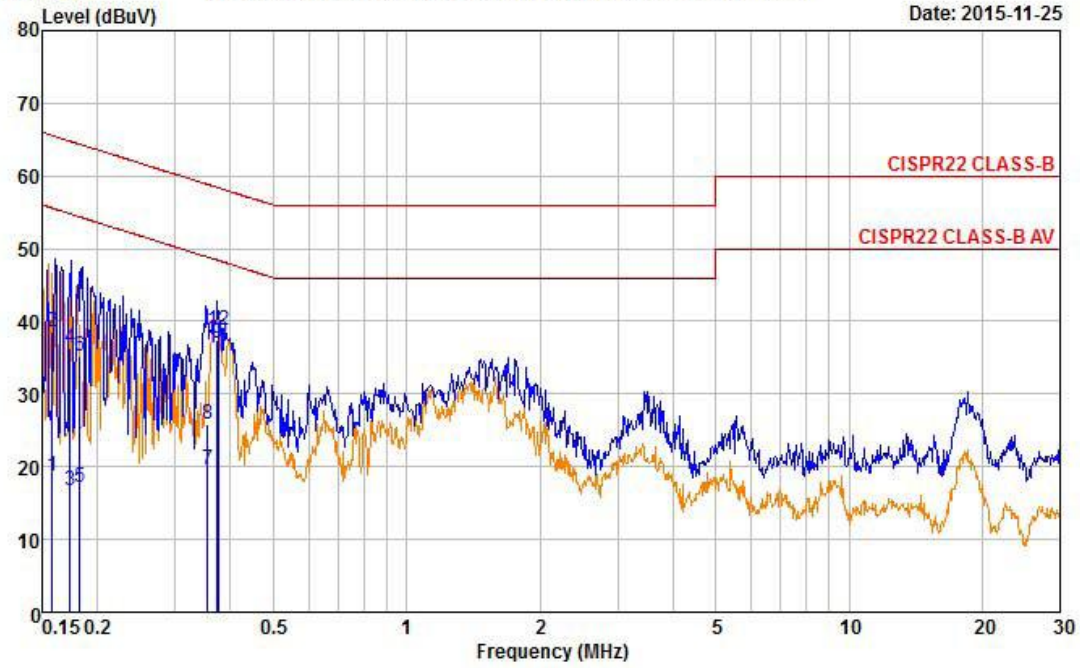
Fax:+82-31-3236010

EUT / Model No.	: MSM320	Phase	: LINE
Test Mode	: RFID mode	Test Power	: 120 / 60
Temp. / Humi.	: 27 / 39	Test Engineer	: YOO B C

Data: 955 File: D:\Conducted Data\2015\LTA_Conduction_2015_11.EM6 (975)



Freq	RD QP	RD AV	C.F	Result QP	Result AV	Limit QP	Limit AV	Margin QP	Margin AV
MHz	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dBuV	dB	dB
0.158	19.06	-0.92	19.55	38.61	18.63	65.56	55.56	26.95	36.93
0.173	16.88	-2.86	19.53	36.41	16.67	64.81	54.81	28.40	38.14
0.183	15.59	-2.37	19.52	35.11	17.15	64.37	54.37	29.26	37.22
0.356	6.41	0.24	19.44	25.85	19.68	58.83	48.83	32.98	29.15
0.373	17.98	17.47	19.43	37.41	36.90	58.44	48.44	21.03	11.54
0.375	19.36	16.79	19.43	38.79	36.22	58.39	48.39	19.60	12.17

Remarks: C.F (Correction Factor) = Insertion loss + Cable loss + Pulse Limiter

Conducted Emission – NEUTRAL

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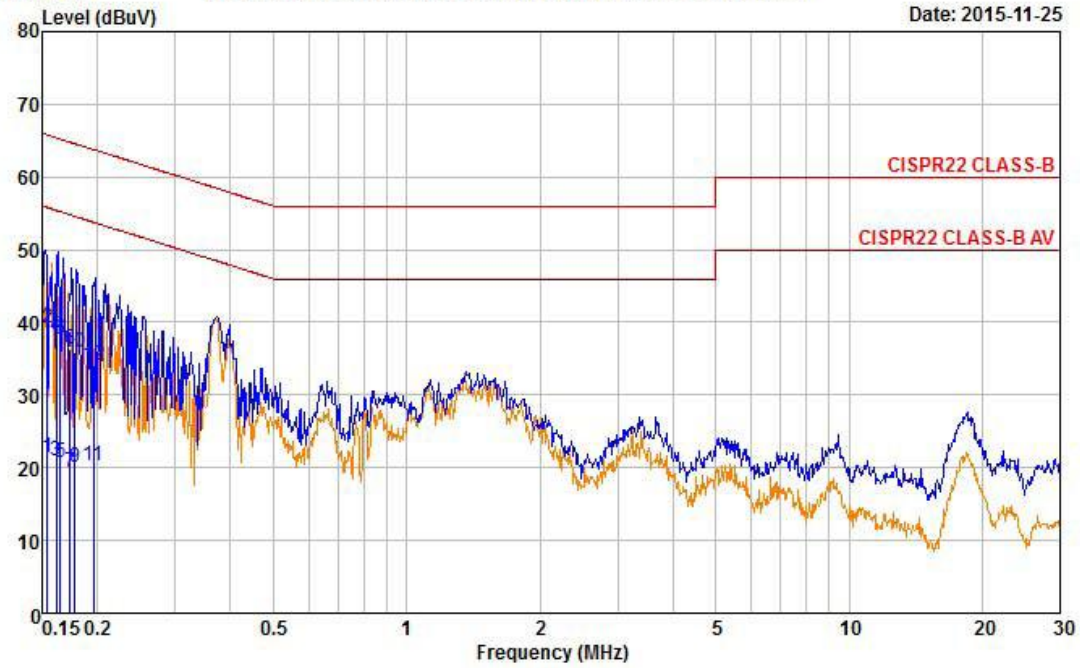
EUT / Model No.	: MSM320	Phase	: NEUTRAL
Test Mode	: RFID mode	Test Power	: 120 / 60
Temp. / Humi.	: 27 / 39	Test Engineer	: YOO B C

