

TG7112B-S3IE0

High Performance Low Power BLE 5.4 SoC

Preliminary Datasheet

General Descriptions

The TG7112B-S3IE0 is a high performance, low power System-on-Chip (SoC) integrating a Bluetooth® 5.4 compliant 2.4-GHz transceiver, 24 MHz proprietary 32 bit MCU with a RAM of 8 KB and a One-Time Programmable (OTP) memory of 8KB .

The TG7112B-S3IE0 supports Bluetooth Low Energy and Bluetooth 5.4 features including high-throughput 2 Mbps, Long Range and the Direction Finding. It can be paired through HCI interface with a more powerful MCU for applications requiring advanced wireless connectivity.

The fully-featured multiprotocol radio, +8 dBm output power, -96.5 dBm sensitivity and extended temperature range of -40 to 125°C makes it suitable for lighting applications.

The TG7112B-S3IE0 features built-in USB, proprietary 32-bit MCU clocked at 24 MHz, integrated capless LDOs supporting 1.6-5.5V supply range, making it a perfect microcontroller for cost-sensitive applications.

Key Features

- MCU subsystems
 - 24 MHz 32-bit proprietary MCU for system control and PHY/link layer management
 - AES128 HW encryption
 - Serial wire debug
- Memories
 - 8 KB OTP with internal charge pump
 - 8 KB data RAM (4 KB with retention)
 - 8 KB Patch RAM with retention
- Radio transceiver
 - Bluetooth 5.4/Long Range
 - +8 dBm TX power
 - -96.5 dBm RX sensitivity @ BLE 1 Mbps
 - -93 dBm RX sensitivity @ BLE 2 Mbps
 - -98.5 dBm RX sensitivity S2
 - -103 dBm RX sensitivity S8
 - Integrated balun with single-ended output and direct connection to antenna
 - 5.4mA RX system current @ BLE 1 Mbps -97 dBm sensitivity (3V ideal DC-DC converter)
 - 9.5 mA TX system current (3V ideal DC-DC converter, 0 dBm)
- Power management
 - Always-On (AON) supply: 1.6~ 5.5V
 - Main supply: 1.5 ~ 5.5V supporting external DCDC through a dedicated wakeup pin
 - Integrated LDOs requiring no external decoupling capacitors
 - 1.2 µA in sleep mode (wake on RTC, no RAM retention)
- 6 µA in sleep mode (wake on RTC, 12 KB RAM retention)
- Clock generation
 - Dedicated PLL to support 16M/24M/32M crystals
 - Crystal trimming
 - 24MHz RC oscillator for fast wakeup
 - Low jitter low power 32 KHz RC oscillator
- 9-channel 12-bit ADC
- Digital peripherals
 - Up to 24 GPIOs w/ functions fully multiplexed
 - 8 x PWMs up to 24 Mbps
 - Two-wire master (I²C compatible) up to 600 kbps
 - 1 x UART(RTS/CTS) with HCI-H5 protocol up to 3.25 Mbps
 - 1 x SPI Master up to 24 Mbps
 - 1-axis Quadrature Decoder
 - Tscan
 - IR
 - 12 Mbps Full Speed USB 2.0
- Audio Codec
 - Mono differential PWM DAC
 - Mono audio ADC with PGA
 - Microphone bias generator
 - ADPCM support
- Temperature range: -40°C to +125°C
- HBM 2KV, CDM 500V
- Internal SPI connected 2M bit flash

