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# Approval Sheet

for Product Specification

Product Name : Bluetooth Module

Model No. : M5G

Customer Approval

Signature / Stamp

sonorix

**Change History**

<b>Rev.</b>	<b>Date</b>	<b>Author</b>	<b>Reason for Change</b>
0.9	2008.5.26	S.H.Cho	Preliminary Drafting
1.0	2008.6.18	S.H.Cho	Antennae characteristics and reliability test data supplements
1.1	2009.5.23	Y.Y.Lim	Change the Connector (SMD > DIP)

**Internal Check/Approval**

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<b>Date</b>	2009.5.23		
<b>Signature</b>			

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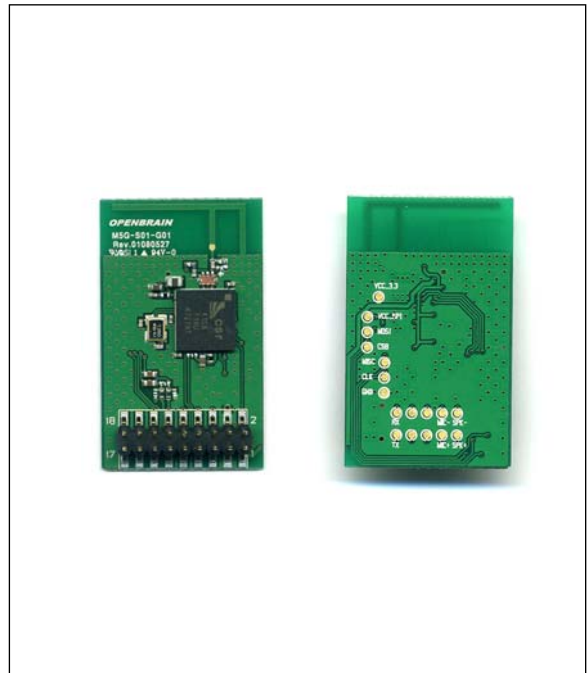
## 1. Summary

This document defines the product specifications of Bluetooth voice communication module (M5G) including electrical and mechanical characteristics manufactured by OPENBRAIN for customer approval purposes.

### 1.1. Product Summary

OPENBRAIN's M5G is a compact Bluetooth module designed to provide easy Bluetooth audio application for communication devices without Bluetooth functionality. By integrating the module into communication devices that use speaker/microphone or wired ear-sets, it enables the communication device to be used with Bluetooth headsets within a range of 10m distance.

M5G integrates all the functions needed to replace existing audio connection wirelessly and has been designed such that it is possible to control and monitor the functions externally via serial (UART) communication thereby enabling Bluetooth functionality to be implemented into devices in a short period of time. Also, the module has been designed to be ultra-small and light with minimal power consumption thereby making it ideal for integration without sacrificing electrical and mechanical design factors of existing devices. The advantages of using M5G are, it makes production easy and simple as the modules are RF tuned and tested before supply and it is not necessary for customers to secure additional Bluetooth test/measuring equipments.



### 1.2. Product Features

- Wireless application possible without having to change circuit or software of existing communication devices
- Built-in antennae eliminates the need for separate antennae
- Control of all functions and state monitoring via UART communication
- Can be customized according to customer requirements

### 1.3. Specifications

- Bluetooth V2.0, 1.2, 1.1 compatible
- Frequency Band : 2,400 ~ 2,483 MHz
- Embedded Protocol : L2CAP, RFCOMM, SDP

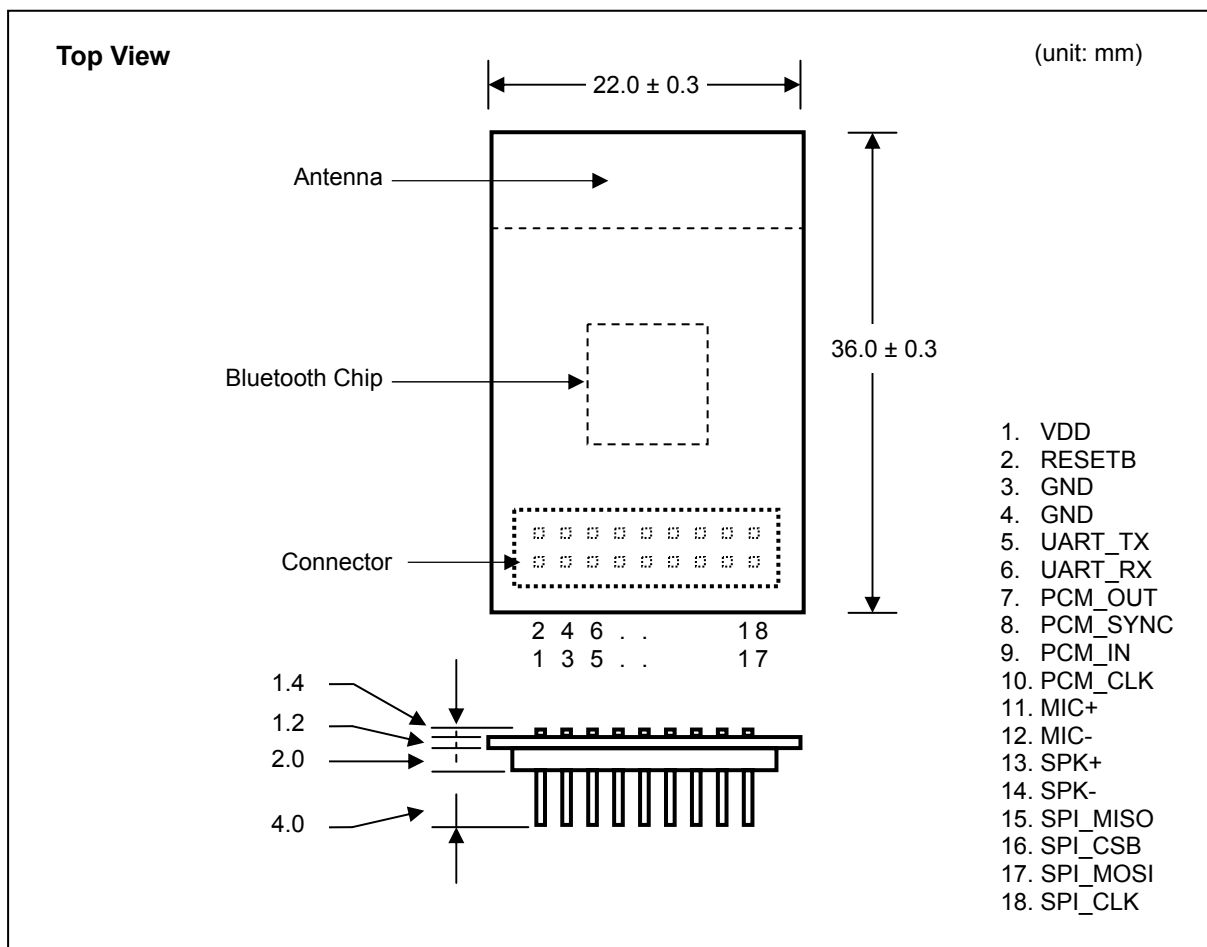
- Embedded Profile : Handsfree AG
- Output Power: 0dBm (Power Class 2)
- Receiver Sensitivity : < -80dBm
- Max. Data Rate : 702kbps
- Antennae Gain: 0dBi Max.
- Voice Signal Interface: Analog Single Ended or Differential
- Host Interface: UART (1.8V Level, 115,200bps).
- Operating Voltage: 3.3V
- Operating Temp: -25 ~ +85℃
- Size: 22.0mm X 36.0mm X 8.4mm

