Revision History

Rev.	History	Issue Date	Remark
0.1	Version TM1002 V0.1, preliminary version	20181012	Preliminary by Randall Lan
1.0	Data sheet status changed from Preliminary to Product data sheet	20181129	Randall Lan

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TM1002 2.3~2.7GHz Low Noise Amplifier, LNA MMIC

General Description

The TM1002 is a Low-Noise Amplifier (LNA) with bypass switch for 2.3~2.7 GHz receiver applications, available in a WLCSP. This product is only used in an over molded module. The TM1002 delivers system-optimized gain for both primary and diversity applications where sensitivity improvement is required. The high linearity of this low noise device ensures the required receive sensitivity independent of transmit power level in FDD systems. To lower power consumption it provides sufficient receive signal strength. The TM1002 can be switched off to operate in bypass mode at a 1μA current. The TM1002 requires only one external matching inductor. The TM1002 is optimized for 2300MHz to 2690MHz.

Features

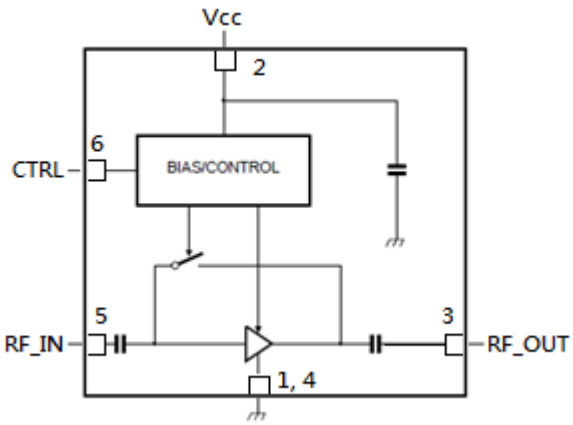
- Operating frequency from 2300MHz to 2690MHz
- Noise figure=0.95dB
- Gain13dB with matching circuit
- Bypass switch insertion loss of -2.2dB
- High input 1dB compression point up to -1dBm
- High in band $IP3_i$ of 3.5 dBm
- Supply voltage1.5V to 3.1V
- Integrated supply decoupling capacitor in the IC already
- Optimizedperformanceatasupplycurrentof5.8mA
- Integrated temperature stabilized bias for easy design
- Requires only one input matching inductor
- Available in a WLCSP type package of ball pin (0.69mm×0.44mm×0.29mm)
- ESD protection on all pins (HBM>2kV)

Applications

- LNA for LTE reception in smart phones
- LNA good for 2.4GHz applications
- LNA good for Zigbee
- 2.4Ghz RF front-end modules
- Feature phones

Product Photo

Functional Block Diagram



Absolute Maximum Rating

Absolute maximum ratings are given as limiting values of stress conditions during operation that must not be exceeded under the worst probable conditions.

Parameter	Min	Max	Unit	condition
supply voltage	−0.5	+5.0	V	RF input AC coupled
input voltage on pin CTRL	−0.5	+5.0	V	$V_{I(CTRL)}<V_{CC}+0.6V$
input voltage on pin RF_IN	−0.5	+5.0	V	DC;$V_{I(RF\_IN)}<V_{CC}+0.6V$
input voltage on pin RF_OUT	−0.5	+5.0	V	DC;$V_{I(RF\_OUT)}<V_{CC}+0.6V$
input power		26	dBm	[1]
total power dissipation		55	mW	$T_{sp}\leq 130°C$
storage temperature	−65	+150	°C	
Junction temperature		150	°C	
Electro-static discharge voltage		±2	kV	Human Body Model (HBM)according to
		±1	kV	Charged Device Model(CDM)according to JEDEC

[1] Stressed with pulses of 1 sin duration. V_{CC} connected to a power supply of 2.8V with 500mA current limit.

[2] Warning: Due to internal ESD diode protection, to avoid excess current, the applied DC voltage must not exceed V_{CC}+0.6V or 5.0V.

[3] The RF input and RF output are AC coupled through internal DC blocking capacitors.

