SG24T1

24 GHz transmitter MMIC

Data Sheet

Revision 0.0, 2015-11-18

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SG24T1: 24 GHz transmitter MMIC

1 Features

- SiGe MMIC
- 24 -25.25 GHz band: ISM and Chinese requirement for auto-application
- Switchable prescaler between 1/16 or 1/1048576
- Prescaler with en- or dis-able function
- On-chip temperature sensor
- Differential LO and TX outputs
- Tunable output power (max. 12 dBm)
- Switchable TX output
- Phase noise: -80 dBc/Hz @ 100 kHz
- Supply voltage 5 V
- Fully ESD protected device
- QFN-32 leadless plastic package
- TS16949

Typical Applications

- Automotive Radar, especially in Chinese application
- FMCW or pulse radar for short range application

Description

The SG24T1 is a Silicon Germanium MMIC for signal generation 24 GHz band. The SG24T1 integrates VCO, output power amplifiers for both TX antenna and LO, and the switchable prescaler between 1/16 and 1/1048576. The prescaler can be disabled to conserve current if not needed. The SG24T1 is packaged in a leadless QFN 4mmx4 mm surface mount package.

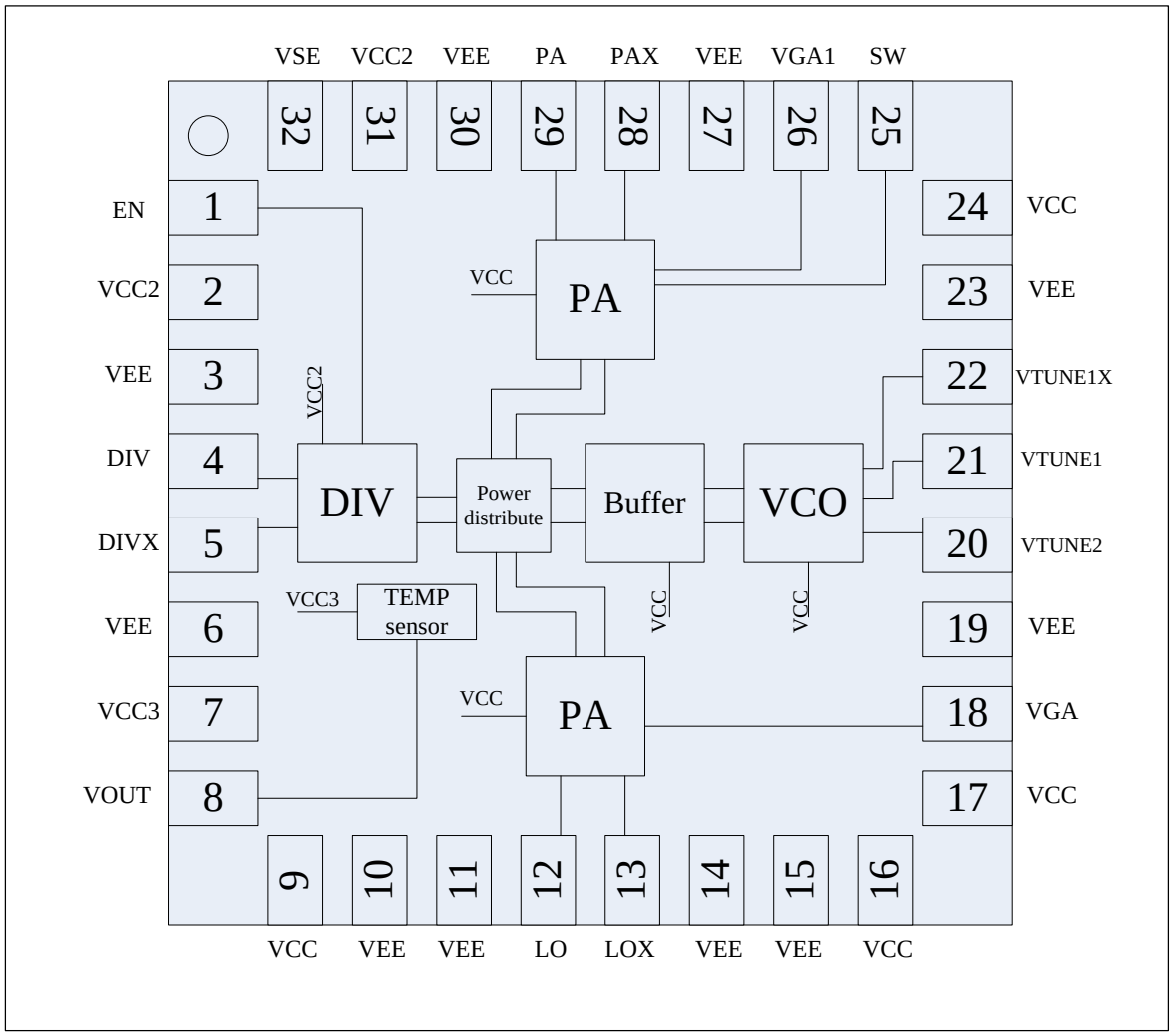


Figure 1 SG24T1 Block Diagram

2 Electrical Characteristics

2.1 Absolute Maximum Ratings

Table 1 Absolute Maximum Ratings

T_A=-40℃ to 105℃; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note / Test Condition
		Min.	Typ.	Max.		
Supply voltage	VCC1	0		5.5	V	INPUT
DIV voltage at pin VCC2	VCC2	0		5.5	V	INPUT
DC voltage at RF Pins LO, LOX, PA, PAX	VDC_{RF}			0	V	MMIC provides short circuit to GND for all RF pins