**1.4. Application**

- Mobile phones, Video phones, VoIP phones
- Other Voice Communication Devices

**1.5. External Appearance and Pin (Pad) Specifications**

**Mechanical Layout**



\* For mechanical part details, refer to 3.4

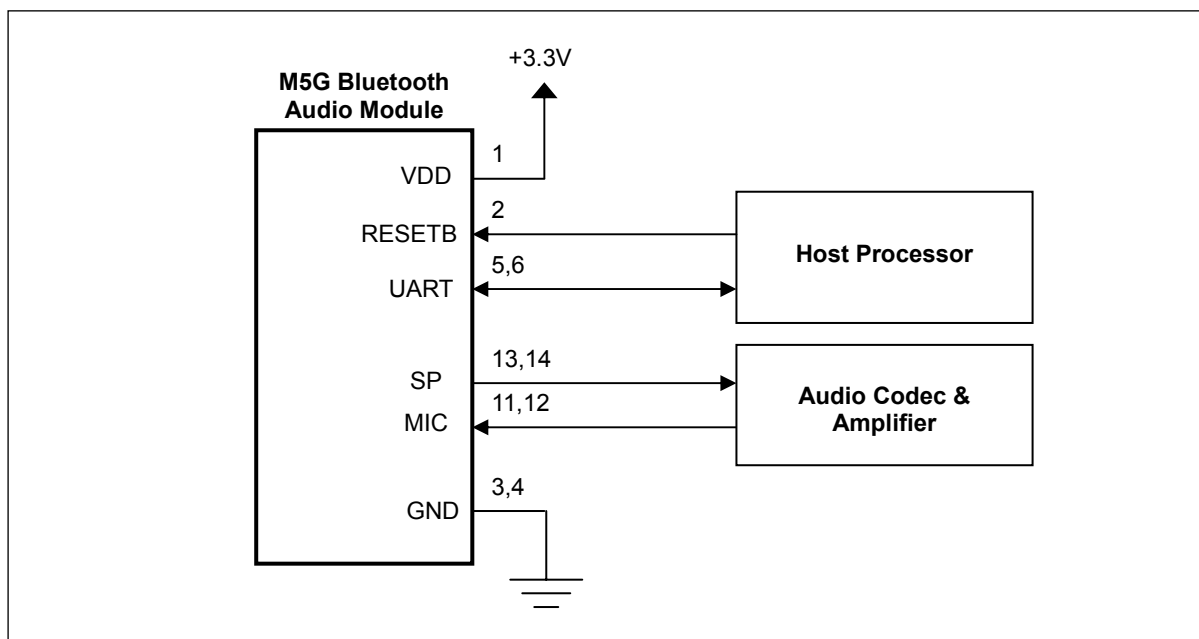
**Pin Description**

Pin No	Name	Description
1	VDD	Positive supply (3.0V~4.2V)
2	RESETB	Reset if low. Input debounced so must be low for > 5ms to cause a reset
3	GND	Ground
4	GND	Ground
5	UART_TX	UART data output
6	UART_RX	UART data input
7	PCM_OUT	PCM Synchronous data out
8	PCM_SYNC	PCM Synchronous data sync
9	PCM_IN	PCM Synchronous data in
10	PCM_CLK	PCM Synchronous data clock
11	MIC+	Microphone differential, Input P
12	MIC-	Microphone differential, Input N
13	SPK+	Speaker differential output P or single ended output
14	SPK-	Speaker differential output N or single ended output
15	SPI_MISO	Serial Peripheral interface data output
16	SPI_CSB	Chip select for synchronous serial peripheral interface
17	SPI_MOSI	Serial Peripheral interface data input
18	SPI_CLK	Serial Peripheral interface clock

## 2. How to Use

### 2.1. Hardware Design Methodology

To use M5G module with existing communication devices, connect Host Processor with RESETB and UART transceiver port as shown and connect SP+, SP-, MIC+ and MIC- to analog audio input/output port of Audio Codec via Differential Mode. To connect audio input/output as Single Ended Mode, use any one of the two terminals or use dedicated audio Amp to change the mode. But Differential Mode is strongly recommended as it has the effect of improving S/N ratio. In case Single Ended Mode has to be used, it is recommended that dedicated Amp be used.



### 2.2. Operating Procedures

The operating procedures for M5G module are as follows: Details on operating procedures and UART communication protocol are defined in a separate document.

- **Pairing Mode:** Searches for Bluetooth devices in the vicinity that support Handsfree and Headset profiles and allows user to connect with a specific selected device.
- **Paging Mode:** Connection attempt with paired device. If pairing information of multiple devices are present, paging will start with the latest device that has been connected.
- **Connected Mode:** Bluetooth link established with paged device.
- **Incoming Call:** The state wherein bell rings when call is coming in.
- **Outgoing Call:** The state wherein user makes a call.
- **Talk Mode:** The state where user is talking with other party.