Recommended Operating Conditions

Parameter	Min	Typ	Max	Unit	Conditions
Supply voltage	1.5		3.1	V	
Ambient temperature	−40	+25	+85	°C	
Input voltage on pin CTRL	0.8			V	in gain mode
			0.3	V	in bypass mode

Thermal Characteristics

Parameter	Typ	Unit	Conditions
thermal resistance from junction to solder point	225	K/W	

Specifications

V_{CC}=2.8V; $V_{I(CTRL)}$≥ 0.8 V;T_{amb}= 25°C; input matched to 50 Ω using a 2.7nH inductor in series.

Parameter	Min	Typ	Max	Unit	Conditions
Frequency Range	2300		2690		
Supply Voltage	1.5		3.1	V	
Supply Current	3.8	5.8	7.0	mA	in gain mode
			1	μA	In bypass mode;
Power Gain		13.0		dB	in gain mode; f = 2350MHz
		−2.2		dB	in bypass mode; f= 2350 MHz
Noise Figure		0.95	1.5	dB	in gain mode; f = 2350MHz
input power at1 dB gain compression	−6	−2		dBm	in gain mode; f = 2350MHz
input third-order intercept point	−1.5	+3.5		dB	in gain mode; f = 2350MHz

[1] E-UTRA operating band40. (2300MHzto2400MHz)

[2] PCB losses are subtracted.

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Characteristics at V_{CC}= 1.8 V

2300MHz≤ f ≤ 2690MHz;V_{CC}=1.8V; $V_{I(CTRL)}$≥ 0.8 V;T_{amb}= 25°C; input matched to 50 Ω usinga2.7nH inductor in series.

Parameter	Min	Typ	Max	Unit	Conditions
phase variation					between gain mode and bypass mode
	−8		+8	deg	f = 2350MHz
					f = 2655MHz
Gain mode					
supply current	3.6	5.6	7.0	mA	
power gain		13		dB	f = 2350MHz
	10.3	12.3	15.0	dB	f = 2500MHz
		11.5		dB	f = 2655MHz
input return loss		9		dB	f = 2655MHz
		10		dB	f = 2655MHz
output return loss		7.5		dB	f = 2655MHz
		6		dB	f = 2655MHz
isolation		23		dB	f = 2655MHz
		22.5		dB	f = 2655MHz
noise figure		1	1.5	dB	f = 2655MHz
		1.05		dB	f = 2655MHz
input power at 1 dB gain compression	−10.5	−6.5		dBm	f = 2655MHz
		−5.5		dBm	f = 2655MHz
input third-order intercept point	−2.0	+3.0		dB	f = 2655MHz
		2.5		dB	f = 2655MHz
Rollett stability factor	1				f = 2655MHz
turn-on time			1.7	μs	Time from VI(CTRL) ON to 90% of the
turn-off time			0.6	μs	time from VI(CTRL) OFF to 10% of the
Bypass mode					
supply current			1	μA	VI(CTRL) < 0.3 V
power gain		−2.2		dB	f = 2350MHz
		−2.5		dB	f = 2655MHz
input return loss		13.0		dB	f = 2350MHz
		13.0		dB	f = 2655MHz
output return loss		11.5		dB	f = 2350MHz
		11.5		dB	f = 2655MHz

[1] Guaranteed by device design; not tested in production.

[2] E-UTRA operating band40. (2300MHzto2400MHz).

[3] E-UTRA operating band7.

(2620MHzto2690MHz).

Characteristics at VCC= 2.8 V

VCC=2.8V; VI(CTRL)≥ 0.8 V;Tamb= 25°C; input matched to 50 Ω usinga2.7nH inductor in series.

Parameter	Min	Typ	Max	Unit	Conditions
phase variation					
	−8		+8	deg	f = 2350 MHz
				deg	f = 2655 MHz
Gain mode					
supply current	3.8	5.8	7.0	mA	f = 2350 MHz
Power gain	-	13.0	-	dB	f = 2350MHz
	10.3	12.3	15.3	dB	f = 2500 MHz
		11.5		dB	f = 2655MHz
input return loss		9.0		dB	f = 2350MHz
		10		dB	f = 2655MHz
output return loss		8		dB	f = 2350MHz
		6		dB	f = 2655MHz
isolation		23		dB	f = 2350MHz
		23		dB	f = 2655MHz
noise figure		0.95	1.5	dB	f = 2350MHz
		1.0		dB	f = 2655MHz
input power at 1 dB gain compression	−6	−2		dBm	f = 2350MHz
		−1		dBm	f = 2655MHz
input third-order intercept point	−1.5	+3.5		dBm	f = 2350MHz
		3.0		dBm	f = 2655MHz
turn-on time			1.3	µs	
turn-off time			0.3	µs	
Bypass mode					
supply current			1	µA	VI(CTRL) < 0.3 V
power gain		−2.2		dB	f = 2350MHz
		−2.5		dB	f = 2655MHz
input return loss		13		dB	f = 2350MHz
		13		dB	f = 2655MHz
output return loss		12		dB	f = 2350MHz
		12		dB	f = 2655MHz

[1] Guaranteed by device design; not tested in production.