Revision History

Version	Date	Owner	Note
1.0	16/11/2023		Initial version

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1 Block Diagram

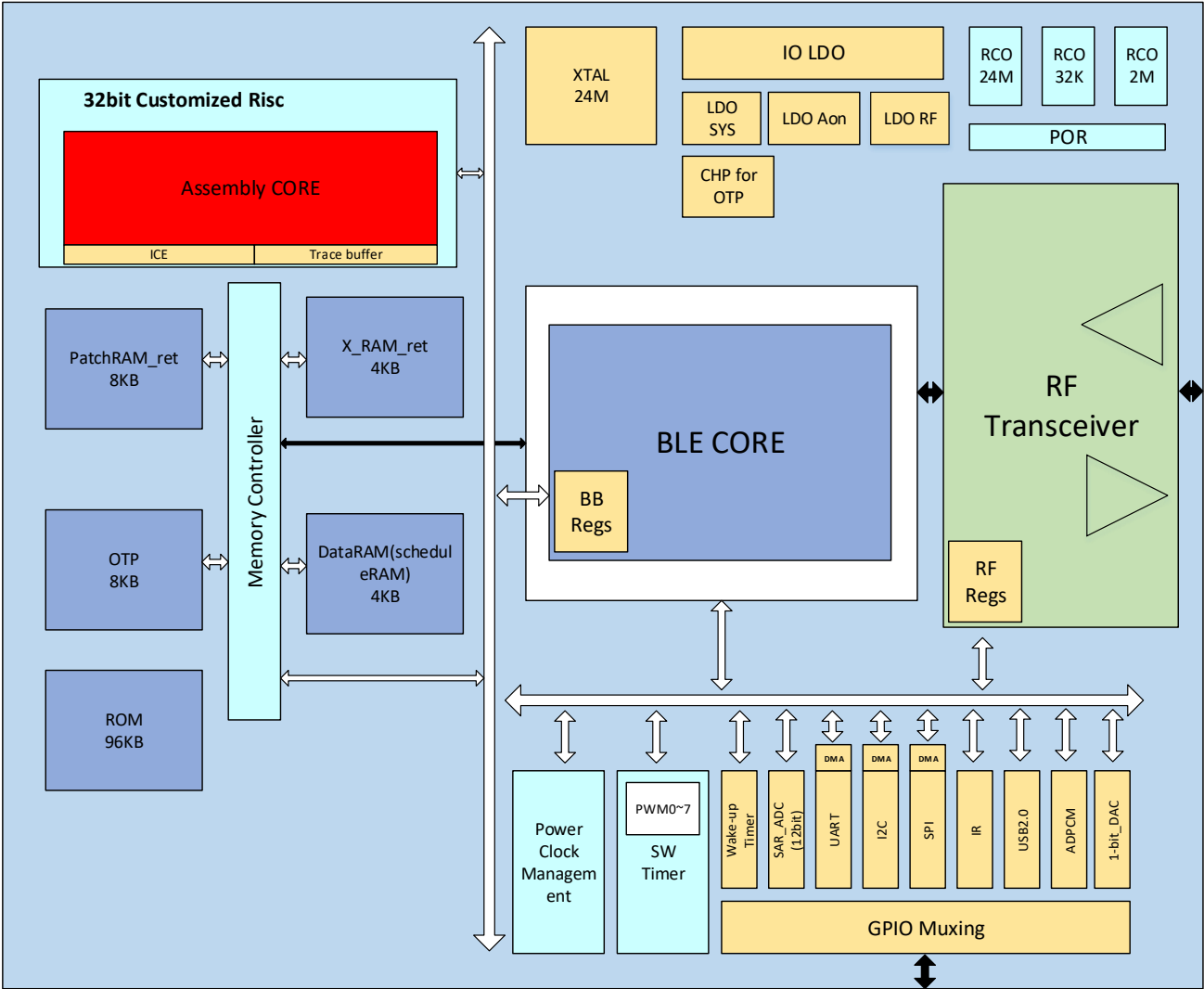


Figure 1-1 Block diagram

2 Pinout Information



Figure 2-1 Pinout top view (SOP16 package)

Abbreviations:

PWR: Power pin

AIO: Analog IO pin

DIO: Digital IO pin

RF: RF IO pin

Table 2-1 Pinout Information

SOP16	Pin Name	Type	Function Description
1	GPIO9/ADC	Dig _IO/Ana_O	pls check "sheet: GPIO_Muxing"; Measure Sar ADC
2	XTALOUT	Ana _O	24M Crystal oscillator output
3	XTALIN	Ana_I	24M Crystal oscillator input
4	RF	RF_Port	ANT port
5	VSS	GND	GND
6	GPIO4	Dig _IO	pls check "sheet: GPIO_Muxing";
7	GPIO6/ADC	Dig _IO/Ana_O	pls check "sheet: GPIO_Muxing"; Measure Sar ADC

8	GPIO7	Dig_IO	pls check "sheet: GPIO_Muxing";
9	GPIO8	Dig_IO	pls check "sheet: GPIO_Muxing";
10	VIN/HVIN	Power_I	HVLDO input
11	GPIO8/ADC	Dig_IO/Ana_O	pls check "sheet: GPIO_Muxing"; Measure Sar ADC
12	GPIO20/ADC	Dig_IO/Ana_O	pls check "sheet: GPIO_Muxing"; Measure Sar ADC
13	GPIO21/ADC	Dig_IO	pls check "sheet: GPIO_Muxing";
14	GPIO22/ADC	Dig_IO/Ana_O	pls check "sheet: GPIO_Muxing"; Measure Sar ADC
15	GPIO12/ADC	Dig_IO/Ana_O	pls check "sheet: GPIO_Muxing"; Measure Sar ADC
16	ICE/GPIO5	Dig_IO	pls check "sheet: GPIO_Muxing"