DC current into Pin VOUT	I_{VOUT}	-0.5		1	mA	Max.values indicate current due to short circuit to GND and Vcc respectivele
DC current into pins DIV, DIVX	I_{DIV}	-18		15	mA	Max.values indicate current due to short circuit to GND and Vcc respectivele
DC voltage at pins Vtune1, Vtune2	V_{tune1} , V_{tune2}	0		3.3	V	
DC voltage at pins VGA,VGA1	V_{VGA} , V_{VGA1} ,	0		1.5	V	
DC voltage at pins SW	V_{SW}	0		5	V	
TX power dissipation	P_{TX}			892.5	mW	
DIV power dissipation	P_{DIV}			577.5	mW	

Total power dissipation	P_{Total}			1470	mW	
Junction temperature	T_J	-40		150	℃	
Ambient temperature	T_A	-40		105	℃	T_A =temperature at package soldering point
Storage temperature rang	T_{STG}	-40		150	℃	

Attention:

Stresses exceeding the max. Values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

2.2 Thermal Resistance

Table 2 Thermal Resistance

Paramerer	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Junction – soldering point	R_{thJS}			40	K/W	

1) For calculation of RthJS please refer to application note thermal resistance

2.3 ESD Integrity

Table 3 ESD Integrity

Paramerer	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
ESD robustness PA, PAX, LO, LOX	$V_{ESD-HBM}$	1000			V	All RF-pins
ESD robustness low frequency and DC pins	$V_{ESD-HBM}$	1000			V	All other pins

1) According to ESDA/JEDEC Joint Standard for Electrostatic Discharge Sensitivity Testing, Human Body Model (HBM)-Component Level, ANSI/ESDA/JEDEC JS-001-2012

