Revision History

Rev.	History	Issue Date	Remark
0.1	Initial issue: TMTM2009	2015/09	Preliminary
1.0	P10 Product marking TM2009 YYWW	2017/09/17	Randall Lan
1.1	Correction: Dimension QFN-4x4mm-20L	2018/02/06	Randall Lan
1.2	At Page 10, Product marking TM2009 ABCD (lot control number),	2020/07/06	Randall Lan

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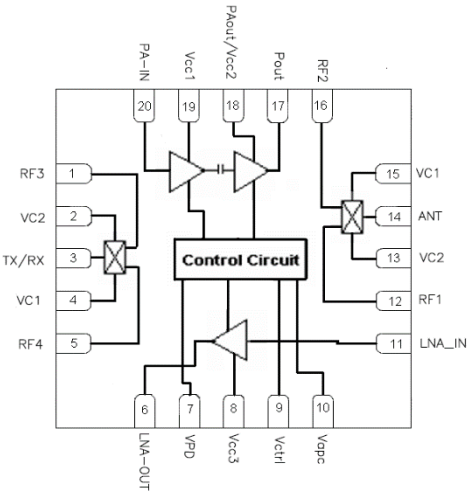
General Description

The TM2009 is a front-end MCM Module and uses an advanced Gallium Arsenide (GaAs) process. The front-end module consists of a Power Amplifier (PA), Low-Noise Amplifier (LNA) and two RF single pole double throw (SPDT) Switch. This device makes it ideal for IEEE 802.11.b/g, *Bluetooth*, 2.4Ghz Audio/Video, Wireless Data Terminal and portable battery powered equipment. The PA delivers +23dBm (maximum) output power with a high Power Added Efficiency (PAE) 41%. The noise figure of LNA is below 1.8dB. The RF SPDT Switch has very low insertion loss 0.4dB in the 2.4GHz to 2.5GHz range. The device is packaged in a QFN 4mm by 4mm 20L package.

Features

- High Efficient Power Amplifier: 41% at Pout = 23dBm
- P–1dB: +21dBm Typical @ +3.3V
- Low-Noise Amplifier (NF typical 1.8dB)
- Low Insertion Loss: 0.4dB @ 2.45GHz
- IIP3: 55dBm @ Input Power up to 20dBm
- QFN 4x4 mm 20L with thermal ground ultra small plastic package
- Green, MSL 1

Functional Block Diagram



Applications

- Bluetooth™ PA (Class 1)
- Wireless Data Terminal
- Wireless Audio
- Portable Battery Powered Equipment

Absolute Maximum Ratings

Parameter	Maximum Rating	Unit
VCC1, VCC2 and VCC3 Supply Voltage	0 to 6	V
Vctrl, Vpd and Vpd Control Voltage	0 to 6	V
Switch Control VC1 , VC2	-6.0 to +6.0 Note	V
RF Switch input Power (>500MHz)	33	dBm
Storage Temperature	-55 to +150	ºC
Power Supply Current	350	mA

Note $|$**VC1-VC2**$| \leqq$ **6.0V**

Notes:

1. Operation of this device in excess of any maximum rating as specified above may cause permanent damage to the device.
2. **Caution! ESD Sensitive Device.**

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Specification Summary

Power Amplifier

Parameter	Min.	Typical	Max.	Unit	Condition
Operating Frequency Range		2.4 to 2.5		GHz	
Maximum Output Power		+23		dBm	
PA Supply Current		100		mA	VCC1=VCC2=Vpd=3.3V, Vapc=2.8V, Pout=20dBm
Power Added Efficiency		30		%	Pout=20dBm,
Harmonics: 2Fo, 3Fo		-35,-32		dBc	Pout=20dBm
PA Small Signal Gain	23	25		dB	P_{IN}=-30dBm
Quiescent Current		47		mA	VCC1=VCC2=VCC3=3.3V Vpd=3.3V, Vapc=2.8V,
P_{-1}dB		21		dBm	VCC1=VCC2=Vpd=3.3V, Vappc=2.8V

Low Noise Amplifier

Parameter	Min.	Typical	Max.	Unit	Condition
Operating Frequency Range		2.4 to 2.5		GHz	
Quiescent Current		7		mA	VCC3=Vctrl=3.3V, Pin=-30 dBm
Noise Figure		1.8		dB	
LNA Gain		13		dB	VCC3=Vctrl=3.3V, Pin=-30 dBm