Table 2-2 GPIO Multiplexing

Pin Name	boot function	function-analog
GPIO[0]		
GPIO[1]		
GPIO[2]		
GPIO[3]		
GPIO[4]		
GPIO[5]	ICE	
GPIO[6]		saradc [4]
GPIO[7]		
GPIO[8]		
GPIO[9]		saradc [2]
GPIO[10]		saradc [1]
GPIO[11]		
GPIO[12]		saradc [3]
GPIO[13]		saradc [8]
GPIO[14]		
GPIO[15]		
GPIO[16]		
GPIO[17]		
GPIO[18]		saradc [0]
GPIO[19]		
GPIO[20]		saradc [5]
GPIO[21]		saradc [6]
GPIO[22]		saradc [7]
GPIO[23]	EXEN	

3 Specifications

3.1 Recommended Operating Conditions

Table 3-1 Recommended Operation Condition

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage for pin VBAT	VBAT		1.6		5.5	V
Supply voltage for pin VDCDC	VDCDC		1.5		5.5	V
Supply voltage for pin VIO	VIO			3.3	3.6	V
Ambient temperature	TA		-40		125	°C

NOTE: the high-voltage(above 4.2V) mode needs to be configured.

3.2 Power Consumption

Table 3-2 Power Consumption Characteristics

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Sleep						
Current through pin VBAT	IVDCDC_SLEEP	VDCDC = 3.3V		1.2		μA
	IVDCDC_SLEEP_4 KB RET			6		μA
Current through pin VDCDC	IVDCDC_SLEEP	VDCDC = 1.5V		10		nA
RX mode 1 Mbps BLE @ -96.5 dBm sensitivity						
Current through pin VBAT	IVDCDC_RX	VDCDC = 3.3V		2.8		mA
Current through pin VDCDC	IVDCDC_RX	VDCDC = 1.5V		5.2		mA
TX mode P_{out} 0dBm						
Current through pin VDCDC	IVDCDC_TX	VDCDC = 3.3V		2.5		mA
Current of pin VDCDC with ideal DC-DC converter	IVDCDC_TX	VDCDC = 1.5V		14.0		mA

3.3 Radio

All parameters are referred to chip port and measured on the condition of VDCDC = 3.3V if not stated otherwise.

Table 3-3 Transmitter Specification

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	f _{TX}		2300		2600	MHz
Output power	P _{out}		-20.0		8	dBm

Power control step	P _{step}	For part-to-part power calibrations		3		dB
Spurious emissions (@ 0dBm)	P _{spur}	30 MHz to 1000 MHz		-43.7		dBm
		1 GHz to 12.75 GHz		-31.0		dBm
		47 MHz to 74 MHz		-75		dBm
		87.5 MHz to 108 MHz		-75		dBm
		174 MHz to 230 MHz		-75		dBm
		470 MHz to 862 MHz		-44.0		dBm

Table 3-4 Receiver Specification

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Frequency range	f _{RX}		2300		2600	MHz
Out-of-band blocking	OOB	30 MHz – 2000 MHz	-30			dBm
		2003 – 2399 MHz	-35			dBm
		2484 – 2997 MHz	-35			dBm
		3000 MHz – 12.75 GHz	-30			dBm
1 Mbps BLE						
RX sensitivity	P _{SENS_1M}	30.8% PER		-96.5		dBm
C/I co-channel	C/I _{CO_1M}	30.8% PER	21	10		dBc
C/I 1 MHz adjacent channel	C/I _{1_1M}	30.8% PER	15	-4		dBc
C/I 2 MHz adjacent channel	C/I _{2_1M}	30.8% PER	-17	-35		dBc
C/I ≥3 MHz adjacent channel	C/I _{3_1M}	30.8% PER	-27	-37		dBc
C/I image channel	C/I _{im_1M}	30.8% PER	-9	-30		dBc
C/I image channel + 1MHz	C/I _{im+1_1M}	30.8% PER	-15	-37		dBc
Maximum input signal level	P _{IN_MAX_1M}	30.8% PER	-10	0.0		dBm
2 Mbps BLE						
RX sensitivity	P _{SENS_1M}	30.8% PER		-93		dBm
C/I co-channel	C/I _{CO_2M}	30.8% PER	21	10		dBc
C/I 2 MHz adjacent channel	C/I _{2_2M}	30.8% PER	15	-4		dBc
C/I 4 MHz adjacent channel	C/I _{4_2M}	30.8% PER	-17	-35		dBc
C/I ≥6 MHz adjacent channel	C/I _{6_2M}	30.8% PER	-27	-40		dBc
C/I image channel	C/I _{im_2M}	30.8% PER	-9	-30		dBc
C/I image channel + 2MHz	C/I _{im+2_2M}	30.8% PER	-15	-40		dBc
Maximum input signal level	P _{IN_MAX_2M}	30.8% PER	-10	0.0		dBm

3.4 24 MHz Crystal Oscillator

Table 3-5 24 MHz Crystal Oscillator Characteristic

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Crystal frequency	f _{XTAL}			24		MHz
Crystal frequency tolerance	Δf _{XTAL}		-20		20	ppm
Load capacitance	C _{L_INN}	Programmable via registers		9		pF

Note: the temperature and pressure limitations of BOM(bill of material), including but not limited to the need for high temperature resistant crystals when used at 125 °C.