### 3. Product Specifications

#### 3.1. Electrical Specifications

##### Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD	Power Input Voltage (Pin 1)	-0.4	+5.6	V
V+, V-	Port Input Voltage	VSS-0.4	VDD+0.4	V
PinRF	RF Input Power		0	dBm
Ts	Storage Temp.	-35	+120	°C

- Be careful not to expose the product to voltages and signals beyond rated values indicated above as this may cause damage.

##### Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
VDD	Power Input Voltage (Pin 1)	2.2	3.3	4.2	V
To	Operating Temp.	-25	+25	+85	°C

##### RF Characteristics

Symbol	Parameter	Condition	Min	Typ	Max	Unit
PoutRF	Transmit Output Power		0	+2	+4	dBm
MODF1avg	Modulation Characteristics	Data = 00001111	140	164	175	kHz
MOFF2max		Data = 10101010	115	150		kHz
F2avg/F1avg			0.8	0.97		
20dB BW				940	1000	kHz
RXsense	Receive Sensitivity	BER < 0.001		-83	-79	dBm
PinRF	Maximum Input Level		-20	-10		dBm
IMP	Inter-Modulation Performance	F1 = +3MHz F2 = +6MHz PinRF = -64dBm	-39	-15		dBm
OOB	Out Of Band Blocking Performance	PinRF = -10dBm 30MHz ~ 2GHz 3GHz ~ 12.75GHz	-10	0		dBm
		PinRF = -27dBm 2000MHz ~ 2399MHz 2498MHz ~ 3000MHz	-27	-15		dBm

\* Measured Temperature : +25°C, Measured Voltage : 3.3V



**Audio Characteristics**

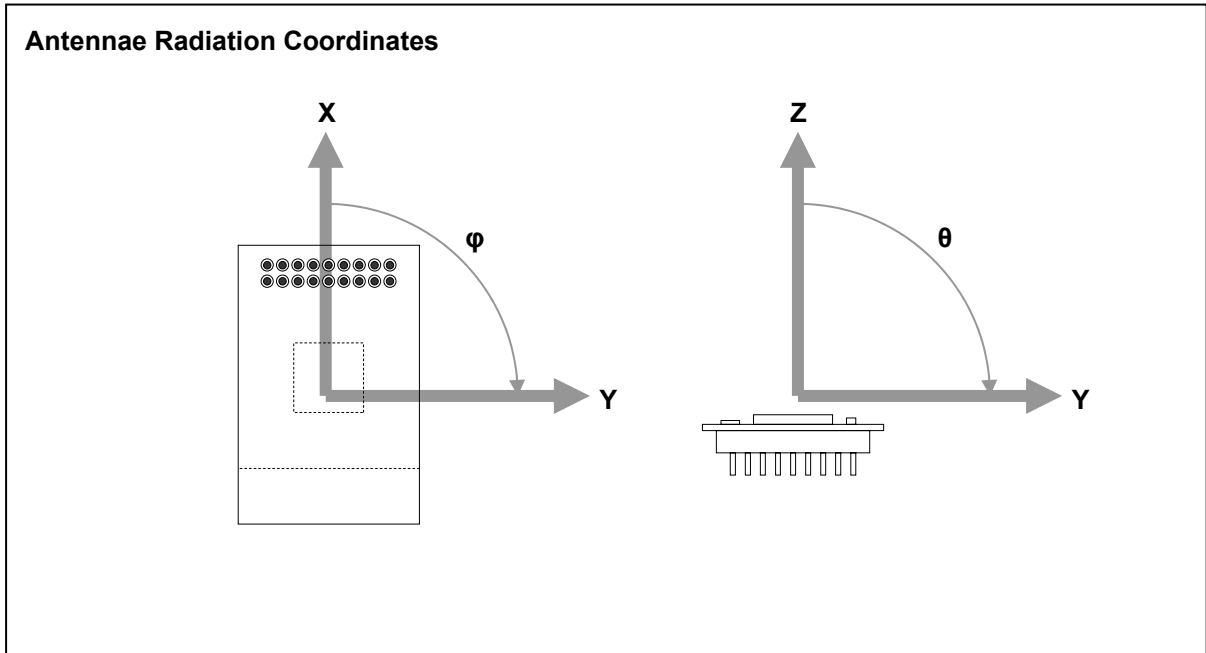
Symbol	Parameter	Min	Typ	Max	Unit
Vain_max	Input Full Scale at Maximum Gain		3		mVrms
Vain_min	Input Full Scale at Minimum Gain		350		mVrms
BWain	Bandwidth of Microphone Amplifier		20		kHz
IMPmic	Mic Mode Input Impedance		20		kohm
IMPin	Input Mode Input Impedance		130		ohm
Vsp_out	Output Voltage Full Scale Swing(Differential)		2.0		Vp-p
Isp_out	Output Current Drive (at Full Scale Swing)	10	20	40	mA
BWaout	Output -3dB Bandwidth		18.5		kHz
Lres	Allowed Load: Resistive	8		Open	ohm
Lcap	Allowed Load: Capacitive			500	pF

**3.2. Current Consumption**

Operating Mode	Connection Type	UART Rate(kbps)	Average	Unit
Page Scan	-	115.2	0.49	mA
Inquiry and Page Scan	-	115.2	0.83	mA
ACL 1.28s sniff	Master	38.4	0.37	mA
SCO HV1	Master/Slave	38.4	41	mA
SCO HV3	Master/Slave	38.4	21~26	mA
Standby Host Connection	-	38.4	76	uA
Reset(RESETB low)	-	-	58	uA

