TEST REPORT

Report Number		RAPA13-O-335
Type of Equipment		Mobile radio for vehicle (Two way radio land mobile service)
Model Name		SM-2102E
FCC ID		RXUSM-2102E
IC Number		153B-SM2102E
Applicant	Name	Maxon CIC Corp.
	Logo	maxon cic
	Address	Chongho Building, #7-61 Yangjae-Dong, Seocho-Gu, Seoul, 137-130, Korea
Manufacturer	Name	Maxon CIC Thailand Co., Ltd(MCTL)
	Address	40/23 Moo 5 Rojana Industrial Park Tambol U-Thai, Amphur U-Thai Ayutthaya 13210 Thailand
Test duration		May 14, 2013 to May 30, 2013
Date of issue		June 04, 2013
Total Page		55 pages (including this page)

SUMMARY

The equipment complies with FCC CFR 47 Part 90 and IC RSS-119.

This test report contains only the results of a single test of the sample supplied for the examination.
It is not a general valid assessment of the features of the respective products of the mass-production.

Date : June 04, 2013

Prepared and tested by Tae Yang, Yoon
Manager /TCA of RAPA

Date : June 04, 2013

Reviewed by SuKil, Park
Executive Managing Director/TCA of RAPA

CONTENTS

1. General description of EUT

1.1 Applicant

• Company name	:	Maxon CIC Corp.
• Address	:	Chongho Building, #7-61 Yangjae-Dong, Seocho-Gu, Seoul, 137-130, Korea
• Contact person	:	Choong Kyun Kim
• Phone/Fax	:	82-2-3498-3041 / 82-2-3498-3113

1.2 Manufacturer

• Company name	:	Maxon CIC Thailand Co., Ltd(MCTL)
• Address	:	40/23 Moo 5 Rojana Industrial Park Tambol U-Thai, Amphur U-Thai Ayutthaya 13210 Thailand
• Phone / Fax	:	66-35-719-498 / 66-35-719-492

1.3 Basic description of EUT

• Product name	:	Mobile radio for vehicle (Two way radio land mobile service)
• Model name	:	SM-2102E
• Frequency	:	136 MHz – 174 MHz
• Output power	:	25 W / 5 W
• Modulation method	:	FM (11k0F3E)
• FCC Rule Part(s)	:	FCC Part 90 / Private land mobile radio services
• IC Rule Part(s)	:	IC RSS-119 / Land mobile and fixed radio transmitters and receivers, 27.4 MHz to 960 MHz
• FCC classification	:	TNB : Licensed non-broadcast station transmitter
• IC classification	:	Land-mobile transmitter and receiver
• Test duration	:	May 14, 2013 to May 30, 2012
• Date of issue	:	June 04, 2013
• Place of test	:	Head office 824, B104, Anyang Megavalley, 799, Gwanyang-dong, Dongan-gu, Anyang-si, Gyeonggi-do, 483-060, Korea Open area test site 80, Jeil-ri, Yangji-myun, Cheoin-gu, Yongin-si, Gyeonggi-do, 449-825, Korea, (FCC Registration Number : 337229) (IC Submission Number : 143881) (KCC Designation Number : KR0027)

1.4 Electrical specification

Item	Specifications
General	
Equipment type	For vehicle
Band	UHF
Channel spacing	12.5 kHz, programmable
RF output power	25 watt / 5 watt
Modulation type	F3E
Audio power	6 W (Ext with 8 ohm)
Intermediate frequency	46.35 MHz & 450 kHz
Number of channels	99
Frequency source	Synthesizer
Operation rating	Intermittent 90:5:5 (Standby : RX:TX)
Power supply	13.6 volts DC nominal (12-volt, negative ground vehicle electrical system)
Temperature range	
Storage	From -40 ℃ to +80 ℃
Operating.	From -30 ℃ to +60 ℃
Current consumption	
Standby	< 200 mA
Receive	< 1.0 A
Transmit 25 Watt RF power	< 6.0 A
Frequency bands	
RX	136 ~ 174 MHz
TX	136 ~ 174 MHz
Mechanical	
Dimensions (H x W x D)	41 x 139 x 170 mm
Weight	1 200 g

1.5 EUT operating conditions & test configuration

1.5.1 Client Condition

- Temperature : -30 ℃ ~ +60 ℃
- Humidity : 95 %

1.5.2 EUT Operating Condition

- Operating Mode : Transmitter was operated in a continues transmission mode with the carrier modulated as specified in the test data.
- TX Frequency Band : 136 MHz ~ 174 MHz
- Test Frequencies : 1st ; 136 MHz, 2nd ; 155 MHz, 3 rd ; 174 MHz
- Modulation : FM Modulation
- Modulation Signal Source : External Source

1.6 DC Voltage and Currents

The DC voltages applied to and DC currents into the several elements of the final radio frequency amplifying stage for normal operation over power range were;

- Standby: 13.2 Vdc, 200 mA
- Receive: 13.2 Vdc, 1 A
- Low power: 13.2 Vdc, 3 A
- High power: 13.2 volts, 6 A

1.7 Emission Designator

- Type of emission : F3E
- Necessary Bandwidth and Emission Bandwidth:
  - 12.5 kHz (Narrow Band) : Bn = 11K0F3E
- Calculation:
  - Maximum Modulation(M) in kHz : 3
  - Maximum Deviation(D) in kHz : 2.5(NB) and 5(WB)
  - Constant Factor(k) : 1
  - Bn = 2M + 2DK

2. General information of test

2.1 Standard for measurement methods

Applied Standard : FCC CFR47 Part 90 IC RSS-119 Issue 11 June 2011			
FCC	**IC**	**Description of Test**	**Result**
15.209	RSS-Gen 6.1	Radiated emission	Pass
2.1046	5.4	RF power output (conducted)	Pass
2.1049	5.5	Occupied bandwidth	Pass
2.1047(a)	5.13	Audio frequency response	Pass
2.1047(a)	5.13	Audio low pass filter response	Pass
2.1047(b)	5.13	Modulation limiting	Pass
2.1051	5.8	Spurious emissions at antenna terminals	Pass
2.1053	5.8	Field strength of spurious radiation	Pass
2.1055	5.3	Frequency stability	Pass
90.214	5.9	Transient Frequency Behavior	Pass

2.2 Description of EUT modification

During the test, there was no mechanical or circuitry modification to improve any RF specification including spurious characteristic, and any RF and spurious suppression device(s) were not added against the device tested.

2.3 Description of test system configuration

• Peripheral equipment used;

Description	Model Name	Serial No.	Manufacturer	FCC ID
EUT	SM-2102E	Proto Type	Maxon CIC	-
Test Fixer	JIG	Proto Type	Maxon CIC	-

• Cables used;

Device from	Device to	Type of Cable	Type of Connecter	Length
EUT	Attenuator	RF Cable	N Type	0.5 m
Attenuator	Spectrum Analyzer	RF Cable	N Type	3.0 m
Test Fixer	Modulation Analyzer	BNC to Audio	8 Ω	0.5 m
Audio Analyzer	Test Fixer	BNC to Audio	8 Ω	0.5 m

3. Measurement data

3.1 Radiated emission

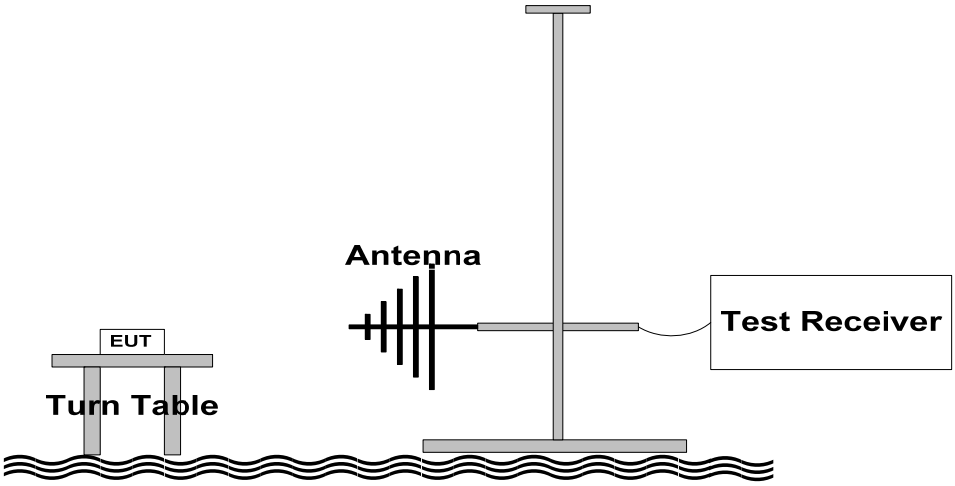
3.1.1 Specification

- FCC Rules Part 15 Section 15.209
- IC Rules RSS-Gen Issue 3 January 2012, Section 6.1

3.1.2 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.12

3.1.3 Set-Up



3.1.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Spectrum analyzer	FSV	R&S
Power supply	E3633A	Agilent
Bi-conical antenna	VHA9103	Schwarzbeck
Log periodic antenna	VULP9118A	Schwarzbeck
Horn antenna	BBHA-9120D	Schwarzbeck
Pre-amplifier	SCU-01	R&S
Pre-amplifier	JS4-00102600	MITEQ

3.1.5 Test condition

- Test place : OATS
- Test environment : 12 °C, 38 % R.H.
- Test mode : RX mode

3.1.6 Test result

Frequency [MHz]	Polarization [H/V]	Detect Mode [Peak/QP/AVG]	Reading [dBμV]	Antenna Factor [dB/m]	Cable Loss [dB]	Pre-Amp Gain [dB]	Emission Level [dBμV]	Limit [dBμV]	Margin [dB]
Operation frequency 136 MHz									
119.24	H	Peak	14.4	13.0	1.4	-	28.9	43.5	14.6
179.38	H	Peak	13.4	16.2	1.7		30.7		12.8
203.63	H	Peak	12.7	16.6	1.8		31.9		11.6
Operation frequency 155 MHz									
119.24	H	Peak	14.4	13.0	1.4	-	28.9	43.5	14.6
203.63	V	Peak	13.4	16.6	1.8		31.9		11.6
Operation frequency 174 MHz									
119.24	H	Peak	13.9	13.0	1.4		28.3	43.5	15.2

Remarks:

1. * H : Horizontal polarization , ** V : Vertical polarization
2. Emission Level = Reading + Antenna factor + Cable loss
3. Margin value = Emission Level - Limit
4. All other emissions not reported were more than 25 dB below the permitted limit.
5. Measurement uncertainty estimated at ±3.90 dB.

The measurement uncertainty is given with a confidence of 95.45 % with the coverage factor, k=2.

3.2 RF power output (conducted)

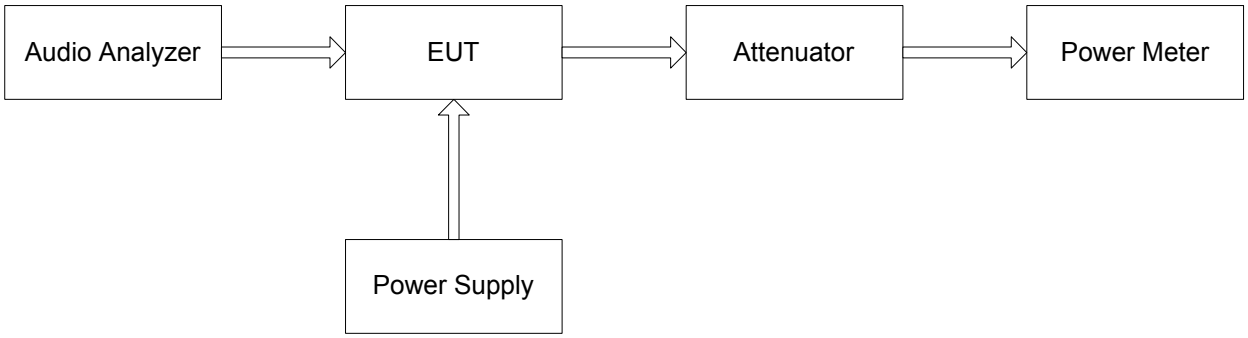
3.2.1 Specification

- FCC Rules Part 2 Section 2.1046
- FCC Rules Part 90 Section 90.205
- IC Rules RSS-119 Section 6.2

3.2.2 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.1

3.2.3 Set-Up



3.2.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Power supply	E3633A	Agilent
Spectrum Analyzer	FSV	R&S
Attenuator	66-30-34	Weinschel

3.2.5 Test condition

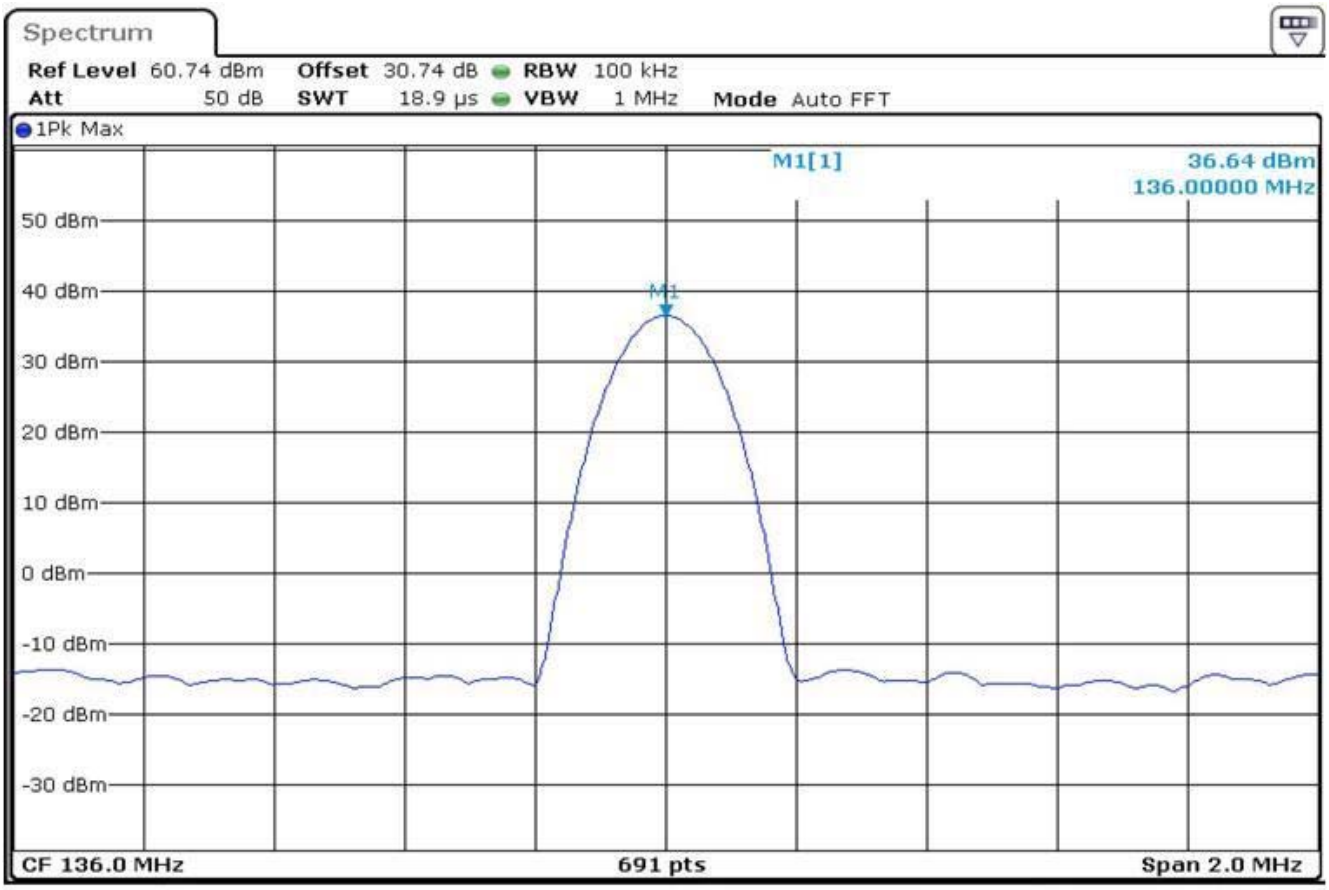
- Test place : Shield Room
- Test environment : 22 °C, 43 % R.H.
- Test mode : TX mode (Non-modulation)

3.2.6 Test result

Frequency [MHz]	Measured power [dBm]	Measured power [W]
Low power (Reference : 5 W)		
136.0	36.64	4.61
155.0	36.81	4.79
174.0	36.76	4.74
High power (Reference : 25 W)		
136.0	43.72	23.55
155.0	43.75	23.71
174.0	43.86	24.32