RF SPDT Switch

Parameter	Min.	Typ.	Max.	Unit	Test Conditions
Insertion Loss		 0.3 0.4 0.4	 0.4 0.5 0.6	 dB dB dB	Input Power +25dBm DC–1.0GHz 1.0 -2.0GHz 2.0 -3.0GHz
Isolation	 24 22 21	 26 24 23		 dB dB dB	Input Power +25dBm DC–1.0GHz 1.0 -2.0GHz 2.0 -3.0GHz
VSWR		1.2 1.2 1.5	1.4 1.4 1.6		DC–1.0GHz 1.0 -2.0GHz 2.0 -3.0GHz
Input Power for 1 dB compression		30		dBm	2.5GHz
Second Harmonics		-75		dBc	f=2.5GHz, Pin=25dBm
Third Harmonics		-80		dBc	f=2.5GHz, Pin=25dBm
Intermodulation Intercept Point (IIP3)		55		dBm	For two tones (f=2.5GHz, 2.501GHz) @ Input power +20dBm
Switch Time		50		ns	
Control Current		4	100	μA	Input Power +25dBm

Notes: All measurements made in 50Ω system, unless otherwise specified. DC=500MHz.

Functional Pin Description

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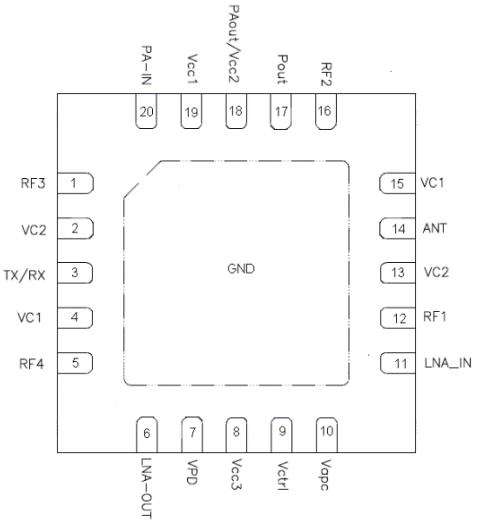

Name	Pin #	Description
RF3	1	TR/RX Switch RF Port
VC2	2	TR/RX Switch, TR/RX-RF4 Control Voltage
TX/RX	3	Control the gain of PA
VC1	4	TR/RX Switch, TR/RX-RF3 Control Voltage
RF4	5	TR/RX Switch RF Port
LNA_OUT	6	LNA output
VPD	7	PA Gain Control
VCC3	8	LNA Vcc
Vctrl	9	LNA ON/OFF control pin
VAPC	10	Control the output power of PA
LNA_IN	11	LNA input
RF1	12	ANT Switch, RF Port
VC2	13	RF Switch, ANT-RF2 Control Voltage
ANT	14	ANT I/O Port
VC1	15	RF Switch, ANT-RF1 Control Voltage
RF2	16	ANT Switch, RF Port
POUT	17	PA Output port
PAOUT/VCC2	18	PA 2nd stage Vcc and Power output pin
VCC1	19	PA 1st stage Vcc

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PA_IN	20	PA input. A matching network with DC block required.
GND	center pad	This pin must be connected to ground

SW Truth Table

VC1	VC2	ANT-RF2	ANT-RF1
High	Low	Isolation	Insertion Loss
Low	High	Insertion Loss	Isolation

VC1	VC2	TX/RX-RF4	TX/RX-RF3
High	Low	Isolation	Insertion Loss
Low	High	Insertion Loss	Isolation