\* Operating Temp: +25°C, Measurement point: 1.8V VDD input terminal

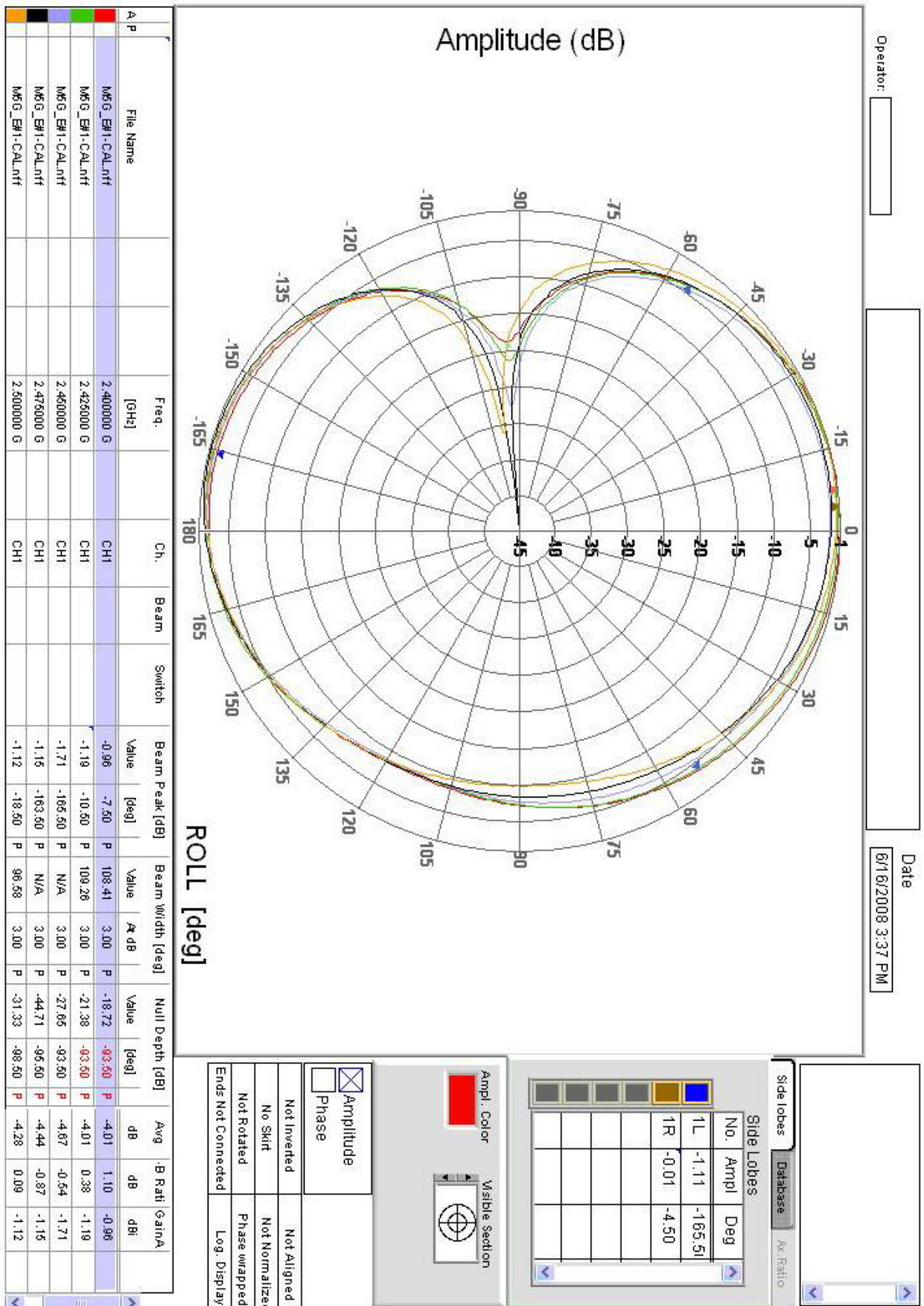
**3.3. Antennae Radiation Characteristics**