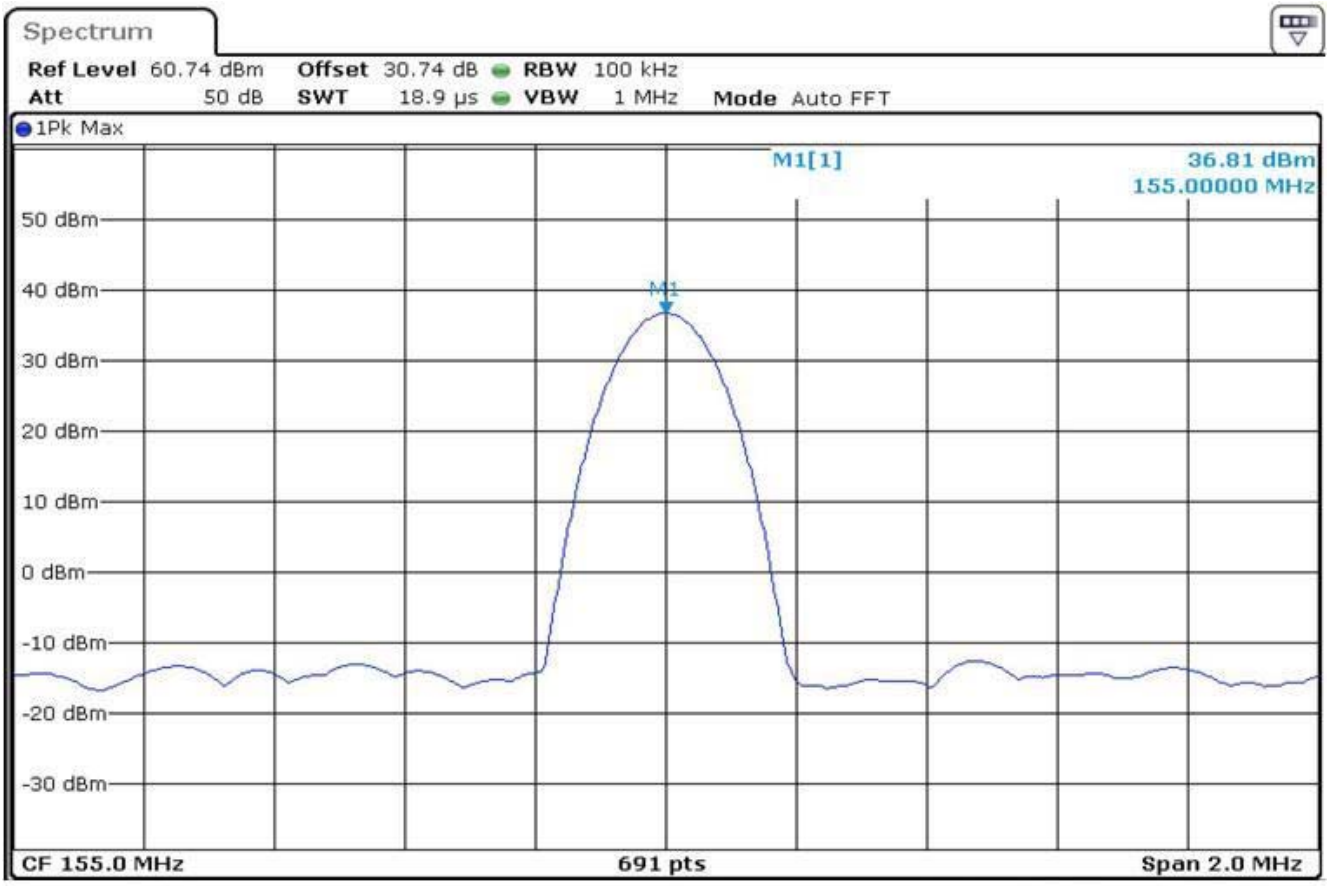
3.2.7 Plots of output power

3.2.7.1 Low power / 136 MHz



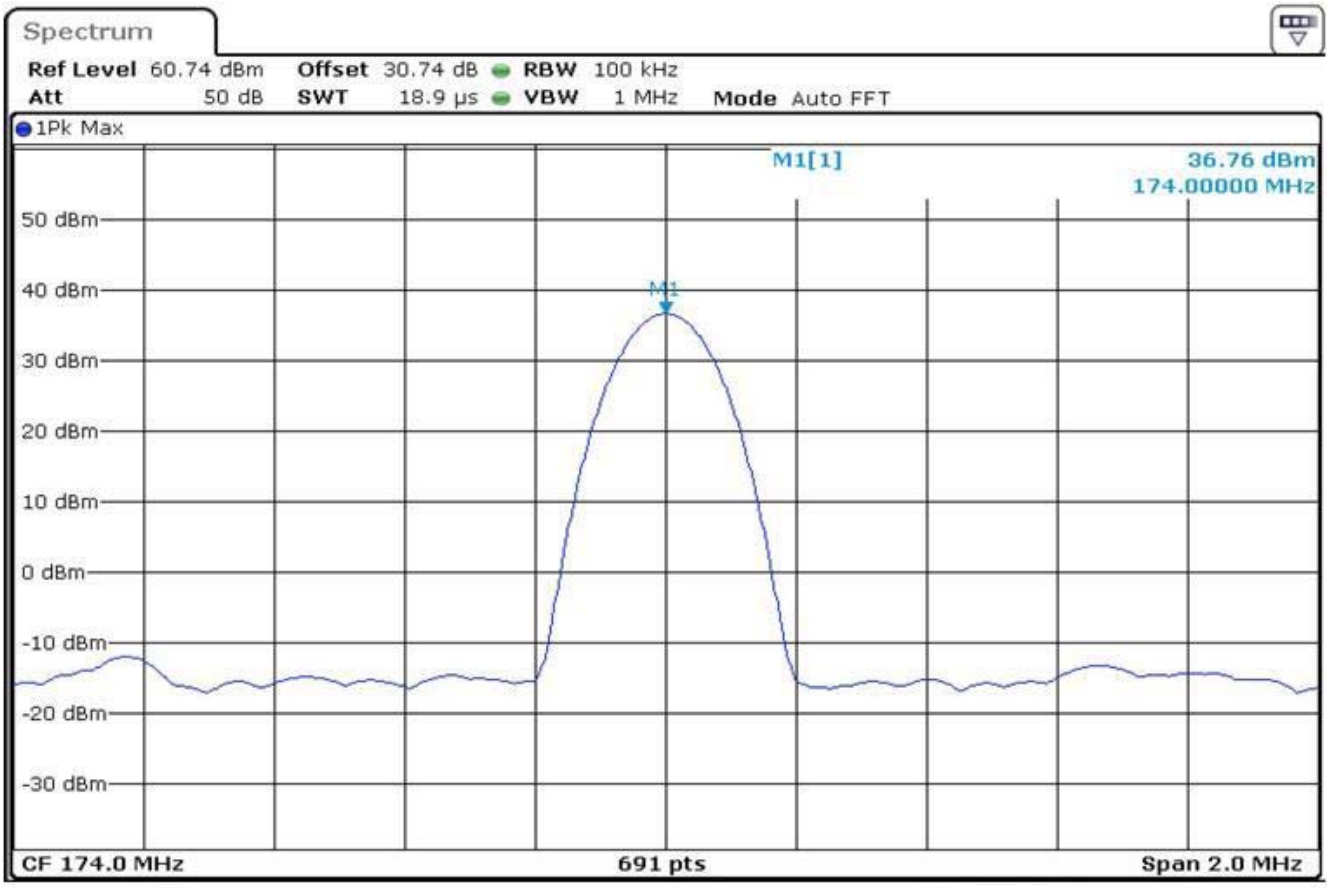
• Test Condition : Operating frequency = 136 MHz / Power setting = Low power
• Test .Result : Output power = 36.64 dBm

3.2.7.2 Low power / 155 MHz



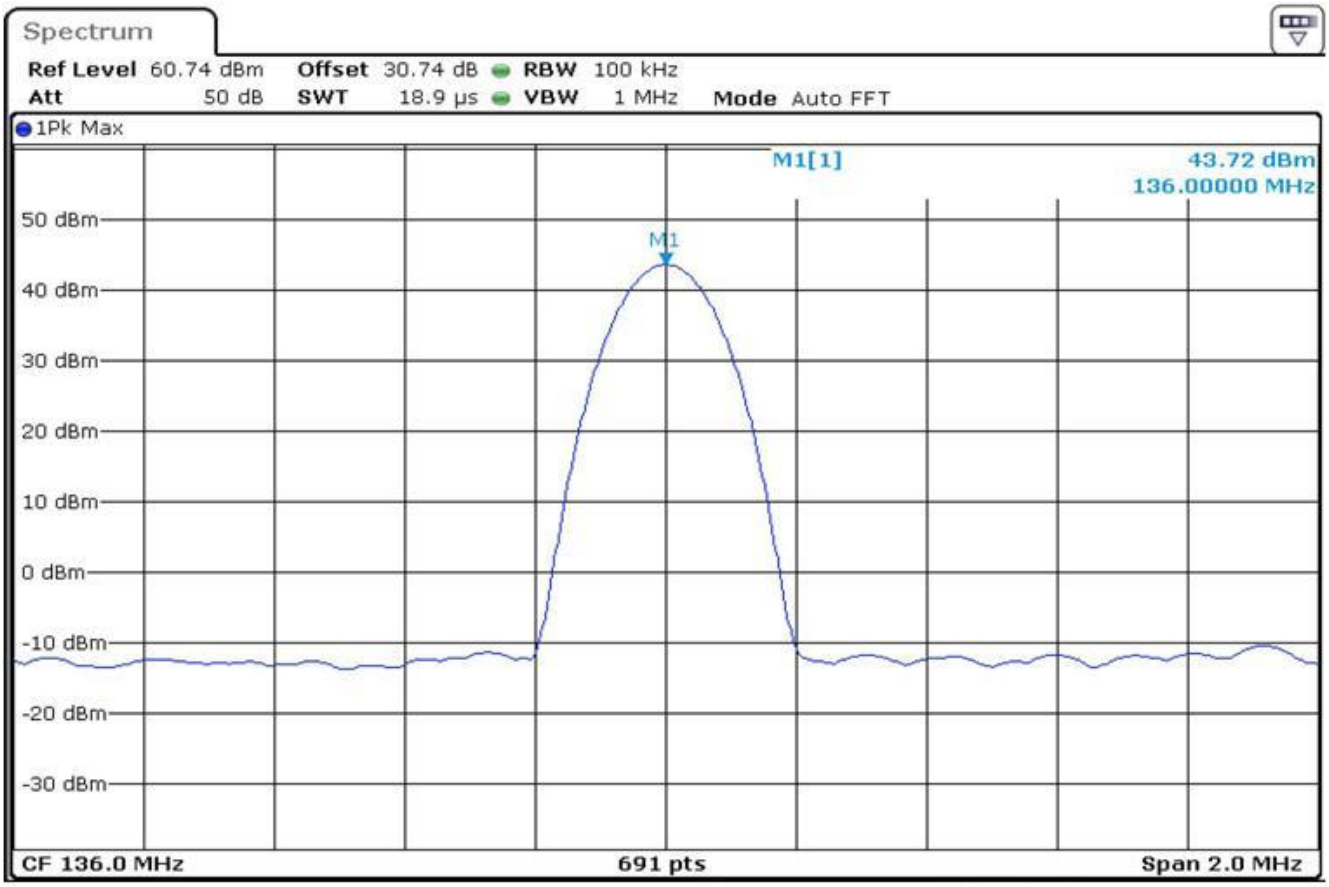
• Test Condition : Operating frequency = 155 MHz / Power setting = Low power
• Test .Result : Output power = 36.81 dBm

3.2.7.3 Low power / 174 MHz



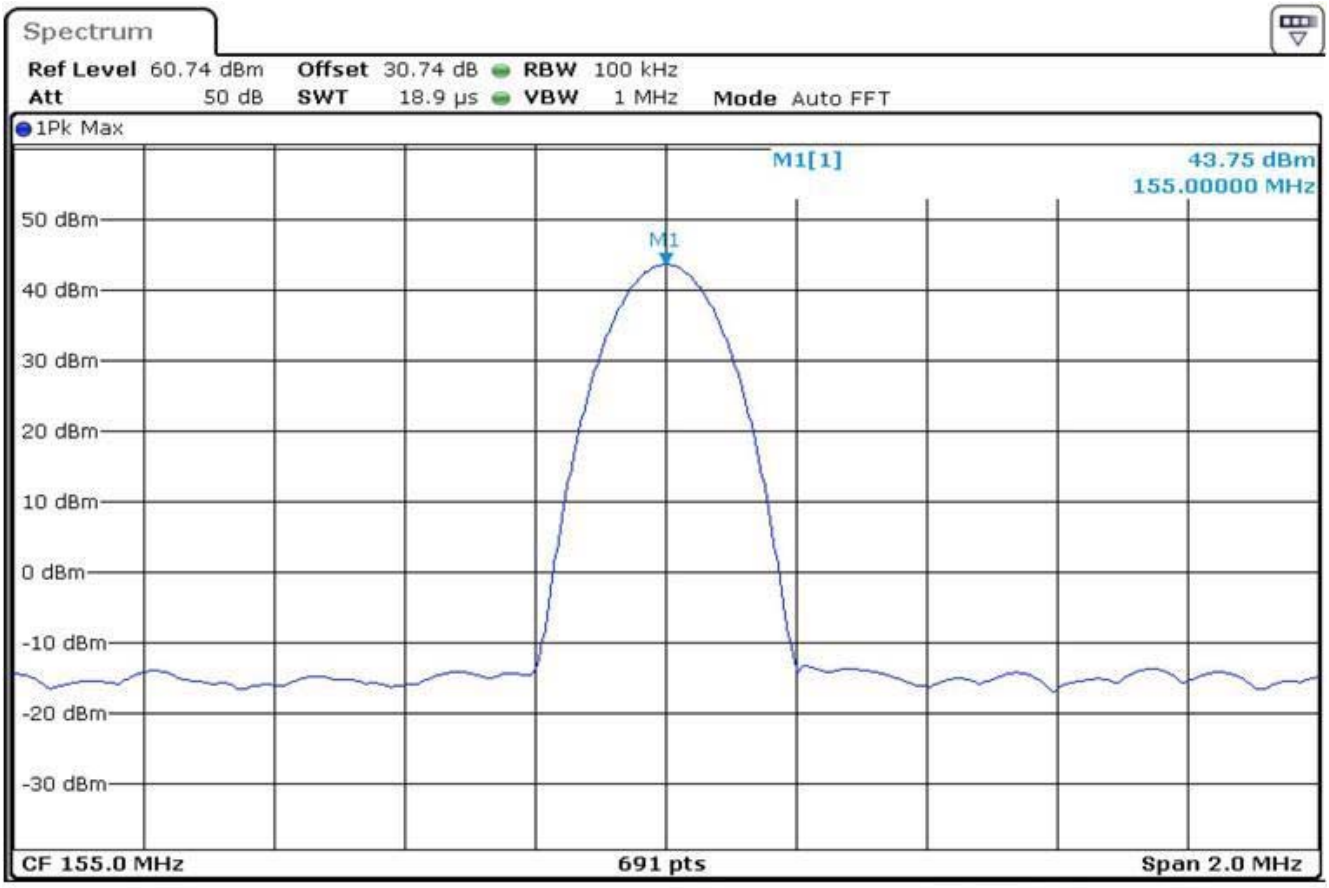
• Test Condition : Operating frequency = 174 MHz / Power setting = Low power
• Test .Result : Output power = 36.76 dBm

3.2.7.4 High power / 136 MHz



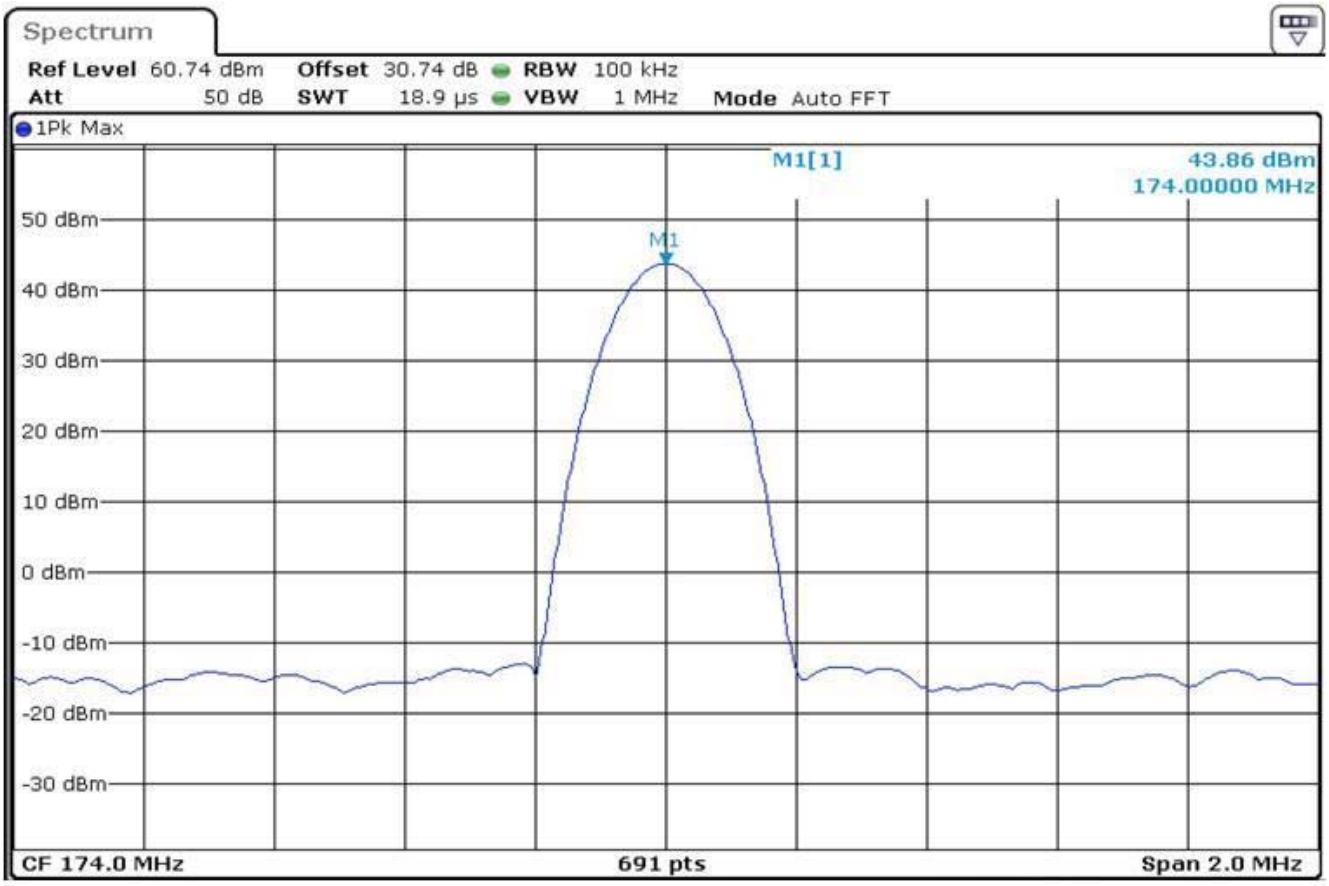
• Test Condition : Operating frequency = 136 MHz / Power setting = High power
• Test .Result : Output power = 43.72 dBm

3.2.7.5 High power / 155 MHz



• Test Condition : Operating frequency = 155 MHz / Power setting = High power
• Test .Result : Output power = 43.75 dBm

3.2.7.6 High power / 174 MHz



• Test Condition : Operating frequency = 174 MHz / Power setting = High power
• Test .Result : Output power = 43.86 dBm

3.3 Occupied bandwidth

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission. Specified limits according to the emission mask per section 90.210 are as below.

• Emission Mask B

For transmitters that are equipped with an audio low-pass filter, the power of any emission must be below the unmodulated carrier power (P) as follows:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 per-cent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized band-width: At least 43 + 10 log (P) dB.

• Emission Mask D

For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:

(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.

(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd ´2.88 kHz) dB.

(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

• Test procedure

(1) The unit was turn-up in accordance with the alignment procedure stated and was loaded into a 50 ohm resistive termination.

(2) The radio transmitter was modulated by a 2 500 Hz tone at an input level 16 dB greater than that necessary to produce 50 percent modulation. The input level shall be established at the frequency of maximum response of the audio modulating circuit.

(3) The occupied bandwidth data is obtained for 25 kHz and 12.5 kHz channel bandwidth.