2.4 Measured RF Characteristics

Table 4 Electrical Specification TA= -40 .. 125 °C

Parameter	Min.	Typ.	Max.	Units	Comments
Supply voltage	4.75	5	5.25	V	TX, prescaler and temperature sensor
Ambient temperature	-40		125	℃	
TX					
Current consumption		150		mA	@ 25℃
Tuning Voltage	0		3.3	V	
Frequency Range	24		24.25	GHz	
Tuning slope			1	GHz/V	Peak @ Vt1 & Vt2
TX Output power		12		dBm	100 Ohm differential load
LO Output power		6		dBm	100 Ohm differential load
Phase noise		-80	-74	dBc/Hz	100 kHz offset @ RT
Prescaler					
Current consumption					
Disabled		48		mA	EN=5V
1/16		86		mA	Temp=25℃ VSE flotation
1/1048576		98		mA	Temp=25℃ VSE=0 V
Output power (1/16)	-10	-3.5		dBm	Differential 100 Ohm load
Output Vpp (1/1048576)		0.9		V	High impedance load
Temperature sensor					
Current consumption		300		uA	
Output voltage	2.7		3.6	V	-40℃~130℃
Sensitivity		4.75		mV/℃	@ 25℃

3 Application Circuit and Block Diagram

3.1 Application Circuit Schematic

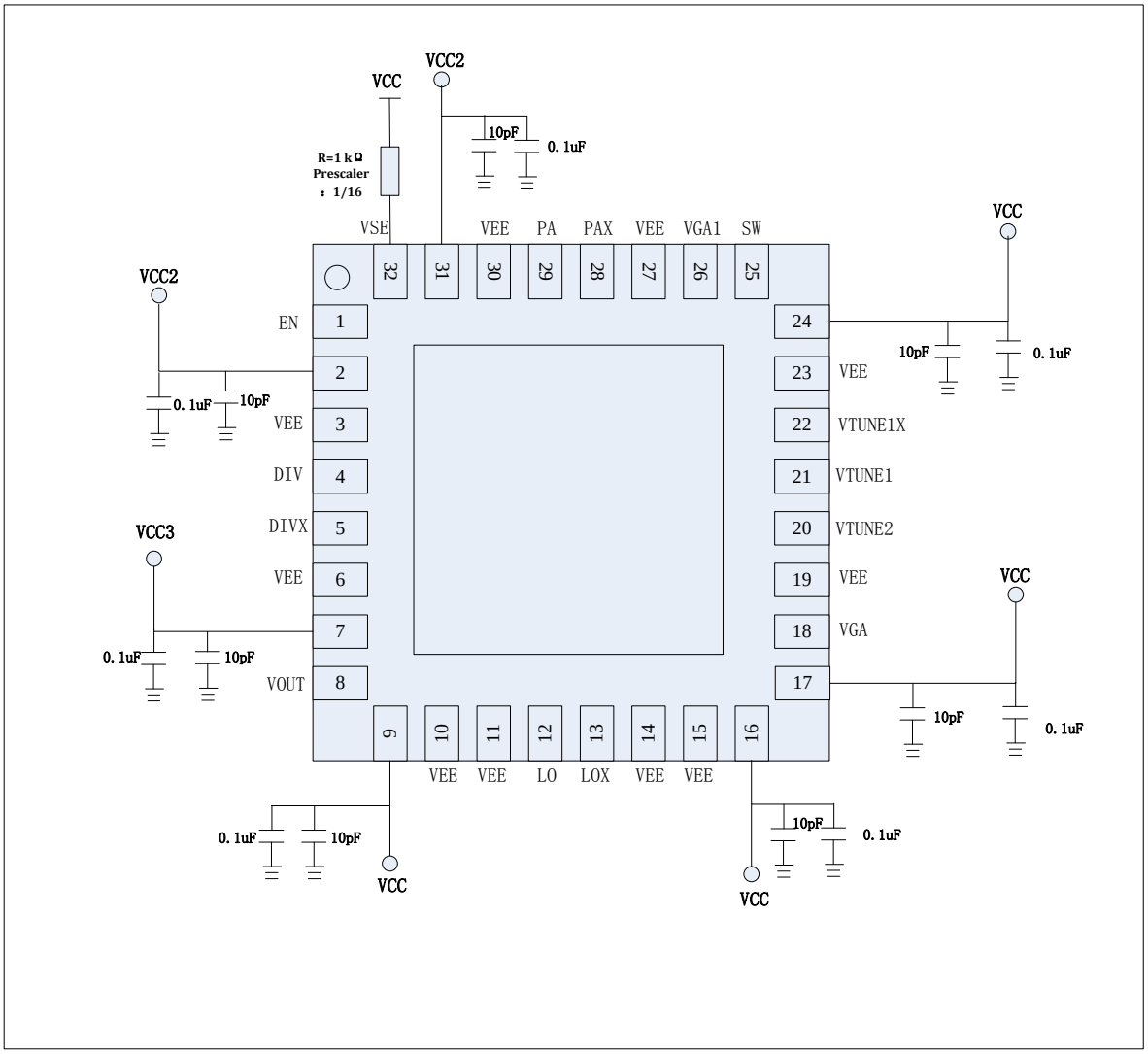
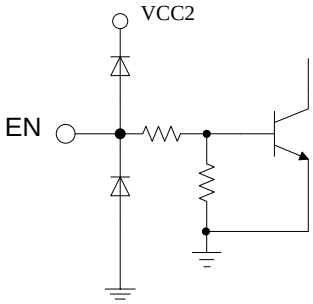
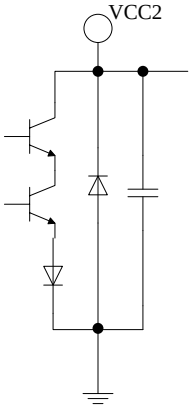
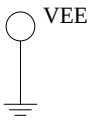
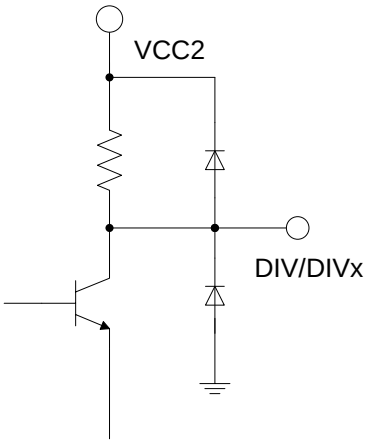
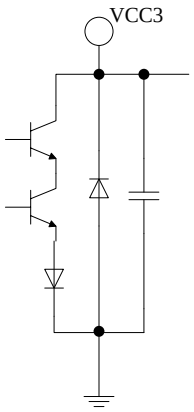
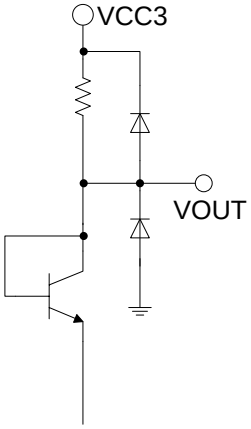
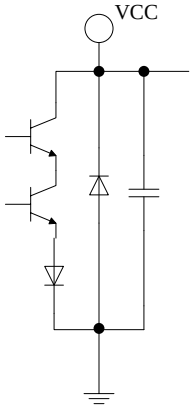
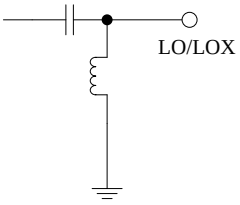