[2] E-UTRA operating band40. (2300MHzto2400MHz)

[3] E-UTRA operating band7. (2620MHzto2690MHz)

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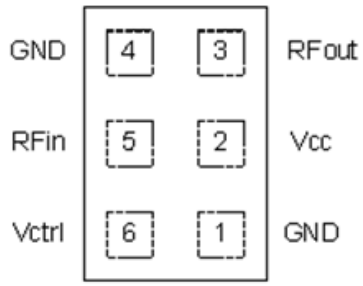
Pin Configuration

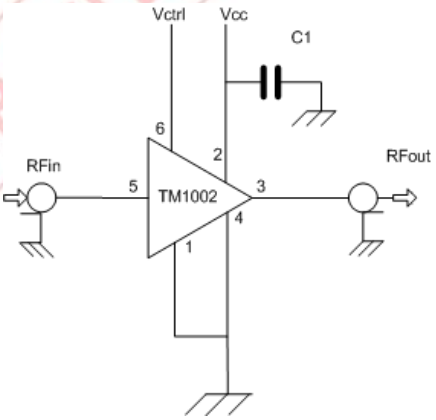
Top View



Pin Description

Pin #	Symbol	Bump	Description
1	GND	A1	ground
2	VCC	B1	supply voltage
3	RF_OUT	C1	RF output
4	CTRL	A2	gain control, switch between gain and bypass mode
5	RF_IN	B2	RF input
6	GND_RF	C2	ground RF

Application circuit



Schematic for LTA LNA

Component	Description	Value	Remarks
Cd	decoupling capacitor	1nF	to suppress power supply noise
IC1	TM1002		Taiwan Microelectronics Technologies Inc
L1	high-quality matching inductor	2.7nH	Murata LQW15A

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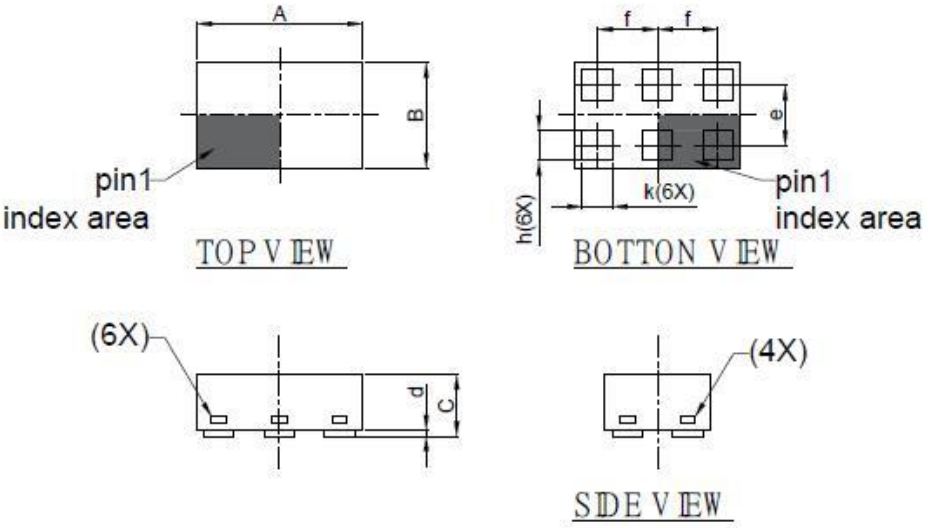
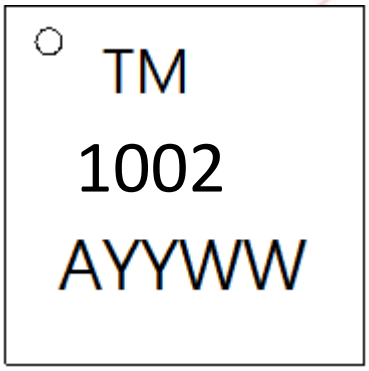
Package Information