High: 3V to 5V, Low: -0.2V to 0.2V

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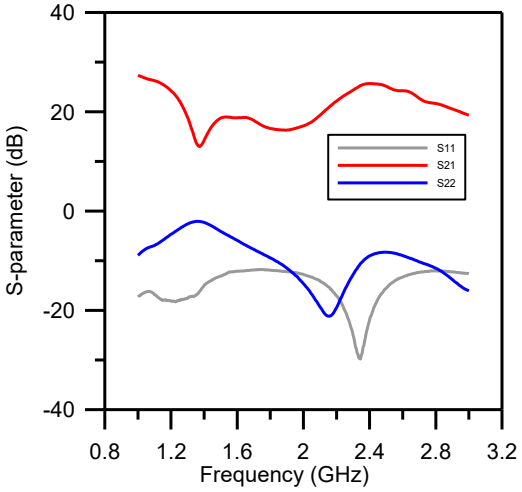
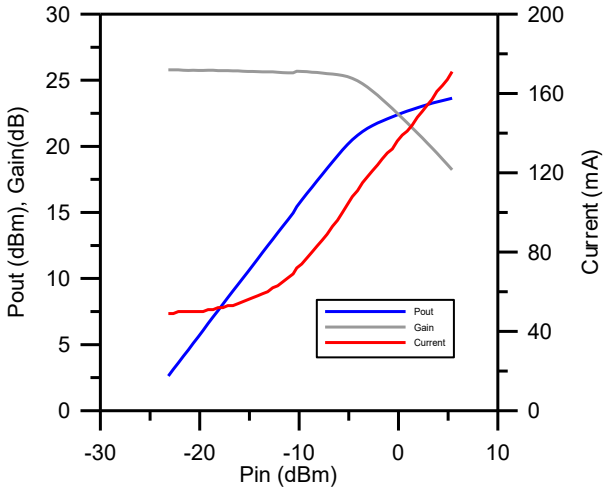
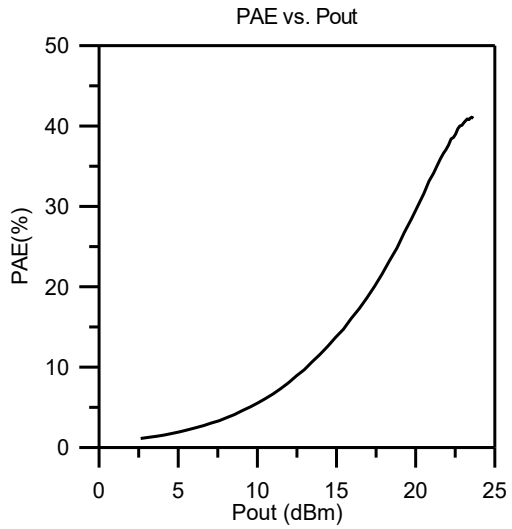
Typical Characteristics



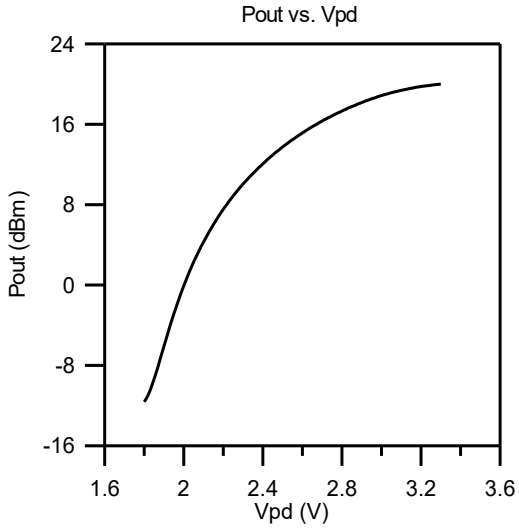
VCC1=VCC2=Vpd=3.3V, Vapc=2.8V and Pin=-30dBm



VCC1=VCC2=Vpd=3.3V
Vapc=2.8V and Freq=2.45GHz



VCC1=VCC2=Vpd=3.3V,
Vapc=2.8V, Freq=2.45GHz



VCC1=VCC2=3.3, Vapc=2.8V
Pin=-5.25dBm, Freq=2.45GHz

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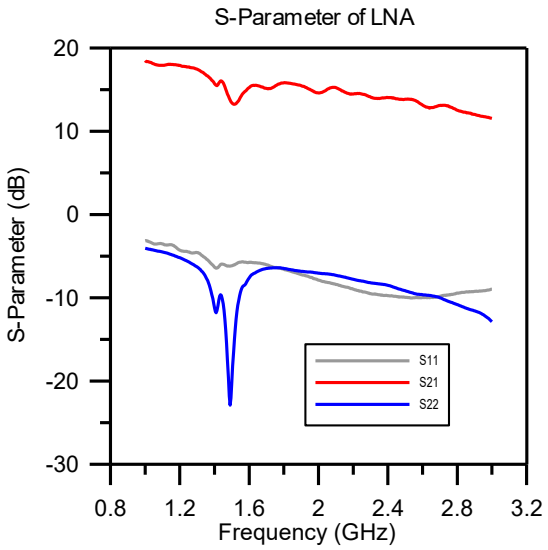