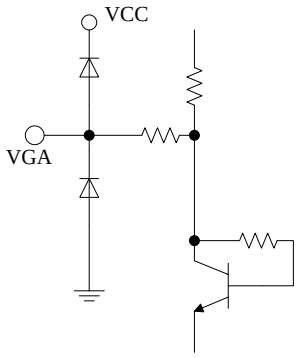
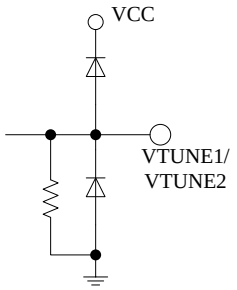
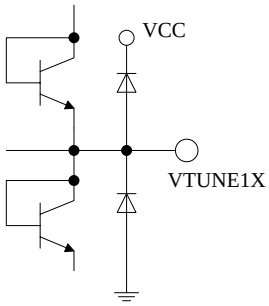
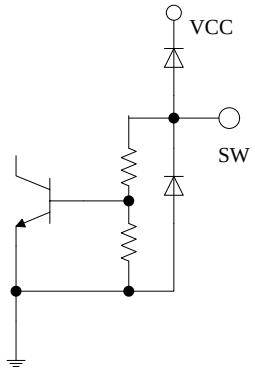
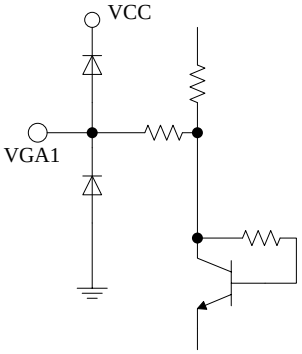
Figure 2 Application circuit with Chip Outline (Top View)
(Application Circuit please refer to Evaluation board)

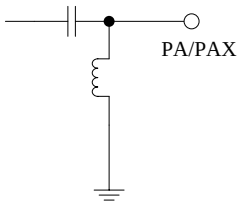
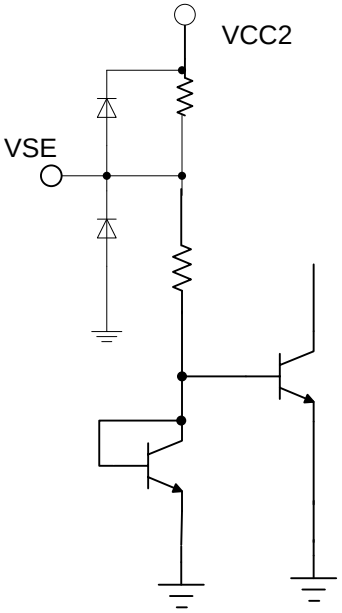
3.2 Pin Description

Table 5 Pin Description and Function

Pin No.	Function	Description	Inter schematic
1	EN	When EN is high voltage (3.5V~5V); divider is disabled; When EN is low voltage or floating; divider is working.	
2,31	VCC2	Independent voltage supply for prescaler.	
3,6,10,11,14, 15,19,23,27,30	VEE	Global ground, package bottom has an exposed metal paddle that must also be connected to ground.	
4,5	DIV/DIVX	Differential divider output	

7	VCC3	Independent voltage supply for temperature sensor	
8	VOUT	Voltage output of temperature sensor	
9,16,17,24,	VCC	Voltage supply for TX (not for divider and temperature sensor)	
12,13	LO/LOX	Differential LO outputs	

18	VGA	power tuning for LO output (0~1.5V)	
20,21	VTUNE2/VTUNE1	VCO frequency tuning inputs	
22	VTUNE1X	VCO tuning reference output	
25	SW	switching control for TX output (0~5V)	
26	VGA1	power tuning for TX (0~1.5V)	

28,29	PA/PAX	TX differential outputs	
32	VSE	Divider ratio selection: VSE: low, 1/1048576; VSE: high or floating, 1/16.	