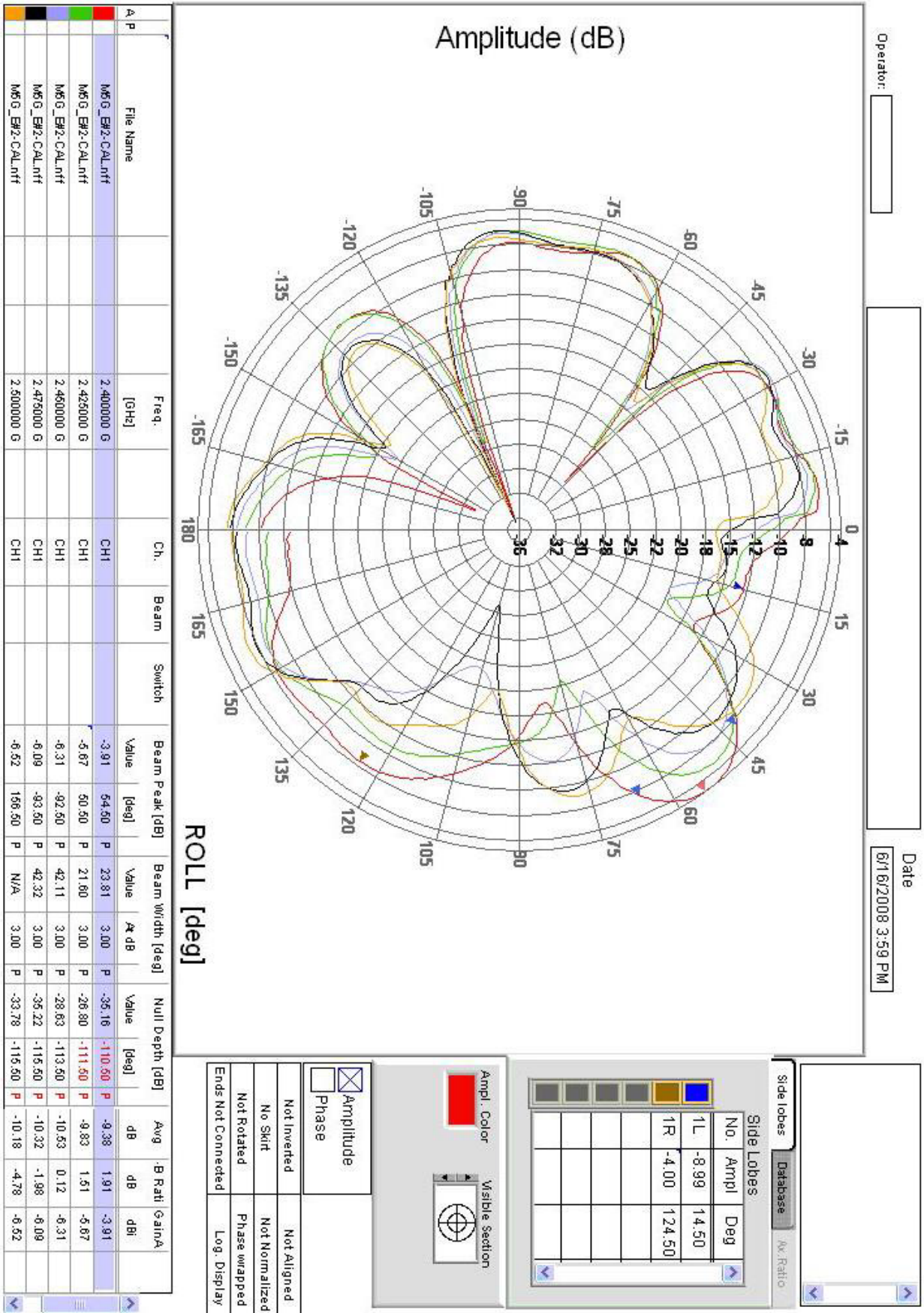
**Radiation gain(E-Field, dBi)**

Freq (GHz)	XY		XZ		YZ		Total Gain	
	Peak	Average	Peak	Average	Peak	Average	Peak	Average
2.400	-0.96	-4.01	-1.11	-4.54	-6.31	-10.45	-0.96	-5.67
2.450	-1.71	-4.67	-1.53	-5.12	-7.27	-11.21	-1.53	-5.23
2.500	-1.12	-4.28	-1.18	-4.55	-7.64	-11.72	-1.12	-5.62

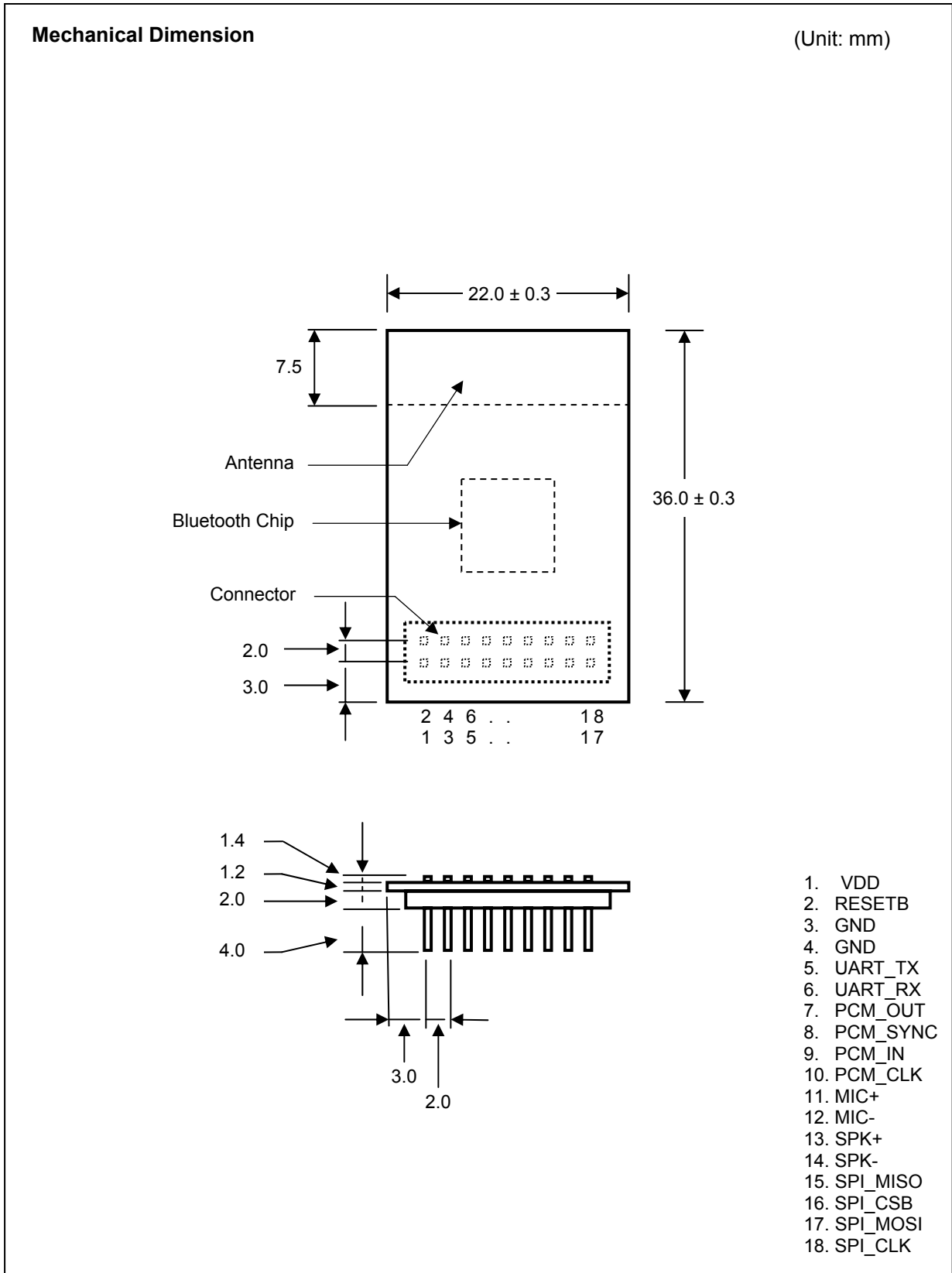
Radiation Pattern - Azimuth XY (E-Field, Standalone Module)



Radiation Pattern - Azimuth XY (E-Field, Module Mounted onto Product)