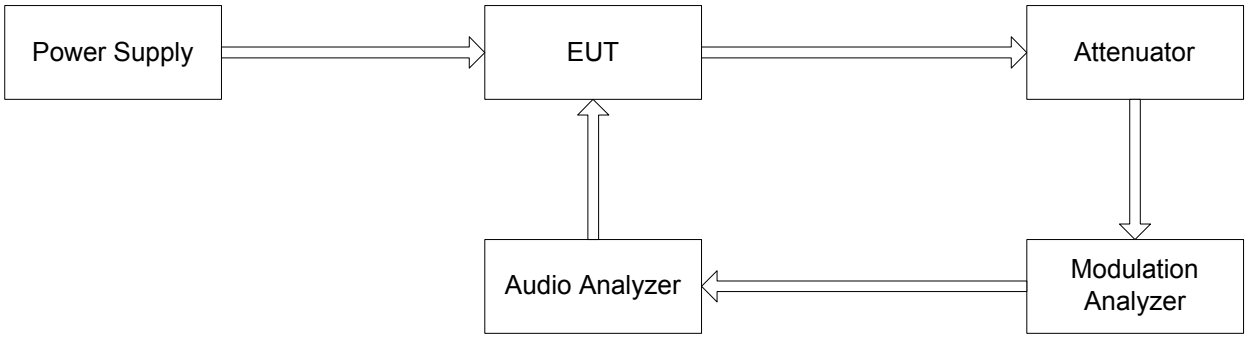
3.3.1 Specification

- FCC Rules Part 2 Section 2.1049
- FCC Rules Part 90 Section 90.210
- IC Rules RSS-119 Section 6.4

3.3.2 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.11

3.3.3 Set-Up



3.3.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Power supply	UP-1000	Unicorn
Spectrum Analyzer	N9020A	Agilent
Attenuator	66-30-34	Weinschel
Audio analyzer	8903B	Agilent
Modulation analyzer	8901B	Agilent

3.3.5 Test condition

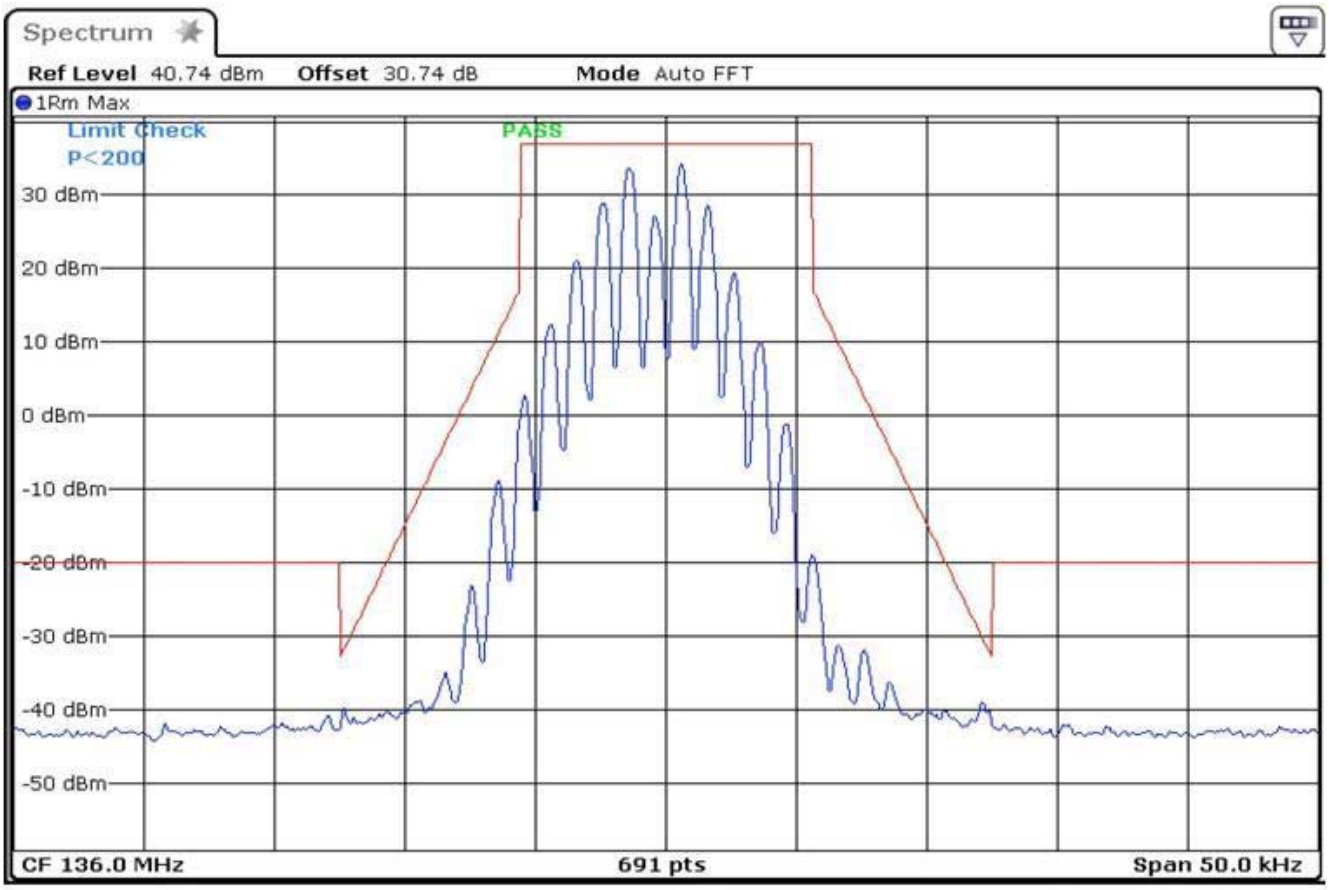
- Test place : Shield Room
- Test environment : 22 °C, 43 % R.H.
- Test mode : TX mode (Modulation)

3.3.6 Test result

Frequency [MHz]	Channel spacing	Mask type	99 % Bandwidth [kHz]		Maximum authorized bandwidth [kHz]
			Low power	High power	
136.0	Narrow	D	6.295	6.222	11.25
155.0	Narrow	D	6.222	6.295	11.25
174.0	Narrow	D	6.222	6.222	11.25

3.3.7 Plots of emission mask

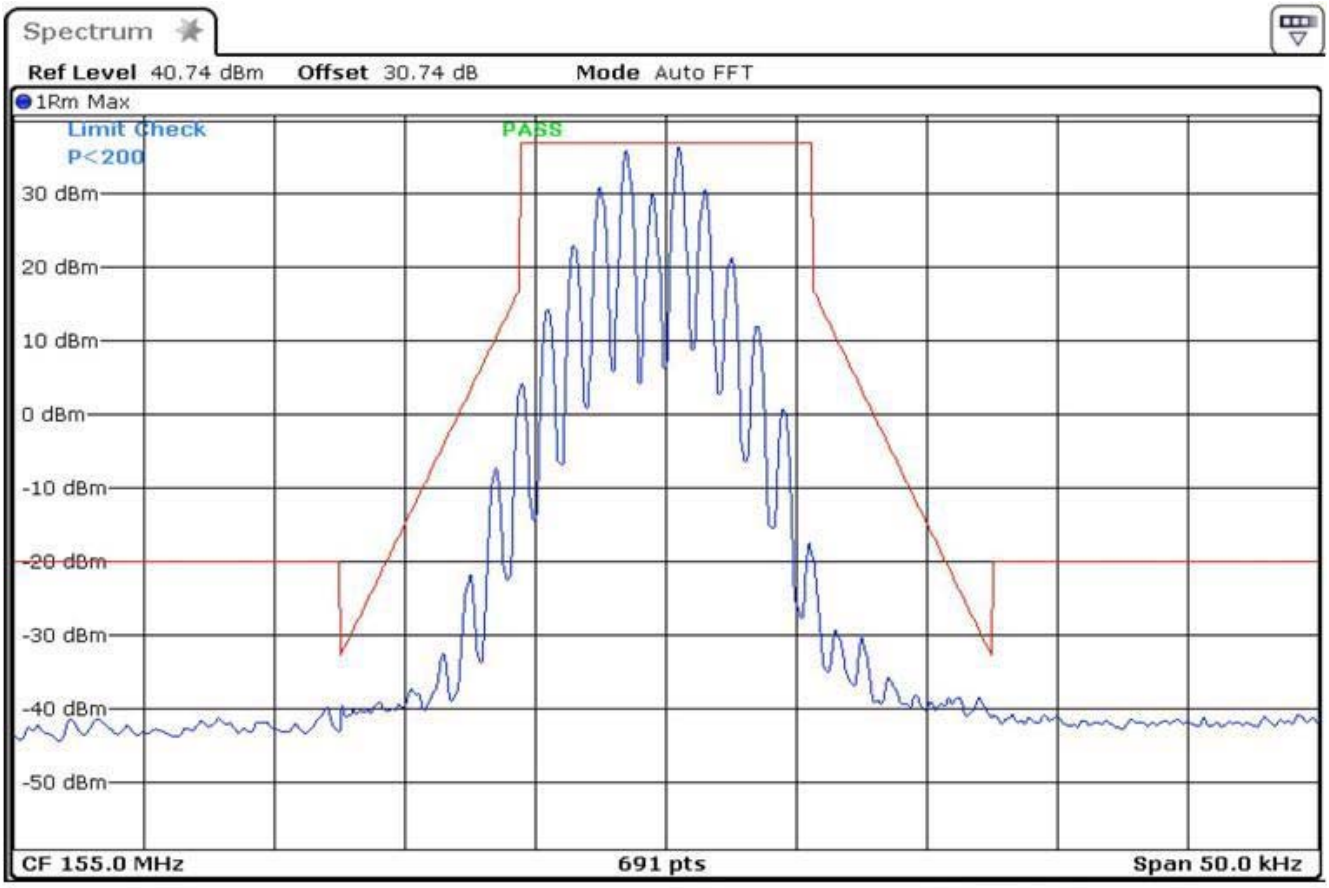
3.3.7.1 Low power / Narrow band / 136 MHz



• Test Condition
  - Operating frequency : 136 MHz
  - Power setting : Low power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave
  - Emission mask : D

• Test .Result : Passed

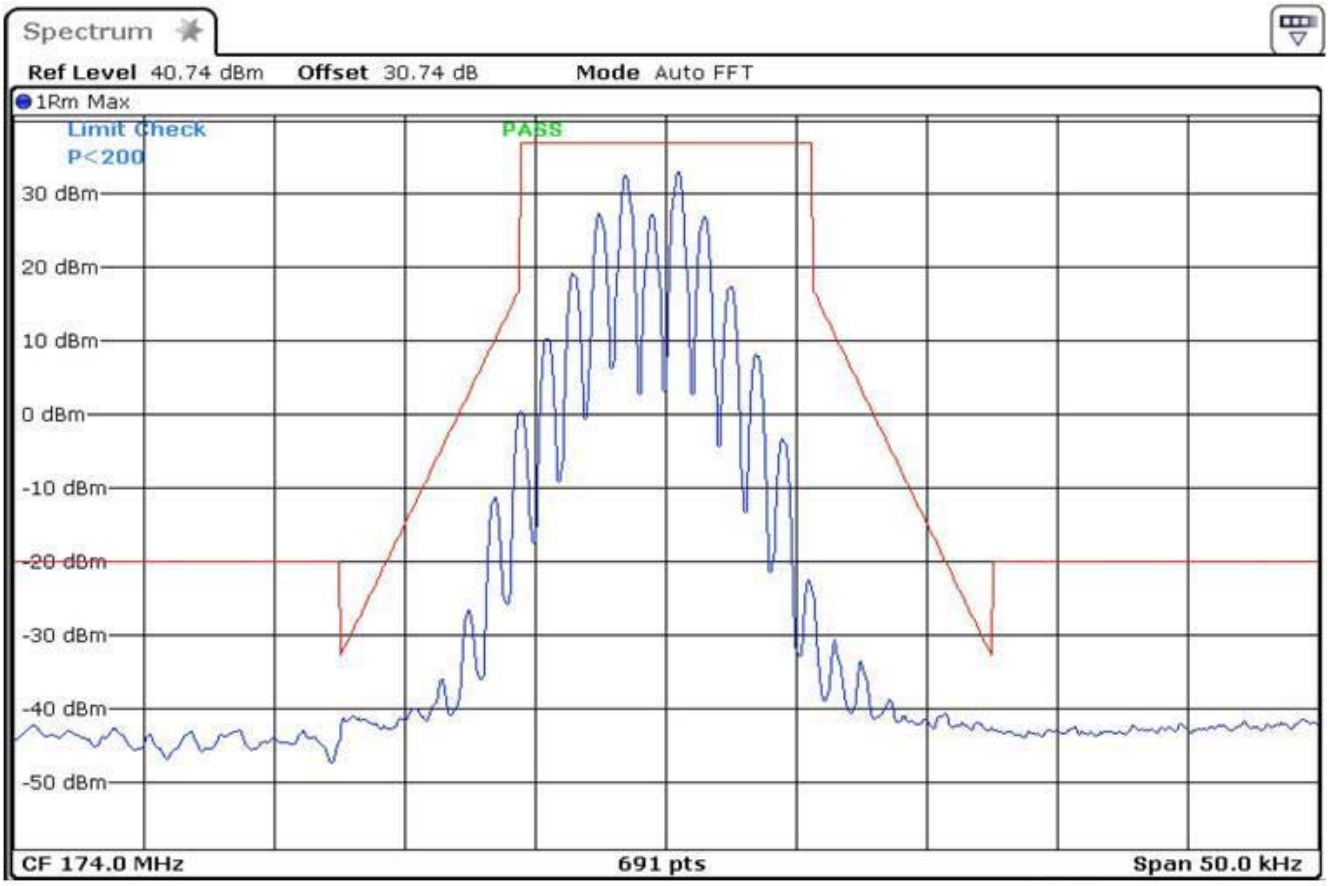
3.3.7.2 Low power / Narrow band / 155 MHz



• Test Condition
  - Operating frequency : 155 MHz
  - Power setting : Low power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave
  - Emission mask : D

• Test .Result : Passed

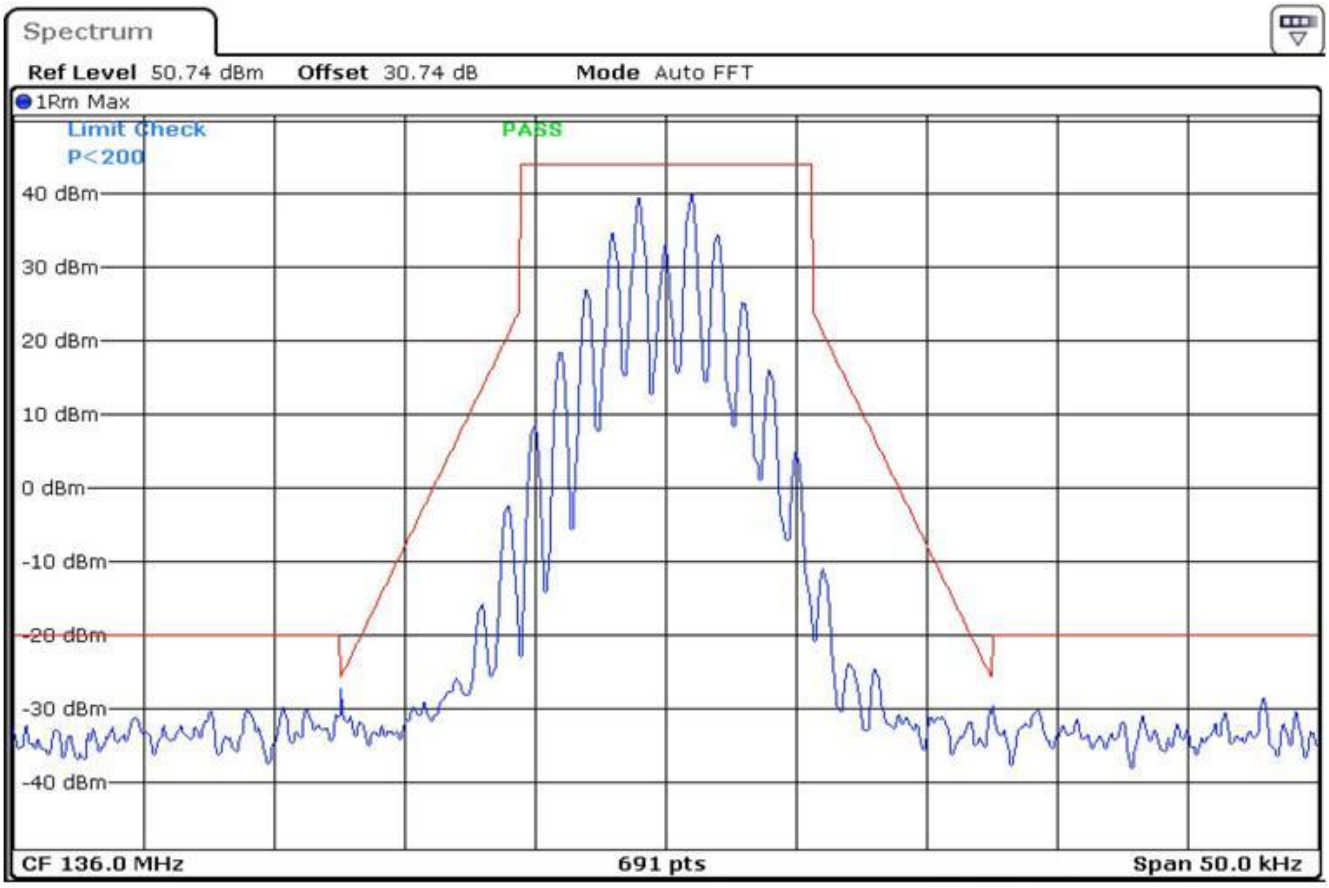
3.3.7.3 Low power / Narrow band / 174 MHz



• Test Condition
  - Operating frequency : 174 MHz
  - Power setting : Low power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave
  - Emission mask : D

• Test .Result : Passed

3.3.7.4 High power / Narrow band / 136 MHz

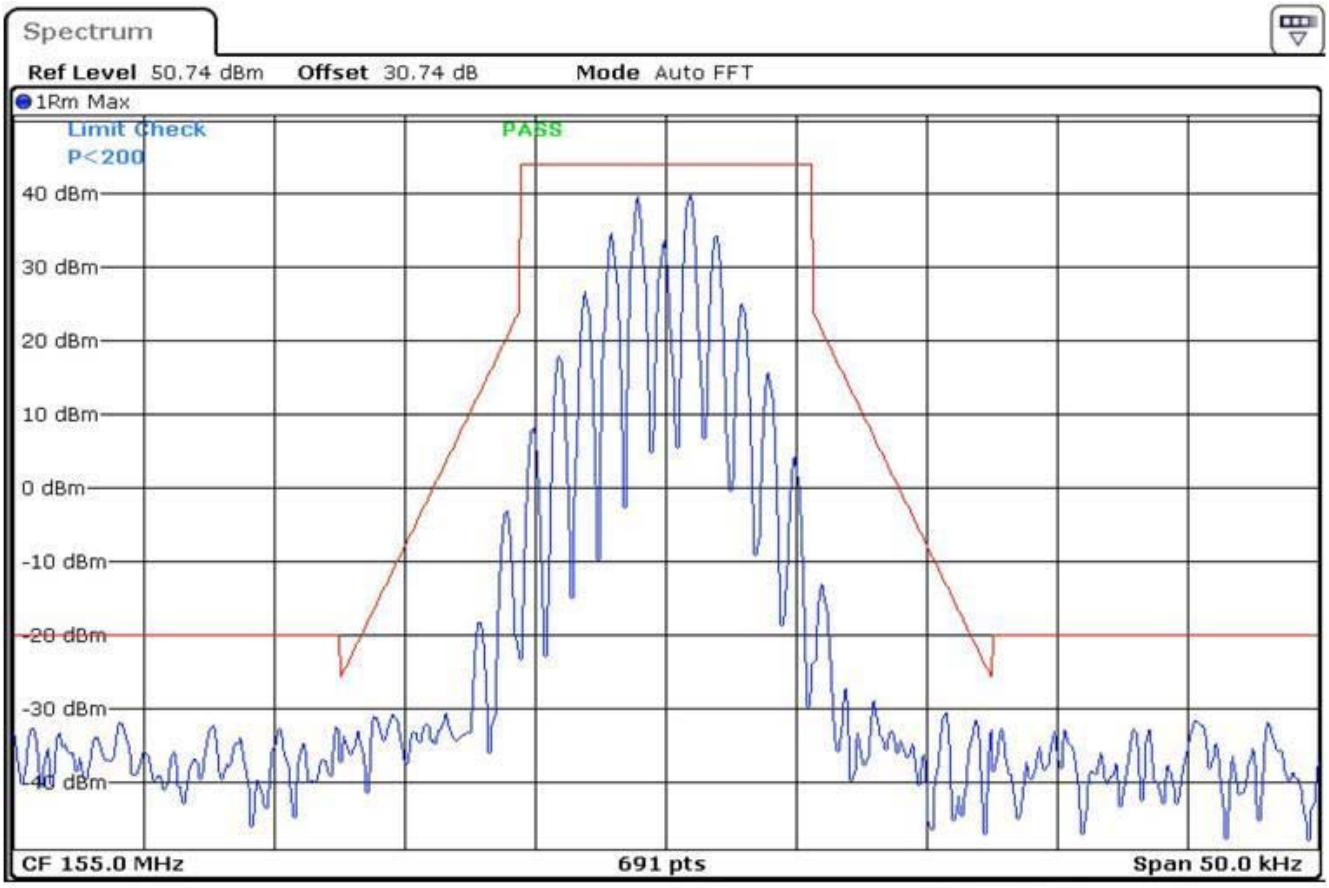


• Test Condition

- Operating frequency : 136 MHz
- Power setting : High power
- Channel spacing : Narrow band
- Modulation signal : FM modulation with 2.5 kHz sine wave
- Emission mask : D