DIMENSIONS IN MILLMETER								
SYMBOLS	**A**	**B**	**C**	**d**	**e**	**f**	**h**	**k**
MIN	1.05	0.65	0.34	0.04			0.17	0.17
MON	1.1	0.7	0.37	-----	0.4	0.4	0.2	0.2
MAX	1.15	0.75	0.4	-----			0.25	0.25

Product Marking



TM: company name

1002: product name

AYYWW: production control code

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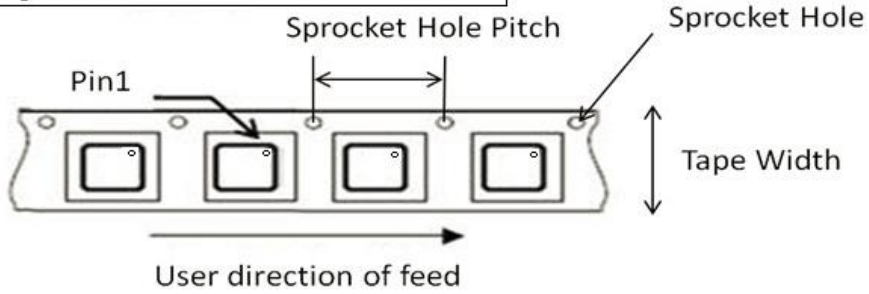
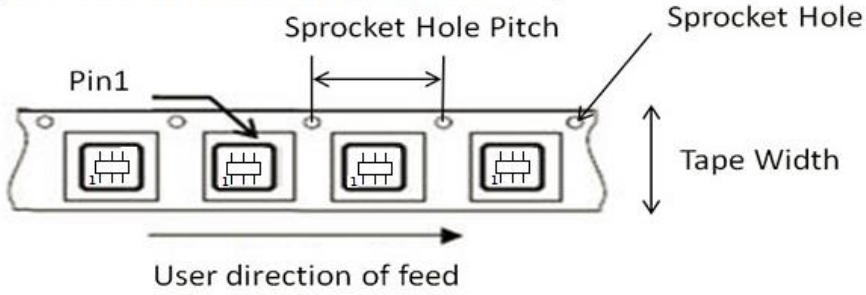
Tape and Reel

QFN / DFN / LGA Type Package



SOT-363 / SOT-343 /M04 / SOT89



Package Type	Reel Size	Tape width (mm)	Sprocket Hole	Sprocket Hole Pitch (mm)	Leader Qty	Trailer Qty	Desiccant (g)
WLCSP 0.69x0.44mm	14"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10
DFN 1.5x1.5mm	7"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10
DFN 2x2mm	7"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10
QFN 2x2mm	7"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10
QFN 3x3mm	7"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10
SOT 343 (M04)	7"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10
SOT 363	7"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10
SOT 89	7"	12±0.03	Φ1.5 +0.1, -0	4.0±0.1	50	50	10

Handling Precaution

SAFETY INFORMATION ON THIS PRODUCT

Cautions on using this product	The product contains Gallium-Arsenide (GaAs). GsAs vapor and power are hazardous to human health if inhaled or ingested. ● Do not destroy or burn the product. ● Do not cut or cleave off any part of the product. ● Do not crush or chemically dissolve the product. Follow related laws and ordinances for disposal. The product should be excluded from general industrial waste or household garbage.

CAUTION: This device is sensitive to Electro-Static Discharge (ESD). Observe precautions for handling electro-static sensitive devices. Such precautions are described in the *ANSI/ESD S20.20*,*IEC/ST 61340-5*, *JESD625-A* or equivalent standards.

Mounting: This WLCSP is only used in an over molded module using MUF.

Abbreviations

Acronym	Description
ESD	Electro-Static Discharge
E-UTRA	Evolved UMTS Terrestrial Radio Access
FDD	Frequency Division Duplex
HBM	Human Body Model
LNA	Low-Noise Amplifier
LTE	Long Term Evolution
MMIC	Monolithic Microwave Integrated Circuit
MUF	Molded Under Fill
PCB	Printed-Circuit Board
SiGe:C	Silicon Germanium Carbon
WLCSP	Wafer Level Chip Scale Package