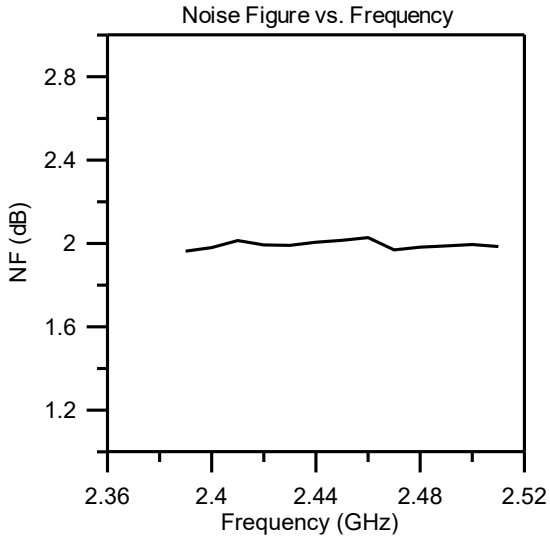

VCC3=Vctrl=3.3V, Pin=-30dBm

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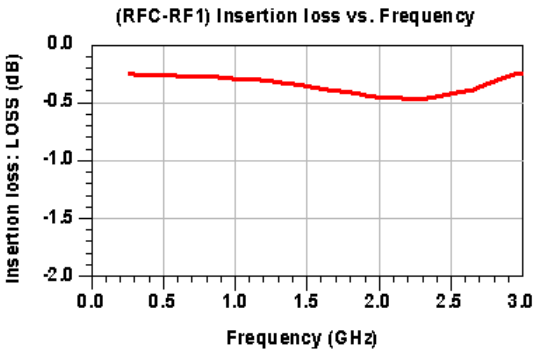
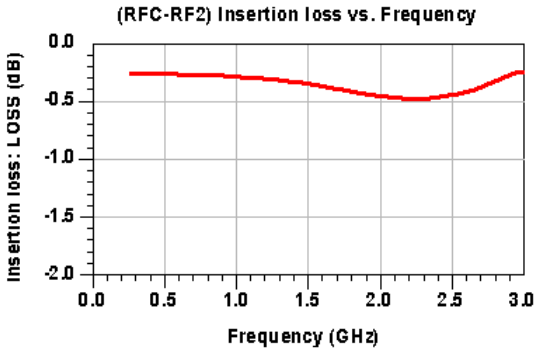
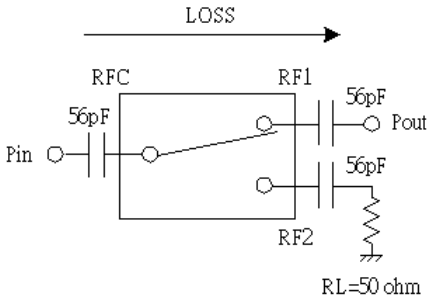
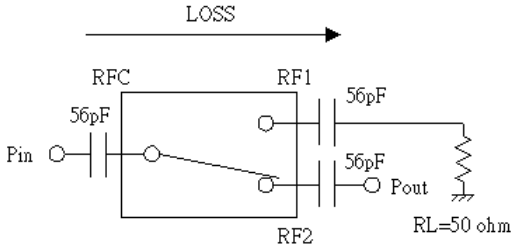
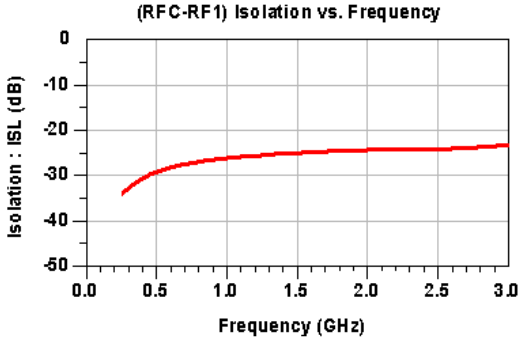
Switch Typical Characteristics (V_{cc}=0V/3.0V , P_{in}=0dBm) [following RFC is pin10 ANT]