• Test .Result : Passed

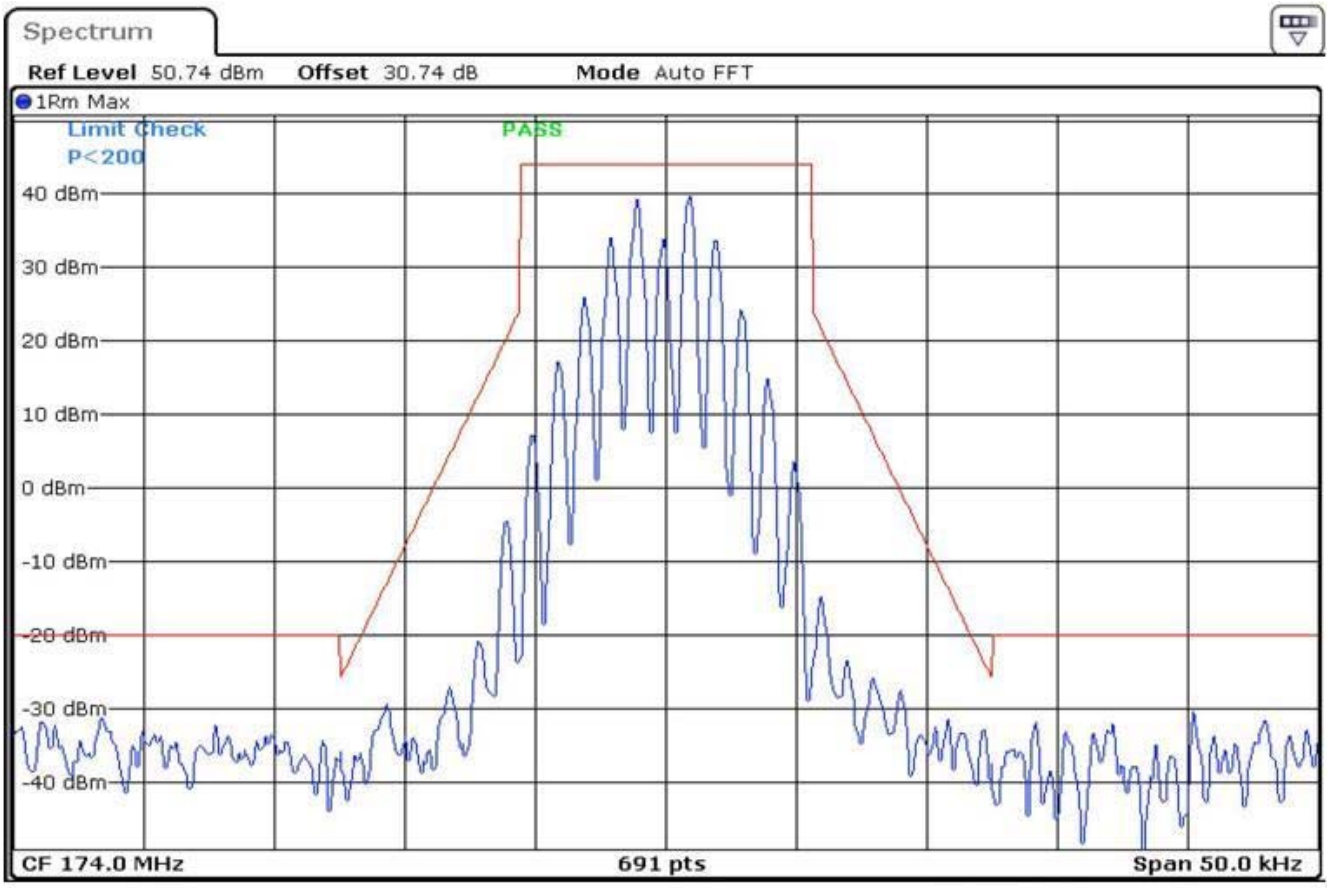
3.3.7.5 High power / Narrow band / 155 MHz



• Test Condition
  - Operating frequency : 155 MHz
  - Power setting : High power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave
  - Emission mask : D

• Test .Result : Passed

3.3.7.6 High power / Narrow band / 174 MHz

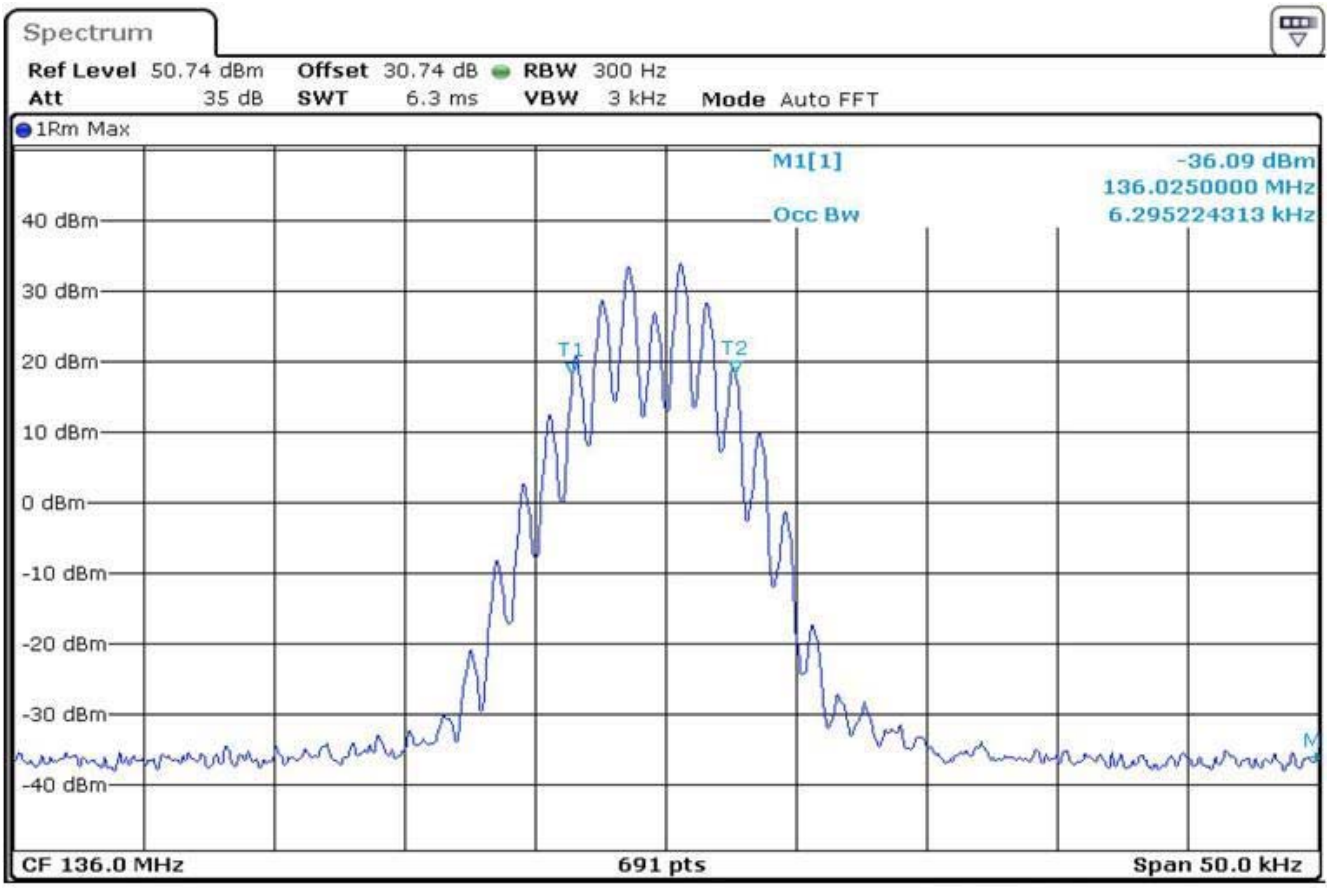


• Test Condition
  - Operating frequency : 174 MHz
  - Power setting : High power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave
  - Emission mask : D

• Test .Result : Passed

3.3.8 Plots of occupied bandwidth

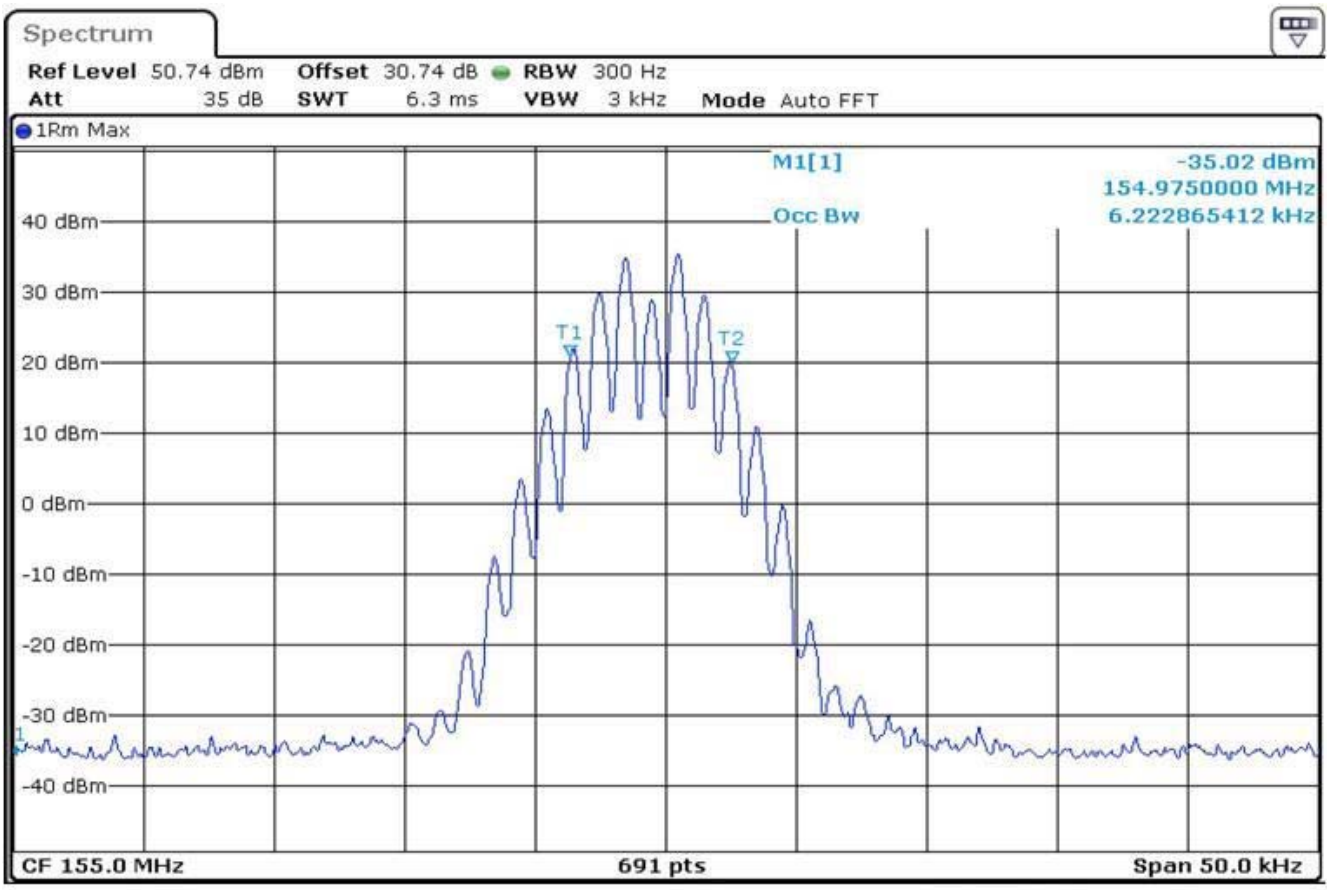
3.3.8.1 Low power / Narrow band / 136 MHz



• Test Condition
  - Operating frequency : 136 MHz
  - Power setting : Low power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave

• Test .Result : 99 % bandwidth = 6.295 kHz

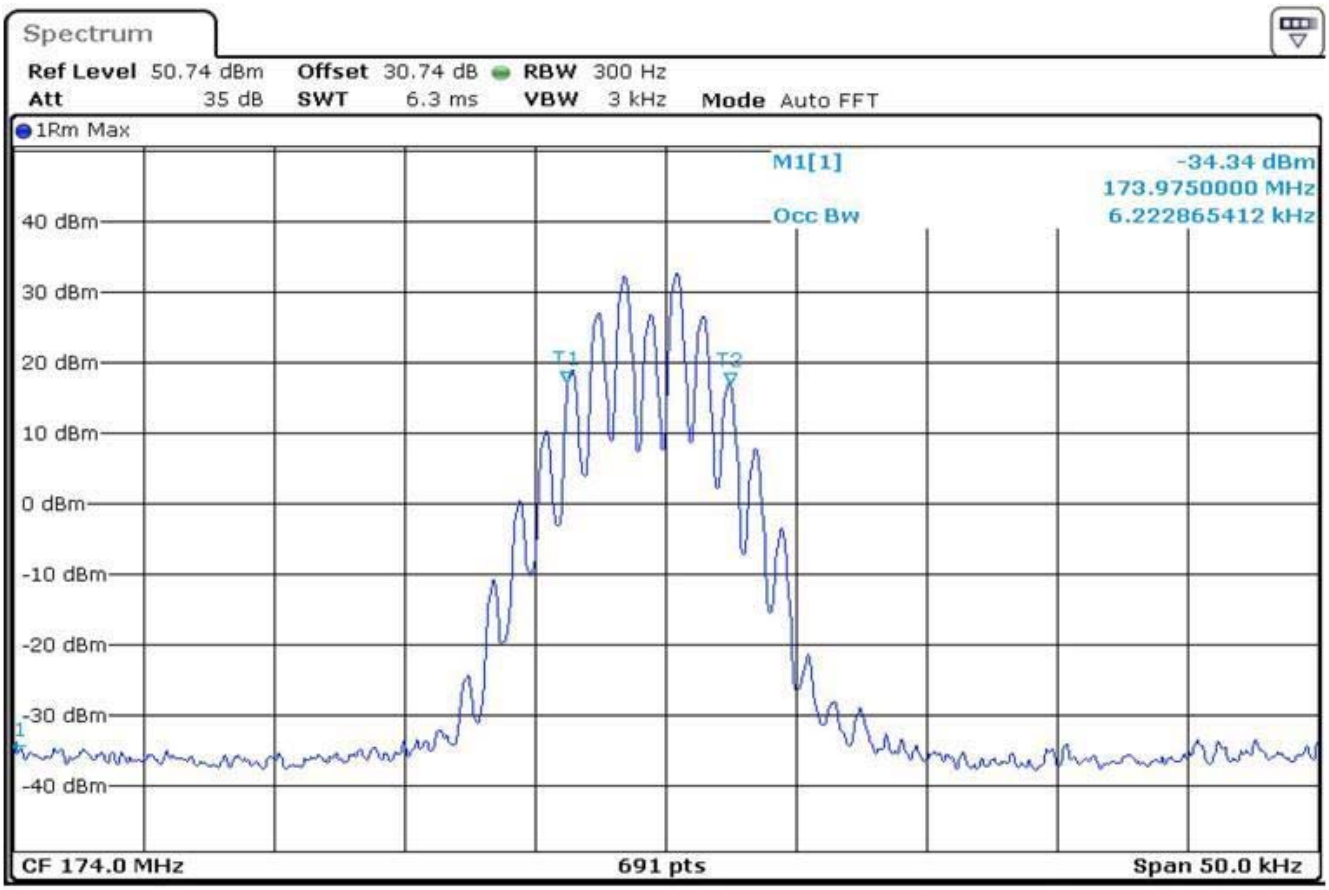
3.3.8.2 Low power / Narrow band / 155 MHz



• Test Condition
  - Operating frequency : 155 MHz
  - Power setting : Low power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave

• Test .Result : 99 % bandwidth = 6.222 kHz

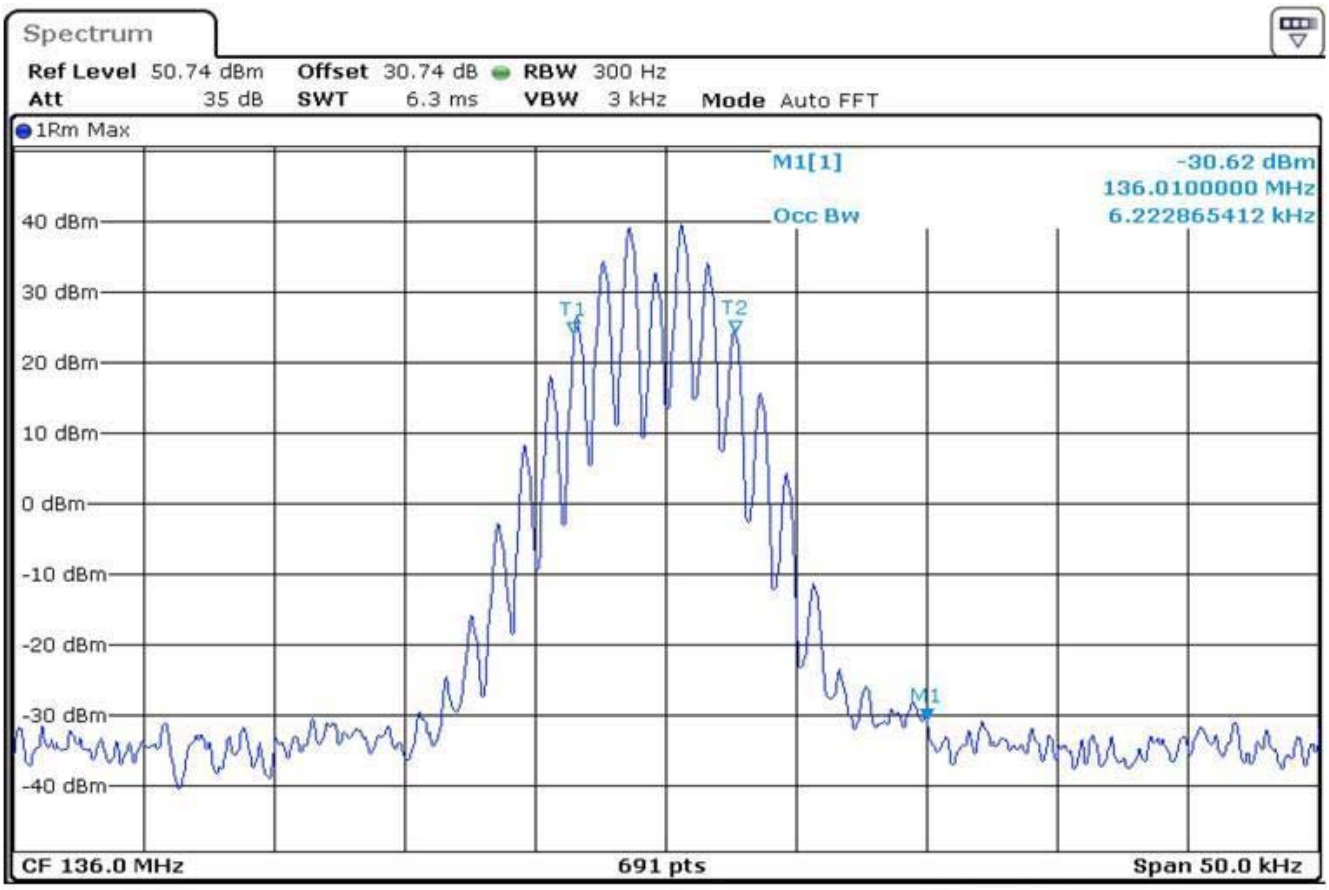
3.3.8.3 Low power / Narrow band / 174 MHz