**3.4. Mechanical Specifications**



## 4. Precautions during handling

### 4.1. General precautions

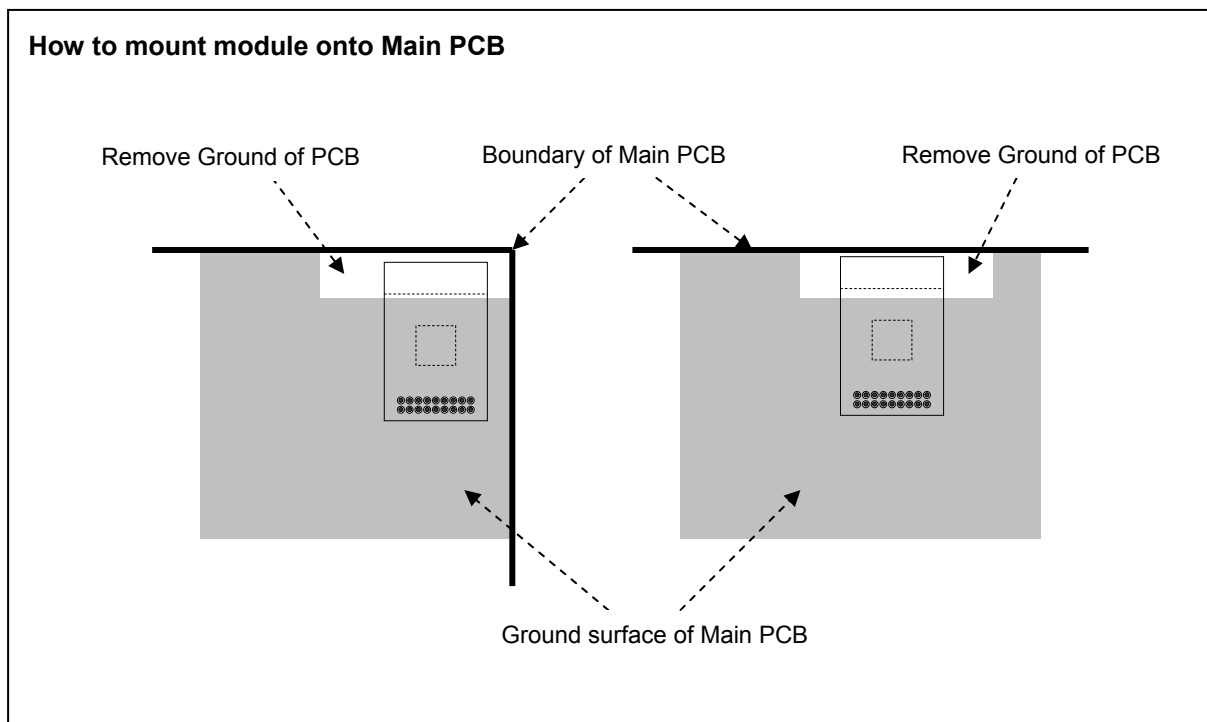
Precautions for handling M5G modules are as follows:

- Do not expose the modules to static electricity as it may cause damage.
- Use power source that will provide enough current to power input terminal of module.
- Use only rated voltage or RF signals.

### 4.2. Maximizing RF Performance

To maximize RF performance of products that use M5G module, PCB has to be designed taking into the consideration the following:

- Sufficient Ground area has to be secured on Main PCB for stable RF performance.
- Objects (conductors, insulators) close to antennae will interfere radiation and distort radiation pattern. For conductors, they should be at least 10mm away from antennae and for insulators such as plastic parts, at least 5mm away.
- Main PCB must be designed such that the ground of Main PCB does not intrude into ground of module and antennae boundary lines as shown in the diagram below.



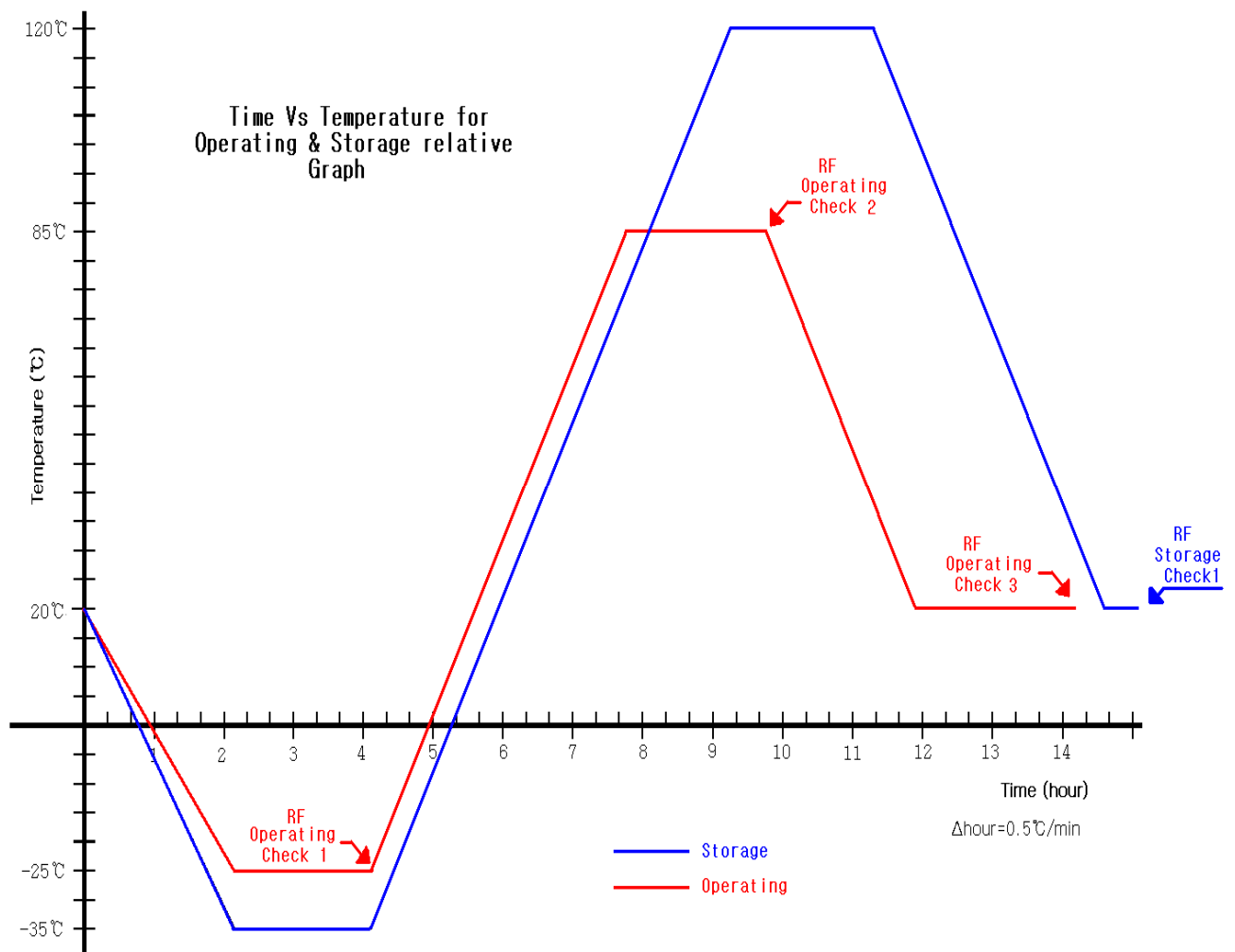
## 5. Reliability Test Result

### 5.1. Operating and storage temperature test results

- M5G module stored in temperature and moisture resistant chamber for 2 hours from -35 ~ +120°C