3.5 LDO Characteristics

Table 3-6 IO LDO Specification

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Input voltage range	VBAT		1.6	3.3	5.5	V
Output voltage	VOUT_ACTIVE	I _{LOAD} =20 mA, when input voltage below 3.3V, output equals input		3.3		V
	VOUT_SLEEP	I _{LOAD} =100 μ A, when input voltage below 3.3V, output equals input		3.3		V
Maximum load current	ILOAD	Active mode@VBAT=5V			150	mA

3.6 Reset Characteristics

Reset voltage is monitored on pin VBAT_HIGH.

Table 3-7 Reset Characteristics

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Reset voltage threshold	VPOR	rising edge		1.6		V
	VPDR	falling edge		1.44		V
POR stretch time	TPOR			12		mS
PDR stretch time	TPDR			500		μ S

3.7 Audio Characteristics

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
DAC PWM Driver			0.5		Watts
PGA gain		-2		36	dB
ADC Signal to Noise Ratio	1kHz 0.5Vrms		72		dB
ADC Full Scale	Vbat=3.3V		1		Vrms

Auxiliary SARADC characteristic (1121sb)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Resolution			12		Bit
input range		0		VREF	V
Input resistance	With input buffer	1M			Mohms

	With 1/2 divider		0.45		
Sampling rate				1.5	MHz
ENOB	VREF=3.3V, GPIO path		10		Bit
	VREF=3.3, internal battery path		8		Bit

VREF can be selected from 3.0V/3.3V/1.8V Ido output.

4 Application Schematic

5 Package Information

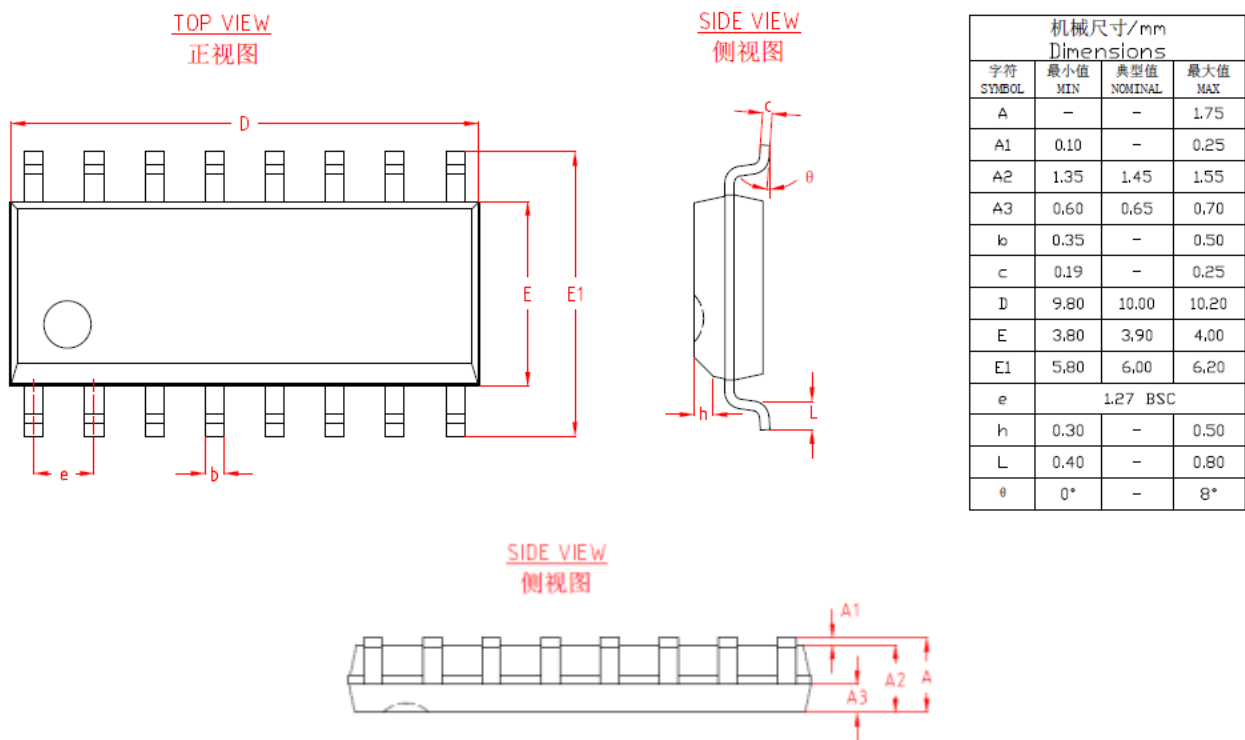


Figure 5-1 SOP16 package dimensions