• Test Condition
  - Operating frequency : 174 MHz
  - Power setting : Low power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave

• Test .Result : 99 % bandwidth = 6.222 kHz

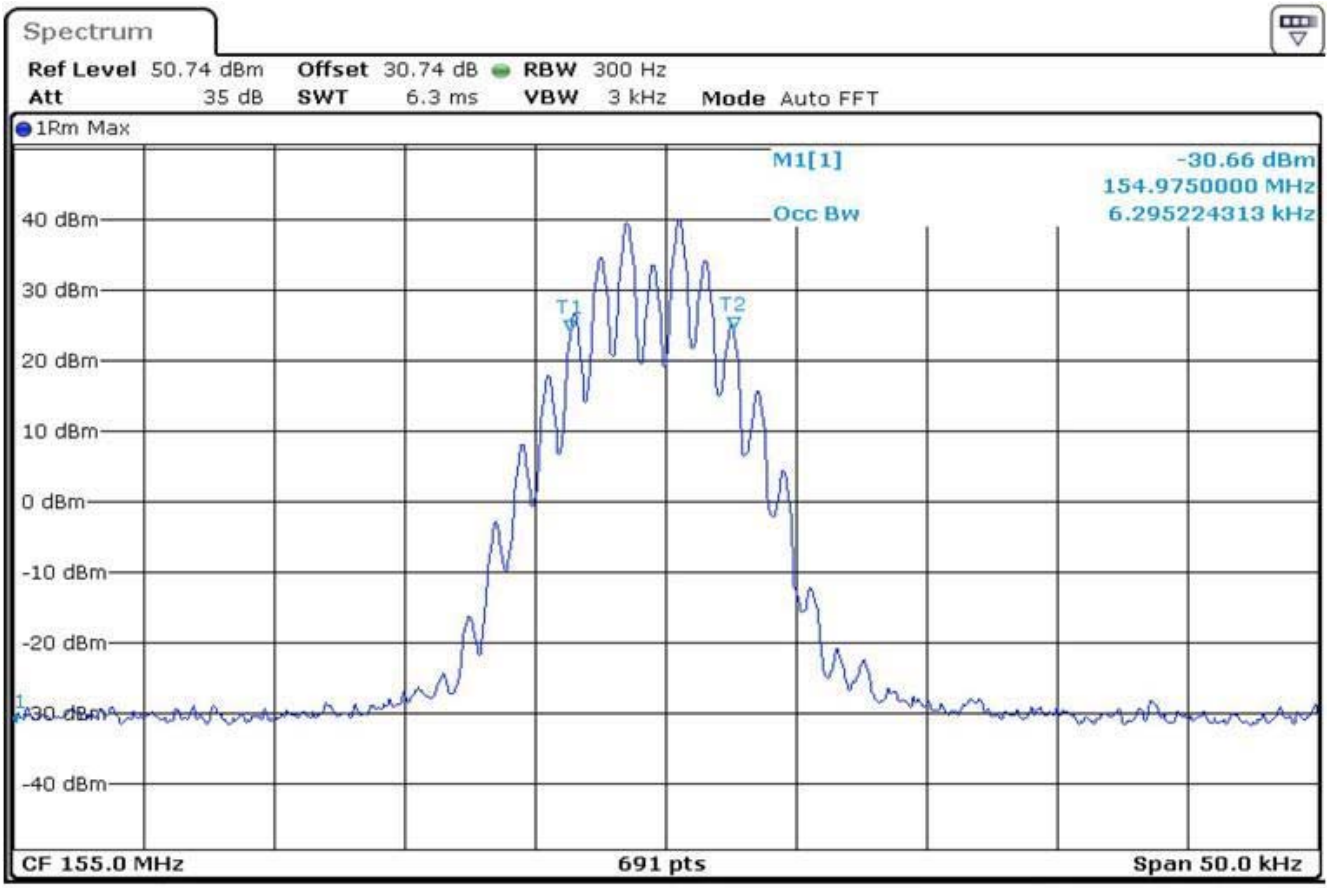
3.3.8.4 High power / Narrow band / 136 MHz



• Test Condition
  - Operating frequency : 136 MHz
  - Power setting : High power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave

• Test .Result : 99 % bandwidth = 6.222 kHz

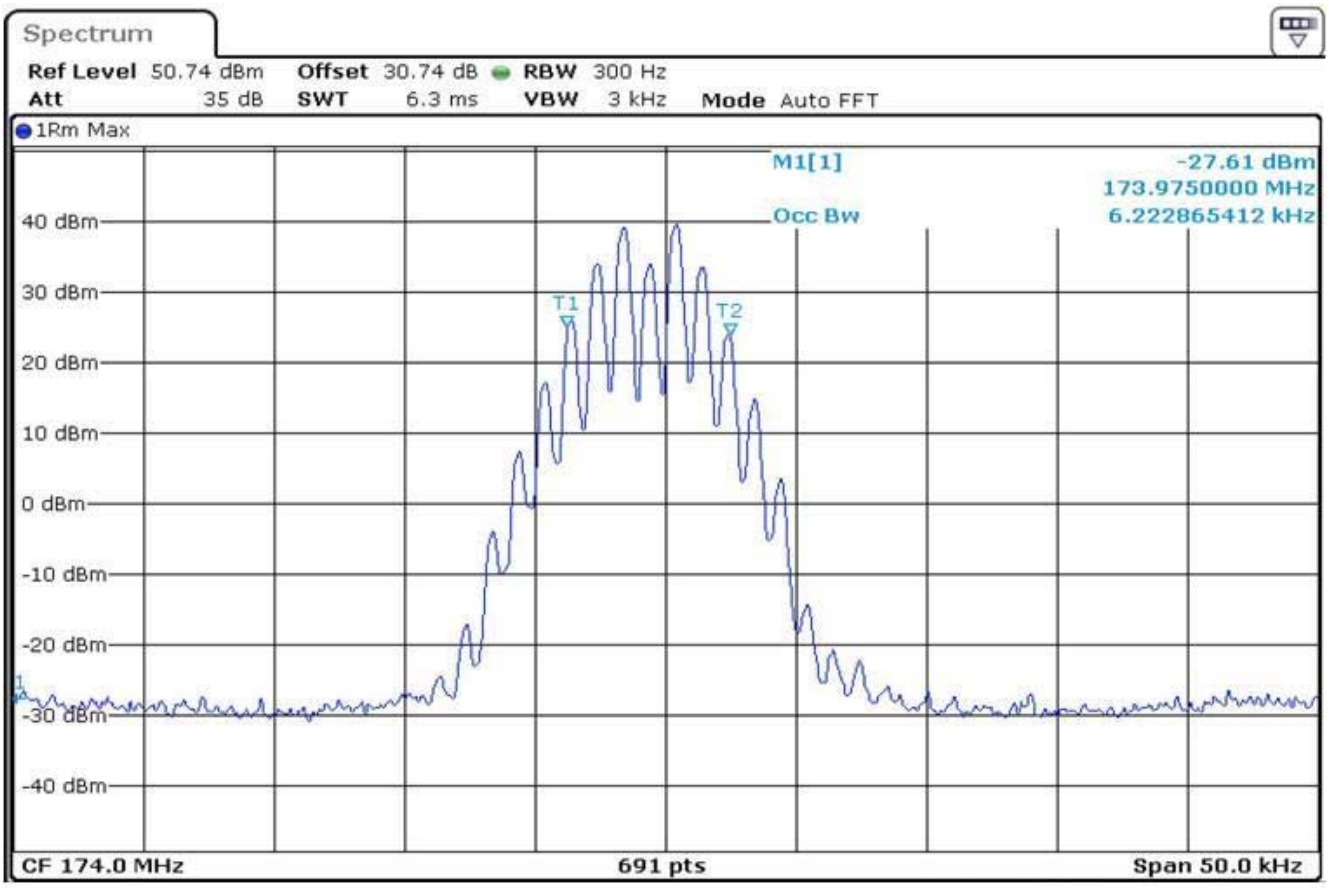
3.3.8.5 High power / Narrow band / 155 MHz



• Test Condition
  - Operating frequency : 155 MHz
  - Power setting : High power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave

• Test .Result : 99 % bandwidth = 6.295 kHz

3.3.8.6 High power / Narrow band / 174 MHz



• Test Condition
  - Operating frequency : 174 MHz
  - Power setting : High power
  - Channel spacing : Narrow band
  - Modulation signal : FM modulation with 2.5 kHz sine wave

• Test .Result : 99 % bandwidth = 6.222 kHz

3.4 Audio frequency response

3.4.1 Test procedure

(1) The unit was turn-up in accordance with the alignment procedure stated and was loaded into a 50 ohm resistive termination.

(2) The audio analyzer was connected to the audio input circuit/microphone of the EUT.

(3) The audio signal input was adjusted to obtain 20% modulation at 1 kHz, and this point was taken as the 0 dB reference level.

(4) With input levels held constant and below limiting at all frequencies, the audio signal generator was varied from 100 Hz to 10 kHz.

(5) The response in dB relative to 1 kHz was then measured, using the HP 8901A Modulation Analyzer.

(6) No limit is required by the FCC for audio frequency response. The measured audio response data shows the role-off curve at 3 kHz.

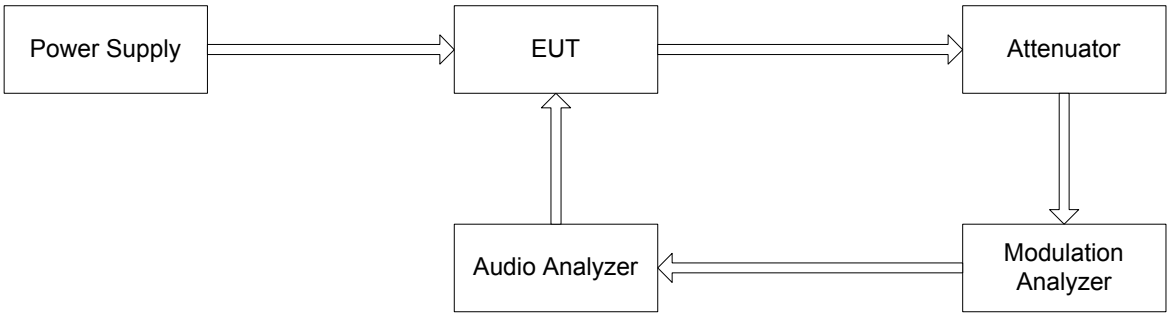
3.4.2 Specification

- FCC Rules Part 2 Section 2.1047(a)
- FCC Rules Part 90 Section 90.207
- FCC Rules Part 90 Section 90.2242(b)(8)
- IC Rules RSS-119 Section 6.6

3.4.3 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.6

3.4.4 Set-Up



3.4.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Power supply	E3633A	Agilent
Attenuator	66-30-34	Weinschel
Audio analyzer	8903B	Agilent
Modulation analyzer	8901B	Agilent

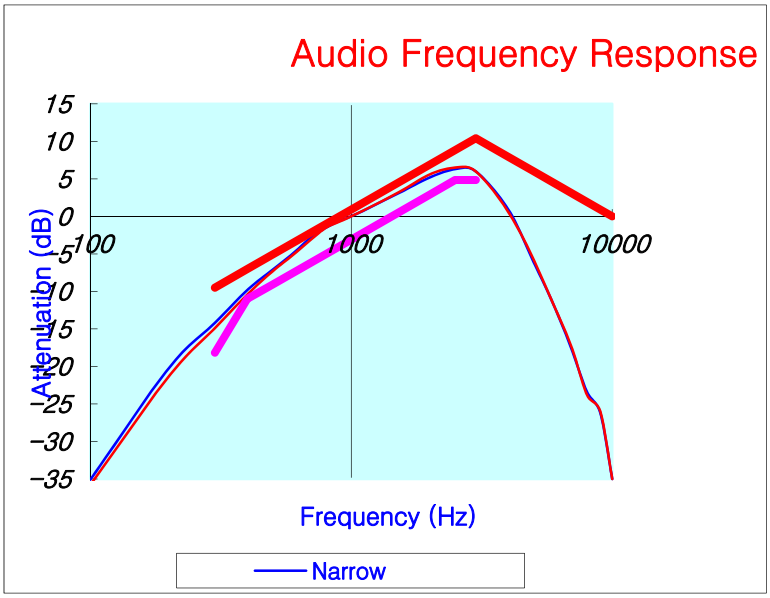
3.4.6 Test condition

- Test place : Shield Room
- Test environment : 22 °C, 43 % R.H.
- Test mode : TX mode (Modulation)

3.4.7 Test result

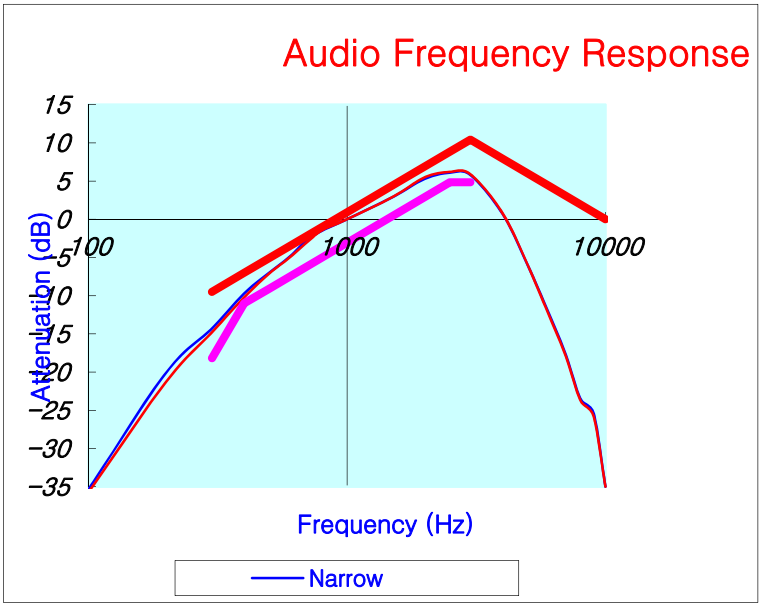
3.4.7.1 Test data and graph 1 / High power / 136 MHz

Test data		Graph
Audio input Frequency [Hz]	Attenuation [dB] Narrow band	
100	-34.6	
200	-32.2	
300	-10.7	
400	-6.3	
500	-5.4	
600	-4.3	
700	-3.1	
800	-2.0	
900	-1.0	
1 000	0	
1 500	3.4	
2 000	4.5	
2 500	4.0	
3 000	2.9	
4 000	-1.8	
5 000	-9.6	
6 000	-18.3	
7 000	-26.4	
8 000	-31.1	
9 000	-34.2	
10 000	-34.7	



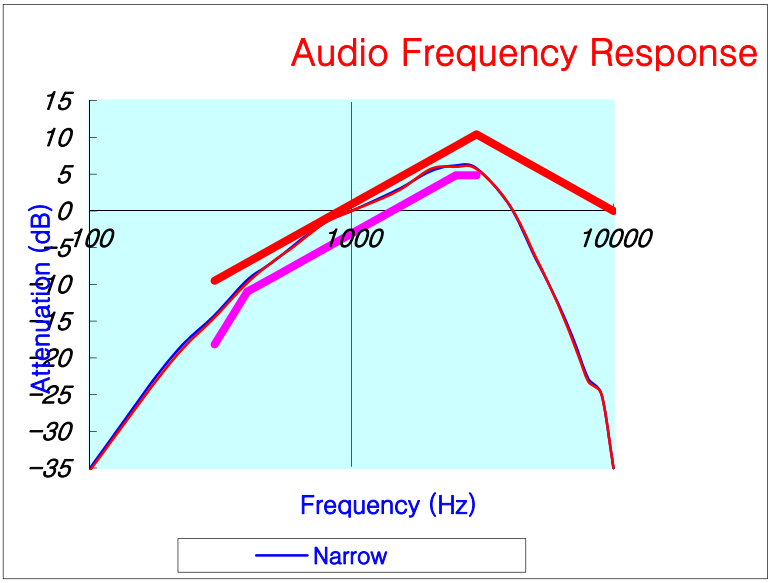
3.4.7.2 Test data and graph 2 / High power / 155 MHz

Test data		Graph
Audio input Frequency [Hz]	Attenuation [dB] Narrow band	
100	-34.8	
200	-32.7	
300	-12.7	
400	-8.1	
500	-6.5	
600	-5.0	
700	-3.6	
800	-2.4	
900	-1.0	
1 000	0	
1 500	2.8	
2 000	4.3	
2 500	3.9	
3 000	2.9	
4 000	-1.8	
5 000	-9.6	
6 000	-18.5	
7 000	-26.9	
8 000	-32.5	
9 000	-34.9	
10 000	-35.0	



3.4.7.3 Test data and graph 3 / High power / 174 MHz

Test data		Graph
Audio input Frequency [Hz]	Attenuation [dB] Narrow band	
100	-33.7	
200	-31.7	
300	-16.3	
400	-10.4	
500	-7.7	
600	-5.5	
700	-3.8	
800	-2.3	
900	-1.0	
1 000	0	
1 500	3.8	
2 000	4.7	
2 500	4.1	
3 000	3.1	
4 000	-1.6	
5 000	-9.2	
6 000	-17.7	
7 000	-25.6	
8 000	-31.6	
9 000	-33.4	
10 000	-34.2	



3.5 Audio low pass filter response

3.5.1 Test procedure

(1) The unit was turn-up in accordance with the alignment procedure stated and was loaded into a 50 ohm resistive termination.

(2) To measure the audio low pass filter response, an audio analyzer was connected to the actual Printed Circuit Board of the transmitter.

(3) Audio analyzer monitored the output of the audio filter.

(4) An AF input level was maintained constant at least 10 dB below the saturation level at 1 kHz tone.

(5) Record the dB level of the 1 kHz tone of the audio analyzer.

(6) Set the audio input frequency to desired test frequency between 3 kHz and upper low pass filter limit.

(7) Record dB level on the audio analyzer.