Operating Temp.	Result	Storage Temp.	Result
+85°C	Normal	+120°C	Normal
+20°C	Normal		Normal
-25°C	Normal	-35°C	Normal

### 5.2. Time Vs Temperature for Operating & Storage Relative Graph



**5.3. Radio Characteristics for Each Check Point**

- Measurement results and Bluetooth specification compliance of modules stored in temperature and moisture resistant chamber for 2 hours at -25°C

RF Operating Check 1(-25°C)						
				Result (dBm)	Bluetooth Spec.(dBm)	Verdict
Output Power				+2.65	-6 to +4	Pass
Sensitivity at 0.1% BER for all packet types				-86	≤-70	Pass
Modulation Characteristics	Channel	df1_avg (kHz)	df2_avg (kHz)	df2/df1 (%)	Bluetooth Spec.	Verdict
	0	164.6	158.7	96.42	140<df1_avg, df2_avg <175 0.80<df2/df1(%)	Pass
	39	164.5	155.7	94.65		Pass
	78	164.7	156.1	94.78		Pass
Initial Carrier Frequency Tolerance (ICFT)		Df0_max (kHz)	Df0_min (kHz)	Bluetooth Spec.(kHz)		Verdict
		0.2	-0.1	±75		Pass
Carrier Frequency Drift(CFD)	Channel	f_drift_max (kHz)	Drift_rate_max (kHz/50us)	Bluetooth Spec.(kHz)		Verdict
	0	10.1	4.7	Drift Rate Max ≤20 f drift max≤40		Pass
	39	9.4	-5.3			Pass
	78	7.4	6.1			Pass
TX Output Spectrum -20dB Bandwidth		f_h-f_l			Bluetooth Spec.(MHz)	Verdict
		0.914			f_h - f_l ≤ 1.000MHz	Pass



- Measurement results and Bluetooth specification compliance of modules stored in temperature and moisture resistant chamber for 2 hours at 85°C)

RF Operating Check 2 (85°C)						
				Result (dBm)	Bluetooth Spec.(dBm)	Verdict
Output Power				+3.8	-6 to +4	Pass
Sensitivity at 0.1% BER for all packet types				-82.5	≤-70	Pass
Modulation Characteristics	Channel	df1_avg (kHz)	df2_avg (kHz)	df2/df1 (%)	Bluetooth Spec.	Verdict
s	0	163.8	156.5	95.54	140<df1_avg, df2_avg	Pass
	39	164.9	157.6	96.16	<175	Pass
	78	164.9	156.5	95.49	0.80<df2/df1(%)	Pass
Initial Carrier Frequency Tolerance (ICFT)		Df0_max (kHz)		Df0_min (kHz)	Bluetooth Spec.(kHz)	Verdict
		29.8		29.3	±75	Pass
Carrier Frequency Drift(CFD)	Channel	f_drift_max (kHz)	Drift_rate_max (kHz/50us)		Bluetooth Spec.(kHz)	Verdict
Drift(CFD)	0	-13.6	6.4		Drift Rate Max	Pass
	39	-10.2	-5.7		≤20	Pass
	78	-15.9	-8.1		f drift max≤40	Pass
TX Output Spectrum -20dB Bandwidth		f_h-f_l			Bluetooth Spec.(MHz)	Verdict
		0.914			f_h - f_l ≤ 1.000MHz	Pass