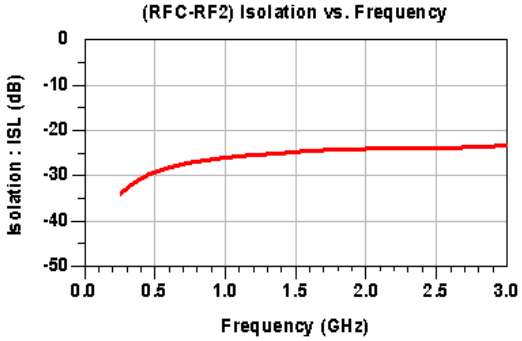


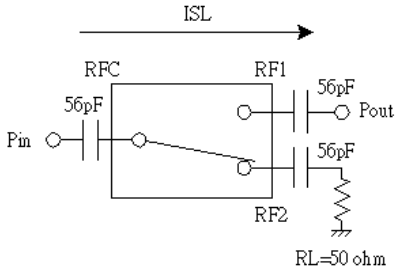


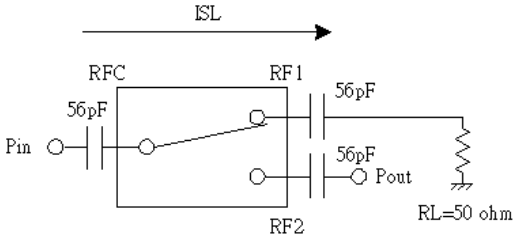












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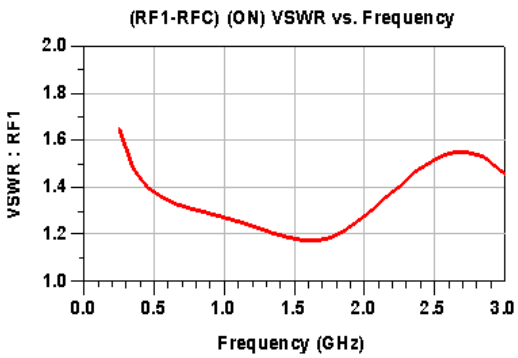