(8) Calculate the audio frequency response as LPF response = LEV_{FREQ} - LEV_{REF}

(9) Audio frequencies in 3 kHz to 20 kHz : Minimum Attenuation to reference point shell be greater than 60log(f/3) dB, above 20 kHz, at least 50 dB attenuation. (“f” in kHz)

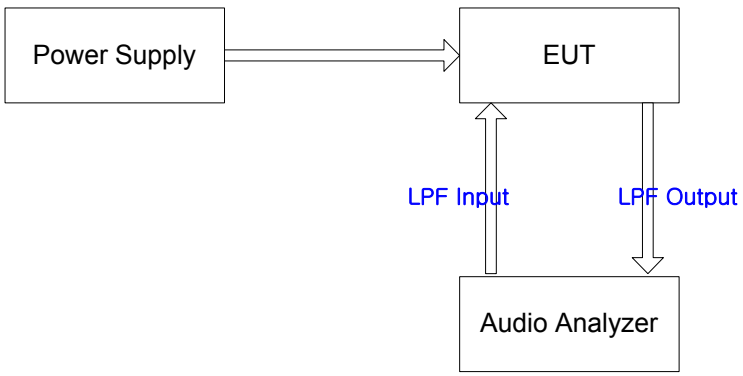
3.5.2 Specification

- FCC Rules Part 2 Section 2.1047(a)
- FCC Rules Part 90 Section 90.207
- FCC Rules Part 90 Section 90.242(b)(8)
- IC Rules RSS-119 Section 6.6

3.5.3 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.15

3.5.4 Set-Up



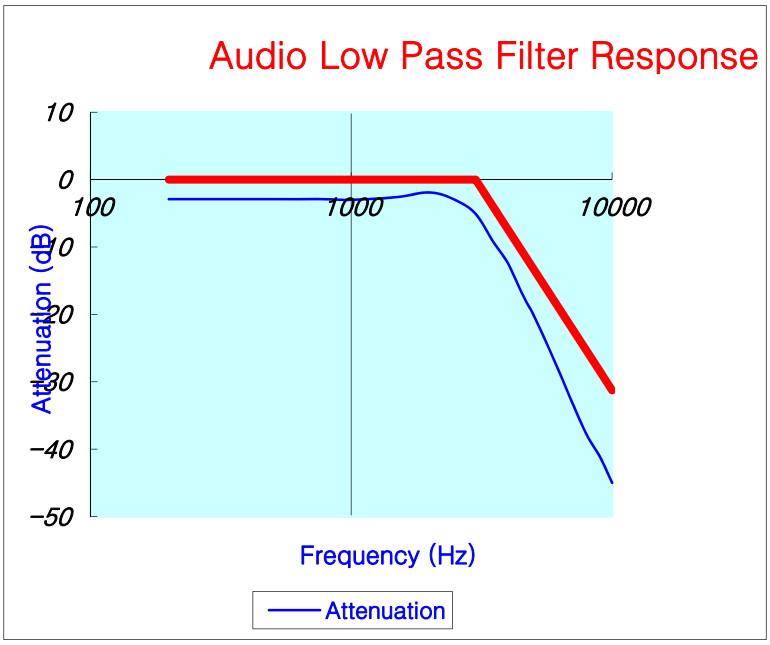
3.5.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Power supply	E3633A	Agilent
Audio analyzer	8903B	Agilent

3.5.6 Test condition

- Test place : Shield Room
- Test environment : 22 °C, 43 % R.H.
- Test mode : TX mode (Modulation)

3.5.7 Test result

Test data			Graph
Audio input frequency [Hz]	Attenuation [dB]	Limit [dB]	
100	-2.9	-	
200	-2.9	-	
400	-2.9	-	
600	-2.9	-	
800	-2.9	-	
1 000	-3.0	-	
1 500	-2.6	-	
2 000	-1.9	-	
2 500	-3.0	-	
3 000	-5.1	0.0	
3 500	-9.2	-4.0	
4 000	-12.5	-7.5	
4 500	-16.8	-10.5	
5 000	-20.1	-13.3	
6 000	-26.8	-18.0	
7 000	-32.9	-22.0	
8 000	-37.9	-25.5	
9 000	-41.2	-28.5	
10 000	-45.0	-31.3	

3.6 Modulation limiting

3.6.1 Test procedure

(1) The unit was turn-up in accordance with the alignment procedure stated and was loaded into a 50 ohm resistive termination.

(2) Apply an 1 kHz modulating signal to EUT from the audio frequency analyzer, and adjust the level to obtain 60 % of full rated system deviation.

(3) Increase the level from the AF generator by±20 dB in one step.

(4) Measure the steady-state deviation.

(5) With the AF generator level hold constant, vary the audio frequency from 300 Hz to 3000 Hz. Record the maximum deviation.

(6) Set the modulation analyzer to measure the peak negative deviation and repeat the test above.

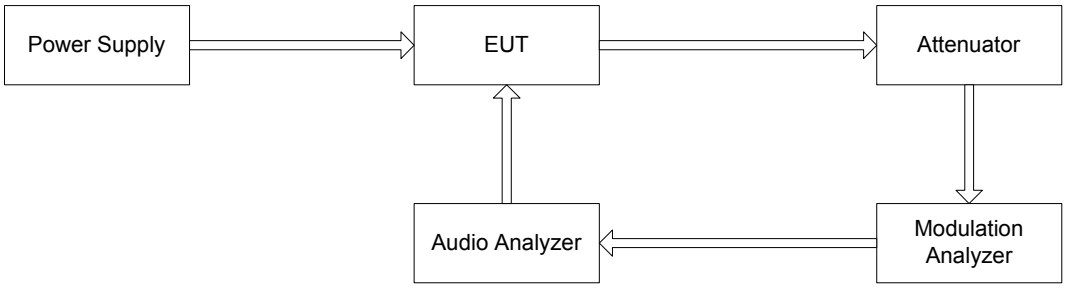
3.6.2 Specification

- FCC Rules Part 2 Section 2.1047(b)
- FCC Rules Part 90 Section 90.207
- IC Rules RSS-119 Section 6.6

3.6.3 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.3

3.6.4 Set-Up



3.6.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Power supply	E3633A	Agilent
Attenuator	66-30-34	Weinschel
Audio analyzer	8903B	Agilent
Modulation analyzer	8901B	Agilent

3.6.6 Test condition

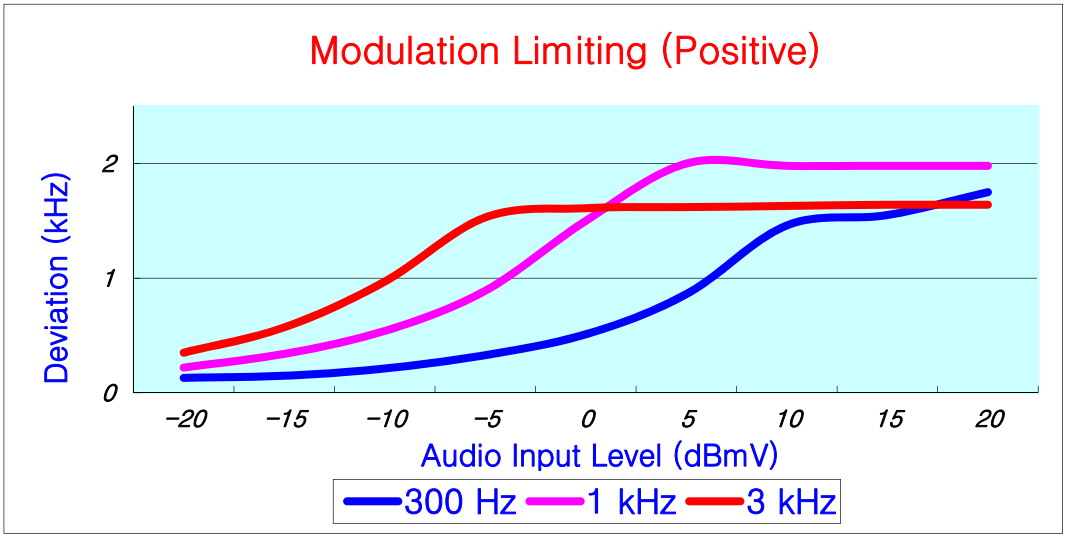
- Test place : Shield Room
- Test environment : 22 °C, 43 % R.H.
- Test mode : TX mode (Modulation)

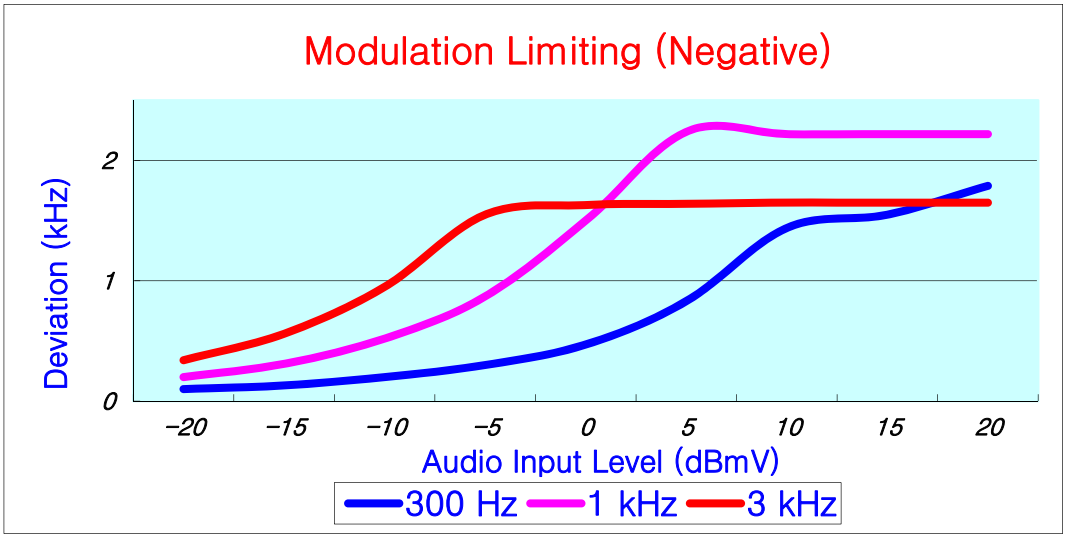
3.6.7 Test result

3.6.7.1 Test data 1 / Narrow band / 135 MHz

Audio input level [dB]	Positive peak deviation [kHz]			Negative peak deviation [kHz]		
	300 Hz	1 kHz	3 kHz	300 Hz	1 kHz	3 kHz
-20	0.13	0.22	0.35	0.10	0.20	0.34
-15	0.15	0.34	0.57	0.13	0.31	0.56
-10	0.21	0.54	0.97	0.20	0.52	0.95
-5	0.33	0.89	1.53	0.30	0.87	1.55
0	0.51	1.50	1.61	0.47	1.50	1.63
+5	0.86	2.00	1.62	0.83	2.24	1.64
+10	1.46	1.98	1.63	1.44	2.22	1.65
+15	1.55	1.98	1.64	1.55	2.22	1.65
+20	1.75	1.98	1.64	1.79	2.22	1.65

3.6.7.2 Graph 1 / Narrow band / 135 MHz

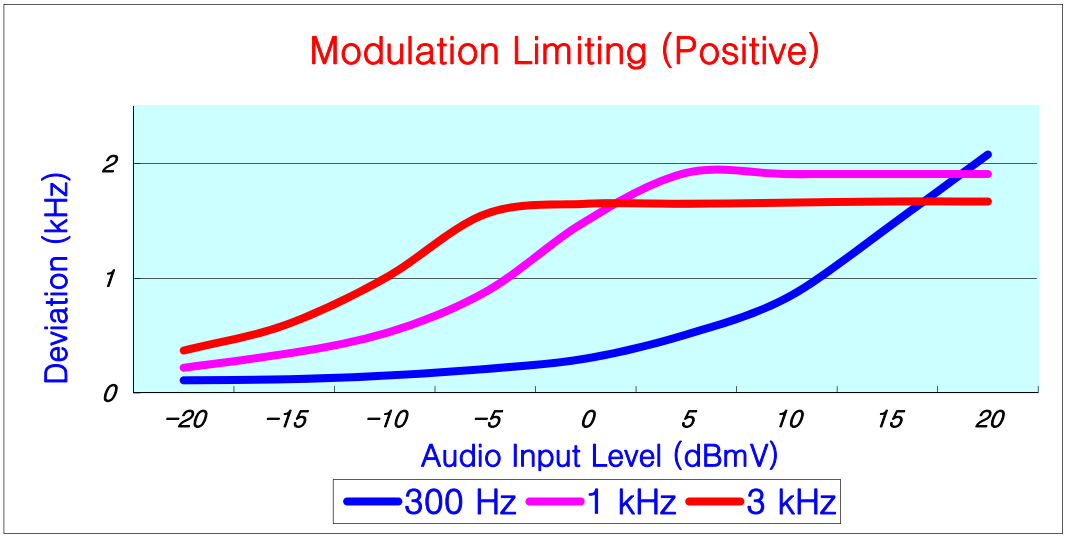


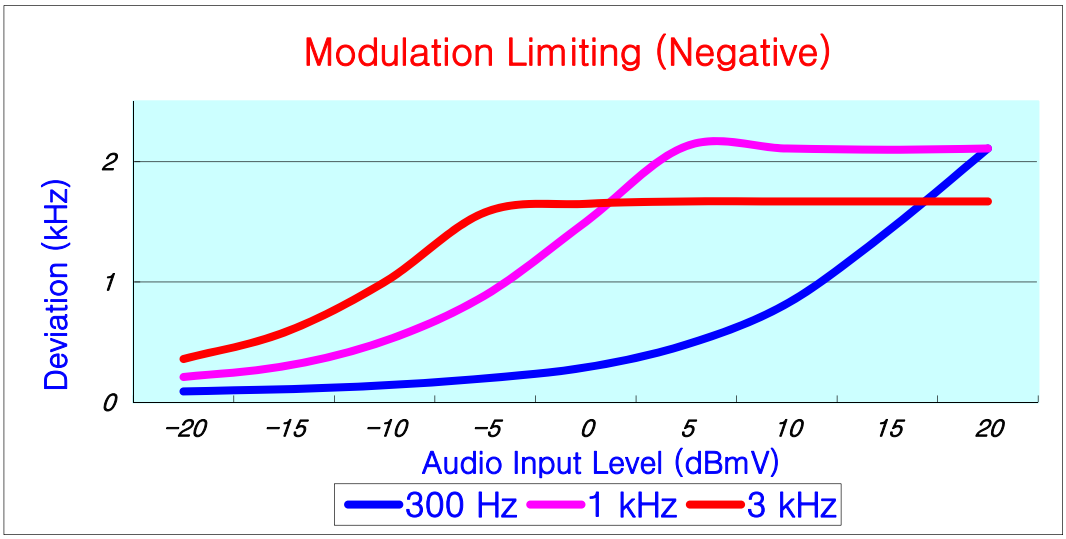


3.6.7.3 Test data 2 / Narrow band / 155 MHz

Audio input level [dB]	Positive peak deviation [kHz]			Negative peak deviation [kHz]		
	300 Hz	1 kHz	3 kHz	300 Hz	1 kHz	3 kHz
-20	0.11	0.22	0.34	0.09	0.20	0.32
-15	0.13	0.33	0.56	0.12	0.31	0.55
-10	0.18	0.51	0.96	0.16	0.50	0.95
-5	0.26	0.88	1.64	0.24	0.86	1.64
0	0.41	1.50	1.87	0.42	1.50	1.95
+5	0.69	1.95	1.87	0.69	2.19	1.96
+10	1.20	1.93	1.87	1.18	2.17	1.96
+15	1.58	1.93	1.87	1.59	2.17	1.96
+20	2.01	1.93	1.88	2.00	2.17	1.96

3.6.7.4 Graph 2 / Narrow band / 155 MHz

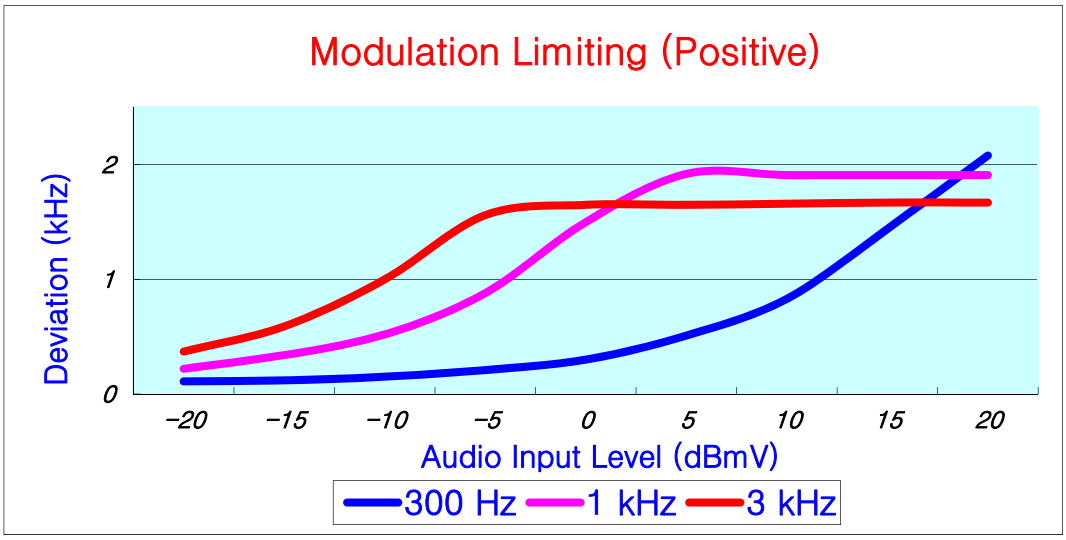


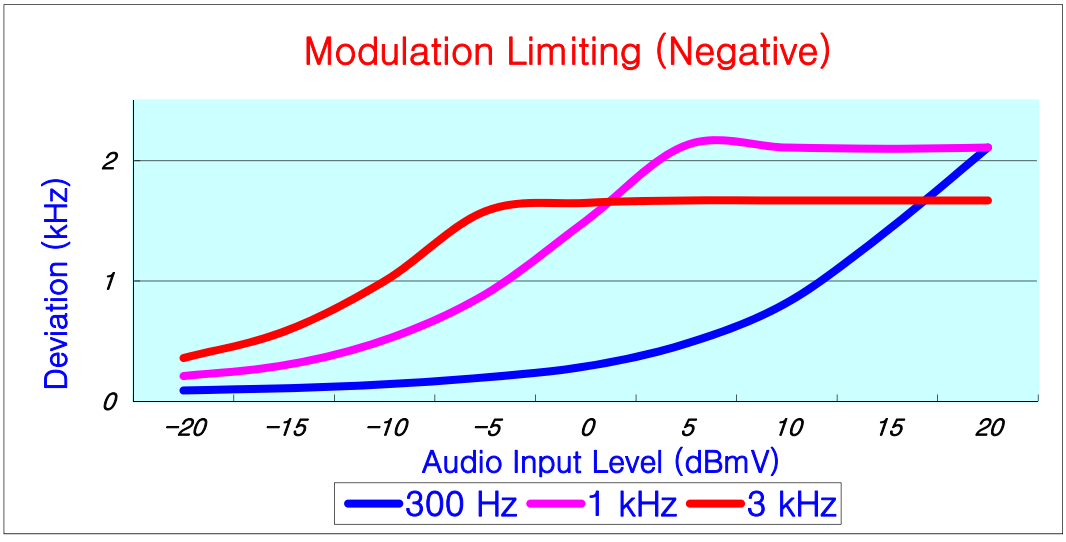


3.6.7.5 Test data 3 / Narrow band / 174 MHz

Audio input level [dB]	Positive peak deviation [kHz]			Negative peak deviation [kHz]		
	300 Hz	1 kHz	3 kHz	300 Hz	1 kHz	3 kHz
-20	0.11	0.22	0.37	0.09	0.21	0.36
-15	0.12	0.34	0.59	0.11	0.30	0.58
-10	0.15	0.52	1.00	0.14	0.51	1.00
-5	0.21	0.88	1.56	0.20	0.89	1.58
0	0.30	1.50	1.65	0.29	1.50	1.65
+5	0.51	1.92	1.65	0.48	2.13	1.67
+10	0.83	1.91	1.66	0.82	2.11	1.67
+15	1.44	1.91	1.67	1.42	2.10	1.67
+20	2.08	1.91	1.67	2.11	2.11	1.67

3.6.7.6 Graph 3 / Narrow band / 174 MHz





3.7 Spurious emissions at antenna terminals

3.7.1 Test procedure

(1) The unit was turn-up in accordance with the alignment procedure stated and was loaded into a 50 ohm resistive termination.

(2) The antenna output terminal of the EUT was connected to the input of a 50 ohm spectrum analyzer through a matched 10 dB attenuator and notch filter.

(3) Transmitter was set to the maximum power output condition.