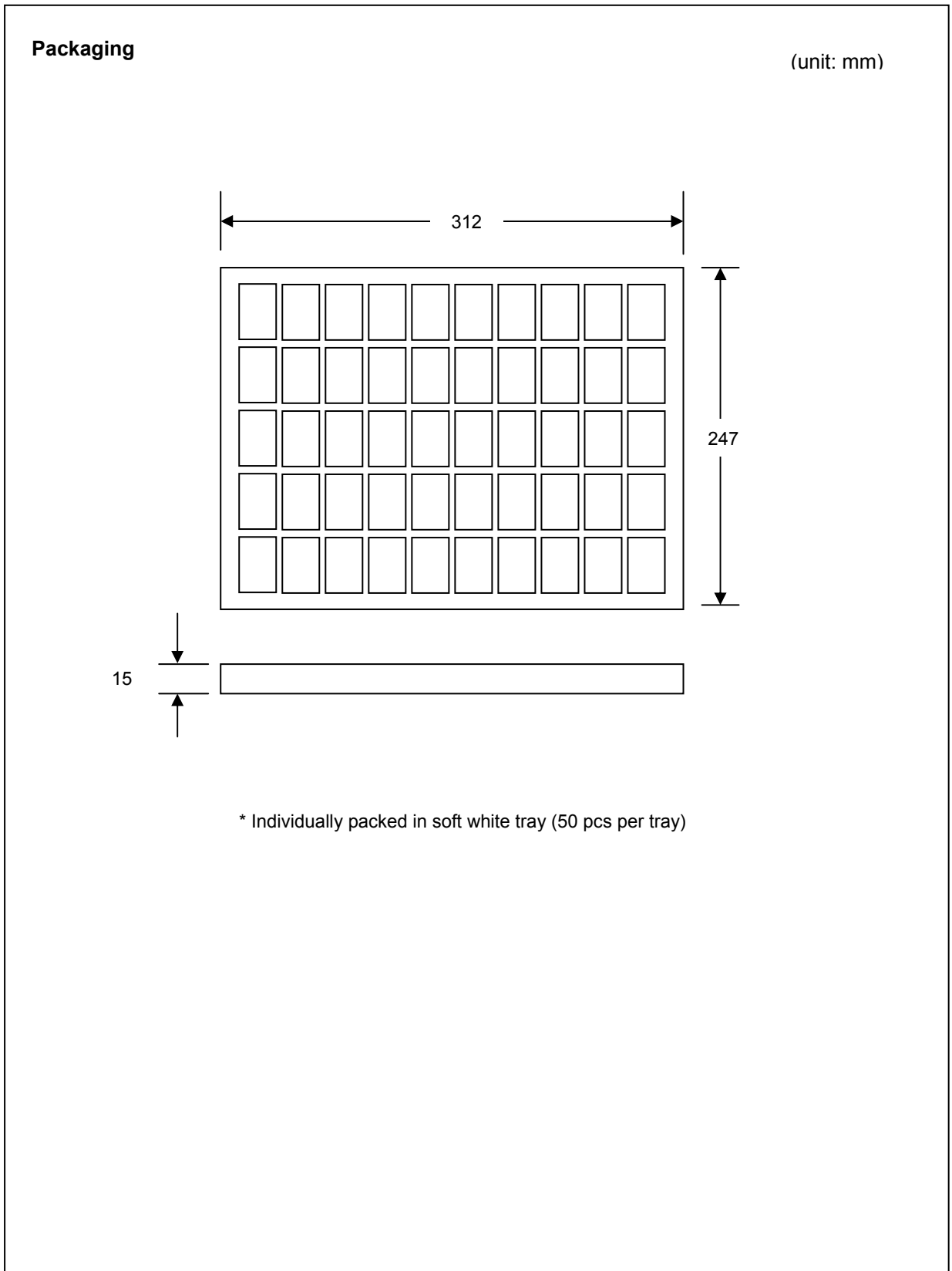
- Measurement results and Bluetooth specification compliance of modules stored in temperature and moisture resistant chamber for 2 hours at 20 °C)

RF Operating Check 3 (20 °C)						
				Result (dBm)	Bluetooth Spec.(dBm)	Verdict
Output Power				+2.54	-6 to +4	Pass
Sensitivity at 0.1% BER for all packet types				-84.5	≤-70	Pass
Modulation Characteristics	Channel	df1_avg (kHz)	df2_avg (kHz)	df2/df1 (%)	Bluetooth Spec.	Verdict
s	0	164.3	160.1	97.44	140<df1_avg, df2_avg	Pass
	39	164.6	159.9	97.14	<175	Pass
	78	164.7	159.4	96.78	0.80<df2/df1(%)	Pass
Initial Carrier Frequency Tolerance (ICFT)		Df0_max (kHz)		Df0_min (kHz)	Bluetooth Spec.(kHz)	Verdict
		13.3		11.5	±75	Pass
Carrier Frequency Drift(CFD)	Channel	f_drift_max (kHz)	Drift_rate_max (kHz/50us)		Bluetooth Spec.(kHz)	Verdict
Drift(CFD)	0	8.4	-5.4		Drift Rate Max	Pass
	39	6.9	-6.4		≤20	Pass
	78	7.0	6.5		f drift max≤40	Pass
TX Output Spectrum -20dB Bandwidth		f_h-f_l			Bluetooth Spec.(MHz)	Verdict
		0.914			f_h - f_l ≤ 1.000MHz	Pass

- Measurement results and Bluetooth specification compliance of modules stored in temperature and moisture resistant chamber for 2 hours at -35°C, 120°C (Storage Graph)

RF Stored Check 1 (-35°C ~ +120°C)						
				Result (dBm)	Bluetooth Spec.(dBm)	Verdict
Output Power				0.1	-6 to +4	Pass
Sensitivity at 0.1% BER for all packet types				-81	≤-70	Pass
Modulation Characteristics	Chann el	df1_avg (kHz)	df2_avg (kHz)	df2/df1 (%)	Bluetooth Spec.	Verdict
	0	164.6	160.3	97.45	140<df1_avg, df2_avg	Pass
	39	164.6	160.2	97.33	<175	Pass
	78	164.5	159.3	96.84	0.80<df2/df1(%)	Pass
Initial Carrier Frequency Tolerance (ICFT)		Df0_max (kHz)	Df0_min (kHz)	Bluetooth Spec.(kHz)	Verdict	
		13.2	11.9	±75	Pass	
Carrier Frequency Drift(CFD)	Chann el	f_drift_max (kHz)	Drift_rate_max (kHz/50us)	Bluetooth Spec.(kHz)	Verdict	
	0	8.3	7.1	Drift Rate Max	Pass	
	39	8.4	7.2	≤20	Pass	
	78	6.4	7.2	f drift max≤40	Pass	
TX Output Spectrum -20dB Bandwidth		f_h-f_l		Bluetooth Spec.(MHz)	Verdict	
		0.922		f_h - f_l ≤ 1.000MHz	Pass	

## 6. Packaging



## 7. Product Setting (Customization)

### Configuration of Bluetooth Parameters - Factory Setting

No	Parameter	Value
1	Local Device Name	“VPAD” (ASCII)
2	Bluetooth Device Address	“00150EE20000 ~ 00150EF00000” (HEX)
3	UART Baud Rate	115,200 bps
4	UART Parity	None
5	UART Stop Bit	1
6	UART Flow Control	None
7	Class Of Device	Audio/Phone/Audio_Gateway (0x20 0x02 0x10)
8	Security Mode	Level 1 (depends on remote device security level)
9	Operating Mode	Active and Sniff Mode Support.
10	Page Scan Mode	Discoverable & Connectable
11	Inquiry Mode	Non-discoverable & Non-connectable

#### Caution

Modifications not expressly approved by the party responsible for compliance could void the user’s authority to operate the equipment.

#### Assure compliance

The use of the modular transmitter is only approved to be used inside SBN Tech equipment. We assure the compliance of the end product when it is assembled inside SBN Tech equipment.

## 8. FCC Information to User

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

**FCC Compliance Information :** This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation

### **IMPORTANT NOTE:**

#### **FCC RF Radiation Exposure Statement:**

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.