Data: 959 File: D:\Conducted Data\2015\LTA_Conduction_2015_11.EM6 (975)



Freq	RD QP	RD AV	C.F	Result QP	Result AV	Limit QP	Limit AV	Margin QP	Margin AV
MHz	dBuV	dBuV	dB	dBuV	dBuV	dBuV	dBuV	dB	dB
0.154	19.66	1.80	19.57	39.23	21.37	65.79	55.79	26.56	34.42
0.162	18.66	1.30	19.56	38.22	20.86	65.38	55.38	27.16	34.52
0.165	18.09	1.26	19.56	37.65	20.82	65.20	55.20	27.55	34.38
0.173	16.81	-0.18	19.54	36.35	19.36	64.81	54.81	28.46	35.45
0.178	16.40	0.61	19.54	35.94	20.15	64.59	54.59	28.65	34.44
0.196	14.68	0.70	19.51	34.19	20.21	63.80	53.80	29.61	33.59

Remarks: C.F (Correction Factor) = Insertion loss + Cable loss + Pulse Limiter

APPENDIX

TEST EQUIPMENT USED FOR TESTS

	Description	Model No.	Serial No.	Manufacturer	Interval	Last Cal. Date
1	Signal Analyzer (9kHz~30GHz)	FSV-30	100757	R&S	1 year	2015-03-24
2	Signal Generator (~3.2GHz)	8648C	3623A02597	HP	1 year	2015-03-23
3	SYNTHESIZED CW GENERATOR	83711B	US34490456	HP	1 year	2015-03-23
4	Attenuator (3dB)	8491A	37822	HP	1 year	2015-09-14
5	Attenuator (10dB)	8491A	63196	HP	1 year	2015-09-14
6	Test Receiver (~30MHz)	ESHS10	828404/009	R&S	1 year	2015-03-23
7	EMI Test Receiver (~7GHz)	ESCI7	100722	R&S	1 year	2015-09-15
8	RF Amplifier (~1.3GHz)	8447D OPT 010	2944A07684	HP	1 year	2015-09-14
9	RF Amplifier (1~26.5GHz)	8449B	3008A02126	HP	1 year	2015-03-23
10	Horn Antenna (1~18GHz)	3115	00114105	ETS	2 year	2015-04-21
11	DRG Horn (Small)	3116B	81109	ETS-Lindgren	2 year	2014-02-26
12	DRG Horn (Small)	3116B	133350	ETS-Lindgren	2 year	2014-02-26
13	TRILOG Antenna	VULB 9160	9160-3237	SCHWARZBECK	2 year	2015-04-21
14	Temp.Humidity Data Logger	SK-L200TH II A	00801	SATO	1 year	2015-04-03
15	Splitter (SMA)	ZFSC-2-2500	SF617800326	Mini-Circuits	-	-
16	Power Divider	11636A	06243	HP	1 year	2015-09-14
17	DC Power Supply	6674A	3637A01657	Agilent	-	-
18	Frequency Counter	5342A	2826A12411	HP	1 year	2015-03-23
19	Power Meter	EPM-441A	GB32481702	HP	1 year	2015-03-23
20	Power Sensor	8481A	3318A99464	HP	1 year	2015-01-13
21	Audio Analyzer	8903B	3729A18901	HP	1 year	2015-09-14
22	Modulation Analyzer	8901B	3749A05878	HP	1 year	2015-09-15
23	TEMP & HUMIDITY Chamber	YJ-500	LTAS06041	JinYoung Tech	1 year	2015-09-14
24	Stop Watch	HS-3	812Q08R	CASIO	2 year	2014-04-03
25	LISN	KNW-407	8-1430-1	Kyoritsu	1 year	2015-09-14
26	Two-Lime V-Network	ESH3-Z5	893045/017	R&S	1 year	2015-03-23
27	UNIVERSAL RADIO COMMUNICATION TESTER	CMU200	106243	R&S	1 year	2015-03-23
28	Highpass Filter	WHKX1.5/15G-10SS	74	Wainwright Instruments	1 year	2015-03-30
29	Highpass Filter	WHKX3.0/18G-10SS	118	Wainwright Instruments	1 year	2015-03-30
30	Active Loop Antenna	FMZB1519	1519-031	SCHWARZBECK	1 year	2015-01-06
31	OSP120 BASE UNIT	OSP120	101230	R&S	1 year	2015-03-23
32	Signal Generator(100kHz~40GHz)	SMB100A03	177621	R&S	1 year	2015-03-24
33	Signal Analyzer (10Hz~40GHz)	FSV40	101367	R&S	1 year	2015-03-24