4 Physical Characteristics

4.1 Package Footprint

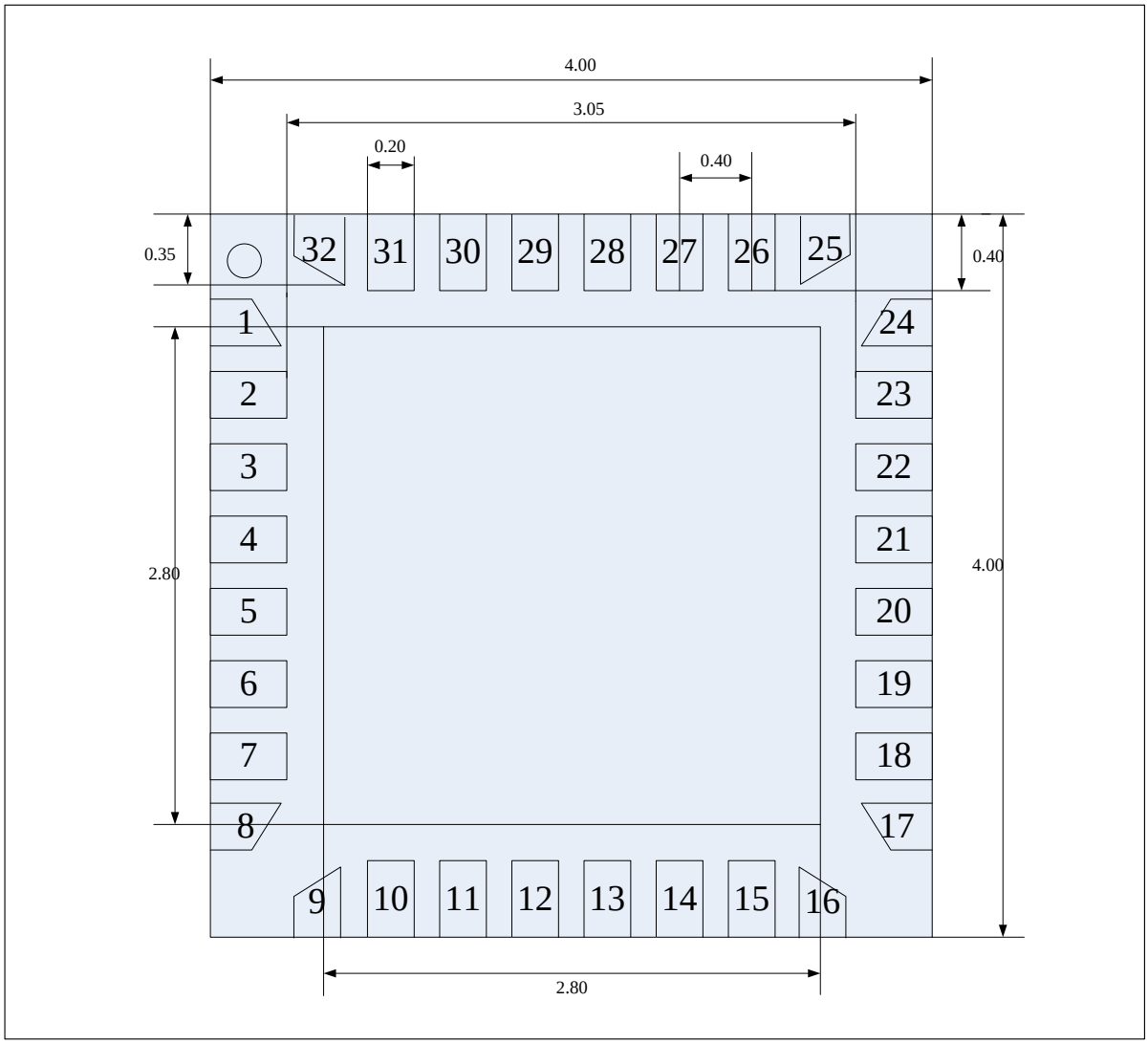


Figure 3 Recommended footprint and Stencil Layout for the QFN32L Package

4.2 Package Dimensions

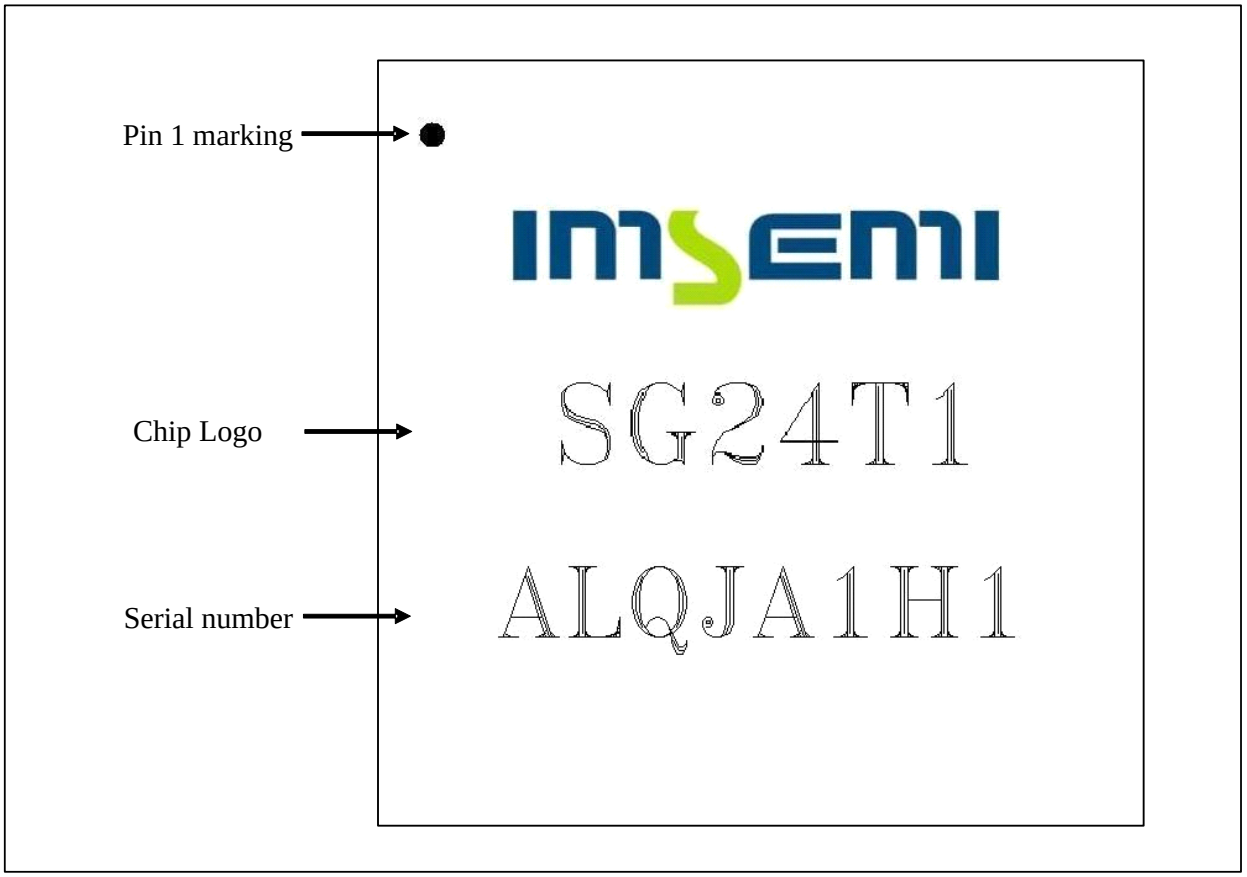