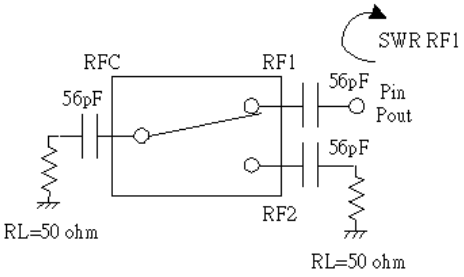

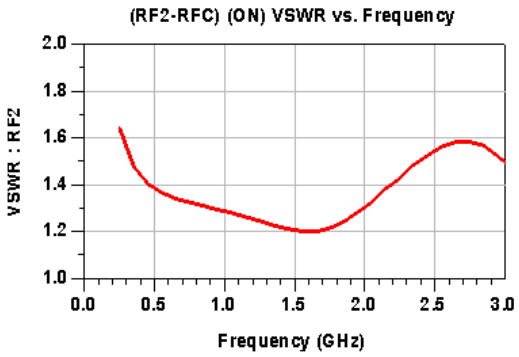

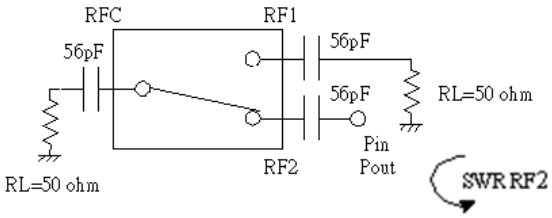

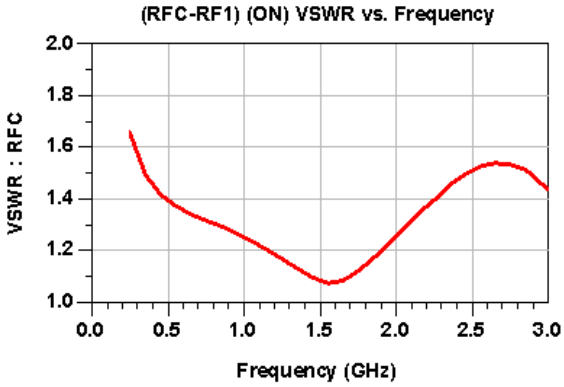

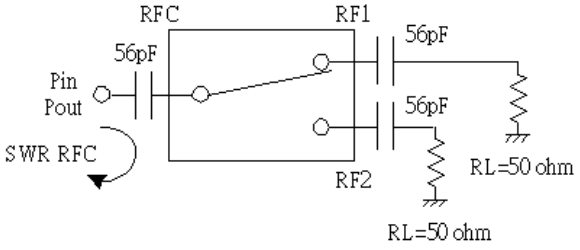

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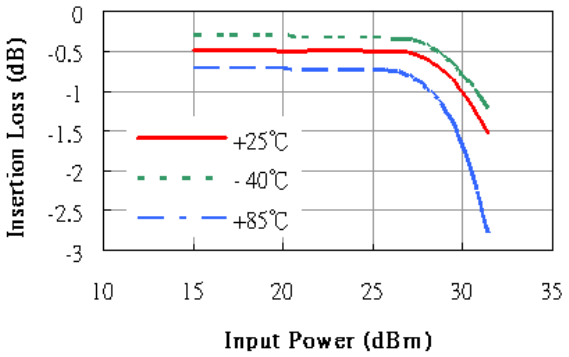
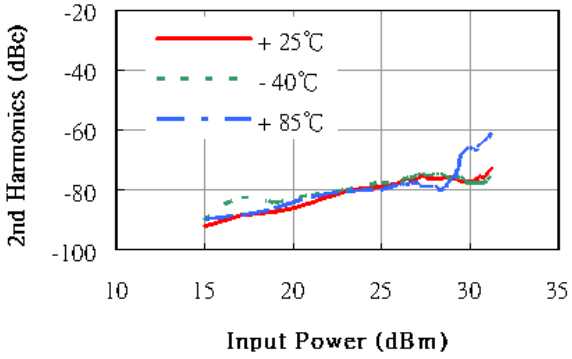
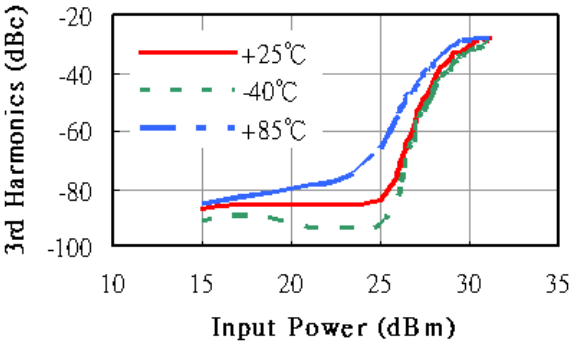
Insertion Loss vs. Input Power
(Vcc=0V/3.0V , 2.5GHz@-40℃,+25℃,+80℃)



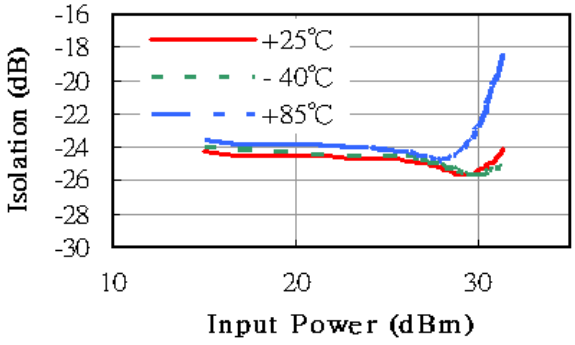
2nd Harmonics vs. Ambient Temperature
(Vcc=0V/3.0V , 2.5GHz@-40℃,+25℃,+80℃)



3rd Harmonics vs. Ambient Temperature
(Vcc=0V/3.0V , 2.5GHz@-40℃,+25℃,+80℃)



Isolation vs. Input Power
(Vcc=0V/3.0V , 2.5GHz@-40℃,+25℃,+80℃)