(4) The unit was modulated with a 2.5 kHz audio tone at an input level 16dB greater than that required 50 % modulation. The spectrum was scanned from the lowest frequency generated in the equipment to the 10^{th} harmonic of the carrier.

(5) The test performed at worst case mode. (High power and Narrow Band)

(6) The limit was applied according the $50+10\log_{10}$(P: mean power in Watts) dB.

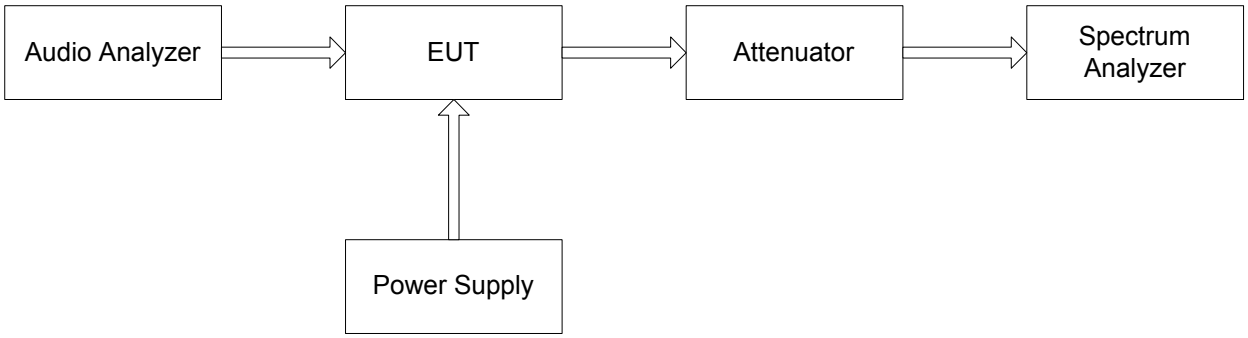
3.7.2 Specification

- FCC Rules Part 2 Section 2.1051
- FCC Rules Part 90 Section 90.210
- IC Rules RSS-119 Section 6.3

3.7.3 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.13

3.7.4 Set-Up



3.7.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Power supply	E3633A	Agilent
Spectrum Analyzer	FSV	R&S
Attenuator	66-30-34	Weinschel
Audio analyzer	8903B	Agilent
Modulation analyzer	8901B	Agilent

3.7.6 Test condition

- Test place : Shield Room
- Test environment : 22 °C, 43 % R.H.
- Test mode : TX mode (High power & Narrow band)

3.7.7 Test result

3.7.7.1 Test data

Frequency [MHz]	Transmitter spurious emission		
	Level [dBm]	Limit [dBm]	Margin [dB]
Operating frequency 400 MHz			
272.00	-49.75	-20	29.75
407.99	-35.22	-20	15.22
544.00	-45.11	-20	25.11
680.00	-50.11	-20	30.11
Operating frequency 435 MHz			
310.00	-37.92	-20	17.92
465.00	-40.98	-20	20.98
620.00	-43.33	-20	23.33
Operating frequency 470 MHz			
347.99	-33.26	-20	13.26

3.8 Field strength of spurious radiation

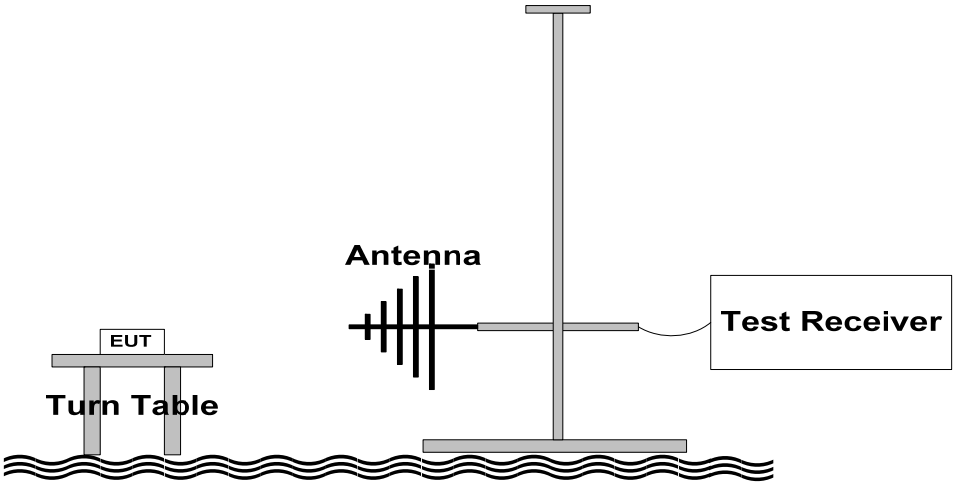
3.8.1 Specification

- FCC Rules Part 2 Section 2.1053(a)
- FCC Rules Part 90 Section 90.210
- IC Rules RSS-119 Section 6.3

3.8.2 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.12

3.8.3 Set-Up



3.8.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Spectrum analyzer	FSV	R&S
Power supply	E3633A	Agilent
Bi-conical antenna	VHA9103	Schwarzbeck
Log periodic antenna	VULP9118A	Schwarzbeck
Horn antenna	BBHA-9120D	Schwarzbeck
Pre-amplifier	SCU-01	R&S
Pre-amplifier	JS4-00102600	MITEQ

3.8.5 Test condition

- Test place : OATS
- Test environment : 12 °C, 38 % R.H.
- Test mode : TX mode

3.8.6 Test result

Frequency [MHz]	Transmitter spurious emission			
	Polarization [H/V]	Level [dBm]	Limit [dBm]	Margin [dB]
Operating frequency 136 MHz				
544.1	H	-49.4	-20.0	29.4
	V	-53.6	-20.0	33.6
Operating frequency 155 MHz				
465.5	H	-56.2	-20.0	36.2
	V	-52.7	-20.0	32.7
Operating frequency 174 MHz				
521.7	H	-44.5	-20.0	24.5
	V	-46.4	-20.0	26.4

Remarks:

1. * H : Horizontal polarization , ** V : Vertical polarization
2. Emission Level = Reading + Antenna factor + Cable loss
3. Margin value = Emission Level - Limit
4. All other emissions not reported were more than 25 dB below the permitted limit.
5. Measurement uncertainty estimated at ±3.90 dB.

The measurement uncertainty is given with a confidence of 95.45 % with the coverage factor, k=2.

3.9 Frequency stability

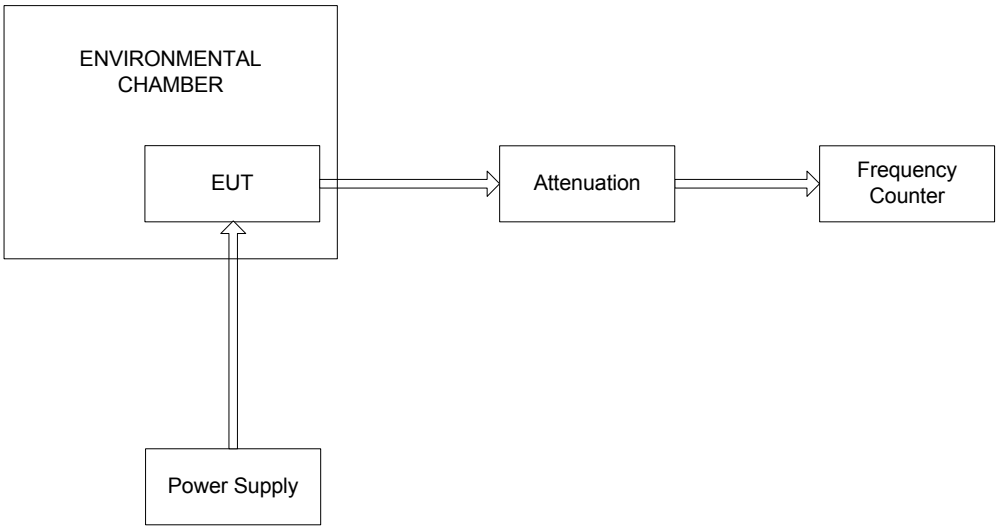
3.9.1 Specification

- FCC Rules Part 2 Section 2.1055
- FCC Rules Part 90 Section 90.231
- IC Rules RSS-119 Section 7.0

3.9.2 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.2

3.9.3 Set-Up



3.9.4 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Frequency counter	53150A	Agilent
Power supply	UP-1000	Unicorn
Attenuator	66-30-34	Weinschel
Environment chamber	SJ-1016-TH	Seo Jin

3.9.5 Test condition

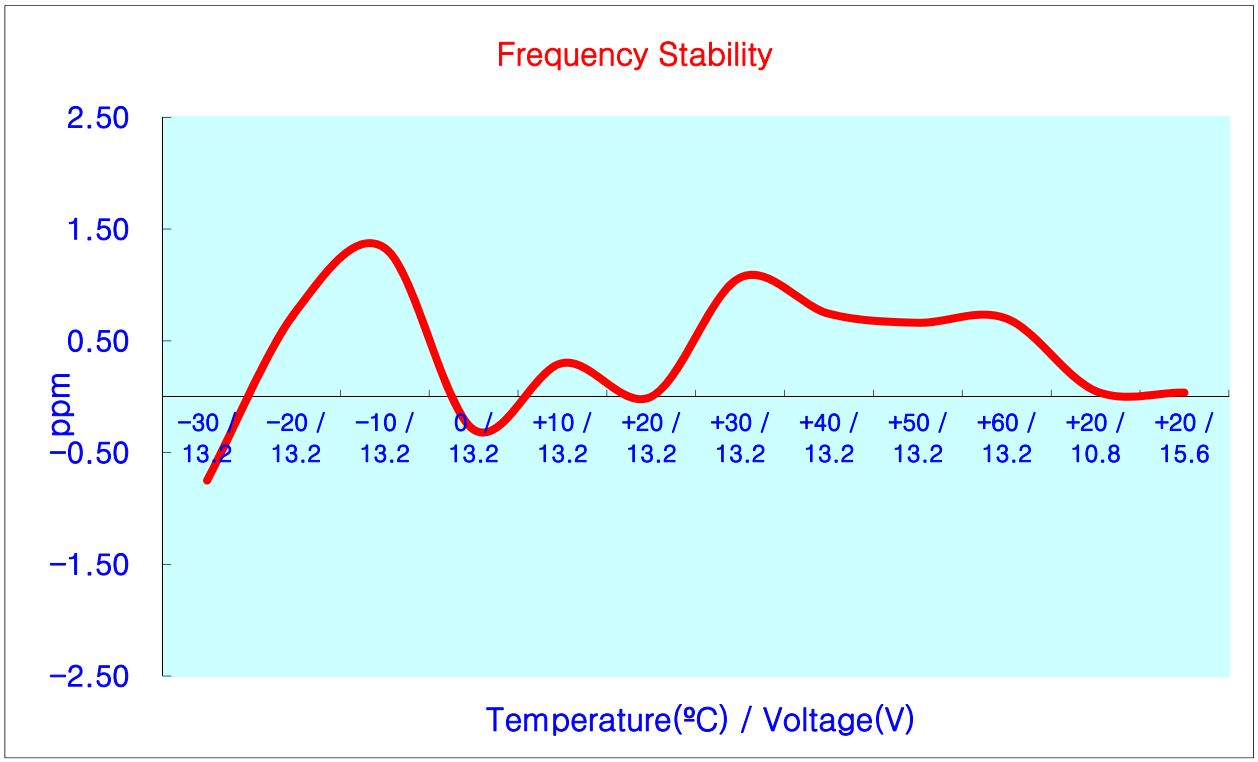
- Test place : Environment chamber
- Test mode : Non-modualtion

3.9.6 Test result

3.9.6.1 Test data 1 / 136 MHz

Voltage [%]	Supplied power [Vdc]	Temperature [ºC]	Frequency [MHz]	Deviation [ppm]	Limit [ppm]
100	13.2	-30	135.999 209	-0.75	2.50
100	13.2	-20	135.999 415	0.76	2.50
100	13.2	-10	135.999 492	1.33	2.50
100	13.2	0	135.999 271	-0.29	2.50
100	13.2	+10	135.999 352	0.30	2.50
100	13.2	+20 (ref.)	135.999 311	0.00	2.50
100	13.2	+30	135.999 456	1.07	2.50
100	13.2	+40	135.999 412	0.74	2.50
100	13.2	+50	135.999 401	0.66	2.50
100	13.2	+60	135.999 406	0.70	2.50
85	10.8	+20	135.999 318	0.05	2.50
115	15.6	+20	135.999 316	0.04	2.50

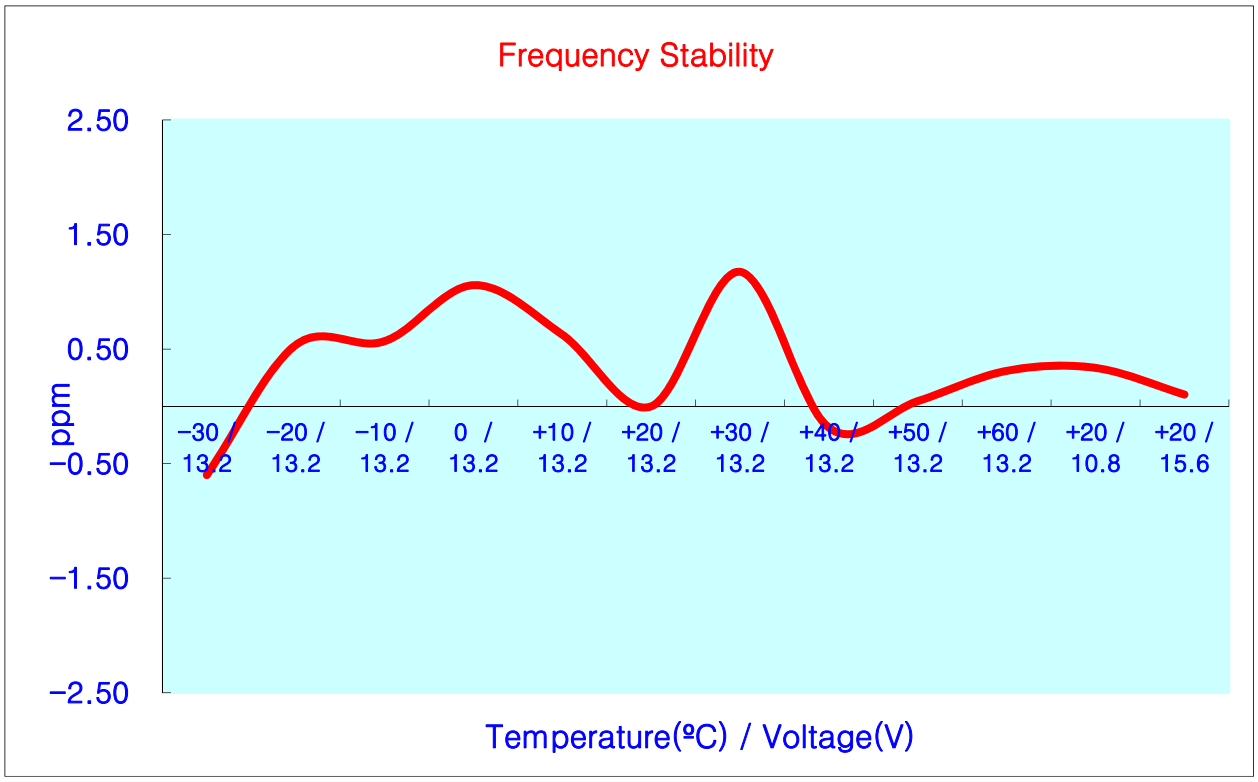
3.9.6.2 Graph 1 / 136 MHz



3.9.6.3 Test data 2 / 155 MHz

Voltage [%]	Supplied power [Vdc]	Temperature [ºC]	Frequency [MHz]	Deviation [ppm]	Limit [ppm]
100	13.2	-30	154.999 215	-0.60	2.50
100	13.2	-20	154.999 391	0.54	2.50
100	13.2	-10	154.999 396	0.57	2.50
100	13.2	0	154.999 472	1.06	2.50
100	13.2	+10	154.999 405	0.63	2.50
100	13.2	+20 (ref.)	154.999 308	0.00	2.50
100	13.2	+30	154.999 490	1.17	2.50
100	13.2	+40	154.999 279	-0.19	2.50
100	13.2	+50	154.999 315	0.05	2.50
100	13.2	+60	154.999 356	0.31	2.50
85	10.8	+20	154.999 360	0.34	2.50
115	15.6	+20	154.999 324	0.10	2.50

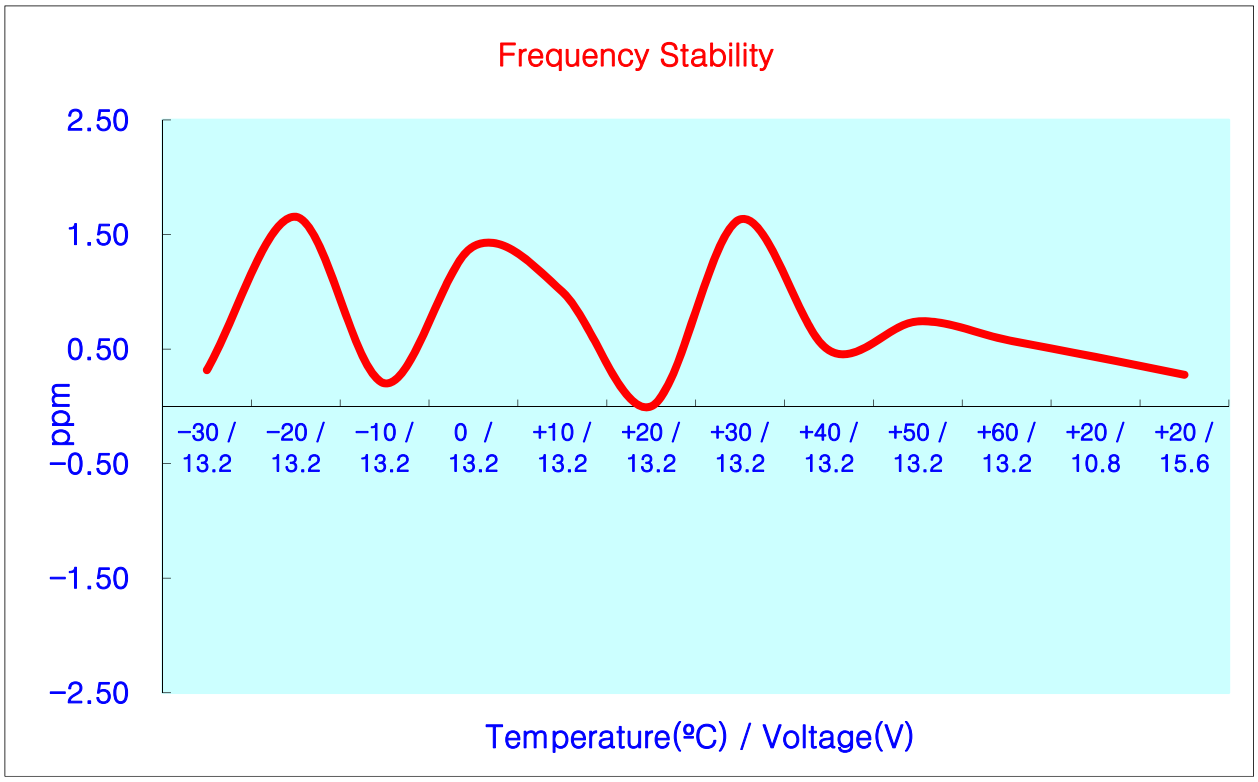
3.9.6.4 Graph 2 / 155 MHz



3.9.6.5 Test data 3 / 174 MHz

Voltage [%]	Supplied power [Vdc]	Temperature [ºC]	Frequency [MHz]	Deviation [ppm]	Limit [ppm]
100	13.2	-30	173.999 273	0.32	2.50
100	13.2	-20	173.999 506	1.66	2.50
100	13.2	-10	173.999 253	0.20	2.50
100	13.2	0	173.999 461	1.40	2.50
100	13.2	+10	173.999 392	1.00	2.50
100	13.2	+20 (ref.)	173.999 218	0.00	2.50
100	13.2	+30	173.999 502	1.63	2.50
100	13.2	+40	173.999 303	0.49	2.50
100	13.2	+50	173.999 347	0.74	2.50
100	13.2	+60	173.999 319	0.58	2.50
85	10.8	+20	173.999 293	0.43	2.50
115	15.6	+20	173.999 266	0.28	2.50

3.9.6.5 Graph 3 / 174 MHz



3.10 Transient frequency behavior

3.10.1 Test procedure

(1) The unit was turn-up in accordance with the alignment procedure stated and was loaded into a 50 ohm resistive termination.