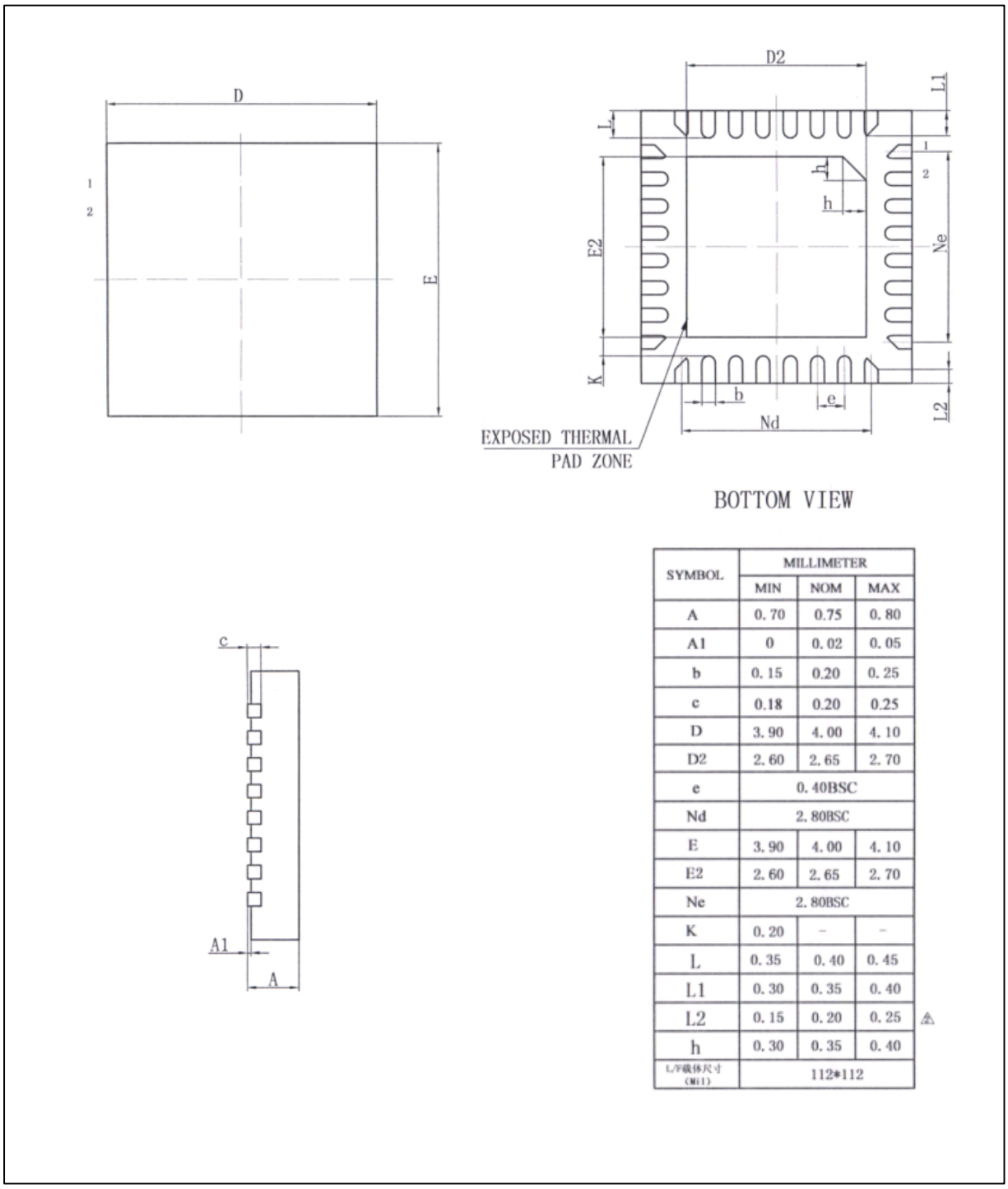


Figure 4 Marking layout QFN32L (0404X0.75-0.40)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0	0.02	0.05
b	0.15	0.20	0.25
c	0.18	0.20	0.25
D	3.90	4.00	4.10
D2	2.60	2.65	2.70
e	0.40BSC		
Nd	2.80BSC		
E	3.90	4.00	4.10
E2	2.60	2.65	2.70
Ne	2.80BSC		
K	0.20	–	–
L	0.35	0.40	0.45
L1	0.30	0.35	0.40
L2	0.15	0.20	0.25
h	0.30	0.35	0.40
L/F载体尺寸 (单位)	112*112		

Figure 5 Package Outline (Top, Bottom, Side View)