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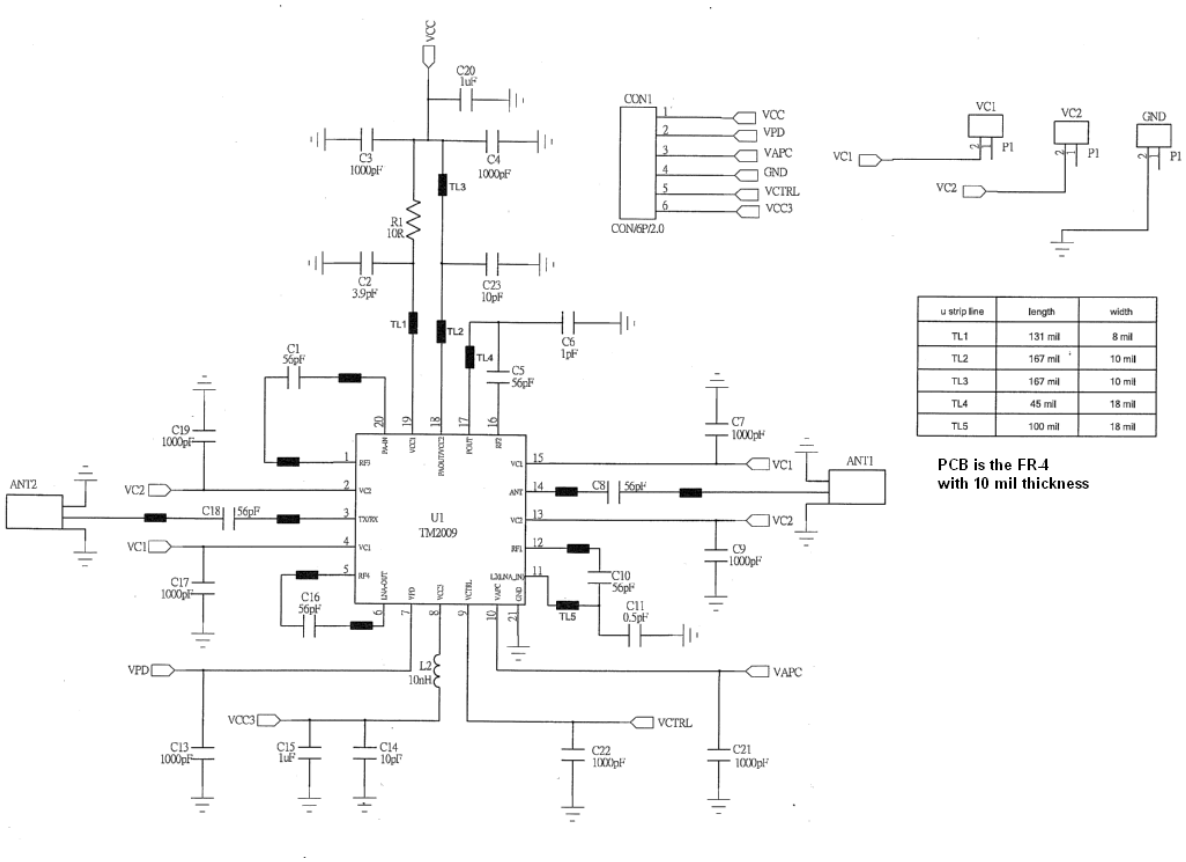
Application circuit



u strip line	length	width
TL1	131 mil	8 mil
TL2	167 mil	10 mil
TL3	167 mil	10 mil
TL4	45 mil	18 mil
TL5	100 mil	18 mil