(2) Using the variable attenuator the transmitter level was set to 40 dB below the test receivers maximum input level, then the transmitter was turned off.

(3) With the transmitter off the signal generator was set 20dB below the level of the transmitter in the above step, this level will be maintained with the signal generator through-out the test.

(4) Reduce the attenuation between the transmitter and the RF detector by 30 dB.

(5) With the levels set as above the transient frequency behavior was observed & recorded.

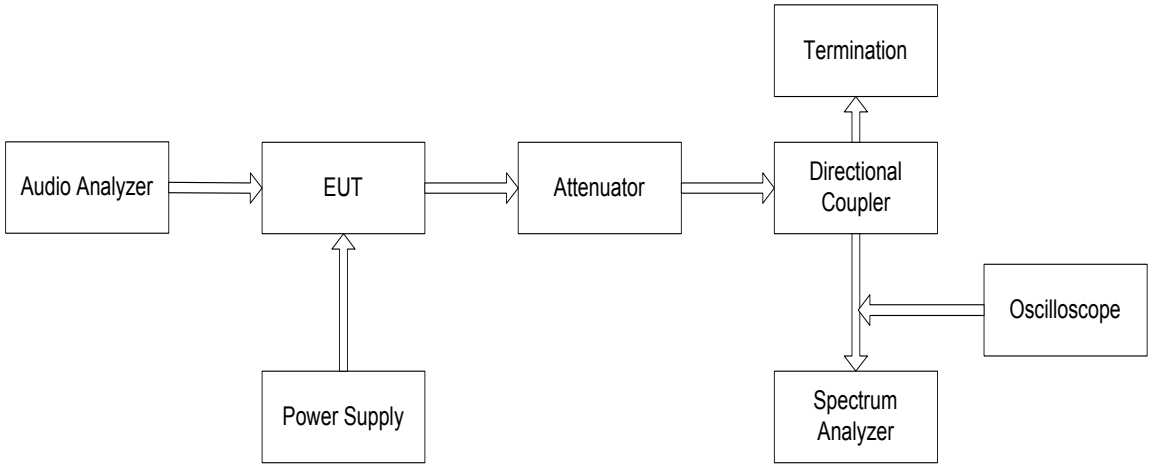
3.10.2 Specification

- FCC Rules Part 90 Section 90.214
- IC Rules RSS-119 Section 7.0

3.10.3 Measurement method

- ANSI/TIA-603-D-2010, Section 2.2.19

3.10.4 Set-Up



3.10.5 Test equipment list

Equipment	Model Name	Manufacturer
EUT	SM-2102E	Maxon CIC Corp.
Oscilloscope	TDS684A	Tectronix
Power supply	E3633A	Agilent
Attenuator	66-30-34	Weinschel
Audio analyzer	8903B	Agilent
Spectrum analyzer	N9020A	Agilent

3.10.6 Test condition

- Test place : Shield Room
- Test environment : 22 °C, 43 % R.H.
- Test mode : TX mode (Narrow band & Wide band)

3.10.7 Limit

Transient Frequency Difference Limits		
Time Interval	**Max. permitted frequency difference for 25 and 30 kHz channel spacing (in kHz)**	**Max. permitted frequency difference for 12.5 and 15 kHz channel spacing (in kHz)**
t_1 or t_3	25.0	12.5
t_2	12.5	6.25

Transient Duration Limits			
Time Intervals	**Frequency Ranges (MHz)**		
	30 to 174	406 to 512	806 to 940
t_1	5.0 ms	10.0 ms	20.0 ms
t_2	20.0 ms	25.0 ms	50.0 ms
t_3	5.0 ms	10.0 ms	10.0 ms

The transient frequency behavior of the transmitter is the variation in time of the transmitter frequency difference from the nominal frequency of the transmitter when the RF output power is switched on and off.

t_{on}: according to the method of measurement described the switch-on instant t_{on} of a transmitter is defined by the condition when the output power, measured at the antenna terminal, exceeds 0,1 % of the nominal power.

t_1: period of time starting at t_{on} and finishing.

t_2: period of time starting at the end of t1 and finishing.

t_{off}: switch-off instant defined by the condition when the nominal power falls below 0,1 % of the nominal power.

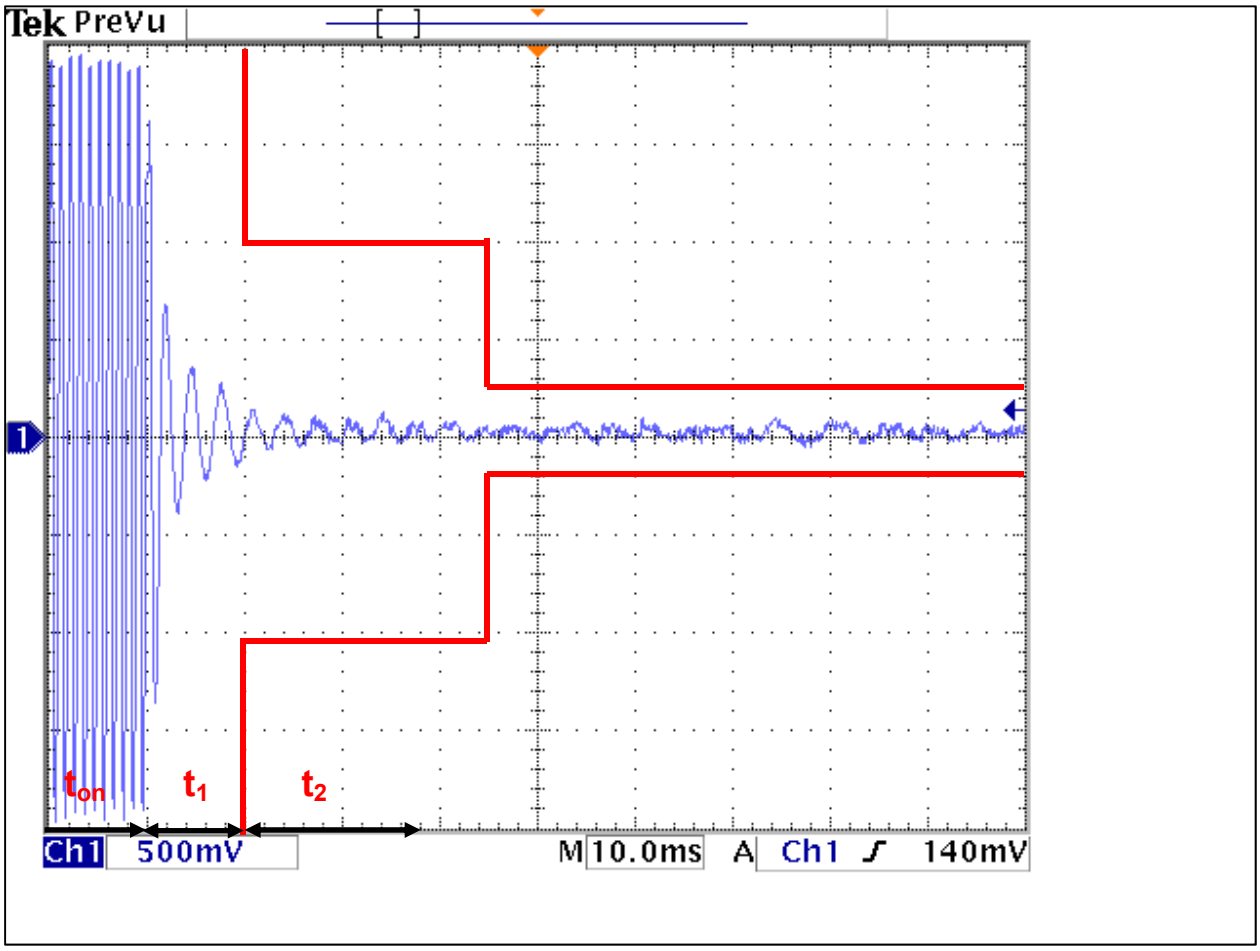
t_3: period of time that finishing at t_{off} and starting.

3.10.8 Test data

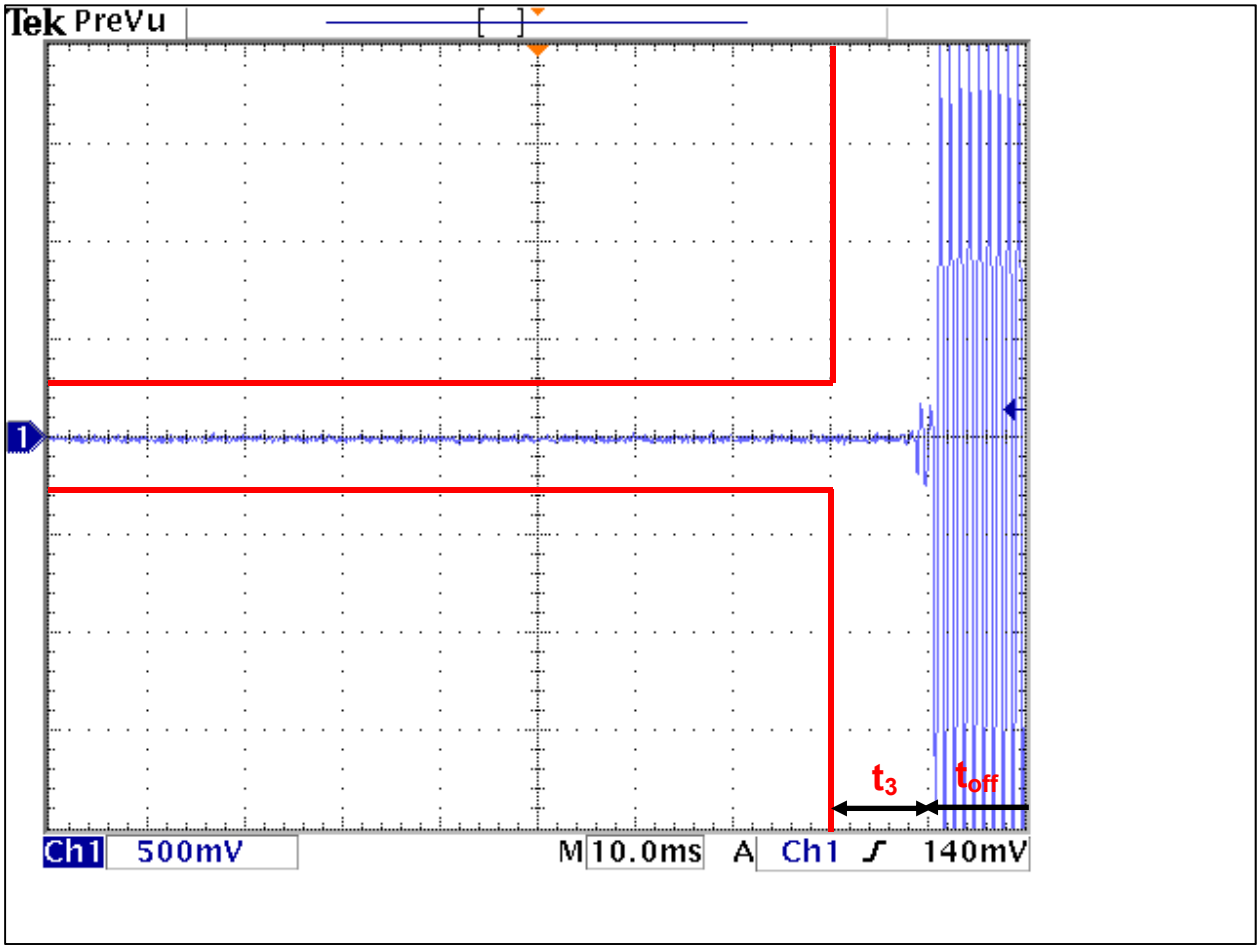
Transient Period	Transient Frequency Period (ms)
t_1	« 10.0 ms
t_2	« 25.0 ms
t_3	« 10.0 ms
Uncertainty (%)	10

3.10.9 Test plot

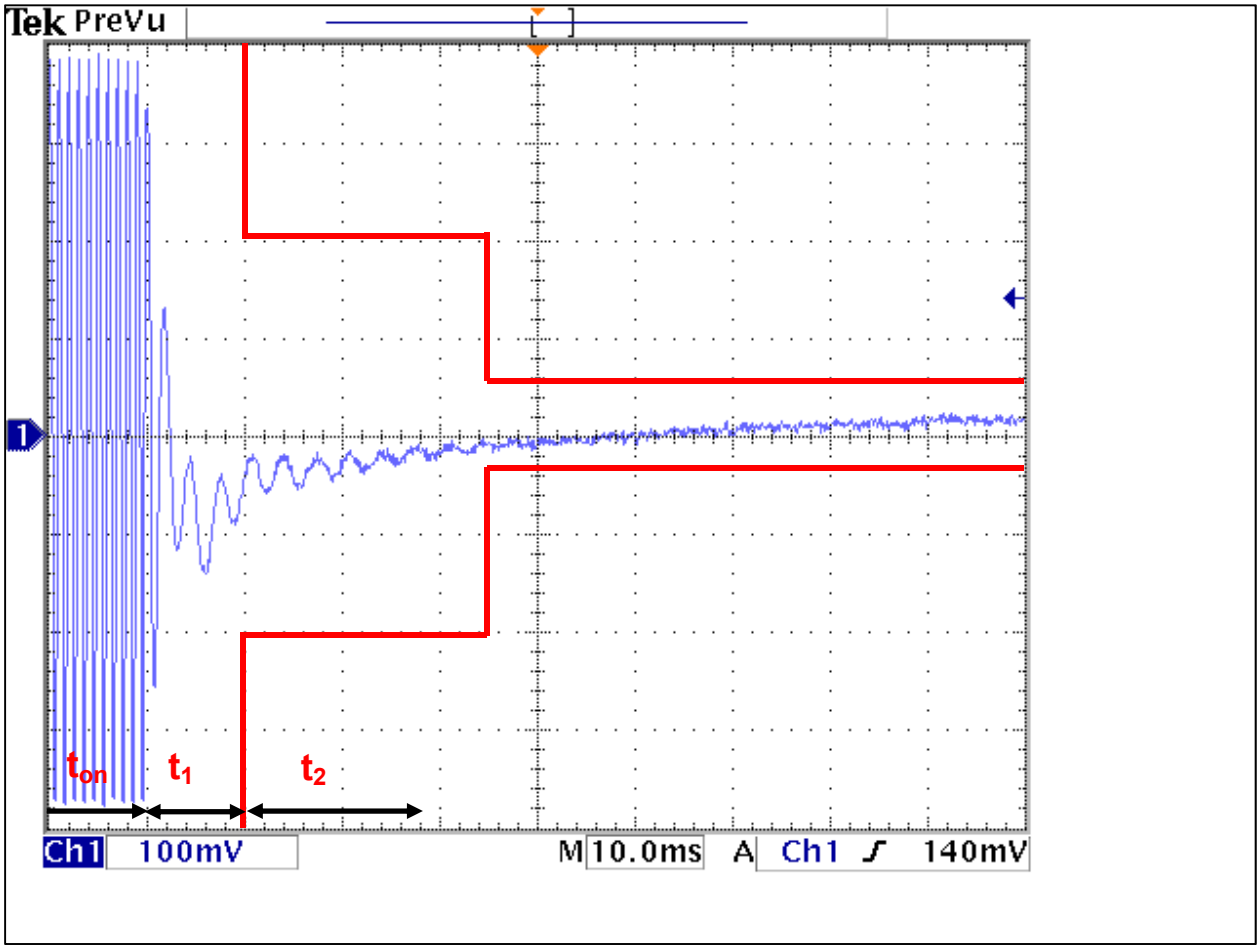
3.10.9.1 Test plot 1 / Narrow band / Switch on condition



3.10.9.2 Test plot 2 / Narrow band / Switch off condition



3.10.9.3 Test plot 3 / Wide band / Switch on condition



4. RF exposure statement

According to §1.1307, systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy level in excess of the Commission's guidelines. According to §1.1310 and §2.1091 RF exposure is calculated.

Limits for General Population/Uncontrolled Exposure

Frequency Range [MHz]	Electric Field Strength [V/m]	Magnetic Field Strength [A/m]	Power Density [mW/cm^2]	Averaging Time [minute]
Limits for General Population/Uncontrolled Exposure				
0.3 – 1.34	614	1.63	100	30
1.34 – 30	824/f	2.19/f	180/f^2	30
30 – 300	27.5	0.073	0.2	30
300 – 1500	-	-	f/1500	30
1500 – 100 000	-	-	1.0	30

※ f = frequency in MHz

4.1 Friis transmission formula

$$P_d = \frac{P_{out} \times G}{4\pi \times R^2}$$

P_d = Power density
P_{out} = power input to antenna
G = power gain
R = distance to the center of radiation of the antenna

$$R = \sqrt{\frac{P_{out} \times G}{4\pi \times P_d}}$$

4.2 Calculation of MPE

Frequency [MHz]	Output power [dBm]	Antenna gain [dBi]	Average power		Power density		Minimum safety distance [cm]
			[dBm]	[W]	[mW/cm^2]	[W/m^2]	
135.0	43.72	2.14	45.86	38.55	0.136	1.364	123.88
155.0	43.75	2.14	45.89	38.82	0.137	1.374	124.31
174.0	43.86	2.14	46.00	39.81	0.141	1.409	125.89

※ Calculated minimum separation distance from antenna : 150 cm

5. Test equipment list

The listing below denotes the test equipment for the test(s).

No.	Equipment	Model	Manufacturer	Serial Number	Calibration Due date
1	Spectrum Analyzer	FSV	R&S	101673	02/04/14
2	Audio Analyzer	8903B	Agilent	3514A16893	01/29/14
3	Modulation Analyzer	8901B	Agilent	3028A02893	01/29/14
4	Oscilloscope	TDS684A	Tektronix	B090597	01/29/14
5	Attenuator	66-30-34	Weinschel	CB0744	01/31/14
6	Power Supply	E3633A	Agilent	SG40002272	01/28/14
7	Loop Antenna	6502	EMCO	9609-9087	02/13/14
8	Biconical Antenna	VHA9103	Schwarzbeck	2217	11/23/13
9	Log-Periodic Antenna	VULP9118A	Schwarzbeck	382	11/23/13
10	Horn Antenna	BBHA 9120 D	Schwarzbeck	395	08/07/13
11	Pre-Amplifier	SCU-01	R&S	10020	09/26/13
12	Pre-Amplifier	JS4-00102600	MITEQ	383521	01/29/14
13	Turn Table	N/A	Daeil EMC	N/A	N/A
14	Antenna Mast	EAM4.5	Daeil EMC	N/A	N/A
15	Controller	DE200	Daeil EMC	AAA69813111	N/A