PCB is the FR-4 with 10 mil thickness

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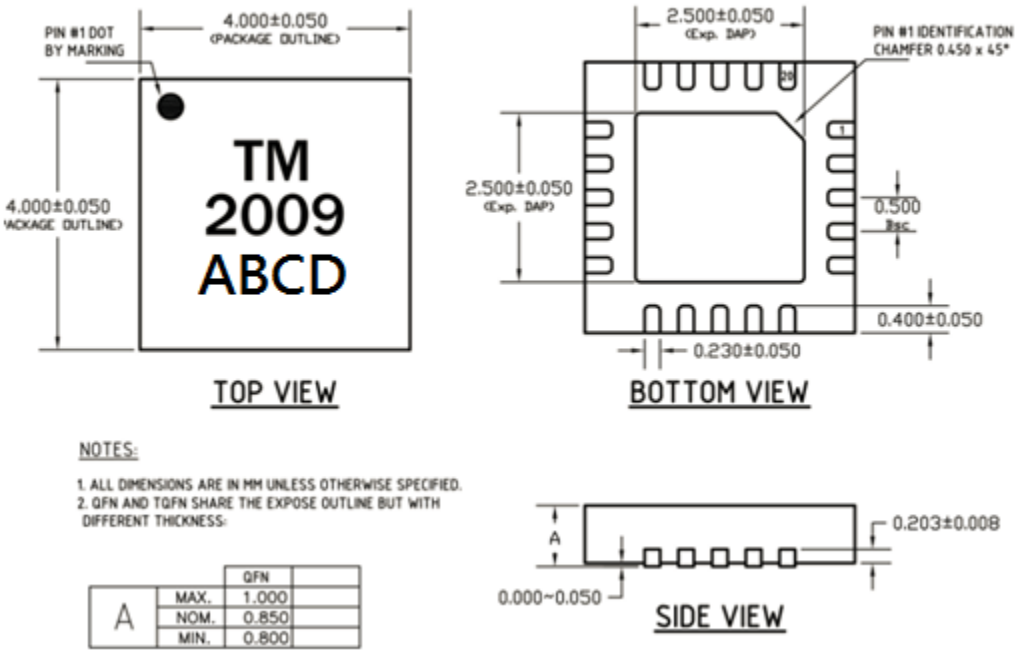
Package Dimension

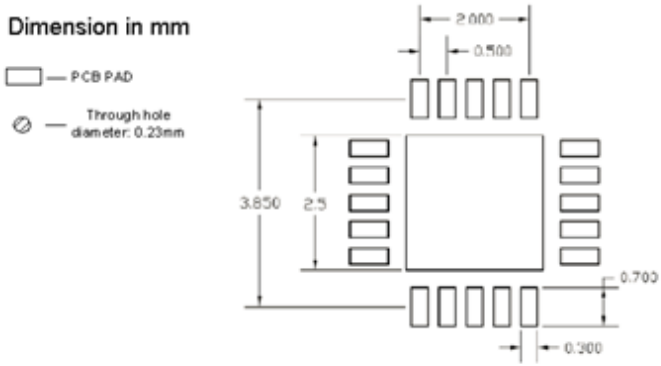


		QFN
A	MAX.	1.000
	NOM.	0.850
	MIN.	0.800

Product Marking

YYWW means lot number

PCB Land Pattern



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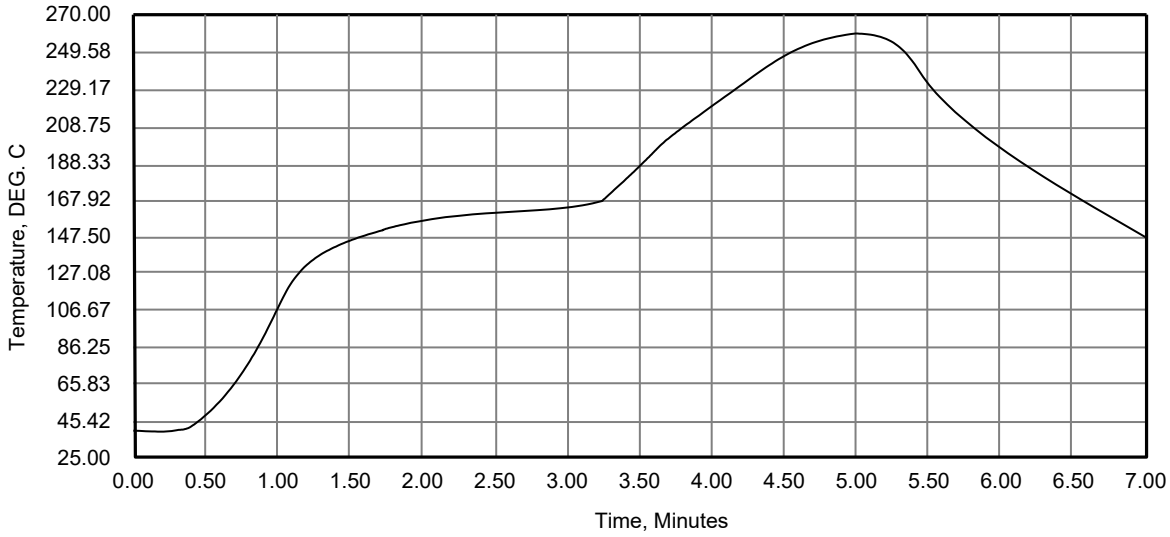
SMT Reflow Profile



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